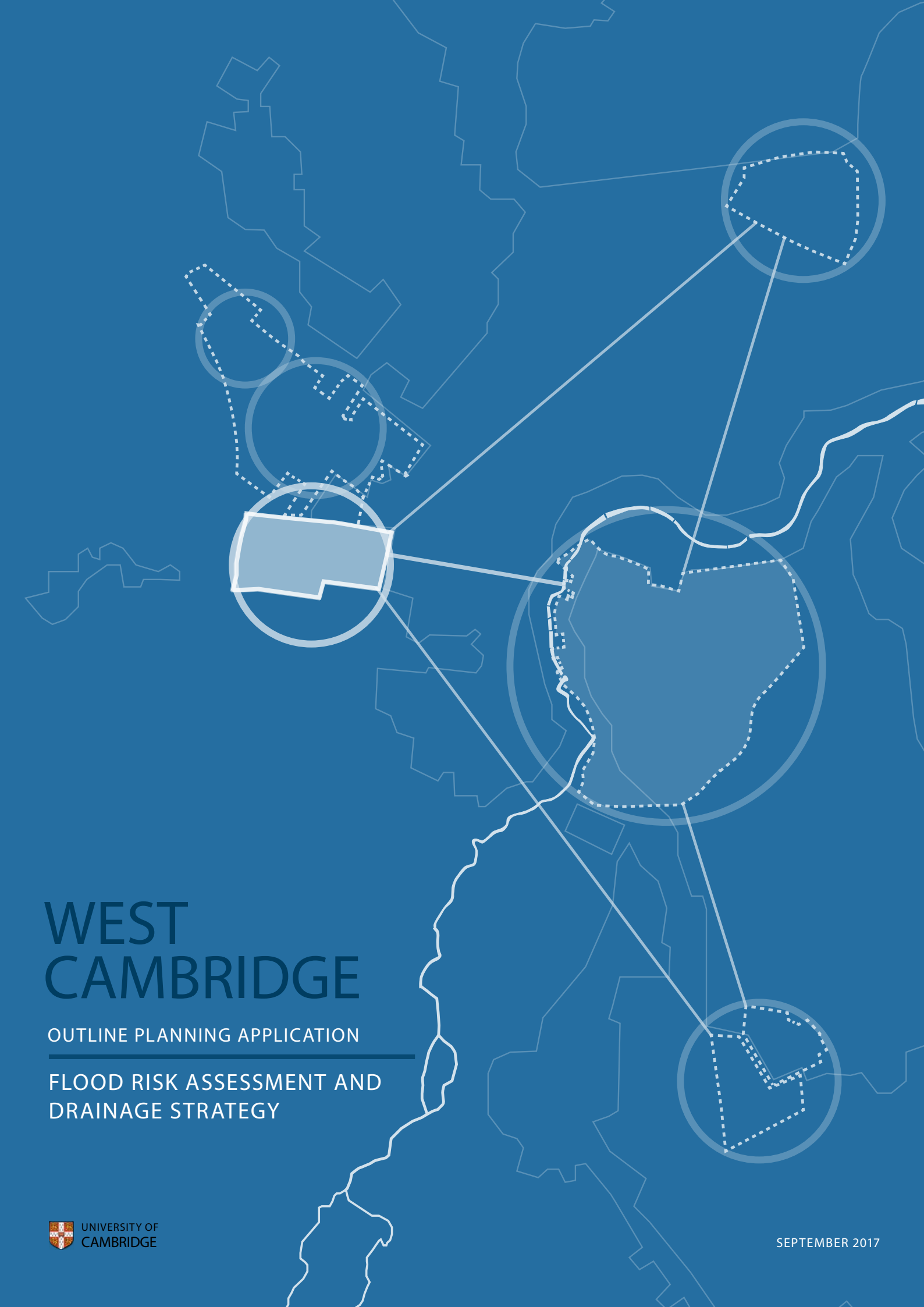

WEST CAMBRIDGE

OUTLINE PLANNING APPLICATION

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

UNIVERSITY OF CAMBRIDGE

SEPTEMBER 2017

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1 Executive Summary

1.1 Executive Summary

1.1.1 The National Planning Policy Framework (CLG, 2012) requires a Flood Risk Assessment (FRA) to be provided for development proposals greater than 1 hectare. This assessment aims to inform the local planning authority of the expected changes in flood risk and vulnerability that could result from the development. Priority is given in the National Planning Policy Framework (NPPF) to the use of sustainable drainage systems (SuDS) as the means for safely managing any residual post development flood risk.

Where ground conditions do not support the use of infiltration based SuD's systems; consideration must be given to other sustainable methods, including retro fitting of existing drainage systems.

1.1.2 This Flood Risk Assessment (FRA) supports an outline planning application for additional development and redevelopment of the University of Cambridge's West Cambridge site.

1.1.3 The majority of the 1999 Master Plan has been built with primary highway and drainage infrastructure constructed to service the current mix of commercial and academic land use.

1.1.4 Development proposals, whilst providing significant economic benefits to the city could increase flood risk to both the development and downstream catchments from increased rates and volumes of surface water. Development will also place a greater demand on potable water, resulting in increased waste water discharges to the public sewer network.

1.1.5 Development has the potential to reduce water quality and increase pollution risk unless effectively mitigated. This FRA demonstrates how these considerations will be mitigated and managed in line with current best practice set out in NPPF and LLFA guidance.

1.1.6 It is recognised that both the Coton Brook and Wash Pit Brook are sensitive watercourses in both ecological and hydrological terms. Mitigation measures will be necessary to ensure there is no adverse impact on water quality. The proposed pollution mitigation measures are set out in **Appendix R.**

1.1.7 The Environment Agency (EA) flood map shows the site is outside the 0.1% annual probability flood extent. For planning purposes, the site is within Flood Zone 1 and is considered at low probability of flooding. Flood Zone 1 is land assessed as having less than 0.1% annual probability (1 in 1000 year) of flooding from fluvial sources.

1.1.8 As required by the NPPF, all forms of potential flooding have been considered. The greatest post-development flood risk is that associated with increased rates and volumes of rainfall run off, resulting from increased impervious areas.

1.1.9 There are physical and spatial constraints (e.g. levels and easements) associated with integrating new development and infrastructure with existing. The drainage strategy has been developed to minimise impact on existing infrastructure and utilities where possible.

1.1.10 The drainage strategy, set out in the following FRA, has been developed to optimise the use of existing strategic drainage infrastructure (such as the Western lake and Payne's Pond and interconnecting canal) as much as possible, whilst accommodating the requirements of the NPPF and Lead Local Flood Authority, (Cambridgeshire County Council), with regard to climate change allowances and long-term surface water storage requirements run-off rates and water treatment.

1.1.11 The proposed construction phasing has been considered in the development of the drainage strategy. Additional strategic storage will be provided within the Lake, Canal and South Eastern (Paynes Pond) pond, with discharges restricted to the agreed 1 in 1 year Greenfield run off rate. This will enable existing underground storage to be removed and facilitate phased development, without increasing flood risk elsewhere.

1.1.12 The proposed construction phasing of drainage measures has been carefully considered in the development of the drainage strategy. Some development will require the removal of existing underground storage and this will be mitigated by free flow discharges to the Western Lake, Payne's Pond and Canal, from affected plots. Some plots will require on plot attenuation, with restricted discharges.

1.1.13 Within the known environmental and technical constraints, existing surface water infrastructure has been optimised to provide attenuation. It will be necessary for some development plots to utilise on plot storage. Whilst the exact details of the majority of plot development are currently unknown, the provision of source control, treatment and attenuation will require innovative solutions (CIRIA C 753 The SuDS Manual) to be delivered by the respective plot developers

1.1.14 It is envisaged that future Reserved Matters Applications will incorporate techniques such as:

- Green Roofs
- Blue Roofs
- Tanked Permeable Paving
- Rills / Swales
- Roadside Bio-retention areas

This list is not exhaustive.

1.1.15 The proposed drainage strategy has been developed to integrate into landscaping proposals. This includes significant improvements to the Lake, Canal and South Eastern pond which will promote biodiversity and assist in water treatment.

1.1.16 Where utilities permit, bio-retention systems will be installed along primary streets, which would assist in the treatment and conveyance of road run off.

1.1.17 The drainage strategy proposes to limit site discharges for all storm events up to and including the 100 year plus 40% climate change event to 2.59 l/s/ha. This rate is the equivalent to a 10% betterment of the 1 in 1-year greenfield run-off rate (2.88 i/s/ha) previously agreed with the Environment Agency, as part of the 1999 masterplan consent.

This will result in substantially lower discharges to both the Coton Brook and Washpit Brook for the 1% (plus climate change) design event, and provides significant betterment for the downstream catchments.

1.1.18 Reinforcement of the private foul sewer network located in Coton footpath, will be necessary through the formal sewer requisition process. Anglian Water has confirmed connections to the downstream public sewer network can be made following reinforcement.

1.1.19 This Flood Risk Assessment concludes that the development proposals are considered appropriate subject to the measures set out in the following sections being implemented on site.

2 Introduction

2.1 Introduction

2.1.1 Peter Brett Associates LLP (PBA) has been appointed by the University of Cambridge to prepare a Flood Risk Assessment (FRA) to support an outline planning application for additional mixed use development at the West Cambridge site located south of Madingley Road, Cambridge.

2.1.2 The existing site is predominantly brownfield and benefits from a site wide drainage infrastructure, built out to service the consented 1999 masterplan. Under the proposals, significant additional development will be delivered. Details of proposed development are set out in Section 4.

2.1.3 The drainage strategy proposes to re-engineer existing drainage assets and implement additional measures which reflect current best practice, with due consideration to the technical and environmental constraints facing development as optimising existing drainage is the most sustainable way of draining the existing site. Careful consideration has been given to supplementing existing surface water provision, by integrating water services infrastructure with established and proposed green infrastructure corridors and drainage.

The objective of the FRA is to:-

i. Liaise with relevant stakeholders to understand capacity constraints of on-site/offsite drainage relating to flood risk;

ii. Evaluate the level of flood risk from all potential sources of flooding on the site and the surrounding area;

iii. Identify the extent to which mitigation measures are required to manage flood risk from all sources;

iv. Establish the evidence base for sustainable mitigation measures for managing post development surface water discharges and flood risk on-site, so that these proposals can be incorporated within the scheme layout, without adverse impact on people, or property;

v. Establish mitigation measures to treat and maintain water quality; so there is no adverse ecological impact to receiving watercourses.

vi. Demonstrate that in flood risk terms, the site is suitable for mixed use development.

vii. Demonstrate that the measures set out in the drainage strategy are sustainable, innovative and provide betterment to existing downstream catchments, and reduce flood risk.

PBA have prepared this FRA in accordance with Section 10 of the Planning Practice Guidance (PPG) on ‘Flood Risk and Coastal Change’ document.

3 Existing Site

3.1 Site Location and Existing Use

3.1.1 The site is bordered to the North by Madingley Road, to the West by M11, to the East by Clerk Maxwell Road and to the South by Coton footpath. The total site area is approximately 66.5ha. A site location plan can be found in **Appendix A**. The site is centred on or near National Grid Reference:542496E, 259085N (NGR TL42496, 59085).

3.1.2 The majority of the site has been developed in line with the original consented 1999 Masterplan. However, the Paddocks associated with the Vet School remain Greenfield.

3.1.3 Since 1999, Reserved Matters planning applications have been approved for a number of plots. Many of the plots have been constructed or are in the process of completion. Currently, the amount of development area represents approximately 34.60ha of the site.

3.2 Topography

3.2.1 A site wide topographical survey was completed in 2014 and is included in **Appendix B**. The northern boundary with Madingley Road falls from approximately 19.50m AOD to 16.80m AOD West to East and the Southern boundary of the site falls from approximately 17.50m AOD to 12.70m AOD West to East. Within the site there is a ridge that falls eastwards from 19.70m AOD to 14.70m AOD, broadly through the upper third of the site. This watershed splits the site into two catchments, with approximately one third of the site draining Northwards and the remainder draining to the South East. The watershed catchments and respective outfalls are shown in **Appendix C.**

The two most prominent drainage features within the site are the lake located West of the Sports Centre, ('The Western Lake') the South Eastern pond (adjacent to Coton Footpath and known as Payne's Pond) and the interlinking ditch, which is known as the Canal.

3.3 Current Drainage Regime

3.3.1 There are two main outfalls from the site into which all site flows eventually drain. Discharges from the Northern catchment drain via a piped network to a series of ditches and culverts located adjacent to Madingley Road, before eventually out falling to the Washpit Brook, located north east of the Site.

Runoff from the remainder of the site is collected and conveyed via a piped network to the existing attenuation features located along the southern boundary. The lake, Canal and South Eastern pond attenuate flows before discharging off-site at restricted rates via the 450mm diameter culvert located to the South East and adjacent to Coton Footpath.

Flows from the site are restricted by a three-stage flow control to Greenfield run off rates previously agreed with the Environment Agency, as part of the consented 1999 FRA. These rates are set out in Section 8 "Surface and Foul Water Drainage Strategy" and permit a maximum discharge up to and including the 1 in 100 year Greenfield run off rate.

Appendix D provides details on the existing off-site public sewer provisions for both surface and foul water. **Appendix B** includes a site wide utilities plan.

Based upon the existing watershed, foul flows drain to either a 300mm diameter public sewer located in Madingley Road, or to the private foul sewer, located within Coton Footpath, which gravitates Eastwards before discharging into a 225mm diameter public sewer located in Wilberforce Road. Details of the arrangements are shown on the Anglian Water sewer plans (**Appendix D**).

3.3.2 Coton Brook is located along the South Eastern boundary of the site. Coton Brook drains Eastwards before draining into a 450mm diameter culvert which passes under the Emmanuel College Sports Grounds and Wilberforce Road, before re-emerging into an open watercourse,

the Bin Brook, located Eastwards. An unnamed watercourse drains North Westward before discharging to the Washpit Brook located westwards.
On-site drainage infrastructure to deliver the 1999 Masterplan has been built out in four phases. Primary sewers have been installed with spurs provided for the majority of the plots shown on the consented masterplan. The majority of the central and North Western / South Western areas drain freely to the Lake, where flows are attenuated before discharging via a three stage flow control to the Canal. These areas enjoy an unrestricted discharge with the lake providing strategic attenuation.

3.3.3 The North Eastern and South Eastern areas were delivered under the earliest phases of build out and, therefore, the majority of storage is provided by underground tanks located beneath the existing car parks. Underground storage is also provided in the car parks located South of Charles Babbage Road. Discharges to the Canal and South Eastern Pond from the areas are restricted by flow controls. The existing arrangements are shown in **Appendix C**. Flows from these plots discharge at restricted Greenfield rates using staged controls for the 1 in 1, 30 and 100-year events, and are conveyed via a 300mm diameter pipe to Coton Brook.

3.3.4 Historically the primary sewers, whilst not offered for adoption to Anglian Water, were designed in accordance with Sewers for Adoption.

In order to establish the condition, capacity and connectivity of the existing primary foul and surface water sewer network, Peter Brett Associates commissioned a CCTV survey on behalf of the University of Cambridge.

In general, the existing sewer network is in good condition. However, a number of pipes were encountered where debris / detritus has reduced the cross-sectional pipe area by up to 20%. The majority of material encountered within the pipework appears to be debris from construction. Clearly, any reduction in pipe capacity could increase flood risk. This can be mitigated by the measures discussed in Section 8.0.

Selected extracts from the CCTV survey showing the worst effected pipes are included in **Appendix E**. The complete survey is available for inspection at the offices of PBA Cambridge.

3.3.5 As discussed in 3.2.1 there is a ridge line that falls in elevation Eastwards. This essentially splits the site into two catchments; with approximately one third of the site area draining Northwards and the remainder draining South East. The ridge and catchments are shown in **Appendix C**.

3.3.6 The Northern catchment is approximately 14.80ha representing 23% of the total site area. The Southern catchment is 50.20ha and represents 77% of the total site area. Of the total site area, approximately 27ha (41%) consists of impervious areas (roofs hard standings and roads etc)

3.3.7 Approximately half of the northern catchment drains surface water via a network of pipes and ditches to Washpit Brook located to the North West of Madingley Road. The remainder of the Northern catchment is conveyed Eastwards via a 300mm diameter public surface water sewer, which ultimately outfalls into Bin Brook located East of the Emmanuel College sports ground.

The entire Southern catchment drains by gravity to the South Eastern corner of the site where it discharges into Coton Brook.

3.3.8 Foul water is also split into two catchments as described above. The northern catchment of the site discharges foul flows to a public foul sewer 300mm diameter located in Madingley Road that gravitates Eastwards connecting into the public sewer, network in Queens Road. The Whittle Laboratory located to the north east of the site also drains into the Madingley Road sewer. The Southern part of the site discharges to a private foul sewer of 300mm diameter located in Coton footpath that gravitates Eastwards to the public sewer network in Wilberforce Road.

3.4 Design Criteria (1999 Consented Masterplan)

3.4.1 The previous site wide consented masterplan produced in 1999, (whilst not completely built out), allowed for 85% of impermeable areas from most of the site, (with the exception of central areas to the north and the landscaped western perimeter) which were proposed to be left to

discharge to the Western lake or Canal. Overall the full 1999 masterplan allowed for an impermeable area of 42.08ha, a PIMP of 64%.

3.4.2 Plan 31500/2001/149 enclosed in **Appendix C** illustrates the catchment areas of the previous consented site wide masterplan and the extent of impermeable area previously designed for.

3.4.3 The Northern catchment is approximately 20.61ha in total area. Of this area, 10.56ha is impermeable. The Southern catchment which ultimately drains to Bin Brook is approximately 45.53ha in area. Of this area, 31.52ha is impermeable. Across both catchments, the total site area is 66.14ha which also includes for 42.08ha of impermeable area. This represents a PIMP of 64% overall.

3.4.4 The South-Eastern portion of the Bin Brook catchment drains to a strategic attenuation pond situated directly in the south east corner of the site. This is historically known as Payne's pond. Currently this pond receives run-off from 31.52ha of impermeable area. Flows are attenuated to the 1 in 1, 30 and 100-year greenfield runoff rates.

3.4.5 The remainder of the South-Western of the catchment, drains to the Western lake. The lake accommodates 17.77ha of impermeable area. Flows are attenuated to the 1 in 1, 30 and 100-year greenfield runoff rates. The existing permanent water level of the lake is 15.300 AOD and the invert 12.200 AOD. The maximum water level is 16.186 AOD.

3.4.6 A 3 stage flow control is located within the Canal located East of the lake. Surface water from the lake flows via a canal feature which conveys flows to the south-east corner where they drain to the Coton Brook watercourse.

3.4.7 The Greenfield run off rates **previously agreed** with the Environment Agency, as part of the Consented 1999 FRA are summarised in Table 1.

Return Period	Flow Rate
1 in 1-year rate	2.88 l/s/ha
1 in 30-year rate	7.96 l/s/ha
1 in 100-year rate	11.79 l/s/ha

Table 1 Historical Consented Greenfield Rates (as agreed previously with EA)

3.4.8 Based on these rates and the extent of impermeable areas allowed for within the original 1999 consented masterplan (shown on plan 31500/2001/149 in **Appendix C),** the current discharge rates for each storm event for each catchment can be assessed. This is shown in Table 2

Return Period	Bin Brook	Washpit Brook
1 in 1 year	91 l/s	30 l/s
1 in 30-year event	251 l/s	84 l/s
1 in 100-year event	372 l/s	125 l/s

Table 2 Existing Discharge Rates (Bin Brook and Washpit Brook catchments)

3.5 Ground Conditions

3.5.1 There have been numerous ground investigations undertaken since 1999 to inform the design of the primary infrastructure (lake, ponds, drainage and roads). In addition, consented plot development required ground investigations to inform detailed design.

As part of our appointment, PBA undertook a desktop review of the reports available. The technical note summarising ground conditions is included in **Appendix F**, and confirms that the

underlying soils generally comprise Gault Clay and Mudstone. A review of existing British Geological Survey borehole confirms the drift deposits are predominantly clay.

3.5.2 The British Geological Surveys (BGS) extracts showing the site's geology are included in **Appendix G**. The site is underlain by the Gault Formation comprising Mudstone. There are limited number of boreholes within the West and Northern parts of the site.

The boreholes located within the Western part of the site describe the ground as consisting of "Firm brownish grey silty clay with a little fine rounded gravel". Review of the Soilscapes website of Cranfield University show the site has "Lime-rich loamy and clayey soils with impeded drainage".

3.5.3 The cohesive nature of the underlying soils suggests infiltration into the underlying ground is very unlikely.

3.5.4 The EA map shows that the site is not within a Source Protection Zone (see **Error! Reference source not found.** below). The EA map indicates the site is not above a bedrock aquifer. The topography of the site, and nature of the underlying soils, indicates groundwater is likely to be encountered at depth.

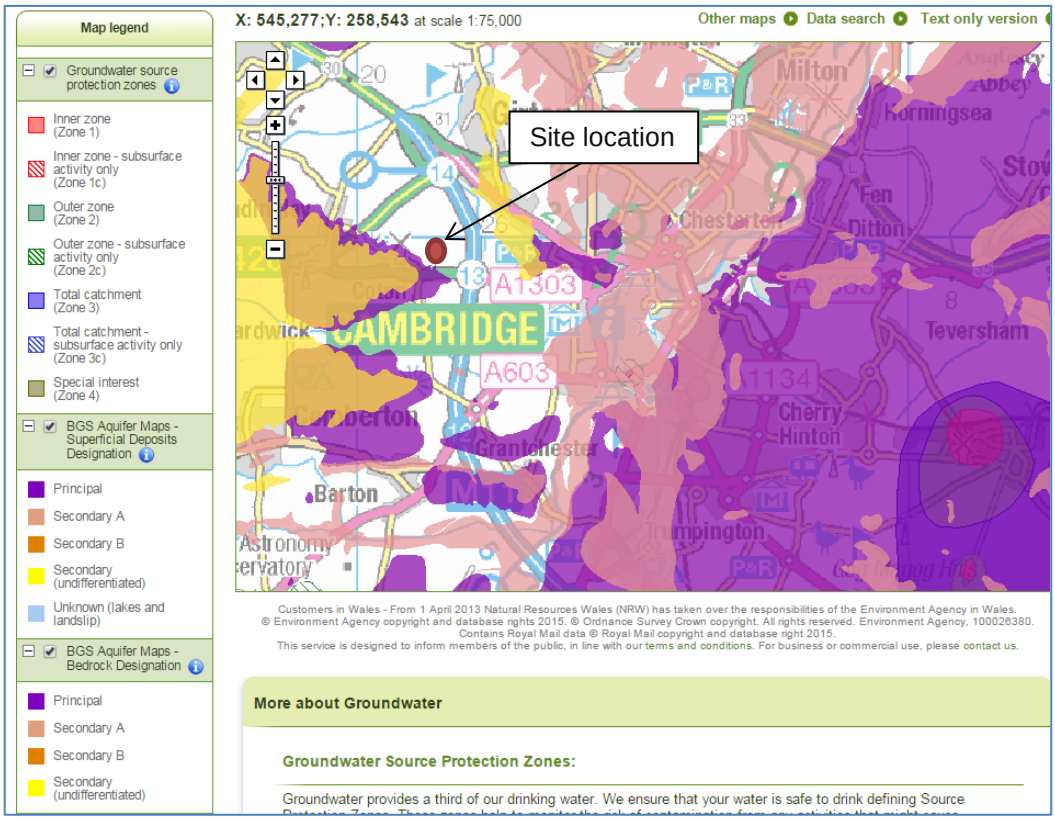

Figure 1: Groundwater source protection zones (EA, 2016)

4 Development Proposals

4.1 Development Proposals

4.1.1 Development proposals include the following land uses:

- Academic research
- Commercial research
- Nursery
- Shops, Café, restaurant/public house
- Assembly and Leisure
- Ancillary Infrastructure (Energy Centre/Car Parks)

The majority of the 1999 consented masterplan has been built out providing approximately 164,550m^2 of floor space. Approximately 70,887m^2 of consented floor space has not been implemented.

4.1.2 Densification of the West Cambridge site will result in a substantial increase of impervious surfaces (car parking, roads, hard standings and roofs), which will increase the rate of surface water runoff and potentially the volume. The potential for infiltration is limited on the site. Unless sustainable mitigation measures are implemented, there is a risk that densification could increase flood risk to the development itself and impact upon downstream catchments.

The concentration of parking by the provision of multi-storey car parking, could also increase the risk of pollution incidents. Consideration of mitigation measures are set out in the following sections.

The existing site benefits from significant drainage infrastructure, which is to be modified and incorporated into the site-wide drainage strategy. To enable flood risk associated with the 1 in 100-year annual probability event, including climate change, to be mitigated and managed in a sustainable manner, a wide range of SuDs techniques have been identified. These are discussed in Section 8.

It is envisaged development will be delivered in three phases, with the majority of the primary drainage infrastructure delivered in Phase 1.

Development will entail demolition of some existing buildings, and replacement with modern facilities.

The proposed developable areas by phase are summarised in the following table.

Phase	Total GEA (m²) *
Existing (including buildings to be demolished)	153,869
Built in Phase 1	177,364
Built in Phase 2	177,846
Built in Phase 3	99,307
Total (Existing and Built)	608,386
Total (Existing and Built – demolished)	**559,196**

Table 3 Development Areas by Phase (* For illustrative purposes)

A detailed breakdown of these areas, by use, is included in the illustrative development schedule included in **Appendix H**.

4.1.3 The total impervious areas, post development, will be approximately 45.65ha which represents 68% of the entire site area (66.50ha).

The remainder of the site area will consist of landscaped public realm and open spaces.

The illustrative plot plan indicating phasing, including public realm areas is included in **Appendix I**.

5 Reference Documents

5.1 Policy Context

PBA have prepared this FRA in accordance with the relevant national, regional and local planning policy guidance as follows:

- National policy regarding flood risk as contained within the National Planning Policy Framework (NPPF) and the Technical Guidance to the NPPF, both issued by the Communities and Local Government (CLG, 2012) in March 2012 and the 'Flood Risk and Coastal Change' document released in March 2014 (CLG, 2014). Table 4 of the EA document 'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities' implies that an increase of 40% over the 1961-1990 peak rainfall intensity should be used as a suitable allowance for the potential impact of climate change on storm events from 2070 onwards.

- A collection and review of available flood risk information within the city of Cambridge is presented within the 'Cambridge and Cambridgeshire Level 1 Strategic Flood Risk Assessment dated September 2010 (WSP, 2010). Extracts from the Assessment are included in **Appendix J**.

- The Cambridge Local Plan 2006 sets out policies and proposals for future development and land use to 2016. The plan contains a policy on Flood Risk but was deleted in 2009 as it was covered in National and Regional Policy. Site 7.06 West Cambridge, South of Madingley Road is identified as a major allocation site. Cambridge City Proposals Map identifies the site as a "Proposal Site". Details of the policies are shown in **Appendix K**.

- The Cambridge Local Plan 2014: Proposed Submission sets out the planning strategy for future growth up to 2031 but the plan is not expected to be adopted until 2017 and is currently subject to examination by the Secretary of State. Policy 18: West Cambridge Area of Major Change states that development in this area will be permitted in line with the existing planning permissions. Policy 31: Integrated water management and water cycle requires SuDS to be integrated into developments where possible and Policy 32: Flood Risk. Policy 40: Development and expansion of business space encourages the West Cambridge site to be developed. Policy 43: University faculty development identifies the West Cambridge site as an opportunity to enhance faculty and research facilities. Details of the policies are shown in **Appendix K**.

- Cambridge and Milton Surface Water Management Plan (SWMP) dated November 2011 (Hyder Consulting & Edenvale Young, 2011) outlines the predicted risk and preferred surface water management strategy for the Cambridge area. Relevant Information from SWMP is included in this assessment in **Appendix J**.

- Department for Environment, Food & Rural Affairs and Environment Agency Flood Risk Assessment for Planning Applications Advice April 2012 'All development in Flood Zones 1 where development is more than 1 hectare (ha)' requires a Flood Risk Assessment.

- The Flood and Water Management Act (2010) gives the EA a strategic overview role for flood risk, and gives local authorities responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas as Lead Local Flood Authorities (LLFA).

- On 24th March 2015, the Government laid a statutory instrument making Lead Local Flood Authorities a statutory consultee by adding the consultation requirement to Schedule 4 of the Development Management Procedure Order. LLFAs are now statutory consultees to LPAs for major developments (10 dwellings or more) for surface water drainage.

- A Preliminary Flood Risk Assessment (PFRA) dated January 2011 (Hyder Consulting, 2011) was produced for Cambridge County Council to fulfil its statutory requirements under the Flood Risk Regulations, which implement the requirements of the European Floods Directive. PFRAs provide evidence to help LLFAs manage local flood risk through their local flood risk management strategies.

6 Methodology

The following key methods and design standards have been followed in the preparation of this FRA:

- The latest method for incorporating climate change allowances into new development is included within *'Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities'* prepared by the Environment Agency in 2016. Within the East Anglian Region, this document stipulates a "central" or "upper" limit for climate change should be made of 20% and 40% respectively dependent upon site characteristic and severity of flooding impact. In accordance with this document, an allowance of 40% in increase in rainfall intensity has been included in the modelling work and output drainage calculations provided (**Appendix L)**.

- The order in which disposing of surface water from development sites should be undertaken is stipulated within **the Building Regulations Requirement Part H3**. This stipulates that desirably, all run off should be disposed of via infiltration. Where this is not reasonably practicable to do so then to a watercourse, and when this not practicable, a sewer. All surface water disposal mechanisms contained within this FRA will be in accordance with this approach.

- Good practice sustainable drainage systems design advice is given in **The SuDS Manual** (C753) released by CIRIA in 2015. This manual defines SuDS as "Drainage systems which are considered to be environmentally beneficial, causing minimal or no long term detrimental impact". SuDS can be in a variety of forms, including detention basins, ponds, wetlands, lakes swales and permeable surfaces. The design of new SuDS systems used for this development site as well as their proposed treatment efficiencies and long term storage provisions will be in full accordance with the SuDS Manual approach.

- Pipe networks for both the surface and foul water will be designed in full accordance with Sewers for Adoption 7th Edition. This includes;

  - Surface water pipes sized to surcharge in 1:30 year storm event with flooding permissible only during 1:100-year storm events (in the event of flooding, flood water will always be a minimum 300mm below finished floor levels), and routed away from buildings.

  - Minimum self-cleansing velocities of 1.0 m/s and 0.75 m/s for surface and foul water pipes respectively

  - Endeavouring to provide a minimum of 1.2m cover to all pipework within hard landscaped areas.

  - All pipes to make soffit to soffit connections will typically no sump allowance made in manholes.

- All SuDS storage features and pipe networks implemented as part of this development will be fully modelled in Micro-drainage hydraulic design software using continuous rainfall series for the critical storm duration. Storage has been assessed using FEH rainfall data.

- All existing pipe alignments, gradients and levels have been established from the CCTV and topographical survey.

- Further specific design measures and considerations are contained within Section 8 of this FRA.

- In addition, PBA have held meetings with the LLFA to discuss and agree the principles of the strategy set out in this report. A copy of the correspondence is included in **Appendix M**.

7 Flood Risk

7.1 Environment Agency Flood Zone

7.1.1 The EA Flood Zone Map, enclosed in **Appendix N** shows the site to be located within Flood Zone 1: Low Probability, having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%) in any year). The risk of fluvial flooding is therefore low. All land uses are deemed appropriate within this zone.

7.2 Surface Water Flooding

7.2.1 The site falls within the 'Bin Brook Wet Spot', an area considered to be at risk of surface water flooding. It has been identified in the SWMP (Surface Water Management Plan) as one of a number of areas within the City which have a history of localised surface water flooding. These areas are identified as 'Wet Spots' in the report.

7.2.2 Although the site is within the Bin Brook Wet Spot, the Stage 1 SWMP modelling results show that the depth of flooding at the lowest elevation of the site is very low (0.1m-0.30m) during a 1 in 200-year rainfall event. Results from the SWMP take precedence over the EA and SFRA surface water maps. Taking the above into consideration, the risk of surface water flooding is considered to be low.

7.3 Groundwater Flooding

7.3.1 A review of historical Ground Investigation reports and BGS borehole records has indicated groundwater flooding is unlikely. The site is underlain by drift deposits of clay above mudstone and hence the rate and quantity of groundwater recharge will be limited. The risk of groundwater flooding is therefore considered to be low. The EA also confirms that the site is underlain by the Gault Formation which is designated as unproductive strata.

7.4 Sewer Flooding

7.4.1 Anglian Water have no records of flooding in the vicinity that can be attributed to capacity limitations in the public sewerage system.

7.5 Reservoir Flooding

7.5.1 The site is not in an area which is at risk of flooding from a reservoir (as indicated on EA on-line data).

7.6 Historical Flooding

7.6.1 The SFRA indicates the site has no flood history. No data relating to historical flooding episodes were identified by Cambridgeshire County Council (CCC).

7.7 Vulnerability

7.7.1 The proposed development will provide a mixed use. The most vulnerable classification is the student halls of residence that are classified as 'More Vulnerable' in Table 2 of the PPG 'Flood Risk and Coastal Change'. Table 3 of the same section states that this classification is appropriate for development within Flood Zone 1.

7.8 Sequential and Exception Tests

7.8.1 The site is located within Flood Zone 1 and therefore the sequential and exception tests are not required.

8 Surface & Foul Water Drainage Strategy

8.1 Strategy Development

This surface water drainage strategy has been developed in full accordance with current best practice, National and Regional Planning Policy Guidance and with regard to the known technical and environmental considerations which exist on site. Proposed measures have been develop following consultation and meetings with the LLFA.

8.1.1 The objective is to mitigate the risk of surface water flooding within the site curtilage boundary and to downstream development. It is intended that development will not increase pollution risk or impact adversely on ecology.

8.1.2 The site is brownfield and incorporates infrastructure (drainage, roads, utilities etc) which have been constructed over the past 16 years. There are physical constraints (levels, service easements, building clearances etc) which have, shaped development of the proposed drainage strategy.

8.1.3 Densification of West Cambridge will see a total impermeable area across the site of 44.68ha. This represents an overall PIMP of 68%, an increase of 2.82ha of impermeable area when compared to the 1999 West Cambridge masterplan.

8.1.4 Whilst the difference in total impermeable area between the 1999 masterplan and the densification proposals are relatively small, best practice associated with design of drainage infrastructure has evolved significantly since 1999, particularly with regards to higher rainfall intensities resulting from climate change predictions. This is reflected in industry standards, such as The SuDS Manual C753 (2015) and National / Local planning policies. Generally, significantly greater volumes of attenuation storage are required.

8.1.5 An important element of the proposed drainage strategy is the re-use of as much of the existing drainage infrastructure as possible to reduce environmental impact. The well-established Western lake, Canal and Payne's Pond have established eco systems. The proposed retrofitting of supplementary SuD's features will provide other benefits, apart from flood risk mitigation, such as water quality treatment and bio-diversity.

8.1.6 Based upon the indicative phasing of development, much of the existing underground storage located in the Eastern and Central areas of the site will need to be removed. In order to mitigate the temporary loss of this storage, it is proposed that enabling works are undertaken to the Lake, Canal and Payne's Pond to replace storage loss, and mitigate the risk of flooding. Some enabling work will need to be implemented before plot development commences. The Construction Phasing is shown in **Appendix O**. The first phase of new development will include the first building of the relocated Cambridge University Engineering Department. This will require removal of existing geocellular storage. However, on plot storage will be provided within the plot boundary with flow restricted to the 1 in 1-year greenfield rate. Flows will discharge to the existing Surface water system in Clerk Maxwell Road. The access road servicing this first plot will drain to a swale which will treat runoff, before attenuating flows and discharging at a restricted rate.

8.1.7 Subsequent extensions to this plot will require removal at storage serving the CAPE/Roger Needham building's and the works to the Pond, Canal and Western lake will need to have been completed in advance.

8.2 Surface Water Drainage Strategy

8.2.1 The proposed drainage strategy is shown in **Appendix P**. This details the modifications required to the surface and foul water piped networks. The drainage strategy plans detail the proposed foul and surface water discharge rates, and storage facilities and storage volumes required. The drawings should be read in conjunction with the Micro Drainage simulation results contained in **Appendix L**. Details of the proposed catchments are also included.

8.3 Method of Surface Water Disposal

8.3.1 The preferred surface water disposal hierarchy set out in The Building Regulations (Part H), has been assessed to ascertain suitability for this development, based upon known constraints.

Infiltration

The preferred method for disposal of surface water in the Building Regulations hierarchy is through infiltration to the ground. However, the underlying geology of this site is not viable due to the cohesive nature of the soils.

Watercourse

8.3.2 The next preferred method of surface water disposal is to discharge to a nearby watercourse. This option is the preferred method underpinning the proposed drainage strategy.

Public Sewer

8.3.3 The least preferred option is to discharge post development flows to a public sewer. It should be noted that existing plots draining to Washpit Brook do enter a small length of public sewer along Madingley Road prior to discharge to the Washpit watercourse. Similarly, some Eastern plots currently discharge to the public surface water sewer in Clerk Maxwell Road. It is not proposed to increase discharges.

8.4 Proposed Discharge Rates

8.4.1 It is proposed the whole site will discharge at the 1 in 1 year Greenfield runoff rate for all storm events up to and including the 1 in 100-year + 40% climate change event. Furthermore, a 10% reduction has been applied to the 1 in 1-year greenfield runoff rate previously agreed with the EA to provide additional flood betterment and to ensure long term storage requirement is met (refer to **section 8.7)**. This results in a discharge rate of **2.592 l/s/ha** being applied across the entire site. Whilst this results in a slight increase in flow for the 1 in 1-year event for flows discharging to the Bin Brook catchment, there is a significant reduction in the discharges for most return periods including the 1 in 100-year design event, plus climate change. The increase in the 1 in 1-year event is due to development driven changes to existing catchments that conversely also help to alleviate known drainage problems in the Washpit Brook catchment, in accordance with the LLFA's objectives.

8.4.2 This proposed strategy results in significant betterment to site discharges specifically during larger storm events where receiving watercourses and sewers are at the greatest risk of flooding. Table 4 indicates the differences between the proposed and existing discharge rates to the existing catchments.

Return Period	Proposed discharge to Bin Brook	Proposed discharge to Washpit Brook	Change to existing discharge to Bin Brook	Change to existing discharge to Washpit Brook
1 in 1-year storm event	101 l/s	16 l/s	+10 l/s	-14 l/s
1 in 30-year storm event	101 l/s	16 l/s	-150 l/s	-68 l/s
1 in 100-year storm event	101 l/s	16 l/s	-271 l/s	-109 l/s

Table 4 Proposed Discharge Rates to Bin Brook and Washpit Catchments

8.5 Surface Water Attenuation Requirements

8.5.1 Reducing all surface water discharge to rates equivalent to the 1 in 1-year greenfield runoff rate will require attenuation storage to be provided throughout the site, using a combination of techniques.

8.5.2 The total volume required for all storage structures provided across the site has been assessed based on the 1 in 1 year Greenfield run-off discharge rate for all storm events up to and including the 1 in 100-year + 40% climate change critical event. A minimum of 0.3m freeboard from maximum water level to storage cover level will be provided at all times. Calculations are included in **Appendix L**.

8.5.3 The provision of plot attenuation is primarily dependent upon the plot location within the masterplan. Plot location determines site level constraints (e.g. existing roads, buildings etc) and whether a gravity connection to a strategic storage structure can be achieved. Maximum volumetric storage requirements are also a consideration. Attenuation for plots utilising free flow surface water discharges are provided by 3 large existing communal storage structures located within public realm areas. These are as follows;

- Western Lake
- South Eastern Pond (Payne's Pond)
- Canal (Wetland corridor)

8.5.4 Due to level constraints, the Western and part of the central area of the proposed development can be drained by gravity to the Western lake and have an unrestricted discharge to it. The total extent of impermeable area draining to the western lake is 20.45ha. Whilst this represents an additional impermeable area of 2.68ha, throttling all flows back to the 1 in 1-year greenfield rate means a substantial increase in storage volume is required. For comparison, the discharge rate from the existing development during a 100-year storm event is 209.51l/s. The proposed development will discharge at 53 l/s.

8.5.5 Additional storage within the Western lake will be achieved by lowering the existing flow control from 15.30 AOD to 14.30 AOD, a change of 1.0m. This will lower standing water level and in effect, increase the total storage volume of the Western lake from 9,466m^3 to 18,334m^3, representing an increase of 8,868m^3. The maximum water level of the lake will still be 16.186 AOD (as existing) and the lowering of the flow control will still result in a permanent water depth of 2.1m. The existing lake profile will remain unchanged. However, additional landscaping to enhance the exposed lake fringes is envisaged.

8.5.6 Flow from the Western lake will drain via a flow control, along the Canal before flowing through another flow control located down-stream of the Canal. The flow is restricted to 59.52 l/s. This secondary flow control is necessary because the Canal receives direct run off from an impermeable area of 0.658ha and receives attenuated flows from the Western lake and also development plots (A_PR12, A18, A19 and A13). The 59.52l/s rate restricts pre-attenuated and direct runoff. It is intended that the Canal will be re-profiled, and increase volume to 554m^3.

8.5.7 The profile of Payne's Pond will remain unchanged however the permanent (normal) water level will be reduced by 0.2m to 12.30 AOD. The maximum (flood) water level will be 12.90 AOD giving an effective storage depth of 0.6m and will utilise the existing pond profile. Payne's Pond attenuates an impermeable area of 1.75ha arising from development located to the South-East of the development area and also provides attenuation to 3 buildings which will have their underground attenuation removed as part of the proposed works. This pond will release flows to Coton Brook watercourse at 5.00 l/s representing the 1 in 1-year rate.

8.5.8 The remainder of the development plots, specifically those situated to the Eastern side of the site, will attenuate their flows on plot. Section 8.9 discusses this in more detail.

Refer to drawings 31500/2006/116, 117 & 118.

8.6 On-Plot Surface Water Attenuation

In order to ensure the 1 in 1 year Greenfield run off rate is not exceeded for the Eastern plots, it is envisaged plot occupiers will need to utilise a variety of SuDS features and techniques to provide sufficient volume of on plot attenuation. This will be required to ensure storage requirements are met. It is envisaged an innovative approach to the use of SuDs systems will be required. Some of the techniques and systems that could be used, are as follows;

- Tanked permeable pavements
- Lined swales and filter drains
- Detention basins
- Green roofs
- Blue roofs
- Rills
- Bio Retention areas

8.6.1 The use of the 1 in 1-year discharge rate for all storm events up to an including the 1 in 100 years plus 40% climate change event means plots will require throttled rates. It is proposed that the minimum flow rate of on plot flow controls is 1 l/s. This equates to an orifice size of around 50mm in diameter, and which will require inspection and maintenance to ensure it operates effectively. It is envisaged plot developers will provide details of their proposed maintenance regime with their Reserved Matters planning applications.

8.6.2 Other implemented measures for attenuation systems include;

- Treatment of storm water prior to entering flow controls reducing the presence of sediment and suspended solids entering the flow control
- Monthly inspection of flow controls and regular cyclic maintenance
- Implementation of overflow weirs to ensure if a blockage does occur storm water is kept underground
- Directing overland flow along roads and using public realm areas for exceedance events

8.7 Surface Water Volume Control (Long Term Storage)

8.7.1 As set out in CIRIA C753 The SuDs Manual, the volume of surface water run off leaving a development site 12 hours after a 100 year, 6-hour storm event should be less than or equal to the green-field volume that would result from that same event.

8.7.2 It is proposed that all attenuation structures, including those situated on the Eastern development plot will release flows at the 1 in 1 year run off rate. This ensures that the volume of surface water leaving the site catchments is less after a 12-hour period than it was before redevelopment. This will result in reduced flood risk to the downstream catchment and will provide significant betterment. Calculations confirming volumes required are included in **Appendix L**. The approach has been agreed with LLFA following consultation.

8.8 Sustainable Drainage Systems (SuDS)

8.8.1 Ground investigations have been carried out to inform previous phases of development. Due to the impermeable nature of the soils there is no potential for infiltration. The spatial and level constraints associated with existing buildings, roads and service corridors further limit the opportunity to provide communal SuDs storage facilities within the site. Due to the nature of

development there is also an extensive utility network across the site. Details showing constraints are included in **Appendix B.**

8.8.2 Notwithstanding these challenges and constraints, it is proposed a number of SuDS elements be integrated into proposals as follows:

Western Lake, Canal and South Eastern (Payne's) Pond

8.8.3 It is proposed these existing water bodies will remain as part of the overall drainage strategy and be integrated into the landscaping proposals. As well as providing flood storage, proposals will ensure these facilities enhance landscaping and improve bio diversity as well as mitigating flood risk and improving water quality.

Bio Retention Areas

8.8.4 Where service corridors and existing and proposed trees permit, road side bio retention areas could be installed. These would collect highway run off and treat flows before discharging back into the existing surface water system. Details are shown in **Appendix P**

8.8.5 As well as providing water quality treatment, they would also promote bio diversity and provide temporary above ground storage during exceedance events.

8.8.6 Inlet gullies will be positioned along the kerb face and will direct run off into bio retention areas. These areas will slow run off and provide treatment. Residue volume will be conveyed via perforated pipes running along the invert of the structures and directed into surface water carrier drains. Areas where these features could be installed are shown in **Appendix P and Appendix S**. Further investigation will be required as the design detail evolves and utility diversions are confirmed.

8.8.7 On plot SuDs features will be implemented by individual developers. Innovative SuDs techniques and solutions will encourage development aspirations to be met as plots move forward to their respective Reserved Matters Applications. The permitted plot discharges and storage requirements are detailed on the drainage strategy drawings. A schedule of plot discharge rates is included in **Appendix Q.**

8.9 Water Quality

8.9.1 Appropriate pollution control measures will be included in the surface water drainage system to minimise the risk of contamination or pollution entering the ground or waterbodies from surface water runoff.

8.9.2 In order to mitigate and / or reduce pollution risk, the drainage systems will be designed to comply with the treatment requirements set out within CIRIA 753 (C753) 'The SuDs Manual'. C753 identifies Pollution Hazard levels based on land use. The pollution hazards for different land uses are shown in Table 26.2 of C753 which is reproduced below.

TABLE 26.2	Pollution hazard indices for different land use classifications				
	Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
	Residential roofs	Very low	0.2	0.2	0.05
	Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
	Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
	Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
	Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Figure 2: Pollution hazard Indices for different land use classifications

A Technical Note setting out the proposed pollution mitigation measures is set out in **Appendix R.**

The Simple Index approach to water quality risk management, as set out in CIRIA SuDs Manual 2015, has been used. Based on proposed land uses, pollution hazard indices have been assigned for Total Suspended Solids, Metals and Hyrdo-carbons, (Table 26.2 CIRIA 753, The SuDs Manual).

8.9.3 Based on, Table 26.2 of C753, the pollution hazard rating applicable on this development would be categorised as *low* to *medium* risk. Table 26.2 and the extent of polluting, Table 26.3 identifies how Total Suspended Solids, Metals and Hydro-carbons can be mitigated by the use of different SuDS components. Table 26.3 is reproduced below;

TABLE 26.3	Indicative SuDS mitigation indices for discharges to surface waters			
		Mitigation indices[1]		
	Type of SuDS component	TSS	Metals	Hydrocarbons
	Filter strip	0.4	0.4	0.5
	Filter drain	0.4[2]	0.4	0.4
	Swale	0.5	0.6	0.6
	Bioretention system	0.8	0.8	0.8
	Permeable pavement	0.7	0.6	0.7
	Detention basin	0.5	0.5	0.6
	Pond[4]	0.7[3]	0.7	0.5
	Wetland	0.8[3]	0.8	0.8
	Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Figure 3: Indicative SuDS Mitigation Indices for discharges to surface waters

8.9.4 The *medium* pollution hazard level is associated with run off from the primary roads and car parking areas. This can be fully mitigated by a combination of methods including, trapped gullies proprietary systems and bio retention areas which discharge to the lake, swales or pond. In all other cases the pollution hazard level is likely to be categorised as *low.*

8.9.5 Runoff will be treated by the three main attenuation features, the Western Lake, Canal and the South Eastern pond. This is helped by the permanent water which will be a minimum of 0.6m in depth. These features along with the Canal (which will accommodate permanent water), will

form a wetland environment through which the majority of development flows will pass, and which provide a very effective treatment train.

8.9.6 As noted in section 8.8, a portion of plots will utilise on-plot attenuation and will therefore not pass flows via the strategic drainage infrastructure. Treatment of runoff from these plots require the use of SuDS components and treatment trains, outlined in section 8.9 and which utilise source control measures.

Where existing discharges are to discharge directly to sewers (e.g. Clerk Maxwell Road), proprietary treatment systems will be installed at strategic locations to ensure flows are treated.

Individual plots will need to demonstrate through their respective Reserved Matters Applications how treatment measures required by C753 'The SuDS Manual' can be delivered. Details of proposed maintenance plans will also be necessary.

A plan showing the proposed treatment and conveyance trains of the proposed SuDs systems is included in **Appendix S.** Mitigation indices for each element are also shown, and are based upon Table 26.3 'Indicative SuDs Mitigation Indices for discharges to Surface Waters'.

As is evident, the proposed range of SuDs measures, will ensure the total mitigation indices is greater than the pollution indices. This demonstrates that the risk of increased pollution risk from development can be adequately mitigated using a flexible range of SuDs techniques. Water quality can be maintained, and assist in the promotion of bio diversity in existing and proposed landscaped areas.

8.10 Exceedance Events and Overflow Flood Routing

8.10.1 An exceedance event is a flood event which exceeds the design capacity of the surface water system. The piped system has been designed to Sewers for Adoption standards – refer to **Section 6**. However, the requirements of the NPPF means whilst flooding is allowed to occur during a 1:100 year return period storm event, it must be controlled and managed in such a way in that it does not compromise buildings or people.

8.10.2 Micro-drainage calculations indicate that during the FSR, 15 minute, 100year plus 40% climate change event (the worse-case 100-year duration storm), flooding above $5m^3$ occurs at some manhole locations. However, the flood water arising from this event is either stored within the carriageway, routed to landscaped areas or routed to strategic attenuation infrastructure. Refer to plan 31500/2001/157 within **Appendix P**.

8.10.3 For storm events greater than the 100year plus 40% climate change event, exceedance overland flow paths will be created where feasible. It should be noted that due to constructed roads and corridors the opportunities to raise or reduce levels to manipulate flood water will be limited. Opportunity exists within individual plot boundaries to direct flows away from the buildings and towards the roads, public realm and strategic surface water storage areas. As detailed applications for individual plot developments come forward finished floor levels of all new buildings will need to be carefully developed to ensure adequate overland flow routes are provided.

8.10.4 Plan 31500/2001/157 within **Appendix P** identifies where flood water from existing corridors will flow. This identifies that around two thirds of the development to the south will ultimately flow to the strategic communal infrastructure. The remainder will flow towards Madingley Road, where it will sit within the carriageway or adjacent highway ditches.

8.11 Adoption, Maintenance and Management

8.11.1 It is anticipated that the University's Estates department will undertake regular maintenance of the strategic drainage infrastructure in accordance with the published *Cambridge County, Cambridge Design and Adoption Guide*. Required maintenance including frequency for the different SuDS components is shown in Table 5 and 6.

8.11.2 A maintenance schedule will, for each individual plot, need to be produced to support the Reserved Matters applications as they come forward.

Western Lake and Payne's Pond	
Regular Maintenance	**Frequency**
Litter removal. Inspect control structures to/from structure clear detritus. Grass cutting on slopes around pond above temporary water level – amenity grass.	Monthly
Occasional Tasks	**Frequency**
Scrub clearance from bankside. Cut 25% to 30% wetland vegetation and remove to site wildlife piles.	Once a year
Remedial Work	**Frequency**
Remove planting and silt from 25% to 30% of base and place in site piles.	Once per 5 years

Table 5 Proposed maintenance requirements for ponds

Swales, Filter Strips and Bio Retention Areas	
Regular Maintenance	**Frequency**
Litter removal. Inspect inlet structures to swale/bio retention zones. Grass cutting in swale – amenity grass.	Monthly
Occasional Tasks	**Frequency**
Rod filter pipes/clear silt. Inspect chambers	Once a year
Remedial Work	**Frequency**
Excavate/replace filter material, cut back vegetation	As required

Table 6 Proposed maintenance requirements for swales, filter strips and rain gardens/bio-retention zones

8.12 Residual Risks

8.12.1 The greatest residual flood risk relates to the potential lack of maintenance to proposed and existing infrastructure.

The CCTV survey has identified some sections of pipework where sedimentation has occurred. This can potentially reduce the capacity of the pipes and increase flood risk. This can be mitigated by pressure jetting of retained pipework.

Due to the low discharge rates and where proposed flow controls include orifices, regular inspections and maintenance will be required in accordance with the manufacturer's recommendations to ensure they continue to operate effectively. Similarly, proprietary treatment systems, such as By Pass Oil Interceptors, should be inspected frequently (typically once a year).

Regular cleaning of trash screens associated with the culverts draining to Washpit Brook and Coton Brook is essential, if this infrastructure is to continue to operate effectively.

9 Proposed Foul Water Drainage

9.1 Proposed Foul On-Site Mitigation Measures

9.1.1 Based upon estimated occupancy rates and building use, the Dry Weather Flow (DWF) is 43l/s. Anglian Water were consulted on development proposals and discharge rates.

9.1.2 To take account of the potential variances in flows a peak factor of 3 was applied. This provided a theoretical peak foul flow rate of 129 l/s.

Anglian Water undertook hydraulic modelling using these agreed rates and concluded:

- A DWF of 3 l/s including a potential peak flow of 9l/s can be discharged to the public foul sewer in Madingley Road.
- A DWF of 40 l/s including a peak flow of 120l/s can be discharged to the 600mm diameter public sewer in Wilberforce Road.

A copy of the 'Addendum to the Pre Planning Assessment Report – 24 December 2015', is included in **Appendix U.**

9.1.3 The proposed foul drainage seeks to use as much of the existing infrastructure as possible. However, diversions, upsizing of pipes and new foul sewers will be required. The proposed network arrangements are shown on the drainage strategy plans (**Appendix P**).

9.1.4 All development flows can be drained by gravity without the need to pump, however plot developments which incorporate basements, may require pumping.

9.1.5 Although the on-site sewers will not be offered for adoption, they have been designed in accordance with Sewers for Adoption. The restricted discharge rates for each plot are shown on the drainage strategy plans. Each plot will be provided with connection spurs.

9.1.6 The foul water drainage infrastructure will be constructed in three phases, with the majority provided in Phase 1 and 2. Refer to the illustrative phasing plans contained in Appendix O

9.1.7 Post development foul water flows will discharge into the public foul sewers, subject to formal agreement with Anglian Water Developer Services.

Proposed Foul Off-Site Measures

9.1.8 Anglian Water has advised that the existing 225 mm diameter sewer in Wilberforce Road, which receives current development flows, has limited capacity. The consented connection point for post development flows is the 600mm sewer located further north along Wilberforce Road. This connection point is shown on the drainage strategy plan.

In order to minimise disruption to the existing facilities, it is proposed a new 300mm diameter sewer is constructed. This will run parallel to the existing private 300mm diameter sewer located along Coton footpath, and will connect directly to the consented connection point which Anglian Water has confirmed has capacity. The land, through which the current private sewer passes, is owned by St John's. Construction of the new corridor will require a Deed of Easement. However, Anglian Water has advised that the construction of a new sewer through this land could be undertaken through a Section 98 (Water Industry Act) Sewer Requisition agreement.

Proposed discharges to the foul sewer in Madingley Road would be subject to a Section 106 (Water Industry Act) application.

Providing the off site server would ensure there is sufficient capacity to accommodate post development waste water flows.

10 Conclusions

10.1.1 Peter Brett Associates LLP (PBA) has been appointed by the University of Cambridge to prepare a Flood Risk Assessment (FRA) to support an outline planning application for additional mixed use development at the West Cambridge site, located South of Madingley Road, Cambridge.

10.1.2 Environment Agency flood maps identify the site is located within Flood Zone 1 and therefore has less than a 1 in 1,000 annual probability of fluvial flooding from rivers or sea flooding. It is not therefore vulnerable to fluvial flood risk. Other sources present a low flood risk and can be readily managed.

10.1.3 Additional development will deliver a total impermeable area of 44.68ha. This is an additional 10.30ha to the 1999 Consented Masterplan. This has potential to increase the rate and volume at Surface water with a corresponding increase in flood risk to the development and downstream catchments if not mitigated.

Foul Water Drainage

10.1.4 The existing foul water sewers are constrained in capacity at the location of the existing outfall. Agreement has been reached with AW that identifies a supplementary point of connection that will not cause off-site impacts to capacity. A new outfall will need to be constructed under either a deed of easement or requisition. No off-site treatment reinforcement is required.

Surface Water Drainage

10.1.5 The existing site consists of two catchments split by one watershed. The Northern catchment drains to Washpit Brook watercourse. The Southern drains to the Bin Brook watercourse. Both of these watercourses are sensitive to increased flows.

If runoff is uncontrolled, the scale of proposed development could result in increased flood risk. Pollution measures, outlined in previous sections will be required to mitigate the risk of pollution associated with receiving watercourses, and ensure water quality is maintained.

10.1.6 Opportunities to create new open SuD's features and modify existing for drainage purposes are limited by topography, geology, and spatial constraints associated with existing buildings, utilities and highway infrastructure.

The Site does benefit from previously constructed infrastructure delivered as part of the consented 1999 masterplan.

The proposals aim to utilise this infrastructure as much as possible to minimise disruption, carbon dioxide emissions waste and impact an established eco system. This includes enhancement to existing strategic infrastructure such as Western Lake and Canal.

10.1.7 Surface water discharge from all strategic attenuation storage will be limited to the 1 in 1 year greenfield run off rate for all storm events up to and including the 1 in 100-year storm plus a 40% allowance for climate change. Treatment of surface water for the site is in full accordance with 'The SuDS Manual' (C753). This includes the use of swales, bio retention areas, ponds, lake, wetland and other landscaped areas with selected planting to deliver treatment trains. This will be supplemented by the strategic use of proprietary systems.

10.1.8 Maintenance of strategic surface water infrastructure will be undertaken by the University of Cambridge and will comply with the maintenance frequencies set out within the Cambridgeshire SuDS Guide.

10.1.9 Due to level and storage volume constraints, it is proposed approximately a third of plots (located to the centre and eastern side of the site) will need to provide their own on plot attenuation storage through a variety of SuDS features. This will promote the innovate use of SuD's to be implemented as each plot is brought forward to a Reserve Matters Applications.

10.1.10 The removal of existing underground storage, as part of the first phases of the development, can be mitigated by ensuring the modifications to the lake, canal and pond are undertaken in advance of plot construction. In this way, the required volumes of storage can be maintained during the construction phases, mitigating flood risk.

10.1.11 Although there are significant technical and environmental constraints facing development, implementation of the drainage strategy set out in this report will mitigate flood risk sustainably, and provide significant betterment to downstream catchments by reducing the overall discharges from the sites.

10.1.12 The integration of green infrastructure with proposed infrastructure modifications, including the retro-fitting of bio-retention zones, will assist with mitigating flood risk and promoting bio diversity.

10.1.13 This drainage strategy sets out the framework for managing flood risk as individual plots come forward for development. It identifies the constrains and opportunities that exist and delivers an integrated and sustainable approach to mitigating post development flood risk.

10.1.14 The FRA therefore considers the Site appropriate for development in accordance with NPPF.

11 References

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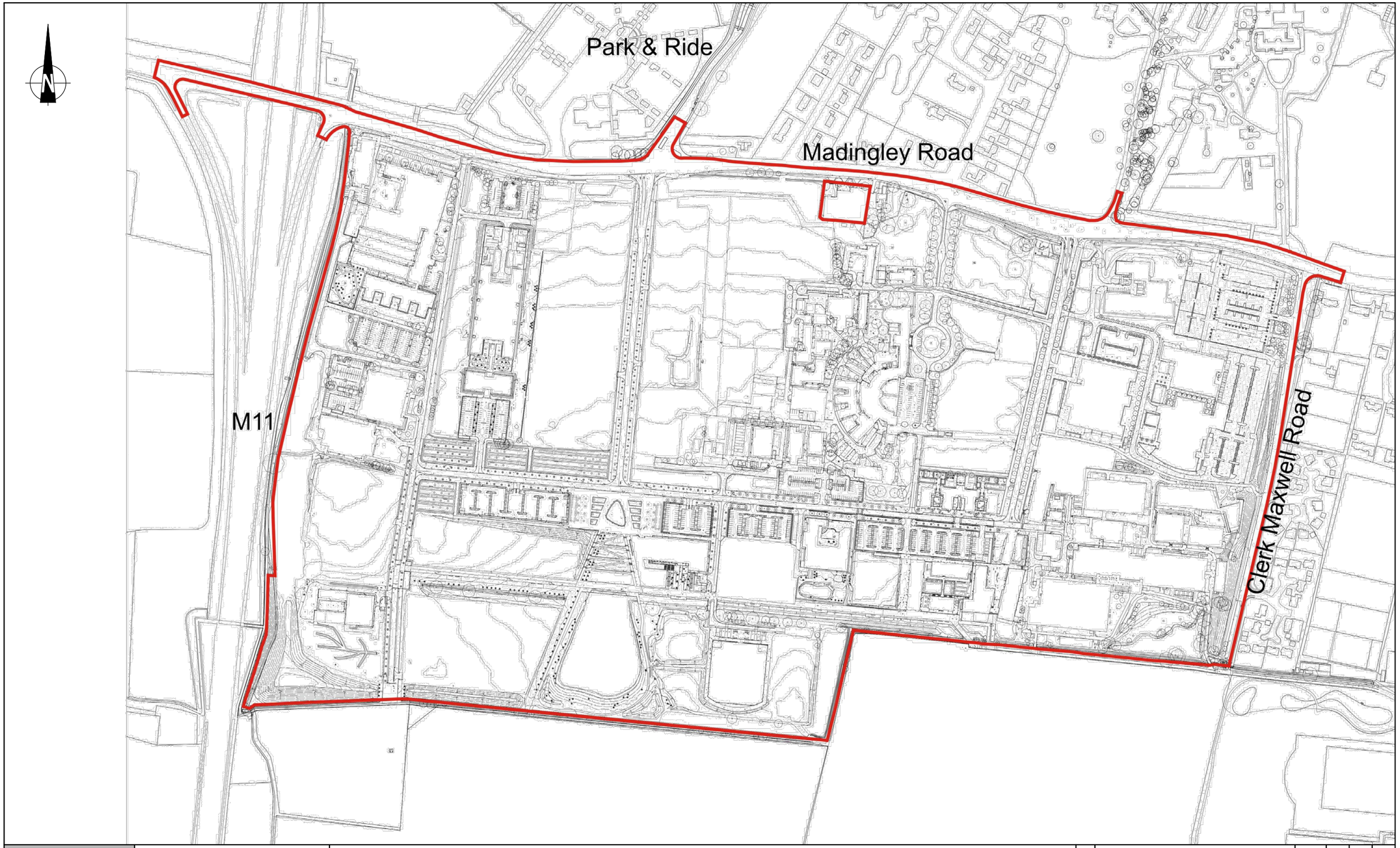
Appendix A West Cambridge Location (Application Site Boundary) Plan



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Client
UNIVERSITY OF CAMBRIDGE

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.
UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

WEST CAMBRIDGE

APPLICATION SITE BOUNDARY

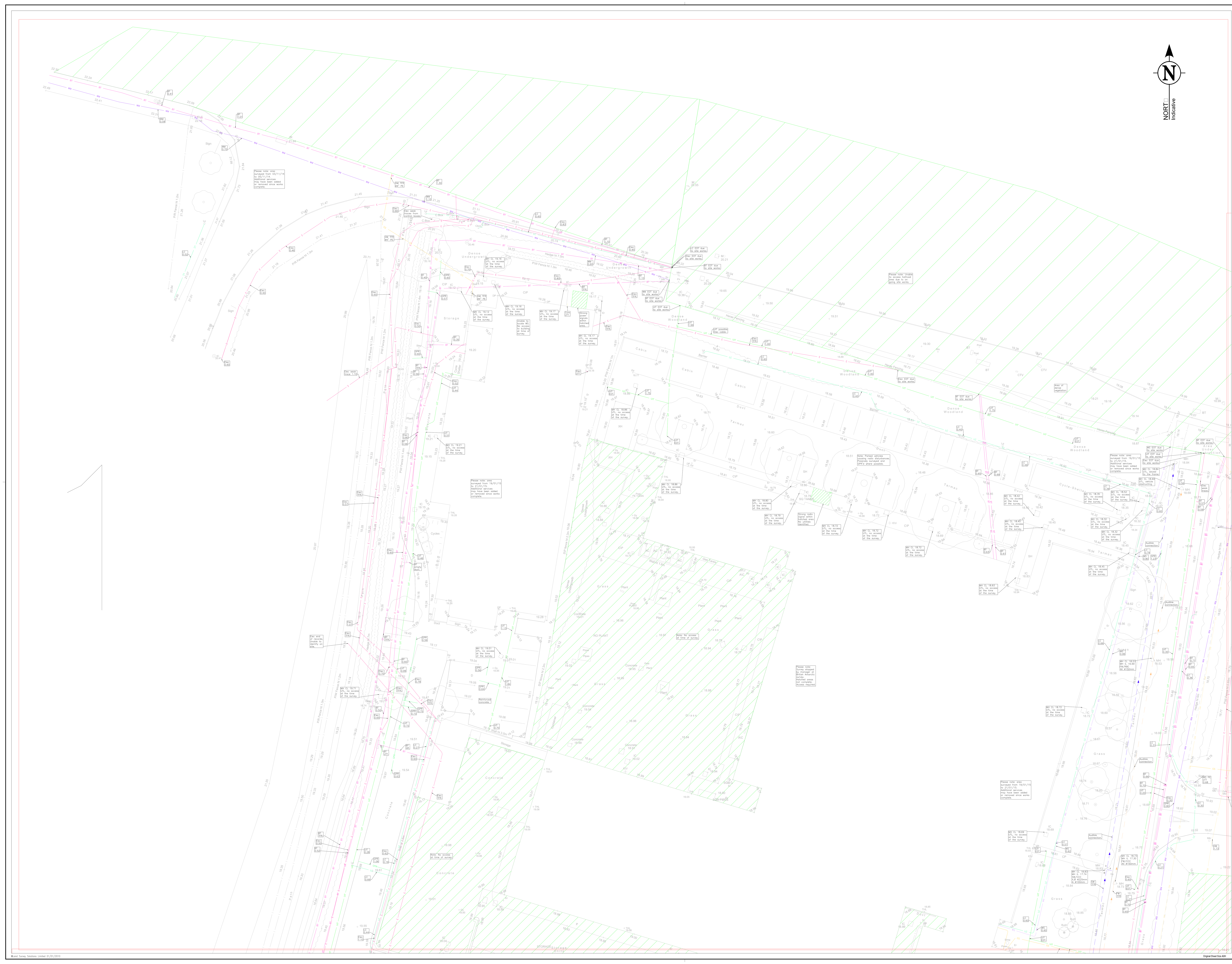
Mark	Revision	Date	Drawn	Chkd	Appd

Drawing Status: PRELIMINARY

Date of 1st Issue	14.06.2017			Drawing Number	Revision
A3 Scale	NTS			31500/2001/200	-
Design	-	Drawn	GC		
Chkd	ST	Appd	ST		

File Location: j:\31500 west cambridge masterplan\drawings\31500_2001_200 application site boundary.dwg

Appendix B Topographic Survey and Utilities Plan



UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
CBC	Circular Brick Chamber	DTB	Depth To Base	SL	Silt Level
CCC	Circular Conc Chamber	DTW	Depth To Water	SuL	Surcharge Level
CL	Cover Level	DTS	Depth To Silt	UTC	Unable To CCTV
				UTL	Unable To Lift
				UTT	Unable To Trace
				TFR	Taken From Records
				EBD	External Backdrop

BT — BT CABLE(S)
O/BT — OVERHEAD BT CABLE(S)
COM — COMMUNICATIONS CABLE(S)
CTV — CABLE TV CABLE(S)
E — ELECTRIC CABLE(S)
O/E — OVERHEAD ELECTRIC CABLE(S)
FO — FIBREOPTIC CABLE(S)
GM — GAS MAIN
GS — GAS SERVICE
GPR — GROUND PENETRATING RADAR (GPR) TRACE
HW — HOT WATER PIPE
LC — LIGHTING CIRCUIT
SEC — SECURITY CABLING
UIT — UNIDENTIFIED TRACE
WM — WATER MAIN
WS — WATER SERVICE
COMBINED SEWER
FOUL SEWER
RISING MAIN
SURFACE WATER SEWER
UTILITIES INVESTIGATION EXTENTS

MH CL 4□.□3 — UTILITIES COMMENT BOX
WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

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AVAILABILITY OF UTILITY RECORD DRAWINGS

UTILITY	AVAILABILITY	UTILITY	AVAILABILITY	UTILITY	AVAILABILITY
SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

REV	DESCRIPTION	DRAWN	APPR	DATE

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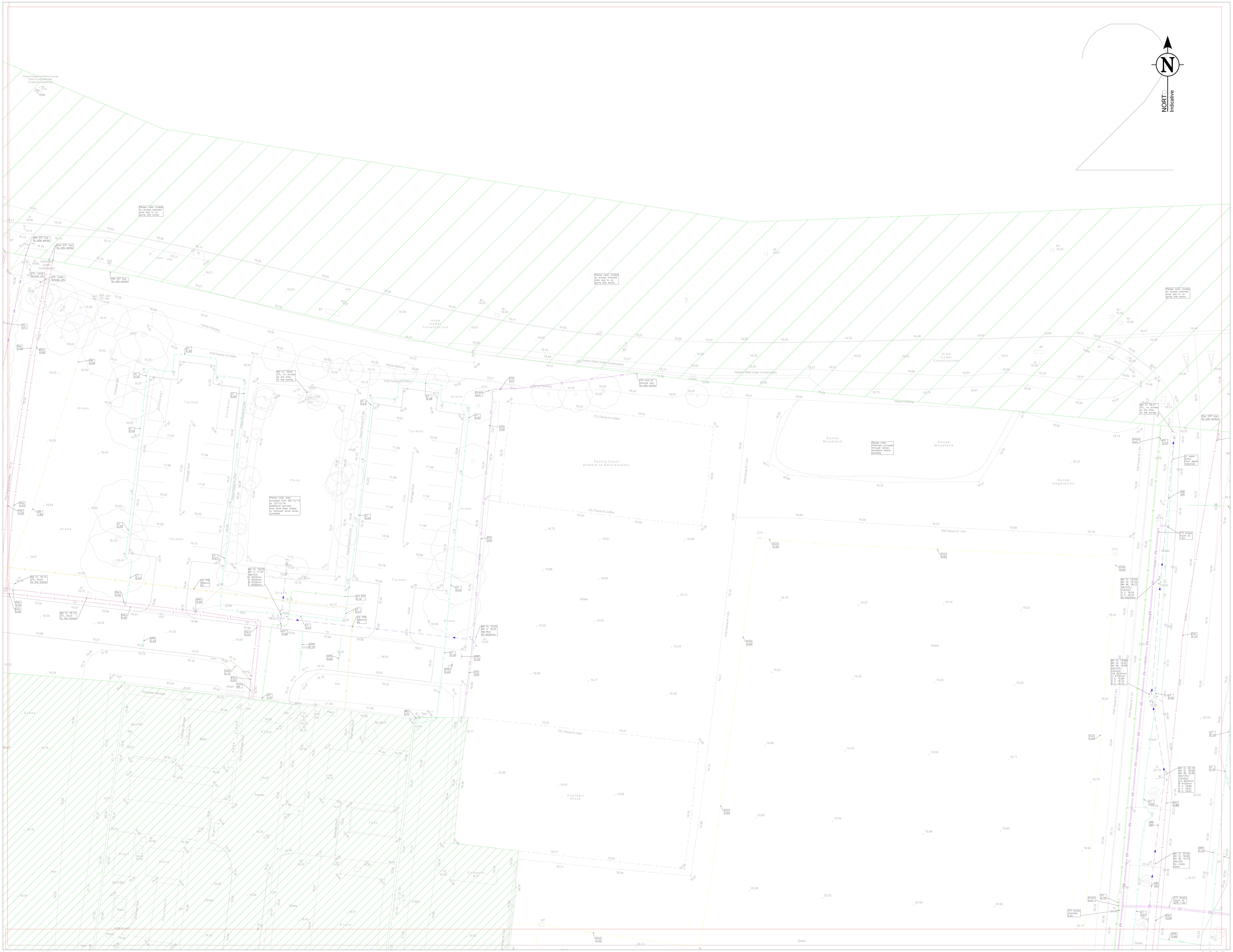
PROJECT TITLE: WEST CAMBRIDGE DENSIFICATION SCHEME, MADINGLEY ROAD, CB3 0EL				
DRAWING DETAIL: UTILITIES AND DRAINAGE INVESTIGATION SHEET 1 OF 2□				
CLIENT: PETER BRETT ASSOCIATES				SCALE: 1:200
SURVEYOR: DWR/PI	SURVEY DATE: 03/11/2014	CHECKED BY: □TM	APPROVED BY: RAG	DWG STATUS: FINAL
DRAWING NUMBER: 15415UG-01			REVISION:	ISSUE DATE: APR 2015

Original Sheet Size A0H



UTILITIES & UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

1D 5C	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
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CL	Cover Level	DTS	Depth To Silt	UTC	Unable To CCTV
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WM — WATER MAIN
WS — WATER SERVICE
COMBINED SEWER
FOUL SEWER
RISING MAIN
SURFACE WATER SEWER
UTILITIES INVESTIGATION EXTENTS

MH CL 4□.□3 — UTILITIES COMMENT BOX
WM 0.61 — DEPTH TO SERVICE

DRAWING NOTES

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SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OTHERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

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PROJECT TITLE: WEST CAMBRIDGE DENSIFICATION SCHEME MADINGLEY ROAD, CB3 0EL				
DRAWING DETAIL: UTILITIES AND DRAINAGE INVESTIGATION SHEET 2 OF 2				
CLIENT: PETER BRETT ASSOCIATES				SCALE: 1:200
SURVEYOR: DWR/PI	SURVEY DATE: 03/11/2014	CHECKED BY: □TM	APPROVED BY: RAG	DWG STATUS: FINAL
DRAWING NUMBER: 15415UG-02		REVISION:		ISSUE DATE: APR 2015

Original Sheet Size A0H

UTILITIES □ UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

10 SC	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
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CCC	Circular Conc Chamber	DTW	Depth To Water	SuL	Surcharge Level
CL	Crown Level	DTS	Depth To Silt	UTC	Unable To CCTV
BT	BT CABLE S			UTL	Unable To Lift
	COMMUNICATIONS CABLE S			UTT	Unable To Trace
	COMMUNICATIONS CABLE S			TFR	Taken From Records
CTV	CABLE TV CABLE S			EBD	External Backdrop
E	ELECTRIC CABLE S				
EAS	OVER: EAD ELECTRIC CABLE S				
FO	FIBRE OPTIC CABLE S				
G	GAS MAIN				
GS	GAS SERVICE				
GPR	GROUND PENETRATING RADAR: GPR: TRACE				
HP	: OT WATER PIPE				
LP	LIGHTING CABLE				
SC	SECURITY CABLING				
UT	UNIDENTIFIED TRACE				
W	WATER MAIN				
WS	WATER SERVICE				
WT	WATER TANK/TOWER				
FM	FOUL SEWER				
R	RISING MAIN				
SW	SURFACE WATER SEWER				
	UTILITIES INVESTIGATION E: TENTS				

BT CL:4 : 3 — UTILITIES COMMENT BO :

GAS 0.6 S — DEPT : TO SERVICE

DRAWING NOTES

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SEWER	SITE	BT	PUBLIC	OIL PIPES	SITE
WATER MAIN	SITE	CABLE TV	SITE	OT: ERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

NORT□ Indicative

REV.	DESCRIPTION	DRAWN	APPR.	DATE

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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PRO: ECT TITLE
WEST CAMBRIDGE DENSIFICATION SC□ EME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
S□ EET 3 OF 2□

CLIENT		SCALE
PETER BRETT ASSOCIATES		1:200

SURVEYOR	SURVEY DATE	C□ EC□ ED BY	APPROVED BY	DWG STATUS
DWR/PI	03/11/2014	□TM	RAG	FINAL

DRAWING NUMBER	REVISION	ISSUE DATE
15415UG-03		APR 2015

Original Sheet Size A3H

UTILITIES □ UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

10 SC	1 Duct 5 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CrL	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
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CCC	Circular Conc Chamber	DTW	Depth To Water	SuL	Surcharge Level
CL	Cover Level	DTS	Depth To Silt	UTC	Unable To CCTV
BT	BT CABLE S :			UTL	Unable To Lift
CW	COMMUNICATIONS CABLE S :			UTT	Unable To Trace
CTV	CABLE TV CABLE S :			TFR	Taken From Records
E	ELECTRIC CABLE S :			EBD	External Backdrop
EO	OVER 1EAD ELECTRIC CABLE S :				
ST	STREET LIGHT CABLE S :				
GM	GAS MAIN				
GS	GAS SERVICE				
GPR	GROUND PENETRATING RADAR :GPR: TRACE				
W	: OT WATER PIPE :				
UT	UNDERGROUND UTILITY				
SC	SECURITY CABLING				
UT	UNIDENTIFIED TRACE				
WM	WATER MAIN				
WS	WATER SERVICE				
FM	FOUL SEWER RISING MAIN				
FS	FOUL SEWER				
R	RISING MAIN				
SW	SURFACE WATER SEWER				
UI	UTILITIES INVESTIGATION E: TENTS				

BT: CL:4 : 3 — UTILITIES COMMENT BO :

GM:0.65 — DEPT : TO SERVICE

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WATER MAIN	SITE	CABLE TV	SITE	OT: ERS	NO
GAS MAIN	PUBLIC	ELECTRICITY	SITE		

NORTH □ Indicative

REV	DESCRIPTION	DRAWN	APPR	DATE

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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PRO: ECT TITLE
WEST CAMBRIDGE DENSIFICATION SC:: EME
MADINGLEY ROAD, CB3 0EL

DRAWING DETAIL
UTILITIES AND DRAINAGE INVESTIGATION
S:: EET 4 OF 2 ::

CLIENT		SCALE
PETER BRETT ASSOCIATES		1:200
SURVEYOR	SURVEY DATE / C: EC: ED BY	APPROVED BY / DWG STATUS
DWR/PI	03/11/2014 / .TM	RAG / FINAL
DRAWING NUMBER		REVISION / ISSUE DATE
15415UG-04		APR 2015

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UTILITIES □ UNDERGROUND INVESTIGATIONS

ABBREVIATIONS & SYMBOLS

10 SC	1 Duct 0 Cables	CPC	Circ Plastic Chamber	EOT	End Of Trace
Ø	Diameter	CS	Crown Level	IBD	Internal Backdrop
AR	Assumed Route	DCr	Depth To Crown	IL	Invert Level
BL	Base Level	DI	Depth To Invert	RBC	Rectangular Brick Chamber
CB	Concrete Benching	DS	Depth To Surcharge	RCC	Rectangular Conc Chamber
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BT	BT CABLE S :			UTL	Unable To Lift
? BT	UNKNOWN BT CABLE S :			UTT	Unable To Trace
CTV	COMMUNICATIONS CABLE S :			TFR	Taken From Records
CTV	CABLE TV CABLE S :			ESO	External Backdrop
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?	: UNKNOWN USE				
ST	SECURITY CABLING				
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WS	WATER SERVICE				
SW	SURFACE WATER SEWER				
FW	FOUL SEWER				
R	RISING MAIN				
? SW	SURFACE WATER SEWER				
?	UTILITIES INVESTIGATION E: TENTS				

BT CL:4 : 3 — UTILITIES COMMENT BO :

Cmd:0.65 — DEPT : TO SERVICE

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NORTH □ Indicative

REV	DESCRIPTION	DRAWN	APPR	DATE

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LAND SURVEYING BUILDING SURVEYING UNDERGROUND SURVEYING

PROJECT TITLE: WEST CAMBRIDGE DENSIFICATION SC □ EME MADINGLEY ROAD, CB3 0EL			
DRAWING DETAIL: UTILITIES AND DRAINAGE INVESTIGATION S □ EET 5 OF 2 □			SCALE: 1:200
CLIENT: PETER BRETT ASSOCIATES			
SURVEYOR: DWR/PI	SURVEY DATE: 03/11/2014	C □ EC: ED BY: □TM	APPROVED BY: RAG
DRAWING NUMBER: 15415UG-05		REVISION:	ISSUE DATE: APR 2015

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