

Arundel Street, Manchester

Detailed Drainage Strategy

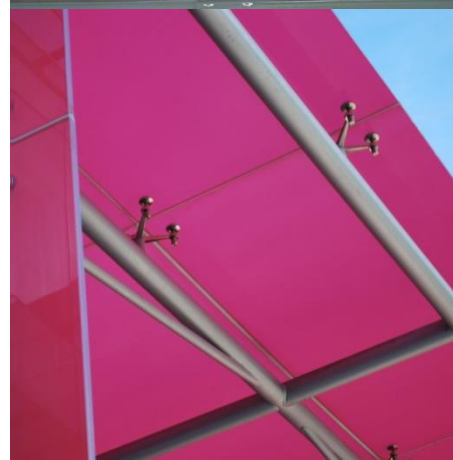
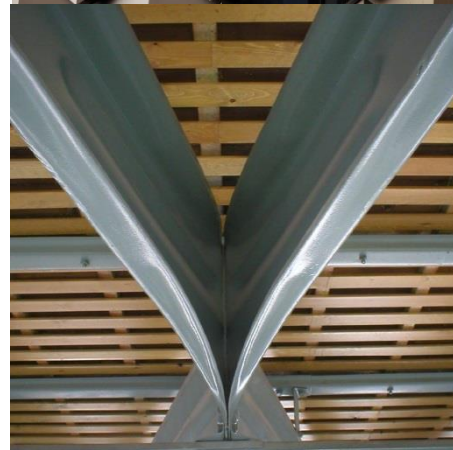
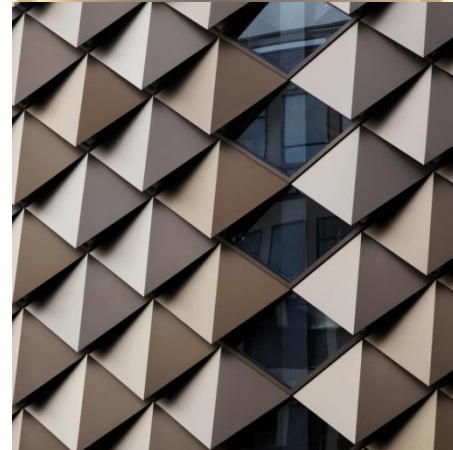
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Existing and Proposed Impermeable Areas

Existing (Assumed) Calculations: - 1, 30 and 100 Year Events

Existing 100 Year 6 Hour Event Volumes

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Proposed Drainage Strategy

Proposed Calculations: - 1 Year, 30 Year, 100 Year +40%cc Events

Proposed 100 Year 6 Hour Event Volumes

1.0 Introduction

1.1 Project Background

- 1.1.1 Curtins was appointed by Logik Developments (Arundel Street) Ltd to provide a Detailed Drainage Strategy for the proposed development of residential apartments with associated parking on land east of Arundel Street, Manchester. The nearest postcode to the site is M15 4JZ and the site is centred around National Grid Ref: 382833, 397364.
- 1.1.2 The report provides a brief assessment of flood risk and an assessment of the drainage proposals. The assessment follows Government guidance with regard to development and flood risk.
- 1.1.3 The report is based on currently available information and preliminary discussions.
- 1.1.4 Proposals contained or forming part of this report represent the design intent and may be subject to alteration or adjustment in completing the detailed design for this project. Where such adjustments are undertaken as part of the detailed design and are deemed a material deviation from the intent contained in this document, prior approval shall be obtained from the relevant authority in advance of commencing such works.
- 1.1.5 Where the proposed works to which this report refers are undertaken more than twelve months following the issue of this report, Curtins shall reserve the right to re-validate the findings and conclusions by undertaking appropriate further investigations at no cost to Curtins.

1.2 Scope of Assessment

- 1.2.1 The assessment is to be undertaken in accordance with the standing advice and requirements of the Environment Agency (EA) for Flood Risk Assessments as outlined in the Communities and Local Governments Planning Policy Guidance to the National Planning Policy Framework (NPPF).
- 1.2.2 The total site area is approximately 0.5 hectares.
- 1.2.3 Following scrutiny of the Environment Agency flood zone maps it has been identified that the existing site lies entirely within an area classified as Flood Zone 1 indicating that the risk of flooding from rivers and sea is low (less than 0.1% each year). The site is located within the Conurbation Core Critical Drainage Area, therefore the Flood Risk associated with the development shall be assessed in order to inform the drainage strategy.
- 1.2.4 In April 2015, the Government made changes to the National Planning Policy Framework which made Sustainable Urban Drainage Systems (SuDS) a material consideration in the determination of planning applications for major developments.

1.2.5 A Detailed Drainage Strategy will therefore be required as part of the full Planning Application for the development, as the site is considered to be 'major' development by the Town and Country Planning Order 2015.

1.2.6 The assessment will:

- Investigate all potential risks of flooding to the site,
- Consider the impact the development may have elsewhere with regards to flooding,
- Consider design proposals to mitigate any potential risk of flooding determined to be present; and
- Consider foul & surface water drainage proposals for the proposed development.

1.2.7 The Detailed Drainage Strategy report reviews the following information:

- Environment Agency flood maps for rivers and sea flooding.
- UK Government Flood Warning Information Service maps for surface water flooding and reservoir flooding.
- Strategic Flood Risk Assessment (SFRA) for Manchester, Salford and Trafford Level 1 Dated March 2010 and Level 2 dated March 2011.
- Preliminary Flood Risk Assessment for Manchester City Council dated May 2011.
- United Utilities Public Sewer Records, dated December 2016.
- British Geological Survey (BGS) Infiltration SuDS GeoReport dated December 2016.
- Arundel Street Development Drainage Strategy by Eckersley O'Callaghan, dated December 2016.

1.3 Proposed Development

1.3.1 The development is expected to comprise of the following:

- 357 apartments across two new buildings and the retained 4-storey DOT Building, for a mix of rent and sale:
 - 129 one bed units
 - 218 two bed unit; and
 - 10 three bed units
- 379 sq. m of ground floor commercial floorspace (A1, A2, B1, D1 and D2) within units fronting Arundel Street and in the DOT Building fronting Ellesmere Street.
- 35 car parking spaces
- 323 secure cycle parking spaces
- Access and servicing arrangements from Arundel Street.

- A roof garden for occupiers of Building 1.

1.3.2 The proposed site plan and floor plans for the site are enclosed in *Appendix A*.

2.0 Existing Site Details

2.1 History and Current Use

- 2.1.1 The site is located approximately 1.2 km south-west of Manchester City Centre. The site is bordered by the A57 to the north-east, Ellesmere Street to the south-east, Arundel Street to the south-west and Worsley Street to the north-west. Balmforth Street currently bisects the site from the south-easterly boundary in a north-easterly direction. Access to the existing site is via Arundel street onto Balmforth Street.
- 2.1.2 The majority of the existing site is occupied by buildings or hardstanding areas for car parking and access routes, with an area of landscaping forming a mound along the north-easterly boundary. Therefore, the site is considered to be brownfield.
- 2.1.3 The wider area surrounding the site; north, south and west consists of commercial and residential developments with associated landscaping.
- 2.1.4 The aerial photograph is illustrated in Figure 1.

Figure 1: Aerial Photograph (© Microsoft)



2.2 Existing Watercourses

2.2.1 There are no open channel watercourses or culverted watercourses identified within the site boundary or in the immediate vicinity of the site.

2.2.2 The nearest watercourses to the site are identified as follows:

- The Bridgewater Canal is located approximately 65m north-west of the site.
- Approximately 205m north of the site is the confluence of the Rivers Medlock and Irwell.
- The Rochdale Canal is located approximately 315m north-east of the site where it connects with the Bridgewater Canal.
- The River Medlock is located approximately 500m east of the site where it passes via siphon beneath the Bridgewater Canal, prior to its confluence with the Irwell.
- The Corn Brook is culverted approximately 600m south-west of the site and outfalls into the River Irwell.

2.3 Existing Drainage

2.3.1 The public sewer records have been obtained for the development site. The records indicate that there are no public sewers recorded within the site.

2.3.2 The public sewer records indicate that the following public sewers are located adjacent to / within the vicinity of the site:

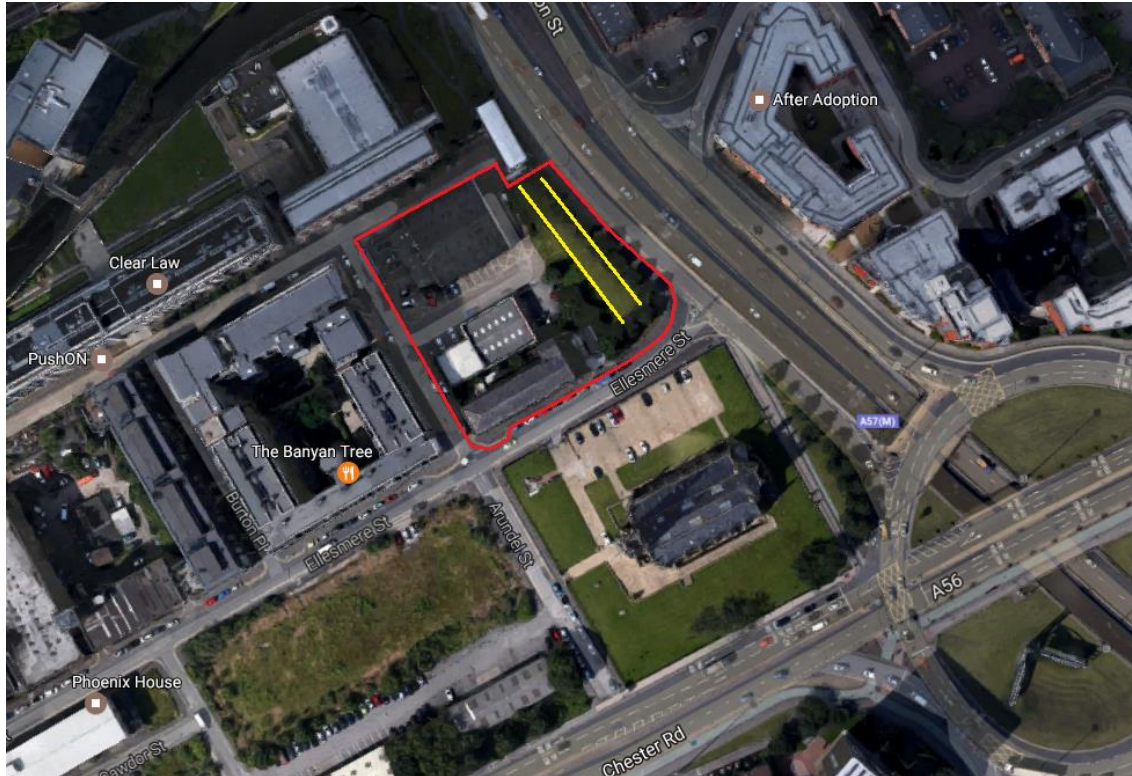
- There is a 300mm combined public sewer within Arundel Street to the west of the site, which flows in a north-westerly direction from manhole 8301 to 7302. The sewer then flows north-east within Worsley Street where the sewer is recorded as a 600 x 900mm sewer up to the junction of Egerton Street at manhole 8406. The sewer passes through a Combined Sewer Overflow (CSO) chamber which continues as a 300mm combined sewer flowing in a south-easterly direction along Egerton Street. The CSO connects into a surface water public sewer network at Blantyre Street which discharges in a north-easterly direction.
- There is a 590 x 660mm combined public sewer within Ellesmere Street to the south of the site, at the junction of Ellesmere Street and Egerton Street which flows in a north-easterly direction. The sewer passes through a CSO chamber which connects into a 450mm combined sewer flowing in a south-easterly direction. The CSO connects into a separate combined sewer in Blantyre Street which discharges in a north-easterly direction.
- There is a 225mm highway drain immediately adjacent to the site at the junction of Ellesmere Street and Egerton Street which connects into the surface water public sewer in Egerton Street at manhole 8304 and flows in a north-westerly direction.

- 2.3.3 The public sewer records are enclosed in *Appendix B*.
- 2.3.4 The proposed site has previously been developed and therefore private drainage is anticipated within the site. A drainage survey of the site has not been carried out, however the topographical survey indicates that there are gullies, manholes and downpipes within the site.
- 2.3.5 The condition and location of existing private drainage routes is not known, and therefore it is recommended that a GPR and CCTV Survey is carried out to confirm the location, route, depth, condition, and any outfalls prior to detailed design.
- 2.3.6 The report by Eckersley O'Callaghan identifies that there are two existing drainage outfalls from the site, however all drainage is recommended to be surveyed in order to confirm this.
- 2.3.7 It is recommended that the invert levels of the public sewers in Arundel Street and Worsley Street are confirmed as soon as possible.

2.4 Topography

- 2.4.1 A topographical survey was carried out on the proposed site in June 2016. The Topographical Survey is to a temporary benchmark, which when compared to ordnance levels deviates from ordnance levels by 10-11m. Initial observations from the survey indicate that the site generally falls in a south-east to north-westerly direction with levels falling from boundary to boundary by approximately 1 metre.
- 2.4.2 It is recommended that the Topographical Survey is converted to ordnance datum to minimise setting out errors.
- 2.4.3 The landscaped mound which is located along the north-easterly boundary is approximately 2m high; the approximate position of this is shown in Figure 2.

Figure 2: Aerial view of site showing top of crest of existing mound (© Microsoft)



2.4.4 The Topographical survey is enclosed in *Appendix B*.

2.5 Geology

2.5.1 The British Geological Survey (BGS) identifies the following geological succession underlying the site;

- Superficial deposits – None recorded
- Bedrock – Chester Formation– Sandstone.

2.5.2 There is no Made Ground recorded on the site in the BGS maps, however due to the brownfield nature of the site and the 2 metre existing landscaped mound, made ground is anticipated across the site to varying depths.

3.0 Development and Flood Risk

3.1 National Planning Policy Framework (NPPF) and Planning Practice Guidance

- 3.1.1 In February 2019 the Department of Communities and Local Government published the National Planning Policy Framework document (NPPF) and the Planning Practice Guidance was published in March 2014 which provides guidance on how flood risk should be assessed during the planning and development process.

Table 1: (Extract from Planning Practice Guidance) Flood Zone Classifications

These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences. They are shown on the Environment Agency's [Flood Map for Planning \(Rivers and Sea !\[\]\(8942d28dc4da2a769efbb41dc37c5a1c_img.jpg\)](#)), available on the Environment Agency's web site, as indicated in the table below.

Flood Zone	Definition
Zone 1 Low Probability	Land having a less than 1 in 1,000 annual probability of river or sea flooding. (Shown as 'clear' on the Flood Map – all land outside Zones 2 and 3)
Zone 2 Medium Probability	Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding; or Land having between a 1 in 200 and 1 in 1,000 annual probability of sea flooding. (Land shown in light blue on the Flood Map)
Zone 3a High Probability	Land having a 1 in 100 or greater annual probability of river flooding; or Land having a 1 in 200 or greater annual probability of sea flooding. (Land shown in dark blue on the Flood Map)
Zone 3b The Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Not separately distinguished from Zone 3a on the Flood Map)

Table 2: (Extract from Planning Practice Guidance) Flood Risk Vulnerability Classification

Essential Infrastructure • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable • Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as ‘Essential Infrastructure’).
More Vulnerable • Hospitals • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill* and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less Vulnerable

- Police, ambulance and fire stations which are **not** required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'More Vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.

Water-Compatible Development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.
- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 3: (Extract from Planning Practice Guidance) Flood Risk Vulnerability and Flood Zone Compatibility

Flood Zones	Flood Risk Vulnerability Classification				
	Essential infrastructure	Highly vulnerable	More vulnerable	Less vulnerable	Water compatible
Zone 1	✓	✓	✓	✓	✓
Zone 2	✓	Exception Test required	✓	✓	✓
Zone 3a †	Exception Test required †	x	Exception Test required	✓	✓
Zone 3b *	Exception Test required *	x	x	x	✓*

Key:

✓ Development is appropriate

x Development should not be permitted.

Notes to table 3:

- This table does not show the application of the Sequential Test which should be applied first to guide development to Flood Zone 1, then Zone 2, and then Zone 3; nor does it reflect the need to avoid flood risk from sources other than rivers and the sea;
- The Sequential and Exception Tests do not need to be applied to minor developments and changes of use, except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site;
- Some developments may contain different elements of vulnerability and the highest vulnerability category should be used, unless the development is considered in its component parts.

† In Flood Zone 3a essential infrastructure should be designed and constructed to remain operational and safe in times of flood.

* In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

- remain operational and safe for users in times of flood;
- result in no net loss of floodplain storage;
- not impede water flows and not increase flood risk elsewhere.

3.2 Site Specific NPPF Flood Risk Categorisation

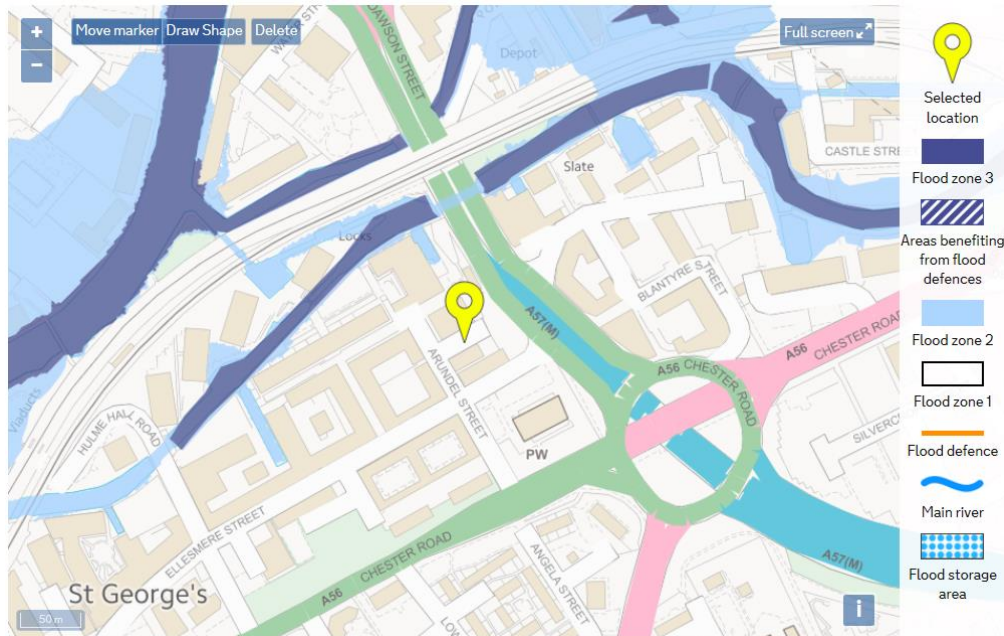
3.2.1 To assess the NPPF flood risk classification for the site, the first step was to inspect the UK Government web based 'Flood Map for Planning' which is used to inform planning of a site's Flood Zone(s) and the probability of flooding from rivers or sea (not taking into account the presence of flood defences). However, the web based 'Long Term Flood Risk Assessment for Locations in England' should also be used to identify the flood risks from rivers and seas, surface water and reservoirs.

3.2.2 From the Flood Map for Planning map:

- Where a site is located in a clear (unshaded) area, it is deemed to be classified as Flood Zone 1 (low probability) and is defined as land having a less than 1 in 1,000 (0.1%) annual probability of river or sea flooding.
- Where a site is located in a light blue shaded area, it is classified as Flood Zone 2 (medium probability) and is defined as land having between a 1 in 100 (1%) and 1 in 1,000 (0.1%) annual probability of river flooding; or land having between a 1 in 200 (0.5%) and 1 in 1,000 (0.1%) annual probability of sea flooding.
- Where a site is located in a dark blue shaded area, it is generally classified as Flood Zone 3. Flood Zone 3 is further divided into the following zones:
 - Flood Zone 3a (high probability) and is defined as land having a 1 in 100 (1%) or greater annual probability of river flooding; or land having a 1 in 200 (0.5%) or greater annual probability of sea flooding.
 - Flood Zone 3b (the Functional Flood Plain) which comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify in their Strategic Flood Risk Assessments areas of functional floodplain and its boundaries accordingly, in agreement with the Environment Agency. (Flood Zone 3b is not separately distinguishable from Zone 3a on the flood map).

3.2.3 The Flood Map for Planning is shown below in Figure 3, and it can be seen that the proposed site is located entirely in an area classified as Flood Zone 1 (low probability of flooding from rivers or sea).

Figure 3: Flood Map for Planning (© Crown Copyright)



3.3 Site Specific Flood Zone Compatibility

3.3.1 The proposals for the development site are likely to fall within the following category:

- Building used for dwellings
- Buildings used for shops

3.3.2 This type of development is classed as 'More Vulnerable' development in the Flood Risk Vulnerability Classification (Table 2), with the commercial units classed as 'Less Vulnerable'.

3.3.3 The site is located within Flood Zone 1, of which is acceptable for any classification of development. Refer to Table 3 for the Flood Zone compatibility table taken from NPPF technical guidance.

3.4 Sequential and Exception Test

3.4.1 As the site is located entirely within Flood Zone 1 with proposals classified as 'More Vulnerable' development, the sequential and exception test are not required to be undertaken.

4.0 Hydrological Assessment

4.1 Sources of Flood Risk

- 4.1.1 This study assesses the risk from different types of flooding to the development and the risk of flooding from the development, taking into consideration climate change, as well as how flood risks should be managed. The approach to assessing flood risk at the development site was informed by the requirements of NPPF in conjunction with the client and Environment Agency requirements.

4.2 Fluvial Flooding (Rivers and Streams)

- 4.2.1 Flooding to the site from rivers and seas is indicated below in Figure 4, taken from the UK Government's Long Term Flood Risk Information.

Figure 4: Long Term Flood Risk Assessment Map – Flood Risk from Rivers or Sea (© Crown Copyright)



- 4.2.2 The detailed flood risk information taken from the UK Government Long Term Flood Risk Assessment website (Figure 4A) indicates that the area has less than 0.1% chance of flooding each year, taking into account the effect of any flood defences in the area. Therefore, the site is considered to be at very low residual risk from fluvial flooding.

Figure 4A: Long Term Flood Risk Assessment (Detailed Information) – Flood Risk from Rivers or Sea (© Crown Copyright)

Flood risk from rivers or the sea

Very low risk means that each year this area has a chance of flooding of less than 0.1%. This takes into account the effect of any flood defences in the area. These defences reduce but do not completely stop the chance of flooding as they can be overtopped, or fail.

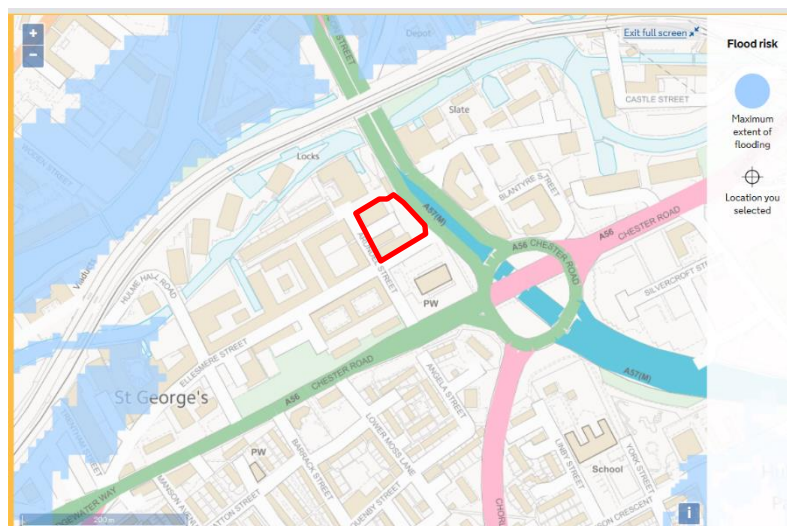
4.3 Tidal Flooding (Coastal or Estuarine)

- 4.3.1 There is currently no flood risk identified on the Environment Agency flood maps for the site and it is therefore regarded to be at low risk from tidal flooding.

4.4 Reservoir Flooding

- 4.4.1 Reservoir flooding is extremely unlikely to happen and there has been no loss of life in the UK from reservoir flooding since 1925. The Environment Agency is the enforcement authority and ensures that reservoirs are inspected regularly and essential safety work is carried out.
- 4.4.2 The Flood Warning Information Service Flood Risk from Reservoirs map shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. Since this is a prediction of a worst-case scenario, it is very low risk that a reservoir flood would be this large.
- 4.4.3 The site is located outside of an area that could be affected by reservoir flooding and is therefore considered being at very low risk.

Figure 5: Long Term Flood Risk Assessment Map – Flood Risk from Reservoirs (© Crown Copyright)



4.5 Canal Flooding

- 4.5.1 The Bridgewater Canal is located approximately 65m north-west of the site and the Rochdale Canal is approximately 315m north-east of the site where it connects with the Bridgewater Canal.
- 4.5.2 There are few recorded instances of flooding from the canal networks as they tend to be heavily regulated and controlled. However, flood risk from canals and navigable waterways still exists where canals can overtop or breach.
- 4.5.3 The Manchester SFRA maps indicate that the site is located outside of a Canal Breach Zone or Canal Overtop Hazard Zone.
- 4.5.4 Given the above information, it is considered that the risk of canal flooding to the site is low.

4.6 Groundwater Flooding

- 4.6.1 Groundwater flooding tends to be more persistent than other sources of flooding, typically lasting for weeks or months rather than hours or days. Groundwater flooding does not generally pose a significant risk to life due to the slow rate at which the water level rises; however, it can cause significant risk to property.
- 4.6.2 The Manchester City Council SFRA maps indicate that the site is located outside of an area at risk of groundwater flooding, shallow groundwater or groundwater rebound.
- 4.6.3 There has been no ground investigation work carried out on the site and therefore site specific groundwater levels are not available. The British Geological Survey Infiltration Report indicates that Groundwater is likely to be less than 3 metres below the ground surface for at least part of the year.
- 4.6.4 Due to the lack of site specific groundwater levels it is assumed that there may be a potential risk of groundwater flooding. Therefore, mitigation measures are proposed in Section 5.

4.7 Public Sewers or Highway Drainage Flooding (Infrastructure Failure)

- 4.7.1 There are no public sewers or highway drains recorded within the development site. There are public sewers and highway drains recorded adjacent to the site.
- 4.7.2 The SFRA does not confirm any historical flood events at the development site and Manchester City Council have confirmed that they hold no records of historic flooding at the site.
- 4.7.3 A pre-development enquiry has been issued to United Utilities and they have confirmed that they hold no records of hydraulic flooding at the site.
- 4.7.4 The Manchester City Council and United Utilities correspondence is enclosed in *Appendix C*.

- 4.7.5 Providing United Utilities and Manchester City Council maintain their drainage assets in the vicinity of the site, the risk of flooding to the proposed development site from public sewers or highway drainage is considered as low.

4.8 Surface Water Flooding to the site

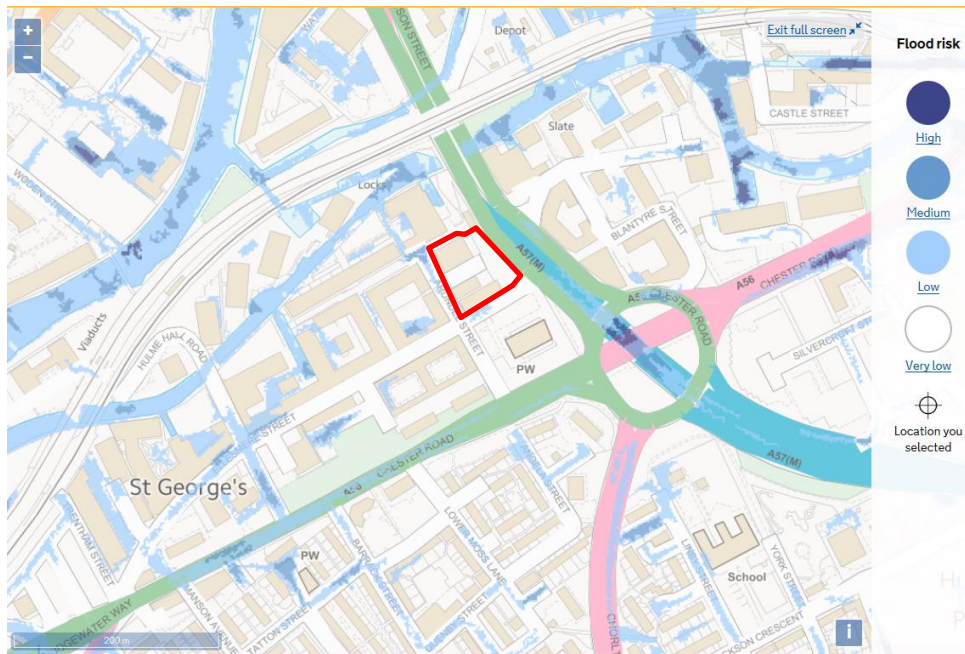
- 4.8.1 Surface water flooding can be caused when rainwater during extreme rainfall events does not drain away through the normal drainage system or soak into the ground with flooding occurring, principally from manholes and gullies. Surcharging sewers can result in overland flows which if originating at a higher elevation than a development site can potentially pose a flood risk.

- 4.8.2 From the UK Government's Long Term Flood Risk Assessment (Surface Water Extent map);

- Where a site is located in a dark blue shaded zone, this indicates that the site is at high risk of flooding, where flooding occurs as a result of rainfall with a greater than 1 in 30 (3.3%) chance in any given year.
- Where a site is located in a mid-blue shaded zone, this indicates that the site is at medium risk of flooding, where flooding occurs as a result of rainfall of between 1 in 100 (1%) and 1 in 30 (3.3%) chance in any given year.
- Where a site is located in a light blue shaded zone, this indicates that the site is at low risk of flooding, where flooding occurs as a result of rainfall of between 1 in 1000 (0.1%) and 1 in 100 (1%) chance in any given year.
- Where a site is located in a clear (unshaded) area; this indicates that the site is at very low risk of flooding, where flooding occurs as a result of rainfall with less than 1 in 1000 (0.1%) chance in any given year.

- 4.8.3 The extent of flooding to the site from surface water is indicated in Figure 6 and it can be seen that the site is located entirely in an area classified as being at 'Very Low' risk of flooding from surface water. Arundel Street, at its junction with Worsley Street, is considered to be at low-medium risk of flooding from surface water and Ellesmere Street, immediately south of the site, is considered to be at low risk of flooding.

Figure 6: Risk of Flooding from Surface Water - Extent of Flooding



- 4.8.4 The potential depth of surface water flooding within Arundel Street is 300-900mm and within Ellesmere Street is up to 300mm, however the maximum depth is expected to be at low risk of occurring.
- 4.8.5 Considering the above information, the risk of surface water flooding to the site is considered very low, however given the proximity to surface water flood risk areas outside of the site, mitigation measures are proposed in Section 5.

4.9 Surface Water Flooding from the site

- 4.9.1 Developers are responsible for ensuring that new development does not increase the flood risk elsewhere. This is so as not to cause damage to buildings, essential services or adjoining developments and services.
- 4.9.2 The proposed surface water drainage network shall be designed to not flood for the critical 1 in 30-year storm event and flood water generated up to the critical 1 in 100-year plus climate change storm event shall be constrained within areas on site so as not to cause damage to buildings, essential services or adjoining developments and services.
- 4.9.3 The development has the potential to increase flood risk where additional run-off from proposed roads, car parks and building roofs are discharged freely into the downstream drainage network. It is therefore encouraged to propose permeable areas, landscaping areas and incorporate sustainable drainage feature utilising infiltration or attenuation where possible.

4.9.4 Mitigation measures are therefore proposed in section 5 and a detailed assessment of the proposed surface water flows is carried out within the drainage strategy within section 6 of this report.

4.10 Historical Flooding

4.10.1 Manchester City Council LLFA have confirmed that they hold no records of historic flooding at the site. United Utilities have confirmed that they hold no records of hydraulic flooding at the site.

4.11 Summary of Flood Risk

4.11.1 From the evidence collated and subsequent negotiations the main types of flooding that may apply to the proposed development site are as follows:

- surface water flooding to the site; and
- surface water flooding from the site.

5.0 Mitigation

5.1 Fluvial/Tidal Flood Mitigation

- 5.1.1 The development site lies entirely within Flood Zone 1 and therefore is at low risk of fluvial and tidal flooding.
- 5.1.2 No specific measures are required at this location in order to mitigate against fluvial and tidal flooding.

5.2 Groundwater Flood Mitigation

- 5.2.1 Groundwater flooding tends to be more persistent than other sources of flooding, typically lasting for weeks or months rather than hours or days. Groundwater flooding does not generally pose a significant risk to life due to the slow rate at which the water level rises; however, it can cause significant risk to property.
- 5.2.2 The site is proposed at similar level to existing ground levels. As there is no report of the existing site flooding from groundwater, this should be a sufficient mitigation method to ensure the proposed site does not have an increased risk of groundwater flooding in the future.
- 5.2.3 Providing the above mitigation measures were imposed, the risk from groundwater flooding would therefore be considered low post development.

5.3 Surface Water Flooding to the site Mitigation

- 5.3.1 The Environment Agency surface water flood maps indicate that the site is located in an area classified as being at 'Very Low' risk of flooding from surface water. Arundel Street; at its junction with Worsley Street is considered to be at low-medium risk of flooding from surface water and Ellesmere Street immediately south of the site is considered to be at low risk of flooding.
- 5.3.2 It is recommended that proposed external ground levels across the site should fall away from the proposed buildings in a manner which does not create low points where water might collect unintentionally. This will ensure that any surface water will not flow towards the proposed buildings.
- 5.3.3 It is unclear whether the condition or capacity of gullies/highway drainage and public sewers along Arundel Street and Ellesmere Street are a factor in the surface water flood risk within the surrounding highways however the assets should be subject to Manchester City Council Highways and United Utilities drainage maintenance schedule.
- 5.3.4 Providing the above measures are implemented the flooding risk to the development site from surface water is therefore considered low post development.

5.4 Surface Water Flooding from the site Mitigation

- 5.4.1 Any new development site drainage should be designed in accordance with current best practice to provide adequate capacity not to flood for the critical 1 in 30-year storm event and flood water generated from up to the critical 1 in 100-year plus climate change storm event shall be constrained within the areas on site so not to cause damage to buildings, essential services or adjoining developments & services.
- 5.4.2 In February 2016, the Environment Agency released updated climate change allowances for peak rainfall intensities which should be applied to new developments. Table 4 demonstrates the climate change allowances with central and upper end allowances being considered.
- 5.4.3 Based on the nature of the development, a lifespan in excess of 60 years is anticipated. Therefore, the potential climate change allowance for 2070-2115 ranges between 20% for the central allowance and 40% for the upper end allowance. As such, an allowance of 40% for climate change on peak rainfall intensity will be included in calculations.

Table 4: (Extract Environment Agency Guidance) Peak Rainfall Intensity Allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Upper end	10%	20%	40%
Central	5%	10%	20%

- 5.4.4 In following the standard hierarchy of drainage solutions, consideration should firstly be given to the discharge of surface water runoff by sustainable methods such as infiltration.
- 5.4.5 Section 6 describes the options for surface water discharge. The surface water is proposed to discharge into the combined public sewer network at a restricted rate.
- 5.4.6 To minimise localised flooding within the site, the drainage design should ensure that gullies, drainage channels and drains are all suitably sized to accommodate peak storm flows. Also, all inlet features should have suitably sized sumps to catch silts and should be subject to a documented routine maintenance and cleansing regime.
- 5.4.7 For any sustainable drainage systems employed in the development, an appropriate management and maintenance plan for the sustainable drainage system for the lifetime of the development should be submitted which should include:

- Any arrangements for adoption by an appropriate public body or statutory undertaker, management and maintenance by a Residents' Management Company
- Arrangements concerning appropriate funding mechanisms for its on-going maintenance of all elements of the sustainable drainage system (i.e. inspections, regular maintenance)
- Means of access for maintenance and easements where applicable

5.4.8 Assuming that the proposed drainage system is designed to provide adequate capacity as stated in 5.4.1 and that the private and adopted sewers will be maintained by their adopted authority, it can be assumed risk of flood from blockage or overloading is minimal.

5.4.9 The final design of the drainage networks shall be in accordance with the legislation set by the Environment Agency, Manchester City Council, and United Utilities.

6.0 Drainage Strategy

6.1 Existing Drainage

6.1.1 The public sewer records indicate that there are no public sewers recorded within the site.

6.1.2 The public sewer records indicate:

- a 300mm combined public sewer within Arundel Street to the west of the site which flows in a north-westerly direction from manhole 8301 to 7302. The sewer then flows north-east within Worsley Street where the sewer is recorded as a 600 x 900mm sewer up to the junction of Egerton Street at manhole 8406 where the sewer passes through a Combined Sewer Overflow (CSO).
- A 590 x 660mm combined public sewer within Ellesmere Street; south of the site which flows in a north-easterly direction which passes through a CSO chamber at the junction of Ellesmere Street and Egerton Street.
- A 225mm highway drain immediately adjacent to the site at the junction of Ellesmere Street and Egerton Street which connects into the surface water public sewer in Egerton Street at manhole 8304 and then flows in a north-westerly direction.

6.1.3 The proposed site has previously been developed and therefore private drainage is anticipated within the site. A drainage survey of the site has not been carried out, however the topographical survey indicates that there are gullies, manholes and downpipes within the site.

6.1.4 The report by Eckersley O'Callaghan states that there are two existing drainage outfalls from the site, which are assumed to be:

- A combined connection into the existing 300mm combined public sewer in Arundel Street at manhole 8801; and
- A combined connection into the existing 600x900mm combined public sewer in Worsley Street at manhole 8807.

6.1.5 It is recommended that a GPR and CCTV Survey is carried out to confirm the location, route, depth, condition, and any outfalls prior to detailed design.

6.1.6 It is recommended that the invert levels of the public sewers in Arundel Street and Worsley Street are confirmed as soon as possible.

6.2 Proposed Foul Water Drainage

6.2.1 A separate foul and surface water system is proposed within the development site.

- 6.2.2 The ground floor areas are proposed to be set between 30.500m and 31.500m AOD.
- 6.2.3 There are potentially two locations for discharge into the public sewer network; the public sewer in Arundel Street and the public sewer in Worsley Street. However, as the horseshoe building (building 1) extends fully along the northern boundary, access for an off-site connection will be unlikely and therefore it is proposed that a single foul outfall is proposed into the combined public sewer in Arundel Street (subject to confirmation of the existing DOT building drainage).
- 6.2.4 The depth of the public sewer in Arundel Street is anticipated to be approximately 3.7m, however the invert level should be confirmed as early as possible to allow co-ordination with the structure and determine if adequate gravity falls into the combined public sewer can be achieved.
- 6.2.5 The strategy assumes at this stage that a gravity solution will be suitable for all ground and upper floor drainage.
- 6.2.6 The peak flow rate for the residential areas has been calculated based on assumed discharge units taken from Table 2 of BS-EN 12056-2:2000 Gravity Drainage Systems Inside Buildings.
- 6.2.7 The peak flow rate for the commercial areas has been calculated based on Sewers for Adoption 7th Edition, assuming 0.6 litres for the domestic element plus 0.5 litres for the trade element per second per hectare.
- 6.2.8 The peak flow discharge for the residential areas based on 357 apartments discharging at 4000l/d/d/ (litres per dwelling per day) is 16.5 l/s, however discharge units should be confirmed prior to detailed design.
- 6.2.9 The peak flow discharge for the commercial areas based on approximately 3375m² is 0.37 l/s, however discharge units should be confirmed prior to detailed design.
- 6.2.10 A Pre-Development Enquiry was previously issued to United Utilities and they have confirmed that foul will be allowed to drain to the public combined sewer network at an unrestricted rate. The connection to the public sewer can be at a convenient location.
- 6.2.11 The United Utilities correspondence is enclosed in *Appendix C*.
- 6.2.12 Connection to the public sewer will be subject to a Section 106 Agreement with United Utilities.
- 6.2.13 The proposed drainage strategy drawings are enclosed in *Appendix E*.

6.3 Proposed Surface Water Drainage

- 6.3.1 Any new development site drainage should be designed in accordance with current best practice to provide adequate capacity not to flood for the critical 1 in 30-year storm event and flood water generated for up to the critical 1 in 100-year plus climate change storm event shall be constrained within the areas on site so not to cause damage to buildings, essential services or adjoining developments and services.

- 6.3.2 In following the standard hierarchy of drainage solutions, consideration should firstly be given to the discharge of surface water runoff by sustainable methods such as infiltration.
- 6.3.3 The discharge of surface water in accordance with the sustainability hierarchy is summarised in Table 5.

Table 5: Summary of Surface Water Disposal

Surface Water Disposal	Potential	Description
Infiltration	X	Made Ground is likely to be present across the site. The British Geological Survey (BGS) infiltration report confirms that Groundwater may be vulnerable to contamination. Groundwater is likely to be less than 3m below the ground surface for at least part of the year, which may inundate the infiltration system. Therefore, infiltration is not considered to be a suitable option.
Watercourse	X	The nearest watercourse is the Bridgewater Canal which is approximately 65m north-west of the site. Therefore, discharge to watercourse is not considered to be a feasible option.
Surface Water Sewer	X	There are no surface water public sewers in the vicinity of the site. There is a highway drain (MCC) located adjacent to the site at the junction of Ellesmere Street/Egerton Street however to connect into this would require adoption of the drain by United Utilities under Section 102 agreement. MCC have advised that as there are alternative options for drainage, the solution should utilise connections into the public sewers. Therefore, discharge to a surface water sewer/highway drain is not considered viable.
Combined Water Sewer	✓	The nearest public sewers are located north and west of the development site. It is assumed that there are existing connections into the public sewer network which could be reused where suitable. United Utilities have confirmed that connection can be made into the public sewer network at an unrestricted rate.

- 6.3.4 Considering the above information, it is therefore proposed that the surface water will outfall into the existing combined public sewer due to the lack of alternative discharge points. Locations, invert levels and capacity at the connection point(s) should be confirmed.
- 6.3.5 The existing site has previous industrial use and would be considered Brownfield. The existing drainage network on site is unknown, however the run-off rate from the existing site has been estimated by creation of an existing assumed model discharging 0.3ha of run-off. The 1 in 1, 30 and 100 year return periods have been simulated and the flow rates are as follows:

- 1 year = 30.5 l/s
- 30 year = 73.4 l/s
- 100 year = 90.4 l/s

6.3.6 The volumes generated from the existing site in the 100 year 6-hour event is approximately 150.926m³.

6.3.7 The existing calculations are enclosed within *Appendix D*.

6.3.8 There are potentially two locations for discharge into the public sewer network; the public sewer in Arundel Street and the public sewer in Worsley Street. However, as the horseshoe building (building 1) extends fully along the northern boundary, access for an off-site connection will be unlikely and therefore it is proposed that a single surface water outfall is proposed into the combined public sewer in Arundel Street (subject to confirmation of the existing DOT building drainage).

6.3.9 The depth of the public sewer in Arundel Street is anticipated to be approximately 3.7m, however the invert level should be confirmed as early as possible to allow co-ordination with the structure and determine if gravity falls into the combined public sewer can be achieved.

6.3.10 The strategy assumes at this stage that a gravity solution will be suitable for all ground and upper floor drainage.

6.3.11 The proposed flow rates will be restricted to a maximum of 50% of the pre-development flow rates with an allowance of 40% climate change for the proposed 100-year event. The restriction of 50% pre-development flow rates is based on Manchester City Council SuDS requirements. The 40% climate change allowance is based on Environment Agency guidance for developments.

6.3.12 Therefore, the proposed flow rates should not exceed:

- 1 year = 15.25 l/s
- 30 year = 36.7 l/s
- 100 year +up to 40%cc = 45.2 l/s

6.3.13 The flow rates currently modelled achieve the 1-year flow restriction of 15.25 l/s. Variable flow rates could be achieved by introducing a complex control, multiple flow control devices or an overflow pipe system and as a result, attenuation volumes may be reduced. This will be subject to ensuring existing volumes are not exceeded; (refer to cl. 6.3.19).

6.3.14 It is recommended that sustainable methods of attenuation are implemented where possible. As space is limited on site, this can be achieved using a combination of permeable paving with high voids sub-base and percolation pipes. Use of permeable paved areas would also be considered as methods of filtration to improve water run-off quality.

6.3.15 Other methods of sustainability could be provided by use of rainwater harvesting tanks or rainwater butts for the Building elements.

- 6.3.16 The proposals indicate that a green roof is to be incorporated on building 1, and this would provide additional sustainable benefit. However, this element has not been included in the drainage calculations at this stage.
- 6.3.17 Detailed modelling confirms that the attenuation requirements are approximately 66m³ provided within the permeable paved external areas (assuming a 300mm layer of stone with a 30% void ratio).
- 6.3.18 The Drainage Strategy assumes that the outfall is un-surcharged.
- 6.3.19 Manchester City Council requires evidence that the run-off volume in the 1 in 100-year, 6 hours' rainfall shall be constrained to a value as close as is reasonably practical to the Greenfield runoff volume for the same event, but never to exceed the runoff volume from the development site prior to redevelopment.
- 6.3.20 The volumes generated from the proposed site in the 100 year 6-hour event is approximately 173.979m³ and are therefore exceed the existing volume in the same event. The volumes exceed the existing volumes in the 100-year event, however flows are restricted to 1 year flows. Any increase in flows for the 30 year and 100 year must ensure volumes do not exceed existing.
- 6.3.21 Surface water run-off from hard paved areas at risk of contamination should receive water quality treatment. Low traffic access roads and car parking is considered low hazard in terms of contamination. Figure 7 illustrates the pollution hazard indices for different land use classifications from The CIRIA SuDS Manual C753 (2015).

Figure 7: Pollution Hazard indices for land use classification (Table 26.2 the CIRIA SuDS manual 2015)

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways ¹	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways ¹	High	0.8 ²	0.8 ²	0.9 ²

6.3.22 Figure 8 illustrates the SuDS Component mitigation indices from The CIRIA SuDS Manual C753 (2015).

Figure 8: Indicative SuDS mitigation indices (Table 26.3 the CIRIA SuDS manual 2015)

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters				
Type of SuDS component	Mitigation indices¹			
	TSS	Metals	Hydrocarbons	
Filter strip	0.4	0.4	0.5	
Filter drain	0.4 ²	0.4	0.4	
Swale	0.5	0.6	0.6	
Bioretention system	0.8	0.8	0.8	
Permeable pavement	0.7	0.6	0.7	
Detention basin	0.5	0.5	0.6	
Pond ⁴	0.7 ³	0.7	0.5	
Wetland	0.8 ³	0.8	0.8	
Proprietary treatment systems ^{5,6}	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.			

Notes

- 1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.
- 2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.
- 3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.
- 4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.
- 5 See **Chapter 14** for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at: <http://tinyurl.com/qf7yuj7>
- 6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

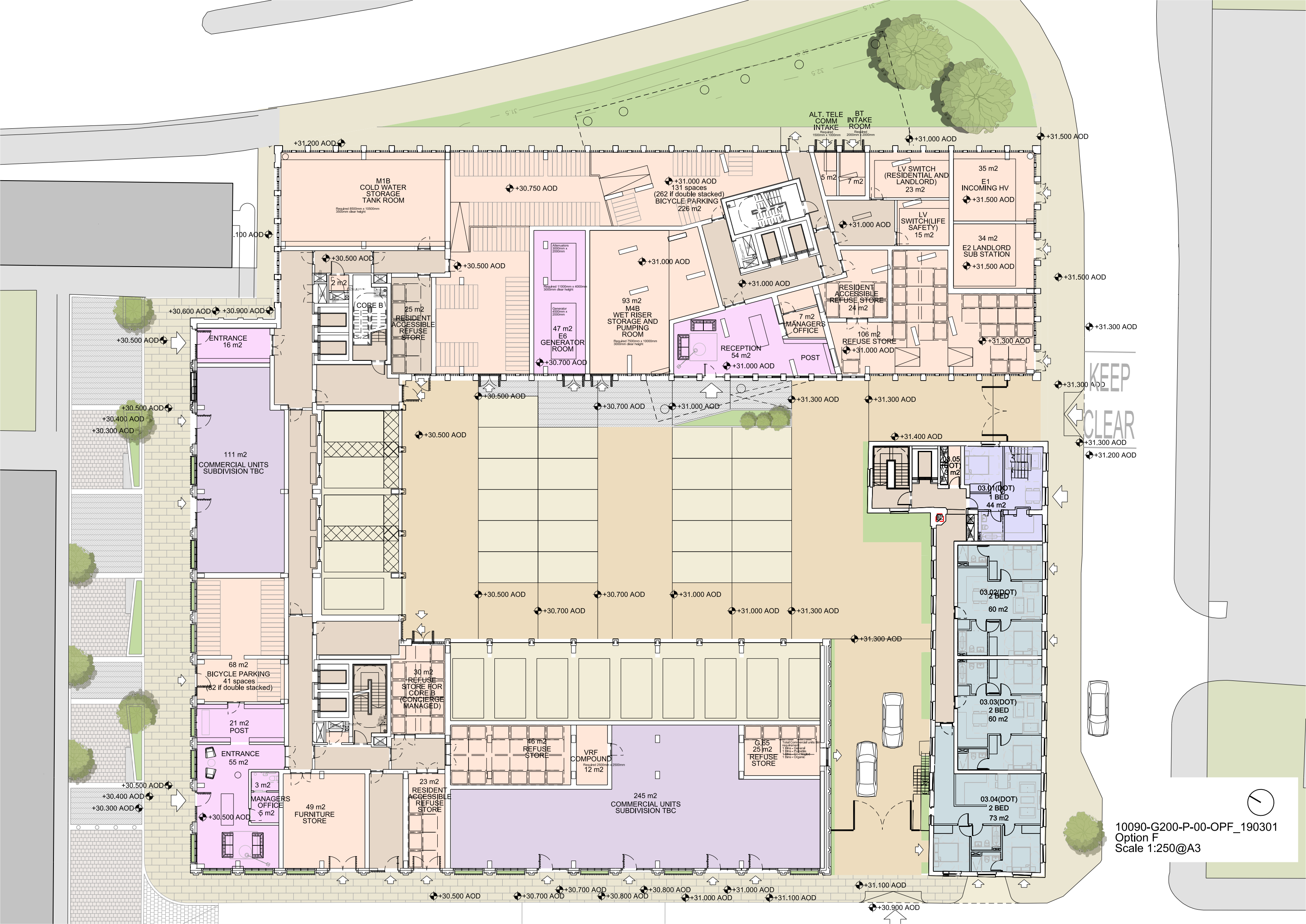
- 6.3.23 It is recommended that sustainable features are implemented where possible. The selection of treatment should ensure that the SuDS mitigation component index (Figure 8) exceeds the pollution hazard index (Figure 7). Where two stages of treatment are required, the second stage of treatment should account for reduced performance due to lower inflows; therefore 0.5 (mitigation index) should be used.
- 6.3.24 A level of treatment is proposed to the Building 2, the external areas are to be served by permeable paving and therefore considered to pass through a stage of treatment.
- 6.3.25 The proposals for pollution protection should be agreed with Manchester City Council.
- 6.3.26 The proposed outline drainage strategy and proposed drainage calculations is enclosed in *Appendix E*.
- 6.3.27 The final design of the drainage networks shall be in accordance with the legislation set by the Environment Agency, Manchester City Council and United Utilities.

6.4 Maintenance

- 6.4.1 A suitable maintenance strategy should be adopted to ensure the drainage network is cleaned regularly and the routine maintenance and cleansing regime should be documented.
- 6.4.2 It is recommended that the drainage system is inspected as a minimum twice a year, with the system also being inspected after any major storm event. Significant sediment deposition is likely in areas used for storage, so a post clean-up operation may be required including the removal of litter, vegetation, sewerage debris and larger objects.
- 6.4.3 A management company may be required for maintenance of attenuation facilities.

Appendix A

Proposed Site Plan



Appendix B

United Utilities Public Sewer Records

Topographical Survey

British Geological Survey (BGS) Infiltration Data

**Curtins Consulting Engineers
1st Floor Merchant Exchange
17-19 Whitworth Street West
Bishopsgate
Manchester
M1 5WG**

FAO:

Dear Sirs

Location:

I acknowledge with thanks your request dated 07/12/16 for information on the location of our services.

Please find enclosed plans showing the approximate position of our apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read our access statement before you start work to check how it will affect our network.

<http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please telephone us on 0370 7510101.

Yours Faithfully,



Amanda Simmonds
Property Searches Manager

United Utilities Water Limited

Property Searches
Ground Floor Grasmere House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

DX 715568 Warrington
Telephone 0370 751 0101

Property.searches@uuplc.co.uk

Your Ref: ARUNDEL STREET - 062979

Our Ref: 16/ 1255058

Date: 7/12/2016

TERMS AND CONDITIONS - WASTERWATER & WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self-construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

1. This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
2. This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
3. In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only and given in accordance with the best information available. The nature of the relevant system and/or its actual position may be different from that shown on the plan and UUWL is not liable for any damage caused by incorrect information provided save as stated in section 199 of the Water Industry Act 1991. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
4. The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
5. The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
6. This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
7. No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
8. If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
9. This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

WASTE WATER SYMOLOGY

Combined	Foul	Surface	Overflow	
				Manhole
				Manhole, side entry
				Public sewer
				Private sewer
				S104 sewer
				Rising Main, public
				Rising Mian, private
				Rising main, S104
				Highway Drain, private
				WW Pumping Station
				Inspection Chamber
				Extent of Survey
				Head of System
				Soakaway
				Rodding Eye
				Lamp Hole
				T Junction/Saddle
				Gulley
				Air Valve
				Non Return Valve
				Sewer Overflow
				Cascade
				Flow Meter
				Hatch Box
				Hydrobrake
				Inlet
				Bifurcation
				Catchpit
				Oil Interceptor
				Penstock
				Summit
				Valve
				Valve chamber
				Washout Chamber
				Drop Shaft
				WW Treatment Works
				Septic Tank
				Vent Column
				Network Storage Tank
				Orifice Plate
				Vortex Chamber
				Penstock Chamber
				Screen Chamber
				Discharge Point
				Outfall

MANHOLE FUNCTION

FO	Foul
SW	Surface Water
CO	Combined
OV	Overflow

SEWER SHAPE

CI	Circular	SQ	Square
EG	Egg	TR	Trapezoidal
OV	Oval	AR	Arch
FT	Flat Top	BA	Barrel
RE	Rectangular	HO	Horse Shoe
		U	Unspecified

SEWER MATERIAL

AC	Asbestos Cement	DI	Ductile Iron
BR	Brick	VC	Vitrified Clay
CO	Concrete	PP	Polypropylene
CSB	Concrete Segment	PF	Pitched Fibre
CSU	Concrete Segment	MA	Masonary, Coursed
CC	Concrete Box Culverted	MA	Masonary, Random
PSC	Plastic	RP	Reinforced Plastic
GR	Glass Reinforced	CI	Cast Iron
GRP	Glass Reinforced	SI	Spun Iron
PVC	Polyvinyl Chloride	ST	Steel
PE	Polyeththlene	U	Unspecified



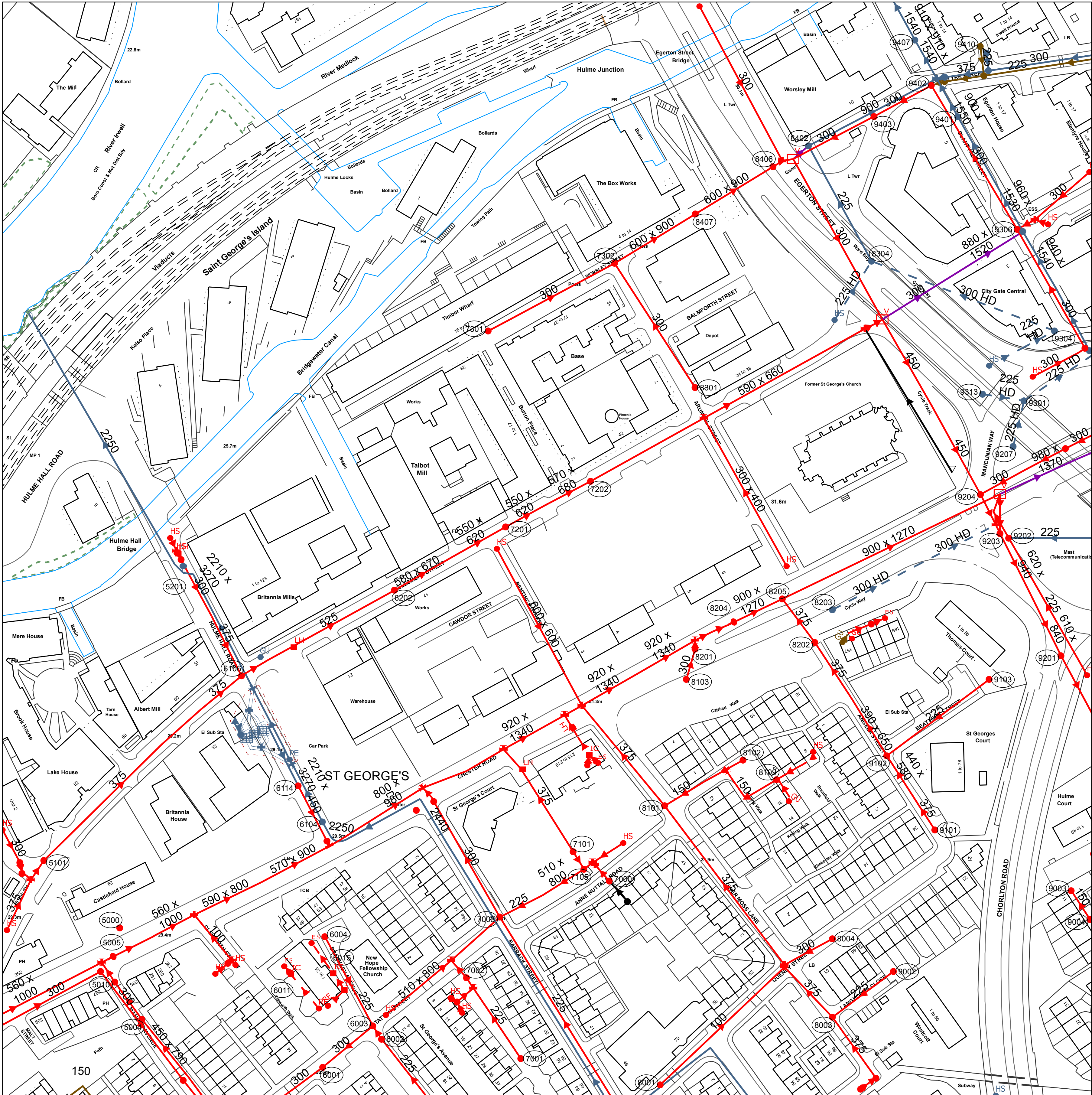
Control Kiosk



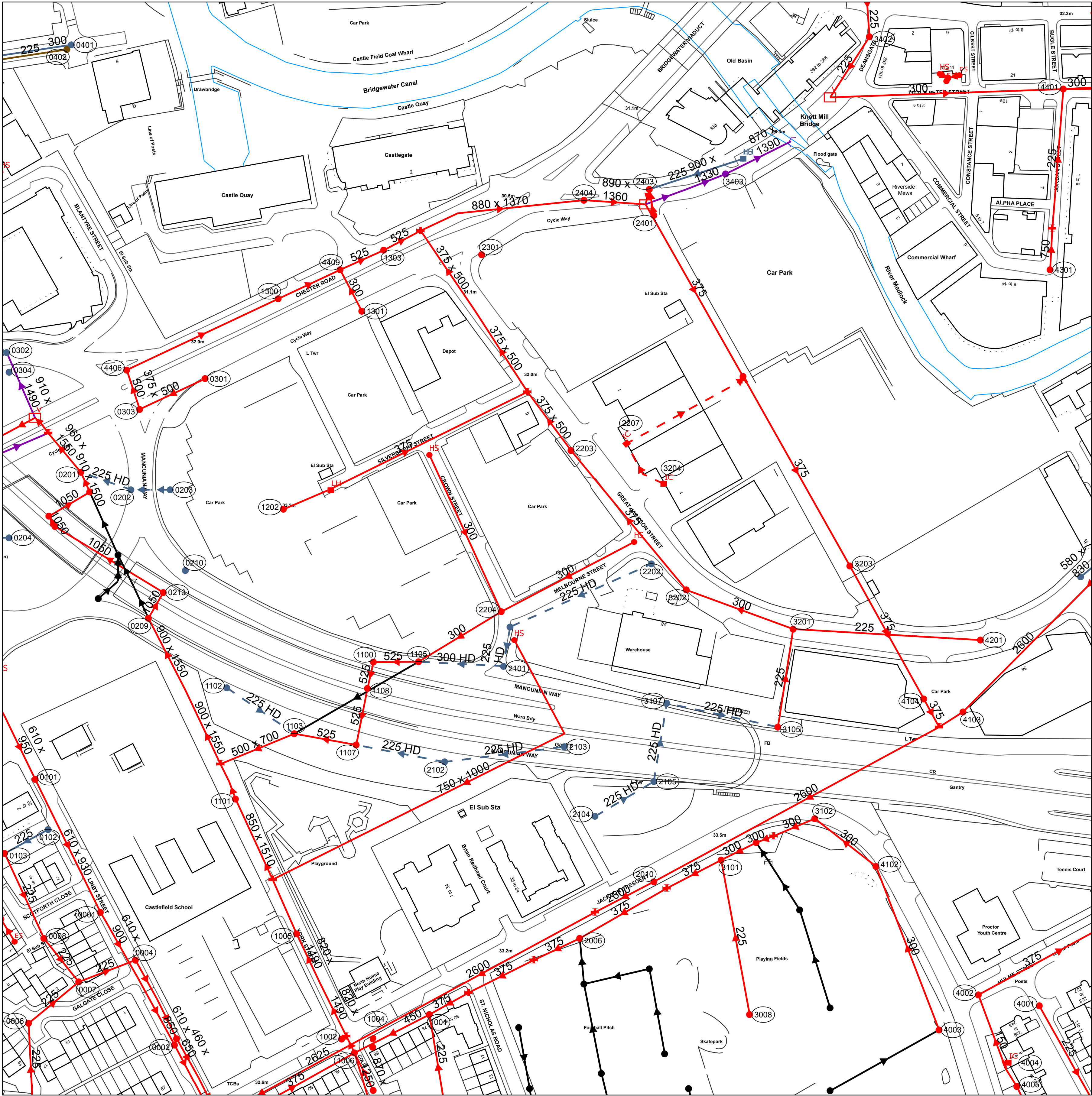
Sludge Main

ABANDONED PIPE

	Public Sewer
	Rising Main
	Private Sewer
	Sludge Main



Rchro	Cover	Func	Invert	Size	xSize	yShape	Mat	Length	Grad	Rchro	Cover	Func	Invert	Size	xSize	yShape	Mat	Length	Grad
5000	29.4	CO								5006		CO							
5001	30.44	CO								5007		CO							
5002	29.5	CO								5003		CO							
5004	29.9	CO	24.69	470	780	UN	BR	21.16		5204		CO							
5005	29.5	CO	0	500	600	HO	BR	10.84		5008		CO							
5010	29.55	CO								6107		CO							
5101	29.31	CO								6108		CO							
5102	29.35	CO								6117		SW							
5103	29.08	CO								6118		SW							
5201	29.38	SW	21.76	2250		CI	BR	138.75		6119		SW							
5202	29.4	CO								6120		SW							
6001	30.68	CO	25.76	300		CI	VC	52.2	193	6201		CO							
6002	30.85	CO	28.74	225		CI	VC	7.21	4	7005		CO							
6003	30.64	CO								7010		CO							
6004	29.78	CO	0	225		CI	VC	46.53		7102		CO							
6007	29.64	CO								7103		CO							
6011	29.4	CO								7104		CO							
6014		CO								7106		CO							
6015		CO								7107		CO							
6101	29.51	CO	24.41	450		CI	CO	2.65	19	7108		CO							
6102	29.98	CO								8005		CO							
6103	30.12	CO								8006		CO							
6104	29.33	SW								8112		CO							
6106	29.2	CO								8206		CO							
7007	29.21	SW								8302		CO							
6122	29.21	SW								8303		CO							
6202	29.37	CO								8403		CO							
7000		CO								9008		CO							
7301	30.08	CO	25.77	300		CI	VC	65.76	104	9202		CO							
7302	30.28	CO								9203		CO							
8001	31.81	CO	0	100		CI	CO	78.52		9204		CO							
8002	30.28	CO	28.92	570	630	RE	BR	5	6	9313		CO							
8003	32.15	CO	28.04	300		CI	VC	25.06		9314		CO							
8004	32.33	CO								9315		CO							
8101	31.82	CO								9316		CO							
8102	32.3	CO	29.95	150		CI	VC	20.59	9	9317		CO							
8103	31.8	CO	27.9	300		CI	VC	14.56	4	9318		CO							
8109		CO								9319		CO							
8201	31.83	CO								9320		CO							
8202	32.12	CO	27.2	375		CI	CO	25		9321		CO							
8203	32.28	SW	30.39	300		CI	CO	42.94		9322		CO							
8204	31.94	CO								9323		CO							
8205		CO								9324		CO							
8209		CO								9325		CO							
8304	31.05	CO	27.29	300		CI	VC	67.96	38	9326		CO							
8402	30.32	SW								9327		CO							
8406		CO								9328		CO							
8407	30.23	CO								9329		CO							
9001	32.14	CO	30.25	225		CI	VC	35	10	9330		CO							
9002	32.06	CO								9331		CO							
9004		CO								9332		CO							
9101	32.44	CO	29.05	375		CI	VC	20.25	45	9333		CO							
9102	32.28	CO								9334		CO							
9103	32.42	CO	30.14	225		CI	VC	58.6	163	9335		CO							
9201	32.78	CO								9336		CO							
9202	32.69	CO								9337		CO							
9203	30.67	EG	20.03	620	940	EG	BR	31.3		9338		CO							
9204	30.83	CO								9339		CO							
9206	33.08	CO	22.75	300		CI	VC	21.47	21	9340		CO							
9207	32.44	SW	30.15	225		CI	VC	21.59	7	9341		CO							
9301	28.96	SW								9342		CO							
9302	31.2	CO								9343		CO							
9303	30.53	SW	30.09	300		CI	VC	89.89		9344		CO							
9304	31.76	SW								9345		CO							
9306	31.86	CO								9346		CO							
9307	31.63	SW								9347		CO							
9313		SW	225						19.24	9348		CO							
9401	29.27	SW								9349		CO							
9402	28.75	CO								9350		CO							
9403	28.99	CO	23.46	300		CI	VC	41.92	140	9351		CO							
9407	27.75	SW	0	910	1540	UN	CO	34.96		9352		CO							
9410	27.32	FO								9353		CO							
9411	27.31	SW	25.6	225		CI	VC	8.09	10	9354		CO							
9412	28	SW	24.56	375		CI	CO	20.22	12	9355		CO							
9413	28.7	SW	22.83	375		CI	CO	3.53	17	9356		CO							
9414	28	FO	24.18	225		CI	VC	18.25	59	9357		CO							
9415	28.6	CO	23.67	225		CI	VC	6.34	317	9358		CO							
5008		CO	0	375		CI	CO	25.5		9359		CO							
5011		CO	0	225		CI	VC	7.52		9360		CO							
5013		CO	24.98	450	790	UN	BR	33.42	159	9361		CO							
5104		CO								9362		CO							
5105		CO	0	300		CI	VC	17		9363		CO							
5106		CO	0	375		CI	VC	23.92		9364		CO							
5206		CO	0	300		CI	VC	6.71		9365		CO							
5207		CO								9366		CO							
6005		CO	0	100		CI	VC	2.72		9367		CO							
6006		CO	0	510	800	UN	BR	68.96		9368		CO							
6009		CO								9369		CO							
6111		CO	0	2250		CI	BR	54.54		9370		CO							
6112		CO								9371		CO							
6113		SW								9372		CO							
6203		CO								9373		CO							
7006		CO								9374		CO							
7008		CO								9375		CO							
7009		CO								9376		CO							
7109		CO	0	560	800	FT	BR	21.64		9377		CO							
7110		CO								9378		CO							
7112		CO	0	920	1340	EG	BR	30.02		9379		CO							
7113		CO	0	600	600	UN	CO	81.88		9380		CO							
7203		CO								9381		CO							
7204		CO								9382		CO							
7205		CO								9383		CO							
8008		CO								9384		CO							
8104		CO	27.73	150		CI	CI	21.1	9	9385		CO							
8105		CO	27.68	375		CI	VC	31.06	68	9386		CO							
8106		CO								9387		CO							
8107		CO	150			CI	VC	13.41		9388		CO							
8108		CO								9389		CO							
8110		CO								9390		CO							
8111		CO								9391		CO							
8207		CO	0	300	450	CI	VC	10.28		9392		CO							



Reno	Cover	Func	Invert	Size	x	y	Shape	Mat	Length	Grad
0001	32.84	CO	21.89	610	800	EG	BR	34.48		313
0002	32.82	CO	21.77	610	820	EG	BR	19.24		
0003	32.88	CO	28.4	460	650	EG	BR	20.50		
0004	32.62	CO	28.66	510	530	EG	BR	20.59		
0006										
0007	32.87	CO								
0008	32.38	CO								
0101	32.38	CO	22.08	610	930	EG	BR	67.98		309
0102	32.4	SW	30.3	225		CI	VC	22.83		143
0103	32.19	CO	30.15	225		CI	VC	42.95		233
0200		CO								
0201	31.54	CO								
0202	28.93	SW	27.59	225		CI	VC	24.35		116
0203		SW								
0204		SW	0	225		CI	VC	41		
0209	33.32	CO								
0210	33.21	SW								
0213		CO								
0214		CO								
0215		CO	0	500		CI	CO	33.11		
0301		CO								
0302	30.51	SW								
0303		SW	0	375	500	EG	CO	18.97		
0304		SW								
0401	26.65	SW	25.16	300		CI	CO	79.83		151
0402	26.7	FO	24.7	225		CI	VC	79.88		154
1001	32.84	CO								
1002	32.84	CO								
1003	32.67	CO	27.39	450		CI	VC	2.47		
1004	32.89	CO								
1005	32.84	CO								
1006	33	CO								
1009	32.75	CO	30.45	300		CI	VC	19.28		12
1100		CO								
1101	32.89	CO								
1102	33.39	SW	30.89	225		CI	VC	37.44		267
1103	33.2	CO	28.64	500	700	EG	BR	38.77		
1105		CO	0	525		CI	VC	20.73		
1107		CO								
1108		CO	0	525		CI	VC	26.49		
1202	33.17	CO	28.72	375		CI	VC	124.37		
1300		CO	0	0	525	CI	CO	31.37		
1301	30.98	CO	27.92	300		CI	VC	21.47		
1303		CO								
2006	33.17	CO	28.87	375		CI	CO	23.38		
2010	33.45	CO	20.15	600		CI	BR	30.41		
2101	32.72	SW	29.82	300		CI	VC	39.05		
2102	33.24	SW	31.09	225		CI	VC	41.32		86
2103	33.15	SW	31.29	225		CI	VC	55.44		277
2104	32.11	SW	30.25	225		CI	VC	31.38		23
2105	29.61	SW	30.78	225		CI	VC	18.25		55
2201	32.8	SW	31.5	225		CI	VC	71.18		108
2202	33	SW								
2203		SW	0	375	500	EG	VC	33.6		
2204		CO	0	300		CI	VC	44.42		
2207		CO								
2301	30.7	CO								
2401	29.43	CO	26.45	600	740	EG	BR	6.08		4
2403	29.24	CO	23.16	225		CI	VC	7.14		238
2404	30.4	CO								
3008	33.44	CO	31.13	225		CI	VC	72.18		62
3101	33.45	CO								
3102	33.68	CO								
3105	33.7	CO								
3108	33.95	CO	29.96	300		CI	VC	17.89		119
3107	29.25	SW								
3201	32.69	CO	27.81	300		CI	VC	82.2		71
3202	33.27	CO	28.94	225		CI	VC	53.1		
3203	32.14	CO								
3204		CO								
3301	32.07	CO								
3402	28.41	CO	25.86	225		CI	VC	33.15		104
3403	28.38	OV								
4001	33.57	CO	31.51	225		CI	VC	70.72		93
4002	33.57	CO								
4003	33.47	CO	30.73	300		CI	VC	80.41		212
4004		CO								
4005		CO	30.29	300		CI	VC	45.81		170
4102	33.8	CO								
4103	33.46	CO								
4104	32.93	CO								
4201	33.28	CO	31.45	225		CI	VC	86.15		84
4202		SW	0	590	830	EG	BR	22.02		
4301	28.73	CO	25.33	750		CI	VC	19.93		
4401	30.31	CO	23.99	300		CI	VC	53.08		
4404		CO						1.51		
4406		CO								
4408		CO								
0005		CO	0	610	900	EG	BR	19.24		
0009		CO								
0010		CO	0	450	650	UN	BR	20.12		
0011		CO								
0104		CO	0	900	1550	UN	BR	37.12		161
0105		CO	22.26	610	950	EG	BR	32.2		
0206		SW								
0309		SW	22.86	300		CI	VC	15.65		174
0310		CO								
1008		CO	0	820	1490	UN	BR	25.5		
1106		CO								
1203		CO	0	300		CI	VC	79.2		
2205		CO	0	300		CI	VC	68.86		
2206		CO	0	750	1000	EG	VC	198.58		
2303		CO	0	375	500	EG	CO	44.65		
2407		CO	24.81	225		CI	VC	6.08		4
3303		CO								
3406		CO								
4402		CO								
0308		CO								
1007		CO								
1050		CO								
1104		CO								
1201		CO								
1304		CO								
2014		CO	0	375		CI	CO	20.59		
2015		CO	0	375		CI	CO	33.54		
2016		CO	0	2600		CI	BR	119.13		
2302		CO								
3010		CO	0	375		CI	CO	46.14		
3108		CO	0	300		CI	VC	8.54		
3302		CO								
3404		SW								
4006		CO								
4105		CO								
4303		CO								
0205		CO								
0207		CO								
0208		CO								
0211		CO								
0212		CO								
2007	32.89	CO								
2008	32.68	CO								
2011	32.99	CO								
2012	32.83	CO								
2013		CO								
3001	33.35	CO								
3002	33.01	CO								
3003	33.7	CO								
3005	33.46	CO								
3007	32.93	CO								
3109		CO								
0307		CO	22.84	910	1490	UN	BR	14.73		
2402		CO								
2401		CO								

Foul

Surface

Combined

Overflow



Topographical Survey Legend			
B	Butt	h	Height
BS	Bus Stop	Hyd	Hydrant
BT	Telecommunications IC	IC	Inspection Cover
CPS	Concrete Paving Slabs	JB	Junction Box
CTV	Cable Television Cover	KO	Kerb Outlet
DP	Downpipe	LB	Letter Box
DR	Drain	LP	Lamp Post
Elec	Electrical IC	Mx	Mix
EP	Elec. Pole	MP	Mile Post
EP	Earth Pole	NP	Name Plate
FP	Flagpole	P	Post
FT	Floodlight	PM	Parking Meter
G	Gully	RE	Rodding Eye
GP	Gate Post	RS	Road Sign
GV	Gas Valve	RTW	Retaining Wall
Fence Annotation			
B/W	Barbed Wire		
C/B	Closed Boarded		
C/I	Corrugated Iron		
C/L	Chain Link		
C/P	Concrete Panel		
H/R	Hand Rail		
I/R	Iron Railings		
O/B	Open Boarded		
P/C	Post & Chain		
P/R	Post & Rail		
P/W	Post & Wire		
W/M	Wire Mesh		
RWP	Rain Water Pipe		
SP	Soil Pipe		
SPS	Stone Paving Slabs		
ST	Stop Tap		
SV	Stop Valve		
TCS	Telephone Call Box		
TL	Traffic Light		
TP	Telegraph Pole		
TFS	Traffic Fencing Slabs		
VP	Vent Pipe		
WM	Water Meter		
WO	Water Outlet		
UTL	Unable To Lift		
Th	Threshold Level		
WL	Water Level		
Level Prefix Descriptions			
AL	Arch Level		
BL	Bed Level		
CL	Cover Level		
EL	Earth Level		
FL	Floor Level		
IL	Invert Level		
OL	Overhead Cable Level		
PL	Pavement Level		
RL	Roadbridge Level		
SL	Soil Level		
Spr	Arch Springing Level		
TF	Top Of Fence Level		
Th	Threshold Level		
WL	Water Level		
Spot Level			
Survey Control Station (coordinated point)			
Tree M.T. Multi Trunk			

Survey Station Coordinates			
Stn	Easting	Northing	Level
0001	5054.35	5033.30	22.66
0002	5000.00	5000.00	19.93
0003	4993.90	5033.75	19.77
0004	5029.65	5056.75	19.80
001A	5042.17	5018.14	20.23
001B	5080.28	5000.98	20.92
002A	5033.71	4963.58	20.71

Levels are related to TBM
Value 20.00m
Sited on IC cover indicated on plan by arrow.

Coordinates are related to Local Grid

Scale 1:200
0 2 4 6 8 10 12 14 16 18
metres

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Client **Zagora Management Ltd**

Title
**Topographical Survey
Balmforth Street
Manchester**

Surveyed **AL AF** Drawn **BP**
Date **June 2016** Checked **AG**
File name **17318** Revision No. Sheet size **A1**
Drawing No **SSL:17318:200:1:1**

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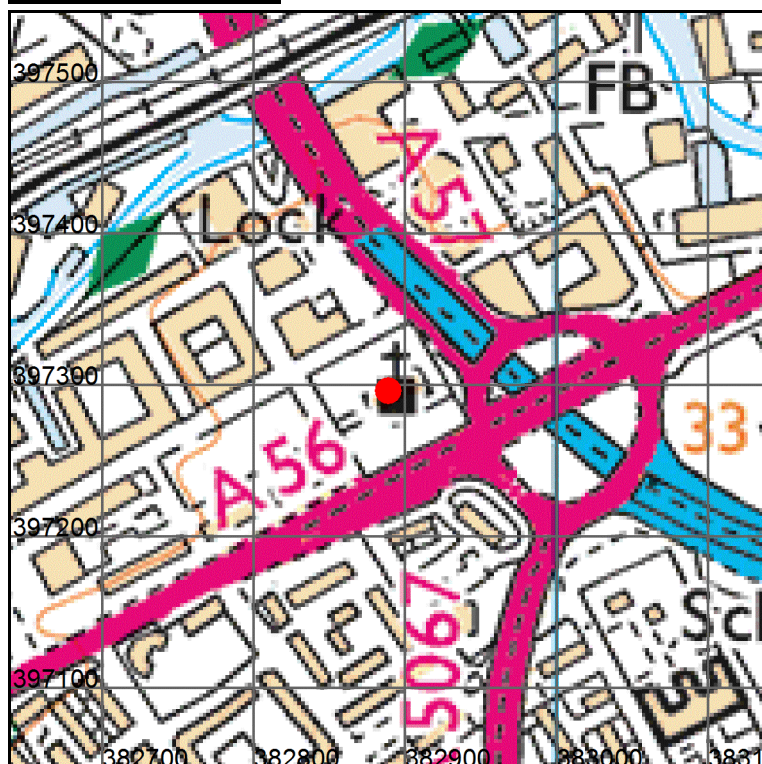
Infiltration SuDS GeoReport:

This report provides information on the suitability of the subsurface for the installation of infiltration sustainable drainage systems (SuDS). It provides information on the properties of the subsurface with respect to significant constraints, drainage, ground stability and groundwater quality protection.

Report Id: *GR_215061/1*

Client reference: 062979-Arundel Street

Search location



Point centred at:
382889,397296

Search location indicated in
red

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Scale: 1:5 000 (1cm = 50 m)



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Assessment for an infiltration sustainable drainage system

Introduction

Sustainable drainage systems (SuDS) are drainage solutions that manage the volume and quality of surface water close to where it falls as rain. They aim to reduce flow rates to rivers, increase local water storage capacity and reduce the transport of pollutants to the water environment. There are four main types of SuDS, which are often designed to be used in sequence. They comprise:

- **source control:** systems that control the rate of runoff
- **pre-treatment:** systems that remove sediments and pollutants
- **retention:** systems that delay the discharge of water by providing surface storage
- **infiltration:** systems that mimic natural recharge to the ground.

This report focuses on infiltration SuDS. It provides subsurface information on the properties of the ground with respect to drainage, ground stability and groundwater quality protection. It is intended principally for those involved in the preliminary assessment of the suitability of the ground for infiltration SuDS, and those involved in assessing proposals from others for sustainable drainage, but it may also be useful to help house-holders judge whether or not further professional advice should be sought. If in doubt, users should consult a suitably-qualified professional about the results in this report before making any decisions based upon it.

This GeoReport is structured in two parts:

- **Part 1. Summary data.**

Comprises three maps that summarise the data contained within Part 2.

- **Part 2. Detailed data.**

Comprises a further 24 maps in four thematic sections:

- **Very significant constraints.** Maps highlight areas where infiltration may result in adverse impacts due to factors including: ground instability (soluble rocks, non-coal shallow mining and landslide hazards); persistent shallow groundwater, or the presence of made ground, which may represent a ground stability or contamination hazard.
- **Drainage potential.** Maps indicate the drainage potential of the ground, by considering subsurface permeability, depth to groundwater and the presence of floodplain deposits.
- **Ground stability.** Maps indicate the presence of hazards that have the potential to cause ground instability resulting in damage to some buildings and structures, if water is infiltrated to the ground.
- **Groundwater protection.** Maps provide key indicators to help determine whether the groundwater may be susceptible to deterioration in quality as a result of infiltration.

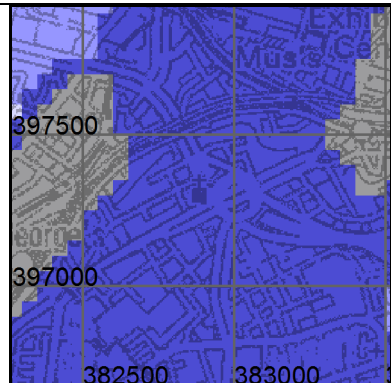
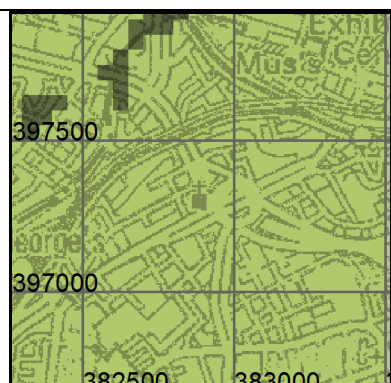
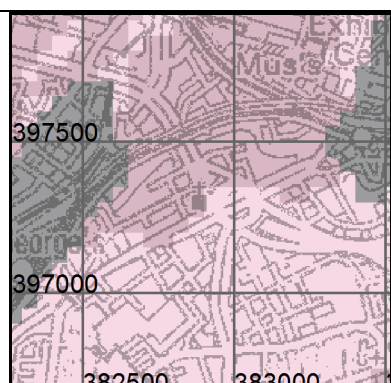


This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration SuDS are, or are not, appropriate as this is highly dependent on the design of the individual system. This report therefore describes the subsurface conditions at the site, allowing the reader to determine the suitability of the site for infiltration SuDS.

The map and text data in this report is similar to that provided in the '*Infiltration SuDS Map: Detailed*' national map product. For further information about the data, consult the '*User Guide for the Infiltration SuDS Map: Detailed*', available from <http://nora.nerc.ac.uk/16618/>.

PART 1: SUMMARY DATA

This section provides a summary of the data on the following pages.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Highly compatible for infiltration SuDS. The subsurface is likely to be suitable for free-draining infiltration SuDS.
	 Probably compatible for infiltration SuDS. The subsurface is probably suitable although the design may be influenced by the ground conditions.
	 Opportunities for bespoke infiltration SuDS. The subsurface is potentially suitable although the design will be influenced by the ground conditions.
	 Very significant constraints are indicated. There is a very significant potential for one or more hazards associated with infiltration.
Is ground instability likely to be a problem?	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is very unlikely to result in ground instability.
	 Ground instability problems may be present or anticipated, but increased infiltration is unlikely to result in ground instability
	 Ground instability problems are probably present. Increased infiltration may result in ground instability.
	 There is a very significant potential for one or more geohazards associated with infiltration.
Is the groundwater susceptible to deterioration in quality?	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 The groundwater is not expected to be especially vulnerable to contamination.
	 The groundwater may be vulnerable to contamination.
	 The groundwater is likely to be vulnerable to contaminants.
	 Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

PART 2: DETAILED DATA

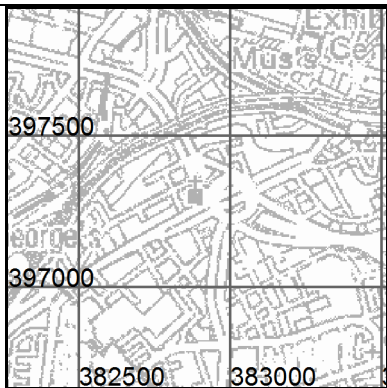
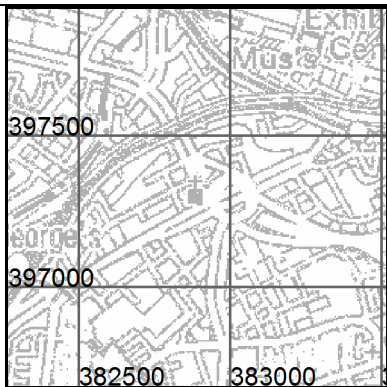
This section provides further information about the properties of the ground and will help assess the suitability of the ground for infiltration SuDS.

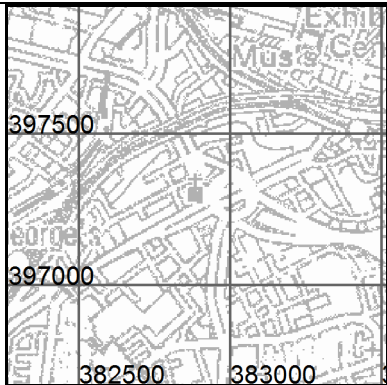
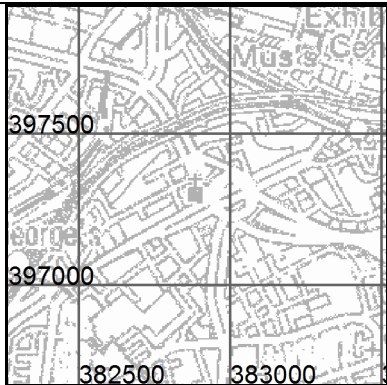
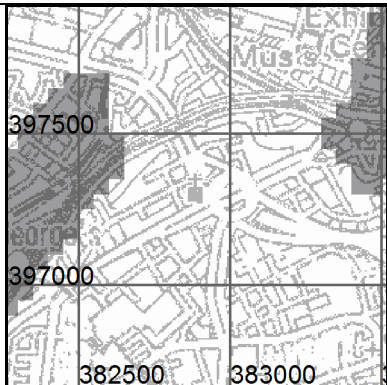
Section 1. Very significant constraints

Where maps are overlain by grey polygons, geological or hydrogeological hazards may exist that could be made worse by infiltration. The following hazards are considered:

- soluble rocks
- landslides
- shallow mining
- shallow groundwater
- made ground

For more information read 'Explanation of terms' at the end of this report.

Soluble rock hazard	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Very significant soluble rock hazard. Soluble rocks are present with a very significant possibility of localised subsidence that could be initiated or made worse by infiltration. The site investigation should consider whether the potential for or the consequences of subsidence as a result of infiltration are significant.
	 Very significant soluble rock hazards are not present; however this hazard may still need to be considered. See Part 3.
Landslide hazard	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Very significant landslide hazard. Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail. The site investigation should consider whether the potential for or the consequences of landslide as a result of infiltration are significant.
	 Very significant landslide hazards are not present; however this hazard may still need to be considered. See Part 3.

Shallow mining hazard	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	☒ Very significant mining hazard. Shallow mining is likely to be present with a very significant possibility of localised subsidence that could be initiated or made worse by increased infiltration. Also, infiltration may increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of subsidence and/or remobilisation of pollutants as a result of infiltration are significant. ☐ Very significant mining hazards are not present; however this hazard may still need to be considered. See Part 3.
Persistent shallow groundwater	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	☒ Very high likelihood of persistent or seasonally shallow groundwater. Persistent or seasonally shallow groundwater is likely to be present. Infiltration may increase the likelihood of soakaway inundation, or groundwater emergence at the surface. The site investigation should consider whether the potential for or the consequences of groundwater level rise as a result of infiltration are significant. ☐ See Part 2 for the likely depth to water table.
Made ground	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	☒ Made ground present. Made ground is present at the surface. Infiltration may affect ground stability or increase the possibility of remobilising pollutants. The site investigation should consider whether the potential for or consequences of ground instability and/or pollutant leaching as a result of infiltration are significant. ☐ None recorded

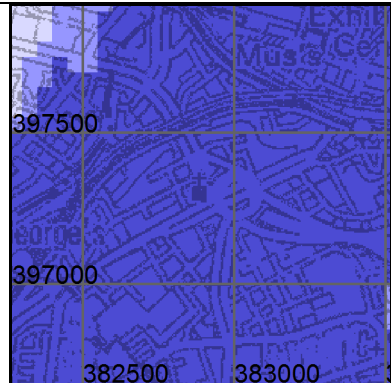
Section 2. Drainage potential

The following pages contain maps that will help you assess the drainage potential of the ground by considering the:

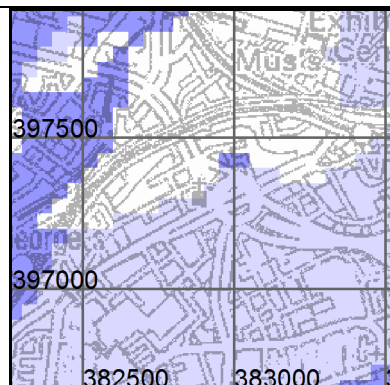
- depth to water table
- permeability of the superficial deposits
- thickness of the superficial deposits
- permeability of the bedrock
- presence of floodplains

Superficial deposits are not present everywhere and therefore some areas of the *superficial deposit permeability* map may not be coloured. Where this is the case, the *bedrock permeability* map shows the likely permeability of the ground. Superficial deposits in some places are very thin and hence in these places you may wish to consider both the permeability of the superficial deposits and the permeability of the bedrock. The *superficial thickness* map will tell you whether the superficial deposits are thin (< 3 m thick) or thick (>3 m). Where they are over 3 m thick, the permeability of the bedrock may not be relevant.

For more information read 'Explanation of terms' at the end of this report.

Depth to groundwater table	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Groundwater is likely to be more than 5 m below the ground surface throughout the year.
	 Groundwater is likely to be between 3 and 5 m below the ground surface for at least part of the year.
	 Groundwater is likely to be less than 3 m below the ground surface for at least part of the year.

Superficial deposit permeability



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 Superficial deposits are likely to be **free-draining**.

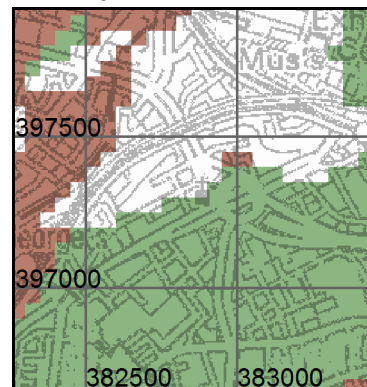
 The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

 Superficial deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

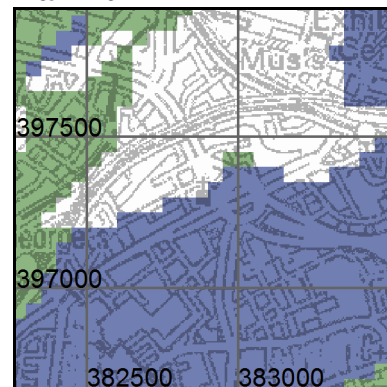
 Very Low
 Low
 Moderate
 High
 Very High

Minimum



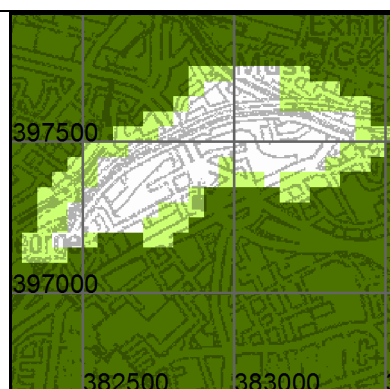
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Maximum



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Superficial deposit thickness

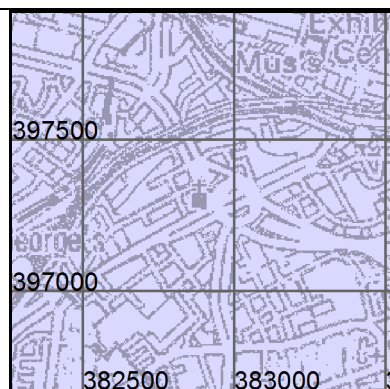


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 The thickness of superficial deposits is **< 3 m** and hence the permeability of the ground may be dependent on both the superficial deposits (where present) and underlying bedrock (see below).

 The thickness of superficial deposits is **> 3 m** and hence the permeability of the superficial deposits is likely to determine the permeability of the ground.

Bedrock permeability



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Bedrock deposits are likely to be **free-draining**.



The bedrock permeability is **spatially variable**, but likely to permit moderate infiltration.



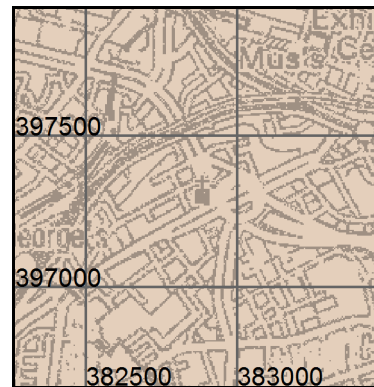
Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

Key

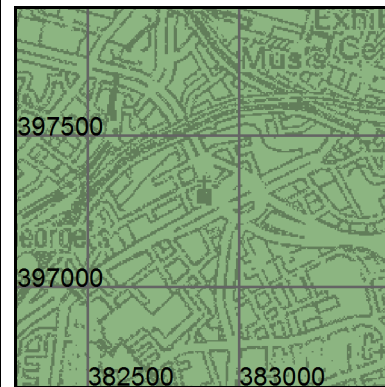
-  Very Low
-  Low
-  Moderate
-  High
-  Very High

Minimum



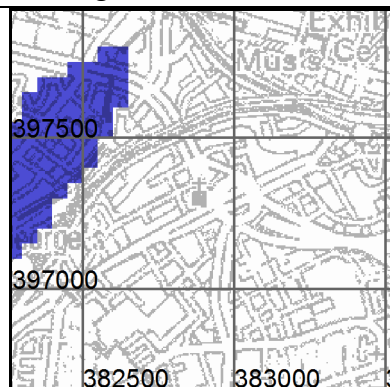
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Maximum



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Geological indicators of flooding



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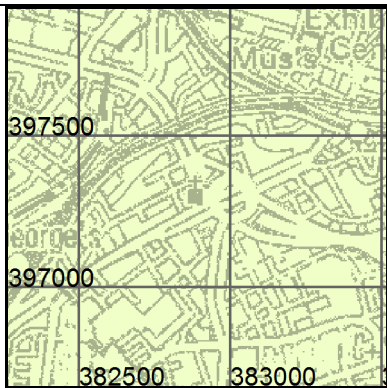
Superficial floodplain deposits or low-lying coastal areas have been identified. Groundwater levels may rise in response to high river or tide levels, potentially causing inundation of subsurface infiltration SuDS.

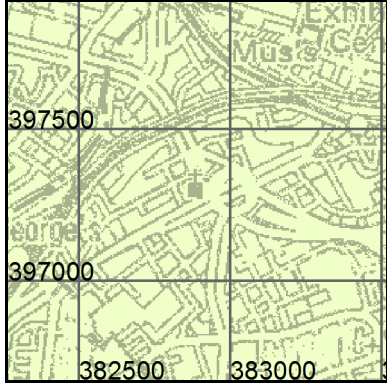
Section 3. Ground stability

The following pages contain maps that will help you assess whether infiltration may impact the stability of the ground. They consider hazards associated with:

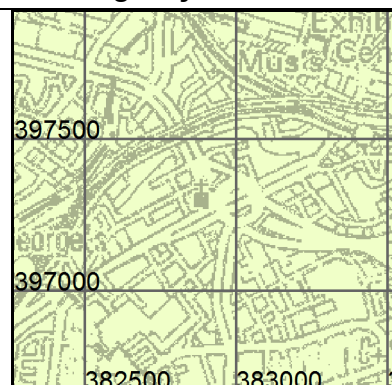
- soluble rocks
- landslides
- shallow mining
- running sands
- swelling clays
- compressible ground, and
- collapsible ground

In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to result in subsidence.
	 Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	 Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	 Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

Landslides	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to lead to slope instability.
	 Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
	 Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability.
	 Slope instability problems are almost certainly present and may be active. An increase in moisture content as a result of infiltration may cause the slope to fail.
Shallow mining	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to lead to subsidence.
	 Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	 Shallow mining could be present with a significant possibility that localised subsidence could be initiated or made worse by increased infiltration.
	 Shallow mining is likely to be present, with a very significant possibility that localised subsidence may be initiated or made worse by increased infiltration.
Running sand	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	 Increased infiltration is unlikely to cause ground collapse associated with running sands.
	 Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
	 Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

Swelling clays



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Increased infiltration is unlikely to cause shrink-swell ground movement.

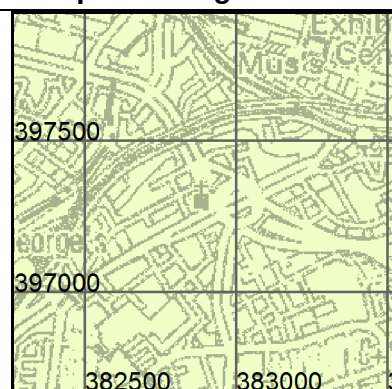


Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.



Ground is susceptible to shrink-swell ground movement. Increased infiltration may result in a geohazard.

Compressible ground



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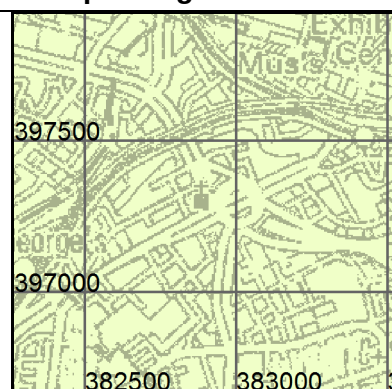


Increased infiltration is unlikely to lead to ground compression.



Compressibility and uneven settlement hazards are probably present. Increased infiltration may result in a geohazard.

Collapsible ground



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Increased infiltration is unlikely to result in subsidence.



Deposits with potential to collapse when loaded and saturated are possibly present in places. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.



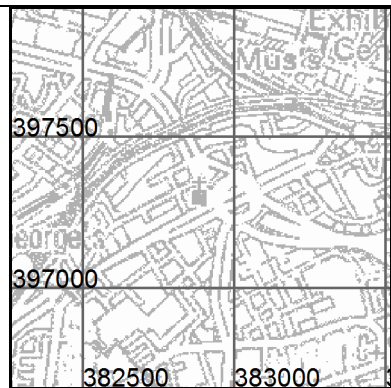
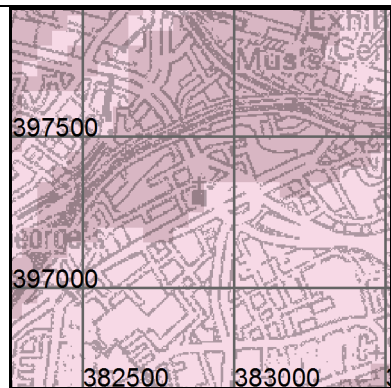
Deposits with potential to collapse when loaded and saturated are probably present in places. Increased infiltration may result in a geohazard.

Section 4. Groundwater quality protection

The following pages contain maps showing some of the information required to ensure the protection of groundwater quality. Data presented includes:

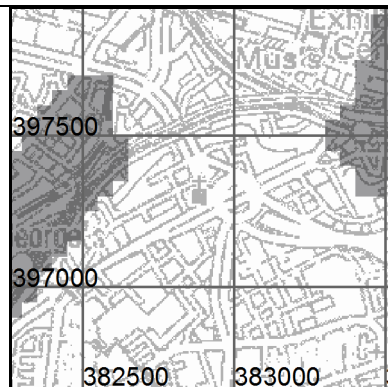
- groundwater source protection zones (Environment Agency data)
- predominant flow mechanism
- made ground

For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL Derived in part from Source Protection Zone data provided under licence from the Environment Agency © Environment Agency 2016.	Groundwater is not within a source protection zone.
	Source protection zone IV
	Source protection zone III
	Source protection zone II
	Source protection zone I.
Predominant flow mechanism	
 © Crown Copyright and/or database right 2016. All rights reserved. Licence number 100021290 EUL	Water is likely to percolate through the unsaturated zone to the groundwater through either the pore space in granular media or through porespace and fractures; these processes have some potential for contaminant removal and breakdown.
	Water is likely to percolate through the unsaturated zone to the groundwater through fractures, a process which has little potential for contaminant removal and breakdown.



Made ground



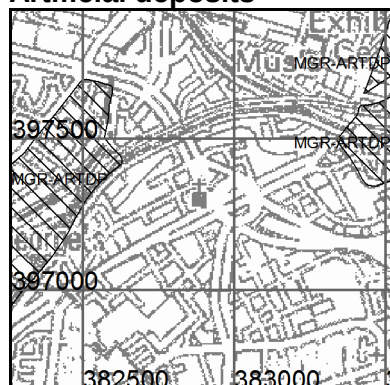
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Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

Section 5. Geological Maps

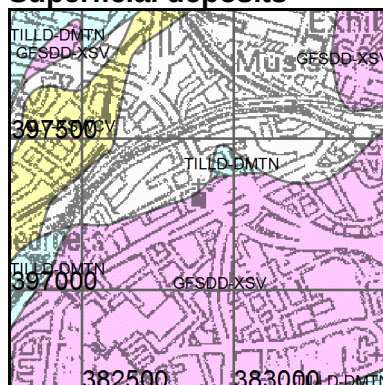
The following maps show the artificial, superficial and bedrock geology within the area of interest.

Artificial deposits



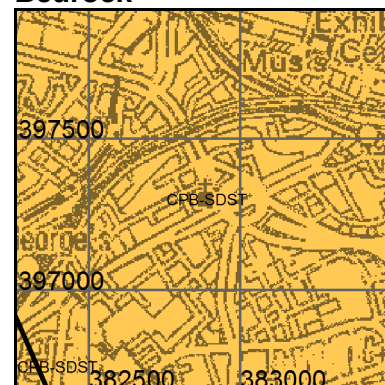
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Superficial deposits



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Bedrock



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Fault

Coal, ironstone or mineral vein

Note: Faults and Coals, ironstone & mineral veins are shown for illustration and to aid interpretation of the map. Not all such features are shown and their absence on the map face does not necessarily mean that none are present

Key to Artificial deposits:

Map colour	Computer Code	Rock name	Rock type
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT

Key to Superficial deposits:

Map colour	Computer Code	Rock name	Rock type
	ALV-XSWCV	ALLUVIUM	SAND WITH CLAY AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME - EXTENDED]
	GFSDD-XSV	GLACIOFLUVIAL SHEET DEPOSITS, DEVENSIAN	SAND AND GRAVEL [UNLITHIFIED DEPOSITS CODING SCHEME]
	TILLD-DMTN	TILL, DEVENSIAN	DIAMICTON



Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	CPB-SDST	CHESTER PEBBLE BEDS FORMATION	SANDSTONE



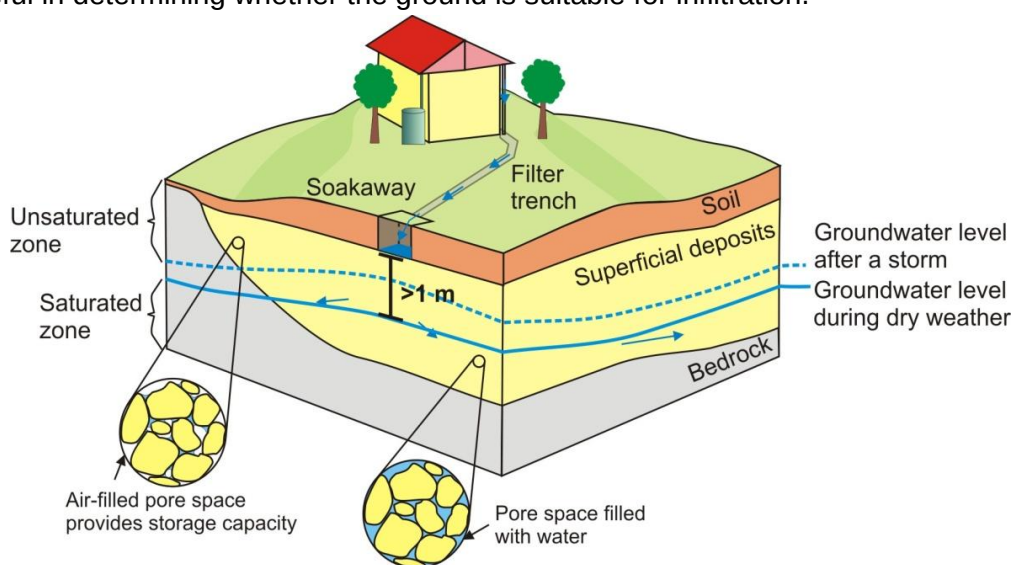
Limitations of this report:

- This report is concerned with the potential for infiltration-to-the-ground to be used as a SuDS technique at the site described. It only considers the subsurface beneath the search area and does NOT consider potential surface or subsurface impacts outside of that area.
- This report is NOT an alternative for an on-site investigation or soakaway test, which might reach a different conclusion.
- This report must NOT be used to justify disposal of foul waste or grey water.
- This report is based on and limited to an interpretation of the records held by the British Geological Survey (BGS) at the time the search is performed. The datasets used (with the exception of that showing depth to water table) are based on 1:50 000 digital geological maps and not site-specific data.
- Other more specific and detailed ground instability information for the site may be held by BGS, and an assessment of this could result in a modified assessment.
- To interpret the maps correctly, the report must be viewed and printed in colour.
- The search does NOT consider the suitability of sites with regard to:
 - previous land use,
 - potential for, or presence of contaminated land
 - presence of perched water tables
 - shallow mining hazards relating to coal mining. Searches of coal mining should be carried out via The Coal Authority Mine Reports Service: www.coalminingreports.co.uk.
 - made ground, where not recorded
 - proximity to landfill sites (searches for landfill sites or contaminated land should be carried out through consultation with local authorities/Environment Agency)
 - zones around private water supply boreholes that are susceptible to groundwater contamination.
- This report is supplied in accordance with the GeoReports Terms & Conditions available separately, and the copyright restrictions described at the end of this report

Explanation of terms

Depth to groundwater

In the shallow subsurface, the ground is commonly unsaturated with respect to water. Air fills the spaces within the soil and the underlying superficial deposits and bedrock. At some depth below the ground surface, there is a level below which these spaces are full of water. This level is known as the groundwater level, and the water below it is termed the groundwater. When water is infiltrated, the groundwater level may rise temporarily. To ensure that there is space in the unsaturated zone to accommodate this, there should be a minimum thickness of 1 m between the base of the infiltration system and the water table. An estimate of the *depth to groundwater* is therefore useful in determining whether the ground is suitable for infiltration.



Groundwater flooding

Groundwater flooding occurs when a rise in groundwater level results in very shallow groundwater or the emergence of groundwater at the surface. If infiltration systems are installed in areas that are susceptible to groundwater flooding, it is possible that the system could become inundated. The susceptibility map seeks to identify areas where the geological conditions and water tables indicate that groundwater level rise could occur under certain circumstances. A high susceptibility to groundwater flooding classification does not mean that groundwater flooding has ever occurred in the past, or will do so in the future as the susceptibility maps do not contain information on how often flooding may occur. The susceptibility maps are designed for planning; identifying areas where groundwater flooding might be an issue that needs to be taken into account.

Geological indicators of flooding

In floodplain deposits, groundwater level can be influenced by the water level in the adjacent river. Groundwater level may increase during periods of fluvial flood and therefore this should be taken into account when designing infiltration systems on such deposits. The *geological indicators of flooding* dataset shows where there is geological evidence (floodplain deposits) that flooding has occurred in the past.

For further information on flood-risk, the likely frequency of its recurrence in relation to any proposed development of the site, and the status of any flood prevention measures in place, you are advised to contact the local office of the Environment Agency (England and Wales) at www.environment-agency.gov.uk/ or the Scottish Environment Protection Agency (Scotland) at www.sepa.org.uk.

Artificial ground

Artificial ground comprises deposits and excavations that have been created or modified by human activity. It includes ground that is worked (quarries and road cuttings), infilled (back-filled quarries), landscaped (surface re-shaping), disturbed (near surface mineral workings) or classified as made ground (embankments and spoil heaps). The composition and properties of artificial ground are often unknown. In particular, the permeability and chemical composition of the artificial ground should be determined to ensure that the ground will drain and that any contaminants present will not be remobilised.

Superficial permeability

Superficial deposits are those geological deposits that were formed during the most recent period of geological time (as old as 2.6 million years before present). They generally comprise relatively thin deposits of gravel, sand, silt and clay and are present beneath the pedological soil in patches or larger spreads over much of Britain. The ease with which water can percolate through these deposits is controlled by their permeability and varies widely depending on their composition. Those deposits comprising clays and silts are less permeable and thus infiltration is likely to be slow, such that water may pool on the surface. In comparison, deposits comprising sands and gravels are more permeable allowing water to percolate freely.

Bedrock permeability

Bedrock forms the main mass of rock forming the Earth. It is present everywhere, commonly beneath superficial deposits. Where the superficial deposits are thin or absent, the ease with which water will percolate into the ground depends on the permeability of the bedrock.

Natural ground instability

Natural ground instability refers to the propensity for upward, lateral or downward movement of the ground that can be caused by a number of natural geological hazards (e.g. ground dissolution/compressible ground). Some movements associated with particular hazards may be gradual and of millimetre or centimetre scale, whilst others may be sudden and of metre or tens of metres scale. Significant natural ground instability has the potential to cause damage to buildings and structures, especially when the drainage characteristics of a site are altered. It should be noted, however, that many buildings, particularly more modern ones, are built to such a standard that they can remain unaffected in areas of significant ground movement.

Shrink-swell

A shrinking and swelling clay changes volume significantly according to how much water it contains. All clay deposits change volume as their water content varies, typically swelling in winter and shrinking in summer, but some do so to a greater extent than others. Contributory circumstances could include drought, leaking service pipes, tree roots drying-out the ground or changes to local drainage patterns, such as the creation of soakaways. Shrinkage may remove support from the foundations of buildings and structures, whereas clay expansion may lead to uplift (heave) or lateral stress on part or all of a structure; any such movements may cause cracking and distortion.

Landslides (slope stability)

A landslide is a relatively rapid outward and downward movement of a mass of ground on a slope, due to the force of gravity. A slope is under stress from gravity but will not move if its strength is greater than this stress. If the balance is altered so that the stress exceeds the strength, then movement will occur. The stability of a slope can be reduced by removing ground at the base of the slope, by placing material on the slope, especially at the top, or by increasing the water content of the materials forming the slope. Increase in subsurface water content beneath a soakaway could increase susceptibility to landslide hazards. The assessment of landslide hazard refers to the stability of the present land surface. It does not encompass a consideration of the stability of excavations.

Soluble rocks (dissolution)

Some rocks are soluble in water and can be progressively removed by the flow of water through the ground. This process tends to create cavities, potentially leading to the collapse of overlying materials and possibly subsidence at the surface. The release of water into the subsurface from infiltration systems may increase the dissolution of rock or destabilise material above or within a cavity. Dissolution cavities may create a pathway for rapid transport of contaminated water to an aquifer or water course.

Compressible ground

Many ground materials contain water-filled pores (the spaces between solid particles). Ground is compressible if a building (or other load) can cause the water in the pore space to be squeezed out, causing the ground to decrease in thickness. If ground is extremely compressible the building may sink. If the ground is not uniformly compressible, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The compressibility of the ground may alter as a result of changes in subsurface water content caused by the release of water from soakaways.

Collapsible deposits

Collapsible ground comprises certain fine-grained materials with large pore spaces (the spaces between solid particles). It can collapse when it becomes saturated by water and/or a building (or other structure) places too great a load on it. If the material below a building collapses it may cause the building to sink. If the collapsible ground is variable in thickness or distribution, different parts of the building may sink by different amounts, possibly causing tilting, cracking or distortion. The subsurface underlying a soakaway will experience an increase in water content that may affect the stability of the ground. This hazard is most likely to be encountered only in parts of southern England.

Running sand

Running sand conditions occur when loosely-packed sand, saturated with water, flows into an excavation, borehole or other type of void. The pressure of the water filling the spaces between the sand grains reduces the contact between the grains and they are carried along by the flow. This can lead to subsidence of the surrounding ground. Running sand is potentially hazardous during the drainage system installation. During installation, excavation of the ground may create a space into which sand can flow, potentially causing subsidence of surrounding ground.

Shallow mining hazards (non coal)

Current or past underground mining for coal or for other commodities can give rise to cavities at shallow or intermediate depths, which may cause fracturing, general settlement, or the formation of crown-holes in the ground above. Spoil from mineral workings may also present a pollution hazard. The release of water into the subsurface from soakaways may destabilise material above or within a cavity. Cavities arising as a consequence of mining may also create a pathway for rapid transport of contaminated water to an aquifer or watercourse. The mining hazards map is derived from the geological map and considers the potential for subsidence associated with mining on the basis of geology type. Therefore if mining is known to occur within a certain rock, the map will highlight the potential for a hazard within the area covered by that geology.



For more information regarding underground and opencast **coal mining**, the location of mine entries (shafts and adits) and matters relating to subsidence or other ground movement induced by **coal mining** please contact the Coal Authority, Mining Reports, 200 Lichfield Lane, Mansfield, Nottinghamshire, NG18 4RG; telephone 0845 762 6848 or at www.coal.gov.uk. For more information regarding other types of mining (i.e. non-coal), please contact the British Geological Survey.

Groundwater source protection zones

In England and Wales, the Environment Agency has defined areas around wells, boreholes and springs that are used for the abstraction of public drinking water as source protection zones. In conjunction with Groundwater Protection Policy the zones are used to restrict activities that may impact groundwater quality, thereby preventing pollution of underlying aquifers, such that drinking water quality is upheld. The Environment Agency can provide advice on the location and implications of source protection zones in your area (www.environment-agency.gov.uk/)



Contact Details

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Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

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British Geological Survey
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Tel: 0131 6671000
Email: enquiry@bgs.ac.uk



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- The data, information and related records supplied in this Report by BGS can only be indicative and should not be taken as a substitute for specialist interpretations, professional advice and/or detailed site investigations. You must seek professional advice before making technical interpretations on the basis of the materials provided.
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- Detail, which is clearly defined and accurately depicted on large-scale maps, may be lost when small-scale maps are derived from them.
- Although samples and records are maintained with all reasonable care, there may be some deterioration in the long term.
- The most appropriate techniques for copying original records are used, but there may be some loss of detail and dimensional distortion when such records are copied.
- Data may be compiled from the disparate sources of information at BGS's disposal, including material donated to BGS by third parties, and may not originally have been subject to any verification or other quality control process.
- Data, information and related records, which have been donated to BGS, have been produced for a specific purpose, and that may affect the type and completeness of the data recorded and any interpretation. The nature and purpose of data collection, and the age of the resultant material may render it unsuitable for certain applications/uses. You must verify the suitability of the material for your intended usage.
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- The topography shown on any map extracts is based on the latest OS mapping and is not necessarily the same as that used in the original compilation of the BGS geological map, and to which the geological linework available at that time was fitted.
- Note that for some sites, the latest available records may be quite historical in nature, and while every effort is made to place the analysis in a modern geological context, it is possible in some cases that the detailed geology at a site may differ from that described.

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**Report issued by
BGS Enquiry Service**

Appendix C

Manchester City Council Correspondence

United Utilities Correspondence

Chloé Grimsley

From: z.todorovic@manchester.gov.uk on behalf of
floodriskmanagement@manchester.gov.uk
Sent: 11 January 2017 15:39
To: Chloé Grimsley
Cc: floodriskmanagement@manchester.gov.uk
Subject: RE: Arundel Street, Manchester
Attachments: ARUNDEL STREET-062979.pdf

Follow Up Flag: Follow up
Flag Status: Completed

Hi Chloe

Manchester City Council would consider discharge into the highway drain only if there is no alternative option and even then it would be done on a case by case basis assessing capacity and risk to flooding in that location. As there are alternative options for drainage, we advice you to develop solutions that would utilise connections into the public sewers.

Kind regards

Zorica

Flood Risk Management
The Neighbourhoods Service
Growth and Neighbourhoods
Manchester City Council

Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: <http://www.manchester.gov.uk/>

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

Chloé Grimsley <Chloe.Grimley@curtins.com>

To "floodriskmanagement@manchester.gov.uk"
<floodriskmanagement@manchester.gov.uk>

05/01/2017 10:20

cc

Subject RE: Arundel Street, Manchester

Good Morning Zorica,

Thank you for your quick response to our enquiry.

With regards to the surface water outfall location, the nearest outfall (as opposed to connection to the combined sewer network) would be to the existing 225 Highway drain which crosses below the Mancunian way. However to connect site drainage to this would require the sewer to be designated as a public sewer. I have requested whether UU would adopt this however please could you confirm who I would need to liaise with in Highways to confirm if Manchester Highways would accept this to become public?

I have attached the sewer records for information which shows the existing 450mm highway drain.

Kind Regards,
Chloé

Chloé Grimsley Senior Engineer

Curtins

T. 0161 236 2394 | chloe.grimsley@curtins.com

From: z.todorovic@manchester.gov.uk [mailto:z.todorovic@manchester.gov.uk] **On Behalf Of** floodriskmanagement@manchester.gov.uk
Sent: 04 January 2017 14:57
To: Chloé Grimsley <Chloe.Grimley@curtins.com>
Cc: floodriskmanagement@manchester.gov.uk
Subject: Re: Arundel Street, Manchester

Chloe

Thank you for the email.

Our Drainage Records:

With regards to the proposed site we could confirm the following:

- We do not hold any record of historic flooding on site;
- We do not hold any record of drainage assets in the area.
- Please note that some areas of Arundel Street are prone to surface water flooding. You could find relevant maps on the Environment Agency's website.

Relevant Policies and Guidance:

With regards to relevant policies and guidance, our SuDS guidance gives reference to these documents. Please note that since we issued our SuDS guidance, the Environment Agency revised proposed allowances related to climate change impact and they should be taken into account in your design.

Flow Reduction:

We agree in principle with your proposal for surface water reduction as it is in line with MCC SFRA. Please note that we prefer that current flows are assessed based on the capacity of the existing system rather than approximation using rational method to assess flows.

If you need further clarifications, please let us know.

Regards

Zorica Todorovic

Flood Risk Management
The Neighbourhoods Service
Growth and Neighbourhoods
Manchester City Council

Tel: 0161 219 6295
Email: floodriskmanagement@manchester.gov.uk
Web: <http://www.manchester.gov.uk/>

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

Chloé Grimsley <Chloe.Grimley@curtins.com>

21/12/2016 15:23

To: "floodriskmanagement@manchester.gov.uk"
<floodriskmanagement@manchester.gov.uk>

cc

Subject: Arundel Street, Manchester

Good Afternoon Sir/Madam,

We are currently preparing a Detailed Drainage Strategy to support a Full Planning Application for the refurbishment of the existing building (DOT) adjacent to Ellesmere Street for 12 apartments and construction of a new building providing 150 apartments. I have attached a site location plan for information.

The site has previously been developed and appears to be covered by approximately 0.33 ha of impermeable finish. A drainage survey is not currently available however we assume that the existing site discharges to the existing combined public sewer in Arundel Street or to the existing ϕ 225mm surface water sewer to the east which crosses below the Mancunian way.

We would propose to discharge into the existing 225mm Surface Water public sewer and we have issued a pre-development enquiry to United Utilities to confirm this is acceptable.

Based on the Manchester SFRA recommendations for brownfield development in a Critical Drainage area; proposed flow rates should be restricted by 50% of existing flow rates as a minimum. We would therefore propose this as the strategy and the flow rates will be confirmed once the existing drainage is confirmed, however we have run a quick estimated model and the existing drainage is likely to be in the region of:

1 Year = 38.2 l/s
30 Year = 84.2 l/s
100 Year = 104.3 l/s

Therefore the proposed would be restricted to allow a maximum of:

1 Year = 19.1 l/s
30 Year = 42.1 l/s
100 Year = 52.1 l/s

We have the Manchester CC SuDS Guidance, however please confirm if there are any other documents we should refer to?

Please could you also confirm if you have any drainage records for the area and whether there have been any historic flood events at the site?

Please could you provide any information which would be useful to include within the assessment or any advice on the above.

If you require any further information, please let me know.

Kind Regards,
Chloé

Chloé Grimsley
Senior Engineer
T. 0161 236 2394
chloe.grimsley@curtins.com



Merchant Exchange
17-19 Whitworth Street West
Manchester M1 5WG



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Please contact internet.administrators@manchester.gov.uk with any queries.

Chloé Grimsley

From: O'Brien, Neil <Neil.O'Brien@uuplc.co.uk>
Sent: 05 January 2017 14:29
To: Chloé Grimsley
Cc: Wastewater Developer Services; Heaton, Daniel
Subject: REPEAT: Land at Arundel Street, Manchester -DE2993

Follow Up Flag: Follow up
Flag Status: Flagged

Dear Customer

Thank you for your email of 28/12/16 in relation to my initial Pre Development Enquiry response.

There are two ways forward with this connection. The highway drain can be put forward for adoption under S102. However, UU will only adopt it if it is in perfect condition, thus a CCTV survey would be required. Alternatively, you can put the lateral drain (from the site boundary to the highway drain) forward for adoption under S104 and make a connection to the highway drain under S115 of the Water industry Act.

Please note, should you intend to enter into an adoption agreement with UU and although your proposal may comply with the principal strategy set out in the advice above, we do reserve the right to request changes to any future design proposals put forward for adoption, as we need to be sure that the proposals meet the requirements of Sewers for Adoption and UU Asset Standards. Any design proposals should take in to consideration long term operability whilst also offering cost effectiveness for the life of the assets. Where a developer would like to progress a Section 104 Agreement, it must be emphasised that any works commenced on site on the basis of the Pre-Development Enquiry Advice without an approved S104 technical assessment will be at the Designers/ Developers own risk and may be subject to change.

Regards,

Developer Services

From: Chloé Grimsley [mailto:Chloe.Grimmsley@curtins.com]
Sent: 05 January 2017 10:15
To: O'Brien, Neil <Neil.O'Brien@uuplc.co.uk>
Subject: RE: Land at Arundel Street, Manchester -DE2993

Good Morning Neil,

As the drainage hierarchy will encourage use of the surface water drain, it is likely that Manchester City Council LLFA will insist on connection to the existing 'HS' 225mm surface water sewer to the east which is recorded as a Highway Drain and crosses below the Mancunian way in favour of the combined sewer. This would designate the sewer as public and therefore would require your approval. Please confirm what UU would require to allow this to be changed from a highway drain to a public sewer.

We will also liaise with Highways to confirm they would allow designation on the highway drain to public sewer.

Kind Regards,
Chloé
Chloé Grimsley Senior Engineer
Curtins

From: O'Brien, Neil [<mailto:Neil.O'Brien@uuplc.co.uk>]
Sent: 28 December 2016 15:14
To: Chloé Grimsley <Chloe.Grimmsley@curtins.com>
Cc: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: RE: Land at Arundel Street, Manchester -DE2993

Dear Customer

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

Foul will be allowed to drain to the public combined sewer network at an unrestricted rate. The connection(s) to the public sewer can be at a point(s) convenient to yourself

Surface water will be allowed to drain to the public sewer network at an unrestricted rate. The connection(s) to the public sewer can be at a point(s) convenient to yourself

United Utilities have no records of hydraulic sewer flooding in the area

Connection Application

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

<http://www.unitedutilities.com/connecting-public-sewer.aspx>

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

Regards

Neil O'Brien

Developer Engineer
Developer Services and Planning

From: Chloé Grimsley [<mailto:Chloe.Grimmsley@curtins.com>]
Sent: 15 December 2016 12:51
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: Land at Arundel Street, Manchester

Good Morning Sir/Madam,

Please find attached the pre-development enquiry form for the above site. I have attached a site location plan for information.

The proposal is for refurbishment of the existing building (DOT) adjacent to Ellesmere Street for 12 apartments and construction of a new building providing 150 apartments.

The site has previously been developed and appears to be covered by approximately 0.33 ha of impermeable finish. A drainage survey is not currently available however we assume that the existing site discharges to the existing combined public sewer in Arundel Street or to the existing 'HS' 225mm surface water sewer to the east which crosses below the Mancunian way.

It is proposed that existing connections off site are reused where suitable, however where surface water connects to the combined sewer we would propose a new connection into the existing 'HS' 225mm surface water sewer at a restricted rate.

Based on the Manchester SFRA recommendations for brownfield development in a Critical Drainage area; proposed flow rates should be restricted by 50% of existing flow rates as a minimum. We would therefore propose this as the strategy and the flow rates will be confirmed once the existing drainage is confirmed, however we have run a quick estimated model and the existing drainage is likely to be in the region of:

1 Year = 38.2 l/s
30 Year = 84.2 l/s
100 Year = 104.3 l/s

Therefore the proposed would be restricted to allow a maximum of:

1 Year = 19.1 l/s
30 Year = 42.1 l/s
100 Year = 52.1 l/s

The proposed peak foul flows are expected to be approximately 7.5 l/s based on 162 apartments at 4000l/d/d.

Please could you confirm if the above is acceptable and whether any further flow restriction would be imposed on the development.

Please could you also confirm if there have been any historic flood events at the site?

If you require any further information, please let me know.

Kind Regards,
Chloé

Chloé Grimsley
Senior Engineer
T. 0161 236 2394
chloe.grimsley@curtins.com

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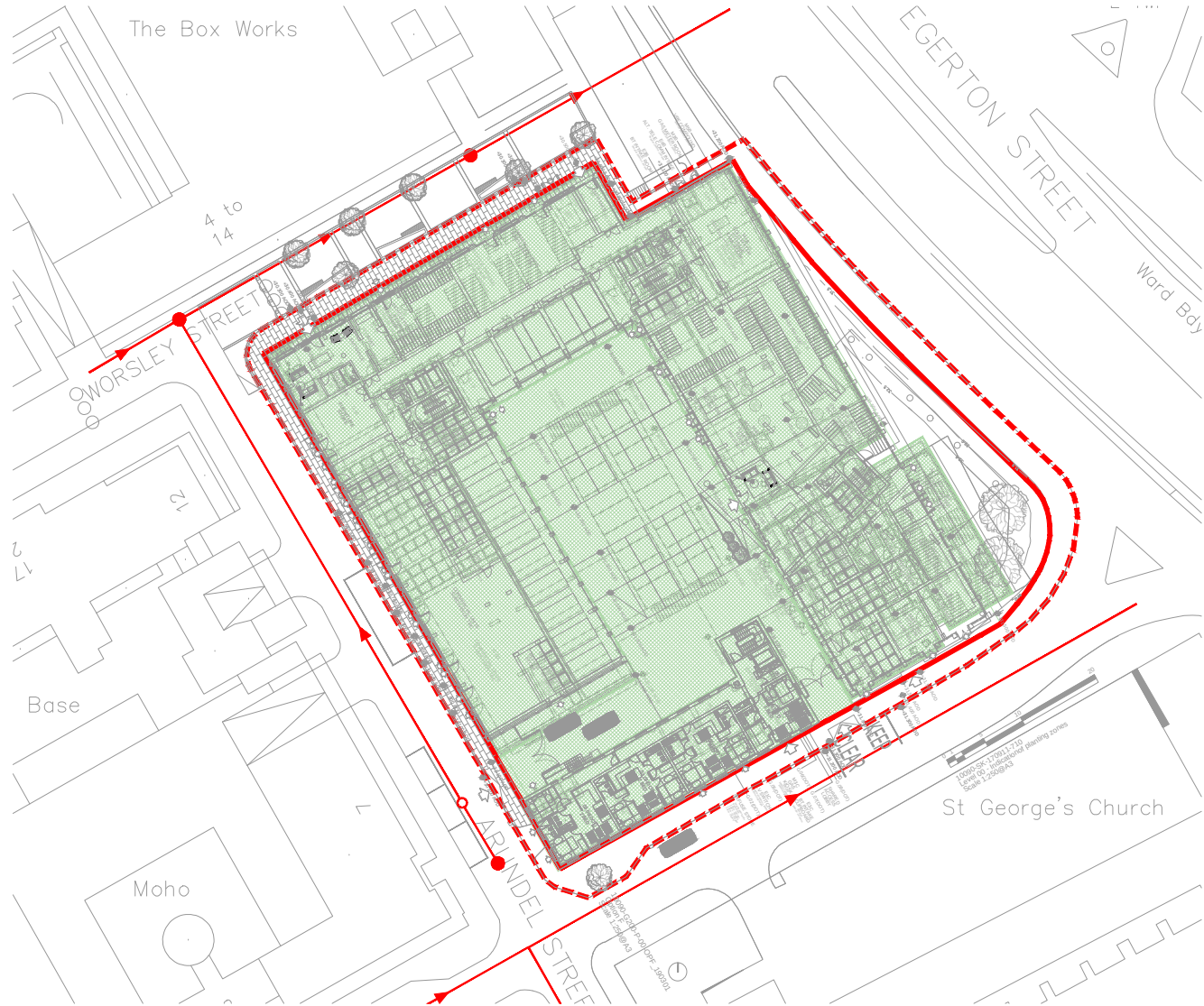
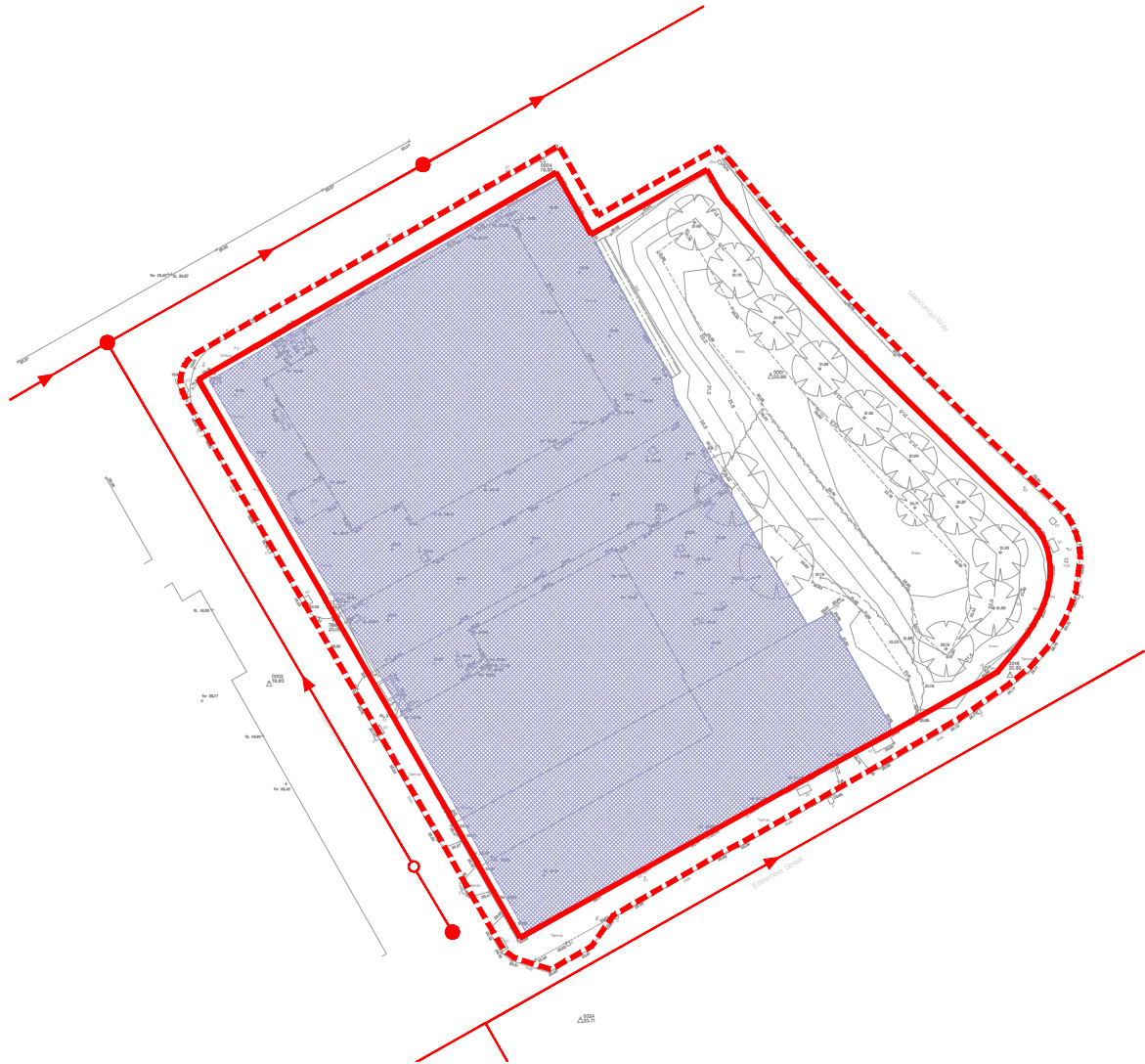
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Appendix D

Existing and Proposed Impermeable Areas

Existing (Assumed) Calculations: - 1, 30 and 100 Year Events

Existing 100 Year 6 Hour Event Volumes



THE TOPOGRAPHICAL SURVEY IS TO A TEMPORARY BENCHMARK, WHICH WHEN COMPARED TO ORDNANCE LEVELS DEVIATE BY 10-11M. IT IS RECOMMENDED THAT LEVELS ARE CONFIRMED IN RELATION TO ORDNANCE DATUM.

NOTES

OUTFALL NOTES

AREA E1

THE EXISTING AREA E1 IS APPROXIMATELY 3040m²

THE EXISTING SITE IMPERMEABLE AREA IS APPROXIMATELY 0.304 HA AND THE EXISTING FLOW RATES FOR THE TOTAL SITE HAVE BEEN CALCULATED BASED ON AN ASSUMED MODEL OF THE EXISTING NETWORK.

THE FLOW RATES FOR THE TOTAL SITE ARE APPROXIMATELY:

- 30.5 l/s FOR THE 1 IN 1 YEAR EVENT
- 73.4 l/s FOR THE 1 IN 30 YEAR EVENT
- 90.4 l/s FOR THE 1 IN 100 YEAR EVENT

THE EXISTING VOLUMES FROM SITE IN THE 100 YEAR 6 HOUR EVENT IS 150.926m³

REFERENCE SHOULD BE MADE TO THE EXISTING DRAINAGE MODEL CALCULATIONS

OUTFALL NOTES

AREA P1

THE PROPOSED AREA P1 IS APPROXIMATELY 4033m²

THE PROPOSED SITE IMPERMEABLE AREA IS APPROXIMATELY 0.355 HA AND THE PROPOSED FLOW RATES FOR THE TOTAL SITE SHOULD BE RESTRICTED TO THE MAXIMUM FLOWS AS FOLLOWS:

- 15.25 l/s FOR THE 1 IN 1 YEAR EVENT
- 36.7 l/s FOR THE 1 IN 30 YEAR EVENT
- 45.2 l/s FOR THE 1 IN 100 YEAR +40% CC EVENT

THE CURRENT SYSTEM IS BASED ON A 1 YEAR RESTRICTION TO 15.2 l/s

THEREFORE THERE IS SCOPE TO PROVIDE A COMPLEX CONTROL TO ALLOW ADDITIONAL FLOWS FROM THE 30 YEAR AND 100 YEAR EVENTS.

THE PROPOSED VOLUMES FROM SITE IN THE 100 YEAR 6 HOUR EVENT IS 173.979m³. THIS EXCEEDS THE EXISTING 100 YEAR EVENT, HOWEVER FLOWS ARE RESTRICTED TO 1 YEAR FLOWS. ANY INCREASE IN FLOWS FOR THE 30 YEAR AND 100 YEAR MUST ENSURE VOLUMES DO NOT EXCEED EXISTING.

REFERENCE SHOULD BE MADE TO THE PROPOSED DRAINAGE MODEL CALCULATIONS

D	Updated Layout	15.03.19	OJT	CG
C	Updated to suit revised proposals	25.10.17	TM	CG
B	Updated to suit revised proposals	27.09.17	TG	CG
A	Updated to suit revised proposals	31.07.17	CG	CG
Rev:	Description:	Date:	By:	Chkd:



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Status:

PRELIMINARY

Project:

ARUNDEL STREET
MANCHESTER

Dwg Title:

EXISTING AND PROPOSED
IMPERMEABLE AREAS

Scale:	Size:	First Issue:	Drawn:	Checked:
1:500	A1	02.03.17	ZG	CG

Dwg No:	Rev:
063365-502	D

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Curtins Consulting		Page 1
Merchant Exchange 17-19 Whitworth Street West Manchester M1 5WG	Arundel Street Manchester Assumed Existing	
Date February 2017 File Assumed SW For flows on...	Designed by CG Checked by	
Micro Drainage	Network 2014.1.1	

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)
1.000	o	225	1	21.000	20.000	0.775	Open Manhole	1200
2.000	o	225	2	21.000	20.000	0.775	Open Manhole	1200
2.001	o	225	3	21.000	19.700	1.075	Open Manhole	1200
1.001	o	225	4	21.000	19.650	1.125	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)
1.000	50.000	142.9	4	21.000	19.650	1.125	Open Manhole	1200
2.000	50.000	166.7	3	21.000	19.700	1.075	Open Manhole	1200
2.001	10.000	200.0	4	21.000	19.650	1.125	Open Manhole	1200
1.001	10.000	200.0		31.000	19.600	11.175	Open Manhole	0

**360 minute 100 year Winter I+0%
Average Rainfall Intensity 9.847 mm/hr**

Storm Selector

360 minute 100 year Winter I+0%

Time (mins)	US Level (m)	DS Level (m)	Surcharged Depth (m)	Pipe Velocity (m/s)	Pipe Flow (l/s)
6	19.665	19.623	-0.210	0.2	0.2
12	19.679	19.623	-0.196	0.4	0.8
18	19.688	19.623	-0.187	0.4	1.7
24	19.694	19.623	-0.181	0.5	2.4
30	19.696	19.623	-0.179	0.5	2.8
36	19.697	19.623	-0.178	0.5	2.9
42	19.698	19.623	-0.177	0.5	3.1
48	19.698	19.623	-0.177	0.5	3.1
54	19.698	19.623	-0.177	0.5	3.1
60	19.698	19.623	-0.177	0.5	3.1
66	19.698	19.623	-0.177	0.5	3.1
72	19.699	19.623	-0.176	0.5	3.2
78	19.700	19.623	-0.175	0.5	3.3
84	19.701	19.623	-0.174	0.5	3.6
90	19.705	19.623	-0.170	0.5	4.0
96	19.707	19.623	-0.168	0.6	4.3
102	19.712	19.623	-0.163	0.6	5.0
108	19.716	19.623	-0.159	0.6	5.5
114	19.722	19.623	-0.153	0.6	6.5
120	19.726	19.623	-0.149	0.6	7.2
126	19.732	19.623	-0.143	0.7	8.4
132	19.737	19.623	-0.138	0.7	9.2
138	19.743	19.623	-0.132	0.7	10.7
144	19.747	19.623	-0.128	0.7	11.4
150	19.754	19.623	-0.121	0.7	12.9
156	19.758	19.623	-0.117	0.7	13.8
162	19.763	19.623	-0.112	0.8	15.0
168	19.766	19.623	-0.109	0.8	15.7
174	19.770	19.623	-0.105	0.8	16.8
180	19.772	19.623	-0.103	0.8	17.2
186	19.773	19.623	-0.102	0.8	17.6
192	19.771	19.623	-0.104	0.8	17.4
198	19.767	19.623	-0.108	0.8	16.6
204	19.764	19.623	-0.111	0.8	16.1
210	19.759	19.623	-0.116	0.8	14.8
216	19.755	19.623	-0.120	0.8	14.1
222	19.748	19.623	-0.127	0.7	12.6

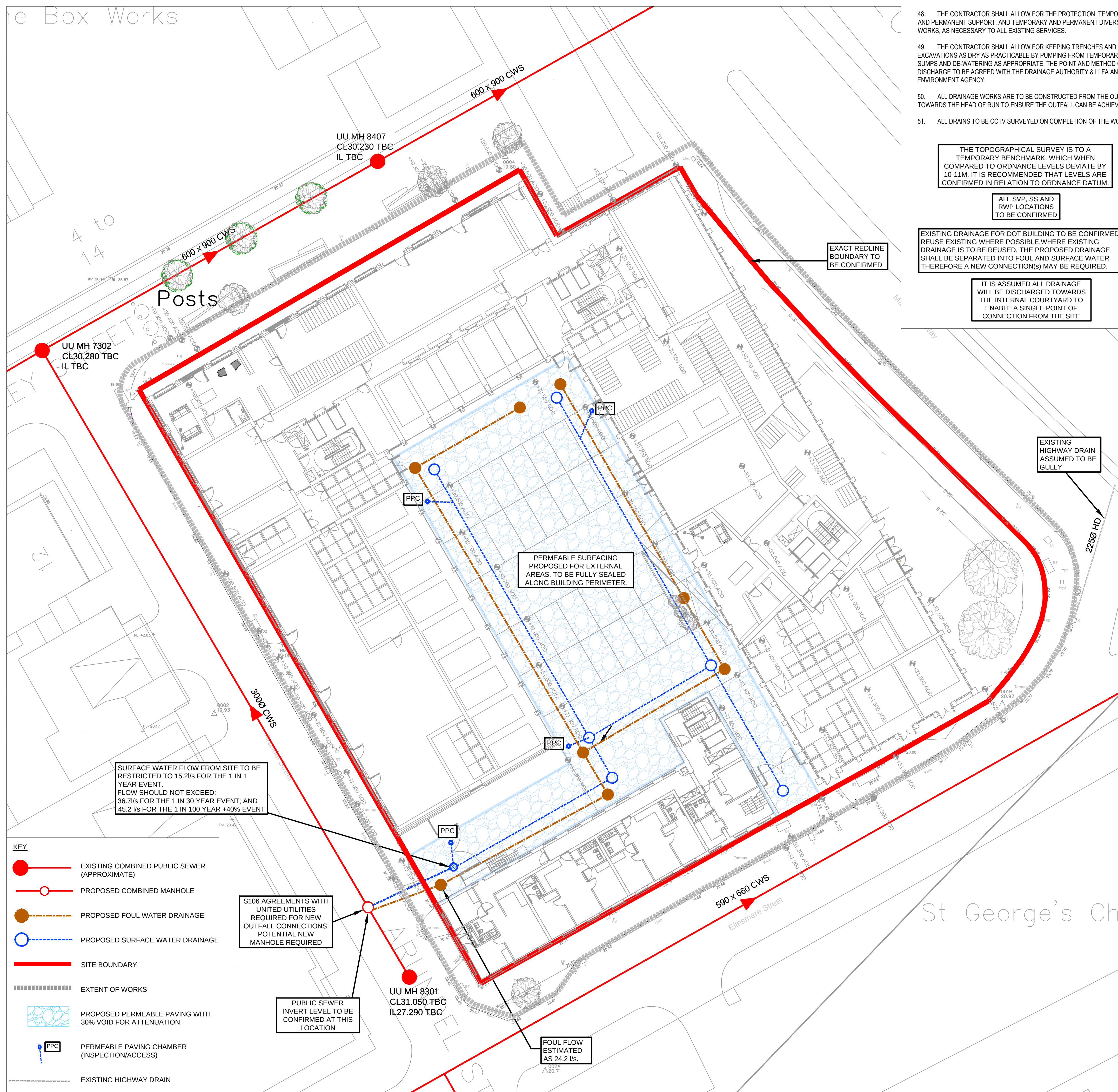
Total Volumes: Over Overflow (Spill Flow) 0.000m³ Pipe 150.926m³

Appendix E

Proposed Drainage Strategy

Proposed Calculations: - 1 Year, 30 Year, 100 Year +40%cc Events

Proposed 100 Year 6 Hour Event Volumes



- THE CONTRACTOR SHALL ALLOW FOR KEEPING TRENCHES AND EXCAVATIONS AS DRY AS PRACTICABLE BY PUMPING FROM TEMPORARY SUMPS AND DE-WATERING AS APPROPRIATE. THE POINT AND METHOD OF DISCHARGE TO BE AGREED WITH THE DRAINAGE AUTHORITY & LLFA AND ENVIRONMENT AGENCY.

ALL DRAINAGE WORKS ARE TO BE CONSTRUCTED FROM THE OUTFALL TOWARDS THE HEAD OF RUN TO ENSURE THE OUTFALL CAN BE ACHIEVED.

ALL DRAINS TO BE CCTV SURVEYED ON COMPLETION OF THE WORKS.

THE TOPOGRAPHICAL SURVEY IS TO A TEMPORARY BENCHMARK, WHICH WHEN COMPARED TO ORDNANCE LEVELS DEVIATE BY 10-11M. IT IS RECOMMENDED THAT LEVELS ARE CONFIRMED IN RELATION TO ORDNANCE DATUM.

ALL SVP, SS AND RWP LOCATIONS TO BE CONFIRMED

EXISTING DRAINAGE FOR DOT BUILDING TO BE CONFIRMED. REUSE EXISTING WHERE POSSIBLE. WHERE EXISTING DRAINAGE IS TO BE REUSED, THE PROPOSED DRAINAGE SHALL BE SEPARATED INTO FOUL AND SURFACE WATER THEREFORE A NEW CONNECTION(S) MAY BE REQUIRED.

IT IS ASSUMED ALL DRAINAGE WILL BE DISCHARGED TOWARDS THE INTERNAL COURTYARD TO ENABLE A SINGLE POINT OF CONNECTION FROM THE SITE

EXISTING HIGHWAY DRAIN ASSUMED TO BE GULLY

2250 HD

St George's Church

 - BACKFILL TO DRAINAGE TRENCHES UNDER HORIZONTAL AREAS TO BE TYPE 1 SUB BASE MATERIAL, ELSEWHERE BACKFILL TO BE FREE DRAINING READILY COMPATIBLE MATERIAL FREE FROM RUBBISH AND ORGANIC MATTER, FROZEN SOIL, CLAY LUMPS AND LARGE STONES. TO BE COMPACTED IN LAYERS NOT EXCEEDING 150mm THICK.
 - BEDDING AND BACKFILL MATERIALS TO CONFORM TO THE REQUIREMENTS OF WIS 4-08-02 (TABLE A2).
 - WHERE FOUL SEWERS RUN ABOVE SURFACE SEWERS, CONCRETE PROTECTION MAY BE REQUIRED AT CROSSOVERS TO PREVENT ANY POTENTIAL CONTAMINATION.
 - THE FIRST PIPE OUT OF MANHOLES TO BE AS SHORT AS PRACTICABLE SO AS TO PROVIDE A FLEXIBLE JOINT AS CLOSE AS POSSIBLE TO THE OUTSIDE FACE OF THE CONCRETE SURROUND AND CONNECTED TO A LENGTH OF ROCKER PIPE.
 - ALL CONNECTIONS PASSING THROUGH BASES OR EDGE BEAMS TO BE IN SEALED SLEEVES. ALTERNATIVELY CONNECTIONS MAY BE CAST-IN WITH FLEXIBLE JOINTS NOT GREATER THAN 150MM FROM FACE OF CONCRETE.
 - WHERE DRAINAGE PIPES ARE LESS THAN 300mm BELOW THE UNDERSIDE OF THE GROUND FLOOR SLAB, CONCRETE ENCASEMENT IS REQUIRED (CLASS 2). COMPRESSIBLE JOINTS ARE TO BE PROVIDED AT EVERY PIPE JOINT WITHIN THE CONCRETE.
 - WHERE PIPES ARE MORE THAN 300mm BELOW THE UNDERSIDE OF THE SLAB, CLASS 8 BEDDING IS ACCEPTABLE.
 - SEWER PIPES TO BE LAID IN MAXIMUM 3 METRE LENGTHS UNLESS THERE IS A SPECIFIC OPERATIONAL NEED TO LAY LONGER LENGTHS.
 - PLASTIC CHANNEL SECTIONS WILL NOT BE PERMITTED WITHIN MANHOLE CHAMBERS. CLAYWARE CHANNELS SHALL BE USED WITHIN MANHOLES FOR PIPE SIZES UP TO AND INCLUDING 300mm DIAMETER.
 - ALL NEW CONNECTIONS INTO EXISTING MANHOLES (OR INTO EXISTING SEWERS) TO BE 'SOFFITS LEVEL' UNLESS OTHERWISE NOTED.
 - SULPHATE RESISTANT CEMENT (C20-DC2) AND PRECAST CONCRETE PRODUCTS MUST BE USED OR A LABORATORY REPORT PROVIDED TO PROVE THAT SUCH PRECAUTIONS ARE NOT REQUIRED.
 - SEWERS MUST HAVE 5m CLEARANCE FROM TREES AND HEDGES OR TO HAVE SUITABLE ROOT PROTECTION IN ACCORDANCE WITH SFA REQUIREMENTS.
 - THE CHAMBER SIZE OF MANHOLES WITH MORE THAN ONE CONNECTION IN THEM MAY NEED TO BE INCREASED TO ACCOMMODATE THE CONNECTIONS AND BENDS.
 - ALL INTERNAL DRAINAGE CONNECTIONS ARE PROVIDED TO THE PENETRATION POSITIONS SHOWN ON ARCHITECT AND M&E DRAWINGS. REFER TO DIMENSIONED LOCATIONS ON ARCHITECT'S GROUND FLOOR SETTING-OUT PLANS.
 - RAINWATER AND FOUL WATER POP UP LOCATIONS AND SIZES TO BE CONFIRMED BY ARCHITECT AND M&E ENGINEER.
 - ALL UNDERGROUND FOUL DRAINAGE SHOULD BE SUITABLY VENTED AT OR NEAR TO THE HEAD OF RUNS.
 - ALL ACCESS FITTINGS, STACKS, RWPS AND GULLIES TO BE RODDABLE. ALL TO HAVE LOW LEVEL RODDING ACCESS PLATES UNLESS AN ALTERNATIVE MEANS OF ACCESS IS AGREED. ACCESS POINT TO BE ABOVE ANY GROUND FLOOR CONNECTED APPLIANCE SPILL LEVEL.
 - LARGE ACCESS FITTING REQUIRED ABOVE GROUND WHERE GREATER THAN 12M UP TO 22M TO A JUNCTION. SMALL ACCESS FITTING REQUIRED UP TO 12M TO A JUNCTION.
 - ALL GULLY AND CHANNEL DRAIN OUTLETS AND TERMINATION POINTS TO BE TRAPPED AND RODDABLE. INTERNAL GULLIES AND CHANNEL DRAINS TO BE SPECIFIED BY OTHERS.
 - ALL BRANCH CONNECTIONS TO BE MADE WITH SWEEPED BENDS IN THE DIRECTION OF FLOW IN THE MAIN SEWER.
 - WHERE NO WCS ARE CONNECTED UPSTREAM, UNDERSLAB FW DRAINAGE TO BE LAID AT 1:40 MIN. AFTER THE CONNECTION OF AT LEAST 1NO WC, A MIN. FALL OF 1:80 APPLIES.
 - ALL INTERNAL COVERS TO HAVE MECHANICALLY JOINTED CORNERS AND DOUBLE SEALED WITH RECESSED TRAY TO ALLOW FOR FINISHES.
 - ALL MANHOLE COVERS IN BLOCK/SLAB AND EXTERNAL PAVING AREAS TO HAVE RECESSED COVERS OF THE APPROPRIATE GRADE TO ACCEPT ARCHITECT'S PAVING PROPOSAL.
 - UNLESS NOTED OTHERWISE IN THE MANHOLE SCHEDULE, ALL MANHOLE, GULLY AND CHANNEL COVERS (IRONWORK) SHOULD BE THE FOLLOWING SPECIFICATION:
 - B125 LOAD CLASS IN PEDESTRIAN AREAS
 - D400 LOAD CLASS IN VEHICULAR AREAS.
 - COVER LEVELS, GULLY POSITIONS, AND BUILDING LOCATION ARE APPROXIMATE AND SHALL BE CONFIRMED BY ARCHITECT/LANDSCAPE ARCHITECT. CONTRACTOR TO ALLOW FOR ADJUSTMENT TO SUIT AGREED POSITIONS AND FINISHED LEVELS, AND CONFIRM ALL COVER LEVELS ON SITE.
 - OUTFALL CONNECTION(S) SUBJECT TO AGREEMENT WITH THE APPROVING AUTHORITY.
 - THE CONTRACTOR SHALL COMPLY WITH THE FOLLOWING:-
 - ALL OPERATIONS SHOULD BE CARRIED OUT IN ACCORDANCE WITH THE GENERAL HEALTH AND SAFETY POLICY OF THE DEVELOPER AS REQUIRED BY SECTIONS 2 OF THE HEALTH AND SAFETY AT WORK ACT 1974 AND IN PARTICULAR THE CONSTRUCTION (GENERAL PROVISIONS) REGULATIONS.
 - THE LOCAL AUTHORITY AND UTILITIES COMPANIES ARE TO BE NOTIFIED PRIOR TO COMMENCEMENT OF WORK ON SITE.
 - PRIOR TO CONSTRUCTION THE ACTUAL POSITIONS AND DEPTHS OF SERVICES LIKELY TO BE AFFECTED BY THE WORKS SHOULD BE ESTABLISHED BY MEANS OF HAND DIG IN CLOSE LIAISON WITH THE UTILITIES COMPANIES. THE CONTRACTOR SHALL IMMEDIATELY ADVISE THE ENGINEER OF ANY SERVICES EXPOSED WHICH MAY AFFECT THE DESIGN.
 - ALL OPERATIVES WORKING ON THE HIGHWAY WORKS MUST HAVE STREET WORKS ACCREDITATION.
 - THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING THAT PIPES ARE ADEQUATELY PROTECTED FROM CONCENTRATED LOADING BY CONSTRUCTION TRAFFIC DURING THE CONSTRUCTION PERIOD.

GENERAL NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.
2. DO NOT SCALE THIS DRAWING. ANY AMBIGUITIES, OMISSIONS AND ERRORS ON DRAWINGS SHALL BE BROUGHT TO THE ENGINEERS ATTENTION IMMEDIATELY. ALL DIMENSIONS MUST BE CHECKED / VERIFIED ON SITE.
3. ALL DRAINAGE WORKS TO BE IN ACCORDANCE WITH THE CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY (CESWI) AS INCLUDED IN SEWERS FOR ADOPTION 7TH EDITION, THE REQUIREMENTS OF APPROVED DOCUMENT H (2002 EDITION) AND BUILDING REGULATIONS 2000.
4. DO NOT SCALE THIS DRAWING. ALL DETAILS AND DIMENSIONS ARE TO BE CHECKED BY THE CONTRACTOR. ANY DISCREPANCIES TO BE REPORTED TO THE ENGINEER.
5. ALL DIMENSIONS ARE IN METRES AND LEVELS IN METRES ABOVE ORDNANCE DATUM UNLESS OTHERWISE NOTED.
6. THE CONTRACTOR MAY WISH TO SURVEY ALL EXISTING DRAINAGE PRIOR TO COMMENCEMENT TO CONFIRM LOCATION AND CONDITION OF EXISTING DRAINAGE. POTENTIAL PRE-CLEANING TO BE UNDERTAKEN IN ORDER TO FACILITATE SURVEY IF REQUIRED.
7. EXISTING SEWER LOCATIONS WHERE THE PROPOSED DRAINAGE IS TO CONNECT, ARE TO BE SURVEYED AND EXACT LEVELS CONFIRMED AND PROVIDED TO ENGINEER PRIOR TO COMMENCEMENT OF WORKS.
8. ALL EXISTING SERVICES TO BE LOCATED PRIOR TO COMMENCEMENT OF ANY DRAINAGE WORKS, AND WHERE NECESSARY PROTECTION OR DIVERSIONS TO BE UNDERTAKEN TO AVOID CONFLICT WITH THE PROPOSED WORK.
9. ALL EXISTING DRAINS TO BE ABANDONED SHALL BE EITHER GRUBBED OR GROUTED UP. GROUTING TO BE PERFORMED BY CAPPING ALL ENDS / CONNECTIONS AND FILLING THE RETAINING VOID WITH GROUT, IN ACCORDANCE WITH CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY 7th EDITION (CESWI) 7TH EDITION.
10. ALL SOFT SPOTS TO BE REMOVED FROM BOTTOM OF EXCAVATIONS AND TO BE REFILLED TO FORMATION LEVEL WITH THE SAME MATERIAL AS PERMANENT WORKS WHICH REST IN IT.
11. FILLED GROUND MUST BE FILLED AND CONSOLIDATED BEFORE ANY SEWER WORKS ARE CARRIED OUT.
12. ALL ADAPTABLE DRAINAGE WORKS INCLUDING WORKS TO EXISTING PUBLIC SEWERS TO BE UNDERTAKEN IN ACCORDANCE WITH "SEWERS FOR ADOPTION 7th EDITION" AND "CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY 7th EDITION" AND CONSTRUCTED TO THE RELEVANT STATUTORY UNDERTAKERS DETAILS.
13. ALL PRIVATE DRAINAGE WORKS TO BE IN ACCORDANCE WITH "CIVIL ENGINEERING SPECIFICATION FOR THE WATER INDUSTRY 7th EDITION", BS EN 752 2008 DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS" AND THE BUILDING REGULATIONS APPROVED DOCUMENT H.
14. ALL SEWERS, UNLESS AGREED OTHERWISE STATED, SHALL BE:
 - 150mm DIA TO BE VITRIFIED CLAY.
 - 225mm DIA TO BE VITRIFIED CLAY.
 - 300mm DIA TO BE VITRIFIED CLAY.
 - 375mm DIA AND GREATER TO BE CLASS 120 CONCRETE PIPES.
15. ALL PIPE DIAMETERS GIVEN ARE NOMINAL INTERNAL PIPE DIAMETERS.
16. PIPE MATERIALS IN ACCORDANCE WITH THE FOLLOWING:
 - ALL VITRIFIED CLAY PIPES TO BS EN 295-1.
 - ALL CONCRETE PIPES TO BE TO BS EN 1916.
 - ALL CONCRETE MANHOLES TO BE TO BS EN1917.
17. AS AN ALTERNATIVE THE CONTRACTOR MAY USE AN APPROVED UNPLASTICISED POLYVINYL CHLORIDE (PVCU).
18. ALL ADAPTABLE DRAINAGE PIPES WILL REQUIRE A MINIMUM OF 1200mm COVER, IN ACCORDANCE WITH SEWERAGE UNDERTAKERS REQUIREMENTS.
19. ALL PRIVATE DRAINAGE PIPES WITH A COVER OF LESS THAN 600mm IN NON-TRAFFICKED AREAS AND LESS THAN 900mm IN TRAFFICKED AREAS TO BE BEDDED AND SURROUNDED IN CONCRETE (CLASS 2). COMPRESSIBLE MATERIAL SHALL BE PROVIDED AT EVERY PIPE JOINT. WHERE COVER EXCEEDS THIS DEPTH, PIPES ARE TYPICALLY BEDDED AND SURROUNDED IN CLASS 5. REFER TO PIPE EMBEDMENT DETAILS DRAWING FOR SPECIFIC TYPES.

P01	UPDATED PROPOSALS FOR PLANNING	15.03.19	OJT	CG
Rev:	Description:	Date:	By:	Chkd:



Status

PRELIMINARY

Project

ARUNDEL STREET

Drug Tit

PROPOSED DRAINAGE LAYOUT

Size:		Date:		Drawn By:		Designed By:		Checked By:	
A1		07/03/17		OJT		CG		CG	
Scale: 1:200									
Project No:		Originator:		Zone:		Level:		Type:	
						Discipline:		Category / Number:	
								Rev:	

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XP Solutions	Network 2016.1													
<u>Time Area Diagram for Storm</u> <table><tr><td>Time</td><td>Area</td><td>Time</td><td>Area</td></tr><tr><td>(mins)</td><td>(ha)</td><td>(mins)</td><td>(ha)</td></tr><tr><td>0-4</td><td>0.301</td><td>4-8</td><td>0.055</td></tr></table> Total Area Contributing (ha) = 0.356 Total Pipe Volume (m³) = 2.452			Time	Area	Time	Area	(mins)	(ha)	(mins)	(ha)	0-4	0.301	4-8	0.055
Time	Area	Time	Area											
(mins)	(ha)	(mins)	(ha)											
0-4	0.301	4-8	0.055											
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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)
1.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
1.001	o	225	1	20.000	19.450	0.325	Open Manhole	1500
2.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
2.001	o	225	3	20.000	19.450	0.325	Open Manhole	1500
1.002	o	225	2	20.000	19.150	0.625	Open Manhole	1500
3.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
1.003	o	225	3	20.000	19.025	0.750	Open Manhole	1500

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)
1.000	5.000	100.0	1	20.000	19.450	0.400	Open Manhole	1500
1.001	30.000	100.0	2	20.000	19.150	0.625	Open Manhole	1500
2.000	5.000	100.0	3	20.000	19.450	0.400	Open Manhole	1500
2.001	10.000	33.3	2	20.000	19.150	0.625	Open Manhole	1500
1.002	5.000	100.0	3	20.000	19.100	0.675	Open Manhole	1500
3.000	5.000	12.5	3	20.000	19.100	0.750	Open Manhole	1500
1.003	10.000	153.8		20.000	18.960	0.815	Open Manhole	1500

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.003		20.000	18.960	0.000	1500	0

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 3, DS/PN: 1.003, Volume (m³): 1.9

Unit Reference	MD-SHE-0182-1530-0520-1530
Design Head (m)	0.520
Design Flow (l/s)	15.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	182
Invert Level (m)	19.025
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.520	15.3
Flush-Flo™	0.263	15.3
Kick-Flo®	0.428	14.0
Mean Flow over Head Range	-	11.8

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	6.4	1.200	22.8	3.000	35.4	7.000	53.2
0.200	15.0	1.400	24.5	3.500	38.1	7.500	55.1
0.300	15.2	1.600	26.1	4.000	40.6	8.000	56.9
0.400	14.4	1.800	27.7	4.500	43.0	8.500	58.7
0.500	15.0	2.000	29.1	5.000	45.3	9.000	60.4
0.600	16.4	2.200	30.5	5.500	47.1	9.500	62.1
0.800	18.8	2.400	31.8	6.000	49.2		
1.000	20.9	2.600	33.0	6.500	51.3		

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Storage Structures for Storm

Porous Car Park Manhole: PP, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	24.0
Max Percolation (l/s)	66.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Simulation Criteria

Number of Input Hydrographs	0	Number of Storage Structures	3
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Rainfall Model	FSR	Ratio R	0.355
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Profile(s)	Summer and Winter
n(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
(s) (years)	1
Change (%)	0

									Water
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Level (m)
1.000	PP	240	Winter	1	+0%				19.517
1.001	1	15	Winter	1	+0%				19.545
2.000	PP	240	Winter	1	+0%				19.517
2.001	3	15	Winter	1	+0%				19.538
1.002	2	15	Winter	1	+0%	1/15	Summer		19.529
3.000	PP	120	Winter	1	+0%				19.509
1.003	3	15	Winter	1	+0%	1/15	Summer		19.519

PN	US/MH Name	Surcharged	Flooded	Flow / Cap.	Overflow (l/s)	Pipe	Status	Level Exceeded
		Depth (m)	Volume (m³)			Flow (l/s)		
1.000	PP	-0.133	0.000	0.03		0.4		OK
1.001	1	-0.130	0.000	0.23		11.2		OK
2.000	PP	-0.133	0.000	0.03		0.4		OK
2.001	3	-0.137	0.000	0.15		11.2		OK
1.002	2	0.154	0.000	0.50		15.9	SURCHARGED	
3.000	PP	-0.141	0.000	0.01		0.5		OK
1.003	3	0.269	0.000	0.43		15.2	SURCHARGED	

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Existing Network Details 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
1.000	5.000	0.050	100.0	0.037	5.00	0.0	0.600	o	150	Pipe/Conduit
1.001	30.000	0.300	100.0	0.111	0.00	0.0	0.600	o	225	Pipe/Conduit
2.000	5.000	0.050	100.0	0.037	5.00	0.0	0.600	o	150	Pipe/Conduit
2.001	10.000	0.300	33.3	0.111	0.00	0.0	0.600	o	225	Pipe/Conduit
1.002	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
3.000	5.000	0.400	12.5	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit
1.003	10.000	0.065	153.8	0.036	0.00	0.0	0.600	o	225	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	19.500	0.037	0.0	1.00	17.8
1.001	19.450	0.148	0.0	1.31	52.0
2.000	19.500	0.037	0.0	1.00	17.8
2.001	19.450	0.148	0.0	2.27	90.4
1.002	19.150	0.296	0.0	1.31	52.0
3.000	19.500	0.024	0.0	2.87	50.6
1.003	19.025	0.356	0.0	1.05	41.8

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 3, DS/PN: 1.003, Volume (m³): 1.9

Unit Reference	MD-SHE-0182-1530-0520-1530
Design Head (m)	0.520
Design Flow (l/s)	15.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	182
Invert Level (m)	19.025
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.520	15.3
Flush-Flo™	0.263	15.3
Kick-Flo®	0.428	14.0
Mean Flow over Head Range	-	11.8

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	6.4	1.200	22.8	3.000	35.4	7.000	53.2
0.200	15.0	1.400	24.5	3.500	38.1	7.500	55.1
0.300	15.2	1.600	26.1	4.000	40.6	8.000	56.9
0.400	14.4	1.800	27.7	4.500	43.0	8.500	58.7
0.500	15.0	2.000	29.1	5.000	45.3	9.000	60.4
0.600	16.4	2.200	30.5	5.500	47.1	9.500	62.1
0.800	18.8	2.400	31.8	6.000	49.2		
1.000	20.9	2.600	33.0	6.500	51.3		

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Storage Structures for Storm

Porous Car Park Manhole: PP, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	24.0
Max Percolation (l/s)	66.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

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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 Coefficient 0.800
Manhole Headloss Coeff (Global) 0.500	Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000	

Number of Input Hydrographs 0	Number of Storage Structures 3
Number of Online Controls 1	Number of Time/Area Diagrams 0
Number of Offline Controls 0	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R 0.355
Region England and Wales Cv (Summer)	0.750	
M5-60 (mm)	18.000 Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0	DVD Status OFF
Analysis Timestep	Fine Inertia Status OFF
DTS Status	ON

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) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	PP 60	Winter	30	+0%					19.609
1.001	1 15	Summer	30	+0%	30/15	Summer			19.781
2.000	PP 60	Winter	30	+0%					19.600
2.001	3 15	Summer	30	+0%	30/15	Summer			19.769
1.002	2 15	Winter	30	+0%	30/15	Summer			19.752
3.000	PP 30	Winter	30	+0%					19.592
1.003	3 15	Winter	30	+0%	30/15	Summer			19.734

PN	US/MH Name	Depth (m)	Surcharged Volume (m³)	Flooded Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	PP	-0.041	0.000	0.39		5.5	OK	
1.001	1	0.106	0.000	0.38		18.4	FLOOD RISK	
2.000	PP	-0.050	0.000	0.38		5.3	OK	
2.001	3	0.094	0.000	0.26		19.3	FLOOD RISK	
1.002	2	0.377	0.000	0.73		23.0	FLOOD RISK	
3.000	PP	-0.058	0.000	0.12		4.6	OK	
1.003	3	0.484	0.000	0.51		17.7	FLOOD RISK	

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Existing Network Details 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
1.000	5.000	0.050	100.0	0.037	5.00	0.0	0.600	o	150	Pipe/Conduit
1.001	30.000	0.300	100.0	0.111	0.00	0.0	0.600	o	225	Pipe/Conduit
2.000	5.000	0.050	100.0	0.037	5.00	0.0	0.600	o	150	Pipe/Conduit
2.001	10.000	0.300	33.3	0.111	0.00	0.0	0.600	o	225	Pipe/Conduit
1.002	5.000	0.050	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit
3.000	5.000	0.400	12.5	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit
1.003	10.000	0.065	153.8	0.036	0.00	0.0	0.600	o	225	Pipe/Conduit

Network Results Table

PN	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Vel (m/s)	Cap (l/s)
1.000	19.500	0.037	0.0	1.00	17.8
1.001	19.450	0.148	0.0	1.31	52.0
2.000	19.500	0.037	0.0	1.00	17.8
2.001	19.450	0.148	0.0	2.27	90.4
1.002	19.150	0.296	0.0	1.31	52.0
3.000	19.500	0.024	0.0	2.87	50.6
1.003	19.025	0.356	0.0	1.05	41.8

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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)
1.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
1.001	o	225	1	20.000	19.450	0.325	Open Manhole	1500
2.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
2.001	o	225	3	20.000	19.450	0.325	Open Manhole	1500
1.002	o	225	2	20.000	19.150	0.625	Open Manhole	1500
3.000	o	150	PP	20.000	19.500	0.350	Open Manhole	150
1.003	o	225	3	20.000	19.025	0.750	Open Manhole	1500

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)
1.000	5.000	100.0	1	20.000	19.450	0.400	Open Manhole	1500
1.001	30.000	100.0	2	20.000	19.150	0.625	Open Manhole	1500
2.000	5.000	100.0	3	20.000	19.450	0.400	Open Manhole	1500
2.001	10.000	33.3	2	20.000	19.150	0.625	Open Manhole	1500
1.002	5.000	100.0	3	20.000	19.100	0.675	Open Manhole	1500
3.000	5.000	12.5	3	20.000	19.100	0.750	Open Manhole	1500
1.003	10.000	153.8		20.000	18.960	0.815	Open Manhole	1500

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Online Controls for Storm

Hydro-Brake Optimum® Manhole: 3, DS/PN: 1.003, Volume (m³): 1.9

Unit Reference	MD-SHE-0182-1530-0520-1530
Design Head (m)	0.520
Design Flow (l/s)	15.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	182
Invert Level (m)	19.025
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.520	15.3
Flush-Flo™	0.263	15.3
Kick-Flo®	0.428	14.0
Mean Flow over Head Range	-	11.8

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	6.4	1.200	22.8	3.000	35.4	7.000	53.2
0.200	15.0	1.400	24.5	3.500	38.1	7.500	55.1
0.300	15.2	1.600	26.1	4.000	40.6	8.000	56.9
0.400	14.4	1.800	27.7	4.500	43.0	8.500	58.7
0.500	15.0	2.000	29.1	5.000	45.3	9.000	60.4
0.600	16.4	2.200	30.5	5.500	47.1	9.500	62.1
0.800	18.8	2.400	31.8	6.000	49.2		
1.000	20.9	2.600	33.0	6.500	51.3		

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Storage Structures for Storm

Porous Car Park Manhole: PP, DS/PN: 1.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 2.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	37.0
Max Percolation (l/s)	102.8	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

Porous Car Park Manhole: PP, DS/PN: 3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	24.0
Max Percolation (l/s)	66.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	19.500	Cap Volume Depth (m)	0.300

**360 minute 100 year Winter I+0%
Average Rainfall Intensity 9.971 mm/hr**

Storm Selector

360 minute 100 year Winter I+0%

▼

Time (mins)	US Level (m)	DS Level (m)	Surcharged Depth (m)	Pipe Velocity (m/s)	Pipe Flow (l/s)
6	19.046	18.983	-0.204	0.1	0.1
12	19.064	18.983	-0.186	0.4	0.7
18	19.074	18.983	-0.176	0.5	1.5
24	19.079	18.983	-0.171	0.5	1.9
30	19.083	18.983	-0.167	0.6	2.3
36	19.085	18.983	-0.165	0.6	2.5
42	19.086	18.983	-0.164	0.6	2.6
48	19.086	18.983	-0.164	0.6	2.7
54	19.086	18.983	-0.164	0.6	2.7
60	19.086	18.983	-0.164	0.6	2.7
66	19.087	18.983	-0.163	0.6	2.7
72	19.087	18.983	-0.163	0.6	2.7
78	19.089	18.983	-0.161	0.6	2.8
84	19.091	18.983	-0.159	0.6	3.0
90	19.094	18.983	-0.156	0.6	3.3
96	19.099	18.983	-0.151	0.7	3.6
102	19.110	18.983	-0.140	0.7	4.5
108	19.117	18.983	-0.133	0.7	5.2
114	19.126	18.983	-0.124	0.8	6.0
120	19.134	18.983	-0.116	0.8	7.0
126	19.143	18.983	-0.107	0.8	8.0

Total Volumes: Over Overflow (Spill Flow) 0.000m³ Pipe 173.979m³

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