Flood Risk Assessment and Surface Water Drainage Strategy

Prepared for:
Protea Holdings Ltd

December 2018

Location:
Barnes Home Guard Association,
76A Richmond Park Road,
London
SW14 8LA

Our reference:
88496-BucklandPool-BarnesHomeGuard-v1.0

Unda Consulting Limited, Southpoint, Old Brighton Road, Gatwick, West Sussex, RH11 0PR
+44 (0) 1293 214 444
enquiries@unda.co.uk

Document Issue Record

Location:	Barnes Home Guard Association, 76A Richmond Park Road, London, SW14 8LA				
Application:	Construction of a new swimming pool and ancillary facilities				
Prepared for:	Protea Holdings Ltd				
Title:	Flood Risk Assessment and Surface Water Drainage Strategy for Planning				
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Written By:	T. Smith BSc (Hons)	**Checked By:**	E. Bouet, BSc (Hons) J. Stone, MSc (Hons)	**Authorised By:**	T. Smith BSc (Hons)

1. Introduction

1.1. This Flood Risk Assessment and Surface Water Drainage Strategy has been prepared by Unda Consulting Limited on behalf of Protea Holdings Ltd, in support of a planning application for the construction of a new swimming pool and ancillary facilities at Barnes Home Guard Association, 76A Richmond Park Road, London, SW14 8LA. This report assesses flood risk and surface water drainage for the proposed development.

1.2. The proposed planning application is for the construction of a new swimming pool and ancillary facilities. Post development the total roof area of the new swimming complex will cover approximately 237m².

1.3. In order to mitigate flood risk posed by post development runoff, adequate control measures will be required within the site. This will ensure that surface water runoff is dealt with at source and the flood risk off site is not increased.

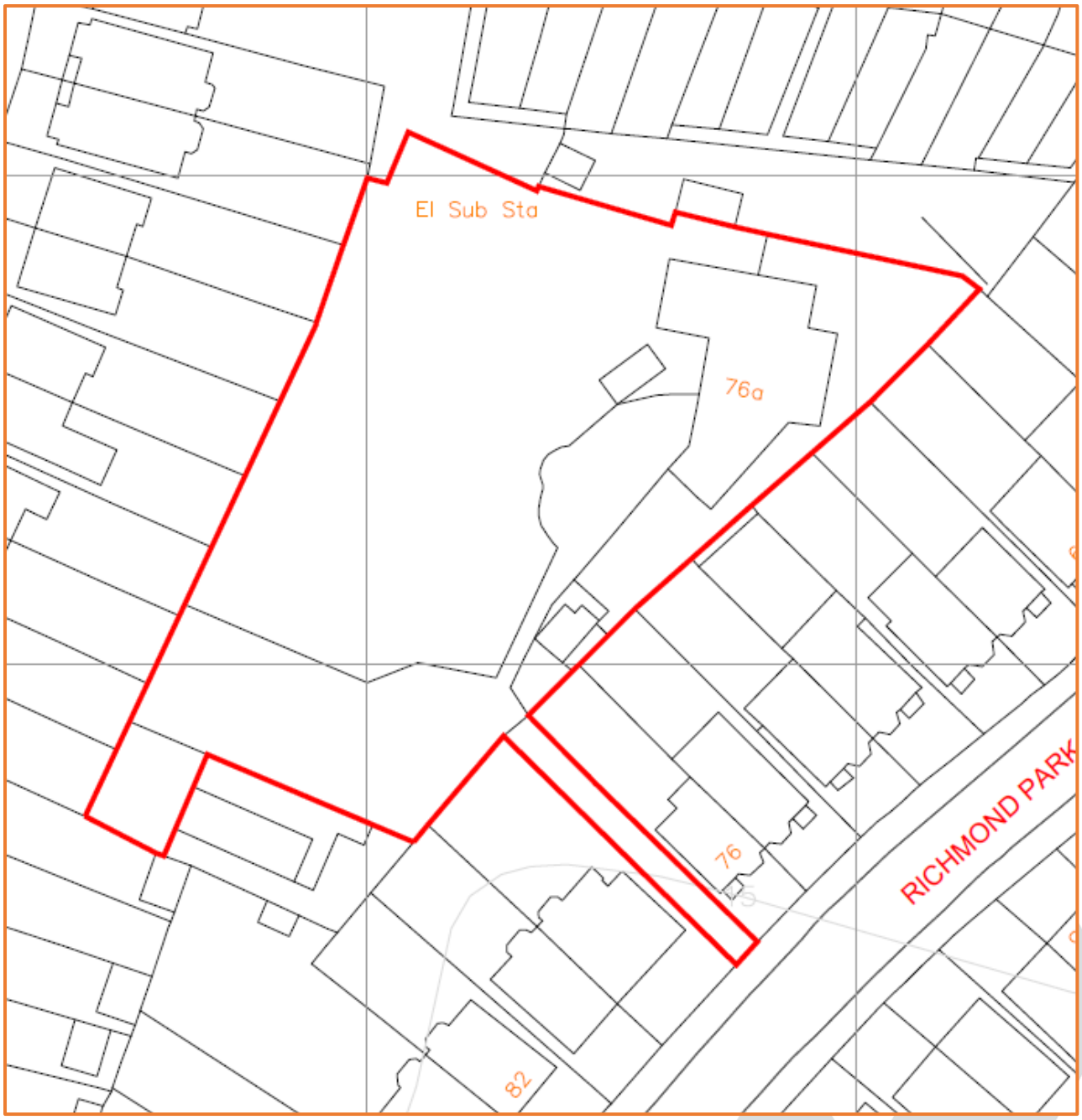


Figure 1: Site location plan (Source: Reigate Architects)

2. Existing Site:

2.1. The existing site is occupied by the Barnes Home Guard Association (BHGA) and is approximately 3305m^2 in size. The site is partially covered by impermeable surfacing of approximately 1210m^2, including approximately 336m^2 of existing built footprint. The remaining impermeable areas are predominately made up of concrete footpaths, parking spaces and a tarmac entrance drive. The existing site is therefore formed of approximately 36% impermeable surfaces.

2.2. Several buildings are located at the site, including a main club house in the north east and three outbuildings. A tarmacked entrance drive is located in the south east of the site, off Richmond Park Road, with associated vehicle parking in the south. Grassland is located in the centre and north west of the site utilised predominantly for social events.

2.3. A topographical survey has not been provided by the client however, 0.5m resolution LiDAR data is available for the site. This indicates that levels on site range between 13.00mAOD and 14.60mAOD, with the site sloping gently down from higher land in the south towards the centre north.

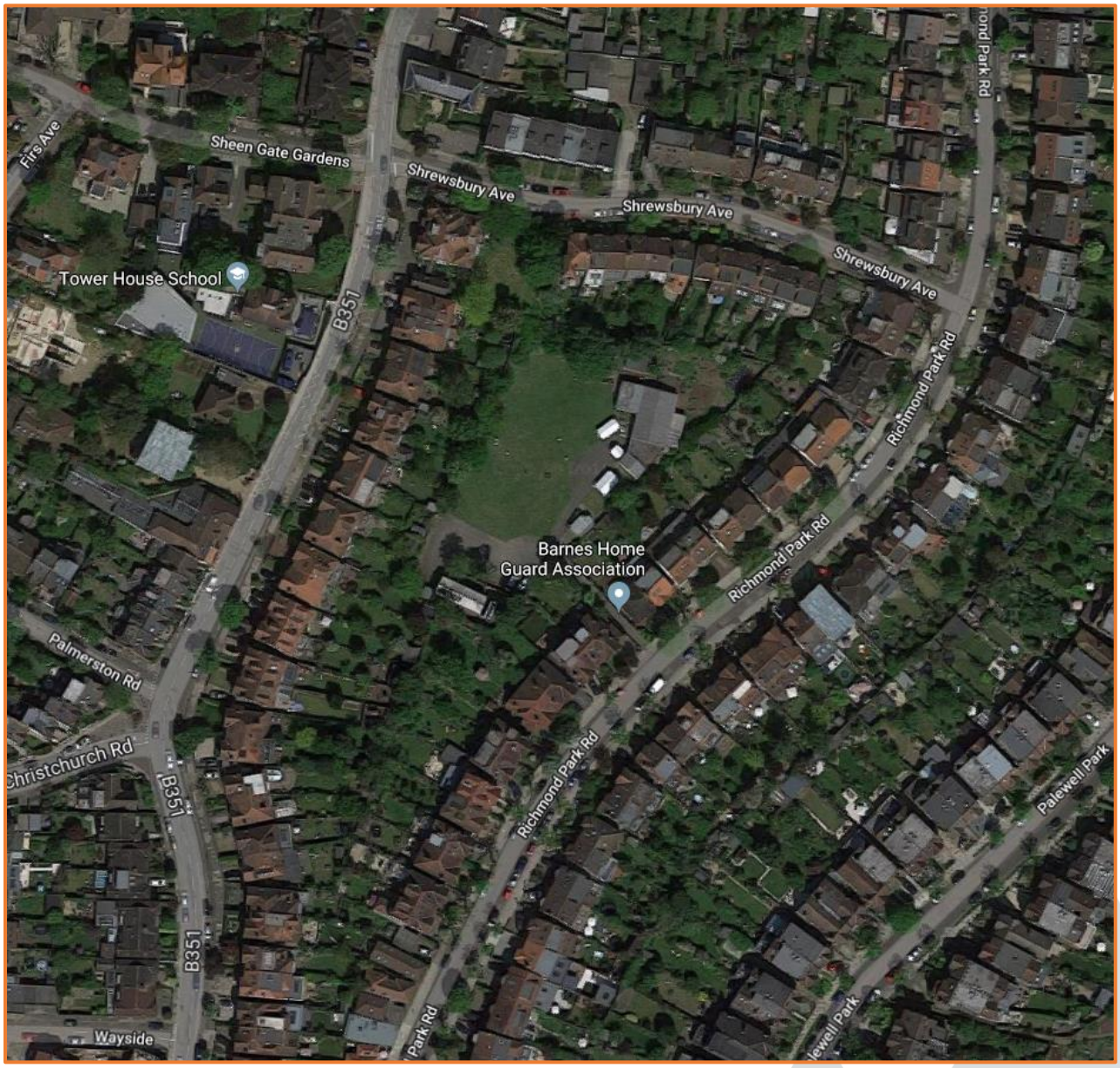


Figure 2: Site location (Source: Google)

Existing Ground Conditions:

2.4. The 1:50,000 BGS map shows the site to be located directly upon the bedrock of London Clay.

2.5. BGS mapping indicates that superficial deposits comprising Taplow Gravel Member and Head – Clay, Silt, Sand and Gravel underlie the site.

2.6. The soil type taken from the BGS UKSO Soil Map Viewer, shows a soil parent material of Deep Colluvium with a soil texture of Clayey Loam to Sandy Loam.

2.7. Nearby BGS borehole logs show that a resting groundwater level could be sited within 10m of the surface.

2.8. The published Environment Agency Groundwater Vulnerability map shows the site is not located within an area classified as a Groundwater Source Protection Zone.

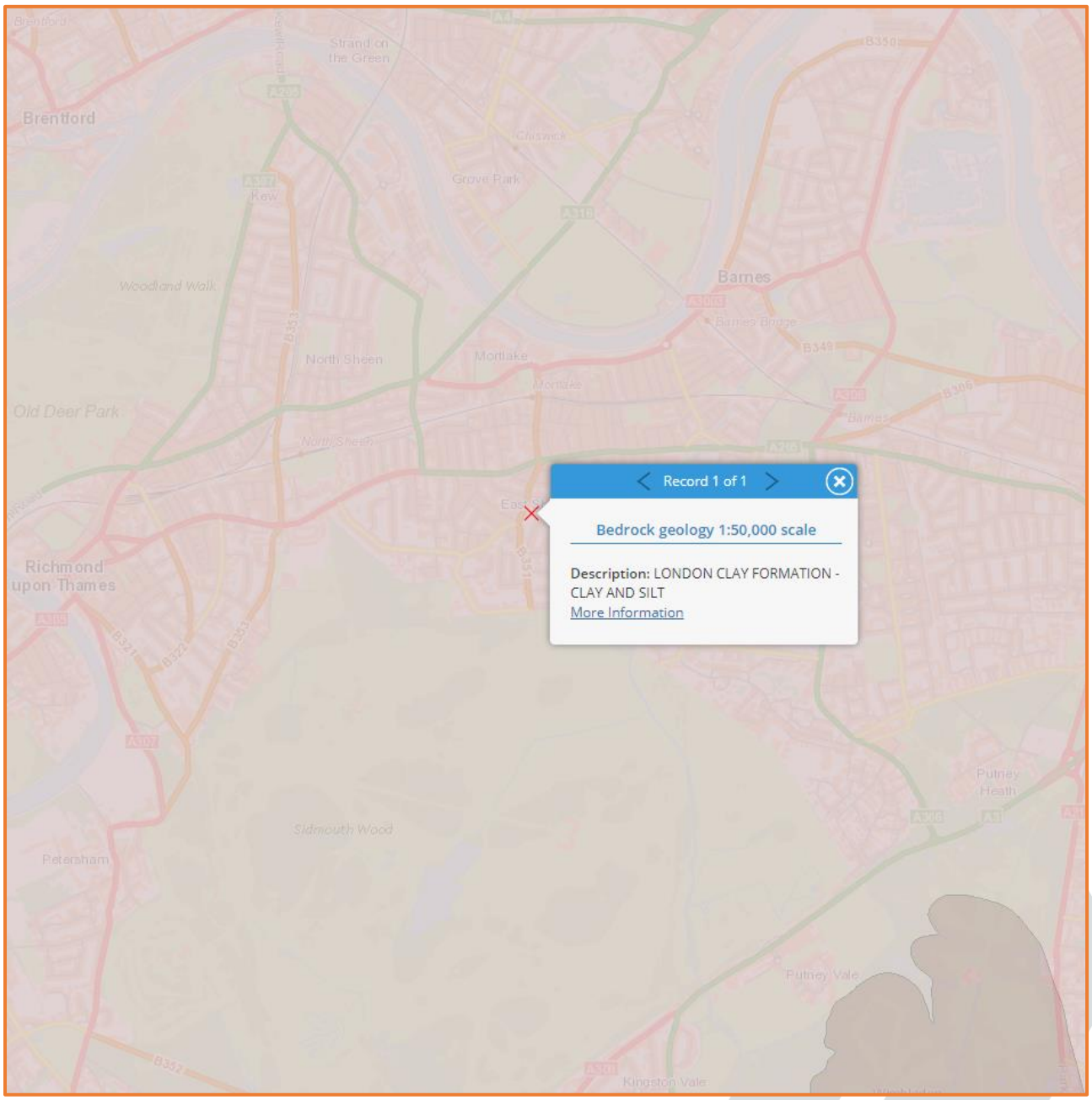


Figure 3: BGS Bedrock Geology (Source: BGS)

Figure 4: BGS Superficial Deposits (Source: BGS)

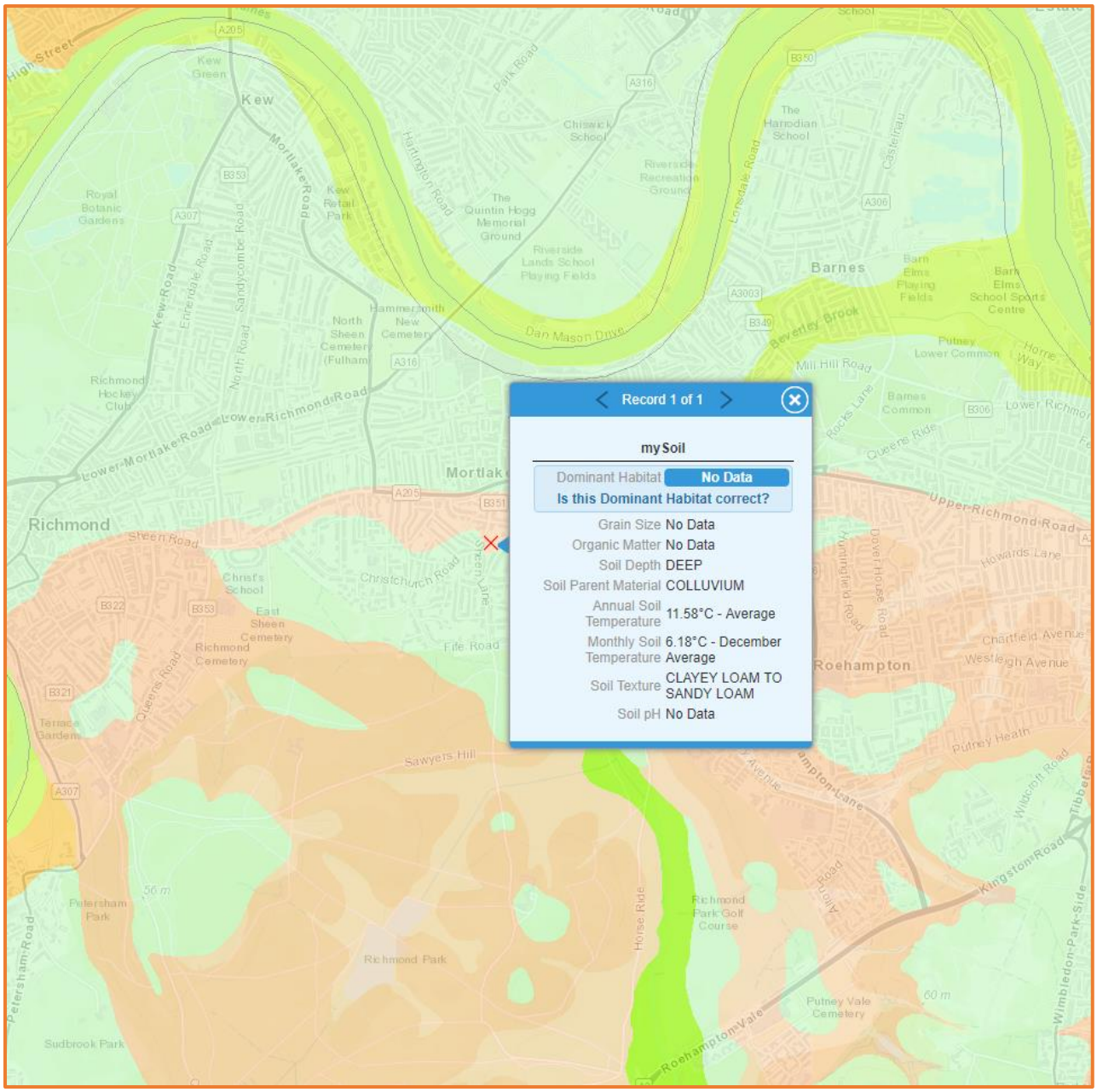


Figure 5: Soil Map (Source: UK Soils, BGS)

Nearby Watercourses / Drainage Features:

2.9. There are no existing watercourses or rivers within a close proximity to the site.

Existing Drainage:

2.10. Asset records obtained from Thames Water Utilities Ltd (TWU) indicate the presence of a 150mm diameter surface water sewer flowing from south to north beneath the north eastern periphery of the site, connecting to a 225mm sewer along Shrewsbury Avenue.

2.11. This surface water sewer is assumed to service the existing clubhouse building in the north east of the site.

2.12. Surface water generated within the existing site boundary is likely to currently discharge at an uncontrolled rate to ground and the existing sewer network.

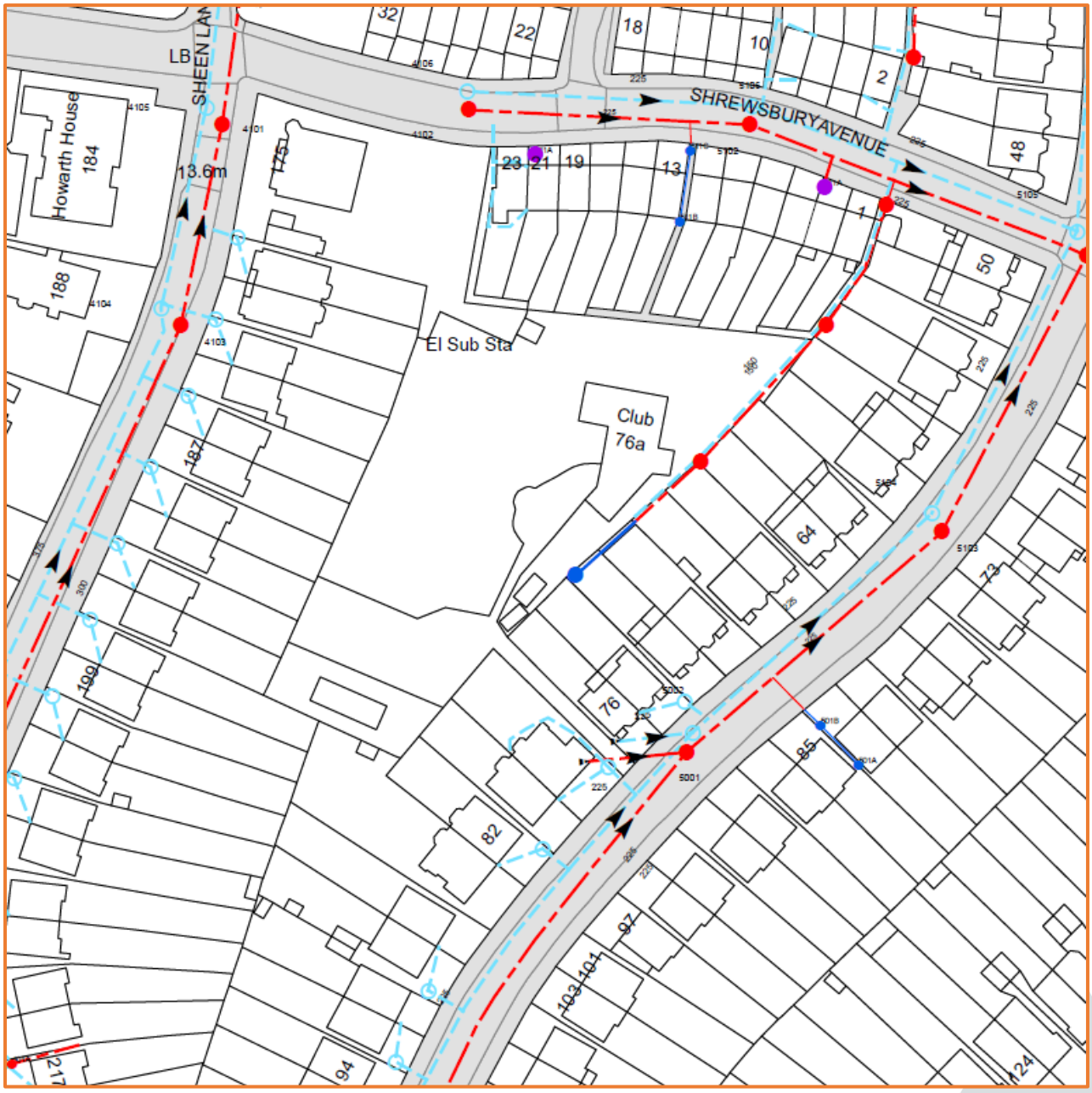


Figure 6: Local sewer network (Source: Thames Water)

3. Development Proposals:

Proposed Development:

3.1. The proposed planning application is for construction of a new swimming pool with ancillary facilities in the south western corner of the site. Post development the total roof area of the swimming complex will cover approximately 237m².

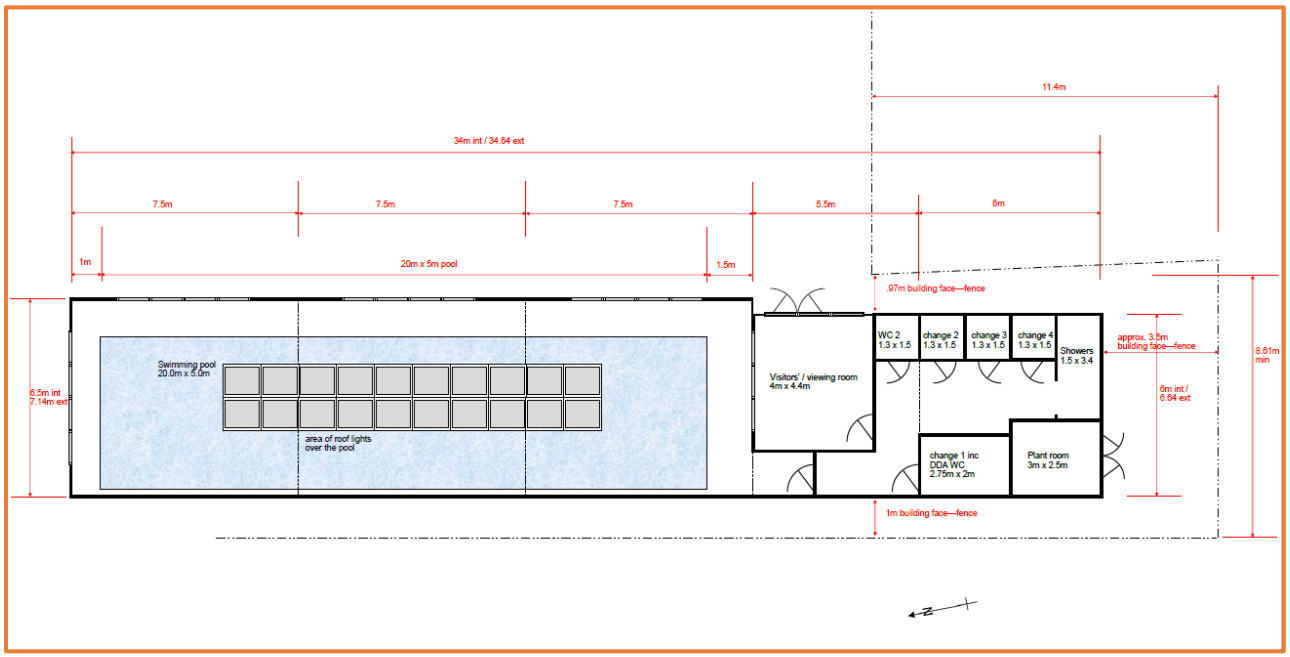


Figure 7: Proposed site layout plan (Source: Buckland Pool and Building Company)

4. Flood Risk Assessment:

Flood Zones:

4.1. Within planning, Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's Flood Map for Planning (Rivers and Sea), available on the Environment Agency's website.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 1: Environment Agency Flood Map for Planning (Rivers and Sea) (Source: EA)

4.2. The Flood Zones shown on the Environment Agency's Flood Map for Planning (Rivers and Sea) do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding.

Vulnerability to flooding:

4.3. The NPPF classifies property usage by vulnerability to flooding. The existing site is a social club which is classified as "less vulnerable" under the NPPF. Post development, the site will remain "less vulnerable", as the application is for the construction of a new swimming pool.

4.4. Accordingly, it is considered that the vulnerability of the site as a whole will not increase post development.

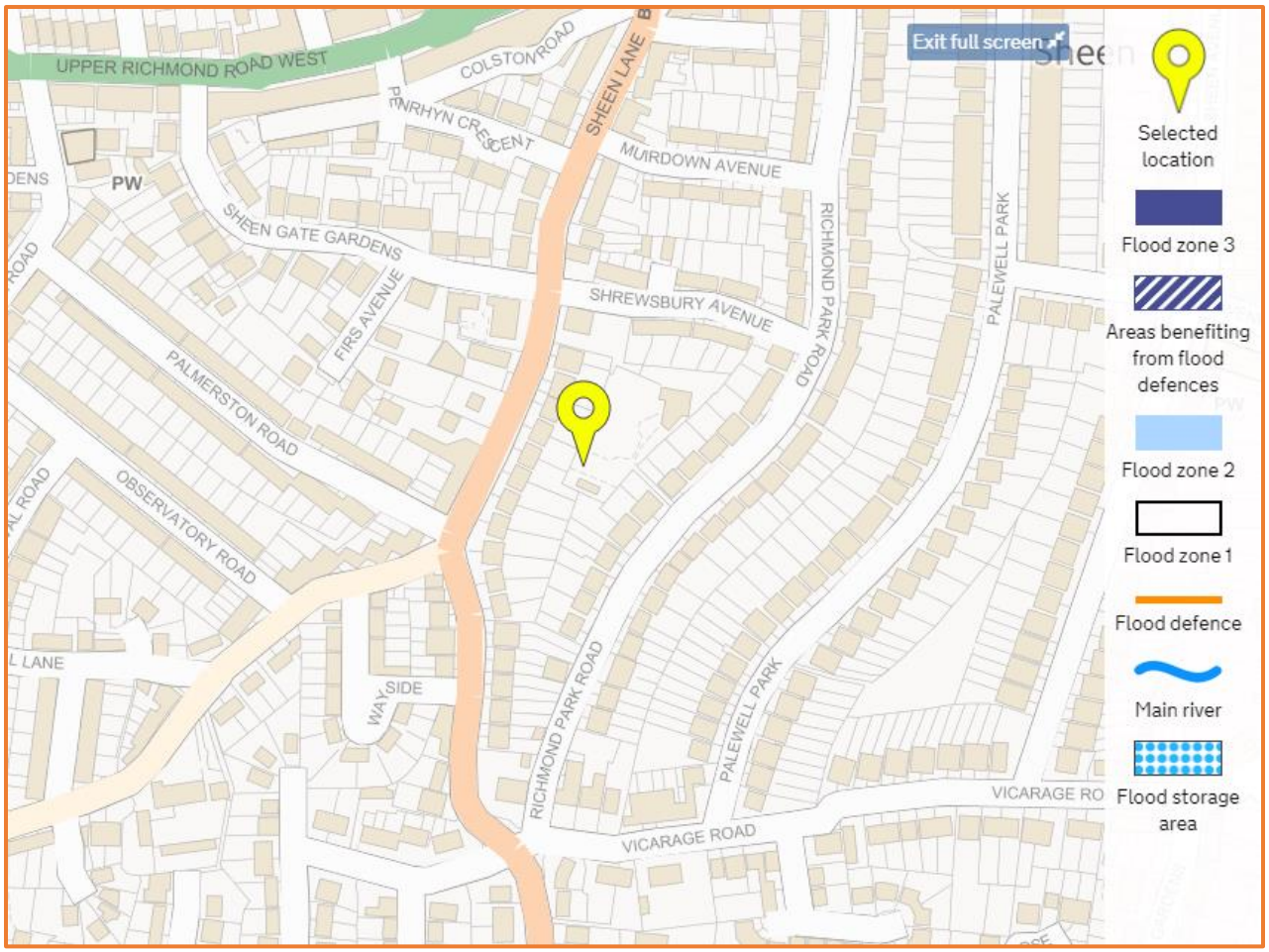


Figure 8: Environment Agency Flood Map for Planning (Rivers and Sea) (Source: EA)

4.5. The site is located entirely within Flood Zone 1 (Low Probability) which means it is defined as land having less than a 1:1000 annual probability of tidal flooding.

Fluvial:

4.6. Due to the site topography and distance to the nearest watercourse, the risk of fluvial flooding is considered to be very low.

Tidal:

4.7. Due to the site topography and distance to the nearest tidally influenced watercourse (the River Thames), the risk of tidal flooding is considered to be very low.

Pluvial:

4.8. Pluvial (surface water) flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead.

4.9. In 2013 the EA, working with Lead Local Flood Authorities (LLFAs), produced an updated Flood Map for Surface Water. It is considered to represent a significant improvement on the previous surface water flood maps available, both in terms of method and representation of the risk of flooding. The modelling techniques and data used are considerably improved, and also incorporated locally produced mapping where this is available to represent features best modelled at a local scale.

4.10. The Flood Map for Surface Water assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year (annual probability of flooding is shown in brackets):

- 1:30 (3.3%)
- 1:100 (1%)
- 1:1000 (0.1%)

4.11. The mapping below shows the Risk of Flooding from Surface Water centred on the site. Please note that the EA to not consider this information suitable to be used to identify the risk to individual properties or sites. It is useful to raise awareness in areas which may be at risk and may require additional investigation.

4.12. The EA Risk of Flooding from Surface Water Map suggests that the majority of the site lies within an area of "Very Low" risk of flooding from surface water. A swathe of land, across the centre of the site, appears to be at "Low" risk of surface water flooding.

4.13. The main road that offers access to the site, Richmond Park Road, has been modelled at "Low" risk of surface water flooding.

4.14. The rear gardens of Shrewsbury Avenue, adjacent north of the site, has been identified at "Medium" and "High" risk of surface water flooding according to the Environment Agency.

4.15. According to London Borough of Richmond upon Thames Surface Water Management Plan 2011 the site is located within a Critical Drainage Area (Group8_004).

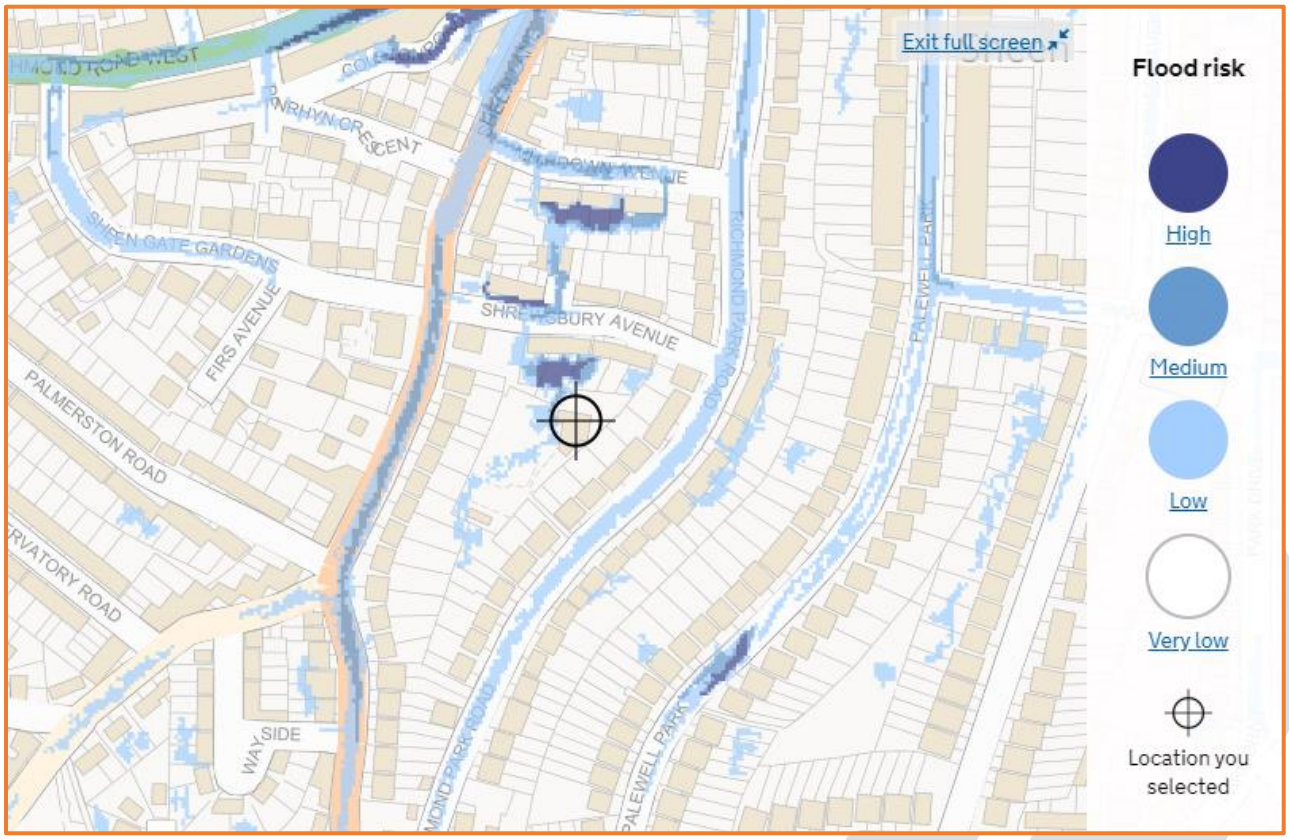


Figure 9: Extract from Environment Agency RoFSW map (Source: EA)

Groundwater:

4.16. Groundwater flooding occurs as a result of water rising up from the underlying rocks or from water flowing from abnormal springs. This tends to occur after much longer periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. Groundwater tends to flow from areas where the ground level is high, to areas where the ground level is low. In low-lying areas the water table is usually at shallower depths anyway, but during very wet periods, with all the additional groundwater flowing towards these areas, the water table can rise up to the surface causing groundwater flooding.

4.17. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). These may be extensive, regional aquifers, such as chalk or sandstone, or may be localised sands or river gravels in valley bottoms underlain by less permeable rocks. Groundwater flooding takes longer to dissipate because groundwater moves much more slowly than surface water and will take time to flow away underground.

4.18. According to London Borough of Richmond upon Thames Strategic Flood Risk Assessment (SFRA) Update March 2016, the site is located within an area where there is the 'potential for groundwater flooding of property situated below ground level'.

Sewer:

4.19. Sewer flooding occurs when the sewer network cannot cope with the volume of water that is entering it. It is often experienced during times of heavy rainfall when large amounts of surface water overwhelm the sewer network causing flooding. Temporary problems such as blockages, siltation, collapses and equipment or operational failures can also result in sewer flooding.

4.20. All Water Companies have a statutory obligation to maintain a register of properties/areas which have reported records of flooding from the public sewerage system, and this is shown on the DG5 Flood Register. This includes records of flooding from foul sewers, combined sewers and surface water sewers which are deemed to be public and therefore maintained by the Water Company. The DG5 register records of flood incidents resulting in both internal property flooding and external flooding incidents. Once a property is identified on the DG5 register, water companies can typically put funding in place to address the issues and hence enable the property to be removed from the register. It should be noted that flooding from land drainage, highway drainage, rivers/watercourses and private sewers is not recorded within the register.

4.21. According to London Borough of Richmond upon Thames SFRA (2016), the site is located within a postcode area where 1-5 properties have flooded as a result of sewer overloading. However, despite this, there is no information to suggest that the site itself has ever historically flooded.

Other Sources:

4.22. The EA Risk of Flooding from Reservoirs Map suggests that the site lies outside the "Maximum extent of flooding" from reservoir failure. The EA also advise on their website that reservoir flooding is extremely unlikely. All major reservoirs have to be inspected by specialist dam and reservoir Engineers. These inspections are monitored and enforced by the EA themselves. The risk to the site from reservoir flooding is therefore minimal and is far lower than that relating to the potential for fluvial flooding to occur.

4.23. No further information has been provided to suggest the site is susceptible to from the failure of reservoirs, canals or other artificial infrastructure from the risk of flooding.

5. Surface Water Drainage Strategy:

5.1. In order to mitigate flood risk posed by post development runoff, adequate control measures will need to be considered within the site. This will ensure that surface water runoff is dealt with at source and flood risk is not increased elsewhere.

Drainage Hierarchy:

5.2. The drainage strategy for the site has been prepared according to the drainage discharge hierarchy from CIRIA C753 The Suds Manual, as follows:

- Infiltration to the maximum extent that is practical;
- Discharge to surface waters;
- Discharge to surface water sewer.

Infiltration Potential:

5.3. Records from the BGS indicate that the site is underlain by London Clay and Lambeth Group – Clay, Silt and Sand, therefore infiltration potential is considered poor.

Discharge Location:

5.4. There are no existing watercourses or rivers within a close proximity to the site.

5.5. Surface water from the existing building in the north east of the site is assumed to flow at an unrestricted rate into the main public surface water sewer located along the north eastern periphery of the site.

5.6. Thames Water records indicate that the surface water sewer beneath the north east of the site has a diameter of 150mm and connects to a 225mm surface water sewer under Shrewsbury Avenue.

5.7. Therefore, it is proposed to attenuate surface water on site and discharge post development runoff at a **controlled rate via the existing surface water main sewer connection.**

Proposed Discharge Rate:

5.8. Existing greenfield runoff rates for the total site have been calculated as 0.4 l/s for the 1:1 annual runoff event, 1.1 l/s for the 1:30 year event and 1.6 l/s for the 1:100 year event. Refer to calculations in Appendix.

5.9. However, the existing site is brownfield and covered by approximately 1210m^2 of impermeable surfacing, comprising the existing built footprint and hardstanding. The existing site is therefore approximately 36% impermeable surfaces. Runoff rates for the existing site (including the 36% impermeable coverage) have been calculated using MicroDrainage as 0.9 l/s for the 1:1 annual runoff event, 2.0 l/s for the 1:30 year event and 2.5 l/s for the 1:100 year event. Refer to calculations in Appendix.

5.10. Runoff from the proposed roof area will be collected and stored in an attenuation storage tank, located beneath the recreation field in the centre of the site.

5.11. From the attenuation storage tank, runoff will be gradually discharged existing surface water connection in the north east of the site (refer to Thames Water asset search in the report Appendix).

5.12. Outflow from the proposed drainage system (attenuation storage) to the surface water sewer will be limited to 1.6 l/s for all storms up to, and including, the 1:100 year + 40% climate change event via a hydrobrake. The hydrobrake will be installed in an inspection chamber within the site.

5.13. Given that the proposed swimming pool development is partially underlain by concrete hardstanding, a significant betterment will be provided post development through offering attenuation controlled discharge to the greenfield runoff rate (1.6l/s).

Attenuation Storage:

5.14. Runoff from the proposed roof area will be collected and stored in an attenuation storage tank, located beneath the recreation field in the centre of the site.

5.15. From the attenuation storage tank, runoff will be gradually discharged existing surface water connection in the north east of the site (refer to Thames Water Asset Search in the report Appendix).

5.16. Preliminary calculations indicate that sufficient storage required to attenuate runoff from the proposed impermeable areas (237m^2) arising from the critical 1:100 year + 40% climate change event can be provided within an attenuation storage tank of dimensions 15m^2 x 0.6m deep.

5.17. Preliminary calculations indicated that some 7.4m^3 of storage is required to attenuate the runoff for all storms up to and including the 1:100 year + 40% climate change event.

5.18. All preliminary surface water drainage calculations have been undertaken using MicroDrainage software. Refer to the Appendix.

Rainwater Harvesting (Optional Addition):

5.19. The London Plan Policy 5.15 highlights the need to *'...protect and conserve water supplies and resources in order to secure London's needs in a sustainable manner by...minimising use of mains water'*. Therefore, rainwater harvesting is considered to be a possible sustainable solution for the proposed development.

5.20. Runoff from the proposed development, could be collected, filtered and stored in a RWH tank, which would be buried under the grassed area in the centre of the site. From the tank, water could be piped to the three toilets in the swimming pool complex, and to an outlet where it can be drawn off for irrigation use. The toilet and outlet would have a back-up connection to a mains water supply, to provide water when the RWH tank is empty.

5.21. If the RWH tank contains more water than the 6900l required for toilet and garden usage, the additional water will be discharged **via the existing surface water sewer** at a runoff rate of 1.6l/s, via an orifice plate (refer to Appendix).

Water Quality:

5.22. Runoff from roof areas is considered to be uncontaminated thus does not warrant any form of treatment process to improve water quality, in accordance with *Ciria C753: The SuDS Manual*. Nevertheless, it is suggested to include debris / sediment traps on any new drainage.

Design Exceedance:

5.23. Should the onsite drainage system fail under extreme rainfall events or blockage, flooding may occur within the site. In the event of the drainage system failure, the runoff flow can be managed through detailing the new external levels to direct water away from structures.

Adoption and Maintenance:

5.24. It is proposed that all SuDS facilities will be maintained privately by the end user.

5.25. A draft Maintenance Schedule is outlined in the Table below.

Cellular Storage:

5.26. It is not envisaged that silt build up within the cellular crate systems will require a rigorous maintenance regime so long as silt is removed from upstream catch pits and inspection chambers on a regular basis. Notwithstanding this, a suitable maintenance regime for the systems will comprise of routine inspection and silt removal (as necessary). Inspection should be undertaken using CCTV equipment offered up the inspection tunnels located within the crate system. Camera access can be gained via inspection chambers and inlet pipework located at each end of the tunnels.

5.27. Silt removal can be achieved by jetting the inspection tunnels. Jetting should be undertaken in accordance with current jetting guidelines, in particular the Code of Practice for Sewer Jetting published by The Water Research Centre. Jetting at 150bar at 300l/min should be more than adequate in removing any build-up of material within the tunnel. The crate system will take higher pressures. However, unlike regular jetting which relies heavily on high pressure to remove hardened deposits on the inner bore of pipes, effective cleansing of a crate system relies more on the delivery flow rate to flush solids back through the system.

5.28. A standard jet head with rear facing nozzles should be used. The head should be fed to the far end of the crate tunnel via the nearest inspection chamber, activated and retracted. As the nozzle is removed, debris will be swept back into the inspection chamber where it can then be removed with the use of a standard gully sucker. This method will ensure the effective removal of

gross solids (carrier bags, cans, leaf litter etc.) from the system. Whilst 100% removal cannot be guaranteed, it has been shown that this jetting method will also remove an element of finer material which would otherwise be 'lost' within the system.

Rainwater Harvesting System (if installed):

5.29. Routine inspection of the filter system at quarterly intervals is advised, even if they do not appear to need specific intervention. Pumps need very little attention, but their design life is generally regarded as only being 10 years. Where automatic provision of potable water occurs (if and when rainwater is either not available or the system has failed), sensor warnings should be relayed in such a manner as to inform the user of the current status of the system.

5.30. Rainwater harvesting systems should be designed so that when there is an absence of rain, or a need to disconnect the system for maintenance or repair, that potable water is safely available for all appliances to avoid inconvenience. Tanks should be available for internal inspection, and the cover should be lockable. The proposed outlets for garden usage will require a sign to inform users that the water is not suitable for drinking.

Pipework and Catchpits:

5.31. It is not envisaged that silt build up within the pipework systems will require a rigorous maintenance regime so long as silt is removed from upstream catch pits on a regular basis. Notwithstanding this, a suitable maintenance regime for the systems will comprise of routine inspection (every three months) and silt removal (as necessary).

Drainage Element	Maintenance Requirement	Frequency
Gutters & downpipes	▪ Inspect and remove silt/ debris	▪ To be inspected every three months and silt/ debris removed as necessary.
Catchpits and inspection chambers	▪ Inspect and remove silt	▪ To be inspected every three months and silt/ debris removed as necessary. Flow control to be checked for blockages.
Cellular Storage	▪ Inspect and remove debris	▪ CCTCV inspection following first storm event. Monthly CCTV inspections for first 3 months. 6 monthly CCTV inspections thereafter. Jetting to remove silt as necessary.
Rainwater Harvesting Tanks	▪ Cleaning and/or replacement of filters	▪ Three times a year or as necessary
	▪ Inspection of tank for debris and sediment build-up ▪ Inspection of inlets, outlets, withdrawal devices, overflow areas, pumps and filters ▪ Cleaning of tank, inlets, outlets, gutters, withdrawal devices and roof drain filters to remove silt and other debris	▪ Annually or as necessary
	▪ Repair of overflow erosion damage or damage to tank ▪ Pump repairs	▪ As required
Flow Controls	▪ Inspected for blockage and blockage / debris build up removed	▪ Every six months

Table 2: Suggested Maintenance Regime for Elements of the Drainage Infrastructure

Note: In addition to the above maintenance requirements, it is recommended that all drainage elements are inspected:

- Following the first storm event
- Monthly for the first 3 months following commissioning

6. Flood Risk Mitigation:

Physical Design Measures:

6.1. The site is shown to be entirely within Flood Zone 1 on the EA Flood Map for planning (Rivers and the Sea), and is identified to be at "Very Low" and "Low" Risk of Flooding from Surface Water.

6.2. It is recommended that finished internal floor level of the proposed swimming pool complex is set 150mm above adjacent ground levels.

Fluvial floodplain storage:

6.3. The NPPF requires that where development is proposed in undefended areas of floodplain, which lie outside of the functional floodplain, the implications of ground raising operations for flood risk elsewhere needs to be considered. Raising existing ground levels may reduce the capacity of the floodplain to accommodate floodwater and increase the risk of flooding by either increasing the depth of flooding to existing properties at risk or by extending the floodplain to cover properties normally outside of the floodplain. Flood storage capacity can be maintained by lowering ground levels either within the curtilage of the development or elsewhere in the floodplain, in order to maintain at least the same volume of flood storage capacity within the floodplain.

6.4. In undefended tidal areas, raising ground levels is unlikely to impact on maximum tidal levels so the provision of compensatory storage should not be necessary.

6.5. For development in a defended flood risk area, the impact on residual flood risk to other properties needs to be considered. New development behind flood defences can increase the residual risk of flooding if the flood defences are breached or overtopped by changing the conveyance of the flow paths or by displacing flood water elsewhere. If the potential impact on residual risk is unacceptable then mitigation should be provided.

6.6. The site is situated in Flood Zone 1 when using the Environment Agency Flood Map for Planning (Rivers and Sea). No fluvial floodwater would be displaced by the proposed development.

7. Discussion and Conclusions:

7.1. This Flood Risk Assessment and Surface Water Drainage Strategy has been prepared by Unda Consulting Limited on behalf of Protea Holdings Ltd, in support of a planning application for the construction of a new swimming pool and ancillary facilities at Barnes Home Guard Association, 76A Richmond Park Road, London, SW14 8LA. This report assesses flood risk and surface water drainage for the proposed development.

7.2. The existing site is occupied by the Barnes Home Guard Association (BHGA) and is approximately 3305m^2 in size. The site is partially covered by impermeable surfacing of approximately 1210m^2, including approximately 336m^2 of existing built footprint. The remaining impermeable areas are predominately made up of concrete footpaths, parking spaces and a tarmac entrance drive. The existing site is therefore formed of approximately 36% impermeable surfaces.

7.3. A topographical survey has not been provided by the client however, 0.5m resolution LiDAR data is available for the site. This indicates that levels on site range between 13.00mAOD and 14.60mAOD, with the site sloping gently down from higher land in the south towards the centre north.

7.4. The proposed planning application is for construction of a new swimming pool with ancillary facilities in the south western corner of the site. Post development the total roof area of the swimming complex will cover approximately 237m^2.

7.5. The 1:50,000 BGS map shows the site to be located directly upon the bedrock of London Clay.

7.6. BGS mapping indicates that superficial deposits comprising Taplow Gravel Member and Head – Clay, Silt, Sand and Gravel underlie the site.

7.7. The soil type taken from the BGS UKSO Soil Map Viewer, shows a soil parent material of Deep Colluvium with a soil texture of Clayey Loam to Sandy Loam.

7.8. Nearby BGS borehole logs show that a resting groundwater level could be sited within 10m of the surface.

7.9. The published Environment Agency Groundwater Vulnerability map shows the site is not located within an area classified as a Groundwater Source Protection Zone.

7.10. There are no existing watercourses or rivers within a close proximity to the site.

7.11. Due to the site topography and distance to the nearest watercourse, the risk of fluvial and tidal flooding is considered to be very low.

7.12. The EA Risk of Flooding from Surface Water Map suggests that the majority of the site lies within an area of “Very Low” risk of flooding from surface water. A swathe of land, across the centre of the site, appears to be at “Low” risk of surface water flooding.

7.13. The main road that offers access to the site, Richmond Park Road, has been modelled at “Low” risk of surface water flooding. The rear gardens of Shrewsbury Avenue, adjacent north of the site, has been identified at “Medium” and “High” risk of surface water flooding according to the Environment Agency.

7.14. According to London Borough of Richmond upon Thames Surface Water Management Plan 2011 the site is located within a Critical Drainage Area (Group8_004).

7.15. Despite the site being situated within Flood Zone 1 and at “Low” risk of surface water flooding it is recommended that the finished internal floor level of the proposed building is set 150mm above adjacent ground levels.

7.16. Asset records obtained from Thames Water Utilities Ltd (TWU) indicate the presence of a 150mm diameter surface water sewer flowing from south to north beneath the north eastern periphery of the site, connecting to a 225mm sewer along Shrewsbury Avenue.

7.17. This surface water sewer is assumed to service the existing clubhouse building in the north east of the site.

7.18. Surface water generated within the existing site boundary is likely to currently discharge at an uncontrolled rate to ground and the existing sewer network.

7.19. Existing greenfield runoff rates for the total site have been calculated as 0.4 l/s for the 1:1 annual runoff event, 1.1 l/s for the 1:30 year event and 1.6 l/s for the 1:100 year event. Refer to calculations in Appendix.

7.20. However, the existing site is brownfield and covered by approximately 1210m^2 of impermeable surfacing, comprising the existing built footprint and hardstanding. The existing site is therefore approximately 36% impermeable surfaces. Runoff rates for the existing site (including the 36% impermeable coverage) have been calculated using MicroDrainage as 0.9 l/s for the 1:1 annual runoff event, 2.0 l/s for the 1:30 year event and 2.5 l/s for the 1:100 year event. Refer to calculations in Appendix.

7.21. Runoff from the proposed roof area will be collected and stored in an attenuation storage tank, located beneath the recreation field in the centre of the site.

7.22. From the attenuation storage tank, runoff will be gradually discharged existing surface water connection in the north east of the site (refer to Thames Water asset search in the report Appendix).

7.23. Outflow from the proposed drainage system (attenuation storage) to the surface water sewer will be limited to 1.6 l/s for all storms up to, and including, the 1:100 year + 40% climate change event via a hydrobrake. The hydrobrake will be installed in an inspection chamber within the site.

7.24. Given that the proposed swimming pool development is partially underlain by concrete hardstanding, a significant betterment will be provided post development through offering attenuation controlled discharge to the greenfield runoff rate (1.6l/s).

7.25. Preliminary calculations indicate that sufficient storage required to attenuate runoff from the proposed impermeable areas (237m^2) arising from the critical 1:100 year + 40% climate change event can be provided within an attenuation storage tank of dimensions 15m^2 x 0.6m deep.

7.26. Preliminary calculations indicated that some 7.4m^3 of storage is required to attenuate the runoff for all storms up to and including the 1:100 year + 40% climate change event.

7.27. The client may wish to utilise Rainwater Harvesting as part of the scheme. This has been factored into the report as an optional addition and does not require any additional space as shown within the Appendix.

7.28. Runoff from roof areas is considered to be uncontaminated thus does not warrant any form of treatment process to improve water quality, in accordance with *Ciria C753: The SuDS Manual*. Nevertheless, it is suggested to include debris / sediment traps on any new drainage.

7.29. Should the onsite drainage system fail under extreme rainfall events or blockage, the runoff flow can be managed through detailing the new external levels to direct water away from structures.

7.30. This drainage strategy has been undertaken in accordance with the principles set out in NPPF. We can conclude that providing the development adheres to the conditions advised above, the said development proposals can be accommodated without increasing flood risk within the locality in accordance with objectives set by Central Government and the EA.

Unda Consulting Limited

December 2018

8. Appendix

A - Plans by others:

- Site Plan – Buckland Pool and Building Company;
- Proposed Development Plan – Buckland Pool and Building Company.

B - Water Authority:

- Thames Water Asset Search.

C - Flood Data:

- EA Flood Zone Map.

D – Southwark Flood Risk Maps:

- London Borough of Richmond upon Thames Critical Drainage Areas;
- London Borough of Richmond upon Thames Areas at Susceptible to Flooding from Groundwater;
- London Borough of Richmond upon Thames Sewer Flood Incidents.

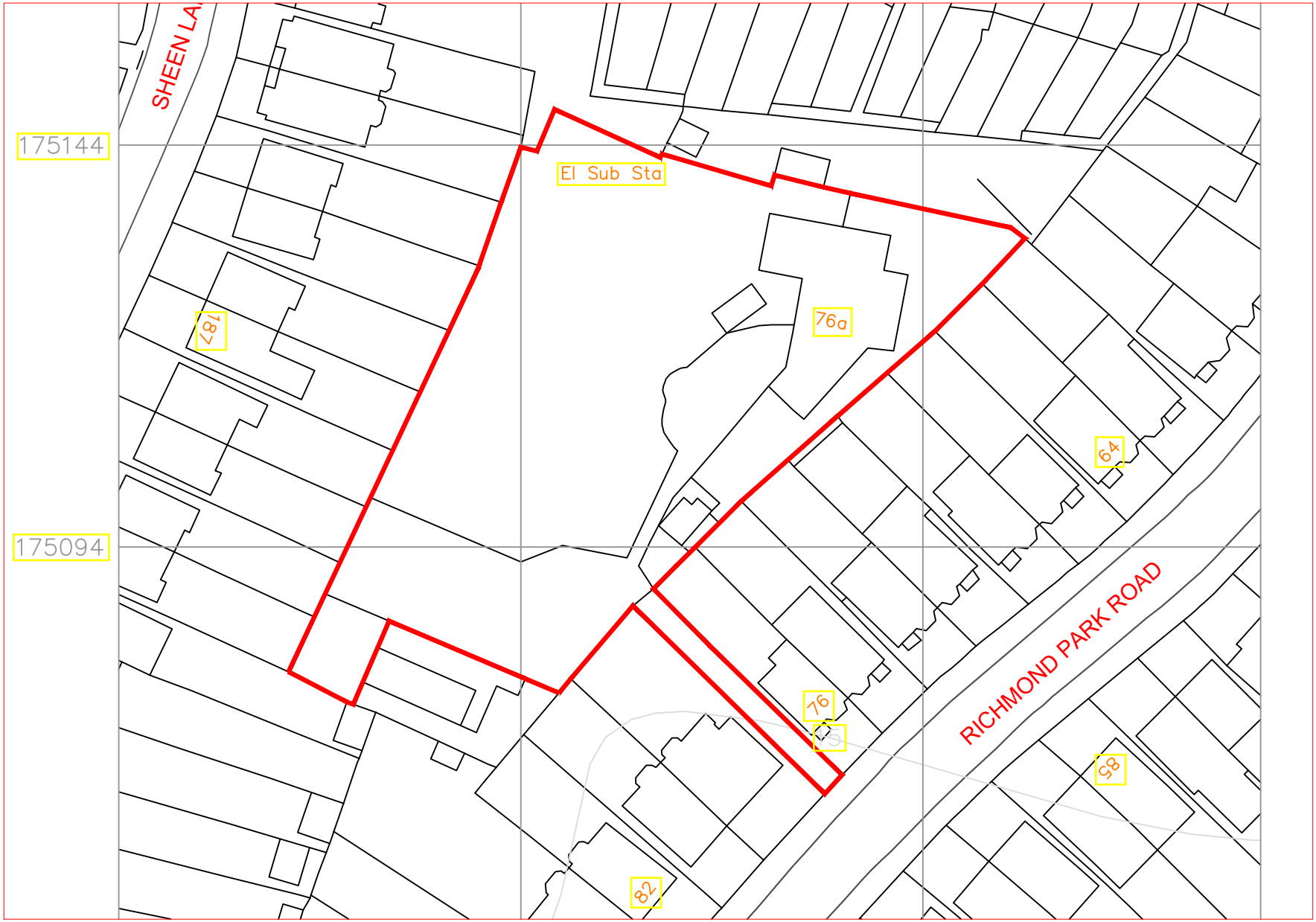
E - MicroDrainage Calculations:

- ICP SUDS Rural Runoff Calculations;
- ICP SUDS Urban Runoff Calculations;
- Attenuation Storage Calculations;
- Attenuation Storage and Rainwater Harvesting Product Specifications – RainWater Harvesting Ltd.

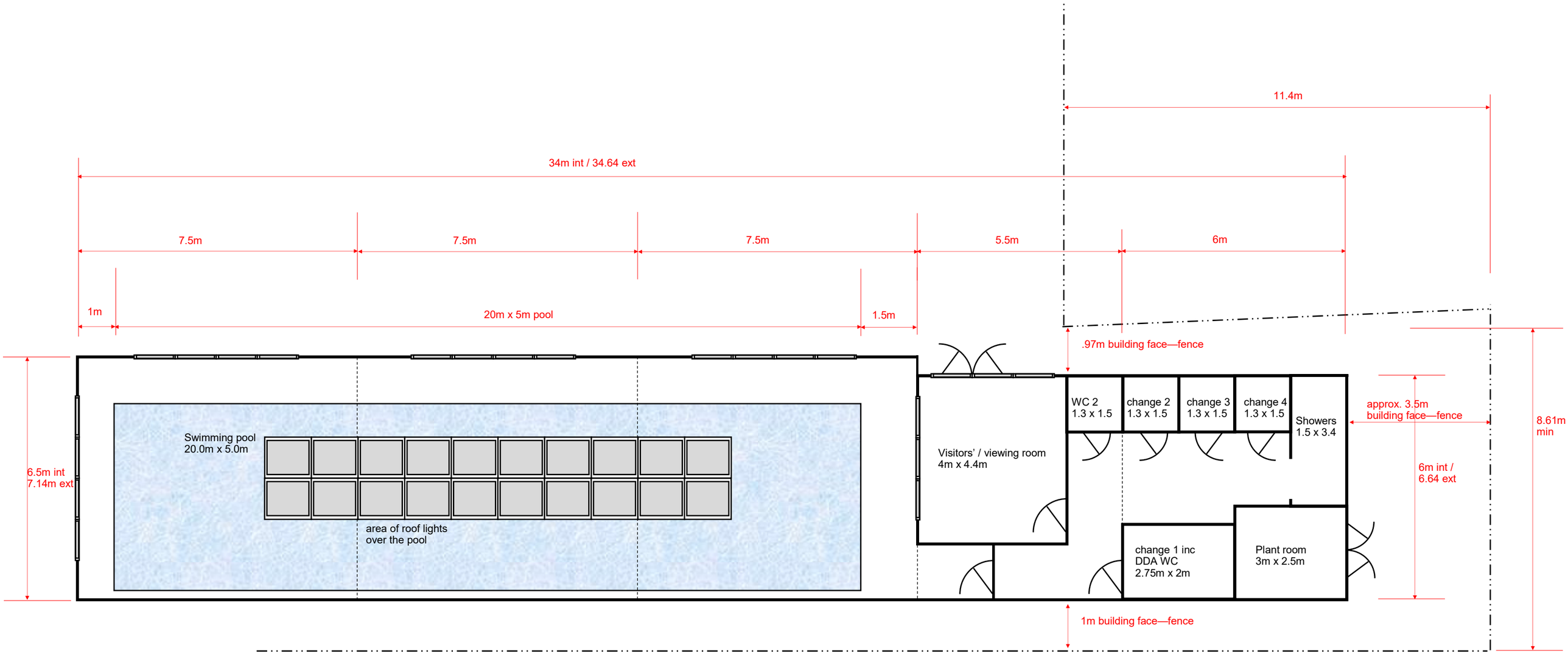
F - Plans:

- Proposed Drainage Layout.

Appendix A


SHEEN LA
175144
El Sub Sta
187
76a
64
175094
RICHMOND PARK ROAD
76
85
82

BUCKLAND POOL
& building company



Floor plan

Proposed swimming pool for Barnes Home Guard Association

1441.05, 11 Dec 2018

Appendix B

Asset location search

Property Searches

Unda Consulting Limited

GATWICK
RH11 0PR

Search address supplied

Barnes Home Guard Association
76a
Richmond Park Road
London
SW14 8LA

Your reference 88496

Our reference ALS/ALS Standard/2018_3923847

Search date 11 December 2018

Keeping you up-to-date

Notification of Price Changes

From 1 September 2018 Thames Water Property Searches will be increasing the price of its Asset Location Search in line with RPI at 3.23%.

For further details on the price increase please visit our website: www.thameswater-propertysearches.co.uk
Please note that any orders received with a higher payment prior to the 1 September 2018 will be non-refundable.

Thames Water Utilities Ltd
Property Searches, PO Box 3189, Slough SL1 4WW
DX 151280 Slough 13

searches@thameswater.co.uk
www.thameswater-propertysearches.co.uk

0845 070 9148

searchcode

Asset location search

Property Searches

Search address supplied: Barnes Home Guard Association, 76a, Richmond Park Road, London, SW14 8LA

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 searchprovides 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
Web: www.thameswater-propertysearches.co.uk

Waste Water Services

Please provide a copy extract from the public sewer map.

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 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.

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 0800 316 9800. The Customer Centre can also arrange for a full flow and

pressure test to be carried out for a fee.

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.

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: 0800 009 3921
Email: developer.services@thameswater.co.uk

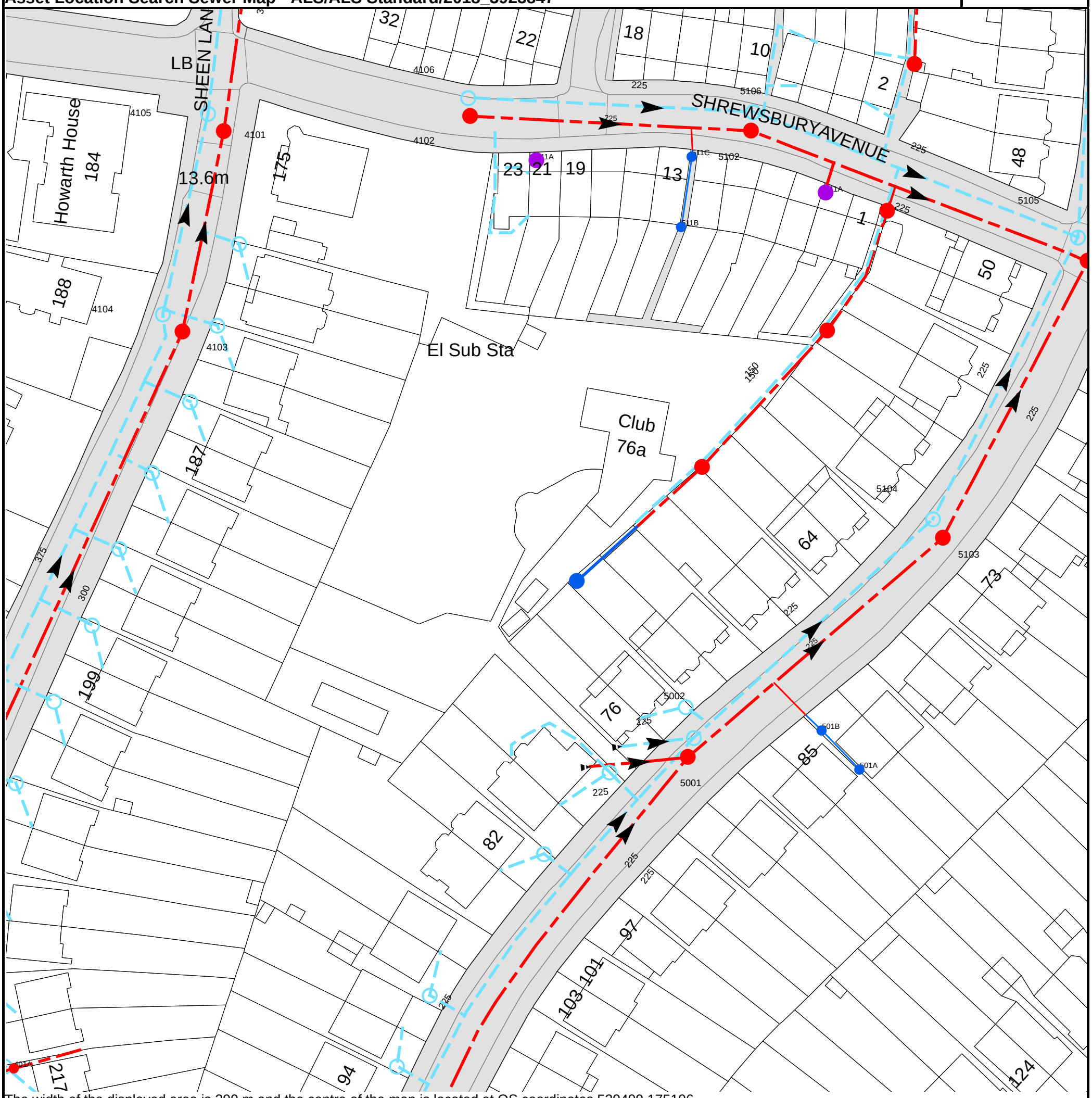
Clean Water queries

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: 0800 009 3921
Email: developer.services@thameswater.co.uk

Asset Location Search Sewer Map - ALS/ALS Standard/2018_3923847



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 520499,175106

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.

Based on the Ordnance Survey Map with the Sanction of the controller of H.M. Stationery Office, License no. 100019345 Crown Copyright Reserved.

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
40LN	n/a	n/a
40LK	n/a	n/a
41MN	n/a	n/a
41MK	n/a	n/a
4104	14.17	11.05
4103	14.19	10.76
41MF	n/a	n/a
4105	13.47	10.48
41MC	n/a	n/a
4101	13.48	10
41LL	n/a	n/a
4106	12.8	11.36
4102	12.8	10.84
411A	n/a	n/a
511B	n/a	n/a
511C	n/a	n/a
401A	n/a	n/a
30NJ	n/a	n/a
40MM	n/a	n/a
40ND	n/a	n/a
40NL	n/a	n/a
40MD	n/a	n/a
51NH	n/a	n/a
5102	12.95	10.32
5106	12.93	10.83
511A	n/a	n/a
51NF	n/a	n/a
51ND	n/a	n/a
51NM	n/a	n/a
5104	13.79	11.09
5103	13.77	10.53
5105	13.1	10.2
5101	13.07	9.75
50NK	n/a	n/a
501A	n/a	n/a
5001	12.86	11.57
5002	14.35	11.99
501B	n/a	n/a
50MC	n/a	n/a
51MH	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)

Foul: A sewer designed to convey waste water from domestic and industrial sources to a treatment works.

Surface Water: A sewer designed to convey surface water (e.g. rain water from roofs, yards and car parks) to rivers or watercourses.

Combined: 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

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

Gulley

Culverted Watercourse

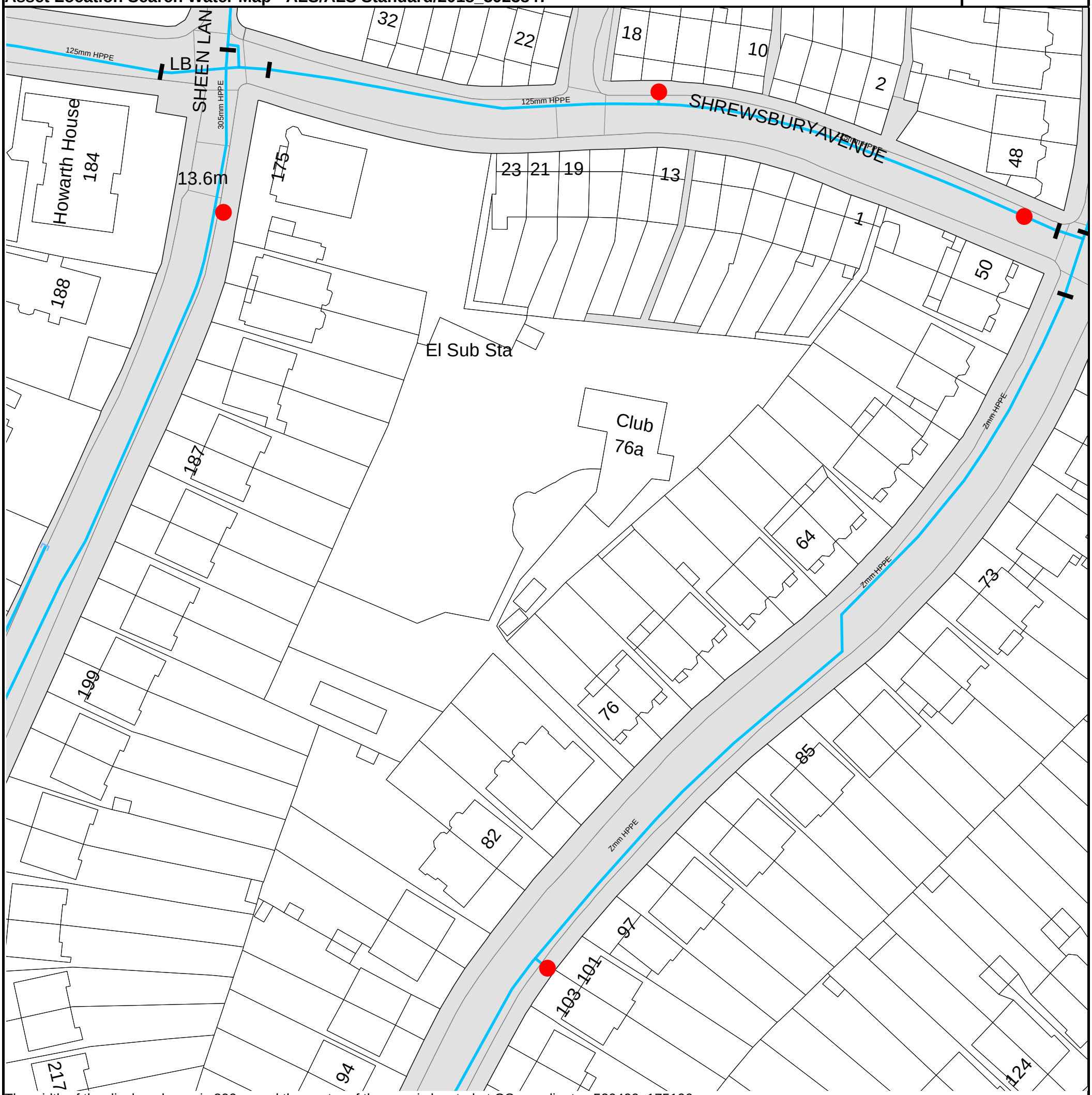
Proposed

Abandoned Sewer

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.
6) The text appearing alongside a sewer line indicates the internal diameter of the pipe in milimetres. 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.

Asset Location Search Water Map - ALS/ALS Standard/2018_3923847



The width of the displayed area is 200 m and the centre of the map is located at OS coordinates 520499, 175106.

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 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.

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

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')

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: Indiates 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.

Terms and Conditions

All sales are made in accordance with Thames Water Utilities Limited (TWUL) standard terms and conditions unless previously agreed in writing.

1. All goods remain in the property of Thames Water Utilities Ltd until full payment is received.
2. Provision of service will be in accordance with all legal requirements and published TWUL policies.
3. All invoices are strictly due for payment 14 days from due date of the invoice. Any other terms must be accepted/agreed in writing prior to provision of goods or service, or will be held to be invalid.
4. Thames Water does not accept post-dated cheques-any cheques received will be processed for payment on date of receipt.
5. In case of dispute TWUL`s terms and conditions shall apply.
6. Penalty interest may be invoked by TWUL in the event of unjustifiable payment delay. Interest charges will be in line with UK Statute Law 'The Late Payment of Commercial Debts (Interest) Act 1998'.
7. Interest will be charged in line with current Court Interest Charges, if legal action is taken.
8. A charge may be made at the discretion of the company for increased administration costs.

A copy of Thames Water's standard terms and conditions are available from the Commercial Billing Team (cashoperations@thameswater.co.uk).

We publish several Codes of Practice including a guaranteed standards scheme. You can obtain copies of these leaflets by calling us on 0800 316 9800

If you are unhappy with our service you can speak to your original goods or customer service provider. If you are not satisfied with the response, your complaint will be reviewed by the Customer Services Director. You can write to her at: Thames Water Utilities Ltd. PO Box 492, Swindon, SN38 8TU.

If the Goods or Services covered by this invoice falls under the regulation of the 1991 Water Industry Act, and you remain dissatisfied you can refer your complaint to Consumer Council for Water on 0121 345 1000 or write to them at Consumer Council for Water, 1st Floor, Victoria Square House, Victoria Square, Birmingham, B2 4AJ.

Ways to pay your bill

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

Thames Water Utilities Ltd Registered in England & Wales No. 2366661 Registered Office Clearwater Court, Vastern Rd, Reading, Berks, RG1 8DB.

Search Code

IMPORTANT CONSUMER PROTECTION INFORMATION

This search has been produced by Thames Water Property Searches, Clearwater Court, Vastern Road, Reading RG1 8DB, which is registered with the Property Codes Compliance Board (PCCB) as a subscriber to the Search Code. The PCCB independently monitors how registered search firms maintain compliance with the Code.

The Search Code:

- provides protection for homebuyers, sellers, estate agents, conveyancers and mortgage lenders who rely on the information included in property search reports undertaken by subscribers on residential and commercial property within the United Kingdom
- sets out minimum standards which firms compiling and selling search reports have to meet
- promotes the best practise and quality standards within the industry for the benefit of consumers and property professionals
- enables consumers and property professionals to have confidence in firms which subscribe to the code, their products and services.

By giving you this information, the search firm is confirming that they keep to the principles of the Code. This provides important protection for you.

The Code's core principles

Firms which subscribe to the Search Code will:

- display the Search Code logo prominently on their search reports
- act with integrity and carry out work with due skill, care and diligence
- at all times maintain adequate and appropriate insurance to protect consumers
- conduct business in an honest, fair and professional manner
- handle complaints speedily and fairly
- ensure that products and services comply with industry registration rules and standards and relevant laws
- monitor their compliance with the Code

Complaints

If you have a query or complaint about your search, you should raise it directly with the search firm, and if appropriate ask for any complaint to be considered under their formal internal complaints procedure. If you remain dissatisfied with the firm's final response, after your complaint has been formally considered, or if the firm has exceeded the response timescales, you may refer your complaint for consideration under The Property Ombudsman scheme (TPOs). The Ombudsman can award compensation of up to £5,000 to you if he finds that you have suffered actual loss as a result of your search provider failing to keep to the Code.

Please note that all queries or complaints regarding your search should be directed to your search provider in the first instance, not to TPOs or to the PCCB.

TPOs Contact Details

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

You can get more information about the PCCB from www.propertycodes.org.uk

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

Appendix C

Flood map for planning

Your reference	Location (easting/northing)	Created
88496	**520460/175091**	**13 Nov 2018 4:37**

Your selected location is in flood zone 1, an area with a low probability of flooding.

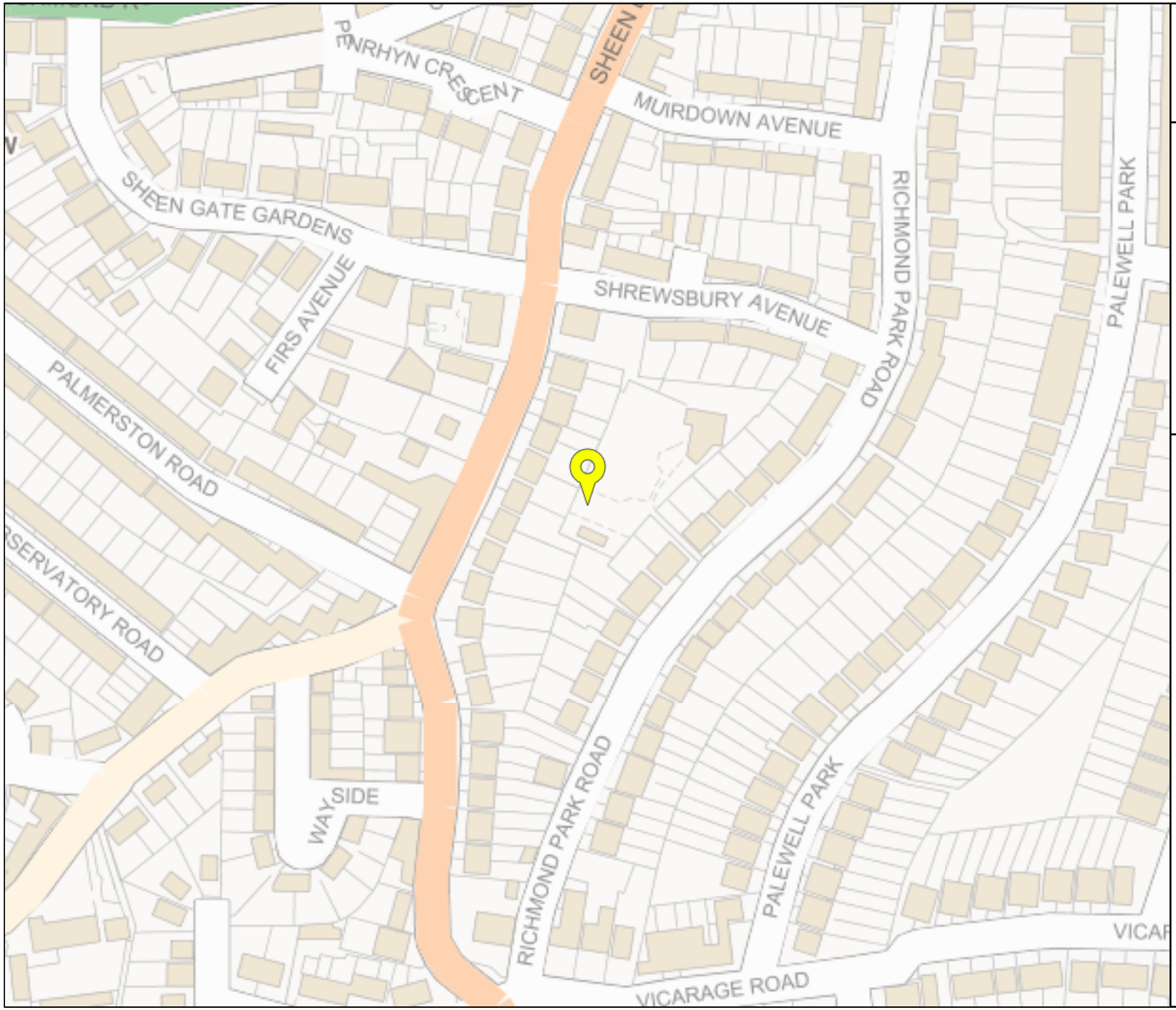
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
88496

Location (easting/northing)
520460/175091

Scale
1:2500

Created
13 Nov 2018 4:37

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

0 20 40 60m

Appendix D

NORTH

Group8_004

Group8_005

RICHMOND

North Sheen

Mortlake

East Sheen

Richmond Park
Deer Park

Golf Course

Petersham Common

East Sheen Common

The Bog

Teck Plantation

Two Storm Wood

Saw Pit Plantation

Sheen Cross Wood

Duke's Meadow

0 250 500m

- Borough Administrative Boundary
- Critical Drainage Area
- Permanent Water Body
- Main River
- Ordinary Watercourse
- Culverted Watercourse

Flood Depth

- <0.1m
- 0.1m to 0.25m
- 0.25m to 0.5m
- 0.5m to 1.0m
- 1.0m to 1.5m
- >1.5m

Notes

1. This map only shows the predicted likelihood of surface water flooding (this includes flooding from sewers, drains, small watercourses and ditches that occurs in heavy rainfall) for defined areas, and due to the coarse nature of the source data used, are not detailed enough to account for precise addresses.
2. Users of this map should refer to section 3.2 of the Surface Water Management Plan for a complete description of limitations and accuracy of the flood/hazard extents shown.
3. This map provides a strategic overview of surface water flood risk and may be subject to further analysis in the future.

London Borough of Richmond upon Thames

LONDON BOROUGH OF RICHMOND UPON THAMES

Surface Water Management Plan

Scale at A3	Date	Drawn by	Approved by
1:13,500	20/07/11	A.HARRIS	J.ROBINSON

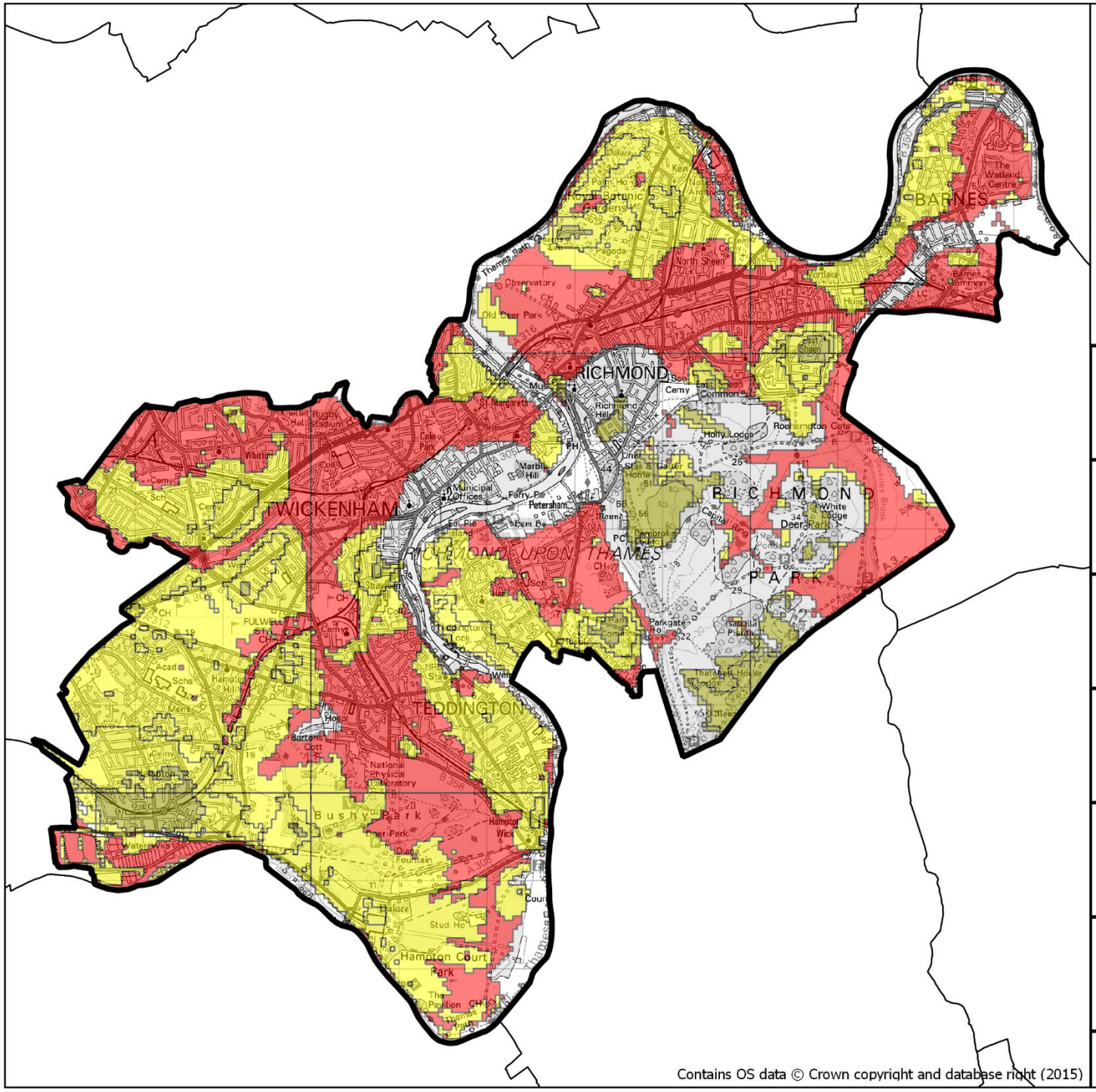
Gp8_004 Richmond Town Centre & Mortlake
Surface Water Depth (m)
1 in 100 Chance of rainfall event occuring in any given year (1% AEP)

Consultants
CAPITA SYMONDS
Scott Wilson
Flood Risk Management
URS / Scott Wilson
6 - 8 Greencoat Place
London
SW1P 1PL

Drain London Programme Board Members

Environment Agency · Thames Water · LONDON COUNCILS · GREATERLONDONAUTHORITY

FIGURE 3.8.4a



Legend

Borough Boundary

BGS Susceptibility to Groundwater Flooding

- Limited potential for groundwater flooding to occur
- Potential for groundwater flooding of property situated below ground level
- Potential for groundwater flooding to occur at surface

in association with

Environment Agency

Metis Consultants Limited

METIS

Client

LONDON BOROUGH OF RICHMOND UPON THAMES

Project Title

London Borough of Richmond Upon Thames Strategic Flood Risk Assessment Level 1

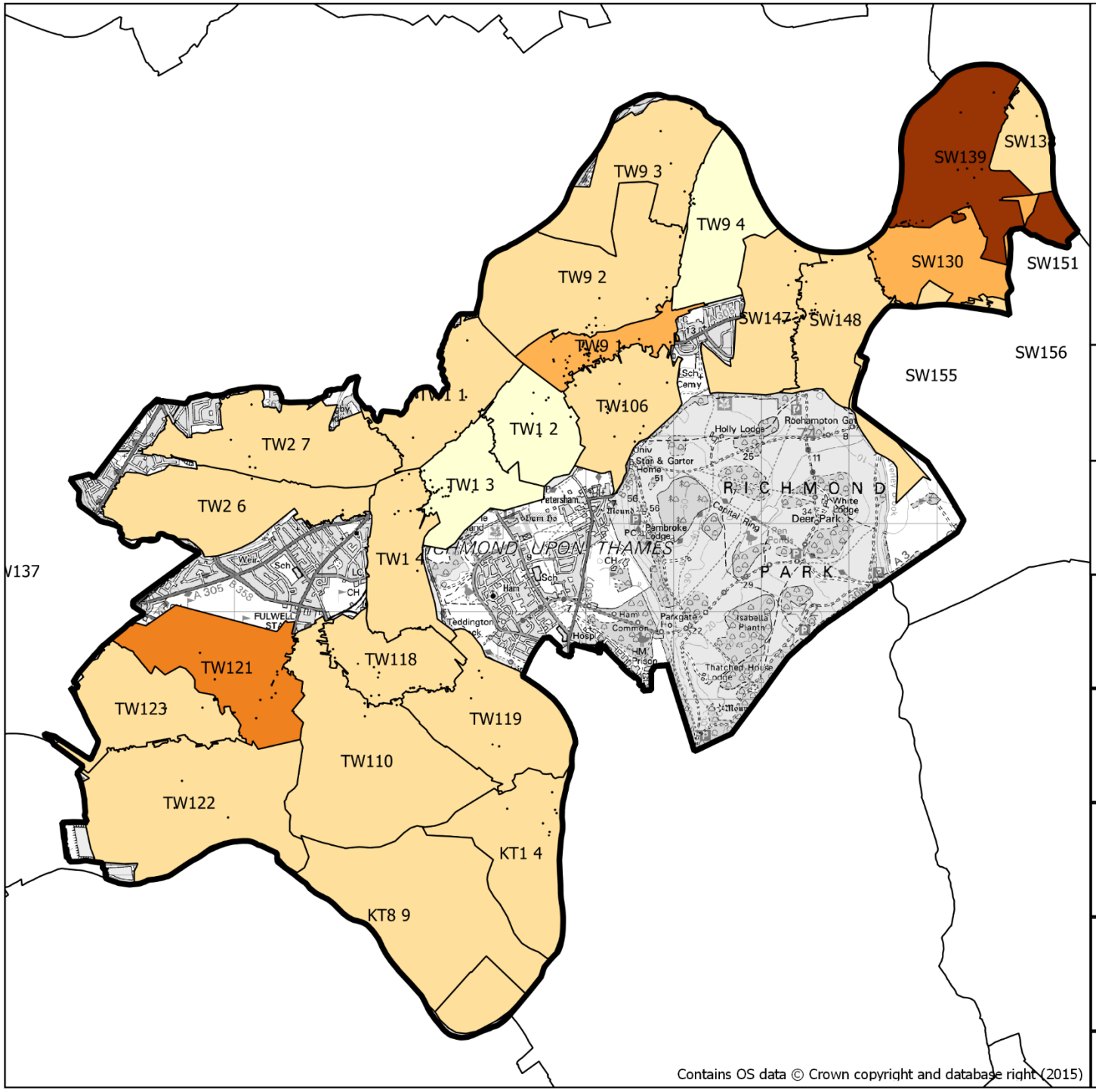
Drawing Title

BGS Susceptibility to Groundwater Flooding

Drawing Number

FIGURE E

1:65,000



Legend

Borough Boundary

Number of Sewer Flooding Incidents based on DG5 data

- 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20
- 21 - 25

in association with Thames Water

Metis Consultants Limited

Client: London Borough of Richmond Upon Thames

Project Title

London Borough of Richmond Upon Thames Strategic Flood Risk Assessment Level 1

Drawing Title

Sewer Flooding Incidents

Drawing Number: FIGURE I

1:65,000

Appendix E

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	0.331	Urban	0.000
SAAR (mm)	600	Region Number	Region 6

Results l/s

QBAR Rural	0.5
QBAR Urban	0.5
Q100 years	1.6
Q1 year	0.4
Q30 years	1.1
Q100 years	1.6

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.300
Area (ha)	0.331	Urban	0.360
SAAR (mm)	600	Region Number	Region 6

Results l/s

QBAR Rural	0.5
QBAR Urban	1.0
Q100 years	2.5
Q1 year	0.9
Q30 years	2.0
Q100 years	2.5

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

Half Drain Time : 43 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	12.974	0.374	0.0	1.6	1.6	5.3	Flood Risk
30 min Summer	13.039	0.439	0.0	1.6	1.6	6.3	Flood Risk
60 min Summer	13.051	0.451	0.0	1.6	1.6	6.4	Flood Risk
120 min Summer	13.013	0.413	0.0	1.6	1.6	5.9	Flood Risk
180 min Summer	12.958	0.358	0.0	1.6	1.6	5.1	Flood Risk
240 min Summer	12.897	0.297	0.0	1.6	1.6	4.2	O K
360 min Summer	12.801	0.201	0.0	1.6	1.6	2.9	O K
480 min Summer	12.739	0.139	0.0	1.6	1.6	2.0	O K
600 min Summer	12.704	0.104	0.0	1.6	1.6	1.5	O K
720 min Summer	12.686	0.086	0.0	1.5	1.5	1.2	O K
960 min Summer	12.669	0.069	0.0	1.2	1.2	1.0	O K
1440 min Summer	12.652	0.052	0.0	0.9	0.9	0.7	O K
2160 min Summer	12.642	0.042	0.0	0.7	0.7	0.6	O K
2880 min Summer	12.636	0.036	0.0	0.5	0.5	0.5	O K
4320 min Summer	12.630	0.030	0.0	0.4	0.4	0.4	O K
5760 min Summer	12.626	0.026	0.0	0.3	0.3	0.4	O K
7200 min Summer	12.624	0.024	0.0	0.2	0.2	0.3	O K
8640 min Summer	12.622	0.022	0.0	0.2	0.2	0.3	O K
10080 min Summer	12.620	0.020	0.0	0.2	0.2	0.3	O K
15 min Winter	13.025	0.425	0.0	1.6	1.6	6.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	141.688	0.0	6.4	17
30 min Summer	91.882	0.0	8.3	31
60 min Summer	56.713	0.0	10.2	48
120 min Summer	33.838	0.0	12.2	82
180 min Summer	24.703	0.0	13.3	118
240 min Summer	19.656	0.0	14.1	148
360 min Summer	14.176	0.0	15.3	206
480 min Summer	11.248	0.0	16.2	262
600 min Summer	9.394	0.0	16.9	316
720 min Summer	8.104	0.0	17.5	372
960 min Summer	6.416	0.0	18.5	492
1440 min Summer	4.610	0.0	19.9	734
2160 min Summer	3.308	0.0	21.4	1088
2880 min Summer	2.611	0.0	22.6	1464
4320 min Summer	1.869	0.0	24.2	2156
5760 min Summer	1.473	0.0	25.4	2872
7200 min Summer	1.224	0.0	26.4	3616
8640 min Summer	1.052	0.0	27.3	4360
10080 min Summer	0.925	0.0	28.0	5056
15 min Winter	141.688	0.0	7.1	17

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	13.102	0.502	0.0	1.6	1.6	7.2	Flood Risk
60 min Winter	13.116	0.516	0.0	1.6	1.6	7.4	Flood Risk
120 min Winter	13.062	0.462	0.0	1.6	1.6	6.6	Flood Risk
180 min Winter	12.982	0.382	0.0	1.6	1.6	5.4	Flood Risk
240 min Winter	12.884	0.284	0.0	1.6	1.6	4.0	O K
360 min Winter	12.749	0.149	0.0	1.6	1.6	2.1	O K
480 min Winter	12.691	0.091	0.0	1.5	1.5	1.3	O K
600 min Winter	12.675	0.075	0.0	1.3	1.3	1.1	O K
720 min Winter	12.664	0.064	0.0	1.1	1.1	0.9	O K
960 min Winter	12.653	0.053	0.0	0.9	0.9	0.7	O K
1440 min Winter	12.642	0.042	0.0	0.7	0.7	0.6	O K
2160 min Winter	12.634	0.034	0.0	0.5	0.5	0.5	O K
2880 min Winter	12.630	0.030	0.0	0.4	0.4	0.4	O K
4320 min Winter	12.625	0.025	0.0	0.3	0.3	0.4	O K
5760 min Winter	12.622	0.022	0.0	0.2	0.2	0.3	O K
7200 min Winter	12.620	0.020	0.0	0.2	0.2	0.3	O K
8640 min Winter	12.618	0.018	0.0	0.2	0.2	0.3	O K
10080 min Winter	12.617	0.017	0.0	0.1	0.1	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	91.882	0.0	9.3	30
60 min Winter	56.713	0.0	11.4	50
120 min Winter	33.838	0.0	13.6	90
180 min Winter	24.703	0.0	14.9	128
240 min Winter	19.656	0.0	15.8	158
360 min Winter	14.176	0.0	17.1	212
480 min Winter	11.248	0.0	18.1	256
600 min Winter	9.394	0.0	18.9	314
720 min Winter	8.104	0.0	19.6	376
960 min Winter	6.416	0.0	20.7	490
1440 min Winter	4.610	0.0	22.3	734
2160 min Winter	3.308	0.0	24.0	1096
2880 min Winter	2.611	0.0	25.3	1416
4320 min Winter	1.869	0.0	27.1	2148
5760 min Winter	1.473	0.0	28.5	2856
7200 min Winter	1.224	0.0	29.6	3608
8640 min Winter	1.052	0.0	30.5	4288
10080 min Winter	0.925	0.0	31.3	5040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.430	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.024

Time (mins) From:	To:	Area (ha)
0	4	0.024

Model Details

Storage is Online Cover Level (m) 13.200

Cellular Storage Structure

Invert Level (m) 12.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	15.0	15.0	0.700	0.0	15.0
0.600	15.0	15.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SCL-0062-1600-0600-1600
Design Head (m)	0.600
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	12.600
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	1.6
Flush-Flo™	0.148	1.6
Kick-Flo®	0.360	1.3
Mean Flow over Head Range	-	1.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.6	1.400	2.3	3.500	3.6	7.500	5.1
0.300	1.5	1.600	2.5	4.000	3.8	8.000	5.3
0.400	1.3	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.5	2.000	2.8	5.000	4.2	9.000	5.6
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.8
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.8		

Quotation for the supply of Rainwater Harvesting Equipment

Client :

Thomas Smith
Unda Consulting Limited

Site Reference :

Combined Rain Activ for
Barnes Home Guard Association
76a Richmond Park Road, London. SW14 8LA

Prepared by:

Ian Woodcock

ianw@rainwaterharvesting.co.uk

01733 405104 / 07736 45 46 45

Our reference : IMW229083

Date of proposal : 14/12/2018

Your Proposal

Thank you for your email and time on the telephone yesterday and as requested please find the following information regarding our proposed system.

SHALLOW DIG F-LINE TANK	7500
Weight Kg	310
Length	3340
Width	2310
Overall Height	1415 - 1815
Ground to Invert VS60 (Pedestrian 635mm Shaft)	310 - 710
Minimum Attenuation Capacity	8100
Invert to Outlet	**591**

EXCAVATION	15000 (2 x 7500 side by side)
Length	3740
Width	5520
Overall height VS60	1515 - 1915

Overall height allows for 100mm compacted aggregate

The overall height difference above is because up to 400 mm can be cut off of the 635 mm shaft on site so as to achieve your exact invert level.

Option 1 Below = SuDS Only System
Option 2 Below = Combined SuDS & Direct pumped harvesting system

If the tanks are to be in an area where vehicles will drive over them please add £300.00 ex vat to the prices quoted below as we will have to upgrade the tank shaft and lid.

Please see Drainage Calculation Summary on page 11

Rainwater Harvesting Limited is a private family owned company, our strong service ethos has been built on many years of experience and this is reflected in our ability to offer both simple to install rainwater harvesting systems and mix and match components to provide bespoke solutions reflecting clients needs. At our 100,000sq ft warehouse in Peterborough we hold over 3000 stock items, we are the largest stockholder of the Shallow Dig Rewatec tanks in the UK and we regularly despatch to site complete rainwater harvesting systems within 5-7 days of order, we also provide full technical support on all our products.

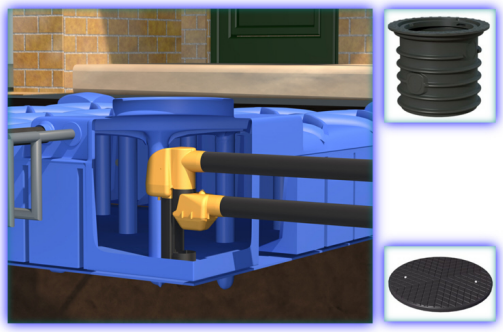
We would welcome the opportunity of supplying your rainwater harvesting system and I can easily be contacted either by phone or email as shown on the previous page.

Components and Prices – Supply Only

Option 1

Product Code **: RWH15000FL-RA**

15,000 Litre Rain Activ Attenuation System



Components

Product Code	Description	Qty
RWFT7500	F-LINE 7500L TANK	2
RWDS0062	F-LINE TANK 635mm EXTENSION SHAFT - VS60	2
RWDS0066	F-LINE TANK WALK ON LID	2
GF-332033	DN100 SEALS FOR TANK CONNECTION	2
RWH-RV01	RAINVANTAGE FILTER KIT INC SIPHON & OVERFLOW	1
RWH-RA02	**RAIN ACTIV SUDS COMPONENT PRE FITTED ALLOWING FOR A MINIMUM OF 8100 LITRES WORTH OF ATTENUATION AND A CONTROLLED DISCHARGE RATE OF 1.5 LITRES PER SECOND**	1
RWH-RA01	MICRO DRAINAGE CALCULATIONS	1

Price : £4,900.00 (£5,880.00 Inc. VAT)

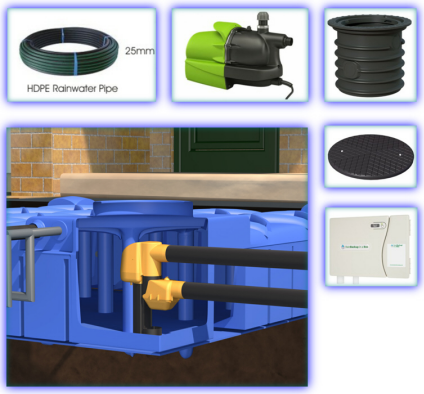
UK delivery is included in the price (Highlands and islands extra)

Components and Prices – Supply Only

Option 2

Product Code **: RWH15000FL-RA**

15,000 Litre Combined Rainwater Harvesting & Rain Activ Controlled Attenuation System



Components

Product Code	Description	Qty
RWFT7500	F-LINE 7500L TANK	2
RWDS0062	F-LINE TANK 635mm EXTENSION SHAFT - VS60	2
RWDS0066	F-LINE TANK WALK ON LID	2
GF-332033	DN100 SEALS FOR TANK CONNECTION	2
RWH-RV01	RAINVANTAGE FILTER KIT INC SIPHON & OVERFLOW	1
RWH-RA02	**RAIN ACTIV SUDS COMPONENT PRE FITTED ALLOWING FOR 6900 LITRES OF RAINWATER HARVESTING FOR RE-USE AND A MINIMUM OF 8100 LITRES WORTH OF ATTENUATION WITH A CONTROLLED DISCHARGE RATE OF 1.5 LITRES PER SECOND**	1
RWH-RA01	MICRO DRAINAGE CALCULATIONS	1
RWH-HYD03FL	HYDROFORCE SERIES 3 PUMP / INC STRAINER	1
RWH-BUB02	RAIN BACKUP IN A BOX / SD	1
RWH-HDPE25/25	25mm HDPE RAINWATER PIPE - 25m ROLL	1
RWH-PKFLINE-STD	FLINE INSTALLATION PACK STANDARD / INC LABELS & 90° ELBOW	1

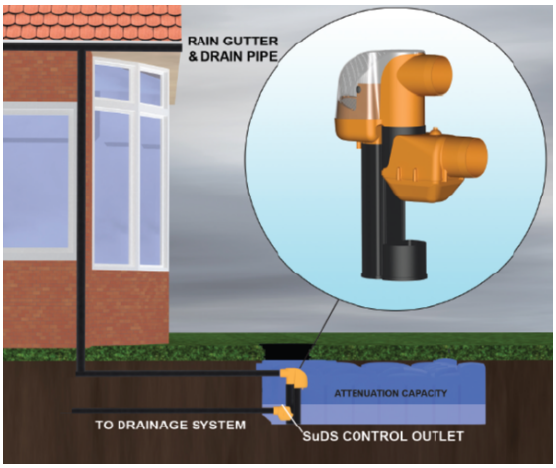
Price : £5,250.00 (£6,300.00 Inc. VAT)

UK delivery is included in the price (Highlands and islands extra)

Rain Activ SuDS Solution

Rain Activ is a totally new concept within the storm attenuation market. Utilising shallow dig underground water tanks as well as a filtration and controlled discharge module.

Rain Activ collects water from the roof and removes debris via a self-cleaning filter. Once inside the tank, the clean water is attenuated and discharged slowly at a calculated rate through an orifice.



- Ultra-low discharge SuDS system.
- Peak discharge rates as low as 0.05 L/sec per property.
- Primary solution reduces secondary SuDS infrastructure and costs.
- Each system individually calibrated to site requirement.
- Can be used in combination with Rainwater Harvesting.

Rain Activ is ideal for sites where low rates of storm water discharge are required. With peak discharge rates as low as 0.05 L/sec, the system provides a solution for applications where flow is typically not sufficient for vortex flow control systems.

By collecting and slowing the water at source, the scale and cost of secondary SuDS infrastructure such as balancing ponds and geocellular storage can be heavily reduced. For many developments this can increase the available land for development.

Where applicable, Rain Activ can be used in conjunction with Rainwater Harvesting by simply adding a pump and management system.

Mains backup and rainwater management

Direct feed with simple, 12v automatic float switch & solenoid valve for mains water backup

Most often used on a direct feed system, the automatic electrically-actuated solenoid valve (or tap) admits some mains water into the rainwater storage tank as a simple means of maintaining water flow to toilets and washing machine fed by a rainwater harvesting system. This method is sometimes referred to as a trickle-feed mains backup.

a) Filtered rainwater flows as normal to the tank

b) The home is plumbed with a separate pipe network for toilets and washing machine.

c) When there is rainwater in the tank the pump supplies rain water to the toilets and washing machine. The principle is the same whether the pump is indoors or submerged in the tank.

d) The pump is a pressure sensitive type or fitted with a pressure-sensitive switch which turns off when water is not being used in the house.

e) When the tank is nearly empty a float switch turns ON a mains-powered solenoid valve which allows some mains water to flow into the rainwater tank.

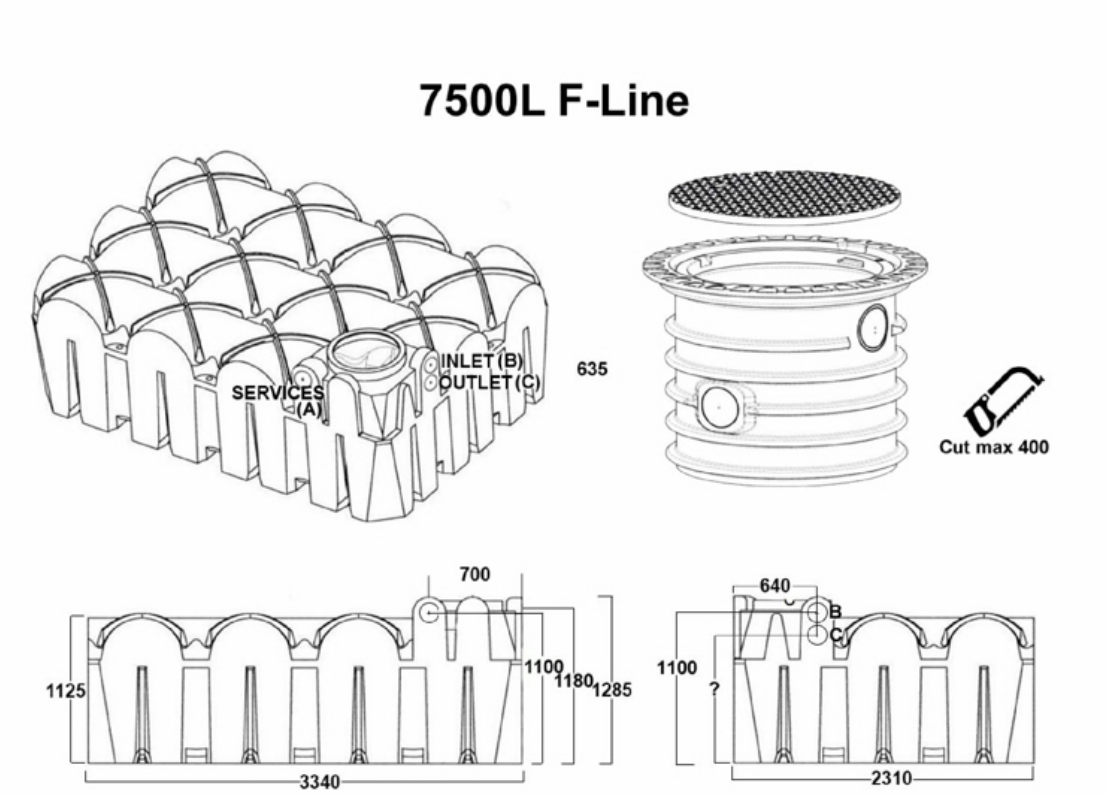
f) The provision of a “Air Gap” is a regulation requirement. This i) provides a visible warning of water flow if the valve sticks open and ii) prevents any possibility of rain water flowing into the mains (drinking) water. After a few moments the floating switch turns the solenoid valve OFF.

g) Although this simple mains backup can be criticised by some for admitting mains water back into the rainwater tank, it should be pointed out that the tank remains largely empty and can receive new rain water from a downpour at any time.

h) This is sometimes referred to as “trickle feed” because the tank does not get filled up with water; the level is simply lifted to the level (about 10 cms) where the inlet of the pump can draw water when next called upon.

i) There is no risk of rainwater being drawn into the mains water supply so there is no risk of breaching building regulations in this respect.

j) To ease the installation of a variety of components and rather complex wiring, RainWaterHarvesting.co.uk introduced in early 2009 the Rain Backup in a Box® which replaced the higgle piggle of components with a single wall mounted unit, one 12v electric plug to a wall socket, mains water input and a pipe to the underground storage tank. This is supplied as a default with “standard” DUK-2 kits.



15,000 is achieved by linking 2 x 7500 tanks using the DN100 seals supplied

Recommended Rainwater Pipe

Rainwater Pipe in HDPE (High Density Polyethylene) for rainwater use as recommended by Water Authorities is available as an option for all tanks and systems. Black with 4 green stripes and available in both 25mm and 32mm diameter. High quality HDPE.

RainWater Harvesting Limited has worked with the UK Rainwater Harvesting Association and listened to WRAS and several of the water companies, to bring to the market the pipe marked with four green stripes. The identification helps maintenance staff and the end user, after installation, to know which pipes on site carry rainwater (which is non-potable in the UK Building Regs). We stock the following two sizes preferred by contractors fitting rainwater systems.

25mm diameter,
flexible, in 25 or 50m coils
Product ID: RWH-HDPE25/25

Ship weight of one 25m coil: 4.3 kg

32mm diameter,
flexible, in 25 or 50m coils
Product ID: RWH-HDPE32/25

Ship weight of one 25m coil: 5.5 kg

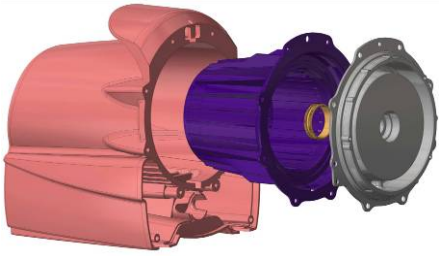
Other sizes available upon request

The **Series 3** water pump from HydroForce Pumps Ltd.

The Series 3 pump has been engineered by HydroForce Pumps Ltd in Peterborough to respond to the demand for the highest quality pump for use underwater in rainwater harvesting tanks. Using the most rugged components it has been exhaustively tested for trouble-free running. The pump features a self-controlling pressure switch and dry run protection. It is suitable for total immersion in rainwater or it can be externally connected to the tank above ground. The Series 3 will deliver up to 3.5 bar (household pressure is around 2.5-4.0 bar). If connected to a hose or tap, the pump will automatically start to pump water when the tap or hose is turned on. The pump delivers over 2500 litres per hour using a 1" connector and runs at 230v AC delivered by a 10 metre cable.

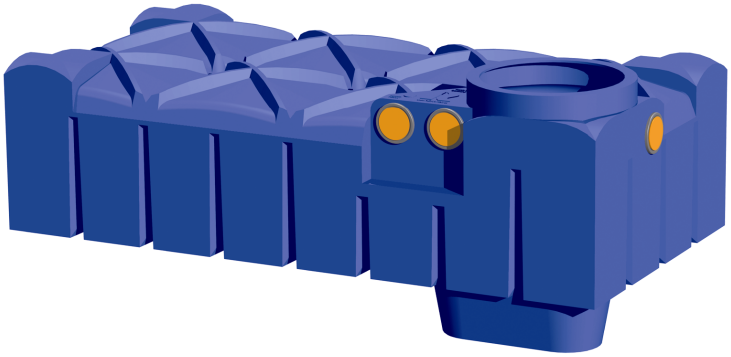
Specifications

- Submersible: for underwater use in a rainwater tank, or can be used above ground
- Extended two year guarantee
- Nominal pump pressure at outlet 3.5 bar
- Max head 35 metres
- Pressure-sensitive (demand) pump: turns itself off until there is demand for water
- Dry-run Protection: when no water is detected for 8 seconds, the pump is turned off in order to protect the motor and pump from burning out. Automatic reset after a period of 30 minutes.
- Radial flow centrifugal roto-dynamic pump with no reciprocating parts
- **New:** Alloy bulkhead, pressure release gap and twin chamber design prevents ingress of water to motor, electrical components and to bearing oil.
- **New:** Double bearing seal prevents egress of bearing oil.
- **New:** Alloy bulkhead dissipates motor heat to water in the second chamber.
- **New:** Logic processors in Series 3 printed circuit board prevent other pump anomalies and permit factory programming of reset timings.



- **New:** Each pump is tested before leaving our factory. Factory measurements are on record for each individual pump. No user-serviceable parts
- Electricity consumption 800 watts at 230 Volts AC 50 Hz (requires 10 or 13 amp fuse and RCD mains socket). Connection cable 10m H07RN-F.
- Dimensions L 565 W 185 H 260 mm, weight 12 kg
- Max suction 8 metres deep, preferable operating regime 4 metres deep
- Inlet port to the non-removable cartridge filter 1 inch (25mm) female BSP
- Outlet port 1 inch (25mm) female BSP provided with push-fit connector for 1 inch (25mm) MDPE pipe.
- Supplied with an inline filter, 1" intake strainer and 1" outlet connection.

F-Line Flat Tank shallow dig underground tank



Why buy this tank?

- The F-Line is a high quality, rotationally moulded, one piece rainwater tank that can be installed without the need for concrete, thereby minimising installation costs and supported by our long term 25 year tank guarantee.
- Minimal installation depth
- Easy and quick to install
- Small excavation pit and little earth excavation preserves your garden
- Ideal for installation in new or existing properties
- Can be installed in ground water up to tank shoulder
- Easy to install

The F-line flat tank can be installed into much higher water tables than a standard round tank. If you don't know what your water table will be like in the winter, you're safer to install a flat tank. The F-Line tanks are flat and the installation depth is up to 60% less than other rainwater tanks. The excavation can be up to 70% less, meaning little earth excavation, easy handling and less cost for you! The small excavation pit is easily filled in and your garden will look just like it did before.

Drainage Calculation Summary

The calculations below have been based on the following criteria:

1:100 Year Storm Event

40% Climate Change

Geographical Location; Barnes Home Guard Association – 76a Richmond Park Road, London. SW14 8LA

Total impermeable area = 237 sqm

We have run the Micro Drainage Calculations (see pages below) and designed a system as follows;

- 15000L tank with a 25 mm orifice, providing 8100 litres of attenuation with a peak discharge of 1.5 l/s and if required a further 6900 litres of Rainwater Harvesting for re-use for toilet flushing, external irrigation etc.

- The highest stress put on the system was during the 1:100 year (+40%), 60 minute winter storm.

- Various other events were trailed; (38 in total) all at or below a peak discharge of 1.5 l/s

The reason we can use a very small orifice (between 5-50mm) without risk of blockage is because;

- High quality pre filtration, removing any particles larger than 1000 micron. *(So nothing larger than 1mm can enter the tank.)*
- The filter is self cleaning but does require an annual check for any major debris. As detailed in the maintenance guide.
- The orifice and filter have been developed for simple auditing. (Remove the manhole and look directly below to check for blockage.)

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	0.380	0.380	1.3	0.0	1.3	5.5	O K
30 min Summer	0.455	0.455	1.4	0.0	1.4	6.6	O K
60 min Summer	0.490	0.490	1.4	0.0	1.4	7.2	O K
120 min Summer	0.487	0.487	1.4	0.0	1.4	7.1	O K
180 min Summer	0.459	0.459	1.4	0.0	1.4	6.7	O K
240 min Summer	0.427	0.427	1.3	0.0	1.3	6.2	O K
360 min Summer	0.369	0.369	1.2	0.0	1.2	5.4	O K
480 min Summer	0.323	0.323	1.2	0.0	1.2	4.7	O K
600 min Summer	0.285	0.285	1.1	0.0	1.1	4.2	O K
720 min Summer	0.254	0.254	1.0	0.0	1.0	3.7	O K
960 min Summer	0.205	0.205	0.9	0.0	0.9	3.0	O K
1440 min Summer	0.144	0.144	0.7	0.0	0.7	2.1	O K
2160 min Summer	0.095	0.095	0.6	0.0	0.6	1.4	O K
2880 min Summer	0.070	0.070	0.5	0.0	0.5	1.0	O K
4320 min Summer	0.045	0.045	0.4	0.0	0.4	0.7	O K
5760 min Summer	0.034	0.034	0.3	0.0	0.3	0.5	O K
7200 min Summer	0.030	0.030	0.2	0.0	0.2	0.4	O K
8640 min Summer	0.027	0.027	0.2	0.0	0.2	0.4	O K
10080 min Summer	0.025	0.025	0.2	0.0	0.2	0.4	O K
15 min Winter	0.428	0.428	1.3	0.0	1.3	6.3	O K
30 min Winter	0.517	0.517	1.5	0.0	1.5	7.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	140.294	0.0	6.3	0.0	17
30 min Summer	91.420	0.0	8.2	0.0	31
60 min Summer	56.713	0.0	10.2	0.0	48
120 min Summer	33.998	0.0	12.2	0.0	82
180 min Summer	24.878	0.0	13.4	0.0	116
240 min Summer	19.821	0.0	14.3	0.0	150
360 min Summer	14.335	0.0	15.5	0.0	216
480 min Summer	11.393	0.0	16.4	0.0	280
600 min Summer	9.527	0.0	17.1	0.0	342
720 min Summer	8.228	0.0	17.8	0.0	404
960 min Summer	6.525	0.0	18.8	0.0	522
1440 min Summer	4.699	0.0	20.3	0.0	764
2160 min Summer	3.378	0.0	21.9	0.0	1124
2880 min Summer	2.671	0.0	23.1	0.0	1472
4320 min Summer	1.916	0.0	24.8	0.0	2204
5760 min Summer	1.512	0.0	26.1	0.0	2928
7200 min Summer	1.257	0.0	27.2	0.0	3656
8640 min Summer	1.082	0.0	28.0	0.0	4288
10080 min Summer	0.952	0.0	28.8	0.0	5104
15 min Winter	140.294	0.0	7.1	0.0	17
30 min Winter	91.420	0.0	9.2	0.0	30

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
60 min Winter	0.556	0.556	1.5	0.0	1.5	8.1	O K
120 min Winter	0.543	0.543	1.5	0.0	1.5	7.9	O K
180 min Winter	0.500	0.500	1.4	0.0	1.4	7.3	O K
240 min Winter	0.453	0.453	1.4	0.0	1.4	6.6	O K
360 min Winter	0.371	0.371	1.2	0.0	1.2	5.4	O K
480 min Winter	0.308	0.308	1.1	0.0	1.1	4.5	O K
600 min Winter	0.260	0.260	1.0	0.0	1.0	3.8	O K
720 min Winter	0.221	0.221	0.9	0.0	0.9	3.2	O K
960 min Winter	0.166	0.166	0.8	0.0	0.8	2.4	O K
1440 min Winter	0.105	0.105	0.6	0.0	0.6	1.5	O K
2160 min Winter	0.064	0.064	0.5	0.0	0.5	0.9	O K
2880 min Winter	0.045	0.045	0.4	0.0	0.4	0.7	O K
4320 min Winter	0.032	0.032	0.3	0.0	0.3	0.5	O K
5760 min Winter	0.028	0.028	0.2	0.0	0.2	0.4	O K
7200 min Winter	0.025	0.025	0.2	0.0	0.2	0.4	O K
8640 min Winter	0.022	0.022	0.2	0.0	0.2	0.3	O K
10080 min Winter	0.021	0.021	0.1	0.0	0.1	0.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
60 min Winter	56.713	0.0	11.4	0.0	50
120 min Winter	33.998	0.0	13.7	0.0	88
180 min Winter	24.878	0.0	15.0	0.0	126
240 min Winter	19.821	0.0	16.0	0.0	160
360 min Winter	14.335	0.0	17.3	0.0	228
480 min Winter	11.393	0.0	18.4	0.0	294
600 min Winter	9.527	0.0	19.2	0.0	356
720 min Winter	8.228	0.0	19.9	0.0	418
960 min Winter	6.525	0.0	21.0	0.0	538
1440 min Winter	4.699	0.0	22.7	0.0	778
2160 min Winter	3.378	0.0	24.5	0.0	1124
2880 min Winter	2.671	0.0	25.8	0.0	1472
4320 min Winter	1.916	0.0	27.8	0.0	2168
5760 min Winter	1.512	0.0	29.3	0.0	2920
7200 min Winter	1.257	0.0	30.4	0.0	3656
8640 min Winter	1.082	0.0	31.4	0.0	4256
10080 min Winter	0.952	0.0	32.2	0.0	4984

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.418	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.024

Time (mins) From:	To:	Area (ha)
0	4	0.024

Model Details

Storage is Online Cover Level (m) 1.000

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	14.6	0.825	14.6	0.826	0.0

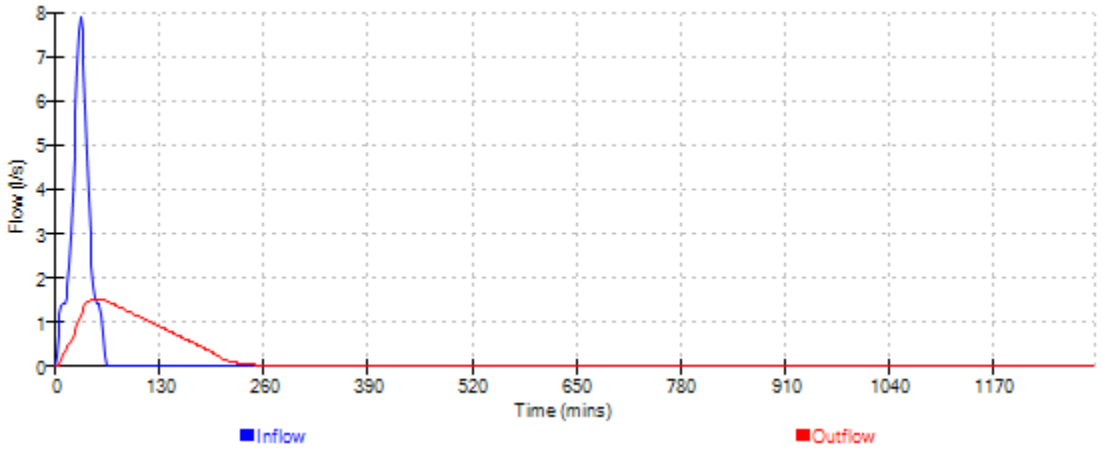
Orifice Outflow Control

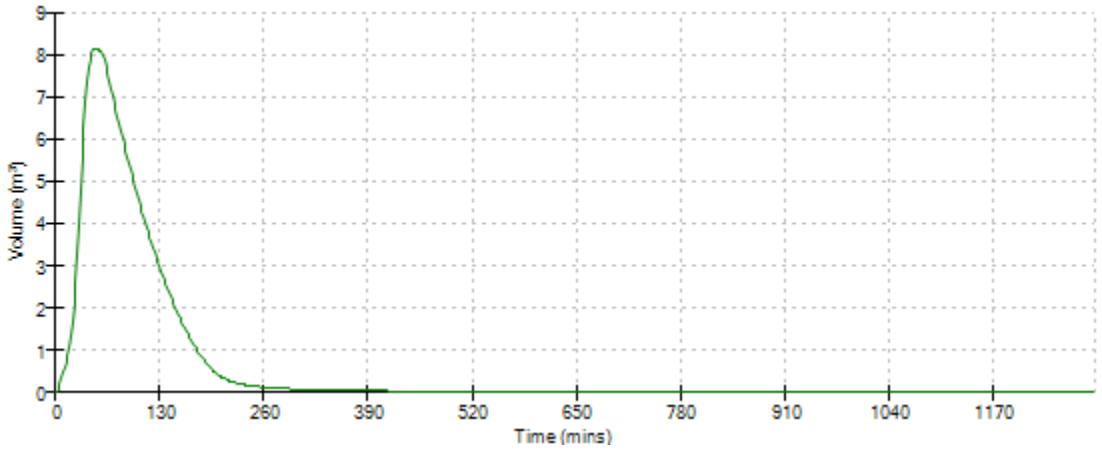
Diameter (m) 0.025 Discharge Coefficient 0.950 Invert Level (m) 0.000

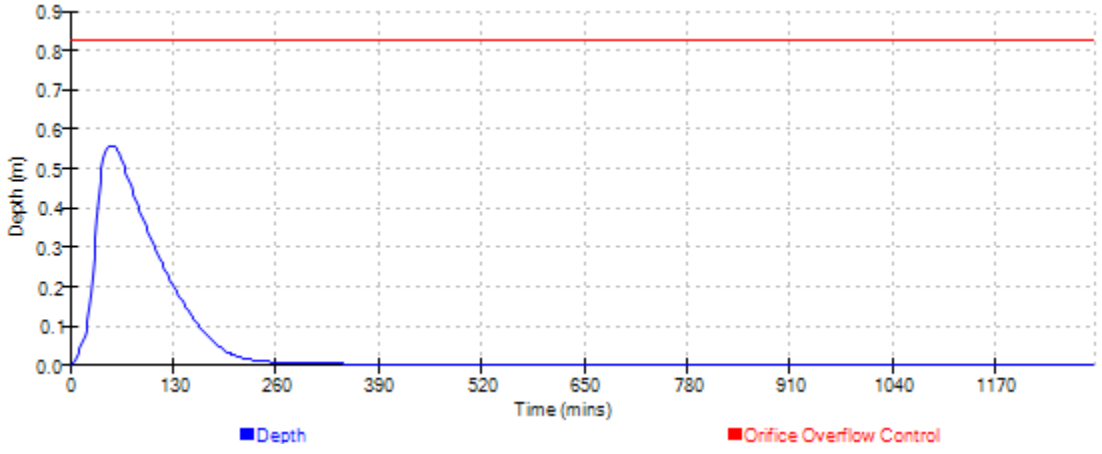
Orifice Overflow Control

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 0.824

Event: 60 min Winter



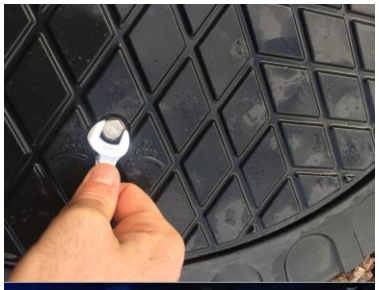




Rain Activ maintenance schedule.

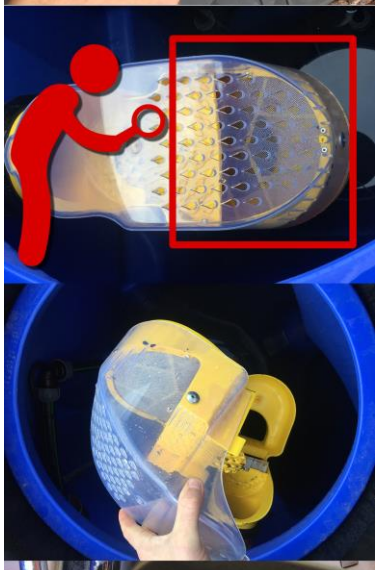
Filter: *Warranty 2 years. Expected service life 100 years.*

Self cleaning filter with 1000 micron screen.



Every 6 months. Visually check the filter for larger blockages.

1. Release child locks on the lid. (13mm bolt).



2. Inspect filter for visible large blockage.
If large or non moving debris is found refer to stage 3. Is none is found refer to stage 6.

NB: Small debris will we periodically self cleaned during storms. Leaves, moss and other smaller debris will self clean and do not require removing unless obvious they are causing a blockage.

3. (If a blockage has been found) Remove filter lid.

4. Remove debris, wash filter head under a tap.

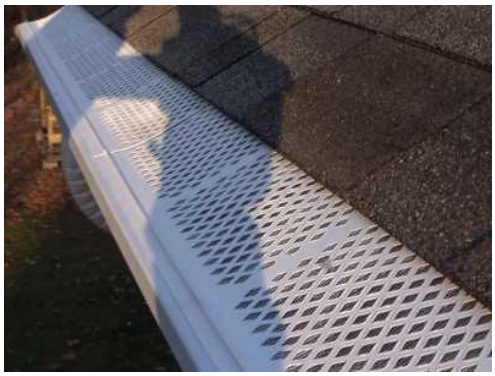
5. Replace filter head.

6. Replace lid, ensure 13mm child safe locks are tight.

Risk if neglected: Very low, possible reduction of filter efficiency. Reduction in quality of water for rainwater harvesting.

NB: the filter is fully self cleaning under normal conditions. Only abnormal or large debris from gutters can cause a blockage.

Maintenance frequency can be reduced by adding additional leaf and debris guards to gutters. Dependant on the quality of guarding and location, maintenance intervals can be reduced to 12, 18, or 24 months.
Examples of gutter guarding systems.



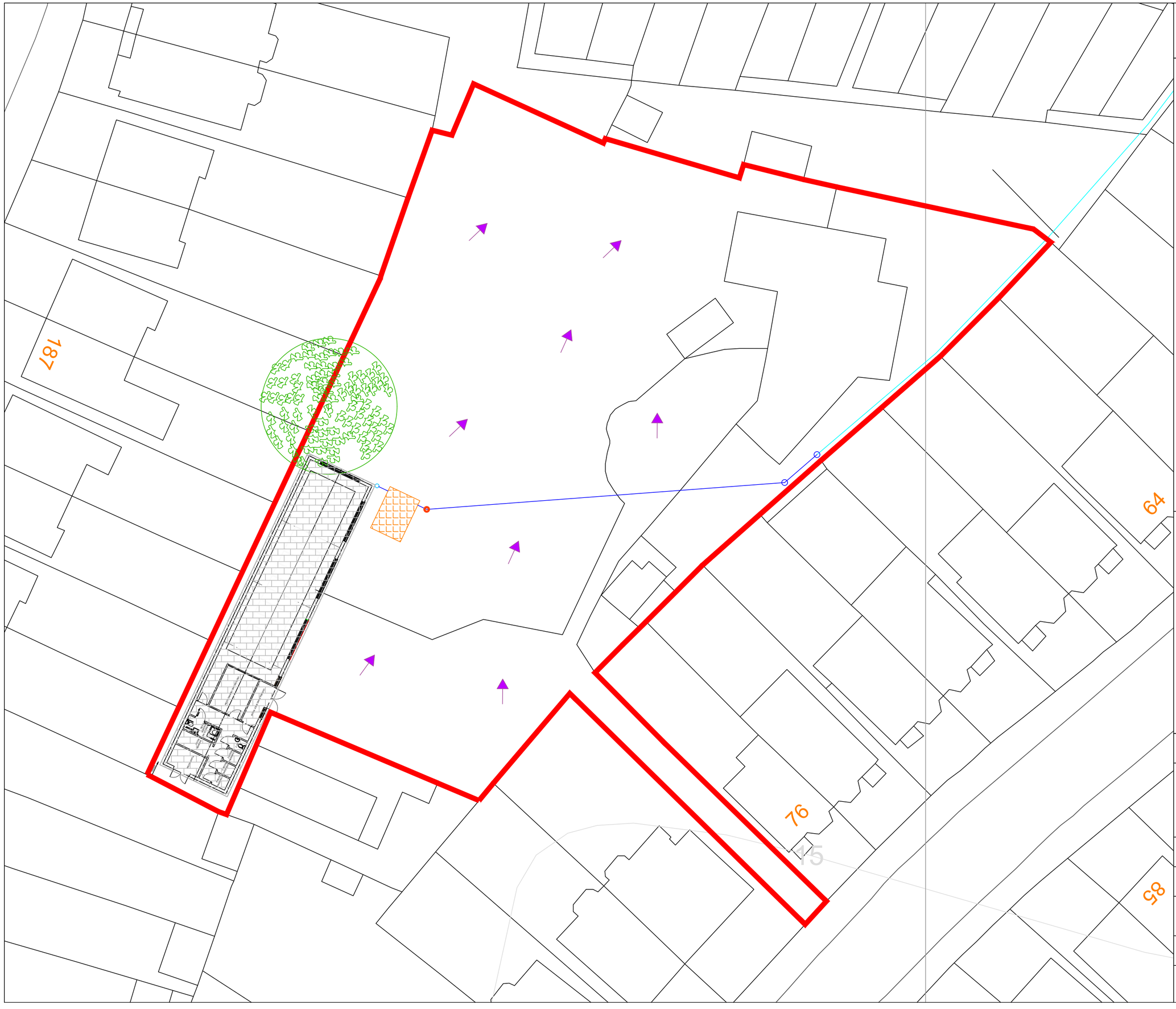
F-Line Tank. *Warranty 25 years. Expected service life 100 years.*

Every 10 years. Pump out completely and clean sidewalls with pressure washer, pump out using dirty water pump. (Around 0.5cm of very fine silt builds per year.)
Risk if missed: Low, potential reduction in water quality for rainwater harvesting. If missed multiple times (circa 50 years), potential blockage of outlet orifice.

Gutters: N/A

Clean every 10 years to reduce strain on self cleaning filter. Remove all leaf matter, moss, debris. Wash through.
Risk if missed: Very low, increased fine sediment entering the tank.

Appendix F



Key

- Proposed Building (237m^2)
- Proposed Attenuation Storage / RWH
- Proposed Downpipe
- Proposed Surface Water Drainage Pipes
- Proposed Hydrobrake Flow Control
- Inspection Chambers
- Existing Surface Water Drainage Pipes
- Design Exceedance Route
- Existing Tree

Notes:

1. Discharge of surface water via an attenuation storage tank. Preliminary calculations indicate that sufficient storage required to attenuate runoff from the proposed impermeable areas (237m^2) arising from the critical 1:100 year + 40% climate change event can be provided within an attenuation storage tank of dimensions 15m^2 x 0.6m deep.
2. Post development discharge limited to 1.6l/s via hydrobrake flow control.
3. All levels are in metres above ordnance datum

Client:
Barnes Home Guard Association

Site Address:
Barnes Home Guard Association,
76A Richmond Park Road,
London
SW14 8LA

Job Reference:	**Date:**
88496-BucklandPool-BHG	17-Dec-18
Drawing Number:	**Revision:**
88496-01	v1.0

Designed by:	**Drawn by:**	**Checked by:**
TS	TS	EB

Scale:
1:250@A2

Disclaimer:
The drawings provided are for planning purposes only.

Unda Consulting Ltd
Southpoint
Old Brighton Road
Gatwick
RH11 0PR