Crossfield Consulting Limited

Geotechnical and Environmental Consultants

McCARTHY & STONE RETIREMENT LIFESTYLES LIMITED

LONDON ROAD, WATERLOOVILLE

SITE INVESTIGATION REPORT

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1. INTRODUCTION

McCarthy & Stone Retirement Lifestyles Limited proposes to redevelop a site at London Road, Waterlooville. Currently, the site is vacant, but was previously occupied by a builders merchant. The proposed development is understood to comprise a three- to four-storey block of sheltered accommodation apartments, together with associated car parking and areas of managed landscaping.

Crossfield Consulting Limited has been commissioned to undertake an investigation of the site to identify potential constraints to redevelopment relating to the ground conditions and including a risk-based environmental assessment and recommendations for remediation works, foundations, road pavement design and general construction advice in the context of the above development proposals.

This report presents the information obtained from a desk study and ground investigation. Sections 2 to 4 of the report, together with the associated Figures and Appendices, provides a Ground Investigation Report (GIR), as defined in BS EN 1997-1:2004 and BS EN 1997-2:2007.

A risk-based assessment of potential contamination is included in Section 6 of the report. This assessment makes reference to a desk study, ground investigation information and a Conceptual Site Model. It is considered that the report complies with Planning Policy Statement 23 and is in general accordance with guidance published by the Environment Agency, NHBC and Havant Borough Council.

The report also includes information required to form a Geotechnical Design Report as defined in BS EN 1997-1:2004, and the salient information, assessments and recommendations are presented in Sections 7 to 12 of the report, together with the associated Figures and Appendices.

It is considered that the report is suitable for submission in support of a planning application and the report is appropriate to assist in an appraisal of development solutions and costs, together with the preparation of engineering designs for the development. The report also complies with the published guidance relating to the requirements of a Building Control authority.

2. THE SITE

2.1 Location

The site is located on London Road, approximately 1.2 km to the northwest of Junction 3 of the A3(M), as shown on Figure 1. The National Grid Reference for the site is SU 684 096. The site is bound by London Road to the northwest, Beaconsfield Road to the northeast and residential properties to the southwest and southeast, as shown on Figure 2.

2.2 Site Description

The site description is based on observations made at the time of the ground investigation and the topographic survey provided by the Client, as shown on Figure 3.

The site is rectangular-shaped and approximately 0.35 ha in area. The site slopes down to the southeast by approximately 3.5 m. Trees are present along the southwestern boundary.

A small retaining wall (retaining approximately 0.6 m of soils) is defines the northwestern boundary and a small tarmac-surfaced car park is present between the retaining wall and the buildings on site. The buildings on site are all attached and comprise a two-storey former house with a large, two-storey high, flat-roof building to the southwest. To the rear of the former house lies a three-storey building, behind which is a single-storey structure. A small retaining wall (retaining approximately 0.4 m of soils) is present to the northeast of the boundary between the house and three-storey building. The three-storey and two-storey high structures have lorry loading bays along the northeastern sides. Surfacing to the northeast and east of the buildings comprises concrete.

2.3 Site History

The site history has been researched with reference to old editions of the County Series and National Grid Ordnance Survey Plans obtained from the British Library, London. Extracts from a selection of these plans are presented in Appendix I. The plans indicate the following development has taken place on and around the site.

The County Series Plan, dated 1860, shows the southwestern half of the site to lie within the ground of Wellington Cottage. Two small structures are present within the southern part of the site. The northeastern half of the site lies within an open field. The northwestern boundary is defined by a road later identified as London Road.

The 1895 plan shows that one of the structures present within the site boundary had been extended and a house had been built to the immediate east of the site. A road, later identified as Beaconsfield Road, lies along the northeastern site boundary. No significant changes are shown on the map dated 1907.

By 1930, the grounds of Wellington House, which occupy the southwestern half of the site, are shown to have been divided into four new residential properties.

The National Grid Plan, dated 1952, identifies the northeastern part of the site as a Builder's Yard and shows that two small structures had been built to the northwest of the main building. By 1965, a building identified as No. 344 had been built in the northern part of the site and the main building to the rear of this property had been extended.

By 1985, the residential properties within the southwestern half of the site had been demolished and a single-footprint structure had been built incorporating No. 344. This plan shows that the structures to the west and south of the site had been demolished and new houses and flats had been built in their place. A new road junction had been built to the southwest of the site.

It is understood that the site was used as a builder's yard until recently when the site was vacated.

2.4 Desk Study Enquiries

Enquiries were made to the Groundsure Environmental Database regarding the site and surrounding area. Information obtained from these enquiries is presented in Appendix II and summarised below.

There are no facilities associated with integrated pollution preventions or controls, radioactive substance authorisations, planning hazardous substance enforcements or consents or fuel stations within 250 m of the site.

There are 25 land uses listed within the report. The closest land use is an electricity sub-station located approximately 28 m to the southeast. Other land uses listed within 250 m of the site include 10 other sub-stations, a hospice, a formwork production company and a furniture fabric shop.

There are no current or former landfill sites, nor are there any waste transfer sites, within 250 m of the site.

The solid strata underlying the site are classified by the Environment Agency as 'unproductive strata'. The site does not lie within a groundwater source protection zone and there are no groundwater abstraction points listed within 1 km of the site.

There are no discharge consents or records of pollution incidents within 250 m. The site does not lie within a designated flood plain, as defined by the Environment Agency.

The site does not lie within an area designated as being environmentally sensitive.

With reference to the Building Research Establishment Document *BR211 (2007) Radon: Guidance on Protective Measures for New Buildings* indicates that the site does not lie within an area where radon precautions are required in new buildings.

3. PUBLISHED GEOLOGY

Reference to the 1:50,000 scale solid and drift geology map of Fareham (Sheet 316), produced by the British Geological Survey, indicates that the site is underlain by London Clay strata. Superficial deposits are shown to be absent from the site.

4. GROUND CONDITIONS AND GEOLOGICAL MODEL

4.1 Ground Investigation

Details of the rationale and scope of the ground investigation and laboratory testing, together with exploratory hole logs, monitoring, in situ and laboratory test results, are given in Appendix III. The investigation has identified the presence of the following, below the site.

4.2 Buried Foundations and Services

No buried foundations or services were encountered during the ground investigation. However, services and foundations, associated with the current structures, should be anticipated beneath the site.

4.3 Strata Encountered

Made Ground
Ground conditions at the site consist of either tarmac or concrete surfacing overlying variable Made Ground deposits which locally include fragments of ash and coal. Made Ground was observed to between 0.5 m and 1.0 m depth.

London Clay
Weathered London Clay strata underlie the Made Ground and typically comprise firm consistency medium strength (becoming stiff consistency high strength with depth), light grey mottled orange-brown (becoming grey-brown with depth) clay. Roots and rootlets have been observed in these strata up to 3 m depth. The majority of the roots and rootlets are remnant from former trees which would have been removed prior to the development of the current layout of the site (around the 1970s). However, trees are present along the southwestern boundary and roots will be present in soils close to this boundary.

4.4 Groundwater

Groundwater was not encountered within the exploratory holes.

The groundwater conditions are based on observations made at the time of the fieldwork. It should be noted that groundwater levels may vary due to seasonal and other effects.

5. PROPOSED DEVELOPMENT

The proposed development, as shown on Figure 4, includes the following:

- Three- to four-storey split-level block of sheltered accommodation apartments which will be occupied by persons only over the age of 55 years
- Conventional construction with load-bearing brick/block walls
- Retaining walls which are both internal and external to the structure
- Access driveway and area of car parking
- Areas of managed landscaping

6. ASSESSMENT OF POTENTIAL CONTAMINATION AND GROUND GASES

6.1 Assessment Criteria

Assessment of potential contamination and ground gases has been undertaken using a risk assessment based approach, as recommended within the Environmental Protection Act (1990), CLR11 (2004) CLEA Model (2004-2009), BS 10175 (2001), CIRIA C552 (2001) and NHBC R&D Report 66 (2008). This approach considers the likely source of contamination, given the history and location of the site, and the possible migration pathways by which these potentially hazardous substances may reach likely receptors, such as end users of the site, controlled waters or the wider environment, in the context of the proposed development.

Part IIA of the Environmental Protection Act (1990) states that

"Contaminated Land is any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that –

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or
(b) pollution of controlled waters is being, or is likely to be caused;"

All risk assessments carried out as part of this investigation have been carried out with respect to the definition of "contaminated land" within Part IIA of the Environmental Protection Act (1990) and have considered the site both before and on completion of the development.

Analytical laboratory analyses have been undertaken to confirm the presence, of potentially hazardous substances identified by the desk study researches, site reconnaissance and following inspection of the ground conditions revealed during the investigation. The rationale for the sampling and testing is set out in Appendix III. The results of the analytical testing are presented in Appendix III and summarised in Table 1.

The conceptual site model used in this assessment is presented in Table 2.

6.2 Potential Sources of Contamination

Ground conditions beneath the site comprise Made Ground, associated with past development, overlying London Clay strata. There is a potential for underground tanks to be present within the site. However, no evidence of underground tanks was found during the ground investigation.

Selected samples of Made Ground were tested for the presence of potential inorganic and organic contaminants. Table 1 shows that the Made Ground typically has concentrations of heavy metals and organic substances below the Generic Assessment Criteria (GAC) for a 'residential without plant uptake' site end use. However, in one location, concentrations of arsenic, lead and benzo(a)pyrene were recorded above the relevant GAC.

No putrescible material has been identified at the site and there are no recorded landfills within influencing distance. The site is not within an area where precautions against the ingress of radon gas are required in new dwellings. Therefore, it is considered that there are no sources of hazardous ground gases at the site and ground gas protection is not required for the proposed development.

6.3 Pollution Linkages – Solids and Liquids

Based on the Conceptual Site Model, consideration is given below to identified pollution linkages and a risk evaluation is undertaken of each possible source-pathway-receptor linkage that may occur at the site. The risk evaluation considers the potential consequences and probability of occurrence in accordance with CIRIA C552 (2001). Where risks are identified as "negligible", then by implication such risks are within normally accepted levels for the proposed development, and the further reduction of such risks by remediation works is considered unnecessary. Where risks are identified that are "low" as defined in CIRIA C552 (2001), or worse, then consideration is given to the management of the identified risks, with appropriate recommended actions that may include engineering solutions / remediation works as described in the following sections.

6.3.1 Human Health

There is a localised area in the northern corner of the site, in an area of proposed landscaping, in which concentrations of arsenic, lead and benzo(a)pyrene are elevated above the relevant GAC. As there is no topsoil present at the site, there will be a requirement to import soils into proposed areas of landscaping. However, there may be a requirement to import a minimum thickness of 450 mm of 'clean' soils into this area to form a barrier between the shallow soils and end users of the site. It is considered that additional soil samples should be taken following demolition and clearance of the site

to define the area in which a minimum thickness may be required and to take additional samples in areas of proposed landscaping which are covered by the current structure.

If underground tanks are found to be present within the site boundary, due to their age, any hydrocarbon spillages/leakages are likely to have degraded. In addition, the low permeability London Clay will negate the risk of migration of these substances. The proposed development is understood to comprise a three- to four-storey block of apartments with associated car parking and limited areas of managed landscaping. Therefore, if there are substances present within the shallow soils that are considered to pose a potential risk to human health, there will be a barrier between the shallow soils and end users of the site and the risks to end users are considered to be negligible. However, if the tanks are present within an area of landscaping, there may be a requirement to import 450 mm of topsoil/soil-forming materials in this area. Additional soil sampling and analysis will be required if tanks are found.

There may be a risk to construction workers from substances within the shallow soils. Therefore, ground workers should wear appropriate personal protective equipment and maintain high levels of personal hygiene. Soils should be kept damp during earth moving operations to prevent dust becoming airborne and impacting on the general public.

6.3.2 Durability of Buried Structures and Services

In view of the low soluble sulphate content and near-neutral soil conditions, there are no special precautions required for the protection of good quality buried foundation concrete. Based on guidance within *BRE Special Digest 1* (2005), the specified DC Class of concrete for buried structures and foundations should be suitable for an ACEC site classification of AC-1s.

Certain organic substances have been identified at concentrations above those identified, by WRAS (2002) for assessment of soils in which potable water supply pipes are to be laid. However, up-dated information published by UKWIR (2004) indicates that the use of conventional MDPE pipes placed within clean granular surround would generally be acceptable for the concentrations of essentially immobile organic substances identified at the site. It should be noted that individual water companies may have their own in-house acceptability requirements for water supply pipes and, therefore, it may be prudent to allow for the use of ductile iron or proprietary multi-layer water supply pipes.

6.3.3 Landscape and Garden Areas

Elevated concentrations of substances have been found in the northern corner of the site within an area of proposed landscaping. As there is no topsoil present at the site, there will be a requirement to import topsoil in to areas of proposed managed landscaping. However, there may be a requirement to import a minimum thickness of soils (450 mm in planting areas and 300 mm in lawn areas) within the northern corner and further assessment is required.

6.4 Recommended Remedial Works

On the basis of the available information, it is considered that there may be a requirement to place a minimum thickness of topsoil in the northern corner of the site. However, additional testing is required.

It is considered that the water supply may required to be made of either ductile iron or proprietary multi-layer pipes. However, this will be dependent on the requirements of the individual water company.

If underground tanks are uncovered during redevelopment of the site, there will be a requirement to undertake additional work within the vicinity of the tanks and this is likely to lead to tank removal and validation of the works.

6.6 Potential Liabilities

Based on the available data, it is considered that, following development of the site and the completion of additional investigation and any associated remedial works, there should be no environmental liabilities associated with contaminated land, ground gases or controlled waters.

7. ASSESSMENT OF MINING, QUARRYING AND OVERALL GROUND STABILITY

The site does not lie within an area of past mining or quarrying. Therefore, there should be no associated issues with ground stability at the site.

With reference to published information provided by the British Geological Survey, and in the context of the low sensitivity of the proposed structure to very minor background seismic events recorded in the UK, it is considered that the foundation solution should not be constrained by potential ground vibrations from natural sources and that more detailed assessment is not necessary.

8. ASSESSMENT OF RETAINING STRUCTURES

There is a change in level across the site of approximately 3.5 m. Therefore, the proposed development includes the construction of a split-level building which is between three- and four-storeys in height. It is considered that retaining walls will be incorporated into the design of the building.

On the basis of the foregoing assessment and the details presented in Appendix III, it is considered that reinforced masonry or reinforced concrete walls, founded within the weathered London Clay strata, provide the most appropriate retaining structure solution for the proposed development. On the basis of the ground conditions and structures described in the report, the recommended parameters for the retaining structure design are in Appendix IV.

Retaining walls should include adequate drainage measures to ensure that there is no build up of water pressure behind the wall. With reference to Appendix IV, the design parameters for the retained materials will depend upon the backfill conditions, which will be dependent upon the temporary works employed during the construction of the retaining walls. It should be noted that the actual coefficient of earth pressure used for design should reflect the form of construction employed and the temporary works required. For the London Clay strata present beneath the site, the coefficient of earth pressure may be about 1.0.

Based on guidance published within BRE Special Digest 1 (2005), the specified DC Class of concrete for buried structures and foundations should be suitable for an ACEC site classification of AC-1s.

9. FOUNDATION RECOMMENDATIONS

9.1 Design Approach

In compliance with the requirements of the National Annex of BS EN 1997-1:2004 the geotechnical design assessment is based on Design Approach 1 (as defined in BS EN 1997-1:2004). As the structural loads for the proposed building are well defined, uncertainty and risks of potential unfavourable conditions (or deviations from characteristic values) are primarily associated with the ground conditions.

Consideration is give to the assessment of ultimate limit state (ULS) conditions, where full collapse or failure conditions are considered, and relevant design information is presented in Appendix V in this regard. In addition, the assessment considers serviceability limit states (SLS), to ensure that the recommended design parameters are compatible with an acceptably low risk of serviceability criteria being exceeded during the standard design life of the structure. It is noted that the SLS has a greater influence on the design parameters in comparison to ULS conditions and this is considered in the following assessment.

9.2 Proposed Structural Loadings and Serviceability Criteria

Details of imposed foundation loads (i.e. actions imposed by the building structure) and serviceability limit values are not presently available for the proposed structures. The geotechnical assessment presented in the report has considered generic values for the proposed development type, which is considered appropriate for the appraisal of engineering solutions and preliminary design, and these are listed below:

Preliminary Values, for appraisal purposes:

Maximum Imposed Load on Foundations:	190 kN/m run for three-storey structure 250 kN/m run for four-storey structure

Serviceability Limit Values (associated with above action)

Maximum Total Settlement:	25 mm (Terzaghi & Peck (1967))
Maximum Deflection:	1/1000 for masonry walls

9.3 Geotechnical Category of Proposed Structures

In view of the nature of the proposed structure, comprising a three- to four-storey block of sheltered accommodation, and with reference to the indicated ground conditions, as outlined in Section 4, it is considered that the development is compatible with Geotechnical Category 2, as defined in BS EN 1997-1:2004, and the necessary information relating to the Ground Investigation and Geotechnical Design Reports has been obtained and assessed on this basis.

9.4 Assessment of Foundation Solutions

With reference to the recorded ground conditions and corresponding geotechnical model presented in Section 4, characteristic values relating to the geotechnical properties of the strata within influencing

distance of the proposed structure are presented in Appendix V. Salient elements of the geotechnical model are outlined below.

The site is underlain by London Clay strata with typical SPT N values within the top 2 m of 11 and typical undrained shear strengths of 70 kN/m^2. These strata improve in strength with depth.

Where the majority of the four-storey element of the development is to be located, between 1 and 2.5 m of materials require to be removed from site to permit construction. Therefore, foundations will be located deeper down within the recorded London Clay strata and, as stated above, these strata improve in strength with depth. Therefore, it is considered that the ground conditions at the site are suitable to support the proposed three- to four-storey development on conventional footings.

It is considered that a small part of the development may require to have deepened footings as "medium to high volume change" potential strata is present beneath the site and part of the proposed structure lies within the influencing distance of trees.

As roots and rootlets have been observed across the site to 3 m depth, there may be a requirement from the NHBC to deepen foundations. It is considered that piling would probably be more economical than constructing the building on footings deeper than 2.5 m. However, where former trees were present and roots and rootlets have been observed, it appears that the strata are not desiccated. Further tests (in the form of continuous soil sampling, moisture content profiling and suction tests) should be undertaken to provide additional information.

9.5 Recommended Foundation Design Parameters

On the basis of the foregoing assessment and the details presented in Appendix V, it is considered that shallow strip/trench-fill foundations provide the most appropriate foundation solution for the proposed structure. On the basis of the ground conditions and structures described in the report, the recommended parameters for the foundation design are as follows:

Foundation Strata :	Firm consistency, medium strength, light grey mottled orange-brown clay (London Clay)
Foundation Depth :	Minimum 1.0 m, deepened within influence of trees, or through Made Ground, as required
Foundation Width/Size:	0.6 m to 2.0 m maximum
Nett Allowable Bearing Pressure:	150 kN/m^2 (foundations placed at shallow depth i.e. <2 m)

It is considered that total settlement of foundations designed on the above basis should be less than the normal serviceability limit state for this development (i.e. total settlements of 25 mm) as outlined in the assessment presented in Appendix V.

Laboratory testing results indicate the clayey horizons at the site comprise "high volume change" potential soils, as defined in NHBC Standards (2008). Within the influence zones of existing or proposed trees, suitable foundation precautions should be adopted, as outlined in NHBC Standards (2008).

Based on guidance published within BRE Special Digest 1 (2005), the specified DC Class of concrete for buried structures and foundations should be suitable for an ACEC site classification of AC-1s.

9.6 Floor Slab Recommendations

It is considered that there will be ground disturbance associated with the demolition and clearance of the site. Therefore, allowance should be made for a suspended ground floor slab within the proposed structure.

Within influencing distance of existing trees, there will be a requirement to incorporate an 225 mm under-floor void into the design, as required by the NHBC.

9.7 General Construction Advice

All formations should be cleaned, and subsequently inspected by a suitably qualified engineer prior to placing concrete. Should any soft, compressible or otherwise unsuitable materials be encountered they should be removed and replaced by blinding concrete.

Foundation concrete, or alternatively, a blinding layer of concrete, should be placed immediately after excavation and inspection in order to protect the formation against softening and disturbance.

Generally, all formations should be placed wholly within the same material type, unless specific geotechnical inspection and assessment have been undertaken.

Care should be taken to ensure that any field drains encountered are carefully and satisfactorily blocked to prevent water seeping through the drains and into any excavations.

10. TEMPORARY WORKS

Conventional excavation plant is considered to be suitable for excavation works at the site. However, hydraulic breakers will be required to break up existing foundations and retaining walls. The shallow ground is anticipated to remain stable in the short term. However, instability should be anticipated in excavations left open for extended periods of time. Support should be provided, or the sides battered back, in any excavations in excess of 1.2 m requiring man entry.

Temporary slopes for the construction of the retaining walls may be excavated to slopes of 1 to 1.5 but should not be exposed for any period in excess of one month.

Groundwater is considered to lie at depth beneath the site. Therefore, there should be no requirement for pumping from excavations.

11. ASSESSMENT OF SOAKAWAY DRAINAGE

The strata underlying the site are clays of low permeability. Therefore, soakaway drainage will not be feasible for the proposed development.

12. ROAD PAVEMENTS

Based on an examination of the soils present at site, and the guidance of TRRL Report LR1132 and the Highways Agency Interim Advice Note 73/06 (Rev. 1), it is considered that an equilibrium design CBR value of 4% may be used for road pavement design. It is considered that the materials at shallow depth are not frost susceptible.

13. ASSESSMENT OF MATERIALS FOR WASTE DISPOSAL

There is no requirement to remove materials from site to permit development. Therefore, excavated materials should be retained and reused on site where possible. However, if materials are excess to requirements, then they should taken to a suitably classified landfill facility or to an exempt site.

The natural strata should be classified as "inert" waste if taken off site. However, soils which contain roots and rootlets may be classified as "non-hazardous" waste due to the potential total organic content associated with the presence of roots. It is considered that Made Ground should be classified as "inert" but if roots and rootlets are present, Made Ground is likely to be classified as "non-hazardous" waste.

It is important that, during excavations on site, the arisings are segregated into different waste streams. Failure to separate the different materials could result in all the waste being classified as "non-hazardous" waste resulting in high waste disposal costs.

Landfill tax would be payable on any materials removed from site and taken to landfill. However, inert waste may also be taken to a Waste management Licence Exempt site, subject to specific exemption requirements.

14. RECOMMENDATIONS FOR SUPPLEMENTARY GROUND INVESTIGATIONS

It is considered that, following demolition and clearance of the site, additional soil samples should be taken from the northern corner where elevated concentrations have been recorded and from areas of the site previously inaccessible due to the presence of existing buildings. Analytical testing should be carried out on these samples.

As roots and rootlets have been observed across the site to 3 m depth, there may be a requirement to pile the proposed structure. It appears that the shallow strata are not desiccated but further geotechnical tests should be undertaken to confirm this. As a piled foundation solution may be required, light cable percussion boreholes should also be undertaken to provide additional information and to obtain pile design parameters.

15. RECOMMENDED SUPERVISION AND MONITORING

In compliance with the requirements in BS EN 1997-1:2004 and BE EN 1997-2:2007, construction and workmanship of the engineering solutions recommended in this report shall be supervised. In particular, issues listed in Section 9.7 General Construction Advice shall be considered in the implementation of the works and design of any necessary temporary works set out in Section 10.

In relation to the foundation solution(s) and ground floor slab recommendations in Section 9.6, the following supervision and monitoring is recommended.

- Inspections of formation strata in excavations for shallow strip/pad footings

16. SUMMARY

It is proposed to redevelop a site at London Road, Waterlooville. Currently, the site is unoccupied, but was previously occupied by a builders merchant.

Ground conditions at the site consist of variable Made Ground deposits which locally include fragments of ash and coal, overlying weathered London Clay strata. At shallow depth, the London Clay strata typically comprise firm consistency, medium strength, light grey mottled orange-brown clay with roots and rootlets. These strata improve in strength with depth.

Groundwater was not encountered within the exploratory holes.

There is a potential for underground tanks to be present within the site but no evidence of underground tanks was found during the ground investigation. However, they may be present within areas yet to be investigated.

The Made Ground typically has concentrations of heavy metals and organic substances below the Generic Assessment Criteria for a 'residential without plant uptake' site end use. However, in one location, elevated concentrations were recorded and there may be a requirement to import a minimum thickness of 'clean' soils into this area to form a barrier between the shallow soils and end users of the site.

It is considered that there are no sources of hazardous ground gases at the site and ground gas protection is not required for the proposed development.

The use of conventional MDPE pipes placed within clean granular surround is considered to be acceptable for potable water supply. However, allowance should be made for the use of ductile iron or multi-layer proprietary pipes.

The proposed development includes the construction of a split-level, three- to four-storey high building with associated retaining walls. It is considered that reinforced masonry or reinforced concrete walls provide the most appropriate retaining structure solution and that the ground conditions at the site are suitable to support the proposed structure on conventional footings. However, a small part of the development may require to have deepened footings as "high volume change" potential strata are present beneath the site and part of the proposed structure lies within the influencing distance of trees.

As roots and rootlets have been observed across the site to 3 m depth, there may be a requirement to deepen footings or use a piled foundation solution. It appears that the strata are not desiccated but further tests should be undertaken to confirm this assessment.

Allowance should be made for a suspended ground floor slab within the proposed structure and, within influencing distance of existing trees, an under-floor void should be incorporated into the design.

Soakaway drainage will not be feasible for the proposed development due to the presence of low permeability clay.

It is considered that, following demolition and clearance of the site, additional investigation should be undertaken including additional analytical laboratory testing and continuous sampling for suction tests to confirm the foundation solution.

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WRAS Report 9-04-03 (2002) *The Selection of Materials for Water Supply Pipes to be Laid in Contaminated Land* Water Regulation Advisory Service

GENERAL NOTES

1. This report is provided in the context of the stated development proposals and should not be used in a different context.

2. The accuracy of map extracts cannot be guaranteed and it should be recognised that different conditions on site may have existed between and subsequent to the various map surveys.

3. Any borehole data from the British Geological Survey sources are included on the following basis: "The British Geological Survey accept no responsibility for omissions or misinterpretation of the data from their Data Bank as this may be old or obtained from non-BGS sources and may not represent current interpretation.

4. Where any data supplied by the Client or by other external sources, including previous site investigation data, have been used it has been assumed that the information is correct unless otherwise stated. No responsibility can be accepted by Crossfield Consulting Limited for inaccuracies within the data supplied by others.

5. Exploratory hole locations provided in the report are generally established by tape measurement from existing features or boundaries. Hole locations are not accurately surveyed and ground levels at these locations are not obtained unless specifically requested.

6. Any assessments made in this report are based on the ground conditions indicated by the trial pits and/or boreholes, together with the results of any field or laboratory testing undertaken and, where appropriate, other relevant site data which may have been obtained for the site. Variations in ground conditions may occur between exploratory hole locations and there may be special conditions appertaining to the site which have not been revealed by the investigation and which have not been taken into account in the report. The assessment may be subject to amendment in the light of additional information becoming available.

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TABLES

SUMMARY OF ANALYTICAL TEST DATA: SOILS
POTENTIAL RISKS TO HUMAN HEALTH

Determinand	Units	No of Tests	Concentration		Generic Environmental Assessment Criteria (mg/kg) Residential without plant uptake		Remarks
			Min	Max	Value	No>Value	
Arsenic	mg/kg	5	6	62	35[2]	1	
Cadmium	mg/kg	5	<0.1	1.5	18[2]	0	
Chromium (III) [3]	mg/kg	5	9.1	25	3000[2]	0	
Lead	mg/kg	5	53	1100	450[1]	1	
Inorganic Mercury	mg/kg	5	<0.1	2.2	235[2]	0	
Nickel	mg/kg	5	6.2	49	130[2]	0	
Selenium	mg/kg	5	<0.2	0.58	595[2]	0	
Copper	mg/kg	5	9.3	220	6200[2]	0	
Zinc	mg/kg	5	51	1200	40,400[2]	0	
Boron	mg/kg	5	0.6	5.0	10,300[2]	0	
Phenols	mg/kg	5	<0.3	<0.3	515[2]	0	
pH	-	9[4]	6.4	9.6	-	-	
Total Organic Carbon	%	5	0.46	8.5	-	-	
Petroleum Hydrocarbons							
Aliphatics $C_5 – C_6$	mg/kg	5	<0.1	<0.1	110[2]	0	
Aliphatics $C_6 – C_8$	mg/kg	5	<0.1	<0.1	370[2]	0	
Aliphatics $C_8 – C_{10}$	mg/kg	5	<0.1	85	110[2]	0	
Aliphatics $C_{10} – C_{12}$	mg/kg	5	<0.1	32	535[2]	0	
Aliphatics $C_{12} – C_{16}$	mg/kg	5	<0.1	51	3040[2]	0	
Aliphatics $C_{16} – C_{35}$	mg/kg	5	<0.1	102	76,600[2]	0	
Aromatics $C_6 – C_7$	mg/kg	5	<0.1	<0.1	975[2]	0	
Aromatics $C_7 – C_8$	mg/kg	5	<0.1	<0.1	2710[2]	0	
Aromatics $C_8 – C_{10}$	mg/kg	5	<0.1	<0.1	190[2]	0	
Aromatics $C_{10} – C_{12}$	mg/kg	5	<0.1	<0.1	865[2]	0	
Aromatics $C_{12} – C_{16}$	mg/kg	5	<0.1	8.8	1710[2]	0	
Aromatics $C_{16} – C_{21}$	mg/kg	5	<0.1	23	1320[2]	0	
Aromatics $C_{21} – C_{35}$	mg/kg	5	<0.1	18	1330[2]	0	

Determinand	Units	No of Tests	Concentration		Generic Environmental Assessment Criteria (mg/kg) Residential without plant uptake		Remarks
			Min	Max	Value	No>Value	
VOCs							
Benzene	mg/kg	5	<0.0001	0.002	1.0[2]	0	
Toluene	mg/kg	5	<0.0001	0.0013	2710[2]	0	
Ethylbenzene	mg/kg	5	<0.0001	<0.0001	840[2]	0	
Xylene	mg/kg	5	<0.0002	<0.0002	285[2]	0	
Total PAH	mg/kg	5	<0.2	13	-	-	
Naphthalene	mg/kg	5	<0.01	0.67	9.2[2]	0	
Acenaphthylene	mg/kg	5	<0.01	<0.01	3870[2]	0	
Acenaphthene	mg/kg	5	<0.01	<0.01	3910[2]	0	
Fluorene	mg/kg	5	<0.01	<0.01	2870[2]	0	
Phenanthrene	mg/kg	5	<0.01	1	970[2]	0	
Anthracene	mg/kg	5	<0.01	0.1	20,400[2]	0	
Fluoranthene	mg/kg	5	<0.01	2	1000[2]	0	
Pyrene	mg/kg	5	<0.01	1.6	2400[2]	0	
Benz(a)anthracene	mg/kg	5	<0.01	1.2	6.2[2]	0	
Chrysene	mg/kg	5	<0.01	1.2	10.1[2]	0	
Benzo(b)fluoranthene	mg/kg	5	<0.01	2.2	7.4[2]	0	
Benzo(k)fluoranthene	mg/kg	5	<0.01	0.56	10.4[2]	0	
Benzo(a)pyrene	mg/kg	5	<0.01	1.4	1.04[2]	1	
Indeno(123cd)pyrene	mg/kg	5	<0.01	<0.01	4.4[2]	0	
Dibenzo(ah)anthracene	mg/kg	5	<0.01	0.46	0.9[2]	0	
Benzo(ghi)perylene	mg/kg	5	<0.01	0.52	47[2]	0	

NOTES

1. Soil Guideline Value for residential without plant uptake. Environment Agency (2002) – 6% soil organic matter.
2. GAC residential without plant uptake. Calculated using CLEA Software version 1.06 (Environment Agency, 2009) and based on toxicology and physical-chemical data published by the Environment Agency (2009) or LQM (2009). GAC assumptions comprise 6% soil organic matter, soil pH of 7 and sandy loam soil type.
3. In the absence of desk study or historical map evidence indicating a potential source of chromium (VI) usage at or in the near vicinity of the site, total chromium concentrations have been compared to the GAC for chromium (III).
4. Includes the results from the geotechnical laboratory testing

TABLE 2

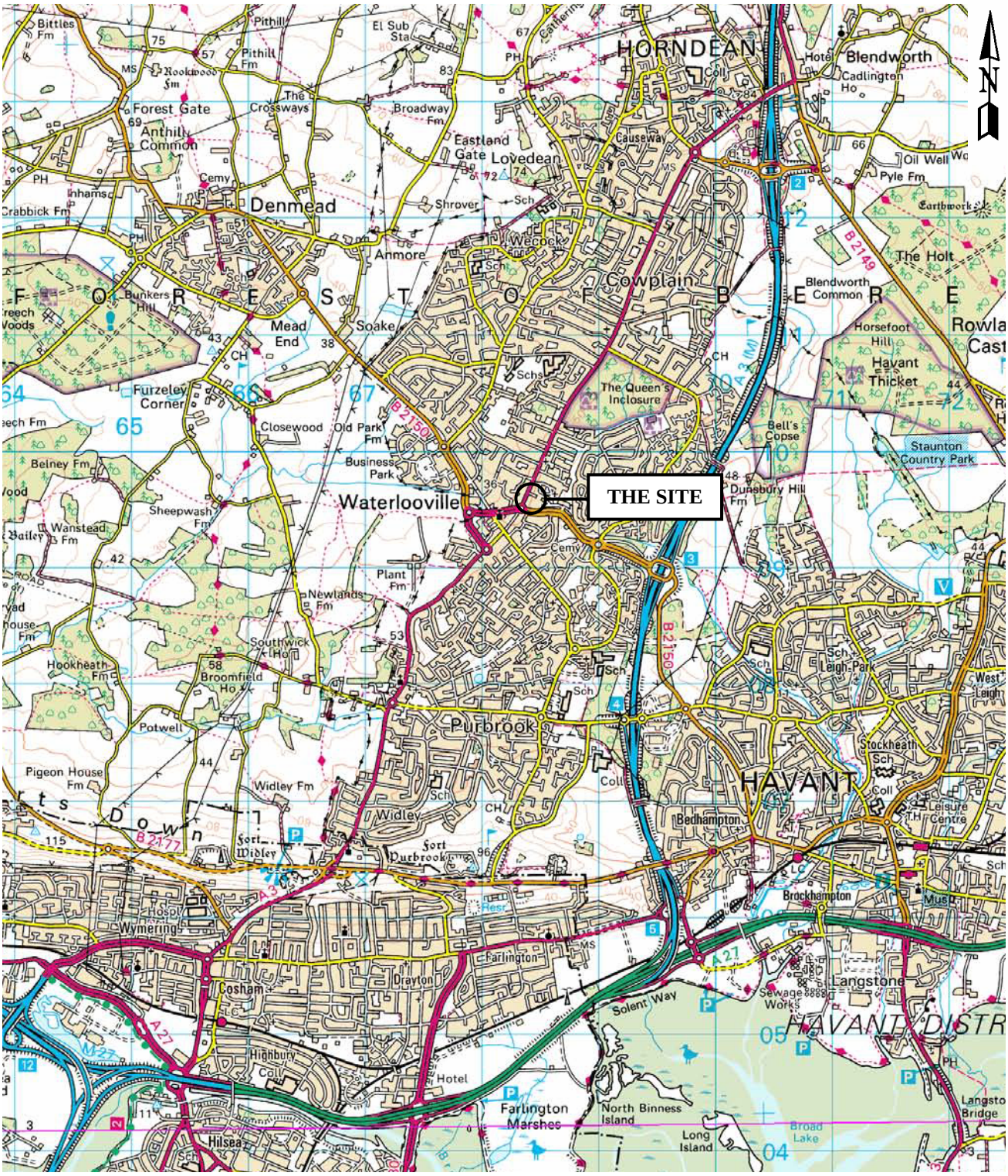
CONCEPTUAL SITE MODEL

Potential Contaminant Source	Potential Migration Routes	Receptors and Assessed Pollutant Linkage
Solids *Toxic Heavy Metals:* Localised elevated concentration of arsenic and lead *Organic Substances:* Localised elevated concentration of benzo(a)pyrene	***Movement of Solids*** Ingestion of soil or inhalation of dust. Pathway is present during construction but should not be present following construction due to the presence of building and hardstanding. Possible migration through soft landscaping areas ***Release into Liquid Phase*** Limited availability of water for leaching following development due to presence of building and hardstanding	***Human Health*** *Construction Workers:* Potential pollutant linkage *End Users:* Potential pollutant linkage ***Buried Structures & Services*** *Plastic Pipes for Potable Water Supply:* No pollutant linkage *Other Buried Services:* No pollutant linkage ***Landscape and Garden Areas*** No pollutant linkage
Liquids No source	***Movement of Liquids*** Not applicable (no source)	***Controlled Waters*** *Groundwater:* Unproductive strata, no source protection zone – No pollutant linkage *Surface Water*: No surface water within 1 km of the site – No pollutant linkage
Gases *Radon Gas:* No significant source *Landfill Gases:* No source	***Movement of Gases*** Not applicable (no significant source)	***Human Health*** No pollutant linkage

NOTE: The above conceptual model is based on CIRIA C552 (2001) and BS 10175 (2001).

FIGURES

FIGURE 1

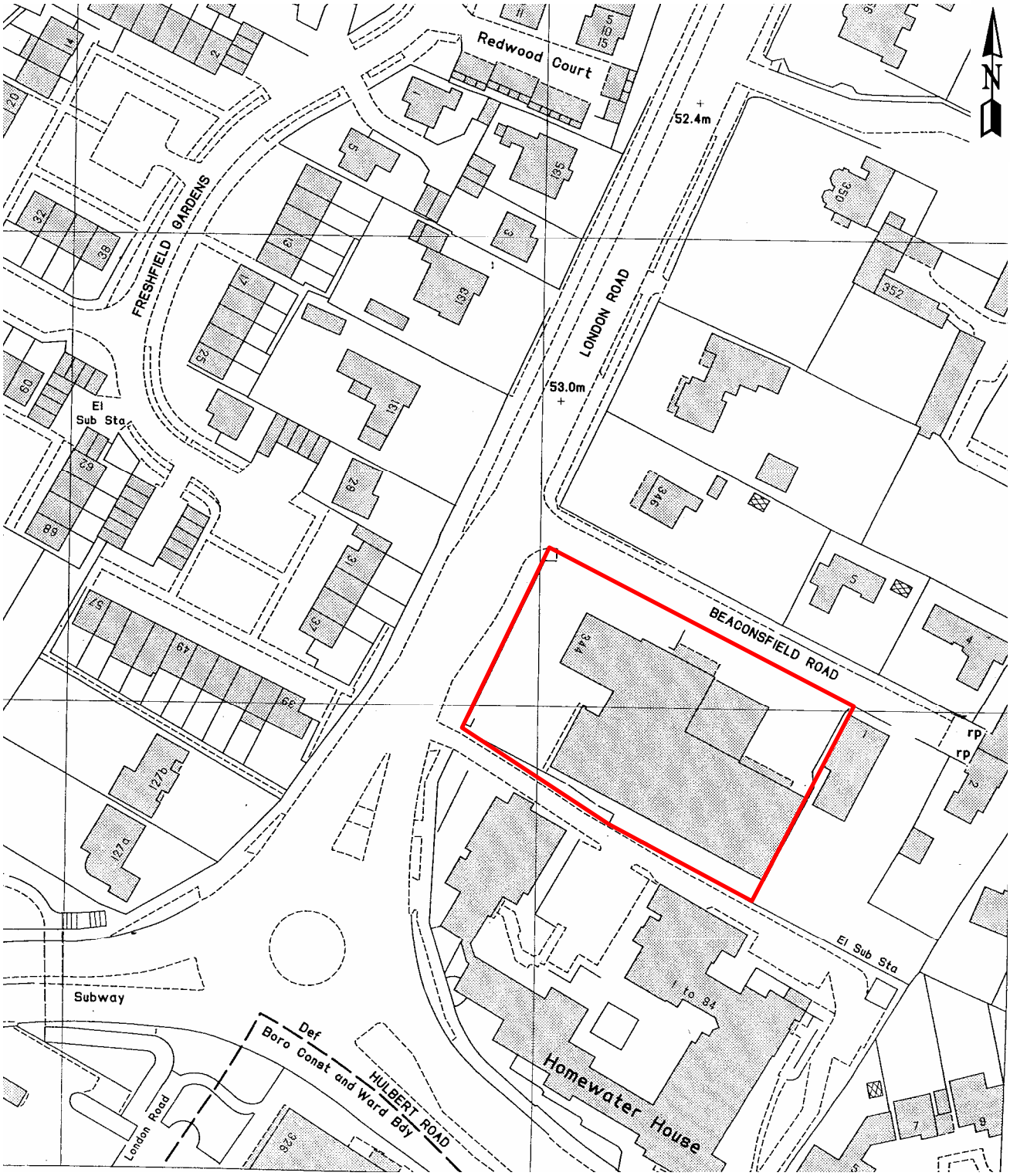


SITE LOCATION PLAN

Scale 1: 50,000

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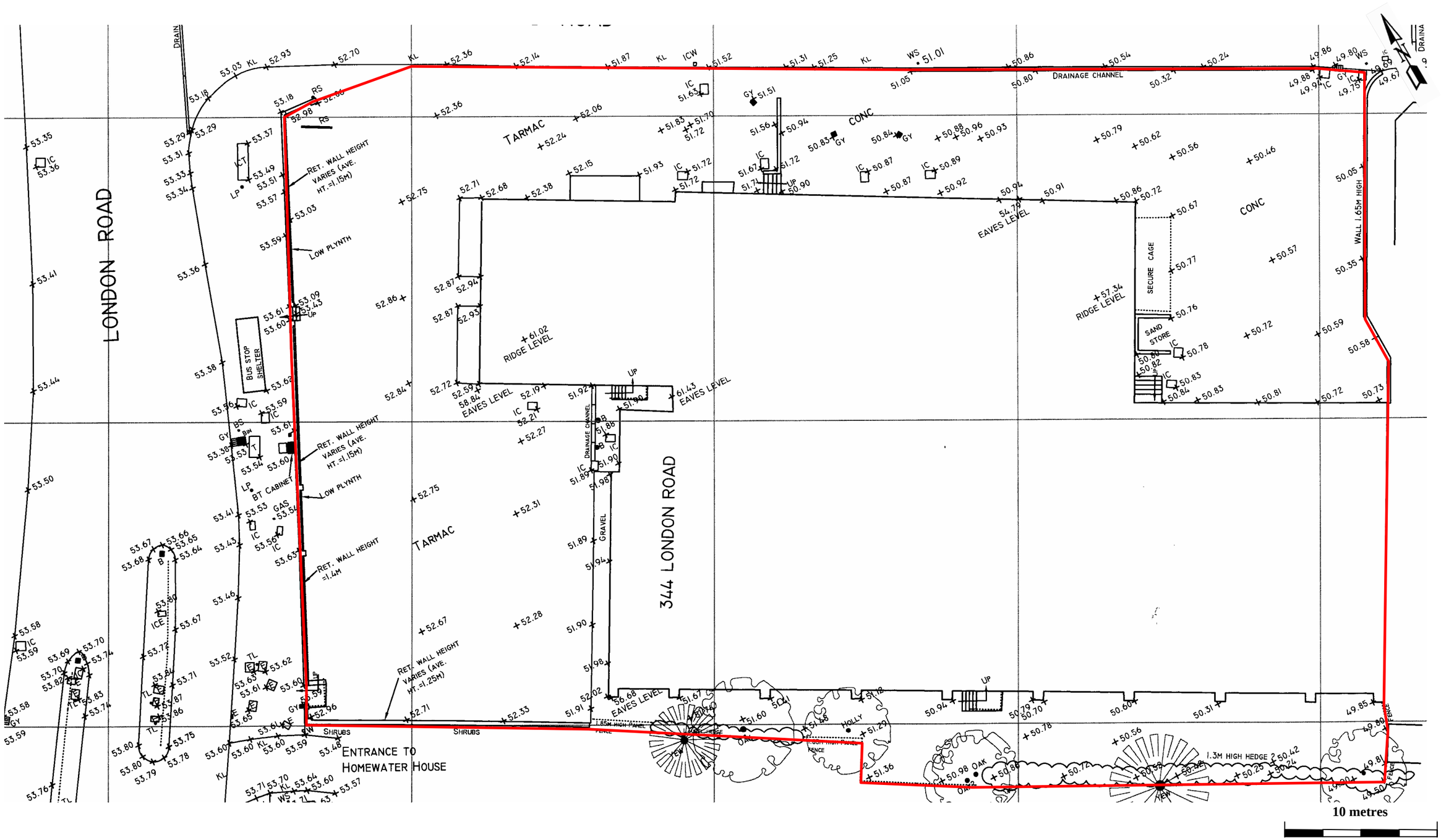
FIGURE 2



SITE PLAN

Scale 1: 1250

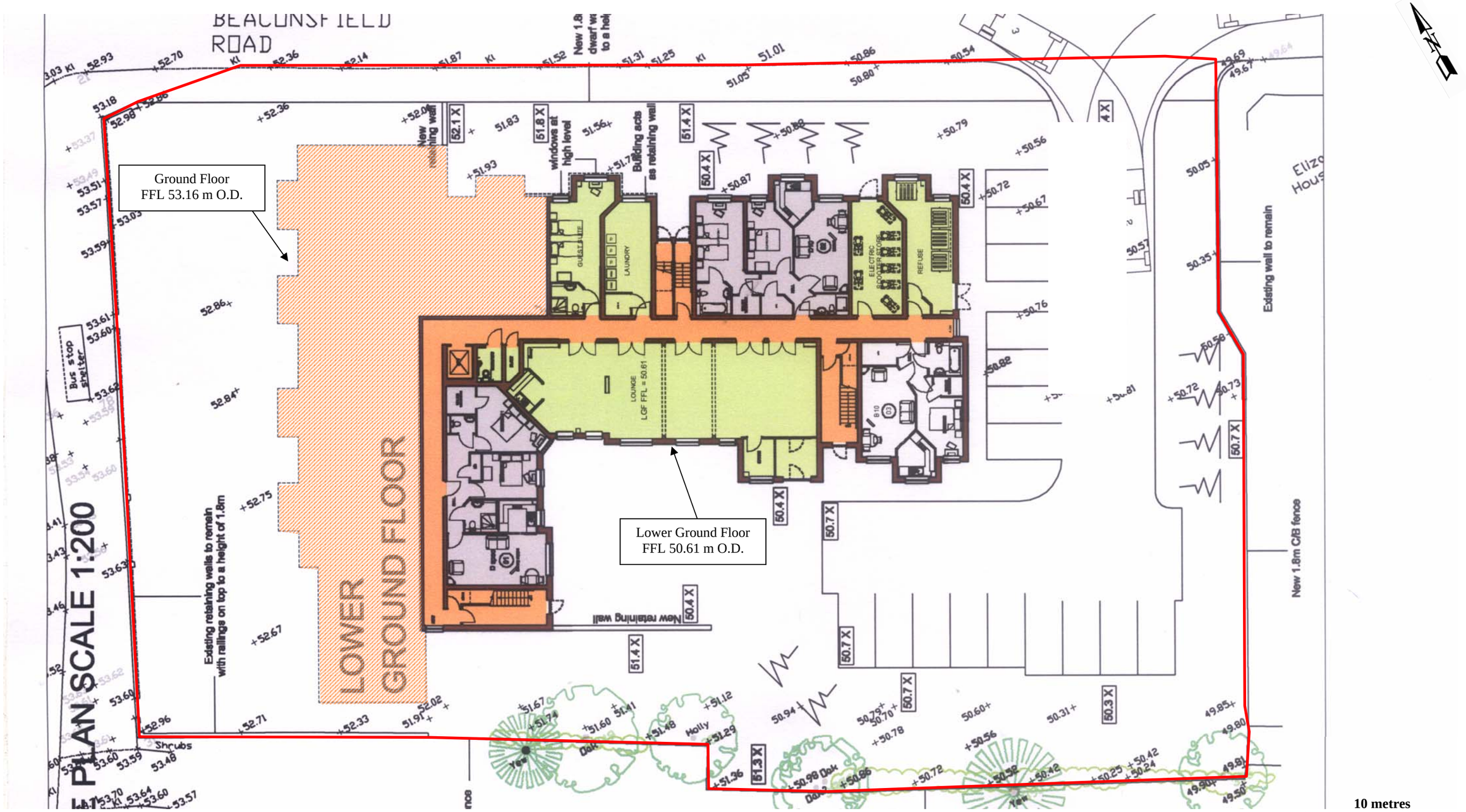
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TOPOGRAPHIC SURVEY SITE PLAN

Scale 1:250

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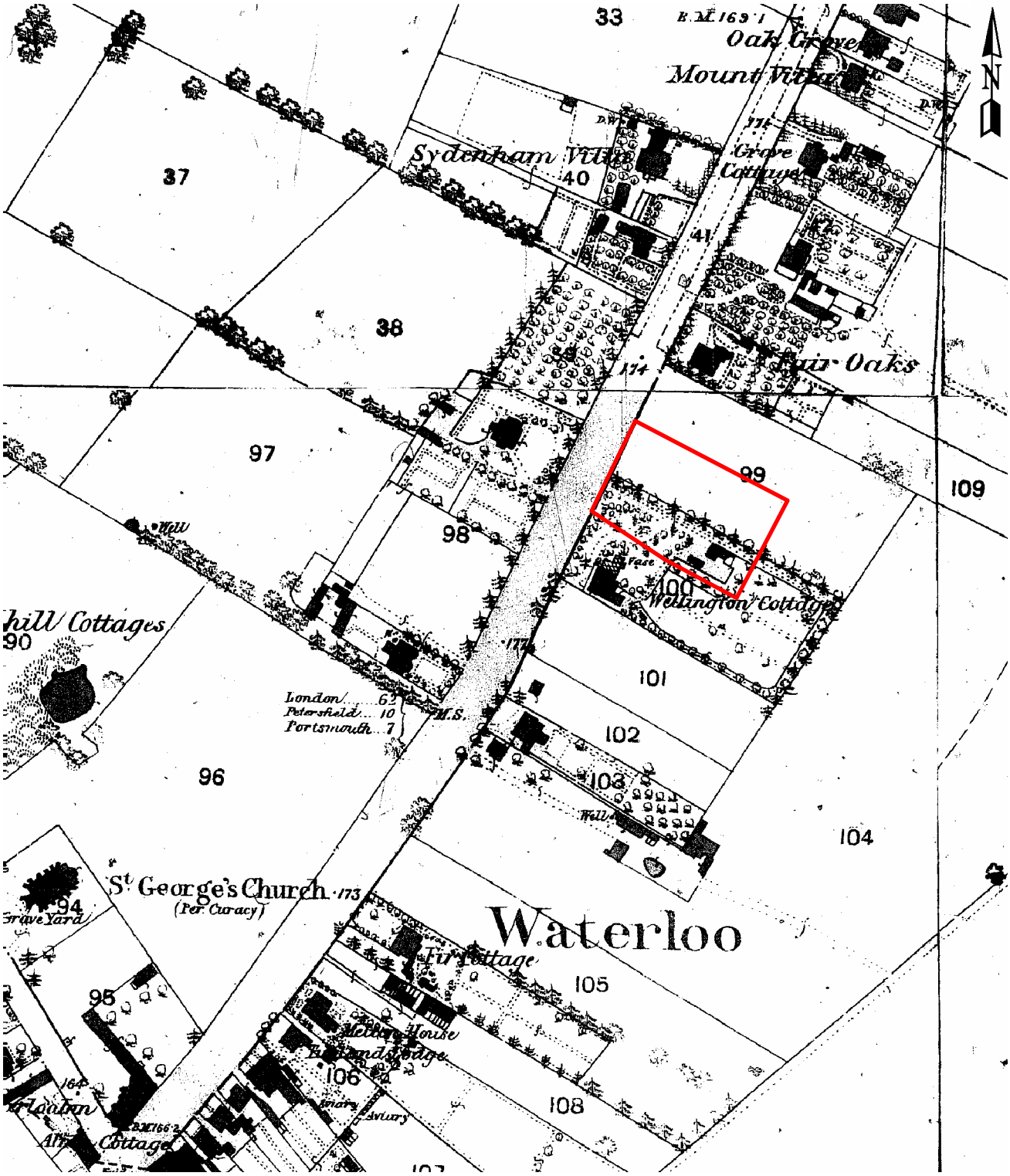


PROPOSED DEVELOPMENT PLAN
Scale 1:250

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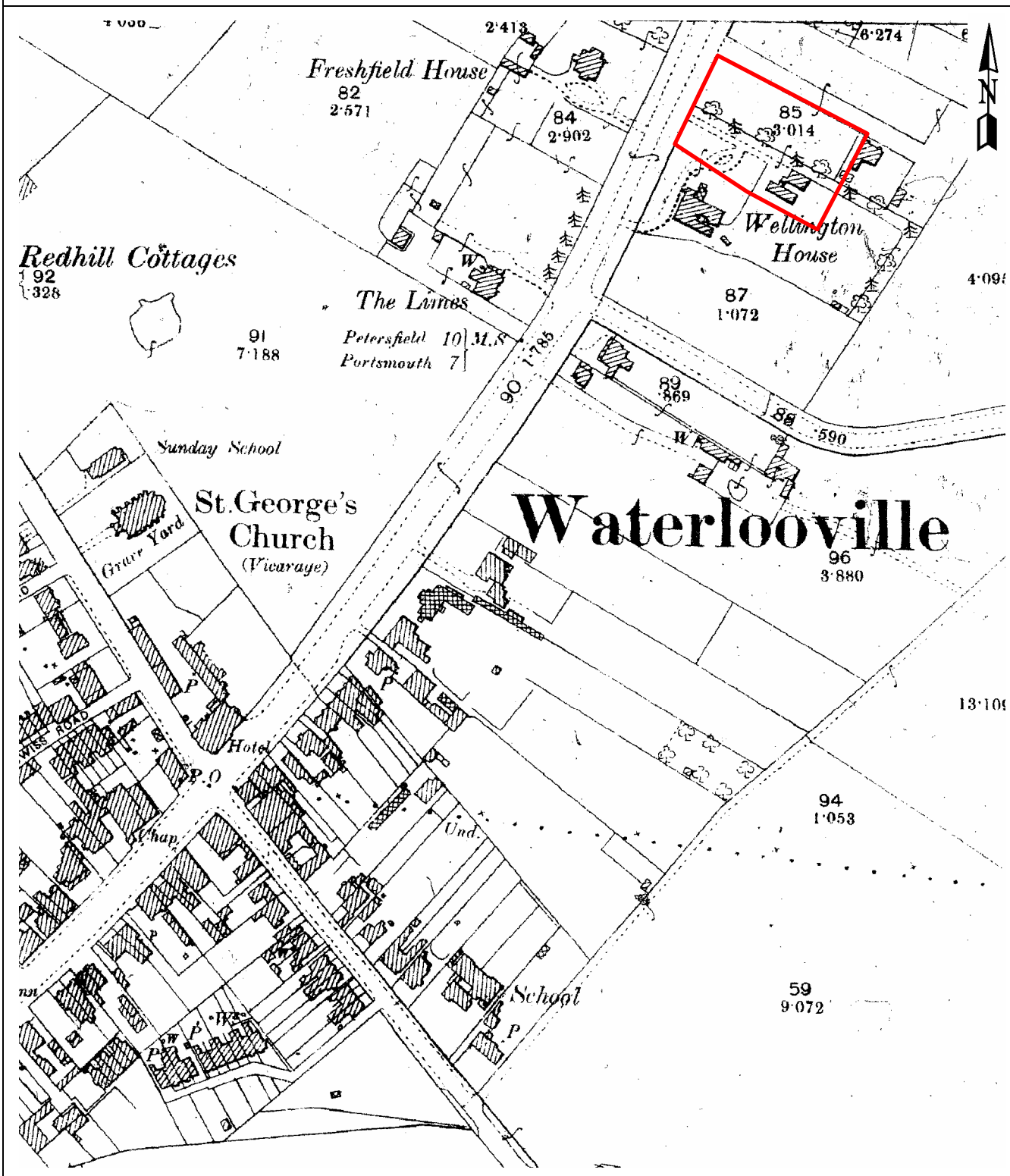
APPENDIX I

FIGURE I-1



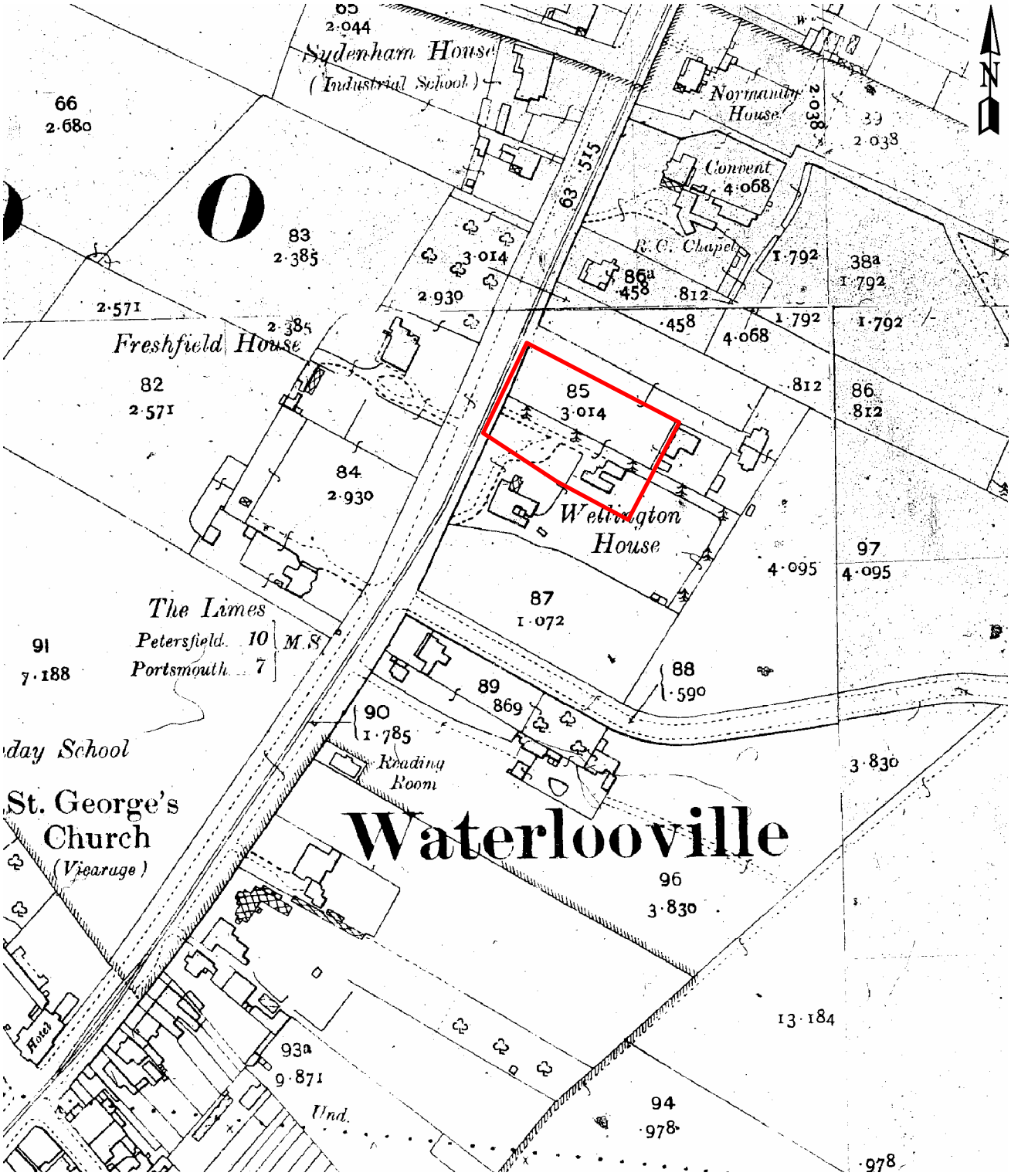
COUNTY SERIES PLAN 1860
Scale 25": 1 mile

FIGURE I-2



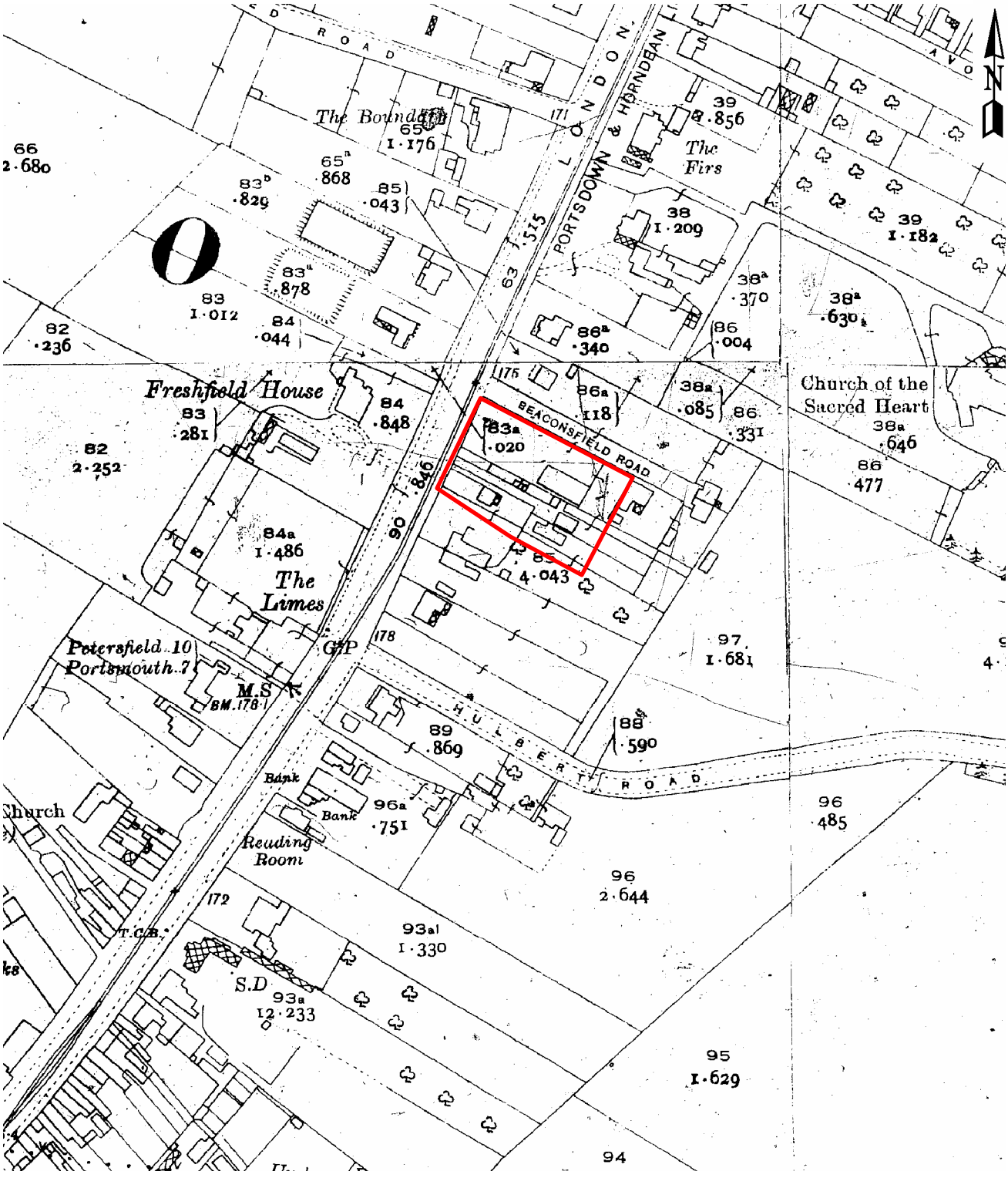
COUNTY SERIES PLAN 1895
Scale 25": 1 mile

FIGURE I-3



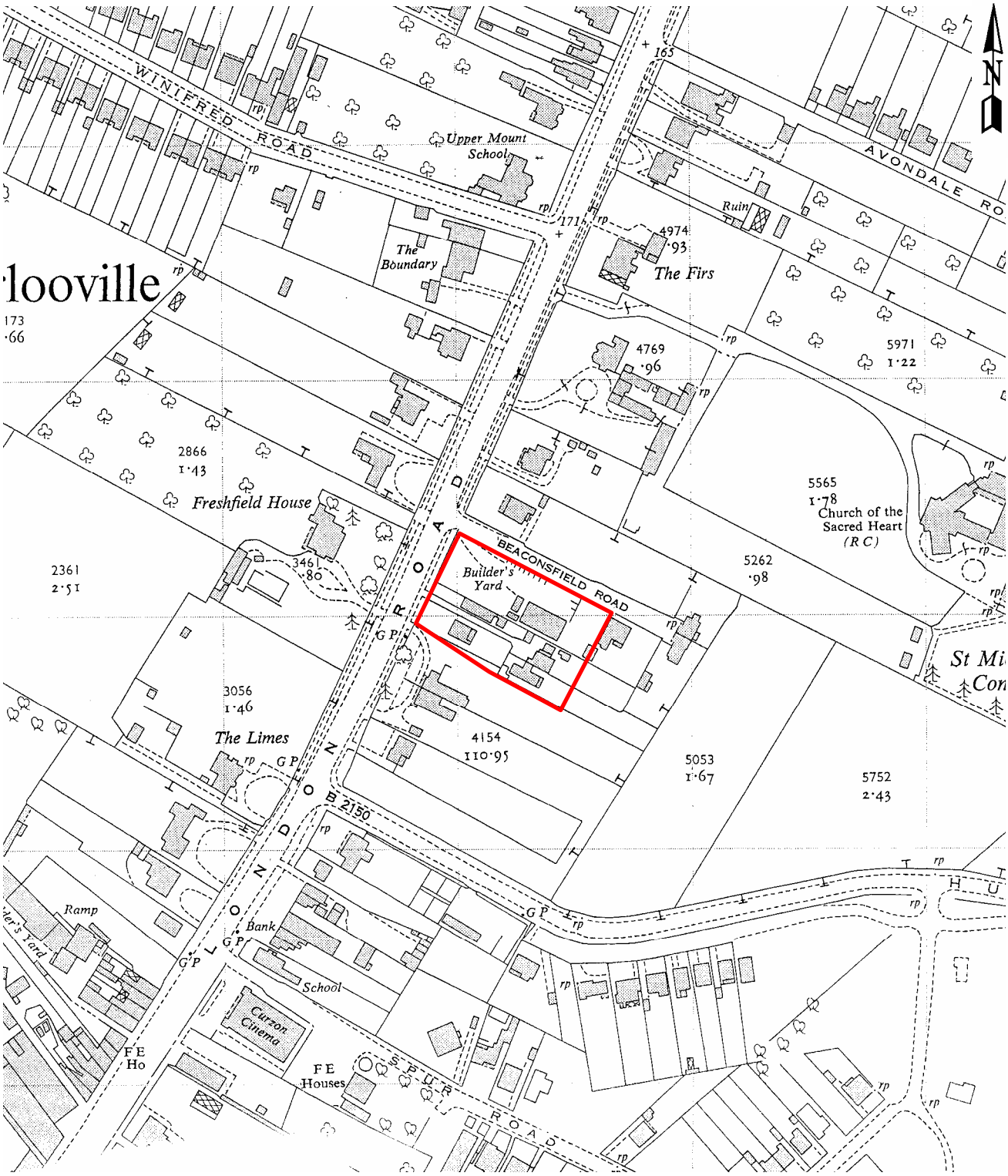
COUNTY SERIES PLAN 1907
Scale 25": 1 mile

FIGURE I-4



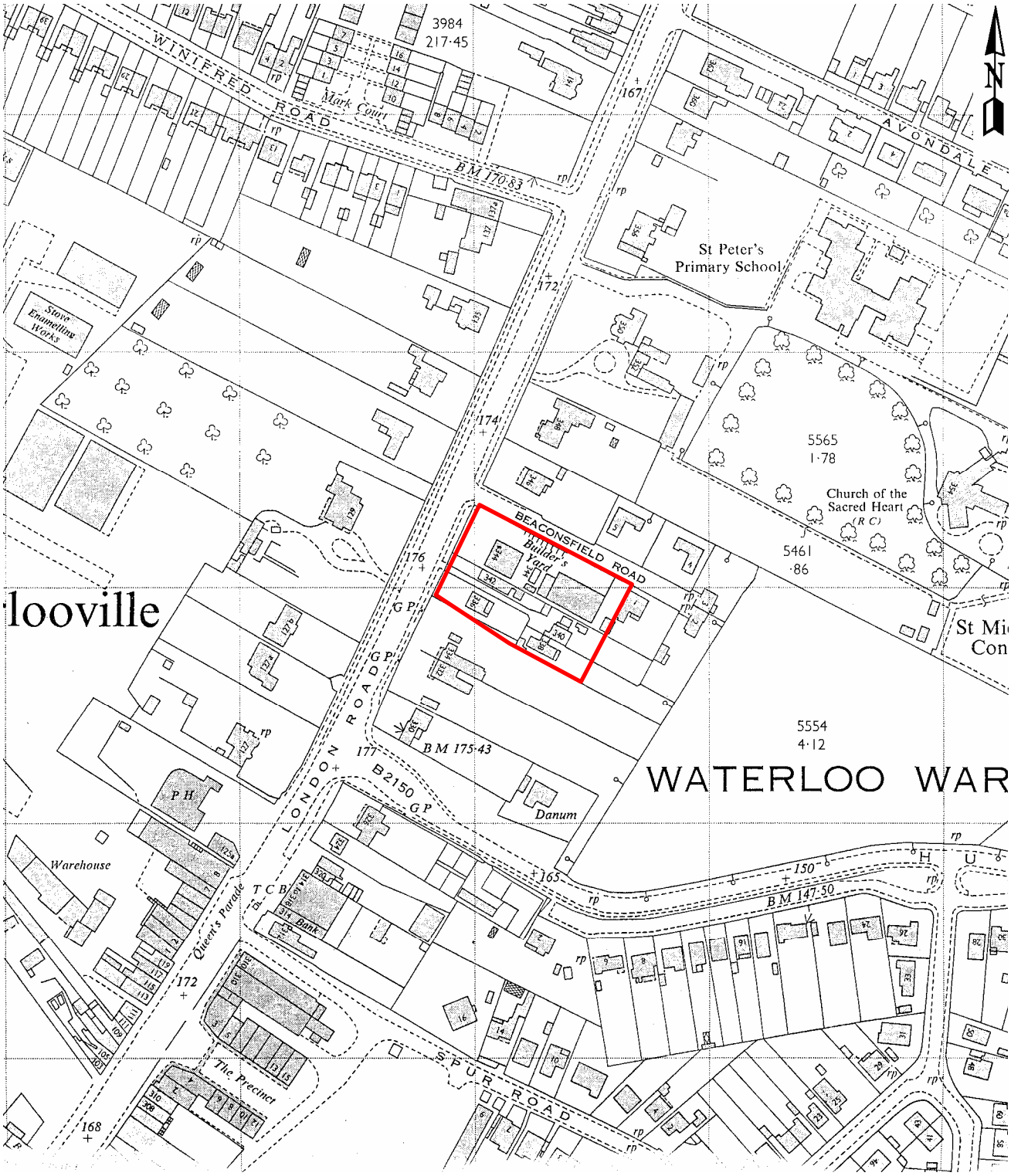
COUNTY SERIES PLAN 1930
Scale 25": 1 mile

FIGURE I-5



NATIONAL GRID PLAN 1952
Scale 1: 2500

FIGURE I-6

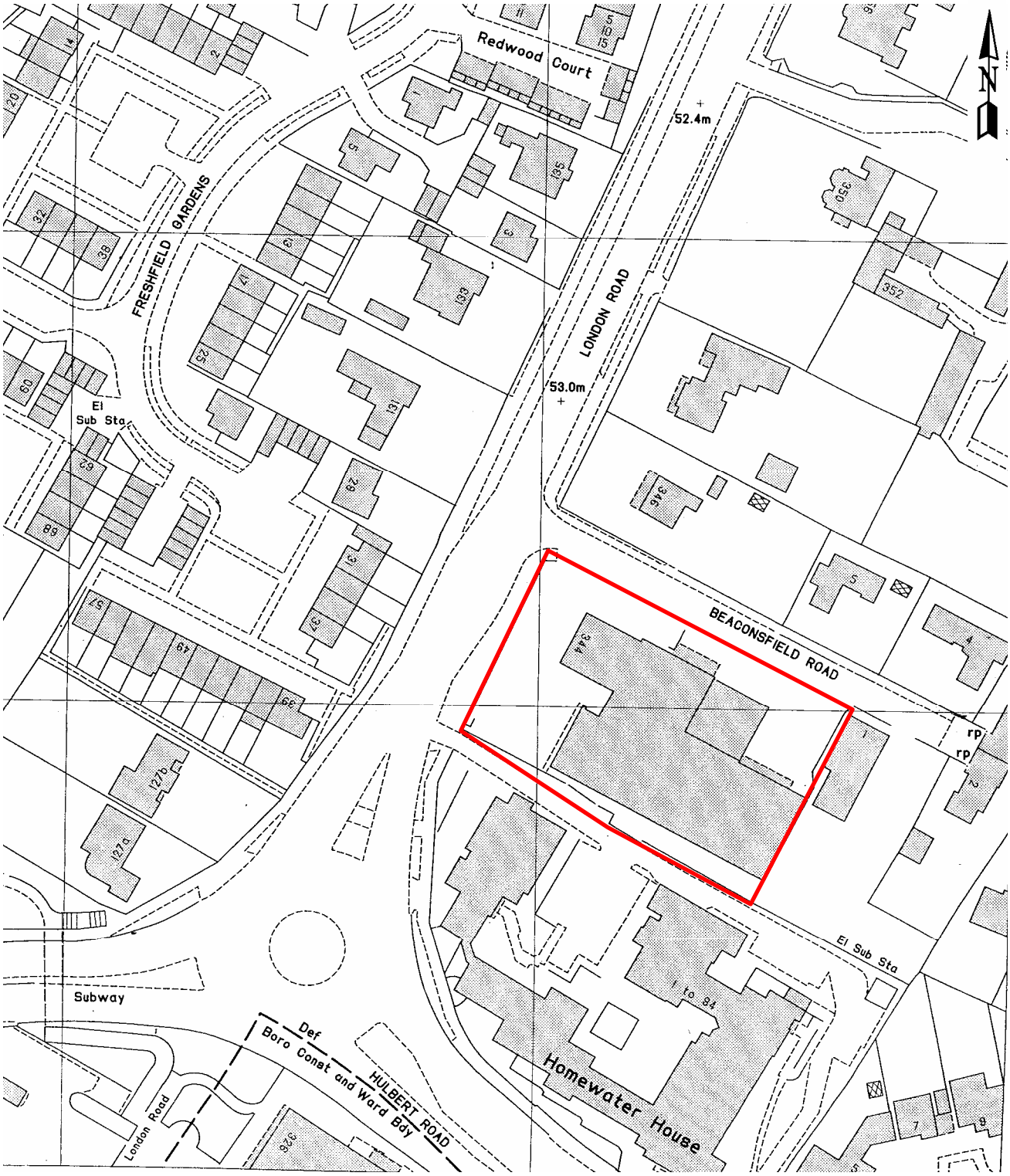


NATIONAL GRID PLAN 1965

Scale 1: 2500

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FIGURE I-7



NATIONAL GRID PLAN 1985

Scale 1: 1250

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