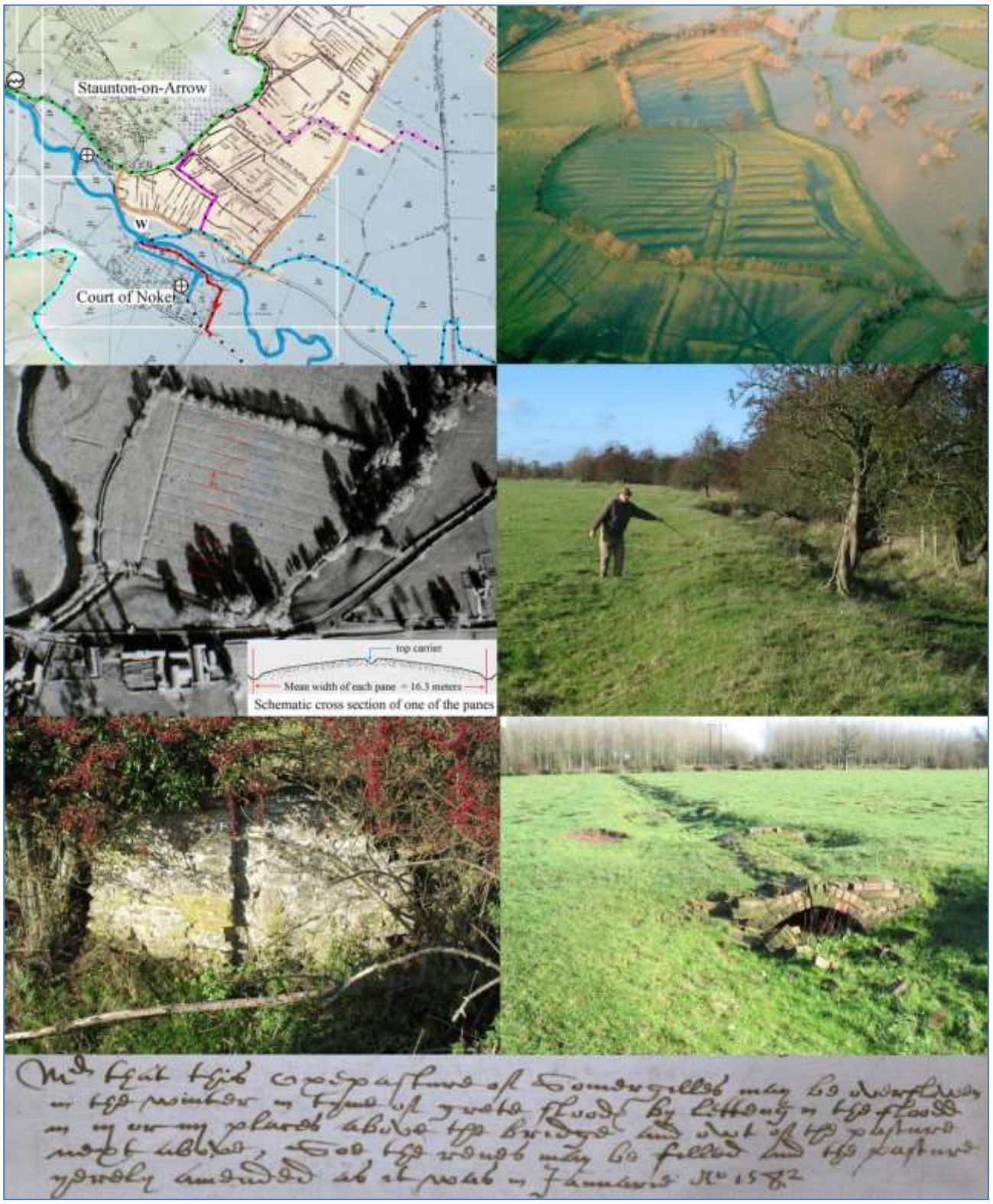
Herefordshire Water Meadows Identification Project



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1. Summary and acknowledgements

David Whitehead Associates (David Whitehead, David Lovelace and Caroline Hanks) are pleased to have been commissioned by Historic England (project number 7158) to identify the resource of water meadows in Herefordshire.

We have elucidated the origins and history of irrigated meadows in their various forms throughout the county of Herefordshire from their earliest appearance in the documentary record to their decline through the latter part of the 19th century and demise as working systems in the earlier part of the 20th century. We consider how the development of water meadows in the county was influenced by the ideas of writers and landowners within and outside Herefordshire.

There is much variability in the type of meadow irrigation practiced in the county. Simple „catchwork" systems whereby a channel is fed from a natural water course to irrigate grasslands were frequent both on hill sides and in the lowland and river valley meadows. Other methods included the control of natural flooding by entrance and exit sluices sometimes called „floating upward". Map and historical air photo evidence shows that the more sophisticated „bedwork" systems with regular ridges or „panes" (described later) and well known in southern counties like Wiltshire were also present in the county and some existed up to the 1940s. More frequent are the ridged meadows on valley floors and flood plains which have the appearance somewhere between bedworks and „ridge and furrow" originating from Medieval arable cultivation. In general there seems to have been quite a mix of grassland irrigation methods developed to suit local circumstance and economy including hybrid systems which are difficult to classify. We also examine the complex relationship between mills, mill races and water meadow management, how millers and water meadow operators co-operated and the problems that ensued when they didn"t.

A series of flights by the RAF in the winter of 1946 reveals the remarkable extent of the survival of water meadows as earthwork features in the landscape, whether active or not. The seven decades since of post war agricultural development has not been kind to the heritage of traditional farming and water management practices in the county but nonetheless many earthworks associated with water management still survive and more remain to be found.

The digital age has given us tools not available to earlier landscape historians such as the Geographic Information System (GIS), Light Detection and Ranging (LIDAR) and availability of high resolution aerial photography and we have made full use of these and our workflows we hope are transferable to similar studies in other parts of the UK.

In this report we have described 120 water meadow sites details of which are on the accompanying DVD with illustrative examples throughout this report. Some are only historic, some are candidate water meadow sites yet to be definitely classified, some sites are known and/or already on the Historic Environment Record (HER) to which we have added extra information. Characterising and defining surviving sites is important for helping land managers, owners and statutory bodies ensure their recognition, conservation and appropriate management. To this end our results will be useful to those statutory bodies such as Natural England, County Archaeology Service, advisors and the farmers themselves.

The memories of farmers and their families of the workings of irrigation systems have been especially valuable in bringing these systems to life and showing how integral they were to the pastoral economy of the county. The increasing emphasis of sustainable methods of land use especially in relation of catchment management, nutrient cycling and flood alleviation has brought a recognition of the value of these traditional systems which may yet find a role in the future countryside of the county.

One us (CH) has initiated the Herefordshire Meadows Group a recently funded project which over the next five years will be promoting and sharing with graziers and meadow owners practical methods for restoring biodiversity as well as recognising and conserving any associated historic attributes.

This project has relied on many contributors including farmers, local historians, archivists and the many organisations from whom we had sought information and advice. We are grateful for the co-operation of the many famers and landowners who have given us access to their land, guided us around their fields and hedgerows and have also shared their memories and given us first hand information about how some of these water meadows may have operated. We especially wish to thank Tony Norman of the Leen Farm (also of the Wye and Usk Foundation), Bevan of the Forge Farm, Hugh Lowe of Court Farm, Mr Lewis for memories of Moorcourt, Bill Layton and Sally Whittall of Ivingtonbury, Edward Bulmer and the Court of Noke, James Hawkins and the Warren Farm and Leonard Chase for his unparalleled knowledge of the history of drainage in the county and to farm advisor Mike Williams of the Wye and Usk Foundation. Thanks to archivist Sue Hubbard who has given us valuable archive references to meadow irrigation, to John Freeman for sharing his exhaustive field names database for indications of water meadows and to Geoff Gwatkins for his incredibly useful tithe map transcriptions with their land use and field names conveniently annotated and Beryl Lewis her meticulous transcription of the only known map of a working Herefordshire water meadow.

The staff at the search room of the English Heritage Archive and Library at Swindon have been most patient in dealing with our requests to access the many 100"s of historic aerial photographs which have proved so crucial in revealing the extent of meadow related earthworks in the county in the mid 20th century. We thanks the staff of the Hereford Archive and Resource Centre (HARC) who have help us find much of the local documentation. We have had the benefit of experience and local knowledge from local historians Barbara Joss, Kate Lack, Roz Lowe and members of the Golden Valley History Group. The project has benefitted from discussions with the land management team at Natural England and their historic landscape advisors Esther and Jez Bretherton, with county archaeologist Tim Hoverd and Historic Environment Record officer Liam Delaney for their advice and also access to some of the recent air photos taken by the Council staff. Finally we would like to thank our project manager Nicky Smith at Historic England for her support and great patience as the project overran its agreed time constraints.

We trust that this report and data base will stimulate further study, appreciation and conservation of a neglected aspect of the Herefordshire countryside.

Meadows at Ivingtonbury (see sequence SO45_Ivingtonbury_meadows)
Left: Leonard Chase, former chairman of the Lugg Internal Drainage Board, explaining the operation of the water channel supplying the main meadow water.
Middle: Remains of a wood and metal sluice gate in the hedge the controlled the channel.
Right: brick arches over the drain channels in the far water meadow.

2. Water Meadows in Herefordshire: Introduction

Just before the grassland plough-up campaign of WWII, Captain Eustace King-King (1880–1975) decided to record for posterity the details of his water meadow system at Staunton-on-Arrow that had been operating on his family‟s land for many decades previously. This he did by annotating his 25 inch to the mile ordnance survey map in pencil meticulously marking all the supply channels, draining channels, ridges and sluice gates with arrows showing the directions of flow. Such in-field structures were not depicted even on the most detailed official maps of the time but meadow irrigation can still be inferred since, as in this case, the sluices and weirs on water courses supplying the irrigated fields are usually shown. Nonetheless, King-King‟s annotations constitute the only known map of a water meadow system in Herefordshire see pages 30 and 66.

Most permanent grassland in Herefordshire, along with any earthworks such as water meadow structures, has been ploughed up at some time during the last century, a large proportion since the 1950s. It was therefore fortuitous that there was an air photographic sortie undertaken by the RAF over parts of Herefordshire on the 4th December 1946[1]. At this date the sun casts long shadows enhancing surface topography which for low lying land was made more visible on this date by the water lying in hollows and channel bottoms. This remarkable series of vertical air photos shows that ridges and channels especially in valley bottom meadows were common place even after the plough-up campaign during WWII. Below is a geo-referenced example:

The practice of irrigating grassland has a long history and has been observed in many countries. The aim is to stimulate more early productive forage growth and to supply water during dry spells by using only the natural resources of the locality. The factors conferring these advantages include nutrient enrichment, increasing ground temperature in early spring, oxygenation, increasing pH and these aspects have been investigated by a number of researchers[2]. The effort of construction and management needed to be repaid by benefits to the pastoral economy both for individual farmers and the countryside as a whole. Past advocates of „watering meadows" included John Fitzherbert[3] (1523), Rowland Vaughan[4] (1610), Samuel Hartlib[5] (1651), George Boswell[6] (1779) as well as the examples of actual systems carried out by entrepreneurial improvers such as the Earl of Pembroke on his Wiltshire estates in the 17th century. To question as what extent the various advocated methods were transferred to Herefordshire or whether meadow irrigation practices were already well established in the county has been obscured by the latter day fame of Herefordshire landowner Rowland Vaughan and his book published in 1610 *Most Approved and Long experienced Water Works* a subject we consider in detail. In his book Vaughan tells us that he was inspired to embark upon his water meadow projects by observing the beneficial effects on grass growth of water escaping from a mill race. We find a close connection, not always complementary, between the requirements of the water mill and those of meadow irrigation.

One of the simplest forms of meadow irrigation is the „catch-work" system whereby a spring or water course is interrupted by a channel or series of channels dug to follow the contours of a hillside or along the raised parts of a lowland meadow. To allow the water to spill out into the meadow, breaches are made in the channels which could be as simple as removing clods of earth at intervals or permanent sluice gates. We have found a number of examples of these systems both in the hill areas (The Quakers Farm in the Escley valley page 57) and the lowlands (Lugg valley at Aymestrey page 42) and the Curl brook at Moorcourt (page 34). In the case of the Quakers Farm a number of channels radiate out from just below the farm yard onto the meadows below to distribute water and nutrients along the hillside meadows of the valley.

Another simple form of meadow irrigation is referred to as „floating upwards" whereby entrance and exit sluices are in place to temporarily impound and otherwise control flood water on a meadow especially to encourage silt and nutrient disposition. This practice appears to have been in operation in the late 16th century at Eyton on the Lugg (see page 8) and probably on the Dore valley water meadows (see page 10). The flood water should not lie too long otherwise anaerobic conditions would develop damaging the grass roots and offsetting any advantages of the inundation. It is easier to control the movement of water on land with the small gradients typical of river valleys if the water is channelled by ridges, as Hadrian Cook (with his co-authors) observes in his study of the origins of water meadows in England „Without ridges it would not have been possible to keep the water moving steadily across the surface, as the technique required: moving water dissolves oxygen but stagnant water creates anaerobic conditions, inimical to grass growth"[7].

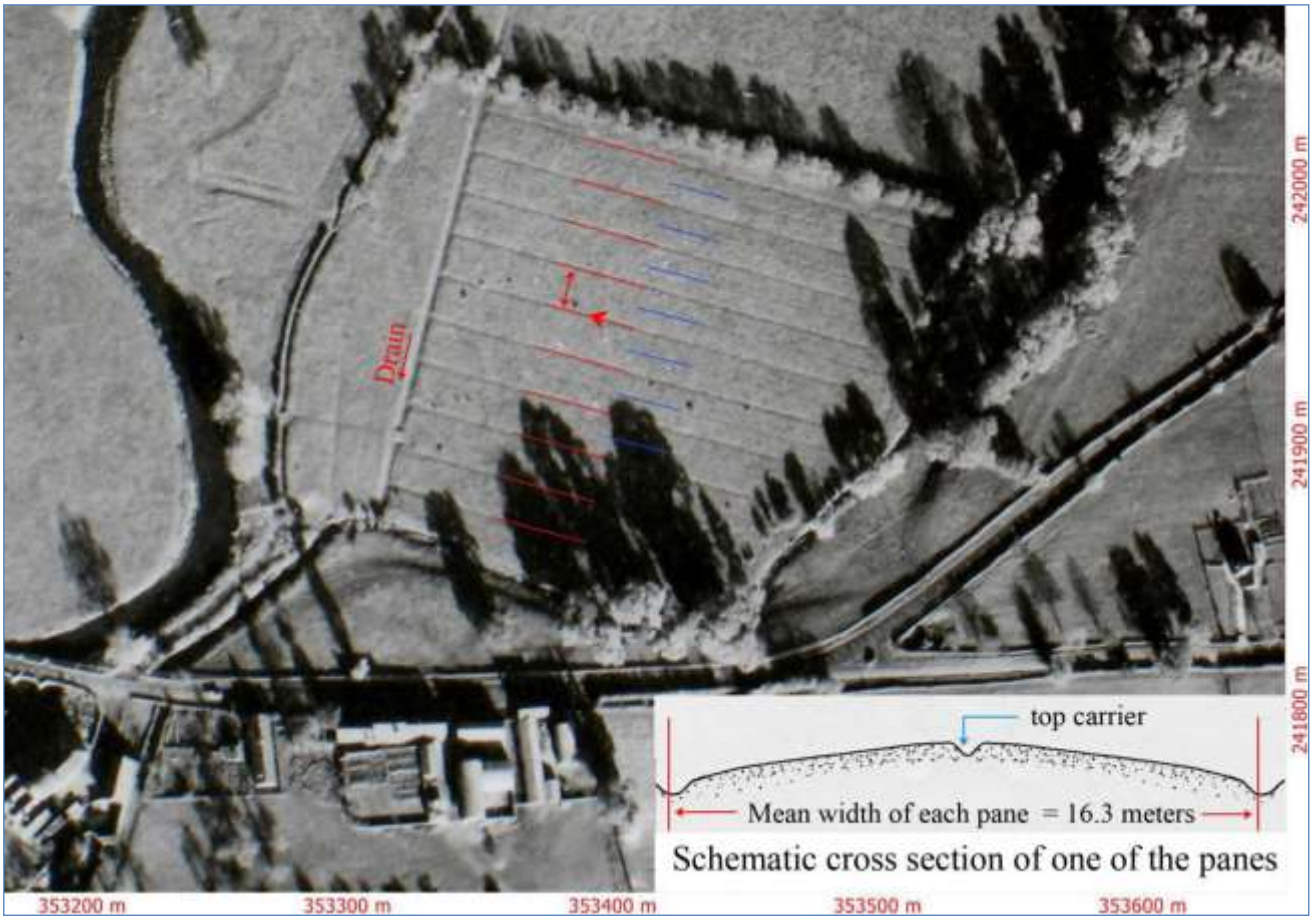
Indeed a great many valley bottom meadows, likely to have in grass for many centuries[8], are ridged as shown by the 1946 air photos and presently in well preserved surviving examples in the Lugg valley between around Sutton and Shelwick (see pages 47, 48). Some of these ridged meadows are probably artefacts of Medieval arable cultivation whose plough teams, anticipating the turn at each headland, produced ridges with a characteristic sinuous „reversed „S" shapes. If such ridges had no utility or were an encumbrance farmers were quite capable of flattening them out by ploughing if they wanted to as was evident in a court case of 1627 referring to a meadow in the manor of Credenhill (probably in the Yazor valley). The tenant there, accused by his landlord of damaging the lands, claimed that on the contrary he had improved the lands including the „Great Leasow" which „lay in highe ridges.. and that the same leasowe was the better for the plowinge and laying playne"[9].

A court case between the operator of Lugg mill and the owners of those meadows around Sutton and Shelwick in 1847 proves that these ridged meadows were being indeed being operated as „floated" water meadows and that the ridges were being used to assist in the control water flow whatever their origins may have been (see pages 47-49).

At appears that ridges created by arable cultivation in river valley valleys, perhaps during the expansion of Medieval arable cultivation prior to the Black Death, had utility in water control when returned to grassland. A possible additional benefit of the corrugated surface is the water table height varying to suit sward growth at different conditions through the year. The extent to which arable ridge and furrow later served meadow irrigation is difficult to determine but the overlap between the two is clearly established.

A more difficult question to answer is to what extent the „bedworks" system of „floated" water meadows was in operation in Herefordshire and to what extent the county"s ridged water meadows past and present were similar. The bedwork systems is more sophisticated and involves the creation of parallel ridges or „panes" along the tops of which water runs along a small gully or „top channel" and then flows out on either side over the grassland and into lower receiving channels between the „panes".

These systems were generally constructed on meadows in valley bottoms where the more level ground required the greater control of water flow afforded by the ridges and channels. The best surviving examples are along the river Avon in Wiltshire: the Harnham water meadows and those at Lower Woodford[10]. It is unclear whether the ridges of the Shelwick meadows had top channels along them; if so, they are not visible today, although decades of livestock grazing may well have erased them. There are however some meadows that appear in the RAF photos of the 1940s which are clearly well planned with ridges that are entirely straight and parallel in contrast to those with more sinuous and variable ridges. One example is the meadow just north of Lugg Mill and part of the legal case mentioned above (and see pages 47-49). In this RAF air photo below which was taken on the 7th November 1941 both the top and drain channels of the panes are visible. The building in the SW corner is Lugg Mills, see SO54_LuggBridgeFarm.



From what can be deduced from the King-King map of the Staunton-on-Arrow meadows they appear, in part at least, to be a bedwork system. The water meadows that he mapped occupied about 80 hectares but the evidence from maps and oral history indicates that this was a small fraction of the total area of managed irrigated meadow that had extended over 100s of hectares of the low lying land of the River Arrow valley as it opens out from the confined valleys of the uplands and into the expansive flat lands between Pembridge and Staunton-on-Wye. The main channels alone which supplied the water meadows (those that appear on the contemporary OS map or can be traced on the ground) have a combined length of at least 17 km (see page 30). The water meadows of the Wigmore Basin were of similar extent and complexity (see page 23) and in both valley landscapes the main channels also supplied water mills.

One overlooked benefit of these large extended valley system with their myriad of channels, mill races, sub-channels, controlling weirs and leats was their role in distributing and reducing the kinetic energy of their associated main rivers. Anecdotal evidence is that the operation of water meadows thereby reduced flood events, at pertinent issue at present so it would be useful to quantify the effect in a hydrological simulation.

By the end of the war the King-King meadows were almost all erased by the plough by order of the county War Agricultural Executive Committee (WAEC) (see page 66) and although many other water meadows survived to be photographed by the RAF in the 1940s most have been destroyed since. Nonetheless, the remains of former water meadows and their channels can still be found on many farms in the form of old sluice gates, abandoned channels and indeed sometimes unploughed meadows or parts thereof.

This project has recently contributed to the Herefordshire Meadows Group, a new five year facilitation project funded by DEFRA to encourage the conservation management of grassland on farms along with their historic attributes including the identification of water meadows or their remnants.

Our results will increase the awareness of the water meadow resource in the county, stimulate further research and field work, add to the knowledge base of the Historic Environment Record and assist farm advisors to identify any features associated with water meadows and to help target agri-environment funds for their conservation management.

In recent years there has been an upsurge of interest in water meadows, their history conservation, restoration and community engagement. In the coming years there will be much discussion and lobbying regarding the future of farm and rural support post-Brexit so this report we hope will contribute to the advocacy for proper recognition of water meadows not just as an important heritage aspect of the countryside but also as a contribution to a sustainable rural future.

C. R. H. Sturgess, a drainage officer who was also involved with the work of the WAEC, published the notes of the system supplied by King-King and writing in 1947:

„that since the late [nineteen] eighties the "floater" ceased to have been employed by one farmer after another, but that in the course of the preceding 200 years the texture of the soil was changed from poor heath soil into that described as alluvial, as over the course of the years the silt was floated on to the land from the irrigation channels. There were more such systems in Herefordshire, but I do not know of one in working order; this is a very great pity, as I feel that even with all our modern methods in agriculture we may have lost something worth while“[11].

3. Methods

3.1. Documentary sources

We have used a variety of primary and secondary sources for this study which have been augmented by the discussions we have had with a number of farmers who have given us unique insights into meadow irrigation practices otherwise unrecorded in documentation. Our primary sources include those from the British Library, the National Archives, English Heritage Archive and Library at Swindon, Brasenose College Oxford archives and the Herefordshire Archives and Records Centre (HARC). We are grateful to fellow local researchers who have kindly shared the fruits of their labours, notably John Freeman in allowing us access to his Herefordshire field names database and to Sue Hubbard for references to water meadow management of which we would not otherwise have been aware. We highlight the War Agricultural Executive Committee (WAEC) farm surveys, maps and minutes (TNA series MAF32, 73 and 80) which are essential in helping to understand the pressures on farmers and administrators to increase arable production during and just after WWII. The mechanised decline of traditional farming practices set the direction for farming in subsequent decades and sealed the fate of many water meadows and indeed other earthworks in grassland.

3.2. Maps, LIDAR and historic aerial photographs

In presenting the evidence for past and surviving water meadows along with their associated infrastructure such as sluice gates, weirs, channels, leats and mill races, we have relied heavily on maps of different epochs and aerial photographs, historic and recent, oblique and vertical. The release in 2014 of the national data set of Digital Terrain Model (DTM) data derived from LIDAR flights (2006 onwards) by the Environment Agency opened a new window of opportunity to discover and/or confirm the presence of earthworks. We have used a Geographic Information System (GIS) to geo-reference these various maps, air photos and DTM files into a serious of time-ordered raster layers for each site that we have identified. Bounding rectangles for each site are defined as an additional vector layer containing tabular data pertinent to each site. We have attempted as far as possible in the time available to cross reference the GIS layered raster site with the documentary, archive and oral history evidence. Each site has a uniform set of geo-referenced GIS layers comprising the following:

3.2.1. Tithe Maps

The tithe commutation act of 1838 sought to formalise the parish ecclesiastical tax system of customary payments in terms of a standard based upon land area and its productivity. This required surveys for each parish resulting in a data set for each of the land parcels, the „apportionment", identified on a large scale „tithe map" mostly made in the years 1840 to 1842. The apportionment recorded ownership, tenant, area, land use and field name for each parcel in a parish so producing a detailed picture of the landscape at that time. We have made use of the set of printed black and white county tithe maps transcribed by historian and calligrapher Mr. Geoffrey Gwatkins. These had been scanned, colour coded for land use and geo-referenced to the modern grid. This map set defines the earliest time layer in our site sequences and is useful in showing field names which can be suggestive of land use and associations. A good example are field associated with mills and mill races typically "Mill Meadow" and occasionally a name such as "Water Furrows". The tithe surveys were conducted at a time of comparatively high arable but it is noticeable at this time is that the valley bottom fields are almost always grassland, usually „meadows" otherwise „pasture".

3.2.2. 25 inch to the mile Ordnance Survey maps 1st and 2nd editions (c1885, c1902).

These maps give the greatest detail and are considered the high point of British cartography. Of particular interest to this project is they provide detail of watercourses and associated features such as weirs and sluice gates. As with the tithe maps, we have used the digital geo-referenced versions of the maps for importing as raster layers into GIS.

3.2.3. The Dudley Stamp Land Utilisation Survey map 1936

These maps were created as part of a national study of agriculture in England and Wales and record grassland, arable, orchard, woodland and marginal land at field level on 1" OS maps. They can be used to an approximate extent to determine the continuity of grassland from earlier maps especially the tithe maps and also as baseline when comparing the same fields with post war agricultural developments..

3.2.4. The RAF aerial photography 1946 to 1959.

These high resolution vertical air photographs are a valuable record of the countryside before the period of post war subsidised agricultural intensification which erased many of traditional features including earthworks, field boundaries. We have been able to identify a number of features in the photographs associated with water management and other earthworks. Of particular interest are the flight sorties carried out in the winter months of December and January when the sun is low bringing out the topographical relief of the countryside below. The appearance of ridges, channels and other earthwork features in grassland are further enhanced due to water lying in the channel bottoms and for one of the sorties snow lingers highlighting earthwork features. Some of these features do not appear on the earlier detailed maps and where they have been subsequently destroyed ,these air photos are often the only evidence that they ever existed. All such aerial photographs have be digitised and geo-referenced.

3.2.5. Oblique aerial photography 1950s to present.

We made extensive use of the site specific aerial photography held in the „red boxes" at the National Monument Records Centre at Engine Hose, Swindon part of the Heritage England. These air photos have been occasionally augmented by recent air photos held at HARC.

3.2.6. Modern colour aerial photography

We have used two sets of available recent geo-referenced photography: the UK Perspectives aerial photography flown around 2000 and that available via the online Bing Maps (formerly Microsoft"s Virtual Earth) which are from the year 2012. These give an indication of whether earthwork features identified in earlier years still survive, for example if the field in question is now arable or whether boundaries and watercourses have been removed and ploughed out. Comparing 2000 and 2012 can show if features have been lost or damaged in more recent years.

3.2.7. Digital Terrain Model (DTM) data

Just before the start of the project the Environment Agency released its DTM data derived from LIDAR scans commissioned to create 3D topology for flood defence and prediction purposes. For Herefordshire, the released data sets are from 2006 to 2009 and have horizontal resolution of 2 meters (some small areas 1 meter) fairly low by modern LIDAR scan standard. However this resolution is sufficient to show much earthwork topography. The most frequently used technique in visualising DTM numeric files is as hill shade however this is often insufficient for features with small height variations. We have experimented with various methods of visualising the often very subtle height variations in possible sites of irrigated meadows, especially if they have been degraded over the years by farming practices, and have found that the Local Relief Model (LRM) method[12], which essentially applies a high pass spatial filter to the DTM height matrix, gives the most consistent visualisations. We then amplify the heights in resulting resampled DTM file and then apply colour coding and/or shading to the result. This process can also be considered as taking the differential in „x" and „y" of the 3D surface function at each pixel so I have identified DTM image files so processed as „DTMdiff".

The DTM data also allows the creation within GIS of fine contour lines to show small changes in height across fields which is important in determining the direction of water flow and to confirm that what appear to be channels supplying water as part of a catch-work system actually do follow along the contours.

3.3. The project GIS and site data formats

We have mainly used the GIS software package QGIS (www.qgis.com) and for specific functions such as the Local Relief Model algorithm for DTM processing, Manifold GIS (www.manifold.net). For each site, its vector bounding box is used to create a sequence of geo-referenced maps, air photos and DTM visualisations with identical dimensions determined by the bounding box. The bounding box vector layer also has the data relevant to each site in its attribute table which includes site name, raster layers which make up the sequence, status and HER number (in any). These raster layers include the above data sets of maps, air photos and DTM where relevant or existing. Each site will have typically 6 to 8 raster layers depending upon availability of the historic . Since the raster layers cover all of Herefordshire and are several Gbytes in size, the site specific layers are exported from their locations in GIS as jpg images with OS grid lines around each individual map image. The map sequence for each site is most conveniently viewed as a „slide show" web page which can used on or off line. The sequence of images for each site is also placed into a single zip file so that individual maps/air photos/DTM visualisations can be viewed independently or assembled as a layered image file in a package such as Adobe Photoshop as required. The site bounding boxed vector layer can be exported as a shape file and/or the attribute table exported as an excel spreadsheet or database.

There are 126 sites that we have identified whether historic, existing or degraded and whether definite or candidate sites requiring further investigation. This means that there are about 1,000 individual map/air photo/DTM images. This does not include the photos from field surveys which are included in the sequences for sites where we have carried out field work.

The component images files in the sequence for each site are identified by their file name which consists of the 10 km square of its location, the name of the nearest farm or land mark and the type of image, whether air photo, map or DTM. For example the map sequence for the field system just south of Lower Kinsham Mill has 6 components to its sequence:

SO36_LowerKinshamMill_TMG.jpg	Tithe map (Geoff Gwatkins Transcription)
SO36_LowerKinshamMill_1885.jpg	25" to mile OS map 1st series
SO36_LowerKinshamMill_25000.jpg	Current 1:25,000 OS map
SO36_LowerKinshamMill_AP1946.jpg	1946 RAF air photo
SO36_LowerKinshamMill_AP2000.jpg	2000 air photo
SO36_LowerKinshamMill_DTMdiff.jpg	LIDAR derived DTM surface differential

All this data is in the form of an interactive zoomable map of the county where the sites can be clicked to trigger the slide sequence web page for that site. This can be placed on a server, a local machine, DVD or other portable storage device.

3.4. Field surveys

This project is mainly a „desk exercise" but we have visited a number of sites where we have taken geo-located photographs of the main features. Given the time constraints of the project we have not undertaken full surveys of those sites but the combination of DTM visualisation, air photos and maps together with our field photos where we have taken them should give a reasonable impression of each site and from which further study can be made.

3.5. Oral history

We are most grateful to some farmers and farm workers with long memories for their unique personal recollections as to the nature of the water meadows and how they operated. These we have recorded in note form which also contain much valuable information about farming systems some of which were dying out when our interviewees were children.

4. The earlier history of the Herefordshire water meadows

Known documentary evidence for the control of water in the county in Medieval times is mainly concerns water mills and by implication the mill leats and mill ponds which supplied them. Domesday records a mill in Shelwick Manor (SO530430, and see below) and a high proportion of Inquisitions Post Mortem surveys of manors have references to water mills, an early one being the water mill in Gillow manor (SO531256) dated 1275[13]. There are a number of legal cases involving people being accused of interrupting water supplies to mills, for example a 1275 King"s Bench case[14] against a six people for „interruption of the flow of water to two mills in Wellington". The reason is not specified but the diversion of water for land irrigation is a possibility since our field survey, map analysis and later documentation establish that the controlled supply of water to mills was also used to irrigate meadows.

Direct documentary evidence for the managed irrigation of grassland has yet to be found earlier than the Elizabethan period but there are many field names suggestive of the practice such as "Waterlodemedue" (Ballingham c1310), "le Flodgatesmeduwe" (Colwall 1320), "Watermede" (Netherwood 1413), "les Floodyates" (Hampton Bishop 1500), "le Flodiat" (Much Marcle 1543), "Carriers meadow" (Sarnesfield 1631) and "Water Furrows" (Sutton 1632)[15].

The earliest known record for managed irrigation so far found is from the manor Eyton in the Lugg Valley: "*That this ox pasture of Somergilles may overflown in the winter in time of great flood by letting in the flood in 3 or 4 places above the bridge and out of the pasture next above, so the renes may be filled and the pasture yearly amended and it was in January 1582*"[16].

This describes the practice of „floating upwards", a primitive type of managed irrigation whereby inundation of a meadow by a natural flood event is controlled by entrance and exit sluice gates. The location of this field can be identified from the tithe map (1840) for Eyton and lies alongside the river Lugg whose valleys were had many water meadows (see section 12). The LIDAR derived DTM raster image for this field reveals strong ridging and these maybe the „renes" referred to in the document. Notice how one part of the Sommergall meadows have been ploughed destroying the earthworks. The date mentioned, 1582, is same date that Rowland Vaughan entered into Newcourt estate on his marriage. See SO47_Coxall for the full sequence.

5. Rowland Vaughan (1569 – 1628)

The water meadows of Herefordshire will for ever be associated with Rowland Vaughan whose precocious book *The Most Approved and Long Experienced Water Workes* (1610) might well have been forgotten had it not been re-published by Ellen Beatrice Wood as a literary curiosity in 1897.[17] Ironically, this at the time when the use of water meadows was in terminal decline. Locally, Vaughan‟s work was acknowledged by John Duncumb in *The General View of the Agriculture of the County of Hereford* (1805) and by John Beale (1608-83), the author of *Herefordshire Orchards: A Pattern for All England*, whose letter to Samuel Hartlib in 1657 was published and re-issued in 1724, where water meadows were noticed by local commentators when they came to write about the agriculture of the county in the late 18th and early 19th centuries. Beale, however, was happy to celebrate Vaughan‟s work.

His first marriage to his cousin Elizabeth Vaughan in 1582 brought Rowland into possession of the Newcourt estate by the Dore Valley. This included a mill and mill race and that seems to have kindled his interest in water management and meadow irrigation. Vaughan dedicated his book to William Herbert of Wilton, 2nd earl of Pembroke whose ancestor, Sir William Herbert, shared a common descent from „Gladis de Gam‟, daughter of David Gam, the hero of Agincourt. He tells us in the text that his uncle was in the service of the earl of Pembroke. Vaughan had a dual purpose in appealing to his aristocratic patron: first of all he was eager to demonstrate his mastery of drowning but more important was his local campaign to improve the salmon fisheries on the Wye, interrupted by the building of weirs, especially for ironworks. Pembroke was President of the Council for the Marches of Wales from 1586 until his death in 1601 and had overall authority over local matters in the border counties and Wales.[18] By the 1620s Pembroke was creating water meadows on his estates in Wiltshire where sophisticated systems of bed-works would be developed. Vaughan offered to inspect Herbert‟s estates in south Wales to find suitable locations to implement his system[19].

Attempts in recent years by agricultural historians, archaeologists and archivists to reconcile the „polemical, discursive and meandering‟ text of Vaughan‟s *Water Works* with historical and field evidence have proved frustrating. The stylised “*map of the Water-workes*”[20] which originally was part of the publication bears no relation to the geography or water courses of the Dore valley. The recent publication[21] by the Golden Valley Study Group (2016) about Vaughan, his life and times, his diverse interests, legal disputes and practical works provides the most up-to-date and definitive account including a comprehensive review of primary documentary sources. However no corroborative evidence of implementation of his plans was found. Whatever system Vaughan is attempting to describe it was clearly an expensive operation. His kinsman, John Davies, the Hereford poet resident in London, commented in his panegyric that „for 20 years his pounds by thousands he his groundes hath lent‟. Moreover, with much digging to be done and the need to employ a professional „waterman‟ or „drowner‟, the system was well beyond the average farmer in the Golden Valley.[22]

As Vaughan admits, few of his farming neighbours would have been able to implement his system which required constant attention nor perhaps could Vaughan himself as he was often away dealing with his many litigious sessions in London. Elsewhere he complains that his labourers could not be relied upon to take the initiative and water his meadows at the opportune moment, notwithstanding a whipping from their master. There was also a problem of malicious damage so the system needed constant supervision from a resident proprietor. Moreover, at least two of Vaughan‟s neighbours could see a conflict between the use of water for drowning and its employment in driving a water-corn-mill. One wasted his water in feeding his „unsatiable glutton the undershot mill‟; the other was not prepared to give up £10 per annum provided by his mill albeit he had water sufficient to irrigate 300 acres of land forever. Vaughan‟s glib response was that it would have profited him more had he erected a windmill.[23] From Alan Stoyal‟s *Survey of Watermills in Herefordshire* it seems that mill-owners gradually overcame their reservations and were happy to share their superfluous water[24].

Vaughan describes his frequent falling out with surveyors and contractor including a „levellour‟ called John because he claimed he was „the principal party in the Invention‟ of the system. He was skilled in the use of a plumb line and could survey accurately within a tolerance of one inch and create a meadow as „level as a garden plot‟. Vaughan sacked him for his arrogance saying „I had employed his hand not his head‟ but then apparently employed a less skilled carpenter who also had his own ideas, so that when it came to constructing sluices he put stakes in the river bed on the „Venetian model‟, which were subsequently undermined, starving the meadows of water in the summer.[25]

An intriguing excuse put forward by one of the locals was that drowning damaged the native flora. One of the meadows identified by Vaughan for irrigation hosted some cowslips, which were valued by his neighbour‟s daughter and used by her to „tricke the maypole up withall‟. We may sympathise today since restoring a water meadow system is a from of intensification and may not be optimum for the diversity of meadow native flora.[26]

Vaughan explains that his Trench Royal took water from the springs and small streams that issued out of the rising ground on the west side of the Dore Valley. He annexed a waterfall on a neighbour‟s land, which was 7-8 feet above his meadows and found another „bastard brook‟ coming from the bottom of his deer park at Newcourt that was just twenty feet from the Trench Royal. This sounds more like a „catch-work‟ system which captures hill-side springs and streams[27] in a channel running along the contour of a hillside and distributed via shallow gullies across the meadows to be delivered to a valley-bottom stream. This was a relatively simple process, which required little expertise and was widely adopted in Herefordshire. Vaughan also knew about „warping‟, which involved damming streams and allowing the water „float upwards‟ to inundate meadowland.[28] This practice as described in the contemporary Eyton survey above may well have been commonplace and familiar to Vaughan.

The best that one can divine from Vaughan‟s rather incoherent text is that it appears to use both catchwork channels and meadows „floated upward‟ since there is no mention of ridges or panes. In the intervening 400 years much will have changed in the Dore Valley including possible ploughing in the era of the Neopoleonic wars, livestock poaching of the finer features and silt deposition and general intensification since WWII. However evidence from LIDAR-derived DTM still reveals a complex picture of ridges, channels and possible earlier ridge and furrow.

We identify four sites (SO33_HintonFarm, SO33_LowerTrenantBrook, SO33_Turnastone (figure), SO33_PostonCourtFarm and SO33_Newcourt) associated with meadow irrigation in the Dore Valley some of which are reproduced in reference 21.

Fields between the Whitehouse and Turnastone Court Farm occupied by Rowland Vaughan from the late 1590s. Air photo from 2000 and DTM render showing a complex of channels and ridges

Towards the end of his book he mentions a number of gentlemen by name who had taken an interest in his work. The first was „Master Hoord – a famous man in Shropshire" undoubtedly a member of the prolific family that lived at Apley, to the north of Bridgnorth. Apley Hall looks down over an extensive Severn-side meadow, crossed to-day by a stream, which issues from the hillside and demands to be managed as an irrigation feeder. He came looking for Vaughan"s advice as he suffered from a lack of water in summer and winter.[29] Hoord apparently viewed Vaughan"s system with three Herefordshire gentlemen. First, there was Mr. Brainton (Breynton), probably John, who lived in the late 16th century at Stretton Court which included extensive meadows along a tributary of the Yazor Brook a suitable source of water for an irrigation system for meadows marked as such on the estate map dated 1757.[30] Fragments of ridges on these meadows still survive, see site SO44_StrettonCourt.

According the Vaughan accompanying Mr. Brainton was „Maister Pearle", likely to be Richard junior (1566-1644) of Dewsall Court to the SW of Hereford. This property looked cross the flatlands of Cold Moor – a sump, once within the royal forest of Haywood, which fed the Worm Brook. Again the topography lends itself to drowning.[31] Finally, among this elect group who came to view the water works was „Maister Wolridge" (Wulridge, Wolrych): a family that had recently arrived in Herefordshire from Dudmaston in Shropshire, to the south of Bridgnorth and a few miles from Apley. In 1559 they had acquired the manor of the dissolved military order of the Knights of St John at Dinmore which included by royal grant a water-mill and extensive meadowland beside the River Lugg including a tithe of the hay gathered at Adford"s Meadow.[32] Vaughan does not record if his visitors adopted his system, but they were all possessed of low lying and well-watered estates where drowning by one means or another, would certainly be feasible, if not desirable, but probably not using Vaughan"s elaborate system.

Ellen Wood, who republished Vaughan"s book, explains that in addition to the copy she used in the British Museum, there were some manuscript notes in a 17th century hand indicating that his brother Henry Vaughan who lived at Moccas took up the idea of drowning. Her manuscript informs her that the remains of trenches can still be seen, which she believes „might possibly have been for irrigation purposes". [33] Today this can be identified with an area of wetland called the Meres in the SE corner of Moccas deer park, see SO34_TheMeres. Here there is a central trench with radiating feeders, which receives water from a spring above a hillside-paddock. A sluice at the NW end of the Meres, recently restored, controls the water. The Meres is mentioned in a document of 1691 when it is in the possession of Henry Vaughan the younger, probably Rowland Vaughan"s great nephew and in the mid-18th century, the Meres is used as a hay meadow, grazed in spring and cut in July. In 1801 the channels are referred to as „water furrows", giving credence to the suggestion that these are the „trenches" referred to in Mrs. Wood"s manuscript.[34]

The claimed objective of Vaughan"s system was to improve the profitability of his farming and makes ambitious claims to encourage others to master the „mistery of winter and sommer drownings", which enabled himto keep 300 young cattle and 3000 sheep, however he makes no reference to folding them on the arable to improve its fertility, as was the case in the South Country. He recommends watering throughout the winter and if snow threatens, watering prevents it from settling and allows the cattle to graze. At the beginning of March, when the temperature begins to rise, he recommends keeping the cattle off the meadows, since its low temperature will inhibit growth. However, if March is dry, then flooding may be necessary but the sessions should be short, allowing the grass to „become as dry as a child under the hands of a dainty nurse" i.e. moist. He is also insistent that flooding should not take place in May, again because of the cool water in summer „kills the vital spirits". However, on fertile land grazing could continue to the 1st May without hurting the hay crop. He incidentally mentions that this was the practice in the Frome and Leadon Valleys.[35]

Vaughan also mentions several incidental advantages of regular drowning. On the eve of mowing, flooding helps to revive the grass after it has been cut. He describes the procedure on the morning of mowing, when the drowner, armed with a board two feet by one foot deep directing the water at the hay to be cut later in the day. Vaughan is conscious the water is most effective if it carries „substance" i.e. muddy deposits and elsewhere emphasises its usefulness by suggesting that whilst the water contains „substance" it should be left on the meadows as long as possible. Clear water is probably best kept in the river, he believes, especially if it is cold. Muddy water he also rates highly for fertilizing barren fields, which can be returned after drowning to arable usage. Furthermore, he suggests, that regular fertilizing in this manner would give the farmer flexibility, in being able to move land from arable to pasture and visa versa.[36]

He describes a rather labour intensive way of dispersing the dung of cows on tired meadows. These should be broken-up by hand and the meadow, enriched by the new deposit, flooded for two weeks before the cattle were returned. He was especially excited by the prospect of de-silting his main carrier – the Trench Royal – which, he believed „contained all the dung hills in the county" – the „quintessence" of fertility, he anticipated. The spoil was spread on his wheat lands and garden.[37] This sort of opportunism in capturing the run-off from farmyards and the sweet juices from the midden were common feature of hill farming and often fed into the catch-work systems of watering meadows. (See the examples the surviving hill slope catch-works at Quakers Farm and Little Garway Farm pages 57, 58)

Throughout his text Vaughan makes bold claims for the effectiveness and profitability of his system. For an outlay of £500 he expected a return of £2000 to £3000 and one meadow let at £5 before flooding was worth £15 after. On another occasion he reckoned that his estate, excluding his park, had been worth £40 per annum and was now worth £300.[38] Elsewhere he claimed that his system could flood 1000 acres and extinguish all moles and worms as well as all weeds, including cowslips for the maypole! From one of his neighbours he hoped to acquire 300 acres of worn-out pasture worth 3s an acre, which with his sluices installed would be worth £100 yearly within four years.[39]

Although there is so far no evidence that the practices described in his book were actually put into practice, managed irrigated meadows were clearly a feature of grassland management in the Dore valley. The water meadow authority Hadrian Cook describes Vaughan"s book as "more principle than practice"[40] and it may have been a kind of prospectus for potential clients.

Casting further doubts upon the veracity of the Water Works a 1588 court case shows that alluvial grassland in the Dore Valley that Vaughan later occupied was already productive enough to attract livestock tenants from a wide area. As one witness states stated "they spared the same pastures for a second spring by reason thereof there was upon the same pasture as good grass being a second spring as was at the first"[41] yet Vaughan makes the unlikely claim to have been able to more than double the rent as a result of his works . His claims in the same book to have established a "commonwealth of mechanicals" is described as "a figment of his imagination" by Arthur Wood[42].

6. John Beale (1608-1683)

Beale was a native of Herefordshire and an Anglican divine who admired Erasmus, Bacon and the Dutch for their thrift, sobriety and capitalism. He was interested in practical science and for a while during the 1650s lived on a small estate at Cobhall in the parish of Allensmore where he carried out agricultural and horticultural experiments. Via his mother Joanna Pye, he was related to the First Viscount Scudamore who had taken the advice of Beale"s father and developed cider production on his estate at Holme Lacy. Beale the younger had visited Scudamore whilst he was domiciled in Paris as the English ambassador. Beale also enjoyed the patronage of Sir Richard Hopton of Canon Frome in holding the living of Stretton Grandison.[43]

The polymath and agriculturist Samuel Hartlib (c1600 – 1660) seems not to have heard of Vaughan when he bemoaned what he saw as the general failure to improve grasslands by means of managed water meadows, proclaiming in a publication[44] of 1651:

"That we do not float our lands as they do in Lombardy where they mow their lands 3 or 4 times yearly… We here in England have great opportunities by brooks and rivers in all places to do so, but we are negligent; yet we might hereby double if not treble our profits, kill all rushes etc. But they who desireth to know the manner how to do this let him read Mr. Blithes Book of Husbandry lately printed."

In 1656 Beale became a weekly correspondent of Hartlib and other members of the putative Royal Society, which included John Evelyn, Henry Oldenburg and Robert Boyle. Two of Beale‟s letters to Harlib were published as *Herefordshire Orchards: a Pattern for all England* (1656 and reprinted in 1724). Several other books followed, all of a practical nature, and many contributions were made to the *Philosophical Transactions*- the journal of the Royal Society.[45]

Beale wrote with a garrulous and meandering style, hence *Herefordshire Orchards* contains much information on the general state of agriculture in the county as well as much practical advice on pomology. Rowland Vaughan is named as one of „a great number of admirable contrivers for the public good‟, which includes Lord Scudamore „a great preserver of woods….always keeping able Servants to promote the best expedience of all kinds of Agriculture‟ and Sir Henry Lingen (Sir H.L.) of Stoke Edith and Freen‟s court „ who heartedly prosecuted the same Encouragements‟. There follows a short list of improvers indicated by their initials, which are not easy to identify but F. of B. calls for attention who‟ hath raised his poor pastures from 2s 6d to be better worth more than 20s yearly‟. This would appear to be John Flackett of Buckenhill, near Bromyard where a possible catch work system is discernable in the valley to the SW of the mansion (SO64_Buckenhill).

Beale ends his complimentary list by stating „I must cease to name Men, since in every Village there is some excellent Republican‟ i.e. an agricultural improver working to better the Commonwealth.[46]

Returning in *Orchards* to his main theme he comments on the means of turning barren land into improved pastures and relates that „though we have great advantage of land-floods, and other fat waters (i.e. carrying nutrients) and the ground seems very likely for pasture, yet it is almost as good to give away, as to go about to turn it into pasture‟. Despite this pessimistic assessment about the general adoption of irrigation systems he later adds: „Other helps to Pasture we do omit every rill of Water is carefully conducted to the best use. If it runs from a fat Stream, Land-flood, or lime-stone, we find benefit in it, if withal we let it Passover and away, before it exchanges it‟s fatness into cold hunger, which falls out in a very few Days. Some Water we find so hungry, that we dare not receive it, but at Seasons of necessity‟. All this sounds very much like Vaughan. He continues: „I have seldom seen pastures forced by compost in this Country (Herefordshire) as I have seen elsewhere. Only in the Winter we feed our Cattel on the higher Pastures, and in the hazard of a rot some (put) out their Sheep all Nights; which hath proved a safeguard to the Sheep, and a great help to the Pasture‟. Here Beale is clearly referring to the practice of folding, which was commonly employed in the South Country.[47]

From the manner of Beale‟s writing it seems that water meadows and other forms of irrigation were not yet common practices in Herefordshire and like the use of lime, which he advocates elsewhere, were not yet regularly adopted.

Another local collaborator was Beales uncle, Peter Smith who farmed at Duffryn on the western slopes of the old royal forest of Treville in the parish of Dore. Smith was also a correspondent of Hartlib and was able to speak knowledgeably about the agriculture of the Netherlands as well as fertilizers, lime and, most pertinently, the different qualities of waters used in irrigation. He carried out experiments at „barren Duffryn‟, as he called it, watering the land from different springs, growing fruit and planting coppices. He fully embraced the Georgic life-style and

wrote a series of essays on agrarian themes imitating Virgil‟s *Eclogues*. Beale was also carried away with Roman parallels with Cromwell‟s Republic and when another relative began farming at Kenchester close to the site of the Roman town of Magnis he believed a new golden age was dawning and the new Romans in Britain emerging from the Civil War were turning their swords into plough shares. Smith and Beale both saw agricultural reform as a route to national greatness.[48] Even a poor war widow who fell on hard times found encouragement when she discovered a small spring „gushing out the side of a hill‟, the water from which was conducted east, west, north and south across her large garden and in the summer heat with „besomes scoupes‟ she scattered the stream in the alleys between her crops. For Beale, and for Vaughan, in the ever-running springs of Herefordshire lay the source of endless fecundity.[49]

Beale and his collaborators saw a strong link between enclosure, draining and irrigation. Farmers needed to have complete control over their lands to carry out improvements and since Herefordshire was a landscape of old enclosures, it was an ideal laboratory for the rest of England. Farmers in Midland England were unlikely to drain, irrigate and fertilize their lands without enclosure. He also saw that draining and irrigation went hand-in-hand and wrote to Henry Oldenburg, the first Secretary of the Royal Society and editor of its *Philosophical Transactions* that the „greatest service yt can be done to ye public by agriculture‟ was draining since the re-claimed land could benefit from the use of managed water for irrigation. He even suggested that landowners should be provided with mechanical pumps „to cast water on banks out of a river‟.[50]

Drainage and irrigation were frequently discussed at the meetings of the Georgical Committee of the Royal Society established in 1664. Beale sat on this committee and was responsible for reporting on Somerset and Herefordshire, where he held livings, to feed into an inquiry into the improvement of arable and meadows. Also on this committee with Beale was John Hoskins (1634-1705) who owned estates at Harewood, near Ross and at Morehampton in the Golden Valley and whose extensive cattle interests were contributed to the improvement of meadows at the end of the 17th century[51]. He also gave advice to his daughter-in-law, Frances, about keeping the pastures at Morehampton „well grown to succeed one another, fresh and fresh‟, which suggests irrigation.

John Evelyn also consulted Beale about his *Elysium Britannicum*, a modern garden that would outshine the greatest antique gardens in Italy. Beale willingly provided advice and also found Evelyn a site tucked under Backbury Hill, near the village of Mordiford in Herefordshire. Backbury was an earthwork associated with the ancient Britons - the Silures, according to Hartlib - where a brisk *fons* (spring) emerged at Sufton where a garden could be constructed on a south-westerly slope, taking in views of the „Valley of Ravishing Beauties‟ where the Lugg and the Frome met the Wye. Evelyn was charmed for now his aspirations were given concrete form as Backbury was „no phantasticall Utopia but a real place‟ and soon he was planning his „Fountains, Jettos, Rivulets, Pricina and Baths‟ but Beale literally poured cold water on his enthusiasm and said that the water was too precious to be wasted on a „narrow mimical‟ garden (i.e. a copy of a classical garden) but should be free to turn the wilderness into a productive paradise. Evelyn never completed his *Elysium Britannicum* but the stream from Backbury runs down into the Frome valley supplying water meadows fragments of whose ridges are visible on an RAF 1946 aerial photograph see SO53_LongworthMilltoFiveBridges.[52]

Beale also collaborated with Harlib on the details of the design of a model estate, which the latter had published with a diagram in *A Diversity of Divisions* (1653). This showed a 2000 acre estate, divided into 16 „great farms‟. Each was connected by a discrete channel to a main river, which provided opportunities for drainage and irrigation. Like Vaughan‟s Trench Royal, each waterway provided a means of transport for agricultural products. The farms were provided with equal amounts of corn-lands and meadow with opportunities to pasture animals beyond the perimeter of the farms. Such an idealised estate was more suitable for West Virginia but the ideas fed into the national consciousness of the country estate as a place of

beauty as well as productivity and underpinned Beale‟s criticisms of Evelyn‟s proposed utopia at Backbury.[53]

Beale‟s idealism and his constant stream of agricultural innovations were widely circulated among his friends who formed the core membership of the nascent Royal Society. His submissions to the *Philosophical Transactions* created an abiding impression that Herefordshire was a georgic paradise in the late 17th century, a theme that was later taken up widely in the writings of both visitors and locals.[54] His work in promoting cider orchards was better known than his support for irrigation but both aspects of his portfolio were adopted by gentry landowners, like the Harleys and Scudamores. But even tenant farmers absorbed the message about irrigation. Thomas Powell of Bridge House, Kenchester left some notes for his son attached to his will in 1693, itemising the routine activities of farming. For December he mentions cutting timber, dressing flower roots with dung and also „water and keep moist your meadows and drink good wine to keep the body warm‟.[55] The site of Powell‟s water meadows is unrecorded but one of his neighbours in 1667 left 20 acres of Long Meadow, on the Wye flood plain below Old Weir to establish a charity in Hereford. Today these meadows (see figure below) are still watered by a copious spring, which earlier provided power for a water mill, before feeding a catch-work system of water meadows.[56]

Spring (S) line supplying meadows with features possibly associated with meadow irrigation. A channel (blue arrows) from W may augment the spring. See sequence for the site SO44_OldWeir

7. Herefordshire and the cattle trade

Vaughan‟s general pessimism and his critical attitude towards the inactivity of his neighbours did not reflect the state of agriculture in Herefordshire in the late 16th and early 17th centuries. As we have seen Beale and other commentators, towards the end of the 17th century were fulsome in their praise of the economic potential of the shire. Camden (1586), a contemporary of Vaughan was found it „fruitful for corn and cattle feeding‟ and the only county in the West Midlands that produced an agricultural surplus. Such judgements have been confirmed from the evidence of wills and inventories where arable crops – wheat, oats, rye and barley – are frequently itemised, with the last being used to develop a trade in malt. The Ryeland sheep from SW Herefordshire still maintained their reputation for producing the finest wool in England but a relatively new area of productivity was the feeding of cattle for the London, Midland and Home Counties meat market.[57] This industry depended on the rich pastures of the county and seems to have flourished particularly during the last decades of the 17th century and for most of the 18th century. Irrigating pasture for an „early bite‟ in the spring was an essential ingredient in the success of the cattle trade.

The shire‟s position on the edge of the Wales enabled it to exploit the „very great trade in cattle‟ that was pouring out of mid-Wales in the 17th century to satisfy the demand for meat and leather in England. Most of the market towns on the Welsh Border were involved in leather working and Leominster was a major wool mart, „Leominster gold‟ as Camden put it although the manufacture of cloth had, with the notable exception of Ledbury, by-passed the county.[58] Its small farmers, with well-watered pasture, could invest in fattening their cattle and avoid unnecessary expense by passing the fattened animals quickly to another entrepreneur. Spring feeding avoided the expense of keeping cattle over the winter and a quick sale at a local market or fair to another dealer, side-stepped the additional expense of driving the cattle long distances, which wasted the investment in feeding. Although for small farmers dairying traditionally provided a regular income, little dairying was carried out in Herefordshire in this period and with the demand for meat and leather pushing up cattle prices, „feeding‟ was the best option, especially for a farmer with well-managed grassland.[59]

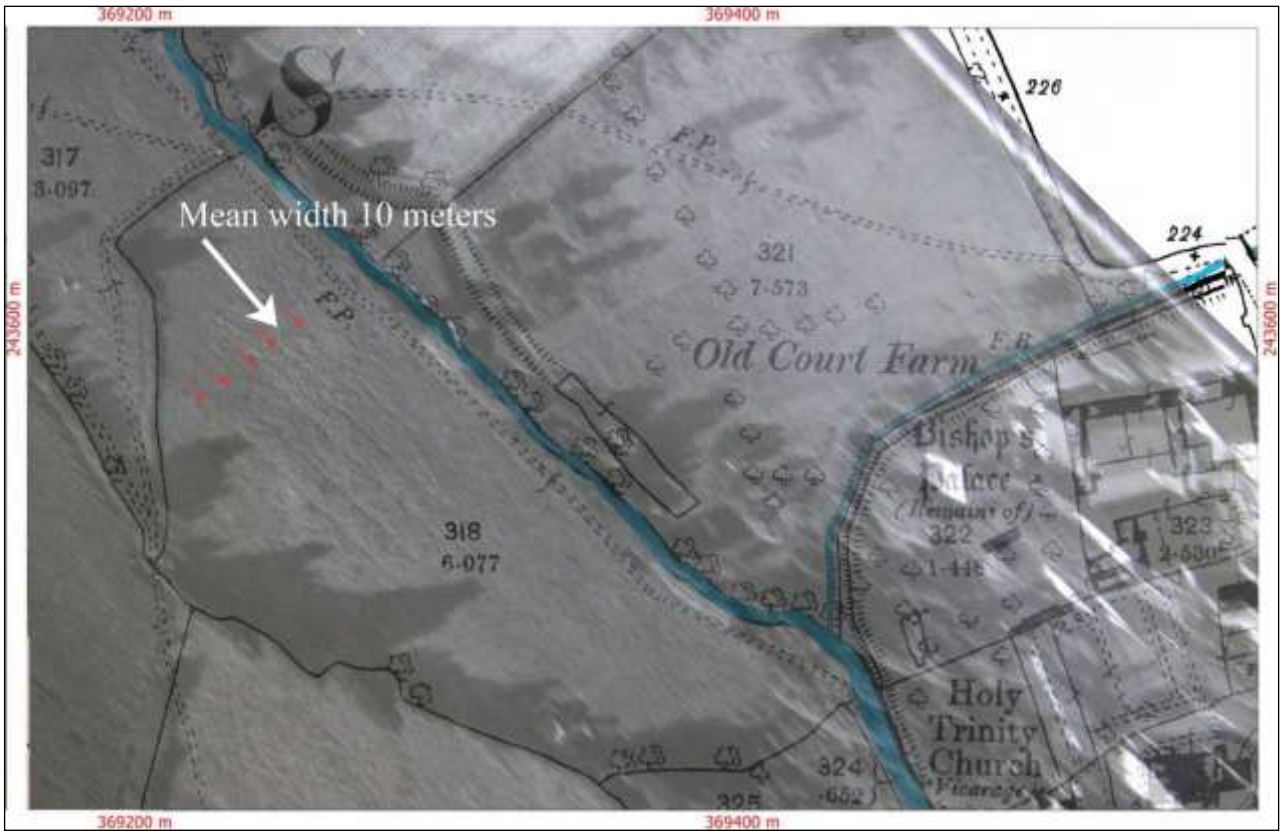
North-West Herefordshire with its river valleys stretching deep into Wales siphoned cattle towards its fairs, held in small towns either side of the new national border. Significantly, many of these fairs took place in the spring time when fresh grazing, facilitated in many cases by irrigation, would have been available. Kington, Leominster, Weobley, Wigmore, Bishop‟s Castle, Ludlow, Knighton and New Radnor all held cattle fairs before the end of April.[60] Details of fairs at Leominster (1556) and Wigmore (1669-1710) have been printed and provide opportunities for useful analysis. Most of the cattle sold at these fairs made a relatively short journey and were sold and bought by farmers who lived within 10 or 20 miles of the site of the fair. At Leominster most of the transactions were for single beasts, especially oxen, which were presumably in demand for ploughing. A few of these were sold and taken to the Midlands and further afield. By the late 17th century at Wigmore there were only a few oxen sold since horses were replacing oxen for ploughing. Instead, there were a large number of farmers and dealers picking up a collection of beasts (7-27) from single transactions. Many of these were locals but there were also a small number form Northamptonshire, Buckinghamshire, Gloucestershire and Wiltshire. The local men like Henry Allen of Letton (15 beasts), William Penny of Wigmore (18), Mr. Capper of Bromyard (16), George Bennet of Bosbury (15), Mr. Adams of Leominster (16) and Francis Woodhouse of Mordiford (26) were clearly intending to feed their cattle and sell them at the autumn fairs later in the year. At Wigmore the direction of trade was mainly west to east, or south, where, as with Leominster over a century earlier, there was more trade up and down the border. The advantage of „fair hopping‟ across the Midlands was that the cattle kept their weight as they developed their full potential over three years in contrast to long distance droving which tended to leave the cattle lean and in bad health. Nevertheless, for long distance dealers from the Home Counties this was offset by price advantages.[61]

The list of local dealers quoted above contains a number of meaningful names and places, which may suggest links with water meadows or other well-known fattening areas. We find a James Allen of Kinnersley, adjoining Letton Lakes, one of the largest areas of river meadow on the Wye. He was assessed for £4 in the Militia Assessments of 1663. Henry, who was at Wigmore Fair in 1692, was probably his son. Walter Penny of Wigmore signed a note in the Wigmore Fair Account Book in 1708 which suggests that he was an official employed by the Harleys and perhaps grazed his cattle on Wigmore Marsh, which the Harleys were draining at this time. A Thomas Penny paid tax at Lucton in 1663, a few miles from Wigmore[62] and a Mr. Capper of Bromyard was probably Christopher, who died in 1718 described in his will as a „grasyer‟. The 16 beasts he bought at Wigmore in April 1697 may well have grazed the Romney Meadows in the river Frome flood plain Stanford Bishop (see the site SO65_Romney). A clue is provided in the 1663 will of John Parker of Stanford in which Capper is mentioned as an executor. Parker lived at Dovehills and held land in Romney Meadow.[63]

Charles Bennett was still purchasing cattle from Welsh farmers at the fairs held at Brampton Bryan, Clun and Bishops Castle. He appears to have grazed the animals on his land for a short

period and sold them on at local markets to cattle dealers. On one occasion he took cattle in on „tack" (temporary grazing) for a dealer from Quatford in Shropshire. Bennet"s activities were presumably sustained by good pasture and improved meadows, such as those given by Ann Bodenham to Elizabeth Harford of Bosbury in 1708. Here 26 acres of meadow at Old Court was conveyed with the „liberty to convey and direct water out of the south part of the Court Field into the Park Meadow"[64].

This clearly describes a facility for „drowning". Bennett lived at Temple Court, adjoining Old Court with land flanking the River Leadon where extensive meadows are referred to in a survey of 1795, which include the „Hams" - a traditional name for a natural water meadow.[65] Most of the meadows along the Leadon are now in arable cultivation but the remains of ridges, possibly bedwork panes, were visible in an aerial photograph of 1954 below and are just detectable by LIDAR now (see SO64_OldCourt sequence).



In general, the long distance traders became more evident in the Wigmore accounts after 1690 and coincided with the general rise in prices for „beasts" rather than horses, sheep and oxen. The spring and autumn fairs at Wigmore were managed by the Harleys of Brampton Bryan who had acquired the manor of Wigmore early in the 17th century and along with it the fair. They received little profit from holding the event, generally £2 or £3, although the April fair was slightly more profitable than that held in July.[66] The Harleys also held a summer fair at Brampton Brian, known as the „Bron Fair", which was also for horned cattle, horse and sheep. In the absence of her husband Sir Robert, Lady Brilliana Harley held the fair of 1642 in very difficult circumstances. The family"s widely known support for Puritanism and the Long Parliament brought about disturbances which required the services of a magistrate and some halberdiers to keep the peace. The fair continued into the mid-19th century, by which time it was solely concerned with the sale of horses. The holding of fairs raised the profile of the Harleys as good landlords and helped their tenants to find markets for their animals. It, thus, indirectly helped the small farmers to pay the rent. As the Harley estates straddled the Welsh Border many of their tenants probably made use of the fairs at Wigmore and Brampton Bryan.[67]

8. The Agricultural Reformers, 1780-1810

By the late 18th century water-meadows had become an accepted part of agricultural practice in Herefordshire. The Revd John Lodge embarked upon his *Topographical History of Herefordshire* in 1793 with a long chapter on the „principal productions‟ of the county reminding his reader of the four „W‟s‟ for which the county had been celebrated, which included „water‟ as well as wheat, wool and wood. He adds that „almost every meadow has a little rivulet or rill, which the farmer leads over his grounds at pleasure, and by that means not only enriches them, but ensures a good crop of hay even in the driest and most unpropitious summers‟. He follows this with the famous quote from Beale „every rill of water carefully conducted for the best use etc‟.[68]

However, a little earlier Nathanial Kent (1739-1814), the agricultural writer and professional land agent, had different views. He knew Herefordshire well and had advised Uvedale Price of Foxley, Lord Essex of Hampton Court and Charles Cocks, first Baron Somers of Castleditch (Eastnor) on the management of their estates. Whilst agreeing that irrigation was sometimes implemented in the county „the practice was by no means general (and albeit) the advantage is often seen by the tenant, unless he has a lease he seldom avails himself of it ….even some owners of land and gentlemen stewards have been known to wave (sic) such beneficial improvements‟.[69]

It seems that the example set by the gentry earlier in the century had not been taken-up by the tenantry. Kent noticed that irrigation in Herefordshire was much more informal than in the South Country. He describes the practice in „hilly countries‟ like Herefordshire where the farmers „throw the scouring of hills and roads, or the dripping of yards, over (their) land‟. This, he asserted, „is sometimes done, and as much in Herefordshire as in any other county….Flooding is truly the best of improvements where it can be affected; and there ought not to be a single acre of land neglected, which is capable of it‟.[70] It seems that his recommendation was taken up at Dunswater, in the parish of Kingstone where an advertisement of 1808 states that a „considerable stream of water, which runs through the fold yard etc irrigates a large part of the estate‟.[71]

A few years later, the Revd John Duncumb was also promoting the virtues of water-meadows in the „General Introduction‟ to his *Collections towards the History and Antiquities of the County of Hereford* (1804). Once again quoting Beale, Virgil and the Bible he takes his cue from Kent and pessimistically notes that „notwithstanding the benefits of watering lands have been known here for at least a century and a half, the practice is still far from general‟. He hoped, however, that this deficiency would be corrected through the encouragement of the newly founded Herefordshire Agricultural Society (f. 1787), for which he was the honorary secretary.[72] It was in this role that a year later (1805) Duncumb took-up the issue again in the *General View of the Agriculture of the County of Hereford* –a publication sponsored by the Board of Agriculture.

Several pages of the Duncomb‟s report are filled with lengthy quotations from Rowland Vaughan whose zeal „seems to have excited some attention to this valuable branch of rural management‟. In passing he also refers to Beale and *Herefordshire Orchards* (1656). With resignation, he states that the „benefits of irrigation are too obvious‟ to need reciting in detail and adds that a „meadow or pasture which without its application produces one load of hay only, will certainly produce two loads in many cases where watering is adopted‟. It is notable that none of these writers – Lodge, Kent or Duncumb –mention the importance of the „early bite‟ for cattle graziers, suggesting that this was no longer a priority in this period. Duncumb describes the „simple and plain‟ catchwork system where a „large trench or reservoir is made on a high level as possible and its water should be conveyed at pleasure by smaller trenches on its side or sides to the ground within its command‟. He adds that the water should not generally remain long on the ground and flooding should be used sparingly on clay soil.[73]

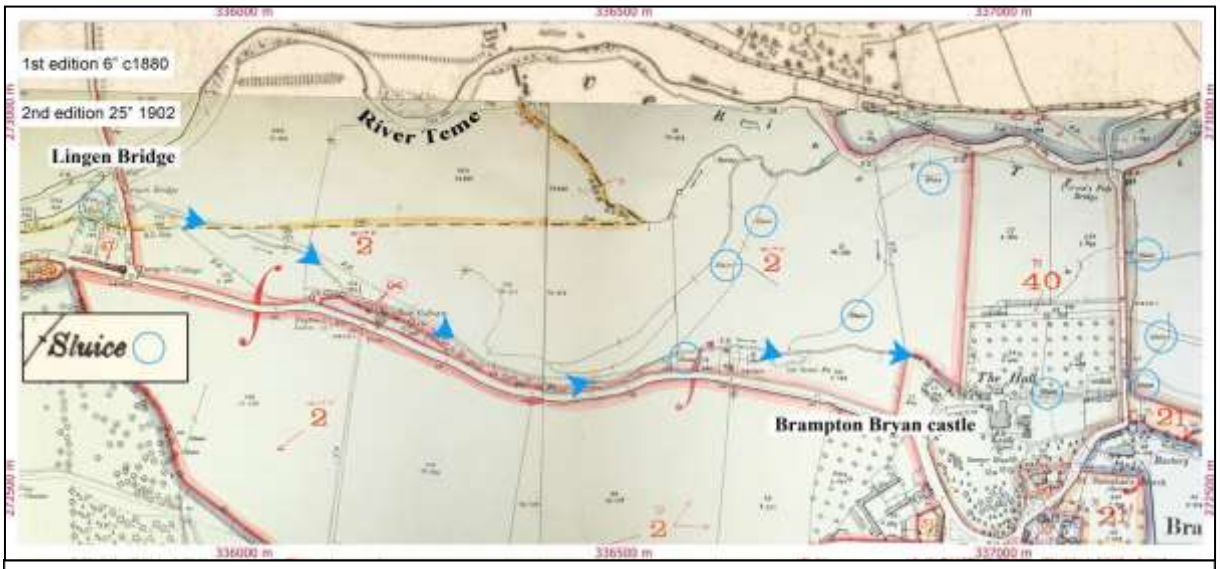
Duncumb draws attention to „one of the greatest experiments in this way" carried out „in late years" by Richard Payne Knight at Downton Castle „with complete success". This involved building a weir across the Teme, which enabled Knight to irrigate 200 acres of land „which were never watered before" (see page 23 on the Wigmore Basin). This could take place both at the time of the „least flood and even in the driest season". The expense of implementing the scheme did not exceed £250. Duncumb believed that the „intelligent farmer" could not fail to adopt the system „at least as a matter of experiment". Most farmers, he suggested, would realise that flooding had been carried out by their forefathers with successful results in the past.[74] Knight was the author of *The Landscape* (1794) –a didactic poem that promoted the Picturesque. Like his contemporary the artist John Constable, Knight"s concept of the Picturesque embraced the pastoral Georgic countryside, not just the rugged, and in his poem he praises the „flowering mead" and „rich meadow" and the enriched water, which feeds „the deepening verdure of fertile meads".[75] In Duncumb"s „Conclusions" , at the end of his survey, he list the „means of improvement and measures calculated" for the purpose of enhancing agricultural production in the county. The most prominent recommendation is that:

„Land should be watered or irrigated in every situation which will admit of it. There are various situations in this county, where some thousand acres of pasture and meadow land of inferior quality might be laid under water by every winter flood, if the several proprietors of adjacent estates would unite in the expense of cutting a common course or reservoir, from which each of the parties might be supplied, by troughs or channels of a given size. In some cases an Act of Parliament on this subject might be necessary to remove difficulties, and would essentially promote the benefit of those concerned".[76]

Knights large scale scheme, notwithstanding Duncumb"s support, was an expensive enterprise and his example was unlikely to be followed by smaller tenant farmers. In the event this coincided with the French Wars and Napoleon"s Continental System, which provided new incentives for increasing the amount of feed for indigenous cattle. Thus, there was a general revival of interest in water-meadows across the country, but principally in Norfolk, Devon, Wiltshire and Gloucestershire. However, building weirs across substantial rivers was far removed from Kent"s farmyard irrigation systems and, no doubt, required the services of a skilled engineer. Knight owned an iron forge at Bringewood, further down the Teme, where a curious concave weir created a head of water for his bellows and tilt hammers. He probably had the expertise at his finger tips or was prepared to call upon the skills of specialist water engineers who appear to have flourished in Gloucestershire at this time and could be called upon to produce expensive bed-work schemes, such as those in Norfolk.[77] The use of iron sluices at various sites in Herefordshire, especially along the Arrow catchment indicates, at some sites, the earlier systems were being renewed with more durable structures, presumably in the 19th century.

9. The Teme Valley Water Meadows

Sir Robert Harley (1579-1656) and his heirs were improving landlords, which some historians have linked to their Puritan ethics. In 1626 Sir Robert introduced an irrigation scheme into one of his meadows at Brampton Bryan but a few years later (1639) he found himself presented as a nuisance at the sessions at Hereford for „spoiling the King‟s highways, by the water that he drawes over his gowndes‟. The bill was brought by his neighbour „Stiche of Walford‟ and perhaps related to the pasture between the river Teme to the north and the road west from Brampton Bryan to the south. This is depicted on a plan of 1722, which shows a leat bringing water from the Teme, near to Lingen‟s Bridge, to fill a T-shaped canal in a garden enclosure in the SE corner of the Meadow.[78] The same channel is shown on 25” to the mile OS map (1902) flowing for about 1 km eastwards towards Brampton Bryan feeding a number of secondary channels to irrigate the meadow suggesting an extensive catch work system of meadow irrigation and/or flood control (see map sequence SO37_Brampton Bryan). Most of the meadows are now in arable cultivation so no trace is visible today in the fields.

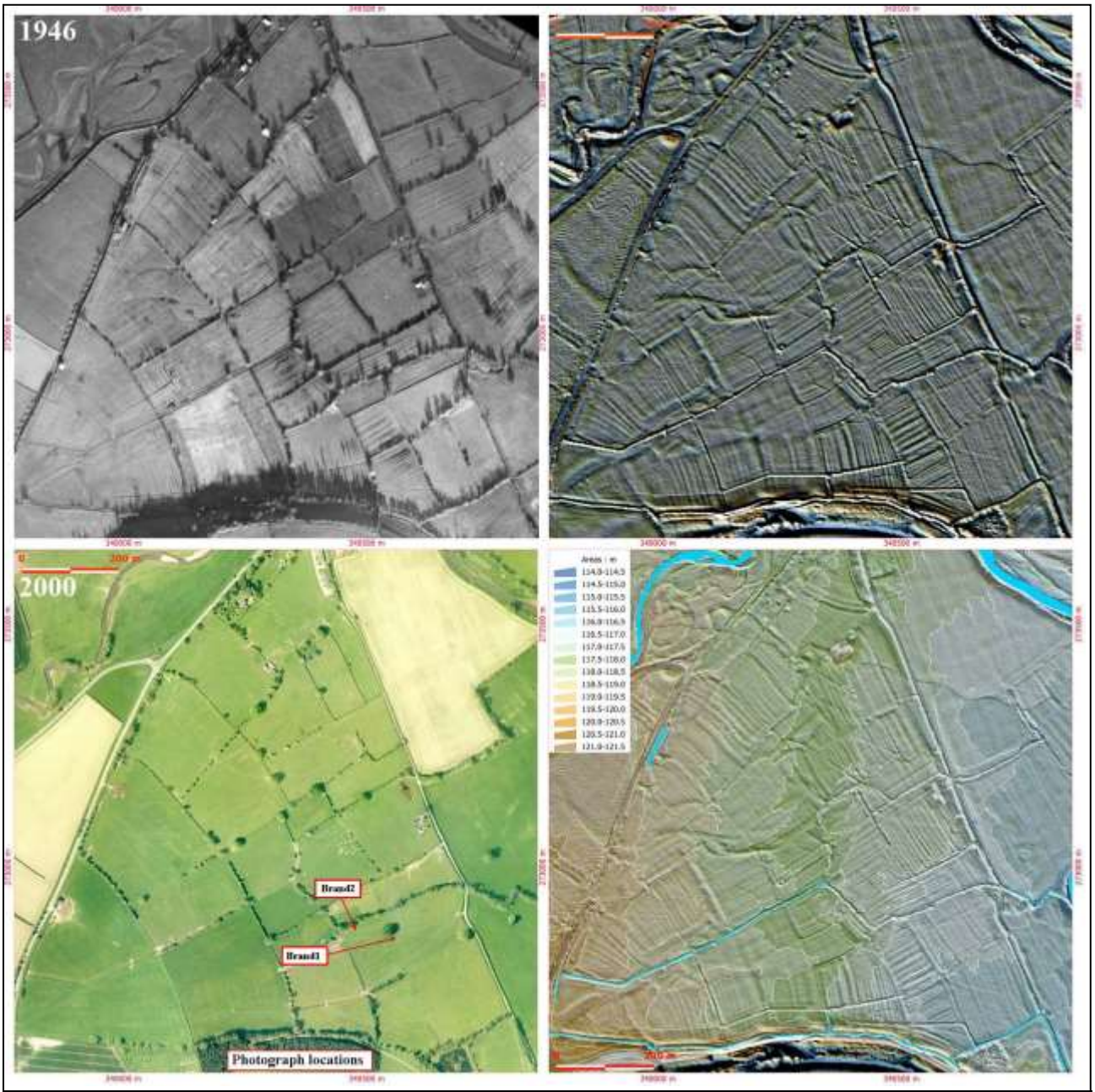


The water carrier channel from Lingen bridge flowing eastwards to Brampton Bryan and the subsidiary channels. Note also the three sluices controlling water to the

Like many other landowners in the 16th and 17th centuries the Harleys were finding demesne farming profitable and were fattening cattle themselves. There were several vendors and buyers at the Wigmore fair who were buying and selling for Edward and his brother Thomas Harley. Moreover, heriots paid by a tenant on his death, took the form of the „best beast‟, which provided the estate with a regular supply of cattle, for which the Cow Meadow provided a fattening facility. Other examples of the family‟s irrigation schemes include the diverting of streams in 1653 in the „great marsh‟ of Wigmore, now known as the Wigmore Basin, and providing an irrigation system in the Teme flood at „Brockley Field‟ to the SW of Leintwardine which retained its name to the Tithe Map and now the adjacent cottage[79].

Just west of Leintwardine is the confluence with the Clun and „Red Lake" tributary. This low lying area has a number remnant water meadows (HER 52401, 53375 and 53376) between Jay Bridge and Leintwardine bridge for which sequence see SO37_JayBridgetoAdleyMoor and SO37_LeintwardineEast. Upstream on the Red Lake tributary is small piece of pasture with possible meadow irrigation ridges evident from DTM, see SO37_RiverRedlakeBucknell.

Between Brandon Camp and Leintwardine is a triangular area of pasture fields extending to 70 hectares in every field has the preserved remnants and water meadow ridges. These are sympathetically managed by the tenant farmer whose family has farmed them for many decades and who has kindly given us the benefit of his knowledge of the system. Their fate of these field is uncertain as they are part of a Council farm holding and it is the intent of Herefordshire Council to sell them off. These meadows were fed from two channels which are fed from two weirs on a long leat which runs from Walford to Wigmore Abbey (4.7 km), see below.

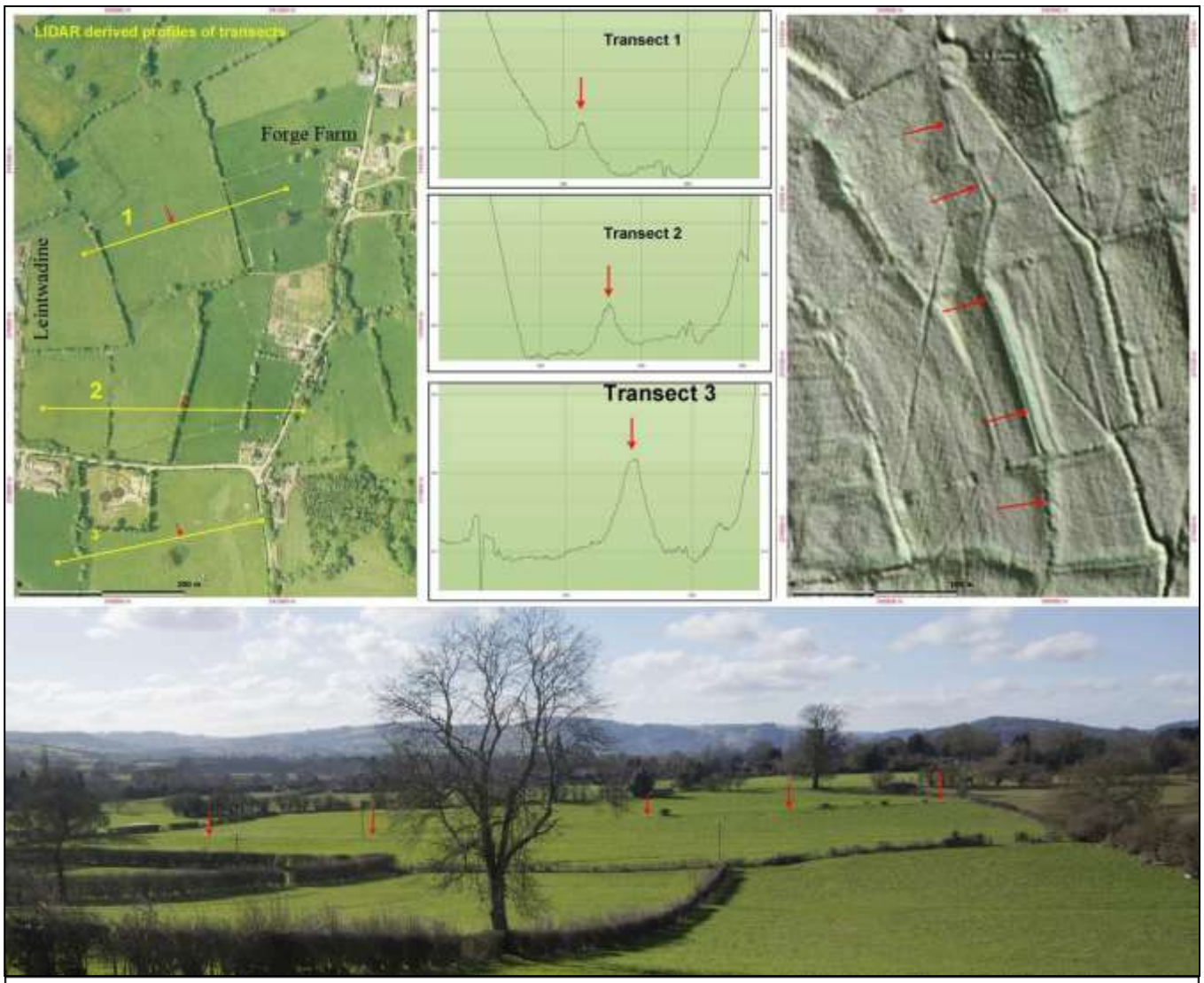


The Brandon to Leintwardine triangle: top left RAF air photo 4th December 1946, top right the differential DTM showing that the meadow earthworks have remained intact since then.

Bottom left: air photo 2000 and photo locations (next page), bottom right 50 cm contours derived from the DTM showing the slight slope and drainage to the west.

Ridged meadows of the Brandon hill/Leintwardine triangle
Left: meadow ridges looking east towards Downton, right: ridges looking towards Brandon hill and the location of the main supply leat which also supplied Wigmore Abbey mill.

Just east of Leintwardine there is a small valley, between Whitton and Leintwardine, through which is raised catchwork channel which carried water from a spring to the north, southwards crossing meadows which were irrigated by allowing water flowing along the channel to spill over into the meadows at various locations along the channel.



Top left and top right: air photo and DTM equivalent showing the raised channel.

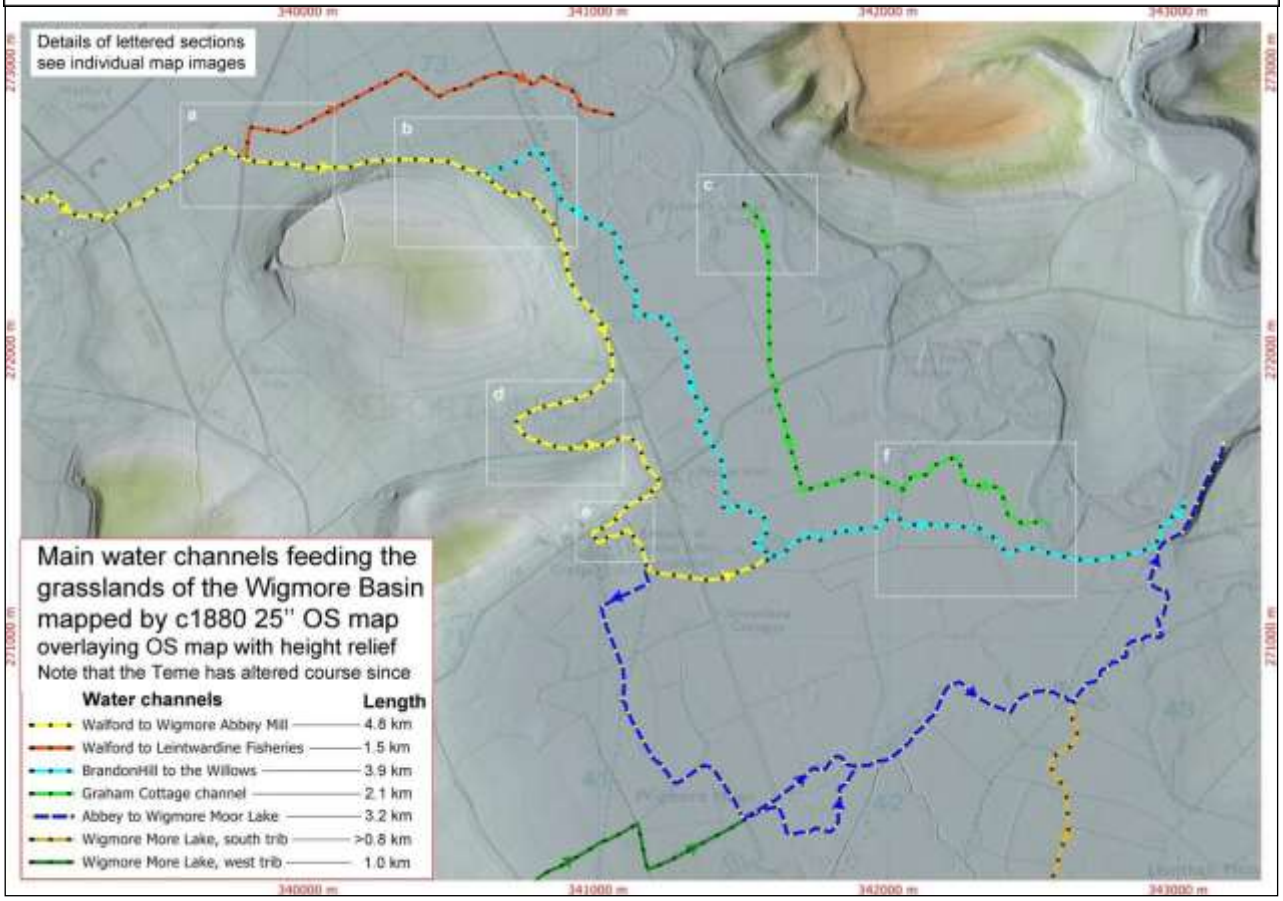
Top middle: use of the profile facility to plot an elevation transect across a defined transect.

Bottom: photo of the channel from the Forge Farm

In his study of the history of land use in the Leintwardine Area D. G. Baylis records that instructions were issued in 1633 for widening and deepening of ditches in the „vale of Wigmore" (another name for the Wigmore Basin) with penalties for not scouring ditches and „impainment" for diverting streams out of their proper courses „presumably for unauthorised water meadows".[80] The grasslands of this area and the low lying land around Leintwardine village were extensively ridged as seen in the geo-referenced 1946 RAF air photos below, only some of which survive today.

The extensive system of main water channels supplying the grasslands of the Wigmore basin is recreated here using by digitising their depiction on the first edition 25" to the mile OS maps. These have been overlaid on the current OS map along with the LIDAR derived relief to show the topography of the area. These channels shown, which do not include the myriad of

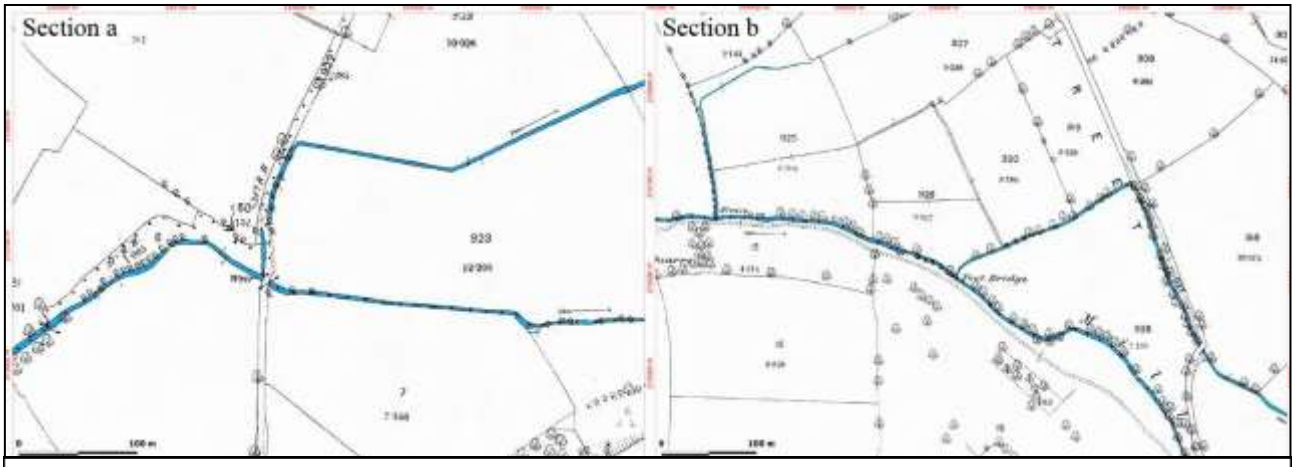
The meadows of the northern part of the Wigmore Basin as revealed by the RAF air photo 4th Dec 1946 showing a complex system of ridges, leats, drainage channels and palaeochannels



subsidiary channels and ditches, extend in total to over 17 km. The longest channel, from Walford to Wigmore abbey (yellow, nearly 5 km) comes from Walford (off the map to the NW) and is linked with another system that arises from Letton. This channel also supplied the mill at Wigmore Abbey („e") and local farmers are of the opinion that this system this channel was created by the monks of the Abbey.

In the latter part of the 19th century there was a three way conflict of interest involving the channel (light green) that arose from a damaged weir on the Teme at Graham"s Cottage („c"). The owner of the lands of the Wigmore basin at that time was Andrew Boughton Knight of Downton Castle, the second largest landowner in the county. The Leintwardine Fishing Club, whose members were of the professional classes from various parts of the West Midlands, requested that this weir be repaired in the interests of the fishing upstream (this part of the Teme flood plain is still called the „Leintwardine Fisheries"). One of the club members, a „well-connected" Reverend James Cook from Pershore, wrote to Knight suggesting that the weir be repaired „at once". An irritated Knight replied on the 29th November 1898 pointing out that the purpose of the weir was not actually for the benefit of fishermen and sarcastically suggested „it shall be, if you will find 6 or 8 men who will stand in the water for 8 or 9 hours a day". Although the weir at its proper height was a „benefit to Black bridge lands" (land watered by the channel) it also „causes [flood] damage to Tippleton" (a hamlet upstream). Knight continued: „raising the weir to a less height than before as you suggest would deprive me of all benefit as the level of the water would be below Black bridge cut [the outfall of the channel]; it would at the same time lessen the damage [to Tippleton]". Knight also said that the presence of weir had the effect of increasing the rate of erosion of his land. He ended his letter by saying that he wouldn"t mind if the whole weir was removed as „the damage certainly exceeds the benefits". This was at a time of declining prices for agriculture so the benefits of controlled meadow irrigation were becoming less than the various problems incurred in maintaining them[81].

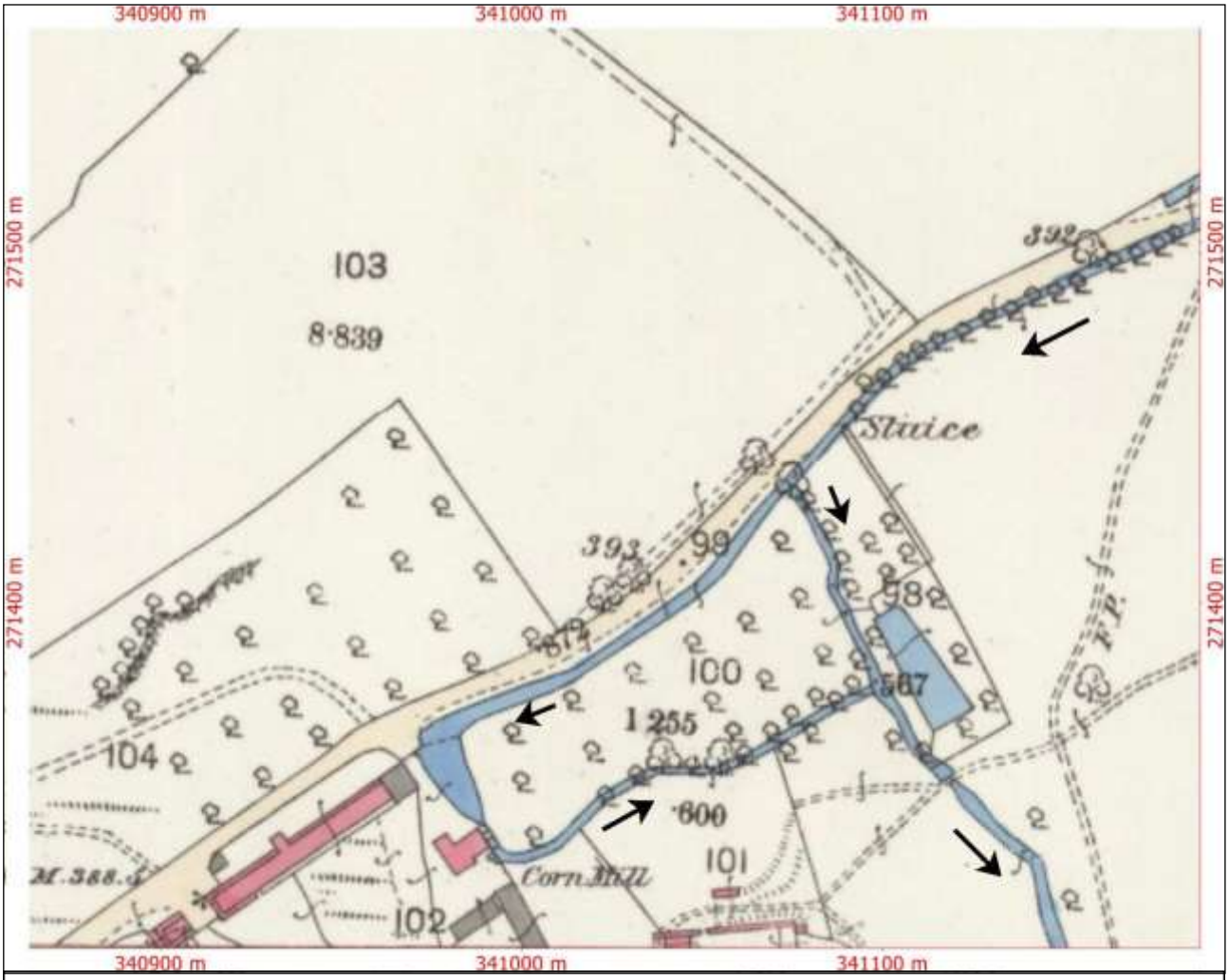
Most of the grassland of the main Wigmore basin is now under the plough apart from some small fields, see SO47_WigmoreAbbey. A water meadow in the area „f" above which was also on the HER (41910) was ploughed since the LIDAR scan of the area (c2007). The following maps show the close-up section „a" to „f":



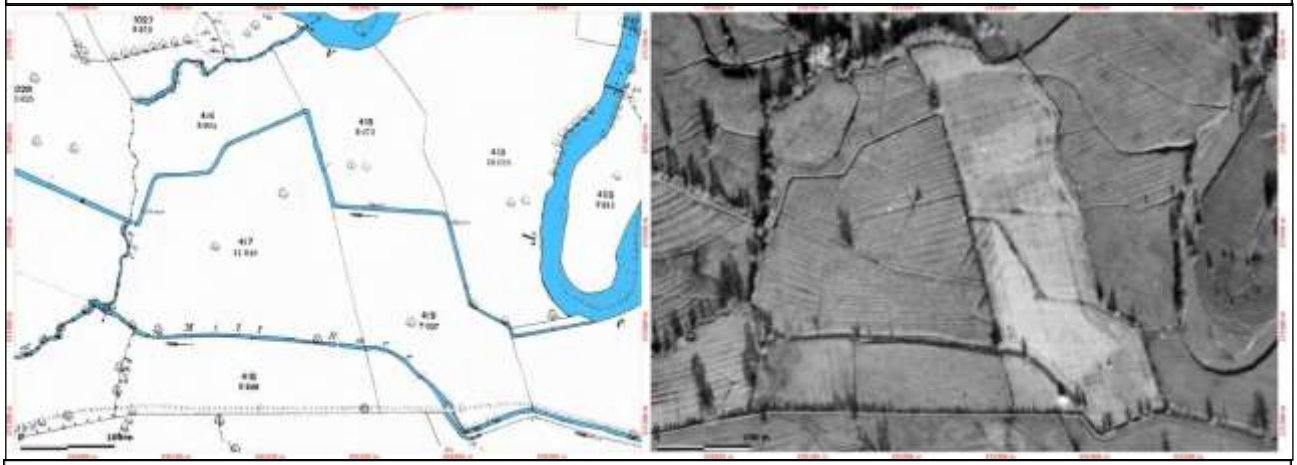
Section „a": the main Walford to Wigmore Abbey channel runs E to W with a take off at the weir supplying the northward channel feeding the meadows between Leintwardine and Brandon Camp (see page xx above).
Section „b": the channel rounding Brandon Hill. A subsidiary channel takes off for the meadows northwards, the 4 km channel to the „The Willows" starts at the footbridge.

Section „c": the weir at Graham"s cottage subject of the dispute between the Leintwardine fishing club and Andrew Boughton Knight in 1879. The Teme has since changed its course washing away whatever remained of this weir and much of the former meadowland that it diverted for irrigation has been ploughed.

Section „d": The Walford to Wigmore Abbey main channel follows the contour around a valley to the east of Brandon hill and is clearly visible in this 1946 RAF air photo and subsequently in an air photo of 1959. The field has since been ploughed probably many times, nonetheless LIDAR reveals the faint trace of its former path.



Section e: Wigmore Abbey corn mill on the 1st edition 252 to the mile OS map (c1885) where the channel all the way from Walford arrives from the NE to the mill pond then reverses into the „tail leat" where it continues for a further 3.2 km on way to the Teme supplying the meadows of the southern part of the Wigmore basin augmented by various channels coming from the west and the south.



Section „f": Left 1st edition 252 to the mile OS map (c1885) and right the RAF 4th December 1946 air photo. The top channel was feed from the weir at „Graham Cottage" cause of the dispute between the Leintwardine Fishing Club and Andrew Broughton Knight with its outflow at Teme. The bottom channel called „Mill Race" is the one which starts from the Walford to Wigmore Abbey channel (see „b" above) and proceeds to „The Willows" where one might expect a mill; however there no mill mapped on the 1885 map, the tithe map of 1840 or Taylor"s county map of 1754 (which maps many mills). The RAF photo shows the fields as ridged meadows although the long vertical field in the middle has been ploughed during WWII. Comparison between 1946 and a recent air photo of the same is compared below:

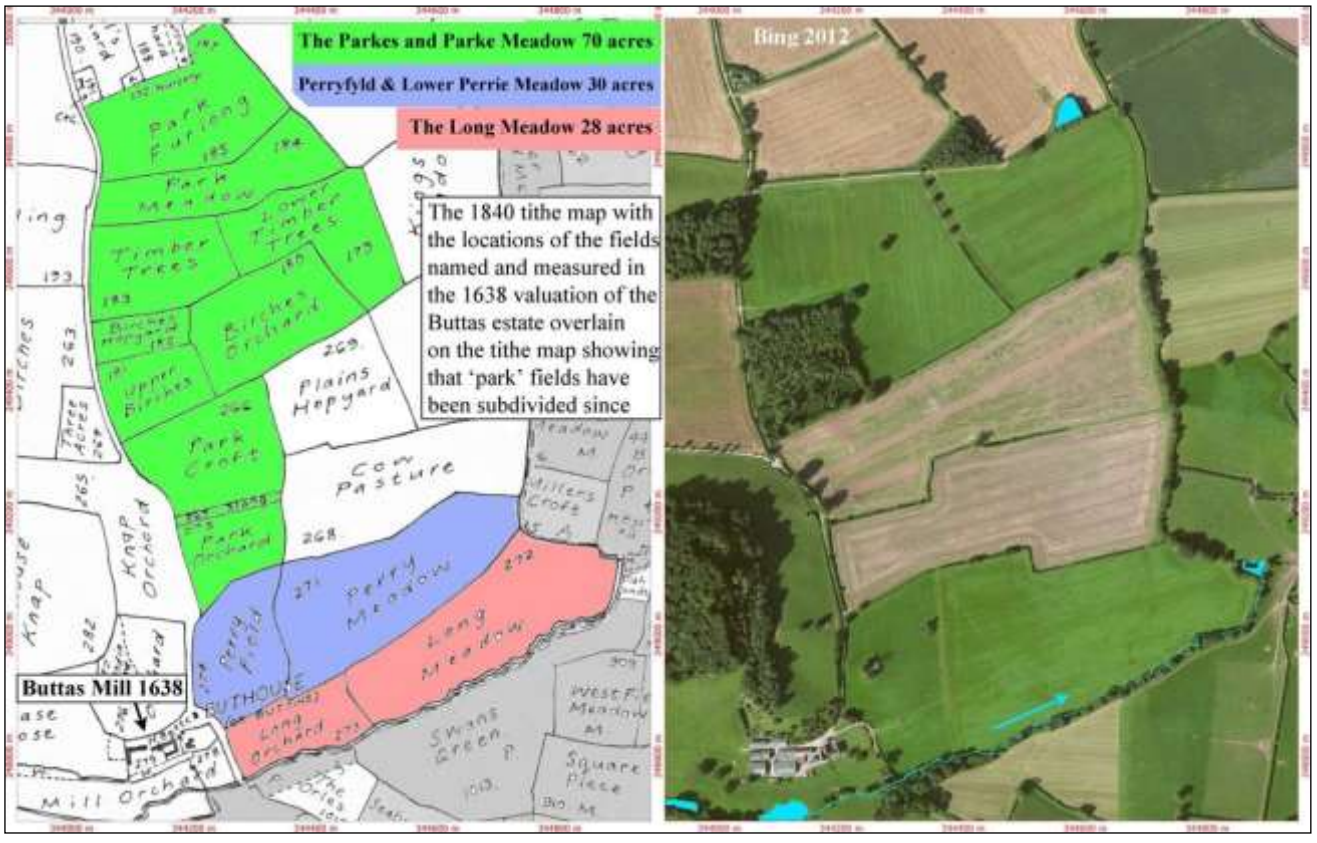
Section „f": RAF 1946 (as above), right 2000 air photo - Complete effacement of earthworks.

10. Water meadows at Kings Pyon and Dilwyn

The valuation of the Buttas Estate of 1638[82] „*A particular of the manor of Buttas and of the Demeyne of the that manor as it now is'* is most likely to be the result of the marriage settlement between Richard Karver of the Buttas and Elinor Vaughan daughter of Roger Vaughan of Bredwardine, a relation of Rowland Vaughan. This detailed survey includes this reference to the controlled flooding of meadows and the resulting increase in fertility:

"*The Long Meadow 28 acres, the Perryfyld and Lower Perrie meadow 30 acres, The Parkes and parke meadow 70 acres. The meadows are watred by a brook at pleasure. Wch is likewise of late drawen over the most part of the Perry fyld and of the parkes alsoe wch in shorte tyme ymprove their values half in half.*"

Whether this has anything to do with Rowland Vaughan's influence is doubtful and is more likely to reflect the prevalence of meadow irrigation as contemporary agricultural practice in Herefordshire. These meadows have been identified and placed in their most likely location:



The field names tithe map of 1840 allows allow us to plot the probable locations of these fields above on the basis of the „Park" names. The 70 acre „The Parkes and Parke Meadow" had clearly been enclosed into smaller parcels by this time perhaps losing its water meadow function to other land uses. It seems however that the and Long Meadow and Perry Meadow being close to the natural stream and down stream of the „tail race" of Buttas Mill remained as water meadow. All these fields have been in arable cultivation for some years yet the possible remnants of ridges and feeder channels from the stream can just be discerned (red arrows) in the LIDAR scan.

A ditch running WNW may be a tail leat (TL on map below) from Buttas Mill which according to the 1638 survey was:

"*newly reedified in verie substanciall Manor and furnished wth new stones, wch is an overshot Mill and driven by a brooke wch Runneth under the Howse*".

The mill appears on Isaac Taylor"s 1754 county map but only its mill pond appears on the OS map of 1885. See full sequence for site SO44_Buttas.

In 1653 a sale agreement[83] between John Seyse yeoman and William Bradford gent both of Dilwyn about a meadow allowed its purchaser (Seyce) the right to the uninterrupted flow of a stream for its "watering and improving".

William Bradford "*is to allow water to have free course by the usual trenches through Elbridge Meadow into Middle Meadow for the watering and improving thereof according to the course of husbandry and will at convenient times allow Seyse to cleanse, scour, fortify and amend the trenches in due form of husbandry for the better carrying and conveying of the said water*".

Elbridge Meadow is adjacent to what is now called the Stretford brook and appears on the Dilwyn tithe map as number 478 „Hellbridge Meadow" [SO407535] and 800 meters NW of the Homme farm now part of an arable field.

Another possible water meadow system which has yet to be investigated fully is the low lying permanent pasture at Sollers Dilwyn, a complex site with channels, with some enclosure history and a possible connection with Tyrrels Court Mill to its east see SO45_SollersDilwyn.

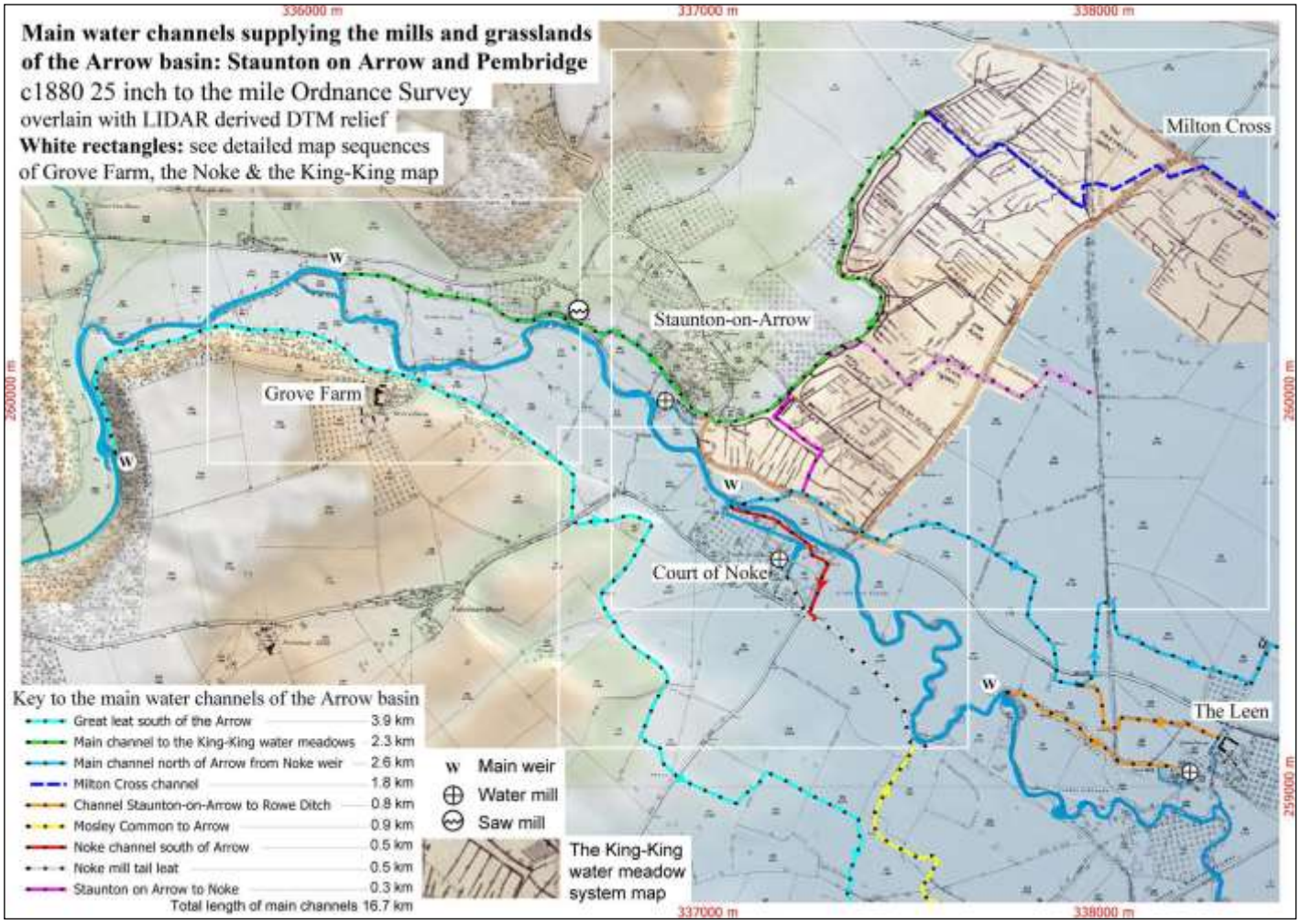
11. Arrow valley water meadows from Staunton-on-Wye to Pembridge

Geographically the water meadow system in the Arrow valley from Staunton-on-Wye to Pembridge has similarities to the Wigmore Basin system detailed above in that water from a strongly flowing river arising from the Welsh hills is channelled by a complex and extensive system of channels to irrigate many 100‟s of hectares of low lying farmland, mainly grassland. So far we have little evidence of the origins and operations of this system from the time before the civil war even though there is likely to have been irrigations systems of some kind. The winter time RAF air photos sorties of the late 1940s, so valuable in recording water meadow earthworks in the Wigmore Basin, did not extend to this part of Herefordshire. In any case there is direct evidence that more of these water meadows were ploughed during WWII than in the Wigmore Basin or the Teme valley.

Whatever the early Arrow irrigation system may have been, between 1660 and 1710 an extensive system of irrigated meadows and feeder channels was constructed on the lowlands of Arrow valley as it fans out eastwards beyond Stanton-on-Arrow and Court of Noke towards the flat lands between Pembridge and Shobdon[84]. This lowland area is fed by four main channels which run along the contours on opposite sides the valley, diverting water the river Arrow from weirs. The main southern channel which runs for about 4 km is diverted from the Arrow by a weir 1 km upstream from Grove Farm and was referred to in 1756 as the „Great Watercourse‟, as part of an agreement relating to the sharing of water between the estate of the Court of Noke and The Leen. The then occupier of the Noke, William Halhead had the power to "*divert the water of the Arrow for Improvement of the lands belonging to the Leen Farm for the space of two weeks in every five weeks*"[85]. Although the system was in decline by the 1880s, part of the water meadow system appears to be still functioning into the early 20th century.

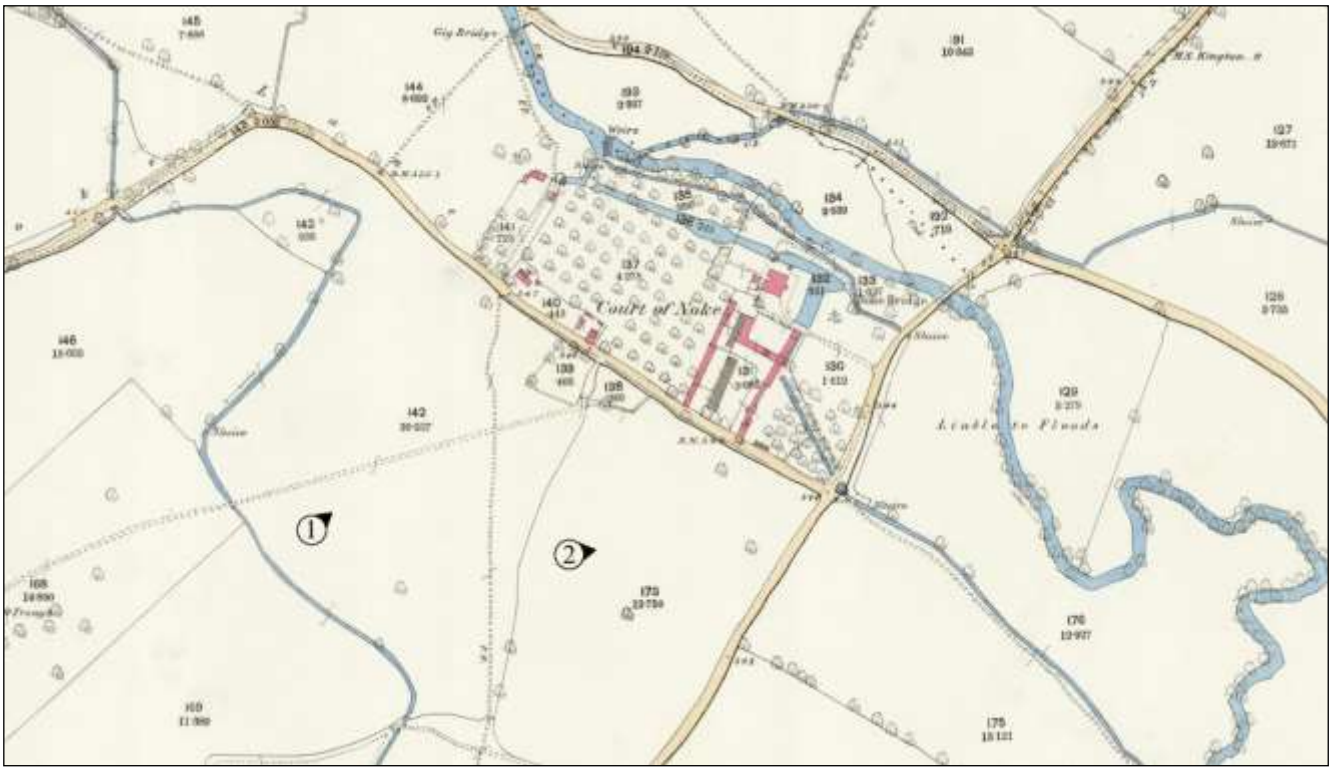
As mentioned in the introduction we have, uniquely for Herefordshire, a map of part of the water meadow system made by Captain King-King and the only map of water meadow in the county. The „King-King‟ system was fed from the northern channel from its take off at the main weir 1 km upstream from the village of Staunton-on-Arrow. At the Court of Noke two major weirs direct water to another pair of main channels, one shooting south of the Arrow supplying the mill at Noke whose tail leat goes on to water lands SW of the Noke and the one shooting north of the Arrow watering lands of the Lean Farm as well as its two mills and lands beyond towards Shobdon Marsh (now Shobdon airfield). See map on next page for details of these channels. The King-King water meadows were destroyed by order of the county War Agricultural Executive Committee (see page 66).

Examples of parts of the still surviving main carriers supplying the Noke and Leen water meadow systems: on the left, is part of the „Great Watercourse‟ feeding the fields south of the Arrow and a number of mills. Right: the carrier feeding the water meadows depicted in the King-King map.

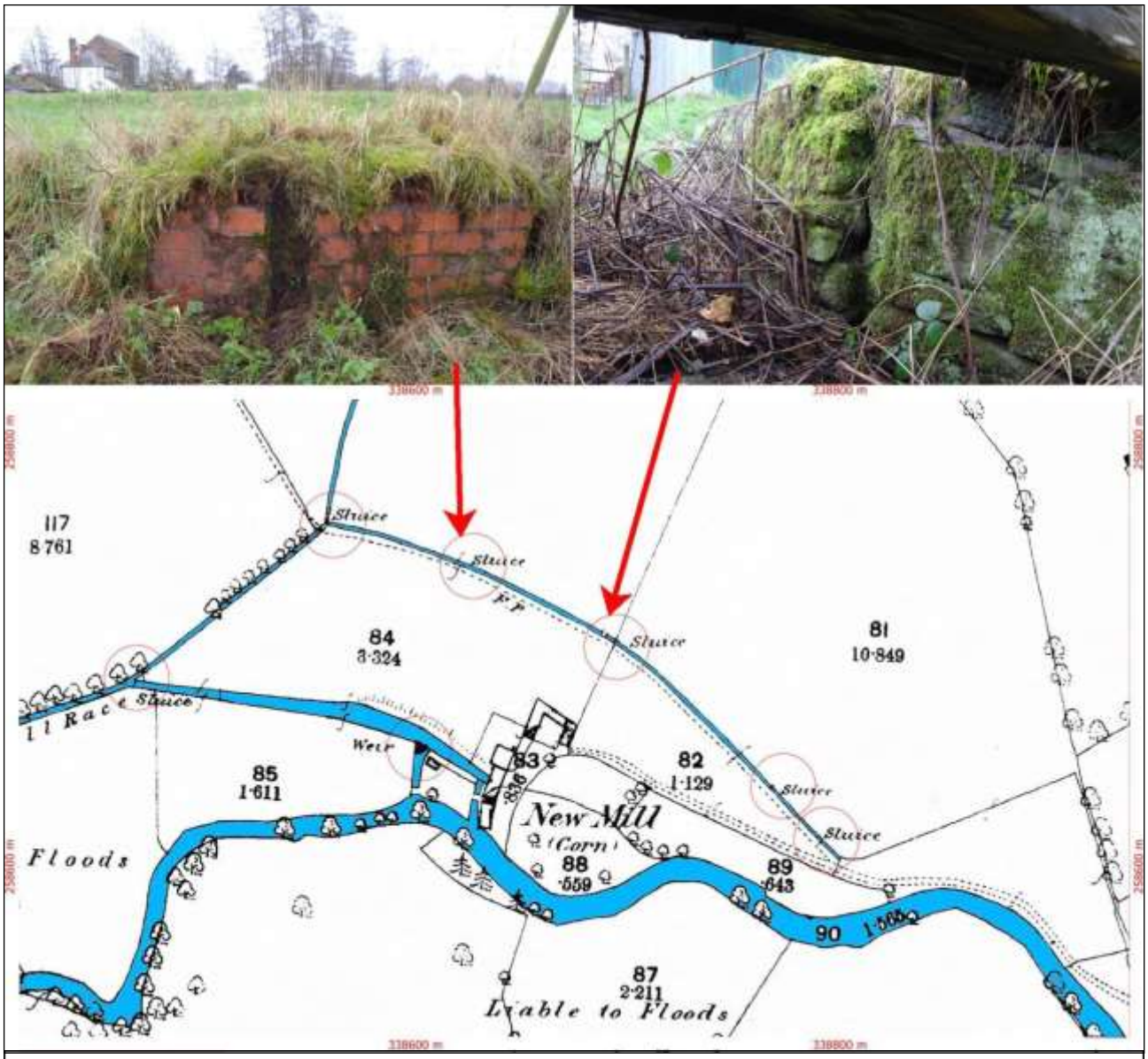


This map above shows the Arrow valley meadow irrigation system showing the main channels as mapped in the 1880s. Captain King-King‟s map of his water meadows was transcribed by historian Beryl Lewis and it is this version that has been digitised and geo-referenced into its correct location. For the detailed map sequences and field photos of 4 sub-areas see sites:
SO36_MowleytoLeenLeatSystem.
SO36_MowleytoLeenLeatSystem_GrovetoNoke.
SO36_StauntononArrowtoMiltonCross.
SO35_NokeCourt, SO35_Lean.

Left: Stone discharge sluice in the main southern channel as it skirts the wooded northern slopes along the contours feeding the water meadows on the south side of the Arrow below and down stream from Grove Farm.
Right: Stone sluice operating a secondary channel in the water meadow below northern channel which is also the mill race to the water saw mill just west of Staunton-on-Wye.



1st edition 25" to mile OS map of the Court of Noke showing the two weirs just to the NE, one which controls the water to the channel flowing north east to the land of the Leen and the other through the Court of Noke, augementing the mill tail leat to irrigate the meadows to the east. The two fields opposite and south of the Noke with the photos (above) are irrigated from the main southern channel to the west as it flows along the contours around the hill.

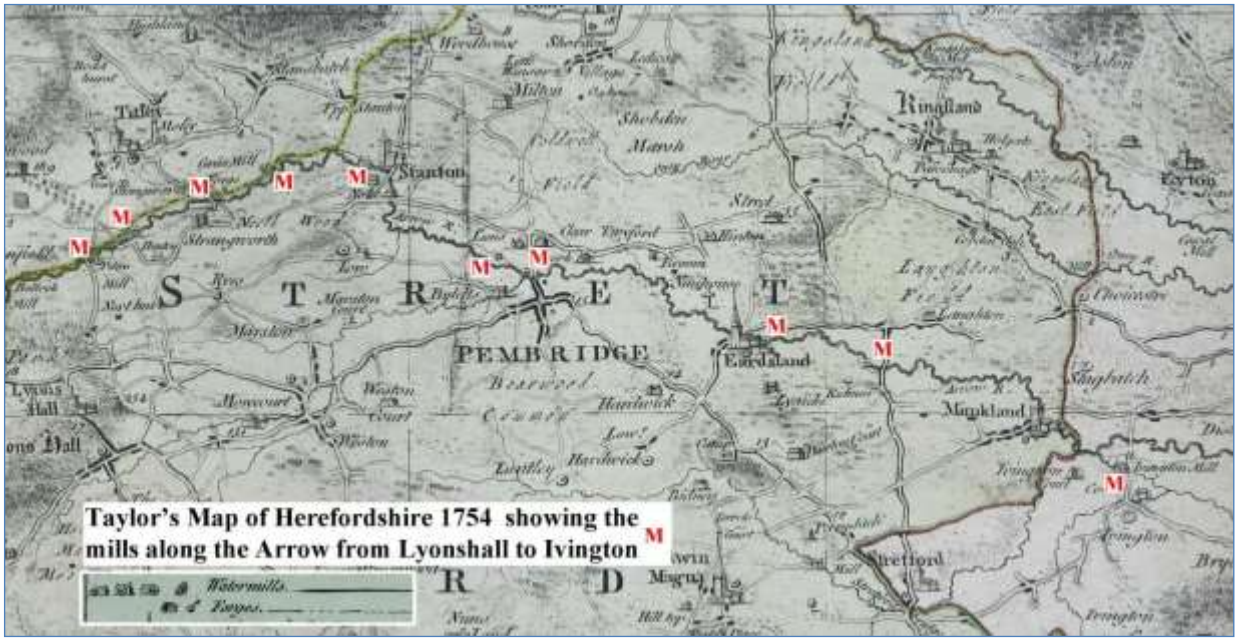


Surviving sluice gate abutments which were part of the catch-works system for the grasslands north of New Mill, downstream from the Leen farm

The main weir on the Arrow providing irrigation to the farmland around the New Mill on the Leen farm including the mill race (just to the west of the above map and the most easterly of weirs „W" on the main map of the Arrow system above. Right: the old mill wheel.

12. Arrow valley meadows and mills, Pembridge to the Lugg confluence.

Isaac Taylor‟s map of Herefordshire 1754 depicts 10 mills on the Arrow between Kington and its confluence with the Lugg near Ivington (see below for sites at Ivington). Our analysis of the Staunton-on-Wye to Pembridge water meadow system above shows how the weirs and sluices, channels and races were integrated to supply both mills and water meadows. We also have a documentary account (Shelwick meadows below) detailing how millers and water meadow owners co-operated for their mutual benefit and the problems that ensued when they didn‟t. Below is Taylor‟s map annotated to show the mills as they appear on the map for a 20 km stretch of the Arrow between Kington and Ivington (near the confluence with the Wye). Throughout that length, the tithe survey of 1840 records almost all fields either side of the river up to the 5 meter contour, some 20,000 hectares, as either meadow or pasture whose productive capacity depended upon the water management infrastructure associated with the mills.



1. Main weir on the Arrow at Twyford diverting water to the Pembridge meadows.
2. A surviving sluice gate for irrigating meadows down stream from Glanarrow Mill, Eardisland
3. Tail leat from Twyford mill irrigating meadows N of Arrow was 1 km long
4. One of a complex of channels irrigating the land by Glanarrow Mill (now arable)

Further details - see the sequences and field photos SO35_Twyford and SO45_GlanarrowMill

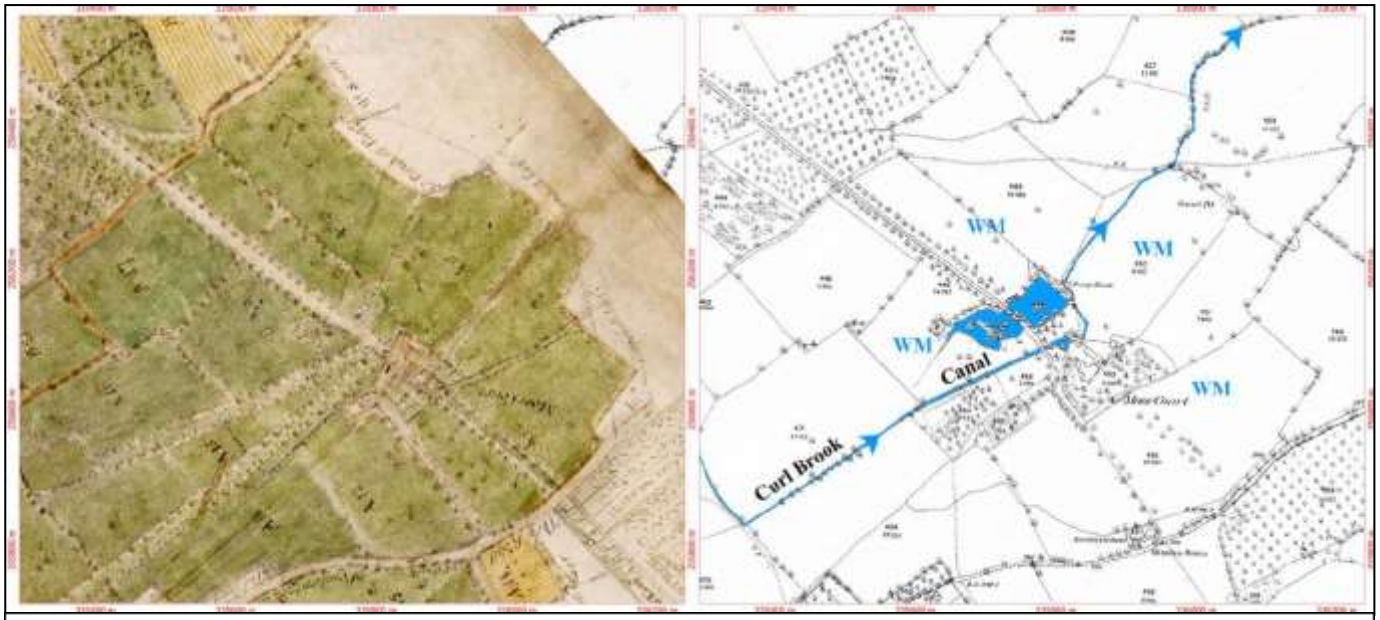
13. Water meadows of the Curl brook catchment

13.1. The Moor Court estate

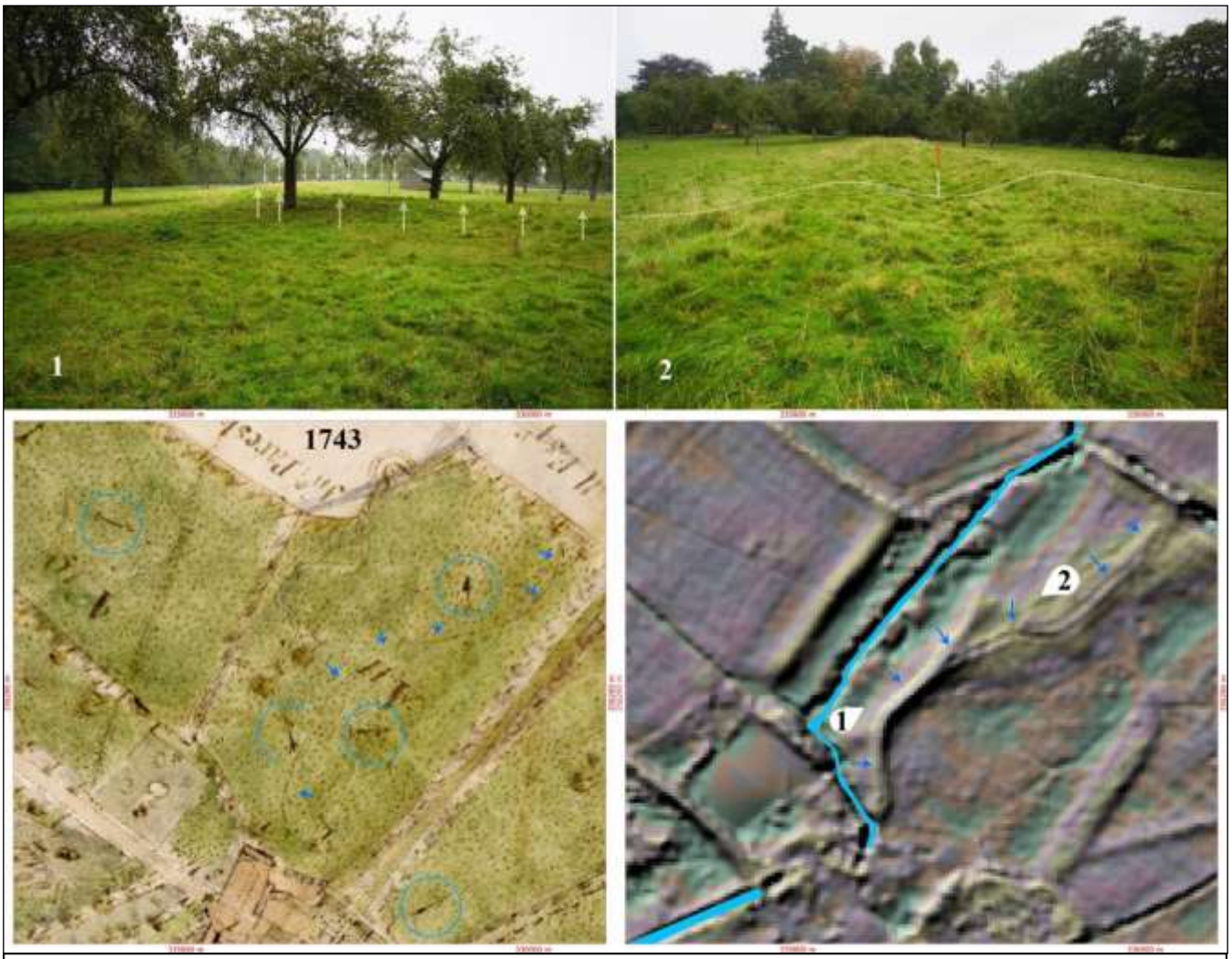
John James inherited the Moor Court estate in the parish of Pembridge in about 1664 and added to it in 1683 by purchasing land from Thomas Harley of Kinsham, 3rd son of Sir Robert Harley of Brampton Bryan, which gave him manorial rights over the property. He built a „capital messuage" at Lower Moorcot, which became Moor Court. Perhaps influenced by the Harleys John James developed a canal garden to the west of the house and utilised the Curl Brook to establish an irrigation system, which is marked on an estate map of 1743 and which continued in operation until the Second World War. The manorial rights may have been important in establishing a water meadow system that was likely to affect his tenant farmers. At Moor Court as at Brampton Bryan the spin-off from the irrigation system was a fashionable canal garden – thus creating a scheme that combined „profits with pleasure". In addition at both Moor Court and Buckton there was a manorial mill involved, which was similarly dependent upon water management.[86]

At Moor Court we interviewed Mr. Lewis, whose family were tenant farmers, who can remember being sent out by his father in February, to pull-up the boards and open the sluices, which brought water from springs issuing from rising ground a half-a-mile to the west of the Court, beneath the village of Lyonshall. The water trickled informally across the meadow lands around the court. At nearby Eardisland on the Arrow similar meadows were still occasionally being irrigated in the 1950s.

The 1743 estate map is notable for depicting the sinuous carriers and uniquely it shows faint arrows which indicate the general direction of water flow (see close up next page). The main carrier, raised on an embankment, is still visible crossing an orchard to the east of the Court.[87]



The Moor Court estate as mapped in 1743 (left) and geo-referenced with the unusual arrows marked showing water directions just visible (see enlargement below) and on the 25 inch to mile OS 1885 (right), showing the avenues, canal, lakes and location of water meadows (WM)



Top photos: The orchard to the NE of the house showing the main carrier slightly raised in relation to the meadow (now an orchard) and which was diverted off of the Curl brook by a weir (destroyed) just after the brook emerges from passing under house, formerly a mill.

Bottom left: an enlargement of the geo-referenced 1743 estate map showing the arrows (highlighted by blue circles for clarity) and also the main carrier as a faint line (blue arrows) which accurately reflects its actual location. The arrows point away from the carrier indicating their flow into meadow. The DTM of the same area brings out the carrier and its top gulley.

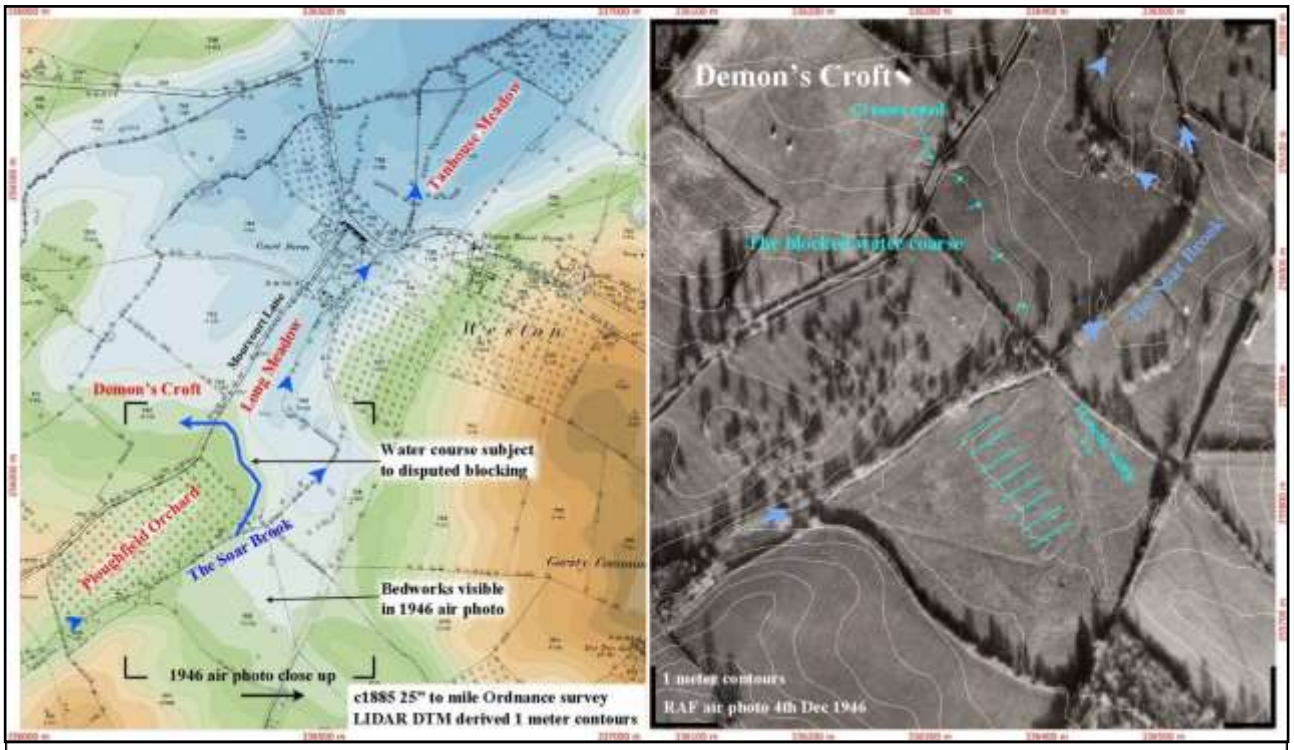
Left: The canal which is a modification of the Curl brook (see above map) with sluice from the lakes (right). There is another sluice on the right hand side of the bank of the canal which lets water into the meadow below.

13.2. Meadows of the Soar brook at Weston

The *Hereford Journal* for 9th August 1848 records a legal case involving a John Bannister of Weston Farm who claimed that his neighbour at Weston Court Farm had obstructed a water course that for the last 20 years had „flowed through certain lands to a close called the Tan-house Meadow belonging to the defendant for the purpose of irrigating the same, and that plaintiff had wrongful1y obstructed and diverted the said water-course".

Bannister got his servant Richard Thomas to „move and displace certain bolts and boards upon a water-course flowing through the said close, and so penned back the water of the said water-course and prevented the same flowing over and across the said close into another close of the plaintiff's, called Demon's Croft and then cut down and levelled the soil of a certain ditch belonging to the plaintiff in the said Long Meadow, and placed a quantity of rubbish etc. upon a certain ditch and fence, whereby the plaintiff had been prevented from having the use and benefit of the said water-course". Bannister also claimed that „that the said water-course flowed across a certain highway, to the great obstruction of her Majesty's subjects." The land surveyor Mr. Fosbrooke was brought in as technical advisor who „produced a first class map showing the water-course, and the diversion through Ploughfield Orchard, Long Meadow, across Moorcourt-lane, into Demon's Croft. He described the water-course across the lane as being about eight inches deep, and from six to eight feet wide."

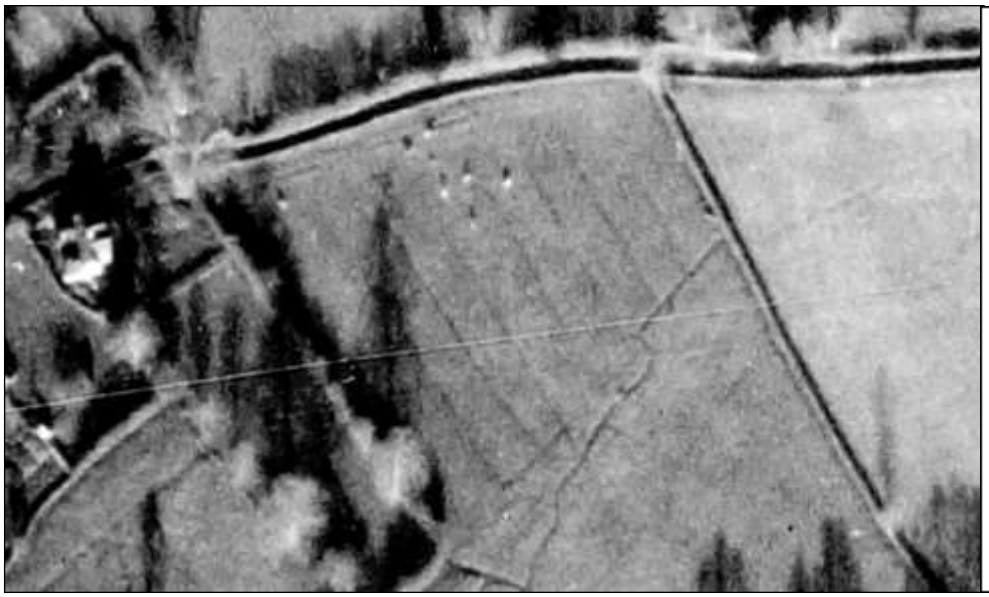
Not only can all the meadows can be identified and mapped from their Tithe map names but the 1946 RAF aerial photographs reveal the actual water course who"s blocking was subject of this legal case. The photograph also shows where the water course crossed the Moorcourt Lane „to the great obstruction of her Majesty's subjects."



Left: The valley landscape of the Soar brook between Weston and Moorcot Farm showing meadows and water courses identified from above legal case of 1848.
Right: an enlargement of the area (black corners) as photographed by the RAF in 1946. This geo-referenced photo shows the water course subject of the dispute (all now under arable cultivation). This image also demonstrates the ability in GIS to add a finely resolved contour layer derived from DTM which confirms that the water course is part of a catchwork system following the contours as it should. Also noticeable in the 1946 air photo is a possible bedwork system south of the Soar brook, see sequence SO35_WestonburyMill.

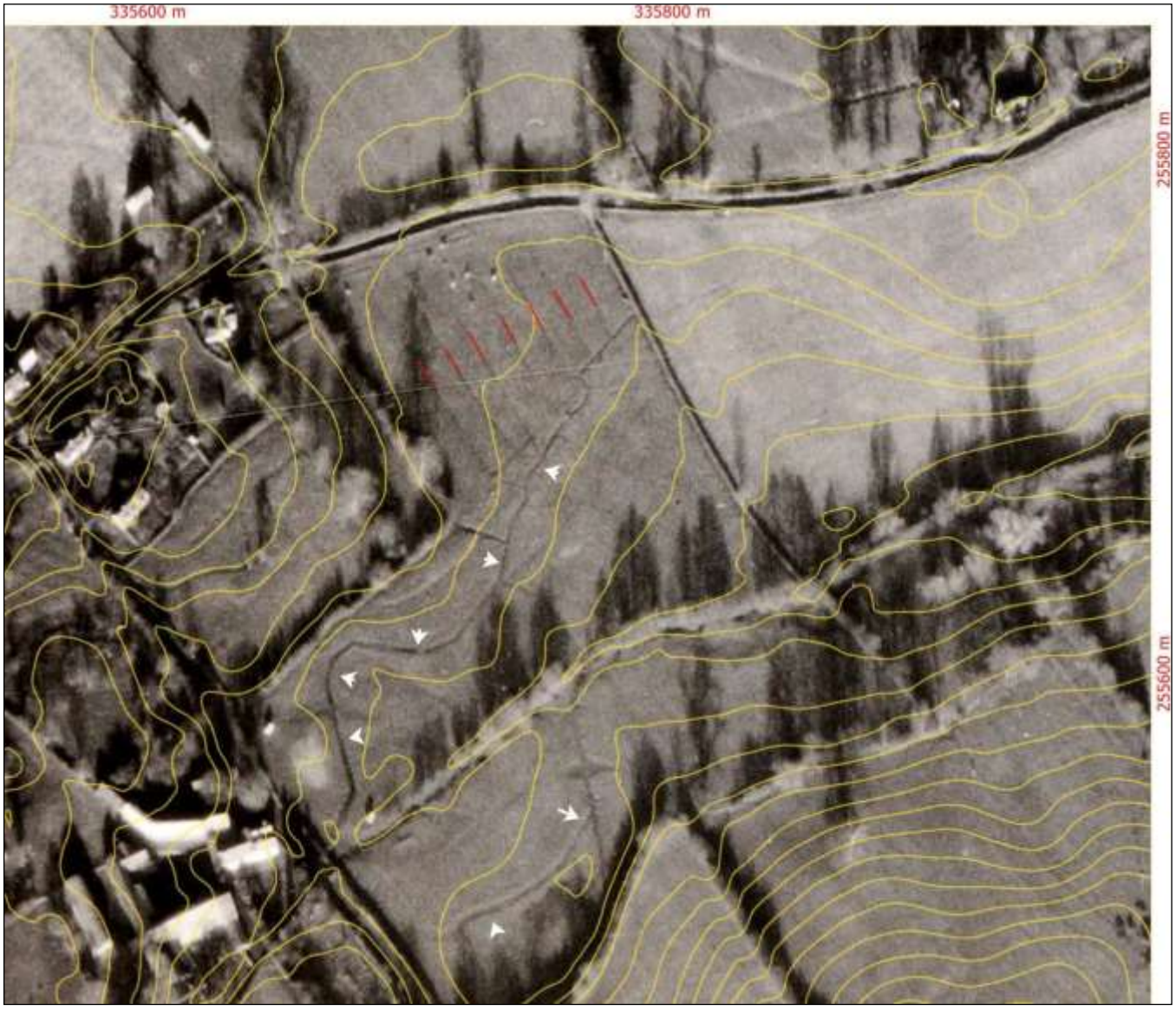
13.3. Possible bedworks system at Moorcourt Farm

Moorcourt Farm is 650m south of Moor Court and the field just to its east appears from the RAF 1946 to be a bedworks water meadow similar in appearance to the one near Lugg Mill. Here, any possible top channel on the panes would be below the resolution limit of this air photo which was taken at high altitude. The meadow has since been ploughed.



◂ Apparent bedworks with what seems to be the supply carrier at the top of the field.

☐ Same photo with DTM derived 1 meter contours (NE is higher) showing that the drain channel from the bedworks serves as a catchwork carrier for lower meadows. The mean width of panes (red lines) is 14 meters.

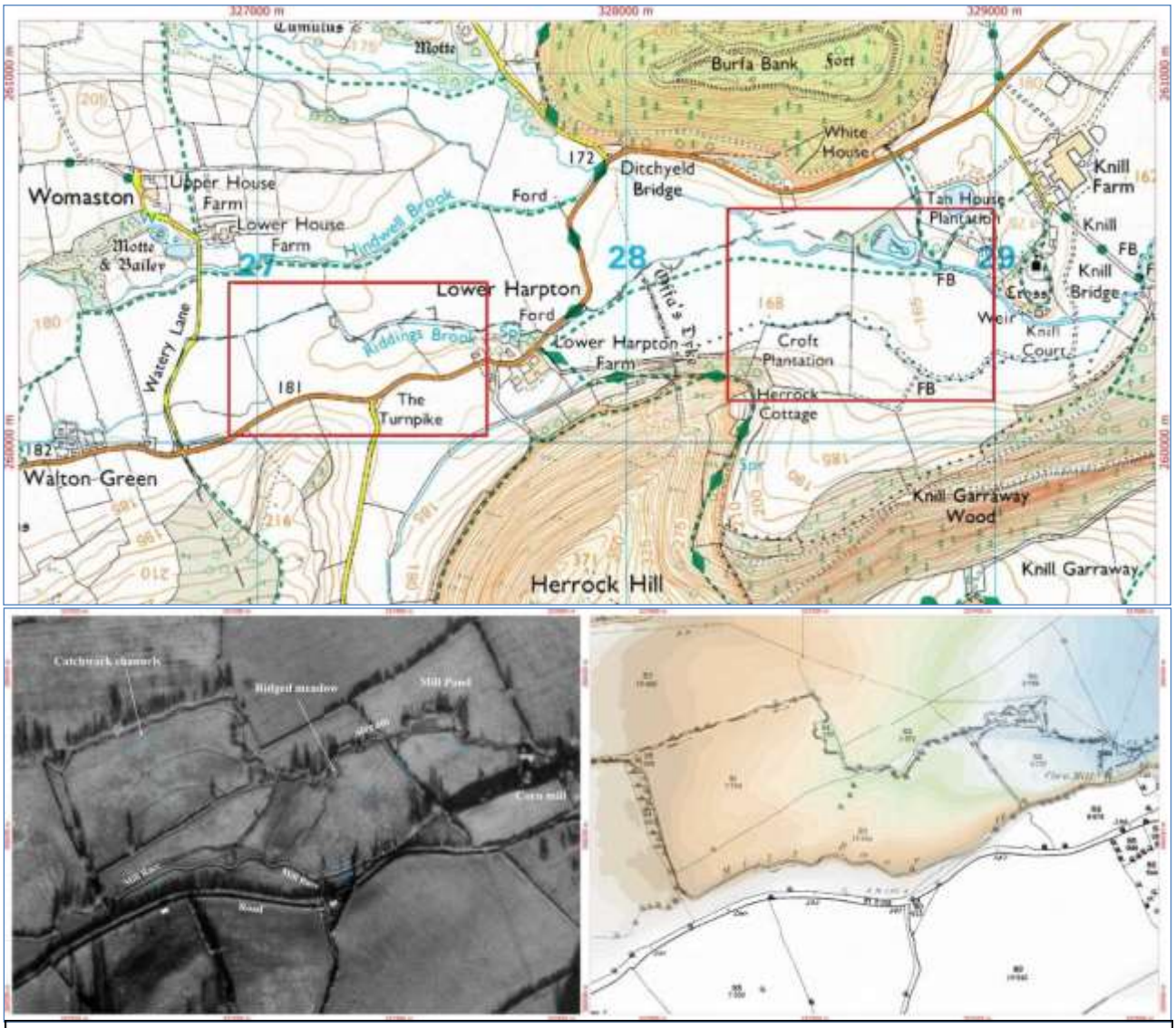


14. Water meadows of the Lugg valley

14.1. Hindwell valley to Combe

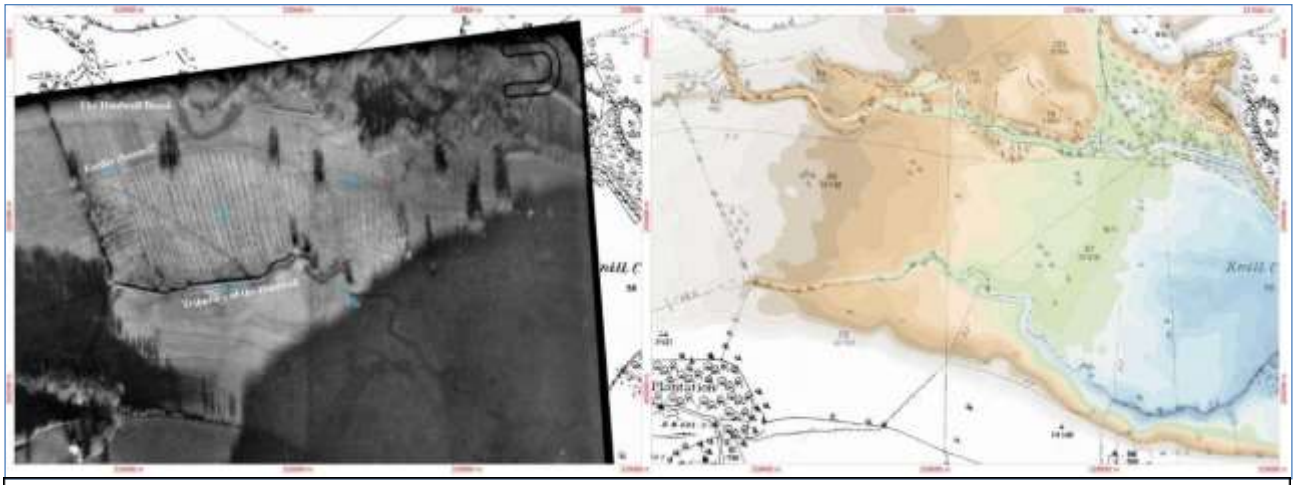
The river Lugg enters Herefordshire on its way from the Radnorshire hills just north of the border market town of Presteigne and some 3 km east of which at Combe it is joined by the Hindwell Brook which arises from the hills around Old Radnor. In the low lying area of this confluence and upstream along the Hindwell valley there are, or mostly were, a number of water meadow systems of which the best preserved is next to Byton Marsh SSSI (see below).

Along the Hindwell on the county boundary with Radnorshire, the RAF 1946 winter air photos show evidence of catchworks, channels and ridges in meadows, one associated with the corn mill at Lower Harpton and the other just upstream from Knill Court, see location map. Both meadows have irregular ridge widths varying between 6 and 8 meters with a few up 10 meters.



Fields west of Lower Harpton Farm.
Left: RAF 1946 where three parallel curved catchwork channels are visible and what appears to be ridge irrigation of the meadow being fed from the mill race to the corn mill at lower Harpton. Right: To avoid cluttering the RAF photo the DTM derived 10cm contours of the fields are shown overlaying the 1885 25 inch to mile – as will the Knill Court meadows.

Both these fields and those of Knill Court below are ploughed and their no trace of earthworks in the LIDAR derived DTM. See full sequence: SO26_LowerHarptonFarm

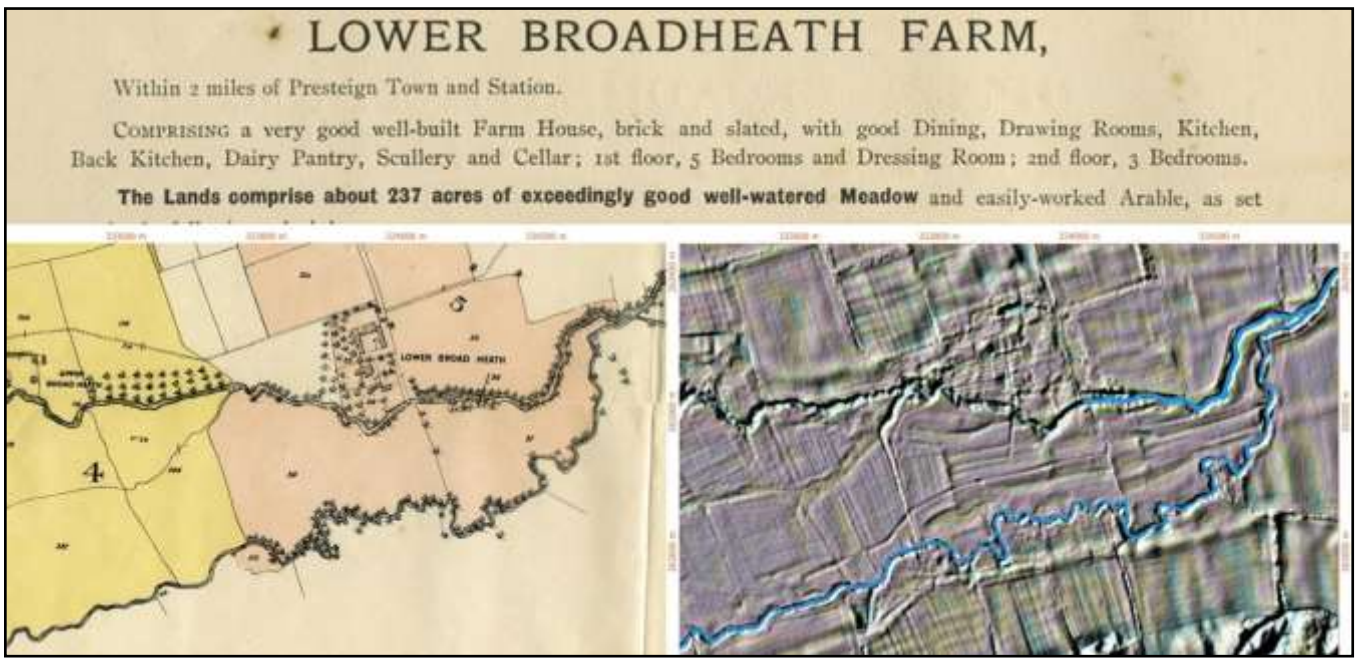


Fields west of Knill Court:
Left: RAF 1946 showing ridge meadows probably fed by the visible feeder channel to the NW and drained by a natural tributary of the Hindwell. Also ploughed with no trace.
Full sequence: SO26_KnillCourt

Further downstream along the Hindwell past Nash Wood is the low lying area around Wegnal Mill where there were a number of catchwork channels and raised carriers supplying meadows. Although most of the fields are now ploughed some remnants of irrigation ridges and parts of catchment channels remain visible under the DTM see SO36_WegnalMill.

East of Wegnal Mill and on the county boundary with Radnorshire is Broadheath Farm where there are a complex of earthworks in the meadows between the Hindwell and the Back Brook a tributary, a couple of 100 meters to its south. The DTM reveals a main channel, transverse ridges and some linear features parallel to the water courses along with some fields showing modern ploughing. We do have documentation for water meadows at the farm and specifically for the fields in question in the form of the auction sale details of June 1911 for Lower Broadheath Farm [now just Broadheath Farm SO 312626]. These describe the land as comprising „about 237 acres of exceedingly good well-watered meadow and easily worked arable of which the pasture extends to 160 acres“ [88].

These include the fields on the sale map of lots 4 and 5 which are also the ones showing the earthworks today, reproduced below and geo-referenced along side the differential DTM.
See SO36_BroadheathFarm.



LOWER BROADHEATH FARM,

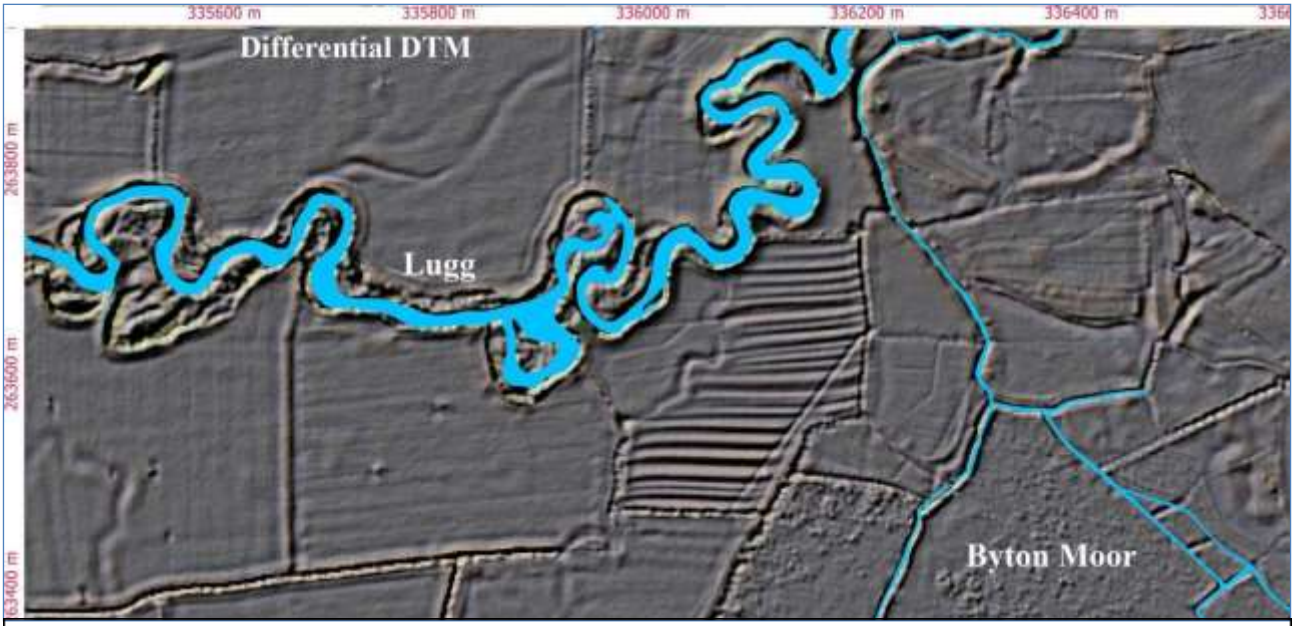
Within 2 miles of Presteign Town and Station.

Comprising a very good well-built Farm House, brick and slated, with good Dining, Drawing Rooms, Kitchen, Back Kitchen, Dairy Pantry, Scullery and Cellar; 1st floor, 5 Bedrooms and Dressing Room; 2nd floor, 3 Bedrooms.

The Lands comprise about 237 acres of exceedingly good well-watered Meadow and easily-worked Arable, as set

The Hindwell joins the Lugg in the parish of Combe much of which occupies a sump surrounded by Wapley Hill (and Camp), Shobdon Hill and the high ground of Kinsham. The lowest part the SSSI Byton Moor. The 1946 aerial photography shows ridges and channels in most of the meadows, see below for the area just south of Lower Kinsham. As the sequence SO36_LowerKinshamMill shows all of these fields have been ploughed, the DTM showing only some major field boundaries.

The best surviving example of water meadows in this area are ones next to and west of Byton Moor which consist of an impressing series of ridges which may have been bedworks although the top gullies are not visible. As discussed below in the case of the Shelwick meadows, top gullies, if they existed at all, probably would not survive decades of livestock pasturing once the meadow has ceased to be operational and the gullies kept dug, see SO36_Combe:

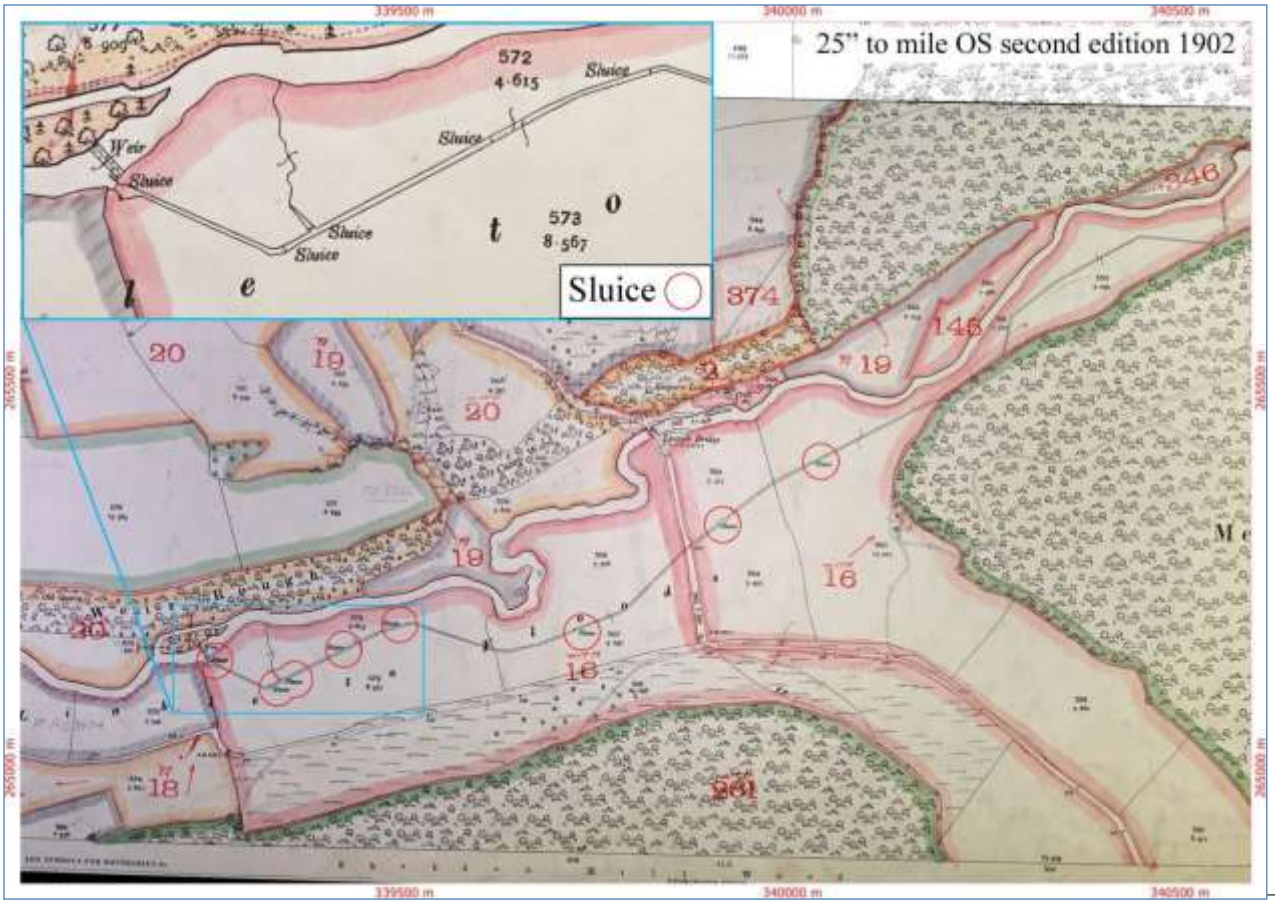


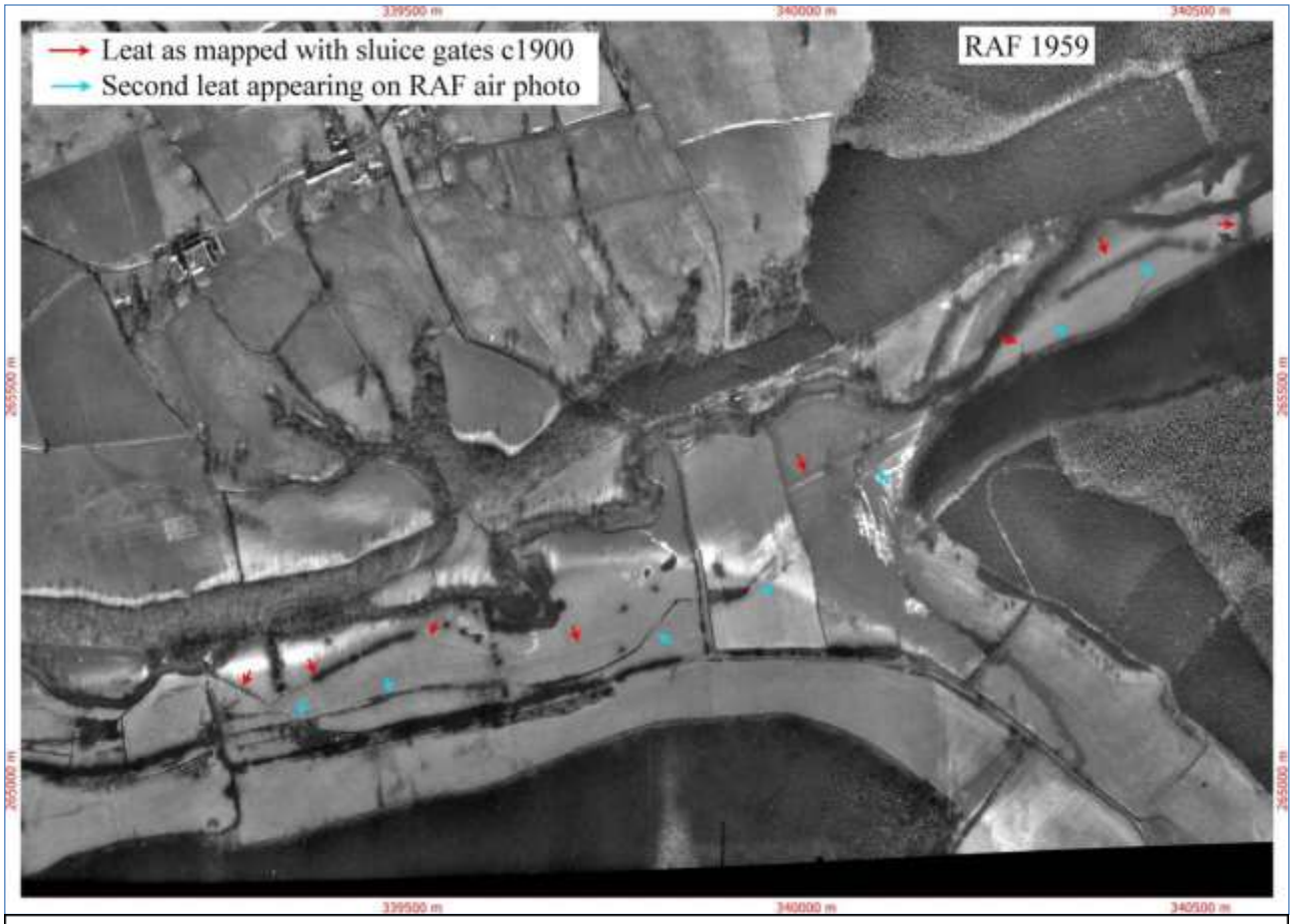
Ridged water meadows at Combe. Note that formerly all the meadows to the west of this field up to and including the Combe Motte showed ridges that could also be bedworks, see SO36_CombeMotte

14.2. Catchwork water meadows in Aymestrey parish

Here are two examples of meadows without ridges beside the Lugg served by channels or carriers see full sequences: SO46_LyepoleBridge and SO46_WaterCourseFarm.

The meadows on the south side of Lyepole Bridge were served by a channel 1.6 km long taken off at the weir 650 meters upstream of the bridge (insert map image below). This channel crossed the road and continued parallel to the Lugg, returning 900 meters downstream. Along the way are 8 sluices marked on the 25" inch map (1902) but there were probably more smaller one. It is interesting to compare this map with geo-referenced RAF air photo of 1959 (below) which shows that a new channel had been dug in the interim. These meadows have been ploughed for some years but differential DTM is able to show the channels (see sequence).





RAF 1959 photograph of the Lyepole meadows showing the creation of a new channel – at least one not mapped in 1885, the rectangular field may have been ploughed by this time.

4.5 km downstream from Lyepole bridge the Lugg turns SE to Aymestrey village where at Yatton court there is weir and sluice which diverts water to channels which flow for about 1.5 km to irrigate the meadows along the Lugg which by this point is now flowing due south:

The meadows between Aymestrey and Mortimers cross: 1885, 1946 and now. See SO46_WaterCourseFarm (name of the present farm)

14.3. Lugg valley water meadows: Leominster to Sutton

The low lying land between Eaton bridge just SE of Leominster and the confluence of the Arrow and the Lugg was an extensive area of grassland at the time of the tithe survey some it meadow managed in strips (Volka Meadow SO510570, now arable). The grassland around Easton Hall is still permanent pasture with a complex of earthworks. Field survey found some evidence of a mill site and concluded that the earthworks were most probably a water meadow system perhaps developed after the mill ceased operation and which itself fell out of use in the late 19th century.[89] The Brabazon papers relating to Eaton Hall describe mills on the property up to 1687 but none after 1707 probably the result of the Wye and Lugg Navigation Act 1695 which required the removal of weirs and such obstructions. No mill appears on Taylor‟s county of 1754 even though no less than four mill are depicted on the Lugg in Leominster itself. The lost mills nonetheless appear as names the 1840 tithe survey of these same fields including “Mill Meadow”, “Mill Butts” and “Mill Furlong”.

Left: Differential DTM scan showing a complex of channels, meadow irrigation ridges and more modern drainage on either side of the river Lugg but confirming the above field work above referenced. Right: 2000 air photo of same area.

6 km south and down stream from Eaton Hall the Lugg starts its loop around the eastern end of Dinmore Hill which is where at Hampton Court an elaborate late 17th century water garden was developed in tandem with an irrigation system. The late 17th century birds-eye views of the gardens by Stevens and Kip show a leat leaving the Lugg at Hampton Bridge above the court where there remains a weir. This feeder can still be traced and appears to have irrigated the meadows near Hampton Green Farm. On the south side of the gardens the Humber Brook was used to feed a long canal and for this purpose the water level was raised by a weir, see SO55_HamptonCourt. In 1786 Nathanial Kent, an advocate of water-meadows, carried out a survey of the Hampton Court estate for the earl of Essex which may have included recommendations for irrigating the Lugg-side meadows. This could easily have been facilitated using the weir to the south of the court albeit modern ploughing has eradicated all trace.[90]

An account of a deer hunt at Hampton Court in the *Hereford Journal* for 23rd March 1842 incidentally gave a brief insight into the nature of the meadows between Hampton Court and the River Lugg: “On Monday last John Arkwright Esq invited supporters of the Bodenham Harriers to hunt a buck … [a description of the chase where the buck ran] ..to the beautifully-irrigated meadows below Hampton Court”.

Where the Lugg winds round the north-eastern tip of Dinmore Hill, it envelops the Smeadal meadow to the east of Bodenham Church. This was a common meadow and was watered by a leet taken off the Lugg at the church weir, from whence the main carrier for the system can be traced across the meadows, eventually returning to the river beside Bodenham Bridge[91], see SO55_Bodenhamchurchmeadow.

After rounding Dinmore Hill, the Lugg flows south again to widen out over a 4 km length of its Lugg valley down to Marden. The December 1946 RAF aerial photography confirms the general picture of these flood plain meadows (all grassland in 1840 too) as being mostly ridged. By analogy with the well documented and similarly ridged meadows in the Shelwick area these are likely to had some measure of control even if only the relatively crude „floating upward" system we documented for the meadows at Eyton on the Lugg (see page 8).

A 500 meter wide E-W transect across the Lugg valley, Green Farm to Wisteston Court. All the ridged meadows that are present in the RAF photo of 1946 have been ploughed out . See the sequences SO55_BurghopeFarm and SO54_Wisteston.

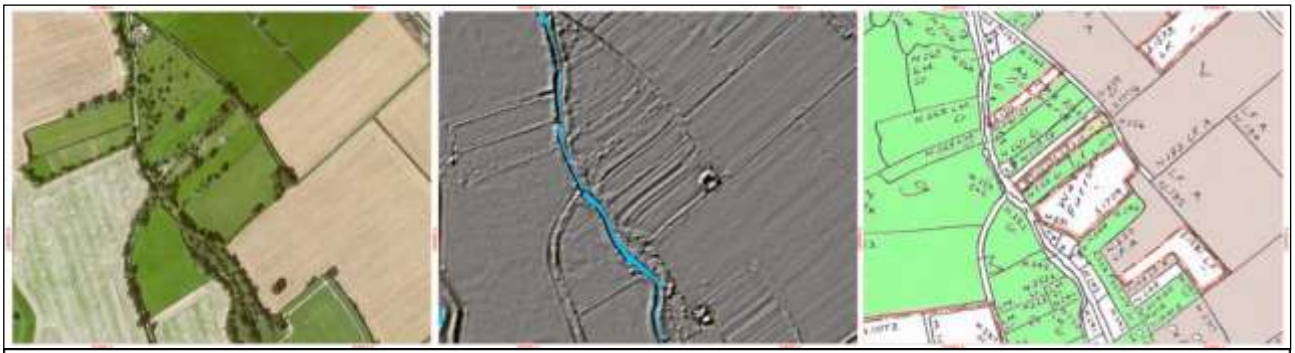
At Moreton-on-Lugg the remnants of water meadow bedworks are visible in 1946 and the DTM reveals that some of these have survived to the present day see SO54_MoretononLugg.

Fragments of what appear to be bedworks are visible in this RAF air photo. The Lugg is meandering on the right and the Moreton on Lugg army camp on the left.

At Freen"s Court, on the eastern flank of the Lugg opposite to Moreton-on-Lugg there was a 17th century water garden adjacent to the former moated manor house and in the meadows surrounding are signs of bedworks, as well as ridge and furrow[92] although much reduced in area since the 1946 aerial photography below, see SO54_FreensCourt.

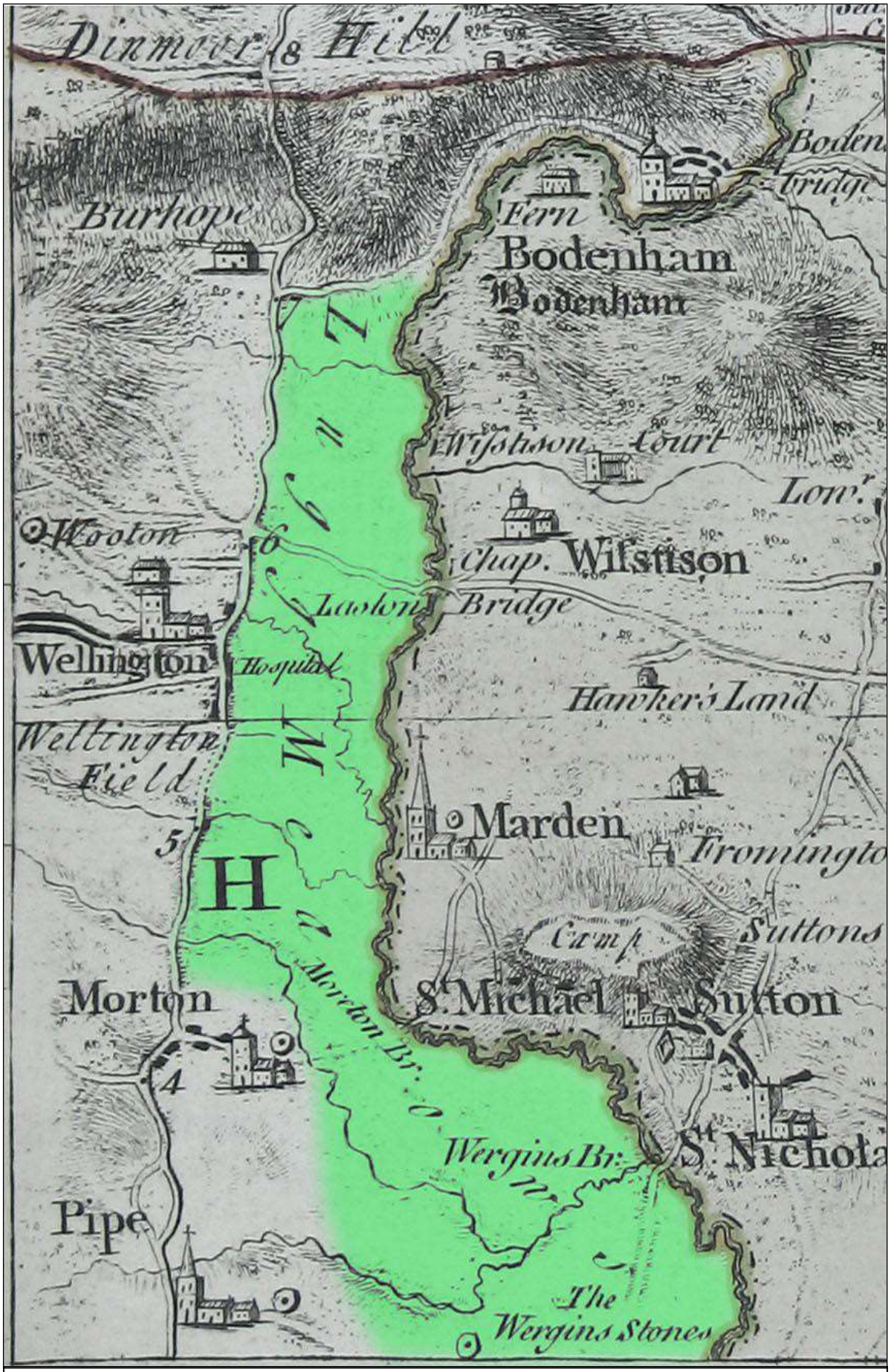
In the royal manor of Sutton, the Wirgins Meadow occupied the land west of the Lugg and up to Lyde Hill and irrigated by the „Eau Book" which arises from west of Moreton-on-Lugg and skirts Lyde Hill. Wirgins was part of an open common meadow system similar to the well-known „Luggs meadows" just east of Hereford (and more of that below) but was enclosed in 1808. Tenants of remote manors such as Pencombe, Ullingswick and Preston Wynne had grazing and hay-rights in Wirgins Meadow, together with the vicar of Little Cowarne. [93]

Just south of Sutton next to the Sutton Rhea one of these enclosures is a ridged meadow that still survives whose name on the tithe survey as "Water Furrows" (SO537446) see SO54_SuttonRhea and sequence below:



The meadow called „Water Furrows" on the 1840 tithe survey. Air photo 2012, differential DTM and the Geoff Gwatkin transcription. Clearly originating as arable ridge and furrow the tithe name is suggestive of meadow irrigation especially since it abuts the Sutton Rhea water course. The land use is not given for this particular parcel but is likely to be meadow as now.

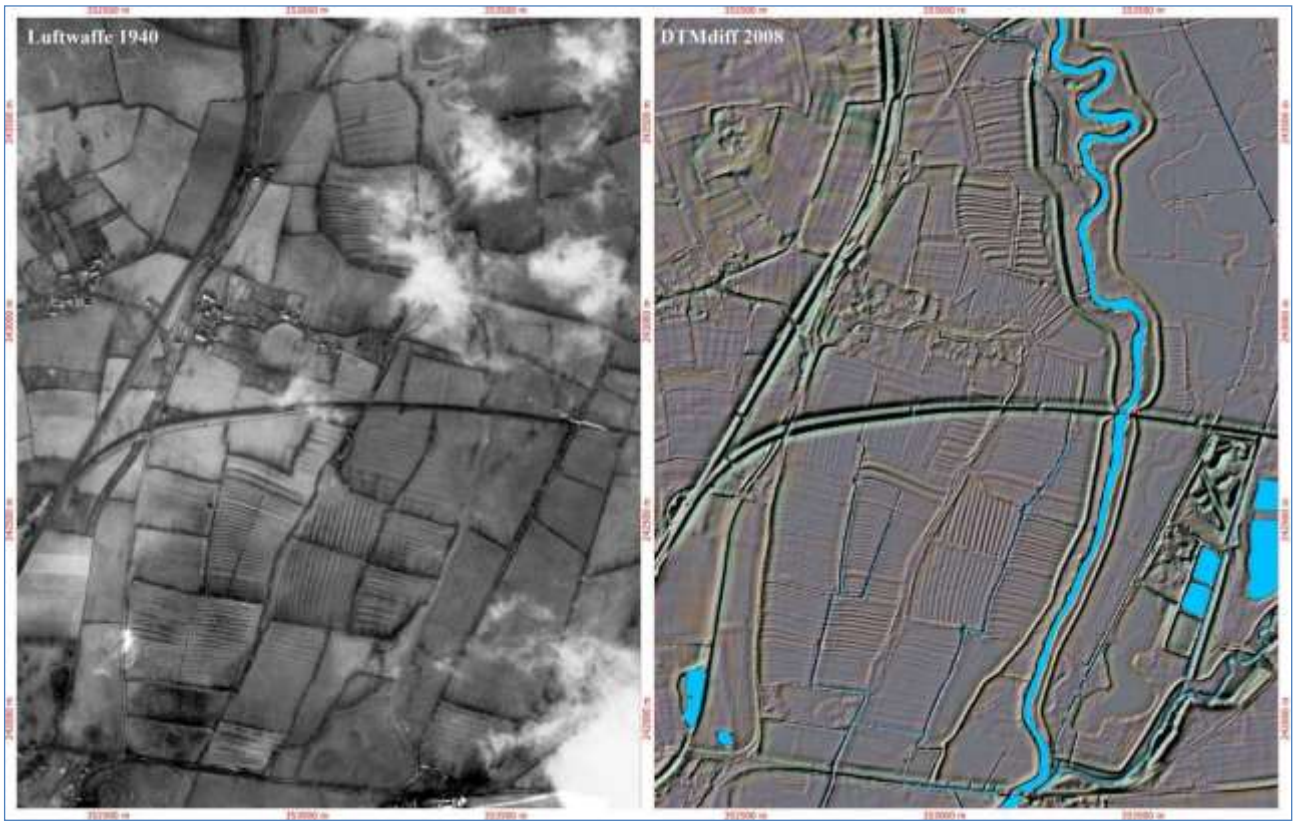
Silas Taylor, writing in the 1650s, described the meadows near Sutton and Marden, which „delight the eye with its green prospects in summer".[94]



Part of the Isaac Taylor"s county map showing the continuous extent of the Lugg meadows between Bodenham and Sutton at this time and before the 1808 enclosure of the southern part around Sutton and Marden mentioned above (our colouring).

14.4. The Shelwick meadows

One of the most impressive meadow irrigation systems that has survived occurs on the Lugg is at Shelwick Green, between Hereford and Sutton St Nicholas. In December 1940 the Luftwaffe, who were obtaining reconnaissance of the Rotherwas munitions factory and its surroundings, took the photograph below. As with the RAF photographs in December the following year, the low sun angle and lack of reflected light from low lying water highlights the earthworks. We have geo-referenced this aerial image and placed it side by side with the differential DTM. Unlike most of the other ridged meadow systems in the immediate post war period this Shelwick system has survived remarkably unscathed. In the 1970s, the Lugg Valley flood alleviation scheme (of limited effectiveness) damaged parts of the system and cut across the old channels, see the DTM and the oblique photo below.[95]



Shelwick was a manor belonging to the bishop of Hereford where, on the river, at the end of a long causeway he had a water-mill.[96] In 1642 this property was leased to Sir William Scudamore (d.1649) of Ballingham, a cousin of the first Viscount who sub-let it to Sir Robert Pye (d.1662) the uncle of John Beale and one of his principal patrons. In a long document relating to the confused affairs of the Scudamore family it mentions that Sir Robert had been granted a 44 year lease for Shelwick by Bishop George Coke (1636-46) which included „certain lands, meadows and pastures lying in and near the village of Shelwick". The attribution of the water-meadows to one or both of them seems plausible.[97] The Shelwick meadows are discussed at length in the *Hereford Times* on 9th January 1847. This is a detailed account with witness statements, occupying over two pages of the newspaper in small print, of the legal action against Richard Wheeler, occupier of Lugg Mills, just below the meadows, by Messrs" Bulmer, Probert and Pye who together claimed damages for flood waters lying on their lands:

„by the damming up of the waters of that river for the purpose of driving the machinery of the defendant"s mills [such that] the lands of the plaintiffs were rendered wet, miry, marshy, swampy weedy and rushy and greatly injured and deteriorated in value".

These are lands on either side of the Lugg just upstream of the mill where the inundation was caused by Wheeler raising his sluice gates to maximise the power of his mill but preventing the controlled irrigation of meadows necessary for optimising grass growth. This was in contrast to the previous miller, Mr. Prince who had co-operated with water meadow owners and indeed operated a water meadow himself. The court was assisted by technical advice from Land surveyor William Fosbrooke who stated that „the meadows spoken of lie so that the surface water may be drained off into the river below… on the Shelwick side there are paddles for letting the water out to irrigate the meadows.. in some seasons many of those meadows may be irrigated with advantage; saw in No. 3 a grip which leads to 3 or 4 cross gutters across the field; they were stanked up last summer.“ [„Paddle“ = sliding panel of a sluice gate].

Meadow „No.3“ with the „cross gutters“ can identified as one of the ridged meadows that still exist today see below. Fosbrooke“s map for the court seems not to have survived but the meadows can identified with some confidence since are we are told that the waters „extend on that side to Proberts field opposite Shelwick Ford [SO534431]“.

Mr. Prince the previous miller managed water levels in the meadows to complement the requirements of driving his mill wheels as this testimony by a former employee makes clear:

Mr. John Howells, miller, Kington „was 10 years in the employ of Mr. Prince at Lugg Mill; the water at that time was kept up to a mark on the bridge called the “set off”, Mr. Prince would lower it for persons to pass through Shelwick ford… The water had been kept higher within the last five years than ever it was in Mr. Princes time, except when he wanted to float his meadows, he then used to shut down the gates at dusk of night and draw them up first thing in the morning; never put any boards on top of the lashers [= opening in the weir] to float his meadows.“

Other meadow owners would also rely on the miller“s co-operation to adjust the upstream water levels as noted by witness Richard Hodges, a carpenter who described how he would „put the tackle up for Mr. Prince to float Mr. Terry“s meadows“.

Another John Howells, of Castle Mill Hereford „occupied the Lugg-mills for five years with his mother for 13 years, before Mr. Wheeler had them [1841] had many times put false planks, in summer, on the top of the lashers, about inches high to work the mill or when requested by occupiers of land for the purpose of irrigating the lands of Mr. Pye and Mr. Lewis of Shelwick, they then let the water out by grips cut through the banks of the river into their meadows.“

Summer irrigation of the meadows is described by Mr. Bulmer“s bailiff Thomas Walters who „last June when the weather was burning up the meadows ….he let the water out it ran into three ditches; stanked up the ends of the ditches to send water over the meadows.“Richard Wheeler engineer recollected „the mill and the dam in Prince“s time and the meadows above the bridge; the banks had holes cut in the banks of Prince“s meadows for the purpose of irrigation; I

have seen grips in other meadows cut for irrigation. There were sluices on the meadows; I have known the water penned up for irrigation ; they used to put planks on the top of the lashers".

Bedworks just NE of the Lugg Mills (bottom left) may well be those floated by the miller Mr. Prince. Compare 1941 and 2012, most lost to gravel working but two southern panes visible. The old bridge over the Lugg is visible at the bottom right part of the Hereford/Worcester road after it crosses the Lugg valley on a causeway.

14.5. Water Meadows in the Lugg Valley: Shelwick to the Wye/Lugg confluence

The bedwork system at Shelwick Green contrasts markedly with the unimproved Lugg Meadows scheduled as SSSI for their characteristic flood plain meadow flora which includes the Fritillary *Fritillaria meleagris* and which stretch from the Lugg Causeway (Hereford to Worcester road which crosses the Lugg flood plain) southwards to Hampton Bishop. Modern experience indicates that the meadows flood regularly during the winter months whereas at Shelwick, even before the arrival of the modern „stanks", flooding was more intermittent. This has led to the assumption that the „flood plain meadows" of the Wye and Lugg were quite different from managed water meadows. In fact the two were often combined, for in the past, before the advent of extensive land-drainage, both the Wye and the Lugg were relatively well-behaved rivers and flooded less frequently.[98]

A neglected feature of the meadows was the presence of a „gutter" running around the edge of Aylestone Hill on the west side of the Lugg meadows, separated from the main River of the Lugg which lies deep within its alluvial cutting in the summer months. This „gutter" is known as the Lugg Rhea flows from the Shelwick meadows southwards towards the Frome at Hampton Bishop. The Lugg Rhea is augmented by a stream coming down from Holmer and Munstone, which about1845 was used to feed the Herefordshire and Gloucestershire Canal as it emerged from the Aylestone tunnel. It is likely that the water from the Rhea was used to irrigate the Lugg meadows in the summer, before the hay harvest. It is noteable that Lugg Meadows are entirely flat and featureless even This presumably only provided partial flooding but the natural state of the meadows allowed the water to move quietly around the „swillies" (ditches) and islets, which are still visible today. Between 2nd February and 1st August the meadow was in the hands of the owners of individual strips who could take a hay crop and tether their cattle for grazing. Presumably, in collaboration with their neighbours they could

operate sluices on the Lugg Rhea and keep their strips moist.[99] Evidence for this activity comes from an unlikely source – the watercolours of David Cox who for many years in the early 19th century lived on Aylestone Hill and for part of that time occupied a cottage in Baynton Wood, a few yards above the Rhea. He reproduced images of the hay meadows, sometimes with rustic sluices in the foreground, many times during his life, recalling happy times in Hereford before he went to London to seek his fortune.[100] We have created sequences for the Lugg Meadows: SO54_LuggMeadowsNorth, as well as nearby sites on the eastern terrace of the Lugg valley in Lugwardine which show (in the 1940s) catchwork channels and meadow irrigation ridges: SO54_LuggBridgeFarmSouth and SO54_NewCourt_AP1946.

Further down the valley near Hampton Bishop the waters of the Lugg were augmented by the River Frome and together they produced one of the most extensive areas of flood meadows in the county. In the 20th century this area has been much drained and „improved" but before this era four important estates existed here – represented by the bishop of Hereford"s manor at Hampton bishop, Longworth Hall, Larport and Sufton Court. A small area of bedwork can be found visible in DTM and was more extensive in 1946, close to Longworth, on the northern edge of the Hampton Meadow, which was in common ownership, SO53_TidnorMill&HamptonMeadow:

The Bishop held Hampton Bishop including mills and meadowland squeezed between the Lugg and Wye. From the earliest times the bishop and his tenants struggled to control the flood-water. Even today long stretches of embankment and deep ditches are found all round the village nucleus. However, from the late 17th century regulated flooding was welcomed and Hampton Bishop is one of the few places in the county where professional expertise in water management could be found. In 1781 Thomas Davies and „his company" offered to „undertake Wear (sic) work anywhere in the county".[101]

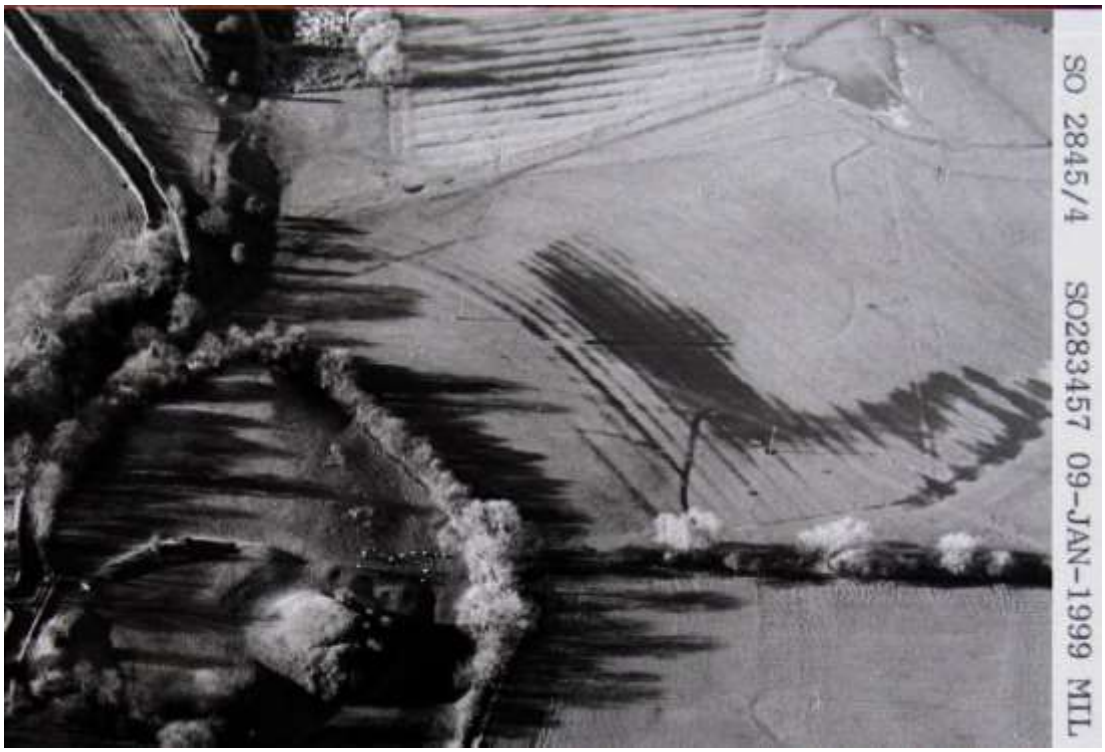
Longworth Hall had become a discrete estate in the 15th century and the Walwyn and Phillips family reclaimed land on the NE side of the Frome, below their extensive deer park. Robert Biddulph Phillips (1798-1844) was a notable improver holding cattle fairs at Hagley. As a result of draining the Frome Meadows he was able to build a new drive to his house from the Ledbury road below Bartestree. Eventually in the late 19th century the meadows were imparked. However, a sale catalogue of 1886 noticed that nearly all the land on the estate was pasture with some „prime fattening land". This was at a time when grazing in Herefordshire was in decline [102]. The Woodhouse family of Larport, a small hamlet below Priors Frome just up from the confluence of Frome with the Lugg and on the opposite flank of the Frome from Longwoth Hall, were also notable improvers in the 18th century who were unlikely to ignore the extensive grazing at their front door. Some meadow irrigation ridges and catchwork channels along this stretch of the Frome valley (that is from the Lugg confluence to the A438) are visible in the 1946 RAF air photos and a few ridges still remain to be visible in differential DTM, see SO53_LongworthMilltoFiveBridges.

Similarly, the Hereford‟s of Sufton Court at Mordiford, where Beale noticed a stream suitable for Evelyn‟s „jettos‟, were conscientious landowners. Their extensive court rolls, which begin in the 14th century show that their tenants held parcels of land in the „Prior‟s Frome common Meadow‟ on the east side of the Frome and Lugg. In the 17th century the estate begins to show sensitivity about the diversion of water courses. In May 1666 a tenant is fined 20s for allowing a stream to flood the king‟s highway, presumably the main road that ran through the village of Mordiford where the Pentaloe Brook worked a watermill. Careful fieldwork suggests that a leat from the mill pools carried water across the Fownhope Road, just to the west of the village into a meadow where DTM reveals a compact catchwork system, just above the Lugg[103], sequence SO53_Mordiford.

15. The water meadows of the wye valley

15.1. The river Wye from Hay-on-Wye to Hereford

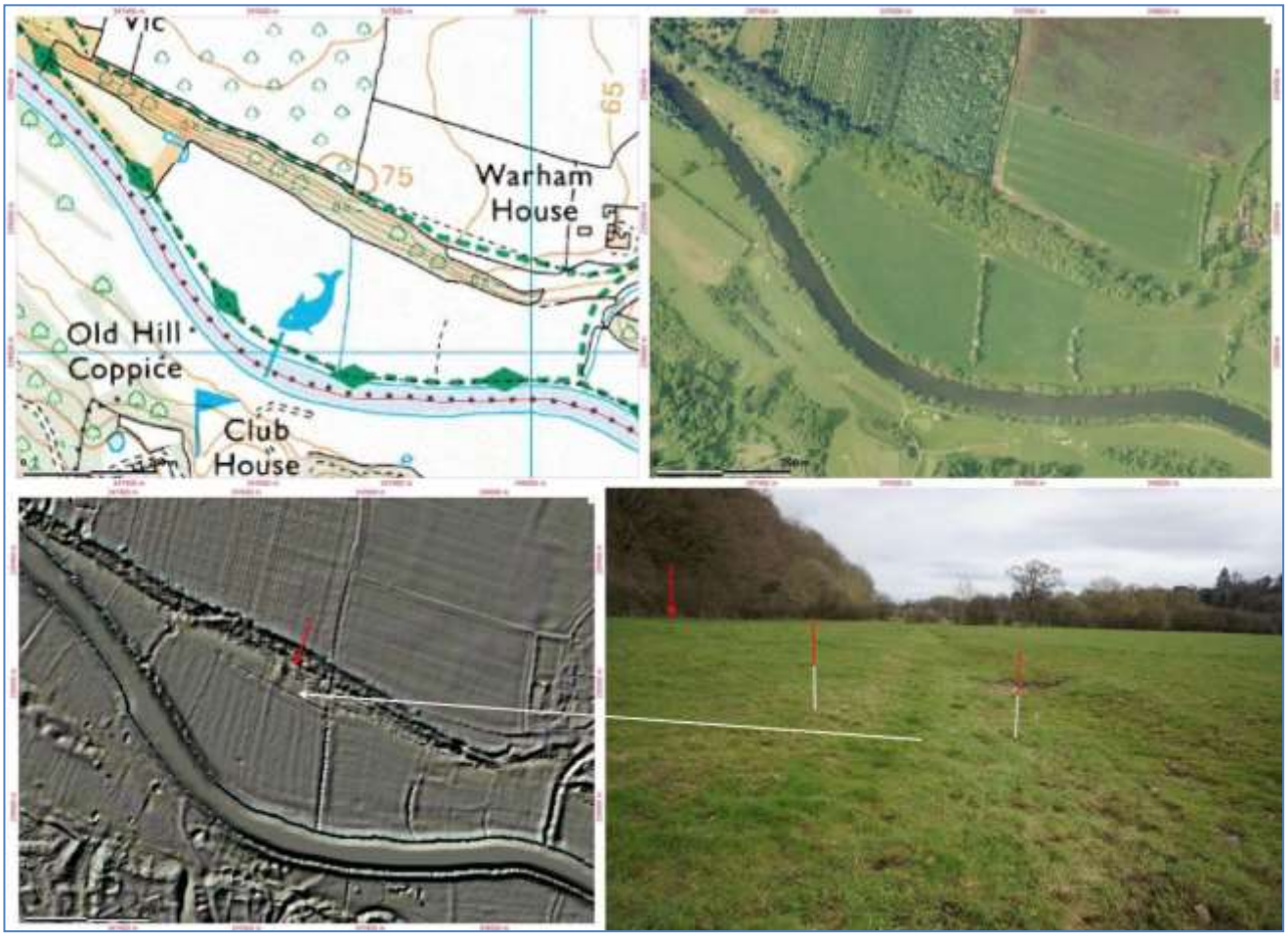
The Wye enters the county at Hay-on-Wye and valley floor flattens out over as it passes through the parishes of Clifford, Whitney, Willersley, Winforton, Bredwardine and Letton at which point it joins a wide palaeo-channel which extends NW to the „Staunton Moraine‟ known as „Letton Lake‟ and having some similarities to the Wigmore Basin. This is a large flood plain formerly almost entirely grassland up the early 1970s and is periodically inundated, sometimes covering several square km. A soil survey described this plain "*their main use is as fattening land for stock. Good crops of hay and grass can be produced and the depth of soil ensures that growth is not checked by dry spells*"[104]. As with the Wigmore Basin, the RAF December 1946 photographic flights reveals many a ridged meadow and by comparison with modern aerial photographs also that few have survived post-war farming. Probably due to the comparative strength and unpredictability of the Wye there seems to be no history of mills on the Wye in this stretch nor around the flood plain. Taylor‟s map which marks 10 mills on the Arrow shows none at all on the Wye nor any where about the flood plain except for just a couple on tributaries (Clifford and Eardisley). The 1695 Rivers Wye and Lugg Navigation Act may also be an explanation and there was certainly river traffic that extended up to Glasbury upstream from Hay[105]. Whatever the reason we have not found the long leats and channels for irrigation and mills that we observe for the Arrow valley and the Wigmore Basin. Nonetheless there are a number of ridged meadows and possibly bedwork remnants such as appears at the top of this oblique air photo of the motte and bailey at Lower Castleton, see SO24_LowerCastleton.



Other sites of meadow irrigation and/or ridge and furrow are found along this stretch, often from the RAF flights including: SO34_TheSturts (now an SSSI grassland), SO34_LadyArborFarm, SO34_TurnersBoat and SO44_OldWeir (see page 15 above).

There are possible water meadow remnants at Breinton (see SO43_Breinton) where there are degraded channels (white arrow below), a system of transverse ridges and a pond or two. Here there are steep, wooded river cliffs (red arrow), which weep water throughout the summer months. Again this is collected in a well defined gutter, occasionally coalescing into a pond or two. Even today it is still possible to detect the carriers taking the water at regular intervals to the river, which shows signs of having a containing bank.

Here the landowner in the late 18th century was John Matthews of Belmont, whose mansion looks down upon the water meadow system from across the river. His fastidious approach to estate management was noted by contemporary writers.[106]



15.2. The river Wye meadows downstream from Hereford

It has been assumed that managed water-meadows are rare on the Wye since where it passes through lowland Herefordshire it cuts a deep trench into the alluvium.[107] Moreover, many of the mills sites on the Wye, which provided weirs, were swept away when the river was made navigable in 1695. However, the Scudamore weir at Holme Lacy survived the Navigation Act into the early 18th century, if not beyond. As we have seen on the Lugg, the proximity of highland near the river provided an opportunity to collect water in a gutter.

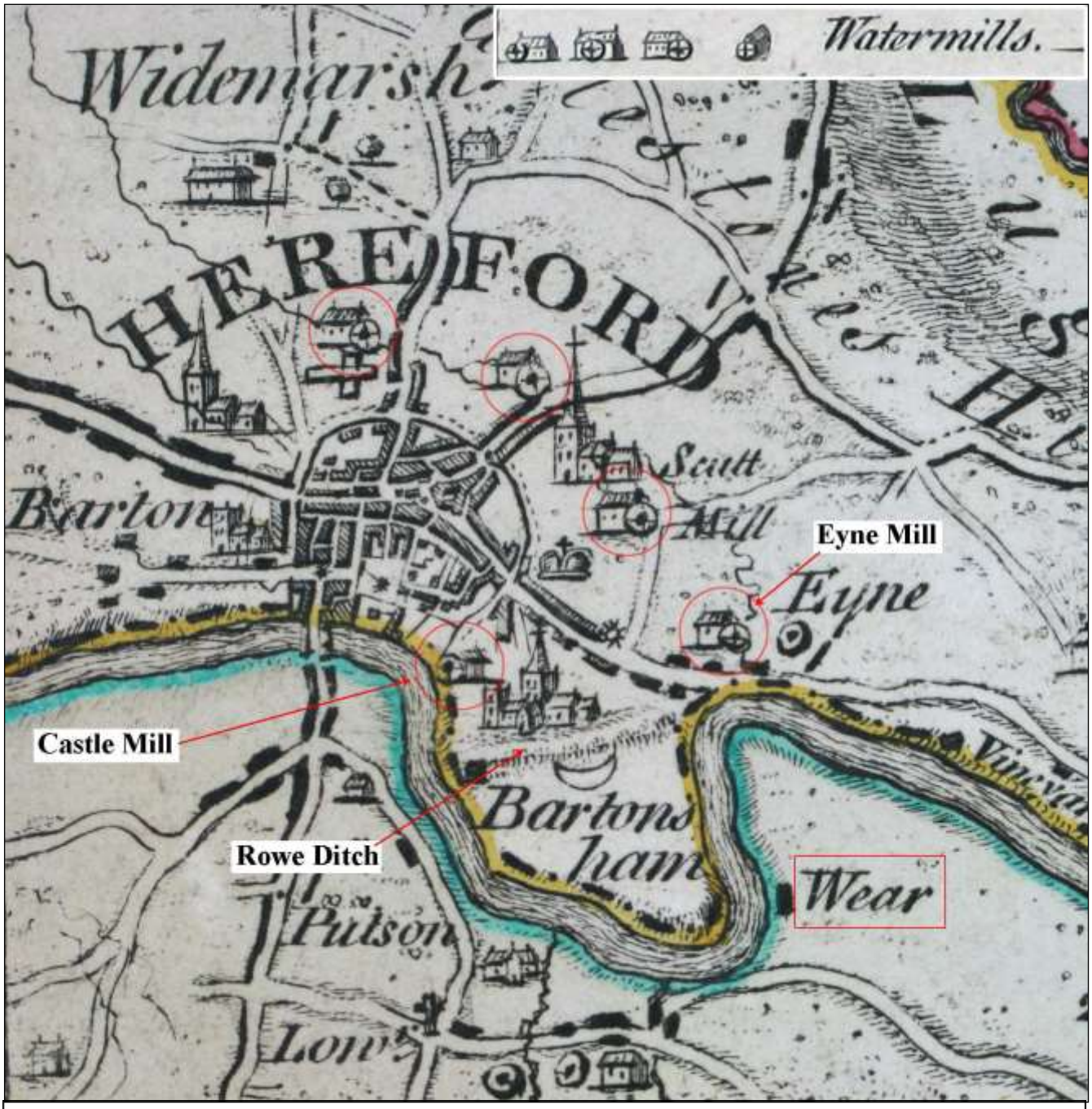
Nearly opposite Holme Lacy the Lechmeres of Fownhope Court seemed to have managed to organise the watering of the Fownhope Meadow. Although the majority of the meadow is today planted with maize, the eastern portion is still used as pasture. A small stream runs out of the Woolhope Hills – suitably lime rich – through the pleasure grounds of the Court and down across the meadow. On the late 19th century OS plan it was diverted around the north side of the meadow with distributors carrying the water across the meadow to the Wye. Visible today is a continuous linear earthwork along the Wye bank, creating a bowl-like effect in the meadow. The outflow to the river was presumably controlled with sluices.

Thus, the meadow was not dependent upon the river for inundation and an „early bite" plus a fertilised hay-crop could be contrived. Sir Nicholas Lechmere (1613-1701) of Hanley Castle, who was the lord of Fownhope was a moderate Puritan, on the fringe of the Hartlib circle and a friend and collaborator of the 3rd Viscount Scudamore of Holme Lacy. His garden beside the court with cascades and pools was viewed as a model for Highnam Court, Gloucestershire in the late 18th century.[108] Once again the management of water for utilitarian purposes had a spin-off in supplying rills and cascades for an ornamental landscape.

In the city of Hereford the Bartonsham Meadows, an extensive area of river-side pasture to the south-west of the castle and cathedral was separated from the arable lands of the city"s Portfields by an ambiguous earthwork called the Row Ditch, which has traditionally been regarded as a military „entrenchment". The *berton* „barley-farm" reserved for the king"s use in the Middle Ages had an attached *ham* or „meadow".

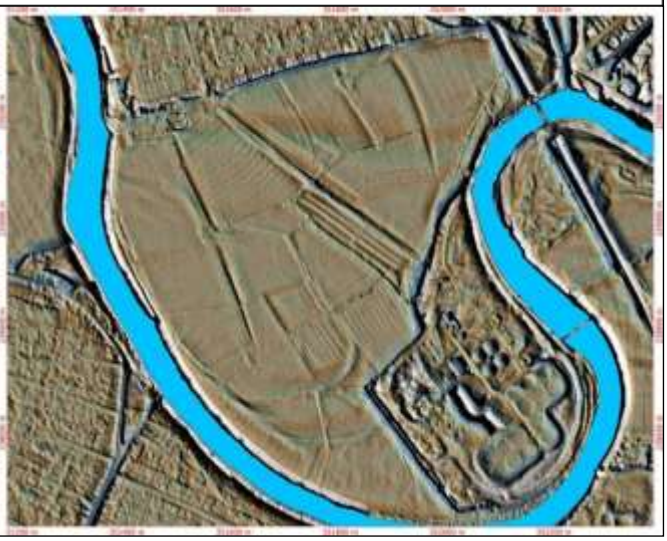
A recent geo-physical survey by Headland Archaeology has dispelled the military theory of the Row Ditch, since the 11 metre earthwork had a relatively low outer bank with the ditch running along the perimeter of the earlier medieval field system, now occupied by a 19th century suburb of Hereford. Both air-photographs and Lidar show a system of ridged earthworks covering the meadow, which has usually been regarded a ridge and furrow. However, the ditch runs from the Wye, just below the Castle Green at Bartonsham Farm, across the meadows to the Wye again at Eign, cutting off a large area of alluvial grassland.

Until the late 17thcentury the Hereford Mills occupied a weir half a mile below Wyebridge i.e. at Bartonsham; it therefore seems very likely that the Row Ditch was a carrier for an irrigation system on the Bartonsham Meadows supplied by excess water impounded for the mill., which in 1697 had a weir five feet high and a lock. It was subsequently demolished to make the river navigable.[109]



▲ Isaac Taylor‟s 1754 county map showing the mills of Hereford, the Row Ditch and a weir which may have diverted water to the Rotherwas water meadows to the east.

▼ OS 1:25,000 map and DTM of the meadows showing a complex of ridges, channels & banks.



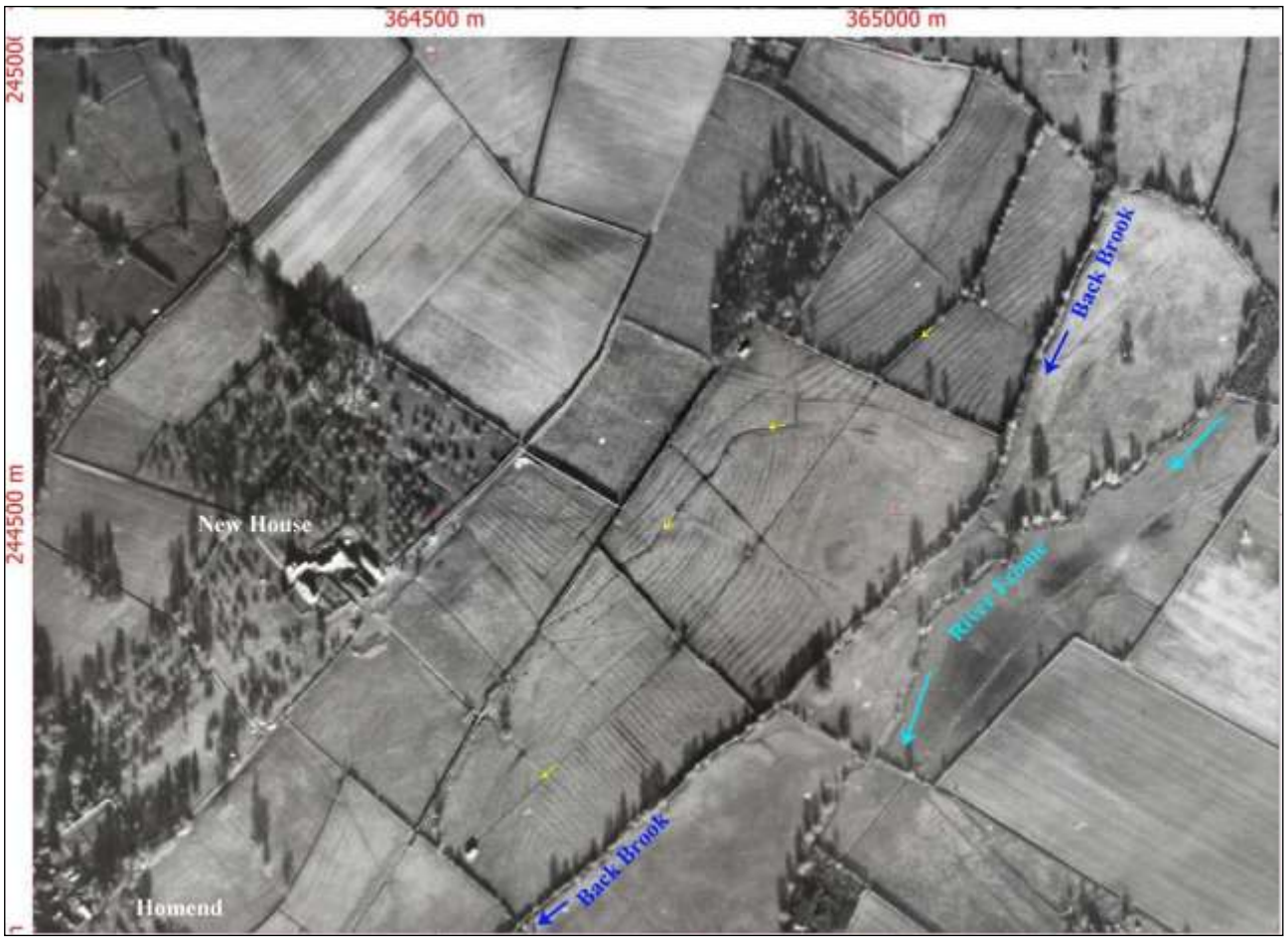
Just to the east of the Bartonsham meadows on the south side of the Wye are the river side meadows of the Rotherwas estate, acquired by the Herefordshire council in 1912, developed as a munitions factory and now part of the Rotherwas industrial estate. Aerial photographs show narrow channels in the pasture transverse to the river (HER 53270). It is not clear what these are nor where the water carrier from higher ground may have come from but it is temping to speculate that it may have been diverted from the „Wear" that appears on Taylors map.

▲ Features in the riverside meadows are faint but definite in the 1941 RAF and 2007 photo by Neil Rimmington of the council. They were ploughed up to the banks of the Wye sometime between 2007 and 2012. ▼ A little further east these faint earthwork features are just east of Rotherwas chapel

16. The Frome valley meadow irrigation

The river Frome arises from the high ground north of Thornbury some 8 km NNW of Bromyard through which it flows southwards joining the Wye at the Hampton meadows by Lugwardine and Hampton Bishop. Similarly with the Arrow there is a rich history of water management along its length with some 13 mills recorded, 4 of them north of Bromyard[110] and although most of the valley floor grasslands have been ploughed, some of the mill race, weir and water channel infrastructure remains. We had identified or add extra information to 8 historic water meadow sites, both speculative and definite: SO64_CanonFrome, SO64_Freetown, SO64_StrettonGrandison, SO65_BromyardSewageWorks, SO65_BuckenhillManor, SO65_RomneyMeadow, SO65_RowdenAbbey, SO65_WalkMill and SO65_Venn.

The RAF December 1946 reveals that at this time ridged meadows, bedworks and catchworks were frequent in a number of places along the Frome although how many were actually operational is questionable. All these below captured in this frame in the parish of Stretton Grandison are now in amalgamated fields of arable cultivation.



Some 5km downstream from Bromyard are the remains of a large leat with stone weirs and bridges built expensively by the Paunton estate in 1802 (a stone bearing that date is built into one of the stone abutments of one of the weirs. This supplied Paunton corn mill from weir across the Frome about 800 meters up stream from the mill. On its way the stone weir could be opened presumably by way of wooden boards or hatches to float the meadows between the leat of the Frome, for the full sequence and field photos see SO65_Venn.

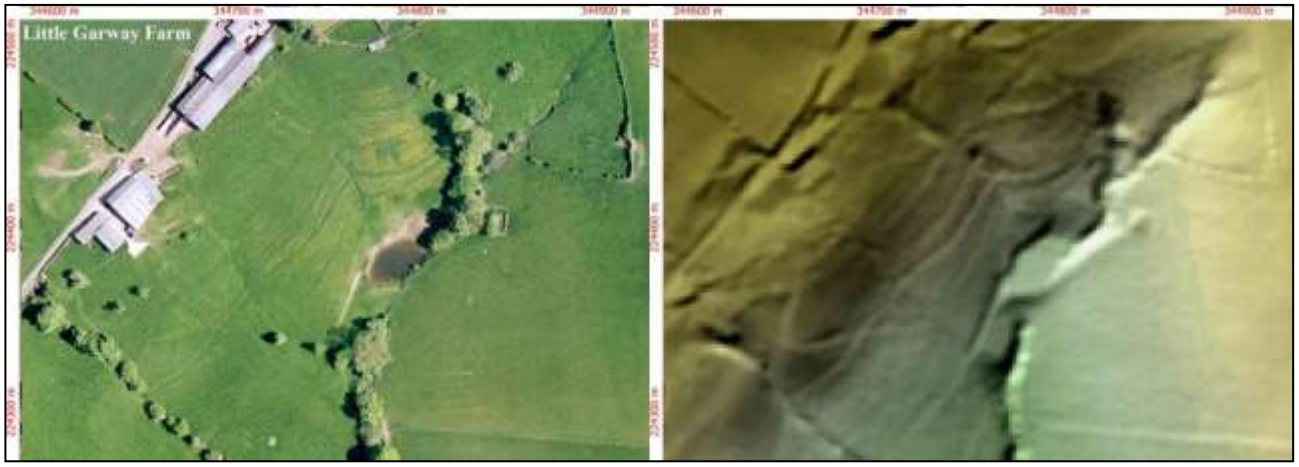
Although the meadows have been ploughed (and now in grass) bedworks are just still visible in differential DTM (top right) image next page:

17. Catchworks on upland farms

Constructing a channel that intercepts a natural water course on a hillside so that the water is directed transverse to the slope direction is one of the earliest and simplest means of irrigation. When the water source also flows through a farm yard nutrients are also spread about the meadows. There are examples of ponding the effluent from stock who are then encouraged to tread down an earthen retaining bank and so to fertilise the pasture below.

At the Quakers Farm in Longtown parish above the Escley Brook a number of catchwork channels fan out below the farm and alongside the contours of the fields below, some three of them running roughly parallel (see SO33_Quakers for full sequence):

A similar arrangement of contour hugging catchwork channels radiating out from below the farm buildings can be seen at Little Garway Farm[111]:



Below Firhouse Farm a channel arises from what was presumably a weir (difficult to see now) on a tributary of the Dulas Brook following the contour but petering out into the next field:

18. Water meadows in Herefordshire in the 19th century.

The balance of grassland to arable fluctuated throughout this period with the proportion of arable in Herefordshire increasing to around 60% during the shortages of Napoleonic Wars of the 1800s which continued into the 1840s. However the Tithe surveys (c1840) show that the alluvial flood plains of the main rivers remained in grass. The repeal of the Corn Laws in 1846 removed import barriers to grain restoring the traditional reliance on Herefordshire‟s productive grasslands, their economy further bolstered by the quality of the Hereford cattle.

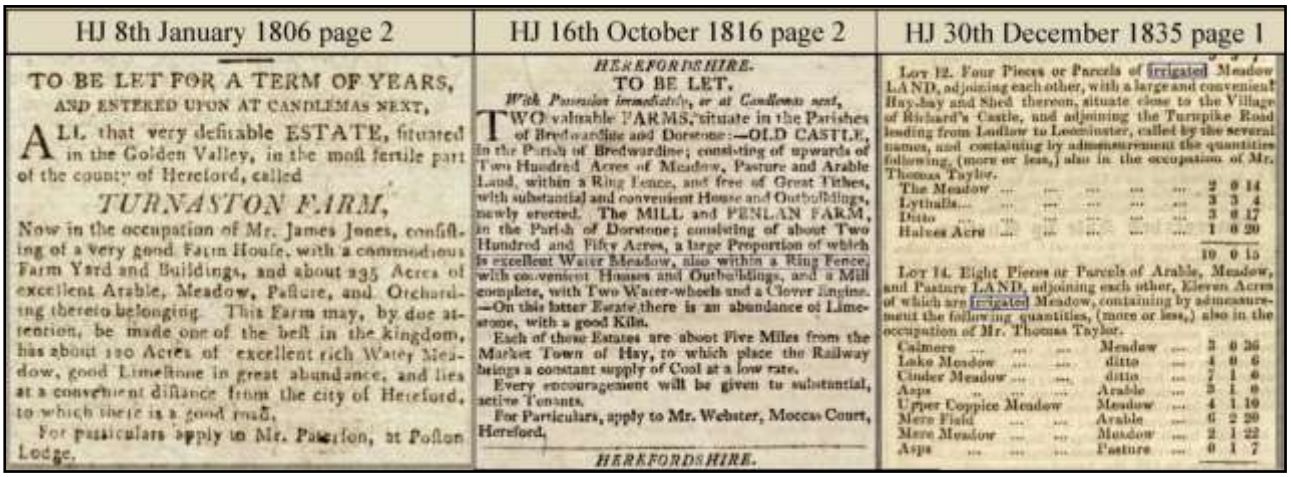
Accounts from two Herefordshire estates, Hampton Court and Guy‟s Hospital indicates that investment was increasing from c1840 and so work to maintain and innovate meadow irrigation systems made economic sense. This is borne out by analysis of agricultural items in the county journals during the 19th century (see below). Lowering farm prices due to trade liberalisation

and increasing labour costs from c1870 led to under investment which will have affected the more sophisticated meadow irrigation systems. Evidence from the owner of one of the most extensive systems at Staunton-on-Arrow indicates that their economic rationale was being undermined. Even so "well watered meadows" continued to be a strong selling point in farmland sales and some systems are known to have continued to WWII.

During the 18th century Herefordshire farmers discovered two new crops – hops and apples – which suited their soils, climate and their traditional methods and these were the two crops high on John Beale‟s agenda of improvements. Cattle-dealing in Herefordshire appears to have stagnated during the 18th century as Parliamentary enclosure in the Midlands enabled farmers to take up cattle farming for the London market in a more systematic way and to some extent, exclude the Herefordshire graziers. Certain pockets of grazing, in the Arrow and Frome valleys, for example, continued to flourish, but across a swathe of central and eastern Herefordshire, it declined. Arable farming also stagnated in the same areas and small farmers converted arable and pasture to hops and cider. The cattle dealer Charles Bennett of Bosbury was already growing hops in 1740 and taking them to Worcester, which became the greatest hop-mart in the Midlands. He also produced cider, which he marketed via the Severn-side port of Upton-on-Severn.[112]

Hops are a greedy crop and need moisture, manure and shelter but the profits were high and the only extra labour required came in the late summer when Welsh women, who accompanied their husbands to Herefordshire for the grain harvest, carried out the stripping. Small farmers could work a hop-yard with a plough and a single horse and intercrop with cabbage, potatoes and turnips. Cattle were not allowed to graze a hop-yard because of compaction. Agricultural writers like Duncumb and large landowners were generally opposed to hop growing. As the Trustees of Christ‟s Hospital reported in 1762, relating to their estate at Collington, near Bromyard, „the tenants lay out all their strength on the hop-ground, ploughing up the best pasture land and laying all their dung on the hop-ground‟. Another attraction for the small farmer was the increasing demand for hop poles. Since most Herefordshire farms and estates had woodlands, poles readily available for the hop growers via rotational coppicing.[113]

During the Napoleonic Wars hop and cider prices declined and there was a brief Indian summer for grain and cattle but the price of labour for arable farming failed to stop the drift towards hops and cider. Duncumb believed that unprofitable tillage should be turned to pasture but there were few incentives in this direction. He took a moralistic attitude towards farming, deploring the lack of dairying in Herefordshire and the decline in grazing, which suited his vision of Herefordshire as Arcadia. He railed against hops and cider becoming staple crops which, in his view, sterilised 1000‟s of acres producing „no nutrient sufficient to support a single human being‟. In his time apple growing took-off to meet the demand for cider in the Black Country and the North and with the Herefordshire and Gloucestershire canal reaching Ledbury in 1798, the town became the marketing centre for the fashionable tipple. Thus, water meadows, particularly across the south and eastern parts of the county, increasingly became redundant as Herefordshire gave-up traditional forms of agriculture and re-orientated itself towards the burgeoning market for hops and cider.[114]



HJ 8th January 1806 page 2

TO BE LET FOR A TERM OF YEARS,
AND ENTERED UPON AT CANDLEMAS NEXT,

ALL that very desirable ESTATE, situated in the Golden Valley, in the most fertile part of the county of Hereford, called

TURNASTON FARM,

Now in the occupation of Mr. James Jones, consisting of a very good Farm House, with a commodious Farm Yard and Buildings, and about 235 Acres of excellent Arable, Meadow, Pasture, and Orcharding thereto belonging. This Farm may, by due attention, be made one of the best in the kingdom, has about 120 Acres of excellent rich Water Meadow, good Limestone in great abundance, and lies at a convenient distance from the city of Hereford, to which there is a good road.

For particulars apply to Mr. Powell, at Poston Lodge.

HJ 16th October 1816 page 2

HEREFORDSHIRE.

TO BE LET,

With Possession immediately, or at Candlemas next,

TWO valuable FARMS, situate in the Parishes of Bredwardine and Dorstone:—OLD CASTLE, in the Parish of Bredwardine; consisting of upwards of Two Hundred Acres of Meadow, Pasture and Arable Land, within a Ring Fence, and free of Great Tithes, with substantial and convenient House and Outbuildings, newly erected. The MILL and PENLAN FARM, in the Parish of Dorstone; consisting of about Two Hundred and Fifty Acres, a large Proportion of which is excellent Water Meadow, also within a Ring Fence, with convenient Houses and Outbuildings, and a Mill complete, with Two Water-wheels and a Clover Engine.—On this latter Estate there is an abundance of Limestone, with a good Kiln.

Each of these Estates are about Five Miles from the Market Town of Hay, to which place the Railway brings a constant supply of Coal at a low rate.

Every encouragement will be given to substantial, active Tenants.

For Particulars, apply to Mr. Webster, Moccas Court, Hereford.

HEREFORDSHIRE.

HJ 30th December 1835 page 1

LOT 12. Four Pieces or Parcels of Irrigated Meadow LAND, adjoining each other, with a large and convenient Hay-barn and Shed thereon, situate close to the Village of Richard's Castle, and adjoining the Turnpike Road leading from Ludlow to Leominster, called by the several names, and containing by admeasurement the quantities following, (more or less,) also in the occupation of Mr. Thomas Taylor.

The Meadow	2	0	14
Lythalls	3	3	4
Ditto	3	0	17
Halves Acre	1	0	20
	10	0	15

LOT 14. Eight Pieces or Parcels of Arable, Meadow, and Pasture LAND, adjoining each other, Eleven Acres of which are Irrigated Meadow, containing by admeasurement the following quantities, (more or less,) also in the occupation of Mr. Thomas Taylor.

Calmore	Meadow	3	0	26
Lake Meadow	ditto	4	0	6
Cinder Meadow	ditto	7	1	6
Asps	Arable	3	1	0
Upper Coppice Meadow	Meadow	4	1	10
Mere Field	Arable	6	2	20
Mere Meadow	Meadow	2	1	22
Asps	Pasture	0	1	7

Throughout the 19th century the term „water meadow" and „irrigated meadow" was in frequent use when describing land and estates in Herefordshire as the following examples from the Hereford Journal (HJ) and Hereford Times (HT) will show:

HJ 8th January 1806 page 2 „All that very desirable estate situated in the Golden valley" including "Turnastone Farm 235 acres of excellent arable, meadow and pasture and orchard belonging thereto has about 120 acres of excellent rich Water Meadow."

HJ 12th March 1806 page 3 „Wanted a working man, capable of garden grounds, and nursery, floating (or irrigation) of meadowland".

HJ 24th April 1811 page 2 „Cromp Oke estate 280 acres including water meadow".

HJ 16th October 1816 page 2 „To be let… The Mill and Penlan Farm in the Parish of Dorstone consisting of about 250a, a large proportion of which is excellent Water Meadow".

Here we have a demonstration of the practical transfer of meadow irrigation methods from other parts of England is revealed in this entry:

HJ 26th May 1824 page 3. For sale Purslow Hall near Ludlow in extent 560 acres including „a trout stream (the river Clun) which runs though the estate and 140a may be irrigated at pleasure; complete water meadow 80 acres are already formed on the plan of the Meadows in the vicinity of Cirencester and are highly productive".

HJ 25th June 1828 page 3. Auction for the New Court estate Lugwardine [SO522411]

'6 acres orchard, a piece of very rich water meadow adjoining of over 4 acre and another water meadow 10 acre" In this case the meadows in question can be identified as a catchwork system in a 1941 RAF aerial photograph 1941 (see below).

HJ 28th June 1826 page 2. Whitchurch: „131acres including a stream of water springs on the estate and irrigates the meadowland".

HJ 13th February 1833 page 3. „To be sold at auction .. Burghill Lodge 240 acres and land of the very best quality of which a great proportion is water meadow (130 acres)". Now Lodge Farm Barns SO475467.

HJ 4th June 1834 page 3. „The Bury of Weston estate 300 acres the greatest proportion of which consists of Pasture and Irrigated Meadows situate in the Parish of Pembridge".
[Westonbury Farm SO360562] see site sequence SO35_WestonburyMill and example page 36.

HJ 30th December 1835 page 1. „Lot 12: Four parcels of irrigated Meadow Land adjoining each other .. close to the village of Richards castle, Lot 14: (includes) 11 acres of irrigated Meadow".

In order to show off the attributes of a new strain of Rye Grass, its growth rate in early spring and its feed quality are compared favourable to those of a water meadow:

HJ 29th June 1836 page 4. „A new Rye-grass.. it appears to be a very early grass and when sown on warm soil in good condition, it affords as much feed and quite as early as a good water meadow‟.

HT 2nd September 1854 page 5 Sale: New Lodge 330 acres. „The farms contain good and sound turnip, barley, wheat and pasture lands which are intersected by three small stream with sluices and catchpools for irrigating the meadow land. This property may be truly described as one of the most desirable in the far-famed Golden Valley‟. Probably Poston Lodge Farm above the Dore Valley SO360380.

HJ 5th September 1855 page 2. „Lynch Court Eardisland 295 acres of capital land and the greater part irrigated meadow and noted for having reared some of the finest stock in the country situate on the banks of the famous trout stream the Arrow.‟ Lynch Court SO415581.

HT 14 December 1861 page 4. „Richard Hotchkiss begs to respectfully inform the gentleman farmers of the neighbourhood, that he has had much experience in floating, draining and improving the culture of meadow land‟.

A comprehensive search of the documentation for Bosbury, carried out for the VCH Herefordshire, produced the following. At Old Court in Bosbury the meadows were clearly under threat in 1828 when an indenture was drawn up with a new tenant, which insisted that ploughing up the meadows could only take place with the agreement of the landlord. In 1840 the Catley Cross estate, which shared the same meadows, was for sale and the particulars stated that there was still some meadowland which „may well be irrigated from the Leadon and other streams‟. Catley Cross included 20 acres of orchard in 1840. Today the meadows are entirely planted with fruit trees.[115] Even in the 20th century sale particulars occasionally refer to water meadows. When 3,370 acres of the Stoke Edith estate were sold in 1919, hidden among the numerous parcels of land a great deal of it planted with hops, was 57 acres of water meadow on either side of the Frome, near Stoke Bridge in the parish of Tarrington. In contrast in 1907 a small farm at The Kelin, just over the county border at Llanigion, near Hay-on Wye in Breconshire, was for sale with „very superior meadow land….mostly under irrigation‟. No doubt, with a good deal of searching similar sale particulars could be found all over Herefordshire, especially in the Arrow Valley where from oral evidence we know that the sluices were still in working order until the 1950s.[116]

19. Herefordshire water meadows in the 20th century.

By the turn of the century the general downturn in agricultural fortunes will have made labour intensive meadow irrigation systems difficult to justify. Nonetheless, descriptions of land from farm sales just before WWI were still often referring to „water meadows‟ as selling points.

The latter part of Great War of 1914-1918 reversed what had been a steady decline in arable cultivation due to the agricultural depression from the 1880s. In 1917 under the Defence of Realm Act „Cultivation of Land Orders‟ were administered by county War Agricultural Executive Committees (WAEC) who had powers of entry on to all farms to survey, waive restricted covenants on cultivation and draw up tillage schemes for individual farms enforced if necessary by threats of eviction. While it was a culture shock for farmers to suddenly be subservient to Government rather than landlord (most farmers were tenants in this time) many of the complaints centred around the apparent failure by officials to distinguish between valued productive grassland including water meadows and low productivity grassland on poorer soils, complaints that would be heard in Herefordshire during the more aggressive plough up campaigns of WWII. To sweeten pill of this loss of independence and the uncertain profits from ploughing, Government introduced for the first time in 1917 guaranteed prices for cereals but by 1921 all subsidies were revoked and UK farming faced a long world recession without assistance[117].

The inter war years were characterised by low prices for produce, low land prices, little investment and a drift of labour from the countryside. Apart from catch-works and other simple irrigation systems it is very unlikely that any of the more sophisticated irrigated meadow systems, whatever the quality of their grass, would be maintained let alone renewed.

In 1926 Brasenose College Oxford, which already had land Herefordshire holdings from the dissolution of Leominster Priory, was considering acquiring part of the alluvial grasslands at Ivington adjacent to its existing holdings of Ivingtonbury and Broadward. The local agent‟s valuation stated „The land has at one time been used as water meadows but the sluices or bolts and irrigation ditches are in a dilapidated condition and so far gone that they are not worth repairing‟.[118]

19.1. The role of the River Lugg Internal Drainage Board between the wars.

The Lugg Mills legal case above demonstrates the fine balance between the interests of millers optimising water levels for operations and those farming land along rivers wanting to optimise the irrigation of their land including water meadows. This required close co-operation between millers and farmers and if that broke down for whatever reason then the consequences could be serious for the farmers whether in having too much and too little water. Some of the resulting legal cases are fruitful sources of information on the history mills.

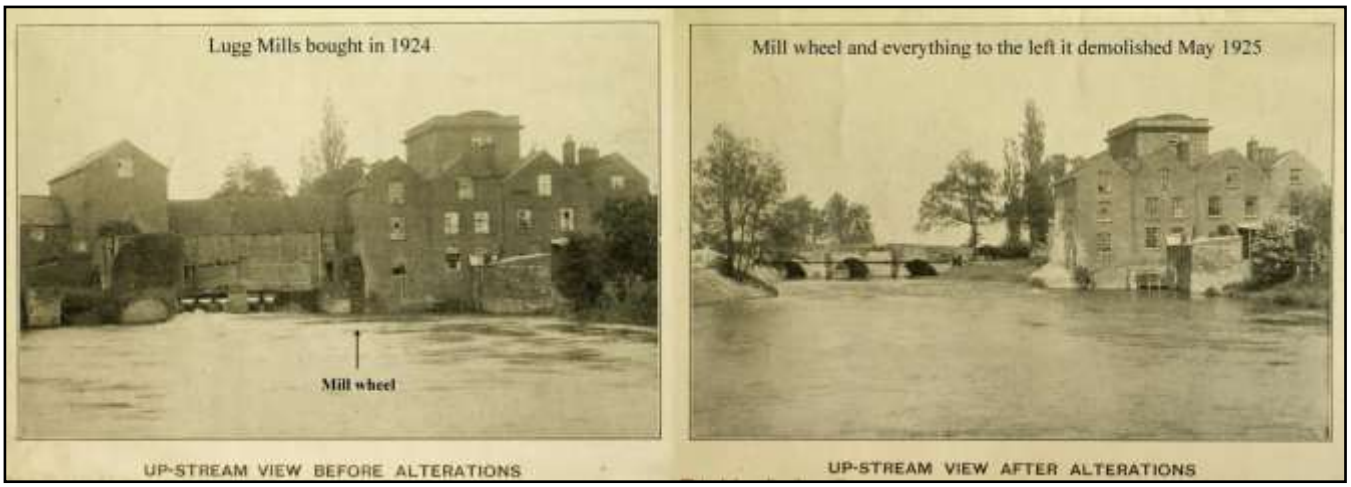
The Arrow and Lugg both had extensive and sophisticated systems to control water flow for mills and to distribute water throughout the wide area of receiving farmland by means of sluices, leats and a myriad of channels and ridges. In their heyday these systems, especially those on the Arrow, must necessarily have had the effect of distributing total kinetic energy of the flows from the main river and ameliorating the flood waters downstream.

By the end the WWI the traditional balance between mill and farm regarding the control of water was clearly breaking down as these complex water meadow systems became more difficult to maintain through lack of skilled labour, knowledge of the local systems being formerly passed down through families. A hypothesis can be constructed that once these systems of water control became abandoned, the frequency of uncontrolled natural flooding increased and mill operators who had been controlling water flow and levels in leats and mill ponds with their weirs and sluice gates for centuries now found themselves cast as the agents causing flood waters to damage farmland and property and making highways impassable, eben though mills, and many more of them, had operated on these rives for centuries.

Due to age-old legal water rights, the mill operators had control over the operation of weirs and sluice gates to maintain adequate water levels to power mill wheels, a situation which did not benefit farmers upstream subject to flooding over which they had no control. Some farms in the Arrow and Lugg flood plains found that that their low lying lands were being increasingly subject to extended periods of flooding with little redress so long as mill owners had control of water levels. The damaging effects on grassland of such uncontrolled winter flooding was the reverse of the benefits from the traditional managed irrigation or floating of water meadows whereby the water travelled thinly and quickly over the meadow surface.

Water ponding on grassland for long periods especially in summer is highly damaging to any sward. The situation was made worse during and just after the 1914-18 Great War because a number of meadows had been ploughed so the inundation onto such cultivated fields was even less welcome. In May 1918 the Herefordshire WAEC members invited landowners and Herefordshire councillors to a meeting in Leominster to set up a drainage board with the objective of making „something like 20,000 acres immune from flooding” on lands for some of which during WWI “much had been ploughed up” and which lands should now be “saved from damage by flooding‟[119].

The River Lugg Drainage Board was duly constituted in 1920 under the 1918 Land Drainage Act with powers to levy drainage rates upon land owners and occupiers. The Board started systematically to „clean" the main rivers ridding them of all obstructions. A particularly large „obstruction" was the Lugg Mills subject of the 1848 legal case detailed above. The board managed to buy it from the owner in 1924 and by May 1925 the Board had demolished all the sluices, mill wheel and associated structures dropping the level of the Lugg at that point by 5 feet. Tidnor mill 1.2 km downstream from Lugg Mill was similarly purchased and demolished in September of 1925 dropping the river level by another 2 feet. The show off their work the Board published a pamphlet showing the „before and after" photographs from both the upstream and downstream view- points – this is looking upstream at the Lugg bridge. The „before" photographs were taken by Alfred Watkins.



The Board was keen to hear from owners wanting them to continue their works on the rivers. In putting the case against meadow irrigation Evan Andrews of Stretton Court was keen to down play the contribution that flood-borne silt had in supplying nutrients to the flood plain swards claiming that the „The alleged benefit to flood lands arising from silt deposits in the Lugg Valley in my opinion simply does not exist".

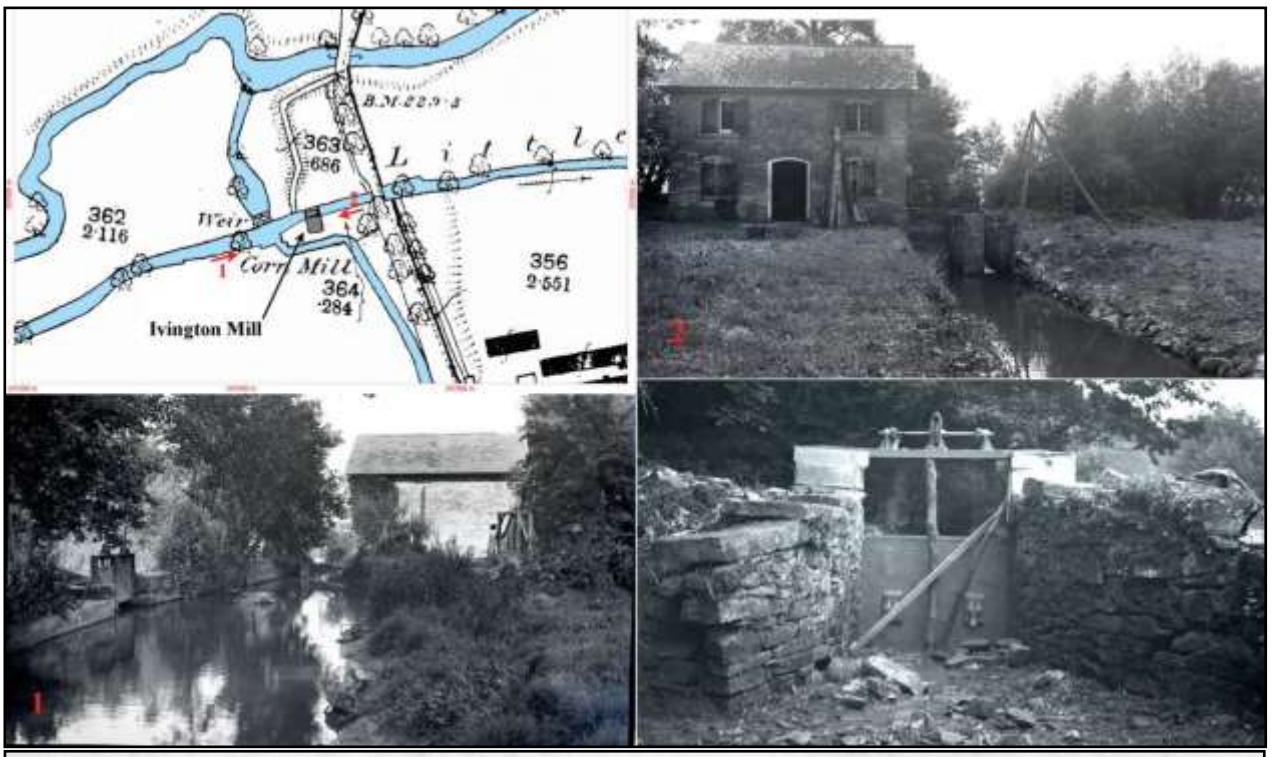
In the four years since its formation the Board had succeeded in buying out both Lugg Mills and the Tidnor Mill 3 km downstream removing all the sluices and so dramatically lowered the water level in the Lugg along this stretch. However removing the sluices of the mills upstream proved more difficult. The Board was especially keen to get its hands on Ivington Mill on the Arrow and Pinsley Mill in Leominster and it set up a „Mills sub- committee" to set about achieving this outcome, for which it was assisted by the wealthy Brasenose College Oxford who owned much of land along the Arrow valley to the south and west of Leominster.

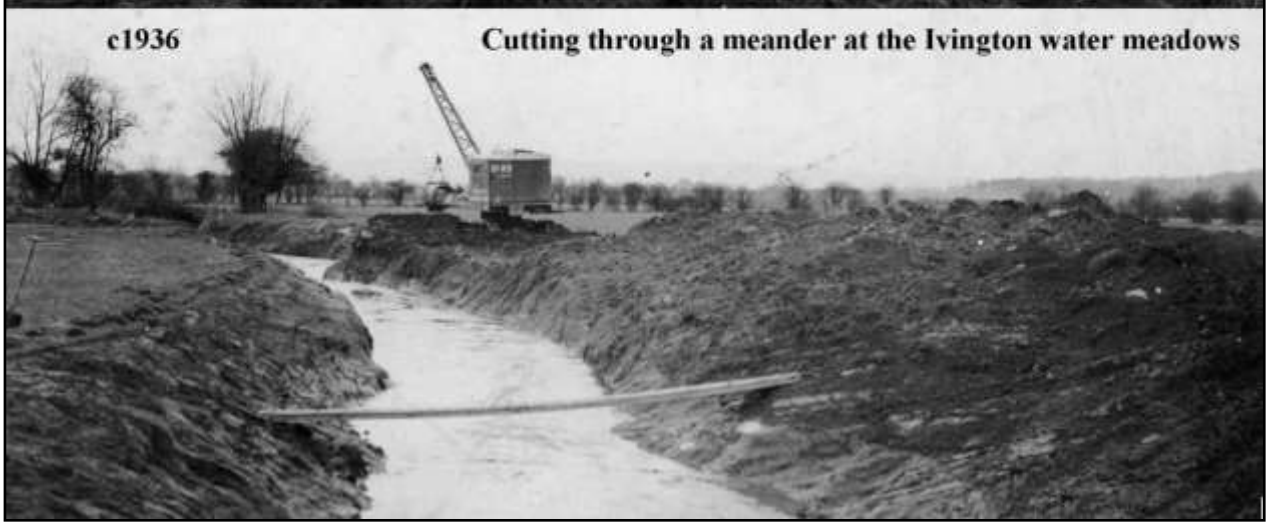
The owner of Ivington mill which was part of the Ivingtonbury farm was not willing to sell or indeed co-operate with the Board. Mr. S. Goodwin of Ivington Court was one of a number of the College"s tenants to have complained. In August 1924 that wrote that the „damage done by the water there is between 20 and 30 acres covered with water the whole of the summer". The college accused the owner of the mill of illegally placing extra boards on his sluice gate.

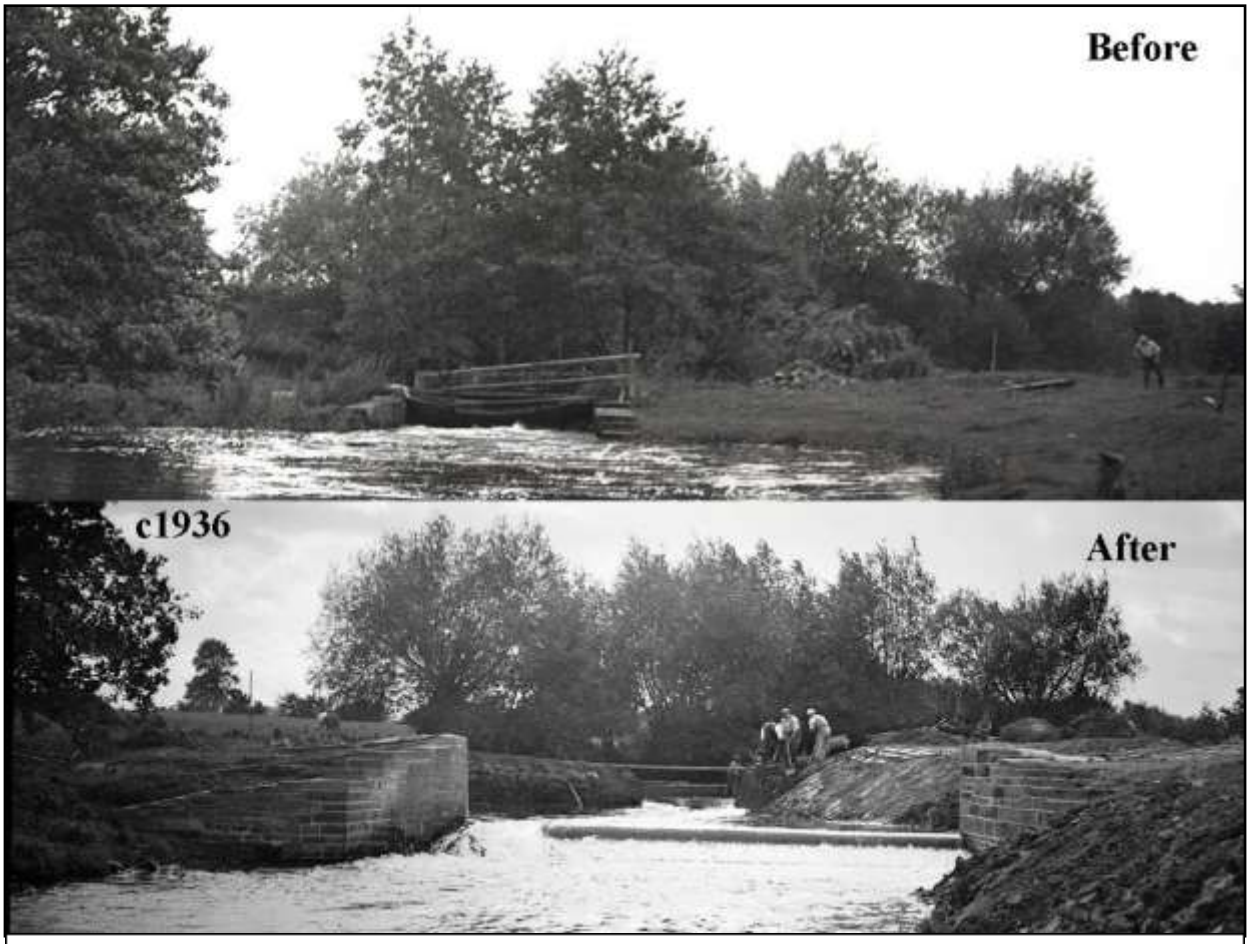
Unfortunately for the Board, the legal instruments to force the mills to remove or lower their sluices were insufficient even after the new Drainage act in 1927. The atmosphere worsened when one of the college"s tenants, Mr. Law of Stretford „drowned in Stretford Brook when carrying fodder to stock in his upper meadows by Ivington Common".

Mr. Armitage the agent for another landowner effected (Mr. Bengough) suggested in a letter 23/2/1927 „what do you think of my idea of combining to buy the farm? If it could be bought at a reasonable rate and doing away with the sluices ourselves and perhaps re-selling the farm". Another idea was to suggest that „an oil engine be substituted at Ivingtonbury to do all the work at present done by water power".

After Board eventually got control of Ivington and Pinsley mills by about 1935 the sluice gates from both had been removed. With these obstructions removed, water course engineering such as widening, deepening and straightening could begin spelling the end of any possibility of traditional meadow irrigation in this part of the Arrow valley. Below are photos from the National Rivers Authority archives taken about 1936.







A weir on the Little Arrow upstream of the dismantled Ivington mill before and after

19.2. Herefordshire water meadows and WWII plough up policy

Herefordshire water meadows, along with all earthworks in permanent grassland, were additionally vulnerable simply for being a subset of permanent pasture. By the late 1930s there had developed a consensus amongst a small but influential a group academics and agronomists that as much permanent grassland in the UK as possible should be ploughed up.

„In England and Wales there were (in 1938-39) no less than 9,147,000 acres of permanent grassland that were excellent subjects for the plough – acres which in their existing state were a standing reproach to our agriculture and to our methods of farming".

So wrote the influential agronomist Sir George Stapledon who had been championing the case for ploughing up any and all permanent grassland throughout the inter war years and in whose opinion England was a country „*riddled with derelict land and worthless grassland*"[120]. This negative view tended to lump together all permanent swards of native species and closely echoed the contemporary attitude to native woodland concerning which the similarly influential chairman of the Forestry Commission Lord Lovat had called upon the owners „*of the 3,000,000 acres of so-called woodlands in this country to replant them on sound forestry principles*"[121]. Both men had a vision of re-structuring the country"s farming and forestry on „scientific" principles disparaging of many traditional forms of management.

By 1937 68% of the farmed area of Herefordshire was permanent pasture (excluding rough grazing) amounting to 320,000 acres, probably higher than at any time for the past four centuries. During 1939-40 Stapledon"s team carried out a grassland survey of Herefordshire ranked the quality of its grasslands according to Rye Grass content finding that 70% of the grassland had little or no Rye Grass and therefore deemed of „poor quality"[122].

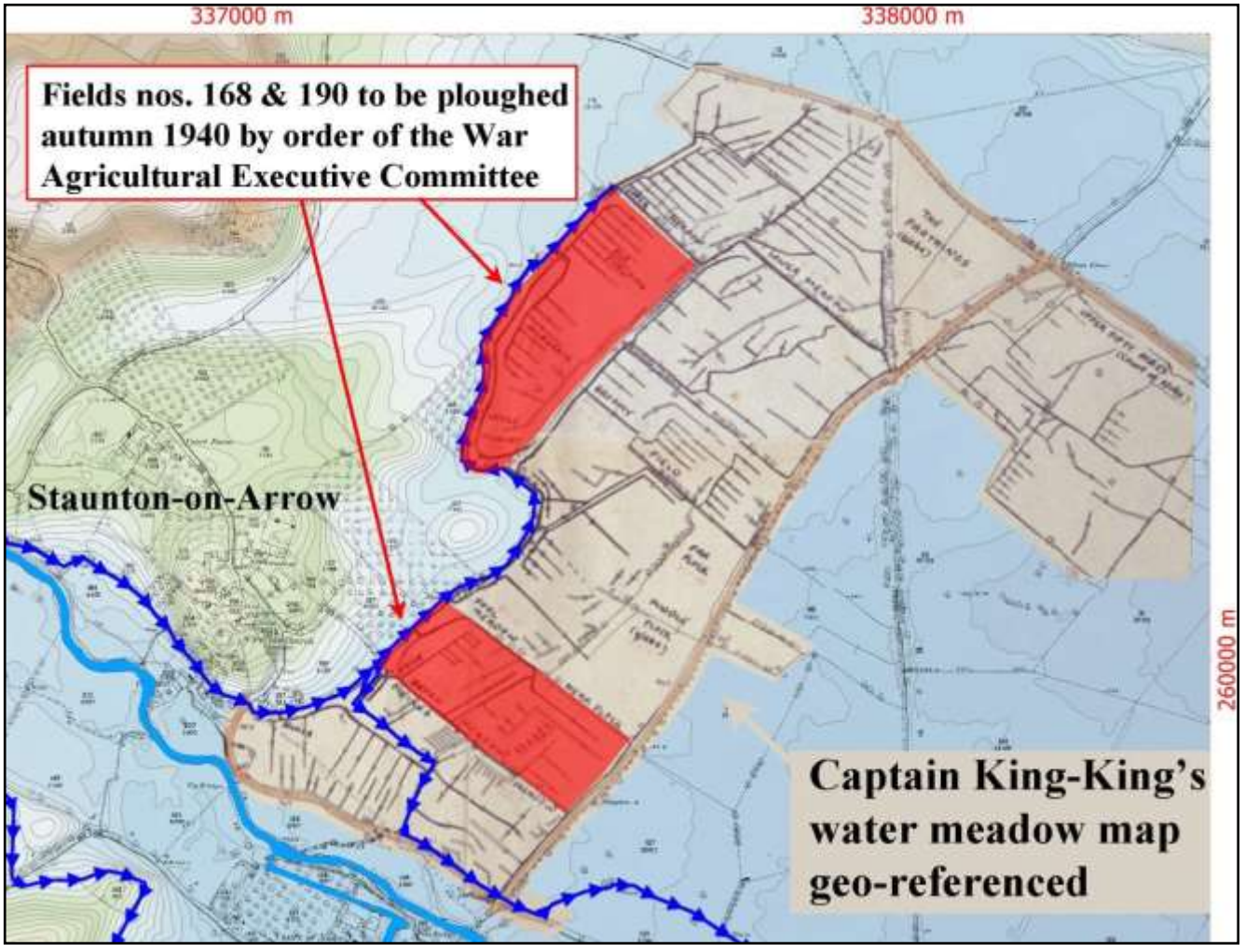
In September 1939 UK farming was placed under the Defence of the Realm Act and the structure of county and district WAECs, on the WWI model, was set up with immediate effect. Each county was allocated target acreages for the amount of grassland to be ploughed-up, Herefordshire‟s being 25,800 acres for 1940. In January of 1940 no less than 917 cultivation orders covering 12,056 acres had been served to farms by the Herefordshire WAEC.

In November 1939 the county WAEC had the Staunton-on-Arrow water meadow complex in its sights the ploughing up of which Captain King-King attempted to resist:

„[the county WAEC] then had before them Mr. King-King. After hearing his statement they decided that they would not require the land at Staunton on Arrow to be ploughed this year but that it should be inspected at a later date by Col. Verdin and Mr. Bray with a view to seeing whether any was suitable for ploughing next autumn‟.

At the next meeting „Mr. Bray reported that he had inspected Capt. King-King‟s land accompanied by Col Verdin and Mr. Smith the parish representative. A full report[123] has been made to the cultivation committee we recommended that Capt. King-King be informed that the committee will require fields Nos. 168 and 190 to be ploughed in the Autumn 1940‟ (County WAEC meeting 3/1/1940, minute 80).

Lack of machinery was a perennial problem for those carrying out the orders of the WAEC and in 1942 Capt. King-King was finding it difficult to extend the ploughing of his permanent pasture, most like these water meadows. WAEC meeting 13/4/1942, minute 189/6: „A letter from captain King-King was read asking to the released from ploughing 9 acres as he was not able to obtain the necessary machinery‟[124].
Below is a close up annotated version of the map of the King-King water meadows that appears on page 30 showing which fields were ordered to be ploughed in 1940.



Local anecdotal evidence suggests that the remainder was ploughed by the end of the war. Some fragments of ridges are visible in the winter 1959 RAF air photo (see). Even with the highest contrast differential analysis (< 10 cm vertical resolution) there is now no trace of any earthworks in any of the fields subject of King-Kings map.

George Stapledon was especially influential as a Government advisor during WWII during which time an aggressive plough up policy was being applied in all counties by the newly re-formed county and district WAEC who were each given specific acreage targets by central Government. As an energetic proponent of ploughing up grassland he gave many presentations including one in the Shirehall in Hereford on the 24th July 1940 which the county WAEC minuted as „most successful and extremely well attended". The WAEC appointed a "grasslands improvement officer" to be responsible for „an intensive campaign amongst individual farmers".

Not everyone was convinced by this enforced ploughing of grassland and, a number experienced farmers, felt it could be counter- productive. In a representation to the county committee in July 1940 the Chairman of the Ross district WAEC „pointed out that any large additional acreage to be ploughed up would have to be found in the best pasture land and would interfere with the stock carrying capacity of the district and ultimately result in loss of fertility". He was making a similar point about the impact of the WWI plough policy quoted above.

In September 1940 „[members of the Ross committee] had received several complaints from farmers who has received order to plough up grassland by November 1st 1940 and that it was not in the best interests of the Country or the farmers concerned".

That same month Mr. Perkins a dairy farmer Ufton Court, Holme Lacy intimated his willingness to plough the remainder of a 12 acre field, as ordered, but appealed against the ploughing of part a 40 acre field „on the grounds that they were valuable pasture land already producing to capacity, the ploughing of which would seriously interfere with milk production on his farm". Since he would have to fence the part off with barbed wire which was „unobtainable" he was ordered to plough.

By 1944 circumstances had forced a reduction in tillage due in part to „the impracticability of keeping in tillage the river meadows, steep slopes etc. which were ploughed and cropped in 1943" and „the necessity of restoring a balanced rotation on farms which have been over-cropped with corn in the emergency period" [Dore district WAEC minutes 17th June 1944].

The end of hostilities did not mean an end to the powers of WAECs to enforce cultivation targets. Section 95 of the Agriculture Act 1947 which limited the area under grass on any agricultural unit was extended to 31st Dec 1951. District WAECs in Herefordshire were still issuing „Grassland Restriction Orders on farms where there was a deficiency of tillage" in that year although it seems that by this stage WAECs had rather given up on recalcitrant farmers: „referring to Boars Hill Farm he had observed that the grass field that the occupier had promised to plough had been staged and he doubted whether it was intended to cultivate the field" [Dore district WAEC minutes April 11th 1951].

By 1953 WAECs only had the carrot of a £5 per acre ploughing grant which they reported „had achieved little more than maintaining the tillage acreage" [County WAEC minutes 16th March 1953]. However by this time capital grants for many types for farming improvement schemes had become available from the generous Government financial commitment to farming enshrined in the 1947 Agriculture Act so ushering in the present era of guaranteed subsides.

Despite the acreage of permanent pasture which had been ploughed during WWII, aerial photography of the county in the years immediately after the war shows a surprisingly high survival rate of earthworks in clearly unploughed grassland including irrigated meadows, both bedworks and catch-works along with carriers, channels and leats, ridge and furrow and intermediate system with ridges. Even if these systems were not operational they remained an integral part of the Herefordshire landscape and its long heritage of water management.

20. Water meadows and their remnants in the post war period

The objectives of post-war Government agriculture policy, through the incentives of capital grants and guaranteed prices, were to increase output per hectare (intensification), promote economies of scale by enlarging holdings (concentration) and to encourage farmers to focus one just one or two farm products rather than the multiple enterprises of traditional mixed farm systems (specialization)[125]. This process was reinforced with the UK‟s accession into the European Community in 1972 and the full operational effect of the Common Agricultural Policy (CAP) from 1977. Landscape, ecology and heritage attributes which had previously been created and managed by previous generations of farmers were ignored or destroyed, often by Ministry of Agriculture grant aid, to stimulate production and for some sectors over-production. Budgetary, production and environmental problems caused by the CAP became politically embarrassing in the early 1980s, so measures were introduced to curtail production starting in the dairy sector with the introduction of milk quotas (1984), a cereals storage tax (1987) and the payments for voluntary set-aside of arable land in 1988. In 2004 CAP subsidies were decoupled from production altogether and replaced by a flat rate area-based Basic Payment Schemes of about £250 per hectare.

The impact of the loss of easily visible features such as hedgerows and farm woodlands was becoming a political issue in the early 1980s. Less easily quantified was the impact of post war policy upon the ecological and heritage aspects of permanent grassland which for previous centuries had enjoyed symbiosis with traditional pastoral farming systems. A 1988 review of national surveys estimated that 97% of all species rich grassland that existed in England and Wales in 1930 had been lost by 1984 to conversion to arable, reseeding, over-stocking or species impoverishment due to artificial fertilisers[126]. Loss of earthworks within this grassland would have been substantial but this aspect had yet to become a conservation issue at this time. For Herefordshire anecdotal evidence supports this scale and rate of loss, which continues to the present.

1985 saw the introduction the agri-environment regulations of the CAP which allowed member states to allocate a small proportion of EU farm subsidies, co-funded from member state treasuries, to voluntary conservation management schemes[127] and in 1991 the first such schemes were applied in Hereford and Worcester and at present a high proportion of Herefordshire farms are in some kind of agri-environment scheme the vast majority of which are for wildlife and habitat objectives rather then heritage and archaeology. Although these voluntary schemes have encouraged some farmers who are already sympathetic to conservation objectives to conserve permanent pasture on their land, there was and is little incentive for those who are not.

In 2001 Environmental Impact Assessment (Uncultivated Land and Semi-natural Areas) regulations were introduced February 2002 as a Statutory Instrument to implement an equivalent EEC directive[128]. An intention to „intensify“ a piece of permanent pasture for example, typically by ploughing, required a „screening test“ to determine whether the land qualified under the regulation was protection and so protected it by law from „intensification“.

Although the associated guidelines included wording about archaeology including „ancient earthworks and ridge-and-furrow patterns“[129], in practice the EIA regulations have proved almost impossible to implement in practice and many species rich grassland sites and some earthwork sites are known have been ploughed after statutory bodies were notified of their imminent loss.

This experience of the implementation of EIA in Herefordshire is confirmed by a commissioned national report in 2004[130]. To date, only one example is known in Herefordshire where permanent pasture with earthworks has been protected by this legislation: namely Turnastone Court Farm, the site of part of the presumed Rowland Vaughan water meadows. This outcome was almost certainly due to the national publicity that ensued when an applicant applied for permission to plough the meadows for potato production[131].

These 2002 EIA regulations were further weakened by the „Alford case“ in 2005 whose outcome allowed a very liberal interpretation of „intensification“ requiring only that the intended agricultural operation was intensive on a local area level and not site specific, so finally rendering the regulations entirely inoperable[132].

A revised version of the EIA regulations was introduced in 2006[133] but this was weaker even than the 2002 version and is generally considered unenforceable. Of the 46 applications in Herefordshire on the public register to „cultivate grassland“ under the 2006 EIA regulations from 2006 to 2017, all were allowed to go ahead except 3 which required „environmental screening“ but the outcome of these three cases is not recorded[134].

In 2011 a putative Deserted Medieval Village (DMV) site in the village of Lyonshall was identified by previous surveys as having potential Statutory Ancient Monument status. The intention to plough it up was well known locally and despite appeals in advance to English Heritage, Natural England and Herefordshire Council the site was ploughed for maize. This case does not appear on the public register of EIA applications.

In the course of this survey we are aware of at least two cases (one illustrated below) of identified water meadow sites being ploughed between 2000 and 2012, one of the cases since 2007. This latter is at Rotherwas see SO53_SewageWorks Rotherwas and also does not appear on the EIA public register. This Rotherwas case and that of Lyonshall show that it is likely that a number of cases of ploughing of permanent pasture may not appear on the EIA public register which seems likely to underestimate the scale of loss of permanent grassland from 2006.

Water meadow site HER 41910 (Water meadow, Willows Farm). Top right: on the December 1946 RAF air photo the bedworks are fairly evident with a mean width of 7.3m the 2000 aerial photograph also shows up the ridges/panes even though the photo is taken in summer and field appears as permanent pasture probably not ploughed since the earthworks are prominent enough to be recorded as HER site. However by 2012 the whole field is in arable cultivation.

21. Water meadows, Stewardship targeting and liaison with Natural England and Herefordshire Archaeology.

21.1. Future management of water meadow sites

This 2015-17 study has reviewed potential sites of water meadows and other historic water features in Herefordshire. There are a range of features and sites described and recorded in this report in several different categories including:

- Sites that are already on Herefordshire Council"s Historic Environment Record (HER) as water meadow sites.
- Sites that have come to light during this project, but not currently on the HER and are new records
- Sites that are on the HER as earthworks often as ridge and furrow but which may have water meadow features
- Sites that are from historic records and that are ploughed out and little evidence remains on the ground or in the LIDAR. These are often not on the HER either.

The sites recorded in this study are listed in Appendix 2 and on the accompanying CD

Site that are priorities for maintenance and preservation are primarily in the first three categories. If the features are in grassland then the potential exists for the owner or land manager to retain the site as grassland and manage it without any damaging operations such as ploughing, use of heavy machinery, topping, burning or dumping material on the ground, scrub invasion etc. Sympathetic management could be done:

- Voluntarily
- Through existing agri - environment scheme such as Environmental Stewardship (Entry Level ELS or Higher Level HLS) agreements starting up to and including 2015 for 5 or 10 years.
- Through the new Countryside Stewardship (CS) – agreements starting 2016 onwards.

Ideally all water features would be sympathetically managed and preserved, but there is always scope to raise awareness with landowners and managers about the value of the features on their land, to give advice on the best management techniques and to signpost to grants and further assistance. (eg. existing guidance "Conserving Historic Water Meadows" can be found at https://historicengland.org.uk/images-books/publications/conserving-historic-water-meadows/ and http://www.helm.org.uk/guidance-library/farming-the-historic-landscape-grassland/).

21.2. Incentives for management of sites

Incentives are most likely to operate through grant schemes and both the Mid Tier and the Higher Tier of the new CS are competitive. Chances of gaining access to the scheme payments are increased by the applicant carefully matching options to manage historic (or wildlife) features with local priorities and target sites. Target sites are Scheduled and Protected Sites and sites on the SHINE inventory. However many sites in Herefordshire including those in this study are not on the SHINE inventory and a meeting was held on 23 May 2016 between Jez Bretherton and Esther Stephens of NE, Liam Delaney of Herefordshire Archaeology and David Lovelace and Caroline Hanks of David Whitehead and Associates. The discussion focussed on the criteria and procedure for sites to be entered onto the SHINE database so that it reflects the most important and vulnerable sites from this study as an incentive to them being managed and protected in CS options in the future.

21.2.1. Selected Heritage Inventory for Natural England - SHINE

Natural England has developed SHINE which is a single, nationally consistent dataset of undesignated historic environment features from across England that could benefit from management within agri-environment schemes administered by Natural England on behalf of Defra. The data about suitable sites has been created by local authority Historic Environment Records (HERs) and has fed into a national SHINE dataset that has been reviewed and corrected and added to since 2011. SHINE features and sites are provided to the scheme applicants on an application map and SHINE has been used to enable farmers and landowners to identify archaeological and historic sites on their holding that might be eligible for grant-aided management in ELS and also as part of HLS consultations. At best SHINE provides a nationally consistent dataset of eligible features for which management recommendations can be defined.

21.2.2. SHINE Selection Criteria from NE 2013 guidelines

The summarised SHINE selection criteria are as follows:

· The site must be *substantive* – i.e. an upstanding earthwork or ruin, or a buried archaeological site.
· The site must be *verified* – i.e. it should have a physical manifestation on the surface, or should have been confirmed by survey, aerial photography or excavation thereby enabling its character and extent to be defined. (further details below)
· The site should be *of known character* - i.e. confidently indexed with at least one term from the English Heritage thesaurus of Monument Types.
· The site must be closely *mappable* – i.e. it must be possible to draw a polygon (meeting the SHINE GIS polygon standards) that closely defines the visible extents of the site. (further details below)
· The site must be *able to benefit from one of the management options* available in Environmental Stewardship (ES) or Countryside Stewardship (CS).

21.2.3. Examples of sites that should be included and excluded in SHINE

Coherent water meadow complexes are listed among the eligible above ground archaeological sites including earthworks and structures that are eligible and would merit inclusion, provided they have a known location, a mappable extent, an unambiguous character and are eligible for management under Environmental Stewardship.

Built water features are also mentioned as features that are eligible including industrial water features such as mill ponds, leats and races. Isolated or degraded elements of water meadows are likely to be ineligible for SHINE as they may be of ambiguous character and extent, and/ or of limited value for management under Environmental Stewardship.

In the majority of cases ineligible features are likely to be of ambiguous character, and/ or have no known location or mappable extent. Where this is not the case, a judgement on the type of archaeological feature in question should be made at a landscape scale, taking into consideration the nature of the local archaeological resource. For example in a landscape predominantly under arable cultivation, isolated fragments of earthwork features are likely to be of greater significant due to their rarity, and would therefore benefit from management under Environmental Stewardship to ensure their survival.

21.3. CS targeting as a tool for ensuring appropriate management of water meadow features in Herefordshire.

The new Countryside Stewardship scheme is competitive both in the Mid Tier (MT) and the Higher Tier (HT):

21.3.1. Higher Tier Countryside Stewardship.

The Higher Tier is by invitation of Natural England advisers and potential HT schemes are worked up by the applicant and their NE adviser together. The opportunity also exists for others to make an application to Higher Tier but in this case they would need to work up the application themselves. Generally Higher Tier applications will include designated or very high value sites for environmental features. In the case of historic environment this will include Scheduled Monuments and other high value sites.

Natural England‟s Herefordshire team have indicated that any high priority features that fit SHINE criteria, even if they are not actually on the SHINE database, are likely to score highly enough in a HT application to be included in the scheme.

The opportunity also exists for potential HT sites with poorly understood features to be supported with a PA1 implementation plan, for a £1,100 payment, prior to an HT stewardship application being submitted. This could be very useful for some of the sites in this study that have not yet been visited and where potential exists to work up a competitive HT scheme across the farm.

21.3.2. Mid Tier Countryside Stewardship

The majority of new CS schemes will be at the Mid Tier. Mid Tier applications are dealt with as a paper based assessment exercise (originally intended to be scored through a computerised application system which is not expected to be available in the foreseeable future) but without input from a Natural England adviser. The applicant is provided with a map of SHINE and designated features on the land in the application through a Historic Environment Farm Environmental Record (HEFER). Designated sites and other high and medium priority sites on the SHINE database which have appropriate options placed on them in the application should score more highly and make MT applications more competitive. So for this reason having sites identified on the SHINE database is an important mechanism to enable their inclusion in a MT scheme. Appropriate option choice should lead to sensitive management of the feature.

At the moment there is no mechanism for sites known to the applicant but which are not on the SHINE database to score points in MT even if suitable management options are chosen in the MT application.

Because there is no possibility for NE adviser discretion in the MT scoring system this means that it is actually *more* important for MT success than HT to have sites recognised on the SHINE database to act as an incentive to landowners and scheme applicants.

21.4. HER updates and addition of water meadow features to SHINE to help protect and manage sites in Herefordshire.

The ultimate usefulness of the SHINE (or any) database is entirely dependent on the quality of the data held within it. And if this is to be a useful tool to encourage land owners to water meadow features in grassland and other crops then consistent and regular updating of the SHINE database may be an important determinant of beneficial site management. However we recognise that the HER has not been fully resourced in Herefordshire in recent years and there is a backlog for entering sites on the HER let alone to SHINE.

It was agreed that priority for SHINE updates include the 10 sites that have been visited during this study. Data for the extent and location of these sites has been digitised and polygons can be transferred to SHINE.

Key sites for inclusion in SHINE will be larger sites and features such as leats and carriers that extend over more than one farm or holding see # below.

There was agreement that all extant and destroyed sites from this study should be entered onto or updated on the HER as soon as possible.

Data will be supplied to Herefordshire Archaeology in a format that is most useful to the HER database. It will also be available in a form so that NE Historic Environment staff can easily interrogate the study sites when necessary for existing and new CS schemes.

21.5. HEFER process and its role in addition of sites to SHINE

When MT application packs are being generated it falls to Herefordshire Archaeology to prepare the HEFER consultation. Data provided in this study can feed directly into this process.

Sites identified and described in this study can be added to the HER and will be included in the application pack and added to SHINE.

There is a lag of up to a year before new sites added to SHINE will be reflected as increased scoring of a MT application. If a HEFER request adds new sites to SHINE in 2016, although the applicant will not benefit from a higher score that year there will be a benefit to future MT applications on adjacent farms that contain part of the same SHINE water meadow feature(s) eg leats and carriers etc that extend across both farms.

Meanwhile despite the absence of some water meadow sites on the SHINE database, there is still an incentive for grassland sites with water meadow features to be included in MT schemes. This is because the whole of the River Wye catchment in Herefordshire is high priority for resource protection and so sites next to watercourses that are entered into very low input grassland option GS2 (£95/ha/year) for resource protection would score more points than sites with water meadow features that are not on the SHINE database. Ironically many of the sites in this study would therefore score on resource protection rather than on historic environment.

There is scope to lobby Natural England and DEFRA to increase the flexibility of the MT scoring system to reflect know sites that are not yet on the SHINE database. This anomaly is also true for unmapped sites of high biodiversity value which do not receive extra points either.

22. The Herefordshire Meadows Facilitation Group

This 5 year project (September 2016 to September 2021) initiated by one of the authors (CH) has just started with funding from DEFRA to bring together farmers, advisors, ecologists, archaeologists and historians to foster collaboration, share information and skills and to improve understanding of meadow management for multiple benefits. In particular there is an historical element to the project which will work with historians and archaeologists to advise grassland managers and owners, to foster interest in the historic aspects and to discover new earth work sites and/or further understand existing ones. At present there are 34 landowners/landholders who are signed up and who between them manage over 3,000 hectares of farmland.

The first meeting of the group (22nd February this year) was held in a one of the low lying meadows identified as a potential water meadow site by this project (SO45_Sollersdilwyn) with the theme of archaeology and farm history.

With the uncertainties surrounding future rural policies this kind of initiative which fosters cooperation and partnership working will assume particular importance.

23. Appendix 1 Fact sheet for the 'History of your farm'

Many farmers have interest in the history of the land and buildings which may been in their family for generations. Water meadows and associated structures may be just one of many aspects of their farmland heritage that may come to light in addition to those that we have found using the methods in this project. We have found from meetings with farmers that there is a demand for a fact and resources documents that gives guidance on the many resources now available to help farmers investigate the archaeological, farming and heritage aspects of their farm, even though they and their family may well have generations of unique local knowledge. Below is the fact sheet that we will be handing out to farmers on request and during forthcoming meetings of the Herefordshire Meadows Group or any other gatherings:

"History of your farm

This a short list and description of sources of information that may be useful for studying the history of your farm and farming generally in your area.

Personal and family farming knowledge.
If the farm has been in your family for some time you probably know more about its history than anyone else. You may have photos of your farm taken in past decades and such photos can be valuable records of general farming history. Your farm may have historic deeds, maps and other documents that are unique records of its history. Sometimes these are sitting in solicitor"s offices and owners may not always be aware of their importance or even existence so they are at risk of inadvertent loss. Making a digital copy is easy these days and will help preserve them. For fragile and ancient documents owners might like to consider donating them to the Herefordshire Archive and Records Centre (HARC) who have the expertise to preserve, interpret and catalogue them. Senior members of your farming family may have valuable experience and reminiscences so if agreeable it would be a valuable contribution to local history to record them for posterity. HARC has collections of photographs of Herefordshire life including farming from the late Victorian period onwards.

Historic maps and associated data
Pre 1800 maps
Large scale maps that show field level detail earlier than 1800 are a rarity for Herefordshire. These are mainly estate maps and a comprehensive list of those known so far has been published: *Herefordshire Maps 1577 to 1800* by Brian Smith, Logaston Press 2004. A supplement to this publication with additional maps published by the Woolhope Club 2012. Recently, a set of 18th century maps of farms on the Kentchurch Estate has turned up so who knows what other pre-1800 maps still survive somewhere?

Tithe maps of about 1840
The Tithe Commutation Act of 1838 „commuted" customary payments to parish vicars to a monetary tax based upon land holding and productivity. This act required the making of large scale parish maps and the recording of each land parcel for ownership, tenant, area, land use and field name. This information is recorded on a separate document known as the „apportionment". This „second Domesday" gives an unusually detailed picture of the landscape and farming at that time. The original maps and their apportionments are held at HARC with reference copies at the National Archives but they have also been conveniently transcribed, along with field names and field numbers, to a 6" to the mile scale by historian and calligrapher Mr. Geoffrey Gwatkins who can be contacted through his web site: www.geoffgwatkinmaps.co.uk.

First edition 25 inch and 6 inch to the mile Ordnance Survey maps
These were published nationally in the 1880s and represent the most detailed maps ever produced, for example, every mature tree is plotted. The coloured editions of the 25" inch series maps are especially fine and beautiful and recently the National Library of Scotland (NLS) have

placed high resolution scans of them online, including the majority of those for Herefordshire. NLS also have most other historic map editions for all of Britain including the first edition 6 inch to the mile series. http://maps.nls.uk

1909 Land Tax survey.
This attempt by the Lloyd George liberal government to introduce a property tax required, like the tithe survey 70 years previously, a valuation of every building and land holding in the country. Land ownership and tenancy is recorded on numbered and colour coded 6" and 25" OS maps with the individual valuations entered into a series of hand written books. Of particular interest are the often detailed descriptions of farmhouses, barns and contents. The original maps and books of surveys are held at the National Archives in Kew (reference series IR 128 and IR 58 respectively). HARC also has copies although only short summaries of the surveys.

The Royal Commission survey of Herefordshire buildings 1929-1932.
This was the first attempt at listing buildings for their historical interest and included those deemed to be earlier than about 1700 in construction including many farmhouses and sometimes barns. These surveys are arranged by parish and can be detailed, in particular every building was photographed which is often the earliest such photograph. These are held at the English Heritage Archive and Library at Engine House, Fire Fly Ave., Swindon SN2 2EH contact number 01793 414600.

War Agricultural Executive Committee (WAEC) farm survey and maps
WAECs were charged with dramatically expanding arable production during WWII and had powers over private interests by virtue of the Defence of Realm Act. Every farm, even tiny smallholdings, was subject to a survey to judge their potential. These surveys along with the individual „June return" for each farm were released to the public domain under the 50 years rule in 1992. Associated with these farm surveys are maps annotated to show who was farming which field. Individual grassland fields for each farm subject to compulsory plough up orders are identified. This data set is comparable with the 1840 tithe survey in the level detail but additionally records data for each farm, including for example the number of working horses. The minutes of the deliberations of the WAEC, both county and district, are also preserved and give a fascinating insight into the way farming was controlled and carried out in the county during WWII. These are all at the National Archives: maps are in the reference series MAF 73, individual farm surveys are held in parish folders MAF 32 and the WAEC minutes MAF 80. Parish summaries of June returns are held for each year from 1880 to 1988 (MAF 68) and provide a unique series of statistics for farming in each parish.

Aerial photography
For a true landscape record nothing beats a high resolution aerial photograph.
Oblique air photos (i.e. those taken out of a light aircraft window)
Historic England has acquired the so called „Aerofilms collection", huge collection of mainly commercial air photos that date back to the 1920s and are now available online: www.britainfromabove.org.uk
There is also a large set of oblique air photos of particular sites of archaeological and historic interest. These are usually earthworks (humps and bumps) or crop marks (near surface soil characteristics reflected in patterns of differential light reflectance from the crop). Most of these are held at the air photographic library part of English Heritage Archive and Library in Swindon but the HARC also has a set of oblique APs which includes more recent air photos taken by aerial photographer Chris Musson and by former council staff member Neil Rimmington. These and the full list of archaeological and heritage sites for the county can be accessed via the Herefordshire Historic Environment Record (HER): http://htt.herefordshire.gov.uk.

Vertical air photos (for mapping and military purposes)
These high resolution photos are especially useful in analysing landscape changed since WWII. The earliest known for Herefordshire are those taken by the Luftwaffe in December 1940 but

they only cover Rotherwas, its vicinity and some parts of the Lugg and Wye valleys (I have a set). The RAF photographed all the county in a series of flights from 1946 to 1959, those taken in winter being very useful in identifying archaeological sites and farming systems such as water meadows and ridge and furrow arable which may no longer exist. Recent vertical colour photography is now well known and used via Google Earth and Bing Maps but there is some earlier colour aerial photography from around 2000 also available on the „history slider" of Google Earth. HARC has 1400 contact prints of vertical APs covering most of the county from 1946 to 1959. I have scanned all of them and I"ll hand them over to HARC when they have sorted out their digital storage and database system but happy to receive inquiries myself. A more complete set of vertical APs of Herefordshire is held at the English Heritage Archive and Library, Swindon.

Light Detection and Ranging (LIDAR)

LIDAR is a laser scanning technology which creates a 3D simulation of the object in view. When used to illuminate land below an aircraft, LIDAR produces a 3D model of the countryside. From about 2005 the Environment Agency has commissioned LIDAR scans of catchments in England and Wales for flood defence modelling purposes. Recently, the EA has released processed versions of LIDAR data which have proved uniquely useful for archaeological investigations on farmland and in woods. Raw LIDAR data consists of 3D „point clouds" from the reflected surfaces from which a Digital Elevation Model (DEM) which can be visualised in software. What is available for download are two types of DEM: (a) Digital Terrain Model (DTM) which is the bare ground with trees and buildings digitally removed from the point cloud data and (b) Digital Surface Model (DSM) which consists only of the tops of objects first intercepted by the laser pulses. LIDAR data is available as flat images of the DTM and DSM data and the actual numeric height data for DTM and DSM. By far the most useful for archaeological purposes are the DTM height data files. When imported into a Geographic Information System (GIS) – see below – these DTM files can show very subtle height variations revealing earthworks such as deserted settlements, lost field systems and water meadow ridges etc. Because the LIDAR laser pulses partially penetrate woodland canopies the resulting DTMs can reveal earthworks within woods. The EA LIDAR store: http://www.geostore.com/environment-agency/survey.html

Archives

There is vast body of original documents held in local and national archives going back to Domesday (and even further) relating to all aspects of rural life, economy and landscape. Increasingly comprehensive online searchable archive data bases have transformed historical research and the digital camera can capture quality copies of original archives. Both these development make it much easier than in the past for anyone to research local farming and landscape history, families and buildings. The most comprehensive online database is that maintained by the National Archives which includes all the local archives such as HARC: http://discovery.nationalarchives.gov.uk/

The HARC web site itself: www.herefordshire.gov.uk/archives.

Note that while the references to originals are mostly on an online catalogue, only a very small fraction of the originals have been photographed and available online.

A fruitful source historical information about county farms are the sale notices and sometimes legal land disputes printed in the Hereford Journal and Hereford Times all of whose editions up to 1900 have been digitised by the British Library and are word searchable – you will need to register and pay for this service: http://www.britishnewspaperarchive.co.uk

The Historic Environment Record

A detailed list of all known archaeological and heritage sites is held at HARC, but the online database can be searched by parish, location and through an interactive map:

http://htt.herefordshire.gov.uk/her-search/monuments-search

However a huge amount of detail of these archaeological and heritage sites and many other resources such as sites surveys and air photos is held at HARC itself which can visited by appointment with the Historic Environment Record Officer: Liam Delaney liam.delaney@herefordshire.gov.uk

Earthwork features on farms and historic water management.
Any permanent pasture which has not known to have ploughed in living memory is likely to have „humps and bumps" which can indicate a range of interesting and possibly unique features. These may turn out to be deserted settlements, ancient field systems or ridges that can be relics of Medieval arable cultivation or for meadow irrigation (and sometimes both).

Even where pasture has been long ploughed, there may be water channels and/or remains of sluice gates. On hillside pastures look out for channels which follow the contours as these can be for irrigating meadows along the hillside. Herefordshire had a great many mills even on water courses which now may seem quite small so may be remains on your farm such a stone pliths, remains of weirs in brooks and disused water channels. Such mill races were sometimes associated with meadow irrigation. As well as field observation and local knowledge, old maps, air photos and LIDAR can help with discovery and identification.

The Meadows Group has access to expertise in this area so contact the Meadows Group officer Caroline Hanks caroline.hanks@farming4wildlife.co.uk or County archaeologist Tim Hoverd thoverd@herefordshire.gov.uk.

DIY digital mapping
Geographic Information Systems (GIS) used to be expensive and difficult to use but the Open Source free package known as QGIS is user friendly and allows people create their own digital maps by importing a variety of data sources including aerial photography, scanned maps, geo-located photos from a smart phone etc. The QGIS web site www.qgis.org includes a manuals and links to tutorials. There are some Herefordshire specific resources online at www.r5r.eu/awir.html under „FOSS4G" (= Free and Open Source Software for Geospatial) including the processing of LIDAR derived DTM files.

Other useful free online map sources:
* Ordnance Survey free data

www.ordnancesurvey.co.uk/opendatadownload/products.html

* Government data mapping sets

https://data.gov.uk - go to „mapping".

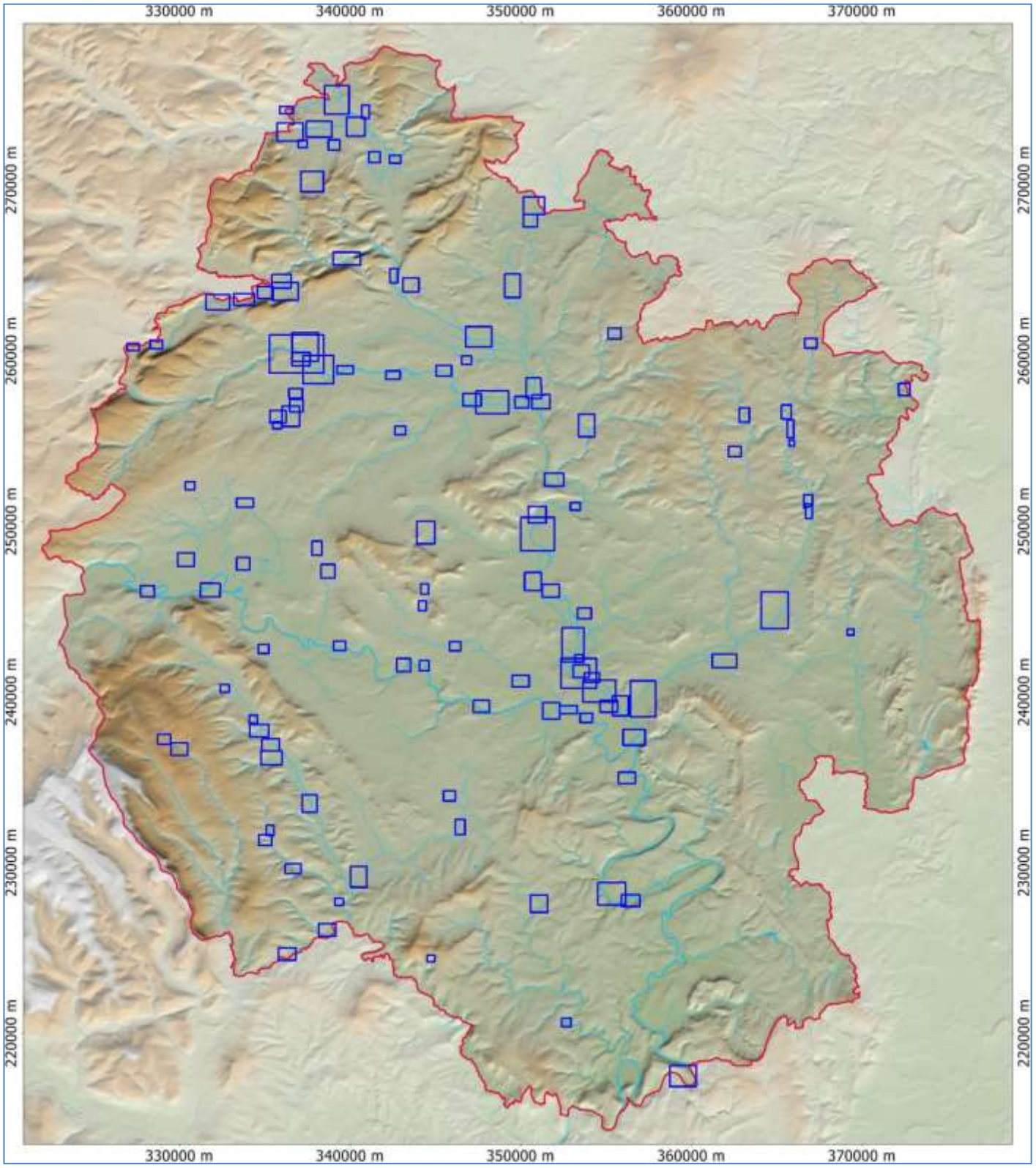
* Historic Environment records (including parks and gardens) for England. Set the map view first and then tick the desired boxes under the what/when and resources tabs:

http://www.heritagegateway.org.uk/gateway/advanced_search.aspx

For further queries feel free to contact me: david@dlovelace.freeserve.co.uk of the Herefordshire Water Meadows identification project, courtesy of Historic England."

24. Appendix 2 distribution of water meadow sites

Location and extent of the bounding boxes of the 120 water meadow sites, historic, putative and remnant identified by the project and subject to historic map, air photo and LIDAR derived DTM sequences. These sequences, field photos and data are included on the accompanying DVD and are online http://h2om.uk



References:

[1] English Heritage air photographic library sortie RAF/CPE/UK/1873 4th Dec 1946
[2] Cook, H. and Williamson, T. editors, *Water Meadows, History, Ecology and Conservation*. Windgather Press 2007. including the many references therein.
[3] John Fitzherbert, *The Boke of Surveying and Improvements*, London 1523
[4] Rowland Vaughan, *Most Approved and Long experienced Water Works*, 1610. Republished and prefaced by Ellen Beatrice Wood, *Rowland Vaughan: His Booke* (John Hodge, London, 1997) – reprinted (2015) by the British Museum.
[5] Samuel Hartlib, *Discourse of Husbandry* London 1651
[6] George Boswell, *A Treatise on Watering Meadows*. London 1779
[7] Cook, H. Stearne, K. and Willianson, T. *The origins of water meadows in England*, Agricultural History Review (2003), volume 52 part II, 155-162
[8] County tithe surveys (c1840) show that the river valleys in Herefordshire were almost entirely grassland and this was a time of relatively high arable production. Combined with 1936 Land Utilisation Survey for Herefordshire and occasional Tudor records of meadows in valleys implies a continuity of 4 centuries or so.
[9] TNA E134\13CHAS\MICH10, evidence of John ffarmer of Kenchester witness for the defendant in the case of Lord Talbort vs Francis Smith his tenant.
[10] Michael Cowan, *Floated Water Meadows in the Salisbury Area*, South Wiltshire Industrial Archaeology Society, 1982
[11] Sturgess C.R.H. *Land Drainage and Irrigation* TWNFC 1947 pp 85-07
[12] Hesse, Ralf., *LiDAR-Derived Local Relief Models – a New Tool for Archaeological Prospection*. 2010. Archaeological Prospection 17(2): 67-72.
[13] TNA, C133/75
[14] TNA, KB27/106
[15] The „Waterlodemedue" in Ballingham is from the St. Guthlac Cartulary folio 35 Balliol College MS 271. The other names in this section are from John Freeman"s Herefordshire field names research database which records 23 such suggestive names prior to 1650.
[16] British Library Harley MS 7369, survey for Eyton taken by Richard Huckliutt.
[17] Ellen Beatrice Wood, *Rowland Vaughan: His Booke* (John Hodge, London, 1997) – reprinted (2015) by the British Museum.
[18] Wood, Rowland Vaughan, IX, 28, 50-62; Penry Williams, The Council in the Marches of Wales under *Elizabeth I* (1958), 276-96.
[19] Wood, Rowland Vaughan, 62.
[20] The Huntington Library, California, MM 69724. Reproduced in the book below.
[21] The Man who Drowned the Meadows, Rowland Vaughan 1558 – 1627. Golden Valley Study Group (2016), Logaston Press.
[22] *Oxford DNB*, „John Davies (1564/5-1615)"; Wood, *Rowland Vaughan*, 16-24.
[23] Wood, *Rowland Vaughan*, 85, 90, 120-27, 137, 140-1.
[24] Herefordshire Historic Environment Records (HER), Alan Stoyel, Pilot Study of Mills and Associated Water Arrangements within the Catchment Area of the River Lugg (January, 2015).
[25] Wood, *Rowland Vaughan*, 88-89.
[26] Wood. *Rowland Vaughan*, 45, 127; Kathy Stearne, „Management of Water Meadows: Four Hundred Years of Intensive Integrated Agriculture" in Hadrian Cook & Tom Williamson, *Water Meadows* (2007), 117-20.
[27] Wood, *Rowland Vaughan*, 85, 118.
[28] Wood, *Ibid*., 93, 109; Christopher Taylor, „The Archaeology of Water Meadows" in Cook & Williamson, *Water Meadows*, 28-29.
[29] Wood, *Ibid.*, 171-3; Compton Reade, *The House of Cornewall* (1908), 202-3; Paul Stamper, *Historic Parks and Gardens of Shropshire* (1996), 19.
[30] C.J. Robinson, The Mansions and Manors of Herefordshire (1872), 263; Brian Smith, Herefordshire Maps, 1577-1800 (2004), 122, plate 36.
[31] Robinson, *Mansions*, 89.
[32] Robinson, *Ibid*., 98-99.
[33] Wood, *Rowland Vaughan*, XXVI.
[34] Discussed and referenced in Ashmead-Price, Moccas Court Parkland Plan (July, 2013), 41-2, map 17.
[35] Wood, *Rowland Vaughan*, 76, 95, 99, 119, 127.
[36] Wood, *Ibid.*, 76, 95, 102-3.
[37] Wood, *Ibid*., 126,135.
[38] Wood, *Ibid*., XIII, 121.
[39] Wood, *Ibid*., 105, 122 – it is debatable whether flooding killed moles and worms.
[40] Floodplain agricultural systems: functionality, heritage and conservation. Hadrian Cook. *Journal of Flood Risk Management*, Vol. 3 (2010), 192-200.
[41] Walter Daunce a yeoman of Madley one of the many local stock farmers who rented grassland in the Dore valley TNA E178/994 (1588).

[42] *TWNFC* (1958-60), 203. Arthur S. Wood wrote a number of papers on Herefordshire‟s agricultural history and occupied the Whitehouse where Rowland Vaughan lived.
[43] *Oxford DNB*, „ John Beale (1608-1683)‟.
[44] An Enlargement of the Discourse of Husbandry 1651 page 50. London 1651.
[45] Mayling Stubbs, „John Beale, Philosophical Gardener of Herefordshire‟ in *Annals of Science* 39 (1982), 477-88.
[46] John Beale, *Herefordshire Orchards: A Pattern for All England* (1657), 22-3 –for Flackett see Robinson, *Mansions*, 49. Although an Anglican clergyman Beale had Puritan sympathies. He was an opponent of Laudianism and a chaplain in the Parliamentary army for the governor of Shrewsbury garrison during the Civil War – *Oxford DNB*, „John Beale‟.
[47] Beale, *Orchards*, 29-32; for the importance of the fold see Joe Bettey, „The Floated Water Meadows of Wessex: a Triumph of English Agriculture‟ in Cook & Williamson, *Water Meadows*, 8-9; for an alternative view on folding see Gavin Bowie, „Reflections on Water Meadows‟ in *Rural History Today* 27 (August 2014), 6-7.
[48] Leslie and Raynor, Culture and Cultivation, 4-5; Joan Thirsk (ed.), The Agrarian History of England and Wales, 1670-1750 V.II (1985), 532, 559.
[49] Douglas Chambers, „ “Wild Pastoral Encounter”: John Evelyn, John Beale and the Regeneration of the Pastoral in the mid-Seventeenth Century‟ in Leslie & Raylor, *Culture and Cultivation*, 181-2.
[50] *Oxford DNB* „John Beale‟; Mayling Stubbs, *Annals of Science* 46 (1989), 342-345.
[51] Stubbs, Ibid., 328; Louise Brown Osborn, The Life, letters and Writings of John Hoskyns, 1566-1638 (1973), 94-96.
[52] Peter Goodchild, „ “No Phantasticall Utopia, but a real Place” : John Evelyn, John Beale and Backbury Hill, Herefordshire‟ in *Garden History* 19 (1991), 105-27.
[53] John Dixon Hunt, Greater Perfections: the Practice of Garden Theory (2000), 180-83.
[54] David Whitehead, „The Picturesque in 18th century Herefordshire‟ in *West Midlands History* 3(I) (2015), 17-18.
[55]John Macklin, Bishopstone and Bunshill, Herefordshire (2011), 70-1.
[56] *Charity Commissioners' Report: Herefordshire* (1838), 33-4; David Whitehead, The Weir, Kenchester: Historical Survey for the National Trust (2005), 9.
[57] Joan Thirsk (ed.), *Agrarian History of England and Wales, 1500-1640* IV (1967), 100, 190, 644; E.L. Jones, „Agricultural Conditions and Changes in Herefordshire, 1660-1815‟ in *TWNFC* (1966), 33.
[58] Thirsk, Ibid., *534*; Sylvia Pinches, *Ledbury: Market Town* (2009), 32-49.
[59] Thirsk, Agrarian History IV, 644-7; John Duncumb, A General View of the Agriculture of the County of Hereford (1802), 68-9.
[60] Thirsk, *Agricultural History* IV, 471,534-5, 644-7, 671-2; *Owen's New Book of Fairs* (1813), 41, 31-2, 57-60.
[61] J. Bathurst & J.L. Cole, „Leominster Fair, 1556‟ in *TWNFC* XLII (1976), 72-88; Brian Smith, „Wigmore Fairs, 1669-1710‟ in *TWNFC* (2002), 356-85.
[62] Smith, *Ibid*., 360, 368-9; Faraday, *Militia Assessments*, 109, 162.
[63] Phyllis Williams, „Borough and Town‟ in J. Hillaby & E. Pearson (eds.), *Bromyard: A Local History* (1970), 47; Phyllis Williams, *The Three Stanfords* (2006), 199-200.
[64] HAS, HDI/5.
[65] HAS, AS94/101; HD1/5 – Bishop‟s estates; D96/86; AS94/288.
[66]Smith, Wigmore Fair, 363-5, 375.
[67] *Owen's Fairs* (1813), 31; *Newsletter of the Friends of Hereford Record Office* 82 (2008), 2; Thomas Taylor Lewis (ed.), „Letters of Lady Brilliana Harley‟ in *Camden Society* (1853), 168.
[68] J. Lodge, A Topographical History of the County of Hereford (1793), 8-9.
[69] Nathanial Kent, *Hints to Gentlemen of Landed Property* (2nd edition, 1776), 62.
[70] *Ibid*., 62-3.
[71] Delphine Coleman, *Kingstone* (1996), 118.
[72] J. Duncumb, Collections towards the History and Antiquities of the County of Hereford I (1804), 172.
[73] J. Duncumb, General View of the Agriculture of the County of Hereford (1805), 108, 114.
[74] *Ibid*., 115.
[75] Richard Payne Knight, *The Landscape: a Didactic Poem* (1794), 91 lines 591-3.
[76] Duncumb, *General View*, 162.
[77] S. Wade Martins & T. Williamson, „Floated Water-Meadows in Norfolk: a Misplaced Innovation‟ in *Agricultural History Review* 42.1 (1994), 20-37.
[78] Jacqueline Eales, *Puritans and Roundheads* (1990), 34; Lewis, *Letters*, 62; the plan is disussed and illustrated in Whitehead, *Herefordshire Miscellany*, 173.
[79] Eales, *Puritans and Roundheads*, 33-4; Smith, *TWNFC*, 257-8 quoting Brampton Bryan Archives; HAS, F76/1/46; HER 8297, 8305, 37671, 37675-7 plus annexed Farm Environmental Plan (CPH 17/244/0003.
[80] The Leintwardine Area of North Herefordshire, its physical geography, land-use and distribution of population MA Thesis D.G Baylis Manchester 1957.
[81] Barney Rolfe-Smith, *The History of the Leintwardine Fishing Club* Stonebrook 2011. ISBN 978-0-9568972-0-6
[82] *TWNFC* (1948), 242, 243.
[83] Bargain and Sale 9 April 1653 between John Seyse of The Homme, Dilwyn yeoman, wife Margery and son Edward and William Bradford of Dilwyn gent. Thanks to Sue Hubbard for supplying this reference which is part of a private collection.
[84] C. R. H. Sturgess Land Drainage and Irrigation TWNFC 1947 pp 85-94 and Inett Homes HAS BD20/6/1-5.

[85] HAS A77/82 and quoted in *An archaeological desk-based assessment of a canal-like water feature at Court of Noke, Pembridge, Herefordshire* by Christopher K. Currie. Report to Mr. & Mrs Edward Bulmer May 1997.
[86] Smith, *Ibid*., 357; Faraday, *Militia Assessments*, 113,141,147; Robinson, *Mansions and Manors*, 195, 254; HAS, CJ87/197.
[87] HAS, CJ 87.
[88]Auction of Upper and Lower Broadheath Farms 2nd June 1911. Possession of the author (DL)
[89] Natalie Preece and David Williams, field surveys at Eaton Hall. *The Lugg Valley*, Herefordshire archaeology 2007 pages 46 - 49.
[90] J. Harris, *The Artist and the Country House* (1979), pls. XV-XVI; Jones, *TWNFC* (1966), 43.
[91] Brian, *Herefordshire Miscellany*, 215, 217; the weir is noticed by Stoyal, Pilot Study of Mills and Associated Water Arrangements within the Catchment Area of the River Lugg (2015), photograph collection (HAS).
[92] Richardson & Musson, *Herefordshire*, 7; HAS J94/1.
[93] Brian, *TWNFC* (2004), 73; Jean Hopkinson, *Little Cowarne* (1983), 32.
[94] Keith Ray, Archaeology of Herefordshire, 356; Brian, Herefordshire Miscellany, 215.
[95] Ruth Richardson & Chris Musson, *Herefordshire Past and Present: an Ariel View* (2004), 7; Peter Dorling, *The Lugg Valley, Herefordshire* (Herefordshire Studies in Archaeology 4 (2007), 38-9; Keith Ray, *The Archaeology of Herefordshire: an Exploration* (2015), 356-7.
[96] Cal. Inq. Miscellaneous VII (1969), 149-52 – a survey of 1404; Register of Bishop Charles Bothe, 1516-35, 242, 266.
[97] HAS, CF50/269 – previously Hereford City Library, LC Deeds 324.
[98] Anthea Brian, „Lammas Meadows" in *Herefordshire Miscellany* (2000), 203.
[99] Anthea Brian, „A Tenurial History of Lugg Meadows" in *TWNFC* LXII (2004), 57-63.
[100] Scott Wilcox, Sun, Wind and Rain: the Art of David Cox (2008) pl.20.
[101] Domesday Book, f.182b; *Hereford Journal* 21 June 1781.
[102] HAS, BJ/97/5/1
[103] HAS, Local Collection Deeds, 913, Sufton Court, Mordiford Court Rolls. Infromation via e-mail from Andy Tatchell, proprietor of Mordiford Mill, 31st January 2016.
[104] Soil survey of England and Wales, *Soil Survey record No. 11 Soils in Herefordshire* sheet 34. 1972
[105] Heather Hurley, *Herefordshire's River Trade* Logaston Press 2013, Pages 143-150
[106] J. Price, *An Historical Account of the City of Hereford* (1795), 190-1; David Whitehead, Warham House, Breinton: a Landscape Appraisal (2011), 8-11; HAS, C38/22/141.
[107] Peterken, *Wye Valley*, 141.
[108] Robinson, *Mansions* 121-2; Whitehead, *Survey* (2001), 161.
[109] Row Ditch Community Archaeology Project *Bulletin* 1 (2014); Headland Archaeology, *Survey of Row Ditch, Hereford* (March, 2014); David Whitehead, *The Castle Green at Hereford* (2007), 18; Victor Stockinger, *The River Wye and Lugg Navigation: a Documentary History* (1996), 125.
[110] Paul White, *The Frome Valley, Herefordshire: Archaeology, Landscape Change and Conservation,* 2011 pages 83 – 85
[111] We are grateful to Jean Wynne-Jones for informing us about this site.
[112] HAS, AS94/101; Duncumb, *General View*, 41-44, 59-64; T.A. Knight, *Communications to the Board of Agriculture* V (1804), 54.
[113] Lodge, *Topographical History*, 28-33; Duncumb, *General View*, 93; Alan Wyatt, *Edwin Loach* (2014), 347-8.
[114] Duncumb, *General View*, 59-62, 93; Lodge, *Topographical History*, 96; Jones, *TWNFC* (1961), 35-6.
[115] HAS, D96/86; AS94/288; A81/11/112.
[116] Author"s (DW) collection of sale particulars.
[117] Pamela Horn, *Rural Life in England in the First World Wa* , Gill and MacMillan New York 1984
[118] Messrs J. Carter Jonas & Sons 13/1/26 to the Bursar of Brasenose, Brasenose College Muniments collection
[119] *Leominster News* 10th May 1918 page 4.
[120] Journal of the Royal Agricultural Society of England, volume 101 part II 1941 pp 17-27
[121] Lord Lovat in the Journal of the Empire Forestry Association, March 1922
[122] West Midlands Group on Post-War Reconstruction and Planning 1946, *A Planning Survey of Herefordshire*
[123] This report to the cultivation committee appears not to be amongst the WAEC papers at the NA.
[124] TNA MAF/80 Herefordshire WAEC series.
[125] Bowler, I. (1985) *Some consequences of the industrialization of agriculture in the European Community*. In Healey, M. and Ilbery, B. (eds) The Industrialization of the Countryside. GeoBooks, Norwich. pp75-97.
[126] Fuller, R. M. T*he Changing Extent and Conservation Interest of Lowland Grassland in England and Wales. 1930 to 1984* Biological Conservation Vol 40, pages 281-300.
[127] Council Regulation 797/85 on improving the efficiency of agricultural structures (OJ L93 30.3.85)
[128] Council Directive 85/337/EEC
[129] English Nature 2002. *Guidelines Environmental impact assessment for use of uncultivated land or semi-natural areas for intensive agricultural purposes*
[130] English Nature Research Reports Number 605 *The effectiveness of Environmental Impact Assessment (EIA) for uncultivated land and semi-natural areas,* March 2004
[131] Daily Telegraph 8th July 2002 "*Meadows at risk after 400 years*" by Charles Clover

[132] Alford v Department of Environment, Food and Rural Affairs. Queen‟s Bench Division, Divisional Court, 5 May 2005.
[133] Environmental Impact Assessment (Agriculture) Statutory Instrument (SI) 2006 no. 2522
[134] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/592902/eia-public-register.pdf