| Stratum | Depth to Top of Strata (m bgl) | Thickness (range) (m) | Comments |
|---|---|---|---|
| Topsoil & Topsoil/Made Ground | GL | 0.15 – 0.35 | Encountered across the site. Topsoil/Made Ground only encountered in TP79 and TP94. |
| Made Ground and Possible Made Ground | GL | 0.60 – 2.10 | Made Ground only encountered in TP92. Possible Made Ground encountered in TP24 and TP79. |
| Subsoil | 0.20 – 0.35 | 0.10 – 0.40 | Encountered locally, mainly in the south eastern/southern areas of the western section of the site. |
| White Limestone Formation | 0.20 – 2.10 | 0.10 – 1.60 | Encountered across the site. Base not proven |

## 5.2 Topsoil and Topsoil/Made Ground

An initial layer of Topsoil was encountered across the whole site from ground level to depths of between 0.15m and 0.35m bgl.

The Topsoil generally comprised soft dark brown slightly silty slightly gravelly clay with occasional cobbles and occasional to frequent rootlets. The gravel comprised fine to coarse angular to subrounded limestone and quartzite, and the cobbles were of angular to subrounded limestone.

Exceptions to this were where Topsoil/Made Ground and Made Ground were found to be present. Material classified as Topsoil/Made Ground was encountered in two locations (TP79 and TP94), from ground level to depths of 0.30m and 0.20m bgl respectively. This material was very similar to the natural Topsoil materials described above. However, due to the presence of Possible Made Ground soils underlying this material (TP79) or the presence of rare asphalt gravel and cobbles (TP94), it has been termed Topsoil/Made Ground and is considered likely to have been imported/relocated to its current location.

## 5.3 Subsoil

Subsoil was deemed to be present in forty-nine of the one hundred and fifty-six trial pits excavated across the site, from beneath the Topsoil to general depths of between 0.30m and 0.70m bgl. In one location (TP18) in the northwest of the western section of the site, this material was noted to extend to 0.90m bgl. These subsoils were encountered sporadically across the site, although were more predominant in the southeast and northwest of the western section and the western and eastern margins of the eastern section of the site.

The subsoil was mainly described as soft reddish brown slightly silty slightly gravelly clay with rare rootlets and occasional cobbles. The gravel was fine to coarse subangular to subrounded quartzite and limestone and the cobbles comprised subangular to subrounded limestone.

In TP79 material classified as Subsoil/Possible Made Ground was present. This material essentially identical the natural subsoils, however, due to the presence of

Possible Made Ground soils beneath this material it has been designated 'Subsoil/Possible Made Ground' to reflect that it may have been imported/relocated to its current location.

## 5.4 Made Ground and Possible Made Ground

Made Ground and Possible Made Ground was only encountered in three of the one hundred and fifty-six trial pits, constrained to within the western section of the site.

Material deemed to be Made Ground was only encountered in TP92, located in the area of the former temporary service station in the far west of the western section. This material was encountered from ground level to a depth of 0.60m bgl and comprised soft dark brown slightly gravelly slightly silty clay with occasional cobbles and rare pieces of black plastic. The gravel comprised fine to coarse subangular to subrounded quartzite, limestone and rare asphalt with cobbles of the same material.

Materials designated 'Possible Made Ground' were encountered in two locations; TP24 from ground level to a depth of 2.10m bgl, located on the northern edge of the western section of the site, and TP79 from beneath a layer of 'Subsoil/Possible Made Ground' (0.40m bgl) to a depth of 1.50m bgl, located in the northeastern corner of the western section of the site.

In TP24 this material comprised soft to firm dark reddish brown slightly silty slightly gravelly clay with gravel of fine to coarse angular to subrounded limestone and rare to occasional near surface cobbles of limestone and rootlets. Below 1.20m bgl, this material changed becoming soft to firm dark orangish brown slightly mottled orange slightly silty clay with inclusions of black organic material. In TP79 this material comprised soft to firm greyish brown slightly mottled red slightly gravelly clay with gravel of limestone and cobbles of limestone and occasional fragments of decomposing wood.

Two Atterberg Limit Tests were undertaken on samples of the Possible Made Ground, from TP24 at a depth of 1.80-1.90m bgl and TP79 at a depth of 0.90m bgl. The results indicate corrected plasticity index values of 19% and 13% respectively (based on the percentage passing the 425µm sieve) indicating the material to be of low shrinkability in the samples tested as defined by the NHBC standards. Uncorrected plastic limits of 24% and 21%, liquid limits of 47% and 43% and natural moisture contents of between 32.1% and 20.2% were also recorded in the samples. This suggests the material to be of intermediate plasticity.

## 5.5 White Limestone Formation

The White Limestone Formation was encountered across the entire site beneath the above surface/shallow materials. The depth to the top of the stratum was fairly uniform across the site, mainly being influenced only by the thickness of the overlying Topsoil/Subsoil or very localised Made Ground/Possible Made Ground. The base of this stratum was not encountered in any of the one hundred and fifty-six trial pits, with all of the pits terminating in this stratum on competent rock strength material at depths of between 0.80m and 2.90m bgl.

The White Limestone Formation comprised an initial variable (both in depth and composition) weathered horizon, which became more competent with depth, eventually becoming competent rock strength material. The weathered horizon was

found to extend to depths of between 0.70m and 2.49m bgl. Generally, this horizon was thinner (extending to <1m bgl) in the southwest of the western section (the lowest topographically) and also in the western margins of the eastern section. The thickest weathered horizons (extending to >2m bgl) were noted generally in the central/northern parts of the western section.

The weathered strata of the White Limestone Formation were highly variable, comprising light creamy yellowish white, light and dark orangish brown slightly clayey to clayey sandy gravel and soft to firm slightly gravelly to gravelly clay with gravel of fine to coarse angular to subangular limestone and occasional to frequent cobbles/boulders of angular to subangular tabular limestone. There were no obvious patterns or trends in the distribution of the varied materials, although clay horizons were more often encountered at shallower depths with gravel beneath. Variations across the site were extensive, with cohesive and granular materials sometimes either interbedded or absent.

Underlying the initial weathered horizon, the materials became competent rock strength material at depths ranging between 0.70m and 2.49m bgl, depending on the depth and degree of weathering above. The depth of penetration of excavator into this material was noted to vary quite dramatically between 0.01m and 0.85m, suggesting a variable initial rock strength possibly again the result of weathering effects. This material typically comprised moderately strong thinly bedded light creamy brown and creamy brownish white fossiliferous limestone, which was recovered as gravel, cobbles and boulders of angular to subangular tabular limestone.

Sixteen Atterberg Limit Tests were undertaken on samples of the weathered White Limestone Formation taken at depths of between 0.50m and 1.10m bgl. The results indicate corrected (based on the percentage passing the 425µm sieve) plasticity index values between 4% and 21%. This indicates the material to vary between non-shrinkable and medium shrinkability with the bulk of the results in the low shrinkability range. Uncorrected plastic limits of 14% and 32%, liquid limits of 27% and 72% and natural moisture contents of between 12% and 49% were also recorded in the samples. This suggests the material to be of low to very high (generally intermediate) plasticity.

Twenty Particle Size Distribution (PSD) tests were undertaken on samples of the weathered White Limestone Formation. The results of this testing and the resultant classifications are given in the table below:

| Location | Depth (m bgl) | Sample Proportion (%) | | | | |
|---|---|---|---|---|---|---|
| | | Clay | Silt | Sand | Gravel | Cobbles |
| TP102 | 0.80-0.90 | 12.4 | | 10.3 | 34.5 | 42.8 |
| TP108 | 0.90 | 17.5 | | 12.7 | 60 | 9.8 |
| TP125 | 0.90-1.00 | 87.4 | | 9.1 | 3.6 | 0.0 |
| TP13 | 0.70 | 14.7 | | 13.0 | 52.1 | 20.2 |
| TP138 | 0.60 | 15.9 | | 14.4 | 58.4 | 11.3 |
| TP142 | 0.60 | 33.0 | | 20.7 | 44.2 | 2.1 |
| TP145 | 0.70 | 19.1 | | 19.0 | 52.8 | 9.0 |

| Location | Depth (m bgl) | Sample Proportion (%) | | | | |
|---|---|---|---|---|---|---|
| | | Clay | Silt | Sand | Gravel | Cobbles |
| TP15 | 0.70 | 30.8 | | 23.3 | 27.9 | 18.0 |
| TP2 | 0.90 | 26.2 | | 13.7 | 27.8 | 32.4 |
| TP28 | 0.50-0.60 | 21.3 | | 13.9 | 47.7 | 17.1 |
| TP38 | 1.60-1.70 | 5.4 | | 5.4 | 46.3 | 42.9 |
| TP44 | 0.40-0.50 | 28.3 | | 21.6 | 41.5 | 8.5 |
| TP48 | 0.50-0.60 | 8.8 | | 21.0 | 70.2 | 0.0 |
| TP60 | 0.70-0.80 | 71.5 | | 22.4 | 6.0 | 0.0 |
| TP62 | 0.50 | 10.5 | | 10.4 | 48.3 | 30.8 |
| TP75 | 0.80 | 14.4 | | 12.9 | 39.8 | 32.9 |
| TP79 | 0.90 | 76.5 | | 22.3 | 1.2 | 0.0 |
| TP89 | 0.80 | 19.0 | | 17.9 | 32.9 | 30.2 |
| TP94 | 0.70 | 10.4 | | 6.5 | 31.4 | 51.7 |
| TP97 | 1.00-1.10 | 43.9 | | 21.7 | 12.2 | 22.1 |

The results of PSD testing reflect and confirm the high degree of variability that was observed particularly in the weathered materials.

## 5.6 Groundwater and Soakaway Tests

Groundwater was encountered in just fifteen of the one hundred and fifty-six trial pits during excavation. The groundwater occurrence was sometimes observed as discrete seepages or inflows emanating from the sides or base of trial pits or sometimes simply as standing water in the base of the pits.

Groundwater, as standing water in the excavations, was recorded in TP74, TP88, TP89 and TP122 at depths of 1.60m, 1.40m, 0.90m and 1.90m respectively. All of these are noted to be at locations within the topographically low-lying areas of both the western (TP74, TP88 and TP89) and eastern (TP122) sections of the site. This standing water appeared to be generally associated with the zone between weathered and competent rock strength strata of the White Limestone Formation.

Discrete groundwater seepages were recorded in TP41, TP52, TP62, TP68, TP75, TP76, TP86, TP87, TP88, TP111 and TP124 at depths varying between 0.90m and 2.00m bgl. These seepages were also generally associated with the interface zone between the weathered and competent rock strength strata of the White Limestone Formation.

Soakaway tests were undertaken in TP38A, TP72A, TP88A (western section) and TP121A and TP136 (eastern section). Calculated infiltration rates for the western section ranged between $7 \times 10^{-4}$m/s and $7 \times 10^{-6}$m/s and in the eastern section of the site ranged between $1 \times 10^{-3}$m/s and $2 \times 10^{-5}$m/s. These quite substantial variations are considered likely to reflect the high degree of variability within the weathered rock horizons.

The groundwater occurrence and soakaway test results suggest variable ground permeability/infiltration rates across the site and also some relatively shallow groundwater within the topographically lower areas of the site. Whilst the infiltration rates included within this report will be suitable for preliminary design purposes, it would be prudent to consider further location specific testing in full accordance with BRE DG guidance, to provide final information for detailed design.

Groundwater occurrences are recorded on the trial pit logs in Appendix C. The soakaway test results are included in Appendix D.

### 5.7 Contamination

There was no visual or olfactory evidence of contamination observed during the fieldwork, although the Made Ground encountered in TP92 was noted to contain fragments and cobbles of asphalt.

## 6.0 GEOENVIRONMENTAL ASSESSMENT

### 6.1 Human Health Risk Assessment

The results of the chemical testing on soils have been assessed as described in Appendix F, with specific details as follows:

- Proposed end-use – Commercial/Industrial development with perimeter soft landscaping;
- Screening criteria – Commercial/Industrial, assuming 2.5% SOM;
- A single dataset is assumed based on the history, current land-use and the proposed development of the site.

A spreadsheet summarising the laboratory results and relevant screening values is presented in Appendix E. The summary spreadsheet confirms that none of the determinands recorded concentrations above that of the corresponding screening value, with many of the determinands, including the Polycyclic Aromatic Hydrocarbons (PAHs), Phenols (total), BTEX and MTBE being recorded below the limit of laboratory detection.

TPH concentration were all below the relevant human health screening criteria, with the majority of the results having been recorded below the limit of laboratory detection. The only exception to this were samples from TP5 at 0.20m bgl and TP79 at 0.10m bgl which recorded very low total TPH concentrations of 100mg/kg and 23mg/kg respectively. These are noted to be well below the relevant screening criteria and therefore are not considered to be of concern.

The pesticide testing undertaken on selected samples recorded all concentrations to be below the limit of laboratory detection.

The Asbestos screening tests did not detect the presence of any Asbestos fibres.

Based on the findings of the desk study and the testing undertaken to date, the risks to human health receptors associated with the proposed development of the site would appear to be low or negligible.

## 6.2 Controlled Waters Risk Assessment

No potential sources of contamination were identified during the intrusive ground investigation works, with only very localised and limited Made Ground/Possible Made Ground having been encountered containing predominately reworked natural soils with occasional brick, asphalt and concrete.

The soil testing has not found concentrations of any determinands above those values considered typical of background concentrations.

Leachate testing undertaken on nine samples of soils did not identify any exceedances of the screening values in any of the samples.

Based on findings of the desk study, together with the results of soil and leachate testing, the risks to Controlled Waters associated with the proposed development at the site would appear to be negligible to low.

## 6.3 Disposal of Soil Arisings

General comments regarding the procedures for the assessment of waste soil for off-site disposal purposes is included in Appendix F.

The localised Made Ground encountered during this investigation would likely be classified as non-hazardous based on the testing undertaken to date. Waste acceptance criteria (WAC) testing is not required for materials classified as non-hazardous, therefore, the results of the testing included in this report should be provided to the receiving landfill for confirmation of this classification.

It is likely that the natural strata encountered beneath the site would be classified as inert waste if sent for disposal. Inert WAC testing is generally required in order to dispose of natural soils at an inert landfill. WAC tests were undertaken on six samples of natural soil. All of the results from each of the six samples tested demonstrated compliance with the WAC limits for inert landfills. Further testing of the actual waste stream will likely be required for any materials destined for landfill disposal. WAC testing results are included in Appendix E.

## 6.4 Conclusions and Recommendations

No obvious sources of contamination were identified by the desk study, walkover and site observations during the fieldwork. Furthermore, all of the testing undertaken on the soils as part of the investigation did not reveal any contaminants elevated above the relevant screening criteria.

On this basis, the risk assessments have established a negligible to low risk to human health and Controlled Water receptors. Remedial actions are therefore not considered necessary based on existing information.

Consideration should be given to supplementary investigation once proposed layouts are finalised as part of detailed design, especially within the areas where localised Made Ground (associated with the former temporary service station) and other Possible Made Ground was encountered.

Issues with respect to ground gas and potential effects of contaminants on buried concrete and water supply pipework are included in Section 7.0.

## 7.0 GEOTECHNICAL ASSESSMENT

### 7.1 General

At the time of writing this report, outline planning permission was being sought for each site for the erection of Class B8 buildings and Class Eq(i) ancillary office floorspace along with new site accesses from the B4100, internal access roads, parking and servicing, hard and soft landscaping and other associated infrastructure.

In order to achieve the above proposed development, reprofiling of both sites by way of a cut and fill earthworks exercise will be required. A plan showing 'Concept Site Levels', ref. S1299-Ext-05 B, dated 9th August 2021, has been provided by the Engineer for use within this preliminary assessment. It is understood that the proposals shown on this plan are indicative and therefore could be subject to changes.

The preliminary proposals are that the western site may be reprofiled to create three separate development platforms to accommodate individual warehouse units, with finish floor levels (FFL's) of 118m, 122m and 124m AOD for Units 1, 2 and 3 respectively. Comparison of the FFL's and topographic contours, also provided on the drawing suggest that both cut and fill could be up to a maximum of around 3 to 4m.

The eastern site is currently indicated to be reprofiled into two separate development platforms, to accommodate individual warehouse units, with FFL's of 115m AOD (Unit 4) and 114m AOD (Unit 5). Maximum cuts of 1m and fills of up to 3m are suggested to achieve the levels.

At the time of writing this report, detailed design information (structural building loads etc) was not available. However, it is understood that warehouse floor slab loads are anticipated to be in the order of 75 kN/m$^2$.

The investigations identified an initial layer of Topsoil of between 0.15m and 0.35m thick across the entire site with localised areas of underlying subsoil. A few localised areas of Topsoil/Made Ground, Made Ground and Possible Made Ground were also present. In turn these materials were underlain by the White Limestone Formation, comprising an initial weathered horizon of varying depth and composition (both cohesive and granular), becoming competent rock strength Limestone with depth. The presence of rock strength limestone prevented any of the trial pits extending to depth, with all of the trial pits terminating on or within this material at a maximum depth of 2.90m bgl.

Groundwater as standing water was encountered at the interface between the weathered and competent rock strength strata of the White Limestone Formation in the topographically low-lying areas of the site at depths of between 0.90m and 1.90m. Groundwater as discrete seepages was also recorded sporadically across the site, also usually within the zone between the weathered and competent rock strength strata of the White Limestone Formation (depths between 0.9m and 2.0m bgl.)

## 7.2 Preliminary Earthworks Assessment

A selection of bulk and small disturbed samples taken from the weathered White Limestone Formation in the likely proposed cut areas (assumed by topographical levels) were chosen to undergo a series of earthworks acceptability tests, in order that a preliminary assessment could be made as to their suitability for re-use. For the purpose of assessment, the testing results have been divided into sub-sections (studies 1 – 4) relating to the nature and classification of the materials, and the results are discussed in the following paragraphs. Testing has not been undertaken on organic Topsoil, Topsoil/Made Ground or Subsoil materials encountered across the site, or the localised area of Made Ground encountered in TP92, which are considered unsuitable for use in engineered earthworks.

The classification of soils has been made with respect to the general requirements given in the Manual of Contract Documents for Highway Works, Specification for Highway Works [SHW]: Volume 1: Series 600: Amended 2009 and BS 6031:2009. It should be noted and clear reference made to the fact that the engineering performance of an earthwork's material can be greatly influenced by the moisture content at time of assessment and excavation/placement and compaction. With variation in the moisture content, the end performance of a material can be both improved and reduced, and consideration should be given to the management of the moisture as a key element of any earthworks control. With respect to this, the information included in the following sections should be used for guidance on the potential use of materials, with additional testing on the bulk fill required at time of earthworks construction to confirm acceptability.

The grading limits chosen for comparison to the results of the laboratory analysis were taken from the SHW Table 6/2, with the description of the material being referenced from SHW Table 6/1 and Table 6/2.

The materials have been divided for the purposes of this preliminary earthworks assessment as summarised below:

| Study | Source Location | Material Type | SHW Class |
|---|---|---|---|
| Study 1 | TP125 (0.90-1.00m bgl) | Weathered White Limestone Formation (Clay) | 2A/2B (wet/dry cohesive) |
| | TP60 (0.70-0.80m bgl) | Weathered White Limestone Formation (Clay) | 2A/2B (wet/dry cohesive) |
| Study 2 | TP138 (0.60m bgl) | Weathered White Limestone Formation (Gravel) | 2C (stony cohesive) |
| | TP15 (0.70m bgl) | Weathered White Limestone Formation (Gravel) | 2C (stony cohesive) |
| | TP28 (0.50-0.60m bgl) | Weathered White Limestone Formation (Gravel) | 2C (stony cohesive) |
| Study 3 | TP75 (0.80m bgl) | Weathered White Limestone Formation (Gravel) | 1C (granular) |

| Study | Source Location | Material Type | SHW Class |
|---|---|---|---|
| **Study 4** | TP79 (0.90m bgl) | Possible Made Ground (Clay) | 2A/2B (wet/dry cohesive) |

The Engineering properties obtained from the earthworks testing are summarised below:

| | Natural moisture content (%) and number of tests | Maximum Dry Density (2.5% rammer) ($Mg/m^3$) | Optimum Moisture Content (2.5% rammer) (%) | Maximum Dry Density (4.5% rammer) ($Mg/m^3$) | Optimum Moisture Content (4.5% rammer) (%) | Particle Density (Mg/m3) |
|---|---|---|---|---|---|---|
| **Study 1** | 37 & 49 (2 tests) | 1.59 & 1.62 | 13.7 & 17.7 | 1.75 & 1.76 | 13.5 & 14.4 | 2.62 |
| **Study 4** | 20 (1 test) | 1.69 | 11.5 | 1.80 | 11.2 | 2.60 |

| Parameter | Natural moisture content (%) and number of tests | Maximum Dry Density (Vibrating Hammer) ($Mg/m^3$) | Optimum Moisture Content (Vibrating Hammer) (%) | Particle Density (Mg/m3) |
|---|---|---|---|---|
| **Study 2** | 13 – 22 (3 tests) | 1.96 – 2.05 | 8.8 - 10.4 | 2.67 |
| **Study 3** | 15 (1 test) | 1.98 | 10.7 | 2.66 |

### 7.2.1 Weathered White Limestone Formation (Clay) (Study 1)

Natural moisture contents in the Weathered White Limestone Formation (Clay) class 2A/B ranged between 37% and 49%. The compaction studies carried out on this material indicated maximum dry densities of 1.59Mg/m$^3$ and 1.62Mg/m$^3$ allied to optimum moisture contents of 13.7% and 17.7% for the 2.5kg compaction test and maximum dry densities of 1.75Mg/m$^3$ and 1.76Mg/m$^3$ and optimum moisture contents of 13.5% and 14.4% for the 4.5kg compaction test. The materials are considered suitable for re-engineering at the site as Class 2A/B cohesive materials. A preliminary range of acceptable moisture contents of between around 13 to 20% has been initially estimated. Most of the measured natural moisture contents were found to be higher than this range suggesting that some moisture modification is likely to be required on site before the materials are compacted. This may be undertaken by air drying or the use of additives, subject to appropriate testing.

### 7.2.2 Weathered White Limestone Formation (Gravelly Clay) (Study 2)

Natural moisture contents in the Weathered White Limestone Formation (Gravelly Clay) class 2C ranged between 13% and 22%. The relevant compaction studies indicated maximum dry densities of between 1.96Mg/m$^3$ and 2.05Mg/m$^3$ with associated optimum moisture contents of between 8.8% and 10.4% for the vibrating hammer compaction test. The materials are considered suitable for re-engineering at the site as Class 2C cohesive materials. A preliminary range of acceptable moisture contents of between around 8 to 14% has been initially estimated. The measured natural moisture contents fall partly with this range, although a

substantial proportion were found to be higher suggesting that some moisture modification is likely to be required on site before the materials are compacted. This may be undertaken by air drying or the use of additives, subject to appropriate testing.

### 7.2.3 Weathered White Limestone Formation (Gravel) (Study 3)

The natural moisture content of the Weathered White Limestone Formation (Gravel) Class 1C was recorded at 15%. The compaction study indicated a maximum dry density of 1.98Mg/m$^3$ together with an optimum moisture content of 10.7% for the vibrating hammer compaction test. The materials are considered suitable for re-engineering at the site as Class 1C granular materials. A preliminary range of acceptable moisture contents of between around 10 to 16% has been initially estimated. A single measured natural moisture content does fall within the upper part of this range, although this material is anticipated to be relatively free draining anyway and hence careful site management should ensure that it is readily suitable for engineering compaction.

### 7.2.4 Possible Made Ground (Clay) (Study 4)

The natural moisture content of the Possible Made Ground (Clay) Class 2A/B was recorded at 20%. The relevant compaction indicated a maximum dry density of 1.69Mg/m$^3$ and optimum moisture content of 11.5% for the 2.5kg compaction test and a maximum dry density of 1.80Mg/m$^3$ and optimum moisture content of 11.2% for the 4.5kg compaction test.

The compaction curve suggests that the Possible Made Ground material does not achieve <10% air voids at optimum moisture content and therefore the material may not be suitable for use in engineered filling works.

### 7.2.5 Protection of the Works

Given the grading of the soils identified in particular the presence of variable clay/silt fractions, rapid loss of strength may occur in wet weather conditions. It will be essential that provision is made for protecting the works and that the works should be suspended in wet weather. Following rain, it is likely that the near surface materials will have deteriorated and will need to be removed prior to the commencement of filling works.

### 7.2.6 Earthworks Specification

It is recommended that the results from the earthworks laboratory testing and design requirements (such as compaction, CBR, settlement, shear strength etc) be developed into a detailed Earthworks Specification for use in the construction contract. The testing undertaken as part of this investigation suggests essentially that there are likely to be two main types of earthworking material on the site, namely Class 2 cohesive and Class 1 granular materials. Careful segregation will be necessary during excavation to enable these materials to be appropriately stockpiled and re-used as engineering fill materials. In order to compile the earthworks specification there will be a need for further testing and assessment.

Given the anticipated depths of cut required, rock is also likely to be excavated/ broken out during the reprofiling exercise. Rock strength materials that are excavated will require processing (crushing, screening and grading) prior to re-use.

Therefore, this material would need to be tested, classified and assessed with respect to its compaction characteristics after processing.

Prior to any filling, the site must be stripped of topsoil/subsoil and the formation should be carefully inspected. Any localised organic or soft material should be removed and replaced with compacted stone.

Placement of the Engineered Fill will induce some settlement of the underlying strata and the settlement of the surface of the Engineered Fill will be a function of the thickness of placed Engineered Fill, the nature of the placement and compaction, and the settlement of the underlying pre-loaded soils. Settlement of subsequent structures and/ or slabs placed on the Engineered Fill will be a function of the imposed loads and the time between placement of the Engineered Fill and foundation/slab construction. It is therefore recommended that sufficient time be allowed following placement of the Engineered Fill for settlement to occur, before construction commences. Given the nature of the source materials for use as Engineered Fill and underlying strata together with thickness proposed, it is generally anticipated that settlements will occur relatively quickly.

It should be noted that if any excavated material is to be reused on site, a Waste Management Plan (WMP) and/or a Materials Management Plan (MMP) will probably be required. Any such materials must be suitable for re-use without further treatment, and only the quantity necessary for the specified works should be used. Any materials not within these definitions may need to be considered as waste whereby a Waste Management Licence Exemption will may also be required. Reference should be made to CL:AIRE Definition of Waste Code of Practice for further guidance.

## 7.3 Foundation Design

Based on the findings of this preliminary ground investigation, the natural strata of the White Limestone Formation at the site are considered suitable to support conventional strip/trench fill or pad foundations. Depending on likely structural loads, settlement tolerances, and the extent of any cut/fill earthworks exercise, foundation may either need to be placed within the weathered or intact competent rock strength zones.

Owing to the presence of cohesive materials of medium volume change potential within the weathered zones of the White Limestone Formation, a minimum founding depth of 0.90m bgl will apply to cater for seasonal effects. Further deepening will be required for existing, recently felled and proposed trees/deep rooting vegetation in line with current guidance, such as NHBC standards. Mature trees and hedgerows were noted to be present along the majority of the site and internal field boundaries. The deepening requirements are likely to be influenced considerably by the reprofiling exercise and also the variable depths of weathering.

Foundation placed within the weathered in situ materials should be suitable to support light to moderate loads in the order of around 100 – 125 kN/m$^2$. If higher loadings intensities are required, it may be necessary to deepen foundations to bear within the competent rock strength strata which would likely be suitable to support net bearing intensities in the order of 200-250kN/m$^2$. Further investigation, by means of rotary drilling techniques, is recommended to investigate the rock profile and confirm allowable bearing pressures for detailed design purposes.

The reprofiling exercise will have a considerable influence on foundation design. Where cut is to occur, understood to be in the region of c. 4m for the western section of the site and c. 1m for the eastern section of the site, competent rock strength strata of the White Limestone Formation are likely to be exposed at formation level. Where fill is to be placed, understood to be in the region of c. 4m in the western section of the site and c. 3m in the eastern section of the site, it may be feasible to place foundations within the engineered fill, although this will depend on the details of loadings, fill levels and hence the anticipated total and differential settlements.

## 7.4 Floor Slab and Gas Protection

It is anticipated that ground bearing floor slabs will be required for the proposed development.

As mentioned in Section 7.2, following the site strip and prior to any engineered filling, the exposed formation should be carefully inspected. Any localised organic or soft material should be removed and replaced with compacted stone.

Subsequent to successful completion the earthworks, the floor slab should be constructed on a compacted granular mattress of appropriately designed thickness.

In view of the substantial adjustments to levels and the anticipated floor slab loads within the high-bay warehouses, differential settlements across the footprints of individual units should be analysed and assessed against the tolerances of the floor slabs as part of the detailed design.

Based on the conceptual model and the ground conditions encountered and the calculated GSVs the site can be characterised as Situation 1 (CIRIA C665) for which no special ground gas measures are required. The desk study also indicates that radon protection measures are not required.

## 7.5 Excavations

Excavations up to 3-4m deep are locally envisaged as part of the reprofiling works to create the required development platforms. At these depths excavations are expected to be in a combination of weathered rock strata comprising gravelly clay and clayey gravel and competent rock strength strata (limestone).

Limited penetration into the competent rock strength strata was achieved during the investigation utilising a wheeled backhoe excavator (c. 8 Tonne), with all trial pits terminating on or within this material. Further penetration is likely to be possible using larger plant and within larger excavations, however, breakers or additional plant may be required depending on the quality of the rock strength material at depth. The rotary drilling needed for final foundation design will also provide further useful information with regards to the likely excavatability of these materials.

The weathered rock materials may be prone to some short-term instability and spalling and may need to be graded back to a stable angle or trench support should be provided. Trench support or the angle of batter should be designed by an appropriately qualified engineer or competent person to suit the required depth and the ground and groundwater conditions.

Significant groundwater ingress is not expected across the majority of the site, although it is recommended that some provision for obtaining sump pumping equipment is made to control any minor seepage and run off in wet weather conditions. An exception to this would be for excavations in the south/southeast of the western section of the site and the south of the eastern section of the site, in topographically low-lying areas. In these areas groundwater was encountered, occurring as standing water at depths of between 0.90m and 1.90m bgl. Should excavations be proposed in these areas below these depths, groundwater interference is likely be experienced, which would need to be controlled either by sump pumping or alternative groundwater control measures, if larger inflows are encountered.

## 7.6 Pavement Design

Topsoil, subsoil and organic material should be removed from beneath any proposed roads and pavements.

The equilibrium CBR value for the proposed Engineered Fill will be governed by the Earthworks Specification and the quality of the compaction and moisture control of the filling operation. However, provided the filling is carried out competently and is closely controlled/validated, then typically a minimum CBR value of 5% is likely to be achieved. The laboratory testing has indicated remoulded CBR values varying dramatically between <1% and 21% for the weathered White Limestone Formation at natural moisture content using standard compactive effort. For preliminary design purposes, it is suggested that values of 3% and 5% are assumed initially for the in situ cohesive and granular dominant materials respectively.

Based on the visual description of the weathered White Limestone Formation during the intrusive investigation, the results of the Particle Distribution Test and the measured plasticity results, both the cohesive and granular soils are considered likely to be frost susceptible. Therefore, such soils should not be present in the top 450mm of pavement construction.

## 7.7 Soakaways

The results of the soakaway testing carried out as part of this preliminary ground investigation are discussed in full in Section 5.6 of this report.

The calculated infiltration rates from the testing undertaken demonstrate quite substantial variations, with the rates for the western section ranging between $7 \times 10^{-4}$m/s and $7 \times 10^{-6}$m/s and the eastern section ranging between $1 \times 10^{-3}$m/s and $2 \times 10^{-5}$m/s. This variation is considered likely to be as a result of the high degree of variability within the weathered rock horizons, with both cohesive (gravelly clay), granular (clayey gravel and gravel) and mixture of cohesive and granular material having been encountered.

The results of the preliminary soakaway testing suggest that the site will be suitable for the use of soakaway drainage, however, the variable ground permeability/ infiltration rates across the site and the localised presence of some relatively shallow groundwater within the topographically lower areas will need to be taken into account. Detailed design is considered likely to result in the need for a 'hybrid' surface water drainage system (a mix of soakaways, attenuation tanks, swales, etc).

Whilst the infiltration rates included within this report are considered suitable for preliminary design purposes, it would be prudent to consider further location specific testing in full accordance with BRE DG guidance, to provide final information for detailed design.

## 7.8 Buried Concrete and Services

The results of the testing in the soils on site indicate characteristic values as following:

- water soluble sulphate: 0.013g/l;
- total potential sulphate: 0.022%;
- pH: 8.2.

The results of the sulphate tests carried out have been combined into one assessment, given all the natural material on site were derived from the one geological formation and are essentially considered to be weathered in situ. The combined results of the sulphate tests have identified the Design Sulphate Class to be DS-1 with the Aggressive Chemical Environment for Concrete (ACEC) being AC-1 as defined by the BRE Special Digest 1, Concrete Aggressive Ground, 2005 for a greenfield site and mobile groundwater regime. Special cements or other measures to counter sulphate attack are therefore not likely to be required. Further reference may be made to BRE Special Digest 1 for requirements in respect of types of cement and aggregate to be used and variations in type of concrete construction.

Chemical testing has not identified significant petroleum hydrocarbons or any detectable phenols that may affect buried water supply pipes or buried concrete. Therefore, no special precautions are envisaged with regards to water supply pipes. However, it should be noted that the full suite of testing required by the UKWIR guidance has not been undertaken as part of this investigation and such testing could be required by the Water Authority once the pipeline routes are known.

## 7.9 Conclusions and Recommendations

Earthwork's testing indicates that the natural materials won from areas of cut will be suitable for re-engineering on site (as a combination of Class 2A/B wet/dry cohesive, Class 2C stoney cohesive and Class 1C granular materials) in order to provide the required development plateaus. A substantial proportion of the materials are likely to be wetter than the acceptable moisture content range and hence some moisture modification is likely to be required on site before compaction. It will be necessary to produce a detailed specification for the earthworks to include methods, controls, and verification testing with target end performance criteria geared towards the detailed structural building requirements. Some further testing will be needed to facilitate this.

Depending on likely structural loads, settlement tolerances, and the extent of any cut/fill earthworks exercise, conventional strip/trench fill or pad foundations may be adopted either within the weathered or intact competent rock strength zones. Weathered in situ materials may support foundation loads in the order of c. 100 – 125kN/m$^2$, increasing to the order of 200-250kN/m$^2$ within the competent rock strength strata.

Ground bearing floor slabs are envisaged for the proposed development placed on engineered fill. In view of the substantial adjustments to levels and the anticipated floor slab loads within the high-bay warehouses, differential settlements across the footprints of individual units should be assessed against the tolerances of the building floor slabs as part of the detailed design.

Special ground gas measures are unlikely to be required for the proposed development.

Buried concrete should be designed in accordance with DS1 AC-1 classification.

The site is likely to be suitable for the use of soakaway drainage, however, the variable ground permeability/infiltration rates and localised presence of shallow groundwater will need to be taken into account in detailed design. It is understood that a 'hybrid' surface water drainage system (soakaways, attenuation tanks, swales, etc) is being considered.

In order to confirm the findings and recommendation of this preliminary Phase II Ground Investigation and to provide sufficient information to enable full detailed design, some supplementary investigation is recommended including the following:

- A series of Rotary Cored Boreholes to establish the competent rock strength profile.
- Further detailed/targeted testing to assess settlements and facilitate a detailed Specification for Earthworks. The scope of this testing must take into account the final proposed cut/fill model and detailed building layout/loading information.
- Localised investigation around the area of Made Ground encountered in the location of the former temporary service station (TP92) and the Possible Made Ground (TP24) to confirm conditions.

This supplementary work should be undertaken when the final site layout, finished levels and detailed structural loading information for the site is known. Hence it would be prudent to allow appropriate timescales for this supplementary work within the programme.

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## GENERAL NOTES

a) The Client has requested that a Desk Study and combined geotechnical and geoenvironmental ground investigation ("The investigation") be performed in order to provide guidelines for safe site development and long term usage. The scope of work is as defined in Section 1 of this report.

b) The "investigation" was conducted and this report has been prepared for the sole internal use and reliance of the Client This report shall not be relied upon or transferred to any other parties without the express written authorisation of Applied Geology Limited. If any unauthorised third party comes into possession of this report they rely on it at their peril and the authors owe them no duty of care and skill.

c) The findings and opinions conveyed via this "investigation" report are based on information obtained from a variety of sources as detailed within this report, (eg desk study data, service plans, proposal layouts etc) and which Applied Geology Limited believes are reliable. Whilst Applied Geology Limited has used all reasonable care in obtaining and using this data, it does not guarantee its reliability.

d) The report represents the findings and opinions of experienced geoenvironmental consultants. Applied Geology Limited does not provide legal advice and the advice of lawyers may also be required.

e) The opinions presented in this report are based on findings derived from a site inspection and walkover and offsite surveys, a review of records and historical sources, comments made by interviewees (if relevant), and the findings of the physical investigation. The assumed subsurface geological profiles and other plots are generalised by necessity and have been based on the information found at the locations of the exploratory holes and depths sampled and tested. Other Conditions could exist between exploratory hole locations which have not been identified and therefore have not been taken into account in assessments. Applied Geology Limited has not found indicators that suggest that hazardous substances exist at the site at levels likely to warrant mitigation or consideration appropriate to the end use stated by the Client.

# APPENDIX A

APPLiED GEOLOGY LIMITED

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AG2255-15-V99
26th May 2015

For the attention of Bill Bailey

Dear Bill

**Re: Ardley, Junction 10, M40**

Further to your instruction of the 18th May 2015 to carry out a Phase 1 geotechnical and geoenvironmental desk study, we have pleasure in presenting a summary of our findings. This report has been prepared on behalf of Albion Land to assess the potential for hazardous substances or conditions to exist on, at or near the site at levels or in a situation likely to warrant mitigation or consideration appropriate to the intended end use proposed by the Client and to establish likely geological conditions for use in preliminary development appraisal.

## SITE DESCRIPTION

The site is located adjacent to the north of Junction 10 of the M40, approximately 1km north of the centre of Ardley in Oxfordshire. The Ordnance Survey grid reference for the centre of the site is SP 547 289 as shown on the Site Location Plan in Appendix A.

The site is an irregular shape and covers 66.7Ha. It is split into two by the A43, which is a dual carriageway in a shallow cutting. The eastern part of the site is bound by the B4100 to the north, fields to the east and woodland to the south and was accessed via a gap in the hedge along the B4100. The western part of the site is bound by the M40 to the southwest, fields and a possible aggregate depot to the northwest and the B4100 to the north, with access via a double gate off the B4100. The site gently slopes down towards the southeast.

## SITE WALKOVER SURVEY

A walkover survey was carried out by Applied Geology Ltd on the 19th May 2015.

Eastern Part of the Site

The eastern part of the site comprised cropped fields with a drainage ditch running along the hedge forming the northern site boundary and an approximately 0.5m deep depression just north of the centre filled with nettles and surrounded by trees. The depression may represent a former pond.


View of eastern part of site, looking southwest from B4100


Depression in ground in eastern part of site

Western Part of the Site

The western part of the site comprised fields cropped with oil seed rape with a drainage ditch running along part of the southwestern site boundary and two buildings and a possible pump/hydrant near the centre. The smaller of the buildings comprised a barn with stone walls and a pitched roof. It was mostly empty except for some hay bales. The larger of the buildings comprised a barn with stone walls and a steel frame with a sloping roof of possible corrugated asbestos sheeting. This barn was full of hay bales. A line of deciduous trees ran through the east of this part of the site and a mobile phone mast and possible electricity substation in the southwestern corner.


View of western part of site, looking east from southwestern corner


Barns in western part of site

An Esso petrol station was noted northwest of the roundabout at the intersection of the A43 and the B4100 (off site).

## SITE PROPOSALS

At time of this assessment proposed layouts were not available though it is understood the development will comprise large B8 Storage Units with associated offices and service yards. These are likely to be around 100,000 to 300,000 $Ft^2$ in plan area and 15m to 20m high, with a total developed area of 2 to 3M $Ft^2$.

## SITE HISTORY

Historical maps were obtained as part of the GroundSure Report, commissioned by Applied Geology on the 19th May 2015, in order to determine any significant past activity or land usage. Copies of these maps are presented in Appendix B of this report and are described below:

**Site History Summary**

| Map Date | On The Site | In The Vicinity Of The Site |
|---|---|---|
| 1880-1881 | The site comprises several fields to the west, south and southeast of Baynards Green with a possible pond in the eastern part of the site and buildings near the centre of the western part of the site. The two areas are divided by the Brackley to Oxford Road which subsequently becomes the A43. | A road orientated north-south is between the two site areas. Padbury Brook is 35m south of the eastern part of the site at its closest, flowing to the east. An old quarry is 280m south of the site. |
| 1900 | A pump is marked adjacent to the buildings. | Another old quarry is 350m south of the site. Woodland 1km northeast of the site is labelled Sharman's Pit. |
| 1919-1923 | No significant changes. | No significant changes. |
| 1950-1954 | No significant changes. | No significant changes. |
| 1965 | No significant changes. | No significant changes. |
| 1980-1981 | One building has been demolished and the pump is no longer marked. | The road between the two site areas has been slightly altered, with a roundabout constructed north of the site. The old quarries are no longer marked. A garage is 110m north of the site and a sewage works is 450m southwest of the site. |
| 1992-1994 | No significant changes. | The M40 together with Junction 10 has been constructed adjacent to the southwest of the site. |
| 2002 | The buildings have been demolished and replaced with another building. | A motorway service area is adjacent to the south of the Padbury Brook, with a tributary issuing 100m southeast of the site. |
| 2010-2014 | No significant changes. | The road between the two site areas (A43) has been widened, extending up to the western boundary of the eastern part of the site. The garage appears to have been demolished and replaced with the current Esso petrol station on the opposite side of the A43. |

## ANTICIPATED GEOLOGY

The available geological information from the 1:50,000 scale British Geological Survey (BGS) map, Sheet 219 solid and drift edition, suggests the following geological sequence at the site:

| | |
|---|---|
| **Made Ground/ Topsoil** | No Made/Disturbed Ground is indicated on site, but is shown adjacent to the southwest of the site, 61m southwest of the site and 72m south of the site. Localised Made Ground is however anticipated around the buildings in the western part of the site. Topsoil is anticipated at ground surface across the remainder of the site. |
| **Drift Geology** | Drift deposits are not indicated to be present on the majority of the site. Alluvium is identified along the line of Padbury Brook on the southeastern and southern site boundaries of the eastern site. A narrow area of Head deposits extends from Junction 10 onto the western part of the site. |
| **Solid Geology** | The site is underlain by the Jurassic White Limestone Formation, which comprises pale grey to off-white or yellowish limestone. |
| **BGS records** | There are several trial pit and borehole records available along the line of the A43 and within and adjacent to the western part of the site. The ground conditions generally comprised:<br>• Topsoil to depths of between 0.2m and 0.5m bgl.<br>• Soft to firm brown/yellow brown/red brown sandy very silty clay with limestone gravel and occasional cobbles and brown clayey silt with limestone sand and |

| | |
|---|---|
| | gravel to depths of between 0.55m and 1.8m bgl (Highly Weathered Bedrock or Superficial Deposits).<br>• Light grey fossiliferous oolitic limestone with closely spaced yellow brown clay infilled discontinuities and occasional vertical and sub vertical joints interbedded with bands of stiff dark brown grey very silty sandy clay/mudstone to the base of the holes at a maximum depth of 12.9m bgl (White Limestone Formation).<br>• Groundwater was encountered at depths of 1.73m, 4.0m and 7.0m within the White Limestone Formation. |

## MINING/QUARRYING

The GroundSure Report identifies the closest ground workings to be a former limestone quarry 450m east of the site. This is not shown on the historical maps. Whilst the historical maps show evidence of old pits and quarries in the surrounding area, there is no evidence of mining on the site itself, although the possibility cannot be entirely ruled out.

A review of the DoE regional reports for Natural Underground Cavities in Great Britain (1993) indicates that the site is not located in an area of recorded natural cavity formation.

## RADON

Reference to the BRE document 211:2007 (Radon: guidance on protective measures for new buildings) and the GroundSure Report indicates that the site does not lie in an area where the geological strata may be susceptible to radon emissions. Hence, no precautions against ingress of radon into buildings are necessary.

## HYDROLOGY

The nearest surface watercourse is the Padbury Brook which is located approximately 35m south of the site and flows to the east. The Environment Agency Chemical Quality Grade for this watercourse is 'A' (excellent).

According to the GroundSure report there are no surface water abstractions within 2km of the site. There are many licensed discharges within 500m of the site, the nearest one being 29m south of the site of emergency discharges from Cherwell Valley Services into the Padbury Brook. The majority of the other licensed discharges are for storm overflow.

The Environment Agency web site indicates that the site lies outside of any flood zone. However this report is not intended to be a full hydrological study and if a flood risk assessment is needed, additional analysis by others is recommended to confirm this aspect of the development.

## HYDROGEOLOGY

According to the Environment Agency, the Alluvium is classified as a Secondary A Aquifer and the Head deposits as a Secondary (undifferentiated) Aquifer. The White Limestone Formation is classified as a Principal Aquifer.

There are three groundwater abstractions within 500m of the centre of the site, the nearest being 146m northeast of the site for household (potable) use and for general farming use. The site is not located within a groundwater Source Protection Zone. The BGS suggest that there is potential for groundwater flooding at surface within 50m of the site. It is expected this relates to the interface of groundwater at surface within the unconfined limestone aquifer adjacent to the Padbury Brook to the south of the site. Groundwater flooding at surface is considered unlikely across the main site area away from the Brook given existing levels.

## OTHER ENVIRONMENTAL DATA

Information pertaining to environmental issues was obtained from the GroundSure report, a copy which is included in Appendix B.

There are no recorded historic or current landfill sites within 250m of the site.

There are two currently operational petrol stations within 250m of the site, namely Baynards Green Service Station operated by Esso 110m north of the site and Cherwell Valley Service Area operated by Moto Hospitality 170m south of the site. There are no other recorded current industrial land uses within 250m of the site.

There are three recorded pollution incidents within 250m of the site, all for oils and fuel in 2002 and 2003. They were classified as having a minor impact on water and minor or no impact to land.

The site is within a nitrate vulnerable zone. There are several ancient and semi-natural woodlands and ancient replanted woodlands within 2km of the site, the closest being 384m south of the site. There are two SSSI within 2km of the site, namely Ardley Cutting and Quarry 1.25km southwest of the site and Ardley Trackways 1.7km south of the site.

## PRELIMINARY COMMENTS

### Geoenvironmental Aspects

Based on the desk study carried out, it is considered there is limited potential for significant contamination to be present at the site as a result of its history and former uses. Localized hotspots could be present associated with small areas of imported Made Ground, asbestos cement building materials, leakages from farm plant/refuelling etc. The presence of elevated pesticide concentrations cannot be discounted but are considered unlikely. Offsite, the nearby Petrol Filling Station poses a low though potential risk of hydrocarbons contamination. Naturally elevated heavy metal contamination can be associated with some Jurassic strata in the region and Superficial strata derived from them. Whilst unlikely to pose a significant risk in the context of the proposed development, it is possible that elevated concentrations in topsoil could be present, which could potential make such material unsuitable for re-use in a more sensitive residential end use.

## GEOTECHNICAL COMMENTS

Competent natural solid geology is expected at shallow depth. Such strata are expected to be suitable to support conventional shallow foundations and floor slabs. Subject to appropriate selection moisture content control, compaction and possible processing, cut materials are likely to be suitable for use in a Controlled Earthworks programme. Where significant cut is proposed, intact rock is likely to be present which may require use of high capacity plant, breakers, rippers or other techniques. Current information suggests groundwater may be present at depths as shallow as 1.75m bgl in places, hence this would need to be carefully investigated if any significant cut or excavations were proposed.

The Solid Geology is likely to be suitable for infiltration drainage, subject to depth groundwater.

Should you have any queries please do not hesitate to contact us.

Yours sincerely
**For and on behalf of Applied Geology Ltd**

**Prepared by:** **Checked by:**

**N Laws BSc (Hons) CGeol FGS**
Senior Geoenvironmental Engineer

**J B Cartwright BEng (Hons) MSc FGS**
Managing Director

**APPENDICES**

**Appendix A – Site Location Plan**
**Appendix B – Desk Study Information**

# APPENDIX A

# Site Location Plan

Site: **Ardley, Junction 10, M40**
Title: **Taken from Ordnance Survey (1:50,000) Map 164, Oxford, Chipping Norton and Bicester**

NGR: **SP 547 289** Project No: **AG2255-15**

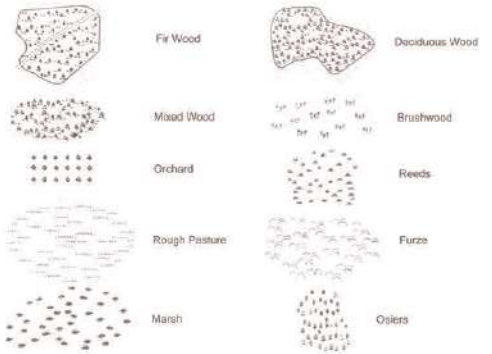



APPLiED GEOLOGY

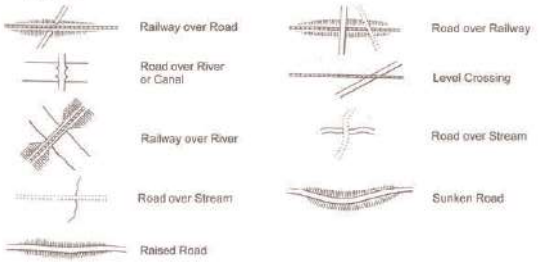
# APPENDIX B

## County Series 1:10,560 scale

### VEGETATION




### ROADS




### RAILWAYS


### GENERAL FEATURES


### BOUNDARIES


## National Grid 1:10,000 scale

### HEIGHTS (METRES)

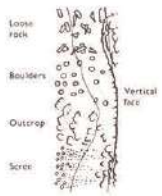
Values are given in metres above mean sea level at Newlyn.

Surface heights determined by ground survey / air survey

Bench marks and their values are shown on large scale maps, and bench mark lists, containing fuller and possibly later levelling information are obtainable from the Director General, Ordnance Survey.

Contours are at 5 metres vertical interval.

### ROCK FEATURES

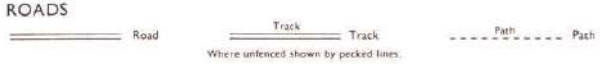



### CONVERSION SCALE


### ABBREVIATIONS

| | | | |
|---|---|---|---|
| BP,BS | Boundary Post or Stone | PO | Post Office |
| Ch | Church | PC | Public Convenience |
| CH | Club House | PH | Public House |
| F Sta | Fire Station | S | Stone |
| FB | Foot Bridge | Spr | Spring |
| Fn | Fountain | TCB | Telephone Call Box |
| GP | Guide Post | TCP | Telephone Call Post |
| MP,MS | Mile Post or Stone | TH | Town Hall |
| P | Pole or Post | W | Well |
| Pol Sta | Police Station | Y | Youth hostel |

### ROADS

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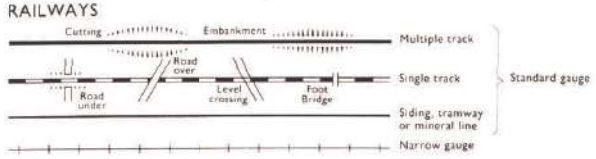
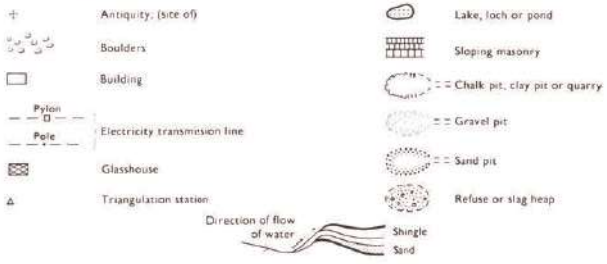



### GENERAL FEATURES




### VEGETATION


In some areas bracken ( ) and rough grassland ( ) are shown separately.

GroundSure

# Historical Map Pack Legend

## County Series & National Grid

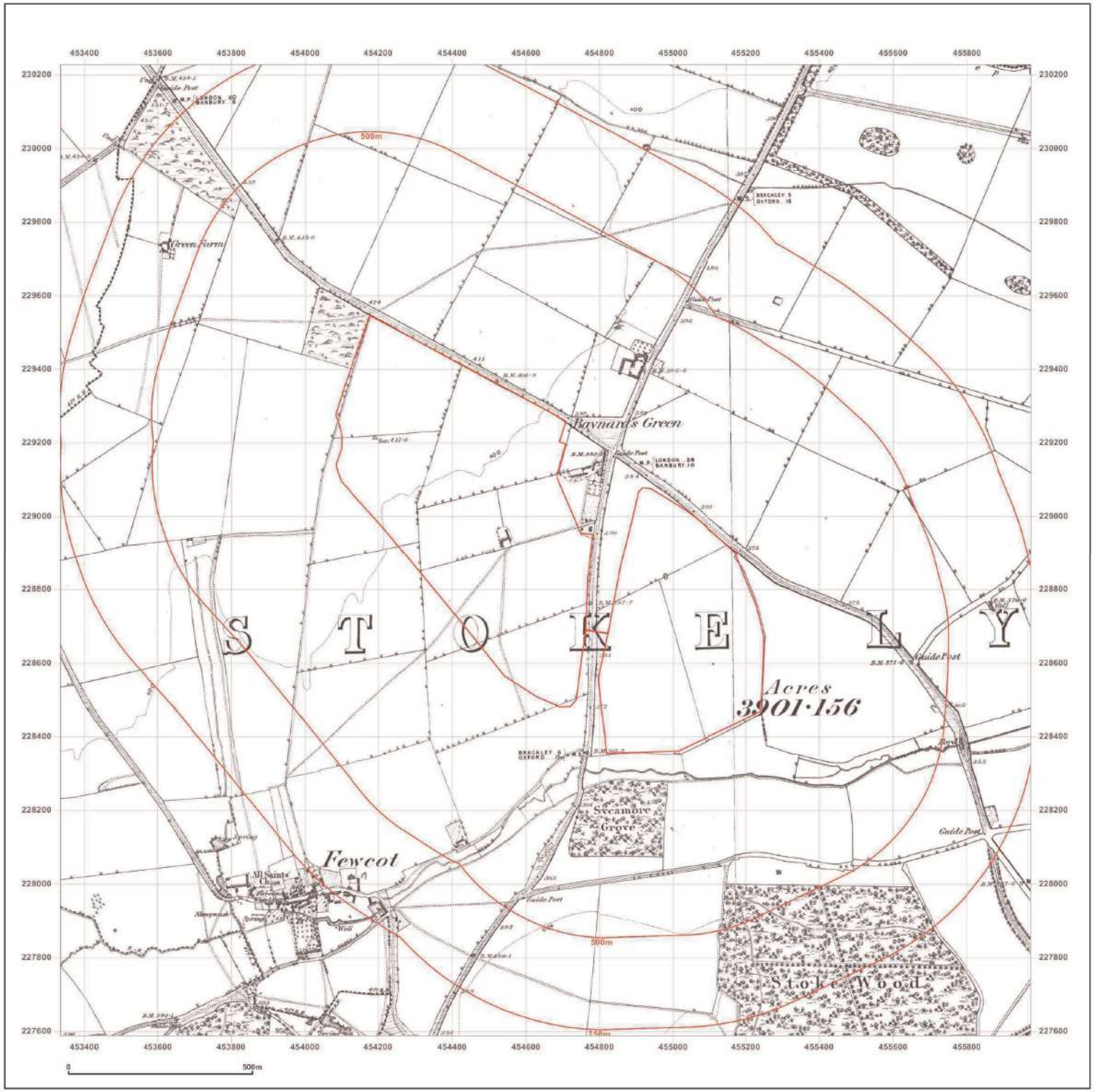
## 1:10,560 scale & 1:10,000 scale

**Information present on these legends is sourced from the same Ordnance Survey mapping as the maps used in this product.**

**If you have a query regarding any of the maps provided please contact GroundSure's technical helpline. We will endeavour to answer any queries you may have.**


**Technical Helpline**

**Tel:01273 819 700**
maps&data@groundsure.com
www.groundsure.com

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Ardley,Junction 10
M40,Oxfordshire,OX27 7SS

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**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

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**Scale:** 1:10,560
**Printed at:** 1:10,560

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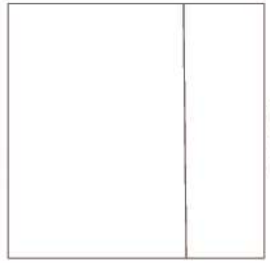

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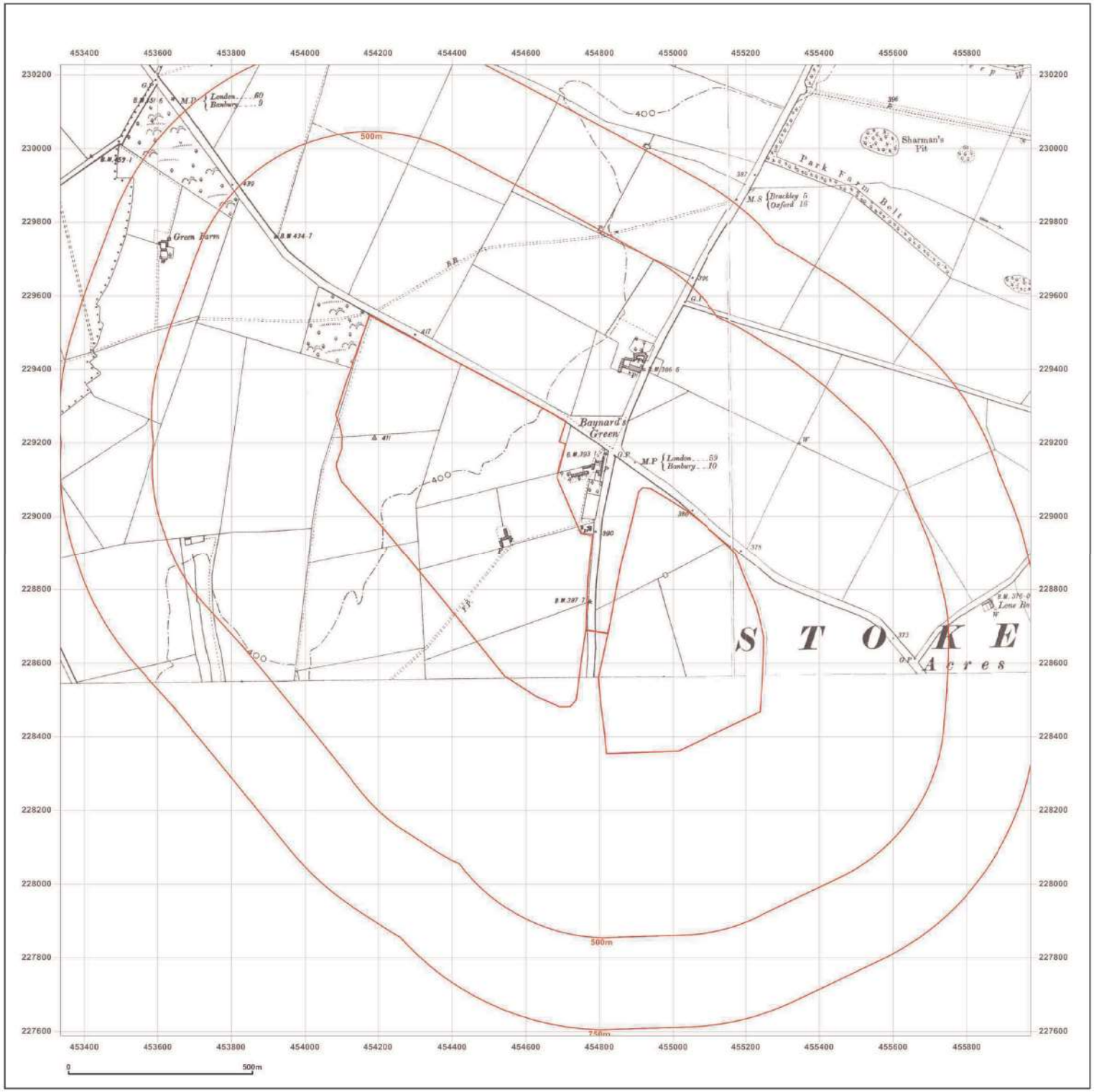


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Surveyed 1606
Revised 1900
Edition N/A
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Levelled N/A

Surveyed 1879
Revised 1900
Edition N/A
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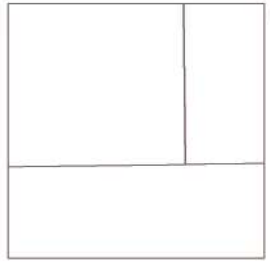
Levelled N/A



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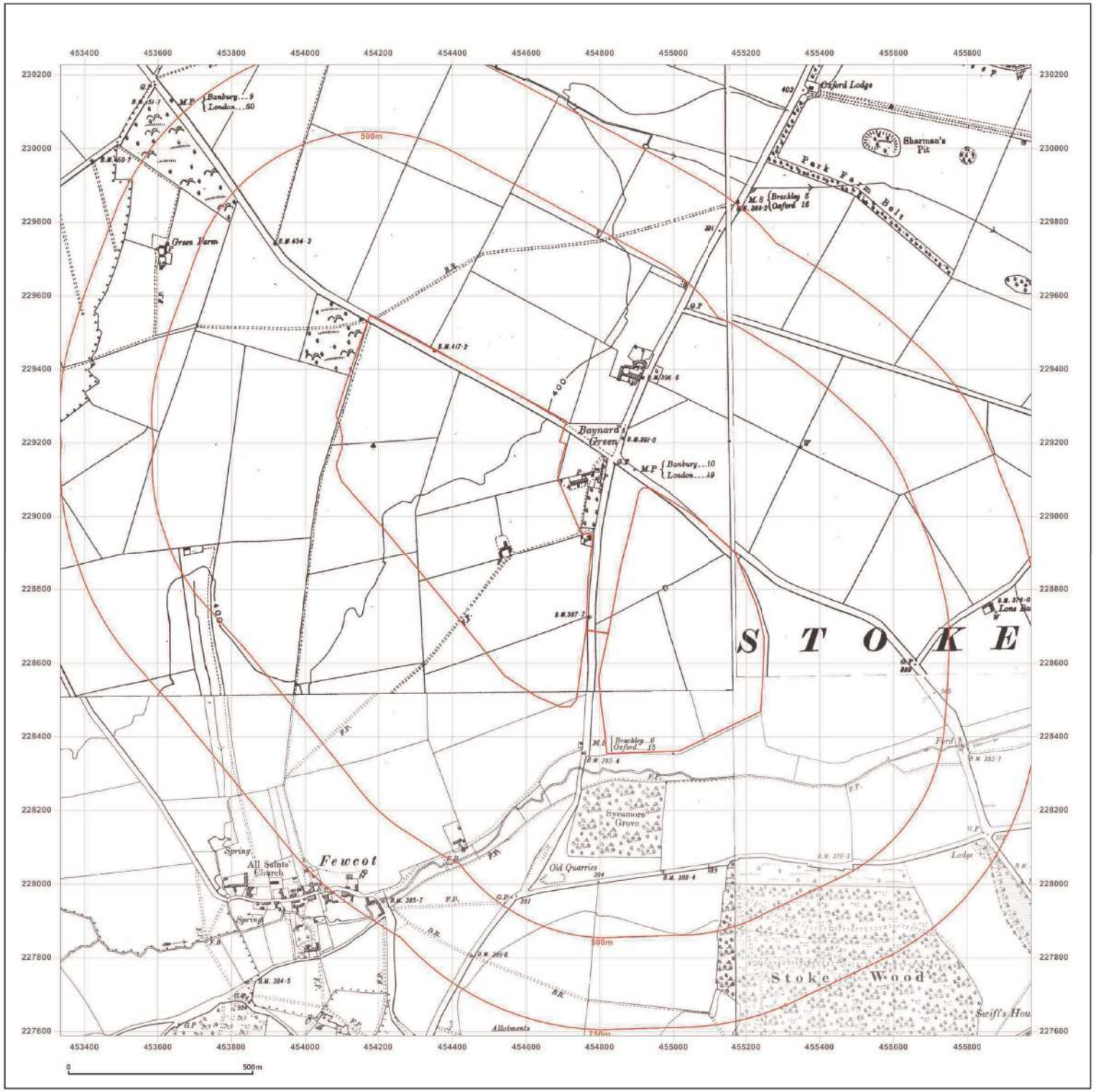


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Ardley,Junction 10
M40,Oxfordshire,OX27 7SS

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**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** County Series
**Map date:** **1919-1920**
**Scale:** 1:10,560
**Printed at:** 1:10,560

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Surveyed N/A
Revised N/A
Edition N/A
Copyright N/A
Levelled N/A

Surveyed N/A
Revised N/A
Edition N/A
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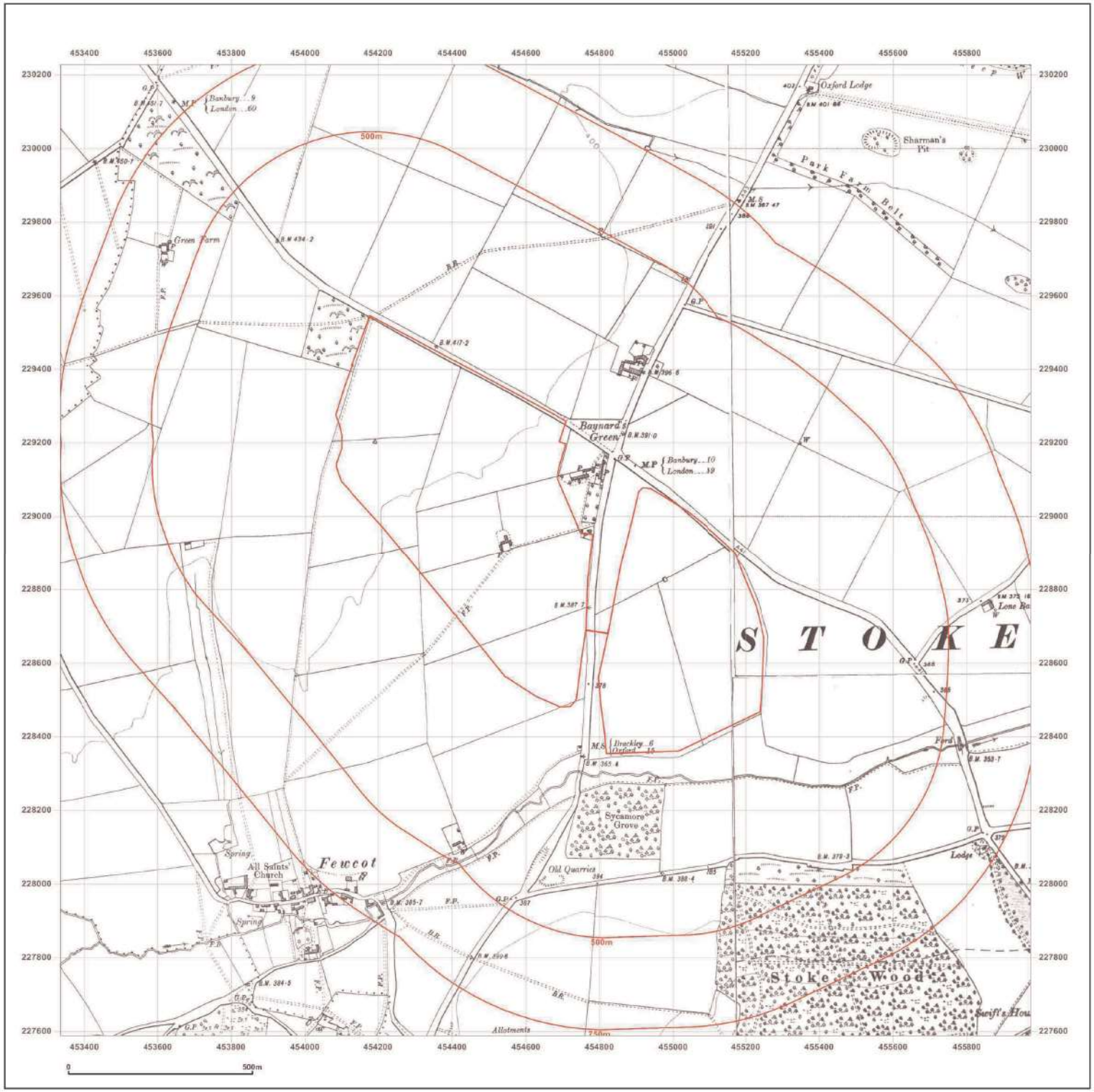


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**Site Details:**

Ardley,Junction 10
M40,Oxfordshire,OX27 7SS

**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** County Series
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**Scale:** 1:10,560
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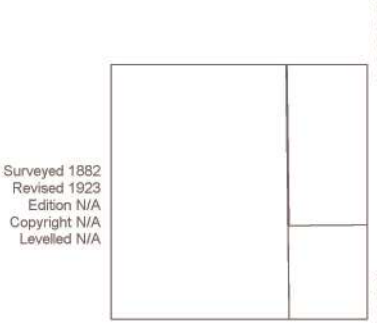


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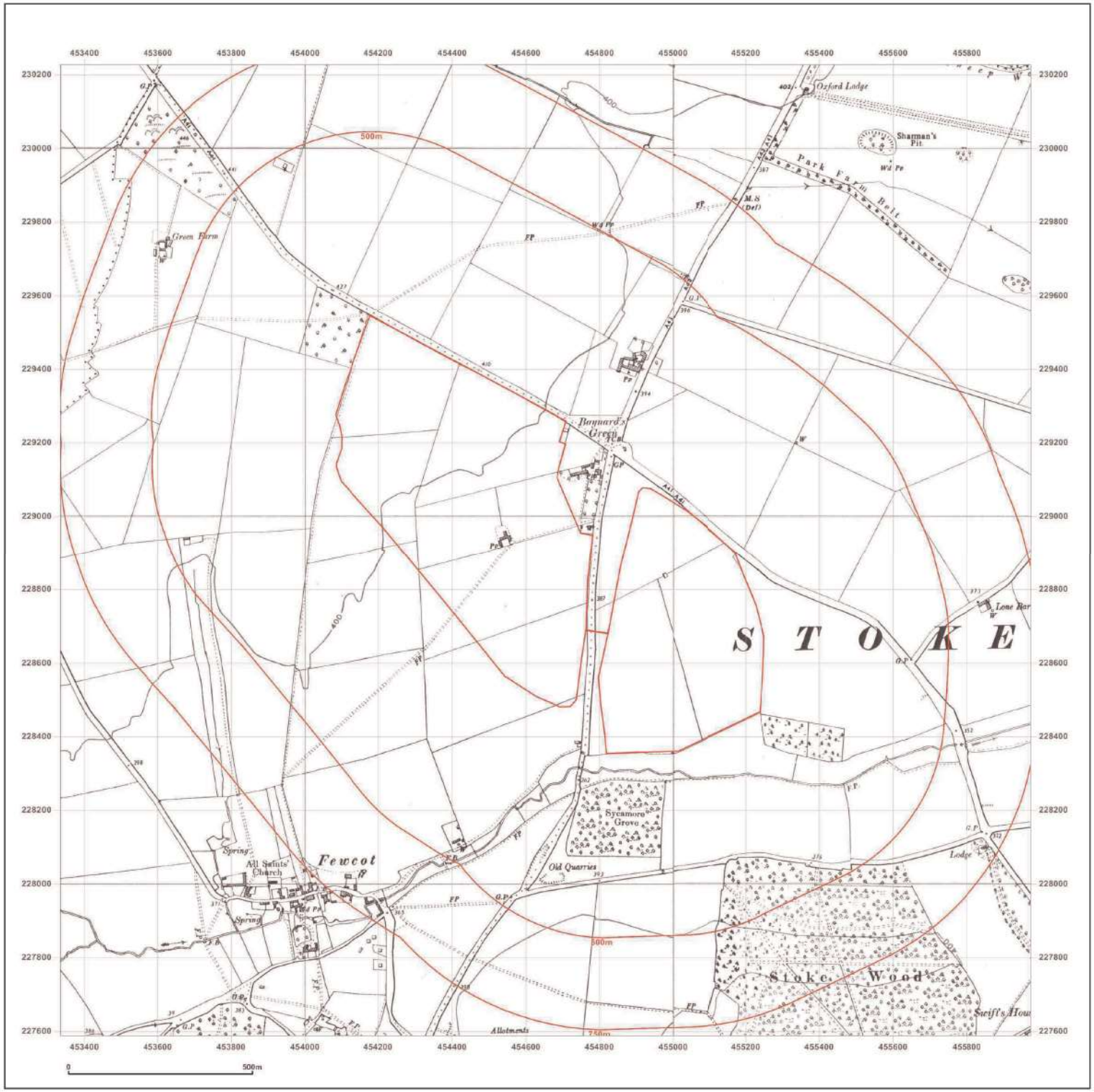


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** Provisional
**Map date:** **1950-1954**
**Scale:** 1:10,560
**Printed at:** 1:10,560

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Surveyed N/A
Revised 1954
Edition N/A
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Surveyed 1950
Revised 1950
Edition N/A
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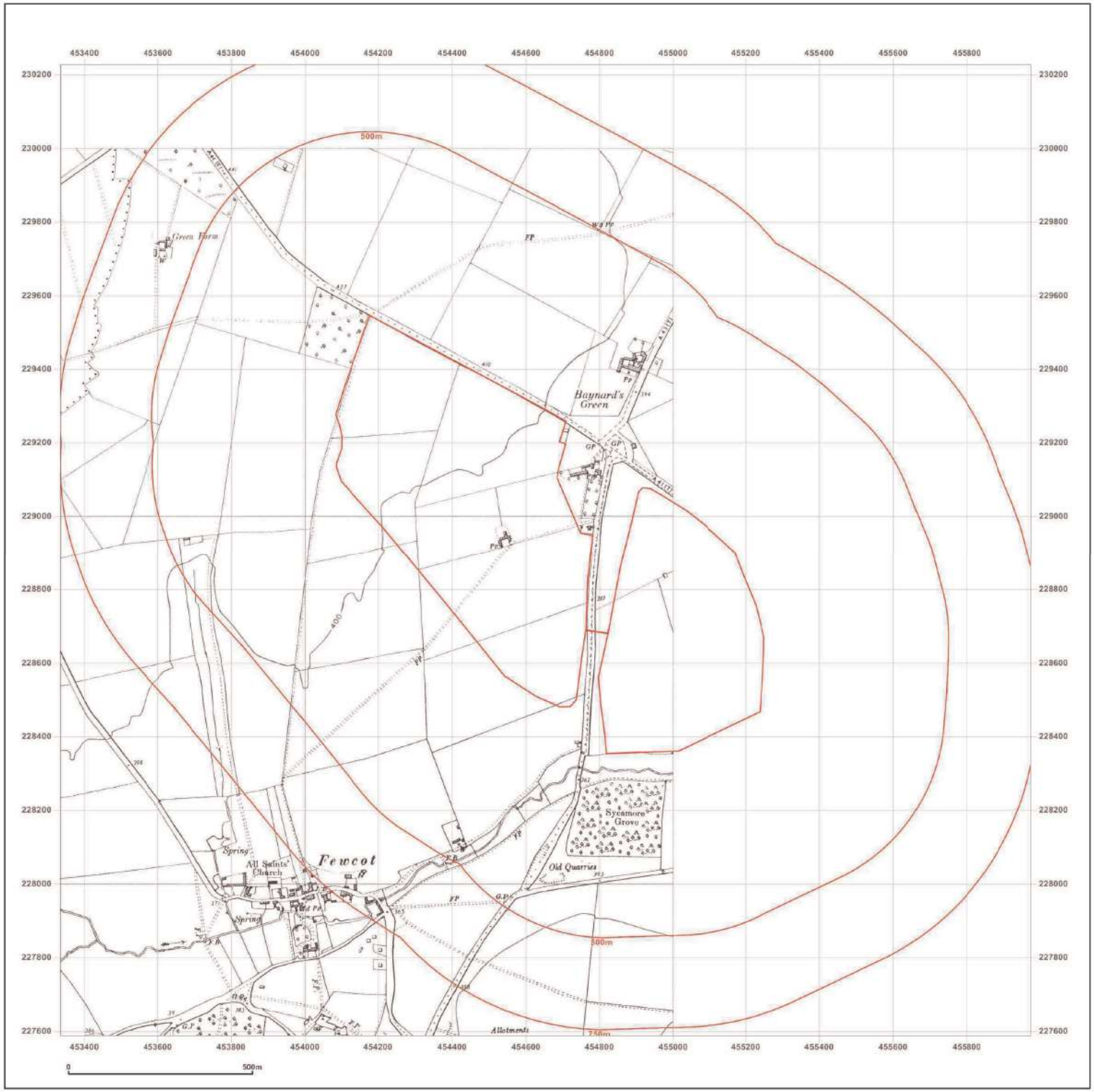


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** Provisional
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**Scale:** 1:10,560
**Printed at:** 1:10,560

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Revised 1965
Edition N/A
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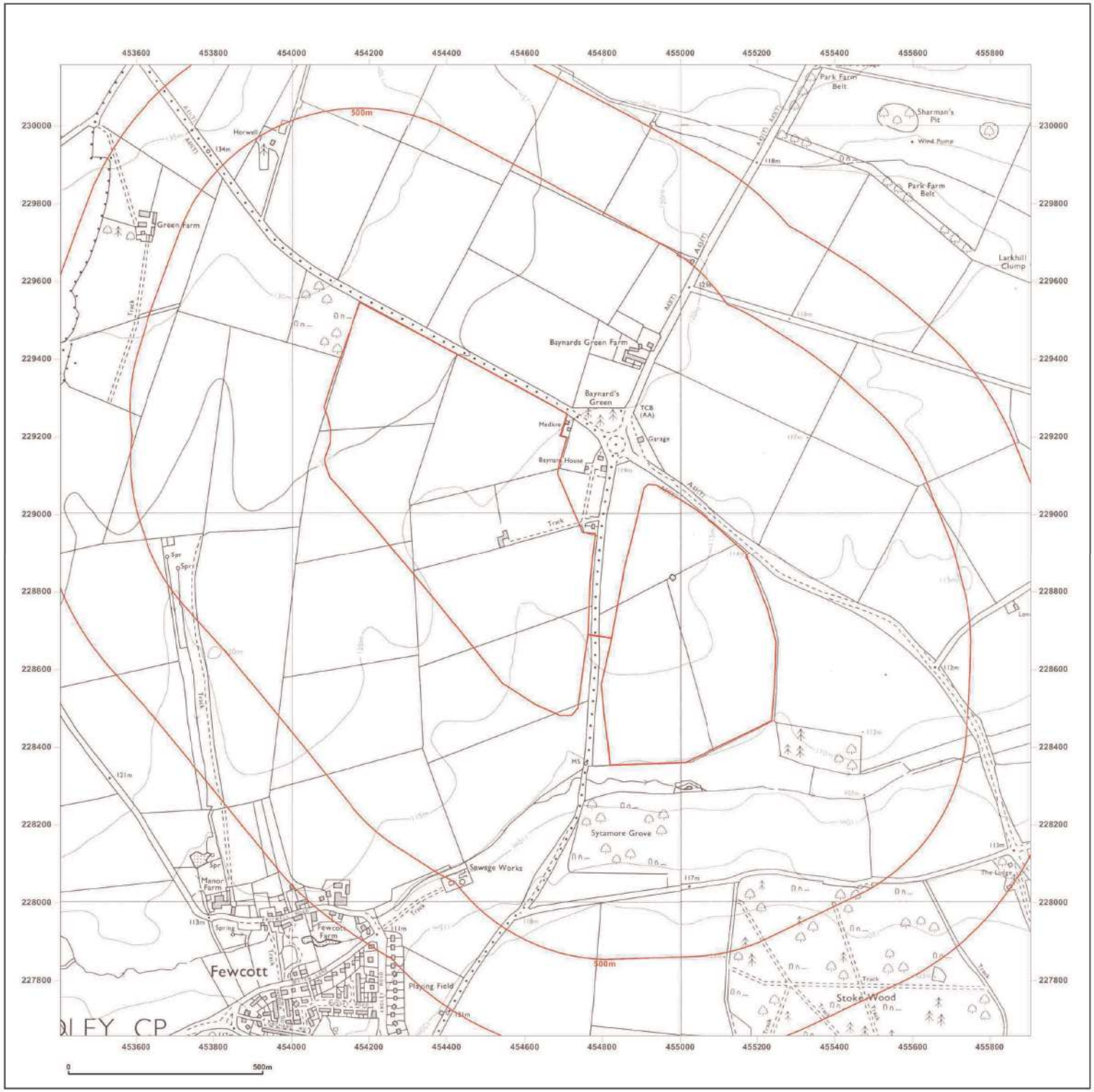


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** National Grid
**Map date:** **1980-1981**
**Scale:** 1:10,000
**Printed at:** 1:10,000

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Surveyed 1977
Revised 1981
Edition N/A
Copyright N/A
Levelled N/A

Surveyed 1977
Revised 1981
Edition N/A
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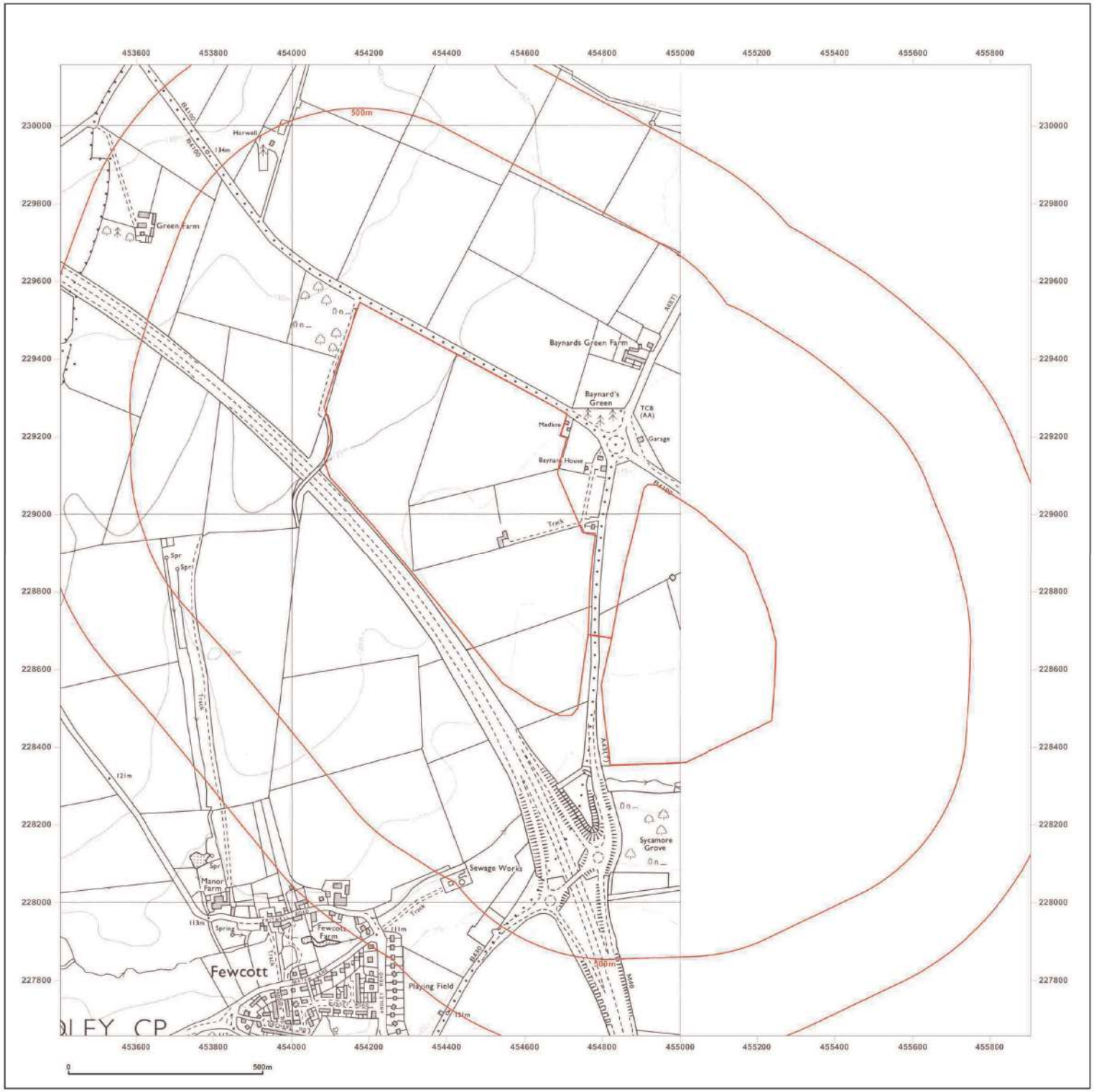


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** National Grid
**Map date:** **1992**
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**Printed at:** 1:10,000

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Surveyed 1977
Revised 1992
Edition N/A
Copyright N/A
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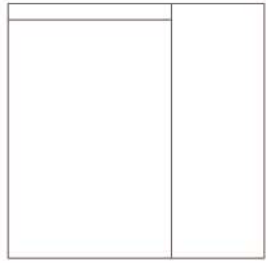

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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** 1:10,000 Raster
**Map date:** **2002**
**Scale:** 1:10,000
**Printed at:** 1:10,000

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2002

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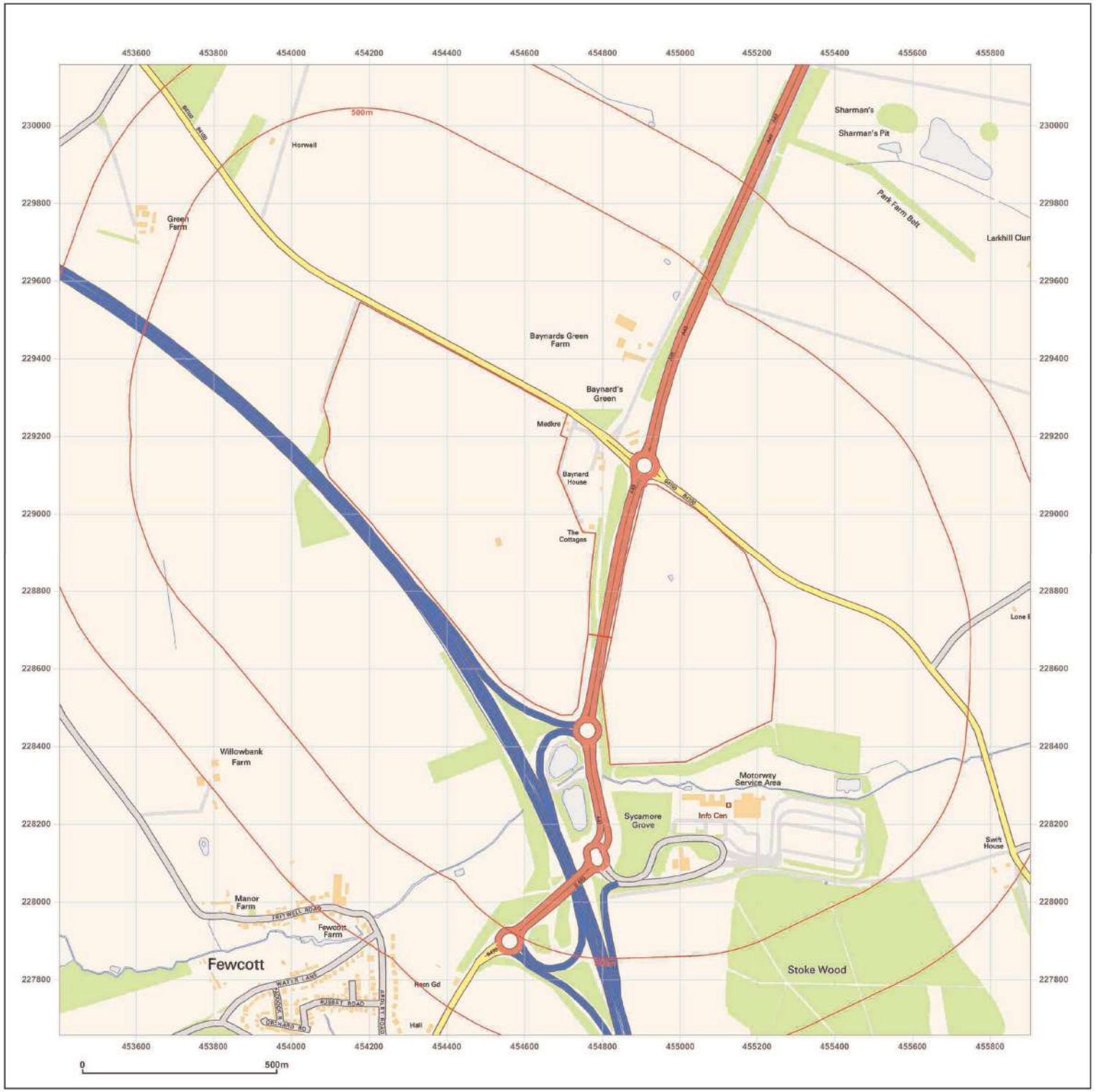


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** National Grid
**Map date:** **2010**
**Scale:** 1:10,000
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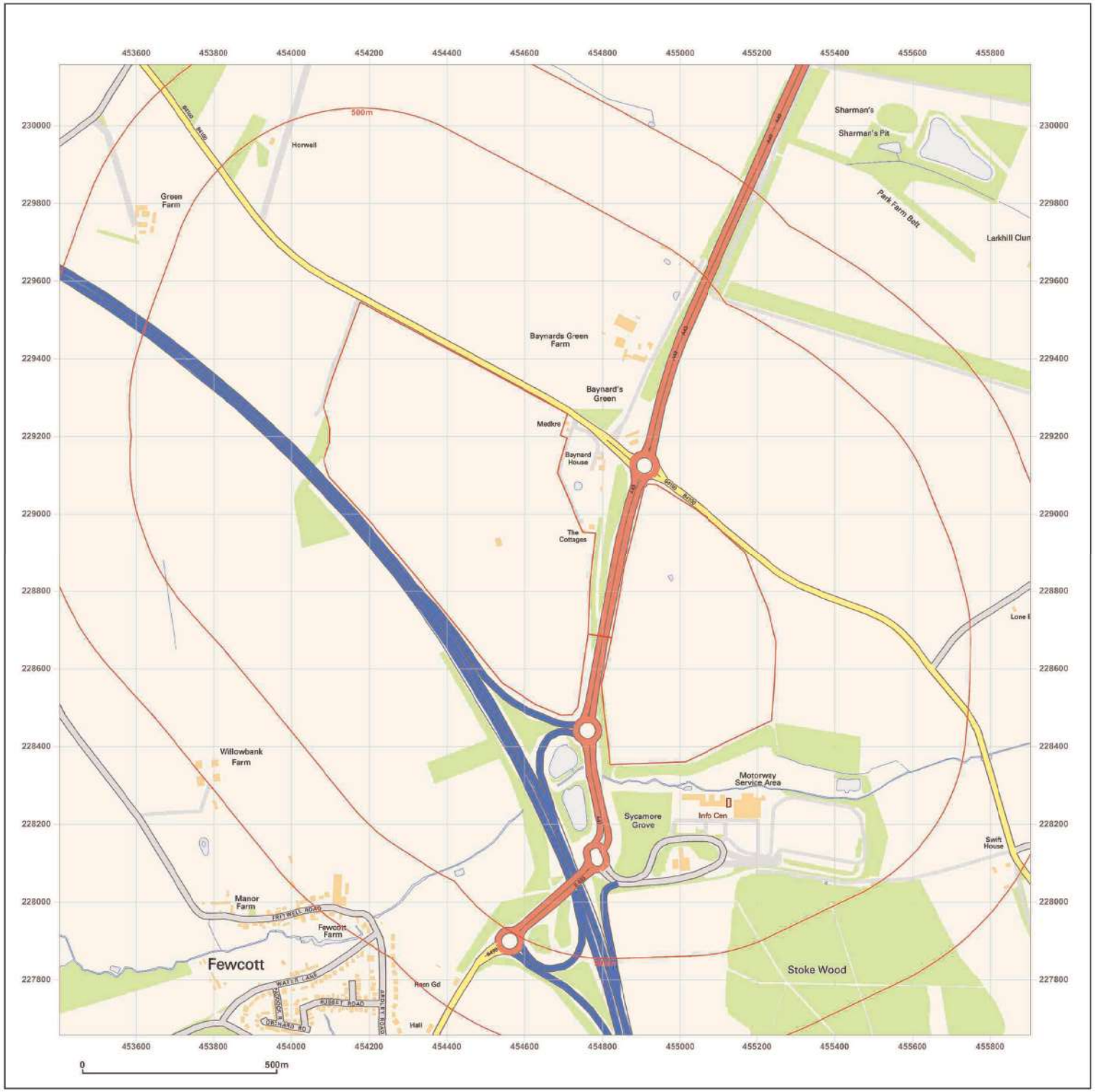


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360
**Grid Ref:** 454654, 228907

**Map Name:** National Grid
**Map date:** **2014**
**Scale:** 1:10,000
**Printed at:** 1:10,000

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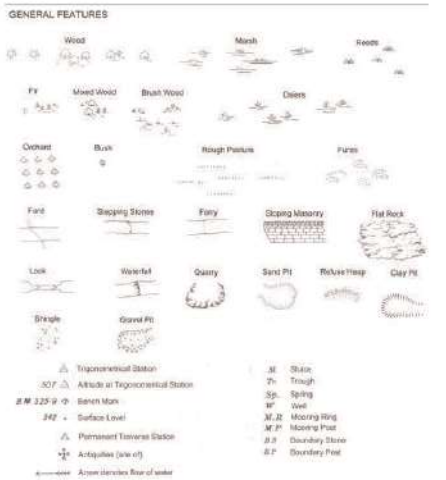
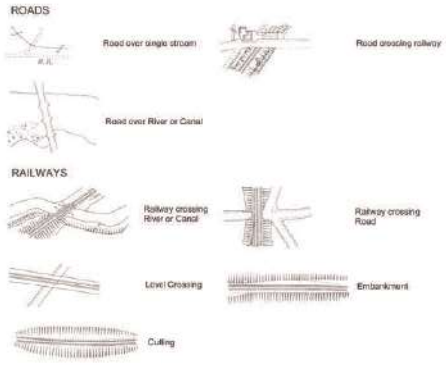
## County Series 1:2,500 scale

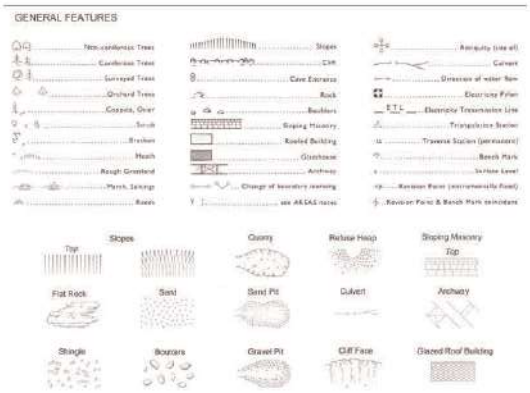



ABBREVIATIONS

| | | | |
|---|---|---|---|
| △ | Trigonometrical Station | St. | Stone |
| 507 △ | Altitude of Trigonometrical Station | Tr. | Trough |
| B.M. 325·9 | Bench Mark | Sp. | Spring |
| 342 | Surface Level | W | Well |
| △ | Permanent Traverse Station | M.R. | Mooring Ring |
| | Antiquities (site of) | M.P. | Mooring Post |
| ←←← | Arrow denotes flow of water | B.S. | Boundary Stone |
| | | B.P. | Boundary Post |

## National Grid 1:2,500 / 1:1,250 scale




BOUNDARIES

England & Wales

- County Boundary (geographical)
- County & Civil Parish Boundary coterminous
- Admin County or County Borough Boundary
- London Borough Boundary
- M B Bdy, U D Bdy, R D Bdy — County District Boundaries based on civil parish

England, Wales & Scotland

- Civil Parish Boundary
- Boro (or Burgh) Const. & Ward Bdy / Co Const Bdy — Parly & Ward Boundaries based on civil parish
- Boro (or Burgh) Const. & Ward Bdy / Co Const Bdy — Parly & Ward Boundaries not based on civil parish

Scotland

- County Boundary (geographical) *
- Co Cnl Bdy * / † — County Council Boundary
- Co of City Bdy * / † — County of the City Boundary
- Burgh Bdy * / † — Burgh Boundary
- Dist Bdy * / † — District Council Boundary

* Not with parish  † Coincident with parish

ABBREVIATIONS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B H | Beer House | F Sta | Fire Station | M P U | Mail Pick-up | S L | Signal Light |
| B M | Bench Mark | G P | Garde Post | M S | Mile Stone | Sl | Sluice |
| B P | Boundary Post | G V C | Gas Valve Compound | N T | National Trust | S P | Signal Post |
| B S | Boundary Stone | H | Hydrant or Hydraulic | N T L | Normal Tidal Limit | Spr | Spring |
| C | Crane | Ha | Hectares | N T S | National Trust for Scotland | S Sta | Signal Station |
| C H | Club House | L B | Letter Box | P | Pillar, Pole or Post | T C B | Telephone Call Box |
| Chy | Chimney | L B Sta | Lifeboat Station | P C | Public Convenience | T C P | Telephone Call Post |
| Cn | Capstan | L C | Level Crossing | P C B | Police Call Box | Tk | Tank or Track |
| D Fe | Drinking Fountain | L G | Loading Gauge | P H | Public House | Tr | Trough |
| Dk | Dock | L Ho | Lighthouse | P O | Post Office | Tr | Traverse Station |
| E P | Electricity Pillar or Post | L Twr | Lighting Tower | Pp | Pump | W | Well |
| E T L | Electricity Transmission Line | m | Metres | P T P | Police Telephone Pillar | W B | Weighbridge |
| F A | Fire Alarm | M H W | Mean High Water | Resr | Reservoir | W Cp | Wind Pump |
| F A P | Fire Alarm Pillar | M H W S | Mean High Water Springs | R M | Reed House | Wks | Works |
| F B | Pillar Bed, Foot Bridge | M L W | Mean Low Water | rp | Revision Point | W Pt | Water Point |
| F B M | Fundamental Bench Mark | M L W S | Mean Low Water Springs | S | Stone | W T | Water Tap |
| F S | Flagstaff | M P | Mile or Mooring Post | S B | Signal Box | | |

# GroundSure

# Historical Map Pack Legend

## County Series

## 1:1,250 scale

## ~

## County Series & National Grid

## 1:2,500 scale

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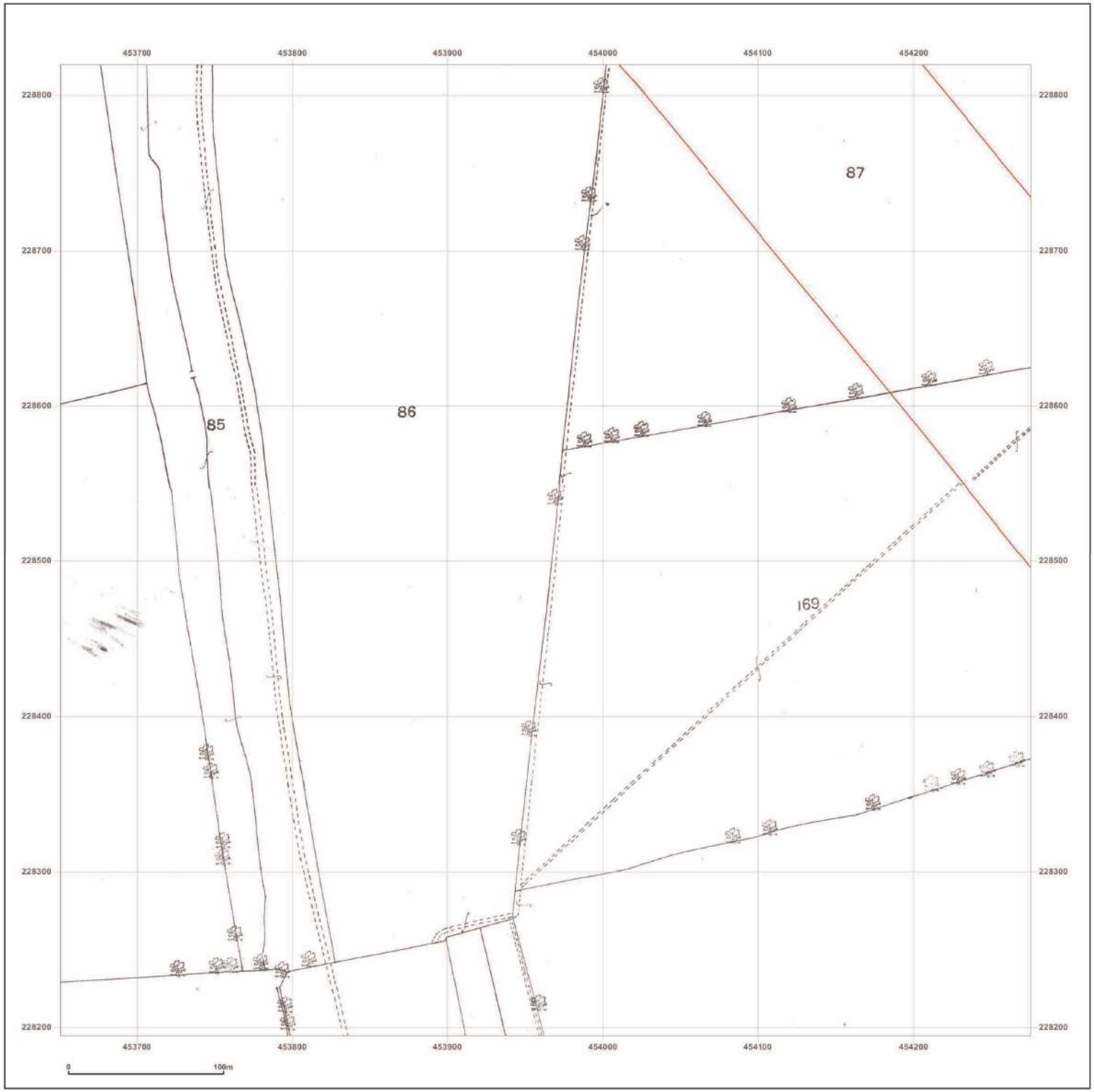


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M40,Oxfordshire,OX27 7SS

**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_2
**Grid Ref:** 453963, 228507

**Map Name:** County Series
**Map date:** **1880-1881**
**Scale:** 1:2,500
**Printed at:** 1:2,500

N
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Edition N/A
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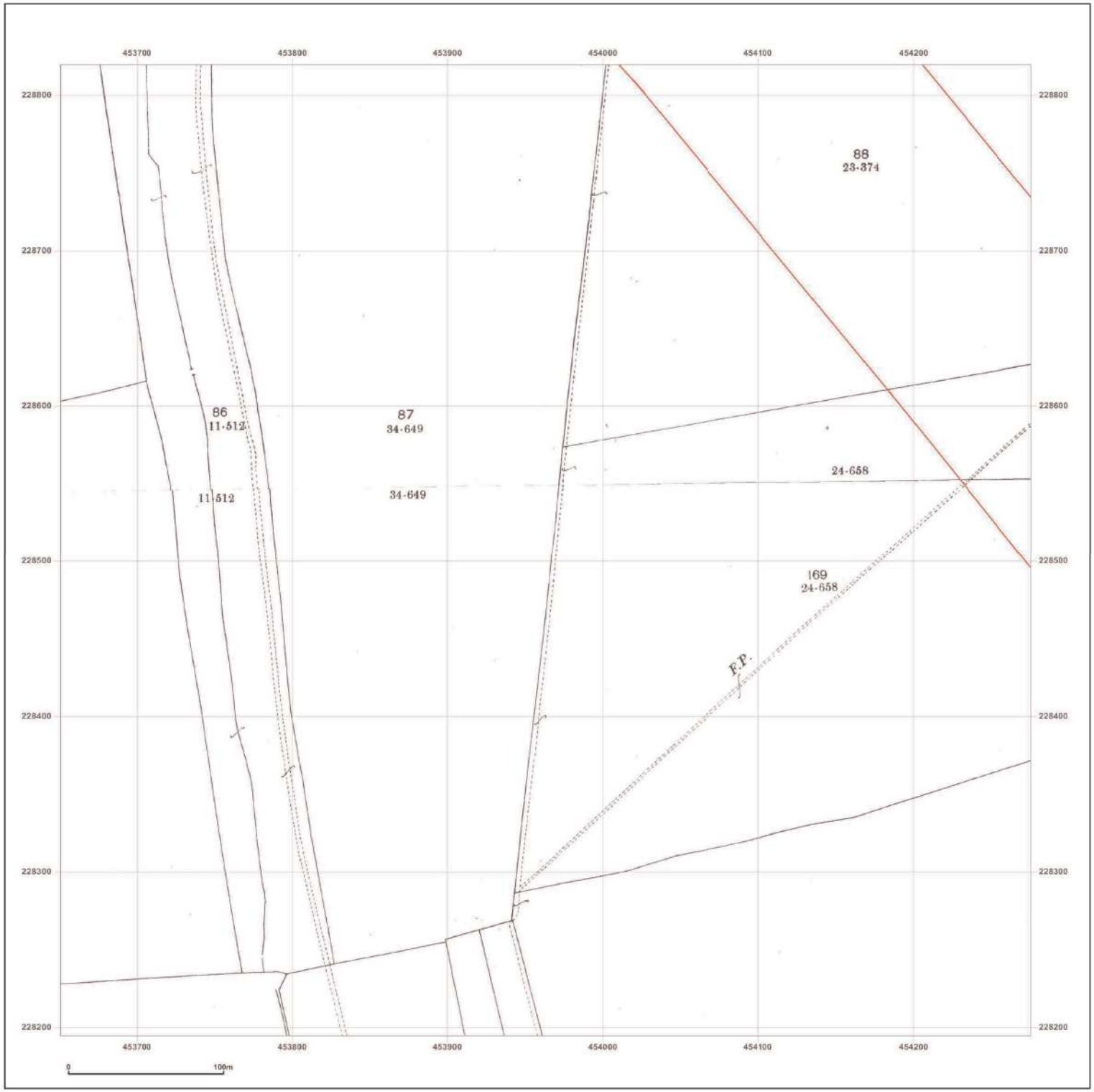


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_2
**Grid Ref:** 453963, 228507

**Map Name:** County Series
**Map date:** 1900
**Scale:** 1:2,500
**Printed at:** 1:2,500

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Revised 1900
Edition N/A
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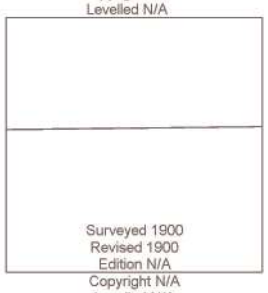
Levelled N/A



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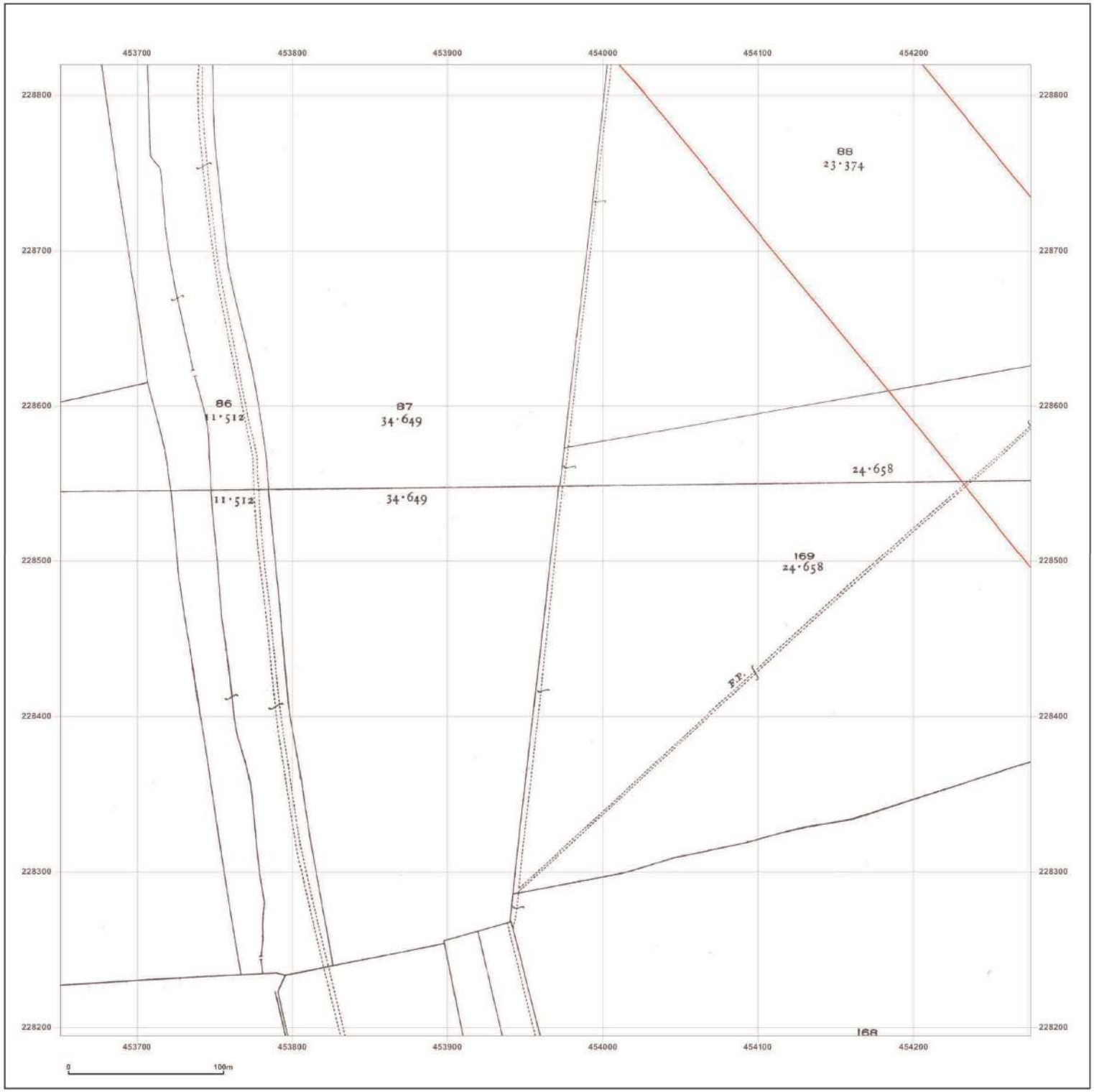


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_2
**Grid Ref:** 453963, 228507

**Map Name:** County Series
**Map date:** 1922
**Scale:** 1:2,500
**Printed at:** 1:2,500

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Surveyed 1922
Revised 1922
Edition N/A
Copyright N/A
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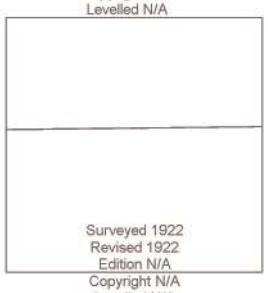

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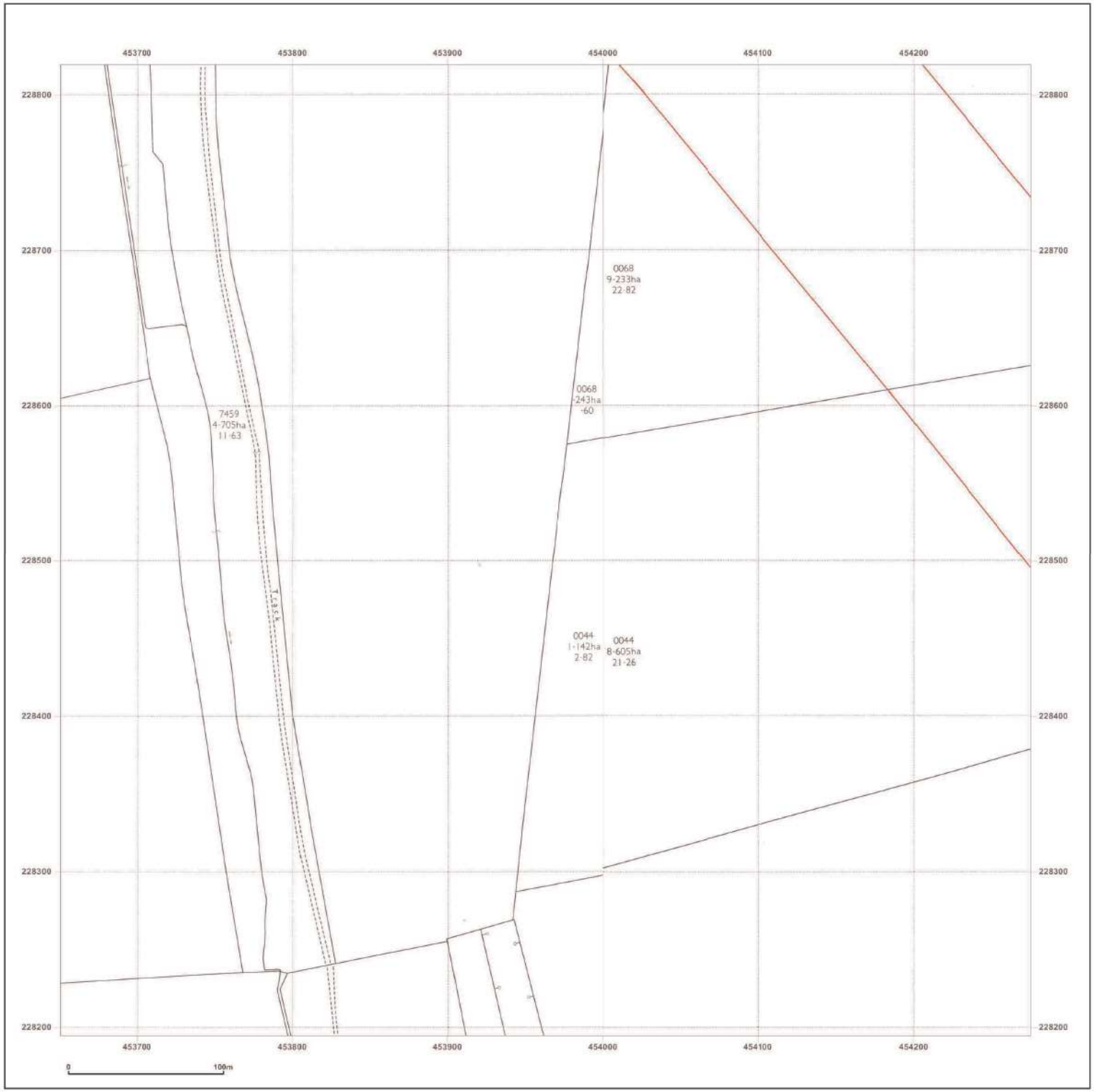


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_2
**Grid Ref:** 453963, 228507

**Map Name:** National Grid
**Map date:** **1974-1975**
**Scale:** 1:2,500
**Printed at:** 1:2,500

N
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Revised 1975
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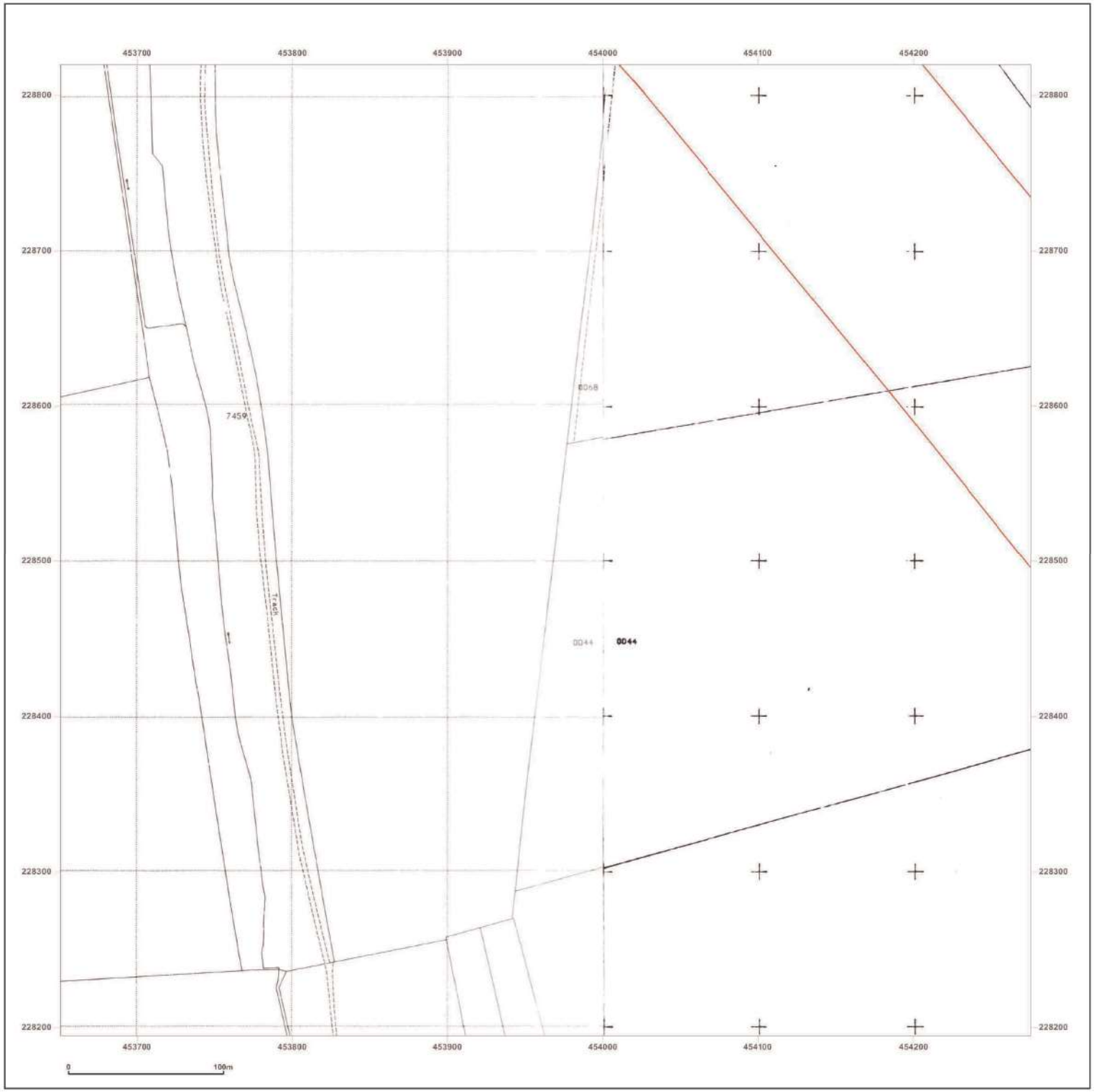


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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_2
**Grid Ref:** 453963, 228507

**Map Name:** National Grid
**Map date:** **1992-1994**
**Scale:** 1:2,500
**Printed at:** 1:2,500

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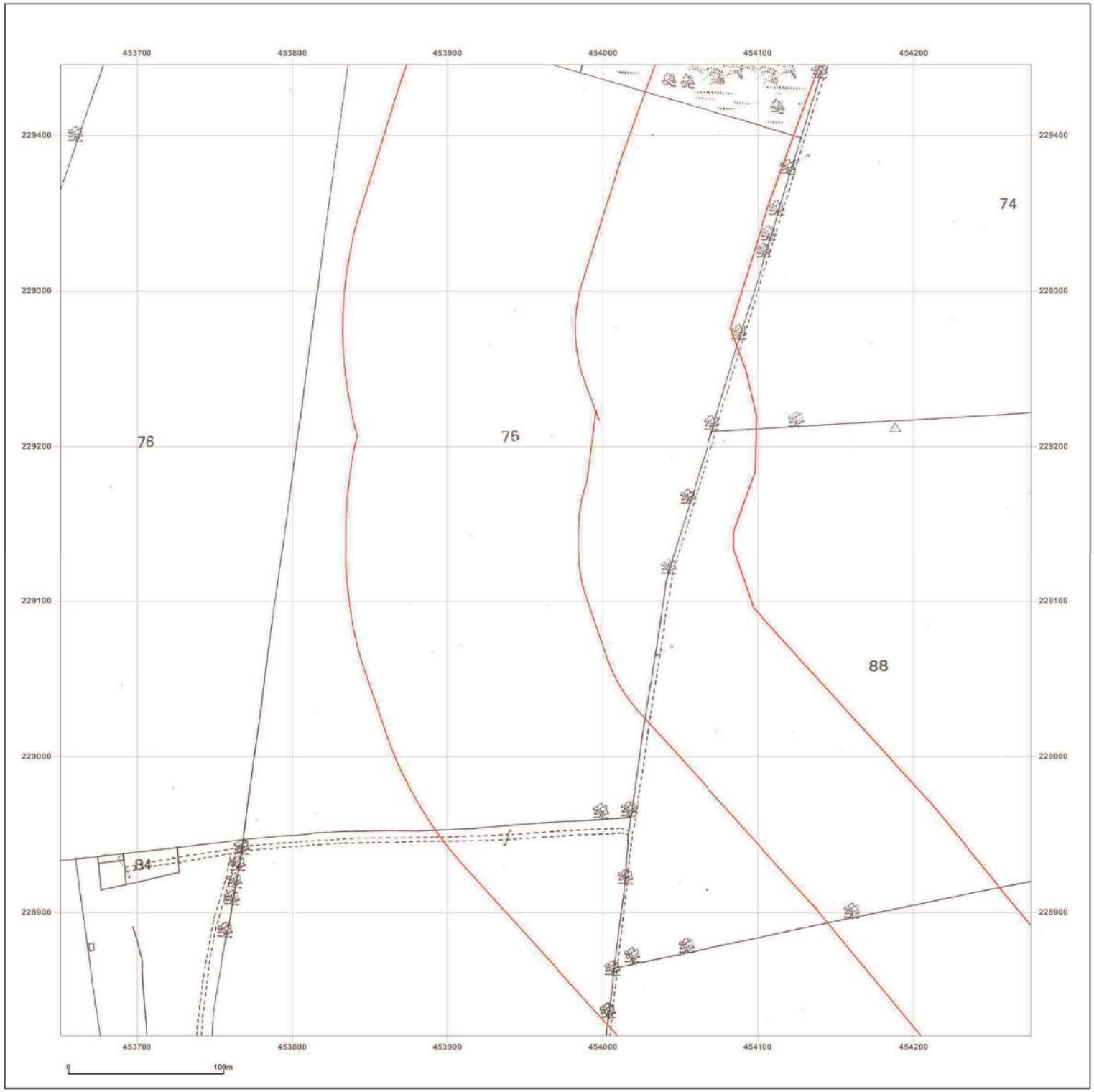


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**Site Details:**

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**Client Ref:** EMS_304528_411360
**Report Ref:** EMS-304528_411360_LS_1_3
**Grid Ref:** 453963, 229133

**Map Name:** County Series
**Map date:** **1880**
**Scale:** 1:2,500
**Printed at:** 1:2,500

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