
Pen y Cefn Water Treatment Works: **Dolgellau, Gwynedd**



Archaeological Assessment

GAT Project No. 2110

Report No. 850

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Archaeological Assessment: **Pen y Cefn WTW, Dolgellau**

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G2110 PEN Y CEFN WATER TREATMENT WORKS, DOLGELLAU

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PEN Y CEFN WATER TREATMENT WORKS (G2110)

ARCHAEOLOGICAL ASSESSMENT

SUMMARY

An archaeological desk-based assessment has been carried out on land surrounding the Water Treatment Works at Pen y Cefn, Dolgellau. The land, consisting of improved grassland, was shown to have been the property of the Nannau estate from the 16th century, and divided into the properties of Pen y Cefn Uchaf and Caeau Pen y Cefn, by the later part of the 18th century. This suggests that the properties were formerly one holding. The pattern of field boundaries survives from at least 1760, with only the subsequent loss of some of the smaller field divisions. Modern development in the study area consists of a radio mast station, the water treatment works, and the encroachment of housing to the west, forming a northern expansion to Dolgellau.

The farmhouse of Pen y Cefn Uchaf was identified as being an important vernacular building with probable 18th century origins, and the site of the 'beudy' or cow-house associated with the holding of Caeau Pen y Cefn was identified. The associated lane and field boundaries are considered to be an important survival of an enclosed landscape of hedgerows and small fields.

No other previously unidentified archaeological sites were noted, however there was thought to be a moderate potential for the survival of buried remains and a magnetometer survey had been requested by the SNPA Archaeologist, carried out by Stratascan Ltd. Although the results of the survey were somewhat inconclusive, a number of possible archaeological were identified. It is recommended that a programme of trial trenching be carried out, targeted on potential archaeological features, and covering 5% of the development area.

1 INTRODUCTION

Gwynedd Archaeological Trust (GAT) was asked by Caulmert Ltd on behalf of their clients Dwr Cymru Welsh Water to carry out an archaeological assessment and magnetometer survey in advance of the construction of an extension to the Water Treatment Works at Pen y Cefn, Dolgellau (NGR SH 72891856). This report forms the archaeological assessment part of the project, and the Geophysical Survey Report is attached as Appendix 2.

1.1 Acknowledgements

The staff at Gwynedd Archives, Dolgellau and the National Library of Wales are thanked for their help with providing archive material. Claire Graham and Melanie Biggs of *Stratascan Ltd.* are thanked for the provision of the geophysical survey the results of which accompany this report.

2 DESIGN BRIEF AND SPECIFICATION

A detailed brief has not been prepared for this scheme, however an archaeological assessment was required by the Snowdonia National Park Authority (SNPA), an outline of requirements having been presented to Howard Jones of Caulmert in December 2009. A specification for the assessment was submitted to the SNPA by GAT (Appendix 3). This report conforms to that specification, and to the guidelines specified in *Standard and Guidance for Archaeological Desk-based Assessment* (Institute of Field Archaeologists, 1994, rev. 2001).

A desk-based assessment is defined as 'a programme of assessment of the known or potential archaeological resource within a specified area or site on land, inter-tidal zone or underwater. It consists of a collation of existing written, graphic, photographic and electronic information in order to identify the likely character, extent, quality and worth of the known or potential archaeological resource in a local, regional, national or international context as appropriate' (*Standard and Guidance for Archaeological Desk-based Assessment*, IFA 2001, 2).

The aims of the assessment as given in the specification are:

- to identify and record the cultural heritage within the defined study area;
- to evaluate the importance of what has been identified;
- to recommend ways in which impact upon the cultural heritage can be avoided or minimised.

To comply fully with the aims expressed above it can be necessary to undertake a programme of Field Evaluation following the Desktop study and Field Visit. This is because some sites cannot be assessed by desktop or field visit alone, and additional fieldwork is therefore required. This typically takes the form of geophysical survey or trial excavation, although measured survey is also a possible option. A full programme of assessment and evaluation may therefore consist of:

- Desktop study
- Field walkover
- Initial report
- Field evaluation
- Draft report
- Final report

The phase of the project concerns the first three phases and an element of field evaluation, consisting of magnetometer and geophysical survey and recommendations are made concerning intrusive field evaluation.

3 METHODS AND TECHNIQUES

3.1 Desk top study

The desktop study comprised the consultation of maps, documents, computer records, written records and reference works, which form part of the Historic Environment Record (HER), located at Gwynedd Archaeological Trust (GAT), Bangor. The archives held by the Meirionnydd Record Office, Dolgellau and Bangor University were also consulted. Information about listed buildings was consulted by means of the CARN (Core Archaeological Index), which is the online index of the Royal Commission on Ancient and Historic Monuments, Wales. Relevant aerial photographs from the collection at RCAHM, Wales were examined.

Sites, buildings and find spots listed in the GAT HER were identified (Fig. 2), with PRN referring to the Primary Record Number given to each individual site.

3.2 Field Search

The field search was undertaken during February 2010, when the area of the proposed development was examined. Notes were taken, sketches and measurements were taken of sites of potential archaeological interest and a photographic record was made.

3.3 Report

The available information was synthesised to give a summary of the archaeological and historic background and of the assessment and recommendations, as set out below. The separate features, their evaluation and recommendations are listed separately, and a summary of the overall assessment of the area is given at the end.

The criteria used for assessing the value of features was based upon those used by the Secretary of State for Wales when considering sites for protection as scheduled ancient monuments, as set out in the Welsh Office circular 60/96. The definitions of categories used for impact, field evaluation and mitigation are set out below.

3.3.1 Categories of importance

The following categories were used to define the importance of the archaeological resource.

Category A - Sites of National Importance.

Scheduled Ancient Monuments, Listed Buildings of grade II* and above, as well as those that would meet the requirements for scheduling (ancient monuments) or listing (buildings) or both.

Sites that are scheduled or listed have legal protection, and it is recommended that all Category A sites remain preserved and protected *in situ*.

Category B - Sites of regional or county importance.

Grade II listed buildings and sites which would not fulfil the criteria for scheduling or listing, but which are nevertheless of particular importance within the region.

Preservation *in situ* is the preferred option for Category B sites, but if damage or destruction cannot be avoided, appropriate detailed recording might be an acceptable alternative.

Category C - Sites of district or local importance.

Sites which are not of sufficient importance to justify a recommendation for preservation if threatened.

Category C sites nevertheless merit adequate recording in advance of damage or destruction.

Category D - Minor and damaged sites.

Sites that are of minor importance or are so badly damaged that too little remains to justify their inclusion in a higher category.

For Category D sites, rapid recording, either in advance of or during destruction, should be sufficient.

Category E - Sites needing further investigation.

Sites, the importance of which is as yet undetermined and which will require further work before they can be allocated to categories A - D are temporarily placed in this category, with specific recommendations for further evaluation. By the end of the evaluation there should usually be no sites remaining in this category within the development area.

3.3.2 Definition of Impact

The impact of the road development on each site was estimated. The impact is defined as *none, slight, unlikely, likely, significant, considerable or unknown* as follows:

None:

There is no construction impact on this particular site.

Slight:

This has generally been used where the impact is marginal and would not by the nature of the site cause irreversible damage to the remainder of the feature, *e.g.* part of a trackway or field bank.

Unlikely:

This category indicates sites that fall within the band of interest but are unlikely to be directly affected. This includes sites such as standing and occupied buildings at the margins of the band of interest.

Likely:

Sites towards the edges of the study area, which may not be directly affected, but are likely to be damaged in some way by the construction activity.

Significant:

The partial removal of a site affecting its overall integrity. Sites falling into this category may be linear features such as roads or tramways where the removal of part of the feature could make overall interpretation problematic.

Considerable:

The total removal of a feature or its partial removal which would effectively destroy the remainder of the site.

Unknown:

This is used when the location of the site is unknown, but thought to be in the vicinity of the proposed works.

3.3.3 Definition of field evaluation techniques

Field evaluation is necessary to fully understand and assess most class E sites and to allow the evaluation of areas of land where there are no visible features but for which there is potential for sites to exist. Two principal techniques can be used for carrying out the evaluation: geophysical survey and trial trenching. Topographic survey may also be employed where sites are thought to survive as earthworks.

Geophysical survey most often involves the use of a magnetometer, which allows detection of some underground features, depending on their composition and the nature of the subsoil. Other forms of geophysical survey, including resistivity survey and ground penetrating radar might also be of use.

Trial trenching allows a representative sample of the development area to be investigated at depth. Trenches of appropriate size can also be excavated to evaluate category E sites. Trenching is typically carried out with trenches of between 20 to 30m length and 2m width. The topsoil is removed by machine and the resulting surface is cleaned by hand, recording features. Depending on the stratigraphy encountered the machine may be used to remove stratigraphy to deeper levels.

3.3.4 Definition of Mitigatory Recommendations

Below are generic measures that may be recommended to mitigate the impact of the development on the archaeology.

None:

No impact so no requirement for mitigatory measures.

Detailed recording:

This requires a full photographic record and measured survey prior to commencement of works.

Basic recording:

Requiring a photographic record and full description prior to commencement of works.

Strip, Map and Sample:

The technique of Strip, Map and Sample involves the examination of machine-stripped surfaces to identify archaeological remains. The stripping is undertaken under the supervision of an archaeologist. Stripping and removal of the overburden is undertaken in such a manner as to ensure damage does not take place to surfaces that have already been stripped, nor to archaeological surfaces that have not yet been revealed.

Stripping is undertaken in as careful a manner as possible, to allow for good identification of archaeological features. A small team of archaeologists will be responsible for subsequently further cleaning defined areas where necessary. Complex sites which cannot be avoided will need to be fully excavated.

Watching brief:

This is a formal programme of observation and investigation conducted during any operation carried out for non-archaeological reasons. This will be within a specified area or site on land, inter-tidal zone or underwater, where there is a possibility that archaeological deposits may be disturbed or destroyed. The programme will result in the preparation of a report and ordered archive.

Preservation by record- Excavation

Full archaeological excavation may also be required depending on the particular feature and the extent and effect of the impact, where evaluation reveals the presence of significant archaeological remains within the development area.

Avoidance:

Features, which may be affected directly by the scheme, or during the construction, should be avoided. Occasionally a minor change to the proposed plan is recommended, but more usually it refers to the need for care to be taken during construction to avoid accidental damage to a feature. This is often best achieved by clearly marking features prior to the start of work.

Reinstatement:

The feature should be re-instated with archaeological advice and supervision.

4 ARCHAEOLOGICAL RESULTS

4.1 Topographic description

The solid geology of the Dolgellau region consists of intrusive igneous formations and Cambrian imbedded pale grey quartzose siltstone and silty mudstone with Dolgellau black siltstone and mudstone of the Mawddach Group in the Wnion valley (BGS 1982). These are overlain by Quaternary glacial till and thick accumulations of alluvium (Allen and Jackson 1985).

The confluence of the Mawddach and Wnion river valleys forms a distinct natural basin situated between the southern ends of the Rhinog and Arenig Mountains and the northern flanks of Cader Idris. Above the basin floor, which is only just above sea level, the slopes rise steeply on all sides, reaching 629m above OD at the summit of Y Garn in the north-west, 400m above OD at the summit of Moel Offrwm in the north east, and 893m above OD at the summit of Cader Idris in the south. The latter dominates prospects of the basin from most directions. Between 100m and 200m above OD however, shelves of land with gentler gradients occur which have assisted communications and attracted settlement from the earliest times (Smith and George 1961).

4.2 Archaeological and historical background

A total of 6 sites are recorded in the Gwynedd Historic Environment Record within 500m of the study area. There are no Scheduled Ancient Monuments or Listed Buildings within 250m of the Water Treatment Works.

4.2.1. Earlier Prehistoric

In the earlier Neolithic several areas of concentrations of chambered tombs in north-west Wales demonstrate human occupation, but there are none close to Dolgellau, the nearest group being that in Ardudwy to the north-west. However, there are several finds of Neolithic stone axes along the valley of the Mawddach, demonstrating the presence of people in the Mid to Late Neolithic. One such axe has been found here at Cefn Meulan, just north-east of Dolgellau.

Pollen studies of buried peat horizons in the uplands of Ardudwy show the first indications of human activity are from about 4000 BC but that there was much greater wide-scale clearance of forest in the Early Bronze Age, during the second millennium BC (Chambers and Price 1988). This expansion of human activity is illustrated in the Dolgellau area by the presence of numerous funerary and ritual monuments of the second millennium BC, of which there are 15 in the immediate area and many more close by. The most important group in this area is that at Hafod Dywyll, Islaw'r Dref, where there are seven cairns close together. These demonstrate a widespread human presence and activity in the landscape at this time. It is possible that monuments of this type could be located within or close by the development area, as its mid slope plateau height of approximately 100m OD is a typical location for such site types.

One of the largest known burial monuments of this period in North Wales is from the lowland close to Dolgellau at Pentre Farm near Cymer on the north side of the valley. The mound is about 22m diameter and 2.5m high and excavation in the 19th century suggested it was of complex construction and probably of several phases of re-use (Bowen and Gresham 1967, 93-40). There are also two high status finds of this period from close to Dolgellau, a stone battle-axe and a stone axe-hammer. Another high status object of the Middle Bronze Age has also been found, comprising a gold torc or neck-ring, from a hill south-west of Dolgellau. A bronze palstave axe-head has also been found close to the town.

A Graiglwyd axe (PRN 4,116) has been found at Cefnmadan Farm, close to Dolgellau to the north-east at SH 370880. In the vicinity of Dolgellau a number of axe-hammers have been found, one in the late 1920s in the garden of Brynmarian, a house on the northern outskirts of Dolgellau standing on the slope above the Afon Wnion, about 200m from the right bank (PRN 4,121). It was made of Picrite dolerite. Another was found about 5.2km upstream of it, and about 600m from the Afon Wnion on the same side at Cae-Gwyn farm, and now in the National Museum in Cardiff (PRN 4,122). It is made of Greenstone, a form of dolerite and is of considerable size weighing about 4kg. An unidentified wooden object of prehistoric date (PRN 806) has also

been found. The quantity of prehistoric stray artefacts found in the vicinity in not dissimilar locations suggests a moderate potential for the discovery of artefacts within the development area

4.2.2 Late Prehistoric / Romano-British

The earliest known prehistoric settlements in this area are represented by examples on the fringes of the upland above of Dolgellau, consisting of groups of small circular houses and attached fields. By analogy with other excavated examples in north-west Wales these belong to the last centuries of the first millennium BC and into the Roman period (Smith 1999). Their presence on the upland fringes may be a matter of survival and there may have been other, perhaps more affluent settlement on lower and better quality land, the remains of which have been removed by many centuries of agriculture. Possible remains of such settlement was found sealed beneath a Roman period building close to the Roman fortlet at Brithdir, 4km east of Dolgellau (White 1978, 36-8).

Other evidence of settlement here in the first millennium BC is in the form of four defended sites around the fringes of the area. These forts are set high up in strong natural defensive positions, between about 300m to 400m OD. Three lie to the north on the ridge between the Wnion and Mawddach valleys and one is to the south-west in Islaw'r Dref. There is also one lower-lying defended site on a promontory at Cymer, overlooking the Mawddach estuary. All are similar in having very prominent positions with wide viewpoints but relatively inaccessible as settlements. None have been excavated or otherwise dated and may all have been constructed not long before the Roman conquest. Only one fort, the largest, at Moel Offrwm, has evidence of much actual settlement, two are suggested to have been deliberately demolished (Bowen and Gresham 1967, 142, 153) and one, that at Islaw'r Dref, is unfinished.

The most significant Roman monuments in the landscape of Meirionydd are a series of auxiliary forts belonging to the Flavian consolidation of Roman rule in North Wales in the late 70s AD. No evidence has yet emerged for the campaigns of Paulinus (as recorded by Tacitus) culminating in the attack on Anglesey in 60 AD.

The auxiliary forts are about 17-20 km apart and would have been linked by an all-weather road system. Davies (in Arnold and Davies 2000, 16) notes that 'the garrison posts would have been mutually supporting with any serious trouble being tackled by a concentration of auxiliary regiments'. He also notes that well engineered roads would have opened up the country for trade and exploitation of mineral resources (*ibid.*, 35).

Forts

The presence of a small Roman fort is noted at Brithdir, 4.8km east of Dolgellau (PRN 1546, NGR SH 77141890), on the south side of the Wnion valley. The site is on a broad natural shelf which provides a level and commanding position some 170m above sea level and about 100m above the bottom of the valley a mile to the north. There has long been a belief that a fort must be located at Dolgellau (Hemp 1949, 294; Cambrian Archaeological Association 1949, 294 and Jones 1959, 208), based on the identified system of Roman roads although it has not been possible to identify one as yet, and it is significant that they were all writing before the discovery of the fortlet at Brithdir (Hopewell 1997). Waddelove (1999, 190-2) suggests that these writers were correct and the street layout of Dolgellau follows the layout of a Roman fort. There is however no reason to suppose that the main streets in Dolgellau are anything other than medieval and post-medieval in date. Ellis (1928, ch 6) suggests an 11th century foundation for the town. The persistence of the street plan of a Roman fort therefore seems unlikely.

The recent discovery of a Roman site at Gwanas Fawr, near Cross Foxes is a most important discovery. It was recognized from the air by Bob Jones, a pilot from Welshpool Airport with long experience of archaeological aerial reconnaissance. This appears to be a hitherto unknown Roman fort at NGR SH77111645, 4km south-east of Dolgellau (Hopewell 2008). The site survives as a rectangular, bivallate earthwork, with rounded corners. The enclosure has external dimensions of 168m x 130m enclosing an area of 2.6ha. It is probably a temporary or marching camp rather than a fort (Barker *et al.* 2008, 88-90).

Roman Roads

The Roman roads of north-west Wales have been the subject of a Cadw project which was initiated in 2002/03 and follows on from a study of Roman fort environs (Hopewell 2006). This has resulted in the identification of previously unknown or postulated sections of Roman road. The roads seem to centre on the area of Dolgellau,

possibly suggesting that there was a Roman presence in the area. RRN58 (Margary 1957), the road leading from Tomen y Mur to Dolgellau (PRN 17826) runs north-south approximately 550m west of the proposed development area. It is unlikely that the road crossed through the development area; however the relatively good soils and gently sloping ground would provide a more than adequate site for Romano-British settlement. The presence of such settlements around Dolgellau is indicated by finds from the area. For example Roman pottery (PRN 1,577) has been found at Bryn Mainan, Dolgellau, and tile at Maes Brith (PRN 1,578). The find of various Roman coins has been noted in the vicinity of Ffynnon Fair, Dolgellau (PRN 4,115). These are recorded by Edward Lhuyd in 1695 as having included coins of the Emperors Trajan and Hadrian (RCAHMW 1921, 25).

4.2.3 Medieval

Cymer Abbey, one of the last and smallest of the Cistercian houses to be founded in Wales was built in 1198-9 close to the estuary of the Afon Mawddach at its lowest bridging point. The 1209 Charter of Llywelyn Fawr granted it extensive lands. The abbey was never very wealthy but was involved with dairying, fulling, shipping, fishing and possibly iron-making at Dol y Clochdydd (Beverly-Smith 2001, 225-253).

The early growth of Dolgellau appears to have been organic with the appearance of a small native *tref* at the bridgehead on the eastern side of St. Mary's Church. This was not a substantial settlement, and at the time of Edward I's victory there were only three taxpayers recorded in 1292-3 (Soulsby 1983, 131). During the following century there was significant growth within the town, and it emerged as the principal town in the area, overshadowing Bala. The market, noted first in the early 14th century, was claiming a monopoly over trade in the area by the mid 15th century (Alfrey 2009, 7). This growth was a gradual process which probably partly accounts for the haphazard street pattern seen in the town. The one known medieval building within the town *Cwrt Plas yn Dre*, was demolished in 1885 (*ibid.*).

4.2.4 Post-Medieval

Although the Nannau estate had its origins in the 12th century, it was greatly extended as a result of the acquisition of the Cymer Abbey landholdings after the dissolution of the monasteries and the family also strengthened its hold through marriage to other influential families (Jones, G. 2001, 654). The land at Pen y Cefn became part of the Nannau estate around this time, although the first documentary reference for the land comes from 1778, when the rent for Pen y Cefn is assessed at £7 10s per annum, with an additional £3 to be paid for one of the property's fields (UCB Nannau MSS 1403). Medieval settlement in the area is likely to have been no more extensive than it is at present.

By the mid 16th century the town of Dolgellau had overshadowed Bala and had 23 taxpayers in 1543, and had become known for the manufacture of coarse woollen cloth (*ibid.*, 132). During the 17th century the town probably developed its urban character, and a number of buildings, such as the old courthouse, probably date from this time.

4.2.5 Early-Modern/Modern

A 1760 Nannau estate map (NLW 7425) shows Pen Y Cefn Uchaf, with much the same field boundaries as today, although the sub divisions in the property and fields to the east of C4, known as Caeau Pen y Cefn (Fig.3), where the current water treatment works stands, have since been lost. A Nannau Estate Survey of 1794 (Fig.4, ZM/3667) shows no alteration to the field system, however it provides a detailed cartographic and descriptive record of Caeau Pen y Cefn and Pen y Cefn Uchaf. Field X1 appears to contain a *beudy* (cowshed) shown on the survey map, as suggested by the field name evidence. The estate maps cartographic annotations also suggest that arable cultivation has taken place, which may explain some of the potential agricultural evidence shown on the geophysical survey. The schedules for the two properties are as described below:

Caeau pen y Cefn- Richard Roberts

Number	Names of Fields	Quantities	Observations
		A R P	
x1	<i>Cae Beudy</i>	1- 1- 17	
	Wood	1- 32	
x2	<i>Cae Fawr</i>	2- 2- 6	

x3	<i>Cae Isa</i>	<i>1- 35</i>	
x4	<i>Do</i>	<i>1- 2- 22</i>	
x5	<i>Cae Cannol</i>	<i>1- 1- 17</i>	
x6	<i>Cae Hir</i>	<i>2- 3- 37</i>	

Pen y Cefn Ucha- Thomas Lewis

Number	Names of Fields	Quantities A R P	Observations
y1	<i>House and Garden &c</i>	<i>20</i>	
y2	<i>Llock</i>	<i>1 22</i>	
y3	<i>Cae ty</i>	<i>4 2 3</i>	
y4	<i>Cae Cannol</i>	<i>3 1 24</i>	
y5	<i>Coed pen y Cefn</i>	<i>32 25</i>	
	Clear Land	<i>2 17</i>	
y6	<i>Coed Tan y Ffordd</i>	<i>1 32</i>	
y7	<i>Cae Pant</i>	<i>3 3 39</i>	
y8	<i>Fournog</i>	<i>4 2 20</i>	

By the time of the tithe survey of Dolgellau in 1842 (NLW, Fig.5) the land occupation around Pen y Cefn Uchaf had become fragmented. The tithe schedule for the farm fields and those immediately adjacent to it are given below:

Landowner	Occupiers	Numbers Referring to the plan	Name and Description of Lands and Premises	State of Cultivation	Quantities ion Statute Measure A R P
Griffith Howel Vaughan Esq.	William Roberts	233	Garthmaclanbach		18
	Evan Griffith	221	Tyddyn bach		35
	Mrs Mary Owen	234	Caeau near Pen y Cefn		10
		220	Caemawr		8
	Lewis Thomas	212	Pen y Cefn		26
	R W Vaughan Esq	210	Hengwrt		20
	Robert Evans	219	Pandu bach		15

The *beudy* to the east of Pen-y-Cefn Uchaf, noted on the estate maps is present on the 1st edition Ordnance Survey map of 1889 (Fig. 6), where the field boundaries remain remarkably consistent with those seen on the 18th century plans.

The road from Pen y Cefn leads down towards the town of Dolgellau, crossing the Afon Wnion on a seven arched bridge of 1638 (Lewis 1833). The town of Dolgellau was described as low and mean before the later part of the 18th century; Pennant considered that the town had ‘nothing remarkable in it but the church (Pennant 1784, 97). Bingley describes the town as having ‘streets [that] are as irregular as it is possible to imagine them. The houses in general are low, and ill built’, however he does say that there are ‘considerable manufactories of flannel’ (Bingley 1814, 335-6). The remoteness of the town somewhat restricted its development, and most goods and supplies to the town are described as having to be ‘shipped from Liverpool to Barmouth and then conveyed up the Maw in small vessels’ (Lewis 1833, *sub* Dolgelley).

However the town had expanded greatly as a result of the growth in the woollen trade, employing 1,400 people by 1833 (Haslam *et al.* 2009, 584). As a result the low vernacular houses with hipped dormers begin to be replaced by tall houses. The woollen industry declines in the town after about 1860, tanning remaining significant into the mid 20th century. The arrival of the railway in 1867 had a decisive influence on the town

and visitors increased, resulting in new building. Development of the town of Dolgellau north of the river, towards Pen y Cefn, commenced in the 1920s on land formerly owned by the Llwyn estate (Alfrey 2009, 14).

In the 20th century the water treatment works were built at NGR SH 72891856 (Plate 4), and a radio mast station in the south east corner of the field known as *cae isa* at NGR SH 7274 1854 (Fig. 7, Plate 4).

4.3 Statutory and non-statutory designations

The development area lies within the Snowdonia National Park and the Ardudwy Landscape of Outstanding Historic Interest (HLW (Gw) 2), where it is described as ‘a large, exceptionally rich and well-studied landscape, situated on the western flanks of the Rhiniog Mountains, containing extensive relict evidence of recurrent land use and settlement from prehistoric to recent times’ (Cadw 1998, 76).

4.4 The Archaeological Survey (Fig. 2)

Two features were identified during the assessment contiguous with the proposed development area, defined as within 250m of the Water Treatment Works at Pen y Cefn Uchaf; the features are located on Fig. 2). These are initially described listed below with recommendations for further assessment and mitigatory measures, where appropriate. A further seven features were identified as part of the geophysical survey, and these are included in the recommendations below. The site numbers refer to those identified during the survey, and are noted on the final figure in Appendix 2.

4.5 Summary of Geophysical Survey Results (Appendix 2)

The geophysical survey was carried out over the proposed development area and potential compound site, consisting of the fields known as *coed pen y cefn* and *cae hir*, consisting of 2.6 hectares of pasture land at Pen y Cefn (Appendix 2, figs 2-7). A significant amount of activity was noted, which may include relict archaeological features. Positive anomalies, those with low resistance, are interpreted as filled in evidence of past activity, such as ditches and pits, negative ones representing the remains of earthen banks or compacted soil.

In Area 1 (Plate 6), the survey revealed a number of positive linear features (Feature 4; Sites 1-3), which may be relict field boundaries, but are more likely to be modern features. Feature 5; Sites 4- 5 appear to be the relict remains of enclosures with a bank and ditch, and may be significant archaeological features. It is possible that these represent the ploughed out remains of prehistoric barrow mounds, with surrounding ditches. A number of possible pits (Feature 7) were identified as dipolar responses, particularly scattered within the area to be developed (Fig. 8). They may be indicative of prehistoric settlement activity, as for example at Cwm Meudwy, Llandysul, where a significant number of Neolithic pits were uncovered (Murphy and Evans 2006). The significance of these pits will be determined as part of the trial trenching. Magnetic anomalies (Feature 6; Sites 6-7) suggest the presence of debris and may be associated with disturbed ground. This could be the result of either archaeological or modern activity. A buried service trench was noted running north-west to south-east across Area 1 towards or from the Water Treatment Works.

Discrete patches of positive and negative anomalies were noted across Area 2. Apart from clear evidence of ploughing, these do not form any identifiable pattern and may be attributed to varying geological deposits, although some may be the result of archaeological activity. A service or pipe trench runs along the northern or western boundary of Area 2 (Plate 4).

4.6 Archaeological Sites (Fig. 2).

The recommendations given below apply based on the current development proposals, in the event of any additional impact on the features noted below; further recommendations may have to be made.

Feature 1

Pen y Cefn Uchaf Farmhouse (Plate 1)

SH 7271 1867

Period: Early Modern

Category: B Impact: None

A probable 18th century farmhouse of four bays with a modernised former byre attached to the east. It is enclosed within a farm yard which can be seen on the 1760 map (Fig. 3), surrounded by a dry stone wall of 18th century or earlier in date. A number of outbuildings survive to the rear.

Recommendations for further assessment: None

Recommendations for mitigatory measures: Will not be affected by proposed scheme

Feature 2 (Figs. 3 to 4)

Former Cow House

SH 7291 1865

Period: Probably Early Modern

Category: E Impact: None

A *beudy* or cowhouse, mentioned on the schedule associated with the 1794 Nannau Estate map (ZM/3667). It was in different occupation in 1794 and at the time of the tithe survey of 1842 from Pen y Cefn Uchaf (Fig. 5), and was associated with the group of small fields to the east of the study area. It is possible that it is the site of a former dwelling house.

Recommendations for further assessment: None

Recommendations for mitigatory measures: Will not be affected by proposed scheme

Feature 3 (Figs. 3 to 7)

Hedgerows (Plates 3, 5)

Period: Probably Early Modern

Category: E Impact: Unknown

The hedgerows of the fields associated with Pen y Cefn farm can be shown to pre-date 1760, and may be considerably earlier. They are associated with the farming practices of the Nannau Estate, the largest landowner in the area, and are an important element of the local landscape.

Recommendations for further assessment: None

Recommendations for mitigatory measures: Avoidance, or basic recording if breaches in the hedgerows have to be made, and reinstatement where possible.

Feature 4 (Appendix 2, Fig. 7- Sites 1-3) Possible Relict Field Boundaries

Period: Unknown

Category: E Impact: Considerable

These features are identified in the geophysical survey as potential relict field boundaries. However their regularity and the fact that the current field boundaries pre-date 1760 raises questions about this interpretation. They may be fairly modern features associated with drainage.

Recommendations for further assessment: Trial Trenching

Recommendations for mitigatory measures: Await results of trial trenching

Feature 5 (Appendix 2, Fig. 7- Sites 4-5) Curvilinear enclosures

Period: Unknown

Category: E Impact: None

These features can be interpreted as curvilinear features which may be ditched enclosures and therefore potentially significant archaeological sites, possibly of prehistoric date.

Recommendations for further assessment: None

Recommendations for mitigatory measures: Avoidance; will not be affected by the proposed development or associated works

Feature 6 (Appendix 2, Fig. 7- Sites 6-7) Magnetic Debris

Period: Unknown

Category: E Impact: None

These areas of weak magnetic debris suggest disturbed ground and the possible presence of debris, which may be archaeological, or associated with modern activity, such as the construction of the Water Treatment Works.

Recommendations for further assessment: None

Recommendations for mitigatory measures: Avoidance; will not be affected by the proposed development or associated works

Feature 7 (Appendix 2, Fig. 7) Possible Pits

Period: Unknown

Category: E Impact: None

Nine dipolar responses shown in the geophysical survey may represent archaeological features, possibly pits. Their significance will be determined as a result of the programme of trial trenching.

Recommendations for further assessment: Trial Trenching

Recommendations for mitigatory measures: Await results of trial trenching

5. SUMMARY OF ARCHAEOLOGICAL POTENTIAL

5.1 Location Summary

The Water Treatment Works are located at NGR SH 72891856. The water treatment works lies north of and above Dolgellau, at a height of some 100m above OD.

5.2 Aerial Photographs

Seven vertical aerial photographs were examined at the NMR in Aberystwyth, which are noted in Section 9. The field boundaries are as noted on the map evidence, and no new evidence was revealed. There is evidence that the fields have been ploughed within historic and recent times. Aerial photograph 71/283 frame 417, taken on 4th June 1971 is reproduced as figure 7.

5.3 Environmental Remains and Soil Morphology

The topsoils on the agricultural land next to the water treatment works are likely to be reasonably deep, as there is evidence for field improvement. There is no information available about the potential for the survival of environmental remains. However significant survival of late prehistoric plant macrofossils and pollen have been uncovered in the wider Ardudwy area. In 1981 at Moel y Gerddi near Harlech material was recovered that enabled a study of the deterioration of soil conditions and the increasing importance of heath land over time to take place (Chambers and Price 1988, 93-100).

5.4 Artefactual Potential

The likely presence of artefacts is unknown; however they could survive in association with any prehistoric sites uncovered, and a limited quantity of Romano-British artefacts were uncovered from the recent excavations at Rhiwgoch, Harlech (Evans, 2009 and *forthcoming*), although there was less agricultural improvement in that area. The discovery of isolated prehistoric and Roman artefacts in the vicinity is significant here, and may indicate the presence of hitherto unidentified archaeological activity.

6. SUMMARY OF RECOMMENDATIONS

6.1 Summary of Mitigation Recommendations

Feature Number	Name	Importance	Impact	Recommendation for further evaluation	Mitigation recommendations
1	Pen y Cefn Uchaf Farmhouse	B	None	None	Will not be affected by the proposed scheme
2	Former Cow house	E	None	None	Will not be affected by the proposed scheme
3	Hedgerows	E	Unknown	None	Avoidance, or basic recording if avoidance not possible
4	Possible relict field boundaries	E	Considerable	Trial Trenching	Await results of trial trenching
5	Curvilinear enclosures	E	None	None	Avoidance, will not be affected by the proposed development or associated works
6	Area of magnetic anomalies	E	None	None	Avoidance, will not be affected by the proposed development or associated works
7	Possible Pits	E	Considerable	Trial Trenching	Await results of trial trenching

6.2 Recommendations

6.2.1 General Introduction

No archaeological sites have been noted within the development area as part of the archaeological assessment, although the surviving field boundaries can be seen to date from the 18th century or earlier. The Geophysical Survey Report (Graham, C and Biggs, M. 2010, Appendix 2) identified some evidence of possible buried archaeological activity across the site (Appendix 2, Fig. 7). Two curvilinear features (Appendix 2, fig. 7, features 4 and 5) are interpreted as possible ditched enclosures. A number of anomalies (Feature 7) might represent pits, and therefore of potential archaeological significance. Some linear features (Appendix 2, fig. 7, features 1-3) are identified as possible relict field boundaries, although the map evidence suggests they would have to be pre 18th century in date, and their regularity and the fact that they are parallel suggests that an alternative explanation could be sought, possibly suggesting deep ploughing activity. Areas of disturbed ground are suggested (Appendix 2, fig. 7, features 6-7), which may be associated either with modern or archaeological activity.

There is some suggestion of archaeological activity within the development area (Graham and Biggs 2010, 7), and it is therefore recommended that a programme of archaeological trial trenching be carried out. This should be targeted on the features identified in the geophysical survey, and additional trenches placed so that 7.5% of the development area has been evaluated. The features identified need to be evaluated sufficiently to be able to determine their character, and the trenches have been placed to ensure this is possible.

6.2.2 Specific Recommendations

Black and Veatch drawing number 166716-00-5021 (Fig. 8, overlain with proposed trial trenches), outlines the proposed development areas. An area of topsoil strip, where a Terram and stone surface is to be laid, is shown shaded in green, where the proposed work compounds are to be situated. The non shaded areas, which include the potential archaeological features 5 and 6, will not be disturbed. These areas will be protected and the topsoil reinstated after the works have been carried out, and no archaeological work will be required. Care needs to be taken that the Terram and stones are laid in such a manner that the underlying archaeology is not disturbed.

The areas to be developed and incorporated into the new Water Treatment Works are shown shaded in blue. This consists of an area of 8400m² and it is recommended that a programme of trial trenching, targeted on the possible features identified in the geophysical survey, and also additional trenches, to make up 7.5% of the total area (610m²), be excavated to evaluate the nature and quality of the surviving archaeology. The proposed location of these 7 trenches is shown in Fig. 8. Three trenches of 30m by 5m are recommended, targeting potential archaeological features, and four trenches of 20m by 2m. The larger trenches are particularly necessary to enable the nature and context of the possible pits (Feature 7) to be understood. A toothless ditching bucket will be used for the excavation. Recommendations for mitigation of any archaeological remains would follow the results of the trial trenching, which could include full excavation of identified features.

7. CONCLUSIONS

The farmland around Pen y Cefn Uchaf can be seen to have been the property of the Nannau Estate from the 16th century, with surviving documents and maps relating to it dating from 1760 to 1794. The fields appear to have been ploughed up to the 18th century, and are now improved grassland. They have similar boundaries to those noted on the 25 inch 1st edition Ordnance Survey map of 1889 (Fig.6), although some of the small field sub divisions have been lost to the east of the Water Treatment Works. The farmhouse at Pen y Cefn Uchaf appears to be of 18th century date, and is noted on all the surviving cartographic evidence, although it has undergone some more recent modifications.

The site of the Water Treatment Works at Pen y Cefn Uchaf can be seen to be part of a landscape of dispersed agricultural settlement that dates from at least the middle of the 18th century. The area had been the property of the very extensive the Nannau estate since the 16th century, and although there has been development to the west of the proposed development area as part of the 20th century expansion of Dolgellau, it retains its character. No known archaeological sites have been identified within 250m of the development area, however the geophysical survey has indicated that there is a moderate potential for the presence and survival of below

ground archaeological remains. A programme of archaeological trial excavation trenching is recommended to assess the potential for the survival of archaeological remains and this is indicated on Figure 8.

8. ARCHIVE

The archive consists of historic maps, plans and aerial photographs, along with notes and digital images taken on the field visit.

Three copies of the bound report and a disk will be sent to the SNPA archaeologist, and a further copy sent to the HER Archaeologist at the curatorial division of Gwynedd Archaeological Trust, Bangor, for deposition in the Regional HER. A copy of the report, with a disk containing all digital files, will be provided to the National Monument Record, Royal Commission on the Ancient and Historic Monuments of Wales, Aberystwyth.

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GAT Historic Environment Record

Ordnance Survey maps

25 inch 1st edition 1889 Meirioneth Sheet XXXIII.15

25 inch 2nd edition 1901 Meirioneth Sheet XXXIII.15

Bangor University Archives

Nannau MSS 1403 *Rent Roll for the Nannau Estate 1778*

Gwynedd Archives, Dolgellau

ZM/3667 *A Survey of Several Estates in the County of Merioneth belonging to Griffith ap Howell Vaughan* 1794

National Library of Wales

MAP 7425 Map of Several Estates in the County of Meirioneth belonging to Griffith ap Howell Vaughan
Tithe Map of the Parish of Dolgellau, Meirionydd 1842

RCAHM Wales Aberystwyth

Aerial Photographs

Verticals

RAF

106G UK 1468 Frame 4181 Taken 4th May 1946

106G UK 1468 Frame 4182 Taken 4th May 1946

106G UK 1468 Frame 4183 Taken 4th May 1946

Ordnance Survey

ZEIS 054 71-234 Frame 417 Taken 4th June 1971

WILD 704 71-286 Frames 128 Taken 4th June 1971
RC10 1237/1010 76-120 Frame 019 taken 30th June 1976
ZEISS 630 304.81 Frame 132 Taken 13th October 1994

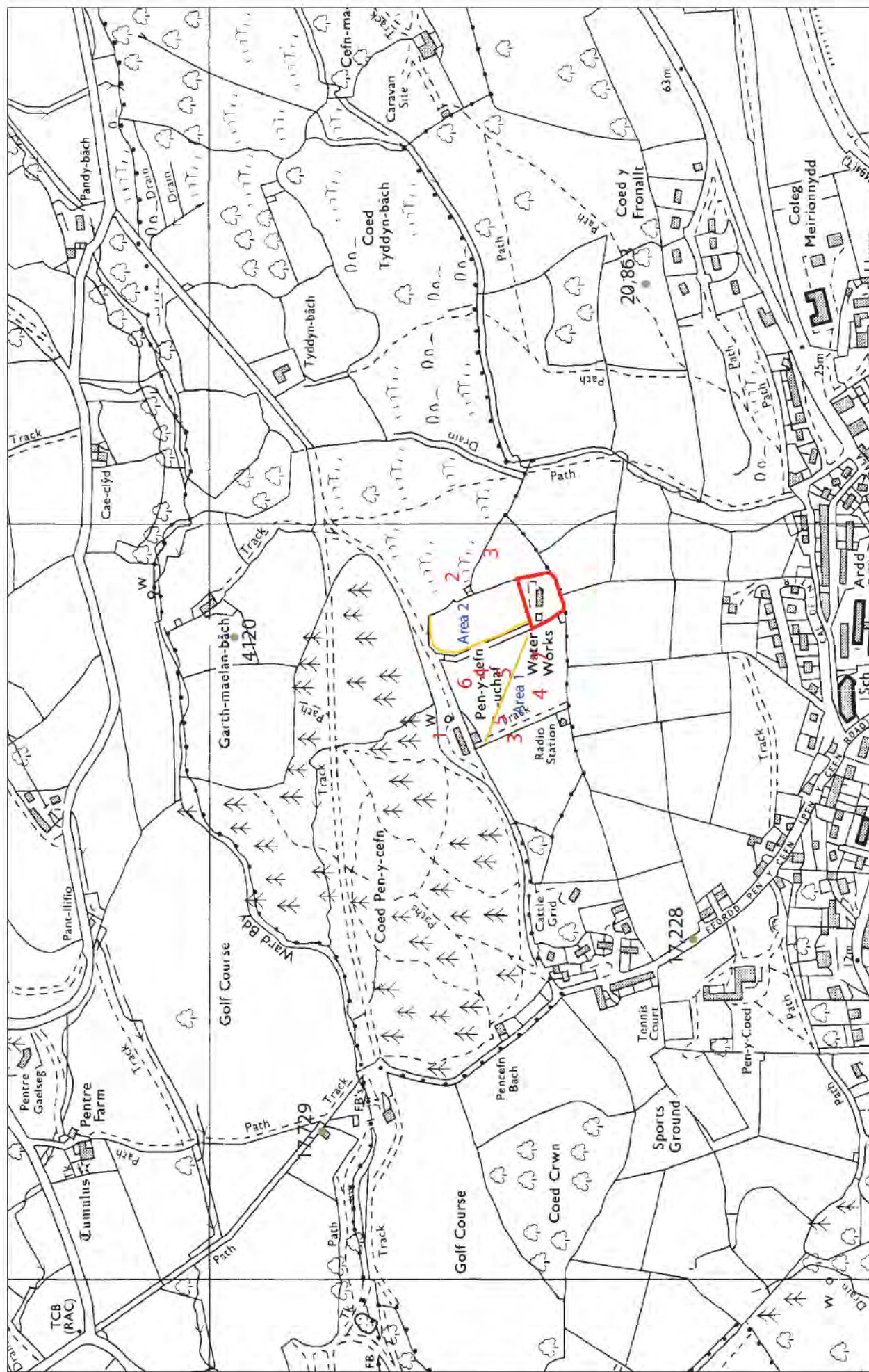


Fig. 2 Location of Sites mentioned in the text, labelled in red. Sites noted on the Gwynedd HER with their PRN numbers are noted with green dots (Appendix 1). The site of the current Water Treatment Works is outlined in red. The geophysical survey areas are labelled in blue, and the service trenches outlined in yellow. Scale 1:5000

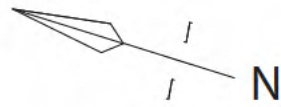


Fig. 3 Extract from 1760 Nannau Estate map showing Pen y Cefn Uchaf (NLW Map 7425). The location of the current WTW is outlined in red. North arrow added, not to scale

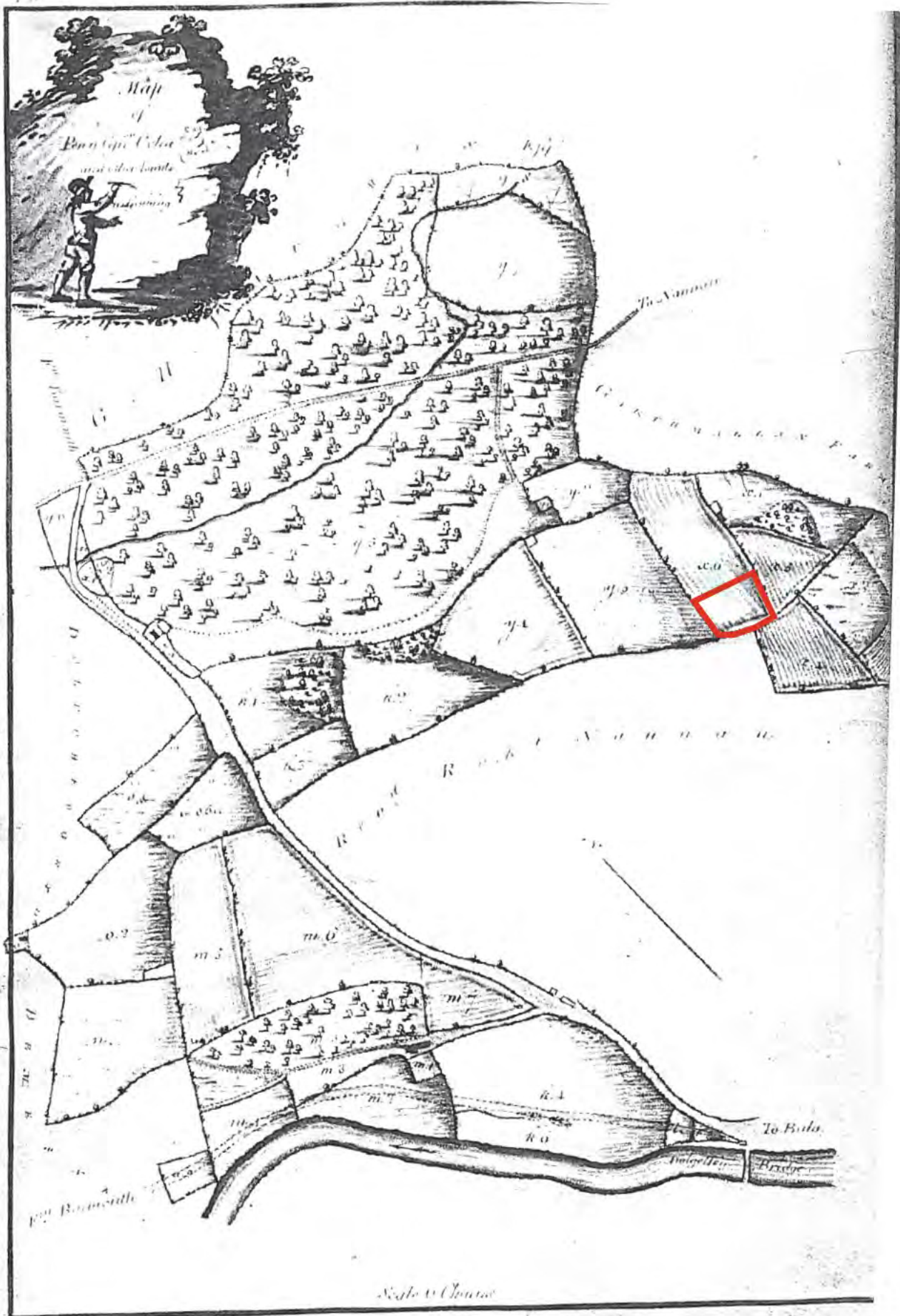


Fig. 4 Pen y Cefn Uchaf, as shown on the Nannau Estate map of 1794 (ZM/3667). Location of the current WTW outlined in red. Not to scale



Fig. 5 Extract from the Tithe Map of the parish of Dolgellau of 1842 (NLW). The approximate location of the current WTW is outlined in red.

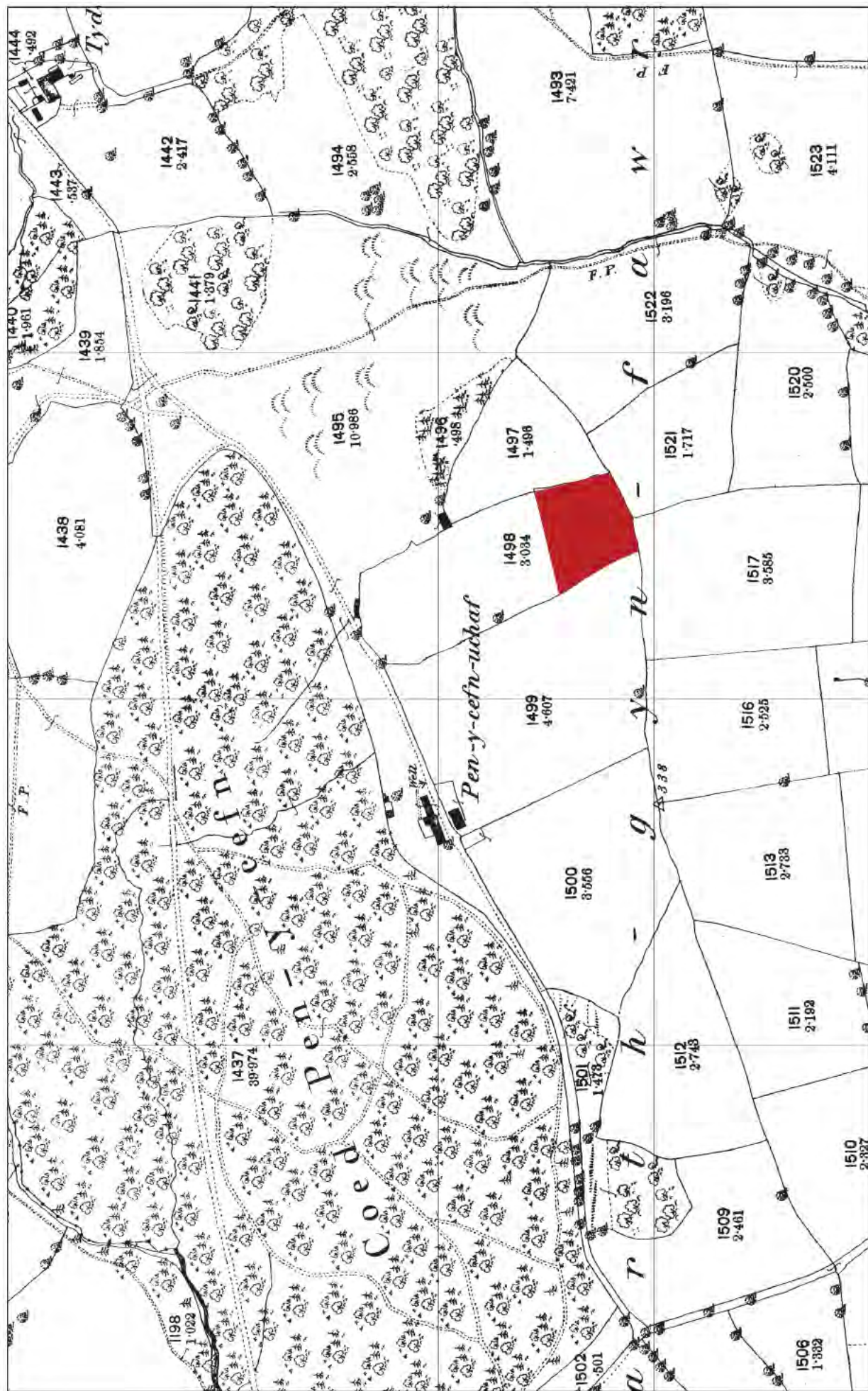


Fig. 6 Ordnance Survey 25 inch 1st edition map of 1889: Merioneth Sheet XXXIII.15. The location of the current WTW is shown in red. Scale 1:2500@A4

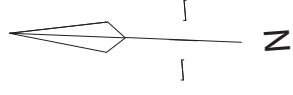


Fig. 7 Extract from Ordnance Survey Aerial Photograph 71/283 frame 417, taken 4th June 1971. Water Treatment Works and geophysical survey area outlined in red



Plate 1 Pen y Cefn Uchaf farmhouse from the south east



Plate 2 View from Water Treatment Works looking north west towards Pen y Cefn Uchaf and radio mast.



Plate 3 The field boundary looking north from the west of the Water Treatment Works



Plate 4 The Water Treatment Works looking south, showing the proposed development area in the foreground, in the field known as 'Cae Hir'



Plate 5 The trackway and hedgerow looking south from Pen Y Cefn Uchaf



Plate 6 The proposed compound area, known as 'Coed Pen y Cefn', from the south



Plate 7 View looking north east towards 'Cae Beudy'

APPENDIX 1

Sites within 500m of the Pen y Cefn Water Treatment Works noted on the Gwynedd HER					
PRN	NPRN	SITENAME	NGR	SITETYPE	PERIOD
4120	55414	GARTH-MAELAN-BACH - UNIVALLATE ENCLOSURE	SH72851898	ENCLOSURE	Unknown
4122	55416	PERFORATED AXE HAMMER, FINDSPOT - DOLGELLAU	SH72601820A	FINDSPOT	Prehistoric
1577	59951	ROMAN POTTERY - FINDSPOT, BRYN MARIAN, DOLGELLAU	SH72901820	FINDSPOT	Roman
5479	60202	AXE-HAMMER - FINDSPOT, BRYN-MARIAN, DOLGELLAU	SH72601820A	FINDSPOT	Prehistoric
20863	61440	QUARRY, COED Y FRONALLT	SH73301840	QUARRY	Post-Medieval
17728	0	PART OF ROMAN ROAD : TOMEN Y MUR - BRITHDIR	SH72451836		Roman
17729	0	PART OF ROMAN ROAD : TOMEN Y MUR - BRITHDIR	SH 72201885		Roman

Geophysical Survey Report

**Pen y Cefn,
Gwynedd**

for

Gwynedd Archaeological Trust

March 2010

Job ref: J2700

Claire Graham BA (Hons) &
Melanie Biggs BSc (Hons)



Document Title: **Geophysical Survey Report
Pen y Cefn, Gwynedd**

Client: **Gwynedd Archaeological Trust**

Stratascan Job No: **J2700**

Techniques: **Detailed magnetic survey (gradiometry)**

National Grid Ref: **SH 728 186**

Field Team: **Adam Cooper MA (Hons) & Karl Hanson MA**

Project Manager: **Simon Stowe BSc. (Hons)**

Report written by: **Claire Graham BA (Hons) & Melanie Biggs BSc (Hons)**

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1 SUMMARY OF RESULTS

A detailed gradiometer survey was undertaken over approximately 2.6 hectares of pasture land to the north of Dolgellau, Gwynedd. The survey identified some evidence of possible archaeological activity across the site. Positive anomalies have been interpreted as in filled cut features such as ditches and pits. Negative anomalies may represent the remains of earthen banks or compacted earth. Some of these are seen in close association which may suggest some form of bank and ditch arrangement. A positive linear anomaly with an associated negative response is noted in Area 1 which is probably caused by a service trench. A series of agricultural marks are seen in Area 2. Individual moderate and high aptitude responses are seen across the survey area, many of which may be caused by buried ferrous material. Areas of magnetic disturbance and debris are noted across the survey area which may obscure the identification of anomalies of possible archaeological origin.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey of an area outlined for development. This survey forms part of an archaeological investigation being undertaken by Gwynedd Archaeological Trust.

2.2 Site location

The site is located near Dolgellau at OS ref. SH 728 186.

2.3 Description of site

The survey area was carried out over approximately 2.6 hectares of pasture land which is split into 2 adjacent fields. Both fields are enclosed by fences and trees. The topography of the site slopes downhill from the south-east corner of both fields towards the north-west corner. A pile of tree branches obstructs the north-east corner of the bigger field.

2.4 Geology and soils

The underlying geology is Upper Cambrian, including Tremadoc (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The drift geology is boulder clay and Morainic drift (British Geological Survey South Sheet, First Edition Quaternary, 1977).

The overlying soils are known as Conway which are typical alluvial gley soils. These consist of deep, stoneless, fine silty and clayey soils which are variably affected by groundwater (Soil Survey of England and Wales, Sheet 2, Wales).

2.5 Site history and archaeological potential

No specific details were available to Stratascan.

2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order that they may be assessed prior to development.

2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

3 **METHODOLOGY**

3.1 Date of fieldwork

The fieldwork was carried out over 2 days from 1st – 2nd March 2010. Weather conditions during the survey were dry and sunny.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information. Grids were set out using a Leica 705auto Total Station and referenced to suitable topographic features around the perimeter of the site.

3.3 Survey equipment

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and

ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

3.4.2 Depth of scan and resolution

The Grad 601 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.5m centres provides an optimum methodology for the task balancing cost and time with resolution.

3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily downloaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3*. This can emphasise various aspects contained within the data but which are often not easily seen

in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

1. *Despike* (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters:

X radius = 1, y radius = 1, threshold = 3 std. dev.
Spike replacement = mean

2. *Zero mean traverse* (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters:

Least mean square fit = off

3.5.2 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figure 3) and colour plots of the minimally processed data showing extreme magnetic values (Figure 4), together with a greyscale plot of the processed data (Figure 5). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 6).

4 RESULTS

The gradiometer survey which was undertaken at over 2.6 hectares of pasture land at Pen y Cefan identified a significant amount of activity. Positive linear and area anomalies have been identified throughout the site. Positive anomalies may be caused by in-filled cut features such as ditches and are of possible archaeological origin. Some of these stronger linear features (**1-3**) may be caused by former field boundaries. The parallel positive anomalies which are seen in Area 2 have been interpreted as agricultural marks. Discrete positive area anomalies are observed across the site. These features are caused by small cut features, such as pits, and are of possible archaeological origin. A positive linear anomaly with an associated negative response is noted running from north west to south east across Area 1. This is of uncertain origin although it may be caused by a service trench.

Negative linear and area anomalies have been identified in Area 1. These have been interpreted as the remains of earthen banks or areas of compacted earth of possible archaeological origin. These are often seen in close proximity to the positive anomalies which may suggest some bank and ditch arrangement. Two curvilinear features are observed in Area 2 (**4 & 5**) which may represent ditched enclosures with associated banks of possible archaeological origin. Further positive and negative responses are observed across the site, as many of these do not appear to be in any identifiable pattern it is possible that they are caused by geological deposits.

Discrete dipolar anomalies are seen across this area. These are moderately high amplitude responses with an associated negative response. Their origin is unclear but they may be associated with ferrous material buried at depth.

Two areas of weak magnetic debris are observed in the north of Area 1 (**6 & 7**). Magnetic debris is often caused by made or disturbed ground containing magnetic material such as bricks or scattered debris and so may be associated with modern or archaeological activity. Areas of magnetic disturbance are noted around the perimeter of the site, these are caused by modern fences and field boundaries. A strong magnetic linear response is seen running along the western and northern perimeter of Area 2. This is caused by a buried pipe or service. A number of strong positive anomalies with associated negative returns can be seen across the site, which are typical of near surface ferrous objects.

5 CONCLUSION

The gradiometer survey provided some evidence of archaeological activity. Positive and negative anomalies have been identified across the site which may be associated with cut features, such as ditches and pits and earthen banks respectively, both of which are of possible archaeological origin. Some of the weaker anomalies may be caused by geological deposits.

Individual magnetic anomalies are noted across the survey area, some of which are high amplitude, others of which are weaker and more discrete. These are of uncertain origin but many may be related to buried or surface ferrous objects of modern origin.

6 REFERENCES

British Geological Survey, 2001. *Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid)*. British Geological Society.

Soil Survey of England and Wales, 1983. *Soils of England and Wales, Sheet 5 Southwest England*.

British Geological Survey South Sheet, 1977. *Geological Survey Ten Mile Map, South Sheet First Edition (Quaternary)*. Institute of Geological Sciences.

APPENDIX A – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth's magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth's magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

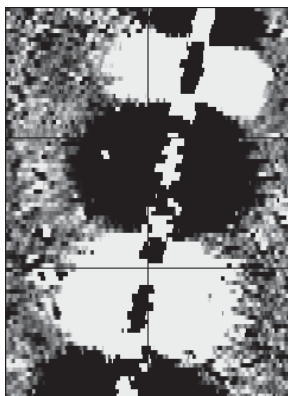
Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth's magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

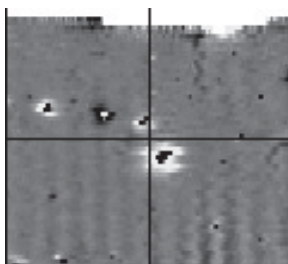
APPENDIX B – Glossary of magnetic anomalies

Bipolar



A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.

Dipolar

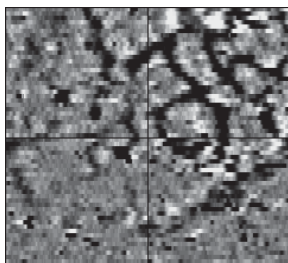


This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

Positive anomaly with associated negative response

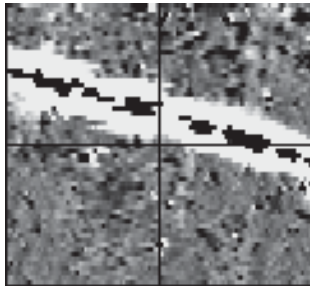
See bipolar and dipolar.

Positive linear



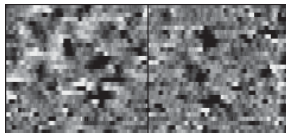
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.

Positive linear anomaly with associated negative response



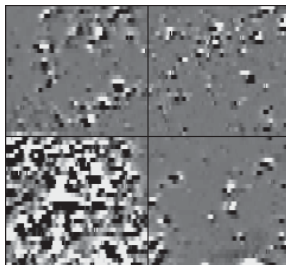
A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.

Positive point/area



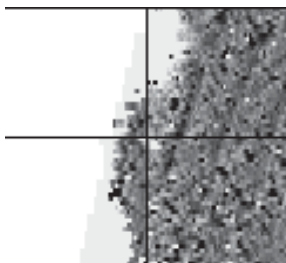
These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree bowls or other naturally occurring depressions in the ground.

Magnetic debris



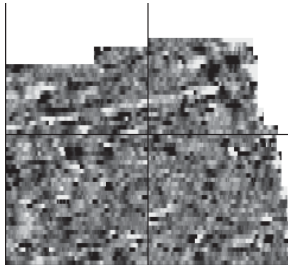
Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low ($\pm 3\text{nT}$) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly ($\pm 250\text{nT}$) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremanent material such as bricks or ash.

Magnetic disturbance



Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

Negative linear

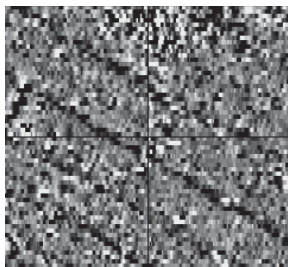


A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.

Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity



Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

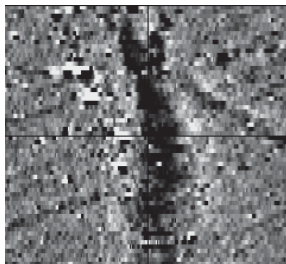
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a 10m² area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Trace plots are used to show the amplitude of response.

Thermoremnant response

A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately ± 100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred insitu (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

Weak background variations

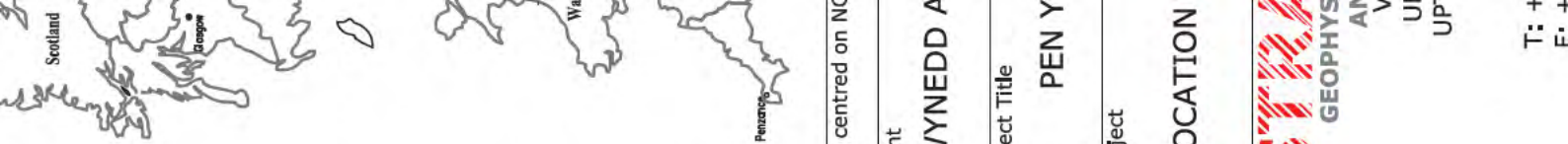


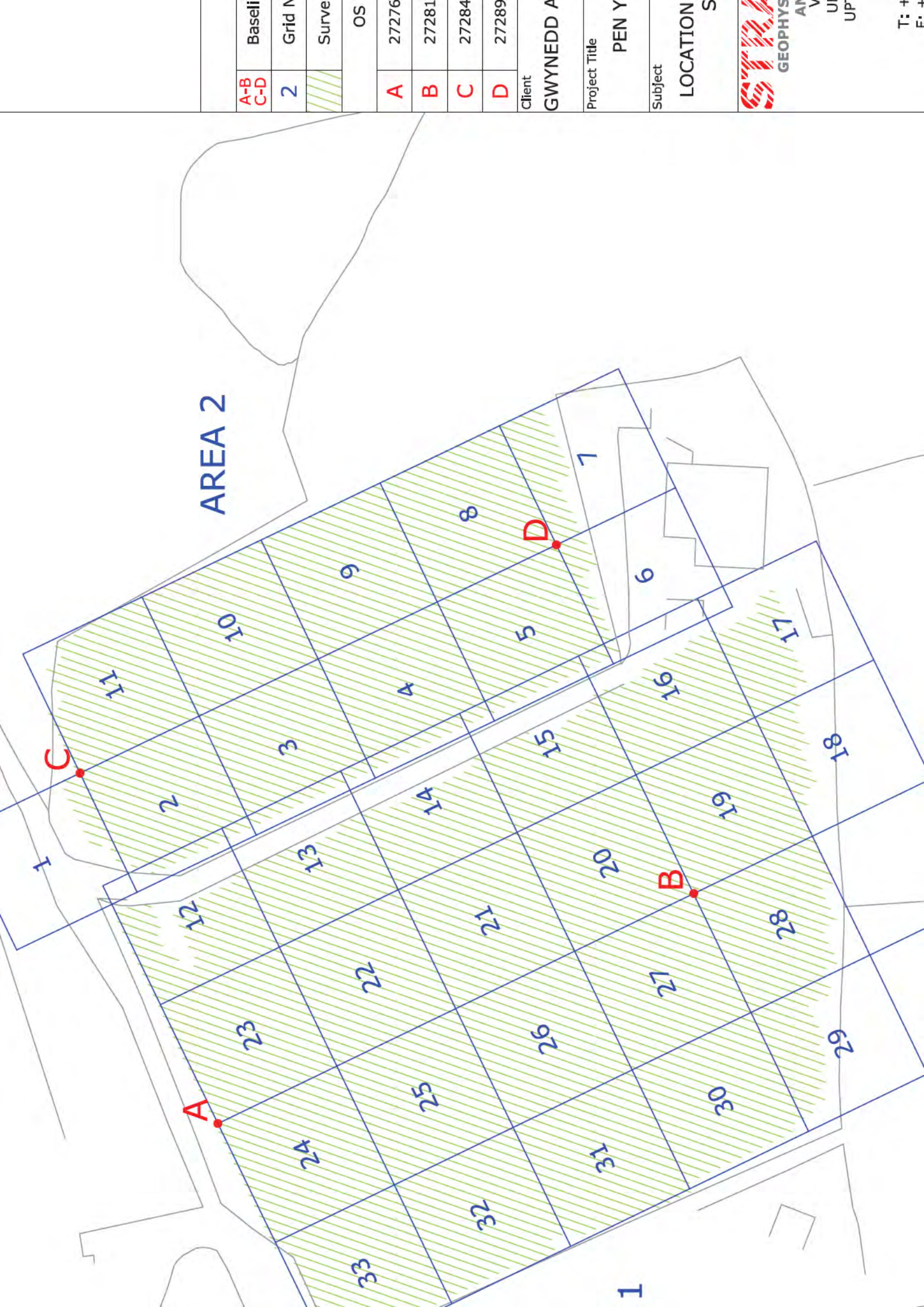
Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.



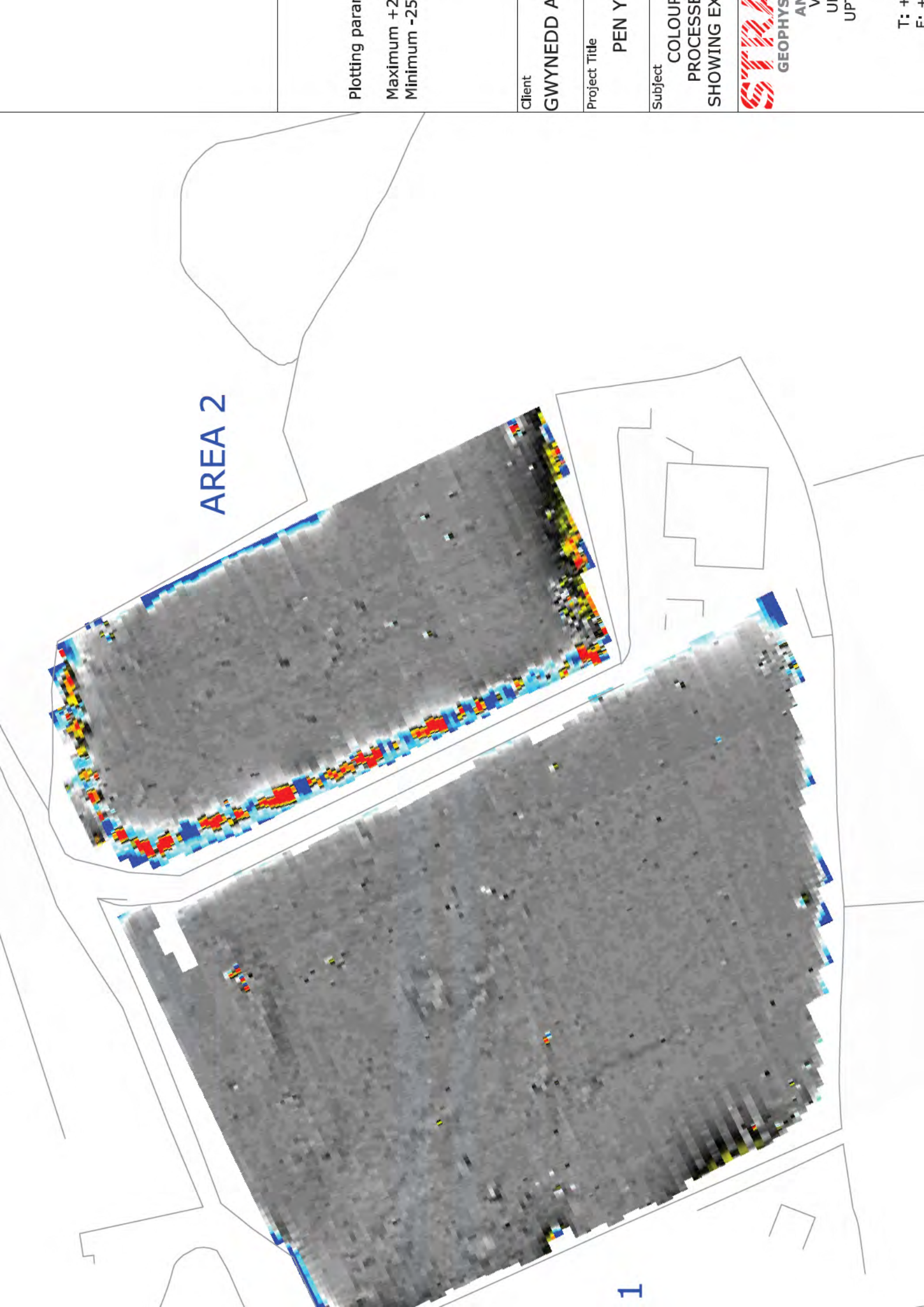
Survey Area

Site centred on North Wales		Client
GWYNEDD A		Project Title
PEN Y		Subject
LOCATION		
 GEOPHYSICS		









AREA 2

1

Plotting parameters
Maximum +25
Minimum -25

Client
GWYNEDD A

Project Title
PEN Y

Subject
COLOUR
PROCESS
SHOWING EX

ST
GEOPHYS

AN
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Plotting para

Maximum 2n
Minimum -2n



Area 2
Plotting para

Maximum 2n
Minimum -2n



Client
GWYNEDD A

Project Title

PEN Y

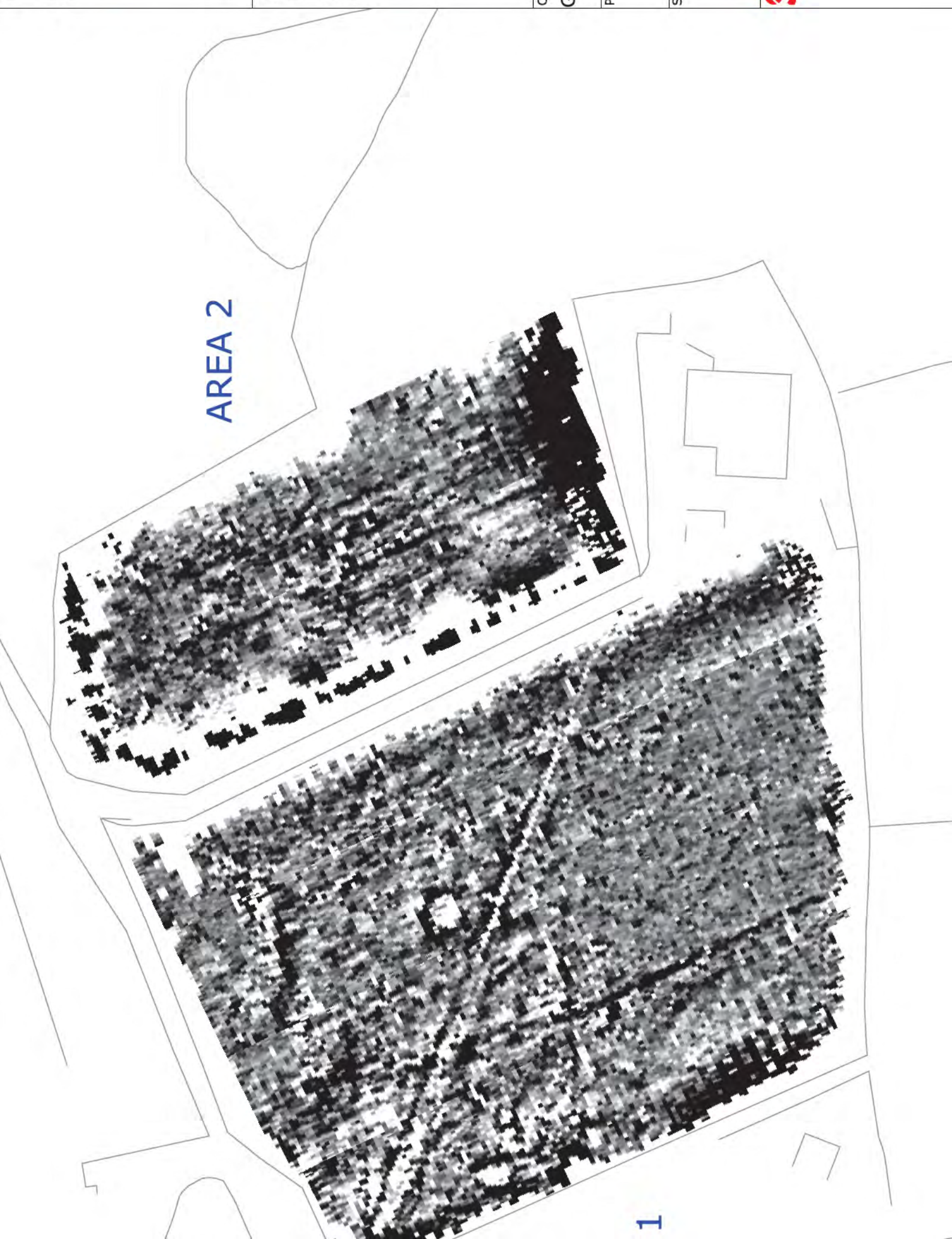
Subject

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PROPOSED DEVELOPMENT AT
PEN Y CEFN WTW, DOLGELLAU

PROJECT DESIGN FOR
ARCHAEOLOGICAL ASSESSMENT
AND
MAGNETOMETER SURVEY

Prepared for

Caulmert

January 2010

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

APPENDIX 3

PEN Y CEFN WTW, DOLGELLAU

PROJECT DESIGN FOR ARCHAEOLOGICAL ASSESSMENT AND MAGNETOMETER SURVEY (G2110)

Prepared for Caulmert, January 2010

1. PROJECT BACKGROUND

Gwynedd Archaeological Trust has been asked by Caulmert to provide a cost and project design for carrying out an archaeological assessment in advance of a proposed extension to the Water Treatment Works at Pen y Cefn, Dolgellau (SH 729185).

A detailed archaeological brief has not been prepared for this scheme, but the Snowdonia National Park Archaeologist has recommended a desk-based study and field visit to form the first part of an Archaeological Assessment, and a magnetometer survey if the initial assessment results recommend this.

This design will conform to the guidelines specified in *Standard and Guidance for Archaeological Desk-based Assessment* (Institute of Field Archaeologists, 1994, rev. 2001).

2. ARCHAEOLOGICAL AIMS

A desk-based assessment is defined as “a programme of assessment of the known or potential archaeological resource within a specified area or site on land, inter-tidal zone or underwater. It consists of a collation of existing written, graphic, photographic and electronic information in order to identify the likely character, extent, quality and worth of the known or potential archaeological resource in a local, regional, national or international context as appropriate” (IFA 2001, 2)

The aims of the assessment are:

- to identify and record the cultural heritage within the defined study area;
- to evaluate the importance of what has been identified;
- to recommend ways in which impact upon the cultural heritage can be avoided or minimised.

To comply fully with the aims expressed above it can be necessary to undertake a programme of Field Evaluation following the Desktop study and Field Visit. This is because some sites cannot be assessed by desktop or field visit alone, and additional fieldwork is therefore required. This typically takes the form of geophysical survey or trial excavation, although measured survey is also a possible option. A full programme of assessment and evaluation may therefore consist of:

- Desktop study
- Field walkover
- Initial report
- Field evaluation
- Draft report
- Final report

This design is for the first three phases, and for the first stage of field evaluation. Recommendations will be made following the initial assessment for any field evaluation required, and the magnetometer survey will be undertaken if required.

3. ARCHAEOLOGICAL BACKGROUND

The water treatment works lies north of and above Dolgellau, at a height of some 100m above OD. No known sites lie within the study area, however a number of prehistoric and Roman sites lie within 500m of the site. The study area lies on improved land, and there is potential for the survival of relict archaeology below ground

which is not currently visible. The area lies within a registered landscape of outstanding historic interest (Vale of Dolgellau).

4. PROGRAMME OF WORK

4.1 Introduction

The project will take into account:

- The history of the site
- The potential impact of the development on archaeological remains
- The potential impact of the development on the setting of sites of archaeological importance
- The requirements for further assessment in the form of non-intrusive and intrusive field evaluation.

The project will be undertaken in four stages:

- Desk-based assessment
- Field visit
- Report compilation
- Project archive

4.2 Desk-based assessment

The desk-based assessment will involve a study of the following records

The regional Historic Environment Register (HER) will be examined for information concerning the study area. This will include an examination of the core HER, and secondary information held within the record which includes unpublished reports, the 1:2500 County Series Ordnance Survey maps, and the National Archaeological Record index cards. The National Monuments Record (NMR) will be checked for sites additional to the HER, and if required additional supporting information will be examined at the NMR.

Information about Listed Buildings and Scheduled Ancient Monuments from Cadw will be examined in the regional HER, with supporting information from Cadw if required. The Register of Outstanding and Special Historic Landscapes and the Register of Parks and Gardens will be checked, and also the location of World Heritage Sites.

Secondary sources will be examined, including the Inventories of the Royal Commission on Ancient and Historical Monuments for Wales, and works held within the regional libraries. Indices to relevant journals, including county history and archaeology society journals and national society journals such as *Archaeologia Cambrensis* will be checked. Also at this stage 19th century topographical dictionaries, antiquarian tours and trade directories will be examined where relevant.

Evidence from aerial photographs will be collated. Vertical and oblique collections held by the NMR, CCW and Welsh Assembly Government will be considered for examination. All photographs examined will be listed in the assessment report.

Archive maps, where relevant, will be consulted in the regional and national archives, and at the archives of the University of Wales, Bangor. This will include the relevant tithe map and information from Land Tax Assessments, and the manuscripts of relevant estates. Other general maps to be used will include those by John Speed, John Evans and the OS first edition 2nd manuscript maps. If relevant antiquarian prints and photographs from the national and regional archives will be examined.

Results from previous archaeological work will be reviewed. These results, combined with the results from the desk-based assessment and field survey will be used to assess environmental potential, faunal potential and artefactual potential of the study area.

4.3 Field survey

This part of the assessment will involve walking the study area and assessing the sites identified during the desk-based study. Any additional sites noted will also be assessed. The location of potentially well-preserved environmental deposits will be noted.

The aims of this stage of the work are to:

- verify the results of the desk based assessment
- identify any further archaeological sites which may exist as above ground features
- assess the potential for the preservation of below-ground archaeology
- assess the impact upon the historic landscape
- photograph and record the present condition of all sites noted.

Access onto land is to be arranged by the Clients.

4.4 Field Evaluation

4.4.1 Magnetometer survey

If recommended following the initial assessment, a magnetometer survey will be conducted across the proposed area of development, which amounts to some 1.5ha in area. The survey will be carried out in a series of 20m grids, which will be tied into fixed local topographic features. The survey will be conducted using a Bartington Grad 601-2 Dual Sensor fluxgate gradiometer. The survey will be carried out at standard resolution.

4.2.1 Instrumentation

The Bartington Grad 601-2 dual Fluxgate Gradiometer uses a pair of Grad-01-100 sensors. These are high stability fluxgate gradient sensors with a 1.0m separation between the sensing elements, giving a strong response to deeper anomalies.

The instrument detects variations in the earth's magnetic field caused by the presence of iron in the soil. This is usually in the form of weakly magnetised iron oxides which tend to be concentrated in the topsoil. Features cut into the subsoil and backfilled or silted with topsoil therefore contain greater amounts of iron and can therefore be detected with the gradiometer. This is a simplified description as there are other processes and materials which can produce detectable anomalies. The most obvious is the presence of pieces of iron in the soil or immediate environs which usually produce very high readings and can mask the relatively weak readings produced by variations in the soil. Strong readings are also produced by archaeological features such as hearths or kilns because fired clay acquires a permanent thermo-remnant magnetic field upon cooling. This material can also get spread into the soil leading to a more generalised magnetic enhancement around settlement sites.

Not all surveys can produce good results as anomalies can be masked by large magnetic variations in the bedrock or soil or high levels of natural background "noise" (interference consisting of random signals produced by material within the soil). In some cases, there may be little variation between the topsoil and subsoil resulting in undetectable features.

The Bartington Grad 601 is a hand held instrument and readings can be taken automatically as the operator walks at a constant speed along a series of fixed length traverses. The sensor consists of two vertically aligned fluxgates set 1.0m apart. Their Mumetal cores are driven in and out of magnetic saturation by an alternating current passing through two opposing driver coils. As the cores come out of saturation, the external magnetic field can enter them producing an electrical pulse proportional to the field strength in a sensor coil. The high frequency of the detection cycle produces what is in effect a continuous output.

The gradiometer can detect anomalies down to a depth of approximately one metre. The magnetic variations are measured in nanoTeslas (nT). The earth's magnetic field strength is about 48,000 nT, typical archaeological features produce readings of below 15nT although burnt features and iron objects can result in changes of several hundred nT. The instrument is capable of detecting changes as low as 0.1nT.

4.2.2 Data Collection

The gradiometer includes an on-board data-logger. Readings in the surveys are taken along parallel traverses of one axis of a 20m x 20m grid. The traverse interval is 0.5m. Readings are logged at intervals of 0.5m along each traverse.

4.2.3 Data presentation

The data is transferred from the data-logger to a computer where it is compiled and processed using ArchaeoSurveyor 2 software. The data is presented as a grey-scale plot where data values are represented by modulation of the intensity of a grey scale within a rectangular area corresponding to the data collection point within the grid. This produces a plan view of the survey and allows subtle changes in the data to be displayed. This is supplemented by an interpretation diagram showing the main features of the survey with reference numbers linking the anomalies to descriptions in the written report. It should be noted that the interpretation is based on the examination of the shape, scale and intensity of the anomaly and comparison to features found in previous surveys and excavations etc. In some cases the shape of an anomaly is sufficient to allow a definite interpretation e.g. a Roman fort. In other cases all that can be provided is the most likely interpretation. The survey will often detect several overlying phases of archaeological remains and it is not usually possible to distinguish between them. Weak and poorly defined anomalies are most susceptible to misinterpretation due to the propensity for the human brain to define shapes and patterns in random background 'noise'. An assessment of the confidence of the interpretation is given in the text.

4.2.4 Data Processing

The data is presented with a minimum of processing although corrections are made to compensate for instrument drift and other data collection inconsistencies. High readings caused by stray pieces of iron, fences, etc are usually modified on the grey scale plot as they have a tendency to compress the rest of the data. The data is however carefully examined before this procedure is carried out as kilns and other burnt features can produce similar readings. The data on some noisy or very complex sites can benefit from 'smoothing'. Grey-scale plots are always somewhat pixellated due to the resolution of the survey. This at times makes it difficult to see less obvious anomalies. The readings in the plots can therefore be interpolated thus producing more but smaller pixels and a small amount of low pass filtering can be applied. This reduces the perceived effects of background noise thus making anomalies easier to see. Any further processing would be noted in relation to the individual plot.

Recommendations for any further field evaluation considered necessary will be contained within the report.

4.5 Data processing and report compilation

Following completion of the stages outlined above, a report will be produced incorporating the following:

Non-technical summary

1. Introduction
2. Aims and purpose
3. Specification and Project Design
4. Methods and techniques, including details and location of project archive
5. Archaeological Background
6. Results of assessment in the form of a gazetteer
7. Assessment of impacts
8. Proposals for field evaluation and/or mitigation
9. Summary and conclusions
10. List of sources consulted.

Illustrations will include plans of the location of the study area and archaeological sites. Historical maps, when appropriate and if copyright permissions allow, will be included. Photographs of relevant sites and of the study area where appropriate will be included.

A draft copy of the report will be sent to the regional curatorial archaeologist and to the client prior to production of the final report.

4.6 Definition of category of importance

To assess the importance of sites and to allow the appropriate mitigatory action to be proposed for each, a framework of categories will be used with each site allocated to a particular category according to its relative importance:

Category A - Sites of National Importance.

This category includes Scheduled Ancient Monuments and Listed Buildings (Grade I and II*) as well as those sites which would meet the requirements for scheduling (ancient monuments) or listing (grade I and II* and certain grade II) or both.

Sites that are scheduled or listed have legal protection, and it is recommended that all Category A sites remain preserved and protected *in situ*.

Category B - Sites of Regional Importance

These sites are those which would not fulfil the criteria for scheduling, but may include Listed Buildings at grade II. They are sites of particular importance within the region. Preservation *in situ* is the preferred option for Category B sites, but if damage or destruction cannot be avoided, appropriate detailed recording might be an acceptable alternative. Sites that are Listed have legal protection, and it is recommended that all listed buildings are preserved *in situ*.

Category C - Sites of District or Local Importance

These sites are not of sufficient importance to justify a recommendation for preservation if threatened, but nevertheless merit adequate recording in advance of damage or destruction.

Category D - Minor and Damaged Sites

These are sites which are of minor importance or are so badly damaged that too little remains to justify their inclusion in a higher category. For these sites the most appropriate mitigation is often rapid recording either in advance or during destruction.

Category E - Sites needing further investigation

Sites, the importance of which is as yet undetermined and which will require further work before they can be allocated to categories A-D, are temporarily placed in this category, with specific recommendations for further evaluation. This category can also apply to areas as well as to individual sites.

5. DISSEMINATION AND ARCHIVING

A full archive including plans, photographs, written material and any other material resulting from the project will be prepared. All plans, photographs and descriptions will be labelled, and cross-referenced, and lodged in an appropriate place within six months of the completion of the project. The location is to be agreed with the Curatorial Archaeologist.

Copies of the report will be sent to the regional HER, the Snowdonia National Park and the NMR.

The results of the assessment will be published in a suitable journal (e.g. Archaeology in Wales) if relevant.

6. PERSONNEL

The work will be supervised by Mr Andrew Davidson, Principal Archaeologist. The work will be undertaken by one of the Trust's Archaeologists experienced in the relevant skills/periods required. Full details of personnel involved, with *curricula vitae*, can be supplied upon request.

7. MONITORING AND TIMING

Monitoring visits can be arranged during the course of the project with the clients and with the appropriate Development Control archaeologist.

8. HEALTH AND SAFETY

The Trust subscribes to the SCAUM (Standing Conference of Archaeological Unit Managers) Health and Safety Policy as defined in **Health and Safety in Field Archaeology** (2006). Risks will be assessed prior to and during the work.

9. INSURANCE

The Trust holds public liability insurance with an indemnity limit of £5,000,000 through Russell, Scanlon Limited Insurance Brokers, Wellington Circus, Nottingham NG1 5AJ (policy 01 1017386 COM), and Professional Indemnity Insurance for £2,000,000 per claim (policy No. 59A/SA11818791).

10. OTHER

Any queries concerning the above should be directed to Mr Andrew Davidson or Mr John Roberts at the Gwynedd Archaeological Trust Offices, Garth Road, Bangor. Telephone (01248) 352535.



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ARCHAEOLEGOL
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