

Digitising the Inter-War Land Use Survey of Great Britain: Scanning and Geo- referencing Project

A project funded jointly by DEFRA and the Environment Agency

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Executive Summary

- During the 1930s, the Land-Utilisation Survey (LUS) of Great Britain, directed by Professor L. Dudley Stamp, created a detailed record of the major land uses in England, Wales and southern Scotland. They published this information on a set of 169 map sheets, 135 of which cover England and Wales, using Ordnance Survey 1" maps as a base, and displaying land uses via a colour overlay:



- The Ordnance Survey's copyright in the 1920s base maps has long expired but copyright in the land use data belonged to Stamp and lasts for 70 years from his death in 1966. **Stamp's copyright passed to his assistant, Audrey Clark, who has given written permission for the maps to be used in a not-for-profit project providing public access to the data.**
- **This report describes a project to source, scan, geo-reference and disseminate a full set of the (170) published LUS maps of Great Britain.**
- Given the variety of conditions of the paper maps, as well as the colour variation between maps caused by the number of different printers used by the Survey, the best approach has been to source sheets from different libraries and organisations.
- Scanning and geo-referencing of the maps has been successful, despite the lack of a printed grid and coordinate system on the maps. The lack of printed coordinates has been overcome by using an existing, out of copyright, geo-referenced series of scanned maps to geo-reference LUS maps.
- Geo-referencing the LUS maps enables them to be overlaid on modern spatial data products such as the CEH Land Cover Maps.
- The original scanned material and geo-referenced scans have been written to DVD and deposited with both the Environment Agency and DEFRA.
- The maps have also been made freely available to anyone via a Web Map Server at http://www.visionofbritain.org.uk/phase2/demo_init.html. This will soon change to a more stable address (<http://www.visionofbritain.org.uk>).
- The use of Open GIS Consortium standards means that the maps can also be accessed and used by other Web Map Servers, allowing the display and integration of the LUS maps with data sets from other organisations.

Introduction

This report describes the results of a project to digitise a full set of published maps of Great Britain, created and published by the Land Utilisation Survey of Britain in the 1930s and 1940s. In spring 2003, a pilot study was undertaken by the Great Britain Historical GIS Project to investigate digitising and disseminating these maps, including developing a methodology to extract land use classes to produce a digital vector map of Great Britain (Southall et al, 2003). The result of the pilot study led to the identification of two distinct phases of further digitisation projects.

- Source, scan, geo-reference and disseminate a set of maps of Great Britain
- Extract systematic land-use information from the scanned and geo-referenced imagery

This report describes the results of the first of these two phases. The second phase is a much larger project for future consideration.

The first part of the report covers the available data. Although covered comprehensively in the Pilot Study it is worth reproducing the text here along with further details uncovered during this project. Its main concern is the 1930s Land Utilisation Survey of Britain directed by Professor L. Dudley Stamp (later Sir Dudley) of the London School of Economics (hereafter called simply the ‘Stamp Survey’), but it more briefly covers the Second Land Utilisation Survey of the 1960s, directed by Alice Coleman of King’s College London (the ‘Second Survey’). We outline how the surveys were carried out, and then provide more detailed information on what materials now exist and who owns copyright in them.

The remainder of the report describes the methodology that has been used to computerise and disseminate the 1930s Land Use Survey’s maps. It describes the sources of the maps and then the methodology for creating, geo-referencing and making available on-line the resultant digital imagery.

1: The Land Use Surveys

There has recently been some interest in the place of land use mapping within the intellectual history of British geography (Rycroft and Cosgrove, 1995; Rycroft and Cosgrove, 1999). However, our own main concern is the actual data created by the surveys: the field survey data, various compilations from them and the published maps. Although our initial assumption was that these materials and copyright in them would be held by institutions, it became clear that much belonged to individuals involved in the projects, and significant materials are currently in private houses. Contact details are included in Appendix A.

1.1 The Stamp Survey

This outline history of the Land Utilisation Survey is largely based on the account in the first chapter of Stamp’s *The Land of Britain, Its Use and Misuse* (1948, and later editions). The origins of the Survey lay in earlier work supported by the Geographical Association, but these were all on a very local scale. Following earlier work in Burma, Stamp joined the London School

of Economics in 1926, and in 1929 began to plan a national land use survey to be carried out primarily through local schools. In 1930, he obtained a grant (£500) from the Rockefeller Foundation for a pilot project covering Surrey. He obtained support from local education authorities and particular government departments and agencies, such as the Ministry of Agriculture and the Forestry Commission, but this was not an official survey.

Work was organised by administrative county, the first contact usually being with the Director of Education. Arrangements were in place for most English counties by the summer of 1931, and for most Welsh and Scottish counties a year later. The first of the resulting 1" maps was published in January 1933. By the autumn of 1934, 90% of the field survey maps had been returned, but two problems were emerging. Firstly, it proved impossible to find local volunteers for many areas and the Survey had had to organise university students and its own staff to fill the gaps; the very last area to be surveyed was part of the Isle of Arran in September 1941, all other areas being completed before the outbreak of war. The second and more serious problems was funding the publication of the maps: disagreements with the Ordnance Survey over the cost of printing a single sheet, and with Durham County Council over a verbal order for maps, led to the Survey becoming insolvent in September 1934. New funding was obtained from the Pilgrim Trust, but one of the project's staff had to fund publication of a map she had worked on herself, and in June 1936 Stamp signed an agreement with the LSE in which he took on 'complete personal responsibility for the finances and conduct of the survey' (Stamp, 1948, p.12).

The practical consequence of this tortured history was an extremely delayed and complex publishing programme. The first nineteen sheets were printed for Stamp by the Ordnance Survey, but early in 1935 the OS complained that printing the land use maps was straining their resources. From then on, the OS supplied the 'base plates' (black, contours and water) for printing, and took a royalty of £1 per 100 maps sold. Between 1935 and 1949, the remaining sheets were produced by eight separate printers. Between 1935 and 1942, most maps were printed by G.W. Bacon & Co., and when the LSE was evacuated at the outbreak of war this firm provided the Survey with temporary office space. However, in May 1942 their works was completely destroyed in a German raid and the Survey lost all its office records, its main stock of printed maps and nearly all printing plates. Thereafter, printing work was shared between Stanford's and W. & A.K. Johnston. Obviously, this history means that the available maps may vary, especially in their colours, not only because of differing amounts of wear and tear but because of variations in printing methods, paper and inks.

The Second World War did, however, bring greater official support for the Survey. The emergency County Agricultural Committees were loaned the six-inch field sheets, and an annual Treasury grant of £1,500 funded publication of the remaining maps. In 1942, Stamp was appointed Chief Adviser to the Ministry of Agriculture on rural land utilisation, and in practice the Survey and some of its staff were absorbed into the Ministry's new planning branch. In 1943, the Scottish Departments of Health and of Agriculture funded publication of twenty-one maps covering the more populous parts of Scotland. Government funding ended in late 1945. The remaining sheets for England and Wales all appeared in 1946. Further sheets for Scotland appeared between 1947 and 1949, but sheets covering northern Scotland were compiled and placed in the Royal Geographical Society collection, but never published.

In all, the Land Utilisation Survey published 135 maps of England and Wales, an additional 35 of Scotland, and 92 County Reports (see below). The total cost of the survey was £52,918, of

which £33,729 was printing costs; Stamp noted that the cost would have been far greater had staff been paid at market rates. The survey's total income was £40,716, of which £3,000 came from the Pilgrim Trust, £4,242 from the Rockefeller Foundation, £11,000 from the Treasury during the war, and £18,855 from sales. How the net loss of £12,201 was absorbed is unclear, although the LSE wrote off all losses up to June 1936.

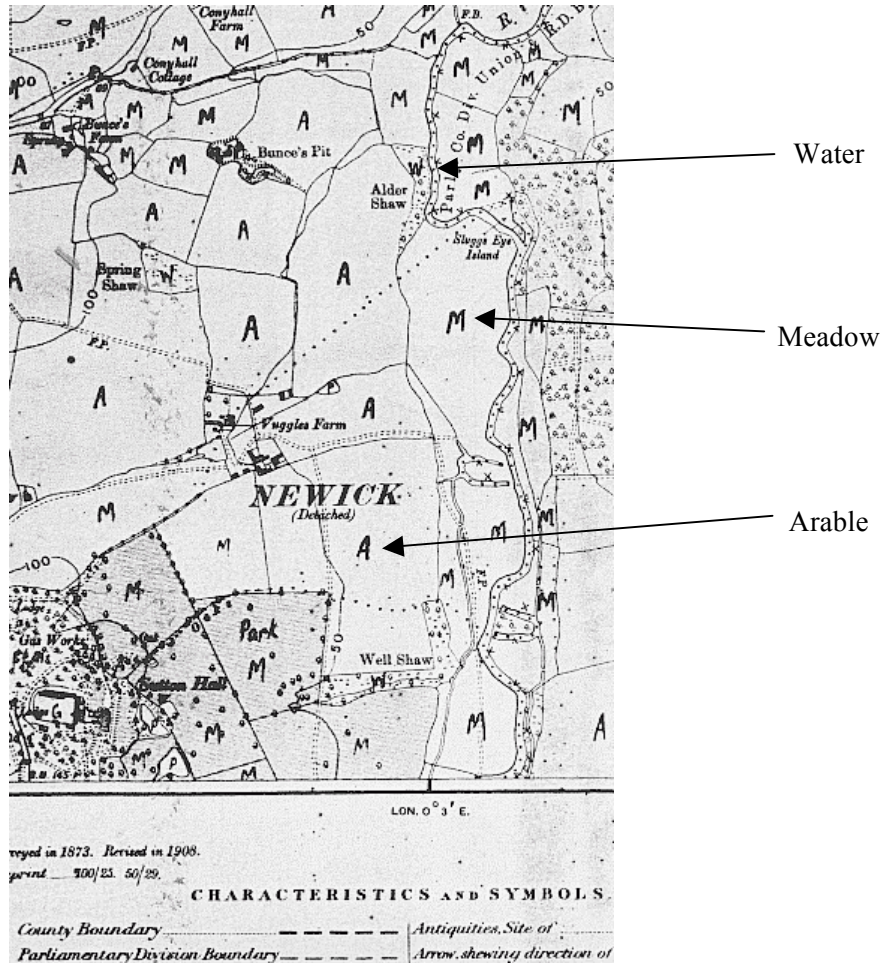
Northern Ireland: Although Stamp's Land Utilisation Survey was limited to Great Britain, a separate survey of Northern Ireland was carried out in 1937-9, organised by the Geographical Association (N. Ireland) with Douglas Hill as honorary Director. This published a set of eleven sheets at 1:63,360 scale in 1947-51, using an OS 1" *Popular Edition* base map.

1.2 Surviving Materials

These are described in order of creation:

Field survey maps: A substantial fraction of the original field maps, as sent back by the schools participating in the survey, are still held by the London School of Economics. They were originally stored in the Geography department, but were moved to the main library in 1979; in May 2003 they occupied about 60 map cabinet drawers in a closed area of the library basement, made particularly inaccessible by nearby building work. These sheets are OS six inch to the mile maps; one example came from an edition published 1919-20, another was originally published in 1902. The Survey rubber stamped each sheet to create a small form on which the name of the surveyor, the month and year of the survey but not, usually, the institution. The majority of surveyors recorded land use by simply adding letter codes, as in figure 1, and their sheets therefore contain no information that does not appear in more easily used form on the published LUS maps. However, about 40% of the sheets were also coloured by the surveyor, and some include additional marginal notes, so providing more detailed land use information which does not appear on the published maps. Note that for some counties, the LSE held only Photostats, the originals being returned to the relevant education authority.

Figure 1: Sample Field Survey map from the Stamp Survey



Unfortunately, a large number of these maps were destroyed by a fire started during student protests at the LSE in 1969. The whole of Hampshire, Herefordshire, Hertfordshire, Kent, Lancashire and Leicestershire was lost, and no county is complete with the possible exception of Rutland. Other sheets may have been ‘borrowed’ by LSE staff, and some sheets requisitioned by County Agricultural Committees during WW II may not have been returned. Black and white microfilms of all surviving sheets were made immediately after the 1969 fire but these seem to have been lost.

Colour separations: Samples of the colour separations used in printing the Stamp maps were preserved by Christie Willatts, Stamp’s deputy, who died relatively recently. These are now held at his home by Dr. Board, who is willing to be contacted about them.

Published ‘One Inch’ maps: The principal output from the Stamp Survey was, as already discussed, a set of 170 1” maps, over-printing land use information onto reproductions of the Ordnance Survey’s *Popular Edition* maps. This report contains several samples from these sheets, while a detailed study of the base maps is provided by Hodson (1999). The individual sheets are listed in Appendix B. England and Wales is fully covered by 135 maps and Scotland is partially covered by 35 maps.

Unpublished ‘One Inch’ maps of Scotland: Approximately 57 hand-coloured sheets covering rural areas of Scotland were compiled and placed in the Royal Geographical Society collection, but never published. Copies of these have since been made and are in the National Library of Scotland. Progress has been made towards arranging to have these unpublished maps scanned and geo-referenced but has not been carried out in time for the completion of this project.

Published ‘Ten Inch’ maps: Summary sheets at ten miles to the inch or (very similar) 1:625,000 were prepared during the war by the Ministry of Town and Country Planning, under the direction of Christie Willatts, Stamp’s deputy who had become their Research Maps Officer. Four distinct maps were published, each covering Great Britain in two sheets:

- Land Utilisation
- Land Classification
- Types of Farming
- Grasslands (of England and Wales) and Vegetation (of Scotland)

The Land Utilisation pair of maps have been digitised and geo-referenced as part of this project, to provide a high level overview of land-use when zooming in on the larger scale maps in a GIS or the web map server. More information about ‘ten mile’ planning maps is given by Hellyer (1992). See also Oliver (1992) for an overview of published land use maps.

The Land of Britain: The Stamp Survey also published a national overview (i.e. Stamp, 1948) and a series of 92 reports each covering one of the Administrative Counties of England, Wales and Scotland in between 40 and 200 pages; unlike the published maps, coverage of Scotland is complete. These reports were available individually and as a set of nine bound regional volumes. Each describes the work of the Survey in the relevant county; its geology, relief, soils and climate; the distribution of each land use; and a detailed description of ‘land use regions’ within the county. They also report special investigations by the particular author, which generally include processes of historical change.

1.3 Copyright

Dudley Stamp was very clearly the principal author of the maps published by the Land Utilisation Survey, so under current law copyright on the maps will last for seventy years from his death on August 8th 1966, i.e. until 2036. The Ordnance Survey would have held an additional copyright in the maps when they were first published, but as Crown Copyright lasts for only fifty years from the date of publication this is no longer an issue.

Any project to digitise the Stamp maps clearly depends on the agreement of the copyright holder. The maps themselves do not include a copyright notice, but they were in fact published by Geographical Publications Ltd, a company established for the purpose in which Stamp himself was the principal shareholder (the company’s role is clearer in the books published by the Survey). Under Stamp’s will, a copy of which is held by Will Pilfold of Sussex University, his shares passed to Audrey Clark, his long time secretary/personal assistant. Geographical Publications was wound up in September 1993. However, Dr. Southall was able to speak to Audrey Clark (now aged 82) by telephone on May 12th 2003, and she confirmed that the copyright was transferred to her personally before the company was wound up.

In the same conversation, Mrs. Clark said she was happy for the maps to be used in a not-for-profit project which made them publicly accessible. This extremely generous offer has since been confirmed in writing. She explained that she has arranged for the copyright to be inherited by her son Giles Clark, who works for the publishing arm of the Open University. Dr. Southall has also discussed the situation with him, on July 1st 2003, and he was integral in the drawing-up of a formal agreement. This agreement is in the form of a non-exclusive Electronic Publishing License permitting the Environment Agency and DEFRA to scan, encode, store and publish the results for non-commercial, research and educational use.

1.4 The Second Land Use Survey

The Second Land Use Survey, directed by Professor Alice Coleman and again based in the Joint School of Geography of the LSE and King's College London, aimed to build on the experience of the first and employed a broadly similar geography, including the use of schools. In a number of respects, however, it was more ambitious: more detailed land use information was gathered, and they planned to publish the results at 1:25,000 rather than at one mile to the inch. The survey was launched in 1960 and survey work was half complete by 1963. Their survey of England and Wales was completed, but only 110 (15%) of the maps, each covering 200 km², were published. Two different printers were used.

Figure 2: Second Survey Colour Conventions

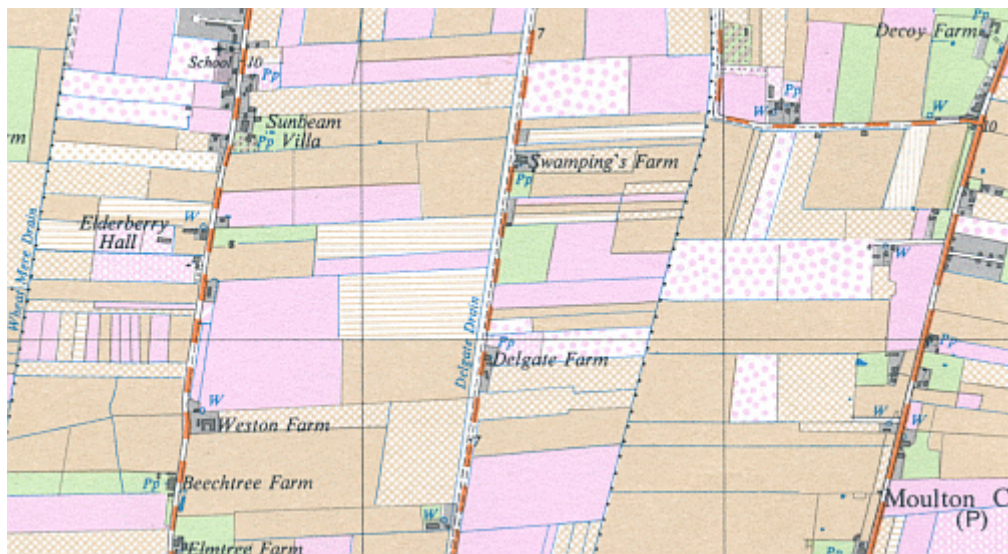


They recorded 70 different land uses. Figure 2, taken from Coleman and Shaw (1980, pp. 38-9) provides a key for 55 of them, printed using 11 colours. Rather than the Stamp Survey's classification of agricultural land primarily into just arable and pasture, they identified types of crop in some detail. Figure 3 below provides two contrasting samples from the published maps,

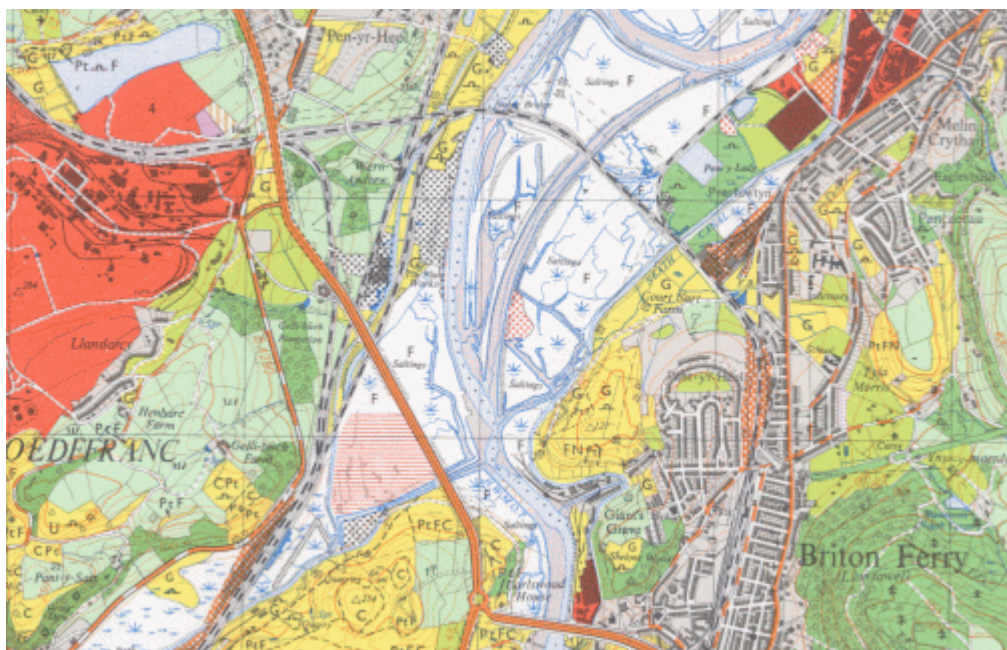
and the greater detail compared to the Stamp survey is obvious. There are two reasons for suggesting that the work of the Second Survey is of interest despite the partial coverage:

Field Sheets: The original survey sheets exist for the whole country, at 1:10,000 scale, and were produced to a substantially higher standard than those of the Stamp Survey. They record 250 uses rather than 25 and, possibly crucially, the major uses were shown by colouring in areas rather than by pencil symbols; surveyors were required to use fifteen specific pencils from the ‘Lakeland Derwent’ range (Coleman & Shaw, 1980, p.11). There may therefore be some basis for automated extraction of data from the field sheets, although particular types of crop or farm animal are indicated by text, not colours.

Figure 3: Samples from Second Survey 1:25,000 sheets



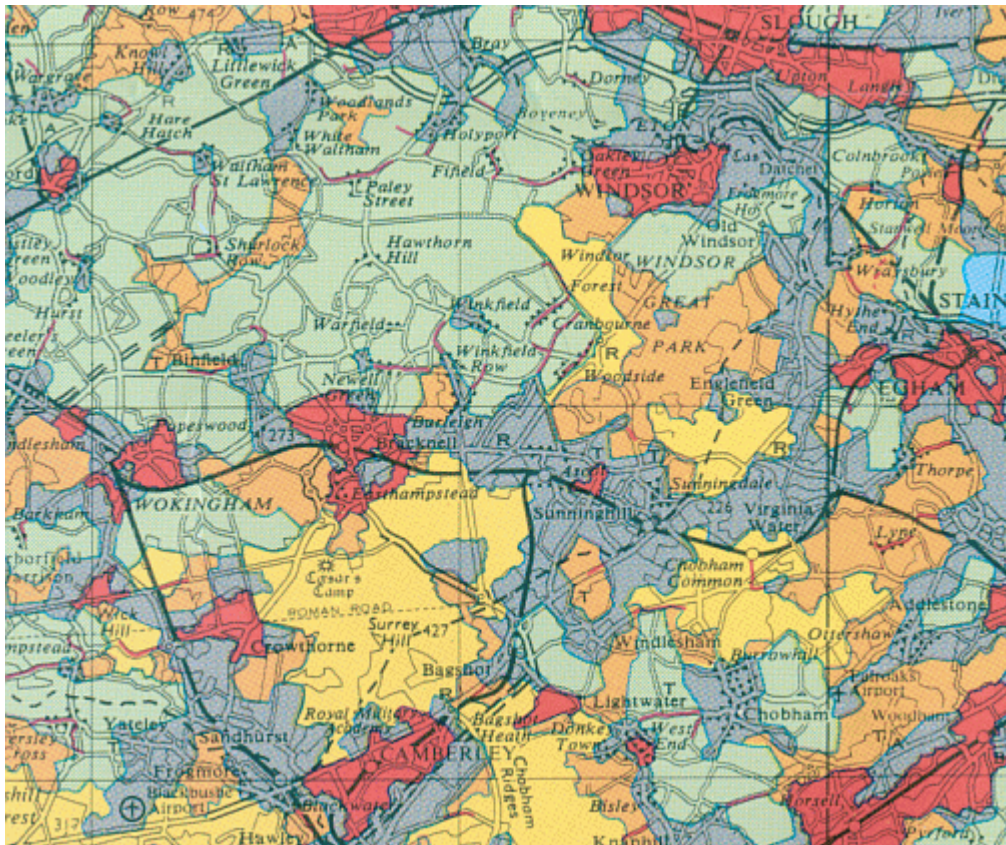
(a) Rural fenlands



(b) Briton Ferry, near Swansea

‘Scapes and Fringes’ maps: Although only a fraction of the 1:25,000 maps were published, the Second Survey **did** publish a map of the whole of England and Wales (Coleman *et al*, 1992). This map, at 1:400,000 scale, summarises land use as four ‘scapes’ and two ‘fringes’: *Townscape*, *Farmscape*, *Wildscape* and *Waterscape*, plus *Rurban Fringe* and *Marginal Fringe* (generally between Farmscape and Wildscape). Each ‘scape’ was a pattern of uses, not just an amalgamation of similar uses, and although classification was manual it followed very systematic principles, described in detail in the accompanying booklet. In particular, specific areas were included or generalised away using threshold sizes, and these were such that individual airfields are identifiable as ‘Rurban Fringe’ within farming areas. The result is arguably not dissimilar to the automated generalisation carried out in our own experiments with the Stamp Survey maps. Although the published ‘Scapes and Fringes’ map is at 1:400,000, the compilation sheets at 1:100,000 have been preserved. Figure 4 shows a sample from the published map covering roughly the same area as the Bracknell study area used in our pilot analysis of the Stamp maps (Southall *et al*, 2003).

Figure 4: Second Survey ‘Scapes and Fringes’ map



Access and copyright: Copies of published Second Survey maps are available in various libraries, and we were given some surplus copies by King's College. All the unpublished material assembled by the Survey is now held by Professor Coleman in a second house adjoining her own in Dulwich, south London (see Appendix A). Published 1:25,000 maps are available for £4 per sheet, and unpublished 1:10,000 maps may be consulted for a fee. The 'Scapes and Fringes' sheets are available as a pack, including a 98-page book detailing the method of classification, for £30 and a copy was bought for the pilot study.

Professor Coleman is unquestionably the principal author of the Second Survey maps, and is still actively running the project. She is clearly disappointed by the lack of official support for her work, has invested a substantial amount of personal funds in the project, and would expect significant payment for any computerisation project. This in itself means that any immediate project should clearly focus on the Stamp Survey. She expects that in the future the material gathered by the Second Survey will be looked after by her family.

1970s re-mapping: The Second Survey re-mapped Buckinghamshire, Merseyside and Surrey, and isolated other sheets, in the 1970s. Field maps are available in Dulwich.

1.5 The 'Land Use UK' Survey, 1996-7

A third survey was conducted by the Geographical Association in the 1990s, under the leadership of Dr. Rex Walford of Cambridge University as National Secretary. The survey work was carried out by school pupils working to a detailed brief in a specially published survey handbook. However, unlike the earlier surveys and with the exception of one specific region, the data was collected by using a stratified sample of 1000 1 km square units, so no overall map of the country was produced. Nevertheless, this might provide an interesting benchmark, using essentially the methodology of the Stamp and Second surveys to gather data for a period when satellite imagery is also available. The results of the survey are reported in detail in Walford (ed.), 1997. Dr. Walford has advised us that the data sets are kept in an archive at the Geographical Association's offices in Sheffield.

2: Sourcing maps for scanning

The Survey printed only 1,000 copies of each sheet, many were clearly lost in the war and the remainder are probably mostly held in libraries. It was therefore unlikely that we would be able to purchase a complete set of maps in truly excellent condition.

The aim of sourcing the maps was to create a complete set of scans using maps in the best possible condition during the time available to the project. The variation of colour within the maps, although important for any future project concerned with extraction of land use classification, was not of primary concern due to the wide variation in colour caused, not by mistreatment of the maps, but by the use of at least eight different printers during their original publication. Instead, it was deemed important that the map should just be as clean a copy as possible with little internal variation in colour.

The best possible set of image scans of the LUS 1" sheets had to be assembled via more than one route:

Purchase of second hand sheets: The project team and, independently, the Environment Agency were directed to David Archer as a very experienced dealer in Ordnance Survey maps. In March 2003, he was able to supply the Agency with 68 sheets for England and Wales, 22 of Scotland and 6 of N. Ireland, at prices varying between £10 and £12 per sheet. Of these 96 sheets, 85 (88%) were graded as in ‘very nice condition’, but the quality of some seemed problematic.

Scanning of copies owned by map libraries: Due to the condition that the resulting scanned digital maps are to be made publicly available on-line, many map libraries have been keen to assist in providing maps for scanning and/or scan maps themselves for the project at a reasonable cost. Unfortunately, despite the assistance of many organisations, their collections are often worn or contain duplication.

In summary, the sheets for England and Wales have been obtained from the following libraries and organisations:

- National Library of Scotland 63 sheets
- Environment Agency 76 sheets
- University of East Anglia 10 sheets
- University of Portsmouth 9 sheets
- University of Surrey Roehampton 9 sheets
- plus the two 10 mile-to-the-inch index sheets)
- University of Sussex 2 sheets

The source for each sheet is listed in Appendix B. In addition to these institutions, the project also had offers of assistance from Liverpool University, the London School of Economics and the Royal Geographical Society.

3: Image scanning

3.1 Resolution: Within the library and archiving sector, it is generally agreed that when scanning material, in order to convert an important collection into digital form, the material should be captured at a resolution of at least 300 dots per inch (dpi) and at a colour depth of 8 bits per channel (24 bit colour). Any increase of resolution above 300 dpi is usually determined by the storage capacity available to the project, the physical size of the material, and the printing and dissemination techniques applied to the subsequent imagery. There is also a threshold to resolution where any further increase will not yield a noticeable improvement in quality.

Given the level of detail and physical size of the map sheets of the Land Utilisation Survey (LUS) it was decided that the maps should be scanned at 400 dpi, 24 bit colour.

3.2 Working resolution: Although 400 dpi, 24 bit colour is required for archive purposes, it was considered that this resolution is not required for the imagery that is geo-registered for use within a Geographical Information System or for presentation within a Web Map Server. Therefore, the resolution of each scan has been reduced to 300 dpi, 8 bit colour. This has reduced the storage size of each of the 170 scans to around 50 Mb, a more manageable size for the display of multiple images.

3.3 Scanning: Digitising has been undertaken using Contex A0 sheet-feed scanners. These are quick to use but have the disadvantage of not being appropriate if the original material is considered to be very delicate as the maps are fed through the scanner using rollers. The National Library of Scotland scanned 63 sheets using their own scanner whilst the rest were scanned by the project team using a scanner loaned by English Heritage's Centre for Archaeology.

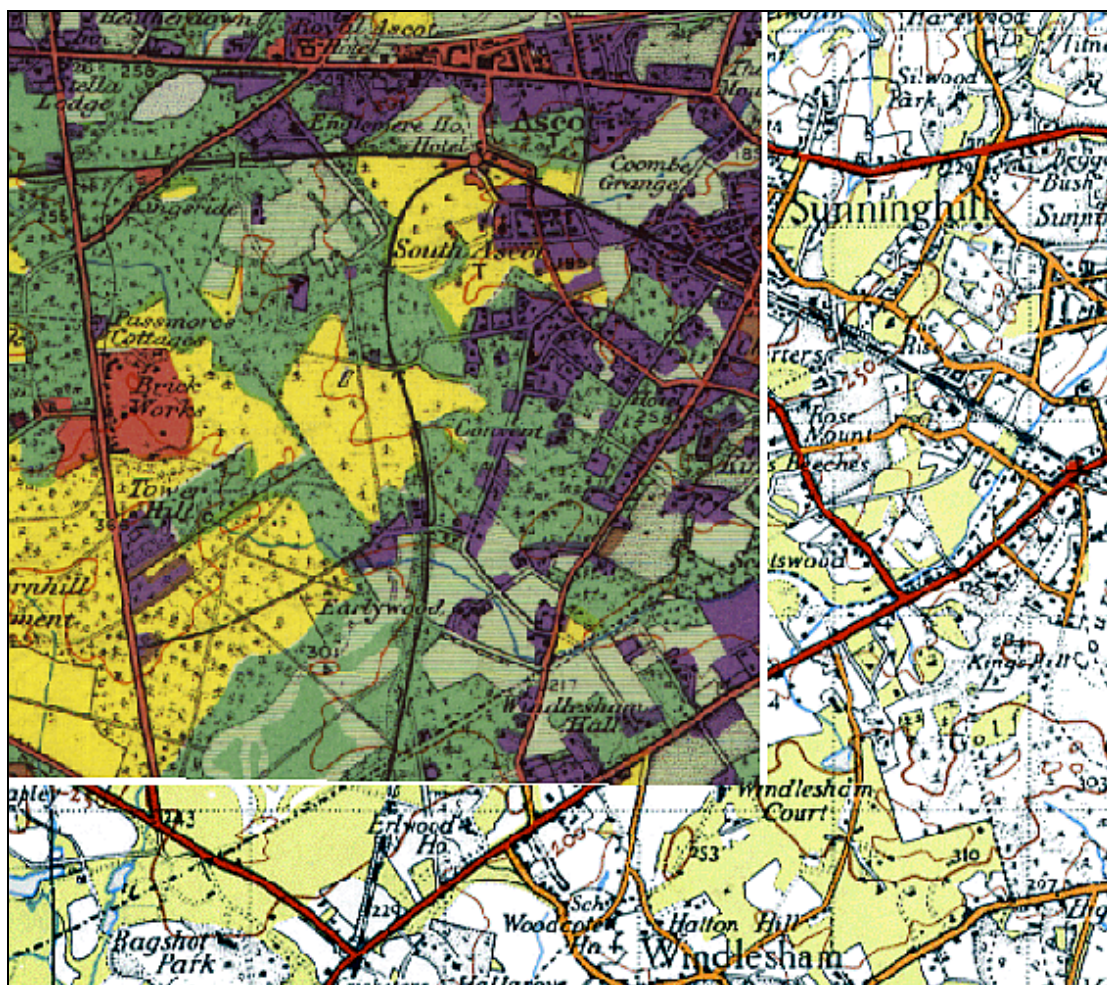
3.4 Storage: At 400 dpi, 24 bit colour, each image is approximately 310 Mb uncompressed, meaning that the total storage requirement for the raw scanned material for Great Britain is 53 Gb. A single DVD can typically store approximately 12 maps. Each 300 dpi, 8 bit colour, image is approximately 50 Mb in size meaning that the total storage requirement for the geo-referenced material is approximately 6.8 Gb or 2 DVDs.

The scans have been stored on DVD and backed up on tape. All the material has also been supplied on DVD to the Environment Agency and DEFRA to accompany this report.

4: Geo-referencing

The digital files of the scanned maps do not contain any systematic information as to where the area represented on the map is located on the ground. This means that it is not possible to view, query or analyse the data with other geographic data, or indeed with any other of the scanned maps.

Figure 5: Part of a geo-referenced LUS map overlaid on a New Popular Edition map. The latter has been used to geo-reference the former



In order to create this functionality it is necessary to align, or geo-reference, the image to a map coordinate system, in this case the GB National Grid. Maps containing a printed grid are simple to geo-reference as it is possible to click on an intersection of the grid and type in the coordinates for that point. However, the LUS maps have no grid and therefore prominent landmarks must be used whose coordinates one could go out and survey or that can be identified on another, already geo-referenced, source. Using the latter approach it is possible to geo-reference a map by clicking on four or more landmarks within the LUS image, such as churches or road junctions, and then click on the same four features within an already geo-referenced map such as those that can be obtained from the Ordnance Survey.

One large disadvantage of using a product from the Ordnance Survey to geo-reference the LUS images is that the resulting combination of information would probably be regarded by the OS as a 'derived work' in which they held a copyright, and could control dissemination. Fortunately, the GBH GIS project have already created a complete set of geo-referenced 1"-to-the-mile maps that contain grid lines but were published more than fifty years ago, and are therefore free from OS copyright. These New Popular Edition maps from the 1940s have therefore been used as the source of coordinate information for geo-referencing the all of the LUS maps.

Using Adobe Photoshop, each scan has had its resolution reduced to 300 dpi, 8 bit colour. Next, the image is cropped to remove the margins of the map, leaving only the map itself. This is so that once geo-referenced, maps can be displayed contiguously without the margins and legend of one map obstructing the detail of its neighbouring sheet. Once saved, the image is opened using ArcGIS, a GIS package. A corresponding, previously geo-registered, map from the OS New Popular Edition is then opened up so that both are displayed on screen. It is then possible to click on common features in both the maps, transferring the correct coordinates from the New Popular Edition map to the LUS map with each new reference point added. While this is being done the software calculates the Root Mean Square (RMS) error. This indicates the discrepancy between known point locations (those points identified on the New Popular Edition map) and their digitised locations on the LUS map, and is kept as low as possible, discarding any points that give large RMS errors.

Once finished, the LUS image is rectified to permanently transform the image into the new coordinate system, allowing it to be displayed in its correct location and integrated with other geographical information.

Known sources of error: As with the digitisation of most types of spatial material there are various sources of error. These include: initial data capture by surveyors; cartographic generalisation; printing; the instability of paper maps; the precision of the scanner; the accuracy with which the New Popular Edition maps were geo-referenced; and the accuracy with which the LUS maps were geo-referenced. These errors become most apparent when displaying sheets next to each other as, when zoomed in, there are often very small gaps between sheets, or slight overlapping. Despite best efforts to minimise errors and avoid this where possible, the amalgamation of errors means that these features can not be removed completely¹.

¹ Please note that if there are large gaps appearing between sheets when viewing them in a GIS package then this is not due to any error but not displaying the maps correctly. Please see the DVD readme file for details.

5: Dissemination

5.1 Formats: The formats used are intended to make the imagery as widely accessible as possible and have been chosen in consultation with DEFRA's Geographic Unit, and with consideration of the most widely used software products.

The 400 dpi, 24 bit raw scans have been stored in uncompressed Tagged Image File Format (TIFF or .tif).

The geo-registered images have been saved as GeoTIFFs. These are a similar format to TIFF except that the spatial reference information that allows the image to display at the correct location and scale is embedded within the file. In addition, each geo-registered image also has an associated 'world file' (.tfw). This can be used to display the image at the correct location and scale if the software does not support GeoTIFFs, or the GeoTIFF spatial information has become lost or corrupted.

5.1 Raw scans. As mentioned above, these have been stored onto DVD and passed to the Environment Agency and DEFRA as part of this report.

5.2 Web Map Server. The geo-referenced scans, as well as being stored on DVD, have been stored and disseminated via the Internet using MapServer, a Web Map Server (WMS). A WMS is a piece of software designed to deliver maps and other GIS content to the Internet along with tools which allow the user to query maps and navigate around the data. Because each sheet has been geo-referenced and superfluous parts of each map have been removed, what appears in the web browser is a single seamless LUS map for the whole of England and Wales.

Furthermore, additional layers can be displayed on top of these maps, such as vector coverages, or smaller scale maps included to provide the user with index maps for viewing larger areas of the country. The two ten-mile-to-the-inch land utilisation index maps mentioned earlier in this report have been scanned, geo-registered and included in the WMS for this purpose. This means that as a user zooms in to a particular area, they are presented with the smaller scale map and then, once zoomed in further, this map will disappear and be replaced by the larger scale 1" to-the-mile LUS maps.

One very important feature of the software used is that it complies with Open GIS Consortium standards for Web Map Servers. This means that the software is able to receive requests from other websites and serve the relevant portion of LUS map for display and integration with their geographic data and vice versa. This means that the Environment Agency and DEFRA can display the data within their website map servers (if applicable) through their website whilst the data is stored and served from only one location. It also means that the maps can be made to look integrated with their current websites as well as displayed with their existing data sets.

The maps are currently being stored in Edinburgh by EDINA for the Great Britain Historical GIS Project and is being served at the following location as part of the GBHGIS Map Library:

http://www.visionofbritain.org.uk/phase2/demo_init.html

Please note that, firstly, this will soon be integrated into the main GBHGIS website, <http://www.visionofbritain.org.uk> where it will be more stable, and secondly, all of these pages

are currently undergoing user testing and redesign by external consultants, including the map server.

Once in the map library a user can choose the option 'LUS maps' from the 'Select century' drop down menu and zoom in through the smaller scale maps until they are at an appropriate scale to view the LUS maps. Once at this scale the navigation map on the right can be used to move to other parts of the country. Finally, the query tool will display metadata about whichever sheet is selected in the map window.

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Appendix A: Individuals Contacted

NB: Home addresses not presented.

Name	Position	Address	Tel./E-mail
Beaumont, Roma	Map Librarian, Kings College, and former staff member on 2 nd Survey	Department of Geography, King's College London, Strand, London WC2R 2LS	020 7848 2802 roma.beaumont@kcl.ac.uk
Board, Christopher (Dr.)	Retired from Dept. of Geography, London School of Economics; has access to surviving materials from Stamp survey		
Cadge, Norman	Librarian, London School of Economics; responsible for surviving 6" field survey sheets	British Library of Political and Economic Science, London School of Economics, 10 Portugal Street, London WC2A 2HD	(020) 7955 7941 n.cadge@lse.ac.uk
Clark, Audrey (Mrs.)	Last surviving staff member of Stamp survey; copyright holder		
Clark, Giles	Son of Audrey Clark, and works in publishing; should be contacted re. copyright		
Coleman, Alice (Prof.)	Director and copyright holder, 2 nd Land Use Survey		
Herbert, Francis	Curator of Maps, Royal Geographical Society; holds Stamp Survey materials.	Royal Geographical Society, 1 Kensington Gore, London SW7 2AR	(020) 7591 3050 F.Herbert@RGS.org
Pilfold, Will	Sussex Univ. D.Phil. student researching the life and work of Sir L. Dudley Stamp	CulCom Graduate Research Centre, Essex House, University of Sussex, Falmer, Brighton BN1 9RH	H: (01273) 516309 william@wpilfold.freemove.co.uk
Walford, Rex (Dr.)	National Secretary to Geographical Association "Land use UK" project, 1996-97	Emeritus Fellow, Wolfson College, Barton Road, Cambridge CB3 9BB	H: (01223) 323519 raw1000@cam.ac.uk

The assistance of other map librarians and professionals is also gratefully acknowledged: Peter Barber (British Library), Tinho da Cruz (Liverpool University), David Sherren (Portsmouth University), Brian Attewell and Claire Jones (English Heritage, Centre for Archaeology).

Appendix B: Map Sheets published by the Stamp Survey

This checklist is taken primarily from Appendix IV of Stamp (1948), but has been re-ordered by sheet numbers in the *Popular Edition*. NB some of Stamp's maps contain parts of more than one *Popular* sheet, as indicated by the 'Oth.Sheets' column. 'Seq.' gives the sequence in which sheets were published within a particular year.

The 'Source' column indicates whose maps have been scanned (EA: Environment Agency; NLS: National Library of Scotland; UP: University of Portsmouth; ROE: University of Surrey Roehampton; US: University of Sussex; UEA: University of East Anglia). Three of the sheets cover parts of both Scotland and England.

Nation	Pub.Yr.	Seq.	Sheet	Oth.Sheets	Area	Source	Notes
E & W	1948-9	6	1		Lower Tweed	ROE	<i>Same sheet as Scotland no. 81</i>
E & W	1946	1	2		Holy Island	EA	
E & W	1947	1	3		The Cheviot Hills	EA	<i>Same sheet as Scotland no. 86</i>
E & W	1946	2	4		Alnwick & Rothbury	EA	
E & W	1948-9	11	5		Solway Firth & River Esk	UEA	<i>Same sheet as Scotland no. 89</i>
E & W	1946	3	6		Hexham	EA	
E & W	1936	1	7		Newcastle-upon-Tyne	NLS	
E & W	1947	8	8	pts 15 & 18	Workington & Cockermouth	EA	
E & W	1946	4	9		Carlisle	NLS	
E & W	1946	5	10		Alston & Weardale	EA	
E & W	1934	1	11		Durham & Sunderland	NLS	
E & W	1933	7	12		Keswick & Ambleside	EA	
E & W	1946	6	13		Kirkby Stephen & Appleby	EA	
E & W	1946	7	14	pt 15	Darlington & Middlesbrough	EA	
E & W	1938	1	16		Whitby & Saltburn	NLS	
E & W	1946	8	17		Isle of Man	UP	
E & W	1946	9	18	19	Windermere	NLS	
E & W	1947	2	20		Kirkby Lonsdale & Hawes	EA	
E & W	1946	10	21		Ripon & Northallerton	EA	
E & W	1938	2	22		Pickering & Thirsk	EA	
E & W	1944	1	23		Scarborough	EA	
E & W	1946	11	24		Lancaster & Barrow	EA	
E & W	1946	12	25		Ribblesdale	EA	
E & W	1945	1	26		Harrogate	EA	
E & W	1944	2	27		York	EA	
E & W	1940	1	28		Great Driffield & Bridlington	NLS	
E & W	1936	2	29		Preston, Southport & Blackpool	NLS	
E & W	1937	1	30		Blackburn	NLS	
E & W	1938	3	31		Leeds & Bradford	NLS	
E & W	1940	2	32		Goole & Pontefract	NLS	
E & W	1938	4	33	34	Hull	NLS	
E & W	1933	4	35		Liverpool & Birkenhead	EA	
E & W	1936	3	36		Bolton & Manchester	NLS	
E & W	1937	2	37		Barnsley & Sheffield	NLS	
E & W	1938	5	38		Doncaster	NLS	

Nation	Pub.	Yr.	Seq.	Sheet	Oth.	Sheets	Area	Source	Notes
E & W	1938	6	39				Scunthorpe & Market Rasen	NLS	
E & W	1942	1	40	48			Grimsby & Louth	NLS	
E & W	1944	3	41				Anglesey	EA	
E & W	1943	3	42				Llandudno & Denbigh	EA	
E & W	1937	3	43				Chester	NLS	
E & W	1935	1	44				Northwich & Macclesfield	EA	
E & W	1939	1	45				Buxton & Matlock	NLS	
E & W	1937	4	46				The Dukeries	NLS	
E & W	1940	3	47				Lincoln	UEA	
E & W	1944	4	49				Portmadoc & Criccieth	EA	
E & W	1944	5	50				Bala	EA	
E & W	1943	4	51				Wrexham & Oswestry	EA	
E & W	1938	7	52				Stoke on Trent	NLS	
E & W	1939	2	53				Derby	NLS	
E & W	1935	8	54				Nottingham	NLS	
E & W	1935	2	55				Grantham	EA	
E & W	1937	5	56				Boston	NLS	
E & W	1935	10	57				Fakenham	UP	
E & W	1933	3	58				Cromer	NLS	
E & W	1945	2	59	pt 68			Dolgelly & Lake Vyrnwy	EA	
E & W	1943	1	60				Shrewsbury & Welshpool	EA	
E & W	1938	8	61				Wolverhampton	NLS	
E & W	1937	6	62				Burton & Walsall	NLS	
E & W	1935	9	63				Leicester	NLS	
E & W	1937	7	64				Peterborough	NLS	
E & W	1937	8	65				Wisbech & Kings Lynn	NLS	
E & W	1935	3	66				Swaffham & East Dereham	NLS	
E & W	1934	3	67				Norwich & Great Yarmouth	EA	
E & W	1945	3	69	pt 68			Llanidloes	EA	
E & W	1942	5	70				Bishop's Castle	EA	
E & W	1939	3	71				Kidderminster	NLS	
E & W	1934	4	72				Birmingham	NLS	
E & W	1940	4	73				Rugby	NLS	
E & W	1942	2	74				Kettering & Huntingdon	EA	
E & W	1940	5	75				Ely	NLS	
E & W	1935	11	76				Thetford	EA	
E & W	1937	9	77				Lowestoft & Waveney Valley	NLS	
E & W	1946	13	78				Lampeter	UP	
E & W	1947	3	79				Llandrindod Wells & Tregaron	EA	
E & W	1942	6	80				Kington	EA	
E & W	1937	10	81				Worcester	NLS	
E & W	1937	11	82				Stratford on Avon	NLS	
E & W	1942	3	83				Northampton	EA	
E & W	1937	12	84				Bedford	NLS	
E & W	1938	8	85				Cambridge	NLS	
E & W	1939	4	86				Bury St Edmunds & Sudbury	NLS	
E & W	1933	5	87				Ipswich	UP	
E & W	1936	4	88				St. David's & Cardigan	NLS	
E & W	1947	4	89				Carmarthen	NLS	
E & W	1947	5	90				Brecon & Llandovery	EA	
E & W	1945	4	91				Abergavenny	EA	

Nation	Pub.	Yr.	Seq.	Sheet	Oth.	Sheets	Area	Source	Notes
E & W	1942	7	92				Gloucester & Forest of Dean	UP	
E & W	1942	8	93				Stow on the Wold	EA	
E & W	1942	4	94				Bicester	ROE	
E & W	1934	2	95				Luton	ROE	Reprinted in 1938
E & W	1937	13	96				Hertford & Bishop's Stortford	EA	
E & W	1939	5	97	98			Colchester & Clacton on Sea	UEA	
E & W	1935	12	99				Pembroke	NLS	
E & W	1937	14	100				Llanelly	NLS	
E & W	1936	5	101				Swansea & Aberdare	NLS	
E & W	1936	6	102				Newport	NLS	
E & W	1935	18	103				Stroud & Chepstow	NLS	
E & W	1942	9	104				Swindon & Cirencester	UP	
E & W	1940	6	105				Oxford & Henley on Thames	NLS	
E & W	1935	13	106				Watford	EA	
E & W	1935	14	107				N.E.London & Epping Forest	EA	
E & W	1937	15	108				Southend & District	NLS	
E & W	1936	7	109				Pontypridd & Barry	NLS	
E & W	1939	6	110	111			Bath & Bristol	NLS	
E & W	1935	15	112				Marlborough	NLS	
E & W	1936	8	113				Reading & Newbury	NLS	
E & W	1933	1	114				Windsor	EA	
E & W	1935	16	115				S.E.London & Sevenoaks	EA	
E & W	1938	11	116				Chatham & Maidstone	NLS	
E & W	1936	9	117				East Kent	NLS	
E & W	1945	5	118	119			Exmoor	UP	
E & W	1936	10	120				Bridgwater & Quantock Hills	NLS	
E & W	1940	7	121				Wells & Frome	NLS	
E & W	1939	7	122				Salisbury & Bulford	NLS	
E & W	1936	11	123				Winchester	EA	
E & W	1938	12	124				Guildford & Horsham	EA	
E & W	1938	13	125				Tunbridge Wells	US	
E & W	1939	8	126	135			Weald of Kent & Hastings	UEA	
E & W	1945	6	127				River Torridge	UEA	
E & W	1945	7	128				Tiverton	EA	
E & W	1943	6	129	139			Chard & Axminster	EA	
E & W	1943	5	130	131			Yeovil & Blandford	EA	
E & W	1937	16	132				Portsmouth & Southampton	NLS	
E & W	1936	12	133				Chichester & Worthing	NLS	
E & W	1936	13	134				Brighton & Eastbourne	NLS	
E & W	1946	14	136				Boscastle & Padstow	EA	
E & W	1942	10	137				Dartmoor, Tavistock & Launceston	UP	
E & W	1938	14	138				Dartmoor & Exeter	NLS	
E & W	1943	2	140				Weymouth & Dorchester	EA	
E & W	1936	14	141				Bournemouth & Swanage	NLS	
E & W	1933	2	142				Isle of Wight	EA	
E & W	1946	15	143				Truro & St Austell	UP	
E & W	1942	11	144				Plymouth	EA	
E & W	1946	16	145				Torquay & Dartmouth	EA	
E & W	1935	4	146				Land's End & Lizard	EA	
Scot	1933	6	4				South Mainland (Shetland	EA	

Nation	Pub.	Yr.	Seq.	Sheet	Oth.	Sheets	Area	Source	Notes
							Islands)		
Scot	1939		9	6			Orkney Islands (Mainland)	EA	
Scot	1936		15	12			Wick	EA	
Scot	1940		8	28			Nairn & Cromarty	US	
Scot	1940		9	29			Elgin & Keith	EA	
Scot	1948-9		1	30	pt 31		Banff & Fraserburgh	EA	Peterhead on 31
Scot	1948-9		2	40	pt 31		Inverurie & Ellon	UEA	Peterhead on 31
Scot	1935		17	45			Aberdeen	EA	
Scot	1948-9		3	51			Stonehaven & Brechin	ROE	
Scot	1935		5	53			Sound of Mull	EA	
Scot	1948-9		4	58			Arbroath & Montrose	EA	
Scot	1935		6	59			Iona & Colonsay	UEA	
Scot	1935		7	60			North Jura & Firth of Lorne	UEA	
Scot				63			Perth & Strath Earn	EA	Not listed by Stamp but published.
Scot	1948-9		5	64			Dundee & St.Andrews	EA	
Scot	1947		6	66			Loch Lomond	ROE	
Scot	1947		7	67			Stirling & Dunfermline	ROE	
Scot	1933		8	68			Firth of Forth	ROE	
Scot	1940		10	72			Glasgow	UEA	
Scot	1940		11	73			Falkirk & Motherwell	EA	
Scot	1936		16	74			Edinburgh	UEA	
Scot	1944		7	75			Dunbar & Lammermuir	ROE	
Scot	1937		17	78			Kilmarnock & Ayr	EA	
Scot	1945		8	79			Lanark	EA	
Scot	1945		9	80			Peebles & Galashiels	EA	
Scot	1948-9		6	81			Kelso/Lower Tweed	ROE	(Same as E & W sheet 1)
Scot	1948-9		7	82			Ailsa Craig & Girvan	EA	
Scot	1948-9		8	83			Loch Doon	EA	
Scot	1944		8	84			Nithsdale & Moffat	EA	
Scot	1945		10	85			Hawick & Eskdale	EA	
Scot	1947		1	86			The Cheviot Hills	EA	(Same as E & W sheet 3)
Scot	1948-9		9	87			Newton Stewart	EA	
Scot	1948-9		10	88			Dumfries	EA	
Scot	1948-9		11	89			Solway Firth & River Esk	UEA	(Same as E & W sheet 5)
Scot	1948-9		12	90			Stranraer	EA	
Scot	1948-9		13	91			Wigtown		Appears not to have been published.
Scot	1948-9		14	92			Castle Douglas & Kirkcudbright		Appears not to have been published.

Appendix C: Software used during the project

Task	Software
Crop image to remove margins	Adobe Photoshop 7.0.1
Decrease resolution and colour depth	Adobe Photoshop 7.0.1
Geo-reference imagery	ESRI ArcGIS 8.3
Check status of GeoTIFFs	Mentor GeoTiffExamine
Edit shapefile used to serve maps	ESRI ArcView 3.2
Serve maps on the Internet	MapServer 4.0

Appendix D: Digital data supplied on DVD

Geo-referenced scans (300 dpi, 8 bit colour, GeoTIFF plus .tfw world files)

DVD number:	Contents:
1	A copy of this report. Ten-miles-to-the-inch maps of Great Britain and associated world files: Sheets 1 and 2 (of 2) One-mile-to-the-inch maps of England and Wales and associated world files: Sheets 2 to 94 (of 146) (sheet 1 is covered by Scottish sheet 81)
2	One-mile-to-the-inch maps of England and Wales and associated world files: Sheets 95 to 146 (of 146) One-mile-to-the-inch maps of Scotland and associated world files: Sheets 4 to 90 (of 90)

Raw scans (400 dpi, 24 bit colour, TIFF):

DVD number:	Contents:
3	Ten-miles-to-the-inch maps of Great Britain: Sheets 1 and 2 (of 2) One-mile-to-the-inch maps of England and Wales: Sheets 1 to 12 (of 146)
4	One-mile-to-the-inch maps of England and Wales: Sheets 13 to 29 (of 146)
5	One-mile-to-the-inch maps of England and Wales: Sheets 30 to 45 (of 146)
6	One-mile-to-the-inch maps of England and Wales: Sheets 46 to 61 (of 146)
7	One-mile-to-the-inch maps of England and Wales: Sheets 62 to 76 (of 146)
8	One-mile-to-the-inch maps of England and Wales: Sheets 77 to 91 (of 146)
9	One-mile-to-the-inch maps of England and Wales: Sheets 92 to 107 (of 146)
10	One-mile-to-the-inch maps of England and Wales: Sheets 108 to 122 (of 146)
11	One-mile-to-the-inch maps of England and Wales: Sheets 123 to 140 (of 146)
12	One-mile-to-the-inch maps of England and Wales: Sheets 141 to 146 (of 146) One-mile-to-the-inch maps of Scotland: Sheets 4 to 53 (of 90)
13	One-mile-to-the-inch maps of Scotland: Sheets 58 to 79 (of 90)
14	One-mile-to-the-inch maps of Scotland: Sheets 80 to 90 (of 90)

Appendix E: Index to the footprints of published LUS maps

INDEX TO PUBLISHED LAND
UTILISATION SURVEY MAPS

S: SCOTTISH SHEETS

