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OVG Manchester

Drainage Strategy to Support FRA

BRA-BHE-XX-XX-RP-CI-0132

0042841

3 November 2020

Revision 04

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Revision	Description	Issued by	Date	Checked
00	Draft Issue for FRA	SVR	22.11.19	NH
01	Issue for inclusion in EIA	SVR	12.12.12	NH
02	Strategy updated with CCTV survey results	SVR	17.01.20	NH
03	Updated with current strategy	AJH	12.08.20	NH
04	Updated to reflect LLFA Discussion	AJH	03.11.20	NH

https://burohappold.sharepoint.com/sites/0042841projectbradford/05_Discipline Specific/08_Civil Engineering/03 Reports/0042841_BHE_XX_XX_DN_C_0001 - Drainage Strategies/201103 AH 0042841 Drainage Strategy to Support FRA 04.docx

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author	**Allan Hoodless**
date	**03.11.2020**
approved	**Nick Hall**
signature	
date	**03.11.2020**

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1 Introduction

1.1 Site Setting

The site is located north of the Ashton Canal adjacent to Alan Turing Way with the culverted River Medlock running approximately 100m north of the site (Figure 1-1).

The existing site is brownfield with historic site uses comprising a gas works, hosting sporting events for the Commonwealth Games in 2002 and currently being used as a car park for events hosted within the Etihad Campus. A site walkover undertaken in June 2019, indicated the majority of the site to be compacted made ground with a capping layer isolating contaminated fill below.

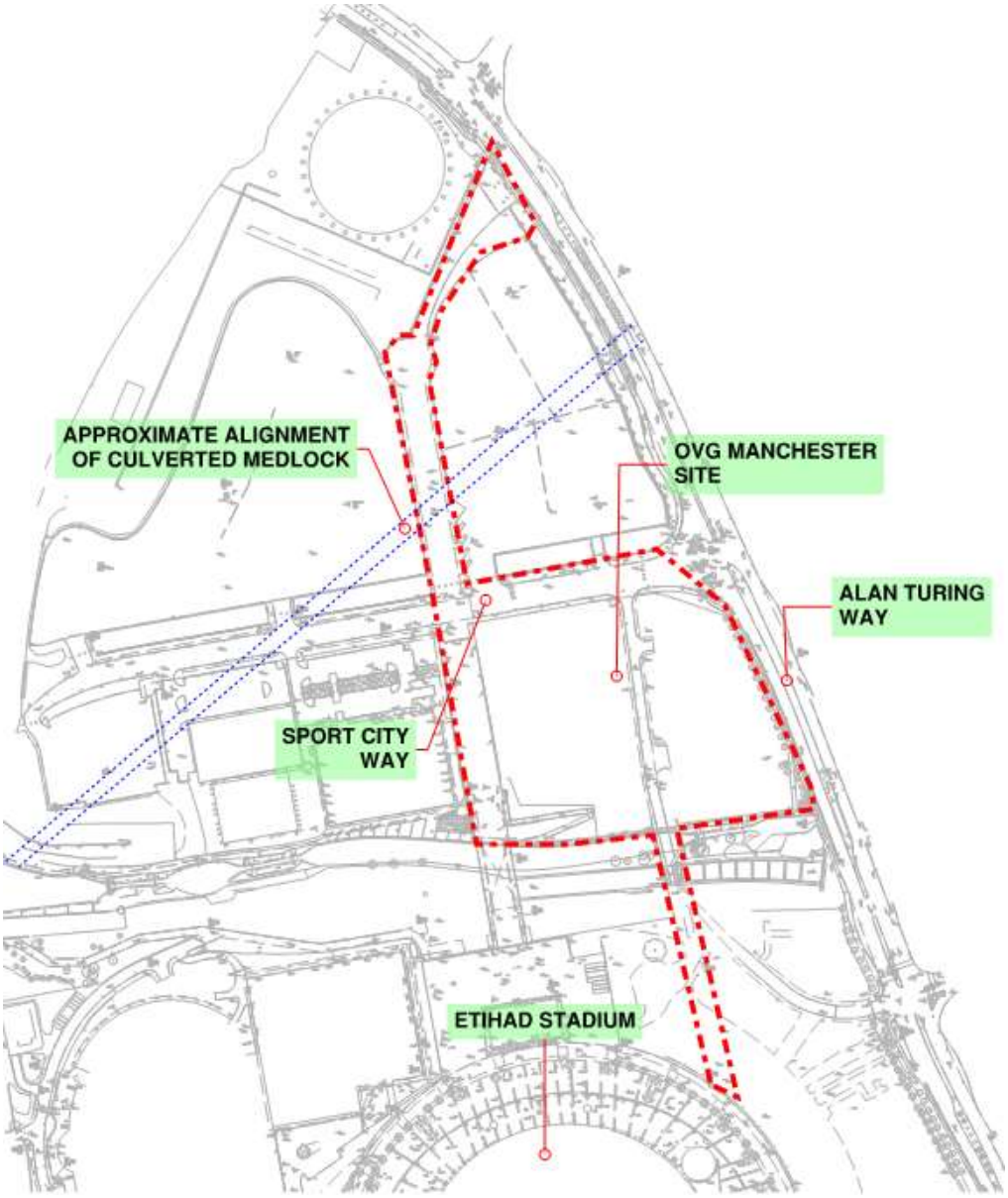


Figure 1-1: Location plan

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1.2 Existing Infrastructure

The following sources of data have been provided which identify existing infrastructure in the vicinity:

1.2.1 Statutory Utility Records (Groundsure Premier Utilities Report, May 2019)

United Utilities Asset maps indicate three main combined sewers running under the site, flowing from south to north, shown on the constraints plan in Figure 1-2. CCTV drainage survey investigations indicate sewer no.1 to be very deep (almost 12m at the southern manhole) and sewers 2 and 3 to have been previously abandoned. Sewer 1 is to be diverted as part of this project.

The sewers ultimately combine in the car park area to the north of the site, and discharge to a large culvert flowing from north-east to south-west. Discussions held with United Utilities on 17 Oct 2019 has confirmed that foul water flows will be allowed to connect into foul water sewer at the north east connection manhole (Refer to email correspondence in Appendix A).

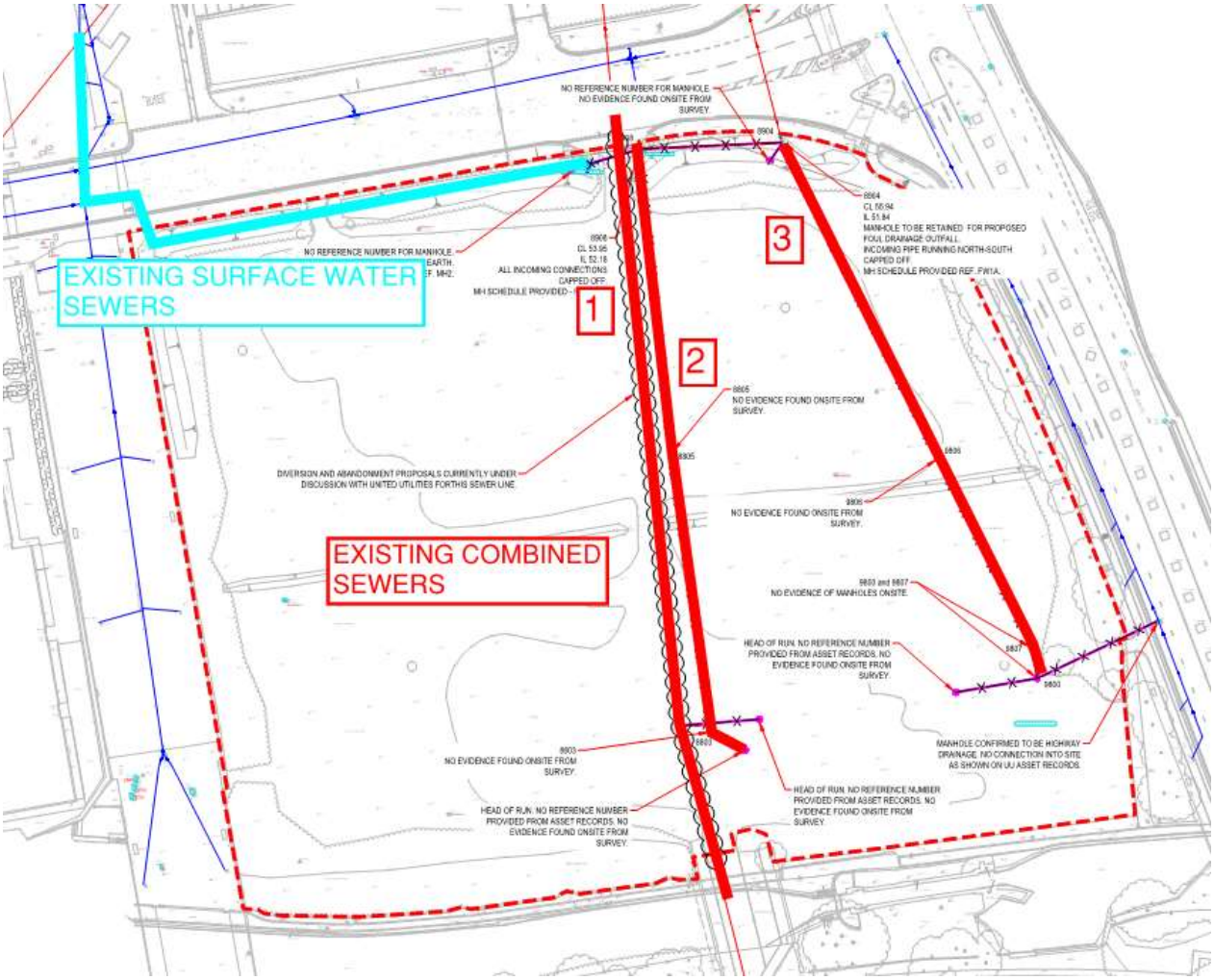


Figure 1-2: Extract of constraints plan drawing 0042841_BHE_XX_XX_DR_C_0020 showing abandoned sewers

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1.2.2 Sport City Constraints Establishment Context Report (ARUP, October 2008)

The CCTV surveys that have since been undertaken have confirmed that this drainage serves Sport City Way and connects to the car park drainage network north of Sport City Way to subsequently outfall into the culverted River Medlock via a hydrocarbon interceptor.

1.2.3 CCTV Survey

CCTV surveying has been carried out for the existing drainage on site. The site is shown to connect to a 525mm dia pipe in the north-west corner, with a series of V-shaped ditches directing the runoff to this location. This 525mm pipe then connects into the private highways drain located in Sportcity Way to the north of the site, which then connects to the culverted River Medlock. The existing site catchment area is circa 2.3ha and is currently used as a car park.

1.2.4 Existing runoff

As the site is currently brownfield, permissible flow rates should be benchmarked against existing brownfield rates. Through discussion with the LLFA (see Appendix B), rather than basing brownfield flow rates on a rational method calculation approach (which would result in a flow rate of 509l/s) the existing drainage should be used the benchmark. Through discussion with the LLFA a 50% reduction of existing drainage capacity should be provided, this equates to 92 l/s, based on the 525mm dia pipe off site having a capacity of 184 l/sec.

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2 Surface Water Strategy

2.1 Proposed Strategy

The surface water management strategy for the arena aims to protect the site from extreme storm events to maintain business continuity and deliver visitor comfort in the most adverse weather conditions. The strategy is developed to ensure flood events up to the 1 in 100 year event with 40% increase due to climate change are dealt within the site boundary.

The proposed design follows the NPPF hierarchy of drainage discharge options. Commentary found below:

- Discharge to ground – not considered viable due to contamination of the existing ground on site. Ground investigation has indicated the much of the made ground on site is contaminated with hydrocarbons. As such infiltration is not advised to avoid mobilising the existing contaminants.
- Discharge to a surface water body – not considered viable. The only watercourse located close to the site is the Ashton Canal, which we have not considered a viable option due to:
    - Surface water for the entire site would need to be pumped to the canal due to the elevations of the canal relative to the building.
    - As the site does not currently drain to the canal an increase in discharge rates would result.
- Discharge to surface water drain – The existing site drains to a private drainage system located in Sportcity Way. This discharges to the River Medlock approximately 70m to the north of the site It is proposed to connect to this drain for the proposed scheme.

In order to determine the permissible discharge rates off site, discussions have been undertaken with Manchester City Council as the Lead Local Flood Authority (LLFA) for the area. In discussions with the LLFA, historical site use has been considered with proposed discharge rates aligned to brownfield rates of runoff whilst providing 50% betterment on existing rates of runoff.

The proposed surface water drainage strategy is based on the initial correspondence with the LLFA confirming that surface water flows from the site will have to provide a min. 50% betterment over the capacity of the existing pipework serving the site (Refer to email correspondence in Appendix B). Attenuation tanks will be utilised to provide this betterment in offsite rate. Surface water storage tanks are positioned below the ground floor slab in the service yard area and sized to store the 1 in 100 year rainfall event with 40% increase in rainfall intensities due to climate change. CCTV survey data has verified that the existing site drains to the highway network in Sportcity Way.

For ease of access and maintenance the attenuation tank has been positioned in the service yard. To maximise water re-use, the surface water attenuation tanks will be combined to function as rainwater harvesting tanks to allow collected surface water to be utilised for non-potable uses such as toilet flushing within the arena building. The proposed rainwater harvesting system is termed an “active” system whereby telemetries linked to weather forecasting equipment will discharge harvested rainwater from the “active” tanks prior to a storm event in order to ensure that the storm event can be captured and held in the tank. This results in discharge from the site prior to a storm event (when the downstream network will have capacity) and less discharge during/ after the storm event when the network is under greater stress. The drawing details of the rainwater harvesting tank are included in Appendix C.

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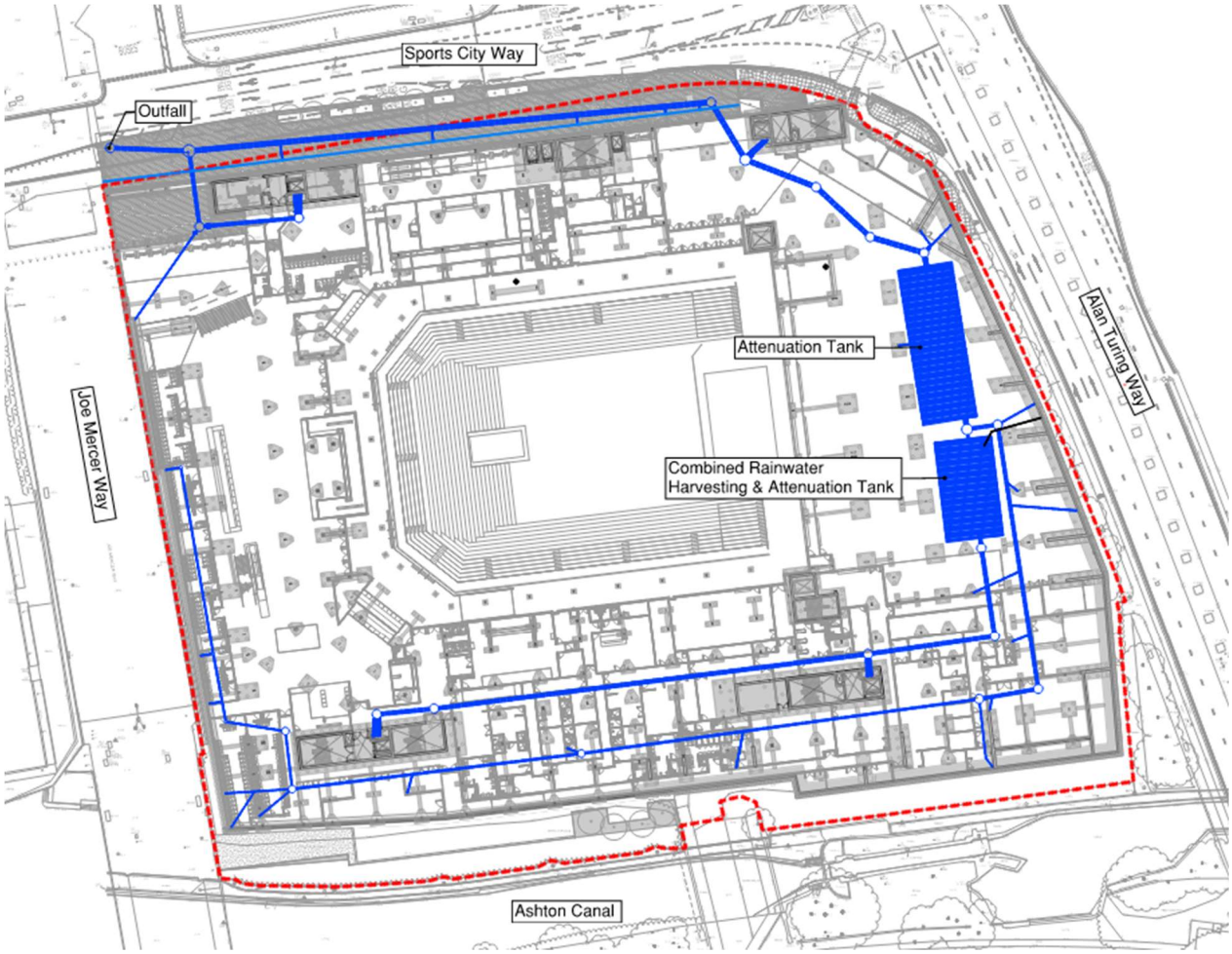


Figure 2-1: Surface water drainage strategy with tanks positioned to the east and west of the arena floor

The surface water system will provide measures to improve the quality of runoff where appropriate. Guidance is provided in The SuDS Manual (2015) reproduced in Table 1 below, with risk of pollution presented as 'Pollution Hazard Indices'. Areas of the site discharging to the surface water drainage network are assessed as having a low pollution hazard level, applicable to:

- Commercial Roofs
- Low traffic roads

The site incorporates permeable paving, catchpit manholes and an attenuation tank which should all provide an improvement in the quality of surface water discharge from the site. A hydrocarbon interceptor is not deemed appropriate for the arena site as it does not accommodate any open car parking areas.

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Table 1 Pollution Hazard Indices from CIRIA C753 (2015), 'The SuDS Manual'.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

2.2 Selection of SuDS

Sustainable Drainage Systems (SuDS) seek to achieve one or more of three main aims:

- Reduce the quantity and rate of water discharging from a site;
- Improve the quality of runoff; and,
- Promote biodiversity and amenity.

SuDS features can be arranged into a hierarchy, ranked for their performance as a hydraulic control or their ability to improve water quality. The suitability of a number of features ranked for water quality has been assessed to establish those that may be appropriate for use at the site, shown in Table 2.

The viability and inclusion of features has been considered as part of the wider external works and landscape design. Where suitable these measures have now been incorporated within the surface water management strategy.

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Table 2 - SuDS Features: Assessment of Suitability

SuDS Device	Suitable on Site	Comments
Permeable Pavement	High Potential	Level 1 podium paving will be designed as permeable where practical. In order to tie with existing boundary levels, where surface falls are mandated at the podium level, permeable paving has been excluded.
Infiltration Trench	No	Infiltration not considered viable due to proximity to building footprint and presence of contaminated ground.
Infiltration Basin	No	Infiltration not considered viable due to presence of contaminated ground.
Soakaway	No	Infiltration not considered viable due to presence of contaminated ground.
Bio-retention/filter strips	No	Non-infiltrating arrangements suitable for use in any landscape buffers.
Filter Trench	No	Infiltration not considered viable due to presence of contaminated ground.
Enhanced Dry Swale	No	No suitable landscape corridors identified due to presence of contaminated ground.
Enhanced Wet Swale	No	Open water bodies not considered appropriate for an arena setting.
Shallow Wetland	No	Insufficient external space available for open water bodies unlikely to be considered appropriate for an arena building.
Extended Detention Wetland	No	Insufficient green space available
Pond/wetland	No	Insufficient external space available and open water bodies unlikely to be considered appropriate for an arena building.
Pocket Wetland	No	Insufficient external space available
Submerged Gravel Wetland	No	Insufficient external space available
Wetland Channel	No	Insufficient external space available
Retention Pond	No	Insufficient external space available
Conveyance Swale	No	Insufficient space to accommodate conveyance swale.
Detention Basin	No	Insufficient external space available
Sub-surface Storage	High Potential	Below ground tanks provided for surface water attenuation
Rainwater Harvesting	High Potential	Rainwater harvesting utilised to maximise water reuse.
Green/Brown Roof	No	The provision of large spaces that are clear of columns to facilitate unobstructed sightlines within the arena result in long structural spans. A heavy green roof build-up does not lend itself to this functional requirement and has hence been excluded. A lighter (or shallower) green roof build-up is not expected to provide the required benefits and the cost of such a provision would override the benefits achievable. Green roofs have therefore been discounted from the project scheme.

•

2.3 Overland Flows

The external areas of the arena are split into two separate levels:

1. Podium Level - connects to Alan Turing Way, Joe Mercer Way and the Forge Lane Bridge (which spans the Ashton Canal). Elevations vary from 61.08 – 61.90.
2. Level 00 – connects directly to Sportcity way. Elevation vary from 55.39 – 56.50.

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In the event of storm events in excess of 1:100 year + CC, or major drainage failure, overland flow routes for the podium level will flow away from the arena building and exit the site via Joe Mercer Way, see image below.

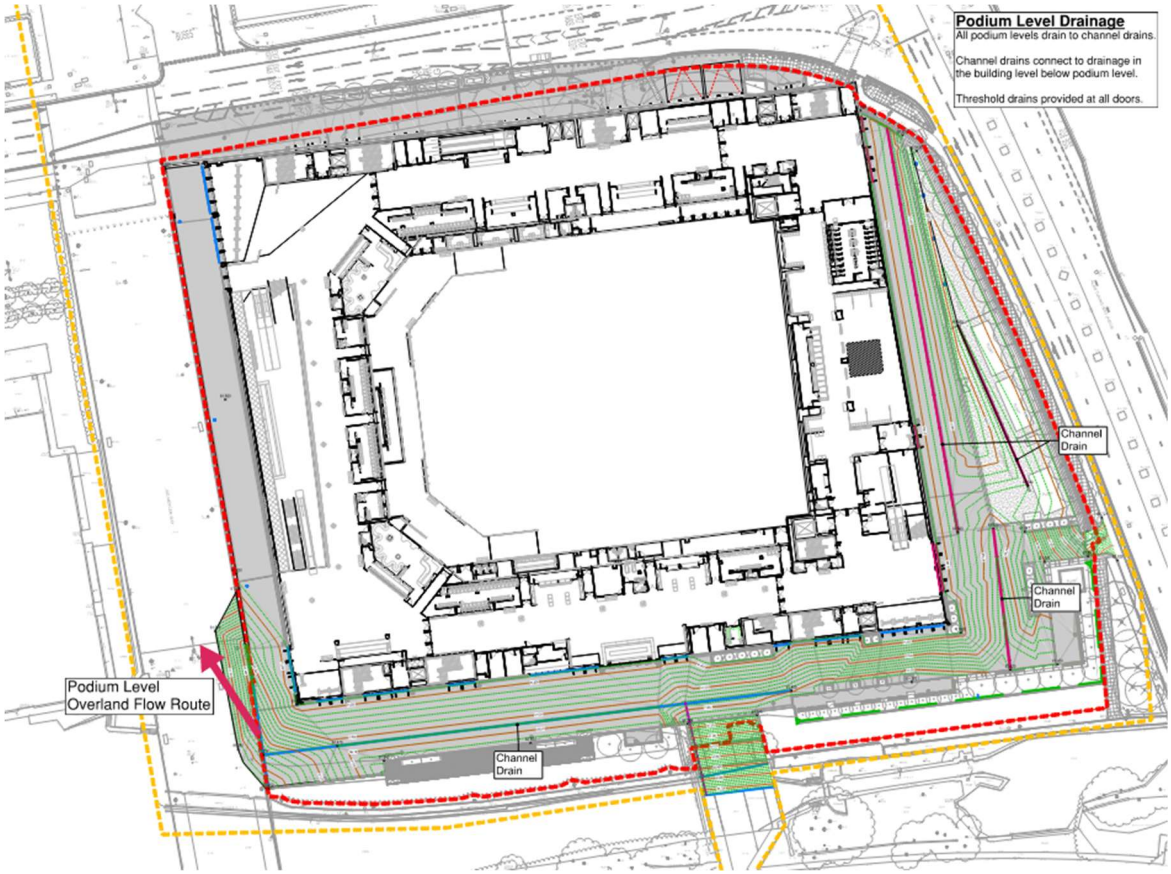


Figure 2—2 – Overland flow from podium

Topography is such that Joe Mercer Way, the west side of Alan Turing Way and the south side of Sports City Way would all drain to a low point on front of the vehicular entrance to the new arena. However, a separate drainage system serves Alan Turing Way to Sportcity Way/Joe Mercer Way, therefore the likelihood of both systems failing simultaneously is unlikely.

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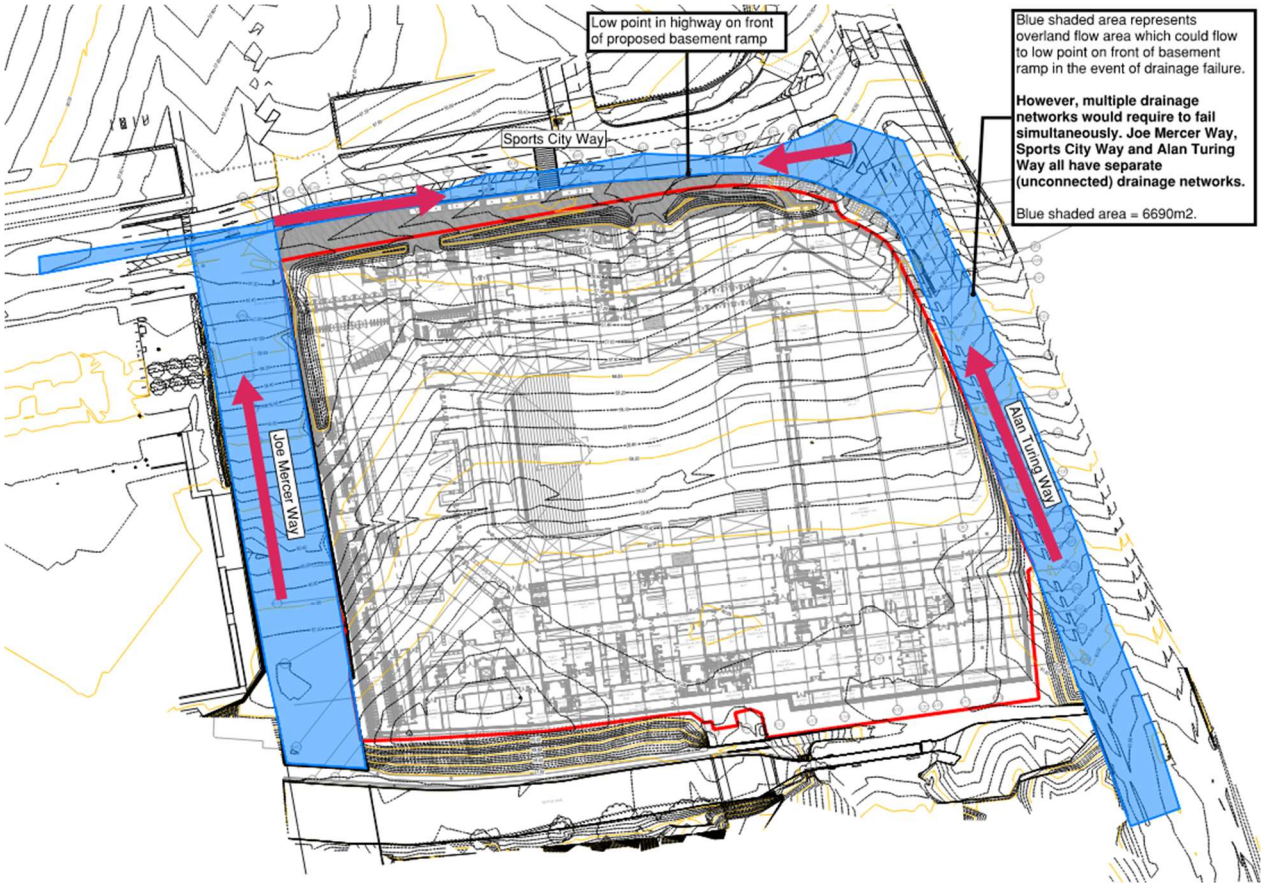


Figure 2—3 Overland flow from Joe Mercer Way, Alan Turing Way and Sports City Way

In order to mitigate against overland flow from the three highways entering the arena, the following is proposed:

- Adding an additional road gully next to the existing gully which is currently located at the low point on Sportcity Way. The new gully will connect to the main drainage system with a new. Sperate pipe rather than using the existing gully connection pipe.
- Creating a high point on the pedestrian footpath between the arena entrance and the low point on the highway. This provides an area for ponding on the road in the event of the gully's capacity being exceeded.
- Providing a high capacity road drainage channel in front of the entrance to the arena in the event that the road gullies capacity is exceeded and ponding overtops the high point in the footpath.
- The provision of an internal channel drain (inside the building) which would drain any resultant overland flow.

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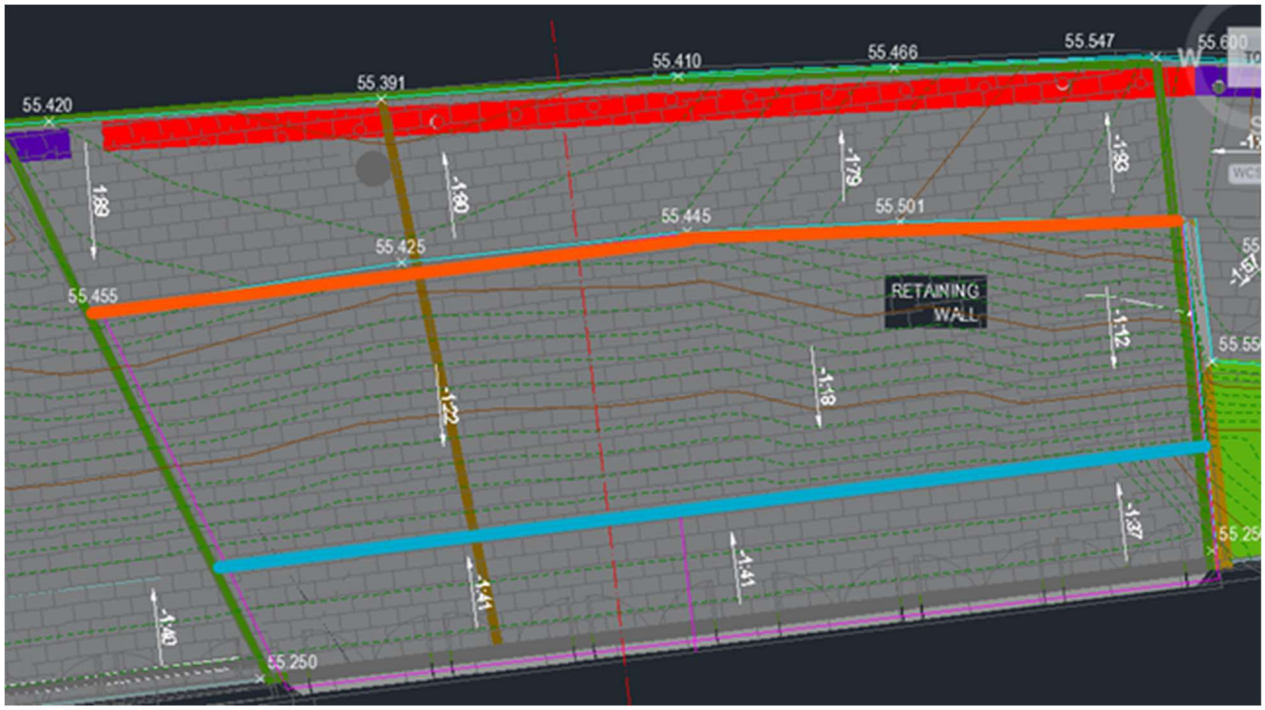


Figure 2—4 – Drainage arrangement at entrance to arena

The above approach has been discussed and agreed with the LLFA, see Appendix B.

2.4 Conclusion and Recommendations

Based on the assessment completed, the widespread implementation of natural systems of sustainable drainage are not suitable for the site. The use of more engineered physical methods like permeable paving and below ground tanks to improve water quality and quantity of runoff will therefore be implemented to address the pollution hazard indices noted in Table 1.

Whilst there is a low point on front of the arena entrance, sufficient safeguards in the form of an additional gully, a high capacity channel drain and a high point in the footpath have been put in place to mitigate severe risk of flooding,

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Appendix A Appendix A - Email correspondence with United Utilities

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Nick Hall

From: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Sent: 07 November 2019 17:16
To: Nick Hall
Cc: Edwards, Stuart; O'Brien, Neil; Wastewater Developer Services
Subject: PDE 4200028804 Project Bradford, Sportcity Way, Manchester, M11 3U
Attachments: RE: Etihad Campus - general predevelopment enquiry - 4200028724

**** External Email ****

Good afternoon,

We have carried out an assessment of your application which is based on the information provided. This pre-development advice will be valid for 12 months.

Foul

The foul water flows emanating from this site will be allowed to drain freely in to the nearest available public foul/combined sewerage system located within a public highway. Our preference would be to discharge into the 375mm diameter public combined sewer located within Sport City Way to the northeast of the proposed development.

Surface Water

Surface water from the site is proposed to drain into a private drainage network which ultimately discharges into the River Medlock. As a reuslt, United Utilties cannot comment further but suggest that you discuss the matter with the relavant risk management authority.

Existing Sewers Crossing the Site

There are public sewers crossing the site of which, we will require unrestricted access to the sewer for maintenance purposes, we would ask that you maintain a minimum clearance of (6m refer to table 2.1 SFA) which is measured 3m from the centre line of the pipe unless there happens to be a formal easement agreement in place, in which case the specified detail would apply, assuming that they will remain insitu. However, it is understood that you are considering abandonment of the on-site sewers. If this is the case we suggest that you submit a sewer closure application along with all supporting information as outlined within the guidance document available on our website via the following link:

https://www.unitedutilities.com/builders-developers/wastewater/sewer-closures/

The information provided should determine that there are no live flows within the length of sewers which are being proposed to be abandoned or upstream of this location, as identified on the attachment my colleagues has recently provided to you. As discussed on our telephone conversation, as a mimum we request the plan which allows us to cross reference the CCTV drainage survey provided.

It may be possible to divert the flows upstream into a different network which could be assessed as part of a diversion application.

Should abandonment of the on-site public sewer not be possible, United Utilities would encourage the investigation of potential diversion of these sewers as we would not accept building over at this time due to the potential post development access restrictions resulting from the site. We understand you may have evidence of a build over agreement which we did not have on record, if you are able to provide this, we will take it under consideration.

Please refer to the link below to obtain full details of the processes involved with sewer diversions.

https://www.unitedutilities.com/builders-developers/wastewater-services-and-connections/sewer-diversions/

Connection Application

Although we may discuss and agree discharge points & rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below:

https://www.unitedutilities.com/builders-developers/wastewater-services-and-connections/sewer-connections/

Sewer Adoption Agreement

You may wish to offer the proposed new sewers for adoption. United Utilities assess adoption application based on Sewers adoption 6th Edition and for any pumping stations our company addenda document. Please refer to link below to obtain further guidance and application pack:

https://www.unitedutilities.com/builders-developers/wastewater-services-and-connections/sewer-adoptions/

Please be aware that on site drainage must be designed in accordance with Building Regulations, National Planning Policy, and local flood authority guidelines, we would recommend that you speak and make suitable agreements with the relevant statutory bodies.

Please note, if you intend to put forward your wastewater assets for adoption by United Utilities, the proposed detail design will be subject to a technical appraisal by an Adoption Engineer as we need to be sure that the proposals meets the requirements of Sewers for adoption and United Utilities Asset Standards. The proposed design should give consideration to long term operability and give United Utilities a cost effective proposal for the life of the assets. Therefore, further to this enquiry should you wish to progress a Section 104 agreement, we strongly recommend that no construction commences until the detailed drainage design, submitted as part of the Section 104 agreement, has been assessed and accepted in writing by United Utilities. Any works carried out prior to the technical assessment being approved is done entirely at the developers own risk and could be subject to change.

If I can be of any further assistance please don't hesitate to contact us further.

Kind regards,

Robert Brenton
Developer Engineer
Developer Services and Planning
Network Delivery
United Utilities

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From: Nick Hall [mailto:Nick.Hall@BuroHappold.com]
Sent: 22 October 2019 21:14
To: Edwards, Stuart ; Wastewater Developer Services
Cc: Ross Cuming ; Richard.hattan ; Ben Luffman ; Andrew Pottinger ; 042841 Project Bradford
Subject: Etihad Campus - general predevelopment enquiry

Dear Stuart

Many thanks for making time to meet us last week to discuss the Bradford site at the Etihad Campus. I have attached a set of meeting minutes, I'd be grateful if you could let me know if there are any errors or omissions.

As promised, the report attachment to this email presents the information we have obtained about the site to date and presents the current proposals relating to existing foul water sewers and the disposal of foul water from the proposed new development. There is a mark-up summarising the sewer survey info obtained to date contained in Appendix F at the very end of the report.

I have also attached a pre-development enquiry form, completed as far as is possible at this stage.

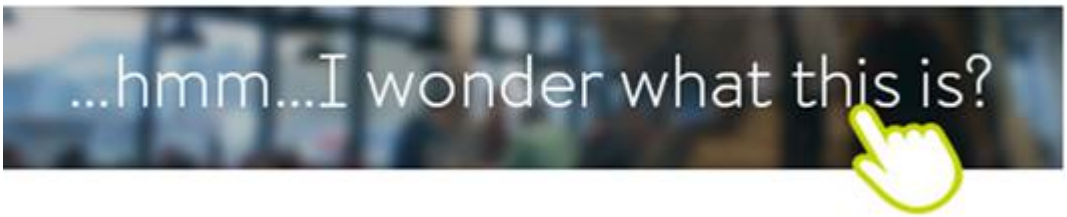
Surface water from the site is to discharge into the culverted River Medlock within the campus boundary, via an existing private campus SW drainage system. I have therefore not presented SW proposals within this email.

I have also not discussed potable water supply within this email. This is being by a different consultant within the design team so we shall progress this element separately.

Please don't hesitate to call should you have any queries or require any further information from us.

Kind regards,

Nick Hall BEng (Hons) CEng MICE
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Appendix B Appendix B - Email correspondence with Lead Local Flood Authority

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Nick Hall

From: z.todorovic@manchester.gov.uk on behalf of floodriskmanagement@manchester.gov.uk
Sent: 22 October 2019 13:46
To: Siddhesh Raute
Cc: 042841 Project Bradford; floodriskmanagement@manchester.gov.uk; Nick Hall; Rodoula Gregoriou
Subject: RE: Project Bradford: LLFA consultation
Attachments: NTH 185 420 A.pdf

**** External Email ****

Siddhesh

Thank you for the email.

We have noted that you mentioned that the site is currently draining by positive drainage into the v-ditch and into the highway drain. The assessment of the existing flows should not be based on the rational method as they are suggesting unrealistic high flows that are drained through the existing drainage system. Instead, the existing flows need to be estimated based on the capacity of the existing drainage system to convey peak flows based on the diameter of the outfall pipe into the ditch. These much smaller flows are in line with reported regular ponding on site after each rainfall event which indicate that a lot of runoff does not drain straight into the drainage system.

With regards to the next steps, we have already sent you the guidance for developing the design and we trust that it provide sufficient guidance. We would recommend that you send us the fully developed proposal for review and comments and not send developed proposal in steps.

Kind regards

Flood Risk Management
Highways Service, Growth and Neighbourhoods Directorate
Manchester City Council
Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: http://www.manchester.gov.uk/

POSTAL ADDRESS: Manchester City Council, Public Realm, The Neighbourhood Service, PO Box 532, Town Hall, Manchester M60 2LA

From: Siddhesh Raute <Siddhesh.Raute@BuroHappold.com>
To: "floodriskmanagement@manchester.gov.uk" <floodriskmanagement@manchester.gov.uk>,
Cc: 042841 Project Bradford <042841ProjectBradford@BuroHappold.com>, Nick Hall <Nick.Hall@BuroHappold.com>, Rodoula Gregoriou <Rodoula.Gregoriou@BuroHappold.com>
Date: 09/10/2019 22:29
Subject: RE: Project Bradford: LLFA consultation

Dear Zorica

Many thanks for your email. Having reviewed the document attached within your email, I have outlined our design philosophy for managing surface water runoff from the site and we welcome your comments.

Existing site:

The existing site is brownfield with historic site uses comprising a gas works, hosting sporting events for the Commonwealth Games in 2002 and currently being used as a car park for events hosted within the Etihad Campus. Historic reports detailing the soil characteristics of the site indicate a mixture of demolition rubble, ash, colliery spoil, refuse and reworked natural material. Ongoing site investigations are confirming these observations and are revealing contaminated ground conditions at the site. The existing site covers an area of approximately 2ha.

Existing Drainage:

The existing site is currently drained positively to its northern boundary. Drawing NTH/185/420 received from our client (and attached here) illustrates that existing drainage is conveyed to a V-ditch along the northern perimeter from where its discharged to the highway drainage network. The highway network subsequently drains to the culverted River Medlock north of the site via a hydrocarbon interceptor.

The drainage strategy drawing identifies a 75% run-off rate for surface water and we believe that the lime stabilised material that sits close to surface could be the key reason for impermeable conditions resulting in this assumption. Regular ponding has been reported on site after rainfall events.

Proposed Strategy:

The proposed building footprint occupies approx. 90% of the site area, with external landscaped and hardscaped spaces making up the remaining 10%. In order to improve the quality and quantity of surface water runoff, design proposals currently aim to provide permeable paved areas wherever possible. Additionally an active rainwater harvesting system is being investigated to maximise rainwater capture and re-use. The presence of contaminated ground will make using infiltration techniques unsuitable, however, permeable pavements combined with active rainwater harvesting should capture pollutants from the first flush thus helping improve quality of offsite discharge.

Using the Modified Rational Method and assuming 75% impermeability of existing ground, a resultant discharge rate of 508.6l/s is expected from a 1 in 100 year storm event. The design will aim to provide a min. of 50% betterment on this rate of runoff, but we will aim to extend this to 70% betterment assuming this can be successfully achieved within the building constraints. The betterment in rate of runoff will be provided by a below ground attenuation tank comprising cellular units. Whilst the intention will be to minimise excavations in contaminated ground and offsite transfer of such material the design team will endeavour to maximise the storage that can be provided to reduce the offsite discharge rate.

Next Steps:

- Agree with the Manchester City Council proposed surface water drainage strategy
- Develop drainage proposals in further detail to provide attenuation storage volume and final flow rates being adopted.

We look forward to receiving your feedback.

Thanks and kind regards
Siddhesh

Siddhesh Raute IEng MICE
Senior Engineer
BuroHappold Engineering | Cities
T: +44 (0)1225 320600
Please note: My normal working days are Monday to Thursday

From: z.todorovic@manchester.gov.uk <z.todorovic@manchester.gov.uk> **On Behalf Of** floodriskmanagement@manchester.gov.uk
Sent: 17 September 2019 09:07
To: Siddhesh Raute <Siddhesh.Raute@BuroHappold.com>
Cc: 042841 Project Bradford <042841ProjectBradford@BuroHappold.com>; floodriskmanagement@manchester.gov.uk; Nick Hall <Nick.Hall@BuroHappold.com>; Rodoula Gregoriou <Rodoula.Gregoriou@BuroHappold.com>
Subject: RE: Project Bradford: LLFA consultation

**** External Email ****

Hi Siddhesh

Thank you for the email. Attached is our guidance for developers related to SuDS/surface water management.

If you need further clarifications please let us know.

Regards

Zorica Todorovic
Flood Risk Management
Highways Service, Growth and Neighbourhoods Directorate
Manchester City Council
Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: http://www.manchester.gov.uk/

POSTAL ADDRESS: Manchester City Council, Public Realm, The Neighbourhood Service, PO Box 532, Town Hall, Manchester M60 2LA

Siddhesh Raute <Siddhesh.Raute@BuroHappold.com> 11/09/2019 16:21	To "floodriskmanagement@manchester.gov.uk" <floodriskmanagement@manchester.gov.uk>, cc Nick Hall <Nick.Hall@BuroHappold.com>, 042841 Project Bradford <042841ProjectBradford@BuroHappold.com>, Rodoula Gregoriou <Rodoula.Gregoriou@BuroHappold.com> Subject RE: Project Bradford: LLFA consultation

Dear Flood Risk Management Team

Following on from the email from Muniza Usmani, we are commencing preliminary design for a site in the Etihad Stadium Campus that is adjacent to the Ashton Canal.

The snapshot below shows the site extents in red for the plot marked as 'Car Park'. The site is a brownfield site and drains to the culverted River Medlock.

We want to engage with Manchester City Council (MCC) to understand the principles to adopt in order to develop the surface water management strategy. We would like to understand MCC's requirements related to limiting surface water runoff rates to the River Medlock and any other SuDS requirements that MCC would mandate for developments on brownfield sites.

I look forward to hearing from you.

Kind regards
Siddhesh



Siddhesh Raute IEng MICE
Senior Engineer
BuroHappold Engineering | Cities
T: +44 (0)1225 320600
Please note: My normal working days are Monday to Thursday

From: Muniza Usmani <m.usmani@manchester.gov.uk>
Sent: 11 September 2019 16:04
To: Siddhesh Raute <Siddhesh.Raute@BuroHappold.com>; floodriskmanagement@manchester.gov.uk
Subject: Re: Project Bradford: LLFA consultation

**** External Email ****

Hi Siddhesh

Please contact the MCC Flood Risk team via floodriskmanagement@manchester.gov.uk to discuss.

Kind regards
Muniza Usmani
Engineer
Highways Service, Growth and Neighbourhoods Directorate
Bridgewater House
Whitworth Street
Manchester
M1 6LT

(PLEASE NOTE: Usual working days are Tuesday, Wednesday and Friday)

Tel 0161 234 1680 / Internal: 801 1680

Email: m.usmani@manchester.gov.uk
Web: http://www.manchester.gov.uk

POSTAL ADDRESS: Manchester City Council, PO Box 532, Town Hall, Manchester, M60 2LA

On Wed, 11 Sep 2019 at 15:54, Siddhesh Raute <Siddhesh.Raute@burohappold.com> wrote:

Dear Muniza

I was given your contact details by a colleague of mine who recently corresponded with you on the Mayfield project.

We are commencing preliminary design for a site in the Eithad Stadium Campus that is adjacent to the Ashton Canal. See snapshot below showing site extents in red identified as 'Car Park'. The site is a brownfield site and drains to the culverted River Medlock. We wanted to understand the principles to adopt in order to develop the surface water discharge. It would be useful to determine the flow rates we should be restricting the site for surface water runoff and any other SuDS requirements that MCC would mandate.

Could you please let me know if you are the person to discuss this with or provide details of a colleague with whom I could liaise?



Many thanks and regards
Siddhesh

Siddhesh Raute IEng MICE
Senior Engineer
BuroHappold Engineering | Cities
T: +44 (0)1225 320600
www.burohappold.com | @burohappold
Please note: My normal working days are Monday to Thursday



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Allan Hoodless

From: z.todorovic@manchester.gov.uk on behalf of floodriskmanagement@manchester.gov.uk
Sent: 28 September 2020 17:55
To: Allan Hoodless
Cc: floodriskmanagement@manchester.gov.uk; Nick Hall
Subject: RE: Fw: Planning Ref 126431/FO/2020 - Drainage Conditions

**** External Email ****

Hi Allan

This is acceptable.

Kind regards

Zorica

Flood Risk Management
Highways Service, Growth and Neighbourhoods Directorate
Manchester City Council
Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: http://www.manchester.gov.uk/

POSTAL ADDRESS: Manchester City Council, Public Realm, The Neighbourhood Service, PO Box 532, Town Hall, Manchester M60 2LA

From: Allan Hoodless <Allan.Hoodless@BuroHappold.com>
To: Zorica Todorovic <z.todorovic@manchester.gov.uk>,
Cc: Nick Hall <Nick.Hall@BuroHappold.com>, "floodriskmanagement@manchester.gov.uk" <floodriskmanagement@manchester.gov.uk>
Date: 16/09/2020 20:52
Subject: RE: Fw: Planning Ref 126431/FO/2020 - Drainage Conditions

---

Hi Zorica,

Many thanks for the response.

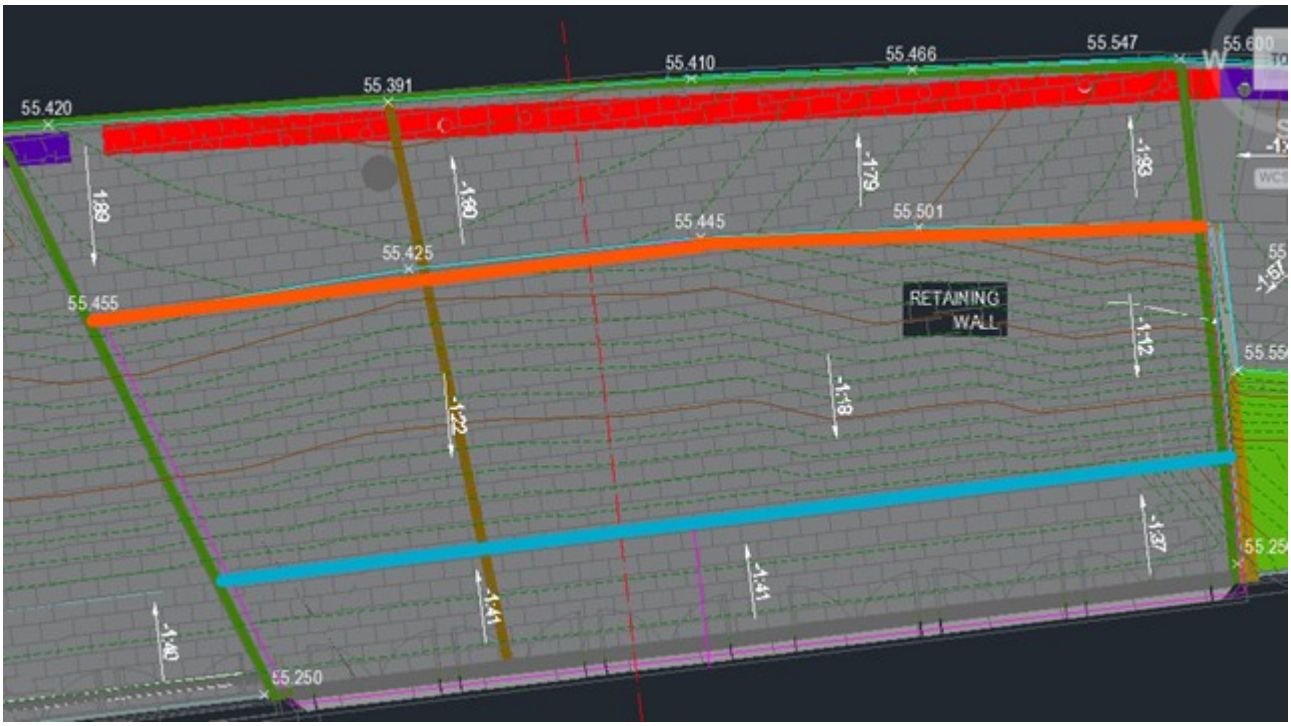
Regarding the channel drain, we have oversized this to cater for a storm event in excess of 1:100 year storm event to limit the possibility of it being overwhelmed. Additionally we have provided two outlets from the channel drain to limit blockage risk.

In addition the two gullies at the roadside should limit the catchment draining to the channel drain to a very small area (circa 125m2).

We will ensure that the project O&M manual informs the Client that they should inspect (and clean if necessary) the channel and gullies every 3 months, and additionally that the Client inspects the channels and gullies prior to any forecast major storm event.

If the above channel and gullies were blocked, there is also an internal channel drain (inside the building) which would drain any resultant overland flow.

With regards to altering the levels at the building threshold, we can move the low point such that it is 2.5m from the threshold. We cannot unfortunately move it any further than this due to the resultant excessively steep slopes which would cause issues for wheelchair users. The image below shows this (High point is orange line, low point is blue line).



Can you please confirm that the above is acceptable?

Many thanks,
Allan

From: Zorica Todorovic <z.todorovic@manchester.gov.uk>
Sent: 15 September 2020 10:17
To: Allan Hoodless <Allan.Hoodless@BuroHappold.com>
Subject: Fwd: Fw: Planning Ref 126431/FO/2020 - Drainage Conditions

**** External Email ****

From: Flood Risk Management/MCC
To: Allan Hoodless <Allan.Hoodless@BuroHappold.com>, Jennifer Atkinson/Chief.Executives/MCC@MCC,
Cc: "floodriskmanagement@manchester.gov.uk" <floodriskmanagement@manchester.gov.uk>, Nick Hall <Nick.Hall@BuroHappold.com>
Date: 26/08/2020 12:09
Subject: RE: Fwd: Planning Ref 126431/FO/2020 - Drainage Conditions
Sent by: Zorica Todorovic

Hi Allan

Thank you for the email and the attached drainage strategy.
We welcome your risk assessment around the entrance to the arena and mitigation measures proposed. In our experience the channels at the entrance of the buildings are usually overwhelmed during flash flood storms and we suggest to rethink the levels at the very entrance to allow for more slopes away from the building if possible.
Apart from that we are in agreement with your proposal.

Regards

Zorica Todorovic

Flood Risk Management
Highways Service, Growth and Neighbourhoods Directorate
Manchester City Council
Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: http://www.manchester.gov.uk/

POSTAL ADDRESS: Manchester City Council, Public Realm, The Neighbourhood Service, PO Box 532, Town Hall, Manchester M60 2LA

From: Allan Hoodless <Allan.Hoodless@BuroHappold.com>
To: "floodriskmanagement@manchester.gov.uk" <floodriskmanagement@manchester.gov.uk>,
Cc: Nick Hall <Nick.Hall@BuroHappold.com>
Date: 12/08/2020 12:31
Subject: RE: Fwd: Planning Ref 126431/FO/2020 - Drainage Conditions

Hi Zorica,

Please find attached our planning report which hopefully covers all of you planning requirements stated in your guidance document.

If you need anything further or would like to discuss further please get in touch.

Many thanks,

Allan Hoodless CEng MICE
Senior Engineer
Buro Happold Engineering | Infrastructure
T: +44 (0)113 204 2200
M: +44 (0)7525 766229
www.burohappold.com | @burohappold

From: z.todorovic@manchester.gov.uk <z.todorovic@manchester.gov.uk> On Behalf Of floodriskmanagement@manchester.gov.uk
Sent: 17 July 2020 13:46
To: Allan Hoodless <Allan.Hoodless@BuroHappold.com>
Cc: Flood Risk Management <floodriskmanagement@manchester.gov.uk>
Subject: Re: Fwd: Planning Ref 126431/FO/2020 - Drainage Conditions

** External Email **

Hi Allan

I am attaching the MCC guidance for developers that details what is required for planning and discharging the conditions. I trust that will answer your questions. If you need further clarifications please let us know.

Regards

Flood Risk Management
Highways Service, Growth and Neighbourhoods Directorate
Manchester City Council
Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: http://www.manchester.gov.uk/

POSTAL ADDRESS: Manchester City Council, Public Realm, The Neighbourhood Service, PO Box 532, Town Hall, Manchester M60 2LA

From: Zorica Todorovic <z.todorovic@manchester.gov.uk>
To: Flood Risk Management <floodriskmanagement@manchester.gov.uk>,
Date: 01/07/2020 08:21
Subject: Fwd: Planning Ref 126431/FO/2020 - Drainage Conditions

---------- Forwarded message ---------
From: Allan Hoodless <Allan.Hoodless@burohappold.com>
Date: Tue, 30 Jun 2020 at 17:22
Subject: Planning Ref 126431/FO/2020 - Drainage Conditions
To: z.todorovic@manchester.gov.uk <z.todorovic@manchester.gov.uk>
Cc: Nick Hall <Nick.Hall@burohappold.com>

Hi Zorica,

The purpose for emailing you is to discuss the anticipated planning conditions I received from Turner and Townsend who are the planning consultant on Project Bradford (Planning Ref 126431/FO/2020), particularly the condition below in red.

“Within three months of the development commencing, a surface water drainage scheme, based on the hierarchy of drainage options in the National Planning Practice Guidance with evidence of an assessment of the site conditions, shall be submitted to and approved in writing by the Local Planning Authority.

The surface water drainage scheme must be in accordance with the Non-Statutory Technical Standards for Sustainable Drainage Systems (March 2015) or any subsequent replacement national standards and unless otherwise agreed in writing by the Local Planning Authority, no surface water shall discharge directly to the public sewerage system. The development shall be completed in accordance with the approved details.

For the avoidance of doubt no works shall take place on site that would compromise the delivery of compliance with the above before a scheme is agreed."

Hierarchy of Drainage

The proposed surface water drainage design will outfall (by gravity) to an existing surface water drain, located in Sports City Way. Based on existing topographical levels the site currently drains to the same surface water drain as we propose to outfall to, as such we do not increase flow rates to this drainage outfall.

With regards to alternative methods of drainage discharge options, I have added comments below:

- Discharging to the ground (infiltration) - not possible as the building covers the vast majority of the site area, as such infiltration could cause instability issues for building foundations and would not be compliant with Building Regulations Part H.
- Discharge to watercourse – The only watercourse located close to the site is the Ashton Canal, which we have not considered a viable option due to the following reasons:
  - Surface water for the entire site would need to be pumped to the canal due to the elevations of the canal relative to the building.
  - The need to increase discharge rates/ volume to the canal.

Compliance with National Planning Practice Guidance and Non-Statutory Technical Standards for Sustainable Drainage Systems

I can confirm that the drainage design is compliant with the National Planning Practice Guidance and Non-Statutory Technical Standards for Sustainable Drainage Systems guidance documents.

I have added the following key points which confirm the current strategy:

- Drainage design restricts offsite discharge to greenfield flow rates for 1:100 year event + 40% Climate Change. Currently the site is brownfield, as such this results in significant betterment on the existing conditions.
- Attenuation provided by use of a tank
- It is proposed to drain the roof via an actively managed rainwater harvesting tank. The actively managed tank is linked to weather forecasting controls and will release water from the tank before a rainfall event to ensure there is enough capacity to store water once the rainfall event comes. This means that it is unlikely that we will have significant discharge during/ after a major storm event as this water should be stored for re-use. The stored water will be used for toilet flushing and irrigation.
- Proposed design uses porous paving and filter drains to drain external areas of the building where possible.
- Offsite discharge will be restricted by using a vortex flow control.

Can you please confirm if you need any further details on the proposed drainage strategy and if so can you confirm the form of this is required to be?

Happy to discuss any of the points above via the phone if this is useful.

Many thanks,

Allan Hoodless CEng MICE

Senior Engineer
Buro Happold Engineering | Infrastructure
T: +44 (0)113 204 2200

M: +44 (0)7525 766229
www.burohappold.com | @burohappold

From: Jennifer Atkinson <j.atkinson@manchester.gov.uk>
Sent: 30 June 2020 08:47
To: Allan Hoodless <Allan.Hoodless@BuroHappold.com>; Zorica Todorovic <z.todorovic@manchester.gov.uk>
Subject: Fwd: ONLINE CONTACT FORM (PLANNING): Other (please say what below)

** External Email **

Allan

Further to your email below, I have copied Zorica into the email from our drainage team.

Many thanks

Jen

_____

Jennifer Atkinson

Principal Planner

Development Management North

Planning Building Control and Licensing - Growth and Development

Manchester City Council

Tel: 0161 234 4517

Mobile: 07930635898

Email: j.atkinson@manchester.gov.uk

www.manchester.gov.uk

Location address: Manchester City Council Town Hall Extension Lloyd Street Manchester M2 5DB.

Postal Address: Manchester City Council P.O. Box 532 Town Hall Manchester M60 2LA

[Please note I am currently working from home until further notice. I can be contacted directly on my mobile]

---------- Forwarded message ---------
From: Planning MCC <planning@manchester.gov.uk>
Date: Tue, 30 Jun 2020 at 06:55
Subject: Fwd: ONLINE CONTACT FORM (PLANNING): Other (please say what below)
To: Jennifer Atkinson <j.atkinson@manchester.gov.uk>

Jen

An application you are dealing with.

Technical Support Team (Planning)

Planning, Building Control & Licensing

Growth & Development Directorate

Postal address: Manchester City Council, P O Box 532, Town Hall, Manchester

M60 2LA

Location address: Level 6 Town Hall Extension, Manchester M2 5DB

Tel: 0161 234 4516

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---------- Forwarded message ---------
From: <planning@manchester.gov.uk>
Date: Mon, 29 Jun 2020 at 16:59
Subject: ONLINE CONTACT FORM (PLANNING): Other (please say what below)
To: <planning@manchester.gov.uk>

Please reply to: Allan.Hoodless@BuroHappold.com

Question	Response
First name:	Allan
Surname:	Hoodless
Email address:	Allan.Hoodless@BuroHappold.com
House or flat number or building name:	
Street:	
Area:	

Postcode:	
What do you want to contact us about? :	Other (please say what below)
Put your question, or tell us what you were looking for or trying to do.:	I am working on a drainage design for planning application 126431/FO/2020. The planning application has some planning conditions related to drainage that i would like to discuss further with the relevant drainage officer in the council.

****

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Zorica Todorovic
Flood Risk Management
Highways Service
Growth and Neighbourhoods Directorate

Office: 0161 219 6295

Email: z.todorovic@manchester.gov.uk
Web: http://www.manchester.gov.uk

POSTAL ADDRESS: Manchester City Council, The Highways Service, PO Box 532, Town Hall, Manchester, M60 2LA

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**********[attachment "0042841_BHE_XX_XX_DN_C_0002 - SW Drainage Strategy for 03.pdf" deleted by Zorica Todorovic/Corporate.Services/MCC]

--
Zorica Todorovic

Flood Risk Management
Highways Service
Growth and Neighbourhoods Directorate

Office: 0161 219 6295

Email: z.todorovic@manchester.gov.uk
Web: http://www.manchester.gov.uk

POSTAL ADDRESS: Manchester City Council, The Highways Service, PO Box 532, Town Hall, Manchester, M60 2LA

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Appendix C Appendix C - Drawings

0042841_BHE_XX_XX_DR_C_0300 – Surface Water Drainage General Arrangement

0042841_BHE_XX_XX_DR_C_0556 – Drainage Details Sheet 6

0042841_BHE_XX_XX_DR_C_0557 – Drainage Details Sheet 7

0042841_BHE_XX_XX_DR_C_0558 – Drainage Details Sheet 8

0042841_BHE_XX_XX_DR_C_0559 – Drainage Details Sheet 9

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Suitability Code (as defined in ISO 19650-2:2018)

Work in Progress (WIP)
S0 - Initial Status

Shared (Non- Contractual)
S1 - Suitable for co-ordination
S2 - Suitable for information
S3 - Suitable for review & comment
S4 - Suitable for stage approval
S5 - Withdrawn
S6 - Suitable for PIM authorisation
S7 - Suitable for AIM authorisation

Published (Contractual)
A1, A2, A3, Etc - Authorised and accepted
B1,B2,B3, Etc, - Partial sign-off (with comments)

Published (AIM Acceptance)
CR - As constructed record document

SAFETY HEALTH AND ENVIRONMENTAL INFORMATION

IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING.

CONSTRUCTION.

EXCAVATIONS IN CONTAMINATED GROUND
FINAL CONNECTION TO LIVE SEWER

MAINTENANCE/CLEANING/OPERATION.

HYDRO-BRAKE FLOW CONTROL DEVICE
ATTENUATION TANK
RAINWATER HARVESTING TANK EQUIPMENT

DECOMMISSIONING/DEMOLITION

NO UNUSUAL RISKS

Notes

1. THIS DRAWING REFERENCE FOLLOWING INFORMATION:
   - POPULUS (ARCHITECT) - LEVEL 00 RECEIVED ON THE 10.03.20
   - CCTV SURVEY FROM SURVEY OPERATIONS REFERENCE 190065 A RECEIVED ON THE 12.09.2019
2. ALL INTERNAL MANHOLES TO HAVE DOUBLE SEALED COVERS
3. ALL PIPES TO BE Ø150mm UNLESS SHOWN OTHERWISE ON THE DRAWING.
4. FOR PODIUM LEVEL SURFACE WATER DRAINAGE REFER TO DRAWING BRA-BHE-XX-01-DR-C-0301
5. FOR HIGHWAY DRAINAGE REFER TO DRAWING BRA-BHE-XX-XX-DR-C-0310.
6. FOR ABOVE GROUND DRAINAGE REFER TO ME ENGINEERING DRAWINGS.
7. FOR LONG SECTIONS REFER TO DRAWINGS BRA-BHE-XX-XX-DR-C-0320 SERIES.
8. FOR MANHOLE & PIPE SCHEDULE REFER TO DRAWING: BRE-BHE-XX-XX-DR-C-0391.

LEGEND

- LAND OWNERSHIP BOUNDARY
- PLANNING APPLICATION BOUNDARY
- PROPOSED SURFACE WATER DRAINAGE & MANHOLE
- PROPOSED SURFACE WATER CHANNEL DRAIN ACO MULTIDRAIN M150D 0.0 CHANNEL BRICKSLOT WITH OUTLETS
- PROPOSED SURFACE WATER ATTENUATION TANK
- EXISTING SURFACE WATER DRAINAGE
- EXISTING GAS MAIN
- INDICATIVE RISING MAIN

THRESHOLD CONNECTIONS FROM PODIUM LEVEL TO BE COORDINATED WITH THE MEP ENGINEER, CONTRACTOR TO MAKE ALLOWANCE FOR EXTRA PIPE LENGTHS

Rev	Appr/Drn	Date	Description
P05	SBH TH	03.07.20	STAGE 4a TENDER
P04	TB NJH	03.04.20	STAGE 3
P03	TB NJH	20.03.20	STAGE 3
P02	SBH NJH	13.02.20	STAGE 3
P01	JZ JB	29.11.19	DRAFT STAGE 3

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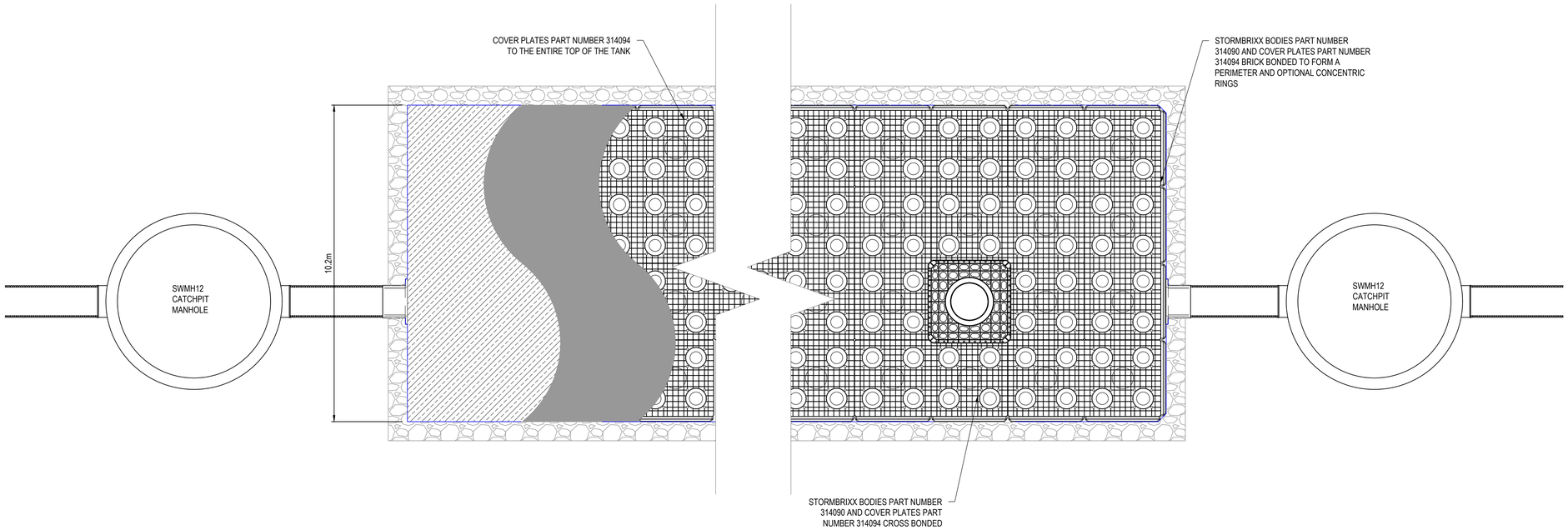
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title: SURFACE WATER DRAINAGE BELOW GROUND GENERAL ARRANGEMENT

purpose of issue: STAGE 4a

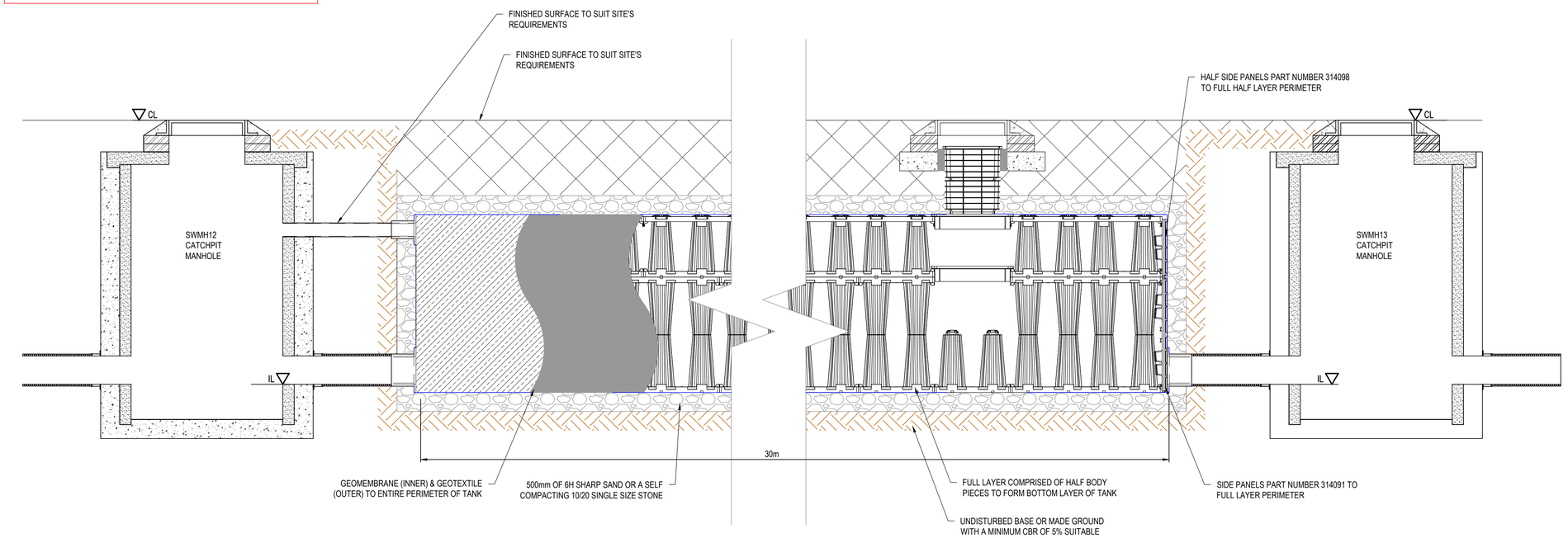
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date	Nov-19	checked	NJH		0042841	S4

	project code	originator	volume	level	type	role	number	rev.
reference	BRA-BHE-XX-XX-DR-C-0301							P05



ACO STORMBRIXX HD ATTENUATION 1.5 LAYER TANK
PLAN
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ATTENUATION TANK TO BE HANDLED AND INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS



ACO STORMBRIXX HD ATTENUATION 1.5 LAYER TANK
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Notes

Rev	Appr/Drn	Date	Description
P05	SBH TH	03.07.20	STAGE 4a TENDER
P04	SBH NJH	20.03.20	STAGE 3
P03	SBH NJH	13.02.20	STAGE 3
P02	JZ JB	29.11.19	DRAFT STAGE 3
P01	JZ SR	01.11.19	DRAFT STAGE 3

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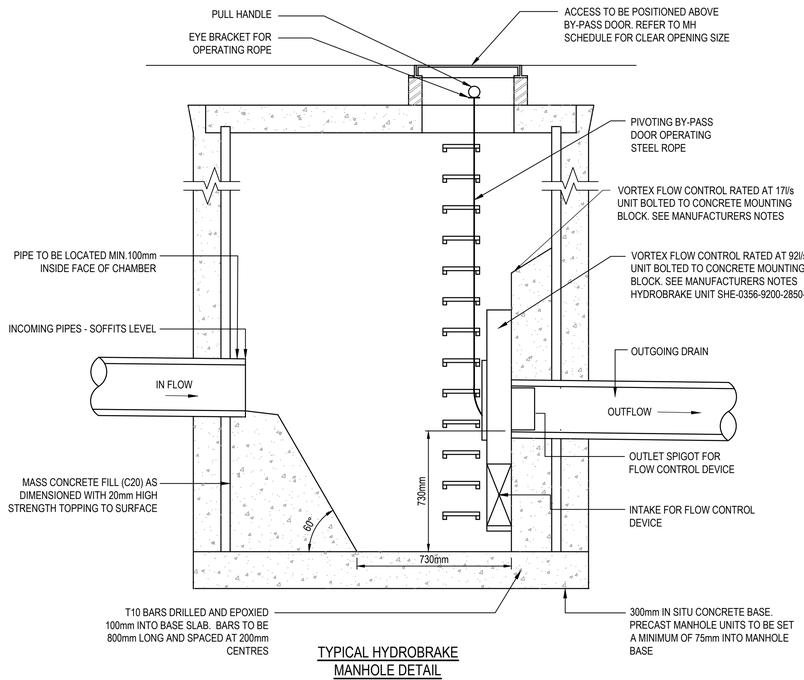
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title DRAINAGE DETAILS
SHEET 6

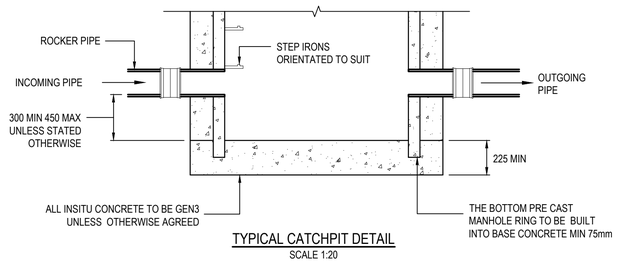
purpose of issue
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scale	1:20	drawn	JZ	Job no.	Suitability
date	Nov-19	checked	NJH	0042841	S4

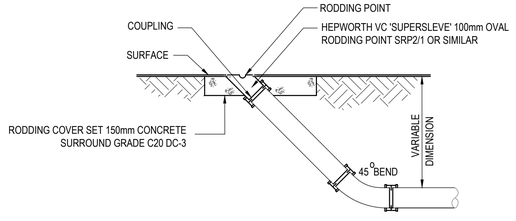
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	BRA	BHE	XX	XX	DR	C	0556	P05



TYPICAL HYDROBRAKE MANHOLE DETAIL
NTS



TYPICAL CATCHPIT DETAIL
SCALE 1:20



RODDING EYE IN LANDSCAPE
SCALE 1:20

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Rev	Appr/Drn	Date	Description
P01	FR AH	03.07.20	STAGE 4a TENDER

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purpose of issue: STAGE 4a

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date	Jul-20	checked	AH	0042841	S4

	project code	originator	volume	level	type	role	number	rev.
reference	BRA-BHE-XX-XX-DR-C-0557							P01

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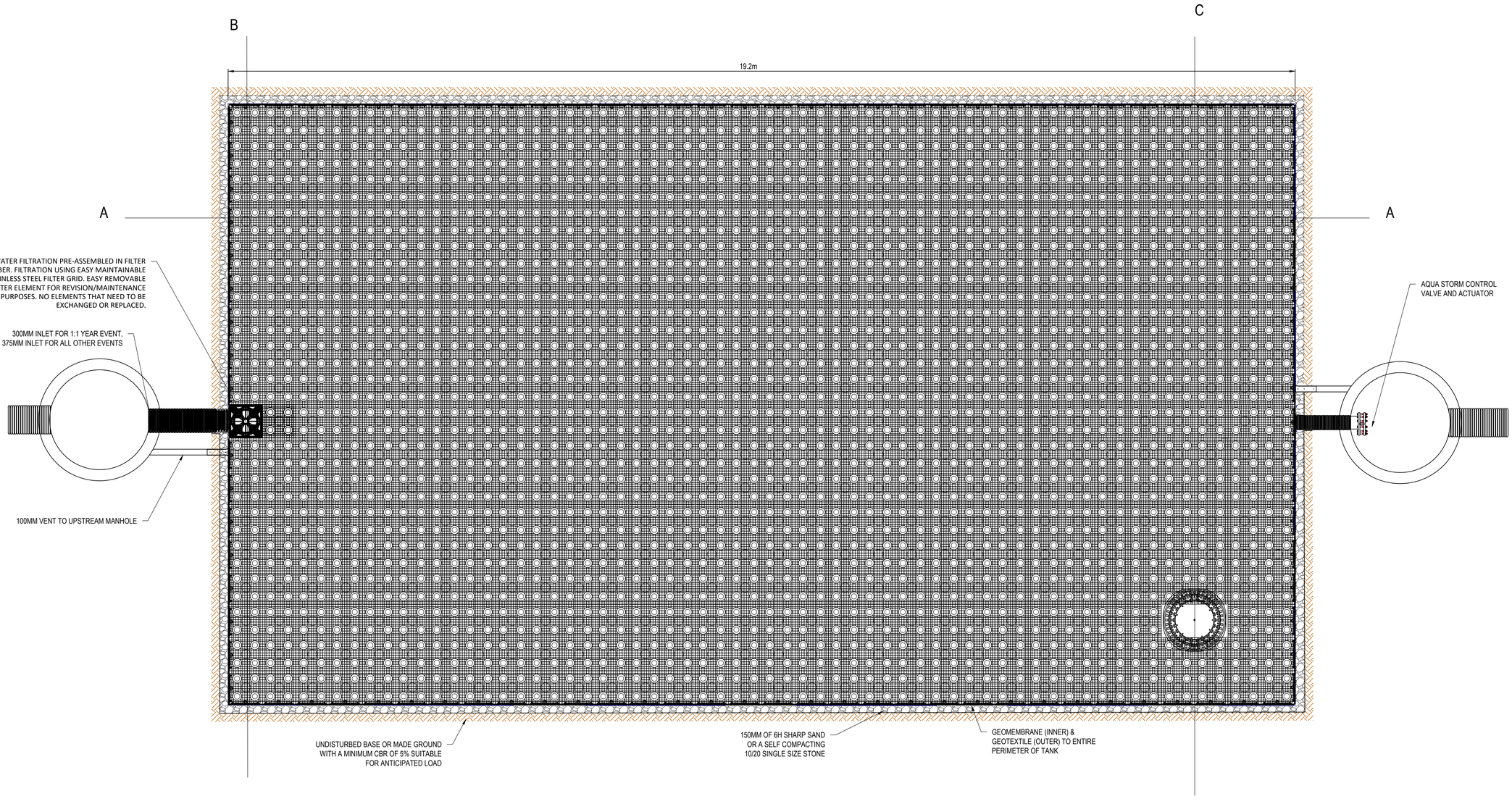
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Notes



RAINWATER HARVESTING TANK
ACO STORMBRIXX HD ATTENUATION 1.5 LAYER TANK
PLAN
NOT TO SCALE

RAINWATER HARVESTING TANK TO BE HANDLED AND INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS
REFER TO DRAWING 0559 FOR SECTIONS

P01 FR AH 03.07.20 STAGE 4a TENDER

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SHEET 8

purpose of issue
STAGE 4a

scale	1:20	drawn	FR	Job no.	Suitability
date	Jul-20	checked	AH	0042841	S4

	project code	originator	volume	level	type	role	number	rev.
reference	BRA-BHE-XX-XX-DR-C-0558							P01

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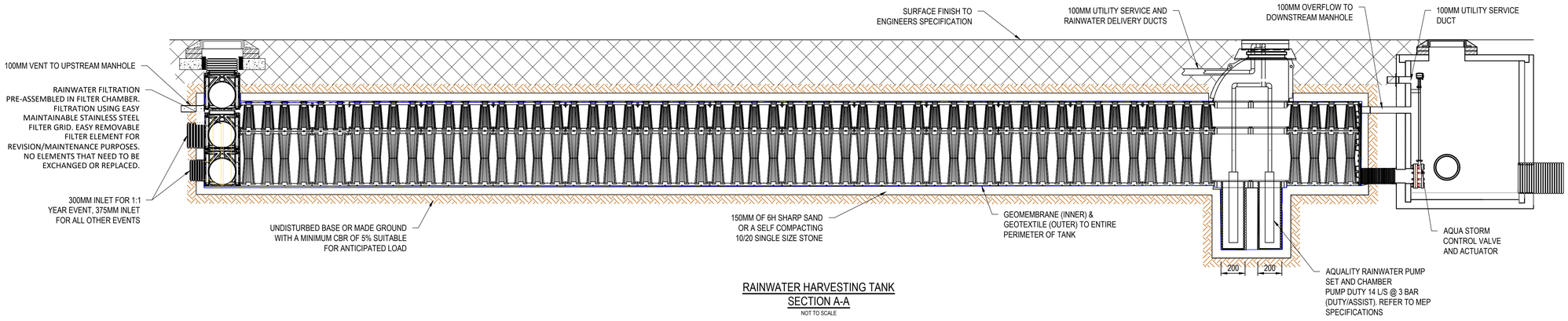
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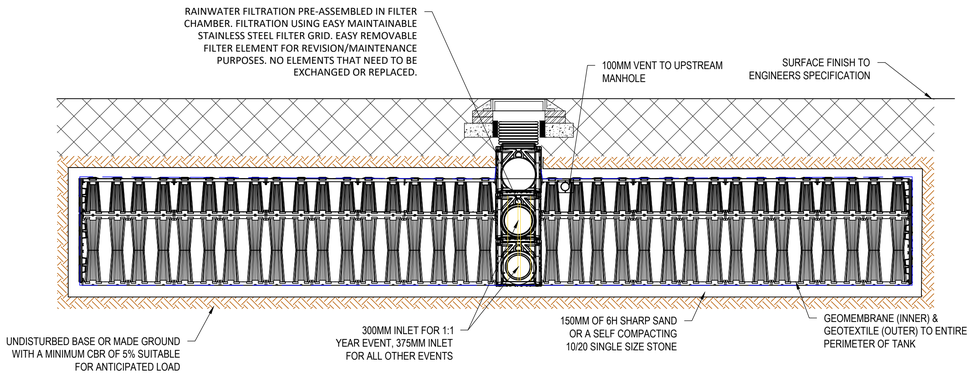
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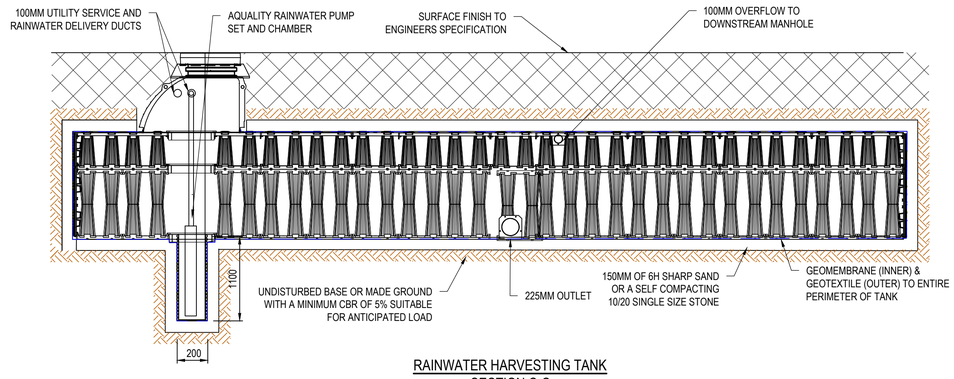
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RAINWATER HARVESTING TANK
SECTION A-A
NOT TO SCALE



RAINWATER HARVESTING TANK
SECTION B-B
NOT TO SCALE



RAINWATER HARVESTING TANK
SECTION C-C
NOT TO SCALE

RAINWATER HARVESTING TANK TO BE HANDLED AND INSTALLED IN STRICT ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS
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P01 FR AH 03.07.20 STAGE 4a TENDER

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SHEET 9

purpose of issue
STAGE 4a

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date	Jul-20	checked	AH	0042841	S4

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reference	BRA-BHE-XX-XX-DR-C-0559							P01

Appendix D Appendix D - Calculations

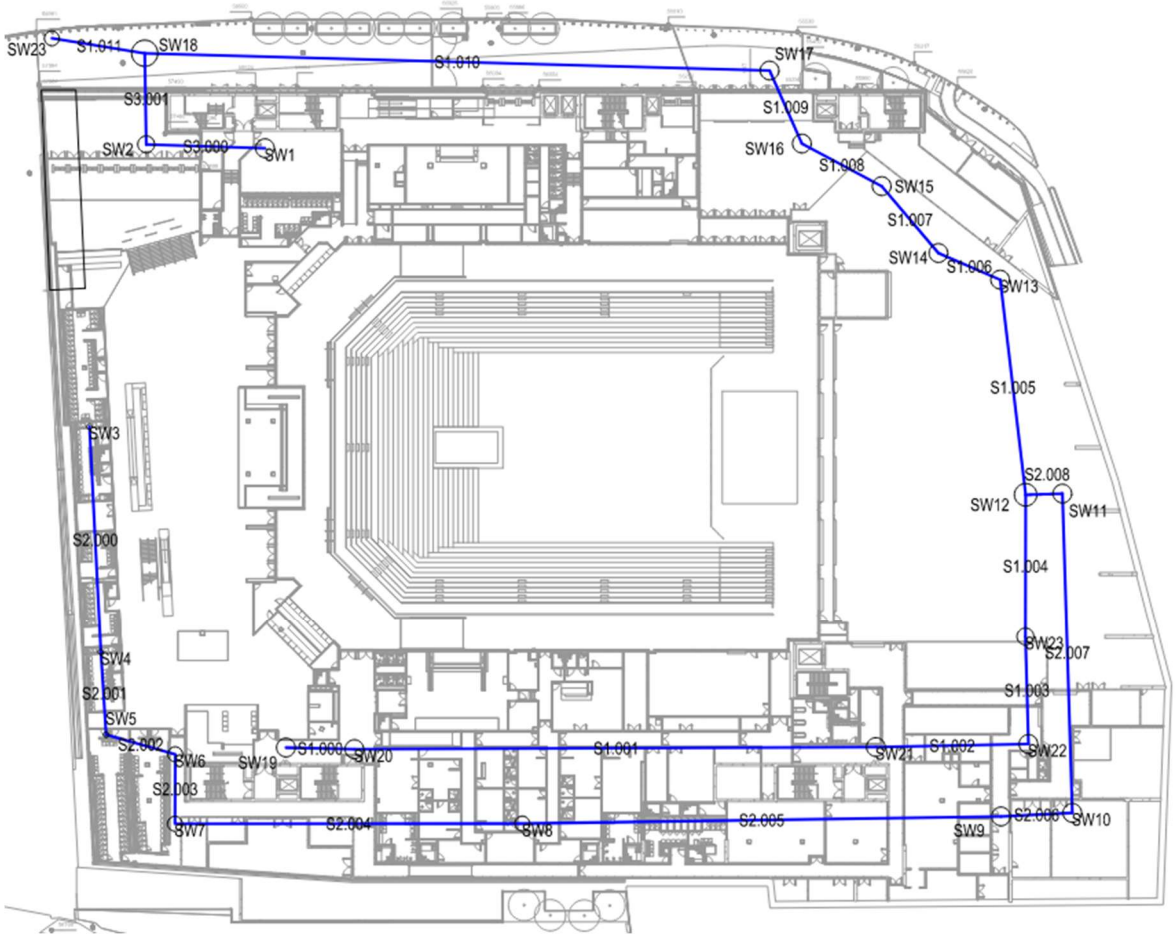


Figure 2—5 MicroDrainage Network Layout

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.360	Minimum Backdrop Height (m)	0.600
Maximum Rainfall (mm/hr)	75	Maximum Backdrop Height (m)	4.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.75
Volumetric Runoff Coeff.	1.000	Min Slope for Optimisation (1:X)	600

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	10.949	0.090	121.2	0.486	5.00	0.0	0.600	o	450	Pipe/Conduit	
S1.001	83.428	0.540	154.5	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.002	24.405	0.155	157.0	0.402	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.003	17.134	0.050	343.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.004	22.807	0.045	506.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	36.236	0.240	151.0	0.020	5.00	0.0	0.600	o	150	Pipe/Conduit	
S2.001	13.197	0.090	147.0	0.018	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.002	11.489	0.200	57.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.003	11.077	0.195	56.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S2.004	55.573	0.370	150.0	0.054	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	59.41	5.10	53.500	0.486	0.0	0.0	0.0	1.85	293.5	104.3
S1.001	55.64	5.95	53.410	0.486	0.0	0.0	0.0	1.63	259.8	104.3
S1.002	54.64	6.20	52.870	0.888	0.0	0.0	0.0	1.62	257.7	175.2
S1.003	53.63	6.46	52.715	0.888	0.0	0.0	0.0	1.09	173.7«	175.2
S1.004	51.27	7.12	52.665	0.888	0.0	0.0	0.0	0.57	22.8«	175.2
S2.000	56.52	5.74	54.700	0.020	0.0	0.0	0.0	0.82	14.4	4.1
S2.001	55.41	6.01	54.460	0.037	0.0	0.0	0.0	0.83	14.6	7.5
S2.002	54.84	6.15	54.370	0.037	0.0	0.0	0.0	1.33	23.5	7.5
S2.003	54.30	6.29	54.170	0.037	0.0	0.0	0.0	1.34	23.6	7.5
S2.004	51.16	7.16	53.900	0.092	0.0	0.0	0.0	1.07	42.4	17.0

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.005	76.584	0.510	150.2	0.058	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.006	11.419	0.030	381.0	0.119	0.00	0.0	0.600	o	375	Pipe/Conduit	
S2.007	51.123	0.130	393.1	0.111	0.00	0.0	0.600	o	375	Pipe/Conduit	
S2.008	5.884	0.015	392.3	0.030	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	34.647	0.060	577.4	0.029	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.006	10.751	0.022	489.0	0.053	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.007	14.037	0.028	501.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.008	14.467	0.030	482.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.009	12.772	0.025	511.0	0.390	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.010	100.000	0.740	135.1	0.034	0.00	0.0	0.600	o	600	Pipe/Conduit	
S3.000	19.014	0.475	40.0	0.502	5.00	0.0	0.600	o	375	Pipe/Conduit	
S3.001	14.568	0.365	39.9	0.018	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.011	15.040	0.150	100.3	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.005	47.47	8.36	53.530	0.150	0.0	0.0	0.0	1.06	42.3	25.7
S2.006	46.90	8.56	52.870	0.270	0.0	0.0	0.0	0.92	101.9	45.6
S2.007	44.49	9.50	52.840	0.380	0.0	0.0	0.0	0.91	100.3	61.1
S2.008	44.23	9.61	52.710	0.411	0.0	0.0	0.0	0.91	100.4	65.6
S1.005	42.91	10.18	52.470	1.328	0.0	0.0	0.0	1.01	284.5	205.7
S1.006	42.55	10.35	52.410	1.381	0.0	0.0	0.0	1.09	309.4	212.1
S1.007	42.09	10.56	52.388	1.381	0.0	0.0	0.0	1.08	305.7	212.1
S1.008	41.63	10.78	52.360	1.381	0.0	0.0	0.0	1.10	311.7	212.1
S1.009	41.22	10.98	52.330	1.771	0.0	0.0	0.0	1.07	302.6	263.6
S1.010	39.69	11.78	52.305	1.805	0.0	0.0	0.0	2.09	591.8	263.6
S3.000	59.36	5.11	53.930	0.502	0.0	0.0	0.0	2.87	317.2	107.6
S3.001	59.00	5.19	51.930	0.520	0.0	0.0	0.0	3.23	513.0	110.7
S1.011	39.46	11.90	51.565	2.325	0.0	0.0	0.0	2.03	322.9«	331.3

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Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	1.000
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.359		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: SW18, DS/PN: S1.011, Volume (m³): 47.9

Unit Reference	MD-SHE-0356-9200-2850-9200
Design Head (m)	2.850
Design Flow (l/s)	92.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	356
Invert Level (m)	51.565
Minimum Outlet Pipe Diameter (mm)	375
Suggested Manhole Diameter (mm)	Site Specific Design (Contact Hydro International)

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.850	91.9
Flush-Flo™	0.847	91.9
Kick-Flo®	1.838	74.3
Mean Flow over Head Range	-	79.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.3	1.200	90.1	3.000	94.2	7.000	142.4
0.200	35.9	1.400	87.8	3.500	101.6	7.500	147.3
0.300	66.6	1.600	83.8	4.000	108.4	8.000	152.0
0.400	83.8	1.800	76.5	4.500	114.8	8.500	156.6
0.500	87.7	2.000	77.4	5.000	120.8	9.000	161.0
0.600	90.0	2.200	81.1	5.500	126.6	9.500	165.3
0.800	91.9	2.400	84.6	6.000	132.1		
1.000	91.5	2.600	87.9	6.500	137.3		

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Storage Structures for Storm

Cellular Storage Manhole: SW23, DS/PN: S1.004

Invert Level (m) 52.665 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	207.4	207.4	1.393	0.0	291.4
1.392	207.4	291.4			

Cellular Storage Manhole: SW13, DS/PN: S1.006

Invert Level (m) 52.410 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	306.0	306.0	1.393	0.0	418.6
1.392	306.0	418.6			

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.360
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	SW19	15 Winter	1	+0%	30/15 Summer				53.684
S1.001	SW20	15 Winter	1	+0%	30/15 Summer				53.559
S1.002	SW21	15 Winter	1	+0%	30/15 Summer				53.081
S1.003	SW22	15 Winter	1	+0%	30/15 Summer				52.991
S1.004	SW23	60 Winter	1	+0%	1/30 Winter				52.900
S2.000	SW3	15 Winter	1	+0%	100/15 Summer				54.742
S2.001	SW4	15 Winter	1	+0%	30/15 Summer				54.517
S2.002	SW5	15 Winter	1	+0%	100/15 Summer				54.415
S2.003	SW6	15 Winter	1	+0%	30/15 Winter				54.215
S2.004	SW7	15 Winter	1	+0%	30/15 Summer				53.974
S2.005	SW8	15 Winter	1	+0%	30/15 Summer				53.623
S2.006	SW9	15 Winter	1	+0%	30/15 Summer				53.035
S2.007	SW10	15 Winter	1	+0%	30/15 Summer				53.002
S2.008	SW11	15 Winter	1	+0%	30/15 Summer				52.897
S1.005	SW12	30 Winter	1	+0%	30/30 Winter				52.664
S1.006	SW13	180 Winter	1	+0%	30/30 Winter				52.602
S1.007	SW14	180 Winter	1	+0%	30/15 Summer				52.578
S1.008	SW15	180 Winter	1	+0%	30/15 Summer				52.549

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	SW19	-0.266	0.000	0.34		58.1	OK	
S1.001	SW20	-0.300	0.000	0.23		56.3	OK	
S1.002	SW21	-0.239	0.000	0.44		94.8	OK	
S1.003	SW22	-0.174	0.000	0.69		94.5	OK	
S1.004	SW23	0.010	0.000	1.25		25.4	SURCHARGED	
S2.000	SW3	-0.108	0.000	0.17		2.3	OK	
S2.001	SW4	-0.093	0.000	0.31		4.1	OK	1
S2.002	SW5	-0.106	0.000	0.19		4.1	OK	
S2.003	SW6	-0.105	0.000	0.19		4.1	OK	
S2.004	SW7	-0.152	0.000	0.23		9.2	OK	
S2.005	SW8	-0.131	0.000	0.36		14.7	OK	
S2.006	SW9	-0.210	0.000	0.37		25.5	OK	
S2.007	SW10	-0.213	0.000	0.37		34.7	OK	
S2.008	SW11	-0.188	0.000	0.49		36.6	OK	
S1.005	SW12	-0.406	0.000	0.23		54.2	OK	
S1.006	SW13	-0.408	0.000	0.18		28.8	OK	
S1.007	SW14	-0.410	0.000	0.18		28.9	OK	
S1.008	SW15	-0.411	0.000	0.17		28.9	OK	

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.009	SW16	15 Winter	1	+0%	30/15 Summer				52.523
S1.010	SW17	15 Winter	1	+0%	30/15 Summer				52.409
S3.000	SW1	15 Winter	1	+0%	30/15 Summer				54.052
S3.001	SW2	15 Winter	1	+0%	30/15 Summer				52.060
S1.011	SW18	15 Winter	1	+0%	2/15 Summer				51.965

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.009	SW16	-0.407	0.000	0.23		35.5	OK	
S1.010	SW17	-0.496	0.000	0.07		38.1	OK	
S3.000	SW1	-0.253	0.000	0.23		60.4	OK	
S3.001	SW2	-0.320	0.000	0.18		61.6	OK	
S1.011	SW18	-0.050	0.000	0.38		83.8	OK	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.360
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	SW19	15 Winter	2	+0%	30/15 Summer				53.712
S1.001	SW20	15 Winter	2	+0%	30/15 Summer				53.582
S1.002	SW21	15 Winter	2	+0%	30/15 Summer				53.120
S1.003	SW22	15 Winter	2	+0%	30/15 Summer				53.044
S1.004	SW23	60 Winter	2	+0%	1/30 Winter				52.952
S2.000	SW3	15 Winter	2	+0%	100/15 Summer				54.748
S2.001	SW4	15 Winter	2	+0%	30/15 Summer				54.526
S2.002	SW5	15 Winter	2	+0%	100/15 Summer				54.421
S2.003	SW6	15 Winter	2	+0%	30/15 Winter				54.221
S2.004	SW7	15 Winter	2	+0%	30/15 Summer				53.985
S2.005	SW8	15 Winter	2	+0%	30/15 Summer				53.638
S2.006	SW9	15 Winter	2	+0%	30/15 Summer				53.062
S2.007	SW10	15 Winter	2	+0%	30/15 Summer				53.029
S2.008	SW11	15 Winter	2	+0%	30/15 Summer				52.928
S1.005	SW12	30 Winter	2	+0%	30/30 Winter				52.691
S1.006	SW13	120 Winter	2	+0%	30/30 Winter				52.639
S1.007	SW14	120 Winter	2	+0%	30/15 Summer				52.614
S1.008	SW15	120 Winter	2	+0%	30/15 Summer				52.585

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	SW19	-0.238	0.000	0.44		75.2	OK	
S1.001	SW20	-0.278	0.000	0.30		73.0	OK	
S1.002	SW21	-0.200	0.000	0.56		121.1	OK	
S1.003	SW22	-0.121	0.000	0.89		120.8	OK	
S1.004	SW23	0.062	0.000	1.67		33.9	SURCHARGED	
S2.000	SW3	-0.102	0.000	0.22		3.0	OK	
S2.001	SW4	-0.084	0.000	0.40		5.3	OK	1
S2.002	SW5	-0.099	0.000	0.25		5.3	OK	
S2.003	SW6	-0.099	0.000	0.25		5.3	OK	
S2.004	SW7	-0.141	0.000	0.29		11.9	OK	
S2.005	SW8	-0.117	0.000	0.45		18.4	OK	
S2.006	SW9	-0.183	0.000	0.47		32.5	OK	
S2.007	SW10	-0.186	0.000	0.48		44.8	OK	
S2.008	SW11	-0.157	0.000	0.63		47.2	OK	
S1.005	SW12	-0.379	0.000	0.29		69.3	OK	
S1.006	SW13	-0.371	0.000	0.26		40.2	OK	
S1.007	SW14	-0.374	0.000	0.25		40.2	OK	
S1.008	SW15	-0.375	0.000	0.23		40.3	OK	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.009	SW16	120 Winter	2	+0%	30/15 Summer				52.557
S1.010	SW17	15 Winter	2	+0%	30/15 Summer				52.426
S3.000	SW1	15 Winter	2	+0%	30/15 Summer				54.070
S3.001	SW2	15 Winter	2	+0%	30/15 Summer				52.146
S1.011	SW18	15 Winter	2	+0%	2/15 Summer				52.120

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.009	SW16	-0.373	0.000	0.31		47.9	OK	
S1.010	SW17	-0.479	0.000	0.09		48.9	OK	
S3.000	SW1	-0.235	0.000	0.30		78.1	OK	
S3.001	SW2	-0.234	0.000	0.23		79.7	OK	
S1.011	SW18	0.105	0.000	0.41		89.1	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.360
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	SW19	15 Winter	30	+40%	30/15 Summer				54.149
S1.001	SW20	15 Winter	30	+40%	30/15 Summer				54.043
S1.002	SW21	15 Winter	30	+40%	30/15 Summer				53.748
S1.003	SW22	60 Winter	30	+40%	30/15 Summer				53.474
S1.004	SW23	60 Winter	30	+40%	1/30 Winter				53.455
S2.000	SW3	15 Winter	30	+40%	100/15 Summer				54.784
S2.001	SW4	15 Winter	30	+40%	30/15 Summer				54.626
S2.002	SW5	15 Winter	30	+40%	100/15 Summer				54.463
S2.003	SW6	15 Winter	30	+40%	30/15 Winter				54.360
S2.004	SW7	15 Winter	30	+40%	30/15 Summer				54.276
S2.005	SW8	15 Winter	30	+40%	30/15 Summer				54.098
S2.006	SW9	15 Winter	30	+40%	30/15 Summer				53.445
S2.007	SW10	15 Winter	30	+40%	30/15 Summer				53.407
S2.008	SW11	120 Winter	30	+40%	30/15 Summer				53.293
S1.005	SW12	120 Winter	30	+40%	30/30 Winter				53.290
S1.006	SW13	120 Winter	30	+40%	30/30 Winter				53.278
S1.007	SW14	15 Winter	30	+40%	30/15 Summer				53.414
S1.008	SW15	15 Winter	30	+40%	30/15 Summer				53.742

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	SW19	0.199	0.000	1.12		189.3	SURCHARGED	
S1.001	SW20	0.183	0.000	0.73		177.8	SURCHARGED	
S1.002	SW21	0.428	0.000	1.44		309.3	SURCHARGED	
S1.003	SW22	0.309	0.000	1.29		176.0	SURCHARGED	
S1.004	SW23	0.565	0.000	2.72		55.3	SURCHARGED	
S2.000	SW3	-0.066	0.000	0.57		8.0	OK	
S2.001	SW4	0.016	0.000	1.11		14.8	SURCHARGED	1
S2.002	SW5	-0.057	0.000	0.69		14.7	OK	
S2.003	SW6	0.039	0.000	0.73		15.5	SURCHARGED	
S2.004	SW7	0.150	0.000	0.79		32.1	SURCHARGED	
S2.005	SW8	0.343	0.000	1.13		46.3	SURCHARGED	
S2.006	SW9	0.200	0.000	1.24		85.1	SURCHARGED	
S2.007	SW10	0.192	0.000	1.30		121.2	SURCHARGED	
S2.008	SW11	0.208	0.000	0.76		56.7	SURCHARGED	
S1.005	SW12	0.220	0.000	0.47		111.6	SURCHARGED	
S1.006	SW13	0.268	0.000	0.83		129.9	SURCHARGED	
S1.007	SW14	0.426	0.000	0.94		154.3	SURCHARGED	
S1.008	SW15	0.782	0.000	0.90		154.2	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.009	SW16	15 Winter	30	+40%	30/15 Summer				53.910
S1.010	SW17	15 Winter	30	+40%	30/15 Summer				53.951
S3.000	SW1	15 Winter	30	+40%	30/15 Summer				54.643
S3.001	SW2	15 Winter	30	+40%	30/15 Summer				54.277
S1.011	SW18	15 Winter	30	+40%	2/15 Summer				54.014

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.009	SW16	0.980	0.000	0.94		146.5	SURCHARGED	
S1.010	SW17	1.046	0.000	0.21		116.0	SURCHARGED	
S3.000	SW1	0.338	0.000	0.83		218.0	SURCHARGED	
S3.001	SW2	1.897	0.000	0.74		252.6	SURCHARGED	
S1.011	SW18	1.999	0.000	0.42		91.8	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	2
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.360
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 40, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	SW19	15 Winter	100	+40%	30/15 Summer				54.819
S1.001	SW20	15 Winter	100	+40%	30/15 Summer				54.642
S1.002	SW21	15 Winter	100	+40%	30/15 Summer				54.151
S1.003	SW22	120 Winter	100	+40%	30/15 Summer				53.876
S1.004	SW23	120 Winter	100	+40%	1/30 Winter				53.864
S2.000	SW3	15 Winter	100	+40%	100/15 Summer				55.141
S2.001	SW4	15 Winter	100	+40%	30/15 Summer				55.050
S2.002	SW5	15 Winter	100	+40%	100/15 Summer				54.943
S2.003	SW6	15 Winter	100	+40%	30/15 Winter				54.849
S2.004	SW7	15 Winter	100	+40%	30/15 Summer				54.788
S2.005	SW8	15 Winter	100	+40%	30/15 Summer				54.562
S2.006	SW9	120 Winter	100	+40%	30/15 Summer				53.776
S2.007	SW10	120 Winter	100	+40%	30/15 Summer				53.773
S2.008	SW11	120 Winter	100	+40%	30/15 Summer				53.763
S1.005	SW12	120 Winter	100	+40%	30/30 Winter				53.759
S1.006	SW13	120 Winter	100	+40%	30/30 Winter				53.749
S1.007	SW14	120 Winter	100	+40%	30/15 Summer				53.810
S1.008	SW15	15 Winter	100	+40%	30/15 Summer				53.968

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	SW19	0.869	0.000	1.36		230.0	SURCHARGED	
S1.001	SW20	0.782	0.000	0.92		225.5	SURCHARGED	
S1.002	SW21	0.831	0.000	1.85		397.9	SURCHARGED	
S1.003	SW22	0.711	0.000	1.08		147.8	SURCHARGED	
S1.004	SW23	0.974	0.000	2.66		54.1	SURCHARGED	
S2.000	SW3	0.291	0.000	0.70		9.8	SURCHARGED	
S2.001	SW4	0.440	0.000	1.23		16.5	SURCHARGED	1
S2.002	SW5	0.423	0.000	0.76		16.0	SURCHARGED	
S2.003	SW6	0.529	0.000	0.92		19.6	SURCHARGED	
S2.004	SW7	0.663	0.000	0.84		34.4	SURCHARGED	
S2.005	SW8	0.807	0.000	1.29		53.0	SURCHARGED	
S2.006	SW9	0.532	0.000	0.73		50.1	SURCHARGED	
S2.007	SW10	0.558	0.000	0.71		65.7	SURCHARGED	
S2.008	SW11	0.678	0.000	0.96		71.4	SURCHARGED	
S1.005	SW12	0.689	0.000	0.51		121.0	SURCHARGED	
S1.006	SW13	0.739	0.000	1.09		169.7	SURCHARGED	
S1.007	SW14	0.822	0.000	1.04		170.7	SURCHARGED	
S1.008	SW15	1.008	0.000	1.13		193.2	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.009	SW16	15 Summer	100	+40%	30/15 Summer				54.265
S1.010	SW17	15 Summer	100	+40%	30/15 Summer				54.360
S3.000	SW1	15 Winter	100	+40%	30/15 Summer				55.288
S3.001	SW2	15 Winter	100	+40%	30/15 Summer				54.829
S1.011	SW18	15 Winter	100	+40%	2/15 Summer				54.546

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.009	SW16	1.335	0.000	0.98		153.4	SURCHARGED	
S1.010	SW17	1.455	0.000	0.22		120.7	SURCHARGED	
S3.000	SW1	0.983	0.000	1.14		301.6	SURCHARGED	
S3.001	SW2	2.449	0.000	1.00		338.9	SURCHARGED	
S1.011	SW18	2.531	0.000	0.42		92.1	SURCHARGED	

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