JNP GROUP
CONSULTING ENGINEERS

Flood Risk Assessment and Drainage Strategy

Project: Wixam Woods, Bedford

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EXECUTIVE SUMMARY

jnp**group** was commissioned by Wates Developments Ltd to undertake a Preliminary Flood Risk Assessment and Drainage Strategy for a proposed development located at Wixam Woods, Bedford.

The proposed development is intended to comprise of between 400-450 No. residential dwellings with access provided from the A6 which runs along the eastern boundary of the site.

The redline boundary of the site measures approximately 24.84ha and is made up of six fields currently used for agriculture and part of another field to the south with development on 4 or 5 of these fields. The developed area equates to approximately half of the redline boundary which is approximately 12.5ha. The site is bounded to the east by the A6, agricultural fields to the south and another residential development to the north. A dirt road runs parallel to the A6 providing access each field.

The site is located on a hill which peaks within the southernmost field. Levels fall to the north-west and south-east towards the two watercourses. South of the southern watercourse, levels fall north, towards the watercourse.

An ordinary watercourse runs along the north-western boundary of the site flowing north-east where it joins a ditch which serves residential properties on Bedford Road. It then flows under the A6 via a 600mm diameter culvert. Another watercourse flows parallel to this watercourse before turning west and discharging into a holding pond.

A watercourse passes through the southern part of the site flowing in a north-easterly direction. It passes under the dirt road via 2x900mm diameter culverts and emerges briefly before passing under the A6 via a 1800mm diameter culvert. A 300mm dia. inlet discharges run-off from a highway ditch, into the watercourse prior to it flowing into the 1800mm dia. culvert.

An interception ditch runs along the southern-western boundary of the site. This ditch intercepts overland flows from the southern fields outside of the site boundary and directs them into the northern and southern watercourses.

The Environment Agencies 'Flood Risk from Rivers and Sea' maps show that a small area adjacent to the northern boundary watercourse is identified as Flood Zone 2. The plans indicate that this watercourse was modelled in detail due to the neighbouring development to the north. The maps do not identify any flooding along the southern watercourse which indicates that no flood modelling has been produced for this stretch of watercourse.

Preliminary hydraulic modelling has been undertaken as summarised in this report, concluding that the risk to the development from flooding of the southern watercourse is low and only a small area adjacent to the downstream boundary along the A6 shown to be within the modelled Flood Zone 2. No development is proposed in this area.

The Environment Agency and Bedford Borough Council's SFRA plans indicate surface water flooding along in high and medium risk events within the vicinity of the watercourses and low risk events showing a larger flood extent spanning into the site.

The hydraulic modelling demonstrates that this surface water flood risk does not result from the watercourses. Furthermore, a preliminary drainage system is proposed manage all surface water generated within the proposed development, thus managing the risk of surface water flooding and ponding from within the site.

The Bedford Borough Council's SFRA indicates that the site is identified as an area with a low susceptibility of Groundwater Flooding (less than 25%).

The SuDS hierarchy states that the developments surface water run-off should first be considered for discharge via infiltration, if this is not feasible it should be discharged to a nearby watercourse or if there are no watercourses nearby, the public sewer.

Infiltration is not likely to be feasible as the site is underlain by a low permeability mudstone bedrock. This will be confirmed in due course by in-situ ground investigation and BRE 365 infiltration testing.

The proposed development surface water drainage will mimic the existing site drainage; run-off will be conveyed by a combination of a piped network and conveyance swales to the existing watercourses via detention basins sized to store surface water generated in the 1 in 100 year storm event plus a 40% allowance for climate change. Outflow into the watercourses will be restricted to the existing greenfield Qbar runoff rate.

The proposals integrate SuDS within the concept masterplan in line with best practice SuDS guidance to convey, store, and treat run-off prior to discharge from site, thereby preventing flooding or pollution to the receiving watercourses.

The closest public foul sewer is located 490m north of the development area, within Bedford Road. It is likely that a pump station will be needed to lift flows from the site up into a new sewer in the A6 which is higher than the site, from here a new sewer will run north to Bedford Road.

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1.1 Terms of Reference

1.1.1 JNP Group has been commissioned by Wates Development Ltd. to prepare a flood risk assessment for the proposed development in Wixam Woods, Bedford.

1.1.2 This report assesses flood risk at the development site from all potential sources and describes the measures adopted in the master planning process to manage such risks. It has been prepared in compliance with current policies and best practices.

1.2 Policy Framework and Key Stakeholders

1.2.1 The *National Planning Policy Framework* (NPPF) (February 2019) sets strict tests to protect people and property from flooding which all local planning authorities are expected to follow. Where these tests are not met, national policy is clear that new development should not be allowed.

1.2.2 In areas at risk of flooding or for sites of one hectare (ha) or more, developers must undertake a site-specific flood risk assessment to accompany applications for planning permission (or prior approval for certain types of permitted development).

1.2.3 In decision-taking, local planning authorities must ensure a sequential approach to site selection and master planning is followed so that development is, as far as reasonably possible, located where the risk of flooding (from all sources) is lowest, taking account of climate change and the vulnerability of future uses to flood risk.

1.2.4 Where development needs to be in locations where there is a risk of flooding, local planning authorities and developers must ensure development is appropriately flood resilient and resistant, safe for its users for the development's lifetime, and will not increase flood risk elsewhere.

1.2.5 The Environment Agency (EA) is a statutory consultee on applications where there is a risk of flooding from the sea or main rivers.

1.2.6 Lead local flood authorities (unitary authorities or county councils) are responsible for managing local flood risk from ordinary watercourses, surface water or groundwater, and for preparing local flood risk management strategies. Local planning authorities work with lead local flood authorities to ensure local planning policies are compatible with the local flood risk management strategy.

1.2.7 Bedford Borough Council (BBC) is the lead local flood authority (LLFA) and its strategy for managing local flood risk is set out in its Local Flood Risk Management Strategy (November 2015).

1.2.8 Bedford Borough Council is also the local planning authority (LPA) and its policies on flood risk management are set out in Bedford Borough Local Plan 2030 (January 2020).

1.2.9 Where relevant, local planning authorities and developers must also take advice from:

- Internal drainage boards (IDB); to identify the scope of their interests.
- Sewerage undertakers; to ensure they can assess the impact of new development on their assets and plan any required improvements. Anglian Water (AW) is the local sewerage undertaker.

- Reservoir undertakers; to avoid an intensification of development within areas at risk from reservoir failure and ensure they can assess the cost implications of any reservoir safety improvements required due to change in land use downstream of their assets.
- Navigation authorities: in relation to developments adjacent to, or which discharge into, canals (especially where these are impounded above natural ground level).

1.3 Sources of Information

1.3.1 This flood risk assessment has been based on the following sources of information:

- Bespoke topographic survey undertaken by CD Surveys Ltd. in January 2020;
- British Geological Survey's *GeoIndex*; *(http://mapapps2.bgs.ac.uk/geoindex/home.html)*
- Cranfield University's soils data; *()*
- DEFRA / EA's aquifer and source protection data *(https://magic.defra.gov.uk/MagicMap.aspx)*
- British Geological Survey's borehole scans; *(http://mapapps.bgs.ac.uk/geologyofbritain/home.html)*
- UK Centre for Ecology & Hydrology's catchment and rainfall data; *(https://fehweb.ceh.ac.uk/)*
- EA's Flood Map for Planning; *(https://flood-map-for-planning.service.gov.uk/)*
- EA's Long-Term Flood Risk Information; *(https://flood-warning-information.service.gov.uk/long-term-flood-risk/map)*
- BCC's Upper River Great Ouse Tri Lead Local Flood Authority Preliminary Flood Risk Assessment for Bedford Borough Council, Central Bedfordshire Council and Milton Keynes Council (PFRA) (June 2011);
- BCC's Level 1 Strategic Flood Risk Assessment (SFRA) (June 2015);
- *Preliminary Flood Risk Modelling* (ref. C86343-JNP-XX-XX-RP-C-1002) undertaken by JNP Group in July 2020;
- AW's Asset Location Plan.

2 DEVELOPMENT SITE

2.1 Location

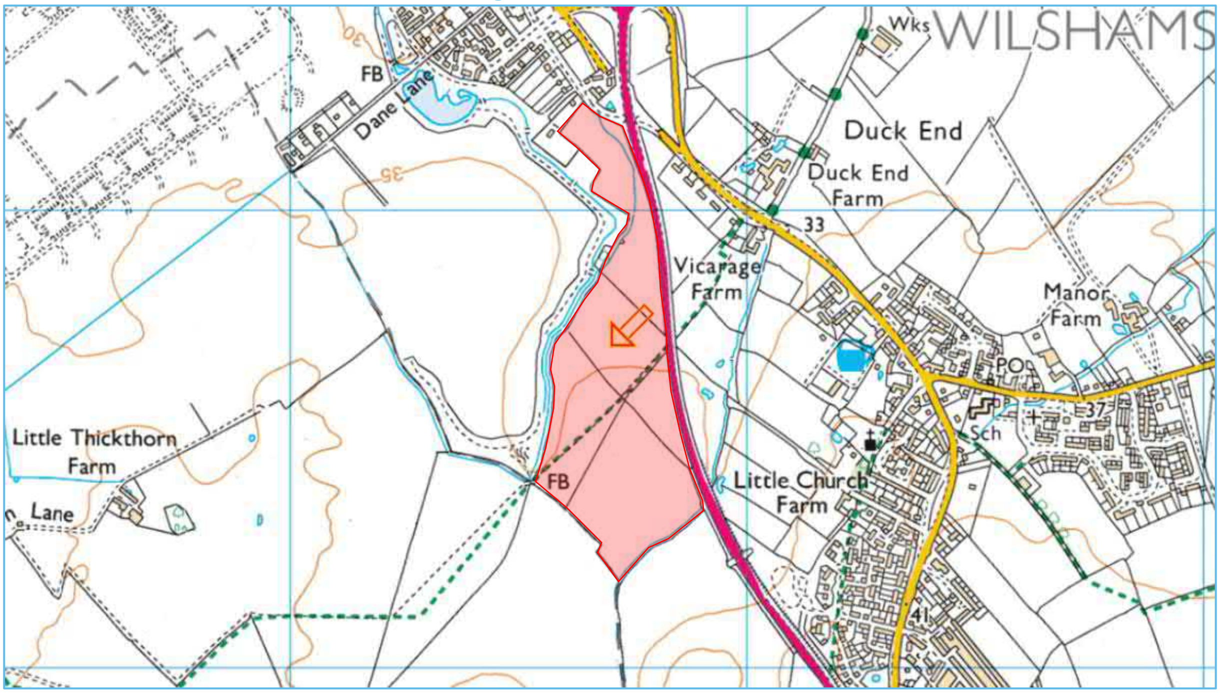
2.1.1 The development site is located south of Wixam and west of Wilstead, in Bedford, Bedfordshire (Table 2.1, Figure 2.1 and Appendix A).

2.1.2 The 24.84 hectare greenfield site is bounded by residential developments to the north, the A6 to the east and agricultural fields to the south and west. The developed area equates to approximately half of the redline boundary, equating to 12.5ha.

Table 2.1: Site Location

OS X	OS Y	National Grid Reference	Nearest Postcode
505700	243700	TL 05700 43700	MK42 6DZ

Figure 2.1: Site Location



2.2 Topography

2.2.1 The available topographic information (Appendix A) shows that ground levels within the flattish development site range between 36.5 m AOD (south-west) and 30.6 m AOD (north-east), falling towards the ordinary watercourses along the site's southern and northern boundaries with slopes of 1:150 to 1:130.towards.

2.3 Hydrology

2.3.1 The development site is bounded by ordinary watercourses along its southern and northern boundaries.

2.3.2 The southern watercourse flows west to east along the site's southern boundary, crossing an access track (2 x Ø900 mm culvert) just before leaving the site under the A6 (Ø1800 mm culvert). The southern watercourse is classified as an ordinary watercourse and defines a catchment area of 2.9 km^2 (Appendix A) at the point where it leaves the development site under the A6.

2.3.3 The northern watercourse flows south-west to north-east along the site's northern boundary, leaving the site through a (Ø600 mm) culvert under the A6. The northern watercourse is classified as an ordinary watercourse and defines a catchment area of 0.92 km^2 (Appendix A) at the point where it leaves the development site under the A6.

2.3.4 A large swale part of the adjacent residential development's sustainable drainage system runs parallel to the northern watercourse before veering north-west and discharging into a detention basin.

2.3.5 The development site also comprises several land drainage ditches connected to the southern and northern watercourses.

2.4 Geology and Hydrogeology

2.4.1 In accordance with BGS' *GeoIndex*, the development site lies on mudstone bedrock (Peterborough Member) underlying pockets of superficial deposits of clay, silt, sand and gravel (in the south part of the site). Cranfield University's *Soilscapes* describes the site's soils as "lime-rich loamy and clayey soils with impeded drainage".

2.4.2 DEFRA / EA's MAGIC mapping classifies the site's bedrock and superficial deposits as Unproductive Strata.

2.4.3 The EA defines Unproductive Strata as "layers of rock or drift deposits with low permeability that have a negligible significance for water supply or river base flow".

2.4.4 In accordance with DEFRA / EA's MAGIC mapping, the development site is not in a source protection zone.

2.4.5 BGS' *Geology of Britain Viewer* has no (publicly available) borehole records within 250 m of the development site.

2.4.6 Based on the available geologic and hydrogeologic information – namely the permeability of the mudstone bedrock – infiltration drainage is unlikely to be feasible at the development site. Nevertheless, this must be confirmed through a bespoke ground investigation including infiltration tests in accordance with BRE 365.

3 PROPOSED DEVELOPMENT

3.1.1 The proposed residential development (Figure 3.1 and Appendix B) comprises approximately 400-450 dwellings with associated infrastructure (i.e. access roads, parking areas and public open spaces).

3.1.2 As the proposed development is currently in an early concept stage, its impermeable area has been estimated based on typical values for developments of similar nature and dimension. This equates to 55% of the developed area, which measures 12.5ha. This includes approx. 8.45 ha of hard paved / impermeable surfaces (e.g. roofs, roads, driveways, parking areas, etc.) and 1.3 ha of soft paved / permeable surfaces (e.g. gardens, green corridors, public open spaces, etc.).

3.1.3 Under *Table 2* of the *Flood Risk and Coastal Change Guidance* (March 2014), the proposed residential development is classified as more vulnerable.

Figure 3.1: Proposed Development

4 FLOOD RISK ASSESSMENT

4.1 Overview

4.1.1 All potential sources of flood risk at the development site have been assessed based on the information listed in Section 1.3 and are summarised in Table 4.1. The key sources of flood risk to the proposed development are further described in the ensuing sections.

Table 4.1: Potential Sources of Flood Risk

Source	Flood Risk
Fluvial	Very low to low risk of fluvial flooding from the southern watercourse.
Surface Water	Very low risk of surface water flooding in general, but low to high risk expected along the southern and northern watercourses.
Groundwater	Unconfirmed risk, but underlying geology (i.e. low-permeability mudstone bedrock) suggests low risk of groundwater flooding (subject to confirmation via bespoke ground investigation).

4.2 Climate Change

4.2.1 The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account.

4.2.2 In accordance with the EA's guidance *Flood Risk Assessment: Climate Change Allowances* (February 2016), the proposed development with anticipated life span into the 2080's (2070 to 2115) must take account of the following allowances:

- Peak River Flows (Anglian river basin district)
  - Central 65%
  - Higher Central 35%
  - Upper End 25%
- Peak Rainfall Intensity
  - Central 40%
  - Upper End 20%

4.3 Fluvial Flood Risk

4.3.1 Fluvial flooding occurs when a catchment area receives greater than usual amounts of water (e.g. rainfall or snow melt). When the converging runoff exceeds the conveyance capacity of the receiving channel, water spills onto the surrounding floodplains and fluvial flooding occurs.

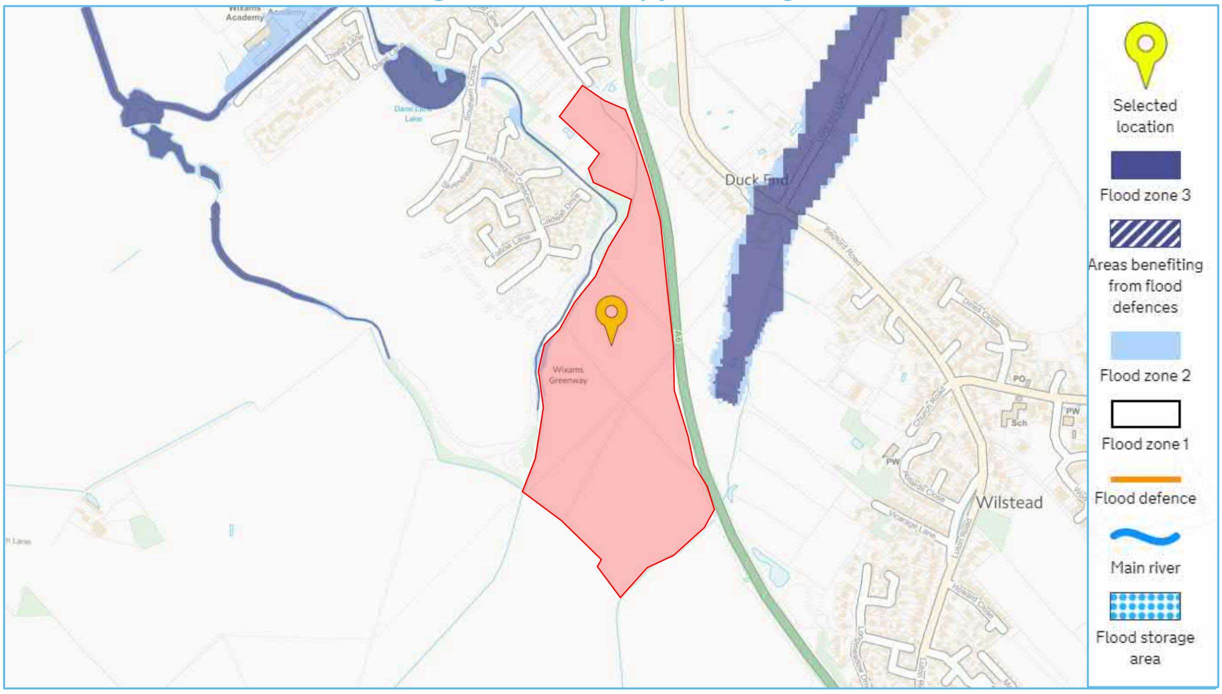
4.3.2 Fluvial flooding usually occurs hours or days after heavy and / or prolonged rainfall and its effects often last several hours or days.

4.3.3 Besides posing a direct flood risk to floodplain areas, high water levels in watercourses can exacerbate other sources of flood risk by surcharging / locking outfalls, thus preventing the normal discharge of flows or even back flowing into tributary drainage systems.

4.3.4 In accordance with the EA's *Flood Map for Planning* (Figure 4.1 and Appendix C), the site is almost entirely in Flood Zone 1 (< 0.1% AEP), with the exception of a very small area of Flood Zone 2 (0.1% to 1.0% AEP) adjacent to the northern watercourse.

4.3.5 The development site does not benefit from any formal flood defences.

Figure 4.1: Flood *Map for Planning*



4.3.6 BCC's PFRA and SFRA (Appendix C) largely confirm the flood extents in the EA's *Flood Map for Planning*. However, the SFRA's modelled flood zones for the southern watercourse appear to extent into the development site, suggesting even Flood Zone 2 (i.e. 0.1% AEP) stays in-bank.

4.3.7 There are no records of historic flooding at the site, with the nearest recorded incidents (by the local IDB) located in the surrounding villages of Wixams, Duck End and Wilstead.

4.3.8 As the available large scale fluvial flood risk information does not cover the ordinary watercourses along the site's southern and northern boundaries, preliminary site-specific hydraulic modelling was undertaken by JNP Group in July 2020 (ref. C86343-JNP-XX-XX-RP-C-1002) to better assess fluvial flood risk at the development site. This has been included in Append C.

4.3.9 The preliminary hydraulic modelling predicts that fluvial flows stay largely in-bank along both the southern and northern watercourses for the baseline / best estimate scenario and for all storm events considered (i.e. 3.3%, 1.0%, 1.0% +35%, 1.0%+65% and 0.1% AEP), with negligible impact on the developable area.

4.3.10 Even when estimated flows are conservatively increased by 50%, results show that fluvial flows stay largely in-bank along both watercourses for storm events up to 1.0% AEP + 35%, with more significant flooding of the site's low-lying area adjacent to the A6 (southern watercourse) only predicted for the most extreme storm events (1.0% AEP + 65% and 0.1% AEP) (Appendix C).

4.3.11 The flood risk management measures proposed to deal with the low fluvial flood risk estimated for the development site are described in Section 5.2.

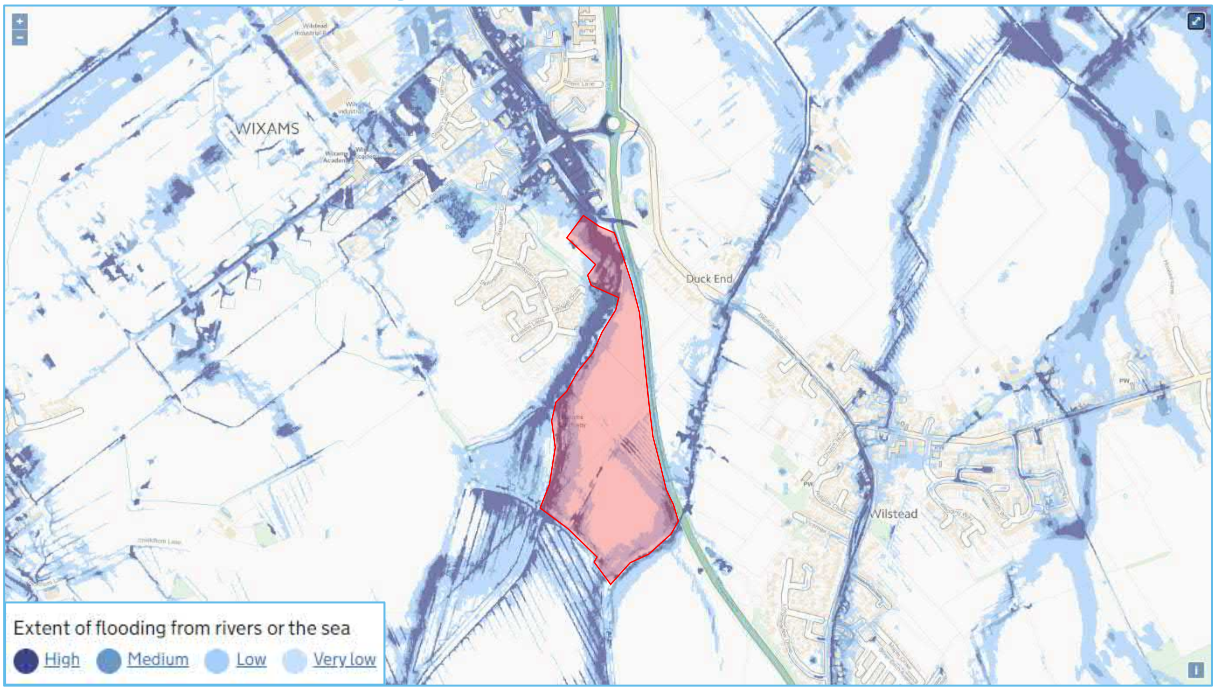
4.4 Surface Water Flood Risk

4.4.1 Surface water flooding is a description for excessive overland flows that have yet to enter a natural or manmade receptor (e.g. aquifer, watercourse, or sewer). Surface water flooding also occurs when the amount of runoff exceeds the capacity of the collecting system and spills onto overland flow routes.

4.4.2 Surface water flooding is usually the result of very intense, short lived rainfall events, but can also occur during milder, longer lived rainfall events, when collecting systems are at capacity or the ground is saturated. It often results in the inundation of low points in the terrain.

4.4.3 In accordance with the EA's *Long Term Flood Risk Information* (Figure 4.2 and Appendix C), the development site is mostly at very low (< 0.1% AEP) risk of surface water flooding. However, significant areas near the southern and northern watercourses are at low (0.1% to 1.0% AEP), medium (1.0% to 3.3% AEP) and high (> 3.3% AEP) risk of surface water flooding.

Figure 4.2: Flood Risk from Surface Water



4.4.4 BBC's PFRA and SFRA are based on the EA's *Long Term Flood Risk Information* and do not provide any additional information regarding surface water flood risk.

4.4.5 The available information suggests that surface water flood risk is largely due to off-site runoff reaching the development site via the southern and northern watercourses, effectively providing a coarse proxy for fluvial flood risk. However, as described in Section 4.3, the preliminary site-specific hydraulic modelling of the southern and northern watercourses shows that these pose a low flood risk to the proposed development.

4.4.6 In addition, the land drainage ditch spanning the south-western boundary of the site (between the southern and northern watercourses) is expected to intercept any out-of-bank flows reaching the development site via overland routes.

4.4.7 Any surface water flood risk at the proposed development is expected to be the result of runoff generated on site and shall be managed by the general measures described in Section 5.3. and the sustainable drainage strategy described in Section 6.

4.5 Groundwater Flood Risk

4.5.1 Groundwater flooding occurs when the level of water filling the pores and / or cracks in the underlying soil and / or rock (i.e. water table) rises and emerges on the surface. The level of the water table varies seasonally and depends upon long term rainfall, thickness and porosity of the underlying strata and groundwater abstraction.

4.5.2 Groundwater flooding is most common in areas where the underlying bedrock and superficial deposits are very porous, but it can also happen at locations where superficial layers of sand or gravel overlay impermeable bedrock.

4.5.3 Groundwater flooding usually occurs after days or weeks of prolonged rainfall and often lasts for days or weeks, as subsiding of the water table can be a very slow process.

4.5.4 Besides posing a direct flood risk to developments (particularly basements), high water table levels can exacerbate other sources of flood risk by preventing infiltration and / or leaking into drainage systems.

4.5.5 In accordance with the BBC's SFRA, the development site is in an area with low (< 25%) susceptibility to groundwater flooding. The SFRA states that the only recorded case of groundwater flooding in Bedfordshire occurred in Keysoe, approximately 20 km north of the development site.

4.5.6 All available geologic, hydrogeologic and flood risk information indicate a low risk of ground water flooding at the development site. Nevertheless, this should be confirmed by a bespoke ground investigation in due course.

5 FLOOD RISK MANAGEMENT

5.1 Sequential and Exception Tests

5.1.1 The sequential, risk-based approach to the location of development is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. The aim is to keep development out of medium and high flood risk areas (Flood Zones 2 and 3) and other areas affected by other sources of flooding where possible.

5.1.2 Application of the sequential approach in the master planning process, in particular application of the *Sequential Test*, helps ensure that development can be safely and sustainably delivered, and developers do not waste resources promoting proposals which are inappropriate on flood risk grounds.

5.1.3 The *Sequential Test* ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The aim is to steer new development to Flood Zone 1 (areas with a low probability of sea or river flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of sea or river flooding), applying the *Exception Test* if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of sea or river flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the *Exception Test* if required.

5.1.4 *Table 2* of the *Flood Risk and Coastal Change Guidance* categorises different types of uses and development according to their vulnerability to flood risk. *Table 3* of the *Flood Risk and Coastal Change Guidance* (Table 5.1) maps these vulnerability classes against flood zones to indicate where development is appropriate and where it should not be permitted.

Table 5.1: Flood Risk Vulnerability and Flood Zone Compatibility

Flood Zone	Flood Risk Vulnerability				
	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test	✓	✓	✓
Zone 3a	Exception Test	×	Exception Test	✓	✓
Zone 3b	Exception Test	×	×	×	✓

Key:
✓ Development is appropriate
× Development should not be permitted

5.1.5 The *Exception Test* is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

5.1.6 Essentially, the two parts of the *Exception Test* require proposed development to show that it will:

- Provide wider sustainability benefits to the community that outweigh flood risk; and
- Be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.

5.1.7 The ensuing sections describe how the sequential approach to the location of development shall be implemented in the proposed development's master planning, precluding any need for the Sequential or Exception Tests.

5.2 Fluvial Flood Risk

5.2.1 The following fluvial flood risk management measures shall be incorporated in the proposed development's master plan:

- All more vulnerable parts of the proposed development (i.e. residential dwellings and emergency access / egress routes) shall be located entirely outside of Flood Zones 2 and 3 (including the predicted impacts of climate change).
- External ground levels shall be located at least 300 mm above the relevant 1.0% AEP + 65% (climate change allowance) flood level.
- Finished floor levels shall be at least 600 mm above the relevant 1.0% AEP + 65% flood level.
- Any floodplain impingement for events up to 1.0% AEP + 65% shall be compensated on site in a level-by-level, volume-by-volume manner.

5.3 Surface Water Flood Risk

- As discussed in Sections 4.4.4 - 4.4.7, surface water flood risk is low, therefore no mitigation other than the maintenance of existing ditches/watercourses will be required.
- As per the existing drainage regime, off-site runoff reaching the development site from the south will be intercepted by a boundary ditch which will direct run-off to the northern and southern watercourses as (Section 6 and D) before discharge offsite via the A6. The boundary ditch will be enhanced to retain its drainage capacity.

5.4 Groundwater Flood Risk

5.4.1 The location and depth of SuDS features and underground structures (e.g. foundations and drainage infrastructure) must consider groundwater levels in their design and construction.

5.4.2 Despite the expected low risk of groundwater flooding, groundwater monitoring shall be undertaken at a later stage to confirm groundwater levels and steer the design of SuDS features and underground structures.

6 SURFACE WATER DRAINAGE STRATEGY

6.1 Existing Drainage (Greenfield Runoff)

6.1.1 The undeveloped (greenfield) site does not benefit from a formal surface water drainage system. Runoff is expected to partially percolate into the tilled soil and/or flow overland towards the northern or southern watercourses.

6.1.2 Greenfield runoff rates of 49.66l/s for the whole site and 2.25 l/s/ha (Q_{BAR})have been calculated using the *FEH* methodology (Appendix D).

6.2 Surface Water Discharge Hierarchy

6.2.1 In line with best practice the drainage strategy considers discharge hierarchy which states that surface water discharge via infiltration methods must be considered first. If this is not possible the strategy must then consider discharging run-off to a watercourse or within or adjacent to the site. Discharge to a public sewer must only be considered as a last resort.

6.2.2 Section 2.4 discusses the geology of the development site in detail. As the site is underlain by mudstone bedrock, infiltration is most likely unfeasible due to the low permeability of mudstone. Confirmation of infiltration rates via full BRE 365 infiltration testing will be provided in due course.

6.2.3 As infiltration is considered unfeasible, discharge to a watercourse is considered. A watercourse runs along the north-western boundary and another passes through the south of the site, receiving existing runoff. The proposed development will therefore mimic the existing site and discharge surface water run-off to these two watercourses.

6.3 Preliminary SuDS Drainage Strategy

6.3.1 The surface water drainage strategy is high level based given the early stage of development proposals, however SuDS have formed an integral part of concept masterplanning.

6.3.2 In accordance with the *NPPF*, (major) developments should incorporate sustainable drainage systems (SuDS) unless there is clear evidence that this would be inappropriate. In addition to water quantity control, SuDS should consider opportunities to provide water quality and amenity / biodiversity benefits (i.e. multifunctionality approach).

6.3.3 Impermeable area for runoff calculations has been estimated based on typical values for developments of similar density. The impermeable area is assumed to be equal to 55% of the developed area. This equates to approx. 8.45 ha and consists of impermeable surfaces (e.g. roofs, roads, driveways, parking areas, etc.).

6.3.4 An additional 10% hardstanding has been included to account for Urban Creep i.e. future extensions. Another 10% is included to account for run-off from soft paved/landscaped areas, this equates to an additional 1.3 ha. The total impermeable area considered is 9.75ha.

6.3.5 The preliminary drainage strategy is included in Appendix D.

6.3.6 The strategy limits all off-site discharge to the greenfield Qbar runoff rates of 2.25 l/s/ha, providing a betterment on existing runoff rates and mitigating flood risk from the additional volumes of runoff generated from the new impermeable area.

6.3.7 The site has been split into seven sub-catchments and multiple basins proposed. This integrates SuDS within the development in accordance with best practice and allows run-off to travel shorter distances under gravity to a basin and outfall whereas a larger combined basin would require longer runs and therefore likely pumping to reach the shallow outfalls.

6.3.8 Run-off is conveyed by pipes and / or swales to the detention basins which have been sized using MicroDrainage quick storage estimates to store run-off for all storm events up to and including the critical 1 in 100 year storm event, including an allowance of 40% for climate change. The storage estimates are included in Appendix D.

6.3.9 Areas for potential permeable pavement are also indicated, on parking court areas, for which they are ideally suited.

6.4 Additional Sustainable Drainage Systems (SuDS)

6.4.1 While the preliminary drainage strategy is largely reliant on swales and detention basins, Table 6.1 outlines the principles of other SuDS and reviews them for potential compatibility with the development proposals. Those considered appropriate will be considered as the design moves into more detailed phases.

6.4.2 It is important to note the need to remove silt from runoff prior to discharge into SUDS features. SuDS such as filter drains, swales, bioretention systems and pervious pavements are sustainable alternatives to proprietary treatment systems otherwise required to manage silt.

Table 6.1: Sustainable Drainage Systems (SuDS)

SuDS Component	Description and Opportunities
Green / Blue Roofs	Green roofs are areas of living vegetation installed on the top of buildings for a range of reasons including visual benefit, ecological value, enhanced building performance and reduction of surface water runoff. A blue roof is a roof designed explicitly to store water for use within the building (rainwater harvesting) or controlled discharge. Green roofs that include reservoir storage zones beneath the growing medium could also be considered blue roofs. Green roofs can improve the thermal performance of buildings, help combat the urban heat island effect and contribute to improved air quality. Through evapotranspiration, green roofs can reduce peak flow rates to a site drainage system (principally for small and medium-sized events) but are unlikely to a have a significant impact on downstream attenuation storage requirements. Blue roofs can be designed to provide significant attenuation (and evapotranspiration). Green roofs are generally unsuitable for pitched roofs as proposed within the majority of low-rise housing developments which can preclude their use. They it is not anticipated that they will be appropriate within this development.
Filter Drains/Strips	Filter drains are trenches filled with stone/gravel that create temporary subsurface storage for the filtration, attenuation, and conveyance of surface water runoff. Ideally, filter drains receive lateral inflow from adjacent impermeable surfaces pre-treated over a filter strip. Filter drains can help manage peak flows by naturally limiting rates of conveyance through the filter medium and by providing attenuation storage when the rate of flow at the outlet is controlled. Filter drains can be effectively incorporated into the landscape and public open spaces and can have minimal land-take requirements. The use of filter drains is typically restricted to flat sites (unless placed parallel to contours). Filter drains are best located adjacent to (small) impermeable surfaces such as car parks and roads / highways. Where the preliminary drainage strategy indicates a Swale, a Filter Drain or Strip can be installed instead. As the detail of the scheme progresses opportunities for filter drains alongside small hardstanding areas such as parking courts will be investigated.

SuDS Component	Description and Opportunities
Swales	Swales are shallow, flat bottomed, vegetated open channels designed to treat, convey and often attenuate surface water runoff. Swales can also provide aesthetic and biodiversity benefits. Swales can help reduce flow rates by facilitating infiltration and / or providing attenuation storage when flow at the outlet is controlled. Coarse to medium sediments and associated pollutants can be removed by filtration through surface vegetation and ground cover. Swales are well suited for managing runoff from linear features such as main roads / highways. Swales are generally difficult to incorporate into dense urban developments, where space is limited. Swales have been indicated in the preliminary drainage strategy to convey and treat surface water run-off prior to it being discharged into one of the proposed detention basins. As the detail of the scheme progresses opportunities for integrating swales within the layout will be investigated, in particular alongside major estate roads.
Bioretention Systems	Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce runoff rates and volumes and treat pollution. They also provide attractive landscape features and biodiversity. Bioretention systems can help reduce flow rates from a site by promoting infiltration / evapotranspiration and providing some attenuation storage. Bioretention systems can also provide very effective treatment functionality. Bioretention systems are a very flexible surface water management component that can be integrated into a wide variety of developments / densities using different shapes, materials, planting and dimensions. As the detail of the scheme progresses opportunities for integrating rain gardens within the layout will be investigated, in particular within more urbanised areas with greater areas of hardstanding where basins and swales are not appropriate but rain gardens can provide a good opportunity to bring water management, amenity and biodiversity into the public space.
Pervious Pavements	Pervious pavements provide a pavement suitable for pedestrian and / or vehicular traffic, while allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before use, infiltration to the ground or controlled discharge downstream. Pervious pavements help reduce flow rates from a site by providing attenuation storage. A flow control structure is required to constrain the rate of water discharged from the sub-base via an outlet pipe. Pervious pavement drainage has been shown to have decreased concentrations of a range of surface water pollutants, including heavy metals, oil and grease, sediment and some nutrients. Pervious pavements are typically built as an alternative to impermeable surfaces and therefore require no extra development space for their construction. The preliminary drainage strategy indicates areas of permeable paving on large parking courts where they can be designed to collect, treat and store large volumes of runoff, however the suitability on smaller areas such as private drives will be investigated at detail stage.
Detention Basins	Detention basins are landscaped depressions that are normally dry expect during and immediately following storm events. They can be on-line components where surface runoff from regular events is routed through the basin or off-line components into which runoff is diverted once flows reach a specific threshold. Detention basins can be vegetated depressions (providing treatment in on-line components) or hard landscaped storage areas. Off-line basins will normally have an alternative principal use (e.g. amenity or recreational facility or urban (hard) landscaping). Multiple detention basins have been proposed across the development site. These will attenuate and treat run-off prior to it being discharged into one of the two boundary watercourses at a limited rate.

SuDS Component	Description and Opportunities
Attenuation Storage Tanks	Attenuation storage tanks are used to create a below-ground void space for the temporary storage of surface water before use, infiltration, or controlled release. Attenuation storage tanks can help reduce flow rates from a site by providing significant attenuation storage. Storage tanks do not provide any form of treatment of surface water runoff and therefore need to be combined in a "management train" with other methods that do provide suitable treatment of all relevant pollutants (coarse sediment must always be removed upstream of a storage tank). The inherent flexibility in size and shape of the typical attenuation storage tank systems means that they can be tailored to suit the specific characteristics and requirements of any site. However, the lack of amenity and biodiversity benefits means that storage tanks should be a last resource in any surface water drainage strategy for a major development. Whilst Attenuation Storage Tanks area convenient way to store run-off below ground and do support reduction in runoff rates, they do not have the ecological or amenity benefits of overland SuDS. They are also less easy to maintain than overland SuDS. Whilst its unlikely attenuation tanks are suitable for the proposed development they should not be entirely ruled out as they can provide a means of incorporating storage on a scheme where site constraints prevent other SuDS.

6.5 Exceedance Events

6.5.1 Plot levels will be set above external ground levels and preliminary levels have been designed to safely route exceedance flows away from buildings, towards the road and swale network and onwards to one of the two boundary watercourses.

6.6 Water Quality Management

6.6.1 The suitability of the preliminary drainage strategy to manage the development's pollution risk has been assessed using the simple index approach in *The SuDS Manual* (2015), as summarized in Table 6.2. This sets out the pollution indices of the runoff sources (roofs, roads, parking) and compared these to the cumulative mitigation indices of the proposed SuDS train.

6.6.2 Permeable paving is proposed in the preliminary strategy, however as it is not proposed for all areas it is not included in the assessment below.

Table 6.2: Surface Water Quality Management (Simple Index Approach)

Runoff Route / Treatment Train				
Land Use / SuDS	**Hazard Level**	**TSS**	**Metals**	**Hydro-Carbons**
Pollution Hazard Indices				
Residential Roofs	Very Low	0.20	0.20	0.05
Driveways, residential car parks and low traffic roads	Low	0.50	0.40	0.40
SuDS Mitigation Indices				
Detention Basin	-	0.50	0.50	0.60
Swale	-	0.50	0.60	0.60
Total SuDS Mitigation Index ≥ Pollution Hazard Index (for each contaminant type)				

6.6.3 Further SuDS as identified in Table 6.1 for inclusion within the detailed scheme will further improve water quality management.

6.7 Operation and Maintenance

6.7.1 The function of the surface water drainage system must be understood by those responsible for maintenance, regardless of whether individual components are below ground or on the surface. In any system properly designed, monitored, and maintained, performance deterioration can usually be minimised.

6.7.2 Maintenance plans will be produced at the detail stage to clearly identify who is responsible for maintaining proposed SuDS as well as the maintenance regime to be applied. Maintenance plans can also form a useful tool for public engagement with SuDS and understanding their wider benefits.

6.7.3 The anticipated responsibility for long-term operation and maintenance of the surface water drainage system is set out in Table 6.3. Appropriate legal agreements defining maintenance responsibilities and access rights over the lifetime of the proposed development must be established prior to construction.

Table 6.3: Entities Responsible for SuDS Maintenance

SuDS Component	Location	Function	Responsible Entity
Filter Drain	Roadsides	Store, convey and treat runoff	Local highways authority or private management company
Swale	Roadsides	Store, convey and treat runoff	Local highways authority or private management company
Bioretention System	Individual plots	Store & treat runoff	Owner or private management company
Pervious Pavement	Private & public parking areas	Store & treat runoff	Owner or private management company
Detention Basin	Public open spaces	Store & treat runoff	Local authority, water company or private management company
Attenuation Storage Tank	Public open spaces	Store runoff	Private management company

6.8 Drainage During Construction

6.8.1 Drainage is typically an early activity in the construction of a development, taking form during the earthworks phase.

6.8.2 A construction surface water management plan will be produced at detail stage to set out the activities and staging required to collect, store and treat construction runoff prior to discharge from site.

7 FOUL WATER DRAINAGE STRATEGY

7.1.1 The nearest Anglian Water public foul sewer is a 300mm diameter pipe along Bedford Road, 490m north of the development area. This sewer has an invert level of approximately 29.49m.

7.1.2 The lowest ground levels within the development are around 29.5m AOD which is the same level as the Bedford Road sewer, therefore most of the site will require pumping.

7.1.3 The A6 is higher than the site therefore it appears feasible to pump up from within the site into a new sewer within the A6 which will drain via gravity north to the public sewer in Bedford Road. This is to be confirmed by topographic survey of the A6.

7.1.4 The 490m of new offsite foul sewer within A6 could either be installed by the developer under S104 agreement or under requisition with Anglian Water.

7.1.5 As proposals progress, liaison will be undertaken with Anglian Water to make them aware of the proposals and set out timeframes for delivery, to enable planning of any upgrades to the off-site drainage infrastructure.

7.1.6 Anglian Water will undertake these upgrades to the existing network in compliance with sewerage undertakers legal obligation under the Water Industries Act 1991 to provide developers with the right to connect to public (foul) networks and to carry out works required to accommodate additional flows into their networks.

8 CONCLUSIONS AND RECOMMENDATIONS

In accordance with the published flood risk information, the site is almost entirely in Flood Zone 1 (i.e. less than 0.1% probability of flooding in any year). However, the large scale published flood risk information does not cover the ordinary watercourses along the site's northern boundary and in the south of the site. Preliminary site specific hydraulic modelling was therefore undertaken to better assess risk at the development site. **This conservative modelling confirmed low risk of flooding from these watercourses.**

The envisaged master plan follows the sequential approach to the location of development as set out in the National Planning Policy Framework, locating all development outside of Flood Zones 2 and 3 and should preclude any need for the Sequential or Exception Tests.

The Environment Agency and Bedford Borough Council's SFRA plans indicate that the site experiences surface water flooding along both the northern and southern watercourses in high and medium risk events with the low risk event showing a larger a larger flood extent spanning into the site.

The hydraulic modelling demonstrates that this surface water flood risk does not result from the watercourses. Furthermore, a drainage system will be designed to manage all surface water generated within the proposed development, thus managing the risk of surface water flooding.

Based on the information provided in this assessment the flood risk to the envisaged masterplan is considered to be low.

The preliminary surface water drainage strategy manages rates, volumes, and water quality of runoff by routing run-off from new impermeable areas via pipes and swales to detention basins where it is attenuated and discharged to one of the watercourses at the Greenfield Qbar rate.

Seven basins are proposed to integrate SuDS within the proposals and avoid the need to pump, sized for all storm events up to and including the 1 in 100-year event (+40% climate change).

It is expected that foul will need to be pumped up into a new gravity foul sewer in the A6, which will connect into the existing Anglian Water Foul Sewer within Bedford Road, 490m to the north of the site.

Based on the information provided in this assessment the preliminary drainage strategy is considered to be suitable for development.

9 LIMITATIONS

9.1.1 The information, conclusions and recommendations presented within this report are deemed to be current at the time of issue. No guarantee can be given to the status of this information other than at the time of issuing. Where necessary, the user shall confirm the status of any applicable assessments and consents.

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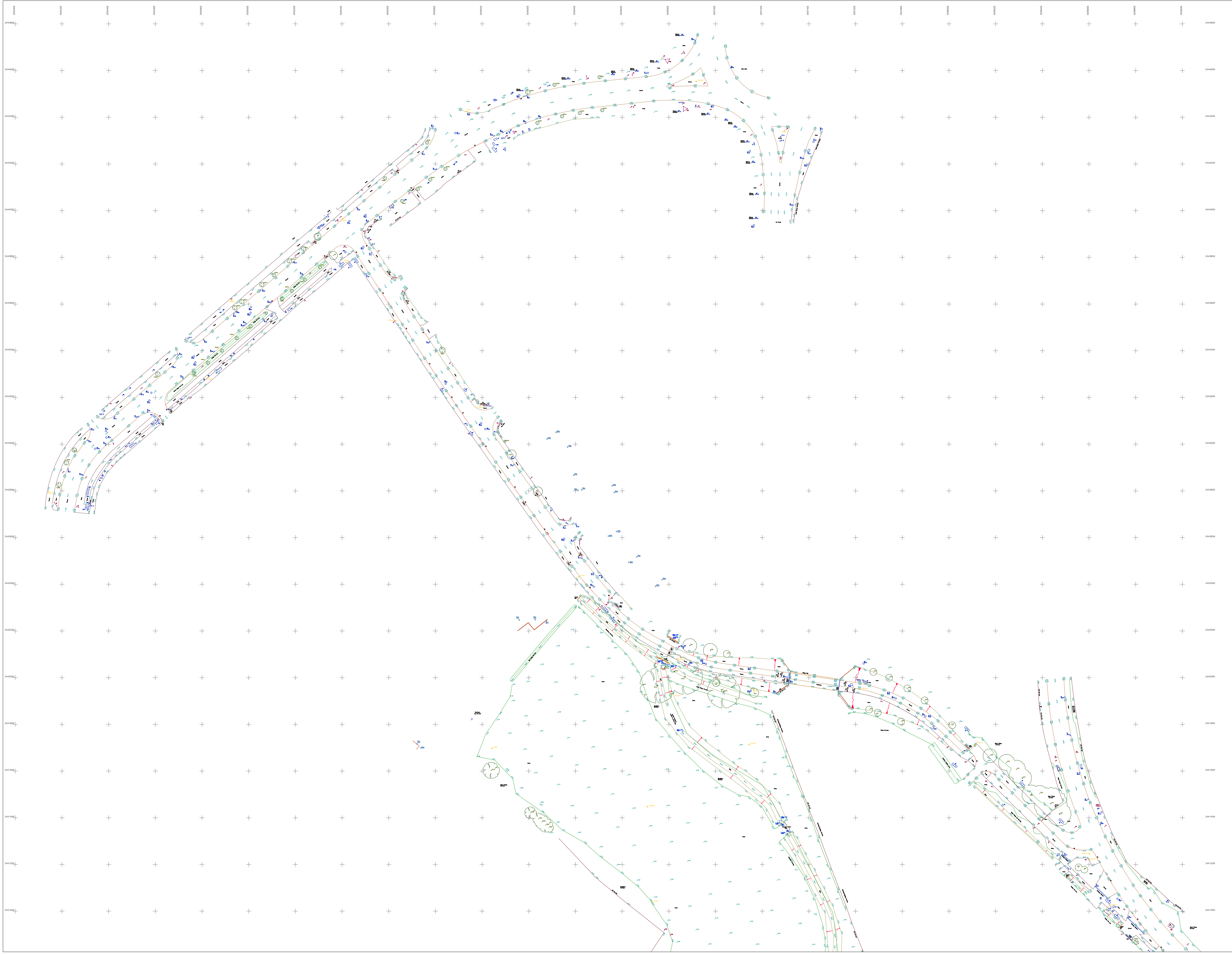
APPENDIX A
Site Information



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INDICATIVE

Legend:

Fences

Walls

Hedges

Trees

Buildings

Overhead Electric

Overhead Phone

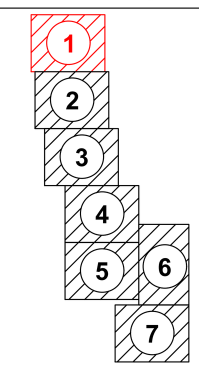
Gate

Fences:	
Barbed Wire Fence	B/W
Corrugated Iron Fence	C/I
Closed Board Fence	C/B
Chestnut Paling Fence	C/P
Iron Railing Fence	I/R
Post and Chain Fence	P/C
Post and Rail Fence	P/R
Post Wire Fence	P/W
Interwoven	I/W
Chain Link Fence	C/L
Larch Lap Fence	L/L
Wire Mesh Fence	W/M

Abbreviations:

BOLLARD	BO	MARKER	MK
BRITISH TELECOM IC	BT	PARKING METER	PM
CONCRETE PAVING SLABS	CPS	ROAD NAME PLATE	RNP
COVER LEVEL	CL	ROAD SIGN	RS
DROP KERB	DK	RODDING EYE	RE
ELECTRICITY POLE	EP	RETAINING WALL	Rtw
FIRE HYDRANT	FH	RAINWATER PIPE	RPW
FLOWER BED	F/B	SOIL VENT PIPE	SVP
FOOTPATH	FP	STOP VALVE	SV
GAS VALVE	GV	TELEGRAPH POLE	TP
GULLY	GY	TRAFFIC LIGHT	TL
INSPECTION COVER	IC	UNABLE TO LIFT	UTL
PIPE INVERT LEVEL	IL	VENT PIPE	VP
KERB OUTLET	KO	WATER METER	WM
MAN HOLE	MH		

Sheet Layout



Coordinate Table

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STN1	505729.489	244434.281	31.339
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STN11	505618.342	243729.445	33.798
STN12	505563.300	243650.020	34.027
STN13	505569.328	243609.064	34.350
STN14	505565.211	243530.752	34.687
STN15	505653.298	243432.335	35.399
STN16	505741.517	243207.689	36.142
STN16A	505722.915	243048.805	37.559
STN17	505928.794	243318.288	35.595
STN17A	505974.302	243211.398	37.397
STN18	505902.306	243363.457	35.020
STN19	505815.892	243490.388	35.333
STN2	505593.564	244442.379	31.021
STN20	505725.780	243588.732	35.273
STN21	505795.257	243755.243	34.266
STN22	505802.528	243911.723	33.694
STN23	505765.742	244073.340	32.298
STN24	505748.017	242898.224	39.504
STN25	505790.616	242750.265	39.899
STN26	505922.942	242639.871	40.710
STN27	506035.234	242574.764	42.692
STN3	505540.209	244396.426	31.470
STN31	506250.468	242460.588	43.886
STN32	506339.133	242670.487	45.624
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STN36	506036.145	243131.528	40.695
STN36A	506041.793	243136.817	40.682
STN4	505641.450	244243.097	31.448
STN5	505716.321	244194.824	31.789
STN5A	505714.356	244171.374	32.387
STN5A	505714.356	244171.374	32.387
STN5A1	505681.187	244192.959	31.715
STN6	505604.123	244169.725	31.852
STN7	505672.960	244103.849	31.955
STN8	505747.349	243997.821	32.559
STN9	505732.629	243953.887	32.517
STNBR1	505670.804	244144.724	31.655
STNG1	505599.183	244316.480	31.647
STNG10	505761.688	244194.962	29.227
STNG100	505677.232	244207.981	31.705
STNG11	505811.240	244171.309	32.814
STNG13	505860.251	244121.964	33.354
STNG14	505868.120	244101.711	33.325
STNG15	505721.629	243946.764	31.982
STNG2	505562.959	244352.993	31.645
STNG3	505541.671	244377.731	31.532
STNG4	505492.704	244361.661	31.178
STNG5	505414.230	244279.743	31.693
STNG6	505482.547	244328.549	31.211
STNG7	505691.752	244455.341	30.966
STNG8	505683.520	244208.145	31.503
STNGPS1	506386.919	242305.075	47.485
STNGPS2	506380.646	242479.510	46.749
STNP1	506391.130	242217.006	47.926
STNRB2	505709.416	244070.421	32.071

Rev. Suffix	Date	Initial	Revision Details

Surveyor	PD/MB	Verified By	PD/MB	CAD Operator	TJH	Approved By	ARL	Date	15.01.20

Levelling GNSS Datum OSGB36

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Client

Wates Developments Ltd

Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 1 of 7

Job No. 1910073	Old Job No.
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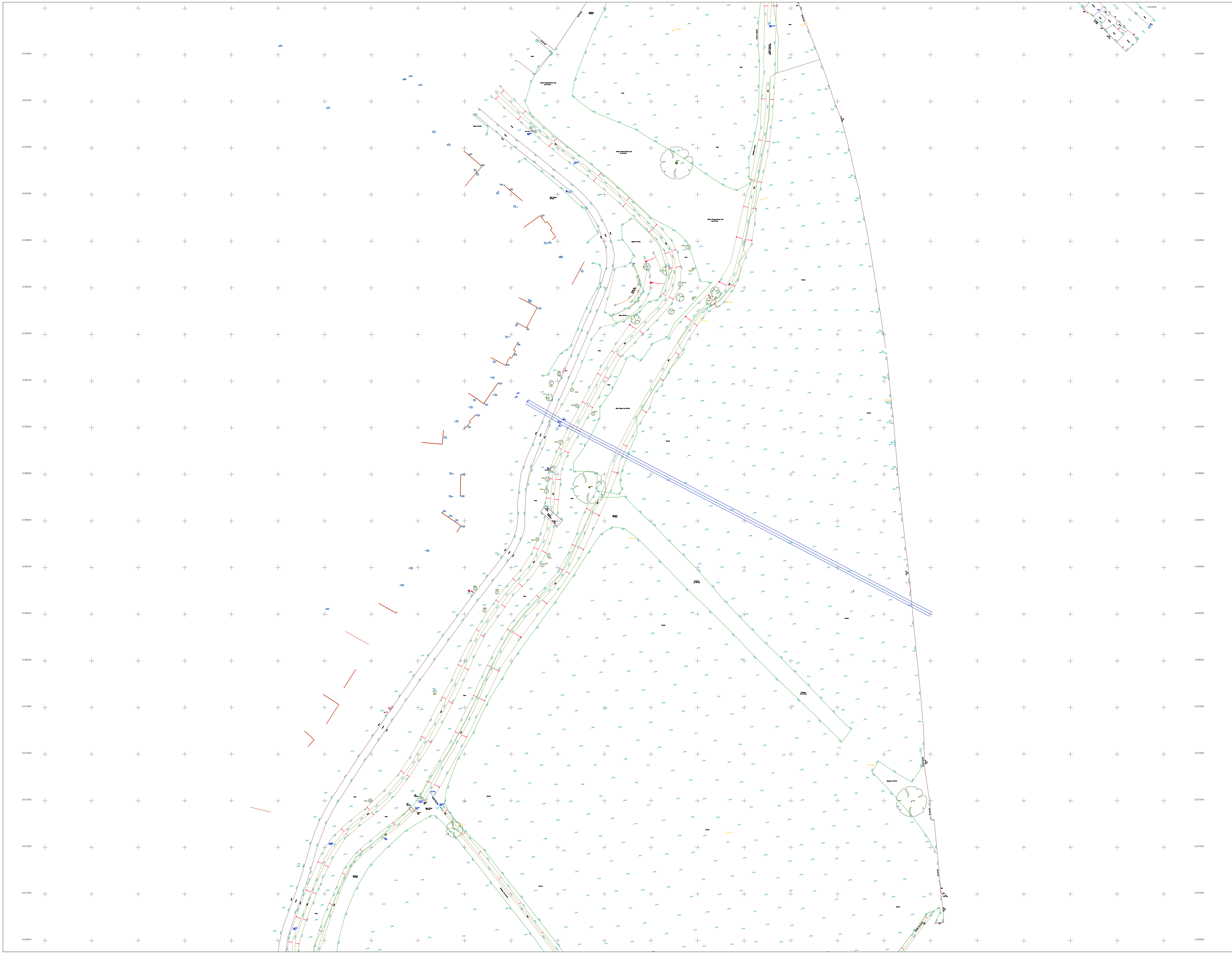

Notes:

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Grid coordinates are based on an OS GNSS system on a plane grid with a scale factor of 1.0000.

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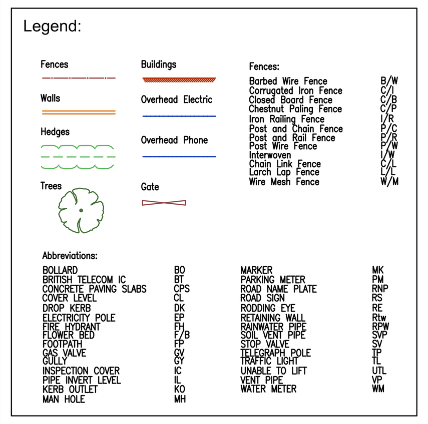

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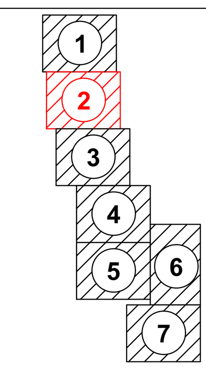

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Client

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Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 2 of 7

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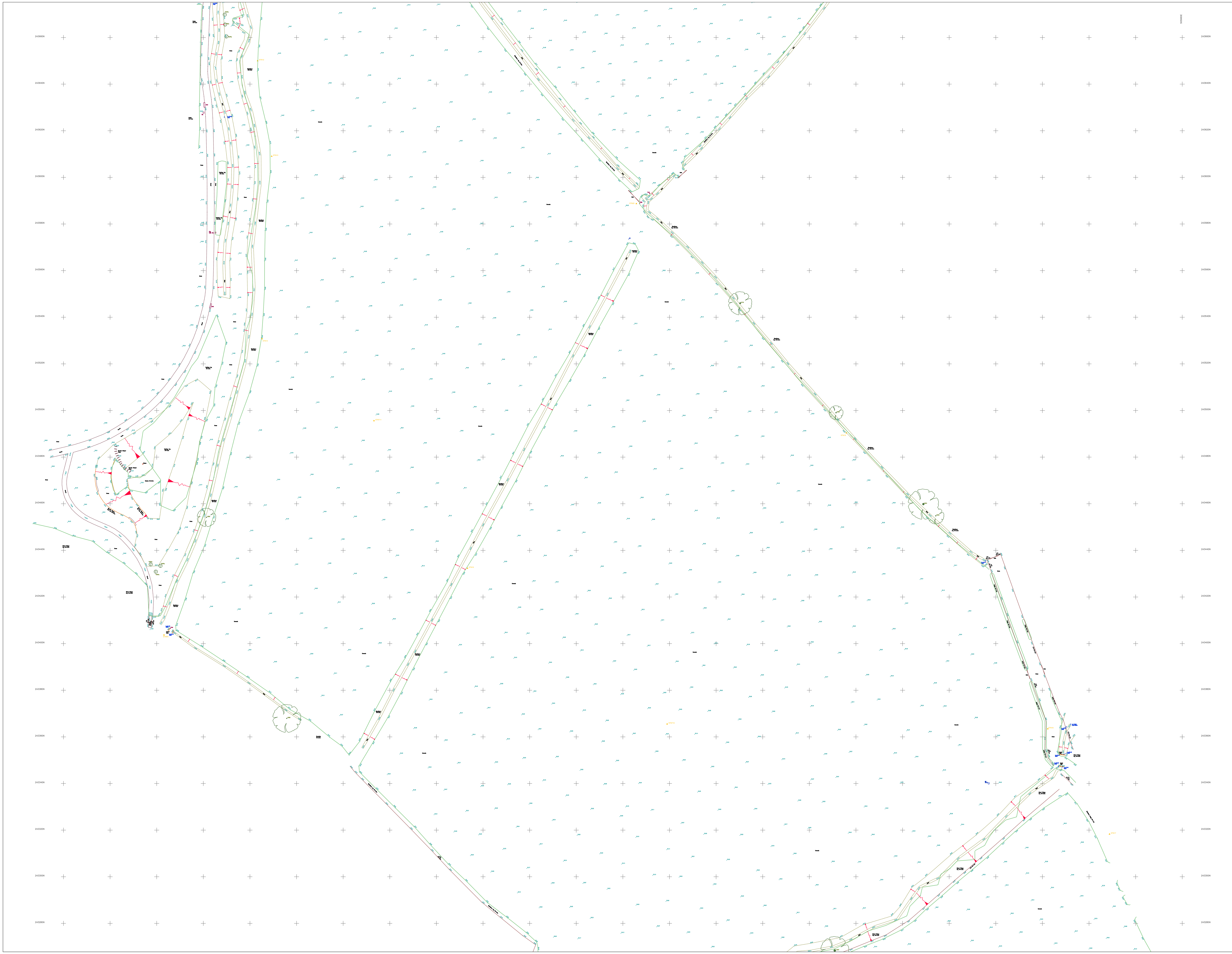

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INDICATIVE

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Wates Developments Ltd

Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 3 of 7

Job No. 1910073

Old Job No.

Drawing Number WD/1910073/3

Revision Suffix

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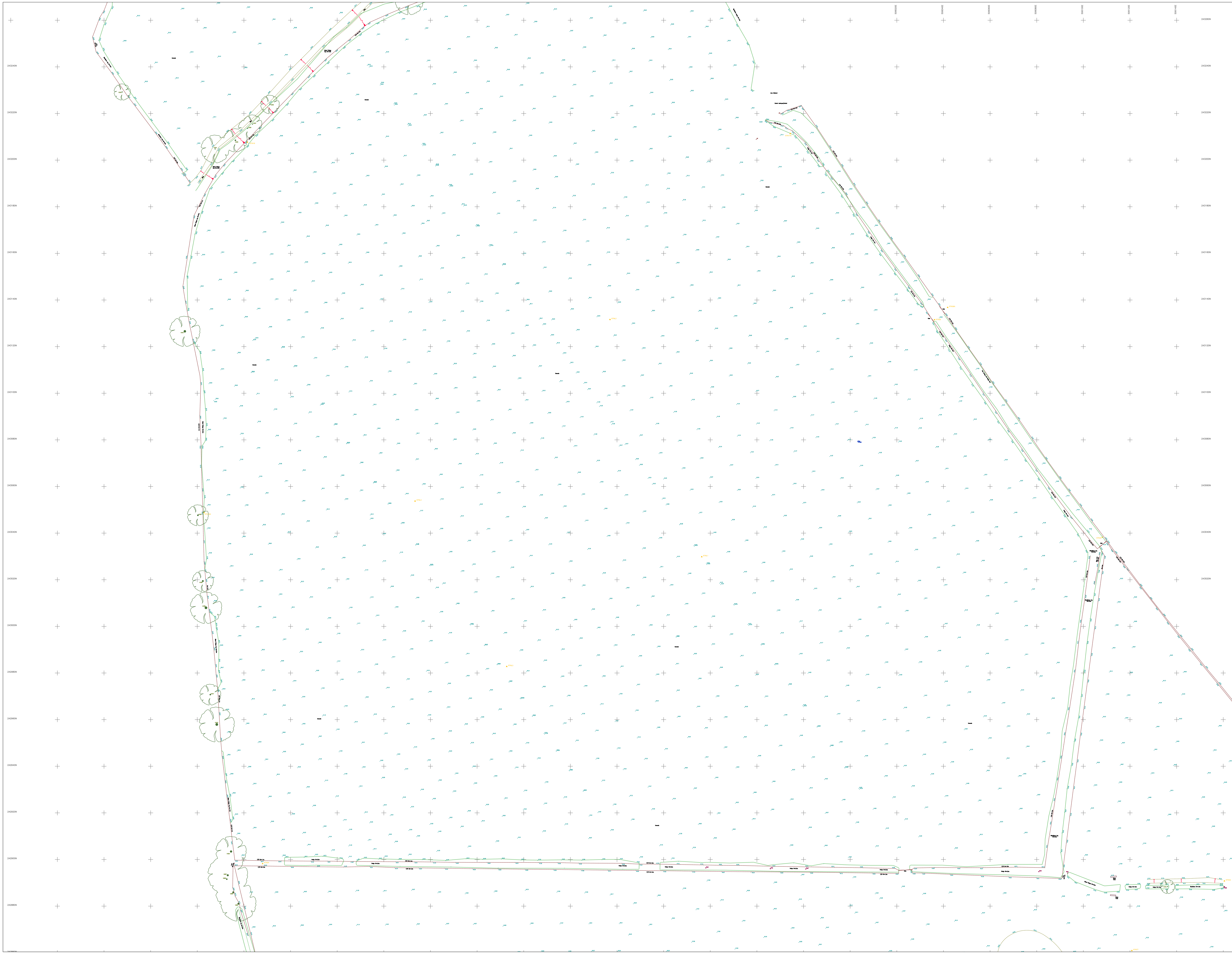

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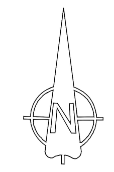

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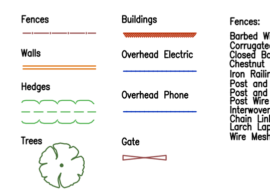

Fences:

Barbed Wire Fence	B/W
Corrugated Iron Fence	C/I
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INSPECTION COVER	IC	UNABLE TO LIFT	UTL
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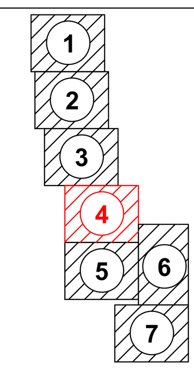
KERB OUTLET	KO	WATER METER	WM
MAN HOLE	MH		

Sheet Layout



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Drawing Title

Topographical Survey Sheet 4 of 7

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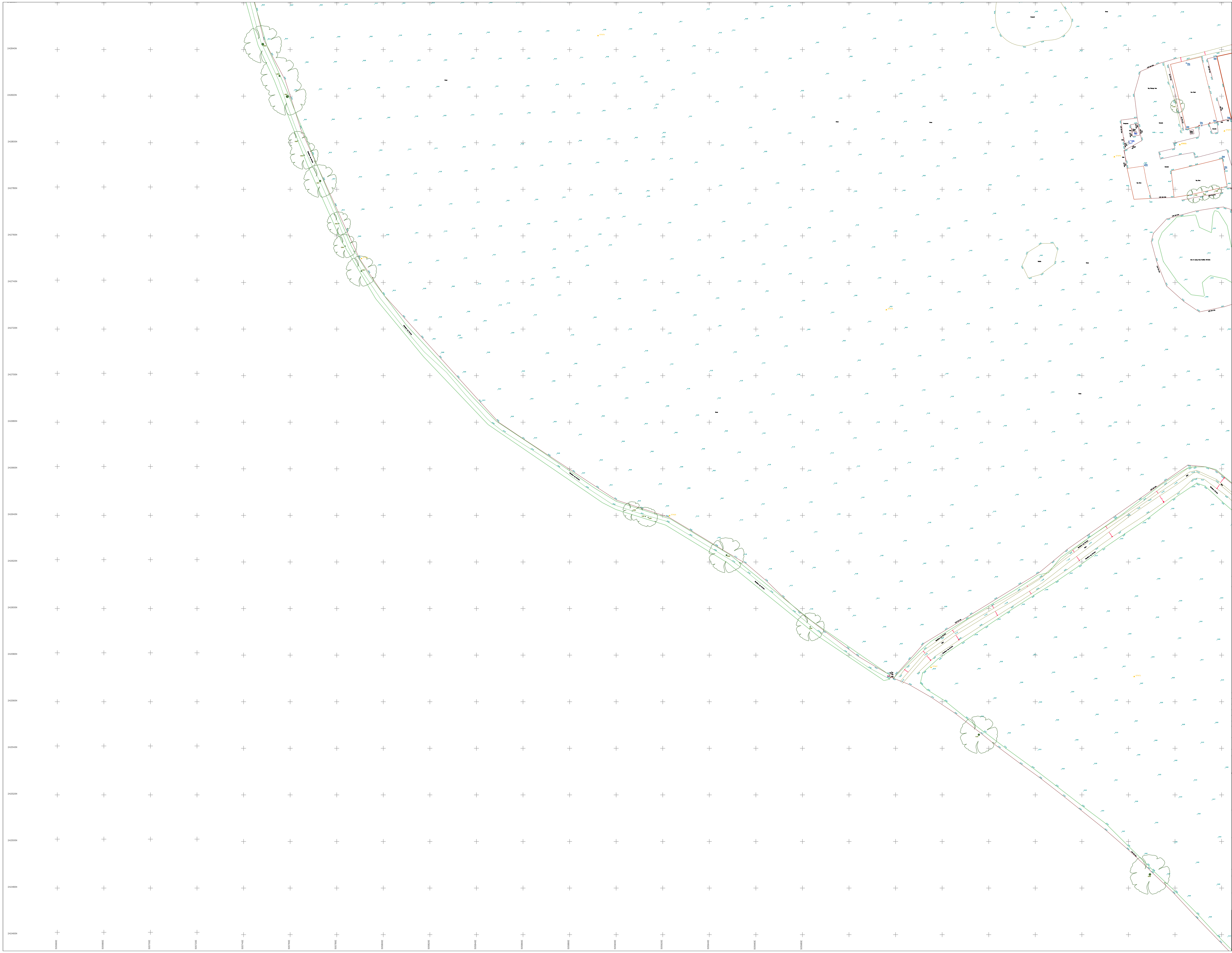

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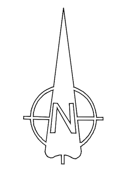

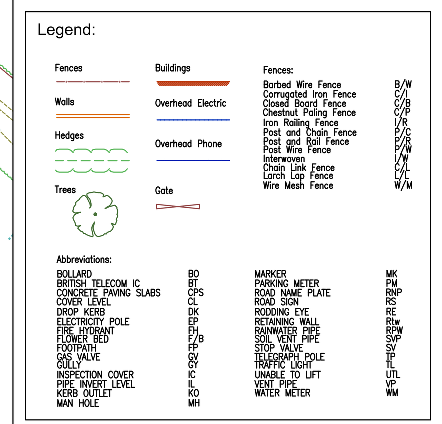

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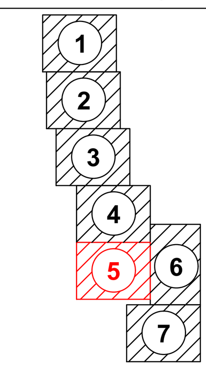

Rev. Suffix	Date	Initial	Revision Details

Surveyor	PD/MB	Verified By	PD/MB	CAD Operator	TJH	Approved By	ARL	Date	15.01.20

Levelling GNSS Datum OSGB36

To an OS GNSS Datum

Client

Wates Developments Ltd

Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 5 of 7

Job No. 1910073	Old Job No.
Drawing Number WD/1910073/5	Revision Suffix
Scale 1:500m (A0)	Date January 2020

CD SURVEYS LTD
LAND, BUILDING & SITE ENGINEERING
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SUNBURY-ON-THAMES
MIDDLESEX, TW16 6AX
Tel (01932) 761196
Fax (01932) 786419
Email: mail@cdsurveys.com
Visit us at: www.cdsurveys.com

Notes:

Whilst every effort has been made to correctly identify species of trees on the site, we advise that an arborologist be consulted before any final decisions are made.

All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction.

Grid coordinates are based on an OS GNSS system on a plane grid with a scale factor of 1.0000.

INDICATIVE

Legend:

Fences
Walls
Hedges
Trees
Buildings
Overhead Electric
Overhead Phone
Gate

Fences:

Barbed Wire Fence	B/W
Corrugated Iron Fence	C/I
Closed Board Fence	C/B
Chestnut Paling Fence	C/P
Iron Railing Fence	I/R
Post and Chain Fence	P/C
Post and Rail Fence	P/R
Post Wire Fence	P/W
Interwoven	I/W
Chain Link Fence	C/L
Larch Lap Fence	L/L
Wire Mesh Fence	W/M

Abbreviations:

BOLLARD	BO	MARKER	MK
BRITISH TELECOM IC	BT	PARKING METER	PM
CONCRETE PAVING SLABS	CPS	ROAD NAME PLATE	RNP
COVER LEVEL	CL	ROAD SIGN	RS
DROP KERB	DK	RODDING EYE	RE
ELECTRICITY POLE	EP	RETAINING WALL	Rtw
FIRE HYDRANT	FH	RAINWATER PIPE	RPW
FLOWER BED	F/B	SOIL VENT PIPE	SVP
FOOTPATH	FP	STOP VALVE	SV
GAS VALVE	GV	TELEGRAPH POLE	TP
GULLY	GY	TRAFFIC LIGHT	TL
INSPECTION COVER	IC	UNABLE TO LIFT	UTL
PIPE INVERT LEVEL	IL	VENT PIPE	VP
KERB OUTLET	KO	WATER METER	WM
MAN HOLE	MH		

Tree Schedule

Pt No	Spread	Bole	Height	Species
215	4.0	0.20	6.0	TREE UNKOWN
220	4.0	0.20	6.0	TREE UNKOWN
355	3.5	0.15	5.0	TREE UNKOWN
3760	4.0	0.20	6.0	HAWTHORN
3761	4.0	0.20	6.0	HAWTHORN
3762	4.0	0.20	6.0	HAWTHORN
3041	14.0	0.35	0.0	TREE UNKOWN
3069	6.0	0.20	8.0	TREE UNKOWN
3070	7.0	0.25	11.0	TREE UNKOWN
3073	8.0	0.25	11.0	TREE UNKOWN
3074	8.0	0.40	12.0	TREE UNKOWN
3079	8.0	0.30	12.0	TREE UNKOWN
3080	7.0	0.20	8.0	TREE UNKOWN
3081	10.0	0.40	10.0	TREE UNKOWN
3284	3.0	0.15	4.0	PINE
3285	3.0	0.15	4.0	PINE
2219	4.0	0.11	5.0	TREE UNKOWN
2233	3.0	0.09	4.0	TREE UNKOWN
2321	6.0	0.30	8.0	TREE UNKOWN
2322	6.0	0.30	8.0	TREE UNKOWN
2344	3.0	0.10	5.0	TREE UNKOWN
2536	3.0	0.10	5.0	TREE UNKOWN
2537	3.0	0.10	5.0	TREE UNKOWN
2538	3.0	0.10	5.0	TREE UNKOWN
2539	3.0	0.10	5.0	TREE UNKOWN
2540	3.0	0.10	5.0	TREE UNKOWN
2563	3.0	0.10	5.0	TREE UNKOWN
2564	3.0	0.10	5.0	TREE UNKOWN
2565	3.0	0.10	5.0	TREE UNKOWN
885	3.0	0.10	6.0	TREE UNKOWN
10163	8.0	0.25	8.0	ASH
10164	8.0	0.25	7.0	ASH
10268	6.0	0.20	6.0	OAK
10269	6.0	0.15	6.0	OAK
10475	6.0	0.20	6.0	OAK
10476	6.0	0.20	6.0	OAK
10477	6.0	0.20	6.0	OAK
10478	7.0	0.20	7.0	ASH
10479	7.0	0.20	7.0	ASH
10480	7.0	0.20	7.0	OAK
10481	7.0	0.20	7.0	OAK
10482	8.0	0.30	8.0	OAK
10483	8.0	0.30	8.0	OAK
10484	8.0	0.25	8.0	ASH
10616	6.0	0.20	6.0	ASH
10617	6.0	0.20	6.0	ASH
10625	6.0	0.25	6.0	ASH
10693	7.0	0.25	7.0	ASH
10717	8.0	0.30	8.0	ASH
10718	10.0	0.50	9.0	ASH
10719	7.0	0.30	8.0	ASH
10881	11.0	0.50	10.0	ASH
10892	16.0	0.50	13.0	OAK
10893	16.0	0.60	13.0	OAK
10894	16.0	0.40	9.0	OAK
10895	16.0	0.50	13.0	OAK
10896	10.0	0.50	10.0	OAK
10897	8.0	0.25	8.0	OAK
10926	17.0	0.90	17.0	OAK
10943	6.0	0.20	8.0	ASH
10944	6.0	0.20	8.0	ASH
10945	6.0	0.20	8.0	ASH
10946	8.0	0.30	8.0	ASH
10947	10.0	0.40	9.0	ASH
11247	16.0	0.80	14.0	OAK
11317	14.0	0.40	14.0	OAK
11318	14.0	0.60	14.0	OAK
11319	14.0	0.40	14.0	ASH
11320	10.0	0.30	9.0	OAK
11321	10.0	0.40	10.0	ASH
11322	8.0	0.30	9.0	OAK
11323	12.0	0.40	13.0	ASH
11324	14.0	0.50	13.0	ASH
11325	12.0	0.80	11.0	OAK
11326	14.0	0.40	14.0	OAK
11327	14.0	0.50	17.0	ASH
11382	16.0	0.80	18.0	OAK
11383	18.0	0.90	18.0	OAK
11384	14.0	0.50	18.0	ASH
11385	16.0	0.80	18.0	ASH
11477	5.0	0.15	5.0	CHERRY
11515	5.0	0.15	6.0	ALDER
11570	8.0	0.40	7.0	ASH
11571	6.0	0.15	6.0	ASH
11859	6.0	0.15	7.0	HAWTHORN
11860	6.0	0.15	8.0	ASH
11861	6.0	0.15	8.0	ASH
12100	6.0	0.20	6.0	TREE UNKOWN
12148	6.0	0.30	5.0	HAWTHORN
12380	8.0	0.30	8.0	MAPLE
12381	8.0	0.30	8.0	MAPLE
12382	8.0	0.30	8.0	MAPLE
12383	15.0	0.60	15.0	OAK
12384	12.0	0.40	14.0	OAK
12844	13.0	0.50	14.0	ASH
12845	10.0	0.40	12.0	ASH
12846	10.0	0.30	12.0	MAPLE
12847	14.0	0.80	12.0	OAK
12849	12.0	0.40	12.0	OAK
12850	8.0	0.25	9.0	ASH
12851	16.0	1.10	17.0	OAK
12852	16.0	0.70	17.0	OAK
12853	16.0	1.00	17.0	OAK
12854	15.0	0.70	17.0	OAK
12855	15.0	0.70	17.0	OAK
12856	13.0	0.50	14.0	OAK
12857	17.0	0.70	15.0	ASH
13179	10.0	0.60	11.0	OAK
13203	7.0	0.35	8.0	MAPLE
13204	13.0	0.80	10.0	OAK
13209	6.0	0.40	8.0	MAPLE
13333	7.0	0.30	9.0	ASH
13334	12.0	0.30	10.0	ASH
13335	10.0	0.50	7.0	ASH
13336	8.0	0.30	7.0	ASH
13337	8.0	0.30	7.0	ASH
13338	8.0	0.30	7.0	ASH
13351	12.0	0.90	9.0	OAK
13839	7.0	0.40	9.0	ASH
13862	8.0	0.30	9.0	ASH
13869	12.0	0.30	12.0	OAK
14240	13.0	0.40	12.0	OAK
30140	7.0	0.30	7.0	WILLOW
30203	5.0	0.10	9.0	ASH
30204	5.0	0.10	9.0	ASH
30205	6.0	0.10	8.0	ASH
30206	6.0	0.10	8.0	ASH
30207	4.0	0.10	7.0	ASH
30236	14.0	1.10	15.0	OAK
30370	14.0	0.50	13.0	ASH
30371	7.0	0.30	12.0	ASH
30372	15.0	0.50	14.0	ASH
30373	15.0	0.50	14.0	ASH
30435	15.0	0.50	14.0	ASH
30440	9.0	0.30	13.0	ASH
30441	9.0	0.30	13.0	ASH
41617	9.0	0.50	8.0	OAK
41618	15.0	1.00	9.0	OAK
41624	13.0	0.80	10.5	OAK
41941	13.0	0.90	9.5	OAK
41953	9.0	0.60	8.5	OAK
41958	9.0	0.70	8.5	OAK
41959	13.5	1.00	10.0	OAK

Sheet Layout

1
2
3
4
5
6
7

Rev. Suffix	Date	Initial	Revision Details

Surveyor	PD/MB	Verified By	PD/MB	CAD Operator	TJH	Approved By	ARL	Date	15.01.20

Levelling GNSS Datum OSGB36

To an OS GNSS Datum

Client

Wates Developments Ltd

Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 6 of 7

Job No. 1910073
Old Job No.

Drawing Number
WD/1910073/6

Revision Suffix

Scale
1:500m (A0)

Date
January 2020

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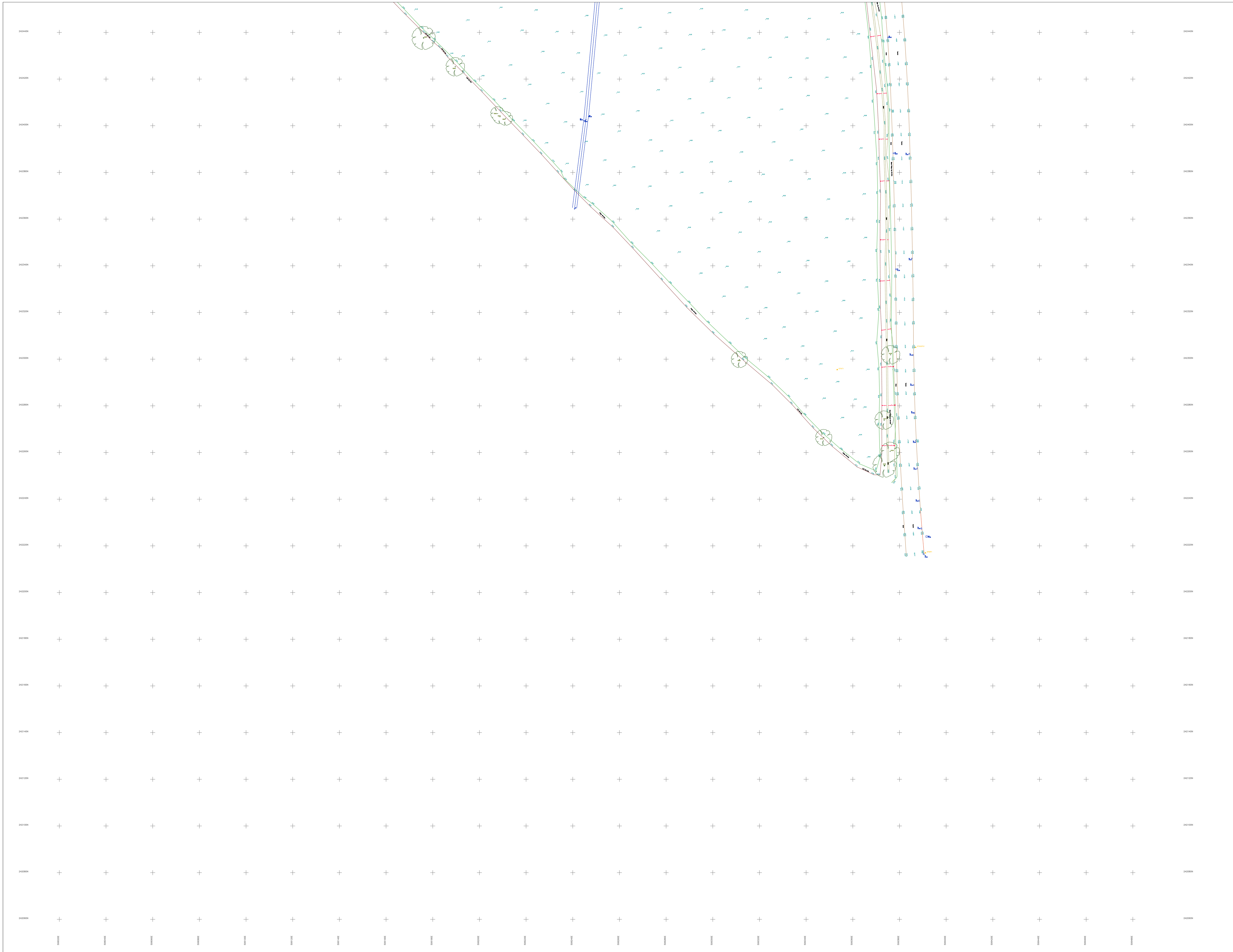

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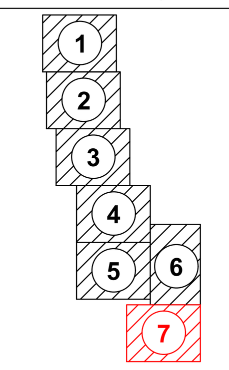
INDICATIVE

Legend:

Sheet Layout



Rev. Suffix	Date	Initial	Revision Details

Surveyor	PD/MB	Verified By	PD/MB	CAD Operator	TJH	Approved By	ARL	Date	15.01.20

Levelling GNSS Datum OSGB36

To an OS GNSS Datum

Client

Wates Developments Ltd

Location

Land off A6, Wixhams Bedford

Drawing Title

Topographical Survey Sheet 7 of 7

Job No. 1910073	Old Job No.
Drawing Number WD/1910073/7	Revision Suffix
Scale 1:500m (A0)	Date January 2020

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PENTIRE - STABLE 1
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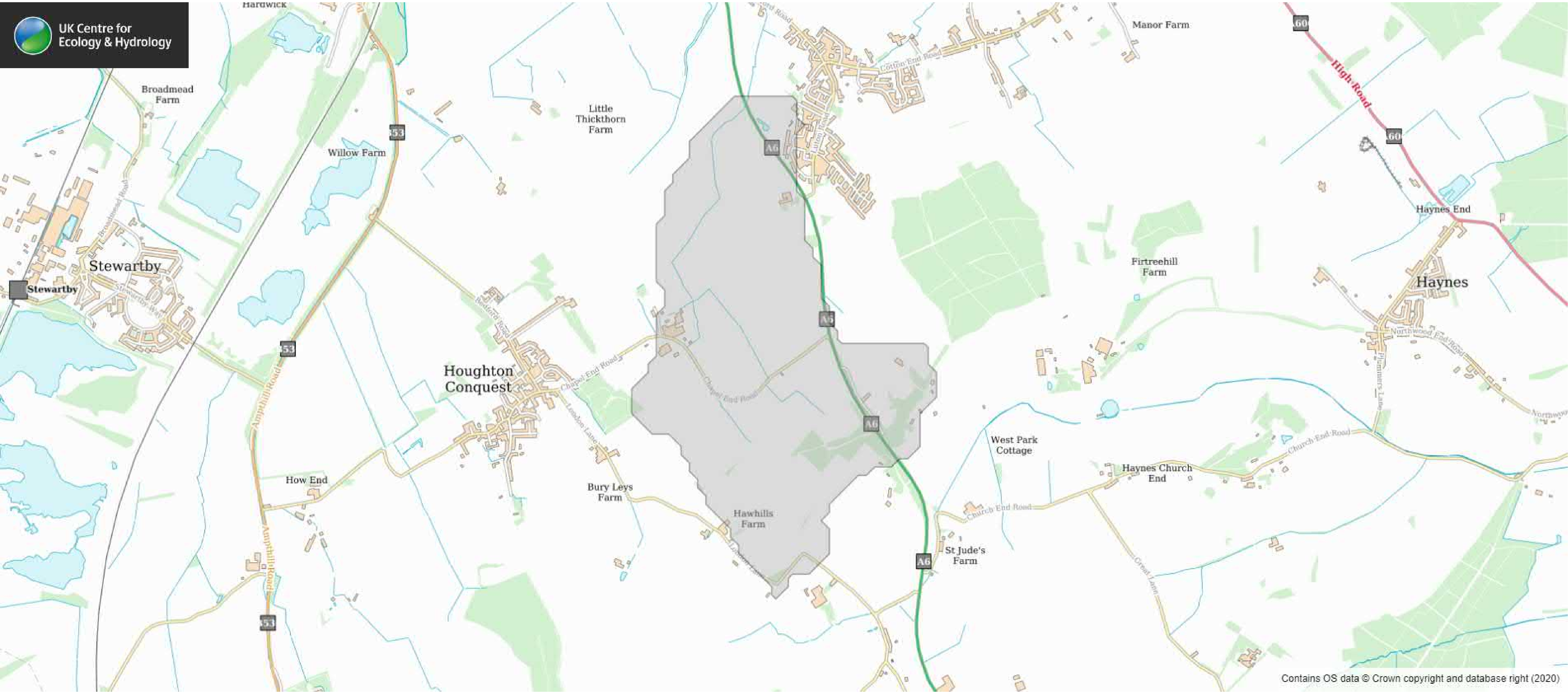
UK Centre for Ecology & Hydrology
Hardwick
Broadmead Farm
Willow Farm
Little Thickthorn Farm
Manor Farm
Stewartby
Houghton Conquest
How End
Bury Leys Farm
Hawhills Farm
Firtreehill Farm
Haynes End
Haynes
West Park Cottage
Haynes Church End
St Jude's Farm
High Road
Ampthill Road
Chapel End Road
London Lane
Church End Road
Northwood End Road
Plummers Lane
Great Lane
Cotton End Road
A6
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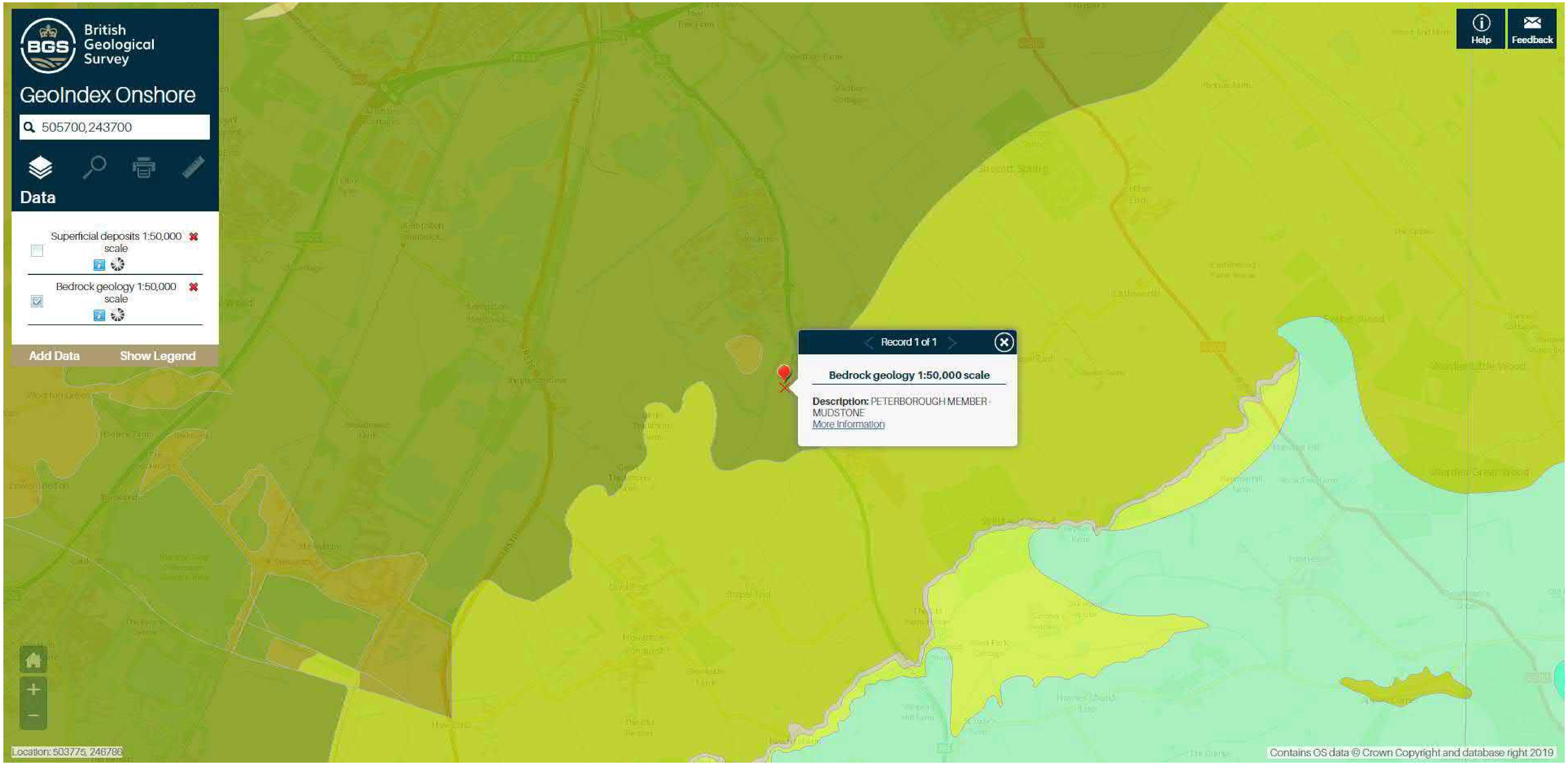
UK Centre for Ecology & Hydrology
Cp Cottage
Kempston Hardwick
Broadmead Farm
Berry Farm
Willow Farm
Little Thickthorn Farm
Duck End
Manor Farm
Exeterwood Farm House
High Road
Stewartby
Houghton Conquest
How End
Bury Leys Farm
Firtreehill Farm
West Park Cottage
Haynes Church End
A6
Bedford Road
Chapel End Road
Cotton End Road
Church End Road
Ampthill Road
Manor Road
London Lane
Fields Road


British Geological Survey
BGS
GeoIndex Onshore
505700,243700
Data
Superficial deposits 1:50,000 scale
Bedrock geology 1:50,000 scale
Add Data
Show Legend
Help
Feedback
Record 1 of 1
Bedrock geology 1:50,000 scale
Description: PETERBOROUGH MEMBER - MUDSTONE
More Information
Location: 503775, 246786
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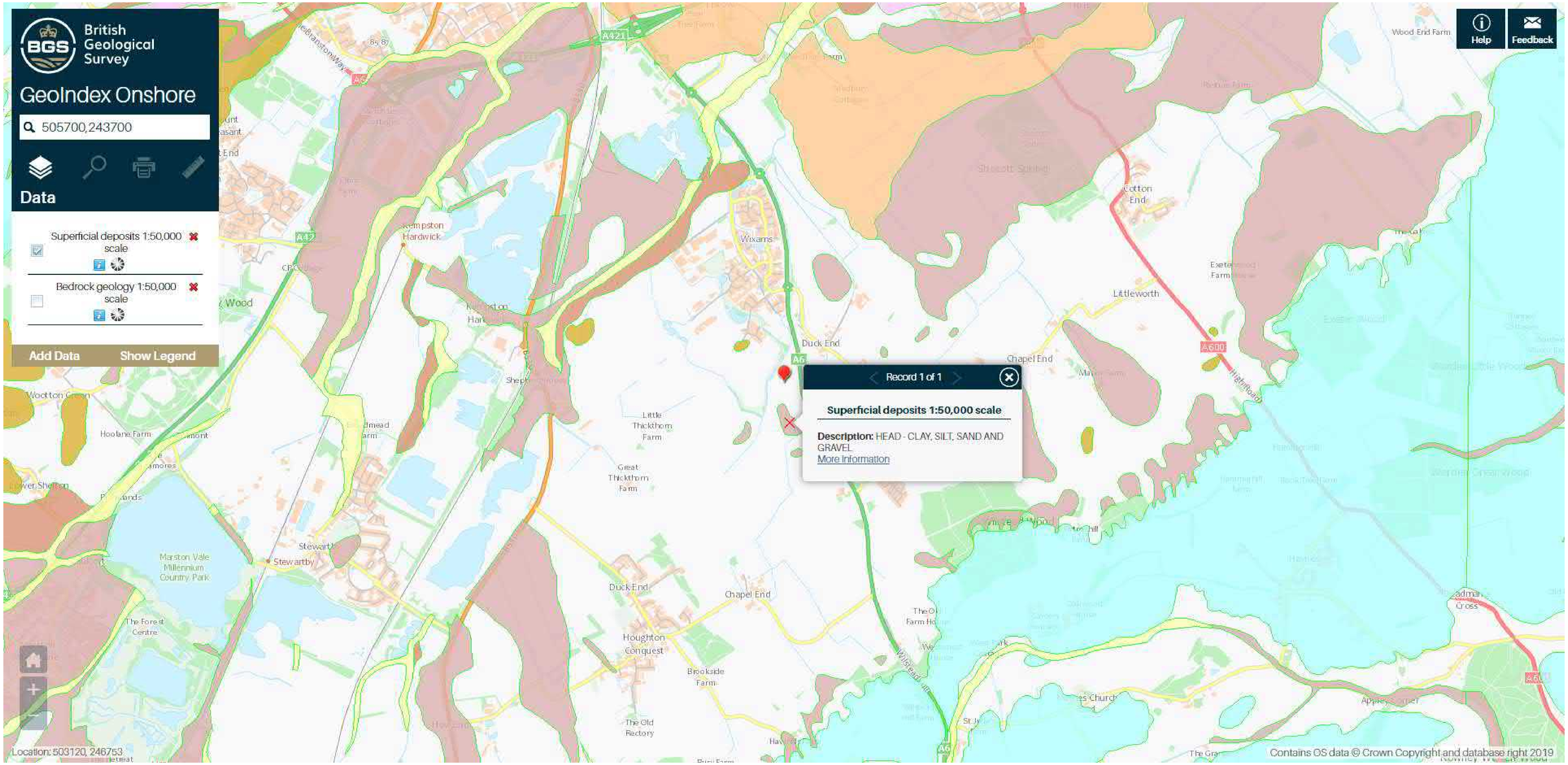
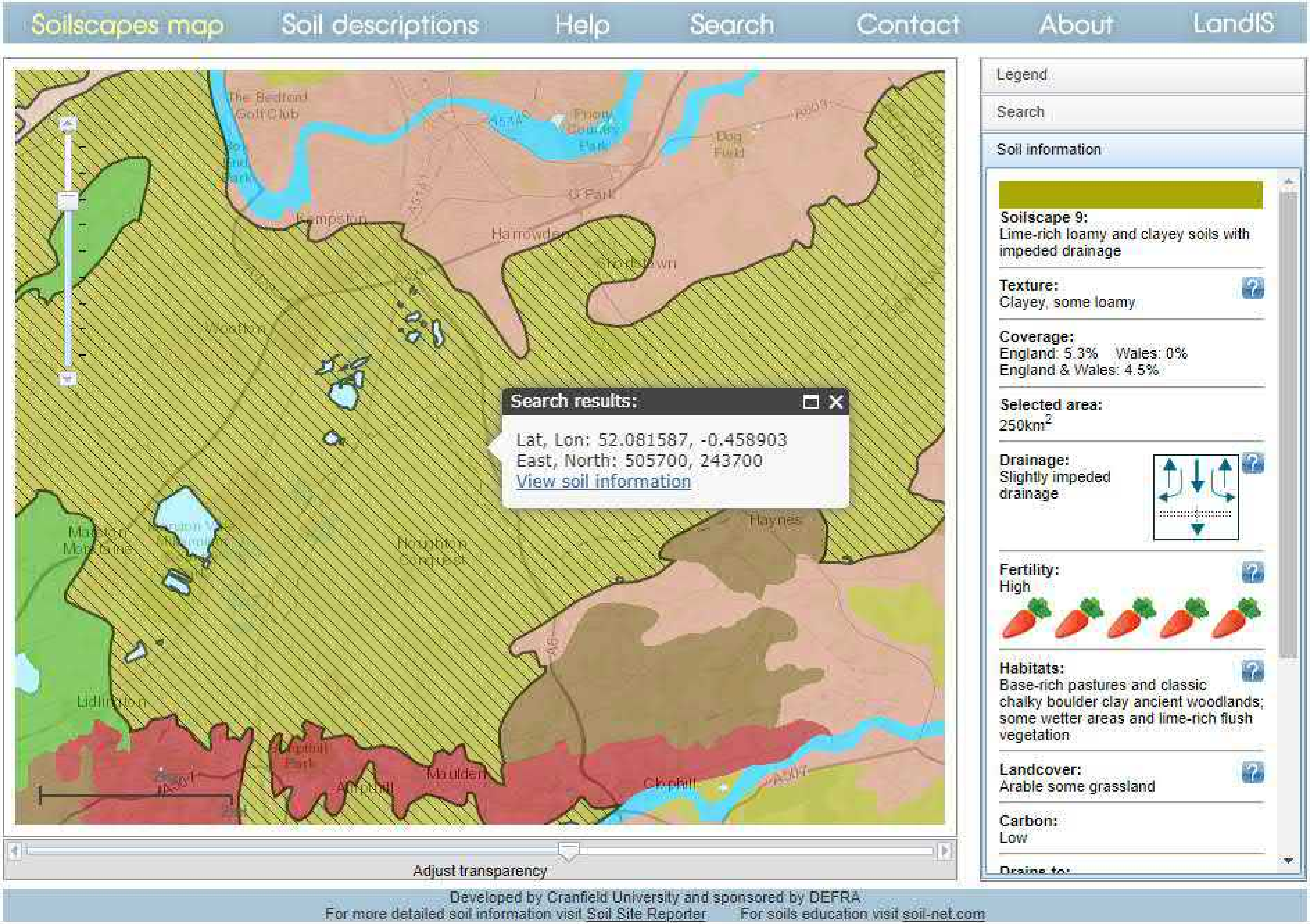
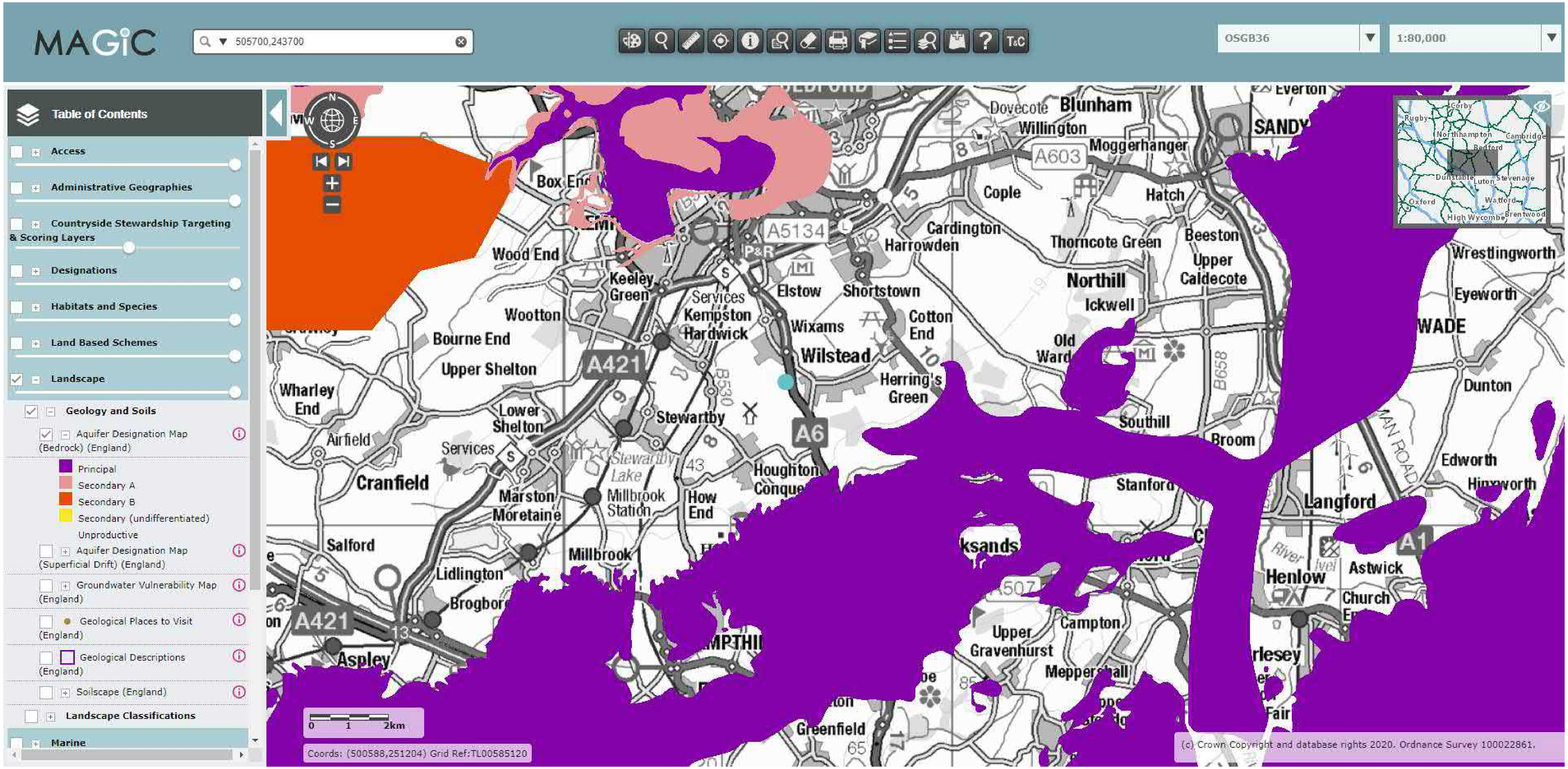


British Geological Survey
GeoIndex Onshore
505700,243700
Data
Superficial deposits 1:50,000 scale
Bedrock geology 1:50,000 scale
Add Data
Show Legend
Help
Feedback
Record 1 of 1
Superficial deposits 1:50,000 scale
Description: HEAD - CLAY, SILT, SAND AND GRAVEL
More Information
Location: 503120, 246753
Contains OS data © Crown Copyright and database right 2019
Kempston Hardwick
Wixams
Duck End
Chapel End
Littleworth
Cotton End
Little Thickthorn Farm
Great Thickthorn Farm
Houghton Conquest
Brookside Farm
The Old Rectory
Stewartby
Marston Vale Millennium Country Park
The Forest Centre
Hoolane Farm
Wootton Green
Wood End Farm
Exeter Wood Farm
Haynes Church
Appley Corner
A6
A421
A600


Soilscapes map
Soil descriptions
Help
Search
Contact
About
LandIS
The Bedford Golf Club
Priory Country Park
Harrowden
Haynes
Houghton Conquest
Maulden
Clophill
Lidlington
Search results:
Lat, Lon: 52.081587, -0.458903
East, North: 505700, 243700
View soil information
Adjust transparency
Legend
Search
Soil information
Soilscape 9:
Lime-rich loamy and clayey soils with impeded drainage
Texture:
Clayey, some loamy
Coverage:
England: 5.3% Wales: 0%
England & Wales: 4.5%
Selected area:
250km²
Drainage:
Slightly impeded drainage
Fertility:
High
Habitats:
Base-rich pastures and classic chalky boulder clay ancient woodlands; some wetter areas and lime-rich flush vegetation
Landcover:
Arable some grassland
Carbon:
Low
Developed by Cranfield University and sponsored by DEFRA
For more detailed soil information visit Soil Site Reporter
For soils education visit soil-net.com



MAGiC
505700,243700
OSGB36
1:80,000
Table of Contents
Access
Administrative Geographies
Countryside Stewardship Targeting & Scoring Layers
Designations
Habitats and Species
Land Based Schemes
Landscape
Geology and Soils
Aquifer Designation Map (Bedrock) (England)
Principal
Secondary A
Secondary B
Secondary (undifferentiated)
Unproductive
Aquifer Designation Map (Superficial Drift) (England)
Groundwater Vulnerability Map (England)
Geological Places to Visit (England)
Geological Descriptions (England)
Soilscape (England)
Landscape Classifications
Marine
Blunham
Willington
Moggerhanger
SANDY
Cople
Hatch
Cardington
Harrowden
Thorncote Green
Beeston
Upper Caldecote
Northill
Ickwell
Elstow
Shortstown
Cotton End
Wixams
Wilstead
Herring's Green
Old Warden
Southill
Broom
Stanford
Langford
Henlow
Astwick
Edworth
Hinxworth
Dunton
Eyeworth
Wrestlingworth
Campton
Upper Gravenhurst
Meppershall
Greenfield
Box End
Wood End
Keeley Green
Kempston Hardwick
Services
Wootton
Bourne End
Upper Shelton
Lower Shelton
Wharley End
Cranfield
Stewartby
Stewartby Lake
Houghton Conquest
How End
Marston Moretaine
Millbrook Station
Millbrook
Salford
Lidlington
Brogborough
Aspley
A421
A6
A603
A5134
A1
0 1 2km
Coords: (500588,251204) Grid Ref:TL00585120
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MAGiC
505700,243700
OSGB36
1:80,000
Table of Contents
Access
Administrative Geographies
Countryside Stewardship Targeting & Scoring Layers
Designations
Habitats and Species
Land Based Schemes
Landscape
Geology and Soils
Aquifer Designation Map (Bedrock) (England)
Aquifer Designation Map (Superficial Drift) (England)
Principal
Secondary A
Secondary B
Secondary (undifferentiated)
Unknown (lakes+landslip)
Unproductive
Groundwater Vulnerability Map (England)
Geological Places to Visit (England)
Geological Descriptions (England)
Soilscape (England)
Landscape Classifications
SANDY
B1042
A421
A6
A1
Houghton
Millbrook Station
Stewartby Lake
Services
Lidlington
Aspley Guise
Ickwell
Cotton End
Dunton
Hinxworth
Stotfold
Shillington
Upper Stondon
Coords: (495402,251331) Grid Ref:SP95405133
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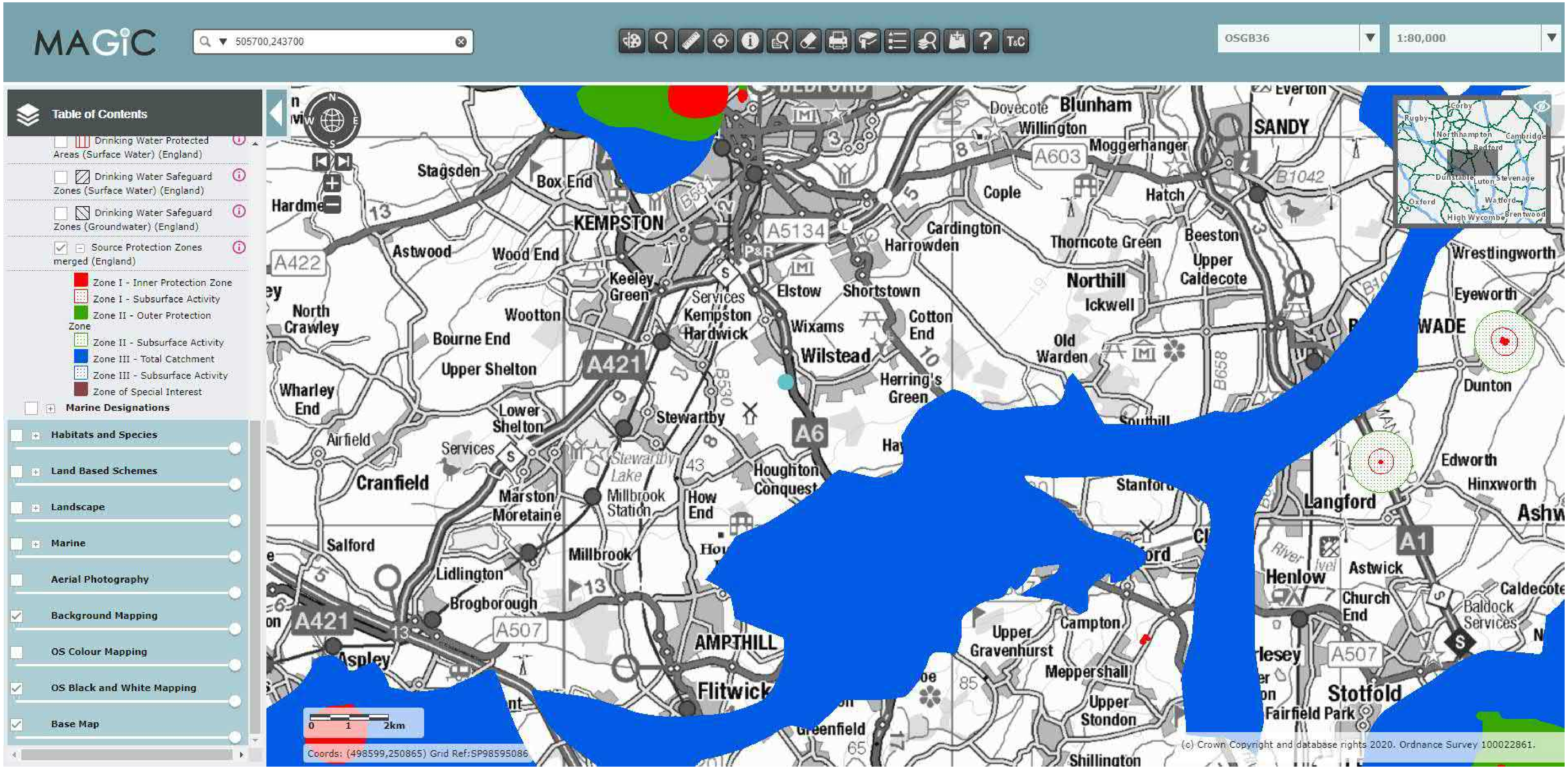
Northampton
Cambridge
Bedford
Luton
Stevenage
Oxford
Watford
High Wycombe
Brentwood
Rugby
Corby
Dunstable


MAGIC
505700,243700
OSGB36
1:80,000
Table of Contents
Drinking Water Protected Areas (Surface Water) (England)
Drinking Water Safeguard Zones (Surface Water) (England)
Drinking Water Safeguard Zones (Groundwater) (England)
Source Protection Zones merged (England)
Zone I - Inner Protection Zone
Zone I - Subsurface Activity
Zone II - Outer Protection Zone
Zone II - Subsurface Activity
Zone III - Total Catchment
Zone III - Subsurface Activity
Zone of Special Interest
Marine Designations
Habitats and Species
Land Based Schemes
Landscape
Marine
Aerial Photography
Background Mapping
OS Colour Mapping
OS Black and White Mapping
Base Map
Stagsden
Box End
KEMPSTON
Hardmead
Astwood
Wood End
A422
North Crawley
Keeley Green
Kempston Hardwick
Elstow
Shortstown
Wootton
Bourne End
Upper Shelton
A421
Wilstead
Cotton End
Wharley End
Lower Shelton
Stewartby
A6
Herring's Green
Airfield
Services
Cranfield
Stewartby Lake
Houghton Conquest
Marston Moretaine
Millbrook Station
How End
Salford
Millbrook
Lidlington
Brogborough
A507
AMPTHILL
Flitwick
Aspley
Greenfield
Blunham
Dovecote
Willington
SANDY
Moggerhanger
A603
Cople
Hatch
B1042
Cardington
Harrowden
Thorncote Green
Beeston
Upper Caldecote
Northill
Ickwell
Old Warden
B658
Wrestlingworth
Eyeworth
Dunton
Edworth
Hinxworth
Langford
A1
Astwick
Henlow
Church End
Caldecote
Baldock Services
Upper Gravenhurst
Campton
Meppershall
Upper Stondon
Shillington
A507
Stotfold
Fairfield Park
River Ivel
0 1 2km
Coords: (498599,250865) Grid Ref:SP98595086
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APPENDIX B
PROPOSED DEVELOPMENT

rev.	date	changes description	status	issued by
P03	8/11/2020	Amended to engineer comments	S1	
P02	8/11/2020	Amendements from consultant comments	S1	
P01	2/11/2020		S0	RP

RE–FOR MAT

www.re-format.co.uk
mail@re-format.co.uk
+44 (0)1730 778778

drawn by	date created	project title
RP	Jan 2020	Land west of A6, Wixams
checked by	scale at A3	document title
MS	1:5000	Site Layout

project	originator	volume	level	type	role	number
F19146 -	RFT -	01 -	XX -	DR -	A -	0103

status	suitability description	revision
S1	Suitable for Co-ordination	P03