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Wetland Landscape Restoration and Maintenance in the Gwent Levels – Costings



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1 Executive Summary

- 1.1 The report sets out an analysis of likely costs to farm businesses associated with the application of the Welsh Governments policies regarding the Sustainable Management of Natural Resources with particular regard to: the restoration and management of surface water features; the management of grassland and wider habitats for pollinators; the management of hedgerows for wildlife; and the restoration of orchards.
- 1.2 The Gwent Levels comprise eight extensive SSSIs designated for their aquatic habitats comprising a complex network of watercourses. Post war agricultural Improvement has resulted in changes to the wider drainage network and destruction of landscape features such as ridge and furrow landforms and associated grips draining to reens.
- 1.3 Good management of the drainage network and farming of land is essential for a sustainable future for the Levels, controlling water levels, reducing pollution risk and delivering ecosystems services for the benefit of society.
- 1.4 The system of watercourses in the Levels has evolved over centuries to the existing network that permits the area's agricultural and natural ecosystems to function and thrive. By managing ditches for nature, they also protect the agricultural, visual and cultural landscapes of the area delivering diversity in what otherwise might be a uniform landscape.
- 1.5 Watercourses are managed at three levels: main rivers and reens maintained by NRW; smaller reens managed by the IDD; and field ditches managed by riparian owners.
- 1.6 The report describes the management protocols required to establish and maintain private riparian drainage features, hedgerows and orchards in the area and makes recommendations for the development of policies for the distribution of farm subsidies and grants in a way that will ensure that a sustainable rural community and functioning natural ecosystem environment can thrive in the area.

2 Introduction

- 2.1 This report is part of the Sustaining the Gwent Levels, sustainable management scheme project and has been commissioned by the RSPB in partnership with the Living Levels project with support from the Welsh Government Rural Communities - Rural Development Programme 2014-2020, which is funded by the European Agricultural Fund for Rural Development and the Welsh Government. The report sets out the potential costs to farm businesses of implementing locally-important measures to deliver improved SSSI features and general drainage in the area. These actions are aligned with the principles of sustainable farm management and the Sustainable Management of Natural Resources (SMNR) as set out in Part 1 of the Welsh Government's Environment (Wales) Act 2016.
- 2.2 The report has been researched and written by Reading Agricultural Consultants Ltd (RAC) with guidance from a project steering group comprising representatives of the RSPB and Natural Resources Wales (NRW).
- 2.3 The area of study is shown in **Figure 1** below.



Figure 1 The extent of the Gwent Levels

- 2.4 The report sets out an analysis of likely costs to farm businesses associated with the application of SMNR. The analysis focuses on the following main areas:
- The restoration and management of surface water features including the restoration and ongoing sustainable management of reens, ditches and grips;

- The management of grassland and wider habitats for pollinators, including the creation and management of field margins and pollinator strips, and the establishment of herbal leys for the benefit of pollinators and soil health;
- The management of hedgerows for wildlife, including the restoration, establishment and management of hedgerows for wildlife, including cutting and laying regimes designed to maximise provision of habitat and food sources for wildlife; and
- The restoration of orchards, including scrub clearance and tree replacement where necessary but excluding ongoing orchard management.

2.5 The application in agriculture of SMNR principles, as set out in the 2016 Environment Act, requires that the sustainable management of natural resources be integrated into farming systems. This policy move will encourage the integration of sustainable farming techniques with the provision of wider public goods and conservation measures to realise opportunities for the improvement the ecological potential of agricultural land and associated features such as hedgerows, orchards, grassland and watercourses.

2.6 In September 2021, the Welsh Government in its response to its own consultation on the Agriculture (Wales) White Paper (published 16th December 2020) announced its intention to continue with the Basic Payment Scheme until 2023 whilst transitioning to its Sustainable Farming Scheme. The transition period will see the implementation of a range of interventions to help prepare the ground for the new scheme and pilot the processes which will be used to deliver it. This report seeks to inform that process.

3 Background

3.1 The Gwent Levels comprise eight extensive SSSIs covering 5,856ha of land. The SSSIs are designated because their drainage networks support a wealth of plant species and communities, with associated populations of aquatic and terrestrial invertebrates as well as larger fauna that feed or prey on the plants and insects. The range of forms of the watercourses making up the networks is diverse, in terms of morphology, vegetation and maintenance, and it is this diversity that supports the range of species found in the area. Regular maintenance of wet ditches and reens provides habitat for submerged plants, whilst annual raising of water tables ensures that ditches that are draining during the winter can support more ephemeral aquatic communities in the summer months.

- 3.2 Post war agricultural intensification has seen increased use of manufactured fertiliser and regular cultivations to improve productivity and the range of crops grown. Some land that was formerly used for grassland has been converted to arable production and has proved itself capable of sustaining high yields of cereals over a long period. Dairy farming has also intensified, replacing permanent pasture with highly productive grass mixes and maize to improve output and establish competitive dairy units.
- 3.3 Improvement has however resulted in changes to the wider drainage network, ridge and furrow landforms have been ploughed out, and ditches and reens filled in or culverted to ease cultivations using larger machines. The use of modern piped drainage, although long-established, has spread and is used to augment or replace traditional drainage systems. With reductions in soil water table levels that allow longer access periods for land work and poor maintenance of the historic drainage network the extent and condition of the wet habitats that characterise the Gwent Levels has declined.
- 3.4 This report is written not only in the light of history but also of the Environment (Wales) Act, the Well-being of Future Generations (Wales) Act, climate change, declining condition of the Gwent Levels' SSSIs, pressures on Government and proposed changes to agricultural and rural support regimes in Wales.

4 Surface water features

- 4.1 The Gwent Levels are rich in a diversity of surface drainage features, from ridge and furrow fields, and associated grips and dry ditches to wet ditches linking into an extensive system of reens that drain excess water from the land to Pills from where it outfalls *via* tidal flaps into the Severn Estuary.
- 4.2 Whilst some farmers have worked with and maintained traditional drainage systems, others have filled in or culverted ditches and extended or installed piped land drainage systems. Many parts of the system are, however, ineffective for drainage through years of neglect, often resulting from a lack of understanding of the need for and workings of the system, which has not been passed on as land has changed hands.
- 4.3 The ongoing good management of wet and seasonal ditches and sensitive farming of associated agricultural land is critical to a sustainable future for the Levels. With good management, the system can support a vibrant farming community and a variety of

wetland plant species, invertebrates and other wildlife found in lowland drainage systems, including birds and smaller mammals, eels and other fish.

- 4.4 The main purpose of ditches in the Levels is drainage, to control water levels, improve crop yield and quality, provide wet fences, and secure access to land for grazing. But ditches also provide important ecosystem services, including: soil profile recharge; flood attenuation; water purification; and biodiversity conservation, all of which rely on sensitive appropriate management.
- 4.5 The features of ditches that govern their drainage and ecological functions are: vegetative cover; ditch cross section and gradient; slope orientation; interconnections, such as piped sections and weirs; soil, sediment and litter properties; biota and biofilms; and network topology. Each feature serves a specific purpose and often the original design purposes of a ditch system or feature are not considered when it comes to maintaining watercourses.
- 4.6 The system of watercourses in the Levels has evolved over centuries to the existing network of conduits that, when properly maintained, interact to provide drainage pathways that allow the agricultural and natural ecosystems to function and thrive.
- 4.7 The wildlife value of ditches can be improved by appropriate management that maintains capacity and flows, providing a range of conditions that benefit different species, for example some:
- plant species need a diversity of watercourse environments and good water quality;
 - insects, need shallow water, and muddy and vegetated areas;
 - birds, need tall vegetation and reeds;
 - mammals, need permanent water and bankside cover; and
 - fish, need permanent deep water.
- 4.8 Managed ditches establish water levels to suit different habitats and maintain and improve SSSI status. Ditches are used to:
- drain lowland meadows for grazing, silage making, or a summer hay cut, and arable fields for access for drilling and harvest;
 - provide high water levels to maintain water supplies for crops and breeding birds;
 - provide flood defence capacity whilst supporting important habitats for flora and insects; and

- maintain high water levels for wet fences, drinking water for livestock and habitat creation.

4.9 By managing ditches effectively for nature, they are also protected as features of the agricultural, visual and cultural landscapes, where they act as 'wet hedges', sources of drinking water, water supply to growing crops and add diversity to what might otherwise be a uniform landscape.

4.10 Watercourse management in the Levels is hierarchical and works are cyclical:

- NRW is responsible for and undertakes maintenance works on main rivers, with main reens being desilted/cast out every four years, de-weeded every year and bankside vegetation cut bi-annually.
- IDD reens are now also the responsibility of NRW, which are desilted/cast out every seven years, de-weeded every year and bankside vegetation managed annually in rotation.
- Field ditches are managed by riparian owners (farmers and land managers) and should be desilted/cast out every ten to thirty years and bankside vegetation managed in rotation at least once every two years.

4.11 Guidance, setting out the background of and protocols for ditch management in the Levels is summarised in internal NRW and IDD guidance (Appendix 1).

4.12 Expected minimum standards for the protection of water from pollution are set out in the Code of Good Agricultural Practice¹ and annual Cross Compliance publications², which set out Statutory Management Requirements (SMR) and criteria for maintenance of land in Good Agricultural and Environmental Condition (GAEC).

Ditch management

4.13 Ditch management techniques used in reens and grips range from annual mowing of banks and de-weeding of reens, through to desilting/casting of all ditches on a much longer rotation of between four and ten years. Operations are carried out in rotation and on alternative sides of ditches to both maintain ditch function and retain plants and cover for wildlife.

¹ <https://gov.wales/code-good-agricultural-practice>

² <https://gov.wales/cross-compliance-2021>

4.14 Historically, the management of ditches in many areas has been neglected, partly through lack of resources to carry out routine maintenance and partly through a loss of understanding of the drainage system generally. In addition to the problems caused by neglected maintenance regimes, contractors carrying out routine maintenance face not only watercourses overgrown with shrubs and trees growing in banks, but on reaches with public access, such as along roads. Problems with fly tipping and litter generally mean that litter has to be removed before work starts to avoid spreading debris across agricultural land, with associated risks to livestock.

Mowing banks

4.15 Ditch banks should be mown in autumn and winter to avoid disturbing wildlife, and a range of vegetation patterns should be maintained whilst retaining capacity for flow:

- avoid mowing all areas at the same time – cut single sides of reaches on a three or four year rotation;
- leave more open reaches for up to ten years between mowing; and
- mow to a height of 10cm or more.

4.16 Shrubs and scrub should be cleared from banks leaving no more than 20% heavily shaded. Occasional bushes can be retained for shade and cover for breeding birds.

Operation	Outcome	Cost	Unit
Mowing ³	Annual mowing of ditch bank (one side) – single pass (annual)	£0.04	/m
	Double pass (annual)	£0.8	/m
	Alternate sides mowed annually (Double pass)	£80	/km/yr

³ Data gathered by RSPB Sustaining the Gwent Levels SMS Project



Figure 2: Greentec hydraulic flail mower

Silt removal

4.17 Ditch systems are often designed with areas that focus silt deposition, in order to reduce the frequency of cleaning long runs of watercourse. These reaches should be identified and desilted over autumn and winter to maintain the flow of water. Over-deepening of ditches and reens in some areas will have caused changes to the hydrological relationships between areas, particularly the winter when water levels in the reen and ditch systems are generally lower to allow water to escape and avoid flooding. One consequence of over deepening will be the deposition of silt in areas where that may not have been the intention and there may not be adequate access for the regular desilting operations necessary to maintain the new profile.

4.18 It is important that desilting operations only desilt. They should:

- retain the original ditch profile and cross section - ditches should not be deepened or cross section extended beyond their original design in a way that fails to maintain the hydrological regime;
- use an appropriate ditching bucket and weight of machine to avoid damage to banks;
- remove silt from ditch sections on different rotations to provide conditions for a range of wildlife; and

- leave time between clearance operations on alternate banks – a minimum of five years for reaches focusing silt deposition, and maximum of ten years for reaches focusing on conveyance of water.

4.19 The material removed from the base of a ditch or reen should be silt, comprising only topsoil washed from fields and organic matter from decaying vegetation in the ditch. The arisings should not contain any clay from ditch bank or bottom and thus are suitable for spreading on adjacent land for agricultural benefit. Silt should not be deposited in a narrow bank along the ditch top but should be spread on the ditch-side fields at a depth that allows existing vegetation to grow back, maintaining a 2m grass buffer on the bank top at all times in order to comply with GAEC. Spoil left to raise the bank along the line of a watercourse requires a D1 waste exemption for depositing waste from desilting. Spoil from ditches may also be spread on land remote from its source, which is due for cultivation in order to improve the soil under a U10 waste exemption.



Figure 3: Desilting and spreading using a boom-mounted spreader (Klose Engineering)



Figure 4: Desilting leaving arisings on bank top



Figure 5: Spreading arisings left on bank top (Bos rotary cutter WA-150)

Operation	Outcome	Cost	Unit
De-silting ⁴	Clean out base of wet or dry ditch to original profile (excavator and ditching bucket)	£6.50	/m
	(five year rotation – alternate sides)	£1,300	/km/yr
	Clean out base of wet or dry ditch to original profile (boom mounted cleaner)(double pass) ⁵	£0.12	/m
	(five year rotation – alternate sides)	£24.00	/km/yr

⁴ Data gathered by RSPB Sustaining the Gwent Levels SMS Project

⁵ Estimated cost based on mowing

Maintain water quality

- 4.20 Good water quality is essential to maintain and improve the ditch habitat to protect the features for which they are designated SSSIs, and steps in line with Good Agricultural Practice and Cross Compliance requirements should be taken to stop manure, fertiliser or soil getting into water bodies⁶.
- 4.21 In arable fields grass strips can be created beside ditches, to help reduce runoff of soil, fertiliser and pesticides into the ditch. Two metre wide grass buffer strips should be maintained along watercourses alongside arable land.
- 4.22 In grassland, ditch banks are traditionally profiled and maintained to limit access for livestock but ditch lines can be fenced out where strictly necessary and alternative drinking sources such as pasture pumps, or fenced and profiled access areas can be provided to maintain the integrity of boundaries. Stock fencing against ditches in the SSSI should be avoided because light grazing and trampling of certain ditch banks can benefit some species of wildlife, it should not be allowed extensively.
- 4.23 Cross compliance and good practice also require that certain potentially polluting operations should only be carried out with specified separation distances from watercourses⁷:
- Manufactured and inorganic fertiliser must not be applied within two metres;
 - Pesticides and herbicides must not be applied within two metres;
 - Manure and slurry must not be spread within ten metres (six metres when using precision equipment such as a slurry injector, trailing shoe or dribble bar; and
 - Supplementary feeding must not be carried out within ten metres.
- 4.24 In the Gwent Levels, restrictions on slurry and manure spreading have a significant impact on farming operations with a significant housed period for livestock, particularly dairy units and more intensive beef operations. Long, narrow fields, which are typical in many areas, have a significant proportion of non-spreading land compared with squarer fields

⁶ <https://gov.wales/code-good-agricultural-practice>

⁷ <https://gov.wales/sites/default/files/publications/2018-01/cross-compliance-2014-establishment-of-buffer-strips-gaec-1.pdf>

and informal discussion with farmers suggest that spreading buffers are commonly eroded in order to gain sufficient spreading land for manure arisings.

- 4.25 Such failures to comply with regulation can only be detected by surveillance or close inspection of spreading records and so are likely to go unaddressed, posing an ongoing risk to surface water quality.

Watercourse clearance (hedges)

- 4.26 In some areas, agricultural hedges established on one or both banks of a reen or ditch have become overgrown, significantly shading the water surface and depositing leaves in the watercourse, sometimes affecting flow across the network and negatively impacting on the features for which the area was designated as SSSI. NRW guidance recommends that hedgerows should only be on one bank of any ditch, and clearance can be a relatively straightforward operation. In many locations across the Levels, both banks are affected by overgrowth and the watercourse requires complete clearance, recasting and reprofiling the bank top.
- 4.27 Aerial imagery from 1945 (Figure 6) suggests that hedges and hedgerow trees were a common feature at that time, but it is not possible to state with certainty for how long they had been established or for what purpose. Comparison of images taken in 1945 and 2021 suggests that whilst vegetation along ditch lines may have been maintained, there is significantly more vegetation today to contribute to deposition in and obstruction of watercourses and their maintenance. This natural process requires management to allow the hydrological system of the area to be restored to work effectively.

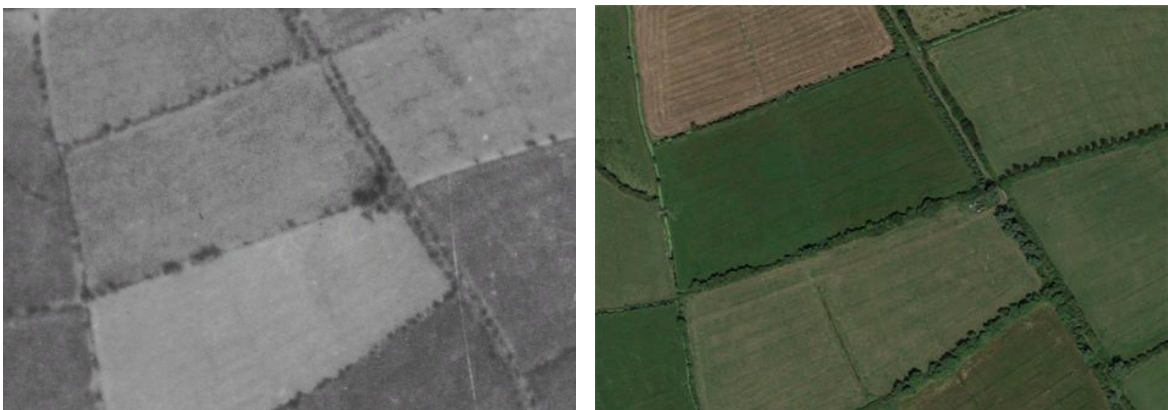


Figure 6: Established hedgerows and hedgerow plants along ditch lines. 1945 and 2021 (Google Earth)

Operation	Outcome	Cost	Unit
Hedge removal ⁸	Cut back hedge on one bank, remove brash and dispose	£12.00	/m
Casting ⁹	Reprofile one side and cast after hedge removal, including spreading spoil	£7.00	/m

4.28 Alternatively, an existing hedge on one side of a ditch can be managed to reduce leaf drop, by regular trimming on its ditch side and hedge laying. Section 6 of this report describes hedge laying techniques that can be used to create a stockproof barrier and reduce the risk of shading and obstruction of ditches.

Ditch/reen restoration

4.29 A significant number of ditches and reens in the area have been neglected and are affected by overgrowth of vegetation including, at some sites, significant Blackthorn infestations. It is a matter of urgency to restore these broken-down watercourses in order that they can play the role for which they were built in the complex drainage network of which they are part, they can also help restore the ecological value of the Gwent Levels and provide flood alleviation benefits for neighbouring communities.

4.30 It is important that overgrown reaches are restored to their original dimensions and grades for them to work effectively in the network in the way they were intended. Such restoration work will vary significantly from simple clearance of large amounts of annual and perennial weed growth and silt to the wholesale removal of well-established small trees and mature shrubs, which are likely to have rooted through accumulations of silt into the underpinning native clays and silts.

4.31 In interviews with local farming stakeholders, it was suggested that there was some willingness to restore features provided ongoing maintenance costs were lower than those for existing overgrown field boundaries. It is extremely unlikely therefore, that riparian owners will be willing to accept any major investment in restoration that is not financially self-sustaining or significantly cheaper than the *status quo*. In advance of any decision to

⁸ Pers. Comm. RSPB

⁹ Estimated from standard costs

subsidise restoration work the costs of legacy maintenance has to be taken into account and the benefits of a drainage network in good condition communicated to riparian owners. Ideally, funding should include initial capital costs for restoration of degraded features and ongoing management in terms of a cycle of vegetation cutting that delivers habitat variation.

- 4.32 Any commitment to the restoration of watercourses includes by implication a commitment to the ongoing routine maintenance of the restored reach, including mowing and desilting.
- 4.33 No ground should be taken out of agricultural production for ditch restoration or maintenance, since the material removed can be beneficially spread on land, and the creation of higher banks should be avoided. Bank slopes and ditch widths should generally reflect existing structures but may be modified to create drinking sites or establish habitat for breeding birds as described below.
- 4.34 In interviews carried out during the Project, it was clear that some stakeholders believed that ditches are burdensome, in that they provide no financial gain to farm businesses, nor can revenue be generated from any ditch. Casting was regarded as extremely unproductive, particularly where silt removed from a ditch was placed in a way that removes that land from production for a short period. Individuals with this point of view generally believed that ditches should be filled in and replaced with a hedge.
- 4.35 This attitude is clearly uninformed and unaware of both the advantages of, and relatively low costs associated with well-maintained watercourses, as well as their SSSI status and obligations associated with that. A well-maintained ditch requires less maintenance than a well-maintained, stockproof hedge, which first has to be planted and subsequently flailed or laid to maintain a stockproof barrier. A ditch is existing and requires biennial mowing and less frequent desilting to maintain a drainage outlet for land, and a stockproof barrier.

Operation	Outcome	Cost	Unit
Hedge removal	Cut back vegetation on two banks, remove brash and dispose	£24.00	/m
Casting	Reprofile two sides and recast after hedge removal, including spreading spoil	£12.00	/m

Grip restoration

- 4.36 Ridge and furrow systems in the Levels often have crossing, second order furrows to convey water more directly to the ditch system than along a single long furrow. Second order furrows are sometimes called grips locally and sometimes have a secondary ditch measuring approximately 100mm wide by 100mm deep running in their base connected either directly to a wet or dry ditch or by way of a length of underground drain running under raised banks along ditch lines. These grips are excavated using backhoe excavator or a Maletti 'French' drainage machine, or similar, and provide an immediate vector for surface runoff from fields direct to perimeter ditches.
- 4.37 Some farmers, instead of digging an open ditch to assist drainage, install one or more mole drains along the base of second order furrows. This provides a less direct route for drainage from fields but has the advantage of mitigating the loss of nutrients and sediments from land by holding them in the field. In order to preserve the efficacy of ridge and furrow systems, any accumulation of silt in furrows should be removed by more extensive gripping or excavated and spread along ridge tops using a rotary drainer such as that used to excavate traditional foot drains in other wetland areas (Figure 7). The resulting scrapes have potential to provide temporary wet habitat for colonising plants and wading birds or they can be reseeded.

Operation	Outcome	Cost	Unit
Gripping ¹⁰	Standard form 100mm deep	£1.00	/m
	150mm – 200mm deep	£1.50	/m
	Distribute excavated spoil	£0.50	/m
Rotary Drainer	Restoration of grips and furrows and spoil spreading	Large scale only	

¹⁰ Pers. Comm. RSPB



Figure 7: RSPB Rotary Drainer excavating a foot drain – the depth and width of the feature and spoil spreading can be adapted for use in the restoration of grips and furrows.

Other functions

- 4.38 Watercourses in wetlands have additional functions to those addressed above, amongst those that could be developed through better management within the project area are water supply for livestock, wet hedges, and feeding/breeding areas for birds using the neighbouring SAC and the area more generally. The diversity of the ditch network in the area means that there is no one size fits all prescription for drainage works on the Levels and any operations should be appropriate at given locations and assessed and approved by NRW before being implemented.
- 4.39 Wet hedges form effective boundaries for livestock in many wetland areas and the Gwent Levels are no exception. Whilst there is no prescription for a wet hedge the normal dimensions of a wet ditch to prevent livestock movement in the Levels is greater than 2m wide by 1.5m deep, but in many locations ditch cross sections are driven by flow rather than function as a livestock barrier.

Operation	Outcome	Cost	Unit
Profile for wet hedge ¹¹	Cut both banks to grades recommended by the GLIDD for wet hedge. (Excavator and bucket)	£15.00	/m

¹¹ Estimated from Standard Costs

4.40 Wetland ditches are sometimes accessible for drinking by livestock, taking the form of shallow gradients along part of their length for animals to gain access to standing water. These areas can use stone or concrete but are more often unprotected and associated with poaching, puddling and movement of silt into the water body. Light to medium poaching can provide important habitat for marginal plants and associated invertebrates in high water conditions provided it does not breach cross compliance requirements, but access to open water for drinking is generally seen as a negative feature of grazing livestock on marshland.

Operation	Outcome	Cost	Unit
Construct drinking area ¹²	Profile bank (20m) lay geotextile and 200mm stone for access	£850.00	/Site

4.41 Where conditions are not suitable for direct access, drinking water can be supplied by the installation of pasture pumps, which enable cattle to lift water from open water into drinking bowls on the bank-top, or photovoltaic pumping systems that can reliably maintain full water troughs across a grazing area.

t	Example source	Cost	Unit
Pasture pump	https://mcveighparker.com/aquammat-ii-pasture-pump-kit	£400.00	/item
Solar Pump (ex-trough)	https://www.farmcareuk.com/waterpumpsolar.html	£800.00	/item

4.42 Historically, the Levels have supported populations of breeding waders that also use the nearby SAC for feeding. Bird numbers have declined significantly over the past 30 years, with loss of extent and quality of habitat possibly due to improved drainage and other agricultural practices a key factor. The integration of wet and watercourse features with potential to support wading birds into wetlands is well established, although they often displace relatively intensive agriculture by rewetting fields.

4.43 In the Gwent Levels there is potential to adapt suitable wet ditches to establish habitat by creating asymmetric cross sections with one or two berms with potential to provide damp,

¹² Estimated from Standard Costs

vegetated areas for feeding and breeding waders. This would involve the loss of a strip of about three metres of land on one side of a ditch line, which, when single-sided could be seeded or left to regenerate from established vegetation on the opposite bank.

Operation	Outcome	Cost	Unit
Construct wader area ¹³	Profile bank (100m) and prepare for regeneration.	£2,250.00	/100m

5 Grassland and associated habitats

- 5.1 Wet grassland is a rapidly diminishing habitat across Britain and large areas of the Gwent Levels are based on this traditional farming system. The value of wet grassland is recognised for provision of benefits over and above its conservation value. Carbon sequestration, flood alleviation, nutrient and pollution absorption and groundwater recharge are all services delivered by the habitat. The Levels have extensive areas of occasionally inundated pasture or meadow with ditches that maintain summer water levels and drain land in the winter. Almost all remaining areas of wet grassland are grazed and some are cut for forage, although traditional ridge and furrow topography does not lend itself to the use of modern farm machinery. Seasonal flooding of dry ditches and grips during and following periods of intense rainfall encourages variation in the sward but not over extensive areas.
- 5.2 Grassland and associated habitats can also be managed for pollinators and other beneficial insects. Measures include the establishment and management of field margins including pollinator strips and banks, and wildflower headlands as well as the larger scale establishment of herbal leys that have benefits for pollinators, soil health and soil organic matter levels.
- 5.3 Experience gained on wetland pastures in Norfolk suggests that some permanent pasture can thrive with long-term waterlogging, but modern herbal/pollinator seed mixes can be carefully specified for the conditions prevailing in the Gwent Levels but would probably need to be reseeded or otherwise refreshed every three to five years. Whilst there are few scientific papers describing outputs from herbal leys there is a great deal of hearsay evidence and published information that suggests that yields from well managed herbal

¹³ Estimated from standard construction costs: John Nix Pocketbook for Farm Management. 2020. 52nd edition

leys can match or even exceed those from the ryegrass leys that have been widely adopted in grazing systems since the 1940s.

5.4 In the Gwent Levels, thin rectangular field shapes and small field sizes mean that margins that require separate management are generally longer and therefore occupy a disproportionate area of fields in relation to the 'productive' area. Consequently, the establishment of perimeter pollinator strips, which also have to be fenced off from the grazing block, is unlikely to be attractive to farmers and landowners without significant support.

5.5 Costs for the establishment of pollinators strips are set out in the table below.

Operation	Outcome	Cost	Unit
Pollinator strips ¹⁴	Damp meadow wildflower mix @ £52.60/ha – cultivations etc.	£25.00	/500m ²
	5m wide strip	£2.63	/100m
	10m wide strip	£5.26	/100m

5.6 It is more likely that greater benefit to insect populations and better returns would be realised from the establishment of herbal leys, which include nitrogen fixing plants, across entire or parts of fields, which can then be managed as a whole for production rather than as long, conserved strips, which can carry significant cost of fencing and mowing to a business. There are two systems of management of these leys, 'mob' and 'set stocking' grazing.

5.7 Many successful herbal leys are mob grazed, that using a relatively high stocking rate but for a short time, with stock being moved on in as little as 12 hours but sometimes every one or two days, leaving at least 100mm of leaf on plants. This technique is claimed to avoid selective grazing by livestock and ensure maximum uptake of grazed vegetation. The level of husbandry required for this can involve more time spent moving fencing and livestock than is often the case with traditional grazing systems, but this can be incorporated into dairy grazing regimes or included in beef and sheep rotations.

5.8 Set stocking grazing is more traditional, where plants are grazed close to the floor because livestock are kept on land for longer. This is less labour intensive than mob grazing and as

¹⁴ The Agricultural Budgeting and Costing Book. May 2021. Agro Business Consultants and Cotswold Seeds

practiced in organic farming systems can produce competitive liveweight gains that make it economic when compared with ryegrass leys that require significant inputs of manufactured fertiliser to achieve optimum outputs.

5.9 Concerns over the contraceptive effects in sheep of the red clover included in herbal and clover-based leys, mean that whilst these leys may be suited to rearing and finishing animals, they may not be well-suited to breeding flocks. Where stock cannot keep up with plant growth, which it is understood is often the case with herbal and clover leys grown in soils that maintain a good moisture content, the surplus material conserves well as either hay or silage.

5.10 Anecdotal feedback from farmers trialing leys in the area with beef and sheep suggests that they are satisfied with the outcomes in terms of finished animals and sward resilience. The use of similar leys containing a greater proportion of red clover and little or no ryegrass is well established in organic agriculture, providing good returns driven by good animal health and minimal inputs¹⁵.

5.11 The costs of establishing leys and seed costs are set out in the table below¹⁶.

Operation	Outcome	Cost	Unit
Grazing establishment	Cultivations & Drilling	£450.00	/ha
	Fertiliser (unnecessary with herbal ley)	£138.00	/ha
	Crop protection (unnecessary for organic)	£80.00	/ha
Grass Ley	Perennial ryegrass with clover and Timothy (5y)	£66.92	/ha
Herbal Ley	Ryegrass with Timothy, fescue, clover, chicory and plantain (5y) ¹⁷	£86.80	/ha

5.12 Whilst farmers are generally reluctant to adopt systems that might reduce overall output, it is imperative that options for change are presented in ways that set out comparisons of profits likely to arise from practices. It would be beneficial for support in the form of advice to be provided for farmers in the Levels in order that decision-making regarding wetland management is properly informed. This would ensure that the full range of management options were considered when forming strategic plans in an economic

¹⁵ Pers. Comm. Mark Measures, Jake Fiennes, Mark Smart

¹⁶ The Agricultural Budgeting and Costing Book. May 2021. Agro Business Consultants

¹⁷ Cotswold Seeds

environment where subsidies for stocking and production are likely to be replaced by payments for public goods, such as those delivered by some of the measures described in this paper.

5.13 The table below sets out a comparison between outputs from three grassland systems producing forage. Comparison of yields against each other and production costs per tonne taken from standard costs shows that the improved grassland not only produces the greatest yield but that it does so most economically. In this example, the reduced cost per tonne produced does not compensate for the lower output¹⁸.

Improved grassland (ryegrass)	Unimproved grassland	Herbal ley
3 x cuts of 14.8t/ha = 44.4t/ha (100%)	2 x cuts of 16.05t/ha = 32.1t/ha (73%)	1 x cut of 15t/ha + 1 cut of x 12t/ha = 27t/ha (61%)
3 x application of fertiliser @£86 per app = £258.00	2 x applications of fertiliser @ £86 per app = £172.00	No fertiliser requirement
£444.60 per ha reseed / four years = £111/ha/year		£470.00/ha reseed/four years = £117.50/ha/year
3 x £167.96/ha/year harvesting cost = £503.88	2 x £167.96/ha/year harvesting cost = £335.92	2 x £167.96/ha/year harvesting cost = £335.92
Cost: £19.84/tonne (100%)	Cost: £15.82/tonne (80%)	Cost: £16.79/tonne (85%)

Comparison of forage outputs and value by grassland type

5.14 Whilst the simple economics of grassland production are relatively straightforward, and show that there is an evident financial benefit from the improvement of grassland for grazing and forage production, the additional benefits in terms of ecosystem services and reduction of pollution risk delivered by alternative grazing systems should also be considered.

5.15 Stock kept on unimproved grass often also require supplementary feeding with concentrates to achieve the daily live weight gains achieved from young ryegrass and herbal leys. This is very likely to drive the equivalent cost per tonne of feed beyond that of improved grassland.

5.16 If the yield of a herbal ley can be increased to 37t/ha, for instance with grazing, then it would be as economic as ryegrass production on a weight for weight basis. If equivalent yields were achieved, and evidence suggests that herbal leys are capable of producing

¹⁸ Pers. Comm. RSPB and Cotswold Seeds

greater fresh weight outputs¹⁹, then the value of outputs would be about £14.15/tonne, that is about 28% less than the cost of grass from a conventional ryegrass ley.

- 5.17 The actual performance of leys in specific situations, as with specially designed mixes in the Gwent Levels, can only be determined through crop trials and the tabular data for herbal leys is very conservative.
- 5.18 In the context of a livestock business, the performance of both grazing and housed livestock can be measured by Daily Live Weight Gain (DLWG). There are only a few monitoring points throughout the life of the cattle. Taking the following points as the average:
- a calf weighs 40kg at birth, growing to 400kg at 12 months, 500kg at 24 months and finishing at 720kg;
 - cattle have to be finished before 30 months to avoid a 60p/kg penalty applied on animals between 30 and 36 months. Cattle older than three years cannot enter the food chain; so
 - ideally animals would be finished at 29 months, which equates to an average 0.77kg live weight gain per day.
- 5.19 In order for any grazing system to be viable sustainable and competitive with established systems, the diet should not only achieve a good liveweight gain but should also provide sufficient energy, protein and vitamins to ensure that animals are healthy and robust.
- 5.20 In addition to verbal evidence from farmers on the Levels, an article in Farmers Weekly²⁰ described a beef operation on well-drained brash land in the Cotswolds, running a herd of 45 pedigree Hereford beef cattle plus followers with calves weaned at nine months and finishing at 22 months. Animals from this herd were finished at a minimum 270kg deadweight (540kg live weight with a Kill Out %age of 50%), driven by an average spring liveweight gain of 1.32kg/day, well in excess of the required performance.
- 5.21 In this system, finishing cattle were turned out to graze in April in mobs of 54, followed by groups of 56 younger stock on paddocks between 0.4ha and 0.8ha. They were moved every 24-48 hours, leaving residual grass on pastures that were then rested for about 30 days in periods of vigorous grass growth, extending up to 90 days when growth slows in

¹⁹ <https://www.soilassociation.org/media/18970/grass-seed-mixes-final-report.pdf>

²⁰ <https://www.fwi.co.uk/livestock/grassland-management/a-guide-to-mob-grazing-livestock>

the autumn or during dry periods. It is unlikely that growth would be suppressed by drought in the Levels except in the most extreme droughts, so soil water content is seldom a factor limiting growth making it likely that this level of performance would be achievable throughout the growing season.

- 5.22 Verbal evidence from farmers using similar leys in extensive wetland grazing systems suggests that broadly similar performance would be achievable in the Gwent Levels¹⁵.
- 5.23 The farm described above was in England's Higher-Level Organic Countryside Stewardship scheme, which helped to cover herbal ley establishment costs. Whilst similar funding is available under Glastir, both for conversion to and maintenance of organic status, there may be resistance from farmers to registering land as organic. Whilst it is necessary to register as organic to be able to sell produce labelled as such, many farmers operate systems that are effectively managed as organic within an integrated farm management system.
- 5.24 Unlike cattle, sheep are less target driven and can be finished on any grassland system, governed by a generality that input equates to live weight gain. Thus, provided grazing is palatable it will produce results; hearsay evidence from local farmers suggest that sheep and lambs thrive on herbal leys.
- 5.25 Other factors, including weather, ground conditions, parasitic worm burden and the condition of animals also play a role in production. Again, hearsay evidence strongly suggests that a rich, diverse and vigorous sward dries the soil surface, does not support a significant level of worms (where it is not grazed too tightly) and presents animals with a varied diet supplying a wide variety of plants and nutrients.

6 Hedgerows

- 6.1 Responses by farmers to interviews with this project have found that some in the Levels regard a hedge as the cheapest and easiest way to maintain a stockproof boundary. This reasoning may also underlie the lack of maintenance of ditches and reens where there is a hedge alongside. However, many waterside hedges also go unmaintained, and this results in conditions where stock are from time-to-time lost in relict reens obscured by dense, often impenetrable, vegetation during the summer months. The consequence of this is often that carcasses of lost animals are left in blocked watercourses until autumn, when they can be found and removed.

- 6.2 This phenomenon suggests that whilst farmers favour options that are perceived as cheaper, this is not always the case because the boundary is unmaintained and encroaches on the grazing area. A good stockproof hedgerow has to be planted correctly and well-maintained in order to provide a stockproof barrier and maintain the maximum grazing area. However, hedgerow planting is often not appropriate in the Levels landscape and most often good management and even removal is required to protect surface water features.
- 6.3 Glastir requires that planted hedgerows should comprise a double row of native trees and shrubs planted at a density of seven plants per metre with 0.2m between each row. The plants should be protected from livestock and failed plants replaced. There is no support for specific hedgerow maintenance.
- 6.4 Hedgerows with some feature trees are an historical feature in the local landscape, as seen in aerial imagery from 1945 taken from Google Earth, below. The purpose of these features is unknown but many individual shrubs and trees are clearly visible across the Levels in the images rather than laid, stockproof hedge lines. It is possible that rapidly growing species such as willow could have grown to the sizes seen during the war years when vegetation management may have been neglected but this could only be determined by detailed examination of this and other aerial photographic records.



Figure 8: Aerial imagery from 1945 showing field boundaries and watercourses defined by hedgerow trees and shrubs

- 6.5 Hedgerows do not only provide a service to farms, they also sequester carbon in root and branch systems and can be managed for wildlife. Conventionally, hedgerows managed for wildlife should be diverse with a wide variety of species including fruiting plants, although

managed Blackthorn does support specific populations of rare butterflies. The amount of benefit to wildlife delivered by hedgerows relies not only on diversity of plant species, but also on a varied cutting regime designed to maximise provision of habitat and food sources.

- 6.6 Such benefits would not necessarily be delivered by a conventional hedgerow maintenance regime and it may be necessary to provide financial incentives to increase the services to nature delivered by hedgerows.
- 6.7 New hedgerows should be planted to avoid shading open water areas and minimise the risk of leaf drop into ditch bottoms, and overgrown or established features restored or managed to the same ends. Hedges, standard trees and tall vegetation in a wetland landscape provide cover to protect vulnerable species from predators but can also provide vantage points for predators and so need to be located and managed appropriately.
- 6.8 In order to recreate and maintain hedgerows in the Gwent Levels, the following operations will be necessary. The tables below set out a schedule of operations with associated outcomes and costings taken from standard costs publications, including such as Nix’s Farm Management Pocketbook or personal communications with local contractors.

Operation	Outcome	Cost	Unit
Hedge trimming	Flail well-maintained hedge to triangular cross section ²¹	£**.*	/m
Hedge laying	Cutback and lay existing hedge in local style ²²	£10.00	/m
	Glastir payment rate ²³	£5.53	/m
	SAC Farm Management Handbook ²⁴	£15.00	/m
Hedge planting	Glastir payment rate ²³	£4.50	/m
Hedge coppicing and gapping up	Glastir payment rate ²³	4.50	/m
	Coppice hedge, burn brash and plant up gaps ²⁵	8.50	/m
Planting a hedgerow	SAC Farm Management Handbook ²⁴	5.40	/m
	Glastir payment rate ²³	4.50	/m

²¹ Pers. Comm. Ieuan Williams

²² National Hedgelaying Society

²³ <https://gov.wales/glastir>

²⁴ <https://www.fas.scot/downloads/farm-management-handbook-2020-21/>

²⁵ John Nix Pocketbook for Farm Management (2022)

7 Orchards

- 7.1 Orchards have played a significant role in the cultural history of the Gwent Levels and Gwent Wildlife Trust has run an Orchards and Community Enterprise project as part of the wider Living Levels project. Historic mapping of the area around Redwick shows the relationship between settlements and orchards in the first part of the twentieth century. Orchards were established in association with clusters of houses and along routes through villages rather than in open countryside, providing a diversified rural economy.
- 7.2 The Project has sought to strengthen the role of orchards in the rural economy and communities by creating new focal points and sources of income. Although this is a long term project and it will take more than five years for freshly established orchards to reach good levels of productivity, the lasting benefits to nature and local people will be significant.
- 7.3 Orchards also reinforce green space within villages providing linkages and a mosaic of trees, grasses and flowers that are habitats for invertebrates and birds as well as for higher plants, mosses, lichens and fungi.

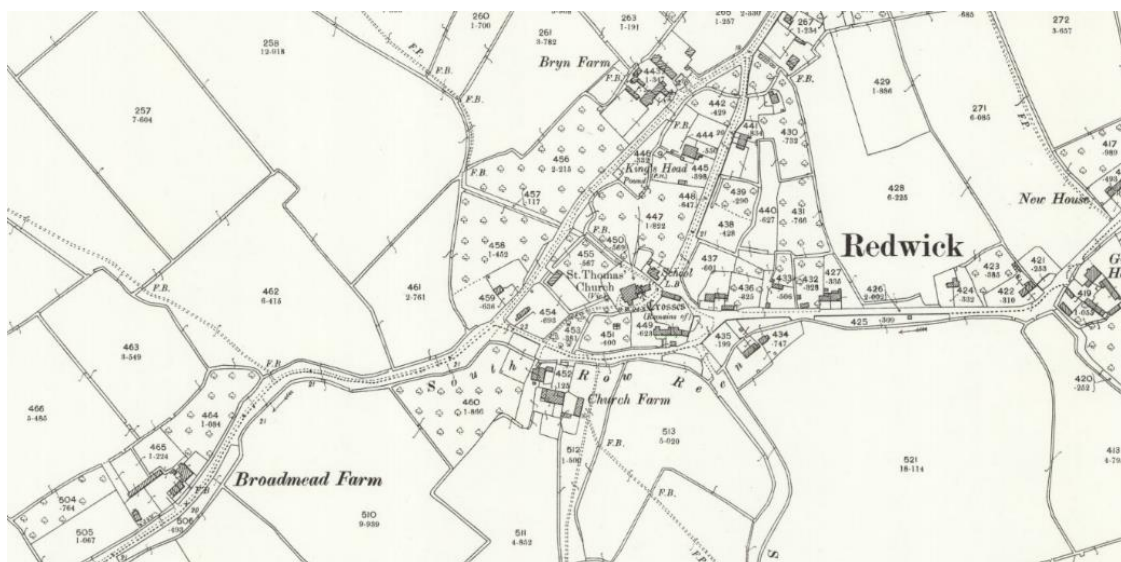


Figure 9: Extract from Ordnance Survey 1:10,560 map showing the extent of orchards in and around Redwick in 1899 (National Library of Scotland) NTS

- 7.4 Additional income can be taken from orchards by grazing sheep, which have been shown to provide benefits including scab control, rodent reduction and manure for fertiliser²⁶. Work has been carried out on several silvo-pastoral systems, including in cider orchards

²⁶ <https://www.shropshire-sheep.co.uk/sheep-in-trees/>

using Shropshire sheep, which have been shown to browse low growing foliage as well as grass but with negligible damage to trees or fruit production.

- 7.5 This dual use of orchard land would go some way toward overcoming the objections of some stakeholders, who feel that taking land out of grass production would have a negative impact on agricultural productivity. Productivity would be likely to be maintained, if not increased, if a market were established for orchard products, including speciality apples, juices and cider.
- 7.6 The combination of managed grassland and trees would also contribute to carbon sequestration in the area. Orchards may be reestablished on old sites, although this can prove difficult because of apple trees' tendency to leave residual chemicals after they have been removed, intended by individual trees to reduce competition but also preventing root growth in new plantings in areas previously stocked with apple trees.
- 7.7 Restoration of orchards has been an objective of Glastir since 2014, including capital costs of scrub removal and re-establishment of trees where required, within strict management protocols²⁷. Ongoing management of existing and restored orchards would be considered part of business costs due to the potential for a cash crop to be taken. Glastir has also included points towards a farm's qualification for inclusion in the scheme for plantings of less than 100 trees. The retention of old orchard trees is prioritised over replacement trees and new orchards, as established trees are important for biodiversity value and the majority can be pruned to prolong their life.
- 7.8 The following operations necessary to restore, recreate and maintain orchards in the Gwent Levels have been costed for this report. The tables below set out a schedule of operations with associated outcomes and costings taken from standard costs publications such as Nix's Farm Management Pocketbook or personal communications with local contractors.

Operation	Outcome	Cost	Unit
Orchard management ²³	(Glastir Option 172)	£204.00	/ha
Orchard Planting ²⁸	Orchard tree plus guard and stake	£59.83	each

²⁷ <https://gov.wales/sites/default/files/publications/2018-01/glastir-advanced-2018-rules-booklet-2-whole-farm-code-and-management-options.pdf>

²⁸ <https://gov.wales/sites/default/files/publications/2018-02/glastir-small-grants-carbon-guidance.pdf>

8 Example farms

- 8.1 In order to place the costs of works in the context of the Gwent Levels a set of scenarios have been compiled based on typical farm sizes and drainage layouts.
- 8.2 The size of farm units and density of the associated drainage network varies considerably across the study area. In the west of the area, there are several smallholdings that have not historically benefitted from farm payments along with larger units with beef or dairy production. There is more arable production in the east of the area often farming multiple parcels of land rotating arable crops with grass used for grazing and forage for beef herds. There are also dairy farms in the east ranging in size from less than 100 cows to more than 200, some with year-round housing.
- 8.3 The type of husbandry practiced has negligible impact on the applicability or cost of measures so in order to allow direct comparison a net farm income of £200.00 per hectare has been assumed, based on an income of £100/ha from farming²⁹ with the balance made up by income from basic farm and Agri-environment payments, and some diversification.
- 8.4 Farm X is a lowland mixed farm of 90ha, average net income for this type of farm is £18,000 a year.
- 8.5 Farm Y is a similar farm extending to 56ha, average net farm income from a unit of this size is £11,200 a year.
- 8.6 Smallholding Z extends to 15ha and has an income of £1,500 a year from farming but does not benefit from basic farm or Agri-environment payments.
- 8.7 Through this project we have established the costs of delivering a suite of SMNR actions that may apply to some or all of the farm types comprising:
- Ditch management = £1,300/km/yr;
 - Management to benefit pollinators = £25/500m²;
 - Management of hedgerows = £10/m every 20 years; and
 - Establishing/Managing Orchards = £204/ha

²⁹ Brexit and our land: Securing the future of Welsh farming. A consultation by the Welsh Government (2018)

Farm X

- 8.8 On the Gwent Levels a farm of 90ha with larger than average fields could have 7km of SSSI ditch, the restoration and management of which would cost **£9,100** a year.
- 8.9 A farm of this size may be able to deliver 5,000m² (0.5ha) of pollinator habitat in the form of blocks or strips at a cost of **£250** a year.
- 8.10 The farm might have 4km of ditch-side hedgerow which would be managed for wildlife/stock management at a cost of **£2,000** a year
- 8.11 The farm might elect to establish an area of 1ha of orchard near the farmstead to diversify the business, which could be managed at a cost of **£204** a year.
- 8.12 The total annual cost to the farm business of delivering this suite of actions would be in the region of **£11,554** a year against an average annual net farm income of £17,000.
- 8.13 The cost of delivering the suite of SMNR actions in this case is more than the 50% of net farm income, which includes both basic farm and Agri-environment payments. Thus, if payments were maintained at current levels, compliance would constitute a reduction in income from farming of about 26%.

Farm Y

- 8.14 A mixed farm of 56ha with a mix of field sizes could reasonably have 12km of SSSI ditch the restoration and management of this ditch would cost **£15,600** a year.
- 8.15 A farm on this scale, it may also be reasonable to deliver 5,000m² of pollinator habitat at a cost of **£250** a year.
- 8.16 The farm might have 5km of ditch-side hedgerow which would be managed for wildlife/stock management at a cost of **£2,500** per year
- 8.17 The farm might also establish an area of 0.5ha of orchard for diversification, which could be managed at a cost of **£102** per year
- 8.18 In all this shows the costs to the farm business of delivering the suite of actions is about **£18,452** per annum against an average net income of £10,578 per annum.
- 8.19 In this case, the cost of delivering a similar suite of SMNR actions to the larger farm exceeds income by £7,874, that is £2,585 more than the 50% of net farm income made up by basic farm and Agri-environment payments, eroding income from agriculture by almost 50%.

8.20 The primary drivers for the difference in impact between Farms X and Y are the lengths of ditch and hedgerow habitat requiring regular maintenance to maintain them in a condition that will not only both provide efficient surface drainage and adequate flood storage, but also maintain and improve the condition of the SSSIs.

Smallholding Z

8.21 A smallholding of 15ha with uniform small fields typical of the western study area could reasonably have 3km of SSSI ditch the restoration and management of this ditch would cost **£3,900** a year.

8.22 The area of pollinator habitat that would be created if a similar proportion, slightly less than 1%, of the farm to that taken in Farm Y was converted, would be about 0.135ha and the benefits of scale afforded to larger conversions would not be available. Further, it is very likely that a large proportion, possibly all, of the grassland on the farm would be unimproved and not suitable for conversion.

8.23 If the holding has a significant area of improved grassland, it may be attractive to the smallholder to convert a significant area of the holding to a herbal ley approved by NRW that would deliver services similar to a pollinator mix whilst providing forage to support beef or sheep production. The cost of converting the whole holding to herbal ley would be in the region of **£7,050** (£470/ha).

8.24 The holding might have 1.5km of ditch-side hedgerow which would be managed for wildlife/stock management at a cost of **£750.00** a year.

8.25 If the farm has a suitable area of improved grassland the establishment of an area of 0.5ha of orchard for diversification may be an attractive way option for a smallholding in the Levels. The cost of managing the orchard would be **£102** per year

8.26 In all this shows the costs to the farm business of delivering the suite of actions, excluding the conversion of grassland to herbal ley would be about **£4,752** per annum against an average net income of £1,500 per annum, that is more than three times the average net income for the holding.

8.27 In this case, the cost of delivering SMNR actions is so excessive, requiring significant subsidy from other sources to make it possible. This analysis suggests that it is unreasonable to expect smallholders and small farmers to bear the costs of maintenance

operations necessary to maintain the drainage network in good operating condition and support the good status of most of the SSSI ditches in the area.

9 Policy Recommendations

- 9.1 Policy changes would have to be consulted on with technical and other stakeholders before being formally proposed. The recommendations set out here have been developed in the light of findings from the wider consultations carried out in association with this project, particularly the opinions of riparian owners and others working in lowland and coastal marsh lands.
- 9.2 Whilst farmers and land managers are generally reluctant to adopt systems that might reduce overall output, it is imperative that options for change are presented in ways that set out comparisons of profits likely to arise from practices. It would be beneficial for support in the form of advice to be provided for farmers in the Levels in order that decision-making regarding wetland management is properly informed. This would ensure that the full range of management options were considered when forming strategic plans in an economic environment where subsidies for stocking and production are likely to be replaced by payments for public goods, such as the measures described in this paper.
- 9.3 Provision of separate AES options that would allow currently ineligible ditches to be improved and maintained would fill one gap. Ditches not eligible for support would benefit from directed management to increase the amount of open water or reduce the area of heavy shade from associated hedges. Simple measures such as barriers to increase the amount of water in the ditch may also be beneficial where it does not affect drainage from third party land, if appropriate to the ditch and surrounding area and fitted with overflow pipes in case of heavy rain.
- 9.4 Ecosystem service benefits from a ditch which has a hedge next to it are often assumed to be the combined impacts of hedges and ditches, this is not necessarily the case in the Gwent Levels, where poorly-maintained hedgerows can have a significant negative impact in both drainage and habitat. The current English AES framework has existing separate options for ditch management alone, or ditch and hedge combined management where appropriate. The combined management option for ditches and hedges is similar for these features when they occur on their own. The combined option recommends that hedge trimmings should not be allowed to fall in the ditch. However, these management options

currently do not include information about reducing over-shading from the hedge next to the ditch. Hedges which create a high level of shade over the associated ditch should be cut back on the side next to the ditch. The increase in light available to plant communities may result in increased plant biomass which may in turn may lead to increased deposition of organic matter which may in turn lead to a need to increase the frequency of ditch management to maintain drainage function.

- 9.5 Payments to land managers should take into account the appropriateness of boundary features and require that hedgerows are located and maintained in ways that do not risk the degradation of associated aquatic habitats.
- 9.6 This cost to the land manger may be offset by the wider benefit of reduced sediment and potentially agricultural pollutants in water leaving farmland, leading to an improvement in both the biodiversity value of ditches and improvement in the quality of surface waters.
- 9.7 It is clear from the financial analysis that the principal environmental cost to any riparian owner in the Gwent Levels is the maintenance of ditches and waterside hedges. These costs are not related to any unit area of farmed land or number of fields farmed, but directly to the length of field boundaries within any landholding, be they internal or perimeter features. Historically, these costs may have been covered in part by payments for the maintenance of SSSI features, which are still available at the time of writing, but these are not necessarily widely taken up by farmers in the Levels. Similarly, it is understood that farmers in the area have not engaged with Glastir, possibly because of difficulties qualifying to join the scheme or simply unwillingness to engage with the grant/subsidy regime. Consideration should be given to alternative means of calculating payments, such as making use of the length of field margins on a land holding rather than its area. Such a metric could be used to direct a greater proportion of aid to farms with a significant length of field margins and boundaries which offer greater potential for delivering environmental benefit than the middle of fields that are used mainly for production.
- 9.8 In the case of the study area the most equitable way to ensure that maximum benefits are delivered to the environment would be to relate payments directly to the length of field perimeters rather than the accumulated area of individual fields. This form of payment, if monitored in line with rotational maintenance programmes submitted in support of

claims, would also ensure that maximum benefit to the environment is gained from payments.

- 9.9 The level of benefit achieved would be enhanced if land management practices, such as controlling the timing of machinery and livestock access to land or mowing regimes, were integrated into conditions attached to any agreement that may be made regarding the management and maintenance of ditches.

Gwent Levels Guidance Document (Draft)

History/Background

The Gwent Levels is an area of flat, low lying land that borders the Severn Estuary and stretches from the east of Cardiff through to Caldicot. This area has been gradually reclaimed from the sea since Roman times, and today represents the largest area of coastal and inland floodplain grazing marsh (wet pasture) in Wales, comprising two component blocks, separated by the River Usk – Wentlooge Level to the west and Caldicot Level to the east.

The landscape we know today is entirely man made, a result of reclamation from the sea which started over 2000 years. The remains of a submerged, Bronze Age forest have been recorded at Collister Pill. During this period wild boar, deer and cattle known as aurochs roamed this landscape. Mesolithic footprints have been recorded within the inter-tidal muds in the Goldcliff area, as have recently exposed Crane footprints.

Sea level has varied and at times was much lower than today. Tidal saltmarshes were gradually drained and enclosed through the creation of a complex network of drainage channels. Today much of the land is below mean high-water level and there is a general fall in land height of around 2 metres going inland from the extensive sea defences which keeps out the sea.

Traditional field drainage is by ridge and furrow or 'grips' (shallow trenches) which drain to ditches surrounding each field. Field ditches connect to larger ditches known as IDD reens that generally run east to west, they link to wider and deeper watercourses, known as main reens (main rivers) that run from north to south which convey water to the Severn Estuary via tidal flaps. The field ditches were carefully constructed so that the system drains by gravity.

The pattern and sequencing of land reclamation and enclosure is still visible today and recognised by its inclusion in the Register of Landscapes of Outstanding Historic Interest in Wales.

The Gwent Levels SSSIs

SSSIs are the most important sites for Wales' natural heritage. They help conserve and protect the best wildlife, geological and physiographical heritage for the benefit of present and future generations. SSSIs are notified under the Wildlife and Countryside Act 1981, as amended ('the 1981 Act') by the relevant country agency; in Wales this is NRW. SSSIs are highly protected to safeguard the range, quality and variety of habitats, species and geological features in all parts of Wales. The protection of SSSIs falls under Section 28 of the 1981 Act.

The Gwent Levels Sites of Special Scientific Interest (SSSIs) consist of a series of SSSIs that total 5,856 hectares. They are mostly on agricultural land (arable and pasture) and are one of the most extensive areas of reclaimed wet pasture in Great Britain, and the largest in Wales with a wide range of aquatic plants and invertebrates associated with the water in the reens and field ditches.

Comparable sites in England are the Somerset Levels, Romney Marsh and the Pevensey levels.

This biological interest was recognised as important and led to the notification of 7 SSSIs across the Gwent Levels between 1982 and 2010, as shown on the following map:



The survival of the aquatic plants and invertebrates is dependent on the sympathetic management of the surrounding land which is why the land in between the watercourses is included within the SSSI boundaries.

The qualifying features of the SSSI's can be categorised under four headings:

- **Reen and Ditch Habitat** – this standing water habitat is a qualifying feature in own right due to the species it supports
- **Plant Species** – both individually qualifying species and assemblage of rare wetland and marginal plant species including -

<i>Potamogeton trichoides</i>	Hairlike Pondweed
<i>Wolffia arrhiza</i>	Rootless Duckweed (the smallest flowering plant on Earth)
<i>Hydrocharis morsus-ranae</i>	Frogbit
<i>Oenanthe fistulosa</i>	Tubular Water-dropwort
<i>Ceratophyllum submersum</i>	Soft Hornwort
<i>Sagittaria sagittifolia</i>	Arrowhead
- **Insects and Other Invertebrates (aquatic)** – both individually qualifying species and assemblage of grazing marsh invertebrates. Over 260 species of wetland insect and

other invertebrates have been recorded throughout the Gwent Levels. For several species including the soldier fly *Odontomyia ornata* and the water beetle *Hydaticus transversalis*, the Gwent Levels are the only recorded locations in Wales

- **Shrill Carder Bee** – a terrestrial insect, once fairly widespread, now known from less than 20 sites in the UK. Within the Gwent Levels SSSIs it is associated with the reens, ditch and field margins as well as road verges and the sea wall, where there are abundant sources of pollen.

The Vision

The vision for each of the six Gwent Levels SSSIs and Newport Wetlands is detailed in individual site management statements. In summary for the whole Gwent Levels SSSIs the vision adapted from the SMS is:

‘The reens and ditches vary in appearance from deep, wide open water channels to small field ditches which may only hold water for part of the year. The majority of field ditches are unshaded by hedgerows for the majority of their length. In mid-summer water levels are still high in all the main reens and as many as half of the field ditches have water at least 20cm deep. There is very little algae to be found anywhere.

Recently cast reens and ditches contain little vegetation while others may be full of plants, this mosaic of watercourses provides an ideal habitat for invertebrates. Plants such as water plantain with its delicate white flower can be seen in almost all the ditches and others such as arrowhead can be found on many of the main reens. Submerged plants such as pondweeds and floating-leaf plants such as water starworts and frogbit, are also common throughout the drainage system.

On still, sunny days in mid-summer lots of different dragonflies, damselflies and other insects fly over the water, feeding and resting on the emergent vegetation. They are also providing plenty of food for birds such as swifts and swallows.’

The Gwent Levels flora and fauna are dependent on the following:

- Appropriate water quality
- Appropriate water quantity;
- Connectivity and diversity of the drainage system; and,
- Appropriate management.

Water Quality

Poor water quality affects all aquatic habitats, with pollution events having multiple impacts on freshwater habitats and their species.

Land adjacent to reens and ditches varies and includes grassland, arable land and developed land. The differences in land use contributes to the differences in the structure of the watercourses and the amount and quality of water it receives.

Water Quantity (Water Level Management)

Without enough water the special features (both plants and invertebrates) of the Gwent Levels would be unable to complete their lifecycles.

The Gwent Levels has a very restricted water supply as the catchment is small and the rainfall in the coastal belt is low, so water needs to be carefully managed. NRW, as the Internal Drainage District has responsibility for water level management.

Water levels are managed by various water level control structures including penstock sluices, tilting weir sluices and automatic sluices. Sluices are adjustable dams built across watercourses to hold back or release water.

For about six months over the summer water levels are kept high known as Summer Penning Level (SPL). This stops water draining into the Severn Estuary and supports the SSSI interest, provides water for livestock, bank stability, field boundaries and irrigation.

This management practice essentially creates a static water body during the summer period. In winter, the boards/sluices are removed or lowered to a Winter Penning Level (WPL) to increase the capacity of water to drain from the fields, preventing land being flooded. It also 'flushes' the summer retained nutrient-rich waters which have accumulated in the ditches.

The historic use of boards to pen the water levels in summer led to the establishment and preservation of the special aquatic flora and fauna for which the SSSIs were notified.

The IDD have a degree of flexibility to regulate the penning levels on a local basis to provide beneficial SSSI habitat, manage flood risk and assist with farming needs.

Continuation of the current pattern of water level management, including the practice of a SPL, is important and necessary to support the SSSI features.

To maintain this situation, all discharges to the Gwent Levels drainage network must occur at the equivalent of greenfield run-off rate

Connectivity and diversity of the drainage system

The drainage system of the Wentlooge Level and Caldicot Level form an inter-connected drainage network of grips, field ditches and reens which vary in physical form. For example, water depth; marginal, shallow water areas support a wide range of aquatic and wetland plants whereas deep water areas support a more restricted range of mainly submerged and floating species.

These variations increase habitat diversity and contribute to the rich diversity of the features of interest of the SSSIs. This connectivity also provides resilience to changing environmental conditions including natural habitat succession and enables the features of interest to recolonise areas following management operations.

Management

The drainage network (including reens and field ditches) are subject to varying periodic management to desilt and manage vegetation growth.

Where management of bankside vegetation has not occurred for some time, the watercourse becomes over grown and the aquatic plant assemblages, especially those that are floating and submerged, are lost. Bramble is a problem on the Gwent Levels

as it is fast growing creating a tunnel of scrub that shades out ditch vegetation if not managed. Overgrown, silted up reens and ditches reduce biodiversity and the flood storage capacity of the drainage system which could lead to increased localised flooding.

Management includes re-casting/desilting (removal of silt and organic debris from the watercourse), de-weeding and flailing (clearing of bankside vegetation (brambles, saplings, nettles, reeds and tall grasses) to keep the reens and ditches open to sunlight).

NRW undertake maintenance works on main rivers and IDD reens.

- Main reens are desilted/cast out every 4 years, de-weeded every year and bankside vegetation is usually managed bi-annually.
- IDD reens are desilted/cast out every 7 years, de-weeded every year and bankside vegetation is usually managed annually.

The landowner has responsibility for management of field ditches.

- Field ditches should be desilted/cast out every 10-30 years and bankside vegetation managed at least once every 2 years

This staggered pattern of management is an essential part of maintaining their water carrying and flood storage functions. It also ensures that a wide range of habitat conditions are present - from open water to mature wetland habitat which has led to the establishment of a rich variety of plants, animals and invertebrates.

Avoid clearing out (casting) too many adjacent /interconnected ditches at the same time to ensure that a mosaic of ditch succession is maintained across the Gwent Levels and the effective establishment of diverse wildlife communities.

Leave castings on the bankside so less mobile species have the chance to recolonise the ditches.

Invasive Non-Native Species

Vigilant for invasive species, particularly Floating Pennywort, *Hydrocotyle rununculoides*, Parrot feather *Myriophyllum aquaticum* and the presence of occasional Red slider turtles *Trachemys scripta elegans* check The Gwent Levels INNS booklet for more details on the current species found, horizon species and action to take.

Invertebrates

The presence of a good variety of habitat on a reen or field ditch should provide appropriate conditions for the variety of Gwent Levels invertebrate features to continue to survive in the watercourses. However, there is limited knowledge about the precise ecological requirements of many of the rare aquatic invertebrates. Some invertebrates have an aquatic larval stage and an adult terrestrial stage so suitable habitat needs to be present in close proximity for both stages if the species is to thrive on the Gwent Levels. A degree of poaching of the water margin by grazing livestock is important.

Other Legal and 'good practice' guidance

Dredging spoil spread away from the place where it had been dredged requires a permit not an exemption. These are not free and the standard rules permit 2010 no4 for land spreading application fee is currently set at £1,630.

<https://naturalresources.wales/apply-and-buy/waste/waste-permitting/mobile-plant-permitting/?lang=en>

<https://naturalresources.wales/how-we-regulate-you/our-charges/?lang=en>

It is a requirement under cross compliance to maintain ditches, the farmer may choose to do this himself or get a contractor to do so. Failure to comply may result in a reduction of Basic Payment scheme.

<http://gov.wales/docs/drah/publications/150111gaec7factsheeten.pdf>

This could also be a useful guide.

<https://cyfoethnaturiolcymru.sharepoint.com/en-gb/ourtools/kb/Pages/Riverside-Property-Owners---Rights-and-Responsibilities.aspx>

Farms required to observe at least the standard of Good Farming Practice over the whole of the farm

CoGAP Wales 2011 <https://beta.gov.wales/code-good-agricultural-practice>

Nutrient Management Guide RB09 – date

<https://projectblue.blob.core.windows.net/media/Default/Imported%20Publication%20Docs/RB209%20Grass%20and%20forage%20crops.pdf>

CAP Cross compliance – GAEC; SMRs

<https://gov.wales/topics/environmentcountryside/farmingandcountryside/farming/crosscompliance/?lang=en>

CAP Environmentally Sensitive Permanent Grassland

Environmental Permitting (England and Wales) Regulations 2016

Wildlife and Countryside Act 1981 (as amended) OLDSI list

Water Framework Directive

Pictures of over grown ditches with X in it ?

picture of open hedge cleared with a tick by it?

Do's - Field ditches that have been recently cast must be maintained – particularly if fencing has been erected. banks should be cut at least every other year to prevent the hedge/scrub/brambles growing back up and overshadowing the ditch.

retained hedges (ideally on one side only) should be well managed to avoid overshadowing – set height limit to aid farmer 2m??

Maintain traditional gripped pasture – what this looks like

grips help to maintain a high water table and stable hydrological regime, thereby reducing seasonal fluctuations that could dry out ditches

minimise nutrient run-off – **adequate buffer strips or headlands which prevents soil erosion, nutrient run-off and spray drift and support SCB and terrestrial inverts. Picture of good and bad? as simple as a farmer keeping a strip at the edge of his silage field for example so it remains rough grassland which will better filter any runoff from the field before it gets into ditches / reens**

pesticide spray drift -

Don't - No herbicide is to be applied within 10 m of any reen or ditch to prevent leachate entering the drainage system.

Avoid leaving soil bare for long periods, especially over winter and consider the most appropriate use of fields arable or pasture. These measures help limit soil erosion which results in a loss of nutrients and causes pollution and sedimentation problems in watercourses.

Super summary!

NATURE CONSERVATION INTEREST

The Gwent Levels is made up of a series of SSSIs located between Chepstow and Cardiff

The nature conservation interests are mostly associated with the network of drainage ditches (reens) which drain and supply water from and to all parts of the Levels.

The variety of management practices and the timing and location of management within the reens and ditches has led to the establishment of a rich variety of plants and associated populations of invertebrates.

Many species are rare or absent in other levels systems in Great Britain.

The Gwent Levels are important for both submerged plant species associated with open water, such as the hairlike pondweed (Potamogeton trichoides), and emergent plants such as arrowhead (Sagittaria sagittifolia). The invertebrate interest is associated with open water, emergent dominated ditches, flowery banks and adjacent hedgerows

MANAGEMENT OBJECTIVES

To maintain and enhance the flora and fauna in the drainage ditches by maintaining the present hydrological regime, minimising nutrient runoff from the land and encouraging a diversity of habitats within the vicinity of the ditch, its banks and any associated hedgerows.

Do - maintain a range of ditches at different stages of plant and animal succession. A planned rotation of ditch management allows an area to retain ditches at different stages of development and so support a rich variety of wildlife.

Don't - Clear all the ditches in one area or a very long length of ditch can be very damaging to the nature conservation interest.

In summary to protect Gwent Levels and ensure compliance with the various legislation the following must be applied

A min 2 metre buffer strip must be retained between cultivation and the watercourses surrounding the fields.

- Inorganic fertilisers and manufactured fertilisers must not be applied within 2 metres of surface water.
- Plant Protection Products (pesticides) must not be applied within 2 metres of surface water
- Herbicides must not be applied within 2 metres of surface water
- Organic fertilisers (including manures and slurry) must not be applied within 10 metres of surface water (6 metres if using precision spreading equipment e.g. injector system, trailing shoe or dribble bar).
- Organic fertilisers (including manures and slurry) must not be applied within 50 metres of boreholes, springs and wells.
- Any storage of material for example manure/lime/oil must have a 10m buffer
- Supplementary feeding must not occur within 10 metres of surface water.

We recommend you consider general farm management practice, and using the advice in SMR, identify areas where you could make simple management changes to protect the environment.

Ditch Maintenance in the Gwent Levels – Operations and Timings

A summary prepared by John Southall, Gwent Levels Internal Drainage District, Natural Resources Wales

The maintenance/management of the ditches is undertaken annually on a rotational basis working East to West one year and West to East the following year. It is planned and assented at the start of each year and is laid out in the work programme which we follow as closely as possible. The main tasks in reen management are set out below.

Flail Mowing

This work is undertaken mostly throughout the Summer months. We aim to mow the banks of all the ditches at least once a year. We use tractor mounted flail mowers with the heads raised as high as possible, approx. a 9' cut and we leave a 6' – 9' fringe at the base of the bank as a "wildlife corridor" where possible. The main benefits of flail mowing is to create a safe working environment for our excavator drivers when carrying out de-weeding/de-silting as they are able to see the edge of the banks. It also keeps scrub/briers from overtaking the banks casting unwanted shade onto the reens as they benefit greatly from light penetrating the waterbody.

De-weeding

This process is carried out from the 3rd week of September through to April 1st to comply with SSSI guidelines. We attempt to de-weed all of our reens annually mostly using excavators mounted weed cutting baskets. The removed vegetation is placed on the banks of the watercourse and any inorganic waste is removed. Where possible, we try not to cut tight to the banks leaving a 9" fringe as a

“wildlife corridor” as with the flail mowing. The main benefit of this is managing flood risk by creating unhindered conveyance of water.

De-silting

We aim to de-silt/dredge our reens once every seven years so we generally de-silt 7th (15%) of our reens annually. This creates greater capacity in the reen system helping to reduce flood risk. This work is undertaken by excavators mounted with ditching buckets. The removed material is placed on the land within seven metres of the top of the bank to comply with SSSI standards. This work is carried out in the same timeframe as the de-weeding.

Water Level Management

We manage water levels in the reens throughout the year to provide a reduction of flood risk and for SSSI betterment. Basically, we keep water levels high in the Summer and low in the Winter. We constantly monitor water levels and make any necessary adjustment throughout the year.

Construction

To undertake water level management effectively we need to ensure that our sluices are fully functional so our construction team undertake repairs, rebuilding and refurbishing of our sluice structures and there are approximately 150 of them.

INNS Control

Due to the sensitive nature of the ecosystem any non-native species need to be controlled/eradicated. Our most problematic species would be Japanese Knotweed, Himalayan Balsam, Floating Pennywort and Parrot Feather. We use a combination of manual pulling and chemical spraying to control these species.