REPORT N^O GLP-SPEC-002

# GREATER LONDON HOUSE ASOS -INFILL OFFICES

## DRAINAGE STATEMENT

CONFIDENTIAL

DECEMBER 2016

# GREATER LONDON HOUSE ASOS –INFILL OFFICES

## DRAINAGE STATEMENT

**GLP**

**Type of document (version)**
**Confidential**

Date: December 2016

**GLP Consulting Engineers Ltd**
**Unit 5, Howarth Court**
**Gateway Crescent**
**Oldham Broadway Business Park**
**Chadderton**
**Greater Manchester**
**OL9 9XB**

# QUALITY MANAGEMENT

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| Signature | | | | |
| Project number | | | | |
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## APPENDICES

# 1 GENERAL

## 1.1 INTRODUCTION

This statement has been produced for use in support of submission to London Borough of Camden council to demonstrate that the drainage strategy has been adequately developed for the redevelopment of Greater London House, London. *Under condition 10 'Prior to commencement of the development, a lifetime maintenance plan demonstrating how the sustainable drainage system as approved in the "SuDS Calculation Report" dated 22 August 2016 will be maintained submitted to and approved in writing by the local planning authority* and that the proposed drainage philosophy will not increase flood risk to the development or properties elsewhere.

The drainage proposals are in line with the original outline strategies for (SUDS) as defined in the Flood Risk Assessment. Please refer to the approved (SUDS) report

## 1.2 LOCATION OF PROJECT

The survey works shall be undertaken generally at the following existing/proposed location:

ASOS HQ
Greater London House
Hampstead Road
Camden Town
London
NW1 7FB
These works are specifically related to the new build infill offices to the existing courtyard

## 1.3 CLIENT ORGANISATION

### 1.3.1 Project Contacts

The principal contract names and addresses relating to this Project are as follows:

PRIMARY CLIENT

| | |
|---|---|
| Name: | Nicholas Lazari |
| Address: | Lazari Investments Ltd<br>Greater London House<br>Hampstead Road<br>London<br>NW1 7QX<br>United Kingdom |
| Tel: | 0207 388 5444 |
| Email: | Nicholas@lazari.co.uk |

## CLIENT REPRESENTATIVE FOR MATTERS CONCERNING THIS PROJECT

| | |
|---|---|
| Name: | Peter Elias (Building Manager) |
| Address: | Greater London House |
| | Greater London House |
| | Hampstead Road |
| | London |
| | NW1 7QX |
| Tel: | 07572 278025 |

# 2 DESIGN PHILOSOPHY

The drainage proposals are in line with the original outline strategies for (SUDS) as defined in the Flood Risk Assessment.

The Initial Quick Storage assessment within the Flood Risk Assessment carried out by UK Flood Risk Consultants confirmed the following.

*The area of the proposed infilled courtyard is approximately 1,540m2 which is approximately 11% of the total building footprint area. It is therefore proposed that the surface runoff will be attenuated by 11% which is in proportion of the infilled courtyard area. This means approximately 110m3 (11% of 998 m3) of storage will be required to attenuate the surface runoff generated from this area.*

Please Note the above mentioned volume is indicative and is based on HR Wallingford's Storm Water Storage Analysis Tool.

Within the current design period we have carried out our own design Microdrainage calculations for the attenuation design we are putting forward for acceptance and we have noted that the total storage volume required to cater for the redeveloped area of the infill offices will be 53m3 and not 110m3 as mentioned above.

Within the current design period we have carried out our own design Microdrainage calculations for the attenuation design we are putting forward for acceptance and we have noted that the total storage volume required to cater for the redeveloped area of the infill offices is approx. 53m3 and not 110m3 as mentioned above.

This meets the Greenfield run off rates of 6.28l/s as written within FRA.

Surface Water drainage from the north and south roofs of the building will be transferred to an attenuation tank located within the building at basement car park level. Downpipes associated will convey flows from these areas into a gravity network at basement level which in turn will discharge into the attenuation tank.

Due to site constraints we are not able to direct all the roof rainwater to a single attenuation tank and are proposing 3 individual tanks in discrete locations that have a specified catchment directed through them, these tanks will all come complete with flow control devices, to restrict the run-off to no more than 2l/s per tank outfall.

The Surface Water drainage system comprise of three attenuation tanks with the combined outflow restricted to 6.28 l/s as agreed with Camden Council in principal. The volume of attenuation tanks are designed to accommodate the critical 1 in 100 year +30% climate change storm event and therefore do not increase risk of flooding to the site or adjacent properties.

This is better illustrated on our drawing 1607-M106 Rev T2.

Please Note: No oil interceptors are required prior to the above ground storage tanks as they will be receiving roof rainwater only.

We trust that our updated calculations and corresponding drawing meets the requirements of the SUDS planning conditions, (in particular condition 10).

This statement should be read in conjunction with the following:

- Camden ProForma Documentation
- Micro Drainage Attenuation Calculations
- Drainage Drawing

## 2.1 MAINTENANCE GENERAL

To enable these maintenance works to occur access will need to be provided to all areas of the greenroofs and some parts of the basement car park.

## 2.2 MAINTENANCE PLANS GREEN ROOF

Greenroofs will be installed to some of the roof surfaces and may attenuate flows to some degree until the point the roof is saturated and provide improved water run-off quality. To ensure these Sustainable Drainage Systems function correctly they will require maintenance activities in line with the specialist's requirements.

This is not limited to the following:

General maintenance is normally carried out annually during springtime. However, certain tasks which will be dependent upon the location of the roof, such as the removal of weeds, seedlings and accumulated leaf litter from overhanging trees may also need to be done during the autumn.

The following procedures should be carried out as indicated below, in order to ensure that the roof is maintained in good condition and to protect the validity of the guarantee.

## 2.3 LIFETIME MAINTENANCE PROCEDURES

- Ensure safe access can be gained to the roof and that relevant Health and Safety procedures are followed when working at roof level. It is advised that the contractor should always seek proof of current maintenance for any man-safe roof access systems prior to proceeding with the work on site.
- Remove all dead vegetation and debris from the roof surface, taking particular care to ensure that all chute outlets, gutters and downpipes are clear. Where the species mix incorporates wild flowers and grasses it is recommended that all dead vegetation is strimmed off and the waste lowered to the ground and carted away.
- Please note Roofs in the vicinity of taller trees will need more frequent maintenance.
- We recommend removing dead leaves during the spring and again in the autumn, to ensure that they do not damage the roof vegetation.
- Remove the lids of all Inspection chambers, ensure that all rainwater outlets and downpipes are free from blockages and that water can flow freely away.
- Ensure that any protective metal flashings and termination bars remain securely fixed in place. Advise the client of the need to repair or renew as necessary.
- Examine all mastic sealant and mortar pointing for signs of degradation. Advise the client of the need to repair or renew as necessary.
- Check that all promenade tiles and paving slabs are securely fixed to the roof surface and in good condition.
- Ensure that any new items of plant/equipment on the roof are mounted on suitable isolated slabs and that any fixings used to secure the plant/equipment in place do not penetrate the waterproofing. If in doubt, please contact Bauder for further advice.

- The Building owner should keep a record of all inspections and maintenance carried out on the roof.
- Any signs of damage or degradation to the waterproofing should be reported to Bauder immediately, in order that arrangements can be made for remedial work to be carried out if necessary.  Damage to the landscaping should be reported to the building owner Maintenance Plans Attenuation Tanks

## 2.4 LIFETIME MAINTENANCE PLANS ATTENUATION TANKS

- The surface water drainage strategy directs water via piped systems to the basement car park via a series of attenuation tanks. The attenuation tanks have been designed to accommodate for the 1 in 100 year storm event including an allowance for climate change.
- The proposed (SUDS) attenuation tanks (sectional steel) to be installed in the basement car park. Come with a life expectancy in excess of 20 years this is based on confirmation from Balmoral the tank manufacturer. As to the location of the tanks the requirement to replace the tanks during the design life of the development is limited as the tanks will be protected external conditions. It is proposed to provide a diverter valve on the inlets to the tanks should emergency maintenance of the tank be required. (refer to typical tank detail drawing within the appendices of this report.
- This is to provide dry working conditions for maintenance in the event that the surface tank has a serious blockage. During this event surface water will accumulate on the basement slab into, although this is considered to only be a small amount of surface water and as such is a low risk, further more there are drainage channels that could convey the flows to drain if another storm was to take place.
- The tanks which shall be sited ‘above ground’ will all come complete with free access around the tank to inspect the tank seals and all interconnecting rainwater pipework.
- The tanks can be inspected or cleaned and flushed out easily if required, making it a low-maintenance solution, each  tank will come with an integral flow control device, this will require infrequent visual inspection from the access turret. There will be a lifting chain provided should the flow control device require removal.
- Each tank will come complete with an overflow warning pipe link to the trigger a warning to the maintenance staff, the contents are not clearing effectively. As the tank is not a buried entity, maintenance can be carried out without needing permits or preventing the day to day operations of the offices.
- The tanks will be constructed from stainless steel and are deemed suitable for the environment they will be installed in; each tank will also come with a ventilation pipe to deal with pressure fluctuations.
- Each tanks restricted outfall will be connected to the existing drainage via a robust non return valve. The tanks shall come complete with level probes linked to the building management system to also provide an audible warning should there be a tank surcharge event taking place that requires further investigation by the building maintenance team.

# 3 CONCLUSION

The contents of this drainage statement highlight the proposed drainage designs at the GLH site, as specified in this report and corresponding drawing work, have been designed to incorporate the maintenance requirements of its drainage features, for the design life of the site.

# Appendix A

PRO FORMA DOCUMENT

# Advice Note on contents of a Surface Water Drainage Statement

***London Borough of Camden***

## 1. Introduction

1.1 The Government has strengthened planning policy on the provision of sustainable drainage and new consultation arrangements for 'major' planning applications will come into force from 6 April 2015 as defined in the Written Ministerial Statement (18th Dec 2014).

1.2 The new requirements make Lead Local Flood Authorises statutory consultees with respect to flood risk and SuDS for all major applications. Previously the Environment Agency had that statutory responsibility for sites above 1ha in flood zone 1.

1.3 Therefore all 'major' planning applications submitted from 6 April 2015 are required demonstrate compliance with this policy and we'd encourage this is shown in a **Surface Water Drainage Statement**.

1.4 The purpose of this advice note is to set out what information should be included in such statements.

## 2. Requirements

2.1 It is essential that the type of Sustainable Drainage System (SuDS) for a site, along with **details of its extent and position**, is identified within the planning application to clearly demonstrate that the proposed SuDS can be accommodated within the development.

2.2 It will now not be acceptable to leave the design of SuDs to a later stage to be dealt with by planning conditions.

2.3 The NPPF paragraph 103 requires that developments do not increase flood risk elsewhere, and gives priority to the use of SuDS. Major developments must include SuDS for the management of run-off, unless demonstrated to be inappropriate. The proposed minimum standards of operation must be appropriate and as such, a **maintenance plan** should be included within the Surface Water Drainage Statement,clearly demonstrating that the SuDS have been designed to ensure that the maintenance and operation requirements are economically proportionate Planning Practice Guidance suggests that this should be considered by reference to the costs that would be incurred by consumers for the use of an effective drainage system connecting directly to a public sewer.

2.4 Camden Council will use planning conditions or obligations to ensure that there are clear arrangements in place for ongoing maintenance over the lifetime of the development.

2.5 Within Camden, SuDS systems must be designed in accordance with London Plan policy 5.13. This requires that developments should utilise sustainable urban drainage systems (SUDS) unless there are practical reasons for not doing so, and should aim to achieve **greenfield run-off rates** and ensure that surface water run-off is managed as close to its source as possible in line with the following **drainage hierarchy**:

**1 store rainwater for later use**
**2 use infiltration techniques, such as porous surfaces in non-clay areas**
**3 attenuate rainwater in ponds or open water features for gradual release**
**4 attenuate rainwater by storing in tanks or sealed water features for gradual release**
**5 discharge rainwater direct to a watercourse**
**6 discharge rainwater to a surface water sewer/drain**
**7 discharge rainwater to the combined sewer.**

2.6 The hierarchy above seeks to ensure that surface water run-off is controlled as near to its source as possible to mimic natural drainage systems and retain water on or near to the site, in contrast to traditional drainage approaches, which tend to pipe water off-site as quickly as possible.

2.7 Before disposal of surface water to the public sewer is considered all other options set out in the drainage hierarchy should be exhausted. When no other practicable alternative exists to dispose of surface water other than the public sewer, the Water Company or its agents should confirm that there is adequate spare capacity in the existing system taking future development requirements into account.

2.8 Best practice guidance within the non-statutory technical standards for the design, maintenance and operation of sustainable drainage systems will also need to be followed. Runoff volumes from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the **greenfield runoff volume** for the same event.

2.9 Camden Development Policy 23 (Water) requires developments to reduce pressure on combined sewer network and the risk of flooding by limiting the rate of run-off through sustainable urban drainage systems. This policy also requires that developments in areas known to be at risk of surface water flooding are designed to cope with being flooded. Camden's SFRA surface water flood maps, updated SFRA figures 6 (LFRZs), and 4e (increased susceptibility to elevated groundwater) , as well as the Environment Agency updated flood maps for surface water (ufmfsw), should be referred to when determining whether developments are in an area at risk of flooding.

2.10 Camden Planning Guidance 3 (CPG3) requires developments to achieve a greenfield run off rate once SuDS have been installed. Where it can be demonstrated that this is not feasible, a minimum 50% reduction in run off rate across the development is required. Further guidance on how to reduce the risk of flooding can be found in CPG3 paragraphs 11.4-11.8.

2.11 Where an application is part of a larger site which already has planning permission it is essential that the new proposal does not compromise the drainage scheme already approved.

## 3. Further information and guidance

3.1 Applicants are strongly advised to discuss their proposals with the Lead Local Flood Authority at the pre-application stage to ensure that an acceptable SuDS scheme is submitted.

3.2 For general clarification of these requirements please Camden's Local Planning Authority or Lead Local Flood Authority

# Surface Water Drainage Pro-forma for new developments

This pro-forma accompanies our advice note on surface water drainage. Developers should complete this form and submit it to the Local Planning Authority, referencing from where in their submission documents this information is taken. The pro-forma is supported by the Defra/EA guidance on Rainfall Runoff Management and uses the storage calculator on www.UKsuds.com. This pro-forma is based on current industry best practice and focuses on ensuring surface water drainage proposals meet national and local policy requirements. The pro-forma should be considered alongside other supporting SuDS Guidance.

## 1. Site Details

| | |
|---|---|
| **Site** | GREATER LONDON HOUSE |
| **Address & post code or LPA reference** | HAMPSTEAD ROAD CAMDEN TOWN NW1 7QY |
| **Grid reference** | 529 106 183 267 |
| **Is the existing site developed or Greenfield?** | DEVELOPED |
| **Is the development in a LFRZ or in an area known to be at risk of surface or ground water flooding? If yes, please demonstrate how this is managed, in line with DP23?** | NO |
| **Total Site Area served by drainage system (excluding open space) (Ha)*** | 1.5Ha ONLY 0.156Ha IS BEEN REDEVELOPED |

***** The Greenfield runoff off rate from the development which is to be used for assessing the requirements for limiting discharge flow rates and attenuation storage from a site should be calculated for the area that forms the drainage network for the site whatever size of site and type of drainage technique. Please refer to the Rainfall Runoff Management document or CIRIA manual for detail on this.

## 2. Impermeable Area

| | Existing | Proposed | Difference (Proposed-Existing) | Notes for developers |
|---|---|---|---|---|
| **Impermeable area (ha)** | 0.156 | 0.156 | N/A | If the proposed amount of impermeable surface is greater, then runoff rates and volumes will increase. Section 6 must be filled in. If proposed impermeability is equal or less than existing, then section 6 can be skipped and section 7 filled in. |
| **Drainage Method** (infiltration/sewer/watercourse) | | | N/A | If different from the existing, please fill in section 3. If existing drainage is by infiltration and the proposed is not, discharge volumes may increase. Fill in section 6. |

## 3. Proposing to Discharge Surface Water via

| | Yes | No | Evidence that this is possible | Notes for developers |
|---|---|---|---|---|
| **Existing and proposed MicroDrainage calculations** | ✓ | | REFER TO MICRODRAINAGE CALCULATIONS PROVIDED FOR ALL RETURN PERIODS REQUIRED | Please provide MicroDrainage calculations of existing and proposed run-off rates and volumes in accordance with a recognised methodology or the results of a full infiltration test (see line below) if infiltration is proposed. |
| **Infiltration** | | ✓ | | e.g. soakage tests. Section 6 (infiltration) must be filled in if infiltration is proposed. |
| **To watercourse** | | ✓ | | e.g. Is there a watercourse nearby? |
| **To surface water sewer** | ✓ | | CCTV RESULTS HAVE PROVEN SITE IS CURRENTLY POSTIVELY DRAINED THROUGH A NETWORK OF SUSPENDED DRAINAGE RUNS WITHIN THE BASEMENT | Confirmation from sewer provider that sufficient capacity exists for this connection. |
| **Combination of above** | | | | e.g. part infiltration part discharge to sewer or watercourse. Provide evidence above. |
| **Has the drainage proposal had regard to the SuDS hierarchy?** | ✓ | | THE SITE HAS REGARDED SECTION 2.5 OF THE HIERARCHY AND WE WILL BE PROVIDING ATTENUATION TANKS FOR THE REDEVELOPED AREA OF THE SITE, THERE WILL ALSO BE PARTS OF THE NEW ROOF PROVIDED WITH A GREEN ROOF TO FURTHER ENHANCE OUR SUDS TECHNIQUES, WATER WILL BE LIMITED TO GREENFIELD RUN OFF RATES AND WILL ULTIMATELY DISCHARGE TO THE BASEMENT COMBINED DRAINAGE RUNS | Evidence must be provided to demonstrate that the proposed Sustainable Drainage strategy has had regard to the SuDS hierarchy as outlined in Section 2.5 above. |
| **Layout plan showing where the sustainable drainage infrastructure will be located on site.** | ✓ | | ATTENUTATION TANK 1, 2 + 3 WILL BE SITED AS INDICATED ON OUR CURRENT BELOW GROUND DRAINAGE DRAWING, WE HAVE HAD TO SEGEMENT THE TANKS AS THE EXISTNG CAR PARK IS IN USE AND THERE ARE SEVERAL NEW STUCTURAL COLUMS THAT PREVENT HAVING ONE LARGER TANK TO DEAL WITH SURFACE RUN OFF. THE TANKS HAVE BEEN POSITIONED SO THAT FUTURE MAINTAINACE CAN BE CARRIED OUT EASILY. | Please provide plan reference numbers showing the details of the site layout showing where the sustainable drainage infrastructure will be located on the site. If the development is to be constructed in phases this should be shown on a separate plan and confirmation should be provided that the sustainable drainage proposal for each phase can be constructed and can operate independently and is not reliant on any later phase of development. |

**4. Peak Discharge Rates** – This is the maximum flow rate at which storm water runoff leaves the site during a particular storm event.

| | Existing Rates (l/s) | Proposed Rates (l/s) | Difference (l/s) (Proposed-Existing) | % Difference (difference /existing x 100) | Notes for developers |
|---|---|---|---|---|---|
| Greenfield QBAR | 32.5 | N/A | N/A | N/A | QBAR is approx. 1 in 2 storm event. Provide this if Section 6 (QBAR) is proposed. |
| 1 in 1 | 14.1 | 4.7 | -9.4 | 66 | Proposed discharge rates (with mitigation) should aim to be equivalent to greenfield rates for all corresponding storm events. As a minimum, peak discharge rates must be reduced by 50% from the existing sites for all corresponding rainfall events. |
| 1 in 30 | 34.5 | 5.1 | -29.4 | 85 | |
| 1in 100 | 34.8 | 5.4 | -29.4 | 85 | |
| 1 in 100 plus climate change | N/A | 5.7 | -29.2 | 84 | The proposed 1 in 100 +CC peak discharge rate (with mitigation) should aim to be equivalent to greenfield rates. As a minimum, proposed 1 in 100 +CC peak discharge rate must be reduced by 50% from the existing 1 in 100 runoff rate sites. |

**Note: Attenuating to Greenfield run off rates through the tank (s) improves the current run off for the redeveloped area by a significant 85%**

**5. Calculate additional volumes for storage** –The total volume of water leaving the development site. New hard surfaces potentially restrict the amount of stormwater that can go to the ground, so this needs to be controlled so not to make flood risk worse to properties downstream.

| | Greenfield runoff volume ($m^3$) | Existing Volume ($m^3$) | Proposed Volume ($m^3$) | Difference ($m^3$) (Proposed-Existing) | Notes for developers |
|---|---|---|---|---|---|
| 1 in 1 | 10 | 4.1 | 52.5 | 40 | Proposed discharge volumes (with mitigation) should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable and as a minimum should be no greater than existing volumes for all corresponding storm events. Any increase in volume increases flood risk elsewhere. Where volumes are increased section 6 must be filled in. |
| 1 in 30 | 25.2 | 10.3 | 52.5 | 27.3 | |
| 1in 100 6 hour | 18.5 | 24.5 | 52.5 | 34.5 | |
| 1 in 100 6 hour plus climate change | 33.5 | 27.3 | 52.5 | 19 | The proposed 1 in 100 +CC discharge volume should be constrained to a value as close as is reasonably practicable to the greenfield runoff volume wherever practicable. As a minimum, to mitigate for climate change the proposed 1 in 100 +CC volume discharge from site must be no greater than the existing 1 in 100 storm event. If not, flood risk increases under climate change. |

**6. Calculate attenuation storage –** Attenuation storage is provided to enable the rate of runoff from the site into the receiving watercourse to be limited to an acceptable rate to protect against erosion and flooding downstream. The attenuation storage volume is a function of the degree of development relative to the greenfield discharge rate.

| | | **Notes for developers** |
|---|---|---|
| **Storage Attenuation volume (Flow rate control) required to meet greenfield run off rates ($m^3$)** | 53 | Volume of water to attenuate on site if discharging at a greenfield run off rate. Can't be used where discharge volumes are increasing |
| **Storage Attenuation volume (Flow rate control) required to reduce rates by 50% ($m^3$)** | | Volume of water to attenuate on site if discharging at a 50% reduction from existing rates. Can't be used where discharge volumes are increasing |
| **Storage Attenuation volume (Flow rate control) required to meet [OTHER RUN OFF RATE (as close to greenfield rate as possible] ($m^3$)** | | Volume of water to attenuate on site if discharging at a rate different from the above – please state in 1st column what rate this volume corresponds to. On previously developed sites, runoff rates should not be more than three times the calculated greenfield rate. Can't be used where discharge volumes are increasing |
| **Storage Attenuation volume (Flow rate control) required to retain rates as existing ($m^3$)** | | Volume of water to attenuate on site if discharging at existing rates. Can't be used where discharge volumes are increasing |
| **Percentage of attenuation volume stored above ground,** | | Percentage of attenuation volume which will be held above ground in swales/ponds/basins/green roofs etc. If 0, please demonstrate why. |

## 7. How is Storm Water stored on site?

Storage is required for the additional volume from site but also for holding back water to slow down the rate from the site. This is known as attenuation storage and long term storage. The idea is that the additional volume does not get into the watercourses, or if it does it is at an exceptionally low rate. You can either infiltrate the stored water back to ground, or if this isn't possible hold it back with on site storage. Firstly, can infiltration work on site?

| | | | **Notes for developers** |
|---|---|---|---|
| **Infiltration** | **State the Site's Geology and known Source Protection Zones (SPZ)** | n/a | Avoid infiltrating in made ground. Infiltration rates are highly variable and refer to Environment Agency website to identify and source protection zones (SPZ) |
| | **Are infiltration rates suitable?** | n/a | Infiltration rates should be no lower than $1x10^{-6}$ m/s. |
| | **State the distance between a proposed infiltration device base and the ground water (GW) level** | n/a | Need 1m (min) between the base of the infiltration device & the water table to protect Groundwater quality & ensure GW doesn't enter infiltration devices. Avoid infiltration where this isn't possible. |

| | | | |
|---|---|---|---|
| | **Were infiltration rates obtained by desk study or infiltration test?** | | Infiltration rates can be estimated from desk studies at most stages of the planning system if a back up attenuation scheme is provided.. |
| | **Is the site contaminated? If yes, consider advice from others on whether infiltration can happen.** | | Advice on contaminated Land in Camden can be found on our supporting documents webpage Water should not be infiltrated through land that is contaminated. The Environment Agency may provide bespoke advice in planning consultations for contaminated sites that should be considered. |
| **In light of the above, is infiltration feasible?** | **Yes/No? If the answer is No, please identify how the storm water will be stored prior to release** | | If infiltration is not feasible how will the additional volume be stored?. The applicant should then consider the following options in the next section. |

## Storage requirements

The developer must confirm that either of the two methods for dealing with the amount of water that needs to be stored on site.

**Option 1 Simple –** Store both the additional volume and attenuation volume in order to make a final discharge from site at the greenfield run off rate. This is preferred if no infiltration can be made on site. This very simply satisfies the runoff rates and volume criteria.

**Option 2 Complex** – If some of the additional volume of water can be infiltrated back into the ground, the remainder can be discharged at a very low rate of 2 l/sec/hectare. A combined storage calculation using the partial permissible rate of 2 l/sec/hectare and the attenuation rate used to slow the runoff from site.

| | | **Notes for developers** |
|---|---|---|
| **Please confirm what option has been chosen and how much storage is required on site.** | | The developer at this stage should have an idea of the site characteristics and be able to explain what the storage requirements are on site and how it will be achieved. |

## 8. Please confirm

| | | Notes for developers |
|---|---|---|
| **Which Drainage Systems measures have been used, including green roofs?** | Each new roof will be provided with a green roof approx 500m2 of green roof will be provided | SUDS can be adapted for most situations even where infiltration isn't feasible e.g. impermeable liners beneath some SUDS devices allows treatment but not infiltration. See CIRIA SUDS Manual C697. |
| **Drainage system can contain in the 1 in 30 storm event without flooding** | See micro-drainage calculations | This a requirement for sewers for adoption & is good practice even where drainage system is not adopted. |
| **Will the drainage system contain the 1 in 100 +CC storm event? If no please demonstrate how buildings and utility plants will be protected.** | yes as above | National standards require that the drainage system is designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of: a building (including a basement); or in any utility plant susceptible to water (e.g. pumping station or electricity substation) within the development. |
| **Any flooding between the 1 in 30 & 1 in 100 plus climate change storm events will be safely contained on site.** | | **Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased. |
| **How will exceedance events be catered on site without increasing flood risks (both on site and outside the development)?** | n/a | **Safely:** not causing property flooding or posing a hazard to site users i.e. no deeper than 300mm on roads/footpaths. Flood waters must drain away at section 6 rates. Existing rates can be used where runoff volumes are not increased.<br><br>Exceedance events are defined as those larger than the 1 in 100 +CC event. |
| **How are rates being restricted (vortex control, orifice etc)** | orifice within tank, Hydrobreak type, there will be access provided via the tank to deal with obstruct | Detail of how the flow control systems have been designed to avoid pipe blockages and ease of maintenance should be provided. |
| **Please confirm the owners/adopters of the entire drainage systems throughout the development. Please list all the owners.** | Private drainage on site | If these are multiple owners then a drawing illustrating exactly what features will be within each owner's remit must be submitted with this Proforma. |
| **How is the entire drainage system to be maintained?** | yes, the site will be maintained by the clients on-site maintenance team. | If the features are to be maintained directly by the owners as stated in answer to the above question please answer yes to this question and submit the relevant maintenance schedule for each feature. If it is to be maintained by others than above please give details of each feature and the maintenance schedule.<br>Clear details of the maintenance proposals of all elements of the proposed drainage system must be provided. Details must demonstrate that maintenance and operation requirements are economically proportionate. Poorly maintained drainage can lead to increased flooding problems in the future. |

**9. Evidence** Please identify where the details quoted in the sections above were taken from. i.e. Plans, reports etc. Please also provide relevant drawings that need to accompany your proforma, in particular exceedance routes and ownership and location of SuDS (maintenance access strips etc

| Pro-forma Section | Document reference where details quoted above are taken from | Page Number |
|---|---|---|
| Section 2 | REPORT | |
| Section 3 | MAINTAINANCE INFORMATION | |
| Section 4 | DRAINAGE LAYOUT APPENDIX A1 | |
| Section 5 | MICRODRAINAGE CALCULATIONS APPENDIX A2 | |
| Section 6 | | |
| Section 7 | | |
| Section 8 | | |

The above form should be completed using evidence from the Flood Risk Assessment and site plans. It should serve as a summary sheet of the drainage proposals and should clearly show that the proposed rate and volume as a result of development will not be increasing. If there is an increase in rate or volume, the rate or volume section should be completed to set out how the additional rate/volume is being dealt with.

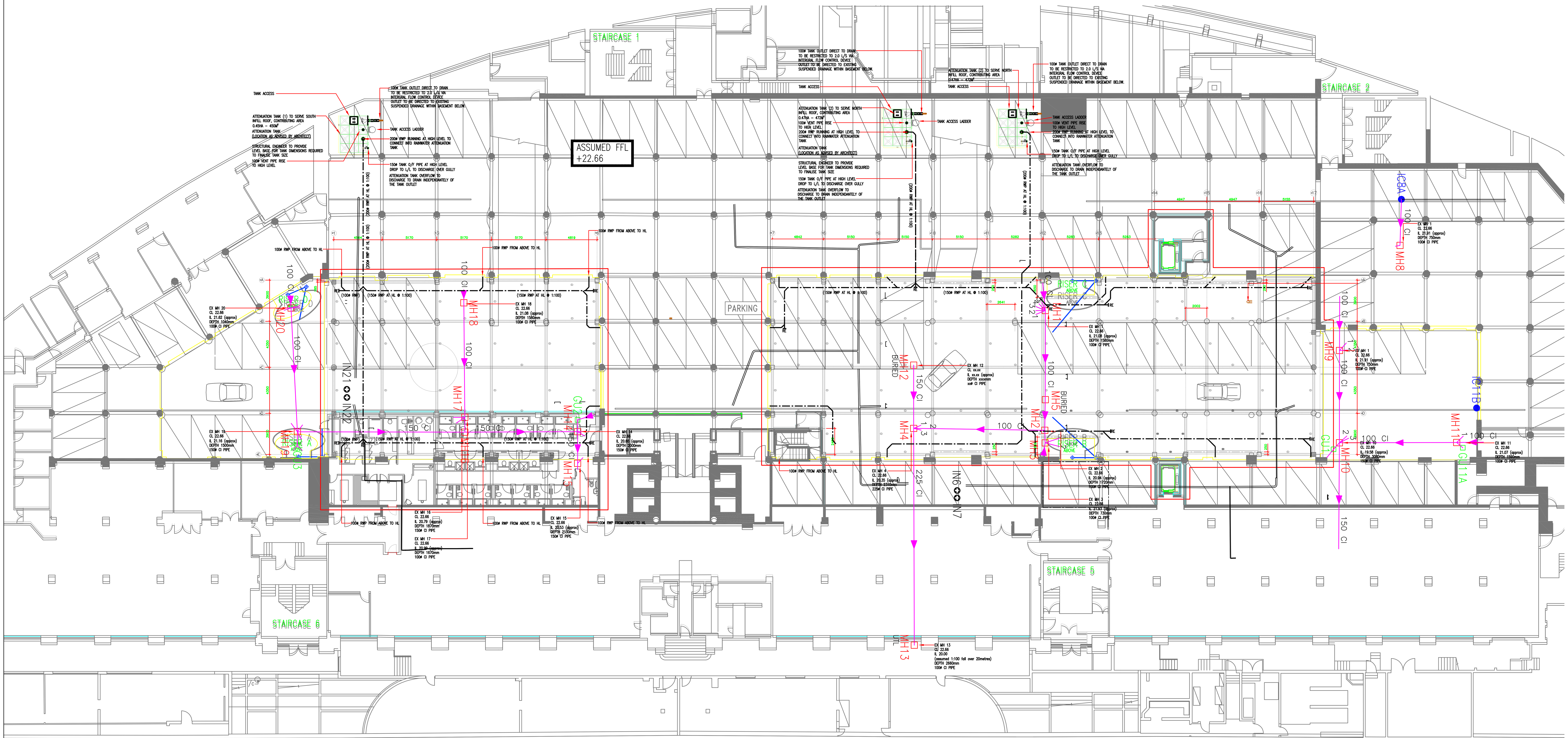
This form is completed using factual information from the Flood Risk Assessment and Site Plans and can be used as a summary of the surface water drainage strategy on this site.

Form Completed By……RICKESH MIYANGAR……
Qualification of person responsible for signing off this pro-forma CHARTERED ENGINEER……

Company……GLP……
On behalf of (Client's details) LANZARI INVESTMENTS LTD……
Date:……09/12/2016……

# Appendix B

**GLP BELOW GROUND DRAINAGE DRAWING-1607-M106 REV T2/TYPICAL TANK DETAIL**




## NOTES

1. THE POSITION AND LOCATION OF ALL EXISTING SERVICES INDICATED ON THIS DRAWING ARE APPROXIMATE ONLY.
2. THE NATURE AND CONDITION OF EXISTING SERVICES SHALL NOT BE RELIED UPON, AND IT IS EXPECTED THAT THE CONTRACTOR SHALL VERIFY ALL NECESSARY INFORMATION.
3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL AVAILABLE RECORD DRAWINGS AND DOCUMENTATION FOR THE SITE, STRUCTURES AND ENGINEERING SERVICES TOGETHER WITH HEALTH AND SAFETY PRE-CONSTRUCTION INFORMATION, WHICH HAS BEEN PROVIDED TO GLP
4. GLP ARE NOT RESPONSIBLE FOR UNDERTAKING INVESTIGATIONS AND SURVEYS TO DETERMINE THE NATURE OF THE SITE, EXISTING SERVICES, LOCAL CONDITIONS AND RESTRICTIONS LIKELY TO EFFECT THE EXECUTION OF THE WORKS PRIOR TO COMMENCEMENT.
5. ALL DIMENSIONS WHERE SHOWN ARE IN MILLIMETRES (mm) UNLESS STATED OTHERWISE.
6. THE WORKS SHALL BE CARRIED OUT BY SPECIALIST COMPETENT AND EXPERIENCED CONTRACTORS WHO ARE MEMBERS OF A RECOGNISED NATIONAL ORGANISATION. OPERATIVES SHALL HAVE RECEIVED FULL AND APPROPRIATE TRAINING FOR THE OPERATIONS THEY ARE TO UNDERTAKE. ALL WORKS SHALL BE CARRIED OUT IN ACCORDANCE WITH ALL PERTINENT HEALTH AND SAFETY REGULATIONS.
7. GAPS AROUND SERVICE PENETRATIONS ARE TO BE FIRE STOPPED WITH INTUMESCENT MASTIC SEALANT. INTUMESCENT FIRE COLLARS ARE TO BE PROVIDED ON ALL NON METALLIC PIPEWORK ABOVE 50mm TO ENSURE FIRE INTEGRITY IS MAINTAINED.
8. EXISTING RAINWATER INSTALLATION TO BE INSPECTED, CLEANED, TESTED & REPAIRED WHERE NECESSARY, AND LEFT IN A SOUND WORKING CONDITION.

## ABOVE GROUND DRAINAGE NOTES

### GENERAL

THIS DRAWING SHALL BE READ IN CONJUNCTION WITH THE GLP PARTNERSHIP SPECIFICATION OF WORKS AND ALL RELEVANT GLP PARTNERSHIP SERVICES, GLP PARTNERSHIP STRUCTURAL AND ARCHITECTS DRAWINGS.

THIS DRAWING IS FOR ABOVE GROUND DRAINAGE PURPOSES ONLY.

THE ABOVE GROUND FOUL WATER DRAINAGE INSTALLATION SHALL BE INSTALLED, TESTED AND COMMISSIONED IN ACCORDANCE WITH BS EN 12056:2000 PARTS 2 & 3.

THE ABOVE GROUND FOUL WATER DRAINAGE INSTALLATION SHALL CONFORM TO ALL PARTS OF THE BUILDING REGULATIONS, APPROVED DOCUMENT H AND BE SUBJECT TO BUILDING CONTROL APPROVAL.

ALL ABOVE GROUND FOUL WATER DRAINAGE, 75mm AND ABOVE SHALL BE CARRIED OUT USING 'ENSIGN' LIGHT WEIGHT CAST IRON SYSTEM. ALL ABOVE GROUND FOUL DRAINAGE 50ø AND BELOW SHALL BE CARRIED OUT USING MuPVC, SOLVENT WELDED SYSTEM.

ALL ABOVE GROUND SURFACE WATER DRAINAGE TO BE INSTALLED USING 'ENSIGN' LIGHT WEIGHT CAST IRON SYSTEM FOR PIPE SIZES 100mm – 300mm.

ALL LEVELS INDICATED ON THIS DRAWING ARE IN METERS UNLESS OTHERWISE STATED.

ALL SETTING OUT DIMENSIONS INDICATED ON THIS DRAWING ARE IN MILLIMETRES UNLESS OTHERWISE STATED

ALL SETTING OUT DIMENSIONS QUOTED ARE TAKEN FROM THE STRUCTURAL GRID TO THE CENTRE OF DRAINAGE COMPONENTS UNLESS OTHERWISE STATED.

### CAST IRON PIPEWORK

DRAINAGE PIPEWORK OF NOMINAL DIAMETERS, 100MM TO 300mm SHALL BE INSTALLED USING LIGHTWEIGHT CAST IRON SOCKETLESS PIPE AND FITTINGS CONFORMING TO A BRITISH BOARD AGREEMENT CERTIFICATE AND MEET WITH EN 877.

PIPEWORK SURFACE SHALL BE COATED AS FOLLOWS:–

EXTERNALLY – TWO COATS OF RED WATER BASED PAINT. COMPRISING BASE COAT AND SEMI-GLOSS TOP COAT. GIVING A COMBINED AVERAGE THICKNESS OF 70 MICRONS WITH A MINIMUM THICKNESS OF 40 MICRONS.

INTERNALLY – A BLACK EPOXY TAR LINING WITH AN AVERAGE THICKNESS OF 150 MICRONS, A MINIMUM THICKNESS OF 120 MICRONS. THIS IS COMPRISING TWO SOLVENT BASED COMPONENTS OF EPOXY RESIN AND TAR PITCH TO GIVE INTERNAL PROTECTION AND ANTI-CORROSIVE FEATURES.

FITTINGS – THESE SHALL BE PROTECTED INTERNALLY AND EXTERNALLY WITH A SINGLE COAT OF RED POWDER EPOXY RESIN ELETROSTATICALLY APPLIED. THIS GIVES AN AVERAGE THICKNESS OF 70 MICRONS WITH A MINIMUM THICKNESS OF 40 MICRONS.

COUPLINGS / BRACKETS – PROTECTED WITH A RED WATER BASED SEMI-GLOSS PAINT, AVERAGE THICKNESS OF 40 MICRONS. WHERE PIPES ARE CUT ON SITE, ENDS SHALL BE CUT CLEAN AND SQUARE WITH BURRS REMOVED. ALL CUT ENDS SHALL BE MADE GOOD/RECOATED STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS.

ALL PIPES AND FITTINGS SHALL BE JOINTED BY MEANS OF DUCTILE IRON COUPLINGS WITH SET SCREWS AND NUTS AND A NITRILE RUBBER GASKET SUPPLIED TO SPECIAL ORDER. EARTH CONTINUITY MUST BE PROVIDED FOR ACROSS ALL COUPLINGS.

JOINTS TO BELOW GROUND PIPEWORK (BY OTHERS) SHALL BE MADE USING STANDARD COUPLINGS OR STEP COUPLINGS AS INDICATED ON THE STANDARD CONSTRUCTION DETAIL SHEET.

CONNECTION TO SMALL DIAMETER WASTE, RAINWATER AND VENTILATING PIPEWORK OR OTHER MATERIALS SHALL BE MADE USING MECHANICAL "COMPRESSION-FIT" BOSS PIPES OR PUSH-FIT MANIFOLD OR BLANK ENDS AS NECESSARY.

PIPEWORK SHALL BE SUPPORTED TRUE TO LINE BY METHODS STRICTLY IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS. PROPRIETARY ADJUSTABLE DUCTILE IRON BRACKETS TYPE EF048 OR EF049 SHALL BE USED AS NECESSARY.

ABOVE GROUND DRAINAGE PIPEWORK TO BE INSTALLED USING MANUFACTURER'S RECOMMENDED INSTALLATION GUIDELINES. ALSO BS EN 12056 PARTS 1 TO 5 AND RELEVANT BUILDING REGULATIONS.

THE CAST IRON ABOVE GROUND SYSTEMS SHALL BE SAINT GOBAIN PIPELINE LIMITED "ENSIGN" BBA NO. 95/3125. REFER TO GLP PARTNERSHIP DETAIL SHEET FOR FITTING REFERENCES.

ALL ABOVE GROUND PIPEWORK SHALL BE SUITABLY RESTRAINED/BRACKETED IN ORDER TO WITHSTAND THE WEIGHT OF PIPEWORK WHEN FULL OF WASTE/5 BAR STATIC HEAD.

### 3.00 PVC-u SOIL PIPEWORK

ALL SOIL WASTE AND VENT PIPEWORK AND FITTINGS SHALL BE GEBERIT TERRAIN LTD OR SIMILAR, TYPE PVC-u 100 SYSTEM WITH SOLVENT WELDED JOINTS EXCEPT WHERE SEAL RING JOINTS ARE REQUIRED FOR THERMAL MOVEMENTS OF THE SOCKETS OR STANDARD FITTINGS SHALL BE CONVERTED TO SEAL JOINTS BY THE ADDITION OF A SEAL RING ADAPTER.

ALL PIPES AND FITTINGS SHALL COMPLY IN ALL RESPECTS WITH BSEN 1329 AND SHALL WHERE APPROPRIATE, BEAR THE BRITISH STANDARD KITEMARK.

THE GRADE OF PVC-U USED FOR FITTINGS SHALL HAVE A MINIMUM SOFTENING POINT OF 80 DEGREES CENTIGRADE WHEN TESTED BY THE VICAT METHOD AS DESCRIBED IN BSEN ISO 206.

THE PIPE AND FITTINGS SHALL BE COLOUR GREY OR BLACK, TO BRITISH STANDARD 5252: 10.A.07.

THE RUBBER SEALS OR SEAL RING JOINTS SHALL BE OF A SECTION THAT GIVES MORE THAN ONE POINT OF CONTACT WITH THE PIPE AND SHALL BE TO THE MATERIAL REQUIREMENTS OF BRITISH STANDARD 2494.

WHEN USED INTERNALLY HOLDERBATS SHALL BE MADE OF MILD STEEL PROTECTED FROM CORROSION BY GALVANISING OR PLASTIC COATING. THEY SHALL HAVE A TWO-POSITION FIXING SUITABLE FOR EITHER ACTING AS A PIPE SUPPORT BUT ALLOWING THERMAL MOVEMENT OR AS A CLAMP FIT ON A FITTING CREATING A FIXED POINT. FOR OPTIMUM FIT TO PIPE SUPPORTS PVC PACKING PIECES MAY BE USED. PVC HOLDERBATS MAY BE USED FOR EXTERNAL USE.

ACCESS SHALL BE PROVIDED WHERE NECESSARY EITHER BY MEANS OF AN INTEGRALLY MOULDED DOOR IN AN ACCESS FITTING WITH AN EXTERNALLY FITTED RUBBER SEAL AND SECURED WITH TWO GALVANISED BOLTS AND NUTS, OR ALTERNATIVELY BY A TWO-PIECE CLAMP TYPE DOOR FITTED INTO THE PIPE RUN.

PIPES SHALL BE SUPPLIED IN PLAIN ENDED LENGTHS.

THE MINIMUM ACCEPTABLE WALL THICKNESS OF PIPE AND FITTINGS SHALL BE AS FOLLOWS:–

| Nominal Size (mm) | Pipe Thickness (mm) | Fitting Thickness (mm) |
|---|---|---|
| 82 | 3.20 | 3.20 |
| 110 | 3.20 | 3.20 |
| 160 | 3.30 | 3.50 |

THE RUBBER SEALS FOR SEAL RING JOINTS SHALL BE OF A SECTION THAT GIVES MORE THAN ONE POINT OF CONTACT WITH THE PIPE AND SHALL BE TO THE MATERIAL REQUIREMENTS OF BSEN 7874 AND BSEN 681. WATER CLOSET CONNECTIONS SHALL BE TO THE SAME STANDARD.

WASTE BOSS CONNECTIONS WHEN FITTED TO PIPES SHALL CONSIST OF TWO PARTS WITH INNER AND OUTER FLANGES, SOLVENT WELDED AS A COMPLETE UNIT WITH IN BUILT GRADIENTS FOR THE WASTE PIPES OF 1¼ DEGREES. WHERE IT IS NOT POSSIBLE TO GAIN ACCESS TO THE BORE OF THE SOIL PIPE, SELF LOCKING BOSSES WITH INTEGRAL CLAMPING ACTION MAY BE USED PROVIDING THAT THE MATING SURFACES ARE SUITABLE FOR, AND USED WITH, SOLVENT WELD CEMENT.

ALTERNATIVE WASTE BOSS CONNECTIONS MAY BE MADE USING UNEQUAL JUNCTIONS CONFORMING TO BSEN 1329 WITH SOLVENT WELD JOINTS CONFORMING TO BSEN 1329.

### 4.00 PVC-Mu WASTE PIPES

ALL WASTE PIPES AND FITTINGS SHALL BE GEBERIT TERRAIN LTD OR SIMILAR, TYPE PVC-Mu 200 SYSTEM WITH SOLVENT WELDED JOINTS EXCEPT WHERE SEAL RING JOINTS ARE REQUIRED FOR THERMAL MOVEMENT.

ALL PIPES AND FITTINGS SHALL COMPLY IN ALL RESPECTS WITH THE REQUIREMENTS OF BSEN 1329 AND SHALL WHERE APPROPRIATE, BEAR THE BRITISH STANDARD KITEMARK.

ALL COMPONENTS SHALL BE MANUFACTURED BY GEBERIT TERRAIN LTD OR AN EQUALLY APPROVED SYSTEM.

THE MINIMUM ACCEPTABLE WALL THICKNESS OF PIPE AND FITTINGS SHALL BE AS FOLLOWS:–

| Nominal Size (mm) | Pipe Thickness (mm) | Fitting Thickness (mm) |
|---|---|---|
| 32 | 1.80 | 1.80 |
| 40 | 1.90 | 1.90 |
| 50 | 2.00 | 2.00 |

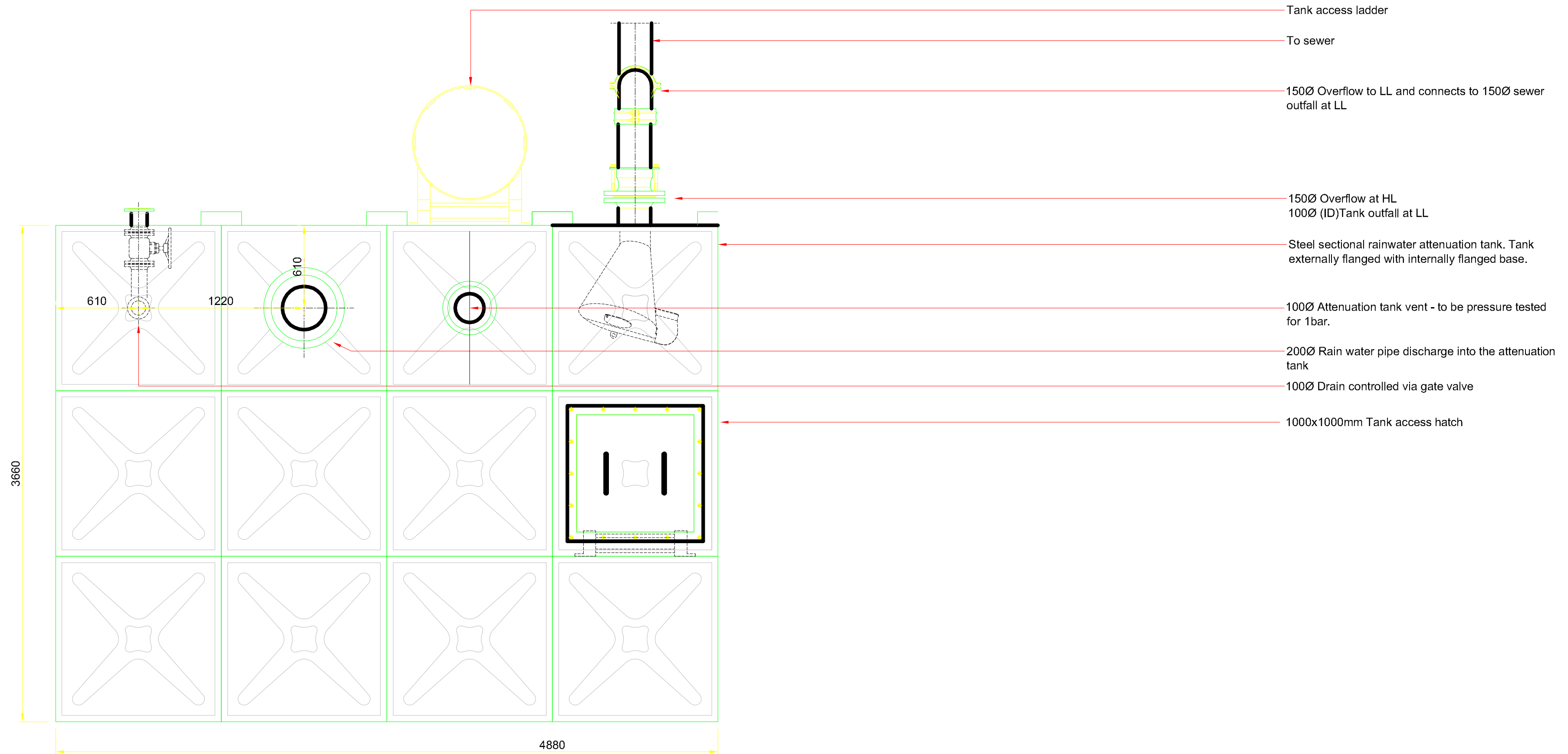
| Rev | Description | Ref | Eng | Date |
|---|---|---|---|---|
| T2 | TENDER ISSUE - FOR PLANNING | | TT | DEC 2016 |
| P1 | PRELIMINARY ISSUE | | TT | FEB 2016 |

Revisions

glp mechanical and electrical consulting engineers
UNIT 5 HOWARTH COURT, GATEWAY CRESCENT, OLDHAM
BROADWAY BUSINESS PARK, CHADDERTON, OL9 9XB
Tel: 0161 681 7070
Fax: 0161 219 1968

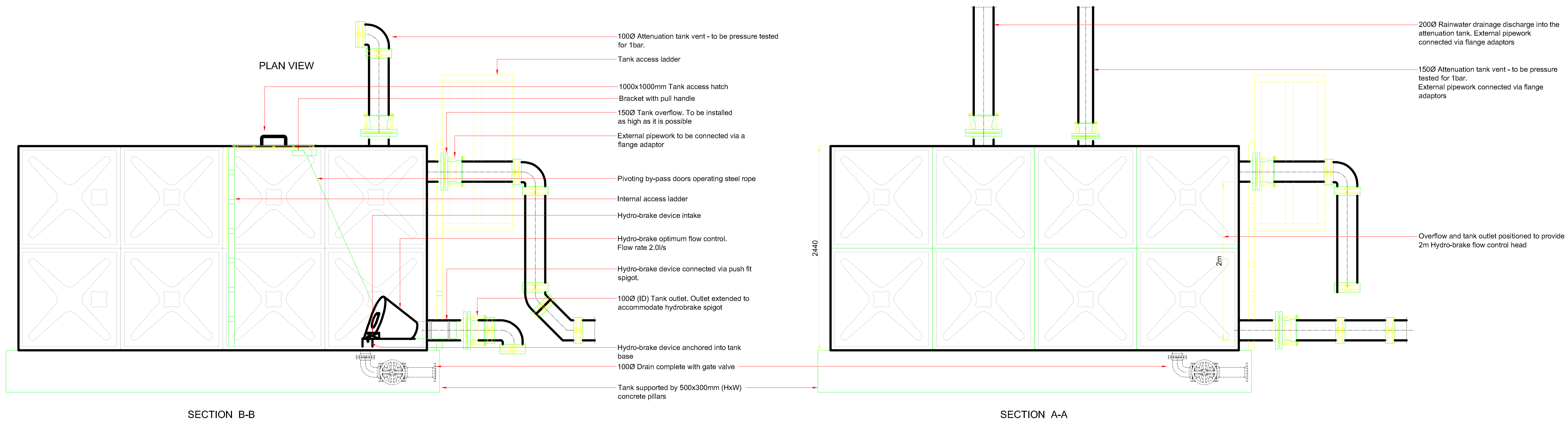
| | |
|---|---|
| Client | LAZARI INVESTMENTS LTD |
| Project Title | GREATER LONDON HOUSE NEW OFFICE SPACE |
| Drawing Title | PROPOSED SPA AND SHOWER BLOCK DRAINAGE STRATEGY DRAWING |
| In Association with | FORME UK |
| Drawn by | TT |
| Checked by | PTK |
| Date | FEB 2016 |
| Scales | 1:50@A1 (work to figured dimensions) |
| DRG No. | 1607-M106 |
| Rev. | T2 |

# TYPICAL ATTENUATION TANK DETAIL DRAWING




Due to static pressure from rainwater system tank to be tested for 1 bar pressure

Final connections positions TBC with tank manufacturer



# Appendix C

MICRODRAINAGE CALCULATIONS

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.055 | 0.355 | 2.2 | 0.0 | 2.2 | 10.6 | O K |
| 30 min Summer | 23.120 | 0.420 | 2.3 | 0.0 | 2.3 | 12.6 | O K |
| 60 min Summer | 23.127 | 0.427 | 2.3 | 0.0 | 2.3 | 12.8 | O K |
| 120 min Summer | 23.094 | 0.394 | 2.3 | 0.0 | 2.3 | 11.8 | O K |
| 180 min Summer | 23.055 | 0.355 | 2.2 | 0.0 | 2.2 | 10.6 | O K |
| 240 min Summer | 23.015 | 0.315 | 2.2 | 0.0 | 2.2 | 9.4 | O K |
| 360 min Summer | 22.941 | 0.241 | 2.2 | 0.0 | 2.2 | 7.2 | O K |
| 480 min Summer | 22.877 | 0.177 | 2.1 | 0.0 | 2.1 | 5.3 | O K |
| 600 min Summer | 22.824 | 0.124 | 2.1 | 0.0 | 2.1 | 3.7 | O K |
| 720 min Summer | 22.782 | 0.082 | 2.1 | 0.0 | 2.1 | 2.5 | O K |
| 960 min Summer | 22.725 | 0.025 | 2.1 | 0.0 | 2.1 | 0.7 | O K |
| 1440 min Summer | 22.700 | 0.000 | 1.8 | 0.0 | 1.8 | 0.0 | O K |
| 2160 min Summer | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2880 min Summer | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 4320 min Summer | 22.700 | 0.000 | 0.7 | 0.0 | 0.7 | 0.0 | O K |
| 5760 min Summer | 22.700 | 0.000 | 0.6 | 0.0 | 0.6 | 0.0 | O K |
| 7200 min Summer | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 8640 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 10080 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 15 min Winter | 23.107 | 0.407 | 2.3 | 0.0 | 2.3 | 12.2 | O K |
| 30 min Winter | 23.188 | 0.488 | 2.3 | 0.0 | 2.3 | 14.6 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 137.274 | 0.0 | 12.8 | 0.0 | 17 |
| 30 min Summer | 88.737 | 0.0 | 16.6 | 0.0 | 31 |
| 60 min Summer | 54.549 | 0.0 | 20.3 | 0.0 | 54 |
| 120 min Summer | 32.389 | 0.0 | 24.3 | 0.0 | 86 |
| 180 min Summer | 23.570 | 0.0 | 26.5 | 0.0 | 120 |
| 240 min Summer | 18.708 | 0.0 | 28.0 | 0.0 | 154 |
| 360 min Summer | 13.486 | 0.0 | 30.3 | 0.0 | 220 |
| 480 min Summer | 10.688 | 0.0 | 32.0 | 0.0 | 282 |
| 600 min Summer | 8.919 | 0.0 | 33.4 | 0.0 | 340 |
| 720 min Summer | 7.689 | 0.0 | 34.5 | 0.0 | 398 |
| 960 min Summer | 6.081 | 0.0 | 36.5 | 0.0 | 508 |
| 1440 min Summer | 4.363 | 0.0 | 39.3 | 0.0 | 0 |
| 2160 min Summer | 3.126 | 0.0 | 42.2 | 0.0 | 0 |
| 2880 min Summer | 2.465 | 0.0 | 44.4 | 0.0 | 0 |
| 4320 min Summer | 1.762 | 0.0 | 47.6 | 0.0 | 0 |
| 5760 min Summer | 1.387 | 0.0 | 49.9 | 0.0 | 0 |
| 7200 min Summer | 1.152 | 0.0 | 51.8 | 0.0 | 0 |
| 8640 min Summer | 0.989 | 0.0 | 53.4 | 0.0 | 0 |
| 10080 min Summer | 0.870 | 0.0 | 54.8 | 0.0 | 0 |
| 15 min Winter | 137.274 | 0.0 | 14.4 | 0.0 | 17 |
| 30 min Winter | 88.737 | 0.0 | 18.7 | 0.0 | 31 |

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.211 | 0.511 | 2.3 | 0.0 | 2.3 | 15.3 | O K |
| 120 min Winter | 23.161 | 0.461 | 2.3 | 0.0 | 2.3 | 13.8 | O K |
| 180 min Winter | 23.104 | 0.404 | 2.3 | 0.0 | 2.3 | 12.1 | O K |
| 240 min Winter | 23.043 | 0.343 | 2.2 | 0.0 | 2.2 | 10.3 | O K |
| 360 min Winter | 22.932 | 0.232 | 2.2 | 0.0 | 2.2 | 7.0 | O K |
| 480 min Winter | 22.840 | 0.140 | 2.1 | 0.0 | 2.1 | 4.2 | O K |
| 600 min Winter | 22.768 | 0.068 | 2.1 | 0.0 | 2.1 | 2.0 | O K |
| 720 min Winter | 22.718 | 0.018 | 2.1 | 0.0 | 2.1 | 0.6 | O K |
| 960 min Winter | 22.700 | 0.000 | 1.8 | 0.0 | 1.8 | 0.0 | O K |
| 1440 min Winter | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2160 min Winter | 22.700 | 0.000 | 0.9 | 0.0 | 0.9 | 0.0 | O K |
| 2880 min Winter | 22.700 | 0.000 | 0.7 | 0.0 | 0.7 | 0.0 | O K |
| 4320 min Winter | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 5760 min Winter | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 7200 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |
| 8640 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |
| 10080 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 54.549 | 0.0 | 22.8 | 0.0 | 58 |
| 120 min Winter | 32.389 | 0.0 | 27.3 | 0.0 | 92 |
| 180 min Winter | 23.570 | 0.0 | 29.8 | 0.0 | 130 |
| 240 min Winter | 18.708 | 0.0 | 31.4 | 0.0 | 166 |
| 360 min Winter | 13.486 | 0.0 | 34.0 | 0.0 | 234 |
| 480 min Winter | 10.688 | 0.0 | 35.9 | 0.0 | 296 |
| 600 min Winter | 8.919 | 0.0 | 37.4 | 0.0 | 350 |
| 720 min Winter | 7.689 | 0.0 | 38.7 | 0.0 | 398 |
| 960 min Winter | 6.081 | 0.0 | 40.9 | 0.0 | 0 |
| 1440 min Winter | 4.363 | 0.0 | 44.0 | 0.0 | 0 |
| 2160 min Winter | 3.126 | 0.0 | 47.3 | 0.0 | 0 |
| 2880 min Winter | 2.465 | 0.0 | 49.7 | 0.0 | 0 |
| 4320 min Winter | 1.762 | 0.0 | 53.3 | 0.0 | 0 |
| 5760 min Winter | 1.387 | 0.0 | 55.9 | 0.0 | 0 |
| 7200 min Winter | 1.152 | 0.0 | 58.1 | 0.0 | 0 |
| 8640 min Winter | 0.989 | 0.0 | 59.8 | 0.0 | 0 |
| 10080 min Winter | 0.870 | 0.0 | 61.4 | 0.0 | 0 |

## 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) | 20.700 | Shortest Storm (mins) | 15 |
| Ratio R | 0.436 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 0.050

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.050 |

## Model Details

Storage is Online Cover Level (m) 25.100

## Tank or Pond Structure

Invert Level (m) 22.700

| Depth (m) | Area (m²) |
|---|---|
| 0.000 | 30.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0060-2000-1600-2000 |
| Design Head (m) | 1.600 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 60 |
| Invert Level (m) | 21.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.600 | 2.0 |
| Flush-Flo™ | 0.263 | 1.5 |
| Kick-Flo® | 0.536 | 1.2 |
| Mean Flow over Head Range | - | 1.5 |

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 | 1.3 | 1.200 | 1.8 | 3.000 | 2.7 | 7.000 | 4.0 |
| 0.200 | 1.5 | 1.400 | 1.9 | 3.500 | 2.9 | 7.500 | 4.1 |
| 0.300 | 1.5 | 1.600 | 2.0 | 4.000 | 3.0 | 8.000 | 4.2 |
| 0.400 | 1.5 | 1.800 | 2.1 | 4.500 | 3.2 | 8.500 | 4.3 |
| 0.500 | 1.3 | 2.000 | 2.2 | 5.000 | 3.4 | 9.000 | 4.4 |
| 0.600 | 1.3 | 2.200 | 2.3 | 5.500 | 3.5 | 9.500 | 4.6 |
| 0.800 | 1.5 | 2.400 | 2.4 | 6.000 | 3.7 | | |
| 1.000 | 1.6 | 2.600 | 2.5 | 6.500 | 3.8 | | |

## Pipe Overflow Control

| | | | |
|---|---|---|---|
| Diameter (m) | 0.150 | Entry Loss Coefficient | 0.500 |
| Slope (1:X) | 200.0 | Coefficient of Contraction | 0.600 |
| Length (m) | 2.500 | Upstream Invert Level (m) | 24.900 |
| Roughness k (mm) | 0.600 | | |

Summary of Results for 100 year Return Period (+30%)

| 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 | 23.071 | 0.371 | 2.2 | 0.0 | 2.2 | 11.1 | O K |
| 30 min Summer | 23.141 | 0.441 | 2.3 | 0.0 | 2.3 | 13.2 | O K |
| 60 min Summer | 23.152 | 0.452 | 2.3 | 0.0 | 2.3 | 13.6 | O K |
| 120 min Summer | 23.118 | 0.418 | 2.3 | 0.0 | 2.3 | 12.5 | O K |
| 180 min Summer | 23.078 | 0.378 | 2.2 | 0.0 | 2.2 | 11.3 | O K |
| 240 min Summer | 23.038 | 0.338 | 2.2 | 0.0 | 2.2 | 10.1 | O K |
| 360 min Summer | 22.963 | 0.263 | 2.2 | 0.0 | 2.2 | 7.9 | O K |
| 480 min Summer | 22.897 | 0.197 | 2.2 | 0.0 | 2.2 | 5.9 | O K |
| 600 min Summer | 22.842 | 0.142 | 2.1 | 0.0 | 2.1 | 4.3 | O K |
| 720 min Summer | 22.797 | 0.097 | 2.1 | 0.0 | 2.1 | 2.9 | O K |
| 960 min Summer | 22.735 | 0.035 | 2.1 | 0.0 | 2.1 | 1.0 | O K |
| 1440 min Summer | 22.700 | 0.000 | 1.9 | 0.0 | 1.9 | 0.0 | O K |
| 2160 min Summer | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2880 min Summer | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 4320 min Summer | 22.700 | 0.000 | 0.7 | 0.0 | 0.7 | 0.0 | O K |
| 5760 min Summer | 22.700 | 0.000 | 0.6 | 0.0 | 0.6 | 0.0 | O K |
| 7200 min Summer | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 8640 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 10080 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 15 min Winter | 23.125 | 0.425 | 2.3 | 0.0 | 2.3 | 12.8 | O K |
| 30 min Winter | 23.212 | 0.512 | 2.3 | 0.0 | 2.3 | 15.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 137.274 | 0.0 | 13.4 | 0.0 | 17 |
| 30 min Summer | 88.737 | 0.0 | 17.3 | 0.0 | 31 |
| 60 min Summer | 54.549 | 0.0 | 21.2 | 0.0 | 54 |
| 120 min Summer | 32.389 | 0.0 | 25.3 | 0.0 | 86 |
| 180 min Summer | 23.570 | 0.0 | 27.5 | 0.0 | 120 |
| 240 min Summer | 18.708 | 0.0 | 29.0 | 0.0 | 154 |
| 360 min Summer | 13.486 | 0.0 | 31.6 | 0.0 | 220 |
| 480 min Summer | 10.688 | 0.0 | 33.2 | 0.0 | 284 |
| 600 min Summer | 8.919 | 0.0 | 34.8 | 0.0 | 344 |
| 720 min Summer | 7.689 | 0.0 | 36.0 | 0.0 | 400 |
| 960 min Summer | 6.081 | 0.0 | 37.9 | 0.0 | 510 |
| 1440 min Summer | 4.363 | 0.0 | 40.8 | 0.0 | 0 |
| 2160 min Summer | 3.126 | 0.0 | 43.9 | 0.0 | 0 |
| 2880 min Summer | 2.465 | 0.0 | 46.1 | 0.0 | 0 |
| 4320 min Summer | 1.762 | 0.0 | 49.5 | 0.0 | 0 |
| 5760 min Summer | 1.387 | 0.0 | 51.9 | 0.0 | 0 |
| 7200 min Summer | 1.152 | 0.0 | 53.9 | 0.0 | 0 |
| 8640 min Summer | 0.989 | 0.0 | 55.6 | 0.0 | 0 |
| 10080 min Summer | 0.870 | 0.0 | 57.0 | 0.0 | 0 |
| 15 min Winter | 137.274 | 0.0 | 15.0 | 0.0 | 17 |
| 30 min Winter | 88.737 | 0.0 | 19.4 | 0.0 | 31 |

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.240 | 0.540 | 2.3 | 0.0 | 2.3 | 16.2 | O K |
| 120 min Winter | 23.190 | 0.490 | 2.3 | 0.0 | 2.3 | 14.7 | O K |
| 180 min Winter | 23.133 | 0.433 | 2.3 | 0.0 | 2.3 | 13.0 | O K |
| 240 min Winter | 23.072 | 0.372 | 2.2 | 0.0 | 2.2 | 11.1 | O K |
| 360 min Winter | 22.958 | 0.258 | 2.2 | 0.0 | 2.2 | 7.8 | O K |
| 480 min Winter | 22.863 | 0.163 | 2.1 | 0.0 | 2.1 | 4.9 | O K |
| 600 min Winter | 22.787 | 0.087 | 2.1 | 0.0 | 2.1 | 2.6 | O K |
| 720 min Winter | 22.731 | 0.031 | 2.1 | 0.0 | 2.1 | 0.9 | O K |
| 960 min Winter | 22.700 | 0.000 | 1.9 | 0.0 | 1.9 | 0.0 | O K |
| 1440 min Winter | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2160 min Winter | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 2880 min Winter | 22.700 | 0.000 | 0.8 | 0.0 | 0.8 | 0.0 | O K |
| 4320 min Winter | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 5760 min Winter | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 7200 min Winter | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 8640 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |
| 10080 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 54.549 | 0.0 | 23.9 | 0.0 | 58 |
| 120 min Winter | 32.389 | 0.0 | 28.2 | 0.0 | 94 |
| 180 min Winter | 23.570 | 0.0 | 30.8 | 0.0 | 132 |
| 240 min Winter | 18.708 | 0.0 | 32.7 | 0.0 | 168 |
| 360 min Winter | 13.486 | 0.0 | 35.3 | 0.0 | 236 |
| 480 min Winter | 10.688 | 0.0 | 37.3 | 0.0 | 298 |
| 600 min Winter | 8.919 | 0.0 | 38.9 | 0.0 | 356 |
| 720 min Winter | 7.689 | 0.0 | 40.3 | 0.0 | 404 |
| 960 min Winter | 6.081 | 0.0 | 42.5 | 0.0 | 0 |
| 1440 min Winter | 4.363 | 0.0 | 45.7 | 0.0 | 0 |
| 2160 min Winter | 3.126 | 0.0 | 49.1 | 0.0 | 0 |
| 2880 min Winter | 2.465 | 0.0 | 51.7 | 0.0 | 0 |
| 4320 min Winter | 1.762 | 0.0 | 55.4 | 0.0 | 0 |
| 5760 min Winter | 1.387 | 0.0 | 58.2 | 0.0 | 0 |
| 7200 min Winter | 1.152 | 0.0 | 60.4 | 0.0 | 0 |
| 8640 min Winter | 0.989 | 0.0 | 62.2 | 0.0 | 0 |
| 10080 min Winter | 0.870 | 0.0 | 63.8 | 0.0 | 0 |

## 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) | 20.700 | Shortest Storm (mins) | 15 |
| Ratio R | 0.436 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 0.052

| **Time (mins) From:** | **To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.052 |

## Model Details

Storage is Online Cover Level (m) 25.100

## Tank or Pond Structure

Invert Level (m) 22.700

| Depth (m) | Area (m²) |
|---|---|
| 0.000 | 30.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SCL-0057-2000-1600-2000 |
| Design Head (m) | 1.600 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise blockage risk |
| Diameter (mm) | 57 |
| Invert Level (m) | 21.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.600 | 2.0 |
| Flush-Flo™ | 0.233 | 1.5 |
| Kick-Flo® | 0.514 | 1.2 |
| Mean Flow over Head Range | - | 1.5 |

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 | 1.4 | 1.200 | 1.8 | 3.000 | 2.7 | 7.000 | 3.9 |
| 0.200 | 1.5 | 1.400 | 1.9 | 3.500 | 2.9 | 7.500 | 4.1 |
| 0.300 | 1.5 | 1.600 | 2.0 | 4.000 | 3.0 | 8.000 | 4.2 |
| 0.400 | 1.4 | 1.800 | 2.1 | 4.500 | 3.2 | 8.500 | 4.3 |
| 0.500 | 1.3 | 2.000 | 2.2 | 5.000 | 3.4 | 9.000 | 4.4 |
| 0.600 | 1.3 | 2.200 | 2.3 | 5.500 | 3.5 | 9.500 | 4.5 |
| 0.800 | 1.5 | 2.400 | 2.4 | 6.000 | 3.7 | | |
| 1.000 | 1.6 | 2.600 | 2.5 | 6.500 | 3.8 | | |

## Pipe Overflow Control

| | | | |
|---|---|---|---|
| Diameter (m) | 0.150 | Entry Loss Coefficient | 0.500 |
| Slope (1:X) | 200.0 | Coefficient of Contraction | 0.600 |
| Length (m) | 2.500 | Upstream Invert Level (m) | 24.900 |
| Roughness k (mm) | 0.600 | | |

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.071 | 0.371 | 2.2 | 0.0 | 2.2 | 11.1 | O K |
| 30 min Summer | 23.141 | 0.441 | 2.3 | 0.0 | 2.3 | 13.2 | O K |
| 60 min Summer | 23.152 | 0.452 | 2.3 | 0.0 | 2.3 | 13.6 | O K |
| 120 min Summer | 23.118 | 0.418 | 2.3 | 0.0 | 2.3 | 12.5 | O K |
| 180 min Summer | 23.078 | 0.378 | 2.2 | 0.0 | 2.2 | 11.3 | O K |
| 240 min Summer | 23.038 | 0.338 | 2.2 | 0.0 | 2.2 | 10.1 | O K |
| 360 min Summer | 22.963 | 0.263 | 2.2 | 0.0 | 2.2 | 7.9 | O K |
| 480 min Summer | 22.897 | 0.197 | 2.2 | 0.0 | 2.2 | 5.9 | O K |
| 600 min Summer | 22.842 | 0.142 | 2.1 | 0.0 | 2.1 | 4.3 | O K |
| 720 min Summer | 22.797 | 0.097 | 2.1 | 0.0 | 2.1 | 2.9 | O K |
| 960 min Summer | 22.735 | 0.035 | 2.1 | 0.0 | 2.1 | 1.0 | O K |
| 1440 min Summer | 22.700 | 0.000 | 1.9 | 0.0 | 1.9 | 0.0 | O K |
| 2160 min Summer | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2880 min Summer | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 4320 min Summer | 22.700 | 0.000 | 0.7 | 0.0 | 0.7 | 0.0 | O K |
| 5760 min Summer | 22.700 | 0.000 | 0.6 | 0.0 | 0.6 | 0.0 | O K |
| 7200 min Summer | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 8640 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 10080 min Summer | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 15 min Winter | 23.125 | 0.425 | 2.3 | 0.0 | 2.3 | 12.8 | O K |
| 30 min Winter | 23.212 | 0.512 | 2.3 | 0.0 | 2.3 | 15.4 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 137.274 | 0.0 | 13.4 | 0.0 | 17 |
| 30 min Summer | 88.737 | 0.0 | 17.3 | 0.0 | 31 |
| 60 min Summer | 54.549 | 0.0 | 21.2 | 0.0 | 54 |
| 120 min Summer | 32.389 | 0.0 | 25.3 | 0.0 | 86 |
| 180 min Summer | 23.570 | 0.0 | 27.5 | 0.0 | 120 |
| 240 min Summer | 18.708 | 0.0 | 29.0 | 0.0 | 154 |
| 360 min Summer | 13.486 | 0.0 | 31.6 | 0.0 | 220 |
| 480 min Summer | 10.688 | 0.0 | 33.2 | 0.0 | 284 |
| 600 min Summer | 8.919 | 0.0 | 34.8 | 0.0 | 344 |
| 720 min Summer | 7.689 | 0.0 | 36.0 | 0.0 | 400 |
| 960 min Summer | 6.081 | 0.0 | 37.9 | 0.0 | 510 |
| 1440 min Summer | 4.363 | 0.0 | 40.8 | 0.0 | 0 |
| 2160 min Summer | 3.126 | 0.0 | 43.9 | 0.0 | 0 |
| 2880 min Summer | 2.465 | 0.0 | 46.1 | 0.0 | 0 |
| 4320 min Summer | 1.762 | 0.0 | 49.5 | 0.0 | 0 |
| 5760 min Summer | 1.387 | 0.0 | 51.9 | 0.0 | 0 |
| 7200 min Summer | 1.152 | 0.0 | 53.9 | 0.0 | 0 |
| 8640 min Summer | 0.989 | 0.0 | 55.6 | 0.0 | 0 |
| 10080 min Summer | 0.870 | 0.0 | 57.0 | 0.0 | 0 |
| 15 min Winter | 137.274 | 0.0 | 15.0 | 0.0 | 17 |
| 30 min Winter | 88.737 | 0.0 | 19.4 | 0.0 | 31 |

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.240 | 0.540 | 2.3 | 0.0 | 2.3 | 16.2 | O K |
| 120 min Winter | 23.190 | 0.490 | 2.3 | 0.0 | 2.3 | 14.7 | O K |
| 180 min Winter | 23.133 | 0.433 | 2.3 | 0.0 | 2.3 | 13.0 | O K |
| 240 min Winter | 23.072 | 0.372 | 2.2 | 0.0 | 2.2 | 11.1 | O K |
| 360 min Winter | 22.958 | 0.258 | 2.2 | 0.0 | 2.2 | 7.8 | O K |
| 480 min Winter | 22.863 | 0.163 | 2.1 | 0.0 | 2.1 | 4.9 | O K |
| 600 min Winter | 22.787 | 0.087 | 2.1 | 0.0 | 2.1 | 2.6 | O K |
| 720 min Winter | 22.731 | 0.031 | 2.1 | 0.0 | 2.1 | 0.9 | O K |
| 960 min Winter | 22.700 | 0.000 | 1.9 | 0.0 | 1.9 | 0.0 | O K |
| 1440 min Winter | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 2160 min Winter | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 2880 min Winter | 22.700 | 0.000 | 0.8 | 0.0 | 0.8 | 0.0 | O K |
| 4320 min Winter | 22.700 | 0.000 | 0.5 | 0.0 | 0.5 | 0.0 | O K |
| 5760 min Winter | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 7200 min Winter | 22.700 | 0.000 | 0.4 | 0.0 | 0.4 | 0.0 | O K |
| 8640 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |
| 10080 min Winter | 22.700 | 0.000 | 0.3 | 0.0 | 0.3 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 54.549 | 0.0 | 23.9 | 0.0 | 58 |
| 120 min Winter | 32.389 | 0.0 | 28.2 | 0.0 | 94 |
| 180 min Winter | 23.570 | 0.0 | 30.8 | 0.0 | 132 |
| 240 min Winter | 18.708 | 0.0 | 32.7 | 0.0 | 168 |
| 360 min Winter | 13.486 | 0.0 | 35.3 | 0.0 | 236 |
| 480 min Winter | 10.688 | 0.0 | 37.3 | 0.0 | 298 |
| 600 min Winter | 8.919 | 0.0 | 38.9 | 0.0 | 356 |
| 720 min Winter | 7.689 | 0.0 | 40.3 | 0.0 | 404 |
| 960 min Winter | 6.081 | 0.0 | 42.5 | 0.0 | 0 |
| 1440 min Winter | 4.363 | 0.0 | 45.7 | 0.0 | 0 |
| 2160 min Winter | 3.126 | 0.0 | 49.1 | 0.0 | 0 |
| 2880 min Winter | 2.465 | 0.0 | 51.7 | 0.0 | 0 |
| 4320 min Winter | 1.762 | 0.0 | 55.4 | 0.0 | 0 |
| 5760 min Winter | 1.387 | 0.0 | 58.2 | 0.0 | 0 |
| 7200 min Winter | 1.152 | 0.0 | 60.4 | 0.0 | 0 |
| 8640 min Winter | 0.989 | 0.0 | 62.2 | 0.0 | 0 |
| 10080 min Winter | 0.870 | 0.0 | 63.8 | 0.0 | 0 |

## 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) | 20.700 | Shortest Storm (mins) | 15 |
| Ratio R | 0.436 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +30 |

## Time Area Diagram

Total Area (ha) 0.052

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.052 |

## Model Details

Storage is Online Cover Level (m) 25.100

## Tank or Pond Structure

Invert Level (m) 22.700

| Depth (m) | Area (m²) |
|---|---|
| 0.000 | 30.0 |

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SCL-0057-2000-1600-2000 |
| Design Head (m) | 1.600 |
| Design Flow (l/s) | 2.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise blockage risk |
| Diameter (mm) | 57 |
| Invert Level (m) | 21.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.600 | 2.0 |
| Flush-Flo™ | 0.233 | 1.5 |
| Kick-Flo® | 0.514 | 1.2 |
| Mean Flow over Head Range | - | 1.5 |

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 | 1.4 | 1.200 | 1.8 | 3.000 | 2.7 | 7.000 | 3.9 |
| 0.200 | 1.5 | 1.400 | 1.9 | 3.500 | 2.9 | 7.500 | 4.1 |
| 0.300 | 1.5 | 1.600 | 2.0 | 4.000 | 3.0 | 8.000 | 4.2 |
| 0.400 | 1.4 | 1.800 | 2.1 | 4.500 | 3.2 | 8.500 | 4.3 |
| 0.500 | 1.3 | 2.000 | 2.2 | 5.000 | 3.4 | 9.000 | 4.4 |
| 0.600 | 1.3 | 2.200 | 2.3 | 5.500 | 3.5 | 9.500 | 4.5 |
| 0.800 | 1.5 | 2.400 | 2.4 | 6.000 | 3.7 | | |
| 1.000 | 1.6 | 2.600 | 2.5 | 6.500 | 3.8 | | |

## Pipe Overflow Control

| | | | |
|---|---|---|---|
| Diameter (m) | 0.150 | Entry Loss Coefficient | 0.500 |
| Slope (1:X) | 200.0 | Coefficient of Contraction | 0.600 |
| Length (m) | 2.500 | Upstream Invert Level (m) | 24.900 |
| Roughness k (mm) | 0.600 | | |

## Summary of Results for 100 year Return Period (+30%)

| 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 | 23.315 | 0.615 | 5.3 | 0.0 | 5.3 | 34.5 | O K |
| 30 min Summer | 23.444 | 0.744 | 5.5 | 0.0 | 5.5 | 41.7 | O K |
| 60 min Summer | 23.497 | 0.797 | 5.5 | 0.0 | 5.5 | 44.6 | O K |
| 120 min Summer | 23.448 | 0.748 | 5.5 | 0.0 | 5.5 | 41.9 | O K |
| 180 min Summer | 23.395 | 0.695 | 5.4 | 0.0 | 5.4 | 38.9 | O K |
| 240 min Summer | 23.342 | 0.642 | 5.4 | 0.0 | 5.4 | 36.0 | O K |
| 360 min Summer | 23.243 | 0.543 | 5.2 | 0.0 | 5.2 | 30.4 | O K |
| 480 min Summer | 23.153 | 0.453 | 5.1 | 0.0 | 5.1 | 25.4 | O K |
| 600 min Summer | 23.072 | 0.372 | 5.0 | 0.0 | 5.0 | 20.8 | O K |
| 720 min Summer | 23.000 | 0.300 | 4.9 | 0.0 | 4.9 | 16.8 | O K |
| 960 min Summer | 22.883 | 0.183 | 4.8 | 0.0 | 4.8 | 10.2 | O K |
| 1440 min Summer | 22.740 | 0.040 | 4.6 | 0.0 | 4.6 | 2.2 | O K |
| 2160 min Summer | 22.700 | 0.000 | 3.9 | 0.0 | 3.9 | 0.0 | O K |
| 2880 min Summer | 22.700 | 0.000 | 3.1 | 0.0 | 3.1 | 0.0 | O K |
| 4320 min Summer | 22.700 | 0.000 | 2.2 | 0.0 | 2.2 | 0.0 | O K |
| 5760 min Summer | 22.700 | 0.000 | 1.7 | 0.0 | 1.7 | 0.0 | O K |
| 7200 min Summer | 22.700 | 0.000 | 1.4 | 0.0 | 1.4 | 0.0 | O K |
| 8640 min Summer | 22.700 | 0.000 | 1.2 | 0.0 | 1.2 | 0.0 | O K |
| 10080 min Summer | 22.700 | 0.000 | 1.1 | 0.0 | 1.1 | 0.0 | O K |
| 15 min Winter | 23.401 | 0.701 | 5.4 | 0.0 | 5.4 | 39.2 | O K |
| 30 min Winter | 23.556 | 0.856 | 5.6 | 0.0 | 5.6 | 47.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 137.494 | 0.0 | 39.7 | 0.0 | 18 |
| 30 min Summer | 88.809 | 0.0 | 51.3 | 0.0 | 32 |
| 60 min Summer | 54.549 | 0.0 | 62.8 | 0.0 | 60 |
| 120 min Summer | 32.365 | 0.0 | 74.5 | 0.0 | 92 |
| 180 min Summer | 23.543 | 0.0 | 81.6 | 0.0 | 126 |
| 240 min Summer | 18.683 | 0.0 | 86.4 | 0.0 | 160 |
| 360 min Summer | 13.462 | 0.0 | 93.5 | 0.0 | 228 |
| 480 min Summer | 10.666 | 0.0 | 98.6 | 0.0 | 292 |
| 600 min Summer | 8.898 | 0.0 | 102.8 | 0.0 | 356 |
| 720 min Summer | 7.671 | 0.0 | 106.4 | 0.0 | 418 |
| 960 min Summer | 6.064 | 0.0 | 112.0 | 0.0 | 538 |
| 1440 min Summer | 4.349 | 0.0 | 120.5 | 0.0 | 754 |
| 2160 min Summer | 3.115 | 0.0 | 129.5 | 0.0 | 0 |
| 2880 min Summer | 2.456 | 0.0 | 136.2 | 0.0 | 0 |
| 4320 min Summer | 1.755 | 0.0 | 145.9 | 0.0 | 0 |
| 5760 min Summer | 1.381 | 0.0 | 153.2 | 0.0 | 0 |
| 7200 min Summer | 1.147 | 0.0 | 159.0 | 0.0 | 0 |
| 8640 min Summer | 0.985 | 0.0 | 163.8 | 0.0 | 0 |
| 10080 min Summer | 0.866 | 0.0 | 168.0 | 0.0 | 0 |
| 15 min Winter | 137.494 | 0.0 | 44.5 | 0.0 | 18 |
| 30 min Winter | 88.809 | 0.0 | 57.3 | 0.0 | 31 |

Summary of Results for 100 year Return Period (+30%)

| 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 | 23.636 | 0.936 | 5.7 | 0.0 | 5.7 | 52.4 | O K |
| 120 min Winter | 23.586 | 0.886 | 5.6 | 0.0 | 5.6 | 49.6 | O K |
| 180 min Winter | 23.510 | 0.810 | 5.5 | 0.0 | 5.5 | 45.4 | O K |
| 240 min Winter | 23.433 | 0.733 | 5.5 | 0.0 | 5.5 | 41.1 | O K |
| 360 min Winter | 23.284 | 0.584 | 5.3 | 0.0 | 5.3 | 32.7 | O K |
| 480 min Winter | 23.150 | 0.450 | 5.1 | 0.0 | 5.1 | 25.2 | O K |
| 600 min Winter | 23.033 | 0.333 | 5.0 | 0.0 | 5.0 | 18.6 | O K |
| 720 min Winter | 22.932 | 0.232 | 4.9 | 0.0 | 4.9 | 13.0 | O K |
| 960 min Winter | 22.778 | 0.078 | 4.7 | 0.0 | 4.7 | 4.4 | O K |
| 1440 min Winter | 22.700 | 0.000 | 4.0 | 0.0 | 4.0 | 0.0 | O K |
| 2160 min Winter | 22.700 | 0.000 | 2.8 | 0.0 | 2.8 | 0.0 | O K |
| 2880 min Winter | 22.700 | 0.000 | 2.2 | 0.0 | 2.2 | 0.0 | O K |
| 4320 min Winter | 22.700 | 0.000 | 1.6 | 0.0 | 1.6 | 0.0 | O K |
| 5760 min Winter | 22.700 | 0.000 | 1.3 | 0.0 | 1.3 | 0.0 | O K |
| 7200 min Winter | 22.700 | 0.000 | 1.0 | 0.0 | 1.0 | 0.0 | O K |
| 8640 min Winter | 22.700 | 0.000 | 0.9 | 0.0 | 0.9 | 0.0 | O K |
| 10080 min Winter | 22.700 | 0.000 | 0.8 | 0.0 | 0.8 | 0.0 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 54.549 | 0.0 | 70.3 | 0.0 | 60 |
| 120 min Winter | 32.365 | 0.0 | 83.7 | 0.0 | 98 |
| 180 min Winter | 23.543 | 0.0 | 91.4 | 0.0 | 136 |
| 240 min Winter | 18.683 | 0.0 | 96.9 | 0.0 | 174 |
| 360 min Winter | 13.462 | 0.0 | 104.4 | 0.0 | 246 |
| 480 min Winter | 10.666 | 0.0 | 110.4 | 0.0 | 314 |
| 600 min Winter | 8.898 | 0.0 | 115.0 | 0.0 | 378 |
| 720 min Winter | 7.671 | 0.0 | 119.2 | 0.0 | 440 |
| 960 min Winter | 6.064 | 0.0 | 125.4 | 0.0 | 548 |
| 1440 min Winter | 4.349 | 0.0 | 135.0 | 0.0 | 0 |
| 2160 min Winter | 3.115 | 0.0 | 145.1 | 0.0 | 0 |
| 2880 min Winter | 2.456 | 0.0 | 152.5 | 0.0 | 0 |
| 4320 min Winter | 1.755 | 0.0 | 163.4 | 0.0 | 0 |
| 5760 min Winter | 1.381 | 0.0 | 171.5 | 0.0 | 0 |
| 7200 min Winter | 1.147 | 0.0 | 178.0 | 0.0 | 0 |
| 8640 min Winter | 0.985 | 0.0 | 183.5 | 0.0 | 0 |
| 10080 min Winter | 0.866 | 0.0 | 188.1 | 0.0 | 0 |