Preliminary Drainage Strategy Report

Land off Upper Hoyland Road, Barnsley

Eton Construction Ltd

Report prepared by:

Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW
0114 266 9292

May 2016

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Ecus Ltd

Report to: **Eton Construction Ltd**
79a Wellgate
Rotherham
South Yorkshire
S60 2LZ

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Land off Upper Hoyland Road, Barnsley

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Originated By:

A. Lake
Senior Geo-environmental Engineer Date: 10th May 2016

Reviewed By:

I. Griffin
Technical Director
Water Environment Date: 11tn May 2016

Prepared by:
Ecus Ltd.
Brook Holt
3 Blackburn Road
Sheffield
S61 2DW
0114 266 9292

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Contents

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1. Introduction

1.1 Terms of Reference

1.1.1 This Drainage Assessment has been produced on behalf of Eton Construction Ltd in support of a proposed development for land off Upper Hoyland Road, Hoyland, Barnsley, South Yorkshire, hereafter referred to as 'the site'.

1.2 Future Site Use

1.2.1 It is understood that the site is to be developed with 14no. residential dwellings; a proposed site layout plan has been provided (Eton Construction drawing no. EC02-22 Rev. A, dated April 2016). This report is based on this layout; any alterations to these proposals will require revision of this report.

1.3 Objectives of the Preliminary Drainage Strategy Report

1.3.1 The general objectives of this assessment are as follows:

- To identify existing drainage features at and in the vicinity of the site;
- To determine the geological, hydrogeological and hydrological setting of the site;
- To establish potential future drainage options for the site, including any required mitigation measures;
- To present a preferred preliminary drainage strategy for the site.

2. Methodology

2.1 Introduction

2.1.1 This assessment has been undertaken based on a walkover survey of the site and with consideration of available reference materials.

2.2 Sources of Information and Consultation

2.2.1 The sources of information and guidance that have been consulted in producing this Preliminary Drainage Assessment are presented in Table 1, below.

Table 1: Sources of Information and Search Results

Source	Results
Client	Has provided information about the current site and the development proposals.
Site Walkover	Information about the site was gained from visual inspection during a site walkover survey.
Yorkshire Water	A pre-planning enquiry was obtained to determine the presence of public sewers in the area and gain information on any restrictions on drainage from the site.
British Geological Survey (BGS).	BGS 1:50,000 scale Geological Map No. 87, Barnsley (Solid Geology and Superficial Deposits Edition) and the BGS Open Geoscience website were consulted for geological information relating to the site and surrounding area. A BGS infiltration SuDS GeoReport was also obtained for the site.
Ecus Ltd	Further information relating to the site was obtained from a Phase 1 Geo-environmental Site Investigation report prepared by Ecus (ref. RZ/7918/160418/P1).

3. Development Description and Location

3.1 Site Location

3.1.1 The site is approximately 0.6 hectares in area and is situated to the north of Upper Hoyland Road, Hoyland, Barnsley, South Yorkshire. Figure A1, Appendix A shows the location of the site, which centres on National Grid Reference 436080, 401420.

3.1.2 A site walkover was carried out on 4th May 2016. The current layout of the site is shown in Figure A2, Appendix A. Photographs of the site are presented in Appendix B.

3.2 Site Description

3.2.1 The site is a parcel of land which consists of four interconnected fields. The fields are grassed and currently in use as pasture for horses.

3.2.2 Hedgerows are present between the fields, and also on the western and southern site boundaries, and are generally around 1.5m in height and predominantly composed of hawthorn, with some holly and elder. A gateway in the site's southeastern corner provides the main access onto the site.

3.2.3 The northern and eastern boundaries are formed by a wooden post and rail fence, which is around 1.5m high, beyond which are areas of planted trees, with the trees comprising semi-mature willow, hawthorn, cherry, etc.

3.2.4 Soils were generally not visible at the site, however a number of molehills were present on the site which appeared to consist of natural topsoil. A small area near to the main gate was observed to have many fragments of burnt shale at surface. This material appeared to have been imported to provide a hard surface at the site entrance

3.3 Topography

3.3.1 For a detailed appreciation of the site topography, refer to the topographical survey drawing, Eton Construction drawing reference EC02-40 dated December 2015, as included within Figure A3 to this report.

3.3.2 The site lies at an elevation of approximately 145m above Ordnance Datum (AOD) adjacent to its southern boundary, sloping down towards the northwest to an approximate elevation of 139.5m AOD, giving an approximate gradient of 1 in 11 across the site.

3.3.3 The site lies on a northwest facing hillside, meaning that land adjacent to the site to the west and south is at approximately the same elevation as the site. Beyond the site's northern boundary, a steeper embankment is present, which forms a cutting in which the Dearne Valley Parkway is located. Immediately east of the site is an embankment which leads up to a continuation of Upper Hoyland Road, which is approximately 3 to 4m higher than the site and the land on its far side.

3.4 Underground Structures and Services

3.4.1 Information was received from Yorkshire Water which included a plan of mains sewers in the vicinity of the site, see Figure A3 in Appendix A, and Appendix D to this report. This shows that there is a combined foul and surface water sewer which runs past the south and west of the site, with manholes located in Upper Hoyland Road.

3.4.2 During the walkover survey of the site, two of the marked manholes were identified; however, the manhole shown on the plan as being 3.32m deep could not be located.

3.4.3 A manhole was also observed on site, adjacent to the site's western boundary. This did not have cover on it, and was observed to be approximately 0.6m deep, with 225mm diameter vitreous clay pipes entering at the northern and southern sides; no flow was present at the time of the survey. It is assumed that this drain is associated with the highway drainage system, as surface water gullies were also noted within Upper Hoyland Road.

3.5 Geology

3.5.1 The geological map for the area has been studied to infer the likely geology of the site and surrounding area.

3.5.2 The site is shown on the map to be underlain by solid strata of the Carboniferous Middle Coal Measures Formation, which are described as undifferentiated mudstone and siltstone with sandstones, coal seams, seatearth beds and marine bands. An un-named sandstone unit within the Middle Coal Measures may be present in the north-western corner of the site.

3.5.3 No drift deposits or made ground are shown to underlie the site. A large area of made ground is shown c.200m west of the site.

3.5.4 No faults are shown to affect the site.

3.5.5 Records for boreholes in the vicinity of the site are available via the British Geological Survey (BGS) Open Geoscience website[1]. The nearest borehole records to the site, dated 1989 and located approximately 260m northwest of the site show that clay strata, representing highly weathered Coal Measures rocks, are present to depths of around 1.5m below ground level (bgl) underlain by mudstone or siltstone rock.

3.5.6 During the site walkover survey shallow site soils were generally not visible at surface, but appeared to comprise natural topsoil.

3.6 Hydrogeology

3.6.1 A GroundSure EnviroInsight report was obtained as part of the Phase 1 Site Investigation carried out at the site by Ecus; this report included information relating to the hydrogeology of the area.

3.6.2 According to the GroundSure report, the solid strata underlying the site are classified by the Environment Agency (EA) as a Secondary A Aquifer. The EA describe these aquifers as permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

3.6.3 The GroundSure report shows that the site is not located within a Source Protection Zone, set by the Environment Agency for the protection of potable groundwater resources.

3.6.4 The GroundSure report indicates that there are no registered, active groundwater abstractions within 2,000m of the site.

3.6.5 The GroundSure report shows that there are no licensed discharge consents to groundwater within 500m of the site.

3.7 Hydrology

3.7.1 The GroundSure report indicates that the nearest surface water feature located down gradient from the site is a tertiary river named Owlet Dike, located approximately 410m northeast of the site.

[1] BGS, 2016. *Geology of Britain Viewer.* Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html Accessed 25th April 2016.

3.7.2 The GroundSure report indicates that there are no licensed surface water abstractions within 2,000m of the site.

3.7.3 The GroundSure report states that there are no registered discharge consents to surface water within 500m of the site.

3.8 Flood Risk

3.8.1 According to the GroundSure report, the site is located within Flood Zone 1, the lowest risk category in the Environment Agency's classification system.

3.9 Site History

3.9.1 Historical maps contained within the GroundSure report show that the site has remained as undeveloped fields since the first available maps of 1850-55.

4. Assessment of Drainage Options

4.1 Introduction

4.1.1 The Building Regulations Approved Document H[2], Requirement H3, establishes a preferred hierarchy for surface water disposal. This states that consideration should firstly be given to discharge to ground via an infiltration system, then watercourse, then public sewer in that order of priority.

4.1.2 The existing drainage regime at the site is described below, followed by an assessment of the likely feasibility of using each of the above disposal options.

4.2 Existing Drainage Regime

4.2.1 The site has remained as undeveloped fields. The site can therefore be considered to be a Greenfield site. No existing drainage infrastructure has been identified serving the site, and therefore rain falling on the site must currently either infiltrate, or run off site prior to infiltration or capture by positive drainage systems associated with the nearby Dearne Valley Parkway.

4.2.2 No drainage ditches are present on site, and no evidence for surface water ponding or runoff (runnels etc.) were observed during the walkover survey.

4.2.3 It is also considered unlikely that significant volumes of surface water will flow onto the site from adjacent land. Land to the west is at approximately the same elevation as the site and sloping parallel to the site. Land to the north is lower than the site. Land to the south slopes down towards the site, but is developed with housing with associated positive drainage, and furthermore is separated from the site by Upper Hoyland Road, which will intercept any surface water flows. Land to the east is separated from the site by the embankment of Upper Hoyland Road.

4.3 Proposed Site Development

4.3.1 The site is being considered for development with residential dwellings. In line with current best practice, it should be ensured that any future development does not increase surface water run-off rates or volumes from the site; and will actually provide a reduction in peak flows in order to allow for the future potential effects of climate change.

4.3.2 A proposed site layout has been provided and is included within Figure A3 in Appendix A. An analysis of this layout shows that following redevelopment, approximately 54% of the site will be surfaced with impermeable materials, comprising an access road, driveways, houses and patio areas. The remainder of the site will remain as permeable garden and soft landscaped areas.

4.4 Assessment of Infiltration

General Information

4.4.1 Given the grassed site surfacing, and no evidence for surface water ponding or run-off features, it is considered likely that most rainfall currently infiltrates on site.

Information from the British Geological Survey

4.4.2 An infiltration SuDS GeoReport was obtained from the BGS to gain information on the likelihood of the local ground conditions being conducive to the disposal of surface water via infiltration; this is included in Appendix C to this report.

[2] HM Government, The Building Regulations 2010. *Approved Document H. Drainage and Waste Disposal*. 2002 edition incorporating 2010 amendments.

4.4.3 Overall, the GeoReport states that in terms of drainage potential, the site is Probably Compatible for infiltration SuDS, which is the second highest out of four categories of compatibility.

4.4.4 This classification is based on the following factors:

- No superficial deposits are present beneath the site;
- Bedrock deposits are likely to be free-draining, with a likely permeability range of between Low and Moderate;
- Groundwater is likely to be more than 5m below the ground surface throughout the year (in line with the CIRIA SuDS Manual[3], soakaways should not be used in ground where the water table reaches a level within 1m below the base of the soakaway at any time of the year, with standard soakaway systems being around 2m in depth);
- Slope instability problems are probably present or have occurred in the past, and increased infiltration may result in slope instability;
- Underlying groundwater may be vulnerable to contamination.

Conclusion

4.4.5 The infiltration SuDS GeoReport concludes that the site is Probably Compatible for infiltration SuDS, although the design may be influenced by the ground conditions.

4.4.6 In addition, it is likely that some infiltration of rainfall into shallow site soils currently occurs at the site.

4.4.7 From our past experience of undertaking infiltration assessments in the South Yorkshire area, Coal Measures mudstones and siltstones, and the sub-soils arising from their weathering, generally have low permeability, and are consequently not suitable for the use of soakaways as the main method of surface water disposal. However, the geological map shows that there may be an area in the northwest of the site which is underlain by sandstone, which may be more suitable for the use of soakaways.

4.4.8 It is therefore concluded that the use of infiltration SuDS cannot be discounted at this time, and may be a feasible method for the disposal of surface water from the site.

4.4.9 This will require that infiltration testing is carried out at the site, in order to prove the viability of such a method, and to provide infiltration rates to inform the design of any infiltration structures. This testing should be undertaken in line with guidance contained within BRE Digest 365, Soakaway Design.

4.5 Assessment of Drainage to Watercourse

General Information

4.5.1 As noted above, there are no surface water features in the vicinity of the site, with the nearest watercourse down gradient of the site being located 410m northeast.

Conclusion

4.5.2 Due to the topography of the local area, and the distance to the nearest watercourse, draining the site to watercourse is not considered to be a viable method of surface water disposal for the site.

[3] CIRIA, 2015. *C753 - The SuDS Manual*.

4.6 Assessment of Drainage to Sewer

General Information

4.6.1 As noted above, infiltration SuDS may be a viable method for surface water disposal at the site. Nonetheless, in the absence of infiltration test results for the site, and with no nearby watercourses, it is necessary to consider drainage to sewer as an alternative option to infiltration, in the event that testing shows infiltration is not viable.

Information from Yorkshire Water

4.6.2 A Pre-planning Sewerage Enquiry was ordered from Yorkshire Water (YW), to give an assessment of the likelihood of surface water being able to drain to the public sewer; this is included in Appendix D.

4.6.3 YW have stated in their Pre-planning Sewerage Enquiry that, development of the site should take place with separate systems for foul and surface water drainage, and the separate systems should extend to the points of discharge to be agreed.

4.6.4 YW have identified that foul water domestic waste should discharge to the 225 mm diameter public combined sewer recorded in Upper Hoyland Road, at a point adjacent to the site.

4.6.5 YW have also stated that if a foul water pumping station is required, discharge must not exceed 3 litres per second (however, it is considered that the site will be able to drain by gravity).

4.6.6 In terms of surface water flows, YW have stated that as the site is currently undeveloped, no surface water is known to have previously discharged to the public sewer network, and as such, the local public sewer network does not have capacity to accept any surface water from the proposed site.

4.6.7 YW have also stated that if SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority with a view to establishing a suitable watercourse (if any nearby) for discharge. As previously noted, there are no watercourses nearby.

4.6.8 However, a phone conversation with a member of the YW Developer Services Team confirmed that, if conclusive evidence is received by them that no other form of surface water drainage is available for the site, then as a last resort, they could accept surface water drainage into the public sewer at a restricted rate.

Conclusion

4.6.9 Should no other surface water drainage option be available for the site, a controlled discharge to the public surface water sewer could be feasible, but would require prior agreement with Yorkshire Water.

4.7 Conclusions

4.7.1 Infiltration drainage to ground may be a viable method for surface water disposal, subject to suitable infiltration assessment. However, should infiltration not be viable, then there may be an option to discharge surface water to the adjacent public sewer system, with flows being limited and excess volumes of water attenuated on site.

4.7.2 An assessment of surface water run-off rates, required attenuation volumes, and a proposed drainage strategy are presented in Section 5, below.

5. Proposed Drainage Strategy

5.1 Introduction

5.1.1 A technical assessment of the data cited in the sections above is undertaken in the following section, focussing on the production of a drainage strategy showing how surface water drainage can be satisfactorily managed.

5.2 Surface Water Drainage

5.2.1 It is required to demonstrate that the redevelopment of the site will not have a detrimental impact on the risk of flooding and the surface water drainage in the area. This can occur if the new development generates significant additional volumes of surface water run-off.

5.2.2 Extra run-off can be generated if the development leads to a greater proportion of the site being surfaced with impermeable materials. Additionally, the predicted future effects of climate change may lead to an increase in rainfall intensity. Current guidance produced by the Environment Agency[4] states that an increase in rainfall intensity of between 20% and 40% could be expected within the likely lifetime of such a development.

Current Site Drainage

5.2.3 As described in Section 4, the site is Greenfield, and is not currently served by any formal drainage.

5.2.4 The site is wholly surfaced with grass, which appeared to be relatively permeable (i.e. no areas of past surface water ponding or evidence for run-off were noted).

Future Site Development

5.2.5 As noted above, the site is being considered for development with residential housing.

5.2.6 It has been determined that infiltration SuDS could be a viable method of surface water disposal for the site; however, in the absence of infiltration testing data to prove this, an assessment will be undertaken assuming that discharge will occur to the public sewer, to show that it will be possible to drain the site even if infiltration is not viable. Additionally, if infiltration can only be used for a percentage of drainage from the site, excess flows could then drain to the sewer.

5.2.7 Detailed drainage calculations will be required for any proposed scheme; however, a basic assessment of surface water drainage is given below.

Greenfield Run-off Rates

5.2.8 In line with DEFRA guidance[5] for Greenfield developments, the peak runoff rate from the development to any sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event should never exceed the peak greenfield runoff rate for the same event.

5.2.9 In order to analyse the likely surface water run-off rates, the current Greenfield surface water run-off rates were calculated for the site using the methods contained

[4] Environment Agency, 2016. *Flood risk assessments: climate change allowances - Detailed guidance.* Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed 3rd May 2016]

[5] DEFRA, 2015. *Sustainable Drainage Systems. Non-statutory technical standards for sustainable drainage systems.* Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/415773/sustainable-drainage-technical-standards.pdf [accessed 3rd May 2016].

within Institute of Hydrology Report No. 124[6] (IH 124) and also using the Flood Estimation Handbook (FEH)[7] rainfall-run-off statistical correlation method.

5.2.10 Using these methods, the mean annual flood flow for the site (Q_{BAR}) was calculated, and from this the 1 in 1 year, 1 in 30 year, and 1 in 100 year peak discharge rates were obtained, assuming a Greenfield site at this location. Calculations are included in Appendix E and summarised in Table 3, below.

Table 3: Simulated Greenfield Peak Discharge Rates

Return Period	IH24		FEH	
	Peak Discharge Rate (l/s)	Peak Discharge Rate (l/s/ha)	Peak Discharge Rate (l/s)	Peak Discharge Rate (l/s/ha)
Q_{BAR}	1.07	1.75	2.62	4.30
1 year	0.92 (5)*	1.50	2.25 (5)*	3.69
30 years	1.86 (5)*	1.75	4.59 (5)*	7.52
100 years	2.22 (5)*	2.08	5.45	8.93

*Where the discharge rate is less than 5l/s, this value should be used as it can be problematic to provide flow control within drainage below this rate without significantly increasing the risk of system blockages.

5.2.11 Using the IH24 rates as a precautionary approach, as they are lower than the FEH rates, the peak permissible discharge for the site should not exceed 5 l/sec for the 1 in 1 and 1 in 100 year events. An assessment of the likely effects on these rates due to climate change is given below.

Attenuation Volume Assessment

5.2.12 During rainfall events where the discharge would be higher than the calculated allowable discharge rate, limiting the discharge rate from the site will require the excess volume of surface water to be stored on site. It will therefore be necessary to provide a drainage system for the site which will attenuate the increase; this is discussed below.

5.2.13 A storm duration sensitivity analysis been carried out in order to determine the likely volume of attenuation storage required to reduce the surface water run-off rate to the Greenfield rate. These calculations are included in Appendix E, and are summarised below.

5.2.14 Data was obtained from the Flood Estimation Handbook CD-ROM[8] for 3.3% (30 year) and 1% (100 year) Annual Exceedance Probability (AEP) storms. For each storm, the depth of rainfall was calculated which would fall during different duration storms, from 15 minutes up to 16 days. The rainfall depth for each storm duration was applied to the impermeable area of the site (it is considered that impermeable site areas contribute 100% run-off, and permeable areas 0%) to determine the volume of water which would be generated; this was done for the baseline and climate change scenarios.

5.2.15 The volume of water which would be discharged at the Greenfield rate during the storm event was also calculated, and this volume was subtracted from the rainfall volumes calculated above, to give the volume of storage required in an attenuation feature.

5.2.16 For all of the storm durations assessed, the minimum, maximum and average storage volumes were determined. For this site, the calculations show that the following storage volumes would be required:

[6] Institute of Hydrology (June 1994). *Report No. 124 - Flood Estimation for Small Catchments.*
[7] Centre for Ecology & Hydrology. *Flood Estimation Handbook*. NERC (CEH) 2008.
[8] Institute of Hydrology (1999). *Flood Estimation Handbook CD-ROM*. Centre for Ecology & Hydrology.

Table 4: Attenuation Storage Volumes

Return Period	Minimum Volume of Storage (m^3)	Maximum Volume of Storage (m^3)	Average Volume of Storage (m^3)
30 yr	62.84	91.37	77.10
100 yr	96.16	145.13	120.65

Climate Change Allowance

5.2.17 Allowances for the effects of climate change were published by the Environment Agency in February 2016[9]. These include peak rainfall intensity increases which should be applied to baseline rainfall data from 1961 to 1990; the FEH data used to calculate the above volumes are based on standard average annual rainfall (SAAR) the 1961 to 1990 period.

5.2.18 When considering peak rainfall intensity allowances it is necessary to know the expected lifespan of the development to ensure the correct allowances are applied. In the case of residential development, it can be anticipated that the development will remain beyond 2069; therefore, the allowances that have been applied are the total potential change anticipated for the 2080s (2070 to 2115).

5.2.19 The range of climate change allowances are based on percentiles, which are used to describe the proportion of possible scenarios that fall below an allowance level. For example, the 50th percentile is the point at which 50% of possible scenarios fall above it, and 50% fall below it. Three allowances are used in the EA guidance, as detailed below:

- Central allowance: 50th percentile.
- Higher Central allowance: 70th percentile.
- Upper End allowance: 90th percentile.

5.2.20 For assessments of peak rainfall intensity, the EA require that the Central and Upper End allowances are considered to understand the range of impacts.

5.2.21 For the 2080s scenario, the Central and Upper End allowances are 20% and 40% respectively. These allowances have been applied to the FEH-derived attenuation storage volumes, and the anticipated storage volumes plus climate change allowance are shown in Table 5, below.

Table 5: Attenuation Storage Volumes with Climate Change Allowances

Return Period	Minimum Volume of Storage (m^3)	Maximum Volume of Storage (m^3)	Average Volume of Storage (m^3)
30 yr + 20% CC	76.31	118.46	97.39
30 yr + 40% CC	89.77	**147.52**	118.65
100 yr + 20% CC	116.29	186.09	151.19
100 yr + 40% CC	136.43	**229.52**	182.97

5.2.22 From the above, as a suitably conservative approach, it can therefore be assumed that 150m^3 of attenuation storage would be required for the 30 year plus 40% climate change event, and 230m^3 of storage would be required for storm events of up to 100 years, to provide release in a controlled manner to the chosen discharge point.

[9] EA 2016. Flood risk assessments: climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [accessed 3rd May 2016].

5.2.23 Usual best practice is to provide attenuation storage for rainfall events up to the 30 year plus climate change event, and for storms greater than the 30 year event, up to the 100 year plus climate change event, the network can be allowed to surcharge, with any flooding routed away from buildings, but retained on the site. This is known as long term storage.

5.2.24 Long term storage is usually provided above ground in features such as detention basins, swales, or within large car parking areas. However, given the sloping nature of the site which would promote run-off, and the lack of space for surface storage, it is considered that underground storage would be required to attenuate volumes up to the 1 in 100 year plus climate change event.

Assessment of Required SuDS Features

5.2.25 As noted above, in order to attenuate surface water discharge to current Greenfield rates, attenuation features will be required within the drainage scheme.

5.2.26 Due to the relatively small size of the site, there are no areas of communal open space within the layout in which surface SuDS features such as ponds, basins, wetlands, etc., could be located. It is therefore considered that surface water attenuation should be provided by the use of more traditional systems such as tanks, oversized pipes, or storage crates, etc. This attenuation should control discharge of surface water to the appropriate discharge rate using a flow control device.

5.2.27 The SuDS treatment train components considered to be suitable for use at the site are discussed below. An Indicative Drainage Layout drawing is included as Figure A3 in Appendix A.

Source Control Features (Interception Storage) and Pollution Prevention

5.2.28 In addition to attenuation storage, treatment storage or interception storage is also required. This involves ensuring the first 5 mm of any rainfall event is captured and not discharged. This prevents any discharge from the majority of annual rainfall events, and reduces pollutant concentrations discharged, as these concentrations are highest in the early stages of a rainfall event. From the calculations carried out in Appendix E, it is considered that 5mm of rainfall at the site would generate approximately 19m^3 of surface water.

5.2.29 In line with Tables 26.3 and 26.4 of the CIRIA SuDS Manual[10], for run-off from building roofs only, one treatment train component should be sufficient, and for run-off from residential roads and parking areas, one or two treatment train components may be required.

5.2.30 Initial collection of rain water should be undertaken by source control features, which will also provide initial treatment to rainwater, removing suspended material and pollutants. These could include permeable paving and/or filter strips adjacent to any non-permeable areas, as well as individual water butts. As mentioned above, it is currently unknown whether the geological strata beneath the site are likely to be suitable for the use of soakaways as the primary method of surface water disposal. However, permeable paving systems are likely to allow a limited rate of infiltration into shallow soils, and therefore such a system may be a viable method for treatment and disposal of at least some of the surface water generated by the development. Alternatively, if infiltration is not feasible, proprietary treatment devices such as filtration or vortex separators may be required.

5.2.31 In addition to surface water treatment and infiltration, some of these features will also promote evaporation, further reducing the volume of run-off requiring attenuation and discharge.

[10] CIRIA, 2007. *CIRIA C697. The SUDS Manual*.

Conveyance

5.2.32 The use of surface swales for the conveyance of water provides additional benefits such as further treatment of water quality and promotion of evaporation, as well as adding amenity value. However, given the small size of the site, the use of surface swales may not be feasible, and therefore a piped system is likely to be required.

Attenuation Storage

5.2.33 The proposed development of the site will leave little room for SuDS features such as ponds, wetlands, detention basins, etc., and therefore attenuation features such as tanks or cellular crate storage may be required.

5.2.34 The public sewer adjacent to the site is relatively deep, at 3.31m below ground level, meaning that there is the option to use either shallow or relatively deep storage structures, depending on requirements.

5.2.35 Discharge from the attenuation storage should be routed via a flow control device such as a Hydrobrake™, to limit the discharge off the site to the calculated Greenfield run-off rate. It is impractical to provide flow control below 5l/s, without significantly increasing the risks of system blockage, and thus this peak discharge rate has been applied to the development outfall.

5.2.36 Storage volume calculations have been undertaken and are included in Appendix E. These assume a 6 hour storm duration with a 1 in 100 year return period; include an allowance for the effects of climate change; and allow for the volume of water which will be discharged during the duration of the storm. For the area of the site which will drain to the proposed attenuation structure, the calculations show that a volume of around 230m^3 will be required to attenuate a 1 in 100 plus climate change event.

5.2.37 Based on a cellular storage system of 9.6m by 9.6m in plan area (based on a block system with blocks of 0.8m square) then a storage depth of 1.67m (two blocks deep) with a void ratio of 95% would provide 146m^3 of storage. Alternatively, a suitably sized tank could be used.

5.2.38 As most of the site will comprise houses or their gardens, the most likely place for such an attenuation structure to be located is beneath the private driveway in the centre of the site. Due to the topography of the site, the ground surface at this central location is higher than the plots in the far northwest of the site. Despite this, these plots may still be able to drain by gravity to this central location; however, this would require a deep attenuation structure to be provided, which may not be considered suitable, or feasible, for the development. If this proves to be the case, these plots could alternatively be served by individual attenuation structures located, for example, beneath their driveways, garages, or gardens.

Treatment Storage

5.2.39 Treatment Storage refers to the provision of a permanent body of water (usually within a surface pond) into which surface water drains and is diluted, so that some treatment occurs. In England, this is usually defined as the volume of run-off from 15mm of rainfall. However, treatment storage may not be required where the run-off from contributing paved surfaces has been effectively pre-treated by methods such as those noted above.

Conclusions

5.2.40 From the above, it is considered likely that the site can be developed in such a way that no extra discharge of surface water will occur from the site above the Greenfield rate. This will ensure that the risk of surface water flooding to the site and nearby sites will not increase.

Foul Drainage Options

5.2.41 YW have identified that foul water domestic waste should discharge to the 225 mm diameter public combined sewer recorded in Upper Hoyland Road, at a point adjacent to the site. Assuming that the manhole used is the one adjacent to the site's northwestern corner, which is shown to be 3.3m deep, it is considered that there would be sufficient gradient across the site so that all proposed houses will drain by gravity to this point.

5.2.42 This manhole could not be located on site and is possibly located within the dense vegetation to the north of its indicated location, or alternatively is located within the roadway and has been covered over with asphalt. The developer should therefore be aware that a new inspection chamber may need to be constructed to make this connection.

5.2.43 A basic assessment of foul drainage flows has been carried out using the methodology outlined in Sewers for Adoption[11]. In this methodology, it is considered that a private dwelling will produce 4,000 litres/day. For the proposed development of 14no. dwellings, this totals 56,000 litres/day, or a peak foul flow of 0.65 litres/second.

[11] Sewers for Adoption, 7th Edition. 2012

6. Conclusions

6.1.1 This preliminary drainage assessment demonstrates that:

- The site has not previously been developed and there is no formal drainage connections serving the site.
- There are no watercourses nearby which would be suitable to receive surface water discharge.
- It is possible that infiltration drainage will be suitable as the primary method of surface water disposal for the site, subject to infiltration testing being carried out.
- Should infiltration drainage not be suitable as the primary method of surface water disposal, Yorkshire Water has confirmed that surface water could be discharged to the nearby public sewer; however, prior to providing a formal agreement, they will require conclusive evidence that infiltration and discharge to watercourse are not feasible options.
- If surface water is discharged to the public sewer, this should be limited to the Greenfield run-off rate with any additional volume of water generated attenuated on site. Attenuation could be achieved by provision of an attenuation structure beneath the central private driveway; however, plots in the far northwest of the site may require individual attenuation structures due to the site topography.
- Foul drainage can be discharged to the public sewer adjacent to the site.

Appendix A: Figures

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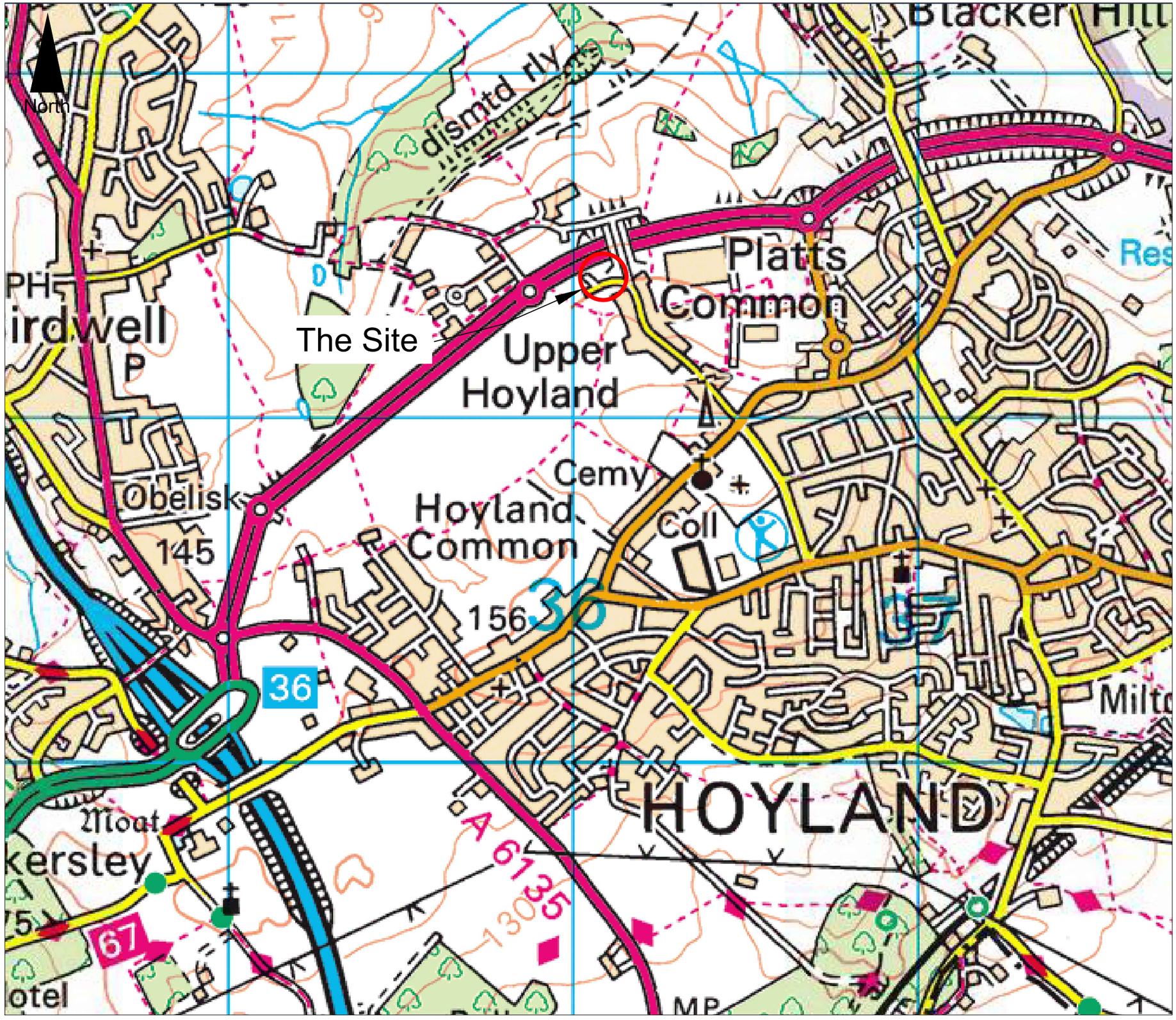

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Preliminary Drainage Strategy Report

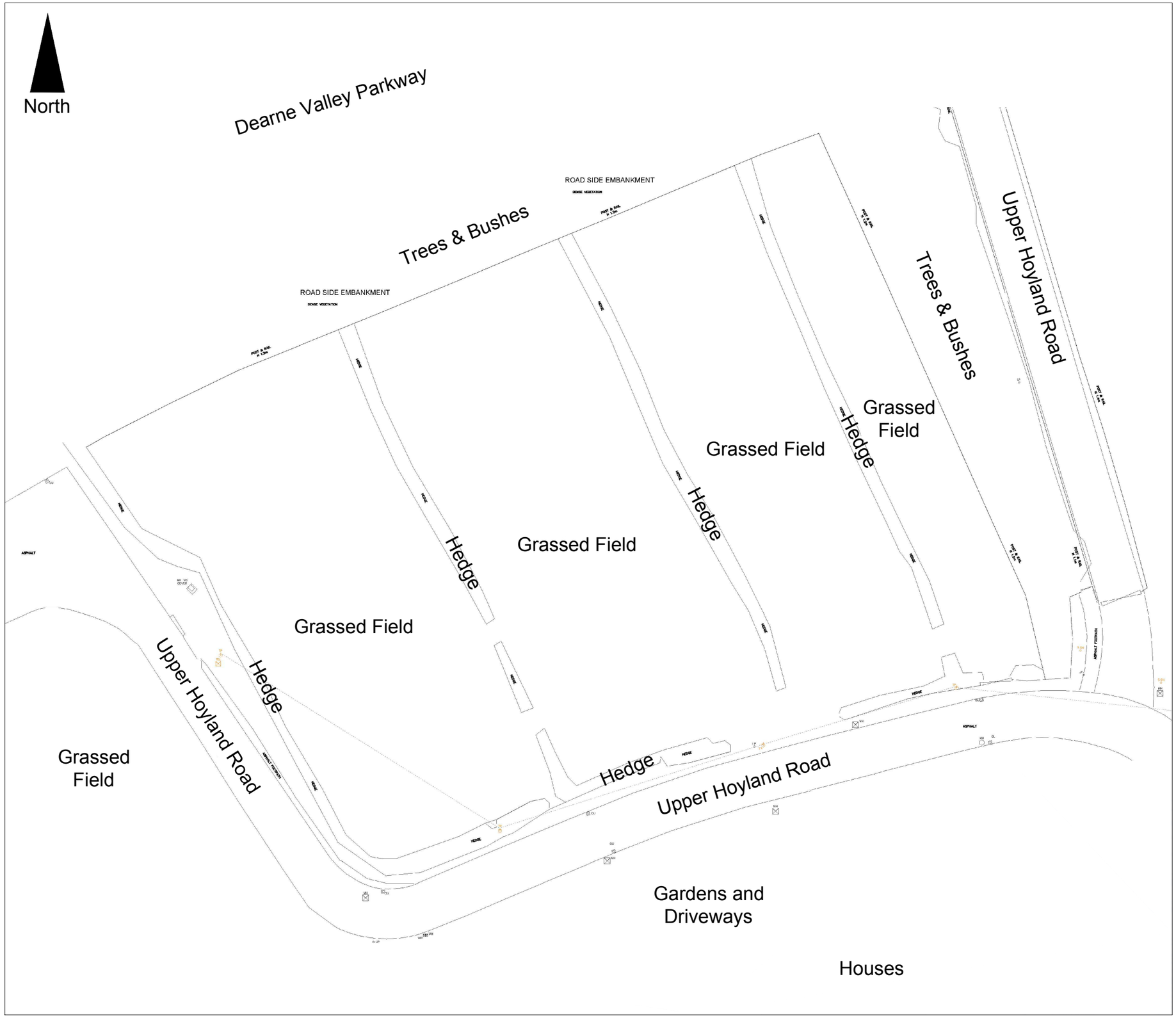
Land off Upper Hoyland Road, Barnsley

Job No. 7918

Site Location Plan

Brook Holt ■ Blackburn Road ■ Sheffield ■ S61 2DW
■tel: 0114 266 9292 ■ www.ecusltd.co.uk

Date: April 2016 | Scale: Not to Scale | Figure: A1



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Preliminary Drainage Strategy Report

Land off Upper Hoyland Road, Barnsley

Job No. 7918

Site Features Plan

Brook Holt ■ Blackburn Road ■ Sheffield ■ S61 2DW
■tel: 0114 266 9292 ■ www.ecusltd.co.uk

Based on Eton Construction Ltd Drawing No. EC02-21, dated 18.12.15.

Date: May 2016 | Scale: Not to Scale | Figure: A2

North

Attenuation structure providing at least 230m^3 of storage.

Manhole not observed on site. YW indicate sewer is 3.31m deep at this point.

Manhole identified on site. YW have no record of depth.

ROAD SIDE EMBANKMENT

ROAD SIDE EMBANKMENT

PRIVATE DRIVEWAY

UPPER HOYLAND ROAD

UPPER HOYLAND ROAD

AGRICULTURAL LAND

GRASS AREA

EXISTING GARDENS AND DRIVEWAYS

THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ETON CONSTRUCTION DRAWING REF : EC02-25

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Key:

Yorkshire Water combined sewer.

Yorkshire Water sewer manhole.

Area proposed for attenuation structure, if required.

Preliminary Drainage Strategy Report

Land off Upper Hoyland Road, Barnsley

Job No. 7918

Indicative Drainage Layout Plan

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Based on Eton Construction Ltd Drawing No. EC02-40, dated 18.12.15.

Date: May 2016 | Scale: Not to Scale | Figure: A3

Appendix B: Site Photographs

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Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View south along site's western boundary.**

Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View east across the site, from the site's western boundary.**

Ecus Ltd
Brook Holt
3 Blackburn Road
Sheffield. S61 2DW

Tel : (0114) 2669292

www.ecusltd.co.uk

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Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View northeast across the site from the site's western boundary.**

Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View north across the site, from the site's southern boundary.**

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3 Blackburn Road
Sheffield. S61 2DW

Tel : (0114) 2669292

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Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View north across the east of the site.**

Job: Preliminary Drainage Strategy Report **Site:** Land off Upper Hoyland Road, Barnsley **Ref:** 7918	**View east along the site's northern boundary.**

Ecus Ltd
Brook Holt
3 Blackburn Road
Sheffield. S61 2DW

Tel : (0114) 2669292

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Appendix C: BGS Infiltration SuDS Report

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Andrew Lake
Ecus Ltd
Brook Holt
3 Blackburn Road
Sheffield
South Yorkshire
S61 2DW

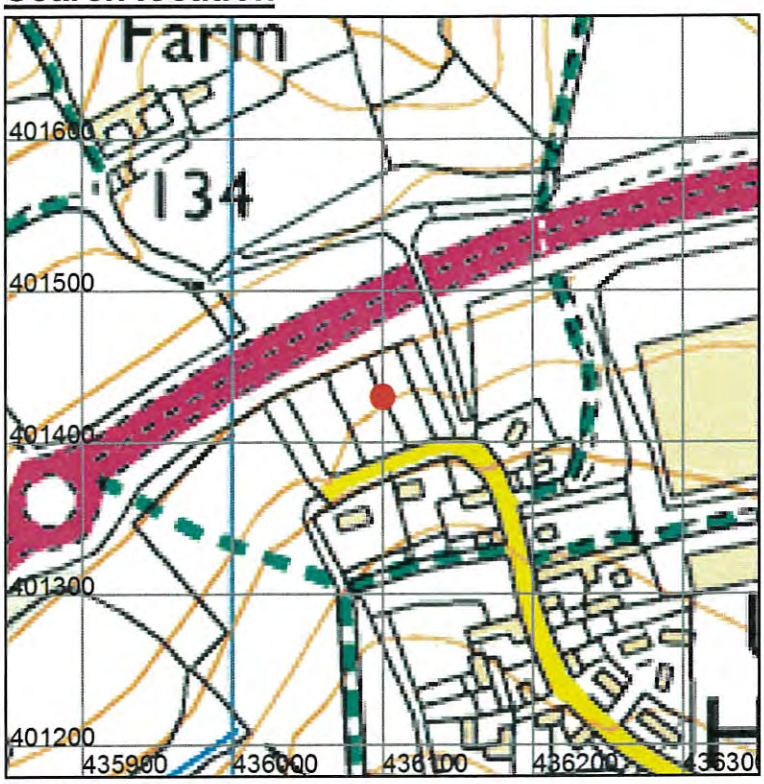
Infiltration SuDS GeoReport:

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_213567/1***

Client reference: 7918

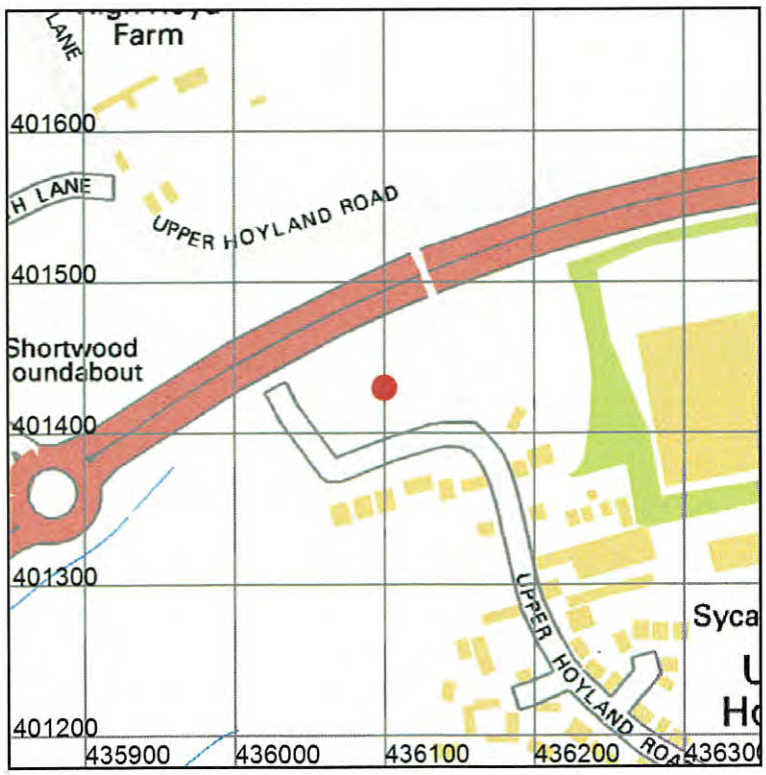
Search location



Point centred at:
436100,401430

Search location indicated in red

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



OS Street View: Scale: 1:5 000 (1cm = 50 m)

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.

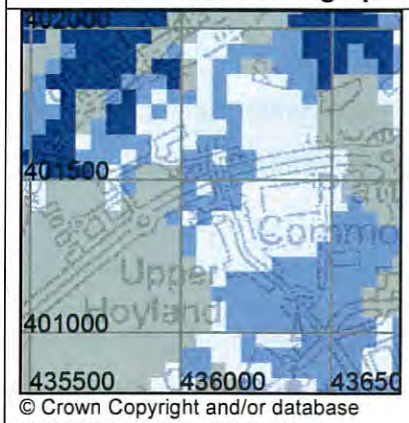
This report considers the suitability of the subsurface for the installation of infiltration SuDS, such as soakaways, infiltration basins or permeable pavements. It provides subsurface data to indicate whether, and which type of infiltration system may be appropriate. It does not state that infiltration 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

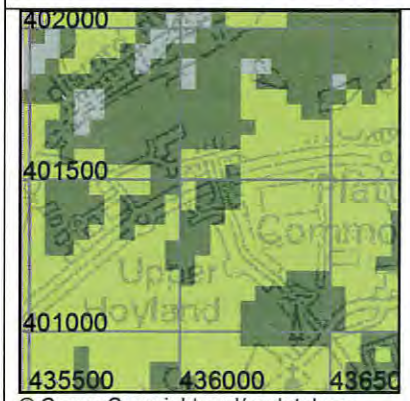
This section provides a summary of the data on the following pages.

In terms of the drainage potential, is the ground suitable for infiltration SuDS?



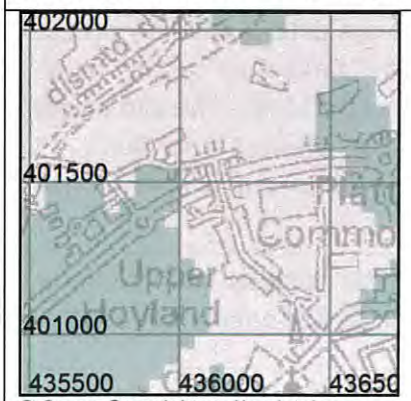
- Highly compatible for infiltration SuDS.
  The subsurface is likely to be suitable for free-draining infiltration SuDS.
- Probably compatible for infiltration SuDS.
  The subsurface is probably suitable although the design may be influenced by the ground conditions.
- Opportunities for bespoke infiltration 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?



- 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?



- 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.

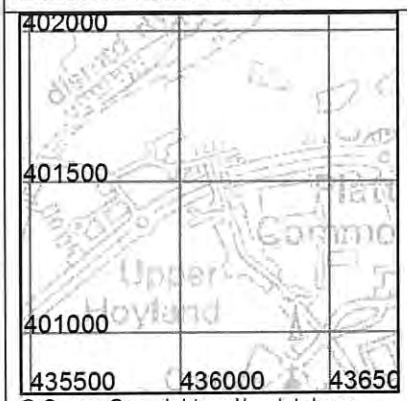
Section 1. Very significant constraints

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



■ 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.

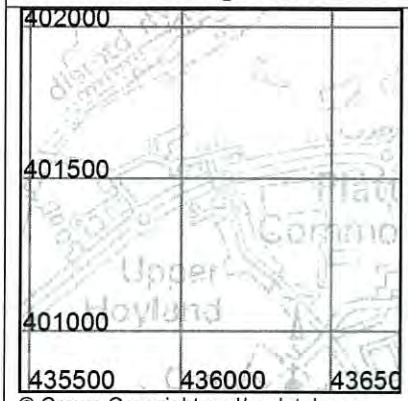
Landslide hazard

■ 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

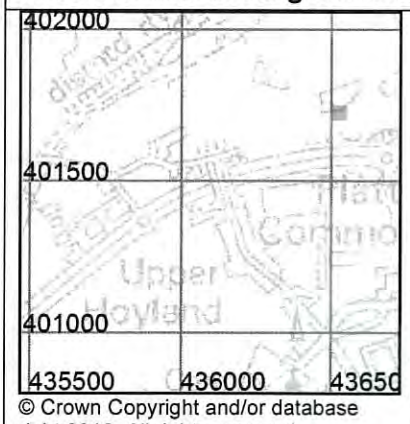


■ Very significant mining hazard.

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

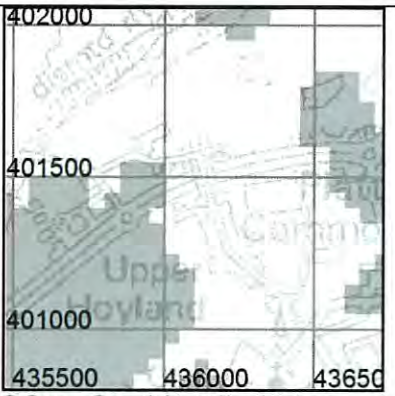


■ Very high likelihood of persistent or seasonally shallow groundwater.

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



■ 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

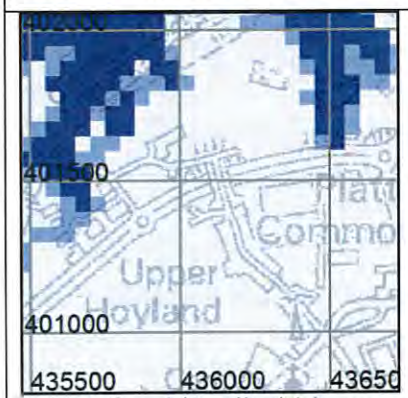
Section 2. Drainage potential

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

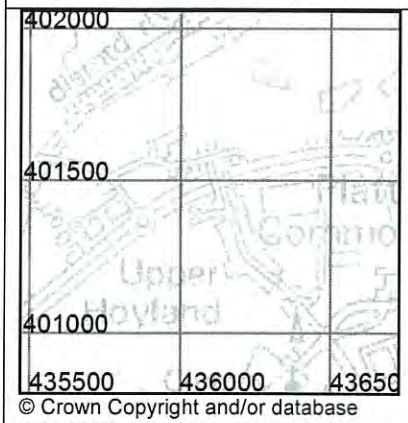


Groundwater is likely to be **more than 5 m** below the ground surface throughout the year.

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



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

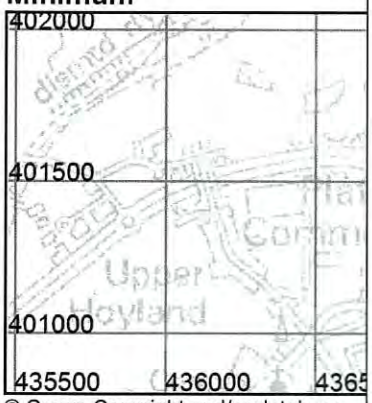
The superficial deposit permeability is **spatially variable**, but likely to permit moderate infiltration.

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

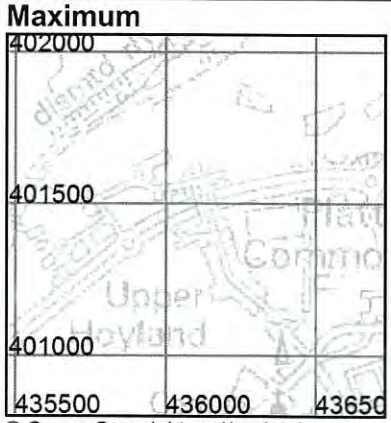
These maps show the permeability range that is summarised above.

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

Minimum



Maximum

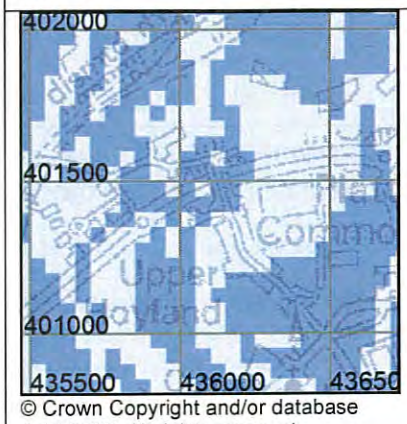


Superficial deposit thickness

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



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

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

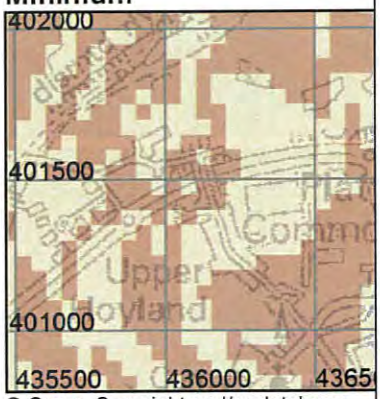
Bedrock deposits are likely to be **poorly draining**.

These maps show the permeability range that is summarised above.

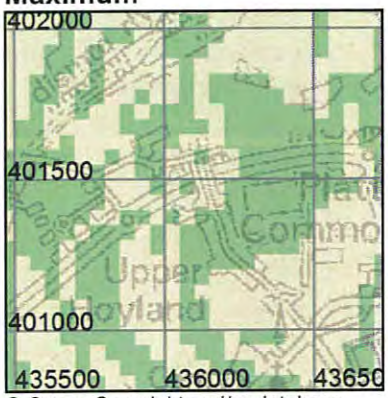
Key

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

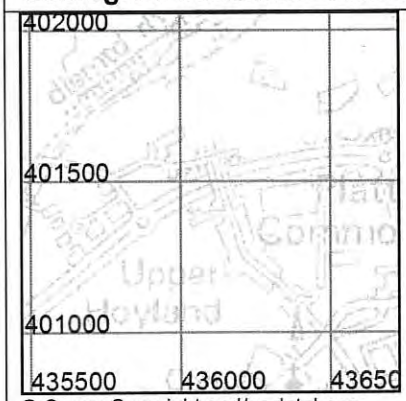
Minimum



Maximum



Geological indicators of flooding



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.

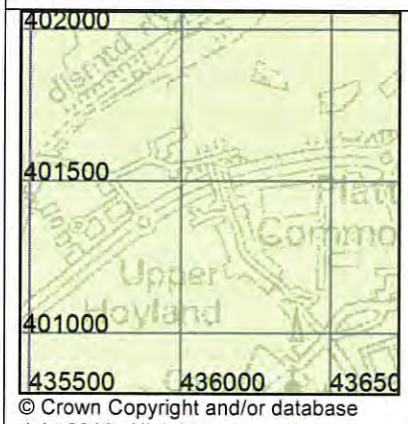
Section 3. Ground stability

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

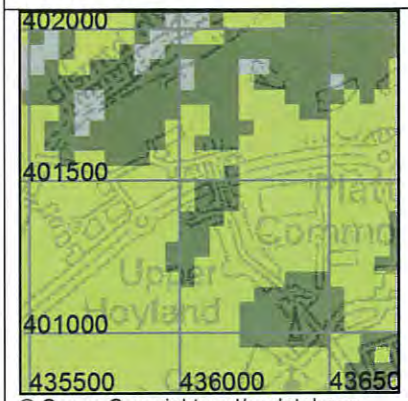
In the following maps, geohazards that are identified in green are unlikely to prevent infiltration SuDS from being installed, but they should be considered during design. For more information read 'Explanation of terms' at the end of this report.

Soluble rocks



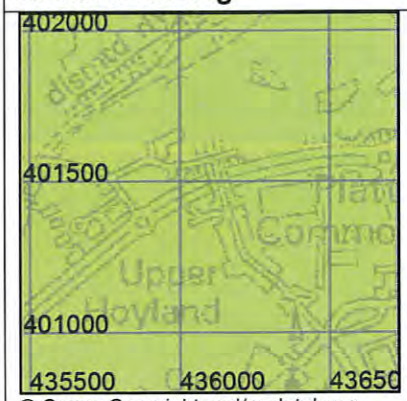
	Increased infiltration is unlikely to result in subsidence.
	Increased infiltration is unlikely to cause localised subsidence, but potential impacts should be considered.
	Increased infiltration may result in localised subsidence. The potential for or the consequences of subsidence associated with soluble rocks should be considered.
	Very significant possibility of localised subsidence that could be initiated or made worse by infiltration.

Landslides



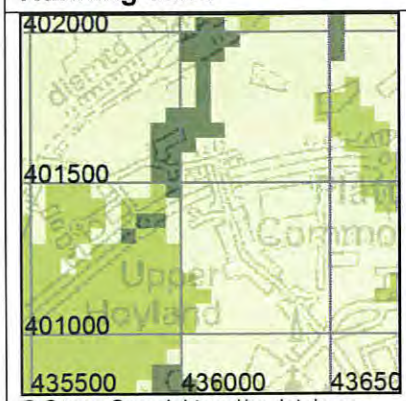
- Increased infiltration is unlikely to lead to slope instability.
- Slope instability problems may be present or anticipated, but increased infiltration is unlikely to cause instability
- Slope instability problems are probably present or have occurred in the past, and increased infiltration may result 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



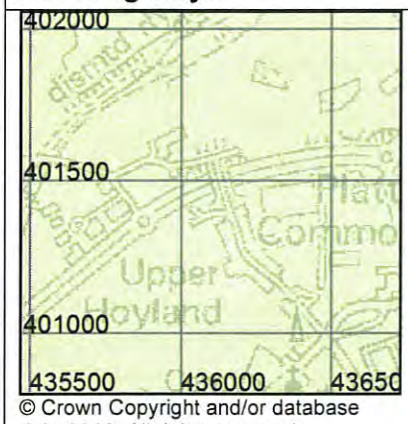
- Increased infiltration is unlikely to lead to subsidence.
- Shallow mining is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
- Shallow mining could be present with a significant possibility that localised subsidence could be initiated 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



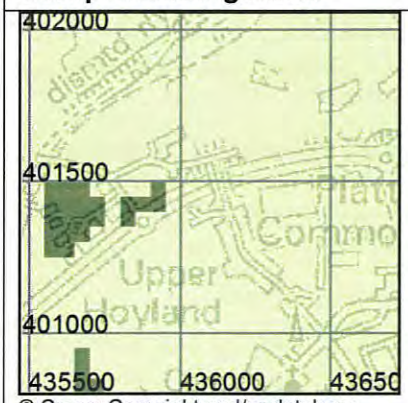
- Increased infiltration is unlikely to cause ground collapse associated with running sands.
- Running sand is possibly present. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
- Significant possibility for running sand problems. Increased infiltration may result in a geohazard.

Swelling clays



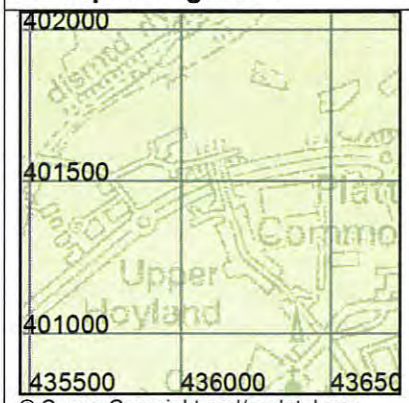
- Increased infiltration is unlikely to cause shrink-swell ground movement.
- Ground is susceptible to shrink-swell ground movement. Increased infiltration is unlikely to cause a geohazard, but potential impacts should be considered.
- Ground is susceptible to shrink-swell ground movement. Increased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

Compressible ground



- 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



- 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.

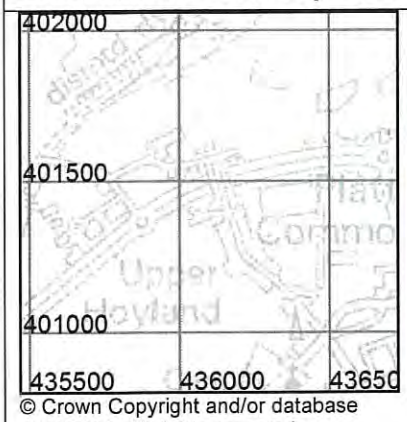
Section 4. Groundwater quality protection

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

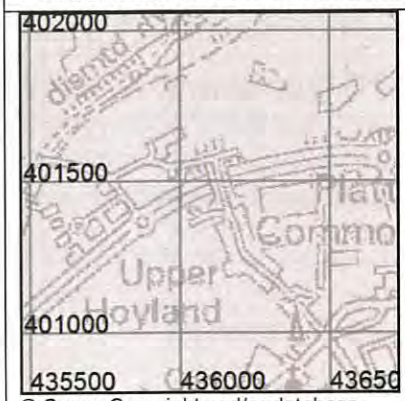
For more information read 'Explanation of terms' at the end of this report.

Groundwater source protection zones



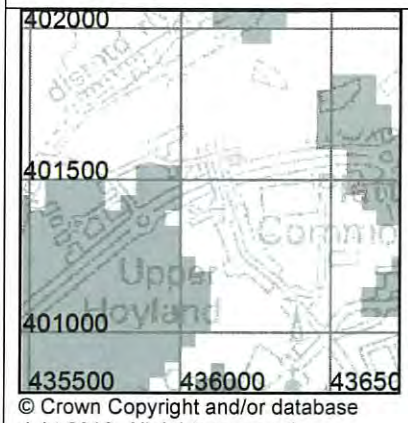
- ☐ Groundwater is not within a source protection zone.
- Source protection zone IV
- Source protection zone III
- Source protection zone II
- Source protection zone I.

Predominant flow mechanism



- ☐ 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



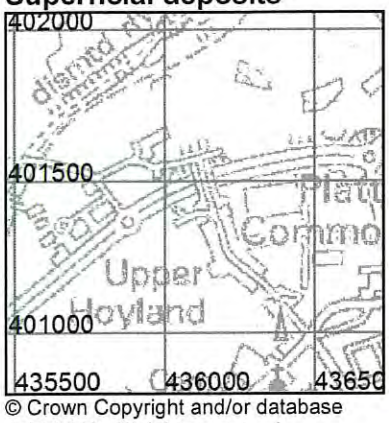
Made ground is present at the surface. Infiltration may increase the possibility of remobilising pollutants.

Section 5. Geological Maps

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

Artificial deposits

Superficial deposits



Bedrock

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
	WMGR-ARTDP	INFILLED GROUND	ARTIFICIAL DEPOSIT
	MGR-ARTDP	MADE GROUND (UNDIVIDED)	ARTIFICIAL DEPOSIT

Key to Superficial deposits:
No deposits recorded by BGS in the search area

Key to Bedrock geology:

Map colour	Computer Code	Rock name	Rock type
	ABR-SDST	ABDY ROCK	SANDSTONE
	BNR-SDST	BARNSLEY ROCK	SANDSTONE
	KNR-SDST	KENT'S ROCK	SANDSTONE
	PMCM-MDSS	PENNINE MIDDLE COAL MEASURES FORMATION	MUDSTONE, SILTSTONE AND SANDSTONE
	PMCM-SDST	PENNINE MIDDLE COAL MEASURES FORMATION	SANDSTONE

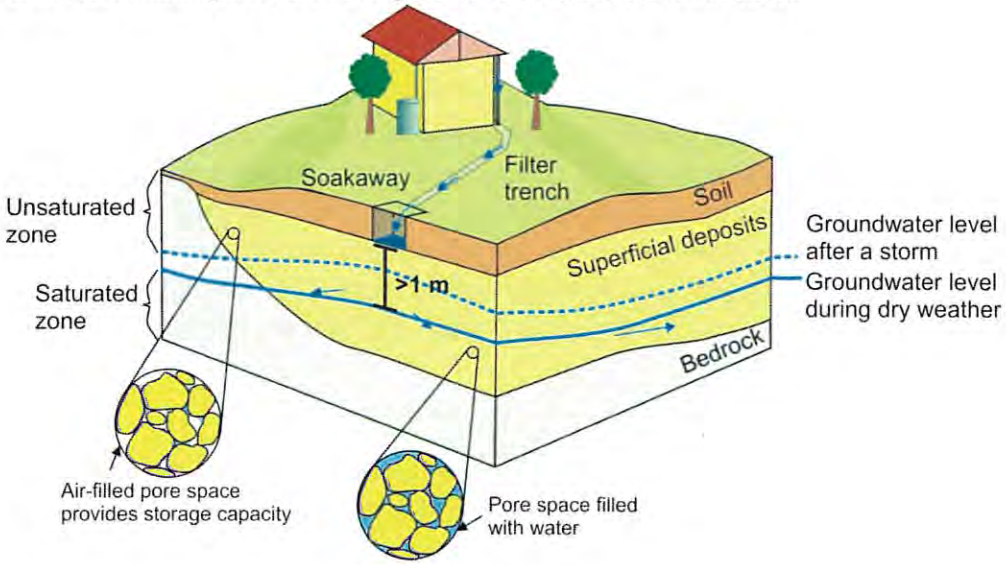
Limitations of this report:

- 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

Keyworth Office
British Geological Survey
Environmental Science Centre
Nicker Hill
Keyworth
Nottingham
NG12 5GG
Tel: 0115 9363143
Fax: 0115 9363276
Email: enquiries@bgs.ac.uk

Wallingford Office
British Geological Survey
Maclean Building
Wallingford
Oxford
OX10 8BB
Tel: 01491 838800
Fax: 01491 692345
Email: hydroenq@bgs.ac.uk

Edinburgh Office
British Geological Survey
Lyell Centre
Research Avenue South
Edinburgh
EH14 4AP
Tel: 0131 6671000
Email: enquiry@bgs.ac.uk

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General Terms & Conditions

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Important notes about this Report

- 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.
- Geological observations and interpretations are made according to the prevailing understanding of the subject at the time. The quality of such observations and interpretations may be affected by the availability of new data, by subsequent advances in knowledge, improved methods of interpretation, and better access to sampling locations.
- Raw data may have been transcribed from analogue to digital format, or may have been acquired by means of automated measuring techniques. Although such processes are subjected to quality control to ensure reliability where possible, some raw data may have been processed without human intervention and may in consequence contain undetected errors.
- 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.
- If a report or other output is produced for you on the basis of data you have provided to BGS, or your own data input into a BGS system, please do not rely on it as a source of information about other areas or geological features, as the report may omit important details.
- 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.

Report issued by
BGS Enquiry Service

Appendix D: Yorkshire Water Information

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YorkshireWater

RECEIVED
04 MAY 2016

Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO BOX 52
Bradford
BD3 7AY

Tel: 0345 120 8482
Fax: (01274) 372 834

Email:
Technical.Sewerage@yorkshirewater.co.uk

For telephone enquiries ring:

Kashif Khan on 0345 120 8482

Ecus Ltd
Brook Holt
Blackburn Road
Rotherham
S61 2DR

FAO Andrew Lake

Your Ref:
Our Ref: S006013

29th April 2016

Dear Andrew,

Upper Hoyland Road, Hoyland, Barnsley, S74 9NL - Pre-Planning Sewerage Enquiry (Residential) R155006

Thank you for your recent enquiry and remittance. Our official VAT receipt has been sent to you under separate cover. Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records.

The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months:

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul water domestic waste should discharge to the 225 mm diameter public combined sewer recorded in Upper Hoyland Road, at a point adjacent to the site.

From the information supplied, it is not possible to determine if the whole site will drain by gravity to the public sewer network. If the site, or part of it, will not drain by gravity, then it is likely that a sewage pumping station will be required to facilitate connection to the public sewer network. If sewage pumping is required foul water discharge must not exceed 3 (three) litres per second.

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

As the proposal site is currently undeveloped no surface water is known to have previously discharged to the public sewer network

As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. If SuDS are not viable, the developer is advised to contact the Environment

Agency/local Land Drainage Authority with a view to establishing a suitable watercourse (if any nearby) for discharge.

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority, with regard to surface water disposal from the site.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

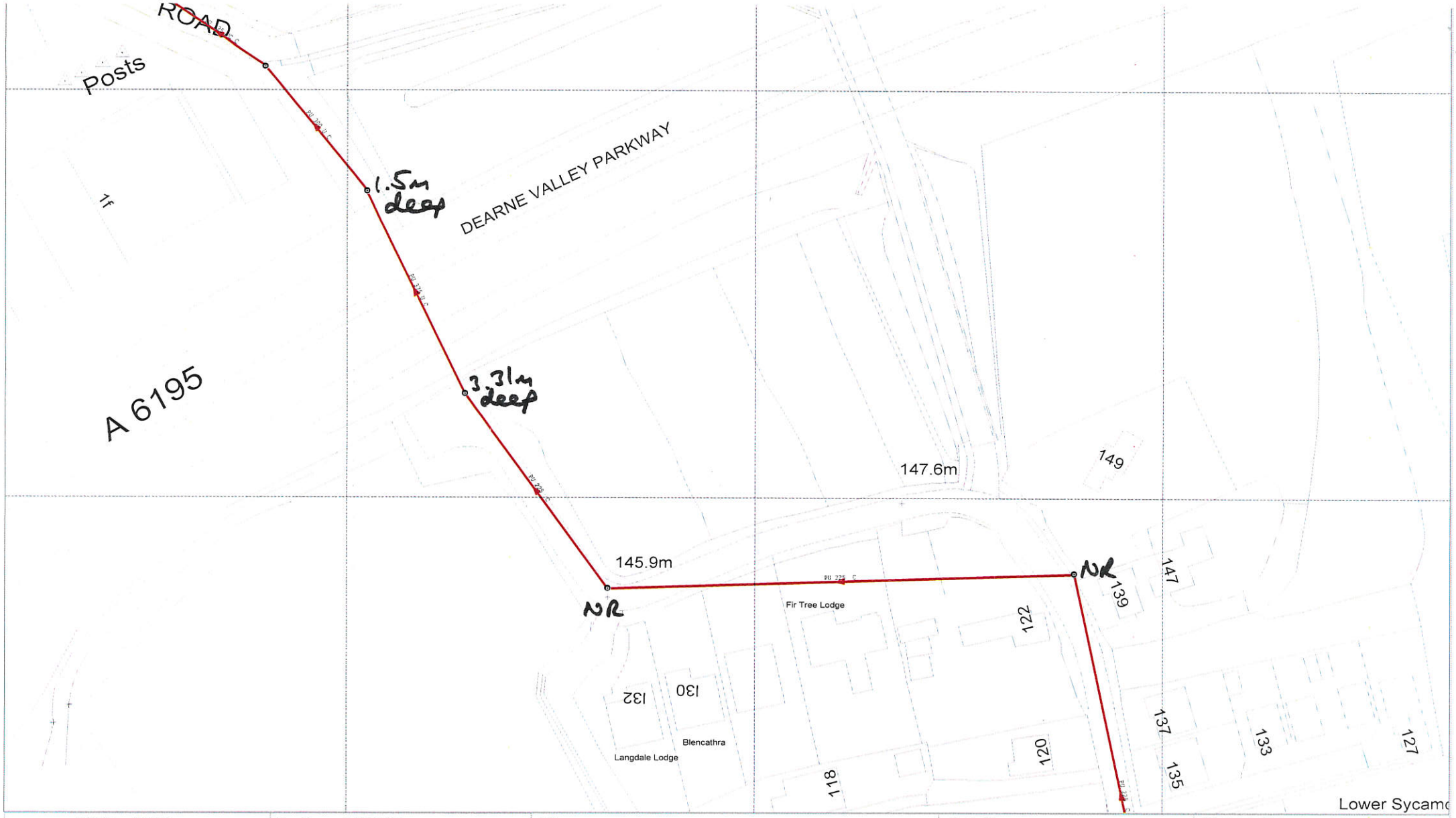
The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where a suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage to be connected/discharged to public sewer.

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith. Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

Developer Services Team



435885 : 401304

Map Name : SE3501SE

Yorkshire Water,
PO Box 500,
Halifax Road,
Bradford BD6 2LZ
Contact Name :
K KHAN
Contact Tel :

Title

Notes

NR. No recorded depth

Partial Key

Foul Sewer = F
Combined Sewer = C
Surface Water Sewer = SW
Trade Sewer = TD
Partially Separate = PS

Date Req : 29/04/2016, 16:32:01

Date Gen : 29/04/2016, 16:32:02

Source : Sewer Network Enquiry

UPN: Undefined

Originator: K KHAN, New Development - Waste Water,

Appendix E: Surface Water Run-off and Attenuation Volume Calculations

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HR Wallingford
Working with water

Greenfield runoff estimation for sites

Site name:	Land off Upper Hoyland Road
Site location:	Barnsley

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site coordinates

Latitude:	53.50839° N
Longitude:	1.45732° W

Reference:	gcwbqufucyz7 / 0.61
Date:	26 Apr 2016

Site characteristics

Total site area	0.61	ha
Significant public open space	0	ha
Area positively drained	0.61	ha

Methodology

Greenfield runoff method	IH124

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type
SOIL type	2
HOST class	N/A
SPR	0.30

Hydrological characteristics

	Default	Edited	
SAAR	675	675	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.3	0.3	
FEH/FSR conversion factor	0.9	0.9	
Hydrological region	3	3	
Growth curve factor: 1 year	0.86	0.86	
Growth curve factor: 10 year	1.45	1.45	
Growth curve factor: 30 year	1.75	1.75	
Growth curve factor: 100 year	2.08	2.08	

Greenfield runoff rates

	Default	Edited	
Qbar	1.07	1.07	l/s
1 in 1 year	5.00	5.00	l/s
1 in 30 years	5.00	5.00	l/s
1 in 100 years	5.00	5.00	l/s

Please note that a minimum flow of 5 l/s applies to any site

HR Wallingford
Working with water

Greenfield runoff estimation for sites

Site name:	Land off Upper Hoyland Road
Site location:	Barnsley

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the CIRIA SUDS Manual (2007). It is not to be used for detailed design of drainage systems. It is recommended that every drainage scheme uses hydraulic modelling software to finalise volume requirements and design details before drawings are produced.

Site coordinates

Latitude:	53.50839° N
Longitude:	1.45732° W

Reference:	gcwbqufucyz7 / 0.61
Date:	26 Apr 2016

Site characteristics

Total site area	0.61	ha
Significant public open space	0	ha
Area positively drained	0.61	ha

Methodology

Greenfield runoff method	FEH

Qmed estimation method	Calculate from BFI and SAAR	
BFI and SPR estimation method	Specify BFI manually	
HOST class	N/A	
BFI / BFIHOST	0.34	
Qmed	2.463	l/s
Qbar / Qmed Conversion Factor	1.064	

Hydrological characteristics

	Default	Edited	
SAAR	675	675	mm
M5-60 Rainfall Depth	20	20	mm
'r' Ratio M5-60/M5-2 day	0.3	0.3	
FEH/FSR conversion factor	0.9	0.9	
Hydrological region	3	3	
Growth curve factor: 1 year	0.86	0.86	
Growth curve factor: 10 year	1.45	1.45	
Growth curve factor: 30 year	1.75	1.75	
Growth curve factor: 100 year	2.08	2.08	

Greenfield runoff rates

	Default	Edited	
Qbar	2.62	2.62	l/s
1 in 1 year	5.00	5.00	l/s
1 in 30 years	5.00	5.00	l/s
1 in 100 years	5.45	5.45	l/s

Please note that a minimum flow of 5 l/s applies to any site

SuDS Storage Volume Calculator - Summary

Design Parameters:

Site Impermeable Area	3,318	m^2
Design run-off rate	5	l/s
Climate change increase	20	%
Site area increase due to urban expansion	10	%

Calculation Outputs:

Storm event	Maximum Discharge Rate	Minimum Storage Volume	Maximum Storage Volume	Average Storage Volume
	l/sec	m^3	m^3	m^3
3.33% AEP	5	62.84	91.37	77.10
3.33% AEP plus Climate Change	5	76.31	118.46	97.39
1% AEP	5	96.16	145.13	120.65
1% AEP plus Climate Change	5	116.29	186.09	151.19

Discharge from First 5mm of Rainfall (m^3)	18.25

SuDS Storage Volume Calculations

Duration	Rainfall with Climate Change										
	3.33% AEP + CC	1% AEP + CC									
minutes	mm	mm	Outfall Volume ($Design\ Runoff\ Rate \times Storm\ duration$) × 1000	3.33% AEP Storage Volume ($Impermeable\ Area \times Urban\ expansion$) × (3.33% $AEP\ Rainfall\ Depth \div 1000$)	3.33% AEP Net Storage Volume 33.3% AEP Volume − Outfall Volume	3.33% AEP CC Storage Volume ($Impermeable\ Area \times Urban\ expansion$) × (3.33% $AEP + CC\ Rainfall\ Depth$) ÷ 1000)	3.33% AEP CC Net Storage Volume 33.3% AEP + CC Volume	1% AEP Storage Volume ($Impermeable\ Area \times Urban\ expansion$) × (1% $AEP\ Rainfall\ Depth \div 1000$)	1% AEP Net Storage Volume 1% AEP Volume − Outfall Volume	1% AEP CC Volume ($Impermeable\ Area \times Urban\ expansion$) × (1% $AEP + CC\ Rainfall\ Depth \div 1000$)	1% AEP CC Net Storage Volume 1% AEP +CC Volume − Outfall Volume
			m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
15	22.14	33.096	4.50	67.34	62.84	80.81	76.31	100.66	96.16	120.79	116.29
30	27.48	40.224	9.00	83.58	74.58	100.30	91.30	122.34	113.34	146.81	137.81
45	31.128	45	13.50	94.68	81.18	113.61	100.11	136.87	123.37	164.24	150.74
60	33.972	48.684	18.00	103.33	85.33	123.99	105.99	148.07	130.07	177.69	159.69
120	41.856	58.74	36.00	127.31	91.31	152.77	116.77	178.66	142.66	214.39	178.39
180	47.232	65.472	54.00	143.66	89.66	172.39	118.39	199.13	145.13	238.96	184.96
240	51.432	70.68	72.00	156.43	84.43	187.72	115.72	214.97	142.97	257.97	185.97
255	52.368	71.832	76.50	159.28	82.78	191.13	114.63	218.48	141.98	262.17	185.67
270	53.256	72.924	81.00	161.98	80.98	194.37	113.37	221.80	140.80	266.16	185.16
285	54.12	73.98	85.50	164.61	79.11	197.53	112.03	225.01	139.51	270.01	184.51
300	54.936	74.988	90.00	167.09	77.09	200.51	110.51	228.08	138.08	273.69	183.69
315	55.74	75.96	94.50	169.53	75.03	203.44	108.94	231.03	136.53	277.24	182.74
330	56.508	76.908	99.00	171.87	72.87	206.24	107.24	233.92	134.92	280.70	181.70
345	57.252	77.808	103.50	174.13	70.63	208.96	105.46	236.65	133.15	283.98	180.48
360	57.972	78.696	108.00	176.32	68.32	211.59	103.59	239.35	131.35	287.22	179.22
375	58.68	79.548	112.50	178.48	65.98	214.17	101.67	241.95	129.45	290.33	177.83
390	59.352	80.376	117.00	180.52	63.52	216.62	99.62	244.46	127.46	293.36	176.36
405	60.024	81.18	121.50	182.56	61.06	219.08	97.58	246.91	125.41	296.29	174.79
420	60.66	81.96	126.00	184.50	58.50	221.40	95.40	249.28	123.28	299.14	173.14
435	61.296	82.716	130.50	186.43	55.93	223.72	93.22	251.58	121.08	301.90	171.40
450	61.908	83.46	135.00	188.29	53.29	225.95	90.95	253.84	118.84	304.61	169.61
465	62.508	84.18	139.50	190.12	50.62	228.14	88.64	256.03	116.53	307.24	167.74
480	63.096	84.888	144.00	191.91	47.91	230.29	86.29	258.19	114.19	309.82	165.82
495	63.66	85.584	148.50	193.62	45.12	232.35	83.85	260.30	111.80	312.36	163.86
510	64.224	86.256	153.00	195.34	42.34	234.40	81.40	262.35	109.35	314.82	161.82
525	64.776	86.916	157.50	197.02	39.52	236.42	78.92	264.36	106.86	317.23	159.73
540	65.304	87.564	162.00	198.62	36.62	238.35	76.35	266.33	104.33	319.59	157.59
555	65.832	88.2	166.50	200.23	33.73	240.27	73.77	268.26	101.76	321.91	155.41
570	66.348	88.812	171.00	201.80	30.80	242.16	71.16	270.12	99.12	324.15	153.15
585	66.864	89.424	175.50	203.37	27.87	244.04	68.54	271.98	96.48	326.38	150.88
600	67.356	90.024	180.00	204.86	24.86	245.84	65.84	273.81	93.81	328.57	148.57
615	67.848	90.6	184.50	206.36	21.86	247.63	63.13	275.56	91.06	330.67	146.17
630	68.328	91.176	189.00	207.82	18.82	249.38	60.38	277.31	88.31	332.77	143.77
645	68.796	91.74	193.50	209.24	15.74	251.09	57.59	279.03	85.53	334.83	141.33
660	69.264	92.304	198.00	210.67	12.67	252.80	54.80	280.74	82.74	336.89	138.89
675	69.72	92.844	202.50	212.05	9.55	254.46	51.96	282.39	79.89	338.86	136.36
690	70.176	93.384	207.00	213.44	6.44	256.13	49.13	284.03	77.03	340.83	133.83
705	70.608	93.912	211.50	214.75	3.25	257.71	46.21	285.63	74.13	342.76	131.26
720	71.052	94.428	216.00	216.10	0.10	259.33	43.33	287.20	71.20	344.64	128.64
735	71.604	95.112	220.50	217.78	-2.72	261.34	40.84	289.28	68.78	347.14	126.64
750	72.168	95.784	225.00	219.50	-5.50	263.40	38.40	291.33	66.33	349.59	124.59
765	72.708	96.456	229.50	221.14	-8.36	265.37	35.87	293.37	63.87	352.05	122.55
780	73.248	97.116	234.00	222.78	-11.22	267.34	33.34	295.38	61.38	354.45	120.45
795	73.776	97.764	238.50	224.39	-14.11	269.27	30.77	297.35	58.85	356.82	118.32
810	74.304	98.412	243.00	226.00	-17.00	271.19	28.19	299.32	56.32	359.18	116.18
825	74.832	99.048	247.50	227.60	-19.90	273.12	25.62	301.25	53.75	361.51	114.01
840	75.348	99.672	252.00	229.17	-22.83	275.01	23.01	303.15	51.15	363.78	111.78
855	75.852	100.284	256.50	230.70	-25.80	276.84	20.34	305.01	48.51	366.02	109.52
870	76.356	100.896	261.00	232.24	-28.76	278.68	17.68	306.88	45.88	368.25	107.25
885	76.86	101.508	265.50	233.77	-31.73	280.52	15.02	308.74	43.24	370.48	104.98
900	77.352	102.108	270.00	235.27	-34.73	282.32	12.32	310.56	40.56	372.67	102.67
915	77.832	102.696	274.50	236.73	-37.77	284.07	9.57	312.35	37.85	374.82	100.32
930	78.324	103.284	279.00	238.22	-40.78	285.87	6.87	314.14	35.14	376.97	97.97
945	78.792	103.86	283.50	239.65	-43.85	287.58	4.08	315.89	32.39	379.07	95.57
960	79.272	104.436	288.00	241.11	-46.89	289.33	1.33	317.64	29.64	381.17	93.17
975	79.74	105.012	292.50	242.53	-49.97	291.04	-1.46	319.39	26.89	383.27	90.77
990	80.208	105.564	297.00	243.95	-53.05	292.74	-4.26	321.07	24.07	385.29	88.29
1005	80.664	106.128	301.50	245.34	-56.16	294.41	-7.09	322.79	21.29	387.35	85.85
1020	81.12	106.68	306.00	246.73	-59.27	296.07	-9.93	324.47	18.47	389.36	83.36
1035	81.576	107.22	310.50	248.11	-62.39	297.74	-12.76	326.11	15.61	391.33	80.83
1050	82.02	107.76	315.00	249.46	-65.54	299.36	-15.64	327.75	12.75	393.30	78.30
1065	82.464	108.3	319.50	250.81	-68.69	300.98	-18.52	329.39	9.89	395.27	75.77
1080	82.896	108.828	324.00	252.13	-71.87	302.55	-21.45	331.00	7.00	397.20	73.20
1095	83.34	109.356	328.50	253.48	-75.02	304.17	-24.33	332.61	4.11	399.13	70.63
1110	83.772	109.872	333.00	254.79	-78.21	305.75	-27.25	334.18	1.18	401.01	68.01
1125	84.192	110.4	337.50	256.07	-81.43	307.28	-30.22	335.78	-1.72	402.94	65.44
1140	84.624	110.904	342.00	257.38	-84.62	308.86	-33.14	337.31	-4.69	404.78	62.78
1155	85.044	111.42	346.50	258.66	-87.84	310.39	-36.11	338.88	-7.62	406.66	60.16
1170	85.464	111.924	351.00	259.94	-91.06	311.93	-39.07	340.42	-10.58	408.50	57.50
1185	85.872	112.416	355.50	261.18	-94.32	313.42	-42.08	341.91	-13.59	410.30	54.80
1200	86.292	112.908	360.00	262.46	-97.54	314.95	-45.05	343.41	-16.59	412.09	52.09
1215	86.7	113.4	364.50	263.70	-100.80	316.44	-48.06	344.91	-19.59	413.89	49.39
1230	87.096	113.892	369.00	264.90	-104.10	317.88	-51.12	346.40	-22.60	415.68	46.68
1245	87.504	114.372	373.50	266.14	-107.36	319.37	-54.13	347.86	-25.64	417.43	43.93
1260	87.9	114.852	378.00	267.35	-110.65	320.82	-57.18	349.32	-28.68	419.19	41.19
1275	88.296	115.332	382.50	268.55	-113.95	322.26	-60.24	350.78	-31.72	420.94	38.44
1290	88.692	115.8	387.00	269.76	-117.24	323.71	-63.29	352.21	-34.79	422.65	35.65
1305	89.076	116.268	391.50	270.92	-120.58	325.11	-66.39	353.63	-37.87	424.35	32.85
1320	89.46	116.736	396.00	272.09	-123.91	326.51	-69.49	355.05	-40.95	426.06	30.06
1335	89.856	117.192	400.50	273.30	-127.20	327.96	-72.54	356.44	-44.06	427.73	27.23
1350	90.228	117.66	405.00	274.43	-130.57	329.31	-75.69	357.86	-47.14	429.44	24.44
1365	90.612	118.104	409.50	275.60	-133.90	330.72	-78.78	359.21	-50.29	431.06	21.56
1380	90.984	118.56	414.00	276.73	-137.27	332.07	-81.93	360.60	-53.40	432.72	18.72
1395	91.368	119.004	418.50	277.90	-140.60	333.47	-85.03	361.95	-56.55	434.34	15.84
1410	91.728	119.46	423.00	278.99	-144.01	334.79	-88.21	363.34	-59.66	436.01	13.01
1425	92.1	119.892	427.50	280.12	-147.38	336.15	-91.35	364.65	-62.85	437.58	10.08
1440	92.472	120.336	432.00	281.25	-150.75	337.50	-94.50	366.00	-66.00	439.20	7.20
1455	92.832	120.768	436.50	282.35	-154.15	338.82	-97.68	367.32	-69.18	440.78	4.28
1470	93.192	121.2	441.00	283.44	-157.56	340.13	-100.87	368.63	-72.37	442.36	1.36
1485	93.552	121.632	445.50	284.54	-160.96	341.45	-104.05	369.94	-75.56	443.93	-1.57
1500	93.912	122.064	450.00	285.63	-164.37	342.76	-107.24	371.26	-78.74	445.51	-4.49
1515	94.272	122.484	454.50	286.73	-167.77	344.07	-110.43	372.54	-81.96	447.04	-7.46
1530	94.62	122.904	459.00	287.79	-171.21	345.34	-113.66	373.81	-85.19	448.58	-10.42
1545	94.968	123.324	463.50	288.85	-174.65	346.61	-116.89	375.09	-88.41	450.11	-13.39
1560	95.316	123.744	468.00	289.90	-178.10	347.88	-120.12	376.37	-91.63	451.64	-16.36
1575	95.664	124.152	472.50	290.96	-181.54	349.15	-123.35	377.61	-94.89	453.13	-19.37
1590	96.012	124.572	477.00	292.02	-184.98	350.42	-126.58	378.89	-98.11	454.66	-22.34
1605	96.348	124.98	481.50	293.04	-188.46	351.65	-129.85	380.13	-101.37	456.15	-25.35
1620	96.696	125.388	486.00	294.10	-191.90	352.92	-133.08	381.37	-104.63	457.64	-28.36
1635	97.032	125.784	490.50	295.12	-195.38	354.15	-136.35	382.57	-107.93	459.09	-31.41
1650	97.368	126.192	495.00	296.14	-198.86	355.37	-139.63	383.81	-111.19	460.58	-34.42
1665	97.704	126.588	499.50	297.17	-202.33	356.60	-142.90	385.02	-114.48	462.02	-37.48
1680	98.04	126.984	504.00	298.19	-205.81	357.83	-146.17	386.22	-117.78	463.47	-40.53
1695	98.364	127.38	508.50	299.17	-209.33	359.01	-149.49	387.43	-121.07	464.91	-43.59
1710	98.7	127.764	513.00	300.20	-212.80	360.24	-152.76	388.59	-124.41	466.31	-46.69
1725	99.024	128.16	517.50	301.18	-216.32	361.42	-156.08	389.80	-127.70	467.76	-49.74
1740	99.348	128.544	522.00	302.17	-219.83	362.60	-159.40	390.97	-131.03	469.16	-52.84
1755	99.672	128.928	526.50	303.15	-223.35	363.78	-162.72	392.13	-134.37	470.56	-55.94
1770	99.996	129.312	531.00	304.14	-226.86	364.97	-166.03	393.30	-137.70	471.96	-59.04
1785	100.32	129.696	535.50	305.12	-230.38	366.15	-169.35	394.47	-141.03	473.36	-62.14
1800	100.632	130.08	540.00	306.07	-233.93	367.29	-172.71	395.64	-144.36	474.77	-65.23
1815	100.956	130.452	544.50	307.06	-237.44	368.47	-176.03	396.77	-147.73	476.12	-68.38
1830	101.268	130.824	549.00	308.01	-240.99	369.61	-179.39	397.90	-151.10	477.48	-71.52
1845	101.58	131.196	553.50	308.96	-244.54	370.75	-182.75	399.03	-154.47	478.84	-74.66
1860	101.892	131.568	558.00	309.90	-248.10	371.89	-186.11	400.16	-157.84	480.20	-77.80
1875	102.204	131.94	562.50	310.85	-251.65	373.02	-189.48	401.30	-161.20	481.55	-80.95
1890	102.516	132.312	567.00	311.80	-255.20	374.16	-192.84	402.43	-164.57	482.91	-84.09
1905	102.816	132.672	571.50	312.71	-258.79	375.26	-196.24	403.52	-167.98	484.23	-87.27
1920	103.128	133.032	576.00	313.66	-262.34	376.40	-199.60	404.62	-171.38	485.54	-90.46
1935	103.428	133.392	580.50	314.58	-265.92	377.49	-203.01	405.71	-174.79	486.85	-93.65
1950	103.728	133.752	585.00	315.49	-269.51	378.59	-206.41	406.81	-178.19	488.17	-96.83
1965	104.04	134.112	589.50	316.44	-273.06	379.73	-209.77	407.90	-181.60	489.48	-100.02
1980	104.34	134.472	594.00	317.35	-276.65	380.82	-213.18	409.00	-185.00	490.80	-103.20
1995	104.628	134.82	598.50	318.23	-280.27	381.87	-216.63	410.06	-188.44	492.07	-106.43
2010	104.928	135.18	603.00	319.14	-283.86	382.97	-220.03	411.15	-191.85	493.38	-109.62
2025	105.228	135.528	607.50	320.05	-287.45	384.06	-223.44	412.21	-195.29	494.65	-112.85
2040	105.516	135.876	612.00	320.93	-291.07	385.11	-226.89	413.27	-198.73	495.92	-116.08
2055	105.816	136.224	616.50	321.84	-294.66	386.21	-230.29	414.33	-202.17	497.19	-119.31
2070	106.104	136.572	621.00	322.72	-298.28	387.26	-233.74	415.38	-205.62	498.46	-122.54
2085	106.392	136.908	625.50	323.59	-301.91	388.31	-237.19	416.41	-209.09	499.69	-125.81
2100	106.692	137.256	630.00	324.50	-305.50	389.40	-240.60	417.46	-212.54	500.96	-129.04
2115	106.98	137.592	634.50	325.38	-309.12	390.46	-244.04	418.49	-216.01	502.18	-132.32
2130	107.256	137.928	639.00	326.22	-312.78	391.46	-247.54	419.51	-219.49	503.41	-135.59
2145	107.544	138.276	643.50	327.10	-316.40	392.51	-250.99	420.57	-222.93	504.68	-138.82
2160	107.832	138.612	648.00	327.97	-320.03	393.57	-254.43	421.59	-226.41	505.91	-142.09
2175	108.108	138.936	652.50	328.81	-323.69	394.57	-257.93	422.57	-229.93	507.09	-145.41
2190	108.396	139.272	657.00	329.69	-327.31	395.62	-261.38	423.60	-233.40	508.31	-148.69
2205	108.672	139.608	661.50	330.53	-330.97	396.63	-264.87	424.62	-236.88	509.54	-151.96
2220	108.96	139.932	666.00	331.40	-334.60	397.68	-268.32	425.60	-240.40	510.72	-155.28
2235	109.236	140.268	670.50	332.24	-338.26	398.69	-271.81	426.63	-243.87	511.95	-158.55
2250	109.512	140.592	675.00	333.08	-341.92	399.70	-275.30	427.61	-247.39	513.13	-161.87
2265	109.788	140.916	679.50	333.92	-345.58	400.70	-278.80	428.60	-250.90	514.32	-165.18
2280	110.064	141.24	684.00	334.76	-349.24	401.71	-282.29	429.58	-254.42	515.50	-168.50
2295	110.34	141.564	688.50	335.60	-352.90	402.72	-285.78	430.57	-257.93	516.68	-171.82

VERSION FEH CD-ROM Version 3 exported at 12:08:49 GMT Mon 25-Apr-16
Parameters
Calculation Design rainfall
Calculation Typical point in catchment
Calculation Catchment GB 435300 401400 SE 35300 01400
Catchment 1.48 km**2
Duration= 6 1 (hours)
Fixed durat no
Return peri 30 1 (years)
Annual ma: yes

c	d1	d2	d3	e	f
-0.025	0.37025	0.45878	0.23257	0.29609	2.38741

An areal reduction factor of 0.977 has been applied to a point rainfall of 49.5 mm to yield a catchment design rainfall of 48.3 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

Duration minutes	Duration hours	Duration days	10 year rainfall mm	20 year rainfall mm	50 year rainfall mm	100 year rainfall mm	200 year rainfall mm	500 year rainfall mm	30 year rainfall mm
15	0.25	0.010417	12.68	16.09	21.89	27.58	34.71	47.02	18.45
30	0.5	0.020833	16.05	20.11	26.94	33.52	41.69	55.59	22.9
45	0.75	0.03125	18.39	22.87	30.34	37.5	46.31	61.17	25.94
60	1	0.041667	20.23	25.04	33	40.57	49.86	65.42	28.31
75	1.25	0.052083	21.78	26.85	35.2	43.11	52.77	68.89	30.28
90	1.5	0.0625	23.13	28.42	37.1	45.3	55.27	71.85	31.99
105	1.75	0.072917	24.34	29.81	38.78	47.22	57.46	74.44	33.51
120	2	0.083333	25.42	31.07	40.29	48.95	59.42	76.75	34.88
135	2.25	0.09375	26.42	32.23	41.67	50.52	61.2	78.84	36.13
150	2.5	0.104167	27.35	33.29	42.94	51.96	62.84	80.75	37.28
165	2.75	0.114583	28.21	34.28	44.12	53.31	64.36	82.51	38.35
180	3	0.125	29.02	35.21	45.23	54.56	65.77	84.16	39.36
195	3.25	0.135417	29.79	36.09	46.27	55.74	67.09	85.7	40.3
210	3.5	0.145833	30.51	36.92	47.25	56.85	68.34	87.14	41.2
225	3.75	0.15625	31.21	37.71	48.18	57.9	69.53	88.51	42.05
240	4	0.166667	31.87	38.46	49.07	58.9	70.65	89.81	42.86
255	4.25	0.177083	32.5	39.18	49.92	59.86	71.72	91.04	43.64
270	4.5	0.1875	33.11	39.88	50.73	60.77	72.74	92.22	44.38
285	4.75	0.197917	33.69	40.54	51.52	61.65	73.72	93.34	45.1
300	5	0.208333	34.25	41.18	52.27	62.49	74.66	94.43	45.78
315	5.25	0.21875	34.8	41.8	52.99	63.3	75.57	95.46	46.45
330	5.5	0.229167	35.33	42.4	53.69	64.09	76.44	96.47	47.09
345	5.75	0.239583	35.84	42.98	54.37	64.84	77.29	97.43	47.71
360	6	0.25	36.33	43.54	55.02	65.58	78.1	98.36	48.31
375	6.25	0.260417	36.81	44.08	55.66	66.29	78.89	99.27	48.9
390	6.5	0.270833	37.28	44.61	56.28	66.98	79.66	100.14	49.46
405	6.75	0.28125	37.74	45.13	56.88	67.65	80.4	100.99	50.02
420	7	0.291667	38.19	45.63	57.46	68.3	81.13	101.81	50.55
435	7.25	0.302083	38.62	46.12	58.03	68.93	81.83	102.61	51.08
450	7.5	0.3125	39.04	46.6	58.59	69.55	82.52	103.39	51.59
465	7.75	0.322917	39.46	47.06	59.13	70.15	83.18	104.15	52.09
480	8	0.333333	39.86	47.52	59.66	70.74	83.84	104.89	52.58
495	8.25	0.34375	40.26	47.97	60.17	71.32	84.47	105.61	53.05
510	8.5	0.354167	40.65	48.4	60.68	71.88	85.09	106.31	53.52
525	8.75	0.364583	41.03	48.83	61.18	72.43	85.7	107	53.98
540	9	0.375	41.4	49.25	61.66	72.97	86.3	107.68	54.42
555	9.25	0.385417	41.77	49.66	62.14	73.5	86.88	108.33	54.86
570	9.5	0.395833	42.13	50.07	62.6	74.01	87.45	108.98	55.29
585	9.75	0.40625	42.48	50.46	63.06	74.52	88.01	109.61	55.72
600	10	0.416667	42.83	50.85	63.51	75.02	88.56	110.23	56.13
615	10.25	0.427083	43.17	51.23	63.95	75.5	89.09	110.83	56.54
630	10.5	0.4375	43.51	51.61	64.38	75.98	89.62	111.43	56.94
645	10.75	0.447917	43.84	51.98	64.81	76.45	90.14	112.01	57.33
660	11	0.458333	44.16	52.34	65.22	76.92	90.65	112.59	57.72
675	11.25	0.46875	44.48	52.7	65.64	77.37	91.15	113.15	58.1
690	11.5	0.479167	44.79	53.05	66.04	77.82	91.64	113.7	58.48
705	11.75	0.489583	45.11	53.4	66.44	78.26	92.12	114.25	58.84
720	12	0.5	45.41	53.74	66.83	78.69	92.6	114.78	59.21
735	12.25	0.510417	45.8	54.18	67.34	79.26	93.24	115.52	59.67
750	12.5	0.520833	46.18	54.61	67.84	79.82	93.87	116.24	60.14
765	12.75	0.53125	46.55	55.03	68.34	80.38	94.49	116.96	60.59

780	13	0.541667	46.92	55.45	68.83	80.93	95.1	117.67	61.04
795	13.25	0.552083	47.29	55.86	69.31	81.47	95.71	118.36	61.48
810	13.5	0.5625	47.65	56.27	69.79	82.01	96.3	119.05	61.92
825	13.75	0.572917	48.01	56.68	70.26	82.54	96.89	119.73	62.36
840	14	0.583333	48.37	57.08	70.73	83.06	97.48	120.4	62.79
855	14.25	0.59375	48.72	57.48	71.19	83.57	98.05	121.06	63.21
870	14.5	0.604167	49.07	57.87	71.65	84.08	98.62	121.72	63.63
885	14.75	0.614583	49.41	58.26	72.1	84.59	99.18	122.36	64.05
900	15	0.625	49.75	58.64	72.55	85.09	99.74	123	64.46
915	15.25	0.635417	50.09	59.02	72.99	85.58	100.29	123.63	64.86
930	15.5	0.645833	50.42	59.4	73.43	86.07	100.83	124.26	65.27
945	15.75	0.65625	50.75	59.77	73.86	86.55	101.37	124.87	65.66
960	16	0.666667	51.08	60.14	74.29	87.03	101.9	125.48	66.06
975	16.25	0.677083	51.41	60.5	74.71	87.51	102.43	126.09	66.45
990	16.5	0.6875	51.73	60.87	75.13	87.97	102.95	126.68	66.84
1005	16.75	0.697917	52.05	61.22	75.55	88.44	103.47	127.27	67.22
1020	17	0.708333	52.36	61.58	75.96	88.9	103.98	127.86	67.6
1035	17.25	0.71875	52.67	61.93	76.37	89.35	104.48	128.44	67.98
1050	17.5	0.729167	52.99	62.28	76.77	89.8	104.99	129.01	68.35
1065	17.75	0.739583	53.29	62.63	77.17	90.25	105.48	129.58	68.72
1080	18	0.75	53.6	62.97	77.57	90.69	105.97	130.14	69.08
1095	18.25	0.760417	53.9	63.31	77.96	91.13	106.46	130.7	69.45
1110	18.5	0.770833	54.2	63.65	78.35	91.56	106.94	131.25	69.81
1125	18.75	0.78125	54.5	63.98	78.74	92	107.42	131.79	70.16
1140	19	0.791667	54.79	64.31	79.13	92.42	107.89	132.33	70.52
1155	19.25	0.802083	55.09	64.64	79.51	92.85	108.36	132.87	70.87
1170	19.5	0.8125	55.38	64.97	79.88	93.27	108.83	133.4	71.22
1185	19.75	0.822917	55.67	65.29	80.26	93.68	109.29	133.93	71.56
1200	20	0.833333	55.95	65.61	80.63	94.09	109.75	134.45	71.91
1215	20.25	0.84375	56.24	65.93	81	94.5	110.2	134.97	72.25
1230	20.5	0.854167	56.52	66.25	81.36	94.91	110.65	135.48	72.58
1245	20.75	0.864583	56.8	66.56	81.72	95.31	111.1	135.99	72.92
1260	21	0.875	57.08	66.87	82.08	95.71	111.54	136.49	73.25
1275	21.25	0.885417	57.36	67.18	82.44	96.11	111.98	136.99	73.58
1290	21.5	0.895833	57.63	67.49	82.8	96.5	112.41	137.49	73.91
1305	21.75	0.90625	57.9	67.79	83.15	96.89	112.84	137.98	74.23
1320	22	0.916667	58.17	68.1	83.5	97.28	113.27	138.47	74.55
1335	22.25	0.927083	58.44	68.4	83.84	97.66	113.7	138.95	74.88
1350	22.5	0.9375	58.71	68.7	84.19	98.05	114.12	139.43	75.19
1365	22.75	0.947917	58.97	68.99	84.53	98.42	114.54	139.91	75.51
1380	23	0.958333	59.24	69.29	84.87	98.8	114.96	140.38	75.82
1395	23.25	0.96875	59.5	69.58	85.21	99.17	115.37	140.85	76.14
1410	23.5	0.979167	59.76	69.87	85.54	99.55	115.78	141.32	76.44
1425	23.75	0.989583	60.02	70.16	85.87	99.91	116.19	141.78	76.75
1440	24	1	60.27	70.45	86.2	100.28	116.59	142.24	77.06
1455	24.25	1.010417	60.53	70.73	86.53	100.64	116.99	142.69	77.36
1470	24.5	1.020833	60.78	71.01	86.86	101	117.39	143.15	77.66
1485	24.75	1.03125	61.04	71.3	87.18	101.36	117.79	143.59	77.96
1500	25	1.041667	61.29	71.58	87.5	101.72	118.18	144.04	78.26
1515	25.25	1.052083	61.53	71.85	87.82	102.07	118.57	144.48	78.56
1530	25.5	1.0625	61.78	72.13	88.14	102.42	118.96	144.92	78.85
1545	25.75	1.072917	62.03	72.4	88.45	102.77	119.34	145.36	79.14
1560	26	1.083333	62.27	72.68	88.77	103.12	119.73	145.79	79.43
1575	26.25	1.09375	62.52	72.95	89.08	103.46	120.11	146.23	79.72
1590	26.5	1.104167	62.76	73.22	89.39	103.81	120.48	146.65	80.01
1605	26.75	1.114583	63	73.49	89.7	104.15	120.86	147.08	80.29
1620	27	1.125	63.24	73.75	90	104.49	121.23	147.5	80.58
1635	27.25	1.135417	63.48	74.02	90.31	104.82	121.6	147.92	80.86
1650	27.5	1.145833	63.71	74.28	90.61	105.16	121.97	148.34	81.14
1665	27.75	1.15625	63.95	74.55	90.91	105.49	122.34	148.75	81.42
1680	28	1.166667	64.18	74.81	91.21	105.82	122.7	149.17	81.7
1695	28.25	1.177083	64.42	75.07	91.51	106.15	123.06	149.57	81.97
1710	28.5	1.1875	64.65	75.32	91.8	106.47	123.42	149.98	82.25
1725	28.75	1.197917	64.88	75.58	92.1	106.8	123.78	150.39	82.52
1740	29	1.208333	65.11	75.84	92.39	107.12	124.14	150.79	82.79
1755	29.25	1.21875	65.34	76.09	92.68	107.44	124.49	151.19	83.06
1770	29.5	1.229167	65.56	76.34	92.97	107.76	124.84	151.59	83.33
1785	29.75	1.239583	65.79	76.59	93.26	108.08	125.19	151.98	83.6
1800	30	1.25	66.01	76.84	93.54	108.4	125.54	152.37	83.86

1815	30.25	1.260417	66.24	77.09	93.83	108.71	125.88	152.76	84.13
1830	30.5	1.270833	66.46	77.34	94.11	109.02	126.23	153.15	84.39
1845	30.75	1.28125	66.68	77.59	94.39	109.33	126.57	153.54	84.65
1860	31	1.291667	66.9	77.83	94.67	109.64	126.91	153.92	84.91
1875	31.25	1.302083	67.12	78.07	94.95	109.95	127.25	154.3	85.17
1890	31.5	1.3125	67.34	78.32	95.23	110.26	127.58	154.68	85.43
1905	31.75	1.322917	67.55	78.56	95.5	110.56	127.92	155.06	85.68
1920	32	1.333333	67.77	78.8	95.78	110.86	128.25	155.43	85.94
1935	32.25	1.34375	67.99	79.04	96.05	111.16	128.58	155.81	86.19
1950	32.5	1.354167	68.2	79.28	96.32	111.46	128.91	156.18	86.44
1965	32.75	1.364583	68.41	79.51	96.59	111.76	129.24	156.55	86.7
1980	33	1.375	68.63	79.75	96.86	112.06	129.56	156.91	86.95
1995	33.25	1.385417	68.84	79.98	97.13	112.35	129.89	157.28	87.19
2010	33.5	1.395833	69.05	80.22	97.4	112.65	130.21	157.64	87.44
2025	33.75	1.40625	69.26	80.45	97.66	112.94	130.53	158	87.69
2040	34	1.416667	69.46	80.68	97.93	113.23	130.85	158.36	87.93
2055	34.25	1.427083	69.67	80.91	98.19	113.52	131.17	158.72	88.18
2070	34.5	1.4375	69.88	81.14	98.45	113.81	131.48	159.08	88.42
2085	34.75	1.447917	70.08	81.37	98.71	114.09	131.8	159.43	88.66
2100	35	1.458333	70.29	81.6	98.97	114.38	132.11	159.78	88.91
2115	35.25	1.46875	70.49	81.82	99.23	114.66	132.42	160.14	89.15
2130	35.5	1.479167	70.7	82.05	99.49	114.94	132.73	160.48	89.38
2145	35.75	1.489583	70.9	82.27	99.74	115.23	133.04	160.83	89.62
2160	36	1.5	71.1	82.49	100	115.51	133.35	161.18	89.86
2175	36.25	1.510417	71.3	82.72	100.25	115.78	133.66	161.52	90.09
2190	36.5	1.520833	71.5	82.94	100.5	116.06	133.96	161.86	90.33
2205	36.75	1.53125	71.7	83.16	100.75	116.34	134.26	162.2	90.56
2220	37	1.541667	71.9	83.38	101	116.61	134.56	162.54	90.8
2235	37.25	1.552083	72.09	83.6	101.25	116.89	134.86	162.88	91.03
2250	37.5	1.5625	72.29	83.81	101.5	117.16	135.16	163.22	91.26
2265	37.75	1.572917	72.49	84.03	101.75	117.43	135.46	163.55	91.49
2280	38	1.583333	72.68	84.25	101.99	117.7	135.76	163.88	91.72
2295	38.25	1.59375	72.88	84.46	102.24	117.97	136.05	164.21	91.95
2310	38.5	1.604167	73.07	84.68	102.48	118.24	136.34	164.54	92.17
2325	38.75	1.614583	73.26	84.89	102.72	118.5	136.64	164.87	92.4
2340	39	1.625	73.45	85.1	102.97	118.77	136.93	165.2	92.62
2355	39.25	1.635417	73.65	85.31	103.21	119.03	137.22	165.52	92.85
2370	39.5	1.645833	73.84	85.53	103.45	119.3	137.51	165.85	93.07
2385	39.75	1.65625	74.03	85.74	103.69	119.56	137.79	166.17	93.29
2400	40	1.666667	74.21	85.95	103.92	119.82	138.08	166.49	93.52
2415	40.25	1.677083	74.4	86.15	104.16	120.08	138.36	166.81	93.74
2430	40.5	1.6875	74.59	86.36	104.4	120.34	138.65	167.13	93.96
2445	40.75	1.697917	74.78	86.57	104.63	120.6	138.93	167.44	94.18
2460	41	1.708333	74.96	86.77	104.87	120.86	139.21	167.76	94.39
2475	41.25	1.71875	75.15	86.98	105.1	121.11	139.49	168.07	94.61
2490	41.5	1.729167	75.33	87.18	105.33	121.37	139.77	168.39	94.83
2505	41.75	1.739583	75.52	87.39	105.56	121.62	140.05	168.7	95.04
2520	42	1.75	75.7	87.59	105.79	121.87	140.33	169.01	95.26
2535	42.25	1.760417	75.89	87.79	106.02	122.13	140.6	169.32	95.47
2550	42.5	1.770833	76.07	88	106.25	122.38	140.88	169.63	95.69
2565	42.75	1.78125	76.25	88.2	106.48	122.63	141.15	169.93	95.9
2580	43	1.791667	76.43	88.4	106.71	122.88	141.42	170.24	96.11
2595	43.25	1.802083	76.61	88.6	106.93	123.12	141.69	170.54	96.32
2610	43.5	1.8125	76.79	88.79	107.16	123.37	141.96	170.84	96.53
2625	43.75	1.822917	76.97	88.99	107.38	123.62	142.23	171.14	96.74
2640	44	1.833333	77.15	89.19	107.61	123.86	142.5	171.45	96.95
2655	44.25	1.84375	77.33	89.39	107.83	124.11	142.77	171.74	97.16
2670	44.5	1.854167	77.5	89.58	108.05	124.35	143.03	172.04	97.37
2685	44.75	1.864583	77.68	89.78	108.27	124.59	143.3	172.34	97.57
2700	45	1.875	77.86	89.97	108.5	124.84	143.56	172.63	97.78
2715	45.25	1.885417	78.03	90.17	108.72	125.08	143.83	172.93	97.98
2730	45.5	1.895833	78.21	90.36	108.93	125.32	144.09	173.22	98.19
2745	45.75	1.90625	78.38	90.55	109.15	125.56	144.35	173.51	98.39
2760	46	1.916667	78.56	90.74	109.37	125.79	144.61	173.81	98.59
2775	46.25	1.927083	78.73	90.94	109.59	126.03	144.87	174.1	98.8
2790	46.5	1.9375	78.9	91.13	109.8	126.27	145.13	174.38	99
2805	46.75	1.947917	79.07	91.32	110.02	126.5	145.38	174.67	99.2
2820	47	1.958333	79.25	91.51	110.23	126.74	145.64	174.96	99.4
2835	47.25	1.96875	79.42	91.69	110.45	126.97	145.9	175.24	99.6

SuDS Storage Volume Calculator - Summary

Design Parameters:

Site Impermeable Area	3,318	m^2
Design run-off rate	5	l/s
Climate change increase	40	%
Site area increase due to urban expansion	10	%

Calculation Outputs:

Storm event	Maximum Discharge Rate	Minimum Storage Volume	Maximum Storage Volume	Average Storage Volume
	l/sec	m^3	m^3	m^3
3.33% AEP	5	62.84	91.37	77.10
3.33% AEP plus Climate Change	5	89.77	147.52	118.65
1% AEP	5	96.16	145.13	120.65
1% AEP plus Climate Change	5	136.43	229.52	182.97

Discharge from First 5mm of Rainfall (m^3)	18.25

SuDS Storage Volume Calculations

Duration	Rainfall with Climate Change 3.33% AEP + CC	Rainfall with Climate Change 1% AEP + CC	Outfall Volume $(Design\ Runoff\ Rate \times Storm\ duration) \times 1000$	3.33% AEP Storage Volume $(Impermeable\ Area \times Urban\ expansion) \times (3.33\%\ AEP\ Rainfall\ Depth \div 1000)$	3.33% AEP Net Storage Volume 3.33% AEP Volume − Outfall Volume	3.33% AEP CC Storage Volume $(Impermeable\ Area \times Urban\ expansion) \times (3.33\%\ AEP + CC\ Rainfall\ Depth) \div 1000)$	3.33% AEP CC Net Storage Volume 3.33% AEP + CC Volume	1% AEP Storage Volume $(Impermeable\ Area \times Urban\ expansion) \times (1\%\ AEP\ Rainfall\ Depth \div 1000)$	1% AEP Net Storage Volume 1% AEP Volume − Outfall Volume	1% AEP CC Volume $(Impermeable\ Area \times Urban\ expansion) \times (1\%\ AEP + CC\ Rainfall\ Depth \div 1000)$	1% AEP CC Net Storage Volume 1% AEP +CC Volume − Outfall Volume
minutes	mm	mm	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
15	25.83	38.612	4.50	67.34	62.84	94.27	89.77	100.66	96.16	140.93	136.43
30	32.06	46.928	9.00	83.58	74.58	117.01	108.01	122.34	113.34	171.28	162.28
45	36.316	52.5	13.50	94.68	81.18	132.55	119.05	136.87	123.37	191.61	178.11
60	39.634	56.798	18.00	103.33	85.33	144.66	126.66	148.07	130.07	207.30	189.30
120	48.832	68.53	36.00	127.31	91.31	178.23	142.23	178.66	142.66	250.12	214.12
180	55.104	76.384	54.00	143.66	89.66	201.12	147.12	199.13	145.13	278.79	224.79
240	60.004	82.46	72.00	156.43	84.43	219.00	147.00	214.97	142.97	300.96	228.96
255	61.096	83.804	76.50	159.28	82.78	222.99	146.49	218.48	141.98	305.87	229.37
270	62.132	85.078	81.00	161.98	80.98	226.77	145.77	221.80	140.80	310.52	229.52
285	63.14	86.31	85.50	164.61	79.11	230.45	144.95	225.01	139.51	315.01	229.51
300	64.092	87.486	90.00	167.09	77.09	233.92	143.92	228.08	138.08	319.31	229.31
315	65.03	88.62	94.50	169.53	75.03	237.35	142.85	231.03	136.53	323.45	228.95
330	65.926	89.726	99.00	171.87	72.87	240.62	141.62	233.92	134.92	327.48	228.48
345	66.794	90.776	103.50	174.13	70.63	243.78	140.28	236.65	133.15	331.31	227.81
360	67.634	91.812	108.00	176.32	68.32	246.85	138.85	239.35	131.35	335.10	227.10
375	68.46	92.806	112.50	178.48	65.98	249.87	137.37	241.95	129.45	338.72	226.22
390	69.244	93.772	117.00	180.52	63.52	252.73	135.73	244.46	127.46	342.25	225.25
405	70.028	94.71	121.50	182.56	61.06	255.59	134.09	246.91	125.41	345.67	224.17
420	70.77	95.62	126.00	184.50	58.50	258.30	132.30	249.28	123.28	348.99	222.99
435	71.512	96.502	130.50	186.43	55.93	261.00	130.50	251.58	121.08	352.21	221.71
450	72.226	97.37	135.00	188.29	53.29	263.61	128.61	253.84	118.84	355.38	220.38
465	72.926	98.21	139.50	190.12	50.62	266.17	126.67	256.03	116.53	358.45	218.95
480	73.612	99.036	144.00	191.91	47.91	268.67	124.67	258.19	114.19	361.46	217.46
495	74.27	99.848	148.50	193.62	45.12	271.07	122.57	260.30	111.80	364.43	215.93
510	74.928	100.632	153.00	195.34	42.34	273.47	120.47	262.35	109.35	367.29	214.29
525	75.572	101.402	157.50	197.02	39.52	275.82	118.32	264.36	106.86	370.10	212.60
540	76.188	102.158	162.00	198.62	36.62	278.07	116.07	266.33	104.33	372.86	210.86
555	76.804	102.9	166.50	200.23	33.73	280.32	113.82	268.26	101.76	375.56	209.06
570	77.406	103.614	171.00	201.80	30.80	282.52	111.52	270.12	99.12	378.17	207.17
585	78.008	104.328	175.50	203.37	27.87	284.71	109.21	271.98	96.48	380.78	205.28
600	78.582	105.028	180.00	204.86	24.86	286.81	106.81	273.81	93.81	383.33	203.33
615	79.156	105.7	184.50	206.36	21.86	288.90	104.40	275.56	91.06	385.78	201.28
630	79.716	106.372	189.00	207.82	18.82	290.95	101.95	277.31	88.31	388.24	199.24
645	80.262	107.03	193.50	209.24	15.74	292.94	99.44	279.03	85.53	390.64	197.14
660	80.808	107.688	198.00	210.67	12.67	294.93	96.93	280.74	82.74	393.04	195.04
675	81.34	108.318	202.50	212.05	9.55	296.87	94.37	282.39	79.89	395.34	192.84
690	81.872	108.948	207.00	213.44	6.44	298.82	91.82	284.03	77.03	397.64	190.64
705	82.376	109.564	211.50	214.75	3.25	300.66	89.16	285.63	74.13	399.89	188.39
720	82.894	110.166	216.00	216.10	0.10	302.55	86.55	287.20	71.20	402.08	186.08
735	83.538	110.964	220.50	217.78	-2.72	304.90	84.40	289.28	68.78	405.00	184.50
750	84.196	111.748	225.00	219.50	-5.50	307.30	82.30	291.33	66.33	407.86	182.86
765	84.826	112.532	229.50	221.14	-8.36	309.60	80.10	293.37	63.87	410.72	181.22
780	85.456	113.302	234.00	222.78	-11.22	311.90	77.90	295.38	61.38	413.53	179.53
795	86.072	114.058	238.50	224.39	-14.11	314.15	75.65	297.35	58.85	416.29	177.79
810	86.688	114.814	243.00	226.00	-17.00	316.39	73.39	299.32	56.32	419.05	176.05
825	87.304	115.556	247.50	227.60	-19.90	318.64	71.14	301.25	53.75	421.76	174.26
840	87.906	116.284	252.00	229.17	-22.83	320.84	68.84	303.15	51.15	424.41	172.41
855	88.494	116.998	256.50	230.70	-25.80	322.99	66.49	305.01	48.51	427.02	170.52
870	89.082	117.712	261.00	232.24	-28.76	325.13	64.13	306.88	45.88	429.63	168.63
885	89.67	118.426	265.50	233.77	-31.73	327.28	61.78	308.74	43.24	432.23	166.73
900	90.244	119.126	270.00	235.27	-34.73	329.37	59.37	310.56	40.56	434.79	164.79
915	90.804	119.812	274.50	236.73	-37.77	331.42	56.92	312.35	37.85	437.29	162.79
930	91.378	120.498	279.00	238.22	-40.78	333.51	54.51	314.14	35.14	439.79	160.79
945	91.924	121.17	283.50	239.65	-43.85	335.50	52.00	315.89	32.39	442.25	158.75
960	92.484	121.842	288.00	241.11	-46.89	337.55	49.55	317.64	29.64	444.70	156.70
975	93.03	122.514	292.50	242.53	-49.97	339.54	47.04	319.39	26.89	447.15	154.65
990	93.576	123.158	297.00	243.95	-53.05	341.53	44.53	321.07	24.07	449.50	152.50
1005	94.108	123.816	301.50	245.34	-56.16	343.48	41.98	322.79	21.29	451.90	150.40
1020	94.64	124.46	306.00	246.73	-59.27	345.42	39.42	324.47	18.47	454.25	148.25
1035	95.172	125.09	310.50	248.11	-62.39	347.36	36.86	326.11	15.61	456.55	146.05
1050	95.69	125.72	315.00	249.46	-65.54	349.25	34.25	327.75	12.75	458.85	143.85
1065	96.208	126.35	319.50	250.81	-68.69	351.14	31.64	329.39	9.89	461.15	141.65
1080	96.712	126.966	324.00	252.13	-71.87	352.98	28.98	331.00	7.00	463.40	139.40
1095	97.23	127.582	328.50	253.48	-75.02	354.87	26.37	332.61	4.11	465.65	137.15
1110	97.734	128.184	333.00	254.79	-78.21	356.71	23.71	334.18	1.18	467.85	134.85
1125	98.224	128.8	337.50	256.07	-81.43	358.50	21.00	335.78	-1.72	470.09	132.59
1140	98.728	129.388	342.00	257.38	-84.62	360.34	18.34	337.31	-4.69	472.24	130.24
1155	99.218	129.99	346.50	258.66	-87.84	362.13	15.63	338.88	-7.62	474.44	127.94
1170	99.708	130.578	351.00	259.94	-91.06	363.91	12.91	340.42	-10.58	476.58	125.58
1185	100.184	131.152	355.50	261.18	-94.32	365.65	10.15	341.91	-13.59	478.68	123.18
1200	100.674	131.726	360.00	262.46	-97.54	367.44	7.44	343.41	-16.59	480.77	120.77
1215	101.15	132.3	364.50	263.70	-100.80	369.18	4.68	344.91	-19.59	482.87	118.37
1230	101.612	132.874	369.00	264.90	-104.10	370.86	1.86	346.40	-22.60	484.96	115.96
1245	102.088	133.434	373.50	266.14	-107.36	372.60	-0.90	347.86	-25.64	487.01	113.51
1260	102.55	133.994	378.00	267.35	-110.65	374.29	-3.71	349.32	-28.68	489.05	111.05
1275	103.012	134.554	382.50	268.55	-113.95	375.97	-6.53	350.78	-31.72	491.10	108.60
1290	103.474	135.1	387.00	269.76	-117.24	377.66	-9.34	352.21	-34.79	493.09	106.09
1305	103.922	135.646	391.50	270.92	-120.58	379.29	-12.21	353.63	-37.87	495.08	103.58
1320	104.37	136.192	396.00	272.09	-123.91	380.93	-15.07	355.05	-40.95	497.07	101.07
1335	104.832	136.724	400.50	273.30	-127.20	382.62	-17.88	356.44	-44.06	499.02	98.52
1350	105.266	137.27	405.00	274.43	-130.57	384.20	-20.80	357.86	-47.14	501.01	96.01
1365	105.714	137.788	409.50	275.60	-133.90	385.83	-23.67	359.21	-50.29	502.90	93.40
1380	106.148	138.32	414.00	276.73	-137.27	387.42	-26.58	360.60	-53.40	504.84	90.84
1395	106.596	138.838	418.50	277.90	-140.60	389.05	-29.45	361.95	-56.55	506.73	88.23
1410	107.016	139.37	423.00	278.99	-144.01	390.59	-32.41	363.34	-59.66	508.67	85.67
1425	107.45	139.874	427.50	280.12	-147.38	392.17	-35.33	364.65	-62.85	510.51	83.01
1440	107.884	140.392	432.00	281.25	-150.75	393.76	-38.24	366.00	-66.00	512.40	80.40
1455	108.304	140.896	436.50	282.35	-154.15	395.29	-41.21	367.32	-69.18	514.24	77.74
1470	108.724	141.4	441.00	283.44	-157.56	396.82	-44.18	368.63	-72.37	516.08	75.08
1485	109.144	141.904	445.50	284.54	-160.96	398.35	-47.15	369.94	-75.56	517.92	72.42
1500	109.564	142.408	450.00	285.63	-164.37	399.89	-50.11	371.26	-78.74	519.76	69.76
1515	109.984	142.898	454.50	286.73	-167.77	401.42	-53.08	372.54	-81.96	521.55	67.05
1530	110.39	143.388	459.00	287.79	-171.21	402.90	-56.10	373.81	-85.19	523.34	64.34
1545	110.796	143.878	463.50	288.85	-174.65	404.38	-59.12	375.09	-88.41	525.13	61.63
1560	111.202	144.368	468.00	289.90	-178.10	405.87	-62.13	376.37	-91.63	526.91	58.91
1575	111.608	144.844	472.50	290.96	-181.54	407.35	-65.15	377.61	-94.89	528.65	56.15
1590	112.014	145.334	477.00	292.02	-184.98	408.83	-68.17	378.89	-98.11	530.44	53.44
1605	112.406	145.81	481.50	293.04	-188.46	410.26	-71.24	380.13	-101.37	532.18	50.68
1620	112.812	146.286	486.00	294.10	-191.90	411.74	-74.26	381.37	-104.63	533.91	47.91
1635	113.204	146.748	490.50	295.12	-195.38	413.17	-77.33	382.57	-107.93	535.60	45.10
1650	113.596	147.224	495.00	296.14	-198.86	414.60	-80.40	383.81	-111.19	537.34	42.34
1665	113.988	147.686	499.50	297.17	-202.33	416.03	-83.47	385.02	-114.48	539.02	39.52
1680	114.38	148.148	504.00	298.19	-205.81	417.46	-86.54	386.22	-117.78	540.71	36.71
1695	114.758	148.61	508.50	299.17	-209.33	418.84	-89.66	387.43	-121.07	542.40	33.90
1710	115.15	149.058	513.00	300.20	-212.80	420.27	-92.73	388.59	-124.41	544.03	31.03
1725	115.528	149.52	517.50	301.18	-216.32	421.65	-95.85	389.80	-127.70	545.72	28.22
1740	115.906	149.968	522.00	302.17	-219.83	423.03	-98.97	390.97	-131.03	547.35	25.35
1755	116.284	150.416	526.50	303.15	-223.35	424.41	-102.09	392.13	-134.37	548.99	22.49
1770	116.662	150.864	531.00	304.14	-226.86	425.79	-105.21	393.30	-137.70	550.62	19.62
1785	117.04	151.312	535.50	305.12	-230.38	427.17	-108.33	394.47	-141.03	552.26	16.76
1800	117.404	151.76	540.00	306.07	-233.93	428.50	-111.50	395.64	-144.36	553.89	13.89
1815	117.782	152.194	544.50	307.06	-237.44	429.88	-114.62	396.77	-147.73	555.48	10.98
1830	118.146	152.628	549.00	308.01	-240.99	431.21	-117.79	397.90	-151.10	557.06	8.06
1845	118.51	153.062	553.50	308.96	-244.54	432.54	-120.96	399.03	-154.47	558.65	5.15
1860	118.874	153.496	558.00	309.90	-248.10	433.87	-124.13	400.16	-157.84	560.23	2.23
1875	119.238	153.93	562.50	310.85	-251.65	435.19	-127.31	401.30	-161.20	561.81	-0.69
1890	119.602	154.364	567.00	311.80	-255.20	436.52	-130.48	402.43	-164.57	563.40	-3.60
1905	119.952	154.784	571.50	312.71	-258.79	437.80	-133.70	403.52	-167.98	564.93	-6.57
1920	120.316	155.204	576.00	313.66	-262.34	439.13	-136.87	404.62	-171.38	566.46	-9.54
1935	120.666	155.624	580.50	314.58	-265.92	440.41	-140.09	405.71	-174.79	568.00	-12.50
1950	121.016	156.044	585.00	315.49	-269.51	441.68	-143.32	406.81	-178.19	569.53	-15.47
1965	121.38	156.464	589.50	316.44	-273.06	443.01	-146.49	407.90	-181.60	571.06	-18.44
1980	121.73	156.884	594.00	317.35	-276.65	444.29	-149.71	409.00	-185.00	572.60	-21.40
1995	122.066	157.29	598.50	318.23	-280.27	445.52	-152.98	410.06	-188.44	574.08	-24.42
2010	122.416	157.71	603.00	319.14	-283.86	446.79	-156.21	411.15	-191.85	575.61	-27.39
2025	122.766	158.116	607.50	320.05	-287.45	448.07	-159.43	412.21	-195.29	577.09	-30.41
2040	123.102	158.522	612.00	320.93	-291.07	449.30	-162.70	413.27	-198.73	578.57	-33.43
2055	123.452	158.928	616.50	321.84	-294.66	450.58	-165.92	414.33	-202.17	580.06	-36.44
2070	123.788	159.334	621.00	322.72	-298.28	451.80	-169.20	415.38	-205.62	581.54	-39.46
2085	124.124	159.726	625.50	323.59	-301.91	453.03	-172.47	416.41	-209.09	582.97	-42.53
2100	124.474	160.132	630.00	324.50	-305.50	454.31	-175.69	417.46	-212.54	584.45	-45.55
2115	124.81	160.524	634.50	325.38	-309.12	455.53	-178.97	418.49	-216.01	585.88	-48.62
2130	125.132	160.916	639.00	326.22	-312.78	456.71	-182.29	419.51	-219.49	587.31	-51.69
2145	125.468	161.322	643.50	327.10	-316.40	457.93	-185.57	420.57	-222.93	588.79	-54.71
2160	125.804	161.714	648.00	327.97	-320.03	459.16	-188.84	421.59	-226.41	590.22	-57.78
2175	126.126	162.092	652.50	328.81	-323.69	460.33	-192.17	422.57	-229.93	591.60	-60.90
2190	126.462	162.484	657.00	329.69	-327.31	461.56	-195.44	423.60	-233.40	593.03	-63.97
2205	126.784	162.876	661.50	330.53	-330.97	462.74	-198.76	424.62	-236.88	594.46	-67.04
2220	127.12	163.254	666.00	331.40	-334.60	463.96	-202.04	425.60	-240.40	595.84	-70.16
2235	127.442	163.646	670.50	332.24	-338.26	465.14	-205.36	426.63	-243.87	597.28	-73.22
2250	127.764	164.024	675.00	333.08	-341.92	466.31	-208.69	427.61	-247.39	598.65	-76.35
2265	128.086	164.402	679.50	333.92	-345.58	467.49	-212.01	428.60	-250.90	600.03	-79.47
2280	128.408	164.78	684.00	334.76	-349.24	468.66	-215.34	429.58	-254.42	601.41	-82.59
2295	128.73	165.158	688.50	335.60	-352.90	469.84	-218.66	430.57	-257.93	602.79	-85.71

VERSION FEH CD-ROM Version 3 exported at 12:08:49 GMT Mon 25-Apr-16
Parameters
Calculation Design rainfall
Calculation Typical point in catchment
Calculation Catchment GB 435300 401400 SE 35300 01400
Catchment 1.48 km**2
Duration= 6 1 (hours)
Fixed durat no
Return peri 30 1 (years)
Annual ma: yes

c	d1	d2	d3	e	f
-0.025	0.37025	0.45878	0.23257	0.29609	2.38741

An areal reduction factor of 0.977 has been applied to a point rainfall of 49.5 mm to yield a catchment design rainfall of 48.3 mm.
No warning(s) or note(s) were present for this calculation.
The data in the following table have been computed using sliding durations.

Duration minutes	Duration hours	Duration days	10 year rainfall mm	20 year rainfall mm	50 year rainfall mm	100 year rainfall mm	200 year rainfall mm	500 year rainfall mm	30 year rainfall mm
15	0.25	0.010417	12.68	16.09	21.89	27.58	34.71	47.02	18.45
30	0.5	0.020833	16.05	20.11	26.94	33.52	41.69	55.59	22.9
45	0.75	0.03125	18.39	22.87	30.34	37.5	46.31	61.17	25.94
60	1	0.041667	20.23	25.04	33	40.57	49.86	65.42	28.31
75	1.25	0.052083	21.78	26.85	35.2	43.11	52.77	68.89	30.28
90	1.5	0.0625	23.13	28.42	37.1	45.3	55.27	71.85	31.99
105	1.75	0.072917	24.34	29.81	38.78	47.22	57.46	74.44	33.51
120	2	0.083333	25.42	31.07	40.29	48.95	59.42	76.75	34.88
135	2.25	0.09375	26.42	32.23	41.67	50.52	61.2	78.84	36.13
150	2.5	0.104167	27.35	33.29	42.94	51.96	62.84	80.75	37.28
165	2.75	0.114583	28.21	34.28	44.12	53.31	64.36	82.51	38.35
180	3	0.125	29.02	35.21	45.23	54.56	65.77	84.16	39.36
195	3.25	0.135417	29.79	36.09	46.27	55.74	67.09	85.7	40.3
210	3.5	0.145833	30.51	36.92	47.25	56.85	68.34	87.14	41.2
225	3.75	0.15625	31.21	37.71	48.18	57.9	69.53	88.51	42.05
240	4	0.166667	31.87	38.46	49.07	58.9	70.65	89.81	42.86
255	4.25	0.177083	32.5	39.18	49.92	59.86	71.72	91.04	43.64
270	4.5	0.1875	33.11	39.88	50.73	60.77	72.74	92.22	44.38
285	4.75	0.197917	33.69	40.54	51.52	61.65	73.72	93.34	45.1
300	5	0.208333	34.25	41.18	52.27	62.49	74.66	94.43	45.78
315	5.25	0.21875	34.8	41.8	52.99	63.3	75.57	95.46	46.45
330	5.5	0.229167	35.33	42.4	53.69	64.09	76.44	96.47	47.09
345	5.75	0.239583	35.84	42.98	54.37	64.84	77.29	97.43	47.71
360	6	0.25	36.33	43.54	55.02	65.58	78.1	98.36	48.31
375	6.25	0.260417	36.81	44.08	55.66	66.29	78.89	99.27	48.9
390	6.5	0.270833	37.28	44.61	56.28	66.98	79.66	100.14	49.46
405	6.75	0.28125	37.74	45.13	56.88	67.65	80.4	100.99	50.02
420	7	0.291667	38.19	45.63	57.46	68.3	81.13	101.81	50.55
435	7.25	0.302083	38.62	46.12	58.03	68.93	81.83	102.61	51.08
450	7.5	0.3125	39.04	46.6	58.59	69.55	82.52	103.39	51.59
465	7.75	0.322917	39.46	47.06	59.13	70.15	83.18	104.15	52.09
480	8	0.333333	39.86	47.52	59.66	70.74	83.84	104.89	52.58
495	8.25	0.34375	40.26	47.97	60.17	71.32	84.47	105.61	53.05
510	8.5	0.354167	40.65	48.4	60.68	71.88	85.09	106.31	53.52
525	8.75	0.364583	41.03	48.83	61.18	72.43	85.7	107	53.98
540	9	0.375	41.4	49.25	61.66	72.97	86.3	107.68	54.42
555	9.25	0.385417	41.77	49.66	62.14	73.5	86.88	108.33	54.86
570	9.5	0.395833	42.13	50.07	62.6	74.01	87.45	108.98	55.29
585	9.75	0.40625	42.48	50.46	63.06	74.52	88.01	109.61	55.72
600	10	0.416667	42.83	50.85	63.51	75.02	88.56	110.23	56.13
615	10.25	0.427083	43.17	51.23	63.95	75.5	89.09	110.83	56.54
630	10.5	0.4375	43.51	51.61	64.38	75.98	89.62	111.43	56.94
645	10.75	0.447917	43.84	51.98	64.81	76.45	90.14	112.01	57.33
660	11	0.458333	44.16	52.34	65.22	76.92	90.65	112.59	57.72
675	11.25	0.46875	44.48	52.7	65.64	77.37	91.15	113.15	58.1
690	11.5	0.479167	44.79	53.05	66.04	77.82	91.64	113.7	58.48
705	11.75	0.489583	45.11	53.4	66.44	78.26	92.12	114.25	58.84
720	12	0.5	45.41	53.74	66.83	78.69	92.6	114.78	59.21
735	12.25	0.510417	45.8	54.18	67.34	79.26	93.24	115.52	59.67
750	12.5	0.520833	46.18	54.61	67.84	79.82	93.87	116.24	60.14
765	12.75	0.53125	46.55	55.03	68.34	80.38	94.49	116.96	60.59

780	13	0.541667	46.92	55.45	68.83	80.93	95.1	117.67	61.04
795	13.25	0.552083	47.29	55.86	69.31	81.47	95.71	118.36	61.48
810	13.5	0.5625	47.65	56.27	69.79	82.01	96.3	119.05	61.92
825	13.75	0.572917	48.01	56.68	70.26	82.54	96.89	119.73	62.36
840	14	0.583333	48.37	57.08	70.73	83.06	97.48	120.4	62.79
855	14.25	0.59375	48.72	57.48	71.19	83.57	98.05	121.06	63.21
870	14.5	0.604167	49.07	57.87	71.65	84.08	98.62	121.72	63.63
885	14.75	0.614583	49.41	58.26	72.1	84.59	99.18	122.36	64.05
900	15	0.625	49.75	58.64	72.55	85.09	99.74	123	64.46
915	15.25	0.635417	50.09	59.02	72.99	85.58	100.29	123.63	64.86
930	15.5	0.645833	50.42	59.4	73.43	86.07	100.83	124.26	65.27
945	15.75	0.65625	50.75	59.77	73.86	86.55	101.37	124.87	65.66
960	16	0.666667	51.08	60.14	74.29	87.03	101.9	125.48	66.06
975	16.25	0.677083	51.41	60.5	74.71	87.51	102.43	126.09	66.45
990	16.5	0.6875	51.73	60.87	75.13	87.97	102.95	126.68	66.84
1005	16.75	0.697917	52.05	61.22	75.55	88.44	103.47	127.27	67.22
1020	17	0.708333	52.36	61.58	75.96	88.9	103.98	127.86	67.6
1035	17.25	0.71875	52.67	61.93	76.37	89.35	104.48	128.44	67.98
1050	17.5	0.729167	52.99	62.28	76.77	89.8	104.99	129.01	68.35
1065	17.75	0.739583	53.29	62.63	77.17	90.25	105.48	129.58	68.72
1080	18	0.75	53.6	62.97	77.57	90.69	105.97	130.14	69.08
1095	18.25	0.760417	53.9	63.31	77.96	91.13	106.46	130.7	69.45
1110	18.5	0.770833	54.2	63.65	78.35	91.56	106.94	131.25	69.81
1125	18.75	0.78125	54.5	63.98	78.74	92	107.42	131.79	70.16
1140	19	0.791667	54.79	64.31	79.13	92.42	107.89	132.33	70.52
1155	19.25	0.802083	55.09	64.64	79.51	92.85	108.36	132.87	70.87
1170	19.5	0.8125	55.38	64.97	79.88	93.27	108.83	133.4	71.22
1185	19.75	0.822917	55.67	65.29	80.26	93.68	109.29	133.93	71.56
1200	20	0.833333	55.95	65.61	80.63	94.09	109.75	134.45	71.91
1215	20.25	0.84375	56.24	65.93	81	94.5	110.2	134.97	72.25
1230	20.5	0.854167	56.52	66.25	81.36	94.91	110.65	135.48	72.58
1245	20.75	0.864583	56.8	66.56	81.72	95.31	111.1	135.99	72.92
1260	21	0.875	57.08	66.87	82.08	95.71	111.54	136.49	73.25
1275	21.25	0.885417	57.36	67.18	82.44	96.11	111.98	136.99	73.58
1290	21.5	0.895833	57.63	67.49	82.8	96.5	112.41	137.49	73.91
1305	21.75	0.90625	57.9	67.79	83.15	96.89	112.84	137.98	74.23
1320	22	0.916667	58.17	68.1	83.5	97.28	113.27	138.47	74.55
1335	22.25	0.927083	58.44	68.4	83.84	97.66	113.7	138.95	74.88
1350	22.5	0.9375	58.71	68.7	84.19	98.05	114.12	139.43	75.19
1365	22.75	0.947917	58.97	68.99	84.53	98.42	114.54	139.91	75.51
1380	23	0.958333	59.24	69.29	84.87	98.8	114.96	140.38	75.82
1395	23.25	0.96875	59.5	69.58	85.21	99.17	115.37	140.85	76.14
1410	23.5	0.979167	59.76	69.87	85.54	99.55	115.78	141.32	76.44
1425	23.75	0.989583	60.02	70.16	85.87	99.91	116.19	141.78	76.75
1440	24	1	60.27	70.45	86.2	100.28	116.59	142.24	77.06
1455	24.25	1.010417	60.53	70.73	86.53	100.64	116.99	142.69	77.36
1470	24.5	1.020833	60.78	71.01	86.86	101	117.39	143.15	77.66
1485	24.75	1.03125	61.04	71.3	87.18	101.36	117.79	143.59	77.96
1500	25	1.041667	61.29	71.58	87.5	101.72	118.18	144.04	78.26
1515	25.25	1.052083	61.53	71.85	87.82	102.07	118.57	144.48	78.56
1530	25.5	1.0625	61.78	72.13	88.14	102.42	118.96	144.92	78.85
1545	25.75	1.072917	62.03	72.4	88.45	102.77	119.34	145.36	79.14
1560	26	1.083333	62.27	72.68	88.77	103.12	119.73	145.79	79.43
1575	26.25	1.09375	62.52	72.95	89.08	103.46	120.11	146.23	79.72
1590	26.5	1.104167	62.76	73.22	89.39	103.81	120.48	146.65	80.01
1605	26.75	1.114583	63	73.49	89.7	104.15	120.86	147.08	80.29
1620	27	1.125	63.24	73.75	90	104.49	121.23	147.5	80.58
1635	27.25	1.135417	63.48	74.02	90.31	104.82	121.6	147.92	80.86
1650	27.5	1.145833	63.71	74.28	90.61	105.16	121.97	148.34	81.14
1665	27.75	1.15625	63.95	74.55	90.91	105.49	122.34	148.75	81.42
1680	28	1.166667	64.18	74.81	91.21	105.82	122.7	149.17	81.7
1695	28.25	1.177083	64.42	75.07	91.51	106.15	123.06	149.57	81.97
1710	28.5	1.1875	64.65	75.32	91.8	106.47	123.42	149.98	82.25
1725	28.75	1.197917	64.88	75.58	92.1	106.8	123.78	150.39	82.52
1740	29	1.208333	65.11	75.84	92.39	107.12	124.14	150.79	82.79
1755	29.25	1.21875	65.34	76.09	92.68	107.44	124.49	151.19	83.06
1770	29.5	1.229167	65.56	76.34	92.97	107.76	124.84	151.59	83.33
1785	29.75	1.239583	65.79	76.59	93.26	108.08	125.19	151.98	83.6
1800	30	1.25	66.01	76.84	93.54	108.4	125.54	152.37	83.86

1815	30.25	1.260417	66.24	77.09	93.83	108.71	125.88	152.76	84.13
1830	30.5	1.270833	66.46	77.34	94.11	109.02	126.23	153.15	84.39
1845	30.75	1.28125	66.68	77.59	94.39	109.33	126.57	153.54	84.65
1860	31	1.291667	66.9	77.83	94.67	109.64	126.91	153.92	84.91
1875	31.25	1.302083	67.12	78.07	94.95	109.95	127.25	154.3	85.17
1890	31.5	1.3125	67.34	78.32	95.23	110.26	127.58	154.68	85.43
1905	31.75	1.322917	67.55	78.56	95.5	110.56	127.92	155.06	85.68
1920	32	1.333333	67.77	78.8	95.78	110.86	128.25	155.43	85.94
1935	32.25	1.34375	67.99	79.04	96.05	111.16	128.58	155.81	86.19
1950	32.5	1.354167	68.2	79.28	96.32	111.46	128.91	156.18	86.44
1965	32.75	1.364583	68.41	79.51	96.59	111.76	129.24	156.55	86.7
1980	33	1.375	68.63	79.75	96.86	112.06	129.56	156.91	86.95
1995	33.25	1.385417	68.84	79.98	97.13	112.35	129.89	157.28	87.19
2010	33.5	1.395833	69.05	80.22	97.4	112.65	130.21	157.64	87.44
2025	33.75	1.40625	69.26	80.45	97.66	112.94	130.53	158	87.69
2040	34	1.416667	69.46	80.68	97.93	113.23	130.85	158.36	87.93
2055	34.25	1.427083	69.67	80.91	98.19	113.52	131.17	158.72	88.18
2070	34.5	1.4375	69.88	81.14	98.45	113.81	131.48	159.08	88.42
2085	34.75	1.447917	70.08	81.37	98.71	114.09	131.8	159.43	88.66
2100	35	1.458333	70.29	81.6	98.97	114.38	132.11	159.78	88.91
2115	35.25	1.46875	70.49	81.82	99.23	114.66	132.42	160.14	89.15
2130	35.5	1.479167	70.7	82.05	99.49	114.94	132.73	160.48	89.38
2145	35.75	1.489583	70.9	82.27	99.74	115.23	133.04	160.83	89.62
2160	36	1.5	71.1	82.49	100	115.51	133.35	161.18	89.86
2175	36.25	1.510417	71.3	82.72	100.25	115.78	133.66	161.52	90.09
2190	36.5	1.520833	71.5	82.94	100.5	116.06	133.96	161.86	90.33
2205	36.75	1.53125	71.7	83.16	100.75	116.34	134.26	162.2	90.56
2220	37	1.541667	71.9	83.38	101	116.61	134.56	162.54	90.8
2235	37.25	1.552083	72.09	83.6	101.25	116.89	134.86	162.88	91.03
2250	37.5	1.5625	72.29	83.81	101.5	117.16	135.16	163.22	91.26
2265	37.75	1.572917	72.49	84.03	101.75	117.43	135.46	163.55	91.49
2280	38	1.583333	72.68	84.25	101.99	117.7	135.76	163.88	91.72
2295	38.25	1.59375	72.88	84.46	102.24	117.97	136.05	164.21	91.95
2310	38.5	1.604167	73.07	84.68	102.48	118.24	136.34	164.54	92.17
2325	38.75	1.614583	73.26	84.89	102.72	118.5	136.64	164.87	92.4
2340	39	1.625	73.45	85.1	102.97	118.77	136.93	165.2	92.62
2355	39.25	1.635417	73.65	85.31	103.21	119.03	137.22	165.52	92.85
2370	39.5	1.645833	73.84	85.53	103.45	119.3	137.51	165.85	93.07
2385	39.75	1.65625	74.03	85.74	103.69	119.56	137.79	166.17	93.29
2400	40	1.666667	74.21	85.95	103.92	119.82	138.08	166.49	93.52
2415	40.25	1.677083	74.4	86.15	104.16	120.08	138.36	166.81	93.74
2430	40.5	1.6875	74.59	86.36	104.4	120.34	138.65	167.13	93.96
2445	40.75	1.697917	74.78	86.57	104.63	120.6	138.93	167.44	94.18
2460	41	1.708333	74.96	86.77	104.87	120.86	139.21	167.76	94.39
2475	41.25	1.71875	75.15	86.98	105.1	121.11	139.49	168.07	94.61
2490	41.5	1.729167	75.33	87.18	105.33	121.37	139.77	168.39	94.83
2505	41.75	1.739583	75.52	87.39	105.56	121.62	140.05	168.7	95.04
2520	42	1.75	75.7	87.59	105.79	121.87	140.33	169.01	95.26
2535	42.25	1.760417	75.89	87.79	106.02	122.13	140.6	169.32	95.47
2550	42.5	1.770833	76.07	88	106.25	122.38	140.88	169.63	95.69
2565	42.75	1.78125	76.25	88.2	106.48	122.63	141.15	169.93	95.9
2580	43	1.791667	76.43	88.4	106.71	122.88	141.42	170.24	96.11
2595	43.25	1.802083	76.61	88.6	106.93	123.12	141.69	170.54	96.32
2610	43.5	1.8125	76.79	88.79	107.16	123.37	141.96	170.84	96.53
2625	43.75	1.822917	76.97	88.99	107.38	123.62	142.23	171.14	96.74
2640	44	1.833333	77.15	89.19	107.61	123.86	142.5	171.45	96.95
2655	44.25	1.84375	77.33	89.39	107.83	124.11	142.77	171.74	97.16
2670	44.5	1.854167	77.5	89.58	108.05	124.35	143.03	172.04	97.37
2685	44.75	1.864583	77.68	89.78	108.27	124.59	143.3	172.34	97.57
2700	45	1.875	77.86	89.97	108.5	124.84	143.56	172.63	97.78
2715	45.25	1.885417	78.03	90.17	108.72	125.08	143.83	172.93	97.98
2730	45.5	1.895833	78.21	90.36	108.93	125.32	144.09	173.22	98.19
2745	45.75	1.90625	78.38	90.55	109.15	125.56	144.35	173.51	98.39
2760	46	1.916667	78.56	90.74	109.37	125.79	144.61	173.81	98.59
2775	46.25	1.927083	78.73	90.94	109.59	126.03	144.87	174.1	98.8
2790	46.5	1.9375	78.9	91.13	109.8	126.27	145.13	174.38	99
2805	46.75	1.947917	79.07	91.32	110.02	126.5	145.38	174.67	99.2
2820	47	1.958333	79.25	91.51	110.23	126.74	145.64	174.96	99.4
2835	47.25	1.96875	79.42	91.69	110.45	126.97	145.9	175.24	99.6