

# Parcel N and Linear Park Ph3A, Arborfield Green, Wokingham

Flood Risk Assessment Compliance Note

August 2025

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# Report Reference

19632/FRA-C

# Revision History

| Rev          | Amendments                         | Prepared By | Checked By | Date        |
|--------------|------------------------------------|-------------|------------|-------------|
| First Issue  | N/A                                | GBR         | GBR        | 31/07//2025 |
| Second Issue | Linear Park Ph3A added to Document | SE          | ShD        | 11/08/2025  |
| Third Issue  | Layout revised                     | ShD         | GBR        | 29/09/2025  |
| Fourth Issue | Layout revised                     | ShD         | GBR        | 08.05.2026  |
| Fifth Issue  | Road layout revised                | ShD         | GBR        | 20.05.2026  |

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# Introduction

# Introduction

The following paragraphs state the document's purpose and provide a summary of the site's planning history; together with the relevant conditions to which the report seeks to demonstrate compliance.

- 1.1 This Flood Risk Assessment Compliance Report (FRA-C) has been prepared by Woods Hardwick Ltd on behalf of Crest Nicholson in support of their Reserved Matters Planning Application for a site known as 'Parcel N, Arborfield Green, Wokingham' and the Reserved Matters Planning Application pursuant to outline permission O/2014/2280 comprising landscaping, substation and balancing pond at the site 'Linear Park Ph3A, Arborfield Green'.
- 1.2 This document has been prepared to demonstrate that the proposed FRA-C for Parcel N and Linear Park Ph3A is to be discharged of conditions.
- 1.3 The site forms part of a wider scheme known as Arborfield Green which benefits from Outline Planning Approval (Ref: 14/02121/OUT) for the following;

OUTLINE PERMISSION FOR: Demolition of buildings and phased redevelopment of Arborfield Garrison and adjoining land for: Up to 2,000 new dwellings (including up to 80 units of extra care housing). District centre comprising a foodstore up to 4,000 sq m gross with up to a further 3,500 sq m (gross) floor space within Classes A1, A2, A3, A4, A5, B1, D1 and D2 (with residential above - Class C3)), and transport interchange, village square, car parking, servicing and drop off area. Up to a further 1,500 sq m (gross) floor space within Classes D1 and D2. Neighbourhood centre to provide up to 300 sq m (gross) floor space within Classes A1, A2, A3, A4, A5, B1, D1 and D2, with parking/servicing area. Secondary school for up to 1,500 pupils (Class D1) including sports pitches, floodlit all-weather pitch, and indoor swimming pool and parking areas. Up to three-form primary school (Class D1) with sports pitch and parking areas. Associated phased provision of: car parking; public open space including sports pitches, informal/incidental open space, children's play areas including multi-use games area (MUGA), skate park, community gardens/allotments; landscaping/buffer areas; boundary treatments; new roads, footpaths, cycleways and bridleways; sustainable urban drainage systems, including flood alleviation works.

PART 2 - FULL PERMISSION FOR phased development of: Creation of two new areas of Suitable Alternative Natural Greenspace (SANGS) (In the north-eastern part of the application site ("Northern SANGS") and at West Court ("West Court SANGS") including car parking areas, path/walkways, fencing and associated landscaping; re-use Application No: O/2014/2280 - 2 - of existing MoD gymnasium for sports/community uses/centre (Classes D1/D2; new roundabout junction to A327 Reading Road; junction improvements to Langley Common Road, Baird Road and Biggs Lane; junction improvements and new access at Biggs Lane/Princess Marina Drive; re-use and improvements to existing site accesses from Biggs Lane.

- 1.4 The outline planning application was supported by a Flood Risk Assessment Report dated March 2015 which was prepared by AECOM. A separate Foul and Surface Water Drainage Strategy document was prepared by AECOM also dated March 2015.
- 1.5 Whilst the Outline Planning Permission applies to the entire Arborfield Green development this report specifically pertains to Parcel N and Linear Park Ph3A, located within the central area of the wider site to the south of the existing development.
- 1.6 The development proposals for Parcel N comprise 67 residential dwellings plus associated infrastructure. A Site Layout Plan is included in Appendix A.
- 1.7 This document has been prepared to demonstrate that the proposed drainage strategy for Parcel N complies with the approved documents and to allow discharge of Conditions 19 and 34 of the Outline Planning Consent (14/02121/OUT), which are as follows:

43. The development hereby permitted shall be carried out in accordance with the approved Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001 including the mitigation measures detailed in this strategy unless otherwise agreed in writing by the Local Planning Authority. In addition, an off-site drainage strategy will be submitted to and approved in writing by the Local Planning Authority (in consultation with the Sewage Undertaker) prior to the commencement of development and in any relevant phase. No discharge of foul water from the site shall be accepted into the public system until the drainage works relevant to that phase have been completed in accordance with the approved Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001 and the approved off-site drainage strategy. Application No: O/2014/2280 - 22 -

Reason: To ensure that the development does not increase flood risk and to ensure that sufficient capacity is made available to cope with the new development in order to avoid adverse environmental impact upon the community. Relevant policy: NPPF, Wokingham Borough Core Strategy Policy CP1 and CP18 and the Managing Development Delivery Local Plan Policy CC10 and the Arborfield Strategic Development Location Supplementary Planning Document (2011).

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44. No part of the development within a phase shall take place until a surface water drainage scheme for the phase, based on sustainable drainage principles outlined in the agreed FRA (Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001) and an assessment of the hydrological and hydrogeological context of the development, has been submitted to and approved in writing by the local planning authority. The scheme shall subsequently be implemented in accordance with the approved details before the development is completed. The scheme shall also include:

- a. Detailed surface water drainage calculations for all rainfall events (1 in 1, 1 in 30 and 1 in 100) up to and including the 1 in 100 plus climate change storm event.
- b. Demonstration that there will be no flooding on the site up to the 1 in 30 storm event and that and flooding up to the 1 in 100 plus climate change storm event can be safely stored within the site without increasing flood risk to the surrounding area.
- c. SuDS features shall be located outside of the 1 in 100 year plus 20% allowance for climate change flood level.
- d. Limiting the discharge rate from the entire site to Greenfield rates
- e. Details of the feasibility of the use of soakaways in line with BRE 365 to demonstrate whether they are technically feasible and confirmation that there will be a minimum of 1 metre between the base of the infiltration device and the water table.
- f. Information on the hierarchy of options to explain the choice of any proposed SuDS technique.
- g. Details of how the scheme shall be maintained and managed after completion.

Reason: To prevent the increased risk of flooding, to improve and protect water quality, improve habitat and amenity, and ensure future maintenance of the surface water drainage system.

45. No development shall take place within each phase until full details of the Drainage System(s) have been submitted to and approved in writing by the Local Planning Authority. These shall include:

- a. Wherever practical, measures to manage surface water at the surface through incorporation of SuDS that integrate with wider landscape proposals and provide a range of benefits in terms of amenity provision, ecological enhancements and water quality;
- b. Demonstration of where and how surface water attenuation shall be provided across the site and that attenuation features are adequately sized to serve the development for all events up to and including the 1 in 100 year plus Application No: O/2014/2280 - 23 - allowances for climate change taking into consideration detailed intrusive site investigations at the site;
- c. Details of the phased implementation of the drainage system(s) and demonstration that flood risk will not be exacerbated at any time during installation;
- d. Details of the implementation of the drainage system(s) and demonstration that water quality will not be impacted at any time during installation;
- e. Details of the implementation and final state of the drainage system(s) and demonstration that the structural integrity of receiving watercourses will not be impacted at any time;

- f. Clear definition of where surface water outfalls will discharge and demonstration that discharges and attenuation volumes have accounted for the effect of flood levels on receiving water bodies;
- g. Demonstration that any seasonal variation in groundwater levels has been considered in the sizing and location of SuDS features;
- h. Details of the freeboard allowance for any structures required to cross ditches and/or watercourses requiring demonstration that structures do not increase flood risk in all areas upstream and downstream of the proposed development;
- i. Detailed hydraulic modelling of the drainage system(s) incorporating the watercourses, SuDS features both online and offline and demonstration that SuDS storage is not compromised by fluvial flood flows / levels;
- j. Full details of the maintenance and/or adoption proposals /agreements for the development covering all aspects of the proposed drainage system(s), with provision for annual inspection reports to be submitted to the Local Authority for any SUDS that will be retained by private management companies. Development should be implemented in accordance with the approved details and thereafter retained unless otherwise agreed in writing by the Local Planning Authority.

Reason: To prevent the increased risk of flooding, to improve and protect water quality, improve habitat and amenity, and ensure future maintenance of the surface water drainage system in accordance with NPPF, Wokingham Borough Core Strategy Policy CP1 and CP18 and the Managing Development Delivery Local Plan Policy CC10 and the Arborfield Strategic Development Location Supplementary Planning Document (2011).

- 1.8 The purpose of this report is to demonstrate that the proposed drainage design complies with the principles of the approved Surface Water Drainage Strategy prepared by AECOM.
- 1.9 This report confirms that the strategy is compliant with the approved FRA and meets the necessary requirements to discharge Condition 43, 44 and 45 of the Outline Planning Consent.

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# Review of Approved Documents



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# Review of Approved Documents

This section reviews the FRA and Drainage Statement (Ref 3723.FRA.03) and Drainage Strategy Report (Ref: 5348/DS.05) to ensure that proposals at this stage are in accordance with the approved principles.

## Surface Water Drainage Strategy

- 2.1 The site-wide approved surface water drainage strategy is contained within the approved Foul and Surface Water Drainage Strategy document prepared by AECOM dated March 2015.
- 2.2 The approved surface water drainage strategy split the site into sub-catchments to mimic the natural drainage regime. A copy of Surface Water Drainage Strategy that was included within the approved document is included as Appendix B of this report.
- 2.3 The runoff rate for each catchment was based upon the  $Q_{bar}$  rate of 4.3l/s per impermeable hectare. The agreed rates for each catchment were calculated based upon an assumed impermeable area for each catchment. For residential parcels the calculations were based upon 60% impermeable surfacing.
- 2.4 Parcel N was included within Catchment 11 which also include Parcels L and M. The combined allowable discharge rate of the three parcels is 34.7l/s.
- 2.5 Attenuation for all three parcels was proposed within two attenuation basins within the proposed linear park located to the south of Parcel N.
- 2.6 The eastern attenuation basin will have a discharge rate of 9.7l/s and the western basin will have a discharge rate of 25l/s. Both basins discharge into the existing watercourse located to the immediate south of the proposed basins.
- 2.7 The eastern basin would accommodate flows from Parcel N only while the western basin is designed to accommodate the remainder of Parcel N as well as Parcels L and M.
- 2.8 The total attenuation volume calculated for the parcels to attenuate storms up to the 1 in 100 year event with 40% climate change allowance was 1580m<sup>3</sup>.

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#### Foul Water Drainage Strategy

- 2.9 In terms of foul drainage, the approved (outline) Foul and Surface Water Drainage Strategy proposed to construct a gravity foul sewer network within each of the development parcels that would generally follow the existing topography and discharge into the existing combined sewer that crosses the site.
- 2.10 The strategy proposed 12 connections from the site into the existing sewer network with existing connections being utilised where possible. The proposed outfall from Parcel N was to the Thames water sewer that runs slightly beyond the eastern boundary of the parcel. A copy of the outline sitewide Foul Water drainage strategy is included within Appendix B.
- 2.11 Through discussions with Thames Water it was confirmed that there would be capacity at the treatment works to serve the development at such time as discharge from the site is required.

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# Proposed Drainage Strategy



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# Proposed Drainage Strategy

The following paragraphs provide detail on the proposed drainage strategy which follows the general principles of the approved FRA and DS with some amendments as necessary.

## Proposed Surface Water Drainage Strategy

- 3.1 The proposed drainage strategy for Parcel N has been prepared by Woods Hardwick and is shown on the Drainage Strategy Drawing included in Appendix D.
- 3.2 In order to ensure that the proposals follow the hierarchy for surface water discharge the applicant commissioned Wilson and Bailey Geotechnical & Environmental (WB) to undertake a Desk Study and Phase 1 Ground Investigation Report.
- 3.3 Within their report WB confirm that soakaways are not considered to present a viable option for disposal of surface water due to the predominantly clayey nature of the near surface soils. It is therefore recommended that discharge to the local surface water drainage network of ditches, swales and basins should be explored by the civil engineers as part of the detailed drainage design.
- 3.4 The WB investigations also included groundwater monitoring which confirmed that groundwater seepages and inflows were encountered in a number of exploratory boreholes at depths of between about 2.00 m and 4.00 m below ground level. Limited monitoring of the standpipes installed into the small diameter boreholes indicates boreholes to be generally dry but where groundwater has been detected it is present at inconsistent depths that are indicative of localised pockets of groundwater perched within the sandier layers, rather than being indicative of a single body of laterally consistent and hydraulic continuous groundwater. Relevant extracts from the WB report can be found in Appendix C.
- 3.5 In light of the above and in accordance with the hierarchy it is proposed to discharge to the existing watercourses as per the approved outline strategy.
- 3.6 The strategy comprises two separate drainage networks, each serving a portion of the site. Both networks convey surface water unrestricted into the attenuation basins located within the proposed linear park to the south.
- 3.7 The basins were designed to accommodate flows from Parcel L, M and N. The eastern basin accommodates Parcel N only while the western basin accommodates the remainder of Parcel N as well as Parcels L and M.

3.8 The proposed discharge rates from the eastern and western basins are 9.7l/s and 24.4l/s respectively. The discharge rate of 9.7l/s is equal to the rate approved at the outline planning stage while the rate of 24.4 l/s represents slight betterment on the approved rate of 25l/s from the western basin.

3.9 The surface water drainage calculations, included in Appendix E, demonstrate that the proposed onsite attenuation features are capable of accepting flows from the 1 in 100-year rainfall event including 40% climate change plus 10% urban creep.

Proposed Foul Water Drainage Strategy

3.10 The proposed foul water drainage strategy is also shown on the Drainage Strategy Drawing included in Appendix D.

3.11 The drawing confirms that foul water flows from the site will be discharged via gravity into the existing foul water that crosses the site.

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# Maintenance and Management

# Maintenance and Management

The following paragraphs provide detail on the likely maintenance and management measures that will need to be undertaken across the lifetime of the development.

- 4.1 The arrangements for further maintenance of the surface water drainage system needs to be fully considered to ensure long-term functionality of the drainage system.
- 4.2 It is proposed that the piped surface water network including flow controls and headwalls and will be offered to Thames Water for adoption under S104 of the Water Industry Act. These systems will be subject to the maintenance regime of Thames Water which is subject to regulatory approval.
- 4.3 The maintenance regime defines the scope of inspections and maintenance that is to be carried out on the pipes and flow control device during and following construction, the stormwater drains will need to be regularly inspected in order to assess their performance and to schedule any required maintenance.
- 4.4 Items that are subjected to routine inspections for maintenance may comprise but are not limited to those listed in the table below, the party that will potentially be responsible for the various components are listed in the fourth column.

| Item                         | Routine Inspections for Maintenance                                                                                                                                                                                                                                              | Minimum Frequency                   | Responsibility |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------|----------------|
| Pipes / Manholes / Catchpits | <p>Inspect surface access points to manholes and catchpits as well as the surrounding area.</p> <p>Particular attention should be paid to damage or blockage.</p> <p>To be visually inspected after heavy rainfall events to ensure that they are free of debris and litter.</p> | <p>6 monthly</p> <p>As required</p> | Thames Water   |
| Flow Control Device          | <p>Inspect flow control device for blockages, damage and general condition.</p> <p>To be visually inspected after heavy rainfall events to ensure that they are free of debris and litter.</p>                                                                                   | <p>6 monthly</p> <p>As required</p> | Thames Water   |

- 4.5 In addition, personnel completing the routine inspections for maintenance should be generally observant of items such as equipment failures, leaking water, scouring and/or signs of blockages of water flow. If such items are observed, an immediate inspection for engineering maintenance may be necessary.
- 4.6 Engineering inspections will generally comprise a walk over survey of the site, along with additional investigation activities as considered necessary. These inspections are primarily concerned with checking engineering aspects of the drainage that are not likely to be picked up during a routine inspection such as manhole damage and concrete deterioration.
- 4.7 During inspections for engineering maintenance, care is needed to look for signs of pipe blockages. This can only be checked at the inlet and outlet of manholes at the base. Items that are to be subject to Engineering Inspections for Maintenance will comprise of those listed in the table below:

| Item                 | Engineering Inspections for Maintenance                                                                                                                                                                                                                                                              |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Manholes / Catchpits | <p>All manholes/Catchpits will require to be inspected externally and internally.</p> <p>External inspections will determine the overall condition of the access points, and should record deterioration of exposed concrete, access lids, restricted access due to overgrown vegetation/debris.</p> |
| Flow Control Device  | <p>Inspections will determine the overall condition of the flow control device to ensure it is working efficiently and effectively.</p>                                                                                                                                                              |

- 4.8 As a result of the routine inspections, a schedule of maintenance activities shall be drawn up to address those issues identified during the inspection. Examples of possible maintenance activities may comprise, but not be limited to those listed in the table below:

| Item                        | Scheduled Maintenance Activities             | Minimum Frequency |
|-----------------------------|----------------------------------------------|-------------------|
| Manholes / Catchpits        | Clear accumulated sedimentation              | 6 monthly         |
|                             | Repair/replace damaged pit covers and grates | As required       |
| Pipes / Flow Control Device | Clear accumulated sediment and debris        | 6 monthly         |

- 4.9 The table below highlights the likely renewal and replacement works that will be required and how this work will be funded.

| Item                | Renewal & Replacement Works                                                               | Undertaken / Financed by |
|---------------------|-------------------------------------------------------------------------------------------|--------------------------|
| Flow Control Device | Flow control to be replaced by a competent Contractor to the manufacturer's specification | Thames Water             |

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# FRA Compliance



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# FRA Compliance

Presented below is a summary of how the proposed drainage strategy complies with the requirements of Planning Conditions 6, 8 and 11 and where the relevant information can be found.

- 5.1 On the basis of the information presented below it can be concluded that sufficient information has been provided to allow the discharge of Planning Conditions 43, 44 and 45.

| Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Compliance                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>43. The development hereby permitted shall be carried out in accordance with the approved Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001 including the mitigation measures detailed in this strategy unless otherwise agreed in writing by the Local Planning Authority. In addition, an off-site drainage strategy will be submitted to and approved in writing by the Local Planning Authority (in consultation with the Sewage Undertaker) prior to the commencement of development and in any relevant phase. No discharge of foul water from the site shall be accepted into the public system until the drainage works relevant to that phase have been completed in accordance with the approved Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001 and the approved off-site drainage strategy. Application No: O/2014/2280 - 22</p> <ul style="list-style-type: none"> <li>•</li> </ul> | <p>The proposed Surface and Foul Water drainage strategies for parcel N have been designed in accordance with the plans and strategies that were approved at the outline planning stage. The Strategy for parcel N is described in Section 3 of this report and shown on the plans included within Appendix D. The calculations are included within Appendix E.</p> |

| Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Compliance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>44. No part of the development within a phase shall take place until a surface water drainage scheme for the phase, based on sustainable drainage principles outlined in the agreed FRA (Foul and Surface Water Drainage Strategy Revision 3 Updated drainage strategy plan and phasing plan included dated 03/03/15 Job No 60312043 Reference DS/001) and an assessment of the hydrological and hydrogeological context of the development, has been submitted to and approved in writing by the local planning authority. The scheme shall subsequently be implemented in accordance with the approved details before the development is completed. The scheme shall also include:</p> <p>a. Detailed surface water drainage calculations for all rainfall events (1 in 1, 1 in 30 and 1 in 100) up to and including the 1 in 100 plus climate change storm event.</p> <p>b. Demonstration that there will be no flooding on the site up to the 1 in 30 storm event and that and flooding up to the 1 in 100 plus climate change storm event can be safely stored within the site without increasing flood risk to the surrounding area.</p> <p>c. SuDS features shall be located outside of the 1 in 100 year plus 20% allowance for climate change flood level.</p> <p>d. Limiting the discharge rate from the entire site to Greenfield rates</p> <p>e. Details of the feasibility of the use of soakaways in line with BRE 365 to demonstrate whether they are technically feasible and confirmation that there will be a minimum of 1 metre between the base of the infiltration device and the water table.</p> <p>f. Information on the hierarchy of options to explain the choice of any proposed SuDS technique.</p> <p>g. Details of how the scheme shall be maintained and managed after completion.</p> | <p>a. Calculations for all storm events up to the 1 in 100 year + CC event are included within Appendix E.</p> <p>b. The calculations in Appendix E confirm this requirement.</p> <p>c. All SuDS features are located outside of the Flood Zone.</p> <p>d. The discharge rate from Parcel N is restricted downstream of the basins to the Qbar rate.</p> <p>e. Based upon the underlying ground conditions infiltration is not feasible. This is confirmed in Section 3 and Appendix D.</p> <p>f. The hierarchy of options was reviewed and agreed at the outline stage and confirmed within Sections 2 and 3 of this report.</p> <p>g. A maintenance schedule is included as Section 4 of this report.</p> |

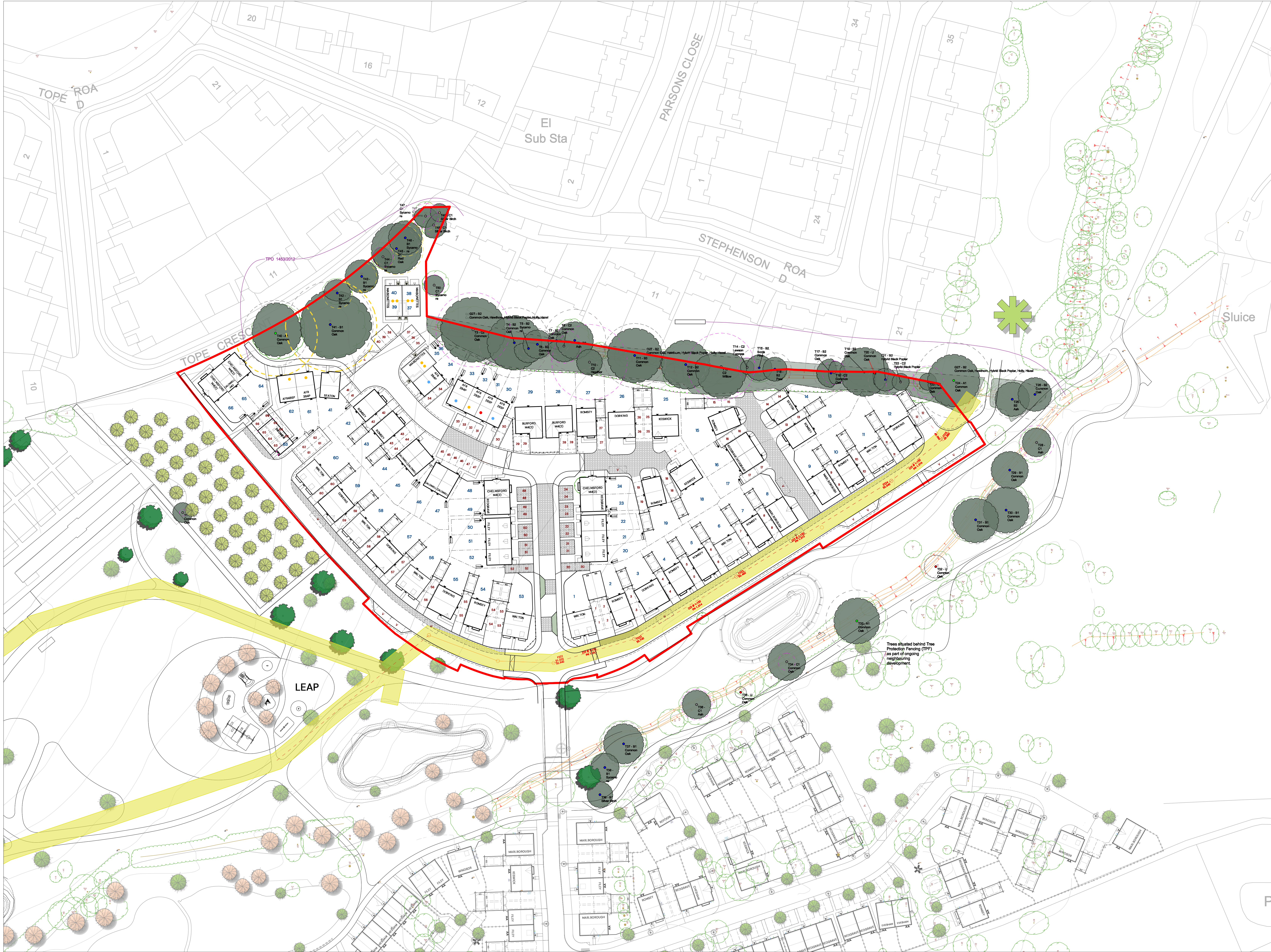
| Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Compliance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| <p>45. No development shall take place within each phase until full details of the Drainage System(s) have been submitted to and approved in writing by the Local Planning Authority. These shall include: a. Wherever practical, measures to manage surface water at the surface through incorporation of SuDS that integrate with wider landscape proposals and provide a range of benefits in terms of amenity provision, ecological enhancements and water quality; b. Demonstration of where and how surface water attenuation shall be provided across the site and that attenuation features are adequately sized to serve the development for all events up to and including the 1 in 100 year plus Application No: O/2014/2280 - 23 - allowances for climate change taking into consideration detailed intrusive site investigations at the site; c. Details of the phased implementation of the drainage system(s) and demonstration that flood risk will not be exacerbated at any time during installation; d. Details of the implementation of the drainage system(s) and demonstration that water quality will not be impacted at any time during installation; e. Details of the implementation and final state of the drainage system(s) and demonstration that the structural integrity of receiving watercourses will not be impacted at any time; f. Clear definition of where surface water outfalls will discharge and demonstration that discharges and attenuation volumes have accounted for the effect of flood levels on receiving water bodies; g. Demonstration that any seasonal variation in groundwater levels has been considered in the sizing and location of SuDS features; h. Details of the freeboard allowance for any structures required to cross ditches and/or watercourses requiring demonstration that structures do not increase flood risk in all areas upstream and downstream of the proposed development; i. Detailed hydraulic modelling of the drainage system(s) incorporating the watercourses, SuDS features both online and offline and demonstration that SuDS storage is not compromised by fluvial flood flows / levels; j. Full details of the maintenance and/or adoption proposals /agreements for the development covering all aspects of the proposed drainage system(s), with provision for annual inspection reports to be submitted to the Local Authority for any SUDS that will be retained by private management companies. Development should be implemented in accordance with the approved details and thereafter retained unless otherwise agreed in writing by the Local Planning Authority.</p> | <ul style="list-style-type: none"> <li>a. All of the proposed attenuation for Parcel N is above ground in accordance with the approved strategy.</li> <li>b. The attenuations features are shown on the Appended Drainage Strategy drawings.</li> <li>c. The attenuation basins required to attenuate Parcel N will be constructed in advance of connections being required from the parcel.</li> <li>d. Details of implementation will be provided at the detailed design stage.</li> <li>e. The required details will be provided at the detailed design stage.</li> <li>f. The required details are shown on the Drainage Strategy drawings.</li> <li>g. Groundwater seepages were encountered at depths between 2.0-4.0m below ground level. The inconsistent depths are inficative of localised pockets of groundwater perched on sandier layers rather thanbeing indicative of a single body of laterally consistent and hydraulic continuous groundwater.</li> <li>h. A minimum of 300mm of freeboard is provided in the basins</li> <li>i. The Calculations relevant for Parcel N are included within Appendix D.</li> <li>j. The maintenance strategy is included within Appendix 4 of this report.</li> </ul> |

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# Appendix A

## Site Layout Plan

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#### KEY: SITE LAYOUT

APPLICATION BOUNDARY

#### SURFACE MATERIALS:

GARDEN/POS/HIGHWAY VERGE  
(SEE DETAILED LANDSCAPE PROPOSALS)

TARMACADUM

BLOCK PAVING

#### ENCLOSURE DETAILS:

1.8M HIGH BRICK WALL

1.8M HIGH CLOSE BOARDED FENCING

0.9M HIGH ESTATE RAILING

#### LANDSCAPING:

INDICATIVE TREE PLANTING  
(SEE DETAILED LANDSCAPE PROPOSALS)

RETAINED VEGETATION  
(SEE TREE RETENTION PLAN)

ROOT PROTECTION AREA

POTENTIAL ALLOTMENTS

#### OTHER:

BIN COLLECTION POINT

GATE/PERSONNEL DOOR

CYCLE STORE

SOCIAL RENT

SHARED OWNERSHIP

AFFORDABLE RENT

PROPOSED DIVERSION TO SEWERS  
AND MANHOLES

EXISTING SEWERS AND MANHOLES

| House Type Schedule - Parcel N, Arborfield Green |        |             |              |      |         |              |     |
|--------------------------------------------------|--------|-------------|--------------|------|---------|--------------|-----|
| Open Mix Housetypes                              | No's   | Sq. ft      | Total Sq. ft | Beds | Storeys | Individual % |     |
| Dorset                                           | 1      | 750         | 750          | 2    | 2       | 2%           |     |
| Caldwell                                         | 5      | 785         | 3,925        | 2    | 2       | 9%           |     |
| Redgrave                                         | 4      | 922         | 3,688        | 3    | 2       | 8%           |     |
| Chelmsford M4(2)                                 | 3      | 997         | 2,991        | 3    | 2       | 6%           |     |
| Chelmsford                                       | 1      | 997         | 997          | 3    | 2       | 2%           |     |
| Seaton                                           | 2      | 1,043       | 2,086        | 3    | 2       | 4%           |     |
| Foley                                            | 6      | 1,127       | 6,762        | 3    | 2.5     | 11%          |     |
| Romsey                                           | 12     | 1,176       | 14,112       | 4    | 2       | 23%          |     |
| Kewick                                           | 2      | 1,226       | 2,452        | 4    | 2       | 4%           |     |
| Marborough                                       | 2      | 1,517       | 3,034        | 4    | 2       | 4%           |     |
| Dorking                                          | 6      | 1,517       | 9,102        | 4    | 2       | 11%          |     |
| Burford M4(2)                                    | 2      | 1,612       | 3,224        | 4    | 2       | 4%           |     |
| Watton                                           | 7      | 1,855       | 12,985       | 5    | 2.5     | 13%          |     |
| Affordable Housetypes                            | No's   | Sq. ft      | Total Sq. ft | Beds | Storeys | Individual % |     |
| Social Rent                                      |        |             |              |      |         |              |     |
| 1B Maisonette M4(2) GF                           | 3      | 538         | 1,614        | 1    | 1       |              |     |
| 1B Maisonette M4(2) FF                           | 3      | 663         | 1,989        | 1    | 1       |              |     |
| AFR 2B3P M4(2)                                   | 1      | 767         | 767          | 2    | 2       |              | 69% |
| AFR 3B4P M4(2)                                   | 1      | 914         | 914          | 3    | 2       |              |     |
| AFR 4B5P M4(2)                                   | 1      | 1,056       | 1,056        | 3    | 2       |              |     |
| Shared Ownership                                 |        |             |              |      |         |              |     |
| AFR 2B3P M4(2)                                   | 1      | 767         | 767          | 2    | 2       |              |     |
| AFR 3B4P M4(2)                                   | 2      | 914         | 1,828        | 3    | 2       |              | 23% |
| Affordable Rent                                  |        |             |              |      |         |              |     |
| AFR 2B3P M4(2)                                   | 1      | 767         | 767          | 2    | 2       |              | 8%  |
| Total Open Market Units                          | 53     |             | 66,008       |      |         |              |     |
| Total Affordable Units                           | 13     |             | 9,702        |      |         |              |     |
| Total Units                                      | 66     |             | 75,710       |      |         |              |     |
| Coverage                                         |        |             |              |      |         |              |     |
| Nett Developable Area                            | 4.15   | Acre        |              |      |         |              |     |
| Nett Developable Hectares                        | 1.68   | Hectares    |              |      |         |              |     |
| Square Foot Per Acre                             | 18,243 | Sq. ft/Acre |              |      |         |              |     |
| Dwellings Per Hectare                            | 39     | DPH         |              |      |         |              |     |
| Dwellings Per Acre                               | 16     | DPA         |              |      |         |              |     |
| % 2.5 storey of OM                               | 25%    |             |              |      |         |              |     |

## PARCEL N, ARBORFIELD GREEN, WOKINGHAM – SITE LAYOUT

| PEGASUSGROUP.CO.UK | TEAM/DRAWN BY: THA/FD | APPROVED BY: STH | DATE: 08/04/2026 | SCALE: 1:500@A0 | DRWG: P24-1739\_DE\_01\_AD\_01 | CLIENT: CREST NICHOLSON (CHILTERN) |

**PEGASUS**  
GROUP

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# Appendix B

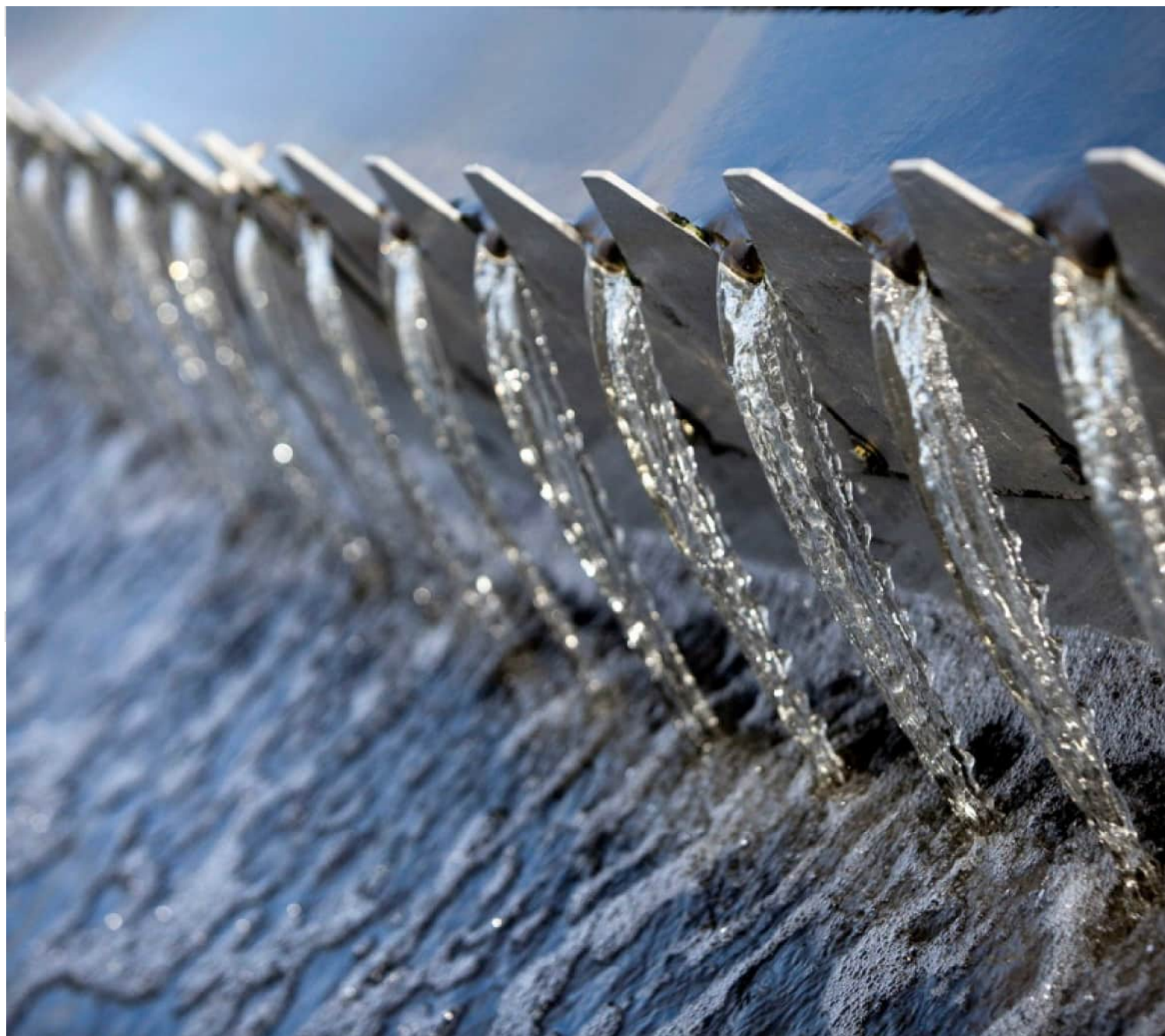
## Approved Outline Surface and Foul Water Drainage Strategy



**Woods Hardwick**  
Architecture | Engineering | Planning | Surveying

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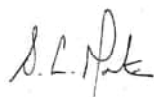
# Arborfield Garrison SDL, Foul and Surface Water Drainage Strategy





Prepared by:

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Checked and  
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Director

Arborfield Garrison SDL,

Foul and Surface Water Drainage Strategy

| Rev No | Comments                           | Checked by | Approved by | Date     |
|--------|------------------------------------|------------|-------------|----------|
| 1      | Issue for comment                  | SLM        | SLM         | 16.09.14 |
| 2      | Issue for inclusion as ES appendix | SLM        | SLM         | 19.09.14 |
|        |                                    |            |             |          |

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Date Created September 2014

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### Appendices

Appendix A – Development Masterplan

Appendix B – Thames Water Sewer Correspondence

Appendix C – Severn Trent Services Records

Appendix D – Existing Drainage Drawings

Appendix E- Notes of meeting Environment Agency Wokingham Borough Council

Wokingham Borough Council Interim SuDS Policy

Appendix F – Proposed Surface Water Drainage Strategy Drawings

*Proposed Surface Water Strategy* 60312043/CIV/001

*Proposed SuDS Sections* 60312043/CIV/009

*Catchment Area Plan* 60312043/CIV/010

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Appendix G - Surface Water Calculations

Appendix H – Proposed Foul Water Drainage Strategy Drawings

*Proposed Foul Water Strategy* 60312043/CIV/002

# 1 Project Overview

## Purpose of the Assessment

- 1.1 AECOM Ltd has been appointed by Arborfield Garrison Landowners Consortium to undertake a preliminary assessment of the foul and surface water drainage requirements for the proposed redevelopment of the Arborfield Garrison SDL.
- 1.2 This report is intended as an initial assessment and will need to be reviewed, refined and updated as the masterplan develops. The report will in due course also incorporate the requirements of the relevant regulators and stakeholders following further consultation.

## Scope of the Assessment

- 1.3 The scope of the assessment is as follows:-

### Surface Water

- o Obtain details of existing surface water sewers, ditch courses, watercourses and any other water bodies within and adjacent to the site.
- o Liaise with the Environment Agency regarding points and rates of discharge and drainage constraints.
- o Calculate expected surface water discharge flows based on likely development proposals.
- o Obtain copies of available borehole records and geological maps to consider the feasibility of utilisation of sustainable drainage systems (SuDS) for the development site.
- o Develop a surface water drainage strategy for the site using the principles of Sustainable Drainage Systems. The surface water drainage strategy will be in accordance with the Environment Agency's and Wokingham Borough Council requirements.

### Foul Water

- o Hold initial meeting with Thames Water to understand current position and actions for going forward.
- o Obtain details of existing foul public water sewers from Thames Water.
- o Obtain details from the MoD of existing private drains, flow information and condition.
- o Assess existing foul water network and review current off site discharge points.
- o Calculate expected foul water discharge flows based on development proposals including an assessment of existing flows that will remain.
- o Instruct Thames Water on behalf of Crest to undertake a scoping exercise of assessment work required.
- o Receive scoping study and instruct Thames Water on behalf of Crest to undertake Drainage Impact Assessment of Sewage Treatment Works and network capacity.
- o Develop a Foul Water Drainage Strategy for the site including consideration of how the MFT site will drain.

## 2 Development Site

### Site Location and Description

- 2.1 The proposed development site is located within the Borough of Wokingham, south-west of Wokingham, and south of Arborfield Cross, as shown in Figure 2.1



Figure 2.1 – Site location

- 2.2 The Arborfield Garrison site forms part of a wider Strategic Development Location (SDL), identified through the WBC Core Strategy which was adopted on the 29<sup>th</sup> January 2010, and capable of delivering approximately 3,500 homes. Figure 2.2. shows the Arborfield Garrison site in the context of the SDL and Suitable Alternative Natural Green Space (SANG) - the red shaded area to the north is the proposed development site, whilst the red shaded area to the south is a Suitable Alternative Natural Green Space (SANG) which forms part of the planning application.

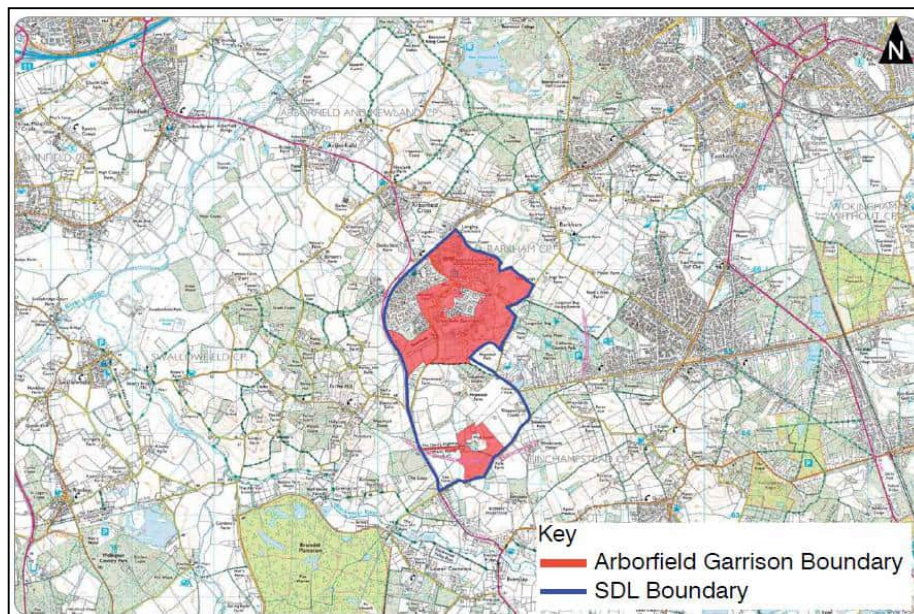
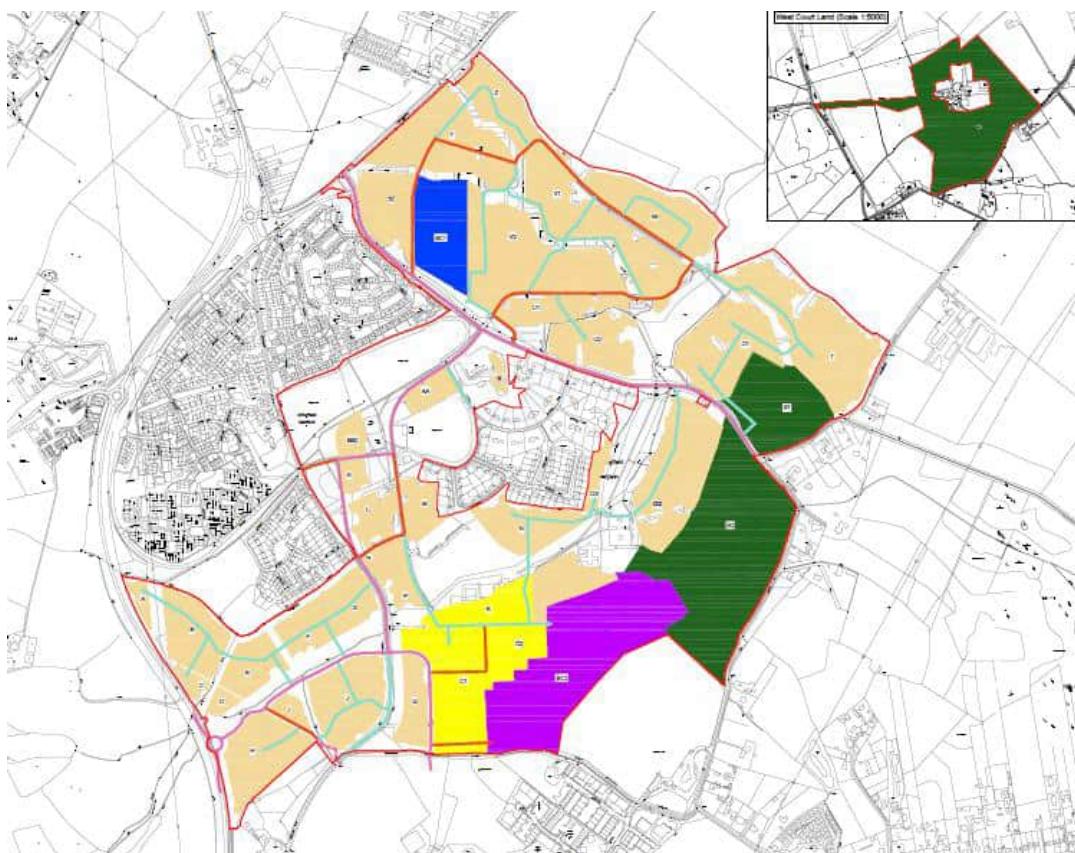


Figure 2.2 – Development Area and SANG

**Site Proposals**

- 2.3 The Arborfield Garrison site is planned to provide 2,000 homes, whilst the Marino Family Trust (MFT) proposed development (south of the Arborfield Garrison site) is planned to provide 1,500 homes.
- 2.4 A copy of the IDP masterplan dated September 2014 reference AR-23 is provided as Appendix A an extract is shown as Figure 2.3 below.



**Figure 2.3 –Site Masterplan**

- 2.5 The total site area is approximately 208 ha with approximately 79 ha attributed to developable area, which is provisionally divided into parcels by the internal road network and likely phasing. The site is proposed to include residential, employment, retail/leisure and a primary and secondary school.

### 3 Existing Site

#### Site Information

- 3.1 The proposed development site is within the Wokingham Borough Council boundary and Thames Water (TW) is the sewerage undertaker.
- 3.2 The land is both a “brownfield” site, or “previously developed land”, and “greenfield”.
- 3.3 The north and centre of the site consists of military buildings, housing, infrastructure, formal and informal open spaces, hardstandings, car parks and security fencing, and is generally typical of a functioning military Site. The military buildings include Hazebrouck Barracks to the north of the site and Rowcroft Barracks located centrally.
- 3.4 The eastern, southern and western edges are less developed and form a more open landscape of agricultural fields, playing fields, grassed areas and natural vegetation.

#### Topography

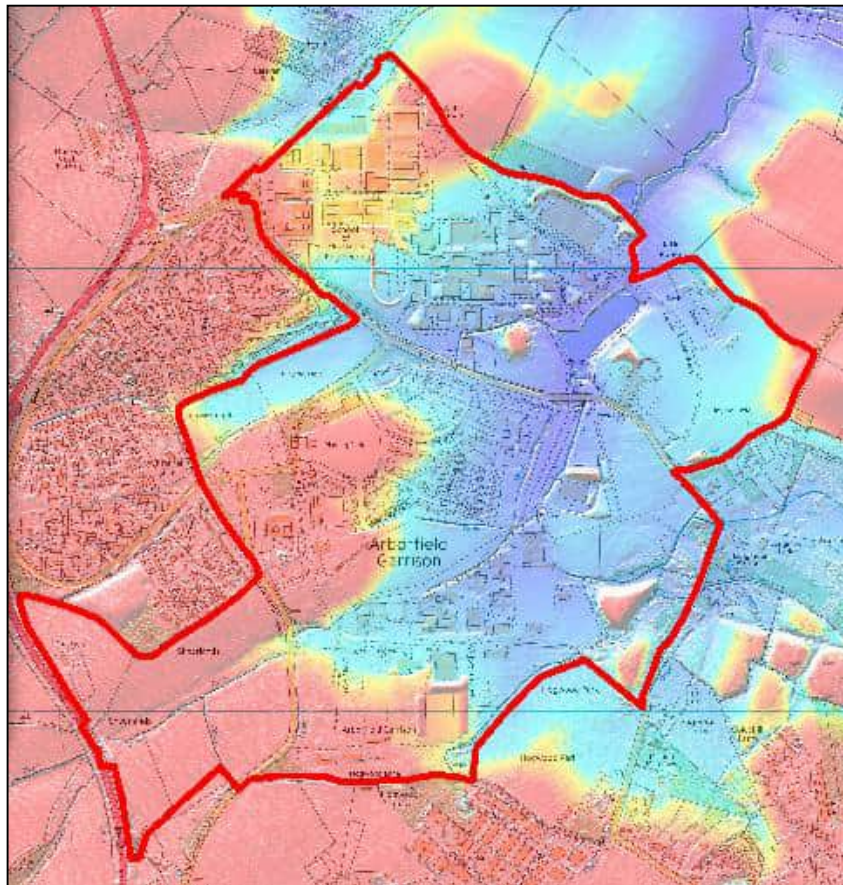
- 3.5 Topographical surveys of the site were undertaken in 2008 (Brunel Surveys Ltd) and in 2014 (K.A.Rylance Ltd). In addition to these, LiDAR ground level data was purchased in January 2014 from Mapshop (emapsite) with a resolution of 1m.
- 3.6 The site topography ranges typically from around 50m AOD to 65m AOD, and is located within one watershed, with the area predominately draining to the north-east, as shown in Figure 3.1.

#### Geology

- 3.7 A geo-environmental interpretive report has been prepared by AECOM in August 2014, and notes the following:  
“With reference to the British Geological Survey (BGS); Geology of Britain Viewer and the 1:50,000 scale survey sheet 268, the Site is primarily underlain by London Clay comprising of clays, silts and sands.
- 3.8 The Bagshot Formation, comprising fine sands, overlies the London Clay to the eastern boundary of the Site.
- 3.9 Shallow alluvium deposits are also identified within the eastern areas of the barracks, associated with Barkham Brook.

#### Hydrogeology

- 3.10 The London Clay Formation is classified as unproductive strata. The Environment Agency defines Unproductive Strata as: ‘.... layers or drift deposits with low permeability that have negligible significance for water supply or river base flow’.
- 3.11 The areas comprising of Alluvium and the Bagshot Formation are classified as Secondary Aquifers. The Environment Agency defines Secondary Aquifers as ‘.... rock layers or drift deposits with an equally wide range of water permeability and storage.’
- 3.12 The soils are classified as Soils of a High Leaching Potential (H) which are ‘soils which have little ability to attenuate diffuse source pollutants and in which non-absorbed diffuse source pollutants and liquid discharges have the potential to move more rapidly to underlying strata or to shallow groundwater’.
- 3.13 There is one licensed groundwater abstraction 546m south east from the Site at Banisters Farm, for general farming and domestic usage. Two groundwater abstractions are located approximately 1.5km north of the Site.
- 3.14 Previous reporting indicates anecdotal evidence of an on-site groundwater abstraction for emergency water supply in Hazebrouck Barracks along with four historical water wells present in the north of Hazebrouck Barracks.



**Figure 3.1 - Arborfield Garrison LiDAR Topography Summary (Areas of high ground shaded red, falling to lower ground areas shown as blue)**

#### **Groundwater Source Protection Zones**

- 3.15 The EA defines Source Protection Zones (SPZ) to help monitor the risk of contamination from any activities that might cause pollution in the area.
- 3.16 The site is not within a Groundwater Source Protection Zone.

#### **Watercourses**

- 3.17 The Arborfield Garrison site is located within the River Loddon Catchment, which lies within the Thames river basin district. The site drains in a general north-easterly direction, and comprises a number of drainage and small fluvial channels that flow through the site, into a balancing pond, before exiting the site and continuing in an north-easterly direction to the confluence with the Barkham Brook at OS NGR SU 77764 66586.

#### **Infiltration to Groundwater**

- 3.18 As discussed in above, the site is primarily Clay so infiltration to groundwater is limited.

#### **Public Sewers**

- 3.19 Thames Water (TW) sewer records, provided as Appendix B, identify the following public sewers in the vicinity of the site:

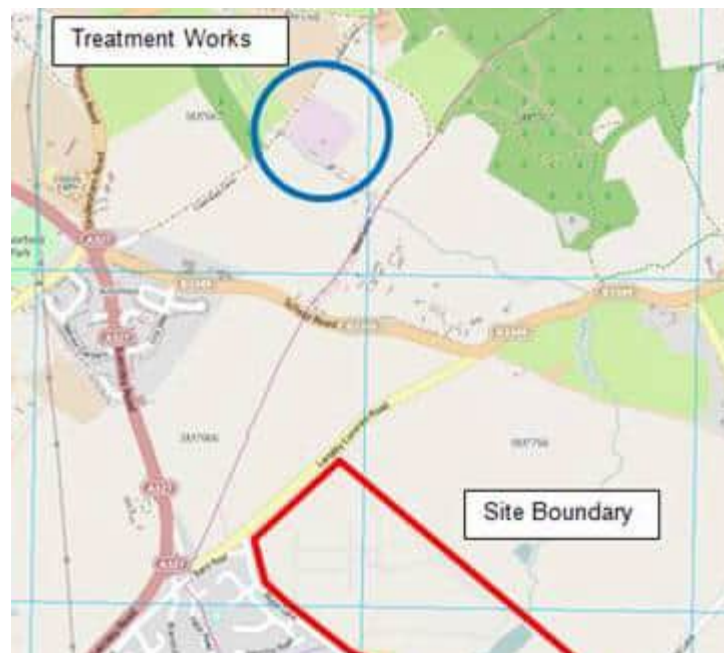
### Surface Water Sewers

3.20 There are no public surface water sewers within the site boundary.

### Foul Water Sewers

3.21 A 225mm diameter foul water sewer (FWS) enters the site at its western boundary and runs across the site in a north-easterly direction. A 225mm diameter FWS also enters the site along its southern boundary, where it runs in a northerly direction until it joins with the 225mm diameter from the west as mentioned. The sewer then upsizes to a 300mm diameter and then a 375mm diameter and exits the site along its north-east boundary and falls towards Arborfield Cross Sewage Treatment Works which is located approximately 1.2km away. The location of the treatment works is shown in Figure 3.2 below. These foul water sewers currently serve the residential areas to the west and south of the site boundary.

A 300mm diameter FWS runs along the eastern boundary of a site and falls in a northerly direction adjacent to Park Lane and then Princess Marina Drive, before exiting the site at the north-east boundary. The sewer then runs parallel to the 375mm diameter as mentioned in 4.7 with eventual discharge at Arborfield STW. This FWS currently serves residential areas to the south of the site.



**Figure 3. 2 - Arborfield Cross Waste Treatment Works**

### Other drainage

- 3.22 The topographical survey of the site identifies a number of other foul and surface water drainage systems within the site, which are likely to be private systems that serve the existing or previous developments.
- 3.23 The existing site is served by private foul and surface water drainage which is privately maintained by Severn Trent Services (previously Costain). The existing drainage records provided by Severn Trent Services are included as Appendix C.
- 3.24 Hazebrouck Barracks is served by a separate system. The surface water drains collect water from the many buildings and paved areas and fall in a southerly direction and discharge into the watercourse running across the site. The

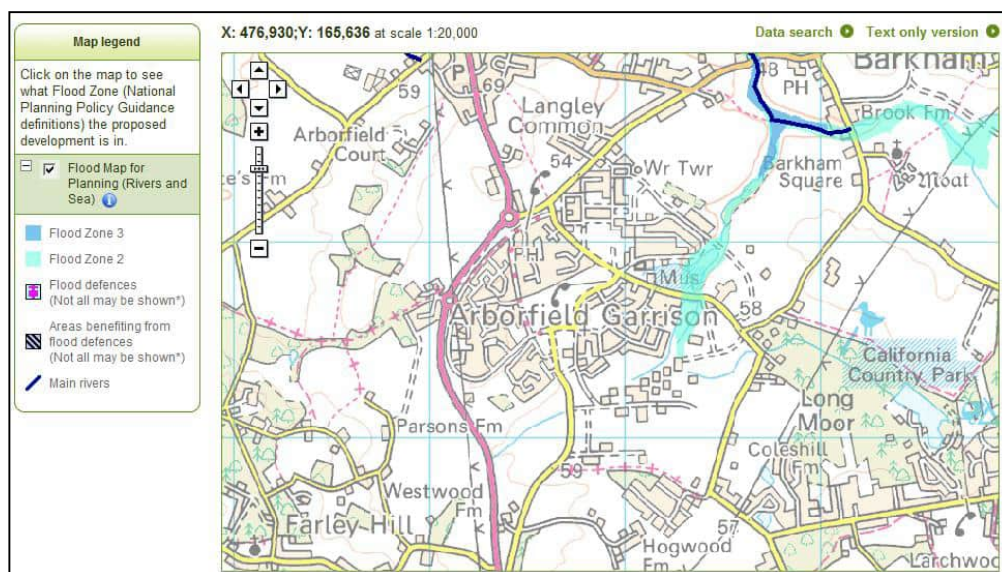
surface water drainage size range from DN150 to DN600. Drainage records also show a small portion of the barracks at the north west boundary draining into the ditchcourse adjacent to Langley Common Road.

- 3.25 A number of surface water outfalls were observed on the bank of the watercourse running across the site.
- 3.26 The foul water drains serving the Hazebrouck Barracks generally fall in a south westerly direction and discharge into the DN225 public sewer running across the site. A sub-catchment to the north west boundary of the Barracks falls in the opposite direction to a public sewer outside of the site boundary adjacent to Langley Common Road.
- 3.27 No details are available for the existing drainage from Rowcroft Barracks and the existing houses to be retained in the centre of the site, however it is understood that the sewerage system is separate with surface water discharge into the watercourse running through the site and foul water discharge in the public FWS.
- 3.28 The drainage records and flow information provided by Severn Trent Services and Thames Water are shown on AECOM Existing Drainage drawing dated March 2014 reference 60312403/CIV/004 included as Appendix D. The drawing identifies the existing catchments and outfall points (some have been assumed) based on the records provided.

## 4 Sources of Potential Flooding and Information on Flood Extents

### Flood Risk from Rivers

- 4.1 AECOM have undertaken a Flood Risk Assessment (FRA) and modelling study (AECOM report dated August 2014 reference 60312043/FRA/002).
- 4.2 The Environment Agency's (EA) Flood Map shows that the site comprises areas of Flood Zone 1 and 2. A copy of the EA Flood Map is shown in Figure 4.1 below.



**Figure 4.1 – Environment Agency Flood Zone Map (Image taken from Environment Agency Website)**

- 4.3 The Environment Agency Flood Zones do not reflect the true fluvial flood risk associated with the tributaries that flow through the Arborfield Garrison site. Therefore a key objective of the FRA report is to understand and quantify the risk associated with the smaller open channel network of tributaries through the site. In order to achieve this and to assess the flood risk the FRA report includes the following:
- a summary of the hydrological and hydraulic modelling study undertaken to understand and quantify fluvial flood risk to the site;
  - an assessment of existing flood risk to the site (from all sources);
  - mitigation options undertaken to reduce the flood risk to the site;
  - information detailing how the FRA process has informed and led the spatial planning of the site to steer development to areas of least flood risk; and
  - a proposed Masterplan design scenario flood risk assessment.
- 4.4 The flood modelling has simulated a range of options which have included the:
- removal of redundant channel structures that increase flood risk;
  - opening up culverted sections of the watercourses; and
  - re-profiling of ground levels – increasing on site flood storage capacity.
- 4.5 The modelling results have shown that the Masterplan concept design scenario:
- reduces the flood extent on site for the 1 in 20, 1 in 100 and 100 year + CC flood events;
  - includes a SuDS scheme that delivers a reduction in surface water flows (reducing runoff rates to calculated Greenfield);

- includes a SuDS scheme that has reduced fluvial flooding; and
- has no increase in flood risk downstream off site.

4.6 A copy of the modelling results is shown in Figure 4.2 below.

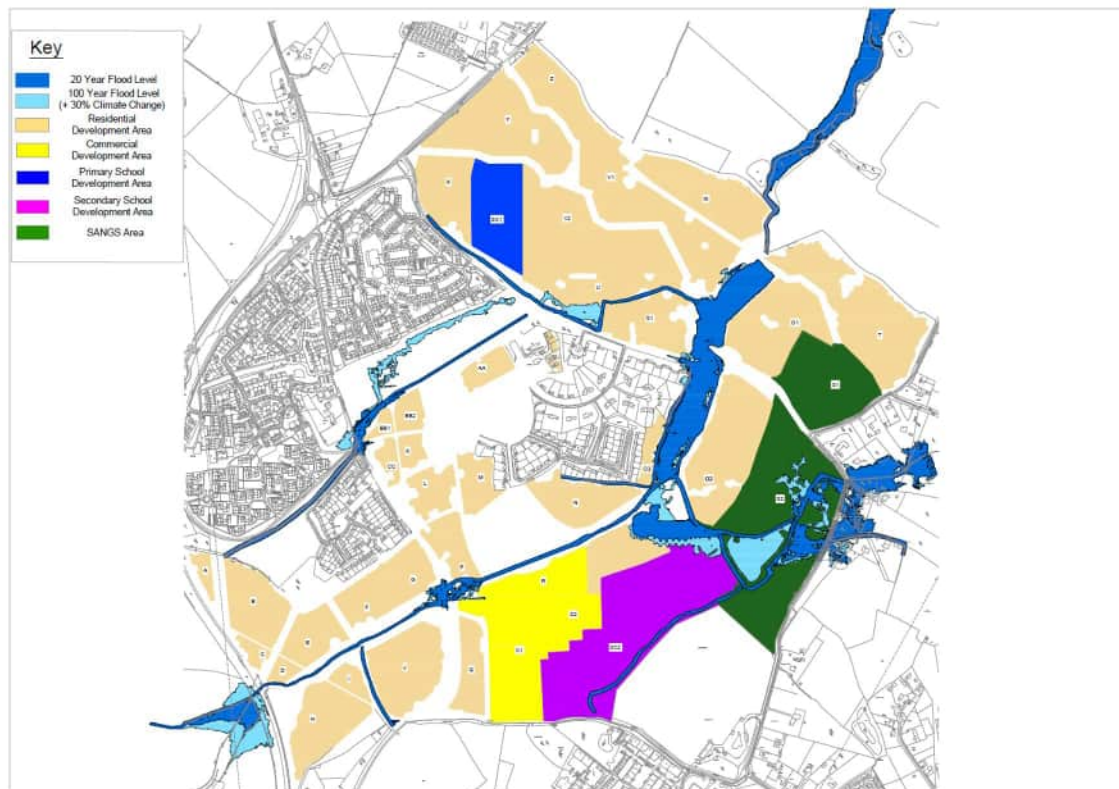


Figure 4.2 – Flood Extent for 1 in 20 year event and 1 in 100 year event plus climate change.

## 5 Sustainable Drainage Systems (SuDS)

### SuDS Objectives

- 5.1 Surface water drainage systems developed in line with the ideals of sustainable development are collectively referred to as Sustainable Drainage System (SuDS). These systems are designed both to manage the environmental risks resulting from urban runoff and to contribute wherever possible to environmental enhancement. It is proposed that SuDS techniques are utilised wherever possible to manage surface water runoff from the development. The following paragraphs describe how SuDS could be incorporated into the development proposals.
- 5.2 SuDS objectives are to minimise the adverse effects from the development on the quantity and quality of the runoff, and maximise amenity and biodiversity opportunities." (CIRIA C697, 2007).
- 5.3 A strong design theme is essential if the maximum aesthetic benefits are to be gained from the SuDS approach. At a more local scale the SuDS should link with the individual plots' structure, planting, public open space requirements and amenity areas, gaining multiple benefits from a limited area of land. Multi-user green corridors could provide a linking theme through the area.
- 5.4 Sufficient space must be allowed for the SuDS features to appear as natural features and not be constrained by the development into inadequate, unattractive areas. Working with nature can ensure that SuDS are in keeping with their setting, minimising management requirements and costs.
- 5.5 The following reference guides will be reviewed and utilised, as appropriate, during the SuDS features design procedure;
  - Planning for SuDS – making it happen (CIRIA C687)
  - Site handbook for the construction of SUDS (CIRIA C698, 2007)
  - Designing for exceedance in urban drainage: Good practice (CIRIA C635, 2006)
  - Flood Risks to People, Defra /Environment Agency 2006
  - Culvert design and operation guide (CIRIA C689, 2010)
  - The GRO Green Roof Guide

### The SuDS Management Train

- 5.6 The 'management train approach' should be central to the surface water drainage strategy of for the proposed site. The main objective is treatment and control of runoff as near to the source as possible protecting downstream habitats and further enhancing the amenity value of the site. This concept uses a hierarchy of drainage techniques to incrementally reduce pollution, flow rates and volumes of stormwater discharge from the site, and is as follows:
  - Prevention - the use of good site design and housekeeping measures to prevent runoff and pollution and includes the use of rainwater reuse/harvesting
  - Source Controls - control of runoff at source or as close to source as possible (e.g. soakaways, green roofs, pervious pavements)
  - Site Control - management of water in a local area and can include; below ground storage/attenuation, detention basins, large infiltration devices
  - Regional Control - management of water from a site or various sites and can include wetlands and balancing ponds

### SuDS Site Constraints

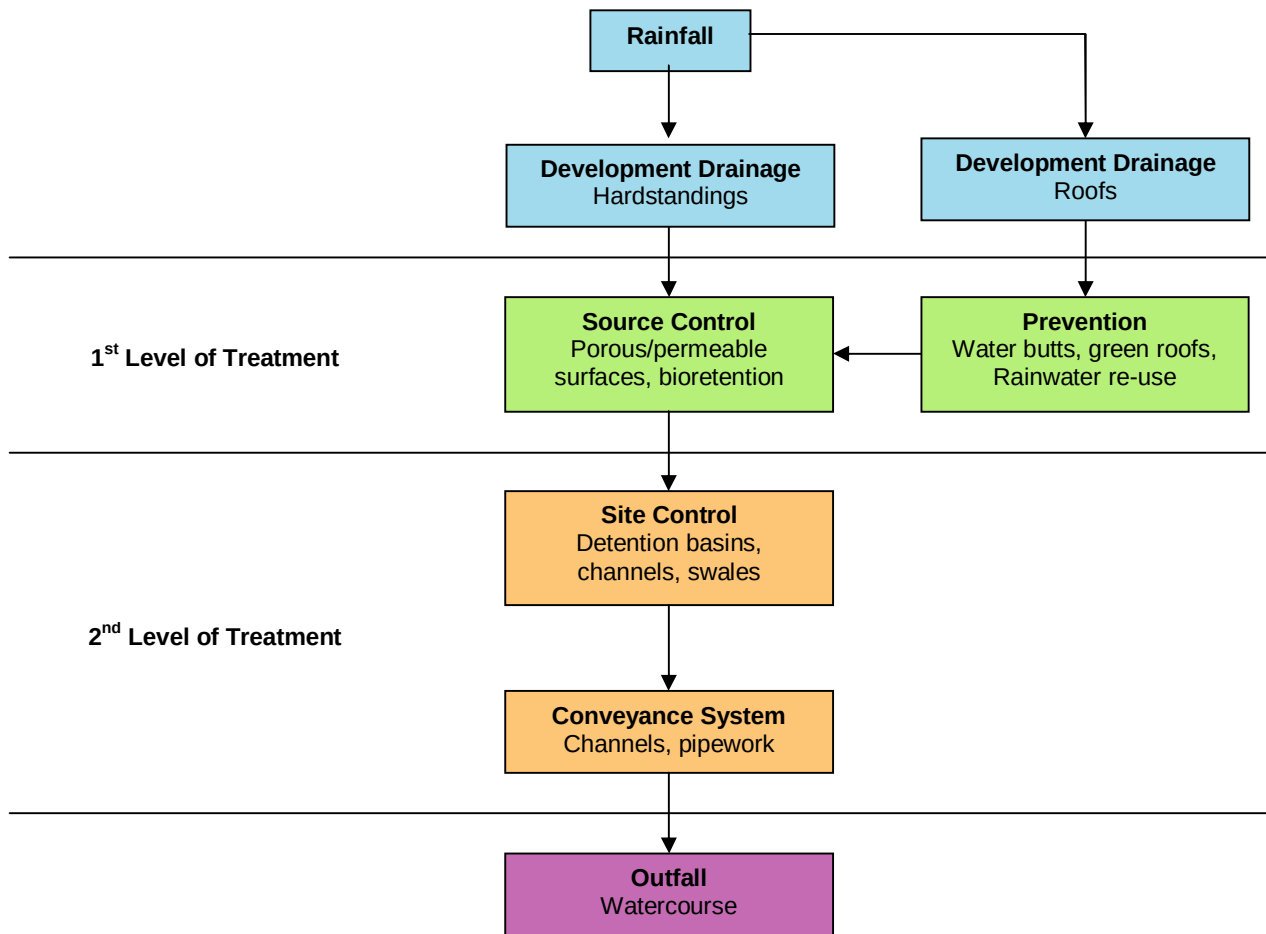
- 5.7 Not all SuDS techniques are suitable for all sites; therefore an assessment of the existing site is required, so that the SuDS limitations can be determined. This assessment considers the following;

- **Land Use Characteristics:** The proposed density and land use of the development will influence the SUDS selection.
- **Site Characteristics:** Geological, groundwater and contamination characteristics could all affect the suitability of infiltration SUDS techniques.
- **Catchment Characteristics:** The site is currently brownfield and the discharge rate from the redeveloped site will need to be limited. This is discussed in more detail in paragraph 6.6 below.
- **Environmental and Amenity Performance:** Factors including maintenance regime, cost, safety and habitat creation need to be considered to influence the SUDS selection for the site.

### SuDS Design Philosophy

- 5.8 The SuDS philosophy for the development site is adding value to engineering design through habitat enhancement, landscape design, provision of an amenity resource and promotion of source control techniques. Landscape and ecological issues, where appropriate, should be given equal priority to the engineering issues and at times may have higher priority in the sizing and detailing options.
- 5.9 The following design philosophy is proposed:-
- Surface Water Treatment using the 'Management Train' approach to remove and isolate contamination at source and site control facilities prior to conveyance from the site.
  - A minimum of two levels of treatment are provided.
  - Integrate SuDS with landscape, habitat and amenity.
  - Restrict development runoff peak flow rates to equivalent pre-development rates.
  - Site control treatment using attenuation of storm runoff and providing conditions for settlement of suspended solids (detention).
  - Use 'soft engineering' techniques to limit the visual impact of the facilities.
  - Use of swales and open channels in lieu of pipelines wherever acceptable and practical.
  - Aim to limit, where possible, the impermeable fraction of development.
  - Provide overland flood routes for extreme events where possible.
  - Maintain existing hedge lines where possible (proposed 'green corridor').
  - Use native species.
  - Create and maintain buffer strips of shrubs, herbs and grasses next to SuDS features such as ponds.
  - Promote community involvement and education.
- 5.10 The drainage techniques proposed for this site include prevention, source controls and site controls. The following SuDS strategy is proposed for the Arborfield Garrison Site. The techniques are discussed in further detail in Section 6.

### Schematic of SuDS Strategy



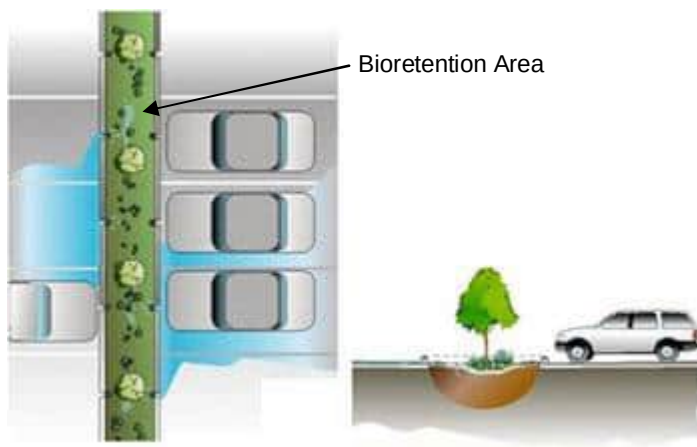
#### First Level of Treatment – Source Control

- 5.11 The main objective of source control is the treatment and control of runoff as near to source as possible.
- 5.12 Prevention in the form of good housekeeping measures can help minimise the contaminants that may wash into the drainage system and extend the life of the system. Permeable surfaces utilising infiltration to groundwater are prime examples of source control. However, it is unlikely that infiltration will be a feasible method of drainage on this site due to the geology and the potential presence of contaminants. Permeable surfaces can still be used, but should be lined such that water is conveyed to a formal drainage system.
- 5.13 Other innovative source control solutions may be considered where possible as part of the overall approach to the Management Train, such as rainwater harvesting and greywater use. Water from roofs and hardstandings can be piped directly to a below ground tanks for water re-use, or 'rainwater harvesting'. Screens on downpipes and oil traps on gullies should be considered for filtering the roof debris and preventing oil entering the tank. The water could be used internally within the buildings for flushing toilets, or could be used for certain processes in the employment development.

- 5.14 Green roofs can act as prevention and source control features and provide good water quality treatment. They reduce the volume and rate of runoff as water is encouraged to remain on the roof. They have the benefit of requiring no land take, and also assist with thermal insulation and sound absorption in the building. They are intended primarily to be viewed rather than used as external space, and if planned properly, can require minimal maintenance. The inclusion of a green roof on a building must be taken into account in the structural design due to the increased imposed loading from the retained water.

#### Suggested Source Control Techniques

- 5.15 Source control techniques could include bioretention, permeable/porous surfaces and green roofs. These provide a means of slowing the runoff rate and treatment of the surface water by filtration, settlement and bio-degradation.
- 5.16 Typical examples of source control systems are given in The SuDS Manual and are briefly described below. The effectiveness of the various systems is inherently vulnerable to inadequate design. Hence particular care should be taken during detailed design.



#### Bioretention

- 5.17 Bioretention areas, also referred to as bioretention filters or rain gardens, are surface runoff controls that capture and treat stormwater runoff from frequent rainfall events. Excess runoff from extreme events is passed forward to other drainage facilities. The surface runoff is treated using soils and vegetation in shallow basins or landscaped areas to remove pollutants. The filtered runoff is then collected and returned to the conveyance system. Part of the runoff volume will be removed through evaporation and plant transpiration. Suitable flow routes or overflows are required to convey water in excess of the design volumes to appropriate receiving drainage systems safely.
- 5.18 Due to their nature, bioretention areas can be integrated into external areas within the site, and are suited to fitting around parking bays without excessive land-take, as illustrated in the images above. They allow small areas of landscaping to be incorporated into what could otherwise be a hard landscaped site.

#### Pervious pavements

- 5.19 Pervious pavements provide a pavement suitable for pedestrian and/or vehicular traffic that allow rainwater to infiltrate through the surface and into the underlying layers, where water is temporarily stored before infiltration to the ground, reuse or release to a drainage system. If the permeability of the soil is insufficient to allow infiltration, or if there are contamination or shallow groundwater issues, a lined system would be required with eventual connection onto the drainage system.
- 5.20 Pervious pavements can be made of porous material or constructed as a permeable surface as described below:

- Porous pavements infiltrate water across their entire surface material, e.g. reinforced grass or gravel surfaces, porous concrete and porous asphalt.
- Permeable pavements are formed of material that is itself impervious. However, the materials are laid to allow surface water to infiltrate through the joints or voids between the blocks into the underlying pavement structure, intercepting surface water runoff and providing a pollutant treatment medium prior to discharge to the downstream system. Treatment processes that occur within the surface structure, the subsurface matrix and the geotextile layers include; filtration, adsorption, biodegradation and sedimentation.



- 5.21 For this site, it is considered that permeable pavements, constructed using interlocking block paving over some or all of the surfacing, would be the most appropriate method within the private parking areas. The use of different surfacing can help, for example, to distinguish between the parking areas and the roadways within the site.
- 5.22 In addition, a positive strategy is required to promote SUDS and raise awareness. The site owners should be made aware of the purpose and importance of SUDS drainage and the maintenance requirements if the system is to remain private.

#### Green Roofs

- 5.23 Where there is limited space on the site, the option of providing green roofs on some of the buildings may be considered to increase the biodiversity on the site and also assist in reducing the volume of runoff and attenuating peak flows.
- 5.24 There are three main type of green roof, as follows:
- Extensive Green Roofs – the whole roof is covered in low growing, low maintenance plants, such as mosses, succulents, herbs and grasses. The growing medium is 25-125mm thick and the roof is intended to be largely self sustaining, with access required only for occasional maintenance. This type of green roof can be used on flat or sloping roofs and are lightweight and cost effective.
  - Intensive Green Roofs (roof gardens) – these roofs are intended to be accessed and provide high amenity benefits. They can include planters, trees and even water features. The loads imposed by these green roofs are much greater than extensive green roofs and they require significant ongoing maintenance.
  - Simple Intensive Green Roofs – as with the intensive green roofs, these can be assessed, but are generally vegetated with lawns or ground covering plants, which do require regular maintenance. The structural loading associated with these green roofs is lower, so they are less expensive than standard roof gardens.

- 5.25 On this site, extensive or simple intensive green roofs are more likely to be the favoured solutions due to the relative low costs. It is recommended that the design of these features is considered at an early stage, with the input of a horticulturalist and structural engineer to ensure the most effective and successful solution is provided.



### **Second Level of treatment – Site Control**

- 5.26 Site control features such as ponds and detention basins can be designed to attenuate storm runoff and provide conditions for settlement of suspended solids. The use of these types of attenuation within the development is proposed for some areas of the site where there is sufficient land available to provide these large features.

#### **Detention Basins**

- 5.27 Detention basins collect surface water runoff from a site. They are generally dry features which are allowed to fill during significant storm events and then empty over time. Basins can also be mixed, including both a permanently wet area for wildlife or treatment of the runoff and an area that is usually dry to cater for flood attenuation.
- 5.28 Detention Basins offer opportunities for the landscape design. Basins should not be built on, but can be used for sports and recreation and can form part of public open space.
- 5.29 Detention basins will attenuate flows from site by use of complex flow controls situated downstream of the basin.



#### Channels and Swales

- 5.30 The site control measures also include landscaped channels and swales. The vegetated channels will drain water evenly off impermeable areas. Rainwater runs through the vegetation alongside of the channel which slows and filters the flow. They are designed to convey water, but can also provide the benefits of detention and treatment of runoff. Incorporation of check dams or pools can slow flows, increase attenuation and promote deposition of suspended solids.
- 5.31 Channels and swales can be incorporated into road verges and areas of public open space to provide an amenity as well as the SuDS function. In such locations they are likely to be dominated by fine-grass species and regularly mown.
- 5.32 The use of SuDS as part of the Site-Wide drainage strategy is described further in Section 6.

#### Pollution Control

- 5.33 Runoff quality control for the proposed development site may include some or all of the control features detailed above, swales, channels, ponds or basins. In addition, where gullies are used to collect surface water from external areas, these should be trapped as a matter of course.

## 6 Surface Water Drainage Strategy

### Surface Water Drainage and Flood Risk Mitigation Parameters

- 6.1 The proposed surface water drainage strategy has been developed in consultation with the Environment Agency (EA) and Wokingham Borough Council (WBC). The principles of the strategy were agreed at Flood Risk Assessment Scoping meeting held on 28<sup>th</sup> November 2013. The minutes of the meeting are included as Appendix E.
- 6.2 The proposed drainage strategy drawings are included in Appendix F.
- 6.3 The SuDS philosophy has been outlined in Section 5. By virtue of the SuDS philosophy the surface water drainage strategy is as set out in the bullet points listed below:
- The runoff from the proposed development will discharge to the existing water courses within the site.
  - Drainage will be by gravity and will mimic the existing situation.
  - Surface water run off rates will be restricted to the equivalent greenfield rate of runoff by the use of complex flow controls.
  - A SuDS management train approach will be used to treat and attenuate runoff.
  - Existing culverted watercourses will be opened up and an on line permanent pond is proposed (included in the AECOM Flood Modelling Study Report dated August 2014 ref: 60312043/FRA/002).
  - Flood exceedence pathways have been identified.
  - A further level of detail of drainage design will be required at each reserved matters application to accurately determine the internal plot layout including a hydraulic model which will be simulated for an extreme storm event to determine flood flow pathways.
- 6.4 The following paragraphs expand the principles of the strategy outlined above.

### Catchment Areas

- 6.5 The AECOM Surface Water Drainage Strategy drawing dated September 2014 ref 60312043/CIV/001 shows the site has been divided into sub catchment areas to mimic the existing situation. It has been assumed that existing levels will be retained and that drainage will be by gravity.

### Surface Water Discharge Options for the Proposed Development

- Option 1 – Infiltration to Groundwater
- 6.6 AECOM have prepared a geo-environmental interpretive report dated August 2014, and notes that the site is primarily underlain by clay therefore infiltration is unlikely.
- Option 2 – Discharge into Watercourse
- 6.7 As the ground conditions are unsuitable for infiltration, discharge into the watercourses that cross the site is considered to be the only viable option for surface water discharge.
- It is therefore proposed that surface water flows are discharged into these watercourses at equivalent greenfield rates of runoff.
- Option 3 – Discharge into Public Sewer(s)
- 6.8 This option has been discounted due to there being no separate public surface water sewers within the development.

### Limiting Piped Outflow from Development

- 6.9 The proposed development site is part brownfield and part greenfield. In consultation with the Environment Agency and Wokingham Borough Council it is proposed that the surface water discharge from the site will be restricted to the equivalent greenfield rate of runoff.
- 6.10 It is proposed that the outflow restriction to the equivalent greenfield rates will be achieved by making use of complex controls located strategically within the new drainage system. These complex flow restrictions could be in the form of a combination of vortex flow controls and/or orifice plates and/or weirs.

- 6.11 The outfall complex flow controls will be designed so that the catchments they serve only discharge into the receiving watercourse at the calculated rates of greenfield runoff for various storm events including  $Q_{BAR}$  and  $Q_{100}$  return periods.

#### **Greenfield Runoff Calculation Method**

- 6.12 Greenfield runoff rates are calculated to determine the level of acceptable rate of discharge from the site to the receiving watercourse and are likely to be used by the environmental regulator to set site-specific drainage constraints. The Institute of Hydrology (IoH) Report 124, Flood Estimation from Small Catchments, has been used to determine peak greenfield runoff rates.

$$Q_{bar_{rural}} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SPR^{2.17}$$

where:

AREA is the area of the catchment in ha.

SAAR is the long term average rainfall = 657mm.

SPR is Standard Percentage Runoff coefficient for the SOIL category = 0.47.

To calculate the equivalent greenfield runoff rate for the 1yr, 30yr and 100yr return period, the growth curve for FSR Region 6 is then applied.

#### **Assumed Percentage Impermeability**

- 6.13 The site can effectively be split into discrete drainage catchments, with differing land uses. Based on the parcel areas in taken from the Masterplan included as Appendix A the following assumptions have been made as to the likely impermeable areas on the site post-development. It should be noted that these assumptions are based on the masterplan and will be subject to review with each reserved matters application.

- Residential – 65%
- Commercial – 80%
- Primary and Secondary School – 50%

- 6.14 A catchment area plan drawing dated September 2014 reference 60312043/CIV/010 is included as Appendix F. The plan identifies the developable areas as set out in the Masterplan within each of the drainage subcatchments.

#### **Return Period**

- 6.15 It is a requirement of the sewerage undertaker that a new adoptable drainage system be designed not to flood any part of the site in a 1 in 30 year return period design storm. New drainage systems should be designed to adoptable standards.
- 6.16 The National Planning Policy Framework identifies that flooding can occur on a local scale due to runoff exceeding the capacity of the minor system during extreme events and it can only be addressed on a site specific basis. Sewers for Adoption 7th Edition (WRc, 2012) states that properties should be protected against flooding from extreme events and that flood pathways are identified when the drainage system is exceeded.
- 6.17 All attenuation features should be designed to store a 1 in 100 year rainfall event plus an allowance for climate change.

### Surface Water Discharge Rates for the Proposed Development

- 6.18 It is proposed that the surface water runoff for all storm events, including the 1 in 100 year plus climate change, from the site is to be limited to equivalent greenfield rates of runoff without climate change. The greenfield runoff rates have been calculated using the methods identified in Section 6.13. using Microdrainage software. The output from the Microdrainage software is included as Appendix G and is summarised in table 6.1 below..

| Rainfall<br>Return<br>Period | Proposed Discharge Rate<br>(l/s/ha) |
|------------------------------|-------------------------------------|
| $Q_{BAR}$                    | 4.3                                 |
| $Q_1$                        | 3.7                                 |
| $Q_{30}$                     | 10.0                                |
| $Q_{100}$                    | 13.8                                |

**Table 6.1 – Existing Greenfield Rates of Runoff**

Note:  $Q_{BAR}$  is defined as the Mean Annual Flood flow rate for a river. This approximates to a return period of 2.3 years.  $Q_{30}$  and  $Q_{100}$  are the runoff rates from a 1 in 30 and 1 in 100 year storm.

- 6.19 The existing greenfield rates of run off have been used to calculate pro-rata discharge rates in Table 6.2 for the individual catchments identified on drawing 60312043/CIV/001 included as Appendix F.

| <b>Catchment</b><br>(Refer to dwg<br><b>Surface Water</b><br><b>Drainage</b><br><b>Strategy</b><br><b>drawing dated</b><br><b>September 2014</b><br><b>reference</b><br>60312043/CIV/<br>001) | <b>Developable</b><br><b>Area (ha)</b> | <b>Impermeable</b><br><b>Area (ha)</b> | <b>QBAR</b><br><b>Discharge</b><br><b>Rate (l/s)</b> | <b>Q1</b><br><b>Discharge</b><br><b>Rate (l/s)</b> | <b>Q30</b><br><b>Discharge</b><br><b>Rate (l/s)</b> | <b>Q100</b><br><b>Discharge</b><br><b>Rate (l/s)</b> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------------------------------------|------------------------------------------------------|----------------------------------------------------|-----------------------------------------------------|------------------------------------------------------|
| 1                                                                                                                                                                                             | 2.1                                    | 1.38                                   | 5.94                                                 | 5.11                                               | 13.81                                               | 19.1                                                 |
| 2                                                                                                                                                                                             | 0.3                                    | 0.19                                   | 0.83                                                 | 0.72                                               | 1.93                                                | 2.7                                                  |
| 3                                                                                                                                                                                             | 2.1                                    | 1.36                                   | 5.85                                                 | 5.04                                               | 13.62                                               | 18.8                                                 |
| 4                                                                                                                                                                                             | 2.9                                    | 1.86                                   | 7.99                                                 | 6.87                                               | 18.57                                               | 25.6                                                 |
| 5                                                                                                                                                                                             | 0.5                                    | 0.35                                   | 1.48                                                 | 1.28                                               | 3.45                                                | 4.8                                                  |
| 6                                                                                                                                                                                             | 2.3                                    | 1.48                                   | 6.38                                                 | 5.49                                               | 14.84                                               | 20.5                                                 |
| 7                                                                                                                                                                                             | 2.4                                    | 1.57                                   | 6.76                                                 | 5.82                                               | 15.72                                               | 21.7                                                 |
| 8                                                                                                                                                                                             | 11.8                                   | 7.67                                   | 32.97                                                | 28.37                                              | 76.68                                               | 105.9                                                |
| 9                                                                                                                                                                                             | 7.0                                    | 4.55                                   | 19.54                                                | 16.82                                              | 45.45                                               | 62.8                                                 |
| 10                                                                                                                                                                                            | 1.1                                    | 0.71                                   | 3.07                                                 | 2.64                                               | 7.14                                                | 9.9                                                  |
| 11                                                                                                                                                                                            | 3.9                                    | 2.51                                   | 10.81                                                | 9.30                                               | 25.14                                               | 34.7                                                 |
| 12                                                                                                                                                                                            | 1.0                                    | 0.63                                   | 2.73                                                 | 2.35                                               | 6.34                                                | 8.8                                                  |
| 13                                                                                                                                                                                            | 0.7                                    | 0.45                                   | 1.95                                                 | 1.68                                               | 4.54                                                | 6.3                                                  |
| 14                                                                                                                                                                                            | 1.9                                    | 1.26                                   | 5.42                                                 | 4.66                                               | 12.60                                               | 17.4                                                 |
| 15                                                                                                                                                                                            | 3.9                                    | 2.53                                   | 10.88                                                | 9.36                                               | 25.31                                               | 35.0                                                 |
| 16                                                                                                                                                                                            | 1.8                                    | 1.19                                   | 5.12                                                 | 4.40                                               | 11.90                                               | 16.4                                                 |
| 17                                                                                                                                                                                            | 2.1                                    | 1.37                                   | 5.89                                                 | 5.07                                               | 13.70                                               | 18.9                                                 |
| 18                                                                                                                                                                                            | 4.8                                    | 3.14                                   | 13.50                                                | 11.62                                              | 31.40                                               | 43.4                                                 |
| 19                                                                                                                                                                                            | 7.0                                    | 4.58                                   | 19.69                                                | 16.95                                              | 45.80                                               | 63.2                                                 |
| 20                                                                                                                                                                                            | 2.1                                    | 1.37                                   | 5.87                                                 | 5.05                                               | 13.65                                               | 18.8                                                 |
| 21                                                                                                                                                                                            | 2.9                                    | 1.90                                   | 8.16                                                 | 7.02                                               | 18.97                                               | 26.2                                                 |
| 22                                                                                                                                                                                            | 6.4                                    | 4.15                                   | 17.86                                                | 15.37                                              | 41.53                                               | 57.4                                                 |
| 23                                                                                                                                                                                            | 2.1                                    | 1.37                                   | 5.87                                                 | 5.05                                               | 13.65                                               | 18.8                                                 |
| 24                                                                                                                                                                                            | 4.0                                    | 2.63                                   | 11.30                                                | 9.73                                               | 26.29                                               | 36.3                                                 |
| 25                                                                                                                                                                                            | 0.6                                    | 0.38                                   | 1.65                                                 | 1.42                                               | 3.83                                                | 5.3                                                  |
| 26                                                                                                                                                                                            | 0.5                                    | 0.32                                   | 1.40                                                 | 1.20                                               | 3.25                                                | 4.5                                                  |
| <b>TOTAL</b>                                                                                                                                                                                  | <b>78.3</b>                            | <b>50.91</b>                           | <b>218.92</b>                                        | <b>188.38</b>                                      | <b>509.12</b>                                       | <b>703.05</b>                                        |

**Table 6.2 – Pro-Rata Limiting Discharge Rates for Individual Development Catchments**

- 6.20 As a comparison a theoretical baseline rate of runoff from the existing Garrison site can be estimated using the Modified Rational Method. The existing positively drained roof area has been calculated at 10.86 ha and there is also up to 11.53 ha of external area including roads and paved areas around buildings which is positively drained.

$$\text{Baseline rate of runoff from roofs only } Q = 3.61CvIA$$

where  $Cv = 0.77$

$I = \text{Rainfall Intensity} = 50\text{mm}$

and  $A = \text{Impermeable Area (ha)}$

$$\text{Therefore, } Q = 3.61 \times 0.77 \times 50 \times 10.86 = \mathbf{1510 \text{ l/s}}$$

- 6.21 Reducing the rate of run off to the equivalent greenfield rate of runoff, can be achieved through on site attenuation which will store surface water from the impermeable areas and release it gradually to the outfall. The options for this are discussed below.

#### **Attenuation and Storage of Surface Water**

- 6.22 Attenuation is required before discharge into the local watercourse and is proposed to be undertaken in above ground features, such as ponds and detention basins.
- 6.23 The use of channels and swales to convey the surface water gives the added advantage of providing attenuation volume within the site.
- 6.24 The Source Control program within the Microdrainage computer modelling suite has been used to estimate the storage requirements for each parcel based on the percentage impermeability assumptions and limiting discharge rates detailed above. The results are provided in Table 6.3.

#### **Storm Events up to and Including 1 in 30 year Return Period**

- 6.25 The below ground drainage system is to be designed to adoptable standards; therefore it is proposed that all surface water sewers will be designed to convey a design storm of a 1 in 30 year return period.

#### **Storm Events up to and Including 1 in 100 year Return Period + 30% Climate Change**

- 6.26 Attenuation storage will also be required to limit the discharge from the site for up to the 1 in 100 return period design storm plus 30% climate change to greenfield rate of runoff.
- 6.27 The estimated volume of attenuation storage required at this site for this return period is shown in Table 6.3. The volumes of storage have been generated using Flood Estimation Handbook (FEH) rainfall data and the source control function within the Microdrainage software. The output from the Quick Storage Estimate (QSE) function within the source control function of MicroDrainage is included in Appendix G.
- 6.28 The table also contains the estimated volume of attenuation storage generated using Flood Studies Report (FSR) data in QSE. By comparison the volumes generated using FEH are more conservative therefore these values have been used in the Masterplan design.

| Catchment    | Developable Area (ha) | Impermeable Area (ha) | Q100 Discharge Rate (l/s) | QSE (Microdrainage). Storage Volume for 100yr Storm Event + 30% cc FSR rainfall Data (m3) | QSE (Microdrainage). Storage Volume for 100yr Storm Event + 30% cc FEH rainfall Data (m3) | Outfall |
|--------------|-----------------------|-----------------------|---------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------|
| 1            | 2.1                   | 1.38                  | 19.1                      | 777                                                                                       | 885                                                                                       | A       |
| 2            | 0.3                   | 0.19                  | 2.7                       | 106                                                                                       | 117                                                                                       | B       |
| 3            | 2.1                   | 1.36                  | 18.8                      | 766                                                                                       | 810                                                                                       | D       |
| 4            | 2.9                   | 2.02                  | 27.9                      | 1049                                                                                      | 1200                                                                                      | C       |
| 5            | 0.5                   | 0.35                  | 4.8                       | 198                                                                                       | 225                                                                                       | C1      |
| 6            | 2.3                   | 1.48                  | 20.5                      | 833                                                                                       | 950                                                                                       | E       |
| 7            | 2.4                   | 1.57                  | 21.7                      | 885                                                                                       | 991                                                                                       | D       |
| 8            | 11.8                  | 7.67                  | 105.9                     | 4323                                                                                      | 5000                                                                                      | G       |
| 9            | 7.0                   | 4.55                  | 62.8                      | 2565                                                                                      | 2900                                                                                      | H       |
| 10           | 1.1                   | 0.71                  | 9.9                       | 399                                                                                       | 460                                                                                       | F       |
| 11           | 3.9                   | 2.51                  | 34.7                      | 1414                                                                                      | 1580                                                                                      | I       |
| 12           | 1.0                   | 0.63                  | 8.8                       | 507                                                                                       | 580                                                                                       | J       |
| 13           | 0.7                   | 0.45                  | 6.3                       | 253                                                                                       | 290                                                                                       | J       |
| 14           | 1.9                   | 1.26                  | 17.4                      | 710                                                                                       | 832                                                                                       | N       |
| 15           | 3.9                   | 2.53                  | 35.0                      | 1414                                                                                      | 1625                                                                                      | T       |
| 16           | 1.8                   | 1.19                  | 16.4                      | 670                                                                                       | 760                                                                                       | O       |
| 17           | 2.1                   | 1.37                  | 18.9                      | 772                                                                                       | 880                                                                                       | O       |
| 18           | 4.8                   | 3.14                  | 43.4                      | 1769                                                                                      | 2010                                                                                      | S       |
| 19           | 7.0                   | 4.58                  | 63.2                      | 2565                                                                                      | 2950                                                                                      | O       |
| 20           | 2.1                   | 1.37                  | 18.8                      | 773                                                                                       | 880                                                                                       | P       |
| 21           | 2.9                   | 1.90                  | 26.2                      | 1071                                                                                      | 1250                                                                                      | R       |
| 22           | 6.4                   | 4.15                  | 57.4                      | 2338                                                                                      | 2600                                                                                      | Q       |
| 23           | 2.1                   | 1.37                  | 18.8                      | 773                                                                                       | 880                                                                                       | M       |
| 24           | 4.0                   | 2.63                  | 36.3                      | 1482                                                                                      | 1700                                                                                      | L       |
| 25           | 0.6                   | 0.38                  | 5.3                       | 214                                                                                       | 253                                                                                       | U       |
| 26           | 0.5                   | 0.32                  | 4.5                       | 200                                                                                       | 225                                                                                       | K       |
| <b>Total</b> | <b>78.3</b>           | <b>50.91</b>          | <b>705</b>                | <b>28825</b>                                                                              | <b>32833</b>                                                                              |         |

Table 6.3 – Attenuation Storage Volumes

### On-Site Attenuation Features

- 6.29 The range of attenuation features described below outline the details of the SuDS features incorporated into the site masterplan. The type and location of attenuation features are identified on the Surface Water Strategy drawing ref 60312043/CIV/001.
- 6.30 The proposed SuDS sections drawing ref 60312043/CIV/009 included in Appendix F illustrate cross sections through proposed SuDS features situated within the site.

#### Detention basin/pond

- 6.31 Basins can provide both attenuation of surface water and provide water quality treatment. Runoff entering the basin is detained and treated by settling out sediments and biological uptake until it is displaced by runoff from the next storm. A basin should preferably be divided into a multiple basin system that provides water quality and quantity volume storage in several independent cells. These can create increased attenuation, flood control, longer pollutant removal pathways an easier maintenance regime and more varied ecology.
- 6.32 The proposed basins will be between 1m and 1.5m deep with slopes at 1 in 3. Low flow channels will be provided through basins to cater for more frequent storm events. Some basins may incorporate some permanent ponds in accordance with landscaping proposals.
- 6.33 It is proposed that each development zone drains to a detention basin where possible.

#### Swales and Landscaped Channels

- 6.34 Swales and channels are linear vegetated drainage features in which surface water can be stored and/or conveyed. Swales should be designed at shallow gradients to promote lower flow velocities which will provide effective pollutant removal. Channels are deeper features again with shallow gradients but with steeper side slopes to reduce land take.
- 6.35 The proposed channel depths are 1m, the widths of the channels vary between 3m and 6m with a 0.5m to 1m wide base. Channel slopes will be between 1 in 3 and 1 in 1. The channels will also incorporate low flow channels along the base to cater for the more frequent rainfall events.
- 6.36 Underdrained swales are also proposed within development parcels. A perforated pipe and sand or gravel can be installed below the bottom (under drain). A particular type of under drained swale can be constructed with enhanced vegetation and filtration; these are known as rain gardens, bioswales or bioretention areas.
- 6.37 The proposed development introduces new swales and channels throughout the site which aid conveyance and pollutant removal.

#### Other means of attenuation

- 6.38 Methods of source control discussed in Section 5 such as permeable paving and green roofs may also be considered at detailed design stage. The use of such features will be reviewed against and in parallel with a site wide design code that will consider the broader sustainability objectives for the development as well as adopting any new best practices that may come online over time.
- 6.39 As infiltration drainage is not a viable option and as such any permeable paving will need to be lined to act as a pollutant removal device. Given the fact that the proposed strategy provides a number of levels of treatment within each catchment in the form of cascading conveyance and attenuation features, it is considered that an additional level of treatment in the form of permeable paving will not be required. If permeable paving were to be used in any part of the site, the storage capacity within this feature will not be used to reduce the overall storage volume as estimated within this strategy.
- 6.40 It is likely that the overall development timescale will exceed twenty years. It is acknowledged that during this period the take up of SuDS will advance resulting in new innovations. Any future SuDS innovations will be considered for use where appropriate, suitable and feasible.

### Surface water outfalls

- 6.41 It is proposed that Aborfield Garrison site has multiple surface water outfalls to the existing watercourses within the red line boundary. The outfalls are shown on Surface Water Strategy Drawing ref 60312043/CIV/001.

### Adoption

- 6.42 In 2010 the Flood and Water Management Act set out a policy to make the use of SuDS compulsory and that the systems would become the responsibility of the local authority. The government have not yet published guidance for the SuDS Approving Bodies (SABS) and some authorities have chosen to develop an interim approach.
- 6.43 Wokingham Borough Council (WBC) has an interim SuDS policy dated 28<sup>th</sup> March 2013 available on the internet included as Appendix E. The document sets out a mechanism for adopting SuDS located within public open space and adopted highway which involves agreement by both parties and commuted sums.
- 6.44 In a telephone conversation with Julia Greene of WBC on 28<sup>th</sup> August 2014 it was confirmed that WBC were in the process of setting up a SAB. WBC is currently drafting a checklist of SuDS principles and it is recommended that the detailed SuDS design is developed in line with this checklist when available.
- 6.45 The alternative arrangement would be for the SuDS to remain unadopted and to be maintained by an estate management company.

### Maintenance and Management of SuDS

- 6.46 Management of SuDS will be undertaken in an ecologically sensitive manner to promote biodiversity across the site. The series of ditches, swales and ponds being introduced across the site will provide a number of wetland habitats, as well as retaining stormwater and releasing it back into the environment.
- 6.47 For below-ground SuDS such as permeable paving the manufacturer or designer should provide maintenance advice. This should include routine and long-term actions that can be incorporated into a maintenance plan.
- 6.48 Marginal vegetation should be monitored to ensure it does not engulf the open water. At least 50% of the water should be managed as open and free from marginal vegetation.
- 6.49 Channels will be monitored annually to ensure that aquatic vegetation does not block the channel and impede water flow and removed as necessary. If cut annually, on a rotational basis, marginal vegetation will ensure a year round supply of vegetative cover and food sources.
- 6.50 Ponds should be kept free from predatory fish. Occasional drying up can be good as it prevents fish from becoming established. Ponds however, need to retain open water for the majority of the amphibian breeding and larval development seasons to ensure adequate numbers of new recruits into the local population.
- 6.51 Silt or water plants should not excessively choke ponds. Areas of open water should be retained.
- 6.52 Management of ponds will be undertaken in late autumn and winter only when amphibians are less likely to be present. Only a small percentage of the pond area will be managed in any one year to leave sections as refuges.
- 6.53 Detailed ecological management plans for water bodies, SuDS features and wetland areas will be developed in conjunction with the overall phased development programme, and included within the Landscape Management Plan for each phase of construction.
- 6.54 The SuDS features on the site will be designed to reflect the landscape proposals and the various maintenance requirements.

### Reserved Matters Application

- 6.55 For each phase of the works a detailed drainage strategy will be submitted as part of the reserved matters application. Each submission will reflect the surface water strategy (in particular Table 7.3) detailed in this document and will include the detailed surface water design and supporting calculations. The proposed storage features will be included in detail to reflect the fixed site layout. The proposed discharge rates for each phase will reflect the impermeable area

contributing to the outfall which may include some temporary control measures until the additional contributing areas are constructed.

#### Exceedance Flows

- 6.56 Sewers for Adoption 7th Edition (WRc, 2012) states that properties should be protected against flooding from extreme events and that flood pathways are identified when the drainage system is exceeded.
- 6.57 Flood pathways for the conveyance of exceedance flows should be built into the proposals for the site by the design of the external layout, with the exceedance flow then being conveyed back into the surface water network. At reserved matters application stage, when a detailed hydraulic model has been built for the surface water network, the amount of storage volume that be accommodated by the external areas can be accurately determined.
- 6.58 Flood Exceedance Route Plan dated September 2014 reference 60312043/CIV/011 included in Appendix E demonstrates the flood exceedance routes based on the proposed Masterplan. The flood flow pathways have been determined based on the indicative internal road layout and existing levels.

#### Flood Risks to People

- 6.59 *"People are at risk of suffering death or serious injury when flooding occurs. People are unable to stand in deep of fast flowing floodwater. Once they are unable to stand, there is a high risk of death or serious injury*  
  
*Adults are unable to stand in still floodwater with a depth of about 1.5m or greater, although this is obviously affected by the height of a person. The depth of flowing floodwater where people are unable to stand is much less. For example, some people will be at risk when the water depth is only 0.5m if the velocity is 1m/s (about 2 mph). If the velocity increases to 2m/s (about 4 mph), some people will be unable to stand in a depth of water of only 0.3m. Most people will be unable to stand when the velocity is 2m/s and the depth is 0.6m."* (Defra / Environment Agency, Flood Risks to People dated March 2006 reference FD2321/TR2)
- 6.60 During detailed design a hydraulic model will be built for the surface water networks. When simulated for an extreme storm event, the flooding locations will become evident and the flood flow pathways can be determined based on the layout and levels of the road network.
- 6.61 The depth of the flood water can be determined from the layout and the velocity of the water can be calculated using the Manning's equation. Reference will then need to be made to Figure 2.1 – Combinations of flood depth and velocity that cause danger to people, in the Defra / EA Flood Risks to People publication dated March 2006 reference FD2321/TR2. The velocity and depth as described above would then give a category of flood hazard and the corresponding risk to people. If the risk is deemed to be too high then the design would require reassessing.

## 7 Foul Drainage Strategy

### Foul Drainage Principles

- 7.1 *"When drawing up sewerage proposals for any development, the first presumption must always be to provide a system of foul drainage discharging into a public sewer. This should be done in consultation with the Sewerage Undertaker of the area.*

*If, by taking into account the cost and/or practicability, it can be shown to the satisfaction of the local planning authority that connection to a public sewer is not feasible, a package sewage treatment plant incorporating a combination of treatment processes should be considered.*

*Only if it can be clearly demonstrated by the developer that the sewerage and sewage disposal methods are not feasible, taking into account cost and/or practicability, should a system incorporating septic tank(s) be considered and proposed if appropriate." (DETR Circular 03/99).*

### Public Sewers

- 7.2 The Sewer records obtained from Thames Water indicate there are public foul / combined water sewers within the site boundary. Foul flows in the development area gravitate in a north-easterly direction towards Barkham Road. From here, flows gravitate in a north-westerly direction towards Arborfield Sewage Treatment Works. Arborfield STW is located approximately 2.8km downstream of the development site.

### Existing Site Dry Weather Flow Discharge Rate

- 7.3 The existing discharge from the site has been estimated using the water consumption figures provided by the Severn Trent Services. The average water usage rate is 6.8 l/s. Assuming that 95% of this water is then returned to the foul water system as waste water, then the total discharge from the site is 6.46 l/s. An allowance of 10% for infiltration into the site foul water sewers has been made, therefore the total site dry weather flow (DWF) is estimated at 7.1 l/s.
- 7.4 The site wide foul water drainage records are incomplete; therefore assumptions have been made on the route and points of discharge.

### Proposed Site Dry Weather Flow Discharge Rate

- 7.5 For the purposes of this assessment, the following discharge criteria has been used to calculate the proposed dry weather flow:
- Residential - 4000 litres / dwelling / day (based on Sewers for Adoption 7th Edition)
  - District centre - 0.0594 l/s/1000m<sup>2</sup> internal floor space
  - Neighbourhood centre - 0.1056 l/s/1000m<sup>2</sup> internal floor space
  - Primary School – 0.099 l/s
  - Secondary School – 0.5278 l/s
- 7.6 Based on the above criteria the total proposed site dry weather flow has been calculated at **16.4 l/s**, therefore an increase of 9.3 l/s over existing DWF.
- 7.7 To estimate dry weather peak flow which takes into account diurnal peaks and seasonal fluctuations in water consumption a multiple of 6 is applied to the DWF. The proposed peak DWF is therefore **99.8 l/s** and when compared to the existing site peak DWF of **42.6 l/s**, this results in an increased discharge of **53.6 l/s**.

### Foul Drainage Proposals

- 7.8 Indicative foul drainage proposals for the site are detailed in Proposed Foul Strategy Drawing ref 60312043/CIV/002 included in Appendix H.
- 7.9 It is proposed to construct a gravity foul water drainage network within each of the development plots which will generally follow the topography of the land and fall towards the existing combined sewer within the development site.
- 7.10 The indicative foul water design allows for 12 connections from the proposed development onto the existing public sewer. Where possible existing connections onto the public sewer will be utilised for the new development.

**Development Impact Assessment**

- 7.11 There has been ongoing liaison with Thames Water regarding the capacity of both their sewerage network and sewage treatment works to cope with the additional flows generated by the new development site.
- 7.12 To determine the available capacity within the sewerage network and the likelihood of network upgrade, Thames Water are carrying out a Development Impact Assessment. This includes building an InfoWorks hydraulic model of the sewerage network and verifying the model against recorded flows in the actual sewer network using recorded rainfall data. The model can then be assessed using pre and post development flow rates and the performance of the sewerage system known for the critical storm duration of a 1 in 20 year rainfall return period. Any detriment in performance (i.e. increase in surcharge/flooding) will be advised by Thames Water and solutions given which may involve the upgrading of the existing public sewerage system.
- 7.13 Thames Water has carried out a pre and post development assessment using an unverified hydraulic model.
- 7.14 In the email dated 2<sup>nd</sup> September 2014 Thames Water has confirmed that the initial assessment shows that the network may cause detriment and therefore some network enhancement may be required. The capacity and extent of detriment will be reassessed once the verification of the assessment has been completed. The final assessment has not been provided at the time of writing this report. A copy of the correspondence is included in Appendix B.

**Arborfield Cross Sewage Treatment Works**

- 7.15 Under Section 94 of the Water Industry Act 1991 sewerage undertakers have an obligation to provide treatment capacity for domestic flows from future development. There is also a requirement to ensure that their assets have no adverse effect on the environment. Thames Water are therefore responsible for assessing and providing future capacity at the STW and this is in line with the Core Strategy Development Plan.
- 7.16 The current upgrade at Arborfield STW, which will be completed in 2015, will increase the capacity from a 2008 base population equivalent (pe) of 18,700 to 26,253 (increase of 7553 pe). The population of Arborfield Garrison is circa. 1000. Therefore once the barracks is decommissioned in 2015, an additional 1000 pe capacity will be provided. The current upgrade will therefore accommodate a pe increase of 8553.
- 7.17 Assuming an average of 3 persons per dwelling, this upgrade would therefore provide capacity for approximately 2851 dwellings for both the Arborfield Garrison Site and the Marino Family Trust Site. Based on the latest build profile (excluding the relatively small loads (10%) from the commercial and school development) there will be capacity at Arborfield STW until approximately 2025. When this capacity is reached, Thames Water will provide further capacity as detailed in Section 8.16.
- 7.18 AECOM wrote to Thames Water on 11<sup>th</sup> June 2014 asking for confirmation of the points set out above. Thames Water confirmed that the letter was acceptable in their email response on 19<sup>th</sup> June 2014. A copy of the correspondence is included in Appendix B.

**Greywater**

- 7.19 For all foul catchments it is recommended that the use of a grey water system is considered. This is the term for water which has been used for washing and can potentially be reused rather than sent straight down the drains. It is recommended to be considered for certain houses in the new development. Greywater includes water from laundry, dishwashers, baths, showers, hand washing etc, but does not include toilet waste (black water). It is recommended not to use kitchen sink waste water as this often contains traces of grease, fats, meat, fish, and oils.
- 7.20 This recycled water can be used for toilet flushing and for watering the garden. It reduces the load on valuable ground water reserves, and also reduces the drainage burden of the foul water system.
- 7.21 The Greywater system involves diverting the water into a container by the use of a valve. This allows normal discharge into the drainage system when required by the owner. Treating greywater typically involves passing it through a filter to remove any solids, disinfection by the addition of a small amount of a chlorine bleach, and then a period of sitting in a

settling tank to cool. Solid particles sink to the bottom, oils and fats rise to the top, and the water in the middle is the treated greywater. More complex systems are possible involving sand and gravel.

## 8 Conclusions and Recommendations

- 8.1 This report has been undertaken to develop a foul and surface water drainage strategy for the Aborfield Garrison Site, and to inform the development of a Masterplan.

### Surface Water

- 8.2 Details of existing surface water sewers, ditch courses, watercourses and any other water bodies have been obtained.
- 8.3 A surface water drainage strategy has been developed in consultation with the Environment Agency and Wokingham Borough council.
- 8.4 The surface water drainage strategy is shown on AECOM Surface Water Drainage Strategy drawing dated September 2014 reference 603012043/CIV/001.
- 8.5 Surface water discharge flows have been calculated based on the development proposals.
- 8.6 Discharge flows have been calculated to restrict the rate of runoff to the equivalent greenfield rate of run off by the use of complex flow controls.
- 8.7 The strategy includes a SuDS management train approach including swales, channels, basins and online ponds.
- 8.8 Flood flow pathways will generally be defined by the road network. Flood waters will be conveyed to the attenuation features by means of these pathways.

### Foul Water

- 8.9 An initial meeting was held with Thames Water on 22<sup>nd</sup> January 2014.
- 8.10 Details of existing foul public water sewers and private drains have been obtained from Thames Water and the MoD.
- 8.11 The expected foul water discharge flows have been calculated based on the development proposals including an assessment of existing flows that will remain.
- 8.12 Thames Water have been instructed on behalf of Crest Nicholson to undertake a scoping exercise of assessment work required. The initial assessment shows that the network may cause detriment and therefore some network enhancement may be required. The capacity and extent of detriment will be reassessed once the verification of the assessment has been completed. The final assessment has not been provided at the time of writing this report.
- 8.13 AECOM has received written confirmation that Thames Water will provide any additional capacity in the sewerage network under Section 94 of the Water Industry Act 1991.
- 8.14 The foul water drainage strategy is shown on AECOM Foul Water Drainage Strategy drawing dated September 2014 reference 603012043/CIV/002.

### Recommendations

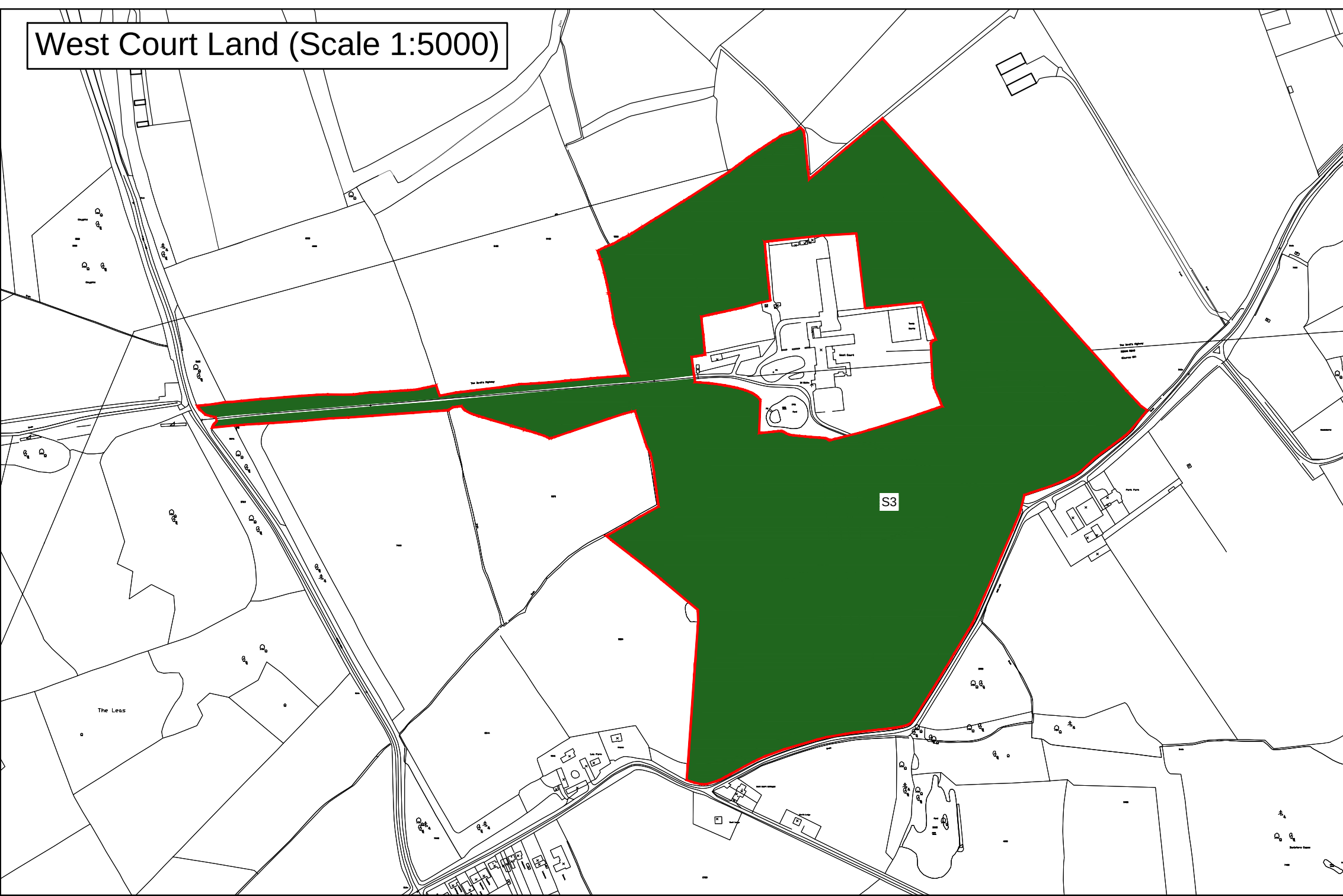
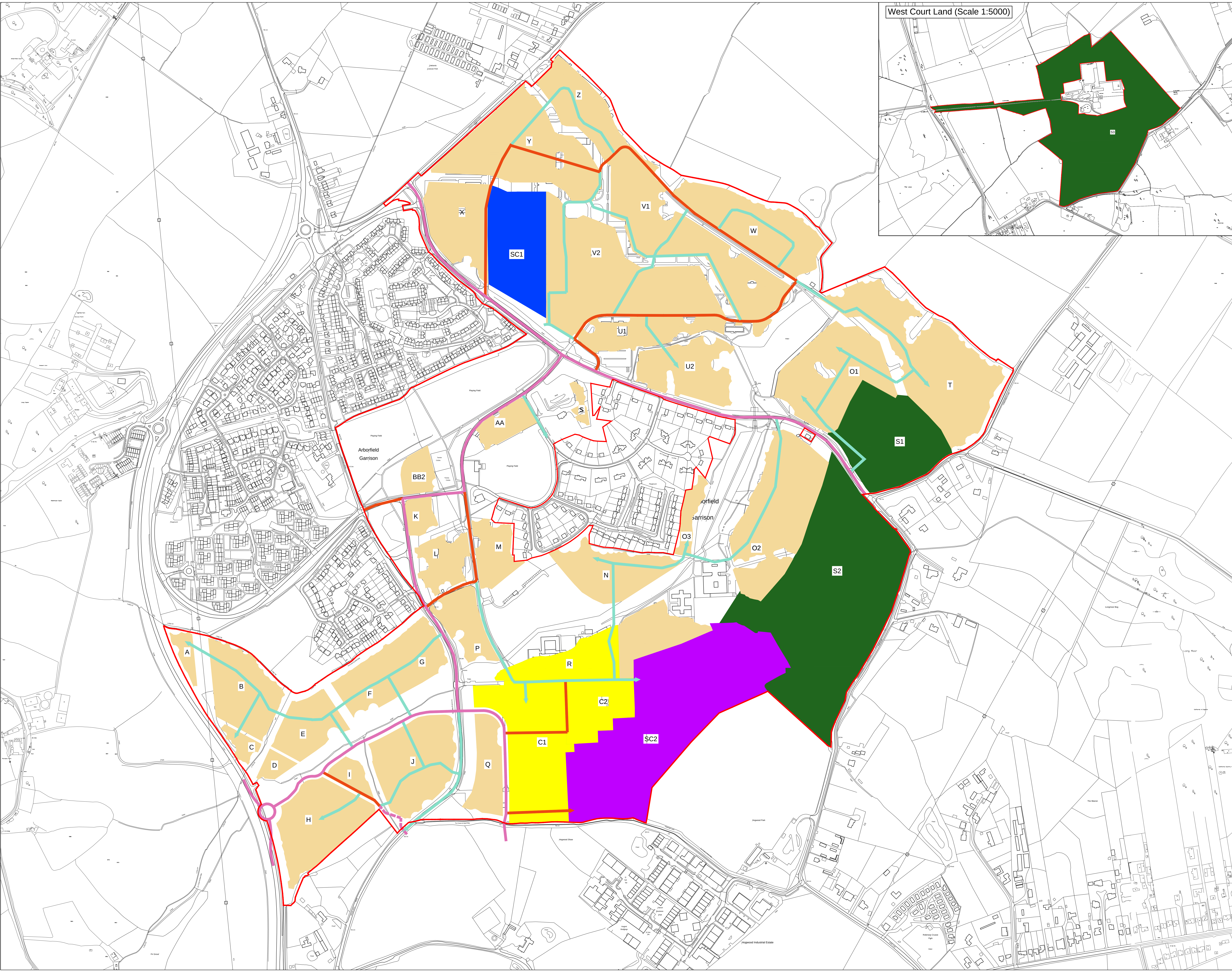
- 8.15 It is recommended that when the site is developed the steps outlined below are taken in the drainage design process.
- 8.16 A detailed Ground Investigation should be carried out to inform geological, hydrological and ground conditions on the site.
- 8.17 Surface water discharge from the site should be limited to equivalent greenfield rates of runoff.
- 8.18 The layout of the proposed development and the design of the new on-site surface water drainage system should allow for the excess runoff from an exceptionally intense local rainstorm to be confined for the duration of the storm within the site.

- 8.19 The detailed design of the on-site surface water drainage system should take into account the possible effects of climate change on storm runoff over the next one hundred years.
- 8.20 The detailed design of the proposed SuDS features should be carried out in consultation with Wokingham Borough Council and Thames Water to ensure that there are no issues with the future adoption of the features.
- 8.21 The foul water design should be refined and reviewed as the site layout develops.
- 8.22 Where possible existing connections onto the public foul sewer should be utilised for the new development.

**Appendix A**

Development Masterplan





DO NOT SCALE  
All dimensions to be checked on site and Architect to be notified of any discrepancies prior to commencement

DESIGNERS RISK ASSESSMENT  
under section 13 - Construction Design and Management Regulations 1994  
RESIDUAL RISKS

| REF | DESCRIPTION                                                                                                                                                                                                   | DATE |
|-----|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| I   | 190914 Relocated A327 junction. Trees to be retained layer updated. Revised alignment of the Nine Mile Ride extension. Revised cells H, J, Q and C1. Red line boundary amended.                               |      |
| H   | 100914 Cells CC and BB1 omitted. Street layout amended to take on board SJA comments. Updated SJA trees to be retained layout.                                                                                |      |
| G   | 140814 Road layout updated. SANGS cells S1 and S2 revised to accommodate bridleway link.                                                                                                                      |      |
| F   | 040814 Revised Flood line option 3B shown. Development cells amended accordingly. SANGS area reduced to now allow for 2000 units. Revised district centre and primary and secondary school sites cells shown. |      |
| E   | 220714 Access off A372 roundabout relocated due to third party land, development cells amended accordingly.                                                                                                   |      |
| D   | 160714 Cells and roads updated and SUDS basins/swales locations added.                                                                                                                                        |      |
| C   | 070714 Cells and roads amended to accommodate green links and SUDS basins/swales.                                                                                                                             |      |
| B   | 200614 Cells, SANGS and roads amended. Trees and flood line shown.                                                                                                                                            |      |
| A   | 110614 Cells and roads amended. Trees and flood line shown.                                                                                                                                                   |      |

IAN DARBY PARTNERSHIP

NORTHERN

ST. JUDES, BARKER STREET, SHIELDFIELD, NEWCASTLE UPON TYNE, NE2 1AS  
TEL (0191) 261 4442 FAX (0191) 261 1090 e-mail - info@idpartnership-northern.com

2617 CLIENT  
Arborfield Garrison  
for Crest Nicholson

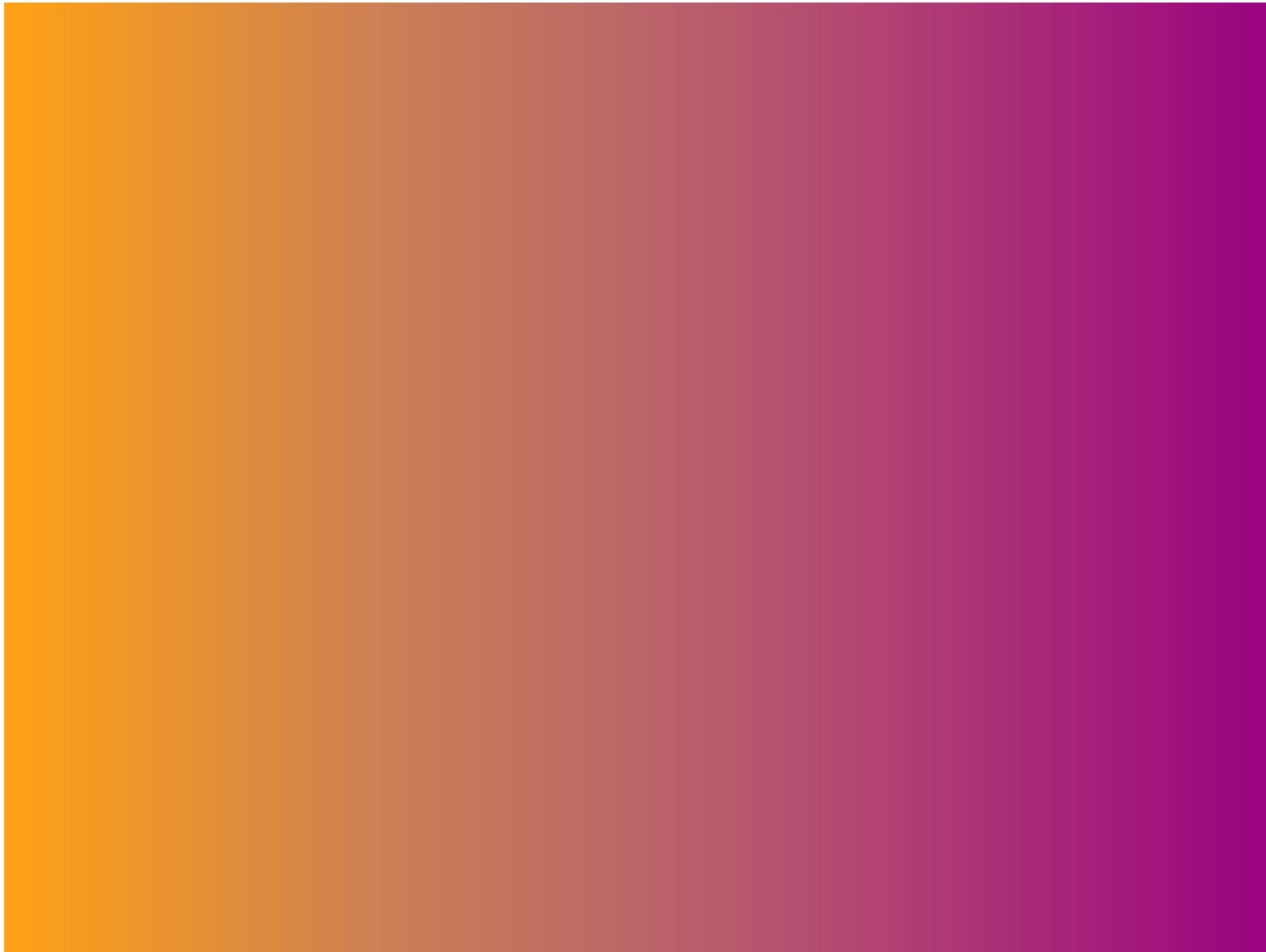
DRAWING TITLE  
Masterplan Diagram  
(with constraints)

|                         |                        |                            |
|-------------------------|------------------------|----------------------------|
| PROJECT ARCHITECT<br>MM | DRAWN BY<br>DJ         | CHECKED                    |
| SCALE<br>1:2500@A0      | PROJECT NO<br>N81:2240 | DRAWING NO. Rev I<br>AR-23 |
| DATE<br>16/05/2014      |                        |                            |
| DWG STATUS              | 2047                   | CONSULTATION               |

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**Appendix B**

Thames Water Correspondence



## Murphy, Siobhan

---

**From:** Martin, Steve L  
**Sent:** 03 September 2014 17:20  
**To:** Murphy, Siobhan  
**Subject:** FW: Arborfield Garrison SDL DIA (SMG1522 X4503/669) - Initial Detriment Results

fyi

---

**From:** Geoff Nokes [<mailto:geoff.nokes@thameswater.co.uk>]  
**Sent:** 03 September 2014 15:39  
**To:** Martin, Steve L  
**Subject:** FW: Arborfield Garrison SDL DIA (SMG1522 X4503/669) - Initial Detriment Results

fyi

---

**From:** Tyrone Parkinson [<mailto:Tyrone.Parkinson@mwhglobal.com>]  
**Sent:** 02 September 2014 15:36  
**To:** Geoff Nokes  
**Cc:** Manuel Dasilva; Simone Rast; Carl Smith  
**Subject:** Arborfield Garrison SDL DIA (SMG1522 X4503/669) - Initial Detriment Results

Dear Geoff

The model build for the Arborfield study is now complete. The scope for the study requires us to provide an initial assessment to the Developer in advance of the completing the flow survey and model verification. An initial assessment of the proposed development has been completed with the newly built but unverified model. This shows that the development may cause detriment and therefore some form of network enhancement may be required. The flow survey is almost complete and so model verification will start shortly. The capacity of the existing network and extend of any detriment caused by the proposed development will be re-assessed once the verification is complete.

Would you like to pass this information on to the Developer?

Regards

Tyrone



**Tyrone Parkinson**  
**Principal Engineer**

MWH Global  
Terriers House  
201 Amersham Road  
High Wycombe HP13 5AJ  
United Kingdom  
Tel: +44 (0) 1494 557692  
Mobile: +44 (0) 7710 944339

[tyrone.parkinson@mwhglobal.com](mailto:tyrone.parkinson@mwhglobal.com)  
[www.mwhglobal.com](http://www.mwhglobal.com)

---

**From:** Graham Moralee  
**Sent:** 02 September 2014 14:36

To: Simone Rast  
Cc: Tyrone Parkinson; Pugazh Thayumanavan; Kishor Patil; Carl Smith  
Subject: RE: Arborfield Garrison SDL DIA - Initial Detriment Results

Hi Simone,

As we don't normally provide actual detriment figures externally, we could provide a themed plan showing the locations of flooding and surcharge detriment?

Kind regards,  
Graham

**Graham Moralee MCIWEM**  
Senior Wastewater Networks Modeller  
Urban Drainage Group



---

From: Simone Rast [<mailto:simone.rast@thameswater.co.uk>]  
Sent: 02 September 2014 13:45  
To: Graham Moralee  
Cc: Tyrone Parkinson; Pugazh Thayumanavan; Kishor Patil; Carl Smith  
Subject: RE: Arborfield Garrison SDL DIA - Initial Detriment Results

Hi Graham,

I'm looking at this now.

We agreed to provide results from an initial run without flow survey data in the scope, so we ought to provide a response, although we'd like to avoid this really.

What did you have in mind to send?

Kind regards,  
Simone

**Simone Rast**  
Wastewater Network  
Modeller

Thames Water Utilities Ltd,  
Reading STW, Island Road,  
Reading, RG2 0RP

☎ 020 3577 9299 (89299)



[Simone.Rast@thameswater.co.uk](mailto:Simone.Rast@thameswater.co.uk)



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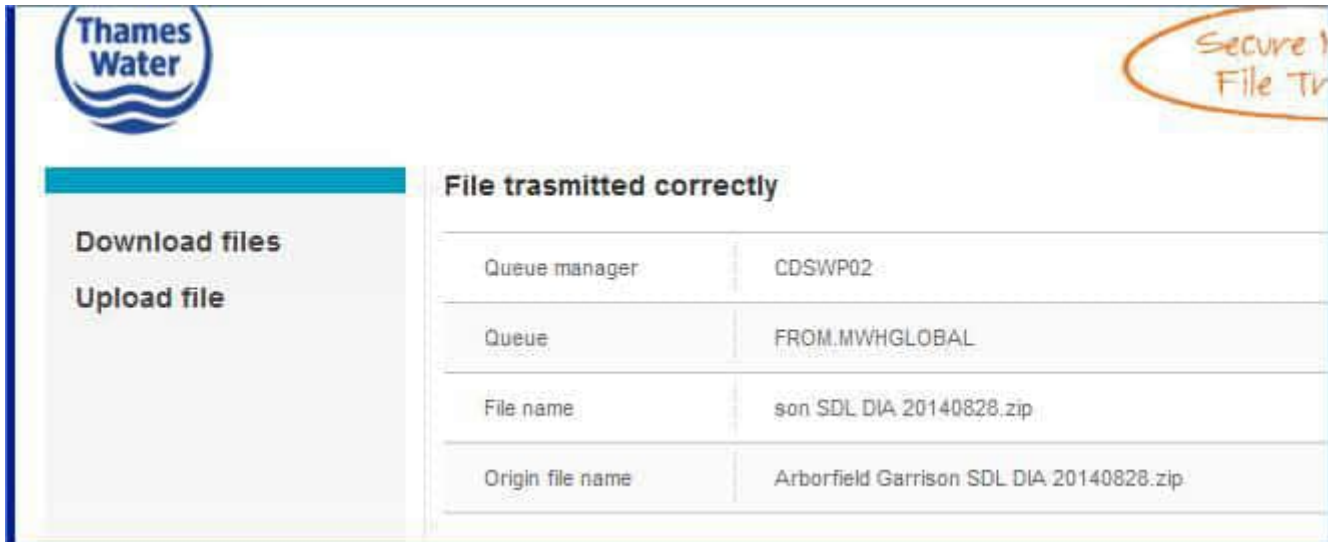
From: Graham Moralee [<mailto:Graham.Moralee@mwhglobal.com>]  
Sent: 28 August 2014 12:00  
To: Simone Rast  
Cc: Tyrone Parkinson; Pugazh Thayumanavan; Kishor Patil; Carl Smith  
Subject: RE: Arborfield Garrison SDL DIA - Initial Detriment Results

Hi Simone,

The model was calibrated using the full SFHD dataset from 1990 to February 2014. The dataset was filtered to remove any XE and XI properties, and only those with a Hydraulic Flood Category Code were considered. In total, there were 90 instances of reported flooding at 48 separate properties that were considered.

Figure 4 in the MBV Report shows the predicted vs. reported flooding locations with the results of an M30 event shown.

Please find an IWC containing the current model files for the Arborfield Garrison study uploaded to the SMFT, as shown.



The screenshot shows the Thames Water logo in the top left corner. On the right, there is a handwritten orange note that says "Secure File Transfer". The main content area is titled "File transmitted correctly". On the left, there are buttons for "Download files" and "Upload file". On the right, there is a table with the following data:

|                  |                                          |
|------------------|------------------------------------------|
| Queue manager    | CDSWP02                                  |
| Queue            | FROM.MWHGLOBAL                           |
| File name        | son SDL DIA 20140828.zip                 |
| Origin file name | Arborfield Garrison SDL DIA 20140828.zip |

Please let me know any further queries.

Thanks,  
Graham

Graham Moralee MCIWEM  
Senior Wastewater Networks Modeller  
Urban Drainage Group



---

From: Simone Rast [<mailto:simone.rast@thameswater.co.uk>]  
Sent: 28 August 2014 11:25  
To: Graham Moralee  
Cc: Tyrone Parkinson; Pugazh Thayumanavan; Kishor Patil; Carl Smith  
Subject: RE: Arborfield Garrison SDL DIA - Initial Detriment Results

Hi Graham,

I am currently in the process of reviewing the Arborfield DAP report.  
It seems that for the historic verification of the Arborfield model you have taken into account properties that flooded only in the extreme event of 20<sup>th</sup> July 2007.

If this is correct, then it is likely that the model over predicts in some areas.

Could you send me your current model please, to have a look?

Kind regards,

Simone

**Simone Rast**  
**Wastewater Network**  
**Modeller**

Thames Water Utilities Ltd,  
Reading STW, Island Road,  
Reading, RG2 0RP

☎ 020 3577 9299 (89299)

📧  
[Simone.Rast@thameswater.co.uk](mailto:Simone.Rast@thameswater.co.uk)



*Driving Intelligent Investment*

---

From: Graham Moralee [<mailto:Graham.Moralee@mwhglobal.com>]  
Sent: 28 August 2014 10:50  
To: Simone Rast  
Cc: Tyrone Parkinson; Pugazh Thayumanavan; Kishor Patil; Carl Smith  
Subject: Arborfield Garrison SDL DIA - Initial Detriment Results

Good Morning Simone,

We've completed our initial assessment of the predicted detriment caused by the Arborfield Garrison SDL site, using the unverified Arborfield model. The consultant acting on behalf of the Developer, URS, requested this initial run as part of the assessment so they could provide an indication to their client of the potential impact.

We must obviously stress that the attached results have been produced using the model that has only been calibrated using historical flooding records, and has not had any verification against measured flow survey data carried out. Therefore, the attached results are subject, and likely to, change.

The attached results spreadsheet indicate a minimum amount of flooding detriment to be caused by the re-development of the Garrison site; however, there is surcharge detriment caused.

Please let me know if you would like to review the model set-up before we look to issuing these initial results to Developer Services and the Developer.

Kind Regards,  
Graham

**Graham Moralee MCIWEM**  
**Senior Wastewater Networks Modeller**  
**Urban Drainage Group**  
MWH Global  
Terrier's House, 201 Amersham Road  
High Wycombe, Buckinghamshire, HP13 5AJ  
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M: +44 (0)79211 72303  
[graham.moralee@mwhglobal.com](mailto:graham.moralee@mwhglobal.com)  
[www.mwhglobal.com](http://www.mwhglobal.com)



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# Asset Location Search



Thames Water Property Searches  
12Vastern Road  
READING  
RG1 8DB

**Search address supplied**      Biggs Lane  
Arborfield  
Reading  
RG2 9LL

**Your reference**                      60312043 - Arborfield Garrison

**Our reference**                      ALS/ALS Standard/2014\_2677085

**Search date**                          8 February 2014

You are now able to order your Asset Location Search requests online by visiting  
[www.thameswater-propertysearches.co.uk](http://www.thameswater-propertysearches.co.uk)



# Asset Location Search



**Search address supplied:** Biggs Lane, Arborfield, Reading, RG2 9LL

Dear Sir / Madam

**An Asset Location Search is recommended when undertaking a site development.** It is essential to obtain information on the size and location of clean water and sewerage assets to safeguard against expensive damage and allow cost-effective service design.

The following records were searched in compiling this report: - the map of public sewers & the map of waterworks. Thames Water Utilities Ltd (TWUL) holds all of these.

This search provides maps showing the position, size of Thames Water assets close to the proposed development and also manhole cover and invert levels, where available.

Please note that none of the charges made for this report relate to the provision of Ordnance Survey mapping information. The replies contained in this letter are given following inspection of the public service records available to this company. No responsibility can be accepted for any error or omission in the replies.

You should be aware that the information contained on these plans is current only on the day that the plans are issued. The plans should only be used for the duration of the work that is being carried out at the present time. Under no circumstances should this data be copied or transmitted to parties other than those for whom the current work is being carried out.

Thames Water do update these service plans on a regular basis and failure to observe the above conditions could lead to damage arising to new or diverted services at a later date.

## Contact Us

If you have any further queries regarding this enquiry please feel free to contact a member of the team on 0845 070 9148, or use the address below:

Thames Water Utilities Ltd  
Property Searches  
PO Box 3189  
Slough  
SL1 4WW

Email: [searches@thameswater.co.uk](mailto:searches@thameswater.co.uk)

Web: [www.thameswater-propertysearches.co.uk](http://www.thameswater-propertysearches.co.uk)

# Asset Location Search



## Waste Water Services

**Please provide a copy extract from the public sewer map.**

The following quartiles have not been printed as they contain no assets:

The following quartiles have been printed as they fall within Thames' sewerage area:

SU7665SW  
SU7665NW  
SU7665SE  
SU7665NE  
SU7666SE  
SU7764NW  
SU7765SW  
SU7765NW  
SU7766SW  
SU7765SE  
SU7765NE  
SU7766SE  
SU7664NW  
SU7664NE

Enclosed is a map showing the approximate lines of our sewers. Our plans do not show sewer connections from individual properties or any sewers not owned by Thames Water unless specifically annotated otherwise. Records such as "private" pipework are in some cases available from the Building Control Department of the relevant Local Authority.

Where the Local Authority does not hold such plans it might be advisable to consult the property deeds for the site or contact neighbouring landowners.

This report relates only to sewerage apparatus of Thames Water Utilities Ltd, it does not disclose details of cables and or communications equipment that may be running through or around such apparatus.

The sewer level information contained in this response represents all of the level data available in our existing records. Should you require any further Information, please refer to the relevant section within the 'Further Contacts' page found later in this document.

For your guidance:

- The Company is not generally responsible for rivers, watercourses, ponds, culverts or highway drains. If any of these are shown on the copy extract they are shown for information only.
- Any private sewers or lateral drains which are indicated on the extract of the public

# Asset Location Search



sewer map as being subject to an agreement under Section 104 of the Water Industry Act 1991 are not an 'as constructed' record. It is recommended these details be checked with the developer.

## Clean Water Services

**Please provide a copy extract from the public water main map.**

The following quartiles have not been printed as they contain no assets:

The following quartiles have been printed as they fall within Thames' water area:

|          |            |
|----------|------------|
| SU7765SW |            |
| SU7765NW |            |
| SU7766SW |            |
| SU7765SE |            |
| SU7765NE |            |
| SU7766SE |            |
| SU7664NW |            |
| SU7665SW |            |
| SU7665NW |            |
| SU7665SE |            |
| SU7665NE |            |
| SU7666SE |            |
| SU7664NE | South East |
| SU7764NW | South East |

The following quartiles have not been printed as they are out of Thames' water catchment area. For details of the assets requested please contact the water company indicated below:

Enclosed is a map showing the approximate positions of our water mains and associated apparatus. Please note that records are not kept of the positions of individual domestic supplies.

For your information, there will be a pressure of at least 10m head at the outside stop valve. If you would like to know the static pressure, please contact our Customer Centre on 0845 920 0800. The Customer Centre can also arrange for a full flow and pressure test to be carried out for a fee.

South East Water Ltd  
3 Church Road  
Haywards Heath  
West Sussex

# Asset Location Search



RH16 3NY

Tel: 0845 301 0845

Website: [www.southeastwater.co.uk](http://www.southeastwater.co.uk).

For your guidance:

- Assets other than vested water mains may be shown on the plan, for information only.
- If an extract of the public water main record is enclosed, this will show known public water mains in the vicinity of the property. It should be possible to estimate the likely length and route of any private water supply pipe connecting the property to the public water network.

## **Payment for this Search**

A charge will be added to your suppliers account.

# Asset Location Search



## Further contacts:

### Waste Water queries

Should you require verification of the invert levels of public sewers, by site measurement, you will need to approach the relevant Thames Water Area Network Office for permission to lift the appropriate covers. This permission will usually involve you completing a TWOSA form. For further information please contact our Customer Centre on Tel: 0845 920 0800. Alternatively, a survey can be arranged, for a fee, through our Customer Centre on the above number.

If you have any questions regarding sewer connections, budget estimates, diversions, building over issues or any other questions regarding operational issues please direct them to our service desk. Which can be contacted by writing to:

Developer Services (Waste Water)  
Thames Water  
Clearwater Court  
Vastern Road  
Reading  
RG1 8DB

Tel: 0845 850 2777  
Email: [developer.services@thameswater.co.uk](mailto:developer.services@thameswater.co.uk)

### Clean Water queries

Should you require any advice concerning clean water operational issues or clean water connections, please contact:

Developer Services (Clean Water)  
Thames Water  
Clearwater Court  
Vastern Road  
Reading  
RG1 8DB

Tel: 0845 850 2777  
Email: [developer.services@thameswater.co.uk](mailto:developer.services@thameswater.co.uk)



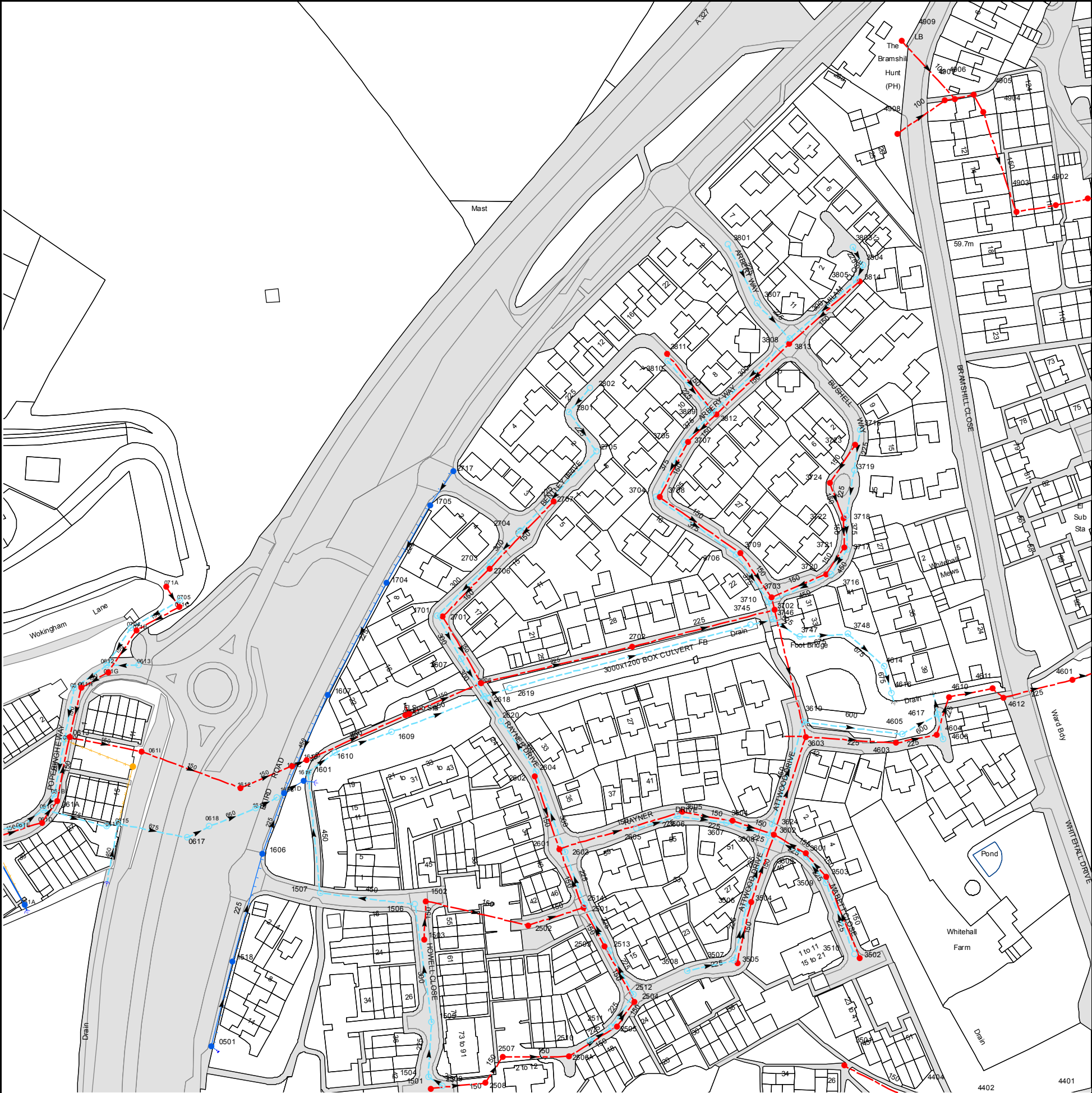
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476250,165250

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NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 4408                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.02               | 57.83                |
| 4415                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.34               | 56.24                |
| 4414                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.08               | 55.95                |
| 4407                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.18               | 57.62                |
| 4405                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.4                | 56                   |
| 4406                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.32               | 56.92                |
| 4403                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.8                | 56.54                |
| 4402                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.95               | 56.38                |
| 4401                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.46               | 55.46                |
| 4404                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.79               | 57.62                |
| 4205                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.77               | 59.34                |
| 4201                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.75               | 58.69                |
| 4207                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.14               | 58.74                |
| 4203                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.14               | 58.16                |
| 4206                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.12               | 58.76                |
| 4202                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.11               | 58.28                |
| 4208                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.16               | 58.72                |
| 4204                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.07               | 58.06                |
| 4306                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.8                | 59.03                |
| 4305                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.81               | 58.5                 |
| 4301                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.46               | 57.77                |
| 4307                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.41               | 58.66                |
| 4308                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.53               | 57.57                |
| 4304                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.51               | 57.38                |
| 4409                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.86               | 56.81                |
| 4416                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 4302                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.11               | 57.63                |
| 3305                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.06               | 58.53                |
| 4303                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.93               | 57.56                |
| 3302                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.65               | 57.61                |
| 3301                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.83               | 58.34                |
| 3406                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.32               | 58.6                 |
| 3401                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.74               | 58.7                 |
| 3404                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.58               | 59.15                |
| 3403                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.78               | 59.18                |
| 3402                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.83               | 58.92                |
| 3405                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.6                | 59.58                |
| 2201                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.49               | 58.73                |
| 3303                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.23               | 58.47                |
| 2307                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.96               | 59.1                 |
| 2306                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.81               | 58.99                |
| 2302                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.62               | 60.07                |
| 2301                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.94               | 59.71                |
| 2303                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.24               | 60.03                |
| 2305                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.16               | 60.84                |
| 2304                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.88               | 60.36                |
| 3407                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.25               | 58.92                |
| 2401                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.34               | 59.55                |
| 2406                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.52               | 60.36                |
| 2402                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.26               | 59.71                |
| 2407                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.98               | 60.66                |
| 2410                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.38               | 60.66                |
| 2403                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.97               | 60.06                |
| 2404                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.09               | 60.46                |
| 2405                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.22               | 61.32                |
| 1306                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.97               | 60.68                |
| 1401                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.1                | 60.94                |
| 1402                                                                                                                                                                                                                                                                                                                                                                                                                   | 63                  | 61.39                |
| 1303                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.82               | 59.59                |
| 1302                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.84               | 59.48                |
| 1304                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.87               | 59.91                |
| 1305                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.67               | 60.08                |
| 1301                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.74               | 59.44                |
| 2408                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.44               | 60.28                |
| 2409                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.34               | 60.45                |
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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476250,165750

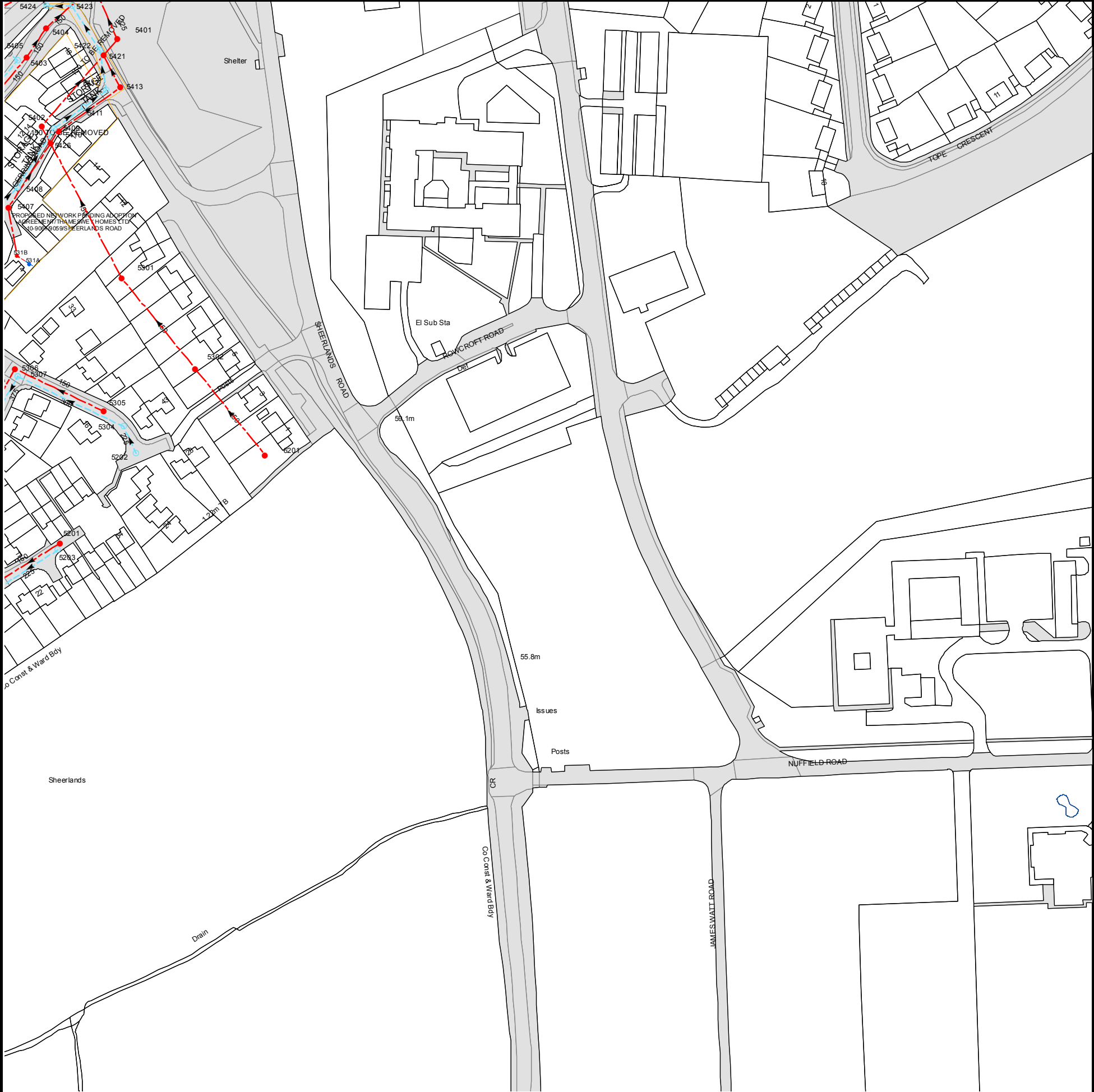
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| Manhole Reference | Manhole Cover Level | Manhole Invert Level |
|-------------------|---------------------|----------------------|
| 4603              | 58.73               | 54.88                |
| 4606              | 56.25               | 55.15                |
| 4604              | 56.33               | 54.77                |
| 4605              | 56.83               | 55.14                |
| 4617              | 56.15               | 55.15                |
| 4612              | 55.95               | 54.52                |
| 4610              | 56.15               | 54.67                |
| 4616              | 56.56               | 54.97                |
| 4611              | 56                  | 54.55                |
| 4601              | 55.73               | 54.17                |
| 4614              | 56.96               | 55.24                |
| 4903              | n/a                 | n/a                  |
| 4902              | 59                  | 56.77                |
| 4901              | 58.82               | 56.56                |
| 4908              | 59.92               | 58.73                |
| 4904              | 59.41               | 57.87                |
| 4907              | 59.69               | 58.44                |
| 4906              | 59.74               | 58.38                |
| 4905              | 59.66               | 58.33                |
| 4909              | 60.68               | 59.35                |
| 3610              | 57.28               | 55.7                 |
| 3747              | 57.73               | 55.46                |
| 3748              | 57.4                | 55.33                |
| 3745              | 57.65               | 55.75                |
| 3746              | 57.69               | 55.65                |
| 3702              | 57.72               | 55.29                |
| 3710              | 57.86               | 55.9                 |
| 3703              | 57.84               | 55.37                |
| 3720              | 57.96               | 56.25                |
| 3716              | 58.05               | 55.99                |
| 3706              | 58.24               | 56.51                |
| 3709              | 58.49               | 55.98                |
| 3717              | 58.19               | 56.02                |
| 3721              | 58.18               | 56.45                |
| 3722              | 58.46               | 56.62                |
| 3718              | 58.46               | 56.2                 |
| 3724              | 58.82               | 57.03                |
| 3719              | 59.14               | 57.39                |
| 3723              | 59.31               | 57.61                |
| 3715              | 59.62               | 57.73                |
| 3813              | 60.75               | 58.26                |
| 3808              | 60.74               | 58.45                |
| 3807              | 61.04               | 59.47                |
| 3814              | 60.54               | 58.26                |
| 3805              | 60.57               | 58.71                |
| 3804              | 60.46               | 58.88                |
| 3803              | 60.45               | 59.03                |
| 3501              | 60.06               | 58.48                |
| 3505              | 60.04               | 58.33                |
| 3507              | 59.98               | 58.52                |
| 3502              | 59.43               | 57.8                 |
| 3510              | 59.55               | 57.98                |
| 3506              | 59.16               | 57.7                 |
| 3504              | 59.11               | 57.32                |
| 3509              | 59.03               | 57.4                 |
| 3503              | 58.96               | 56.99                |
| 3609              | 58.69               | 57.09                |
| 3601              | 58.63               | 56.63                |
| 3608              | 58.48               | 56.69                |
| 3602              | 58.47               | 56.26                |
| 3624              | 58.41               | 55.93                |
| 3604              | 58.48               | 56.49                |
| 3603              | 57.35               | 55.09                |
| 2604              | 58.81               | 57.12                |
| 2620              | 58.62               | 56.8                 |
| 2618              | 58.94               | 56.59                |
| 2619              | 58.77               | 55.75                |
| 2606              | 58.98               | 57.68                |
| 2607              | 59.29               | 57.43                |
| 2702              | 58                  | 56.02                |
| 2701              | 59.64               | 57.61                |
| 1701              | 59.71               | 58                   |
| 2706              | 60.29               | 58                   |
| 2703              | 60.37               | 58.37                |
| 2704              | 60.49               | 58.54                |
| 1705              | 62.25               | 60.9                 |
| 2707              | 60.47               | 58.47                |
| 3704              | 59.47               | 57.75                |
| 3708              | 59.46               | 57.07                |
| 2717              | n/a                 | n/a                  |
| 2705              | 60.37               | 58.96                |
| 3705              | 60.14               | 58.05                |
| 3707              | 60.13               | 57.64                |
| 3812              | 60.55               | 57.93                |
| 3809              | 60.56               | 57.74                |
| 2801              | 61.62               | 59.43                |
| 2802              | 61.49               | 59.77                |
| 3810              | 61.35               | 59.05                |
| 3811              | 61.47               | 59.64                |
| 3801              | 61.15               | 59.7                 |
| 1501              | 62.7                | 61                   |

| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 2509                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.61               | 61.31                |
| 2508                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.54               | 60.59                |
| 1504                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.56               | 61.02                |
| 2507                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.47               | 60.39                |
| 2506                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.88               | 59.99                |
| 2510                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.54               | 60.22                |
| 2511                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.35               | 59.94                |
| 2505                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.35               | 59.5                 |
| 1505                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.22               | 60.82                |
| 2504                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.04               | 59.2                 |
| 2512                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.96               | 59.48                |
| 3508                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.59               | 59.13                |
| 2513                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.28               | 58.83                |
| 2503                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.26               | 58.47                |
| 2502                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.4                | 58.35                |
| 2501                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.64               | 57.99                |
| 2514                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.57               | 58.16                |
| 2603                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.21               | 57.59                |
| 2601                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.17               | 57.01                |
| 2605                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.81               | 57.23                |
| 3607                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.44               | 56.89                |
| 3606                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.45               | 57.17                |
| 3605                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.46               | 56.63                |
| 2602                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.85               | 57.34                |
| 061I                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.67               | 59.07                |
| 071A                                                                                                                                                                                                                                                                                                                                                                                                                   | 64.25               | 62.49                |
| 071C                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.93               | 61.99                |
| 0705                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.98               | 62.38                |
| 0617                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.71               | 58.27                |
| 0618                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 0501                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.32               | 60.83                |
| 1518                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.3                | 60.1                 |
| 1612                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.43               | 58.72                |
| 161E                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1606                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.1                | 58.9                 |
| 161D                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1608                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 161C                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.99               | 58.54                |
| 161F                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 161B                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.74               | 58.44                |
| 1601                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.7                | 57.66                |
| 1507                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.6                | 58.75                |
| 1607                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1610                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.29               | 57.49                |
| 1704                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.5                | 60.2                 |
| 1609                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.91               | 57.14                |
| 161A                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.04               | 58.04                |
| 1603                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.01               | 57.98                |
| 1506                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.75               | 59.09                |
| 1503                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.27               | 59.41                |
| 1502                                                                                                                                                                                                                                                                                                                                                                                                                   | 68.68               | 58.78                |
| 061E                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.96               | 58.93                |
| 051A                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 061D                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.89               | 59.64                |
| 061C                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.82               | 58.87                |
| 061B                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.81               | 59.01                |
| 061A                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.79               | 59.51                |
| 0610                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.89               | 59.37                |
| 061J                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.85               | 59.31                |
| 0611                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.95               | 60.38                |
| 061H                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.95               | 60.16                |
| 061F                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.39               | 58.77                |
| 0612                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.86               | 61.39                |
| 061G                                                                                                                                                                                                                                                                                                                                                                                                                   | 62.93               | 61.05                |
| 0615                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.27               | 58.75                |
| 0704                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.39               | 61.91                |
| 071B                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.48               | 61.75                |
| 0613                                                                                                                                                                                                                                                                                                                                                                                                                   | 63.73               | 62.3                 |
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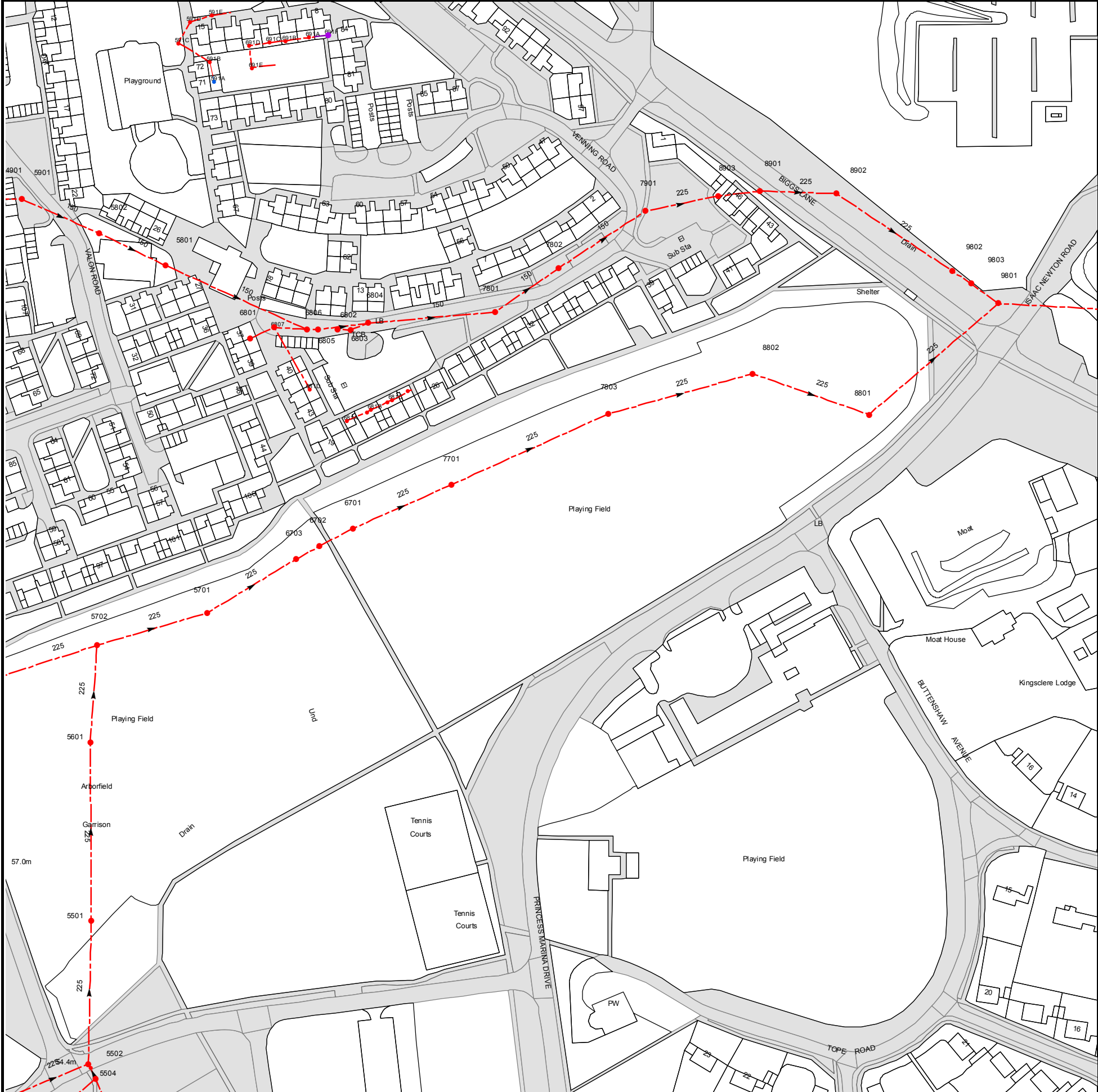
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,165250

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NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 6201                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.34               | 58.57                |
| 5302                                                                                                                                                                                                                                                                                                                                                                                                                   | 59.49               | 58.12                |
| 5408                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5426                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5410                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5409                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5402                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.47               | 56.85                |
| 5411                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5412                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5413                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5405                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.6                | 56.15                |
| 5403                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.55               | 55.67                |
| 5421                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5422                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5401                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.1                | 56.39                |
| 5404                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.2                | 55.56                |
| 5424                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.41               | 56.26                |
| 5423                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5203                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.35               | 59.46                |
| 5201                                                                                                                                                                                                                                                                                                                                                                                                                   | 61.3                | 58.92                |
| 5202                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.67               | 59.44                |
| 5304                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.51               | 59.23                |
| 5305                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.68               | 59.03                |
| 5307                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.59               | 59.19                |
| 5306                                                                                                                                                                                                                                                                                                                                                                                                                   | 60.55               | 58.73                |
| 5301                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 531A                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 531B                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5407                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
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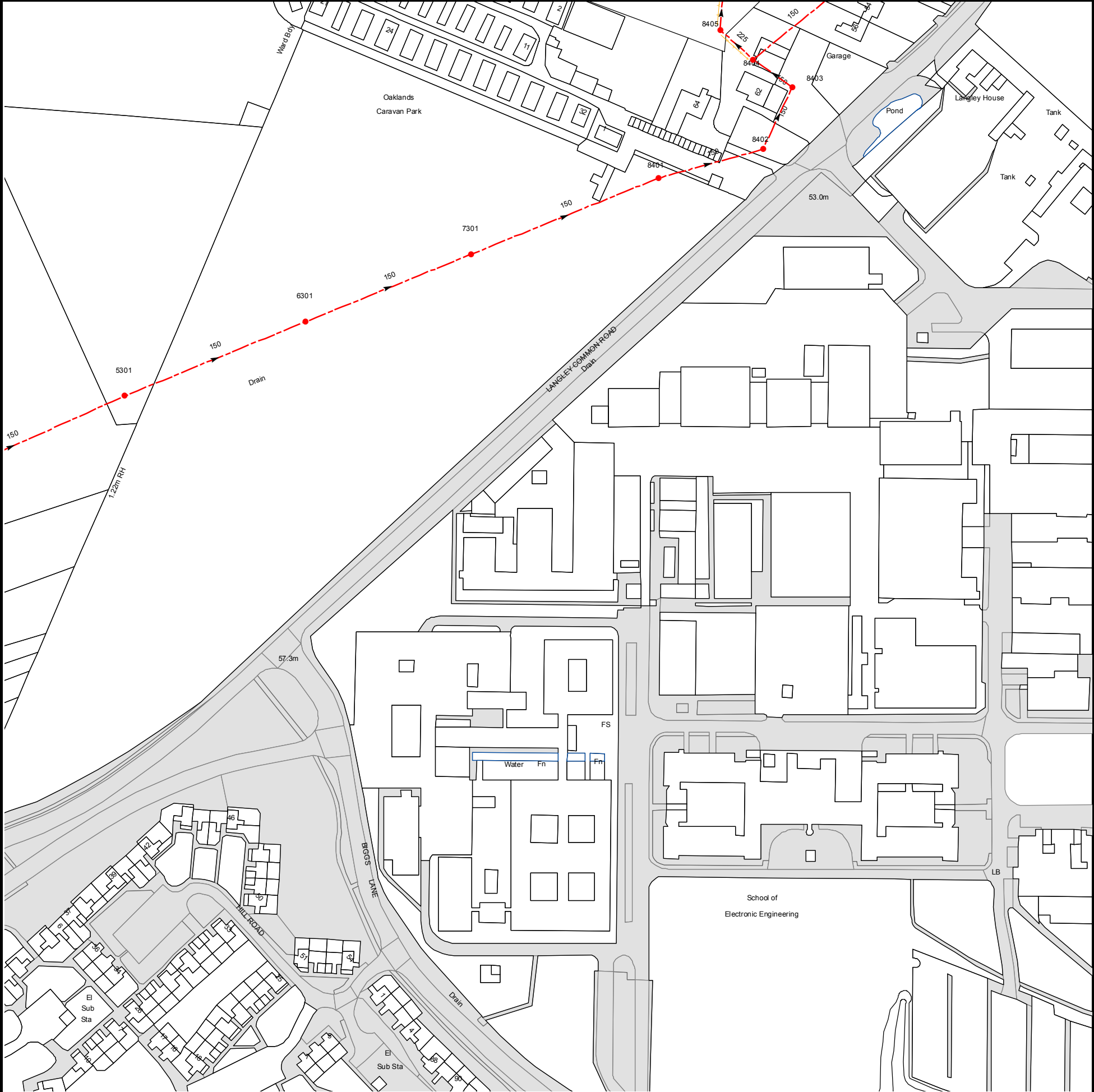
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,165750

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 5701                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.46               | 53.46                |
| 6703                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.22               | 53.09                |
| 6702                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.06               | 53.03                |
| 6701                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.68               | 53                   |
| 7701                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.37               | 52.68                |
| 681A                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 8801                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.25               | 51.3                 |
| 7803                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.96               | 52.14                |
| 681B                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 681C                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 681D                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 8802                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6801                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6803                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.12               | 55.02                |
| 6802                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.12               | 55.2                 |
| 6806                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.13               | 54.63                |
| 6805                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.1                | 54.59                |
| 6807                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.22               | 54.94                |
| 6804                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.93               | 54.32                |
| 7801                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.05               | 53.76                |
| 9801                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.18               | 50.86                |
| 9803                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.4                | 50.92                |
| 9802                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.37               | 50.97                |
| 7802                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.09               | 53.35                |
| 5801                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.65               | 55.3                 |
| 7901                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.18               | 51.8                 |
| 8903                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.46               | 51.55                |
| 8902                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.3                | 51.22                |
| 8901                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 591A                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691E                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 591B                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691D                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 591C                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691C                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691B                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691A                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 691F                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 591D                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 591E                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5504                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | 55.35                |
| 5502                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.06               | 54.97                |
| 5501                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.71               | 54.65                |
| 5601                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5702                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.99               | 53.79                |
| 5802                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.12               | 55.59                |
| 5901                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.77               | 55.96                |
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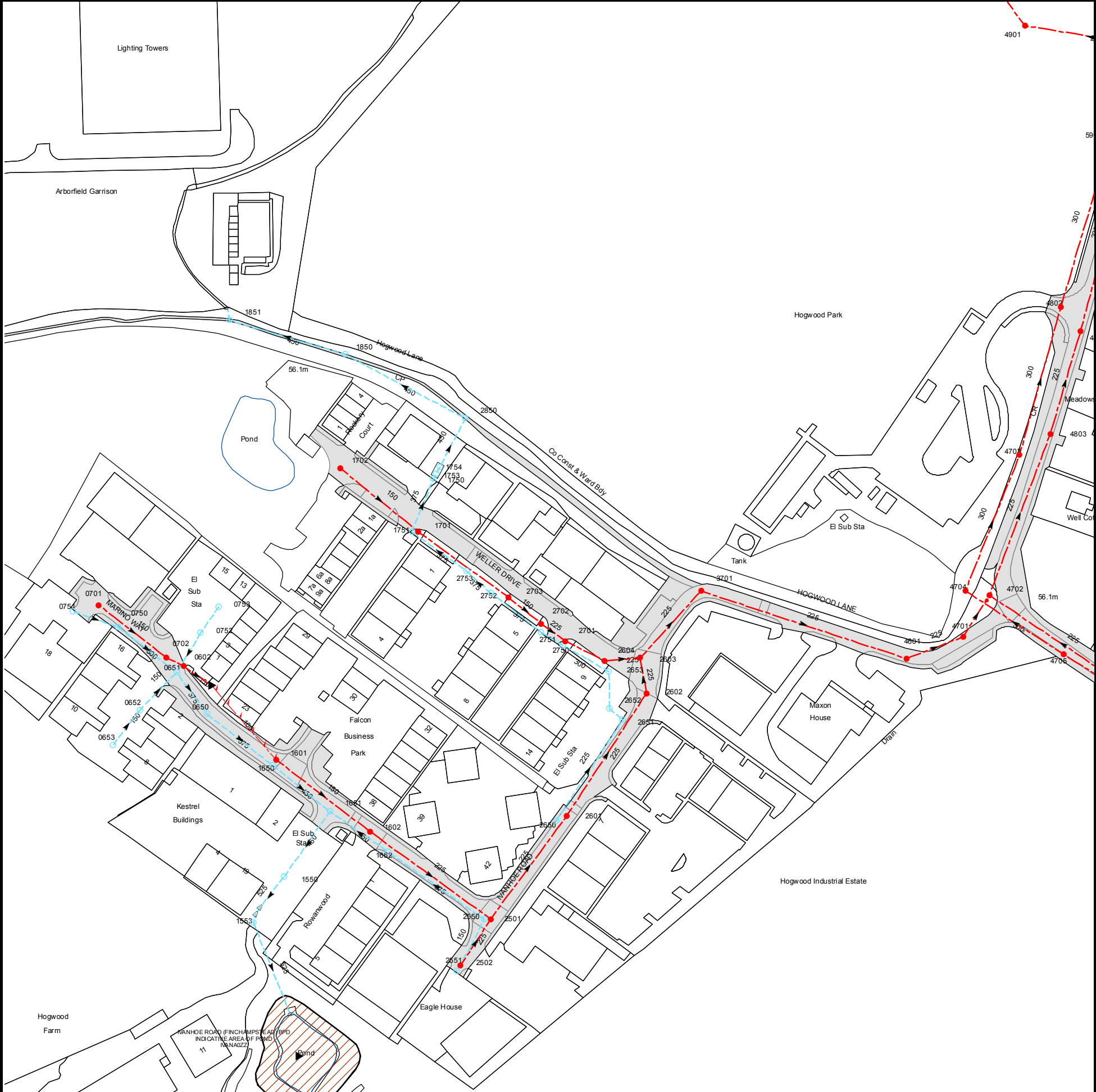
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,166250

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 6301                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.19               | 53.86                |
| 7301                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.35               | 52.94                |
| 8401                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 8402                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.82               | 51.02                |
| 8403                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.11               | 50.58                |
| 8404                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.19               | 50.42                |
| 8405                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.9                | 50.29                |
| 5301                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.4                | 54.98                |
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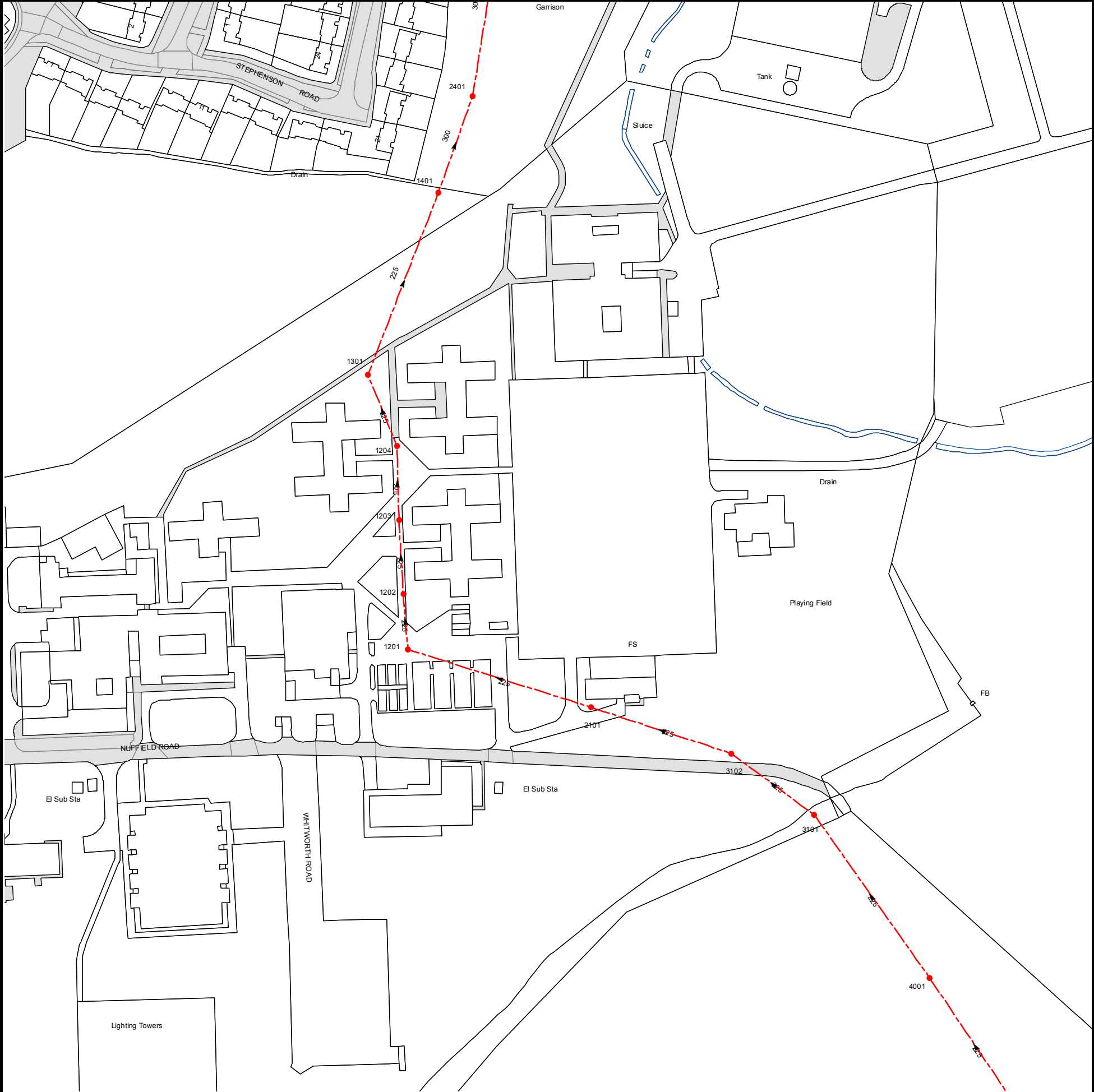
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477250,164750

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 2652                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.7                | 56.45                |
| 2651                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.74               | 56.61                |
| 2603                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.64               | 55.44                |
| 2602                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.75               | 55.72                |
| 3701                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.09               | 55.26                |
| 4601                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.46               | 54.62                |
| 4701                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.25               | 54.53                |
| 4704                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.35               | 53.32                |
| 4702                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.34               | 53.44                |
| 4703                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.65               | 52.92                |
| 4901                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.05               | 52.08                |
| 4803                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.17               | 53.2                 |
| 4802                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.75               | 52.61                |
| 4705                                                                                                                                                                                                                                                                                                                                                                                                                   | 56.4                | 53.6                 |
| 4801                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.55               | 52.95                |
| 1550                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.29               | 56.9                 |
| 1651                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.8                | 57.11                |
| 1702                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.81               | 56.85                |
| 1850                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1602                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.91               | 56.87                |
| 1652                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.83               | 57.28                |
| 1751                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.21               | 55.68                |
| 1701                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.25               | 56.55                |
| 1750                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.62               | n/a                  |
| 1753                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1754                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 2551                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.67               | 57.81                |
| 2502                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.65               | 56.67                |
| 2850                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.22               | 55.4                 |
| 2753                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.04               | 55.91                |
| 2550                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.49               | 57.67                |
| 2501                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.53               | 56.44                |
| 2752                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.05               | 56.02                |
| 2703                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.06               | 56.06                |
| 2751                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.13               | 56.21                |
| 2702                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.09               | 55.68                |
| 2650                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.18               | 56.92                |
| 2750                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.97               | 56.2                 |
| 2701                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.92               | 55.58                |
| 2601                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.16               | 56.07                |
| 2604                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 2653                                                                                                                                                                                                                                                                                                                                                                                                                   | 57.79               | 56.38                |
| 0751                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.72               | 57.56                |
| 0701                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.71               | 56.97                |
| 0653                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 0750                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.81               | 57.38                |
| 0652                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 0702                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.67               | 56.68                |
| 0651                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.75               | 57.26                |
| 0602                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.67               | 56.64                |
| 0752                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.47               | 57.34                |
| 0650                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.58               | 57.23                |
| 0753                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 1851                                                                                                                                                                                                                                                                                                                                                                                                                   | 55.93               | 54.93                |
| 1553                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.21               | 56.8                 |
| 1650                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.6                | 57.19                |
| 1601                                                                                                                                                                                                                                                                                                                                                                                                                   | 58.63               | 57.28                |
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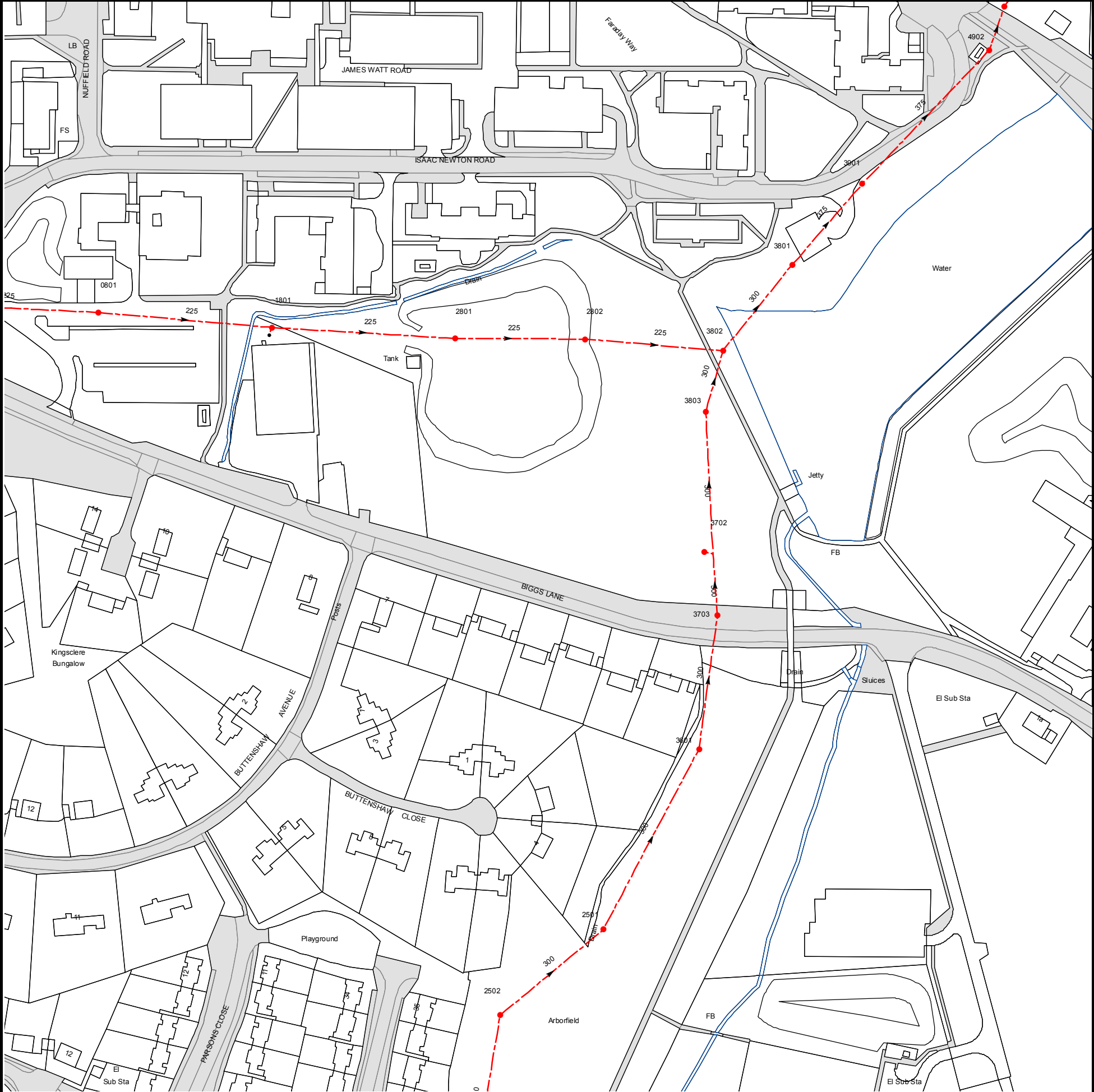
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477250,165250

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 2101                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.4                | 50.73                |
| 3102                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.82               | 51.07                |
| 3101                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.58               | 51.3                 |
| 1201                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.36               | 50.41                |
| 1202                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.27               | 50.28                |
| 1203                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.92               | 50.21                |
| 1204                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.66               | 50.03                |
| 1301                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.26               | 49.87                |
| 1401                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.79               | 49.53                |
| 2401                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.34               | 49.38                |
| 4001                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.32               | 51.81                |
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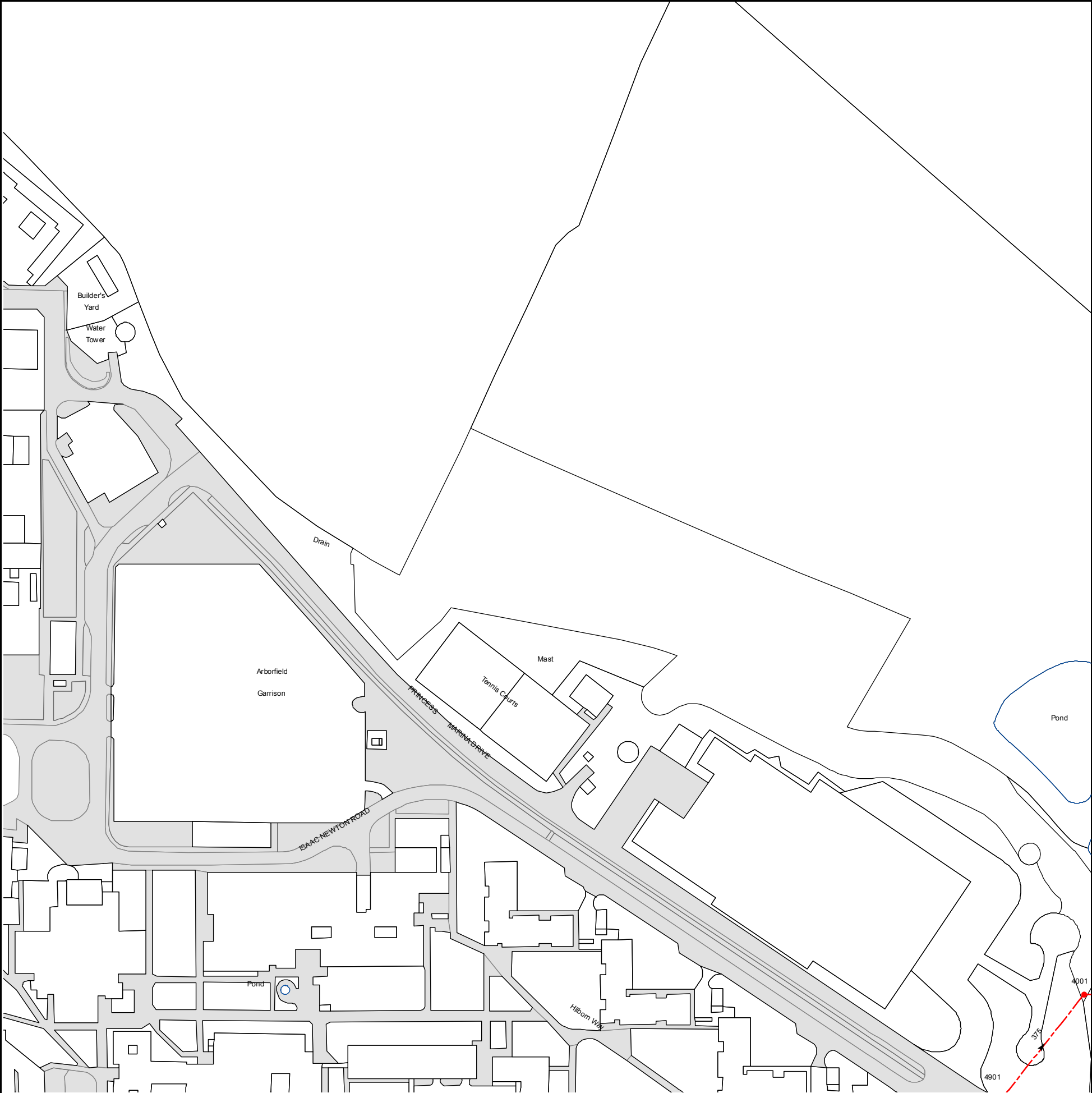
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477250,165750

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 2501                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 3601                                                                                                                                                                                                                                                                                                                                                                                                                   | 50.36               | 48.79                |
| 3702                                                                                                                                                                                                                                                                                                                                                                                                                   | 50.47               | 49.16                |
| 3803                                                                                                                                                                                                                                                                                                                                                                                                                   | 50.04               | 48.49                |
| 3703                                                                                                                                                                                                                                                                                                                                                                                                                   | 50.29               | 48.64                |
| 3802                                                                                                                                                                                                                                                                                                                                                                                                                   | 49.93               | 48.29                |
| 3801                                                                                                                                                                                                                                                                                                                                                                                                                   | 50                  | 48.23                |
| 3901                                                                                                                                                                                                                                                                                                                                                                                                                   | 49.91               | 48.1                 |
| 4902                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 4901                                                                                                                                                                                                                                                                                                                                                                                                                   | 50.52               | 47.64                |
| 2502                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.24               | 49.2                 |
| 2802                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 2801                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.68               | 49.25                |
| 1801                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 0801                                                                                                                                                                                                                                                                                                                                                                                                                   | 51.61               | 50.31                |
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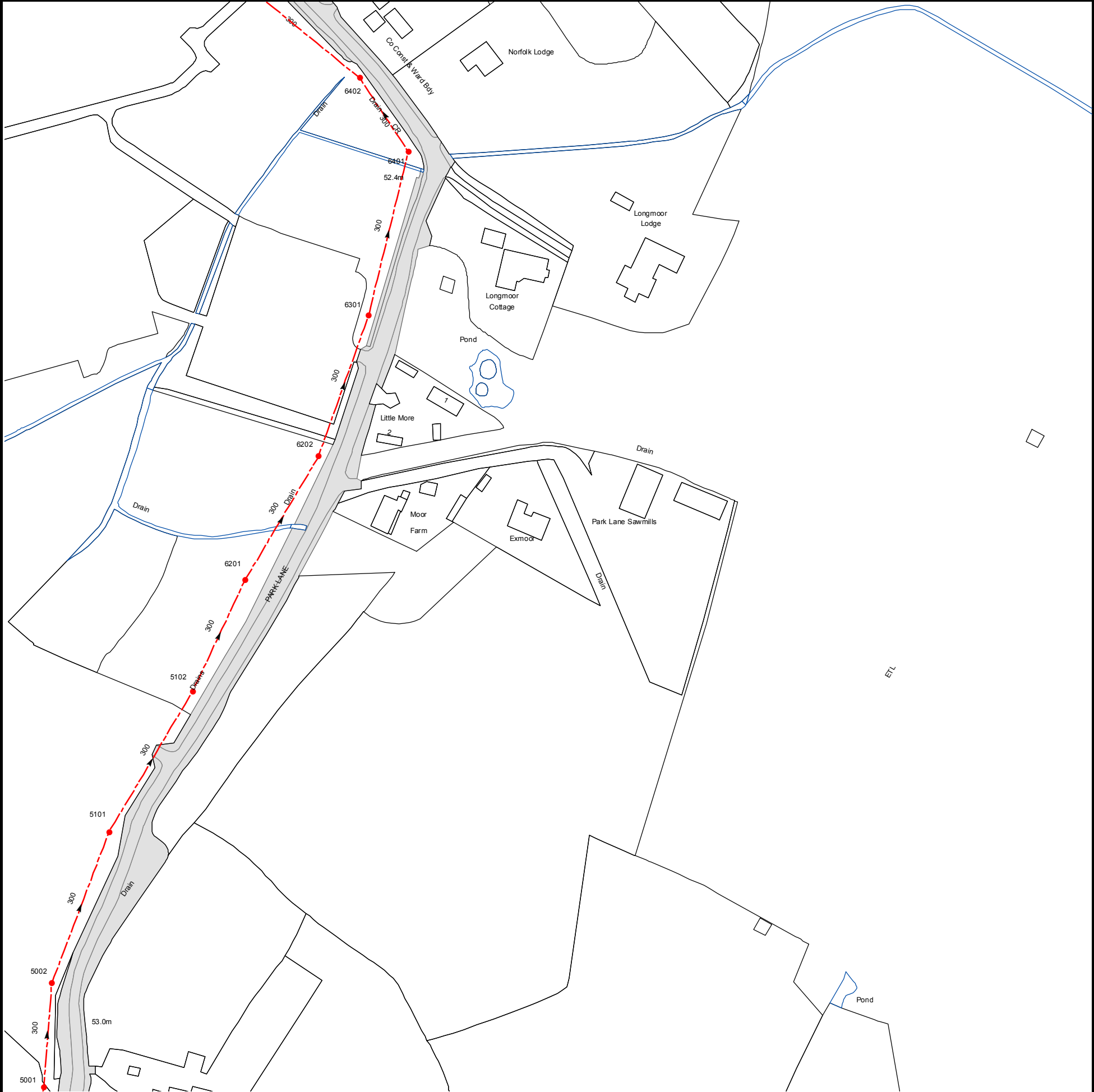
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477250,166250

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 4001                                                                                                                                                                                                                                                                                                                                                                                                                   | 50                  | 47.53                |
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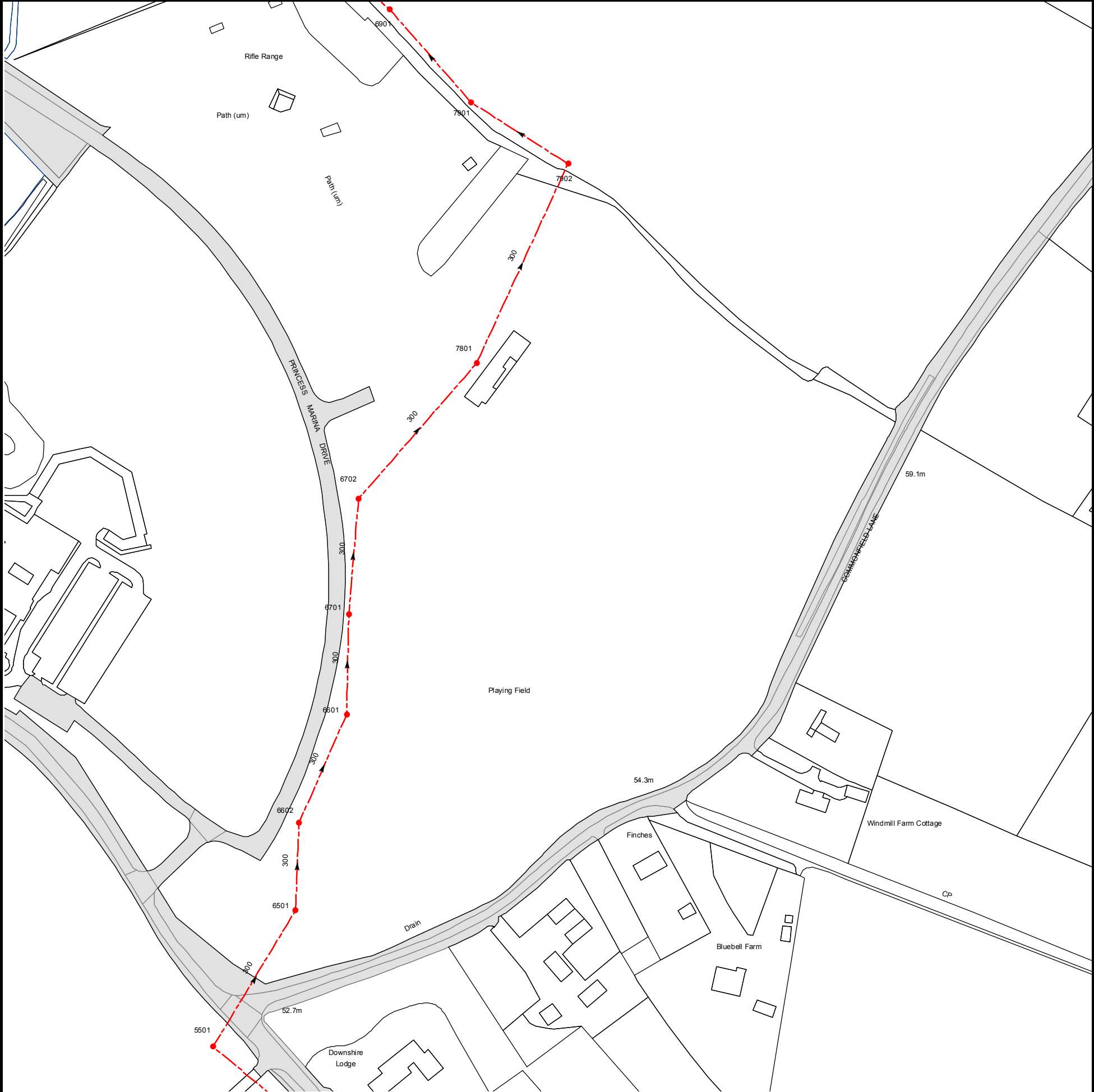
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477750,165250

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 6402                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.89               | 49.53                |
| 6301                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6401                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.47               | 49.67                |
| 5101                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.85               | 51.18                |
| 5102                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.01               | 50.39                |
| 6201                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.43               | 50.22                |
| 6202                                                                                                                                                                                                                                                                                                                                                                                                                   | 52                  | 50.04                |
| 5001                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.7                | 51.6                 |
| 5002                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.1                | 51.45                |
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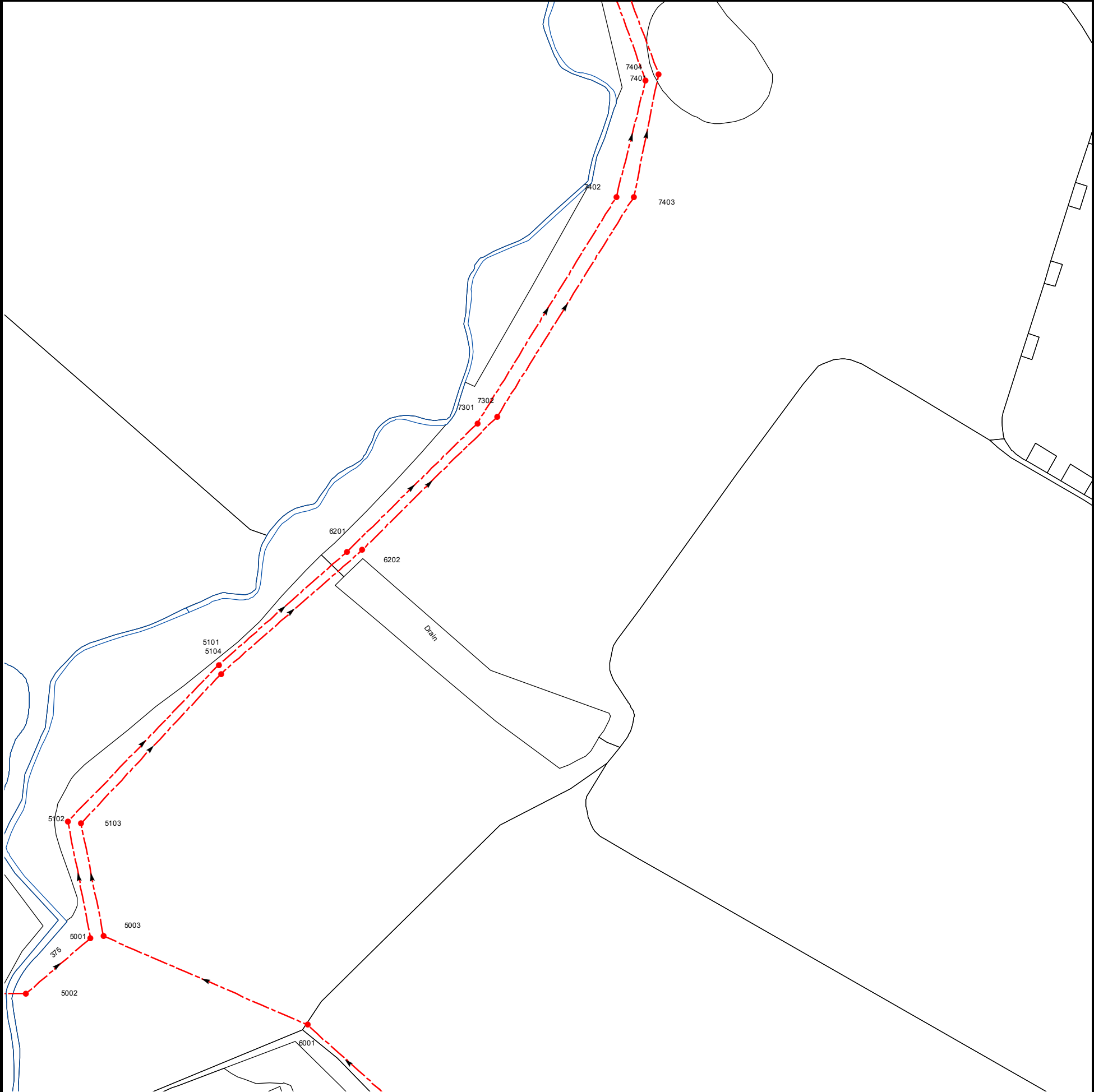
The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477750,165750

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| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 6901                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7901                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7801                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.78               | 48.23                |
| 7902                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6601                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.56               | 48.79                |
| 6701                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.68               | 48.64                |
| 6702                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.17               | 48.48                |
| 5501                                                                                                                                                                                                                                                                                                                                                                                                                   | 52.91               | 49.32                |
| 6501                                                                                                                                                                                                                                                                                                                                                                                                                   | 53.75               | 49.05                |
| 6602                                                                                                                                                                                                                                                                                                                                                                                                                   | 54.2                | 48.89                |
| The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken. |                     |                      |



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 477750,166250

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NB. Levels quoted in metres Ordnance Newlyn Datum. The value -9999.00 indicates that no survey information is available

| Manhole Reference                                                                                                                                                                                                                                                                                                                                                                                                      | Manhole Cover Level | Manhole Invert Level |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|----------------------|
| 6201                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6202                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7301                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7302                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7402                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7403                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7401                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 7404                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5002                                                                                                                                                                                                                                                                                                                                                                                                                   | 49.69               | 47.46                |
| 5102                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5103                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5001                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5003                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 6001                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5101                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| 5104                                                                                                                                                                                                                                                                                                                                                                                                                   | n/a                 | n/a                  |
| The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken. |                     |                      |



# ALS Sewer Map Key

## Public Sewer Types (Operated & Maintained by Thames Water)

|  |                                                                                                                                             |
|--|---------------------------------------------------------------------------------------------------------------------------------------------|
|  | <b>Foul:</b> A sewer designed to convey waste water from domestic and industrial sources to a treatment works.                              |
|  | <b>Surface Water:</b> A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses. |
|  | <b>Combined:</b> A sewer designed to convey both waste water and surface water from domestic and industrial sources to a treatment works.   |
|  | Trunk Surface Water                                                                                                                         |
|  | Trunk Foul                                                                                                                                  |
|  | Storm Relief                                                                                                                                |
|  | Trunk Combined                                                                                                                              |
|  | Vent Pipe                                                                                                                                   |
|  | Bio-solids (Sludge)                                                                                                                         |
|  | Proposed Thames Surface Water Sewer                                                                                                         |
|  | Proposed Thames Water Foul Sewer                                                                                                            |
|  | Gallery                                                                                                                                     |
|  | Foul Rising Main                                                                                                                            |
|  | Surface Water Rising Main                                                                                                                   |
|  | Combined Rising Main                                                                                                                        |
|  | Sludge Rising Main                                                                                                                          |
|  | Proposed Thames Water Rising Main                                                                                                           |
|  | Vacuum                                                                                                                                      |

### Notes:

- 1) All levels associated with the plans are to Ordnance Datum Newlyn.
- 2) All measurements on the plans are metric.
- 3) Arrows (on gravity fed sewers) or flecks (on rising mains) indicate direction of flow.
- 4) Most private pipes are not shown on our plans, as in the past, this information has not been recorded.
- 5) 'na' or '0' on a manhole level indicates that data is unavailable.

## Sewer Fittings

A feature in a sewer that does not affect the flow in the pipe. Example: a vent is a fitting as the function of a vent is to release excess gas.

|  |             |
|--|-------------|
|  | Air Valve   |
|  | Dam Chase   |
|  | Fitting     |
|  | Meter       |
|  | Vent Column |

## Operational Controls

A feature in a sewer that changes or diverts the flow in the sewer. Example: A hydrobrake limits the flow passing downstream.

|  |               |
|--|---------------|
|  | Control Valve |
|  | Drop Pipe     |
|  | Ancillary     |
|  | Weir          |

## End Items

End symbols appear at the start or end of a sewer pipe. Examples: an Undefined End at the start of a sewer indicates that Thames Water has no knowledge of the position of the sewer upstream of that symbol, Outfall on a surface water sewer indicates that the pipe discharges into a stream or river.

|  |               |
|--|---------------|
|  | Outfall       |
|  | Undefined End |
|  | Inlet         |

## Other Symbols

Symbols used on maps which do not fall under other general categories

|  |                                               |
|--|-----------------------------------------------|
|  | Public/Private Pumping Station                |
|  | Change of characteristic indicator (C.O.C.I.) |
|  | Invert Level                                  |
|  | Summit                                        |

### Areas

Lines denoting areas of underground surveys, etc.

|  |                  |
|--|------------------|
|  | Agreement        |
|  | Operational Site |
|  | Chamber          |
|  | Tunnel           |
|  | Conduit Bridge   |

## Other Sewer Types (Not Operated or Maintained by Thames Water)

|  |                       |
|--|-----------------------|
|  | Foul Sewer            |
|  | Surface Water Sewer   |
|  | Combined Sewer        |
|  | Gully                 |
|  | Culverted Watercourse |
|  | Proposed              |
|  | Abandoned Sewer       |

- 6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in millimetres. Text next to a manhole indicates the manhole reference number and should not be taken as a measurement. If you are unsure about any text or symbology present on the plan, please contact a member of Property Insight on 0845 070 9148.



The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476250,164750

The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. Service pipes are not shown but their presence should be anticipated. No liability of any kind whatsoever is accepted by Thames Water for any error or omission. The actual position of mains and services must be verified and established on site before any works are undertaken.

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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476250,165250

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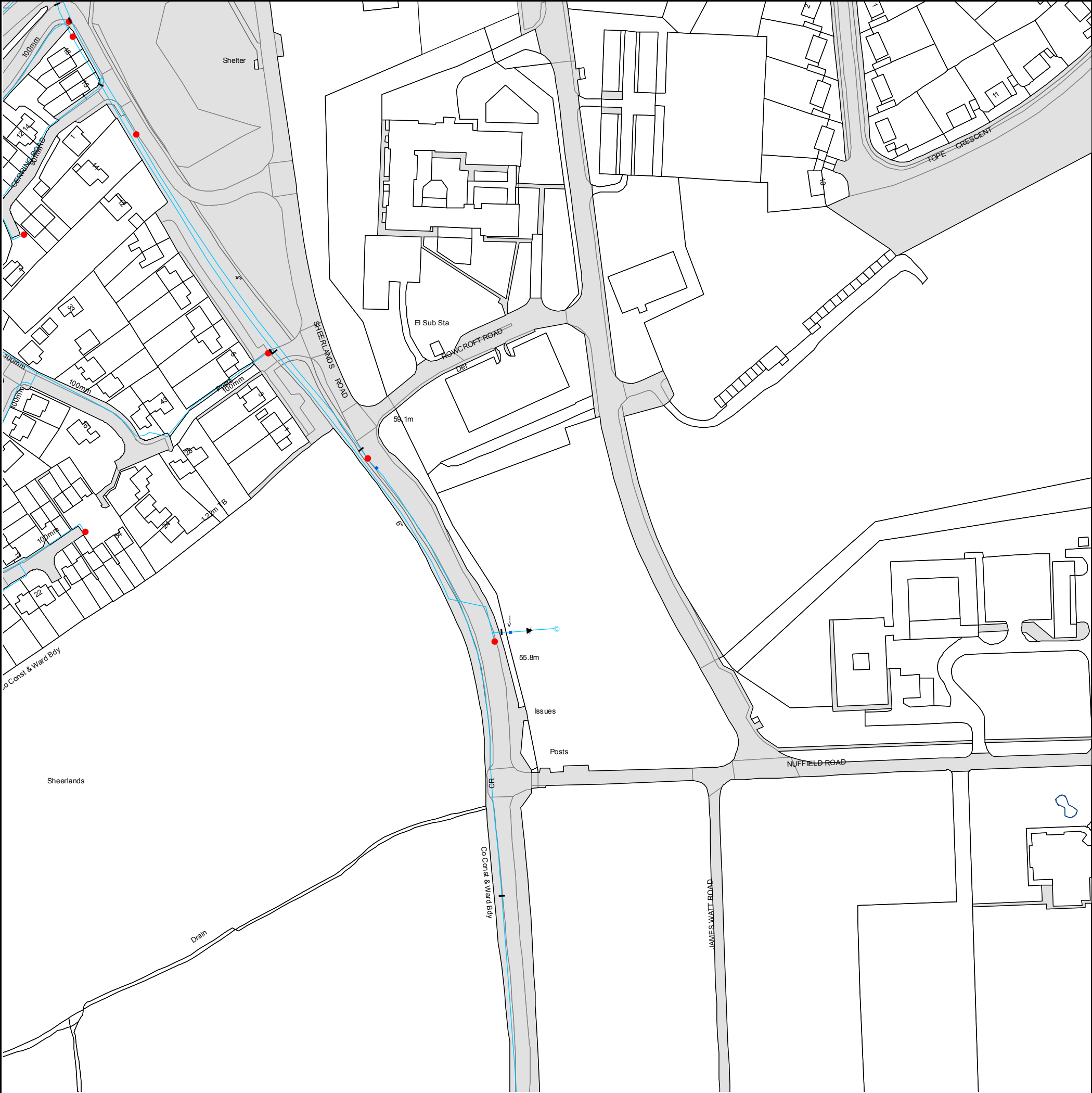
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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476250,165750

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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,165250

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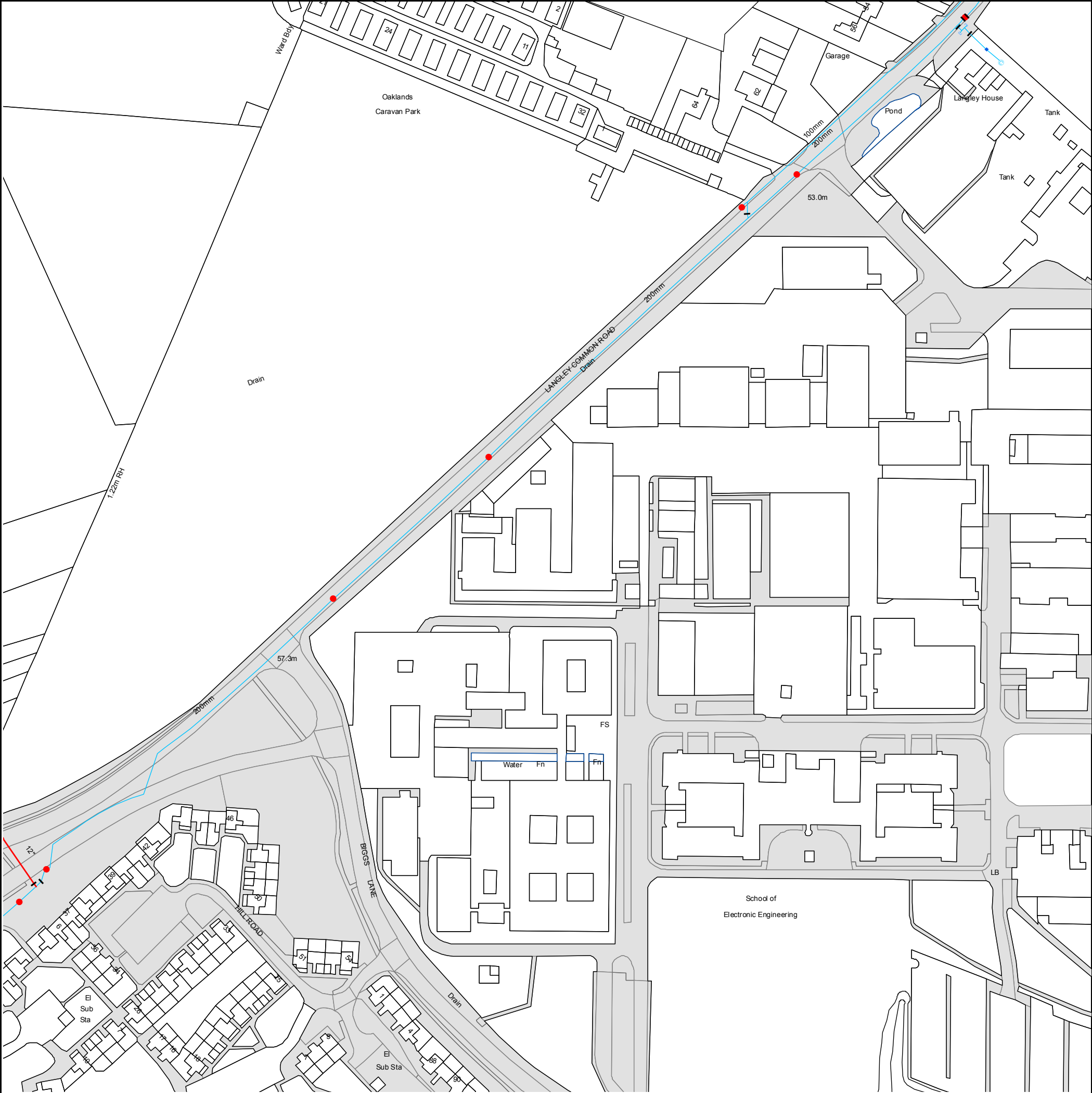
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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,165750

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The width of the displayed area is 500m and the centre of the map is located at OS coordinates 476750,166250

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# ALS Water Map Key

## Water Pipes (Operated & Maintained by Thames Water)

- 4"** **Distribution Main:** The most common pipe shown on water maps. With few exceptions, domestic connections are only made to distribution mains.
- 16"** **Trunk Main:** A main carrying water from a source of supply to a treatment plant or reservoir, or from one treatment plant or reservoir to another. Also a main transferring water in bulk to smaller water mains used for supplying individual customers.
- 3" SUPPLY** **Supply Main:** A supply main indicates that the water main is used as a supply for a single property or group of properties.
- 3" FIRE** **Fire Main:** Where a pipe is used as a fire supply, the word FIRE will be displayed along the pipe.
- 3" METERED** **Metered Pipe:** A metered main indicates that the pipe in question supplies water for a single property or group of properties and that quantity of water passing through the pipe is metered even though there may be no meter symbol shown.
- Transmission Tunnel:** A very large diameter water pipe. Most tunnels are buried very deep underground. These pipes are not expected to affect the structural integrity of buildings shown on the map provided.
- Proposed Main:** A main that is still in the planning stages or in the process of being laid. More details of the proposed main and its reference number are generally included near the main.

| PIPE DIAMETER               | DEPTH BELOW GROUND |
|-----------------------------|--------------------|
| Up to 300mm (12")           | 900mm (3')         |
| 300mm - 600mm (12" - 24")   | 1100mm (3' 8")     |
| 600mm and bigger (24" plus) | 1200mm (4')        |

## Valves

- General Purpose Valve
- Air Valve
- Pressure Control Valve
- Customer Valve

## Hydrants

- Single Hydrant

## Meters

- Meter

## End Items

Symbol indicating what happens at the end of a water main.

- Blank Flange
- Capped End
- Emptying Pit
- Undefined End
- Manifold
- Customer Supply
- Fire Supply

## Operational Sites

- Booster Station
- Other
- Other (Proposed)
- Pumping Station
- Service Reservoir
- Shaft Inspection
- Treatment Works
- Unknown
- Water Tower

## Other Symbols

- Data Logger

## Other Water Pipes (Not Operated or Maintained by Thames Water)

- Other Water Company Main:** Occasionally other water company water pipes may overlap the border of our clean water coverage area. These mains are denoted in purple and in most cases have the owner of the pipe displayed along them.
- Private Main:** Indicates that the water main in question is not owned by Thames Water. These mains normally have text associated with them indicating the diameter and owner of the pipe.

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## Ways to pay your bill

| Credit Card                                                                | BACS Payment                                                                                                                                                                                                                                                             | Telephone Banking                                                                                                              | Cheque                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Call <b>0845 070 9148</b> quoting your invoice number starting CBA or ADS. | Account number<br><b>90478703</b><br>Sort code <b>60-00-01</b><br>A remittance advice must be sent to:<br><b>Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW.</b><br>or email<br><a href="mailto:ps.billing@thameswater.co.uk">ps.billing@thameswater.co.uk</a> | By calling your bank and quoting:<br>Account number<br><b>90478703</b><br>Sort code <b>60-00-01</b><br>and your invoice number | Made payable to ' <b>Thames Water Utilities Ltd</b> '<br>Write your Thames Water account number on the back.<br>Send to:<br><b>Thames Water Utilities Ltd., PO Box 3189, Slough SL1 4WW</b><br>or by DX to <b>151280 Slough 13</b> |

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### **IMPORTANT CONSUMER PROTECTION INFORMATION**

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The Property Ombudsman scheme  
Milford House  
43-55 Milford Street  
Salisbury  
Wiltshire SP1 2BP  
Tel: 01722 333306  
Fax: 01722 332296  
Email: [admin@tpos.co.uk](mailto:admin@tpos.co.uk)

You can get more information about the PCCB from [www.propertycodes.org.uk](http://www.propertycodes.org.uk)

**PLEASE ASK YOUR SEARCH PROVIDER IF YOU WOULD LIKE A COPY OF THE SEARCH CODE**

11 June 2014

Carl Smith  
Thames Water Utilities Ltd  
Reading STW  
Island Road  
Reading  
RG2 0RP

Our Ref: 60312043/TW/003

Dear Carl

### **Arborfield Garrison SDL, Wokingham, Impact at Sewage Treatment Works**

Thank you for providing details of the current capital scheme at Arborfield Sewage Treatment Works (STW) to accommodate known growth in the catchment. It is now our understanding that:

- Under Section 94 of the Water Industry Act 1991 sewerage undertakers have an obligation to provide treatment capacity for domestic flows from future development. There is also a requirement to ensure that your assets have no adverse effect on the environment.
- Thames Water are responsible for assessing and providing future capacity at the STW and this is in line with the core strategy development plan.
- The current upgrade at Arborfield STW, which will be completed in 2015, will increase the capacity from a 2008 base population equivalent (pe) of 18,700 to 26,253 (increase of 7553 pe).
- The population of Arborfield Garrison is circa. 1000. Therefore once the barracks is decommissioned in 2015, an additional 1000 pe capacity will be provided. The current upgrade will therefore accommodate a pe increase of 8553.
- Assuming an average of 3 persons per dwelling, this upgrade would therefore provide capacity for approximately 2851 dwellings for both the Arborfield Garrison Site and the Marino Family Trust Site.
- Based on the latest build profile (excluding the relatively small loads (10%) from the commercial and school development) there will be capacity at Arborfield STW until approximately 2025.
- When this capacity is reached, Thames Water will provide further capacity as detailed in the first point above.

Please can you confirm that our understanding as detailed above is correct. If you require any further information please do not hesitate to contact me.

Yours sincerely

A handwritten signature in black ink, appearing to read 'P. Petherick'.

Paul Petherick  
Senior Engineer  
D +44 (0)121 262 1930  
E [Paul.Petherick@aeom.com](mailto:Paul.Petherick@aeom.com)

**Murphy, Siobhan**

---

**Subject:** FW: Arborfield Garrison Development impact Assessment

---

From: Carl Smith  
Sent: 19 June 2014 09:53:44 (UTC) Dublin, Edinburgh, Lisbon, London  
To: Petherick, Paul  
Subject: RE: Arborfield Garrison Development impact Assessment

Hi Paul,

I am happy with the wording of the letter.

Regards,

Carl Smith  
Wastewater Asset Planner



Thames Water Utilities Ltd, Reading STW, Island Road, Reading, RG2 0RP  
☎ 07747645534 (45534) ✉ [carl.smith@thameswater.co.uk](mailto:carl.smith@thameswater.co.uk)

*Promoting intelligent investment in our wastewater assets*

---

From: Petherick, Paul [<mailto:paul.petherick@aeom.com>]  
Sent: 12 June 2014 08:58  
To: Carl Smith  
Cc: Martin, Steve L; Sammie Bryans; [Stephen.Hollowood@gva.co.uk](mailto:Stephen.Hollowood@gva.co.uk)  
Subject: RE: Arborfield Garrison Development impact Assessment

Carl

We are nearing planning submission for this development and I would like to include a statement on the current capacity of Arborfield STW in the submission. With the previous planning submission for this site it wasn't clear on capacity and there were objections raised regarding this and the timescales for providing more capacity. Therefore I want to make it clear in the new submission that Thames are responsible for the required upgrading and with the ongoing capital scheme there will be capacity for many years to come.

Therefore I have attached a letter which details our understanding of the capacity at Arborfield STW. Please can you confirm in writing that our understanding as detailed in the letter is correct.

If you need any additional information or would like to discuss, please do not hesitate to give me a ring on the number below.

Regards

**Paul Petherick**  
Senior Engineer, Water  
D +44 (0)121 262 1930  
M 07734 382242  
<mailto:paul.petherick@aeom.com>

**AECOM**  
Colmore Plaza

Colmore Circus Queensway  
Birmingham  
B4 6AT  
T +44 (0)121 262 1900  
[www.aecom.com](http://www.aecom.com)

---

From: Carl Smith [<mailto:carl.smith@thameswater.co.uk>]  
Sent: 20 March 2014 12:46  
To: Petherick, Paul  
Subject: RE: Arborfield Garrison Development impact Assessment

Paul,

The upgrade at Arborfield STW is increasing the capacity from a 2008 base population equivalent (pe) of 18,700 to 26,253. Within these calculations the majority of the pe increase is attributed to the Garrison development (3400 properties). It may be that a further upgrade is required at the treatment works after 2021. The scope of this upgrade is unknown, the site has a fair amount of spare land available however this land is not necessarily in the most appropriate area of the site to extend the existing process.

Regards,

Carl Smith  
Wastewater Asset Planner



Thames Water Utilities Ltd, Reading STW, Island Road, Reading, RG2 0RP  
☎ 07747645534 (45534) ✉ [carl.smith@thameswater.co.uk](mailto:carl.smith@thameswater.co.uk)

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---

From: Petherick, Paul [<mailto:paul.petherick@aeacom.com>]  
Sent: 17 March 2014 11:47  
To: Carl Smith  
Subject: FW: Arborfield Garrison Development impact Assessment

Carl

Geoff Nokes has passed on your contact details. I am working on the redevelopment of the Arborfield Garrison site and I'm trying to understand the impact of the development at Arborfield Cross STW. Further to the information you supplied below, please can you confirm details of the upgrade of the works for known growth up to 2021, i.e how many houses this allows for. Also, can the further upgrade be done within the existing site, or is an extension/land purchase likely to be required?

Please can you ring me on 07734382242 to discuss further.

Regards

**Paul Petherick**  
Senior Engineer, Water  
D +44 (0)121 262 1930  
<mailto:paul.petherick@aeacom.com>

**AECOM**  
Colmore Plaza  
Colmore Circus Queensway  
Birmingham  
B4 6AT  
T +44 (0)121 262 1900  
[www.aecom.com](http://www.aecom.com)

---

From: Geoff Nokes [<mailto:geoff.nokes@thameswater.co.uk>]  
Sent: 27 February 2014 13:41  
To: Petherick, Paul  
Subject: FW: Arborfield Garrison Development impact Assessment

FYI

---

From: Carl Smith  
Sent: 27 February 2014 12:04  
To: Brendan Hegerty; Manuel Dasilva; Geoff Nokes  
Subject: RE: Arborfield Garrison Development impact Assessment

Geoff,

The upgrade at Arborfield STW is to cater for known growth upto 2021. The latest SOLAR form for the site does include the Arborfield Garrison development but the upgrade at the works will not cater for the whole development. A further upgrade is likely to be required in AMP6 or AMP7.

Regards,

---

Carl Smith  
Wastewater Asset Planner



Thames Water Utilities Ltd, Reading STW, Island Road, Reading, RG2 0RP  
☎ 07747645534 (45534) ✉ [carl.smith@thameswater.co.uk](mailto:carl.smith@thameswater.co.uk)

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---

From: Brendan Hegerty  
Sent: 27 February 2014 11:20  
To: Manuel Dasilva; Geoff Nokes; Carl Smith  
Subject: RE: Arborfield Garrison Development impact Assessment

Carl

Your area

Regards

Brendan Hegerty  
Asset Planner

Thames Water Utilities Ltd, Oxford STW, Grenoble Rd, Oxford, OX4 4XU

☎ 07747 647327 (47327)  
✉ [Brendan.Hegerty@thameswater.co.uk](mailto:Brendan.Hegerty@thameswater.co.uk)

---

From: Manuel Dasilva  
Sent: 27 February 2014 10:00  
To: Geoff Nokes; Brendan Hegerty  
Subject: RE: Arborfield Garrison Development impact Assessment

Geoff

My understanding is that Arborfield STW is being upgraded to cater for future growth in the catchment and the upgrades will be completed early in 2015. Brendan should be able to confirm if this site is being considered as part of the current upgrades.

Regards

Manuel da Silva  
Principal Wastewater Modeller

Thames Water Utilities Ltd, Reading STW, Island Rd, Reading, RG2 0RP  
Tel: 020 3577 9756 (89756)



---

From: Geoff Nokes  
Sent: 27 February 2014 09:39  
To: Manuel Dasilva; Tyrone Parkinson ([Tyrone.Parkinson@mwhglobal.com](mailto:Tyrone.Parkinson@mwhglobal.com)); Brendan Hegerty  
Subject: FW: Arborfield Garrison Development impact Assessment

Guys

What is the response about the treatment works please?

Regards  
Geoff  
89228

---

From: Petherick, Paul [<mailto:paul.petherick@aecom.com>]  
Sent: 26 February 2014 09:44  
To: Geoff Nokes  
Subject: RE: Arborfield Garrison Development impact Assessment

Geoff

Further to our telephone conversation on Monday, please see attached letter requesting more information on the impact of Arborfield Cross STW due to the proposed development sites.

I look forward to hearing from you.

Regards

**Paul Petherick**  
Senior Engineer, Water  
D +44 (0)121 262 1930  
<mailto:paul.petherick@aecom.com>

**AECOM**  
Colmore Plaza  
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---

From: Geoff Nokes [<mailto:geoff.nokes@thameswater.co.uk>]  
Sent: 21 February 2014 15:59  
To: Petherick, Paul  
Subject: RE: Arborfield Garrison Development impact Assessment

Paul

Please find the following impact study scope and cost;

SMG1522 Arborfield Garrison SDL, Wokingham (Project Ref: X4503-669)

## Background

A foul water impact study has been requested for an area of Strategic Development Land site at Arborfield Garrison, Wokingham.

The proposed development will consist of 2,000 residential properties, a primary school, a secondary school, a supermarket, retail facilities and a district community centre.

The foul flow from the development site has been provided as a net increase of 4.2l/s.

A preferred connection manhole has not been identified.

### Key Background Information

1. The proposed development is on a Brownfield site.
2. The study is to consider foul flows only. Surface water flows are assumed to drain to a nearby watercourse or soakaways.
3. The OS co-ordinates for the site are: 477238 164885.
4. DTS Reference: 12189.

## Scope

The development site is located at Arborfield Garrison, Wokingham.

Foul flows in the development area gravitate in a north-easterly direction towards Barkham Road. From here, flows gravitate in a north-westerly direction towards Arborfield Sewage Treatment Works (STW). Arborfield STW is located approximately 2.8km downstream of the development site.

There is no existing hydraulic model of the Arborfield catchment. A new model will need to be constructed for this study. A manhole survey will be required to confirm pipe sizes and invert levels local to the development site.

A flow survey will be required to confirm the flows in the sewer network, and to undertake model verification.

The existing and proposed foul flows from the development area will need to be confirmed prior to the assessment taking place, as well as the method of connection to the existing public sewer network.

The Thames Water Sewer Flooding History Database (SFHD) indicates one historical flooding location at Park Lane in the vicinity of the development site.

The tasks required to understand the impact of this development on the sewerage system are:

1. Plan and manage the asset and flow surveys.
2. Build a hydraulic model of the Arborfield STW catchment.
3. Update the model with the asset survey results.
4. Verify model.
5. Confirm the development flows / net increases in flow, and the method of connection to the existing sewer networks.
6. Run the model for the 20 year design standard for the baseline condition.

7. Run the model for the 20 year design standard with the proposed development inflows.
8. Review the hydraulic impact and, if required, develop solutions to provide a 'no detriment' condition to the existing system with the proposed additional flow. This would include reviewing alternative connection points.
9. Prepare report.

#### Risks

- a. A site visit is not envisaged as being necessary at this stage.
- b. Allowance has been made for a discussion by telephone with Thames Water Operations to understand the existing catchment issues.
- c. The solutions are subject to change following discussions with Thames Water's Operations and Asset Planning departments.
- d. Thames Water Process team may wish to ensure the impact of any solution will be acceptable at the STW. Any implications on the STW will be assessed by Thames Water and a separate additional study may be appropriate, depending on the outcome of these investigations and assessments.

#### Resources

|                         |         |                   |
|-------------------------|---------|-------------------|
| PM                      | 5 day   | Senior Consultant |
| Estimate                | 0.5 day | Senior Consultant |
| Archiving               | 0.5 day | Technician        |
| Survey Management       | 1 day   | Technician        |
| Project Familiarisation | 0.5 day | Modeller          |
| Data Collection         | 1 day   | Technician        |
| Model Build             | 28 day  | Modeller          |
| Calibration             | 7 day   | Modeller          |
| Performance Testing     | 3 day   | Modeller          |
| Solution Development    | 3 day   | Senior Modeller   |
| Reporting               | 3 day   | Senior Consultant |

Alternatively the flow survey will be removed from the system at the end of 8 weeks and a conservative approach to the system response taken for modelling purposes.

#### Programme Comments

Estimated project completion is within 24 weeks of project commencement, to allow sufficient time for data retrieval. This assumes an eight week lead time for flow surveys and an eight week flow survey. Should the developer decide to extend the flow survey as previously discussed the programme will need to be extended.

Regards

**Geoff Nokes**  
Development Engineer - Waste

✉ Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, RG1 8DB  
☎ helpdesk 0845 850 2777 direct 02035779228  
📧 geoff.nokes@thameswater.co.uk



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From: Petherick, Paul [<mailto:paul.petherick@aeom.com>]  
Sent: 07 February 2014 08:55  
To: Geoff Nokes  
Subject: RE: Arborfield Garrison Development imapct Assessment

Geoff

I have attached the red line boundary plan for the Arborfield Garrison site and also the extracts of the Infrastructure and Utilities Report which was sent to you in the post, which details both sites. Please let me know if you need any additional information.

Regards

**Paul Petherick**  
Senior Engineer, Water  
D +44 (0)121 262 1930  
<mailto:paul.petherick@aeom.com>

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From: Geoff Nokes [<mailto:geoff.nokes@thameswater.co.uk>]  
Sent: 06 February 2014 14:12  
To: Petherick, Paul  
Subject: RE: Arborfield Garrison Development imapct Assessment

Paul

Do you have a site plan you could Email me please.

Regards  
Geoff

---

From: Petherick, Paul [<mailto:paul.petherick@aeom.com>]  
Sent: 29 January 2014 11:53  
To: Geoff Nokes  
Cc: Martin, Steve L  
Subject: RE: Arborfield Garrison Development imapct Assessment

Geoff

Please find attached a letter requesting the FW Impact assessment for Arborfield Garrison SDL, Wokingham as requested. Also attached are the minutes from our meeting last week for your comments.

I have put a copy of the letter with the enclosed report in the post, addressed to yourself.

Regards

**Paul Petherick**

Senior Engineer, Water

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<mailto:paul.petherick@aeom.com>

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From: Geoff Nokes [<mailto:geoff.nokes@thameswater.co.uk>]

Sent: 27 January 2014 10:22

To: Petherick, Paul

Subject: RE: Arborfield Garrison Development impact Assessment

Paul

For an impact study Scope and Cost we require £400+vat cheque and covering letter with information on the site to have our external consultants instigate this.

Regards

**Geoff Nokes**

Development Engineer - Waste

✉ Thames Water Utilities Ltd, Clearwater Court, Vastern Road, Reading, RG1 8DB

☎ helpdesk 0845 850 2777 direct 02035779228

📧 [geoff.nokes@thameswater.co.uk](mailto:geoff.nokes@thameswater.co.uk)



---

From: Petherick, Paul [<mailto:paul.petherick@aeom.com>]

Sent: 27 January 2014 09:45

To: Geoff Nokes

Cc: Martin, Steve L

Subject: Arborfield Garrison Development impact Assessment

Geoff

Thanks for meeting us last Wednesday regarding the Arborfield Garrison development. We are keen to get things moving to understand the implications of the development on the sewerage network and the treatment works in particular.

As requested, I have sent you an email so that you can respond with details on the process for starting a development impact assessment, i.e costs and information you require from us.

I look forward to hearing from you.

Regards

**Paul Petherick**

Senior Engineer, Water

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<mailto:paul.petherick@aeacom.com>

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**Appendix C**

Severn Trent Service Records





Notes

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SERVICES LEGEND

- FW DRAINAGE
- SW DRAINAGE
- WATER SUPPLY
- BUILDING OUTLINE
- ROAD OUTLINE
- MOD BOUNDARY
- DHE BOUNDARY

QA : ISSUED FOR INFORMATION ONLY AND SUBJECT TO VERIFICATION

|     |                           |       |          |
|-----|---------------------------|-------|----------|
| B   | UpdateCompany Information | Sep03 | asm      |
| A   | ADD A59,A60, Dash A68.    | Jan02 | df       |
| Rev | Description               | Date  | Approved |

AMENDMENT RECORD

BABCOCK

Office Of Origin:  
Project Management  
Hazebrook Barracks  
Arborfield Garrison  
Berkshire  
READING RG2 9NH  
Tel: 0118 9763510

FS 25612

Site/Project :

ARBORFIELD GARRISON

Drawing Title :

SITE PLAN

Scales :

Design Manager :

Architect/Engineer :

Drawn : Date :FEBRUARY 2000

Checked : Date :

Approved for issue : Date :

Issue :

Project ID :

Drawing No : Revision  
© A

For Repographic Purpose This Line Is To Equal 85 mm On The Original Drawing

## **Appendix D**

### Existing Drainage





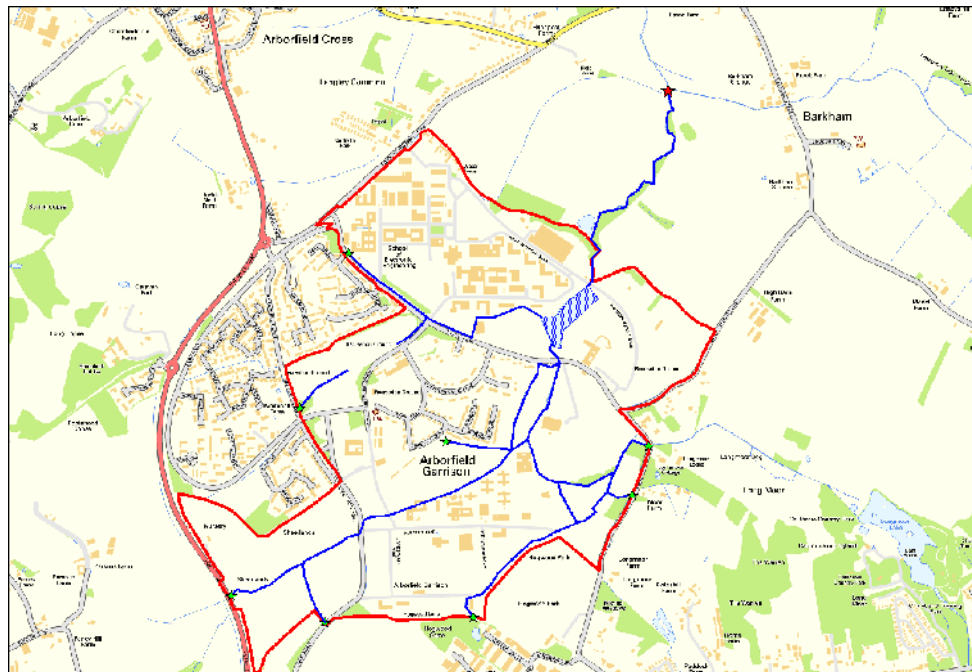
## **Appendix E**

### Notes of meetings



|            |                                               |                                        |                                                                                                                            |                                |
|------------|-----------------------------------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Project:   | Arborfield Garrison SDL                       |                                        | Job No/Ref:                                                                                                                | 60312043                       |
| Purpose:   | Flood Risk Assessment Scoping and Methodology |                                        | Date held:                                                                                                                 | 28 <sup>th</sup> November 2013 |
| Held at:   | WBC's office                                  |                                        | Made by:                                                                                                                   | C Changula                     |
| Present:   | Matt Melville (MM)                            | WBC (Principal Planning Officer)       | Distribution: All +<br><br>Sammie Bryans (Crest Nicholson)<br>Simon Knight (Wates Developments)<br>Stephen Hollowood (GVA) |                                |
|            | Julia Greene (JG)                             | WBC (Drainage Manager)                 |                                                                                                                            |                                |
|            | Natalie Mees (NM)                             | EA (Partnerships & Strategic Overview) |                                                                                                                            |                                |
|            | Niall Connolly (NC)                           | EA (Major Projects)                    |                                                                                                                            |                                |
|            | Eddie Napper (EN)                             | WBC (Flood Risk Manager)               |                                                                                                                            |                                |
|            | Steve Martin (SM)                             | AECOM                                  |                                                                                                                            |                                |
|            | Chipecto Changula (CC)                        | AECOM                                  |                                                                                                                            |                                |
| Apologies: |                                               |                                        |                                                                                                                            |                                |

| No. | Item                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Action By                                        |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| 1   | <p><b>Introductions and Purpose</b></p> <p>SM opened the meeting and introductions were made all round.</p> <p>The purpose of the meeting was to discuss and agree the proposed scope and methodology for undertaking a Flood Risk Assessment comprising fluvial modelling and the preparation of a Surface Water Drainage Strategy.</p> <p>JG reiterated that WBC is overall looking for sufficient modelling evidence to support the FRA application. Amongst other reasons, the previous proposals were considered unacceptable because they showed vulnerable uses in Flood Zone 3 and lacked sequential and exception tests (more detail provided in JG's consultation comments).</p> |                                                  |
| 2   | <p><b>Flood Modelling</b></p> <p><u><b>Survey</b></u></p> <p>The watercourse channels are to be surveyed in accordance with the EA's standard specification. SM sought clarification on whether 100m cross section intervals would be sufficient. NC to liaise with their modelling team and confirm back to AECOM.</p> <p>The channel survey is to capture cross sections at 100m intervals (to be confirmed by the EA), at changes in channel characteristics and structures. The extent of channels to be surveyed is shown in blue lines in Figure 1 (larger plan attached).</p>                                                                                                       | <p>NC</p> <p>External Surveyor through AECOM</p> |



**Figure 1: Survey and Modelling extents**

SM confirmed that the Surveyor will be Maltby Land Surveys Ltd and this was welcomed by both the EA and WBC as they have carried out numerous surveys for both in the past and to a good quality.

### **Hydrology**

SM informed the meeting that a number of methods would be investigated to obtain the best available fluvial inputs into the model. It is envisaged that the following methodologies will be employed dependent upon catchment size and characteristics:

- o FEH
- o IOH Report 124
- o Modified Rational Method

In light of the above JG stated the EA would need to review the hydrological analysis undertaken by AECOM.

NM and JG confirmed that the required fluvial return periods for this FRA would be the following:

- o 20 year
- o 100 year,
- o 100 year + Climate change (20%)

### **Modelling**

Modelling extents agreed, as shown by the blue lines, in Figure 1. The upstream extents are highlighted by the green stars. The downstream extent (red star) would be at the confluence of the stream from the balancing pond and Barkham Brook.

SM made known to the meeting that the overall programme for the resubmission

of a planning application is to include the need for additional data gathering requirements such as the channel survey and a more detailed topographical and tree survey.

During the site visit of 20<sup>th</sup> November discussions with Angie Phillips (facilities manager at the Arborfield Garrison) revealed that there was a proposed programme to undertake channel clearing.

JG queried whether the channel and structure survey would be undertaken prior to or after channel clearing. CC to make enquiries although due to the urgency of the programme, the survey would commence as soon as possible regardless of whether the channel had been cleared or not.

CC

JG mentioned there was a portion of watercourse in the vicinity of Nuffield Road where the watercourse was culverted that required particular attention as it was felt that previous studies had not captured the flooding mechanisms adequately. This is highlighted by a black polygon in Figure 2.

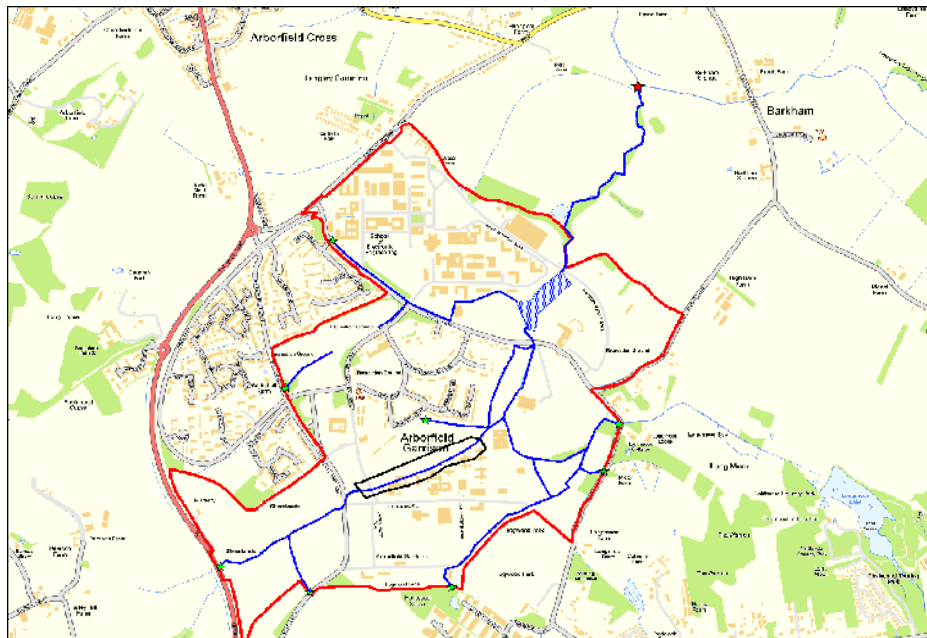


Figure 2: Area of specific interest

All modelling work is to include any proposals for daylighting of culverts and any new structures.

CC confirmed that the fluvial hydraulic modelling would be undertaken using ISIS-TUFLOW hybrid modelling methodology. In addition, AECOM would provide Hazard Mapping outputs.

AECOM

It was agreed that the revised baseline model would be need to be reviewed and agreed upon by the EA, WBC and AECOM prior to the design model runs.

#### Longmoor Lake Reservoir

EN stated Longmoor Lake caused flooding in 2007 and that the EA have data regarding flooding from it. CC noted however that the existing published outlines available on the EA's website appeared coarse and misaligned. EN mentioned

ALL

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                    |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
|   | <p>however that he is aware of two Longmoor Lake breach datasets held by the EA which would most likely be sufficient for analysis. CC to contact the EA's customers relationship team to request copies of data. AECOM to also discuss impact of increased population in reservoir inundation zone with Peter Stuart, WBC's Community Resilience Officer.</p> <p>In light of the existing data it was therefore agreed by all that there would be no need to remodel any breaches from Longmoor Lake. The FRA should include more information on the development that is to be located within the flood area of the Longmoor Lake Reservoir. Assuming EA modelling results show safe development is achievable, information need only include the expected number of dwellings, density, anticipated floor levels above existing ground and discussion on general layout to demonstrate that safe development in that area could be achieved. In such a case, it was agreed that drawings were not required showing layout.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <p>AECOM/<br/>EA/WBC</p> <p>CC</p> |
| 3 | <p><b>Surface Water Drainage</b></p> <p>SM proposed that a surface water drainage strategy document is prepared as a separate report to the FRA. This was agreed by all.</p> <p>SM stated that the new design team will promote the use of Sustainable Drainage Systems throughout the development. AECOM will in particular work with the Landscape Architects to combine green infrastructure with blue infrastructure to maximise amenity and environmental benefits.</p> <p>AECOM are aware of WBC's emerging MDD Policy CC10 which states that '<i>all development proposals must a) reproduce greenfield runoff characteristics and return runoff rates and volumes back to greenfield runoff characteristics. For greenfield sites and brownfield sites both runoff rates and volumes must be reduced to as near greenfield as practibly possible</i>'</p> <p>SM confirmed that the potential flooding envelope will be a major constraint for the development and therefore providing storage to achieve as near to greenfield rates as possible will be particularly challenging.</p> <p>SM suggested that where this policy cannot be achieved for practical reasons then AECOM would seek to provide betterment of 20%. This is however subject to design and modelling and further discussions with the EA and WBC. The onus will be on the developer to demonstrate why greater betterment is unachievable.</p> <p>SM confirmed that a 1 in 100year + 30%cc storm return period will be modelled and flood flow paths provided. SM stated that these flood levels will be used to ensure that there is no residual risk to properties or persons. SM stated that it is also not always necessary to contain the 1 in 100year +30% storm within a pond or detention basis but more importantly that flood flow paths are understood and retained on site as much as practicably possible. <b>Post meeting note from WBC:</b> As plot layouts would not be required at the outline application stage, there are concerns that there would not be sufficient detail to demonstrate that water can be stored safely within the development areas. It is recommended that strategic SuDS are planned to accommodate all the run-off.</p> <p>WBC welcomed the SuDS approach and reinforced that they do not like designs that are 'end pipe' solutions i.e. pipes to ponds.</p> | <p>AECOM</p>                       |

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |       |
|---|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
|   | <p>JG noted the following:</p> <ul style="list-style-type: none"> <li>o A watercourse upstream of the site was reported to be drying – WBC will investigate the catchment draining into this stream and report to the relevant stakeholders if this influences the strategy to attenuate flows below</li> <li>o A Ground Investigation should be undertaken sufficient for the purpose of the planning application. WBC accepted that there may be constraints, however storing flood water on internal roads and car parks should be a last resort and would not usually be considered acceptable.</li> <li>o WBC would like to see contours on a masterplan for SuD's design</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |
| 4 | <p><b>Offsite watercourses</b></p> <p>The only offsite watercourse identified is that running from the outlet of the balancing pond to its confluence with the Barkham Brook.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |       |
| 5 | <p><b>Detailed elements of the application</b></p> <p>Drainage design details are required to support the detailed application elements including the on and off-site highway improvements and SANGS.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | AECOM |
| 6 | <p><b>Any Other Business</b></p> <p>MM noted WBC would require a written scope with respect to all works related to this FRA.</p> <p>CC discussed that in order to undertake the study adequately, requests for data would need to be made. The following information is considered to be required:</p> <ul style="list-style-type: none"> <li>o Existing AMEC model, hydrology and associated reports</li> <li>o LiDAR</li> <li>o Mastermap</li> <li>o 10K OS Tiles</li> <li>o NFCDD and informal defence layers</li> <li>o EA gauge data</li> <li>o Longmor Lake flooding depth data</li> <li>o Barkham Brook model data and results in the vicinity of the confluence.</li> </ul> <p>In terms of timescales, AECOM explained that they expected the channel survey data to be available by the end of January and that a draft FRA report could be issued to EA and WBC in March – to allow for their comments prior to submission.. This approach was welcomed by both.</p> <p>NC stated that from January 2014 the EA will be charging for pre-application work. Costs will be determined on a site by site basis and will be dependent upon work effort involved. Costs will be recovered on a time charge basis.</p> | AECOM |

|                             |                                                           |
|-----------------------------|-----------------------------------------------------------|
| <b>TITLE</b>                | <b>Interim Sustainable Drainage Systems (SuDS) Policy</b> |
| <b>FOR CONSIDERATION BY</b> | The Executive on 28 March 2013                            |
| <b>WARD</b>                 | None Specific                                             |
| <b>STRATEGIC DIRECTOR</b>   | Mark Moon, Strategic Director of Neighbourhood Services   |
| <b>LEAD MEMBER</b>          | Angus Ross, Executive Member for Environment              |

**OUTCOME / BENEFITS TO THE COMMUNITY**

To provide clear guidance to Developers on the procedures for voluntary Sustainable Drainage Systems adoption by Wokingham Borough Council to avoid future uncertainty over ownership and future maintenance and performance, with the potential issues of flooding occurring.

**RECOMMENDATION**

That the Executive approves the attached Interim Policy to go to consultation for a period of 4 weeks.

**SUMMARY OF REPORT**

*Sustainable Drainage Systems ensure water from development sites are managed effectively and sustainably on site. In 2010 the Flood and Water Management Act set out an aspiration for guidance and national policy to be set on such systems making their use compulsory and defining the costs for developers. The Act made it clear that such systems would become the responsibility of local authorities.*

The government have not yet published their guidance on SUDS and so several authorities have chosen to develop an interim approach. This is interim policy for Wokingham sets out a system for the voluntary adoption of Sustainable Drainage Systems. The policy allows Wokingham Borough Council to enter into an adoption agreement with developers via Commuted Sums either through a Section 106 planning agreement, or a Section 38 highway agreement thereby avoiding any future maintenance liabilities for the Borough. This interim policy will help protect the authority's interest as major new development come forward.

## **Background**

The original date for enacting Schedule 3 of the Flood and Water Management Act 2010 to enable adoption of Sustainable Drainage Systems was October 2011, but due to various reasons this date was not met. The Government has now stated that it will not be enacted before April 2014 at the earliest. Wokingham Borough Council has no obligation to approve or adopt any SuDS before the law is commenced and are not able to use the powers related to the new responsibilities

During this interim period between publishing the Flood and Water Management Act 2010 and enacting Schedule 3, other legislation and guidance is requiring or recommending the construction of Sustainable Drainage Systems.

This interim policy is to allow Wokingham Borough Council to voluntarily adopt Sustainable Drainage Systems until Schedule 3 of the Flood and Water Management Act 2010 is enacted based upon the charging, approval and inspection proposals set out in the report.

Research has shown that several other local authorities are either already adopting Sustainable Drainage Systems or are planning to adopt Sustainable Drainage Systems as an interim measure. These include: Bracknell Forest Borough Council, Oxfordshire County Council, Cornwall County Council, Kent County Council, Cambridge City Council, Leeds City Council and Wakefield City Council.

## **Analysis of Issues**

Sustainable Drainage Systems is the practice of controlling surface water runoff as close to its origin as possible, before it is discharged to a watercourse or sewer. This involves moving away from traditional piped drainage systems towards softer engineering solutions which seeks to mimic natural drainage regimes. Sustainable drainage techniques have many benefits such as reducing flood risk, improving water quality, encouraging groundwater recharge and providing amenity and wildlife benefits.

## **Risks**

The lack of adoption could lead to:

- a) Developers being granted planning permission which they may not wish to implement until Sustainable Drainage Systems adoption commences under the Flood and Water Management Act 2010,
- b) Developers constructing Sustainable Drainage Systems and keeping them private, by possibly transferring them to residents or a management company. This would have a future undesirable affect upon maintenance and highway adoption.
- c) Arguing the case with the Local Planning Authority for continued use of conventional drainage systems, thereby undermining the positive benefits of the introduction of Sustainable Drainage Systems

There are no risks associated with adopting the policy.

## FINANCIAL IMPLICATIONS OF THE RECOMMENDATION

Sustainable drainage systems on development sites will be built by developers at their cost. The cost of assessing the proposals will be met through a fee as set out in the policy document.

On going costs relating to the systems will be covered through a commuted sum designed to alleviate the authority of an expense relating to maintaining this new asset for the first 40 years of its life.

The details of how the commuted sums are calculated are set out in Annex A of the policy document. They follow work done by Cambridgeshire County Council and have been used and accepted by developers.

The actual sums charged by the Borough to developers and spent each year on maintenance will vary dependent upon the number of developments that come forward and the type of SUDS implemented.

Overall this policy is cost neutral.

|                                   | How much will it Cost/ (Save) | Is there sufficient funding – if not quantify the Shortfall | Revenue or Capital? |
|-----------------------------------|-------------------------------|-------------------------------------------------------------|---------------------|
| Current Financial Year (Year 1)   | £0                            |                                                             |                     |
| Next Financial Year (Year 2)      | £0                            |                                                             |                     |
| Following Financial Year (Year 3) | £0                            |                                                             |                     |

### Other financial information relevant to the Recommendation/Decision

N/A

### Cross-Council Implications

Need to involve other Council services in the implementation of this policy

### List of Background Papers

Attached Report

|                                  |                                            |
|----------------------------------|--------------------------------------------|
| <b>Contact</b> Eddie Napper      | <b>Service</b> Neighbourhood Services      |
| <b>Telephone No</b> 0118 9746227 | <b>Email</b> eddie.napper@wokingham.gov.uk |
| <b>Date</b> 8 February 2013      | <b>Version No.</b> 2                       |

## **INTERIM ADOPTION OF SUSTAINABLE DRAINAGE SYSTEMS (SuDS) FLOOD AND WATER MANAGEMENT ACT 2010**

### **1 REASONS FOR RECOMMENDATION(S)**

**1.1** Sustainable Drainage Systems (SuDS), are an integral part of sustainable development. As part of its objective to promote strong, resilient, sustainable communities the Council positively encourages the use of such techniques but also wishes to ensure that they are used appropriately and are properly designed and constructed. Sustainable Drainage Systems will need to be fit for purpose, serviceable and not cause future liabilities for the Council.

**1.2** Developers will find themselves in the position where the Local Planning Authority is requiring Sustainable Drainage Systems to be given priority as a means of draining a site (supported by Environment Agency advice) but there will be no mechanism for those Sustainable Drainage Systems to be adopted and maintained by a public body.

**1.3** The Government recognised this possibility in the Consultation on the National Standards for Sustainable Drainage Systems using the phrase "orphan SuDS" for those Sustainable Drainage Systems which were constructed but which did not come under any public maintenance regime. The responses to the Consultation showed that 90% of the respondents felt that the increase in un-adopted Sustainable Drainage Systems should be avoided (including Wokingham Borough Council in their response).

**1.4** The lack of adoption would lead to:

- a) Developers being granted planning permission which they may not wish to implement until SuDS adoption commences under the Flood and Water Management Act 2010,
- b) Developers constructing Sustainable Drainage Systems and keeping them private, by possibly transferring them to residents or a management company. This would have a future undesirable affect upon maintenance and highway adoption.
- c) Arguing the case with the Local Planning Authority for continued use of conventional drainage systems, thereby undermining the positive benefits of the introduction of Sustainable Drainage Systems

**1.5** By offering Developers the opportunity for having their Sustainable Drainage Systems adopted (with an agreed inspection regime, maintenance period and payment of a commuted sum), they will be in a position to proceed with their developments knowing that the majority of the surface water drainage system will be adopted and maintained by a public body.

### **2 ALTERNATIVE OPTIONS CONSIDERED**

**2.1** The adoption of Sustainable Drainage Systems is not pursued until the government enacts Schedule 3 of the Flood and Water Management Act 2010.

**2.2** The Local Planning Authority is faced with the possibility of developers challenging the priority given to the use of Sustainable Drainage Systems to drain a site and insisting upon adoptable "conventional" drainage solutions.

**2.3** Developers construct Sustainable Drainage Systems which remain private and un-adopted which will lead to:

- a) Uncertainty over ownership and future maintenance and performance, with the potential issues of flooding occurring.
- b) The highway authority not agreeing to adopt roads as they would not drain to a suitable outfall (the highway authority requires that highways drain to an adopted surface water sewer or a watercourse which has an enforceable maintenance liability on the owner).

### **3 SUPPORTING INFORMATION**

**3.1** The National Planning Policy Framework (NPPF) expects Local Planning Authorities to give priority to the use of Sustainable Drainage Systems in determining planning applications. The Technical guidance to the National Planning Policy Framework refers.

**3.2** Approved Document Part H of the Building Regulations 2010 also establishes a hierarchy for surface water disposal, which encourages the use of Sustainable Drainage Systems first and a conventional piped system as a last resort.

**3.3** Wokingham Borough Councils Local Planning Authority documents support the use of Sustainable Drainage Systems in developments including The Core Strategy Policy CP1, Sustainable Design & Construction Supplementary Document, Sustainable Design & Construction Supplementary Planning Document (SPD), Borough Design Guide SPD, Strategic Development Location SPDs and the Infrastructure Delivery and Contributions SPD.

### **4 PROPOSED MECHANISM FOR THE INTERIM ADOPTION OF SUSTAINABLE DRAINAGE SYSTEMS**

**4.1** In this interim period the authority would not have powers of entry to inspect Sustainable Drainage Systems, insist on repair works, carry out maintenance, etc; It would therefore be prudent for Wokingham Borough Council to only adopt Sustainable Drainage Systems which fall within adoptable Public Open Space and adoptable Highway so that access is available for inspection works, future maintenance, etc. However any agreement entered into could include for access for the purpose of inspection and maintenance. Wokingham Borough Council will not adopt developments of less than 10 properties unless they fall within the above criteria.

**4.2** Any agreement to adopt Sustainable Drainage Systems would be voluntary on either party.

**4.3** During this interim period and before the Government is prepared to pay for the maintenance of adopted Sustainable Drainage Systems, the Authority should not take on any additional maintenance liabilities which would lead to a budget pressure in the future, without securing a means of paying for future maintenance, repair, etc;

**4.4** The Authority would therefore seek Commuted Sums from Developers either via a Section 106 planning agreement (Town and Country Planning Act 1990 as amended) with respect to Sustainable Drainage Systems in a Public Open Space, or a Section 38 highway agreement (Highways Act 1980) with respect to Sustainable Drainage Systems within the adoptable highway. The sums would cover:

- a) Fees for inspection
- b) Costs involved in adoption of the Sustainable Drainage Systems
- c) Maintenance liabilities for: 40 years in respect of highways and 125 years in respect of POS.

The calculation of the Commuted Sum will be based upon the cost to the Authority of maintaining the Sustainable Drainage Systems for the periods given above, less the cost of maintaining the same highway or Public Open Space as if it didn't contain any Sustainable Drainage Systems. i.e.

the developer would only be expected to pay the additional cost of maintaining the Sustainable Drainage Systems which are "over and above" the usual cost of maintenance.

**4.5** The Authority would charge a fee to deal with the "drainage application" covering both the private and adoptable Sustainable Drainage Systems, based upon the proposed national fees set out in the draft Regulations (Extract shown in Annex A). In order to protect purchasers and the authority from any liability, adoptable Sustainable Drainage Systems within Public Open Space would be subject to a performance Bond (Sustainable Drainage Systems within adoptable highway would be covered by a Bond under the highway adoption agreement).

**4.6** The calculations necessary to determine the Commuted Sums would be based upon "best practice", drawn from other Local Authorities who already adopt Sustainable Drainage Systems.

**4.7** The rates to be used to determine the cost of maintenance would be calculated using figures supplied by those sections of the Authority currently carrying out maintenance of Public Open Space and the public highway, together with comparison with rates used by other Local Authorities who already adopt Sustainable Drainage Systems.

**4.8** The fees and charges to be incorporated in a revision of the annual fees and charges published by the Authority.

**4.9** The Authority would check and approve submissions for adoptable Sustainable Drainage Systems broadly in line with the guidance issued by Department for Environment Food & Rural Affairs, The Environment Agency and any relevant national guidance (such as The SuDS Manual published by the Construction Industry Research and Information Association (CIRIA)).

**4.10** The Authority would inspect the construction and finally adopt the Sustainable Drainage Systems using procedures based upon those used currently used for adoptable highways and Public Open Space

## **5 COMMUTED SUM CALCULATIONS**

**5.1** The Authority would seek Commuted Sums from Developers either via a Section 106 planning agreement (Town and Country Planning Act 1990 as amended) with respect to Sustainable Drainage Systems in a Public Open Space, or a Section 38 highway agreement (Highways Act 1980) with respect to Sustainable Drainage Systems within the adoptable highway. The sums would cover:

- a) Fees for inspection
- b) Costs involved in adoption of the Sustainable Drainage Systems
- c) Maintenance liabilities for: 40 years in respect of highways and 125 years in respect of POS.

**5.2** The calculation of the Commuted Sum will be based upon the cost to the Authority of maintaining the Sustainable Drainage Systems for the periods given above, less the cost of maintaining the same highway or Public Open Space as if it didn't contain any Sustainable Drainage Systems. i.e. the developer would only be expected to pay the additional cost of maintaining the Sustainable Drainage Systems which are "over and above" the usual cost of maintenance.

**5.3** The calculations necessary to determine the Commuted Sums would be based upon rates in the SPON's External Works and Landscape Price Book 2010. The calculation will take into account the maintenance regime recommended for each SuDS component in the SuDS Manual (CIRIA C697). This method will allow each bespoke SuDS component to be calculated accurately.

**5.4** This method of calculating Commuted Sums for SuDS is already in use by other Authorities that have adopted an Interim SuDS policy.

#### Annex B – Recommended maintenance tasks and frequencies.

The following table has been constructed from extracts of The SuDS Manual (CIRIA C697). It provides a guide to the types and frequencies of maintenance for SuDS components. It does not provide a definitive list and the exact type and nature of the maintenance will be heavily dependent on the construction of the individual SuDS technique.

| SuDS Component          | Regular Maintenance                                                                                 |                                               | Occasional Maintenance                            |                    | Monitoring                                                                                                                 |                                                    |
|-------------------------|-----------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
|                         | Item                                                                                                | Frequency                                     | Item                                              | Frequency          | Item                                                                                                                       | Frequency                                          |
| <b>Permeable Paving</b> | Brushing and vacuuming                                                                              | <i>3 times per year</i>                       | Stabilise and mow contributing and adjacent areas | <i>as required</i> | Initial inspection                                                                                                         | <i>monthly for three months after installation</i> |
|                         |                                                                                                     |                                               | Removal of weed                                   | <i>as required</i> | Inspect for evidence of poor operation and/or weed growth. If required take remedial action                                | <i>3-monthly, 48 h after large storms</i>          |
|                         |                                                                                                     |                                               |                                                   |                    | Inspect silt accumulation rates and establish appropriate brushing frequencies                                             | <i>Annually</i>                                    |
|                         |                                                                                                     |                                               |                                                   |                    | Monitor inspection chambers                                                                                                | <i>Annually</i>                                    |
| <b>Cellular Storage</b> | Inspect and identify any areas that are not operating correctly. If required, take remedial action. | <i>Monthly for 3 months, then six monthly</i> |                                                   |                    | Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed | <i>Annually and after large storms</i>             |
|                         | Debris removal from                                                                                 | <i>Monthly</i>                                |                                                   |                    |                                                                                                                            |                                                    |

|                        |                                                                                                                                                                                     |                                         |                                                                                            |                                |                                                                                                                                       |                            |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|--------------------------------------------------------------------------------------------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
|                        | catchment surface (where may cause risks to performance)                                                                                                                            |                                         |                                                                                            |                                |                                                                                                                                       |                            |
|                        | Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary | <i>Monthly (and after large storms)</i> |                                                                                            |                                |                                                                                                                                       |                            |
|                        | Remove sediment from pre-treatment structures                                                                                                                                       | <i>Annually, or as Required</i>         |                                                                                            |                                |                                                                                                                                       |                            |
| <b>Detention Basin</b> | Litter and debris removal                                                                                                                                                           | <i>Monthly</i>                          | Re-seed areas of poor vegetation growth                                                    | <i>Annually or as required</i> | Inspect inlets, outlets and overflows for blockages, and clear if required.                                                           | Monthly/after large storms |
|                        | Grass cutting – for spillways and access routes                                                                                                                                     | <i>Monthly during growing season</i>    | Prune and trim trees and remove cuttings                                                   | <i>2 years or as required</i>  | Inspect banksides, structures, pipework, etc for evidence of physical damage                                                          | Monthly/after large storms |
|                        | Grass cutting – meadow grass in and around basin                                                                                                                                    | half yearly                             | Remove sediment from forebay, when 50% full and from micropools if volume reduced by > 25% | 3-10 years                     | Inspect inlets and facility surface for silt accumulation . Establish appropriate silt removal frequencies. Check penstocks and other | Half yearly                |

|  |                                                                                                                                                                                                                 |          |  |  |                    |  |
|--|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--|--|--------------------|--|
|  |                                                                                                                                                                                                                 |          |  |  | mechanical devices |  |
|  | Manage other vegetation and remove nuisance plants. Tidy all dead growth before start of growing season. Remove sediment from inlets, outlet and forebay. Manage wetland plants in outlet pool – where Provided | Annually |  |  |                    |  |

## Annex A

These fees are to cover checking the submitted design by the LPA.

Extract from:

**The Sustainable Drainage (Procedure) (England) Regulations 2012**

### PART 2

#### Applications

Fees for applications for approval made by 30th September 2015

6.—(1) Until 30th September 2015, an approving body may charge a fee for an application for approval determined as follows—

(a) £350 for each application; and

(b) an additional amount up to £7,500 calculated by reference to the size of the construction area as follows—

(i) £70 for each 0.1 hectare or fraction of a 0.1 of a hectare, for the first 0.5 hectare;

(ii) £50 for each 0.1 hectare or fraction of a 0.1 of a hectare, from 0.5 hectare up to and including 1.0 hectare;

(iii) £20 for each 0.1 hectare or fraction of a 0.1 of a hectare, from 1.0 hectare up to and including 5.0 hectares; and

(iv) £10 for each additional 0.1 hectare or fraction of a 0.1 of a hectare.

**Appendix F**

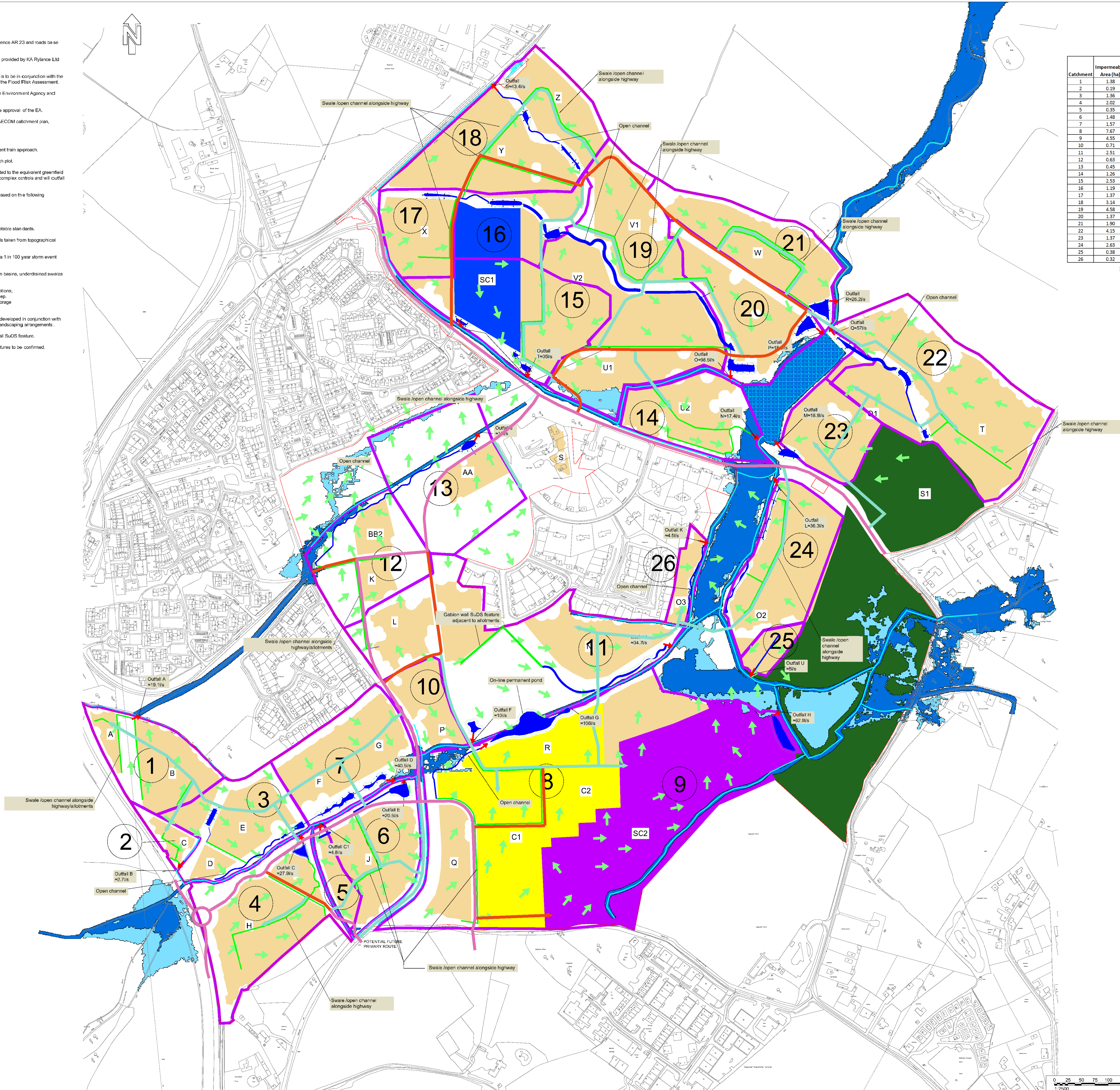
**Surface Water Drainage Strategy  
Drawings**

|                                 |                  |
|---------------------------------|------------------|
| Proposed Surface Water Strategy | 60312043/CIV/001 |
| Catchment Area Plan             | 60312043/CIV/010 |
| Proposed SuDS Sections          | 60312043/CIV/009 |
| Flood Exceedence Routes         | 60312043/CIV/011 |



Notes

1. Drawing based on IOP masterplan reference AR 23 and roads base rev 1 issued 19 September 2014.
  2. Design based on Topographical Survey provided by KA Ryland Ltd dated March 2014 (ref Arbor release v8).
  3. The location of the attenuation features is to be in conjunction with the fluvial flood extents as determined from the Flood Risk Assessment.
  4. Extents of flooding to be agreed with the Environment Agency and Wokingham Borough Council.
  5. On line permanent pond is subject to the approval of the EA.
  6. Drawing to be read in conjunction with AECOM catchment plan, section and flood routing drawings.
- SuDS Strategy**
1. SuDS strategy is based on a management train approach.
  2. Source control to be provided within each plot.
  3. Outflow from the development is restricted to the equivalent greenfield rate of runoff (Q<sub>g</sub> & Q<sub>n</sub>) by the use of complex controls and will outfall to existing watercourses.
  4. Assumed areas of impermeability are based on the following assumptions:
    - Residential - 65%
    - Commercial - 80%
    - Schools - 50%
  5. Drainage system to be designed to adoptable standards.
  6. Drainage design based on existing levels taken from topographical survey.
  7. SuDS features to attenuate runoff from a 1 in 100 year storm event plus 30% climate change.
  8. SuDS storage features include detention basins, underdrained swales and open channels.
  9. SuDS layout based on following assumptions:
    - Basins and channels - 1 - 1.5m deep.
    - Underdrained swales - 1.5m<sup>2</sup>/m storage
    - 150mm freeboard.
  9. SuDS features layout and design to be developed in conjunction with Murdoch Wickham to reflect proposed landscaping arrangements.
  10. Maintenance access to be provided for all SuDS feature.
  11. Adoption and maintenance of SuDS features to be confirmed.



| Catchment | Impermeable Area (ha) | Q100 Discharge Rate (l/s) | FEH Volume | Outfall |
|-----------|-----------------------|---------------------------|------------|---------|
| 1         | 1.35                  | 19.1                      | 885        | A       |
| 2         | 0.19                  | 2.7                       | 117        | B       |
| 3         | 1.36                  | 18.8                      | 810        | D       |
| 4         | 2.02                  | 27.9                      | 1200       | C       |
| 5         | 0.35                  | 4.8                       | 225        | C1      |
| 6         | 1.48                  | 20.5                      | 950        | E       |
| 7         | 1.57                  | 21.7                      | 991        | D       |
| 8         | 7.67                  | 105.9                     | 5000       | G       |
| 9         | 4.55                  | 62.8                      | 2900       | H       |
| 10        | 0.71                  | 9.9                       | 460        | F       |
| 11        | 2.51                  | 34.7                      | 1580       | I       |
| 12        | 0.63                  | 8.8                       | 580        | J       |
| 13        | 0.45                  | 6.3                       | 290        | J       |
| 14        | 1.26                  | 17.4                      | 832        | N       |
| 15        | 2.53                  | 35.0                      | 1625       | T       |
| 16        | 1.19                  | 16.4                      | 760        | O       |
| 17        | 1.37                  | 18.9                      | 880        | O       |
| 18        | 3.14                  | 43.4                      | 2010       | S       |
| 19        | 4.58                  | 63.2                      | 2950       | O       |
| 20        | 1.37                  | 18.8                      | 880        | P       |
| 21        | 1.90                  | 26.2                      | 1250       | R       |
| 22        | 4.15                  | 57.4                      | 2600       | Q       |
| 23        | 1.37                  | 18.8                      | 880        | M       |
| 24        | 2.63                  | 36.3                      | 1700       | L       |
| 25        | 0.38                  | 5.3                       | 253        | U       |
| 26        | 0.32                  | 4.5                       | 225        | K       |

Summary of Proposed Attenuation

**AECOM**

PROJECT

Arborfield Garrison SDL

CLIENT

Crest Nicholson

CONSULTANT

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KEY

- Proposed SuDS Surface water attenuation feature.
- Proposed SuDS Open channel - storage & conveyance.
- Proposed SuDS Swale/Underdrained swale - storage & conveyance.
- Existing watercourse
- Existing pond
- Proposed Site Boundary
- Extent of 100 year flood envelope including 30% climate change
- Extent of 20 year flood envelope
- Existing drainage path
- Existing drainage sub-catchment boundary.
- Drainage catchment reference
- Proposed discharge rate from 1 in 100 year storm event plus climate change
- Proposed outfall point.
- Proposed Highway Network (Primary)
- Proposed Highway Network (Secondary)
- Proposed Highway Network (Tertiary)

**WORK IN  
PROGRESS**

ISSUE/REVISION

| Rev | Date     | Detail                           | Made | Check | App'd |
|-----|----------|----------------------------------|------|-------|-------|
| P1  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P2  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P3  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P4  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P5  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P6  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P7  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P8  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P9  | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |
| P10 | 10/09/14 | Issue added - masterplan updated | SM   | SLM   | SLM   |

PROJECT NUMBER

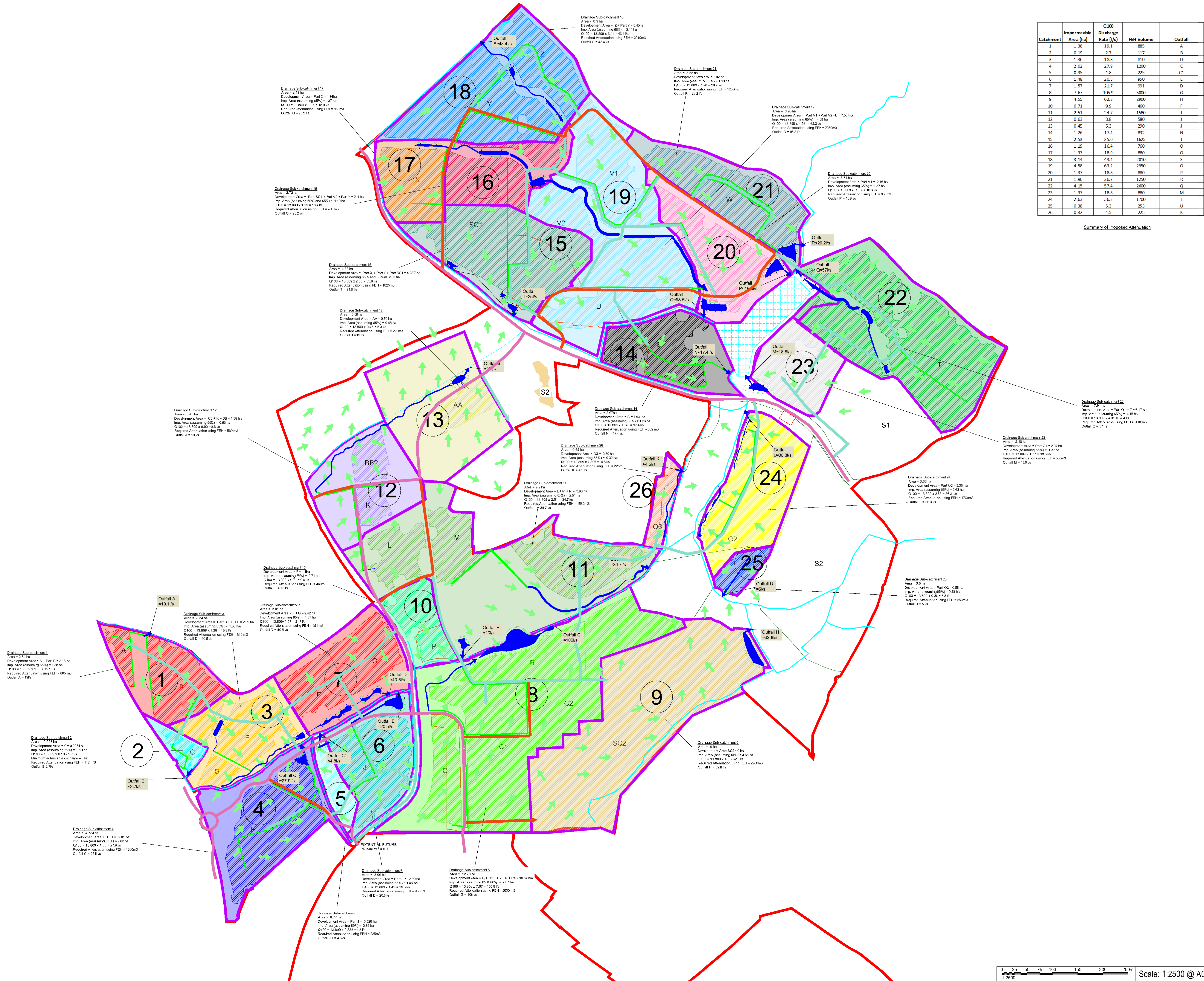
60312043 - Arborfield Garrison SDL

SHEET TITLE

DRAFT Surface Water Drainage Strategy

SHEET NUMBER

60312043/CIV/001

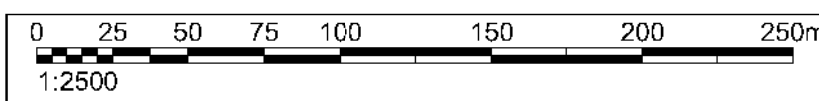


- Proposed SuDS  
Surface water attenuation feature.
- Proposed SuDS  
Open channel - storage & conveyance.
- Proposed SuDS  
Swale/Underdrained swale - storage & conveyance.
- Existing watercourse
- Existing pond
- Proposed Site Boundary
- Existing drainage path
- Existing drainage sub-catchment boundary.
- Drainage catchment reference
- Outfall T = 5 l/s
- Proposed discharge rate from 1 in 100 year storm event plus climate change.
- Proposed outfall point.
- Sub-catchment
- Impermeable area within Sub-catchment

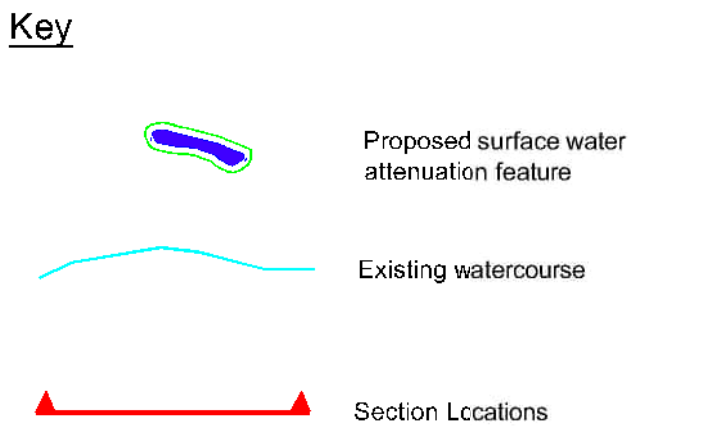
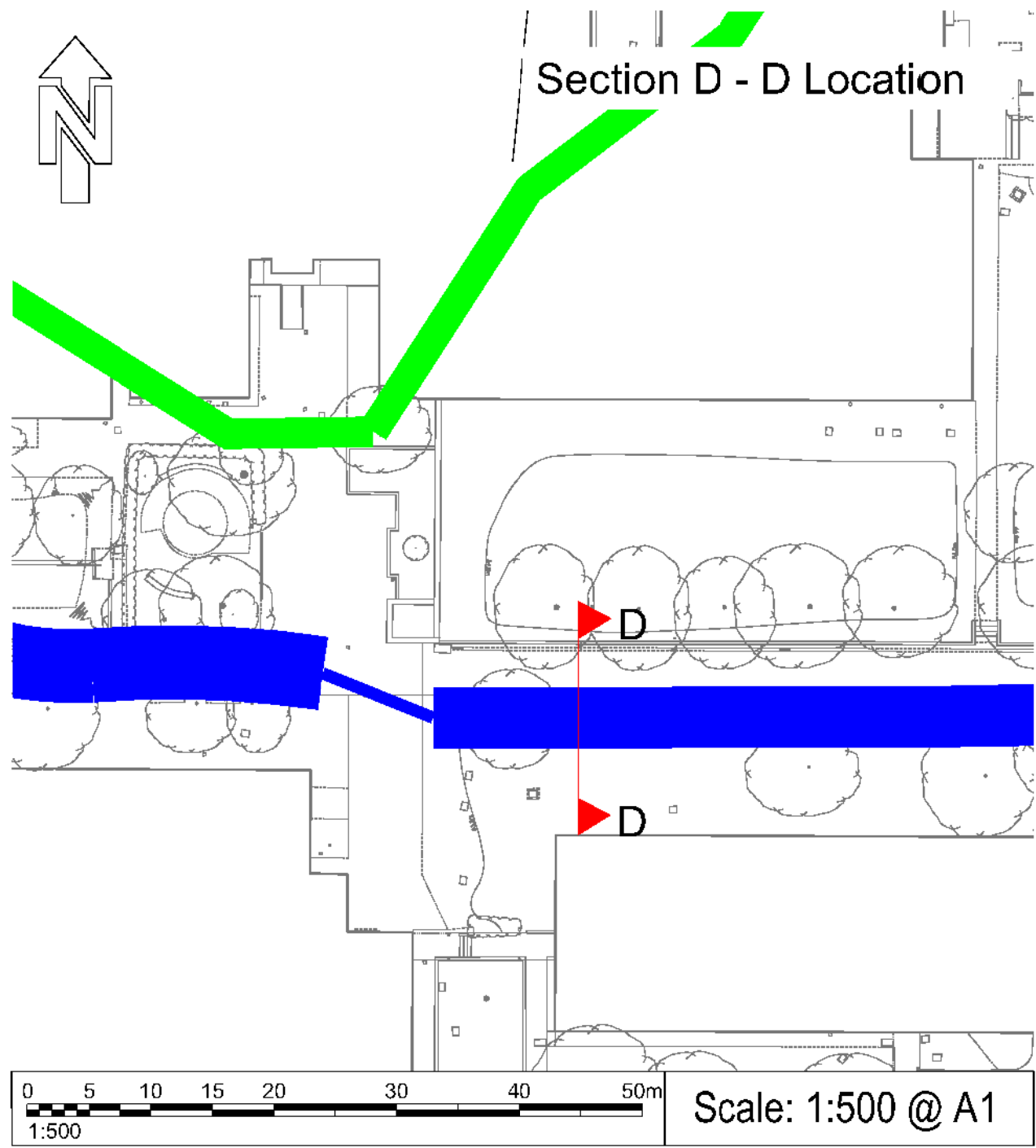
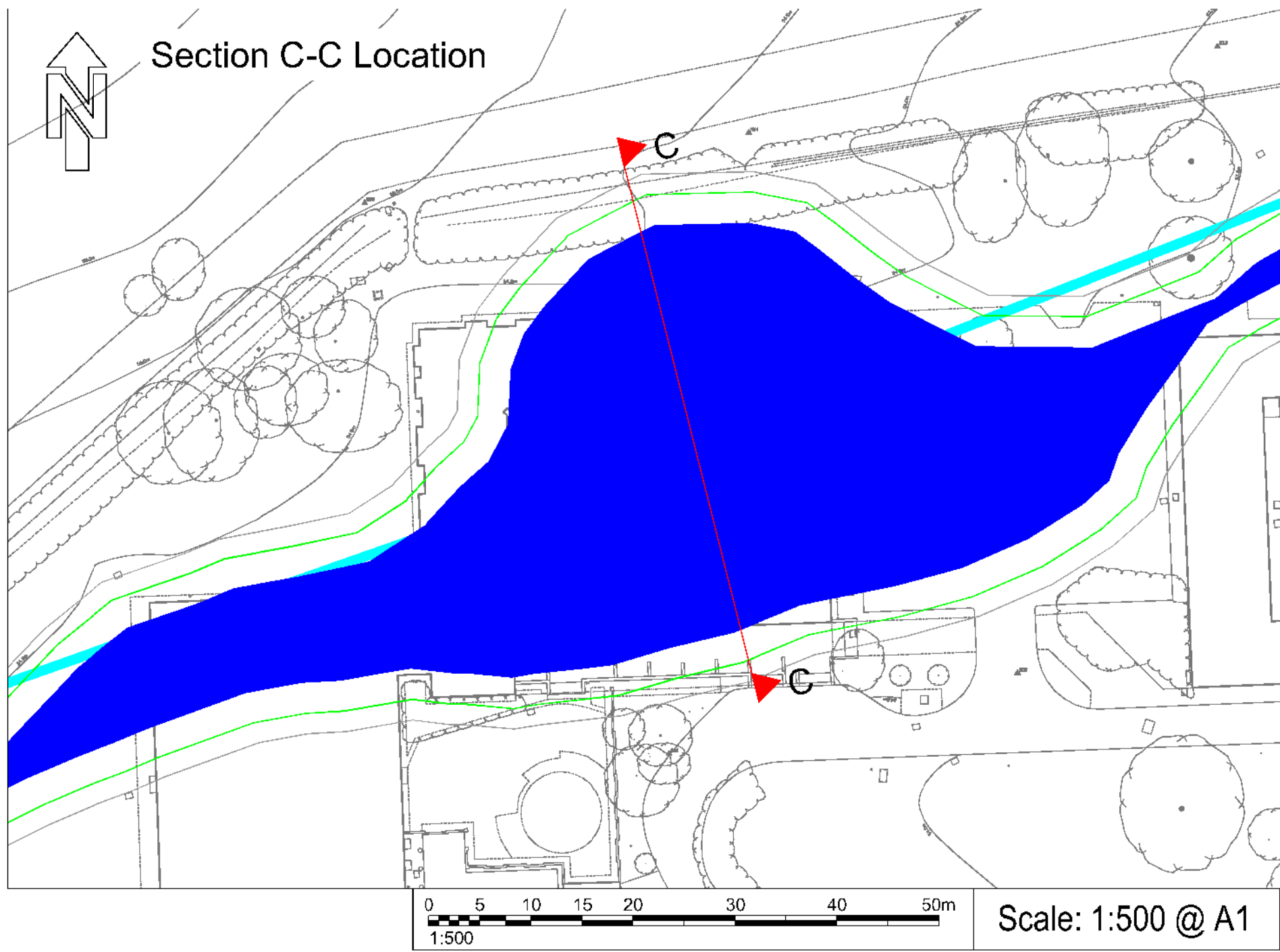
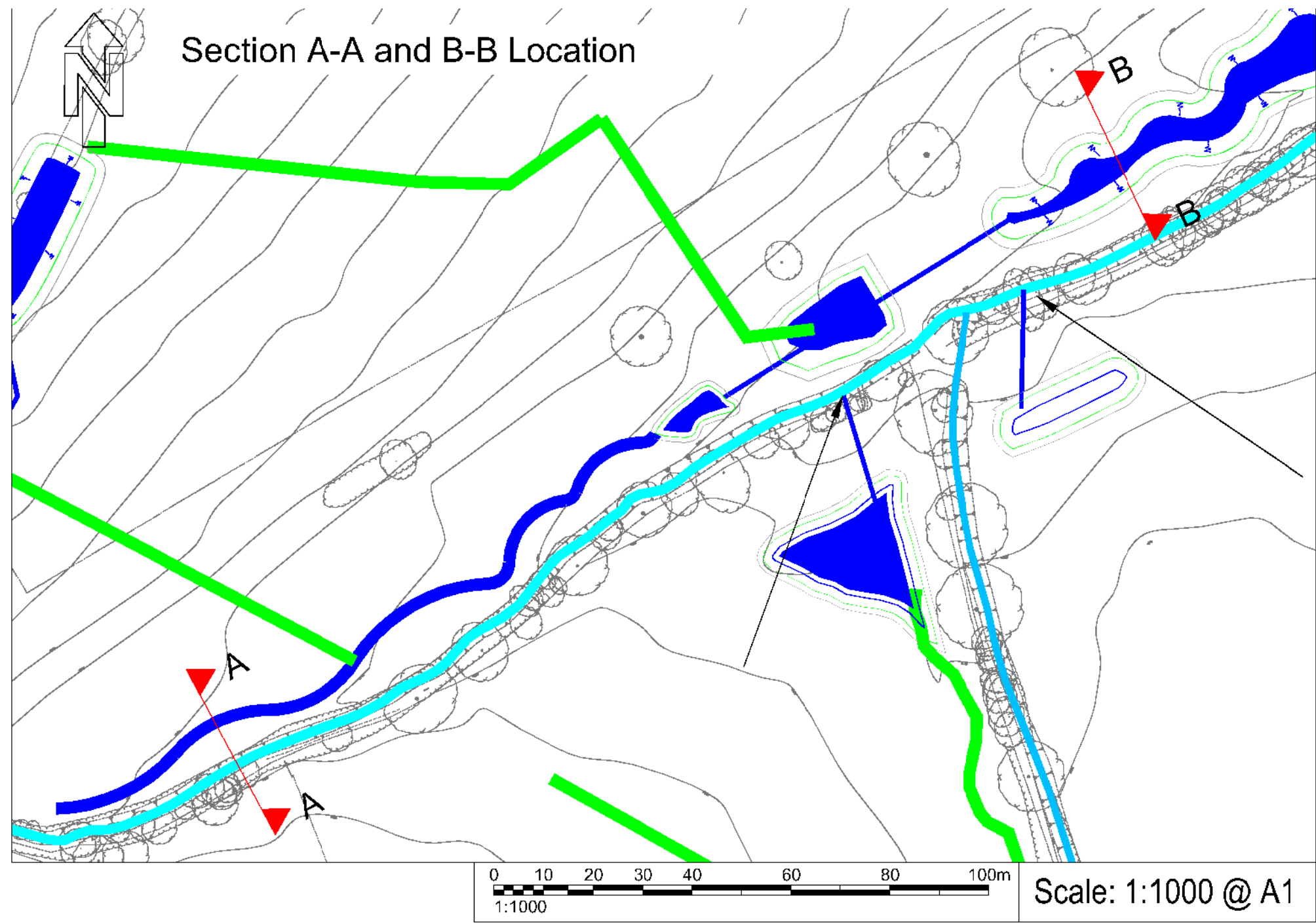
- Do no scale from this drawings.
- Based on "topographical" survey provided by KA Ryanco Ltd dated March 2014 (not Arbor release v6).
- Drawing based on IDP Masterplan reference AR 23 and roads issue rev 1 issued 19 September 2014.
- To be read in conjunction with AECOM drainage strategy drawings.

**WORK IN PROGRESS**

| PI  | 18/09/14 | Preliminary design | LP   | DM      | SLM      |
|-----|----------|--------------------|------|---------|----------|
| Rev | Date     | Detail             | Made | Checked | Approved |

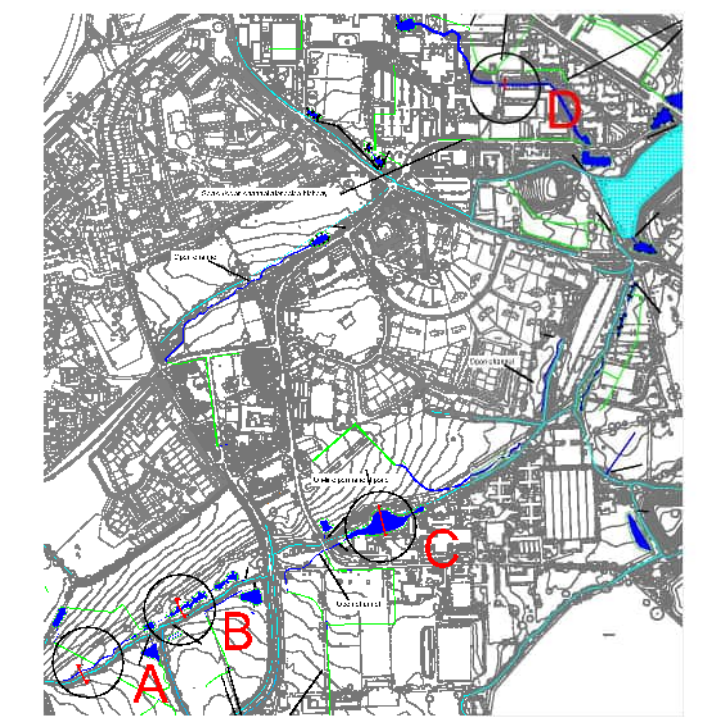


Scale: 1:2500 @ A0



- Notes
- Do not scale from this drawing.
  - Based on Topographical survey provided by KA Ryland Ltd dated March 2014 (ref Arbor release v6).
  - Drawing based on IDP masterplan reference AR 23 and roads base rev H issued 15 September 2014.
  - To be read in conjunction with AECOM drainage strategy drawings.

Key Plan



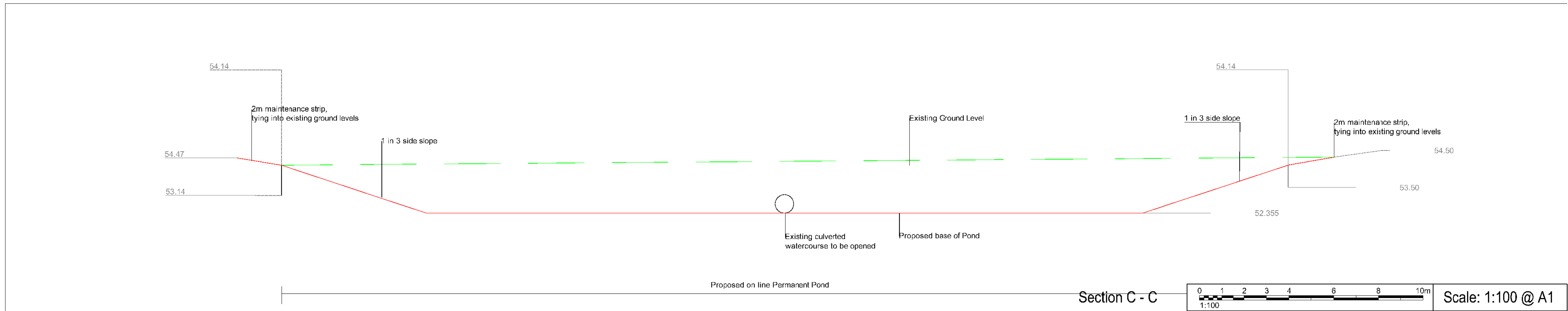
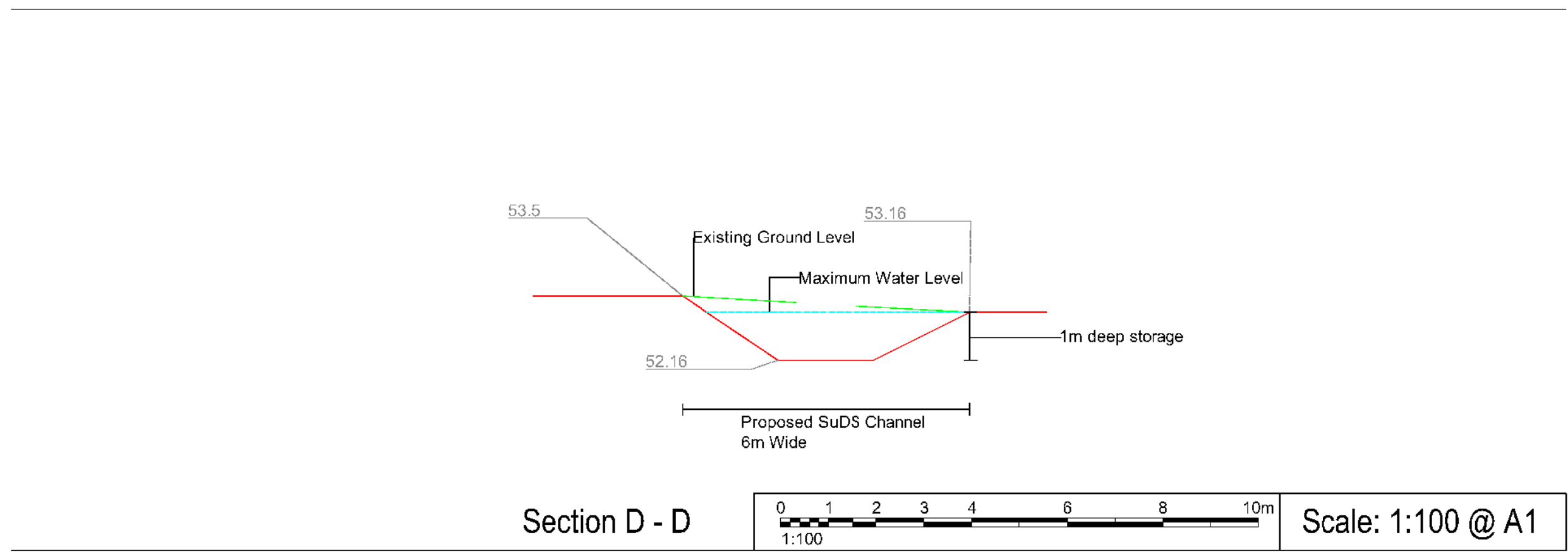
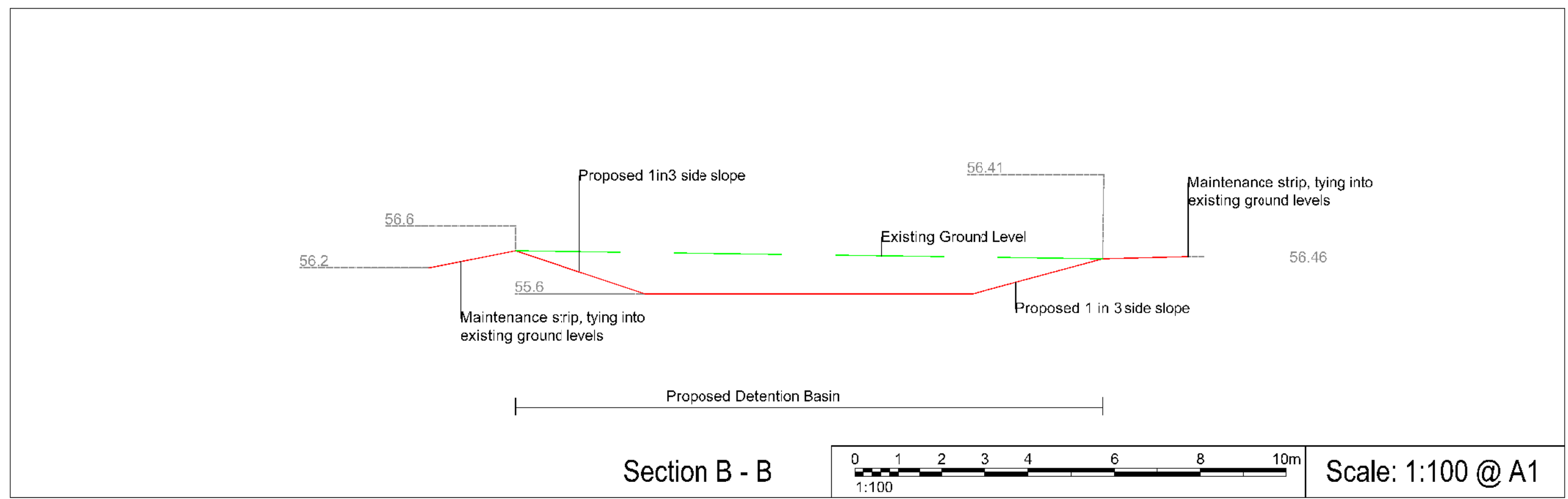
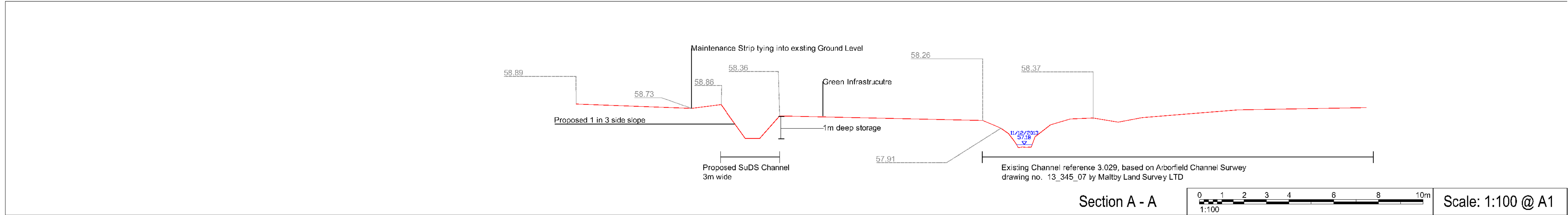
ISSUE/REVISION

| Rev | Date     | Description       | Made | Chkd | Appd |
|-----|----------|-------------------|------|------|------|
| P1  | 15.09.14 | Preliminary Issue | LP   | SB   | SLM  |

PROJECT NUMBER  
60312043 - Arborfield Garrison SDL

SHEET TITLE  
Surface Water Drainage Strategy  
Proposed SuDS Sections

SHEET NUMBER  
60312043/CIV/009



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|                                                                                       |                                                                    |
|---------------------------------------------------------------------------------------|--------------------------------------------------------------------|
|    | Proposed SuDS<br>Surface water attenuation feature.                |
|    | Proposed SuDS<br>Open channel - storage & conveyance.              |
|    | Proposed SuDS<br>Swales/Underdrained swale - storage & conveyance. |
|    | Existing watercourse                                               |
|    | Existing pond                                                      |
|    | Proposed Site Boundary                                             |
|    | Extent of 10 year flood envelope including 30% climate change      |
|    | Extent of 20 year flood envelope                                   |
|    | Existing drainage sub-catchment boundary.                          |
|  | Drainage catchment reference                                       |
|  | Proposed outfall point.                                            |
|                                                                                       | Flood Exceedance Route. To be confirmed with site layout           |

**WORK IN  
PROGRESS**

|          |                   |  |      |       |    |
|----------|-------------------|--|------|-------|----|
|          |                   |  |      |       |    |
|          |                   |  |      |       |    |
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|          |                   |  |      |       |    |
| COVID-14 | Preliminary Issue |  | LP   | SB    | S  |
| Date     | Detail            |  | Mode | Chk'd | Ag |

**HEET TITLE**

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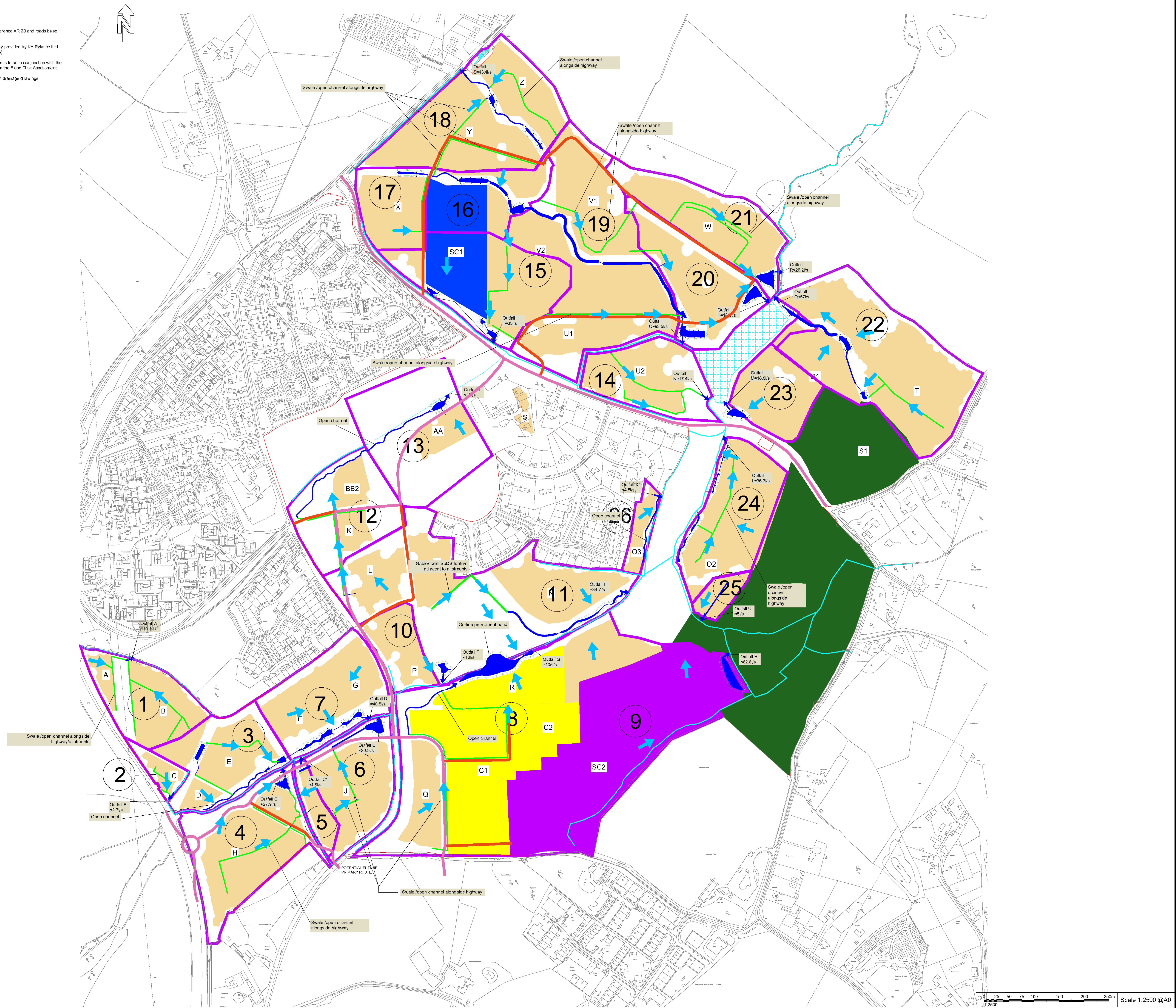
Surface Water Drainage Strategy  
Flood Exceedence Routes

HEET NUMBER

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0312043/CIV/011

1. Drawing based on IDP masterplan reference AR 23 and roads base rev I issued 19 September 2014.
2. Design based on Topographical Survey provided by KA Rylance Ltd dated March 2014 (ref Abor release v6).
3. The location of the attenuation features is to be in conjunction with the fluvial flood extents as determined from the Flood Risk Assessment.
4. To be read in conjunction with AECOM drainage drawings



## **Appendix G**

### Surface Water Calculations



|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|-----------------------|---------------|-----------|-----|-------|-------|-----------|--------|------|-------|---------------|----------|------------|-------|------------|-------|------------|--------|---------|-------|----------|-------|----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|-------|------------|--------|------------|--------|------------|--------|-------------|--------|
| AECOM Ltd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                    | Page 1                                                                              |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Aecom House<br>63-77 Victoria Street<br>St Albans Herts AL1 3ER                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                    |  |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Date 01/09/2014 16:49<br>File                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Designed by murphys3<br>Checked by |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Micro Drainage                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                    | Source Control W.12.6.1                                                             |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| <p style="text-align: center;"><u>IH 124 Mean Annual Flood</u></p> <p style="text-align: center;">Input</p> <table><tr><td>Return Period (years)</td><td>100</td><td>SAAR (mm)</td><td>700</td><td>Urban</td><td>0.000</td></tr><tr><td>Area (ha)</td><td>79.080</td><td>Soil</td><td>0.457</td><td>Region Number</td><td>Region 6</td></tr></table> <p style="text-align: center;"><b>Results      l/s</b></p> <table><tr><td>QBAR Rural</td><td>341.6</td></tr><tr><td>QBAR Urban</td><td>341.6</td></tr><tr><td>Q100 years</td><td>1089.6</td></tr><tr><td>Q1 year</td><td>290.3</td></tr><tr><td>Q2 years</td><td>300.9</td></tr><tr><td>Q5 years</td><td>437.2</td></tr><tr><td>Q10 years</td><td>553.4</td></tr><tr><td>Q20 years</td><td>684.2</td></tr><tr><td>Q25 years</td><td>733.7</td></tr><tr><td>Q30 years</td><td>774.1</td></tr><tr><td>Q50 years</td><td>894.9</td></tr><tr><td>Q100 years</td><td>1089.6</td></tr><tr><td>Q200 years</td><td>1280.9</td></tr><tr><td>Q250 years</td><td>1342.4</td></tr><tr><td>Q1000 years</td><td>1762.5</td></tr></table> |                                    |                                                                                     | Return Period (years) | 100           | SAAR (mm) | 700 | Urban | 0.000 | Area (ha) | 79.080 | Soil | 0.457 | Region Number | Region 6 | QBAR Rural | 341.6 | QBAR Urban | 341.6 | Q100 years | 1089.6 | Q1 year | 290.3 | Q2 years | 300.9 | Q5 years | 437.2 | Q10 years | 553.4 | Q20 years | 684.2 | Q25 years | 733.7 | Q30 years | 774.1 | Q50 years | 894.9 | Q100 years | 1089.6 | Q200 years | 1280.9 | Q250 years | 1342.4 | Q1000 years | 1762.5 |
| Return Period (years)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 100                                | SAAR (mm)                                                                           | 700                   | Urban         | 0.000     |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Area (ha)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 79.080                             | Soil                                                                                | 0.457                 | Region Number | Region 6  |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| QBAR Rural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 341.6                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| QBAR Urban                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 341.6                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q100 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1089.6                             |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q1 year                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 290.3                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q2 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 300.9                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q5 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 437.2                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q10 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 553.4                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q20 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 684.2                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q25 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 733.7                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q30 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 774.1                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q50 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 894.9                              |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q100 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1089.6                             |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q200 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1280.9                             |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q250 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 1342.4                             |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| Q1000 years                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1762.5                             |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |
| ©1982-2011 Micro Drainage Ltd                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                    |                                                                                     |                       |               |           |     |       |       |           |        |      |       |               |          |            |       |            |       |            |        |         |       |          |       |          |       |           |       |           |       |           |       |           |       |           |       |            |        |            |        |            |        |             |        |

## Quick Storage Estimates

The screenshot shows the 'Quick Storage Estimate' dialog box with the 'Variables' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area contains the following fields:

| Variable                          | Value                          |
|-----------------------------------|--------------------------------|
| FEH Rainfall                      | 0.750                          |
| Return Period (years)             | 100                            |
| Cv (Summer)                       | 0.750                          |
| Cv (Winter)                       | 0.840                          |
| Impermeable Area (ha)             | 0.190                          |
| Maximum Allowable Discharge (l/s) | 2.7                            |
| Site Location                     | GB 476950 165250 SU 76950 6525 |
| C (1km)                           | -0.028                         |
| D3 (1km)                          | 0.327                          |
| D1 (1km)                          | 0.261                          |
| E (1km)                           | 0.303                          |
| D2 (1km)                          | 0.255                          |
| F (1km)                           | 2.642                          |
| Infiltration Coefficient (m/hr)   | 0.00000                        |
| Safety Factor                     | 2.0                            |
| Climate Change (%)                | 30                             |

Buttons at the bottom: Analyse, OK, Cancel, Help.

Footer text: Enter Maximum Allowable Discharge between 0.0 and 999999.0

Input data for FEH QSE (Area and Discharge vary by catchment)

The screenshot shows the 'Quick Storage Estimate' dialog box with the 'Results' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area displays the following text:

Global Variables require approximate storage of between 794 m<sup>3</sup> and 958 m<sup>3</sup>.

These values are estimates only and should not be used for design purposes.

Buttons at the bottom: Analyse, OK, Cancel, Help.

Footer text: Enter Maximum Allowable Discharge between 0.0 and 999999.0

Catchment 1

The screenshot shows the 'Quick Storage Estimate' dialog box with the 'Results' tab selected. The left sidebar contains buttons for 'Variables', 'Results', 'Design', 'Overview 2D', 'Overview 3D', and 'Vt'. The main area displays the following text:

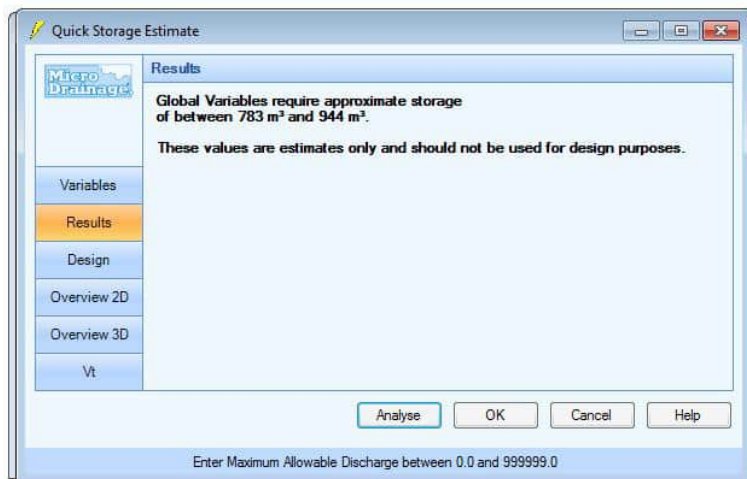
Global Variables require approximate storage of between 109 m<sup>3</sup> and 131 m<sup>3</sup>.

These values are estimates only and should not be used for design purposes.

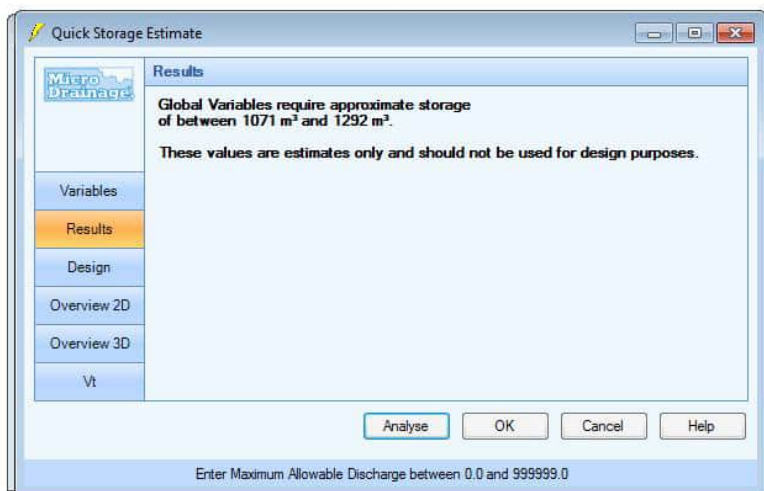
Buttons at the bottom: Analyse, OK, Cancel, Help.

Footer text: Enter Maximum Allowable Discharge between 0.0 and 999999.0

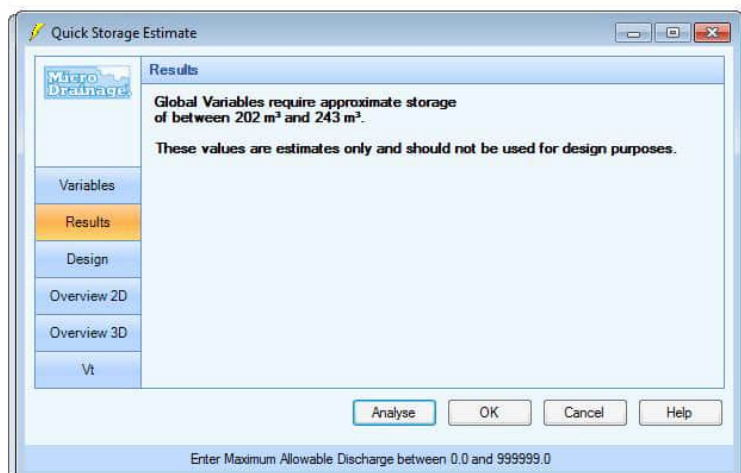
Catchment 2



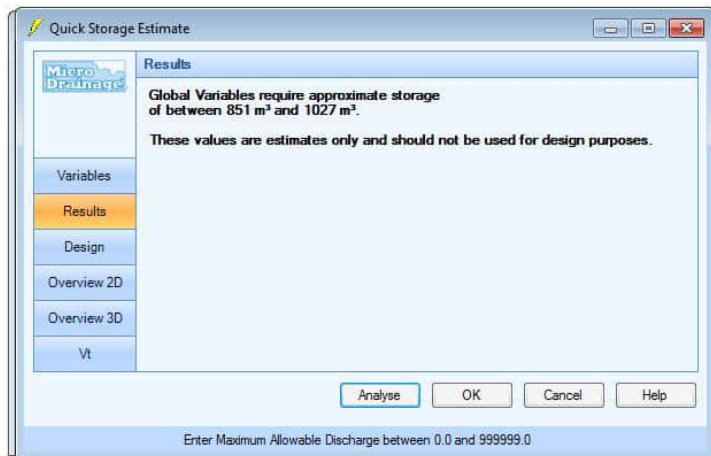
### Catchment 3



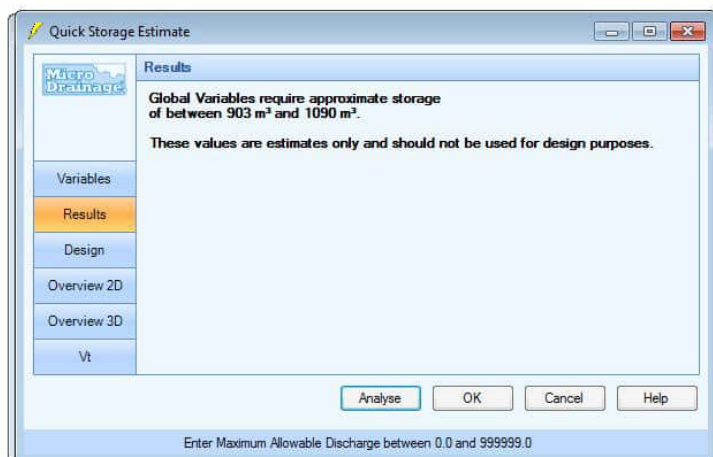
### Catchment 4



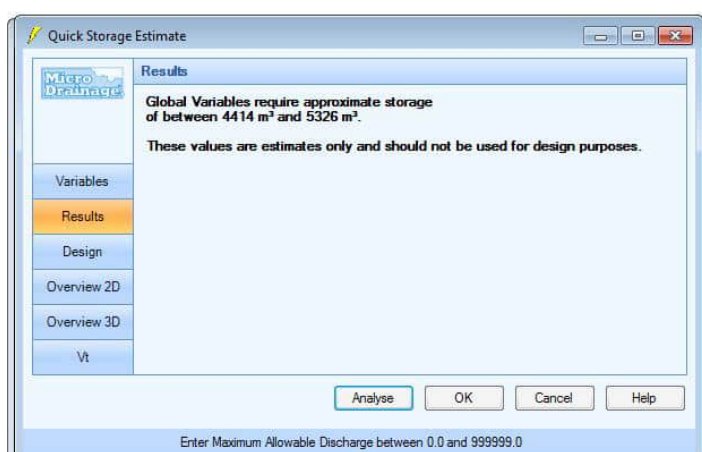
### Catchment 5



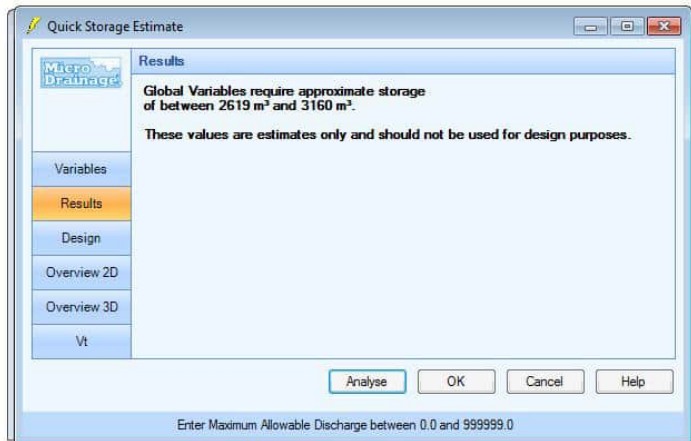
## Catchment 6



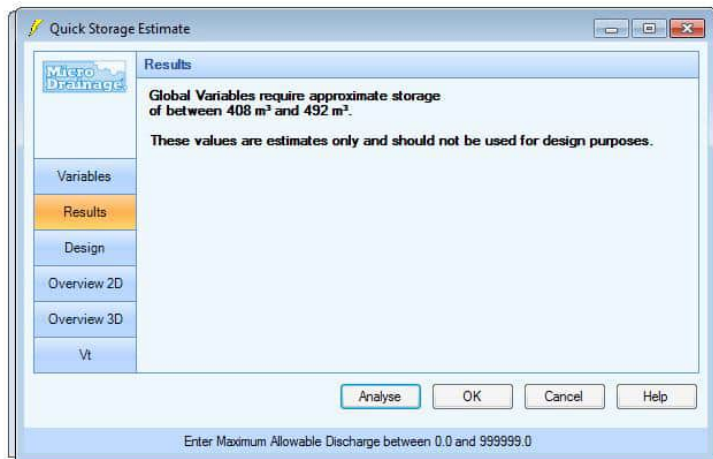
## Catchment 7



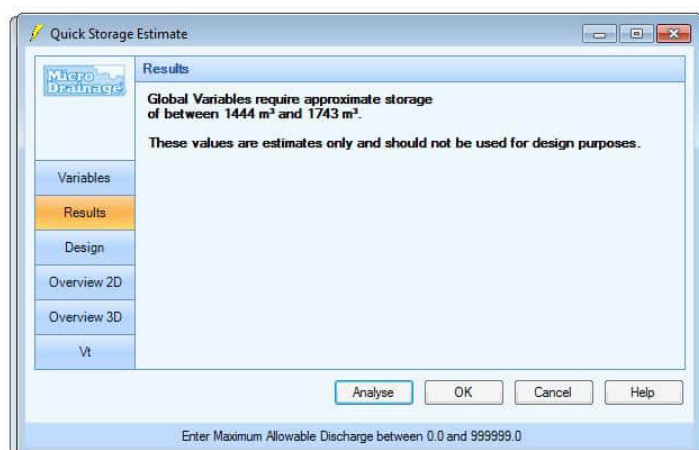
## Catchment 8



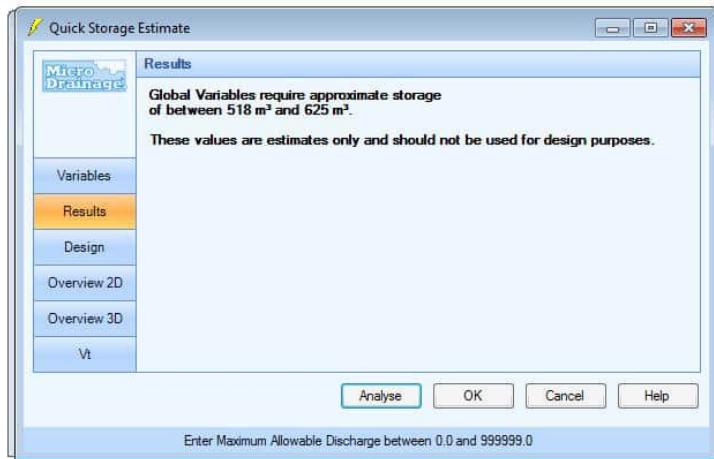
## Catchment 9



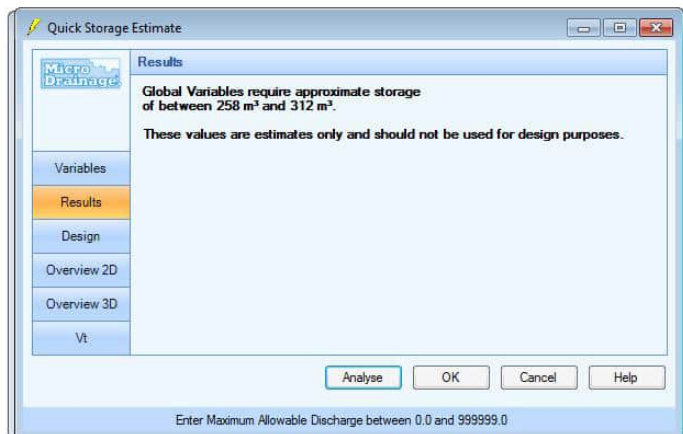
## Catchment 10



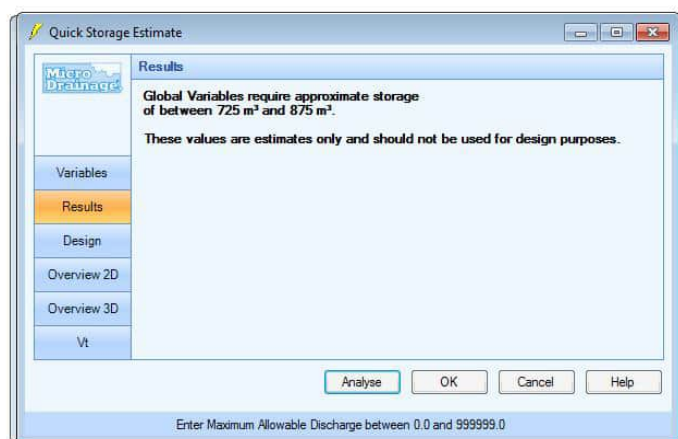
## Catchment 11



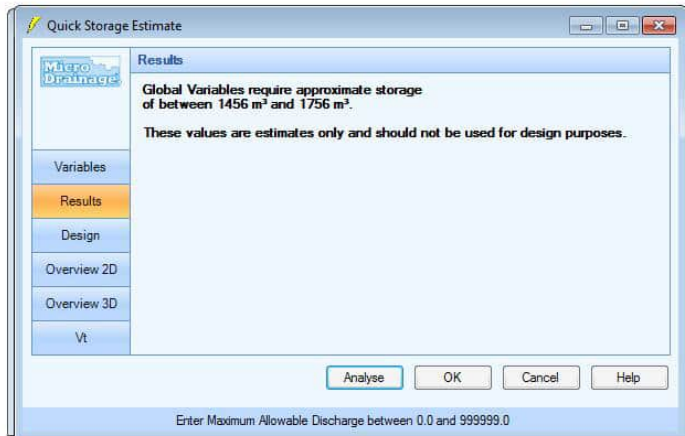
## Catchment 12



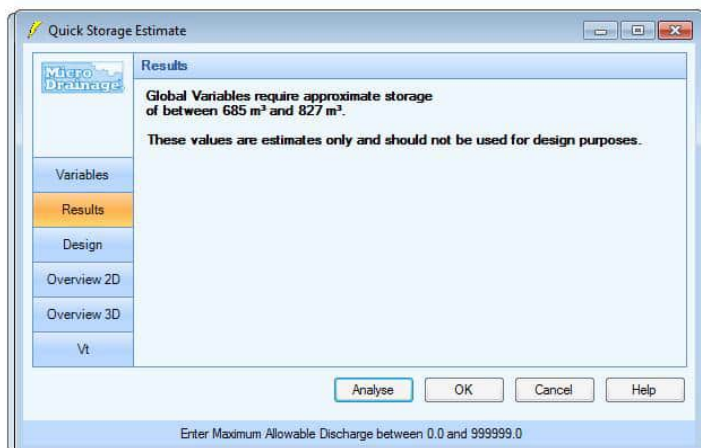
## Catchment 13



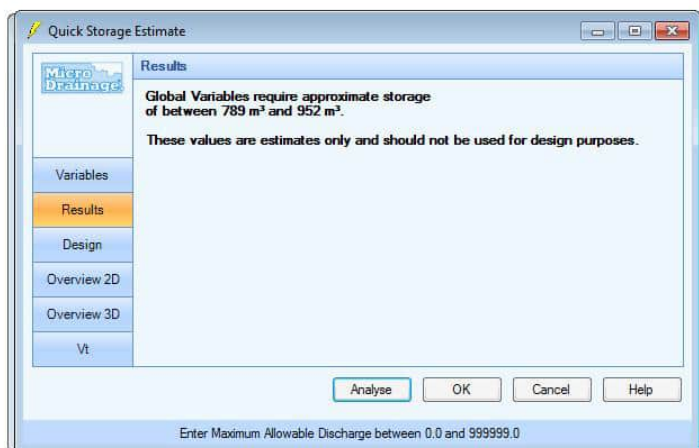
## Catchment 14



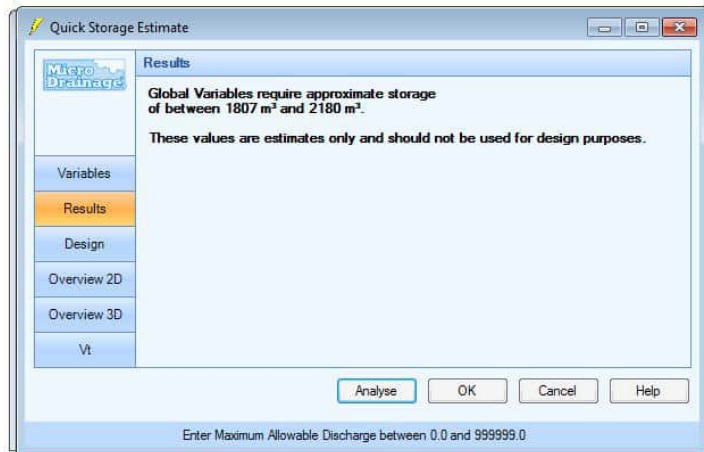
## Catchment 15



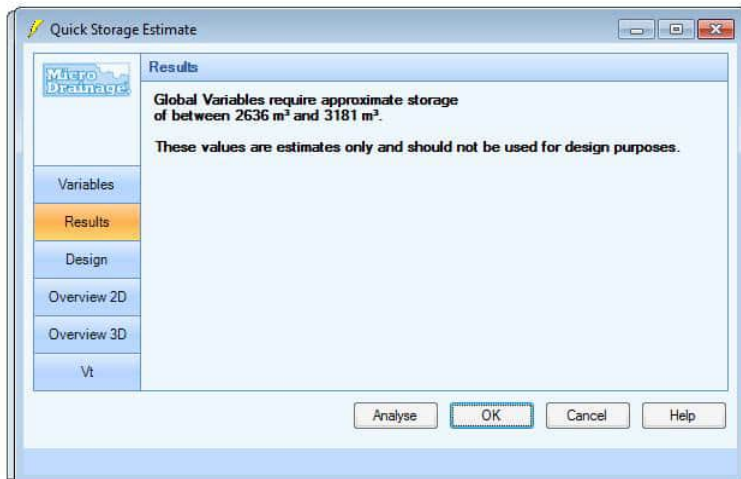
## Catchment 16



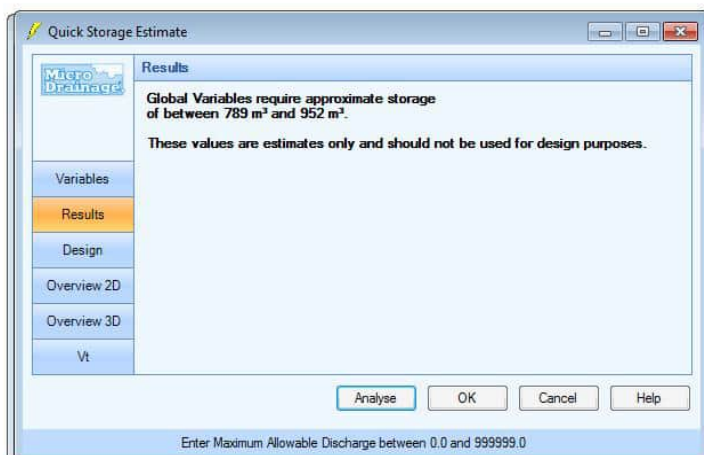
## Catchment 17



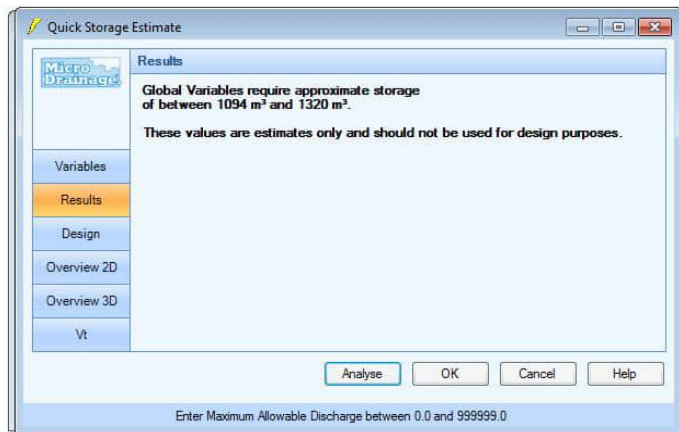
## Catchment 18



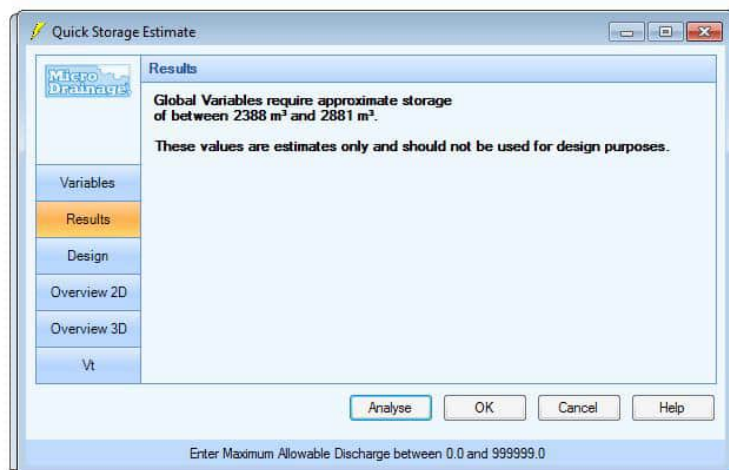
## Catchment 19



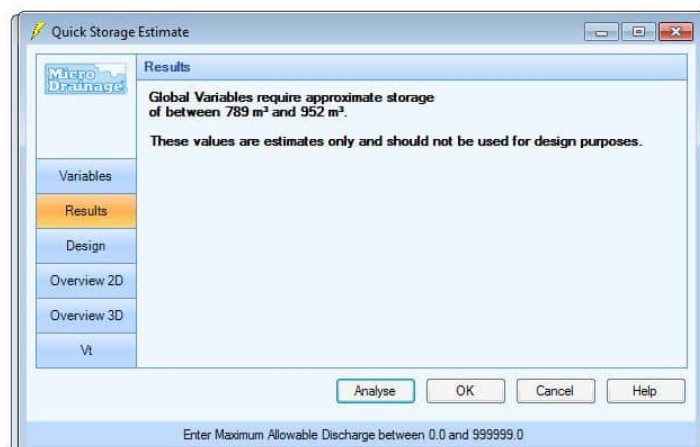
## Catchment 20



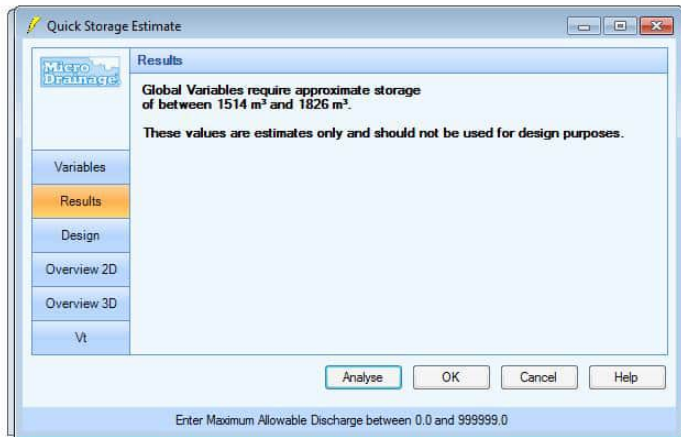
## Catchment 21



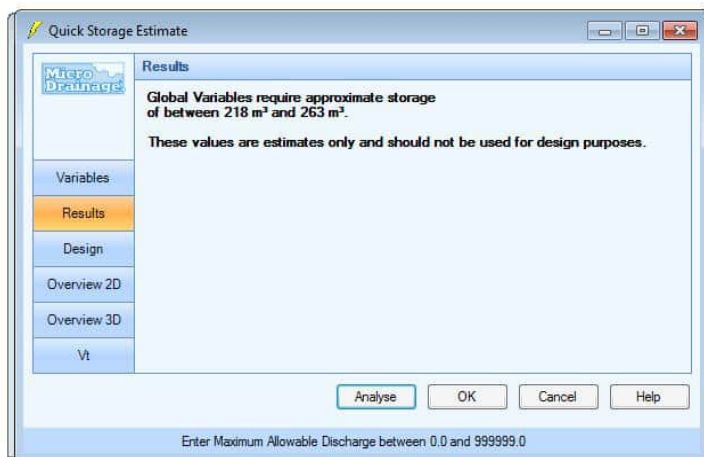
## Catchment 22



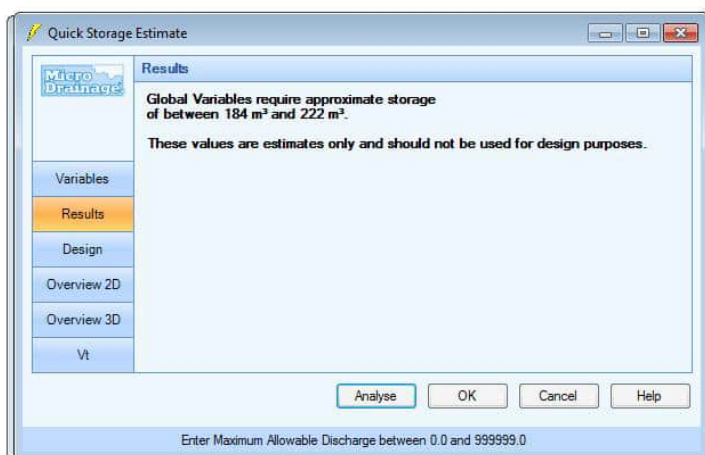
## Catchment 23



## Catchment 24



## Catchment 25



## Catchment 26

## **Appendix H**

### **Foul Water Drainage Strategy Drawings**

Proposed Foul Water Strategy      60312043/CIV/002



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|                                                                                     |                                               |
|-------------------------------------------------------------------------------------|-----------------------------------------------|
|  | Proposed Highway Network<br>(Primary)         |
|  | Proposed Highway Network<br>(Secondary)       |
|  | Proposed Highway Network<br>(Tertiary)        |
|  | Existing Thames Water public foul water sewer |
|  | Proposed foul water sewer                     |

5 

1. Drawing based on IDF masterplan reference AR 23 and now based on issued 19 September 2014.
2. Design based on Topographical Survey provided by KA Ryelande ID dated March 2014 (not AR release 06).
3. The proposed sewers, connection points and discharge rates shown are indicative only and are subject to the final parcel layout and detailed design.
4. All existing foul water sewers have been taken from Thames Water records. The location and nature of these sewers are indicative only and are to be verified by a site survey at earliest opportunity.
5. The proposed sewers as shown on the plan indicate a gravity sewerage system. There may be isolated low spots in the downstream sewerage accumulation of finished ground levels, which may require a pumping station.
6. The proposed foul water discharge rates shown in Table A-2 are based on a design flow of 4000 l/dwelling/day (as per SFA). The flow rates are subject to confirmation of the final masterplan and the detailed sewerage accumulation of finished ground levels, which may require a pumping station.

**WORK IN  
PROGRESS**

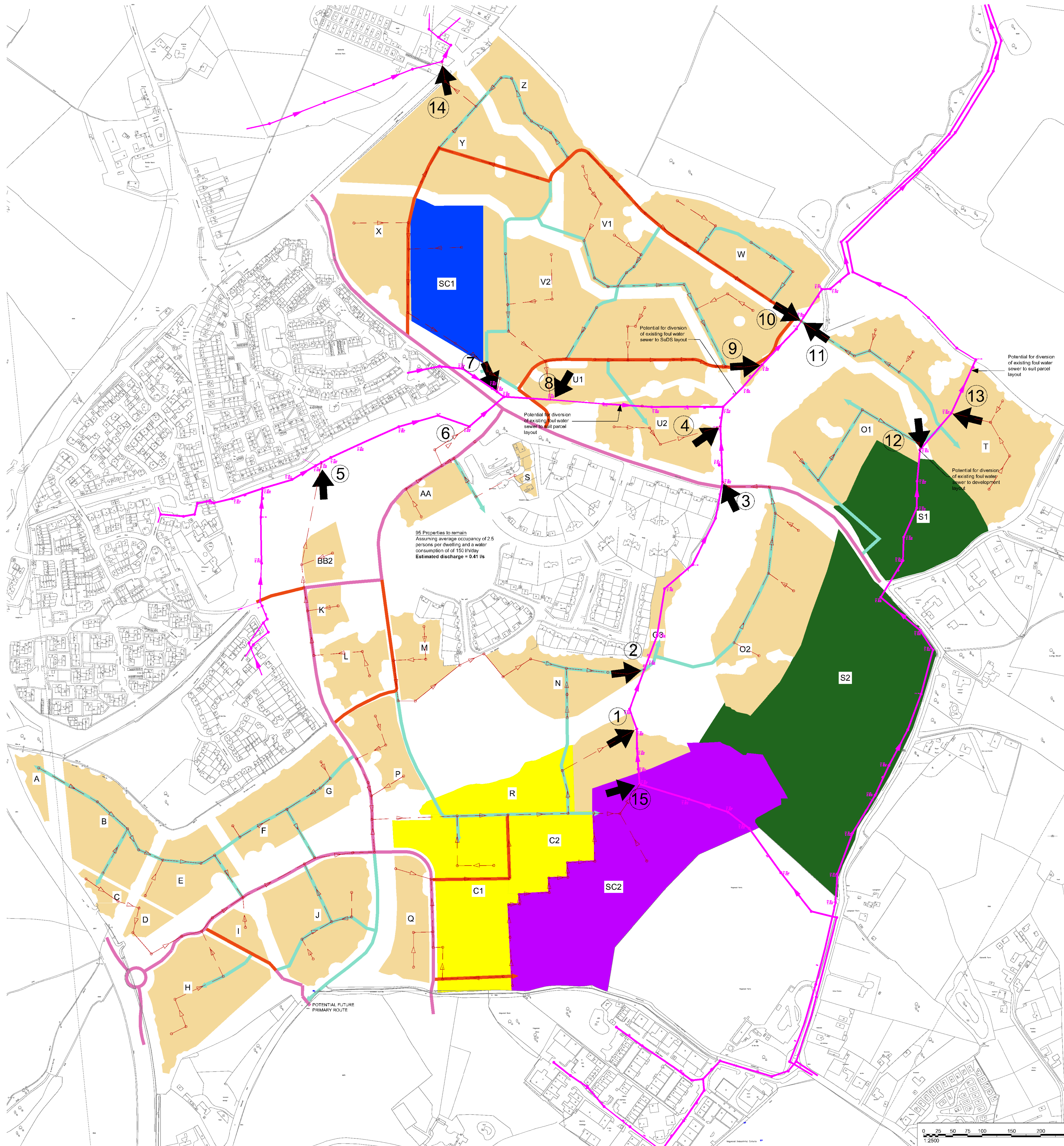
|     |          |                                               |      |       |       |
|-----|----------|-----------------------------------------------|------|-------|-------|
|     |          |                                               |      |       |       |
| PS  | 19/09/14 | Updated to current masterplan and notes added | CH   | SM    | SLM   |
| P4  | 02/07/14 | Updated to current masterplan                 | PP   | SLM   | SLM   |
| P3  | 11/06/14 | Proposals updated                             | PP   | SLM   | SLM   |
| P2  | 23/05/14 | Masterplan Removed                            | AM   | SLM   | SLM   |
| P1  | 21/03/14 | Preliminary issue                             | AM   | SLM   | SLM   |
| Rev | Date     | Detail                                        | Made | Chk'd | App'd |

DRAFT Foul Water Drainage Strategy

60312043/CIV/003

| Discharge point | Average DWF (l/s) | Peak DWF (l/s) |
|-----------------|-------------------|----------------|
| 1               | 5.0               | 30.0           |
| 2               | 0.7               | 4.4            |
| 3               | 1.1               | 6.9            |
| 4               | 0.5               | 2.9            |
| 5               | 0.5               | 2.9            |
| 6               | 0.2               | 1.1            |
| 7               | 0.6               | 3.8            |
| 8               | 0.9               | 5.5            |
| 9               | 2.1               | 12.4           |
| 10              | 0.7               | 4.4            |
| 11              | 0.8               | 4.9            |
| 12              | 0.8               | 5.1            |
| 13              | 0.4               | 2.4            |
| 14              | 1.5               | 9.1            |
| 15              | 0.5               | 3.2            |
| <b>TOTAL</b>    | <b>16.4</b>       | <b>98.8</b>    |

**Table A - Proposed Foul Water Discharge Rates**  
(based on SFA 4000 l/dwelling/day)



A horizontal scale bar with alternating black and white segments. Numerical labels are placed above the bar at intervals of 25, starting from 0 and ending at 250. Below the bar, the text '1:2500' is printed.

Scale - 1:2500 @ A0