Natural England Commissioned Report NECR140

New Forest SSSI Geomorphological Survey Overview

Annex M: Cowleys Heath East Restoration Plan - SSSI Unit 422

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1 Cowleys Heath East Restoration Plan - SSSI Unit 422

1.1 Introduction

Cowleys Heath East (Unit 422) has mire and stream characteristics and eventually flows into the Stock Water to the south of the unit (Figure 1-1). It is considered to be in unfavourable recovering condition and is approximately 18.75ha in size.

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

Figure 1-1: SSSI Unit 422 location (flow direction is north to south)

1.2 Current hydromorphic conditions and issues

A summary of the hydromorphic conditions of Unit 422 is given below in Table 1-1.

Table 1-1: Hydromorphic conditions of unit 422

Geomorphological Assessment Area		Cowleys Heath East
Site name		Cowleys Heath East
Size (ha)		18.8
SSSI unit(s)		422
Channel Condition	River type (s)	Mire to stream transition - stream is active single thread, spread in upstream mire section with a dominant channel only evident in some locations (e.g. d/s of heather bail restoration)
	Responsiveness	Moderate - upstream incision propagation from stream could impact mire, some gravel supply to stream, moderate gradient, straightening, tree clearance (historic) in stream section. If incision managed then mire section should be moderately robust as flows spread
	Sediment delivery, type and mobility	Gravels in downstream stream section, supplied from local gravel sources (banks), mainly silty bed (only minor evidence

		of gravels) in mire section in dominant channel where not spread or multi-thread
	Main source of water	Upstream source (Beaulieu Heath), drains and overland flow
	Aquatic vegetation	At the time of the survey the channel was flooded, however Bog Pondweed, Floating Sweet-grass, Water-starwort and Marsh St John's-wort were evident
	Drainage damage	Drains do not appear significantly damaged or deepened (apart from road drains). No evidence of embankments apart from road drains. Some smaller artificial drains have been dug at u/s end
	Morphology	Pools, riffles / glides / runs in stream section, but limited by floodplain connectivity and incision. Gravel features not well developed. Spreads in mire section in some locations. Silty bed in sections where a dominant channel is evident.
	Incision	There is some incision in the downstream stream section, could impact mire if not managed. Some minor incision in mire section d/s of heather bailing.
	Engineering	Stream section possibly straightened and overdeepened. Road provides barrier to natural flow routes as do the drains alongside them. Heather bailing restoration in mire section, ok condition at present.
	Bank activity	Some lateral activity in downstream stream section, also bank collapse associated to incision. Little activity in mire section as spread in most locations
Floodplain Condition	Flow type (s)	Flows impacted by upstream mire and road drains at upstream end which prevent natural flow paths. Flood peaks concentrated in stream due to floodplain connectivity and incision at downstream end. Heather bailing is raising u/s water levels in floodplain.
	Main source of water	Seepage, drains / overland flow, out of bank flows
	NVC communities	M29, M21a, M16a, W4b
	Key habitat types	Wet heath, Valley mire, Broadleaved woodland
	Drainage	The flow routes into the main mire section appear in reasonable condition and do not appear to be over-deepened. The road and drains along them do alter natural flow route paths. Small dug drains at upstream end could be infilled.
	Scrub / tree encroachment damage	Gorse encroachment
	Palaeo features	No significant palaeo channels identified
	Floodplain connectivity	Moderate to high - high in upstream mire section although some improvements could be made. Moderate to low in stream section due to incision
	Poaching and grazing pressures	Significant grazing damage
Generic restoration options		Incision in stream should be managed by channel blocking by debris jams in wooded section, further blocking in upstream mire section to raise water levels (particularly d/s of existing heather bailing) and / or fill in dominant channel sections where appropriate. Assess whether culverts at road can be improved / increased in size to allow improved flow passage
Additional comments		

The stream within SSSI Unit 422 is mainly a passive single thread channel (Figure 1-2) where one dominant channel is evident (particularly downstream of the heather bailing restoration measures), switching to sections of multi branch / spreading networks where floodplain connectivity is improved and gradients are reduced (Figure 1-3). There are generally low inputs of gravel to the stream, in the upper and middle reaches, locally and from upstream sources, with limited bank erosion. The dominant material on the channel bed is fine sediments / silt (Figure 1-5), with only small sections of exposed gravel bed (in the single thread sections in upstream mire area). In the downstream section, the stream is more active, with evidence of incision (Figure 1-4). The floodplain is also confined in the stream section at the downstream end of the floodplain, limiting floodplain connectivity.

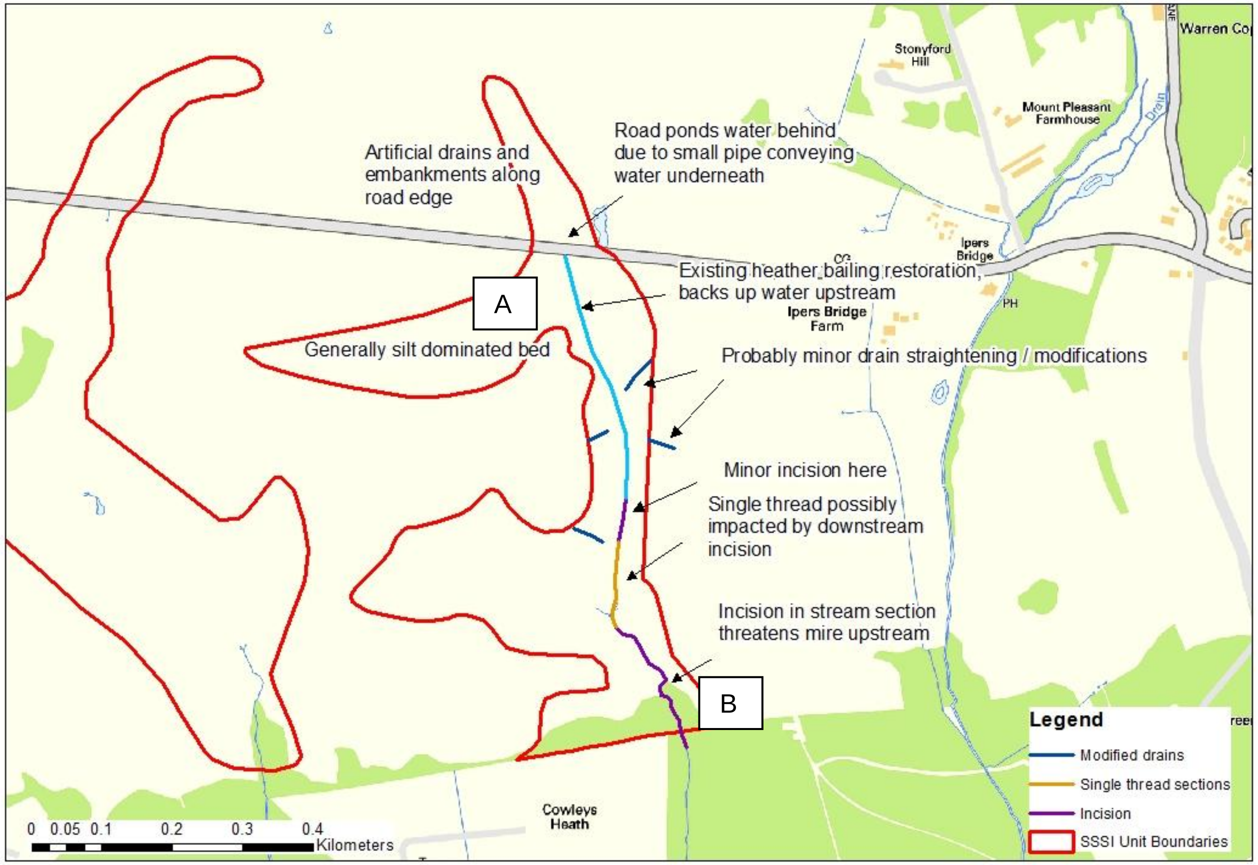
Figure 1-2: Passive single thread channel characteristics - note fine sediment and poaching

Figure 1-3: Multi branch / spreading sections in M25a Molinia mire with M29 Soakways

Figure 1-4: Active single thread stream section downstream

The source of the unit is Beaulieu Heath. Figure 1-5 summarises the existing hydromorphology and pressure impacting unit 422.

Figure 1-5: Current hydromorphic conditions and pressures



The unit in the middle to upper reaches has a generally low gradient (Figure 1-5 - A), particularly in the multi-thread / spreading sections where there is no clear dominant channel and water spreads over a wide area. In the single thread sections, the gradient is still generally low (although does steepen downstream), with some minor locally energetic reaches across riffles where gravel bed sections are exposed (Figure 1-6). Outside of these locally energetic areas, the bed is generally silt dominated due to the low gradients and diffuse sediment inputs (Figure 1-7). Fine sediment inputs to the channel are increased due to poaching and grazing within the unit (Figure 1-2).

This is most notable upstream of the heather bailing restoration where water is ponded, promoting conditions for increased fine sediment deposition. As a result of the generally low gradients and in combination with little incision within the mire section of the unit, bank erosion is limited.

Figure 1-6: Small gravel bed sections downstream of the heather bailing

Figure 1-7: Silty bed channel characteristics

In the downstream reaches of the unit, the channel is more active with a steeper gradient and possibly some past channel straightening towards the Stock Water outside of the SSSI unit boundary. This will have resulted in some loss of channel length leading to a steeper channel, resulting in increased flood shear stress levels promoting erosion of the channel bed, linked to the incision seen in the downstream reaches (Figure 1-5 - B and Figure 1-10). This is particularly the case where the channel banks are stronger (due to the presence of more resistant boulder clays rather than fluvio-glacial gravels or where riparian woody vegetation is dense enough to provide a coherent resistant root mat - Figure 1-8). This incision may be influencing the single thread section immediately upstream and the minor incision knickpoint at this location (Figure 1-9), through channel bed and water level lowering.

Figure 1-8: Vegetated banks and confined floodplain in downstream stream section of this unit

Figure 1-9: Incision knick point within mire section of unit

Figure 1-10: Knick point erosion in downstream stream section

In some locations the single thread channel is more disconnected than others resulting in drier floodplain areas and associated impacts on vegetative assemblages (see section 1.4).

The LIDAR and drainage lines in Appendix A show that there is likely to have been some minor modification to the drainage flow routes, mainly through some drain straightening as shown in Figure 1-5 and possibly an artificially modified drain between units 422 and 423.

There are no significant gravel shoals or features within this unit, with morphologic units limited to riffles and runs where there are minor increases in gradient locally and particularly in the downstream single thread sections where there are more local gravel sources. The stream section of the unit at the downstream end is considered to be a transporting reach to the Stock Water, as a result of the confined floodplain (Figure 1-8) and relatively steep gradient. Therefore, significant stores of gravels are unlikely to be seen in this section, even under restored conditions.

There are no natural woody debris features along the channel due to the surrounding vegetation type in the middle and upper reaches. 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 multi-branched / spreading networks that will improve floodplain connectivity / wetting.

Existing restoration measures to raise water levels within the mire section use heather bailing across the channel to provide an impoundment. These are currently in a reasonable condition but may be prone to deterioration in the longer term (Figure 1-11). Woody debris jams could be used to manage the incision in the downstream single thread reaches as these would naturally occur in the wooded riparian corridor in this area.

Figure 1-11: Heather bailing restoration measure

The artificial drains along the road (Figure 1-12) do impact the natural flow routes through the SSSI unit (from upstream to downstream), often concentrating flows at certain points into the surrounding drainage network. There is no evidence of this causing significant incision at present, although this may be a risk in the longer term. The structure that conveys flow underneath the road (believe to be a small pipe) results in ponding of water upstream of the road due to the backwater effects of the structure and limited conveyance capacity (Figure 1-13).

Figure 1-12: Road drains concentrating flows into the SSSI unit

Figure 1-13: Ponding upstream of the road

1.3 Probable channel development

The channel in the middle and upper reaches is presently relatively stable as a result of limited incision, straightening, embanking and good floodplain connectivity. This is assisted by the presence of the heather bailing restoration measure.

Incision is a continuing process in the downstream single thread reach and threatens to migrate further upstream if not managed. This would threaten the mire areas of this unit through bed and water level lowering, groundwater lowering and consequential floodplain drying. The minor incision knickpoint downstream of the heather bailing in the mire section of the unit should be mitigated as part of the restoration works as this could also migrate further upstream.

Otherwise, in the middle and upper reaches, current processes are likely to promote further silt deposition (some of which will be flushed through during higher flows) that could lead to bed raising in the long term. 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. It is unlikely the nature and distribution of existing features will change significantly over the next decades due to the generally low energy conditions in the upper and middle reaches. The modifications to the drainage network, particularly along the road, may pose a long term risk of incision.

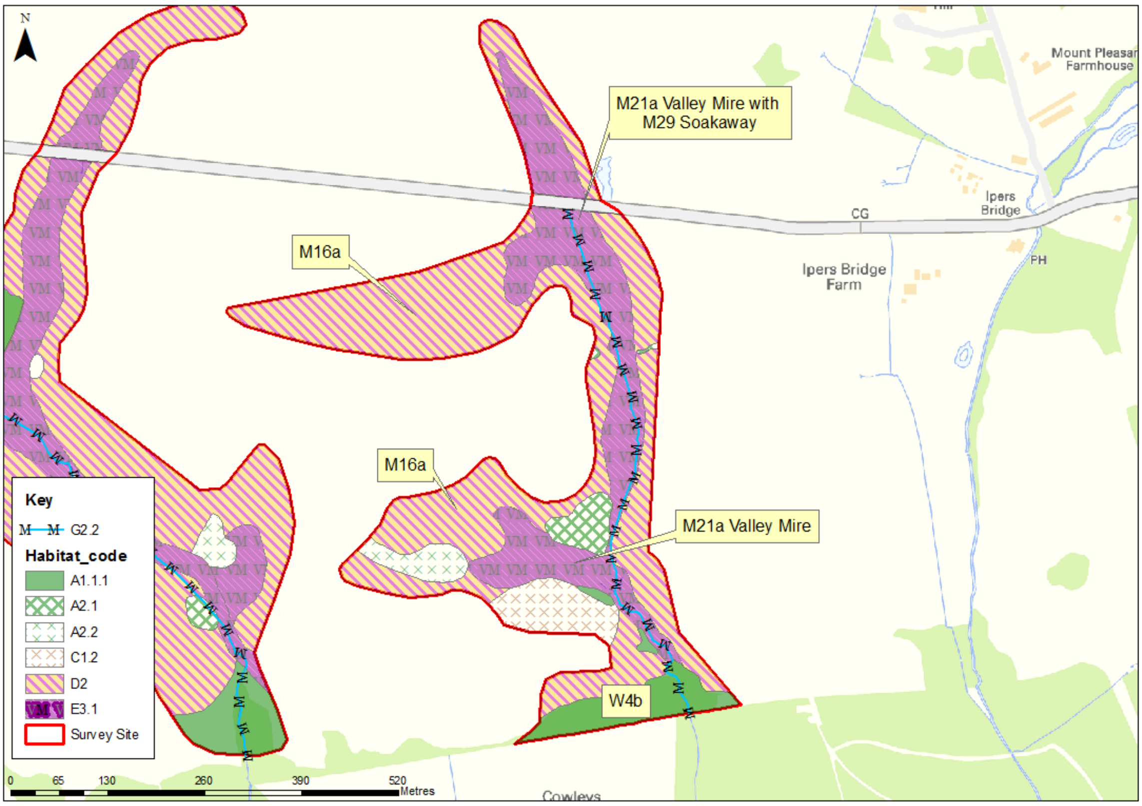
1.4 Current ecological conditions

The unit consists of valley mire which is dominated by Purple Moor-grass *Molinia caerulea* with abundant Cross-leaved Heath *Erica tetralix* and Bog Myrtle *Myrica gale* (M25a). In the wetter areas, White Beak-sedge *Rhynchospora alba* and Deergrass *Trichosporum germanicum* were noted (M21a). The valley mire grades into wet heath, moving away from the central valley bottom, with Cross-leaved Heath more abundant and Heather *Calluna vulgaris* (M16a) also present. Within the wet heath there are patches of Gorse dominated scrub (W23), and scattered Bracken (W25).

The channel, at the time of the survey, was flooded due to the prolonged wet weather preceding the site visit. Vegetation within the channel consisted predominantly of Bog Pondweed *Potamogeton polygonifolius*, Floating Sweet-grass *Glyceria fluitans*, Marsh St John's-wort *Hypericum elodes* and Water-starwort *Callitriche* sp. (M29).

Figure 1-14 shows the Phase 1 Habitat Map for Unit 422.

Figure 1-14: Phase 1 Habitat Map



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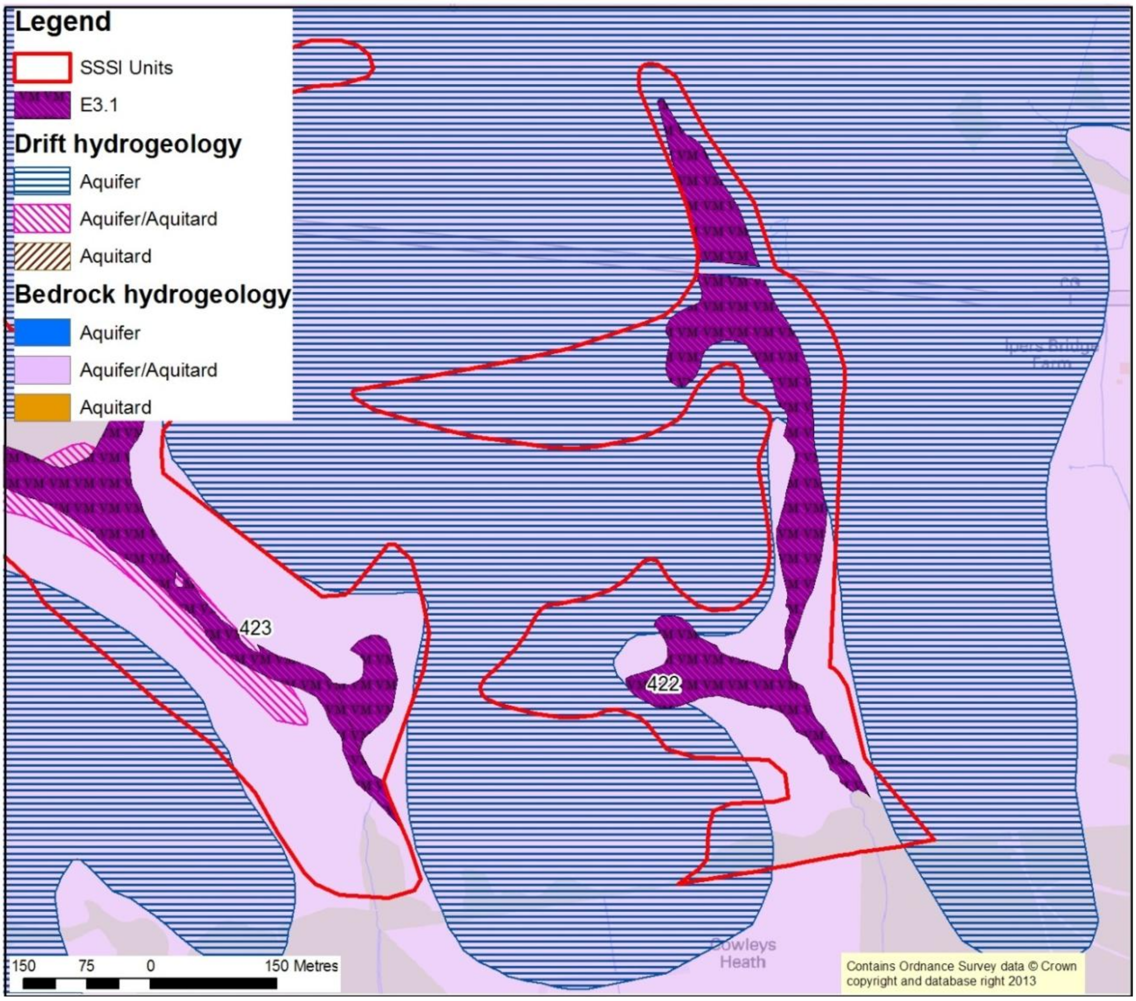
1.5 Ecohydrology

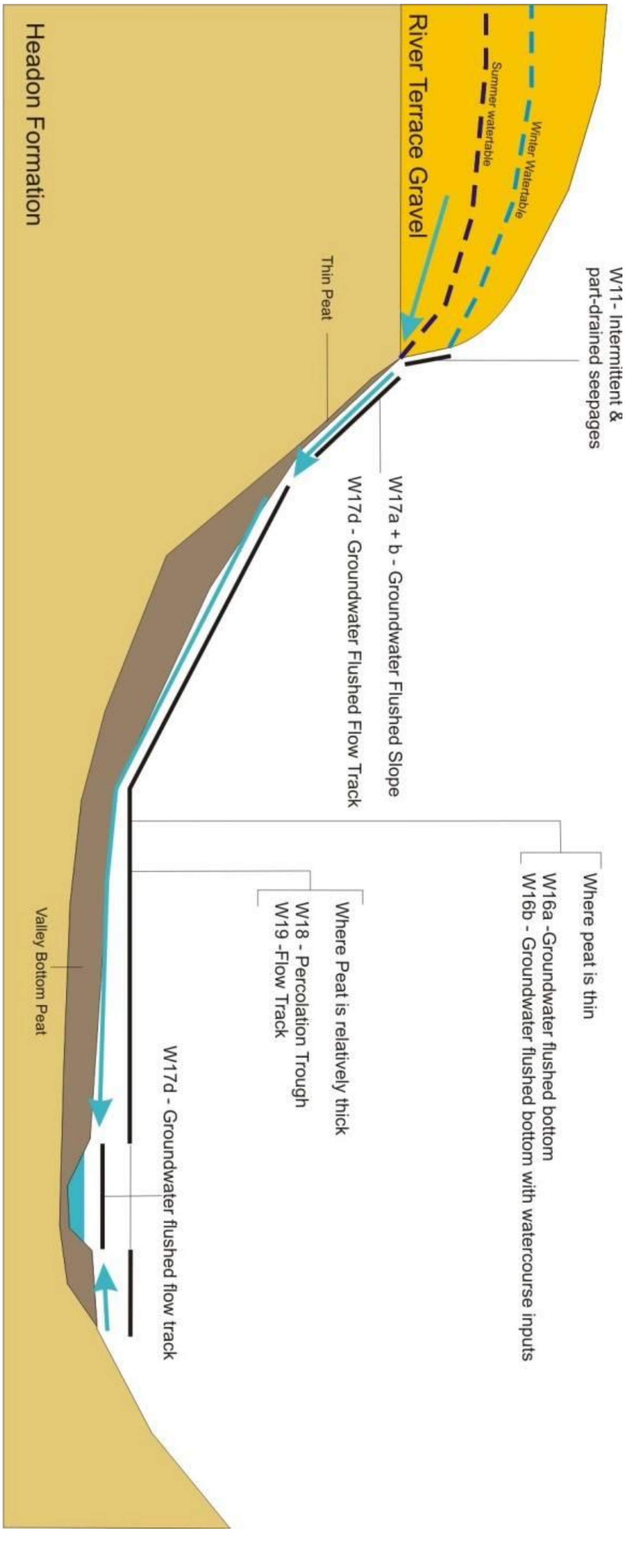
The site is underlain by the Headon Formation which BGS borehole logs (available online) show is locally formed from Clay (likely to act as an aquitard). The plateau above and surrounding the mires is covered by river terrace deposits which are formed of sandy gravels (likely to act as an aquifer). The mires are likely to be flush dominated, supported by a seepage face at the junction between the river terrace gravels and Headon Formation.

Figure 1-15: Ecohydrology Map



Derived from 1:50,000 scale BGS Digital Data under Licence, DEFRA IPR/139-2DY British Geological Survey. ©NERC.

Figure 1-16: Ecohydrology Conceptual Model



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 1-17.

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

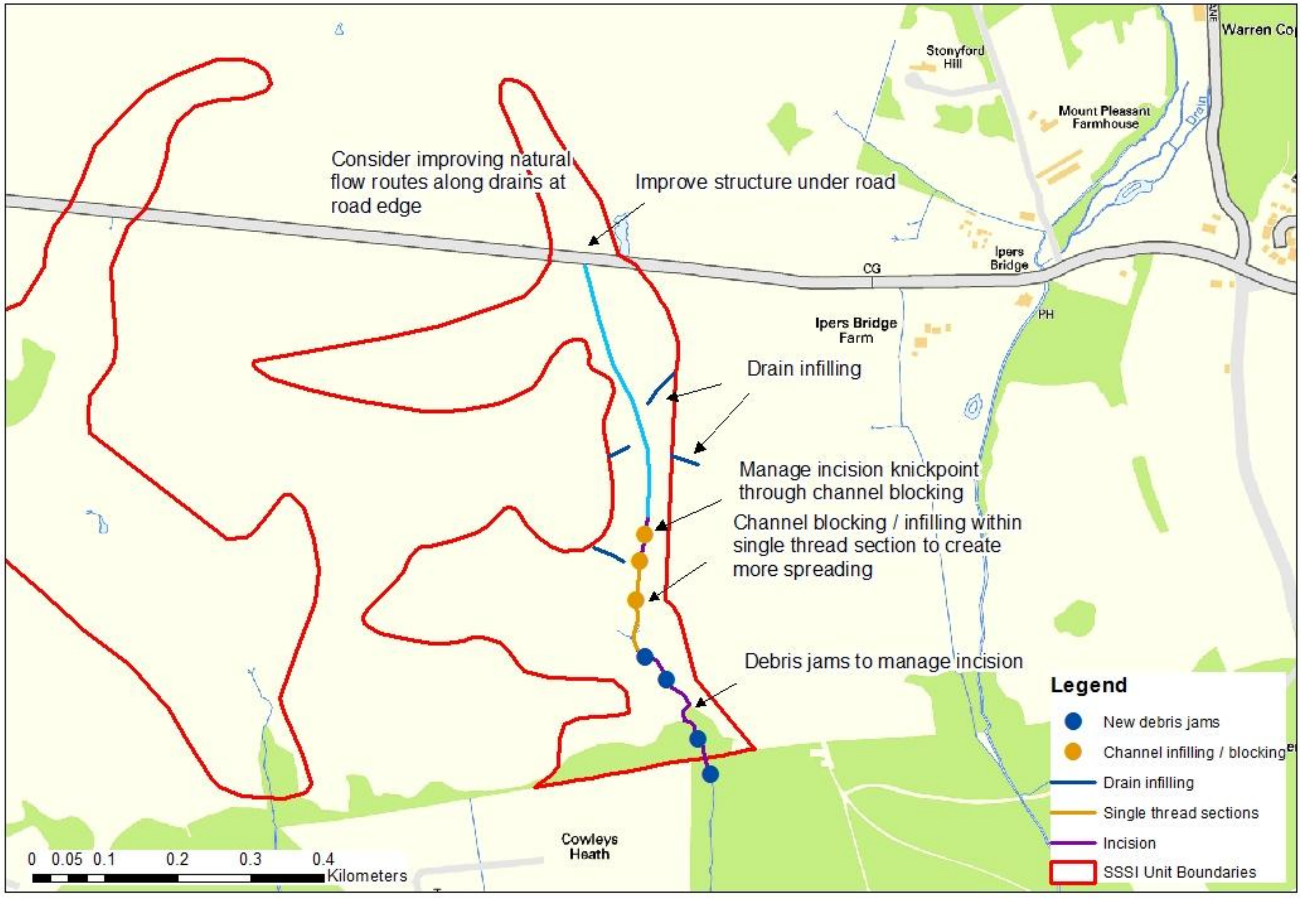
- Bed and water level raising through channel infilling and blocking to create more diffuse flow path spreading sections of channel (where it is currently more single thread) and to improve floodplain diversity;
- Water level raising will improve groundwater levels locally, (linked to channel infilling above);
- Natural flow regime reinstated as a result of artificial drain infilling
- Natural flow hydraulics reinstated following improved conveyance underneath the road;
- Incision management in the downstream single thread reaches will raise bed and water levels. This will also manage the risk of incision propagation upstream into the mire areas;
- Improved extent and quality of valley mire habitat.

Table 1-2: SSSI Unit 422 proposed restoration measures

Pressure	Impact	Restoration proposal	Hydromorphic improvement	Ecological improvement	Constraints / issues
Historic dredging Straightening - in downstream reach	Long term river response, cut and fill activity. Enhanced in-channel energy levels. Disconnected sub-channels. Loss of in-channel features. Incision knickpoint	Incision management - debris jams, morphological restoration, floodplain works. Infill. Restore connectivity. Manage incision knickpoint through either debris jams, wooden dams and/or heather bailing.	Improving connection to the floodplain will improve in-channel hydromorphic condition and will reduce incision. Debris jams would naturally occur along the downstream reach, use local materials. Morphological enhancement to raise bed and water levels will help improve floodplain connectivity. Reduces fine sediment inputs. Slows gravel movement (although this should not starve downstream reaches of sediment).	Reductions in incision will allow the water table to rise in the riparian zone thus preserving the mire habitats and improving connectivity between these and the main channel. Gravels will become colonised by seral vegetation communities increasing the habitat diversity.	Debris jams may form a barrier to fish, however, a fish pass should not be required. Large amounts of material are likely to be required. Cultural objections Cost
Artificial drainage	High flows impacted. Sediment transfer impacted. Water table lowered locally.	Artificial drain infilling.	Restore a natural flow and sediment regime. Reduces flood peaks.	Create a more dynamic wandering channel with numerous sub-channels that can be colonised by wetland species. This will encourage the development of riparian woodland (W1) and associated mire systems (M25a, M21a)	May require import of material with the concomitant risk of introducing invasive species
Floodplain drying	Reduction in wetland habitat (quality and quantity)	Channel blocking using berms and channel infilling - particularly where there is a minor incision knickpoint in the mire section of this unit	Further multi-branch / spreading sections. Improved floodplain connectivity / wetting.	Improve quality and extent of surrounding valley mire by reconnecting the floodplain directly with the stream allowing it to	May require import of material and risk of imported, unwanted species. Cultural objections

Pressure	Impact	Restoration proposal	Hydromorphic improvement	Ecological improvement	Constraints / issues
				over-top more regularly adding nutrients and propagules to the riparian zone.	Loss of grazing
River Crossings - road structures	Natural flow path disruption.	Replace with more suitable structures e.g. larger capacity, concrete circular culverts Fence structures	Reinstates natural flow routes / paths Reduce fine sediment input	Improve quality of surrounding valley mire Prevent overgrazing and poaching in vicinity of structure	Structures will need to be fit for the purposes of vehicle crossings Culturally unacceptable
Riparian grazing	Fine sediment production. Disruption to woody species recruitment.	Exclude livestock	Encourages riparian hydromorphic diversity	Increased floristic diversity of ground flora on floodplain. Recovery of poached areas and overgrazed vegetation	Some grazing is likely to be maintained. Loss of grazing Culturally unacceptable

Figure 1-17: Proposed restoration measures for SSSI Unit 422



1.7 Design considerations

The current hydromorphic condition of the channel 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 associated to a wetter environment in the upper and middle reaches. The downstream incision needs to be managed to ensure this does not propagate further upstream, as does the minor incision knickpoint within the mire section of this unit.

Channel infilling / blocking should use measures suitable to existing conditions. Heather bale dams have been tried previously elsewhere but have failed progressively due to undercutting and outflanking in these steep, high energy systems. 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.

Monitoring of the condition of the existing heather bailing restoration should be undertaken.

Woody debris jams must extend into the adjacent banks to ensure longer term functioning.

Targeted restoration of natural drainage paths should refer to Appendix A and Figure 1-5.

An engineering assessment would be required for modification to any structures under the road.

1.8 Restored channel and monitoring requirements

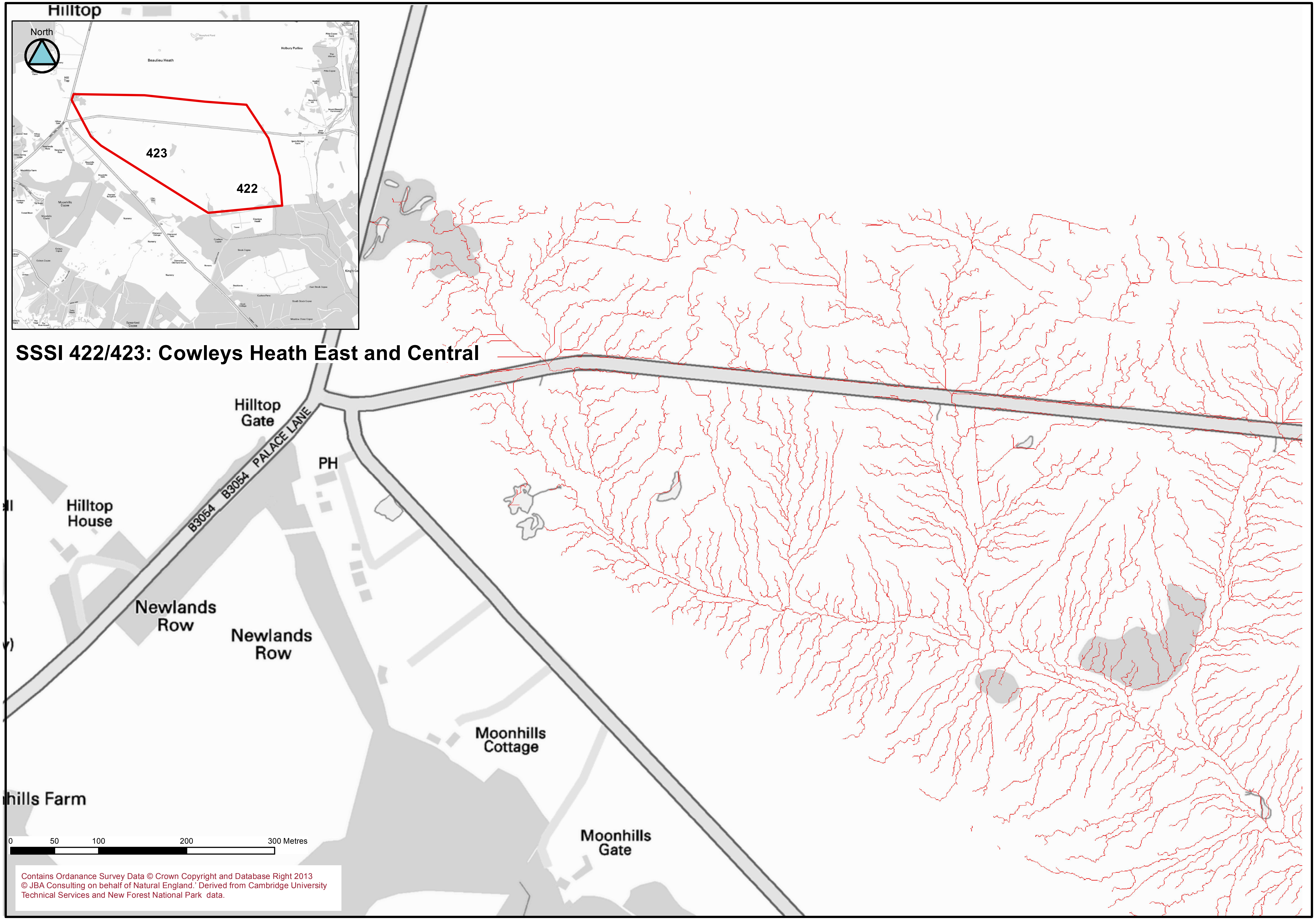
It is anticipated that the proposed restoration works will improve floodplain connectivity. Morphologic change is likely to involve bed raising and the creation / improvement of a multi-branched / spreading channel network. This pattern of development is difficult to document accurately due to the complex nature of the river network and the difficult surveying conditions. 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.

Table 1-3: Monitoring parameters, frequency and suggested approaches for the Unit 422.

<table>
<tr><th>Parameter</th><th>Approach</th><th>Frequency</th><th>Approximate cost</th></tr>
<tr><td>Morphologic unit change</td><td>Time lapse camera / audit</td><td>Daily (Annual statistical summary)</td><td rowspan="4">Capital 3 x £200
Half yearly downloading £200
Annual summary £300
Two - yearly reconnaissance audit £500</td></tr>
<tr><td>Flow change</td><td>Time lapse camera / audit</td><td>Daily (Annual statistical summary)</td></tr>
<tr><td>Sedimentology</td><td>Time lapse camera / audit</td><td>Daily (Annual statistical summary)</td></tr>
<tr><td rowspan="3">Vegetation change</td><td>Fixed point camera survey</td><td>Biennially</td></tr>
<tr><td>Fixed point quadrat survey</td><td rowspan="2">Biennially</td><td rowspan="2">Survey £350
Analysis £500</td></tr>
<tr><td>Fixed point</td></tr>
</table>

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

Appendix A - Artificial drains and flow lines - SSSI Unit 422



SSSI 422/423: Cowleys Heath East and Central

SSSI 422/423: Cowleys Heath East and Central