# Camberwell Old Cemetery, Southwark

## Plot Z Drainage Strategy Review

A099942

Southwark Council

October 2016

Prepared on behalf of WYG Engineering Limited.

Geneva Building, Lakeview Drive, Sherwood Business Park, Annesley, Nottingham, NG15 0ED
Tel: +44 (0)1623 684 550 Fax: +44 (0)1623 684 551
Email: info@wyg.com Website: www.**wyg**.com

WYG Engineering Limited. Registered in England & Wales Number: 01959704
Registered Office: Arndale Court, Otley Road, Headingley, Leeds, LS6 2UJ

## Document control

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# Contents



# Appendices

# 1.0 Introduction

## 1.1 Purpose of the Report

Southwark Council have commissioned WYG Engineering Ltd to undertake a review of the drainage strategy produced by BSP Consulting (BSP) for the redevelopment of Area Z, Camberwell, Old Cemetery, Forest Hill Road, London.

The following documents and standards are considered in the review of the drainage strategy:

a) Planning Practice Guidance – Flood Risk and Coastal Change
b) BRE Digest 365 Soakaway Design
c) The SuDS Manual C753
d) The National Planning Policy Framework (NPPF)
e) Environment Agency Document - Groundwater Protection: Principles and practice (GP3)
f) Water Resources Act

## 1.2 Proposed Development

The proposed redevelopment seeks to introduce approximately 750 burial plots as part of the Southwark Council's cemetery strategy. The site has been subjected to illegal tipping and as a result, this stockpile of material will need to be removed and/or recycled prior to the re-landscaping to provide the additional burial plots.

The Indicative Drainage Strategy, produced by BSP, is contained in Appendix A of this report. The topographical survey showing the site levels including the illegally tipped material is included in Appendix B.

# 2.0 Drainage Strategy Review

## 2.1 Southwark Council

During the tender process, Southwark Council have outlined a number of outcomes which they wish to be addressed as part of this review. A summary of the outcomes are listed below and WYG comments are provided for each.

### 2.1.1 Has the drainage strategy been produced in accordance with current standards and best practices?

a) From the supplied MicroDrainage calculations in Appendix C of the BSP report it can be seen that their proposed soakaway has a half drain time of 7868 minutes (131 hours). As BSP reference the SuDS Manual C753 within their Drainage Strategy report that subsequently references BRE 365 it is considered that the soakaway should drain from full to half full within 24 hours, in readiness for possible subsequent storm in flow. Therefore, it is considered their design is not in accordance with this design document.

b) However, the nature and consequence of the BSP design should be considered. The drainage throughout the proposed cemetery is predominantly serving land drainage and connection to the adjacent public sewer would not be acceptable and no watercourse borders the site, therefore the solution provided will be a significant improvement on the existing scenario.

c) The infiltration rates of between 9.58 x 10^-7 m/s and 1.46 x 10^-6 m/s that have been determined by infiltration testing undertaken by CGL in May 2015, these results are included in Appendix D of this report. These rates are on the limit of what is regarded to be acceptable for the use of soakaways. For this rate of infiltration it is suggested, in C753, that soakaways may not be the most cost effective or appropriate form of discharge of surface water. However, they appear to be only viable solution in this scenario.

d) The true extent of the historical burial areas is unclear but no soakaways should be positioned within 10m of the proposed graves.

### 2.1.2 Are the recommendations made within the Drainage Strategy technically sould and appropriate for the planned burial works?

a) The drainage strategy BSP have designed appears appropriate for the proposed works. However, WYG consider that the rainfall intensity rate of 50mm/hr used to calculate the equivalent impermeable area is excessive. Using FEH data to calculate the rainfall intensity WYG find a figure in the order of 13mm/hr to be more appropriate (based on a 100 year return period storm with a 6 hour duration). Therefore, when using the 13mm/hr to calculate the equivalent impermeable area using the modified rational method and a site area draining to the soakaway of 3,500$m^2$ this would result in an equivalent impermeable area of 360$m^2$ (compared to BSP's figure of 370$m^2$).

### 2.1.3 Does the proposed Drainage Strategy increase risk of flooding to Ryedale properties?

a) The drainage strategy does not increase the risk of surface water flooding to the Ryedale properties from the existing scenario. The proposed introduction of a below ground infiltration tank and filter drains will significantly reduce the risk of flooding to the properties on Ryedale to the north west of the site.

b) The removal/reprofiling of the tipped material and the terracing of the proposed site will also significantly reduce the risk of surface water flooding exiting the site. Based on a site walkover it appears the edge of the site has been built up in the form of a bund to prevent surface water flooding off site towards the Rydale properties. It is considered that should exceedance of the surface water system occur in less frequent storm events the excess surface water will pond in the north east corner of the site where levels are lowest. The flood water would then dissipate through evapotranspiration over time and is unlikely to affect adjacent sites.

## 2.2 Local Residents

In addition, there have been a number of issues raised by the local residents which will be addressed as part of this review.

### 2.2.1 Given that access to the sewer has been rules out (BSP 2.4.3) on grounds that it would "require the pipe to be laid through an area of historic public graves" and the Council has effectively given an assurance to the Diocese of Southwark "not to disturb any interred remains" (Faculty Statement p.4), are there any other options that on-site infiltration?

a) It appears no other options are available for the discharge of surface water from the site as no watercourses are adjacent to the site and Thames Water would not accept discharge of land drainage to their sewers.

**2.2.2 The BSP plan uses an infiltration rate found in a trial pit into "firm fissured friable" old burial clay in May 2015 (trial pit log) "to design the soakaways" (2.8.1). Do you think a trial pit in early summer takes account of:**

i. The effects of compaction due to heavy machinery needed to remove the rubble on top of the clay and the subsequent mechanised excavation and refilling characteristic of burial?

ii. The saturation seen on the surface of all recent burials during the winter and in the clay walls and floor of the proposed soakaway chambers?

a) The tests will take account of these factors, although some compaction may occur, the overall infiltration characteristics of the soil are likely to remain similar to that tested. Also some compaction through the bucket of the excavator will have occurred when the infiltration tests were undertaken on site.

b) Further testing or boreholes is recommended to be undertaken during the winter months to determine the depth of the groundwater in the vicinity of the proposed larger soakaway to make sure the ground water is sufficient depth from the base of the soakaway.

c) The locations and alignment of the filter drains should allow the graves to remain relatively free of ponding assuming the surface levels of each plateau area are sloped to best utilise the filter drains. It is understood the made ground used to create the plateaus will be design such that it will have a similar infiltration rate to the natural ground on site.

**2.2.3 Is there a risk that compaction and saturation will disable the proposed soakaways?**

a) This is very unlikely to happen through compaction, soil is created through compaction over millions of years, compaction from several construction vehicles are very unlikely to change the overall infiltration characteristics of the soil. The soil at the base of the soakaway will be consolidated (compacted) by the mass or overburden of the soil on top of it. Soil at this depth is unlikely to be adversely affected by the movement of plant above it due to the load spreading affect of the near surface soils. Additionally it should be noted that the soakaway tests are undertaken at depth within the pre-consolidated soils and should therefore provide infiltration rates typical of the rates achieved by the constructed scheme.

b) As stated in our response to the question listed in 2.2.2, further information regarding the water table is required to demonstrate no saturation of the base of the soakaways is likely.

c) It should also be noted that the BSP calculations include a factor of safety of 2.0 that allows for variations in the infiltration rate within the soil and silting up of the system over time.

**2.2.4 The map on the last page of the plan, prepared by Harrison Design, shows a drop of at least 5m over a distance of less than 40 metres between the top of soakaway 2 and the visible part of Ryedale (which in fact continues to fall all the way to Forest Hill Road). BSP do not mention any flood safety implications of siting a soakaway on a bank. Do you think there are any?**

a) Detailed geotechnical and hydrological testing and analysis, as well as slope analysis should be undertaken as part of the detailed design to determine if siting the soakaway in this location is likely to induce failure of the slope.

**2.2.5 The map also shows extended contours on the downhill side of soakaway 2. Do you agree that part of the tank is therefore contained in an artificial mound. No mention of this is made by BSP. Would you want to see tests carried out on the possibility of a full tank breaching and flooding the back gardens beyond the end of, and below the level of, the retaining wall below?**

a) The depth of the soakaway and construction methodology of the raised ground should be clarified to make sure the infiltration from the soakaway does not affect the integrity of the slope.

b) Should the soakaways flood in extreme storm events it is considered the topography of the wider site will direct surface water to the north east area of the site and pond in this area. As part of the detailed design measures should be undertaken to make sure this flood routing is retained.

**2.2.6 The Council's Surface Water Management Plan(SWMP) (2011) contains a map dividing most of the borough between 3 categories: Infiltration potentially suitable, unsuitable and uncertain. Camberwell Old cemetery is wholly in the unsuitable category. The Plan defines "Infiltration SUDS potentially unsuitable" as "minimum permeability is low or very low for bedrock" (p.65). Does this include London clay? What steps are required to establish whether this warning applies to the proposed soakaways?**

a) Infiltration testing has been undertaken and it can be seen the results demonstrate the infiltration rate in the area of the proposed soakaways is just above the limited suggested by the latest SuDS Manual C753. Therefore, WYG consider the site specific infiltration test results would provide a more informed indication of the soil infiltration characteristics at the site information provided by the SWMP.

**2.2.7 Kent County Council published a Soakaway Design Guide in 2000 which says "Clearly, some soil deposits will be totally unsuitable for the installation of soakaways. These consist predominantly of the clays from the Cretaceous, Palaeocene and Eocene periods (e.g. Weald, Woolwich and London Clays respectively)". As the authority covers a major deposit of London Clay in the north of the county, and supervises planning in an area where most drinking water is drawn from aquifers, should Southwark heed its warning in relation to soakaways uphill from the housing in Ryedale?**

a) Southwark should look at this site on its own individual merit. Infiltration rates can vary significantly across similar soils, therefore this high level guidance should be superseded by the insitu infiltration test results that have been undertaken.

**2.2.8 All the houses on the South side of Ryedale, from the end of the retaining wall down to the corner with Forest Hill Road, are below the level of the back gardens. There is no gap in the brickwork which could be used as an outlet for floodwater. Does this affect your approach to the flood safety of BSP's proposals?**

a) Flood water will be directed to the lowest part of the site, as stated previously. Therefore, I do not consider this question to be relevant.

# 3.0 WYG Drainage Strategy Design

## 3.1 Proposed Surface Water Run-Off

The total area proposed for redevelopment is approximately 0.35ha (3,500$m^2$). Using the ICP SuDS method in the Source Control module of MicroDrainage the existing QBAR rate was calculated to be 1.3 l/s. Greenfield run-off calculations are included within Appendix E of this report. WYG consider that the ICP SuDS is an appropriate method of calculating run-off from the site. WYG consider the ADAS methodology is better suited to larger rural sites.

FEH data was used to calculate the expected rainfall intensity for a 1 in 100 year storm event over a 6 hour period. The rainfall intensity for this duration was calculated to be in the region of 13mm/hr.

Using the modified rational method (Q=2.78Ai), with the QBAR and rainfall intensity stated above it is assumed that the run-off from the burial areas draining to the plot drainage is equivalent to an impermeable area of 0.036ha (360$m^2$).

The hardstanding areas for the road and footpaths within the application site have been measured at 0.06ha (600$m^2$).

Therefore, the total equivalent impermeable area draining to the proposed soakaway is 0.096ha (960$m^2$).

## 3.2 WYG Drainage Strategy

The CGL testing recorded an infiltration rate of $1.41 \times 10^{-6}$ m/s closest to the proposed tank soakaway and has therefore been used in the WYG calculations. $1.41 \times 10^{-6}$ m/s is also the median value recorded, from the three tests, and as the results are all very similar in value, this has been applied across the site.

In accordance with CIRIA guidance and the latest guidance released by the EA in relation to climate change the drainage designed has been undertaken to make sure that no offsite flooding occurs during the 1 in 100 year storm event + a 40% allowance for climate change. Given that the application site is of a sensitive nature WYG have designed the drainage to make sure that no above ground flooding occurs up to and including the 1 in 100 year storm event + 40% allowance for climate change also.

The filter drains have been designed with check dams in order to slow the conveyance of water and allow for some infiltration prior to discharging the soakaway downstream.

Based on the above criteria, WYG estimate that the soakaways T1 and T2 will be required to have a combined volume of $90m^3$ to serve the proposed development of Area Z of the cemetery. This value represents the same volume of attenuation proposed within the BSP drainage strategy.

The MicroDrainage calculations used to assess the drainage for the site are included within Appendix E of this report.

No drainage strategy drawing has been produced as part of this report as it is considered that the BSP drainage strategy is appropriate in principle and that final arrangements should be undertaken following further testing and detail design.

# 4.0 Conclusions

## 4.1 Surface Water Drainage Strategy Benefits

Despite the ground conditions and lack of options available for the surface water drainage strategy to Southwark Council for the proposed additional burial sites, the drainage strategy will provide the following benefits to the site and the surrounding area:

- The creation of plateaus from the tipped material will increase the infiltration into the ground and reduce run-off from the site from the existing scenario.
- The integration of filter drains within the burial plateaus will better facilitate the infiltration of surface water and precipitation into the ground below.
- Providing there are no geological implications, the inclusion of below ground tanks and filter drains will significantly reduce the risk of flooding to the adjacent Ryedale properties in storm events up to the 1 in 100 year plus climate change storm event.
- The BSP drainage strategy is appropriate in principle, subject to further testing.
- The incorporation of any surface water storage tanks and filter drains within the site will be a significant improvement on the existing scenario and prevent surface water run-off in the vast majority of storm events.

## 4.2 BSP Design

In summary WYG have the following comments regarding the BSP design:

- Low rate infiltration of the existing and proposed soil mean half drain down times will be impossible to achieve with the constraints of the site;
- Timing of trial pits within the calendar year mean future testing should be undertaken prior to construction;
- There is a lack of alternative surface water drainage options and therefore WYG consider BSP have utilised the only option available to them;
- There is a lack of consideration for future maintenance within their report and this should be addressed prior to construction to make sure the soakaways and filter drains remain operational;

- Climate change figures have been revised by the Environment Agency since the BSP report was issued;
- No infiltration has been calculated within the shallow filter drains; and
- BSP use 50mm/hr when calculating the equivalent impermeable area.

It is considered the majority of these points are set site characteristics and further information will be required prior to detailed design.

Despite the difference in approach when modelling the drainage strategy it can be seen that the required soakaway volume, even when using a 40% allowance for climate change, remains at 90m$^3$.

It should be noted that 40% climate change may not be applicable as the report was approved as part of the planning application prior to the change in climate change guidance. However, in order to assess the scheme in line with modern standards WYG are using the 40% allowance for climate change as a sensitivity check for the development.

## 4.3 WYG Assessment

No suitable or viable alternatives were considered possible following a review of the information provided by Southwark Council or following a site visit on the 3 October 2016.

Therefore, an assessment using what WYG deem to be the most suitable parameters (stated in section 3 of this report) was undertaken on the basis of the BSP drainage strategy.

Undertaking a more detailed assessment of the drainage strategy using the Network Module of MicroDrainage, WYG found that the soakaways T1 and T2 would require a total volume of 90m$^3$ to serve the proposed development.

**It should be noted that both designs are stated as subject to further investigative works and detailed design.**

# 5.0 Recommendations

## 5.1 Future works

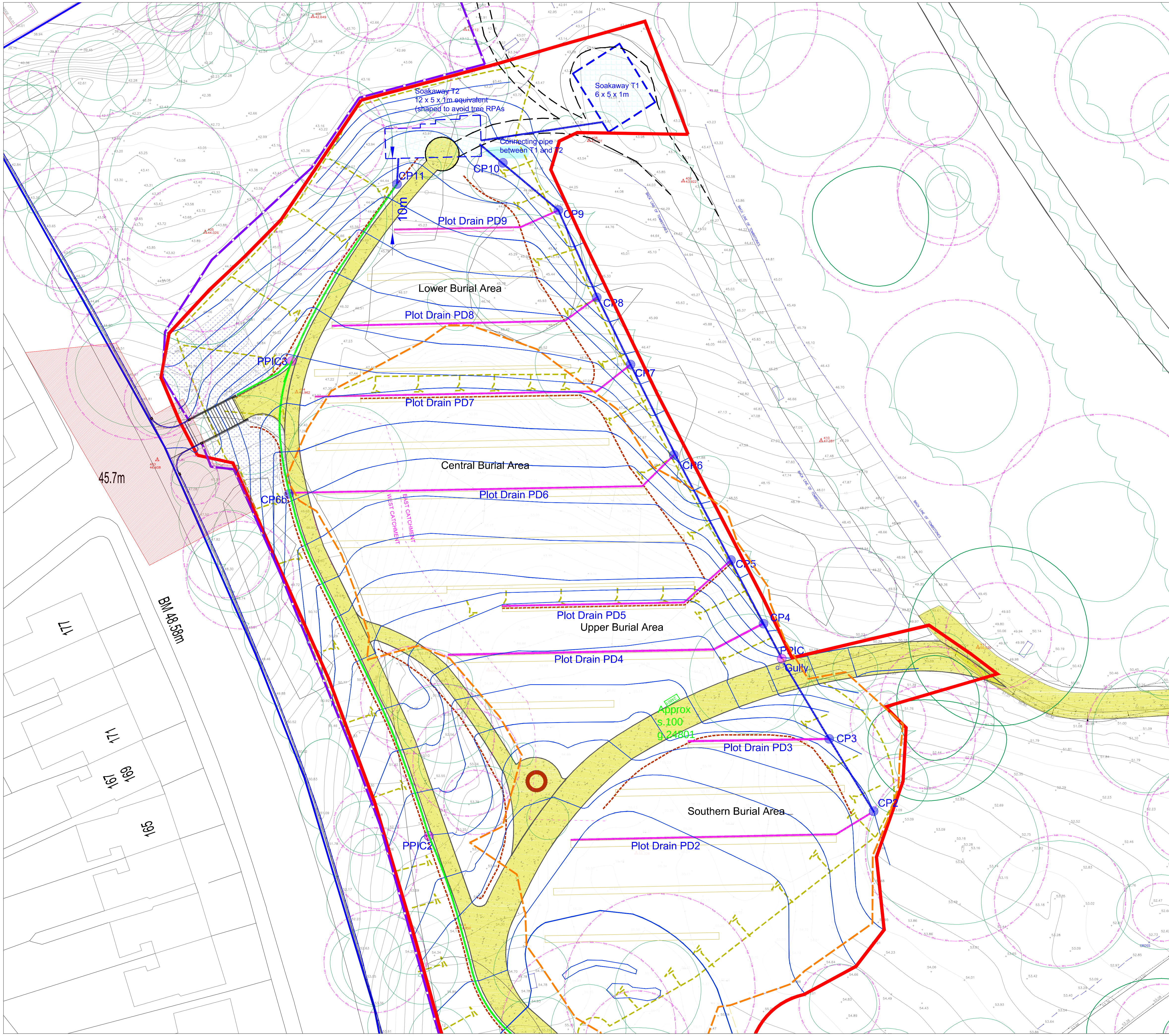
Prior to construction it is considered that further works relating to drainage strategy will be required:

- Investigation work to determine the depth of ground water in the vicinity of the proposed soakaway tanks during the winter months;
- Hydrological and geotechnical testing of the soil around the proposed tank soakaways should be undertaken to ensure the introduction of the tanks will not have a detrimental effect on the stability of the banked ground adjacent to the properties on Ryedale and no to ensure no seepage will occur;
- As part of the full life cycle design consideration of the development, a maintenance regime should be prepared for the drainage system serving the site. In particular maintenance of the soakaways and filter strips will be key to making sure the system performs, as designed, throughout the life of the development;
- Infiltration characteristics of the placed material should be determined as early as possible; and
- Detailed design of the surface water drainage system should be undertaken prior to construction.

# 6.0 Appendices

# Appendix A

## BSP Indicative Drainage Strategy






## KEY

- Site boundary
- Cemetery boundary
- Proposed finish level contours (500mm intervals) (provisional)
- +44.50 Proposed finish spot level (provisional)
- Slope: Top / Bottom
- Gravel bases for memorials with drainage
- Proposed 3.8m/2m wide path (natural gravel dressing over tarmac base)
- Existing cemetery pathway
- Protective fence - Timber post with line wire set in centre of hedgerow
- Temporary Protective fence put in place during boundary work to protect buffer zone
- Existing tree RPA
- Below ground attentuating soakaways
- Plot drainage (perforated pipe)
- Pathway filter drainage (perforated pipe)
- Carrier drainage (solid pipe)
- Catchpit
- Inspection Chamber

bsp CONSULTING

in association with HDD

| rev: | description: | dwn: | chkd: | date: |
|---|---|---|---|---|
| C | Scale note | BB | PH | 26.6.15 |

**Project:** Area Z

**drawing:** Illustrative Drainage Strategy Layout - -

**client:** Southwark Council -

| scale(s): | date: | drawn by: | checked: |
|---|---|---|---|
| 1:250 @ A1 | 20.04.15 | AJDP | PH |

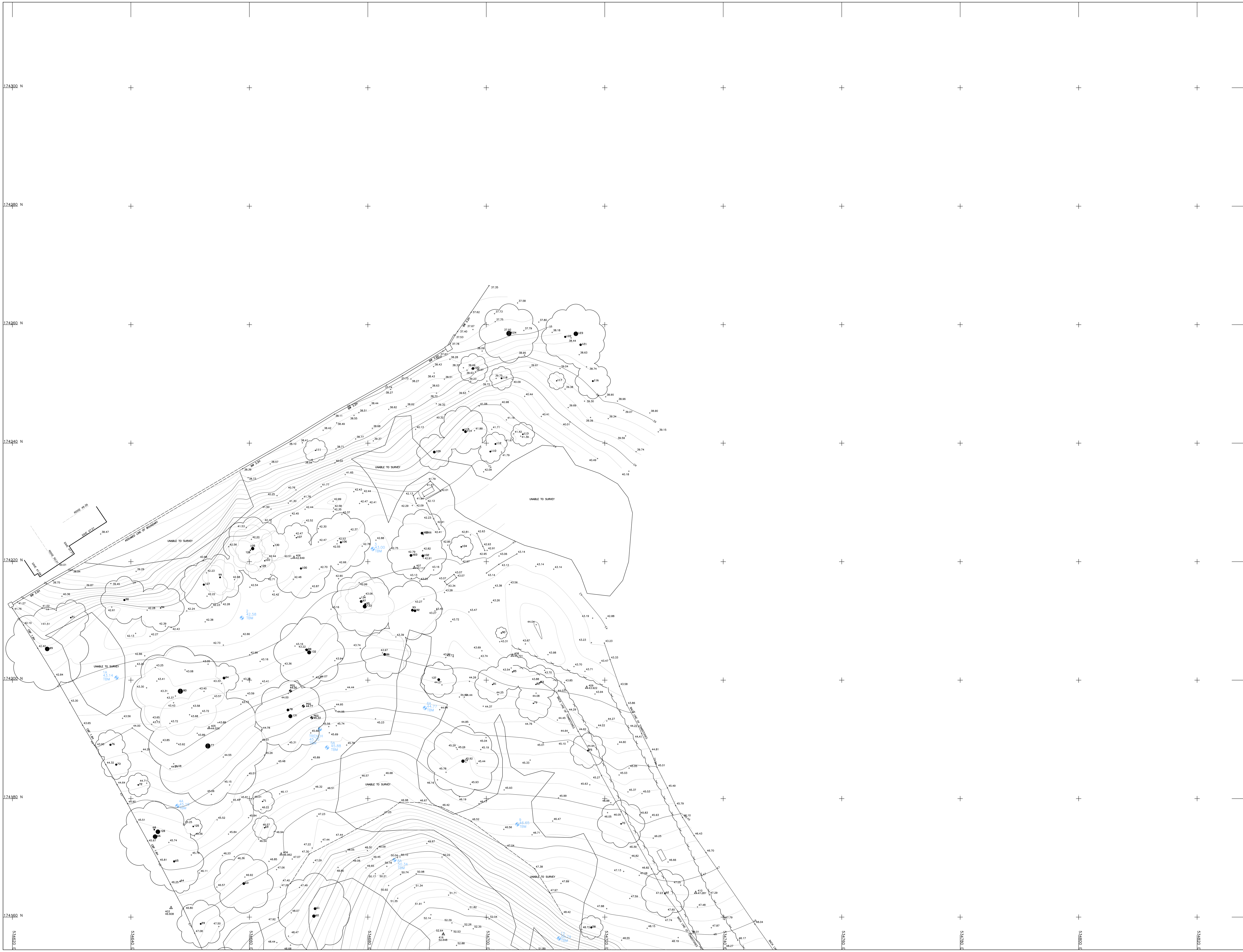
**drawing number:** 048-07-24

| xrefs: | status: | rev: |
|---|---|---|
| - | PLANNING | C |

Harrison Design Development Limited
e. info@harrisondd.co.uk t. 01352 758077 w. www.harrisondd.co.uk

# Appendix B

## Topographical Survey




ABBREVIATIONS

| | | | | | |
|---|---|---|---|---|---|
| AB | Air Brick | DH | Duct Height | PRF | Post & Rail Fence |
| B | Bollard or Bottom Heights | DP | Down Pipe | PWF | Post & Wire Fence |
| BB | Belisha Beacon | ECB | Electricity Control Box | R | Render |
| BD | Back Drop | ELEC | Electricity | RAD | Radiator |
| BH | Borehole or Beam Height | EP | Electricity Pole | RE | Rodding Eye |
| BL | Bed Level | FB | Flower Bed | RG | Rough Ground |
| BP | Brick Paviors | FH | Fire Hydrant | RS | Road Sign |
| BRW | Brick Retaining Wall | FL | Floor Level | RSJ | Rolled Steel Joist |
| BS | Bus Stop | G | Gully | RWP | Rain Water Pipe |
| BT | British Telecom | GV | Gas Valve | S | Spread or Stone |
| BTCB | BT Control Box | H | Height in Metres | SC | Stop Cock |
| BW | Brick Wall | H | Window Head Height | SL | Soffit Level or Skylight |
| BWF | Barbed Wire Fence | HT | Height | SP | Arch Springer Height |
| C | Window Cill Height | IC | Inspection Cover | SPS | Stone Paving Slabs |
| CB | Control Box | IL | Invert Level | SW | Stone Wall |
| CBF | Close Boarded Fence | IRF | Iron Railing Fence | TCSU | Traffic Control |
| CBW | Concrete Block Wall | IWF | Interwoven Fence | T | Top Heights |
| CCB | Cable TV Control Box | KO | Kerb Outlet | TL | Traffic Light |
| CIF | Corrugated Iron Fence | L | Light | TP | Telephone Pole |
| CL | Cover Level | LP | Lamp Post | TPS | Tactile Paving Slabs |
| CLF | Chain Link Fence | MH | Manhole | UTL | Unable To Lift |
| CLSF | Chain Link Security Fence | MKR | Marker | V | Vent |
| CPF | Concrete Panel Fence | OV | Over Flow Pipe | VP | Vent Pipe |
| CPS | Concrete Paving Slabs | O/H | Overhead | W | Window |
| CR | Arch Crown Height | P | Post | WL | Water Level |
| CRW | Concrete Retaining Wall | PALF | Palisade Fence | WM | Water Meter |
| CSU | Ceiling Slopes Up | PF | Picket Fence | WMF | Wire Mesh Fence |
| CTV | Cable Television | PIT | Trial Pit | WPF | Wooden Panel Fence |
| CW | Concrete Wall | PL | Pavement Light | WV | Water Valve |
| D | Diameter or Doors | PM | Parking Meter | ø | Diameter |

Top / Bottom — Banks
Drop Kerbs
Overhead Detail
Change in Elevation
Fences
Overhead Cables
Change in Surface
Edge of Vegetation
3.28 — Floor to Ceiling Height
3.28 F — False Ceiling Height
Gate
Survey Station
Foul Water Sewer
Surface Water Sewer
Combined Sewer

LEVEL NOTE.

ALL CO-ORDINATES RELATE TO THE ORDNANCE SURVEY GRID AND DATUM VIA GPS OBSERVATIONS.

COORDINATE SCHEDULE

| STATION | EASTINGS | NORTHINGS | LEVEL |
|---|---|---|---|
| 401 | 534680.606 | 174304.767 | 59.163 |
| 402 | 534672.842 | 174048.677 | 56.108 |
| 403 | 534646.788 | 174161.358 | 46.608 |
| 404 | 534665.382 | 174170.505 | 46.962 |
| 405 | 534653.182 | 174191.922 | 44.026 |
| 406 | 534667.029 | 174205.889 | 42.649 |
| 407 | 534687.856 | 174218.880 | 43.112 |
| 408 | 534704.387 | 174204.152 | 43.701 |
| 409 | 534716.954 | 174198.739 | 43.922 |
| 410 | 534735.360 | 174164.123 | 47.281 |
| 411 | 534756.266 | 174136.561 | 50.030 |
| 412 | 534756.485 | 174077.244 | 54.467 |
| 413 | 534681.405 | 174072.860 | 56.179 |
| 414 | 534686.642 | 174099.155 | 54.250 |
| 415 | 534690.956 | 174133.525 | 54.337 |
| 416 | 534682.756 | 174157.110 | 52.646 |
| 901 PGM | 534701.250 | 174050.561 | 57.231 |
| 902 PGM | 534710.696 | 174109.083 | 55.328 |

TREE SCHEDULE

| NO | DIA | SPREAD | HEIGHT | TYPE |
|---|---|---|---|---|
| 1 | 0.6 | 12 | 12 | SYCAMORE |
| 2 | 0.8 | 12 | 12 | SYCAMORE |
| 3 | 0.5 | 12 | 14 | OAK |
| 4 | 0.2 | 5 | 8 | UNKNOWN |
| 5 | 0.25 | 5 | 6 | UNKNOWN |
| 6 | 0.3 | 10 | 10 | SYCAMORE |
| 7 | 0.15 | 4 | 6 | UNKNOWN |
| 8 | 0.7 | 8 | 10 | SYCAMORE |
| 9 | 0.2 | 8 | 8 | UNKNOWN |
| 10 | 0.25 | 5 | 8 | UNKNOWN |
| 11 | 0.3 | 12 | 8 | WILLOW |
| 12 | 0.5 | 5 | 12 | SYCAMORE |
| 13 | 0.4 | 10 | 12 | SYCAMORE |
| 14 | 0.2 | 8 | 8 | CHERRY |
| 15 | 0.15 | 4 | 6 | SYCAMORE |
| 16 | 0.2 | 6 | 10 | SYCAMORE |
| 17 | 0.3 | 12 | 10 | SYCAMORE |
| 18 | 0.3 | 10 | 10 | SYCAMORE |
| 19 | 0.7 | 12 | 12 | SYCAMORE |
| 20 | 0.25 | 6 | 8 | SYCAMORE |
| 21 | 0.7 | 12 | 14 | OAK |
| 22 | 0.35 | 10 | 12 | SYCAMORE |
| 23 | 0.4 | 8 | 8 | SYCAMORE |
| 24 | 0.35 | 10 | 12 | SYCAMORE |
| 25 | 0.3 | 8 | 8 | SYCAMORE |
| 26 | 0.25 | 8 | 10 | SYCAMORE |
| 27 | 0.15 | 8 | 10 | SYCAMORE |
| 28 | 0.25 | 8 | 10 | SYCAMORE |
| 29 | 0.6 | 14 | 12 | OAK |
| 30 | 0.3 | 12 | 12 | SYCAMORE |
| 31 | 0.3 | 8 | 8 | SYCAMORE |
| 32 | 0.25 | 8 | 10 | SYCAMORE |
| 33 | 0.15 MB | 4 | 5 | SYCAMORE |
| 34 | 0.3 | 10 | 10 | SYCAMORE |
| 35 | 0.2 | 5 | 5 | UNKNOWN |
| 36 | 0.15 | 5 | 10 | SYCAMORE |
| 37 | 0.7 | 12 | 14 | OAK |
| 38 | 0.3 | 10 | 10 | SYCAMORE |
| 39 | 0.3 | 10 | 10 | SYCAMORE |
| 40 | 0.3 | 8 | 10 | UNKNOWN |
| 41 | 0.3 | 6 | 8 | DEAD |
| 42 | 0.3 | 10 | 14 | SYCAMORE |
| 43 | 0.3 | 10 | 10 | SYCAMORE |
| 44 | 0.3 | 10 | 14 | SYCAMORE |
| 45 | 0.15 | 5 | 6 | SYCAMORE |
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| 74 | 0.5 | 12 | 12 | SYCAMORE |
| 75 | 0.25 | 6 | 8 | SYCAMORE |
| 76 | 0.3 | 5 | 10 | SYCAMORE |
| 77 | 0.7 | 18 | 18 | OAK |
| 78 | 0.4 | 5 | 12 | SYCAMORE |
| 79 | 0.15 MB | 6 | 8 | SYCAMORE |
| 80 | 0.7 4B | 16 | 14 | SYCAMORE |
| 81 | 0.15 MB | 6 | 8 | SYCAMORE |
| 82 | 0.15 MB | 6 | 8 | SYCAMORE |
| 83 | 0.15 MB | 6 | 8 | SYCAMORE |
| 84 | 0.4 | 5 | 12 | SYCAMORE |
| 85 | 0.15 MB | 6 | 8 | SYCAMORE |
| 86 | 0.3 | 8 | 10 | SYCAMORE |
| 87 | 0.3 | 10 | 12 | OAK |
| 88 | 0.4 | 10 | 14 | SYCAMORE |
| 89 | 0.7 | 14 | 14 | SYCAMORE |
| 90 | 0.15 | 2 | 4 | UNKNOWN |
| 91 | 0.2 | 6 | 8 | UNKNOWN |
| 92 | 0.4 | 6 | 10 | OAK |
| 93 | 0.4 | 10 | 14 | SYCAMORE |
| 94 | 0.15 | 8 | 8 | UNKNOWN |
| 95 | 0.3 | 8 | 10 | SYCAMORE |
| 97 | 0.4 | 10 | 14 | SYCAMORE |
| 98 | 0.3 | 8 | 12 | SYCAMORE |
| 99 | 0.15 | 8 | 8 | UNKNOWN |
| 100 | 0.3 | 10 | 10 | SYCAMORE |
| 101 | 0.15 | 6 | 6 | ASH |
| 102 | 0.4 | 8 | 14 | SYCAMORE |
| 103 | 0.4 | 8 | 14 | SYCAMORE |
| 104 | 0.2 | 4 | 5 | UNKNOWN |
| 105 | 0.5 | 10 | 12 | UNKNOWN |
| 106 | 0.3 | 10 | 10 | SYCAMORE |
| 107 | 0.15 | 5 | 5 | UNKNOWN |
| 108 | 0.4 | 8 | 14 | SYCAMORE |
| 109 | 0.4 | 6 | 12 | SYCAMORE |
| 110 | 0.25 | 4 | 6 | SYCAMORE |
| 111 | 0.15 | 4 | 4 | ELDER |
| 112 | 0.25 | 4 | 6 | SYCAMORE |
| 113 | 0.2 | 4 | 5 | SYCAMORE |
| 114 | 0.4 | 6 | 12 | SYCAMORE |
| 115 | 0.3 | 8 | 8 | SYCAMORE |
| 116 | 0.25 | 6 | 8 | ASH |
| 117 | 0.15 | 3 | 3 | UNKNOWN |
| 118 | 0.25 | 4 | 6 | SYCAMORE |
| 119 | 0.25 | 4 | 6 | SYCAMORE |
| 120 | 0.4 | 5 | 12 | SYCAMORE |
| 121 | 0.35 | 8 | 6 | SYCAMORE |
| 122 | 0.3 | 8 | 8 | SYCAMORE |
| 123 | 0.7 | 10 | 14 | SYCAMORE |
| 124 | 0.8 | 10 | 10 | SYCAMORE |

N

FINAL PEG POSITION
TBM LEVEL MARKED ON PEG

MISC. PEG

All underground services information shown on this plan cannot be guaranteed and users should satisfy themselves of the type, size and route before commencing work on site.
Tree types shown on this drawing cannot be guaranteed and if critical should be verified by an arboriculturist.
Tree spreads and diameters are averages unless otherwise indicated.
This plan has been produced for the client detailed below or their appointed agent to an agreed specification and defines the limit of APR Services liability.

THE SURVEY ASSOCIATION

| Rev | Description | Date |
|---|---|---|
| B | MISC PEGS ADDED | SEPT 2013 |
| A | FINAL TRIAL PEGS ADDED CONTOURS UPDATED | SEPT 2013 |
| Revisions | | Date |

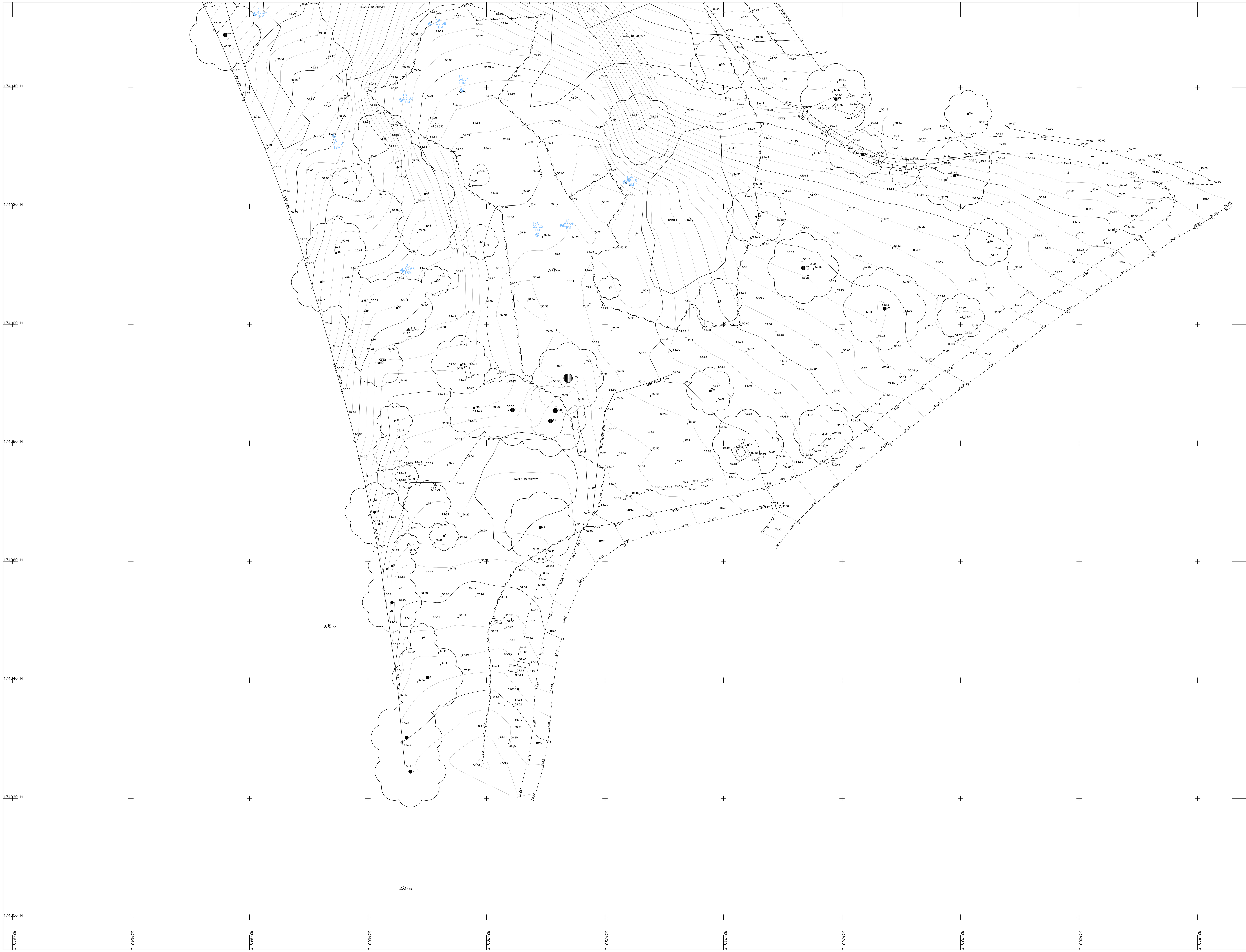
| | | | |
|---|---|---|---|
| Date | DEC 2011 | Drawn | CV |
| Scale | 1:200 | Checked | ASB |
| Dwg. No. | 911383 1 | Job No. | 911383 |

Client
SOUTHWARK COUNCIL

Dwg. Title
LAND SURVEY 2D

Project Title
CAMBERWELL OLD CEMETARY PART 1


apr services
land, building surveys & 3D Laser scanning
Block B, 1st Floor
Queens Road
Barnet
London EN5 4DL
t:020 8449 9143
f:020 8449 9153
www.aprservices.net
Area Offices in:
Salisbury and Plymouth




ABBREVIATIONS

| | | | | | |
|---|---|---|---|---|---|
| AB | Air Brick | DH | Duct Height | PRF | Post & Rail Fence |
| B | Bollard or Bottom Heights | DP | Down Pipe | PWF | Post & Wire Fence |
| BB | Belisha Beacon | ECB | Electricity Control Box | R | Render |
| BD | Back Drop | ELEC | Electricity | RAD | Radiator |
| BH | Borehole or Beam Height | EP | Electricity Pole | RE | Rodding Eye |
| BL | Bed Level | FB | Flower Bed | RG | Rough Ground |
| BP | Brick Paviors | FH | Fire Hydrant | RS | Road Sign |
| BRW | Brick Retaining Wall | FL | Floor Level | RSJ | Rolled Steel Joist |
| BS | Bus Stop | G | Gully | RWP | Rain Water Pipe |
| BT | British Telecom | GV | Gas Valve | S | Spread or Stone |
| BTCB | BT Control Box | H | Height in Metres | SC | Stop Cock |
| BW | Brick Wall | H | Window Head Height | SL | Soffit Level or Skylight |
| BWF | Barbed Wire Fence | HT | Height | SP | Arch Springer Height |
| C | Window Cill Height | IC | Inspection Cover | SPS | Stone Paving Slabs |
| CB | Control Box | IL | Invert Level | SW | Stone Wall |
| CBF | Close Boarded Fence | IRF | Iron Railing Fence | TCSU | Traffic Control |
| CBW | Concrete Block Wall | IWF | Interwoven Fence | T | Top Heights |
| CCB | Cable TV Control Box | KO | Kerb Outlet | TL | Traffic Light |
| CIF | Corrugated Iron Fence | L | Light | TP | Telephone Pole |
| CL | Cover Level | LP | Lamp Post | TPS | Tactile Paving Slabs |
| CLF | Chain Link Fence | MH | Manhole | UTL | Unable To Lift |
| CLSF | Chain Link Security Fence | MKR | Marker | V | Vent |
| CPF | Concrete Panel Fence | OV | Over Flow Pipe | VP | Vent Pipe |
| CPS | Concrete Paving Slabs | O/H | Overhead | W | Window |
| CR | Arch Crown Height | P | Post | WL | Water Level |
| CRW | Concrete Retaining Wall | PALF | Palisade Fence | WM | Water Meter |
| CSU | Ceiling Slopes Up | PF | Picket Fence | WMF | Wire Mesh Fence |
| CTV | Cable Television | PIT | Trial Pit | WPF | Wooden Panel Fence |
| CW | Concrete Wall | PL | Pavement Light | WV | Water Valve |
| D | Diameter or Doors | PM | Parking Meter | ø | Diameter |

Top
Banks
Bottom

Drop Kerbs
Overhead Detail
Change in Elevation
Fences
Overhead Cables
Change in Surface
Edge of Vegetation

3.28 Floor to Ceiling Height
3.28 F False Ceiling Height
Gate
Survey Station
Foul Water Sewer
Surface Water Sewer
Combined Sewer

LEVEL NOTE.

ALL CO-ORDINATES RELATE TO THE ORDNANCE SURVEY GRID AND DATUM VIA GPS OBSERVATIONS.

COORDINATE SCHEDULE

| STATION | EASTINGS | NORTHINGS | LEVEL |
|---|---|---|---|
| 401 | 534685.606 | 174004.787 | 59.193 |
| 402 | 534672.842 | 174048.977 | 56.108 |
| 403 | 534646.788 | 174161.558 | 46.608 |
| 404 | 534665.383 | 174170.595 | 46.962 |
| 405 | 534653.192 | 174191.922 | 44.026 |
| 406 | 534667.529 | 174220.689 | 42.649 |
| 407 | 534687.856 | 174218.980 | 43.112 |
| 408 | 534704.397 | 174204.152 | 43.701 |
| 409 | 534716.954 | 174198.739 | 43.922 |
| 410 | 534735.360 | 174164.123 | 47.281 |
| 411 | 534756.266 | 174136.561 | 50.030 |
| 412 | 534758.485 | 174077.244 | 54.467 |
| 413 | 534691.408 | 174072.880 | 56.179 |
| 414 | 534686.843 | 174099.155 | 54.250 |
| 415 | 534690.956 | 174133.525 | 54.337 |
| 416 | 534692.759 | 174157.110 | 52.648 |
| 901 PGM | 534701.250 | 174050.561 | 57.231 |
| 902 PGM | 534710.696 | 174109.083 | 55.328 |

TREE SCHEDULE

| NO | DIA | SPREAD | HEIGHT | TYPE |
|---|---|---|---|---|
| 1 | 0.6 | 12 | 12 | SYCAMORE |
| 2 | 0.6 | 12 | 12 | SYCAMORE |
| 3 | 0.5 | 12 | 14 | OAK |
| 4 | 0.2 | 5 | 6 | UNKNOWN |
| 5 | 0.2 | 5 | 6 | UNKNOWN |
| 6 | 0.5 | 10 | 10 | SYCAMORE |
| 7 | 0.15 | 4 | 6 | UNKNOWN |
| 8 | 0.3 | 8 | 10 | SYCAMORE |
| 9 | 0.15 | 4 | 6 | UNKNOWN |
| 10 | 0.25 | 5 | 8 | UNKNOWN |
| 11 | 0.5 | 12 | 8 | WILLOW |
| 12 | 0.3 | 8 | 10 | SYCAMORE |
| 13 | 0.4 | 10 | 12 | SYCAMORE |
| 14 | 0.2 | 8 | 8 | CHERRY |
| 15 | 0.15 | 4 | 6 | SYCAMORE |
| 16 | 0.2 | 6 | 10 | SYCAMORE |
| 17 | 0.3 | 12 | 10 | SYCAMORE |
| 18 | 0.3 | 10 | 10 | SYCAMORE |
| 19 | 0.7 | 12 | 12 | SYCAMORE |
| 20 | 0.25 | 6 | 8 | SYCAMORE |
| 21 | 0.7 | 12 | 14 | OAK |
| 22 | 0.35 | 10 | 12 | SYCAMORE |
| 23 | 0.4 | 8 | 8 | SYCAMORE |
| 24 | 0.35 | 10 | 12 | SYCAMORE |
| 25 | 0.3 | 8 | 8 | SYCAMORE |
| 26 | 0.25 | 8 | 10 | SYCAMORE |
| 27 | 0.15 | 8 | 10 | SYCAMORE |
| 28 | 0.25 | 8 | 10 | SYCAMORE |
| 29 | 0.6 | 14 | 12 | OAK |
| 30 | 0.3 | 12 | 12 | SYCAMORE |
| 31 | 0.3 | 8 | 8 | SYCAMORE |
| 32 | 0.25 | 8 | 10 | SYCAMORE |
| 33 | 0.15 MB | 4 | 5 | SYCAMORE |
| 34 | 0.3 | 10 | 10 | SYCAMORE |
| 35 | 0.2 | 5 | 5 | UNKNOWN |
| 36 | 0.15 | 5 | 10 | SYCAMORE |
| 37 | 0.7 | 12 | 14 | OAK |
| 38 | 0.3 | 10 | 10 | SYCAMORE |
| 39 | 0.3 | 10 | 10 | SYCAMORE |
| 40 | 0.3 | 8 | 10 | UNKNOWN |
| 41 | 0.3 | 6 | 8 | DEAD |
| 42 | 0.3 | 10 | 14 | SYCAMORE |
| 43 | 0.3 | 10 | 10 | SYCAMORE |
| 44 | 0.3 | 10 | 14 | SYCAMORE |
| 45 | 0.15 | 5 | 6 | SYCAMORE |
| 46 | 0.5 | 12 | 16 | SYCAMORE |
| 47 | 0.2 MB | 5 | 6 | UNKNOWN |
| 48 | 0.3 | 10 | 14 | SYCAMORE |
| 49 | 0.15 | 4 | 6 | UNKNOWN |
| 50 | 0.5 3B | 8 | 12 | SYCAMORE |
| 51 | 0.25 | 8 | 10 | HOLLY |
| 52 | 0.3 | 10 | 14 | SYCAMORE |
| 53 | 0.3 MB | 12 | 14 | SYCAMORE |
| 54 | 0.3 | 8 | 8 | CYPRESS |
| 55 | 0.5 | 12 | 12 | BEECH |
| 56 | 0.4 | 10 | 10 | SYCAMORE |
| 57 | 0.7 | 12 | 12 | SYCAMORE |
| 58 | 0.3 | 4 | 12 | SYCAMORE |
| 59 | 0.25 | 8 | 8 | SYCAMORE |
| 60 | 0.5 | 12 | 14 | SYCAMORE |
| 61 | 0.4 | 12 | 10 | OAK |
| 62 | 0.2 | 8 | 8 | SYCAMORE |
| 63 | 0.4 | 10 | 12 | SYCAMORE |
| 64 | 0.15 | 4 | 8 | SYCAMORE |
| 65 | 0.3 | 10 | 12 | SYCAMORE |
| 66 | 0.7 | 12 | 10 | SYCAMORE |
| 68 | 0.2 | 4 | 6 | UNKNOWN |
| 69 | 0.15 | 4 | 6 | ASH |
| 70 | 0.2 | 8 | 8 | SYCAMORE |
| 71 | 0.15 | 4 | 6 | ASH |
| 72 | 0.2 | 4 | 8 | SYCAMORE |
| 73 | 0.3 | 5 | 10 | SYCAMORE |
| 74 | 0.5 | 12 | 12 | SYCAMORE |
| 75 | 0.25 | 6 | 8 | SYCAMORE |
| 76 | 0.3 | 5 | 10 | SYCAMORE |
| 77 | 0.7 | 18 | 18 | OAK |
| 78 | 0.4 | 5 | 12 | SYCAMORE |
| 79 | 0.15 MB | 6 | 8 | SYCAMORE |
| 80 | 0.7 4B | 16 | 14 | SYCAMORE |
| 81 | 0.15 MB | 6 | 8 | SYCAMORE |
| 82 | 0.15 MB | 6 | 8 | SYCAMORE |
| 83 | 0.15 MB | 6 | 8 | SYCAMORE |
| 84 | 0.4 | 5 | 12 | SYCAMORE |
| 85 | 0.15 MB | 6 | 8 | SYCAMORE |
| 86 | 0.3 | 8 | 10 | SYCAMORE |
| 87 | 0.3 | 10 | 12 | OAK |
| 88 | 0.4 | 10 | 14 | SYCAMORE |
| 89 | 0.7 | 14 | 14 | SYCAMORE |
| 90 | 0.15 | 2 | 4 | UNKNOWN |
| 91 | 0.2 | 6 | 8 | UNKNOWN |
| 92 | 0.4 | 6 | 10 | OAK |
| 93 | 0.4 | 10 | 14 | SYCAMORE |
| 94 | 0.15 | 8 | 8 | UNKNOWN |
| 95 | 0.3 | 8 | 10 | SYCAMORE |
| 97 | 0.4 | 10 | 14 | SYCAMORE |
| 98 | 0.3 | 8 | 12 | SYCAMORE |
| 99 | 0.15 | 8 | 8 | UNKNOWN |
| 100 | 0.3 | 10 | 10 | SYCAMORE |
| 101 | 0.15 | 6 | 6 | ASH |
| 102 | 0.4 | 8 | 14 | SYCAMORE |
| 103 | 0.4 | 8 | 14 | SYCAMORE |
| 104 | 0.2 | 4 | 5 | UNKNOWN |
| 105 | 0.5 | 10 | 12 | UNKNOWN |
| 106 | 0.3 | 10 | 10 | SYCAMORE |
| 107 | 0.15 | 5 | 5 | UNKNOWN |
| 108 | 0.4 | 8 | 14 | SYCAMORE |
| 109 | 0.4 | 6 | 12 | SYCAMORE |
| 110 | 0.25 | 4 | 6 | SYCAMORE |
| 111 | 0.15 | 4 | 4 | ELDER |
| 112 | 0.25 | 4 | 6 | SYCAMORE |
| 113 | 0.2 | 4 | 5 | SYCAMORE |
| 114 | 0.4 | 6 | 12 | SYCAMORE |
| 115 | 0.3 | 8 | 8 | SYCAMORE |
| 116 | 0.25 | 6 | 8 | ASH |
| 117 | 0.15 | 3 | 3 | UNKNOWN |
| 118 | 0.25 | 4 | 6 | SYCAMORE |
| 119 | 0.25 | 4 | 6 | SYCAMORE |
| 120 | 0.4 | 5 | 12 | SYCAMORE |
| 121 | 0.35 | 8 | 6 | SYCAMORE |
| 122 | 0.3 | 8 | 8 | SYCAMORE |
| 123 | 0.7 | 10 | 14 | SYCAMORE |
| 124 | 0.8 | 10 | 10 | SYCAMORE |

16 56.29 TBM — FINAL PEG POSITION TBM LEVEL MARKED ON PEG

PEG 44.77 — MISC. PEG

All underground services information shown on this plan cannot be guaranteed and users should satisfy themselves of the type, size and route before commencing work on site.
Tree types shown on this drawing cannot be guaranteed and if critical should be verified by an arboriculturist.
Tree spreads and diameters are averages unless otherwise indicated.
This plan has been produced for the client detailed below or their appointed agent to an agreed specification and defines the limit of APR Services liability

ISO 9001 :2008

THE SURVEY ASSOCIATION

| | Revisions | Date |
|---|---|---|
| B | MISC PEGS ADDED | SEPT 2013 |
| A | FINAL TRIAL PEGS ADDED CONTOURS UPDATED | SEPT 2013 |

| | | | |
|---|---|---|---|
| Date | DEC 2011 | Drawn | CV |
| Scale | 1:200 | Checked | ASB |
| Dwg. No. | 911383 2 | Job No. | 911383 |

Client

SOUTHWARK COUNCIL

Dwg. Title
LAND SURVEY 2D

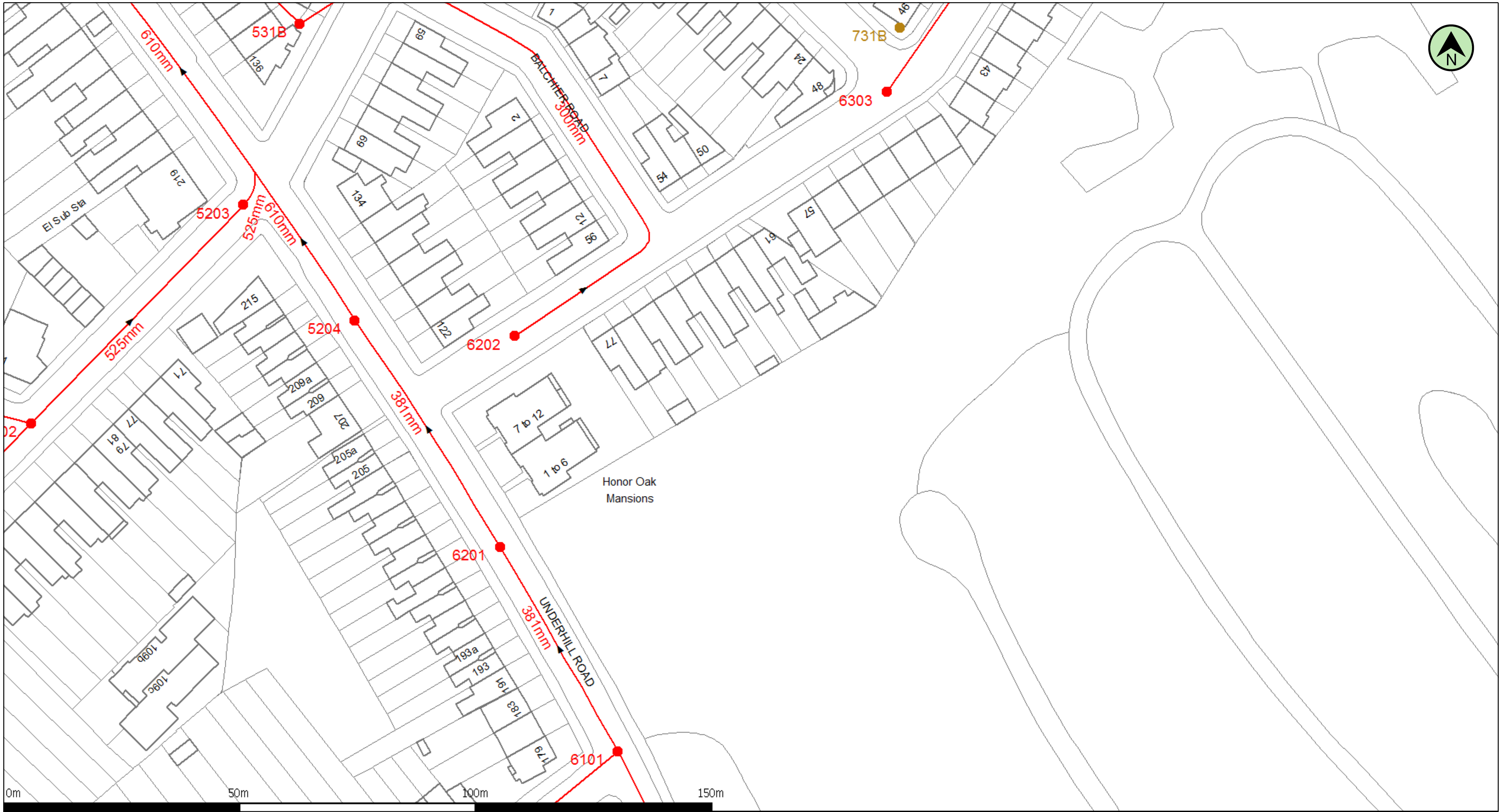
Project Title
CAMBERWELL OLD CEMETARY
PART 1

apr services
land, building surveys & 3D Laser scanning

Block B, 1st Floor
Queens Road
Barnet
London EN5 4DL
t:020 8449 9143
f:020 8449 9153
www.aprservices.net
Area Offices in:
Salisbury and Plymouth

## Appendix C

## Thames Water Sewer Records






Date: 13/05/15 Scale: 1:1144 Map Centre: 534669.1,174236.1 Data updated: 26/03/15 Wastewater Plan A4

Based on the Ordnance Survey Map with the sanction of the Controller of H.M. Stationary Office License Number:- 100019345.This map is to be used for the purposes of viewing the location of Thames Water plant only. Any other uses of the map data orf urther copies are not permitted. The position of the apparatus shown on this plan is given without obligation and warranty, and the accuracy cannot be guaranteed. This information is valid for the date printed. 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 on site before any works are undertaken.

| | |
|---|---|
| Foul Sewer | Foul Manhole |
| Surface Sewer | Surface Manhole |
| Combined Sewer | Combined Manhole |
| Abandoned Sewer | Abandoned Manhole |
| Pressure Main | Other Manhole |
| Private Asset (Colour denotes effluent type) | End Item |
| Proposed Asset (Colour denotes effluent type) | S104 Boundary |

isaac.asante@southwark.gov.uk

ryedale/underhill rd

Thames Water

# Appendix D

# Soakaway Testing Results


N

Base figure provided by the client

**Not to scale**

| Client | Project | Job No |
|---|---|---|
| **BSP Consulting** | **Camberwell Old Cemetery, Southwark** | **CG/18387** |
| CGL | Title<br>**Trial pit location plan** | **Figure 1** |

# TRIAL PIT LOG

CGL

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Camberwell Old Cemetery, Southwark | | | | TP1 |
| Job No: CG/18387 | Date: 12-05-15 | Ground Level (m) | Co-Ordinates (m) | |
| Client: BSP Consulting | | | | Sheet: 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (Thickness) | DESCRIPTION |
| | | | | | | (0.50) 0.50 | Vegetation over soft dark brown slightly gravelly sandy silt. Sand is fine to coarse. Gravel is fine to coarse subrounded to subangular of brick and concrete. [MADE GROUND] |
| | | | | | | (0.60) 1.10 | Firm fissured friable dark orange brown CLAY. [REWORKED LONDON CLAY FORMATION] |
| | | | | | | | *(Pit terminated at 1.1m)* |

DRAFT

## Plan

0.9m × 1.7m

Stability: Stable

## General Remarks

1. No groundwater encountered during excavation.
2 Pit terminated at 1.1mbgl to avoid impacting burial area.
3. Pit backfilled with arisings on completion.
4. Infiltration test undertaken from 0.5mbgl to 1.1mbgl.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Mini digger | Site personnel | JJM | DRAFT |

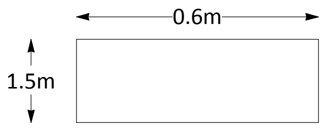
# TRIAL PIT LOG

CGL

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Camberwell Old Cemetery, Southwark | | | | TP2 |
| Job No: CG/18387 | Date: 12-05-15 | Ground Level (m) | Co-Ordinates (m) | |
| Client: BSP Consulting | | | | Sheet: 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (Thickness) | DESCRIPTION |
| | | | | | | 0.05 | Soft dark brown silt. [MADE GROUND] |
| | | | | | | 0.08 | Tarmac. [MADE GROUND] |
| | | | | | | 0.15 | Crushed concrete. [MADE GROUND] |
| | | | | | | 0.20 | Tarmac. [MADE GROUND] |
| | | | | | | (0.10) 0.30 | Loose orange brown silty fine to coarse sand. [MADE GROUND] |
| | | | | | | (0.20) 0.50 | Firm dark orange brown and red orange very gravelly clay. Gravel is fine to coarse subrounded to subangular of brick. [MADE GROUND] |
| | | | | | | (0.50) 1.00 | Firm dark brown gravelly clay. Gravel is fine to coarse subrounded to subangular of brick. [MADE GROUND] |
| | | | | | | (0.10) 1.10 | Firm dark red very gravelly clay. Gravel is fine to coarse subrounded to subangular of brick. Occasional cobble of brick. [MADE GROUND] |
| | | | | | | (0.80) 1.90 | Firm dark orange brown CLAY. [LONDON CLAY FORMATION] |
| | | | | | | | *(Pit terminated at 1.9m)* |

## Plan




Stability: Stable

## General Remarks

1. No groundwater encountered during excavation.
2 Pit terminated at 1.9mbgl to avoid impacting burial area.
3. Pit backfilled with arisings on completion.
4. Infiltration test undertaken from 1.1mbgl to 1.9mbgl.

| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Mini digger | Site personnel | JJM | DRAFT |

# TRIAL PIT LOG

CGL

| Project | | | | TRIAL PIT No |
|---|---|---|---|---|
| Camberwell Old Cemetery, Southwark | | | | **TP3** |
| Job No: CG/18387 | Date: 12-05-15 | Ground Level (m) | Co-Ordinates (m) | |
| Client: BSP Consulting | | | | Sheet: 1 of 1 |

| SAMPLES & TESTS | | | Water | STRATA | | | |
|---|---|---|---|---|---|---|---|
| Depth | Type No | Test Result (N/kPa/ppm) | | Reduced Level | Legend | Depth (Thickness) | DESCRIPTION |
| | | | | | | (0.70) 0.70 | Loose to medium dense dark brown gravelly silty fine to coarse sand. Gravel is fine to coarse subrounded to angular of brick, concrete, ceramic, flint, glass and wood with occasional cobbles of brick and fragments of wood. [MADE GROUND] |
| | | | | | | (0.80) 1.50 | Firm dark brown slightly gravelly sandy clay. Sand is fine to coarse. Gravel is fine to coarse subrounded to subangular of brick and concrete with occasional cobbles of brick. [MADE GROUND] |
| | | | | | | (0.40) 1.90 | Firm fissured friable dark orange brown CLAY. [REWORKED LONDON CLAY FORMATION] |
| | | | | | | | *(Pit terminated at 1.9m)* |

DRAFT

## Plan

0.9m

1.6m

Stability: Stable

## General Remarks

1. No groundwater encountered during excavation.
2 Pit terminated at 1.9mbgl to avoid impacting burial area.
3. Pit backfilled with arisings on completion.
4. Infiltration test undertaken from 1.5mbgl to 1.9mbgl.

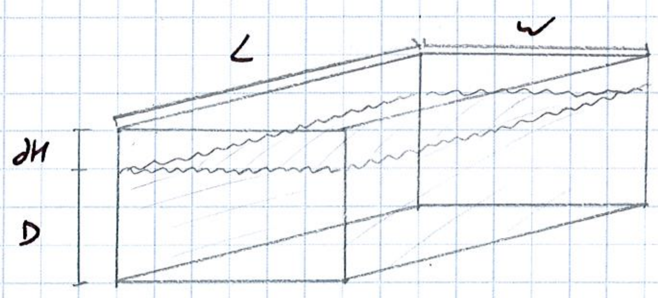
| Method/ Plant Used | Field Crew | Logged By | Checked By |
|---|---|---|---|
| Mini digger | Site personnel | JJM | DRAFT |

# W O R K S H E E T

CGL Providing Ground Solutions
www.cgl-uk.com

| | |
|---|---|
| Client BSP Consulting | |
| Job Title Camberwell Old Cemetery, Southwark | |
| Drawing Ref No. NA | Job No. CG/18387 |
| Date 13/5/15 | Quality Plan |
| Made by JJM | Checked by RJB |

SHEET No. 1 of 1




$r = \frac{\alpha}{\beta}$

$\alpha = \frac{\Delta Vol.}{time} = \frac{\partial H L W}{\partial t}$

$\beta = Area = 2DL + 2DW + LW$

**TP1**

$\partial H = 0.06$ m
$\partial t = 16200$ s
$L = 1.7$ m
$W = 0.9$ m
$D = 0.48$ m

$\alpha = 5.67 \times 10^{-6}$ $m^3/s$
$\beta = 4.026$ $m^2$
$\therefore r = 1.41 \times 10^{-6}$ m/s

**TP2**

$\partial H = 0.08$ m
$\partial t = 12600$ m
$L = 1.5$ m
$W = 0.6$ m
$D = 0.72$ m

$\alpha = 5.71 \times 10^{-6}$ $m^3/s$
$\beta = 3.924$ $m^2$
$\therefore r = 1.46 \times 10^{-6}$ m/s

**TP3**

$\partial H = 0.02$ m
$\partial t = 9000$ s
$L = 1.6$ m
$W = 0.9$ m
$D = 0.38$ m

$\alpha = 3.2 \times 10^{-6}$ $m^3/s$
$\beta = 3.34$
$\therefore r = 9.58 \times 10^{-7}$ m/s

# Appendix E

## WYG Surface Water Calculations

ICP SUDS Mean Annual Flood

Input

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | Soil | 0.450 |
| Area (ha) | 0.350 | Urban | 0.000 |
| SAAR (mm) | 606 | Region Number | Region 6 |

| **Results** | **l/s** |
|---|---|
| QBAR Rural | 1.3 |
| QBAR Urban | 1.3 |
| Q2 years | 1.1 |
| Q1 year | 1.1 |
| Q30 years | 2.9 |
| Q100 years | 4.1 |

## STORM SEWER DESIGN by the Modified Rational Method

## Design Criteria for DRAINAGE MODEL.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

| | |
|---|---|
| Return Period (years) | 2 |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Maximum Rainfall (mm/hr) | 50 |
| Maximum Time of Concentration (mins) | 30 |
| Foul Sewage (l/s/ha) | 0.000 |
| Volumetric Runoff Coeff. | 0.750 |
| Add Flow / Climate Change (%) | 0 |
| Minimum Backdrop Height (m) | 0.200 |
| Maximum Backdrop Height (m) | 0.000 |
| Min Design Depth for Optimisation (m) | 1.200 |
| Min Vel for Auto Design only (m/s) | 0.75 |
| Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

## Time Area Diagram for DRAINAGE MODEL.SWS

| **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** |
|---|---|---|---|
| 0-4 | 0.067 | 4-8 | 0.029 |

Total Area Contributing (ha) = 0.096

Total Pipe Volume (m³) = 10.318

## Network Design Table for DRAINAGE MODEL.SWS

« - Indicates pipe capacity < flow

| **PN** | **Length (m)** | **Fall (m)** | **Slope (1:X)** | **I.Area (ha)** | **T.E. (mins)** | **Base Flow (l/s)** | **k (mm)** | **HYD SECT** | **DIA (mm)** | **Auto Design** |
|---|---|---|---|---|---|---|---|---|---|---|

## Network Results Table

Network Design Table for DRAINAGE MODEL.SWS

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|

## Network Design Table for DRAINAGE MODEL.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 14.014 | 0.100 | 140.1 | 0.006 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S1.001 | 5.839 | 1.350 | 4.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.002 | 11.379 | 0.500 | 22.8 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S2.000 | 13.448 | 0.100 | 134.5 | 0.004 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S2.001 | 6.456 | 1.350 | 4.8 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.003 | 12.434 | 1.500 | 8.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S1.004 | 5.217 | 0.113 | 46.2 | 0.027 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S3.000 | 11.951 | 0.100 | 119.5 | 0.003 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S3.001 | 7.464 | 1.463 | 5.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.005 | 9.491 | 0.387 | 24.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S4.000 | 12.262 | 0.100 | 122.6 | 0.003 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S4.001 | 8.349 | 1.350 | 6.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.006 | 16.015 | 2.000 | 8.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S5.000 | 12.577 | 0.100 | 125.8 | 0.007 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S5.001 | 5.899 | 1.350 | 4.4 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.000 | 50.00 | 5.28 | 54.100 | 0.006 | 0.0 | 0.0 | 0.0 | 0.85 | 15.0 | 0.8 |
| S1.001 | 50.00 | 5.30 | 54.000 | 0.006 | 0.0 | 0.0 | 0.0 | 4.88 | 86.2 | 0.8 |
| S1.002 | 50.00 | 5.35 | 52.500 | 0.006 | 0.0 | 0.0 | 0.0 | 3.31 | 234.0 | 0.8 |
| S2.000 | 50.00 | 5.26 | 53.600 | 0.004 | 0.0 | 0.0 | 0.0 | 0.86 | 15.3 | 0.5 |
| S2.001 | 50.00 | 5.28 | 53.500 | 0.004 | 0.0 | 0.0 | 0.0 | 4.64 | 82.0 | 0.5 |
| S1.003 | 50.00 | 5.39 | 52.000 | 0.010 | 0.0 | 0.0 | 0.0 | 5.49 | 388.3 | 1.4 |
| S1.004 | 50.00 | 5.43 | 50.500 | 0.037 | 0.0 | 0.0 | 0.0 | 2.32 | 164.0 | 5.0 |
| S3.000 | 50.00 | 5.22 | 52.100 | 0.003 | 0.0 | 0.0 | 0.0 | 0.92 | 16.2 | 0.4 |
| S3.001 | 50.00 | 5.24 | 52.000 | 0.003 | 0.0 | 0.0 | 0.0 | 4.49 | 79.4 | 0.4 |
| S1.005 | 50.00 | 5.48 | 50.387 | 0.040 | 0.0 | 0.0 | 0.0 | 3.19 | 225.3 | 5.4 |
| S4.000 | 50.00 | 5.23 | 51.600 | 0.003 | 0.0 | 0.0 | 0.0 | 0.91 | 16.0 | 0.4 |
| S4.001 | 50.00 | 5.26 | 51.500 | 0.003 | 0.0 | 0.0 | 0.0 | 4.08 | 72.1 | 0.4 |
| S1.006 | 50.00 | 5.53 | 50.000 | 0.043 | 0.0 | 0.0 | 0.0 | 5.59 | 395.1 | 5.8 |
| S5.000 | 50.00 | 5.23 | 49.600 | 0.007 | 0.0 | 0.0 | 0.0 | 0.89 | 15.8 | 0.9 |
| S5.001 | 50.00 | 5.25 | 49.500 | 0.007 | 0.0 | 0.0 | 0.0 | 4.86 | 85.8 | 0.9 |

## Network Design Table for DRAINAGE MODEL.SWS

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.007 | 13.378 | 1.500 | 8.9 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S6.000 | 10.054 | 0.100 | 100.5 | 0.005 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S6.001 | 5.766 | 1.350 | 4.3 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.008 | 10.047 | 1.000 | 10.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S7.000 | 11.480 | 0.100 | 114.8 | 0.004 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S7.001 | 5.335 | 1.350 | 4.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.009 | 12.673 | 1.000 | 12.7 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S8.000 | 8.019 | 0.100 | 80.2 | 0.004 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S8.001 | 5.591 | 0.850 | 6.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.010 | 9.758 | 0.500 | 19.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | |
| S9.000 | 12.362 | 0.100 | 123.6 | 0.033 | 5.00 | 0.0 | 0.600 | o | 150 | |
| S9.001 | 18.382 | 1.350 | 13.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 150 | |
| S1.011 | 15.910 | 0.155 | 102.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 100 | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| S1.007 | 50.00 | 5.57 | 48.000 | 0.050 | 0.0 | 0.0 | 0.0 | 5.30 | 374.3 | 6.8 |
| S6.000 | 50.00 | 5.17 | 48.100 | 0.005 | 0.0 | 0.0 | 0.0 | 1.00 | 17.7 | 0.7 |
| S6.001 | 50.00 | 5.19 | 48.000 | 0.005 | 0.0 | 0.0 | 0.0 | 4.91 | 86.8 | 0.7 |
| S1.008 | 50.00 | 5.60 | 46.500 | 0.055 | 0.0 | 0.0 | 0.0 | 4.99 | 352.6 | 7.4 |
| S7.000 | 50.00 | 5.20 | 47.100 | 0.004 | 0.0 | 0.0 | 0.0 | 0.94 | 16.6 | 0.5 |
| S7.001 | 50.00 | 5.22 | 47.000 | 0.004 | 0.0 | 0.0 | 0.0 | 5.11 | 90.2 | 0.5 |
| S1.009 | 50.00 | 5.65 | 45.500 | 0.059 | 0.0 | 0.0 | 0.0 | 4.44 | 313.8 | 8.0 |
| S8.000 | 50.00 | 5.12 | 45.600 | 0.004 | 0.0 | 0.0 | 0.0 | 1.12 | 19.9 | 0.5 |
| S8.001 | 50.00 | 5.14 | 45.500 | 0.004 | 0.0 | 0.0 | 0.0 | 3.95 | 69.9 | 0.5 |
| S1.010 | 50.00 | 5.69 | 44.500 | 0.063 | 0.0 | 0.0 | 0.0 | 3.58 | 252.7 | 8.5 |
| S9.000 | 50.00 | 5.23 | 45.600 | 0.033 | 0.0 | 0.0 | 0.0 | 0.90 | 15.9 | 4.5 |
| S9.001 | 50.00 | 5.34 | 45.500 | 0.033 | 0.0 | 0.0 | 0.0 | 2.74 | 48.5 | 4.5 |
| S1.011 | 50.00 | 6.04 | 44.000 | 0.096 | 0.0 | 0.0 | 0.0 | 0.76 | 6.0« | 13.0 |

## Area Summary for DRAINAGE MODEL.SWS

| Pipe Number | PIMP Type | PIMP Name | PIMP (%) | Gross Area (ha) | Imp. Area (ha) | Pipe Total (ha) |
|---|---|---|---|---|---|---|
| 1.000 | - | - | 100 | 0.006 | 0.006 | 0.006 |
| 1.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.002 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 2.000 | - | - | 100 | 0.004 | 0.004 | 0.004 |
| 2.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.003 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.004 | - | - | 100 | 0.027 | 0.027 | 0.027 |
| 3.000 | - | - | 100 | 0.003 | 0.003 | 0.003 |
| 3.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.005 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 4.000 | - | - | 100 | 0.003 | 0.003 | 0.003 |
| 4.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.006 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 5.000 | - | - | 100 | 0.007 | 0.007 | 0.007 |
| 5.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.007 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 6.000 | - | - | 100 | 0.005 | 0.005 | 0.005 |
| 6.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.008 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 7.000 | - | - | 100 | 0.004 | 0.004 | 0.004 |
| 7.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.009 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 8.000 | - | - | 100 | 0.004 | 0.004 | 0.004 |
| 8.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.010 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 9.000 | - | - | 100 | 0.033 | 0.033 | 0.033 |
| 9.001 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| 1.011 | - | - | 100 | 0.000 | 0.000 | 0.000 |
| | | | | Total | Total | Total |
| | | | | 0.096 | 0.096 | 0.096 |

## Free Flowing Outfall Details for DRAINAGE MODEL.SWS

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| S1.011 | S30 | 45.500 | 43.845 | 0.000 | 0 | 0 |

## Simulation Criteria for DRAINAGE MODEL.SWS

| | | | |
|---|---|---|---|
| Volumetric Runoff Coeff | 0.750 | Additional Flow - % of Total Flow | 0.000 |
| Areal Reduction Factor | 1.000 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start (mins) | 0 | Inlet Coeffiecient | 0.800 |
| Hot Start Level (mm) | 0 | Flow per Person per Day (l/per/day) | 0.000 |
| Manhole Headloss Coeff (Global) | 0.500 | Run Time (mins) | 60 |
| Foul Sewage per hectare (l/s) | 0.000 | Output Interval (mins) | 1 |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 10 |
| Number of Online Controls | 10 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Return Period (years) | 2 |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Summer Storms | Yes |
| Winter Storms | No |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |
| Storm Duration (mins) | 30 |

## Online Controls for DRAINAGE MODEL.SWS

### Weir Manhole: S2, DS/PN: S1.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 54.400

### Weir Manhole: S4, DS/PN: S2.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 53.900

### Weir Manhole: S8, DS/PN: S3.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 52.400

### Weir Manhole: S11, DS/PN: S4.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 51.900

### Weir Manhole: S14, DS/PN: S5.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 49.800

### Weir Manhole: S17, DS/PN: S6.001, Volume ($m^3$): 0.7

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 48.400

### Weir Manhole: S20, DS/PN: S7.001, Volume ($m^3$): 0.7

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 47.400

### Weir Manhole: S23, DS/PN: S8.001, Volume ($m^3$): 0.7

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 45.900

### Weir Manhole: S25, DS/PN: S9.001, Volume ($m^3$): 0.8

Discharge Coef 0.544 Width (m) 0.300 Invert Level (m) 45.500

### Pump Manhole: S30, DS/PN: S1.011, Volume ($m^3$): 2.6

Invert Level (m) 44.000

## Storage Structures for DRAINAGE MODEL.SWS

### Filter Drain Manhole: S2, DS/PN: S1.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 41.3 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 54.000 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

### Filter Drain Manhole: S4, DS/PN: S2.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 18.8 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 53.500 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

### Filter Drain Manhole: S8, DS/PN: S3.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 42.9 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 52.000 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

### Filter Drain Manhole: S11, DS/PN: S4.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 32.6 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 51.500 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

### Filter Drain Manhole: S14, DS/PN: S5.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 49.0 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 49.500 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

## Filter Drain Manhole: S17, DS/PN: S6.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 43.3 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 48.000 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

## Filter Drain Manhole: S20, DS/PN: S7.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 36.3 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 47.000 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

## Filter Drain Manhole: S23, DS/PN: S8.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 22.4 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 45.500 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

## Filter Drain Manhole: S25, DS/PN: S9.001

| | | | |
|---|---|---|---|
| Infiltration Coefficient Base (m/hr) | 0.00508 | Trench Length (m) | 94.5 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | Pipe Diameter (m) | 0.150 |
| Safety Factor | 2.0 | Pipe Depth above Invert (m) | 0.000 |
| Porosity | 0.30 | Slope (1:X) | 500.0 |
| Invert Level (m) | 45.500 | Cap Volume Depth (m) | 0.500 |
| Trench Width (m) | 0.3 | Cap Infiltration Depth (m) | 0.500 |

## Cellular Storage Manhole: S30, DS/PN: S1.011

| | | | |
|---|---|---|---|
| Invert Level (m) | 44.000 | Safety Factor | 2.0 |
| Infiltration Coefficient Base (m/hr) | 0.00508 | Porosity | 0.95 |
| Infiltration Coefficient Side (m/hr) | 0.00508 | | |

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 90.0 | 90.0 | 1.100 | 0.0 | 136.0 |
| 1.000 | 90.0 | 136.0 | | | |

## 1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

### Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 10
Number of Online Controls 10 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080 |
| Return Period(s) (years) | 1, 10, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | 1440 Winter | 1 | 0% | 10/600 Winter | | | | |
| S1.001 | 1440 Winter | 1 | 0% | 10/60 Winter | | | | |
| S1.002 | 360 Winter | 1 | 0% | | | | | |
| S2.000 | 2160 Winter | 1 | 0% | 10/360 Winter | | | | |
| S2.001 | 2160 Winter | 1 | 0% | 1/960 Winter | | | | |
| S1.003 | 360 Winter | 1 | 0% | | | | | |
| S1.004 | 15 Winter | 1 | 0% | | | | | |
| S3.000 | 15 Winter | 1 | 0% | 100/120 Winter | | | | |
| S3.001 | 960 Winter | 1 | 0% | 30/240 Winter | | | | |
| S1.005 | 15 Winter | 1 | 0% | | | | | |
| S4.000 | 15 Winter | 1 | 0% | 100/60 Winter | | | | |
| S4.001 | 960 Winter | 1 | 0% | 30/120 Winter | | | | |
| S1.006 | 15 Winter | 1 | 0% | | | | | |

## 1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S5.000 | 1440 Winter | 1 | 0% | 10/360 Winter | | | | |
| S5.001 | 1440 Winter | 1 | 0% | 1/600 Winter | | | | |
| S1.007 | 15 Winter | 1 | 0% | | | | | |
| S6.000 | 1440 Winter | 1 | 0% | 30/240 Winter | | | | |
| S6.001 | 1440 Winter | 1 | 0% | 10/120 Winter | | | | |
| S1.008 | 15 Winter | 1 | 0% | | | | | |
| S7.000 | 15 Winter | 1 | 0% | 30/600 Winter | | | | |
| S7.001 | 960 Winter | 1 | 0% | 10/180 Winter | | | | |
| S1.009 | 15 Winter | 1 | 0% | | | | | |
| S8.000 | 1440 Winter | 1 | 0% | 10/480 Winter | | | | |
| S8.001 | 1440 Winter | 1 | 0% | 10/60 Winter | | | | |
| S1.010 | 15 Winter | 1 | 0% | 100/480 Winter | | | | |
| S9.000 | 15 Winter | 1 | 0% | 100/15 Summer | | | | |
| S9.001 | 15 Winter | 1 | 0% | | | | | |
| S1.011 | 2880 Winter | 1 | 0% | 1/180 Winter | | | | |

| PN | US/MH Name | Water Level (m) | Surch'ed Depth (m) | Flooded Volume (m³) | Flow / Cap. | O'flow (l/s) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 54.147 | -0.103 | 0.000 | 0.00 | 0.0 | 0.1 | OK |
| S1.001 | S2 | 54.147 | -0.003 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.002 | S3 | 52.500 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S2.000 | S4 | 53.655 | -0.095 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S2.001 | S4 | 53.655 | 0.005 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |
| S1.003 | S5 | 52.000 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.004 | S6 | 50.538 | -0.262 | 0.000 | 0.04 | 0.0 | 3.2 | OK |
| S3.000 | S8 | 52.117 | -0.133 | 0.000 | 0.03 | 0.0 | 0.4 | OK |
| S3.001 | S8 | 52.090 | -0.060 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.005 | S9 | 50.417 | -0.270 | 0.000 | 0.02 | 0.0 | 3.2 | OK |
| S4.000 | S11 | 51.617 | -0.133 | 0.000 | 0.03 | 0.0 | 0.4 | OK |
| S4.001 | S11 | 51.596 | -0.054 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.006 | S12 | 50.014 | -0.286 | 0.000 | 0.01 | 0.0 | 3.2 | OK |
| S5.000 | S14 | 49.656 | -0.094 | 0.000 | 0.00 | 0.0 | 0.1 | OK |
| S5.001 | S14 | 49.656 | 0.006 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |
| S1.007 | S15 | 48.015 | -0.285 | 0.000 | 0.01 | 0.0 | 3.2 | OK |
| S6.000 | S17 | 48.128 | -0.122 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S6.001 | S17 | 48.128 | -0.022 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.008 | S18 | 46.518 | -0.282 | 0.000 | 0.01 | 0.0 | 3.2 | OK |
| S7.000 | S20 | 47.119 | -0.131 | 0.000 | 0.04 | 0.0 | 0.6 | OK |
| S7.001 | S20 | 47.115 | -0.035 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.009 | S21 | 45.518 | -0.282 | 0.000 | 0.01 | 0.0 | 3.2 | OK |
| S8.000 | S23 | 45.648 | -0.102 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S8.001 | S23 | 45.648 | -0.002 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.010 | S24 | 44.526 | -0.274 | 0.000 | 0.02 | 0.0 | 3.2 | OK |
| S9.000 | S26 | 45.659 | -0.091 | 0.000 | 0.31 | 0.0 | 4.6 | OK |
| S9.001 | S25 | 45.560 | -0.090 | 0.000 | 0.10 | 0.0 | 4.5 | OK |
| S1.011 | S30 | 44.165 | 0.065 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |

## 10 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

### Simulation Criteria

| | | | |
|---|---|---|---|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coeffiecient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 10 |
| Number of Online Controls | 10 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | OFF |
| DTS Status | ON | | |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080 |
| Return Period(s) (years) | 1, 10, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | 1440 Winter | 10 | 0% | 10/600 Winter | | | | |
| S1.001 | 1440 Winter | 10 | 0% | 10/60 Winter | | | | |
| S1.002 | 360 Winter | 10 | 0% | | | | | |
| S2.000 | 1440 Winter | 10 | 0% | 10/360 Winter | | | | |
| S2.001 | 1440 Winter | 10 | 0% | 1/960 Winter | | | | |
| S1.003 | 360 Winter | 10 | 0% | | | | | |
| S1.004 | 15 Winter | 10 | 0% | | | | | |
| S3.000 | 720 Winter | 10 | 0% | 100/120 Winter | | | | |
| S3.001 | 720 Winter | 10 | 0% | 30/240 Winter | | | | |
| S1.005 | 15 Summer | 10 | 0% | | | | | |
| S4.000 | 960 Winter | 10 | 0% | 100/60 Winter | | | | |
| S4.001 | 960 Winter | 10 | 0% | 30/120 Winter | | | | |
| S1.006 | 15 Summer | 10 | 0% | | | | | |

10 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S5.000 | 1440 Winter | 10 | 0% | 10/360 Winter | | | | |
| S5.001 | 1440 Winter | 10 | 0% | 1/600 Winter | | | | |
| S1.007 | 15 Summer | 10 | 0% | | | | | |
| S6.000 | 960 Winter | 10 | 0% | 30/240 Winter | | | | |
| S6.001 | 960 Winter | 10 | 0% | 10/120 Winter | | | | |
| S1.008 | 15 Winter | 10 | 0% | | | | | |
| S7.000 | 960 Winter | 10 | 0% | 30/600 Winter | | | | |
| S7.001 | 960 Winter | 10 | 0% | 10/180 Winter | | | | |
| S1.009 | 15 Winter | 10 | 0% | | | | | |
| S8.000 | 960 Winter | 10 | 0% | 10/480 Winter | | | | |
| S8.001 | 960 Winter | 10 | 0% | 10/60 Winter | | | | |
| S1.010 | 15 Summer | 10 | 0% | 100/480 Winter | | | | |
| S9.000 | 15 Winter | 10 | 0% | 100/15 Summer | | | | |
| S9.001 | 15 Winter | 10 | 0% | | | | | |
| S1.011 | 2880 Winter | 10 | 0% | 1/180 Winter | | | | |

| PN | US/MH Name | Water Level (m) | Surch'ed Depth (m) | Flooded Volume (m³) | Flow / Cap. | O'flow (l/s) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 54.264 | 0.014 | 0.000 | 0.01 | 0.0 | 0.1 | SURCHARGED |
| S1.001 | S2 | 54.264 | 0.114 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.002 | S3 | 52.500 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S2.000 | S4 | 53.799 | 0.049 | 0.000 | 0.00 | 0.0 | 0.1 | SURCHARGED |
| S2.001 | S4 | 53.799 | 0.149 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.003 | S5 | 52.000 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.004 | S6 | 50.565 | -0.235 | 0.000 | 0.11 | 0.0 | 8.9 | OK |
| S3.000 | S8 | 52.132 | -0.118 | 0.000 | 0.01 | 0.0 | 0.1 | OK |
| S3.001 | S8 | 52.132 | -0.018 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.005 | S9 | 50.433 | -0.254 | 0.000 | 0.06 | 0.0 | 8.9 | OK |
| S4.000 | S11 | 51.646 | -0.104 | 0.000 | 0.00 | 0.0 | 0.1 | OK |
| S4.001 | S11 | 51.646 | -0.004 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.006 | S12 | 50.033 | -0.267 | 0.000 | 0.03 | 0.0 | 8.9 | OK |
| S5.000 | S14 | 49.782 | 0.032 | 0.000 | 0.01 | 0.0 | 0.1 | SURCHARGED |
| S5.001 | S14 | 49.782 | 0.132 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.007 | S15 | 48.034 | -0.266 | 0.000 | 0.03 | 0.0 | 8.9 | OK |
| S6.000 | S17 | 48.207 | -0.043 | 0.000 | 0.01 | 0.0 | 0.1 | OK |
| S6.001 | S17 | 48.207 | 0.057 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.008 | S18 | 46.536 | -0.264 | 0.000 | 0.04 | 0.0 | 8.8 | OK |
| S7.000 | S20 | 47.182 | -0.068 | 0.000 | 0.00 | 0.0 | 0.1 | OK |
| S7.001 | S20 | 47.181 | 0.031 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |
| S1.009 | S21 | 45.536 | -0.264 | 0.000 | 0.04 | 0.0 | 8.8 | OK |
| S8.000 | S23 | 45.774 | 0.024 | 0.000 | 0.00 | 0.0 | 0.1 | SURCHARGED |
| S8.001 | S23 | 45.774 | 0.124 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.010 | S24 | 44.543 | -0.257 | 0.000 | 0.05 | 0.0 | 8.9 | OK |
| S9.000 | S26 | 45.693 | -0.057 | 0.000 | 0.69 | 0.0 | 10.0 | OK |
| S9.001 | S25 | 45.583 | -0.067 | 0.000 | 0.22 | 0.0 | 10.0 | OK |
| S1.011 | S30 | 44.321 | 0.221 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

### Simulation Criteria

| | | | |
|---|---|---|---|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coeffiecient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 10 |
| Number of Online Controls | 10 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | OFF |
| DTS Status | ON | | |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080 |
| Return Period(s) (years) | 1, 10, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S1.000 | 720 Winter | 30 | 0% | 10/600 Winter | | | | |
| S1.001 | 720 Winter | 30 | 0% | 10/60 Winter | | | | |
| S1.002 | 360 Winter | 30 | 0% | | | | | |
| S2.000 | 1440 Winter | 30 | 0% | 10/360 Winter | | | | |
| S2.001 | 1440 Winter | 30 | 0% | 1/960 Winter | | | | |
| S1.003 | 360 Winter | 30 | 0% | | | | | |
| S1.004 | 15 Winter | 30 | 0% | | | | | |
| S3.000 | 720 Winter | 30 | 0% | 100/120 Winter | | | | |
| S3.001 | 720 Winter | 30 | 0% | 30/240 Winter | | | | |
| S1.005 | 15 Summer | 30 | 0% | | | | | |
| S4.000 | 960 Winter | 30 | 0% | 100/60 Winter | | | | |
| S4.001 | 960 Winter | 30 | 0% | 30/120 Winter | | | | |
| S1.006 | 15 Summer | 30 | 0% | | | | | |

## 30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S5.000 | 480 Winter | 30 | 0% | 10/360 Winter | | | | |
| S5.001 | 480 Winter | 30 | 0% | 1/600 Winter | | | | |
| S1.007 | 15 Summer | 30 | 0% | | | | | |
| S6.000 | 720 Winter | 30 | 0% | 30/240 Winter | | | | |
| S6.001 | 960 Winter | 30 | 0% | 10/120 Winter | | | | |
| S1.008 | 15 Winter | 30 | 0% | | | | | |
| S7.000 | 720 Winter | 30 | 0% | 30/600 Winter | | | | |
| S7.001 | 720 Winter | 30 | 0% | 10/180 Winter | | | | |
| S1.009 | 15 Winter | 30 | 0% | | | | | |
| S8.000 | 960 Winter | 30 | 0% | 10/480 Winter | | | | |
| S8.001 | 960 Winter | 30 | 0% | 10/60 Winter | | | | |
| S1.010 | 15 Summer | 30 | 0% | 100/480 Winter | | | | |
| S9.000 | 15 Winter | 30 | 0% | 100/15 Summer | | | | |
| S9.001 | 15 Winter | 30 | 0% | | | | | |
| S1.011 | 2880 Winter | 30 | 0% | 1/180 Winter | | | | |

| PN | US/MH Name | Water Level (m) | Surch'ed Depth (m) | Flooded Volume (m³) | Flow / Cap. | O'flow (l/s) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 54.375 | 0.125 | 0.000 | 0.01 | 0.0 | 0.2 | FLOOD RISK |
| S1.001 | S2 | 54.376 | 0.226 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.002 | S3 | 52.500 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S2.000 | S4 | 53.905 | 0.155 | 0.000 | 0.00 | 0.0 | 0.1 | FLOOD RISK |
| S2.001 | S4 | 53.905 | 0.255 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.003 | S5 | 52.000 | -0.300 | 0.000 | 0.00 | 0.0 | 0.0 | OK |
| S1.004 | S6 | 50.579 | -0.221 | 0.000 | 0.16 | 0.0 | 13.1 | OK |
| S3.000 | S8 | 52.165 | -0.085 | 0.000 | 0.01 | 0.0 | 0.1 | OK |
| S3.001 | S8 | 52.165 | 0.015 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |
| S1.005 | S9 | 50.445 | -0.242 | 0.000 | 0.08 | 0.0 | 13.2 | OK |
| S4.000 | S11 | 51.693 | -0.057 | 0.000 | 0.01 | 0.0 | 0.1 | OK |
| S4.001 | S11 | 51.693 | 0.043 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |
| S1.006 | S12 | 50.039 | -0.261 | 0.000 | 0.04 | 0.0 | 13.2 | OK |
| S5.000 | S14 | 49.815 | 0.065 | 0.000 | 0.02 | 0.0 | 0.3 | FLOOD RISK |
| S5.001 | S14 | 49.815 | 0.165 | 0.000 | 0.00 | 0.0 | 0.1 | FLOOD RISK |
| S1.007 | S15 | 48.040 | -0.260 | 0.000 | 0.04 | 0.0 | 13.1 | OK |
| S6.000 | S17 | 48.298 | 0.048 | 0.000 | 0.01 | 0.0 | 0.2 | SURCHARGED |
| S6.001 | S17 | 48.298 | 0.148 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.008 | S18 | 46.544 | -0.256 | 0.000 | 0.05 | 0.0 | 13.0 | OK |
| S7.000 | S20 | 47.257 | 0.007 | 0.000 | 0.01 | 0.0 | 0.1 | SURCHARGED |
| S7.001 | S20 | 47.257 | 0.107 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.009 | S21 | 45.544 | -0.256 | 0.000 | 0.05 | 0.0 | 13.1 | OK |
| S8.000 | S23 | 45.887 | 0.137 | 0.000 | 0.00 | 0.0 | 0.1 | FLOOD RISK |
| S8.001 | S23 | 45.887 | 0.237 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.010 | S24 | 44.554 | -0.246 | 0.000 | 0.07 | 0.0 | 13.1 | OK |
| S9.000 | S26 | 45.734 | -0.016 | 0.000 | 1.00 | 0.0 | 14.5 | OK |
| S9.001 | S25 | 45.596 | -0.054 | 0.000 | 0.32 | 0.0 | 14.4 | OK |
| S1.011 | S30 | 44.442 | 0.342 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |

## 100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

### Simulation Criteria

| | | | |
|---|---|---|---|
| Areal Reduction Factor | 1.000 | Additional Flow - % of Total Flow | 0.000 |
| Hot Start (mins) | 0 | MADD Factor * 10m³/ha Storage | 2.000 |
| Hot Start Level (mm) | 0 | Inlet Coeffiecient | 0.800 |
| Manhole Headloss Coeff (Global) | 0.500 | Flow per Person per Day (l/per/day) | 0.000 |
| Foul Sewage per hectare (l/s) | 0.000 | | |

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 10 |
| Number of Online Controls | 10 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

### Synthetic Rainfall Details

| | |
|---|---|
| Rainfall Model | FEH |
| Site Location | GB 534700 174650 TQ 34700 74650 |
| C (1km) | -0.024 |
| D1 (1km) | 0.343 |
| D2 (1km) | 0.318 |
| D3 (1km) | 0.218 |
| E (1km) | 0.313 |
| F (1km) | 2.533 |
| Cv (Summer) | 0.750 |
| Cv (Winter) | 0.840 |

| | | | |
|---|---|---|---|
| Margin for Flood Risk Warning (mm) | 300.0 | DVD Status | OFF |
| Analysis Timestep | Fine | Inertia Status | OFF |
| DTS Status | ON | | |

| | |
|---|---|
| Profile(s) | Summer and Winter |
| Duration(s) (mins) | 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080 |
| Return Period(s) (years) | 1, 10, 30, 100 |
| Climate Change (%) | 0, 0, 0, 40 |

| **PN** | **Storm** | **Return Period** | **Climate Change** | **First X Surcharge** | **First Y Flood** | **First Z Overflow** | **O/F Act.** | **Lvl Exc.** |
|---|---|---|---|---|---|---|---|---|
| S1.000 | 120 Winter | 100 | +40% | 10/600 Winter | | | | |
| S1.001 | 120 Winter | 100 | +40% | 10/60 Winter | | | | |
| S1.002 | 120 Winter | 100 | +40% | | | | | |
| S2.000 | 120 Winter | 100 | +40% | 10/360 Winter | | | | |
| S2.001 | 120 Winter | 100 | +40% | 1/960 Winter | | | | |
| S1.003 | 120 Winter | 100 | +40% | | | | | |
| S1.004 | 15 Winter | 100 | +40% | | | | | |
| S3.000 | 720 Winter | 100 | +40% | 100/120 Winter | | | | |
| S3.001 | 720 Winter | 100 | +40% | 30/240 Winter | | | | |
| S1.005 | 15 Winter | 100 | +40% | | | | | |
| S4.000 | 960 Winter | 100 | +40% | 100/60 Winter | | | | |
| S4.001 | 960 Winter | 100 | +40% | 30/120 Winter | | | | |
| S1.006 | 15 Summer | 100 | +40% | | | | | |

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for DRAINAGE MODEL.SWS

| PN | Storm | Return Period | Climate Change | First X Surcharge | First Y Flood | First Z Overflow | O/F Act. | Lvl Exc. |
|---|---|---|---|---|---|---|---|---|
| S5.000 | 30 Winter | 100 | +40% | 10/360 Winter | | | | |
| S5.001 | 30 Winter | 100 | +40% | 1/600 Winter | | | | |
| S1.007 | 15 Summer | 100 | +40% | | | | | |
| S6.000 | 240 Winter | 100 | +40% | 30/240 Winter | | | | |
| S6.001 | 240 Winter | 100 | +40% | 10/120 Winter | | | | |
| S1.008 | 15 Summer | 100 | +40% | | | | | |
| S7.000 | 360 Winter | 100 | +40% | 30/600 Winter | | | | |
| S7.001 | 360 Winter | 100 | +40% | 10/180 Winter | | | | |
| S1.009 | 15 Winter | 100 | +40% | | | | | |
| S8.000 | 120 Winter | 100 | +40% | 10/480 Winter | | | | |
| S8.001 | 120 Winter | 100 | +40% | 10/60 Winter | | | | |
| S1.010 | 2880 Winter | 100 | +40% | 100/480 Winter | | | | |
| S9.000 | 15 Winter | 100 | +40% | 100/15 Summer | | | | |
| S9.001 | 15 Winter | 100 | +40% | | | | | |
| S1.011 | 2880 Winter | 100 | +40% | 1/180 Winter | | | | |

| PN | US/MH Name | Water Level (m) | Surch'ed Depth (m) | Flooded Volume (m³) | Flow / Cap. | O'flow (l/s) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 54.436 | 0.186 | 0.000 | 0.09 | 0.0 | 1.2 | FLOOD RISK |
| S1.001 | S2 | 54.432 | 0.282 | 0.000 | 0.01 | 0.0 | 0.9 | FLOOD RISK |
| S1.002 | S3 | 52.507 | -0.293 | 0.000 | 0.01 | 0.0 | 0.9 | OK |
| S2.000 | S4 | 53.931 | 0.181 | 0.000 | 0.05 | 0.0 | 0.7 | FLOOD RISK |
| S2.001 | S4 | 53.928 | 0.278 | 0.000 | 0.01 | 0.0 | 0.6 | FLOOD RISK |
| S1.003 | S5 | 52.007 | -0.293 | 0.000 | 0.00 | 0.0 | 1.5 | OK |
| S1.004 | S6 | 50.619 | -0.181 | 0.000 | 0.33 | 0.0 | 28.0 | OK |
| S3.000 | S8 | 52.352 | 0.102 | 0.000 | 0.01 | 0.0 | 0.2 | FLOOD RISK |
| S3.001 | S8 | 52.352 | 0.202 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.005 | S9 | 50.472 | -0.215 | 0.000 | 0.18 | 0.0 | 28.0 | OK |
| S4.000 | S11 | 51.908 | 0.158 | 0.000 | 0.01 | 0.0 | 0.1 | FLOOD RISK |
| S4.001 | S11 | 51.908 | 0.258 | 0.000 | 0.00 | 0.0 | 0.0 | FLOOD RISK |
| S1.006 | S12 | 50.059 | -0.241 | 0.000 | 0.08 | 0.0 | 28.1 | OK |
| S5.000 | S14 | 49.856 | 0.106 | 0.000 | 0.28 | 0.0 | 4.1 | FLOOD RISK |
| S5.001 | S14 | 49.846 | 0.196 | 0.000 | 0.03 | 0.0 | 2.3 | FLOOD RISK |
| S1.007 | S15 | 48.061 | -0.239 | 0.000 | 0.09 | 0.0 | 28.0 | OK |
| S6.000 | S17 | 48.425 | 0.175 | 0.000 | 0.04 | 0.0 | 0.6 | FLOOD RISK |
| S6.001 | S17 | 48.423 | 0.273 | 0.000 | 0.01 | 0.0 | 0.4 | FLOOD RISK |
| S1.008 | S18 | 46.567 | -0.233 | 0.000 | 0.11 | 0.0 | 27.8 | OK |
| S7.000 | S20 | 47.419 | 0.169 | 0.000 | 0.02 | 0.0 | 0.3 | FLOOD RISK |
| S7.001 | S20 | 47.418 | 0.268 | 0.000 | 0.00 | 0.0 | 0.2 | FLOOD RISK |
| S1.009 | S21 | 45.566 | -0.234 | 0.000 | 0.11 | 0.0 | 27.8 | OK |
| S8.000 | S23 | 45.929 | 0.179 | 0.000 | 0.04 | 0.0 | 0.7 | FLOOD RISK |
| S8.001 | S23 | 45.927 | 0.277 | 0.000 | 0.01 | 0.0 | 0.6 | FLOOD RISK |
| S1.010 | S24 | 45.014 | 0.214 | 0.000 | 0.01 | 0.0 | 1.0 | SURCHARGED |
| S9.000 | S26 | 46.087 | 0.337 | 0.000 | 2.08 | 0.0 | 30.1 | FLOOD RISK |
| S9.001 | S25 | 45.649 | -0.001 | 0.000 | 0.65 | 0.0 | 29.5 | OK |
| S1.011 | S30 | 45.014 | 0.914 | 0.000 | 0.00 | 0.0 | 0.0 | SURCHARGED |

bsp CONSULTING

Floor 4
24 De Montfort Street
Leicester
LE1 7GB
T: 0116 204 7766
F: 0116 204 7769
info@bsp-consulting.co.uk
www.bsp-consulting.co.uk

26th October 2016

Our Ref: TW/15166
Your Ref: A099942

Parks & Leisure
Southwark Council
PO Box 64529
London
SE1P 5LX

**For the attention of Sharon Lomas**

Dear Sirs

**Re: Camberwell Old Cemetery, Southwark – WYG Plot Z Drainage Strategy Review**

**BSP Consulting Comments on WYG Drainage Review.**

BSP Consulting (BSP) have reviewed the Plot Z Drainage Strategy Review, ref A099942V2, dated 24 October 2016, undertaken by WYG Engineering Limited. The report is a comprehensive review of the drainage strategy and the issues which resulted in the proposed drainage strategy.

Overall BSP are satisfied that the WYG review concurs that the BSP drainage strategy:

- is the only viable solution for the site (para 2.1.1)
- appropriate for the proposed works (para 2.1.2)
- that the strategy is appropriate in principle and that final arrangements should be undertaken following further testing and detail design (para 3.2).

We are also pleased to note that that:

- WYG conclude that the drainage strategy will significantly reduce the risk of flooding to the properties on Ryedale to the north west of the site (2.1.3).
- The WYG review addresses all of the concerns of the local residents in Section 2.2

We note the recommendations that:

- detailed geotechnical and hydrological testing and analysis, as well as slope analysis should be undertaken as part of the detailed design in respect of soakaway (T2) (2.2.4)
- the depth of the soakaway and construction methodology of the raised ground should be clarified to make sure the infiltration from the soakaways does not affect the integrity of the slope. (2.2.5)
- detailed design measures should be undertaken to make sure the (exceedance) flood routing is retained (2.2.5)
- given infiltration rates in the area of the proposed soakaways is just above the limited suggested by the latest SuDS Manual C753 WYG consider site specific infiltration test results would provide a more informed indication of the soil infiltration characteristics at the site information provided by the SWMP.

In response to these recommendations we confirm that these have all been previously borne in mind during the development of the strategy and all recommendations will be taken forward in full at detail design stage.

We note that WYG have used a different interpretation to the method of calculating proposed run off rates and WYG consider that the ICP SuDS method is more appropriate than the ADAS methodology BSP used. The different methods provide very similar results with the ADAS Method proposed by BSP is being slightly more conservative as it calculated the plot drainage to be equivalent to 370sq.m compared to the 360sq.m calculated by WYG.

We note that WYG have used the latest guidance from the EA in relation to climate change - that guidance was issued after our drainage strategy had been submitted and approved by planning. We agree with WYG's approach in providing an alternative design, based on 40% figure in respect of climate change is useful. However, from our discussions with the EA on other schemes we do not consider that to apply the 40% figure retrospectively in respect of schemes that have already received planning is always appropriate- and we are pleased that WYG confirm this within their own conclusions.

We note that despite the difference in approach and including a climate change allowance of 40% that the volume of soakaway required remains at $90m^3$ which is in accordance with our drainage strategy.

We note WYG also recommend the following future works:

- Investigation work to determine the depth of ground water in the vicinity of the proposed soakaway tanks during the winter months;
- Hydrological and geotechnical testing of the soil around the proposed tank soakaways should be undertaken to ensure the introduction of the tanks will not have a detrimental effect on the stability of the banked ground adjacent to properties on Ryedale and to ensure no seepage will occur
- As part of the full life cycle design consideration of the development, a maintenance regime should be prepared for the drainage system serving the site. In particular
- maintenance of the soakaways and filter strips will be key to making sure the system performs, as designed, throughout the life of the development
- Infiltration characteristics of the placed material should be determined as early as possible.
- Detailed design of the surface water drainage system should be undertaken prior to construction.

The WYG review concludes that the proposed strategy is appropriate in principle and we consider that their recommendations can be taken forward into the detailed design to provide a comprehensive strategy that will discharge surface water from the site without increasing flood risk downstream.

Yours faithfully

**For and on behalf of BSP Consulting**

**Tim Wilson BEng (Hons)**
**Associate**
t.wilson@bsp-consulting.co.uk