# APPENDIX 4

Cotswold Archaeology

# Land to the East of Wimblebury
# Cannock
# Staffordshire

*Heritage and Archaeology Appraisal*

*for*
Church Commissioners for England

CA Project: 6195

CA Report: 17131

March 2017

Andover Cirencester Exeter Milton Keynes

# Land to the East of Wimblebury
# Cannock
# Staffordshire

## Heritage and Archaeology Appraisal

CA Project: 6195

CA Report: 17131

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## CONTENTS



## LIST OF FIGURES

# 1. INTRODUCTION

### *Outline*

1.1 In February 2017, Cotswold Archaeology were commissioned by The Church Commissioners for England (herein, 'The Commissioners'), to carry out a heritage and archaeology appraisal with regard to five parcels of land to the east of Wimblebury, Cannock, Staffordshire, centred on NGR: 402027 311762 (hereafter, 'the Site', Fig. 1).

1.2 Cannock Chase District Council have identified the Site (including the five land parcels) as site options for housing in their *Local Plan (Part 2) Issues and Options*, which is currently under consultation. The Site is entirely owned by The Commissioners who would like to secure a housing allocation in the next stage of the Plan. The suitability of the Site and the development potential of each parcel must therefore be demonstrated. This appraisal will be used to inform the development of a concept masterplan for the entire Site through identifying any potential heritage, including archaeology, constraints.

### *Location and landscape context*

1.3 The Site, which in total measures approximately 65ha, is located to the east of Wimblebury, a village in Cannock Chase District which is now essentially an eastern suburb of Cannock. The Site is surrounded to the north and west by residential development along Littleworth Road and Wimblebury Road, respectively, and to the south and east by rural landscape.

1.4 The Site is formed of five parcels of land (Fig. 1 and 2). These parcels may be developed independently or form part of one phased development and therefore the report will refer to these individually or collectively, as needed to inform the potential future developments. These include:

- **Site 1A**: Land to the east of John Street/Wimblebury Road. This parcel measures *c.* 3.26ha and occupies a single agricultural field in the westernmost part of the Site.
- **Site 1B**: Land east of Sycamore Road/Hawthorne Road. This area measures *c*. 9.57ha and occupies two agricultural fields and an overgrown plot of land to the south-west of the Site.
- **Site 1C**: Land east of Haymaker Way/Barn Way and south of Littleworth Road. This site, which measures *c*. 8.49ha, is located to the north-west of the

Site and occupies an agricultural field, divided into two areas by a pond and a watercourse, with the site of a former farm and timber yard in its south-eastern corner.

- **Site 1D**: Land south of Littleworth Road. This is the largest parcel of land, measuring *c*. 36.9ha, and it occupies a number of large agricultural fields in the central part of the Site.
- **Site 1E**: Land south of Chetwynd Park and west of Cannock Wood Road. This area, *c*. 7.23ha in extent, is located to the north-east of the Site and occupies grassed fields.

1.5 The south-eastern corner of the Site (**Site 1D**) occupies a local hill, which rises to 236m above Ordnance Datum (aOD). From this point, the topography within the Site falls to the north, north-west and west reaching at its lowest point in the north-western corner approximately 180m aOD (**Site 1C**).

1.6 The underlying geology within the Site is mapped as mudstone, siltstone and sandstone of the Pennine Middle Coal Measures Formation, sedimentary bedrock laid down 309-312 million years ago in the Carboniferous Period. Across the majority of the Site, with the exception of the north-easterly areas (**Site 1D**), this is overlain by superficial Quaternary deposits of Diamicton (British Geological Survey 2016).

***Scope and objectives***

1.7 The main aim of this report is to identify any potential archaeological and heritage constraints which may need to be taken into account in the site selection process and the preparation of masterplans. This assessment focuses upon the heritage resource of the Site, although the heritage resource within the wider landscape was considered as and where necessary (1km buffer; Fig. 1-2), to more fully understand any archaeological potential and constraints within the Site. Designated heritage assets within the environs of the Site were also considered to the extent to which their settings may be affected by the proposed residential development.

1.8 The objectives of the assessment are:

- To summarise recorded heritage assets within, and adjacent to, the Site;
- To summarise the potential significance of known or potential buried archaeological remains within the Site; and

- To identify any designated heritage assets that may be considered as sensitive receptors to development within the Site.

***Methodology***

1.9 Whilst this appraisal is not sufficiently detailed to match the criteria for a full heritage desk-based assessment, reference is made to key national and local policy and guidance. This includes the *Standard and Guidance for Historic Environment Desk-Based Assessment* (Chartered Institute for Archaeologists 2014); the English Heritage (now Historic England) guidance *Conservation Principles* (2008) and Historic England guidance *Historic Environment Good Practice Advice in Planning Note 3: The Setting of Heritage Assets* (2015b). It should be noted that any future assessments for the proposed development should be undertaken in accordance with these guidance documents, and with the overarching national policy: the National Planning Policy Framework ('the Framework').

1.10 The main repositions of information consulted in the preparation of this appraisal comprised:

- English Heritage National Heritage List (for information about World Heritage Sites, Scheduled Monuments, Listed Buildings, Registered Parks and Gardens and Registered Battlefields);
- Staffordshire Historic Environment Record (SHER) (via Heritage Gateway online service and Staffordshire County Council online mapping service) for details of known heritage assets within the Site and surrounding landscape;
- Historic Environment Assessment for Cannock Chase District Council, prepared by Staffordshire County Council (2009); and
- Other online sources, including the British Geological Survey (BGS) Geology of Britain Viewer, Local Plan information and digital Ordnance Survey mapping.

1.11 Known and potential heritage assets within the Site and in its environs are discussed in Section 3 and these are illustrated on Fig. 1, for designated heritage assets, and Fig. 2, for recorded archaeological remains. Heritage assets are referred to in the text by a unique reference number **1**, **2**, etc. or, in the case of designated assets, **A**, **B**, etc. A gazetteer of designated and non-designated heritage assets has been compiled, and is presented as Appendix A.

1.12 A bibliography of sources consulted has been included in the References section of this appraisal.

***Limitations***

1.13 This appraisal is not sufficiently detailed to comprise a full heritage desk-based assessment, in line with the Chartered Institute for Archaeologists guidance (2014). No visit to the Site was undertaken as part of the preparation of this report. In addition, this assessment is principally a desk-based study, and has utilised secondary information derived from a variety of online available sources. It must be noted that the SHER data available online is not considered to be sufficiently up to date or accurate to be used for planning purposes. While the data is considered suitable to inform the site selection and masterplanning processes, any detailed planning applications would need to be accompanied by a full desk-based heritage assessment, in line with the relevant guidance (Chartered Institute for Archaeologists 2014), which would incorporate a full and detailed SHER search.

## 2. PLANNING POLICY

***Legislative framework, national planning policy and relevant sector guidance***

2.1 This assessment has been compiled in accordance with the following legislative, planning policy and guidance documentation:

- National Heritage Act 1983 (amended 2002);
- Planning (Listed Buildings and Conservation Areas) Act (1990);
- The Hedgerows Regulations (1997);
- National Planning Policy Framework (2012);
- *National Planning Practice Guidance: Conserving and enhancing the historic environment* (Dept. for Communities and Local Government 2014);
- English Heritage, (2008): *Conservation Principles: policies and guidance for the sustainable management of the historic environment* (2008);
- Historic England, (2015a): *Historic Environment Good Practice Advice in Planning*: *Note 2*: *Managing Significance in Decision-Taking in the Historic Environment*; and
- Historic England, (2015b): *Historic Environment Good Practice Advice in Planning*: *Note 3*: *The Setting of Heritage Assets*.

***Planning (Listed Buildings and Conservation Areas) Act (1990)***

2.2 The Planning (Listed Buildings and Conservation Areas) Act sets out the laws on planning controls with regard of Listed Buildings and areas of special architectural or historic interest (Conservation Areas). The document states that, when making planning decisions with regard to developments affecting Listed Buildings or their settings, the local planning authority or the Secretary of State *shall have special regard to the desirability of preserving the building or its setting or any features of special architectural or historic interest that it possesses* (Section 66).

***National policy: National Planning Policy Framework (2012)***

2.3 The Framework sets out national planning policy relating to the conservation and enhancement of the historic environment. It defines the historic environment as *all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora.*

2.4 Individual components of the historic environment are considered to constitute heritage assets: *buildings, monuments, sites, places, areas or landscapes identified as having a degree of significance meriting consideration in planning decisions, because of their heritage interest*.

2.5 Heritage assets include designated sites and non-designated sites, and policies within the Framework relate both to the treatment of the assets themselves, and their settings, both of which are a material consideration in development decision making.

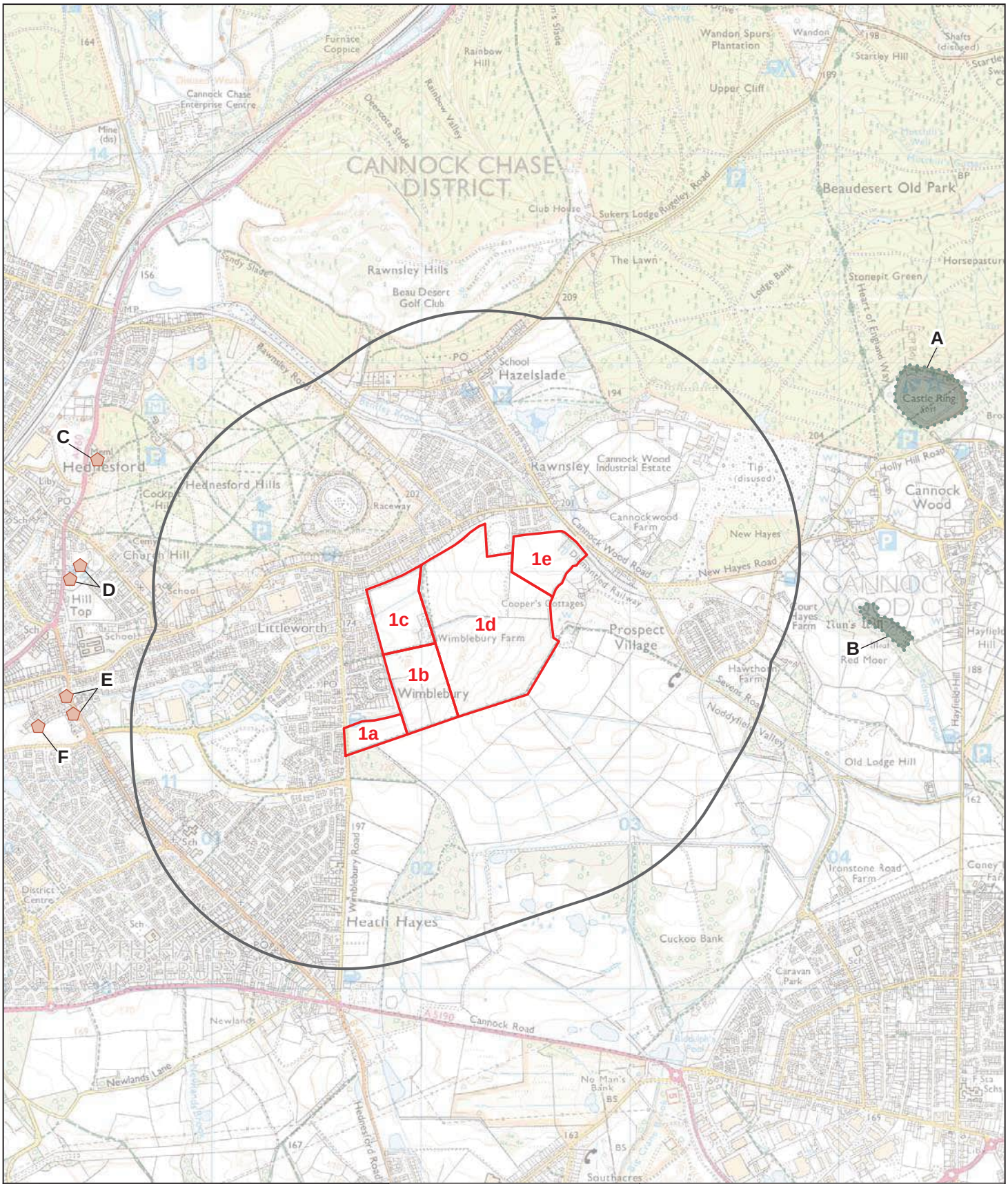
2.6 Key tenets of the Framework are that:

- when considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation. The more important the asset, the greater the weight should be (Paragraph 132);
- significance can be harmed or lost through alteration or destruction of the heritage asset, or development within its setting. As heritage assets are irreplaceable, any harm or loss should require clear and convincing justification. Substantial harm to, or loss of, a Grade II Listed Building, park or garden should be exceptional. Substantial harm to, or loss of, designated heritage assets of the highest significance, notably Scheduled Monuments, Protected Wreck Sites, Battlefields, Grade I and II* Listed Buildings, Grade I and II* Registered Parks and Gardens, and World Heritage Sites, should be wholly exceptional (Paragraph 132);
- where a proposed development will lead to less than substantial harm to the significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal (Paragraph 134); and
- with regard to non-designated heritage assets, a balanced judgement will be required having due regard to the scale of any harm or loss, and to the significance of the heritage asset affected (Paragraph 135).

2.7 Local planning authorities should require an applicant to describe the significance of any heritage assets affected by a proposed development, including any contribution made to significance by their setting. The level of detail required in the assessment should be 'proportionate to the assets' importance, and no more than is sufficient to understand the potential impact of the proposal on their significance.'

### *Local planning policy*

2.8 The Site lies within the administrative boundary of Cannock Chase District Council. The *Cannock Chase Local Plan Part 1: Core Strategy and Rugeley Town Centre* was adopted in June 2014. The policies within this document which relate to the historic environment include Policy CP15: Historic Environment, which defines the Council's approaches to the protection and enhancement of the historic environment within the District. The policy states that the decision-making process *'will be based on an assessment of significance of heritage assets including their setting in relation to development proposals (…). For heritage assets of archaeological interest or sites with potential interest an appropriate level of assessment and/or evaluation will be required to inform decision making*' (Cannock Chase District Council 2014).



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PROJECT TITLE

Land to the East of Wimblebury, Cannock, Staffordshire

FIGURE TITLE

**Site location and designated heritage assets**

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## 3. HERITAGE OVERVIEW AND SUMMARY OF POTENTIAL CONSTRAINTS

***Designated heritage assets***

3.1 There are no designated heritage assets within the Site and therefore no designated heritage assets of highest or less than highest significance would be physically affected by any proposed development within any of the Site.

3.2 There are no designated heritage assets within a 1km buffer around the Site boundary's (Fig. 1). Within the wider environs of the Site, there are no World Heritage Sites, sites included on the Tentative List of Future Nominations for WHS (December 2016), Registered Parks or Gardens, Registered Battlefields or Conservation Areas.

3.3 Two Scheduled Monuments are included within the wider surroundings of the Site. Moated site and bloomery in Courtbanks Covert Scheduled Monument (Fig. 1: **A**), a medieval moated site and associated industrial remains, are situated approximately 1.3km to the south-east of **Site 1E** and *c*. 1.4km east of **Site 1D**.

3.4 Castle Ring Scheduled Monument (Fig. 1: **B**), an Iron Age hillfort, reused in the medieval period as the location of a hunting lodge, is located *c*. 1.6km to the north-east of **Site 1E**.

3.5 There are six Grade II Listed Buildings within the wider environs of the Site, distributed along the B4154 and A460 approximately 1.5km to the east. These include

- Hednesford War Memorial (Fig. 1: **C**), which dates to 1922 and is located *c*. 1.4km north-west of **Site 1C**;
- Roman Catholic Church of Our Lady of Lourdes, with adjacent shrine (Fig. 1: **D**), which dates to the early 20th century and is located approximately 1.4km west of **Site 1C**;
- Cross Keys Inn, which dates to the 18th century, and probably 16th century Farmhouse (Fig. 1: **E**), situated approximately 1.5km east of **Sites 1C** and **1B** and *c*. 1.3km north-east of **Site 1A**; and
- Prospect Place (Fig. 1: **F**), an 18th century house located *c*. 1.4km east of **Site 1A**.

*Settings Appraisal*

3.6 This section considers receptors that might be affected by the proposed development within **Sites 1A**-**1E** through the alteration of their setting. The appraisal at this initial stage in accordance with the guidance contained in the 2015 Historic England guidance *Historic Environment Good Practice Advice in Planning Note 3: The Setting of Heritage Assets* (2015b).

3.7 Step 1 of this guidance involves the identification of those heritage assets likely to be affected by the development proposal. The initial desk-based appraisal included the review of on-line available Ordnance Survey maps, aerial photographs and the descriptions of the heritage assets recorded in the National Heritage List of England.

3.8 Scheduled Castle Ring (Fig. 1: **B**), and the southern part of **Site 1D**, both occupy locally prominent points. Whilst due to vegetation, built form and distance, the Site is considered unlikely to provide a strong contribution to the significance of this asset, it cannot be ruled out at this stage that potential intervisibility exists between the Site and Castle Ring. It is therefore recommended to review the potential for the Site to influence the significance of this Scheduled Monument during a site visit undertaken as part of any desk-based assessments supporting planning applications for development within any of the Site, particularly with regard to **Site 1D**. If needed, the desk-based assessment should incorporate a detailed settings assessment, in accordance with relevant guidance (Historic England 2015b).

3.9 The Scheduled moated site (Fig. 1: **A**) is secluded within woodland and appears to be screened from the Site by topography, vegetation and built form. It is considered that development within the Site would be unlikely to affect the significance of this highly significant designated heritage asset in any way.

3.10 The initial review has concluded that the Site is separated from the Grade II Listed Buildings (Fig. 1: **C**-**F**) by topography and, above all, by modern development. It is considered unlikely that development within the Site would change the settings, and therefore significance, of these assets.

3.11 It should be noted that this initial appraisal is subject to confirmation by means of a site visit and study area walkover, during which a need for a full settings assessment may be identified for all or some of the above assets. However, at this

stage no major constraints that would prohibit development within the Site have been identified.

***Known and potential archaeological remains***

*Prehistoric and Roman period*

3.12 There is no evidence for prehistoric activity within the 1km buffer around the Site and there is limited evidence for Mesolithic/Neolithic activity in the wider landscape, largely comprising findspots (Staffordshire County Council 2009).

3.13 During the Bronze Age, woodland clearance may have commenced across the West Midlands, although there is limited evidence for activity during this period within the environs of the Site, with burnt mounds, interpreted as potential cooking or bathing sites, identified in Cannock Wood to the south of Castle Ring, approximately 1.6km north-east of **Site 1E** (Staffordshire County Council 2009).

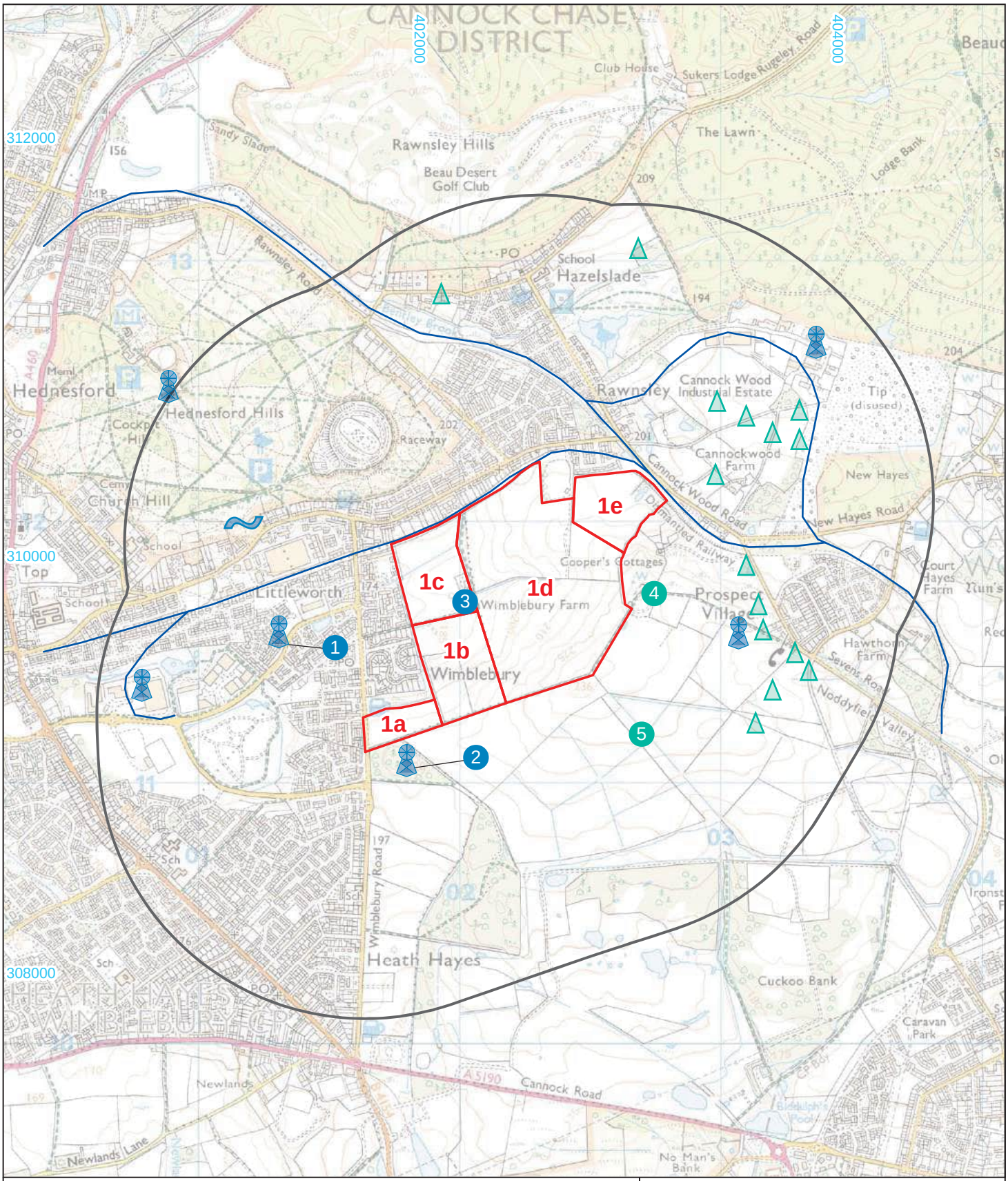
3.14 There is however evidence for Iron Age activity within the surroundings of the Site, in the form of the prominent hillfort Castle Ring (Scheduled Monuemnt; Fig. 1: **B**). Hillforts constitute the most prominent surviving features of Iron Age date in the landscape and display a variety of styles and functional adaptation. They may have comprised sites of permanent settlement, places of refuge and could have served as local and regional centres of redistribution, serving the surrounding hinterland of outlying, enclosed and unenclosed, farms and small settlements (Staffordshire County Council 2009).

3.15 There is no evidence for prehistoric activity within the Site, but the Site (located *c*. 1.6km to the south-west of the hillfort for **Site 1E**) would have been located within the environs of the Castle Ring hillfort and as such the presence of prehistoric remains cannot be ruled out.

3.16 There is no evidence for Roman period activity within the surroundings of the Site and in general, the Roman period is poorly understood within Cannock Chase. As such the potential for the presence of associated remains within the Site is unknown.

*Early medieval and medieval*

3.17 The development of the Site and its surroundings from the medieval period onwards has been characterised within the Cannock Historic Environment Character Zone 9 (CHECZ 9; Staffordshire County Council 2009).




Site boundary
Study area
Post-medieval
Modern
Bell pits
Colliery
Sand pit
Mineral railway

N

0 1km



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PROJECT TITLE
Land to the East of Wimblebury, Cannock, Staffordshire

FIGURE TITLE
**Recorded heritage assets**

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3.18 From at least the medieval period, the Site would have formed part of Cannock Forest, with the Historic Landscape Characterisation, which aimed to reconstruct the medieval landscape, recording the Site within unenclosed land (Staffordshire County Council 2009).

3.19 There are no medieval archaeological remains recorded within the Site or the 1km buffer around the Site boundary, however in the wider landscape, there is evidence for medieval activity including the Scheduled moated site (Fig. 1: **A**) and hunting lodge (Fig. 1: **B**). There is also evidence in the wider landscape for industrial activity, including a coal mine in Beaudesert Park, held by the Bishops of Lichfield, over 1km north-east of the Site. The coal mine is mentioned in 14th century documentary sources and it is likely that some of the bell pits recorded within the park and, perhaps, in the 1km buffer around the Site, from which coal and/or ironstone was extracted, may have been associated with medieval rather than post-medieval industrial activity (Fig. 2) (Staffordshire County Council 2009).

3.20 Whilst the potential for some medieval activity within the Site cannot be ruled out, it is likely to be peripheral and perhaps associated with the agricultural use/exploitation of unenclosed heath, with low potential for the presence of highly significant remains, i.e. associated with settlement or industrial activity.

*Post-medieval and modern*

3.21 During the post-medieval and modern periods, the Site would have comprised agricultural land. It appears that heathland within the Site and their surroundings would have been enclosed as a result of the 18th/19th century semi-planned enclosure. Within this planned landscape, straight field boundaries are characteristic and these are still identifiable however many of the boundaries have been removed throughout the 20th century (Staffordshire County Council 2009).

3.22 There is evidence for post-medieval activity within the surroundings of the Site, including a site of a former building known as Cooper's Lodge adjacent to **Site 1D** to the east (Fig. 2: **4**) and an area of an 18th century coppice, to the south of **Site 1D** (Fig. 2: **5**). The review of the SHER data available online and the historic Ordnance Survey maps (from 1884 onwards) indicates that these remains are unlikely to have extended into the Site.

3.23 Within the enclosed agricultural landscape, farmsteads are recorded, including Wimblebury Farm (Fig. 2: **3**), located in the south-eastern corner of **Site 1C**. This

farmstead was characterised by a regular courtyard plan, which suggests a late 19th century date, however, no historic buildings appear to survive (Staffordshire County Council 2009). This area was later used as a timber yard.

3.24 The majority of recorded heritage assets within the 1km buffer are associated with post-medieval and modern industrial activity (Fig. 2). A large number of bell pits, used in early coal mining, have been identified on aerial photographs within the environs of the Site. Whilst some of these might be associated with medieval mining, they may represent the remains of 17th century activity, when Queen Elizabeth I leased the coal mines to Gilbert Wakering (Staffordshire County Council 2009).

3.25 The surroundings of the Site were subject to landscape reorganisation in the 19th century, as the Enclosure Acts enabled landowners to claim mineral rights, which instigated expansion of industry (Staffordshire County Council 2009). Within the environs of the Site, the industrial activity is represented by a number of collieries, with associated shafts, and extraction pits (Fig. 2). Cannock and Wimblebury Colliery (Fig. 2: **1**) and a pit associated with Cannock Chase Colliery (Fig. 2: **2**) are recorded to the east of **Site 1C** and south of **Site 1A**, respectively, however, the historic Ordnance Survey maps indicate this industrial activity did not extend into the Site.

3.26 The expansion of industrial activity was closely connected with the development of transportation in the form of mineral railways. The line of the former mineral railway, which was utilised for transporting coal from the Cannock Chase collieries to the mainline London and North Western Railway, defines the northern boundaries of **Sites 1B** and **1C** and the north-eastern boundary of **Site 1E** (Fig. 2).

3.27 The Ordnance Survey maps available online do not show any industrial activity within the Site. Apart from Wimblebury Farm and the field boundaries associated with the enclosure of heath, the maps show in the early 20th century a rifle range and activity (including small structures and football ground) to the south of the Cricket Ground within **Site 1D**, although these features do not appear to have survived. Throughout the 20th century, the Site appears to have been in agricultural use, with the former enclosures amalgamated into large fields as a result of boundary removal.

## 4. CONCLUSION

4.1 A heritage appraisal has been prepared to inform the site selection process and preparation of masterplans for potential housing development within the Site. The aim of this appraisal is to provide an overview of the known heritage assets of archaeological interest within **Sites 1A**-**1E** and their wider environs, and to identify any potential archaeological constraints. This appraisal has also examined the potential for impacts on the settings of designated heritage assets which could require further assessment, depending on the final location of the proposed development within the Site. No designated heritage assets have been recorded within any of **Sites 1A**-**1E**.

***Designated heritage assets***

4.2 There are no designated heritage assets within 1km of the Site. The preliminary appraisal of designated heritage assets has indicated that potential development within **Sites 1A**-**1E** is unlikely to change the setting and affect the significance of the majority of the designated heritage assets, including Listed Buildings and Scheduled Monuments.

4.3 However, this has not been tested through a site visit and therefore it is recommended that any full desk-based assessments should incorporate a rapid settings appraisal to confirm the above conclusions. This would especially be required for any development within the prominent parts of the Site (**Site 1D**) which could potentially be inter-visible with the Castle Ring Scheduled Monument (Fig. 1: **B**). If needed, detailed settings assessments should be prepared for any relevant designated heritage assets as part of desk-based assessment for any future planning applications.

***Archaeological remains***

4.4 This appraisal has established that there is limited evidence for prehistoric activity within the surroundings of the Site and from the medieval period onwards, the Site would have comprised an area of unenclosed land peripheral to known settlement or industrial activity. As such, there is limited potential for the presence of archaeological remains of highest significance (commensurate with Scheduled Monuments) within the Site likely to prohibit or significantly influence the design of development proposals.

4.5 In the 18th/19th centuries, the Site was subject to semi-planned enclosure of heathland, which resulted in the creation of enclosed fieldscapes characterised by straight field boundaries. Within this landscape, a farmstead: Wimblebury Farm, was established likely in the latter half of the 19th century on **Site 1C** (Fig. 2: **3**). There are no historic buildings remaining within this farmstead (Staffordshire County Council 2009). Whilst a more detailed assessment will be required to ascertain the origins and potential survival of the farmstead remains on **Site 1C**, to fully understand the heritage significance of any associated buried remains, it is considered that any buried remains associated with this farm would likely be of limited, if any, heritage significance.

4.6 It appears that the Site was located outside areas of industrial activity, recorded to the north and east of **Sites 1C**, **1D** and **1E** (mineral railway; Fig. 2) as well as to south and west of **Sites 1A**, **1B** and **1C** (collieries and associated pits; Fig. 2: **1** and **2**) and the Site is therefore unlikely to comprise remains contributing to our understanding of the industrial development in Staffordshire, however, further research may be required to confirm this initial appraisal.

4.7 Whilst construction impacts associated with development would have potential to damage any buried archaeological remains, it is anticipated that buried archaeological remains within the Site are unlikely to represent an absolute constraint on development. As such these are unlikely to require preservation in situ, although they may require consideration as part of the planning process.

4.8 The assessment of the Cannock Historic Environment Character Zone 9 (CHECZ 9) (Staffordshire County Council 2009), within which the Site is located, has concluded that any development within this zone should consider a strategy for assessing the potential impacts upon known and unknown archaeological remains and subsequent mitigation.

4.9 As potential for the presence and extent of any archaeological remains within the Site is not sufficiently understood to fulfil the requirements of paragraph 128 of the Framework, further archaeological work to fully assess the archaeological potential and inform mitigation measures is likely to be required by Staffordshire County Council's archaeological officers before determination of any planning application. This in the first instance is likely to include a full heritage desk-based assessment, carried out in line with relevant guidance, which may be followed by non-intrusive or intrusive surveys (including trial trench evaluation).

4.10 The historic environment assessment for CHECZ 9 also states that any development should also consider the impact and mitigation upon the historic landscape character, with design measures reflecting the local distinctiveness (Staffordshire County Council 2009). It is recommended therefore that any desk-based assessments produced for potential future planning applications within the Site should include an appraisal of the historic landscape character and potential development impacts upon it. Whilst this historic landscape character within the Site appears to have been substantially altered in the modern period as a result of boundary removal and alteration, the significance of this landscape type should be duly considered and any valuable elements (such as perhaps hedgerows or other field divisions) reflected in the development plans.

4.11 The CHECZ 9 assessment also highlights the importance of the line of the mineral railway to this Character Zone, which should be retained and enhanced as a landscape feature. The plan of **Sites 1A**-**1E** appears to indicate that the mineral railway lies adjacent to but outside the Site. Whilst it may not be possible to incorporate enhancement to the mineral railway as part of the development, it would be advantageous to explore as part of the development of masterplans any potential enhancements the development within **Sites 1C**-**1E** could bring to this industrial asset (including elements such as maintenance, improved access and interpretation).

4.12 It is recommended that the Local Planning Authority's heritage and archaeology advisors should be consulted in advance of any submission of future planning applications, to ensure that the application is submitted in accordance with the Framework, and provides an appropriate level of information with regard to heritage assets to inform a planning decision.

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Historic England 2015b *Historic Environment Good Practice Advice in Planning: Note 3: The Setting of Heritage Assets.*

Ordnance Survey maps viewed on 28/2/17 at: https://www.old-maps.co.uk

Staffordshire County Council 2009 *Historic Environment Character Assessment for Cannock Chase District Council*, https://www.staffordshire.gov.uk/environment/eLand/planners-developers/HistoricEnvironment/Projects/CannockChase DistrictHEAFinalReport.pdf [Accessed: 28/2/17]

Staffordshire County Council: Historic Buildings, Landscape and Archaeology, viewed on 28/2/17 at: https://apps2.staffordshire.gov.uk/WEB/OnTheMap/heritage

## APPENDIX A: GAZETTEER OF RECORDED HERITAGE ASSETS

| No. | Description | Designation/Period | NGR | HE ref.<br>**SHER ref.** |
|---|---|---|---|---|
| **A** | Moated site and bloomery in Courtbanks Covert | Scheduled Monument | 404226 311732 | 1003750 |
| **B** | Castle Ring, a multivallate hillfort and medieval hunting lodge | Scheduled Monument | 404428 312834 | 1014687 |
| **C** | Hednesford War Memorial and Gates | Grade II Listed Building | 400448 312530 | 1391895 |
| **D** | Roman Catholic Church of Our Lady of Lourdes, including boundary walls and railings; and adjacent shrine | Grade II Listed Buildings | 400324 311982 | 1430855<br>1432936 |
| **E** | Cross Keys Inn and Farmhouse | Grade II Listed Buildings | 400305 311415 | 1180326<br>1344627 |
| **F** | Prospect Place | Grade II Listed Building | 400160 311264 | 1344625 |
| **1** | Cannock and Wimblebury Colliery (later Wimblebury Mine). It was operational in late 19th/early 20th century. It included a magazine, mineral railway, shafts and reservoir. | Modern | 401300 311570 | **MST5792** |
| **2** | The site of Cannock Chase Colliery pit no. 8 which opened in 1863 and closed in 1962. | Modern | 401940 310750 | **MST5794** |
| **3** | Wimblebury farm – former farmstead which had a regular courtyard and existed in the late 19th century | Modern | 402020 311680 | **MST21184** |
| **4** | Site of a building known as Cooper's Lodge in the 19th century. | Post-medieval | 402700 311680 | **MST13786** |
| **5** | Cooper's Coppice – area of coppice extant in 18th century | Post-medieval | 402740 311100 | **MST13789** |
| | Bell pits | Post-medieval | Various | **MST5350**<br>**MST5349**<br>**MST3973**<br>**MST17213**<br>**MST17212**<br>**MST19111**<br>**MST19112**<br>**MST19113**<br>**MST19114**<br>**MST3974**<br>**MST17214**<br>**MST17215**<br>**MST17216**<br>**MST17217**<br>**MST17219** |
| | Collieries, mine pits and shafts | Modern | Various | **MST5785**<br>**MST5793**<br>**MST5789**<br>**MST19115** |
| | Sand pit | Modern | 401190 311970 | **MST17819** |
| | Mineral railway | Modern | Various | **MST17193** |

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# APPENDIX 5

# Land at Wimblebury, Cannock Chase, Staffordshire
# Arboricultural Technical Note
# C_EDP3912_02 03 March 2017

## Introduction

1.1 This Technical Note has been prepared by the Environmental Dimension Partnership Ltd (EDP) and has been commissioned by the Church Commissioners for England ('the Client') to inform the proposed development of five parcels of Land at Wimblebury located in Cannock, Staffordshire. This report covers all five compartments of land shown as parcels 1A-E on **Plan EDP 1** which will be collectively referred to as the 'Study Area'. The Study Area is approximately 65.5 hectares and is centred approximately at Ordnance Survey Grid Reference SK 022 117.

1.2 EDP is an independent environmental planning consultancy with offices in Cirencester, Cardiff and Shrewsbury. The practice provides advice to private and public sector clients throughout the UK in the fields of landscape, ecology, archaeology, cultural heritage, arboriculture, rights of way and masterplanning. Details of the practice can be obtained at our website www.edp-uk.co.uk.

## Methodology and Limitations

1.3 A walkover survey was undertaken on 01 March 2017 by EDP to inform a preliminary assessment of the tree stock supported by the Study Area. The extents of the survey area is depicted on the Key Arboricultural Constraints Plan (**Plan EDP 1**).

1.4 The survey sought to identify all trees considered to be of high (category A), moderate (category B) quality, based upon guidance set out in BS 5837:2012 Trees in relation to design, demolition and construction. In this instance, no category C or category U items were recorded due to these not being considered a significant material constraint to development and as such they have not been considered in the context of this 'high level' assessment.

1.5 Any future planning application should be informed by a further more detailed tree survey based on topographic survey data and fully according with BS 5837:2012. The current survey, the subject of this Technical Note, was conducted in such a way that it can be reconciled with topographic data and used as the baseline for further enhancement in the future.

1.6 The survey was undertaken using a GPS enabled tablet PC which provides accuracy to within 0.5 metres. To assist in both the survey and future depiction of the tree population

the survey base mapping comprised a composite of Ordinance Survey data and high resolution aerial imagery.

1.7 All surveyed items are as depicted on **Plan EDP 1** and are detailed in the tree survey schedule (**Schedule EDP 1**) enclosed to the rear of this document.

1.8 All recorded items were allocated a unique reference number, with individual trees being given the prefix 'T', groups of trees the prefix 'G', woodlands the prefix 'W' and hedgerows the prefix 'H'.

1.9 The high level nature of this assessment dictated that only one visually prominent hedgerow was the subject of this survey, however such linear features have been recorded as part of the Ecological Technical Note (**C_EDP3912_01**).

1.10 Designated root protection areas (RPA) for each surveyed item have been calculated in accordance with BS5837:2012, the extent of these areas is depicted on **Plan EDP 1**.

**Overview of Tree Stock and Recommendations**

1.11 As a brief overview, the Study Area extends to 65.5 hectares (ha) in size, and consists of approximately 7 individual field parcels of mixed land use including pasture and arable; whilst water courses, field boundary hedgerows and mature trees are scattered across the wider Study Area.

1.12 The Study Area is located on the urban edge of Cannock, approximately 3km east of the town centre and lies within the administrative boundary of Cannock District Council (CDC).

1.13 No consultation with CDC has been undertaken to date with regards to the possibility of Tree Preservation Orders (TPO) within or immediately adjacent the Study Area, however a desk based assessment has determined that no part of this Study Area lies within or abuts a designated conservation area. It is advised that any future planning application should be informed by a comprehensive data trawl and clarification sought from CDC with respect to statute controls.

1.14 The survey process recorded three individual trees, nine groups of trees, one hedgerow and one woodland, totalling 14 items. Of these 14 items; one has been classified as category A, of high quality and value and 13 as category B, of moderate quality and value.

1.15 A total of 11 species are supported by the Study Area, these comprise native and naturalised species and are considered typical of this semi-rural setting, with oak and birch dominating the hierarchy.

1.16 The constraints posed by each compartment are briefly summarised below:

1.17 Parcel 1A abuts two offsite items, including one woodland (W5) and one dense group (G4), these items are outside of the control of the development but the above and below ground constraints would need to be considered in any future development. This parcel presents minimal arboricultural constraints to development and with informed and considered masterplanning, there would be no impact upon these offsite items.

1.18 Parcel 1B partially contains two moderate quality features that surround the disused timber yard and access road. Field boundary hedgerows bisect the compartment but are of low arboricultural quality. With informed and considered masterplanning, these items could be retained within any future development.

1.19 Parcel 1C contains four moderate quality items which surround the disused timber yard and access road. With informed and considered masterplanning, these items could be retained within any future development.

1.20 Parcel 1D contains one high quality tree, T9, two moderate quality trees, T7 and T8, one moderate quality group, G3, and one moderate quality hedgerow, H6. Field boundary hedgerows also bisect the compartment by are of low arboricultural quality. All items are situated to the fringes of this compartment and with informed and considered masterplanning, these items could be retained within any future development.

1.21 Parcel 1E contains two groups which surround three ponds and separates the Study Area from Cannock Wood Road. These items would restrict access to the compartment from the Cannock Wood Road but would not constrain development if brought forward with other compartments.

1.22 Overall, there are a number of significant arboricultural features across the Study Area, particularly in the northern eastern compartment, 1E, where the mature groups of trees surround ponds. Additionally, a collection of moderate quality items surround a disused timber yard in compartment 1C. In contrast compartments 1A, 1B and 1D are minimally constrained by arboricultural features, with all items of high or moderate quality being situated on the boundaries.

1.23 Of the entire Study Areas tree population T9 is considered to be the most important due to its impressive stature and its ecological benefits, additionally the mature groups of trees surrounding the ponds to the north eastern extent of the site provide important landscape and ecological benefits.

1.24 Whilst the Study Area supports an extensive hedgerow network, though of low quality and not the subject of this survey, a number of weaknesses in this fabric could be readily exploited to provide both interconnectivity and coalescence of individual land parcels to enhance the net developable area.

1.25 Future masterplanning should seek to retain moderate quality and value items as practicable and should respect the constraints posed by such items by virtue of canopy extents and designated Root Protection Areas (RPAs).

**Conclusions**

1.26 Overall the Study Area contains 14 items of high or moderate quality these items should be prioritised for retention due to their condition, age and longevity.

1.27 The majority of arboricultural items present are located within the field boundaries or surrounding properties. The tree resource across the site is an important material consideration and should be given due consideration in any future materplanning

1.28 Future detailed masterplanning should seek to demonstrate a constraints led approach that works with the Study Areas existing green infrastructure whilst additionally seeking opportunities for further enhancement.

1.29 It is recommended that any future masterplanning exercise is informed by a detailed tree survey, based on topographic survey date and in full compliance of BS5837:2012.

# Schedule EDP 1

| | | | |
|---|---|---|---|
| **Client:** | The Church Comissioners for England | **Site:** | Land at Wimblebury, Cannock Chase, Staffordshire |
| **Date of Survey:** | 01/03/2017 | **Consultant** | Tom Cleeton |
| **Tagged** | N/A | **Weather** | Overcast |

| Sequential Reference No. | Species | Height (m) | Stem Diameter (mm) | Branch Spread (m) | | | | Canopy Clearance (m) | Life Stage | Physiological Condition | Structural Condition | Comments / Notes | Recommendations | Estimated Remaining Contribution (Years) | Category Grading | Priority |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | North | East | South | West | | | | | | | | | |
| G1 | Silver birch (Betula pendula); Common hawthorn (Crataegus monogyna); Pine sp. (Pinus sp.); Poplar sp. (Populus sp.) | 10 | 400 | 4 | 4 | 4 | 4 | 0 | Mature | Fair | Fair | Flanking track; some trees felled by axe across track | No Work Recommended | 20+ | B1 | N/A |
| G2 | Horse chestnut (Aesculus hippocastanum); Silver birch (Betula pendula); Common hawthorn (Crataegus monogyna); Pine sp. (Pinus sp.); Poplar sp. (Populus sp.); Willow sp. (Salix sp.) | 10 | 400 | 4 | 4 | 4 | 4 | 0 | Mature | Fair | Fair | Flanking old timber yard | No Work Recommended | 20+ | B1 | N/A |
| G3 | Norway maple (Acer platanoides); Common ash (Fraxinus excelsior) | 10 | 300 | 4 | 4 | 4 | 4 | 0 | Mature | Fair | Fair | Flanking old timber yard | No Work Recommended | 20+ | B1 | N/A |
| G4 | Common hawthorn (Crataegus monogyna); Blackthorn (Prunus spinosa); Willow sp. (Salix sp.) | 5 | 150 | 4 | 4 | 4 | 4 | 0 | Mature | Fair | Fair | Dense offsite group | No Work Recommended | 20+ | B1 | N/A |
| W5 | Scots pine (Pinus sylvestris) | 10 | 200 | 4 | 4 | 4 | 4 | 0 | Early Mature | Fair | Fair | Dense offsite woodland | No Work Recommended | 20+ | B1 | N/A |
| H6 | Common hawthorn (Crataegus monogyna) | 4 | 200 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Mature hawthorn hedgerow; gappy; historically laid | No Work Recommended | 20+ | B1 | N/A |
| T7 | English oak (Quercus robur) | 6 | 300# | 3 | 1 | 3 | 3 | 2 | Mature | Fair | Fair | Leaning; diminutive form | No Work Recommended | 20+ | B1 | N/A |
| T8 | English oak (Quercus robur) | 8 | 300# | 4 | 4 | 4 | 4 | 3 | Mature | Fair | Fair | No Significant Faults Observed | No Work Recommended | 20+ | B1 | N/A |
| T9 | English oak (Quercus robur) | 9 | 500# | 5 | 5 | 5 | 5 | 3 | Mature | Good | Good | No Significant Faults Observed | No Work Recommended | 40+ | A1 | N/A |
| G10 | English oak (Quercus robur); Willow sp. (Salix sp.) | 8 | 250 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Partially offsite; wet soils | No Work Recommended | 20+ | B1 | N/A |
| G11 | Common alder (Alnus glutinosa); Silver birch (Betula pendula); English oak (Quercus robur) | 9 | 250 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Partially offsite | No Work Recommended | 20+ | B1 | N/A |
| G12 | Common alder (Alnus glutinosa); Silver birch (Betula pendula); English oak (Quercus robur) | 9 | 250 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Partially offsite; several removals and items heavily pruned | No Work Recommended | 20+ | B1 | N/A |
| G13 | Common alder (Alnus glutinosa); Silver birch (Betula pendula); English oak (Quercus robur) | 9 | 250 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Partially offsite | No Work Recommended | 20+ | B1 | N/A |
| G14 | Common alder (Alnus glutinosa); Silver birch (Betula pendula); English oak (Quercus robur) | 9 | 250 | 2 | 2 | 2 | 2 | 0 | Mature | Fair | Fair | Partially offsite | No Work Recommended | 20+ | B1 | N/A |

**Sequential Reference Number** -T - Individual specimen; G - Group. Trees that form cohesive arboricultural features either aerodynamically, visually or culturally; H - Linear group of specimens that form a hedge or boundary; W - A larger group or area of trees that should be regarded as a single woodland unit.
**Species** -Common English names are used wherever possible for simplicity.
**Height** -An approximation of height (in metres) is provided for the highest point of the tree.
**Stem Diameter** -This is the measurement of stem diameter in millimetres taken in accordance with Annex C of BS5837:2012. # - estimated
**Branch Spread** -This is taken at four cardinal points, with a stated value in metres to enable an accurate representation of the crown
**Existing Height Above Ground Level** -An approximation of height (in metres) of crown clearance above adjacent ground level.
**Life Stage** -There are five classes to which trees are assigned: Young; Early Mature; Mature; Over Mature; Veteran.
**Physiological Condition** -An indication of the tree's physiological condition is represented and classed as good, fair, poor or dead. this is informed by the following: Canopy Density: It should be taken that, unless otherwise stated with each individual entry, the canopy density of the trees is typical of the species; and Leaf Size and Colouration: It should be taken that, unless otherwise stated with each individual entry, leaf size and colouration is typical of the species.

**Structural Condition** -Additional notes are provided giving details of the tree's structural condition. This is informed by "the presence of any decay and physical defect".
**Preliminary Management Recommendations** -These are made on the basis of optimising the life expectancy of site trees, given their current situation and that which may result from the development proposals. The survey process pays particular attention to implications for life and/or property; defects recorded under the structural condition have the necessary mitigation measures proposed within this section of the schedule.
**Estimated Remaining Contribution** -The definitions of the terms used are as follows and describe the estimated length of time (in years) over which the tree can be expected to make a safe contribution to local amenity: Less than 10; 10+; 20+; and 40+.
**Category Grading** -Trees have been assigned 'U' or Category Grading 'A' to 'C' in accordance with the Cascade Chart given in BS5837:2012
**Tree Works Priority Codes** -Priority codes from 1 to 3 have been given for trees requiring work. The definition of the codes used is as follows: Priority 1: Work that should be undertaken urgently due to the identification of a potential hazard; Priority 2: Work that should be undertaken prior to any works commencing on site; and Priority 3: Work that should be undertaken following the completion of the development.

# Plans

**Plan EDP 1** Key Arboricultural Constraints
(EDP3912/02 03 March 2017 TC/GD/LH)


Site Boundary

T1 Tree/Group Number

Tree/Group Canopy

Tree Stem

Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints Overview**

| | | | |
|---|---|---|---|
| **date** | 02 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |

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Tree and tree group positions were recorded on site with reference to Ordnance Survey data, georeferenced aerial imagery and a tablet computer with a dedicated differential GPS module. To conform to BS5837:2012 Trees in Relation to Design, Demolition and Construction the survey data will require amendment following the receipt of a detailed topographical survey. These plans have been produce to aid early design not submission


Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 1 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

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Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 2 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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N

G10

G11

1E

2

3

5

6

0 20 40 60 80 100 m

Site Boundary

T1 Tree/Group Number

Tree/Group Canopy

Tree Stem

Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 3 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |

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1

2

N

1C

G1

G2

G3

4

5

7

8

0 20 40 60 80 100 m

Site Boundary

T1 Tree/Group Number

Tree/Group Canopy

Tree Stem

Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 4 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |

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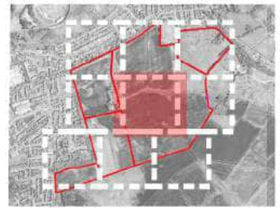
Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value



client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 5 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |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Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 6 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 7 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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Site Boundary

T1 Tree/Group Number

Tree/Group Canopy

Tree Stem

Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 8 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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Tree and tree group positions were recorded on site with reference to Ordnance Survey data, georeferenced aerial imagery and a tablet computer with a dedicated differential GPS module. To conform to BS5837:2012 Trees in Relation to Design, Demolition and Construction the survey data will require amendment following the receipt of a detailed topographical survey. These plans have been produce to aid early design not submission


Site Boundary

T1 Tree/Group Number
Tree/Group Canopy
Tree Stem
Root Protection Area

Category A: Trees of high quality and value

Category B: Trees of moderate quality and value

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Key Arboricultural Constraints (Sheet 9 of 9)**

| | | | |
|---|---|---|---|
| **date** | 03 March 2017 | **drawn by** | TC |
| **drawing number** | EDP3912/02 | **checked** | GD |
| **scale** | Refer to scale bar | **QA** | LH |


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# APPENDIX 6

# Land at Wimblebury, Cannock Chase, Staffordshire
# Ecology Technical Note
# C_EDP3912_01 03 March 2017

## Introduction

1.1 This Technical Note has been prepared by the Environmental Dimension Partnership Ltd (EDP) on behalf of the Church Commissioners for England to inform the proposed development of five parcels of Land at Wimblebury, Cannock, Staffordshire. This report covers all five parcels of land of Site 1 shown on **Appendix EDP 1** (parcels 1A, 1B, 1C, 1D and 1E), which will be collectively referred to as the 'Site'. The Site is approximately 65.5 hectares and is centred at approximately Ordnance Survey Grid Reference SK 022 117.

1.2 The Site is located on farmland east of the town of Cannock in Staffordshire. It is bounded by the residential development of Cannock to the north and west, a dismantled railway, industrial estate and Newlands tip to the east and further arable land, semi improved grassland and patches of woodland to the south. The land falls within the local planning authority area of Cannock District Council and the parcels within it have been selected as a series of sites that present options for housing development in the Cannock Chase Local Plan Part 2: Issues and Options.

1.3 The purpose of this Ecology Technical Note is to consider the ecological sensitivities pertaining to the Site and its respective parcels (1A-1E), and identify opportunities and constraints which influence its potential to support residential development. Recommendations are also given for the scope of further survey work required to inform any future planning application.

## Methodology

1.4 This Ecology Technical Note has been informed by a desk study, which involved the collation of information on designated sites and species records from online resources and Staffordshire Ecological Record (see **Appendix EDP 2**), and an Extended Phase 1 Survey of the Site undertaken by an experienced ecologist in March 2017 (see **Appendix EDP 3**).

1.5 Although March is considered to be a sub-optimal time of year for Extended Phase 1 surveys, for the purposes of providing high level information to inform potential opportunities and constraints afforded by the Site, the findings are not considered to be significantly limited by seasonality.

**Potential Constraints**

***Statutory Designations***

1.6 The Desk Study confirmed that there are no statutorily designated nature conservation sites within the Site. However, there are two Special Areas of Conservation (SACs) within 10km, three Sites of Special Scientific Interest (SSSIs) within 5km and two Local Nature Reserves (LNRs) within 2km. These designated sites have been summarised below and further details can be found in **Appendix EDP 2**.

*Cannock Chase SAC*

1.7 Cannock Chase SAC lies 2.4km north of the Site at its closest point and Cannock Chase SAC Development Management Policy NR7 states: "*any development that results in a net increase in dwellings within a 15km radius of any boundary of Cannock Chase SAC (as shown on the Policies Map) will be deemed to have an adverse impact upon the Cannock Chase SAC unless or until satisfactory avoidance and/or mitigation measures have been secured*."

1.8 Despite the acknowledged 15km Zone of Influence, financial contributions for the required mitigation are being sort in the 0-8km Zone only. Therefore, development within the Study Area should expect to contribute financially to the mitigation Strategy for Cannock Chase SAC.

*Cannock Extension Canal SAC*

1.9 Cannock Extension Canal lies 4.3km south of the Site. This site is a canal with very good water quality supporting floating water plantation and a diverse dragonfly and damselfly assemblage. Identified threats to the quality of this SAC that could occur from outside of the Site boundary are: pollution to groundwater (point sources and diffuse sources), air pollution, air-borne pollutants and invasive non-native species[1].

1.10 Due to its spatial separation from the Site, it is unlikely that development within the Site would result in any of the identified threats to this SAC arising, subject to best practice measures relating to pollution and soil-run off control and prevention being implemented during construction.

***National Statutory Designations***

1.11 The Site is inside the Impact Risk Zone[2] for all three SSSIs identified within 5km (Chasewater and The Southern Staffordshire Coalfield Heaths, Gentleshaw Common and

[1] JNCC 2015, NATURA 2000 – STANDARD DATA FORM, Cannock Extension Canal SAC
[2] Natural England (2016) Natural England's Impact Risk Zones for Sites of Special Scientific Interest: User Guidance v2.5. Available from: http://magic.defra.gov.uk/Metadata_for_magic/SSSI%20IRZ%20User%20Guidance%20v2.5%20MAGIC%2010Mar2016.pdf.

Cannock Chase), whereby residential planning applications will require consultation by the Local Planning Authority with Natural England. Considering the proximity of these SSSIs, their 'unfavourable-recovering' status and the threat to the condition of these sites being classed as 'high', consultation with Natural England (NE) through their discretionary advice service (DAS) is likely to be required to determine the potential for impacts to arise and required mitigation.

1.12 However, these statutory designations do not pose a direct constraint to the development of the Site, and it is considered that any adverse recreational impacts, if identified, could be readily mitigated through sensitive scheme design that provides adequate recreational opportunities for the new population and/or contributions to the management of these designated sites if necessary.

*Hednesford Hills Common LNR*

1.13 Hednesford Hills Common LNR lies 200m north of the Site. This site is also part of the Chasewater and The Southern Staffordshire Coalfield Heaths SSSI and therefore the need to mitigate potential recreational impacts relating to this site will be addressed by any mitigation required for the SSSI.

*Hazelslade LNR*

1.14 Hazelslade LNR lies 400m north of the Site and is important for its Lepidoptra, especially dingy skipper (*Erynnis tages*) and Cannock Chase's largest water vole (*Arvicola amphibious*) colony. Measures are discussed below in relation to potential protected and notable species within the Site which will ensure there will be no impact on the water vole and dingy skipper within this LNR.

***Non Statutory Designations***

1.15 The Site itself is not covered by any non-statutory designations however, there are a number of non-statutory sites within 2km of the boundary. Non-statutory designations in Staffordshire are known as Local Wildlife Sites (LWSs) or Sites of Biological Interest (SBIs). These are included within local development plans. In addition, there are other non-statutory designations which may be pertinent in the locality that are not always shown on local development plans. These include Biodiversity Alert Sites (BASs), which are of Local Importance for Nature Conservation and other areas of interest for wildlife where there may be potential to improve the habitat to LWS/SBI standard with appropriate management. These sites are listed and displayed in **Appendix EDP 2**.

1.16 The measures discussed below in relation to potential protected and notable species constraints would ensure that there is no impact from development within the Site on any of the LWSs or BASs within the Potential Zone of Influence[3].

[3] Zone of Influence - the areas and resources that may be affected by the proposed development

**Habitats**

1.17 The Extended Phase 1 Habitat Survey (see **Plan EDP 1**) confirmed the Site to be predominantly arable land with some areas of semi-improved grassland delineated by fences, partly dry drains, a small number of species-poor hedgerows (within parcel 1D only) and areas of scattered scrub. There are two ponds within the Study Area, in parcels 1C and 1E. Further detailed habitat descriptions can be found in **Appendix EDP 3**.

1.18 Apart from the ponds, and to a lesser extent the two hedgerows, none of the habitats present within the Site are considered to pose a potential constraint to development. With respect to these habitats, it is recommended that there is some further survey of the grassland in parcel 1E at a more optimal time of year (May or June). Some level of on-site retention, buffering and/or compensatory habitat creation/enhancement as part of any future development proposals green infrastructure strategy is recommended.

1.19 Measures to avoid impacts from development on the ponds, and associated habitat corridors (e.g. drains), are discussed below in relation to great crested newts (GCN) (*Triturus cristatus*) and where applicable other low value habitats with potential to support protected or notable species.

***Protected and Notable Species***

1.20 The desk study identified records for a number of protected species within 1km of the Site, details of which can be found in **Appendix EDP 2**. These include a number of Red and Amber listed Birds of Conservation Concern[4], great crested newt, adder (*Vipera berus*) and slow worm (*Anguis fragilis*), two common and widespread bat species, hedgehog (*Erinaceus europaeus*) and brown hare (*Lepus europaeus*) as well as many notable moth, bee and butterfly species.

*Breeding Birds*

1.21 During the Extended Phase 1 survey, displaying male skylark (*Alauda arvensis*) and lapwing (*Vanellus vanellus*) were recorded flying over parcels 1A, 1B, 1C and 1D. These are species of Principle Importance and are in the Staffordshire BAP. The trees and scattered scrub within the Site are also likely to support an assemblage of common and widespread bird species in small numbers.

1.22 It is likely that further breeding bird surveys would be required across the Site to determine the value of the breeding bird assemblage and confirm the breeding status of

[4] Eaton MA, Aebischer NJ, Brown AF, Hearn RD, Lock L, Musgrove AJ, Noble DG, Stroud DA and Gregory RD (2015) Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man. British Birds 108, 708–74

different species within each parcel. If the any of the parcels were brought forward in isolation, parcels 1B, 1C and 1D are considered to be of sufficient size to support a notable breeding bird assemblage and therefore worthy of full breeding bird surveys.

1.23 Should breeding lapwing or skylark be confirmed on any of the parcels, then phasing of the works should ensure that habitat is always available for these ground nesting species. If development was to come forward in any parcel in isolation, the remaining parcels will likely provide enough suitable habitat for them. It should be noted that the habitat within the locality of the site also provides additional suitable nesting habitat for displaced ground nesting birds. However, if development was brought forward across the entire Site, displacement of the existing populations may over-stretch the competition for resources in the surrounding area and further mitigation or compensation may need to be considered.

1.24 Sensitive timing of the clearance of any scrub or trees would ensure that no impact on other breeding birds in the Site occurs.

*Bats*

1.25 There are no roosting opportunities within the Site and the habitats present are only considered to be of low suitability for foraging and commuting bats. However, the pasture, drains and associated scrub in each of the land parcels, and hedgerows within land parcel 1D, are likely to still be used by a small numbers of bats.

1.26 If development was to be brought forward on all, or a combination of the land parcels, a suite of bat activity surveys would need to be conducted in spring, summer and autumn (active season May to September inclusive) to assess the use of the Site by bats and the value of the assemblage. If development were to be brought forward in any parcel in isolation, it is likely that a lower level of bat survey work would be sufficient to inform the development proposals and necessary mitigation.

1.27 If the survey work identifies any key foraging habitats or commuting routes in the Site, there will be a requirement to retain these where possible. If this is not feasible, alternative mitigation or compensation elsewhere within the Site, such as habitat enhancement and creation, would need to be considered. A sensitive lighting strategy would also need to be devised as part of any development proposals to maintain the functionality of any retained or created habitats.

*Great Crested Newts*

1.28 There are records of GCN from pond P2 within parcel 1E as well as the surrounding ponds to the east (P3, P4 and P5 on **Plan EDP 1**). There are also records of GCN within 560m west of the Site. Therefore presence is also likely within pond P1 in parcel 1C.

1.29 To confirm the presence of GCN within the Site and the population present, a suite of traditional presence/absence surveys would be required at ponds P1-P6 between the middle of March and the middle of June.

1.30 Should presence be confirmed in either P1 or P2, which appears likely, then should development of the Site proceed, a European Protected Species (EPS) licence from Natural England (NE) would be required covering the relevant pond(s) and land within 500m of it/them.

1.31 Should GCN be recorded within Pond P1 a licence would be required for development to proceed within parcels 1B, 1C, 1D and 1E and the main requirements for GCN would be maintenance of habitat connectivity between P1 and P2-P6. This would likely involve retention and enhancement of the drains and field margins north and east of pond P1 to connect them with the woodland surrounding ponds P2-P6.

1.32 If historical records of GCN within Pond P2 are confirmed then a licence would likely only be required for development to proceed within parcels 1D and 1E and the main requirement for GCN would be to ensure habitat enhancement around P2 to improve connectivity between it and P3-P6.

*Notable Mammals*

1.33 Brown hare were identified on the Site during the Extended Phase 1 Survey and presence of water vole, badger (*Meles meles*) and hedgehog is considered possible on all land parcels.

1.34 The existing arable land and grassland surrounding the proposed scheme is likely to provide sufficient foraging areas for brown hares and the existing woodland and scrub surrounding the Study Area is likely to provide sufficient foraging and resting areas for hedgehog and badger. Therefore, sensitive methods of working during the construction phase are considered sufficient to avoid impacts upon these species.

1.35 The largest water vole colony on Cannock Chase is 400m north of the Site. Whilst the drains on, or bounding, all land parcels appeared to be sub-optimal for this species at the time of the Extended Phase 1 Survey, further survey for water vole is recommended as a precaution.

1.36 In the unlikely event that water vole presence be confirmed, then the drains on which they are found will either require retention and enhancement or if this is not feasible alternative connections to the surrounding drain network established and an appropriate mitigation strategy agreed with NE via a licence to displace them from the development works.

*Reptiles*

1.37 Records of slow worm and adder were returned from within 500m east and southeast of the Site. Whilst a majority of the Site is of limited suitability for reptiles, the areas identified as Target Notes 3, 4 and 5 are considered to have potential to support reptiles. These areas affect parcels 1A (Target Note 3 and 5) and 1B (Target Note 4 and 5).

1.38 The potential for reptiles to be present on parcels 1A and 1B is considered low and therefore sensitive timing of vegetation clearance and other precautionary measures are considered sufficient to avoid impact and no further survey work is required.

*Invertebrates*

1.39 Records of small heath butterfly (*Coenonympha pamphilus*), a species of principle importance, were returned from within parcel 1D. The food plants for this species are Bents (*Agrostis* spp.), Fescues (*Festuca* spp.) and Meadow-grasses (*Poa* spp.), all of which are present across the Site and within the land surrounding it.

1.40 Records of dingy skipper were also returned from many locations surrounding the Site. The primary larval foodplant of this species is Bird's-foot Trefoil (*Lotus corniculatus*). Greater Bird's-foot Trefoil (*Lotus pedunculatus*) and Horseshoe Vetch (*Hippocrepis comosa*) are also used. These species should, where possible, be retained or planted in compensatory meadow habitat incorporated into the green infrastructure strategy for any proposed development.

**Summary of Further Surveys Required**

1.41 To surmise, further survey work recommended to inform any future development proposals within the Site, includes:

- Botanical survey of the grassland, (parcel 1E only);
- Breeding bird (apart from parcel 1A or 1E in isolation);
- Bat activity (scope of surveys could be reduced if the parcels are brought forward in isolation);
- Great Crested newts (apart from parcel 1A in isolation); and
- Water voles (all parcels).

**Conclusions**

1.42 The potential constraints posed by, and the mitigation required for, each identified receptor are summarised for each land parcel in **Table EDP 1**.

1.43 The designated sites present within the potential zone of influence of the Site do not pose an 'in principle' constraint to development on any land parcel. Financial contributions will be required to the Mitigation Strategy for Cannock Chase SAC and NE will need to be consulted via the DAS in relation to potential impacts upon the three SSSIs within 5km. However, it is considered that any such impacts could readily be mitigated through a sensitive scheme design and/or financial contributions towards the management of these sites if considered necessary.

1.44 The habitats within the Site are predominantly of low intrinsic ecological value and present good opportunities for enhancement. They are not a constraint to development capacity in their own right, but have the potential to support protected species.

1.45 The possible presence of breeding birds, bats, water voles, great crested newts and/or invertebrates, within the Site will need to be determined through further surveys at appropriate times of year. However, it is considered that, even if these protected species were found to be present, the populations could be readily safeguarded through sensitive scheme design and appropriate mitigation measures, and would not represent an 'in principle' constraint to development. Indeed, opportunities for any protected species potentially present, with the possible exception of farmland birds, could be significantly enhanced in the long-term through the appropriate design of future development proposals.

1.46 It is considered therefore that the Site offers sufficient flexibility to ensure compliance with planning policy at all levels and to avoid 'significant harm' to biodiversity. Furthermore, a sensitively designed development incorporating appropriate mitigation and enhancement has the potential to deliver a significant net gain in biodiversity.

**Table EDP 1**. The Constraints Posed by, and the Mitigation Required for the Receptors within Each Land Parcel

| Site | Receptor | Potential Constraints | Requirements |
|---|---|---|---|
| 1A | Reptiles | Likely using surrounding habitat (Target Notes 3 and 5) so possibly using the boundaries of 1A | Phased clearance of any boundary vegetation to move reptiles into more favourable surrounding habitat with an ecologist present. |
| 1B | Reptiles | Possibly using small section of parcel (Target Note 4) | Phased clearance of any boundary vegetation to move reptiles into more favourable surrounding habitat with an ecologist present. |
| | Great Crested Newt (GCN) | Parcel is within 240m of pond P1 | Survey of pond P1.<br>• If GCN are present, this parcel is 240m from P1. NE EPS licence required for work to proceed. Mitigation strategy likely to comprise:<br>- Exclusion fencing, precautionary methods of working and phased clearance of vegetation during the construction phase.<br>- Habitat enhancement and creation in the north of the parcel.<br>• If not breeding in P1, no mitigation required. |
| | Ground nesting birds | Lapwing and skylark possible breeders | Breeding Bird Survey required to determine presence and how many.<br>• If breeding, low numbers expected on this small parcel and surrounding parcels are considered able to compensate for this displacement.<br>• If not breeding, 1B may be required as mitigation land for development on other parcels impacting on these species. |
| 1C | Reptiles | Possibly using the track between parcel 1B and 1C | Phased clearance of any boundary vegetation to move reptiles into more favourable surrounding habitat with an ecologist present. |
| | GCN | GCN likely to be present in P1 | Survey required of pond P1.<br>• If GCN are present and EPS licence is required and mitigation is likely to include:<br>- Exclusion fencing, receptor site creation, precautionary methods of working and phased clearance of vegetation during the construction phase. |

| Site | Receptor | Potential Constraints | Requirements |
|---|---|---|---|
| | | | • If not breeding in P1, no mitigation required. |
| | Ground nesting birds | Lapwing and skylark possible breeders | Breeding Bird Survey required to determine presence and how many.<br>• If breeding, low numbers expected on this small parcel and surrounding parcels are considered able to compensate for this displacement.<br>• If not breeding, 1C may be required as mitigation land for development on other parcels impacting on these species. |
| 1D | GCN | Potentially present in terrestrial habitat as within 500m of pond 1 and 2 | Survey of all ponds P1-P6.<br>• If GCN are present in P1 only, 1D is adjacent to it and an EPS licence is required. Mitigation is likely to include:<br>- Exclusion fencing, receptor site creation, precautionary methods of working and phased clearance of vegetation during the construction phase.<br>• If not breeding in P1, no mitigation required.<br>• If GCN are breeding in P2 then part of this parcel may be included in the trapping and exclusion measures. |
| | Ground nesting birds | Lapwing and skylark possible breeders | Breeding Bird Survey required to determine presence and how many.<br>• If breeding, low numbers expected on this small parcel and surrounding parcels are considered able to compensate for this displacement.<br>• If not breeding, 1D may be required as mitigation land for development on other parcels impacting on these species. |
| 1E | GCN | Records of GCN from 2009 within pond 2 | Survey of all ponds P1-P6.<br>• If GCN are present in P1 only, this parcel will not be affected.<br>• If GCN are present in P2 or P1 and P2 an EPS licence will be required and mitigation will likely include:<br>- Exclusion fencing, receptor site creation, precautionary methods of working and phased clearance of vegetation during the construction |

| Site | Receptor | Potential Constraints | Requirements |
|---|---|---|---|
| | | | phase. |
| | Habitats | Possible grassland interest | Further surveys to assess grassland diversity.<br>If deemed to have botanical interest then habitat retention and enhancement within open space. |
| All parcels | Water voles | Possible presence within drains across Site although habitat sub-optimal | Further surveys to confirm presence/absence<br>If presence then enhancement of the habitat within the relevant drains will be required. |
| | Brown hare | Present on Site | Sensitive methods of working during the construction phase are considered sufficient to avoid impacts on this species. |
| | Hedgehogs | Possible presence on Site | Sensitive methods of working during the construction phase are considered sufficient to avoid impacts on this species. |
| | Badgers | Possible presence on Site | Sensitive methods of working during the construction phase are considered sufficient to avoid impacts on this species. |
| | Breeding birds | Ground nesting farmland birds and presence in trees and scrub within or surrounding the Site | Sensitive timing of vegetation clearance is considered sufficient to avoid impacts on breeding birds. |
| | Bats | Small numbers likely to be Foraging or commuting along drains and boundary vegetation | Further surveys to confirm which species are using the Site/parcel and how<br>Maintenance or enhancement of the identified flight lines |
| | Invertebrates | Small heath likely to be present on all parcels<br>Dingy skipper possibly present | Retain and enhance boundary vegetation.<br>Habitat creation to include relevant foodplants |
| | Cannock Chase SAC | Impact through increased visitor pressure | Financial contribution to mitigation scheme |
| | Cannock Extension | Impact through diffuse water pollution | Ensure relevant PPGs and CRIRA guidance is followed. |

| Site | Receptor | Potential Constraints | Requirements |
|---|---|---|---|
| | Canal SAC | | |
| | SSSIs | Potential Impact through increased visitor pressure | Consult with Natural England through the DAS to agree appropriate mitigation. |

## Appendices

**Appendix EDP 1** Site Plan

**Appendix EDP 2** Desk Study

**Appendix EDP 3** Habitat Descriptions and Illustrative Photographs

## Plans

**Plan EDP 1** Extended Phase 1 Habitat Plan
(EDP3912/01 02 March 2017 MC/VN/LB)

# Appendix EDP 1
# Site Plan

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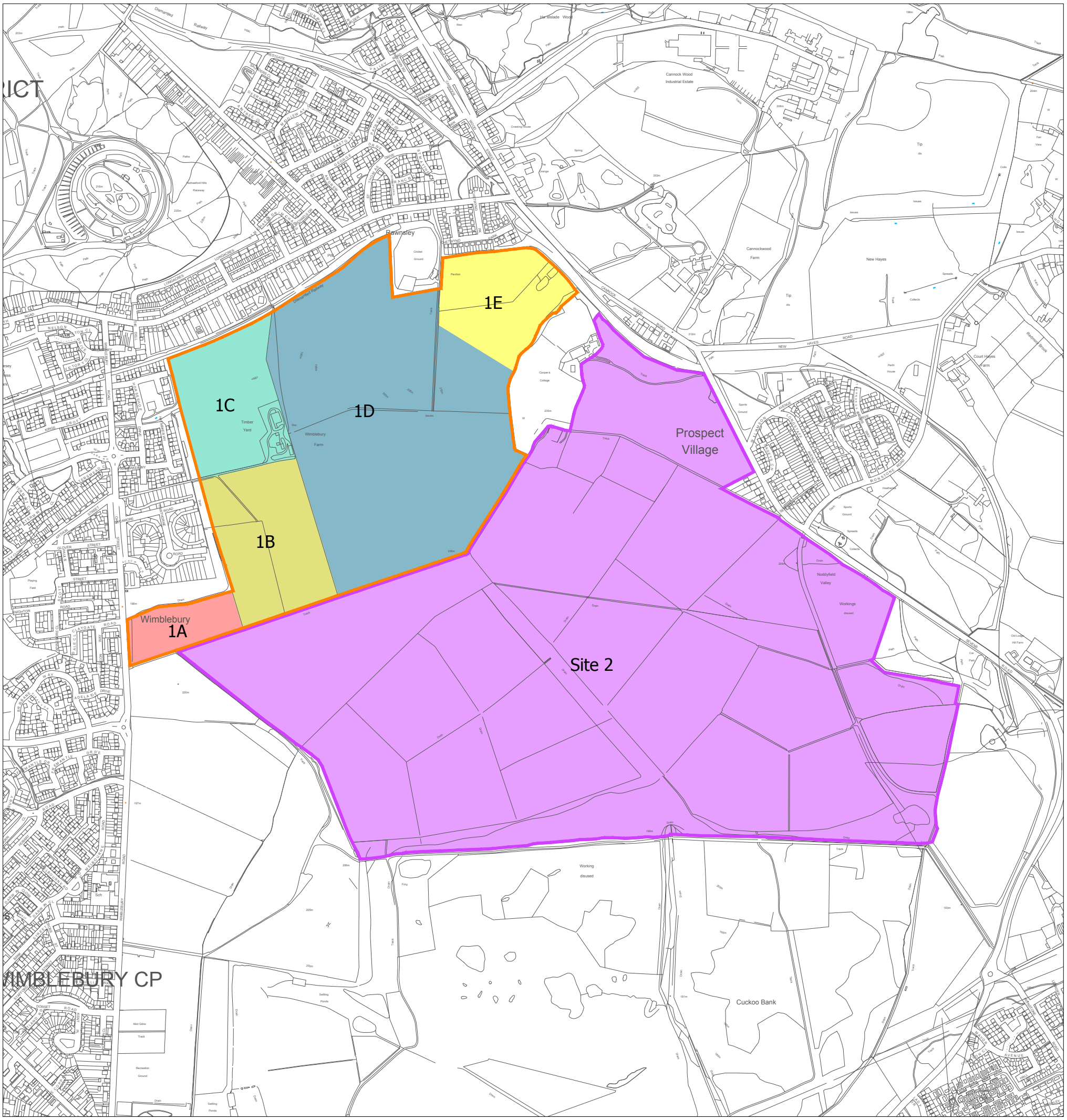


## Legend

- SHLAA Site 1 Overall
  65.50Ha / 161.85Ac
- SHLAA Site 1A
  3.26Ha / 8.06Ac
  Approx 69 Dwellings
- SHLAA Site 1B
  9.57Ha / 23.65Ac
  Approx 201 Dwellings
- SHLAA Site 1C
  8.49Ha / 20.98Ac
  Approx 178 Dwellings
- SHLAA Site 1D
  36.94Ha / 91.28Ac
  Approx 775 Dwellings
- SHLAA Site 1E
  7.23Ha / 17.86Ac
  Approx 152 Dwellings
- SHLAA Site 2 Overall
  141.15Ha / 348.78Ac
- SHLAA Site 2
  141.15Ha / 348.78Ac
  Approx 1976 Dwellings @20dph
  Approx 2964 Dwellings @30dph

Project
**Bleak House,**
**Land to the East of Cannock**

N

Drawing Title
**SHLAA Sites 2016**

| Date | Scale | Drawn by | Check by |
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# Appendix EDP 2
# Desk Study

## Methodology

A2.1 The desk study is an important element of undertaking an initial ecological appraisal of a site proposed for development, since it enables the initial collation and review of contextual information such as designated sites together with known records of protected and priority species.

A2.2 EDP undertook an ecological desk study for the Site in March 2017 to check for information on designated sites and protected species within the Site's potential zone of influence. The desk studies involved collating information from both statutory and non-statutory bodies, including:

(i) Staffordshire Ecological Record (SER); and

(ii) Multi-Agency Geographic Information for the Countryside (MAGIC[5]).

A2.3 Biodiversity information was requested for the following search areas measured from the Site boundary shown in **Plan EDP 1** centred approximately at OSGR SK022 117:

(i) 10km radius for sites of European importance;

(ii) 5km radius for sites of national importance;

(iii) 6km radius for Annex II bat species records;

(iv) 2km radius for sites of local importance;

(v) 500m radius for Priority Habitats; and

(vi) 1km radius for other protected/notable species records.

A2.4 Any pertinent information received as a result of the desk study has been included and specifically referenced within the results section.

## Results

### *Statutory Designations*

A2.5 International statutory designated sites include Natura 2000 sites regarded as being important at a European level including, Special Protection Areas (SPAs), Special Areas of

[5] MAGIC Partners. Interactive Map. [online] Available at: www.magic.gov.uk. Accessed 27/02/17

Conservation (SACs) and globally important wetlands designated as Ramsar Sites. National designations include Sites of Special Scientific Interest (SSSIs) and National Nature Reserves (NNRs).

A2.6 The Site itself is not covered by any statutory designations; however two SACs, three SSSIs and two LNRs occur within the potential zone of influence. The sites and further details are given in **Table EDP A2.1**.

**Table EDP A2.1**: Statutory Sites of Nature Conservation Importance within the Site's Potential Zone of Influence

| Site Name | Designation | Size (ha) | Grid Ref (Closest Point) | Approx Distance from Site | Interest Feature(s) |
|---|---|---|---|---|---|
| Cannock Chase | SAC | 1244 | SK005142 | 2.4km N | Annex 1 habitats: European dry heath and Northern Atlantic wet heaths with *Erica tetralix* |
| Cannock Extension Canal | SAC | 5.2 | SK020068 | 4.3km S | An example of anthropogenic, lowland habitat supporting floating water-plantain at the eastern limit of it's natural distribution in England. Also has a diverse aquatic flora and rich dragonfly fauna, indicative of good water quality. The low volume of boat traffic on this terminal branch of the Wyrley and Essington Canal has allowed open-water plants to flourish, while depressing the growth of emergents. |
| Chasewater and The Southern Staffordshire Coalfield Heaths | SSSI | 530.2 | SK016121 and SK023106 | 200m N and 700m S | Nationally important for wet and dry lowland heath, fens and oligotrophic standing open water habitats, and for its populations of two nationally scarce vascular plants: floating water-plantain (WCA S. 8) and round-leaved wintergreen (a regional rarity). |
| Cannock Chase | SSSI | 1279.1 | SK005142 | 2.4km N | A large, diverse area of seminatural vegetation. Acidic soils support a range of woodland and scrub types. The area of lowland heathland is the most extensive in the Midlands. |

| Site Name | Designation | Size (ha) | Grid Ref (Closest Point) | Approx Distance from Site | Interest Feature(s) |
|---|---|---|---|---|---|
| | | | | | An unusual floristic character, intermediate between heathlands of northern and upland England and Wales and those of southern counties. The valley mire/wet heath communities are rare vegetation types, being some of the most floristically-rich and representative examples of their type in central England. Outstandingly diverse invertebrate fauna. |
| Gentleshaw Common | SSSI | 80.5 | SK045111 | 2km E | Very impoverished, acidic soils. The associated lowland heathland vegetation is of special interest for three main reasons. It represents one of the largest surviving areas of this much reduced habitat in Staffordshire, the floristic character has elements of both oceanic, western and northern heaths, and there is a well developed transition from dry to humid, wet heath. |
| Hednesford Hills Common (also part of Chasewater and The Southern Staffordshire Coalfield Heaths SSSI) | LNR | 107.2 | SK016121 | 200m N | A large area of dry heath/ acid grassland. Hednesford Hills is characteristic of Cannock Chase heathland, sharing geology and soil type, with dry dwarf shrub heath, bilberry, cowberry and acid grassland species. |
| Hazel Slade | LNR | 13.3 | SK025126 | 400m N | Recent surveys of the Lepidoptra confirmed Hazelslade's importance in this region especially for dingy skipper. The pool and it's banks are home to Cannock Chase's largest water vole colony. |

***Non-Statutory Designations***

A2.7 Non-statutory designations in Staffordshire are known as Local Wildlife Sites (LWSs) (previously Sites of Biological Interest [SBIs]). In addition, there are other non-statutory designations which may be pertinent in the locality. These include Biodiversity Alert Sites (BASs). These sites are of Local Importance for Nature Conservation or other areas of interest for wildlife where there may be potential to improve the habitat to LWS/SBI standard with appropriate management. These sites are not normally included within Local Plans.

A2.8 The Site itself is not covered by any non-statutory designations; however 15 LWSs and five BASs or retained BASs occur within 2km of the Site. The sites are listed and further detail (as supplied by SER) is given in **Table EDP A2.2**.

**Table EDP A2.2**: Non-statutory Sites of Nature Conservation Importance within the Site's Potential Zone of Influence

| Site Name | Number (Fig. EDP A1.1) | Grid Ref | Approx Distance from Site | Interest Feature(s) |
|---|---|---|---|---|
| **LWS** | | | | |
| Prospect Village Field | 01/31/08 | SK030118 | 300m E | Semi-improved acidic grassland with two seasonal ponds and associated wetland vegetation. |
| Prospect Village (disused railway Newhayes Rd-Rugeley Rd) | 01/31/39 | SK033119 | 500m E | A disused railway with a complex mosaic of mainly dry habitats. |
| Hazelslade Nature Reserve | 01/22/67 | SK026127 | 500m N | Hazelslade LNR comprises a subsidence pool some associated marshy areas and an area of semi-improved wet acidic grassland all within an area of secondary acidic woodland and scrub. |
| Hednesford Brickworks | 01/01/92 | SK009112 | 700m W | An area of neutral grassland. |
| New Hayes Tip | 01/32/64 | SK036124 | 900m E | An area of colliery spoil with typical ruderal vegetation which also includes common spotted orchids, and has been known to support breeding lapwings. |
| Beaudesert Golf Course, Rawnsley Hills | 01/23/03 | SK020133 | 1.1km N | A golf course on a former heath, which still retains some quite large areas of open heath. The site is included in the EN inventory of Staffordshire Heaths. |
| Sevens Road | 01/31/72 | SK037112 | 1.2km SE | Sevens Road supports species-rich regenerating grassland surrounded by semi-natural and planted |

| Site Name | Number (Fig. EDP A1.1) | Grid Ref | Approx Distance from Site | Interest Feature(s) |
|---|---|---|---|---|
| | | | | woodland areas (for scientific interest). |
| Hednesford Old Park | 01/01/22 | SK002112 | 1.4km W | An area of neutral grassland. |
| Courtbanks Covert, Redmoor Wood | 01/41/36 | SK043116 | 1.6km E | Ancient semi-natural woodland remnant containing a site of archaeological interest. |
| Castle Ring | 01/42/49 | SK044129 | 1.8km NE | Iron age fort with at least 2 ramparts with ditches, the site is colonised by heathy vegetation, some of the ditches are wet and have diverse aquatic floras. |
| Norton Pools | 00/19/93 | SK019093 | 1.8km S | A variety of habitats: dense scrub, semi-improved neutral grassland and heathland. |
| Newlands Brook Fields, Fields and Pool at Newlands Brook | 00/19/04 | SK010094 | 1.8km SW | A group of fields on Newlands Brook between Newlands Lane and the RJB haul road. Each field has its own separate characteristics but all are wet, slightly acidic, semi-improved grasslands. |
| Stoke's Lane | 00/18/28 | SK012088 | 2km S | A small tarmac road with intact hawthorn hedgerow on both sides with wet ditches. Verges are 1-5m wide and mainly grass communities. Plantation woodland on the east is relatively young with oak, hawthorn, rowan, hazel, birch and willow. |
| Hawk's Green Nature Reserve (and dismantled railway) | 91/90/71 | SJ997101 | 2km SW | A varied site including semi-improved neutral grassland, ponds, plantations, hedgerow, streams and a flush. |
| Burntwood Road (heathland north of), Norton Canes | 00/29/53 | SK025093 | 2km S | Wet heath and *Molinia* dominated grassland mosaic with scattered scrub. |
| **BAS/Retained BAS** | | | | |
| Newlands (retained) | 00/19/28 | SK012098 | 1.4km S | A small area of broadleaf woodland which has developed on an area of marshy grassland. |
| Redmoor Hill (west of) | 01/41/00 | SK040110 | 1.5km SE | A small, botanically diverse area of Lowland Heath situated on a steeply-sloping field edge |
| Hayfield Hill (near Redmoor) retained | 01/41/56 | SK045116 | 1.8km E | Two small fields with still species rich semi-improved neutral grassland. |
| Gentleshaw Grassland | 01/41/89 | SK048119 | 2km E | An area of semi-improved neutral grassland with several wet flushes |

| Site Name | Number (Fig. EDP A1.1) | Grid Ref | Approx Distance from Site | Interest Feature(s) |
|---|---|---|---|---|
| (retained) | | | | and two small streams flow through steep-sided ditches leading to a main ditch on the east of the field. A hedgerow contains frequent holly with occasional hawthorn. |
| Long Lane (retained) | 00/19/41 | SK014091 | 2km S | Completely wooded lane with planted oak dominating the canopy. Holly and hawthorn are frequent as hedgerow species. Silver birch, elder and hazel are present in the hedgerow and understorey. Rowan is also present but rarely noted. |

***Priority Habitats***

A2.9 There are several areas of Priority Habitat 'broadleaved woodland' adjacent to the northeast and southwest of the Site as well as the areas of lowland heatherland which are designated under Chasewater and The Southern Staffordshire Coalfield Heaths SSSI.

***Protected and Notable Species***

**Table EDP A2.3:** Notable Bird Records within the Site's Potential Zone of Influence

| Common Name | Grid Ref | Approx Distance from Site | Date | Status |
|---|---|---|---|---|
| **Birds** | | | | |
| Lesser Redpoll, Sky Lark, Teal, Gadwall, Meadow Pipit, Tree Pipit Swift, Nightjar, Black-headed Gull Stock Dove, Common Quail, Cuckoo House Martin, Lesser Spotted Woodpecker, Yellowhammer Reed Bunting, Common Snipe Herring Gull, Lesser Black-backed Gull, Yellow-legged Gull Linnet, Grasshopper Warbler, Yellow Wagtail, Spotted Flycatcher, Eurasian Curlew, House Sparrow, Tree Sparrow Grey Partridge, Common Redstart Willow Warbler, Willow Tit Dunnock, Bullfinch, Turtle Dove Starling, Redwing, Song Thrush Fieldfare, Ring Ouzel, Lapwing | SK0112 SK0210 SK0310 SK0312 SK0313 SK0311 SK0111 SK0310 SK0111 SK0112 SK0210 SK0012 SK0212 | Unknown – all grid squares within 1km<br><br>Hednesford Hills, Cuckoo Bank Biddulph pool | 2007-2016 | BoCC Amber or Red |

**Table EDP A2.4**: Protected and Notable Species Records within 1km of the Application Site

| Scientific Name | Common Name | Grid Ref | Approx Distance from Site | Date | Comments | Status |
|---|---|---|---|---|---|---|
| **Reptiles and amphibians** | | | | | | |
| Triturus cristatus | Great Crested Newt | SK011110<br>SK026121<br>SK030118<br>SK0311<br>SK031120 | 560m W<br>within site<br>350m E<br>unknown<br>250m E | 2016<br>2009<br>2005<br>2009<br>2007 | | EPS |
| *Anguis fragilis* | Slow-worm | SK032115 | 500m SE | 2008 | | NERC S.41 |
| *Vipera berus* | Adder | SK031120 | 300m E | 2007 | | NERC S.41 |
| **Mammals** | | | | | | |
| *Erinaceus europaeus* | West European Hedgehog | SK011117<br>SK014109<br>SK020122 | 650m W<br>350m SW<br>150m N | 2010<br>2009<br>2014 | | NERC S.41 |
| *Lepus europaeus* | Brown Hare | SK0310 | Unknown | 2008 | | NERC S.41 |
| *Mustela putorius* | Polecat | SK0011 | Unknown | 2013 | | NERC S.41 |
| **Bats** | | | | | | |
| *Pipistrellus pipistrellus* | Common Pipistrelle | SK035118 | 700m E | 2009 | | EPS |
| *Plecotus auritus* | Brown Long-eared Bat | SK037120 | 900m E | 2010 | | EPS<br>UK BAP |
| **Plants** | | | | | | |
| *Spergula arvensis* | Corn Spurrey | SK022113 | onsite | 2007 | | Rare |
| **Invertebrates - ladybirds** | | | | | | |
| *Hippodamia variegata* | Adonis' Ladybird | SK017120 | 100m N | 2014 | | Rare |
| *Coenonympha pamphilus* | Small Heath | SK013127<br>SK019111<br>SK021113<br>SK026127<br>SK027128<br>SK034123<br>SK035124<br>SK036124 | 900m N<br>100m S<br>onsite<br>500m N<br>600m N<br>650m E<br>800m NE<br>900m NE | 2008-2009 | Hednesford Hills Hazelslade Nature reserve Cannock Chase | NERC s.41 |

| Scientific Name | Common Name | Grid Ref | Approx Distance from Site | Date | Comments | Status |
|---|---|---|---|---|---|---|
| *Erynnis tages* | Dingy Skipper | SK007111<br>SK008114<br>SK010112<br>SK022106<br>SK027128<br>SK030107<br>SK032122<br>SK033119<br>SK034123<br>SK035124<br>SK036124 | 900m W<br>850m W<br>640m W<br>700m S<br>600m N<br>870m S<br>450m E<br>500m E<br>650m E<br>800m NE<br>900m NE | 2009 | Biddulph Pool<br>Hazelslade<br>Norton Canes | NERC S.41 |
| **Invertebrates – Hymenoptera (bees and wasps)** | | | | | | |
| *Andrena clarkella, Arachnospila minutula, Lasioglossum laevigatum, Megachile versicolor Nomada flava, Vespula rufa* Gwynne's Mining Bee, Grey Mining Bee, Early Mining Bee, Honey Bee Gipsy Cuckoo Bee, Small Garden Bumble Bee, Red Tailed Bumble Bee, White-tailed Bumble Bee Common Carder-bee, Four Coloured Cuckoo Bee, Buff-tailed Bumble Bee, Red Wasp | | SK034123<br>SK035124 | 640m NE<br>820m NE | 2009 | | NERC S.41 |
| *Bombus hypnorum* | Tree Bumble Bee | SK0110 | Unknown | 2016 | | NERC S.41 |
| *Vespa crabro* | Hornet | SK015104 | 750m S | 2014 | | NERC S.41 |
| **Invertebrates - moths** | | | | | | |
| *Rheumaptera hastata* | Argent and Sable | SK029131 | 960m N | 2009 | Beaudesert Old Park (overview) | NERC S.41 |
| *Spilosoma lubricipeda* | White Ermine | SK013120 | 470m NW | 2014 | | NERC S.41 |
| *Timandra comae* | Blood-vein | SK014120 | 380m NW | 2015 | | NERC S.41 |

| Scientific Name | Common Name | Grid Ref | Approx Distance from Site | Date | Comments | Status |
|---|---|---|---|---|---|---|
| The Streak, Latticed Heath, Sallow Small Phoenix, Dusky Thorn Autumnal Rustic, White-line Dart Rustic, Rosy Rustic, Shoulder-striped Wainscot, Rosy Minor Brindled Beauty, Dot Moth, Shaded Broad-bar, Buff Ermine Anomalous, Welsh Clearwing Cinnabar, Dark-barred Twin-spot Carpet, Heath Rustic, Neglected Rustic, Mouse Moth, Dusky Brocade, Minor Shoulder-knot Mottled Rustic, Crescent, Broom Moth, Grey Dagger, Knot Grass | | SK013127 | 900m N | 2009 | Hednesford Hills and Hazelslade nature reserve | NERC S.41 |

# Appendix EDP 3
# Habitat Descriptions and Illustrative Photographs

A3.1 The principal habitats within and around each parcel of Study Area are described below, with illustrative photographs provided where appropriate. The following should be read in conjunction with **Plan EDP 1** – *Phase 1 Habitat Plan.*

A3.2 The Study Area has a whole is predominantly undulating arable land parcels bounded and delineated by fences and a network of partly dry drains with areas of scattered scrub (**Image EDP A3.1**). The soil is poor draining and most of the drains were dry and the fields were very water logged at the time of survey.

**Image EDP A3.1**: The arable nature of the Study Area

## Common Habitat Descriptions

### *Scattered Scrub*

A3.3 Unless otherwise stated, the scattered scrub comprises gorse (*Ulex europaeus*), willow (*Salix* sp.), hawthorn (*Crataegus monogyna*), oak (*Quercus* sp.), holly (*Ilex aquifolium*) and bramble (*Rubus frutisosus* agg.).

***Semi Improved Grassland***

A3.4 Unless otherwise stated, the semi improved grassland is dominated by cocks foot (*Dactylis glomerata*), false oat grass (*Arrhenatherum elatius*) and fescue (*Festuca* sp.) with frequent tufted hair grass (*Deschampsia cespitosa*) and occasional red dead nettle (*Lamium purpureum*), dove's foot crane's bill (*Geranium molle*), creeping buttercup (*Ranunculuc repens*) and common sorrel (*Rumex acetosa*).

***Drains***

A3.5 Unless otherwise stated, the drains hold patches of water from 5-20cm deep and are filled with *Juncus* sp. and the grassland species described in paragraph A1.4 (**Image EDP A3.2**). The banks are lined with a mosaic of scrub and grassland species (described in paragraphs A3.4 and A3.5) and are usually steep and 0.5-1m high.

**Image EDP A3.2**: Typical drain on the Study Area

**Land Parcel Descriptions**

***Parcel 1A***

A3.6 Parcel 1A is a 3.26 hectare arable field in the southwest corner of the Site. On its northern boundary is a drain, beyond which is an area of vegetation that is a mosaic of tussocky semi improved grassland with scattered heather (*Calluna vulgaris*), gorse, silver birch saplings and rhododendron (likely *Rhododendron ponticum*). This is Target Note 5 on **Plan EDP 1** and shown in **Image EDP A3.3**.

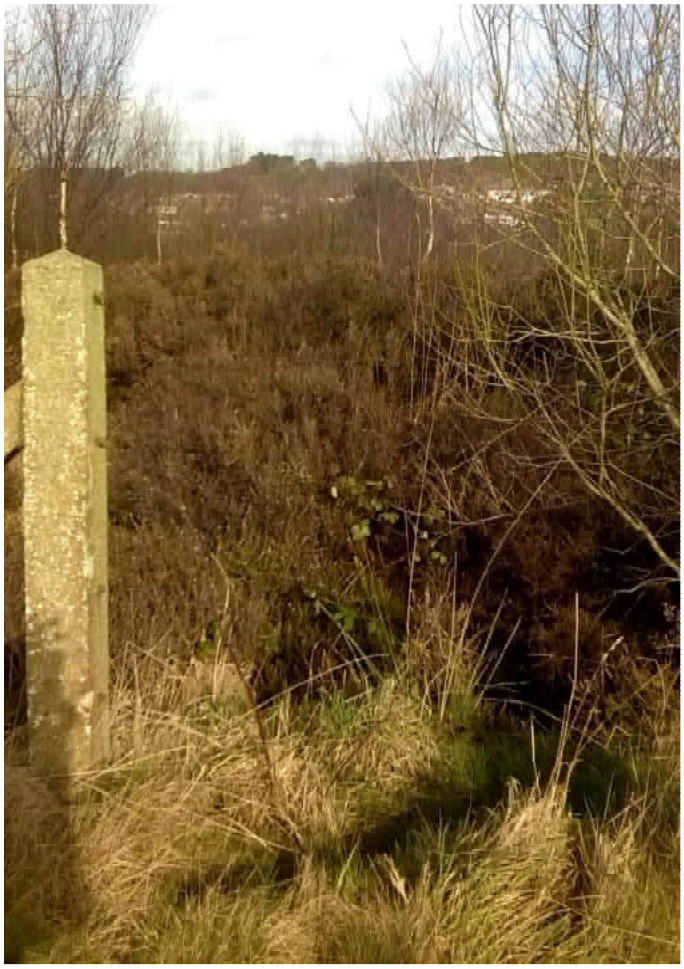


**Image EDP A3.3**: Semi improved grassland, silver birch and heather in Target Note 5

A3.7 On the southern boundary is a public footpath, a fence and another drain beyond which is an area of conifer plantation and an area of unmanaged, tussocky, semi improved grassland with scattered gorse scrub. This is Target Note 3 on **Plan EDP 1**.

***Parcel 1B***

A3.8 Parcel 1B is a 9.57 hectare area that is largely arable with a small area of semi improved grassland and silver birch saplings. This area of the parcel, noted as Target Note 4 on **Plan EDP 1** is delineated by a track and fences. The vegetation is similar to that in Target Note 5.

A3.9 A drain runs along the southern boundary, as described for, and shared with, parcel 1A and Target Note 3 extends along this boundary also. The northern boundary is a track to a disused timber yard (Target Note 1). This track runs parallel to a drain which is dry in parts and is surrounded by a mosaic of scrub, tall ruderal vegetation and semi improved grassland with some mature trees. The trees are a mix of poplar (*Populus* sp.), oak, silver

birch, Cyprus (*Cupressus* sp.) and willow trees and the tall ruderal vegetation is dominated by rosebay willow herb (*Chamaenerion angustifolium*) and dock (*Rumex obtusifolia*).

***Parcel 1C***

A3.10 Parcel 1C is an 8.49 hectare arable field. Its southern boundary is shared with parcel 1B and described above. In the southwest corner is a disused timber yard (Target Note 1) surrounded by a fence and scattered scrub and semi improved grassland. Within the timber yard is a mosaic of bare ground and scattered scrub with rhododendron and pine (*Pinus* sp.) trees.

A3.11 Further along the western boundary is a large pond and area of marginal vegetation dominated by *Typha latifolia* with occasional willow scrub (**Image EDP A3.4**). This area encroaches into parcel 1D where it becomes more dominated by willow scrub with less marginal vegetation.

**Image EDP A3.4**: The large pond in Parcel 1C

A3.12 Along the northern and eastern boundaries is scattered scrub and tall ruderal vegetation which forms a narrow band between the Application Site and the surrounding residential development.

***Parcel 1D***

A3.13 Parcel 1D is a 36.94 hectare area of arable land. Along its southern and part of the eastern boundary is a drain and fence. The remainder of the eastern boundary is semi

improved, heavily horse grazed paddocks delineated by electric fenced and scattered with stables and feeding sheds.

A3.14 Within the centre of parcel 1D, running east-west, is a fast flowing drain along which the hawthorn scrub, which is scattered at the western end, becomes a hawthorn hedge at the eastern end. This hedge is intersected by another hawthorn hedge running parallel to a track in a north-south direction.

A3.15 Parallel to the northeast corner is a cricket club surrounded by fence and scattered scrub and the northern boundary is a drain that runs parallel to a thin strip of oak and willow scrub that is beginning to mature into woodland with little understorey.

A3.16 Along the western boundary is an area of wet willow scrub with some *Typha latifolia* that links to that described for Parcel 1C.

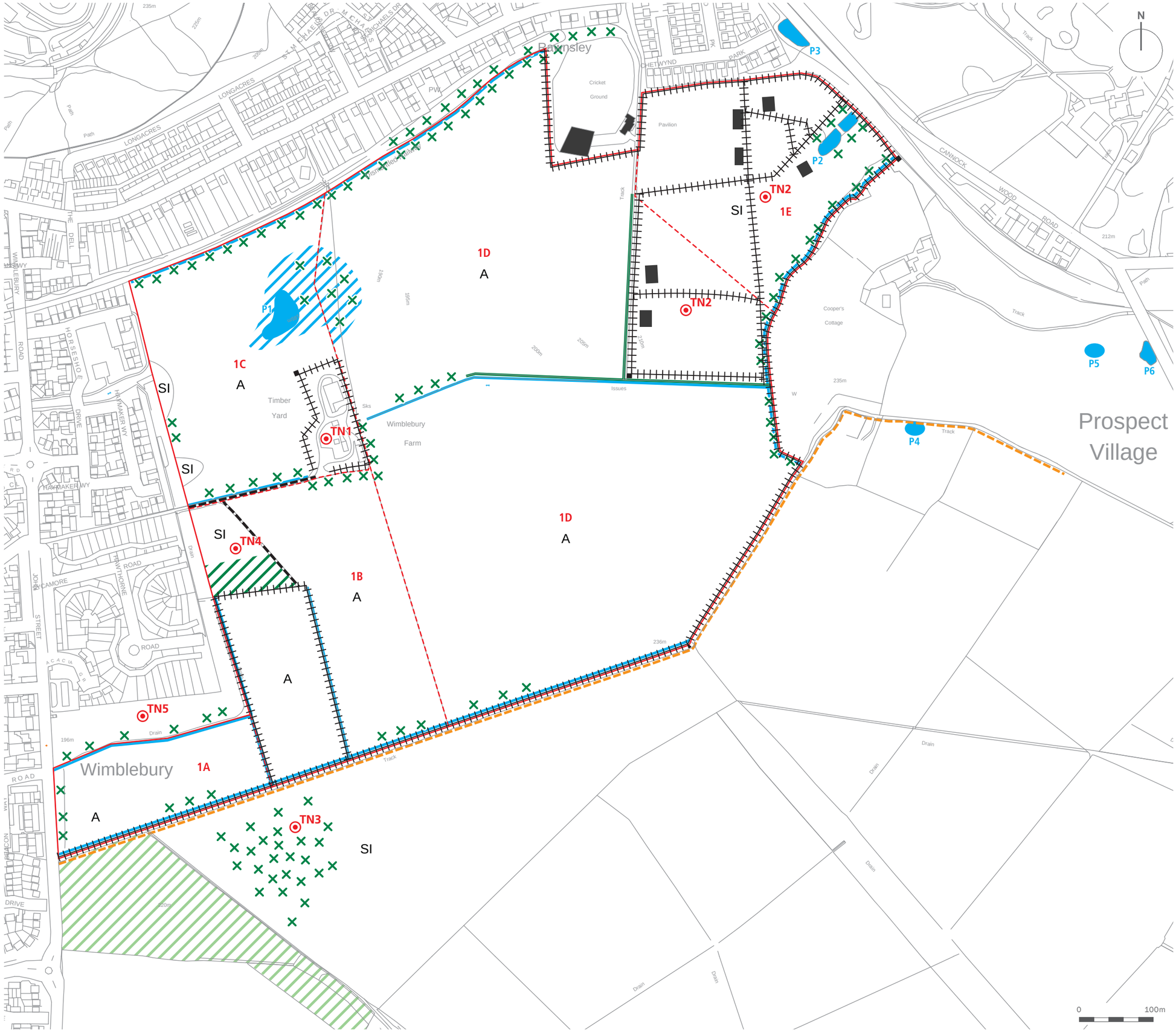
*Parcel 1E*

A3.17 Parcel 1E is a 7.23 hectare parcel in the northeast corner of the Site. It is grazed heavily by horses and there are chickens kept here. The ground is extremely wet and disturbed and contains patches dominated by *Juncus* species. The parcel is split into many paddocks by temporary electric fencing and most paddocks contain small stables and feeding stations for the horses. The eastern edge is bounded by an area of oak dominated woodland that runs along the route of a dismantled railway (**Image EDP A3.5**). The northern edge is bounded by residential development and a drain. The remaining boundaries are further horse grazed paddocks.

**Image EDP A3.5**. The Oak dominated woodland along the dismantled railway to the northeast of Parcel 1E

A3.18 There is a large pond towards the northeast corner of this parcel (**Image EDP A3.6**). This pond contains willow trees and *Thypha latifolia* and are surrounded by semi improved grassland with a much lighter level of grazing. The sward is much higher in this section.

**Image EDP A3.6:** The pond in Parcel 1E




Site Boundary

Deciduous Saplings

Coniferous Plantation Woodland

Intact Species-poor Hedgerow

Scattered Scrub

A — Arable Grassland

SI — Poor Semi-improved Grassland

P1 — Pond

Drain

Marginal Vegetation

Buildings

Fence

Footpath

Track

1A — Parcel Number and Boundary

TN1 — Target Note

client

**Church Commissioners for England**

project title

**Land at Wimblebury, Cannock Chase, Staffordshire**

drawing title

**Plan EDP 1: Extended Phase 1 Habitat Plan**

| | | | |
|---|---|---|---|
| **date** | 03 MARCH 2017 | **drawn by** | MC |
| **drawing number** | EDP3912/01 | **checked** | VN |
| **scale** | 1:5,000 at A3 | **QA** | LB |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# APPENDIX 7

# TRANSPORT NOTE

| | |
|---|---|
| Client: | **Church Commissioners for England** |
| Project: | **Land at Cannock Chase** |
| Date: | **March 2017** |
| Title: | **Initial Access Appraisal** |

## a. Introduction

1. This Transport Note (TN) has been prepared by Iceni Projects on behalf of the Church Commissioners for England (the Commissioners) to provide an initial access appraisal in respect of the existing landholdings to the east of Wimblebury, Cannock Chase.

2. More specifically this TN has been prepared to consider the potential locations for access for the area of land between Wimblebury Road in the west to Cannock Wood Road to the east. It has also been prepared with reference to drawing no. 20485_SL-P-01_Rev A, which details the overall site broken down into five individual parcels with a potential housing capacity in terms of number of units for each. Reference has also been made to the Commissioners' ownership surrounding the site as shown on drawing no. 20485_RG-M-04 which shows additional site fronting the highway.

## b. Existing Situation

### Site Location

3. The site is located approximately 3km east of Cannock town centre, and immediately surrounded by the existing residential areas of the areas of Wimblebury, Littleworth, Rawnsley and Prospect Village. The site appears to be currently used as agricultural land, with woodland to the east and west and a dismantled railway to the north.

4. Wimblebury Road runs along the west of the site, continuing as John Street to the north of the site. Cannock Wood Road runs along the eastern boundary of the site, with Littleworth Road connecting each of these roads although segregated from the site boundary by a row of existing properties and land uses.

## c. Potential Access Arrangements

5. In accordance with the details of the brief, Iceni has considered the potential to access each of the individual sites (1A to 1E) in isolation, and also the potential access strategy if the site was delivered in its entirety. The potential access arrangements have been considered in the context of the capacity of each site in terms of number of units that have been identified as being able to be accommodated, and the number of units which could be reasonably served by differing types of access options.

6. It should be noted that the potential access arrangements have been considered without detailed traffic survey information or highway boundary information and therefore broad assumptions have been made in this regard. The potential capacity of the access arrangements detailed below should also be considered as an estimate and does not consider potential off-site constraints for which traffic survey topographical information may be required.

7. This information would be required in order to clarify and refine the access options considered below.

**Site 1A**

8. Site 1A fronts on to Wimblebury Road (which continues as John Street to the north of the site) with a frontage or around 120m, with Claygate Road located immediately opposite to the northern boundary of the site. To the north of the site there is a section of woodland which is understood to be within the ownership of the Commissioners which would extend the length of frontage onto the highway to around 200m. It is therefore assumed that if required, sections of this land to the north could be used to facilitate an access into Site 1A either to provide visibility or to enable modifications to the highway layout.

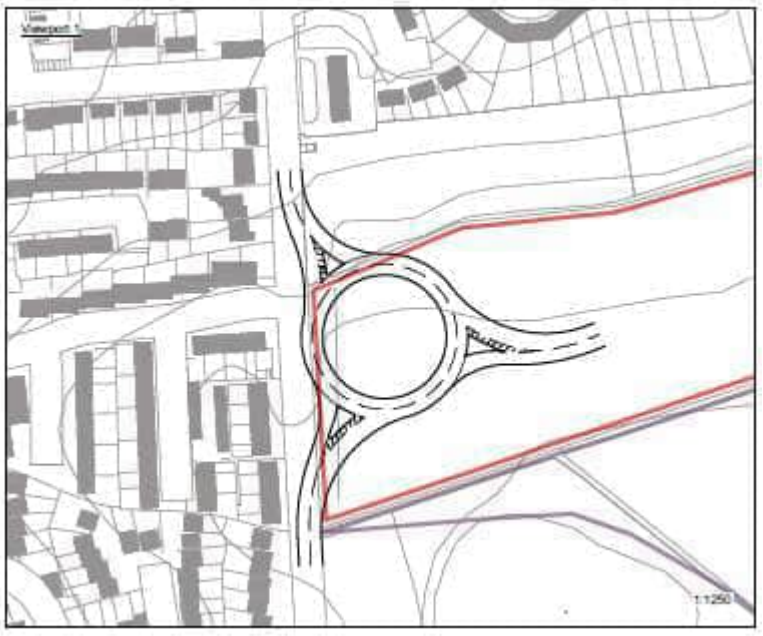
9. It is noted that the gradient of Wimblebury Road / John Street, which falls significantly as it moves northwards from a high point at the southern end of the site, means that access options are potentially restricted by limitations for visibility associated with the vertical alignment of the road. There was also a significant level difference observed between the site and the highway (increasing heading north), although this could potentially be addressed through appropriate earthworks.

10. It is considered that a priority junction could be provided to enable access into the site which would accord with the required standards detailed within Manual for Streets (MfS) for junction layout. In order to maximise the number of units which would be delivered from the proposed access, it is suggested that a right-turn lane is incorporated at the junction. This would also help to mitigate any potential safety issue associated with the gradient of the road by providing the ability for cars to wait safely to turn right into the site.

11. A sketch of the potential junction arrangement is shown on the drawing below and has been appended to this note.


12. Given the ability to use the section of land to the north of the site boundary but within the Commsioners ownership, it is also considered likely that a roundabout junction could be provided to serve the development. This may need to be combined with Claygate Road to provide a four-arm junction, although it would appear that there is sufficient land within the client control to facilitate the associated road alignment required.

13. A sketch of the potential junction arrangement is shown on the drawing below and has been appended to this note.



14. In regard to the number of units that could be served from these junction options, therefore is no longer defined guidance in this regard and each development should be considered on a site by site basis. In this case it would largely depend on the traffic volume passing the access and the ability to demonstrate that any junction would work in capacity terms, and the ability to provide an emergency access onto the highway (which appear feasible given the frontage on to Wimblebury Road / John Street.

15. On the basis of the above, it is suggested that a maximum of 300 dwellings could be served from an access shown above, with the provision of suitable emergency access. It should be noted that this would be considered an upper limit and local highways officer may perceived a lower number to be more appropriate. It is further recommended that should the access solutions be pursued that topographical survey information is used to the check the alignment / visibility.

**Site 1B**

16. In light of the above, given the identified capacity of Sites 1A and 1B combined (270 units) it is considered that Site 1B could be reasonably served from Site 1A, with a connection through to the junction on Wimblebury Road.

17. It may also be possible to provide a connection through to Site 1B from Sycamore Road to the west of the site. The ability to provide this connection would be subject to land ownership constraints and would need to be clarified against the boundary of adopted highway. This possible connection is highlighted on the overall access strategy plan appended to this Note.

**Site 1C**

18. Site 1C does not appear to be afforded direct access on to the highway, and it is considered that any single access onto Wimblebury Road outlined above, would be unsuitable to serve the number of units associated with Site C, in addition to Sites 1A and B.

19. From review of the site, it may be possible to access the site from the existing residential area to the west (Horseshoe Drive) but again this would be subject to land ownership constraints. It is unlikely that any access from the existing residential development would be sufficient to serve the

total capacity of Site 1C (178 units) and therefore it would need to be combined with a wider access strategy to serve a combined development with Sites 1A and B.

20. It may also be possible to provide a connection through to Site 1B from Sycamore Road to the west of the site. The ability to provide this connection would be subject to land ownership constraints and would need to be clarified against the boundary of adopted highway. This possible connection is highlighted on the overall access strategy plan appended to this Note.

**Site 1D**

21. Site 1D is identified as having capacity to accommodate around 775 units and does not benefit from direct access to the highway. Any direct access into Site 1D would require the purchase of property (or properties) to the north of the site to enable a connection onto Littleworth Road. From a review of Littleworth Road there would appear to be a number of options for suitable properties to purchase which would enable access to be provided (including an access shop / nursery located the north of the centre of the site).

22. Any alternative options for connection would need checking as Littleworth Road undulates and has restricted forward visibility along parts of its length. It is for this reason that a shared access with the cricket club cannot be considered.

23. If the site were served by a single point of access from Littleworth Road without a connection to the adjacent sites, the level of development would be restricted by both the capacity of any junction and the link capacity of Littleworth Road.

24. Given the scale of development it is considered that any access strategy to serve Site 1D would need to form part of a wider access strategy which would provide a series of connections to the existing highway layout.

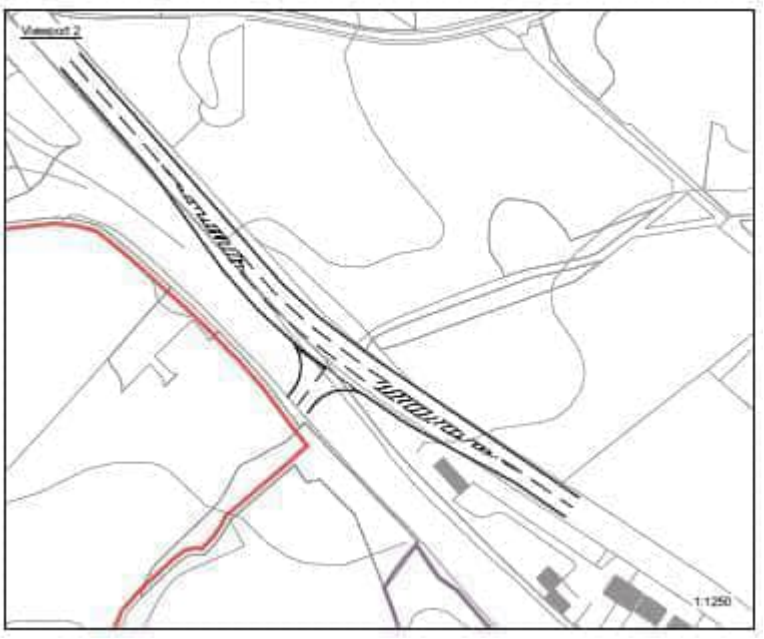
**Site 1E**

25. Site 1E is located immediately to the south-west of Cannock Wood Road and is separated from having direct frontage to the highway by a section of woodland. It is understood that this section of woodland is within the Commissioners' ownership and therefore could be used to provide access into the site. There is a frontage of around 130m within which an access could be provided.

26. From review of the existing highway layout it is suggested that a right-turn lane priority junction could be provided from Cannock Chase Road to serve the site. It should be noted however that the existing speed limit on this section of Cannock Chase Road is 60mph, changing to 30mph to the north of the section of site frontage, and therefore the associated visibility requirements are significantly more onerous than for a 30mph road. Any new access would ideally require a relocation of the speed limit, together with appropriate measures and design to ensure speeds are reduced.

27. Without the existing highway boundary information it is not possible to confirm whether the visibility requirements for a 60mph road 2.4m x 215m), and therefore it may be that a reduction in speed limit would need to be implemented to facilitate access to the site.

28. A sketch of the potential right-turn lane junction arrangement is shown on the drawing overleaf and has been appended to this note.




29. A further access option would be the provision of a roundabout on Cannock Chase Road. This would potentially increase the capacity of the junction in terms of number of units which it could reasonably serve within the site, and would also act as a gateway feature for traffic travelling from the south-east which would make any proposed reduction in speed limit easier to justify.

30. A sketch of the potential roundabout junction arrangement is shown on the drawing below and has been appended to this note.


31. In regards to potential number of units which each of these junctions could serve, it is again suggested that 300 units be considered the upper limit (with the provision of an emergency access to the highway). This could therefore potentially serve the whole of Site 1E (152 units) and part of Site 1D. Given the level differences of coming through the woodland strip, a topographical survey.

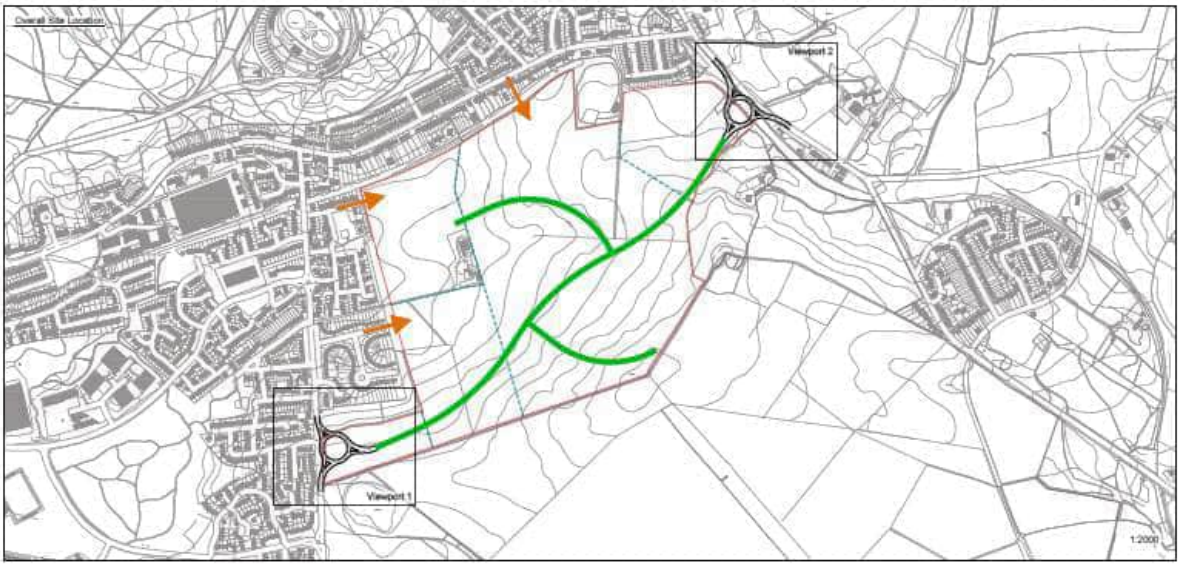
**Overall Site**

32. The overall site (1A to 1E) is identified as having capacity to accommodate 1,375 units, and therefore any access strategy will therefore need to be suitable to serve this quantum of development. It is therefore likely that this will include a link road through the site between Wimblebury Road and Cannock Wood Road, with further links and streets served off the main spine route.

33. It is likely that roundabout junctions would need to be provided at either end of the link road which would provide the primary access points to the site. The layout and scale of these roundabout junctions will depend on the existing traffic volumes passing the site and the highway boundary / land under client control which would available for use.

34. Any access strategy for the overall site would also seek to connect to the existing surrounding residential areas where possible to ensure and improve the potential permeability of any development. As noted previously in this note, there may be potential to access the site in various locations although this may require sections of third party land.

35. A sketch showing the potential access strategy for the overall site is shown on the drawing below with full details appended to this note.




**d. Conclusion**

**36.** Iceni Projects has been instructed to provide an initial access appraisal of the existing Commissioners land holdings.

**37.** It is considered that a suitable junction to serve the site could be provided from the west from Wimblebury Road and from the east from Cannock Wood Road. This could potentially be in the form of a right-turn lane priority junction or roundabout. It is likely that if these were to act as the single main point of access to a development, this is likely to limited to around 300 units, if an emergency access is provided.

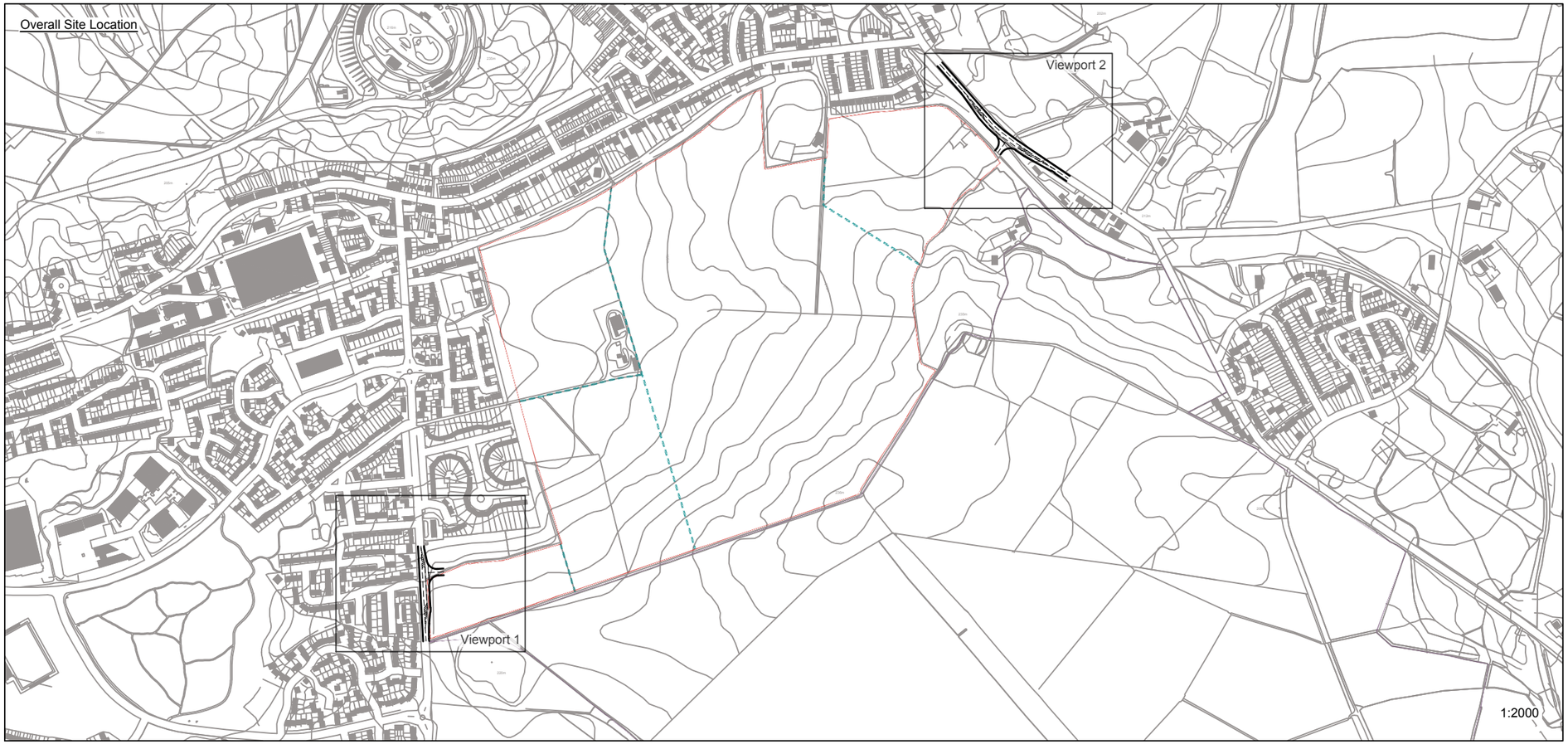
**38.** Further access points may be deliverable from the existing surrounding residential areas but these are likely to be subject to third party land, and may not significantly increase the number of units which could be served given the limited widths of the streets between these potential points of connection and the main highway network.

**39.** It is suggested that if the overall site is development, a complete link between Wimblebury Road and Cannock Chase Road could be provided. This would enable suitable access to be provided

at either end of the site, with potential residential streets and land uses served off this main spine road. This may also provide benefits to existing traffic using Littleworth Road given the poor vertical road alignment and substandard junction with Cannock Wood Road.

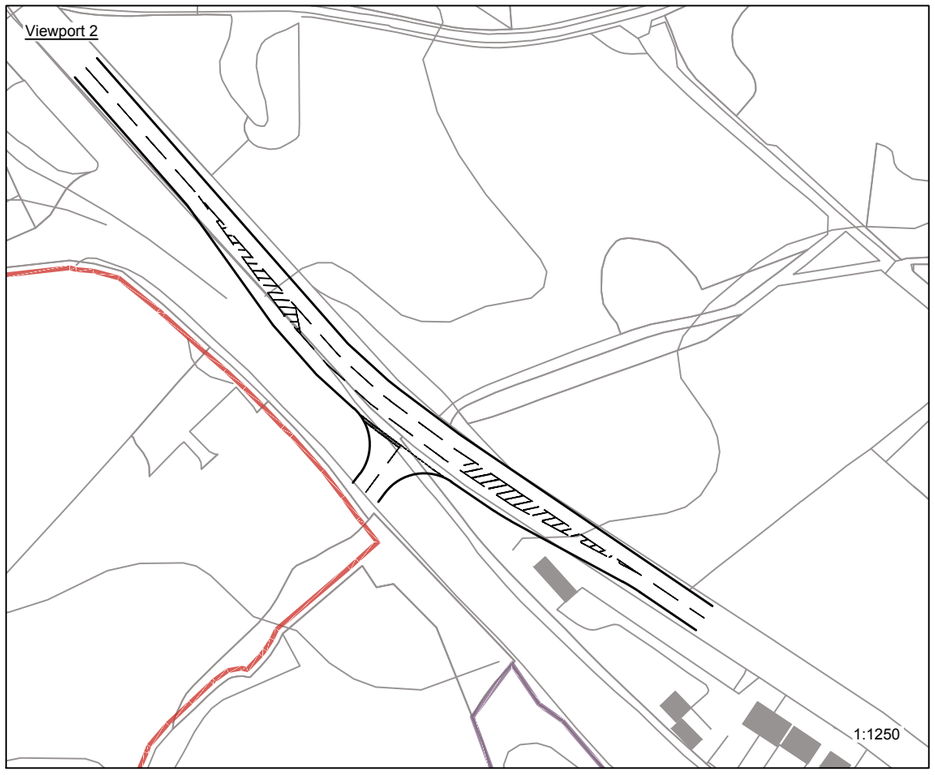
**Iceni Projects Ltd**
**March 2017**

Overall Site Location




Viewport 1


Viewport 2




Notes

1.This drawing is based upon drawing number 20485/RG-M-01 supplied by Barton Willmore and Iceni Projects Ltd. shall not be liable for any inaccuracies or deficiencies.

2.This drawing is indicative and subject to discussions with local & national highway authorities. This design is also subject to confirmation of land ownership, topography, location of statutory services, traffic flows and traffic modelling.

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Client

Church Commissioners For England

Project

Land East of Wimblebury, Cannock Chase

Title

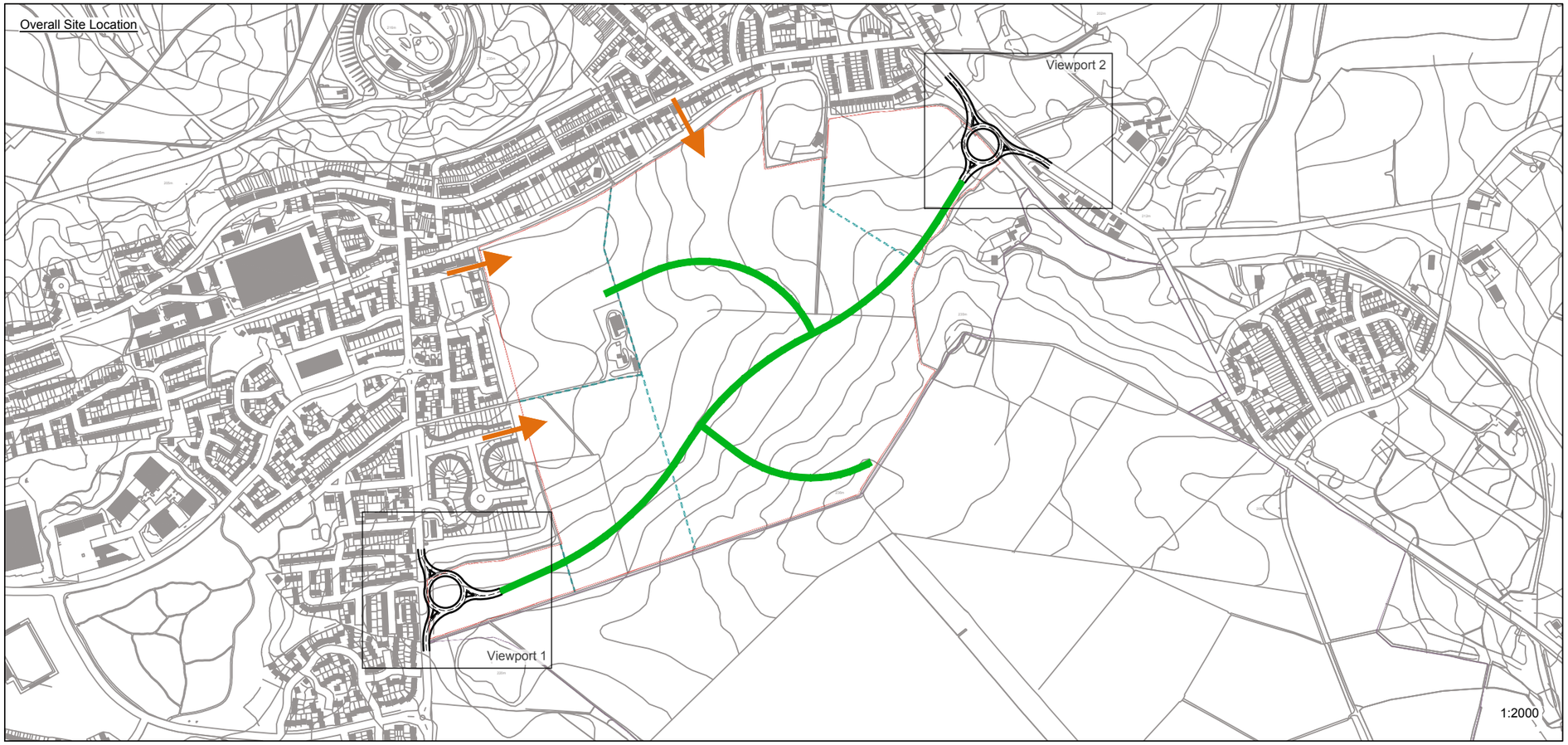
Indicative Potential □unction Arrangement

Option A

| Drawn By | Checked By | Approved By |
|---|---|---|
| TG | PC 10/03/2017 | PC 10/03/2017 |

| Scale @ A3 | Date | |
|---|---|---|
| As Shown | 10/03/2017 | |
| **Project No.** | **Drawing No.** | **Rev.** |
| 17-T039 | 01 | - |

Overall Site Location




Viewport 1


Viewport 2


Notes

1.This drawing is based upon drawing number 20485/RG-M-01 supplied by Barton Willmore and Iceni Projects Ltd. shall not be liable for any inaccuracies or deficiencies.

2.This drawing is indicative and subject to discussions with local & national highway authorities. This design is also subject to confirmation of land ownership, topography, location of statutory services, traffic flows and traffic modelling.

Key

Indicative Potential Link Road Arrangement

Potential Locations of Access Roads to Site

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Project

Land East of Wimblebury, Cannock Chase

Title

Indicative Potential □unction Arrangement

Option B

| Drawn By | Checked By | Approved By |
|---|---|---|
| TG | PC 10/03/2017 | PC 10/03/2017 |

| Scale @ A3 | Date | |
|---|---|---|
| As Shown | 10/03/2017 | |
| **Project No.** | **Drawing No.** | **Rev.** |
| 17-T039 | 02 | - |

# APPENDIX 8

BWB

CONSULTANCY | ENVIRONMENT
INFRASTRUCTURE | BUILDINGS

**ENVIRONMENT**

# Church Commissioners for England
# Land east of Wimblebury
# Wimblebury, Cannock

## SUSTAINABLE DRAINAGE STATEMENT

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**ENVIRONMENT**

# Church Commissioners for England
# Land east of Wimblebury
# Wimblebury, Cannock

## SUSTAINABLE DRAINAGE STATEMENT


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# DOCUMENT ISSUE RECORD

| | |
|---|---|
| **Document Number** | WIM-BWB-HDG-XX-RP-EN-0001_SDS |
| **BWB Reference** | BMT-2333-SDS |

| Status | Revision | Date of Issue | Author | Checked | Approved |
|---|---|---|---|---|---|
| S1 | P2 | 08/03/2017 | R Ward<br>BEng (Hons) | Chris Dodd<br>BEng (Hons) IEng MICE | D Allum-Rooney<br>BSc (Hons) MSc |
| | | |  |  |  |

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All Environment Agency mapping data used under special license. Data is current as of March 2017 and is subject to change.

The information presented and conclusions drawn are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

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# CONTENTS



**TABLES**



**FIGURES**



**APPENDICES**

# 1.0 INTRODUCTION

## Site Details

1.1 This Sustainable Drainage Statement has been produced by BWB Consulting on behalf of the Church Commissioners for England in respect of a site located east of Wimblebury, Cannock (see **Figure 1.1**). The land has been selected as a series of sites which present options for housing development in the Cannock Chase Local Plan Part 2: Issues and Options.

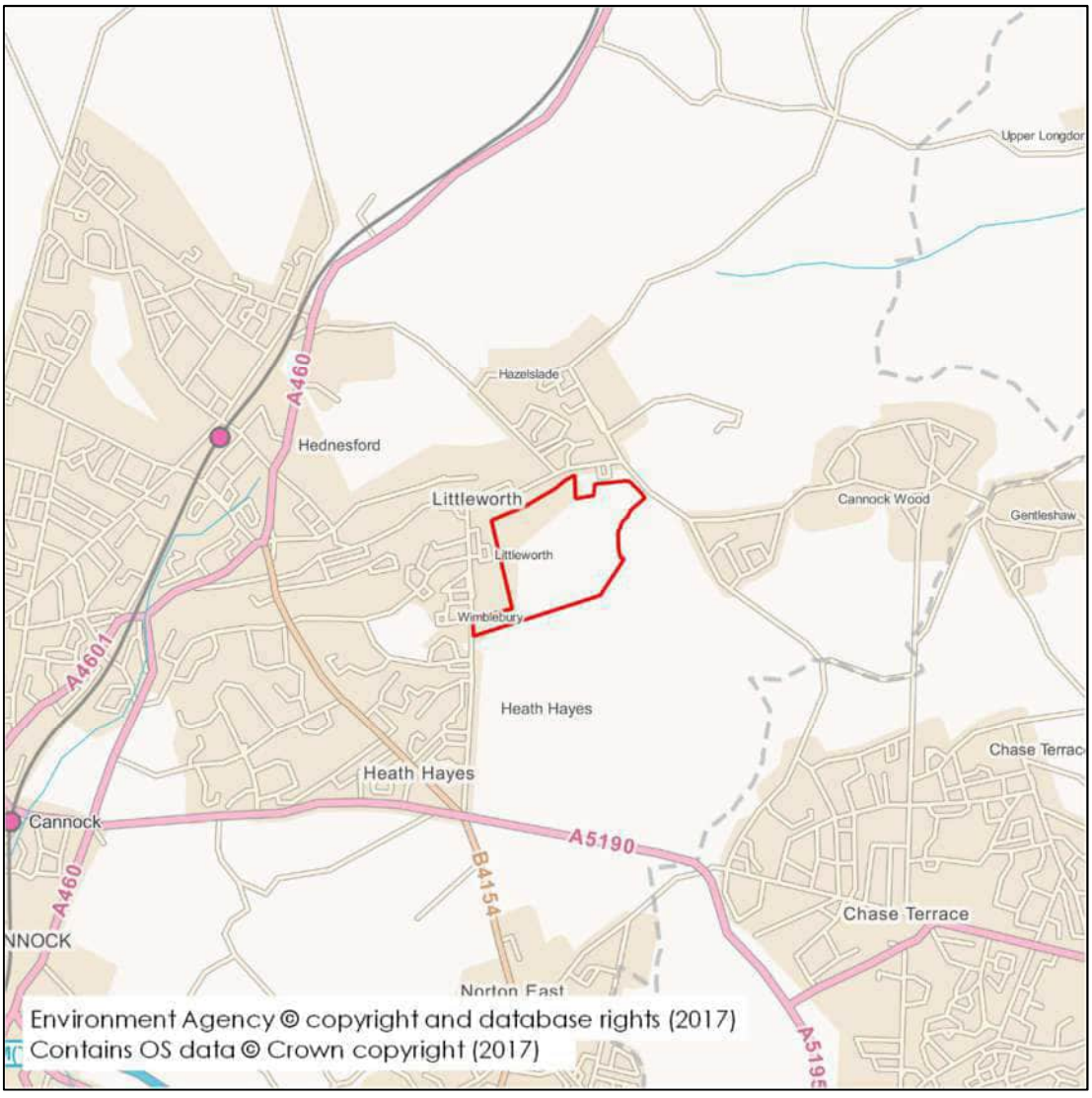



***Figure 1.1 - Site Location***

1.2 A proposed site development plan is included as **Appendix 1.** The proposal shows the whole site compromising of 5 separate development parcels, named sites 1A – 1E. Key site details are summarised in **Table 1.1**.

1.3 This document is to provide a high level drainage approach, to show how a proposed housing development may be positively drained, and the drainage requirements for each parcel.

1.4 The existing site can be classed as greenfield, there are currently no developments on the land and therefore no positive drainage connections.

***Table 1.1 - Existing Site Details***

| | |
|---|---|
| **Site Name** | Land east of Wimblebury |
| **Location** | Wimblebury, Cannock |
| **NGR (approx.)** | 311449, 401791 |
| **Application Site Area (ha)** | 65.5 |
| **Development Type** | Residential |
| **Local Planning Authority** | Cannock Chase District Council |
| **Lead Local Flood Authority** | Staffordshire County Council |

## SuDS Guidance

1.5 The SCC (Staffordshire County Council) SuDS Handbook contains a 'Surface Water Drainage Proforma' which sets out evidence required within the SuDS submission, to demonstrate that both the National Standards and Local Standards have been complied with.

1.6 Although this will be satisfied as part of a planning application submission, design principles outlined within the SuDS Handbook have been followed to form a high level drainage approach in this instance.

1.7 **Table 1.2** summarises the findings of this document with discussion and explanation of the points expanded upon in **Section 2.0**.

***Table 1.2 - SDS Summary***

| | |
|---|---|
| **Outfall Location** | Watercourse |
| **Existing Site Peak Runoff Rate** | 309.4l/s |
| **Infiltration Rate** | Unknown |
| **Existing Runoff Volume (100yr RP 6 hour Storm)** | 18,759m$^3$ |
| **Proposed Runoff Volume (100yr RP 6 hour Storm)** | 45,588m$^3$ |
| **Long Term Storage** | N/A |
| **Proposed Site Peak Runoff Rate** | See **Table 2.3** for breakdown per development parcel |
| **Proposed Storage Volume** | 35140m$^3$ site wide |
| **Flow Control Type** | Vortex |
| **LLFA/EA/WC/IDB Guidance** | Staffordshire County Council SuDS Handbook – February 2017 |

# 2.0 DRAINAGE STRATEGY

## Existing Site Runoff

*Runoff Volume*

2.1 Volume of runoff for proposed developments is compared for a 100 year return period, 6 hour storm. As the existing site is greenfield, this volume has been calculated using the Source Control module within Micro Drainage to be **18,759m³**, results are included within **Appendix 2**. This is based upon the entire site of 65.5ha.

*Runoff Rate*

2.2 The existing site will be considered greenfield as there are currently no positive drainage connections serving the site and it is wholly permeable.

2.3 An assessment of the existing runoff rates has been undertaken using the ICP SUDS calculation method within Micro Drainage and they are summarised in **Table 2.1.** Calculations are included within **Appendix 3**.

## Proposed Site Runoff

*Runoff Volume*

2.4 The proposed runoff volume can be derived using an average rainfall intensity of **11.6mm/hr** as calculated using FEH rainfall data within Micro Drainage, and multiplied by the site area. The rainfall profile is included as **Appendix 4**, and the calculated volume is as follows;

11.6(mm/hr) **x** 6 (hours) **x** 65.5 (ha) x 10 = Runoff Volume 45,588 (m³)

*Runoff Rate*

2.5 The SCC SuDS Handbook Proforma states that *'For greenfield developments, the peak runoff rate from the development to any highway drain, sewer or surface water body for the 100% Annual Exceedance Probability rainfall event and the 1% Annual Exceedance Probability rainfall event should never exceed the peak greenfield runoff rate for the same event'*.

2.6 Therefore a discharge rate from site should not exceed the "greenfield runoff rate", where practicable. In this case it is recommended that surface water discharge post-development should be restricted to equivalent QBAR rates. Post-development discharge rates will be restricted as shown in **Table 2.3** for all storms up to the 100 year + 40% climate change storm, for each development parcel.

2.7 As the volume of runoff has been calculated to increase post development, it is necessary to comply with the volume control criterion as per requirements S4-S6 of the Non-Statutory Technical Standards (otherwise known as long term storage). it is necessary to either prevent any excess volume from leaving the site or otherwise discharge it *"at a rate which does not adversely affect flood risk"* which is taken to be no more than;

- *The pre development 1-year peak flow rate OR*
- *The mean annual flow rate Qbar OR*
- *2l/s/ha*

2.8 The proposed runoff rate for entire the site is therefore 256l/s for the 1 year return period and 309l/s for all other storm events up to and including the 100 year event including a 40% allowance for climate change – as summarised in **Table 2.2**. As the development will restrict to the equivalent QBAR rate, consideration for long term storage is not necessary.

2.9 As the above is based on the entire development site, **Table 2.3** shows the QBAR rate for each separate parcel for which the strategy will be based upon, up to a 1 in100yr (+40%cc) return period. The full breakdown of existing runoff rates for other storm return periods are included within **Appendix 5.** The sum of these separate rates differs slightly from the entire site QBAR, due to the weighted calculation methods within MicroDrainage.

## Site Runoff Summary

2.10 The following tables summarise the calculated runoff volumes and rates for the proposed development.

***Table 2.1 - Existing and Proposed Runoff Volumes***

| Existing Volume ($m^3$) | Proposed Volume ($m^3$) | Difference ($m^3$) |
|---|---|---|
| 18,759 | 45,588 | 26,829 |

***Table 2.2 - Existing & Proposed Runoff Rates (Entire Site)***

| Return Period (Yr.) | Existing Runoff Rate (l/s) | Proposed Runoff Rate (l/s) |
|---|---|---|
| 1 | 256.8 | 256 |
| QBAR | 309.4 | 309 |
| 30 | 606.3 | 309 |
| 100 | 795.2 | 309 |
| 100 + 40% | - | 309 |

***Table 2.3 - Existing & Proposed Runoff Rates (Development Parcels)***

| Development Parcel | Existing QBAR Runoff Rate (l/s) | Proposed Runoff Rate (l/s) |
|---|---|---|
| 1A | 15.9 | 15.9 |
| 1B | 46.6 | 46.6 |
| 1C | 41.3 | 41.3 |
| 1D | 116.8 | 116.8 |
| 1E | 22.9 | 22.9 |

## Drainage Hierarchy

2.11 A preferential hierarchy for discharge of surface water is provided within the SCC SuDS Handbook, which states that surface water should be disposed of in the following order of preference;

- *Infiltration via soakaways*
- *Watercourse*
- *Surface Water Sewer*
- *Combined Water Sewer*

2.12 A Phase 1 Environmental Assessment carried out by Wardell Armstrong in June 2011, states that '*Minor or Secondary A aquifers (which the site is underlain by) are generally fractured or potentially fractured and do not have a high primary permeability*.', adding that '*Unproductive strata have low permeability*.' Although infiltration via soakaways has not been included within this approach, the potential for soakaway drainage should be explored via infiltration testing at a later planning and design stage.

2.13 Drainage ditches are observed to be present on the plan provided, and for the purpose of this exercise it is presumed that these ditches currently convey surface water runoff. At a later stage, is it recommended that the condition and capacity of these existing drainage features are tested.

2.14 There is likely to be an existing sewer network serving developments directly to the north and west boundaries of the site. A connection to this existing network is conditional based on a capacity assessment carried out by the statutory undertaker, Severn Trent Water. A Pre-Development Enquiry will outline allowable discharge locations and limitations on discharge rates should discharge to watercourses not be feasible.

## Attenuation Requirements

2.15 Since the proposed discharge rate is less than the rate that would ordinarily be generated by the proposed development, storage will be required to balance the difference between the runoff generated and limited discharge rate.

2.16 Using restricted runoff rates per development parcel as shown within **Table 2.3**, the volume of attenuation required for each has been calculated for storm events up to the 100 year + 40% storm.

2.17 It has been estimated that 65% of the developable site area will become impermeable through the construction for residential use. The estimates and calculated volumes are considered to be conservative and may be subject to change at the detailed design stage.

2.18 Simulations have been run using Micro Drainage and the results are summarised in **Table 2.4** and calculations included as **Appendix 6**.

***Table 2.4 - Attenuation Requirements***

| Catchment Reference | Assumed Impermeable Area (ha) | Rainfall Method | Critical Storm | Maximum Volume ($m^3$) |
|---|---|---|---|---|
| 1A | 2.12 | FEH | 600 min Winter | 1590 |
| 1B | 6.22 | FEH | 720 min Winter | 4750 |
| 1C | 5.5 | FEH | 720 min Winter | 4200 |
| 1D | 24 | FEH | 960 min Winter | 20,650 |
| 1E | 4.7 | FEH | 960 min Winter | 3950 |

2.19 A minimum of 35,140$m^3$ of site wide attenuation may be required to cater for the maximum anticipated runoff volume for all storm durations up to the 1 in 100 year return period storm, including a 40% climate change allowance.

## Long Term Storage

2.20 As discussed earlier in this report, long term storage would not be required due to the proposed discharge rates meeting the relevant criteria.

## Sustainable Drainage Systems

2.21 At planning and design stage, the use of SuDS will vary dependant on nature of the design, on site conditions and design preferences. The SCC SuDS Handbook should be consulted as a design guide, and Proforma satisfied.

2.22 An indicative surface water layout for the development is shown on BWB Dwg No. WIM-BWB-EWE-00-DR-EN-0001 which is included as **Appendix 7**.

## Residual Risk and Designing for Exceedance

2.23 Exceedance flows should be considered to ensure risk to the development and other areas off site is not increased in extreme events above the design criteria.

2.24 In addition to the volume of storage provided within the main attenuation, there will be capacity within upstream pipes and manholes which has not been accounted for at this stage and a further level of redundancy to the network will therefore be provided.

# 3.0 SUMMARY

3.1 This statement and supporting appendices identify drainage requirements for the proposed development. Further surveys into existing on site conditions are required for a detailed surface water design, to ensure compliance with the relevant local and national standards, specifically the hierarchy of discharge, runoff rate and volume criterion. The development sites can be successfully drained independently of each other in line with best practice guidance, including allowance for climate change.

3.2 The Surface Water Strategy drawing indicates potential outfall locations, which are summarised below.

*Parcel 1A*

Storage pond to discharge directly into existing drainage ditch. Capacity and condition to be surveyed at planning stage

*Parcel 1B*

Storage pond to discharge directly into existing drainage ditch. Capacity and condition to be surveyed at planning stage

*Parcel 1C*

Storage pond to discharge directly into existing drainage ditch. Capacity and condition to be surveyed at planning stage. Ponds storage requirements split over 2 ponds.

*Parcel 1D*

Storage pond to discharge directly into existing drainage ditch. Capacity and condition to be surveyed at planning stage. Ponds storage requirements split over 2 ponds.

Parcel 1E

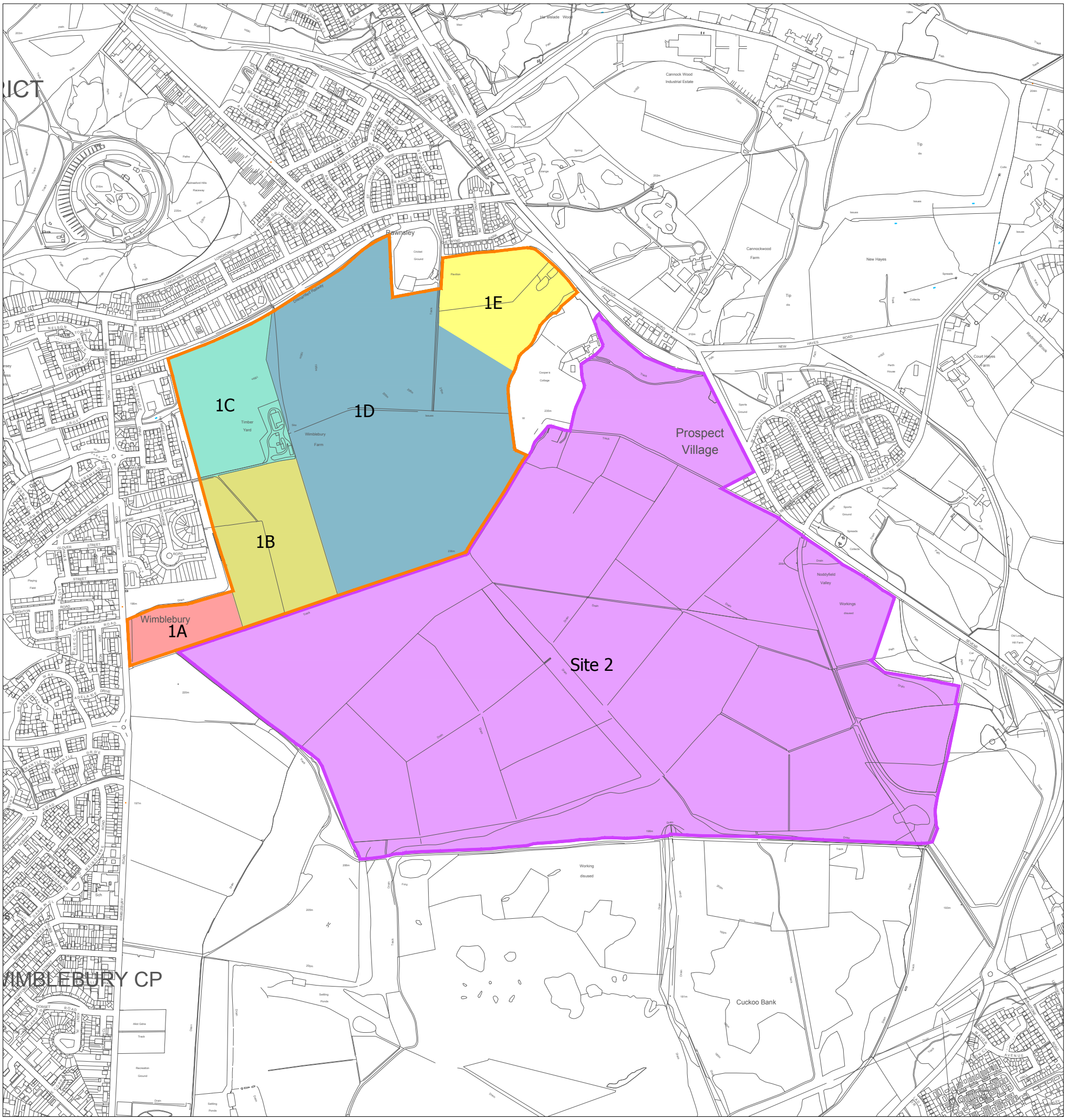
At present there are currently no existing drainage features known within the area. Therefore, surface water runoff is shown to be discharged into an existing SW sewer network. It is recommended to survey for existing features at planning stage.

# APPENDIX 1

Proposed Layout

The scaling of this drawing cannot be assured

| Revision | Date | Drn | Ckd |
|---|---|---|---|
| - | - | - | - |




## Legend

- SHLAA Site 1 Overall
  65.50Ha / 161.85Ac
- SHLAA Site 1A
  3.26Ha / 8.06Ac
  Approx 69 Dwellings
- SHLAA Site 1B
  9.57Ha / 23.65Ac
  Approx 201 Dwellings
- SHLAA Site 1C
  8.49Ha / 20.98Ac
  Approx 178 Dwellings
- SHLAA Site 1D
  36.94Ha / 91.28Ac
  Approx 775 Dwellings
- SHLAA Site 1E
  7.23Ha / 17.86Ac
  Approx 152 Dwellings
- SHLAA Site 2 Overall
  141.15Ha / 348.78Ac
- SHLAA Site 2
  141.15Ha / 348.78Ac
  Approx 1976 Dwellings @20dph
  Approx 2964 Dwellings @30dph

Project
**Bleak House,**
**Land to the East of Cannock**

N

Drawing Title
**SHLAA Sites 2016**

| Date | Scale | Drawn by | Check by |
|---|---|---|---|
| 17.01.17 | 1:10,000@A3 | M.S. | J.R. |

| Project No | Drawing No | Revision |
|---|---|---|
| 20485 | SL-P-01 | A |

0 100 200 300 400 500m



J:\20000 - 20999\20400 - 20499\20485 - Bleak House, Cannock\A4 - Dwgs & Registers\M Planning\20485 - SL-P-01A -SHLAA Site Boundary Plan.dwg - SL01-1

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# APPENDIX 2

Site Runoff Volume

## Greenfield Runoff Volume

FSR Data

| | |
|---|---|
| Return Period (years) | 100 |
| Storm Duration (mins) | 360 |
| Region | England and Wales |
| M5-60 (mm) | 19.100 |
| Ratio R | 0.400 |
| Areal Reduction Factor | 1.00 |
| Area (ha) | 65.500 |
| SAAR (mm) | 762 |
| CWI | 113.000 |
| Urban | 0.000 |
| SPR | 47.000 |

Results

| | |
|---|---|
| Percentage Runoff (%) | 47.67 |
| Greenfield Runoff Volume ($m^3$) | 18759.087 |

# APPENDIX 3

Site Runoff Rates

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 65.500 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 309.4 |
| QBAR Urban | 309.4 |
| Q100 years | 795.2 |
| Q1 year | 256.8 |
| Q30 years | 606.3 |
| Q100 years | 795.2 |

# APPENDIX 4

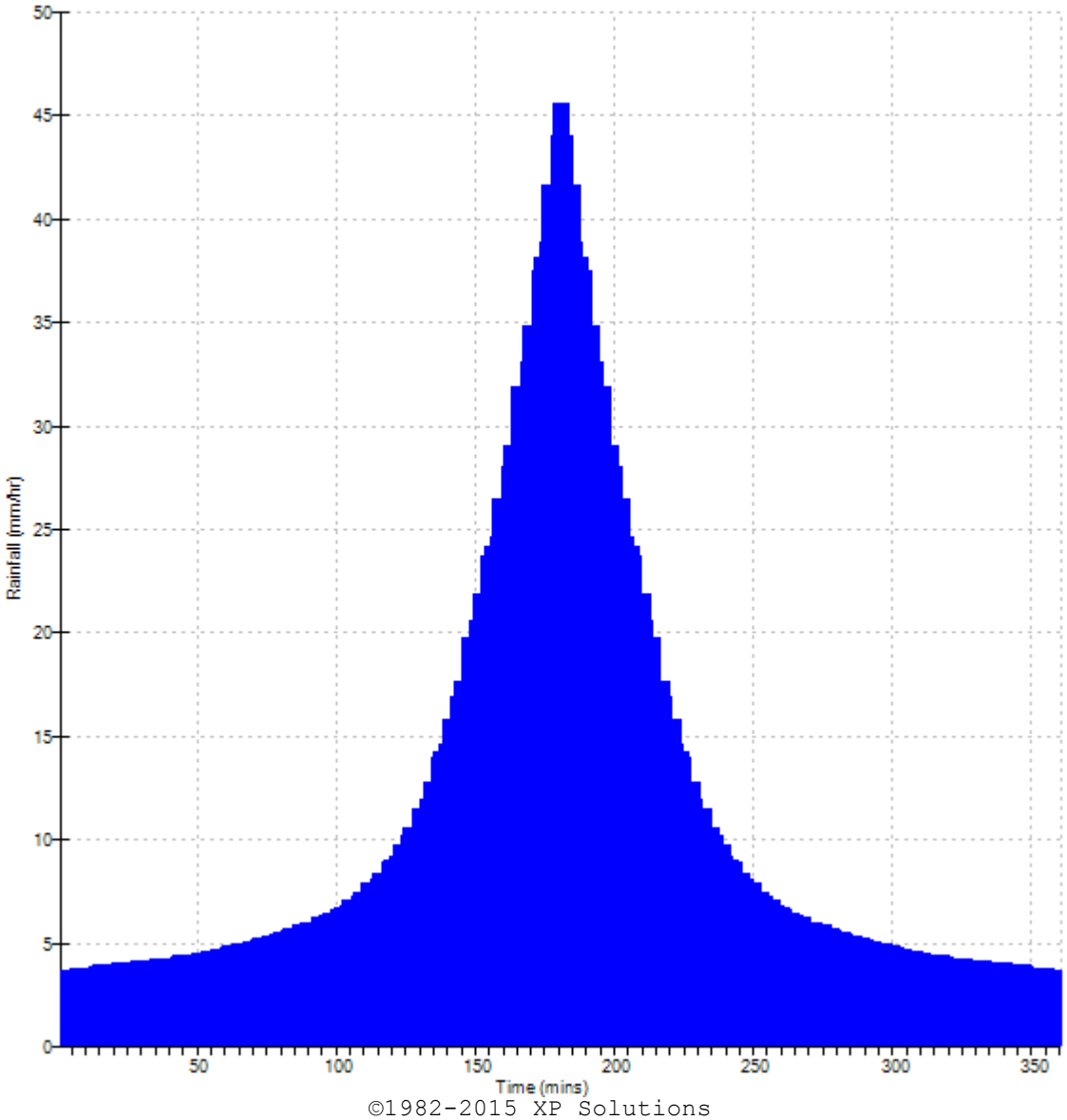
Rainfall Profile

## Rainfall profile

Storm duration (mins) 360

FEH Data

| | |
|---|---|
| C(1km) | -0.026 |
| D1(1km) | 0.371 |
| D2(1km) | 0.322 |
| D3(1km) | 0.241 |
| E(1km) | 0.303 |
| F(1km) | 2.402 |
| Peak Intensity (mm/hr) | 45.632 |
| Ave. Intensity (mm/hr) | 11.641 |
| Return Period (years) | 100 |



# APPENDIX 5

Development Parcel Runoff Rates

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 9.570 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 46.6 |
| QBAR Urban | 46.6 |
| Q100 years | 119.7 |
| Q1 year | 38.7 |
| Q30 years | 91.3 |
| Q100 years | 119.7 |

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 3.260 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 15.9 |
| QBAR Urban | 15.9 |
| Q100 years | 40.8 |
| Q1 year | 13.2 |
| Q30 years | 31.1 |
| Q100 years | 40.8 |

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 4.700 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 22.9 |
| QBAR Urban | 22.9 |
| Q100 years | 58.8 |
| Q1 year | 19.0 |
| Q30 years | 44.8 |
| Q100 years | 58.8 |

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 24.000 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 116.8 |
| QBAR Urban | 116.8 |
| Q100 years | 300.2 |
| Q1 year | 96.9 |
| Q30 years | 228.8 |
| Q100 years | 300.2 |

## ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 100 | Soil | 0.450 |
| Area (ha) | 8.490 | Urban | 0.000 |
| SAAR (mm) | 764 | Region Number | Region 4 |

**Results l/s**

| | |
|---|---|
| QBAR Rural | 41.3 |
| QBAR Urban | 41.3 |
| Q100 years | 106.2 |
| Q1 year | 34.3 |
| Q30 years | 81.0 |
| Q100 years | 106.2 |

# APPENDIX 6

Storage Simulation Results

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.221 | 0.521 | 15.8 | 773.3 | O K |
| 30 min Summer | 99.297 | 0.597 | 15.8 | 895.5 | O K |
| 60 min Summer | 99.379 | 0.679 | 15.8 | 1029.9 | O K |
| 120 min Summer | 99.463 | 0.763 | 15.8 | 1170.1 | O K |
| 180 min Summer | 99.508 | 0.808 | 15.8 | 1247.7 | O K |
| 240 min Summer | 99.537 | 0.837 | 15.8 | 1296.7 | O K |
| 360 min Summer | 99.568 | 0.868 | 15.8 | 1350.5 | O K |
| 480 min Summer | 99.580 | 0.880 | 15.8 | 1371.8 | O K |
| 600 min Summer | 99.581 | 0.881 | 15.8 | 1374.6 | O K |
| 720 min Summer | 99.577 | 0.877 | 15.8 | 1366.6 | O K |
| 960 min Summer | 99.556 | 0.856 | 15.8 | 1329.7 | O K |
| 1440 min Summer | 99.513 | 0.813 | 15.8 | 1256.1 | O K |
| 2160 min Summer | 99.448 | 0.748 | 15.8 | 1145.2 | O K |
| 2880 min Summer | 99.378 | 0.678 | 15.8 | 1027.4 | O K |
| 4320 min Summer | 99.233 | 0.533 | 15.8 | 792.4 | O K |
| 5760 min Summer | 99.117 | 0.417 | 15.8 | 610.5 | O K |
| 7200 min Summer | 99.028 | 0.328 | 15.8 | 473.4 | O K |
| 8640 min Summer | 98.963 | 0.263 | 15.7 | 376.9 | O K |
| 10080 min Summer | 98.918 | 0.218 | 15.4 | 310.6 | O K |
| 15 min Winter | 99.280 | 0.580 | 15.8 | 868.0 | O K |
| 30 min Winter | 99.365 | 0.665 | 15.8 | 1005.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 198.647 | 0.0 | 744.0 | 26 |
| 30 min Summer | 115.749 | 0.0 | 866.0 | 41 |
| 60 min Summer | 67.445 | 0.0 | 1051.7 | 70 |
| 120 min Summer | 39.300 | 0.0 | 1226.4 | 130 |
| 180 min Summer | 28.654 | 0.0 | 1341.3 | 188 |
| 240 min Summer | 22.899 | 0.0 | 1428.9 | 246 |
| 360 min Summer | 16.696 | 0.0 | 1561.7 | 364 |
| 480 min Summer | 13.343 | 0.0 | 1662.4 | 482 |
| 600 min Summer | 11.214 | 0.0 | 1744.2 | 600 |
| 720 min Summer | 9.729 | 0.0 | 1813.2 | 688 |
| 960 min Summer | 7.695 | 0.0 | 1905.4 | 794 |
| 1440 min Summer | 5.529 | 0.0 | 2028.3 | 1044 |
| 2160 min Summer | 3.973 | 0.0 | 2260.1 | 1456 |
| 2880 min Summer | 3.142 | 0.0 | 2382.5 | 1852 |
| 4320 min Summer | 2.224 | 0.0 | 2523.0 | 2600 |
| 5760 min Summer | 1.741 | 0.0 | 2650.3 | 3344 |
| 7200 min Summer | 1.439 | 0.0 | 2737.5 | 4032 |
| 8640 min Summer | 1.232 | 0.0 | 2809.0 | 4672 |
| 10080 min Summer | 1.080 | 0.0 | 2865.8 | 5344 |
| 15 min Winter | 198.647 | 0.0 | 833.1 | 26 |
| 30 min Winter | 115.749 | 0.0 | 966.4 | 41 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.456 | 0.756 | 15.8 | 1158.3 | O K |
| 120 min Winter | 99.548 | 0.848 | 15.8 | 1317.3 | O K |
| 180 min Winter | 99.600 | 0.900 | 15.8 | 1407.2 | O K |
| 240 min Winter | 99.633 | 0.933 | 15.8 | 1465.4 | O K |
| 360 min Winter | 99.671 | 0.971 | 15.8 | 1532.6 | O K |
| 480 min Winter | 99.688 | 0.988 | 15.8 | 1563.6 | O K |
| 600 min Winter | 99.694 | 0.994 | 15.8 | 1574.2 | O K |
| 720 min Winter | 99.693 | 0.993 | 15.8 | 1572.1 | O K |
| 960 min Winter | 99.667 | 0.967 | 15.8 | 1525.3 | O K |
| 1440 min Winter | 99.613 | 0.913 | 15.8 | 1429.6 | O K |
| 2160 min Winter | 99.527 | 0.827 | 15.8 | 1279.4 | O K |
| 2880 min Winter | 99.433 | 0.733 | 15.8 | 1120.8 | O K |
| 4320 min Winter | 99.213 | 0.513 | 15.8 | 760.7 | O K |
| 5760 min Winter | 99.047 | 0.347 | 15.8 | 503.1 | O K |
| 7200 min Winter | 98.939 | 0.239 | 15.6 | 340.7 | O K |
| 8640 min Winter | 98.885 | 0.185 | 14.8 | 262.2 | O K |
| 10080 min Winter | 98.865 | 0.165 | 13.2 | 233.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 67.445 | 0.0 | 1178.7 | 70 |
| 120 min Winter | 39.300 | 0.0 | 1373.9 | 126 |
| 180 min Winter | 28.654 | 0.0 | 1502.2 | 184 |
| 240 min Winter | 22.899 | 0.0 | 1599.9 | 242 |
| 360 min Winter | 16.696 | 0.0 | 1747.6 | 358 |
| 480 min Winter | 13.343 | 0.0 | 1859.2 | 472 |
| 600 min Winter | 11.214 | 0.0 | 1949.3 | 584 |
| 720 min Winter | 9.729 | 0.0 | 2024.5 | 692 |
| 960 min Winter | 7.695 | 0.0 | 2122.6 | 896 |
| 1440 min Winter | 5.529 | 0.0 | 2233.7 | 1112 |
| 2160 min Winter | 3.973 | 0.0 | 2531.8 | 1580 |
| 2880 min Winter | 3.142 | 0.0 | 2668.6 | 2028 |
| 4320 min Winter | 2.224 | 0.0 | 2828.4 | 2776 |
| 5760 min Winter | 1.741 | 0.0 | 2969.2 | 3464 |
| 7200 min Winter | 1.439 | 0.0 | 3067.2 | 4040 |
| 8640 min Winter | 1.232 | 0.0 | 3147.9 | 4584 |
| 10080 min Winter | 1.080 | 0.0 | 3213.3 | 5248 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| Site Location | CATCHMENT GB 401550 311650 SK 01550 11650 |
| C (1km) | -0.032 |
| D1 (1km) | 0.368 |
| D2 (1km) | 0.332 |
| D3 (1km) | 0.295 |
| E (1km) | 0.318 |
| F (1km) | 2.412 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 2.120

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 0.707 | 4 | 8 | 0.707 | 8 | 12 | 0.707 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 98.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 1378.4 | 1.000 | 1801.5 | 1.001 | 1801.5 | 1.300 | 1939.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0179-1590-1000-1590 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 15.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 179 |
| Invert Level (m) | 98.700 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1500 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 15.9 |
| Flush-Flo™ | 0.324 | 15.8 |
| Kick-Flo® | 0.703 | 13.5 |
| Mean Flow over Head Range | - | 13.4 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 6.3 | 1.200 | 17.3 | 3.000 | 26.8 | 7.000 | 40.4 |
| 0.200 | 15.2 | 1.400 | 18.6 | 3.500 | 28.9 | 7.500 | 41.8 |
| 0.300 | 15.8 | 1.600 | 19.9 | 4.000 | 30.8 | 8.000 | 43.1 |
| 0.400 | 15.7 | 1.800 | 21.0 | 4.500 | 32.6 | 8.500 | 44.4 |
| 0.500 | 15.4 | 2.000 | 22.1 | 5.000 | 34.3 | 9.000 | 45.6 |
| 0.600 | 14.9 | 2.200 | 23.1 | 5.500 | 35.9 | 9.500 | 46.8 |
| 0.800 | 14.3 | 2.400 | 24.1 | 6.000 | 37.5 | | |
| 1.000 | 15.9 | 2.600 | 25.1 | 6.500 | 39.0 | | |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.198 | 0.498 | 46.5 | 2273.2 | O K |
| 30 min Summer | 99.274 | 0.574 | 46.5 | 2632.1 | O K |
| 60 min Summer | 99.356 | 0.656 | 46.5 | 3028.8 | O K |
| 120 min Summer | 99.441 | 0.741 | 46.5 | 3447.6 | O K |
| 180 min Summer | 99.491 | 0.791 | 46.5 | 3690.0 | O K |
| 240 min Summer | 99.522 | 0.822 | 46.5 | 3848.0 | O K |
| 360 min Summer | 99.559 | 0.859 | 46.5 | 4030.7 | O K |
| 480 min Summer | 99.576 | 0.876 | 46.5 | 4114.9 | O K |
| 600 min Summer | 99.581 | 0.881 | 46.5 | 4142.8 | O K |
| 720 min Summer | 99.580 | 0.880 | 46.5 | 4136.7 | O K |
| 960 min Summer | 99.565 | 0.865 | 46.5 | 4058.9 | O K |
| 1440 min Summer | 99.531 | 0.831 | 46.5 | 3889.5 | O K |
| 2160 min Summer | 99.472 | 0.772 | 46.5 | 3596.3 | O K |
| 2880 min Summer | 99.407 | 0.707 | 46.5 | 3277.4 | O K |
| 4320 min Summer | 99.275 | 0.575 | 46.5 | 2637.2 | O K |
| 5760 min Summer | 99.169 | 0.469 | 46.5 | 2132.3 | O K |
| 7200 min Summer | 99.088 | 0.388 | 46.3 | 1754.2 | O K |
| 8640 min Summer | 99.029 | 0.329 | 45.7 | 1482.9 | O K |
| 10080 min Summer | 98.988 | 0.288 | 45.0 | 1294.2 | O K |
| 15 min Winter | 99.257 | 0.557 | 46.5 | 2550.4 | O K |
| 30 min Winter | 99.341 | 0.641 | 46.5 | 2955.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 198.647 | 0.0 | 2029.3 | 26 |
| 30 min Summer | 115.749 | 0.0 | 2373.6 | 41 |
| 60 min Summer | 67.445 | 0.0 | 2999.2 | 70 |
| 120 min Summer | 39.300 | 0.0 | 3503.7 | 128 |
| 180 min Summer | 28.654 | 0.0 | 3833.7 | 188 |
| 240 min Summer | 22.899 | 0.0 | 4084.5 | 246 |
| 360 min Summer | 16.696 | 0.0 | 4462.3 | 364 |
| 480 min Summer | 13.343 | 0.0 | 4746.9 | 482 |
| 600 min Summer | 11.214 | 0.0 | 4975.8 | 600 |
| 720 min Summer | 9.729 | 0.0 | 5166.7 | 688 |
| 960 min Summer | 7.695 | 0.0 | 5415.3 | 794 |
| 1440 min Summer | 5.529 | 0.0 | 5724.8 | 1044 |
| 2160 min Summer | 3.973 | 0.0 | 6566.6 | 1456 |
| 2880 min Summer | 3.142 | 0.0 | 6917.8 | 1848 |
| 4320 min Summer | 2.224 | 0.0 | 7300.5 | 2600 |
| 5760 min Summer | 1.741 | 0.0 | 7744.6 | 3336 |
| 7200 min Summer | 1.439 | 0.0 | 7992.8 | 4032 |
| 8640 min Summer | 1.232 | 0.0 | 8189.8 | 4672 |
| 10080 min Summer | 1.080 | 0.0 | 8331.6 | 5344 |
| 15 min Winter | 198.647 | 0.0 | 2281.5 | 26 |
| 30 min Winter | 115.749 | 0.0 | 2657.5 | 40 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.433 | 0.733 | 46.5 | 3404.7 | O K |
| 120 min Winter | 99.530 | 0.830 | 46.5 | 3884.6 | O K |
| 180 min Winter | 99.585 | 0.885 | 46.5 | 4159.6 | O K |
| 240 min Winter | 99.621 | 0.921 | 46.5 | 4340.9 | O K |
| 360 min Winter | 99.663 | 0.963 | 46.5 | 4557.5 | O K |
| 480 min Winter | 99.685 | 0.985 | 46.5 | 4666.8 | O K |
| 600 min Winter | 99.694 | 0.994 | 46.5 | 4715.0 | O K |
| 720 min Winter | 99.696 | 0.996 | 46.5 | 4724.4 | O K |
| 960 min Winter | 99.675 | 0.975 | 46.5 | 4615.5 | O K |
| 1440 min Winter | 99.629 | 0.929 | 46.5 | 4381.8 | O K |
| 2160 min Winter | 99.550 | 0.850 | 46.5 | 3987.0 | O K |
| 2880 min Winter | 99.458 | 0.758 | 46.5 | 3531.2 | O K |
| 4320 min Winter | 99.259 | 0.559 | 46.5 | 2561.2 | O K |
| 5760 min Winter | 99.110 | 0.410 | 46.4 | 1854.9 | O K |
| 7200 min Winter | 99.011 | 0.311 | 45.4 | 1398.6 | O K |
| 8640 min Winter | 98.964 | 0.264 | 42.5 | 1182.7 | O K |
| 10080 min Winter | 98.940 | 0.240 | 38.0 | 1071.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 67.445 | 0.0 | 3366.8 | 70 |
| 120 min Winter | 39.300 | 0.0 | 3928.8 | 126 |
| 180 min Winter | 28.654 | 0.0 | 4296.4 | 184 |
| 240 min Winter | 22.899 | 0.0 | 4575.5 | 242 |
| 360 min Winter | 16.696 | 0.0 | 4994.6 | 358 |
| 480 min Winter | 13.343 | 0.0 | 5308.5 | 472 |
| 600 min Winter | 11.214 | 0.0 | 5559.0 | 584 |
| 720 min Winter | 9.729 | 0.0 | 5765.7 | 692 |
| 960 min Winter | 7.695 | 0.0 | 6027.3 | 896 |
| 1440 min Winter | 5.529 | 0.0 | 6308.9 | 1112 |
| 2160 min Winter | 3.973 | 0.0 | 7358.7 | 1580 |
| 2880 min Winter | 3.142 | 0.0 | 7751.5 | 2020 |
| 4320 min Winter | 2.224 | 0.0 | 8192.7 | 2772 |
| 5760 min Winter | 1.741 | 0.0 | 8680.2 | 3464 |
| 7200 min Winter | 1.439 | 0.0 | 8960.1 | 4040 |
| 8640 min Winter | 1.232 | 0.0 | 9184.4 | 4664 |
| 10080 min Winter | 1.080 | 0.0 | 9352.3 | 5344 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| Site Location | CATCHMENT GB 401550 311650 SK 01550 11650 |
| C (1km) | -0.032 |
| D1 (1km) | 0.368 |
| D2 (1km) | 0.332 |
| D3 (1km) | 0.295 |
| E (1km) | 0.318 |
| F (1km) | 2.412 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 6.220

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 2.073 | 4 | 8 | 2.073 | 8 | 12 | 2.073 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 98.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 4383.6 | 1.000 | 5116.0 | 1.001 | 5116.7 | 1.300 | 5346.7 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0285-4660-1000-4660 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 46.6 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 285 |
| Invert Level (m) | 98.700 |
| Minimum Outlet Pipe Diameter (mm) | 300 |
| Suggested Manhole Diameter (mm) | 1800 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 46.5 |
| Flush-Flo™ | 0.435 | 46.5 |
| Kick-Flo® | 0.778 | 41.2 |
| Mean Flow over Head Range | - | 37.5 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 8.9 | 1.200 | 50.7 | 3.000 | 79.1 | 7.000 | 119.5 |
| 0.200 | 29.4 | 1.400 | 54.7 | 3.500 | 85.2 | 7.500 | 123.6 |
| 0.300 | 45.2 | 1.600 | 58.3 | 4.000 | 90.9 | 8.000 | 127.5 |
| 0.400 | 46.4 | 1.800 | 61.7 | 4.500 | 96.3 | 8.500 | 131.4 |
| 0.500 | 46.3 | 2.000 | 64.9 | 5.000 | 101.4 | 9.000 | 135.1 |
| 0.600 | 45.4 | 2.200 | 68.0 | 5.500 | 106.2 | 9.500 | 138.7 |
| 0.800 | 41.7 | 2.400 | 70.9 | 6.000 | 110.8 | | |
| 1.000 | 46.5 | 2.600 | 73.8 | 6.500 | 115.2 | | |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.200 | 0.500 | 41.1 | 2009.5 | O K |
| 30 min Summer | 99.275 | 0.575 | 41.1 | 2326.8 | O K |
| 60 min Summer | 99.357 | 0.657 | 41.1 | 2677.4 | O K |
| 120 min Summer | 99.442 | 0.742 | 41.1 | 3047.2 | O K |
| 180 min Summer | 99.491 | 0.791 | 41.1 | 3260.7 | O K |
| 240 min Summer | 99.522 | 0.822 | 41.1 | 3398.7 | O K |
| 360 min Summer | 99.558 | 0.858 | 41.1 | 3557.6 | O K |
| 480 min Summer | 99.574 | 0.874 | 41.1 | 3629.8 | O K |
| 600 min Summer | 99.579 | 0.879 | 41.1 | 3652.3 | O K |
| 720 min Summer | 99.578 | 0.878 | 41.1 | 3645.2 | O K |
| 960 min Summer | 99.562 | 0.862 | 41.1 | 3573.1 | O K |
| 1440 min Summer | 99.527 | 0.827 | 41.1 | 3418.0 | O K |
| 2160 min Summer | 99.467 | 0.767 | 41.1 | 3155.0 | O K |
| 2880 min Summer | 99.401 | 0.701 | 41.1 | 2866.8 | O K |
| 4320 min Summer | 99.267 | 0.567 | 41.1 | 2294.5 | O K |
| 5760 min Summer | 99.160 | 0.460 | 41.1 | 1843.8 | O K |
| 7200 min Summer | 99.078 | 0.378 | 41.0 | 1506.9 | O K |
| 8640 min Summer | 99.020 | 0.320 | 40.5 | 1266.1 | O K |
| 10080 min Summer | 98.978 | 0.278 | 39.9 | 1098.5 | O K |
| 15 min Winter | 99.258 | 0.558 | 41.1 | 2254.7 | O K |
| 30 min Winter | 99.342 | 0.642 | 41.1 | 2612.5 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 198.647 | 0.0 | 1814.0 | 26 |
| 30 min Summer | 115.749 | 0.0 | 2119.9 | 41 |
| 60 min Summer | 67.445 | 0.0 | 2663.7 | 70 |
| 120 min Summer | 39.300 | 0.0 | 3110.8 | 128 |
| 180 min Summer | 28.654 | 0.0 | 3403.3 | 188 |
| 240 min Summer | 22.899 | 0.0 | 3626.0 | 246 |
| 360 min Summer | 16.696 | 0.0 | 3961.5 | 364 |
| 480 min Summer | 13.343 | 0.0 | 4214.4 | 482 |
| 600 min Summer | 11.214 | 0.0 | 4418.2 | 600 |
| 720 min Summer | 9.729 | 0.0 | 4588.3 | 688 |
| 960 min Summer | 7.695 | 0.0 | 4810.7 | 794 |
| 1440 min Summer | 5.529 | 0.0 | 5089.8 | 1044 |
| 2160 min Summer | 3.973 | 0.0 | 5815.4 | 1456 |
| 2880 min Summer | 3.142 | 0.0 | 6127.1 | 1848 |
| 4320 min Summer | 2.224 | 0.0 | 6469.3 | 2600 |
| 5760 min Summer | 1.741 | 0.0 | 6852.5 | 3336 |
| 7200 min Summer | 1.439 | 0.0 | 7072.9 | 4032 |
| 8640 min Summer | 1.232 | 0.0 | 7248.8 | 4672 |
| 10080 min Summer | 1.080 | 0.0 | 7377.2 | 5344 |
| 15 min Winter | 198.647 | 0.0 | 2037.9 | 26 |
| 30 min Winter | 115.749 | 0.0 | 2372.1 | 40 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.434 | 0.734 | 41.1 | 3009.9 | O K |
| 120 min Winter | 99.530 | 0.830 | 41.1 | 3433.1 | O K |
| 180 min Winter | 99.584 | 0.884 | 41.1 | 3675.0 | O K |
| 240 min Winter | 99.620 | 0.920 | 41.1 | 3834.1 | O K |
| 360 min Winter | 99.662 | 0.962 | 41.1 | 4023.8 | O K |
| 480 min Winter | 99.683 | 0.983 | 41.1 | 4118.4 | O K |
| 600 min Winter | 99.692 | 0.992 | 41.1 | 4159.2 | O K |
| 720 min Winter | 99.694 | 0.994 | 41.1 | 4165.8 | O K |
| 960 min Winter | 99.672 | 0.972 | 41.1 | 4066.3 | O K |
| 1440 min Winter | 99.625 | 0.925 | 41.1 | 3854.4 | O K |
| 2160 min Winter | 99.545 | 0.845 | 41.1 | 3499.2 | O K |
| 2880 min Winter | 99.453 | 0.753 | 41.1 | 3092.7 | O K |
| 4320 min Winter | 99.250 | 0.550 | 41.1 | 2223.8 | O K |
| 5760 min Winter | 99.099 | 0.399 | 41.1 | 1593.2 | O K |
| 7200 min Winter | 99.000 | 0.300 | 40.3 | 1187.8 | O K |
| 8640 min Winter | 98.953 | 0.253 | 37.7 | 996.9 | O K |
| 10080 min Winter | 98.929 | 0.229 | 33.6 | 901.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 67.445 | 0.0 | 2989.4 | 70 |
| 120 min Winter | 39.300 | 0.0 | 3487.5 | 126 |
| 180 min Winter | 28.654 | 0.0 | 3813.7 | 184 |
| 240 min Winter | 22.899 | 0.0 | 4061.4 | 242 |
| 360 min Winter | 16.696 | 0.0 | 4433.7 | 358 |
| 480 min Winter | 13.343 | 0.0 | 4712.8 | 472 |
| 600 min Winter | 11.214 | 0.0 | 4936.0 | 584 |
| 720 min Winter | 9.729 | 0.0 | 5120.3 | 692 |
| 960 min Winter | 7.695 | 0.0 | 5354.5 | 894 |
| 1440 min Winter | 5.529 | 0.0 | 5608.4 | 1112 |
| 2160 min Winter | 3.973 | 0.0 | 6516.5 | 1580 |
| 2880 min Winter | 3.142 | 0.0 | 6865.1 | 2024 |
| 4320 min Winter | 2.224 | 0.0 | 7259.0 | 2772 |
| 5760 min Winter | 1.741 | 0.0 | 7679.8 | 3464 |
| 7200 min Winter | 1.439 | 0.0 | 7928.3 | 4040 |
| 8640 min Winter | 1.232 | 0.0 | 8128.3 | 4664 |
| 10080 min Winter | 1.080 | 0.0 | 8279.7 | 5344 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| Site Location | CATCHMENT GB 401550 311650 SK 01550 11650 |
| C (1km) | -0.032 |
| D1 (1km) | 0.368 |
| D2 (1km) | 0.332 |
| D3 (1km) | 0.295 |
| E (1km) | 0.318 |
| F (1km) | 2.412 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 5.500

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 1.833 | 4 | 8 | 1.833 | 8 | 12 | 1.833 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 98.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 3855.5 | 1.000 | 4544.2 | 1.001 | 4544.2 | 1.300 | 4761.1 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0271-4130-1000-4130 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 41.3 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 271 |
| Invert Level (m) | 98.700 |
| Minimum Outlet Pipe Diameter (mm) | 300 |
| Suggested Manhole Diameter (mm) | 1800 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 41.2 |
| Flush-Flo™ | 0.418 | 41.1 |
| Kick-Flo® | 0.768 | 36.3 |
| Mean Flow over Head Range | - | 33.4 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 8.6 | 1.200 | 44.9 | 3.000 | 70.0 | 7.000 | 105.7 |
| 0.200 | 27.9 | 1.400 | 48.4 | 3.500 | 75.4 | 7.500 | 109.3 |
| 0.300 | 40.3 | 1.600 | 51.6 | 4.000 | 80.5 | 8.000 | 112.8 |
| 0.400 | 41.1 | 1.800 | 54.6 | 4.500 | 85.2 | 8.500 | 116.2 |
| 0.500 | 40.9 | 2.000 | 57.5 | 5.000 | 89.7 | 9.000 | 119.5 |
| 0.600 | 40.0 | 2.200 | 60.2 | 5.500 | 94.0 | 9.500 | 122.7 |
| 0.800 | 37.0 | 2.400 | 62.8 | 6.000 | 98.0 | | |
| 1.000 | 41.2 | 2.600 | 65.3 | 6.500 | 101.9 | | |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.137 | 0.437 | 114.3 | 8837.0 | O K |
| 30 min Summer | 99.206 | 0.506 | 116.1 | 10255.0 | O K |
| 60 min Summer | 99.283 | 0.583 | 116.7 | 11857.3 | O K |
| 120 min Summer | 99.368 | 0.668 | 116.7 | 13621.7 | O K |
| 180 min Summer | 99.420 | 0.720 | 116.7 | 14701.8 | O K |
| 240 min Summer | 99.456 | 0.756 | 116.7 | 15468.0 | O K |
| 360 min Summer | 99.506 | 0.806 | 116.7 | 16513.5 | O K |
| 480 min Summer | 99.538 | 0.838 | 116.7 | 17195.6 | O K |
| 600 min Summer | 99.560 | 0.860 | 116.7 | 17664.4 | O K |
| 720 min Summer | 99.575 | 0.875 | 116.7 | 17987.9 | O K |
| 960 min Summer | 99.581 | 0.881 | 116.7 | 18114.6 | O K |
| 1440 min Summer | 99.572 | 0.872 | 116.7 | 17906.6 | O K |
| 2160 min Summer | 99.551 | 0.851 | 116.7 | 17469.5 | O K |
| 2880 min Summer | 99.526 | 0.826 | 116.7 | 16936.9 | O K |
| 4320 min Summer | 99.452 | 0.752 | 116.7 | 15390.4 | O K |
| 5760 min Summer | 99.382 | 0.682 | 116.7 | 13912.3 | O K |
| 7200 min Summer | 99.318 | 0.618 | 116.7 | 12574.6 | O K |
| 8640 min Summer | 99.261 | 0.561 | 116.7 | 11389.1 | O K |
| 10080 min Summer | 99.212 | 0.512 | 116.2 | 10376.8 | O K |
| 15 min Winter | 99.189 | 0.489 | 115.8 | 9903.7 | O K |
| 30 min Winter | 99.266 | 0.566 | 116.7 | 11498.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 198.647 | 0.0 | 5683.6 | 30 |
| 30 min Summer | 115.749 | 0.0 | 6747.0 | 45 |
| 60 min Summer | 67.445 | 0.0 | 9996.3 | 74 |
| 120 min Summer | 39.300 | 0.0 | 11731.3 | 134 |
| 180 min Summer | 28.654 | 0.0 | 12827.0 | 192 |
| 240 min Summer | 22.899 | 0.0 | 13628.4 | 252 |
| 360 min Summer | 16.696 | 0.0 | 14758.2 | 370 |
| 480 min Summer | 13.343 | 0.0 | 15516.9 | 488 |
| 600 min Summer | 11.214 | 0.0 | 16037.7 | 606 |
| 720 min Summer | 9.729 | 0.0 | 16382.8 | 724 |
| 960 min Summer | 7.695 | 0.0 | 16582.9 | 962 |
| 1440 min Summer | 5.529 | 0.0 | 15951.6 | 1248 |
| 2160 min Summer | 3.973 | 0.0 | 23690.5 | 1604 |
| 2880 min Summer | 3.142 | 0.0 | 24719.9 | 1992 |
| 4320 min Summer | 2.224 | 0.0 | 25379.7 | 2776 |
| 5760 min Summer | 1.741 | 0.0 | 29216.0 | 3576 |
| 7200 min Summer | 1.439 | 0.0 | 30075.6 | 4328 |
| 8640 min Summer | 1.232 | 0.0 | 30674.1 | 5032 |
| 10080 min Summer | 1.080 | 0.0 | 30958.6 | 5752 |
| 15 min Winter | 198.647 | 0.0 | 6474.3 | 30 |
| 30 min Winter | 115.749 | 0.0 | 7586.4 | 45 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.353 | 0.653 | 116.7 | 13307.0 | O K |
| 120 min Winter | 99.449 | 0.749 | 116.7 | 15309.9 | O K |
| 180 min Winter | 99.507 | 0.807 | 116.7 | 16544.7 | O K |
| 240 min Winter | 99.549 | 0.849 | 116.7 | 17430.4 | O K |
| 360 min Winter | 99.606 | 0.906 | 116.7 | 18647.5 | O K |
| 480 min Winter | 99.644 | 0.944 | 116.7 | 19438.4 | O K |
| 600 min Winter | 99.669 | 0.969 | 116.7 | 19980.6 | O K |
| 720 min Winter | 99.687 | 0.987 | 116.7 | 20358.5 | O K |
| 960 min Winter | 99.696 | 0.996 | 116.7 | 20559.7 | O K |
| 1440 min Winter | 99.687 | 0.987 | 116.7 | 20366.2 | O K |
| 2160 min Winter | 99.654 | 0.954 | 116.7 | 19663.9 | O K |
| 2880 min Winter | 99.619 | 0.919 | 116.7 | 18914.8 | O K |
| 4320 min Winter | 99.511 | 0.811 | 116.7 | 16634.8 | O K |
| 5760 min Winter | 99.404 | 0.704 | 116.7 | 14375.9 | O K |
| 7200 min Winter | 99.309 | 0.609 | 116.7 | 12385.4 | O K |
| 8640 min Winter | 99.228 | 0.528 | 116.4 | 10707.3 | O K |
| 10080 min Winter | 99.162 | 0.462 | 115.1 | 9355.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 67.445 | 0.0 | 11279.5 | 74 |
| 120 min Winter | 39.300 | 0.0 | 13167.4 | 132 |
| 180 min Winter | 28.654 | 0.0 | 14334.7 | 190 |
| 240 min Winter | 22.899 | 0.0 | 15165.5 | 248 |
| 360 min Winter | 16.696 | 0.0 | 16282.6 | 364 |
| 480 min Winter | 13.343 | 0.0 | 16976.9 | 480 |
| 600 min Winter | 11.214 | 0.0 | 17391.1 | 594 |
| 720 min Winter | 9.729 | 0.0 | 17589.3 | 708 |
| 960 min Winter | 7.695 | 0.0 | 17434.3 | 934 |
| 1440 min Winter | 5.529 | 0.0 | 16416.2 | 1364 |
| 2160 min Winter | 3.973 | 0.0 | 26480.5 | 1700 |
| 2880 min Winter | 3.142 | 0.0 | 27523.2 | 2164 |
| 4320 min Winter | 2.224 | 0.0 | 28009.2 | 3036 |
| 5760 min Winter | 1.741 | 0.0 | 32787.7 | 3864 |
| 7200 min Winter | 1.439 | 0.0 | 33781.0 | 4616 |
| 8640 min Winter | 1.232 | 0.0 | 34487.3 | 5288 |
| 10080 min Winter | 1.080 | 0.0 | 34860.0 | 5960 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| Site Location | CATCHMENT GB 401550 311650 SK 01550 11650 |
| C (1km) | -0.032 |
| D1 (1km) | 0.368 |
| D2 (1km) | 0.332 |
| D3 (1km) | 0.295 |
| E (1km) | 0.318 |
| F (1km) | 2.412 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 24.000

| Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) | Time (mins) From: | To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 6.000 | 4 | 8 | 6.000 | 8 | 12 | 6.000 | 12 | 16 | 6.000 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 98.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 19885.8 | 1.000 | 21413.8 | 1.001 | 21413.8 | 1.300 | 21881.6 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0421-1168-1000-1168 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 116.8 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 421 |
| Invert Level (m) | 98.700 |
| Minimum Outlet Pipe Diameter (mm) | 450 |
| Suggested Manhole Diameter (mm) | Site Specific Design (Contact Hydro International) |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 116.6 |
| Flush-Flo™ | 0.577 | 116.7 |
| Kick-Flo® | 0.864 | 108.6 |
| Mean Flow over Head Range | - | 87.4 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 11.4 | 1.200 | 127.4 | 3.000 | 199.3 | 7.000 | 302.0 |
| 0.200 | 40.9 | 1.400 | 137.3 | 3.500 | 214.9 | 7.500 | 312.4 |
| 0.300 | 80.1 | 1.600 | 146.6 | 4.000 | 229.4 | 8.000 | 322.5 |
| 0.400 | 112.7 | 1.800 | 155.3 | 4.500 | 243.1 | 8.500 | 332.2 |
| 0.500 | 116.0 | 2.000 | 163.4 | 5.000 | 256.0 | 9.000 | 341.7 |
| 0.600 | 116.6 | 2.200 | 171.2 | 5.500 | 268.2 | 9.500 | 350.9 |
| 0.800 | 111.9 | 2.400 | 178.7 | 6.000 | 280.0 | | |
| 1.000 | 116.6 | 2.600 | 185.8 | 6.500 | 291.2 | | |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 15 min Summer | 99.159 | 0.459 | 22.6 | 1728.1 | O K |
| 30 min Summer | 99.229 | 0.529 | 22.6 | 2005.6 | O K |
| 60 min Summer | 99.308 | 0.608 | 22.6 | 2317.5 | O K |
| 120 min Summer | 99.392 | 0.692 | 22.6 | 2659.8 | O K |
| 180 min Summer | 99.443 | 0.743 | 22.6 | 2868.1 | O K |
| 240 min Summer | 99.479 | 0.779 | 22.6 | 3013.8 | O K |
| 360 min Summer | 99.525 | 0.825 | 22.6 | 3205.7 | O K |
| 480 min Summer | 99.553 | 0.853 | 22.6 | 3323.7 | O K |
| 600 min Summer | 99.571 | 0.871 | 22.6 | 3398.6 | O K |
| 720 min Summer | 99.582 | 0.882 | 22.6 | 3445.2 | O K |
| 960 min Summer | 99.581 | 0.881 | 22.6 | 3442.0 | O K |
| 1440 min Summer | 99.560 | 0.860 | 22.6 | 3352.1 | O K |
| 2160 min Summer | 99.526 | 0.826 | 22.6 | 3208.2 | O K |
| 2880 min Summer | 99.490 | 0.790 | 22.6 | 3059.2 | O K |
| 4320 min Summer | 99.395 | 0.695 | 22.6 | 2671.2 | O K |
| 5760 min Summer | 99.306 | 0.606 | 22.6 | 2312.7 | O K |
| 7200 min Summer | 99.229 | 0.529 | 22.6 | 2003.7 | O K |
| 8640 min Summer | 99.161 | 0.461 | 22.6 | 1734.9 | O K |
| 10080 min Summer | 99.102 | 0.402 | 22.6 | 1505.7 | O K |
| 15 min Winter | 99.212 | 0.512 | 22.6 | 1937.7 | O K |
| 30 min Winter | 99.291 | 0.591 | 22.6 | 2250.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 198.647 | 0.0 | 1452.9 | 27 |
| 30 min Summer | 115.749 | 0.0 | 1659.5 | 41 |
| 60 min Summer | 67.445 | 0.0 | 2228.9 | 70 |
| 120 min Summer | 39.300 | 0.0 | 2589.6 | 130 |
| 180 min Summer | 28.654 | 0.0 | 2816.6 | 190 |
| 240 min Summer | 22.899 | 0.0 | 2981.6 | 248 |
| 360 min Summer | 16.696 | 0.0 | 3209.3 | 368 |
| 480 min Summer | 13.343 | 0.0 | 3349.2 | 486 |
| 600 min Summer | 11.214 | 0.0 | 3422.5 | 604 |
| 720 min Summer | 9.729 | 0.0 | 3437.0 | 724 |
| 960 min Summer | 7.695 | 0.0 | 3359.6 | 962 |
| 1440 min Summer | 5.529 | 0.0 | 3167.8 | 1254 |
| 2160 min Summer | 3.973 | 0.0 | 4906.9 | 1624 |
| 2880 min Summer | 3.142 | 0.0 | 5144.9 | 2024 |
| 4320 min Summer | 2.224 | 0.0 | 5363.5 | 2816 |
| 5760 min Summer | 1.741 | 0.0 | 5846.5 | 3584 |
| 7200 min Summer | 1.439 | 0.0 | 6035.3 | 4328 |
| 8640 min Summer | 1.232 | 0.0 | 6183.7 | 5096 |
| 10080 min Summer | 1.080 | 0.0 | 6288.8 | 5760 |
| 15 min Winter | 198.647 | 0.0 | 1608.5 | 26 |
| 30 min Winter | 115.749 | 0.0 | 1798.4 | 41 |

## Summary of Results for 100 year Return Period (+40%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|
| 60 min Winter | 99.378 | 0.678 | 22.6 | 2602.5 | O K |
| 120 min Winter | 99.473 | 0.773 | 22.6 | 2991.3 | O K |
| 180 min Winter | 99.530 | 0.830 | 22.6 | 3226.8 | O K |
| 240 min Winter | 99.570 | 0.870 | 22.6 | 3392.4 | O K |
| 360 min Winter | 99.622 | 0.922 | 22.6 | 3614.1 | O K |
| 480 min Winter | 99.655 | 0.955 | 22.6 | 3754.4 | O K |
| 600 min Winter | 99.677 | 0.977 | 22.6 | 3847.0 | O K |
| 720 min Winter | 99.691 | 0.991 | 22.6 | 3908.3 | O K |
| 960 min Winter | 99.695 | 0.995 | 22.6 | 3923.9 | O K |
| 1440 min Winter | 99.676 | 0.976 | 22.6 | 3843.3 | O K |
| 2160 min Winter | 99.630 | 0.930 | 22.6 | 3645.2 | O K |
| 2880 min Winter | 99.583 | 0.883 | 22.6 | 3450.6 | O K |
| 4320 min Winter | 99.463 | 0.763 | 22.6 | 2947.6 | O K |
| 5760 min Winter | 99.328 | 0.628 | 22.6 | 2400.0 | O K |
| 7200 min Winter | 99.212 | 0.512 | 22.6 | 1934.9 | O K |
| 8640 min Winter | 99.113 | 0.413 | 22.6 | 1547.4 | O K |
| 10080 min Winter | 99.033 | 0.333 | 22.6 | 1240.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 67.445 | 0.0 | 2493.6 | 70 |
| 120 min Winter | 39.300 | 0.0 | 2882.5 | 128 |
| 180 min Winter | 28.654 | 0.0 | 3120.5 | 186 |
| 240 min Winter | 22.899 | 0.0 | 3285.2 | 244 |
| 360 min Winter | 16.696 | 0.0 | 3480.5 | 360 |
| 480 min Winter | 13.343 | 0.0 | 3545.5 | 478 |
| 600 min Winter | 11.214 | 0.0 | 3524.3 | 592 |
| 720 min Winter | 9.729 | 0.0 | 3487.8 | 708 |
| 960 min Winter | 7.695 | 0.0 | 3407.2 | 932 |
| 1440 min Winter | 5.529 | 0.0 | 3247.4 | 1362 |
| 2160 min Winter | 3.973 | 0.0 | 5482.3 | 1712 |
| 2880 min Winter | 3.142 | 0.0 | 5733.4 | 2168 |
| 4320 min Winter | 2.224 | 0.0 | 5859.5 | 3080 |
| 5760 min Winter | 1.741 | 0.0 | 6550.9 | 3912 |
| 7200 min Winter | 1.439 | 0.0 | 6765.3 | 4624 |
| 8640 min Winter | 1.232 | 0.0 | 6935.0 | 5352 |
| 10080 min Winter | 1.080 | 0.0 | 7059.9 | 5960 |

## Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 100 |
| Site Location | CATCHMENT GB 401550 311650 SK 01550 11650 |
| C (1km) | -0.032 |
| D1 (1km) | 0.368 |
| D2 (1km) | 0.332 |
| D3 (1km) | 0.295 |
| E (1km) | 0.318 |
| F (1km) | 2.412 |
| Summer Storms | Yes |
| Winter Storms | Yes |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Shortest Storm (mins) | 15 |
| Longest Storm (mins) | 10080 |
| Climate Change % | +40 |

## Time Area Diagram

Total Area (ha) 4.700

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|---|---|---|
| 0 | 4 | 1.567 | 4 | 8 | 1.567 | 8 | 12 | 1.567 |

## Model Details

Storage is Online Cover Level (m) 100.000

## Tank or Pond Structure

Invert Level (m) 98.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 3615.9 | 1.000 | 4283.8 | 1.001 | 4283.8 | 1.300 | 4494.4 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0210-2290-1000-2290 |
| Design Head (m) | 1.000 |
| Design Flow (l/s) | 22.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 210 |
| Invert Level (m) | 98.700 |
| Minimum Outlet Pipe Diameter (mm) | 225 |
| Suggested Manhole Diameter (mm) | 1500 |

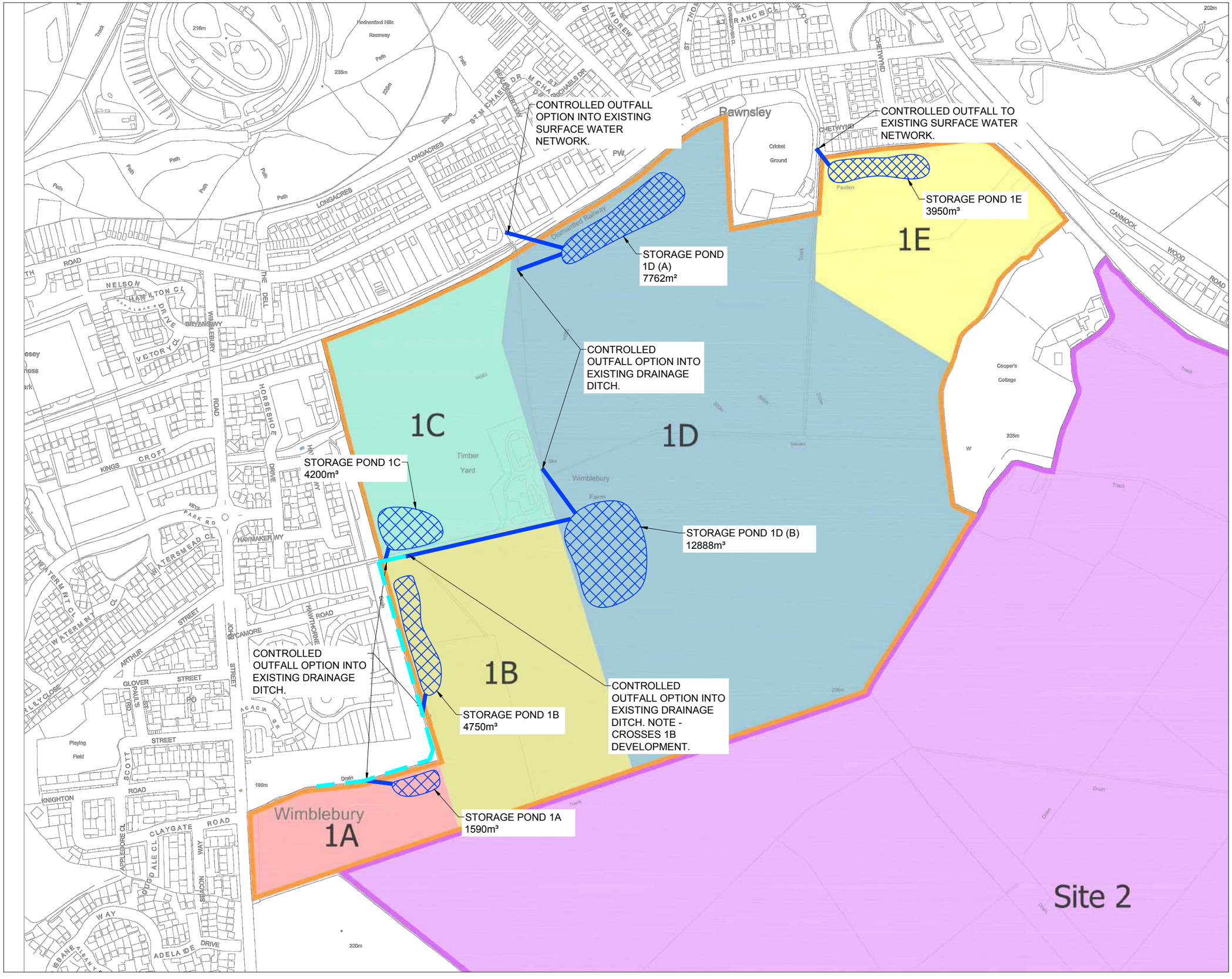
| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.000 | 22.7 |
| Flush-Flo™ | 0.350 | 22.6 |
| Kick-Flo® | 0.727 | 19.5 |
| Mean Flow over Head Range | - | 18.9 |

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 7.1 | 1.200 | 24.7 | 3.000 | 38.4 | 7.000 | 57.8 |
| 0.200 | 20.2 | 1.400 | 26.6 | 3.500 | 41.3 | 7.500 | 59.8 |
| 0.300 | 22.5 | 1.600 | 28.4 | 4.000 | 44.1 | 8.000 | 61.7 |
| 0.400 | 22.6 | 1.800 | 30.0 | 4.500 | 46.7 | 8.500 | 63.5 |
| 0.500 | 22.2 | 2.000 | 31.6 | 5.000 | 49.1 | 9.000 | 65.3 |
| 0.600 | 21.5 | 2.200 | 33.0 | 5.500 | 51.4 | 9.500 | 67.1 |
| 0.800 | 20.4 | 2.400 | 34.4 | 6.000 | 53.6 | | |
| 1.000 | 22.7 | 2.600 | 35.8 | 6.500 | 55.8 | | |

# APPENDIX 7

Surface Water Strategy Drawing




## Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.

## Key Plan

## Legend

- STORAGE POND
- OUTFALL ROUTE
- EXISTING DRAINAGE DITCH

| Rev | Date | Details of issue / revision | Drw | Rev |
|---|---|---|---|---|
| P1 | 08.03.17 | FOR INFORMATION | RW | DAR |

Issues & Revisions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Client

**CHURCH COMMISSIONERS OF ENGLAND**

Project Title

**LAND EAST OF WIMBLEBURY, CANNOCK**

Drawing Title

**OUTLINE SURFACE WATER STRATEGY**

| Drawn: | R WARD | | Reviewed: | D ALLUM-ROONEY |
|---|---|---|---|---|
| BWB Ref: | BMT2333 | Date: | 08.03.17 | Scale@A3: NTS |

Drawing Status

**FOR INFORMATION**

| Project - Originator - Zone - Level - Type - Role - Number | Status | Rev |
|---|---|---|
| WIM-BWB-EWE-00-DR-EN-0001 | S2 | P1 |



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