Section 3: Survey Methods and Practice

Overview - OS Basic Scales

This section is concerned with the methods used to capture real world features, how those methods are chosen, and some of the principles and rules that govern what is captured and how it will be represented in the final map product. Much of these principles and rules form the specification that is described in the user guides[1] which serve as a reference for the main large scale data products i.e. Land Line and OS MasterMap. These guides extend to several hundreds of pages however so this section of the reference notes will include the more important points bearing in mind the overall objectives of the Introduction to Survey Practice course.

Basis scales mapping represents real world features in digital format. The land surveys performed to capture those real world features are based on a set of basic principles. Instructions, rules and guidance are all related to these basic principles and in some cases judgement is required in their interpretation. While in many cases the same rules apply to all three scales, in other circumstances different rules apply to each of the three different basic scales. An understanding of how these principles and rules are applied will provide an insight into why certain features appear as they do, and why apparent anomalies can occur between Ordnance Survey mapping and other, for example deed plan, mapping.

Methods of Survey

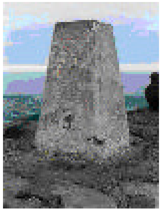
The introduction section of these notes explained some basic principles of mapping – the problem of depicting features on a curved surface of the earth on a flat surface such as a paper map or the plane reference system of a GIS. In order to survey the land and its features this fundamental problem has to be addressed – unless the mapping is within a relatively small area, and done in isolation from features further away. This concerns the geodetic framework – the structure within which everything else fits. Having sorted that out the surveyor has a number of methods available for data capture and each one will have its advantages and disadvantages.

Geodetic framework

Since the earth is a sphere, it is impossible to map accurately on a flat piece of paper. To achieve accuracy in mapping the earth's surface with minimum distortion, projections are used. As was described in the introduction Ordnance Survey use a cylindrical projection known as a Modified Transverse Mercator. The earth is of course not all at sea level and therefore, to reduce the distortion due to height, measurements are taken in the horizontal plane, and not as a slope distance.

[1] Much of the reference material for this section follows the guidance given in the Land-Line User Guide v5.0, Jan 2004 and OS MasterMap User Guide v5.1, Feb 2004 ©Crown Copyright

The key to all good survey practice, which all surveyors are taught at a very early stage is **"to work from the whole to the part"**. In other words you need a framework to survey within (the geodetic framework) and if that is correct then everything within that framework should "fit" and be correct.



As described in the introductory section of this reference guide the early framework in Great Britain was provided by Ordnance Survey triangulation - a series of triangles in the horizontal plane, which form a network lattice covering the country, known as the Primary Trig Network. This main network of triangles were broken down successively, until it was possible to physically measure ground distances, initially with chains, to supply the map detail.

The reason why the initial geodetic framework was created in this way was because in the 18th and 19th centuries it was much more accurate to measure angles than distances. By measuring a baseline extremely accurately, and then measuring the internal angles of the triangle the distances between the two unknown sides of the triangle could be calculated. By building up a triangular network from a baseline on Hounslow Heath London distances between the points could be calculated until a check line was measured when the triangulation reached Sutherland at the other end of Great Britain. This primary network was then broken down into a smaller triangles which provided what was known as "minor control". This was then used, initially to run chain lines from, and then as electronic distance measurement (EDM) instrumentation developed the minor control was used as the terminals for traverses.

As an aside, if the geodetic network had been created in the 1970s or 1980s it would have been done by tri-latteration – in which the triangle sides are measured, because by then electronic distance measurement meant that very accurate and precise distance measurement was possible. Now we have moved into the 21st century and GPS makes much of the old geodetic framework redundant. Until recently, much of the new detail being supplied at basic scales required traversing between higher level control within the framework. Today, GPS positioning has allowed for control points to be fixed without the need for extensive traversing, hence reducing the time required in this method of survey. The cost savings made by GPS have been substantial, but this has brought its own short term problems for Ordnance Survey in terms of manpower numbers and distribution.

In the vertical plane, Fundamental Bench Marks form the framework for the levelling network, from which the lines of levels are run to create Bench Marks.

Field survey

To supply detail on large scale maps, surveyors can use different methods for each of the scales. The more detailed the map, the greater the measurement accuracy required. Hence in 1:1250 surveys, updating is mainly based on instrumentally co-ordinated control points, ensuring that an accurate framework is maintained. For graphic survey, to complete the infill of the detail, it should be possible not to have to tape any line over 60m, without being able to check against a point of detail provided by instrumental control. This might mean having to use lines of sight to create intersections or tri-sections which can act as control to "tie-out" a tape line. This is explained in more detail in the Graphic Survey section of the reference notes.

For 1:2500 surveys, survey methods in general are less rigorous. Much of the 1:2500 surveying is done in blocks of aerial photography but most of the ground survey is carried out by graphic methods, i.e. using lines of sight, intersections and taped distances, etc. Detail survey is not created directly from co-ordinated points, but is supplied relative to the framework of local detail. Exceptions arise in areas of new housing and commercial developments greater than 4 hectares in extent, and a National Grid co-ordinated framework is then created by using GPS – until recently this would have been an instrumental divorced survey using EDM equipment.

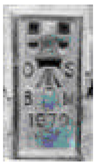
Similar methods to 1:2500 are used in 1:10000 mapping, but due to the limitations in scaling and plotting detail, and the generalisation of detail, tolerances allow for less precise methods, such as plane tabling, laser range finding and differential GPS. In practice very little 1:10000 survey is now completed solely in the field.

Survey using Aerial Photography

With the exception of 1:1250 revision, the majority of new surveys will at least consider the use of this method. Using precise photography, stereoscopic pairs of photographs, or scanned images are created, and the plotter is able to extract new survey detail against a framework of control or relative to local detail. This is a very effective and economic method, but in most cases requires a subsequent field visit to complete detail not visible, and to collect names and numbers.
One drawback in aerial surveys is the inability to capture the target if the weather or the season make it impossible to obtain the quality photographic results required. Where there is a short turn round time required in update, photogrammetric methods can rarely be relied on.

Levelling

As with the horizontal network, there is also a vertical network of control, broken down successively, which provide height information required in the survey process, particularly in setting out and engineering surveys.



Based on a datum at mean sea level at Newlyn or local datum, the lines of levelling form a network of Bench Marks, providing height information relative to the datum. In generating the network, the change points used between the Bench Marks are also recorded on the map, and are known as spot heights.

On the 1:10000 maps the change in height is shown using contours, which represent the lines of equal height at 5m intervals. The contours are generated from air survey.

It is now possible to use the GPS network to collect height information. By using satellite receivers on the ground and a model of the Earth's gravity field, it is possible to obtain the three-dimensional data necessary to compute height. GPS is not yet as accurate as spirit levelling however over short distances.

Ordnance Survey – selection of methods

In choosing which method of survey to use Ordnance Survey will be guided by a set of criteria that mainly focus on resources and required accuracy. Certain rules need to be followed to ensure the continuing accuracy of the map data. For example:

- all infill sites greater than 1 ha in extent, where the RMSE[2] is 0.4 m, and sites greater than 4 ha in extent, where the RMSE is 1.0 m should be controlled by GPS, instrumental, or photogrammetric survey to ensure that the original accuracy standard is maintained;
- development of greenfield sites (and brownfield sites in greenfield areas) greater than 4 ha in extent are normally controlled by GPS, instrumental or photogrammetric survey tied to the National Grid. Local Ordnance Survey staff are given discretion to decide if 0.4 m or 1.0 m RMSE level of accuracy is appropriate is appropriate having regard to likely future development, the complexity of detail and cost;
- for sites less than 4 ha in extent, Local Ordnance Survey staff has discretion to use rigorous survey methods as described above, balancing the overall aim of improving quality against the availability of control and cost.

Ordnance Survey staff will use a number of factors in deciding the optimum survey method including:

- What are the relative costs of photogrammetric survey, instrumental survey, GPS control, detail survey and survey from external sources?
- What resources are available?
- Does suitable air photography already exist?
- What is the timescale for completion of the survey?
- Can air photography be acquired in time to meet the requirements?
- The proximity of existing control;

[2] RMSE = Root Mean Square Error, a statistical method of defining "average" error

- The fit to existing detail, for example, it may be easier to resolve discrepancies in rural rather than in urban areas;
- Longer-term plans for further development in the area;
- Difficulty of graphic revision;
- Amount of change;
- Health and Safety.

Measuring Change
OS has historically quantified and recorded the amount of change taking place on any basic scale map by the number of house units of change. One house unit equates to the complete mapping of one new house and all its associated features, i.e. peripheral fencing, garage, drive, etc. Other types of change are measured as parts, or multiples of the basic house unit. A few examples are tabulated below:

Category	Type of Change / Feature description	House Unit (HU) value
A	A new house and associated features	1
A	A new house for which fences still have to be erected.	0.75
A	Property boundary fences	0.25
A	House names and numbers associated with a new house	1 per 5 names.
A	New Commercial, Industrial and Public Sector buildings	20 per hectare
A	Motorway and Dual Carriageway (incl. paths, fencing).	10 per 100 m.
A	All other roads, std. gauge railwaysand canals (incl. associated paths and fences.	5 per 100 m.
A	Survey of / changes in kerb lines, e.g. creation of parking bays.	1 per 100 m.
A	Demolition/deletion of any Category 1 feature	0.25 per HU value.

This is used to monitor change, and forms part of the Ordnance Survey management system for monitoring change, recording work, and determining priorities for revision.

Basic Principles of Basic Scales Survey (and digitising)

Certain basic principles form the foundation of Ordnance Survey data capture and depiction of basic scales mapping features.

Permanent detail
Ordnance Survey defines this as physical features, which it is reasonable to assume will remain in position for at least 10 years, taking into account the nature of construction or character. Land-Line digital maps show all permanent detail which can be shown at the scale of survey. Natural relief features are not normally shown. Detail which is too small to be digitised at scale but is sufficiently important or prominent is shown by a symbol. Administrative boundaries and archaeological information are shown.

Indefinite detail
Indefinite detail is defined as physical features of sufficient importance and which have an outline which is either liable to change or not defined precisely by any surveyable feature. The nature of surface vegetation is shown, except for trees and scrub (bushes, brambles and undergrowth) standing in permanent water. Indefinite detail is not surveyed precisely. The accuracy of survey is related to the degree of definition of the detail on the ground.

Names
The names of all physical features, objects and areas are included. A selection of house numbers or house names is shown (name if no number has been allocated). Road centrelines are not surveyed, but are created in the data to indicate the public road network.

Ground Surface Level
Large scales features are captured to show physical features by their outline at ground surface level. The definition of this term is usually self-evident. Where more than one level of detail exists, ground surface level is defined as the upper level of through public communications. Those features which are less than 0.3 metres in height are shown by pecked lines and given different coding attributes to distinguish them from those above 0.3 metres. These are normally features which do not pose an obstruction to pedestrians. Features above 0.3 metres in height are shown traditionally by solid lines.

Permanent Buildings
Permanent buildings and other objects whose plan outline covers an area of 8 m^2 or more are shown, unless they are within a private garden, when the minimum criteria is 12 m^2. This is a change of rule dating from the late 1980's – before this time buildings over 8 m^2 were shown in private gardens. This can lead to some apparent inconsistencies. Smaller buildings and objects covering an area of 4 m^2 or more and whose smallest dimension is 1 m or more are shown when they are in such a detached position as to be a relatively important topographical feature. Features

are shown regardless of size when used to identify the alignment of or mere an administrative boundary or as a site for a bench mark.

Overhead Detail

This is defined by Ordnance Survey as those features which are above ground surface level. Overhead detail is normally shown if it is of such size and character as to constitute a meaningful topographic feature. Buildings which have supporting pillars are recorded as overhead detail if they meet the permanent detail criteria described above. Overhead features which are less than 1.0m wide (for 1:1250 scale) or 2.0m wide (for 1:2500 or 1:10 000 scale) are not shown unless of particular importance, such as a motorway gantry. Again there is scope for apparent inconsistencies because is the past a 5.0 m minimum width has been applied to 1:10 000 scale. Overhead features, such as pipes within an industrial installation, are not shown where they form an integral part of that installation. Depiction of overhead features entering such installations is terminated at the first support or building within the perimeter.

Underground detail

This is defined by Ordnance Survey as those features which are below those at ground surface level. Underground features are not normally shown, except for some communications in tunnels or subways, if these communications usually run on ground surface level, and specified features within complex multilevel structures. Because of their nature, tunnel alignments are not captured to the same accuracy as features on the surface.

Parallel Features

Where a fence, hedge or wall runs approximately parallel to another feature and so close that they cannot both be plotted correctly at scale of survey then only one feature is surveyed. In determining which feature to include, the following hierarchy is used by the surveyor:

1. include if the feature is used to mere[3] an administrative boundary;
2. include if the feature *appears* to define the extent of a property;
3. include if the feature appears more important, for example, a hedge next to a cattle protection fence, show the hedge.

Depiction of coincident alignments of features

Generally, Land-Line depiction of the real world features it shows is in the form of a series of discrete features; the geometry of each feature appears only once in the data. The same geometric alignment or position is not recorded more than once, even though a particular feature may serve more than one function, e.g. a roadside wall may also be the edge of a pond. The only exception to this principle is where,

[3] Mere = to attach the boundary to a permanent physical feature e.g "Face of Wall"

for example, an intangible feature such as an administrative boundary is mered (attached to a physical feature) along the centre of a hedge or fence. Because of this, there are no dual or multiple feature codes or layers. Where physical features are coextensive planimetrically the following hierarchy is used to determine the appropriate feature code or layer for those features:

1. Mean high water (springs).
2. Building.
3. Water detail.
4. Road detail.
5. Other detail.
6. Mean low water (springs).

The significance of this is that where two features are so close as to be shown as one, the stream may be shown in position, and the fence, wall of hedge omitted. At 1:2500 there may be up to 2.0m difference in these positions.

An example is the Houses of Parliament in London. These are situated on the bank of the River Thames which at that point is tidal. The side of the building which is at the water's edge is represented by the mean high water (MHW) and not the building's outline, so the single feature code used would be that for MHW.

Feature coding

As features are captured, or in some cases as part of the HQ data completion process (e.g. road centrelines) they are given a specific code. Types of feature may be grouped, for example, fences hedges and walls are described as a general line feature - National Transfer Format (NTF) Code 0030. Understanding feature codes may in some cases help to identify the detail depicted on the map where this is not explicit, for example a ditch or a wall.

Other important subsidiary principles:

- **Generalising due to minimum size rules** - It is important to be aware that some features will be generalised due to scale and minimum size rules. Measurement from these features may not give accurate results.
- **Missing detail due to minimum size** - not all detail is shown if it does not meet the minimum size rule. Conversely if of significant importance and to be consistent, some features will be shown larger to meet the minimum size criteria. For example pylons or buildings where a Bench Mark has been positioned;
- **Building divisions** - are only shown where there is a different construction, or the division is evident from ground to roof and can be surveyed from the

outside. This means, for example, that shops at ground level will not be divided, as the division does not extend to the floors above;

- **Juts and recesses** - The ability to survey juts and recesses depends on their minimum size, method of survey and whether the jut forms an obstruction or the corner of the building;
- **Roof projections** - The ability to capture detail at ground surface level is more difficult when aerial photography is used as the principle source of data capture. In areas of "over throw" (where the angle of photography is such that ground surface level cannot be seen) only the roof line may be seen. Awareness of this limitation and the subsequent differences in building size, compared to ground survey, may be important – although well within stated tolerance, there may be inconsistency and differences between ground and mapped distances.
- **Vegetation** - No vegetation will be shown in private gardens unless it is a continuous feature. Also the minimum size rules may mean that small strips of shelter belt, and areas in the corners of fields where there are clearly trees planted and fenced, may not be shown. Reliance on measurements from indefinite extents of vegetation should be treated with caution.

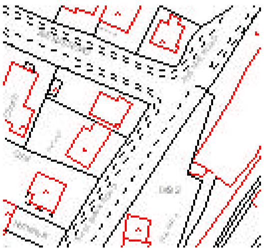
Ordnance Survey Large Scale Data – Specification

As mentioned already the Land Line and OS MasterMap User Guides[4] contain hundreds of pages of information which include details of the map specification. It is not worth repeating all that information in this reference guide but it is helpful to outline out the main structure of the specification and to elaborate on some of the more important elements. Some features are particularly relevant to the registration process and so these are included here, whereas other, less relevant ones will be omitted. In general the specification reflects the surveying data capture specification, which then becomes the Land-Line or OS MasterMap data product specification. There are some differences between the two product specifications however. Unless OS MasterMap is specifically mentioned below the specification described refers to Land-Line. If in doubt over the depiction of specific features consult the User Guides referred to.

Land-Line shows many real-world features, both tangible and intangible. The User Guide groups them into 12 main categories:

1. Buildings and structures

[4] Land-Line User Guide v5.0, Jan 2004 and OS MasterMap User Guide v5.1, Feb 2004 ©Crown Copyright



All permanent buildings and structures which are large enough to be included are shown - the minimum ground area for a building shown true to scale is 8 m².

For buildings in private gardens, the minimum size is 12 m² (although as previously mentioned this has been smaller in the past). The main corners of buildings are shown in their correct positions.

Features included in the buildings and structures group include:

- roofed buildings (of sufficient size to be included);
- mobile or park homes that are permanent, residential and have a postal address*;
- archways and covered passageways where the alignment can be surveyed from outside the building (indicated by diagonal lines and coded as minor line detail);
- horticultural glasshouses over 50 m2 (other glass structures will now be shown as conventional buildings;
- detached monuments;
- cooling towers;
- tanks shown true to scale and described;
- ruined buildings (shown by their outer walls only); and
- bridges, viaducts, aqueducts and piers.

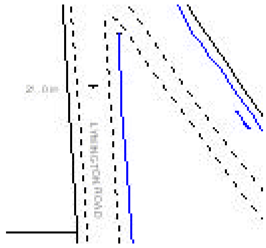
**These features are recent additions to the specification and are being retrospectively captured as part of the revision process*

With a few exceptions, for example, by describing government offices or hypermarkets, no distinction is made between residential, private, public, commercial or industrial buildings. To ensure consistency of depiction for the many diverse complex multilevel structures which exist today, the upper level of through public communications (ULC) is the level to which survey is related. The main building outlines, overhead and underground detail, names and descriptions which provide information consistent with clarity, are also shown.

Juts and porches which are an integral part of a building, bay windows and recesses are shown when their smallest dimension is not less than 1.0m at 1:1250 scale and 2.0m at 1:2500 and 1:10,000 scales. Historically a 5.0m dimension was applied to 1:10,000 scale and features will still be found in the data captured to this specification. Despite these minimum dimensions smaller juts and projections are shown when they abut onto a public thoroughfare or they carry height information.

2. Roads

For mapping purposes Ordnance Survey define a road as a metalled way for vehicles. Land-Line contains information relating to those roads which form the public road network and those in private property which are over 100 metres in length. No attempt is made to separately identify roads by their Department for Transport (DfT) classification. Names of roads are recorded. Unnamed roads are not normally described but in cases of ambiguity an annotation may be included. Land-Line data contain representations of the following road features:



Kerb lines or the limits of metalling representing:

- carriageway limits, including any hard shoulder or shallow drainage gullies forming the side of the road on dual carriageways or motorways;
- kerbed roundabouts;
- traffic islands in roads, except when very small (traffic islands must be 8 m² or more);
- Traffic calming measures forming a physical obstruction, including pinch points;
- dedicated cycle lanes delineated by kerbstones;
- fords; and
- car parks.

Road furniture such as:

- mile posts;
- guide posts (traditional finger posts only);
- kerb barriers;
- gates across roads;
- posts preventing vehicular access;
- weighbridges; and
- cattle grids.

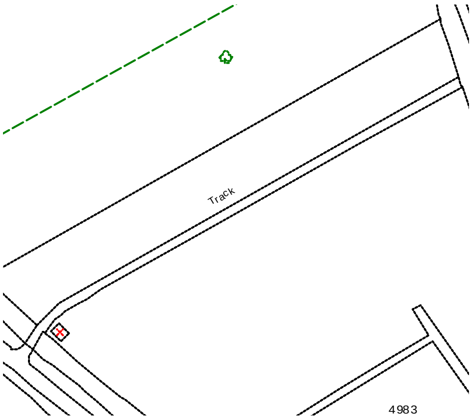
Road bounding features such as:

- hedges, walls, fences and banks; and
- crash barriers (where they form the sole bounding feature of a carriageway).

Although not surveyed the central alignment of all roads "which are accessible and normally used by the public" are derived and shown. Street furniture such as drain covers, manholes, lamp posts and traffic control signs are not captured.

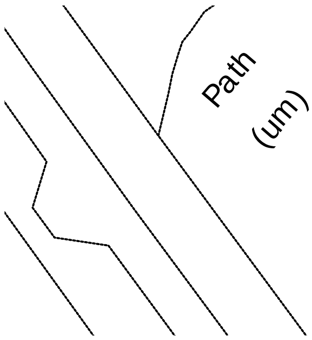
3. Tracks and paths

As a general principle, the alignments of tracks and paths are captured at basic scales and shown in Land-Line as line features. A textual description is also included, although there are some exceptions which are explained below. The text description is normally aligned centrally to the feature and parallel to it.



Tracks - Ordnance Survey define a track as an unmetalled[5] way which is clearly marked, permanent and used by vehicles. They are described as Track, or Tk if it needs to be abbreviated. Tracks are only recorded in private gardens if they are 100 metres or more in length. They need not be all weather. The edges of such tracks are recorded in Land-Line as line features. Distinctively named tracks have their name recorded in Land-Line.

Paths – these can be "made" or "unmade" and are defined by Ordnance Survey as any established way other than a road or track. Paths are recorded in Land-Line as line features. *Made* paths are those whose surface is paved or metalled. Only the major paths are shown in parks, public gardens, cemeteries and so on. Made paths are described in Land-Line by the annotation Path, except in built-up areas or if the path has a distinctive name, such as Rope Walk.

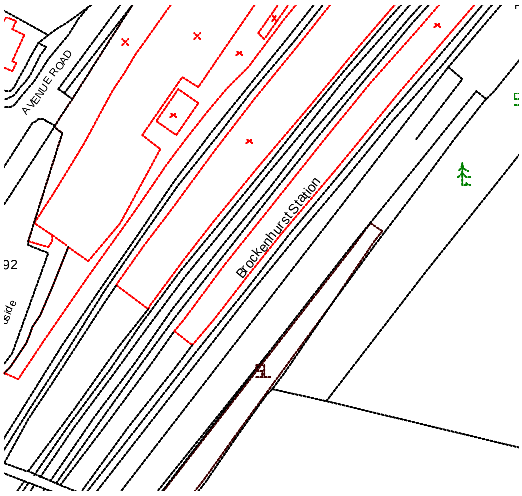


Unmade paths are those which are neither paved nor metalled.An unmade path is included in Land-Line when its entire length is evident on the ground and it starts at a road, track or path and finishes at a similar feature or a specific place of interest. Unmade paths are described by the annotation Path (um) in 1:1250 and 1:2500 scale areas.

Rights of way are not identified in Land-Line so any representation in Land-Line of a road, track or path should not betaken as evidence of a right of way.

4. Railways

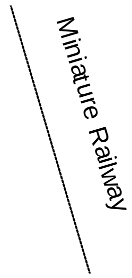
[5] Metalling is the crushed stone used to surface a road – usually using tar to bind it in a "tarmac" covering.



Land-Line contains information relating to permanent railways that form communication between two specific points; this may be from railway station to railway station or from an industrial building to a private quarry.

Land-Line includes the names of all stations, junctions and termini. The relevant User Guide lists the types of physical railway features captured and shown (and examples of some features not captured) on basic scales mapping.

Standard gauge railways are shown to scale by a pair of lines, separated by the correct distance (1.435 m). Railways narrower than 1.435 m are deemed to be narrow gauge and the central alignment is shown by a single line. Tramways and light rapid transit systems are treated as standard gauge railways. Privately owned railways or railways constructed solely for the transport of minerals are annotated to indicate the purpose for which the railway is used.



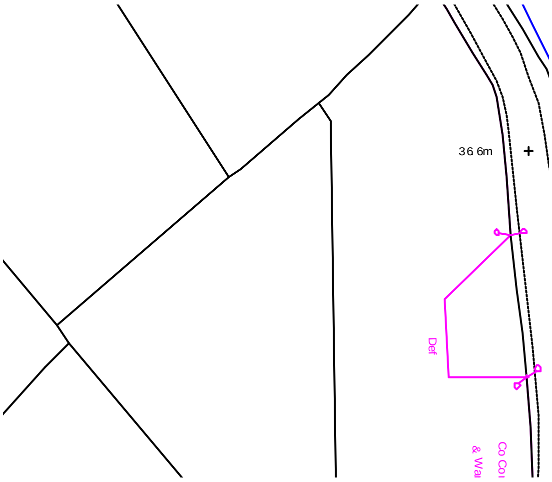
Where railways or tramways have closed but the rails exist in a usable state they are textually described. When the rails have been removed but the formation has not been converted to an alternative use, such as a road or a track, the remaining feature is described as Dismantled railway or Dismantled tramway. The extent of the permanent way (railway ballast) is also shown.

Where a deep level London Underground tube railway comes to the surface and continues as a normal railway it is shown as a normal standard gauge railway. In other cities only the sections of underground railways that are open to the sky are shown in Land-Line.

5. Fences, hedges and walls

The two topographic basic scales products' user guides give a comprehensive list of all the types of physical features included under this category. As a general principle no attempt is made by Ordnance Survey to distinguish between fences, hedges or walls in basic scale mapping. These features are normally those physical features which commonly divide open areas, for example, agricultural land, into fields or enclose private properties. Small gaps in these linear features are ignored.

Grass or earth banks are shown. Permanent and clearly defined unploughed steps or ridges between fields are identified separately. Gates are shown in the closed position, and open gateways are shown as if they were gated. Certain features are listed in the User Guides as being not shown, for example ring fences protecting single trees, crop rotation fences, crash barriers, and fences under 0.3m high.



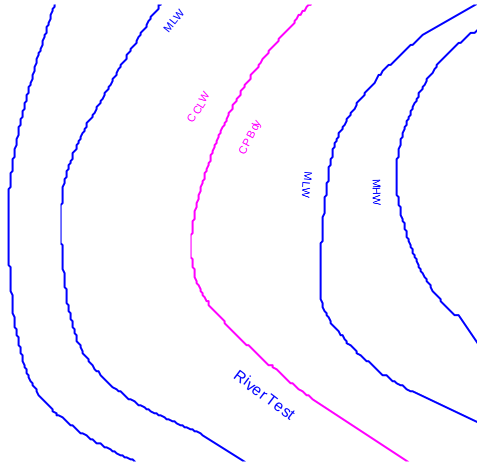
Hedges - broken hedges, fences, walls and banks are shown when they are the only defining feature of a land parcel or in areas where there is little other detail, such as mountain and moorland areas. It is the centre of the root alignment of all hedges which is positioned on the map regardless of the hedge width.

Hedges which have frequent and significant breaks in their alignment are separately identified in Land-Line.

Walls - the central alignment is shown for walls whose width is less than 1.0m for 1:1250 scale and 2.0m for 1:2500 and 1:10,000 scale (again there is the historical 5.0m legacy for some features at 1:10,000). Very thick walls are shown by their outer faces and a textual description "double wall" is added. Sloping masonry walls have their alignments recorded using the same criteria as standard walls, except that they have a textual description "Sloping Masonry" added if their horizontal width is greater than 1.0m -1:1250 scale, or 2.0m -1:2500 and 1:10 000 scale.

6. Water

Linear water features (such as streams and rivers) are normally shown to scale. If, however, the width of such features is less than 1.0m in 1:1250 scale or 2.0m in 1:2500 or 1:10,000 scale they are shown as a single line. Continuous topographical water features which extend into private gardens are shown.
Lakes and ponds are surveyed at normal winter level; reservoirs are shown at top water level, i.e. spill-over level. All water features are described.



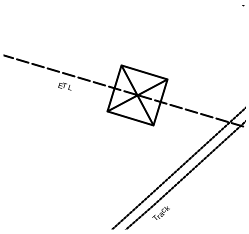
Ordnance Survey shows high and low water marks of a mean average tide, that is an average tide halfway between spring and neap tides, in England and Wales, and of average spring tides in Scotland.

In tidal rivers the point to which mean tides (or spring tides in Scotland) flow at high or low water is included. The highest point in a river to which normal tides flow is described as normal tidal limit (NTL).

Where the point coincides with a firm line feature across a river, for example, a weir, it is shown as mean high water (springs). Where there is no feature, the actual NTL is shown as general ground level or overhead detail.
As with the minimum dimension for building juts and porches etc there has historically been a 5.0m dimension minimum applied to 1:10,000 scale water features – i.e. below this size water features would have been shown as a single line, and features will still be found in the data captured to this specification

7. Overhead features

The main points covering overhead features have already been described above under the description of general principles. Cantilevered buildings, balconies and buildings supported on pillars are treated as overhead detail.



Electricity pylons, flare stacks, radio masts and lighting towers are shown by an oriented symbol when they are square in shape.

Only those pylons which are isolated and unconnected are textually annotated.

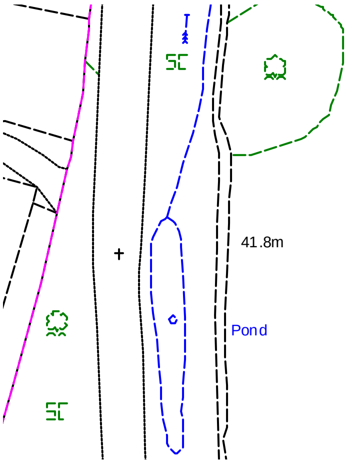
As with other features the 1.0m (1:1250) and 2.0m (1:2500 and 1:10,000) rule applies for minimum width i.e roof projections and overhead features less than this are not shown unless of particular importance. In general, no detail is shown beneath roads (which when elevated become the upper level of communication – ULC).

8. Underground features

This has been described in the general principles section above.

9. Landscape, surface features and landform

Generally speaking Ordnance Survey basic scale data does not include many landscape features. This scale of mapping does not attempt to record the shape of the earth, and the limits of geographical features such as hills and valleys are not recorded – but the distinctive names of these geographical features are shown. The majority of the landscape features which are shown are area polygons which define areas of water, cliff, coastal slopes, man-made slopes, vegetation, and surface features such as woodland, rough grass, orchard, marsh (above the high tide line), boulders and so on.



Vegetation and surface features are shown only when of sufficient size. The minimum dimensions are:

Area	Width	Scale
0.1 ha	5 m	1:1250
0.1 ha	10 m	1:2500
1.0 ha	10m	1:10000

Individual trees are not normally shown unless they are prominent landmarks, are of historical interest or are points defining an administrative or electoral boundary.

Rows and small groups of trees are not normally shown unless they are named. The individual trees within rows are shown in approximate surveyed positions, except when spaced closer than the minimum distance - in which case they are shown accurately to the scale of survey. The minimum distances are:

15m	1:1250
15m	1:2500
50 m	1:10 000

Isolated areas of vegetation are not subdivided unless of sufficient size. The minimum dimensions are:

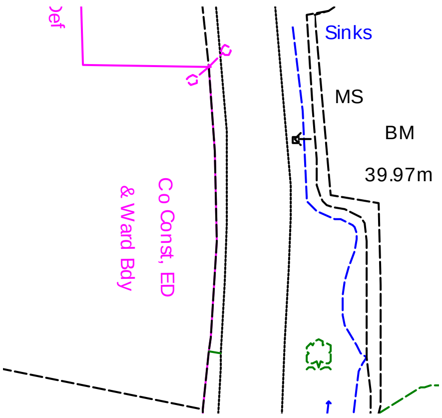
0.25 ha	1:1250
1.00 ha	1:2500
1.00 ha	1:10 000

In wooded areas, any type of vegetation forming less than 10% of the whole area is ignored. In larger areas of vegetation, subdivisions less than a certain size are not made. The minimum sizes for subdivided areas are:

0.1 ha	1:1250
0.4 ha	1:2500

1.0 ha 1:10 000

10. Administrative and electoral boundaries



This particular category is probably not one that will be of major significance to the registration process so it will only be discussed in brief. Historically, the role of the Ordnance Survey field surveyor is that of "mereing" boundaries to real world physical features. The boundary map was sent to the field office showing the position of the new or changed boundary and the surveyor had to "attach" the boundary to a feature on the ground by describing it – for example "face of wall" or "root of hedge".

A full list of all mereing descriptions is provided in the relevant basic scale product User Guides. As from October 2002 the boundary mereing relationships for new or changed boundaries are no longer recorded by Ordnance Survey. The alignment of the boundary is still shown however. Any mereing relationship descriptions existing before October 2002 are retained in the data and if the feature to which an existing boundary is mered is destroyed the mereing annotation will be changed to "defaced" (Def). Aspects of administrative boundaries which are shown in Land-Line are:

- the alignment;
- its mereing - the boundary's relationship to real-world topographic features; and
- descriptions of the boundary type, where necessary for clarification.

The following types of boundary are shown in Scotland:

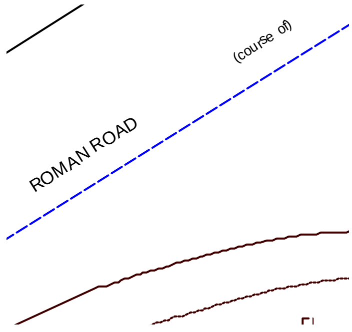
- parliamentary boundaries:
- European electoral region;
- county constituency;
- burgh constituency;
- parliamentary electoral region and parliamentary constituency
- local government boundaries - unitary authority and ward.

11. Antiquities

As with boundaries these probably have low importance in the registration process and so are only described in brief. The investigation, recording and surveying of archaeological features is the responsibility of the three Royal Commissions on Historical Monuments (RCHMs), England, Scotland and Wales. The antiquities shown in Ordnance Survey large scale data are:

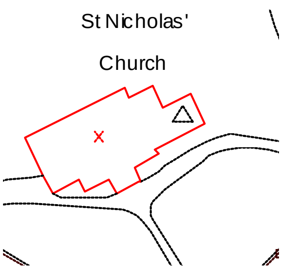
- artificial features or their sites, and artificial portable objects and their find sites; and
- battlefields and natural features connected with important historical events.

Ordnance Survey uses the age of the antiquity to make a distinction between Roman, non-Roman, and other antiquities. There is no list of features in the user guides because they encompass such a wide range of real world objects such as standing stones, earthworks, hill figures, ruined buildings and tombs.



Generally the features shown are existing artificial features, together with natural features connected with important historical events.

12. Horizontal and vertical control

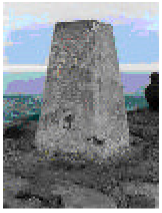


Although some horizontal and vertical control points are shown on Ordnance Survey large scale maps much more comprehensive information is held in its archive of horizontal and vertical control data. This includes transformations, three-dimensional control from its national GPS (global positioning system) network (OSGPS93®) and higher resolution information.

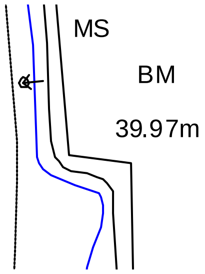
The three types of control point that are shown on Ordnance Survey large scale maps are:

- triangulation stations - these are physical marks which represent one point in the national triangulation scheme. The best known form is the triangulation pillar, often found on hill or mountain tops.

  Although it is unlikely to be required for the registration process more up-to-date and detailed information e.g co-ordinates about a triangulation station will be held by Ordnance Survey. The coordinates of a triangulation station in the large scale map data are not usually the very accurate coordinates for the control point. All triangulation stations are shown except for buried and surface blocks.



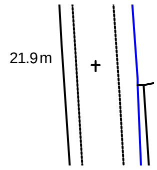
- bench marks - these are physical marks, the altitude of which (relative to Ordnance Datum) has been determined by levelling. The best known form is an arrow cut into masonry, often found on building corners and bridges.



All current bench marks (except for those on a triangulation pillar) are shown by a point feature or symbol.
The altitude to two decimal places of a metre is shown by a textual description. If required more up-to-date and detailed information about a bench mark is held by Ordnance Survey.

- spot heights - these are non-physical points, the altitude of which (relative to OS Datum) has been determined by levelling.

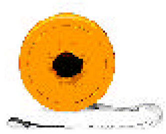
All current spot heights are shown by a point feature or symbol.The altitude to one decimal place of a metre is shown by a textual description.



Survey Instruments

As technology has moved on, the type of survey instruments used by Ordnance Survey have changed dramatically over the years. This is worth remembering when one considers that the map being used in the registration process might be derived from data captured within the last few days – or from 100 years ago!

Graphic Survey



The basic principles of graphic survey have remained the same for decades, and even over the last forty years the only difference in simple ground measurement has been the phasing out of the "chain" and its replacement with a simple tape measure. Today, the basic tools of the trade for an OS field surveyor, for basic graphic infill revision, are a tape measure and an optical prism – or "popeye" as they are more affectionately known. Clearly a GPS kit is required for extensive areas of detail, particularly if these are classed as Category A units of change.

The biggest technological change in recent years has been the introduction of tablet PCs into which data is recorded in the field. Twenty years ago surveyors had to draw change onto plans printed on sheets of plastic which they carried around with them on lightweight sketching case – boards onto which the maps (around 0.8m sq) were taped. Back in the office the pencil work would be "penned up" in ink and then forwarded to Ordnance Survey HQ (OSHQ) for digitising. Gradually, digitising systems were devolved to the field offices themselves, and the digitised work would be sent to OSHQ overnight. In January 1998 the national roll out of the PRISM (Portable Revision and Integrated Survey Module) project was completed. All of Ordnance Survey's 450 surveyors were now using pen computers running PRISM data capture software to digitally capture topographic change on site. Ordnance Survey's 400+ field surveyors currently use Fujitsu Siemens FT 3400 or FT3500 tablet PCs running Windows 98 and PRISM (portable revision and integrated survey module) software from Edinburgh based Tadpole-Cartesia. Around 5,000 new and changed map features are captured and forwarded to OSHQ each day.

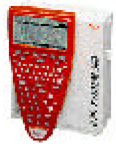
PRISM is based on the Conic software developed by Tadpole Cartesia. Development has continued since its introduction; the emphasis now being on exploiting the potential of the system to increase efficiency. The latest changes see the evolution of PRISM from a field data capture tool specialising in ground survey techniques to a topographic editor, linking to the latest survey devices. The "topographic editor - polygon version" is the first edit/update system that maintains topology and it is now used as the main topographic editor tool throughout Ordnance Survey, both in the field and in the office. Ordnance Survey has undertaken the huge task of converting its entire large-scale digital archive to a seamless, polygon-based dataset. As a result an edit/update system that maintains the data as structured polygons is required. With the introduction of OS MasterMap new demands are being put on this technology and Ordnance Survey is currently (May 2004) in the process of upgrading to MicroSoft Windows XP Tablet PC edition and a new Field Object Editor based on ESRI software and adapted by Tadpole. PRISM enables and facilitates the transition to the new logical structured dataset because it has been developed so that the user is largely unaffected when it comes to the field capture process. The Tadpole development team have implemented the complex polygon structuring and TOID maintenance rules while maintaining the existing user level functionality. As a result PRISM now works by applying the rules at the polygon or real world feature level while editing is carried out at the simple line or point feature level. The redundancy of legacy systems from Ordnance Survey field offices meant that the office-based functionality of printing, plotting and digitising also had to be integrated into PRISM. The Conic product already had a plotting interface, PlotView, which was readily adapted to fill the printing requirements. A simple digitiser interface was also developed. Different plot templates can be designed to suit the different requirements of user groups throughout the organisation. PRISM also has a total station, laser rangefinder and GPS interface. The strategy used to implement the interfaces is intended to future proof PRISM and enable exploitation of advances in positioning systems, such as the Ordnance Survey Active GPS Network. A simple import routine even allows rectified orthophotographs to be displayed as a backdrop to the vector map data.

Changes to the central Ordnance Survey National Topographic Database will mean that data will be controlled by a transaction management system from Tadpole, enabling multiple user access instead of the single user access, as at present. The significance of this for registration work is that the Ordnance Survey field office should always be able to access the required data for survey work, rather than have to wait its turn if the data is being used elsewhere in Ordnance Survey.

GPS

Along with the field tablet PC and PRISM software the introduction and development of GPS has been the biggest technological change in Ordnance Survey's field data capture in the last decade or so.

In particular the development of the National GPS network, described in more detail later in this reference guide in the section "Ordnance Survey – Current Issues", has enabled centimetre accuracies in real time (i.e. without post-processing) which has had a tremendous impact in terms of accuracies and economies of survey.

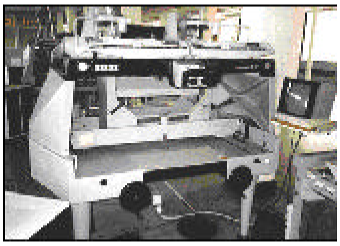


After an 8-month pilot project to investigate the use of different systems, beginning in 2000, Ordnance Survey chose the Leica System 500 GPS kit. Four field offices throughout Great Britain were selected to carry out this pilot project and one of the aims was to investigate different ways of collecting data using the new kit such as using it in conjunction with a short range laser measuring device – a Leica DISTO. Today all OS surveyors using Leica System 500 GPS are now equipped with a DISTO. Another aim of the pilot project was to find out if the quantity of data collected using the new kit increased over the more traditional methods of collecting data. (traditional methods include taping and total stations for example). The ultimate aim of the pilot project was to gauge potential efficiency gains and to determine the changes in working procedures that would have to be followed by surveyors using the new equipment. Using the field tablet PC and PRISM software the surveyor can view the map of the area in which he is working as he/she works. He can then survey the new features - roads, buildings etc, updating and creating the new map as he works. The System 500 sensor sends the surveyed coordinates to the tablet computer. The tablet computer is mounted on a pole and the surveyor uses a "pen" to operate the software and to update the map. The Prism software uses the signals received to give the necessary co-ordinates to the locations of features on the map. At the end of the day, this updated map is uploaded back into the National Topo Database. The normal Leica TR500 Teminal is not used by the surveyor, instead the tablet computer runs "Terminal Emulator" software which has been specifically developed for Ordnance Survey.

Photogrammetry

Ordnance Survey revises around 30 000 maps a year using aerial photography. In some surveys up to 80% of ground detail is collected using aerial photography. Specially modified aircraft mounted with sophisticated cameras fly over the designated area. Each photograph (approximately 23 cm by 23 cm) overlaps the next by 60%.

When developed, two adjacent prints are viewed through the binocular eyepiece of a stereo-plotting machine. Because of the reaction of our eyes and brain, the image appears in 3-D. A floating mark in the eye-piece, represented by a black dot, can be manipulated to trace detail onto the survey document which is then returned to the surveyor for the addition of detail not recorded by the camera.



Because of the stereo effect it is also possible for accurate measurements to be taken from individual features. Corrections have to be made for the roll and tilt of the aircraft.

This is achieved by having the extract orientation (the relative position) of the aircraft recorded on each frame as it is exposed. It is also possible to calculate the relative heights of ground detail, above or below a Mean Sea Level, thus recording the information needed for contours that appear on some maps.

From a user point of view, bearing in mind the use of Ordnance Survey mapping for land registration, it is worth bearing in mind that a great deal of current mapping is derived from aerial photography, that there are some problems in being able to adequately view ground surface level on some parts of the photograph, and that only a limited amount of the survey will be given a thorough ground check.

OS MasterMap Imagery Layer

The Imagery Layer of OS MasterMap has been created from high-quality aerial photography and provides a detailed aerial map of Great Britain. This is different from the photography used for basic scales revision but is mentioned briefly here to complete the picture regarding Ordnance survey's use of aerial photography.

The imagery has been compiled from a number of sources, with contractors having to submit data to stringent criteria to ensure a high uniform standard over Great Britain. All the Imagery Layer images have been fully orthorectified, which means that the height distortions have been removed, to represent truly and accurately what is on the ground. Ordnance Survey has selected the best available photos at 25cm resolution and 24 bit colour and corrected the positional and geometric distortions arising through the camera's position relative to points on the ground and through variations in height on the ground surface. Although only a limited percentage of the country is currently available Ordnance Survey plans complete national cover of the imagery layer.

Ordnance Survey Pre-build data

This section about survey methods and practice would not be complete without a brief mention of pre-build data – as this is another form of data capture which is becoming increasingly important to Ordnance Survey. Pre-Build data is derived from plans of sites under development that are supplied to Ordnance Survey by external sources such as architects and construction engineers. The finalised plans are received by Ordnance Survey after planning approval by the local authority planning office, so confidence is high that the data represents what the developers will build, usually within the next three months. The data is edited, transformed to its National Grid position, and brought in line with Land-Line specification. Currently, this method of update is accounting for around one third of new features captured and as much as two thirds of new housing (typically from large new housing estates)

Key points from this section

- Basic scales mapping represents real world features in digital format; the representation is based on certain basic principles, subsidiary principles, guidelines and specification;
- Survey methodology is constrained by the problem of representing a curved surface on a flat plane – within a geodetic framework;
- Historically this framework was provided by triangulation, minor control and traversing. Today the framework is dictated by a GPS network of control, both continue the principle of working "from the whole to the part";
- Survey is done graphically, on the ground using GPS, or photogrammetrically. Choosing which methods involves many factors including where the new detail is, relative costs, available resources, urgency, quantity of changed detail, topography and health and safety;
- Change is measured in standard "house" units;
- All features which are expected to remain in position for more than 10yrs, and are over certain minimum size criteria, will be shown. There are a number of exceptions such as small features which are prominent or important for some reason e.g. they have a Bench Mark;
- Graphic survey is still done using an optical prism and tape measure – but features are recorded directly in electronic form in the field using PRISM tablet PC and data recording software;
- GPS has revolutionised data capture in the last decade or so – with increasing accuracy and economy possible;
- Photogrammetry is the method used to capture very large areas of rural mapping, often by contractors. It is very economical but has some limitations in terms of field completion.
- An increasing amount of new map detail is being supplied by builders, using their site plans. Approximately one third of new detail is being captured this way and around two thirds of new housing.