historic environment. Mapping at a scale of 1:2 500 was considered to be ideal both for allowing adequate portrayal of archaeological field monuments and for practical coverage of large areas of ground into manageable sheets for fieldwork. Therefore, it was necessary as a first stage to create a new map base. In the 1980s the most appropriate way of doing this was from vertical aerial photography, followed by ground survey.

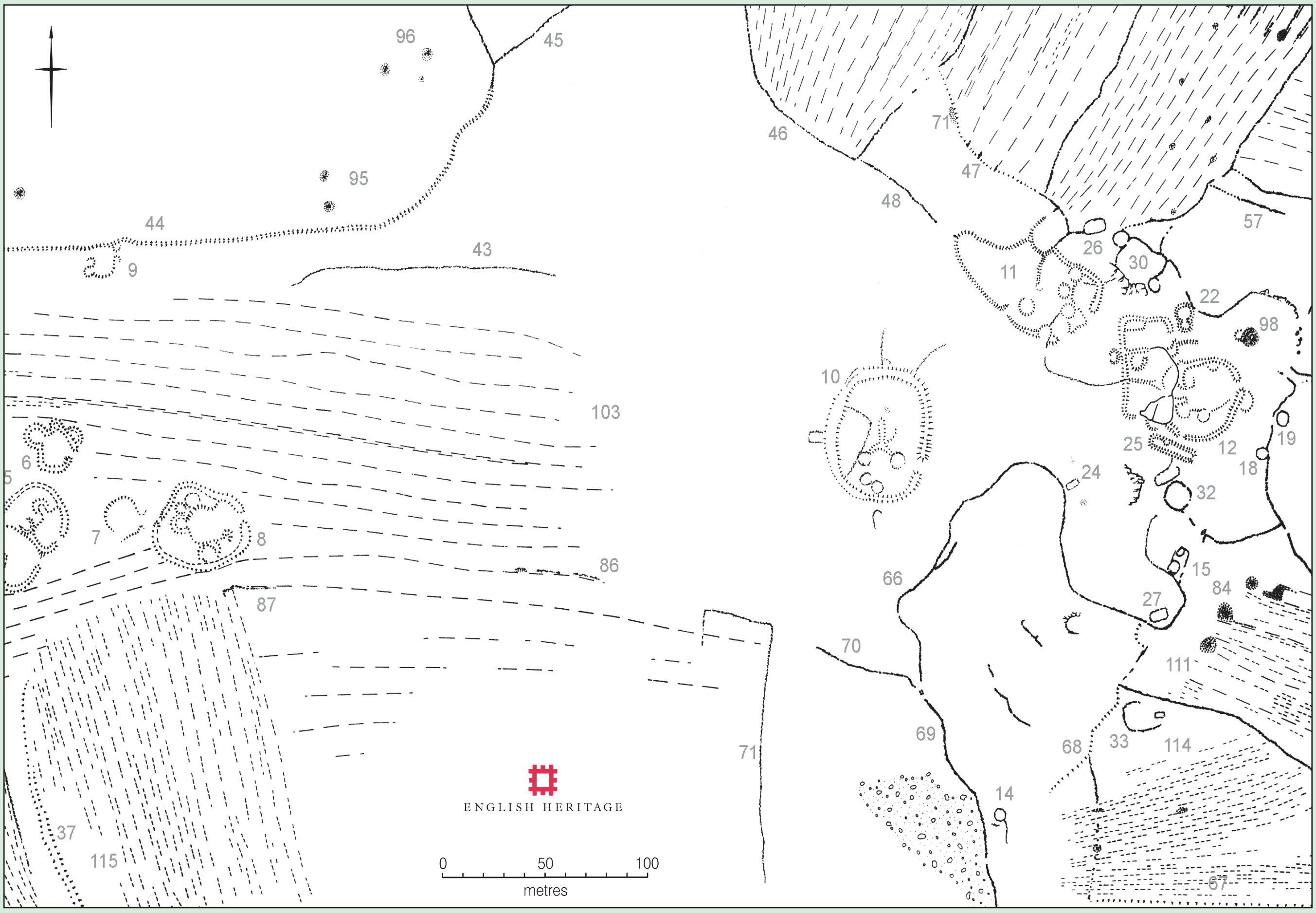
Aerial photographic transcription was used to create plots covering the area in 1km squares based on OS National Grid sheet lines. The plots (on archive-stable plastic film) recorded topographic information as well as archaeological detail, including many features not normally mapped, such as isolated boulders, rock outcrops and peat cuttings, all of which were indispensable locators for the ground survey in areas of open moorland. Reconnaissance and oblique aerial photographs had shown the complexity of this landscape, and as the plots recorded everything accurately, a series of conventions was developed to illustrate this complexity and to record and interpret change in the historic landscape.

Among the most common features in this area were cultivation remains of all periods. To demonstrate change between the various types, three separate conventions were used to depict prehistoric cord rig, medieval broad ridge-and-furrow, and post-medieval narrow ridge-and-furrow. Hachures were used for cultivation terraces. The remaining conventions for all other earthworks were those traditionally used in the highland zones.

Initially, the accuracy of the aerial transcription plots was checked in the field using EDM and tied to the OS National Grid using a combination of triangulation pillars and fixed hard topographic detail. It was found that the results were metrically within tolerance for mapping at 1:2 500 scale. The next stage was then a systematic ground-based exercise which included checking the depiction of archaeological features, enhancement, interpretation and adding detail not recorded by the aerial transcription. As a result of the completeness and accuracy of the transcriptions, generally only graphical survey techniques were required to upgrade the detail. Fieldwork therefore principally consisted of interpretation, assessment of relationships and associations, and the use of the appropriate conventions for recording and characterisation.

As a survey technique of the late 1980s, the field enhancement of aerial transcription plots was a highly efficient method of accurately recording large archaeological landscapes. Similar projects today would be more efficiently undertaken as purely ground-based exercises using differential survey-grade GPS.

Individual pen and ink drawings at 1:2 500 scale were produced covering the entire project area; 2,428 archive reports were written, ranging from 2 to 160 per square km, and keyed with a numbering system to the individual sheet. In addition, 16 large-scale surveys of key sites were produced at scales varying between 1:100 and 1:1 000. The project archive has been deposited in the NMR in Swindon.



Extract from sheet NT 9815. The detail is hand drawn at a scale of 1:2 500. The numbers refer to individual reports.

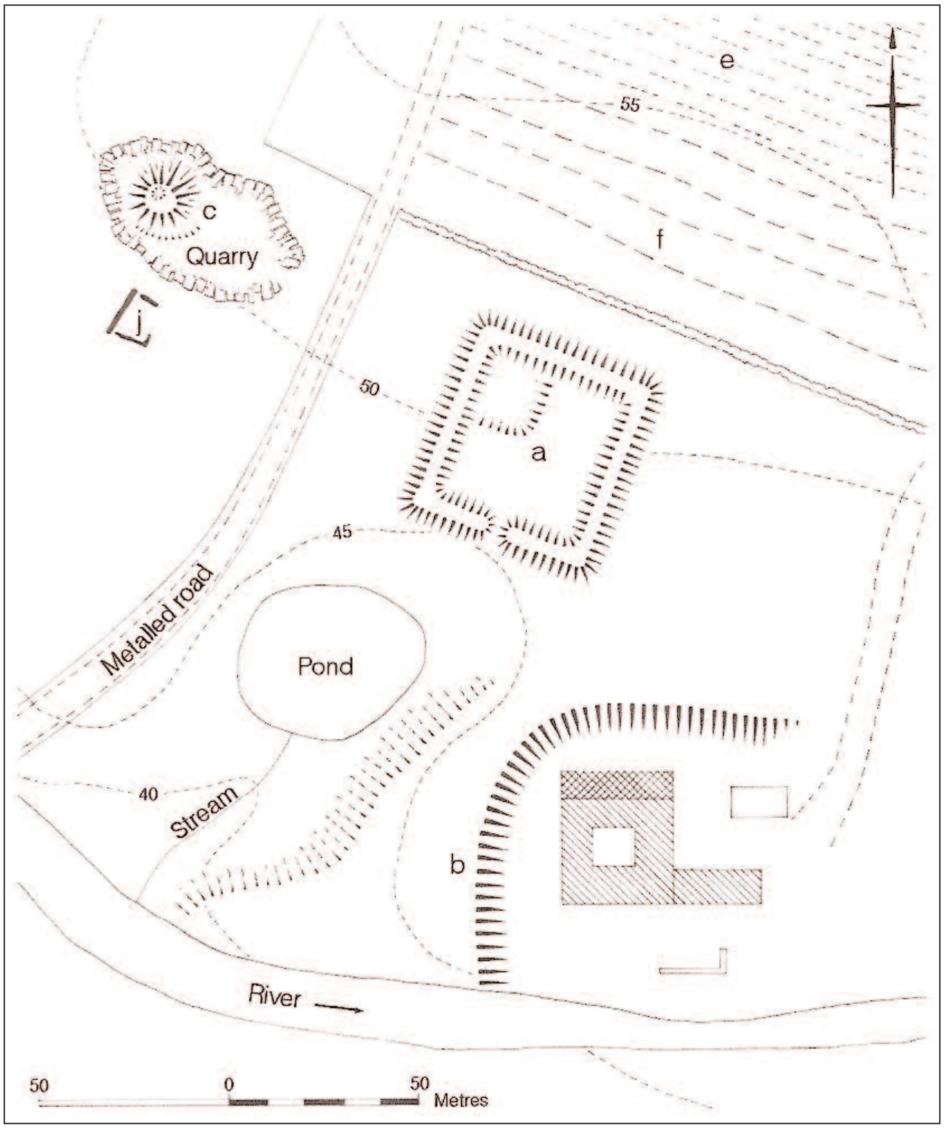
2 Detail survey

Having established the accurate framework of control the next stage is to survey the archaeological features so that their morphology and relationships can be portrayed in plan form by conventions, such as hachures. This is the essence of analytical survey – using the measuring process to examine slopes and other features, their forms and patterns, and to examine relationships and compare them with analogous examples.

Control and 'hard' detail are now routinely supplied electronically, by 'total-station' EDM or GPS. The recording technology of 'total-stations' and differential GPS allows large numbers of points to be recorded accurately and rapidly, and computers can plot these with lines, colours and text annotations. Therefore, 'soft' detail can be recorded by this technology, although where this is complex it is best supplied at large scale by traditional methods, usually tape-and-offset or plane-table (Bowden 2002). Each technique has its own strengths, which are appropriate to the different parts of the task (*see* Bowden 1999, 60).

The detail control points that have been positioned close to archaeological features now become the points from which measurements are taken, so that earthwork remains are portrayed in their correct relationship to these points and to each other. The process of measurement and drawing of each section of earthwork, as well as ensuring that a good and accurate plan is being made, also facilitates critical observation, so that surface stratigraphy is perceived, and the relationship and function of earthworks can be understood. If accurate control has been established, confidence can be placed in emerging patterns.

Detail survey – the third dimension
In the majority of cases the artificial slopes of archaeological earthworks are best represented by hachured plans. On many sites natural slopes are also of archaeological interest, revealing much about form and location, and must be included in the detail survey. In some cases depicting them with a 'natural hachure' (*see* Conventions 1) is sufficient; for more complex inter-relationships contouring the natural topography may be necessary. In extreme cases even contours may not adequately represent very steep or complex slopes; where this occurs other methods of depiction, such as 3D representation, may be necessary (*see* Case Study 10). Any decision to embark on contouring would normally have been made at the reconnaissance stage and therefore appropriate equipment and methodology would have been used. Interpolating contours from spot heights is one of the most tedious exercises in surveying. GPS equipment and digital ground modelling software now presents the most efficient way of gathering and processing large amounts of 3D co-ordinate data for depiction of contours and modelling (Ainsworth and Thomason 2003).



Conventions 1

The value of contouring *archaeological* earthworks for analytical purposes is extremely limited and best restricted to simple sites and low, spread monuments, such as ploughed-out barrows and single-phase fieldworks (Bowden 1999, fig 28). The advantages of hachured survey over contour survey for earthworks are that it can:

- distinguish between natural and artificial slopes
- show chronological relationships between features
- give a consistent depiction of features as they turn across or along slopes

Contour surveys are sometimes said to be 'objective' (although judgements have to be made, for instance, about horizontal and vertical intervals). The corresponding 'subjectivity' of hachured survey is its strength, because that is where the fieldworker's judgement, experience, knowledge and interpretative skill can be deployed. The best solution is to show archaeological earthworks by hachures and natural slopes by contours.

Electronic data, especially that derived from GPS and photogrammetry, can be used to generate 3D surface models for slope analysis and presentation (*see below*). Where these methods are not available, recording height values around a site in the form of spot heights at strategic points can also enhance the value of the detail survey. This can be particularly relevant on sites, for example, where water management is significant. Measured profiles across earthworks are an effective means of conveying changes in height where vertical differences are dramatic, and also help to illustrate interpretations (Bowden 2002, 12–13; *see* Case Study 10).

Depiction

The depiction of hard detail is subject to generally accepted cartographic systems – sets of symbols, lines and annotations known as conventions. The depiction of archaeological features is also subject to conventions, such as those used by the Royal Commissions, EH and the OS; many individuals and archaeological units have developed additional conventions to meet particular circumstances. Conventions such as those used by EH and the Royal Commissions can form the core of any survey, and site-specific conventions can be added where necessary. Conventions vary according to the scale and purpose of the plan being drawn (*see* Archaeological drawing conventions).

Any convention or symbol should look like what it is trying to portray. Some conventions can be used to convey a feeling of depth or height, and at large scales (1:2 500 and larger) conventions should enable accurate depiction of detail. For small-scale surveys (1:10 000 and smaller), a combination of lines, schematic symbols and colours is usually adequate (*see* Case Study 5). Conventions must be clear, unambiguous and consistent. Interpretation, analysis and presentation can be enhanced by the selective use of colour.

Most surveying software packages have a range of embedded computer line styles and symbols that can be coded in the field with data-loggers. Annotations and notes on the drawing can be used to good effect as an alternative to developing large numbers of conventions. However, drawings should always be kept as clean as possible and detail drawn clearly. Before leaving, check unclear elements and make any necessary notes.

Advanced survey technology

Surveying equipment and techniques of recording have become increasingly automated. The main advances have been in speed and accuracy of measurement, automated computation and drawing, as well as in coding and categorisation of information, so that it can be accessioned electronically into databases. However, no technology has yet been developed that can emulate the human skills of observation and analysis of archaeological earthworks.

Global Positioning System (GPS)

High-precision National Grid co-ordinates for control can be achieved with GPS (Ainsworth and Thomason 2003) by relating the survey to a network of three or more OS active stations around the site, the accurate co-ordinate position of which can be obtained from the OS. (It must be borne in mind that linking a site or landscape survey accurately to the National Grid in this way might mean that its relationship to local map detail is incorrect.)

Besides being a powerful tool for providing survey control, GPS is increasingly in use as a flexible, rapid way of planning archaeological features. In kinematic (constantly moving) mode, the system accurately records its three-dimensional position at a preset (time or space) interval. A surveyor carrying a GPS receiver can record the position and shape of archaeological features by walking around them. Alternatively, individual points can be selected – along the top or bottom of a scarp, for instance, and feature-coding software will join them with a choice of line-styles, colours or thicknesses. Using this method the surveyor is literally drawing the feature with the GPS and has more control over the final depiction. For small-scale surveys, hand-held GPS can achieve this (*see* Case Study 3), while survey-grade GPS can produce a detailed plan at large scale, requiring only minimal field checking at the end (*see* Case Study 6). Textual tags recording the significance of particular points can be added to the data. Feature codes can also be inserted by the surveyor at the time of the survey, so that when the data is processed in the office, modern features are clearly distinguished from archaeological features by line-type and colour. GPS also provides three-dimensional information across an archaeological landscape, which can be used to construct a Digital Terrain Model (DTM). DTMs can be manipulated so that subtle features can be more easily seen; these digital models can then be rendered to provide images of the site upon which interpretative reconstructions can be built.

Total-station EDM

The use of EDMs in archaeology is now well established (*see* Bowden 1999, 199–200; Bedford *et al* forthcoming). Advances have been made with interchangability of EDM and survey-grade GPS; in woodland, for example, the position of a point in a clearing can be fixed with GPS, then a total-station

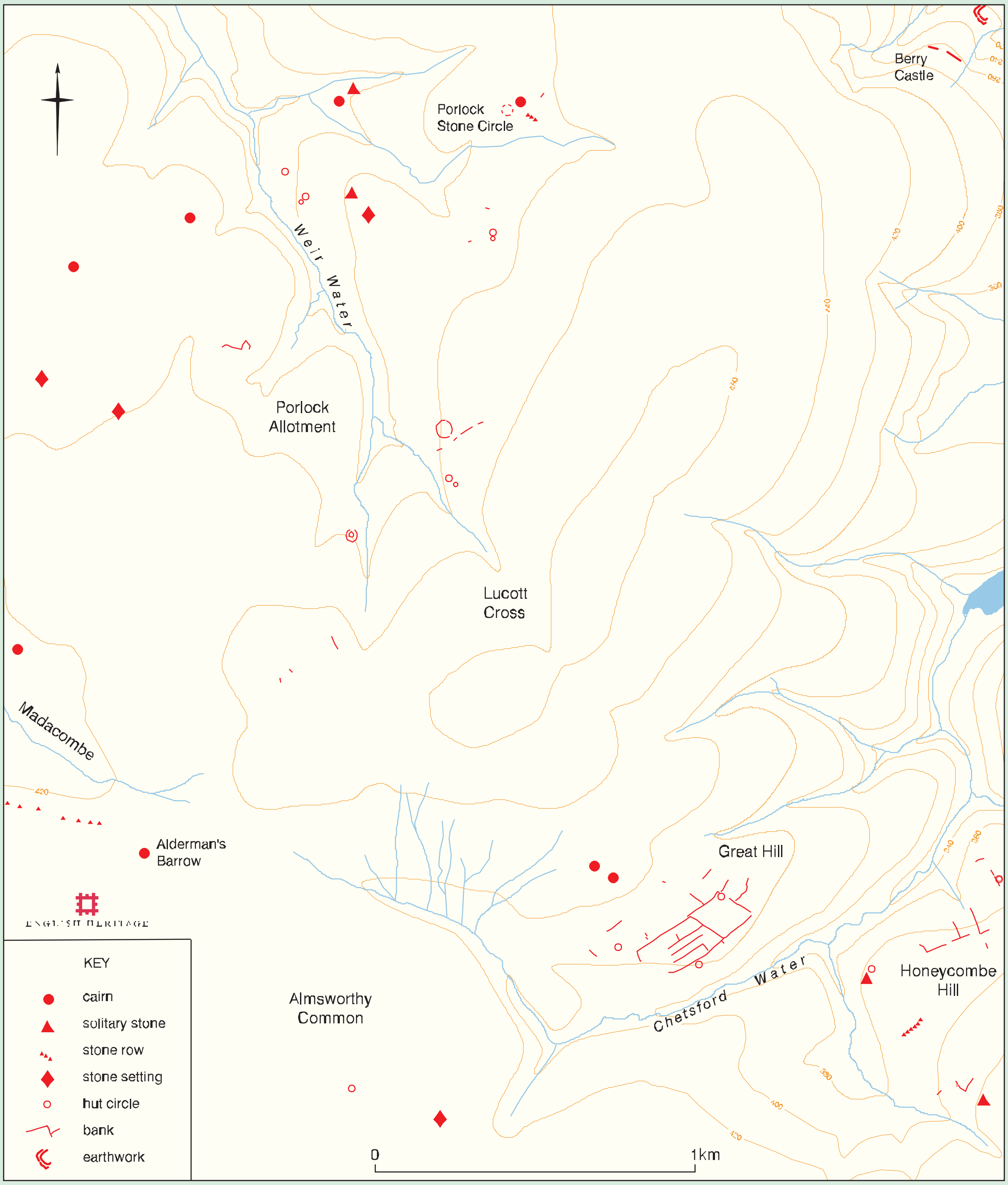
Case Study 5

Exmoor, Devon: a Level 2 survey of an upland prehistoric landscape

A survey of the archaeology of Exmoor, published in 1970, was unable to identify any convincing remains of Bronze Age settlement on the moor, although the potential for the discovery of such sites had been noted (Grinsell 1970, 50–1). The low level of record and investigation on Exmoor was the main reason why, following a meticulous transcription of the archaeology visible on air photographs by Richard McDonnell in the 1980s, the former RCHME was asked to undertake a survey of the surviving field archaeology within the Exmoor National Park. The identification and location of prehistoric remains on open moorland was one of the priorities in the survey.

The large size of the area covered by the project, combined with the necessity for both survey and analysis, dictated a Level 2 methodology. All published and unpublished records of prehistoric or possible prehistoric field remains were located on the ground and assessed. To ensure consistency of positional recording it was important to relate the surveys to OS mapping. To achieve this, their location in relation to the OS National Grid was undertaken by total-station EDM using the established framework of triangulation pillars, or, after 1995, by differential survey-grade GPS. The map-based results were collated and stored in a computer environment using AutoCAD® software. A written description of the field remains accompanied each site and a survey at 1:2 500 scale was undertaken. In addition to visiting each known site, all areas of unenclosed moorland were subject to a walkover survey, covering areas where the potential for the survival of prehistoric features was strongest, for example in areas surrounding known sites.

The project massively increased the understanding of the prehistoric landscape of Exmoor, revealing greater numbers of settlement sites and areas of field systems which date from the 2nd or early 1st millennia BC. The collation of this information against a map base, to further understanding of the wider landscape, was essential for both research and management purposes. The area around the headwaters of Weir Water is a good example of the sort of pattern which emerged as the extent of the prehistoric landscape was mapped, allowing its extent to be appreciated for the first time. The results of the survey have been published (Riley and Wilson-North 2001) and the project archive has been deposited with the NMR and the Exmoor National Park.



The prehistoric landscape of Weir Water and Chetsford Water. The use of symbols enables the main archaeological monument types to be depicted clearly against the topography, here represented by contours and water courses. This method facilitates analysis of the distribution of particular classes of sites over large areas in relation to topographic determinants. Drawing produced using AutoCAD® *software.*

can be mounted on the same tripod and, using the same co-ordinate information and software, survey can be carried into areas without satellite reception. Pen computers can also be linked (*see below*).

Electronic drawing boards

A technical advance in portable computer design, which has benefits for the surveyor, is the pen computer. Rather than a keyboard with an attached screen, this design places the emphasis on the screen. The computer software is controlled with a stylus. Software for pen computers enables the surveyor to use digital maps in the field. Data can be collected electronically, but the surveyor can see the survey developing and can adjust it graphically. This system combines the benefits of digital data recording with the immediacy of using a plane-table or other hand drawn method. Pen computers can be linked to electronic theodolites and GPS receivers, so that when a point is recorded it appears as a point on the computer screen – 'real time' survey. The surveyor can tag each surveyed point with textual information. Taped measurements can be incorporated and data can be organised by colour and layer for transfer to a CAD package for finishing and plotting.

lidar

Light detecting and ranging provides a high-definition representation of the ground surface across a given area through the use of laser scanning equipment mounted in an aircraft. At the highest resolution the scan is able to resolve features less than 1m across (although digital files at this resolution are extremely large). As well as providing a 2D 'photographic' image of the ground surface, the height information in the lidar scan can be fed into surface modelling packages to produce 3D representations of the surveyed area.

The use of lidar by archaeologists for mapping earthwork sites and landscapes is developing rapidly, but already the main advantages are clear. Because the laser scanner can penetrate vegetation it enables the mapping of features in woodland and undergrowth that are invisible to aerial photography and may be difficult to recognise on the ground. The ability of lidar to record large areas rapidly and in some detail enables ground survey teams to target specific areas for detailed investigation and interpretation. One disadvantage, as with all remotely collected datasets, is that the data is of limited value if not critically compared and analysed against the real landscape.

Interpretation

Archaeological earthwork and landscape survey, however achieved, is a means to an end – interpretation and understanding. This is discussed in Bowden (1999, 80–96 and elsewhere). Survey plans and diagrams must depict matters of interpretation correctly and survey reports must include interpretation, not just description.

Photography

Making a photograpic record

Photographs are taken to record specific features – such as buildings, architectural details or finds – or to illustrate the broader context of a site, aiding the visualisation of the site in its landscape by a record user. They can be used to illustrate publications, particularly where their use supplements the interpretation of significant visual aspects of a site. New photography can also reproduce an earlier viewpoint, such as a topographical drawing, showing how the drawing has emphasised certain features, or how the landscape has changed.

The scope of subject matter in field archaeology offers the photographer a diverse and challenging role in record making, although earthwork sites are notoriously difficult to photograph. For general advice on archaeological field photography see Bowden 1999, chapter 6, and for more detailed information see Menuge 2006, section 4.4.

Digital photography

Digital cameras are rapidly improving in quality and dropping in price. There are issues over the archival stability of electronic images (see below). However, the advantages in digital download for desk-top publishing and digital projection may outweigh any disadvantages. Furthermore, digital photos provide a cheap and disposable *aide memoire* for site notes and preparing drawings.

Making notes

The most brilliant photograph is useless without a record of where and what the image is. The best time to make this record is at the time of exposure on site. The information should be written down or recorded electronically. Any caption should record at least:

- the subject matter
- its location (this may be the site itself or detail within the site)
- viewpoint (if building or landscape)
- date of photography

It must be emphasised that this represents a minimum requirement. Ideally the surveyor should relate the photographs more intimately to the other elements of the record, by making them physically part of 'component sheets' (*see* Bowden 1999, 154) or by marking the location and direction-of-view of the photographs on a version of the survey drawing as a key to the photography.

Drawings and reports

In archaeology, as in other field sciences, illustrations and written reports are two sides of the same coin; the text explains and qualifies the plan. For some projects the recording methodology may appropriately involve the use of a pro-forma recording sheet as an alternative to survey plans (*see* Case Study 1). The information recorded on such forms has to be tailored to the individual task.

Plans

Having applied best practice to the survey, it is essential that the same standards are achieved in drawing-up: a good survey loses impact and credibility if badly drawn. The aim is to present the graphical results of a survey – whether hand-drawn or digital – as clearly as possible, able to be understood by specialists and non-specialists alike. The plans should carry forward the analytical processes of the survey itself, and clarify arguments put forward in the accompanying text.

Preparation

Field drawings

At the completion of fieldwork the product should be a well-drawn and complete pencil field drawing or, if using digital methods, an annotated computer plot. Before commencing work on the final version, the illustrator should be satisfied that the drawing is complete and that no information is missing or unclear. Even if the draughtsman undertook the survey, a delay between fieldwork and drawing can result in some of the site's subtleties being forgotten if they were not recorded clearly.

Objective

Before beginning the drawing the objectives should be clear: publication, a working or management plan, or an archive drawing? There must always be an archive drawing, at full survey scale and including all survey information, whether the survey is to be published or not.

Equipment

The finished plan (if not digitally generated) is a fair-drawn version of the field drawing, and polyester drawing film is the best medium for this. It is easy to draw on with pens and pencil. Alterations are made easily and the material itself is durable, maintaining its stability indefinitely. A suitable grade for penned drawings is 125micron. Suitable technical pens come in a range of sizes. The 0.18mm is used for both hachures and linework. A 0.13mm or 0.10mm is useful for smaller hachures. Other useful sizes are 0.25mm, for linework and stipple, and 0.35mm and 0.5mm for heavier lines. Inks designed specifically for use on film must be used. Alterations can be made using a film ink eraser or a sharp blade. The only other drawing instruments and materials needed are standard technical drawing items.

Illustrations

Further illustrations may be required for specific purposes, such as popular publication and presentation displays. The possible requirements are too varied for standards to be set, although the draughtsman must always aim for clarity. This will often require drawing at sufficiently large scale to allow for reduction on printing. Illustrations of this type are now routinely prepared with computer drawing software, which is flexible and easily obtainable. Drawings can be printed or output in various digital formats. Computer drawing also enables a rapid trial-and-error approach – mistakes are easily corrected and colour options can be explored. Colour can significantly enhance interpretation (*see* Case Studies 6 and 7) but excessive use can over-complicate and be aesthetically disastrous. Subsidiary illustrations can, of course, like the site plan, still be adequately produced by traditional methods.

Drawing techniques

Earthwork depiction – the hachured plan, basic techniques

The hachured plan remains the most effective means of depicting earthworks. Even if plans are simplified for wider dissemination, the hachured earthwork plan is still the basis for the archival record. Hachures are elongated delta-shaped symbols which, when arranged in arrays, convey the positions of the top and bottom of a slope accurately, where the wide end (head) represents the top and the narrow end (tail) the bottom. Variations on this basic convention can be used to depict a diversity of subtle differences in earthwork forms and gradients (*see* Case Study 8 and Archaeological drawing conventions, *below*).

The most important basic principle in drawing hachures is the uniformity of spacing, size and alignment within each array. Secondly the different gradients or 'weights' of slopes must be shown and this is achieved by varying hachure thickness and spacing between arrays. Without this variation all slopes appear the same, giving a misleading impression. Subtleties are best portrayed by hand-drawn hachures but good presentation can now be achieved with computer-drawn hachures.

Spacing and weight

Although steep slopes will have very closely spaced hachures, those for shallow slopes cannot be very widely spaced, as there is a limit at which too great a spacing will cause the form of the slope to be lost. A balance has to be drawn between thickness and spacing to achieve a visible variation in the depicted slope. It is important that the hachures of opposing sides of a linear feature are similarly spaced and opposite each other. Failure to do this results in an untidy plan, which is difficult to read. Similarly for curving or rounded features, any changes in spacing must be gradual, to maintain the continuity of the array.

Break of slope

Some slopes do not have even gradients and may steepen or flatten out gradually, to blend with the natural topography. If this is so pronounced that there is a break of slope, this should be surveyed and depicted by drawing the slope as two gradients, with the tails of the upper hachures touching the heads of the lower. Where a slope starts to level out and has no clearly defined base, the tail of the hachure can be broken to depict this. Through a combination of all these effects, it is possible to depict subtle changes in gradient.

Natural slopes

Where natural slopes form an important element of a site they should if possible be surveyed and depicted, using contours or the natural hachure convention (*see* Case Study 12; *see* Conventions 1, on page 11). When using the latter technique, it is important that the plan does not become unduly cluttered with natural slopes, detracting from the archaeological detail.

Additional methods of depiction

Contours

Where contours are included they should not interfere with the hachured areas and they should, like the natural hachure, be used with caution, so as not to over-complicate parts of a drawing that are already heavily detailed with earthworks. A careful decision has to be made on the appropriate vertical interval. Interpolation of contours from spot heights is time-consuming and prone to error but GPS data can easily be edited (and integrated with OS data) to produce plots.

Profiles

Profiles are valuable to illustrate the shape of earthworks and to record current heights and angles of slopes where erosion is a problem. The positions of profiles should be accurately plotted on the plan, and the profile itself should be conventionalised so that it is clear what features the section cuts through. It is sometimes necessary, where gradients are slight, to exaggerate the heights of a profile by varying the vertical/horizontal scale ratio. This scale difference must be clearly stated on the drawing.

Maps and smaller-scale plans

Large, dispersed sites such as field systems, or multi-period archaeological landscapes, need to be drawn at smaller scales if all relevant features are to be included on one plan. These plans can be surveyed at the intended scale or can be made up of several larger-scale plans accurately reduced, simplified and re-drawn. Often they are a combination of both. The most suitable scales to use are 1:2 500, 1:10 000 (OS basic scales) and occasionally 1:5 000. This last scale is particularly useful when preparing maps digitally using CAD.

When using these scales, fine detail has to be omitted, although a 1:2 500 scale plan can still include a surprising amount of detail (*see* Case Study 4, for instance). Hachures can be used for larger features, and stony banks and cairns can be depicted using stipple. However, some features – such as leats – need to be conventionalised. At 1:10 000 scale the main aim is to show geographic location and site type, and nearly all features have to be conventionalised. For large landscape surveys where data is collected within a GIS environment it is very important to define a standard, both for the database and for the plan conventions (*see* Case Study 2).

Annotation

Annotation of illustrations should be neat, unobtrusive and minimal. However, all archive plans should contain a metric scale bar and a north point, as well as a title box containing essential information (*see* Archaeological drawing conventions). Publication drawings should, if possible, be oriented with north approximately to the top, and appropriate grid intersections should be shown where necessary. A key must be included for any conventionalised features.

Text placed within the drawing should be kept to a minimum. For archive drawings of very complex detail, such as industrial landscapes, it is sometimes best to place annotations on a separate overlay. There are several means of adding annotation to the drawing (Bowden 1999, 173) but now the most effective is to scan the drawing and add lettering digitally.

Beyond the earthwork plan

While plans and maps remain the basic means of depicting and recording earthwork sites, it is often necessary to develop the ideas and interpretations that result from the survey into a form that can convey them more readily to others. By selective simplification and conventionalising of significant features it is possible to convey phases of activity or distinctly different types of evidence that have been brought to light as a result of survey.

The inclusion of colour, if available, is by far the best method of highlighting differing elements or phases of an earthwork plan (*see* Case Studies 6 and 7). In some cases, several versions of the plan may be necessary, highlighting separate features. At smaller scales, such as 1:2 500, a multi-phase field system, for example, can be understood at a glance when reproduced in colour. This technique is also useful for combining information from differing sources, eg earthwork survey, geophysical survey and air photographic transcription, where all three produced in monochrome on the same plan could be confusing, and if prepared separately the impact would be lost.

Although colour is sometimes available when producing one-off reports for limited circulation, archive plans and for exhibition or display work, its use in publications is still restricted, due to cost. The best alternative is the use of grey tones. Such plans can be produced by conventional means, preparing the plan in separate layers and instructing the printer on the percentage of tint or, more usually, using a computer graphics program. Although more limiting than colour, grey shades can still effectively break down a site into its component parts. Line weight is another alternative for linear monuments where different elements can be highlighted by a combination of heavier and lighter lines.

Another option is the DTM, which enables suitably surveyed topographical and archaeological features to be presented as a '3-dimensional' model, either on screen or on paper. The earthworks can then be viewed from any angle on screen. This is particularly useful where aerial photographs of a site are not available and a ground survey can provide the first 'view' of the earthwork features as a whole.

Computer graphics

Many of the methods of interpretive depiction described here can be effectively carried out using computer graphics programs. The advantages of computer graphics are that data can be easily manipulated and assembled, and laborious hand drawing routines, such as hatching, stippling and shading can be performed accurately and with speed. Drawings can be altered easily, and many different versions of the same basic drawing can be produced. Computers also handle colour with much greater ease than can be achieved using traditional drafting methods. The production of hachured plans to high standard using a computer is now becoming a reality. It must be noted, however, that digital media are not archivally stable.

Survey data can be input to a computer environment by scanning hand-drawn images and editing them using a graphics package or, if using CAD, field survey data can be downloaded directly from a data capturing device. CAD is particularly useful, as it can enable data from differing accurately gathered sources to be combined into one drawing, as long as proper provision has been made for its use at the survey stage and common points of reference are established within each data set. In CAD, different types of information can be kept on separate layers, using different colours, symbols and line types; for example, a ground survey could be overlaid onto an aerial photo plot, together with geophysical, field-walking and excavation data; or for management plans the position of footpaths and erosion, vegetation and animal burrows, or planned future encroachments at the site.

Once prepared in this way a wide range of options is available for a finished product. The material can be retained in its digital format and transferred to a suitable GIS, where it can be viewed and contrasted with a vast array of other geographical data, or it can be plotted onto paper or film in its CAD format for management and archive plans and, if suitable plotting equipment is available, for publication. However, publication quality is often better produced by transferring the drawings into a graphics program specifically designed to produce high quality illustrations. Within such

Case Study 6

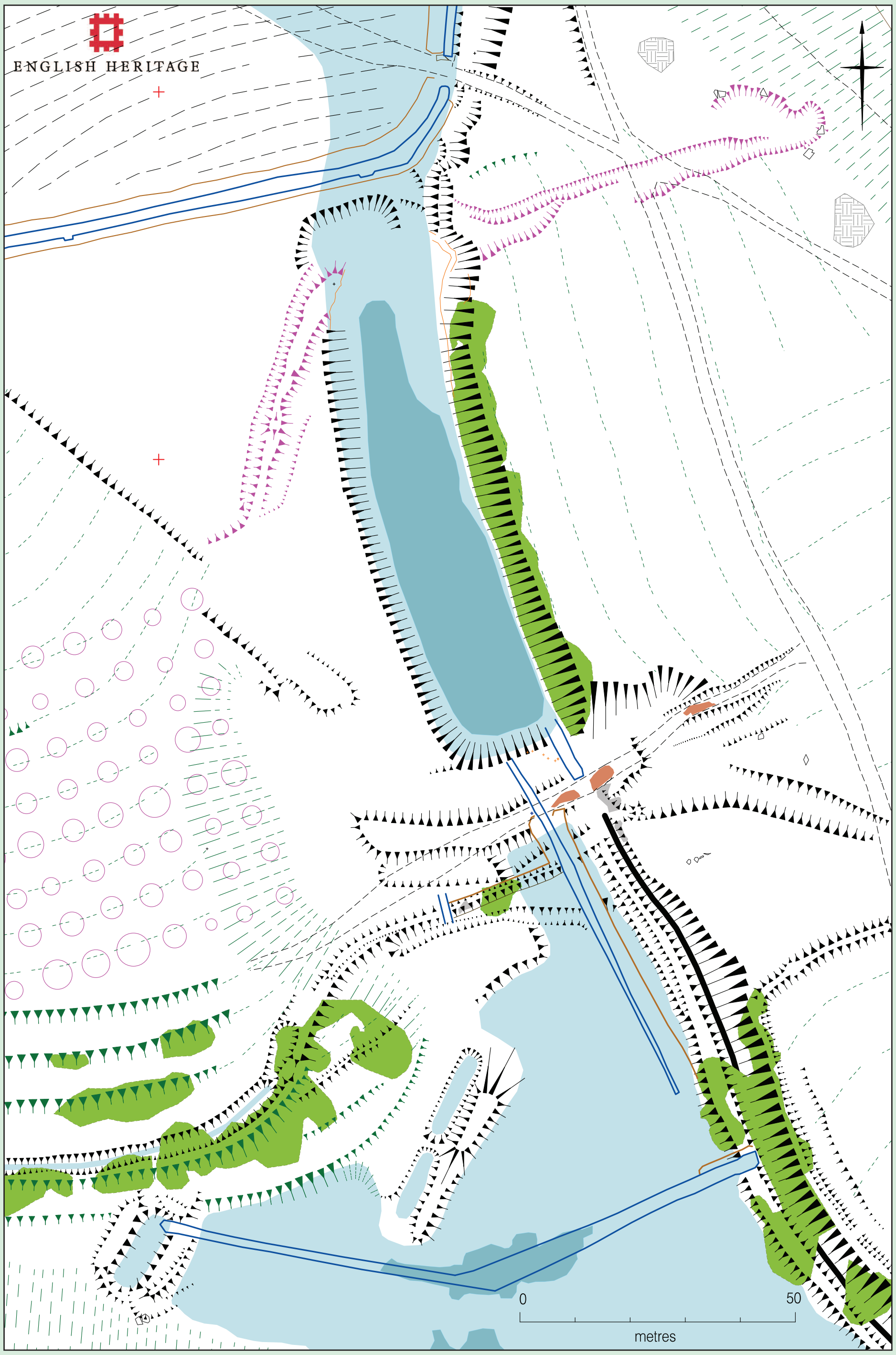
Dunstanburgh Castle, Northumberland: a Level 3 survey of a landscape managed by EH and the National Trust

In November 2003, EH, in partnership with the National Trust, embarked on a research project at Dunstanburgh Castle – built by Thomas, Second Earl of Lancaster in 1313 and once one of the most impressive castles in northern England. Various types of earthworks had previously been recognised surviving in the fields around the castle but these had never been studied in any detail. Reconnaissance indicated that a detailed survey of the landscape setting of the castle would significantly improve understanding of why it was built on such a lavish scale in such a remote location. This understanding in turn would provide a foundation for holistic land management, as well as conservation and interpretation of the Guardianship monument. The project comprised fresh analysis of the standing masonry, analytical field survey of the surrounding landscape, environmental sampling, archival research, re-analysis of the finds and records left by excavations in 1929–31 and the gathering of oral history from local residents.

The survey was undertaken entirely using survey-grade differential GPS, which offers accuracy in the region of 20mm. Yet sophisticated technology, such as differential GPS, does not automatically lead to a sophisticated interpretation of an archaeological or architectural site. On the contrary, it is all too easy for the accuracy and expense of a piece of survey equipment to lull a surveyor into forgetting that the entirely human skills of observation and analysis remain fundamental to a good piece of work.

Speed, without any loss of plan accuracy, is one of the key advantages of survey-grade differential GPS. At Dunstanburgh Castle a team of three archaeologists working independently with three 'rover' receivers was able to map 36ha of dense archaeological remains and natural features in less than three weeks. This included stone-by-stone recording of several features, the plan of which is suitable for reproduction at 1:50 scale. The plan as a whole is suitable for reproduction at up to 1:500 scale. An existing EDM survey of the standing buildings was incorporated into the same electronic dataset.

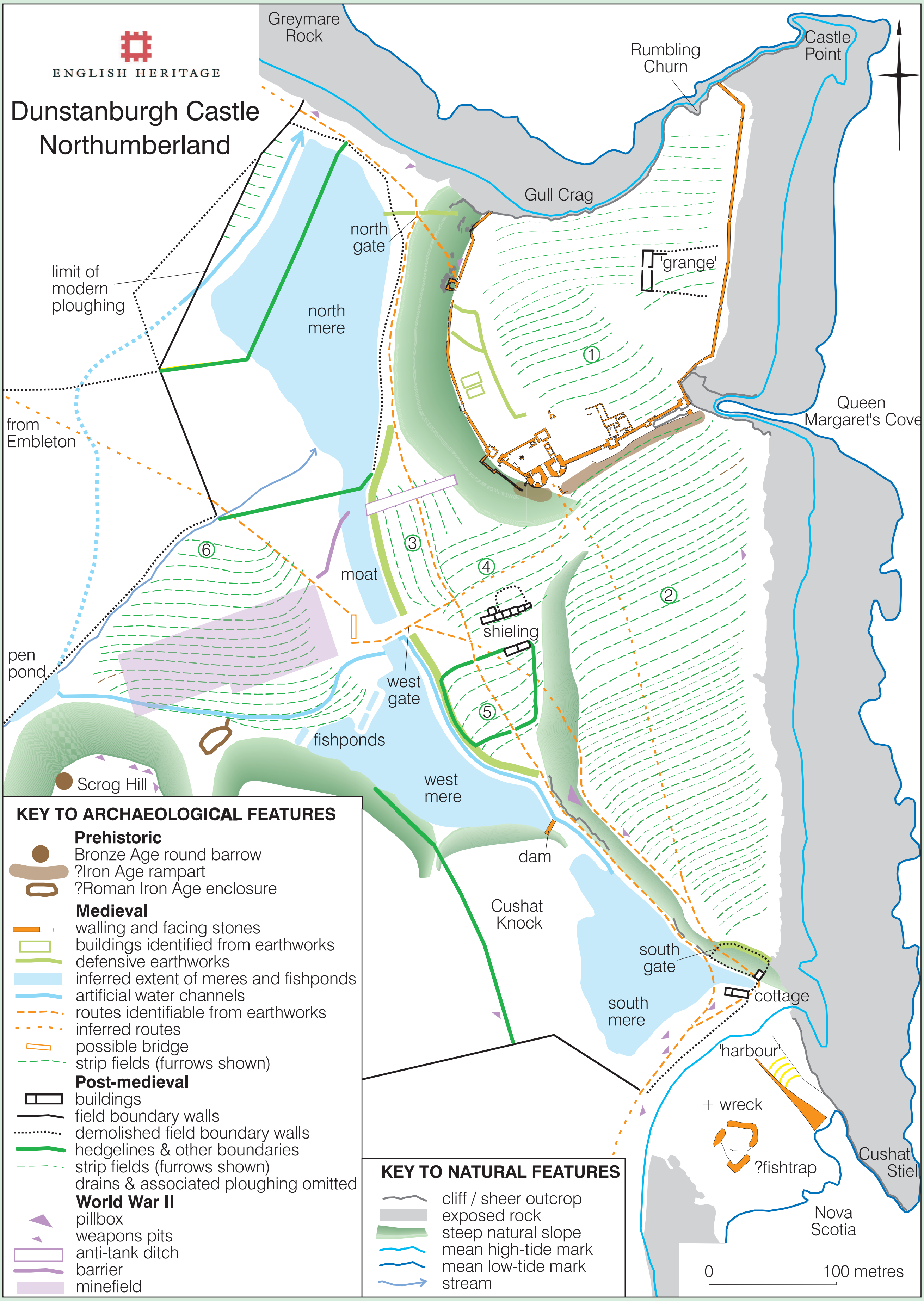
All the survey points were recorded on the GPS controller using a feature code library developed by EH to record the historic environment. This data was subsequently transferred into AutoCAD® software, automatically producing a layered drawing structure, reflecting the feature codes used in the field, which could then be edited, enhanced and plotted. For example, the limits of gorse clumps were recorded in the field with the feature code edge-of-vegetation, while medieval ridge-and-furrow agriculture was recorded as broad-ridge-and-furrow and demonstrably later ploughing as narrow-ridge-and-furrow. Ranks of shallow pits, recognized in the field as the product of the extraction of Second World War mines, were recorded using a feature code that produces a circle whose radius is determined



Extract from the earthwork survey. The light blue areas represent the interpreted extent of the former meres, with the darker blue indicating pools of standing water at the time of survey. The circles indicate the diameters of the pits created when the Second World War mines were dug out.

by recording two points on the ground, one at the centre and one on the circumference. In general, earthworks were recorded using the convention of red-line to record tops of scarps and short-pecked-red-line to record the bottoms. Some earthworks recorded in this way, such as those subsequently recognized on the evidence of 1946 RAF aerial photographs as the remains of a Second World War anti-tank ditch, were transferred to a newly created layer, termed military, when the AutoCAD® drawing was eventually edited. Conventional hachure symbols were added on a separate layer, but in places these do not adequately depict the level of detail captured in the field. Regardless of whether a firm interpretation could be reached as the survey progressed, particular care was taken to ensure that stratigraphic relationships between earthworks would be evident when the plan was eventually examined on screen or plotted out.

The accurate 3-D data produced by differential GPS has the advantage of enabling both the natural landscape and archaeological features to be modeled, if sufficient data is collected. This advantage is particularly revealing where water management is involved. In the course of the fieldwork at Dunstanburgh, it became evident that the castle had been surrounded by a chain of three large meres, all now boggy and with scattered shallow pools. This and other discoveries have led to the re-interpretation of Dunstanburgh as one of the great 'show castles' of the early 14th century. Certain features, such as the height of retaining banks and the surviving fragments of dams, allowed the likely original water level to be estimated with a degree of confidence. Differential GPS then allowed this level to be traced on the ground, allowing the former extent of each mere to be plotted and a secure understanding of the medieval water management to be reached.



Interpretative plan showing the full extent of the survey area.