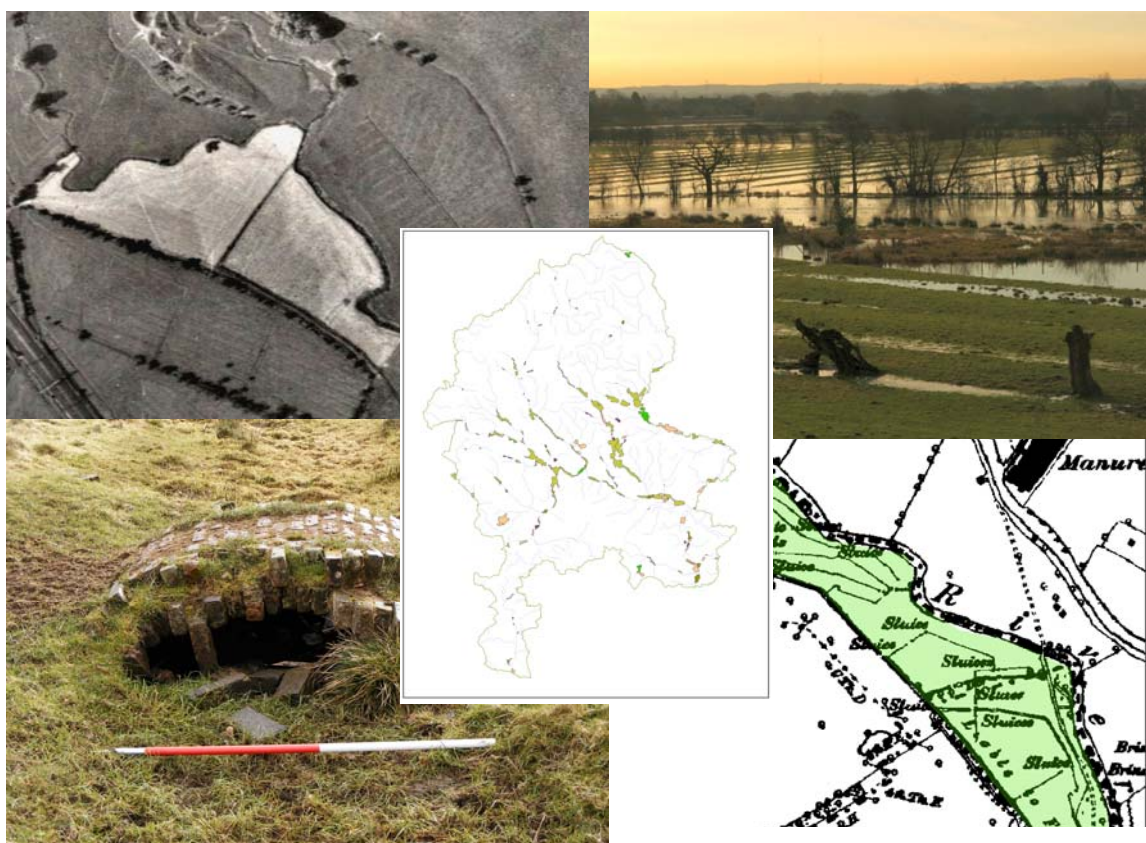


Staffordshire Water Meadows Survey



March 2008

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SUMMARY

The Staffordshire water meadows survey was commissioned in September 2007 by Staffordshire County Council, and took the form of a large scale landscape assessment of the location, extent and survival of the predominantly post-medieval agricultural systems known as water meadows within the county.

This survey comprised the analysis of 1st edition Ordnance Survey data for the entire length of all identifiable watercourses within the county of Staffordshire, followed by the examination of identified targets within two series of aerial photographs, and was focused around the major river valleys. A total of 1543km of watercourses were visually examined within the 1st edition dataset, followed by an estimated 300 aerial photographs, from two catalogues of imagery, the Staffordshire County Council 1963 and 2000 vertical series.

This analysis was intended to allow the identification of the location and extent of possible water meadows within Staffordshire, and the assessment of the changing condition of water meadow sites over time, through the production of a GIS database. This desk-based assessment was then to be followed by field examination of a representative sample of targets in order to test the veracity of the GIS model.

Desk-based survey identified a total of 182 possible water meadow targets, which were recorded in detail and classified according to apparent condition in 1963 and 2000. These targets were distributed across the county, primarily along the major rivers, but with select examples more distal from the main river valleys upon streams and brooks. The largest concentrations of apparent water meadows were found along the major lowland rivers, the Trent, Sow and Blithe.

Target morphology appeared governed by valley topography, as to be expected, and identified targets ranged in size from a single hectare to 451 hectares in size, covering a combined total of 8420 hectares.

Field survey was unfortunately hindered by restricted permissions for land access, preventing representative sampling. However, the field survey indicated the GIS model to have been broadly effective, with a total of 14 out of 18 investigated targets appearing to represent former water meadows, and the identification and recording of a variety of water meadow features.

Assessment of changing condition over time was also hindered as a consequence of 1963 aerial imagery resolution, preventing an effective measure of changing condition. However, a total of 73 sites appeared to be well preserved in the year 2000, with 48 moderately preserved sites and a total of 15 meadows appearing to have been completely destroyed between 1963 and 2000.

Further work to enhance the results of this survey has been suggested, with more detailed aerial photographic analysis coupled with airborne lidar survey at the forefront of this.

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1 INTRODUCTION

1.1 Study area

The study area for this assessment was the immediate vicinity of all major rivers and their tributaries within the county of Staffordshire. This comprised a survey area of approximately 1550km in length, with the exact width of the survey area varying dependant upon the topography of the river valleys.

Staffordshire is crossed and bounded by 12 major rivers, with various minor rivers, streams and brooks composing the tributaries of these. The study area can roughly be divided into a central and southern lowland area defined by the major lowland rivers, and a northern upland area (composed of the Peak district and the foothills of the Pennines).

Where watercourses form the boundary of the county (such as the Dove to the east and the Dane to the north) only the Staffordshire side of the watercourse shall be examined, the remainder lying beyond the survey extent.

1.2 Historical background

1.2.1 *Water meadows*

The term ‘water meadow’ typically refers to an area of land, usually adjacent to a watercourse, which could be deliberately flooded under the control of the landowner, usually via the use of a series of artificial, graded channels. The point of deliberate, controlled flooding should be emphasized here, as it is the use of a careful system to manage the flow of water across the field which truly characterises these features and distinguishes them from fields allowed to flood naturally. The benefits of leaving land to flood, when conditions are right, have long been known, with evidence for deliberate flooding of land from the medieval period (Everard, Cook and Cutting, 2005:8), and the concept likely stretching back almost as far as the origins of agriculture, coupled closely as it is with the idea of irrigation.

However, the careful control of this flooding, to a prescribed timescale in order to create the maximum benefit to the landowner is largely a post-medieval technology, particularly in regards to its pinnacle, the bedwork water meadow. The benefits of flooding or ‘floating’ a meadow are multiple, so long as the system is managed. By floating the fields early in the year, usually between Christmas and March (Cook and Williamson 2007:I), the farmer could reduce the effects of frost and gain an early growth of grass, allowing him to over-winter his sheep for a shorter period. Selective floating later in the year could also produce a further hay crop by maintaining moisture levels within the fields. Additionally, floating served to fertilise the fields, with the key component being the maintenance of a constant flow of water over the meadow, with no areas of standing water. It is this factor which leads to the development of the features which typify water meadows, the use of carefully designed channels, coupled with sluice hatches for flow control.

Three primary forms of water meadow have been identified, although internal variations of typology within these categories have led to some studies designating as many as five. Typology being largely beyond the scope of this study, this debate shall be bypassed, and the three main types mentioned merely due to the differing principles they employ, and the differing indicators these will leave in the records examined within this study.

From the early seventeenth century we see the extensive employment, in area of steep topography, of the catchwork meadow system. Many variations in form exist; however the basic principle is that this system uses a main carrier to divert a stream along the flanks of the hill from which it springs, following the contours. This gutter is then blocked by turves and overflows across swathes of the hillside, sending the water running through the grass (sometimes via more drains lower down and also following the contours), before reaching the base of the field where the main drain takes it away, achieving a constant flow through the field through the employ of gravity. This simple system seems likely the oldest of the three, with some suggestions of use in England as early as the 12th century (Taylor 2007:31)

The floating upwards system, documented from the 17th century (Cutting & Cummings 1999:158), but likely even earlier in principle, involved simply damming a watercourse to force the water to accumulate upstream and flood over the adjacent areas of farmland. The primary feature of this system to be visible in the field would be the remains of a former sluice gate blocking the course of the stream at the downstream end of field systems.

However, it is the bedwork system that is the primary system seen in the archaeological record, and is in essence the classic water meadow. This system, much more sophisticated than the others, is usually seen adjacent to major rivers with broad floodplains, and involved the use of sluice gates to divert the river water into a series of carefully created channels. A 'main carrier' took the water from the river, which had often been partially dammed by a weir, into a series of 'carriers'. These were graded channels on top of wide grassy banks that were designed to overflow, watering the sides (or 'panes') of the banks. Excess water was then taken by drains at the bottom of the banks to a large 'tail drain' which led back to the River. This careful system meant that fresh water moved in a constant flow over the meadow, without producing standing water, and resulted in intricate interlocking patterns of channels and banks, known as bedworks (Figure 1). This method, employable over large areas, and carefully maintained, was the largest and most technically involved form of water meadow management, allowing the strict control of the floating of the fields to suit the landowner. This resulted in large swathes of landscape being occupied by the ornate bedwork features, which were flexible enough in principle, if carefully maintained (often by a skilled craftsman known as a *drowner*), to conform to the vagaries of the river valley and meanders, resulting in a huge variety of earthwork patterns. The origins of this system are difficult to ascertain, however it is generally taken that the system was in use by the 16th century, and widely adopted within it (particularly following the publication of works undertaken on the Herefordshire estate of Roland Vaughan in 1610- Vaughan, R. 1610). It is this system which is principally visible within the archaeological record, and which this study is primarily geared towards the identification of, although any visible traces indicative of other forms of water meadow shall also be examined, analysed and discussed.

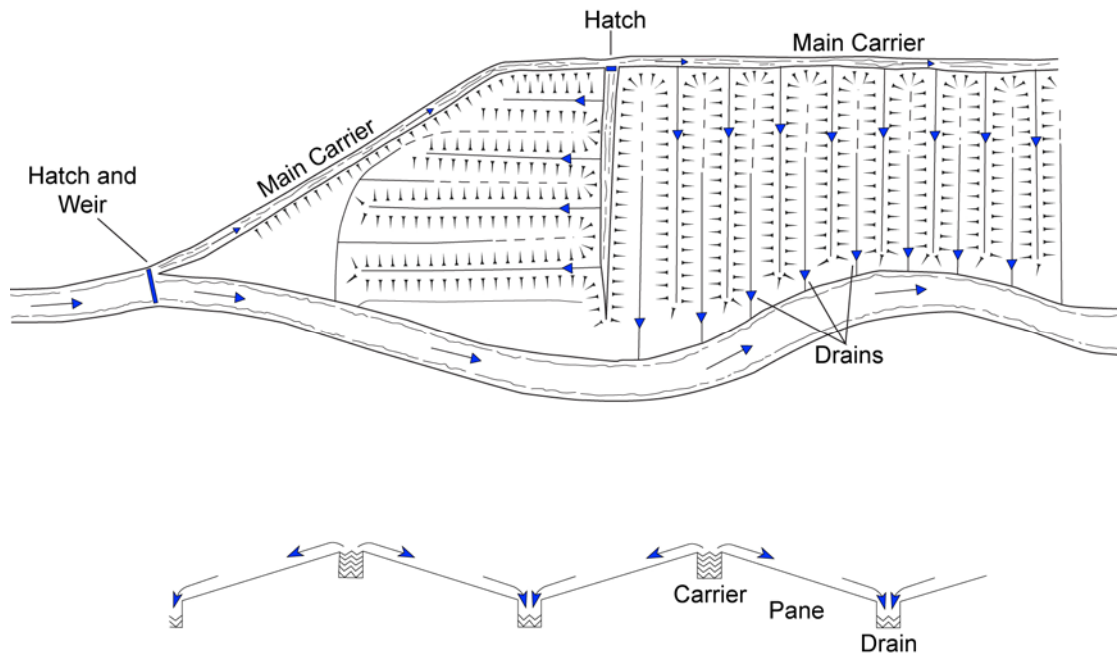


Figure 1- Stylised plan of a bedwork water meadow

Adapted from Williamson and Cook 2007

The heartland of water meadows can be considered to be the southern counties of Dorset, Hampshire and Wiltshire, where the system was adopted with the greatest vigour, applied across more of the landscape, and in use for longer than in other areas. By the early eighteenth century water meadow management had spread from this heartland and was in use across Britain. The spread of meadows appears in large due to the high profile the system had at the time in the eyes of agricultural improvers, who, based upon the benefits described above, enthusiastically extolled its use. An additional spur to the development of water meadow across the country was the increased value it conferred upon the land, with landowners often encouraging, and even paying for, their tenants to create areas of water meadow. In some cases it has been suggested that the conversion of land parcels into meadow could confer as much as a three-fold increase in the value of the land, although the exact increase was of course subject to many factors.

Water meadows were in widespread usage from the seventeenth century onwards, and were still in use until the early twentieth century, when the increased availability of artificial fertilisers and the growth of mechanisation began to provide easier solutions than the high maintenance system of using water meadows. A few select examples continued to be used after this point, with rare examples still in use today, such as the famous Britford and Harnham systems near Salisbury.

Relatively little is known about the use of water meadows within Staffordshire. Select historical records show that the system was in use on land owned by the Marquess of Stafford by the early nineteenth century (Loch 1820: 199-200 & Appendix IX.70-75), and a bedwork system at Drayton park, created for Lord Weymouth, is recorded as early as 1676 (Taylor 2007:32).

Whilst Williamson (2007:47) suggests Staffordshire to have been one of the counties within which water meadows were most widely adopted, relatively little detail is available as to the distribution, history and form of water meadows within the county.

1.2.2 Previous large scale surveys of Water Meadow systems

The most notable prior work in terms of this study are the ‘Pilot study of water-meadows in the Rivers Allen and Frome, Dorset’ (Southern Archaeological Services, 1998), and the ‘Hampshire Water Meadows Survey’, (Oxford Archaeological Unit, 1999). These represent the only previous large-scale landscape surveys of water meadows undertaken, and informed the basic methodological framework of this study.

There has previously been a predominantly southern bias to large scale water meadow studies, due to the understandable concentration of research upon areas where water meadow systems are known to have been extensively employed. This study forms a partial step away from this trend, with the suggestion that Staffordshire in essence stands between areas where this form of agriculture was most widely adopted and those where it remained a more restricted practice. Consequently this study may be of value in gaining a partial estimation of the relative value survey of this form may have in the identification of water meadows in areas more distant from their known heartlands.

1.3 Aims and objectives

The following aims and objectives were proposed for the research:

- To utilise provided data sources to map the location, extent and condition of water meadows in Staffordshire in a GIS database presented in ESRI shape file format and compatible with the SCC ArcInfo GIS.
- To produce a report detailing the work undertaken, and describing the form, and survival of identified water meadow targets
- To identify sites for field investigation and undertake field survey to verify results of the desk-based assessment.
- To brief field surveyors with Staffordshire Wildlife Trust in recognising water meadows and to produce a publicity leaflet aimed at the general public.

The project was to include all river systems in Staffordshire and their associated tributaries, approximately 1550km of watercourse.

2 METHOD STATEMENT

2.1 Desk-based methodology

Desk-based survey methodology was composed of three stages:

- Initial GIS setup, to provide a base mapping system into which data derived during survey could be imported and contextualised,
- Targeted analysis of historic mapping data for the subject area,
- Targeted examination of aerial photography for the subject area (based upon targets derived from historic mapping),

2.1.1 Base GIS setup

In order to provide an effective background into which survey data could be contextualised, a series of data sets were used to create a base GIS for the study area.

All GIS-based phases of the project were undertaken using ESRI Incorporated ArcGIS software (version 9.1).

Georeferenced contemporary map data was used to relate survey data to the current environment. The primary data source utilised was Ordnance Survey (OS) 1:50,000 data in raster format, with selected usage of OS 1:10,000 detail mapping during the fieldwork stage of the project. In addition, further detailed cartographic and topographic data, in the form of OS Meridian and Landform datasets was used to generate a drainage dataset detailing all river and tributary systems (both major and minor) within the study area, allowing targeting of likely areas of historical water meadow cultivation (Figure 2).

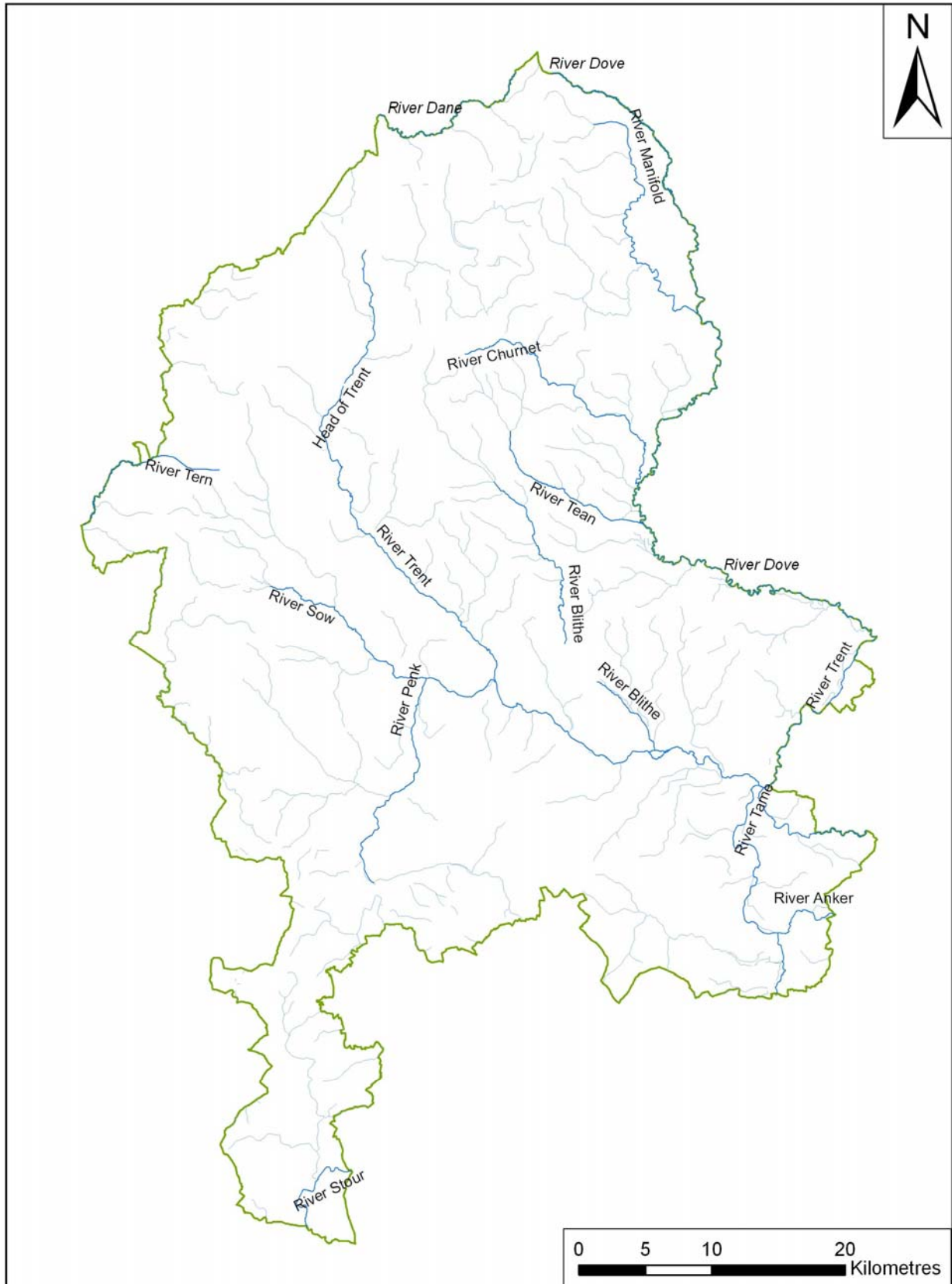


Figure 2- Rivers and tributary systems within the study area

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2.1.2 Historic Mapping

Analysis of historic mapping data for all major and minor watercourses within the study area was undertaken, utilising the aforementioned drainage dataset in combination with georeferenced 1st and 2nd Edition (dating from 1849-99, and 1888-1914, respectively) Ordnance Survey Map data, provided by Staffordshire County Council.

Analysis took the form of visual scanning following the full length of all watercourses within the study area (a total length of 1543km of rivers and minor tributaries). First edition OS map data was used as the primary dataset, due to its greater proximity to the likely high periods of meadow cultivation within the county, with 2nd edition data used to provide contrast or further definition where required.

This data was used to define targets to be examined further during the later phases of the project. Target identification was on the basis of the presence of features which are either diagnostic, or typical of, water meadow systems. Consequently, features which appeared likely to represent channel systems, areas labelled as possessing sluice systems, and land marked as 'liable to floods', were defined with polygons as targets, particularly where these features were seen in combination (Figure 3). It should be noted that these polygons depict the apparent visible extent of individual self-enclosed meadow *systems*, rather than individual former meadow fields.

These shapefile polygons were furnished with the following attributes in order to provide detailed information regarding the defined possible water meadow:

Field Name	Data Type	Example	Description
UID	Integer	12345	Unique ID Number
NGRE	Float	32500	Nat Grid Easting of Centroid
NGRN	Float	43900	Nat Grid Northing of Centroid
Area	Float	3.56	Polygon area in hectares
OS 1 st Ed Map Sheet	Text	32045ne1	Map sheet
OS 1 st Ed Date	Text	1849-1899	
OS 2 nd Ed Map Sheet	Text	32045ne3	Map sheet
OS 2 nd Ed Date	Text	1888-1914	
1963 AP Ref	Text	R31, F7314	Photo ref number
1963 AP Condition	Integer	3	See table 2
2000 AP Ref	Text	SK0134	Photo ref number
2000 AP Condition	Integer	2	See table 2

Table 1- GIS data attributes for Staffordshire Water Meadows Survey

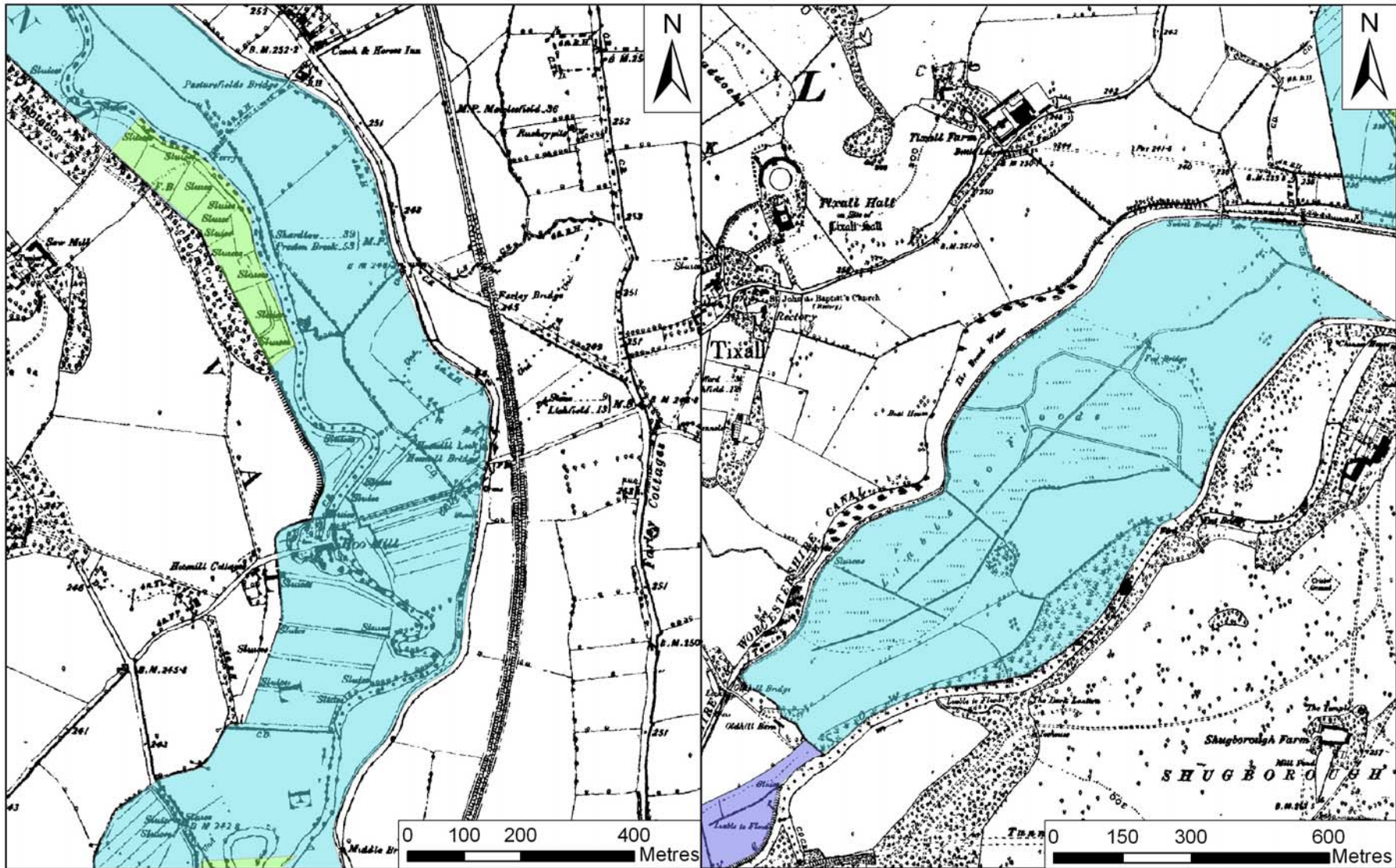


Figure 3- Features indicative of water meadow cultivation. Ordnance Survey 1st edition historic map data

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2.1.3 Aerial Photographic Analysis

Following the definition of likely water meadow targets during the historic analysis phase, aerial photographic analysis was undertaken, through the examination of aerial photographic catalogues and imagery provided by Staffordshire County Council. Imagery was available from two series of photographic survey flights undertaken on behalf of the council, the first during 1963, and the second in 2000 (Figure 4). This chronological spread of images allowed analysis to perform several functions.

Primary amongst these was the refinement of targets defined during the historic analysis. Based upon the presence of typical earthwork patterns or extant channel systems visible from the air, it was possible to obtain a further measure of the likelihood that a particular area represented former water meadow systems, and of the prior extent of these systems. Since, in some cases, water meadow panes and their flanking drains can be easily misinterpreted from the air as medieval ridge and furrow (and vice versa), particular care was taken to refine targets based on as many concurrent points of data and images as possible, to minimise misidentification.

A further purpose of the analysis of imagery from different periods and flights was to obtain a preliminary measure of the likely state of preservation of former water meadow systems within the study area. In order to quantify this information, numerical values, representative of target condition in 1963 and in 2000, were assigned to the defined polygons as attribute data. It should be noted of course, that whilst the 2000 flight represented the most recently available data, this imagery was already outdated by more than 7 years at the time of this assessment, consequently the values of condition provided by the desk-based components of this project can merely be considered to reflect *recent* condition, rather than current condition at the time of completion.

Code	Description
0	Unable to ascertain water meadow condition from aerial photographs due to woodland cover
1	Well-preserved water-meadow with upstanding earthworks, notable carriers (Over 50% total area) across most of the meadow
2	Upstanding earthworks with carriers surviving as earthworks across 10-50% of the total area
3	Partial survival, only the basic elements of the water meadow survive as earthworks, such as the head and main drains. Carriers may survive as earthworks in less that 10% of the total area and drains as crop or soil marks
4	Combination of conditions 3 and 5. Part of the water meadow, usually the head main drains survive as earthworks while carriers and drains survive as crop or soil marks
5	Flattened water meadow now only identified as crop or soil marks
6	Former water meadow now completely destroyed
7	Uncertain- aerial photographic image insufficient to provide condition estimation

Table 2- Scale of condition for identified water meadows



Figure 4- 1963 and 2000 Aerial photographic imagery (Trentham Water Meadow).

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Whilst full visual scanning of aerial imagery of the full length of all watercourses within the study area was not possible within the timescale of the project, a further benefit of using imagery from two periods was the identification of several further water meadow targets, which had not been identifiable based upon the historical data alone, but which appeared to be supported by the historical data upon re-examination.

However, whilst results proved encouraging, this methodology was subject to several limitations, which should be noted. Much of the available imagery was of a scale and resolution which prohibited the visibility of finer meadow features such as carriers and minor drains, and consequently, target identification and definition erred on the side of caution. In addition, this inhibited conclusive assessment of target condition, and required the addition of a value representative of uncertainty to the condition attributes.

Furthermore, due to the varying factors which can affect the visibility of archaeological features in aerial photography (as diverse as time of flight during the day or year, current land use, weather, and underlying geology) it is always the ideal to formulate assessments based upon multiple flights, undertaken in varying conditions, and from both vertical and oblique perspectives (for detailed discussions on the factors influencing interpretation of aerial imagery, see Wilson 2000). Since all imagery available during this assessment was obtained through single survey flights, and recorded from a vertical perspective, there therefore remains the possibility that further meadow systems may be present within the study area which remained effectively invisible to this rapid aerial assessment.

2.2 Fieldwork methodology

The fieldwork component of the project was designed with the primary aim of providing an effective measure of the validity of the desk-based survey and the conclusions generated from it, and an assessment of the limitations of the desk-based survey from the perspective of individual target sites. Secondary purposes of the field survey were to provide information (where possible) as to the general form of water meadow features within the county, dating information where possible, and an assessment of potential threats to these features.

The overall strategy proposed for the field survey was to undertake a real-world examination of a selection of the targets which had been identified during the desk-based assessment.

Initial fieldwork target selection was based upon a variety of factors designed to provide a relatively comprehensive measure of the effectiveness of the GIS-generated data. Consequently, survey targets were chosen to cover a broad range, in terms of both geography and parent river systems, and of projected current condition. Unfortunately, due to lack of permissions for land access for many of the selected targets, the final spread of examined systems (and the level of detail in which they could be recorded), was skewed somewhat (Figure 5), preventing a comprehensive measure of desk-based survey efficacy, as shall be discussed in the results section of this report.

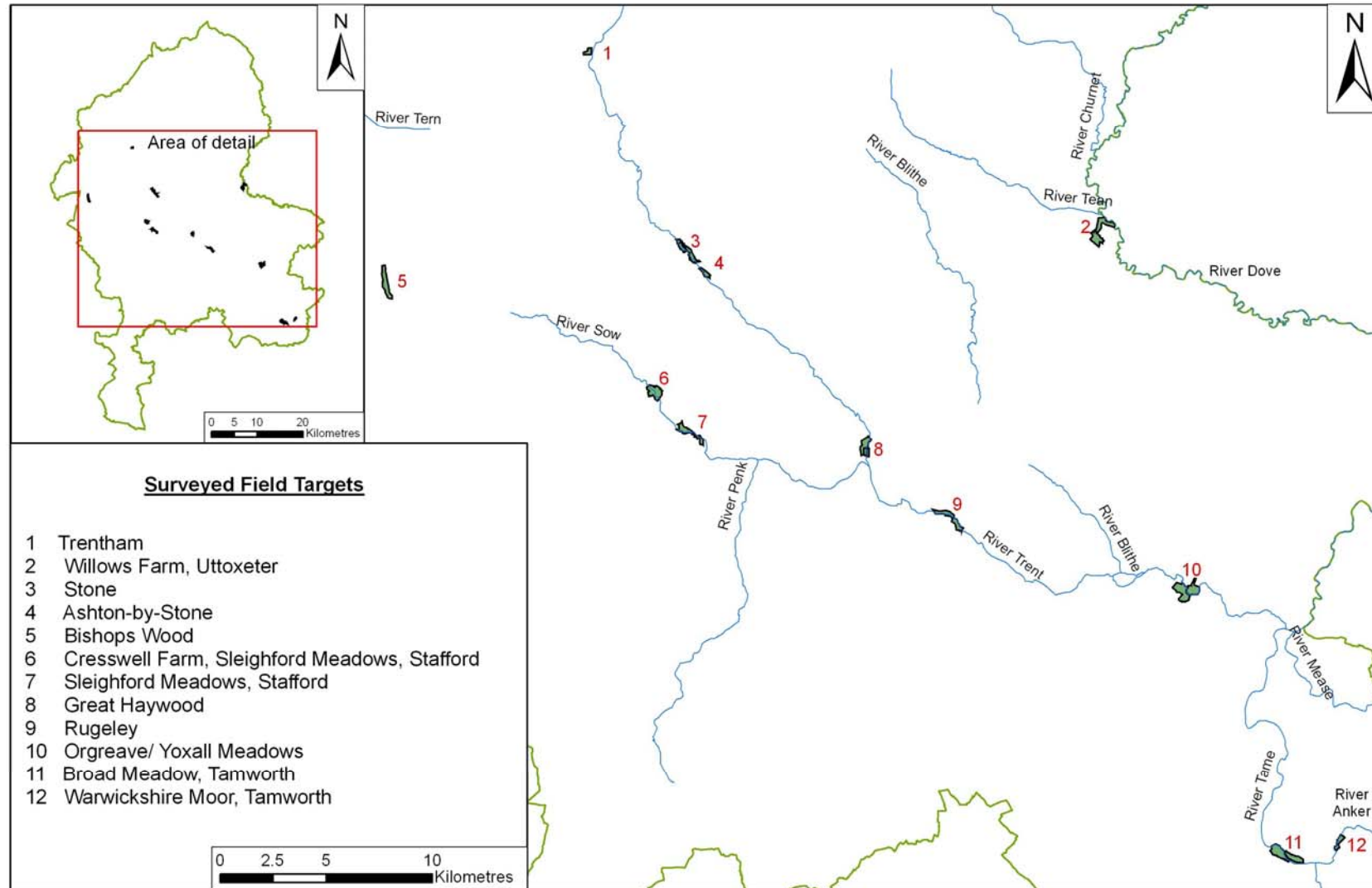


Figure 5- Targets tested through field survey.

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On-site survey strategy was focused upon providing evidence which could confirm or deny the status of the target as a potential former water meadow, an assessment of its potential date range, its current state of preservation, and of possible threats to the continued preservation of its features. Whilst desk-based survey had been focused primarily upon historically recorded structural features and the visibility of large-scale earthwork features, the on-site assessment was geared towards the visibility of earthworks from current ground level, the presence of diagnostic and potentially dateable water meadow structures, and the visibility of finer scale features, to examine whether the available aerial imagery provided an effective measure of the current/recent status of these systems.

In terms of system dating, as there is as of yet no conclusive typology available for bedwork systems based upon earthwork form, the only dateable features within a meadow system remain the structural features such as sluices and lined channels. Even in the case of these more readily dateable features, it should be considered that meadow systems may be reused and re-cut over a long period of time, with sluices and structural features requiring periodic replacement throughout the 'life' of a system. Hence these features, whilst providing us with our only dateable evidence, can only provide us with a *terminus post-quem*, a last known date for the use of a system, rather than a date for its creation.

In order to achieve the above objectives, on-site field methodology comprised the following:

- ◆ Manual walk-over inspection of the targets, examining them for visible earthworks and structural features diagnostic of historic water meadow,
- ◆ Photographic survey of visible earthworks and all visible structural remains,
- ◆ The recording of the presence of any structural features through the use of a pro-forma record card (designed specifically for the recording of water meadow structures as part of this project and visible in Appendix 1)
- ◆ The recording of the location of significant structures through the use of hand-held GPS (Global Positioning Systems)- with a typical accuracy to within 5m of exact position.

The photographic survey was undertaken using a Fujifilm S5700 7.1 Megapixel digital camera, and, where appropriate, made use of standard survey ranging rods for scale (divided by colour into 0.5m divisions).

3 RESULTS

3.1 Introduction

Following the compilation of data from the aforementioned project phases, and the elimination of targets which had been deemed extraneous and highly unlikely to represent water meadow features, a total of 182 potential former water meadow targets had been identified through the desk-based assessment.

It should be noted however, that the lower the condition value attributed to a target, the stronger the possibility that it may not represent former meadow, as only a few cases are present where historic map analysis alone can be taken as sufficient evidence of the former presence of historic water meadow. As the lowest condition values reflect either partial earthwork remains or the presence solely of drainage features likely to represent meadow features, with little corroborating evidence other than their location, the potential for misinterpretation is substantially increased. Consequently, this number should be considered more a reflection of the possible maximum, rather than minimum, number of former meadow systems. This caveat aside, the results remain highly encouraging, with the fieldwork results strongly supporting the efficiency of the desk-based research in effectively identifying former meadow.

Potential meadow remains were identified within the catchment zones of almost every river within the study area, and, as expected, both the most numerous and the apparent largest meadow systems were identified within the low land river valleys of the county's major rivers, the Trent, Dove, Sow, Penk, Blythe and Tame.

The following detailed description of survey results compiles both the desk and field-based elements of the project, with the results subdivided by geography and river systems, as detailed below. Targets covered a total area of 8387 hectares within the county. Follow-up field survey recorded a total of 22 structural features likely to be associated with water meadow usage, and assessed a total area of 398 hectares, across 18 target polygons.

Figures 6 and 7 depict the overall identified water meadow targets and their varying conditions between the two datasets.

3.2 Water Meadows in the Trent, Tame, Blithe, Sow and Penk Valleys

This geographical subdivision, comprising the major lowland rivers of Staffordshire and of the catchment zone of the River Trent, was found to contain the largest proportion of apparent former water meadows within the county. Of 182 potential meadow targets identified during the survey, 140 were found to lie within these valleys, covering a combined area of 6134 hectares, and with recent conditions covering the whole range of values assigned by this study.

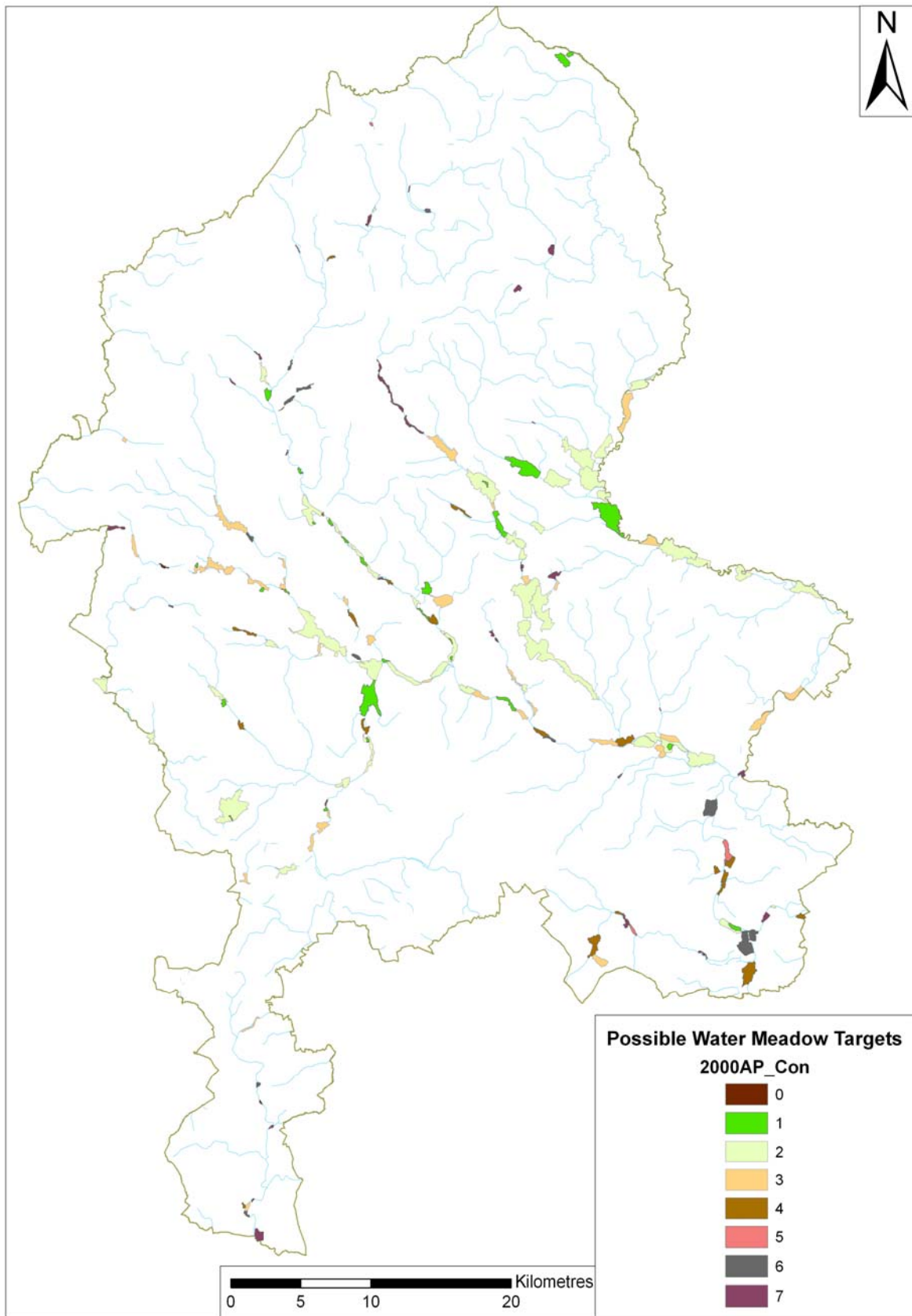


Figure 6- Possible Water Meadow targets, distribution and recent condition

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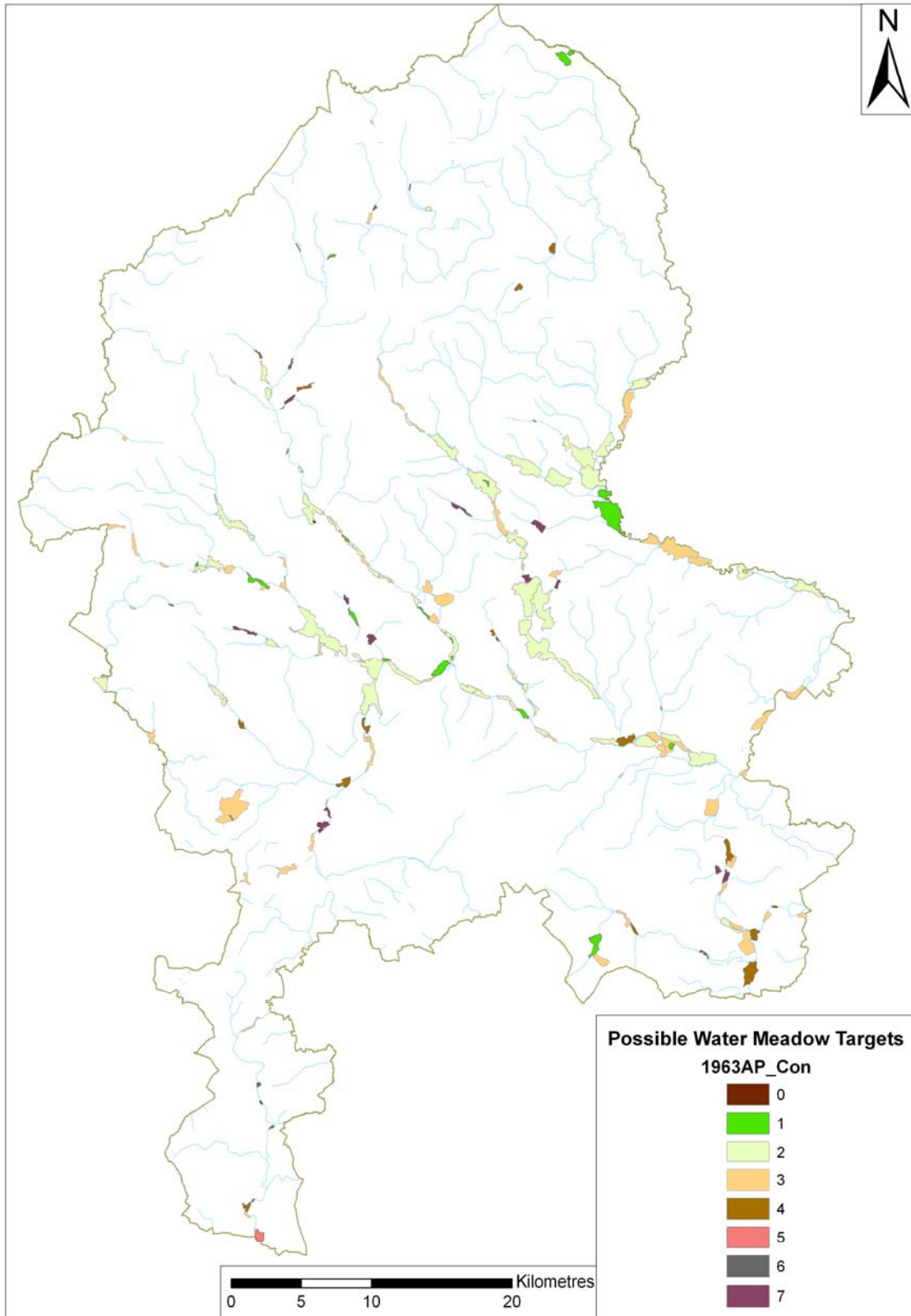


Figure 7- Possible Water Meadow targets, distribution and 1963 condition

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3.2.1 Trent River Valley

The Trent valley contained the largest number of potential meadow sites of any valley within the study, with a total of 59 potential meadow systems identified (Figures 8 and 9).

These systems are present along almost the entire length of the Trent River system, and in the more central areas of the county (between the towns of Stone and Alrewas) survey identified an almost continuous string of possible meadow cultivation. Typically these collections of targets were found to be spaced no more than 2km apart along the entire of the Staffordshire length of the Trent, with the exception of the area proximal to the source of the Trent, between Biddulph and Stoke-on-Trent). The wider apparent spacing between visible areas of possible meadow in this area may have a two-fold explanation. Firstly, due to the proximity to the source of the Trent, river levels in these more upland areas may have been too shallow, and the valley floor too narrow, to support the extensive bedwork systems most likely to be visible to this form of survey. Secondly, this area is now dominated by the city of Stoke-on-Trent and its substantial associated hinterland of late post-medieval industrial development and mineral exploitation. This urban and industrial spread is likely to have destroyed any earlier areas of meadow which lay in proximity to the source of the Trent, and to have precluded the late post-medieval development of new systems in this area.

Many of the identified targets proved to have a good level of visibility within the available data sources, and to have a good level of recent preservation. Twelve targets were present which were found to have a condition value of 1 (very well-preserved) and 14 which were rated as having a recent value of 2. There appeared no particular pattern amongst the distribution of these targets, with well preserved systems along the whole extent of the Trent within the study area. Ten targets proved to have a condition value of 3, and were loosely distributed along the southeastern extent of the Trent within the study area. Seven targets were judged to have a recent condition of 4, reflecting minimal survival of earthworks within a potential system, whilst major drains remain, and a single target was recorded of condition 5 (a likely former meadow with major drains present, but all other earthworks flattened). Survey suggested that eight identifiable former systems along the river Trent had been completely destroyed by 2000, with three of these systems destroyed since the 1960's. Destroyed systems were predominately distributed at the head of the Trent, within the vicinity of the city of Stoke-on-Trent and its suburbs.

The morphological appearance of targets identified within this valley proved interesting, with individual potential systems appearing more elliptical than in other areas of the survey, forming long, thin areas following the Trent. This would appear to be a product of topography, with the relatively narrow base of the Trent valley favouring the use of systems of this form.

Field Assessed Systems (Figure 5)

A total of 6 target areas were examined upon the Trent, composed of perhaps 8 individual systems (taking as a system an area which appears to be enclosed and distinct, hence, areas on opposite sides of a river have been taken as two systems, although they may previously have been joined by an aqueduct). These were distributed between Stoke-on-Trent in the northwest and Orgreave to the southeast, and were located in proximity to the settlements of Trentham, Stone, Ashton-by-Stone, Great Haywood, Rugeley and Orgreave. These shall be examined sequentially working south along the river, away from its source.

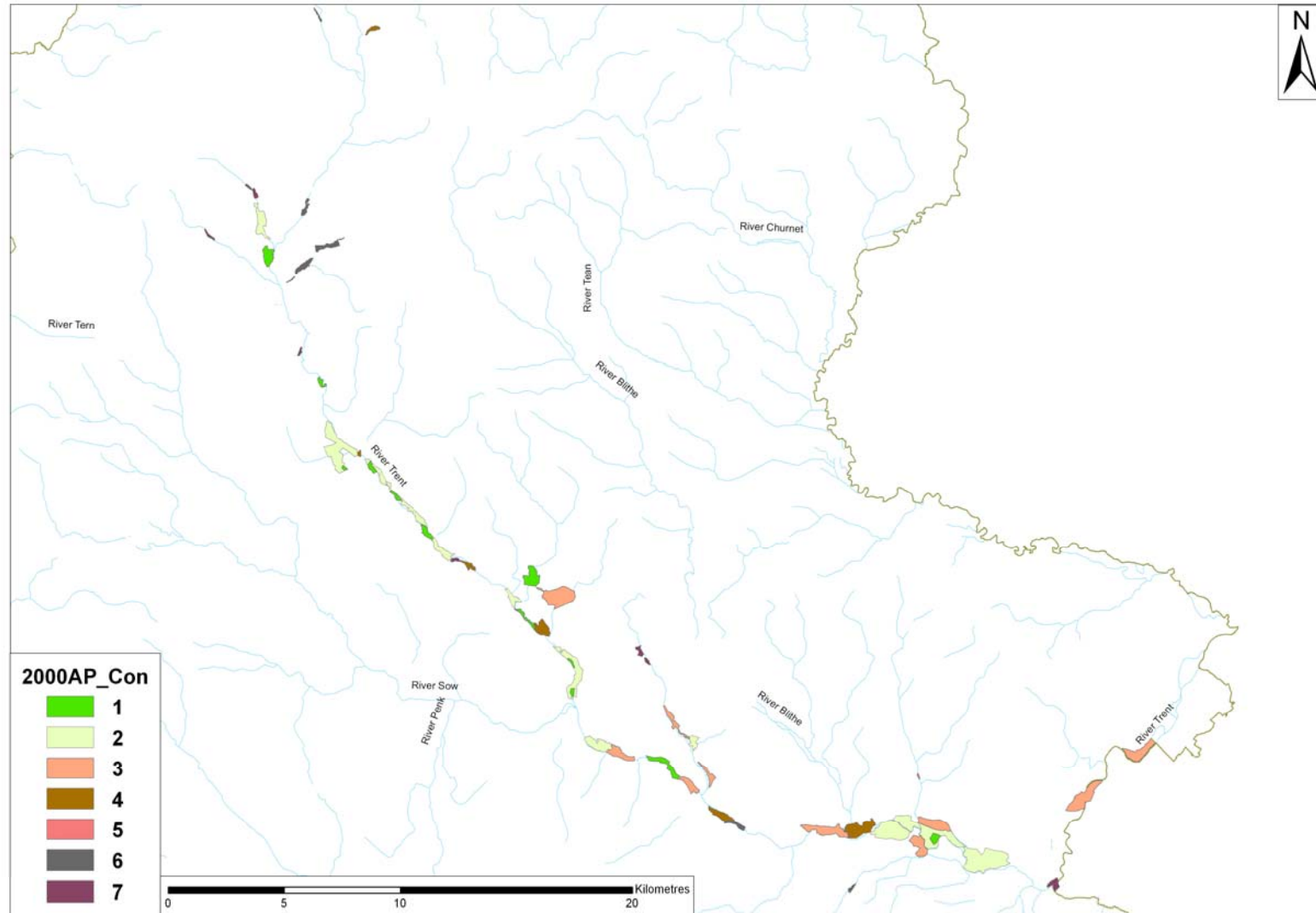


Figure 8- River Trent possible water meadow targets- recent condition

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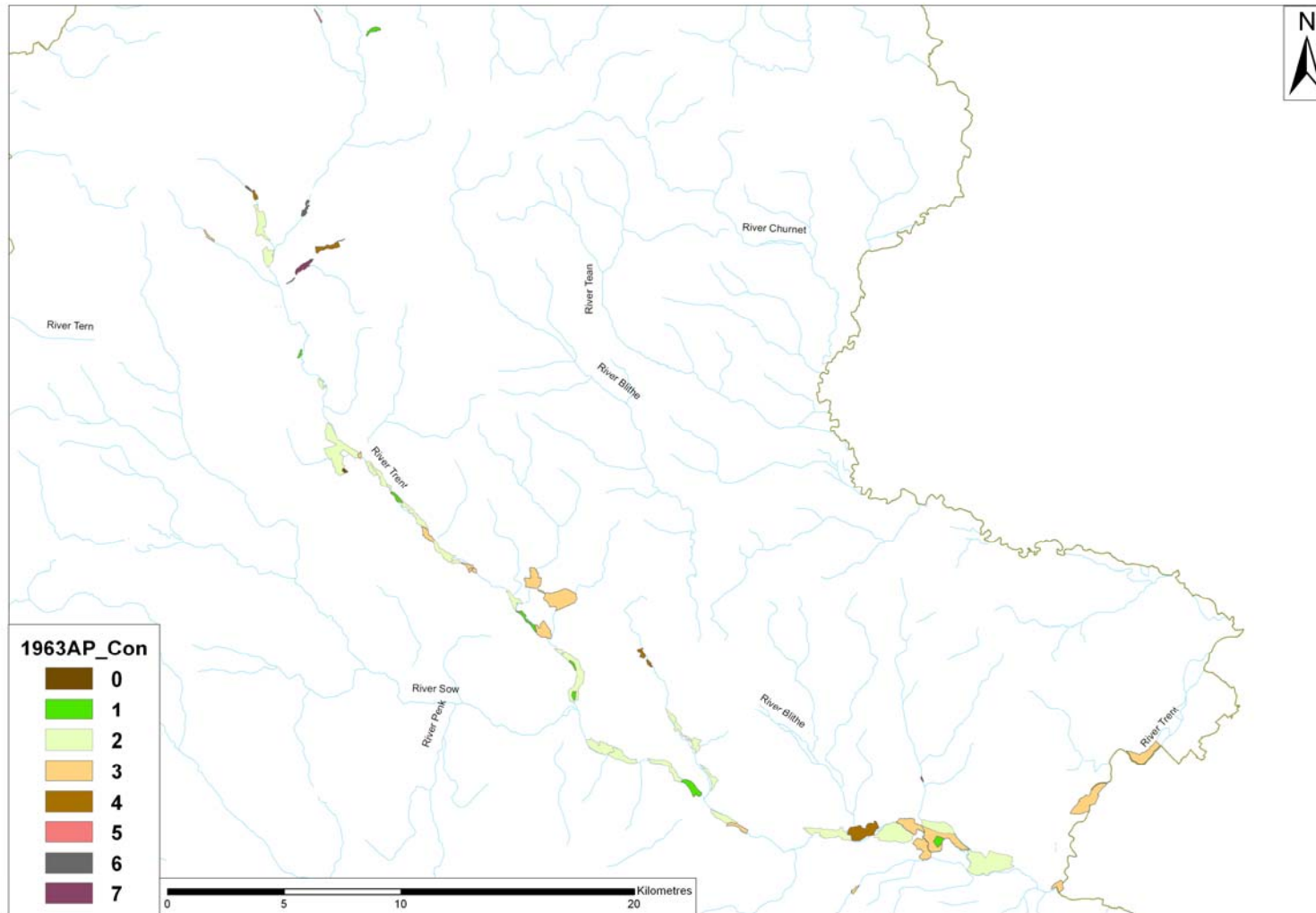


Figure 9- River Trent possible water meadow targets- 1963 condition

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Trentham- NGR SJ 86299, 42096 (Figure 5, Target 1)

Trentham lies to the southeast of Stoke-on-Trent, approximately 5 kilometres from Stoke itself. The target highlighted during survey lies to the west of the current settlement, upon land immediately to the south of the Trent Vale pumping station to the west of the River.

Figure 11 depicts the overall system, as visible in aerial photography from 2000, whilst a comparison of the detail of the northern end of the system, as seen in both series of aerial photography can be seen in Figure 4. This system appeared to be one of the most clearly defined, and complete systems encountered within the study, with an area of 28.08 hectares. The system appears to be defined by a probable main drain which runs along the western extent of the lowland fields before rejoining the Trent at the base of the image with clearly defined drains and carriers to the east of this feature. The northern extent of the system (and the origin of the main drain) appears to have been lost to development associated with the A500 road (Figure 12).

Fieldwork showed the system to be well preserved along its central core, with substantial preservation of large numbers of earthwork panes within the area of survey, and of the drains flanking these features which empty into the main drains (Figure 10).



Figure 10- Carriers and drains visible within surveyed land at Trentham

These well preserved earthworks appeared only to be present in the western extent of the target meadow, with the eastern portion of the target (east of the sewage pipes) appearing to have been largely landscaped, destroying any remains in this area. It should be noted that the high level of the ground relative to its former level (as indicated by the structures to be discussed below) is likely due to alluviation from the frequent flooding of the area. Consequently, the emphasised nature of the extant banks and ditches may in fact represent recent re-cutting of the drains and emplacement of material upon the panes in order to further prevent flooding, in effect a partial recent maintenance of the former system. The antiquity of the major extant channel courses can however be confirmed by their concurrence with the historical mapping data, and by the presence of structures typical of water meadows within these channels.



Figure 11- Trentham Water Meadow, 2000 aerial imagery.

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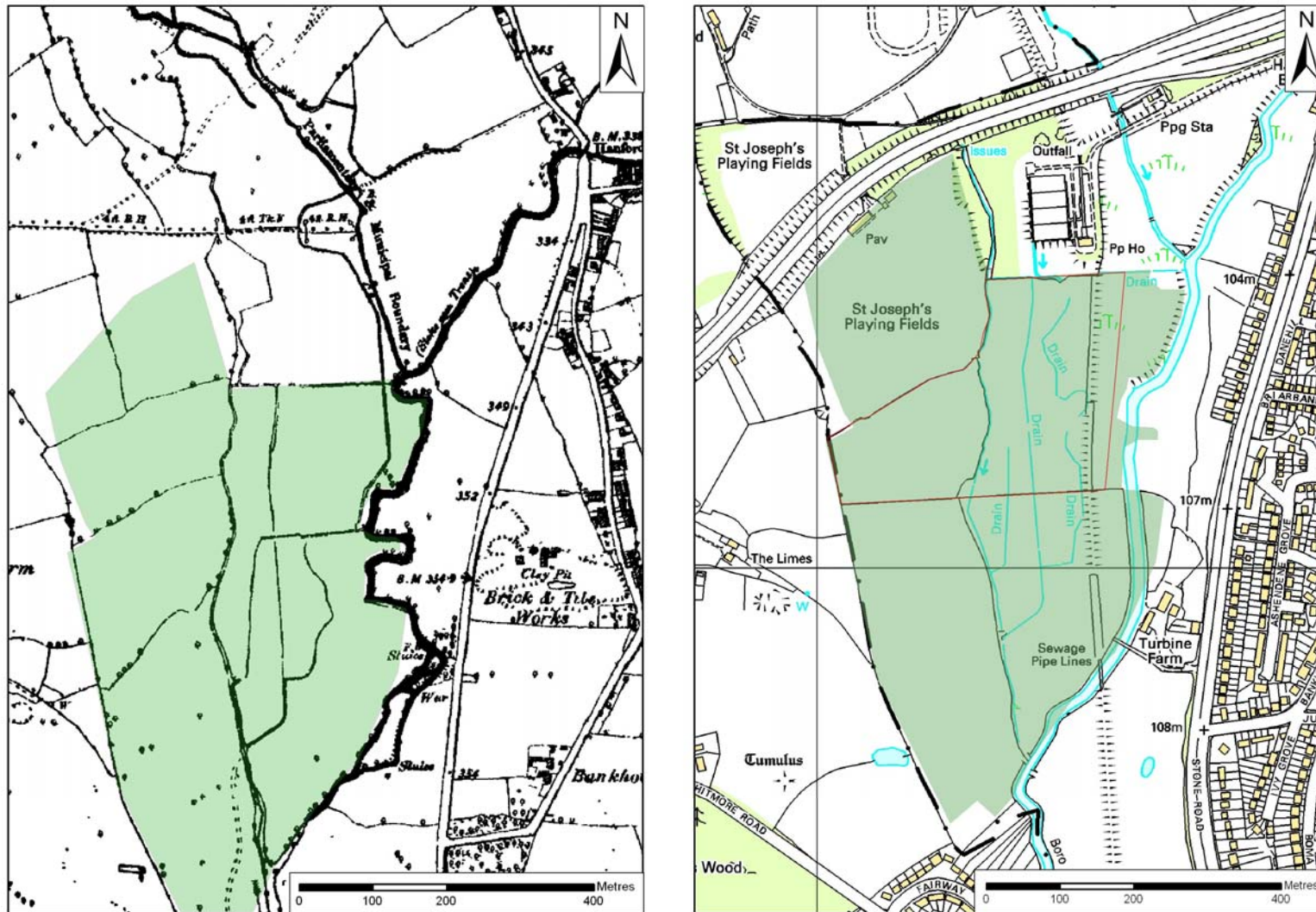


Figure 12- Trentham, 1st edition and modern mapping (target area- green, area of field survey- red).

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At Trentham a total of six structural features were recorded within the surveyed area, apparently consisting of the remains of culverts under access routes and a possible bridge associated with the courses of extant channels. Recorded structural features were composed of apparently mid to late 19th century brick, some of which was industrial blue brick, possibly of the Staffordshire blue brick style. This suggests relatively recent usage of this system, although as the features are reflective of water management for access and drainage, rather than sluice control systems, they cannot be taken as confirmation of recent cultivation and controlled floating of the system.

The combination of well-preserved earthwork and structural remains within the surveyed area confirmed the efficacy of the survey within this area, with the prediction of the overall system as having a likely preservation level of 2, and the central portion of the system as having a likely preservation of 1 confirmed during the fieldwork (with the exception of the eastern portion of the meadow which appears to have been subject to extensive re-working).



Figure 13- Water meadow structures visible at Trentham

A historical description of water meadows in this area can be found in Loch 1820 (199-200), detailing the improvements made by the owner, the Marquess of Stafford to the estate of Trentham. This portrays the local farmers as having a strong enthusiasm for water meadows, stating ‘one improvement the tenants have paid much attention to...is the construction of water meadows... they have lost no opportunity in making use of whatever water they could obtain for this purpose’. The increased productivity offered by meadow cultivation, and the support of the landlord in covering some of the expense, appears to have led to more than ten tenants in the local area adopting the practice, on varying scales (Loch 1820: Appendix IX 70-75). This enthusiasm almost seems to have run to excess as ‘much money, however...has been thrown away by watering land which has not been previously thoroughly drained’ (Loch, 1820:199-200). This may be in part due to the encouragement of the Marquess, who provided for his tenants ‘the rough materials to construct the flood-gates and the example...as to what could be done in this respect to a very great extent at Trentham’. This example was a new meadow, finished around 1820, described as consisting of ‘a small deep dingle, with steep banks, in which a copious spring rises at the top; the upper part being formed into a fish pool. From this head the water is conducted on the different levels on each side with the proper catchwater drains carrying the water around the various knolls. The whole being adorned by some fine trees it forms for its extent a very perfect union of useful and ornamental farming’ (Loch, 1820).

This historical information has interesting implications in regard to the surveyed meadow. The nearest farm, owning part of the land today, is Northwood farm; however this farm is listed in Loch as having no meadows. Additionally, the target lies in close proximity to the likely position of the home farm, and shares some of the characteristics mentioned in the description of the home farm meadow. As this study was unable to uncover exact ownership details for this land parcel, it may be that this area indeed represents survival of the home farm 'model' meadow, perhaps with later refurbishment of its structures in brick. Alternatively, it may be that in the decades following the publication of Loch, the tenants of Northwood farm too came to embrace water meadow cultivation. Regardless, the field survey showed this system to be one of the most well-preserved seen within the survey, with survival of large scale earthworks and structures in the surveyed area.

Stone- NGR SJ 90882, 32813 (Figure 5, Target 3)

Stone lies to the southeast of Trentham, almost equidistant between Stoke and Stafford, and is divided along its length by the River Trent and the Trent and Mersey Canal, which run through its centre. Figure 14 depicts the apparent system extent, as visible on modern and 1st edition mapping, whilst Figure 15 illustrates the possible earthwork remains visible from an aerial perspective in 2000. This system was predicted as having a condition of 2 during the desk-based survey, and to cover a total area of 29.59 hectares, with a single portion of land appearing to be well-preserved (condition 1) at the northern end of the system.

Due to access constraints, only the portion of meadow to the north of the river adjacent to Andre Mills Bridge could be directly assessed, with other portions of the system assessed from public access vantage points as close as possible to the fields. However, this assessment was sufficient to demonstrate the preservation of carrier earthworks within the southern portions of the system, and of drains to the north (Figure 16). No meadow structures were visible within the surveyed area, and the area recorded during the desk-based survey as being of condition 1 was inaccessible. Consequently, effective assessment of this land portion was impossible, however, visual assessment from ground level suggested that remains in the area may be present but subtle in form, requiring further assessment, ideally through an on-site survey, or secondarily from a more elevated vantage point (of which no publicly accessible examples were available).

Field survey revealed relatively few extant remains in comparison to the implications of the desk-based assessment; however, the remains present were sufficient to confirm the former presence of water meadow across the defined extent. Field assessment also showed the current condition of the system to be lower than suggested, with an on-site condition value of 3 at the time of publication of this report.

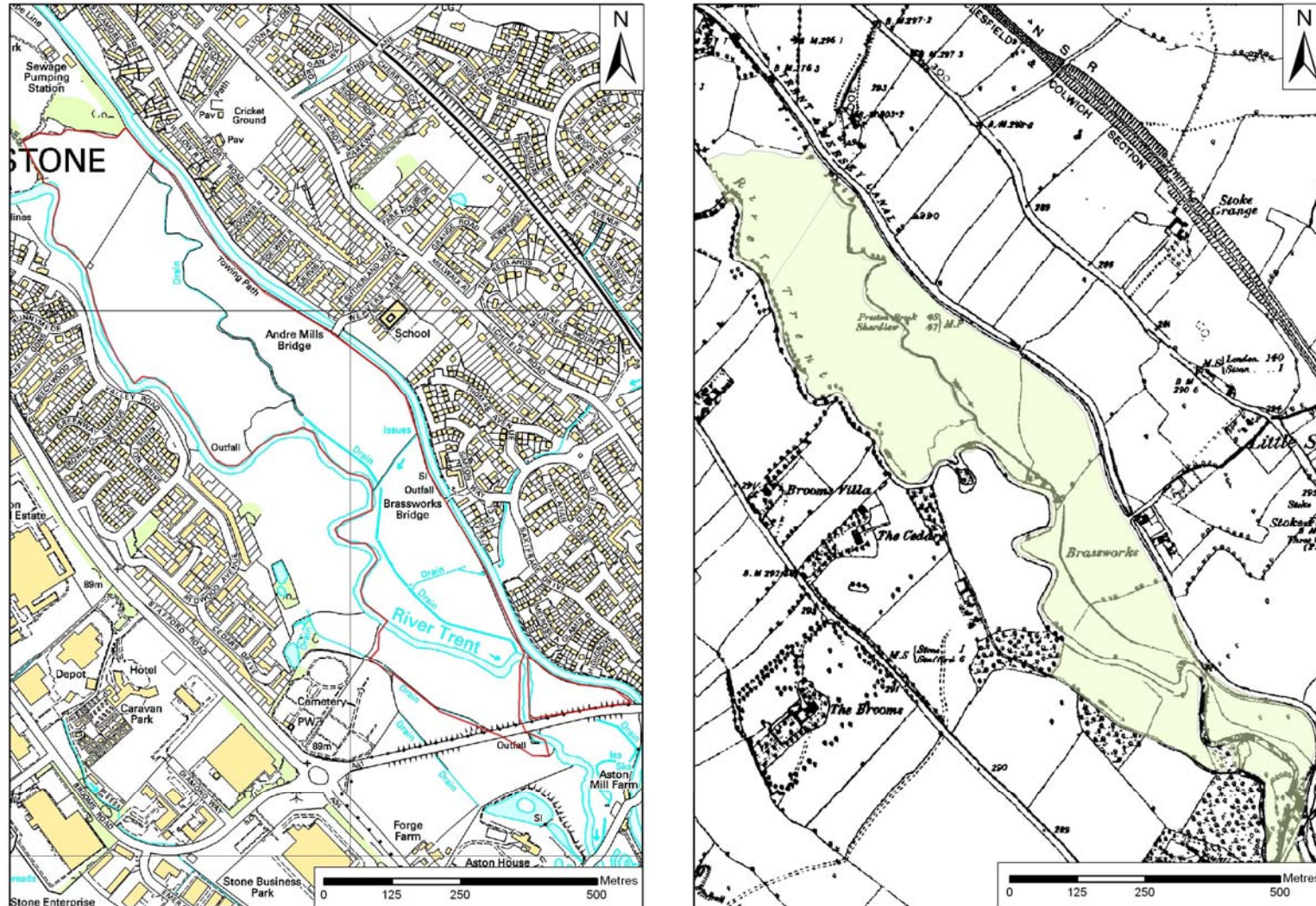


Figure 14- Stone target, Modern and 1st edition mapping (red defines surveyed area).

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Figure 15- Stone target, 2000 aerial imagery.

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Figure 16- Extant earthworks of water meadow carriers and drains at Stone

Ashton-By-Stone- NGR SJ 91743, 31727 (Figure 5, Target 4)

Ashton-By-Stone lies immediately to the southeast of Stone, adjacent to the southernmost portion of the previously discussed system. Figure 17 depicts the extent and form of this potential system, based upon aerial photography from 2000, and upon 1st edition OS map data. This system was identified through the presence of the clearly defined drainage features visible within the 1st edition data, and of the earthwork network visible within the 2000 aerial photography. The primary feed (main carrier) for the system appears to connect to a drain forming the tail of the aforementioned water meadow at Stone; consequently both systems may reflect a single former system of connected meadows which now has widely differing conditions across its extent. For the sake of simplicity, due to the differing condition of meadow features between these systems they shall be treated as separate systems within this assessment.

Whilst access was limited to the northern central area of the system, field assessment revealed a wealth of water meadow remains within the area, visible from this vantage point. The majority of the defined area (7.3 hectares in size) was found to contain a clearly defined complex of earthwork features, ranging from main carriers and main drains to the more subtle individual carriers and flanking drains.



Figure 17- Ashton-by-Stone 2000 aerial imagery and 1st edition mapping.

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Figure 18- Extant earthworks at Ashton-By-Stone.

(Some survival even within emplaced wetland area- bottom right image)

These remains appeared to reflect a fully intact system of earthworks, apart from within the north-eastern area of the system, which has been subject to recent development as a wetland environment for conservation and fishing. Select remains survive even within this area, where it appears some larger carriers/drains have been altered and flooded in order to create the modern fishing ponds. No remains of structural features associated with the extant earthworks were visible within the accessible area; however, due to the limited land access available, this may not preclude the possibility of structural features surviving within the larger target area.

Consequently, this system, the most intact (in terms of earthworks) seen within the study, was judged to have a current condition of 1 based upon the field assessment, confirming the results of the desk-based assessment in regards to this target.

Great Haywood- NGR SJ 99332, 23271(Figure 5, Target 8)

Great Haywood lies approximately 7km to the east of Stafford, to the northeast of the Shugborough estate, with the targeted area of possible water meadow lying immediately northwest of the settlement. Figure 20 depicts the 2000 aerial photography available for the area, and the 1st edition historic mapping, with the assessed area marked in red. Due to a lack of access permissions, this site was assessed entirely from the elevated vantage points provided by local roads and road bridges, and as such can only be considered a approximation of on-site condition.

The 1st edition survey illustrates a profusion of sluice systems within the area; all marked at the head of what appear to be defined channels. The line of many of these channels is subtly visible on the 2000 aerial photography, and highly visible within publicly available Google Maps satellite imagery for the area.

Field survey results for the area proved limited. The lines of drainage features which appeared to represent water meadow drains appeared clearly visible within the southern area of survey, previously allocated a recent condition of 1 in the desk-based assessment (light green polygon (Figure 20)). However, a provisional condition of 2 has been assigned to this area on the basis of field survey having demonstrated the presence of some features and of aerial imagery inferring substantial meadow preservation, however, actual on-site assessment at a future date is strongly recommended.



Figure 19- Drain features at Great Haywood

Field survey to the immediate northeast of this area, investigating the sluice systems marked on the 1st edition mapping on the opposite side of the road revealed little trace of these remains. Despite the apparent visibility of channel lines within aerial photography no trace of these features could be seen on the ground, with the field in question extremely flat in nature. It would appear, therefore, that these features are either too subtle to be seen from this perspective, or that they have been destroyed by ploughing subsequent to the date of the aerial images. A single brick-built structure (Figure 21) was visible from the vantage point of a road bridge above it, and correlates with the apparent position of a sluice marked on the 1st edition mapping, however further investigation with access to the feature would be required before it can be confirmed whether this may represent the remains of a sluice system.

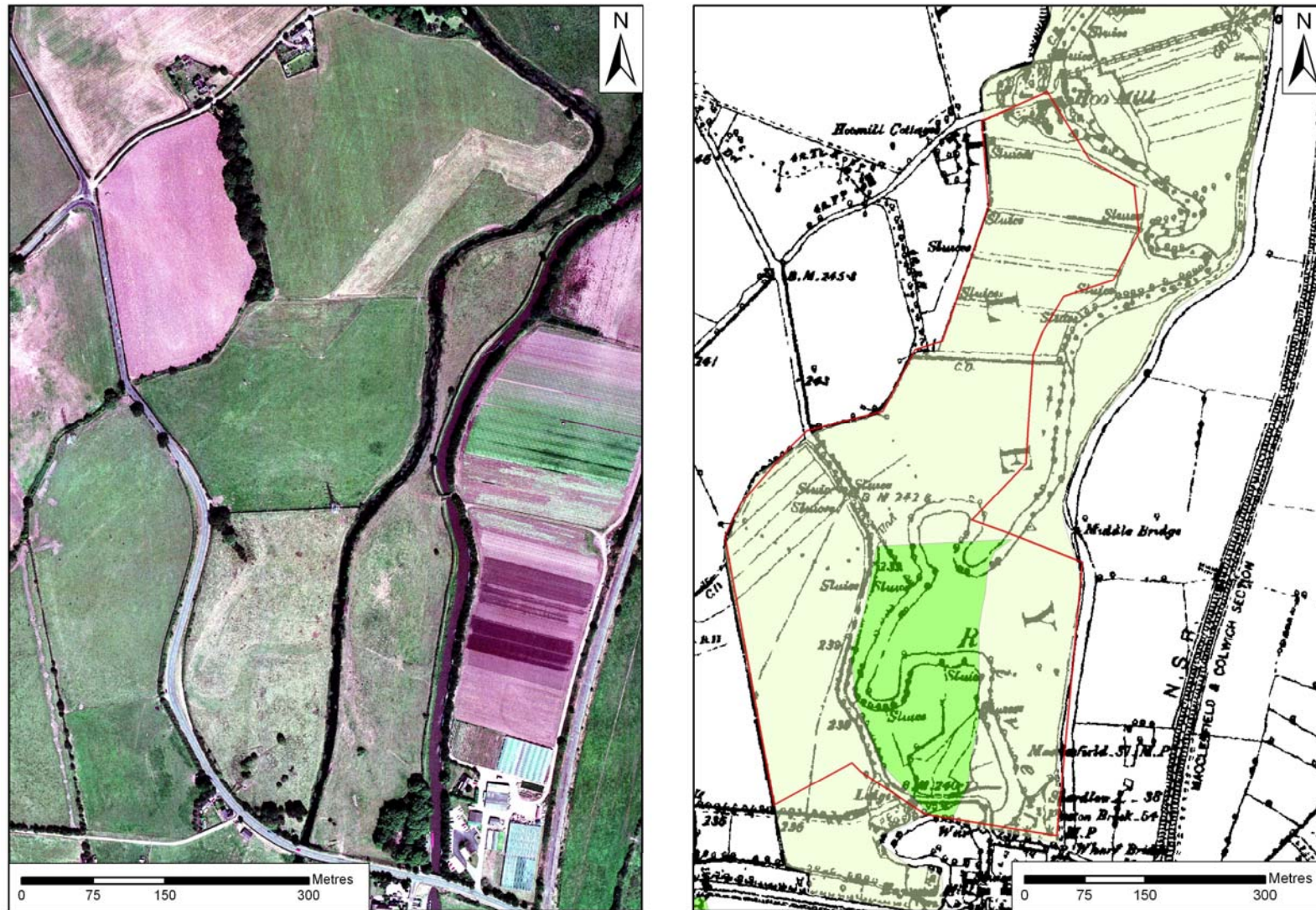


Figure 20- Great Haywood target 2000 aerial imagery and historic mapping.

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Figure 21-Unknown brick structure in proximity to historic sluice location-Great Haywood

At the northern extent of the surveyed area lies a further of historically recorded sluice and channel systems which also appear visible within the aerial imagery, however survey at a distance again suggested no evidence for the survival of these features. At the time of survey it appeared that the field containing these points of interest had been recently turned-over or ploughed, and consequently, these features may have been destroyed. Should further survey suggest the partial survival of any of these remains, it should be noted that these would appear to be under threat, should further ploughing of the area continue.

Based upon the lack of definitive evidence supporting the survival of features within this area, a field condition of 6 (representing destroyed meadow) has been assigned to this target area (with the exception of the southern area of survey previously mentioned).

Rugeley- NGR SK 03340, 20105 (Figure 5, Target 9)

The potential water meadow target surveyed at Rugeley lies immediately northwest of the modern settlement and is bounded to the north by the Trent and Mersey canal, and to the south by the A51 road (Figure 22). This area is in essence an island between the two bodies of water of the Trent and Mersey canal and the River Trent itself, and an area of fields flanking the southern side of the Trent as it approaches the modern town. First edition historic mapping depicts a series of apparent channels crossing the area (Figure 22) which appear to correlate with potential earthwork features visible within aerial imagery from 2000 (although once again the clearest imagery can be found within the Google Maps public resource).

Field access was made available for the fields to the east of the Toft Bridge, which allowed the detailed assessment of the central 'island' and limited assessment of land opposite this on the other side of the Trent River. The southernmost extent of the target system, on the south side of the River was inaccessible, but was visually assessed from an elevated road bridge which overlooks the site.



Figure 22- Rugeley target, 2000 aerial imagery and historic mapping

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Field survey revealed a distinct difference in conditions within adjacent land parcels within the target area. The field to the west of the Toft Bridge was seen to contain striking remains of both main and minor drains, many of which were still directing water at the time of survey (Figure 23). Carrier remains between these features appeared relatively shallow, although it was unclear whether this was reflective of the true height of the carriers, or merely an impression created by the drains being in flood to some depth. A small collapse of large apparently faced sandstone blocks was also visible in this area, reminiscent of sluice remains seen at Willows Farm, Uttoxeter (section 3.3.1), however as direct access was not possible it was unclear whether these remains may represent part of a former meadow structure. This area was inaccessible to walkover survey, preventing detailed assessment of any structural remains which may be present in association with the extant channels, and would benefit from further survey, should the opportunity arise.



Figure 23- Well-preserved water meadow drains- Rugeley



Figure 24- Main drains defined by water- Rugeley

To the east of the Toft Bridge, a further series of preserved drains was also visible, but upon a much reduced scale, with only main drains surviving. A palaeochannel was also visible within this area, corresponding with the position of an arched line visible upon the 1st edition historic mapping, previously thought to represent a possible meadow channel during the desk-based assessment. The southernmost area of the target (visible above right) revealed yet another series of channels, which were again well-defined due to the presence of water within the system at the time of survey.

Following field assessment, the system was judged to have an overall current condition of 2, in comparison with a prior predicted condition of 1. This remains a conservative estimate as a consequence of the lack of direct access to the western portion of the target area. Meadow remains within this area appear to be very highly preserved, and should direct access be available and future survey undertaken to confirm the extent of these remains, it may be that this condition value would need revising to a level of 1.

Orgreave/ Yoxall Meadows- SK 14955,16936 (Figure 5, Target 10)

The village of Orgreave lies approximately 6.5km northeast of Lichfield, with the targeted area of possible water meadow positioned to the northwest of Orgreave village, on both sides of the Trent (Figure 25) Two distinct water meadow systems were identified during the desk-based analysis, one on each side of the Trent, however, due to variation in condition across the extent of the northern system a total of 3 polygons were generated for this area. These were judged to have recent (2000) condition values of 1, 2 and 3 respectively. Field access was limited to select areas of the northern target, whilst the entirety of the southern target, (with a predicted condition value of 3) was surveyed.

Aerial photography and modern mapping data had suggested the presence of significant remains of earthwork features within this area, particularly within the area designated as condition 1 (dark green within Figure 25, note that earthwork features are again most clearly visible within the Google Maps resource).

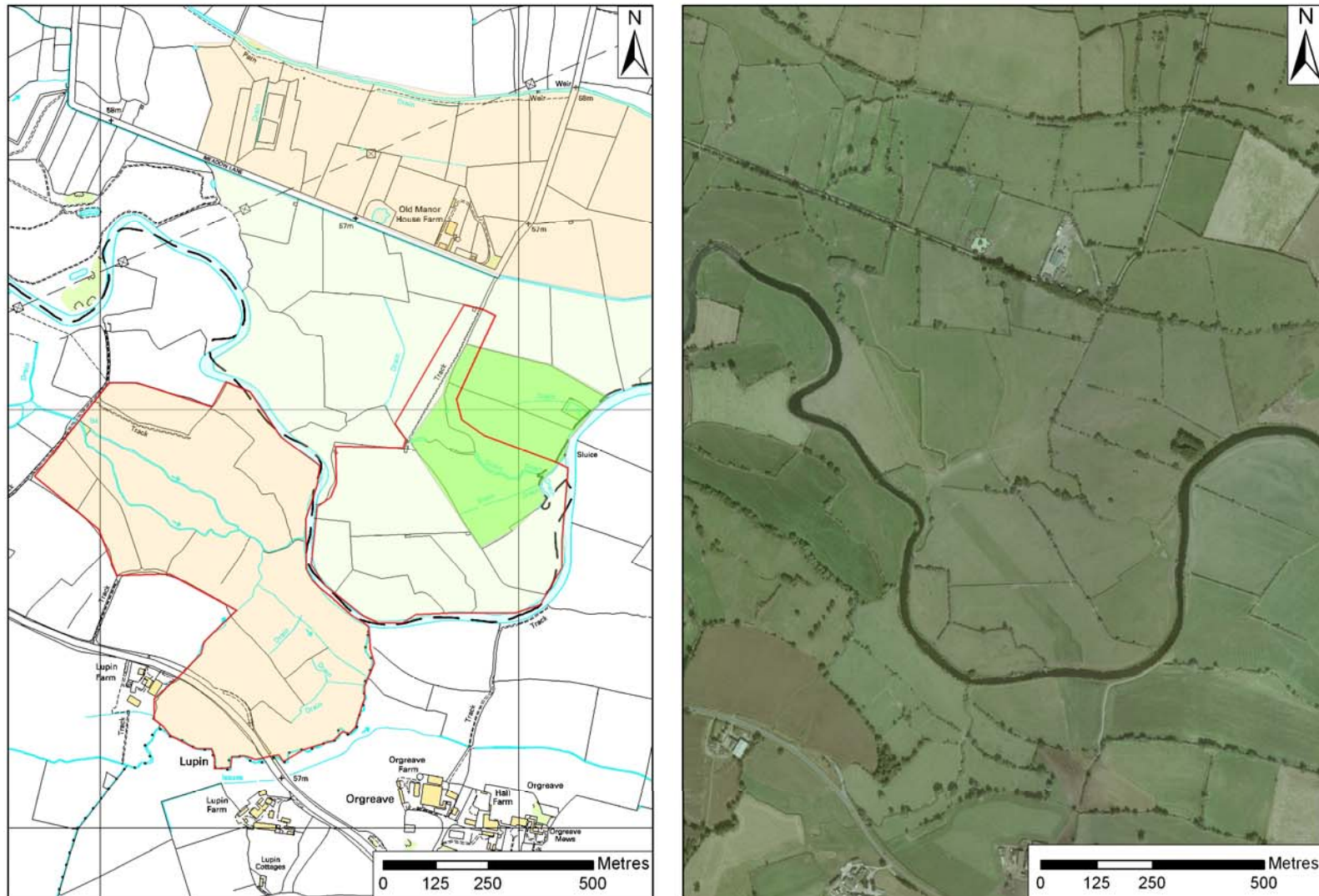


Figure 25- Orgreave target, modern mapping and 2000 aerial imagery.

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Survey to the north of the Trent demonstrated the survival of earthworks representative of main drains, and select minor drains and carriers across the area. No structural remains were visible during the field survey, and earthwork remains were significant and demonstrative of the presence of former water meadow, however these remains were somewhat scattered, suggesting partial survival of former meadow within this area. Relatively little evidence was seen of carrier banks, and the majority of drainage features visible were shallow, potentially suggesting that across much of the surveyed area only the deepest original features have survived, perhaps due to plough damage.



Figure 26- Earthwork remains of Main and minor drains, northern area- Orgreave

It should also be noted that a modern subterranean gas pipeline crosses the area (clearly visible in Figure 25), running northwest to southeast across the surveyed area. Additionally, the area is due to be selectively flooded within the near future as part of a Natural England conservation scheme (pers. comm. Mr G Hall, landowner), potentially presenting a threat to water meadow remains within the area.

The north-western portion of the survey area had previously been designated as having a likely condition of 1 during the desk-based analysis. This appeared to be confirmed during field survey, with the apparent well-preserved remains of both major and minor water meadow earthworks within this area (Figure 27), potentially representing a fully-preserved portion of meadow. However, due to lack of access permissions, this area could only be assessed from a distance, and would benefit from survey should further opportunity arise.



Figure 27- Well preserved subtle earthwork features- northern area, Orgreave

Survey to the south of the Trent, within land to the north of Lupin farm, also demonstrated the presence of subtle apparent water meadow earthworks, along with a few major drains still holding water. These features were consistently present across the majority of the surveyed area, and appeared within a grid pattern. It should be noted that this form of pattern is equally plausible for either water meadow or extensive field drainage, and consequently field assessment within this area should be considered provisional until further research can be undertaken to confirm or deny these remains as former water meadow. A single structure, in the form of a concrete bridge, was recorded in the area; however, as this feature is merely access related and recent in date, this provides little support in the interpretation of this area.



Figure 28- Probable water meadow earthworks- southern area, Orgreave Meadows

Field assessment therefore supported the results of the desk-based survey in this area, with target conditions remaining unchanged as the northern targets were judged to have conditions of 2 and 1 respectively, and the southern target judged to be of condition value 3.

3.2.2 Tame River Valley

The Tame river valley was found to contain a total of 21 possible water meadow targets. The largest of these targets were distributed along the Tame itself, which held marginally more targets than its tributaries, as to be expected. Targets upon tributaries of the Tame (which can be considered to lie within its valley for the sake of this study) lay upon three tributaries, The River Anker, The Black Brook/Bourne Brook, and on the brook at Fisherwick.

Targets within the Tame valley appear relatively evenly distributed, with a maximum spacing of 2km between systems on the Tame itself, and a slight clustering of targets towards the head of the Bourne Brook, apparently exploiting the wide area of relatively flat topography at this point (see Figure 29).

Targets on the Tame were found to have current condition values (Figure 30) ranging from 1 (well-preserved across their entire area) through to 7 (uncertain). Of these, a single target appeared to have a recent condition of 1, two to have a recent condition value of 2, and one of 3. Of the remainder of the targets, the majority (8) proved to have a condition of 4, reflecting only minor preservation of former meadow remains, whilst 3 targets appeared to have been completely destroyed, all since the 1960's (Figure 31). Finally, a total of 4 targets remained of uncertain condition, reflecting cases where aerial photography was restricted in its applicability to these areas (due to low resolution, vegetation cover, etc), rendering

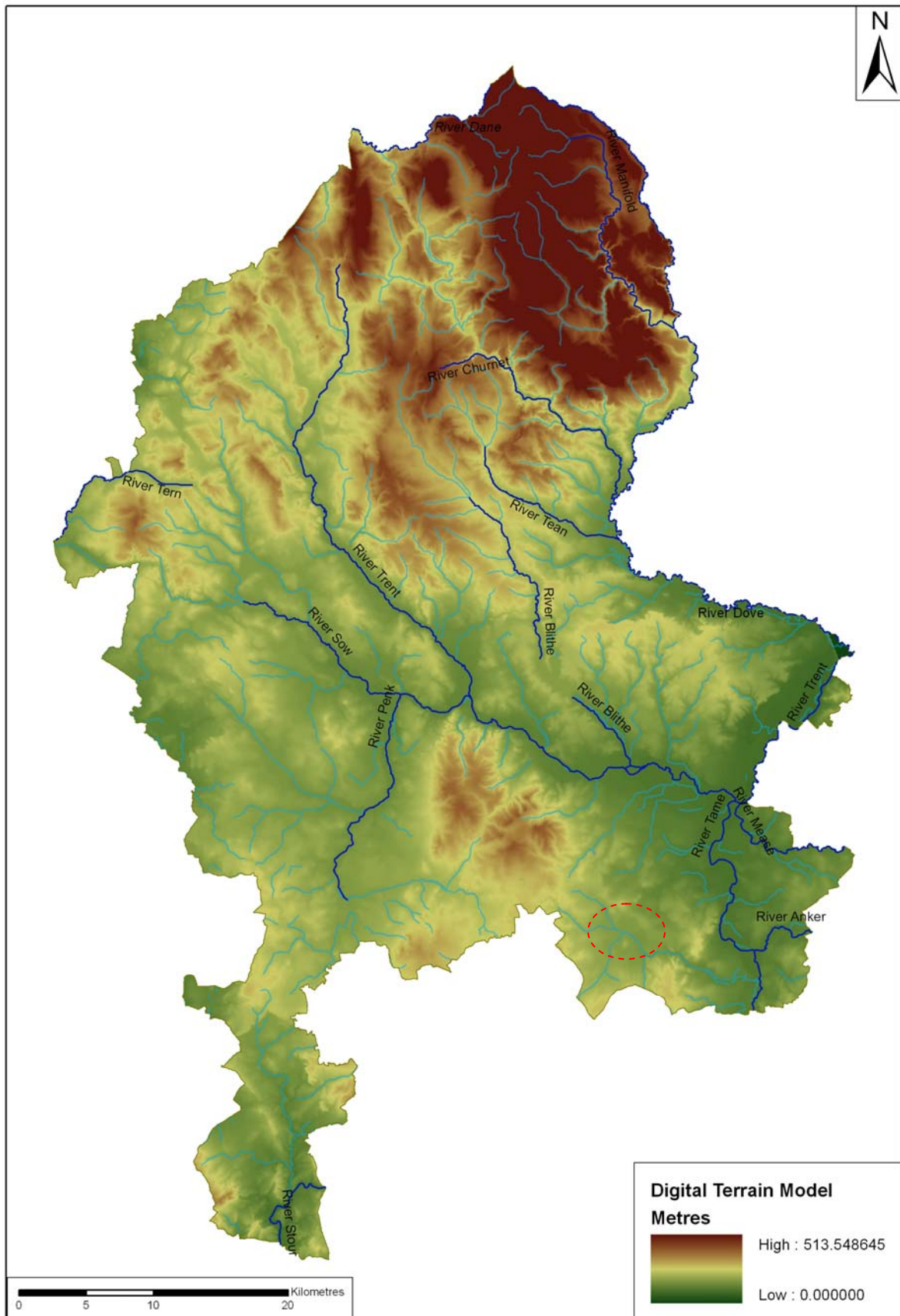


Figure 29- Digital Topographic Model of study area. The head of the Bourne Brook is marked in red.

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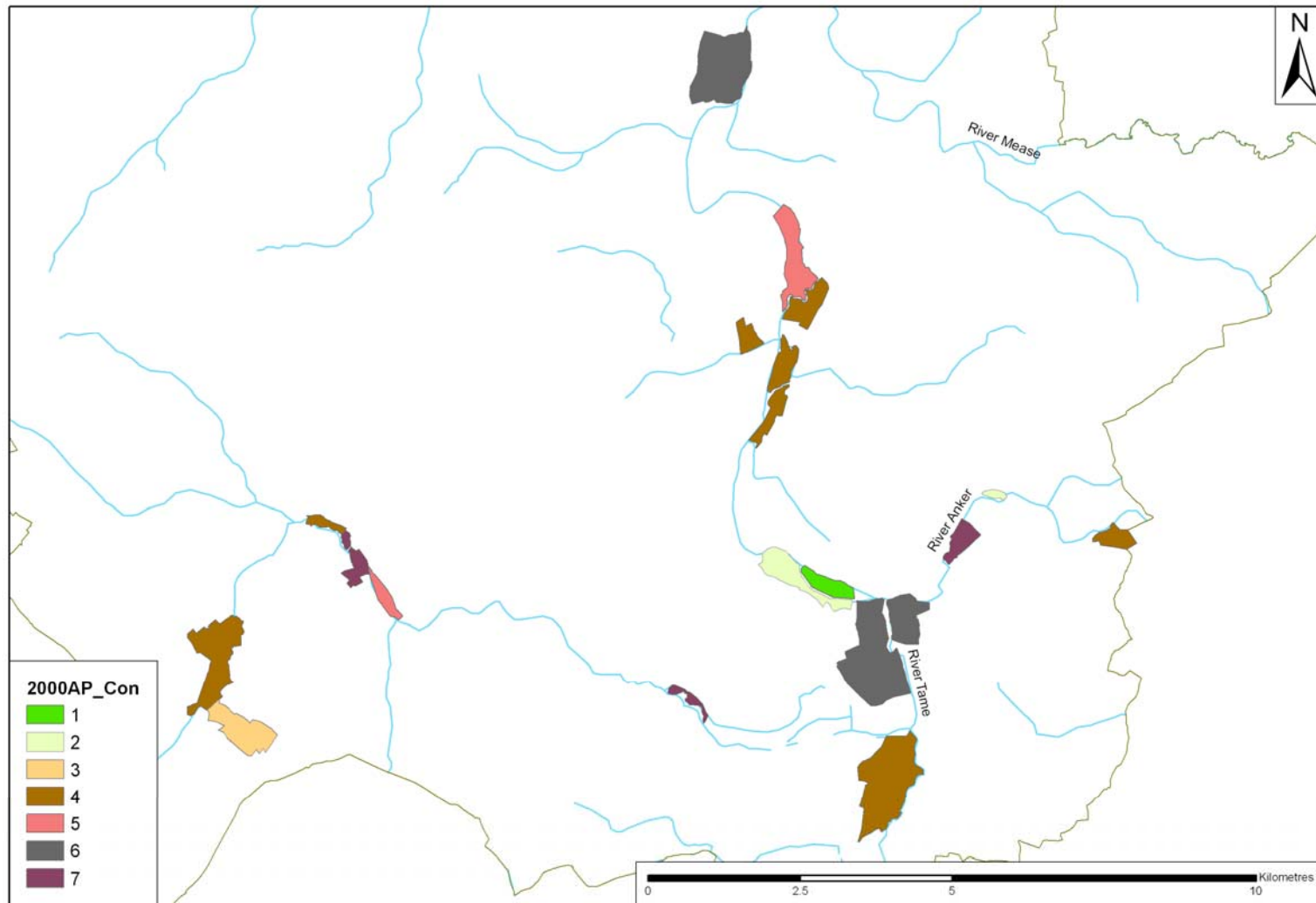


Figure 30- Target distribution on the River Tame, recent conditions.

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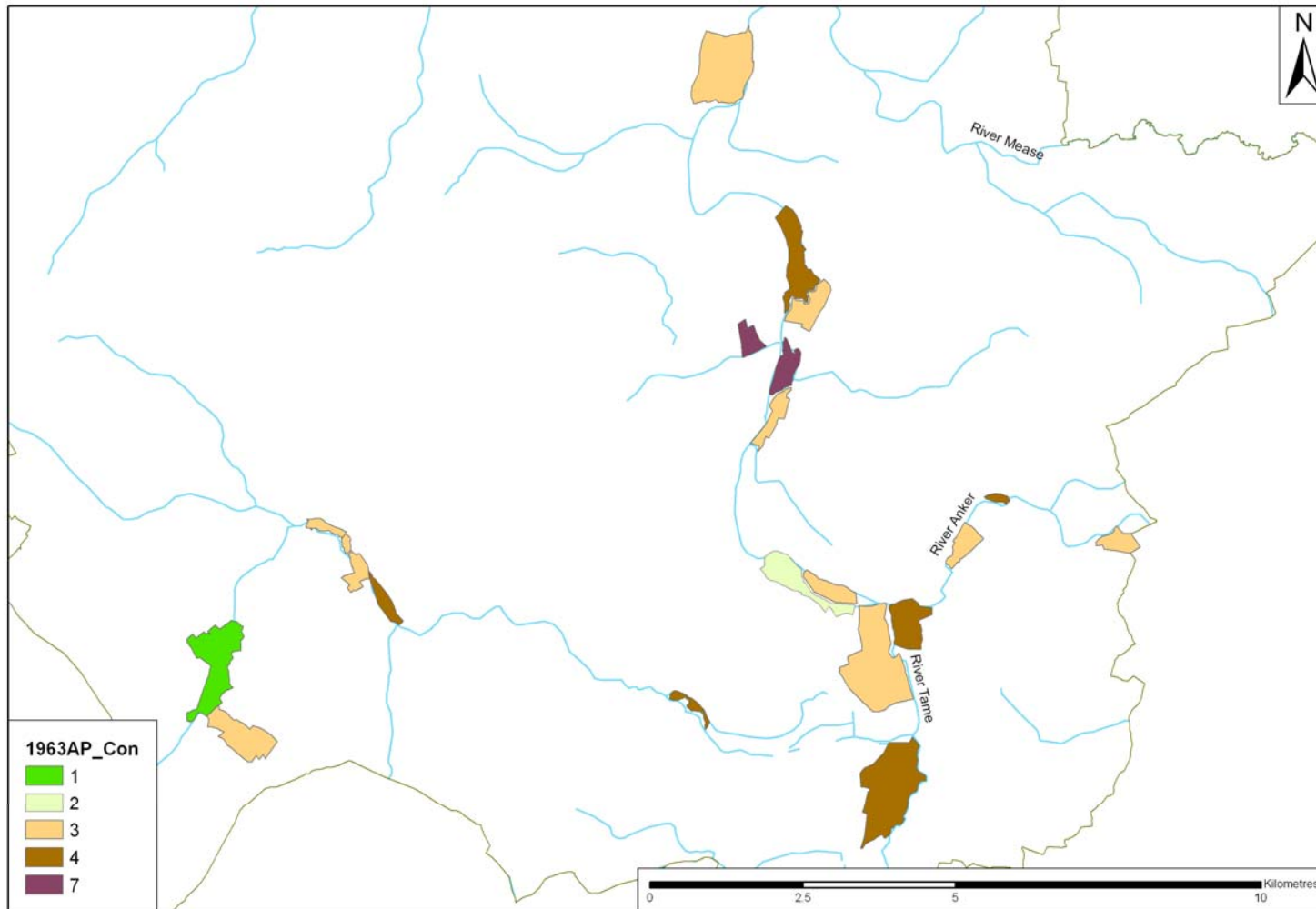


Figure 31- Target distribution on the River Tame, 1963 conditions.

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conclusive assessment impossible. One of these sites, included here due to its being referenced as a field example, was later removed on the basis of field survey demonstrating that this site did not represent a former water meadow. Two discernable patterns were visible within the distribution of these targets, relating to the targets which had been destroyed since the 1960's and the clustering of targets of conditions 4 and 5 to the north of Tamworth.

Destroyed water meadow targets within this area appear, as to be expected, to be focused upon the city of Tamworth and associated development, with two areas of possible meadow (of 118 and 38 hectares in size, respectively) having been destroyed since the 1963 aerial survey. Both of these targets were of limited preservation prior to their destruction (with conditions of 3 and 4 respectively) and appear to have been lost primarily to retail estate development on the city outskirts.

The clustering of targets of low preservation to the northwest of the city appears likely to reflect degradation of former meadow through either intensive farming, or through flooding, with each of these targets apparently representing farmland adjacent to the river. With the possible exception of two targets whose condition was unascertainable within the 1963 aerial imagery, each of these targets appears to have degraded in condition since the 1960's.

Meadow morphology along the river system again seems governed by topography, with larger areas of former meadow on the Tame concentrated upon the open areas to the south, and with the size of meadows appearing to narrow in response to the narrowing of the valley to the north (before it widens again at the confluence with the Trent).

Field Assessed Targets

Two target areas were assessed within the River Tame Valley, composed of a total of three probable water meadow systems. These were located in relatively close proximity to each other (due to lack of access permissions preventing a further spread) at Broad Meadow to the southwest of Tamworth, and at Warwickshire Moor, southeast of the city.

Broad Meadow- NGR SK 19594, 04021 (Figure 5, Target 11)

Broad meadow lies to the southeast of modern Tamworth, and is characterised primarily by an island, bounded to the north by the River Tame, and to the south by the recent flood relief channel (Figure 32). For the purposes of brevity, the area to the immediate south of the flood relief channel has also been included with this area for the purposes of this study. As can be seen, the form of Broad meadow island has been altered to the southeast by works associated with the flood relief channel, with the former extent of the island (visible on the 1st edition mapping) much smaller than the modern extent.

1st edition mapping of the island area shows a series of possible channels crossing the island, with the place name itself indicative of the probability of the area representing a former meadow system, particularly when in association with an area with bodies of water on both sides. In addition, aerial photography from 2000 demonstrates the apparent presence of an extensive network of channels in place upon the island (Figure 33), further strengthening the possibility that the area represents former meadow, although it is to be expected that any island within a flood-prone river would also possess drainage features.

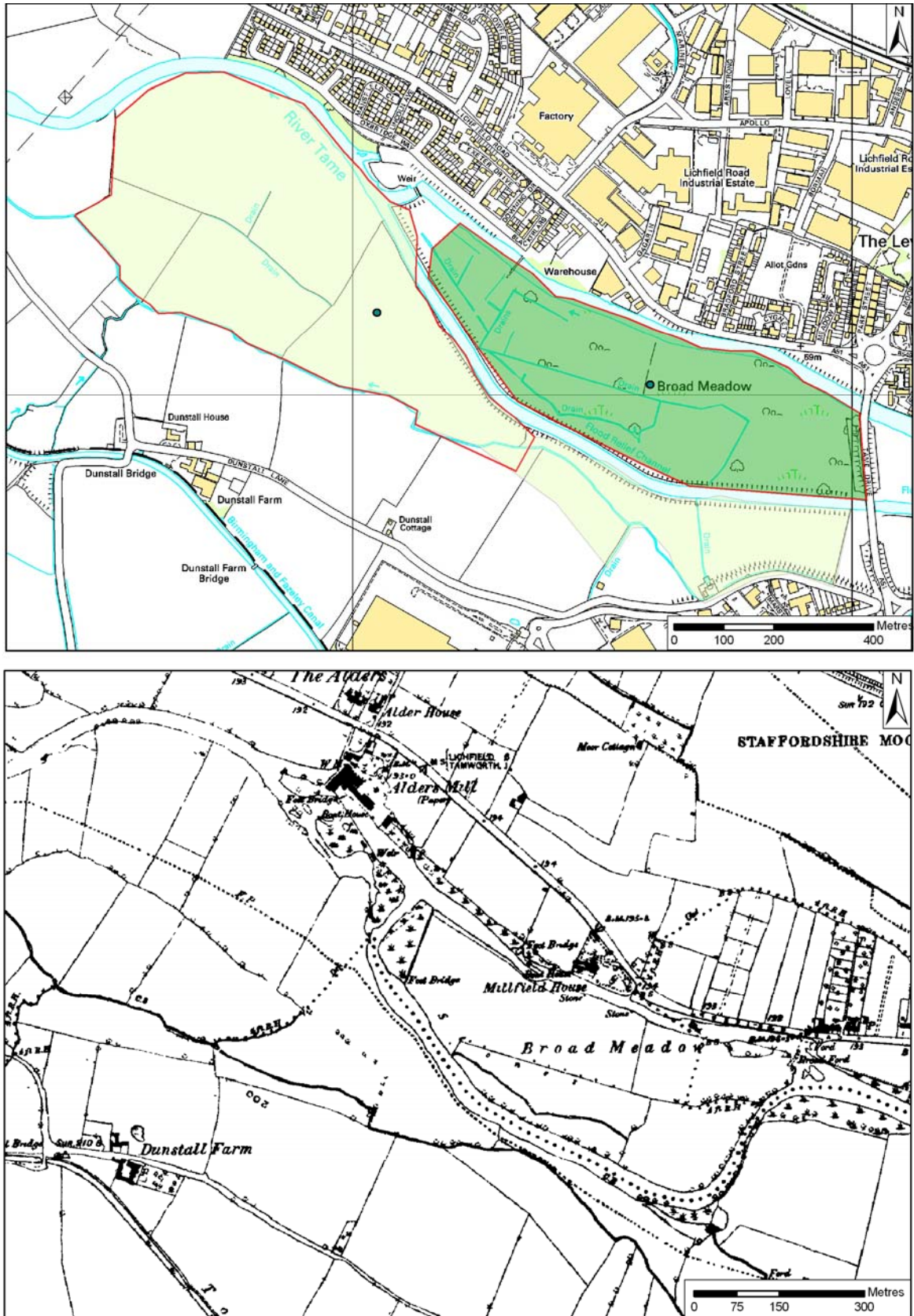


Figure 32- Broad Meadow, modern and historic mapping. Identified targets and surveyed areas marked.

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Figure 33- Broad Meadow 2000 aerial imagery.

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Field assessment of the island area supported the possibility that this target may represent a former water meadow system, with the identification of a series of channels, and collapsed brick features, potentially representative of sluice systems. However, whilst the channel features appeared to share many of the features of water meadow drains, certain aspects of the morphology of these features raised questions. Channel features to the northwestern end of the island, whilst appearing similar to many of those seen elsewhere, possessed flanking bank features (Figure 34), a characteristic which annuls their usefulness as meadow channels and apparently suggesting these features may represent drainage. However, due to the known extensive remodelling of the island, it remains a possibility that this area represents former water meadow which has been truncated to provide material for the creation of the further island extent to the east, with remaining channels reinforced for drainage purposes. The major channels visible on the historic mapping, within the southern area of the island, have certainly been recently modified in order to provide drainage into the flood relief channel, with the addition of concrete drainage features. Detailed topographic survey (LIDAR or Differential GPS) would be required in order to resolve the origin of the land patterns visible, through helping to identify any subtle earthwork traces invisible within the on-site undergrowth.



Figure 34- Channel features at Broad Meadow Island

Note banks visible in central picture, and width of channel above right

The collapsed brick structures remain enigmatic, with brick form and dimensions (and the stamp 'Douglas X' visible on one of the bricks), suggesting a likely late 19th to early 20th century date for these features. Due to frost conditions on the ground at the time of survey it was not possible to clear these features sufficiently for full identification, and whilst such structures could represent meadow features, there remains the equal possibility that these features represent late 19th century drainage.

Field survey to the south of the flood relief channel revealed no evidence for water meadow remains in this area, which appeared to have been ploughed flat. This may suggest that any potential remains within the area have either been destroyed since the 2000 aerial photography flights, or are subtle enough to be invisible from a ground perspective. Consequently, the island area was judged to have a field condition of 3, with questions having been raised over its use as meadow within the late post-medieval period and further investigation recommended. The fields to the south and west of the flood relief channel have been assigned a field condition of 6, apparently having been destroyed within the last few years, or calling into question the original interpretation of this area as potential water meadow.

Warwickshire Moor- NGR SK 21779, 04766 (Figure 5, Target 12)

Warwickshire Moor lies to the southeast of modern Tamworth, immediately to the northeast of the Tamworth railway station on the opposite side of the River.

This target was designated based upon apparent channel features present on historic mapping (Figure 36) and a large channel visible on the aerial photography. However, the ambiguity of the large possible channel feature, complimented by the lack of visibility of obvious meadow features, and the presence of woodland across the area, led to the assignment of an uncertainty condition of 7 to the target in regards to its recent condition.

In order to investigate whether this feature may represent an area of water meadow, it was decided to perform field survey of the site.

Field survey demonstrated the lack of any earthworks or structures typical to water meadow sites, and confirmed the large channel to be a substantial drainage feature associated with the dismantled railway running northwest to southeast across the site.



Figure 35- Disused Railway drainage feature and uncultivated land- Warwickshire Moor

Whilst disappointing that this site did not appear to represent a former water meadow, it served to emphasize the robustness that the addition of an uncertainty value provided to this form of survey, helping to prevent wholesale misinterpretation.

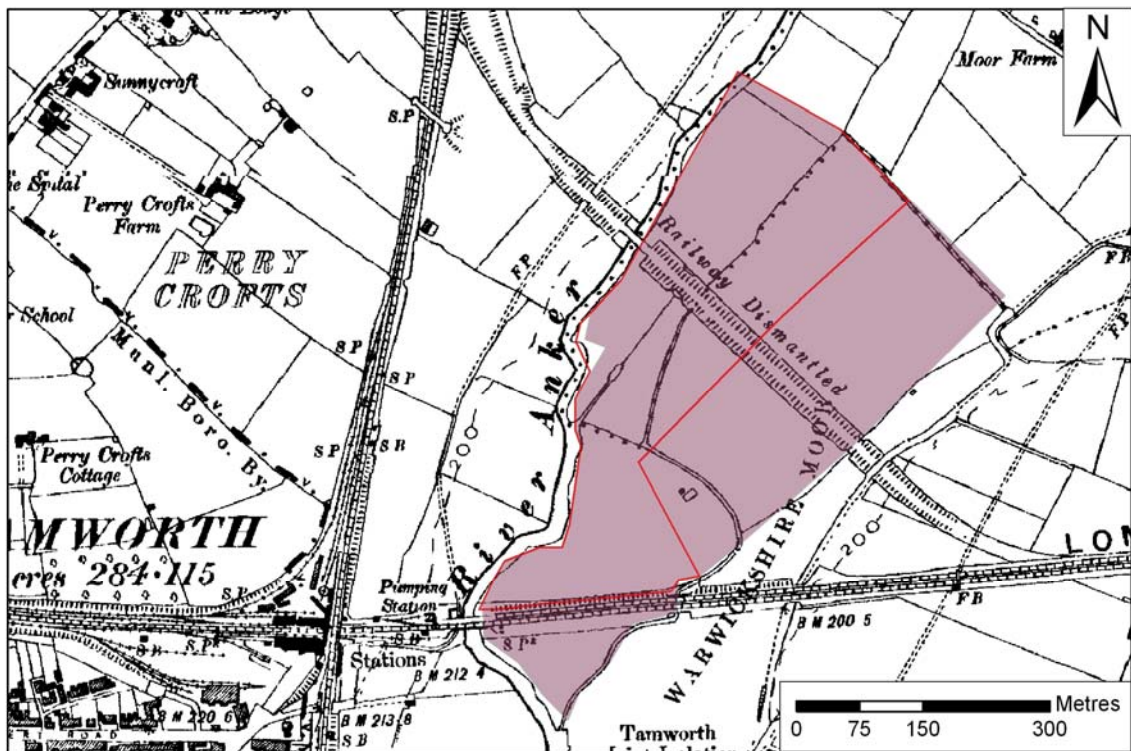


Figure 36- Warwickshire Moor 2000 aerial imagery and historic mapping.

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3.2.3 *Blithe River Valley*

Desk-based survey identified 18 targets within the Blithe river valley area (Figures 36 & 37), distributed within a relatively continuous chain from the northern head of the Blithe to its southern confluence with the Trent. Of these targets only four appeared to be fed by tributaries of the Blithe, the remainder fed by the river itself.

Target morphology once again corresponded with the topography of the valley, with potential meadow targets which appeared long and thin in form near the source, widened within the central area of the valley, and narrowed prior to the confluence with the Trent, in response to a narrowing of the valley at this point (see Figure 29).

Targets within the valley showed a range of current conditions, with the presence of two targets showing a likely condition value of 1, six targets with a condition of 2, including the largest targets seen upon the Blithe, four targets of condition 3, one of condition 4 and five of condition 7.

Targets of recent condition 2 formed the largest targets identified within the valley, with individual target systems ranging from 27 hectares to 450 hectares in size. However, the largest and most promising of these targets was identified primarily from the 1st edition historic mapping, and has lost 174 hectares of its initial extent to the construction of the Blithfield Reservoir, opened in 1953. Figure 38 depicts the area lost to the reservoir, as visible on first edition historic mapping, with clearly marked channels and sluice systems visible flanking the River.

The only other distribution pattern visible within the condition data was the apparent clustering of targets of uncertain condition (7) towards the source of the river. These targets appeared visible in the 1963 aerial photography as possible meadow, however recent detailed imagery has been hampered by many of these targets now comprising overgrown areas of land between pockets of urbanisation, with earthwork features hard to identify from aerial imagery within overgrown conditions. The clustering of these targets therefore appears to correspond to the encroaching urbanisation of highland areas unsuitable for large scale farming, although the narrow nature of these targets (often a single field in width on either side of the river) coupled with their proximity to the river, appears to have led to their preservation in the face of this urban expansion, allowing for future field survey to conclusively test the nature of these targets.

Visible degradation of target quality since the 1963 aerial photography has only been seen in a single instance, however, the large quantity of uncertainty values required within the dataset for this area impedes a conclusive assessment of changing condition, and as such, future field testing of select targets within this valley would be highly recommended.

Due to the aforementioned access restrictions, no field survey was possible within this valley area during this project.

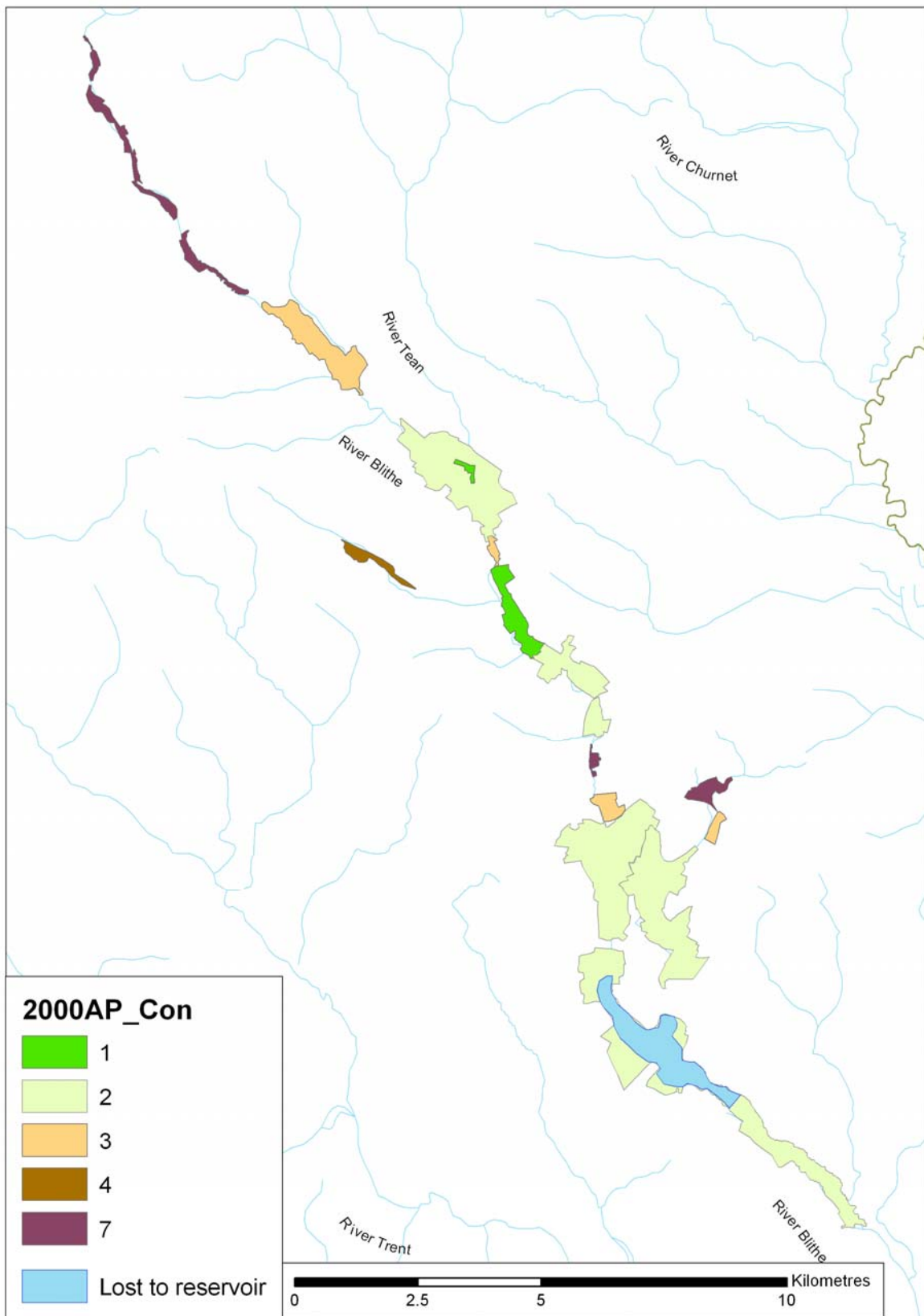


Figure 37- Identified possible water meadow targets on the river Blithe. Recent conditions.

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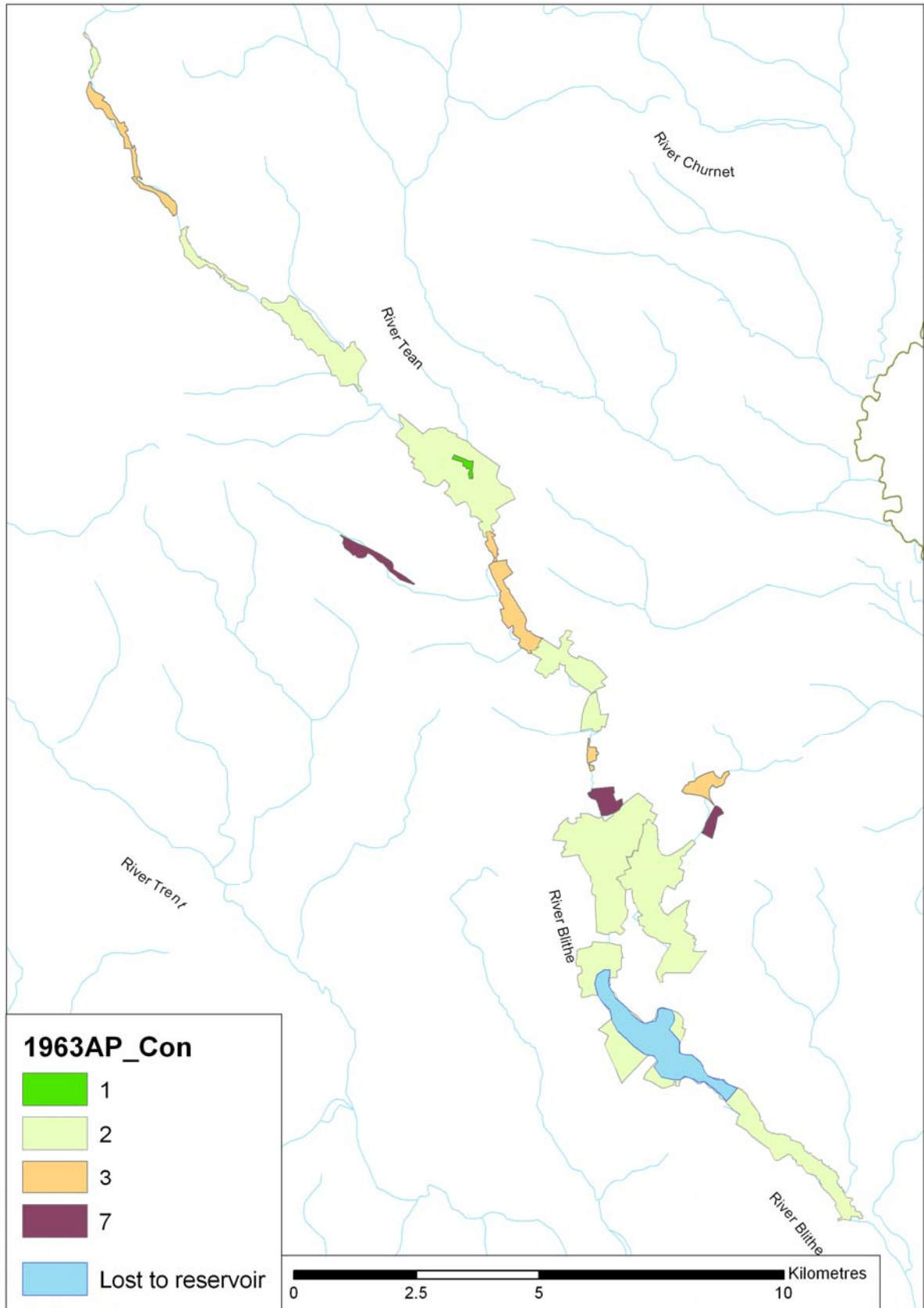


Figure 38- Identified possible water meadow targets on the river Blithe. recent conditions

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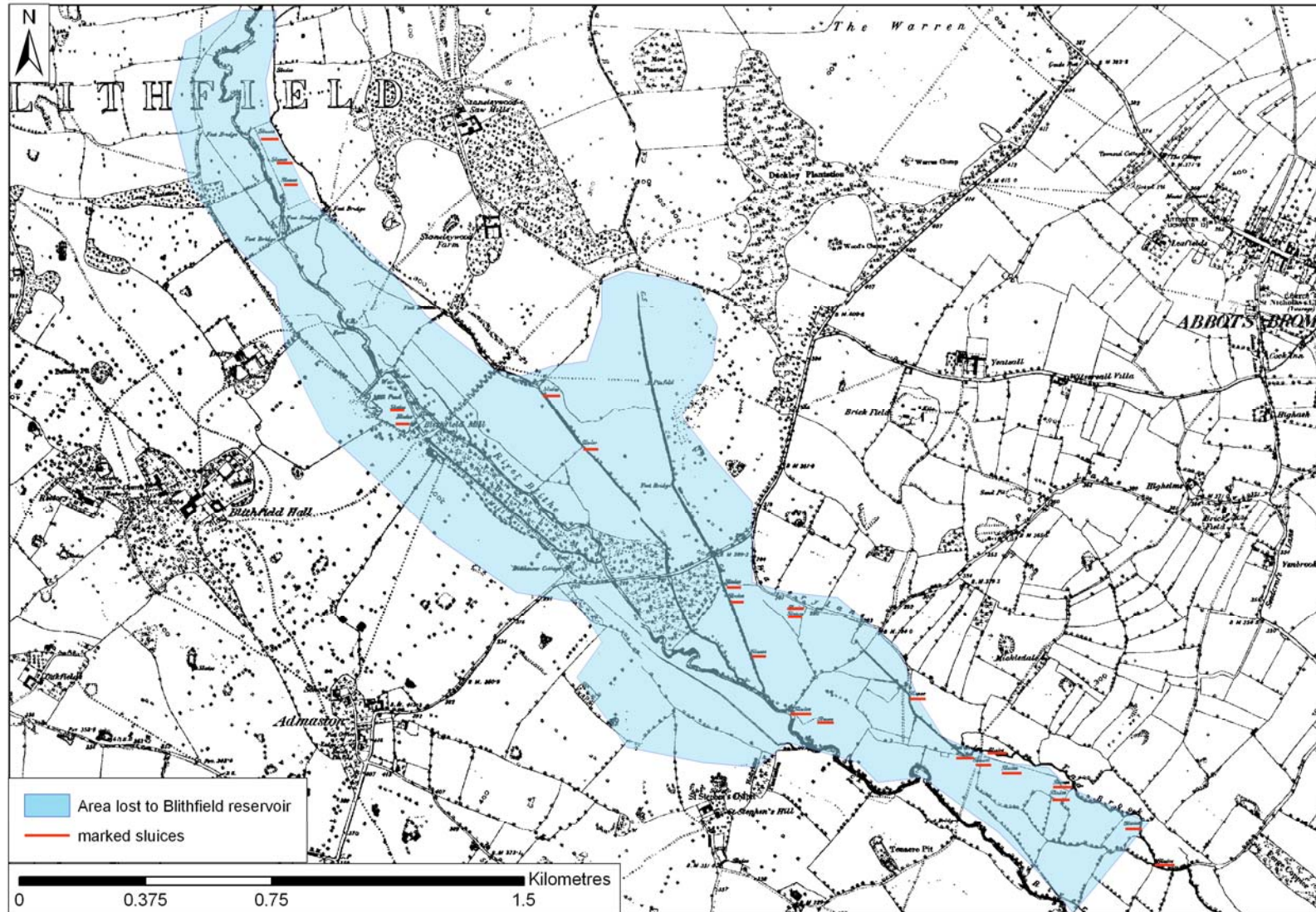


Figure 39- Area lost to Blithfield reservoir- note sluice systems marked on historic mapping

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3.2.4 *Sow River Valley*

A total of 27 targets were identified within the area of the Sow river valley. These targets were again present from close to the river source through to its confluence with the Trent, and had a relatively even distribution. Once again, the largest targets were present within the lowland open areas, in this case around the county town of Stafford.

Recent target conditions covered all values apart from value 5 (Figure 40). A total of four targets were identified with a recent condition of 1, all of which took the form of small areas of high preservation adjacent to less well-preserved systems, potentially indicative of the original nature of the larger systems. Three of these targets were positioned within the central area of the valley, near to the market town of Eccleshall, whilst the fourth lies to the southeast of Stafford city centre. A general trend appeared to be in place within the recent condition data of targets of condition 2 (6 targets in total) being positioned to the southeast, whilst targets of condition 3 (of which there were 11) lay to the northwest. Since several of the condition 3 targets had shown degradation since the 1960's, this pattern may simply be indicative of the areas of meadow around Stafford and Shugborough having been left relatively unaltered. This could be due to the area of the immediate Sow floodplain being left devoid of development, with these areas of primary value as pasture land due to their tendency to flood. The combination of these factors may have mitigated somewhat against the degradation of these features due to development or farming in this area, and helped to preserve features around Stafford to a higher level than seen elsewhere within the valley.

Of the remaining condition values, two targets were present with a recent condition of 4, two targets that appeared to have been destroyed (condition 6) and a single target each for conditions 7 (uncertain) and 0 (woodland area, possibly representing former meadow).

When the recent condition values are compared with the 1963 values (Figure 41) it can be seen that a total of 7 targets have degraded, two of which appear to have been destroyed since the 1960's, in the environs of Stafford and Coldmece, respectively. During the same time period it appears that two targets have in fact improved in terms of their preservation, a data artefact most likely due to lack of visibility of features within the large scale 1963 images which were more readily visible within the 2000 dataset.

Field Assessed Systems

Bishops Wood- NGR SJ 76685, 31261(Figure 5, Target 5)

Bishops Wood is an area of woodland lying approximately 3.2km to the northeast of Eccleshall, with the area targeted for field survey composed of a series of fields crossed by the river Sow, along the eastern edge of the woodland area (Figure 42). Desk-based survey had suggested the possibility of the area representing former water meadow, with channels visible on the 1st edition historic mapping, and upon modern Ordnance Survey data running perpendicular to the flow of the river, potentially reflective of a floating upwards system. This evidence, supported by the suggestion of a possible further channel flanking the system to the east within the 1963 aerial photographic data, led to the suggestion of this system as a suitable target for field testing, due to its potential for representing a different form of water

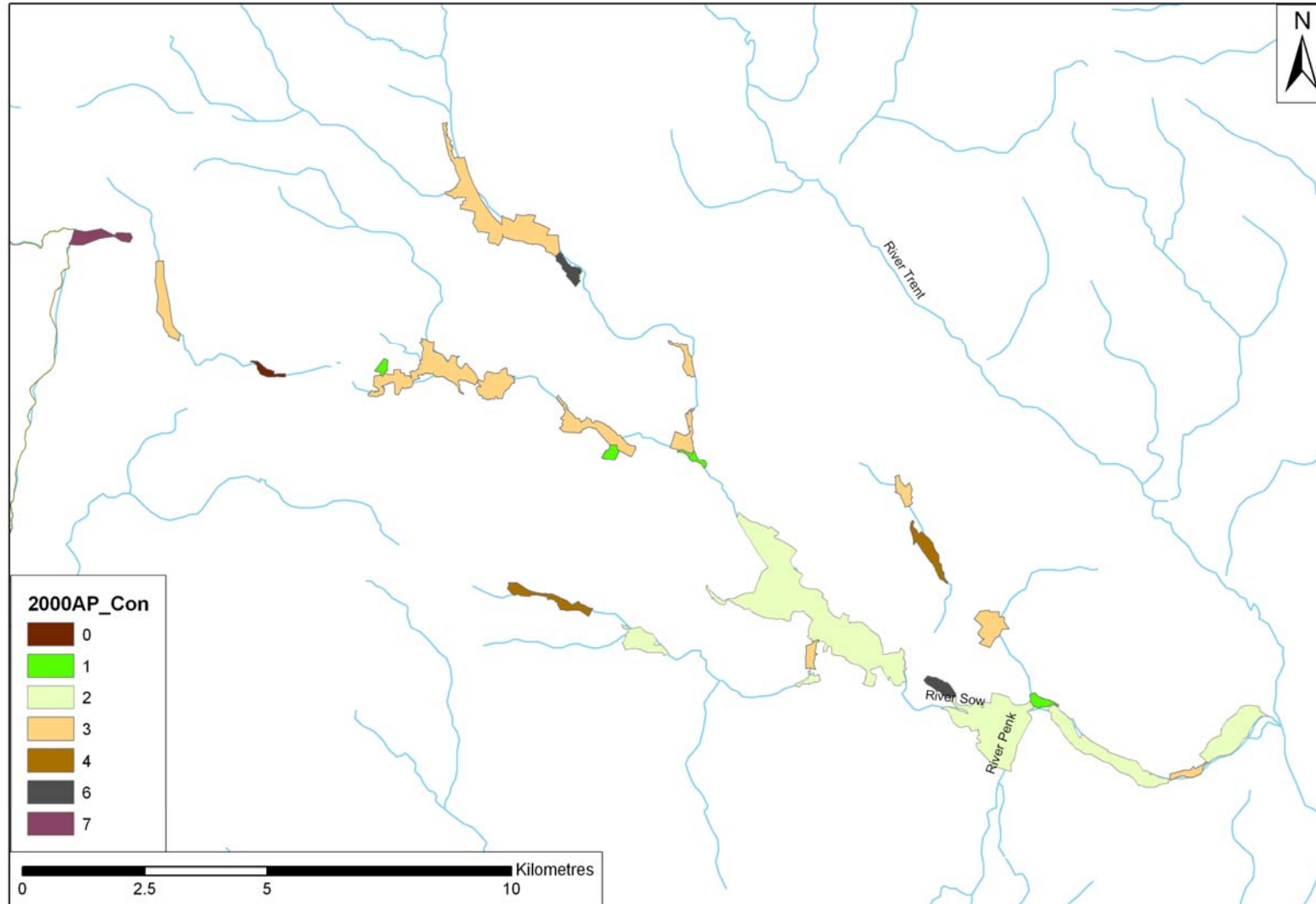


Figure 40- Distribution of identified possible water meadows along the river Sow, and their recent conditions

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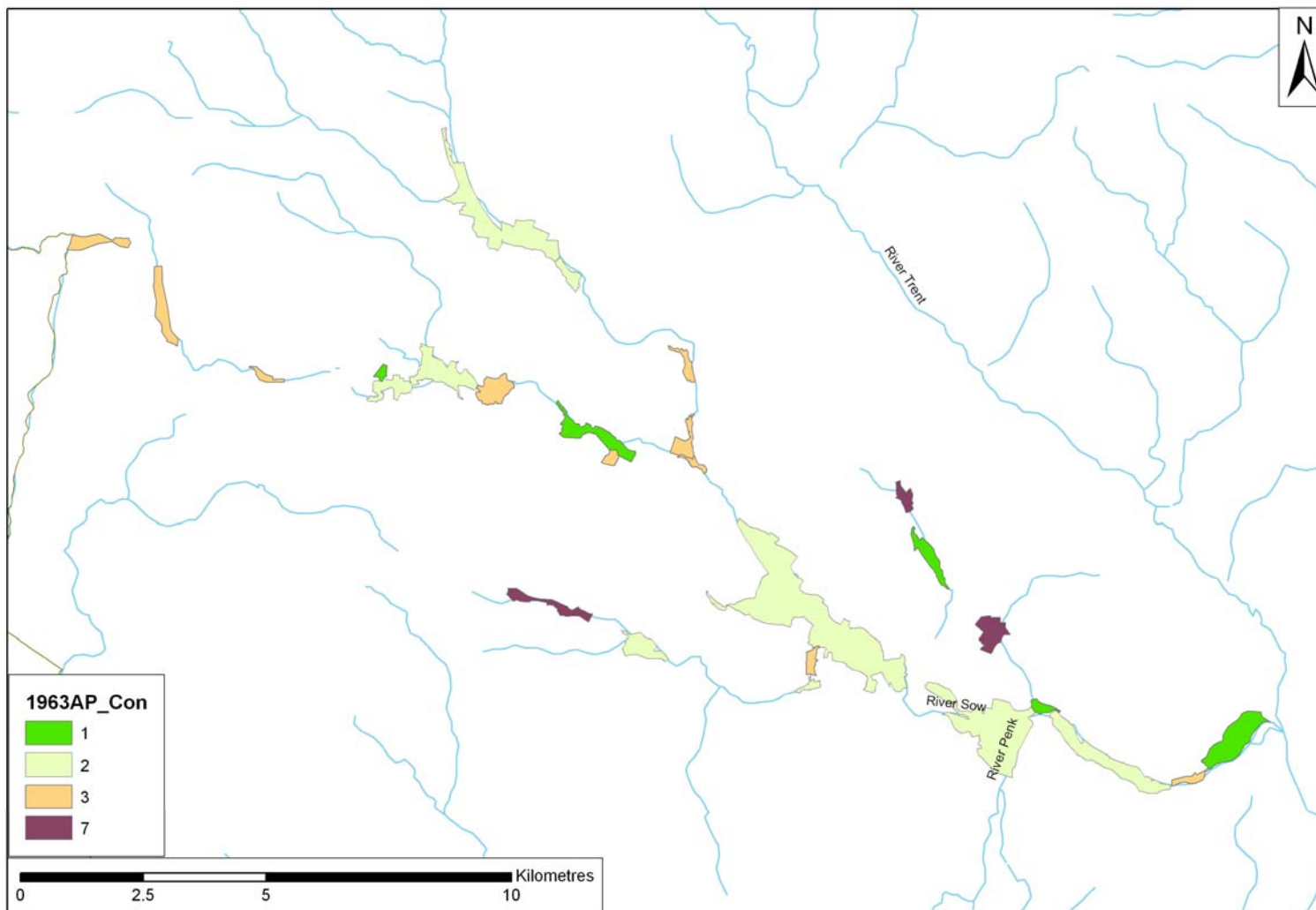


Figure 41- Distribution of identified possible water meadows along the river Sow, and their 1963 conditions

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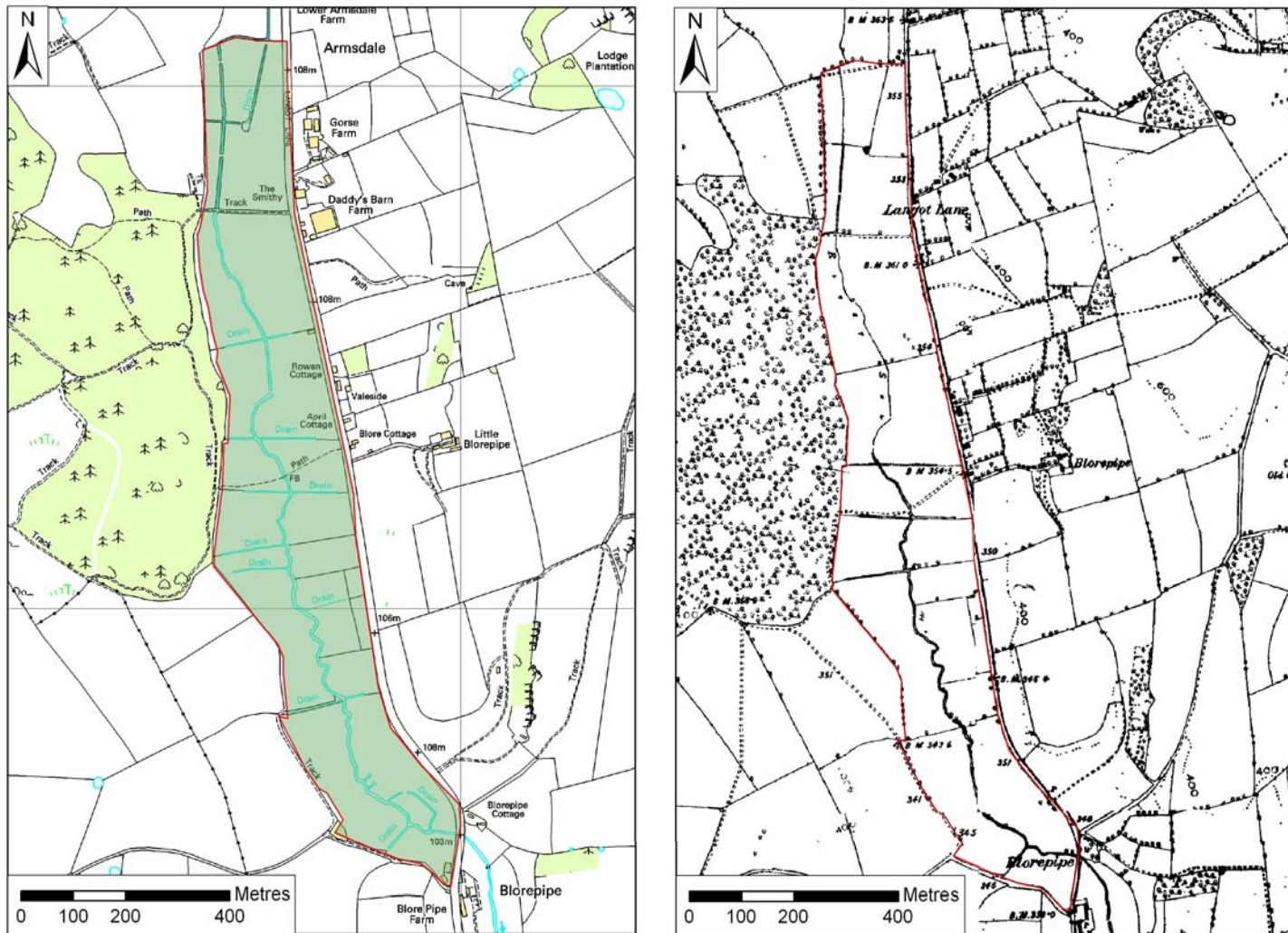


Figure 42- Bishops Wood field target, modern and historic mapping.

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meadow to the bedwork systems seen within the lowland valleys elsewhere within the county. The target had a total area of 32 hectares, all of which was observed during field survey, subject to the restrictions discussed below.

Prior to field analysis, the target was seen to have a condition value of 3 within both available series of historic mapping.

Field survey demonstrated the presence of substantial channels crossing the course of the Sow, potentially representative of floating upwards water meadow channels. However, due to the wet nature of the area, the potential remained for these features to represent drainage features. Confirmation of the nature of these features would be primarily determinable through close examination, due to the remains of sluice systems for damming the river (at the downstream edge of the junction of these channels with the river) being the likely primary indicator of this form of water management. However, due to access limitations, this target was only assessed from public footpaths crossing the area, prohibiting close inspection of any potential features, and rendering the identification of any possible structural remains impossible. The number of these drains, the presence of several smaller channel features (which defined much smaller areas and are visible within Figures 42 and 43 within the southern half of the target area), and the limitation of channels to the immediate area of the river was supportive of the suggestion that this area may have represented an area of former water meadow management, albeit on a small scale.



Figure 43- channel features at Bishops Wood, defined by rushes

Bottom image depicts southern channels, with the wetland area to the fore defined by a channel on three sides, and the River Sow on the fourth.

In conclusion, it can be determined that the desk-based assessment was successful in accurately predicting the condition value of features within this area, with field survey confirming a condition value of 3 for the site. Due to the ambiguity of the channel features however, whilst it has been judged here that the area may represent former water meadow, further field survey is strongly recommended in order to determine conclusively the nature of the channels seen from a distance.

Seighford Meadows Stafford

The area referred to as Seighford Meadows formed one of the largest targets designated within the desk-based survey, an area of some 335 hectares to the west of modern Stafford. This area showed clearly defined channel systems, apparently indicative of former bedwork water meadow within both aerial photographic series and the historic map analysis (Figures 45 & 46). Due to the size of the area, and to limited access permissions, two select areas within the defined target were examined in the field. These areas were land owned by Cresswell Farm to the north of the defined target, and the publicly accessible Doxey Marshes reserve to the south.

Cresswell Farm, Seighford Meadows Stafford- NGR SJ 89363, 26135 (Figure 5, Target 6)

Cresswell farm lies to the northwest of Cresswell village, at the northern end of the defined target area. Desk-based survey suggested the presence of well-defined water meadow features within the area, with main drains and their associated carriers clearly visible in both aerial photographic series, forming one of the most well-defined areas visible within desk-based survey. Figures 47 and 48 show a comparison of the aerial photographic imagery for the area, with a prediction of a field condition of 2 for this target area.

Field survey demonstrated a wealth of well-preserved water meadow features within the area. Within the westernmost field of the surveyed area was found to be present a fully-preserved portion of water meadow earthworks, with only structural sluice remains missing, and with clearly defined main drains still carrying water to the preserved carrier bedworks (Figure 44).



Figure 44- Fully preserved bedworks, Cresswell Farm, Seighford Meadows

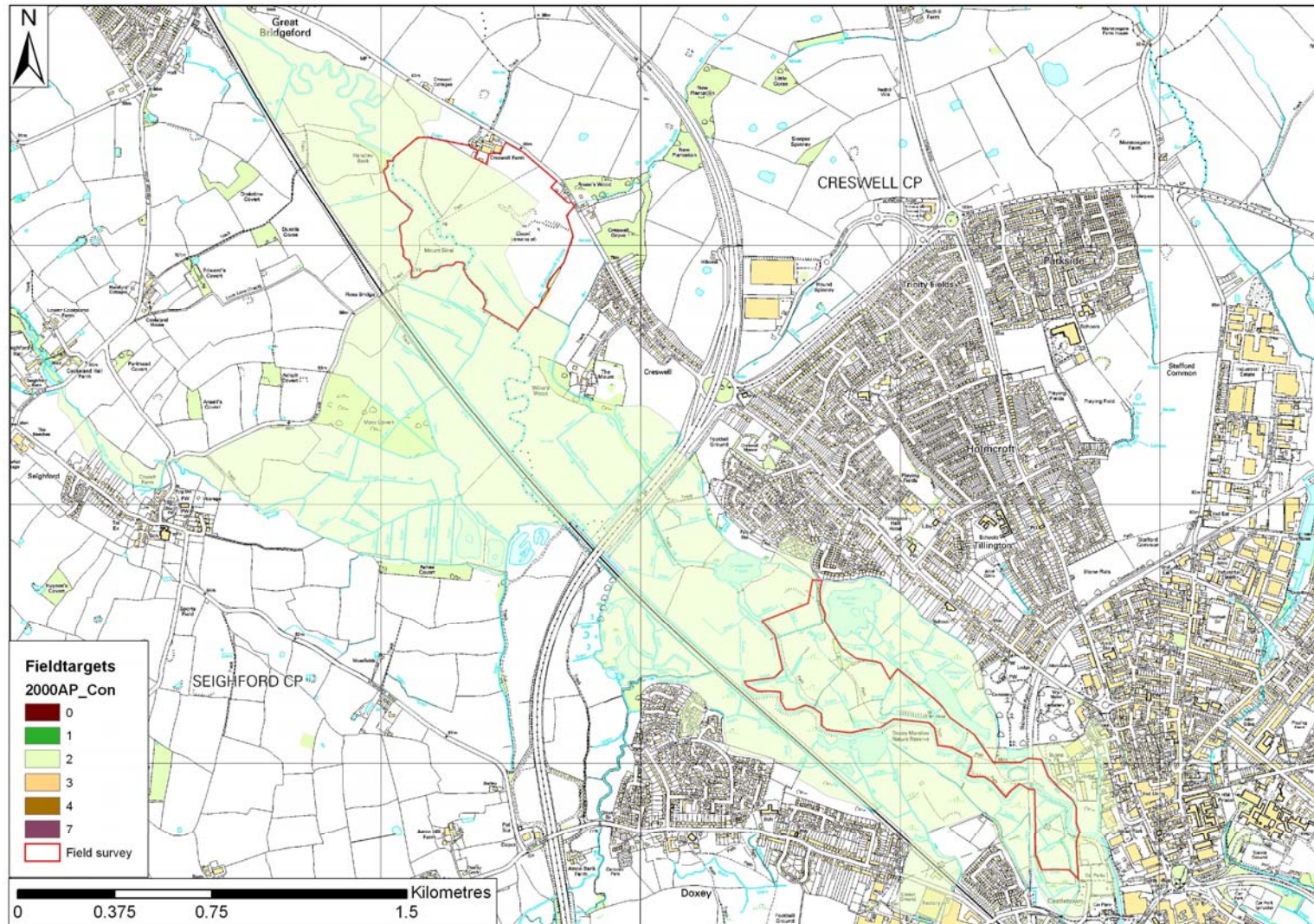


Figure 45- Seighford meadows target, modern map data.

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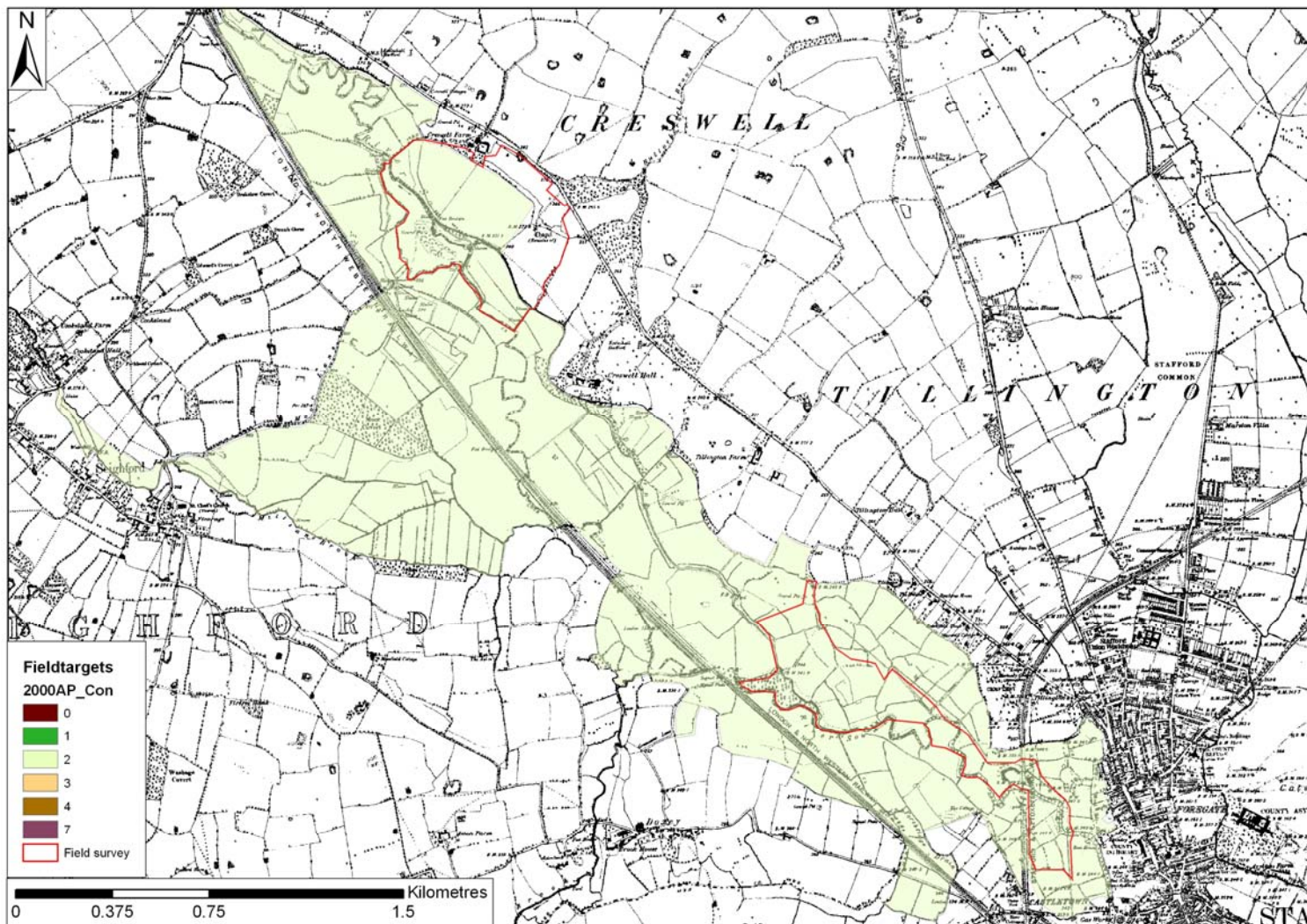


Figure 46- Seighford meadows target, historic map data.

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Figure 47- Cresswell farm, Seighford meadows, 2000 aerial imagery. Red marks area of field survey.

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Figure 48- Cresswell farm, Seighford meadows, 1963 aerial imagery.

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Less complete systems of former channels were visible across the southern portion of the surveyed area, with many modern field boundaries apparently defined by former main drains which were still holding water.



Figure 49- Preserved main drains and carriers- Cresswell Farm, Seighford Meadows

In addition, several water meadow structures were visible within the area, primarily in the form of culverts or bridges. These appeared mainly to be composed of blue industrial brick, (most likely Staffordshire Blue Brick) and appear to suggest mid to late 19th century maintenance of access and drainage. Some large sandstone blocks were visible being used as support for the banks of some channels; however these features were in proximity to modern drainage, and may merely represent recent maintenance.



Figure 50- 19th century culvert and bridge features, Cresswell Farm

Of greater interest were a series of red brick wall remnants partially buried to the immediate north of the modern river course, and potentially suggestive of the course of a previous brick-lined channel feeding one of the former main/head drains for the well preserved bedworks seen to the east. Additionally, used as a support within barbed wire fencing at this point appeared to be a preserved sluice mechanism which had been uprooted presumably from the immediate locality, and potentially from within the aforementioned lined channel (since its current location lies crossing this channel, with the mechanism inverted so that the mechanism screw forms a support for the fencing). Specialist consultation is suggested to confirm this structure is a former sluice; however, its form (a 1.4m long timber, with a central

iron screw of 1.2m length and with sockets at either end of the timber to allow rotation to work a mechanism) is suggestive of a sluice gate control. This feature, should it be proven to be a sluice mechanism, is the only preserved feature of its type seen during field survey, with only sluice gate housings found elsewhere (and these only confirmed in the case of Willows Farm, Uttoxeter).



Figure 51- Apparent brick-lined channel, with possible sluice mechanism (not in-situ)

Potential sluice mechanism has both wooden and iron features preserved (detail image above right)

Consequently, the rich results of the field survey demonstrated the surveyed area of Cresswell Farm to have a field condition of 1, although the Seighford target polygon as a whole retains a recent condition of 2 (as less well-preserved areas elsewhere within the Seighford system serve to reduce the overall preservation value).

Doxey Marshes, Seighford Meadows, Stafford- NGR SJ 91096, 24222 (Figure 5, Target 7)

Desk-based survey suggested the presence of substantial drainage features within the area, apparently indicative of water meadow cultivation within the 1st edition Ordnance Survey mapping (Figure 46).

The Doxey Marshes area is now preserved as a Site of Special Scientific Interest, and has the form of a nature reserve characterised by large expanses of wetland and marsh, divided by drainage channels of varying size.

Field survey confirmed the presence of numerous channels across the area, conforming to the plan seen on 1st edition maps of the area. These feature were similar in appearance to water meadow main drains seen elsewhere during field survey, however, due to the transformation of the area into a wetland reserve, with the flooding or overgrowth of extensive areas, many

more subtle preserved water meadow systems remain obscured. Despite this however, in some areas carrier banks appeared to be visible and some wetland plants appeared to be following linear plots potentially representative of water retention within former carriers and drains.



Figure 52- Drains and possible carrier features at Doxey Marshes, Seighford Meadows

Consequently, based upon the plan and appearance of the whole area, it would appear that many of the drainage features within the surveyed area are representative of water meadow drains; however, further research is recommended to obtain a detailed history where possible of alterations within the area in order to corroborate this preliminary analysis. Based upon this preliminary walk-through (which it should be noted was restricted to areas visible from public footpaths due to the sites designation as an SSSI), this target has been assigned a field condition of 3 within this study, with the wider area of the Seighford meadows having an overall recent condition value of 2, based upon the aerial imagery components of this study.

3.2.5 *Penk River Valley*

A total of 19 potential water meadow targets were identified within the Penk River valley, with recent conditions ranging from level 1 through to level 4, and a single target of condition 7 (Figure 53). Once again targets are primarily distributed along the main river, with a total of 11 targets upon the Penk itself, and 8 upon more minor tributaries. For the sake of brevity a single target beyond the valley which drains into the Penk was also included within this geographical subdivision.

The minimum size of targets defined within this system was 2.7 hectares, with the largest example having an area of 287 hectares, and the mean area being 46 hectares.

Spatially, targets are distributed along the Penk itself from the town of Brewood in the south to Stafford in the north. Along the tributaries of the Penk there appears a slight bias towards targets being located high up the tributary course, away from the confluence with the Penk, with this pattern likely to be a product of local topography.

No targets from this system were field tested (due to the aforementioned access restrictions) and consequently, little formal assessment of the form of systems within this valley can be made, however the 1st edition map evidence suggests that the targets visible within this area are most likely to represent bedwork water meadow systems, rather than catchwork or 'floating upwards' systems.

Within the recent condition range, a total of 5 targets of apparent condition 1 were identified, along with seven of condition 2, four of value 3, two of value 4, and a single target of value 7. There seemed to be relatively little pattern within the distribution of these preservation values, although the river system as a whole shows a high level of preservation of potential water meadows, most likely due to the predominantly rural nature of its hinterland. A concentration of more poorly preserved sites (values 3 and 4) appears centred around an area of the Penk immediately to the south of Acton Trussel. The poor preservation of targets at this point seems likely to be a product of disturbance during the construction of the M6 motorway, which flanks the Penk at this point at a distance of between 50 and 300 metres to the west.

Within this area the majority of targets have the appearance of having improved in condition since the 1963 aerial imagery flights (Figure 54). Once again this artefact is likely a product of the improved resolution and scale of recent imagery for this identification of subtle earthwork features. The lack of degradation in assigned values between the 1963 and 2000 flights, and the lack of any targets marked as destroyed, appears suggestive however of a good level of sustained preservation across this area, with comparatively little threat to these targets unless widespread development or extensive ploughing is undertaken within their vicinity.

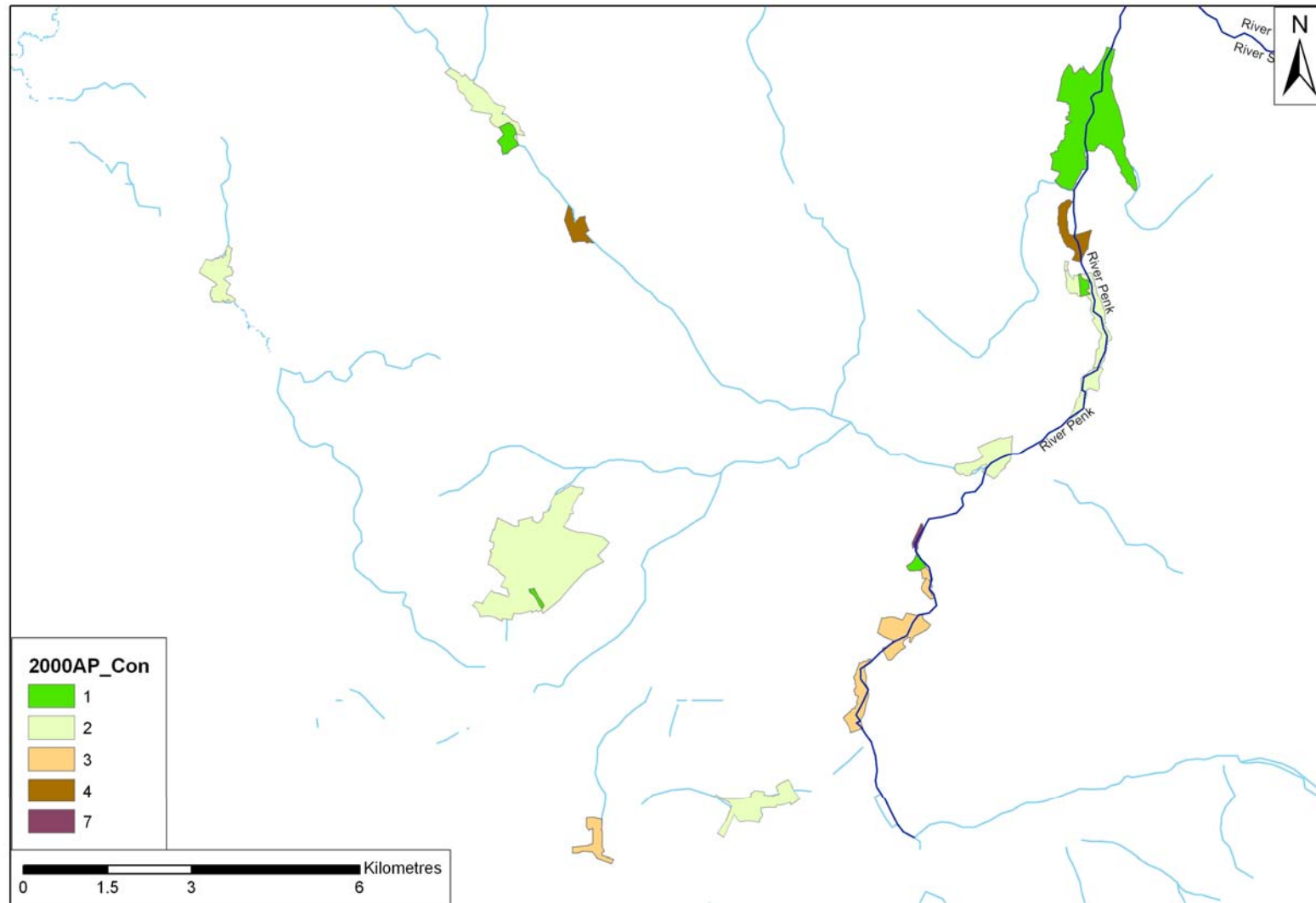


Figure 53- Distribution of possible water meadow targets along the Penk river valley, recent condition

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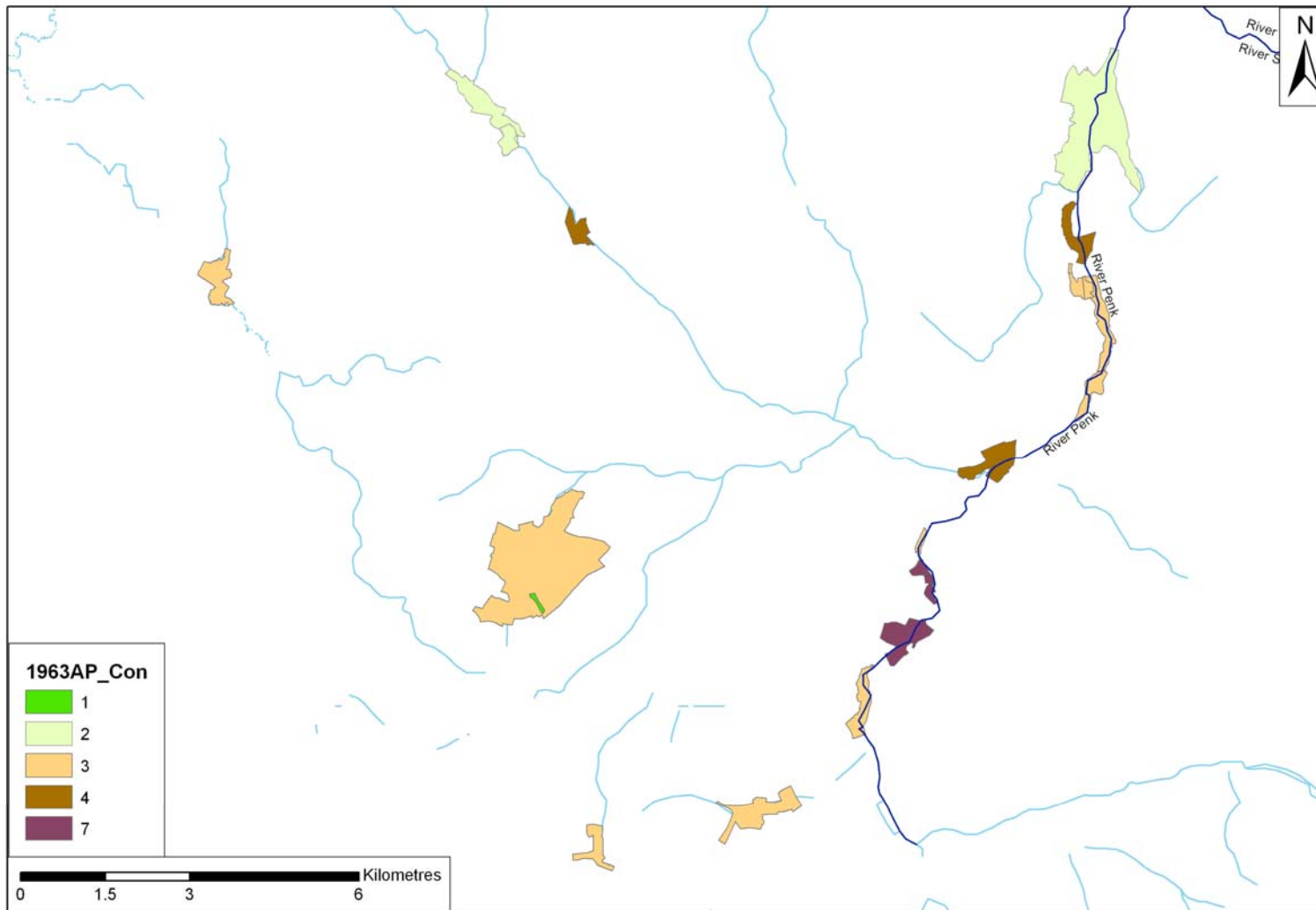


Figure 54- Distribution of possible water meadow targets along the Penk river valley, 1963 condition

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3.3 Water-Meadows in the Dove, Tean, Churnet and Manifold Valleys

This geographical subdivision encompasses much of the major upland areas of the county, (Figure 55) along with the Staffordshire side of the lowland area of the southern Dove valley. This subdivision and its rivers can also be categorised as the area which forms the Staffordshire side of the catchment zone for the major river, the Dove. A total of 24 targets were identified within this area, (Figure 55) the majority of which were within the southern Dove valley. This was to be expected due to the unsuitability of upland areas to bedwork water meadows, and the likely reduced visibility of catchwork and ‘floating upwards’ systems to aerial survey (being largely indistinguishable from simple drainage).

Recent condition values within the area ranged from well to moderately preserved (values 1-3), with a few targets of condition 7 and a single target now destroyed (value 6).

3.3.1 *Dove River Valley*

The Dove river valley was found to contain the largest number of targets within this geographical subdivision, with a total of 15 targets within the valley, all but 3 of which lie upon the Dove itself. The size of identified targets ranged from a single hectare to targets of 226 hectares in size, with a mean size of 99 hectares. The majority of the defined targets lie upon the lowland Dove itself, between Ashbourne in the north and the confluence of the Dove with the Trent just to the north of Burton upon Trent. These are also home to the largest targets within the system, which form wider areas of apparent meadow cultivation, exploiting the wide valley floodplain in these areas. These systems are mirrored along much of this extent by similar systems visible on the opposing side of the Dove; however these areas, lying within the county of Derbyshire rather than Staffordshire, shall not be discussed within this survey.

Water meadow targets along the Dove showed a good recent state of preservation (Figure 56), with 3 targets of condition value 1, nine of condition 2, and only two of condition 3. Additionally, a single target had an uncertain recent condition (value 7). No real pattern can be discerned within the distribution of these values, although the overall good preservation of the area is likely due to the presence of most of the targets within the extant flood plain of the Dove. With this land relatively unsuitable for modern development or intensive crop agriculture, these targets appear to have been spared the greatest threats to sites of this type.

Once again, a comparison of 1963 condition values (Figure 57) with recent condition showed an improvement in condition of all but 1 target, again reflective of the improved resolution of recent imagery.

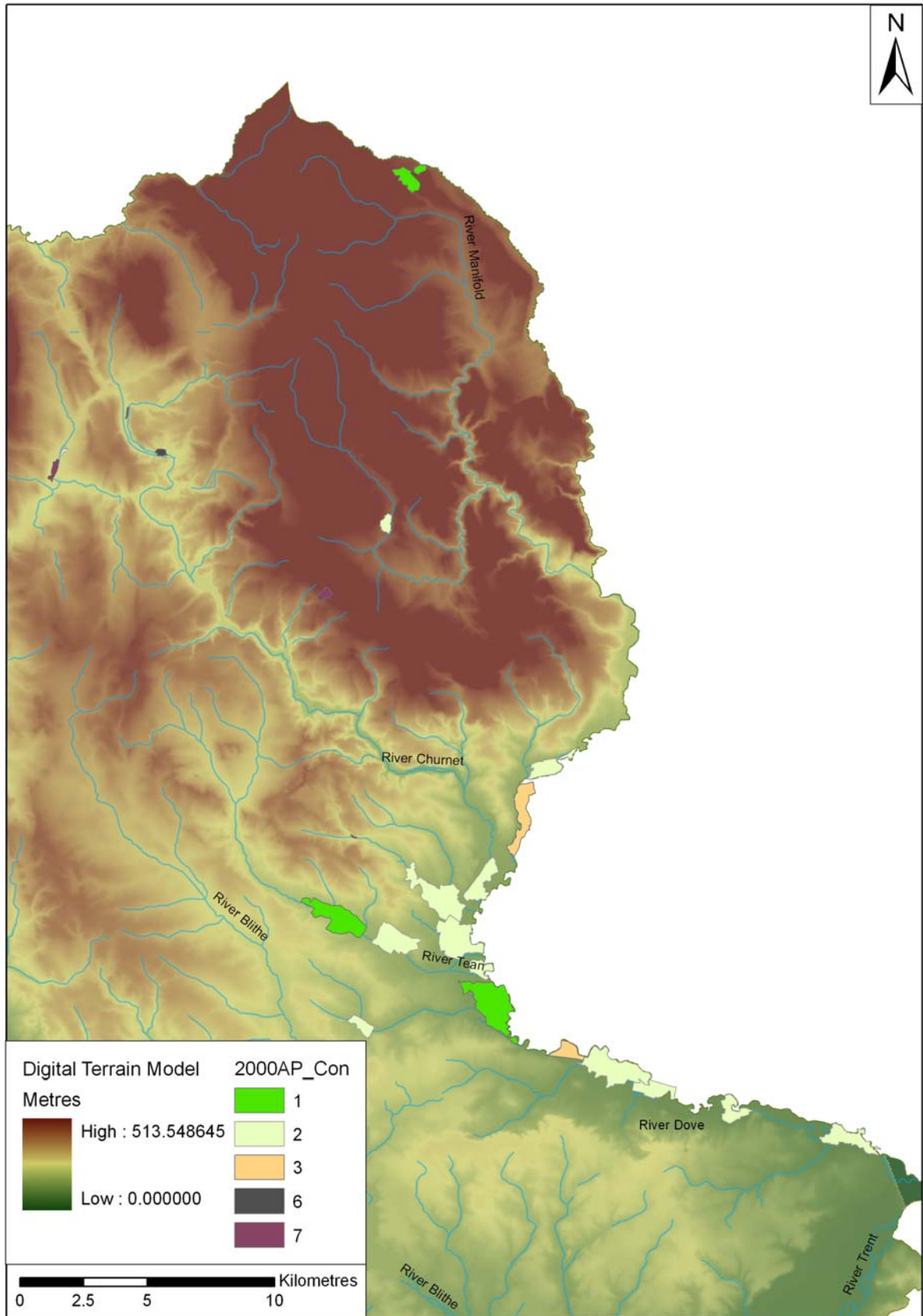


Figure 55- Possible water meadows identified within the Dove, Tean, Churnet and Manifold valleys

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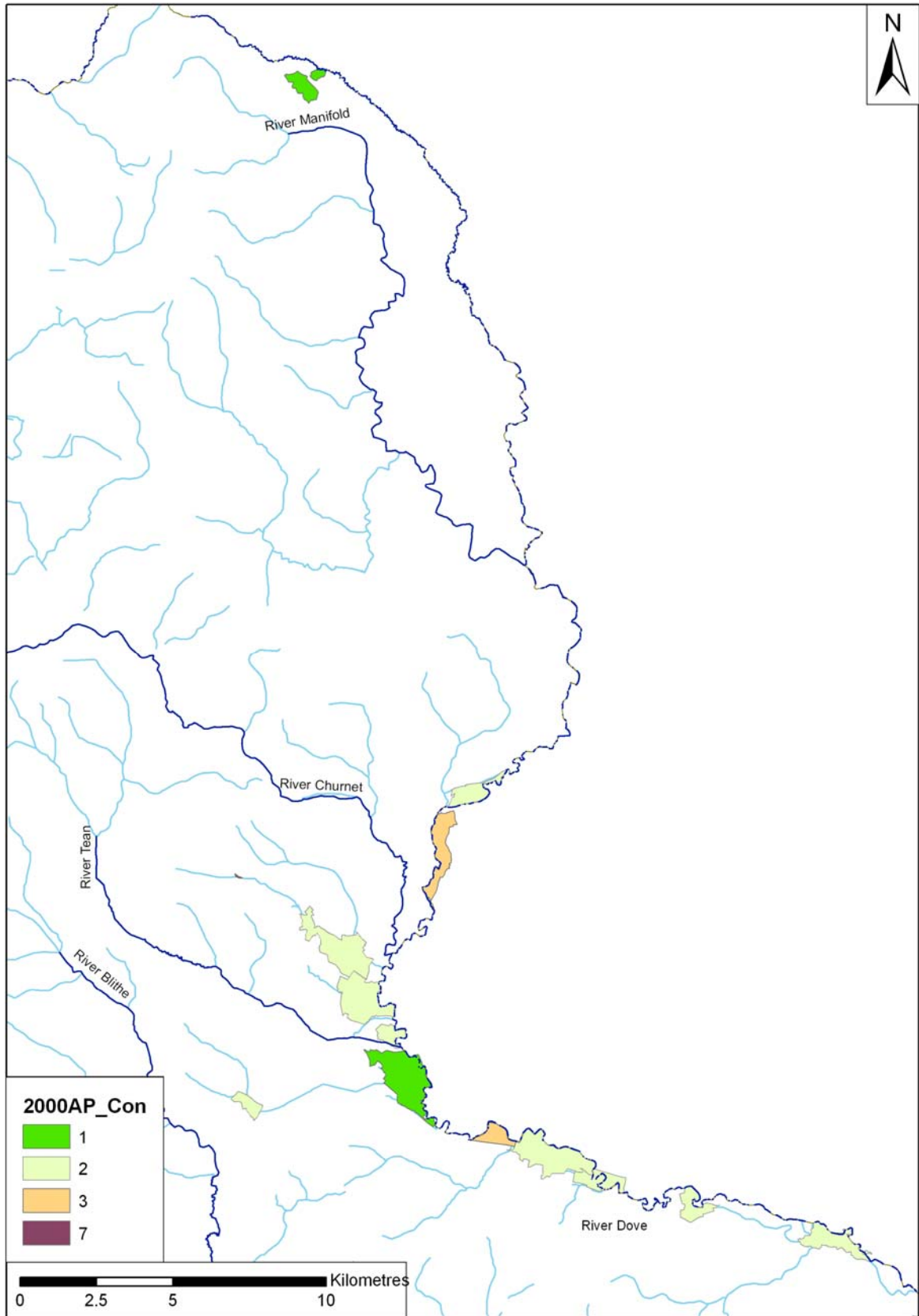


Figure 56- Water meadow targets within the Dove river valley, recent condition

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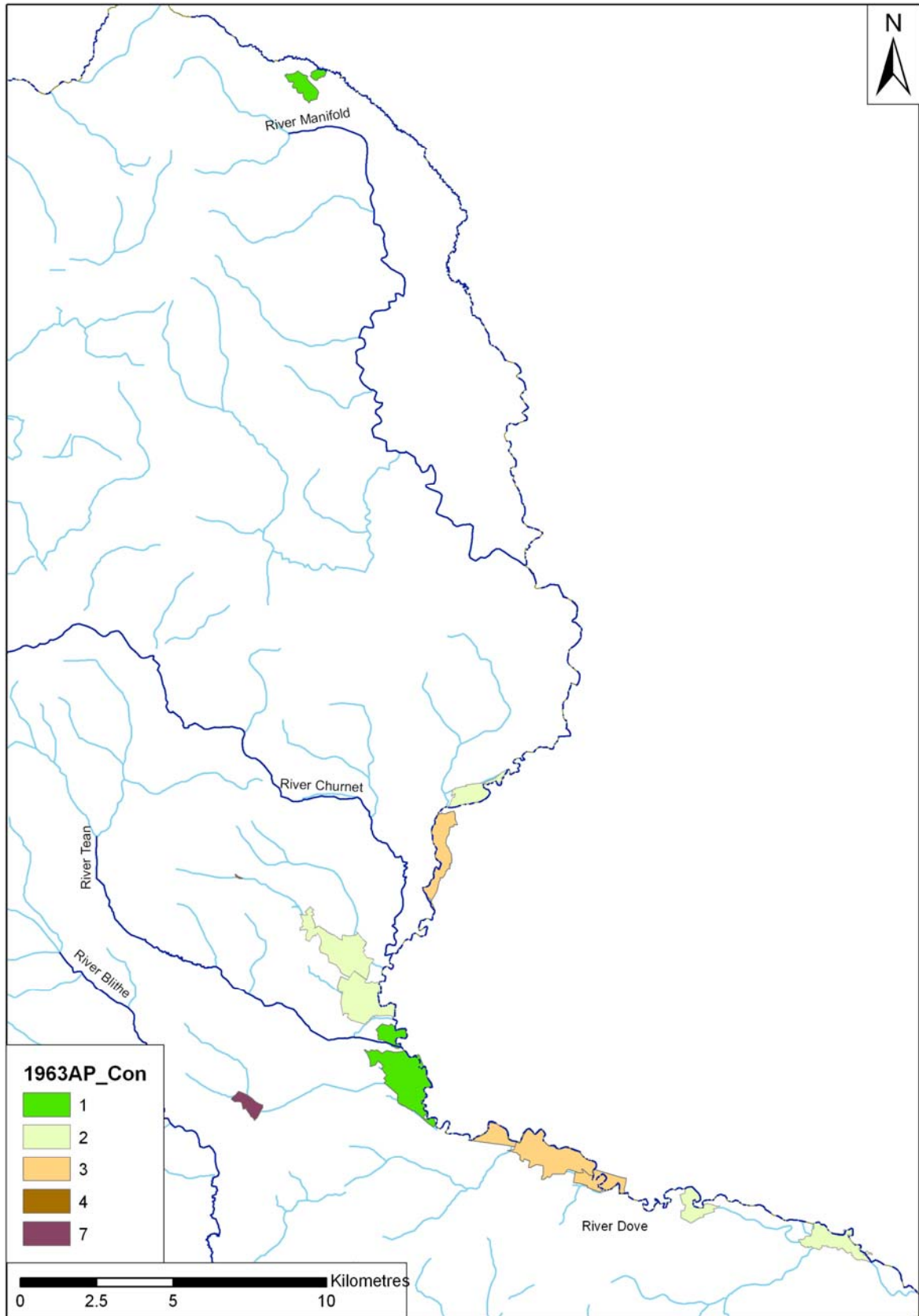


Figure 57- Water meadow targets within the Dove river valley, 1963 condition

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Field Assessed Systems

Willows Farm, Uttoxeter, NGR SK1025933368 (Figure 5, Target 2)

This target lies immediately to the east of modern Uttoxeter, with the farm which gives its name to this target at the centre of the possible water meadow area. The defined target is 226 hectares in area, and was seen to have a condition of 1 in both series of aerial photographs. This value was based upon the aerial visibility of earthwork features apparently representative of carriers and main drains across the area, and was supported by the presence of marked sluice systems within the area upon the 1st edition Ordnance Survey mapping (Figure 59).

Only select areas of the target were available for survey, due to the land access permission problems mentioned previously, these areas being land surrounding Willows Farm itself, and areas to the north visible from public footpaths (Figure 59).

Field survey identified a series of channels crossing some portions of the southern surveyed area, apparently representative of carriers and minor drains, and still retaining the grid pattern of the original meadow plan. Across most of this area the main drain features were clearly visible, although in many places these appeared to utilise and follow the course of natural streams with little alteration of these.



Figure 58- Drain features visible at Willows Farm

The most striking evidence for the status of the area as a former water meadow system came in the form of preserved structural features. These features were primarily comprised of sluice hatch settings, of which seven were recorded, and were constructed from sandstone blocks. These blocks were rough-hewn, and possessed slots for the sluice hatches, and sockets for the sluice hatch mechanisms (Figure 60).

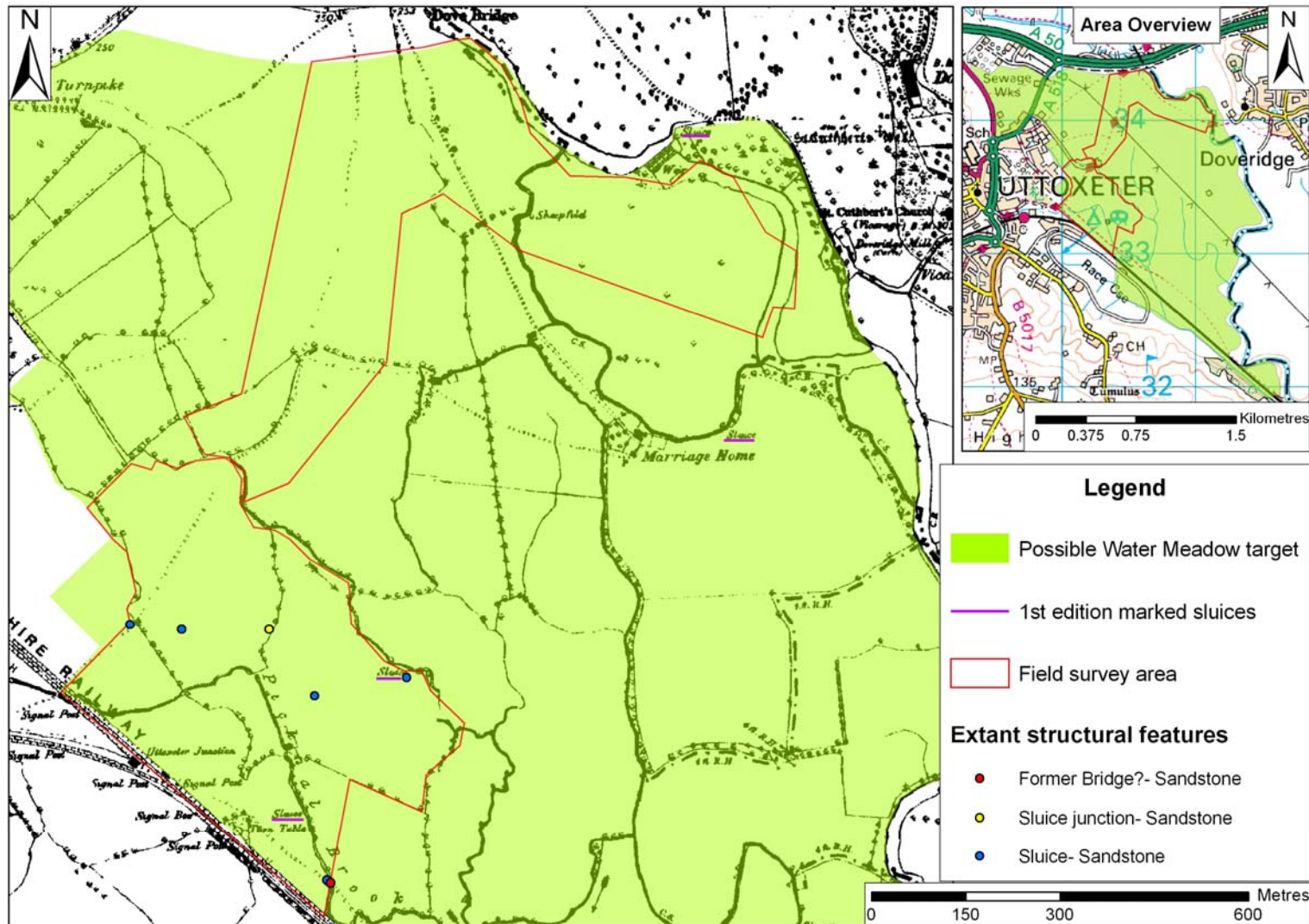


Figure 59- Willows Farm target, historic mapping and structures recorded in the field

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Figure 60- Preserved sluice hatch settings, Willows Farm

In some cases (above left) drains remain in association with these features, in others former drains have dried up or been in-filled whilst sluice settings apparently remain (above right), however there remains the possibility that these settings are in fact not in-situ. Within the surveyed area a single collapsed sluice remained which corresponded to the position of a sluice marked upon the 1st edition mapping. This feature is visible in a much more complete condition within a 1991 photograph provided by Mr Andrew Allen (the owner of Willows Farm at the time of this report), demonstrating one of the threats to meadow structures over time, the encroachment of vegetation into their fabric.



Figure 61- Damage to former sluice structure over time, Willows Farm

Photograph courtesy of Mr Andrew Allen

The monochrome photo in Figure 61 shows this feature in 1991, with the hatch slot clearly visible to an appreciable height, whilst the colour photo (taken looking along the line of the former drain during field survey in February 2007), demonstrates the damage produced by the unchecked growth of the tree seen invading the structure in 1991.

Additionally, a preserved sandstone bridge was discovered, mostly buried, and at the position marked in Figure 59. This structure was composed of rough-hewn sandstone blocks, and whilst occupying dry land now, is positioned across the former line of the Picknall brook as it was until recent memory, when it was diverted to its current course several metres to the west (pers. comm. Andrew Allen, farm owner). Should the opportunity present itself, the future investigation and detailed recording of this feature, potentially via exposure through excavation, (possibly followed by reburial for preservation purposes) would be recommended.



Figure 62- Preserved bridge, Willows Farm, external (left) and internal views (right)

(Foreground image saturation is due to flash photography)

The rough-hewn sandstone construction of these features suggests an earlier date than those seen elsewhere, with Willows Farm perhaps reflecting an early, rather than late, post-medieval example of a water meadow. With the wide-spread availability of brick from the mid 18th century onwards, and the increased time and effort required in the construction of these substantial features in sandstone, it is likely that the use of this water meadow predates the mid eighteenth century, and may indeed be pre-eighteenth century in date.

Based upon the features described above, a field condition of 2 was confirmed for the southern area. It should be noted that these conditions are based only upon extant earthworks, as the southern area of Willows farm proved to have the best preserved meadow structures of any field-tested target. This area would likely prove highly suitable for any display of meadow features or future work (such as detailed meadow planning or survey), due to the highly interested and archaeologically responsible attitude of the owners Mr and Mrs Allen, personally responsible for the preservation of many of the aforementioned features. Additionally, the area remains of high interest due to the indications that it may represent one of the earliest potentially dateable systems within this survey. Petrological sourcing, and the analysis of these features by a local architectural archaeological specialist, may be able to indicate a source for the stone used within the meadow structures, and whether they were

quarried to purpose, or re-used from an earlier stone structure within the area. Such analysis would potentially help to refine the date of use of this water meadow system.

Field survey within the northern area revealed little information regarding further water meadow structures within the area, due to the restriction of access to public footpaths. Some earthwork features were visible, potentially representative of former water meadow features, however these appeared more likely from a distance to represent ridge and furrow features, consequently, a field condition of 3 was applied to the northern area, subject to revision through detailed survey.

3.3.2 *Tean River Valley*

The Tean river valley contained only two potential meadow targets. These were clustered at the southern end of the river, within 7 km of its confluence with the Dove, at Checkley and at Stramshall.

The western target, at Checkley, was judged to have a recent condition of 1 and a 1963 condition of 2 (Figures 63 and 64), whilst the eastern target had a condition of 2 in both image series.

Well-defined earthworks were visible in recent imagery across the majority of the Stramshall target (137 hectares in size), with a few fields where more subtle earthworks such as carrier drains also appeared to be visible. It should be noted however, that whilst the majority of the features seen appear strongly to suggest water meadow there remains the chance that some of the grosser earthworks within this area may represent ridge and furrow lacking the tell-tale sinuosity and differing direction often used to distinguish this agriculture from the air. Final confirmation of the nature of these earthworks would require on-site survey.

The target at Checkley (171 hectares in size) can be seen on the 1st edition mapping to have contained several sluices in the late 19th century, distributed along the Tean. Additionally, recent aerial imagery, particularly that from Google maps, clearly demonstrates portions of typical water meadow earthworks, apparently well preserved, with less well preserved earthworks present across the further extent of the target.

The positioning of these targets appears once again primarily functional, with the wide basin towards the confluence with the Dove providing the only area along the Tean suitable for exploitation through bedwork water meadow systems, and with no evidence seen for systems of any other form upon this river.

3.3.3 *Churnet River Valley*

The Churnet valley was found to contain a total of six potential water meadow targets, three of which are distributed along the Churnet itself, whilst the others lie upon tributaries which drain into the Churnet (Figure 65).

These targets range in size from 2 to 97 hectares, with a mean size of 24 hectares. The single largest target lies in the lowland area to the southeast, at the confluence of the Churnet and Dove rivers, whilst the remaining smaller targets are positioned within the high upland areas of the valley, their size most likely a product of the topography at these points.

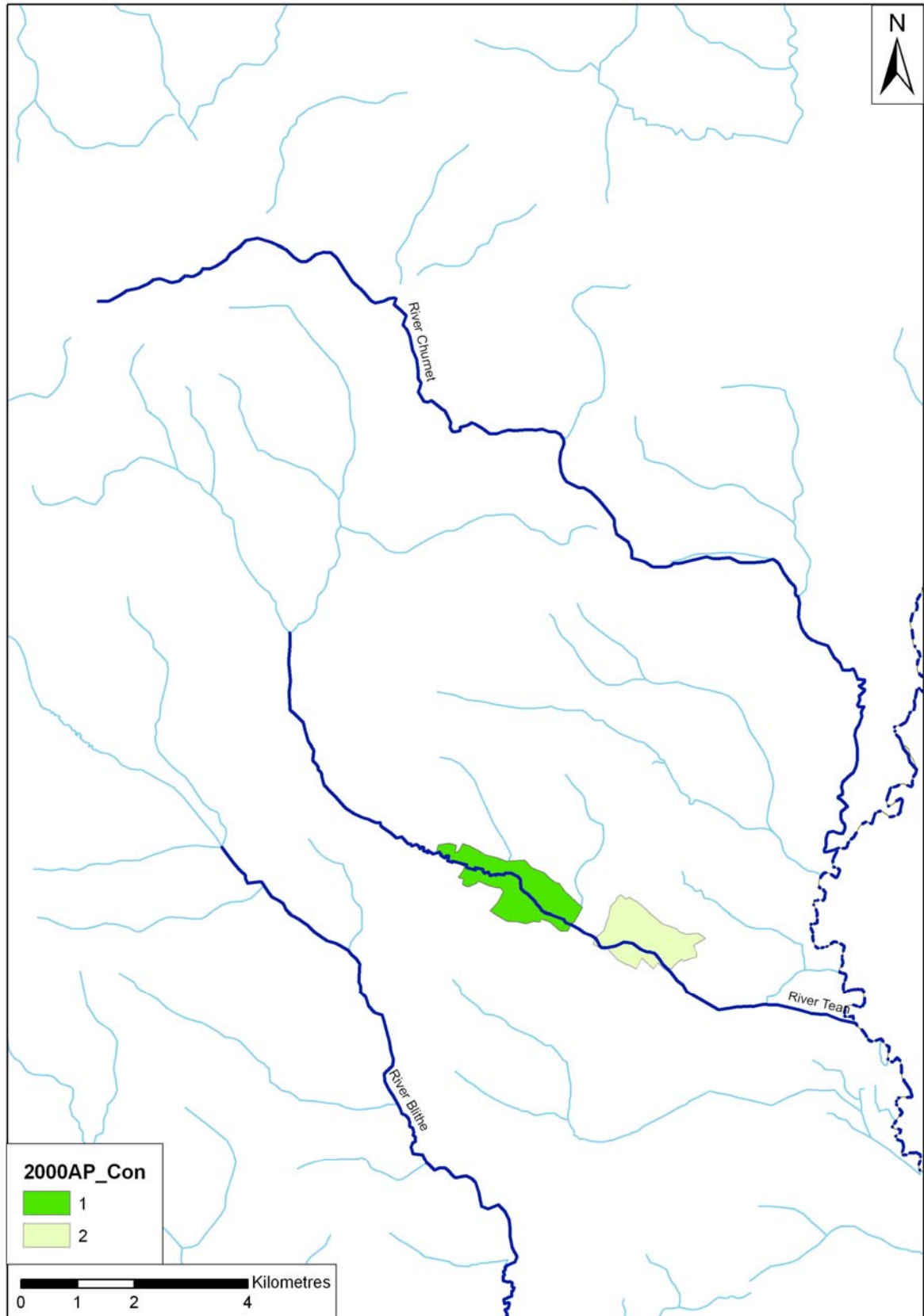


Figure 63- River Tean possible water meadow targets, recent condition

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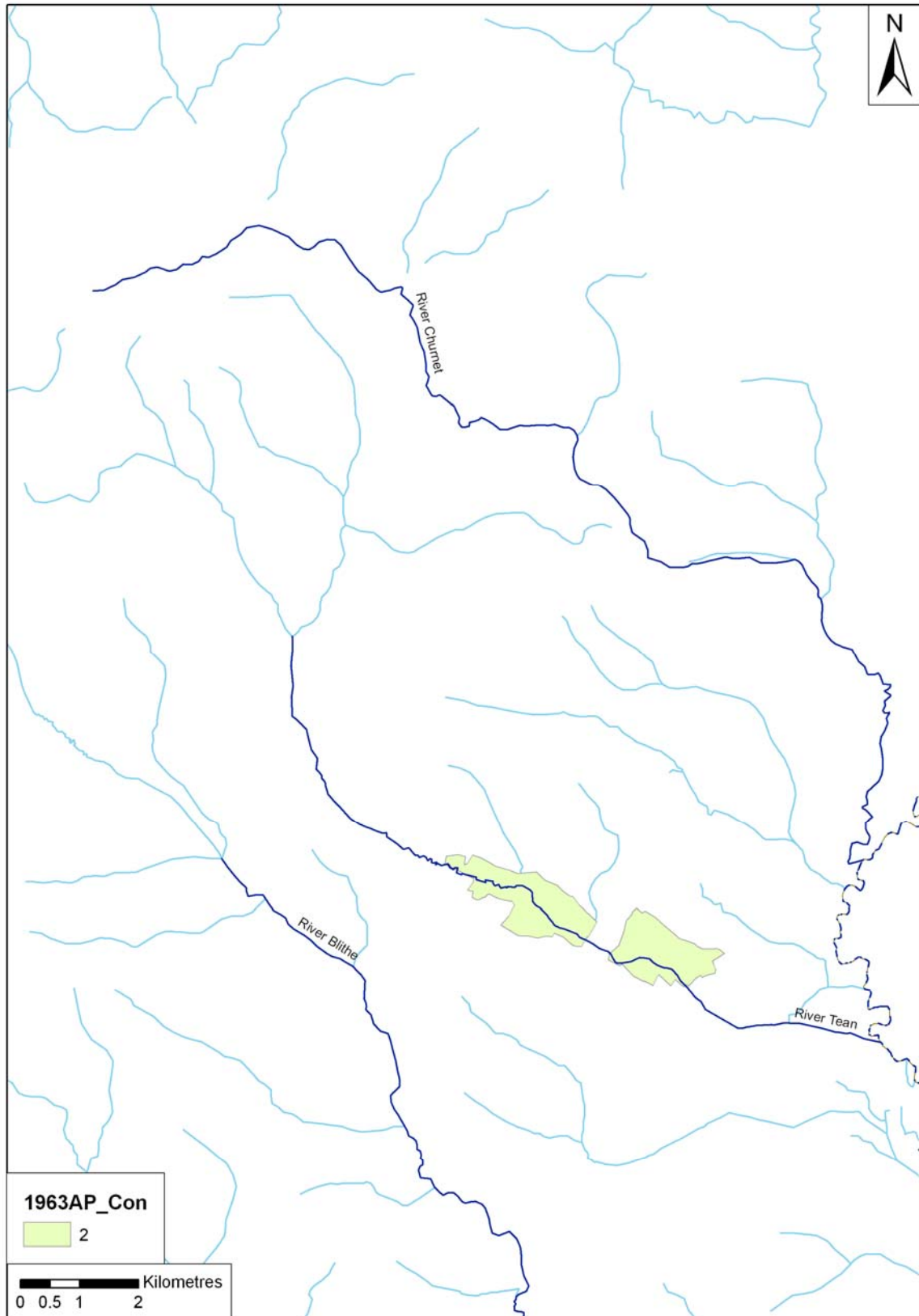


Figure 64- River Tean possible water meadow targets, 1963 condition

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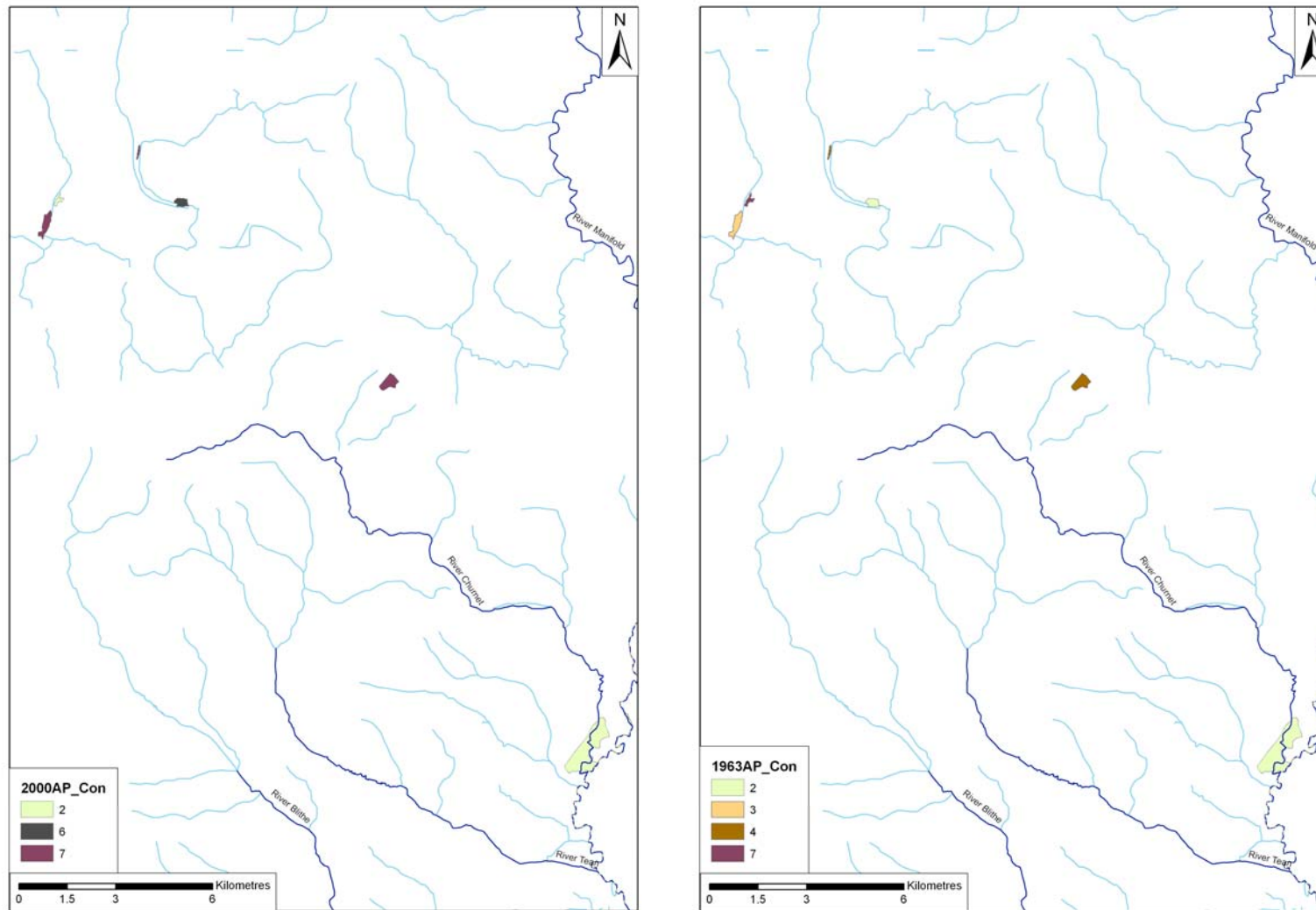


Figure 65- River Churnet possible water meadow targets, recent condition, and 1963 condition

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Of these targets, two had a recent condition of 2, a single target had been destroyed since the 1960's (condition 6) and the nature of three targets was unclear within the recent images, whilst appearing to represent possible meadow in other sources (value 7).

A single target, lying to the northeast of Ipstones, potentially represents a catchwork system, however, recent aerial photography is insufficient to judge whether the drainage features present merely represent field drainage, the most likely explanation for the features seen within the area of this target. Consequently, since field testing of this suspect target could not be achieved due to access restrictions, the target remains within the dataset, albeit with a question mark over its potential to represent a meadow.

3.3.4 *Manifold River Valley*

A single possible meadow was identified within the Manifold valley catchment area (Figure 66), at Martin's Low, on the valley side of the River Hamps (a tributary of the Manifold). This target has an area of 24 hectares, and is defined by a series of drains marked on the modern map data, and some possible earthwork features were visible within the aerial photographic imagery for the area.

The target at Martins Low was judged to have a recent condition of 7, and a condition in 1963 of 4. The potential for this target to represent former water meadow is low, however, due to its position on a valley side, if found to represent a former meadow then this target must take the form of a catchwork system, raising its importance. This target had been marked for field survey in order to ascertain its nature, however, due to access restrictions survey was not possible. Consequently, despite the likelihood that this site does not represent a former meadow it remains within the dataset, to mark the site for future survey in light of the importance should the area prove to be a catchwork system.

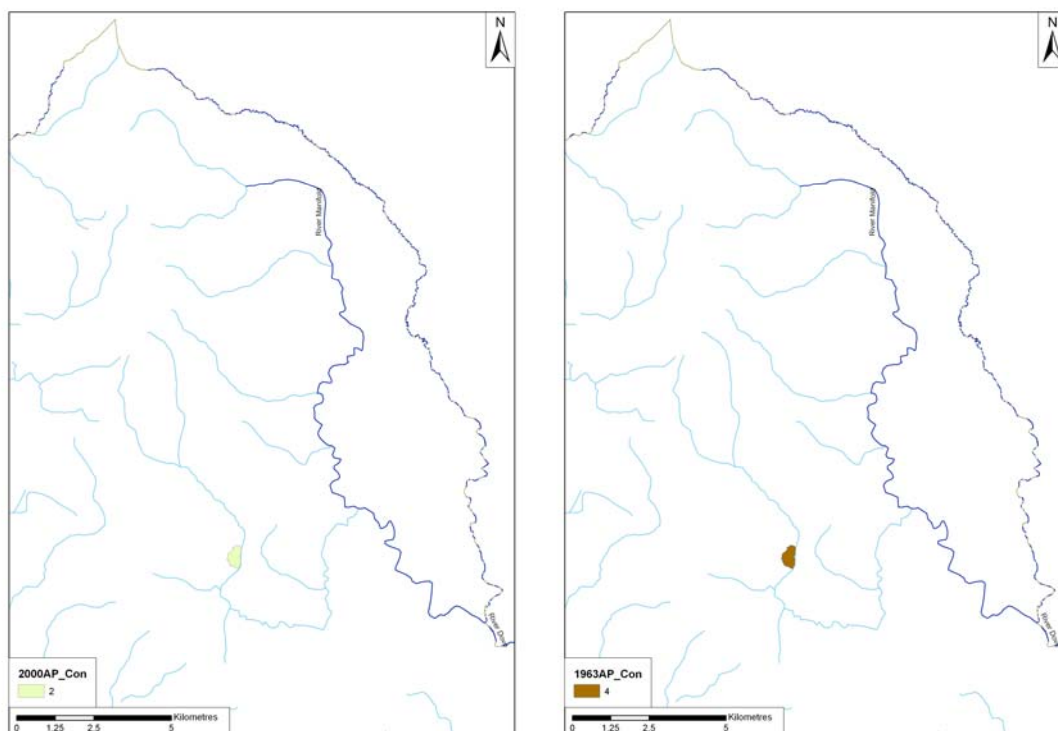


Figure 66- River Manifold possible water meadow target, recent and 1963condition

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3.4 Water-Meadows in the Stour, Tern and Dane Valleys, and miscellaneous targets

This final subdivision encompasses the remaining possible water meadow targets within the county, distributed around the Stour river valley in the south of the county, the Tern in the west, and the Dane in the north. These comprise the minor river valleys of Staffordshire, in terms of their length within the county. Additionally, grouped with these valleys for the sake of simplicity, were several possible water meadow targets present on minor tributaries or rivers which do not drain into any of the aforementioned valley systems. A total of 15 targets were identified within these valley systems, with the greatest individual number of targets attributed to the Stour valley. No field targets were assessed from this subdivision, due to access restraints.

3.4.1 *Stour River Valley*

A total of nine targets were identified within the Stour river valley (Figures 67 & 68), five along the Stour itself, and four along the Smestow Brook. These targets ranged in size from 2 hectares to 41 hectares, with a mean size of 11 hectares.

Targets within this river valley was shown to be generally poorly preserved, with two targets with a recent condition of 3, one of 4, and two targets having been destroyed (value 6). Of the remaining four targets, two received a value of 7, with the aerial photography not providing sufficient information for conclusive assessment, and two were under woodland cover (value 0), again preventing aerial assessment. An assessment of change over time could not be effectively produced for this system, with the aforementioned barriers to assessment meaning that only 2 targets showing change over time, one having been destroyed since the 1960's, and one apparently having improved, again due to improved resolution in recent imagery.

The only discernable pattern within this distribution was the relatively poor preservation seen in a cluster along the central portion of the Stour, around the modern settlement of Kinver. This is once again likely due to the effects of urban remodelling of the landscape, with portions of possible former water meadow now apparently in use as allotments and playing fields.

3.4.2 *Tern River Valley*

A single possible meadow target, of 7 hectares in size, was identified upon the Tern (Figure 69), adjacent to Hungersheath farm, 3 kilometres to the Northeast of Loggerheads, and 500 metres to the southwest of Blackbrook village.

The target lies relatively close to the source of the Tern within the grounds of Maer Hall. A series of possible channels can be seen crossing the area within historic mapping, and aerial photography confirms the presence of apparent channel features, with the target being granted a condition value of 3 in both series of aerial photographic analysis.

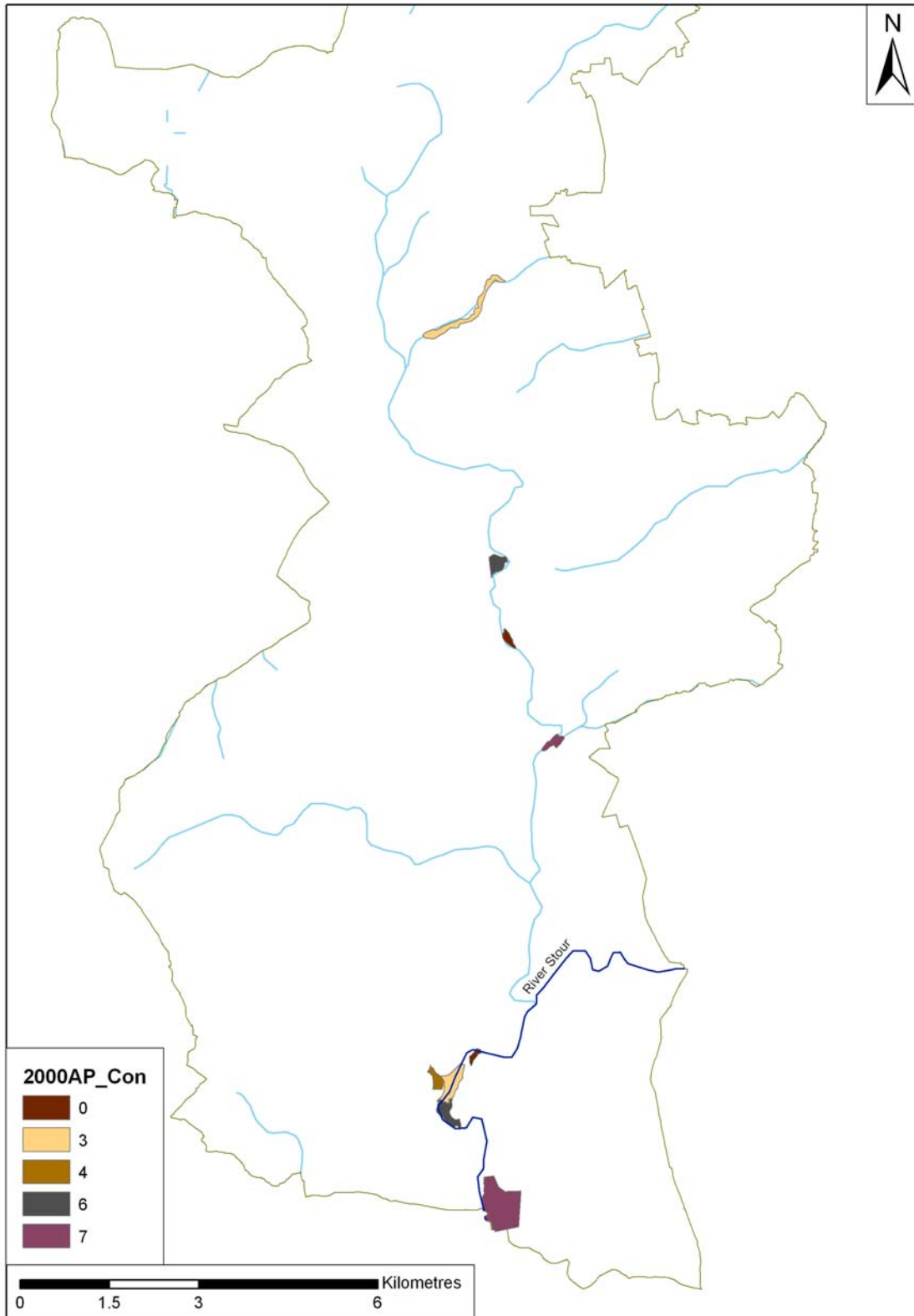


Figure 67- River Stour possible water meadow targets 1963 condition

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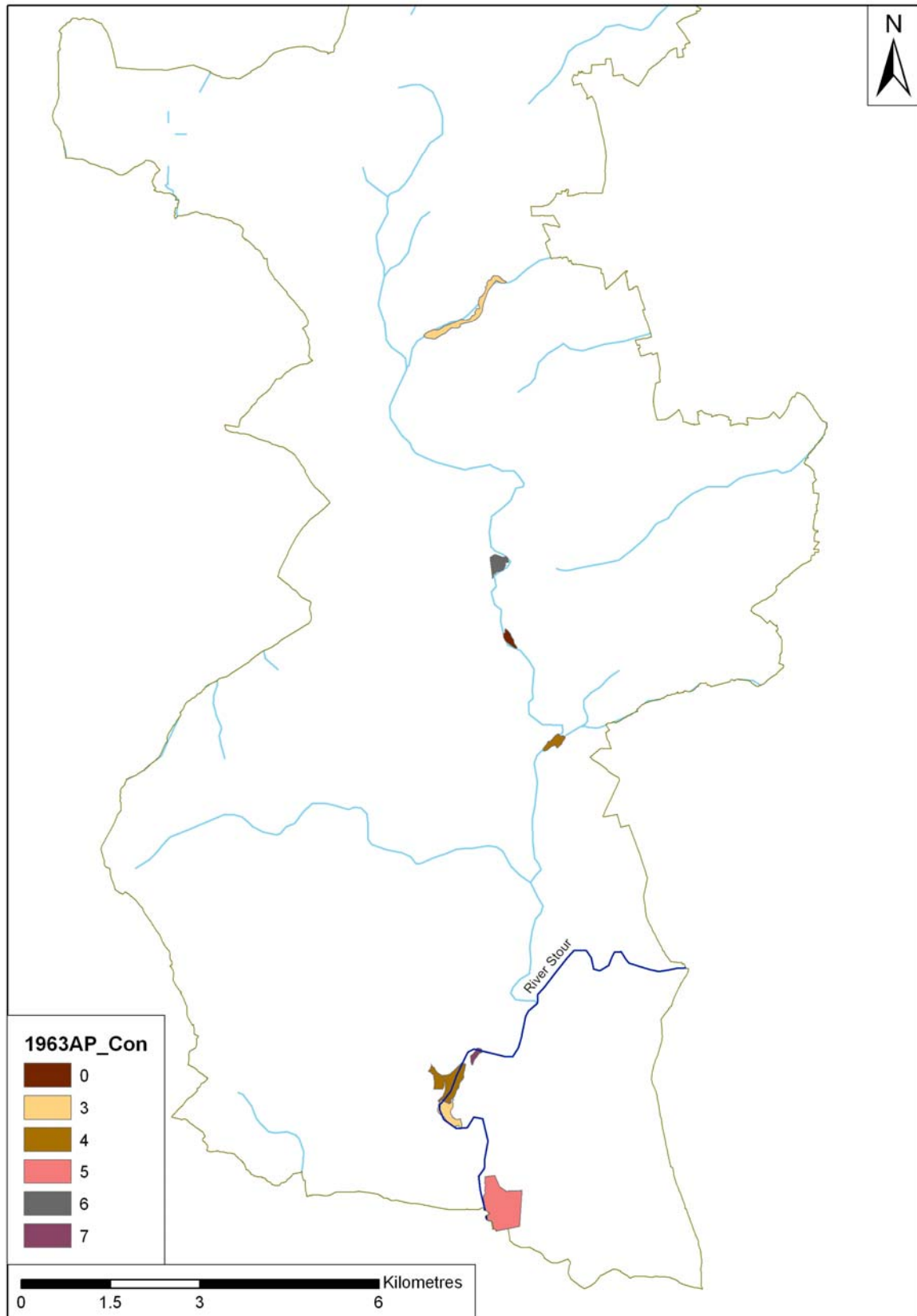


Figure 68- River Stour possible water meadow targets 1963 condition

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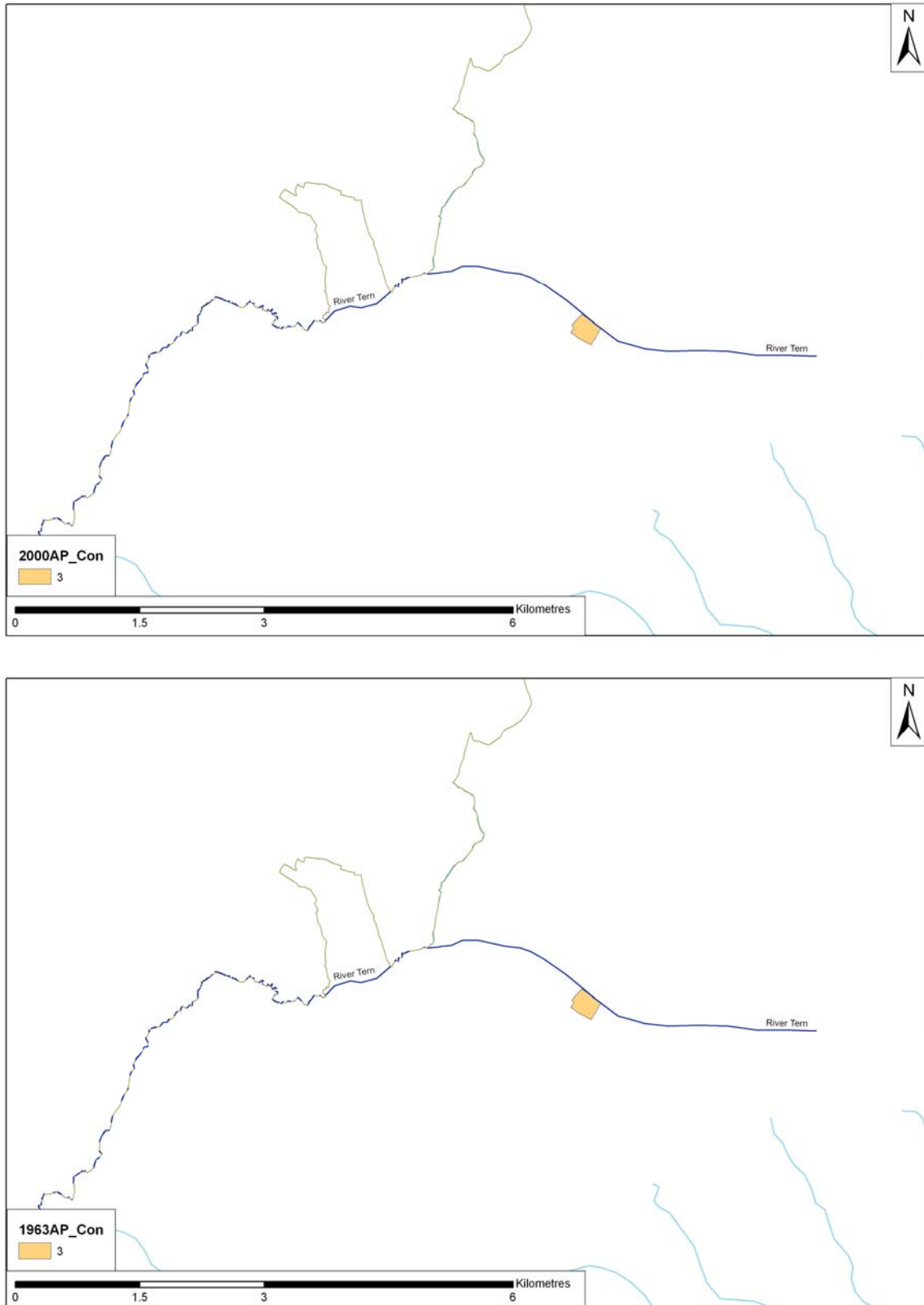


Figure 69- River Tern possible water meadow target recent and 1963 conditions

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3.4.3 Dane River Valley

The course of the Dane itself forms the northernmost boundary of Staffordshire, and consequently, only the areas to the south of the river course were assessed within this study.

This river valley also returned only a single target (Figure 70), immediately to the southeast of the village of Ryecroft Gate. However, this target proved to have relatively poor preservation in both series of aerial photographic images, and with limited information visible upon the historic maps, there remains a strong probability that this target does not reflect former water meadow.

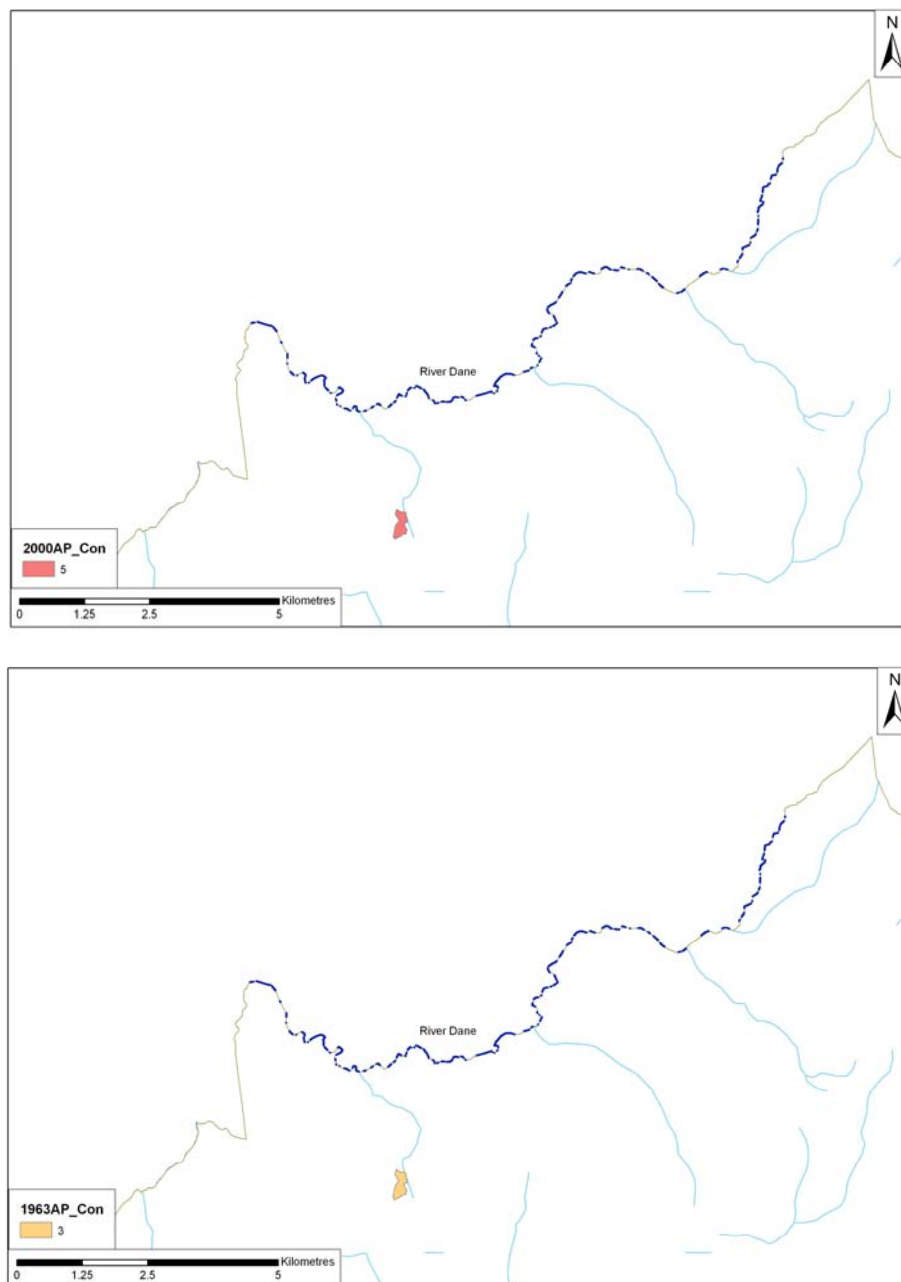


Figure 70- River Dane possible water meadows targets, recent and 1963 conditions

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4.4.4 Miscellaneous possible meadows (away from major rivers).

A total of three possible meadows were identified away from major river systems, all along the western flank of the county, between Newport and Eccleshall. Two of these were positioned on the Lonco Brook, and a single target on the Black Brook to the south of Aqualate Mere.

Targets size ranged from 2 hectares to 31 hectares, and targets appeared moderately well-preserved, with recent conditions of 2 for the largest target, near Newport, and of 3 and 7 respectively for the targets nearest to Eccleshall. These conditions appear to have changed little over time, with only a single target dropping a condition value, from 2 to 3 (Figure 71).

Due to the scattered nature of these targets little can be said about their distribution, other than the demonstration that even minor streams and brooks away from major river valleys were employed in some cases in the creation of water meadow within the county.

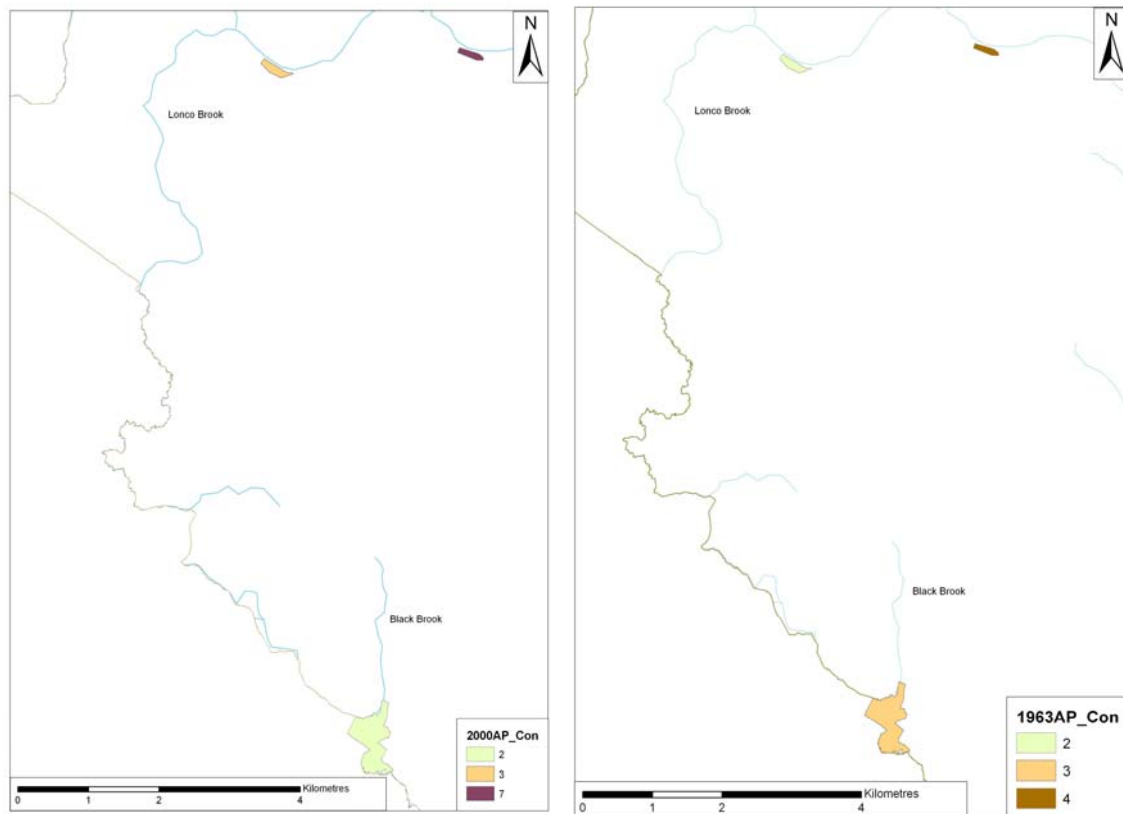


Figure 71- Miscellaneous possible water meadow targets, recent and 1963 condition

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4 DISCUSSION: THE NATURE AND DISTRIBUTION OF WATER-MEADOWS IN STAFFORDSHIRE

From an overall perspective, it can be seen that the primary distribution of likely water meadows within the county is concentrated along the central lowland river valleys, reflective of the conditions ideal for bedwork systems. Where smaller targets have been identified away from major river courses this may be reflective of the enterprising efforts of farmers with smaller landholdings keen to take advantage of the benefits of water meadow cultivation, and, as mentioned in the case of Trentham, 'making use of whatever water they could obtain for this purpose' (Loch 1820:199-200). Some clustering of large targets can be seen towards the confluences of major rivers, as to be expected due to the increased availability of water within the landscape, and the tendency for floodplains to be wider in these areas, facilitating meadow cultivation.

The size of individual systems varies widely, with primary governing factors appearing to be topography, and the whims of drainage- the available land for meadow usage being defined by the space available between the river and the valley flanks. In many areas the full available space does not appear to be utilised, due to spatial restrictions imposed by man-made obstacles such as valley settlements, canals and railways. However, it should be considered that due to the presence of the majority of these features upon the 1st edition maps, it is difficult to determine the relative dates of these features. This leads to questions as to whether the other man-made articles are respecting the meadow spatially, the meadow respecting the obstacles, or neither, with former meadow extent having been larger and portions of this extent having been destroyed by later man-made features. Only further analysis, on a site-by-site basis, in the form of detailed examination of field relationships and of local historical records, can resolve these questions.

The form of systems within the county appears heavily biased towards the use of bedwork systems. Only a few select examples of possible floating upwards or catchwork systems identified within the study, none of which can be considered fully field confirmed as a result of access restrictions. This bias can be seen from two perspectives. Firstly, due to the increased productivity of bedwork systems, and the availability of large areas of lowland river valley to support these systems, it appears inevitable that the majority of meadows within Staffordshire would be of this form. However, the extensive upland areas of Staffordshire would also suggest that alternative systems would still be of benefit within the county, with large areas in which they could be effectively employed. Secondly, this bias may also be seen as a product of visibility, with the features indicative of floating upwards or catchwork systems being harder to identify through aerial photographic and historical mapping perspectives, as only small numbers of drains are required. In upland areas therefore, these may not be readily distinguishable from the many drainage features utilised to remove excess water to the valley bases, or indeed may not be mapped. Consequently, this assessment should be considered to be primarily geared towards the identification of bedwork systems, with the complementary examination of local historical records for upland areas potentially being of benefit in the further identification of other system types.

Amongst the bedwork systems a variety of patterns was seen, although all of course conform to the basic functional model of bedwork systems. The examination of the typology of bedwork systems across the county is beyond the scope of this study, however, following on from the identification of system locations presented here, such future work could be undertaken. Due to differential preservation of systems, and the potential loss of diagnostic system features, any truly detailed comparison of system plans would best be performed through use of rapid methods of high-resolution topographic survey, such as real-time kinematic GPS or airborne laser scanning (lidar) equipment.

The study suggested several key contemporary threats to the survival of water meadow features. Primary amongst these is settlement expansion, as with any form of archaeology which shares its extent with zones suitable for further urbanisation. A further threat identified during the fieldwork is the restoration of areas of wetland, an admirable enterprise, but one which, if unwitting of the presence of former water meadow within the area, can be detrimental to preservation. That said, unlike urbanisation, wetland reinstatement (based upon the limited examples seen during fieldwork) appears less likely to completely destroy a meadow, with main drainage features often preserved and simply flooded permanently. However, subtle earthwork features may be lost, and any landscape alteration in order to generate the wetland areas may compromise the preservation of earthworks and structural features.

A final major threat, typical to archaeology, was seen to impinge upon the preservation of water meadows within the survey area; that of ploughing. Some field survey targets, such as Orgreave and Willows Farm, demonstrated areas which had apparently been subject to ploughing, removing all earthwork features, or at best, leaving only the deepest channels extant. This threat may indeed be the largest, since the majority of water meadow features identified appeared to be upon land still in use as farmland. Whilst the propensity of former water meadows to flood may have protected many from the plough, efforts to prevent this flooding to produce areas suitable for cropland may potentially produce damage equivalent to or exceeding that generated by ploughing.

Consequently, the primary tool in mitigating against these threats lies in prior knowledge as to the whereabouts of former meadow systems, a resource which these survey results, upon integration into Staffordshire County Council HER, are intended to provide.

In terms of assessment of the condition of water meadow features, Table 3 and Figure 72 illustrate the number of sites belonging to each condition value within each series of aerial imagery assessments. As can be seen, there has been an apparent increase over time in the number of well to moderately preserved sites (values 1 and 2), with 40% of the dataset falling into this category in 1963, and 41% in 2000. Additionally, there can be seen to have been a general trend of improved condition across the scale, with more sites improving in condition than deteriorating (Figure 73). This appears reflective of the imagery resolution problem discussed previously. A total of 15 meadows appear to have been completely destroyed between the two aerial imagery surveys, however 43 percent (73 sites) appear not to have changed condition at all (Table 4). Consequently, this study cannot be seen to have been truly effective in terms of estimating changing condition over time, providing merely a broad assessment of probable current condition and of *potential* site deterioration (in the case of the 42 sites to have apparently reduced in condition since the 1963 survey).

1963 condition	No. of sites	% of sites	2000 condition	No. of sites	% of sites
0	3	1.648	0	3	1.648
1	20	10.989	1	28	15.385
2	56	30.769	2	48	26.374
3	60	32.967	3	36	19.78
4	22	12.089	4	21	11.538
5	2	1.099	5	4	2.198
6	3	1.648	6	16	8.791
7	16	8.791	7	26	14.286

Table 3- Condition value assessments- statistics

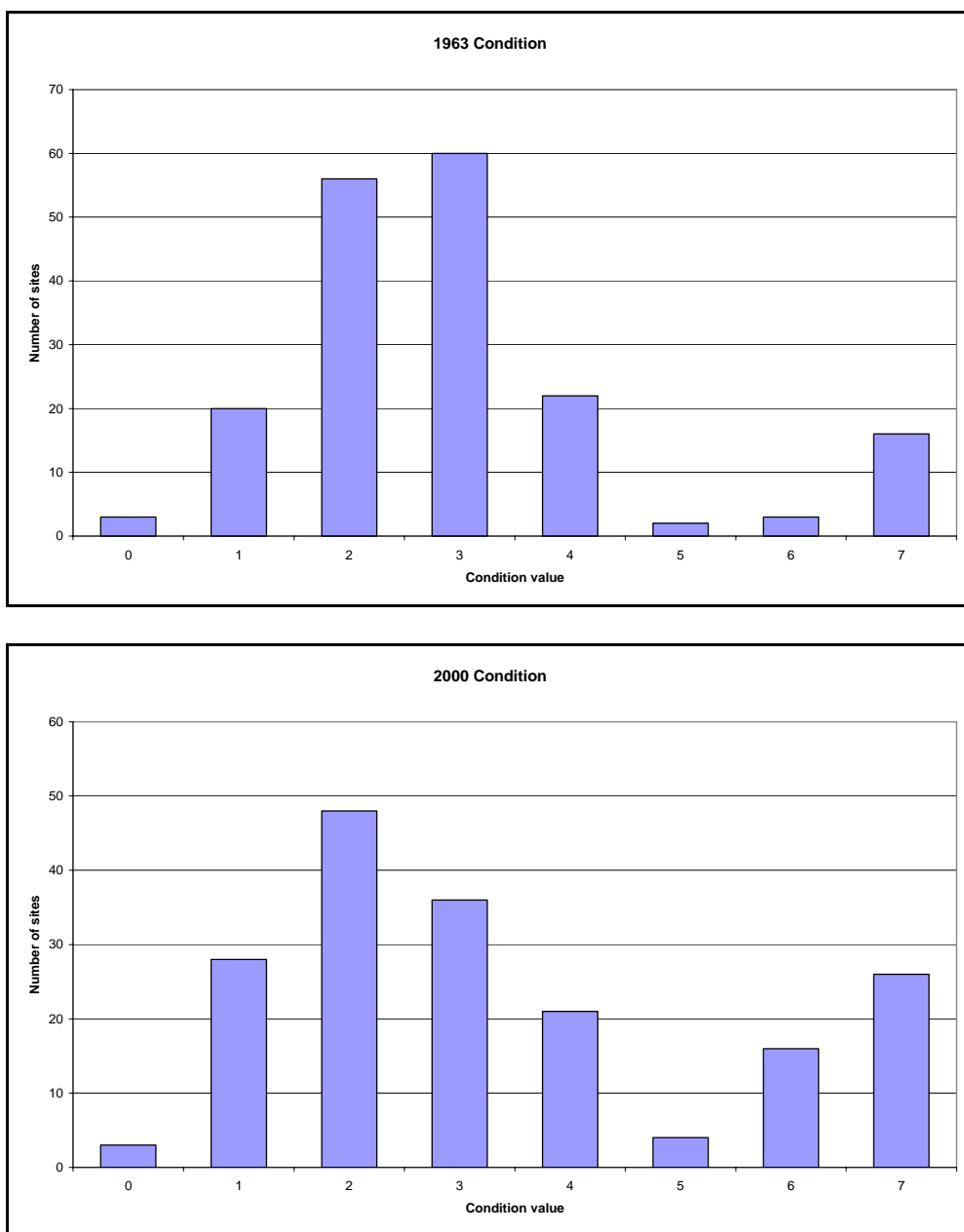


Figure 72- Graphs displaying condition value statistics for targets within each assessment period

Change in condition value (1963-2000)	Number of sites	% of sites
-7	1	0.549
-6	1	0.549
-5	2	1.099
-4	6	3.297
-3	5	2.747
-2	10	5.495
-1	17	9.341
0	73	40.11
1	23	12.637
2	7	3.846
3	18	9.891
4	14	7.692
5	3	1.648
6	2	1.099

Table 4- Proportions of condition change (number of stages of condition change over time)

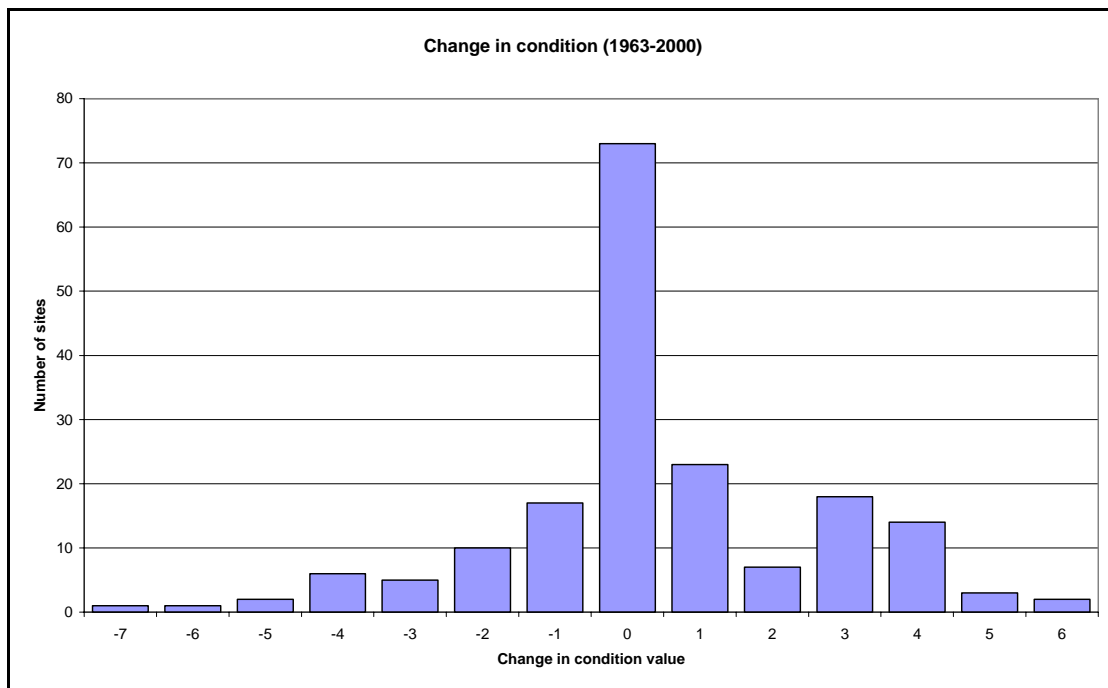


Figure 73- Graph showing proportion of condition change 1963-2000

5 CONCLUSIONS

The desk-based study can be seen to have been broadly effective in terms of its predictions regarding the location, extent and preservation of former water meadows within Staffordshire, based upon field survey results. Of the 18 targets which were examined during field survey, almost all appeared to represent former water meadow systems. Within these assessed targets, the recent (2000) condition value corresponded to current field condition in the case of 8 targets, condition dropped by one value for 6, and 3 targets dropped two values. A single target (adjacent to Broad Meadow) looks likely to have been destroyed in recent years, possibly due to plough damage. However, these results cannot be taken as a full representative sample in terms of testing the model, and so can only be considered an approximation of effectiveness, rather than an objective measure (discussed below).

The survey can be seen to have effectively achieved its aims and objectives and to have expanded upon them where appropriate.

However, all methodologies are subject to limitations, hence, to allow effective employment of the data by further parties, details of the limitations of this form of survey are included below.

5.1 Survey Limitations

As previously stated, when performing any aerial photographic landscape assessment the ideal methodology is to study the subject from a variety of perspectives, using imagery taken from flights flown in differing conditions, and over a period of time. Whilst the aerial photographic sources for this study had a chronological spread, the imagery utilised was only available from a vertical perspective. Since some of the earthwork features associated with water meadows can be subtle in nature, sites should ideally be additionally studied using imagery taken from an oblique perspective at either dawn or dusk, when shadows cast by these features are longest.

Consequently, there remains the possibility that poorly preserved or subtle water meadow targets may have been overlooked during the aerial photographic phase. Additionally, due to the low resolution of available 1963 imagery, effective assessment of the changing condition of water meadow features over time was hindered. In many cases target condition had the illusory appearance of having improved over time, a consequence of the increased resolution of recent imagery allowing the identification of features indistinguishable on the 1963 imagery. In order to mitigate against these effects, the ideal approach to determine maximum levels of current preservation would be to utilise 0.5m resolution airborne lidar to perform a rapid topographic survey of identified targets, coupled with a more detailed aerial photographic survey.

An important point is that, in so far as this data can be considered a model of former meadow distribution, it can only be used to measure that distribution from the date of its earliest source, in this case the 1st edition mapping. The gaps in meadow distribution concurrent with the position of large post-medieval urban centres therefore, may or may not be reflective of the original distribution of water meadows in the county. Whilst it is certain that the majority of these centres were present within the late medieval and early post-medieval periods, and therefore that meadow distribution will respect the contemporary boundaries of these centres,

these boundaries changed substantially over time, particularly in the industrialised areas of the county. This means that large portions of former meadow may well have been destroyed prior to the 1st edition mapping, leaving no trace in the sources examined within this study.

Any assessment of the chronological spread of water meadows within the county can therefore only result from analysis of dateable remains from individual sites, or from detailed local historical records, should these record the presence of meadow corresponding to targets generated by this survey. Within this large scale study itself, since target locations are determined by features visible upon first edition mapping, detailed dating evidence cannot be generated, since all meadows within this study were simply extant within a window between 1849 and 1963. Since the 1st edition mapping itself has a wide date range (1849-1899), and the end of that date range likely corresponds closely with the decline of the use of water meadow systems (based upon trends seen elsewhere in the country), the only dating evidence within this study came from the analysis of structural features, with the identification of 19th century systems, and of a single example of possible early 18th century or before. Further detailed field survey of the targets generated within this study may help to substantially expand our knowledge of the chronological spread of water meadow usage within the county. However, as once again the only dateable features within systems are likely to be structures which are refurbished and maintained over time, these dates can only be taken as a terminus post-quem for system *usage*, rather than system *creation*. It is likely that only a detailed complementary approach, utilising field survey and structural dating, local historical records and visible chronological relationships (between systems and surrounding landscape or structural features), may lead to reliable dates for individual system creation.

Finally, whilst the intention was to robustly test the results of the desk-based assessment through field survey, this proved to be impossible, due to a lack of availability of land access permissions. This prevented the field analysis of an appropriate spread of sites in terms of geography, condition, and topography. A 10% sample of targets was analysed, however this sample was restricted geographically, only assessing targets from four of the 12 major rivers, with available land access biasing the field survey towards systems of higher recent condition values. Consequently, whilst the field work has demonstrated the ability of the model to accurately locate and classify the preservation of some systems, the restricted samples available are not sufficient to allow a conclusive assessment of the effectiveness of the computer modelling. As a result the desk-based assessment should be considered merely a rough guide to possible water meadow location and condition, rather than a conclusive gazette of the above.

5.2 Potential Further Work

A variety of further work could be undertaken, with this model as its basis, in order to expand our knowledge of identified water meadow systems within Staffordshire.

Primary amongst this would be the field assessment of a further spread of targets from within the model, in order to conclusively ascertain its effectiveness in a variety of conditions. Upland targets in particular would benefit from an assessment, as no permissions were available for any upland targets during this phase of field survey.

The use of further data sources to inform and potentially refine the model would also be of benefit. In particular, detailed analysis of local historical sources may prove useful (although this approach is highly time-consuming), in order to refine identified targets or potentially to identify further areas which were overlooked by this survey. Brief examination of the assessment of lands surrounding Trentham (Loch 1820), indicated the presence of more than ten separate areas of water meadow in the vicinity. However, this assessment revealed only four targets, with farms referred to as possessing meadow in Loch showing no indicative features upon the historic mapping. Additionally, suggestions within Loch imply the production of meadow even away from mapped watercourses, rendering them less likely to be identified within studies of this type. If the same is true for other areas then this would suggest that a detailed examination of appropriate historical documents could substantially enhance the picture of water meadow cultivation provided by this survey.

In terms of individual water meadow systems, our understanding would be best complemented through the reconstruction, where possible, of detailed plans of system earthworks, and through dating of any extent structural remains by appropriate specialist parties. This would most likely best be applied to well-defined systems where a detailed examination of how the system was managed may become possible. Relatively few systems seen within this study showed sufficient definition in aerial photographic survey to allow for the composition of a system plan. Hence, due to the subtlety of many original earthwork features, topographic survey would be the most appropriate method for this reconstruction, with on-site RTK GPS survey the method most likely to identify subtle features on a scale too small or large for visual detection. Aerial lidar survey also has the potential to produce topographic information suitable for water meadow system mapping, although due to the small scale of some channel features only 0.5m resolution survey would be sufficient. The results of such could then be utilised to assemble a typology of water meadows within Staffordshire, an endeavour more difficult than that seen elsewhere in the country where more well-defined systems are prevalent.

This survey can be seen to have substantially increased our knowledge of the likely location, number and condition of water meadows in Staffordshire, and would be ideally suited as a springboard for further work such as described above. Any data resulting from such work could readily be incorporated into a GIS database based around the information generated by this study, producing a single, detailed, centralised resource for the examination of these striking agricultural features.

6 ACKNOWLEDGEMENTS

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7 REFERENCES

Cook, H & Williamson, T (ed) 1999. *Water Management in the English Landscape*. Edinburgh University Press, Edinburgh.

Cook, H & Williamson, T (ed), 2007. *Water Meadows, History, Ecology and Conservation*. Windgather Press Ltd, Macclesfield.

Environment Agency 1998. *Pilot Study of Water Meadows on the River Allen and Frome*. Unpublished document.

Everard, M, Cook, H, and Cutting, R. *The origins of Water Meadow Systems*. Pp 5- 19, in Everard (ed) 2005.

Everard, M (ed) 2005. *Water Meadows*. Forrest Text, Ceredigion.

Loch, J, 1820. *An account of the Improvements on the Estates of the Marquess of Stafford*. London.

Oxford Archaeological Unit, 1999. *Hampshire Water Meadows Survey*. Hampshire County Council. Unpublished document

Taylor, C, 2007. *The Archaeology of Water Meadows*. Pp 22-34 in Cook and Williamson (ed), 2007

Southern Archaeological Services Ltd, 1998. *Pilot study of water-meadows in the Rivers Allen and Frome, Dorset. Volume One: Introduction, methods, results and review*. Environment Agency.

Vaughan, R. 1610;1897 edn *The Most Approved and Long Experienced Water Workes containing the manner of Winter and Summer Drowning of Meadow and Pastur*. Republished with preface by Ellen Beatrice Wood, John Hodges, London.

Williamson, T, 2007. 'Floating' in *Context: Meadows in the Long Term*. Pp 35-51 in Cook and Williamson (ed) 2007.

Wilson, D.R, 2000. *Air Photo Interpretation for Archaeologists*. Tempus publishing, Gloucestershire.

IMAGES

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1991 photo of Willows Farm sluice housing provided courtesy of Mr Andrew Allen.

APPENDIX 1. GLOSSARY OF TERMS

Glossary

The following is a list of the terminology used throughout this report, and is adapted from OAU 1999.

<i>Carrier</i>	A shallow artificial channel, one of a series of artificial channels connected to a Head Main, used to distribute water during controlled flooding ('floating') of the water-meadow.
<i>Condition</i>	Condition/state of survival of water-meadow as noted from air photographs and modern OS 1:10,000 scale maps. Condition is on a scale of 0 to 7 outlined in Section 2.1.3 of this report).
<i>Cropmarks</i>	Cropmarks are features recorded by aerial photography as differentially coloured or textured marks in arable crops, grass or any other form of vegetation.
<i>Drain</i>	Artificial channel along the lower edge of a meadow used to collect all water draining from the meadow following controlled flooding.
<i>GIS</i>	Geographic Information System. Digital map database containing OS 1st Edition 6" and OS 1:10,000 scale base maps and all water-meadow survey data.
<i>Hatch</i>	An adjustable wooden board or iron plate used to regulate the flow of water in a main.
<i>Head Main</i>	A major artificial channel along the upper edge of a meadow used to convey water from a natural watercourse into a system of carriers. A dam, weir or hatch was used to divert and control the flow of water from the river into the Head Main. Also known as <i>Main Carrier</i> .
<i>Leat</i>	A Head Main or a smaller channel serving the Head Main.
<i>Main drain</i>	A major artificial channel along the lower edge of a meadow used to collect all water draining from the meadow following controlled flooding. Also known as <i>Tail Drain</i> .
<i>Polygon</i>	Extent of a block of water-meadows expressed in digital terms, within the GIS database.
<i>Sluice</i>	A simple weir, usually consisting of a single hatch.
<i>Water-meadow</i>	An area of grassland next to a river which is artificially flooded at certain times of the year, by means of a network of ridges and channels (carriers), to produce early, good-quality pasture. Water-meadows can be recognised in a field as a network of ridges and shallow channels (similar to ridge and furrow), usually at right-angles to one another, crossing meadows in valley bottoms or on gentle hillsides. The main components include a Head Main, carriers, drains, weirs and hatches. Water-meadows were in general use from the 17th century onwards, although their use declined dramatically in the 19th century.
<i>Weir</i>	A timber or iron framework set across a main or stream to hold two or more hatches to stem and divert the water for flooding.

**APPENDIX 2. RECOGNISING WATER-MEADOWS. A FIELD GUIDE
AND FACT-SHEET.**



Recognising water meadows: A field guide and fact-sheet

Water meadows – Definition and Description

The term ‘water meadow’ typically refers to an area of land, usually adjacent to a watercourse, which could be deliberately flooded under the control of the landowner, usually via the use of a series of artificial, graded channels. The point of deliberate, controlled flooding should be emphasized here, as it is the use of a careful system to manage the flow of water across the field which truly characterises these features and distinguishes them from fields allowed to flood naturally.

The careful control of this flooding, to a prescribed timescale in order to create the maximum benefit to the landowner is largely a post-medieval technology, particularly in regards to the most technically involved system form, the bedwork water meadow. The benefits of flooding or ‘floating’ a meadow are multiple, so long as the system is managed. By floating the fields early in the year, usually between Christmas and March, the farmer could reduce the effects of frost and gain an early growth of grass, allowing him to over-winter his sheep for a shorter period. Selective floating later in the year could also produce a further hay crop by maintaining moisture levels within the fields. Additionally, floating served to fertilise the fields, with the key component being the maintenance of a constant flow of water over the meadow, with no areas of standing water. It is this factor which leads to the development of the features which typify water meadows, the use of carefully designed channels, coupled with sluice hatches for flow control. Water meadows appear in the archaeological record in the seventeenth century and continue in use until the early twentieth century, with select examples still in use today

Three primary forms of water meadow have been identified, known as catchwork, ‘floating upwards’, and bedwork systems.

Catchwork systems

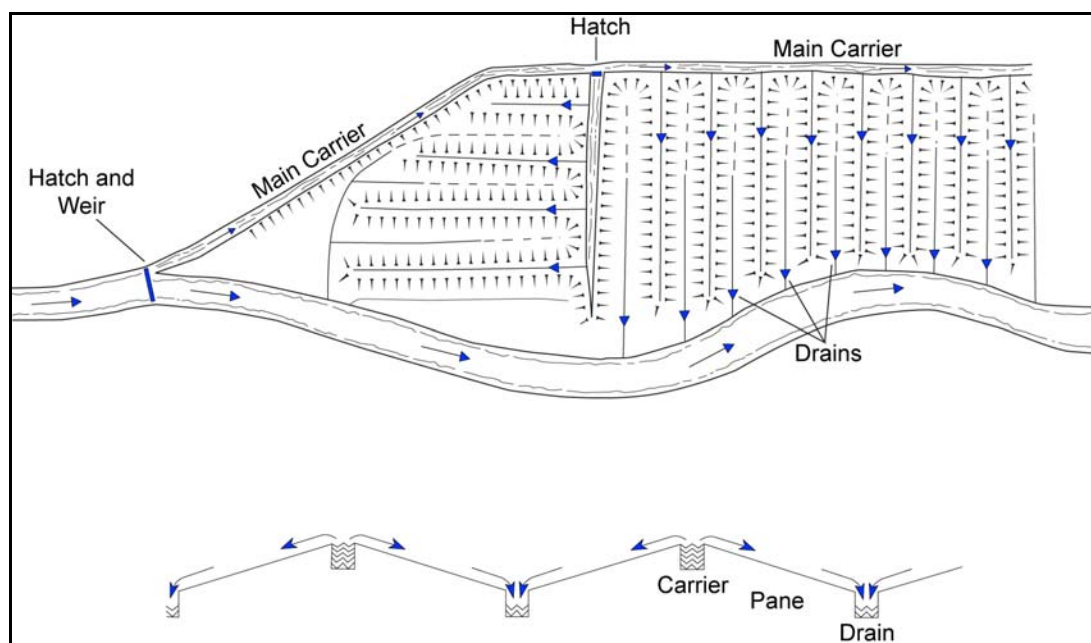
This system uses a main carrier to divert water from a stream along the flanks of the hill from which it springs, following the contours. This gutter is then blocked with turves by the drowner. This causes the water to overflow across swathes of the hillside, running through the grass (sometimes via more drains lower down also following the contours), before reaching the base of the field where another drain takes it away. This process is designed to achieve a constant flow across the field through the employ of gravity. This simple system seems likely the oldest of the three, with some suggestions of use in England as early as the 12th century.

The ‘floating upwards’ system

The floating upwards system, documented from the 17th century, but likely even earlier in principle, involved simply damming a watercourse to force the water to accumulate upstream and flood over the adjacent areas of farmland. The primary feature of this system to be visible in the field would be the remains of a former sluice gate blocking the course of the stream at the downstream end of field systems.

The Bedwork system

This system is usually seen adjacent to major rivers with broad floodplains, and involved the use of sluice gates to divert the river water into a series of carefully created channels. A ‘main carrier’ took the water from the river, which had often been partially dammed by a weir, into a series of ‘carriers’. These were graded channels on top of wide grassy banks that were designed to overflow, watering the sides (or ‘panes’) of the banks. Excess water was then taken by drains at the bottom of the banks to a large ‘tail drain’ which led back to the River. This careful system meant that fresh water moved in a constant flow over the meadow, without producing standing water, and resulted in intricate interlocking patterns of channels and banks, known as bedworks (Figure 1). This method, employable over large areas, and carefully maintained, was the pinnacle of water meadow management, allowing the strict control of the floating of the fields to suit the landowner. This resulted in large swathes of landscape being occupied by the ornate bedwork features, which were flexible enough in principle, if carefully maintained (often by a skilled craftsman known as a *drowner*), to conform to the vagaries of the river valley and meanders, resulting in a huge variety of earthwork patterns. The origins of this system are difficult to ascertain, however it is generally taken that the system was in use by the 16th century, and widely adopted within it.



Plan showing typical arrangement of features within a bedwork water meadow
(adapted from Williamson and Cook 2007)

Recognising Water Meadows In The Field

Earthworks

Earthworks visible in the field indicative of former water meadow include:

- ◆ Grid-like patterns of drains, which may still be carrying water, or lush in vegetation.
- ◆ Areas of wide flat banks (panes) with linear drains or hollows between them, with banks often several metres across.
- ◆ Connected series of drains, particularly when linear drains connect at unusual angles.

Examples of how to spot water meadow features:

Variations in vegetation type and colour



Standing water



Extant channels



Frost and shadows highlighting features



Elevated viewpoints- often allow systems to be seen as a whole which may not be clear from ground level



Structural remains

Particular structural features can be found in association with former water meadows, these can be made of stone, wood, brick or even concrete or metal, depending on the date of the meadow. Common forms of structure typical of meadow include:

Sluice hatch settings- support or housings for sluice hatches, often with a pair with matching vertical slots where a hatch once was.



Bridges and culverts- used to provide access across a meadow and for water control



Other associated structures:

Remains of former lined channels, often seen near to banks of rivers or streams,



Collections of loose structural material, particularly conspicuous in open fields, possibly the remains of former meadow structures such as sluices or culverts.

Recording Water Weadows In The Field

In order to investigate water meadows, archaeologists require particular details which can be simply recorded in the field.

Field notes and record cards

The collection of field notes recording precisely where possible water meadow features have been seen, and the details of these features. Ideally these should include a sketch plan recording how features appear, and their rough dimensions. If drains are numerous and obvious, a quick sketch of how the system may appear from a birds-eye-view is ideal.

Using the following record card will help to record the relevant information. Whilst mainly designed for meadow structures, these cards can also be used to record channels and banks.

Site name will be a convenient name for the area (often the farm name), *feature ID* a number assigned by you to each structure. *Structure type* can be ticked next to the appropriate heading for what the feature is thought to be, as can the material it is made from in the *Material* section. *Orientation* records the direction you are facing when you make the sketch. Within the *Details* section, simply record as much detail as you can think to about the feature, dimensions, etc. If available, *GPS position* should be recorded to the highest number of figures possible. *Part of* refers to what part of a system it may represent, based upon the prior descriptions.

WATER MEADOWS STRUCTURE CARD

FEATURE ID _____ SITE NAME + ID _____

Structure type:

Sluice ___ Sluice (Hatch remains)___ Sluice (Mechanism)___ Aquaduct___

Lined channel___ Weir___ Bridge___ Other (state)_____

Material:

Wood___ Brick___ Concrete___ Metal___ Other_____

Details: (for brick, dimensions in inches, colour +texture)_____

SKETCH

Orientation:

Details: _____

Provisional Date:

Medieval___ Post-Medieval___ Recent___ Modern___

GPS position: _____ Channel Orientation_____

Part of:

Main Drain___ Carrier___ Drain___ River Control ___ Meadow connection _____

Date of survey_____ Recorded by_____

Recording a location

In order to precisely record the location of possible features the ideal approach is to use a hand-held GPS system, if available. Failing this, the recording of the distance of the feature from two to three different landmarks (which occupy a fixed position and will be visible on maps, for example field boundaries) will suffice.

Ground photography

If possible, photographs of features will help archaeologists to determine if the features may represent former water meadow. These should ideally include some form of scale in the foreground which will be easily recognisable in terms of size. Photographs from several angles are useful, with the subject centrally framed.

Who to contact:

If you think you may have found water meadow remains, you can contact:

Stephen Dean

Principal Archaeologist

Environment and Countryside

Staffordshire County Council

Riverway

Stafford, ST16 3TJ

Stephen.dean@staffordshire.gov.uk



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APPENDIX 3. GIS DATA ARCHIVE

The data archive for this project consists of:

GIS project shapefiles

watermeadowsFINAL.shp

Shapefile detailing full extent of all potential water meadows identified, and their associated attributes.

Exceptional_meadows.shp

Simple polygon shapefile highlighting position of features with an apparently exceptionally high level of recent condition

Fieldwork_verified.shp

Polygon shape file highlighting position of targets subjected to field survey, and with attributes attached, including condition of target as seen during field survey.

Meadow_Lost to reservoir.shp.

Simple polygon shapefile highlighting the area of former water meadow apparently lost to Blythfield reservoir.

Documents, and publicity leaflet

Staffordshire Water Meadows Project final report. (Adobe pdf file).

A4 project publicity leaflet. (Adobe pdf file).

Recognising Water Meadows in the field; field guide. (Adobe pdf file).

Images

Folder containing high resolution jpg copies of all imagery used within report.

Folder containing all photography from field survey phase of project.

