Understanding the Archaeology of Landscapes

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Understanding the Archaeology of Landscapes

A guide to good recording practice
The land, both urban and rural, is a document recording the lives of countless past generations. Existing routes, buildings and boundaries, trees and hedges, as well as structures now reduced to earthworks, are all part of the beauty and fascination of the landscape. They can also be analysed to tell the story of the past – economic, social, aesthetic and religious. This document provides practical guidance on the recording, analysis and understanding of earthworks and other historic landscape features by non-intrusive archaeological survey and investigation. Through enhanced understanding comes enhanced care and enjoyment.

Abbreviations used throughout text:

AMIE = Archives and Monuments Information, England
CAD = Computer Aided Design
CBA = Council for British Archaeology
DTM = Digital Terrain Model
EDM = Electromagnetic Distance Measurement
EH = English Heritage
GIS = Geographical Information System
GPS = Global Positioning System
GSB = Geophysical Survey of Bradford
HER = Historic Environment Records
IFA = Institute of Field Archaeologists
Lidar = light detection and ranging
NMR = National Monuments Record
OS = Ordnance Survey
RCHME = Royal Commission on the Historical Monuments of England
SAM = Scheduled Ancient Monument
SMR = Sites and Monuments Records
ULM = Unit for Landscape Modeling

Cover: Middleton Dean hillfort, Liderton, Northumberland (photograph by Alun Bull)
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Introduction
The analytical survey of earthworks and landscapes is a particularly valuable contribution to archaeology, and to related disciplines such as historical geography and local history. It is a tradition spanning 300 years in Britain and is the oldest of archaeological techniques.

It has become increasingly apparent, however, that there is need for wider dissemination of the approaches to investigating and interpreting archaeological sites and landscapes that have been developed over the centuries and that have culminated in the work of the Ordnance Survey Archaeology Division and the Royal Commissions on (Ancient and) Historical Monuments in Scotland, Wales and England (the latter now part of English Heritage). There is great demand for skills that can be brought to bear on the analysis of historic sites and landscapes. This need has been addressed recently in a number of publications (eg Bowden 1999; 2002; Ainsworth and Thomason 2003; Bedford et al forthcoming). This guide builds on those and is an updated and expanded version of the English Royal Commission’s 1999 publication Recording Field Monuments: a descriptive specification. It is also designed to stand alongside Understanding Historic Buildings: a guide to good recording practice (Menuge 2006).

The demand comes from archaeologists working in the commercial sector and, at the other end of the spectrum, from voluntary community groups. Such survey is ideal for the latter, being non-intrusive, requiring little equipment or back-up and producing worthwhile results as it progresses. In the commercial field, time and resources will be limited and a brief set by a curator or consultant will necessarily be followed exactly by a contractor. In the voluntary sector there may be much flexibility and the original ‘brief’ may be considerably modified in the course of the work. This guide attempts to cover all such eventualities.

The aim is a representation, appropriate to the scale, of all visible features of archaeological interest. In the case of earthworks, which form a considerable proportion of such remains, the preferred representation is by means of hachures. Contouring has sometimes been employed but rarely with success, for the reasons set out below.

There is much to be gained from the non-intrusive techniques described here (and the related techniques of building, aerial and geophysical survey, and surface artefact mapping), at a time when it is increasingly important to emphasise that archaeology is much more than merely excavation. Analytical survey provides an understanding of sites and landscapes for conservation and management, for the provision of broad context to more narrowly focused investigations, and for public enjoyment.

This guide describes and illustrates approaches to archaeological survey, drawing conventions and Levels of Survey for rock art sites to a common standard; and bringing them to fruition.

Case Study 1
The rock art recording pilot project, Northumberland and County Durham: a Level 1 survey focussed on demonstrating best practice for the creation of a national database

The rock art pilot project was conducted as a methodological trial for a national project. It was supported by EH in partnership with Northumberland and Durham County Councils and it had four main aims:

- to record all rock art sites to a common standard;
- to ensure that the locations of all the sites are recorded as accurately as hand-held navigation-grade GPS sets and/or
simple graphical survey techniques allow:

- to report briefly on the present condition of known examples;
- to develop a Web-based database that could form the basis of an accessible national archive.

Following recruitment and training of local volunteers at the end of 2004, more than 50 people worked in small teams to review the extensive records of rock art sites compiled by local enthusiasts. As a pilot project, it was important to develop a consistent, repeatable and user-friendly recording system that could be applied by anyone, with a minimum of training.

The methodology was refined in the course of the fieldwork, taking on board specialist advice and feedback from the volunteers themselves. To ensure that there was negligible impact on the rock surfaces and fragile motifs, the recording methods employed were non-invasive. For each engraved panel, the volunteers took high-resolution digital photographs and panoramas. They also completed a specially designed recording form, covering various categories of information, mostly in the form of tick lists, including the content of the motif, its immediate context, present condition and any identifiable threats. In addition, the volunteers experimented with low-cost photogrammetry to capture 3D imagery of the motifs. This innovative approach proved successful and extremely cost-effective: it could potentially replace traditional recording techniques such as tracing and rubbing, which can be inaccurate and harmful to the rock surface.

For the purposes of determining the OS National Grid Reference of each site, the volunteers primarily used hand-held navigation-grade GPS satellite mapping sets. Rock art commonly survives in open moorland, which is often completely devoid of mapped features, making GPS the ideal surveying tool for this purpose. The project particularly attracted walkers and other outdoor enthusiasts, so many of the volunteers proved to be already familiar with the operation of the GPS sets, or to own them themselves. All the same, to ensure consistency, training was provided by EH field surveyors. The volunteers, even those with long experience of using hand-held GPS, were generally surprised to learn that their navigation-grade sets could not be relied upon for accuracy of better than 10m, notwithstanding the accuracies displayed on screen, which might be as little as ±4m (Ainsworth and Thomason 2003, 9). It came as a real shock to hear that better accuracy could often be achieved using simple, old-fashioned taped survey, in conjunction with OS maps at 1:2500 or 1:10000 scale. Wherever convenient (or necessary, for example due to overhanging trees or rock outcrops obscuring the reception of the satellites), the volunteers were encouraged to qualify the GPS readings they obtained by using 30m tapes to plot the sites graphically against a map background. Where rock art survives within enclosed fields, and especially where rocks bearing motifs have been incorporated into post-medieval field walls, it is neither difficult nor time-consuming to determine locations, sometimes with map accuracy as good as ±2m. The recording form required the volunteers to state which survey technique(s) they had used and to draw sketch plans if appropriate.

In addition to describing the topographic setting of each site, volunteers were also asked to record briefly their comments on any other features in the environs which they considered might be of relevance to the survival or condition of the rock art. For example, prehistoric field clearance cairns or post-medieval quarrying in the environs of a rock art panel might well shed a very different light on the distribution pattern of sites. However, there was no expectation that these written observations would approach the detailed, contextual study that a Level 3 Survey should constitute.

As a pilot, the project was expected to be a learning process for professionals and amateurs alike, and so it proved. The digital archive of recording forms and photographs resulting from the project will be invaluable in helping to inform conservation and management decisions about the sites that have been examined. It will improve access to the sites, both physically and through remote research. Above all, perhaps, the pilot has created a pool of enthusiastic and skilled volunteers, who are already beginning to turn their attention to other fieldwork.

**Preparation**

Depending on circumstances, background research begins before or concurrently with field reconnaissance. At this stage all that may be necessary is a check of the standard archives and main published references. Detailed study of historic maps and documents is often better done at a later stage. The desire to know as much as possible in advance about the site or landscape to be surveyed, has to be balanced against the wish to see that site or landscape with fresh eyes and without prejudice (Bowden 1999, 31–2).

Archaeological databases in Britain contain a wealth of existing records of the sort created by the activities described here. These include antiquarian drawings, plans and reports, OS Archaeology Division records, aerial photographs and excavation records. Some of these have inherent problems, but careful study may, nevertheless, reap substantial rewards.

A number of organisations compile indexes to sites and other information that might be relevant in the planning stages of a survey project. The addresses of these organisations (in Britain) can be found in the yearbooks and directories published by the Council for British Archaeology (CBA) and by the Institute of Field Archaeologists (IFA) and on their websites.

The main sources of information are:

- National Monuments Records (NMR)
- Historic Environment Records (HER) or Sites and Monuments Records (SMR)
- Ordnance Survey (OS) plans: basic scale, derived and historical maps
- EH (or equivalent), particularly in

Volunteers recording rock art at Gled Law in Northumberland (photograph by Tertia Barnett).
respect of Scheduled Sites, Monument Class Descriptions, etc
● published sources (authoritative books and journals)
● historic maps (pre-OS): tithe maps, estate maps, enclosure awards, etc
● British Geological Survey maps at 1:50

000 and 1:10 000 scales
● air photographs: the principal collections (verticals and obliques) in England are held by the NMR and Unit for Landscape Modeling (ULM: formerly Cambridge University Committee for Aerial Photography);
● other local or specialist data, such as museum, archaeological unit, university or local knowledge
● County Records Offices, private records collections and National Archives

Case Study 2
MOD Shoeburyness Range, Essex: a Level 1 study of a diverse archaeological landscape

Five of the six low-lying islands forming the Foulness archipelago on the north side of the Thames estuary in Essex lie within the boundary of the Ministry of Defence Shoeburyness artillery range. In 2003, the Shoeburyness range was chosen by EH for one of a number of pilot studies to investigate how changes to the legislation covering the protection of archaeological sites and historic buildings might be implemented. The range was selected because it has a diverse historic environment and is in single ownership (Defence Estates). The historic features include seventeen listed buildings, one scheduled Romano-British burial site, the former Atomic Weapons Research Establishment (AWRE), a section of model Atlantic Wall used in Second World War military training and extensive evidence for medieval and later land-reclamation. The intertidal zone also preserves a variety of archaeological remains, while there are records of over 70 shipwrecks in the part of the estuary covered by the range.

The first stage of the pilot study involved a Level 1 survey of the range. The survey was a restricted to a desk-top study aimed at assembling information on historical and archaeological sites and finds within the range in a single database linked to a digital map of the area in order to form a GIS.

The study began by assembling a base map for use in the GIS in AutoCAD® 2004. The requirement was for a large-scale background map onto which data produced by the pilot study could be overlain and therefore the OS 1:10 000 Raster® map was selected in preference to the more complex 1:2 500 scale MasterMap®. As the name suggests the OS Raster® map is a scanned map background offered in 5km by 5km tiles in either black and white or colour. The black and white version was selected in order to lessen the file size and also to ensure that

Shoeburyness. Excel database linked to the electronic map in AutoCAD® Map 2004 software.
Two main problems were encountered when compiling the project database. The first was the poor quality of the positional information recorded in the existing databases. Of the 400 records in the area of the pilot study, about 50 (12%) are located to an accuracy of worse than 100m. The second was the lack of detail contained in the majority of the recorded descriptions, which limits the use of the existing records as a decision-making tool for heritage protection. In some instances it was not clear if an individual record referred to an extent site or one that had been destroyed. Nor was it always clear when records from different data sources referred to the same site. These issues will be addressed in a later phase of the pilot study, which will allow for more detailed background research and for the checking of selected features on the ground.

The main product of the survey was the GIS created by linking the database to the map. Through use of the GIS it is possible to create distribution maps and to locate specific sites earmarked for inspection on the ground. Information was taken from the GIS to compile an assessment report highlighting those sites recommended for designation in the register of historic assets. The text of the assessment report was supported by a series of distribution maps created directly from the GIS and brought into Adobe Illustrator software for completion to publication standard. The project archive will be deposited in the NMR in Swindon.

### Survey strategy

The choice of survey strategy will then come into consideration. That choice can range from a line or dot on a map with the briefest of notes (Level 1), to a large-scale measured survey and detailed report (Level 3). A number of factors will have to be taken into account:

- **Purpose of the survey**: Is it a detail survey for management purposes or a rapid identification survey? The time and cost of large-scale surveys has to be justified. The level may have been specified by a client but flexibility of approach has to be built into the reconnaissance, as field observations may change the initial desk-based perception and lead to re-definition of the brief. In a commercial situation the brief will be prepared by a curator or consultant and they should satisfy themselves, through reconnaissance, that the level is correctly set; once the contract is awarded the contractor will not exceed the brief.

- **Size of area**: This is often the biggest single influence on the choice of surveying methodology. If the area is large but adequately covered by large-scale OS maps (1:2 500 or 1:1 250) surveying within mapped detail, such as field boundaries, may be the most cost-effective method; any surveying technique can be applied to recording the archaeology within a map base. Where
there is no large-scale map detail to work from, surveys of large areas become more demanding in terms of maintaining accuracy (see Case Studies 4 and 5).

**survey methodology and equipment.** What are the most appropriate techniques and equipment to suit the proposed task? Methodology may be dictated by the available equipment but one of the tasks at the reconnaissance stage is to identify the most appropriate equipment to undertake the task.

**scale of survey.** Scale will be influenced mostly by the purpose of the survey. If it is intended to be used as a management document and has to include fine detail of earthworks and structures, then the largest scale practical is required (1:500 or occasionally 1:250). A scale particularly suited to earthwork portrayal, showing detail and yet covering large areas sensibly, is 1:1 000. If the purpose is less geared to detail and more to wide coverage, identification and basic interpretation, OS large-scale mapping at 1:2 500 or 1:1 250 offers a solution. Large areas can be covered at 1:2 500 while still allowing the salient details of individual monuments to be portrayed. Very large area landscape recording is best addressed at 1:10 000 scale, the most detailed map scale available in upland Britain; alternatively, air photographic transcription provides a method of supplying custom-made, accurate large-scale maps, and lidar may be of value here. Doubling the scale may mean quadrupling the number of measurements needed, and therefore the time taken. As a rough guide, at 1:1 000 scale it is possible for an experienced team to survey 1ha of open ground in a day. The use of electronic survey equipment does not absolve the surveyor from thinking about scale at the reconnaissance stage, because the scale of the final product dictates the level of detail to be recorded and therefore the number of measurements that must be taken.

**personnel.** Identification of the number and skills of people required for the survey, and any training requirements (see Case Study 1).

**timescale.** Time limits, possibly subject to external factors over which the fieldworker has no control, can be a significant influence on the choice of methodology. It may be more efficient when dealing with large areas to undertake rapid surveys to identify the nature and extent of archaeological remains, followed by more detailed survey of specific areas, rather than attempting large-scale survey at the start.

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**Case Study 3**

**Stafford Common, Staffordshire: a Level 2 survey arising from a national study of town commons**

As part of a project studying archaeological remains on urban commons, EH carried out Level 1 (reconnaissance) surveys across England and followed this up with a number of Level 3 (detailed) surveys of selected sites. During a Level 1 survey of Stafford Common, archaeological earthworks of field boundaries and ridge-and-furrow dating from the time before the Common was created in the late 18th century were discovered. In addition to this, there were old quarries and the site of a pumping house used to supply the town’s brine baths. Combined with interesting documentary information about the Common, the features still visible on the ground today illustrate well the story of the Common’s past, and it was felt that they were sufficiently important to warrant a higher level of recording. However, as time and resources were limited, Level 2 rather than Level 3 was the chosen option.

The method selected was to use navigation-grade hand-held GPS with data recording capability to survey the features discovered on the Common at a final plan-scale of 1:2 500. This would normally give an accuracy of only 10m, which would produce errors unacceptable at that scale, but by using a post-processing option (where the data collected by the hand-held navigation-grade receiver is processed against the OS Active GPS base stations after downloading to computer) this error was refined to an order of 1m. The method was found to be fast and cost effective, taking a single person 4.5 days to survey an area of 45ha, much of which was densely covered with earthworks. The methodology adequately filled the gap between reconnaissance and detailed survey. The EGNOS satellite was not functional at the time of the survey, but when it is available the accuracy of surveys using hand held GPS equipment such as this will be increased, such that errors are always better than 1m (see Ainsworth and Thomason 2003).

The survey data was converted into AutoCAD® drawing files, and a finished plan is to be prepared using Adobe Illustrator software. The information gained from the survey will be published and the project archive will be deposited in the NMR in Swindon.
Site logistics

Some of the unpredictability of fieldwork can be eliminated by assessing:

- ownership and access
- health-and-safety
- legal constraints. Is the site a SSSI or is there any other constraint on the land?
- other potential problems. Is the site frequently used by the general public? Will there be grazing animals on site? Will vegetation (trees, undergrowth, bracken) preclude survey at certain times of the year?

Observation and measurement

Principles of surveying

The main principles of survey must be applied to all surveys whatever the extent or final scale of plan: (1) Control, (2) Economy of accuracy and consistency, (3) The independent check and (4) Revision and safeguarding. Work should always proceed from control to detail – making sure the whole framework is accurate before surveying individual components within that framework.

1. Control

Control is an accurate framework of carefully measured points within which the rest of the survey is fitted. Survey of detail between these control points can then be carried out by less elaborate methodology or equipment. Control can take the form of a network of points placed by the surveyor, such as pegs, or existing features, such as telegraph poles, fence junctions, building corners, whose relative positions are carefully measured. The principle of control applies regardless of the scale of survey, although generally the larger the scale the more carefully control has to be measured. The accuracy of the finished plan is determined by how carefully this control is surveyed; the larger the scale, the more errors become identifiable.

Previously mapped features are a ready-made control framework to which archaeological detail can be related, but only at the scale at which they were originally surveyed; enlargement of a plan will enlarge any errors in the original. Control can also be established by using GPS and tied to OS National Grid using the network of ‘active stations’ (details on the OS website). However, the accuracy of the control is dependant upon the type of GPS equipment used (see Ainsworth and Thomason 2003).

2. Economy of accuracy and consistency

This applies to both linear and angular measurements; as a general rule, the higher the standard of metrical accuracy, the higher the cost in time and money. It is important therefore to decide at the planning stage what standards of accuracy are required. In determining accuracy requirements, the main considerations are: the best method of presenting the survey information, the scale of final plot or maps and possible re-use of data (such as co-ordinate values).

Accuracy is usually quoted as a representative fraction that shows the ratio of the magnitude of the error (the difference between true value and measured value of a quantity) to the magnitude of the measured quantity. An error of 0.1m over 1,000m gives 1/10 000 – high accuracy (the error would not show on most map and plan scales). An error of 1.0m over 1,000m would result in an accuracy of 1/1 000, which would still be acceptable for most archaeological surveys. To achieve 1/10 000 over large areas requires precise techniques and equipment, whereas 1/1 000 can be achieved with careful tape measuring and basic equipment. Because accuracy is a relative term it is important to define the context of its use in relation to archaeological survey.

There are three areas of accuracy that the archaeological surveyor needs to be aware of:

- accuracy of measurement – governed by care and consistency in reading measurements
- accuracy of equipment – ensured by choosing appropriate equipment for the task
- accuracy of portrayal – equivalent care and precision is required in drawing technique and employing methods of depiction appropriate to the scale of survey, to ensure that the final plan reproduces the field observations faithfully

The archaeological surveyor should also be aware of three categories of error which are likely to affect accuracy:

(a) gross – eliminated by care in observing, measuring and drawing
(b) systematic – caused by a constant factor such as a stretched tape, or a poorly calibrated theodolite or EDM; these errors are cumulative – their effect will increase throughout the survey
(c) random or accidental – less quantifiable errors can still occur even though all effort has been made to eliminate (a) and (b).

Checking a finished survey ‘by eye’ is often the best way of identifying such errors (see 3 below).

The standard of accuracy can change with each stage of the survey but it can never be more accurate than the control. Standards at each stage of survey must be consistent. Therefore, economy dictates that accuracy at all stages is of the necessary standard to achieve consistency and that time and resources are not wasted trying to achieve a higher standard of accuracy than necessary.

3. Independent check

Checks should be undertaken at each stage, so that any errors or problems are solved before moving on to the next. Some methods are self-checking, such as mathematical solutions when computing co-ordinates; others may be more mechanical, such as checking regularly that a plane-table is correctly aligned.

Clearly it is important to ensure that the control is right before moving on to detail survey. At the end of the job, the surveyor should walk over the ground with the finished field plan in hand to see if it ‘looks right’ and to make sure that nothing has been missed.

4. Revision and safeguarding

It is usually possible to plan and execute a survey so that it can be added to or revised at a later date, thus increasing the value of the original investment in time and resources. This process can be aided by simple procedures, such as recording the positions of ground markers in relation to nearby permanent features, so that they can be found again and re-used, or ensuring that topographical detail that is likely to have permanence, such as walls and buildings, forms part of the control and appears on the final plot.

Surveying equipment

Surveying is about measuring two components: angles and distances. All surveying equipment is designed to measure one or both of these. What usually differentiates equipment, and consequently cost, is the accuracy attainable.

It is quite possible to produce surveys with basic equipment, although when the area is large and there is a requirement to...
preserve accuracy more sophisticated equipment may be necessary. However, lack of access to modern electronic surveying equipment should be no barrier even to undertaking large surveys. Before the 1970s all surveying was undertaken with manual theodolites, plane-tables and chains, to very high accuracies; the principles never change, only the practice and level of technology. Surveys of almost any size can be achieved with a combination of a theodolite, plane-table and tape measures. Small to medium-sized areas can be recorded, even at large scales, using a plane-table, optical squares and tapes. Compass and pacing alone can be perfectly adequate for small-scale (1:10 000) surveys, although hand-held GPS now offers a cheap solution and is rapidly coming into universal use.

**Personnel**

Most instrumental survey, optical or electronic, requires a team of two or, occasionally three. Tape-and-offset can be done by a single person but the advantages of working in teams must be considered; solving problems in survey and in archaeological interpretation benefits from dialogue, and working alone can be a health-and-safety risk.

Usually one person, who will be responsible for drawing the final plan and writing the report, will take the lead. This is because there is no single ‘right’ way to survey any site or landscape; decisions have to be made at every stage and those decisions must be consistent. The part of the job requiring skill and thought is knowing what to record, ie positioning the prism or staff, and consequently the team leader generally takes this role.

**The process of surveying**

At small to medium scales (1:10 000–1:2 500) archaeological detail can be added to existing map bases by taping or pacing, and the use of simple angle-measuring instruments such as optical squares and compasses (Farrer 1987). In remote areas, where local map detail is sparse, archaeological features can be supplied by resectioning or traversing (Bowden 1999, 52–3, 56–7), but handheld GPS is now frequently deployed (Ainsworth and Thomason 2003).

After reconnaissance the process of measured survey at larger scales (1:2 500 and larger) can be broken down into two main tasks: (1) Control survey and (2) Detail survey.

### 1. Control survey

Where the control framework is not provided by map detail it must be supplied from scratch. Factors identified at reconnaissance stage such as the size of the area, accuracy, scale and equipment required will all influence the most appropriate control methodology. There are two main types of survey control, regular grid and irregular grid. A rectangular grid of pegs as control for an excavation is an example of a regular grid.

The irregular or mathematical grid is a scatter of detail control points observed from control stations and placed on or near to archaeological and topographic features at the will of the surveyor; the grid is invisible and exists only as a mathematical background when computing co-ordinates. This is the type of grid system used by most surveyors and mapping organisations.

The mathematical grid used by the OS is known as the National Grid. If an archaeological survey project utilises the same system of co-ordinated control points established by the OS this will ensure that it can be fitted to existing mapping. This is automatically supplied by the use and transformation of differential GPS, but it is not necessary for small, discrete archaeological sites surveyed by more traditional methods, although sufficient immovable detail must be surveyed to ‘fix’ the site so that the survey can be related to OS mapping for location. These ‘divorced surveys’ can be referenced to a site grid with a false origin. Although convention expects surveys to be oriented to the north this is not necessary with divorced grids as the control is laid out to suit the site. To avoid any confusion north arrows should appear on all plots and drawings.

Most modern electronic survey tools have on-board co-ordinate displays and calculation facilities, which allow divorced grids to be defined, and most will accommodate OS National Grid calculations on site, or via computer software. Values read from any angle measuring instrument and any linear measurement technique (polar co-ordinates) can be converted to rectangular co-ordinates for plotting on a grid system with a calculator with trigonometric functions, or they can be plotted manually on graph paper; it is not necessary to have electronic instruments to establish this type of grid system for a site.

Control consists of two parts, Control Stations (where instruments are set up during control survey) from which Detail Control (points from which the detail will be surveyed) is supplied. The control scheme should also include ‘hard’ detail. ‘Hard’ detail consists of objects where there is no question as to the point to be measured, including buildings, walls and telegraph poles, but also any masonry elements of archaeological interest. Many natural features, such as rock outcrops, bullders and cliffs can often be treated as ‘hard’ detail, as can well developed and distinct ridge-and-furrow. ‘Soft’ detail includes all other archaeological earthworks where the points to be measured are a matter for subjective judgement.

**The control plot**

However control survey is undertaken the final result will be a control plot, on polyester film for stability and ease of use, showing all the positions of the stations, detail control and ‘hard’ detail. Because of the variety of printers and plotters, and rapid advances in technology, defining standards is difficult. However, the minimum recommended thickness for plotter film for use in the field is 100 microns. As most plotter inks are not waterproof it is advisable to print a reverse image of the plot and place this face-down on the drawing board to protect it from rain. This plot will then be taken into the field to form the basis of the detail survey.

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**Case Study 4**

**The South-East Cheviots Project, Northumberland: a Level 2 survey of an upland landscape for management purposes**

This project was undertaken by the former RCHME (now part of EH) between 1985 and 1989 to record and study this remarkably well preserved historic landscape. The project area covered 66 km², mostly within the Northumberland National Park, and was designed to inform research and management of this upland landscape. Because of the size of the area, recording against a map background was considered essential. However, the area was only covered by 1:10 000 scale OS mapping, which was not considered to be sufficiently detailed to allow portrayal of the
historical environment. Mapping at a scale of 1:2500 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 1 km 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 1:2500 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 1:2500 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 1:1000. 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 1:2500. 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).

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 interchangeability 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.
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 photographic 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-
continuity of the array. A visible variation in the depicted slope. It must be gradual, to maintain the rounded features, any changes in spacing do this results in an untidy plan, which is spaced and opposite each other. Failure to be lost. A balance has to be drawn there is a limit at which too great a slope, this should 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 redrawn. 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 scarp 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.
software, colour, grey shading, annotation and lettering can all be incorporated and reproduced through suitable printing equipment to high standards.

The finished product
The final report resulting from a piece of fieldwork should contain a balanced selection of relevant illustrations, drawn to a consistent standard. By using a variety of drawings of differing scales, it is possible to convey not only highly detailed plans of the archaeological features, using data from a variety of sources, but also the geographical context and relationships with the landscape and with other monuments. The inclusion of interpretative plans can, in addition, convey many of the thoughts and conclusions regarding the chronology and nature of the site that come about as a result of the survey.

Reports
The principal written product resulting from a survey will be the archive report. This is distinct from the publication report (Bowden 1999, 186–8).

Producing a coherent written description that integrates the available evidence is a particular skill. This description, with the drawings, provides the communication of understanding by those involved in the fieldwork, who have had privileged access to the field remains, to their readers, now or in the future, who may not have that access.

Objectivity cannot be a valid aim in the light of the necessary choices about inclusion, order and weighting, and the imperative to allow the understanding resulting from fieldwork to be developed and conveyed must be the culmination of the process. Yet at the heart of the activity lies the observation and recording of field remains, and similarly at the heart of the resulting report must be a description of those remains, sometimes even a catalogue of features, including observations of relationships, out of which grows the interpretation and understanding.

Dissemination
Archaeology depends upon a fragile and finite resource. It is the archaeologist’s duty to conserve this resource and to make the results of a fieldwork project, including the original archive, available to the public. Archiving issues are covered by guidance notes, codes of conduct and standards (eg MGC 1992; SMA 1993; Handley 1999).

Archiving principles
The archive should be deposited in an appropriate and accessible public record within a reasonable period of the end of the project, even if the project has been fully published (ACAO 1993, 10.1; IFA 1993, 4.2). For non-destructive fieldwork, public access to the archive may not appear critical, but there are strong reasons for its public deposition:

- The archive created by a survey is a point-in-time record of condition. If the site is subsequently destroyed or eroded, or even restored for display, the archive remains an invaluable source of evidence for what has been lost.
- Publication media usually impose limitations of scale. A survey plan will often have to be reduced, with loss of detail. The full-size plan will only be available as archive.
- Public access to the archive will help disseminate any insight gained by the fieldwork – especially if the project remains unpublished, but true even after formal publication.
- Publication should be at a level appropriate to the importance of the results (EH 1991, A7.2.1.i). Much detail will therefore remain unpublished and available only in the archive.

Materials
From the outset of a project, due consideration must be given to permanence (using the correct materials). Published guidance on the preparation of archaeological archives is available (Ferguson and Murray 1997; Walker 1990; see also IFA 1994, 3.6.3, 3.6.5).

Storage
Long-term storage in the correct environment is the responsibility of the repository but the surveyor is responsible for ensuring that the correct materials are used and that the archive is maintained in good condition prior to its deposition (IFA 1993, 3.5). This requires attention to some house-keeping issues:

- Masking tape must be peeled off drawing film as soon as possible.
- Do not store or use the archive in areas prone to damp, dust or dirt, or of fluctuating temperature or humidity.
- Do not leave the archive in strong light.
- Do not expose the archive to risk from food, drink or tobacco.
- Do not use steel paper-clips, staples, pressure-sensitive adhesive tape or rubber bands.
- Do not fold or roll the archive unnecessarily – where possible, store it flat.
- Always handle documents with care: wash your hands.

Case Study 7
Jervaulx Abbey, North Yorkshire: a Level 3 survey of a rural monastic landscape

In 1998–9, the former RCHME surveyed a large area of complex multi-period earthworks surrounding the ruins of the Cistercian Abbey of Jervaulx. The survey was undertaken on behalf of EH, who wished to know if and how the earthwork landscape related to the ruined abbey church and claustral buildings, which at the time was the only part of the site enjoying legal protection. EH also needed an accurate map depiction of both ruins and earthworks (the latter had never previously been recorded) to assist in the conservation and management of the site as a whole.

The scale selected for the survey was 1:1 000, enabling the accurate plotting of slight scarps as small as c 0.4m wide. The survey pre-dated the widespread availability of survey-grade GPS equipment, and was therefore carried out as a divorced survey capable of later graphical fix to OS National Grid by overlay of detail common to both the survey and OS maps. A total-station EDM was employed to observe a ring traverse of control stations around the edge of the site from which points of hard detail and a network of subsidiary ground-control points were recorded; a number of additional internal link traverses was also observed in order to control parts of the site not directly visible from stations on the outer ring traverse. No attempt was made at this stage to record earthwork detail directly via the total station, as it was felt that the complexity of the features demanded more considered observation than this would allow.

Once the data from the control survey had been computed, a series of scaled overlapping polyester-film plots showing all the...
Publication should be considered wherever a survey has produced significant new information or insights. Advice on the publication of survey projects can be found in Bowden 1999, 186–8.

Recording Levels: a description of archaeological investigation of sites and landscapes is undertaken for a variety of reasons:
- To promote the understanding and appreciation of archaeological sites and landscapes;
- To establish proper curatorial concern for what are often fragile remains;
- Through improved analysis and understanding to generate appropriate processes of conservation and management;
- To inform academic research across a range of disciplines;
- To establish proper curatorial concern for what are often fragile remains;
- Through improved analysis and understanding to generate appropriate processes of conservation and management;

The findings of the survey were presented in an interpretative report integrating both graphical and textual information (Jecock 1999). The final survey plan was inked up by hand in traditional hachured form. Hachures have the distinct advantage over other forms of earthwork depiction that they permit the portrayal of stratigraphic relationships between features. However, at a scale of 1:1000 a plan of the size of Jervaulx is a large document incapable of easy reproduction and dissemination; it was therefore photographically reduced to a scale of 1:2500 which could be included in the report as an A3 foldout. Also, on a plan of multiperiod earthworks as complex as this, it is impossible for the reader to take in and make immediate sense of all the information presented. A series of interpretative diagrams was produced at this smaller scale to fit into the report, therefore, highlighting features that could be assigned to each of seven broad phases, into which the earthworks were divided on the basis of form, stratigraphy and context. These diagrams were generated electronically by scanning the reduced copy of the inked plan into AutoCAD®. The use of different colours on each phase diagram then enabled features to be distinguished graphically by function. Each feature-type was also allocated a unique alphanumeric code to tie in with the written description and interpretation in the main report, which is ordered chronologically. The project archive has been deposited in the NMR in Swindon.
A record should chart the historical development of an archaeological site or landscape and provide a clear statement of its significance.

A record should aim to be accurate, clear and concise.

The scope or level of the record and its limitations should be stated.

A record should make a clear distinction between observation and interpretation, thereby allowing data to be reinterpreted at a later date.

Wherever practicable, a record should have regard to the context of the site, including its wider archaeology, known and potential, whether in terms of below-ground deposits or landscape archaeology.

A record should include an indication of any sources consulted.

A record should identify the compilers and give the date of creation. Any subsequent amendments to the record should be similarly endorsed.

The report and supporting material should be produced on a medium that can be copied easily and which ensures archival stability.

A record should be made accessible through deposit in a permanent archive.

Those creating a record should be mindful at all times of the rights and sensitivities of owners and occupants, and of the health-and-safety implications of working in historic landscapes.

Note that no fieldwork can be regarded as complete until all the necessary documentation has been entered in the appropriate database and archive.

In addition, all records generated by survey should be indexed to a core data standard compatible with national and international standards for records, such as RCHME (1998 – currently being updated by EH) and CIDOC (1995). NMR Thesauri should be used where appropriate to ensure standardisation of terminology: http://thesaurus.englishheritage.org.uk/

Within EH the results of all survey work have been summarised in a Monument record entry (or multiple entries as appropriate) compiled to core data standards on the AMIE database. An Event record (or records) also has to be entered on AMIE in order to provide a digital link between the survey and any connected project work. This is linked to all Monuments records created or enhanced as a result of the survey.

In addition to the core data, most records of an archaeological monument will combine a written description and analysis, with a visual record made by a metrically accurate survey drawing.

Three levels of recording have been identified and are described below; they range from the least detailed (Level 1), comprising a basic map/plan depiction and brief annotation, to the most comprehensive (Level 3), which consists of the fullest combination of archaeological source material, surveys, descriptions, interpretations and contextual analyses.

Archaeological survey and recording will normally correspond to one of these levels. It is, however, not possible to be prescriptive about the levels of record for all circumstances – objectives, time and resources will vary from case to case. Furthermore, initial aims must be flexible in practice; procedures adopted at the outset of a survey may require subsequent modification. The paramount considerations are accuracy and clarity. For example, more complex investigations will result in a number of other outputs including:

- large-scale survey of a particular monument;
- a plan at 1:2 500 of its setting and context within the wider historic environment;
- a landscape survey fitted on to the OS digital map base and with possible long-term further research through GIS;
- establishment of permanent survey control to aid excavation, water flow monitoring, land use change, environmental impacts and similar studies;
- creation of a digital three-dimensional model of the monument.

Each of the descriptions of the three levels of recording is followed by a specification of the recommended components (Items) that can be combined to make up an archaeological record to the standards set by EH. These Items are set out under three headings:

- the written account
- survey drawings
- ground photography (Ground photography of field monuments must be regarded as complementary to a survey and not as a substitute.)

The descriptions of the three levels are followed by reference lists, which define each of the numbered Items.

In any record where it is not appropriate to conform exactly to one of the three prescribed levels, components may be included or omitted but any substantial departure should be noted.

Multiple-level recording of an archaeological field monument, using the appropriate level criteria, is permissible: Level 1 verification of previously recorded Level 2 and Level 3 field investigations; Level 3 investigation of previously recorded Level 1 field inspections, etc. Fieldworkers are strongly urged to tailor the format of their records to the NMR model or to that adopted by the relevant County SMR or HER.
Case Study 8
The Earthworks of South Wiltshire: RCHME research-led Level 3 surveys

The area covered by the fieldwork comprised the southern third of the county of Wiltshire, an area of approximately 1,100 square kilometres. It is bounded on the north by Salisbury Plain (McOmish et al 2002); to the west, south and east by the county boundaries with Somerset, Dorset and Hampshire, respectively.

The work built upon the results of the survey of the Stonehenge area (RCHME 1979), and the aerial photographic transcription of the Danebury hillfort environs (Palmer 1984) but additionally drew inspiration from a much longer history of investigation in the area that incorporated the pioneering work of Stukeley, Colt Hoare and Pitt Rivers.

Four main recording techniques were employed – analytical earthwork survey, air photography, geophysical survey, and surface collection of artefacts (field-walking). Relying largely on archaeological field survey conferred two major benefits. Firstly, in a period of unprecedented destruction of the rural landscape, those remains that do survive become rare and valuable, and so survey, which can elicit information without excavation, is particularly valuable. Secondly, archaeological survey is much more cost-effective than excavation, and makes possible the investigation of entire landscapes.

The project was undertaken at a time when the use of electronic survey equipment in the archaeological sector was in
its infancy. Nonetheless, all of the surveys employed either an electronic theodolite and EDM or a total-station to position accurately and plan a network of control points and record OS map detail. Archaeological detail was recorded using taped offsets from base lines extended between these control points. Most sites were surveyed at a scale of 1:1 250, 1:1 000 or 1:500.

Air photography was utilised to enhance the information derived from field survey and this project also marked a watershed in investigation, witnessing the first large-scale use of geophysical prospection to complement traditional methods. In one example, geophysical survey on the Late Neolithic henge at Sutton Common showed that the monument had undergone significant alterations, including a blocking of one entrance and a re-alignment of another, which were completely undetectable from the surface. At Yarnbury hillfort and the Late Iron Age – Romano-British complex at Hanging Langford Camp, field-walking was carried out across areas of the earthworks that were either being actively eroded or destroyed by cattle and burrowing animals, or were under cultivation. In all cases this technique proved invaluable in terms of better understanding of site chronology, for example, but was also of great use in aiding improved site management.

**Level 1**

Level 1 is mainly a visual record, supplemented by the minimum of information needed to identify the archaeological site’s location, possible date and type (Case Studies 1 and 2). This is the least complex record, and will typically be undertaken when the aim is to provide essential core information to agreed standards, including structured indexes of the location, period, condition and type of the monument that, typically, would result from rapid field investigation (see The written account, below: Items 1–5), such as assessments of change to the historic environment, historic landscape characterisation, for an initial assessment determining the scope of a project, or whenever resources are limited and much ground has to be covered in a short time. This would be accompanied by a simplified cartographic record, often at 1:10 000, of the location and extent of the site.

There should be basic consultation of easily available related information sets: these may include field surveys, records of buildings, archives, aerial and ground photography, geophysical survey, field-walking, excavation records and other local sources.

A Level 1 record will typically consist of:

- The core monument record
- The written account: Items 1–5, and 12
- Survey drawings: an annotated 1:10 000 map (either digital or hardcopy), indicating location and extent (Item 13) and a cartographic record (Item 14)

**Level 2**

This is a descriptive record that provides qualitative information beyond the scope of Level 1 inspection (Case Studies 3–5). It may be made of an archaeological site that is judged not to require any fuller record, or it may serve to gather data for a wider project.

A Level 2 record provides a basic descriptive and interpretive record of an archaeological monument or landscape, as a result of field investigation. It is both metrically accurate and analytical, depicting the real landscape context of the archaeological features. The examination of the site will have produced an analysis of its development and use, and the record will include the conclusions reached, but it will not discuss in detail the evidence on which this analysis is based.

This record must include the core monument data. Beyond that, the information provided at Level 2 should be able to satisfy broad academic and management requirements. It will normally include a divorced (i.e. non-map based) measured survey or an accurately located map-based survey at a scale that will represent the form of the monument. In addition, the location and extent will be indicated on a 1:10 000 index map to ensure consistency with other levels of recording. Some statement of method, accuracy, and of the quality of investigation and survey will normally be included. Related information sets consulted at this Level may include field surveys, records of buildings, archives, aerial and ground photography, geophysical survey, field-walking, excavation records and other local sources.

A Level 2 record will typically consist of:

- the core monument record
- the written account: Items 1–5, 8–12
- survey drawings: accurate cartographic location and extent of the monument(s) at scales of 1:10 000 and 1:2 500; site plan at a scale of up to 1:2 500. Items 13–14 and 18 (and in exceptional cases Item 15)
- ground photography: as appropriate

**Level 3**

A Level 3 record provides an enhanced and integrated, multi-disciplinary record of an archaeological field monument or landscape, resulting from the process of field investigation (Case Studies 6–12). This is often enhanced in one or more ways by additional specialist research or fieldwork such as geophysical survey; aerial survey; field-walking programmes; specialist assessment of artefacts; the analytical recording of standing structures; and excavation. In many cases such enhancements would result from contracted-out arrangements of negotiated partnerships. A distinguishing characteristic of this Level is that the
enhancement will be included in the design of the project or task and will form an integrated part of the resulting record and analysis (rather than being simply an information set that has been consulted, or a separate event). Taken to its logical conclusion, this Level extends to an all-inclusive ideal of interdisciplinary investigation.

This record will provide a quality of description, interpretation, graphical depiction and analysis beyond the scope of a Level 2 entry. It must include the core monument data. Level 3 investigation will normally be used only for selected monuments, reflecting their importance, or where a specific management/client need has been identified that makes this level of detail appropriate (eg threat, Scheduling requirement, research, etc). An accurately located, measured survey (map-based or divorced) at an appropriate scale (at 1:250 or larger), designed to represent adequately the form and complexity of the monument, will always be part of the record; additional documentary and cartographic material may also be generated as part of the detailed recording and analysis.

To some extent, Level 3 field investigation may be seen as being open ended, with specifications tailored individually to suit a variety of requirements, but it always demands a detailed descriptive and analytical approach, complemented by an accurate measured survey or surveys. A statement of method, of accuracy and of the quality of investigation and survey will always be included. All related and readily accessible information sets should be consulted at this Level. These may include field surveys, records of buildings, unpublished documents, aerial and ground photography, geophysical survey, field-walking, excavation records and other local sources.

A Level 3 record will typically consist of:

- the core monument record
- the written account: Items 1–12
- survey drawings: accurate location of the monument(s) at scales of 1:10 000 and 1:2 500
- site plan at a scale of 1:2 500 or larger. Items 13–21
- ground photography: as appropriate

A guide to potential uses of the Levels is outlined below:

<table>
<thead>
<tr>
<th>circumstance</th>
<th>principal need</th>
<th>level of record</th>
<th>form of record</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic heritage planning at national, regional or local level; studies of landscapes, pilot projects</td>
<td>Information on the distribution, survival, variation and significance of archaeological sites, defined geographically, typologically or chronologically, and understanding of their evolution, to inform a range of national and local policy initiatives, to underpin heritage management decisions and as a contribution to academic knowledge</td>
<td>Generally low-level record – typically Level 1 or 2, but in selected cases 3. Map accuracy required is c 10m.</td>
<td>May make extensive use of external photography, supplemented by written accounts of individual sites and/or synthetic text. Drawn element may be omitted, simplified, limited to maps or restricted to key examples. Locations to be identified by a grid reference and plotted on a 1:10 000 base map</td>
</tr>
<tr>
<td>Management planning for individual sites or components within the landscape</td>
<td>Baseline information on the nature and significance of archaeological sites, providing a foundation for long-term decision-making, and identifying where further knowledge is required</td>
<td>Level 2 (or, on occasion 3), is required. Map accuracy required is c 1m.</td>
<td>Measured drawings may form an important and cost-effective component, meeting a range of non-historical as well as historical needs. Where sites form a tight geographical group, or belong to an historic estate, more extensive documentary research may be practical. Objects and monuments to be plotted against an OS 1:2 500 map, or production of a plan of similar scale</td>
</tr>
<tr>
<td>Full contextual assessment of an archaeological site and its landscape setting for research/academic and curatorial reasons</td>
<td>Understanding of the significance of the archaeological site and providing detailed analytical appraisal of its context, date and function</td>
<td>At all times Level 3. Map accuracy required is c 0.10m</td>
<td>An account of the site and its landscape setting accompanied by a full range of measured and annotated drawings as well as photographs and reconstruction/phased diagrams. An accurate, measured survey plan is essential, at a scale of 1:1 000 or larger, alongside three-dimensional data</td>
</tr>
<tr>
<td>Rescue or remedial survey when rapid response is required</td>
<td>Proper contextual appraisal of damage or threat to monument or landscape</td>
<td>Dependent on scale of site/landscape and the nature of response to the threat. This may well include all Levels of survey.</td>
<td>Could require the use of all available methods of analysis. Thoroughness of the resulting record is dependent upon the nature and extent of the threat but will include, as a minimum, a measured drawing and annotated text</td>
</tr>
</tbody>
</table>

**Case Study 9**

**The Cumbrian Gunpowder Industry Project: Level 3 surveys of industrial remains**

The Cumbrian Gunpowder Industry Project has been undertaken by EH as a follow up to the Monuments Protection Programme, which studied the gunpowder industry nationally. Several of the Cumbrian works were recommended for scheduling but required survey in order to understand the remains so that essential information for site management and conservation could be provided. Previous researchers have
concentrated on the documentary evidence relating to these sites and there has been little formal recording and analysis of the surviving physical remains. In order to rectify this situation, the EH project considered all seven of the Cumbrian sites, irrespective of their current designation, in order to enhance overall understanding of this once important regional industry and also to contribute to knowledge about the gunpowder industry at a national level.

The remains of this industry survive as a combination of extant buildings and earthworks. The former tend to be the buildings connected with the storage and processing of raw materials, and houses for the site managers, together with ancillary buildings such as stables, saw mills and cooperages. The actual buildings connected with gunpowder manufacture had by law to be demolished or burnt down when a works closed, so that there was no danger of any residual gunpowder adhering to their fabric accidentally igniting and causing explosions. Low platforms and ruined walls sometimes mark the sites of these deliberately destroyed buildings. Other archaeological remains include weirs, leats, waterwheel pits, blast walls/banks together with the track beds of the former tramways that served the works.

The sites are often complex and occupy a considerable area because individual process buildings were widely separated, to reduce the likelihood of an accidental explosion at one building spreading to others. The majority of the sites are in woodland; survey has to be undertaken chiefly in the winter months and it is impossible to use GPS, so survey was carried out using a total-station EDM to create a series of interlinked traverses. Much of the archaeological detail, together with buildings and walls, was recorded electronically at this stage but temporary points were also established for the recording of those parts that are either difficult to reach or where the remains require more time to understand. Once the electronically captured data was processed and a plan generated, these temporary points were used as the framework for tape and offset survey plotted directly on to the plan by hand. The hand-drawn material was later digitised to produce a digital plan of the whole site at a scale of 1:1 000. Where insufficient survives to warrant large scale survey, the OS 1: 2 500 map was used as a base on which any surviving remains were either annotated or added. The buildings were measured with hand tapes, but where parts are either inaccessible or dangerous, an electronic theodolite with a reflectorless EDM was used.

Documentary research also formed a vital component of the methodology. Gunpowder processing buildings were subject to government legislation, changes of function, and also to explosions that resulted in rebuilding, sometimes at a new location. The only way to understand how a site evolved and what the surviving remains actually represent is through the study of a variety of sources including early OS maps, historic site plans, the reports of the Explosives Inspectorate, local newspaper accounts of gunpowder explosions and inquests, and the manufacturing method books. The latter were produced for each site by the Imperial Chemical Industries (ICI) who owned the Cumbrian gunpowder works in their final years. Early photographs, often in private collections, of the sites when still in operation and verbal testimonies from some of the last surviving gunpowder workers also contribute an important element to the story.
The written account

Taking account of:

- existing practices and formats
- the circumstances that led to the generation of the record and the uses to which the information will be put
- the need to adopt common data standards and models
- whether information is presented as text or in tabular format

The introductory material should always include Items 1 to 3 (below).

Item 4 may prove adequate for the description at Level 1, and Item 5 for Level 2. However, in Level 3, Item 6 is the mandatory minimum in order to give the much fuller description and analysis demanded. Exactly how this information is given may vary, depending on the type of field monument being investigated: accuracy and clarity are more important than rigid structure. Unnecessary descriptions and measurements that can be obtained readily from the survey drawings, should be avoided. Where complex relationships exist, the use of interpretive drawings is to be encouraged. A clear and explicit distinction must always be made between the descriptive part of a report and the interpretation.

A written account may contain the following Items:

1. The type (classification) of the archaeological field monument being investigated, and its period; normally the Thesaurus of Monument Types (EH 1998; http://thesaurus.english-heritage.org.uk/) should also be used.
2. The exact location of the site; the NGR (up to 8 figures, as appropriate) and the Civil Parish, District, and County or Unitary Authority; along with identification numbers (NMR, SMR, HER, SAM) for the site.
3. The name of the compiler, the date of the investigation and reason(s) for the survey, with details of site ownership and present land use.
4. The key source (eg an aerial photograph or principal publication).
5. A summary of the salient features – this is particularly important for monuments that have lengthy and complex descriptive reports.
6. A concise description of the site, including information on plan, form, dimensions and area, function, age, developmental sequence and past land use.
7. A detailed description of the site, including the same information as Item 6 plus full analysis and interpretation with supporting evidence presented.
8. Consideration of the topographical setting of the monument and its relationship to other sites and landscapes, and to historic buildings in the immediate vicinity.
9. The potential for further investigation and for other forms of survey should be assessed and recommendations made. Any finds made during the investigation should be noted.
10. Relevant information from other sources, including published or unpublished accounts and oral information; the location of unpublished records must always be given. Relevant bibliographical references must be included, but an inclusive bibliography need not be assembled.
11. A brief assessment of the local, regional and national significance of the site or landscape with regard to its origin, purpose, form and status (ie its academic context).
12. A brief Event Record: this is a succinct description of the activities that were necessary for the compilation of the monument record, which may be coupled with the information provided in Item 3.

Case Study 10

Kettleness Alum Works, North Yorkshire: a Level 3 study of a threatened coastal industrial landscape

Kettleness Alum Works occupies a small coastal promontory a few kilometres north of Whitby. It comprises a massive shale quarry, an alum house and associated processing facilities. The site is a scheduled monument, but sits above cliffs that are collapsing into the North Sea. In 1999, EH selected the site for analytical survey at Level 3. The aims of the survey were to improve our understanding of the history and development of the site, at the same time as creating a permanent record of it in advance of further attrition and loss.

The site presented a very peculiar set of hazards and difficulties. The cliffs along this stretch of coast are retreating at an average rate of perhaps a metre or two each century; most of the erosion is small-scale and gradual, but periodically larger sections fail catastrophically without warning. Because of the friable nature of the shale, much of the floor of the quarry is also

Hand-drawn reconstruction of the incorporating mills at the Blackbeck Gunpowder Works. Reconstruction diagrams such as this can help clarify how the surviving ground remains, which are often incomplete, relate to the original industrial process.

This drawing was produced by Tony Berry using coloured pencils.
covered by a blanket of scree, which shifts with wind and rain, masking and re-exposing features. Furthermore, the archaeological interest is not confined to the headland but extends onto the foreshore at the base of the cliffs.

Because of the obvious dangers in working near crumbling shale cliffs over 50m high, which also provide few safe points of access to the beach, a methodology was formulated that entailed surveying the more hazardous parts of the site (the foreshore, cliff and quarry faces, and a zone close to the top and bottom of the latter) remotely via photogrammetry and aerial transcription. The results would then be checked visually and amended by survey-grade GPS fieldwork if practicable and safe, at the same time as the remaining parts of the site were recorded by the same technique. The advantage of such a methodology was not just that it minimised risk, but also that it would result in an accurate, three-dimensional, interpretative record of the visible surface archaeology of the entire headland and foreshore. Because of the threat to the site’s long-term survival and the fact that structures periodically disappear from view beneath scree (and the tide), it was decided that a detailed ground photographic record would also be made of all visible features.

The first step in surveying the site was the creation of a high-quality photogrammetric DTM as far out as the low spring-tide mark, for which new vertical aerial stereo-photography was commissioned at a flown scale of 1:3 000. Recent advances in aerial photogrammetric photography mean that images can now be geo-referenced in flight, but in 2000 when fieldwork at Kettleness began, this had to be carried out as a separate task using differential survey-grade GPS ground survey to acquire OS National Grid coordinates for a number of selected control points (for example, small boulders) common to adjacent images in each run. The images were then scanned at a 25-micron pixel resolution using a high definition photogrammetric scanner. This resulted in each pixel representing approximately 0.095m on the ground, and enabled the DTM to be created automatically using the terrain extraction module of the photogrammetric workstation sampling points on a 1m grid. Archaeological and topographical features visible on the images were then plotted from the stereoscopic view, and a 2D plot of the data was taken into the field at 1:1 000 scale for checking and enhancement, again using differential GPS survey. The various datasets were subsequently edited and merged within a computer environment using AutoCAD® software, and new combined plots generated were field checked by eye.

The report (Jecock et al 2003) detailed and described the findings of the survey and as far as possible sought to phase the archaeology with the aid of hachured survey plans, interpretative diagrams, reconstruction drawings and photographic evidence. Because most survey data were collected electronically and in 3D, all drawings were produced on the computer; the production of a DTM also enabled profiles to be generated at will to illustrate changes in level almost anywhere across the site. However, the use of photogrammetry also enabled the production of a number of other products not normally available, principally an orthophotograph (a single true-to-scale aerial image of the site stitched together from all the stereo-photographs, in which scale errors caused by camera tilts and ground-height displacements are rectified), which could be draped over the DTM. The project archive has been deposited in the NMR, Swindon.

Conventional methods of depiction such as natural hachures and contours often do not adequately show very steep and complex slopes. This still image of the orthophotograph draped over the 3D model illustrates well how the understanding of the site topography can be enhanced by a visual representation of the data. For very unstable and dangerous sites photogrammetry is also the ideal technique for providing a baseline record and field plot for further analysis. The computer model can also be viewed from any angle and rotated in 3D space. This type of visualisation can be very effective for display and presentation purposes.
Survey drawings
The scale of a survey drawing must be appropriate to the level of recording, the nature and extent of the site, the amount of detail that is available and the use that will be made of the survey. A Level 1 survey will require little more than a location symbol on a map or a delineated area showing the approximate extent of the site. Level 2 surveys will normally be drawn or designed at scales of up to 1:2 500, whereas surveys at Level 3 will require plans at 1:1 250 scale or larger. The same scale should, so far as is possible, be adhered to throughout a project (especially a thematic one) in order to facilitate the comparison of different examples. To help make complicated remains comprehensible, interpretive diagrams or phase plans should be provided. Terrain modelling can be used very effectively to illustrate and explain the relationship between the site and its topography: in certain circumstances this may be preferable to contour modelling which is less easy to understand.

Particularly complex relationships within a site may need to be drawn at a larger scale than the rest of the survey; these may be shown as an insert or window. Profiles should be drawn where it is necessary or helpful to show the ground surface, especially that of a bank or ditch in section; these will normally be drawn at a much larger scale (eg 1:1 250) as appropriate. As a general rule, exaggeration of the vertical axis is to be discouraged, but is sometimes necessary. For both profiles and for detailed windows, the scale, position and orientation of the supplementary drawing must be shown clearly.

All drawings must include a north point and a metric scale bar. There may be occasions when the inclusion of an imperial scale is necessary. This may be particularly appropriate in the case of a new survey of a site with a history of investigation prior to the introduction of metrification. All drawings (except those for publication) must be clearly labelled with the name of the site, the surveyor and the date of the survey. Drawings in a set must be cross-referenced to each other.

Drawings may be executed by hand, or computer generated: hand-drawn plans can be scanned into the digital environment to allow further manipulation. The growth and development of digital archives have led to an increasing requirement for the provision of survey information in an electronic format to allow manipulation and interrogation within GIS. Survey data are captured using EDM and GPS equipment. These developments have prompted the increasing use of CAD and Desktop Publishing software in the processing and presentation of survey data. This has made survey data more flexible and easier to manipulate into different formats than when drafted in traditional hand-drawn format.

The drawing conventions at each Level should follow standard EH practice as laid out in the archaeological drawing conventions below. Surveys should also contain the appropriate corporate logo. In order to record this, and other pertinent information, EH has devised a standardised information block, which must be included and completed on all survey drawings prepared for the NMR.

A set of drawings may include the following Items:

13 A diagrammatic plan showing the location or extent of the monument or landscape.
14 A metrically accurate site plan, typically at 1:1 000 or 1:2 500, showing the form of the site or landscape. The plan should be related to topographical features and to modern detail (field boundaries etc), whether or not they are depicted on OS maps. The use of larger scales (e.g. 1:500 or 1:250) may occasionally be justified, where relatively intricate detail needs to be shown. The scale 1:1 250 may be justified in urban areas where this is the OS basic scale. (Note. As cartographic information in digital form is now the norm, the concept of basic scale weakens as the reproduction of maps at a greater range of scales becomes possible; however, the traditional suite of mapping scales remains a useful benchmark.)
15 Profiles illustrating salient vertical and horizontal differences in the ground surface. Their position must be marked on the site plan and their orientation distinguished by means of a reference letter and arrow at each end of the section line.
16 Interpretive diagram(s) showing successive phases of development; phase plans must be accompanied by an unaltered copy of the survey from which the interpretation has been devised. Full cross-referencing must be included.
17 Reconstruction drawings may be particularly relevant. Such drawings must always be fully cross-referenced and must be accompanied in the record by copies of the survey plans on which they are based.
18 Copies of transcriptions of aerial photographs, either undertaken as part of the National Mapping Programme (1:10 000) or as specific larger-scale exercises.
19 Copies of plans that throw light on the history and interpretation of the monument. This includes any excavation plans which contribute to an understanding of the visible remains. The location of excavation trenches should be clearly shown on the new survey, with some indication of their accuracy. If a report is to be published, the copyright of any plan or photograph must be taken into account.
20 Copies of any plans derived from geophysical or geochemical investigation. The limits of survey or common points must be shown. An accessible presentation of the data should be superimposed on a second copy of the new survey.
21 Copies of gridded plans showing the location of archaeological objects and the extent of artefact spreads found by ‘field-walking’.

Records are now often produced wholly or partly in digital form, whether as a word-processed computer file, an EDM or GPS survey of a site, a CAD drawing or a digital photographic image. Detailed guidance on this and a range of digital archiving issues are available from EH: [Link to EH's Technical Guide](http://www.englishheritage.org.uk/upload/pdf/M0RPHE_Technical_Guide_1_Digital_Archiving_and_Dissemination.pdf)

While in theory it is possible to store all such material in digital form in perpetuity, experience has shown already that even the storage media themselves can be rapidly superseded by technical developments. Additionally, the long-term stability of magnetic and digital data is currently unproven.

It is necessary to distinguish in this area between data that is stored in an active computer system (on-line) and data that is stored on other media, such as floppy discs, CDs or DVDs (off-line). In the case of on-line data, curation problems are reduced if the system is backed up regularly and the data adequately migrated when the system
is itself upgraded, but it is important to appreciate that the advent of new software and hardware platforms may result in restricted access or functionality.

Where digital data is to be deposited as part of the archive record it is imperative that the intended repository is contacted as early in the recording process as possible. This will help to ensure that the repository is willing and able to accept and access the data in the hardware and software configurations used. While some national archive repositories can store data in on-line systems, most local repositories are likely to store material in off-line formats, at least in the short term.

Where records are written to off-line storage media it is recommended that at least two copies are created, preferably on different types of storage media, and that these are stored in different locations. The long-term storage of off-line data presents a number of problems in maintenance and curation. It requires stable storage conditions, regular copying to ensure that magnetic-based information is not lost, and regular up-grading to keep it accessible as software changes. Additionally, the pace of change in computer hardware means that some early storage formats have already become obsolete, and it may be necessary to transfer data between different types of media to ensure continued use.

At present, therefore, it is always advisable to hold a hard copy of all data deposited in digital form. While the digital record can provide information not susceptible of reproduction on paper (eg three-dimensional views, or the ability to examine minute areas of a drawing in close detail) the paper archive at least ensures the currency and accessibility of most of the information. Further guidance on digital data issues can be obtained from the Archaeology Data Service (http://ads.ahds.ac.uk/).

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Case Study II

Chester amphitheatre: a Level 3 survey of an urban landscape

In 2004, EH in partnership with Chester City Council commenced a programme of excavation and non-invasive survey at the site of the Roman amphitheatre, close to the city centre. The aim of project on this internationally important monument was to provide both organisations with up to date and well-researched information about the site and its role in the development of the urban landscape of Chester. The results of the investigation were intended to inform the future management, conservation and display of the monument, as well as underpinning the excavation recording process and providing context for its results.

Although approximately half of the site had been extensively excavated in the 1960s, little of the site’s post-Roman context had been recorded, or even acknowledged. There was, therefore, a massive gap in the contextualisation of the excavation findings as well as in the overall understanding of the historic landscape. To formulate sensible management and conservation plans for the future of the site and its landscape character it was necessary to address this imbalance of understanding through non-invasive survey.

One of the problems of studying the development of a part of an urban landscape is defining the physical limits of survey, and in this case a rapid desk-top study of historical cartography, published history and previous excavation was made to establish sensible boundaries to the study area. This initial rapid survey provided sufficient background information to define the limits of a wide enough landscape area to provide context and understanding, but without diluting the primary aims of the project.

A number of survey methodologies were then identified that were appropriate to that area and the project aims. As existing OS digital urban mapping at 1:1 250 scale was insufficiently detailed to act as a base-map, the first stage was to undertake a new detailed topographic survey of the study area at a scale of 1:500; this was commissioned from an external contractor. This provided a highly accurate plan of all structures and features in the area. The data was captured electronically using a total-station EDM and the results were presented as computer-based AutoCAD® drawing files to ensure file exchange compatibility between the various non-invasive surveys and client organisations. Because future management of the area was an issue, it was necessary to include even small details such as wall thicknesses, trees, shrubs and street furniture, and all ground points were recorded in plan and height to permit production of computerised 3D ground models and allow inclusion of depth data derived from excavation. This was tied into OS National Grid using differential survey-grade GPS.

Even though this was an urban area, there were sufficient open spaces to allow geophysical survey to be used to clarify the existence of buried structures. Resistivity, magnetometry and ground-probing radar were commissioned from an external contractor, and applied as appropriate. The resulting data was provided in an electronic form compatible with the base dataset, and as an analytical report (Geophysical Surveys of Bradford [GBS] 2004). More building blocks for the study were established by the capture of up-to-date oblique aerial photography, using fixed-wing aircraft for general context coverage and tethered balloon for low level capture. Ground photogrammetry was used to record standing fabric of the amphitheatre and laser-scanning of the previously excavated area was also undertaken to provide a 3D record of the site and form the basis for computer-based reconstruction models.

All these surveys provided the building blocks from which the understanding of the historic components and development of the landscape could be formulated, as well as forming a metrically accurate record. In addition, Architectural Investigators from EH undertook a rapid survey of the standing buildings, which was made available in report form (Menuge et al. 2004). This was then followed by a detailed ground survey and study of the historical mapping by archaeologists from EH. This involved researching and acquiring historic cartography from the County Records Office, museums and other library sources. All the survey data and historic map data was converted into a common electronic format for comparative use with the other datasets. A similar trawl and analysis of historic topographic prints, paintings, illustrations and vertical aerial photography was undertaken.

A specialist researcher with knowledge of local records was commissioned to examine documentary sources. The modern history of the site was pursued through a community involvement programme to acquire memories and photographic images.

Armed with this material, and by using observation and analytical skills, ground survey was undertaken using the metrically accurate base-map against which to record and analyse the historic development of the landscape. The area was divided into 16 map sheets each covering an area of 80m², which were plotted on polyester at a scale of 1:200. Various historic plans...
Extract from OS 1:500 scale map of 1874 of the study area using colour to convey interpretation of mapped features and correlation with the modern road layout and buried archaeological remains (© and database Crown Copyright and Landmark Information Group Ltd (All rights reserved 2006). Licence numbers 000394 and TP0024). Map regression forms an integral part of urban studies, and computer software makes the process of the comparison of different editions, scaling, adjustment and presentation simple. GIS can also be used to enhance the value of the collected information. The inset shows the same area as mapped in 1791 (© Grosvenor Museum, Chester City Council).
Archaeological drawing conventions

Background considerations
The purpose of a set of drawing conventions is to provide consistency and clarity in the production of archive or publication plans, regardless of whether they are hand-drawn or produced digitally on a computer. As well as the employment of a standard scale bar, north arrow and style of lettering, consistency is achieved through standardisation of symbols for the depiction of archaeological features (e.g., earthworks, cairns, ruined walls) and non-archaeological features (e.g., modern fences, roads and tracks). Clarity is achieved by adapting the conventions to the scale of the finished plan; by the selective use of annotation and by the provision of a key explaining the conventions used. As a minimum standard, all the plans within a project or publication must use the same conventions but the ultimate aim for an organisation is to have a single set of conventions for all its mapping output. This aim towards consistency should also extend to the naming of computer files and to layers and blocks within files where maps or plans are to be stored digitally.

Computer drawing packages help in the setting up of mapping conventions by enabling the user to design a library of symbols and line-types that are easily transferred between drawing files across a range of projects. Computer technology also gives access to colour although care should be taken to use coloured conventions sympathetically, to avoid a garish image that is difficult to read, and therefore ends up masking information. The use of colour is unrestricted when it comes to preparing maps and plans for digital, on-screen presentations and for inclusion in office reports produced on desk-top colour printers. Colour is less widely available for published illustrations due to the increased production costs. Where a map or plan is for publication it is important to ascertain at the outset if it is going to appear in black and white or colour in order to design the conventions accordingly.

Objectives
EH uses a standard set of mapping conventions for the depiction of archaeological sites and landscapes. (It is acknowledged that special circumstances sometimes require additional or alternative conventions.) The aim in issuing the EH conventions is:

- to promote the use of a set of conventions across the profession adapted to the recording and interpretation of archaeological sites and landscapes;
- to facilitate the comparison of plans of different archaeological sites and landscapes through the use of a standard set of conventions;
- to facilitate the comparison of plans produced by different archaeological organisations by promoting the use of a standard set of conventions;
- to provide guidance on the level of information and the preferred conventions for drawings acceptable to the NMR archive;
- and to indicate a minimum level of information that should be included in archive and publication drawings.

General points
As a minimum standard, all plans should include:

- a metric scale bar, and if appropriate, an imperial bar
- a north point. This should be annotated with MN to indicate that the direction relates to magnetic north (in which case the date should also be included); with GN to indicate direction related to the orientation of the national grid; or with TN to indicate direction to True North calculated by reference to information on local OS map sheets.
- a key to illustrate the conventions used.

To avoid repeating the key on each map or plan in a publication, the conventions used could form a separate figure that appears before the first of the illustrations to which it relates.

All archive plans should include an information block containing:

- site name
- County
- District
- Parish
- scale of survey
- date of survey
- surveyor(s)
- survey method
- associated plans
- office of origin
- project name
- document status
- NGR
- any unique identifying number (e.g., SAM number, NMR, SMR or HER)

Where the plan is to be stored digitally, the information block need not appear on the drawing but could be embedded in the file as metadata.

All archive plans should have a grid, preferably depicted by means of marginal ticks, with numeric values qualified by a statement as to whether it is a local grid (i.e., a site grid) or related to the National Grid. There is no need for a drawn grid on digital maps and plans where the base co-ordinates of the drawing relate either to a local grid or to the National Grid. However, the statement as to the origin of the grid still needs to appear as text on the drawing or stored as metadata.

Case Study 12
Spadeadam Rocket Establishment, Cumbria: a Level 3 survey of a technological landscape
Spadeadam Waste lies between the border towns of Brampton, Cumbria and Haltwhistle, Northumberland. In the late 1950s this high desolate moorland was chosen as the site for the testing of Britain’s indigenous, intermediate range ballistic missile Blue Streak. The construction of the rocket establishment transformed the moorland into a complex technological landscape, inter-connected by roads, electric transmission lines, water pipes and more specialised linkages, such as high pressure nitrogen pipe lines, and command and control cables. Since 1976 this 3,000ha range has been used by the RAF as an electronic warfare tactics range.
As part of continuing improvements to the management of its estate, the Ministry of Defence, through the RAF and Defence Estates, is producing Integrated Rural Management Plans (IRMPs). The primary aim of the investigation was to identify and record the remains of the rocket establishment to aid their future management.

The starting point for the investigation was a topographic survey of the main rocket test areas. These were open and ideally suited to recording using differential survey-grade GPS equipment. The use of GPS equipment allowed widely-spaced locations to be easily positioned on the same grid and produced an electronic data set that could be plotted at a variety of scales.

Some original site drawings did survive but their coverage was patchy and for some areas non-existent. They also often represented the engineers’ intentions (rather than as-built plans) and in some locations omitted modifications made during construction. They also did not show many significant features associated with the site’s construction, including a temporary navvy camp, building workers’ huts and the foundations of a concrete mixing plant. Also absent from the original drawings were features associated with the site’s use in the 1960s by the European Launcher Development Organisation (ELDO) and later by the RAF.

The new survey provided a point in time record that could be used to produce a detailed analysis of the development sequence of each area, but also provided the estate’s managers with precise identifications of all the Rocket Establishment’s buildings and ancillary features. Architectural drawings were also prepared for some of the key installations, including the main rocket stands and the heavily protected block houses from where the tests were controlled and monitored. These were recorded by a combination of a total-station EDM, hand measuring and booking techniques. The resulting drawings were prepared using AutoCAD® software. In addition to the drawn record an inventory was made of all the Rocket Establishment’s buildings and key features, using a standardised form and cross-referenced by number to the drawings. Information on the sheets included grid references, and notes of documentary sources confirming construction dates and former functions. In nearly all instances a photograph was attached to the forms.

The forms provide a record of the different features and are an important source of data for the management of the range’s historic assets. They allow the significance of different structures to be quickly appreciated, so that, for example, training activities may be modified to avoid damage.

Survey of the earthworks associated with the abandoned 1959 underground launching facility project. This drawing was produced using traditional pen and ink techniques.
Even on a recent site as comparatively well-documented as Spadeadam, aspects of the site’s history remained poorly understood and the archaeological remains of those activities are the only substantial confirmation of their existence. One persistent rumour was that work had started on an experimental underground launcher facility, or silo, for the Blue Streak missile.

Contemporary air photographs revealed disturbed ground in an area where it was suggested that the silo excavation might lie. Earthworks in the area revealed a roughly circular hole with traces of a concrete lining around its lip and a by-pass channel with sluices to divert water around the excavations (Cocroft 2006).

An important aspect of this project was the collaboration with an oral history project run by Tullie House Art Gallery and Museum, Carlisle, and the video installation artist Louise K Wilson. The oral history project had many benefits: the stories told by the veterans were a significant contribution to the social history of the establishment and helped to clarify aspects of the site’s operation and history. Another valuable gain was the unearthing of many contemporary photographs. Louise’s film was important in exploring the character of the range and what it meant to different groups of people.

The archaeological survey was presented as an illustrated, hardcopy report setting the site in its historical context and describing its development. This was supported by drawings and a separate volume containing the forms with the descriptions of the individual features. It was also converted to pdf format for supply on compact disc. The work of the oral history project was presented by an exhibition of images and artefacts, supported by an archive of recordings, photographs and other documents. Louise K Wilson’s film was shown at exhibitions and conferences elsewhere. Less tangible is the increased local awareness of the work that had gone at Spadeadam. In the future modern technology not only offers the possibilities of presenting such projects on a single CD, but also offers a means for the electronic interactive exploration of an historic environment and what it means to different groups of people.

This project illustrates how an archaeological survey of a recent defence site may act as a catalyst for other forms of research and activities, and through which a local community can appreciate the significance of historic landscapes where physical access may be barred. The survey archive has been deposited in the NMR, Swindon.
are drawn with thin heads and broken, wavy tails to distinguish them from hachures representing artificial slopes (see below).

Water features
The edges of wide stretches of water, such as a pond or a river, are shown by a continuous line, paralleled by a wavy broken line simulating water. A stream may be too narrow to show both sides, in which case it is shown by a single line representing the centre of the watercourse. Use an arrow to indicate the direction of flow for all types of watercourse.

Rock exposures and boulders
Outcrops are shown by a combination of long and short lines at right angles to the rock edge, with the length of the longest lines determined by the width of the exposed face. Reference should be made to large-scale OS mapping for examples of this convention. Surface exposures of bedrock are depicted by hatching.

Large rocks and boulders are shown in outline, but where they form part of a structure they can be filled in for emphasis (see below). Spreads of rocks, such as debris, are shown by stippling. Use a varied dot size to suggest a mixture of rock and smaller stones (see Conventions 1, page 11 and Conventions 2).

Archaeological features
Artificial slopes
Hachures are used to depict artificial slopes. They are an extremely versatile method of depicting the wide range of slopes encountered on an earthwork site (see Conventions 1, page 11 and Conventions 2); see also Bowden 2002, fig 20). Used with care, they can show a wide variety of earthworks ranging from very slight slopes shown by small-headed hachures with broken tails (a) to very steep, wide slopes shown by thick-headed hachures (b). For, as well as the shape of the hachure, the spacing along an earthwork also conveys much about the type of slope. Narrowly spaced hachures indicate a steeper slope than where they are drawn widely apart. Care is needed not to place hachures too closely together as there is danger that the heads will coalesce into an unintelligible mass. Equally, if the hachures are too far apart they will not define either the shape or the alignment of an earthwork adequately. The most difficult slopes to define by

Stony features
Stipple can be used in among hachures to indicate earthworks with a high stone content, such as stony banks, or used without hachures where the feature is comparatively flat. Where major slopes are formed entirely of stone, such as the collapsed stone rampart of a prehistoric hillfort, the hachures are drawn as strings of dots with larger dots used to define the head of the hachure (g). Wall faces are indicated by a continuous solid line or, if the scale allows, by showing the individual stones as filled shapes (h). Standing stones and orthostats are also shown in this way (i).

Quarrying
Quarried faces are depicted in the same way as natural rock edges. Annotation should be used to distinguish quarries from natural rock exposures when both occur on the same plan. Dumps of quarry spoil are shown by hachures with stippling to indicate stony material.
The modern landscape

Standing buildings
Standing buildings are shown with diagonal hatching. Where individual buildings abut, the party wall is shown. Cross-hatching is used to show glass structures. Roofless buildings are shown in outline. Free-standing walls are shown in outline or can be emphasised with a solid fill where of archaeological significance.

Walls, hedges and fences
Stone walls are shown by two parallel lines, while fences are shown by a single continuous line. Hedges are shown by a double wavy line to give the impression of vegetation. Stone walls are shown in outline or can be made of symbols, tone and (where possible) colour to construct the map allowing the freedom to develop conventions specific to a particular map or project (see, eg, Oswald et al 2007).

Natural features and the modern landscape
The conventions used are based on the large-scale mapping conventions described above, but simplified to accommodate the reduced scale. For example, stone walls should be shown by single, rather than double lines, while cross-hatching to denote buildings can be replaced by a solid fill.

Road, tracks and paths
The sides of a metalled road are shown by a solid line, with a dashed line to indicate the edge of the metalling. The edges of an un-metalled track are shown by a dashed line.

Conventions for small-scale drawings
(1:2 500 and 1:5 000)

Archaeological features
The capacity to show small detail is restricted on maps at these scales (but see Case Study 4). Instead, greater use can be made of symbols, tone and (where possible) colour to construct the map

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Landscape of former lead mining, Scordale, Cumbria (photograph by Bob Skingle) © English Heritage.
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