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National Trust Purbeck:
Swan Brook NFM Opportunities

Feasibility Assessments

Dr Peter Stone

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1. Introduction

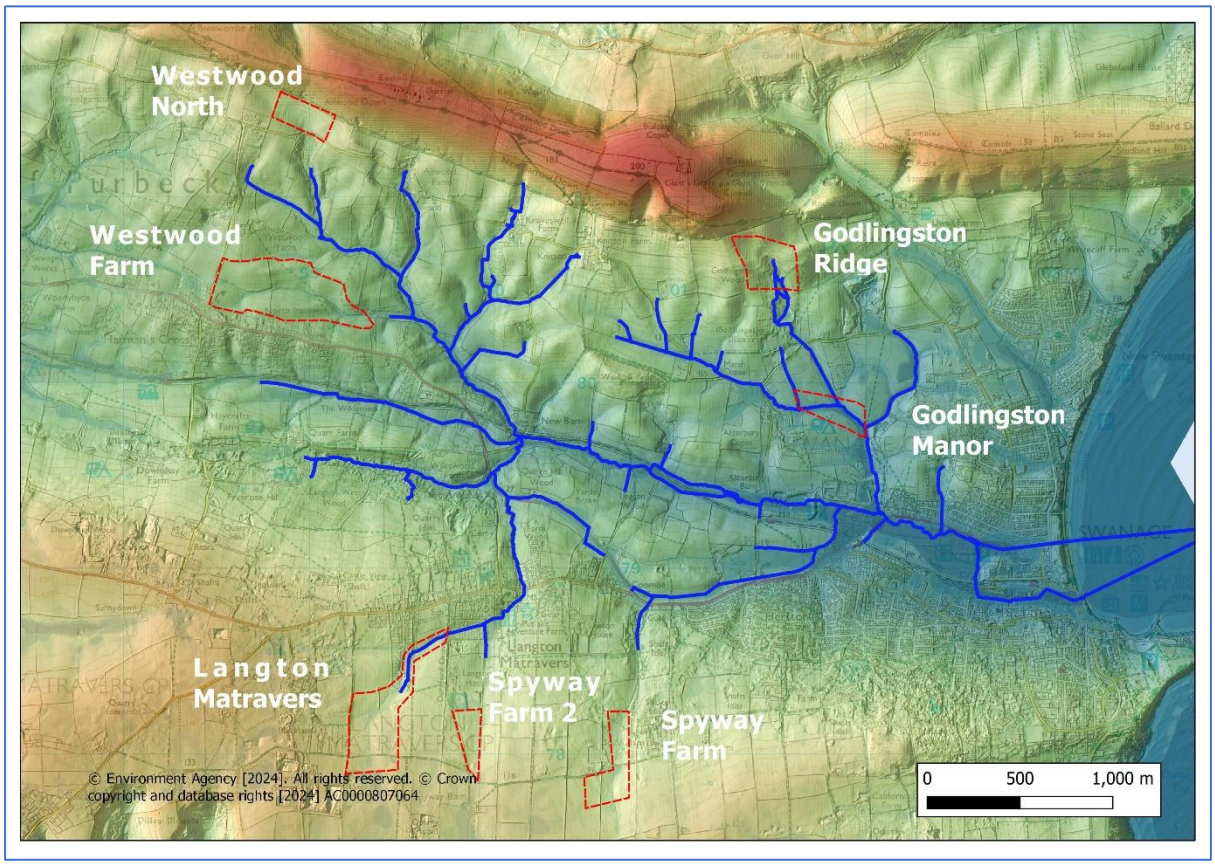
The National Trust are managing an area of approximately 3600 hectares of land at Purbeck. The land is generally farmed but is also being managed for conservation including in this case improvements to surface water hydrology. Within the holding is the Swan Brook catchment which drains to Swanage.

A Natural Flood Risk Management approach is being implemented in the Swan Brook catchment to complement existing management approaches. Funding has been secured to implement measures at 7 sites which are in the holding of the National Trust.

An investigation is reported below to document surface flow pathways on the selected sites and to identify if there is are potential measures to work with natural processes to reduce flood risk through catchment interventions. The investigation to identify potential measures has:

- Undertaken desk-based site characterisation from mapping and interrogated the Environment Agency LiDAR (DTM) data for an understanding of localised topography;
- Completed a site visit to develop site specific detail, identifying site-specific processes and defining measures to work with natural processes to reduce flood risk;
- Developed an inventory of potential measures.

Seven locations are considered in the following report.



N.B. Detailed locations are provided within the report using the What3words referencing system

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3. Westwood Farm

Surface Water Drainage and Topography

The catchment area draining to the tributary channel at Westwood Farm concentrates surface flow from two runoff pathways that generate from southern slopes. During a site visit in June 2023, the runoff pathways were dry and there was only a minor groundwater (base) flow in the tributary channel. The runoff pathways are likely to only flow in response to rainfall which generates a surface runoff flow. The channel flowing through the National Trust land is supported by emerging groundwater with a clear start of the channel as a spring type emergence.

The channel initially flows through a relatively narrow valley form with steep slopes. A further analysis is provided from the Environment Agency LiDAR DTM to define areas that are regarded as flat and can be regarded as the valley floor (blue areas in the map above). The flatness is defined as a combination of low slope combined with relative elevation to surrounds. Flat areas can be regarded as potential floodplain or wetland, and represent the natural topography where water might flow or accumulate.

Upstream of the start of the defined channel, there is a dry valley form with a defined valley floor where water can accumulate. The valley floor of the upper reach of the channel is narrow (<15m) and follows in a wooded corridor. The final 150m reach of the channel to the ownership boundary shows that there is an area of flatter valley floor to the south of the channel with the course of the channel sitting perched (elevated) above the natural low point in the topography.

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Approach to restoring natural processes.

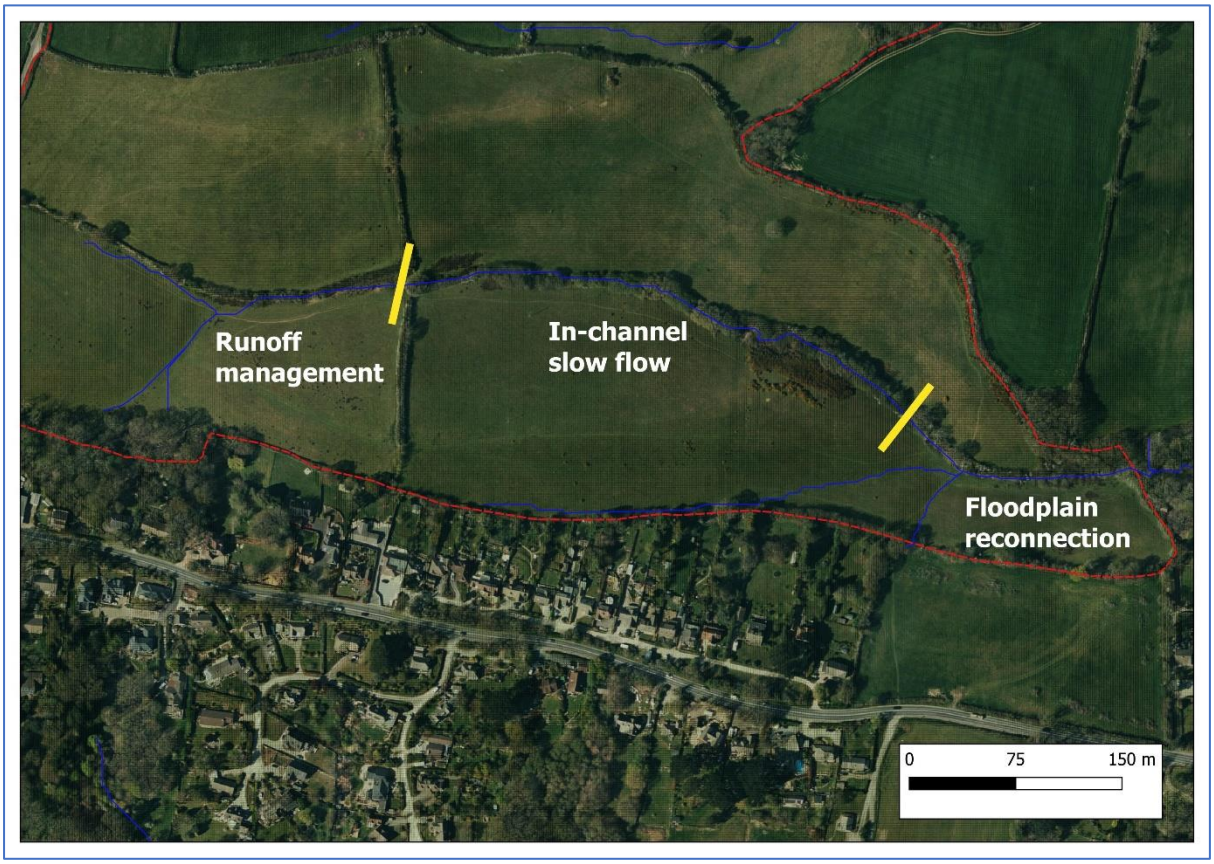
The investigation of surface flow and topography features suggests drainage from the catchment area is semi-natural although modified in places. The interaction with land use impacts natural drainage. Livestock movement in the runoff and channel pathway has a notable impact through poaching and is an associated source of fine sediment in the channel. Crossing of the channel also regulates flow with a culverted access track and 2 x footpath crossings.

The channel itself appears to have been historically realigned outside of the natural valley floor for a length of 150m. Consequently, there is an area of "floodplain" which is occasionally connected with overtopped spate flows from the channel but is largely detached from its floodplain.

The land use and modifications to drainage impact on the natural delivery of flow from the catchment meaning there is a reduction in runoff and flow storage within the catchment slopes and floodplain. The approach to restoration in the catchment area is to recognise the land use but attempt to restore the storage function by seeking natural flood management type measures creating storage of water within the catchment area.

Three approaches are considered for natural flood management in the catchment area:

- Creating storage of runoff generated along the upper slopes of the tributary;
- Slowing of the flow concentrated within the channel and managing the downstream delivery of fine sediment; and
- Reconnecting the floodplain area.



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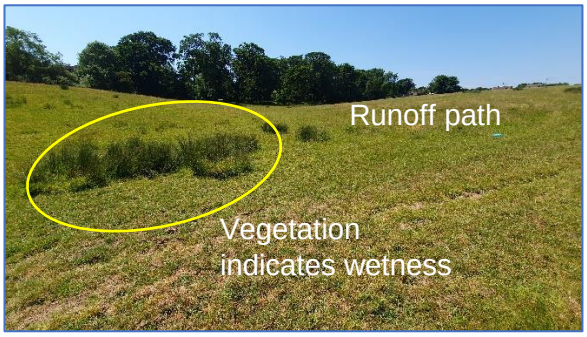
Natural Flood Management Opportunity – Runoff Management

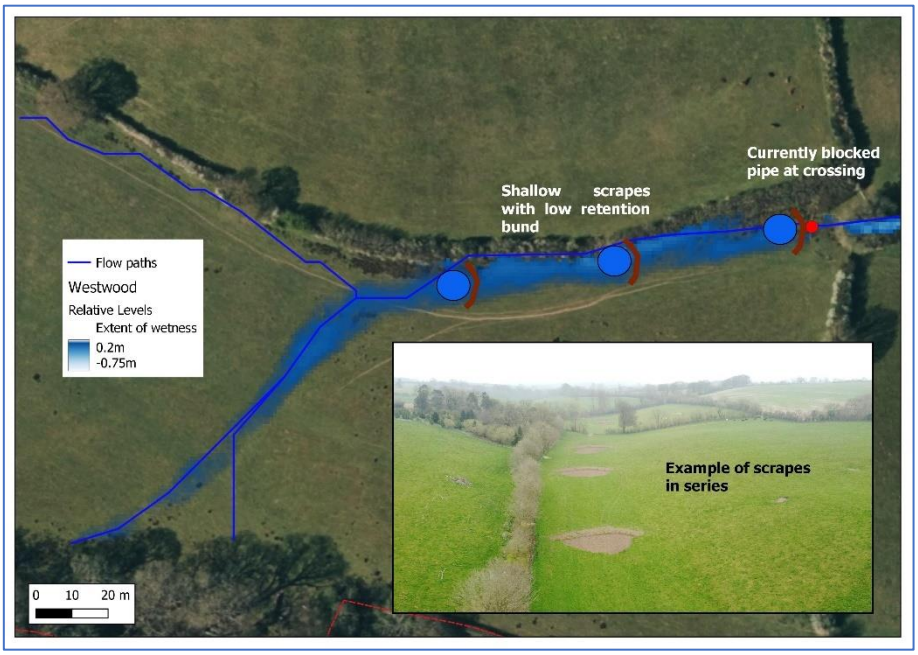
Upstream of the start of the formal channel, runoff clearly originates in response to rainfall-runoff generating events in a field which is currently used for livestock farming. The topography analysis shows that there is flatter land where water may accumulate and observation from June 2023 noted evidence of seasonal wetness within an area of the field.



There are two potential issues to address. The land use may lead to accelerated runoff generation and delivery, but secondly, livestock poaching will help to increase fine sediment delivery to the downstream Swan Brook and on to Poole Harbour.

Land use change (tree planting) and restricting livestock access to the flatter land during the winter can be considered but are not necessarily compatible with current farming. The location and access for livestock drinks should also be reviewed.

To slow the delivery of flow and create storage for flow and mobilised sediment, an approach of creating a series of three shallow bunded depressions (scrapes) should be considered. The scrapes will be created within the valley floor and are located based on topography. Typically, existing flatter areas are modified by scraping out surface material from an area of approximately 10m wide and 10-15m length downstream, with won material used to create a small wide mounding <0.25m of scraped material at the downstream end to retain water. A lowered notch (approximately the width of the flow pathway and half the mound height) in the mounded material and within the flow pathway allows downstream flow without full overtopping the scrape feature (and generating erosion).



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It is intended that the scrapes will create temporary “floodplain” storage of water within the valley floor during ephemeral flows. The scrapes will retain water within the catchment for a longer period but slowly drain and are not expected to be permanent storage of water. It is likely they will mainly function during the winter period during wetter rainfall patterns but isolated intense summer storms may generate occasional flows.

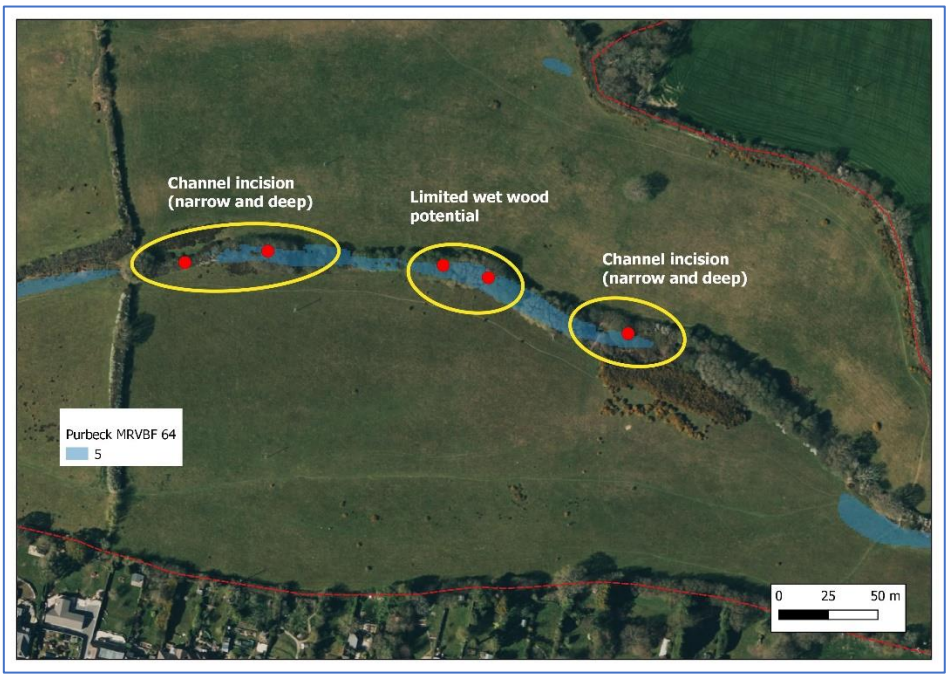
Three scrape features are proposed. The furthest downstream feature will need further consideration to connect flow into the start of the formal channel. Currently a pipe concentrates any flow under an access track crossing the flow pathway just before the start of the channel. The pipe concentrates flow into the channel. The opening of the pipe currently appears to be buried or blocked with sediment. Flow from the downstream scrape will need to be connected into the existing pipe.

The opening of the pipe will need to be identified then a formal “L” shaped and elevated connection is proposed that will allow retention of water within the scrape and a level triggered drainage. The elevated entrance will also help prevent blockage.

Natural Flood Management Opportunity – In-channel

The headwater reaches of the formal channel flow in a confined valley with a limited valley floor/floodplain area, although small pockets of wet wood type potential can be identified. The channel is in places also over-deepened which means it is frequently detached from the limited area of floodplain, and flow is retained within the channel form. The deep channel is an efficient pathway to deliver flow and any associated fine sediment downstream.

Further storage in the catchment (reducing downstream impacts) can be created by a combination of raising the bed of the channel and increasing frequency of interaction with any available floodplain. Woody debris installed within the channel can be used to trap sediment (and consequently raise channel bed level) and to hold back water which raises water level (and consequently frequency of over bank spill on to adjacent floodplain area).



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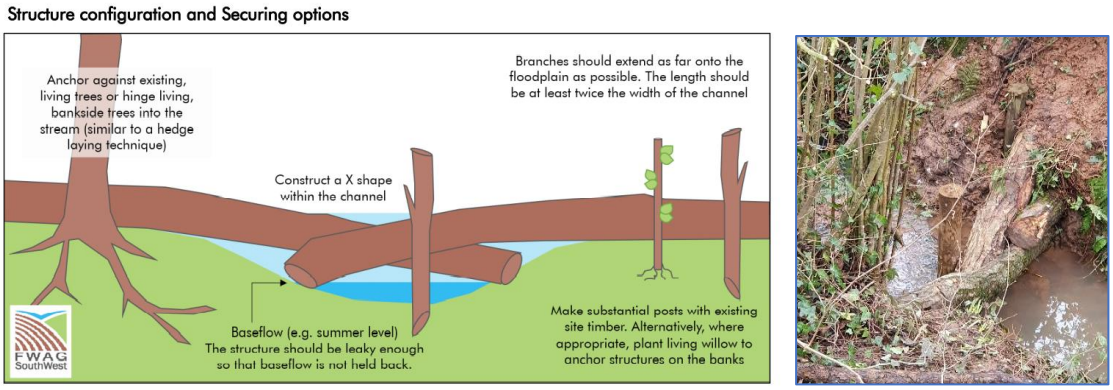
A basic design of woody debris in the channel is shown below, along with an example. Given the incised nature of the channel the strucutre will be secured into the banks of the channel rather than sitting on top.



The leaky woody debris dams will be installed manually. Works will be undertaken using a chainsaw and debris manually manoeuvred into place. Any fixings will be manually installed.

The approach to installation will be:

- Fell and lever the entire tree partially or entirely into the watercourse from the riverbank, with the branches facing either upstream or downstream;
- Fell with :
    - no hinge so that the tree is detached from the stump (requires staking of the trunk or securing to other trees on bank); or
    - (if possible) a hinge to enable the tree to carry on living, and to naturally secure it to the bank;
- Secure the head of the tree (main branches) and the trunk, with stakes made from local durable wood;
- Stakes securing the tree should be on the downstream side, angled so the top of the stake is pointing upstream and >0.1m above the top of the felled tree;
- Where stakes are used to secure the tree to the river bank and retain in-channel, the wood will be attached to the stake to minimise the risk that the tree floats away.

Natural Flood Management Opportunity – Floodplain reconnection

Downstream of the incised channel section, the valley floor widens out to a recognisable floodplain area. The analysis of flatness from the LiDAR DTM shows that the current route of the channel has been aligned outside of the floodplain and now sits perched in elevation to the north of the naturally lower topography.

There is evidence from vegetation and measures to maintain footpath passage, that a wet patch regularly forms to the south of the channel. Currently, water spills from the channel during infrequent periods of higher water level or spate events but the floodplain area is not fully connected to the channel.

Restoring the pathway of channel to the natural topography will create a full floodplain reconnection. An area of floodplain approximately 10m wide and 75m long can potentially be reconnected.

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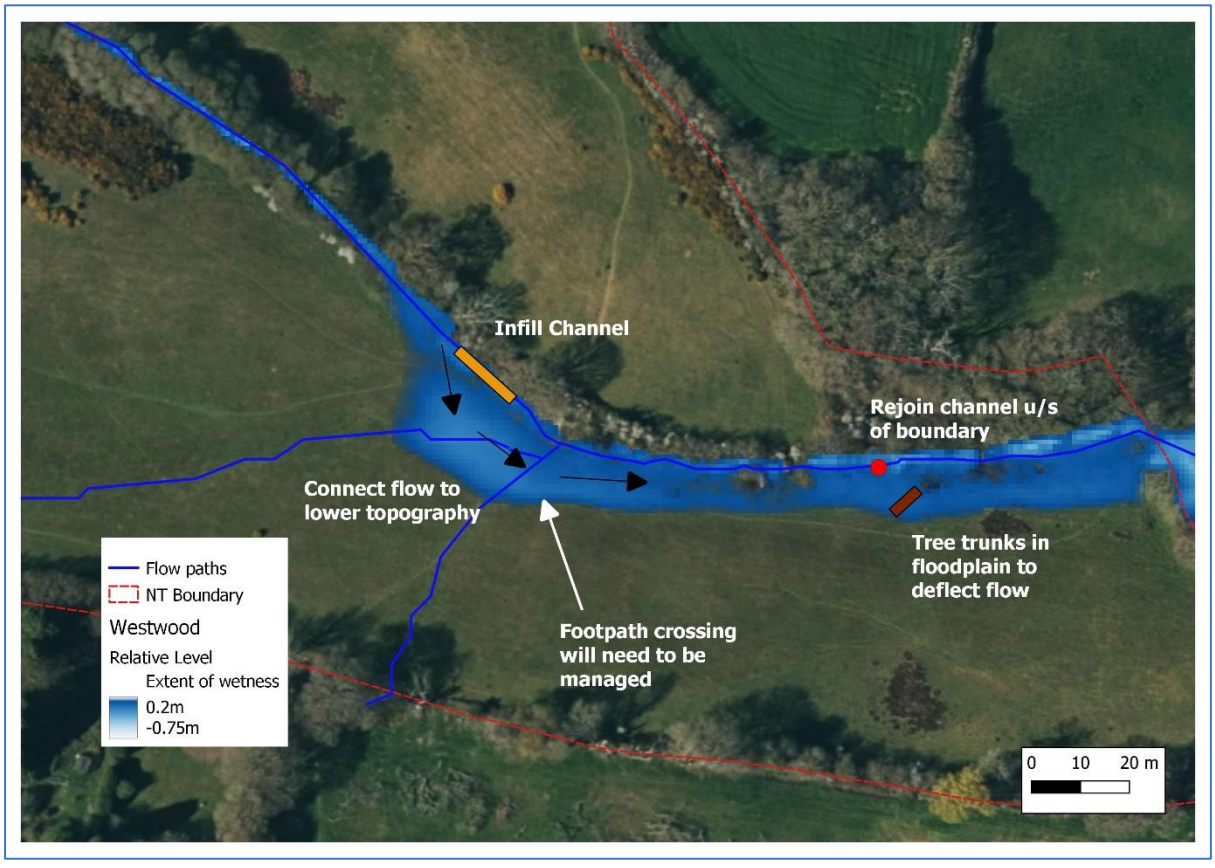
There is a clear location at the upstream of the natural valley floor area where the channel becomes detached from the floodplain. Infill of the existing channel at the location where the level of the bed of the channel is closest to the level of the adjacent floodplain will allow flow to connect to the floodplain. A small pilot channel may be required to overcome any local topography variants but the flow over the floodplain should then be allowed to follow a diffuse pattern within the area.

Rehydration of the valley floor will require consideration of the footpath that crosses the floodplain. Diversion and creation of a new channel crossing upstream of the flat area should be considered but if that isn't possible, then a walkway will be required over the newly re-wetted area.

Whilst the downstream extent of the reconnected floodplain continues further downstream, the ownership boundary of National Trust land is a constraint to further floodplain reconnection. It is therefore necessary to introduce measures to restore flow back into the single channel. Analysis of the relative levels on the floodplain area indicate a location where current micro-topography will help concentrate flow back into the channel. Addition of large tree trunks into the potential flow path should also be used to help divert flows, and if necessary, a wide shallow pilot channel which lowers the bank of the channel can help to return flow.



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6. Langton Matravers

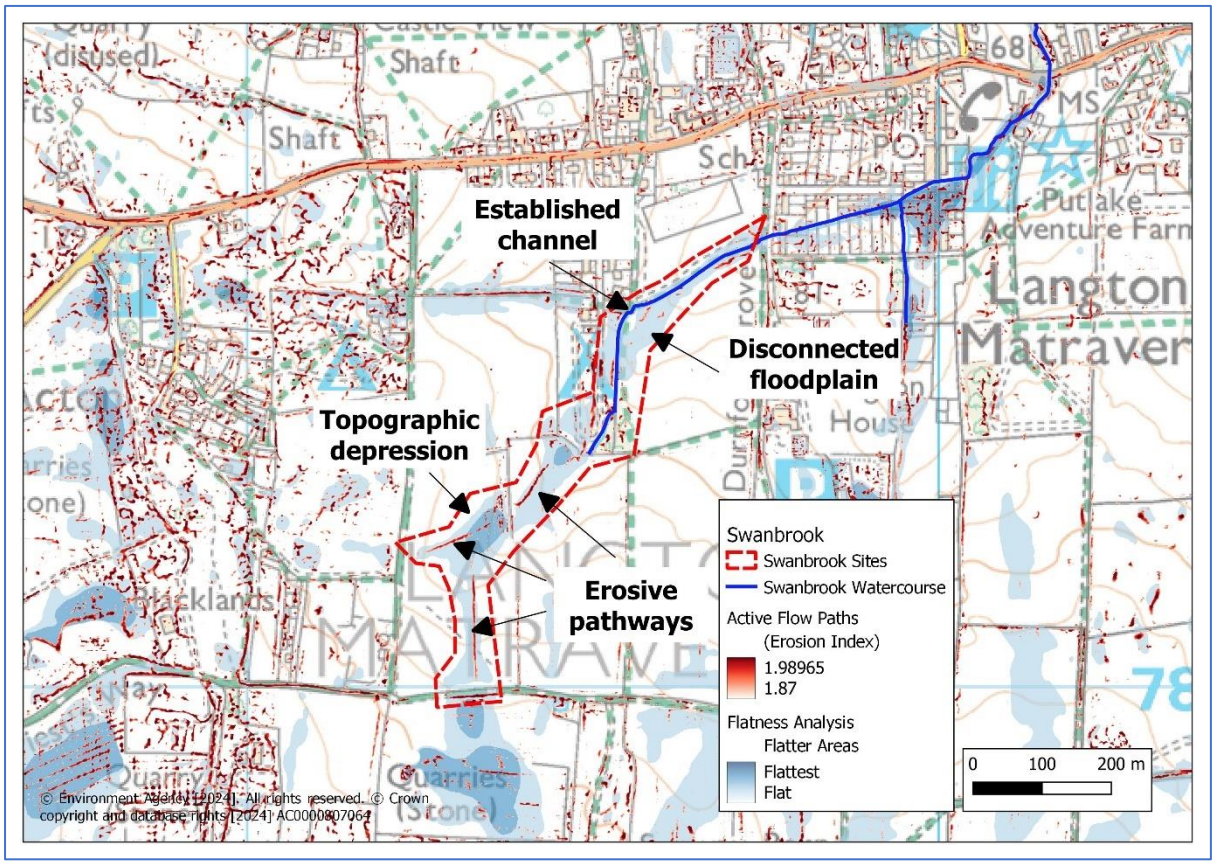
Surface Water Drainage and Topography

An ephemeral flow pathway develops over limestone bedrock in fields upstream of Tom's Field Campsite. The flow pathway develops within 3 x fields crossing through field boundaries. Flow is concentrated sufficiently to cause erosion and establish a defined ephemeral channel (red pathways in the figure below). There is no obvious change in bedrock geology within the site to impact on flow.

On reaching Tom's Field Campsite, a channel is established. The channel is however modified and routes water around the campsite rather than following a natural topography driven pathway.

Analysis of the Environment Agency LiDAR DTM to identify areas of flatness within the landscape can be considered to define the natural floodplain where water will occupy due to gravity. Flatness is defined as a measure of slope combined with elevation which is then classified. The figure below shows where the flatter land is classified (darker blue) and its association with the tributary channel. The light blue shaded areas represent flat levels which are at the fringes of the floodplain or are associated with the ephemeral flow pathway. Natural flow will be within the shaded area.

Downstream of the campsite, the modified path of the channel eventually joins a channel within the valley floor. The valley floor of the downstream reach is narrow and relatively steep sided. The channel itself is over deep and incised.



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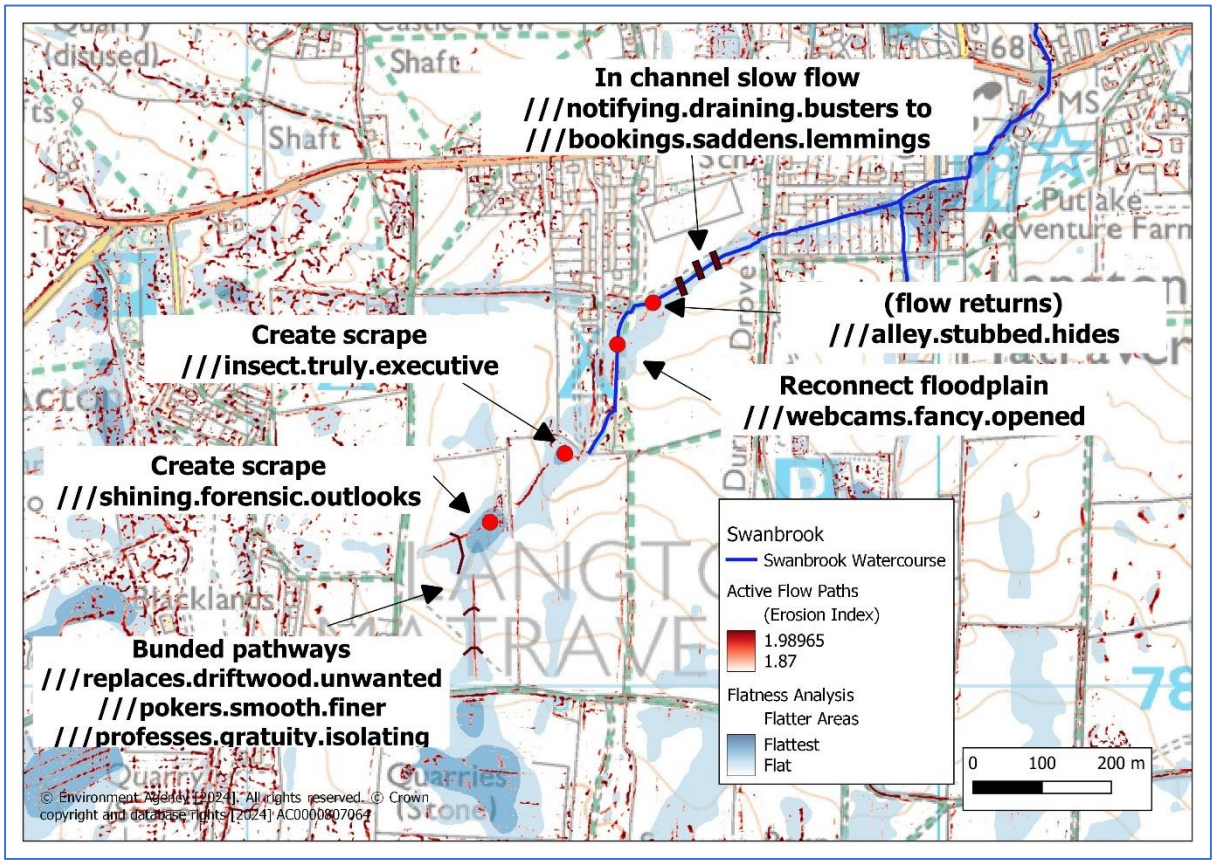
Approach to working with natural processes.

The current runoff pathway is concentrating flow from rainfall-runoff generating storms to the point that it is eroding an ephemeral channel within the landscape. Methods to slow the delivery of runoff downstream are proposed initially. Rather than a concentrated flow, a shallow diffuse flow will create more in-catchment storage and slow velocity.

In combination with slowing flow delivery, there are opportunities to create storage within the catchment fields which generate runoff.

Once flow is concentrated into an established stream channel, and accelerated delivery of flow occurs through flow being contained within an over deep and re-aligned channel. The efficient channel means there is a disconnection from flow being stored within the available riparian floodplain area which will hold more water in the catchment.

Measures are proposed to slow the delivery of runoff through field sources and within the stream channel. Where possible, natural topographic opportunities will be used to create storage of flow within the catchment and slow downstream delivery.



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Natural Flood Management Opportunity – Runoff Management

Modification to slow the delivery of runoff from the upstream field sources can initially be achieved by creating shallow bunds across the pathway using the available topography depression along the pathway. The cross-pathway features need only be ca. 30cm high and take the form of a curved “speed bump”. Material from upstream can be scraped from the surface and compacted to create the shallow bund. It is intended that flow will overtop the feature and a further flow control will not be required.

Natural Flood Management Opportunity – Runoff Storage

The flatness analysis suggests that there are two natural depressions which can be expanded to create temporary storage in scrape features within the fields. Both locations identified in the figure above are close to field boundary walls which will help control downstream flow. The scrape features can be created using a digger to remove a shallow depth of top soil ca. 20-30cm to enhance the depression feature. Removed material can be used to define the feature but also to infill the upstream runoff pathway that feeds into the scrape feature.

The two features suggested will both be in the order of 30m in diameter.

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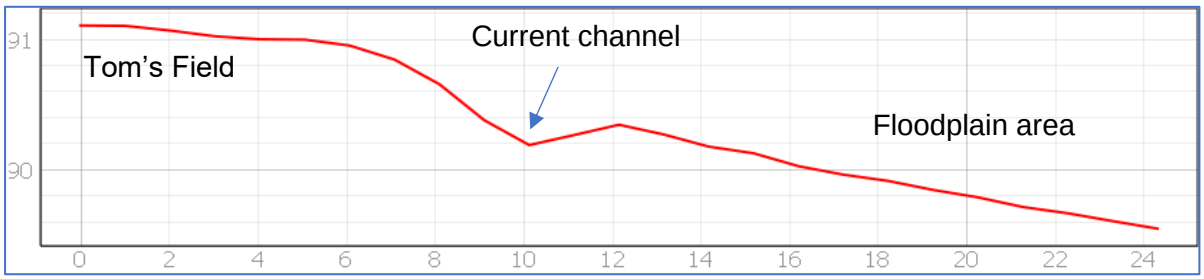
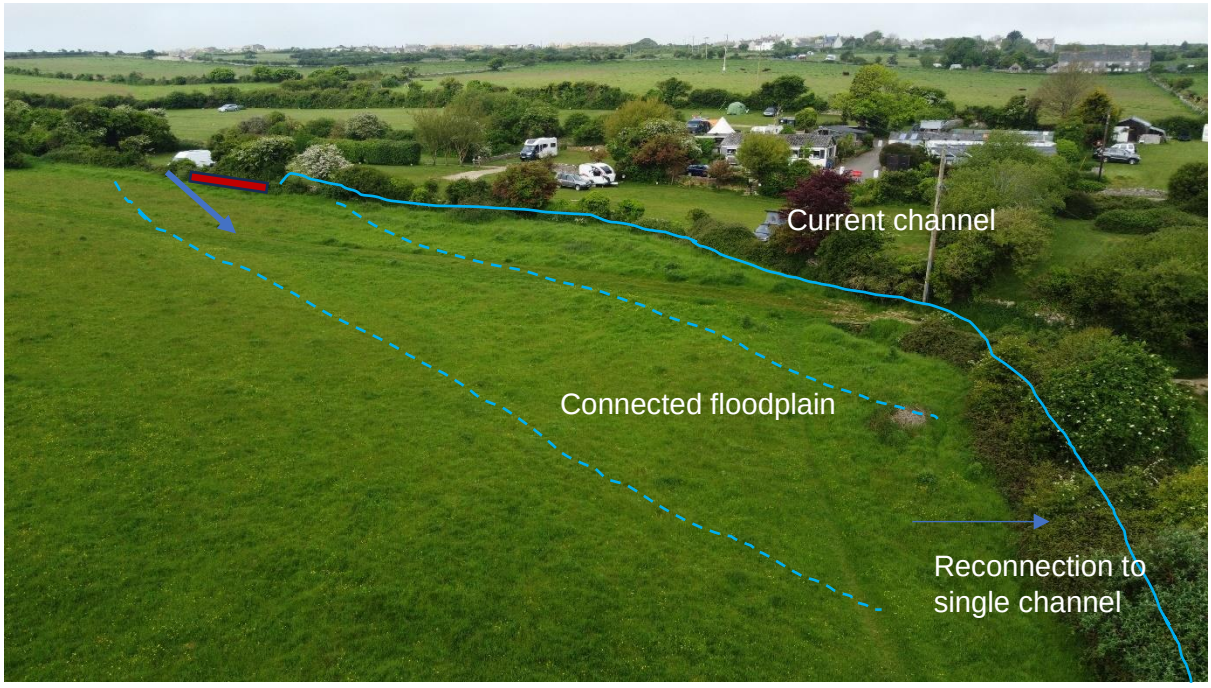
Natural Flood Management Opportunity – Floodplain reconnection

Where the established channel has been realigned around Tom's Field Campsite, there is a point where the channel crosses a natural depression/floodplain area and becomes detached from the adjacent lower-lying land. A simple lowering of the right bank of the channel (looking downstream) where it crosses the floodplain can restore flow to a natural low-lying topography.

A cross section of the channel and adjacent floodplain suggests a bank lowering of ca. 20cm over a width of 3m will create a connection to the floodplain. The downstream channel will need to be blocked and the material taken from the bank lowering can be used to infill the channel.





NOTE: A public footpath crosses the floodplain area that is proposed for reconnection. The crossing of the current stream will need to be moved downstream of the point where flow is reconnected back into a single channel.

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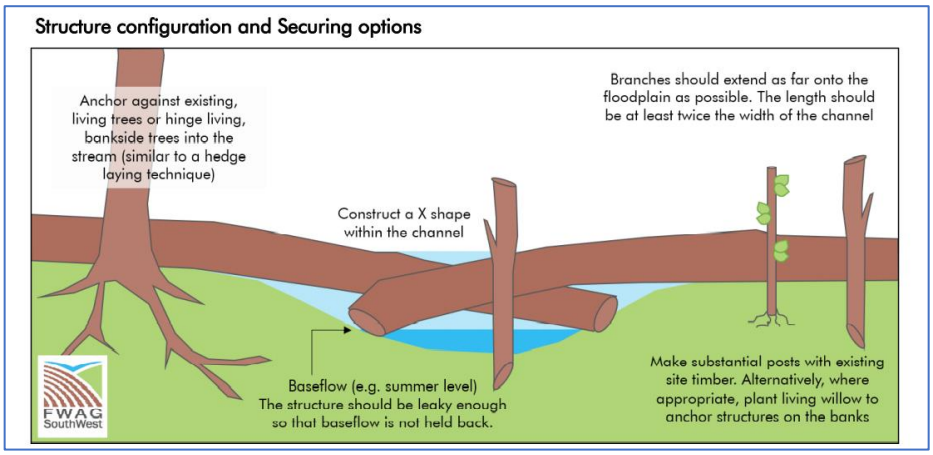
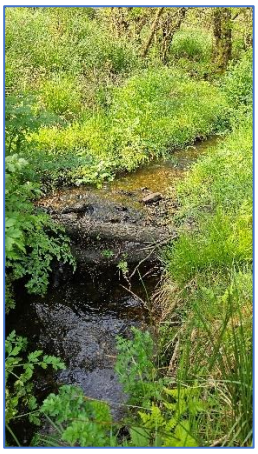
Natural Flood Management Opportunity – In-channel slow flow

The incised form of the channel downstream of the campsite is part of the reason that the floodplain has been disconnected. There is a limited width of floodplain but reducing channel incision will increase the cross section width of the channel, slowing delivery and increasing storage. Addition of woody debris to the channel is proposed specifically with the intention to trap sediment and raise the bed level of the channel. The woody debris as a leaky dam will also raise water level but at the locations proposed there is a limited floodplain space.

Within the reach are proposed, addition of up to 3 to 4 dams is proposed.

A basic design of woody debris in the channel is shown below along with an example.





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