Chantry Avenue, Kempston, Bedford

Flood Risk Assessment and Drainage Strategy

12/07/2022
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Disclaimer

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1.0	12/07/2022		[redacted]

Contents

1.0 Introduction

RAB Consultants has prepared this Flood Risk Assessment (FRA) & Drainage Strategy (DS) in support of the proposed residential development located at Chantry Avenue, Kempston, Bedford.

The development site is located in Flood Zone 1 according to the Environment Agency's Flood Map for Planning (Rivers and Sea). A Flood Risk Assessment for this site is required under the Planning Practice Guidance for the National Planning Policy Framework (NPPF). The site-specific FRA is required to ensure that the development is safe from flooding and will not increase the risk of flooding elsewhere.

The Secretary of State for Communities and Local Government laid a Written Ministerial Statement in the House of Commons on 18th December 2014 setting out changes to planning that will apply for major development from 6 April 2015. Therefore, from 6 April 2015 local planning policies and decisions on planning applications relating to major development are required to ensure that sustainable drainage systems (SuDS) are used for the management of surface water. As the Lead Local Flood Authority, Bedford Borough Council is required under Article 18 of the Town and Country Planning (Development Management Procedure) (England) Order 2015 (the Development Management Procedure Order) to provide consultation response on the surface water drainage provisions associated with major development.

Major development is defined within the Development Management Procedure Order as development that involves any one or more of the following:

1. the winning and working of minerals or the use of land for mineral working deposits;
2. waste development;
3. the provision of dwelling houses where:

3.1. the number of dwelling houses to be provided is 10 or more; or

3.2. the development is to be carried out on a site having an area of 0.5 hectares or more and it is not known whether the development falls within sub-paragraph 3.1;

4. the provision of a building or buildings where the floor space to be created by the development is 1,000 square metres or more; or
5. development carried out on a site having an area of 1 hectare or more.

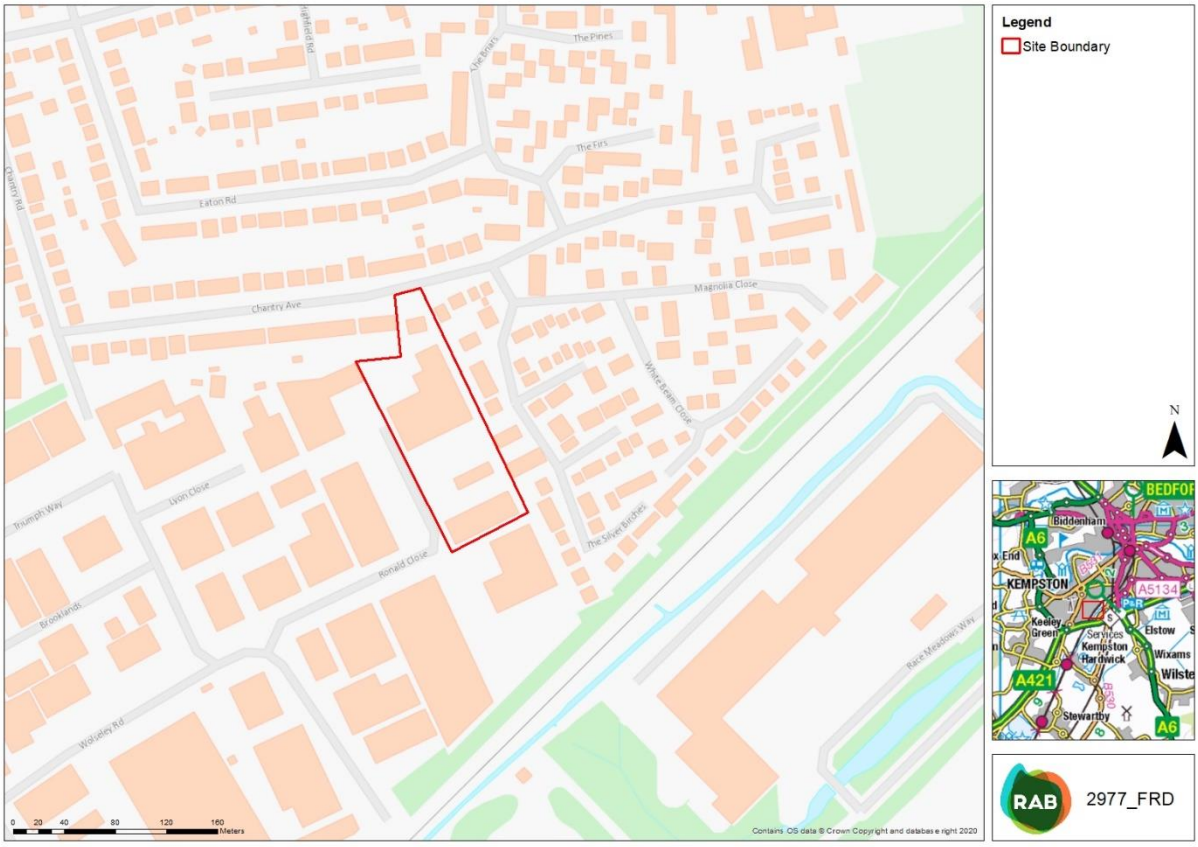
As such, the development is classed as a major development given the number of dwellings to be provided is to be 43. The drainage strategy will be in line with the 2018 Bedford Borough Council SuDS SPD.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	Chantry Avenue, Kempston, Bedford, MK42 7QX
Site area:	1.20ha
Existing land use:	Commercial
OS NGR:	TL034468
Local Planning Authority:	Bedford Borough Council



2.2 Site description

The site is located in south Kempston in an industrial estate with residential housing to the north and east and commercial buildings to the south and west. The site can be accessed from Chantry Avenue and currently comprises several industrial buildings with surrounding concrete hardstanding. A small section in the centre of the site is greenfield land.

The closest watercourse to the site is the River Great Ouse which is approximately 100m to the south-east.

2.3 Development proposal

Development proposals include the demolition of the existing commercial buildings and construction of 43 dwellings with subsequent parking and an access road.

Development plans can be found in Appendix A.

3.0 Flood Risk

3.1 Sequential test

According to the Environment Agency's Flood Map for Planning the site lies in Flood Zone 1, which is described in the NPPF as land having a less than 1 in 1,000 annual probability of river or sea flooding (less than 0.1% AEP).

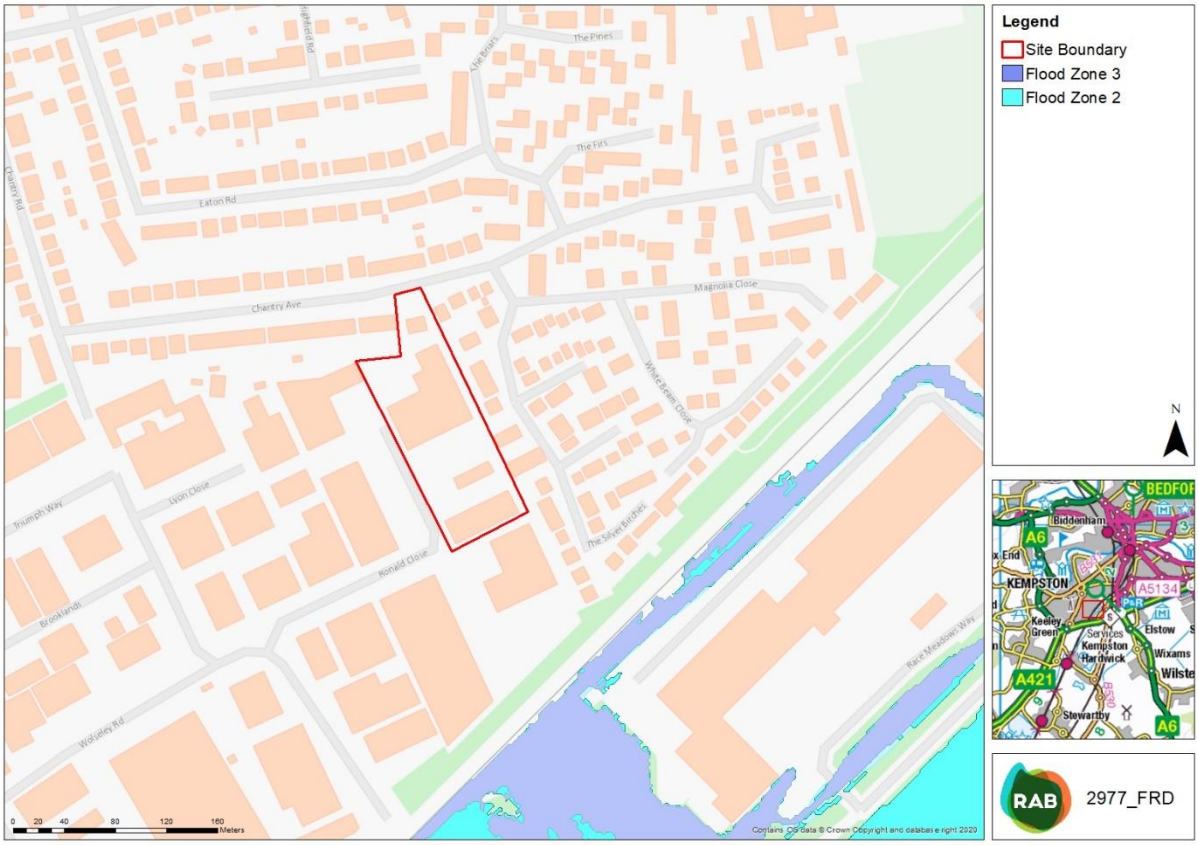


FIGURE 1: ENVIRONMENT AGENCY FLOOD MAP FOR PLANNING

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. NPPF Planning Practice Guidance (PPG) Table 2 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 3 'Flood risk vulnerability and flood zone compatibility' to determine whether:

- The proposed development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development

The proposed development is classed as a 'more vulnerable' development in accordance with NPPF PPG within Flood Zone 1 and is therefore appropriate for the location.

3.2 Flooding history

According to the Bedford Borough Council 2020 Level 1 Strategic Flood Risk Assessment (SFRA), the site area is not within an area that has experienced flooding in the past.

An online search also gave no results of flooding in the local vicinity of the site.

3.3 Fluvial (Rivers)

According to the Environment Agency's Flood Map for Planning the site lies in Flood Zone 1, which is described in the NPPF as land having a less than 1 in 1,000 annual probability of river or sea flooding (less than 0.1% AEP). As such, the site is at low risk of fluvial flooding.

3.4 Flood defence breach or overtopping

3.4.1 Breach risk

The site is not protected by any formally raised defences and as such, is not at risk of flooding from this source.

3.4.2 Overtopping risk

The site is not protected by any formally raised defences and as such, is not at risk of flooding from this source.

3.5 Coastal/tidal

The site is located at a considerable distance from the coast and is therefore not at risk of flooding from this source.

3.6 Pluvial (Surface water)

When the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded, excess rainwater flows overland. This water will collect in topographic depressions and at obstructions, which can inundate development in low lying areas. The severity of the rainfall event, the degree of saturation of the soil before the event, the permeability of soils and geology, and the gradient of the surrounding land and it's use; all contribute to and affect the severity of overland flow.

The Environment Agency Flood Map for Surface Water (Figure 2), can be used to see the approximate areas that would experience surface water flooding from a range of AEPs, which is used to categorise the risk (Table 2).

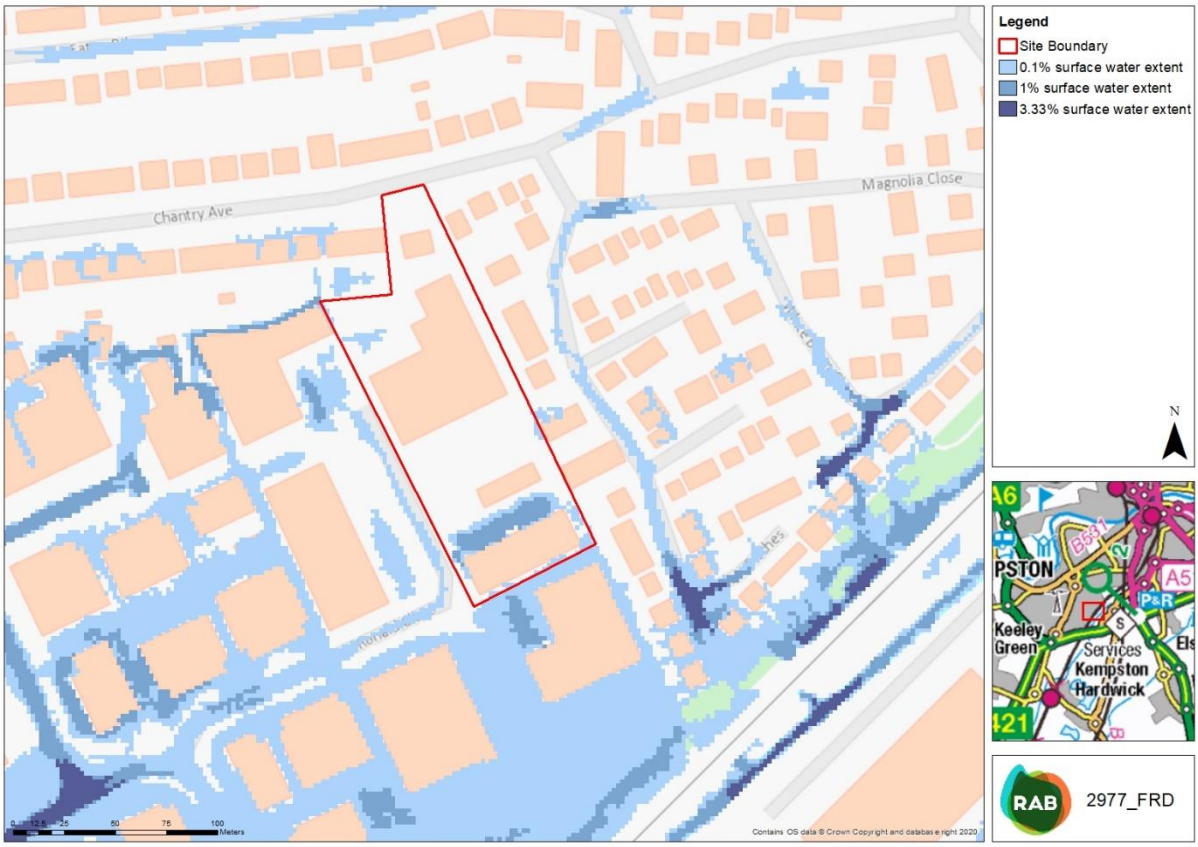


FIGURE 2: ENVIRONMENT AGENCY FLOOD RISK FROM SURFACE WATER

TABLE 2: ENVIRONMENT AGENCY SURFACE WATER RISK CATEGORIES

Surface Water Risk Category	Surface water flooding Annual Exceedance Probability
Very Low	< 0.1%
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	> 3.3% (1 in 30 years)

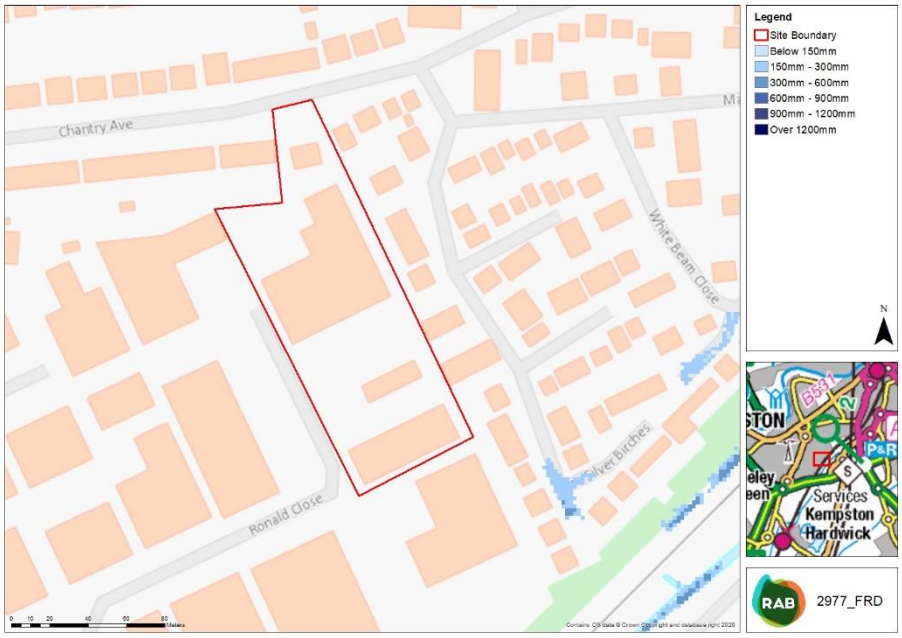
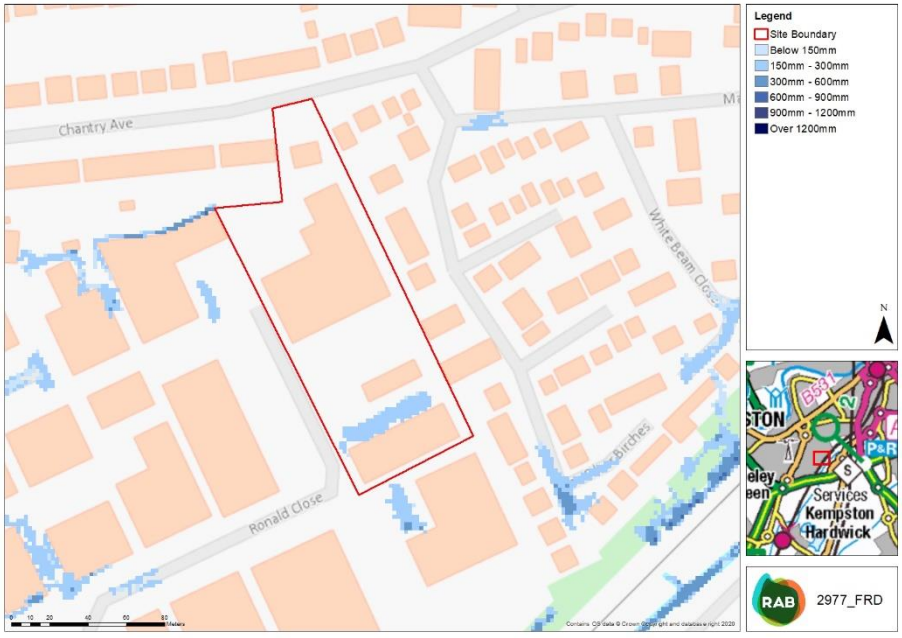
The Surface Water map identifies that there is a medium risk of surface water flooding for the site but only at a specific and limited part of the site. The site should remain dry during the 3.33% AEP surface water event.

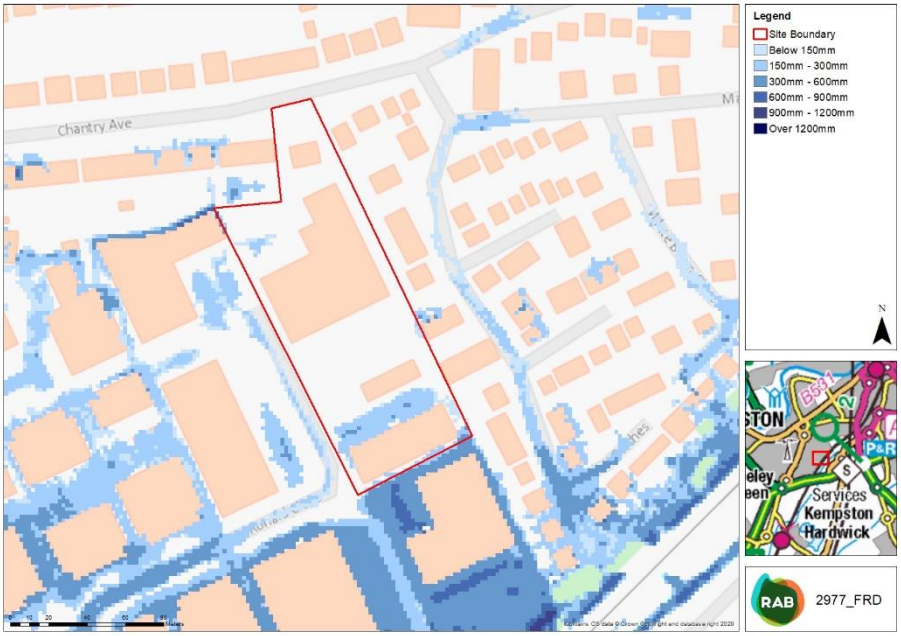
A small section to the south of the site is shown in

Table 3 below to experience flood depths of up to 300mm. During the 0.1% AEP, an additional section is shown to experience flooding with depths reaching 600mm at the southern area. This risk is clearly associated with runoff ponding at that area due to the local topography.

The addition of a SuDS scheme will better manage surface water, compared to the existing condition, and reduce the risk of surface water flooding on the site.

TABLE 3: SURFACE WATER FLOOD DEPTHS FOR A RANGE OF AEP'S

AEP	Flood depth
3.33%	
1%	

AEP	Flood depth
0.1%	

3.7 Artificial water bodies

According to the Environment Agency's reservoir flood map (

Table 3), the site is not at risk of flooding from reservoirs.

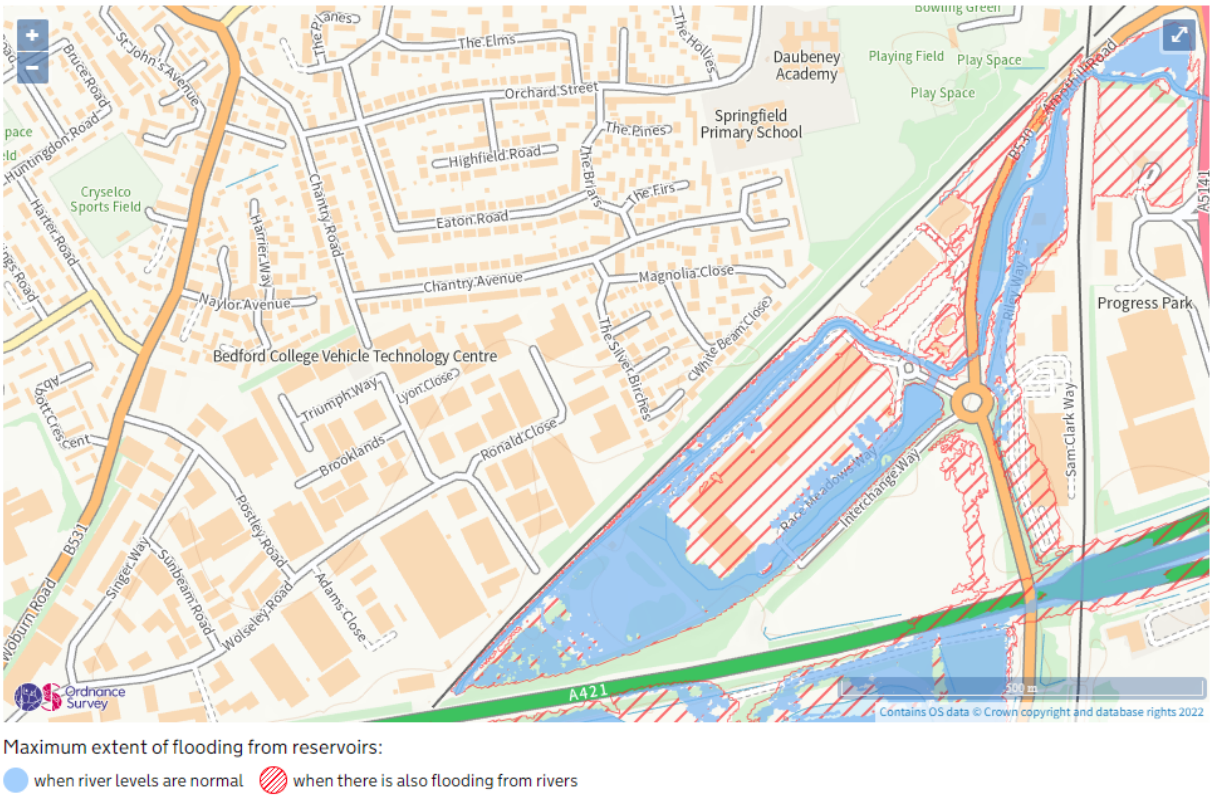


FIGURE 3: ENVIRONMENT AGENCY RESERVOIR FLOOD MAP

3.8 Groundwater

Groundwater flooding is water originating from sub-surface permeable strata which emerges from the ground, either at a specific point or over a wide diffuse location and inundates low lying areas. A groundwater flood event results from a rise in groundwater level sufficient for the water table to intersect the ground surface and inundate low lying land.

British Geological Survey (BGS) records indicate that the proposed development site overlies bedrock composed of Peterborough Member - mudstone. There is no recorded evidence of the superficial deposits in the area.

Borehole TL04NW284 located on-site details the site to comprise silty clay up to a depth of 4m below ground level.

The Magicmaps tool indicates the site to be within an area of low groundwater vulnerability.

The Soilscapes application suggests the site is within an area comprising lime-rich loamy and clayey soils with impeded drainage. This suggests that the ground material is impermeable and could provide a barrier to rising groundwater levels.

As there is a high degree of variability when considering groundwater flooding, using historic flooding is not a robust measure of the risk of flooding in future years.

3.9 Sewers

Anglian Water is responsible for the adopted surface and foul sewer networks within the District and maintain a DG5 register of sites affected by sewer flood incidents on a post code basis. According to the 2020 SFRA, the post code area of ‘MK42 7’ has experienced 3 incidents of sewer flooding in the past.

It is important to note that previous sewer flood incidents, or the lack thereof, do not indicate the current or future risk to the site. Upgrade work could have been carried out to alleviate any issues or conversely, in areas that have not experienced sewer flooding incidents, the local drainage infrastructure could deteriorate leading to future flooding.

4.0 Mitigation measures

4.1 Risk to buildings

4.1.1 Finished floor levels

In accordance with BS8533:2017 ‘Assessing and managing flood risk in development – code of practice’, in order to afford a level of protection against flooding it is recommended that finished floor levels should be set at a nominal 300mm above either the 1% AEP of fluvial flooding or the 0.5% AEP of tidal flooding depending on which is greater (both including climate change).

The site is located in Flood Zone 1 with certain limited site areas being at medium surface water risk due to the local topography. Given the proposed inclusion of SuDS, which will efficiently manage surface water at site level, it is being proposed to set the finished floor level 150mm above surrounding ground level to mitigate against the unpredictable occurrence of infrastructure failure.

4.1.2 Flood resistance

Flood resistance is a strategy of temporary or permanent measures taken to reduce the amount of flood water that will enter buildings. It is not considered appropriate to adopt a water exclusion (or 'resistance') strategy given the assessed likelihood of flooding to the building.

4.1.3 Flood recoverability

It is not considered appropriate to adopt a flood recoverability strategy given the assessed likelihood of flooding to the building.

4.2 Risk to occupiers

4.2.1 Safe access/egress

The site entrance and access road should remain dry during events up to and including the surface water 0.1% AEP and as such, safe access and egress is achievable.

4.3 Risk to others

4.3.1 Floodplain compensation

No development is proposed within the 1% AEP + CC fluvial extent and as such, floodplain compensation is not required.

4.3.2 Surface water run-off

Information surrounding potential methods to further reduce surface water run-off, such as through the incorporation of incorporate Sustainable Drainage Systems (SuDS), can be found within section 5.0 below.

5.0 Drainage Strategy

5.1 Existing runoff condition

5.1.1 Existing drainage arrangements

The site naturally slopes towards the south from Chantry Avenue with an average slope of 1:80. It is unknown what the current drainage arrangements are on-site due to the lack of a topographic and utilities survey. It is likely that surface water runoff is collected and discharged directly into the surface water sewer that is present on-site.

5.1.2 Greenfield runoff

The greenfield runoff rate was calculated using the IH124 method for determining Greenfield runoff rate built into Microdrainage WinDes 2013.1 (including the modification given in the Interim Code of Practice for SUDS, Chapter 6):

- SAAR (mm) = 550
- Area (ha) = 0.637
- Soil = 0.450
- Region = 5

The QBAR was calculated at 3.3 l/s/ha (see Appendix D). The greenfield runoff rate was calculated on the basis of the proposed hardstanding area of 0.637ha.

TABLE 4: GREENFIELD RUNOFF RATES

AEP (%)	Greenfield peak flow rate (l/s/ha)	Greenfield peak flow rate (l/s)
100	2.9	1.8
QBAR	3.3	2.1
3.33	8.0	5.1
1	11.8	7.5
1 +30% Climate Change*	15.3	9.7

* Anglian river basin higher central allowance for flow estimations

5.1.3 Brownfield runoff

The brownfield runoff rate has been estimated using the existing hardstanding area of 0.746ha and the Modified Rational Method. The Modified Rational Method calculates runoff based on the following formula:

Q=2.78 x C (Cv x Cr) x i x A

Where Cv and Cr are coefficients, which equal 1 when multiplied together, i is rainfall intensity in mm/hr, and A is area in hectares. Rainfall intensity has been identified using Microdrainage Source Control.

Table 5 below shows the estimated peak flow runoff rates for a range of AEPs for the existing condition using an area of 0.746ha.

TABLE 5: ESTIMATED BROWNFIELD PEAK FLOW RUNOFF RATES

AEP (%)	Rainfall intensity (mm/hr)	Brownfield peak flow rate (l/s)
50	34.792	72.15
3.33	78.504	162.81
1	104.387	216.49
1 + 40% Climate Change**	146.142	303.08

**Upper end peak rainfall intensity allowance for Anglia

5.2 SuDS feasibility

The SuDS Manual (2015) discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and varying degrees. Table 6 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

TABLE 6: FEASIBILITY OF SUDS TECHNIQUES AT THE DEVELOPMENT SITE

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	M – traditional rainwater harvesting is not included in the proposed design due to long-term maintenance concerns however, water butts could be used.

Technique	Description	Feasibility Y / N / M (Maybe)
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus offering attenuation potential, while reducing the rate of runoff (green roofs, pervious paving).	Y – there is opportunity to include porous materials such as permeable paving on the site.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	N – the site geology and soil material would not allow for a viable infiltration rate.
Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	N – there is limited space on site for conveyance features.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (e.g. ponds, wetlands, and detention basins).	Y – there is room on site for storage features to store runoff.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	Y – the above SuDS features can provide treatment benefits to the surface water.

The site has the potential to incorporate a number of SuDS options to manage surface water. These are discussed in more detail below.

5.3 Proposed discharge

The 2015 SuDS Manual recommends a specific hierarchy in terms of surface water discharge destinations:

1. Discharge into the ground.
2. Discharge into a surface water body.
3. Discharge to a surface water sewer.
4. Discharge to a combined sewer.

Discharge into the ground may be challenging at the site due to the soil characteristics comprising clayey soils with slightly impeded drainage. In addition, there is limited room to incorporate infiltration features whilst allowing for a 5m boundary around all site and adjacent buildings.

There is no surface water body in close proximity to the site.

There is an Anglian Water surface water sewer located on the edge of the eastern part of the site which can be used as the ultimate discharge point. It is therefore proposed to discharge surface water at the Anglian Water surface water sewer (manhole 5751) at a control rate of 2.1 l/s. The discharge rate has been limited to QBAR for all events up to and including the 1% AEP + 40% CC (1 in 100 year plus 40% climate change). A pre-planning enquiry has been submitted to Anglian Water to confirm there is discharge capacity in their system (Appendix B).

5.4 Proposed surface water management

The proposed drainage scheme has been modelled in Microdrainage Source Network to understand the evolving flow regime under flood conditions and the potential for flooding. The proposed scheme (see Appendix B) will integrate a range of features, in line with the SuDS Manual philosophy, taking into consideration site constraints. In detail, a combination of permeable paving, a raingarden and a cellular storage device will manage the runoff from the total impermeable site area of 0.637ha.

Permeable paving will be used for all car parking spaces with roof runoff being directed into these structures at each plot. A pipe will run beneath the road to convey surface water from each area of the site to the south where the cellular storage device will be located. The raingarden should be located above the cellular storage device and allow water to infiltrate directly into the tank. Due to the relatively shallow surface water sewer, a pump is required to discharge water from the site into the Anglian Water surface water sewer at a controlled rate of 2.1l/s. The scheme can be seen in Appendix B.

5.4.1 Permeable pavement

A Type A & Type C (see Table 20.1 of the SuDS Manual) permeable pavement will be used to manage roof and road runoff at the site allowing water to infiltrate to the sub-base prior to conveying it downstream via the piped network. The paving will be located at all car parking spaces giving a total area of 1540m^2.

It is recommended to discharge roof runoff directly onto the permeable pavement surface where possible. Alternatively, or where it is not practicable roof runoff should discharge to the sub-base on the permeable pavement via catchpits and diffusers, as described in the Interpave Guidance document (Figure 4).

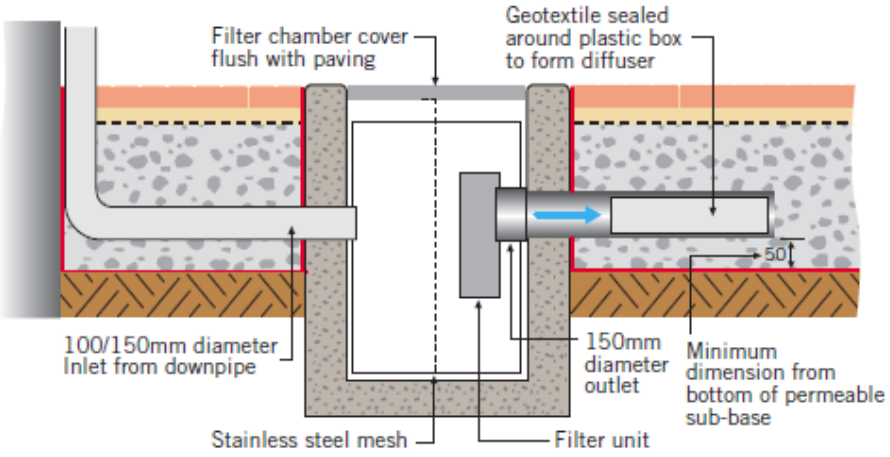


FIGURE 4: TYPICAL ROOF DRAINAGE OUTLET (INTERPAVE GUIDANCE DOCUMENT, 2008)

Road runoff from the access road and relevant parking areas will infiltrate to the permeable pavement and receive an appropriate level of treatment. Kerb design should be in line with local standards and at least 75mm to encourage water to infiltrate to the permeable pavement structure efficiently.

The laying course material must be sufficiently coarse to allow the free vertical flow of water and to prevent its intrusion into the underlying coarse-graded aggregate, yet sufficiently fine to permit the accurate installation of the paving blocks. The material should comply with the requirements of a material of type 2/6.3 Gc 80/20 according to BS EN 13242:2002. All capping materials should meet the requirements of either 6F1 or 6F2 of Table 6.1 of Highways Agency's '*Specification for Highway Works – Series 600 – Earthworks*'.

5.4.2 Raingarden

A raingarden has been incorporated into the site at the south end which can be seen in the relevant drawings in Appendix B. This feature will have a shallow depression (150mm) to allow for standing water followed by a filter medium of compost/sand-amended native soils or specified soil mixes. The base of the structure should have a permeable geotextile laid to allow infiltration of water into the below cellular storage device and to prevent sediment entering the tank.

The raingarden should be constructed in line with the CIRIA Guidance on the Construction of SuDS C768 (2017) report.

5.4.3 Cellular storage

A cellular storage tank (ACO Stormbrixx or similar) should be used to manage the runoff from all impermeable areas on site (impermeable area = 6370m^2). The tank should have an area of 750m^2 and a depth of 0.914m giving a total storage capacity of 651.225m^3. The tank is located in the south of the site and should have a cover of 1.2m. The tank manufacturer must confirm structural reliability.

The tank will receive runoff via an appropriate piped network. All inlets into the tank should have a silt trap installed upstream to prevent build-up of silt in the tank, which reduces its total storage capacity.

The cellular storage units must be installed in line with the CIRIA Guidance on the Construction of SuDS C768 (2017) report.

5.4.4 Water quantity benefits

The scheme will offer significant reductions in runoff rates, compared to the corresponding greenfield/brownfield runoff rate as shown in Table 7. This is to counterbalance the increased volume of runoff as a result of the development. As such, the proposed scheme provides water quantity benefits, in line with the 2015 SuDS Manual.

As such, the proposed scheme provides water quantity benefits, in line with the 2015 SuDS Manual.

TABLE 7: EXISTING AND PROPOSED PEAK FLOW RUNOFF RATES

AEP (%)	Greenfield peak flow rate (l/s)	Brownfield peak flow rate (l/s)	Proposed peak flow rate (l/s)	Change from greenfield (%)
QBAR	2.1	72.15	2.1	0
3.33	5.1	162.81	2.1	58.8

AEP (%)	Greenfield peak flow rate (l/s)	Brownfield peak flow rate (l/s)	Proposed peak flow rate (l/s)	Change from greenfield (%)
1	7.5	216.49	2.1	72.0
1 +40%CC**	10.5	303.08	2.1	80.0

**Upper end peak rainfall intensity allowance for Anglia

5.4.5 Water quality benefits

In line with the SuDS Manual, the water must receive a certain degree of treatment. There are no significant risks of pollution as a result of the development as it is classed a low density residential with no major risks.

According to Table 26.2 of the SuDS Manual and based on the land use, the site has a low pollution hazard level. In detail, the pollution hazard indices are:

- Total Suspended Solids= 0.5
- Heavy Metals= 0.4
- Hydrocarbons= 0.4

Consequently, the proposed SuDS feature(s) must have a higher mitigation index. Mitigation indices for various SuDS components can be found in Table 26.3 of the SuDS Manual (2015).

Total SuDS Mitigation Index = mitigation index$_1$ + (0.5 x mitigation index$_n$)

Where mitigation index$_n$ = mitigation index for component n.

The proposed drainage scheme utilises a cellular storage tank, permeable paving and a raingarden. An SDS Aqua-Swirl (or similar) hydrodynamic separator should be used to remove pollutants from the system before runoff enters the cellular storage device.

Using Table 26.3 of the SuDS Manual (2015), the mitigation indices for each pollutant and for the permeable paving was identified:

- TSS – SuDS mitigation index = 0.7 > 0.5
- Heavy Metals – SuDS mitigation index = 0.6 > 0.4
- Hydrocarbons – SuDS mitigation index = 0.7 > 0.4

Consequently, the proposed scheme is in line with the water quality requirements of the SuDS Manual (2015).

5.5 Future resilience

5.5.1 Designing for exceedance

It is inevitable that as a result of heavy or extreme rainfall, the capacities of sewers and other drainage systems will be exceeded on occasion. Drainage exceedance will occur when the rate of surface water runoff exceeds the inlet capacity of the drainage system, when the receiving water or pipe system becomes overloaded, when the outfall becomes restricted due to flood levels in the receiving water, or due to poor maintenance of the SuDS features.

Minor flooding can be seen to affect the site during the 1% AEP + 40% CC event (Appendix B) however, the flood depths are less than 1mm and therefore, should not prove to be a risk to the site.

Should a blockage occur in the system, surface water would flow south following the topography of the site towards the raingarden and cellular storage device where it would be re-captured and get diverted back into the system. Exceedance flow routes have been mapped in the drainage layout in Appendix B.

A closed board fencing with concrete base should be used at the south and southeast boundaries of the site to ensure flood water from an infrastructure failure is contained within the site boundary. This approach would reduce the risk of downstream flooding should the pump fails.

5.5.2 Urban creep

In line with the local policies of Bedford Borough Council, a 10% increase to the total impermeable site area has been modelled to ensure the system can deal with future building work on site (see Appendix B). Minor flooding was seen to affect manholes S2, S3 and S1a (see Appendix B) with flood depths reaching 2mm. the minor depths should not affected the site buildings and should be re-captured further down in the system by the permeable paving.

5.6 Amenity and biodiversity

Primary consideration should be given to locally native species, and plants that benefit wildlife through their nectar, fruit, or berries. Generally, the choice of plant species should reflect the usual design decisions relating to their location in terms of aspect, sun or shade, height, from, colour, whether evergreen or deciduous, native or ornamental, and soil factors such as pH, depth, nutrient status and organic content. However, the consideration has to be their ability to withstand the fluctuations in soil moisture that will occur.

6.0 Maintenance and Management Plan

The following maintenance and management plan has been formed to assist with ensuring the longevity of the surface water scheme to provide multiple benefits throughout its lifetime. The plan will also aim to prevent any blockages or damage occurring to each component of the scheme to minimise the risk of flooding as much as possible.

The level of inspection and maintenance will vary depending on the type of SuDS component and scheme, the land use, and the type of vegetation. It is vital that SuDS construction is supervised and inspected on completion if owners are to avoid taking on liabilities and to ensure the specified materials are being used and placed correctly. Incorrect materials or installation should be rejected as they will adversely affect the performance, maintenance costs and ultimately the design life of the SuDS components.

The site manager must maintain maintenance logs for all elements.

The SuDS features incorporated to this particular design have to be maintained in order to ensure efficient water treatment and water management.

6.1 SuDS features checklist

- **Attenuation tanks** are used to create a below-ground void space for the temporary storage of surface water before infiltration, controlled release or use.

- **Permeable surfaces** as permeable block paving, porous Asphalt, gravel or free draining soils that allow rain to percolate through the surface into underlying drainage layers. They must be protected from silt, sand, compost, mulch, etc.
- **Raingardens** are planted areas with engineered topsoil over drainage layers that allow water to soak into the ground.
- **SuDS flow control structures** are usually small orifices in control chamber, slots or V notches in weirs. They are usually near the surface so are accessible and easy to maintain. They may be in baskets, in small chambers or in the open.
- **Inspection Chambers** and rodding eyes are used on bends or where pipes come together. They allow cleaning of the system if necessary.
- **Pumping chambers** are used to convey wastewater where a gravity system is not achievable.

6.2 Sustainable Drainage Maintenance Specification

6.2.1 General requirements

Maintenance	Frequency	Owner
Maintenance activities comprise: • Regular maintenance • Occasional tasks • Remedial Work	Will vary depending on activity	(Private or adopted)

Regular maintenance (including inspections and monitoring). Consists of basic tasks done on a frequent and predictable schedule, including vegetation management, litter and debris removal, and inspections.

Occasional maintenance Comprises tasks that are likely to be required periodically, but on a much less frequent and predictable basis than the routine tasks (sediment removal is an example).

Remedial maintenance Comprises intermittent tasks that may be required to rectify faults associated with the system, although the likelihood of faults can be minimised by good design.

Where remedial work is found to be necessary, it is likely to be due to site-specific characteristics or unforeseen events, and as such timings are difficult to predict.

Avoid use of weedkillers and pesticides to prevent chemical pollution.

6.2.2 Raingarden

TABLE 8: MAINTENANCE SCHEDULE FOR RAINGARDENS, ADAPTED FROM CIRIA C753

Maintenance	Frequency	Owner
Regular Monitoring • Remove litter and surface debris and weeds. • Inspect infiltration surfaces for silting and ponding, record de-watering time of the facility to determine if maintenance is required. • Check operation of underdrains by inspection of flows after rain.	Quarterly	Private management company (to be confirmed by developer)

Maintenance	Frequency	Owner
• Assess plants for disease infection, poor growth, invasive species and replace as necessary. • Inspect inlets and outlets for blockages.		
Occasional Tasks • Infill any holes or scour in the filter medium, improve erosion protection if required. • Repair minor accumulations of silt by raking away surface mulch, scarifying surface of medium and replacing mulch.	As required	
Remedial Work • Remove and replace filter medium and vegetation above	As required but likely to be > 20 years	

6.2.3 Permeable pavement

TABLE 9: MAINTENANCE SCHEDULE FOR PERMEABLE PAVEMENTS, ADAPTED FROM CIRIA RP992/23 AND C753

Maintenance	Frequency	Owner
Regular Monitoring • Brush regularly and remove sweepings from all hard surfaces. • Inspect all inflows/outflows along with manholes for blockages. • Check monitoring wells for any signs of siltation.	Quarterly and after flood events	Private management company (to be confirmed by developer)
Occasional Tasks • Brush and vacuum surface once a year to prevent silt blockage and enhance design life. • Check operation of perforated pipes by inspection of flows after rain	Every six months	
Remedial Work • Monitor effectiveness of permeable paving and if water does not infiltrate immediately a reinstatement of the top layers or specialist cleaning. The manufacturer should be contacted to provide further guidance. • Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material. • Rehabilitation of surface and upper substructure by remedial sweeping. • Check monitoring wells and replace permeable layer and sand-bed layer if heavily silted.	As required and after flood events	

6.2.4 Cellular storage

TABLE 10: MAINTENANCE SCHEDULE FOR THE CELLULAR STORAGE TANK, ADAPTED FROM CIRIA RP992/23 AND C753

Maintenance	Frequency	Owner
Regular Cleaning • Inspect and identify any areas that are not operating correctly and ensure free flow is viable. If required, take remedial action. • Remove litter and debris from the catchment surface.	Monthly for 3 months, then annually. Monthly	Private management company (to be confirmed by developer)
Regular Monitoring • Inspect/check all rainwater pipe inlets, pump chamber and vent to ensure that they are in good condition and operating as designed; repair/rehabilitate inlets, outlet, and vent if required following advice from manufacturer. • Make visual inspection of exceedance route and check route is not blocked by new fences, walls, bollards, etc. Remove as necessary.	Annually	
Occasional Tasks • Survey inside of tank for sediment build-up and remove if necessary*. • Replace cellular storage tank at the end of design life**	Every 5 years or as required* Every 25 years**	

*Silt disposal to be undertaken in line with the Environment Agency Regulatory Position Statement 055 and by a qualified professional.

**Assuming maintenance schedule is followed, and remedial action is taken when required.

It is imperative that the management company maintains record logs, including dated images, of the cellular storage access chamber, all inlets, outlet flow control chamber, and silt traps. These records should be shared with the site owner.

Following 25 years from the installation of the proposed cellular storage tank, the tank manufacturer must review the records from the last 5 years and identify whether there is a requirement for replacement of the feature. Should a tank replacement be required, a qualified contractor must be appointed and develop a construction phase plan taking into consideration the piled foundations while clearly identifying the required temporary works to enable the tank replacement.

6.2.5 Inlets, outlets, controls and inspection chambers

Please note that the flow control chambers will require regular maintenance. The maintenance schedule for the chamber must be specified by the manufacturer as different features have different requirements.

TABLE 11: MAINTENANCE SCHEDULE FOR THE INLETS, OUTLETS, CONTROL STRUCTURES, PUMPS AND INSPECTION CHAMBERS/MANHOLES

Maintenance	Frequency	Owner
Regular maintenance Inlets, outlets: • Inspect surface structures removing obstructions and silt as necessary. Check there is no physical damage • Strim vegetation 1m min. surround to structures and keep hard aprons free from silt and debris	Monthly	Private management company (to be confirmed by developer)

Maintenance	Frequency	Owner
Inspection chambers/manholes and below ground flow control chambers: • Remove cover and inspect ensuring water is flowing freely and that the exit route for water is unobstructed. Remove debris and silt. • Undertake inspection after leaf fall in autumn.	Monthly for 12 months, then annually.	
Pumping Chamber: • Remove cover and inspect pump flow capacity ensuring no drop in flow has occurred. • Ensure no build-up of siltation has occurred in pump manhole. • Check operation pressure by calculating difference between inlet and outlet pressure and ensure it is operating on the pressure curve. • Check for corrosion on parts such as main body, flanges, impeller and casing plug. • Monitor pump vibration. Excessive vibration could be a sign of pump misalignment, bearing failures, cavitation, and obstructions in the suction and discharge lines. • Monitor and log bearing temperatures, lubricant level, and vibration. Lubricant should be clear with no signs of bubbling. If bubbling is occurring, this is a good indication to add more lubricant to decrease the temperature of the bearings. If there is an increase in vibration in the bearings, this may be a good indicator of impending bearing failure.	Monthly	
Occasional tasks • Check topsoil levels are 20mm above edges of baskets and chambers to avoid mower damage.	As necessary	
Remedial Work • Repair physical damage if necessary. • Replace seals such as gaskets and mechanical seals on pump if worn.	As required	

6.2.6 Drainage network

TABLE 12: MAINTENANCE SCHEDULE FOR PIPED DRAINAGE NETWORK

Drainage Element	Maintenance	Frequency	Owner
Downpipes and gullies	**Regular maintenance** • Open any covers, inspect integrity of gullies and repair as necessary.	Monthly	Private management company (to

Drainage Element	Maintenance	Frequency	Owner
	• Remove silt / debris by suction.	Annually or as required	be confirmed by developer)
Pipe network	**Regular maintenance** • Remove any sediment within the network and inspection chambers.	Every 3 years or as required	
	• Open covers inspect integrity of chambers and repair as necessary. • Remove silt / debris by suction.	Annually	

7.0 Conclusion

The proposed development at 64 Chantry Avenue, Kempston, Bedford is located in Flood Zone 1 as defined in the NPPF. The proposal includes the demolition of the existing commercial buildings and the construction of 43 dwellings with associated parking and an access road (Appendix A).

On the basis of the available information from the Environment Agency and Bedford Borough Council, the site is at low risk of flooding from fluvial, groundwater and sewer sources. Part of the site could flood during the 1% AEP for surface water however, this risk should be managed by the proposed drainage system.

The proposed development must incorporate SuDS as described in Section 5.4 of this report and in the relevant drawing in Appendix B.

The proposed development can be deemed appropriate, provided that the recommendations in this report are adhered to, it will not increase the flood risk to other people, and it will provide multiple benefits with respect to the sustainable management of surface water runoff.

8.0 Recommendations

- Finished floor level of the proposed building should be set 150mm above local ground level.
- The site should manage surface water through the use of SuDS as described in Chapter 5.0 of this report.
- Contractor to submit a S106 to Anglian Water prior to connecting to the public sewer.
- All SuDS features must be constructed in line with recommendations made in the CIRIA SuDS Manual (2015), Water UK's Design and Construction Guidance (2020), and the CIRIA Guidance on the Construction of SuDS (2017).
- All SuDS features should be maintained in line with Table 8, Table 9, Table 10, Table 11 and Table 12.
- Detailed drainage design should be undertaken at the detailed design stage.
- Developer to confirm details of the SuDS maintenance owner.
- A dual pump mechanism with battery back-up and trigger alarm must be specified in the detailed design stage.

- Closed board fencing with concrete base should be used at the south and southeast boundaries of the site to ensure flood water from an infrastructure failure is contained within the site boundary.
- Construction (Design and Management) Regulations 2015
    - The revised CDM Regulations came into force on April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the designer's responsibilities is to ensure that the client organisation, in this instance Aragon Land & Planning Ltd is made aware of their duties under the CDM Regulations.
    - Contractor to prepare a Construction Phase Plan in line with CDM (2015).
    - Principal designer to develop a health and safety design risk assessment and an accident prevention plan, in line with CDM (2015).

Appendix A – Development proposals

THE SILVER

Additional visitor parking

5m high acoustic fence

3m high acoustic fence

N

Bin storage

Cycle parking

7m High ridge flat over garage

Pedestrian and cycle access

3m high acoustic fence

Additional cycle parking

Additional Bin storage

Existing Cherry tree and Bus Stop relocated

43 UNITS IN TOTAL

1:500

0 10 20 30 40 50 metres

Rev N	June 2022	Landscaping
Rev M	Sept 2019	Houses 20 - 23 removed, more green and parking added

Title	PROPOSED SITE PLAN
Site	Chantry Avenue. KEMPSTON.
Date	September 2019
Scale	1:500 @ A3
Dwg No.	12 - 008 - 200 N

ALP aragon
t: 01234 360655
e:francis@aragonland.co.uk
web:www.aragonland.co.uk
LAND AND PLANNING Ltd

Appendix B – Drainage

- Microdrainage Calculations:
  - 1% AEP + 40% CC
  - 1% AEP
  - 3.33% AEP + 40% CC
  - 3.33% AEP
  - 50% AEP
  - QBAR
  - Urban Creep
- RAB Drawing
- Asset location search

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FEH Rainfall Model

Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Maximum Rainfall (mm/hr)	550
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	1.00
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.037	4-8	0.525	8-12	0.078

Total Area Contributing (ha) = 0.640

Total Pipe Volume (m³) = 19.936

Network Design Table for Storm

« - Indicates pipe capacity < flow

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

Network Results Table

Network Design Table for Storm

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

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	18.175	0.339	53.6	0.060	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	22.225	0.148	150.2	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	21.311	0.228	93.5	0.070	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	15.675	0.632	24.8	0.070	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	34.495	0.431	80.0	0.070	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	33.003	0.220	150.0	0.070	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	73.540	1.026	71.7	0.080	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	30.878	0.702	44.0	0.080	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	5.033	0.067	75.1	0.080	0.00	0.0	0.600	o	150	Pipe/Conduit	
S1.007	10.275	-1.939	-5.3	0.000	0.00	0.0	0.600	o	80	Pipe/Conduit	
S1.008	5.031	0.034	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	176.56	5.17	30.376	0.060	0.0	0.0	0.0	1.79	71.2	28.7
S1.001	172.93	5.46	29.737	0.120	0.0	0.0	0.0	1.28	90.5	56.2
S1.002	170.29	5.68	29.563	0.190	0.0	0.0	0.0	1.63	115.0	87.6
S2.000	177.48	5.10	29.967	0.070	0.0	0.0	0.0	2.64	104.9	33.6
S1.003	166.49	6.00	29.335	0.330	0.0	0.0	0.0	1.76	124.3«	148.8
S3.000	172.22	5.52	29.125	0.070	0.0	0.0	0.0	1.07	42.4	32.6
S1.004	160.21	6.58	28.904	0.480	0.0	0.0	0.0	2.14	236.6	208.3
S1.005	158.25	6.76	27.878	0.560	0.0	0.0	0.0	2.74	302.5	240.0
S1.006	157.51	6.84	27.176	0.640	0.0	0.0	0.0	1.16	20.5«	273.0
S1.007	132.79	9.74	26.866	0.640	0.0	0.0	0.0	0.06	0.3«	273.0
S1.008	132.07	9.84	28.805	0.640	0.0	0.0	0.0	0.82	14.5«	273.0

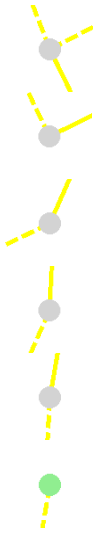
Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	31.501	1.125	Open Manhole	1200	S1.000	30.376	225				
S2	31.162	1.425	Open Manhole	1200	S1.001	29.737	300	S1.000	30.037	225	225
S3	31.063	1.500	Open Manhole	1200	S1.002	29.563	300	S1.001	29.589	300	26
S1a	31.092	1.125	Open Manhole	1200	S2.000	29.967	225				
S4	31.053	1.718	Open Manhole	1200	S1.003	29.335	300	S1.002	29.335	300	
								S2.000	29.335	225	
S2a	30.550	1.425	Open Manhole	1200	S3.000	29.125	225				
S5	30.909	2.005	Open Manhole	1350	S1.004	28.904	375	S1.003	28.904	300	
								S3.000	28.905	225	
S6	29.453	1.575	Open Manhole	1350	S1.005	27.878	375	S1.004	27.878	375	
S7	29.290	2.114	Open Manhole	1350	S1.006	27.176	150	S1.005	27.176	375	
S8	29.300	2.434	Open Manhole	1200	S1.007	26.866	80	S1.006	27.109	150	313
S9	29.320	0.515	Open Manhole	1200	S1.008	28.805	150	S1.007	28.805	80	
S	29.340	0.569	Open Manhole	1200		OUTFALL		S1.008	28.771	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	3465.964	2413.686	3465.964	2413.686	Required	
S2	3464.503	2395.569	3464.503	2395.569	Required	
S3	3473.854	2375.407	3473.854	2375.407	Required	
S1a	3457.637	2349.839	3457.637	2349.839	Required	
S4	3472.714	2354.126	3472.714	2354.126	Required	
S2a	3514.324	2337.274	3514.324	2337.274	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S5	3485.104	2321.934	3485.104	2321.934	Required	
S6	3517.031	2255.686	3517.031	2255.686	Required	
S7	3544.792	2269.205	3544.792	2269.205	Required	
S8	3546.807	2273.817	3546.807	2273.817	Required	
S9	3547.364	2284.077	3547.364	2284.077	Required	
S	3548.222	2289.034			No Entry	



PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S1	31.501	30.376	0.900	Open Manhole	1200
S1.001	o	300	S2	31.162	29.737	1.125	Open Manhole	1200
S1.002	o	300	S3	31.063	29.563	1.200	Open Manhole	1200
S2.000	o	225	S1a	31.092	29.967	0.900	Open Manhole	1200
S1.003	o	300	S4	31.053	29.335	1.418	Open Manhole	1200
S3.000	o	225	S2a	30.550	29.125	1.200	Open Manhole	1200
S1.004	o	375	S5	30.909	28.904	1.630	Open Manhole	1350
S1.005	o	375	S6	29.453	27.878	1.200	Open Manhole	1350
S1.006	o	150	S7	29.290	27.176	1.964	Open Manhole	1350
S1.007	o	80	S8	29.300	26.866	2.354	Open Manhole	1200
S1.008	o	150	S9	29.320	28.805	0.365	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	18.175	53.6	S2	31.162	30.037	0.900	Open Manhole	1200
S1.001	22.225	150.2	S3	31.063	29.589	1.174	Open Manhole	1200
S1.002	21.311	93.5	S4	31.053	29.335	1.418	Open Manhole	1200
S2.000	15.675	24.8	S4	31.053	29.335	1.493	Open Manhole	1200
S1.003	34.495	80.0	S5	30.909	28.904	1.705	Open Manhole	1350
S3.000	33.003	150.0	S5	30.909	28.905	1.779	Open Manhole	1350
S1.004	73.540	71.7	S6	29.453	27.878	1.200	Open Manhole	1350
S1.005	30.878	44.0	S7	29.290	27.176	1.739	Open Manhole	1350
S1.006	5.033	75.1	S8	29.300	27.109	2.041	Open Manhole	1200
S1.007	10.275	-5.3	S9	29.320	28.805	0.435	Open Manhole	1200
S1.008	5.031	150.0	S	29.340	28.771	0.419	Open Manhole	1200

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.060	0.060	0.060
1.001	-	-	100	0.060	0.060	0.060
1.002	-	-	100	0.070	0.070	0.070
2.000	-	-	100	0.070	0.070	0.070
1.003	-	-	100	0.070	0.070	0.070
3.000	-	-	100	0.070	0.070	0.070
1.004	-	-	100	0.080	0.080	0.080
1.005	-	-	100	0.080	0.080	0.080
1.006	-	-	100	0.080	0.080	0.080
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.640	0.640	0.640

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S7, DS/PN: S1.006, Volume (m³): 6.3

Unit Reference	MD-SCL-0065-2900-2114-2900
Design Head (m)	2.114
Design Flow (l/s)	2.9
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	65
Invert Level (m)	27.176
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.114	2.9	Kick-Flo®	0.584	1.6
Flush-Flo™	0.265	2.1	Mean Flow over Head Range	-	2.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.2	3.000	3.4	7.000	5.0
0.200	2.1	1.400	2.4	3.500	3.7	7.500	5.2
0.300	2.1	1.600	2.6	4.000	3.9	8.000	5.4
0.400	2.0	1.800	2.7	4.500	4.1	8.500	5.5
0.500	1.9	2.000	2.8	5.000	4.3	9.000	5.7
0.600	1.6	2.200	3.0	5.500	4.5	9.500	5.8
0.800	1.9	2.400	3.1	6.000	4.7		
1.000	2.1	2.600	3.2	6.500	4.9		

Pump Manhole: S8, DS/PN: S1.007, Volume (m³): 2.8

Invert Level (m) 26.866

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	3.0000	1.500	3.0000	2.000	3.0000
1.000	3.0000	1.800	3.0000		

Storage Structures for Storm

Complex Manhole: S7, DS/PN: S1.006

Cellular Storage

Invert Level (m) 27.176 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	750.0	750.0	0.915	0.0	750.0
0.914	750.0	750.0			

Bio-Retention Area

Invert Level (m) 28.090 Infiltration Coefficient Side (m/hr) 0.00000
Porosity 0.30 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000

Depth (m)	Area (m²)	Perimeter (m)	Depth (m)	Area (m²)	Perimeter (m)
0.000	225.0	70.000	1.200	225.0	70.000

Porous Car Park

Infiltration Coefficient Base (m/hr) 0.00000 Width (m) 26.0
Membrane Percolation (mm/hr) 1000 Length (m) 13.5
Max Percolation (l/s) 97.5 Slope (1:X) 150.0
Safety Factor 2.0 Depression Storage (mm) 5
Porosity 0.30 Evaporation (mm/day) 3
Invert Level (m) 28.090 Membrane Depth (mm) 60

Manhole Headloss for Storm

PN	US/MH Name	US/MH Headloss
S1.000	S1	0.500
S1.001	S2	0.500
S1.002	S3	0.500
S2.000	S1a	0.500
S1.003	S4	0.500
S3.000	S2a	0.500
S1.004	S5	0.500
S1.005	S6	0.500
S1.006	S7	0.500
S1.007	S8	0.500
S1.008	S9	0.500

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Summer	100	+40%	100/15 Summer			
S1.001	S2	15 Summer	100	+40%	100/15 Summer	100/15 Summer		
S1.002	S3	15 Summer	100	+40%	100/15 Summer	100/15 Summer		
S2.000	S1a	15 Summer	100	+40%	100/15 Summer			
S1.003	S4	15 Summer	100	+40%	100/15 Summer			
S3.000	S2a	15 Summer	100	+40%	100/15 Summer			
S1.004	S5	15 Summer	100	+40%	100/15 Summer			
S1.005	S6	15 Summer	100	+40%	100/15 Summer			
S1.006	S7	720 Winter	100	+40%	100/15 Summer			
S1.007	S8	10080 Winter	100	+40%	100/15 Summer			

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	31.286	0.685	0.000	0.58			36.9	FLOOD RISK	
S1.001	S2	31.162	1.125	0.135	0.81			64.9	FLOOD	1
S1.002	S3	31.063	1.200	0.199	0.99			99.5	FLOOD	1
S2.000	S1a	30.995	0.803	0.000	0.48			44.3	FLOOD RISK	
S1.003	S4	30.878	1.243	0.000	1.55			177.4	FLOOD RISK	
S3.000	S2a	30.073	0.723	0.000	1.07			42.6	SURCHARGED	
S1.004	S5	29.832	0.553	0.000	1.15			258.5	SURCHARGED	
S1.005	S6	28.413	0.160	0.000	1.11			297.5	SURCHARGED	
S1.006	S7	27.901	0.575	0.000	0.13		2361	2.1	SURCHARGED	
S1.007	S8	27.213	0.267	0.000	1.53			2.1	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9	10080 Winter	100	+40%					28.848

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.107	0.000	0.18			2.1	OK	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	100	+0%					30.486
S1.001	S2	15 Summer	100	+0%	100/15 Summer				30.291
S1.002	S3	15 Summer	100	+0%	100/15 Summer				30.185
S2.000	S1a	15 Summer	100	+0%					30.090
S1.003	S4	15 Summer	100	+0%	100/15 Summer				30.008
S3.000	S2a	15 Summer	100	+0%	100/15 Summer				29.375
S1.004	S5	15 Summer	100	+0%					29.216
S1.005	S6	15 Summer	100	+0%					28.172
S1.006	S7	600 Winter	100	+0%	100/15 Summer				27.668
S1.007	S8	2880 Winter	100	+0%	100/15 Summer				27.213

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.115	0.000	0.48			30.4	OK	
S1.001	S2	0.254	0.000	0.70			56.2	SURCHARGED	
S1.002	S3	0.322	0.000	0.88			88.4	SURCHARGED	
S2.000	S1a	-0.102	0.000	0.38			35.2	OK	
S1.003	S4	0.373	0.000	1.35			153.7	SURCHARGED	
S3.000	S2a	0.025	0.000	0.86			34.2	SURCHARGED	
S1.004	S5	-0.063	0.000	0.98			219.4	OK	
S1.005	S6	-0.081	0.000	0.95			255.6	OK	
S1.006	S7	0.342	0.000	0.13		1429	2.1	SURCHARGED	
S1.007	S8	0.267	0.000	1.53			2.1	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9	2880 Winter	100	+0%					28.848

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.107	0.000	0.18			2.1	OK	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	30	+40%					30.489
S1.001	S2	15 Summer	30	+40%	30/15 Summer				30.394
S1.002	S3	15 Summer	30	+40%	30/15 Summer				30.291
S2.000	S1a	15 Summer	30	+40%	30/15 Summer				30.192
S1.003	S4	15 Summer	30	+40%	30/15 Summer				30.107
S3.000	S2a	15 Summer	30	+40%	30/15 Summer				29.446
S1.004	S5	15 Summer	30	+40%	30/15 Summer				29.283
S1.005	S6	15 Summer	30	+40%					28.177
S1.006	S7	720 Winter	30	+40%	30/15 Summer				27.686
S1.007	S8	7200 Summer	30	+40%	30/15 Summer				27.213

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.112	0.000	0.50			32.0	OK	
S1.001	S2	0.357	0.000	0.72			57.7	SURCHARGED	
S1.002	S3	0.428	0.000	0.91			91.3	SURCHARGED	
S2.000	S1a	0.000	0.000	0.39			36.2	SURCHARGED	
S1.003	S4	0.472	0.000	1.38			157.4	SURCHARGED	
S3.000	S2a	0.096	0.000	0.88			35.0	SURCHARGED	
S1.004	S5	0.004	0.000	1.00			224.1	SURCHARGED	
S1.005	S6	-0.076	0.000	0.98			261.4	OK	
S1.006	S7	0.360	0.000	0.13		1488	2.1	SURCHARGED	
S1.007	S8	0.267	0.000	1.53			2.1	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9 7200	Summer	30	+40%					28.848

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.107	0.000	0.18			2.1	OK	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	30	+0%					30.469
S1.001	S2	15 Summer	30	+0%					29.907
S1.002	S3	15 Summer	30	+0%					29.815
S2.000	S1a	15 Summer	30	+0%					30.049
S1.003	S4	15 Summer	30	+0%	30/15 Summer				29.698
S3.000	S2a	15 Summer	30	+0%					29.261
S1.004	S5	15 Summer	30	+0%					29.161
S1.005	S6	15 Summer	30	+0%					28.127
S1.006	S7	600 Winter	30	+0%	30/30 Summer				27.522
S1.007	S8	360 Winter	30	+0%	30/15 Summer				27.213

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.132	0.000	0.36			22.9	OK	
S1.001	S2	-0.130	0.000	0.60			48.1	OK	
S1.002	S3	-0.048	0.000	0.72			72.2	OK	
S2.000	S1a	-0.143	0.000	0.29			26.7	OK	
S1.003	S4	0.063	0.000	1.08			123.4	SURCHARGED	
S3.000	S2a	-0.089	0.000	0.66			26.3	OK	
S1.004	S5	-0.118	0.000	0.79			176.5	OK	
S1.005	S6	-0.126	0.000	0.76			204.6	OK	
S1.006	S7	0.196	0.000	0.13		1022	2.1	SURCHARGED	
S1.007	S8	0.267	0.000	1.53			2.1	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9	360 Winter	30	+0%					28.848

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.107	0.000	0.18			2.1	OK	

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Summer	2	+0%					30.436
S1.001	S2	15 Summer	2	+0%					29.836
S1.002	S3	15 Summer	2	+0%					29.672
S2.000	S1a	15 Summer	2	+0%					30.020
S1.003	S4	15 Summer	2	+0%					29.474
S3.000	S2a	15 Summer	2	+0%					29.209
S1.004	S5	15 Summer	2	+0%					29.050
S1.005	S6	15 Summer	2	+0%					28.020
S1.006	S7	600 Summer	2	+0%	2/240 Summer				27.343
S1.007	S8	600 Summer	2	+0%	2/15 Summer				27.186

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.165	0.000	0.16			10.1	OK	
S1.001	S2	-0.201	0.000	0.23			18.5	OK	
S1.002	S3	-0.191	0.000	0.28			28.4	OK	
S2.000	S1a	-0.172	0.000	0.13			11.8	OK	
S1.003	S4	-0.161	0.000	0.44			49.9	OK	
S3.000	S2a	-0.141	0.000	0.29			11.6	OK	
S1.004	S5	-0.229	0.000	0.32			70.7	OK	
S1.005	S6	-0.233	0.000	0.30			80.9	OK	
S1.006	S7	0.017	0.000	0.12		641	1.9	SURCHARGED	
S1.007	S8	0.240	0.000	1.41			1.9	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9	600 Summer	2	+0%					28.846

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.109	0.000	0.17			1.9	OK	

ICP SUDS Mean Annual Flood

Input

Return Period (years) 100 SAAR (mm) 550 Urban 0.000
Area (ha) 1.000 Soil 0.450 Region Number Region 5

Results l/s

QBAR Rural 3.3
QBAR Urban 3.3

Q100 years 11.8

Q1 year 2.9
Q30 years 8.0
Q100 years 11.8

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.060	0.060	0.060
1.001	-	-	100	0.060	0.060	0.060
1.002	-	-	100	0.070	0.070	0.070
2.000	-	-	100	0.080	0.080	0.080
1.003	-	-	100	0.080	0.080	0.080
3.000	-	-	100	0.080	0.080	0.080
1.004	-	-	100	0.090	0.090	0.090
1.005	-	-	100	0.090	0.090	0.090
1.006	-	-	100	0.090	0.090	0.090
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.700	0.700	0.700

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH
FEH Rainfall Version	2013
Site Location	GB 503500 246823 TL 03500 46823
Data Type	Point
Cv (Summer)	0.850
Cv (Winter)	0.850

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S1	15 Summer	100	+40%	100/15 Summer			
S1.001	S2	15 Summer	100	+40%	100/15 Summer	100/15 Summer		
S1.002	S3	15 Summer	100	+40%	100/15 Summer	100/15 Summer		
S2.000	S1a	15 Summer	100	+40%	100/15 Summer	100/15 Summer		
S1.003	S4	15 Summer	100	+40%	100/15 Summer			
S3.000	S2a	15 Summer	100	+40%	100/15 Summer			
S1.004	S5	15 Summer	100	+40%	100/15 Summer			
S1.005	S6	15 Summer	100	+40%	100/15 Summer			
S1.006	S7	960 Winter	100	+40%	100/15 Summer			
S1.007	S8	10080 Winter	100	+40%	100/15 Summer			

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	31.312	0.711	0.000	0.58			37.0	FLOOD RISK	
S1.001	S2	31.163	1.126	0.867	0.88			70.4	FLOOD	1
S1.002	S3	31.065	1.202	2.037	0.94			95.3	FLOOD	1
S2.000	S1a	31.092	0.900	0.434	0.55			51.4	FLOOD	1
S1.003	S4	30.953	1.318	0.000	1.53			174.7	FLOOD RISK	
S3.000	S2a	30.341	0.991	0.000	1.24			49.2	FLOOD RISK	
S1.004	S5	30.018	0.739	0.000	1.19			266.3	SURCHARGED	
S1.005	S6	28.508	0.255	0.000	1.17			312.7	SURCHARGED	
S1.006	S7	27.974	0.648	0.000	0.13		2619	2.1	SURCHARGED	
S1.007	S8	27.213	0.267	0.000	1.53			2.1	SURCHARGED	

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.008	S9	8640 Winter	100	+40%					28.848

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.008	S9	-0.107	0.000	0.18			2.1	OK	

LEGEND

- Cellular Storage Device
- Type C Permeable Paving
- Type A Permeable Paving
- Raingarden (to be planted with small shallow root trees and medium sized plants)
- Surface Water pipes
- Exceedance flow routes
- Existing surface water drainage infrastructure
- Inspection Chamber/Manhole
- Surface water dual pump station with battery back-up and alarm fitted (product to be confirmed at detailed design stage)
- SDS Aqua Swirl (or similar) treatment device)
- Rising main

Structures:

Cellular Storage:
Area=750m²
Storage volume=651.225m³
Cell depth=0.914
Cover depth=1.2m

Raingarden:
Area=225m²
Depth=1.2m
Surface depression=150mm
Side slopes=1:3

Permeable paving:
Combined area=1540m²
Depth (above cellular storage)=0.6m (1.2m)
Filter medium porosity=0.3

Notes:

1. All setting out to be in accordance with the Architects drawings. Any discrepancies between the Engineers and the Architects drawings to be referred to the Architect before proceeding. Dimensions must not be scaled.
2. This drawing must be read in conjunction with all relevant drawings and with the drainage report (RAB2977).
3. A construction phase plan, in line with CDM 2015, must be prepared by the principal contractor prior to any work taking place. The Contractor must comply with all current legislation relating to health and safety.
3. Connections to Public sewers to be agreed and inspected by Water Authority.
4. Until technical approval has been obtained from the relevant Authority, it should be understood that all drawings issued are Preliminary and not for construction. Should the contractor commence the work prior to such approval being given, it is entirely at his own risk.
5. Drainage to be in accordance with BS 7533-13:2009, Building Regulations Part H: Drainage and Waste Disposal, *Design and Construction Guidance for foul and surface water sewers offered for adoption under the Code for adoption agreements for water and sewerage companies operating wholly or mainly in England*, CIRIA Guidance on the Construction of (C768) SuDS and CIRIA SuDS Manual (C735).
6. The minimum depth of cover to the crown of gravity pipes without protection should be 0.35m for domestic gardens and pathways without any possibility of vehicular access; 0.5m in domestic driveways, parking areas and yards with height restrictions to prevent entry by vehicles weighing >7.5 tonnes; 0.9m in domestic driveways, parking areas and narrow streets without footways with limited access for vehicles with a gross vehicle weight in excess of 7.5 tonnes; 1.2m in highways and parking areas with unrestricted access to vehicles with a gross vehicle weight in excess of 7.5 tonnes.
7. All pipes not meeting the criteria 6 MUST include a minimum 150mm thick Class GEN3 Concrete surround in line with the 2020 Design And Construction Guidance document.
8. A detailed utilities survey must be undertaken prior to any works taking place. Designer to be informed of any clashes.
9. Where pipes are bedded and surrounded in concrete, flexible joints should be provided. Compressible boards (fibreboard or polystyrene) shall be provided at a maximum of 8m centres (coinciding with pipe joints). The boards shall be pre-cut to pipe diameter and to a height and width equal to the concrete cross section. A board thickness of 18mm for pipes up to 450mm nominal diameter and 36mm for pipes over 450mm nominal diameter.
10. The Contractor shall make allowance for raising / lowering all access covers & frames to suit finished levels.
11. Cover Class to manholes/inspection chambers are to suit anticipated vehicular loadings in accordance with BSEN 124:2015 (D400 where potential for HGV loading, C250/B125/A15 in footway trafficked areas not accessible by vehicles.
12. All soft / hard paved areas affected by the works shall be fully reinstated upon completion of the works. All surface markings damaged by the works shall be fully reinstated.
13. Before handover, all manholes shall be inspected, all rubble removed, and the whole system shall be thoroughly flushed and cleaned.
14. All levels are in Ordnance datum unless otherwise specified.
15. All pipe runs near buildings to comply with the Building Regulations 2002 Part H1. where a pipe is within 1m of a foundation the trench shall be filled with class GEN3 Concrete up to the lowest level of the foundation. Where the trench is further than 1m from the foundation, the trench shall be filled with class GEN3 Concrete to a level below the lowest level for the foundation equal to the distance from the foundation less 150mm. In both cases, the pipe shall be bedded and surrounded in 150mm thick class GEN3 Concrete
16. All materials delivered to the site associated to the sub-base storage of the permeable pavement must be tested to obtain their porosity and permeability; in line with BS 1377-2:1990 and BS 1377-4:1990
17. Backfill material to drainage trenches under carriageways to be DOT Type 1 sub-base material, elsewhere backfill to be free draining readily compacted material, free from rubbish and organic matter, frozen soil clay lumps and large stones. To be compacted in layers of not exceeding 150mm thick.
18. Joints specification to be provided by manufacturers.
19. Typical pipe bedding to drainage for pipes up to D=525mm is to be Class S (i.e. 10-14mm).
20. Extra care must be taken once the permeable pavement(s) has been installed so that construction traffic does not impact the porosity due to compaction.
21. **Trench temporary formwork is required to all excavations exceeding 1.2m depth to provide adequate support and stability at all times.**
22. Sewers are to be constructed in single sections between manholes only. Trenches to be backfilled prior to excavating the succeeding sewer run.
23. All concrete products to be in accordance with BRE 363 for sulphates.
24. The requirement or not for a capping layer under the porous pavement(s) must be assessed by the highways engineer.
25. No SuDS features should receive construction-related runoff. Alternative methods of surface water disposal must be employed.
26. Where sewer or drains are to be abandoned they shall be removed or infilled by grouting in accordance with the Civil Engineer Specification for the Water Industry 7th edition, Clause S.23.
27. All manholes shall be watertight.
28. Principal designer must develop a health and safety design risk assessment for the entire scheme.
29. Client must fulfil his/her duties under CDM 2015.
30. The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such utilities plant or apparatus may also be present but not shown. The Contractor must therefore undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect the design installation and/or their operations, prior to the commencement of any works and inform the designer should there be any clashes. Should the contractor commence the work prior to such an investigation, it is entirely at his own risk. RAB Consultants accepts no liability should existing utilities clash with the proposed design.
31. RAB Consultants accepts no liability should the proposed drainage not be installed and maintained correctly and to standards, and structural/functional failure occurs.

H&S icons:

- Follow standard HSE protocol during the installation of manholes and structures, placing of fill material, and excavations, especially close to watercourses.
- DANGER Men at work — Follow standard site protection HSE protocol during construction to ensure no unauthorized personnel enters the site.
- Danger Underground services — The principal contractor and maintenance contractor must undertake a thorough investigation and assessment of the impact of utilities on site and take appropriate H & S mitigation measures, prior to construction/maintenance activities commence. Should both contractors commence work without such investigations and assessments, it is entirely at their own risk.
- Obstacles — The principal contractor and maintenance contractor are advised to follow HSE protocol during construction and maintenance, respectively, to manage the risk of trips and falls and adopt appropriate H & S mitigation measures.

RESILIENCE & FLOOD RISK
Kingsbrook House,
7 Kingsway,
Bedford,
MK42 9BA

Client: Aragon Land & Planning Ltd

Project: 64 Chantry Avenue

Drawing: Drainage Strategy Plan View

Checked by AT	Approved by AT	
Drawn by JL	Date: 11/07/2022	Scale: 1:350@ A1

Drawing No.	Revision
RAB2977_001	-

Pre-Planning Assessment Report

Chantry Avenue

InFlow Reference: PPE-0150503

Assessment Type: Used Water

Report published: 11/07/2022

Thank you for submitting a pre-planning enquiry.

This has been produced for ARAGON LAND AND PLANNING LTD.

Your reference number is **PPE-0150503**.

This report can be submitted as a drainage strategy for the development should it seek planning permission.

If you have any questions upon receipt of this report, you can submit a further question via InFlow. Alternatively, please contact the Planning & Capacity team on **07929 786 955** or email planningliaison@anglianwater.co.uk

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Section 1 - Proposed development

The response within this report has been based on the following information which was submitted as part of your application:

List of planned developments	
Type of development	**No. Of units**
Dwellings	43

The anticipated residential build rate is:

Year	Y1
Build rate	43

Development type: Brownfield

Planning application status: Unknown

Site grid reference number: TL0348946814

The comments contained within this report relate to the public water mains and sewers indicated on our records.

Your attention is drawn to the disclaimer in the useful information section of this report.

Section 2 - Assets affected

Our records indicate that we have the following types of assets within or overlapping the boundary of your development site as listed in the table below.

Additionally, it is highly recommended that you carry out a thorough investigation of your proposed working area to establish whether any unmapped public or private sewers and lateral drains are in existence. We are unable to permit development either over or within the easement strip without our prior consent. The extent of the easement is provided in the table below. Please be aware that the existing water mains/public sewers should be located in highway or open space and not in private gardens. This is to ensure available access for any future maintenance and repair and this should be taken into consideration when planning your site layout.

Water and Used water easement information		
Asset type	Pipe size (mm)	Total easement required (m)
Sewer mains	300	3.00 m either side of the centre line
Sewer mains	600	3.50 m either side of the centre line
Sewer mains	150	3.00 m either side of the centre line

If it is not possible to avoid our assets then these may need to be diverted in accordance with Section 185 of the Water Industry Act (1991). You will need to make a formal application if you would like a diversion to be considered.

Due to the private sewer transfer in October 2011 many newly adopted public used water assets and their history are not indicated on our records. You also need to be aware that your development site may contain private water mains, drains or other assets not shown on our records. These are private assets and not the responsibility of Anglian Water but that of the landowner.

Section 3 - Water recycling services

In examining the used water system we assess the ability for your site to connect to the public sewerage network without causing a detriment to the operation of the system. We also assess the receiving water recycling centre and determine whether the water recycling centre can cope with the increased flow and effluent quality arising from your development.

Water recycling centre

The foul drainage from the proposed development is in the catchment of Bedford Water Recycling Centre, which currently does not have capacity to treat the flows from your development site.

Anglian Water are obligated to accept the foul flows from your development with the benefit of planning consent and would therefore take the necessary steps to ensure that there is sufficient treatment capacity should the planning authority grant planning permission.

Used water network

Our assessment has been based on development flows connecting to the nearest foul water sewer of the same size or greater pipe diameter to that required to drain the site. The infrastructure to convey foul water flows to the receiving sewerage network is assumed to be the responsibility of the developer. Conveyance to the connection point is considered as Onsite Work and includes all work carried out upstream from of the point of connection, including making the connection to our existing network. This connection point has been determined in reference to the calculated discharge flow and on this basis, a 150mm internal diameter pipe is required to drain the development site. The nearest practicable connection is to the 150mm diameter sewer at manhole MH4801 in The Silver Birches at National Grid Reference NGR TL 03493 46865. Anglian Water has assessed the impact of gravity flows from the planned development to the public foul sewerage network. We can confirm that this is acceptable as the foul sewerage system, at present, has available capacity for your site. Please note that Anglian Water will request a suitably worded condition at planning application stage to ensure this strategy is implemented to mitigate the risk of flooding.

It is assumed that the developer will provide the necessary infrastructure to convey flows from the site to the network. Consequently, this report does not include any costs for the conveyance of flows.

Surface water disposal

In principle, your proposed method of surface water disposal is acceptable to Anglian Water. It is our understanding that the evidence to confirm compliance with the surface water hierarchy is not available. Once the evidence has been confirmed, then a connection point may be made to manhole MH5751 in the east corner of the site at NGR TL 03550 46755 at a rate of 15l/s. Our assessment has been based on development flows connecting to the nearest surface water sewer of the same size or greater pipe diameter. It is your responsibility to provide the evidence to confirm that all alternative methods of surface water disposal have been explored and these will be required before your connection can be agreed. This is subject to satisfactory evidence which shows the surface water management hierarchy as outlined in Building Regulations Part H has been explored. This would encompass the results from the site specific infiltration testing and/or confirmation that the flows cannot be discharged to a watercourse. Anglian Water's surface water policy follows the Surface Water hierarchy, outlined in Part H of the Building Regulations. Should your assumptions or evidence change then an alternative solution, connection point or flow rate may be required. You are therefore advised to update Anglian Water with the key supporting evidence at your earliest convenience.

As you may be aware, Anglian Water will consider the adoption of SuDs provided that they meet the criteria outline in our SuDs adoption manual. This can be found on our website. We will adopt features located in public open space that are designed and constructed, in conjunction with the Local Authority and Lead Local Flood Authority (LLFA), to the criteria within our SuDs adoption manual. Specifically, developers must be able to demonstrate:

1. Effective upstream source control,
2. Effective exceedance design, and
3. Effective maintenance schedule demonstrating than the assets can be maintained both now and in the future with adequate access.

If you wish to look at the adoption of any SuDs then an expression of interest form can be found on our website

Trade Effluent

We note that you do not have any trade effluent requirements. Should this be required in the future you will need our written formal consent. This is in accordance with Section 118 of the Water Industry Act (1991).

Used Water Budget Costs

Your development site will be required to pay an Infrastructure charge for each new property connecting to the public water and sewerage network that benefits from Full planning permission. The infrastructure charge replaces the zonal charge as previously identified.

You will be required to pay an infrastructure charge upon connection for each new plot on your development site. The infrastructure charge are types of charges set out in Section 146(2) of the Water Industry Act 1991.

The charge should be paid by anyone who wishes to build or develop a property and is payable upon request of connection.

• The Infrastructure Charge is based on the cost of any reinforcement and upgrades to our existing network ("Network Reinforcements"), whether designed to address strategic or local capacity issues. For more information on our Infrastructure Charge, please see the 'Useful Information' section of this report.

Infrastructure charges are raised on a standard basis of one charge per new connection (one for water and one for sewerage).

The Water Recycling Infrastructure charge for your dwellings is:

Infrastructure charge	Number of units	Total
£ 490	43	£21,070.00

Please note that you should also budget for infrastructure charges on non-household premises where applicable and these will be calculated according to the number and type of water fittings in the premises. This is called the "relevant multiplier" method of calculating the charge and the relevant multiplier will be applied to the figures set out in our 2022-23 Developer Charging Arrangements to arrive at the amount payable. Details of the relevant multiplier for each fitting can be found on our website.

Section 4 - Map of Proposed Point of Connection(s)

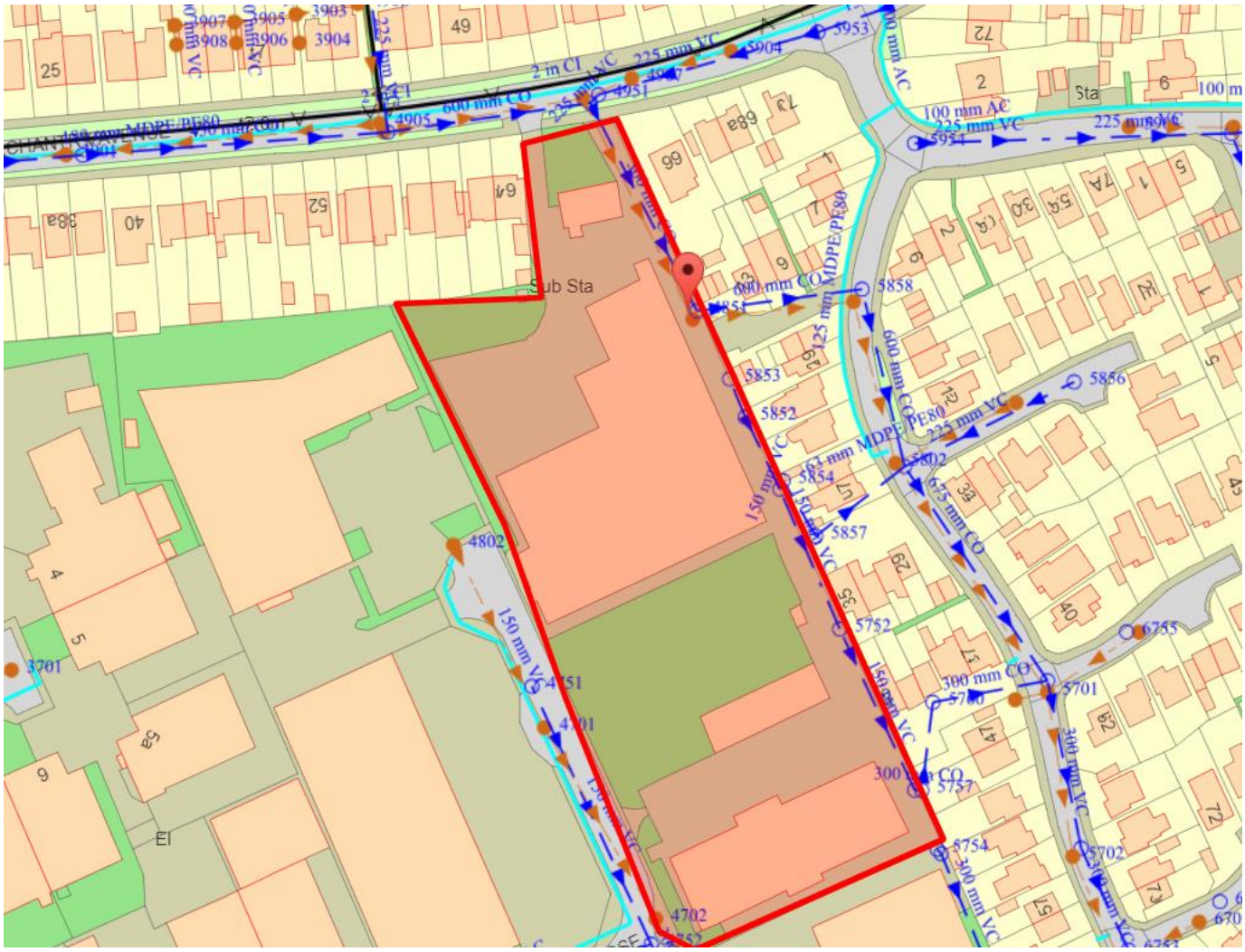


Figure 1: Showing your water recycling foul point of connection

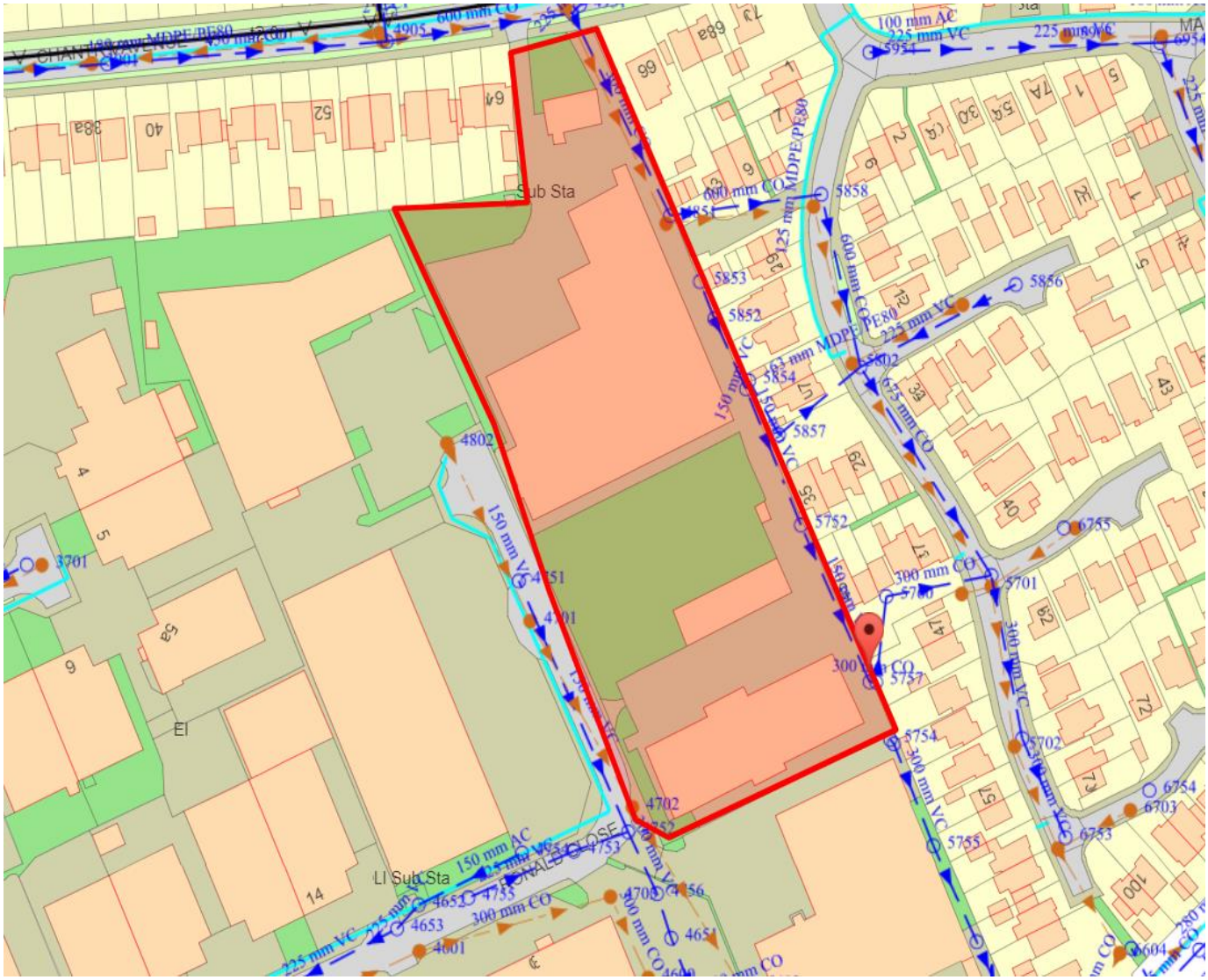


Figure 2: Showing your water recycling surface water point of connection

Section 5 - Useful information

Water Industry Act – Key used water sections

Section 98:

This provides you with the right to requisition a new public sewer. The new public sewer can be constructed by Anglian Water on your behalf. Alternatively, you can construct the sewer yourself under section 30 of the Anglian Water Authority Act 1977.

Section 102:

This provides you with the right to have an existing sewerage asset vested by us. It is your responsibility to bring the infrastructure to an adoptable condition ahead of the asset being vested.

Section 104:

This provides you with the right to have a design technically vetted and an agreement reached that will see us adopt your assets following their satisfactory construction and connection to the public sewer.

Section 106:

This provides you with the right to have your constructed sewer connected to the public sewer.

Section 185

This provides you with the right to have a public sewerage asset diverted.

Details on how to make a formal application for a new sewer, new connection or diversion are available on our website or via our Development Services team on **0345 60 66 087**.

Sustainable drainage systems

Many existing urban drainage systems can cause problems of flooding, pollution or damage to the environment and are not resilient to climate change in the long term. .

Our preferred method of surface water disposal is through the use of Sustainable Drainage Systems or SuDS.

SuDS are a range of techniques that aim to mimic the way surface water drains in natural systems within urban areas. For more information on SuDS, please visit our website

We recommend that you contact the Local Authority and Lead Local Flood Authority (LLFA) for your site to discuss your application.

Private sewer transfers

Sewers and lateral drains connected to the public sewer on the 1 July 2011 transferred into Water Company ownership on the 1 October 2011. This follows the implementation of the Floods and Water Management Act (FWMA). This included sewers and lateral drains that were subject to an existing Section 104 Adoption Agreement and those that were not. There were exemptions and the main non-transferable assets were as follows:

Surface water sewers and lateral drains that do not discharge to the public sewer, e.g. those that discharged to a watercourse.

Foul sewers and lateral drains that discharged to a privately owned sewage treatment/collection facility.

Pumping stations and rising mains will transfer between 1 October 2011 and 1 October 2016.

The implementation of Section 42 of the FWMA will ensure that future private sewers will not be created. It is anticipated that all new sewer applications will need to have an approved section 104 application ahead of a section 106 connection.

It is anticipated that all new sewer applications will need to have an approved Section104 application ahead of a Section 106 connection

Encroachment

Anglian Water operates a risk based approach to development encroaching close to our used water infrastructure. We assess the issue of encroachment if you are planning to build within 400 metres of a water recycling centre or, within 15 metres to 100 metres of a pumping station. We have more information available on our website

Locating our assets

Maps detailing the location of our water and used water infrastructure including both underground assets and above ground assets such as pumping stations and recycling centres are available from digdat

All requests from members of the public or non-statutory bodies for maps showing the location of our assets will be subject to an appropriate administrative charge.

We have more information on our website

Charging arrangements

Our charging arrangements and summary for this year's water and used water connection and infrastructure charges can be found on our website

Section 6 - Disclaimer

The information provided in this report is based on data currently held by Anglian Water Services Limited ('Anglian Water') or provided by a third party. Accordingly, the information in this report is provided with no guarantee of accuracy, timeliness, completeness and is without indemnity or warranty of any kind (express or implied).

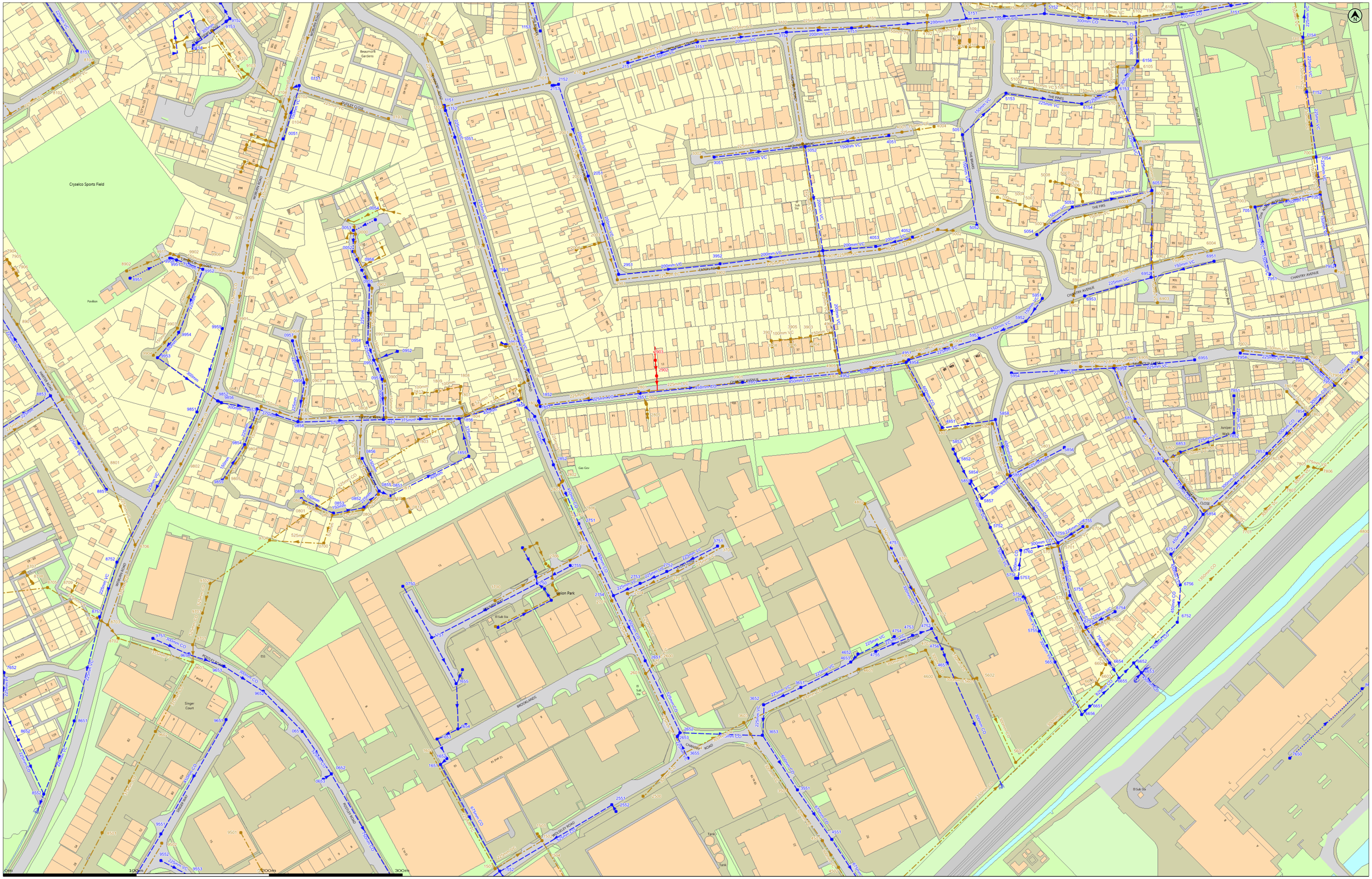
This report should not be considered in isolation and does not nullify the need for the enquirer to make additional appropriate searches, inspections and enquiries. Anglian Water supports the plan led approach to sustainable development that is set out in the National Planning Policy Framework ('NPPF') and any infrastructure needs identified in this report must be considered in the context of current, adopted and/or emerging local plans. Where local plans are absent, silent or have expired these needs should be considered against the definition of sustainability holistically as set out in the NPPF.

Whilst the information in this report is based on the presumption that proposed development obtains planning permission, nothing in this report confirms that planning permission will be granted or that Anglian Water will be bound to carry out the works/proposals contained within this report.

No liability whatsoever, including liability for negligence is accepted by Anglian Water or its partners, employees or agents, for any error or omission, or for the results obtained from the use of this report and/or its content.

Furthermore, in no event will any of those parties be liable to the applicant or any third party for any decision made or action taken as a result of reliance on this report.

This report is valid from the date issued and the enquirer is advised to resubmit their request for an up to date report should there be a delay in submitting any subsequent application for water supply/sewer connection(s). Our pre-planning reports are valid for 12 months, however please note Anglian Water cannot reserve capacity and available capacity in our network can be reduced at any time due to increased requirements from existing businesses and houses as well as from new housing and new commercial developments.



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Foul Sewer	Outfall*	Sewage Treatment Works	
Surface Sewer			
Combined Sewer			
Final Effluent	Inlet*	Public Pumping Station	
Rising Main*			
Private Sewer*	Manhole*	Decommissioned Pumping Station	
Decommissioned Sewer*		*(Colour denotes effluent type)	

alexandros@rabconsultants.co.uk

Q5149

love every drop anglianwater

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
2902	503280	246907	C	-	-	-
2903	503280	246918	C	-	-	-
0000	503054	247013	F	-	-	-
0001	503054	247000	F	-	-	-
0102	503006	247123	F	34.65	32.38	2.27
0103	503079	247100	F	34.69	33.56	1.13
0104	503001	247101	F	34.78	32.36	2.42
0700	503030	246781	F	-	-	-
0801	503015	246802	F	34.91	31.95	2.96
0802	503015	246812	F	-	-	-
0803	503037	246802	F	-	-	-
0804	503060	246807	F	-	-	-
0805	503071	246818	F	-	-	-
0806	503057	246846	F	-	-	-
0807	503077	246876	F	-	-	-
0808	503059	246877	F	-	-	-
0809	503013	246874	F	-	-	-
0810	503085	246814	F	-	-	-
0811	503091	246815	F	-	-	-
0812	503095	246805	F	-	-	-
0813	503097	246893	F	-	-	-
0900	503076	246903	F	-	-	-
0901	503065	246934	F	-	-	-
0902	503067	246973	F	-	-	-
0903	503018	246904	F	-	-	-
0904	503009	246936	F	-	-	-
1001	503150	247005	F	35.06	32.57	2.49
1101	503105	247156	F	34.67	33.48	1.19
1102	503120	247109	F	34.73	32.8	1.93
1103	503108	247163	F	-	-	-
1104	503119	247157	F	-	-	-
1501	503191	246563	F	29.19	27.45	1.74
1502	503194	246558	F	29.11	27.3	1.81
1503	503159	246537	F	29.31	27.53	1.78
1601	503111	246624	F	29.75	27.9	1.85
1700	503159	246738	F	-	-	-
1801	503190	246885	F	32.88	29.39	3.49
1803	503102	246859	F	34.39	32.16	2.23
1804	503137	246877	F	-	-	-
1805	503177	246900	F	-	-	-
1806	503179	246890	F	-	-	-
1807	503133	246887	F	-	-	-
1808	503133	246899	F	-	-	-
1809	503115	246895	F	-	-	-
1900	503184	246903	F	33.48	32.42	1.06
1901	503167	246929	F	-	-	-
2001	503216	247088	F	34.59	33.18	1.41
2002	503227	247055	F	34.63	32.87	1.76
2003	503234	247006	F	-	-	-
2004	503220	247002	F	-	-	-
2101	503200	247127	F	34.51	32.96	1.55
2102	503226	247134	F	34.37	32.86	1.51
2500	503270	246591	F	29.14	27.29	1.85
2600	503282	246695	F	30.01	27.03	2.98
2601	503272	246683	F	29.16	26.99	2.17
2701	503247	246738	F	29.64	28.05	1.59
2703	503296	246760	F	29.68	28.22	1.46
2704	503259	246743	F	29.73	27.95	1.78
2705	503230	246776	F	-	-	-
2706	503202	246762	F	-	-	-
2801	503267	246895	F	32.17	29.67	2.5
2802	503210	246828	F	31.16	29.01	2.15
2803	503207	246825	F	31.06	28.39	2.67
2804	503273	246886	F	-	-	-
2805	503274	246878	F	-	-	-
2807	503218	246801	F	-	-	-
2901	503251	246979	F	34.12	32.32	1.8
3001	503390	247081	F	33.83	31.03	2.8
3002	503314	247071	F	34.3	32.75	1.55
3101	503310	247159	F	33.92	32.07	1.85
3102	503377	247168	F	33.42	31.45	1.97
3501	503378	246596	F	29.14	27.05	2.09
3602	503355	246631	F	29.15	26.76	2.39
3603	503346	246647	F	29.26	26.54	2.72
3604	503301	246624	F	28.92	26.7	2.22
3701	503330	246779	F	29.69	28.5	1.19
3901	503341	246902	F	32.02	29.96	2.06
3902	503327	246988	F	33.86	31.64	2.22
3903	503396	246937	F	-	-	-
3904	503397	246930	F	-	-	-
3905	503381	246934	F	-	-	-
3906	503382	246929	F	-	-	-
3907	503367	246933	F	-	-	-
3908	503367	246929	F	-	-	-
4001	503465	247090	F	33.48	31.96	1.52
4002	503492	247017	F	33.52	32.1	1.42
4003	503448	247002	F	33.6	31.93	1.67
4004	503489	247094	F	33.35	31.97	1.38
4101	503440	247170	F	33.16	31.68	1.48
4102	503483	247166	F	32.97	31.79	1.18
4103	503484	247178	F	32.91	32.06	0.85
4501	503405	246558	F	29.02	27.45	1.57
4502	503417	246538	F	29.02	27.6	1.42
4600	503493	246681	F	28.97	26.27	2.7
4601	503432	246687	F	29.42	26.37	3.05
4701	503460	246768	F	28.57	27.97	0.6
4702	503488	246723	F	29.71	27.14	2.57
4703	503483	246701	F	29.24	26.27	2.97
4801	503494	246866	F	31.03	28.78	2.25
4802	503437	246811	F	29.81	28.56	1.25
4901	503403	246997	F	33.67	30.61	3.06
4903	503418	246909	F	32.01	29.42	2.59
4905	503417	246911	F	32.07	30.25	1.82
4906	503466	246918	F	32.26	29.25	3.01
4907	503478	246923	F	32.41	30.56	1.85
4908	503411	246939	F	-	-	-
5001	503572	247021	F	33.02	31.29	1.73
5002	503503	247016	F	33.51	32.12	1.39
5003	503563	247032	F	-	-	-
5004	503553	247036	F	-	-	-
5005	503537	247041	F	-	-	-
5006	503598	247047	F	-	-	-
5007	503585	247052	F	-	-	-
5008	503576	247053	F	-	-	-
5102	503539	247184	F	32.36	30.5	1.86
5103	503565	247185	F	31.99	30.41	1.58
5105	503548	247125	F	32.7	31.27	1.43
5106	503582	247119	F	32.58	30.94	1.64
5107	503508	247170	F	32.7	31.83	0.87
5108	503526	247154	F	-	-	-
5109	503516	247159	F	-	-	-
5110	503516	247154	F	-	-	-
5111	503508	247154	F	-	-	-
5112	503508	247156	F	-	-	-
5113	503508	247159	F	-	-	-
5601	503518	246679	F	29.25	26.23	3.02
5602	503521	246680	F	28.92	26.23	2.69
5603	503550	246617	F	29.1	26.09	3.01
5701	503582	246779	F	29.57	27.29	2.28
5702	503589	246740	F	29.29	27.14	2.15
5703	503574	246777	F	29.59	27.65	1.94
5801	503533	246871	F	31.24	28.51	2.73
5802	503544	246833	F	30.21	27.59	2.62
5803	503573	246848	F	30.48	28.44	2.04
5901	503595	246974	F	32.92	31.69	1.23
5902	503593	246962	F	32.86	31.81	1.05
5903	503599	246914	F	32.11	30.01	2.1
5904	503502	246930	F	32.56	30.79	1.77
6001	503644	247078	F	32.29	30.49	1.8
6002	503653	247044	F	32.42	30.58	1.84
6003	503634	247034	F	32.64	31.01	1.63
6004	503697	247001	F	32.55	31.24	1.31
6005	503600	247038	F	-	-	-
6101	503601	247178	F	31.84	30.13	1.71
6102	503643	247177	F	31.46	29.93	1.53
6103	503667	247179	F	31.17	29.61	1.56
6105	503642	247139	F	31.97	30.17	1.8
6106	503627	247139	F	32.14	30.18	1.96
6107	503625	247116	F	32.07	30.26	1.81
6602	503611	246676	F	29.76	25.79	3.97
6603	503615	246673	F	29.8	24.8	5
6604	503618	246690	F	28.91	26.86	2.05
6702	503601	246715	F	29.08	27.01	2.07
6703	503620	246725	F	29.22	27.38	1.84
6704	503604	246794	F	29.75	27.88	1.87
6801	503640	246873	F	31.25	29.01	2.24
6802	503673	246849	F	30.54	28.71	1.83
6803	503698	246854	F	30.92	29.24	1.68
6804	503663	246843	F	30.47	28.54	1.93
6805	503692	246806	F	29.72	28.24	1.48
6902	503653	246992	F	32.91	30.93	1.98
6903	503657	246962	F	32.73	31.42	1.31
6904	503624	246914	F	32.12	29.58	2.54
6905	503644	246917	F	32.07	30.15	1.92
7001	503774	247071	F	31.41	30.01	1.4
7003	503727	247034	F	32.04	30.88	1.16
7004	503779	247045	F	31.51	30.12	1.39
7101	503768	247122	F	30.83	29.73	1.1
7102	502795	247104	F	35.88	32.83	3.05
7103	503765	247159	F	30.81	29.45	1.36
7701	503723	246792	F	29.41	25.7	3.71
7801	503754	246895	F	31.73	30.25	1.48
7802	503770	246878	F	31.03	29.06	1.97
7803	503741	246849	F	30.49	28.63	1.86
7804	503703	246811	F	29.67	28.1	1.57
7805	503770	246839	F	31.03	25.31	5.72
7806	503780	246837	F	31.1	24.61	6.49
7807	503754	246823	F	30.02	25.7	4.32
7901	503791	246986	F	31.89	30.62	1.27
7902	503721	246926	F	32.16	30.47	1.69
7903	503769	246921	F	31.72	29.86	1.86
7904	502792	246994	F	-	-	-
7904	503791	246901	F	31.66	29.4	2.26
7905	502794	246991	F	-	-	-
7906	502799	246984	F	-	-	-
8101	502857	247142	F	35.66	33.48	2.18
8102	502827	247123	F	35.76	33.47	2.29
8501	502864	246564	F	30.18	28.45	1.73
8702	502876	246710	F	34.74	31.27	3.47
8703	502868	246720	F	35.02	31.79	3.23
8704	502860	246725	F	35.23	32.14	3.09
8705	502823	246748	F	35.21	32.2	3.01
8706	502889	246780	F	36.99	31.9	5.09
8707	502806	246760	F	-	-	-
8708	502812	246751	F	-	-	-
8709	502841	246745	F	-	-	-
8801	502867	246837	F	36.92	32.1	4.82
8802	502834	246889	F	36.95	32.16	4.79
8901	502800	246946	F	36.77	32.35	4.42
8901	503808	246919	F	31.81	29.75	2.06
8902	502882	246986	F	-	-	-
9001	502976	247024	F	35.32	32.29	3.03
9026	502971	247068	F	-	-	1.2
9027	502980	247065	F	-	-	-
9028	502971	247077	F	-	-	0.9
9029	502973	247080	F	-	-	1
9100	502940	247174	F	-	-	-
9101	502954	247157	F	-	-	-
9102	502966	247139	F	-	-	-
9103	502973	247133	F	-	-	-
9104	502998	247113	F	-	-	-
9501	502968	246564	F	29.78	28.4	1.38
9502	502909	246556	F	30.34	28.63	1.71
9601	502932	246692	F	33.14	30.53	2.61
9602	502904	246640	F	32.51	29.11	3.4
9701	502932	246705	F	33.31	31.74	1.57
9702	502945	246751	F	34.5	31.85	2.65
9703	502939	246729	F	33.84	31.85	1.99
9704	502990	246784	F	-	31.96	-
9801	502950	246898	F	36.96	32.09	4.87
9802	502923	246841	F	37.36	31.99	5.37
9803	502983	246884	F	-	-	-
9804	502972	246853	F	-	-	-
9805	502957	246830	F	-	-	-
9901	502964	246948	F	36.17	32.18	3.99
9902	502921	246997	F	-	-	-
9903	502920	246943	F	-	-	-
9904	502902	246923	F	-	-	-
9905	502970	246984	F	-	-	-
9906	502938	246990	F	-	-	-
9911	502915	246999	F	-	-	-
0051	503000	247085	S	34.94	34.31	0.63
0052	503052	247000	S	-	-	-
0053	503053	247016	S	-	-	-
0054	503069	247024	S	-	-	-
0151	503012	247125	S	34.61	33.79	0.82
0651	503014	246640	S	30.33	28.49	1.84
0652	503036	246608	S	29.73	27.86	1.87
0653	503030	246604	S	29.76	28.18	1.58
0750	503090	246749	S	-	-	-
0851	503080	246817	S	-	-	-
0852	503060	246808	S	-	-	-
0853	503038	246804	S	-	-	-
0854	503014	246815	S	-	-	-
0855	503072	246820	S	-	-	-
0856	503059	246845	S	-	-	-
0857	503075	246874	S	-	-	-
0858	503011	246873	S	-	-	-
0951	503074	246904	S	-	-	-
0952	503086	246925	S	-	-	-
0953	503068	246919	S	-	-	-
0954	503063	246932	S	-	-	-
0955	503065	246975	S	-	-	-
0956	503016	246902	S	-	-	-
0957	503007	246933	S	-	-	-
0958	503059	246986	S	-	-	-
1051	503129	247086	S	34.81	33.87	0.94
1151	503121	247110	S	34.76	33.93	0.83
1152	503122	247106	S	34.79	33.91	0.88
1153	503193	247166	S	34.2	32.75	1.45
1552	503163	246535	S	29.2	27.62	1.58
1651	503118	246615	S	29.59	27.906	1.684
1652	503123	246619	S	29.34	27.913	1.427
1653	503116	246634	S	29.74	27.93	1.81
1654	503131	246642	S	-	-	-
1655	503130	246676	S	-	-	-
1750	503191	246751	S	-	-	-
1751	503111	246710	S	-	-	-
1851	503193	246884	S	32.83	31.59	1.24
1852	503192	246888	S	32.94	31.64	1.3
1853	503189	246876	S	-	-	-
1854	503177	246889	S	-	-	-
1855	503139	246847	S	-	-	-
1856	503132	246875	S	-	-	-
1951	503159	246986	S	34.9	33.65	1.25
1952	503167	246931	S	-	-	-
2051	503229	247057	S	34.55	33.22	1.33
2151	503259	247142	S	34.19	33.29	0.9
2152	503207	247126	S	34.41	33.41	1
2153	503202	247125	S	34.47	33.43	1.04
2551	503247	246585	S	29.01	27.73	1.28
2552	503250	246580	S	29.19	27.76	1.43
2651	503272	246693	S	29.2	27.51	1.69
2652	503298	246639	S	29.06	27.33	1.73
2653	503296	246636	S	29.03	27.57	1.46
2751	503222	246796	S	30.54	29.06	1.48
2752	503288	246760	S	29.66	28.07	1.59
2753	503268	246751	S	29.68	27.92	1.76
2754	503248	246742	S	29.74	27.75	1.99
2755	503216	246764	S	-	-	-
2851	503268	246894	S	32.14	30.94	1.2
2852	503203	246840	S	31.53	29.79	1.74
2951	503252	246983	S	34.19	32.96	1.23
3051	503324	247071	S	34.19	33.34	0.85
3052	503392	247079	S	33.7	32.4	1.3
3151	503311	247158	S	33.92	32.82	1.1
3152	503378	247165	S	33.4	32.44	0.96
3551	503386	246596	S	29.12	27.04	2.08
3651	503389	246673	S	29.16	27.7	1.46
3652	503361	246660	S	29.19	27.35	1.84
3653	503360	246637	S	29.19	27.12	2.07
3655	503304	246620	S	28.97	27.8	1.17
3751	503326	246779	S	29.71	28.38	1.33
3951	503345	246902	S	32.01	30.71	1.3
3952	503328	246991	S	33.8	32.65	1.15
4051	503455	247087	S	33.36	32.77	0.59
4052	503473	247011	S	33.49	32.52	0.97
4053	503445	247004	S	33.54	32.41	1.13
4054	503405	247001	S	33.59	32.21	1.38
4151	503427	247168	S	33.16	32.18	0.98
4551	503412	246559	S	28.97	26.94	2.03
4651	503499	246691	S	29.05	28.35	0.7
4652	503432	246698	S	29.36	28.12	1.24
4653	503426	246692	S	29.26	27.97	1.29
4751	503457	246778	S	29.66	28.75	0.91
4752	503487	246717	S	29.61	28.45	1.16
4753	503473	246712	S	29.41	28.46	0.95
4754	503459	246711	S	29.48	28.3	1.18
4755	503445	246700	S	29.37	28.55	0.82
4756	503495	246702	S	29.71	28.39	1.32
4851	503495	246868	S	31.05	29.52	1.53
4951	503470	246919	S	32.28	30.51	1.77
4952	503419	246909	S	31.99	30.19	1.8
4954	503468	246917	S	32.25	30.03	2.22
5051	503510	247088	S	33.04	31.45	1.59
5052	503521	247020	S	33.4	32.1	1.3
5053	503593	247034	S	32.92	31.16	1.76
5054	503566	247013	S	33.12	31.68	1.44
5151	503513	247175	S	32.54	30.61	1.93
5152	503572	247179	S	31.97	30	1.97
5153	503543	247119	S	32.73	31.03	1.7
5651	503580	246692	S	28.96	28.15	0.81
5751	503550	246755	S	29.34	28.72	0.62
5752	503531	246793	S	29.71	29.29	0.42
5753	503557	246740	S	28.98	28.26	0.72
5754	503556	246741	S	29	28.3	0.7
5755	503568	246715	S	28.97	28.23	0.74
5757	503552	246755	S	29.71	28.52	1.19
5758	503591	246742	S	29.34	27.7	1.64
5759	503582	246782	S	29.58	27.83	1.75
5760	503554	246776	S	29.6	28.39	1.21
5851	503516	246826	S	30.16	29.35	0.81
5852	503507	246843	S	30.47	29.59	0.88
5853	503503	246852	S	30.69	29.66	1.03
5854	503517	246828	S	30.15	29.46	0.69
5855	503546	246832	S	30.17	28.04	2.13
5856	503587	246853	S	30.66	28.93	1.73
5857	503525	246815	S	30.04	28.36	1.68
5858	503535	246874	S	31.37	29.26	2.11
5951	503570	246965	S	32.86	32.13	0.73
5952	503558	246948	S	32.89	31.65	1.24
5953	503523	246935	S	32.76	31.27	1.49
5954	503547	246909	S	32.08	30.56	1.52
6051	503653	247046	S	32.45	30.44	2.01
6151	503640	247172	S	31.46	29.23	2.23
6153	503626	247123	S	32.17	29.52	2.65
6154	503600	247111	S	32.43	30.78	1.65
6156	503642	247143	S	31.92	29.44	2.48
6651	503606	246659	S	29.24	27.44	1.8
6652	503639	246691	S	-	-	-
6653	503645	246684	S	29.65	27.6	2.05
6654	503621	246691	S	28.88	27.51	1.37
6655	503628	246680	S	29.11	27.4	1.71
6656	503600	246653	S	29.01	27.48	1.53
6751	503667	246773	S	29.59	28.42	1.17
6752	503672	246722	S	29.41	28.13	1.28
6753	503603	246718	S	29.13	27.6	1.53
6754	503625	246730	S	29.31	28.28	1.03
6755	503601	246794	S	29.74	28.41	1.33
6756	503674	246750	S	29.29	28.25	1.04
6851	503640	246874	S	31.26	29.51	1.75
6852	503662	246843	S	30.52	28.88	1.64
6853	503674	246850	S	30.57	29.14	1.43
6854	503691	246803	S	29.72	28.59	1.13
6951	503699	246993	S	32.6	31.53	1.07
6952	503652	246981	S	32.82	31.15	1.67
6953	503602	246967	S	32.9	31.34	1.56
6954	503624	246913	S	32.08	30.06	2.02
6955	503685	246919	S	-	-	-
7051	503730	247034	S	32	30.84	1.16
7053	503779	247043	S	31.52	30.12	1.4
7054	503776	247071	S	-	-	-
7151	503712	247185	S	30.74	29.02	1.72
7152	503769	247120	S	30.82	29.75	1.07
7154	503766	247161	S	30.8	29.48	1.32
7650	503756	246620	S	-	-	-
7652	502790	246684	S	33.71	31.29	2.42
7851	503714	246892	S	31.77	30.4	1.37
7852	503714	246864	S	30.97	29.77	1.2
7853	503739	246849	S	30.53	29.09	1.44
7854	503768	246878	S	31.03	29.42	1.61
7951	503741	246983	S	32.3	31.33	0.97
7952	503790	246990	S	31.87	30.64	1.23
7953	503769	246920	S	31.72	30.13	1.59
7954	503719	246924	S	32.19	30.79	1.4
7955	503790	246900	S	31.59	29.68	1.91
8151	502845	247151	S	35.5	34.33	1.17
8552	502820	246593	S	31.83	30.51	1.32
8650	503811	246672	S	-	-	-
8651	502843	246648	S	33.02	31.64	1.38
8652	502801	246634	S	-	-	-
8751	502862	246726	S	35.15	34	1.15
8752	502875	246767	S	36.56	35.63	0.93
8851	502867	246822	S	37.07	35.28	1.79
8853	502825	246892	S	36.94	35.07	1.87
8951	502885	246980	S	-	-	-
8951	503810	246921	S	31.76	30.05	1.71
9151	502953	247187	S	35.05	33.957	1.093
9152	502960	247175	S	34.883	34.013	0.87
9153	502957	247173	S	37.97	34.07	3.9
9154	502932	247155	S	35.567	34.232	1.335
9551	502908	246563	S	30.36	28.92	1.44

Manhole Reference	Easting	Northing	Liquid Type	Cover Level	Invert Level	Depth to Invert
9552	502908	246543	S	30.22	29.24	0.98
9553	502929	246532	S	30.29	29	1.29
9651	502957	246649	S	31.08	29.24	1.84
9652	502985	246670	S	31.29	29.27	2.02
9653	502955	246689	S	32.3	30.58	1.72
9654	502929	246698	S	33.15	30.94	2.21
9751	502902	246710	S	34.07	31.31	2.76
9851	502935	246880	S	37.1	36.21	0.89
9852	502950	246888	S	-	-	-
9853	502980	246882	S	-	-	-
9854	502971	246855	S	-	-	-
9855	502954	246829	S	-	-	-
9856	502954	246887	S	-	-	-
9951	502920	246994	S	-	-	-
9952	502939	246987	S	-	-	-
9953	502906	246921	S	-	-	-
9954	502922	246939	S	-	-	-
9958	502915	246995	S	-	-	-
9959	502954	246942	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