Anglia Square, Norwich
Proposed Surface Water Drainage Strategy

Dated March 2022

Weston Homes

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March 2022

EAS

Anglia Square Regeneration Norwich Norfolk

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TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
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1 Introduction

1.1 This Surface Water Drainage Strategy Report has been prepared by EAS on behalf of Weston Homes Plc (the Applicant) in support of a hybrid (part full/part outline) planning application, (the Application), submitted to Norwich City Council (NCC) for the comprehensive redevelopment of Anglia Square and various parcels of mostly open surrounding land, (the Site), as shown within a red line on drawing 'ZZ-00-DR-A-01-0200'.

1.2 The Site is located in a highly accessible position within the northern part of Norwich City Centre and comprises a significant element of the Anglia Square/Magdalen Street/St Augustines Large District Centre, (the LDC). It is thus of strategic importance to the City, and accordingly has been identified for redevelopment for many years within various local planning policy documents, including the Northern City Centre Area Action Plan 2010, (NCCAAP), (now expired), the Joint Core Strategy for Broadland, Norwich and South Norfolk 2014, (JCS), and NCC's Anglia Square and Surrounding Area Policy Guidance Note 2017, (PGN). The Site forms the principal part of an allocation (GNLP 0506) in the emerging Greater Norwich Local Plan (GNLP).

1.3 This application follows a previous application on a somewhat smaller development parcel, (NCC Ref. 18/00330/F) made jointly by Weston Homes Plc as development partner and Columbia Threadneedle Investments, (CTI), the Site's owner, for a residential-led mixed use scheme consisting of up to 1,250 dwellings with decked parking, and 11,000 sqm GEA flexible ground floor retail/commercial/non-residential institution floorspace, hotel, cinema, multi-storey public car park, place of worship, and associated public realm and highway works. This was subject to a Call-in by the Secretary of State (PINS Ref. APP/G2625/V/19/3225505) who refused planning permission on 12th November 2020, (the 'Call in Scheme').

1.4 In April 2021, following new negotiations with Site owner CTI, Weston Homes decided to explore the potential for securing planning permission for an alternative scheme via an extensive programme of public and stakeholder engagement, from the earliest concepts to a fully worked up application. The negotiations with CTI have secured a "Subject to Planning" contract to purchase the Site, (enlarged to include the southeastern part of Anglia Square fronting Magdalen Street and St Crispins Road), which has enabled a completely fresh approach to establishing a redevelopment scheme for Anglia Square. This has resulted in a different development brief for the scheme, being to create a replacement part of the larger LDC suited to the flexible needs of a wide range of retail, service, business and community uses, reflective of trends in town centre character, integrated with the introduction of homes across the Site, within a highly permeable layout, well connected to its surroundings.

1.5 The new development proposal seeks to comprehensively redevelop the Site to provide up to 1,100 dwellings and up to 8,000sqm (NIA) flexible retail, commercial and other non-residential floorspace including Community Hub, up to 450 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), car club spaces and associated works to the highway and public realm areas (the Proposed Development). These figures are maxima in view of the hybrid nature of the application. This proposes part of the scheme designed in full, to accommodate 367 dwellings, 5,808 sqm non-residential floorspace, and 146 car parking spaces (at least 95% spaces for residential use, and up to 5% for non-residential use), with the remaining large part of the Site for later detailed design as a "Reserved Matters" application, up to those maxima figures.

1.6 A separate report, undertaken by others, deals with the flood risk assessment, hydraulic modelling study and impact assessment and should be read in conjunction with this report.

1.7 This document has been prepared in support of the Planning Application with the following description:

"Hybrid (part full/part outline) application on site of 4.65ha for demolition and clearance of all buildings and structures and the phased, comprehensive redevelopment of the site with 14 buildings ranging in height from 1 to 8 storeys, for a maximum of 1,100 residential dwellings, (houses, duplexes and flats) (Use Class C3); a maximum of 8,000 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, workshops, non-residential institutions, community hub, local community uses, and other floorspace (Use Classes E/F1/F2/Sui Generis (public conveniences, drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))); service yard, cycle and refuse stores, plant rooms, car parking and other ancillary space; with associated new and amended means of access on Edward Street and Pitt Street, closure of existing means of access on Edward Street, New Botolph Street, Pitt Street and St Crispins Road flyover, formation of cycle path between Edward Street and St Crispins Road, formation of wider footways, laybys and other associated highway works on all boundaries, formation of car club parking area off New Botolph Street, up to 450 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), hard and soft landscaping of public open spaces comprising streets and squares/courtyards for pedestrians and cyclists, other landscape works within existing streets surrounding the site, service infrastructure and other associated work; (All floor areas given as maximum Net Internal Area);

Comprising;

Full planning permission on 2.25ha of the site for demolition and clearance of all buildings and structures, erection of 8 buildings ranging in height from 1 to 8 storeys for 367 residential dwellings (Use Class C3) (149 dwellings in Block A, 25 dwellings in Block B, 21 dwellings in Block C, 34 dwellings in Block D, 8 dwellings in Block J3, 81 dwellings in Block K/L, and 49 dwellings in Block M) with associated cycle and refuse stores), and, for 5,808 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, workshops, non-residential institutions, community hub, local community uses, and other floorspace (Use Classes E/F1/F2/Sui Generis (public conveniences, drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))), service yard, cycle and refuse stores, plant rooms, car parking and other ancillary space, with associated new and amended means of access on Edward Street, closure of existing means of access on Edward Street and New Botolph Street, formation of cycle path from Edward Street to St Crispins Road, formation of wider footways, laybys and other associated highway works on Edward Street, New Botolph Street, and Magdalen Street, formation of car club parking area off New Botolph Street, 146 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses) within Blocks A and B, hard and soft landscape works to public open spaces comprising streets and squares for pedestrians and cyclists, other landscape *works, service infrastructure and other associated works; (All floor areas given as maximum Net Internal Areas);*

and

Outline planning permission on 2.4ha of the site, with landscaping and appearance as reserved matters, for demolition and clearance of all buildings and structures, erection of 6 buildings (Blocks E – H and J) ranging in height from 3 to 8 stories for up to 733 residential dwellings, (houses, duplexes, and flats) (Use Class C3), a maximum of 2,192 sqm flexible retail, commercial and other non-residential floorspace (retail, business, services, food and drink premises, offices, non-residential institutions, local community uses and other floorspace (Use Classes E/F1/F2/Sui Generis (drinking establishments with expanded food provision, bookmakers and/or nail bars (up to 550sqm), and dry cleaner (up to 150sqm))); cycle and refuse stores, plant rooms, car parking and other ancillary space; with associated new and altered means of access on Pitt Street and St Crispins Road, closure of means of access on Pitt Street and St Crispins Road flyover, formation of wider footways, laybys and other associated highway works on Pitt Street and St Crispins Road, a maximum of 304 car parking spaces (at least 95% spaces for class C3 use, and up to 5% for class E/F1/F2/Sui Generis uses), service infrastructure and other associated works (landscaping and appearance are reserved matters); (All floor areas given as maximum Net Internal Areas).”

1.8 A location plan is contained in **Appendix A**.

1.9 The proposed Outline/Full Planning Application Boundaries and Development Proposals are contained in **Appendix B**.

1.10 The provision of an effective drainage system for the new development is very important as the site is located at the downstream end of a Critical Drainage Area (CDA). The reduction of surface water runoff from the site will provide a benefit when compared to the existing site. This document discusses the drainage options for the site, to demonstrate that any additional surface water runoff from the proposed development can be managed sustainably without increasing flood risk to others.

2 Policy Framework and Pre-Application Comments

Local Policy

Greater Norwich Local Plan

"We are working with Broadland District Council, Norfolk County Council and South Norfolk District Council to prepare the Greater Norwich Local Plan (GNLP).

The GNLP will build on the long-established joint working arrangements for Greater Norwich which have delivered the current Joint Core Strategy (JCS) for the area. The JCS plans for the housing and job needs of the area to 2026 and the GNLP will ensure that these needs continue to be met to 2036.

The GNLP will include strategic planning policies and will also allocate individual sites for development. It will aim to ensure that new homes and jobs are delivered and the environment is protected and enhanced, promoting sustainability and the effective functioning of the area."

2.1 The GNLP was submitted to the Secretary of Stage for independent examination on 30th July 2021. The emerging plan allocates the Anglia Square site (GNLP0506) for Mixed Use Allocation.

2.2 Emerging Policy: *GNLP Policy 2 would be anticipated to reduce the risk of fluvial flooding that may arise as a result of development, through the requirement to carry out flood risk assessments, and incorporate sustainable drainage measures.*

2.3 Emerging Policy : *GNLP Policy 2 would be anticipated to mitigate the risk of surface water flooding that may arise as a result of development, through the requirement for development to incorporate sustainable drainage measures and contribute to the green infrastructure cover.*

2.4 An indicative drainage plan incorporating sustainable drainage (SuDS) is included in Section 7, detailing how surface water will be managed on the site and the rationale for the approaches used. Surface water runoff from the site will be restricted as far as possible to ensure that the risk of flooding both to the site and elsewhere is minimised, taking into account the effects of climate change.

Development Management Policies Local Plan

2.5 The Development Management Policies Plan (DM policies) sets out policies which will apply across the whole city, as well as policies which apply in designated areas.

Policy DM5 – Planning effectively for flood resilience' details the policy for flooding, sustainable drainage and surface water flooding and surface treatment. The policy states:

"*Developers will be required to show that the proposed development:*

- *would not increase the vulnerability of the site, or the wider catchment, to flooding from surface water run-off from existing or predicted water flows; and*
- *would, wherever practicable, have a positive impact on the risk of surface water flooding in the wider area.*

Development must, as appropriate, incorporate mitigation measures to reduce surface water runoff, manage surface water flood risk to the development itself and to others, maximise the use of permeable materials to increase infiltration capacity, incorporate on-site water storage and make use of green roofs and walls wherever reasonably practicable.

The use of permeable materials, on-site rainwater storage, green roofs and walls will be required unless the developer can provide justification to demonstrate that this would not be practicable or feasible within the constraints or configuration of the site, or would compromise wider regeneration objectives."

2.6 The landscaping of the development in terms of surface water management is also considered in Policy DM5. This states:

"Development proposals will be required to maximise the use of soft landscaping and permeable surfacing materials unless the developer can provide justification to demonstrate that this is not feasible.

Where permission is required, proposals involving the provision of new or replacement paved and other impermeable surfaced areas will only be permitted:

- *in areas of impermeable soils as identified in Appendix 1;*
- *in other areas where it can be demonstrated that permeable surfaces are not practicable due to poor soil infiltration capacity, high groundwater levels or risk of subsidence; and*
- *in areas with soils with average or good infiltration capacity, where it can be demonstrated that there is an exceptional and overriding justification for such surfaces.*

In cases where poor soil infiltration capacity or other factors preclude the use of permeable surfacing materials, development proposals should seek to manage and minimise the impact of surface water run-off by suitable measures for water storage on-site."

2.7 An indicative drainage plan incorporating sustainable drainage (SuDS) is included in Section 7, detailing how surface water will be managed on the site and the rationale for the approaches used. Surface water runoff from the site will be restricted as far as possible to ensure that the risk of flooding both to the site and elsewhere is minimised, taking into account the effects of climate change.

Natural England and Nutrient Neutrality Assessments

2.8 In March 2022, Natural England issued a letter to Local Planning Authorities, Environment Agency and all Heads of Planning and Chief Executives to give advice for development proposals with the potential to affect water quality resulting in adverse nutrient impacts on habitats and sites. The letter provides advice on the assessment of new plans and projects under Regulation 63 of the Habitats Regulations. The purpose of that assessment is to avoid adverse effects occurring on habitats sites as a result of the nutrients released by those plans and projects. This advice does not address the positive measures that will need to be implemented to reduce nutrient impacts from existing sources, such as existing developments, agriculture, and the treatment and disposal of wastewater. It proposes that nutrient neutrality might be an approach that planning authorities wish to explore.

2.9 The following background is given:

"In freshwater habitats and estuaries, poor water quality due to nutrient enrichment from elevated nitrogen and phosphorus levels is one of the primary reasons for habitats sites being in unfavourable condition. Excessive levels of nutrients can cause the rapid growth of certain plants through the process of eutrophication. The effects of this look different depending on the habitat, however in each case, there is a loss of biodiversity, leading to sites being in 'unfavourable condition'. To achieve the necessary improvements in water quality, it is becoming increasingly evident that in many cases substantial reductions in nutrients are needed. In addition, for habitats sites that are unfavourable due to nutrients, and where there is considerable development pressure, mitigation solutions are likely to be needed to enable new development to proceed without causing further harm.

In light of this serious nutrient issue, Natural England has recently reviewed its advice on the impact of nutrients on habitats sites which are already in unfavourable condition. Natural England is now advising that there is a risk of significant effects in more cases where habitats sites are in unfavourable condition due to exceeded nutrient thresholds. More plans and projects are therefore likely to proceed to appropriate assessment.

The principles underpinning HRAs are well established. At the screening stage, plans and projects should only be granted consent where it is possible to exclude, on the basis of objective information, that the plan or project will have significant effects on the sites concerned. Where it is not possible to rule out likely significant effects, plans and projects should be subject to an appropriate assessment. That appropriate assessment must contain complete, precise and definitive findings which are capable of removing all reasonable scientific doubt as to the absence of adverse effects on the integrity of the site.

Appropriate assessments should be made in light of the characteristics and specific environmental conditions of the habitats site. Where sites are already in unfavourable condition due to elevated nutrient levels, Natural England considers that competent authorities will need to carefully justify how further inputs from new plans or projects, either alone or in combination, will not adversely affect the integrity of the site in view of the conservation objectives. This should be assessed on a case-by-case basis through appropriate assessment of the effects of the plan or project. In Natural England's view, the circumstances in which a Competent Authority can allow such plans or projects may be limited. Developments that contribute water quality effects at habitats sites may not meet the no adverse effect on site integrity test without mitigation.

Mitigation through nutrient neutrality offers a potential solution. Nutrient neutrality is an approach which enables decision makers to assess and quantify mitigation requirements of new developments. It allows new developments to be approved with no net increase in nutrient loading within the catchments of the affected habitats site.

Where properly applied, Natural England considers that nutrient neutrality is an acceptable means of counterbalancing nutrient impacts from development to demonstrate no adverse effect on the integrity of habitats sites and we have provided guidance and tools to enable you to do this."

2.10 A Nutrient Neutrality Assessment is to be undertaken by others and will be submitted as part of this planning application.

3 Existing Site Description and Drainage Features

Existing Site Description

3.1 The site is located at Anglia Square, Norwich and consists of a shopping precinct including stores such as Iceland and Boots and a former cinema. Large office blocks are also present at the site; the disused seven-storey Sovereign House which runs north-south along Boltoph Street previously housed Her Majesty's Stationary Office (HMSO) and the under-utilised six-storey Gildengate House, built over shops underneath.

3.2 The existing site is almost entirely impermeable and is served by both private and adopted foul and surface water sewers. Surface water run-off is unrestricted and untreated and ultimately outfalls to the adopted sewer network to the south-east of the site.

Site Levels

3.3 A site-specific topographic survey is included in **Appendix C**. For the main Anglia Square site, levels vary between 5.09m AOD in the north west corner to 2.40m AOD at the existing access road from St Crispin's Road to the south of the site. Away from this low spot, levels in the south east corner of the site are in the region of 3.08m AOD. For the existing Anglia Square shopping centre, levels are around 3.51m AOD. The site slopes in a generally south easterly direction at a gradient of approximately 1:125

3.4 The parcel north west of New Boltoph Street slopes in a southerly direction, at a gradient of approximately 1:185 with the highest level to the north west of the site at 5.40m AOD and the lowest level at 5.11m AOD at the southern extent of the parcel. The site is approximately 0.35-0.4m higher than the carriageway of New Boltoph Street/ Edward Street.

3.5 North of Edward Street the site slopes towards the north, at a gradient of approximately 1:100, with the highest point in the south west corner at a level of 4.27m AOD and the lowest point in the north at 3.87m AOD.

Sewer Network

3.6 Sewer records, obtained from Anglian Water and included in **Appendix D,** show there to be a 675mm surface water sewer and 300mm foul sewer flowing in a south westerly direction through the site.

3.7 A 300mm surface water sewer and 225mm foul sewer also run west to east with Edward Street, to the north of the main portion of the site. Both sewers connect to the respective foul and surface water sewers in Magdalen Street before flowing southwards and discharging into the River between Fye Bridge Street and Whitefriars Bridge.

3.8 A further 525mm combined sewer flows southwards along Magdalen Street. It is highly likely that surface water flows from the Dalymond Dyke flow within this sewer, given the location of the sewer and the available information on the Dalymond Dyke.

3.9 The sewer locations and sizes within the site boundary are shown in more detail on the topographical survey contained in **Appendix C.**

Pre-Development Runoff Rate

3.10 The existing brownfield site is approximately 90% impermeable comprising a shopping centre, office block, paved open spaces and car park. Surface water run-off is unrestricted and untreated and ultimately outfalls to the adopted sewer network to the south-east of the site. As such, it is not suitable to consider the runoff from the site as though it is an undeveloped greenfield site. It is therefore appropriate to use a 'like for like' approach, i.e. quantify the runoff from the existing developed brownfield site and assess it against the proposed developed site whilst provide a betterment in terms of run-off and water quality.

3.11 An existing impermeable area for the hybrid site is calculated at 40,712m^2 or 4.0712ha.

3.12 Using the Modified Rational Method detailed in Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed., SPON, the surface water runoff for the existing site has been calculated as follows: -

$Q = CiA$ where Q = maximum flow rate (l/s)

$C = PIMP/PR$

i= rainfall intensity (mm/hr),

A=area (ha)

3.13 WINDES MicroDrainage was used to assess rainfall intensities for each storm event and using the above formula, the following existing run-off rates have been calculated:

- 1 in 1 year 30.99mm/hr = 350.47 l/s
- 1 in 30 year 76.03mm/hr = 859.87 l/s
- 1 in 100 year 98.68mm/hr = 1115.97 l/s

3.14 Existing run-off rates calculations are contained in **Appendix E**.

3.15 An analysis was undertaken to review the areas of the existing site which drain to the adopted sewer network. For information, this is included in **Appendix F**.

Pre-Development Storage Volumes

3.16 A simple analysis was carried out based on the topographical survey. The various sewers serving the existing site along with the diameters are shown on the topographic survey. These were measured and the available capacity in each sewer has been calculated. This analysis identified only the private sewers which outfall from the existing development to the adopted sewers but does not include the adopted sewers themselves or any outfall pipes from gullies or rainwater pipes. It is noted that there could be additional private sewers which haven't been picked up on the topographical survey so were not included in this analysis.

3.17 The storage volume available in the pipe network serving the existing brownfield site is as follows:

- 150dia – 335.4m = 6.04m3
- 225dia -296.4m = 11.86m3
- 300dia – 71.5m = 5.08m3
- 375dia – 34.9m = 3.84m3

- Assume 1m3 volume for each manhole. 30 x manholes = 30m^3

3.18 The total 'storage' volume available in the surface water sewers on the existing site is therefore approximately **56.82m3**.

Existing Sewers, Diversions and Build-Overs

3.19 The proposals will require the adopted surface and foul water sewers which cross the site to be diverted. It is anticipated that a S185 Sewer diversion Application shall be made to Anglian Water which will preclude the need for any Build-Over Agreements. A sketch showing an indicative route for diverted adopted sewers is contained in **Appendix G**. Further information on sewer diversions are contained in Section 4.

3.20 A number of private surface and foul water sewers serve the existing site. These sewers are not anticipated to be retained as part of the proposed surface water drainage strategy and will therefore be removed and new surface and foul water sewers provided.

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4 Proposed Drainage Strategy

Relevant SuDS Policy

4.1 The NPPF states within Flood Zone 1, *"developers and local authorities should seek opportunities to reduce the overall level of flood risk in the area and beyond through the layout and form of the development, and the appropriate application of sustainable drainage techniques (SuDS)".*

4.2 SuDS mimic the natural drainage system and provide a method of surface water drainage which can decrease the quantity of water discharged, and hence reduce the risk of flooding. In addition to reducing flood risk, these features can improve water quality and provide biodiversity and amenity benefits.

4.3 The SuDS management train incorporates a hierarchy of techniques and considers all three SuDS criteria of flood reduction, pollution reduction, and landscape and wildlife benefit. In decreasing order of preference, the preferred means of disposal of surface water runoff is:

- Discharge to ground.
- Discharge to a surface water body.
- Discharge to a surface water sewer.
- Discharge to a combined sewer.

4.4 The philosophy of SuDS is to replicate as closely as possible the natural drainage from a site pre-development and to treat runoff to remove pollutants, resulting in a reduced impact on the receiving watercourses. The benefits of this approach are as follows:

- Reducing runoff rates, thus reducing the flood risk downstream.
- Reducing pollutant concentrations, thus protecting the quality of the receiving water body.
- Groundwater recharge.
- Contributing to the enhanced amenity and aesthetic value of development areas.
- Providing habitats for wildlife in developed areas, and opportunity for biodiversity enhancement.

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Site-Specific SuDS

4.5 The various SuDS methods need to be considered in relation to site-specific constraints. Several SuDS options are available to reduce or temporarily hold back the discharge of surface water runoff. Table 4.1 outlines the constraints and opportunities to each of the SuDS devices in accordance with the hierarchical approach outlined in The SuDS Manual CIRIA C753. It also indicates what could and could not be incorporated within the development, based upon site-specific criteria.

Device	Description	Constraints / Comments	Appropriate
Living roofs (source control)	Provide soft landscaping at roof level which reduces surface water runoff.	Roof Terraces and Roof Gardens are proposed as part of this development.	Yes
Infiltration devices & Soakaways (source control)	Store runoff and allow water to percolate into the ground via natural infiltration.	Potential for high groundwater and contamination indicated due to brownfield site.	No
Pervious surfaces (source control)	Storm water is allowed to infiltrate through the surface into a storage layer, from which it can either infiltrate and/or slowly release to sewers.	Potential for high groundwater and contamination indicated due to brownfield site. Lined permeable paving is proposed in some pedestrian areas which are outside the main thoroughfares.	Yes
Rainwater harvesting (source control)	Reduces the annual average rate of runoff from the site by reusing water for non-potable uses e.g. toilet flushing, recycling processes.	Potential to use recycled rainwater for toilet flushing. Depends on internal design.	Possibly
Swales (permeable conveyance)	Broad shallow channels that convey / store runoff, and allow infiltration (ground conditions permitting).	Bioretention swales and tree-pits are proposed alongside Botolph Street as part of the highway drainage strategy. Further swales and bioretention swales are proposed within pedestrian areas across the site.	Yes
Filter drains & perforated pipes (permeable conveyance)	Trenches filled with granular materials (to take flows from adjacent impermeable areas) that convey runoff while allowing infiltration.	Potential for high groundwater and contamination indicated due to brownfield site.	No
Filter Strips (permeable conveyance)	Wide gently sloping areas of grass or dense vegetation that remove pollutants from run-off from adjacent areas.	Potential for high groundwater and contamination indicated due to brownfield site.	No
Infiltration basins (end of pipe treatment)	Depressions in the surface designed to store runoff and allow infiltration.	High density city centre site Potential for high groundwater and contamination indicated due to brownfield site.	No
Wet ponds & constructed wetlands (end of pipe treatment)	Provide water quality treatment & temporary storage above the permanent water level.	High density city centre site so no landscaped areas for ponds and wetlands.	No
Attenuation Underground (end of pipe treatment)	Oversized pipes or geo-cellular tanks designed to store water below ground level.	These are proposed as the SuDS listed above will not achieve sufficient volumes to restrict to the required rate. This is likely to be used alongside other means of attenuation at the site to provide the required storage volume.	Yes

Table 4.1: Site Specific Sustainable Drainage

Post- Development Run-off Rate

4.6 Given the potentially high groundwater and contamination of the site, infiltration is not recommended. There are no nearby watercourses to which a connection could be made, and therefore it is proposed that the development will drain to the existing Anglian Water surface water network in the vicinity of the site at a restricted discharge rate.

4.7 As discussed in Section 3, the existing site outfalls unrestricted and untreated into the adopted sewer network. Para. 3.13 summarises the existing outfall rates for each storm event.

4.8 For information only, the greenfield run-off rates were calculated using WINDES MicroDrainage software, these are based on a total proposed impermeable area of 4.51ha and are summarised below and included in **Appendix H**.

- QBAR – 0.3 l/s/ha = 1.353 l/s
- 1:1yr – 0.3 l/s/ha = 1.353 l/s
- 1:30yr – 0.8 l/s/ha = 3.608 l/s
- 1:100yr – 1.2 l/s/ha = 5.412 l/s

4.9 The greenfield runoff rates are very low due to the local geology of chalk. However, in reality the site is almost 100% impermeable as it has been developed into a shopping centre for many years. To achieve the discharge rates in Table 3, it would be necessary to include huge attenuation tanks below the site, which could have impacts on other features such as the local archaeology and geology. It is also acknowledged that there are existing Anglian Water sewers, including a 675mm surface water sewer and 300mm foul sewer, bisecting the site, and significant diversions may be required to locate very large attenuation tanks in these areas.

4.10 The site is clearly in a sensitive location, being at the downstream end of a Critical Drainage Area (CDA). The CDA relates largely to offsite surface water flows being directed through the catchment, through the site and ultimately to the River Wensum. There also appears to be local flood issues relating to the capacity of the local sewer network, although it should be noted that no surface water flooding or sewer flooding has been reported at the existing Anglia Square site.

4.11 As discussed in the separate FRA, measures will be in place to mitigate against the impact of these offsite flows within the site boundary. The proposed drainage system will not be designed to accept offsite flows from the rest of the catchment, but it is considered that a significant improvement can still be made by designing an effective drainage system at the site, which will benefit those downstream of the site by attenuating rainfall within the site boundary. The proposed drainage system will install drainage features which are much smaller and will have less of an impact on other aspects (such as archaeology, sewers and geology). A 50% reduction in runoff from the site, compared to the existing situation, is therefore proposed, which would have been runoff rate of 282 l/s.

4.12 A pre-development enquiry with Anglian Water was submitted for the previous scheme to confirm the required discharge rate from the proposed development into the sewer. Anglia Water initially responded that a reduction of run-off to 282 l/s would be unacceptable and they require a maximum of 125 l/s, based on the existing roof area and a 1 in 1 year runoff rate. This was considered to be very low for the proposed site, so an analysis was carried out of the areas of the existing site draining to the Anglian Water network (enclosed in

Appendix F). Following the submission of this further information to Anglian Water, they confirmed that their required total discharge rate to their system would be the 1 in 1 year discharge rate of 242 l/s. This should be achieved for all storm events up to and including the 1 in 100 year (+40%CC) event. The surface water should be discharged to the same sewers as the existing site, which are in Edward Street, Pitt Street and St Crispins Road. The proposed discharge rate of 242 l/s would be a 57% reduction in flows when compared to the existing site.

4.13 The Anglian Water 'in principle' agreement confirming the discharge rate of 242 l/s and the recommended connection points to the existing Anglian Water network is included in **Appendix I**.

4.14 Anglian Water have been contacted to confirm that their 'in principle' agreement to the 242 l/s outfall rate is still applicable for this scheme, once their response has been received, this report will be updated accordingly.

Proposed Drainage Strategy

4.15 As described in Section 1, it is proposed to make a Hybrid planning application: Full Planning for Blocks, A, B, C, J3, K/L and M and Outline Planning for Blocks E, E/F, F, G, H and J.

4.16 The Hybrid site layout precludes the option for separating drainage for Outline areas from Full-Planning areas. Open spaces will be utilised for locating attenuation devices and in some cases, these areas will serve both Outline and full-Planning Blocks. Where possible, drainage Systems serve only Outline or only Full-Planning areas.

4.17 The total impermeable area for the Hybrid site is calculated at 4.51 ha.

4.18 The development parcels have been split into 8no. drainage catchments:

- System 1 – Serves Block B (Full-Planning)
- System 2 – Serves Block C (Full-Planning)
- System 3 – Serves Block D and Part A (Full-Planning)
- System 4 - Serves Block E (Outline Planning)
- System 5 – Serves Block E/F (Outline Planning)
- System 6 – Serves Block F and existing Surrey Chapel (Outline Planning)
- System 7 – Serves Blocks Part A, M, Part K/L, H, G and existing Epic Studios (Mix of Full and Outline Planning)
- System 8 – Serves Blocks J3 and Part K/L (Full Planning)

System 1

4.19 "System 1" surface water drainage system comprises lined permeable paving attenuation and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 1467m². The maximum outfall rate for this catchment has been set at 5 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event.

4.20 Permeable block paving attenuation covers an area of 659m² and provides surface water attenuation volume within the sub-base voids (usually 30% voids and no-fines). Flows from this permeable paving system are restricted using an orifice-plate flow control chamber – flows are then directed to/cascade a geo-cellular attenuation device which also collects surface water run-off from 808m² of roof area. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the 225dia adopted surface water sewer in Edward Street via a down-stream defender interceptor.

4.21 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the permeable paving and the geo-cellular storage device whilst restricting flows to 5 l/s. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 20.9m³ in the permeable paving system and a volume of 44.1m³ in the geo-cellular storage device with a maximum outfall rate of **5 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 36m² x 1.32m deep with 95% voids – this provides a maximum attenuation volume of 45.14m³. The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.22 Water Quality – This catchment comprises Residential Roofs and Low Traffic Roads. Water Quality and treatment stages are discussed below.

4.23 CIRIA 763 SuDS Manual Table 26.2 shows Low-Traffic Roads have a Pollution Hazard Level of LOW. All low-traffic roads in this catchment are anticipated to comprise lined permeable paving construction with outfall directed to the adopted sewer via the geo-cellular attenuation device and downstream defender interceptor. Table 26.2 shows Low-Traffic Roads have TSS of 0.5 Metals, 0.4 and Hydrocarbons 0.4. Table 26.3, SuDS mitigation indices for discharges to surface waters, shows that Permeable Paving alone provides mitigation for TSS at 0.7; Metals at 0.6 and Hydrocarbons at 0.7. Surface water run-off from low-traffic-road areas is more than sufficiently mitigated by use of Permeable Paving and will further be cleansed by the downstream defender interceptor.

4.24 CIRIA 763 SuDS Manual Table 26.2 shows Residential Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.2 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage.

System 2

4.25 "System 2" surface water drainage system a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 633m². The maximum outfall rate for this catchment has been set at 5 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the 300dia adopted surface water sewer in Edward Street via a down-stream defender interceptor.

4.26 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the geo-cellular storage device whilst restricting flows to 5 l/s. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 16.6m³ in the geo-cellular storage device with a maximum outfall rate of **5 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 15.3m² x 1.32m deep with 95% voids – this provides a maximum attenuation volume of 19.18m$^{3.}$ The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.27 Water Quality – This catchment comprises Residential Roofs. Water Quality and treatment stages are discussed below.

4.28 CIRIA 763 SuDS Manual Table 26.2 shows Residential Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.2 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage.

System 3

4.29 "System 3" surface water drainage system comprises intensive and extensive green roofs, bio-retention tree pits and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 3413m² (assuming 100% impermeable). The maximum outfall rate for this catchment has been set at 22.4 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a hydro-brake with outfall directed to the diverted 675dia adopted surface water sewer to the south of Block D via a down-stream defender interceptor.

4.30 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the geo-cellular storage device whilst restricting flows to 22.4 l/s. Any attenuation volume that may be provided in green roofs and bio-retention areas has not been allowed for to ensure a robust estimation of the required attenuation volumes to serve this catchment are made. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 99.6m^3 in the geo-cellular storage device with a maximum outfall rate of **22.4 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 80m² x 1.32m with 95% voids – this provides a maximum attenuation volume of 100.32m$^{3.}$ The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.31 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.32 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

System 4

4.33 "System 4" surface water drainage system comprises intensive and extensive green roofs, bio-retention swales, bio-retention tree pits/planters and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 5865.5m². The maximum outfall rate for this catchment has been set at 35.7 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a hydro-brake with outfall directed to the diverted 675dia adopted surface water sewer to the north of Block E via a down-stream defender interceptor.

4.34 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the geo-cellular storage device whilst restricting flows to 35.7 l/s. Any attenuation volume that may be provided in green roofs and bio-retention areas has not been allowed for to ensure a robust estimation of the required attenuation volumes to serve this catchment are made. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 198.9m³ in the geo-cellular storage device with a maximum outfall rate of **35.7 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 161.2m² x 1.32m with 95% voids – this provides a maximum attenuation volume of 202.14m³. The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.35 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.36 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

System 5

4.37 "System 5" surface water drainage system comprises intensive and extensive green roofs, bio-retention tree pits, lined permeable paving and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 4562m² (assuming 100% impermeable). The maximum outfall rate for this catchment has been set at 20 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the diverted 675dia adopted surface water sewer to the north of Block E via a down-stream defender interceptor.

4.38 Permeable block paving attenuation covers an area of 695m² and provides surface water attenuation volume within the sub-base voids (usually 30% voids and no-fines). Flows from this permeable paving system are restricted using an orifice-plate flow control chamber – flows are then directed to/cascade a geo-cellular attenuation device which also collects surface water run-off from 2004m² of pedestrian walkway area and 1863m² roof area. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the diverted 675dia adopted surface water sewer to the north of Block E via a down-stream defender interceptor.

4.39 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the permeable paving and the geo-cellular storage device whilst restricting flows to 20 l/s. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 21.8m^3 in the permeable paving system and a volume of 134.0m^3 in the geo-cellular storage device with a maximum outfall rate of **20 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 108m^2 x 1.32m deep with 95% voids – this provides a maximum attenuation volume of 135.43m$^{3.}$ The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.40 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.41 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

System 6

4.42 "System 6" surface water drainage system comprises intensive and extensive green roofs, bio-retention swales, lined permeable paving and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 4901m^2 (assuming 100% impermeable). The maximum outfall rate for this catchment has been set at 10 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the diverted 675dia adopted surface water sewer to the north of block E via a down-stream defender interceptor.

4.43 Permeable block paving attenuation (over two areas) covers a total area of 1844m^2 and provides surface water attenuation volume within the sub-base voids (usually 30% voids and no-fines). Flows from this permeable paving system are restricted using orifice-plate flow control chambers – flows are then directed to/cascade to a geo-cellular attenuation device which also collects surface water run-off from 1473m^2 of pedestrian walkway area and 1585m^2 roof area. Flows from the geo-cellular attenuation device are restricted using a pump with outfall directed to the diverted 675dia adopted surface water sewer to the north of Block E via a down-stream defender interceptor.

4.44 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the permeable paving and the geo-cellular storage device whilst restricting flows to 10 l/s. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 43.2m^3 (PP-03 13 m^3 + PP-04 33.2 m^3) in the permeable paving system and a volume of 206.4m^3 in the geo-cellular storage device with a maximum outfall rate of **10 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 165m² x 1.32m deep with 95% voids – this provides a maximum attenuation volume of 206.9m$^{3.}$ The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.45 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.46 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

System 7

4.47 "System 7" surface water drainage system comprises intensive and extensive green roofs, bio-retention swales, lined permeable paving and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 20,682m² (assuming 100% impermeable). The maximum outfall rate for this catchment has been set at 124.2 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. F

4.48 Permeable block paving attenuation (over two areas) covers a total area of 1121m^2 and provides surface water attenuation volume within the sub-base voids (usually 30% voids and no-fines). Flows from this permeable paving system are restricted using orifice-plate flow control chambers – flows are then directed to/cascade to a geo-cellular attenuation device which also collects surface water run-off from 4636m^2 of pedestrian walkway area and 14,925m^2 roof area. lows from the geo-cellular attenuation device are restricted using a hydro-brake with outfall directed to the diverted 675dia adopted surface water sewer to the south of block K via a down-stream defender interceptor.

4.49 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the permeable paving and the geo-cellular storage device whilst restricting flows to 124.2 l/s. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 51.0m^3 (PP-05 30.6m^3 + PP-06 20.4m^3) in the permeable paving system and a volume of 591.2m^3 in the geo-cellular storage device with a maximum outfall rate of **124.2 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 475m² x 1.32m deep with 95% voids – this provides a maximum attenuation volume of 595.65m$^{3.}$ The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.50 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.51 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

System 8

4.52 "System 8" surface water drainage system comprises intensive and extensive green roofs, bio-retention swales and a geo-cellular attenuation device. The impermeable area for this catchment has been calculated as: 3572m² (assuming 100% impermeable). The maximum outfall rate for this catchment has been set at 20.9 l/s to manage all storms up to and including the 1 in 100yr + 40% Climate Change Event. Flows from the geo-cellular attenuation device are restricted using a hydro-brake with outfall directed to the diverted 675dia adopted surface water sewer to the east of Block L via a down-stream defender interceptor.

4.53 WINDES MicroDrainage modelling software has been used to calculate the required attenuation volume for the geo-cellular storage device whilst restricting flows to 20.9 l/s. Any attenuation volume that may be provided in green roofs and bio-retention areas has not been allowed for to ensure a robust estimation of the required attenuation volumes to serve this catchment are made. The hydraulic output data is contained in **Appendix J** and shows an attenuation volume of 119.4m^3 in the geo-cellular storage device with a maximum outfall rate of **20.9 l/s** is required to manage a 1 in 100 year + 40% Climate Change event. This can be contained within a geo-cellular storage device sized 96.0m² x 1.32m with 95% voids – this provides a maximum attenuation volume of 120.38m^3. The proposed Surface Water Drainage Strategy Drawing is contained in **Appendix K**.

4.54 Water Quality – This catchment comprises Residential and Other Roofs as well as Pedestrian Walkways (which will be assessed the same as a Residential Roof). Water Quality and treatment stages are discussed below.

4.55 CIRIA 763 SuDS Manual Table 26.2 shows Other Roofs have a Pollution Hazard Level of LOW. Resi Roofs will discharge directly to the adopted sewer via green-roofs and a downstream defender interceptor (a proprietary treatment system). Table 26.2 shows Resi Roofs have TSS of 0.3 Metals 0.2 and Hydrocarbons 0.05. Table 26.3, SuDS mitigation indices for discharges to surface waters, states that proprietary treatment systems must demonstrate that they can address each contaminate type to an acceptable level. It is therefore considered that an appropriate treatment device shall be selected at the detailed design stage. It should also be noted that some roof areas comprise green-roof which shall also provide some treatment of runoff.

Summary of Catchments and Proposed Outfall Rates

4.56 As discussed in para. 4.13, the total allowable outfall rate for the Anglia Square Regeneration site has been set at 242 l/s, which is a 57% reduction against the existing situation – a significant betterment. Below is a breakdown of outfall rates for each catchment (System) and total:

- System 1 – Maximum surface water outfall rate of 5 l/s
- System 2 – Maximum surface water outfall rate of 5 l/s
- System 3 – Maximum surface water outfall rate of 22.4 l/s
- System 4 - Maximum surface water outfall rate of 35.7 l/s
- System 5 – Maximum surface water outfall rate of 20 l/s
- System 6 – Maximum surface water outfall rate of 10 l/s
- System 7 – S Maximum surface water outfall rate of 124.2 l/s
- System 8 – Maximum surface water outfall rate of 20.9 l/s
- All Systems – Total 243.2 l/s maximum outfall rate to manage all storms up to and including the 1:100yr + 40% Climate Change Event. The equivalent of 43% of the existing 1:1yr surface water run-off rate. This is a significant improvement to the existing situation. In addition, the existing drainage system does not benefit from any water treatment stages, whilst the proposed drainage strategy allows for water quality and treatment to meet the guidance within CIRIA SuDS Manual.

Attenuation Tank Alarm System

4.57 Due to the surface water flood risk within the city of Norwich, it is proposed that the attenuation tanks will have capacity sensors and alarms fitted within them which monitor how full they become during storm events. It is intended that an alarm system will sound once the tanks reach a certain capacity as this will mean the risk of flooding occurring has increased. As described above, attenuation tanks will likely collect run-off from both roof and hardstanding areas and it is not possible to prevent any exceedance surface water run-off flows from off-site from entering the proposed drainage systems. As such it is recommended that the alarm system triggers when the attenuation tank reaches 75% full. An analysis was carried out to determine the likely return period storm which would result in the tanks becoming 75% full, and it was determined that the tanks filled to 75% at around a 1in40 + 40% Climate Change Event.

4.58 Assuming the overland flows from offsite begin to fill up the onsite attenuation systems, the alarm would trigger should the tanks become 75% full. The alarm would trigger in the Anglia Square management office, and it would be the management's responsibility to distribute the warning to each of the ground floor and retail, commercial and leisure uses. This would allow them time to evacuate, safeguard and close their premises. The flood warning strategy has been discussed further the separate FRA document.

It is not practically possible to separate the drainage systems serving the hardstandings from the offsite overland flows, therefore the alarm and warning system will be used to manage the risk. It is also acknowledged that while the onsite drainage system has been designed to accommodate up to and including a 1 in 100 year (+40%CC) rainfall event, the impact of offsite flows entering some parts of the drainage system could reduce the capacity. However, it is not possible to quantify the overland flows from offsite and in any case, the onsite drainage system should not be designed to manage flows from offsite.

Exceedance Routes

4.59 In the event of a greater than 1 in 100 year (+40%CC) rainfall event occurring, the exceedance routes would be similar to those shown in the 1 in 100 year (+40%CC) velocity vector output from the surface water model. The maximum velocity vectors are shown in Figure 1.

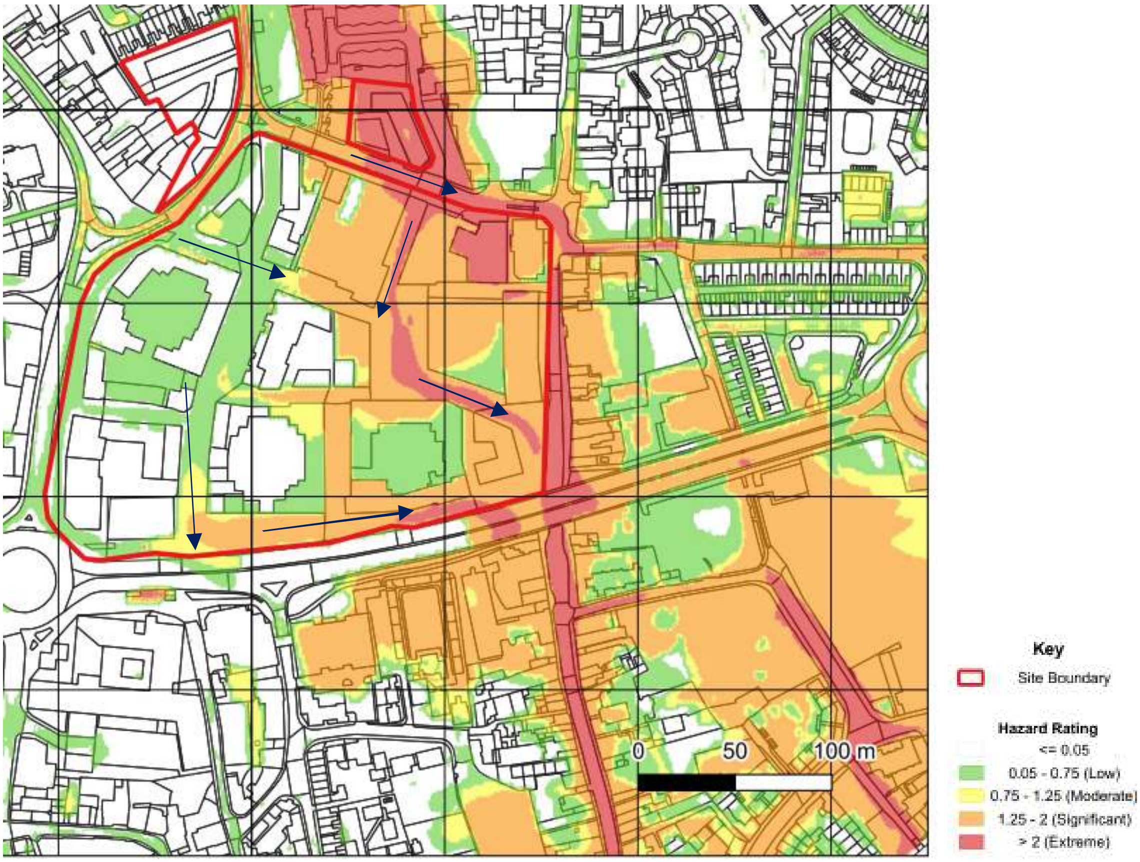

Figure 1: Velocity vector output for 1 in 100 year (+40%CC) surface water event – taken from Royal HaskoningDHV Report

4.60 As discussed in the separate FRA, the hydraulic model assumes the public sewer system is almost at capacity and there is no drainage system within the site boundary. This would result in the overland flows collecting in the pedestrian walkways and passing through the site from north west to south east. The flows would leave the site at Magdalen Street on the western and south western boundary. It is noted that if the drainage system was at capacity, the site layout and sloping pedestrian walkways have been set out to ensure flowpaths are not blocked.

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Sewer Diversions

4.61 As noted in Section 3, there are a number of Anglian Water sewers passing through the existing site. Anglian Water were consulted in 2018 for the previous scheme on the potential diversion of several of their sewers around the proposed development and it is understood that this will need to be considered in detail at a later stage through a diversion application, when information such as the foundation design is available. Anglian Water Drainage Engineer Darren Sewell provided some information on the requirements when diverting sewers within a new development site. This has been included at **Appendix L**. To summarise:

4.62 Any re-development areas falling within 3m of an existing public sewer but remaining only 'built near' an existing sewer, assuming the same clearance and access is available, would in principle be acceptable.

4.63 Any areas falling within 3m of the existing public sewer would need to comply with Part H4 Building Regulations in respect of 'building near' public sewers and Anglian Water criteria on the website.

4.64 Foundation design of the new buildings would need to be carefully considered to ensure that no loading would be transferred on a 45 degree 'angle of repose' onto the sewer.

4.65 The only area which would appear to require consideration of a formal diversion of a sewer would be the existing 675mm diameter surface water sewer and the existing 225mm foul sewer running immediately south of unit A1.01 (675mm surface water sewer close to MH 0453 to 0456 and 225mm foul sewer near to MH 0405 to 0408).

4.66 The above sewer may require a diversion, and the technicalities of this will be considered at a later stage. Anglian Water could consider formally devesting some sections of the existing public sewer which are no longer needed/fall beneath buildings (these need to be sewers serving only the existing site and no third parties). This means the Developer would apply to devest the sewer into their private ownership, and these sections of devested sewer could then be removed if no longer needed.

4.67 It would be necessary to consult Anglian Water further on the diverting and devesting of their public sewers across the site prior to any development taking place, to ensure that the issues raised in the email at **Appendix L** have been addressed.

4.68 It is expected that the advice provided by Anglian Water for the previous scheme is still relevant. It should be noted that Anglian Water have been contacted again to confirm this. Once their response has been received, this section of the report will be amended accordingly.

Foul Sewer Network

4.69 An Anglian Water capacity check was carried out for the previous scheme to determine whether there would be sufficient capacity within their existing foul network to accommodate the foul flows from the proposed development. This has been included in **Appendix M** and confirms that there was sufficient capacity in the existing foul network and no improvements would be needed to the network.

An updated Capacity Check was submitted to Anglian Water for this new scheme, once their response has been received, this section of the report will be amended accordingly.

5 Other Proposed SuDS Features

SuDS Features

5.1 The city center site gives opportunities for "urban types" of SuDS features to be incorporated. These features provide water quality and biodiversity betterments and it is proposed that wherever possible, these features will form the wider SuDS Drainage Strategy. The surface water drainage attenuation requirements for the site do not include any attenuation volumes that may be provided by the following features as such, as detailed design stage, it is possible that overall storage volumes could be reduced.

5.2 For now, the robust surface water drainage strategy as described in Section 4 demonstrates that the proposals can provide a significant betterment to the existing situation in terms of significantly reduced outfall rates and provision of attenuation features which manage all storm events up to and including the 1:100yr + Climate Change event.

Green Roofs

5.3 CIRIA SuDS Manual C753 Chapter 12 describes Green Roofs as follows:

5.4 "*Green roofs area areas of living vegetation, installed on the top of buildings, for a range of reasons including visual benefit, ecological value, enhanced building performance and the reduction of surface water runoff. Types of green roof can be divided into two main categories:*

-Extensive roofs, have low substrate depths (and therefore low loadings on the building structure), simple planting and low maintenance requirements; they tend not to be accessible.

-Intensive roofs (or roof gardens) have deeper substrated (and therefore highwe loadings on the building structure) that can support a wide variety of planting but which tend to require more intensive maintenance; they are usually accessible."

5.5 The proposals include for a number of garden roof terraces which are likely to comprise some areas of extensive and intensive type green roof as well as paved areas – these are currently detailed on Blocks A, D, M and K/L. Green roofs are also shown indicatively on Blocks E, E/F, F, G, J, J3 and H, it is expected that these will also comprise extensive and intensive green roof areas and paved areas. As described above, the drainage calculations in Section 4 do not account for any attenuation that may be available on green roof areas. However, as a general rule, it is assumed that green roofs are saturated when calculating a site's attenuation requirements anyhow.

5.6 Green roofs and Garden Roof Terraces will provide water quality and biodiversity benefits to the overall scheme.

Bio-Retention Swales

5.7 CIRIA SuDS Manual C753 Chapter 18 describes Bio-Retention Systems as follows:

"*Bioretention systems (including rain gardens) are shallow landscaped depressions that can reduce run-off rates and vlumes, and treat pollution thrugh the use of engineered soils and vegetation. They are particularly effective in delivering interception and acan also provide: attractive landscape features that are self-irrigating and ertilising; habitat and biodiversity; and cooling of the micro-climate due to evapotranspiration.*"

5.8 Bio-Retention Swales are proposed for the planted areas in between Block E and Block H; in between Block F and Block G; to the west of Block J and to the east of Block H. It is anticipated that surface water run-off from adjacent hardstanding areas shall be directed to these swales which shall provide a first stage of attenuation and treatment of run-off. Overflow from these bio-retention swales shall be directed into the wider surface water drainage system, which ultimately outfalls to geo-cellular attenuation tanks.

5.9 Norwich County Council's Highway Team have been consulted regarding the provision of bio-retention swales along the western boundary of the site which would collect surface water run-off from Botolph Street and form part of the highway drainage network. Further swales to the north of the site, along Edward Street are also proposed. Initial feedback for the provision of these features is positive, however these off-site highway drainage proposals shall be subject to S278 Agreement, which will be detailed at a later stage.

Tree Planters

5.10 CIRIA SuDS Manual C753 Chapter 19 describes Tree Systems as follows:

"*Trees and their planting structures provide benefits to surface water management in the following ways:*

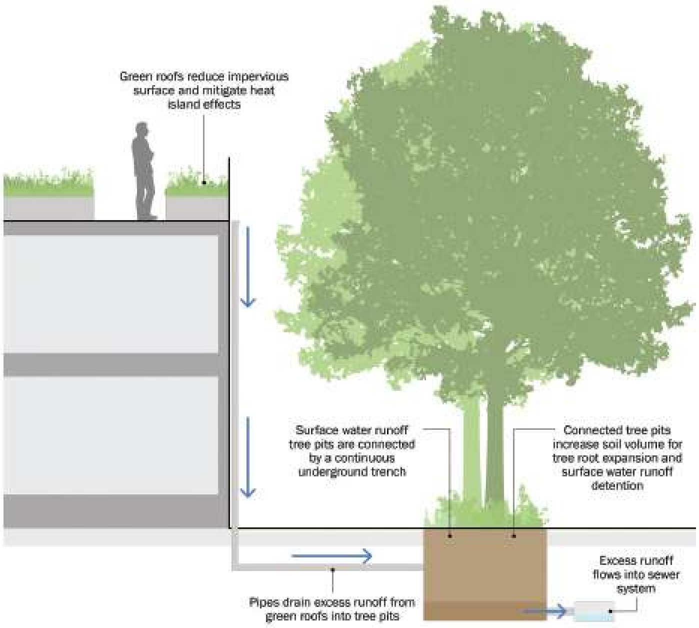
Transpiration – This is the process by which water, taken in from soil by tree roots, is evapourated through the pores or stomata on the surface of leaves. Trees draw large quantities of water from the soil, which can contribute to reducing run-off volumes.

Interception – Leaves, branches and trunk surfaces intercept (store and allow water to evapourate) and absorb rainfall, reducing the amount of water that reached the ground, delaying the onset and reducing the volume of run-off.

Increased infiltration – Root growth and decomposition increase soil infiltration capacity and rate, reducing runoff volues.

Phytoremediation – In the process of drawing water from the soil, trees also take up trace amounts of harmful chemicals, including metals, organs compunds, fuels and solvents that are present in the soil. Inside the tree, these chemicals can be transformed into less harmful substances, used as nutrients and/or storeg in roots, stems and leaves.

…Tree Planters are essentially bio-retention systems with trees in them, to enhance capacity and performance, and/or to deliver amenity and biodiversity benefits. They have similar functionality and design requiements to standard tree pits, but have open surace and generally a larger surface area, so their overall appearance is different"



5.11 Bio-Retention Tree Pits/Planters are proposed along the main thoroughfare crossing the site from west to east – in between Block A and Block H and also in between Block J3 and K/L. Like the bio-retention swales, it is anticipated that run-off from surrounding hardstanding areas will be directed o these tree pits with overflow directed to the wider surface water drainage system.

Pervious Pavements

5.12 CIRIA SuDS Manual C753 Chapter 20 describes Pervious Pavements as follows:

"*Pervious surfaces, along with their associated substructures, are an efficient means of managing surface wate runoff close to its source – intercepting runoff, reducing the volume and frequency of runoff, and providing a treatment medium. Treatment processes that occur within the surface structure, the subsurface matrix and the geotextile layers include:*

-Filtration
-Absorption
-Biodegredation
-Sedimentation"

5.13 Sections of Lined Permeable Block Paving Attenuation System are proposed across the site. The access road and parking areas for Block A in the north of the site; the forecourts in Block H, Block E/F and F; and the hardstanding areas to the south of and in between Blocks G and J will all comprise permeable paving attenuation.

6 Maintenance of Development Drainage

6.1 The responsibility for ongoing maintenance is under discussion with the necessary stakeholders and will be agreed during the determination period.

6.2 The proposed private surface water sewers, attenuation tanks and green/brown roofs should be regularly inspected and maintained to ensure they are effective throughout the lifetime of the development and do not become blocked or damaged over time.

6.3 It is proposed to install secondary (back-up) pumps within the pumping chamber for each of the pumps serving the proposed development. The secondary pumps will be programmed to start should the primary pump fail. Both pumps will have an alarm system in place which will be directed to a control panel within the management's office. In addition, an 'Alarm-Tel' feature will be put in place to monitor the state of operation of the various pumps. When a fault occurs it will automatically dial up to three telephone numbers with a pre-recorded message alerting the problem. In the unlikely event that both pumps fail and maintenance hasn't yet had a chance to resolve the problem, it should be noted that no residential dwelling is present at ground floor or basement level within the main Anglia Square development, so if minor flooding should occur the risk to people is low. Please note – the 'Alarm-Tel' feature should be separate to the flood warning sensor on the attenuation tanks, as the attenuation tank reaching capacity could not be detected by the pump.

6.4 Some maintenance details for elements of the drainage system from CIRIA SUDS Manual (C753) are included in Tables 6.1 and 6.2 below.

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Remove debris from the catchment surface (where it may cause risks to performance) and from silt traps prior to cells.	Monthly
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration as necessary	Annually
	Remove sediment from pre-treatment structures and/or internal forebays	Annually or as required
Remedial actions	Reconstruct soakaway if performance deteriorates or in the event of failure.	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year then annually
	Survey inside of tank for sediment build up and remove if necessary.	Every 5 years or as required

Table 6.1: Maintenance tasks for attenuation tanks (Source: CIRIA C753, The SuDS Manual)

TRANSPORT PLANNING HIGHWAYS AND DRAINAGE FLOOD RISK TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

Maintenance Schedule	**Required Action**	**Frequency**
Regular maintenance	Brushing and vacuuming.	Three times per year at end of winter, mid-summer, after autumn leaf fall, or as required based on site specific observations of clogging or manufacturer's recommendations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weeds.	As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance of soil slip, has been raised to within 50mm of the level of the paving.	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance of a hazard to the user.	As required
	Rehabilitation of surface and upper sub-surface.	As required (if infiltration performance is reduced as a result of significant clogging.)
Monitoring	Initial inspection	Monthly for 3 months after installation. 3 monthly, 48 hours after large storms.
	Inspect for evidence of poor operation and/or weed growth. If required, take remedial action	Annually.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspection chambers.	Annually

Table 6.2: Maintenance tasks for permeable paving (Source: CIRIA C753, The SuDS Manual)

Manholes and Sewers

6.5 Manhole covers should be lifted each year to remove visible debris and check for blockages – it is suggested that this is undertaken every November after the heaviest leaf-fall has occurred.

6.6 Should a blockage occur at any time, it is advised to seek professional help to jet the drainage system to clean and clear the system.

Gutters and Downpipes

6.7 It is good practice to ensure that these are occasionally inspected to ensure they are in good order and free of leaves & debris. Once every 6 months should be sufficient.

Orifice Plate with Suitable Filter

6.8 It is advised that maintenance company take time to review the manufactures maintenance recommendations and follow accordingly, with regular inspections anticipated to be required every 3 months and after heavy rainfall events.

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7 Conclusions

7.1 EAS have been commissioned by Weston Homes Ltd to prepare a Surface Water Drainage Strategy for the redevelopment of Anglia Square, Norwich, Norfolk.

7.2 A separate report, undertaken by others, deals with the flood risk assessment, hydraulic modelling study and impact assessment and should be read in conjunction with this report.

7.3 As described in Section 1, it is proposed to make a Hybrid planning application: Full Planning for Blocks, A, B, C, J3, K/L and M and Outline Planning for Blocks E, E/F, F, G, H and J.

7.4 The proposed surface water drainage strategy for the Hybrid Planning Application site has been based on sustainable principles with aim to provide a significant betterment to the existing situation. Currently the site does not benefit from any attenuation features and as such surface water run-off flows freely into the adopted sewer network, unrestricted and untreated.

7.5 The city center site gives opportunities for “urban types” of Sustainable Drainage Systems (SuDS) features to be incorporated. These features provide water quality and biodiversity betterments and it is proposed that wherever possible, these features will form the wider SuDS Drainage Strategy. The proposals include green roofs, bioretention swales, bioretention tree-pits, lined permeable paving and geo-cellular attenuation devices. These will improve water quality, biodiversity and amenity.

7.6 An assessment was undertaken to determine the existing surface water run-off from the site and what flow rate would likely enter the adopted sewer network. The assessment was discussed with Anglian Water and it was agreed that the proposed site should achieve a reduction of run-off to the adopted network to a maximum of 242 l/s to manage all storms up to and including the 1:100yr + 40% Climate Change Event. This will be the equivalent of 43% of the existing 1:1yr surface water run-off rate, a significant reduction.

7.7 The Hybrid site layout precludes the option for separating drainage for Outline areas from Full-Planning areas. Open spaces will be utilised for locating attenuation devices and in some cases, these areas will serve both Outline and Full-Planning development areas. Where possible, drainage Systems serve only Outline or only Full-Planning areas.

7.8 The development parcels have been split into 8no. drainage catchments. Each catchment has a restricted outfall to the adopted surface water sewer network and attenuation designed to accommodate a 1:100yr + Climate Change Storm Event. Suitable water treatment stages, in line with CIRIA SuDS Manual are proposed and will provide an improvement to the existing situation, where waters enter the adopted sewer network, untreated.

7.9 Due to the surface water flood risk within the city of Norwich, it is proposed that the attenuation tanks will have capacity sensors and alarms fitted within them which monitor how full they become during storm events. The attenuation tanks will likely collect run-off from both roof and hardstanding areas and it is not possible to prevent any exceedance surface water run-off flows from off-site from entering the proposed drainage systems. The alarm would trigger in the Anglia Square management office, and it would be the management’s responsibility to distribute the warning to each of the ground floor and retail, commercial and leisure uses. This would allow them time to evacuate, safeguard and close their premises. The flood warning strategy has been discussed further the separate FRA document

7.10 Maintenance of the attenuation features will remain the responsibility of the site owner or an appointed management company, and will not be offered for adoption. The Anglian Water sewers that pass through the site will remain the responsibility of Anglian Water

7.11 The proposed surface water drainage strategy, covering 8no catchments will significantly reduce surface water runoff, provide significant attenuation volumes and improve water quality, biodiversity and amenity.

8 Appendices

TRANSPORT PLANNING HIGHWAYS AND DRAINAGE FLOOD RISK TOPOGRAPHICAL SURVEYS
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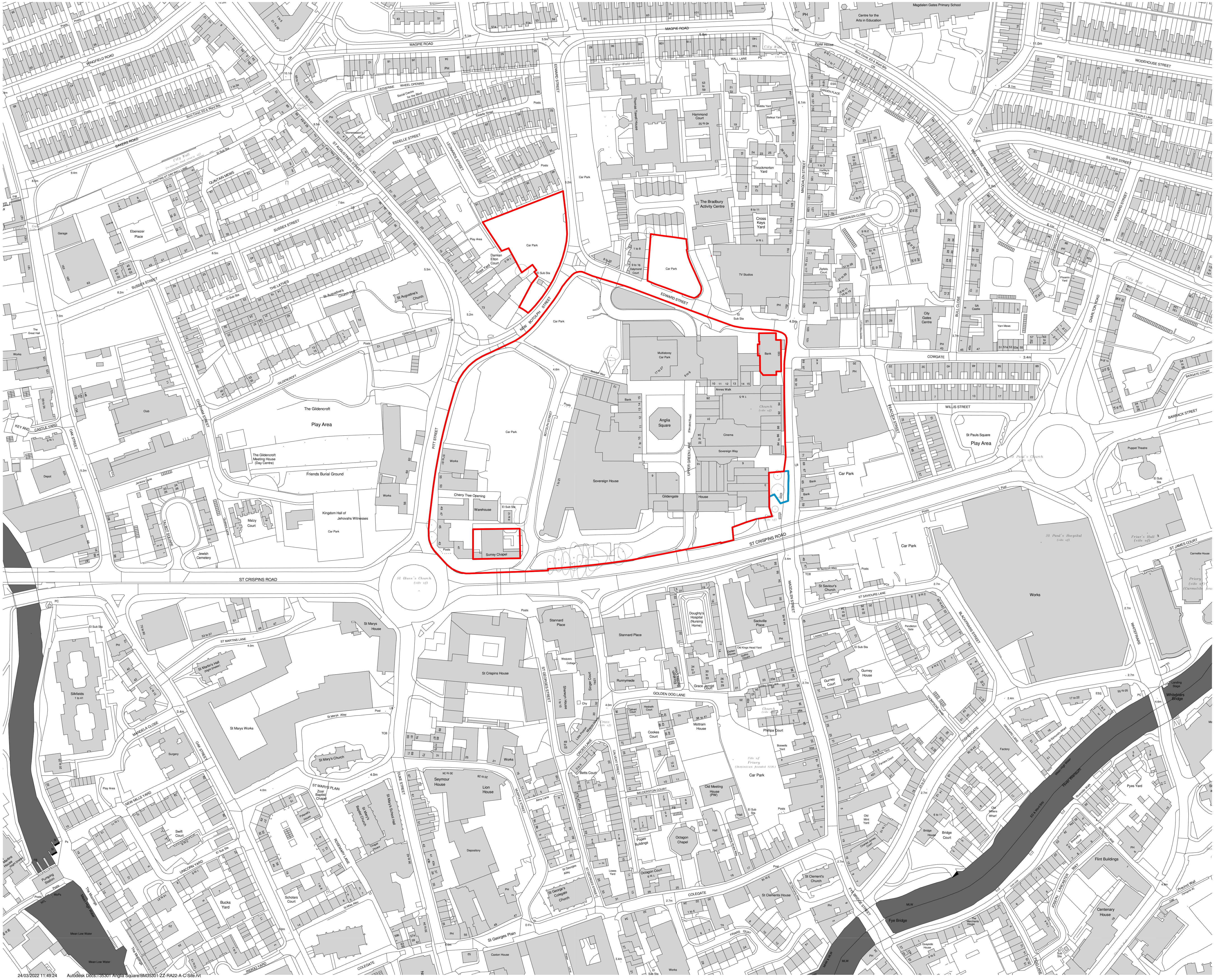

Contractors and consultants are not to scale dimensions from this drawing

The survey information shown on this drawing is based on a topographical survey prepared by a third party and Broadway Malyan Limited accept no responsibility for the accuracy or completeness of the survey.

Drawings to be read in conjunction with the associated Design & Access Statement, associated consultant desin team documents & reports and landscape information

Landscape shown is for illustrative purposes only. For detailed landscape information, please refer to the landscape information & documents.

0m 62.5m 125m

N

General Notes

All figures and areas are approximate only and subject to statutory constraints, detail design & design development

Structural Design: Subject to structural input & coordination

Services Design: Subject to services input & coordination

Fire Strategy: Subject to fire input & coordination

Application Boundary

Land Ownerd by CT to be subject to separate application for part of the Mobility Hub

Revision	Date	Drawn By	Description
D0-1	31.03.22		Issued For Planning

BroadwayMalyan BM

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Client
Weston Homes

Project
Anglia Square
Norwich

Description
Hybrid Application - Location Plan on Existing OS Base

Status
For Planning

Scale	Drawn By	Date
1:1250@A1	BM	31.03.22
Job Number	**Drawing Number**	**Revision**
35301	ZZ-00-DR-A-01-1000	D0-1

Appendix: B – Proposed Development Plans

TRANSPORT PLANNING HIGHWAYS AND DRAINAGE FLOOD RISK TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

24/03/2022 16:44:33 Autodesk Docs://35301 Anglia Square/BM35301-ZZ-RA22-A-C-Site.rvt

Contractors and consultants are not to scale dimensions from this drawing

The survey information shown on this drawing is based on a topographical survey prepared by a third party and Broadway Malyan Limited accept no responsibility for the accuracy or completeness of the survey.

Drawings to be read in conjunction with the associated Design & Access Statement, associated consultant desin team documents & reports and landscape information

Landscape shown is for illustrative purposes only. For detailed landscape information, please refer to the landscape information & documents.

0m 25m 50m

N

General Notes

All figures and areas are approximate only and subject to statutory constraints, detail design & design development

Structural Design: Subject to structural input & coordination

Services Design: Subject to services input & coordination

Fire Strategy: Subject to fire input & coordination

Application Boundary

Land Ownerd by CT to be subject to separate application for part of the Mobility Hub

Existing Buildings

- Site B - Area 0.27 ha
- Site C - Area 0.13 ha
- Applcation Boundary (All Blocks) and public realm - Area 4.65ha
- Detailed Application (Block A,B,C,D,M,KL & J3) and public realm - Area 2.25ha

Revision	Date	Drawn By	Description
D0-1	31.03.22		Issued For Planning

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Client
Weston Homes

Project
Anglia Square
Norwich

Description
Hybrid Application Site Plan
Block Plan on Proposed layout

Status
For Planning

Scale	Drawn By	Date
1:500@A1	BM	31.03.22
Job Number	**Drawing Number**	**Revision**
35301	ZZ-00-DR-A-01-0300	D0-1

Appendix: C – Topographical Survey

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

SERVICE LEGEND

- FOUL DRAINAGE
- SURFACE WATER DRAINAGE
- WATER
- GAS
- ELECTRICITY
- TELEPHONE
- CABLE TV
- MERCURY
- TRAFFIC SIGNAL
- OIL
- UNKNOWN SERVICE
- NEW DETAIL
- UNDERGROUND CHAMBER

Appendix: D – Thames Water Sewer Mapping

Date: 16/01/17

Scale: 1:1250

Map Centre: 623007,309342

Data updated: 24/10/16

Our Ref: 210177 - 1

Wastewater Plan A1

Foul Sewer
Surface Sewer
Combined Sewer
Final Effluent
Rising Main
(Colour denotes effluent type)
Private Sewer
(Colour denotes effluent type)
Decommissioned Sewer
(Colour denotes effluent type)

Outfall
(Colour denotes effluent type)
Inlet
(Colour denotes effluent type)
Manhole
(Colour denotes effluent type)
Sewage Treatment Works
Pumping Station

louisa.wade@eastp.co.uk

Anglia Square Norwic

love every drop
anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
0002	623050	309027	C	2.96	-0.98	3.94
0008	623008	309060	C	3.23	0.28	2.95
0010	623023	309019	C	2.94	-0.87	3.81
0101	623023	309178	C	4	1.85	2.15
0104	623025	309161	C	3.95	1.74	2.21
0105	623036	309101	C	3.43	0.14	3.29
0107	623073	309110	C	3.64	2.28	1.36
0201	623015	309237	C	4.34	2.12	2.22
0202	623010	309274	C	-	-	-
0604	623030	309667	C	-	-	2.4
1006	623105	309035	C	2.71	-1.26	3.97
1015	623192	309077	C	-	-	-
1112	623120	309178	C	3.874	1.179	2.695
1114	623189	309114	C	2.742	1.072	1.67
1201	623196	309247	C	3.13	1.38	1.75
1203	623162	309240	C	3.147	1.647	1.5
1204	623103	309267	C	3.55	1.18	2.37
1205	623147	309279	C	3.38	1.17	2.21
1213	623155	309280	C	3.347	1.747	1.6
1214	623169	309204	C	-	-	-
1215	623159	309280	C	-	-	-
1313	623160	309375	C	-	-	-
1407	623164	309465	C	-	-	-
1504	623169	309561	C	-	-	-
1505	623169	309559	C	5.342	1.407	3.935
2003	623246	309077	C	-	-	4.3
2017	623248	309069	C	-	-	-
2018	623248	309047	C	-	-	-
2019	623206	309033	C	3.107	-1.663	4.77
2101	623281	309151	C	2.47	1	1.47
2103	623255	309184	C	2.99	1.86	1.13
2104	623261	309115	C	-	-	3.95
2201	623212	309251	C	3.28	0.13	3.15
2203	623269	309260	C	-	-	3.275
2205	623294	309270	C	3.02	1.29	1.73
2207	623298	309210	C	-	-	3.1
2208	623207	309272	C	-	-	-
2209	623223	309253	C	-	-	-
2301	623230	309388	C	3.63	1.64	1.99
2305	623256	309366	C	3.4	2.21	1.19
2308	623244	309350	C	3.26	1.24	2.02
2402	623262	309409	C	3.48	1.1	2.38
2403	623210	309430	C	3.88	1.66	2.22
2404	623221	309431	C	3.85	1.59	2.26
2405	623226	309407	C	3.81	1.79	2.02
2407	623280	309471	C	4.32	2.09	2.23
2408	623275	309425	C	-	-	2.35
2502	623285	309527	C	5.82	2.93	2.89
2503	623273	309540	C	6.32	4.95	1.37
2505	623282	309594	C	-	-	-
2506	623229	309537	C	-	-	-
3001	623313	309032	C	2.21	0.6	1.61
3004	623370	309098	C	2.79	0.24	2.55
3006	623394	309092	C	3.5	1.97	1.53
3007	623351	309067	C	-	-	-
3101	623307	309165	C	2.449	0.349	2.1
3102	623319	309175	C	2.406	0.456	1.95
3106	623372	309187	C	-	-	3.48
3107	623337	309129	C	1.76	0.28	1.48
3109	623389	309118	C	-	-	-
3305	623393	309368	C	2.81	0.04	2.77
3306	623387	309387	C	3.16	0.32	2.84
3401	623327	309425	C	3.4	0.67	2.73
3404	623376	309422	C	3.58	0.54	3.04
3405	623318	309407	C	3.47	1.79	1.68
3406	623381	309405	C	3.31	0.45	2.86
3407	623362	309407	C	-	-	2.02
3506	623383	309536	C	-	-	-
3602	623321	309637	C	-	-	-
3611	623383	309669	C	-	-	-
4002	622496	309090	C	-	-	-
4002	623413	309054	C	4.17	2.26	1.91
4005	623430	309037	C	4.96	2.08	2.88
4108	623405	309104	C	3.44	1.23	2.21
4109	623422	309107	C	3.73	2.25	1.48
4110	623416	309115	C	3.36	1.78	1.58
4111	623452	309112	C	3.837	-	-
4201	623410	309220	C	-	-	3.275
4301	623455	309386	C	-	-	-
4509	623455	309579	C	8.19	6.92	1.27
4510	623497	309538	C	-	-	1.7
4511	623471	309527	C	-	-	-
4512	623494	309522	C	-	-	0.62
4513	623490	309568	C	-	-	-
5101	623506	309141	C	-	-	3.125
5405	623513	309401	C	-	-	-
5507	622598	309555	C	-	-	8
5509	622598	309537	C	-	-	-
5510	622584	309590	C	-	-	4.61
5510	623501	309552	C	-	-	1.05
5511	623504	309565	C	-	-	1.42
5608	622573	309651	C	-	-	2.3
5612	622583	309620	C	-	-	1.62
6304	622635	309360	C	-	-	2.62
6351	622654	309301	C	-	-	1.82
6401	622616	309454	C	-	-	3.2
6402	622689	309483	C	-	-	3.82
6506	622664	309587	C	-	-	1.07
6507	622634	309532	C	-	-	1
6508	622669	309584	C	-	-	2.845
6605	622689	309658	C	-	-	1.9
6608	622634	309659	C	-	-	1.67
6612	622651	309618	C	-	-	1.35

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
6613	622670	309643	C	-	-	1.63
6615	622699	309655	C	-	-	1.42
6622	622655	309668	C	-	-	-
7001	622773	309039	C	-	-	2.72
7107	622799	309154	C	-	-	2.58
7201	622736	309218	C	-	-	2.71
7202	622765	309219	C	-	-	1.74
7203	622791	309228	C	-	-	2.83
7210	622706	309269	C	-	-	1.4
7301	622731	309382	C	-	-	1.37
7302	622732	309351	C	-	-	1.43
7303	622737	309356	C	-	-	1.5
7401	622758	309486	C	-	-	2.69
7402	622760	309472	C	-	-	2.015
7403	622761	309469	C	-	-	1.98
7502	622750	309506	C	-	-	3.56
7606	622783	309629	C	10.756	8.12	2.636
7608	622798	309609	C	9.754	7.196	2.558
7611	622793	309607	C	-	-	0.83
8003	622851	309031	C	-	-	1.7
8004	622832	309063	C	-	-	1.92
8103	622872	309129	C	4.18	1.44	2.74
8107	622873	309126	C	4.19	0.94	3.25
8203	622889	309284	C	-	-	2.21
8302	622898	309366	C	-	-	2.565
8303	622892	309327	C	-	-	2.16
8402	622845	309436	C	-	-	2.24
8403	622805	309417	C	-	-	2
8404	622896	309451	C	-	-	2.6
8502	622826	309579	C	7.483	3.292	4.191
8503	622868	309585	C	-	-	2.011
8504	622857	309549	C	7.483	3.292	4.191
8508	622842	309544	C	-	-	1.93
8601	622891	309623	C	-	-	0.84
8606	622899	309648	C	-	-	1.3
8607	622819	309612	C	-	-	0.915
8612	622817	309622	C	-	-	-
8613	622815	309623	C	-	-	-
9101	622981	309175	C	-	-	2.51
9102	622990	309126	C	3.65	1.26	2.39
9103	622995	309110	C	3.6	1.04	2.56
9104	622990	309108	C	3.63	1.43	2.2
9203	622972	309226	C	4.29	1.82	2.47
9207	622939	309245	C	4.76	2.73	2.03
9305	622974	309354	C	-	-	2.77
9306	622985	309400	C	-	-	2.87
9424	622941	309494	C	-	-	2.745
9426	622917	309445	C	-	-	2.92
9427	622906	309403	C	-	-	3.02
9501	622912	309579	C	-	-	1.04
9502	622929	309545	C	-	-	0.915
9503	622993	309573	C	-	-	1.725
9507	622995	309546	C	5.15	3.49	1.66
9508	622997	309522	C	5.09	3.31	1.78
9509	622955	309591	C	-	-	-
9510	622964	309593	C	-	-	0.8
9511	622975	309595	C	-	-	-
9512	622986	309589	C	-	-	-
9515	622949	309535	C	-	-	-
9516	622941	309587	C	-	-	0.5
9601	622900	309629	C	-	-	0.99
9602	622981	309617	C	6.248	4.328	1.92
9605	622925	309601	C	-	-	1.525
9606	622977	309661	C	6.111	4.023	2.088
9610	622904	309648	C	-	-0.61	0.61
0003	623032	309020	F	2.91	-2.59	5.5
0007	623073	309023	F	2.89	-0.28	3.17
0301	623059	309354	F	3.99	0.33	3.66
0302	623080	309355	F	4	0.22	3.78
0303	623060	309310	F	3	1.36	1.64
0304	623060	309304	F	3.23	1.45	1.78
0401	623099	309460	F	4.22	1.41	2.81
0402	623066	309471	F	4.41	1.72	2.69
0403	623025	309487	F	4.65	2.04	2.61
0404	623008	309493	F	4.91	2.36	2.55
0405	623005	309415	F	4.5	1.92	2.58
0406	623033	309408	F	3.98	1.36	2.62
0407	623035	309401	F	3.97	1.14	2.83
0408	623056	309401	F	3.96	0.9	3.06
0409	623001	309497	F	-	-	-
0603	623029	309669	F	-	-	-
0606	623046	309644	F	-	-	-
0607	623086	309645	F	-	-	-
0617	623042	309644	F	-	-	-
0618	623086	309660	F	-	-	-
0619	623099	309645	F	-	-	-
1001	623158	309073	F	2.81	2.04	0.77
1003	623184	309067	F	2.55	-2.02	4.57
1005	623118	309038	F	2.59	-2.14	4.73
1014	623190	309074	F	2.56	0.8	1.76
1107	623171	309190	F	2.826	-0.934	3.76
1211	623153	309285	F	3.42	0.59	2.83
1303	623143	309320	F	3.47	0.99	2.48
1306	623107	309356	F	3.91	-0.02	3.93
1307	623119	309355	F	3.61	-	-
1308	623131	309356	F	-	-	3.35
1309	623160	309343	F	3.18	-0.2	3.38
1310	623152	309346	F	-	-	3.5
1312	623158	309390	F	3.42	1.81	1.61
1401	623118	309453	F	4.1	1.25	2.85
1403	623156	309429	F	3.75	0.25	3.5
1406	623159	309451	F	4.07	1.96	2.11
1502	623163	309525	F	4.558	1.203	3.355

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
1503	623163	309559	F	4.558	1.203	3.355
1614	623161	309637	F	-	-	-
1617	623116	309645	F	7.333	5.473	1.86
2004	623241	309035	F	2.946	-3.864	6.81
2007	623206	309020	F	3.35	1.76	1.59
2008	623204	309029	F	3.01	1.62	1.39
2303	623249	309333	F	3.22	1.1	2.12
2304	623265	309338	F	3.37	1.57	1.8
2307	623257	309307	F	2.917	0.918	1.999
2504	623287	309589	F	-	-	2.5
3008	623347	309072	F	-	-	-
3009	623393	309074	F	-	-	-
3010	623380	309064	F	-	-	-
3011	623364	309049	F	-	-	-
3012	623358	309040	F	-	-	-
3013	623352	309024	F	-	-	-
3014	623351	309017	F	-	-	-
3302	623371	309359	F	2.57	-0.08	2.65
3501	623391	309509	F	-	-	2.1
3502	623332	309534	F	-	-	2.2
3503	623309	309556	F	-	-	2.3
3504	623395	309520	F	-	-	-
3505	623326	309587	F	-	-	-
3601	623306	309624	F	-	-	2.5
3603	623334	309655	F	-	-	2.4
3604	623301	309629	F	-	-	1.2
3605	623360	309651	F	-	-	-
3607	623356	309615	F	-	-	-
3608	623358	309635	F	-	-	-
3609	623364	309603	F	-	-	-
4001	622495	309082	F	-	-	6.045
4003	623433	309080	F	3.95	0.15	3.8
4101	623421	309189	F	-	-	3.455
4401	623479	309476	F	-	-	2.86
4402	623469	309476	F	-	-	2.8
4501	623412	309565	F	-	-	-
4502	623446	309557	F	-	-	-
4503	623457	309594	F	-	-	1.52
4504	623408	309588	F	-	-	-
4505	623413	309587	F	-	-	-
4506	623420	309585	F	-	-	-
4507	623438	309513	F	-	-	-
4508	623445	309538	F	-	-	-
4602	623482	309633	F	-	-	-
4603	623402	309605	F	-	-	-
4604	623406	309670	F	-	-	-
4605	623406	309667	F	-	-	-
5004	622557	309020	F	3.12	-1.53	4.65
5006	622514	309079	F	3.38	-1.95	5.33
5201	622581	309267	F	-	-	-
5301	622563	309365	F	-	-	-
5302	622564	309357	F	-	-	-
5401	622547	309454	F	-	-	-
5402	622563	309412	F	-	-	-
5409	623516	309464	F	-	-	3.265
5501	622529	309569	F	3.08	-	-
5502	622542	309519	F	3.69	-	-
5507	623516	309585	F	-	-	-
5511	622586	309593	F	-	-	8.36
5512	622575	309590	F	-	-	3.886
5513	622570	309586	F	-	-	1.855
5514	622580	309555	F	-	-	0.915
5515	622549	309525	F	-	-	-
5604	622563	309647	F	-	-	9.13
5607	622554	309626	F	-	-	1.22
6000	622669	309095	F	4.042	2.39	1.652
6001	622684	309069	F	4.125	2.591	1.534
6002	622658	309054	F	4.3	2.792	1.508
6003	622700	309044	F	4.117	2.407	1.71
6102	622695	309188	F	-	-	3.4
6103	622699	309193	F	-	-	6.4
6104	622698	309110	F	-	-	1.14
6105	622673	309147	F	-	1.5	-
6106	622660	309127	F	-	1.75	-
6107	622643	309126	F	-	1.95	-
6108	622666	309159	F	-	1.8	-
6109	622667	309183	F	-	2.2	-
6110	622656	309121	F	4	1.966	2.034
6201	622657	309265	F	-	1.411	-
6204	622664	309262	F	-	-	-
6205	622617	309252	F	-	1.643	-
6302	622634	309356	F	-	-	5.82
6404	622614	309454	F	-	-	7
6504	622609	309558	F	-	-	9.45
7002	622744	309099	F	-	-	3.66
7005	622751	309098	F	-	-	6.8
7007	622756	309072	F	3.583	0.51	3.073
7008	622752	309070	F	3.603	2.015	1.588
7009	622727	309058	F	4.04	2.202	1.838
7010	622711	309024	F	4.15	2.557	1.593
7101	622708	309166	F	-	-0.04	-
7104	622720	309122	F	-	-	1.17
7105	622703	309194	F	-	-	2.7
7106	622799	309115	F	-	-	3
7108	622703	309164	F	-	1.1	-
7205	622712	309284	F	-	-	1.845
7206	622782	309285	F	-	-	-
7207	622753	309285	F	-	-	1.635
7404	622758	309477	F	-	-	-
7405	622704	309466	F	-	-	-
7406	622720	309473	F	-	-	-
7501	622718	309599	F	-	-	11.75
7602	622773	309641	F	10.67	8	2.67

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
8001	622884	309059	F	4.27	0.55	3.72
8102	622874	309170	F	4.32	1.71	2.61
8104	622811	309104	F	-	-	1.3
8204	622881	309211	F	-	-	-
8405	622862	309430	F	-	-	-
8509	622892	309570	F	-	-	-
8604	622816	309660	F	-	-	-
8611	622812	309662	F	10.267	7.147	3.12
8614	622811	309625	F	-	-	-
8615	622824	309616	F	-	-	-
8616	622818	309623	F	-	-	-
9001	622961	309099	F	3.87	1.77	2.1
9002	622979	309048	F	3.46	1.44	2.02
9202	622969	309245	F	-	-	2.6
9206	622966	309292	F	-	-	2.185
9208	622967	309283	F	4.3	2.13	2.17
9209	622986	309290	F	-	-	-
9301	622967	309310	F	4.37	2.25	2.12
9401	622973	309428	F	-	-	2.36
9414	622911	309475	F	-	-	2.845
9423	622945	309444	F	-	-	2.59
9425	622921	309458	F	-	-	2.615
9428	622929	309471	F	-	-	-
9429	622935	309475	F	-	-	-
9504	622992	309546	F	-	-	-
9513	622944	309573	F	-	-	-
9514	622905	309577	F	-	-	-
9607	622998	309664	F	5.447	3.487	1.96
9608	622902	309655	F	-	-	1.6
9609	622922	309660	F	6.1	0.176	5.924
9613	622935	309623	F	-	-	-
9614	622948	309627	F	-	-	0.5
9616	622962	309630	F	-	-	-
0251	623009	309263	S	4.47	3.05	1.42
0252	623039	309294	S	3.64	2.03	1.61
0253	623052	309269	S	-	4.66	-
0351	623078	309356	S	3.97	1.07	2.9
0352	623062	309309	S	3.05	1.74	1.31
0353	623062	309303	S	3.28	1.83	1.45
0354	623061	309356	S	4.01	1.03	2.98
0451	623036	309480	S	4.57	2.02	2.55
0452	623004	309492	S	5.01	2.2	2.81
0453	623005	309417	S	4.49	1.32	3.17
0454	623035	309410	S	3.95	1.21	2.74
0455	623046	309404	S	3.98	1.08	2.9
0456	623057	309404	S	3.96	1.08	2.88
0457	623087	309499	S	3.99	2.46	1.53
0458	623095	309478	S	4.19	2.23	1.96
0459	623097	309459	S	4.23	1.85	2.38
1051	623153	309091	S	2.83	1.69	1.14
1057	623187	309075	S	-	-	-
1153	623168	309191	S	-	-	2.49
1251	623156	309286	S	3.51	-0.55	4.06
1252	623103	309279	S	-	7.21	-
1351	623157	309346	S	3.23	0.79	2.44
1352	623108	309357	S	3.88	1.04	2.84
1353	623133	309357	S	-	-	2.45
1355	623145	309319	S	3.49	-0.26	3.75
1357	623156	309388	S	-	-	-
1451	623118	309451	S	4.09	1.64	2.45
1452	623158	309447	S	-	-	-
1453	623154	309427	S	3.78	1.02	2.76
1454	623168	309430	S	-	-	-
1459	623168	309427	S	3.8	2.16	1.64
1553	623167	309558	S	-	-	-
1651	623150	309668	S	-	-	5.73
2051	623206	309030	S	-	-	-
2351	623263	309338	S	-	-	1.93
2352	623207	309309	S	8.37	7.18	1.19
2354	623272	309315	S	3.09	1.29	1.8
2355	623250	309387	S	3.65	2.32	1.33
2361	623258	309307	S	2.918	1.168	1.75
2362	623250	309334	S	-	-	1.93
2363	623265	309326	S	-	4.11	-
2452	623274	309428	S	-	-	-
2552	623282	309589	S	-	-	2.2
3050	623390	309075	S	-	-	-
3051	623378	309064	S	-	-	-
3052	623364	309051	S	-	-	-
3053	623355	309039	S	-	-	-
3054	623350	309025	S	-	-	-
3055	623349	309018	S	-	-	-
3351	623326	309343	S	3.29	1.24	2.05
3352	623321	309343	S	3.38	1.56	1.82
3353	623370	309348	S	2.54	0.65	1.89
3357	623382	309316	S	2.801	0.251	2.55
3358	623368	309351	S	-	-	-
3359	623365	309359	S	-	-	-
3360	623338	309352	S	-	-	-
3361	623346	309384	S	-	-	1.93
3457	623366	309424	S	-	-	3.04
3458	623386	309493	S	-	-	-
3551	623387	309506	S	-	-	2.1
3552	623330	309532	S	-	-	1.8
3553	623305	309554	S	-	-	1.9
3554	623392	309521	S	-	-	-
3555	623324	309590	S	-	-	-
3651	623303	309624	S	-	-	2.1
3652	623332	309659	S	-	-	2.1
3653	623359	309654	S	-	-	-
4051	623435	309080	S	3.97	1.56	2.41
4052	623433	309042	S	4.9	4.9	-
4157	623423	309190	S	-	-	2.77

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
4453	623468	309472	S	-	-	2.7
4551	623409	309568	S	-	-	-
4552	623449	309558	S	-	-	-
4651	623413	309644	S	-	-	-
4652	623468	309633	S	-	-	-
5051	622516	309094	S	3.62	1.01	2.61
5059	622506	309077	S	-	-	3.075
5151	622555	309171	S	4.32	1.38	2.94
5251	622521	309268	S	-	-	2.4
5252	622556	309212	S	5.07	1.53	3.54
5555	622569	309584	S	-	-	-
5556	622558	309579	S	-	-	1.168
6051	622647	309029	S	3.865	2.485	1.38
6052	622678	309021	S	4.255	1	3.255
6053	622699	309042	S	4.15	1.245	2.905
6054	622694	309051	S	4.022	1.333	2.689
6055	622667	309095	S	4.04	1.834	2.206
6056	622642	309083	S	4.319	2.634	1.685
6151	622671	309148	S	-	1.8	-
6152	622659	309129	S	-	2.05	-
6153	622643	309128	S	-	2.2	-
6154	622664	309160	S	-	2.1	-
6155	622665	309185	S	-	2.5	-
6156	622698	309187	S	-	-	1.2
6251	622666	309241	S	-	-	1.83
6252	622660	309259	S	-	1.548	-
6253	622657	309260	S	-	1.829	-
6254	622611	309258	S	-	2.999	-
6551	622622	309568	S	9.29	2.49	6.8
6552	622688	309590	S	10.73	7.65	3.08
6652	622644	309634	S	-	-	1.27
7050	622702	309038	S	4.19	1.449	2.741
7051	622712	309020	S	4.12	1.671	2.449
7052	622725	309056	S	4.102	1.861	2.241
7053	622749	309067	S	3.721	2.26	1.461
7152	622710	309169	S	-	1.3	-
7153	622703	309166	S	-	1.4	-
7154	622737	309117	S	-	-	2.9
7155	622748	309094	S	-	-	-
7156	622771	309107	S	-	-	-
7157	622798	309118	S	-	-	-
7251	622714	309285	S	-	-	1.575
7252	622788	309259	S	-	-	-
7253	622707	309257	S	-	1.734	-
7254	622745	309258	S	-	1.893	-
7351	622780	309326	S	-	-	1.83
7352	622745	309333	S	-	-	1.6
7354	622797	309321	S	-	-	1.3
7451	622760	309476	S	-	-	1.15
7652	622779	309637	S	-	-	3.81
7653	622788	309632	S	-	-	7.77
8151	622873	309169	S	4.32	1.96	2.36
8152	622802	309153	S	-	-	-
8153	622861	309166	S	-	-	-
8253	622833	309254	S	-	2.548	-
8254	622879	309213	S	-	-	-
8255	622882	309233	S	-	-	-
8452	622807	309490	S	-	-	1.38
8557	622860	309511	S	-	-	-
8653	622810	309662	S	10.267	7.447	2.82
9252	622971	309247	S	-	-	2.25
9253	622970	309284	S	-	-	3.99
9254	622973	309261	S	-	-	-
9255	622973	309295	S	-	-	-
9256	622982	309292	S	-	-	-
9351	622973	309312	S	-	-	-
9459	622975	309422	S	-	-	3
9460	622930	309452	S	-	-	3.15
9462	622912	309477	S	-	-	3.48
9465	622991	309411	S	-	-	-

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert

Appendix: E – Existing Run-off Rates

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

Runoff calculations- Modified Rational Method

$Q = CiA$ where $C = \dfrac{PIMP}{PR}$

PIMP = Percentage of impervious area to total area

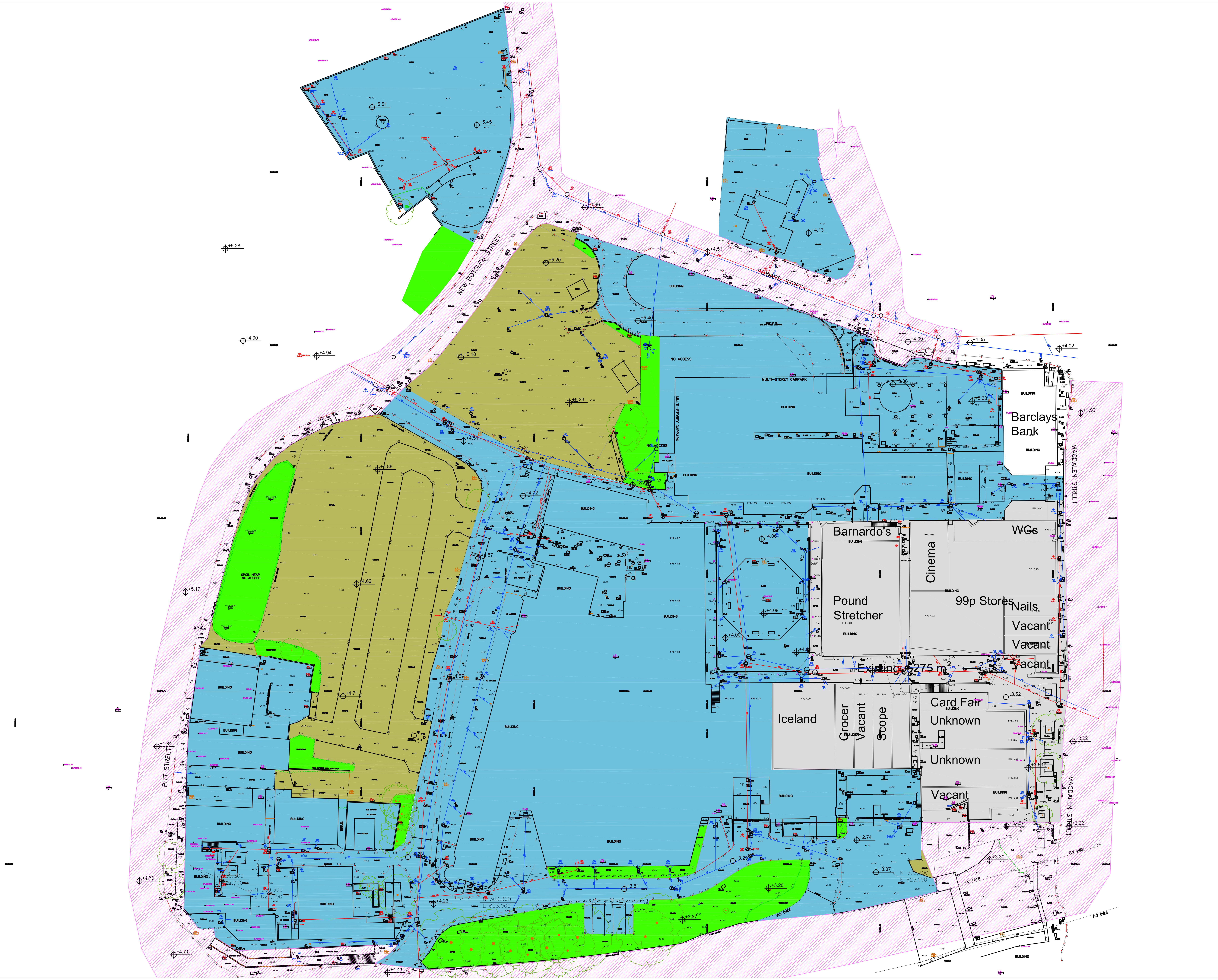
PR = Percentage Runoff

C=1

C	1	
Rainfall intensity (i)	50	mm/hr
	0.05	m/hr
	0.0000139	m/s
Site size (A)	40712	m2
Q for existing site	**565.44**	**l/s**

Ref: Butler, D and Davies, J. (2006), Urban Drainage, 2nd ed, SPON.

Appendix: F – Existing Run-off Catchments



Grey	AREA OF EXISTING SHOPPING CENTER TO BE RETAINED IN ITS CURRENT FORM WITH EXISTING CONNECTIONS TO ANGLIAN WATER SEWERS TO BE RETAINED
Pink hatched	AREAS OF ADOPTED PUBLIC HIGHWAY: NOT INCLUDED IN THESE CALCULATIONS
Green	AREA OF PERMEABLE SURFACE OR LANDSCAPING: DOES NOT DRAIN TO ANGLIAN WATER SEWER (3130m²)
Olive	AREA OF LAND WITHOUT POSITIVE DRAINAGE SYSTEM OR GRAVEL SURFACE: DOES NOTE DRAIN TO ANGLIAN WATER SEWER (7725m²)
Blue	AREA OF IMPERMEABLE SURFACE THAT DRAINS SURFACE WATER RUN-OFF TO EXISTING ANGLIAN WATER SURFACE WATER SEWERS (27613m²)

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: FOR INFORMATION

Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT: WESTON HOMES

ARCHITECT:

PROJECT: ANGLIA SQUARE, NORWICH

TITLE: EXISTING IMPERMEABLE AREAS WHICH DRAIN SURFACE WATER TO ANGLIAN WATER SURFACE WATER SEWERS

SCALE @ A1:	DESIGN-DRAWN:	DATE:
1:500	MD	06.04.2017

PROJECT No:	DRAWING No:
1044	SK01

Appendix: G – Indicative Sewer Diversions

NOTES

LEGEND

	Phase 1
	Phase 2
	Adopted Existing FS Sewer
	Adopted Exisiting FS MH
	Proposed Diverted FS Sewer
	Proposed Diverted FS MH
	Adopted Existing SW Sewer
	Adopted Exisiting SW MH
	Proposed Diverted SW Sewer
	Proposed Diverted SW MH

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: FOR INFORMATION

EAS

Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT: WESTON HOMES

ARCHITECT:

PROJECT: ANGLIA SQUARE, NORWICH

TITLE: OVERALL FOUL AND SURFACE WATER PROPOSED DIVERSIONS

SCALE @ A0:	DESIGN-DRAWN:	DATE:
NTS	JPS	11.03.2022
PROJECT No:	DRAWING No: SK02	

Appendix: H – Greenfield Run-off Rates

TRANSPORT PLANNING HIGHWAYS AND DRAINAGE FLOOD RISK TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.150
Area (ha)	1.000	Urban	0.000
SAAR (mm)	614	Region Number	Region 5

Results l/s

QBAR Rural	0.3
QBAR Urban	0.3
Q100 years	1.2
Q1 year	0.3
Q30 years	0.8
Q100 years	1.2

Appendix: I – Anglian Water Approval In Principle

Louisa Wade

From: Anglian Water <planningliaison@anglianwater.co.uk>
Sent: 21 April 2017 15:57
To: Louisa Wade
Subject: 00021192 St Crispins Road, NORWICH - Mancroft Response

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Louisa Wade

RE: St Crispins Road,NORWICH - Mancroft .

Thank you for your email.

Anglian Water's surface water management policy is as follows: Where a brownfield site is being demolished, the site should be treated as if it was greenfield. no historic right of connection will exist and any sewer connections should be treated afresh. Where this is not practical Anglian Water would assess the roof area of the former development site and subject to capacity, permit the 1 in 1 year calculated rate to discharge to the public surface water system.

Flows in excess of any agreed rate will need to be stored on site to the environment Agency's requirements for all events up to the 1 in 100 year plus climate change rate, unless a greater event has been stipulated

Subject to evidence being provided to confirm that 27,613m2 of hard standing area currently drains to the Anglian Water surface water sewers, we would permit the calculated 1 in 1 year discharge rate of 242l/s. Discharge should be to the same surface water sewers as existing.

Evidence in the form of CCTV survey /drainage layout plan to confirm the hard standing area and current discharge locations can be provided at detailed design stage when applying to connect.

Should you have any questions relating to this please contact 0345 0265 458. Your reference for this enquiry is 00021192.

Kind Regards
Growth and Planning Services Team

Appendix J – Hydraulic Model Outputs

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

Cascade Summary of Results for PP-01.srcx

Upstream Structures	Outflow To	Overflow To
(None)	SY-01.srcx	SY-01.srcx

Half Drain Time : 56 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	5.193	0.093	0.0	2.5	2.5	12.1	Flood Risk
30 min Summer	5.212	0.112	0.0	3.3	3.3	15.8	Flood Risk
60 min Summer	5.223	0.123	0.0	3.9	3.9	18.0	Flood Risk
120 min Summer	5.228	0.128	0.0	4.1	4.1	18.9	Flood Risk
180 min Summer	5.226	0.126	0.0	4.0	4.0	18.6	Flood Risk
240 min Summer	5.223	0.123	0.0	3.9	3.9	17.9	Flood Risk
360 min Summer	5.215	0.115	0.0	3.5	3.5	16.4	Flood Risk
480 min Summer	5.209	0.109	0.0	3.1	3.1	15.1	Flood Risk
600 min Summer	5.203	0.103	0.0	2.7	2.7	13.9	Flood Risk
720 min Summer	5.195	0.095	0.0	2.6	2.6	12.5	Flood Risk
960 min Summer	5.185	0.085	0.0	2.4	2.4	10.3	Flood Risk
1440 min Summer	5.171	0.071	0.0	2.0	2.0	7.7	Flood Risk
2160 min Summer	5.160	0.060	0.0	1.6	1.6	5.5	Flood Risk
2880 min Summer	5.154	0.054	0.0	1.4	1.4	4.4	Flood Risk
4320 min Summer	5.147	0.047	0.0	1.0	1.0	3.4	Flood Risk
5760 min Summer	5.142	0.042	0.0	0.8	0.8	2.6	Flood Risk
7200 min Summer	5.138	0.038	0.0	0.7	0.7	2.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	13.9	23
30 min Summer	90.946	0.0	19.2	34
60 min Summer	56.713	0.0	24.7	54
120 min Summer	34.162	0.0	30.3	86
180 min Summer	25.057	0.0	33.7	120
240 min Summer	19.992	0.0	35.9	154
360 min Summer	14.500	0.0	39.3	220
480 min Summer	11.545	0.0	41.8	284
600 min Summer	9.667	0.0	43.7	352
720 min Summer	8.358	0.0	45.4	414
960 min Summer	6.638	0.0	48.0	532
1440 min Summer	4.791	0.0	51.6	770
2160 min Summer	3.452	0.0	55.3	1128
2880 min Summer	2.733	0.0	57.7	1476
4320 min Summer	1.964	0.0	60.8	2208
5760 min Summer	1.552	0.0	62.6	2936
7200 min Summer	1.292	0.0	63.6	3672

Cascade Summary of Results for PP-01.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	5.135	0.035	0.0	0.6	0.6	1.8	Flood Risk
10080 min Summer	5.133	0.033	0.0	0.5	0.5	1.6	Flood Risk
15 min Winter	5.203	0.103	0.0	2.7	2.7	14.0	Flood Risk
30 min Winter	5.224	0.124	0.0	3.9	3.9	18.1	Flood Risk
60 min Winter	5.236	0.136	0.0	4.5	4.5	20.4	Flood Risk
120 min Winter	5.238	0.138	0.0	4.5	4.5	20.9	Flood Risk
180 min Winter	5.233	0.133	0.0	4.3	4.3	20.0	Flood Risk
240 min Winter	5.227	0.127	0.0	4.1	4.1	18.8	Flood Risk
360 min Winter	5.216	0.116	0.0	3.5	3.5	16.6	Flood Risk
480 min Winter	5.208	0.108	0.0	3.0	3.0	14.9	Flood Risk
600 min Winter	5.199	0.099	0.0	2.6	2.6	13.1	Flood Risk
720 min Winter	5.189	0.089	0.0	2.5	2.5	11.2	Flood Risk
960 min Winter	5.177	0.077	0.0	2.2	2.2	8.8	Flood Risk
1440 min Winter	5.163	0.063	0.0	1.7	1.7	6.0	Flood Risk
2160 min Winter	5.152	0.052	0.0	1.3	1.3	4.2	Flood Risk
2880 min Winter	5.148	0.048	0.0	1.0	1.0	3.5	Flood Risk
4320 min Winter	5.140	0.040	0.0	0.7	0.7	2.4	Flood Risk
5760 min Winter	5.135	0.035	0.0	0.6	0.6	1.9	Flood Risk
7200 min Winter	5.132	0.032	0.0	0.5	0.5	1.6	Flood Risk
8640 min Winter	5.130	0.030	0.0	0.4	0.4	1.3	Flood Risk
10080 min Winter	5.127	0.027	0.0	0.4	0.4	1.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	64.1	4408
10080 min Summer	0.980	0.0	64.3	5136
15 min Winter	138.874	0.0	15.9	23
30 min Winter	90.946	0.0	21.9	34
60 min Winter	56.713	0.0	28.1	56
120 min Winter	34.162	0.0	34.4	92
180 min Winter	25.057	0.0	38.1	128
240 min Winter	19.992	0.0	40.7	162
360 min Winter	14.500	0.0	44.4	230
480 min Winter	11.545	0.0	47.2	300
600 min Winter	9.667	0.0	49.5	372
720 min Winter	8.358	0.0	51.3	428
960 min Winter	6.638	0.0	54.3	550
1440 min Winter	4.791	0.0	58.5	788
2160 min Winter	3.452	0.0	62.7	1128
2880 min Winter	2.733	0.0	65.5	1496
4320 min Winter	1.964	0.0	69.2	2208
5760 min Winter	1.552	0.0	71.5	2952
7200 min Winter	1.292	0.0	73.0	3656
8640 min Winter	1.112	0.0	73.9	4360
10080 min Winter	0.980	0.0	74.4	5152

Cascade Model Details for PP-01.srcx

Storage is Online Cover Level (m) 5.400

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.2
Membrane Percolation (mm/hr)	1000	Length (m)	64.6
Max Percolation (l/s)	183.0	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	5.100	Cap Volume Depth (m)	0.300

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	300.0	Coefficient of Contraction	0.600
Length (m)	5.000	Upstream Invert Level (m)	5.100
Roughness k (mm)	0.600		

Cascade Summary of Results for SY-01.srcx

Upstream Structures	Outflow To	Overflow To
PP-01.srcx	(None)	(None)

Half Drain Time : 74 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.914	0.634	0.0	5.0	5.0	21.7	O K
30 min Summer	4.105	0.825	0.0	5.0	5.0	28.2	O K
60 min Summer	4.274	0.994	0.0	5.0	5.0	34.0	O K
120 min Summer	4.363	1.083	0.0	5.0	5.0	37.1	O K
180 min Summer	4.337	1.057	0.0	5.0	5.0	36.1	O K
240 min Summer	4.289	1.009	0.0	5.0	5.0	34.5	O K
360 min Summer	4.183	0.903	0.0	5.0	5.0	30.9	O K
480 min Summer	4.072	0.792	0.0	5.0	5.0	27.1	O K
600 min Summer	3.962	0.682	0.0	5.0	5.0	23.3	O K
720 min Summer	3.880	0.600	0.0	5.0	5.0	20.5	O K
960 min Summer	3.724	0.444	0.0	5.0	5.0	15.2	O K
1440 min Summer	3.513	0.233	0.0	5.0	5.0	8.0	O K
2160 min Summer	3.446	0.166	0.0	4.2	4.2	5.7	O K
2880 min Summer	3.417	0.137	0.0	3.4	3.4	4.7	O K
4320 min Summer	3.380	0.100	0.0	2.5	2.5	3.4	O K
5760 min Summer	3.360	0.080	0.0	2.0	2.0	2.7	O K
7200 min Summer	3.347	0.067	0.0	1.7	1.7	2.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	38.8	24
30 min Summer	90.946	0.0	51.9	39
60 min Summer	56.713	0.0	65.5	68
120 min Summer	34.162	0.0	79.5	122
180 min Summer	25.057	0.0	87.8	160
240 min Summer	19.992	0.0	93.5	190
360 min Summer	14.500	0.0	101.9	252
480 min Summer	11.545	0.0	108.2	316
600 min Summer	9.667	0.0	113.3	378
720 min Summer	8.358	0.0	117.5	444
960 min Summer	6.638	0.0	124.4	562
1440 min Summer	4.791	0.0	134.4	772
2160 min Summer	3.452	0.0	144.7	1112
2880 min Summer	2.733	0.0	152.1	1476
4320 min Summer	1.964	0.0	162.6	2208
5760 min Summer	1.552	0.0	169.8	2936
7200 min Summer	1.292	0.0	175.2	3672

Cascade Summary of Results for SY-01.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	3.338	0.058	0.0	1.4	1.4	2.0	O K
10080 min Summer	3.331	0.051	0.0	1.3	1.3	1.7	O K
15 min Winter	4.002	0.722	0.0	5.0	5.0	24.7	O K
30 min Winter	4.232	0.952	0.0	5.0	5.0	32.6	O K
60 min Winter	4.439	1.159	0.0	5.0	5.0	39.6	O K
120 min Winter	4.570	1.290	0.0	5.0	5.0	44.1	O K
180 min Winter	4.554	1.274	0.0	5.0	5.0	43.6	O K
240 min Winter	4.475	1.195	0.0	5.0	5.0	40.9	O K
360 min Winter	4.311	1.031	0.0	5.0	5.0	35.3	O K
480 min Winter	4.131	0.851	0.0	5.0	5.0	29.1	O K
600 min Winter	3.968	0.688	0.0	5.0	5.0	23.5	O K
720 min Winter	3.835	0.555	0.0	5.0	5.0	19.0	O K
960 min Winter	3.594	0.314	0.0	5.0	5.0	10.7	O K
1440 min Winter	3.453	0.173	0.0	4.3	4.3	5.9	O K
2160 min Winter	3.409	0.129	0.0	3.2	3.2	4.4	O K
2880 min Winter	3.383	0.103	0.0	2.6	2.6	3.5	O K
4320 min Winter	3.354	0.074	0.0	1.8	1.8	2.5	O K
5760 min Winter	3.338	0.058	0.0	1.5	1.5	2.0	O K
7200 min Winter	3.328	0.048	0.0	1.2	1.2	1.7	O K
8640 min Winter	3.322	0.042	0.0	1.0	1.0	1.4	O K
10080 min Winter	3.317	0.037	0.0	0.9	0.9	1.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	179.5	4400
10080 min Summer	0.980	0.0	182.8	5104
15 min Winter	138.874	0.0	43.9	25
30 min Winter	90.946	0.0	58.5	39
60 min Winter	56.713	0.0	73.8	68
120 min Winter	34.162	0.0	89.5	124
180 min Winter	25.057	0.0	98.7	176
240 min Winter	19.992	0.0	105.2	208
360 min Winter	14.500	0.0	114.6	274
480 min Winter	11.545	0.0	121.7	340
600 min Winter	9.667	0.0	127.4	410
720 min Winter	8.358	0.0	132.2	470
960 min Winter	6.638	0.0	139.9	572
1440 min Winter	4.791	0.0	151.2	758
2160 min Winter	3.452	0.0	162.9	1124
2880 min Winter	2.733	0.0	171.3	1480
4320 min Winter	1.964	0.0	183.3	2208
5760 min Winter	1.552	0.0	191.7	2944
7200 min Winter	1.292	0.0	198.0	3680
8640 min Winter	1.112	0.0	203.0	4392
10080 min Winter	0.980	0.0	207.1	5032

Cascade Model Details for SY-01.srcx

Storage is Online Cover Level (m) 5.400

Cellular Storage Structure

Invert Level (m) 3.280 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m^2)	Inf. Area (m^2)	Depth (m)	Area (m^2)	Inf. Area (m^2)
0.000	36.0	0.0	1.321	0.0	0.0
1.320	36.0	0.0			

Pump Outflow Control

Invert Level (m) 3.280

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	5.0000	1.800	5.0000	3.400	5.0000	5.000	5.0000
0.400	5.0000	2.000	5.0000	3.600	5.0000	5.200	5.0000
0.600	5.0000	2.200	5.0000	3.800	5.0000	5.400	5.0000
0.800	5.0000	2.400	5.0000	4.000	5.0000	5.600	5.0000
1.000	5.0000	2.600	5.0000	4.200	5.0000	5.800	5.0000
1.200	5.0000	2.800	5.0000	4.400	5.0000	6.000	5.0000
1.400	5.0000	3.000	5.0000	4.600	5.0000		
1.600	5.0000	3.200	5.0000	4.800	5.0000		

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

Half Drain Time : 30 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	2.679	0.799	0.0	5.0	5.0	11.6	O K
30 min Summer	2.852	0.972	0.0	5.0	5.0	14.1	O K
60 min Summer	2.872	0.992	0.0	5.0	5.0	14.4	O K
120 min Summer	2.749	0.869	0.0	5.0	5.0	12.6	O K
180 min Summer	2.601	0.721	0.0	5.0	5.0	10.5	O K
240 min Summer	2.460	0.580	0.0	5.0	5.0	8.4	O K
360 min Summer	2.242	0.362	0.0	5.0	5.0	5.3	O K
480 min Summer	2.113	0.233	0.0	5.0	5.0	3.4	O K
600 min Summer	2.067	0.187	0.0	4.7	4.7	2.7	O K
720 min Summer	2.044	0.164	0.0	4.1	4.1	2.4	O K
960 min Summer	2.013	0.133	0.0	3.3	3.3	1.9	O K
1440 min Summer	1.978	0.098	0.0	2.4	2.4	1.4	O K
2160 min Summer	1.951	0.071	0.0	1.8	1.8	1.0	O K
2880 min Summer	1.936	0.056	0.0	1.4	1.4	0.8	O K
4320 min Summer	1.921	0.041	0.0	1.0	1.0	0.6	O K
5760 min Summer	1.912	0.032	0.0	0.8	0.8	0.5	O K
7200 min Summer	1.907	0.027	0.0	0.7	0.7	0.4	O K
8640 min Summer	1.903	0.023	0.0	0.6	0.6	0.3	O K
10080 min Summer	1.900	0.020	0.0	0.5	0.5	0.3	O K
15 min Winter	2.800	0.920	0.0	5.0	5.0	13.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	16.4	21
30 min Summer	90.946	0.0	21.5	32
60 min Summer	56.713	0.0	26.8	50
120 min Summer	34.162	0.0	32.3	82
180 min Summer	25.057	0.0	35.5	116
240 min Summer	19.992	0.0	37.8	146
360 min Summer	14.500	0.0	41.1	204
480 min Summer	11.545	0.0	43.6	258
600 min Summer	9.667	0.0	45.7	314
720 min Summer	8.358	0.0	47.4	374
960 min Summer	6.638	0.0	50.2	494
1440 min Summer	4.791	0.0	54.3	736
2160 min Summer	3.452	0.0	58.7	1100
2880 min Summer	2.733	0.0	62.0	1468
4320 min Summer	1.964	0.0	66.8	2204
5760 min Summer	1.552	0.0	70.4	2920
7200 min Summer	1.292	0.0	73.3	3616
8640 min Summer	1.112	0.0	75.7	4368
10080 min Summer	0.980	0.0	77.8	4976
15 min Winter	138.874	0.0	18.4	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.005	1.125	0.0	5.0	5.0	16.4	O K
60 min Winter	3.022	1.142	0.0	5.0	5.0	16.6	O K
120 min Winter	2.825	0.945	0.0	5.0	5.0	13.7	O K
180 min Winter	2.589	0.709	0.0	5.0	5.0	10.3	O K
240 min Winter	2.376	0.496	0.0	5.0	5.0	7.2	O K
360 min Winter	2.099	0.219	0.0	5.0	5.0	3.2	O K
480 min Winter	2.048	0.168	0.0	4.2	4.2	2.4	O K
600 min Winter	2.022	0.142	0.0	3.5	3.5	2.1	O K
720 min Winter	2.003	0.123	0.0	3.1	3.1	1.8	O K
960 min Winter	1.978	0.098	0.0	2.5	2.5	1.4	O K
1440 min Winter	1.951	0.071	0.0	1.8	1.8	1.0	O K
2160 min Winter	1.931	0.051	0.0	1.3	1.3	0.7	O K
2880 min Winter	1.921	0.041	0.0	1.0	1.0	0.6	O K
4320 min Winter	1.909	0.029	0.0	0.7	0.7	0.4	O K
5760 min Winter	1.903	0.023	0.0	0.6	0.6	0.3	O K
7200 min Winter	1.899	0.019	0.0	0.5	0.5	0.3	O K
8640 min Winter	1.897	0.017	0.0	0.4	0.4	0.2	O K
10080 min Winter	1.895	0.015	0.0	0.4	0.4	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.946	0.0	24.1	33
60 min Winter	56.713	0.0	30.0	54
120 min Winter	34.162	0.0	36.2	90
180 min Winter	25.057	0.0	39.8	122
240 min Winter	19.992	0.0	42.3	154
360 min Winter	14.500	0.0	46.0	200
480 min Winter	11.545	0.0	48.9	254
600 min Winter	9.667	0.0	51.1	314
720 min Winter	8.358	0.0	53.1	374
960 min Winter	6.638	0.0	56.2	494
1440 min Winter	4.791	0.0	60.8	734
2160 min Winter	3.452	0.0	65.8	1104
2880 min Winter	2.733	0.0	69.4	1440
4320 min Winter	1.964	0.0	74.8	2160
5760 min Winter	1.552	0.0	78.8	2864
7200 min Winter	1.292	0.0	82.1	3648
8640 min Winter	1.112	0.0	84.8	4344
10080 min Winter	0.980	0.0	87.1	5112

Model Details

Storage is Online Cover Level (m) 4.000

Cellular Storage Structure

Invert Level (m) 1.880 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	15.3	0.0	1.321	0.0	0.0
1.320	15.3	0.0			

Pump Outflow Control

Invert Level (m) 1.880

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	5.0000	0.600	5.0000	1.000	5.0000	1.400	5.0000
0.400	5.0000	0.800	5.0000	1.200	5.0000	6.000	5.0000

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

Half Drain Time : 49 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	4.165	0.885	0.0	19.0	19.0	67.2	O K
30 min Summer	4.356	1.076	0.0	20.6	20.6	81.8	O K
60 min Summer	4.401	1.121	0.0	21.0	21.0	85.2	O K
120 min Summer	4.324	1.044	0.0	20.3	20.3	79.4	O K
180 min Summer	4.225	0.945	0.0	19.5	19.5	71.8	O K
240 min Summer	4.123	0.843	0.0	18.6	18.6	64.1	O K
360 min Summer	3.937	0.657	0.0	18.3	18.3	49.9	O K
480 min Summer	3.770	0.490	0.0	18.3	18.3	37.3	O K
600 min Summer	3.598	0.318	0.0	18.3	18.3	24.2	O K
720 min Summer	3.441	0.161	0.0	18.3	18.3	12.3	O K
960 min Summer	3.342	0.062	0.0	17.1	17.1	4.7	O K
1440 min Summer	3.283	0.003	0.0	13.3	13.3	0.2	O K
2160 min Summer	3.280	0.000	0.0	9.6	9.6	0.0	O K
2880 min Summer	3.280	0.000	0.0	7.6	7.6	0.0	O K
4320 min Summer	3.280	0.000	0.0	5.5	5.5	0.0	O K
5760 min Summer	3.280	0.000	0.0	4.3	4.3	0.0	O K
7200 min Summer	3.280	0.000	0.0	3.6	3.6	0.0	O K
8640 min Summer	3.280	0.000	0.0	3.1	3.1	0.0	O K
10080 min Summer	3.280	0.000	0.0	2.7	2.7	0.0	O K
15 min Winter	4.292	1.012	0.0	20.1	20.1	76.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	88.7	22
30 min Summer	90.946	0.0	116.2	33
60 min Summer	56.713	0.0	144.9	52
120 min Summer	34.162	0.0	175.0	86
180 min Summer	25.057	0.0	192.8	120
240 min Summer	19.992	0.0	205.4	154
360 min Summer	14.500	0.0	223.0	222
480 min Summer	11.545	0.0	236.9	286
600 min Summer	9.667	0.0	247.9	346
720 min Summer	8.358	0.0	257.0	392
960 min Summer	6.638	0.0	272.4	500
1440 min Summer	4.791	0.0	294.9	736
2160 min Summer	3.452	0.0	318.8	0
2880 min Summer	2.733	0.0	336.5	0
4320 min Summer	1.964	0.0	362.7	0
5760 min Summer	1.552	0.0	382.2	0
7200 min Summer	1.292	0.0	397.8	0
8640 min Summer	1.112	0.0	410.9	0
10080 min Summer	0.980	0.0	422.2	0
15 min Winter	138.874	0.0	99.8	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	4.521	1.241	0.0	21.9	21.9	94.3	O K
60 min Winter	4.591	1.311	0.0	22.4	22.4	99.6	O K
120 min Winter	4.476	1.196	0.0	21.6	21.6	90.9	O K
180 min Winter	4.326	1.046	0.0	20.4	20.4	79.5	O K
240 min Winter	4.174	0.894	0.0	19.1	19.1	68.0	O K
360 min Winter	3.899	0.619	0.0	18.3	18.3	47.1	O K
480 min Winter	3.610	0.330	0.0	18.3	18.3	25.0	O K
600 min Winter	3.379	0.099	0.0	18.1	18.1	7.5	O K
720 min Winter	3.327	0.047	0.0	16.4	16.4	3.6	O K
960 min Winter	3.283	0.003	0.0	13.3	13.3	0.2	O K
1440 min Winter	3.280	0.000	0.0	9.7	9.7	0.0	O K
2160 min Winter	3.280	0.000	0.0	7.0	7.0	0.0	O K
2880 min Winter	3.280	0.000	0.0	5.5	5.5	0.0	O K
4320 min Winter	3.280	0.000	0.0	4.0	4.0	0.0	O K
5760 min Winter	3.280	0.000	0.0	3.1	3.1	0.0	O K
7200 min Winter	3.280	0.000	0.0	2.6	2.6	0.0	O K
8640 min Winter	3.280	0.000	0.0	2.2	2.2	0.0	O K
10080 min Winter	3.280	0.000	0.0	2.0	2.0	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.946	0.0	130.3	34
60 min Winter	56.713	0.0	162.8	56
120 min Winter	34.162	0.0	196.2	92
180 min Winter	25.057	0.0	216.3	130
240 min Winter	19.992	0.0	229.9	166
360 min Winter	14.500	0.0	250.0	236
480 min Winter	11.545	0.0	264.9	302
600 min Winter	9.667	0.0	277.8	330
720 min Winter	8.358	0.0	288.0	382
960 min Winter	6.638	0.0	305.1	496
1440 min Winter	4.791	0.0	330.3	0
2160 min Winter	3.452	0.0	357.0	0
2880 min Winter	2.733	0.0	376.9	0
4320 min Winter	1.964	0.0	406.3	0
5760 min Winter	1.552	0.0	428.1	0
7200 min Winter	1.292	0.0	445.6	0
8640 min Winter	1.112	0.0	460.2	0
10080 min Winter	0.980	0.0	472.9	0

Model Details

Storage is Online Cover Level (m) 5.200

Cellular Storage Structure

Invert Level (m) 3.280 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	80.0	0.0	1.321	0.0	0.0
1.320	80.0	0.0			

Hydro-Brake® Outflow Control

Design Head (m) 1.320 Hydro-Brake® Type Md4 Invert Level (m) 3.080
Design Flow (l/s) 21.0 Diameter (mm) 153

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	20.0	3.000	31.6	7.000	48.3
0.200	13.0	1.400	21.6	3.500	34.1	7.500	50.0
0.300	18.1	1.600	23.1	4.000	36.5	8.000	51.6
0.400	17.1	1.800	24.5	4.500	38.7	8.500	53.2
0.500	15.4	2.000	25.8	5.000	40.8	9.000	54.7
0.600	15.1	2.200	27.1	5.500	42.8	9.500	56.2
0.800	16.4	2.400	28.3	6.000	44.7		
1.000	18.3	2.600	29.4	6.500	46.5		

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

Half Drain Time : 52 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.115	0.835	0.0	35.7	35.7	127.8	O K
30 min Summer	3.324	1.044	0.0	35.7	35.7	159.9	O K
60 min Summer	3.421	1.141	0.0	35.7	35.7	174.8	O K
120 min Summer	3.395	1.115	0.0	35.7	35.7	170.8	O K
180 min Summer	3.311	1.031	0.0	35.7	35.7	158.0	O K
240 min Summer	3.216	0.936	0.0	35.7	35.7	143.3	O K
360 min Summer	3.022	0.742	0.0	35.7	35.7	113.7	O K
480 min Summer	2.829	0.549	0.0	35.7	35.7	84.0	O K
600 min Summer	2.704	0.424	0.0	35.7	35.7	65.0	O K
720 min Summer	2.642	0.362	0.0	34.5	34.5	55.4	O K
960 min Summer	2.579	0.299	0.0	29.8	29.8	45.7	O K
1440 min Summer	2.520	0.240	0.0	22.6	22.6	36.7	O K
2160 min Summer	2.478	0.198	0.0	16.7	16.7	30.3	O K
2880 min Summer	2.454	0.174	0.0	13.3	13.3	26.7	O K
4320 min Summer	2.427	0.147	0.0	9.6	9.6	22.5	O K
5760 min Summer	2.411	0.131	0.0	7.6	7.6	20.0	O K
7200 min Summer	2.400	0.120	0.0	6.4	6.4	18.3	O K
8640 min Summer	2.391	0.111	0.0	5.5	5.5	17.0	O K
10080 min Summer	2.385	0.105	0.0	4.8	4.8	16.0	O K
15 min Winter	3.230	0.950	0.0	35.7	35.7	145.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	155.1	22
30 min Summer	90.946	0.0	203.4	34
60 min Summer	56.713	0.0	254.5	54
120 min Summer	34.162	0.0	306.7	88
180 min Summer	25.057	0.0	337.5	122
240 min Summer	19.992	0.0	359.1	156
360 min Summer	14.500	0.0	390.7	222
480 min Summer	11.545	0.0	414.8	278
600 min Summer	9.667	0.0	434.2	328
720 min Summer	8.358	0.0	450.5	384
960 min Summer	6.638	0.0	477.1	500
1440 min Summer	4.791	0.0	516.3	740
2160 min Summer	3.452	0.0	558.7	1104
2880 min Summer	2.733	0.0	589.7	1468
4320 min Summer	1.964	0.0	635.3	2204
5760 min Summer	1.552	0.0	670.1	2928
7200 min Summer	1.292	0.0	697.4	3664
8640 min Summer	1.112	0.0	720.2	4368
10080 min Summer	0.980	0.0	739.6	5120
15 min Winter	138.874	0.0	173.8	23

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	3.466	1.186	0.0	35.7	35.7	181.7	O K
60 min Winter	3.579	1.299	0.0	35.7	35.7	198.9	O K
120 min Winter	3.525	1.245	0.0	35.7	35.7	190.6	O K
180 min Winter	3.398	1.118	0.0	35.7	35.7	171.2	O K
240 min Winter	3.253	0.973	0.0	35.7	35.7	149.0	O K
360 min Winter	2.934	0.654	0.0	35.7	35.7	100.1	O K
480 min Winter	2.684	0.404	0.0	35.6	35.6	61.9	O K
600 min Winter	2.607	0.327	0.0	32.4	32.4	50.0	O K
720 min Winter	2.568	0.288	0.0	28.6	28.6	44.1	O K
960 min Winter	2.524	0.244	0.0	23.1	23.1	37.3	O K
1440 min Winter	2.479	0.199	0.0	16.8	16.8	30.5	O K
2160 min Winter	2.446	0.166	0.0	12.2	12.2	25.5	O K
2880 min Winter	2.427	0.147	0.0	9.7	9.7	22.5	O K
4320 min Winter	2.405	0.125	0.0	7.0	7.0	19.1	O K
5760 min Winter	2.392	0.112	0.0	5.5	5.5	17.1	O K
7200 min Winter	2.382	0.102	0.0	4.6	4.6	15.7	O K
8640 min Winter	2.376	0.096	0.0	4.0	4.0	14.6	O K
10080 min Winter	2.370	0.090	0.0	3.5	3.5	13.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.946	0.0	228.0	34
60 min Winter	56.713	0.0	285.1	58
120 min Winter	34.162	0.0	343.6	94
180 min Winter	25.057	0.0	378.1	132
240 min Winter	19.992	0.0	402.3	168
360 min Winter	14.500	0.0	437.7	234
480 min Winter	11.545	0.0	464.7	274
600 min Winter	9.667	0.0	486.4	326
720 min Winter	8.358	0.0	504.6	384
960 min Winter	6.638	0.0	534.4	502
1440 min Winter	4.791	0.0	578.5	742
2160 min Winter	3.452	0.0	625.8	1104
2880 min Winter	2.733	0.0	660.6	1472
4320 min Winter	1.964	0.0	711.7	2208
5760 min Winter	1.552	0.0	750.6	2936
7200 min Winter	1.292	0.0	781.2	3672
8640 min Winter	1.112	0.0	806.7	4392
10080 min Winter	0.980	0.0	828.6	5072

Model Details

Storage is Online Cover Level (m) 4.400

Cellular Storage Structure

Invert Level (m) 2.280 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	161.2	0.0	1.321	0.0	0.0
1.320	161.2	0.0			

Hydro-Brake® Outflow Control

Design Head (m) 1.320 Hydro-Brake® Type Md4 Invert Level (m) 2.280
Design Flow (l/s) 36.0 Diameter (mm) 200

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.4	1.200	34.2	3.000	54.0	7.000	82.5
0.200	16.9	1.400	36.9	3.500	58.3	7.500	85.4
0.300	30.0	1.600	39.4	4.000	62.3	8.000	88.2
0.400	35.6	1.800	41.8	4.500	66.1	8.500	90.9
0.500	34.2	2.000	44.1	5.000	69.7	9.000	93.5
0.600	31.2	2.200	46.2	5.500	73.1	9.500	96.1
0.800	29.5	2.400	48.3	6.000	76.4		
1.000	31.5	2.600	50.3	6.500	79.5		

Cascade Summary of Results for PP-02.srcx

Upstream Structures	Outflow To	Overflow To
(None)	SY-05.srcx	SY-05.srcx

Half Drain Time : 52 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	4.281	0.081	0.0	2.6	2.6	12.9	Flood Risk
30 min Summer	4.299	0.099	0.0	3.7	3.7	16.6	Flood Risk
60 min Summer	4.310	0.110	0.0	4.3	4.3	18.9	Flood Risk
120 min Summer	4.315	0.115	0.0	4.6	4.6	19.9	Flood Risk
180 min Summer	4.314	0.114	0.0	4.6	4.6	19.7	Flood Risk
240 min Summer	4.311	0.111	0.0	4.4	4.4	19.1	Flood Risk
360 min Summer	4.304	0.104	0.0	4.0	4.0	17.7	Flood Risk
480 min Summer	4.298	0.098	0.0	3.6	3.6	16.4	Flood Risk
600 min Summer	4.293	0.093	0.0	3.3	3.3	15.3	Flood Risk
720 min Summer	4.288	0.088	0.0	3.1	3.1	14.4	Flood Risk
960 min Summer	4.281	0.081	0.0	2.6	2.6	12.8	Flood Risk
1440 min Summer	4.269	0.069	0.0	2.1	2.1	10.4	Flood Risk
2160 min Summer	4.259	0.059	0.0	1.7	1.7	8.3	Flood Risk
2880 min Summer	4.254	0.054	0.0	1.4	1.4	7.2	Flood Risk
4320 min Summer	4.247	0.047	0.0	1.0	1.0	5.8	Flood Risk
5760 min Summer	4.242	0.042	0.0	0.8	0.8	4.6	Flood Risk
7200 min Summer	4.238	0.038	0.0	0.7	0.7	3.9	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	14.5	23
30 min Summer	90.946	0.0	20.0	34
60 min Summer	56.713	0.0	25.8	52
120 min Summer	34.162	0.0	31.7	84
180 min Summer	25.057	0.0	35.2	118
240 min Summer	19.992	0.0	37.5	152
360 min Summer	14.500	0.0	41.0	216
480 min Summer	11.545	0.0	43.6	280
600 min Summer	9.667	0.0	45.7	342
720 min Summer	8.358	0.0	47.4	404
960 min Summer	6.638	0.0	50.1	528
1440 min Summer	4.791	0.0	53.9	772
2160 min Summer	3.452	0.0	57.7	1128
2880 min Summer	2.733	0.0	60.2	1496
4320 min Summer	1.964	0.0	63.5	2224
5760 min Summer	1.552	0.0	65.3	2944
7200 min Summer	1.292	0.0	66.4	3680

Cascade Summary of Results for PP-02.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	4.235	0.035	0.0	0.6	0.6	3.3	Flood Risk
10080 min Summer	4.233	0.033	0.0	0.5	0.5	3.0	Flood Risk
15 min Winter	4.290	0.090	0.0	3.2	3.2	14.7	Flood Risk
30 min Winter	4.310	0.110	0.0	4.3	4.3	18.9	Flood Risk
60 min Winter	4.321	0.121	0.0	5.0	5.0	21.3	Flood Risk
120 min Winter	4.324	0.124	0.0	5.2	5.2	21.8	Flood Risk
180 min Winter	4.320	0.120	0.0	4.9	4.9	20.9	Flood Risk
240 min Winter	4.314	0.114	0.0	4.6	4.6	19.7	Flood Risk
360 min Winter	4.304	0.104	0.0	4.0	4.0	17.6	Flood Risk
480 min Winter	4.296	0.096	0.0	3.5	3.5	15.9	Flood Risk
600 min Winter	4.289	0.089	0.0	3.1	3.1	14.5	Flood Risk
720 min Winter	4.284	0.084	0.0	2.8	2.8	13.4	Flood Risk
960 min Winter	4.274	0.074	0.0	2.3	2.3	11.4	Flood Risk
1440 min Winter	4.262	0.062	0.0	1.8	1.8	8.9	Flood Risk
2160 min Winter	4.253	0.053	0.0	1.3	1.3	7.0	Flood Risk
2880 min Winter	4.248	0.048	0.0	1.1	1.1	6.0	Flood Risk
4320 min Winter	4.240	0.040	0.0	0.8	0.8	4.4	Flood Risk
5760 min Winter	4.236	0.036	0.0	0.6	0.6	3.4	Flood Risk
7200 min Winter	4.233	0.033	0.0	0.5	0.5	2.9	Flood Risk
8640 min Winter	4.230	0.030	0.0	0.4	0.4	2.4	Flood Risk
10080 min Winter	4.228	0.028	0.0	0.4	0.4	2.1	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	66.9	4408
10080 min Summer	0.980	0.0	67.1	5136
15 min Winter	138.874	0.0	16.6	23
30 min Winter	90.946	0.0	22.8	34
60 min Winter	56.713	0.0	29.3	54
120 min Winter	34.162	0.0	35.9	90
180 min Winter	25.057	0.0	39.8	126
240 min Winter	19.992	0.0	42.5	160
360 min Winter	14.500	0.0	46.4	226
480 min Winter	11.545	0.0	49.4	290
600 min Winter	9.667	0.0	51.7	354
720 min Winter	8.358	0.0	53.6	418
960 min Winter	6.638	0.0	56.7	544
1440 min Winter	4.791	0.0	61.1	784
2160 min Winter	3.452	0.0	65.4	1136
2880 min Winter	2.733	0.0	68.4	1500
4320 min Winter	1.964	0.0	72.3	2256
5760 min Winter	1.552	0.0	74.7	2944
7200 min Winter	1.292	0.0	76.2	3648
8640 min Winter	1.112	0.0	77.1	4408
10080 min Winter	0.980	0.0	77.6	5128

Cascade Model Details for PP-02.srcx

Storage is Online Cover Level (m) 4.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	18.0
Membrane Percolation (mm/hr)	1000	Length (m)	38.6
Max Percolation (l/s)	193.0	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	4.200	Cap Volume Depth (m)	0.300

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	4.200
Roughness k (mm)	0.600		

Cascade Summary of Results for SY-05.srcx

Upstream Structures	**Outflow To**	**Overflow To**
PP-02.srcx	(None)	(None)

Half Drain Time : 63 minutes.

Storm Event	**Max Level (m)**	**Max Depth (m)**	**Max Infiltration (l/s)**	**Max Control (l/s)**	**Max Σ Outflow (l/s)**	**Max Volume (m³)**	**Status**
15 min Summer	3.178	0.798	0.0	20.0	20.0	81.8	O K
30 min Summer	3.387	1.007	0.0	20.0	20.0	103.3	O K
60 min Summer	3.498	1.118	0.0	20.0	20.0	114.7	O K
120 min Summer	3.471	1.091	0.0	20.0	20.0	112.0	O K
180 min Summer	3.397	1.017	0.0	20.0	20.0	104.3	O K
240 min Summer	3.310	0.930	0.0	20.0	20.0	95.5	O K
360 min Summer	3.142	0.762	0.0	20.0	20.0	78.2	O K
480 min Summer	2.992	0.612	0.0	20.0	20.0	62.8	O K
600 min Summer	2.862	0.482	0.0	20.0	20.0	49.4	O K
720 min Summer	2.756	0.376	0.0	20.0	20.0	38.5	O K
960 min Summer	2.615	0.235	0.0	20.0	20.0	24.2	O K
1440 min Summer	2.545	0.165	0.0	16.5	16.5	16.9	O K
2160 min Summer	2.503	0.123	0.0	12.3	12.3	12.6	O K
2880 min Summer	2.479	0.099	0.0	9.9	9.9	10.2	O K
4320 min Summer	2.452	0.072	0.0	7.2	7.2	7.3	O K
5760 min Summer	2.437	0.057	0.0	5.7	5.7	5.8	O K
7200 min Summer	2.428	0.048	0.0	4.8	4.8	4.9	O K

Storm Event	**Rain (mm/hr)**	**Flooded Volume (m³)**	**Discharge Volume (m³)**	**Time-Peak (mins)**
15 min Summer	138.874	0.0	115.2	23
30 min Summer	90.946	0.0	151.9	35
60 min Summer	56.713	0.0	190.4	60
120 min Summer	34.162	0.0	230.0	94
180 min Summer	25.057	0.0	253.3	128
240 min Summer	19.992	0.0	269.6	162
360 min Summer	14.500	0.0	293.5	228
480 min Summer	11.545	0.0	311.6	290
600 min Summer	9.667	0.0	326.2	350
720 min Summer	8.358	0.0	338.4	406
960 min Summer	6.638	0.0	358.3	510
1440 min Summer	4.791	0.0	387.6	740
2160 min Summer	3.452	0.0	418.4	1104
2880 min Summer	2.733	0.0	441.0	1472
4320 min Summer	1.964	0.0	473.9	2200
5760 min Summer	1.552	0.0	497.8	2936
7200 min Summer	1.292	0.0	516.5	3664

Cascade Summary of Results for SY-05.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	2.421	0.041	0.0	4.1	4.1	4.2	O K
10080 min Summer	2.416	0.036	0.0	3.6	3.6	3.7	O K
15 min Winter	3.293	0.913	0.0	20.0	20.0	93.6	O K
30 min Winter	3.538	1.158	0.0	20.0	20.0	118.8	O K
60 min Winter	3.686	1.306	0.0	20.0	20.0	134.0	O K
120 min Winter	3.651	1.271	0.0	20.0	20.0	130.4	O K
180 min Winter	3.540	1.160	0.0	20.0	20.0	119.0	O K
240 min Winter	3.407	1.027	0.0	20.0	20.0	105.3	O K
360 min Winter	3.143	0.763	0.0	20.0	20.0	78.3	O K
480 min Winter	2.913	0.533	0.0	20.0	20.0	54.7	O K
600 min Winter	2.728	0.348	0.0	20.0	20.0	35.7	O K
720 min Winter	2.605	0.225	0.0	20.0	20.0	23.1	O K
960 min Winter	2.550	0.170	0.0	17.0	17.0	17.5	O K
1440 min Winter	2.506	0.126	0.0	12.6	12.6	12.9	O K
2160 min Winter	2.472	0.092	0.0	9.2	9.2	9.4	O K
2880 min Winter	2.453	0.073	0.0	7.3	7.3	7.4	O K
4320 min Winter	2.432	0.052	0.0	5.2	5.2	5.4	O K
5760 min Winter	2.422	0.042	0.0	4.2	4.2	4.3	O K
7200 min Winter	2.415	0.035	0.0	3.5	3.5	3.5	O K
8640 min Winter	2.410	0.030	0.0	3.0	3.0	3.0	O K
10080 min Winter	2.406	0.026	0.0	2.6	2.6	2.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	531.8	4400
10080 min Summer	0.980	0.0	544.8	5096
15 min Winter	138.874	0.0	129.4	23
30 min Winter	90.946	0.0	170.6	36
60 min Winter	56.713	0.0	213.7	62
120 min Winter	34.162	0.0	258.0	102
180 min Winter	25.057	0.0	284.2	140
240 min Winter	19.992	0.0	302.4	176
360 min Winter	14.500	0.0	329.2	244
480 min Winter	11.545	0.0	349.6	306
600 min Winter	9.667	0.0	365.9	360
720 min Winter	8.358	0.0	379.6	402
960 min Winter	6.638	0.0	401.9	506
1440 min Winter	4.791	0.0	434.8	744
2160 min Winter	3.452	0.0	469.4	1104
2880 min Winter	2.733	0.0	494.9	1468
4320 min Winter	1.964	0.0	532.0	2208
5760 min Winter	1.552	0.0	559.0	2936
7200 min Winter	1.292	0.0	580.3	3664
8640 min Winter	1.112	0.0	597.8	4376
10080 min Winter	0.980	0.0	612.6	5112

Cascade Model Details for SY-05.srcx

Storage is Online Cover Level (m) 4.500

Cellular Storage Structure

Invert Level (m) 2.380 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	108.0	0.0	1.321	0.0	0.0
1.320	108.0	0.0			

Pump Outflow Control

Invert Level (m) 2.380

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	20.0000	0.600	20.0000	1.000	20.0000	1.400	20.0000
0.400	20.0000	0.800	20.0000	1.200	20.0000	6.000	20.0000

Cascade Summary of Results for PP-03.srcx

Upstream Structures	Outflow To	Overflow To
(None)	SY-06.srcx	(None)

Half Drain Time : 38 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.972	0.072	0.0	2.2	2.2	8.2	O K
30 min Summer	3.988	0.088	0.0	3.0	3.0	10.4	O K
60 min Summer	3.997	0.097	0.0	3.6	3.6	11.7	O K
120 min Summer	4.000	0.100	0.0	3.8	3.8	12.1	Flood Risk
180 min Summer	3.998	0.098	0.0	3.6	3.6	11.8	O K
240 min Summer	3.995	0.095	0.0	3.4	3.4	11.3	O K
360 min Summer	3.988	0.088	0.0	3.0	3.0	10.4	O K
480 min Summer	3.982	0.082	0.0	2.7	2.7	9.6	O K
600 min Summer	3.976	0.076	0.0	2.4	2.4	8.9	O K
720 min Summer	3.972	0.072	0.0	2.2	2.2	8.3	O K
960 min Summer	3.965	0.065	0.0	1.9	1.9	7.3	O K
1440 min Summer	3.956	0.056	0.0	1.5	1.5	6.1	O K
2160 min Summer	3.950	0.050	0.0	1.2	1.2	5.2	O K
2880 min Summer	3.945	0.045	0.0	0.9	0.9	4.5	O K
4320 min Summer	3.938	0.038	0.0	0.7	0.7	3.6	O K
5760 min Summer	3.934	0.034	0.0	0.5	0.5	3.0	O K
7200 min Summer	3.931	0.031	0.0	0.4	0.4	2.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	9.4	22
30 min Summer	90.946	0.0	13.0	32
60 min Summer	56.713	0.0	16.8	50
120 min Summer	34.162	0.0	20.7	82
180 min Summer	25.057	0.0	22.9	114
240 min Summer	19.992	0.0	24.5	148
360 min Summer	14.500	0.0	26.7	210
480 min Summer	11.545	0.0	28.4	272
600 min Summer	9.667	0.0	29.8	334
720 min Summer	8.358	0.0	30.9	396
960 min Summer	6.638	0.0	32.7	516
1440 min Summer	4.791	0.0	35.2	756
2160 min Summer	3.452	0.0	37.6	1124
2880 min Summer	2.733	0.0	39.3	1484
4320 min Summer	1.964	0.0	41.4	2208
5760 min Summer	1.552	0.0	42.6	2944
7200 min Summer	1.292	0.0	43.3	3680

Cascade Summary of Results for PP-03.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	3.928	0.028	0.0	0.4	0.4	2.3	O K
10080 min Summer	3.927	0.027	0.0	0.3	0.3	2.1	O K
15 min Winter	3.980	0.080	0.0	2.6	2.6	9.4	O K
30 min Winter	3.998	0.098	0.0	3.6	3.6	11.8	O K
60 min Winter	4.007	0.107	0.0	4.2	4.2	13.0	Flood Risk
120 min Winter	4.007	0.107	0.0	4.2	4.2	13.0	Flood Risk
180 min Winter	4.001	0.101	0.0	3.8	3.8	12.2	Flood Risk
240 min Winter	3.995	0.095	0.0	3.5	3.5	11.4	O K
360 min Winter	3.985	0.085	0.0	2.9	2.9	10.1	O K
480 min Winter	3.978	0.078	0.0	2.5	2.5	9.0	O K
600 min Winter	3.971	0.071	0.0	2.2	2.2	8.1	O K
720 min Winter	3.966	0.066	0.0	2.0	2.0	7.4	O K
960 min Winter	3.958	0.058	0.0	1.6	1.6	6.4	O K
1440 min Winter	3.951	0.051	0.0	1.2	1.2	5.4	O K
2160 min Winter	3.944	0.044	0.0	0.9	0.9	4.4	O K
2880 min Winter	3.938	0.038	0.0	0.7	0.7	3.7	O K
4320 min Winter	3.933	0.033	0.0	0.5	0.5	2.9	O K
5760 min Winter	3.929	0.029	0.0	0.4	0.4	2.4	O K
7200 min Winter	3.926	0.026	0.0	0.3	0.3	2.0	O K
8640 min Winter	3.924	0.024	0.0	0.3	0.3	1.7	O K
10080 min Winter	3.923	0.023	0.0	0.2	0.2	1.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	43.6	4408
10080 min Summer	0.980	0.0	43.7	5136
15 min Winter	138.874	0.0	10.8	23
30 min Winter	90.946	0.0	14.9	33
60 min Winter	56.713	0.0	19.1	52
120 min Winter	34.162	0.0	23.4	86
180 min Winter	25.057	0.0	26.0	120
240 min Winter	19.992	0.0	27.7	154
360 min Winter	14.500	0.0	30.3	220
480 min Winter	11.545	0.0	32.2	282
600 min Winter	9.667	0.0	33.7	346
720 min Winter	8.358	0.0	35.0	406
960 min Winter	6.638	0.0	37.0	522
1440 min Winter	4.791	0.0	39.8	766
2160 min Winter	3.452	0.0	42.7	1144
2880 min Winter	2.733	0.0	44.6	1508
4320 min Winter	1.964	0.0	47.1	2252
5760 min Winter	1.552	0.0	48.7	2952
7200 min Winter	1.292	0.0	49.6	3712
8640 min Winter	1.112	0.0	50.2	4496
10080 min Winter	0.980	0.0	50.6	5176

Cascade Model Details for PP-03.srcx

Storage is Online Cover Level (m) 4.300

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	22.7
Max Percolation (l/s)	126.1	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.900	Cap Volume Depth (m)	0.300

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	3.900
Roughness k (mm)	0.600		

Cascade Summary of Results for PP-04.srcx

Upstream Structures	Outflow To	Overflow To
(None)	SY-06.srcx	(None)

Half Drain Time : 32 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	4.313	0.113	0.0	10.2	10.2	20.4	Flood Risk
30 min Summer	4.330	0.130	0.0	10.4	10.4	26.9	Flood Risk
60 min Summer	4.333	0.133	0.0	10.5	10.5	28.5	Flood Risk
120 min Summer	4.325	0.125	0.0	10.4	10.4	25.1	Flood Risk
180 min Summer	4.314	0.114	0.0	10.2	10.2	20.8	Flood Risk
240 min Summer	4.302	0.102	0.0	10.1	10.1	16.5	Flood Risk
360 min Summer	4.277	0.077	0.0	9.8	9.8	9.6	Flood Risk
480 min Summer	4.255	0.055	0.0	9.5	9.5	4.9	Flood Risk
600 min Summer	4.234	0.034	0.0	9.2	9.2	1.9	Flood Risk
720 min Summer	4.214	0.014	0.0	8.9	8.9	0.3	Flood Risk
960 min Summer	4.200	0.000	0.0	7.4	7.4	0.0	O K
1440 min Summer	4.200	0.000	0.0	5.4	5.4	0.0	O K
2160 min Summer	4.200	0.000	0.0	3.8	3.8	0.0	O K
2880 min Summer	4.200	0.000	0.0	3.0	3.0	0.0	O K
4320 min Summer	4.200	0.000	0.0	2.2	2.2	0.0	O K
5760 min Summer	4.200	0.000	0.0	1.7	1.7	0.0	O K
7200 min Summer	4.200	0.000	0.0	1.4	1.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	28.9	21
30 min Summer	90.946	0.0	40.0	32
60 min Summer	56.713	0.0	51.6	50
120 min Summer	34.162	0.0	63.8	84
180 min Summer	25.057	0.0	70.1	116
240 min Summer	19.992	0.0	75.0	148
360 min Summer	14.500	0.0	82.2	208
480 min Summer	11.545	0.0	87.2	266
600 min Summer	9.667	0.0	91.2	320
720 min Summer	8.358	0.0	94.8	374
960 min Summer	6.638	0.0	100.2	0
1440 min Summer	4.791	0.0	107.9	0
2160 min Summer	3.452	0.0	115.4	0
2880 min Summer	2.733	0.0	120.5	0
4320 min Summer	1.964	0.0	126.9	0
5760 min Summer	1.552	0.0	130.6	0
7200 min Summer	1.292	0.0	132.7	0

Cascade Summary of Results for PP-04.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	4.200	0.000	0.0	1.2	1.2	0.0	O K
10080 min Summer	4.200	0.000	0.0	1.1	1.1	0.0	O K
15 min Winter	4.323	0.123	0.0	10.3	10.3	24.1	Flood Risk
30 min Winter	4.341	0.141	0.0	10.6	10.6	31.7	Flood Risk
60 min Winter	4.345	0.145	0.0	10.6	10.6	33.2	Flood Risk
120 min Winter	4.332	0.132	0.0	10.5	10.5	28.0	Flood Risk
180 min Winter	4.315	0.115	0.0	10.2	10.2	21.2	Flood Risk
240 min Winter	4.296	0.096	0.0	10.0	10.0	14.9	Flood Risk
360 min Winter	4.258	0.058	0.0	9.5	9.5	5.4	Flood Risk
480 min Winter	4.218	0.018	0.0	9.0	9.0	0.5	Flood Risk
600 min Winter	4.200	0.000	0.0	7.8	7.8	0.0	O K
720 min Winter	4.200	0.000	0.0	6.8	6.8	0.0	O K
960 min Winter	4.200	0.000	0.0	5.4	5.4	0.0	O K
1440 min Winter	4.200	0.000	0.0	3.9	3.9	0.0	O K
2160 min Winter	4.200	0.000	0.0	2.8	2.8	0.0	O K
2880 min Winter	4.200	0.000	0.0	2.2	2.2	0.0	O K
4320 min Winter	4.200	0.000	0.0	1.6	1.6	0.0	O K
5760 min Winter	4.200	0.000	0.0	1.2	1.2	0.0	O K
7200 min Winter	4.200	0.000	0.0	1.0	1.0	0.0	O K
8640 min Winter	4.200	0.000	0.0	0.9	0.9	0.0	O K
10080 min Winter	4.200	0.000	0.0	0.7	0.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	133.8	0
10080 min Summer	0.980	0.0	134.2	0
15 min Winter	138.874	0.0	33.1	22
30 min Winter	90.946	0.0	45.6	33
60 min Winter	56.713	0.0	58.0	54
120 min Winter	34.162	0.0	71.7	90
180 min Winter	25.057	0.0	79.3	124
240 min Winter	19.992	0.0	85.3	156
360 min Winter	14.500	0.0	92.8	214
480 min Winter	11.545	0.0	98.7	260
600 min Winter	9.667	0.0	103.3	0
720 min Winter	8.358	0.0	107.2	0
960 min Winter	6.638	0.0	113.4	0
1440 min Winter	4.791	0.0	122.2	0
2160 min Winter	3.452	0.0	130.9	0
2880 min Winter	2.733	0.0	136.9	0
4320 min Winter	1.964	0.0	144.6	0
5760 min Winter	1.552	0.0	149.3	0
7200 min Winter	1.292	0.0	152.3	0
8640 min Winter	1.112	0.0	154.1	0
10080 min Winter	0.980	0.0	155.2	0

Cascade Model Details for PP-04.srcx

Storage is Online Cover Level (m) 4.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.7
Membrane Percolation (mm/hr)	1000	Length (m)	130.0
Max Percolation (l/s)	386.4	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	4.200	Cap Volume Depth (m)	0.300

Pipe Outflow Control

Diameter (m)	0.100	Entry Loss Coefficient	0.500
Slope (1:X)	100.0	Coefficient of Contraction	0.600
Length (m)	10.000	Upstream Invert Level (m)	3.900
Roughness k (mm)	0.600		

Cascade Summary of Results for SY-06.srcx

Upstream Structures	Outflow To	Overflow To
PP-04.srcx PP-03.srcx	(None)	(None)

Half Drain Time : 178 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	2.712	0.532	0.0	10.0	10.0	83.4	O K
30 min Summer	2.891	0.711	0.0	10.0	10.0	111.4	O K
60 min Summer	3.077	0.897	0.0	10.0	10.0	140.6	O K
120 min Summer	3.254	1.074	0.0	10.0	10.0	168.4	O K
180 min Summer	3.316	1.136	0.0	10.0	10.0	178.1	O K
240 min Summer	3.294	1.114	0.0	10.0	10.0	174.5	O K
360 min Summer	3.237	1.057	0.0	10.0	10.0	165.6	O K
480 min Summer	3.173	0.993	0.0	10.0	10.0	155.7	O K
600 min Summer	3.109	0.929	0.0	10.0	10.0	145.6	O K
720 min Summer	3.046	0.866	0.0	10.0	10.0	135.8	O K
960 min Summer	2.923	0.743	0.0	10.0	10.0	116.4	O K
1440 min Summer	2.708	0.528	0.0	10.0	10.0	82.8	O K
2160 min Summer	2.487	0.307	0.0	10.0	10.0	48.1	O K
2880 min Summer	2.381	0.201	0.0	10.0	10.0	31.5	O K
4320 min Summer	2.330	0.150	0.0	7.5	7.5	23.5	O K
5760 min Summer	2.300	0.120	0.0	6.0	6.0	18.8	O K
7200 min Summer	2.281	0.101	0.0	5.0	5.0	15.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	118.0	57
30 min Summer	90.946	0.0	157.3	81
60 min Summer	56.713	0.0	198.5	108
120 min Summer	34.162	0.0	241.1	146
180 min Summer	25.057	0.0	265.5	178
240 min Summer	19.992	0.0	283.0	202
360 min Summer	14.500	0.0	308.6	264
480 min Summer	11.545	0.0	327.5	330
600 min Summer	9.667	0.0	342.8	398
720 min Summer	8.358	0.0	355.8	464
960 min Summer	6.638	0.0	376.5	594
1440 min Summer	4.791	0.0	406.8	840
2160 min Summer	3.452	0.0	438.2	1176
2880 min Summer	2.733	0.0	460.8	1480
4320 min Summer	1.964	0.0	492.7	2208
5760 min Summer	1.552	0.0	515.1	2944
7200 min Summer	1.292	0.0	531.8	3672

Cascade Summary of Results for SY-06.srcx

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	2.267	0.087	0.0	4.3	4.3	13.6	O K
10080 min Summer	2.257	0.077	0.0	3.8	3.8	12.0	O K
15 min Winter	2.783	0.603	0.0	10.0	10.0	94.6	O K
30 min Winter	2.986	0.806	0.0	10.0	10.0	126.3	O K
60 min Winter	3.197	1.017	0.0	10.0	10.0	159.4	O K
120 min Winter	3.401	1.221	0.0	10.0	10.0	191.4	O K
180 min Winter	3.497	1.317	0.0	10.0	10.0	206.4	O K
240 min Winter	3.483	1.303	0.0	10.0	10.0	204.3	O K
360 min Winter	3.396	1.216	0.0	10.0	10.0	190.6	O K
480 min Winter	3.305	1.125	0.0	10.0	10.0	176.4	O K
600 min Winter	3.207	1.027	0.0	10.0	10.0	161.0	O K
720 min Winter	3.108	0.928	0.0	10.0	10.0	145.4	O K
960 min Winter	2.917	0.737	0.0	10.0	10.0	115.5	O K
1440 min Winter	2.599	0.419	0.0	10.0	10.0	65.7	O K
2160 min Winter	2.372	0.192	0.0	9.6	9.6	30.1	O K
2880 min Winter	2.334	0.154	0.0	7.7	7.7	24.1	O K
4320 min Winter	2.291	0.111	0.0	5.6	5.6	17.4	O K
5760 min Winter	2.268	0.088	0.0	4.4	4.4	13.8	O K
7200 min Winter	2.253	0.073	0.0	3.7	3.7	11.4	O K
8640 min Winter	2.243	0.063	0.0	3.1	3.1	9.8	O K
10080 min Winter	2.235	0.055	0.0	2.8	2.8	8.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	545.0	4408
10080 min Summer	0.980	0.0	555.6	5136
15 min Winter	138.874	0.0	133.1	64
30 min Winter	90.946	0.0	177.3	89
60 min Winter	56.713	0.0	222.8	116
120 min Winter	34.162	0.0	270.6	154
180 min Winter	25.057	0.0	298.5	186
240 min Winter	19.992	0.0	318.5	228
360 min Winter	14.500	0.0	346.7	284
480 min Winter	11.545	0.0	368.3	358
600 min Winter	9.667	0.0	385.4	432
720 min Winter	8.358	0.0	399.9	502
960 min Winter	6.638	0.0	423.3	634
1440 min Winter	4.791	0.0	457.6	870
2160 min Winter	3.452	0.0	492.9	1132
2880 min Winter	2.733	0.0	518.6	1500
4320 min Winter	1.964	0.0	555.2	2208
5760 min Winter	1.552	0.0	580.9	2944
7200 min Winter	1.292	0.0	600.5	3656
8640 min Winter	1.112	0.0	616.1	4400
10080 min Winter	0.980	0.0	628.8	5136

Cascade Model Details for SY-06.srcx

Storage is Online Cover Level (m) 4.300

Cellular Storage Structure

Invert Level (m) 2.180 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	165.0	0.0	1.321	0.0	0.0
1.320	165.0	0.0			

Pump Outflow Control

Invert Level (m) 2.180

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.200	10.0000	0.600	10.0000	1.000	10.0000	1.400	10.0000
0.400	10.0000	0.800	10.0000	1.200	10.0000	6.000	10.0000

Cascade Summary of Results for PP-05 md.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	SY-07 md.SRCX	(None)

Half Drain Time : 424 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.742	0.092	0.0	0.5	0.5	13.6	O K
30 min Summer	3.767	0.117	0.0	0.6	0.6	18.6	O K
60 min Summer	3.791	0.141	0.0	0.7	0.7	23.5	O K
120 min Summer	3.812	0.162	0.0	0.7	0.7	27.7	Flood Risk
180 min Summer	3.820	0.170	0.0	0.7	0.7	29.5	Flood Risk
240 min Summer	3.824	0.174	0.0	0.7	0.7	30.1	Flood Risk
360 min Summer	3.825	0.175	0.0	0.8	0.8	30.4	Flood Risk
480 min Summer	3.825	0.175	0.0	0.8	0.8	30.3	Flood Risk
600 min Summer	3.824	0.174	0.0	0.7	0.7	30.1	Flood Risk
720 min Summer	3.822	0.172	0.0	0.7	0.7	29.8	Flood Risk
960 min Summer	3.818	0.168	0.0	0.7	0.7	29.0	Flood Risk
1440 min Summer	3.808	0.158	0.0	0.7	0.7	27.0	Flood Risk
2160 min Summer	3.793	0.143	0.0	0.7	0.7	23.8	O K
2880 min Summer	3.779	0.129	0.0	0.6	0.6	21.0	O K
4320 min Summer	3.757	0.107	0.0	0.6	0.6	16.6	O K
5760 min Summer	3.741	0.091	0.0	0.5	0.5	13.3	O K
7200 min Summer	3.728	0.078	0.0	0.5	0.5	10.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	14.0	26
30 min Summer	90.946	0.0	19.4	40
60 min Summer	56.713	0.0	25.0	68
120 min Summer	34.162	0.0	30.8	126
180 min Summer	25.057	0.0	34.1	184
240 min Summer	19.992	0.0	36.5	242
360 min Summer	14.500	0.0	39.8	322
480 min Summer	11.545	0.0	42.3	382
600 min Summer	9.667	0.0	44.3	444
720 min Summer	8.358	0.0	46.0	510
960 min Summer	6.638	0.0	48.6	648
1440 min Summer	4.791	0.0	52.4	920
2160 min Summer	3.452	0.0	56.0	1324
2880 min Summer	2.733	0.0	58.5	1712
4320 min Summer	1.964	0.0	61.6	2468
5760 min Summer	1.552	0.0	63.4	3224
7200 min Summer	1.292	0.0	64.4	3904

Cascade Summary of Results for PP-05 md.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	3.719	0.069	0.0	0.4	0.4	8.9	O K
10080 min Summer	3.712	0.062	0.0	0.4	0.4	7.4	O K
15 min Winter	3.752	0.102	0.0	0.6	0.6	15.7	O K
30 min Winter	3.780	0.130	0.0	0.6	0.6	21.3	O K
60 min Winter	3.808	0.158	0.0	0.7	0.7	26.9	Flood Risk
120 min Winter	3.831	0.181	0.0	0.8	0.8	31.7	Flood Risk
180 min Winter	3.842	0.192	0.0	0.8	0.8	33.7	Flood Risk
240 min Winter	3.846	0.196	0.0	0.8	0.8	34.6	Flood Risk
360 min Winter	3.848	0.198	0.0	0.8	0.8	35.0	Flood Risk
480 min Winter	3.846	0.196	0.0	0.8	0.8	34.7	Flood Risk
600 min Winter	3.845	0.195	0.0	0.8	0.8	34.3	Flood Risk
720 min Winter	3.842	0.192	0.0	0.8	0.8	33.8	Flood Risk
960 min Winter	3.836	0.186	0.0	0.8	0.8	32.5	Flood Risk
1440 min Winter	3.820	0.170	0.0	0.7	0.7	29.4	Flood Risk
2160 min Winter	3.798	0.148	0.0	0.7	0.7	24.9	O K
2880 min Winter	3.779	0.129	0.0	0.6	0.6	21.0	O K
4320 min Winter	3.750	0.100	0.0	0.5	0.5	15.1	O K
5760 min Winter	3.730	0.080	0.0	0.5	0.5	11.0	O K
7200 min Winter	3.716	0.066	0.0	0.4	0.4	8.2	O K
8640 min Winter	3.705	0.055	0.0	0.4	0.4	6.2	O K
10080 min Winter	3.698	0.048	0.0	0.3	0.3	4.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	65.0	4664
10080 min Summer	0.980	0.0	65.2	5352
15 min Winter	138.874	0.0	16.1	26
30 min Winter	90.946	0.0	22.1	40
60 min Winter	56.713	0.0	28.4	68
120 min Winter	34.162	0.0	34.9	124
180 min Winter	25.057	0.0	38.7	182
240 min Winter	19.992	0.0	41.3	238
360 min Winter	14.500	0.0	45.1	346
480 min Winter	11.545	0.0	47.9	400
600 min Winter	9.667	0.0	50.2	470
720 min Winter	8.358	0.0	52.1	546
960 min Winter	6.638	0.0	55.0	700
1440 min Winter	4.791	0.0	59.3	996
2160 min Winter	3.452	0.0	63.5	1412
2880 min Winter	2.733	0.0	66.4	1820
4320 min Winter	1.964	0.0	70.2	2596
5760 min Winter	1.552	0.0	72.5	3336
7200 min Winter	1.292	0.0	73.9	4040
8640 min Winter	1.112	0.0	74.8	4752
10080 min Winter	0.980	0.0	75.4	5360

Cascade Model Details for PP-05 md.SRCX

Storage is Online Cover Level (m) 4.100

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	13.5
Membrane Percolation (mm/hr)	1000	Length (m)	50.0
Max Percolation (l/s)	187.5	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.650	Cap Volume Depth (m)	0.300

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 3.650

Cascade Summary of Results for PP-06 md.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	SY-07 md.SRCX	(None)

Half Drain Time : 297 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.729	0.079	0.0	0.5	0.5	9.1	O K
30 min Summer	3.754	0.104	0.0	0.6	0.6	12.4	O K
60 min Summer	3.777	0.127	0.0	0.6	0.6	15.5	O K
120 min Summer	3.795	0.145	0.0	0.7	0.7	18.0	O K
180 min Summer	3.801	0.151	0.0	0.7	0.7	18.8	Flood Risk
240 min Summer	3.803	0.153	0.0	0.7	0.7	18.9	Flood Risk
360 min Summer	3.803	0.153	0.0	0.7	0.7	19.0	Flood Risk
480 min Summer	3.803	0.153	0.0	0.7	0.7	18.9	Flood Risk
600 min Summer	3.801	0.151	0.0	0.7	0.7	18.7	Flood Risk
720 min Summer	3.798	0.148	0.0	0.7	0.7	18.4	O K
960 min Summer	3.793	0.143	0.0	0.7	0.7	17.6	O K
1440 min Summer	3.780	0.130	0.0	0.6	0.6	15.9	O K
2160 min Summer	3.763	0.113	0.0	0.6	0.6	13.6	O K
2880 min Summer	3.748	0.098	0.0	0.5	0.5	11.7	O K
4320 min Summer	3.728	0.078	0.0	0.5	0.5	8.9	O K
5760 min Summer	3.714	0.064	0.0	0.4	0.4	7.1	O K
7200 min Summer	3.705	0.055	0.0	0.4	0.4	5.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	9.5	26
30 min Summer	90.946	0.0	13.1	40
60 min Summer	56.713	0.0	16.8	68
120 min Summer	34.162	0.0	20.7	124
180 min Summer	25.057	0.0	23.0	182
240 min Summer	19.992	0.0	24.5	218
360 min Summer	14.500	0.0	26.8	278
480 min Summer	11.545	0.0	28.5	342
600 min Summer	9.667	0.0	29.8	410
720 min Summer	8.358	0.0	30.9	478
960 min Summer	6.638	0.0	32.7	616
1440 min Summer	4.791	0.0	35.2	884
2160 min Summer	3.452	0.0	37.7	1276
2880 min Summer	2.733	0.0	39.4	1648
4320 min Summer	1.964	0.0	41.5	2380
5760 min Summer	1.552	0.0	42.7	3112
7200 min Summer	1.292	0.0	43.4	3816

Cascade Summary of Results for PP-06 md.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	3.698	0.048	0.0	0.3	0.3	4.9	O K
10080 min Summer	3.693	0.043	0.0	0.3	0.3	4.3	O K
15 min Winter	3.739	0.089	0.0	0.5	0.5	10.5	O K
30 min Winter	3.767	0.117	0.0	0.6	0.6	14.2	O K
60 min Winter	3.793	0.143	0.0	0.7	0.7	17.7	O K
120 min Winter	3.815	0.165	0.0	0.7	0.7	20.6	Flood Risk
180 min Winter	3.822	0.172	0.0	0.7	0.7	21.6	Flood Risk
240 min Winter	3.824	0.174	0.0	0.7	0.7	21.8	Flood Risk
360 min Winter	3.823	0.173	0.0	0.7	0.7	21.6	Flood Risk
480 min Winter	3.821	0.171	0.0	0.7	0.7	21.4	Flood Risk
600 min Winter	3.817	0.167	0.0	0.7	0.7	20.9	Flood Risk
720 min Winter	3.813	0.163	0.0	0.7	0.7	20.3	Flood Risk
960 min Winter	3.804	0.154	0.0	0.7	0.7	19.1	Flood Risk
1440 min Winter	3.785	0.135	0.0	0.7	0.7	16.5	O K
2160 min Winter	3.760	0.110	0.0	0.6	0.6	13.3	O K
2880 min Winter	3.742	0.092	0.0	0.5	0.5	10.8	O K
4320 min Winter	3.717	0.067	0.0	0.4	0.4	7.5	O K
5760 min Winter	3.702	0.052	0.0	0.4	0.4	5.5	O K
7200 min Winter	3.693	0.043	0.0	0.3	0.3	4.3	O K
8640 min Winter	3.689	0.039	0.0	0.3	0.3	3.7	O K
10080 min Winter	3.686	0.036	0.0	0.2	0.2	3.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	43.8	4504
10080 min Summer	0.980	0.0	44.0	5240
15 min Winter	138.874	0.0	10.9	26
30 min Winter	90.946	0.0	14.9	39
60 min Winter	56.713	0.0	19.1	66
120 min Winter	34.162	0.0	23.5	122
180 min Winter	25.057	0.0	26.0	178
240 min Winter	19.992	0.0	27.8	232
360 min Winter	14.500	0.0	30.3	290
480 min Winter	11.545	0.0	32.2	366
600 min Winter	9.667	0.0	33.7	442
720 min Winter	8.358	0.0	35.0	518
960 min Winter	6.638	0.0	37.0	664
1440 min Winter	4.791	0.0	39.9	944
2160 min Winter	3.452	0.0	42.8	1344
2880 min Winter	2.733	0.0	44.7	1728
4320 min Winter	1.964	0.0	47.3	2464
5760 min Winter	1.552	0.0	48.8	3168
7200 min Winter	1.292	0.0	49.8	3816
8640 min Winter	1.112	0.0	50.4	4504
10080 min Winter	0.980	0.0	50.8	5216

Cascade Model Details for PP-06 md.SRCX

Storage is Online Cover Level (m) 4.100

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	22.3
Max Percolation (l/s)	123.9	Slope (1:X)	1000.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	3.650	Cap Volume Depth (m)	0.300

Orifice Outflow Control

Diameter (m) 0.030 Discharge Coefficient 0.600 Invert Level (m) 3.650

Cascade Summary of Results for SY-07 md.SRCX

Upstream Structures	Outflow To	Overflow To
PP-05 md.SRCX PP-06 md.SRCX	(None)	(None)

Half Drain Time : 54 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	3.026	0.846	0.0	110.9	110.9	421.4	O K
30 min Summer	3.235	1.055	0.0	111.7	111.7	525.4	O K
60 min Summer	3.341	1.161	0.0	116.9	116.9	578.0	O K
120 min Summer	3.334	1.154	0.0	116.5	116.5	574.7	O K
180 min Summer	3.263	1.083	0.0	113.0	113.0	539.1	O K
240 min Summer	3.176	0.996	0.0	110.9	110.9	496.2	O K
360 min Summer	3.004	0.824	0.0	110.9	110.9	410.5	O K
480 min Summer	2.844	0.664	0.0	110.9	110.9	330.6	O K
600 min Summer	2.737	0.557	0.0	110.3	110.3	277.2	O K
720 min Summer	2.670	0.490	0.0	104.7	104.7	243.8	O K
960 min Summer	2.585	0.405	0.0	92.5	92.5	201.7	O K
1440 min Summer	2.502	0.322	0.0	72.2	72.2	160.4	O K
2160 min Summer	2.442	0.262	0.0	54.2	54.2	130.7	O K
2880 min Summer	2.409	0.229	0.0	43.9	43.9	113.9	O K
4320 min Summer	2.370	0.190	0.0	32.1	32.1	94.4	O K
5760 min Summer	2.347	0.167	0.0	25.6	25.6	83.0	O K
7200 min Summer	2.331	0.151	0.0	21.5	21.5	75.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	528.6	22
30 min Summer	90.946	0.0	694.8	33
60 min Summer	56.713	0.0	871.7	54
120 min Summer	34.162	0.0	1051.5	86
180 min Summer	25.057	0.0	1157.4	120
240 min Summer	19.992	0.0	1231.6	154
360 min Summer	14.500	0.0	1340.2	220
480 min Summer	11.545	0.0	1422.9	278
600 min Summer	9.667	0.0	1489.3	332
720 min Summer	8.358	0.0	1545.2	390
960 min Summer	6.638	0.0	1636.1	508
1440 min Summer	4.791	0.0	1770.2	744
2160 min Summer	3.452	0.0	1915.5	1108
2880 min Summer	2.733	0.0	2020.8	1472
4320 min Summer	1.964	0.0	2174.7	2204
5760 min Summer	1.552	0.0	2291.2	2936
7200 min Summer	1.292	0.0	2381.9	3672

Cascade Summary of Results for SY-07 md.SRCX

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
8640 min Summer	2.319	0.139	0.0	18.5	18.5	69.5	O K
10080 min Summer	2.311	0.131	0.0	16.4	16.4	65.0	O K
15 min Winter	3.140	0.960	0.0	110.9	110.9	477.9	O K
30 min Winter	3.376	1.196	0.0	118.6	118.6	595.8	O K
60 min Winter	3.494	1.314	0.0	124.2	124.2	654.3	O K
120 min Winter	3.457	1.277	0.0	122.5	122.5	635.8	O K
180 min Winter	3.344	1.164	0.0	117.0	117.0	579.4	O K
240 min Winter	3.213	1.033	0.0	110.9	110.9	514.7	O K
360 min Winter	2.948	0.768	0.0	110.9	110.9	382.2	O K
480 min Winter	2.738	0.558	0.0	110.3	110.3	277.6	O K
600 min Winter	2.639	0.459	0.0	101.1	101.1	228.4	O K
720 min Winter	2.580	0.400	0.0	91.5	91.5	199.0	O K
960 min Winter	2.513	0.333	0.0	75.2	75.2	165.8	O K
1440 min Winter	2.447	0.267	0.0	55.6	55.6	132.7	O K
2160 min Winter	2.398	0.218	0.0	40.6	40.6	108.6	O K
2880 min Winter	2.371	0.191	0.0	32.4	32.4	95.0	O K
4320 min Winter	2.339	0.159	0.0	23.6	23.6	79.2	O K
5760 min Winter	2.320	0.140	0.0	18.7	18.7	69.8	O K
7200 min Winter	2.307	0.127	0.0	15.6	15.6	63.4	O K
8640 min Winter	2.298	0.118	0.0	13.5	13.5	58.6	O K
10080 min Winter	2.290	0.110	0.0	11.9	11.9	54.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.112	0.0	2457.2	4400
10080 min Summer	0.980	0.0	2520.8	5136
15 min Winter	138.874	0.0	593.0	23
30 min Winter	90.946	0.0	779.1	34
60 min Winter	56.713	0.0	977.2	56
120 min Winter	34.162	0.0	1178.5	94
180 min Winter	25.057	0.0	1297.2	130
240 min Winter	19.992	0.0	1380.3	166
360 min Winter	14.500	0.0	1502.0	232
480 min Winter	11.545	0.0	1594.7	282
600 min Winter	9.667	0.0	1669.1	338
720 min Winter	8.358	0.0	1731.7	394
960 min Winter	6.638	0.0	1833.6	510
1440 min Winter	4.791	0.0	1983.9	750
2160 min Winter	3.452	0.0	2146.8	1108
2880 min Winter	2.733	0.0	2265.1	1472
4320 min Winter	1.964	0.0	2438.1	2200
5760 min Winter	1.552	0.0	2568.7	2936
7200 min Winter	1.292	0.0	2670.8	3672
8640 min Winter	1.112	0.0	2755.7	4408
10080 min Winter	0.980	0.0	2827.8	5136

Cascade Model Details for SY-07 md.SRCX

Storage is Online Cover Level (m) 4.100

Cellular Storage Structure

Invert Level (m) 2.180 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	524.2	0.0	1.321	0.0	0.0
1.320	524.2	0.0			

Hydro-Brake® Outflow Control

Design Head (m) 1.320 Hydro-Brake® Type Md1 Invert Level (m) 2.180
Design Flow (l/s) 125.0 Diameter (mm) 312

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	9.8	1.200	118.8	3.000	187.7	7.000	286.7
0.200	35.1	1.400	128.2	3.500	202.7	7.500	296.8
0.300	65.7	1.600	137.1	4.000	216.7	8.000	306.5
0.400	91.5	1.800	145.4	4.500	229.9	8.500	315.9
0.500	105.8	2.000	153.3	5.000	242.3	9.000	325.1
0.600	110.8	2.200	160.7	5.500	254.1	9.500	334.0
0.800	103.5	2.400	167.9	6.000	265.4		
1.000	109.1	2.600	174.7	6.500	276.3		

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

Half Drain Time : 58 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	2.326	0.846	0.0	18.3	18.3	77.2	O K
30 min Summer	2.533	1.053	0.0	18.7	18.7	96.1	O K
60 min Summer	2.628	1.148	0.0	19.5	19.5	104.7	O K
120 min Summer	2.603	1.123	0.0	19.3	19.3	102.4	O K
180 min Summer	2.527	1.047	0.0	18.7	18.7	95.5	O K
240 min Summer	2.442	0.962	0.0	18.3	18.3	87.8	O K
360 min Summer	2.284	0.804	0.0	18.3	18.3	73.3	O K
480 min Summer	2.138	0.658	0.0	18.3	18.3	60.0	O K
600 min Summer	1.986	0.506	0.0	18.3	18.3	46.2	O K
720 min Summer	1.849	0.369	0.0	18.3	18.3	33.7	O K
960 min Summer	1.748	0.268	0.0	17.4	17.4	24.5	O K
1440 min Summer	1.685	0.205	0.0	13.5	13.5	18.7	O K
2160 min Summer	1.646	0.166	0.0	9.9	9.9	15.2	O K
2880 min Summer	1.625	0.145	0.0	7.9	7.9	13.3	O K
4320 min Summer	1.602	0.122	0.0	5.7	5.7	11.1	O K
5760 min Summer	1.588	0.108	0.0	4.5	4.5	9.8	O K
7200 min Summer	1.578	0.098	0.0	3.8	3.8	9.0	O K
8640 min Summer	1.572	0.092	0.0	3.3	3.3	8.3	O K
10080 min Summer	1.566	0.086	0.0	2.9	2.9	7.8	O K
15 min Winter	2.440	0.960	0.0	18.3	18.3	87.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	138.874	0.0	92.5	23
30 min Summer	90.946	0.0	121.3	34
60 min Summer	56.713	0.0	151.5	54
120 min Summer	34.162	0.0	182.6	88
180 min Summer	25.057	0.0	201.0	122
240 min Summer	19.992	0.0	213.8	156
360 min Summer	14.500	0.0	232.6	224
480 min Summer	11.545	0.0	247.0	290
600 min Summer	9.667	0.0	258.5	350
720 min Summer	8.358	0.0	268.2	396
960 min Summer	6.638	0.0	284.0	502
1440 min Summer	4.791	0.0	307.4	740
2160 min Summer	3.452	0.0	332.5	1104
2880 min Summer	2.733	0.0	351.0	1468
4320 min Summer	1.964	0.0	378.2	2200
5760 min Summer	1.552	0.0	398.8	2936
7200 min Summer	1.292	0.0	415.0	3672
8640 min Summer	1.112	0.0	428.6	4384
10080 min Summer	0.980	0.0	440.3	5104
15 min Winter	138.874	0.0	103.6	23

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	2.675	1.195	0.0	19.9	19.9	108.9	O K
60 min Winter	2.789	1.309	0.0	20.9	20.9	119.4	O K
120 min Winter	2.743	1.263	0.0	20.5	20.5	115.2	O K
180 min Winter	2.630	1.150	0.0	19.6	19.6	104.8	O K
240 min Winter	2.504	1.024	0.0	18.5	18.5	93.4	O K
360 min Winter	2.267	0.787	0.0	18.3	18.3	71.8	O K
480 min Winter	2.018	0.538	0.0	18.3	18.3	49.1	O K
600 min Winter	1.796	0.316	0.0	18.3	18.3	28.8	O K
720 min Winter	1.736	0.256	0.0	16.9	16.9	23.4	O K
960 min Winter	1.689	0.209	0.0	13.8	13.8	19.0	O K
1440 min Winter	1.647	0.167	0.0	10.0	10.0	15.2	O K
2160 min Winter	1.618	0.138	0.0	7.3	7.3	12.6	O K
2880 min Winter	1.602	0.122	0.0	5.7	5.7	11.1	O K
4320 min Winter	1.583	0.103	0.0	4.2	4.2	9.4	O K
5760 min Winter	1.572	0.092	0.0	3.3	3.3	8.4	O K
7200 min Winter	1.564	0.084	0.0	2.7	2.7	7.7	O K
8640 min Winter	1.558	0.078	0.0	2.3	2.3	7.1	O K
10080 min Winter	1.554	0.074	0.0	2.1	2.1	6.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	90.946	0.0	135.9	34
60 min Winter	56.713	0.0	169.8	58
120 min Winter	34.162	0.0	204.6	94
180 min Winter	25.057	0.0	225.1	132
240 min Winter	19.992	0.0	239.5	168
360 min Winter	14.500	0.0	260.6	240
480 min Winter	11.545	0.0	276.6	306
600 min Winter	9.667	0.0	289.5	336
720 min Winter	8.358	0.0	300.4	386
960 min Winter	6.638	0.0	318.1	500
1440 min Winter	4.791	0.0	344.4	740
2160 min Winter	3.452	0.0	372.4	1104
2880 min Winter	2.733	0.0	393.2	1472
4320 min Winter	1.964	0.0	423.6	2200
5760 min Winter	1.552	0.0	446.7	2856
7200 min Winter	1.292	0.0	464.9	3680
8640 min Winter	1.112	0.0	480.1	4400
10080 min Winter	0.980	0.0	493.2	5136

Model Details

Storage is Online Cover Level (m) 3.600

Cellular Storage Structure

Invert Level (m) 1.480 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	96.0	0.0	1.321	0.0	0.0
1.320	96.0	0.0			

Hydro-Brake® Outflow Control

Design Head (m) 1.320 Hydro-Brake® Type Md4 Invert Level (m) 1.480
Design Flow (l/s) 21.0 Diameter (mm) 153

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	3.9	1.200	20.0	3.000	31.6	7.000	48.3
0.200	13.0	1.400	21.6	3.500	34.1	7.500	50.0
0.300	18.1	1.600	23.1	4.000	36.5	8.000	51.6
0.400	17.1	1.800	24.5	4.500	38.7	8.500	53.2
0.500	15.4	2.000	25.8	5.000	40.8	9.000	54.7
0.600	15.1	2.200	27.1	5.500	42.8	9.500	56.2
0.800	16.4	2.400	28.3	6.000	44.7		
1.000	18.3	2.600	29.4	6.500	46.5		

Appendix K – Surface Water Drainage Layout

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

NOTES

LEGEND

- Phase 1
- Phase 2
- Phase 2
- New Roof
- Retained Roof/Plot
- Impermeable Paving
- Planters – Treated as Impermeable
- Permeable Paving – 0.3m Deep, Outlet at Invert level to Attenuation
- Adopted Existing SW Sewer
- Adopted Exisiting SW MH
- Proposed Diverted SW Sewer
- Proposed Diverted SW MH
- Proposed SuDS Main/Sewer
- Proposed SuDS MH
- Proposed SuDS Hydro-brake MH
- Proposed SuDS Pump Station
- Proposed SuDS SW Crates

REV	DATE	BY	DESCRIPTION	CHK	APD

DRAWING STATUS: FOR INFORMATION

EAS
Unit 23, The Maltings, Stanstead Abbotts, Hertfordshire, SG12 8HG
Tel: 01920 871777
www.eastp.co.uk

CLIENT: WESTON HOMES

ARCHITECT:

PROJECT: ANGLIA SQUARE, NORWICH

TITLE: OVERALL SURFACE WATER DRAINAGE STRATEGY

SCALE @ A0:	DESIGN-DRAWN:	DATE:
NTS	JPS	11.03.2022
PROJECT No:	DRAWING No: SK01-A	

Appendix L – Anglian Water Diversion Information

TRANSPORT PLANNING ■ HIGHWAYS AND DRAINAGE ■ FLOOD RISK ■ TOPOGRAPHICAL SURVEYS
Unit 23 The Maltings Stanstead Abbotts Hertfordshire SG12 8HG Tel 01920 871 777 e: contact@eastp.co.uk www.eastp.co.uk

Louisa Wade

From: Fewell Darren A <dFewell@anglianwater.co.uk>
Sent: 17 May 2017 17:18
To: Louisa Wade
Cc: Doneghan Grace
Subject: Proposed Retail Development - Anglia Square Norwich - Development in Close Proximity to Anglian Water Public Sewer Apparatus

Hi Louisa,

Proposed Retail Development – Anglia Square Norwich – Development in Proximity to Anglian Water Public Sewer Apparatus

Further to our detailed phone discussion this afternoon, regarding your overall scope of development proposed at the above site, I am (as requested) just dropping you a line to briefly clarify the main points of our discussion.

I trust this helps with the planning and early design stages Louisa, but if you need anything else then please come back to us and we will do our best to assist you.

- Any re-development areas falling within 3m of the existing public sewer apparatus, but remaining only *'built near'* the public sewers, and maintaining a similar level of clearance and access to that already enjoyed, would in principle be acceptable to us, subject to your clients satisfying themselves that the new foundation designs for the affected new buildings were specifically designed to avoid transferring loading onto the adjacent public sewer apparatus.
- Any areas falling within 3 metres would simply need to comply with usual Part H4 Building Regulations requirements in respect of 'Building Near' public sewer apparatus, and Anglian Water has published self-approval criteria on our website, but the principles of proceeding as outlined in my guidance above would in principle be satisfactory.
- So the designers for the new foundations would need to site survey the affected public sewers to make sure that when considering the relative invert depth of that affected sewer, and the clearance provided to the building structure, that no loading would be transferred on a 45 degree 'angle of repose' design principle.
- Based on drawing A03-P2-052 rev F 'Ground Floor Retail Plan' , the only area that would appear to require direct *consideration* of formal diversion of our apparatus would be the existing 675mm dia SW public sewer, and the existing 225mm dia Foul public sewer that runs immediately south of unit A1.01 (675mm SWS Section close to SW MH's 0453 through to 0456 approx & 225mm FWS Section close to Foul MH's 0405 through to 0408).
- We discussed the principle of it being diverted clear of the retail units footprint but being designed to fall *centrally* within the remaining pedestrian access/walkway areas so that clearance is maximised on either side of the sewers to the buildings.
- This section of drainage could therefore be considered for diversion clear of the footprint of the new retail units, subject to full planning approval, and the correct application being made to Anglian Water under Section 185 of the Water Industry Act 1991, where upon the design would be considered on its individual design merits at that time, but I can confirm that the principle of us being prepared to consider such a diversion to keep the apparatus clear of the building footprint is established.
- The development around retail unit G1.03 would appear to suggest that it may result in a direct build over of our existing foul and surface water manholes/sewers that currently appear to run clear of the existing retail footprint.
- Anglian Water could consider formally devesting the affected sections of public sewer into your clients own private ownership under a Section 116 devesting notice, but they would need to apply to us as the 'owners' of the affected premises served by that drainage, and formally request it is devested into their own private ownership, and they would also need to demonstrate to us that there were no affected 3rd parties connected to the section of public sewer in question, that would otherwise be adversely affected by any proposal to remove (or make redundant) said affected section of public sewer, and they would need to show that the public sewer and its existing connections were *only serving* their own existing retail premises, and this would be done by detailed site survey of the existing drainage with follow up drainage drawings provided, and provision of a CCTV survey with all existing sewer connections identified to us in terms of what they serve and who owns those connections.
- Once a formal devesting was applied for, and we successfully reached a stage whereby we had approved the proposals, and had issued notice under Section 116, then at that point your clients could physically remove the offending sections of apparatus from the ground in order to allow the new building to be constructed without hindrance.

- The existing foul and surface water sewers shown as passing across your 'residential refuse' and 'retail refuse' areas between the Iceland store and retail unit G1.01, which link back towards Anglia Square, are mapped and recorded as *'private'* sewer apparatus and thus are still considered private apparatus accordingly, and Anglian Water would not have any further comment to make regarding any impact the development may have on that section of drainage as the apparatus is not considered to be Anglian Water owned, but any future development, and foundation design arrangements would obviously just need to take any reasonable design allowances and standard construction precautions to prevent risk of damage occurring.

I trust this summarises things but let us know if you need anything else,

Regards
Darren Fewell
Drainage Engineer
Anglian Water Services Ltd

Appendix M – Anglian Water Foul Water Capacity Check

Drainage Impact Assessment

Project Title:

Norwich, St. Crispins Road (Anglia Square)

Anglian Water Services contact:

Rob Morris

Pre-development Senior Engineer

Thorpe Wood House

Thorpe Wood

Peterborough

PE3 6WT

Mobile Number: 07702341018

Our reference number: S-10450/20492

8 June 2017

1. Summary

This report has been undertaken in response to an enquiry from EAS to determine the impact of flows from the site at St. Crispins Road (Anglia Square), Norwich on the performance of the existing foul sewer network and develop a feasible foul drainage solution. It should be read in conjunction with the pre-planning report dated 30 March 2017, which indicated that a direct connection to the public foul sewer system is likely to have a detrimental effect on the existing sewerage network.

The analysis has been performed on the foul system only. There has been no consideration of the surface water flows as this is not within the scope of the study.

The additional foul flows from the development site comprising 1500 C3 dwellings and three commercial development (7,365m2 – A1 Shops, 5,924 m2 - A3 Restaurant & Café and 3,556 m2 - D2 Assembly & Leisure) were modelled connecting to three manholes reference no. TG22098203 (NGR: TG 22889 09284), TG22099208 (TG 22967 09283) and TG23091211 (TG 23153 09285) located at St. Crispins Road.

The study concludes that the development will not cause detriment to the capacity of the sewer system and will not result in increased flood risk.

The topography of the site indicates that a gravity regime is feasible. Due to the proximity of the site boundary to the connection points it is assumed that the developer will provide the necessary infrastructure to convey flows from the site to the network connection point.

2. Hydraulic Modelling and Solutions

The proposed development site is located off St Crispins Road on in the city centre of Norwich (see **Error! Reference source not found.** 1. Foul flows from the site drain to Whitlingham Trowse Recycling Centre (WRC) located to the north of the town. The proposed development comprises of 1500 dwellings plus three other commercial development sites.

To enable the analysis to be performed the existing hydraulic model for Whitlingham Trowse was used.

Modelling assumptions can be found in APPENDIX 1.

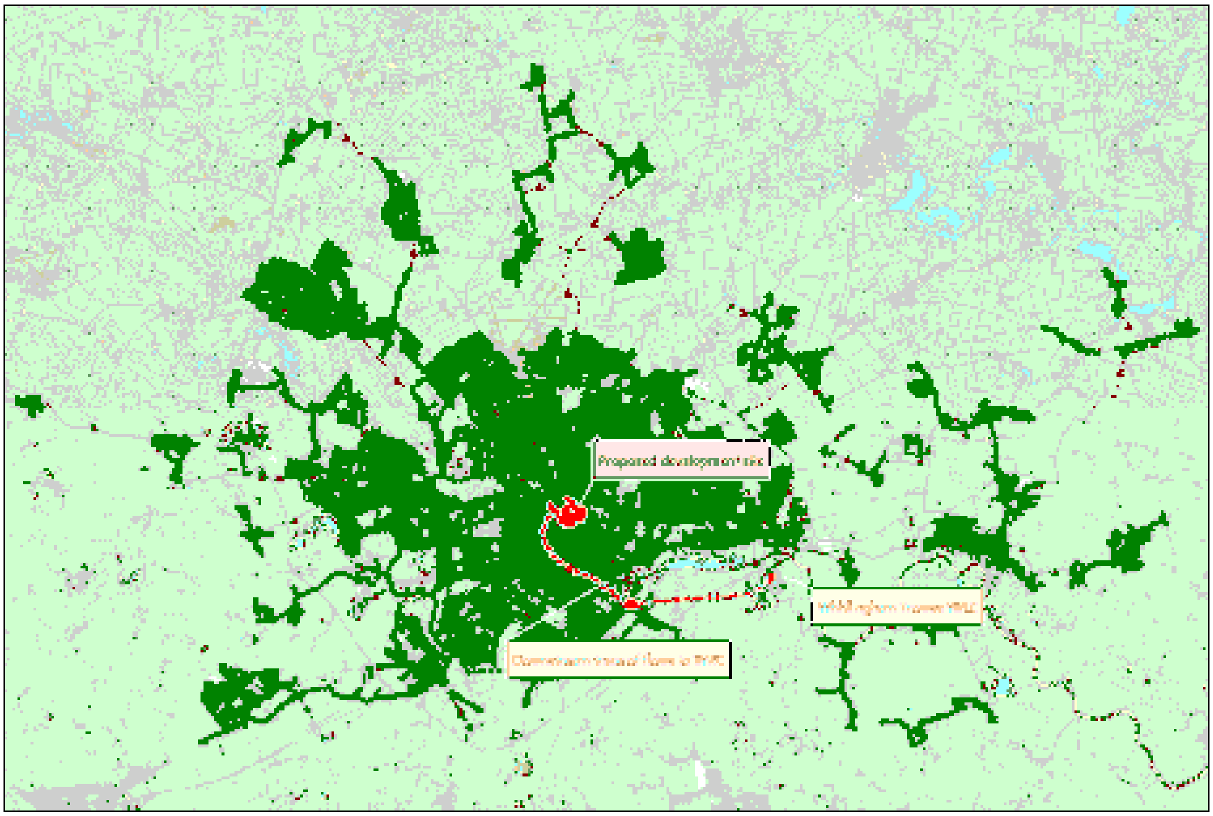


Figure 1: Showing the location of the development site and the proximity of the WRC

Proposed connection point

The proposed connection points for the development are manholes reference no. TG22098203 (NGR: TG 22889 09284), TG22099208 (TG 22967 09283) and TG23091211 (TG 23153 09285), located at St Crispins Road in the city centre of Norwich of Whitlingham Trowse catchment (see Figure 2 and 2a). The diameter of the sewer to which the proposed development will connect are 300mm (TG22098203) and 225mm (TG22099208, TG23091211) respectively. A review of the site topography indicates that a gravity connection is possible.

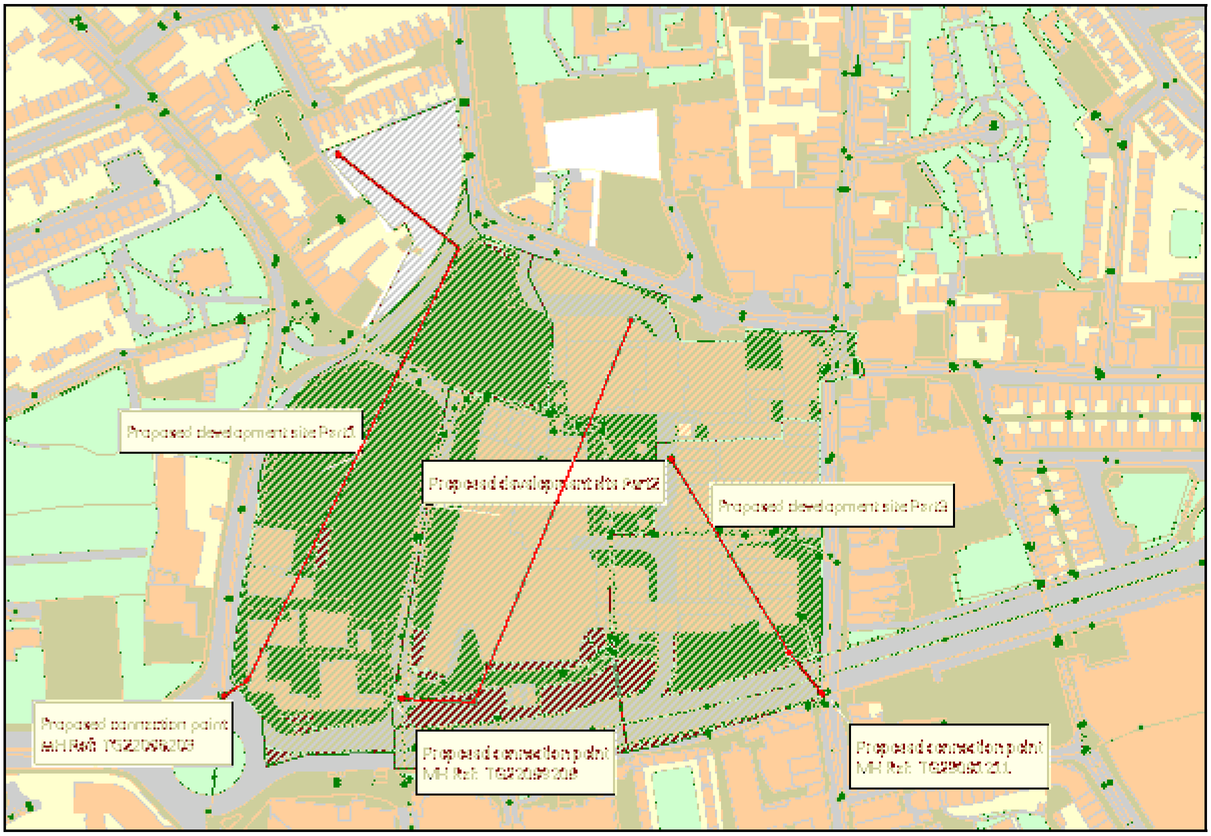


Figure 2: Showing the location of the proposed connection point

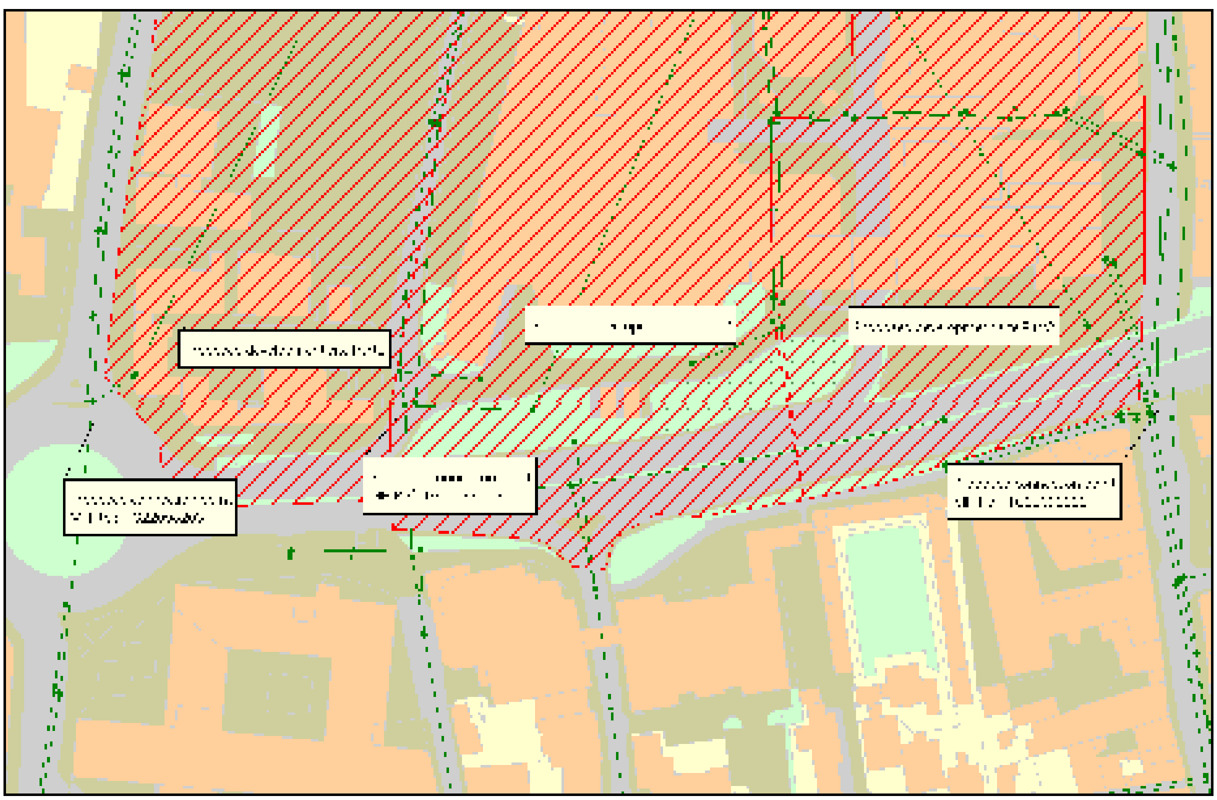


Figure 2a: Showing the location of the proposed connection point (close-up)

Hydraulic modelling

The hydraulic model was run to determine the existing sewer performance during a 1 in 20 year critical duration storm. The model was then re-run with the estimated flows from the site connecting to manholes TG2288909284, TG2296709283 and TG2315309285 via a gravity connection.

The model does not predict any detriment to the network or overflow performance due to the additional flows from the development.

Mitigation Solution

The study demonstrated that the flows from the development site can be connected to the sewer network system without the need for any improvement.

3. Summary and recommendation

Assumed flows from the site at St Crispins Road, Norwich have been modelled connecting via gravity to the existing foul drainage system to three manholes reference no. TG2288909284, TG2296709283 and TG2315309285. No detriment to the existing performance has been predicted.

APPENDIX 1.- Development details

Proposed Connection	
Proposed connection location	St Crispins Road, Norwich
Connection sewer or node reference (incl. X&Y)	TG22098203(X=622889, Y=309284) TG 22889 09284 TG22099208(X=622967, Y=309283) TG 22967 09283 TG23091211(X=623153, Y=309285) TG 23153 09285
Connection sewer diameter	300mm (TG22098203) 225mm (TG22099208) 225mm (TG23091211)
Connection relative to the development	South
Discharge regime	Gravity
Pump discharge rate	N/A
Creep& Storage	
Total creep (5 m^2 per property)	7500
Total development storage (m^3)	907.32
Pump storage volume, m^3	N/A
Highest Point of development (mAOD)	6.0m (TG22098203), 6.9m (TG22099208), 4.0m (TG23091211)
Lowest Point of development (mAOD)	4.7m (TG22098203),4.6m (TG22099208) 3.4m (TG23091211)

DWF Calculations

	Attribute	Value	Totals	Unit / Calculation
	Development size	5.22		Ha (Digitised Sub-catchment area)
	Residential			
A	Residential dwellings	1500		No.
B	Residential occupancy	2.35		No.
C	Residential population (P)	3525		No. (A x B)
D	Residential PCC (G)	125		l/h/d
$E_{(avg)}$	*Residential demand - Average*		**5.10**	l/s (C x D)/86400
$E_{(peak)}$	*Residential demand - Peak*		**10.81**	l/s ($E_{(avg)}$ x 2.12)
F	**Infiltration**		**1.27**	l/s (0.25 x $E_{(avg)}$)
	Industrial/ Trade *			
G	Industrial/trade area	1.68		Ha
H	Industrial/trade discharge per ha	0.34		l/s (average)
I	Industrial/trade domestic element per ha	0		l/s
$J_{(avg)}$	*Commercial/trade - Average*		**0.58**	l/s (GxH+GxI)
$J_{(peak)}$	*Commercial/trade- Peak*		**1.74**	l/s($J_{(avg)}$ x 3)
	Schools			
K	School PCC	0		l/h/d
L	School occupancy	0		No.
$M_{(avg)}$	*School demand - Average*		**0**	l/s (K x L)/86400
$M_{(peak)}$	*School demand - Peak*		**0**	l/s ($M_{(avg)}$ x 3)
	Other			
$N_{(avg)}$	*Other demand - Average*		**0**	l/s
$N_{(peak)}$	*Other demand - Peak*		**0**	l/s
$O_{(avg)}$	**Total Discharge - Average**		**5.68**	l/s ($E_{(avg)}$+ $J_{(avg)}$+ $M_{(avg)}$+ $N_{(avg)}$)
$O_{(peak)}$	**Total Discharge - Peak**		**12.55**	l/s ($E_{(peak)}$+ $J_{(peak)}$+ $M_{(peak)}$+ $N_{(peak)}$)
	DWF Total - Average		**6.95**	l/s($O_{(avg)}$ + F)
	DWF Total - Peak		**13.82**	l/s($O_{(peak)}$ + F)

Breakdown of commercial flow rates

Development Description	Industry Type	Area (ha)	Discharge Allowance per Ha (average) l/s/ha	Commercial Flow (average daily) l/s
Restaurants & Cafes	A3	0.59	0.4	0.24
Assembly and Leisure	D2	0.36	0.4	0.20
Retail space	A1	0.27	0.2	0.054
Retail space	A1	0.46	0.2	0.093
TOTAL		**1.68**		**0.58**

APPENDIX 2.– Embodied carbon and water footprinting

Carbon footprint

In 2006 Anglian Water recognised the impacts of changing climate as one of the most significant challenges facing the organisation. In response we have developed and implemented a strategy of measure, manage and reduce our carbon emissions. We have set ourselves goals to halve our overall greenhouse emissions by 2035 (from 2010 levels) and to halve the embodied carbon in all new assets we build in 2015, compared to those that were built in 2010.

Water footprinting

Water is our most precious resource and at present we do not fully understand how sustainable each litre of water we supply to our customers is over our full supply chain. In response, we are implementing a strategy of 'water footprinting'.

Primarily water footprinting assesses the impact of human activity on the water environment. The process measures the volumes and scarcity of freshwater consumption including geographical and temporal components in producing a product or service. This is followed by an assessment defining actions required to achieve sustainable and equitable water use especially in water scarcity 'hot spots'.