

Alan Wood & Partners

**FLOOD RISK ASSESSMENT
FOR
PROPOSED RETAIL DEVELOPMENT
AT
BARNSELY TOWN CENTRE**



**FOR
BARNSELY METROPOLITAN
BOROUGH COUNCIL**



PROJECT REF:- NW/AD/JF/36760-Rp001

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**FLOOD RISK ASSESSMENT FOR PROPOSED RETAIL
DEVELOPMENT AT BARNSELY TOWN CENTRE, SOUTH YORKSHIRE**

Project Reference: NW/AD/JF/36760-Rp001

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Signed:

Date: 2nd June 2015

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Signed:

Date: 2nd June 2015

Issue	Revision	Revised by	Approved by	Revised Date

For the avoidance of doubt, the parties confirm that these conditions of engagement shall not and the parties do not intend that these conditions of engagement shall confer on any party any rights to enforce any term of this Agreement pursuant of the Contracts (Rights of third Parties) Act 1999.

The Appointment of Alan Wood & Partners shall be governed by and construed in all respects in accordance with the laws of England & Wales and each party submits to the exclusive jurisdiction of the Courts of England & Wales.

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1.0 EXECUTIVE SUMMARY

This presents the salient points of the report and should not be referred to in isolation. All recommendations are subject to approval by the Regulatory Authorities.

Site Location	Land south of Kendray Street, Market Place, Barnsley Town Centre.
Proposed Development	New Market Hall and Retail Development.
Vulnerability Classification	Less vulnerable.
Climate Change	Allow 20% increase in rainfall intensity.
Flood Zone	Flood Zone 1 (Low Risk).
Tidal Flooding	N/A
Fluvial Flooding	Site located 900m from River Dearne. Low risk from flooding.
Pluvial Flooding	Environment Agency flood map shows risk to be high to part of site. Mitigation measures to be adopted. Low and acceptable risk.
Groundwater Flooding	No record of groundwater flooding. Low and acceptable risk.
Private Drains & Public Sewers	Existing drainage present in area of development. Low and acceptable risk.
Canals Reservoirs & other Artificial Sources	None present in vicinity of the development area.
Water Mains	Existing services present within the site. Low and acceptable risk.
Ground Conditions	Ironstone mudstone and coal overlain with made ground.
Ground Water Levels	Ground investigations reveal low water table. Low and acceptable risk.
Water Courses	Local watercourse present within the site (culverted). Low and acceptable risk.
On-Site Surface Water	No increase to impermeable areas. Low and acceptable risk.
Surface Water Drainage Proposals	No additional impermeable area. Drainage network designed to reduce discharge by 30%.
Flood Risk Vulnerability and Flood Zone Compatibility	Development is identified as compatible.
Additional Mitigation Measures	Non-return valves on drainage connections to public sewers.
Conclusions & Recommendations	The report concludes that the scheme should be approved in respect of flood risk.

2.0 INTRODUCTION

2.1 Brief

2.1.1 Alan Wood & Partners have been commissioned by Barnsley Metropolitan Borough Council to undertake a Flood Risk Assessment (FRA) for the proposed re-development of a site in Barnsley Town Centre to assess the risk from flooding and to support the development planning application.

2.2 Layout of Report

2.2.1 Section 2.0 provides an introduction to the FRA, explains the layout of this FRA and provides an introduction to flood risk and the National Planning Policy Framework (NPPF) which is the current planning policy on flood risk in England. Sustainable Drainage Systems (SuDS) and the SuDS hierarchy form an integral part of the NPPF and are also outlined.

2.2.2 Section 3.0 provides an introduction to the site. The site description is based upon information provided by the Client, together with a study of information which is publicly available including consultation with the Statutory Authorities and other interested parties.

2.2.3 Section 4.0 of this report describes the proposed development, and assigns a classification in accordance with NPPF.

2.2.4 Section 5.0 considers the drainage arrangements for the proposed development. The drainage assessment is based on NPPF, and outlines an indicative foul and surface water drainage strategy.

2.2.5 Section 6.0 of this report considers the flood risk to site, and the potential for the development proposals to impact on flood risk. The assessment of flood risk is based on the latest planning policy and uses all the information gathered as part of the FRA.

2.2.6 Section 7.0 of this report provides a summary and any recommendations for further work.

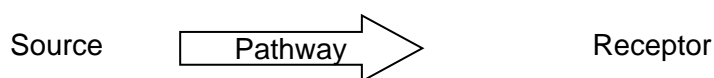
2.3 Flood Risk

2.3.1 Flood risk takes account of both the probability and the consequences of flooding.

Flood risk = probability of flooding x consequence of flooding

2.3.2 Probability is usually discussed in terms of the return period of the event, e.g. 1 in 100 and 1 in 200 year event, with the more severe storms occurring less frequently. This should be interpreted as there being a 1% (1 in 100) chance of a 1 in 100 year storm event or flood occurring in any given year or a similarly 0.5% (1 in 200) chance of a 1 in 200 year event in any given year. The consequence of flooding depends on how vulnerable a receptor is to flooding.

2.3.3 The components of flood risk can be considered using the source-pathway-receptor model.



2.3.4 Sources constitute flood hazards, which are anything with the potential to cause harm through flooding (e.g. rainfall, extreme sea levels, river flows and canals). Pathways represent the mechanism by which the flood hazard would cause harm to a receptor (e.g. overtopping and failure of embankments and flood defences, inadequate drainage and inundation of floodplains). Receptors comprise of the people, property, infrastructure and ecosystems that could potentially be affected should a flood occur.

2.4 National Planning Policy Framework

2.4.1 General

2.4.1.1 NPPF and its associated Technical Guidance set out the planning requirements on development sites should be evaluated with respect to flood risk.

2.4.1.2 A summary of the requirements of NPPF is provided below.

2.4.2 Sources of Flooding

2.4.2.1 General

2.4.2.1.1 NPPF requires an assessment of flood risk to consider all forms of flooding, and lists six forms of flooding that should be considered as part of a flood risk assessment. These forms of flooding are listed in below, along with an explanation of each form of flooding.

2.4.2.2 Flooding From Rivers (Fluvial Flooding)

2.4.2.2.1 Watercourses flood when the amount of water in them exceeds the flow capacity of the river channel. Flooding can either develop gradually or rapidly, depending on the characteristics of the catchment. Land use, topography and the development can have a strong influence on flooding from rivers.

2.4.2.3 Flooding From the Sea (Tidal Flooding)

2.4.2.3.1 Flooding to low-lying land from the sea and tidal estuaries is caused by storm surges and high tides. Where tidal defences exist, they can be overtopped or breached during a severe storm, which may be more likely with climate change.

2.4.2.4 Flooding from Land (Pluvial Flooding)

2.4.2.4.1 Intense rainfall, often of short duration, that is unable to soak into the ground or enter drainage systems can run quickly off land and result in local flooding. In developed areas, this flood water can be polluted with domestic sewage where foul sewers surcharge and overflow. Local topography and built form can have a strong influence on the direction and depth of flow. The design of development down to a micro-level can influence or exacerbate this. Overland flow paths should be taken into account in spatial planning for urban developments. Flooding can be exacerbated if development increases the percentage of impervious area.

2.4.2.5 Flooding from Groundwater

2.4.2.5.1 Groundwater flooding occurs when groundwater levels rise above ground levels. Groundwater flooding is most likely to occur in low-lying areas underlain by permeable rocks (aquifers). Chalk is the most extensive source of groundwater flooding.

2.4.2.6 Flooding from Sewers

2.4.2.6.1 In urban areas, rainwater is frequently drained into sewers. Flooding can occur when sewers are overwhelmed by heavy rainfall, or become blocked. Sewer flooding continues until the water drains away.

2.4.2.7 Flooding from Other Artificial Sources (i.e. reservoirs, canals, lakes and ponds)

2.4.2.7.1 Non-natural or artificial sources of flooding can include reservoirs, canals and lakes. Reservoir or canal flooding may occur as a result of the facility being overwhelmed and/or as a result of dam or bank failure.

2.4.3 Flood Zones

2.4.3.1 For river and sea flooding, NPPF uses four Flood Zones to characterise flood risk. These Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and are detailed in 2.4.3.2 Table 1.

2.4.3.2 Table 1 : Flood Zone Definitions

Flood Zone	Definition
1	Low probability (less than 1 in 1,000 annual probability of river or sea flooding in any year (<0.1%))
2	Medium probability (between 1 in 100 and 1 in 1,000 annual probability of river flooding (1%-0.1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5%-0.1%) in any year).
3a	High probability (1 in 100 or greater annual probability of river flooding (>1%) in any year or 1 in 200 or greater annual probability of sea flooding (>0.5%) in any given year).
3b	Functional floodplain. This zone comprises land where water has to flow or be stored in times of flood. Land which would flood with an annual probability of 1 in 20 (5%), or is designed to flood in an extreme flood (0.1%) should provide a starting point for discussions to identify functional floodplain.

2.4.4 Flood Risk Vulnerability Classification

2.4.4.1 NPPF classifies the vulnerability of developments to flooding into five categories. These categories are detailed in **2.4.4.3 Table 2**.

2.4.4.2 Based on the vulnerability of a development, NPPF states within what Flood Zone(s) a development is appropriate. The flood risk vulnerability and Flood Zone 'compatibility' of developments is summarised in **Table 2**.

2.4.4.3 Table 2 : Flood Risk Vulnerability Classification

Flood Risk Vulnerability Classification	Examples of Development Types
Essential Infrastructure	Transport Infrastructure Utility Infrastructure (e.g. water treatment works and wind turbines)
Water Compatible	Flood Control Infrastructure Water and Sewerage Infrastructure Navigation Facilities Water Based Recreation
Highly Vulnerable	Emergency Services Basement Dwellings Mobile Home Parks
More Vulnerable	Hospitals and other health services Residential Establishments Educational Establishments
Less Vulnerable	Commercial Establishments (e.g. shops, restaurants and offices)

2.4.4.4 Table 3 : Flood Risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test	✓	✓
	3a	Exception Test	✓	✗	Exception Test	✓
	3b	Exception Test	✓	✗	✗	✗

2.4.5 The Sequential Test, Exception Test and Sequential Approach

2.4.5.1 The Sequential Test is a risk-based test that should be applied at all stages of development and aims to steer new development to areas with the lowest probability of flooding (Zone 1). This is applied by the Local Planning Authority by means of a Strategic Flood Risk Assessment (SFRA).

2.4.5.2 The SFRA and NPPF may require the Exception Test to be applied to certain forms of new development. The test considers the vulnerability of the new development to flood risk and, to be passed, must demonstrate that:

- There are sustainability benefits that outweigh the flood risk and;
- The new development is safe and does not increase flood risk elsewhere.

2.4.5.3 The Sequential Approach is also a risk based approach to development. In a development site located in several Flood Zones or with other flood risks, the sequential approach directs the most vulnerable types of development towards the areas of least risk within the site.

2.4.6 Climate Change

2.4.6.1 NPPF makes it a planning requirement to account for climate change in the proposed design. The recommended allowances are summarised in **2.4.6.2 Table 4** and **2.4.6.3 Table 5** below.

2.4.6.2 Table 4 : Recommended Contingency Allowances for Net Sea Level Rises

	Net sea level rise (mm per year)			
	Relative to 1990			
	1990 to 2005	2025 to 2055	2055 to 2085	2085 to 2115
East of England, East Midlands, London, South-East England (South of Flamborough Head)	4.0	8.5	12.0	15.0
South-West England	3.5	8.0	11.5	14.5
North-West England, North-East England (North of Flamborough Head)	2.5	7.0	10.0	13.0

2.4.6.3 Table 5 : Recommended National Precautionary Sensitivity Ranges for Peak Rainfall Intensities, Peak River Flows, Offshore Wind Speeds and Wave Heights

Horizon	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Parameter				
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		
Offshore wind speed	+5%		+10%	
Extreme wave height	+5%		+10%	

2.5 Sustainable Drainage and Storm Water Management

- 2.5.1 The key planning objectives in NPPF are to appraise, manage and where possible, reduce flood risk. Sustainable Drainage Systems (SuDS) provide an effective way of achieving some of these objectives. NPPF and Part H of the Building Regulations (DTLR, 2002) directs developers towards the use of SuDS wherever possible
- 2.5.2 The most appropriate SuDS will need to satisfy three main characteristics, firstly, provide the required volume of storage, secondly, minimise the loss of developable land and thirdly, where possible provide local amenity.
- 2.5.3 A summary of the various types of SuDS and the benefits provided are included in **2.5.9 Table 6**.
- 2.5.4 The application of the 'SuDS Manual' CIRIA report C697 for new developments requires that the runoff from sites is not only restricted to meet the Greenfield runoff characteristics but also that SuDS are utilised to improve the quality of the runoff prior to outfall to watercourses.
- 2.5.5 The application of suitable SuDS can help in the removal of most soluble and particulate contamination from suspended solids to hydrocarbons.
- 2.5.6 The SuDS manual and EA guidance applies a sustainability hierarchy to the various types of SuDS, this is summarised in **2.5.9 Table 6**.
- 2.5.7 Systems at the top of the hierarchy provide a combination of attenuation, treatment and ecology and are deemed the most sustainable options. There are always specific scenarios where systems are more suitable than others and each development will be more suited to a particular SuDS solution.
- 2.5.8 In addition to the SuDS hierarchy the CIRIA SuDS Manual (C697) identifies the number of treatment trains or SuDS devices through which flow should pass from various point sources. This is designed to ensure that the receiving watercourses are not put at risk of pollution by new development.

2.5.9 Table 6 : SuDS Hierarchy (extract from CIRIA C697)

Most Sustainable Least Sustainable	SUDS treatment train	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing/retention ponds - Detention basins	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soak-away - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paving	✓	✓	
	Surface Storage	✓		
	Tanked systems - over-sized pipes/tanks - cellular storage systems	✓		

3.0 EXISTING SITE

3.1 Site Location

- 3.1.1 The development site is located within Barnsley Town Centre.
- 3.1.2 The main western site is centred on OS grid reference 434700, 406295.
- 3.1.3 The area of the new development is approximately 2.75 hectares.
- 3.1.5 A location plan and aerial photograph are provided in Appendix A.

3.2 Site Description

- 3.2.1 The site currently comprises a number of existing buildings and adjacent areas of paving.

3.3 Surrounding Features

- 3.3.1 The site lies within the central area of Barnsley Town Centre. The main site area is bounded by the Barnsley to Sheffield Railway Lines to the east, the Alhambra Shopping Centre to the south, public roads to the west (Cheapside and Burlington Arcade) and Barnsley Interchange/Retail shops to the north.

3.4 Topographic Survey

- 3.4.1 A topographic survey of the site has previously been undertaken.
- 3.4.2 Existing ground levels over the development site area vary from approximately 93.4m to 97.2m OD(N).
- 3.4.3 The existing ground level in the area of the new footbridge access is approximately 92.00 OD(N).
- 3.4.4 Existing road levels on Kendray Street fronting the site vary from approximately 93.3m to 96.0m OD(N).

3.4.5 Existing road levels on Cheapside fronting the site vary from approximately 96.4m to 97.1m OD(N).

3.4.6 Existing road levels on Lambra Road in the area of the site vary from approximately 93.1m to 95.0m OD(N).

3.4.7 Existing road levels on May Day Green vary from approximately 96.1m to 96.2m OD(N).

3.4.8 A copy of the survey drawings are included in Appendix B.

3.5 Utilities including Public Sewerage

3.5.4 A full utility search has not been undertaken.

3.5.5 However, it is known that there are existing sewers present within the area of the site.

3.5.6 There are existing water mains present within the area of the site.

3.5.7 For the purposes of this report the existing services are not considered further.

3.6 Ground Conditions

3.6.4 A ground investigation report has been commissioned in respect of the new development.

3.6.5 The investigation has revealed that ground conditions in the area of the site comprise made ground underlain with ironstone, mudstone and coal.

3.7 Environment Agency Maps

3.6.1 The Environment Agency (EA) flood related maps are contained in Appendix C. In summary:

- The site is in fluvial Flood Zone 1, which is at low risk of flooding, as defined in Section 1.

- The site is not at risk from reservoir flooding
- The site is shown to be at risk locally from overland surface water flooding, from the culverted watercourse which runs through the site (Sough Dyke).
- The site is not within a source protection zone.

3.8 Anecdotal and Site History

3.8.4 There are no historical records of flooding in the vicinity of the development site.

4.0 PROPOSED DEVELOPMENT

4.1 Description

4.1.1 The proposed development will comprise the construction of a new retail complex comprising a new market hall, new retail units, cinema, library and cafeteria together with pedestrian paved areas, external car parks, service yards and associated infrastructure works. A new pedestrian footbridge over the railway lines links the main development to the land to the east, where new stairs, lifts and escalators are to be provided.

4.1.2 Schematic details of the project are included in Appendix E.

4.2 Vulnerability Classification

4.2.1 The development is to be used as retail and is therefore classified as 'Less Vulnerable' in accordance with **2.4.4.3 Table 2**.

4.3 Lifetime of the Development

4.3.1 As the new development is mainly to be used for retail purposes, a design life of 60 years is considered to be applicable.

4.4 Climate Change Allowance

- 4.4.1 In accordance with Section **2.4.6.3 Table 5**, an increase of 20% should be applied to the rainfall intensities for the 1 in 100 year critical events to allow for climate change.

5.0 DRAINAGE ASSESSMENT

5.1 General

- 5.1.1 Following development of the site collection and conveyance of surface water within the boundary of the site poses a possible flood risk. A suitable drainage design should be implemented in accordance with NPPF to ensure that no damage is caused to person or property for storms up to and including the 1 in 100 year event. The collection, conveyance and attenuation of the runoff generated from this impermeable area is a potential flood risk associated with this development.
- 5.1.2 In accordance with NPPF and the recommendations of the Environment Agency the drainage assessment of an FRA must demonstrate that it should be possible to discharge foul and surface water from proposed development safely, without increasing flood risk on or off site. No specific design details will be provided at this stage, only an assessment based on a desk top study using the existing information; this is with the anticipation that planning permission is granted with suitably worded detailed design conditions in relation to foul and surface water, which can be discharged at the appropriate time.

5.2 Existing Foul Water Drainage

- 5.2.1 There are existing drains present serving the existing buildings and in the public roads in the vicinity of the development. The majority of the existing network will become redundant. The capacity and condition is unknown and therefore it has been ignored for the purposes of this report.

5.3 Proposed Foul Water Drainage

- 5.3.1 New foul water drainage is incorporated within the development.
- 5.3.2 The drainage will be designed in compliance with Part H3 of the Building Regulations.
- 5.3.3 The new discharge rate will be less than 2 litres per second.
- 5.3.4 The risk of flooding from this potential source is considered to be 'very low'.

5.4 Existing Surface Water Drainage

- 5.4.1 There is existing drainage pipework present serving the existing buildings and in the public roads in the vicinity of the development.
- 5.4.2 There is an existing culverted watercourse (Sough Dyke) present within the area of the development.
- 5.4.3 Sough Dyke is a culverted watercourse which runs through Barnsley Town Centre.
- 5.4.4 There is a 600 metre length of open watercourse present to the west of the development site, which flows into the culvert at a distance of 1.2km from the site, to the north of Springfield Street.
- 5.4.5 During periods of heavy rainfall, there is a risk that overtopping of the open watercourse could occur if the culvert was at full capacity, thus restricting the discharge of the watercourse.
- 5.4.6 However, the capacity of the open watercourse is not excessive and consequently the volume of any resultant flood waters would be quite limited.
- 5.4.7 Any flood waters overtopping the banks would naturally gravitate towards the lowest lying land, flowing along roadways eastward towards the River Dearne, which lies at a distance of approximately 1km from the development site.

- 5.4.8 Consequently there should be no accumulation of flood water which could attain any significant depth over the area of the development.
- 5.4.9 The map produced for the Strategic Flood Risk Assessment to show pluvial flooding indicates a likely maximum depth of flood water in the vicinity of the proposed development of 0.15 to 0.3 metres.
- 5.4.10 A copy of the map is included in Appendix D.
- 5.4.11 The risk of flooding from this potential source is considered to be 'Low and acceptable'.

6.0 FLOOD RISK ASSESSMENT

6.1 General

- 6.1.1 In accordance with the NPPF flood risk must be assessed for all sources of flooding. The development of any site must also be carried out in such a way as to mitigate any potential flood risk, both on and off site. This section identifies the foreseeable sources of flooding and assesses the flood risk associated with each one.

6.2 Flood Zone

- 6.2.1 A copy of the Environment Agency Flood Outline Map and predicted flood levels is included in Appendix C, which identifies the area of the development to be located within an area designated as Flood Zone 1, Low Probability of flooding, comprising land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year.

6.3 Surface Water Flooding

- 6.3.1 A copy of the Environment Agency map showing the potential risk of flooding from surface water is included in Appendix C.

- 6.3.2 There are a number of areas within the development site which are shown to be at risk from surface water flooding, which would appear to result from overland flooding resulting from the capacity of the existing culverted watercourse being exceeded during periods of heavy rainfall.
- 6.3.3 The map produced within the Barnsley Level 1 Strategic Flood Risk Assessment shows that an area of the development site is prone to overland flooding from rainfall.
- 6.3.4 A copy of the map is included in Appendix D.
- 6.3.5 A study of the topographic survey which has been undertaken reveals that existing ground levels in the May Day Green area of the site are lower than the surrounding road network which could lead to potential ponding of pluvial flows from the surrounding area.
- 6.3.6 The lowest existing ground level is approximately 95.9m, whilst the levels on the adjacent road networks on Kendray Street, Eldon Street and the Southern end of Cheapside are at approximately 97.0m OD(N).
- 6.3.7 Any overland run-off from the land to the west could consequently flow down from Eldon Street/Kendray Street into Cheapside and May Day Green where waters could pond up to a depth of 1.1m before attaining the level of the surrounding land.
- 6.3.8 This situation could, however, only arise if the surface water drainage network exceeded its capacity and the gully network to the road system consequently could not adequately discharge the rainfall over a large area of the town centre.
- 6.3.9 The drainage network will be designed to accommodate at least a 1 in 30 year storm and hydraulic modelling of Sough Dyke has revealed that the watercourse can accommodate a 1 in 150 year storm event.
- 6.3.10 The design of the new development will mitigate the risk of flooding from surface water with appropriate floor levels and attenuation of the surface water drainage, which will incorporate below ground storage tanks, which will have the capacity to adequately remove standing water from the ground surface.

6.3.11 On this basis we consider the risk to the site from overland flooding is low and acceptable.

6.4 Flooding from Reservoirs, Canals and Other Artificial Sources

6.4.1 Investigations show that there are no structures in proximity to the development which are likely to pose any risk from flooding.

6.4.2 A copy of the Environmental Agency map showing likely flooding from reservoirs is included in Appendix C. This indicates that the site lies within an area which is not at risk of flooding from local reservoirs.

6.5 Flooding from Ground Water

6.5.1 The site is not considered to be located in an area which is at particular risk of flooding from ground water.

6.5.2 There is an existing basement present which is currently used for below ground car parking, servicing of existing buildings and storage.

6.5.3 This basement car park will be incorporated into the new development, with adjacent ground levels being slightly raised to prevent overland flow of rainwater entering the basement.

6.5.4 The risk from groundwater flooding is considered to be low and acceptable.

6.6 Public Sewer Flooding

6.7.1 There are a number of public sewers present within the vicinity of the development of various sizes and capacities.

6.7.2 A number of surface water and combined sewers are of relatively large diameter and therefore pose a risk of flooding to the development in the event of a failure.

6.7.3 However, these sewers are owned and maintained by Yorkshire Water and the risk of any blockage or collapse is considered very unlikely.

6.7.4 Various sewers will be diverted outside the footprint of the new development. The new sewers will be designed in accordance with Sewers for Adoption 7th Edition and will subsequently be adopted by Yorkshire Water.

6.7.5 The risk to the development from public sewers is considered to be low and acceptable

6.8 Drainage Impact/Surface Water Drainage

6.8.1 There is no historic record of flooding due to drainage issues in the area of the development.

6.8.2 We have calculated the existing unrestricted surface water run-off from the existing site to be approximately 382 litres per second, based upon an impermeable area of approximately 2.75 hectares.

6.8.3 Current guidelines recommend that a degree of improvement to the current drainage system be provided by incorporating a 30% reduction in surface water run-off within the design of the new development.

6.8.4 On this basis the permitted discharge from the site would be reduced to approximately 267 litres/second (70% of 382 litres/second).

6.8.5 The new development has an equal impermeable area of approximately 2.75 hectares.

6.8.6 Guidelines recommend that surface water run-off from the development be disposed by means of Sustainable Drainage Systems (SUDS). However, ground investigation works have been undertaken which have revealed that the site comprises a considerable depth of made ground underlain with mudstone, ironstone and coal. Consequently the use soakaways/infiltration is not considered to be a suitable method of surface water disposal for this development.

6.8.7 It is therefore proposed that the surface water drainage from the development is discharged into the existing public sewer network.

- 6.8.8 In order to ensure that the surface water discharge from the development does not increase the risk of flooding to others it will therefore be necessary to attenuate the surface water drainage network in order to restrict the discharge rate to the reduced rate of 267 litres/second.
- 6.8.9 The required restriction to the discharge rate would be achieved by incorporating flow control valves within the final manholes prior to discharge to the public sewers.
- 6.8.10 The new drainage design will be based upon the design for a 1 in 100 year storm with an additional allowance of 20% to account for climate change resulting from global warming.
- 6.8.11 The surface water run-off from the design for a 1 in 30 year storm will need to be stored within the new adoptable public sewer network.
- 6.8.12 This volume has been calculated to be approximately 183.6 m³.
- 6.8.13 The additional surface water run-off from the design for a 1 in 100 year storm plus 20% will be stored below ground level within the confines of the site to ensure that the storage water cannot flow off the site and cause flooding to others.
- 6.8.14 This volume has been calculated to be approximately 241m³ (424.6 m³ - 183.6 m³).
- 6.8.15 Copies of the storage calculations are included in Appendix F.
- 6.8.16 In order to incorporate further SUDS techniques within the development, should they be deemed desirable, it will be necessary to include alternative methods such as rainwater harvesting, permeable paving, green roofs etc. as appropriate.
- 6.9 Potable/Raw Water Main Flooding**
- 6.9.1 Yorkshire Water have not identified any concerns with regard to flooding from any such asset. The risk is therefore considered to be low and acceptable.

7.0 MITIGATION & DESIGN FOR EXCEEDANCE

- 7.1 The site lies within an area which is defined as being at 'Low Risk' of flooding on the Environment Agency flood map system.
- 7.2 With the development lying within Flood Zone 1, there should be no requirement for the floor levels of the buildings to be raised to protect against flooding.
- 7.3 Floor levels of the new buildings should, however, be set a minimum of 150mm above adjacent ground level in compliance with the Building Regulations.
- 7.4 At this level of construction the future risk of flooding to the buildings from surface water run-off or overland flow should be minimal.
- 7.5 The surface water drainage system should be designed and attenuated in accordance with the details set out in Section 6 of this report.
- 7.6 Connections from the buildings to the public sewers should be fitted with non-return valves in order to prevent flooding from the public sewer network should the network become surcharged.
- 7.7 External paved areas should fall away from the building to ensure that surface water run-off during extreme rainfall events is collected by the drainage network and discharged into the drainage network without presenting a flood risk to the buildings.

8.0 SUMMARY

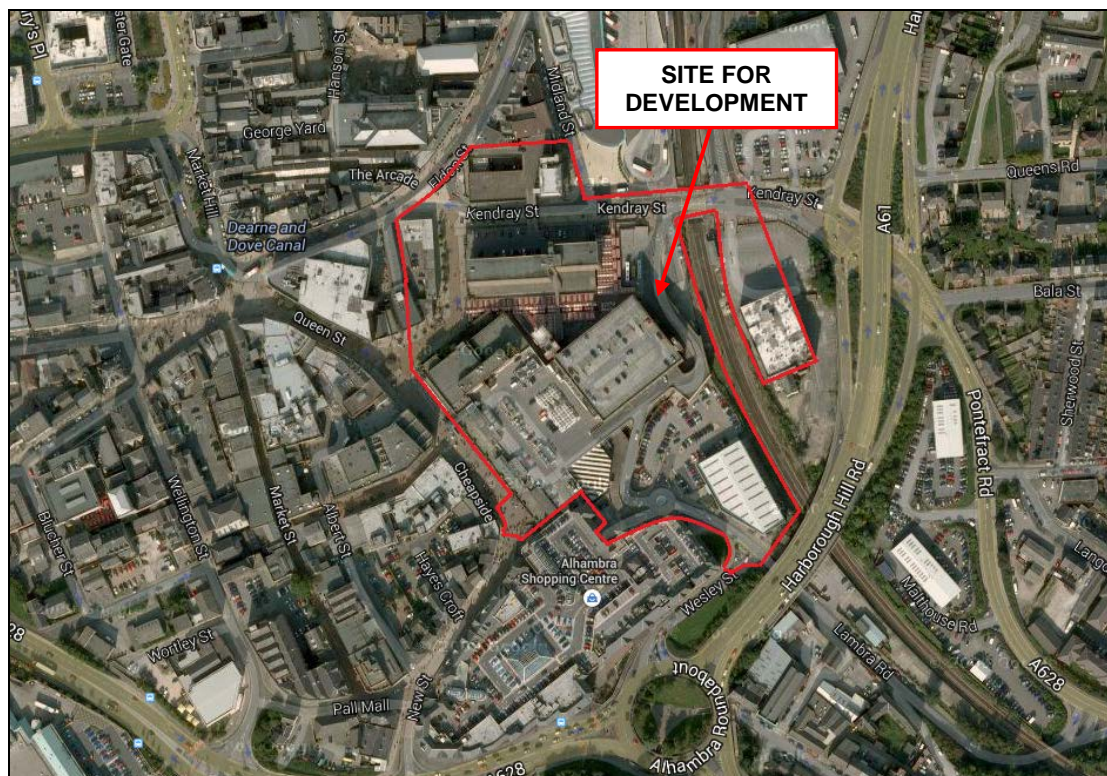
- 8.1 The report has been prepared to assess the flood risk and drainage implications for a new retail development within Barnsley Town Centre.
- 8.2 The site falls in Flood Zone 1 (low flood risk) and the proposals are considered to be 'Less Vulnerable'.

-
- 8.3 The primary risk to the site is from overland flooding from the capacity of Sough Dyke or the public sewer network being exceeded.
- 8.4 Mitigation measures are proposed which we consider will reduce the risk from this event down to an acceptable level.
- 8.5 The primary focus for flood risk assessment is to protect life, and then consideration should be given to buildings, contents, operation and re-use. As the scheme is progressed the design should consider exceedance and routing of flows away from the building.
- 8.6 This report has considered other potential sources of flooding to the site, including groundwater, land, existing sewers water mains and other artificial sources.
- 8.7 Overall, this report demonstrates that the flood risk to the site is reasonable and acceptable providing the mitigation measures detailed within Section 7 are incorporated into the design.

APPENDIX A

Aerial Image of Development Site Showing Site Location

AERIAL PHOTOGRAPH SHOWING SITE LOCATION

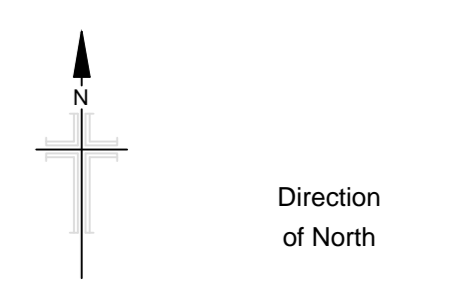


APPENDIX B

Topographic Survey Drawings



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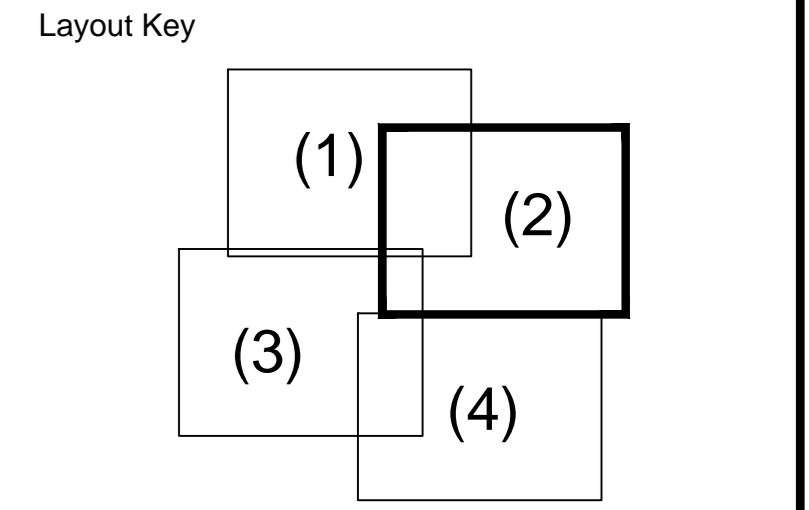


Grid : OS National Grid.
 Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
 Using the OS GPS Network and applying OSGM02 National Geoid Model to obtain local area corrections.

Station Listing

Station	Eastings	Northings	Level
A1	434480.223	406566.819	99.083
A2	434543.374	406401.407	98.570
A3	434555.848	406351.428	96.595
AL1	434520.135	406376.451	90.051
AS2	434783.892	406202.243	93.553
AS10	434481.713	406367.188	99.082
AU1	434592.173	406271.197	96.573
AU2	434551.825	406274.972	101.217
AU3	434673.007	406228.703	101.264
AU5	434583.018	406402.709	97.731
AU6	434705.338	406351.988	97.051
AU7	434662.977	406326.014	97.267
AU8	434778.467	406362.073	91.527
AU10	434625.242	406343.265	96.640
AU11	434653.354	406310.545	97.255
AU12	434681.216	406411.276	94.093
AUA	434690.035	406322.906	96.882
AUB	434652.542	406319.082	97.147
AUC	434681.519	406355.646	97.018
C1	434712.462	406225.869	96.623
C2	434727.503	406419.334	93.150
C3	434721.679	406372.200	92.690
C4	434735.914	406359.097	91.234
C5	434743.984	406331.452	91.022
G1	434753.750	406274.987	94.375
RM1	434632.277	406193.847	98.823
RM2	434663.232	406464.517	95.546
RM3	434598.707	406431.132	97.781
RM4	434637.041	406534.940	97.076
RM5	434646.151	406488.039	96.047
RM6	434752.985	406409.862	92.882
RM7	434822.485	406411.081	92.832
S1	434625.882	406225.994	97.326
S2	434552.494	406300.082	96.717
S3	434500.632	406339.004	97.837
S4	434591.352	406337.611	95.950
S5	434462.262	406339.104	98.714
SD1	434412.220	406315.767	100.782
SD2	434693.601	406357.827	96.797
SD2	434704.574	406374.384	95.560



KEY

▲	AIR VALVE	□	JUNCTION BOX	○	JURK
▲	BENCH MARK	□	HERB OUTLET	○	W
▲	BIN	□	LAMP POST	○	W
▲	BOLLARD	□	MANHOLE (CIRCULAR)	○	W
▲	BORE HOLE	□	MANHOLE (RECTANGULAR)	○	W
▲	BURIED TELECOM COVER	□	MANHOLE (TRIANGULAR)	○	W
▲	BUS STOP	□	MANHOLE (SQUARE)	○	W
▲	CABLE TV COVER	□	ODM	○	W
▲	CABLE TV SUPPLY	□	ROOFING EYE	○	W
▲	COLUMN	□	SIGN POST	○	W
▲	ENTRANCE POINT	□	TELECOM COVER	○	W
▲	ELECTRICITY COVER	□	TELECOM POLE	○	W
▲	ELECTRICITY POLE	□	THRESHOLD LEVEL	○	W
▲	FIRE HYDRANT	□	TRAFFIC LIGHT	○	W
▲	GAS VALVE	□	TRIAL PIT	○	W
▲	GATE	□	WASH OUT	○	W
▲	INSPECTION COVER (CIRCULAR)	□	WATER METER	○	W
▲	INSPECTION COVER (RECTANGULAR)	□	WATER STOP COCK	○	W
▲	INSPECTION COVER (TRIANGULAR)	□	WATER STOP VALVE	○	W
▲	COVER LEVEL	□	CHANGING BASE LEVEL	○	W
▲	PROOF LEVEL	□	WATER SURFACE LEVEL	○	W
▲	UNABLE TO RAISE	□	UNABLE TO MEASURE	○	W
▲	GIRTH OF TREE TRUNK	□	UNABLE TO MEASURE	○	W
▲	HEIGHT TO TOP OF TREE CANOPY	□	DIAMETER OF TREE TRUNK	○	W
▲		□	WALNUT TREE	○	W

Rev	Date	Drawn	Description	Check

Southgate House
 Pomeroy Road
 Stourton
 Leeds
 West Yorkshire
 LS10 1SW

T: +44 (0) 1132 008 900
 F: +44 (0) 1132 008 901
 E: admin@metgeoenvironmental.com
 W: www.metgeoenvironmental.com

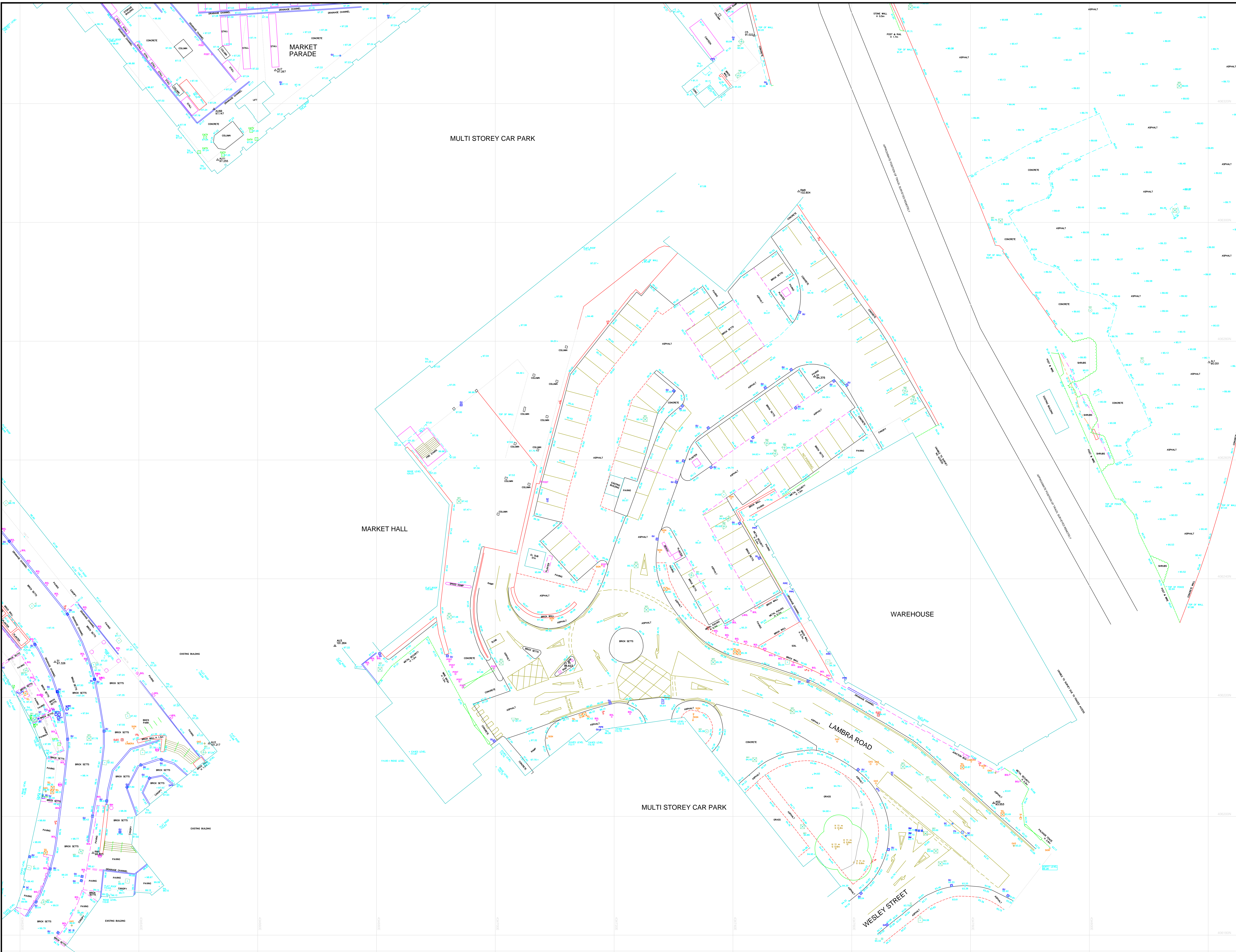
Client : NPS GROUP

Site : BARNSELY TOWN CENTRE
 BARNSELY, SOUTH YORKSHIRE

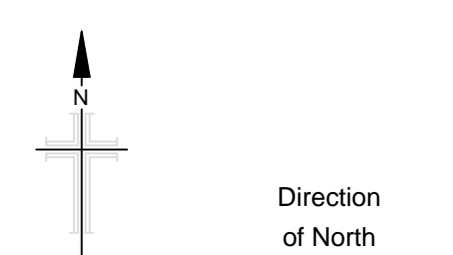
Title : TOPOGRAPHICAL SURVEY
 2D

Scale	[A0 Sheet]	[DWG Ref. (Layout No.)]	Scale
1/200	11549-201_2D(2)	FINAL	

Job No: 11549-201



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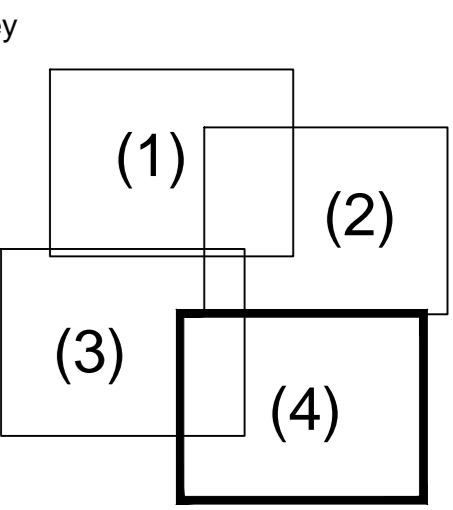


Grid : OS National Grid.
 Using the OS GPS Network and applying OSTN02 transformation and then removing the scale factor for true distances with a one-step transformation centred on S1

Datum : OS Level Datum.
 Using the OS GPS Network and applying OSGM02 National Geoid Model to obtain local area corrections.

Station Listing

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AL1	434400.135	406276.451	90.051
AS2	434783.892	406202.243	93.553
AS10	434481.713	406367.188	99.082
AU1	434592.173	406271.197	96.573
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AU3	434673.007	406228.703	101.264
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AU6	434705.338	406351.988	97.051
AU7	434662.977	406326.514	97.267
AU8	434778.467	406362.073	91.527
AU10	434625.242	406343.265	96.640
AU11	434655.354	406310.545	97.255
AU12	434681.216	406411.276	94.093
AUA	434660.035	406352.906	96.882
AUB	434652.542	406319.382	97.147
AU7C	434681.519	406355.646	97.018
C1	434712.462	406225.869	96.623
C2	434727.503	406419.334	93.150
C3	434721.679	406372.200	92.690
C4	434735.914	406359.097	91.234
C5	434743.584	406331.452	91.022
G1	434753.750	406274.087	94.375
RM1	434632.277	406193.847	98.823
RM2	434663.232	406464.517	95.546
RM3	434598.707	406431.132	97.781
RM4	434637.041	406534.940	97.076
RM5	434646.151	406488.039	96.047
RM6	434752.985	406409.862	92.882
RM7	434822.485	406411.081	92.832
S1	434625.882	406225.994	97.326
S2	434562.494	406300.082	96.717
S3	434501.632	406330.004	97.837
S4	434591.352	406337.611	95.950
S5	434462.262	406339.104	98.714
S6	434412.220	406315.787	100.782
SD1	434693.601	406357.827	96.797
SD2	434704.574	406374.384	95.560



KEY

▲	▲	JUNCTION BOX	J/BOX
○	○	MANHOLE (RECTANGULAR)	M/RE
○	○	MANHOLE (CIRCULAR)	M/CI
○	○	MANHOLE (TRIANGULAR)	M/TRI
○	○	MARKER POST	M/POST
○	○	ROADSIDE EYE	R/EYE
○	○	SUN POST	S/POST
○	○	TELEPHONE POLE	T/POLE
○	○	TELEGRAPH POLE	T/POLE
○	○	THRESHOLD LEVEL	T/LEV
○	○	TRAFFIC LIGHT	T/LIGHT
○	○	WATER METER	W/METER
○	○	WATER STOP COCK	W/COCK
○	○	WATER STOP VALVE	W/VALVE
○	○	CHAMBER BASE LEVEL	C/BL
○	○	WATER SURFACE LEVEL	W/SURF
○	○	CHAMBER TO BEASURED	C/BL
○	○	DIAMETER OF TREE TRUNK	D/TREE
○	○	HEIGHT TO TOP OF TREE CANOPY	H/TREE
○	○	MULTI SOLE TREE	M/TREE

Rev	Date	Drawn	Description	Check

Southgate House
 Pontefract Road T: +44 (0) 1132 008 900
 Stourton F: +44 (0) 1132 008 901
 Leeds E: admin@metgeoenvironmental.com
 West Yorkshire W: www.metgeoenvironmental.com
 LS10 1SW

Client : NPS GROUP

Site : BARNSELY TOWN CENTRE
 BARNSELY, SOUTH YORKSHIRE

Title : TOPOGRAPHICAL SURVEY
 2D

Surveyed	RM, CC, AS, AU, SD, GP, AL	Drawn	RM, CC, AS, AU, SD
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Job No	11549-201	Rev	0

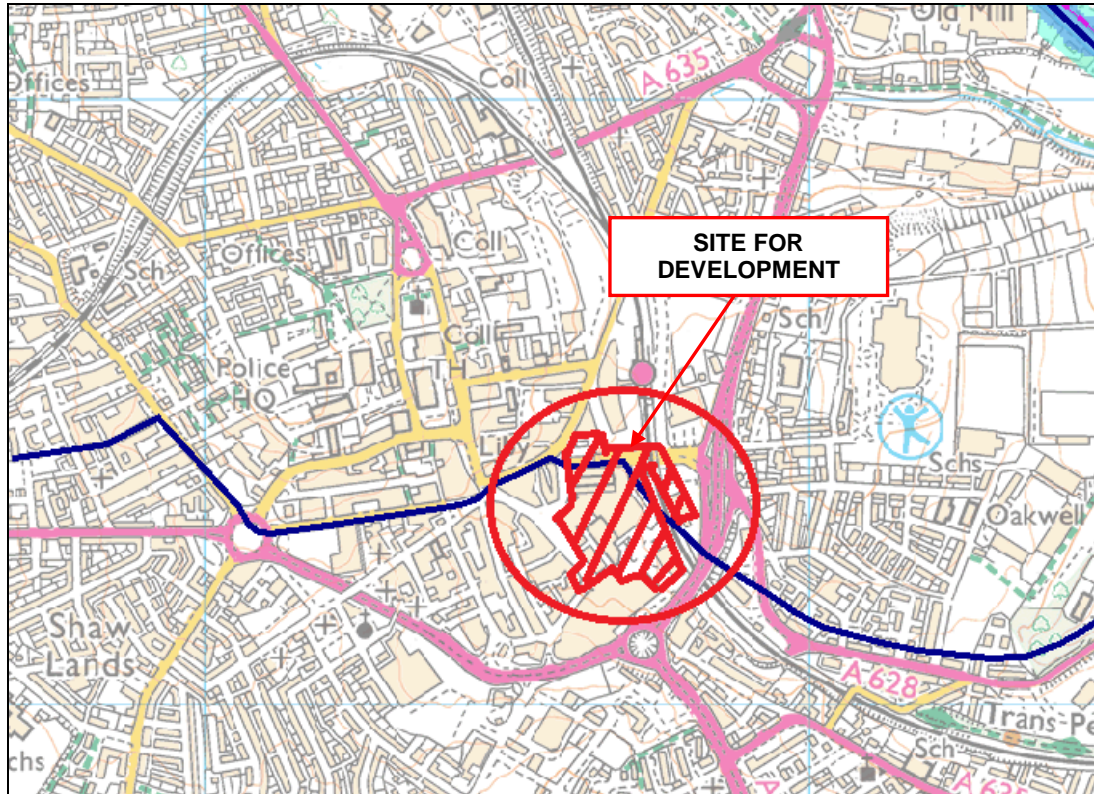
APPENDIX C

Environment Agency Maps

- **Flood Zone**
- **Potential Flooding from Surface Water**
- **Potential Flooding from Reservoirs**

FLOOD OUTLINE MAP

(Source:- Environment Agency Website May 2015)

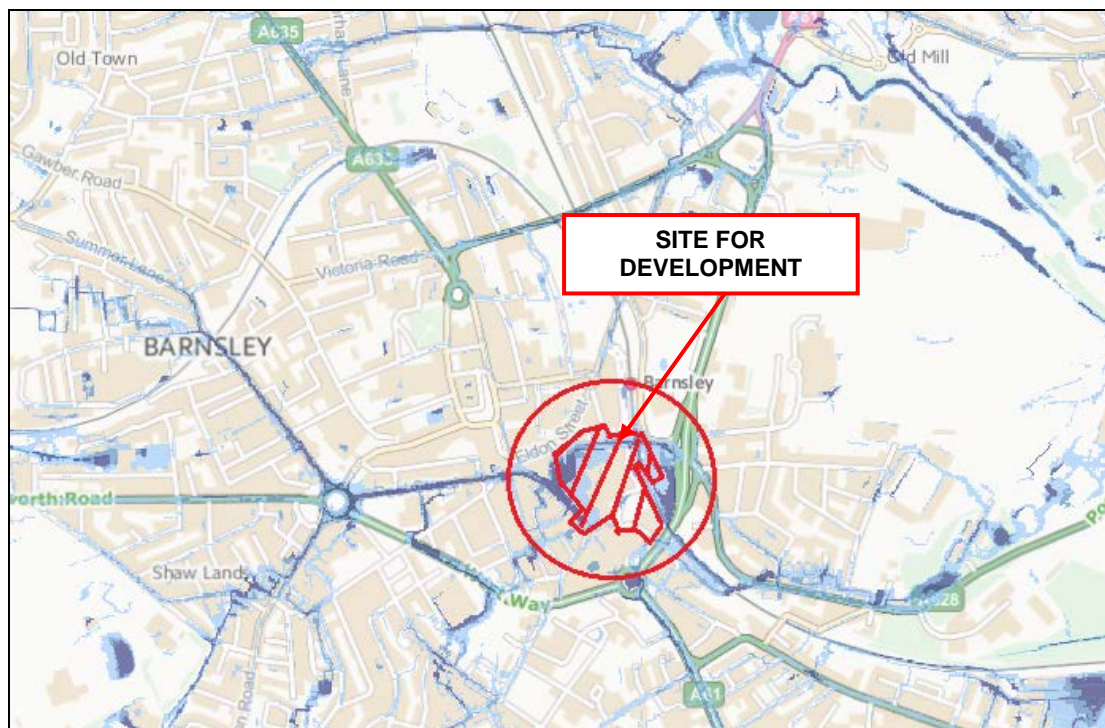


KEY





Map legend	
Click on the map to see what Flood Zone (National Planning Policy Guidance definitions) the proposed development is in.	
<input type="checkbox"/>	<input checked="" type="checkbox"/> Flood Map for Planning (Rivers and Sea) i
<input checked="" type="checkbox"/>	Flood Zone 3
<input checked="" type="checkbox"/>	Flood Zone 2
<input checked="" type="checkbox"/>	Flood defences (Not all may be shown*)
<input checked="" type="checkbox"/>	Areas benefiting from flood defences (Not all may be shown*)
<input type="checkbox"/>	<input checked="" type="checkbox"/> Main Rivers i
<input checked="" type="checkbox"/>	River line

ENVIRONMENT AGENCY MAP SHOWING POTENTIAL RISK OF FLOODING FROM SURFACE WATER

(Source:- Environment Agency Website May 2015)

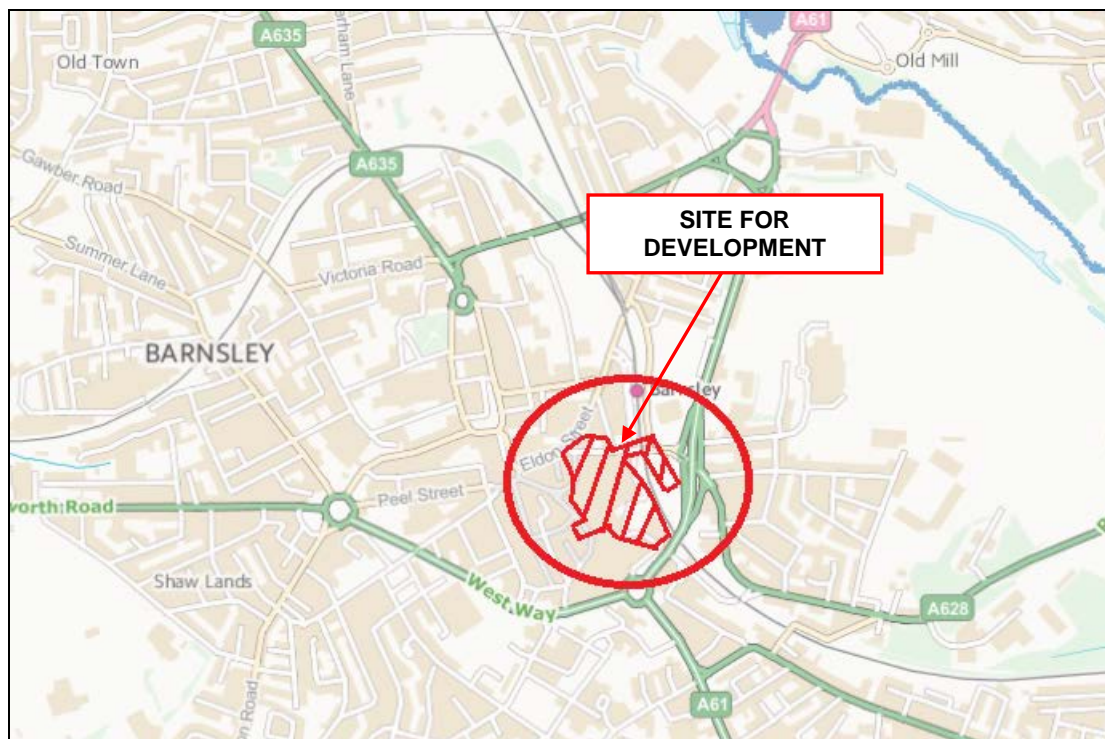


KEY

Map legend	
<input checked="" type="checkbox"/>	Risk of Flooding from Surface Water
	High
	Medium
	Low
	Very Low

ENVIRONMENT AGENCY MAP SHOWING POTENTIAL RISK OF FLOODING FROM RESERVOIRS

(Source:- Environment Agency Website May 2015)

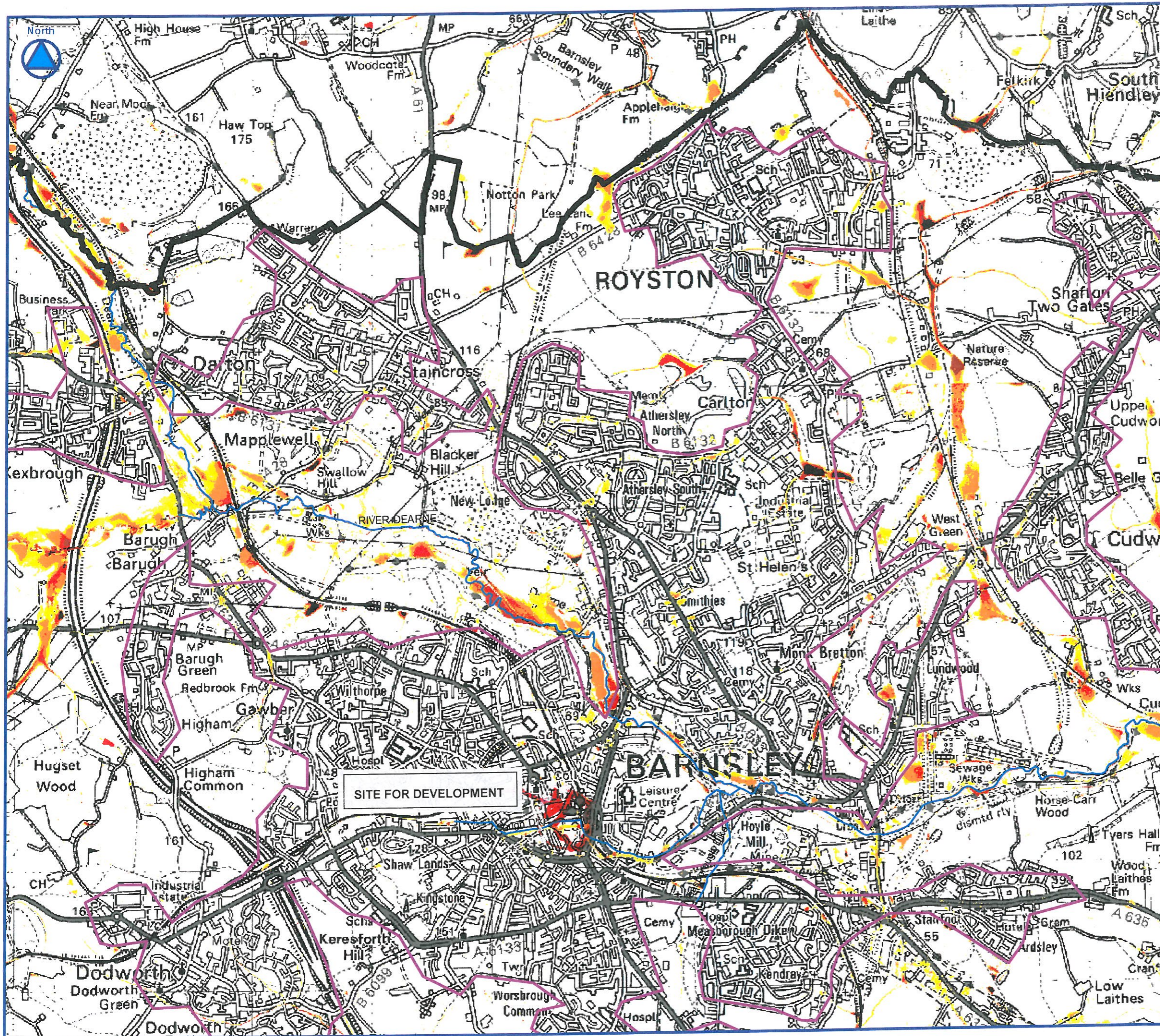


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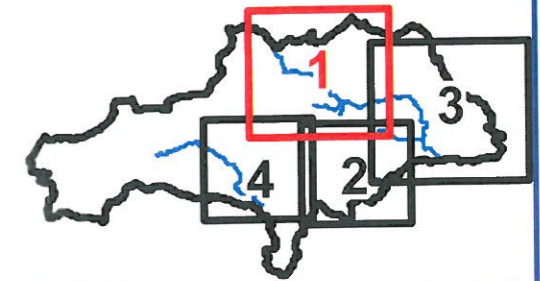
Map legend	
<input checked="" type="checkbox"/>	Risk of Flooding from Reservoirs
<input type="checkbox"/>	Maximum extent of flooding

APPENDIX D

SFRA Map Showing Depth of Pluvial Flooding












KEYPLAN



LEGEND

1:30,809

-  Barnsley MBC Boundary
-  Urban Areas
-  Main River
- Surface Water Flooding
- Flood Depth (m)
-  0.15 - 0.3
-  0.3 - 0.5
-  0.5 - 1
-  1 - 1.5
-  1 - 2
-  > 2

Note:
Please see Section 5.8 of the SFRA
for further details.

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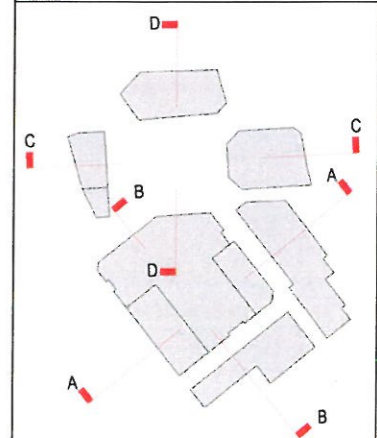
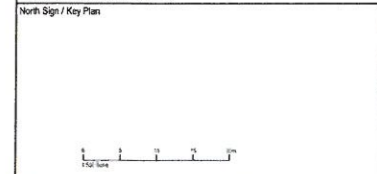
MAP C - 1

PLUVIAL FLOODING CAUSED BY
100YEAR RAINSTORM

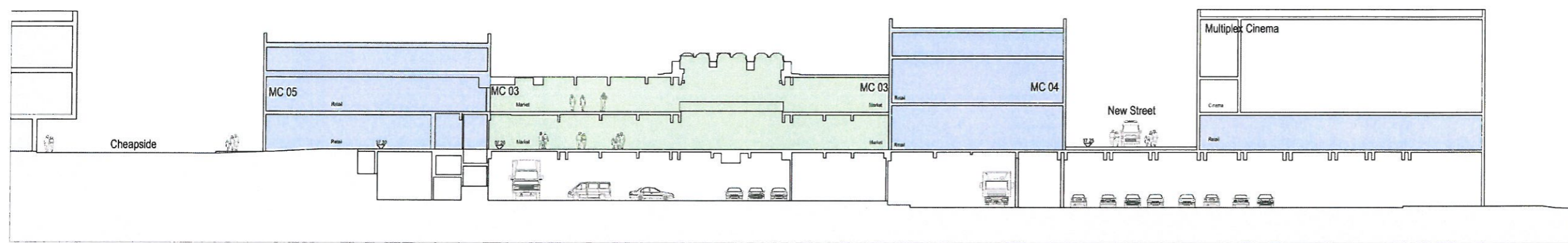
APPENDIX E

Schematic Site Layout Details

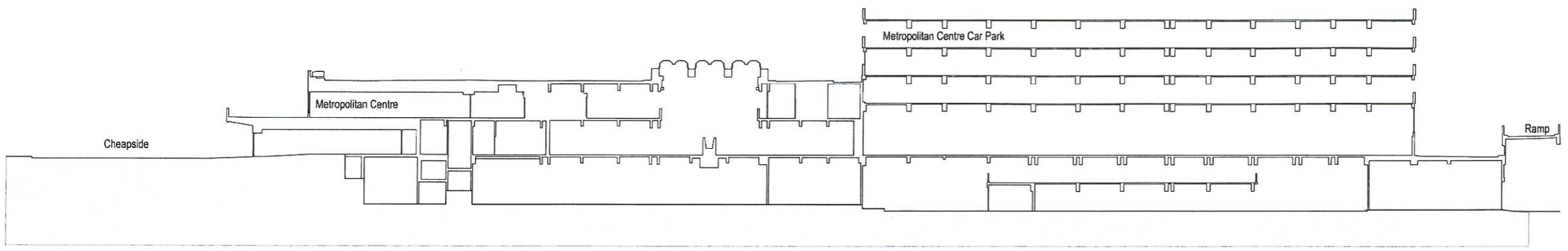
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 • This drawing is to be read in conjunction with all other relevant drawings.
 • All discrepancies on this drawing are to be reported to the architect.
 • Do not modify any element of the drawing.
 • Use drawing only for purpose(s) issued.



Section Key Plan



Proposed Section A : A



Existing Section A : A

Rev	Date	Revision Notes	Dr	Rv
x	00/00/00		x	x

Client / Contractor

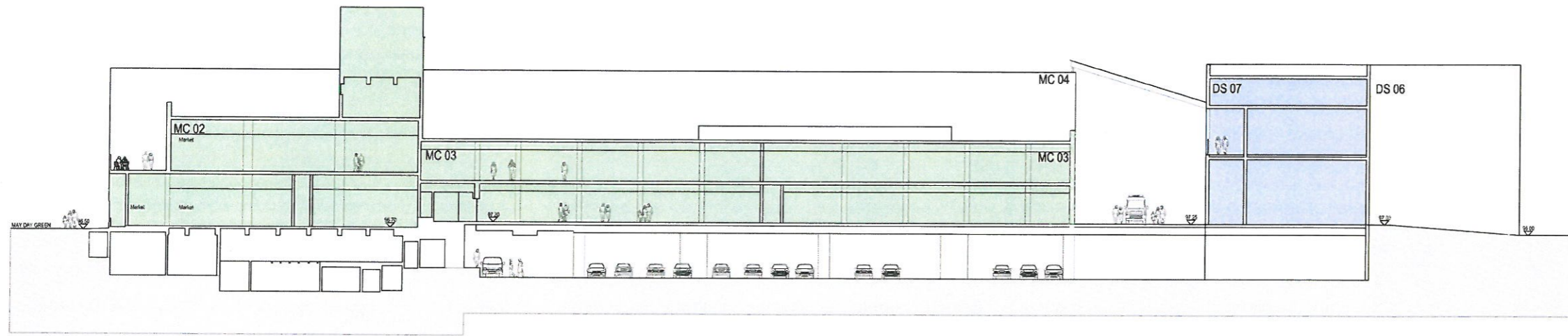
IBI Intelligence Buildings Infrastructure www.ibigroup.com

Project
BETTER BARNSELY TOWN CENTRE DEVELOPMENT

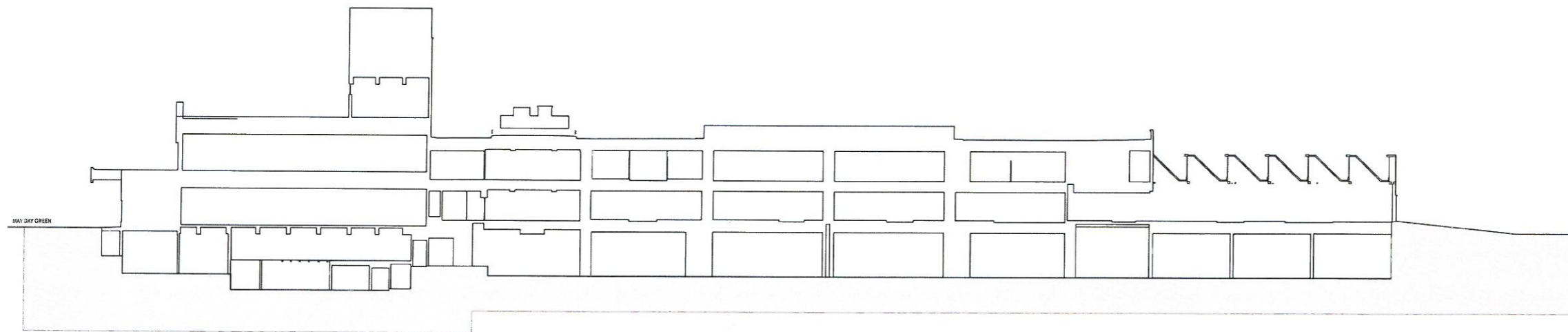
Drawing Title
SITE SECTION A : A

Job Number 6743	Drawing Original Date 22/04/2015	PAS 1192 Status Code -
Scale@A1 1:250	Purpose PLANNING	

Drawing Number BBTC_IBI_MC_A_F100_SE_AA	Revision -
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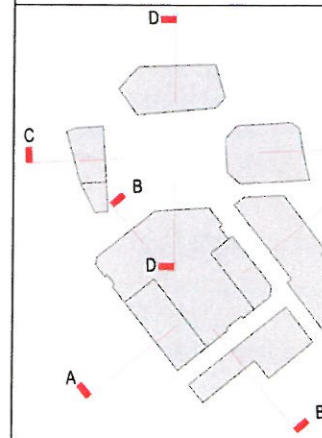
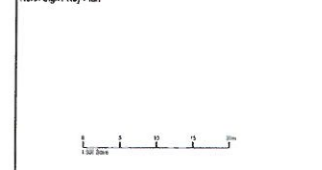


Proposed Section B : B



Existing Section B : B

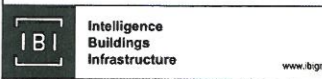
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Section Key Plan

Rev	Date	Reviser Notes	Dr	Rv
x	01/09/02		x	x

Client / Contractor



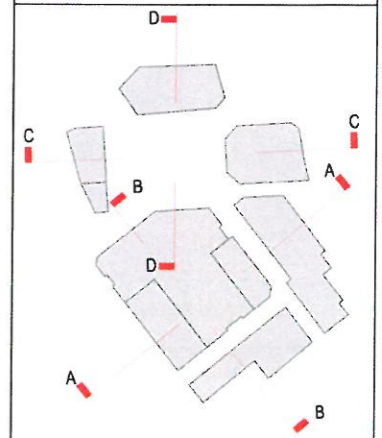
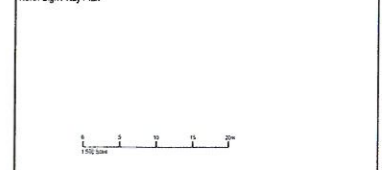
Project
 BETTER BARNSLEY TOWN CENTRE DEVELOPMENT

Drawing Title
 SITE SECTION B : B

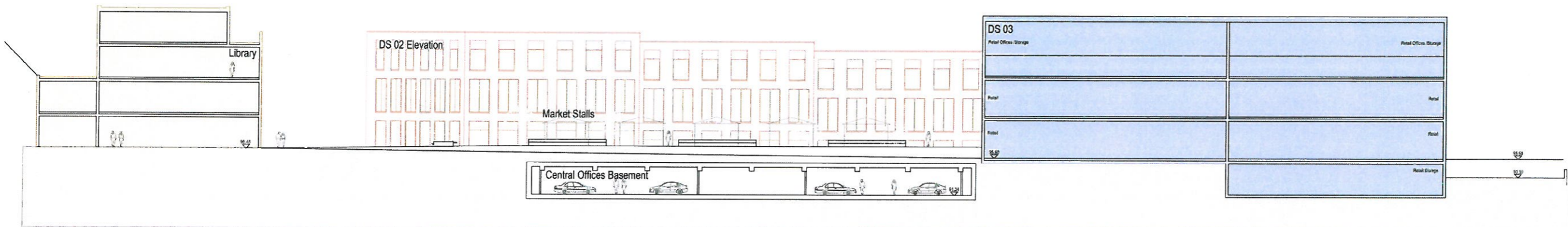
Job Number 6743	Drawing Originated Date 22/04/2015	PAS 1192 Status Code -
Scale@A1 1:250	Purpose PLANNING	

Drawing Number BBTC_IBI_MC_A_F100_SE_BB	Revision -
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Section Key Plan



Proposed Section C : C

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Rev	Date	Revision Notes	Ln	By
x	00/00/00		x	x

Client / Contractor

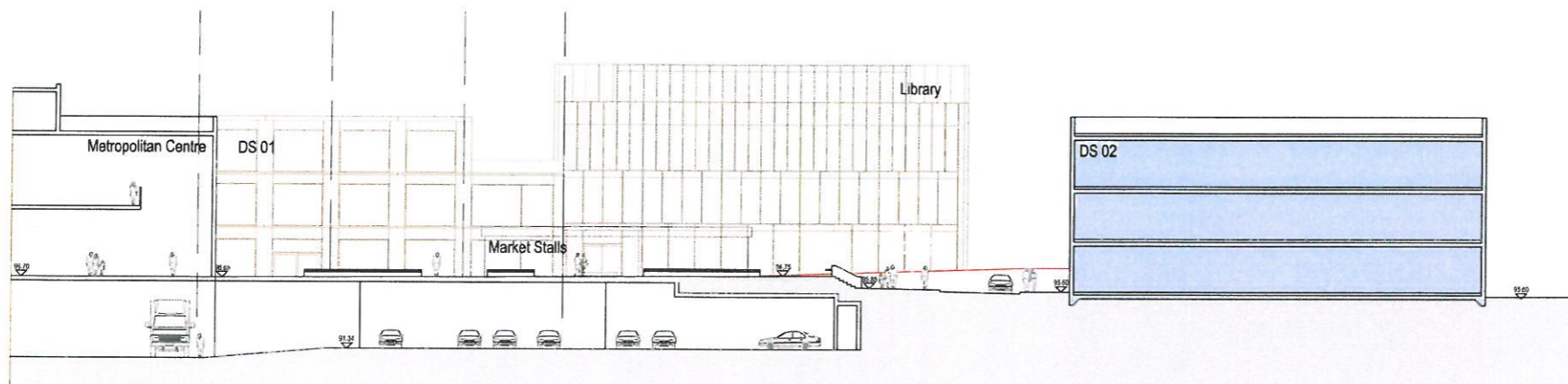


Project
 BETTER BARNSELY TOWN CENTRE DEVELOPMENT

Drawing Title
 SITE SECTION C : C

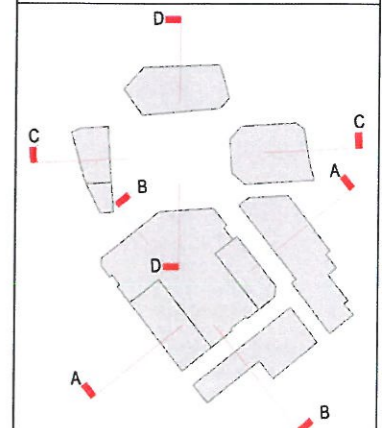
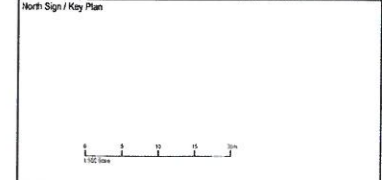
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Scale@A1 1:250	Purpose PLANNING	

Drawing Number BBTC_IBI_MC_A_F100_SE_CC	Revision -
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Proposed Section D : D

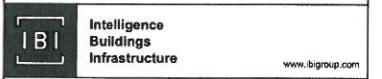
Notes:
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Section Key Plan

Rev	Date	Revision Notes	Dr	Rv
x	00/00/00		x	x

Client / Contractor



Project
BETTER BARNSELY TOWN CENTRE DEVELOPMENT

Drawing Title
SITE SECTION D : D

Job Number 6743	Drawing Originated Date 21/04/2015	PAS 1192 Status Code -
Scale@A1 1:250	Purpose PLANNING	

Drawing Number BBTC_IBI_MC_A_F100_SE_DD	Revision -
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APPENDIX F

Surface Water Storage Calculations

341 Beverley Road
Hull
HU5 1LD

Barnsley Town Center
Redevelopment
Barnsley M.B.C



Date 18/05/2015 16:17
File STORAGE CALCS.SRCX

Designed by Josh Harrison
Checked by

Elstree Computing Ltd


Source Control 2014.1.1

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
15 min Summer	99.688	0.688	267.0	295.7	O K
30 min Summer	99.837	0.837	267.0	360.0	O K
60 min Summer	99.814	0.814	267.0	350.2	O K
120 min Summer	99.632	0.632	267.0	271.8	O K
180 min Summer	99.432	0.432	267.0	185.9	O K
240 min Summer	99.270	0.270	267.0	115.9	O K
360 min Summer	99.102	0.102	267.0	43.8	O K
480 min Summer	99.083	0.083	220.9	35.6	O K
600 min Summer	99.071	0.071	188.9	30.5	O K
720 min Summer	99.062	0.062	164.9	26.6	O K
960 min Summer	99.050	0.050	134.2	21.5	O K
1440 min Summer	99.037	0.037	98.1	15.7	O K
2160 min Summer	99.027	0.027	71.4	11.5	O K
2880 min Summer	99.021	0.021	56.7	9.2	O K
4320 min Summer	99.016	0.016	42.1	6.7	O K
5760 min Summer	99.012	0.012	32.7	5.4	O K
7200 min Summer	99.010	0.010	27.4	4.6	O K
8640 min Summer	99.009	0.009	24.7	4.0	O K
10080 min Summer	99.008	0.008	22.0	3.6	O K
15 min Winter	99.811	0.811	267.0	348.6	O K
30 min Winter	99.987	0.987	267.0	424.6	O K



Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	106.935	0.0	551.2	20
30 min Summer	71.856	0.0	740.8	29
60 min Summer	46.096	0.0	950.5	46
120 min Summer	28.561	0.0	1178.0	78
180 min Summer	21.269	0.0	1316.0	108
240 min Summer	17.134	0.0	1413.3	138
360 min Summer	12.591	0.0	1558.1	190
480 min Summer	10.117	0.0	1669.0	248
600 min Summer	8.530	0.0	1759.2	308
720 min Summer	7.416	0.0	1835.3	368
960 min Summer	5.941	0.0	1960.6	488
1440 min Summer	4.339	0.0	2147.5	736
2160 min Summer	3.162	0.0	2347.3	1084
2880 min Summer	2.522	0.0	2496.9	1428
4320 min Summer	1.831	0.0	2719.2	2160
5760 min Summer	1.457	0.0	2885.5	2936
7200 min Summer	1.220	0.0	3019.1	3672
8640 min Summer	1.056	0.0	3135.2	4256
10080 min Summer	0.934	0.0	3238.0	5096
15 min Winter	106.935	0.0	617.3	21
30 min Winter	71.856	0.0	829.7	31

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341 Beverley Road Hull HU5 1LD	Barnsley Town Center Redevelopment Barnsley M.B.C	
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Elstree Computing Ltd	Source Control 2014.1.1	

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
60 min Winter	99.918	0.918	267.0	394.9	O K
120 min Winter	99.596	0.596	267.0	256.3	O K
180 min Winter	99.290	0.290	267.0	124.9	O K
240 min Winter	99.108	0.108	267.0	46.4	O K
360 min Winter	99.076	0.076	202.3	32.7	O K
480 min Winter	99.061	0.061	163.5	26.3	O K
600 min Winter	99.052	0.052	138.2	22.2	O K
720 min Winter	99.045	0.045	120.8	19.4	O K
960 min Winter	99.036	0.036	96.8	15.5	O K
1440 min Winter	99.027	0.027	71.4	11.4	O K
2160 min Winter	99.019	0.019	51.4	8.4	O K
2880 min Winter	99.016	0.016	42.1	6.7	O K
4320 min Winter	99.011	0.011	30.0	4.9	O K
5760 min Winter	99.009	0.009	24.7	4.0	O K
7200 min Winter	99.008	0.008	20.7	3.4	O K
8640 min Winter	99.007	0.007	18.0	2.9	O K
10080 min Winter	99.006	0.006	15.4	2.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
60 min Winter	46.096	0.0	1064.5	48
120 min Winter	28.561	0.0	1319.4	82
180 min Winter	21.269	0.0	1473.7	112
240 min Winter	17.134	0.0	1582.9	132
360 min Winter	12.591	0.0	1745.0	190
480 min Winter	10.117	0.0	1869.4	248
600 min Winter	8.530	0.0	1970.3	308
720 min Winter	7.416	0.0	2055.6	368
960 min Winter	5.941	0.0	2195.8	488
1440 min Winter	4.339	0.0	2405.2	738
2160 min Winter	3.162	0.0	2629.0	1072
2880 min Winter	2.522	0.0	2796.7	1444
4320 min Winter	1.831	0.0	3045.8	2184
5760 min Winter	1.457	0.0	3232.0	2992
7200 min Winter	1.220	0.0	3382.0	3816
8640 min Winter	1.056	0.0	3511.9	4224
10080 min Winter	0.934	0.0	3626.7	5120

341 Beverley Road
Hull
HU5 1LD

Barnsley Town Center
Redevelopment
Barnsley M.B.C



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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
W5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.351	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 2.750


Time (mins)		Area	Time (mins)		Area	Time (mins)		Area
From:	To:	(ha)	From:	To:	(ha)	From:	To:	(ha)
0	4	0.917	4	8	0.917	8	12	0.917

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
15 min Summer	99.303	0.303	267.0	130.4	O K
30 min Summer	99.362	0.362	267.0	155.7	O K
60 min Summer	99.316	0.316	267.0	135.9	O K
120 min Summer	99.181	0.181	267.0	77.8	O K
180 min Summer	99.100	0.100	267.0	43.0	O K
240 min Summer	99.084	0.084	224.9	36.3	O K
360 min Summer	99.065	0.065	174.2	27.9	O K
480 min Summer	99.053	0.053	142.2	22.9	O K
600 min Summer	99.046	0.046	122.2	19.8	O K
720 min Summer	99.040	0.040	107.5	17.2	O K
960 min Summer	99.033	0.033	87.4	14.0	O K
1440 min Summer	99.024	0.024	64.7	10.4	O K
2160 min Summer	99.018	0.018	47.4	7.7	O K
2880 min Summer	99.014	0.014	38.0	6.2	O K
4320 min Summer	99.011	0.011	28.7	4.6	O K
5760 min Summer	99.009	0.009	23.4	3.8	O K
7200 min Summer	99.007	0.007	19.4	3.1	O K
8640 min Summer	99.006	0.006	16.7	2.9	O K
10080 min Summer	99.006	0.006	15.4	2.5	O K
15 min Winter	99.373	0.373	267.0	160.5	O K
* 30 min Winter	99.427	0.427	267.0	183.6	O K *


Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
15 min Summer	68.903	0.0	355.1	19
30 min Summer	45.851	0.0	472.6	28
60 min Summer	29.238	0.0	603.0	44
120 min Summer	18.103	0.0	746.5	72
180 min Summer	13.524	0.0	836.6	98
240 min Summer	10.942	0.0	902.5	128
360 min Summer	8.096	0.0	1001.8	188
480 min Summer	6.535	0.0	1078.0	248
600 min Summer	5.531	0.0	1140.5	308
720 min Summer	4.824	0.0	1193.7	368
960 min Summer	3.885	0.0	1282.1	490
1440 min Summer	2.860	0.0	1415.6	732
2160 min Summer	2.103	0.0	1561.0	1080
2880 min Summer	1.689	0.0	1671.8	1456
4320 min Summer	1.239	0.0	1839.1	2196
5760 min Summer	0.993	0.0	1966.3	2888
7200 min Summer	0.836	0.0	2070.4	3656
8640 min Summer	0.727	0.0	2160.1	4352
10080 min Summer	0.646	0.0	2239.5	5008
15 min Winter	68.903	0.0	397.7	20
30 min Winter	45.851	0.0	529.3	29

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Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m ³)	Status
60 min Winter	99.323	0.323	267.0	138.8	O K
120 min Winter	99.111	0.111	267.0	47.7	O K
180 min Winter	99.080	0.080	212.9	34.3	O K
240 min Winter	99.065	0.065	174.2	28.1	O K
360 min Winter	99.049	0.049	130.2	21.0	O K
480 min Winter	99.040	0.040	106.1	17.0	O K
600 min Winter	99.034	0.034	90.1	14.4	O K
720 min Winter	99.029	0.029	78.1	12.5	O K
960 min Winter	99.024	0.024	63.4	10.2	O K
1440 min Winter	99.018	0.018	47.4	7.6	O K
2160 min Winter	99.013	0.013	34.0	5.7	O K
2880 min Winter	99.010	0.010	27.4	4.4	O K
4320 min Winter	99.008	0.008	20.7	3.3	O K
5760 min Winter	99.006	0.006	16.7	2.7	O K
7200 min Winter	99.005	0.005	14.0	2.3	O K
8640 min Winter	99.005	0.005	12.7	2.1	O K
10080 min Winter	99.004	0.004	11.3	1.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m ³)	Discharge Volume (m ³)	Time-Peak (mins)
60 min Winter	29.238	0.0	675.2	44
120 min Winter	18.103	0.0	836.2	72
180 min Winter	13.524	0.0	937.0	98
240 min Winter	10.942	0.0	1010.7	128
360 min Winter	8.096	0.0	1121.9	190
480 min Winter	6.535	0.0	1207.5	250
600 min Winter	5.531	0.0	1277.3	310
720 min Winter	4.824	0.0	1337.0	370
960 min Winter	3.885	0.0	1435.8	484
1440 min Winter	2.860	0.0	1585.6	742
2160 min Winter	2.103	0.0	1748.4	1104
2880 min Winter	1.689	0.0	1872.4	1468
4320 min Winter	1.239	0.0	2059.8	2152
5760 min Winter	0.993	0.0	2202.8	3096
7200 min Winter	0.836	0.0	2318.9	3528
8640 min Winter	0.727	0.0	2419.5	4000
10080 min Winter	0.646	0.0	2509.1	5368

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Rainfall Details

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Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Shortest Storm (mins)	15
Ratio R	0.351	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 2.750

Time (mins)		Area	Time (mins)		Area	Time (mins)		Area
From:	To:	(ha)	From:	To:	(ha)	From:	To:	(ha)
0	4	0.917	4	8	0.917	8	12	0.917

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