Technical Note

CD8.1

Hempsted Lane, Gloucester [20/00315/OUT]

Project:	CRM.1132.021.HY.R.002.A - Outline Drainage Strategy
For:	Gladman Developments Ltd
Status:	Issued
Date:	11th August 2022
Author:	Daniel Alstead BSc [Hons], MSc, MCIWEM, C.WEM - Associate Director
Approver:	Matt Travis BSc [Hons], MSc, MCIWEM, C.WEM, CEnv, CSci - Company Director

1. Introduction

Enzygo Ltd was commissioned by Gladman Developments Ltd to carry out a site-specific flood risk assessment [FRA], including an outline surface water drainage strategy, in support of an outline application for a proposed residential development. The Site is located on land east of Hempsted Lane, Gloucester, GL2 5DB [NGR. 381526, 216546] ['the Site'].

Following submission of the FRA report [Reference. CRM.1132.021.HY.R.001.A, December 2019], Enzygo produced an 'LLFA Response Letter' [Reference. CRM.1132.021.HY.L.001.C, 24th June 2022] which provided additional information following receipt of email responses from Gloucester City Council. A copy of the letter issued to Gloucester Council is included in Appendix 1.

Following submission of the LLFA Response Letter, Gloucester City Council confirmed most of the key issues raised had been addressed, except for the basin design, where the incorporation of a wider maintenance bench and the addition of a safety bench was requested [Appendix 2].

2. Purpose of Technical Note

The Technical Note specifically deals with the Inspector's second main issue [relating to the Council's putative reason for refusal 5]. It is understood that subject to appropriately worded planning conditions being imposed, the Council no longer seeks to defend this putative reason for refusal.

3. Revised Drainage Strategy

Existing Drainage System

The 12.22ha Site is comprised of three agricultural [arable] land parcels, divided by hedgerows.

The Site is underlain by soils and geology with low infiltration potential. It is likely that drainage is predominantly via overland flow, following the topography of the Site to the topographic low points [south, towards Hempsted Brook], with a small amount of infiltration to bedrock, and throughflow to watercourse.

There is currently no foul water discharging from the undeveloped Site. Please note that foul drainage is not considered within this Technical Note but is dealt with in a separate standalone report.

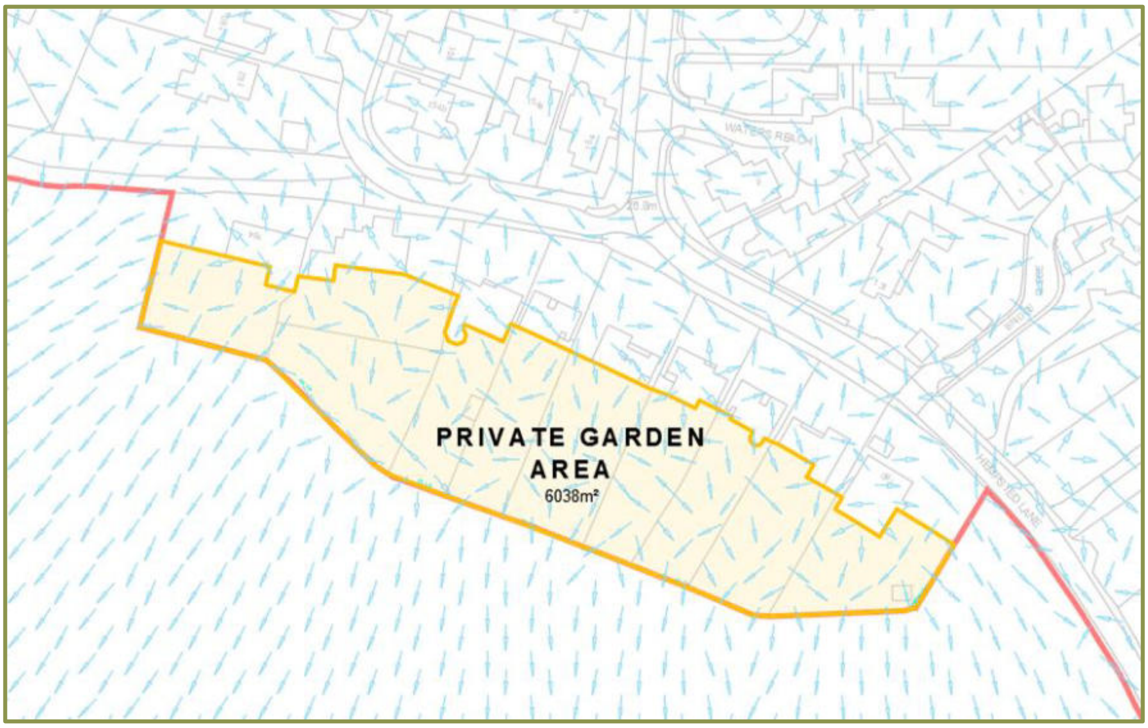
Developable and Impermeable Areas

The proposal is for residential development. An allowance of 55% impermeable area [inclusive of 10% for urban creep] was applied to the 6.4ha developable area [i.e. 3.52ha].

A 20% allowance was applied to the 2.88ha permeable area [i.e. 0.58ha].

KeyTERRA-FIRMA [KTF] flow pathway analysis [using LiDAR data] was used to understand the route of overland flows from topographically higher land to the north of the Site [Figure 3.1]. Overland flows from land to the north-east and north-west of the Site will be intercepted by swales, which will direct runoff around the Site then into to Hempsted Brook to the south. Overland flows from garden areas associated with adjacent dwellings, which are not positively drained and fall south towards the Site, was measured at 0.60ha. A 20% 'impermeable area' factor was applied to this area [i.e. 0.12ha]. Swales will be utilised to intercept any overland flows, which will be directed to the onsite detention basin.

Figure 3.1: Garden Areas



The existing and proposed impermeable areas are shown in Table 3.1. The proposed development will increase the impermeable surfaces and so increase the amount of runoff, unless mitigated as is proposed with this development.

Table 3.1: Impermeable Area

Area	Existing Buildings and Hardstanding	Proposed Buildings and Hardstanding	Difference
Area [ha]	0.00	4.22	+4.22
Percentage of Total Site Area [%]	0	34.5	+34.5

Greenfield Runoff Rates

An assessment of greenfield runoff rates was undertaken to determine the attenuation requirements for the proposed development.

The runoff rates were calculated using the HRWallingford UKSuDS online tool, with FEH method inputs [descriptors obtained from the FEH webservice[1]]. This is a recommended methodology for Sites up to 50ha in area and the approach is in line with the current 'industry best practice' guidelines as outlined in the Interim Code of Practice for SuDS[2], and Environment Agency Report SC030219 - Rainfall runoff management for developments.

The following parameters were used in the runoff calculations:

- Impermeable Area: 3.52ha.
- Average Annual Rainfall [SAAR]: 645mm/year
- BFIHOST19: 0.453
- Region No.: 4

BFIHOST was updated to BFIHOST19 [November 2019] since a number of issues were identified with BFIHOST, which including a tendency to underestimate BFI [Base Flow Index[3]] in clay-dominated catchments.

BFIHOST19 is the baseflow index developed using the Hydrology of Soil Types [HOST] classification and is the baseflow proportion of the flow on average. It is estimated based on the daily mean flow data. Baseflow comprises water entering the watercourse through shallow subsurface flow and groundwater flow [mechanisms other than direct surface runoff]; hence permeable soils and geology tend to yield a higher baseflow.

BFIHOST19 value assigned by the FEH webservice is considered to replicate on-site conditions.

Table 3.2 shows the calculated greenfield runoff rates. Drainage calculations are included in Appendix 3. The QBAR runoff rate has been utilised to inform the drainage calculations in the remainder of the report.

Table 3.2: Greenfield Runoff Rates

Annual Probability [Return Period, years]	Greenfield Runoff [l/s]
QBAR	10.55
100% [1]	8.76
3.33% [30]	21.1
1% [100]	27.11
1% Plus Climate Change	37.95

Note: *40% added to the data to account for long-term climate change as stated in 'Flood Risk Assessment: Climate Change Allowance'. The 1 in 1-year, 30-year and 100-year annual probability events are of importance to the Water Companies and the Environment Agency when looking at sewage discharge and flood risk.*

[1] Centre for Ecology and Hydrology, Flood Estimation Handbook Web Service [https://fehweb.ceh.ac.uk/].
[2] Office of the Deputy Prime Minister, National SuDS Working Group [July 2004] Interim Code of Practice for Sustainable Drainage Systems [https://www.susdrain.org/files/resources/other-guidance/nswg_icop_for_suds_0704.pdf].
[3] *"The BFI may be thought of as a measure of the proportion of the river runoff that derives from stored sources; the more permeable the rock, superficial deposits and soils in a catchment, the higher the baseflow and the more sustained the river's flow during periods of dry weather. Thus the BFI is an effective means of indexing catchment geology"* [https://nrfa.ceh.ac.uk/derived-flow-statistics].

Sustainable Drainage Options [SuDS]

Feasibility of SuDS

Soakaway testing was undertaken during September 2019. A copy of the Infiltration Test Report is included in Appendix 6 of the FRA report. Findings show that infiltration-based SuDS would not feasible due to low infiltration.

Choice of SuDS Options

Sustainable water management measures should be used to control the surface water runoff from the proposed development Site, thereby managing the flood risk to the Site and surrounding areas from surface water runoff. These measures will also improve the quality of water discharged from the Site.

Current guidance promotes sustainable water management using SuDS. Options applicable to this Site are identified in Table 3.3.

Table 3.3: SuDS Options

Green roofs	Infiltration basins
Water butts	Detention basins
Permeable paving	Oversized pipes
Rainwater harvesting	Brown roofs
Filter strips	Swales
Wetland Areas	Cellular Storage

Note: *SuDS appropriate to the development are highlighted green.*

A hierarchy of SuDS techniques is identified[4]:

1. **Prevention** - the use of good Site design and housekeeping measures on individual Sites to prevent runoff and pollution [e.g. minimise areas of hard standing].
2. **Source Control** - control of runoff at or very near its source [such as the use of rainwater harvesting].
3. **Site Control** - management of water from several sub-catchments [including routing water from roofs and car parks to one/several large soakaways for the whole Site].
4. **Regional Control** - management of runoff from several Sites, typically in a detention pond or wetland.

Using SuDS as opposed to conventional drainage systems provides several benefits by:

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream.
- Reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed Sites.
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources.

[4] CIRIA [2004] Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- Reducing potable water demand through rainwater harvesting.
- Improving amenity through the provision of public open spaces and wildlife habitat.
- Replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

SuDS Maintenance

The following SuDS features have been integrated into the drainage strategy:

- A detention basin - Main attenuation feature.
- Swales - Conveyance of development runoff to the detention basin. These swales will be integrated along the reach of the existing onsite land drains, orientated north to south through the Site.
- Interception Swales - Interception of offsite overland flows and direct to watercourse/detention basin.
- Permeable paving for cul-de-sacs.
- Water butts fitted to individual dwellings.

Maintenance of the SuDS features would be in line with the SuDS Manual [CIRIA C753, 2015] as well as the Gloucestershire SuDS Design & Maintenance Guide [November 2015][5]. The maintenance would be undertaken by a private maintenance company.

It is standard for SuDS features within a new development to be maintained by a private maintenance company. If the maintenance company goes into administration, the Site will be contracted to a new maintenance company. Residents will pay a surcharge to the maintenance company and a number of them would be appointed to its board. This will ensure maintenance throughout the lifetime of the development.

Details of other SuDS features and maintenance would be considered further at detailed design when a detailed layout has been produced. The level of detailed provided within this Technical Note should be sufficient at outline stage to demonstrate that SuDS would be deliverable.

Surface Water Management Strategy

Hierarchy of Discharge

In accordance with requirement H3 of the Building Regulations 2000[6] rainwater runoff must discharge to one of the following, listed in order of priority:

1. **An adequate soakaway or some other adequate infiltration system:** The use of infiltration-based SuDS is not feasible due to low infiltration potential [demonstrated through infiltration testing].
2. **A watercourse:** Hempsted Brook conveys flow north-west along the south-west boundary.
3. **A sewer:** There is a public surface water sewer conveying flow south-west through the eastern extent of the Site, with an outfall to Hempsted Brook.

The potential route to discharge from the existing Site will be by outfall to Hempsted Brook.

[5] https://www.gloucestershire.gov.uk/media/6846/gloucestershire_suds_design_and_maintenance_guide_-dec_2015-compressed-63334.pdf
[6] Office of the Deputy Prime Minister, The Building Regulations 2000.

Drainage Design

An indicative drainage layout is included in Appendix 4. Below is a summary of the drainage design, as well as the benefits of the recommended SuDS features. Details of other SuDS features design would be considered further at detailed design when a detailed layout has been produced. The level of detailed provided within this Technical Note should be sufficient at outline stage to demonstrate that SuDS would be deliverable.

1. General

Surface water runoff would be directed to the drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.

Landscaped areas should be incorporated into the layout where possible, and the associated gardens of each unit will allow a proportion of the rainfall to infiltrate into the soil substrate.

2. Water Butts

Individual dwellings to be fitted with a water butt. Water butts encourage water recycling, thereby potentially reducing runoff assuming water is taken out of the system.

3. Permeable Paving

Permeable paving could be utilised for cul-de-sacs, thereby providing additional attenuation and treatment train to improve water quality.

4. Detention Basin

Surface water will be directed to an onsite detention basin, positioned to achieve a gravity fed connection to the Hempsted Brook, and 3D cut into the topography. The revised basin encroaches slightly into the developable area. We note that size of the basin is based on a conservative 55% impermeable area [inclusive of 10% urban creep] and is likely to be oversized in its current design and will be scaled down at detailed design stage when a layout is fixed. The basin size does not account for attenuation provided in other SuDS features, including swales with check dams and permeable paving.

The detention basin will be sized to attenuate runoff from developable areas within the Site boundary, as well as any runoff from the gardens of dwellings to the north of the Site which fall towards the Site.

The detention basin has been designed with a 1:4 side slope, 1.50m water depth [incorporating a 1.50m safety bench at 0.60m below top of water level], 0.30m freeboard allowance for safety, and 3.50m maintenance bench.

The detention basin will provide a level of treatment to improve water quality.

5. Swales

Swales will be integrated into the design to:

- Intercept any overland flows from gardens associated with adjacent dwellings to the north of the Site. Any intercepted flows will be directed to the detention basin.
- Direct runoff from the development to the detention basin [along the reach of the existing onsite land drains], thereby providing an additional treatment train to improve water quality.
- Intercept any overland flows from topographically higher land, which falls towards the Site from the north-east and north-west. Any intercepted flows will be directed to watercourse.

Swales have been 3D cut into the topography and designed with a 0.50m bed width, 1:3 side slope, and 0.30m to 0.50m depth.

Check dams will need to be integrated into the swale design where gradients are steepest to reduce the velocity of flows and preventing erosion, which will also slow the rate of conveyance to the receiving onsite detention basin/watercourse. Check dams will provide a degree of attenuation during lower return period storm events, as well as provide an additional levels of treatment to improve water quality.

Swales will need to be culverted beneath highway and footpath crossings.

Attenuation Requirements

Attenuation storage is required to reduce the post-application surface water runoff from the Site to calculated greenfield runoff rates, up to and including the 1 in 100-year [+40% climate change] rainfall event, assuming no infiltration losses.

The following input parameters were assumed in the calculations:

- Impermeable Area: 3.52ha plus 20% of the permeable area [Site and gardens to the north]
- Cv [proportion of rainfall forming surface water runoff]: 100% summer, 100% winter
- Infiltration losses: 0.00m/hour
- With outfall at QBAR [Table 3.2]

The attenuation volume for the 1 in 100-year event [plus climate change] is 4,520m^3.

Drainage calculations are included in Appendix 3. The calculated runoff rates and attenuation volumes will be reviewed at detailed design stage.

Exceedance Routes

The detention basin will be designed with a capacity up to a 1 in 100-year [plus 40% climate change] event, with a +300mm freeboard allowance, based on the QBAR restricted discharge rate. This provides a betterment [reduction] in runoff when compared to existing undeveloped conditions, where runoff is uncontrolled across all return periods. Furthermore, the detention basin has been designed to accept runoff from the gardens associated with dwellings to the north of the Site.

A storm event in excess of this design standard would be extreme and would cause the detention basin to overtop [with no sudden deluge] and would then shed overland following the topography [south] towards the Hempsted Brook, as per existing conditions.

Finished floor levels of new dwellings will be set above external levels, which will mitigate the residual risk of overtopping.

4. Site Drainage

The proposed development will increase the area of impermeable surfaces and therefore increase the amount of runoff without mitigation.

Surface water runoff from the Site will be restricted to greenfield rate [QBAR], which offers a betterment to existing conditions with uncontrolled runoff across all return periods.

Surface water runoff from the proposed development would be attenuated on-site up to and including the 1 in 100-year event, plus 40% climate change.

A SuDS drainage scheme is proposed to manage excess runoff from the development, comprising a detention basin to maintain runoff at pre-development rates, with an outfall to the watercourse. Swales, permeable paving, and water butt have also been designed into the outline drainage design to provide additional attenuation and will improve water quality.

5. Conclusion

This Technical Note demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere, and is compliant with the requirements of national policy and guidance. The development should not therefore be precluded on the grounds of surface water drainage.

Note, it was agreed that the remaining issue raised by the Council in their most recent response [i.e. incorporation of a wider maintenance bench and the addition of a safety bench added to the basin design] can be dealt with at the reserved matters stage and will be subject to an appropriately worded planning condition.

Attachment 1 - LLFA Response Letter

Samuel House, 5 Fox Valley Way
Stocksbridge, Sheffield, S36 2AA

Date: 24th June 2022

Our Ref: CRM.1132.021.HY.L.001.C

Email: daniel.alstead@enzygo.com

Application No.: 20/00315/OUT

By Email: Joann.Meneaud@gloucester.gov.uk

FAO: Joann Meneaud
Gloucester City Council

Dear Joann

Hempsted Lane, Gloucester, GL2 5DB - LLFA Response Letter

Introduction

Enzygo Ltd produced a Flood Risk Assessment (Reference. CRM.1132.021.HY.R.001.A, December 2019), supported by an outline surface water drainage strategy, for a proposed residential development, located on land west of Hempsted Lane, Gloucester (the 'Site').

Following submission of the Flood Risk Assessment, Gloucester City Council provided an email response (dated 6th July 2020) from the Drainage Advisor, requesting further information and clarity regarding the drainage strategy.

Enzygo Ltd produced a response letter to LLFA comments (Reference. CRM.1132.021.HY.L.001.A, April 2022), for a proposed residential development, located on land west of Hempsted Lane, Gloucester (the 'Site').

Following submission of the response letter, Gloucester City Council provided a further email response (6th June 2022) from the Drainage Advisor, requesting further information and clarity regarding the drainage strategy. Extracts from the email are included below, together with the Enzygo Ltd response. A copy of the email is included as Attachment 1.

Enzygo Ltd Response

An intercept ditch / swale is required along the top of the development to protect it from overland runoff from gardens to the north.

Revised drainage drawings are included in Attachment 2. A swale has been positioned along the northern boundary, which then conveys flows to the central swales, which direct flows into the onsite attenuation basin.

The extent and position of the interception swales are such that a gravity connection to watercourse can be established and considers root protection zones adjacent to bounding trees/hedgerows.

The swales have been designed with the following parameters:

- Depth: 0.30m
- Site slope: 1:3
- Bed width: 0.50m

The swales have been 3D-cut into the topography to show the required land take.

Check dams will be required along the length of the swales to reduce the velocity of flows (preventing erosion) and to provide a degree of attenuation/reduce time runoff takes to enter the swales.

Residual surface water flood risk would be mitigated by setting finished floor levels above external levels.

Some permeable area (that uphill of new drainage provision) will contribute surface water runoff to the new drainage network. An allowance is needed here.

A 20% allowance for the permeable area has been added to the revised drainage calculations, alongside 20% allowance for the 0.604ha private garden area to the north. Revised runoff and attenuation calculations are included in Attachment 3, which are based on an impermeable area of 4.22ha.

The basin volume/size has been amended to allow for additional runoff. A revised attenuation basin is included in Attachment 2.

A summary of the updated developable/impermeable areas, greenfield runoff rates and attenuation requirements is included below.

Developable and Impermeable Areas

An allowance of 55% impermeable area (inclusive of 10% for urban creep) was applied to the 6.4ha developable area. The existing and proposed impermeable areas are shown in the table below.

Impermeable Area

Area	Existing Buildings and Hardstanding	Proposed Buildings and Hardstanding	Difference
Area (ha)	0.00	4.22	+4.22
Percentage of Total Site Area (%)	0	34.5	+34.5

Greenfield Runoff Rates

The following parameters were used in the runoff calculations:

- Impermeable Area: 4.22ha.
- Average Annual Rainfall (SAAR): 645mm/year;
- BFIHOST19: 0.453
- Region No.: 4

The table below shows the revised greenfield runoff rates.

Greenfield Runoff Rates

Annual Probability (Return Period, years)	Greenfield Runoff (l/s)
QBAR	12.72
100% (1)	10.56
3.33% (30)	25.44
1% (100)	32.69
1% Plus Climate Change	45.77

Attenuation Requirements

The following input parameters were assumed in the calculations:

- Impermeable Area: 3.5ha plus 20% of the permeable area (0.6ha) and 20% of the 0.604ha private garden area (0.12ha)
- Cv (proportion of rainfall forming surface water runoff): 100% summer, 100% winter
- Infiltration losses: 0.00m/hour
- With outfall at QBAR.

The attenuation volume for the 1 in 100-year event (plus climate change) is 4,520m^3.

Concern that the new dwellings located closest to the bottom of the site will not be able to discharge by gravity to the surface water drainage network.

Indicative surface water sewer runs have been added to the revised drainage drawing included in Attachment 2. Cover and invert levels are included at the upstream end of the runs closest to the bottom of the Site to demonstrate that a gravity to the basin is feasible.

Sections have been provided but modifications are required so that we can evaluate the basin design fundamentals.

A revised section drawing is also included in Attachment 2. Additional information provided is as follows:

- Chainage and level information at changes in slope.
- Side slope gradients.
- Maximum water level.

The applicant should indicate how the SuDS features will be maintained.

SuDS maintenance is considered under Section 6.5 of the FRA. Maintenance of the SuDS features would be in line with the SuDS Manual (CIRIA C753, 2015) / Gloucestershire SuDS Design & Maintenance Guide (November 2015)[1], and would be undertaken by a private maintenance company.

Clarity is sought on water butt provision.

The revised drainage drawing and calculations demonstrated that the SuDS attenuation features can manage runoff from the development pre-development rates, which provides a betterment (reduction) in runoff when compared to existing undeveloped conditions, where runoff is uncontrolled across all return periods. Water butts can however be fitted to each dwelling. This note has also been added to the revised drainage drawing (Appendix 2).

[1] https://www.gloucestershire.gov.uk/media/6846/gloucestershire_suds_design_and_maintenance_guide_-dec_2015-compressed-63334.pdf

Samuel House, 5 Fox Valley Way
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Closure

The level of detailed provided should be sufficient at outline stage to demonstrate that SuDS would be deliverable.

We trust that the details presented herein are self-explanatory and clear. If, for any reason you should have any queries or comments, please do not hesitate to contact me.

Yours sincerely,

Daniel Alstead BSc [Hons], MSc, MCIWEM, C.WEM
Associate Director

Enzygo Ltd

Attachment 1 - LLFA Email

Attachment 2 - Revised Drainage Drawings

Attachment 3 - Revised Drainage Calculations

Attachment 1 – LLFA Email

Elizabeth Austin

From: Joann Meneaud <Joann.Meneaud@gloucester.gov.uk>
Sent: 06 June 2022 17:47
To: Paul Roberts; Peter Dutton; Christien Lee
Subject: FW: Hill Farm, Hempsted appeal drainage response 20/00315/OUT
Attachments: 21099_01_230_02 drainage strategy.pdf

Hello
Comments from our Drainage Adviser are attached.

He states:

> *I have commented on this one by means reference to my earlier comments (on 20/00315/OUT) which are shown below.*
>
> *Latest comments are in purple font.*
>
> *I have reviewed the applicant's response (their ref : Enzygo CRM.1132.021.HY.L.001.B) to earlier comments below.*
>
> *In summary, the design has been modified to accommodate some of the points I raised, but some issues / outstanding information remains.*
>
> *None of the points I have raised should be insurmountable.*

It would be helpful to know whether you would be intending to address the points raised or provide commentary upon them and the timescale for doing so.

Thanks

Joann

Hi Jo,

My comments on this application are shown below.

The key points are:

- An intercept ditch / swale is required along the top of the development to protect it from overland runoff from the north.

Partly addressed – see below

- A review of QBar (permissible discharge rate) and the attenuation volume is needed. These could have an impact on the space required for the basin.

Partly addressed – see below

- More commitment to SuDS provision is needed.

Mostly addressed – see below

- Basin too rectilinear (man-made) looking.

The shape has been improved

- Sections through the basin are required so we can see if it can be accommodated, in an acceptable manner, into the space allocated.

Sections have been provided, but additional information is sought

- The basin may need reconfiguring to produce an acceptable design (no large bund).

Additional section information is required to provide clarity here

- The culverted watercourses should be opened up.

This now forms part of the proposal - ok

The EA is a statutory consultee and should provide bespoke comments on this application.

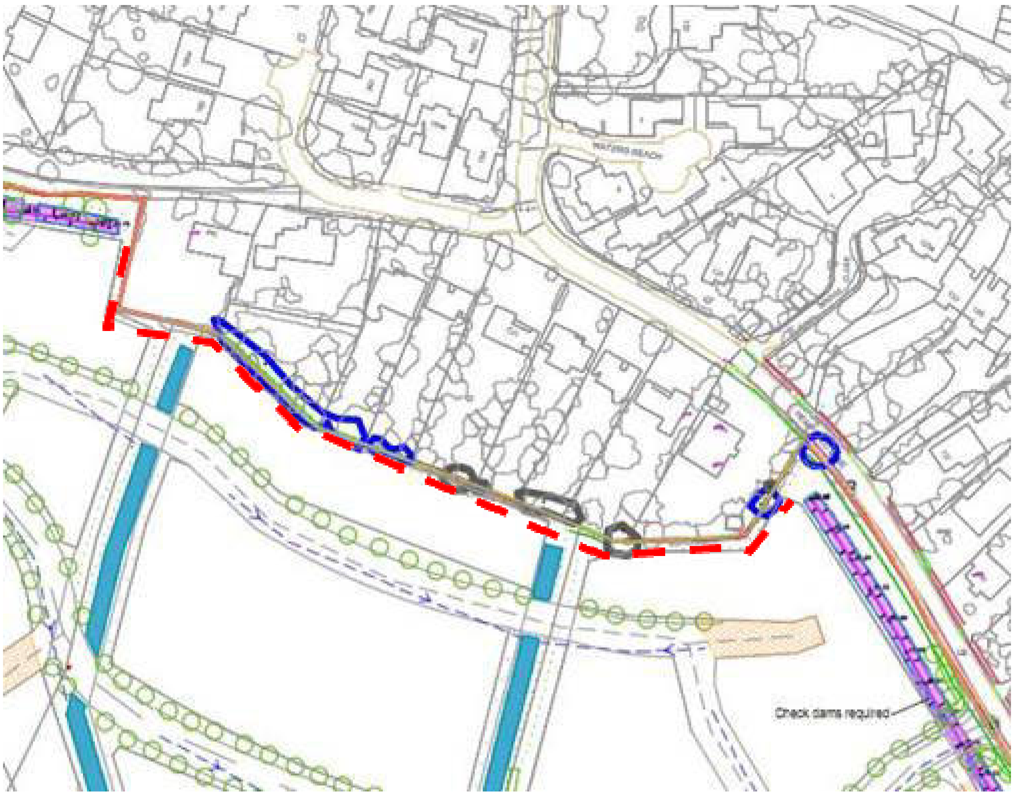
<u>Flood Risk At The Site</u>

Flood maps show that the application site includes flood zone 2 and flood zone 3 areas.

However, no built development is proposed in the flood zone 2 and 3 areas, and so I don't have any concerns about fluvial flood risk at the site.

My only comment on flood risk from other sources is that due consideration will need to be given to surface runoff arriving at the development site from the uphill areas to the north. Due to the sloping site and the clay soils this could be significant. We would expect to see an intercept ditch/swale at detailed design stage.

An intercept swale (with check dams) has been provided along part of the northern boundary – in purple below (where a gravity connection around the east / west of the site is possible). This leaves a section in the centre (shown below in red) which remains unprotected. Can an intercept swale / ditch please be added here. It could be connected into the proposed swales (blue lines), with an appropriate allowance for the attenuation provision. I appreciate that the highway will intercept overland flows from north of the highway, but we have had similar (sloping, clay) sites before where problematic runoff has been generated over a relatively small area.



The sequential test can be considered as passed by virtue of the fact a sequential approach has been taken to site layout and all development is within flood zone 1. The exception test does not need to be addressed ('more vulnerable' development in flood zone 1).

Please note that the EA will make their own evaluation over flood risk at the site, which may differ from my comments.

<u>Impact Of The Development On Flood Risk Elsewhere</u>

- Surface Water Runoff Rates

It is accepted that infiltration is not viable.

In line with GCC/LLFA guidance, surface water runoff is to be attenuated to QBar.

I have some questions over the discharge rate / attenuation volume calculations.

A QBar value for the site of 17.3 l/s has been calculated based on a developable area of 6.3 ha.

However, the attenuation volume calculations seem to have been calculated based on the smaller (impermeable) area of 3.52 ha, with no allowance for the permeable areas.

The runoff from the permeable areas has to go somewhere. It will either:

1) Be captured by the on-site drainage - in which case that area can be include in the QBar calculations, but the attenuation volume calculations will need to make allowance for the runoff.

or

2) Not be captured by the on-site drainage – in which case that area should not be included in the QBar calculations.

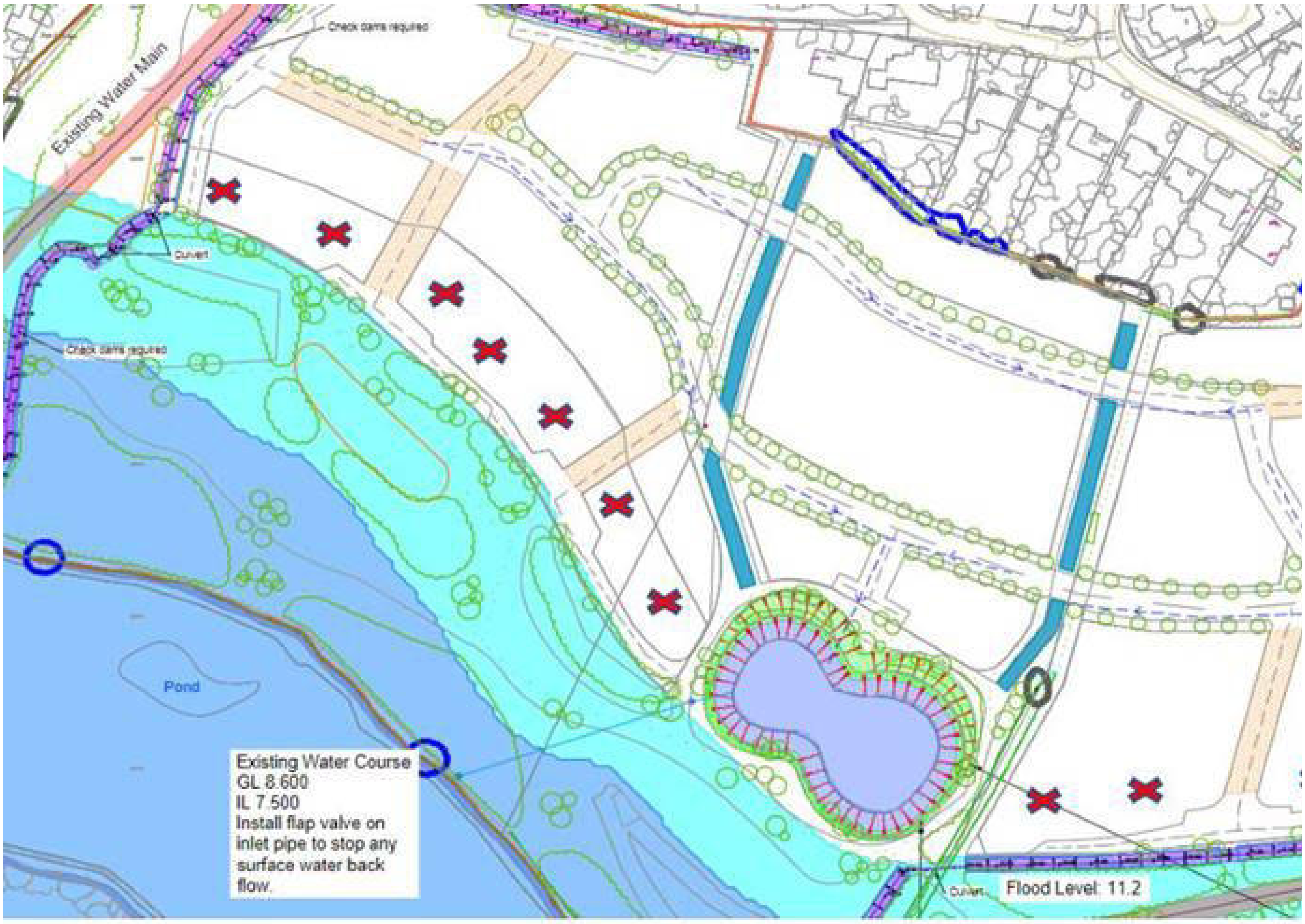
Where runoff volumes are being calculated for a defined area of impermeable surfacing (as they are here), we would normally expect the cv value to be 0.95. Here, Cv values of 0.75 / 0.84 (summer / winter) have been used. Clarification is sought.

N.B. There are some small discrepancies between (developable / impermeable) areas quoted in the different sections / plans but these can be ironed at detailed design.

The permissible site discharge has been re-calculated at 10.3 l/s which is seems like an appropriate rate.

The attenuation volume calculations don't make any allowance for the capture of runoff from permeable area. Presumably some permeable area (that uphill of new drainage provision) will contribute surface water runoff to the new drainage network. An allowance is needed here. Sometimes we see 20% of contributing permeable added at 100% runoff.

The drainage strategy presented is fairly basic. I am concerned that the new dwellings located closest to the bottom of the site ('X's below) will not be able to discharge by gravity to the surface water drainage pipework shown which in places is a long way up hill from new dwellings. Clarity is sought here.



SuDS

On a large Greenfield site such as this we expect to see a very good level of above ground SuDS provision. As well as source control and attenuation, we would expect to see SUDS included for conveyance (for example, swales instead of pipes). Please see the attached SuDS layout for another development site which demonstrates the inclusion of SuDs for surface water conveyance. The FRA does say that swales and filter strips are options applicable to the development however, we require to see more commitment that these will actually be incorporated. For example, the FRA should include text along the lines of, '*swales, filter strips, water butts and permeable paving will be incorporated into the development*', and where possible, some commitment to the extents of these SuDS. For example, '*where practicable, every dwelling shall be fitted with a water butt*'. Also, where possible, indicative positions/extents should be shown on the drainage layout plan (swales for example).

Two swales have been added through the centre of the site (existing drains de-culverted) which is a welcome addition.

The (tanked) permeable paving is a useful addition, helping with water quality and reducing attenuation volumes for the main basin.

Clarity is sought on water butt provision

It is particularly important that SuDS attenuation basins are well designed and well integrated. Basins should be as naturalistic as possible with varying side slopes (max 1 in 4). If they are to form part of public open space / play space they should have good access. Low flows should be channelled within a shallow swale within the basin so the basin is kept as accessible (dry) as possible for as much of the time as possible, unless the basin is designed as a wet pond. The photo below shows the style of basin preferred. A permanently wet area is good for wildlife.

Further notes on attenuation basins:

- Basins to incorporate a 3.5 m wide safety / maintenance bench around the perimeter.
- Basin sides to have varying gradients (max 1 in 4)
- Inlets and outlets to be finished in pitched stone rather than RC concrete
- Key clamp railings to be avoided
- Basin topography to be as naturalistic as possible. In particular, unnatural looking bunds and ‘perched’ basins are to be avoided

Whilst we do not need to see the full detailed design of the basin as part of outline planning application it needs to be demonstrated that the attenuation volume required can be comfortably, and safely, accommodated within the space allocated. With this in mind, an outline planning application should include a few indicative sections. I would like to request that these are submitted.

Sections have been provided but modifications are required so that we can evaluate the basin design fundamentals (extent of bunding / safety & maintenance benches etc).
Please:

- Provide chainage/level information at changes in slope so that we can evaluate the changes in level / heights of bunds / positions and widths of maintenance & safety benches etc
- Add slope gradients to section
- Add proposed max water levels / outfall levels (so we can review water depths / freeboard etc)

Looking at the drainage layout plan, and with reference to the guidance above, a few comments spring to mind:

The basin has rather man-made rectilinear layout; this should be softened.

The basin outline has been softened

I suspect that the layout shown involves a tall bund on the downslope side, although until we see sections it is hard to tell. As set out above, perched basins and large bunds are to be avoided. They look unnatural and also pose a risk in the sense of presenting a potential breach (bank failure) opportunity.

A more linear basin, working with contours, would sit better.

The applicant should indicate how the SuDS features will be maintained~~. Subject to acceptable design, and an agreed commuted sum, the City Council may agree to take on the responsibility for the maintenance of certain above ground SuDS features in public open space~~. Where an application does not include a SuDS maintenance schedule, a condition to this effect will be required.

Please note that the LPA no longer tends to adopt basins on new developments.
The applicant should indicate how the SuDS features will be maintained

From a water quality perspective, the water quality objectives set out in the publication CIRIA C753 should be met. Please note that traditional gullies/slot drains and interceptors alone, will not meet the objectives. All vehicular areas need to meet the required standards. Here, the basin in conjunction with the swales and permeable paving should deliver adequate water quality provison.

The combination of permeable paving, swales, basins should meet water quality requitements

All SuDS proposals will need to be reviewed by the archaeologist.

<u>Watercourses</u>

Gloucester City Council requires that an 8 m corridor be kept free of development to each side of watercourses (measured from top of bank). This is achieved for Hempsted Brook (Black Ditch) as there is no development in this area. The 4 m corridor (4 m to each side) proposed for the smaller on-site watercourses is considered acceptable here.

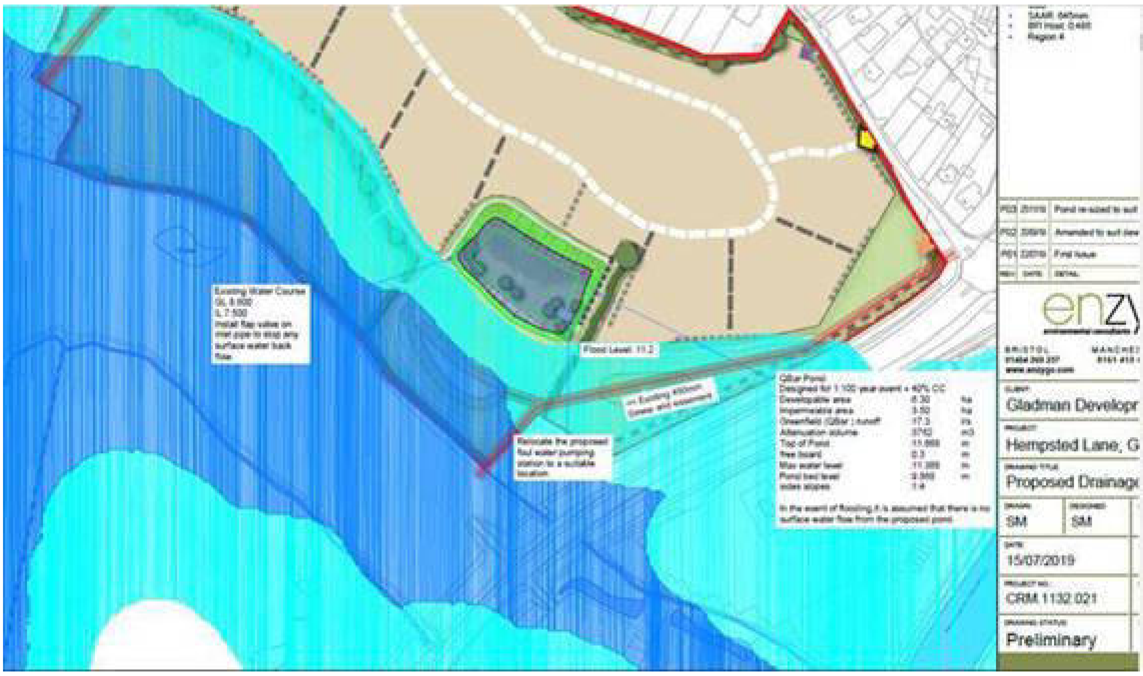
These on-site drains are being converted into swales. ok

These on-site watercourses currently have culverted sections due to previous infilling by the landowner. We require that these culverted sections are removed and the watercourses / ditches reinstated. This is in line with sections 3.5.39 and 3.5.40 of the City Plan. Currently, if the culverted sections block, the repercussions are minimal as flood would simply flow across the fields to the Hempsted Brook. However, in event that the site is developed, blockages could have more serious consequences.

These on-site drains / ditches are being converted into swales. ok

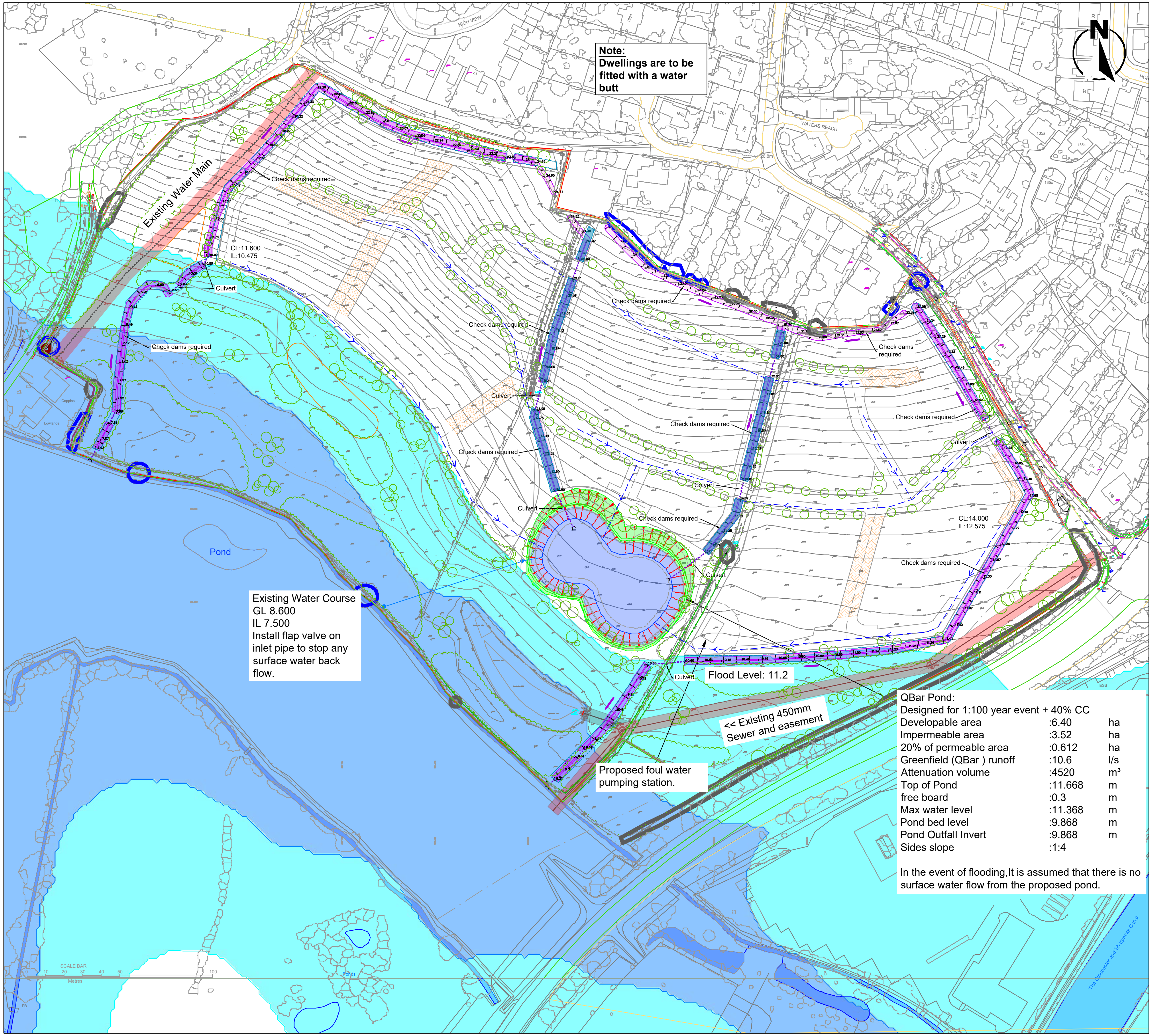
Kind regards

Nick



Flood Level: 11.2
Relocate the proposed foul water pumping station to a suitable location
Gladman Developr
Hempsted Lane, G
Proposed Drainage
SM
SM
15/07/2019
CRM 1132 021
Preliminary

Attachment 2 – Revised Drainage Drawings



NOTES

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3. This drawing is to be read in conjunction with all relevant drawings and documents associated with this project.
4. All surveyed information including levels and layout is provided by others
5. All existing and proposed dimensions, levels and locations to be checked and verified by the main contractor on site prior to the commencement of the works and any anomalies reported to the engineer.
6. All works, workmanship and materials on private drainage to be in accordance with the civil engineering specification for water industry 7th edition published by the water research council.

Drainage Design

- Drainage is designed Using Flow running FEH 13 point data
- SAAR: 645mm
- BFI Host19: 0.453
- Region 4

Key

Indicative Surface Water Sewer

Permeable Paving

REV:	DATE:	DETAIL:	DES:	CHK:	APP:
P07	24/06/22	Updated to suit Client comments	EA	DA	DA
P06	22/06/22	Updated to suit latest LLFA comments	EA	DA	DA
P05	06/04/22	Updated with latest DFP	EA	MT	MT
P04	29/03/22	Pond re-sized to suit LLFA comments, swales and indicative SW routes added	EA	DA	DA
P03	25/11/19	Pond re-sized to suit latest DFP	WW	SM	EC
P02	20/09/19	Amended to suit developable area	SM	MGg	BF
P01	22/07/19	First Issue	SM	MGg	BF

enzygo environmental consultants

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MANCHESTER 0161 413 6444
SHEFFIELD 0114 321 5151 hello@enzygo.com

CLIENT: Gladman Developments Ltd

PROJECT: Hempsted Lane, Gloucester

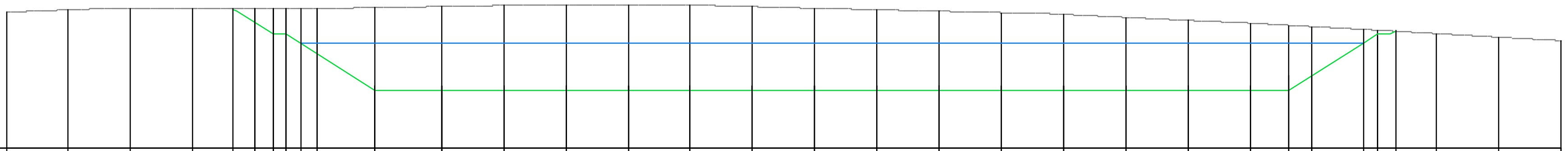
DRAWING TITLE: Proposed Drainage

DRAWN:	DESIGNED:	CHECKED:	APPROVED:
SM	SM	MGg	BF

DATE: 15/07/2019	SCALE @ A3: 1:2000
PROJECT NO.: CRM.1132.021	DRAWING NO.: 001
DRAWING STATUS: Preliminary	ISSUE: P07

Section A-A

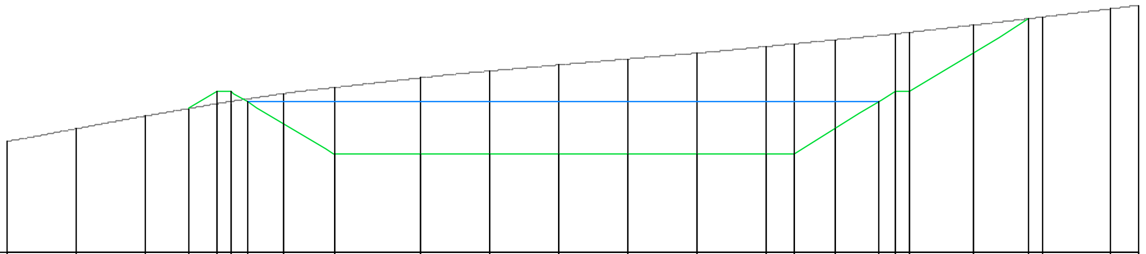
Horiz. 1:250
Vert. 1:100



CHAINAGE	GROUND LEVEL	POND LEVEL	MAX WATER LEVEL	SIDE SLOPE
0.000	12.368			
5.000	12.442			
10.000	12.471			
15.000	12.476			
18.204	12.452			1 in 4
20.000	12.484	12.033		
21.461	12.487	11.668		
22.462	12.489	11.668		1 in 4
25.000	12.494	11.034	11.368	
29.672	12.511	9.868		
35.000	12.550	9.868		
40.000	12.581	9.868		
45.000	12.597	9.868		
50.000	12.604	9.868		
55.000	12.600	9.868		
60.000	12.545	9.868		
65.000	12.491	9.868		
70.000	12.445	9.868		
75.000	12.400	9.868		
80.000	12.354	9.868		
85.000	12.297	9.868		
90.000	12.200	9.868		
95.000	12.104	9.868		
100.000	12.019	9.868		
103.083	11.948	9.868		1 in 4
105.000	11.904	10.347		
110.289	11.794	11.668		
111.713	11.764			
115.000	11.679			
120.000	11.563			
125.000	11.455			

Section B-B

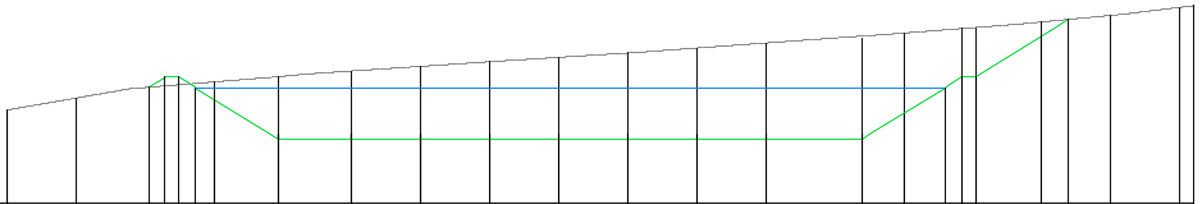
Horiz. 1:250
Vert. 1:100



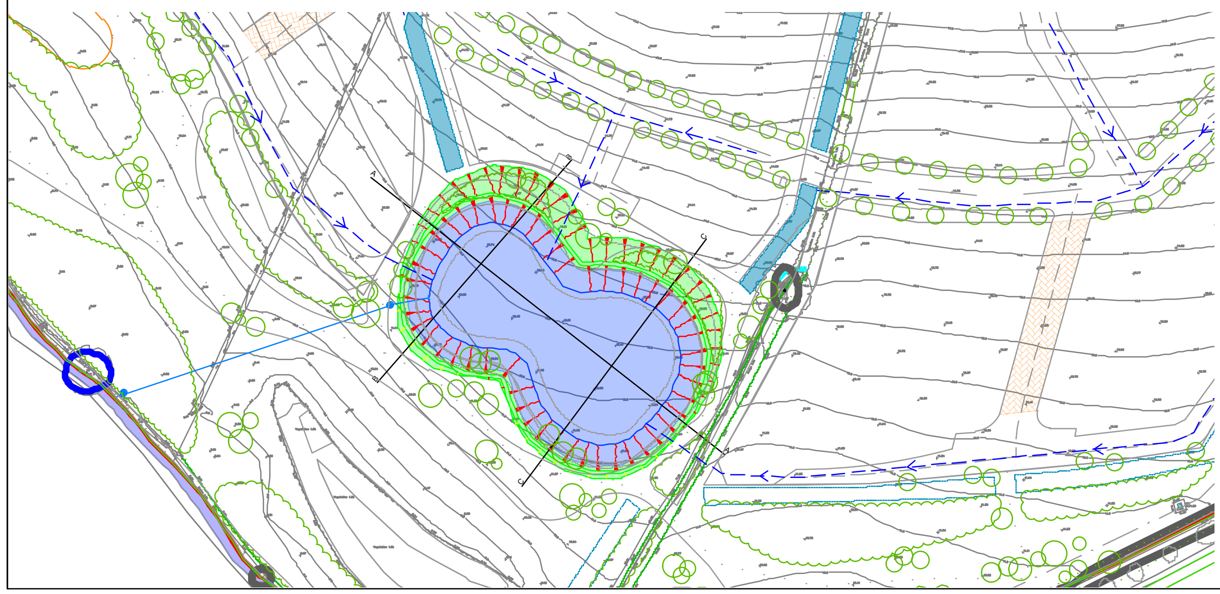
CHAINAGE	GROUND LEVEL	POND LEVEL	MAX WATER LEVEL	SIDE SLOPE
0.000	10.230			
5.000	10.594			
10.000	10.962			
13.132	11.176			1 in 4
15.177	11.307	11.668		
16.216	11.307	11.668		1 in 4
20.000	11.612	10.757	11.368	
25.000	11.847	9.868		
30.000	12.072	9.868		
35.000	12.272	9.868		
40.000	12.449	9.868		
45.000	12.621	9.868		
50.000	12.789	9.868		
55.000	12.980	9.868		
57.029	12.980	9.868		1 in 4
60.000	13.176	10.592		
64.373	13.376	11.668		
65.390	13.376	11.668		1 in 4
70.000	13.601	12.802		
74.018	13.788			
75.000	13.837			
80.000	14.079			
82.000	14.180			

Section C-C

Horiz. 1:250
Vert. 1:100



CHAINAGE	GROUND LEVEL	POND LEVEL	MAX WATER LEVEL	SIDE SLOPE
0.000	10.718			
5.000	11.062			
10.277	11.379			1 in 4
11.433	11.338	11.668		
12.435	11.393	11.668		1 in 4
15.000	11.532	11.029	11.368	
19.654	11.687	9.868		
25.000	11.850	9.868		
30.000	11.985	9.868		
35.000	12.120	9.868		
40.000	12.247	9.868		
45.000	12.373	9.868		
50.000	12.518	9.868		
55.000	12.664	9.868		
61.971	12.865	9.868		1 in 4
65.000	12.953	10.622		
69.197	13.088	11.668		
70.201	13.120	11.668		1 in 4
75.000	13.275	12.863		
76.951	13.350			
80.000	13.466			
85.000	13.699			
86.000	13.747			



NOTES

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2. All dimensions are in meters unless stated otherwise
3. This drawing is to be read in conjunction with all relevant drawings and documents associated with this project.
4. All surveyed information including levels and layout is provided by others
5. All existing and proposed dimensions, levels and locations to be checked and verified by the main contractor on site prior to the commencement of the works and any anomalies reported to the engineer.
6. All works, workmanship and materials on private drainage to be in accordance with the civil engineering specification for water industry 7th edition published by the water research council.

REV:	DATE:	DETAIL:	DES:	CHK:	APP:
P02	22/06/22	Updated to reflect LLFA comments	EA	DA	DA
P01	29/03/22	First Issue	EA	DA	DA

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environmental consultants

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CLIENT:
Gladman Developments Ltd

PROJECT:
Hempsted Lane, Gloucester

DRAWING TITLE:
Proposed Basin Sections

DRAWN:	DESIGNED:	CHECKED:	APPROVED:
EA	EA	DA	DA

DATE:	SCALE @ A3:
29/03/2022	NTS

PROJECT NO.:	DRAWING NO.:
CRM.1132.021	002

DRAWING STATUS:	ISSUE:
Preliminary	P02

Attachment 3 – Revised Drainage Calculations

Print | Close Report

HR Wallingford
Working with water

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Rory Brown
Site name:	Hempsted Lane
Site location:	Gloucester

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	51.84661° N
Longitude:	2.27013° W
Reference:	1623346159
Date:	Jun 24 2022 13:51

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 4.22

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.453
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics	Default	Edited
SAAR (mm):	655	645
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):		12.72
1 in 1 year (l/s):		10.56
1 in 30 years (l/s):		25.44
1 in 100 year (l/s):		32.69
1 in 200 years (l/s):		38.67

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	10.449	0.581	12.7	1513.0	O K
30 min Summer	10.625	0.757	12.7	2028.8	O K
60 min Summer	10.812	0.944	12.7	2605.2	O K
120 min Summer	10.969	1.101	12.7	3115.9	O K
180 min Summer	11.061	1.193	12.7	3426.9	O K
240 min Summer	11.125	1.257	12.7	3646.3	O K
360 min Summer	11.209	1.341	12.7	3940.9	O K
480 min Summer	11.261	1.393	12.7	4127.8	O K
600 min Summer	11.296	1.428	12.7	4254.6	O K
720 min Summer	11.320	1.452	12.7	4343.4	O K
960 min Summer	11.349	1.481	12.7	4449.6	O K
1440 min Summer	11.362	1.494	12.7	4496.4	O K
2160 min Summer	11.331	1.463	12.7	4381.3	O K
2880 min Summer	11.280	1.412	12.7	4195.2	O K
4320 min Summer	11.186	1.318	12.7	3860.1	O K
5760 min Summer	11.114	1.246	12.7	3608.8	O K
7200 min Summer	11.066	1.198	12.7	3442.0	O K
8640 min Summer	11.030	1.162	12.7	3320.6	O K
10080 min Summer	11.005	1.137	12.7	3234.9	O K
15 min Winter	10.449	0.581	12.7	1513.1	O K
30 min Winter	10.625	0.757	12.7	2028.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	145.339	0.0	1068.5	36
30 min Summer	97.425	0.0	1064.8	50
60 min Summer	62.696	0.0	2066.9	80
120 min Summer	37.790	0.0	1965.7	138
180 min Summer	27.931	0.0	1919.5	198
240 min Summer	22.466	0.0	1898.8	256
360 min Summer	16.437	0.0	1891.6	376
480 min Summer	13.106	0.0	1906.8	494
600 min Summer	10.967	0.0	1929.7	614
720 min Summer	9.466	0.0	1945.2	732
960 min Summer	7.484	0.0	1959.0	970
1440 min Summer	5.337	0.0	1946.6	1448
2160 min Summer	3.775	0.0	3813.6	2164
2880 min Summer	2.946	0.0	3721.7	2680
4320 min Summer	2.070	0.0	3536.8	3344
5760 min Summer	1.620	0.0	6511.2	4104
7200 min Summer	1.355	0.0	6745.9	4920
8640 min Summer	1.181	0.0	6717.5	5800
10080 min Summer	1.060	0.0	6373.9	6656
15 min Winter	145.339	0.0	1068.5	36
30 min Winter	97.425	0.0	1065.0	50

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.812	0.944	12.7	2605.3	O K
120 min Winter	10.969	1.101	12.7	3116.8	O K
180 min Winter	11.062	1.194	12.7	3428.6	O K
240 min Winter	11.126	1.258	12.7	3649.0	O K
360 min Winter	11.210	1.342	12.7	3945.6	O K
480 min Winter	11.263	1.395	12.7	4134.4	O K
600 min Winter	11.299	1.431	12.7	4263.2	O K
720 min Winter	11.323	1.455	12.7	4354.0	O K
960 min Winter	11.353	1.485	12.7	4464.2	O K
1440 min Winter	11.368	1.500	12.7	4519.4	Flood Risk
2160 min Winter	11.341	1.473	12.7	4418.8	O K
2880 min Winter	11.293	1.425	12.7	4242.2	O K
4320 min Winter	11.183	1.315	12.7	3850.8	O K
5760 min Winter	11.096	1.228	12.7	3546.8	O K
7200 min Winter	11.027	1.159	12.7	3312.1	O K
8640 min Winter	10.969	1.101	12.7	3117.1	O K
10080 min Winter	10.920	1.052	12.7	2955.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	62.696	0.0	2067.2	78
120 min Winter	37.790	0.0	1966.1	136
180 min Winter	27.931	0.0	1919.7	194
240 min Winter	22.466	0.0	1898.7	252
360 min Winter	16.437	0.0	1890.7	370
480 min Winter	13.106	0.0	1905.3	486
600 min Winter	10.967	0.0	1927.6	604
720 min Winter	9.466	0.0	1942.4	720
960 min Winter	7.484	0.0	1954.8	954
1440 min Winter	5.337	0.0	1940.2	1414
2160 min Winter	3.775	0.0	3805.7	2088
2880 min Winter	2.946	0.0	3716.0	2736
4320 min Winter	2.070	0.0	3544.4	3428
5760 min Winter	1.620	0.0	6513.3	4336
7200 min Winter	1.355	0.0	6758.6	5272
8640 min Winter	1.181	0.0	6819.5	6224
10080 min Winter	1.060	0.0	6540.1	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 381394 216553 SO 81394 16553
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.221

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.875	8	12	0.875	16	20	0.600
4	8	0.875	12	16	0.875	20	24	0.121

Time Area Diagram

Total Area (ha) 0.000

Time From:	**(mins) To:**	**Area (ha)**
0	4	0.000

Model Details

Storage is Online Cover Level (m) 11.668

Tank or Pond Structure

Invert Level (m) 9.868

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2365.0	1.500	3710.0	1.800	4000.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0155-1270-1500-1270
Design Head (m)	1.500
Design Flow (l/s)	12.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	155
Invert Level (m)	9.858
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	12.7
Flush-Flo™	0.445	12.7
Kick-Flo®	0.950	10.2
Mean Flow over Head Range	-	11.0

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	5.6	1.200	11.4	3.000	17.6	7.000	26.5
0.200	11.4	1.400	12.3	3.500	19.0	7.500	27.4
0.300	12.4	1.600	13.1	4.000	20.2	8.000	28.2
0.400	12.7	1.800	13.8	4.500	21.4	8.500	29.1
0.500	12.7	2.000	14.5	5.000	22.5	9.000	29.9
0.600	12.5	2.200	15.2	5.500	23.6	9.500	30.7
0.800	11.8	2.400	15.9	6.000	24.6		
1.000	10.5	2.600	16.5	6.500	25.6		

Daniel Alstead

From: Paul Roberts <P.Roberts@gladman.co.uk>
Sent: 20 July 2022 08:47
To: Daniel Alstead
Cc: Elizabeth Austin; Christien Lee
Subject: FW: Hill Farm, Hempsted appeal 20/00315/OUT drainage

Follow Up Flag: Follow up
Flag Status: Flagged

Dan / Liz

Please see below the comments received this morning in relation to the surface water drainage scheme we submitted a couple of weeks ago.

Could you review and let me know your thoughts please.

If you can come back in the next day or so that would be very helpful as timescales on this one are very tight.

Kind regards,

Paul

Paul Roberts | Project Manager

M: 07912 669 429 | p.roberts@gladman.co.uk
www.gladman.co.uk

From: Joann Meneaud <Joann.Meneaud@gloucester.gov.uk>
Sent: 20 July 2022 08:42
To: Paul Roberts <P.Roberts@gladman.co.uk>; Christien Lee <C.Lee@gladman.co.uk>; Peter Dutton <P.Dutton@gladman.co.uk>
Subject: FW: Hill Farm, Hempsted appeal 20/00315/OUT drainage

Hello,
Sorry if this is a bit confusing but here are the comments in relation to surface water drainage.

Latest comments in green and the immediate text below relates to the basin design.

If you could let me know in the next couple of days, whether you would be intending to submit the modified basin design and sections, that would be helpful.

As we discussed with the affordable housing proposals, it would be very helpful if we could have all the new/revised/updated information in one document that we can the refer to and condition as necessary, and so it is clear to all of us what the proposals are, and to make it easier for the Inspector to read/understand.

Thanks
Joann

Hi Jo,

Very slightly modified comments below – the only slight change from yesterday being that the extra length and width
My preference would be to get modified basin layout and sections from them prior to determination, otherwise this unsuitable basin layout may re-appear at detailed design and slip through if no-one is checking.

If that is not possible then a carefully worded condition would suffice.

Hi Jo,

I have commented on this one by means reference to my earlier comments which are shown below.

Latest comments are shown in green font.

In summary, all my comments have been addressed apart from the issue of demonstrating acceptable / safe basin design.

In order to make the design acceptable, the basin will need to occupy a larger footprint than currently shown
If there is confidence that there is space to accommodate this increase in basin size, and still deliver the number of units proposed, then the modifications can be dealt with at detailed design stage. Otherwise, revised proposals should be submitted prior to determination.

The reasons a larger basin footprint is required is because:

- It needs to incorporate a wider (industry standard) minimum 3.5 m wide dry safety/maintenance bench; it currently has a 1 metre dry safety bench.

- Furthermore, due to the deep water proposed (up to 1.5 metres I believe), it needs a further (min 1.5 metre wide) safety bench 0.6 metres below top water level.

The key points are:

- An intercept ditch / swale is required along the top of the development to protect it from overland runoff from the north.

Partly addressed – see below. Additional length of intercept swale added. Now ok

- A review of QBar (permissible discharge rate) and the attenuation volume is needed. These could have an impact on the space required for the basin.

Partly addressed – see below. Addressed. ok

- More commitment to SuDS provision is needed.

Mostly addressed – see below. Addressed. ok

- Basin too rectilinear (man-made) looking.

The shape has been improved

- Sections through the basin are required so we can see if it can be accommodated, in an acceptable manner, into the space allocated.

Sections have been provided, but additional information is sought. Revised sections have been provided. I am not satisfied that the basin is safe.

- The basin may need reconfiguring to produce an acceptable design (no large bund).

Additional section information is required to provide clarity here. As set out above, I am not satisfied that the basin design is safe

- The culverted watercourses should be opened up.

This now forms part of the proposal - ok

The EA is a statutory consultee and should provide bespoke comments on this application.

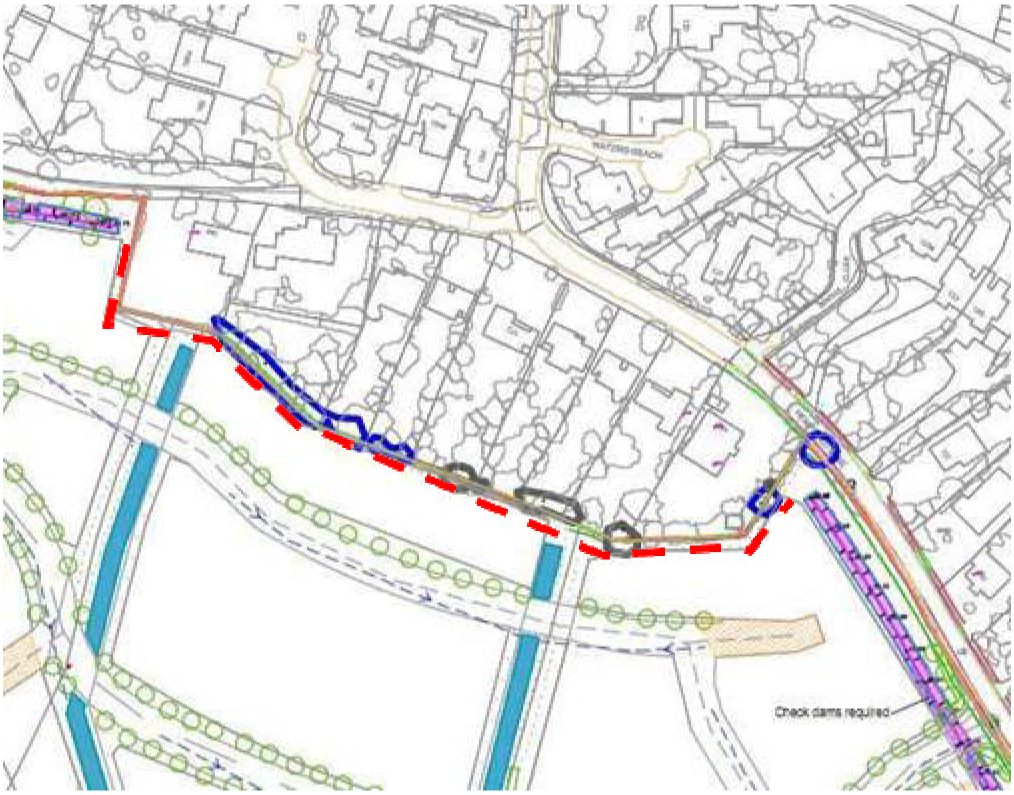
Flood Risk At The Site

Flood maps show that the application site includes flood zone 2 and flood zone 3 areas.

However, no built development is proposed in the flood zone 2 and 3 areas, and so I don't have any concerns about fluvial flood risk at the site.

My only comment on flood risk from other sources is that due consideration will need to be given to surface runoff arriving at the development site from the uphill areas to the north. Due to the sloping site and the clay soils this could be significant. We would expect to see an intercept ditch/swale at detailed design stage.

An intercept swale (with check dams) has been provided along part of the northern boundary – in purple below (where a gravity connection around the east / west of the site is possible). This leaves a section in the centre (shown below in red) which remains unprotected. Can an intercept swale / ditch please be added here. It could be connected into the proposed swales (blue lines), with an appropriate allowance for the attenuation provision. I appreciate that the highway will intercept overland flows from north of the highway, but we have had similar (sloping, clay) sites before where problematic runoff has been generated over a relatively small area. Additional length of intercept swale added. Now ok



The sequential test can be considered as passed by virtue of the fact a sequential approach has been taken to site layout and all development is within flood zone 1. The exception test does not need to be addressed ('more vulnerable' development in flood zone 1).

Please note that the EA will make their own evaluation over flood risk at the site, which may differ from my comments.

Impact Of The Development On Flood Risk Elsewhere

- Surface Water Runoff Rates

It is accepted that infiltration is not viable.

In line with GCC/LLFA guidance, surface water runoff is to be attenuated to QBar.

I have some questions over the discharge rate / attenuation volume calculations.

A QBar value for the site of 17.3 l/s has been calculated based on a developable area of 6.3 ha.

However, the attenuation volume calculations seem to have been calculated based on the smaller (impermeable) area of 3.52 ha, with no allowance for the permeable areas.

The runoff from the permeable areas has to go somewhere. It will either:

1) Be captured by the on-site drainage - in which case that area can be include in the QBar calculations, but the attenuation volume calculations will need to make allowance for the runoff.

or

2) Not be captured by the on-site drainage – in which case that area should not be included in the QBar calculations.

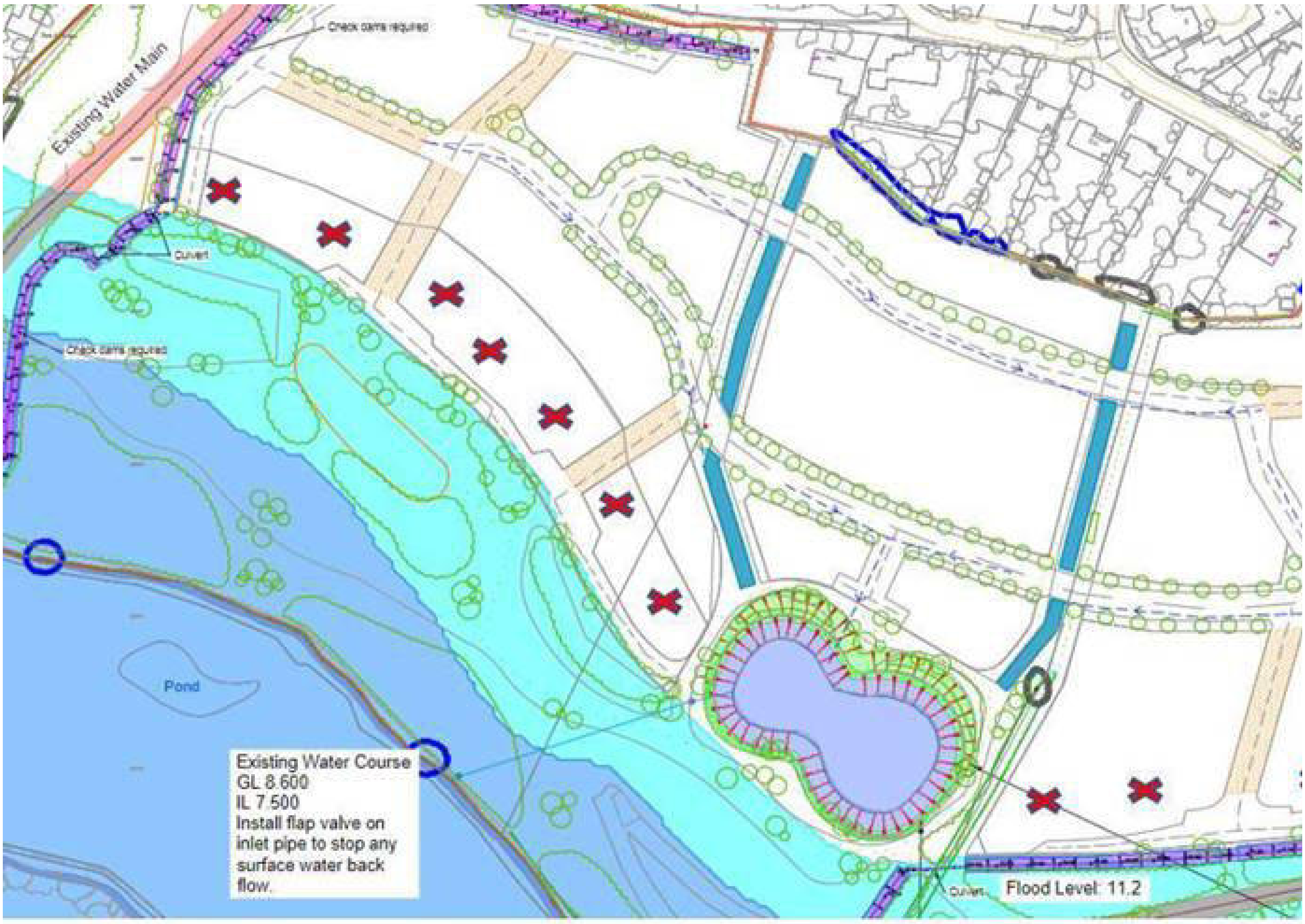
Where runoff volumes are being calculated for a defined area of impermeable surfacing (as they are here), we would normally expect the cv value to be 0.95. Here, Cv values of 0.75 / 0.84 (summer / winter) have been used. Clarification is sought.

N.B. There are some small discrepancies between (developable / impermeable) areas quoted in the different sections / plans but these can be ironed at detailed design.

The permissible site discharge has been re-calculated at 10.3 l/s which is seems like an appropriate rate.

The attenuation volume calculations don't make any allowance for the capture of runoff from permeable area. Presumably some permeable area (that uphill of new drainage provision) will contribute surface water runoff to the new drainage network. An allowance is needed here. Sometimes we see 20% of contributing permeable added at 100% runoff. This has now been done. ok

The drainage strategy presented is fairly basic. I am concerned that the new dwellings located closest to the bottom of the site ('X's below) will not be able to discharge by gravity to the surface water drainage pipework shown which in places is a long way up hill from new dwellings. Clarity is sought here. The applicant has checked and assures us that the levels work. We will take their word for this.



SuDS

On a large Greenfield site such as this we expect to see a very good level of above ground SuDS provision. As well as source control and attenuation, we would expect to see SUDS included for conveyance (for example, swales instead of pipes). Please see the attached SuDS layout for another development site which demonstrates the inclusion of SuDs for surface water conveyance. The FRA does say that swales and filter strips are options applicable to the development however, we require to see more commitment that these will actually be incorporated. For example, the FRA should include text along the lines of, '*swales, filter strips, water butts and permeable paving will be incorporated into the development*', and where possible, some commitment to the extents of these SuDS. For example, '*where practicable, every dwelling shall be fitted with a water butt*'. Also, where possible, indicative positions/extents should be shown on the drainage layout plan (swales for example).

Two swales have been added through the centre of the site (existing drains de-culverted) which is a welcome addition.

The (tanked) permeable paving is a useful addition, helping with water quality and reducing attenuation volumes for the main basin.

Clarity is sought on water butt provision. Clarification provided. ok

It is particularly important that SuDS attenuation basins are well designed and well integrated. Basins should be as naturalistic as possible with varying side slopes (max 1 in 4). If they are to form part of public open space / play space they should have good access. Low flows should be channelled within a shallow swale within the basin so the basin is kept as accessible (dry) as possible for as much of the time as possible, unless the basin is designed as a wet pond. The photo below shows the style of basin preferred. A permanently wet area is good for wildlife.

Further notes on attenuation basins:

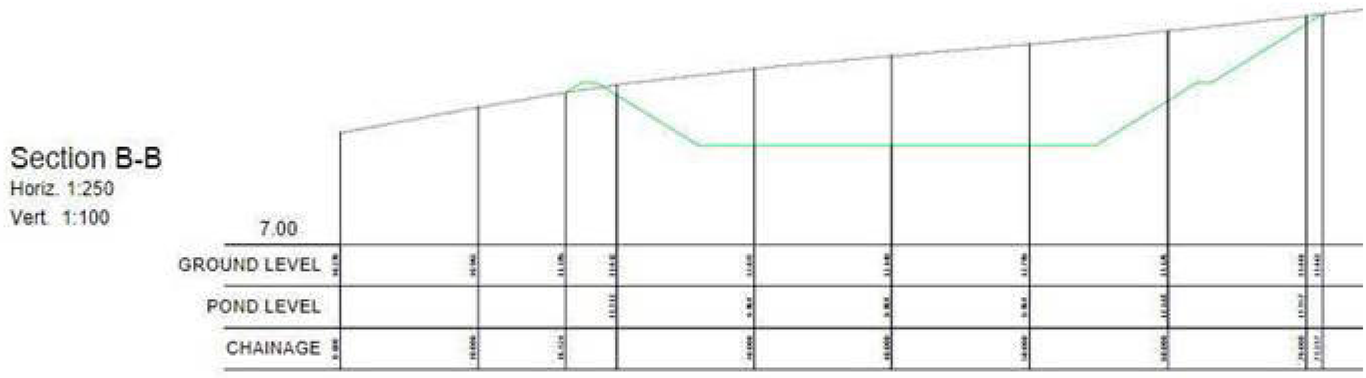
- Basins to incorporate a 3.5 m wide safety / maintenance bench around the perimeter.
- Basin sides to have varying gradients (max 1 in 4)
- Inlets and outlets to be finished in pitched stone rather than RC concrete
- Key clamp railings to be avoided
- Basin topography to be as naturalistic as possible. In particular, unnatural looking bunds and 'perched' basins are to be avoided

Whilst we do not need to see the full detailed design of the basin as part of outline planning application it needs to be demonstrated that the attenuation volume required can be comfortably, and safely, accommodated within the space allocated. With this in mind, an outline planning application should include a few indicative sections. I would like to request that these are submitted.

Sections have been provided but modifications are required so that we can evaluate the basin design fundamentals (extent of bunding / safety & maintenance benches etc).

Please:

- Provide chainage/level information at changes in slope so that we can evaluate the changes in level / heights of bunds / positions and widths of maintenance & safety benches etc
- Add slope gradients to section
- Add proposed max water levels / outfall levels (so we can review water depths / freeboard etc)



I am not satisfied that acceptable / safe basin design has been demonstrated.

In order to make the design acceptable, the basin will need to occupy a larger footprint than currently shown – possibly a circa 10 metre increase in both length and width.

If there is confidence that there is space to accommodate this increase in basin size, and still deliver the number of units proposed, then the modifications can be dealt with at detailed design stage. Otherwise, revised proposals should be submitted prior to determination.

The reasons a larger basin footprint is required is because:

- It needs to incorporate a wider (industry standard) minimum 3.5 m wide dry safety/maintenance bench; it currently has a 1 metre dry safety bench.

- Furthermore, due to the deep water proposed (up to 1.5 metres I believe), it needs a further (min 1.5 metre wide) safety bench 0.6 metres below top water level.

Looking at the drainage layout plan, and with reference to the guidance above, a few comments spring to mind:

The basin has rather man-made rectilinear layout; this should be softened.

The basin outline has been softened

I suspect that the layout shown involves a tall bund on the downslope side, although until we see sections it is hard to tell. As set out above, perched basins and large bunds are to be avoided. They look unnatural and also pose a risk in the sense of presenting a potential breach (bank failure) opportunity.

A more linear basin, working with contours, would sit better.

The applicant should indicate how the SuDS features will be maintained~~. Subject to acceptable design, and an agreed commuted sum, the City Council may agree to take on the responsibility for the maintenance of certain above ground SuDS features in public open space~~. Where an application does not include a SuDS maintenance schedule, a condition to this effect will be required.

Please note that the LPA no longer tends to adopt basins on new developments.
The applicant should indicate how the SuDS features will be maintained

From a water quality perspective, the water quality objectives set out in the publication CIRIA C753 should be met. Please note that traditional gullies/slot drains and interceptors alone, will not meet the objectives. All vehicular areas need to meet the required standards. Here, the basin in conjunction with the swales and permeable paving should deliver adequate water quality provison.

The combination of permeable paving, swales, basins should meet water quality requitements

All SuDS proposals will need to be reviewed by the archaeologist.

<u>Watercourses</u>

Gloucester City Council requires that an 8 m corridor be kept free of development to each side of watercourses (measured from top of bank). This is achieved for Hempsted Brook (Black Ditch) as there is no development in this area. The 4 m corridor (4 m to each side) proposed for the smaller on-site watercourses is considered acceptable here.

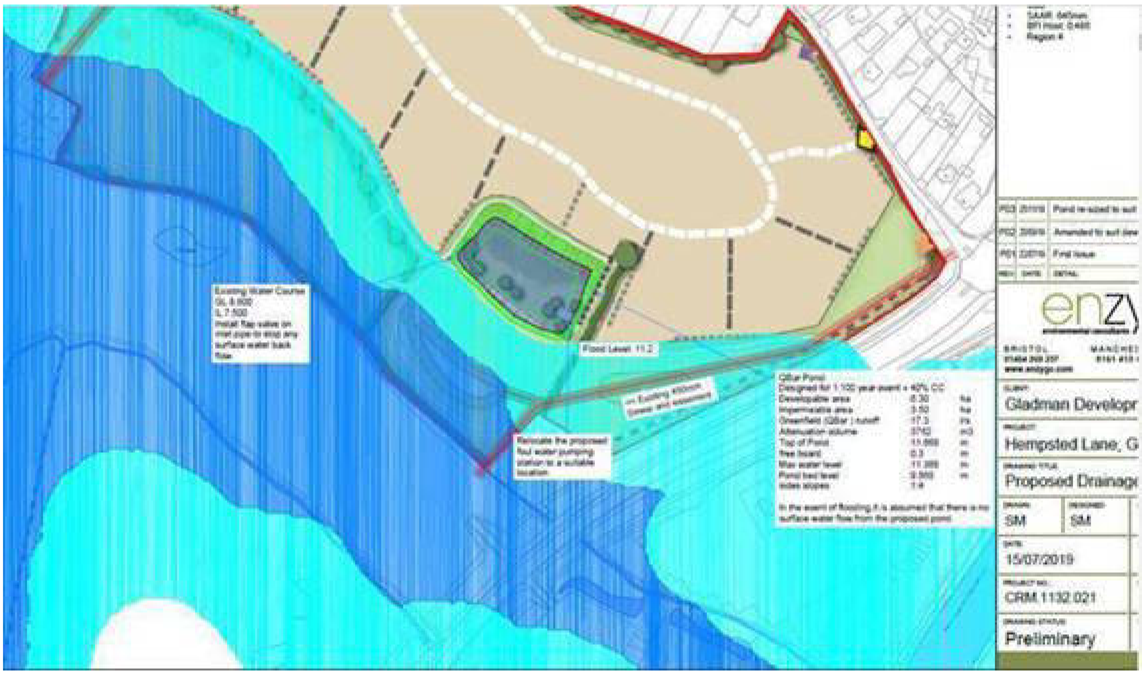
These on-site drains are being converted into swales. ok

These on-site watercourses currently have culverted sections due to previous infilling by the landowner. We require that these culverted sections are removed and the watercourses / ditches reinstated. This is in line with sections 3.5.39 and 3.5.40 of the City Plan. Currently, if the culverted sections block, the repercussions are minimal as flood would simply flow across the fields to the Hempsted Brook. However, in event that the site is developed, blockages could have more serious consequences.

These on-site drains / ditches are being converted into swales. ok

Kind regards

Nick


Flood Level 11.2
Gladman Developr
Hempsted Lane, G
Proposed Drainage
SM
SM
15/07/2019
CRM.1132.021
Preliminary

Attachment 3 - Drainage Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Liz Austin
Site name:	Hempsted Lane
Site location:	Gloucester

Site Details

Latitude:	51.84730° N
Longitude:	2.26985° W
Reference:	1348007850
Date:	Mar 29 2022 14:05

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Runoff estimation approach FEH Statistical

Site characteristics

Total site area (ha): 3.5

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.453
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics	Default	Edited
SAAR (mm):	655	645
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):		10.55
1 in 1 year (l/s):		8.76
1 in 30 years (l/s):		21.1
1 in 100 year (l/s):		27.11
1 in 200 years (l/s):		32.07

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m^3)	Status
15 min Summer	10.472	0.604	12.7	1512.9	O K
30 min Summer	10.653	0.785	12.7	2028.7	O K
60 min Summer	10.836	0.968	12.7	2605.2	O K
120 min Summer	10.981	1.113	12.7	3115.3	O K
180 min Summer	11.066	1.198	12.7	3426.0	O K
240 min Summer	11.125	1.257	12.7	3645.1	O K
360 min Summer	11.203	1.335	12.7	3939.5	O K
480 min Summer	11.252	1.384	12.7	4126.0	O K
600 min Summer	11.284	1.416	12.7	4252.6	O K
720 min Summer	11.307	1.439	12.7	4341.2	O K
960 min Summer	11.334	1.466	12.7	4446.9	O K
1440 min Summer	11.345	1.477	12.7	4492.9	O K
2160 min Summer	11.316	1.448	12.7	4376.3	O K
2880 min Summer	11.268	1.400	12.7	4188.0	O K
4320 min Summer	11.179	1.311	12.7	3848.8	O K
5760 min Summer	11.112	1.244	12.7	3595.8	O K
7200 min Summer	11.067	1.199	12.7	3428.4	O K
8640 min Summer	11.034	1.166	12.7	3307.0	O K
10080 min Summer	11.010	1.142	12.7	3221.5	O K
15 min Winter	10.472	0.604	12.7	1513.0	O K
30 min Winter	10.653	0.785	12.7	2028.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m^3)	Discharge Volume (m^3)	Time-Peak (mins)
15 min Summer	145.339	0.0	1070.5	36
30 min Summer	97.425	0.0	1059.8	50
60 min Summer	62.696	0.0	2050.0	80
120 min Summer	37.790	0.0	1952.0	138
180 min Summer	27.931	0.0	1909.0	198
240 min Summer	22.466	0.0	1890.9	256
360 min Summer	16.437	0.0	1890.0	376
480 min Summer	13.106	0.0	1912.3	494
600 min Summer	10.967	0.0	1934.8	614
720 min Summer	9.466	0.0	1948.9	732
960 min Summer	7.484	0.0	1961.0	970
1440 min Summer	5.337	0.0	1947.9	1448
2160 min Summer	3.775	0.0	3807.9	2164
2880 min Summer	2.946	0.0	3723.5	2684
4320 min Summer	2.070	0.0	3549.6	3344
5760 min Summer	1.620	0.0	6516.1	4112
7200 min Summer	1.355	0.0	6754.5	4920
8640 min Summer	1.181	0.0	6726.0	5800
10080 min Summer	1.060	0.0	6373.8	6656
15 min Winter	145.339	0.0	1070.5	36
30 min Winter	97.425	0.0	1060.0	50

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	10.836	0.968	12.7	2605.3	O K
120 min Winter	10.981	1.113	12.7	3116.3	O K
180 min Winter	11.067	1.199	12.7	3427.9	O K
240 min Winter	11.126	1.258	12.7	3648.1	O K
360 min Winter	11.204	1.336	12.7	3944.4	O K
480 min Winter	11.253	1.385	12.7	4133.0	O K
600 min Winter	11.287	1.419	12.7	4261.7	O K
720 min Winter	11.310	1.442	12.7	4352.2	O K
960 min Winter	11.338	1.470	12.7	4462.1	O K
1440 min Winter	11.351	1.483	12.7	4516.5	O K
2160 min Winter	11.326	1.458	12.7	4414.7	O K
2880 min Winter	11.280	1.412	12.7	4236.6	O K
4320 min Winter	11.177	1.309	12.7	3841.1	O K
5760 min Winter	11.096	1.228	12.7	3535.4	O K
7200 min Winter	11.032	1.164	12.7	3300.2	O K
8640 min Winter	10.978	1.110	12.7	3105.6	O K
10080 min Winter	10.933	1.065	12.7	2945.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	62.696	0.0	2050.4	78
120 min Winter	37.790	0.0	1952.3	136
180 min Winter	27.931	0.0	1909.0	194
240 min Winter	22.466	0.0	1890.5	252
360 min Winter	16.437	0.0	1888.8	370
480 min Winter	13.106	0.0	1910.5	486
600 min Winter	10.967	0.0	1932.3	604
720 min Winter	9.466	0.0	1945.6	720
960 min Winter	7.484	0.0	1956.2	954
1440 min Winter	5.337	0.0	1940.7	1414
2160 min Winter	3.775	0.0	3799.0	2088
2880 min Winter	2.946	0.0	3716.7	2740
4320 min Winter	2.070	0.0	3556.0	3428
5760 min Winter	1.620	0.0	6518.0	4336
7200 min Winter	1.355	0.0	6766.3	5272
8640 min Winter	1.181	0.0	6827.1	6224
10080 min Winter	1.060	0.0	6533.4	7160

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 381394 216553 SO 81394 16553
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	1.000
Cv (Winter)	1.000
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+40

Time Area Diagram

Total Area (ha) 4.221

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.875	8	12	0.875	16	20	0.600
4	8	0.875	12	16	0.875	20	24	0.121

Time Area Diagram

Total Area (ha) 0.000

Time From:	(mins) To:	Area (ha)
0	4	0.000

Model Details

Storage is Online Cover Level (m) 11.668

Tank or Pond Structure

Invert Level (m) 9.868

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2249.5	0.901	3393.3	1.800	4302.3
0.900	3039.5	1.500	3989.9		

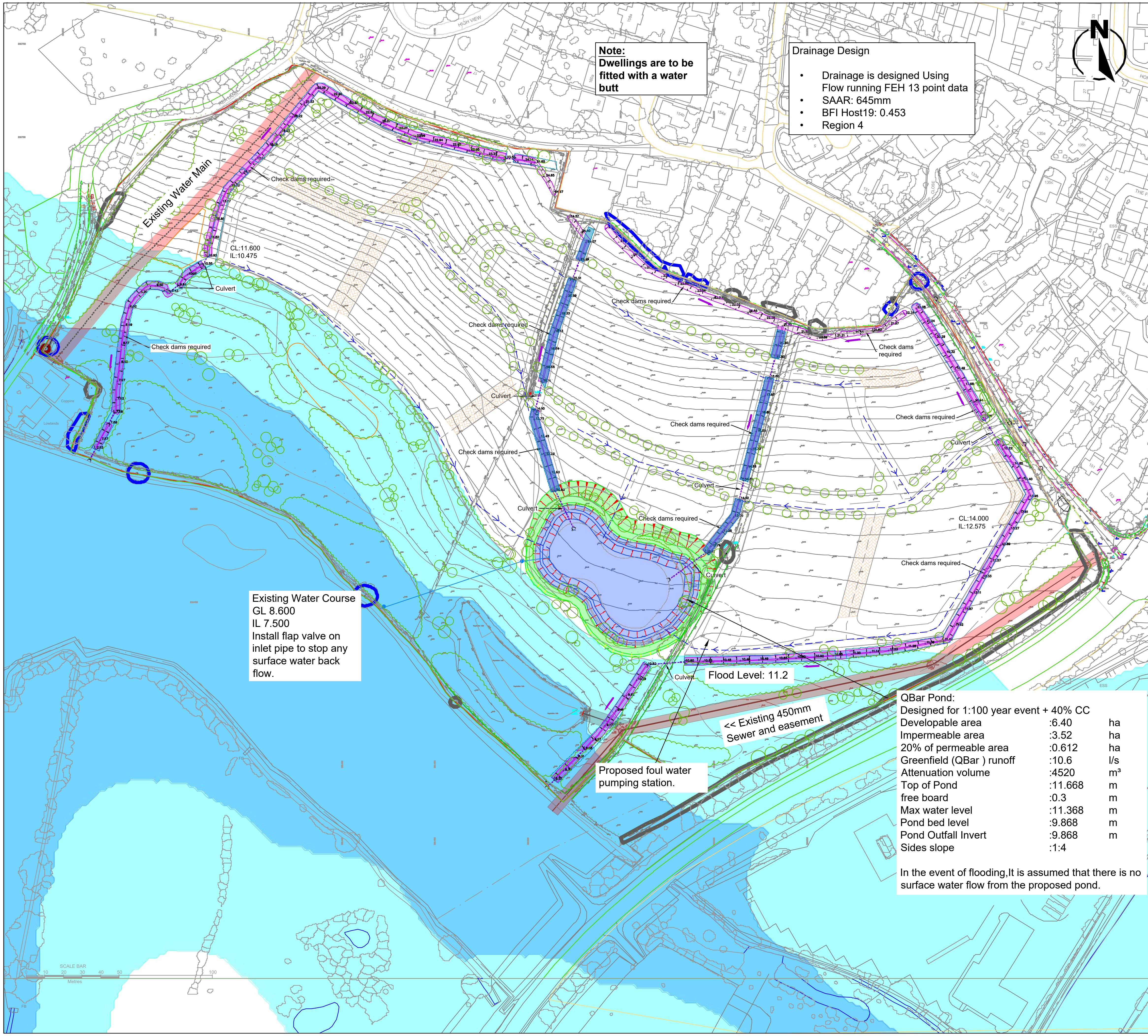
Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0155-1270-1500-1270
Design Head (m)	1.500
Design Flow (l/s)	12.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	155
Invert Level (m)	9.858
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	12.7
Flush-Flo™	0.445	12.7
Kick-Flo®	0.950	10.2
Mean Flow over Head Range	-	11.0

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	5.6	1.200	11.4	3.000	17.6	7.000	26.5
0.200	11.4	1.400	12.3	3.500	19.0	7.500	27.4
0.300	12.4	1.600	13.1	4.000	20.2	8.000	28.2
0.400	12.7	1.800	13.8	4.500	21.4	8.500	29.1
0.500	12.7	2.000	14.5	5.000	22.5	9.000	29.9
0.600	12.5	2.200	15.2	5.500	23.6	9.500	30.7
0.800	11.8	2.400	15.9	6.000	24.6		
1.000	10.5	2.600	16.5	6.500	25.6		



NOTES

1. Do not scale from this drawing
2. All dimensions are in meters unless stated otherwise
3. This drawing is to be read in conjunction with all relevant drawings and documents associated with this project.
4. All surveyed information including levels and layout is provided by others
5. All existing and proposed dimensions, levels and locations to be checked and verified by the main contractor on site prior to the commencement of the works and any anomalies reported to the engineer.
6. All works, workmanship and materials on private drainage to be in accordance with the civil engineering specification for water industry 7th edition published by the water research council.

Key

Indicative Surface Water Sewer

Permeable Paving

REV:	DATE:	DETAIL:	DES:	CHK:	APP:
P08	28/07/22	Basin revised to suit latest LLFA comments	EA	RB	DA
P07	24/06/22	Updated to suit Client comments	EA	EA	DA
P06	22/06/22	Updated to suit latest LLFA comments	EA	DA	DA
P05	06/04/22	Updated with latest DFP	EA	MT	MT
P04	29/03/22	Pond re-sized to suit LLFA comments, swales and indicative SW routes added	EA	DA	DA
P03	25/11/19	Pond re-sized to suit latest DFP	WW	SM	EC
P02	20/09/19	Amended to suit developable area	SM	MGg	BF
P01	22/07/19	First Issue	SM	MGg	BF

enzygo environmental consultants

BRISTOL 01454 269 237 www.enzygo.com
MANCHESTER 0161 413 6444
SHEFFIELD 0114 321 5151 hello@enzygo.com

CLIENT: Gladman Developments Ltd

PROJECT: Hempsted Lane, Gloucester

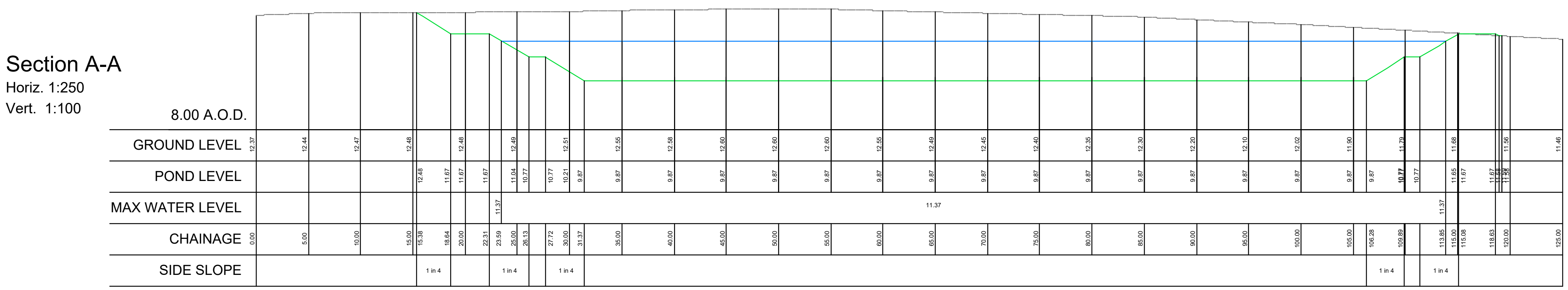
DRAWING TITLE: Proposed Drainage

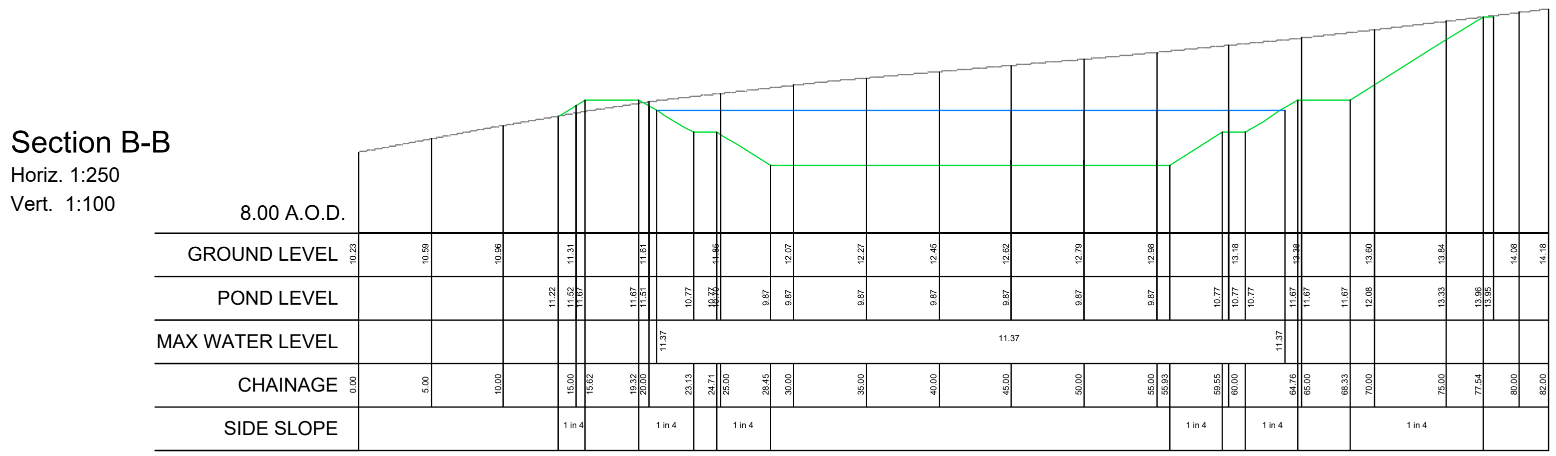
DRAWN:	DESIGNED:	CHECKED:	APPROVED:
SM	SM	MGg	BF

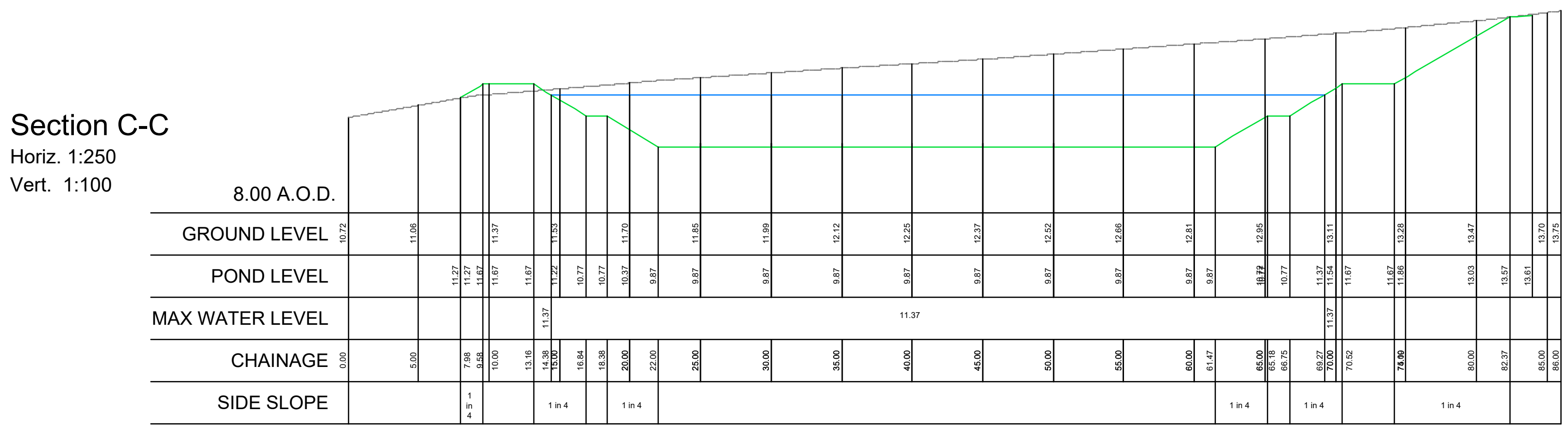
DATE:	SCALE @ A3:
15/07/2019	1:2000

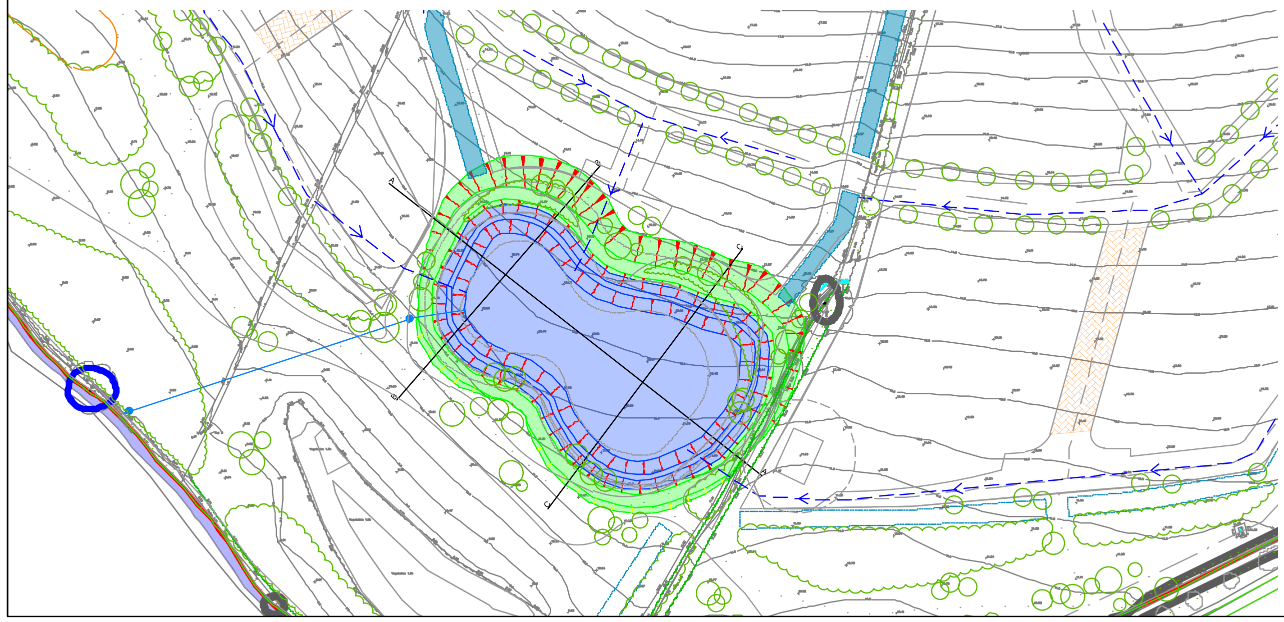
PROJECT NO.:	DRAWING NO.:
CRM.1132.021	001

DRAWING STATUS:	ISSUE:
Preliminary	P08









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6. All works, workmanship and materials on private drainage to be in accordance with the civil engineering specification for water industry 7th edition published by the water research council.

REV:	DATE:	DETAIL:	DES:	CHK:	APP:
P03	11/08/22	Updated to reflect revised basin	EA	RB	DA
P02	22/06/22	Updated to reflect LLFA comments	EA	DA	DA
P01	29/03/22	First Issue	EA	DA	DA

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PROJECT:
Hempsted Lane, Gloucester

DRAWING TITLE:
Proposed Basin Sections

DRAWN:	DESIGNED:	CHECKED:	APPROVED:
EA	EA	DA	DA

DATE:	SCALE @ A3:
29/03/2022	NTS

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DRAWING STATUS:	ISSUE:
Preliminary	P03