Clifton Ings Barrier Bank – SSSI Mitigation Strategy

Version 3:0 **Date: May 2020**

Contents

1. Introduction

1.1. Background

Clifton Ings and Rawcliffe Meadows was designated as a Site of Special Scientific Interest (SSSI) in 2013. It is a nationally important site for species rich neutral grassland, in particular British National Vegetation Classification (NVC) types MG4 and MG8; and the critically endangered tansy beetle.

The SSSI is located within the Clifton Ings flood storage area. This Environment Agency operated offline flood attenuation reservoir is defined by embankments immediately adjacent to the River Ouse (Foreshore Bank) and along the inland margin of the Ings (Barrier Bank). As part of the wider York Flood Alleviation Scheme, improvement works are proposed to the Barrier Bank to improve the standard of flood protection to houses in York.

The proposed works to the Barrier Bank include raising the height, and consequently the footprint, of the embankment. Throughout the options appraisal and design process all reasonable efforts have been made to minimise the impact on the SSSI. However there will be residual impacts on the SSSI, i.e. loss of predominately MG4 grassland adjacent to the current Barrier Bank due to an increased bank footprint and construction works.

1.2. Purpose of this report

This document presents a mitigation strategy for the area of species rich neutral grassland (classified as MG4 grassland using the NVC methodology) which is considered to be impacted (directly and indirectly) by the proposed improvement works to Clifton Ings Barrier Bank.

In developing this strategy the Floodplain Meadows Partnership (FMP) has been consulted to enable their expertise to inform the methodology. The FMP will be involved throughout the development of the mitigation methodology and in future monitoring and reviews to ensure best practice is followed and knowledge is shared.

This report forms an addendum to the Environmental Statement (ES) as part of the Environmental Impact Assessment (EIA) for the scheme and therefore further information on the appraisal process and environmental assessment can be found in these documents.

It should be noted that additional mitigation for the temporary/restorable loss within the SSSI and the wider scheme, including beyond the area of the SSSI, (temporary and permanent) is presented within the main ES.

A separate Tansy Beetle mitigation strategy will be produced as required by Condition 6. Impacts on the Tansy Beetle community and habitat have been assessed to be minimal as the main areas of habitat will be avoided (See Environmental Statement for further detail).

1.3. Advisory Board

Under Condition 7 of application 19/00007/FULM, the Clifton Ings Advisory Board was set up to discuss and agree the strategies and plans related to the SSSI.

The Advisory Board comprises of representatives from the EA, Natural England, CYC, Floodplain Meadow Partnership, Jacobs and the FoRM. FoRM have not attended the meetings or provided any comments on this document.

The third version of the document was issued to the Advisory Board in advance of the meeting on 16th April 2020. The contents of this document was discussed at the Advisory Board meeting. Comments were received from CYC and NE and the latest version has been updated to incorporate those comments.

1.4. MG4 grassland community

MG4 is the designation given to the community of species characteristic of unimproved neutral floodplain meadow grassland under the British NVC system. Floodplain meadows of this type have high species diversity and are characterised by the presence of species such as Greater Burnet (*Sanguisorba officinalis*) and Meadow Foxtail (*Alopecurus pratensis*).

Winter-flooded hay meadows (such as Clifton Ings) are a characteristic feature of the Derwent and Ouse flood plains, with York holding around 8% of the nationally scarce MG4 grassland resource (City of York, 2017). These meadows have a long history of traditional management which has resulted in the species communities present today. This traditional management involves a mid-summer hay crop followed by late summer and autumn "aftermath" grazing (Hammond, 1995). Continuation of this management regime is crucial to the future existence of these habitats.

2. Scheme impacts

2.1. Area of SSSI impacted

The improvements to the Barrier Bank will involve a number of components that will have varying impacts on the SSSI. These components are described below and summarised in Appendix 1.

Embankment

The Barrier Bank improvements will involve raising of the current embankment this will be achieved through a combination of wet side and dry side widening. Where wet side widening is required within the SSSI area this will result in a permanent loss of designated grassland. An updated National Vegetation Classification (NVC) survey was carried out in 2017 (Wallace, 2017) this identifies the majority of grassland to be impacted on the wet side of the Barrier Bank to be of MG4 type (Figure 1). Therefore the mitigation proposed for this loss will focus solely on recreating MG4 grassland.

It has been agreed with Natural England that an appropriate ratio for the area grassland to be created in mitigation for this loss is 1:4 i.e. for every one square metre of SSSI MG4 habitat lost 4 will be created elsewhere.

However, during the development of this scheme a draft version of the new Defra metric for biodiversity net gain was released. We recognise the ambition of this update and the aims to create viable habitat of a similar quality with an overall net gain in biodiversity. The opportunities for further improvement to the existing SSSI and the potential to deliver additional mitigation beyond the 4.8ha calculated under the 1:4 ratio are discussed further in section 3.2.

Based on the precautionary EIA assumptions it was determined that up to 1.2 hectares of SSSI MG4 habitat would be lost as a result of the works. Applying the 1:4 ratio therefore requires 4.8ha of MG4 grassland to be restored elsewhere. Recent amendments to the

design have reduced the area of loss to approximately 0.9ha however it is proposed to still deliver 4.8ha of mitigation for loss associated with embankment works.

The area of calculated loss is based upon the increased footprint of the bank and does not include the slope of the embankment. Although the embankment itself is included within the SSSI the habitat value of the wet side sloping face is poor compared to the rest of Rawcliffe Meadows due to the relatively recent construction of the bank (1980s) and the required maintenance of the asset. Therefore it has not been included in the calculation of loss. Individual plants of value will be identified and translocated prior to the embankment face being stripped, this is included in the SSSI Restoration and Compensatory Habitat Management Plan.

Additionally the scheme will include extensions to the embankment to the north through the "cornfield" and Rawcliffe Bar Country Park and to the south through Homestead Park. These will have no impact on the SSSI.

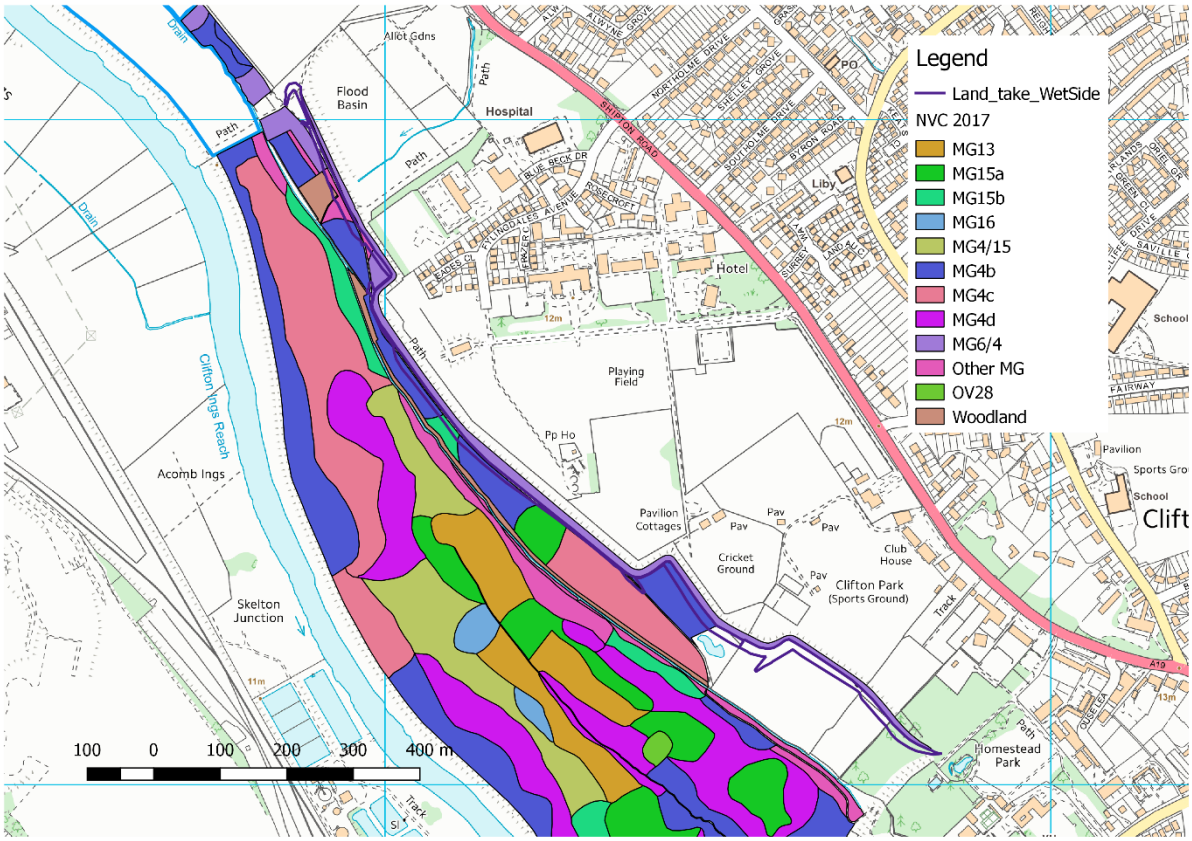

Figure 1. Map of Clifton and Rawcliffe 2017 NVC data with estimated area of wet side land take indicated (Rothero, 2019).

Blue Beck pumping station

A pumping station will be installed in the western corner of the Blue Beck flood basin. The pumping station will be located within the flood embankment with associated access and kiosk on top of the embankment. There will also be some in-channel works to blue beck immediately downstream of the culvert under the embankment to provide scour protection.

The outfall works associated with the pumping station will require stripping turf from the SSSI area impacted and re-instating it afterwards. This will be completed in line with the turf

translocation methodology (Appendix 3) and the turf stripped will be stored appropriately until it can be replaced.

Access route and working areas

To enable the works to the embankment an access route will be required from the compound in the cornfield along the length of the embankment. This equates to a 1.15km length though the SSSI. The ES assumes a worst case scenario of an 8m wide route throughout. However this has been reduced during detailed design and the access track route has mostly been incorporated within the footprint of the new embankment rather than alongside it therefore mitigating the loss to 0.9ha of the SSSI.

Prior to the construction of the working areas top soil will be removed and stored. This will allow the top soil (and seed bank) to be replaced post construction; furthermore the restored areas will be spread with green hay to promote re-establishment of target grassland species.

However the construction of the working areas will still result in significant impacts to the SSSI due to compaction of the sub soil and damage to the top soil structure. Due to the length of time this is likely to take to recover (10+yrs) this has been assessed as a permanent loss of SSSI.

Measures to mitigate compaction of soil from working areas within the SSSI will be included in the construction contractor's detailed method statements and any stockpile locations will be either outside of the SSSI (e.g. Cornfield) or will be included within the area assessed for the access and working areas. Therefore there will be no additional impact.

As restoration of the access route and working areas can take place in situ post construction a compensatory mitigation ratio of 1:1 is proposed. Based on the current assumptions of area to be lost this would result in up to 0.9ha of mitigation to be delivered in addition to the in situ restoration.

Toe drain

As part of the improvement works to the embankment a drain is to be installed along the wet side toe for the length of the embankment, this will allow better drainage of the embankment face and prevent slippage. Allowance for this has been included in the calculations of loss for the footprint of the embankment described above, therefore no further mitigation is required.

Condition 3, Part C, of the Clifton Ings Barrier Bank Planning Permission (19/00007/FULM) states that measures to mitigate the installation of the toe drain along the foot of the flood bank are to be included in the SSSI Mitigation Strategy. There was a discussion at the Advisory Board whether the toe drain could support the hydrology of the meadow however it was confirmed the toe drain will be designed to support drainage of the barrier bank and will be sealed to prevent access of surface water. Therefore there will be no detrimental impact on hydrology within the SSSI.

Drainage into Ings Dyke

In addition to the toe drain four drains will be required from the toe drain into Ings Dyke, crossing the SSSI. Installation of these will involve burial of a pipe drain perpendicular from the toe drain, across the SSSI to discharge into Ings Dyke. Turves from the surface will be removed, the pipe buried to a depth so as not to have an impact on root structures and the turves replaced. Turves will not be stored.

The impact associated with installation of these drains is assessed to be temporary and therefore no compensatory mitigation is required.

Sustrans route diversion

It is proposed to permanently relocate the Sustrans route from within Rawcliffe Meadows to the western bank of Ings Dyke along the route of an existing footpath within Clifton Ings. The majority of the old route will be removed from Rawcliffe Meadows. A short section of tarmac will be retained adjacent to the Tansy pond to facilitate access for maintenance.

The proposed new route is still within the SSSI however the new location is described as "other MG" in the 2017 NVC survey and has a lower habitat value than Rawcliffe Meadows (pers comms, Emma Leighton, Natural England). Although this new location will result in the permanent loss of SSSI which would have had the potential to improve in habitat value in the future. It will also result in an improvement to Rawcliffe Meadows by increasing the area available for development of floodplain meadow grassland and removing pressure from cyclists and pedestrians.

As the proposed relocation of the Sustrans route will allow for improvement within Rawcliffe Meadows it is proposed that removal of the majority of the old route and a 1:1 ratio of compensatory mitigation for the new route in Clifton Ings is sufficient to mitigate for this impact.

Stockpile locations

No stockpiles will be located within the SSSI beyond what is included within the working areas assessed in combination with the access route therefore no compensatory mitigation is required.

Changes in site hydrology

The current concerns over the stability of the Barrier Bank have meant the draw down rate has had to be reduced. This increased inundation period in times of reservoir operation will be detrimental to the SSSI. The improvements to the Barrier Bank proposed will enable the drawdown rate to be returned to standard operating rates therefore reducing the inundation period of the SSSI. Therefore there will be an improvement to the site hydrology.

Summary of compensatory mitigation required

Table 1 provides a summary of the areas of compensatory habitat required to mitigate for the losses to the SSSI described above.

Table 1 Summary of areas of SSSI permanently lost, proposed mitigation ratio and area of mitigation to be delivered.

	Area of SSSI permanently lost	**Mitigation ratio used**	**Area of compensatory mitigation to be delivered**
Embankment	0.9ha	1:4	4.8ha (based on earlier assumed area of loss of 1.2ha)
Access route and working areas	0.9ha	1:1	0.9ha (additional to restoration of SSSI post construction)
Sustrans route	0.3ha	1:1	0.3ha (additional to removal and restoration of old route)

	Total area of compensatory mitigation to be delivered	6ha

2.2. Areas identified for delivery of mitigation

It is proposed to use the area of land within Rawcliffe Ings to the north west of Clifton Ings and Rawcliffe Meadows SSSI to deliver mitigation for the area of SSSI MG4 habitat lost as a result of the Barrier Bank improvement works (Figure 2). This area is currently rough grazing with a seasonal grazing lease. The area is easily accessible from the proposed site compound and will result in minimal additional disturbance.

The area can be effectively divided into five zones (A-E) based on site boundary features (Figure 2 inset), these vary in size from 0.5ha to 4ha with a total of approximately 12ha. The suitability of these areas depends on their elevation, frequency of inundation and nutrient conditions (discussed further below).

Additionally, from discussions with Natural England, Friends of Rawcliffe Meadows and the Floodplain Meadows Partnership it has been identified that improving the drainage from Clifton Ings and Rawcliffe Ings into Ings Dyke would have potentially significant benefits to the floodplain meadow grassland within this area. Works in this area would need to be planned to not cause any detrimental impact to the surrounding SSSI and would be subject to landowner agreement.

Figure 2 Areas identified with potential for delivery of grassland restoration as mitigations for SSSI loss (blue shading)

Figure 3 Proposed grassland restoration site Zone C viewed from north east corner

3. Floodplain Meadows Partnership advice for restoration

Natural England have advised that the MG4 grassland due to be permanently lost should be preserved by turf stripping 1m^2 blocks to approximately 0.3m depth in order to maintain species assemblage and top soil structure. These turves should be translocated to an appropriate receptor site. Turf stripping should be undertaken in accordance with best practice as described in "Habitat translocation, a best practise guide" (Anderson, 2003).

The Floodplain Meadows Partnership have been commissioned by the Environment Agency to provide a literature review outlining grassland translocation policy and methods in the UK in relation to this project, and to collect and interpret information on soil fertility of the mitigation areas to determine suitability (Floodplain Meadows Partnership, 2018) (Appendix 2).

In their report the FMP state:

"…habitat translocation is not an acceptable alternative to maintaining habitats in situ, that evidence shows that the intrinsic value of habitats is not retained after translocation and that translocation should not substitute in-situ conservation. Habitat translocation should not be seen as mitigation for loss through development, and may only be able to offer partial compensation, as many examples of habitat translocation clearly show changes in the final habitat achieved."

"In the context of Rawcliffe Meadow, turf survival would be a sensible objective if any translocation is to be pursued, with the aim of rescuing turves that would otherwise be lost. Mitigation may be achieved, but there are few examples in the literature where a wet grassland has been translocated successfully. Therefore, mitigation should primarily be sought by following other methods (e.g. green hay/seed spreading/plug planting etc) on adjacent sites, with turf translocation viewed as a logical way to use the turves to maximise the potential for them to be maintained."

It is therefore proposed to translocate the MG4 turves that would otherwise be permanently lost under the increased footprint of the embankment. The additional area required to compensate for habitat loss will be delivered by other restoration methods such as green hay, seed spreading, plug planting.

3.1. MG4 turf translocation

Best practice for turf translocation is described in detail in the FMP report (2018) and is summarised below.

Similarity between donor and receptor sites

Features including aspect, slope, soil drainage, soil nutrient status and hydrology need to be as similar as possible. Initial investigations undertaken at the potential mitigation delivery sites within Rawcliffe Ings indicate that the soil nutrient conditions are within the ideal range for restoration with sites A, B and D (Figure 2) being more similar to the conditions within Rawcliffe Meadows.

FMP have recommended that further investigations are undertaken to compare soil-water depths, porosity and soil structure between the donor and potential receptor sites. These results will be used to further refine where translocation may be most successful.

Translocation technique

Turf translocation is the recommended method for translocating grasslands. There are a number of critical points identified by FMP which increase the likelihood of success:

- Do not store turves, move them on the same day to avoid desiccation of the sward and changes to the soil nutrient composition.
- Move turves as thick and as large as possible. Translocating sub-soil may be considered, but it is not recommended to move thin turves.
- Lay turves in same arrangement and position as originally. Lay them tightly together to avoid gaps, press down on each turf with the bucket, and roll after they have been laid to ensure contact with sub-soil and to remove air gaps. Fill in gaps with soil from receptor site and consider grazing after rolling to increase contact between turves and sub-soil, and reduce gaps.
- In the case of a community as hydrologically sensitive as MG4, pressing on turves with the bucket and rolling the turves is only acceptable in dry conditions, if the soil moisture is above the plastic limit of the soil then compaction is liable to occur, compromising the soil's structure and potential to support more species rich grassland in the medium to long term.
- Machinery needs to be appropriate. The 'Translocating wildlife habitats; a guide for civil engineers' (Box and Stanhope, 2010) recommends the use of low ground pressure tyres and large buckets to maximise the size of the turves that can be removed in one go.

- Timing of translocation. Timing needs to be considered so the grassland is not actively growing and the sward is short. Best time is probably Feb/March if conditions are dry enough, or early autumn, after a hay cut and grazing, when soil is still sufficiently dry to avoid compaction and associated damage to soil structure.
- Work on a rolling method, re-profile one section and place turves from a previous section straight away.

These points are included in the Turf Translocation Methodology document included in Appendix 3 prepared by the Environment Agency to detail how the Clifton Ings Barrier Bank MG4 turf translocation process will take place.

Post translocation habitat management

The FMP state that translocation will not be successful unless post translocation management can be guaranteed as an annual hay cut and aftermath grazing, in a similar regime to that of Rawcliffe currently.

Evaluation

Given the long time periods required for a restored floodplain meadow to establish (10+yrs) monitoring and evaluation is vital to ensure objectives are achieves and management adapted accordingly.

FMP have recommended the following evaluations be undertaken at Rawcliffe Meadow include (for both translocation receptor and donor sites):

- NVC survey as a baseline (before translocation), and then 5 years and 10 years post translocation.
- Repeatable botanical monitoring quadrats, monitored before work starts then annually for five years to guide post translocation management.
- Invertebrate surveys as a baseline and then 5 and 10 years post translocation
- Recording of soil-water levels in mitigation sites if dipwells are installed.
- Re-survey of soil phosphorus levels 5 and 10 years post translocation.

These measures have been incorporated into the SSSI Restoration and Compensatory Habitat Management Plan (RCHMP) prepared by the Environment Agency, management and monitoring instructions are detailed in Section 4.4.3 Rawcliffe Meadows.

3.2. Floodplain meadow restoration

Due to the requirement to restore a greater area than that which is lost turf translocation will be accompanied by additional methods of flood plain grassland restoration.

The work done to date by the FMP shows all possible mitigation zones (A-E) show very good potential in terms of soil fertility, for restoration, through a range of different techniques which could include change of management from pasture to hay, combined with various techniques for seed transfer (green hay/seed/plug planting etc.). It is recommended that a mixture of techniques would be desirable across all fields identified if this were feasible.

Within Rawcliffe Ings areas A-E (Figure 2) offer approximately 12ha of Environment Agency owned land that could contribute to the compensatory mitigation for the scheme. There is the potential to change the management of the whole of this area to encourage and support the development of floodplain meadow grassland, (contributing above and beyond the required 6.2ha of compensatory mitigation). However, it needs to be recognised that this would

restrict the potential for future mitigation, should this be required, for works to the Foreshore Bank.

If management is changed on the whole of Rawcliffe Ings it would be considered that the Clifton Ings Barrier Bank scheme had delivered, in part, to any future mitigation required for Foreshore works. Any additional mitigation required would focus on further improvement of this area, based on evidence from monitoring carried out as part of this scheme, rather than creation of additional floodplain meadow habitat elsewhere unless necessary due scale of mitigation required.

Management change

The management regime is crucial to the existence of floodplain meadow grassland therefore getting the right management on the site is a key objective. The Floodplain Meadows Partnership define the following management objectives as required to maintain and conserve floodplain meadows:

- An annual hay cut in late June or early July;
- Livestock grazing to remove the re-growth of grass from August through to early spring, or until the site becomes too wet;
- Management of hedgerows to prevent encroachment of scrub;
- Maintenance of grazing infrastructure such as fencing, stock handling and drinking points;
- Control of weeds or undesirable species such as ragwort, sedges and creeping thistle;
- Maintenance of ditches, gutters and surface drains.

At present Rawcliffe Ings is used for grazing cattle throughout much of the year. Given that the initial analyses suggest favourable conditions for floodplain meadow development changing the management to that described above should have a significant effect. Some initial treatment of the site is likely to be required to remove undesirable species such as Creeping Thistle.

These measures have been incorporated into the SSSI Restoration and Conservation Habitat Management Plan (RCHMP) prepared by the Environment Agency, management and monitoring instructions are detailed in Section 4.1 Grassland and Meadow Management and Section 5 Injurious and Invasive Non-Native Species Control.

Other restoration techniques

FMP advise that once the site characteristics are appropriate it may be necessary to re-introduce specific target species in addition to the general restoration techniques described. This is because some of the key MG4 species within the community are not known to appear readily following the spreading of green hay or locally sourced seed. To enable species-rich grassland to become established, sward disturbance is initially required to create a short sward and 50% bare ground (Rothero et al, 2016). This can be achieved by cutting and removing the arisings and then creating bare ground either by grazing or machinery (e.g. power-harrowing).

Once the site is prepared there are a number of ways to re-introduce appropriate species:

- ***Spreading dry or green hay*** – green hay is thought to be more effective (Natural England 2010a) however FMP have also had success with dry hay (Rothero, pers comm). Green hay should be collected and spread on the same day. Natural

England (2010a) suggest hay collected from a 1ha site should be sufficient to spread on 3ha. It may be necessary to spread hay over several consecutive years before the desired species community develops. Standard farm machinery such as silage making equipment and muck spreaders can be used.
Friends of Rawcliffe Meadows have already had success with this method in the restoration of New Meadow adjacent to Rawcliffe Meadow; this was in combination with removal of the top soil to remove additional nutrients. However, guidance suggests receptor site preparation to achieve a short sward and 50% bare ground should be sufficient.
It is proposed that spreading of green hay would be the main method used at Rawcliffe Ings. This is detailed in Section 4.3.3 Rawcliffe Meadows and 4.4 Rawcliffe Ings of the SSSI Restoration and Conservation Habitat Management Plan (RCHMP).

- ***Sowing brush harvested seed from a nearby meadow*** – Brush harvesting requires specialised equipment and for the seed to be cleaned and stored, additionally low growing species are unlikely to be collected. This option should be considered where collection of green hay is not possible, or to supplement green hay spreading as an alternative restoration technique. This is detailed in Section 4.3.3 Rawcliffe Meadows and 4.4 Rawcliffe Ings of the SSSI Restoration and Conservation Habitat Management Plan (RCHMP).

- ***Hand collection of target species seed/plants*** – This method targets those species which are either less abundant or produce seed outside of the time hay is collected. Seed can then be dried and stored. When the site is ready for these seed can be propagated and introduced to the meadow either as plug plants or small plants.
  Prior to construction seed will have been collected from target species in Rawcliffe Meadows for three seasons (2018, 2019 and 2020). These will be grown on to plug/pot plant stage before being used on site once the mitigation area is prepared and at an appropriate stage.
  Individual, established desirable plants from the face of the bank due to be lost will also be translocated and dispersed throughout the restoration area. These may need to be appropriately stored before replanting to allow the receptor site to establish. This is detailed in Section 4.3.3 Rawcliffe Meadows and 4.4 Rawcliffe Ings of the SSSI Restoration and Conservation Habitat Management Plan (RCHMP).

- ***Clifton Ings enhancement –*** Subject to landowner agreement, undertaking management of the central drain and re-introducing drainage grips will aid the water movement and drainage of Clifton Ings where some areas of MG4 are currently beyond the limit of waterlogging tolerance. This would therefore improve conditions in the favour of the existing MG4. This is detailed in Section 4.3.1 Clifton Ings and 4.3.2 Clifton Ings Dyke of the SSSI Restoration and Conservation Habitat Management Plan (RCHMP).

4. Management

A restoration and Conservation Habitat and Landscape Management Plan for the SSSI areas has been produced prior to the scheme commencing and takes into account the detailed design, construction programme and the requirements set out in this strategy. The

Restoration and Conservation Habitat and Landscape plan provides further details on the following points:

- Timeline of mitigation works – to include pre mitigation site assessment and delivery of compensatory habitat.
- Management plan for the compensatory habitat during the scheme and post scheme.
- Responsibilities
- Monitoring plan post scheme.

Floodplain Meadows Partnership have been involved throughout and their advice and guidance has informed development of this plan.

References

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Appendix 1 – Summary of scheme impacts on MG4 grassland and proposed mitigation

Scheme component	Description of impact on SSSI	Area	Temporary / permanent impact	Proposed mitigation
Embankment	Raising of the current embankment will be achieved through a combination of wet side and dry side widening. Where wet side widening is necessary this will result in a loss of SSSI. The sloping face of the current embankment will also be permanently lost however this does not have the same interest value of the older meadow area	0.9ha (excluding sloping face) – Estimates presented in the ES (1.2ha) were for a worst case scenario. This estimate has now been recalculated, however there is potential for this to be reduced further. To calculate the area of mitigation required the worst case value will be used (i.e. 1.2ha)	Permanent	1:4 ratio of area lost to area of mitigation delivered agreed with NE however it is proposed to deliver a greater area of restored floodplain meadow to meet the ambitions of the draft Defra biodiversity metric. This will be achieved by: • Translocation of MG4 turves • Changing management of Rawcliffe Ings to traditional hay cut followed by aftermath grazing • Introduction of target species to Rawcliffe Ings through spreading of green hay and collected seed. • Specific areas of the slope with greater interest or individual plants will be identified and removed for translocation Delivery of mitigation will follow guidance given by the Floodplain Meadows Partnership described in section 3
Access route and working areas	The current design includes construction of an access road along the wet side of the embankment within the SSSI. The impact on the SSSI has been mitigated within the detailed design with the access route now mostly within the footprint of the new embankment.	0.9ha –reduced from 1.2ha at detailed design and construction planning. To calculate the area of mitigation required the value above will be used (i.e. 0.9ha)	Permanent	As in situ restoration of the SSSI is possible a compensatory mitigation ratio of 1:1 is proposed. Mitigation will include: *In situ* • Stripping and storage of the topsoil and replacement in situ post scheme following the remediation of compaction • Green hay spreading within the SSSI. *Rawcliffe Ings* • Changing management of Rawcliffe Ings to traditional hay cut followed by aftermath grazing • Introduction of target species to Rawcliffe Ings through spreading of green hay and collected seed/plants.
Toe drain installation	The toe drain will be designed to drain the sloping surface of the embankment.	Included within the footprint of the embankment.	N/A	None required
Drainage into Ings Dyke	Associated with the installation of the toe drain will be up to 4 buried pipe drains from the Toe drain to Ings Dyke. This will involve digging trenches across Rawcliffe meadows in which to bury the pipes.		Temporary	Where the drains cross the floodplain meadow turves will be removed with 300mm of topsoil to be replaced after the pipes have been put in place. Pipes will be buried to a suitable depth so not to impact on the root structure of the overlying vegetation. Appropriate machinery will be used so as to minimise compaction of the surrounding meadow.
Blue Beck pumping station	The pumps will be located within the improved embankment. A kiosk will be required however this will be located on the top of the new embankment.		N/A	None required
Sustrans route diversion	It is proposed to permanently move the Sustrans route from its current location in Rawcliffe Meadows to Clifton Ings along the route of an existing footpath on the western bank of Ings Dyke. This is still within the SSSI and will result in an additional loss of SSSI within Clifton Ings. Although this area is of lower habitat quality, permanent re-	Approximately 0.3ha	Permanent	As there will be a betterment to Rawcliffe meadows by removing cyclists and pedestrians from the area and creating and continuous area of meadow grassland a like for like area of mitigation is proposed. This will be delivered through: • Removal of the majority of the old Sustrans route, small sections may be left to facilitate access e.g. Tansy Pond.

	rerouting of the Sustrans route will prevent this area being improved in the future.			• Restoration of the remaining area of the old sustrans route through spreading of green hay and re-seeding. • Changing management of Rawcliffe Ings to traditional hay cut followed by aftermath grazing, green hay spreading/seeding.
Stockpile locations	Any stockpile locations will be either outside of the SSSI (e.g. Cornfield) or will be included within the area assessed for the access and working areas. Therefore there will be no additional impact.	N/A – located outside SSSI or included within area of access route and work areas.	N/A	None required
Changes in site hydrology	Improvements to the stability of the barrier will allow the normal drawdown rate to be achieved therefore draining the Ings of flood water quicker.		N/A	None required

Appendix 2

December 2018

Brief literature review of grassland translocation in the UK and policy summary

Rawcliffe Meadow, York

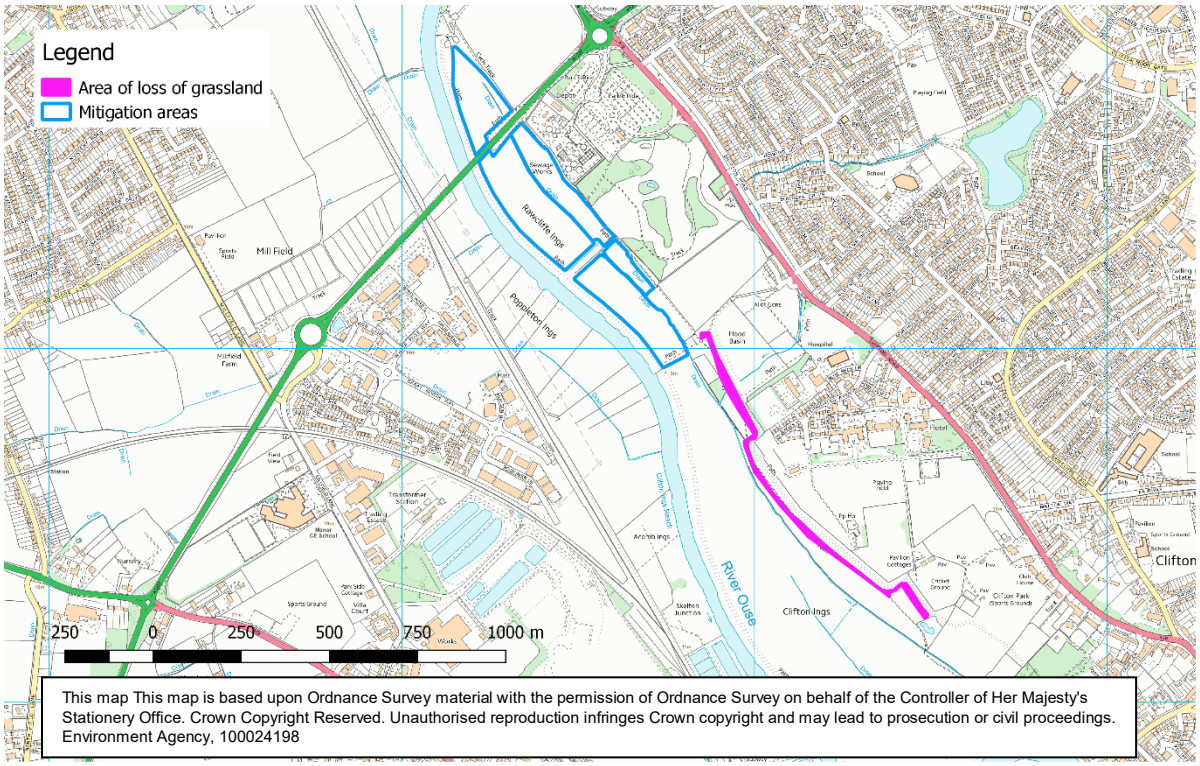
Mitigation project summary

The Clifton Ings Barrier Bank – SSSI Mitigation Strategy (Environment Agency 2018) has come about as a result of an Environmental Impact Assessment undertaken as part of Environment Agency flood defence works proposed on the Clifton Ings Barrier Bank, which is within the Clifton Ings and Rawcliffe SSSI.

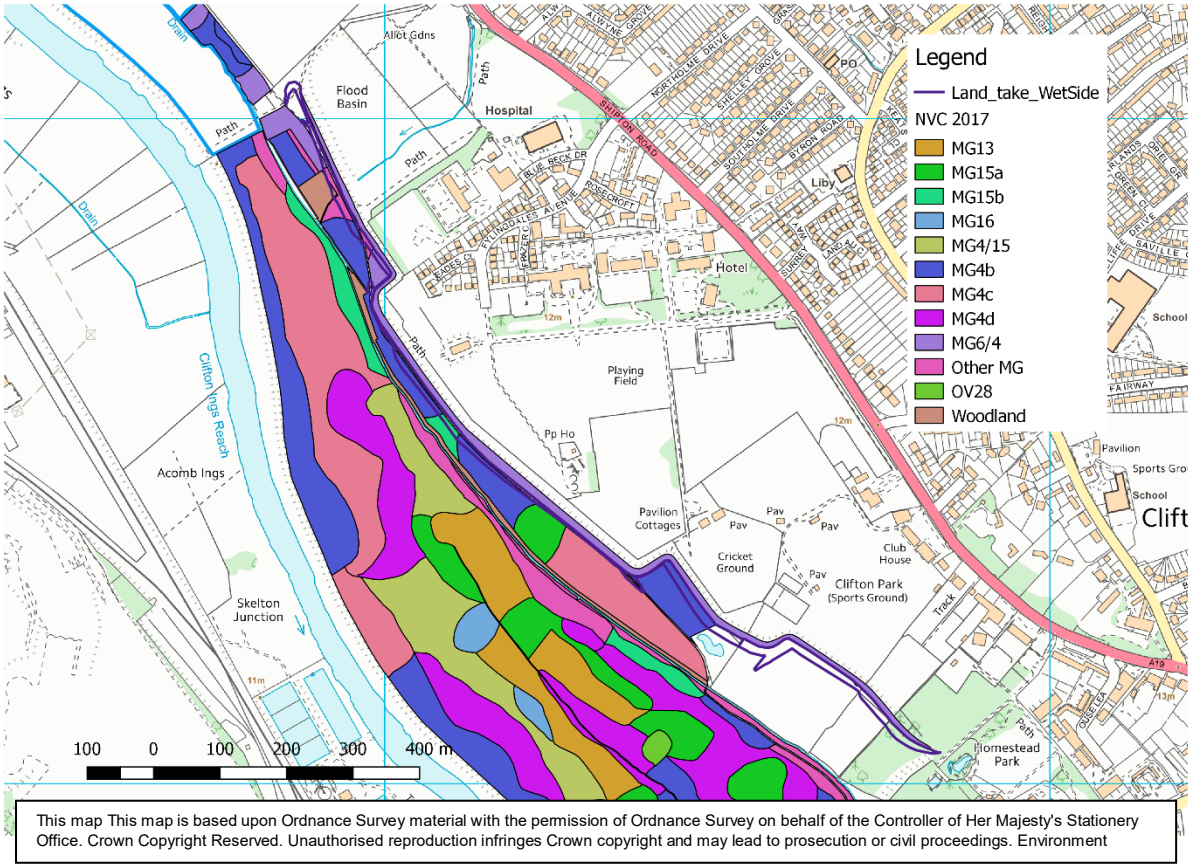
The proposed works to the barrier bank include raising the height and consequently footprint of the embankment, leading to some loss of predominantly MG4 species-rich grassland adjacent to the current barrier bank (Map 1). As a result, the Environment Agency have outlined a mitigation strategy to offset the damage to the SSSI by referring to "Habitat translocation, a best practise guide" (Anderson, 2003). Habitat translocation refers to the movement of assemblages of species, particularly plants (typically including the substrates, such as soil or water, on and in which these species occur) from their original site to a new location (JNCC, 2003). It is proposed to use an area of land within Rawcliffe Ings to the north west of the SSSI, which can be divided into 5 zones A-E (Map 1 and Map 4). The area of loss has been calculated as approximately 1.2 ha (with 0.9 ha of turfs from the toe of the bank on the wet side to be translocated), and the 5 mitigation zones make up a total of 11.9 ha. The vegetation assemblages within the area of loss include MG4b and MG4c (Map 2). The total amount of MG4 (all sub-communities) remaining in the UK is 1171 ha, and MG4b alone, is 398 ha. For such rare grasslands, particularly where there is a long history of management, the first option is to avoid impact altogether.

The Floodplain Meadows Partnership have been asked to provide a literature review outlining grassland translocation policy and methods in the UK in relation to this project, and to collect and interpret information on soil fertility of the mitigation areas to determine suitability. This document summarises both elements of work.

Map 1. Location of area of loss and mitigation areas.



Map 2. Area of loss and NVC communities



1. Translocation policy in the UK

The current policy for habitat translocation is outlined in 'A Habitats Translocation Policy for Britain in 2003' (JNCC), which is considered still relevant (*pers comm*. Richard Jefferson, Natural England National Grasslands Specialist, 2018). This policy clearly states that habitat translocation is not an acceptable alternative to maintaining habitats *in situ*, that evidence shows that the intrinsic value of habitats is not retained after translocation and that translocation should not substitute *in-situ* conservation. Habitat translocation should not be seen as mitigation for loss through development, and may only be able to offer partial compensation, as many examples of habitat translocation clearly show changes in the final habitat achieved.

The policy lists the reasons why habitat translocations cannot be an acceptable substitute for *in-situ* conservation of sites. Those are:

- All ancient habitats are fragile, non-transferrable and cannot be re-created in short timescales.
- Some species cannot be translocated due to their size (e.g. ancient trees) or their fragility (e.g. many specialised animals).
- Many animals depend upon mosaics of habitats that are difficult or impossible to move in combination with each other, hence they are unlikely to survive in their now location.
- The species composition of assemblages changes as a result of the disturbance resulting from the translocation process
- Structure and physical conditions will be different in the new location (geology, soil conditions, hydrology, aspect, topography etc.)
- The history of specific locations (which results in distinctive assemblages of species found in particular locations) cannot be re-created.
- The historical, cultural and other human associations with the original location are severed.

2. Objectives and aspirations for translocation of Rawcliffe Meadow

It is important to be clear about the aim of the translocation from the start of the project. Lack of appropriate objectives was an issue in many of the examples of translocation reviewed by Bullock (1998). If an objective is to **preserve** the habitat through translocation, this is not likely to be met, as in all cases examined by Bullock, community changes were recorded and in most cases these were substantial.

It is likely that Rawcliffe Ings has been grassland since the 1300's (Hammond, 2017) although not always managed for hay, therefore more realistic and achievable aims would be:

- Turf survival (at the most basic)
- Mitigation for loss (by preserving the main features of a community)

Bullock concluded that the mitigation aim was achieved in many of the cases examined, but this was more successful in dry grasslands than wet grasslands.

In the context of Rawcliffe Meadow, turf survival would be a sensible objective if any translocation is to be pursued, with the aim of rescuing turves that would otherwise be lost. Mitigation may be achieved, but there are few examples in the literature where a wet grassland has been translocated successfully. Therefore, mitigation should primarily be sought by following other methods (e.g. green hay/seed spreading/plug planting etc) on adjacent sites, with turf translocation viewed as a logical way to use the turves to maximise the potential for them to be maintained.

3. Current best practise advice for translocation

Box (2003) evaluated 8 case studies of turf translocation in the UK and Bullock assessed 24 case studies (1998). The main recommendations from these reviews to consider are:

a. Similarity between donor and receptor sites

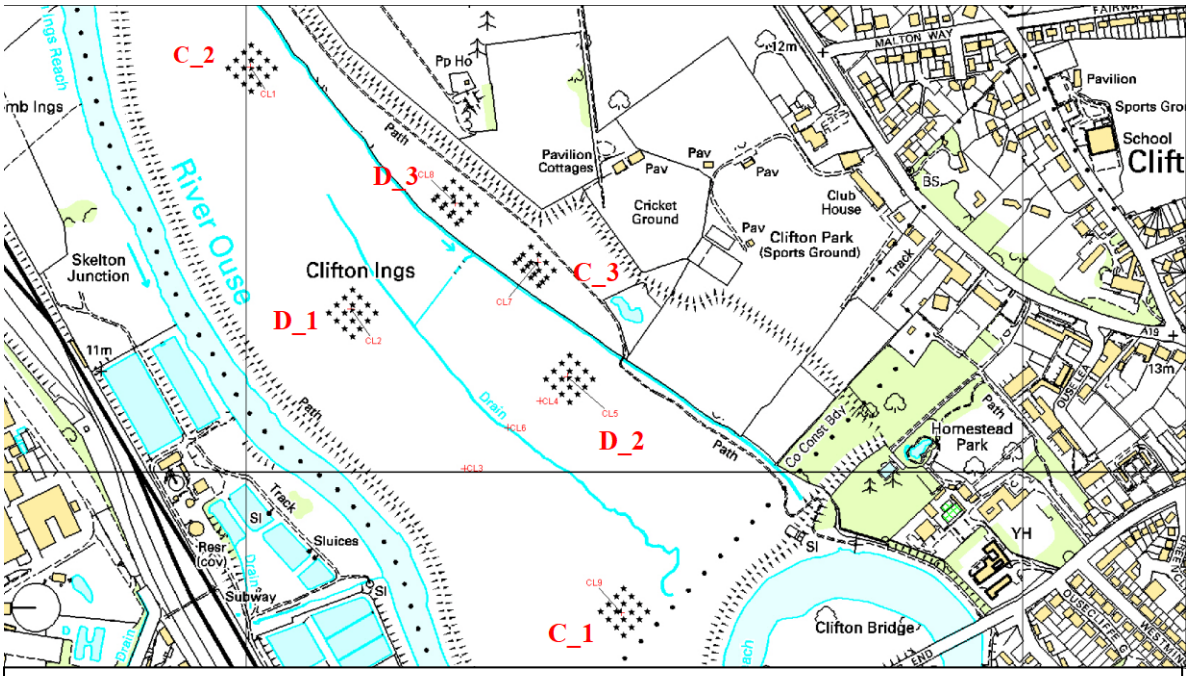
Features including aspect, slope, soil drainage, soil nutrient status and hydrology need to be as similar as possible. In several of the case studies described by Box, the hydrological regime was unsuitable at the receptor site, and similarly in the floodplain-meadow example described by Ward (1995), where the receptor site was hydrologically different, resulting in a drier sward.

Recommendations for assessing suitability for translocation receptor sites. The recommended monitoring should be applied at both Rawcliffe Meadow and potential receptor sites.

1. Soil-water elevation (to assess similarity in soil-water regime) using soil wells.

There are already two dipwells in Rawcliffe Meadow, although not directly in the area to be impacted by the barrier bank works. They are in areas of MG4c grassland (less species rich MG4) as opposed to the MG4b grassland (more species rich) that is more likely to be impacted by the barrier bank works. Automatic dataloggers have been in place since March 2010 and give us a good idea of the soil-water regime of the existing grassland at those locations (Map 3). However, there is no data on the soil-water regime of the proposed mitigation areas (Zones A, C and E, Map 4). Ideally these would be comparable to the area of Rawcliffe that is to be translocated.

Map 3. Location of dipwells (red) and blocks of monitoring quadrats (stars) established in 2010



Map 4. Potential mitigation areas, labelled zones A, B, C, D and E

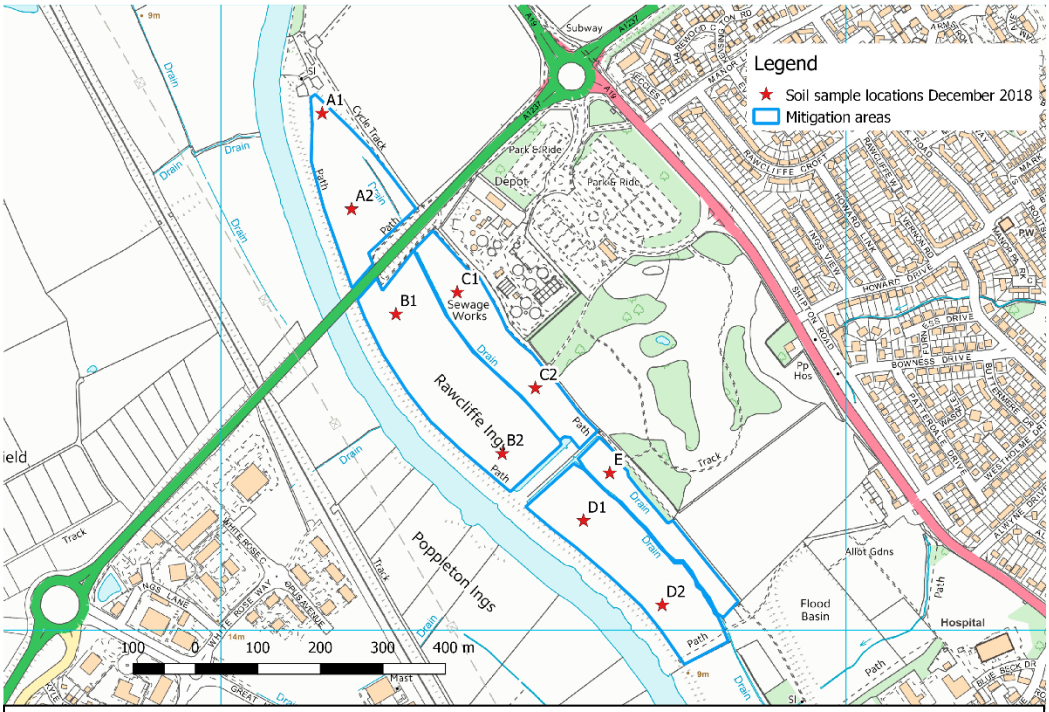
2. Soil-moisture release curve (to assess soil porosity)

It is recommended that some assessment of the similarity of possible receptor sites to Rawcliffe Meadow in terms of soil structure is undertaken. We have not undertaken any similar recordings historically.

3. Nutrient analyses (to assess soil fertility)

We have had 9 soil samples analysed for available phosphorus for Zones A-E, collected and processed through Lancrop laboratories, Pocklington in December 2018 (Map 5).

Map 5. Soil sample locations in 5 mitigation fields, taken December 2018



The results of these are shown in Table 1 below.

Table 1. Results of soil samples taken in December 2018 from the potential mitigation areas.

Soil sample location	Phosphorus (mg/kg)	Index	pH
A1	12	1.4	7.3
A2	12	1.4	7.1
B1	10	1.1	6.7
B2	12	1.4	6.5
C1	12	1.4	6.3
C2	17	2.1	6.3
D1	14	1.7	7.2
D2	14	1.7	7.2
E1	19	2.3	7.2

These recent soil samples suggest that the soil available phosphorus is very low.

We also have some soil phosphorus data for Rawcliffe Meadow from work undertaken in 2010, which showed that Rawcliffe Meadow soil also has an exceptionally low fertility, even when compared to the adjacent Clifton Ings (Table 2). There may be more recent P data for the specific area of Rawcliffe Meadow to be removed as part of the bank works, which would be useful to use as a more recent baseline.

In terms of the restoration potential of the mitigation areas, the soil phosphorus levels are all within the range that is considered ideal for restoration: 5 - 25 mg/l^{-1} P (Rothero *et al*, 2016). The available P range for soils supporting existing MG4 grasslands is typically 5-15 mg/kg (Wheeler *et al*, 2004).

The soil P from Rawcliffe and the mitigation areas are broadly comparable if restoration is the objective. For translocation however, Zones C and E are slightly higher than Rawcliffe, and are less preferable, although still within the range that should support an MG4 species rich grassland.

Table 2. Soil chemical analysis.

Extractable phosphorus content (Olsen reagent) of the top 10 cm of mineral soil (mg/kg) taken in 2010. Rawcliffe Meadow results are highlighted in yellow.

Block	pH	Olsen available P
D_1	7.1	11.6
D_2	6.8	11.8
C_1	7.2	8.5
D_3	6.5	6.9
C_3	6.4	2.8

4. Soil profile assessment

We do not hold information on the soil profile at Rawcliffe Meadow, although this could be collected by examining the soil profile as removed using a Dutch auger.

5. Topographical information to assess flood recession routes

The surface topography at Rawcliffe Meadow is likely to facilitate rapid recession of floodwaters once the washland releases water back to the river. The soil fertility is very low which suggests that flood water does not sit in this area for long periods of time. Lidar may be useful to determine the extent of topographical change, and the EA may hold topographical data for the immediate area of the meadow where the works are planned to take place. Ideally this would be comparable to any mitigation areas where translocation of turves is planned.

Engineering some of these variables may be feasible as part of the relocation exercise if no exactly suitable sites can be found. For example, removing topsoil from receptor sites to reduce soil fertility, or to ensure the turves are laid at the correct height in relation to the local soil-water regime.

b. Translocation technique

There are a number of different ways that grasslands can, and have been, translocated. The two main ones described in the literature are outlined below:

a) Turf translocation. This maintains the underlying soil profile if turves are deep enough and minimises damage to individual plants. However, some critical points are:
   - Do not store turves, move them on the same day to avoid desiccation of the sward and changes to the soil nutrient composition.

- Move turves as thick and as large as possible. Translocating sub-soil may be considered, but it is not recommended to move thin turves.
- Lay turves in same arrangement and position as originally. Lay them tightly together to avoid gaps, press down on each turf with the bucket, and roll after they have been laid to ensure contact with sub-soil and to remove air gaps. Fill in gaps with soil from receptor site and consider grazing after rolling to increase contact between turves and sub-soil, and reduce gaps.
- We would add that in the case of a community as hydrologically sensitive as MG4, pressing on turves with the bucket and rolling the turves is only acceptable in dry conditions, if the soil moisture is above the plastic limit of the soil then compaction is liable to occur, compromising the soil's structure and potential to support more species rich grassland in the medium to long term.

b) Translocating a mix of soil and vegetation (i.e. not as complete turves). This technique has proved even less successful than turf translocation and it is recommended that it is only used to move grasslands of lower value than Rawcliffe Meadow.

Other considerations

- Machinery needs to be appropriate. The 'Translocating wildlife habitats; a guide for civil engineers' (Box and Stanhope, 2010) recommends the use of low ground pressure tyres and large buckets to maximise the size of the turves that can be removed in one go.
- Timing of translocation. Timing needs to be considered so the grassland is not actively growing and the sward is short. Best time is probably Feb/March if conditions are dry enough, or early autumn, after a hay cut and grazing, when soil is still sufficiently dry to avoid compaction and associated damage to soil structure.
- Work on a rolling method, re-profile one section and place turves from a previous section straight away.

c. Post translocation habitat management

Perhaps surprisingly, this was a major factor in the failure of many of the translocation case studies looked at in the literature (although usually in combination with other factors). There are very few examples indeed where post translocation habitat management was actually the desired method, and therefore not prohibitive to a successful project. Therefore, in the context of Rawcliffe, we recommend that translocation is only considered to areas where the post translocation management can be *guaranteed* as an annual hay cut and aftermath grazing, in a similar regime to that of Rawcliffe currently. Otherwise it really is not worth the effort and expense.

d. Evaluation

Box (2003), Bullock (1997) and the JNCC Translocation policy (2003) strongly recommend both pre-project baseline monitoring and long-term post project monitoring to determine success against set objectives. The view is that even after 7 years post-project monitoring at Brocks Farm (Devon), one of the more successful and better monitored case studies, the community was still changing and that a period of at least 10 years is recommended to fully understand long term changes to a community. The National Vegetation Classification (NVC) is suggested as a suitable framework for assessment of

plant community change. A point made in a number of case studies is the lack of assessment of the invertebrate assemblage, something intrinsically related to grassland quality.

Recommendations for evaluation at Rawcliffe Meadow include (for both translocation receptor and donor sites):

- NVC survey as a baseline (before translocation), and then 5 years and 10 years post translocation.
- Repeatable botanical monitoring quadrats, monitored before work starts then annually for five years to guide post translocation management.
- Invertebrate surveys as a baseline and then 5 and 10 years post translocation
- Recording of soil-water levels in mitigation sites if dipwells are installed.
- Re-survey of soil phosphorus levels 5 and 10 years post translocation.

Recommendations

If translocation is to be attempted, Zones A, B and D should be considered for the receptor fields as a preference to Zones C and E.

All possible mitigation zones show very good potential in terms of soil fertility, for restoration, through a range of different techniques which could include change of management from pasture to hay, combined with various techniques for seed transfer (green hay/seed/plug planting etc).

A mixture of techniques would be desirable across all fields identified if this were feasible.

Additional information is desirable for the mitigation zones including assessment of soil-water profile, soil structure and porosity, and existing botanical interest, to refine the information held about the potential sites, and to develop a baseline against which to monitor change.

For practical guidance on restoration and re-creation of MG4 grasslands, the Friends of Rawcliffe Meadows have extensive experience of restoration and would ideally be closely involved in the decision-making process and implementation of restoration methods.

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