Natural England Commissioned Report NECR140

New Forest SSSI Geomorphological Survey Overview

Annex E: Picket Bottom Restoration Plan - SSSI Unit 91

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1 Picket Bottom Restoration Plan - SSSI Unit 91

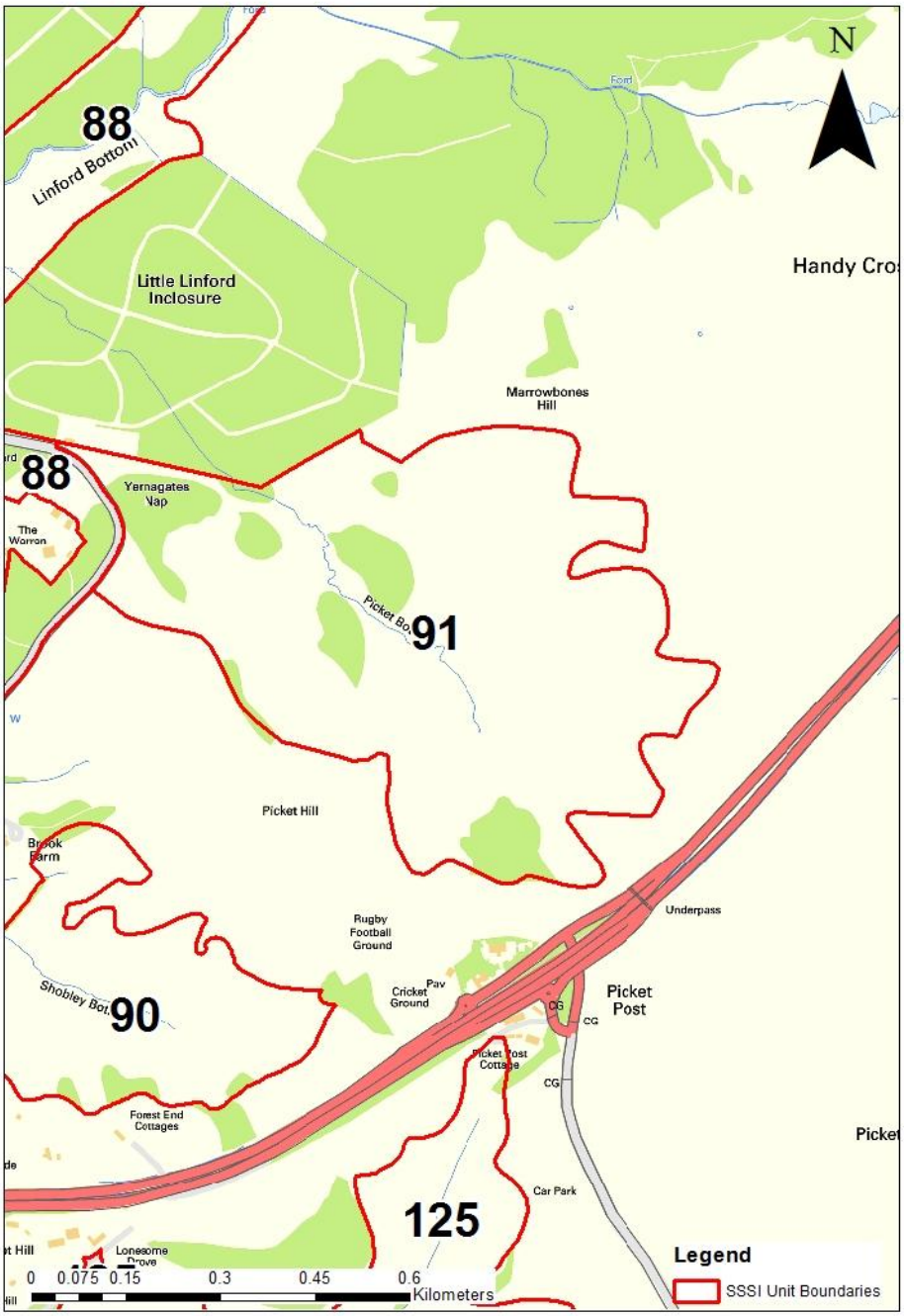
1.1 Introduction

Picket Bottom (Unit 91) has mire and stream characteristics, and flows south-east to north-west into the Linford Brook (Unit 88) (Figure 1-1). It is considered to be in unfavourable recovering condition and is approximately 43.67ha in size.

The unit is predominantly made up of wet heath, marshy grassland (wet lawn habitat) and valley mire, with some areas of broadleaved woodland, scrub, Gorse *Ulex europaeus* and Bracken *Pteridium aquilinum*.

It is important to consider undertaking the proposed works within this unit alongside works for Unit 88 as the incision with the drain / tributary downstream of Unit 91 is partially attributable to incision within the Linford Brook at the downstream end. Therefore, works within Unit 88 will help to manage the incision risk within Unit 91 and should be undertaken either before or at the same time as works within Unit 91.

Figure 1-1: SSSI Unit 91 location (flow direction is south-east to north-west)



1.2 Current hydromorphic conditions and issues

A summary of the hydromorphic conditions of Unit 91 is given below in Table 1-1.

Table 1-1: Hydromorphic conditions of unit 91

Geomorphological Assessment Area		Picket Bottom
Site name		Picket Bottom
Size (ha)		43.7
SSSI unit(s)		91
Channel	River type (s)	Transitional - mire into stream, active single thread at d/s end

Condition	Responsiveness	Moderate - mire at risk from current incision in stream. Mire section does have a weakly defined channel
	Sediment delivery, type and mobility	Delivers sediment to Linford Brook, gravel source in stream section, gravels in banks. Silts at lower end of mire.
	Main source of water	Upstream source (Picket Hill) and small drains / overland flow
	Aquatic vegetation	In-channel aquatic vegetation includes Bog Pondweed, Marsh St John's-wort, Floating Sweet-grass and Rush species
	Drainage damage	Some small drains cut in floodplain that flow into main mire section, could be filled
	Morphology	Pools, riffles in stream section, but limited by incision. Spread in mire section in some locations
	Incision	Yes - stream section incised and has affected mire section upstream as a weakly defined channel is evident. Restoration measures (staked faggots / bundles, one log jam) have been semi-successful in stopping incision, but are failing in places.
	Engineering	Stream section definitely straightened at downstream end, all the way to Linford Brook
	Bank activity	Bank collapse associated to incision in stream, some lateral activity below SSSI boundary, reacting to straightening
	Flow type (s)	Flows impacted by upstream mire but appears relatively natural (smaller drains may have some impact). Flood peaks concentrated in stream due to incision
Floodplain Condition	Valley type	Wide floodplain
	Main source of water	Seepage, drains / overland flow, out of bank flows
	NVC communities	M25a, M29, M16a, M23a, W14
	Key habitat types	Wet heath, Valley mire, Marshy grassland, Broadleaved woodland, Broadleaved plantation woodland, Bracken
	Drainage	Some smaller cut drains in floodplain could be infilled. Main flow routes appear natural.
	Scrub / tree encroachment damage	Some areas of gorse/Hawthorn
	Palaeo features	Little evidence within unit boundary (straightened downstream towards Linford Brook)
	Floodplain connectivity	Poor in stream section due to incision. Better upstream in mire section but could be improved through further blocking
	Poaching and grazing pressures	Yes
Generic restoration options		Additional channel blocking, particularly in mire section to promote further floodplain wetting and spreading. Some incision management in stream section.
Additional comments		

The stream at the downstream end of Unit 91 is an active single thread channel with significant ongoing incision (Figure 1-2). Within the mire section, the main flow route is well connected to the floodplain in most places, with significant spreading occurring (Figure 1-3), in some sections flow coalesces to form a weakly defined channel (Figure 1-4). The gradient is relatively low within the mire sections (Figure 1-5 - B). Incision within the stream at the downstream end (Figure 1-5 - A) has exposed some gravels but there are generally low inputs of gravels from upstream.

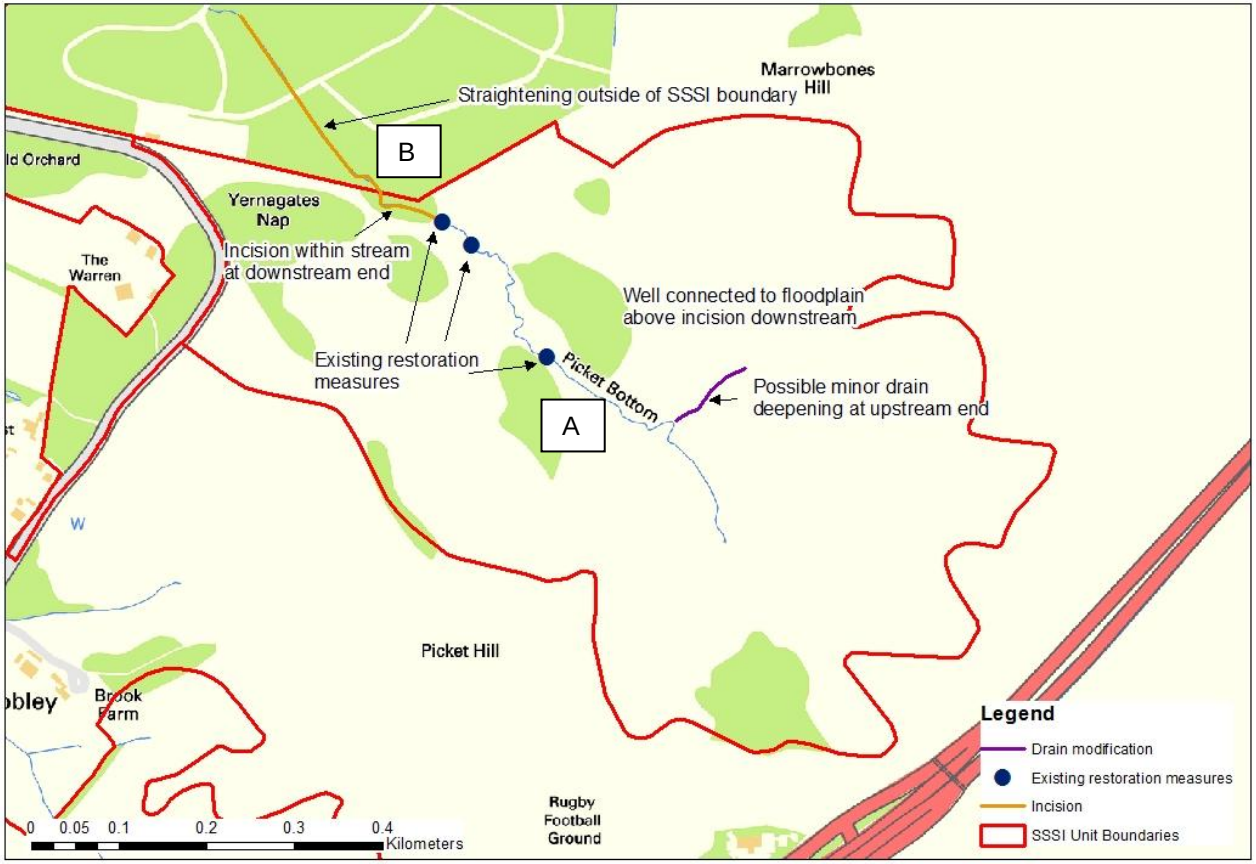
Figure 1-2: Active channel characteristics at downstream end of unit - displaying incision evidence

Figure 1-3: Spreading (M29) areas within the mire section

Figure 1-4: Weakly defined channel sections within mire area

The source for the unit is Picket Hill. Figure 1-5 summarises the existing hydromorphology and pressure impacting unit 91.

Figure 1-5: Current hydromorphic conditions and pressures



The gradient within the main flow route for the mire section of this unit is generally low, allowing flows to spread over the floodplain locally. The bed is generally silt dominated (Figure 1-6) due to the low energy flows and where there are gravels within the mire area, there is suspicion these have been artificially introduced either as part of restoration measures to raise water levels or for cattle crossing purposes (Figure 1-7). There is some flow biotope variation where various interfluves across the floodplain are activated (Figure 1-8).

Figure 1-6: Silty bed within spreading (M29) section

Figure 1-7: Small gravel sections associated with animal crossing points

Figure 1-8: Biotope variation in spreading section (M29, M23a, M25a)

There is little evidence of significant channel straightening upstream of the incision, either from the audit or the LIDAR. However, significant straightening appears to have been undertaken within the stream at the downstream end of the unit (Figure 1-2), extending all the way to Linford Brook. This is a likely cause of the significant incision within the stream, alongside channel deepening that will have occurred concurrently, leading to a steepening of the channel increasing flood shear stress levels. Erosive energy is consequently increased and focused on eroding the channel bed in this instance.

Current restoration measures to manage the downstream incision (Figure 1-5 - A) and to raise water levels within the mire section are shown in Figure 1-9 to Figure 1-11. These have been partially successful in managing ongoing incision and ponding water upstream to improve floodplain wetting, however the staked bales to manage incision at the downstream end of the unit (Figure 1-9) may not survive in the long term.

Figure 1-9: Downstream restoration measure to manage incision

Figure 1-10: Infilled staked bales to raise water levels

Figure 1-11: Log dam to raise water levels

The flow and drainage lines in Appendix A confirm that there is little evidence of significant artificial drainage within this unit. There has possibly been some deepening of the drain route at the upstream end over the right bank (Figure 1-12), although this is not significant. There are very few straightened drains and both the audit and LIDAR confirm no presence of embankments along either the main channel or the drains.

Figure 1-12: Right bank drain showing possible deepening

There are no significant gravel shoals or features within the mire section of this unit. Gravel features would not be expected in conditions associated to this unit.

Fine sediment inputs to the channel are increased due to poaching and grazing up to the channel banks. Several points are used by cattle for crossing.

There are no natural woody debris features along the channel due to the surrounding vegetation type. Therefore, restoration options to improve floodplain connectivity further through the single thread sections of the watercourse are likely to involve channel blocking using consolidated silty berms (which naturally occur through the reach) alongside channel infilling. These will create short lengths of impounded watercourse and spreading sections that will improve floodplain connectivity / wetting.

1.3 Probable channel development

The main flow route through the mire section of the unit is relatively stable, although this may have been assisted by recent restoration measures. Floodplain connectivity is good and therefore it is a relatively stable system until the downstream incision is reached. Fine sediment inputs will remain heightened as a result of surrounding land use and grazing, due to the limited buffer strip between the floodplain and the channel. Further silt deposition within the main flow route is likely (some of which will be flushed through during higher flows) that could lead to bed raising. It is unlikely the nature and distribution of existing features will change significantly over the next decades due to the generally low energy conditions within the unit.

Unmitigated, the incision within the stream at the downstream end of the unit threatens the mire section as current restoration measures are considered to be a relatively short term mitigation measure.

1.4 Current ecological conditions

The unit is predominantly made up of wet heath, marshy grassland (wet lawn habitat) and valley mire, with some areas of broadleaved woodland, scrub, Gorse and extensive areas of Bracken.

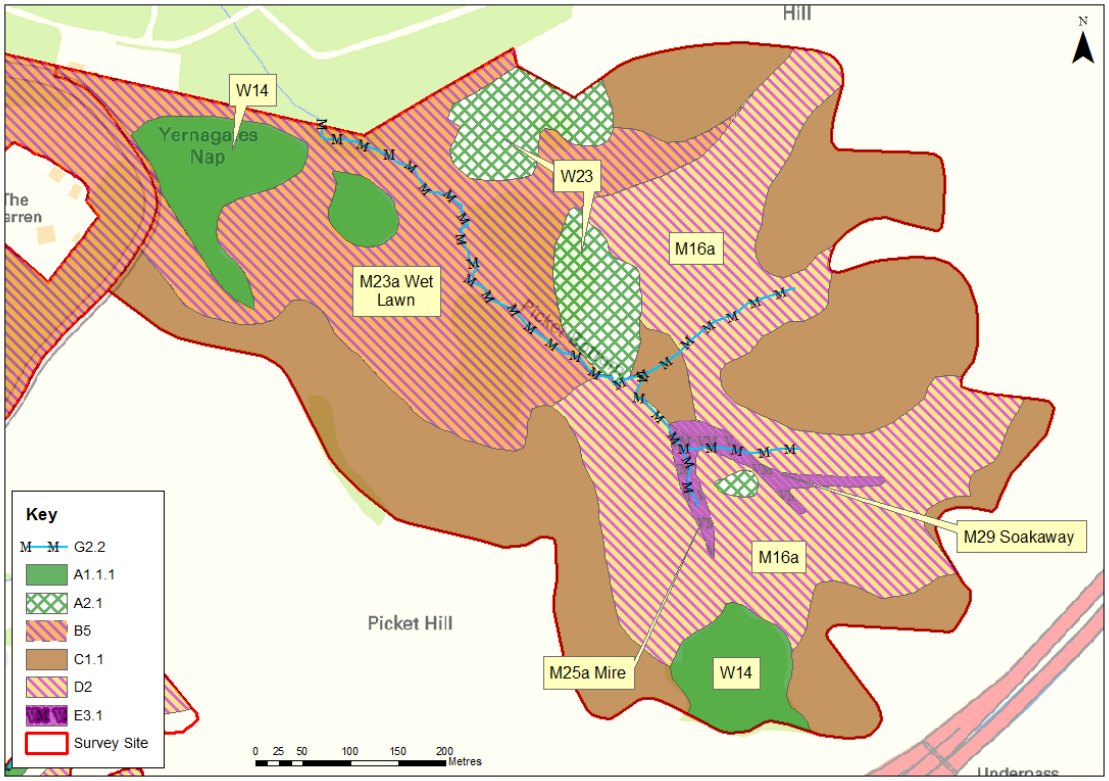
The mire and wet heath habitats appear to be degraded and reduced in extent due to the effects of drainage. However, the valley mire habitat on the higher ground, at the upstream end of the unit, was in good condition with extensive areas of Purple Moor Grass *Molinia careulea* dominated mire.

Wet lawn is quite extensive within the unit and on the higher ground, areas of Gorse and Bracken become more frequent.

At the time of survey, aquatic vegetation within the stream consisted of Bog Pondweed *Potamogeton polygonifolius*, Marsh St John's-wort *Hypericum elodes*, Floating Sweet-grass *Glyceria fluitans* and Rush *Juncus* species. There was evidence of poaching along the stream where cattle and horses cross the channel.

Figure 1-13 shows the Phase 1 Habitat Map for Unit 91.

Figure 1-13: Phase 1 Habitat Map



1.5 Ecohydrology

A full ecohydrological survey report has been produced for SSSI Units 90 and 95 which occupy topographically and geologically similar mires to the east and west, along the same plateaux edge (Ecohydrological Assessment Area H) as Unit 91. It concluded that the mires were mainly flush dominated; mainly receive water from seepage faces at the junction between Quaternary river terrace deposits and the underlying Tertiary bedrock. This conceptualisation appears to also hold for this site too. The areas of mire and wet heath occur on the flushed slope and bottoms in the head of the site. Further down the valley, the flushed water is channelled into small streams. In this area the wet heath and mire is replaced by wet grassland.

1.6 Restoration plan proposals

A summary of the current pressures, unmitigated impacts and restoration proposals is given in Table 1-2 and shown in Figure 1-14.

The key hydromorphological and ecological gains associated to the proposed restoration measures are:

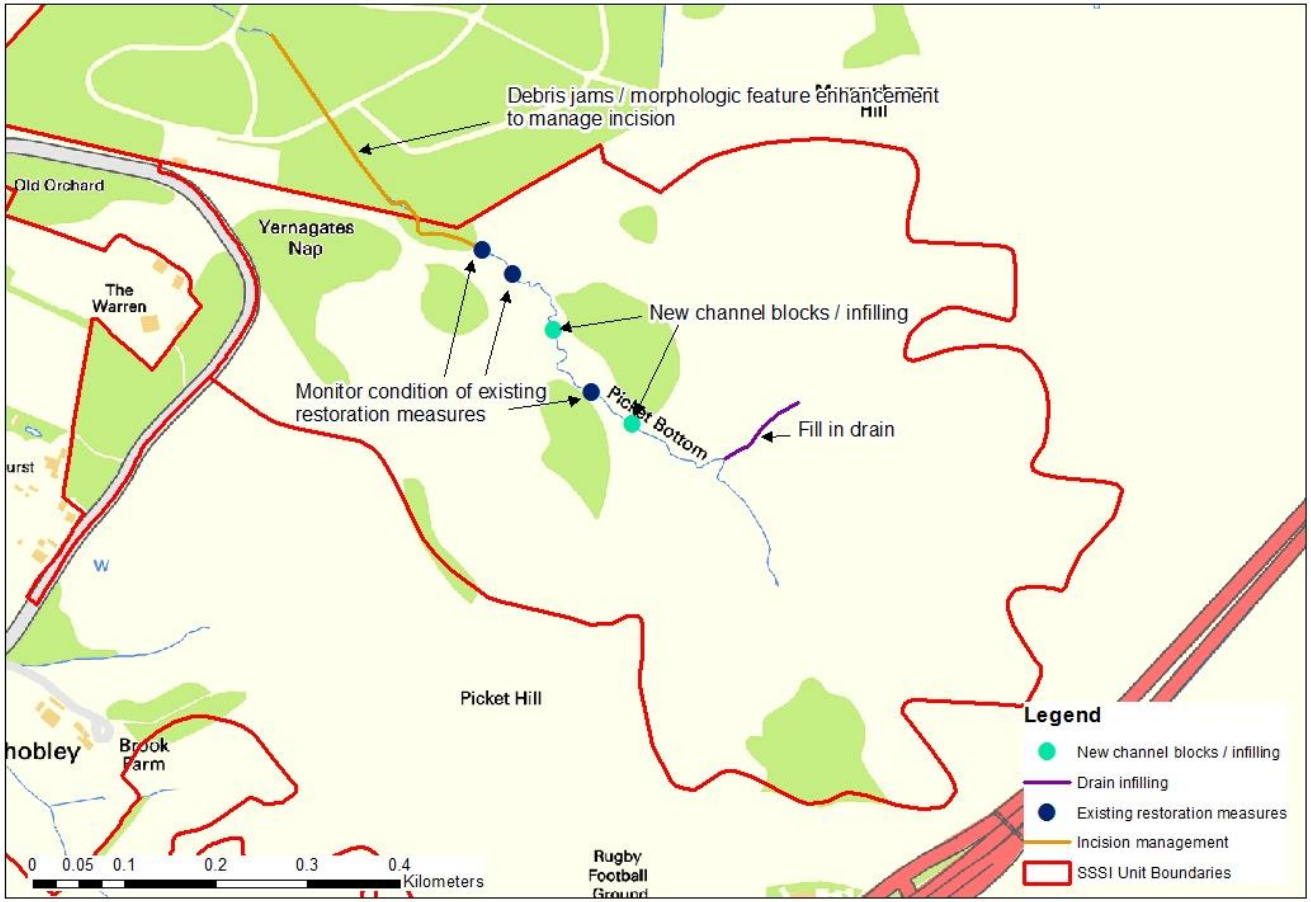
- Bed and water level raising through channel infilling and blocking to create spreading sections of channel and to improve floodplain diversity;
- Water level raising, through channel infilling and blocking, will improve groundwater levels locally;
- Natural flow regime reinstated as a result of artificial drain infilling;
- Management of downstream incision that currently threatens the mire section;
- Increased extent and quality of mire and wet heath habitats.

Table 1-2: SSSI Unit 91 proposed restoration measures

Pressure	Impact	Restoration proposal	Hydromorphic improvement	Ecological improvement	Constraints / issues
Historic dredging Straightening and significant incision - in stream at downstream end of unit and outside of SSSI boundary to Linford Brook.	Long term river response, cut and fill activity. Enhanced in-channel energy levels. Loss of in-channel features. Incision knickpoint	Incision management - debris jams, morphological restoration, floodplain works. Infill. Restore connectivity. Treat knick points. Manage incision knickpoint through either debris jams, wooden dams and/or heather bailing.	Reconnecting the floodplain will improve in-channel hydromorphic condition and will reduce incision that threatens the mire section of this unit. Debris jams would naturally occur along the reach, use local materials. Morphological enhancement to raise bed and water levels will help improve floodplain connectivity. Local floodplain works may be necessary to give sufficient connectivity. Slows gravel movement. Stabilises in-channel features.	Improve diversity of in-channel habitats and restoration of mire and wet heath habitats Raising of water table will allow recolonisation by 25A *Molinia* mire. Increased area of M29 Soakway habitat as channel spreads out an anastomoses. In channel features will vegetate over increasing seral stages within unit and the associated ecological niches available.	Significant works / features may be required to manage the incision. Debris jams may form a barrier to fish, a fish pass may be required but is unlikely. Large amounts of material are likely to be required if bed works are undertaken. May require some felling of trees. Loss of grazing quality. Cultural objections.
Artificial drainage	High flows impacted. Sediment transfer impacted. Water table lowered locally.	Artificial drain infilling (minor works)	Restore a natural flow and sediment regime. Reduces flood peaks. Restore natural floodplain flow routes.	Reconnection of floodplain and increases in the habitat diversity in association with Soakways and *Molinia* mire.	May require import of material Loss of grazing both spatially and temporally.
Floodplain drying	Reduction in wetland habitat (quality and quantity)	Channel blocking using berms and channel infilling	Further multi-branch / spreading sections. Improved floodplain	Increase in quality and quantity of mire and wet heath habitats including an increase in M25a	May require import of material.

Pressure	Impact	Restoration proposal	Hydromorphic improvement	Ecological improvement	Constraints / issues
			connectivity / wetting.	habitat and associated M29 habitat	
Riparian grazing	Fine sediment production. Disruption to woody species recruitment.	Exclude livestock	Encourages riparian hydromorphic diversity	Increased floristic diversity of ground flora on floodplain. Restoration of mire and wet heath habitats May promote growth of bog woodland (W2a) in upper reaches.	Some grazing is likely to be maintained. Culturally unacceptable.

Figure 1-14: Proposed restoration measures for SSSI Unit 91



1.7 Design considerations

The current hydromorphic condition of the main flow route in the mire section is considered to be reasonable given existing processes and controls. Further improvements could be made through improved floodplain connectivity, which is likely to improve vegetative diversity and reduce floodplain drying. Channel infilling / blocking should use measures suitable to existing conditions. Heather bale dams have been tried previously but have failed progressively due to undercutting and outflanking in this steep, high energy system at the downstream end of the unit. As such similar approaches should be avoided as they are unsustainable here. Successful sensitive restoration on such high energy systems has not been reported.

It is suggested that an alternative design be considered that mimics the naturally stable seepage mire transitions zones present elsewhere. Breaches in glacially derived mineral barriers should be repaired to recreate the lower energy peat forming conditions behind the obstruction. Flows exiting past the barrier are naturally diffuse with the majority of the discharge occurring as throughflow. This should be mimicked with the upstream section and upper layer of the breach repair being unfilled with heather bales to encourage internal flow and occasional diffuse surface flow.

Control of knick points along the incised lower reaches where the channel flows through mineral deposits is equally problematic and requires alternative techniques to staked heather bales used previously. Complete or substantive channel infilling with an organic porous base and mineral top layer could be attempted in the most severely eroding areas. This would be a radical approach and requires detailed design which is outside of the scope of this report. Mitigation of the incision downstream within the stream section (outside of the SSSI unit boundary) should focus on managing the causes of the incision as well as preventing upstream propagation. Bed raising through debris jams and morphologic feature installation should be considered as mitigation measures here.

Works within this unit should be prioritised or aligned with works undertaken in Unit 88. The linkage between the units is important and issues identified within Units 88 (incision) are likely to be impacted / mitigated by works undertaken in this unit.

1.8 Restored channel and monitoring requirements

It is anticipated that the proposed restoration works will improve floodplain connectivity and reduce fine sediment inputs to the channel. Morphologic change is likely to involve an improved multi-branched / spreading channel network. This could be monitored qualitatively with automated time lapse photography at key restoration point to record daily images of flow types, morphology and vegetation character. This could be undertaken alongside two-yearly reconnaissance audits to determine hydromorphological change over the entire reach, which fixed point photography will not cover. The daily photographic records should be analysed to estimate and record the parameters detailed in Table 1-3.

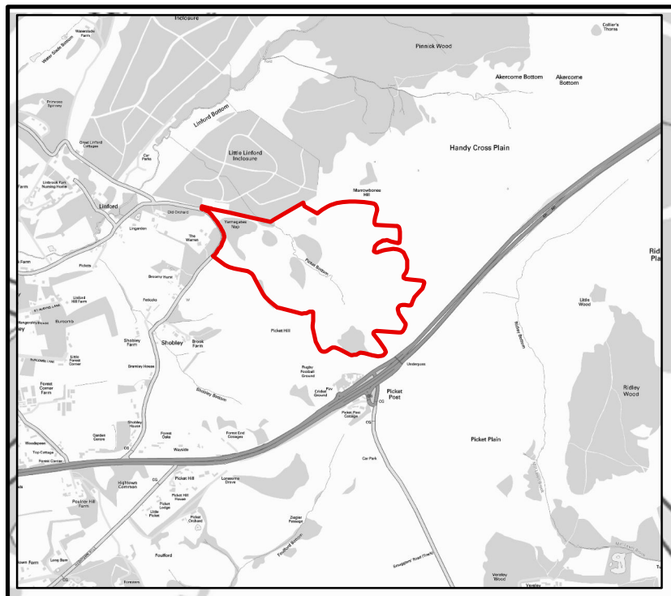
Monitoring of the downstream restoration measure (staked bales) to manage incision should be undertaken as this may need replacing in the short to medium term.

Table 1-3: Monitoring parameters, frequency and suggested approaches for the Unit 91.

Parameter	Approach	Frequency	Approximate cost
Morphologic unit change	Time lapse camera / audit	Daily (Annual statistical summary)	Capital 3 x £200 Half yearly downloading £200 Annual summary £300 Two - yearly reconnaissance audit £500
Flow change	Time lapse camera / audit	Daily (Annual statistical summary)	
Sedimentology	Time lapse camera / audit	Daily (Annual statistical summary)	
Vegetation change	Fixed point camera survey	Biennially	
	Fixed point quadrat survey	Biennially	Survey £350 Analysis £500
	Fixed point aquatic macrophyte survey		

Parameter	Approach	Frequency	Approximate cost
NB. Costs assume downloading and site visits as part of wider field campaign.			

Appendix A - Artificial drains and flow lines - SSSI Unit 91



SSSI 91: Picket Bottom

Inclosure

Marrowbones Hill

Yernagates Nap

The Warren

Picket Bottom

Broomy Hurst

Fetlocks

W

Picket Hill

0 50 100 200 Metres