Additional Parking

Prologis Park

Birmingham Interchange

Flood Risk Assessment & Outline Drainage Strategy Report

Project Ref: **12992**

Report Ref:**JH / FRA / 12992**

Second Issue

December 2020

Client

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REPORT STATUS

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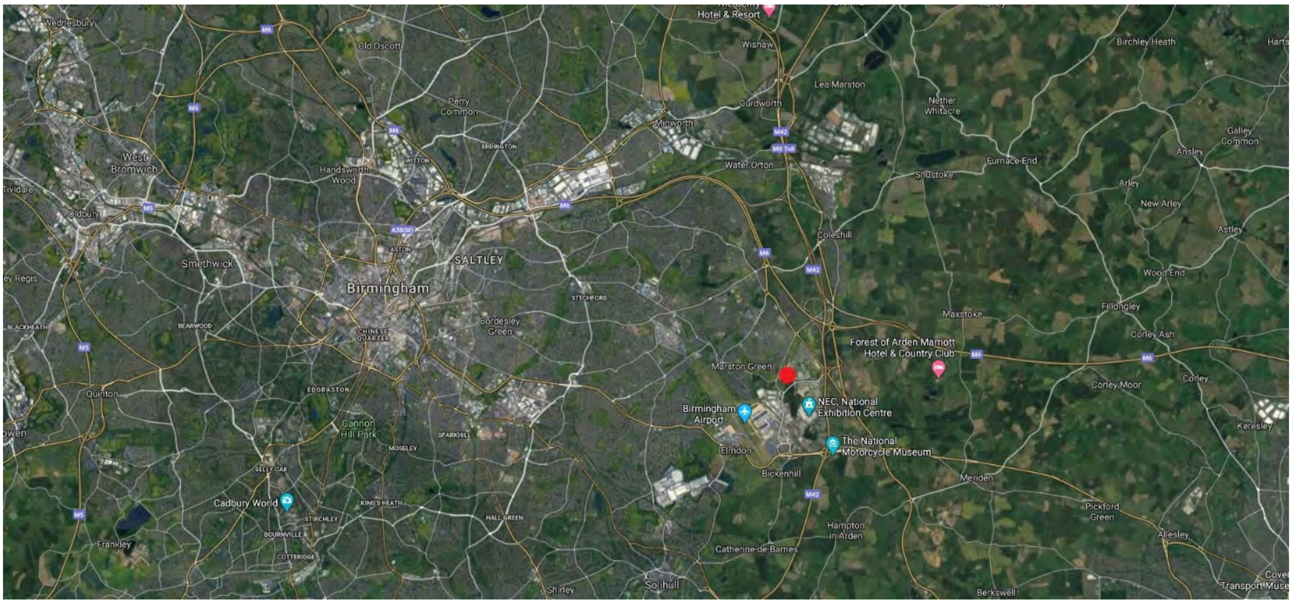

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2 Introduction

Baynham Meikle Partnership has been commissioned on behalf of IAC Group to prepare a Flood Risk Assessment and Drainage Strategy, to support a planning application for the additional parking of 391 No. spaces and circulation road at the existing development named Prologis Park, Birmingham Interchange. The Flood Risk Assessment will be part of a planning application to be made to Solihull Metropolitan Borough Council.

The site is located at Birmingham Interchange, and is located off Bickenhill Parkway. The development area is approximately 5.82 hectares in total and the Ordnance Survey Grid reference is E: 418606, N: 285135. A Site location plan is included in Appendix A.

It is a requirement for development applications to consider the potential risk of flooding over its designed lifetime and any possible impacts on flood risk elsewhere in terms of its effects on flood flows and runoff.

This Flood Risk Assessment has been prepared following guidance set out in the National Planning Policy Framework (NPPF) and is undertaken in consultation with other relevant bodies.

The following aspects of flood risk that have been addressed within this report are:

- The area liable to flooding.
- The probability of flooding occurring now and over time.
- The extent and standard of existing flood defences and their effectiveness over time.
- The rates of flow likely to be involved.
- The likelihood of impacts on other areas, properties, and habitats.
- The effects of climate change which currently requires designs to include 1 in 100-year rainfall events + climate change allowances (40%).
- The nature and current expected lifetime of the development proposed and the extent to which it is designed to deal with flood risk.

Further guidance has been obtained from:

- The SuDs Manual V6 (CIRIA c753).
- “Interim Code of Practice for Sustainable Drainage Systems 2004” (ICOP SUDS).
- “Interim National Procedures” point 3, 10.2 & 10.3.
- The council’s in subject Strategic Flood Risk Assessment for this area.

3 Existing Site

3.1 Site Location

The development site is situated at Birmingham Interchange, with postcode B40 1QA (nearest). The Ordnance Survey National Grid reference to the centre of the site is E: 418606, N: 285135. A site location plan can be found in Appendix A. The development will form part of the Prologis Park development to provide additional car parking to the existing 2 units constructed in 2018.

3.2 Topography

The area in which the majority of the car parking is to be is currently a large bund covered in soft landscaping. The other sections of parking are within the existing circulation road for the development.

A Topographical survey is included within Appendix A.

3.3 Existing Ground Conditions

Using the Ian Farmer Associates site specific Phase 1 and 2 Geo-environmental report that was produced for Prologis Park, the general underground strata that was encountered can be summarised within the below table. The table has been taken from section 6.1.4 of the Ian Farmer Associates report:

Strata Encountered	Depth Encountered (m)		Strata Thickness (m)
	From	To	
Topsoil	0.00	0.50	0.50
Made Ground/Possible Made Ground	0.00 to 0.50	0.30 to >2.10	0.30 to >2.10
Superficial Deposits			
Glaciolacustrine Deposits	0.30 to 2.10	2.00 to 3.50	1.00 to 2.00, >2.70
Glaciofluvial Deposits	0.30 to 3.50	>10.45	>9.45

Although no infiltration tests have been carried out within the site specific testing, it can be assumed that due to the presences of cohesive soils within the underlain strata, discharging surface water via methods utilising infiltration will not be viable.

Full extracts from the available Ian Farmer Associates site investigation are appended within Appendix E.

3.4 Aquifer Designation

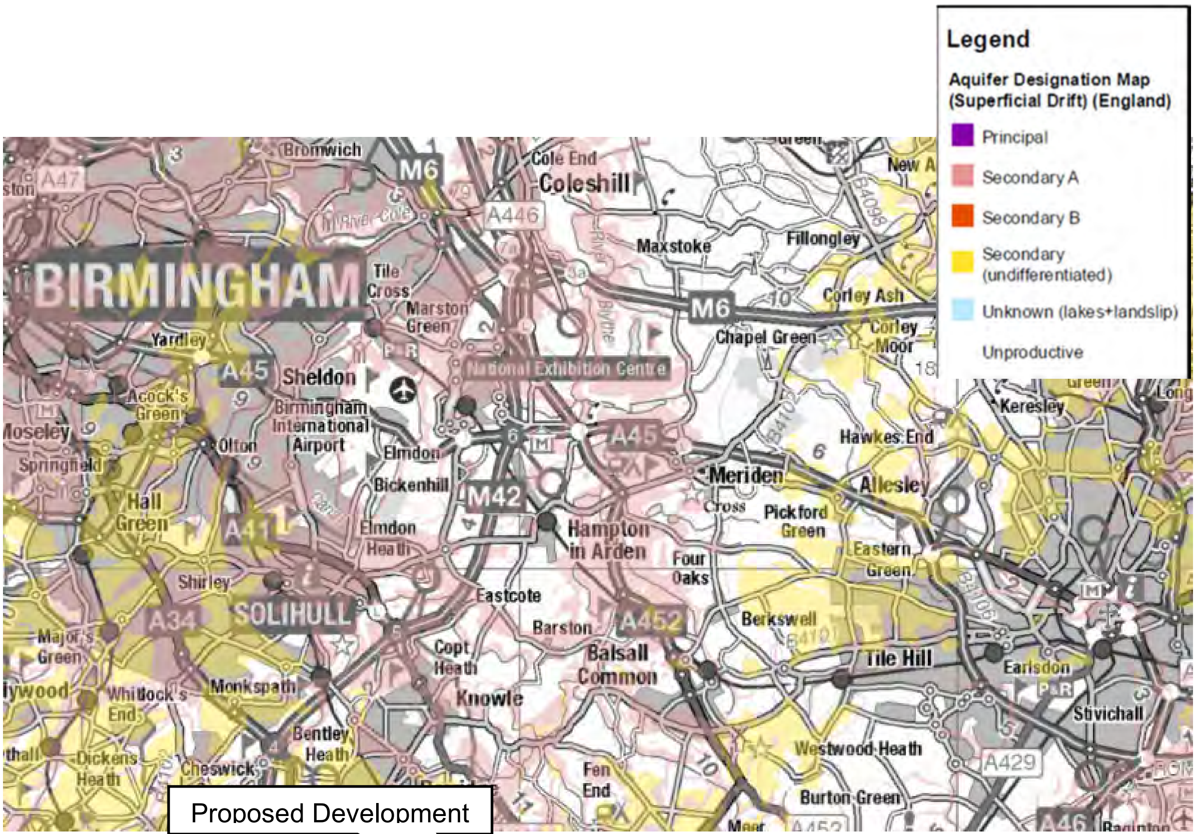
An extract from the geographic information map (

Figure 1 & Figure 2) provided by Natural England indicates that the site is located on an aquifer that is

designated as Secondary B.

Figure 1. Aquifer Bedrock designation map

Figure 2. Aquifer Superficial Drift designation map



3.5 Site Specific Flood Risks

This section reviews the possible sources of flooding relevant for the site and assesses the impacts both on the development itself and on other areas as a result of the proposed development. The Environment Agency is responsible for the provision of information pertaining to flood risk from tidal and main watercourses throughout England and Wales. The EA provides an online information service through its flood map data. An extract from the flood map is given in Figure 3 which indicates that the site is in **Flood Zone 1**, this is described as land of having a less than 1 in 1,000 annual probability of river and sea flooding.

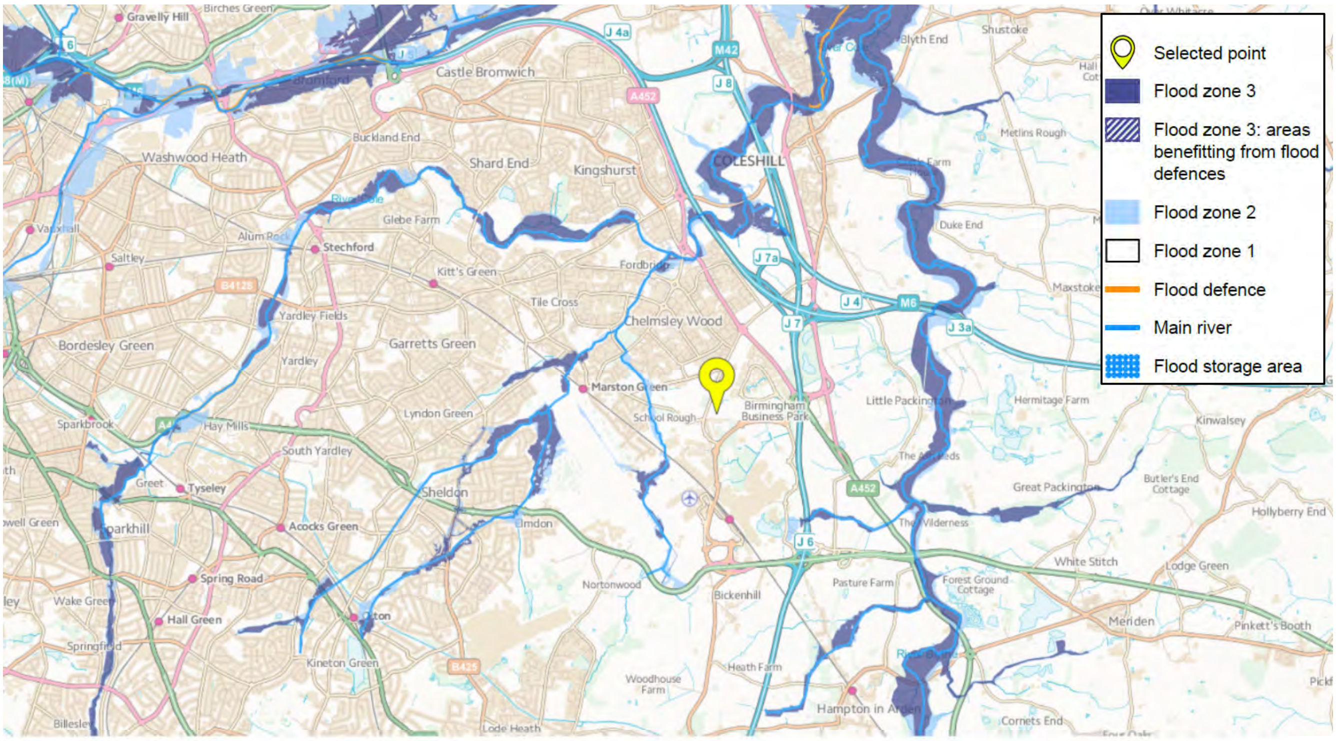


Figure 3.Flood map for planning by EA

3.5.1 Tidal/Fluvial Flooding

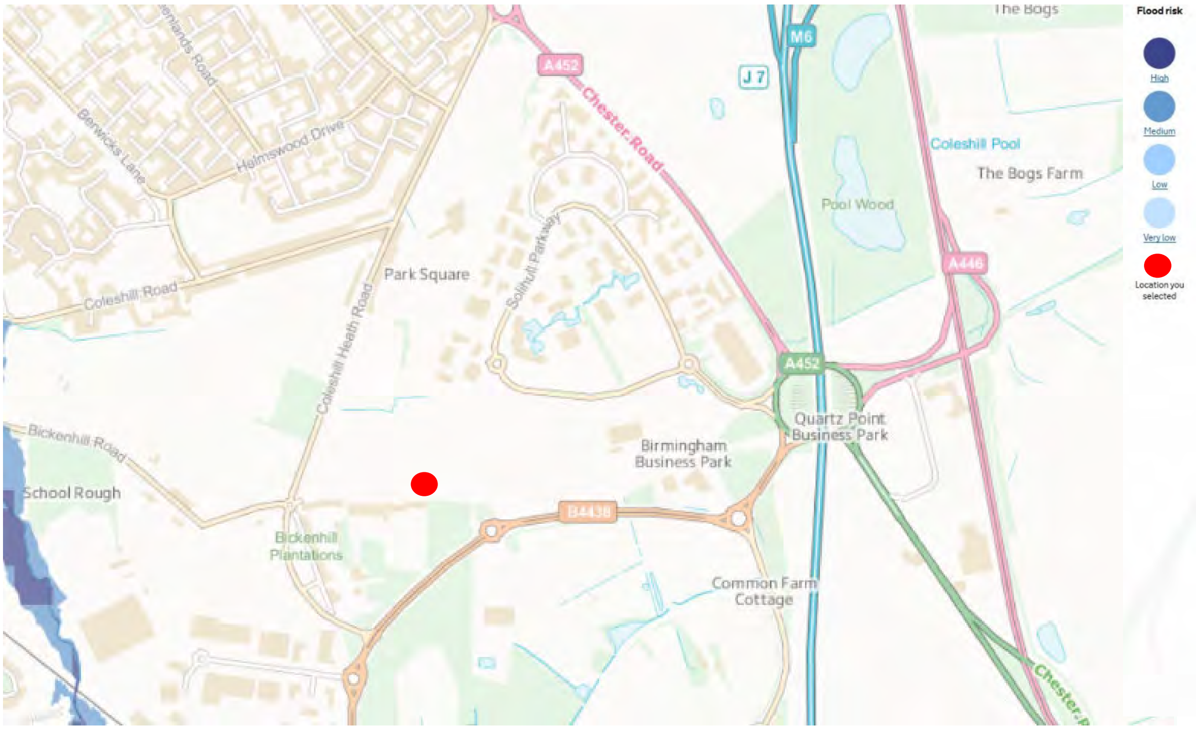


Figure 4.Tidal/Fluvial Flood risk map

Tidal/Fluvial flooding occurs when sea levels rise and flows into a water course. This can cause the water table levels to rise or water to levels rise as a result of high or intense rainfall flowing into a watercourse. This can result in water courses overflowing their banks.

Sea (Tidal) Flooding – The site is **not** located in the vicinity of the coast, and is therefore **not** at risk of flooding due to tidal flows.

River (Fluvial) Flooding – The site is **not** located adjacent in the vicinity to any river. Therefore, there is **no** risk of flooding from fluvial flows.

From Figure 5.Pluvial Flood risk map, we can see that the proposed site is in a very low risk area. Meaning, each year this area has a chance of flooding less than 1 in 1,000 (0.1%) from tidal and fluvial flows.

3.5.2 Surface Water Flooding (Pluvial Flooding)

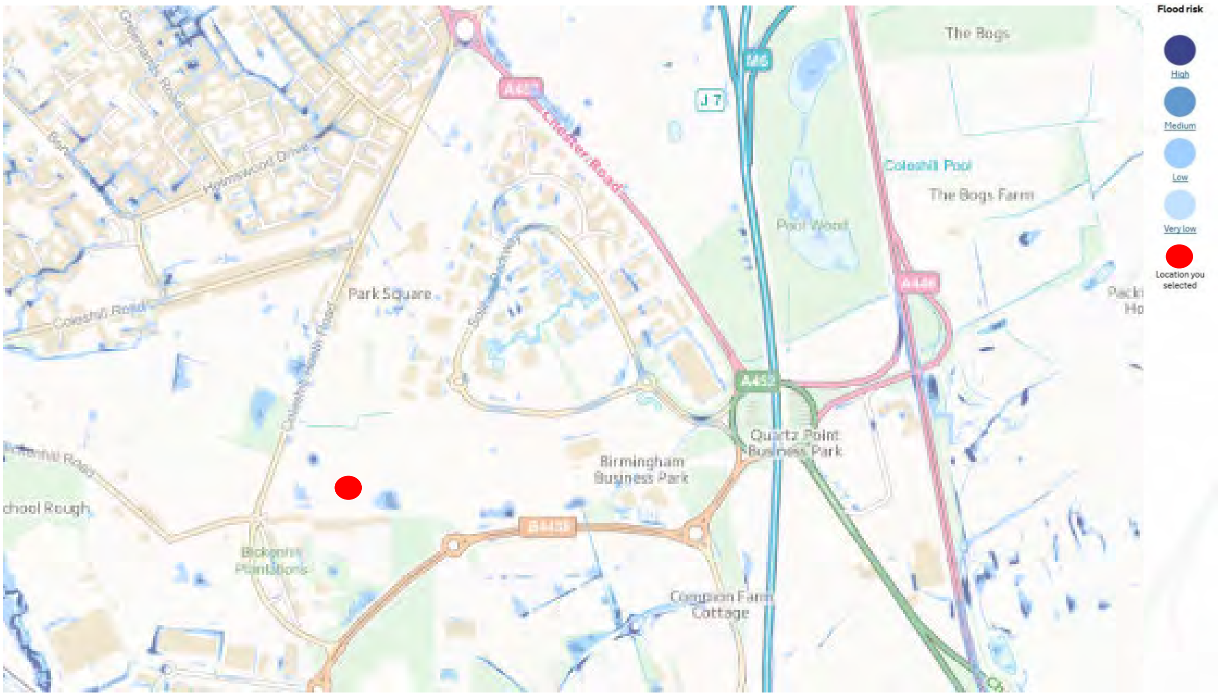


Figure 5.Pluvial Flood risk map

Surface water flooding can occur when heavy rainfall overwhelms the local drainage network and also depends on existing ground levels, rainfall and the local drainage network. The EA website contains mapping of areas believed vulnerable to surface water flooding. An extract from the flood map is given in 5. This shows that the site is in a **very low** flood risk area. Meaning that each year this area has a chance of pluvial flooding of less than 0.1%.

3.5.3 Artificial Sources of Flooding

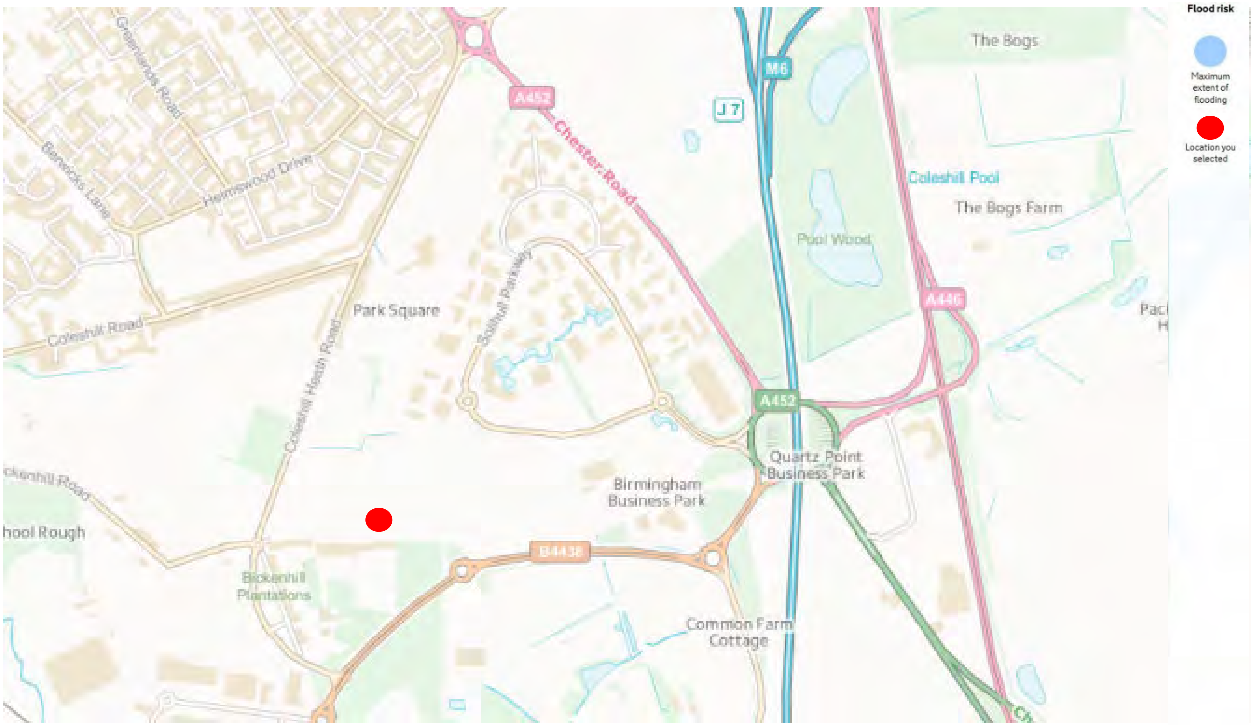


Figure 6.Artifical Sources Flood risk map

Artificial sources include any water bodies not covered under other categories and typically include canals, lakes and reservoirs.

There is no artificial water flooding within the vicinity of the site, and therefore there is **no** flood risk due to artificial sources. This can be seen in figure 6.

3.5.4 Historic Flooding

An extract from the Solihull Metropolitan Council’s SFRA (April 2017) is included in Appendix B and indicates that no historic flooding has occurred within the vicinity of the site.

3.5.5 Sewer Flooding

Sewer flooding usually coincides with heavy rainfall, and may occur if the amount of rainfall exceeds the capacity of the sewer system, the system becomes blocked and/or water surcharges (i.e. rises above the ground) due to high water levels in the receiving watercourse.

An extract from the Solihull Metropolitan Council’s SFRA is included in Appendix B and indicates that sewer flooding records defer to the available EA flood map data available online. Please refer to section 3.5.2 which shows this data.

3.5.6 Groundwater Flooding

Groundwater flooding occurs as a result of water rising up from underlying aquifers or from water flowing from springs. This tends to occur after long periods of sustained heavy rainfall and can be sporadic in both location and time, often lasting longer than a river or surface water flood.

The site is not known to be susceptible from any flooding via ground water. This is reiterated by the available SI which recorded groundwater at depths of 4.70m - 5.20m rising to between 3.70m – 4.25m blg.

3.6 Source Protection Zone

The EA have defined Source Protection Zones (SPZs) for 2000 groundwater sources such as wells, boreholes and springs used for public drinking water supply. These zones show the risk of contamination from any activities that might cause pollution in the area. The closer the activity, the greater the risk. The maps show three main zones (inner which is buffered around the abstraction point, outer and total catchment) and a fourth zone of special interest.

The zones are used in conjunction with the EA's Groundwater Protection Policy to set up pollution prevention measures in areas which are at a higher risk, and to monitor the activities of potential polluters nearby.

As shown in Figure 7, the proposed development is not near or within any source protection zone.

Figure 7. Source protection zones map

4 Proposed Site

4.1 Description of development

The proposed works are an addition to a current development and in its majority is within land which is currently soft landscaping. The proposed application is for the addition of 391 parking spaces and associated paved circulation areas on the newly constructed Prologis park development at Progress way, which was granted outline planning permission (ref: PL/2016/02001/PPOL) and reserved matters approval (PL/2017/01509/PPRM, PL/2018/02297/PPRM). A soft landscaping scheme will also be incorporated into the development.

A total of 97 No. spaces are proposed to be constructed adjacent to the existing Prologis Park circulation road, which is partially hardstanding. These areas are proposed to be drained via the existing Prologis Park surface water drainage system that is shown on drawing 12476_105R within appendix A. These proposed areas will be controlled and attenuated via the existing network.

A copy of the site's layout plan can be found in Appendix A. Allowance will also be made for access and landscaping.

The proposed development will have an impermeable area of 0.635 ha. These figures are subject to change slightly as the layout detail design progresses.

The proposed site levels will be set such that they try (where possible) to follow the contours of the existing site so as to minimise the requirement for any retaining walls and also adhere to best practice and building regulation design standards.

Proposed development levels will also be set such that they try to minimise any surface water flooding from the new development drainage network. This would also ensure; that should any flooding occur, it is controlled and contained within the new development boundaries and therefore will not affect neighbouring properties or highway land.

5 Drainage Policy & Consultation

5.1 Lead Local Flood Authority

The Lead Local Flood Authority (LLFA) is Solihull Metropolitan Borough Council. Solihull Metropolitan Borough Council has a Strategic Flood Risk Assessment and Local Plan which define flooding and drainage requirements.

Key items within the SFRA are:

- Use of SuDS (where possible use of strategic SuDS should be made)
- Discharge rates should be restricted to Greenfield rates as a maximum.
- Brownfield sites should seek to discharge surface water from the redeveloped site at Greenfield rates wherever possible. As a minimum, betterment should be offered (in terms of reduced runoff) for all redeveloped sites.
- 1 in 100-year attenuation of surface water, taking into account climate change.

5.2 Application of Flood Risk Policy

Based on the EA's flood maps it is possible to undertake an initial site flood risk compatibility assessment to ascertain whether the proposed development site is presently suitable for development by referring to the flood zone compatibility matrix (Table 1).

Table 1.Flood Risk Vulnerability and Flood Zone Compatibility

		Essential infrastructure	**Water compatible**	**Highly vulnerable**	**More vulnerable**	**Less vulnerable**
Flood Zones	**Zone 1**	√	√	√	√	√
	Zone 2	√	√	Exception Test required	√	√
	Zone 3a	Exception Test required	√	x	Exception Test required	√
	Zone 3b Functional Floodplain	Exception Test required	√	x	x	x

Key: √ - Development is appropriate

x - Development should not be permitted

Notes to table:

This table does not show:

- The application of the Sequential Test which guides development to Flood Zone 1 first, then Zone 2 and then Zone 3.
- Flood Risk Assessment requirements, or
- The Policy aims for each flood zone.

Table 2. Flood Risk Vulnerability Classification

Essential Infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations and water treatment works that need to remain operational in times of flood. • Wind turbines.
Highly Vulnerable	• Police stations, ambulance stations and fire stations and command centres and telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent (where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations or need to be located in other high flood risk areas, in these instances the facilities should be classified as “essential infrastructure”).
More Vulnerable	• Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels. • Non-residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities and hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops, financial, professional and other services, restaurants and cafes, hot food takeaways, offices, general industry, storage and distribution, non-residential institutions not included in “more vulnerable” and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (expect landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Navigations facilities. • Ministry of Defence installations.

	• Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.
Water Compatible Development	• Water treatment works which do not need to remain operational during times of flood. • Sewerage treatment works (if adequate measures to control pollution and manage sewage during flooding events are in place). • Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewerage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves.

5.2.1 Sequential Test

The Sequential Test is intended to direct new development to an area of lowest probability of flood risk and ensure development is in the most appropriate flood zone.

As the development's extents of the site are within Flood Zone 1 and are in the Less Vulnerable category, the development can be considered appropriate for the proposed use, and therefore passes the Sequential Test.

5.2.2 Exception Test

The Exception Test is not required as the site is located within Flood Zone 1.

5.2.3 Flood Risk Assessment Summary & Mitigation Measures

Table 1 contains a summary of the flood risks to the proposed site. Mitigation measures to address the identified risks are discussed below.

Table 3. Summary of Flood Risks

Flood Risk	Risk Level	Action Required
Tidal/Fluvial	Very Low	None
Surface Water	Low	None
Sewers	Very Low	None
Groundwater	Very Low	None
Artificial	N/A	None
Run-off	Low	Mitigation Required

It can be concluded that there is very little risk of flooding on the development itself. Mitigation measures are required to ensure that run-off from the proposed development <u>will not</u> adversely impact areas downstream.

6 Drainage Strategy

6.1 Hierarchy of Disposal

Generally, the aim should be to discharge surface water run-off as high up the following hierarchy of drainage options as reasonably practicable.

- Into the ground (infiltration)
- To a surface water body
- To a surface water sewer, highway drain, or other drainage systems
- To a combined sewer

6.1.1 Infiltration

Although infiltration tests were not completed within the site specific Phase 2 ground investigation, it can be concluded that due to the presence of cohesive soils within the underlain strata, discharging surface water flows via methods utilising infiltration techniques are not viable for this development.

An extract of the Prologis Park site investigation report used can be found in Appendix E.

6.1.2 Surface Water Body

Desk studies show that there is no viable surface water bodies to discharge surface water too without the requirement to pump vast distances. It can therefore be considered that discharging surface water flows via a surface water body is not feasible for this development.

6.1.3 Surface Water Sewer/Combined Sewer

There is an existing storm water sewer within the vicinity of the development which was constructed as part of the Prologis Park development, therefore it is a feasible option to discharge into the existing storm water sewer at greenfield run off rates.

The location of the sewer can be found in Appendix A.

6.2 Sustainable Drainage

Potential SuDS techniques considered for the proposed site.

6.2.1 Soakaways

Soakaways are excavations either filled with rubble or lined with brickwork, precast concrete or polyethylene rings/perforated storage structures surrounded by granular backfill. They can be grouped and linked together to drain large areas including highways. The supporting structure and backfill can be substituted by modular geo-cellular units. Soakaways provide storm water attenuation, storm water treatment and groundwater recharge.

Due to the presence of cohesive soils within the underlain strata, discharging surface water via methods utilising infiltration are considered unviable.

6.2.2 Swales

Swales are linear vegetated drainage features in which surface water can be stored or conveyed. They can be designed to allow infiltration, where appropriate. They should promote low flow velocities to allow much of the suspended particulate load in the storm water runoff to settle out, thus providing effective pollutant removal.

Roadside swales can replace conventional gullies and drainage pipes. The existing development includes a swale in which road gullies discharge into. It is proposed that a swale is not incorporated into the new drainage strategy and instead a pond will be utilised within the drainage design, this will provide a larger and more effective SuDS feature.

6.2.3 Porous Pavements

Porous pavements provide a pavement suitable for pedestrian and/or vehicular traffic while allowing rainwater to infiltrate through the surface and into the underlying layers. The water is temporarily stored between infiltration to the ground, reuse or discharge to a watercourse or other drainage system. Pavements with aggregate sub-bases can provide water quality treatment.

When permeable paving for car parking bays is used, the stone sub-base not only stores and slows down the rate of discharge, but also raises the water quality. It should not be used in the loading yard areas, due to the impact of the heavily loaded HGVs on the long-term durability of the pavement finish.

Porous paving is proposed to be implemented to the majority of parking aisles on the development to ensure water is being treated prior to entering the proposed storage feature.

6.2.4 Ponds/Infiltration Basin

Ponds can provide both storm water attenuation and treatment. They are designed to support emergent and submerged aquatic vegetation along their shoreline. Runoff from each rain event is detained and treated in the pool. The retention time promotes removal of silt through sedimentation and the opportunity for biological uptake mechanisms to reduce nutrient concentrations.

Due to the nature of the cohesive soils experienced on site, infiltration basins have been ruled out as a form of SuDS feature within the drainage strategy. A pond has been incorporated into the design as an offline attenuation structure which will hold water within the intense critical storms.

6.3 Sustainable Drainage Maintenance

For a full maintenance breakdown of the SUDs drainage systems implemented into the design please see document with reference: 12992 / SUDs Maintenance Plan

7 Drainage Strategy – Surface Water

7.1 Proposed Surface Water Runoff Rate

The proposed area of car parking consists of 0.635ha of impermeable area. The design life for the development is 50 years. Based on the Environment Agency Guidance for climate change, a climate change allowance of 40% should be considered.

In accordance with the LLFA requirements, Greenfield site will seek to discharge surface water from the proposed development at greater of 5l/s or at Qbar rate. Due to our site being less than 1 ha it is proposed that a limiting discharge rate of 5l/s is applied for the surface water design.

7.2 Proposed Surface Water Drainage Strategy

Levels are to be set such that surface water run off falls into the permeable aisles and collected by a perforated pipe prior to entering the main storm water system. Flows will enter an offline pond within the critical storms.

The proposed pond will ensure it can retain a 1 in 100-year 6-hour storm event.

Levels within car parking areas should be designed at the appropriate detailed design stage such that critical 100 year plus 40% climate change storm events are contained above ground, but safely within the site boundaries without risk to surrounding properties, the building or that restricts access / egress.

Storm water discharging from the development will be attenuated and controlled using a vortex flow control unit (Hydrobrake). A drainage modelling exercise using software (MicroDrainage) has been undertaken to confirm that the proposed drainage strategy will achieve the proposed discharge rate of 5.0l/s. These results can be found in Appendix D.

It is proposed that 97 No. out of the total 391 No. additional spaces which are to be constructed adjacent to the existing Prologis Park circulation road are drained utilising the existing network that is in place. The areas will be attenuated and controlled without causing any increase in flooding to the existing Prologis Park development. A plan has been included within Appendix A which shows the 97 No. spaces which are to be drainage utilising the existing network and shows the addition in impermeable area (0.073 Ha). The existing drainage system has been simulated with the additional drainage areas plugged in and has been included within Appendix D. From the calculations is can be seen that the additional drainage areas do not significantly increase the risk of flooding to the existing network and development and any negligible additional flooding within the 100 year event + climate change is contained on site.

The additional impermeable area increases the maximum discharge from the existing network within the 100 year + cc event, the increase is considered negligible as the greenfield limit is 80.5 l/s and the new discharge rate is 80.9 l/s. The maximum allowable discharge rates within the 1yr and 30yr are still respected and are within the greenfield limits. The below table details all discharge rates against the greenfield limits:

	Greenfield Limit	Actual Limit with Additional Impermeable Areas
1 Year	26 l/s	23.9 l/s
30 Year	61.3 l/s	50.9 l/s
100 Year + CC	80.5 l/s	80.9 l/s

8 Summary

The development comprises additional car park bays and circulation aisles. The majority of the development area is currently soft landscaped and is classed as greenfield. The 97 No. additional car parking spaces (out of the 391 total) which are within the Prologis Park circulation road are to be drainage utilising the existing drainage network.

The EA Flood Map for planning depicts the site is within a Flood Zone 1 area, with a very low risk of flooding from surface, tidal & fluvial, and artificial sources. The proposed development is classed as Less Vulnerable usage and it is located in Flood Zone 1 which meets the sequential test. An Exception test is not required.

It is proposed that the site will discharge at 5 l/s. To ensure that the proposed development will discharge at the proposed rates, a vortex flow control unit (Hydrobrake) will be used to limit flows leaving the development. A cellular crate system will be used to store the required volume.

The use of SuDS features has been considered and explanation to why some SuDS techniques were disregarded has been given in section **6.2**. Due to the nature of the ground (See section **3.3**), no infiltration techniques have been implemented. An oil interceptor has been proposed, so it will ensure that the water quality will be raised.

The site **does not** pose any increased flood risk to the site itself or adjacent developments, and it is **not** susceptible to flooding by other means.

9 Appendix A

A.1 Site Location Plan

A.2 Topographical Survey

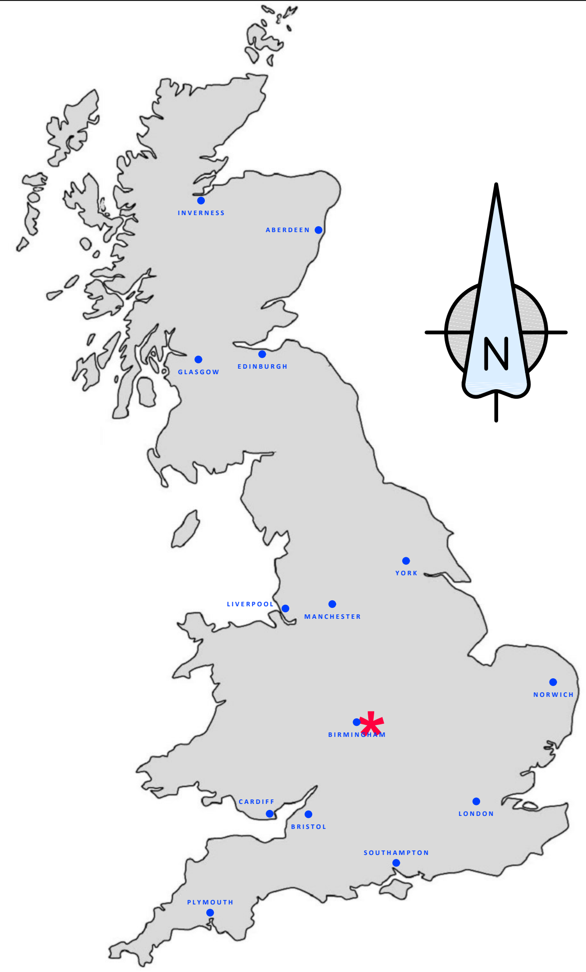
A.3 Existing Drainage Plan (approved under extant outline planning permission reference PL/2016/02001/PPOL)

A.4 Existing Drainage Calculations (approved under extant outline planning permission reference PL/2016/02001/PPOL)

A3

ROAD MAP
SCALE: N.T.S.

OS MAP
SCALE: N.T.S.



SITE DETAILS		
Address:	Prologis Park, Birmingham Interchange, Bickenhill park way, Marston Green, Birmingham	
Nearest Postcode:	B40 1QA	
Grid Co-Ordinates:	E: 418606	N: 285135

FOR INFORMATION

Rev	Date	Description	By	Chkd By
A	17.12.2020	BOUNDARY AMENDED.	JH	G.L.
-	XX.09.2020	FIRST ISSUE.	JH	G.L.

Revision Schedule

Drawn by	Checked by	Project Engineer
JH	G.L.	G.L.

Date	Scale
SEPT 2020	N.T.S.

Project No	Drawing No	Rev
12992	SK100	A

Project Title
ADDITIONAL CAR PARKING
PROLOGIS PARK, BIRMINGHAM INTERCHANGE

Drawing Title
SITE LOCATION PLAN

BAYNHAM MEIKLE
Consulting Structural & Civil Engineers
8 Meadow Road, Edgbaston, Birmingham B17 8BU
Tel: 0121 434 4100 *Fax:* 0121 434 4073 *Email:* admin@bm-p.co.uk

N

Station Information:

Station	Easting (m)	Northing (m)	Level (m)
S1	418563.981	285179.415	99.849
S2	418663.602	285168.848	99.853
S3	418771.449	285143.705	99.853
S4	418886.066	285120.266	100.247
S5	418887.265	285071.374	99.920
S6	418808.684	285074.652	98.977
S7	418688.862	285077.959	98.629
S8	418582.765	285080.082	98.500
S9	418493.066	285085.161	98.599
S10	418422.788	285067.908	99.004
S11	418446.942	285153.699	99.057
S12	418486.468	285201.601	98.385
S13	418503.121	285308.055	98.234
S14	418527.695	285265.352	98.338
S10A	418445.048	285075.284	98.853

OS Note:

Some services may have been omitted due to parked vehicles.

Surveyed Buildings

This survey has been orientated to the Ordnance Survey (O.S) National Grid OSGB36(15) via Global Navigational Satellite Systems (GNSS) and the O.S. Active Network (OS Net).

A true OSGB36 coordinate has been established near to the site centre via a transformation using the OSTN15GB & OSGM15GB transformation models.

The survey has been correlated to this point and a further one or more OSGB36 (15) points established to create a true O.S. bearing for angle orientation.

No scale factor has been applied to the survey therefore the coordinates shown are arbitrary & not true O.S. Coordinates which have a scale factor applied.

Please refer to Survey Station Table to enable establishment of the on-site grid and datum.

Legend:

Buildings
Wall
Kerb line
Line marking
Drop kerb
Centre line
Top of bank
Overhead Cable
Concrete edge
Tarmac edge
Grass verge
Canopy/Overhang
Verge
Bottom of bank

1 / 100.000 — Station and Name / Station Level

Tree / Bush / Sapling
Area of Undergrowth
Woodland
R: Ridge Level
E: Eaves Level
F: Flat Roof Level
Gate

Fence types:
I\W Interwoven
I\R Iron Railings
W\M Wire Mesh
P\R Post & Rail
P\W Post & Wire
C\L Chain Link
W\P Wooden Panels
C\B Close Boarded
S\P Steel Palisade

IC	Inspection chamber	Bo	Bollard
PInv	Pipe invert	IB	Illuminated bollard
Gy	Gully	Bin	Rubbish bin
Bg	Back gully	Vp	Vent pipe
Dp	Down pipe	Grl	Ground light
Pipe	Pipe above ground	Lbox	Letter box
MH	Manhole	Stmp	Tree Stump
WL	Water level	Sty	Stile
Fl	Flood light	IFL	Internal floor level
Lp	Lamp post	THL	Threshold level
Tp	Telegraph post	Sp	Sign post
Ep	Electricity post	TH	Trialhole
Tl	Traffic light	BH	Borehole
Bus	Bus stop	ELC	Electric
Sv	Stop valve	BT	British Telecom
St	Stop tap	C'box	Control box
Er	Earth rod	TT	Tactile
Wm	Water meter	BP	Brick paved
Gas	Gas valve	CPS	Concrete paving slabs
Av	Air valve	CVR	Cover
ICU	Unidentified inspection	R/wall	Retaining wall
Wo	Wash out	TWL	Top of Wall Level
Re	Rodding eye	TCL	Tree canopy level
BB	Belisha beacon	G:	Girth
CTV	Cable tv	MG	Multi girth
Mkr	Marker post	IC	Inspection chamber
Gmkr	Gas marker post	CL:	Cover level
So	Soffit	IL:	Invert level
Fh	Fire hydrant	UTL	Unable to lift

Rev	Date	Description	Drawn	Q. Ref.

greenhatch group

Topographical Surveys
Site Engineering
Utility / CCTV Surveys
Measured Building Surveys
3D Laser Scanning
Revit & BIM Models

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CLIENT

CBRE

PROJECT

Prologis Park Birmingham
Bickenhill Parkway
B40 1QA

TITLE

Topographical Survey

SCALE	DATE
A0@ 1: 500	8/9/20
DRAWN	QUALITY REF
TS	GH8394

Level datum	See note
Grid orientation	See note
Job number	37828

Drawing No.	Rev.
37828_T	0

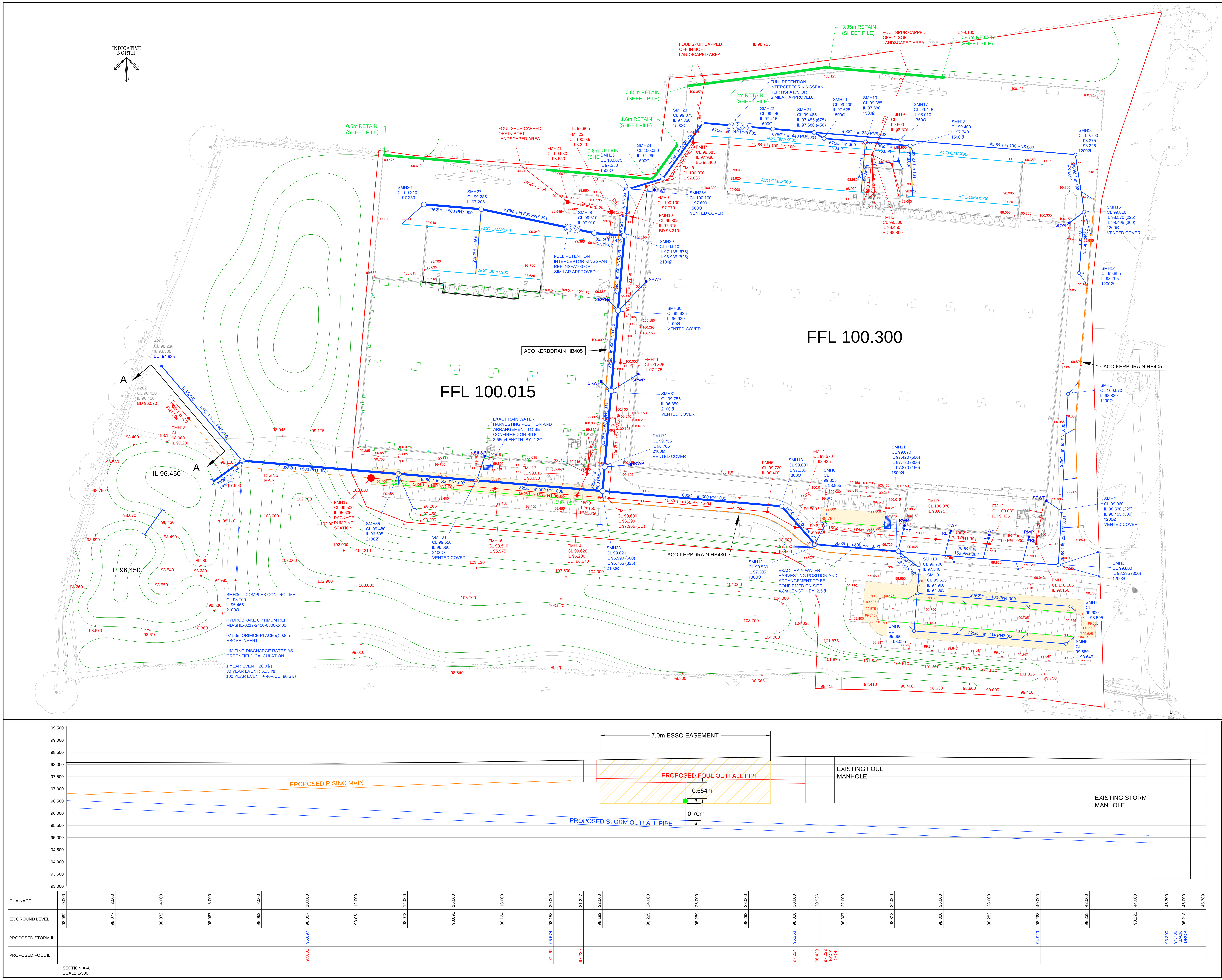
Comments

This plan should only be used for its original purpose. Greenhatch Group accepts no responsibility for this plan if supplied to any party other than the original client.

All dimensions should be checked on site prior to design and construction.

Drainage information (where applicable) has been visually inspected from the surface and therefore should be treated as approximate only.

Notes:



NOTES

A0

1. Do not scale this drawing. All dimensions must be checked / verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Survey work has been carried out by others. Any discrepancies noted on site are to be reported to the Engineer immediately.
5. The base specification for drainage works shall be the Water Authority Association 'Sewers for Adoption (7th Edition).
6. For details of ground conditions refer to the Ground Investigation Report.
7. The following pipe strengths shall be adopted unless noted otherwise:-
- Pipes up to and including 150mm dia to be PVC-U to BS EN 1329, or clayware to BS EN 295 Class 160.
- Pipes 150mm diameter up to and including 225mm to be clayware to BS EN 295 Class 160
- Pipes over 300mm diameter to be concrete to BS 5911 Class M or structured wall plastic pipe as approved by the engineer.
9. All pipe runs to be laid with flexible joints.
10. All pipes entering and exiting manholes are to be connected with pipe soffits level unless noted otherwise.
11. Bedding and surround to be as follows :-

Location	Cover to Soffit	Bedding
Roads/ Service Yard	>1.2m	Class 'S' granular bed and surround.
	<1.2m	Class 'X' Concrete surround.
Hard and soft landscaping.	>0.6m	Class 'S' granular bed and surround.
	<0.6m	Class 'X' Concrete surround.

12. The following concrete mixes are to be used (all in accordance with BS 5800) :-

Location	Mix Reference.
Concrete surround to pipes.	GEN3
Concrete base and surround to manholes.	GEN3

The above concrete mixes have been selected for BS 5800 Class 2 Sulphates.

13. All precast concrete products (ie pipes, manholes rings etc.) shall be of suitable concrete mix to cater for Class 2 sulphates.
14. Pre-formed channels are to be used in manholes where applicable.
15. Granolithic concrete benching to be steel trowelled to a dense smooth face neatly shaped and finished to all branch connections and laid in accordance with the Specification.
16. All connections to be turned in direction of flow using pipe bends.
17. Manhole covers and frames to be ductile iron medium duty Grade D400 circular or rectangular to BS EN124 positions inside vehicular trafficked areas.
All covers within blocked paved areas are to be recessed.
18. First flexible joint in pipes adjacent to a manhole shall be a maximum of 600mm from inside face of manhole, connecting to rocker pipe.

KEY

98.28	EXISTING LEVELS
FFL 100.400	PROPOSED FINISHED FLOOR LEVELS
	EXISTING STORM
	EXISTING FOUL
	PROPOSED STORM
	PROPOSED CONCRETE BED AND SURROUND
	PROPOSED DRAINAGE CHANNEL
	PROPOSED KERB DRAINAGE
	PROPOSED LAND DRAINAGE
	PROPOSED PETROL INTERCEPTOR
SRWP	PROPOSED SYPHONIC RAIN WATER PIPE
	PROPOSED PERMEABLE PAVING
	PROPOSED FOUL DRAINAGE
	PROPOSED FOUL RISING MAIN
	PROPOSED PACKAGE PUMPING STATION
	PROPOSED DOCK RETAINING WALL
	PROPOSED SHEET PILING

ALL SYPHONIC RAIN WATER PIPES ARE TO BE CONFIRMED WITH SPECALIST.

OUTFALL LEVELS TO BE CONFIRMED ON SITE.

PROPOSED 278 WORKS BY OTHERS.

TO BE READ INCONJUNCTION WITH PLAN 12476 / 101

TRIAL HOLES TO BE COMPLETED TO EXPOSE THE ESSO FUEL PIPELINE AND CONFIRM LINE AND LEVEL. FISHER GERMAN TO BE NOTIFIED OF ANY PROPOSED WORKS SO THEY CAN ATTEND SITE AND OBSERVE.

CONSTRUCTION ISSUE

Rev	Date	Description	By	Chkd By
R	25.09.18	LEVELS UPDATED TO SUIT PLAN 12476 / 101 AND NOTES REGARDING RAIN WATER HARVESTING ADDED TO PLAN.	JH	GL
Q	16.08.18	ACO DRAINAGE CHANNEL RUN EXTENDED BENEATH PLATFORM IN UNIT B SERVICE YARD. STORM OUTLETS INTO SWALE RE-POSITIONED.	KM	GL
P	09.08.18	4 No. RWP'S ADDED TO UNIT B. SMH4 REMOVED. FOUL CONNECTION ADDED TO UNIT A TEA POINT.	KM	GL
N	07.08.18	LEVELS UPDATED TO SUIT ARCHITECT'S LAYOUT.	KM	GL
M	27.07.18	FMH20, FMH23 & FMH24 REMOVED. FMH16 BACK DROP REMOVED. MINOR AMENDMENT TO LEVELS. DRAINAGE CHANNEL REFERENCES UPDATED.	KM	GL
L	02.07.18	ADDITIONAL SRWP'S ADDED, ADDITIONAL FOUL INFORMATION ADDED	JD	GL
K	12.06.18	ADDITIONAL FOUL DRAINAGE ADDED, SMH27 LIFTED	JD	GL
J	30.05.18	POSITION OF FMH8 ADJUSTED TO AVOID CLASH WITH FOUNDATION	JD	GL
H	16.04.18	LAYOUT UPDATED TO SUIT ARCHITECTS DETAILS ISSUED FOR CONSTRUCTION	PJ	GL
G	10.04.18	FMH3 AND FMH15 OMITTED, FMH19 ADDED AND LAYOUT UPDATED TO SUIT ARCHITECTS DETAILS	PJ	GL
F	21.03.18	DRAINAGE PLAN AMENDED TO SUIT VE EXERCISE.	JH	GL
E	06.03.18	PROPOSED ORIFICE PLATE SIZE AMENDED.	JH	GL
D	14.02.18	DRAINAGE AMENDED TO SUIT LATEST MODELING.	JH	GL
C	11.01.18	UPDATED TO SUIT LATEST TOPOGRAPHICAL SURVEY INFORMATION.	EB	GL
B	05.01.18	DRAINAGE UPDATED TO SUIT LATEST LEVELS INFORMATION.	EB	GL
A	28.11.17	DRAINAGE UPDATED TO SUIT LATEST LAYOUT.	JH	GL

Revision Schedule

Project Title
PROLOGIS PARK
BIRMINGHAM INTERCHANGE

Drawing Title
PROPOSED DRAINAGE PLAN

Drawn by J.H. Checked by G.L. Project Engineer G.L.

Date	Scale	Project No	Drawing No	Rev
MAY 2017	1:500	12476	105	R

BAYNHAM MEIKLE
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	1	Add Flow / Climate Change (%)	0
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio R	0.400	Maximum Backdrop Height (m)	1.500
Maximum Rainfall (mm/hr)	50	Min Design Depth for Optimisation (m)	0.900
Maximum Time of Concentration (mins)	30	Min Vel for Auto Design only (m/s)	1.00
Foul Sewage (l/s/ha)	0.000	Min Slope for Optimisation (1:X)	500
Volumetric Runoff Coeff.	0.750		

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.894	4-8	3.714	8-12	0.524

Total Area Contributing (ha) = 5.132

Total Pipe Volume (m³) = 373.608

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	48.093	0.515	93.4	0.080	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
1.001	22.180	0.220	100.8	0.174	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
1.002	65.969	0.440	149.9	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
2.000	19.127	0.795	24.1	0.144	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.59	99.045	0.080	0.0	0.0	0.0	1.35	53.8	10.8
1.001	50.00	4.83	98.455	0.254	0.0	0.0	0.0	1.57	110.7	34.4
1.002	49.12	5.69	98.235	0.365	0.0	0.0	0.0	1.28	90.6	48.6
2.000	50.00	4.12	98.665	0.144	0.0	0.0	0.0	2.68	106.5	19.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
3.000	62.532	0.550	113.7	0.146	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	15.480	0.135	114.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.000	63.232	0.635	99.6	0.153	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.002	10.443	0.045	232.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.003	11.017	0.045	244.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.003	34.491	0.115	299.9	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.004	20.652	0.070	295.0	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.005	73.806	0.245	301.2	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
5.000	25.256	0.225	112.2	0.036	4.00	0.0	0.600	o	225	Pipe/Conduit	
5.001	23.766	0.120	198.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.002	72.118	0.190	379.6	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
5.003	35.532	0.095	374.0	0.035	0.00	0.0	0.600	o	450	Pipe/Conduit	
6.000	18.411	0.060	306.9	0.451	4.00	0.0	0.600	o	600	Pipe/Conduit	
6.001	17.078	0.055	310.5	0.418	0.00	0.0	0.600	o	675	Pipe/Conduit	
6.002	4.750	0.030	158.3	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.000	50.00	4.85	98.645	0.146	0.0	0.0	0.0	1.23	48.7	19.8
3.001	50.00	5.06	98.095	0.146	0.0	0.0	0.0	1.22	48.5	19.8
4.000	50.00	4.80	98.595	0.153	0.0	0.0	0.0	1.31	52.1	20.7
3.002	50.00	5.23	97.885	0.299	0.0	0.0	0.0	1.03	72.7	40.5
3.003	50.00	5.41	97.840	0.299	0.0	0.0	0.0	1.00	70.7	40.5
1.003	47.75	6.04	97.350	0.808	0.0	0.0	0.0	1.61	711.6	104.5
1.004	46.98	6.25	97.230	0.808	0.0	0.0	0.0	1.62	717.5	104.5
1.005	44.40	7.02	97.160	0.808	0.0	0.0	0.0	1.61	710.0	104.5
5.000	50.00	4.34	98.795	0.036	0.0	0.0	0.0	1.23	49.0	4.9
5.001	50.00	4.70	98.495	0.036	0.0	0.0	0.0	1.11	78.7	4.9
5.002	48.46	5.86	98.225	0.036	0.0	0.0	0.0	1.04	165.0	4.9
5.003	46.38	6.42	97.775	0.071	0.0	0.0	0.0	1.05	166.2	8.9
6.000	50.00	4.22	97.665	0.451	0.0	0.0	0.0	1.38	391.6	61.1
6.001	50.00	4.41	97.530	0.869	0.0	0.0	0.0	1.48	530.3	117.7
6.002	50.00	4.45	97.625	0.869	0.0	0.0	0.0	2.08	744.5	117.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
5.004	16.981	0.040	424.5	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	
5.005	28.896	0.065	444.6	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	
5.006	28.155	0.065	433.2	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	
5.007	14.487	0.035	413.9	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	
5.008	19.325	0.040	483.1	0.163	0.00	0.0	0.600	o	675	Pipe/Conduit	
7.000	23.613	0.080	295.2	0.238	4.00	0.0	0.600	o	900	Pipe/Conduit	
7.001	47.470	0.095	499.7	0.238	0.00	0.0	0.600	o	900	Pipe/Conduit	
7.002	12.352	0.025	494.1	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
5.009	30.809	0.065	474.0	0.060	0.00	0.0	0.600	o	900	Pipe/Conduit	
5.010	33.199	0.070	474.3	0.884	0.00	0.0	0.600	o	900	Pipe/Conduit	
5.011	31.220	0.065	480.3	1.025	0.00	0.0	0.600	o	900	Pipe/Conduit	
5.012	10.014	0.020	500.7	0.373	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.006	36.556	0.075	487.4	0.000	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.007	47.653	0.095	501.6	0.092	0.00	0.0	0.600	o	900	Pipe/Conduit	
1.008	64.334	0.130	494.9	0.092	0.00	0.0	0.600	o	900	Pipe/Conduit	
8.000	73.902	0.405	182.5	0.219	4.00	0.0	0.600	o	300	Pipe/Conduit	
9.000	30.183	0.040	754.6	0.000	4.00	0.0	0.600	o	600	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
5.004	45.62	6.65	97.455	0.940	0.0	0.0	0.0	1.27	452.9	117.7
5.005	44.35	7.04	97.415	0.940	0.0	0.0	0.0	1.24	442.5	117.7
5.006	43.21	7.41	97.350	0.940	0.0	0.0	0.0	1.25	448.3	117.7
5.007	42.66	7.60	97.285	0.940	0.0	0.0	0.0	1.28	458.7	117.7
5.008	41.89	7.87	97.250	1.103	0.0	0.0	0.0	1.19	424.3	125.1
7.000	50.00	4.22	97.185	0.238	0.0	0.0	0.0	1.82	1156.9	32.2
7.001	50.00	4.78	97.105	0.476	0.0	0.0	0.0	1.39	887.3	64.5
7.002	50.00	4.93	97.010	0.476	0.0	0.0	0.0	1.40	892.4	64.5
5.009	40.93	8.23	96.985	1.639	0.0	0.0	0.0	1.43	911.3	181.7
5.010	39.94	8.61	96.920	2.523	0.0	0.0	0.0	1.43	911.0	272.9
5.011	39.06	8.98	96.850	3.548	0.0	0.0	0.0	1.42	905.2	375.3
5.012	38.78	9.10	96.785	3.921	0.0	0.0	0.0	1.39	886.4	411.8
1.006	37.81	9.53	96.765	4.729	0.0	0.0	0.0	1.41	898.5	484.3
1.007	36.64	10.10	96.690	4.821	0.0	0.0	0.0	1.39	885.6	484.3
1.008	35.23	10.87	96.595	4.913	0.0	0.0	0.0	1.40	891.7	484.3
8.000	50.00	5.06	97.450	0.219	0.0	0.0	0.0	1.16	82.0	29.7
9.000	50.00	4.57	96.505	0.000	0.0	0.0	0.0	0.88	248.4	0.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.009	51.052	1.190	42.9	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.009	34.29	11.42	96.465	5.132	0.0	0.0	0.0	1.54	27.2«	484.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SMH1	100.070	1.025	Open Manhole	1200	1.000	99.045	225				
SMH2	99.960	1.505	Open Manhole	1200	1.001	98.455	300	1.000	98.530	225	
SMH3	99.800	1.565	Open Manhole	1200	1.002	98.235	300	1.001	98.235	300	
SMH4	100.110	1.445	Open Manhole	1200	2.000	98.665	225				
SMH5	99.680	1.035	Open Manhole	1200	3.000	98.645	225				
SMH6	99.660	1.565	Open Manhole	1200	3.001	98.095	225	3.000	98.095	225	
SMH7	99.600	1.005	Open Manhole	1200	4.000	98.595	225				
SMH9	99.525	1.640	Open Manhole	1200	3.002	97.885	300	3.001	97.960	225	
								4.000	97.960	225	
SMH10	99.700	1.860	Open Manhole	1200	3.003	97.840	300	3.002	97.840	300	
SMH11	99.670	2.320	Open Manhole	1800	1.003	97.350	750	1.002	97.795	300	
								2.000	97.870	225	
								3.003	97.795	300	
SMH12	99.530	2.300	Open Manhole	1800	1.004	97.230	750	1.003	97.235	750	5
SMH13	99.800	2.640	Open Manhole	1800	1.005	97.160	750	1.004	97.160	750	
SMH14	99.895	1.100	Open Manhole	1200	5.000	98.795	225				
SMH15	99.810	1.315	Open Manhole	1200	5.001	98.495	300	5.000	98.570	225	
SMH16	99.790	1.565	Open Manhole	1350	5.002	98.225	450	5.001	98.375	300	
SMH17	99.445	1.670	Open Manhole	1350	5.003	97.775	450	5.002	98.035	450	260
SMH18	99.400	1.735	Open Manhole	1500	6.000	97.665	600				
SMH19	99.385	1.855	Open Manhole	1500	6.001	97.530	675	6.000	97.605	600	
SMH20	99.400	1.925	Open Manhole	1500	6.002	97.625	675	6.001	97.475	675	
SMH21	99.485	2.030	Open Manhole	1500	5.004	97.455	675	5.003	97.680	450	
								6.002	97.595	675	140
SMH22	99.440	2.025	Open Manhole	1500	5.005	97.415	675	5.004	97.415	675	
SMH23	99.875	2.525	Open Manhole	1500	5.006	97.350	675	5.005	97.350	675	
SMH24	100.050	2.765	Open Manhole	1500	5.007	97.285	675	5.006	97.285	675	
SMH25	100.180	2.930	Open Manhole	1500	5.008	97.250	675	5.007	97.250	675	
SMH26	99.275	2.090	Open Manhole	1800	7.000	97.185	900				
SMH27	99.285	2.180	Open Manhole	1800	7.001	97.105	900	7.000	97.105	900	
SMH28	99.460	2.450	Open Manhole	1800	7.002	97.010	900	7.001	97.010	900	
SMH29	99.645	2.660	Open Manhole	1800	5.009	96.985	900	5.008	97.210	675	
								7.002	96.985	900	
SMH30	99.755	2.835	Open Manhole	1800	5.010	96.920	900	5.009	96.920	900	
SMH31	99.755	2.905	Open Manhole	1800	5.011	96.850	900	5.010	96.850	900	
SMH32	99.755	2.970	Open Manhole	1800	5.012	96.785	900	5.011	96.785	900	
SMH33	99.620	2.855	Open Manhole	1800	1.006	96.765	900	1.005	96.915	750	
								5.012	96.765	900	

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SMH34	99.580	2.890	Open Manhole	1800	1.007	96.690	900	1.006	96.690	900	
SMH35	99.500	2.905	Open Manhole	1800	1.008	96.595	900	1.007	96.595	900	
SWALE	98.450	1.000	Open Manhole	1200	8.000	97.450	300				
POND	98.110	1.605	Open Manhole	1500	9.000	96.505	600				
SMH36	98.700	2.235	Open Manhole	1800	1.009	96.465	150	1.008	96.465	900	
								8.000	97.045	300	730
								9.000	96.465	600	
	98.230	2.955	Open Manhole	0		OUTFALL		1.009	95.275	150	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	SMH1	100.070	99.045	0.800	Open Manhole	1200
1.001	o	300	SMH2	99.960	98.455	1.205	Open Manhole	1200
1.002	o	300	SMH3	99.800	98.235	1.265	Open Manhole	1200
2.000	o	225	SMH4	100.110	98.665	1.220	Open Manhole	1200
3.000	o	225	SMH5	99.680	98.645	0.810	Open Manhole	1200
3.001	o	225	SMH6	99.660	98.095	1.340	Open Manhole	1200
4.000	o	225	SMH7	99.600	98.595	0.780	Open Manhole	1200
3.002	o	300	SMH9	99.525	97.885	1.340	Open Manhole	1200
3.003	o	300	SMH10	99.700	97.840	1.560	Open Manhole	1200
1.003	o	750	SMH11	99.670	97.350	1.570	Open Manhole	1800
1.004	o	750	SMH12	99.530	97.230	1.550	Open Manhole	1800
1.005	o	750	SMH13	99.800	97.160	1.890	Open Manhole	1800
5.000	o	225	SMH14	99.895	98.795	0.875	Open Manhole	1200
5.001	o	300	SMH15	99.810	98.495	1.015	Open Manhole	1200
5.002	o	450	SMH16	99.790	98.225	1.115	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	48.093	93.4	SMH2	99.960	98.530	1.205	Open Manhole	1200
1.001	22.180	100.8	SMH3	99.800	98.235	1.265	Open Manhole	1200
1.002	65.969	149.9	SMH11	99.670	97.795	1.575	Open Manhole	1800
2.000	19.127	24.1	SMH11	99.670	97.870	1.575	Open Manhole	1800
3.000	62.532	113.7	SMH6	99.660	98.095	1.340	Open Manhole	1200
3.001	15.480	114.7	SMH9	99.525	97.960	1.340	Open Manhole	1200
4.000	63.232	99.6	SMH9	99.525	97.960	1.340	Open Manhole	1200
3.002	10.443	232.1	SMH10	99.700	97.840	1.560	Open Manhole	1200
3.003	11.017	244.8	SMH11	99.670	97.795	1.575	Open Manhole	1800
1.003	34.491	299.9	SMH12	99.530	97.235	1.545	Open Manhole	1800
1.004	20.652	295.0	SMH13	99.800	97.160	1.890	Open Manhole	1800
1.005	73.806	301.2	SMH33	99.620	96.915	1.955	Open Manhole	1800
5.000	25.256	112.2	SMH15	99.810	98.570	1.015	Open Manhole	1200
5.001	23.766	198.1	SMH16	99.790	98.375	1.115	Open Manhole	1350
5.002	72.118	379.6	SMH17	99.445	98.035	0.960	Open Manhole	1350

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
5.003	o	450	SMH17	99.445	97.775	1.220	Open Manhole	1350
6.000	o	600	SMH18	99.400	97.665	1.135	Open Manhole	1500
6.001	o	675	SMH19	99.385	97.530	1.180	Open Manhole	1500
6.002	o	675	SMH20	99.400	97.625	1.100	Open Manhole	1500
5.004	o	675	SMH21	99.485	97.455	1.355	Open Manhole	1500
5.005	o	675	SMH22	99.440	97.415	1.350	Open Manhole	1500
5.006	o	675	SMH23	99.875	97.350	1.850	Open Manhole	1500
5.007	o	675	SMH24	100.050	97.285	2.090	Open Manhole	1500
5.008	o	675	SMH25	100.180	97.250	2.255	Open Manhole	1500
7.000	o	900	SMH26	99.275	97.185	1.190	Open Manhole	1800
7.001	o	900	SMH27	99.285	97.105	1.280	Open Manhole	1800
7.002	o	900	SMH28	99.460	97.010	1.550	Open Manhole	1800
5.009	o	900	SMH29	99.645	96.985	1.760	Open Manhole	1800
5.010	o	900	SMH30	99.755	96.920	1.935	Open Manhole	1800
5.011	o	900	SMH31	99.755	96.850	2.005	Open Manhole	1800
5.012	o	900	SMH32	99.755	96.785	2.070	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
5.003	35.532	374.0	SMH21	99.485	97.680	1.355	Open Manhole	1500
6.000	18.411	306.9	SMH19	99.385	97.605	1.180	Open Manhole	1500
6.001	17.078	310.5	SMH20	99.400	97.475	1.250	Open Manhole	1500
6.002	4.750	158.3	SMH21	99.485	97.595	1.215	Open Manhole	1500
5.004	16.981	424.5	SMH22	99.440	97.415	1.350	Open Manhole	1500
5.005	28.896	444.6	SMH23	99.875	97.350	1.850	Open Manhole	1500
5.006	28.155	433.2	SMH24	100.050	97.285	2.090	Open Manhole	1500
5.007	14.487	413.9	SMH25	100.180	97.250	2.255	Open Manhole	1500
5.008	19.325	483.1	SMH29	99.645	97.210	1.760	Open Manhole	1800
7.000	23.613	295.2	SMH27	99.285	97.105	1.280	Open Manhole	1800
7.001	47.470	499.7	SMH28	99.460	97.010	1.550	Open Manhole	1800
7.002	12.352	494.1	SMH29	99.645	96.985	1.760	Open Manhole	1800
5.009	30.809	474.0	SMH30	99.755	96.920	1.935	Open Manhole	1800
5.010	33.199	474.3	SMH31	99.755	96.850	2.005	Open Manhole	1800
5.011	31.220	480.3	SMH32	99.755	96.785	2.070	Open Manhole	1800
5.012	10.014	500.7	SMH33	99.620	96.765	1.955	Open Manhole	1800

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	o	900	SMH33	99.620	96.765	1.955	Open Manhole	1800
1.007	o	900	SMH34	99.580	96.690	1.990	Open Manhole	1800
1.008	o	900	SMH35	99.500	96.595	2.005	Open Manhole	1800
8.000	o	300	SWALE	98.450	97.450	0.700	Open Manhole	1200
9.000	o	600	POND	98.110	96.505	1.005	Open Manhole	1500
1.009	o	150	SMH36	98.700	96.465	2.085	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.006	36.556	487.4	SMH34	99.580	96.690	1.990	Open Manhole	1800
1.007	47.653	501.6	SMH35	99.500	96.595	2.005	Open Manhole	1800
1.008	64.334	494.9	SMH36	98.700	96.465	1.335	Open Manhole	1800
8.000	73.902	182.5	SMH36	98.700	97.045	1.355	Open Manhole	1800
9.000	30.183	754.6	SMH36	98.700	96.465	1.635	Open Manhole	1800
1.009	51.052	42.9		98.230	95.275	2.805	Open Manhole	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009		98.230	95.275	0.000	0	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Simulation Criteria for Storm

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.400		

Online Controls for Storm

Complex Manhole: SMH36, DS/PN: 1.009, Volume (m^3): 58.7

Hydro-Brake Optimum®

Unit Reference	MD-SHE-0217-2400-0800-2400
Design Head (m)	0.800
Design Flow (l/s)	24.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	217
Invert Level (m)	96.465
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	24.0
Flush-Flo™	0.333	24.0
Kick-Flo®	0.615	21.2
Mean Flow over Head Range	-	19.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.3	1.200	29.1	3.000	45.3	7.000	68.3
0.200	21.3	1.400	31.4	3.500	48.8	7.500	70.6
0.300	23.9	1.600	33.4	4.000	52.0	8.000	72.9
0.400	23.8	1.800	35.4	4.500	55.1	8.500	74.7
0.500	23.1	2.000	37.2	5.000	58.0	9.000	76.9
0.600	21.6	2.200	39.0	5.500	60.7	9.500	79.0
0.800	24.0	2.400	40.6	6.000	63.4		
1.000	26.7	2.600	42.3	6.500	65.9		

Orifice

Diameter (m) 0.150 Discharge Coefficient 0.600 Invert Level (m) 97.265

Storage Structures for Storm

Porous Car Park Manhole: SMH35, DS/PN: 1.008

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	7.3
Membrane Percolation (mm/hr)	1000	Length (m)	80.0
Max Percolation (l/s)	162.2	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	98.800	Membrane Depth (mm)	0

Swale Manhole: SWALE, DS/PN: 8.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	301.9
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	3.0
Safety Factor	2.0	Slope (1:X)	500.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	97.450	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Tank or Pond Manhole: POND, DS/PN: 9.000

Invert Level (m) 96.505

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	389.4	0.500	1934.1	1.600	3207.8

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
1.002	SMH3	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	1	+0%	100/15 Summer			
3.000	SMH5	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.003	SMH10	15 Winter	1	+0%	30/15 Summer			
1.003	SMH11	15 Winter	1	+0%	100/15 Summer			
1.004	SMH12	15 Winter	1	+0%	30/30 Summer			
1.005	SMH13	30 Winter	1	+0%	30/15 Winter			
5.000	SMH14	15 Winter	1	+0%	100/15 Summer			
5.001	SMH15	15 Winter	1	+0%	100/15 Summer			
5.002	SMH16	15 Winter	1	+0%	100/15 Summer			
5.003	SMH17	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
6.000	SMH18	15 Winter	1	+0%	30/15 Summer	100/15 Summer		

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SMH1	99.116	-0.154	0.000	0.21		11.1	OK	4
1.001	SMH2	98.571	-0.184	0.000	0.31		30.3	OK	4
1.002	SMH3	98.385	-0.150	0.000	0.49		42.6	OK	4
2.000	SMH4	98.735	-0.155	0.000	0.21		20.4	OK	
3.000	SMH5	98.749	-0.121	0.000	0.41		19.5	OK	4
3.001	SMH6	98.203	-0.117	0.000	0.46		19.8	OK	3
4.000	SMH7	98.698	-0.122	0.000	0.41		20.5	OK	4
3.002	SMH9	98.072	-0.113	0.000	0.71		40.6	OK	2
3.003	SMH10	98.029	-0.111	0.000	0.71		40.3	OK	
1.003	SMH11	97.564	-0.536	0.000	0.17		98.7	OK	
1.004	SMH12	97.451	-0.529	0.000	0.19		98.0	OK	
1.005	SMH13	97.388	-0.522	0.000	0.12		75.8	OK	
5.000	SMH14	98.845	-0.175	0.000	0.11		5.1	OK	
5.001	SMH15	98.548	-0.247	0.000	0.07		5.0	OK	
5.002	SMH16	98.278	-0.397	0.000	0.03		5.1	OK	
5.003	SMH17	97.847	-0.378	0.000	0.06		8.6	OK	1
6.000	SMH18	97.917	-0.348	0.000	0.21		61.4	OK	5

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	15 Winter	1	+0%	30/15 Winter	100/15 Summer		
6.002	SMH20	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
5.004	SMH21	15 Winter	1	+0%	30/30 Winter			
5.005	SMH22	15 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.006	SMH23	15 Winter	1	+0%	30/15 Winter			
5.007	SMH24	15 Winter	1	+0%	30/15 Winter			
5.008	SMH25	15 Winter	1	+0%	30/15 Winter			
7.000	SMH26	30 Winter	1	+0%	30/30 Summer	100/15 Summer		
7.001	SMH27	30 Winter	1	+0%	30/15 Summer	100/15 Summer		
7.002	SMH28	30 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.009	SMH29	30 Winter	1	+0%	30/15 Winter	100/15 Summer		
5.010	SMH30	30 Winter	1	+0%	30/15 Summer	100/15 Winter		
5.011	SMH31	30 Winter	1	+0%	30/15 Winter	100/15 Winter		
5.012	SMH32	30 Winter	1	+0%	30/15 Summer			
1.006	SMH33	30 Winter	1	+0%	30/15 Summer			
1.007	SMH34	30 Winter	1	+0%	30/15 Summer			
1.008	SMH35	30 Winter	1	+0%	30/15 Summer			
8.000	SWALE	15 Winter	1	+0%	100/15 Summer			
9.000	POND	240 Winter	1	+0%	30/30 Winter			
1.009	SMH36	30 Winter	1	+0%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
6.001	SMH19	97.896	-0.309	0.000	0.28		104.0	OK	5
6.002	SMH20	97.879	-0.421	0.000	0.30		104.2	OK	5
5.004	SMH21	97.749	-0.381	0.000	0.39		110.6	OK	
5.005	SMH22	97.699	-0.391	0.000	0.31		107.5	OK	4
5.006	SMH23	97.640	-0.385	0.000	0.29		102.4	OK	
5.007	SMH24	97.589	-0.371	0.000	0.38		100.1	OK	
5.008	SMH25	97.549	-0.376	0.000	0.40		110.7	OK	
7.000	SMH26	97.462	-0.623	0.000	0.03		23.3	OK	5
7.001	SMH27	97.461	-0.544	0.000	0.05		36.6	OK	5
7.002	SMH28	97.449	-0.461	0.000	0.06		25.2	OK	3
5.009	SMH29	97.447	-0.438	0.000	0.17		116.3	OK	2
5.010	SMH30	97.425	-0.395	0.000	0.26		178.2	OK	1
5.011	SMH31	97.398	-0.352	0.000	0.37		252.0	OK	
5.012	SMH32	97.371	-0.314	0.000	0.75		274.2	OK	
1.006	SMH33	97.357	-0.308	0.000	0.45		309.2	OK	
1.007	SMH34	97.321	-0.269	0.000	0.42		304.3	OK	
1.008	SMH35	97.267	-0.228	0.000	0.39		295.1	OK	
8.000	SWALE	97.568	-0.182	0.000	0.33		25.7	OK	
9.000	POND	96.965	-0.140	0.000	0.12		22.2	OK	
1.009	SMH36	97.191	0.576	0.000	0.90		23.9	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.400
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 19.000 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	30	+0%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
1.002	SMH3	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	30	+0%	100/15 Summer			
3.000	SMH5	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	30	+0%	30/15 Summer	100/15 Summer		
3.003	SMH10	15 Winter	30	+0%	30/15 Summer			
1.003	SMH11	30 Winter	30	+0%	100/15 Summer			
1.004	SMH12	30 Summer	30	+0%	30/30 Summer			
1.005	SMH13	15 Winter	30	+0%	30/15 Winter			
5.000	SMH14	15 Winter	30	+0%	100/15 Summer			
5.001	SMH15	15 Winter	30	+0%	100/15 Summer			
5.002	SMH16	15 Winter	30	+0%	100/15 Summer			
5.003	SMH17	15 Winter	30	+0%	100/15 Summer	100/15 Summer		
6.000	SMH18	15 Winter	30	+0%	30/15 Summer	100/15 Summer		

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SMH1	99.163	-0.107	0.000	0.53		27.1	OK	4
1.001	SMH2	98.912	0.157	0.000	0.78		76.2	SURCHARGED	4
1.002	SMH3	98.780	0.245	0.000	1.25		108.6	SURCHARGED	4
2.000	SMH4	98.780	-0.110	0.000	0.52		49.9	OK	
3.000	SMH5	98.935	0.065	0.000	0.95		44.6	SURCHARGED	4
3.001	SMH6	98.467	0.147	0.000	1.00		42.7	SURCHARGED	3
4.000	SMH7	98.887	0.067	0.000	0.94		47.3	SURCHARGED	4
3.002	SMH9	98.331	0.146	0.000	1.55		88.6	SURCHARGED	2
3.003	SMH10	98.206	0.066	0.000	1.57		88.3	SURCHARGED	
1.003	SMH11	98.097	-0.003	0.000	0.34		192.8	OK	
1.004	SMH12	97.980	0.000	0.000	0.35		180.2	SURCHARGED	
1.005	SMH13	97.955	0.045	0.000	0.28		174.8	SURCHARGED	
5.000	SMH14	98.875	-0.145	0.000	0.28		12.5	OK	
5.001	SMH15	98.580	-0.215	0.000	0.18		12.5	OK	
5.002	SMH16	98.310	-0.365	0.000	0.08		12.0	OK	
5.003	SMH17	98.178	-0.047	0.000	0.12		17.6	OK	1
6.000	SMH18	98.329	0.064	0.000	0.51		148.4	SURCHARGED	5

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
6.002	SMH20	30 Winter	30	+0%	100/15 Summer	100/15 Summer		
5.004	SMH21	30 Winter	30	+0%	30/30 Winter			
5.005	SMH22	30 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.006	SMH23	15 Winter	30	+0%	30/15 Winter			
5.007	SMH24	15 Winter	30	+0%	30/15 Winter			
5.008	SMH25	15 Winter	30	+0%	30/15 Winter			
7.000	SMH26	30 Winter	30	+0%	30/30 Summer	100/15 Summer		
7.001	SMH27	30 Winter	30	+0%	30/15 Summer	100/15 Summer		
7.002	SMH28	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.009	SMH29	15 Winter	30	+0%	30/15 Winter	100/15 Summer		
5.010	SMH30	15 Winter	30	+0%	30/15 Summer	100/15 Winter		
5.011	SMH31	15 Winter	30	+0%	30/15 Winter	100/15 Winter		
5.012	SMH32	15 Winter	30	+0%	30/15 Summer			
1.006	SMH33	15 Winter	30	+0%	30/15 Summer			
1.007	SMH34	15 Winter	30	+0%	30/15 Summer			
1.008	SMH35	15 Winter	30	+0%	30/15 Summer			
8.000	SWALE	15 Winter	30	+0%	100/15 Summer			
9.000	POND	480 Winter	30	+0%	30/30 Winter			
1.009	SMH36	15 Winter	30	+0%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
6.001	SMH19	98.248	0.043	0.000	0.75		280.0	SURCHARGED	5
6.002	SMH20	98.183	-0.117	0.000	0.61		208.9	OK	5
5.004	SMH21	98.164	0.034	0.000	0.73		208.0	SURCHARGED	
5.005	SMH22	98.110	0.020	0.000	0.54		188.4	SURCHARGED	4
5.006	SMH23	98.092	0.067	0.000	0.63		222.5	SURCHARGED	
5.007	SMH24	98.078	0.118	0.000	0.85		222.9	SURCHARGED	
5.008	SMH25	98.062	0.137	0.000	0.89		244.2	SURCHARGED	
7.000	SMH26	98.114	0.029	0.000	0.06		52.1	SURCHARGED	5
7.001	SMH27	98.105	0.100	0.000	0.12		88.2	SURCHARGED	5
7.002	SMH28	98.045	0.135	0.000	0.28		112.3	SURCHARGED	3
5.009	SMH29	98.042	0.157	0.000	0.47		320.4	SURCHARGED	2
5.010	SMH30	98.027	0.207	0.000	0.70		483.8	SURCHARGED	1
5.011	SMH31	97.996	0.246	0.000	0.98		663.7	SURCHARGED	
5.012	SMH32	97.952	0.267	0.000	1.89		691.4	SURCHARGED	
1.006	SMH33	97.922	0.257	0.000	1.14		786.8	SURCHARGED	
1.007	SMH34	97.847	0.257	0.000	1.05		752.9	SURCHARGED	
1.008	SMH35	97.750	0.255	0.000	0.97		732.9	SURCHARGED	
8.000	SWALE	97.642	-0.108	0.000	0.71		56.2	OK	
9.000	POND	97.318	0.213	0.000	0.14		25.5	SURCHARGED	
1.009	SMH36	97.619	1.004	0.000	1.90		50.4	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.400
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	SMH1	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
1.001	SMH2	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
1.002	SMH3	30 Winter	100	+40%	30/15 Summer	100/15 Summer		
2.000	SMH4	15 Winter	100	+40%	100/15 Summer			
3.000	SMH5	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.001	SMH6	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
4.000	SMH7	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.002	SMH9	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
3.003	SMH10	15 Winter	100	+40%	30/15 Summer			
1.003	SMH11	30 Winter	100	+40%	100/15 Summer			
1.004	SMH12	30 Winter	100	+40%	30/30 Summer			
1.005	SMH13	30 Winter	100	+40%	30/15 Winter			
5.000	SMH14	30 Winter	100	+40%	100/15 Summer			
5.001	SMH15	15 Winter	100	+40%	100/15 Summer			
5.002	SMH16	15 Winter	100	+40%	100/15 Summer			
5.003	SMH17	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
6.000	SMH18	30 Winter	100	+40%	30/15 Summer	100/15 Summer		

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SMH1	100.073	0.803	2.612	0.62		32.0	FLOOD	4
1.001	SMH2	99.963	1.208	2.939	1.09		106.1	FLOOD	4
1.002	SMH3	99.805	1.270	4.785	1.49		128.8	FLOOD	4
2.000	SMH4	99.749	0.859	0.000	0.94		90.5	SURCHARGED	
3.000	SMH5	99.687	0.817	6.758	1.31		61.8	FLOOD	4
3.001	SMH6	99.660	1.340	0.262	1.25		53.6	FLOOD	3
4.000	SMH7	99.607	0.787	7.159	1.29		64.9	FLOOD	4
3.002	SMH9	99.528	1.343	2.861	2.01		115.3	FLOOD	2
3.003	SMH10	99.463	1.323	0.000	2.09		117.9	FLOOD RISK	
1.003	SMH11	99.383	1.283	0.000	0.46		262.2	FLOOD RISK	
1.004	SMH12	99.356	1.376	0.000	0.52		267.5	FLOOD RISK	
1.005	SMH13	99.332	1.422	0.000	0.42		264.2	SURCHARGED	
5.000	SMH14	99.488	0.468	0.000	0.37		16.9	SURCHARGED	
5.001	SMH15	99.460	0.665	0.000	0.35		24.7	SURCHARGED	
5.002	SMH16	99.454	0.779	0.000	0.19		29.6	SURCHARGED	
5.003	SMH17	99.445	1.220	0.026	0.36		52.0	FLOOD	1
6.000	SMH18	99.438	1.173	38.286	0.64		186.3	FLOOD	5

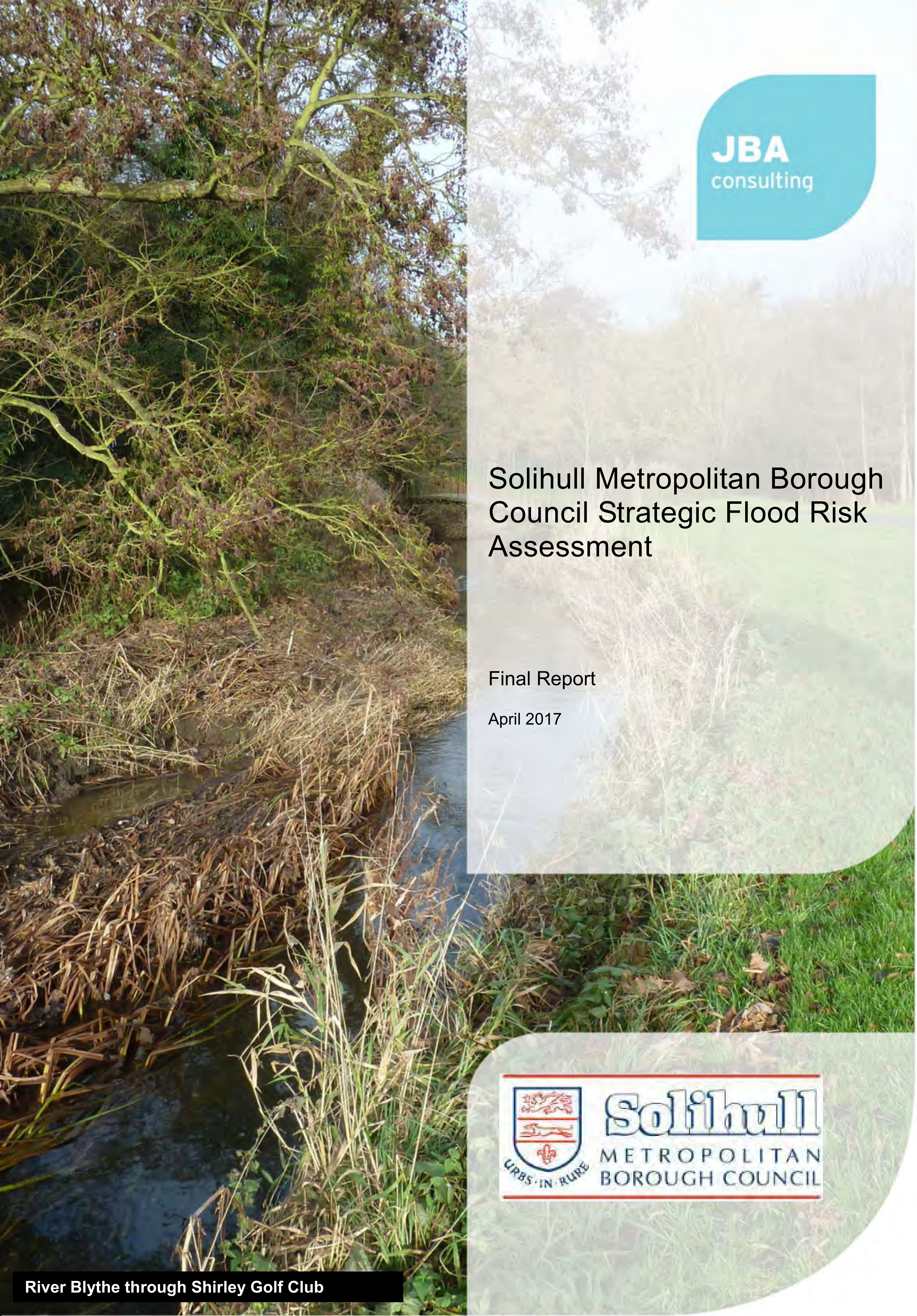
100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
6.001	SMH19	30 Winter	100	+40%	30/15 Winter	100/15 Summer		
6.002	SMH20	15 Winter	100	+40%	100/15 Summer	100/15 Summer		
5.004	SMH21	15 Winter	100	+40%	30/30 Winter			
5.005	SMH22	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.006	SMH23	15 Summer	100	+40%	30/15 Winter			
5.007	SMH24	15 Summer	100	+40%	30/15 Winter			
5.008	SMH25	15 Summer	100	+40%	30/15 Winter			
7.000	SMH26	15 Winter	100	+40%	30/30 Summer	100/15 Summer		
7.001	SMH27	15 Winter	100	+40%	30/15 Summer	100/15 Summer		
7.002	SMH28	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.009	SMH29	15 Winter	100	+40%	30/15 Winter	100/15 Summer		
5.010	SMH30	15 Winter	100	+40%	30/15 Summer	100/15 Winter		
5.011	SMH31	30 Winter	100	+40%	30/15 Winter	100/15 Winter		
5.012	SMH32	30 Winter	100	+40%	30/15 Summer			
1.006	SMH33	30 Winter	100	+40%	30/15 Summer			
1.007	SMH34	30 Winter	100	+40%	30/15 Summer			
1.008	SMH35	30 Winter	100	+40%	30/15 Summer			
8.000	SWALE	60 Winter	100	+40%	100/15 Summer			
9.000	POND	360 Winter	100	+40%	30/30 Winter			
1.009	SMH36	30 Winter	100	+40%	1/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
6.001	SMH19	99.429	1.224	44.018	0.95		352.0	FLOOD	5
6.002	SMH20	99.422	1.122	22.652	1.36		463.8	FLOOD	5
5.004	SMH21	99.441	1.311	0.000	1.45		410.6	FLOOD RISK	
5.005	SMH22	99.460	1.370	20.975	1.10		383.0	FLOOD	4
5.006	SMH23	99.663	1.638	0.000	1.03		363.7	FLOOD RISK	
5.007	SMH24	99.709	1.749	0.000	1.25		328.6	SURCHARGED	
5.008	SMH25	99.689	1.764	0.000	1.29		354.3	SURCHARGED	
7.000	SMH26	99.329	1.244	53.792	0.14		116.4	FLOOD	5
7.001	SMH27	99.349	1.344	64.433	0.28		199.0	FLOOD	5
7.002	SMH28	99.491	1.581	41.794	0.41		161.7	FLOOD	3
5.009	SMH29	99.652	1.767	8.285	0.71		480.5	FLOOD	2
5.010	SMH30	99.757	1.937	6.659	1.05		722.6	FLOOD	1
5.011	SMH31	99.557	1.807	0.000	1.50		1008.0	FLOOD RISK	
5.012	SMH32	99.473	1.788	0.000	3.08		1125.3	FLOOD RISK	
1.006	SMH33	99.295	1.630	0.000	1.83		1268.9	SURCHARGED	
1.007	SMH34	99.014	1.424	0.000	1.76		1261.7	SURCHARGED	
1.008	SMH35	98.689	1.194	0.000	1.66		1253.6	SURCHARGED	
8.000	SWALE	97.944	0.194	0.000	0.63		49.4	SURCHARGED	
9.000	POND	97.776	0.671	0.000	0.21		37.9	SURCHARGED	
1.009	SMH36	98.302	1.687	0.000	3.03		80.5	SURCHARGED	

10 Appendix B

B.1 Solihull Metropolitan District Council SFRA Extracts



River Blythe through Shirley Golf Club

JBA consulting

Solihull Metropolitan Borough Council Strategic Flood Risk Assessment

Final Report

April 2017

Solihull Metropolitan Borough Council

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Revision History

Revision Ref / Date Issued	Amendments	Issued to
Draft v1.0		Maurice Barlow (SMBC) Ed Bradford (SMBC) Harry Savage (SMBC) Nadeem Din (SMBC) Martin Ross (EA)
Final v1.0		Maurice Barlow (SMBC) Ed Bradford (SMBC) Harry Savage (SMBC) Nadeem Din (SMBC)

Contract

This report describes work commissioned by Solihull Metropolitan Borough Council. The Council's representative for the contract was Maurice Barlow. Sophie Dusting and Freyja Scarborough of JBA Consulting carried out this work.

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Purpose

This document has been prepared as a Final Report for Solihull Metropolitan Borough Council. JBA Consulting accepts no responsibility or liability for any use that is made of this document other than by the Client for the purposes for which it was originally commissioned and prepared.

JBA Consulting has no liability regarding the use of this report except to Solihull Metropolitan Borough Council.

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- Becky Clarke and Diane Edwards (Environment Agency)
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- Canal and River Trust
- Severn Trent Water
- Birmingham City Council
- Bromsgrove and Redditch District Council
- Coventry City Council
- North Warwickshire Borough Council
- Warwick District Council

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Executive Summary

Introduction

This Strategic Flood Risk Assessment replaces the Level 1 SFRA originally published by Solihull Metropolitan Borough Council in January 2008. The main purpose of the SFRA update is to provide a comprehensive and robust evidence base to support the production of the Local Plan and to support the selection of site allocations.

SFRA objectives

The key objectives of the 2016 SFRA are:

- To provide up to date information and guidance on flood risk for Solihull Metropolitan Borough Council, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the local plan
- Identify the requirements for site-specific flood risk assessments and the application of Sustainable Drainage Systems (SuDS)

SFRA outputs

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of the surface water management issues and the application of Sustainable Drainage Systems
- Review and update new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc.)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments
- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation
- Mapping areas covered by an existing flood alert / warning
- Identify opportunities to reduce flood risk.

Summary of Level 1 Assessment

Sources of flood risk

- The historical flood record shows that the borough has been subject to flooding from several sources of flood risk, with the principal risk from fluvial and surface water sources. There is also an indication that blockages of undersized culverts (locations unknown) have been an issue. Notable flood events include July 2007, June 2012, November 2012, September 2015, June 2016 and September 2016
- The key watercourses flowing through the study area are the River Blythe and its tributaries. Tributaries of the River Blythe include, but are not limited to the River Cole, Mount Brook, Alder Brook, Purnell's Brook, Shadow Brook, and Hollywell Brook. The Kingshurst Brook, the Hatchford Brook and several other Main River and ordinary watercourses flow through the borough. The River Blythe flows through the majority of the borough. However, the areas it flows through are predominantly rural and the fluvial flood risk from the River Blythe to property in this area is minimal. The River Cole, a tributary of the Blythe, flows through Kingshurst in the north and south east of Solihull. Whilst the River Cole has relatively narrow floodplains, it flows through areas that are heavily urbanised and as such, produces a higher flood risk to properties in the

Kingshurst, Chelmsley Wood and Solihull wards. Several other Main Rivers and ordinary watercourses also present a fluvial flood risk.

- There are no formal flood defences in the borough
- Solihull has experienced a number of historic surface water / drainage related flood events caused by a number of mechanisms such as culvert blockage. The updated Flood Map for Surface Water further shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas
- The sewers are managed by Severn Trent Water. The Hydraulic Sewer Flooding Risk Register (HFRR) was supplied for use in this assessment. The HFRR register is a database of recorded historical sewer flooding incidents, on a post-code basis. A total of 185 recorded flood incidents in the Solihull Metropolitan Borough were listed in the HFRR register. The most frequently flooded localities are Solihull town, Dorridge, and Hampton-in-Arden. 20 incidents were recorded during June and July 2007. A further 12 incidents were recorded in August 1999, 9 incidents were recorded in November 2012 and August 2004. July 2007 and November 2012 are also recorded historical fluvial and blockages indicating that there may be some interaction between the fluvial and surface water drainage networks. However, most the dates do not correlate to significant historic fluvial or surface water flood events, indicating that the events listed in the HFRR are possibly isolated incidents.
- There are no records of flooding from reservoirs impacting properties inside the study area. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low
- There are two canals flowing through the borough; the Grand Union Canal and the Stratford-upon-Avon Canal. There is one record of a canal breach with in the borough, on the Grand Union Canal, dated November 1997

Climate change

Climate change modelling for the watercourses in Solihull has been undertaken based on the new climate change guidance, using a combination of existing Environment Agency hydraulic models and Jflow modelling, run for the 2080s period for all three allowance categories.

The Flood Zone 2 extent is comparatively similar to the 100-year plus 20% allowance for climate change across Solihull. Due to the nature of the topography, the flood zones are largely confined and subsequently, the flood extent is not significantly different when a 20% or 30% or 50% allowance for climate change is used. Whilst the flood extent in more constrained catchments may not increase significantly, the flood depth and hazard may. The Hatchford Brook, Low Brook and Kingshurst Brook appear to be more sensitive to increases in the climate change allowances.

Key policies

There are many relevant regional and local key policies which have been considered within the SFRA, such as the Catchment Flood Management Plan, River Basin Flood Risk Management Plan, the Preliminary Flood Risk Assessment and Local Flood Risk Management Strategy. Other policy considerations have also been incorporated, such as sustainable development principles, climate change and flood risk management.

Development and flood risk

The Sequential and Exception Test procedures for both Local Plans and Flood Risk Assessments have been documented, along with guidance for planners and developers. Links have been provided for various guidance documents and policies published by other Risk Management Authorities such as the Lead Local Flood Authority and the Environment Agency.

Recommendations

Development control

Sequential approach to development

The National Planning Policy Framework supports a risk-based and sequential approach to development and flood risk in England, so that development is in the lowest flood risk areas where possible; it is recommended that this approach is adopted for all future developments within the district.

New development and re-development of land should wherever possible seek opportunities to reduce overall level of flood risk at the site

Site-specific flood risk assessments

Site specific FRAs are required by developers to provide a greater level of detail on flood risk and, where necessary, demonstrate the development passes part b of the Exception Test.

Developers should, where required, undertake more detailed hydrological and hydraulic assessments of the watercourses to verify flood extent (including latest climate change allowances), inform development zoning within the site and prove, if required, whether the Exception Test can be passed. The assessment should also identify the risk of existing flooding to adjacent land and properties to establish whether there is a requirement to secure land to implement strategic flood risk management measures to alleviate existing and future flood risk.

Sequential and Exception tests

The Strategic Flood Risk Assessment has identified that areas of the borough are at high risk of flooding from both fluvial and surface water sources. Therefore, a large number of proposed development sites will be required to pass the Sequential and, where necessary, Exception Tests in accordance with the National Planning Policy Framework. Solihull Metropolitan Borough Council should use the information in this SFRA when deciding which development sites to take forward in their Local Plan.

It is recommended that the Council considers using the SFRA climate change maps when applying the Sequential Test for site allocations and windfall sites.

Developers should consult with Solihull Metropolitan Borough Council, the Environment Agency, Severn Trent Water, where necessary, at an early stage to discuss flood risk including requirements for site-specific FRAs, detailed hydraulic modelling, and drainage assessment and design.

Windfall sites

The acceptability of windfall applications in flood risk areas should be considered at the strategic level through a policy setting out broad locations and quantities of windfall development that would be acceptable or not in Sequential Test terms.

Council review of planning applications

The Council should consult the Environment Agency's 'Flood Risk Standing Advice for Local Planning Authorities', last updated 15 April 2015, when reviewing planning applications for proposed developments at risk of flooding.

Residual risk

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage. They should seek to contact the reservoir owner to obtain information and should apply the sequential approach to locating development within the site. Developers should also consult with relevant authorities regarding emergency plans in case of reservoir breach.

Drainage assessments and promotion of SuDS

Drainage strategies and Sustainable Drainage

Planners should be aware of the conditions set by the Lead Local Flood Authority for surface water management and ensure development proposals and applications are compliant with the Council's policy. These policies should also be incorporated into the Local Plan. Wherever possible, sustainable drainage (SuDS) should be promoted:

- It should be demonstrated through a Surface Water Drainage Strategy, that the proposed drainage scheme, and site layout and design, will prevent properties from flooding from surface water. A detailed site-specific assessment of SuDS would be needed to incorporate SuDS successfully into the development proposals. All development should adopt source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff
- For proposed developments, it is imperative that a site-specific infiltration test is conducted early on as part of the design of the development, to confirm whether the water

table is low enough to allow for SuDS techniques that are designed to encourage infiltration

- Where sites lie within or close to Groundwater Source Protection Zones or aquifers, there may be a requirement for a form of pre-treatment prior to infiltration. Further guidance can be found in the CIRIA SuDS manual on the level of water quality treatment required for drainage via infiltration
- Consideration must also be given to residual risk and maintenance of sustainable drainage and surface water systems
- SuDS proposals should contain an adequate number of treatments stages to ensure any pollutants are dealt with on site and do not have a detrimental impact on receiving waterbodies
- The promotion and adoption of water efficient practices in new development will help to manage water resources and work towards sustainable development and will help to reduce any increase in pressure on existing water and wastewater infrastructure

Safe access and egress

Safe access and egress will need to be demonstrated at all development sites; the development should be above the 1 in 100-year flood level, plus an allowance for climate change, and emergency vehicular access should be possible during times of flood. Finished Floor Levels should be above the 1 in 100-year (1% Annual Exceedance Probability) flood level, plus an allowance for climate change.

Future flood management

- Development should take a sequential approach to site layout
- Upstream storage schemes are often considered as one potential solution to flooding. However, this is not a solution for everywhere. Upstream storage should be investigated fully before being adopted as a solution
- Floodplain restoration represents a sustainable form of strategic flood risk solution, by allowing watercourses to return to a more naturalised state,

Use of Strategic Flood Risk Assessment data

Strategic Flood Risk Assessments are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The Strategic Flood Risk Assessment has been developed using the best available information at the time of preparation.

The Strategic Flood Risk Assessment should be updated when new information on flood risk, new planning guidance or legislation becomes available.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the Strategic Flood Risk Assessment is reviewed internally on an annual basis, allowing a cycle of review, followed by checking with the above bodies for any new information to allow a periodic update.

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Using this document

Hyperlinks

Hyperlinks have been provided where there are useful reference points. These are shown as red text.

Appendix A: Mapping of all sources of flood risk across the borough.

These are a series of interactive maps that show all sources of flooding in Solihull Metropolitan Borough. Clicking on a grid square in the Index Map will open a separate interactive PDF map that has options for turning on and off the map layers of interest.

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Abbreviations and Glossary of Terms

Term	Definition
1D model	One-dimensional hydraulic model
2D model	Two-dimensional hydraulic model
AEP	Annual Exceedance Probability
Brownfield	Previously developed parcel of land
CC	Climate change - Long term variations in global temperature and weather patterns caused by natural and human actions.
CDA	Critical Drainage Area - A discrete geographic area (usually a hydrological catchment) where multiple and interlinked sources of flood risk (surface water, groundwater, sewer, main river and/or tidal) cause flooding in one or more Local Flood Risk Zones during severe weather thereby affecting people, property or local infrastructure.
CFMP	Catchment Flood Management Plan- A high-level planning strategy through which the Environment Agency works with their key decision makers within a river catchment to identify and agree policies to secure the long-term sustainable management of flood risk.
CIRIA	Construction Industry Research and Information Association
Defra	Department for Environment, Food and Rural Affairs
HFRR Register	A water-company held register of properties which have experienced sewer flooding due to hydraulic overload, or properties which are 'at risk' of sewer flooding more frequently than once in 20 years.
DTM	Digital Terrain Model
EA	Environment Agency
EU	European Union
Flood defence	Infrastructure used to protect an area against floods as floodwalls and embankments; they are designed to a specific standard of protection (design standard).
Flood Risk Area	An area determined as having a significant risk of flooding in accordance with guidance published by Defra and WAG (Welsh Assembly Government).
Flood Risk Regulations	Transposition of the EU Floods Directive into UK law. The EU Floods Directive is a piece of European Community (EC) legislation to specifically address flood risk by prescribing a common framework for its measurement and management.
Floods and Water Management Act	Part of the UK Government's response to Sir Michael Pitt's Report on the Summer 2007 floods, the aim of which is to clarify the legislative framework for managing surface water flood risk in England.
Fluvial Flooding	Flooding resulting from water levels exceeding the bank level of a main river
FRA	Flood Risk Assessment - A site specific assessment of all forms of flood risk to the site and the impact of development of the site to flood risk in the area.
FWMA	Flood and Water Management Act
Greenfield	Undeveloped parcel of land
Ha	Hectare
JBA	Jeremy Benn Associates
LFRMS	Local Flood Risk Management Strategy
LIDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority - Local Authority responsible for taking the lead on local flood risk management
mAOD	metres Above Ordnance Datum
Main River	A watercourse shown as such on the Main River Map, and for which the Environment Agency has responsibilities and powers

Term	Definition
Major development	Residential development: 10 dwellings or more, or site area of 0.5 hectares or more is dwelling numbers are unknown. Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more, or where the flood area is not yet known, a site area of one hectare or more.
NPPF	National Planning Policy Framework
NPPG	National Planning Policy Guidance
NRD	National Receptor Database
Ordinary Watercourse	All watercourses that are not designated Main River. Local Authorities or, where they exist, IDBs have similar permissive powers as the Environment Agency in relation to flood defence work. However, the riparian owner has the responsibility of maintenance.
OS NGR	Ordnance Survey National Grid Reference
PFRA	Preliminary Flood Risk Assessment
Pitt Review	Comprehensive independent review of the 2007 summer floods by Sir Michael Pitt, which provided recommendations to improve flood risk management in England.
Pluvial flooding	Flooding as a result of high intensity rainfall when water is ponding or flowing over the ground surface (surface runoff) before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity.
Resilience Measures	Measures designed to reduce the impact of water that enters property and businesses; could include measures such as raising electrical appliances.
Resistance Measures	Measures designed to keep flood water out of properties and businesses; could include flood guards for example.
Risk	In flood risk management, risk is defined as a product of the probability or likelihood of a flood occurring, and the consequence of the flood.
Return Period	Is an estimate of the interval of time between events of a certain intensity or size, in this instance it refers to flood events. It is a statistical measurement denoting the average recurrence interval over an extended period of time.
RoFfSW	Risk of Flooding from Surface Water map.
Sewer flooding	Flooding caused by a blockage or overflowing in a sewer or urban drainage system.
SFRA	Strategic Flood Risk Assessment
SoP	Standard of Protection - Defences are provided to reduce the risk of flooding from a river and within the flood and defence field standards are usually described in terms of a flood event return period. For example, a flood embankment could be described as providing a 1 in 100-year standard of protection.
Stakeholder	A person or organisation affected by the problem or solution, or interested in the problem or solution. They can be individuals or organisations, includes the public and communities.
SuDS	Sustainable Drainage Systems - Methods of management practices and control structures that are designed to drain surface water in a more sustainable manner than some conventional techniques
Surface water flooding	Flooding as a result of surface water runoff as a result of high intensity rainfall when water is ponding or flowing over the ground surface before it enters the underground drainage network or watercourse, or cannot enter it because the network is full to capacity, thus causing what is known as pluvial flooding.
SWMP	Surface Water Management Plan - The SWMP plan should outline the preferred surface water management strategy and identify the actions, timescales and responsibilities of each partner. It is the principal output from the SWMP study.
WFD	Water Framework Directive

1 Introduction

1.1 Purpose of the Strategic Flood Risk Assessment

> ***"Local Plans should be supported by a strategic flood risk assessment and develop policies to manage flood risk from all sources, taking account of advice from the Environment Agency and other relevant flood risk management bodies, such as Lead Local Flood Authorities and Internal Drainage Boards. Local Plans should apply a sequential, risk-based approach to the location of development to avoid, where possible, flood risk to people and property and manage any residual risk, taking account of the impacts of climate change".*** (National Planning Policy Framework, paragraph 100)

This Strategic Flood Risk Assessment (SFRA) 2016 document replaces the Level 1 SFRA originally published by Solihull Metropolitan Borough Council in January 2008. The SFRA study area is shown in Figure 1-1. The main purpose of the SFRA update is to provide a comprehensive and robust evidence base to support the production of the Local Plan and to support the selection of site allocations.

The key objectives of the 2016 SFRA are:

- To provide up to date information and guidance on flood risk for Solihull Metropolitan Borough Council, taking into account the latest flood risk information (including the probable impacts of climate change), the current state of national planning policy and legislation and relevant studies
- To provide the basis for applying the flood risk Sequential Test, and if necessary the Exception Test
- To provide a comprehensive set of maps presenting flood risk from all sources that can be used as part of the evidence base for the local plan
- Identify the requirements for site-specific flood risk assessments and the application of Sustainable Drainage Systems

1.2 Levels of SFRA

The Planning Practice Guidance advocates a tiered approach to risk assessment and identifies the following two levels of SFRA:

1. Level One: where flooding is not a major issue and where development pressures are low. The assessment should be sufficiently detailed to allow application of the Sequential Test.
2. Level Two: where land outside Flood Zones 2 and 3 cannot appropriately accommodate all the necessary development creating the need to apply the NPPF's Exception Test. In these circumstances the assessment should consider the detailed nature of the flood characteristics within a Flood Zone and assessment of other sources of flooding.

This report fulfils the Level One SFRA requirements.

1.3 SFRA outputs

To meet the objectives, the following outputs have been prepared:

- Assessment of all potential sources of flooding
- Assessment of the potential impact of climate change on flood risk
- An assessment of surface water management issues and the application of Sustainable Drainage Systems (SuDS)
- A review and update of new and amended data sources (e.g. Catchment Flood Management Plans, Preliminary Flood Risk Assessment, Updated Flood Maps and modelling, etc)
- Recommendations of the criteria that should be used to assess future development proposals and the development of a Sequential Test and sequential approach to flood risk
- Guidance for developers including requirements for site-specific flood risk assessments

- Mapping of location and extent of functional floodplain
- Mapping areas at risk from other sources including surface water, sewer, ground water, reservoir inundation
- Mapping areas covered by an existing flood alert / warning
- Identify opportunities to reduce flood risk
- High-level screening of proposed development sites against flood risk information

Other outputs requested related to flood defence infrastructure. However, data sources show there are no formal flood defences within the borough.

1.4 SFRA user guide

Table 1-1: SFRA report contents

Section	Contents
1. Introduction	Provides a background to the study, defines objectives, outlines the approach adopted and the consultation performed.
2. The Planning Framework and Flood Risk Policy	Includes information on the implications of recent changes to planning and flood risk policies and legislation, as well as documents relevant to the study.
3.The Sequential, risk based approach	Describes the Sequential Approach and application of Sequential and Exception Tests. Outlines cross-boundary issues and considerations.
4. Climate change	Outlines climate change guidance and the implications for Solihull.
5. Sources of information used in preparing the SFRA	Outlines what information has been used in the preparation of the SFRA.
6. Understanding flood risk in Solihull	Introduces the assessment of flood risk and provides an overview of the characteristics of flooding affecting the borough. Provides a summary of responses that can be made to flood risk, together with policy and institutional issues that should be considered. Outlines the flood warning service in Solihull and provides advice for emergency planning, evacuation plans and safe access and egress.
7. FRA requirements and flood risk management guidance	Identifies the scope of the assessments that must be submitted in FRAs supporting applications for new development. Provides guidance for developers and outlines conditions set by the LLFA that should be followed.
8. Surface water management and SuDS	Advice on managing surface water run-off and flooding and the application of SuDS.
9. Strategic flood risk solutions	Overview of possible strategies to reduce flood risk
10. Summary	Review of the Level 1 SFRA.
11. Recommendations	Identifies recommendations for the council to consider as part of Flood Risk Management policy.
Appendix A: **Flood risk mapping**	Interactive maps showing flood risk information from all sources
Appendix B: **Flood warning coverage**	Maps of flood alerts and flood warning coverage

1.5 Consultation

The following parties have been consulted during the preparation of this version of the SFRA:

- Solihull Metropolitan Borough Council (in their role as the Lead Local Flood Authority)

- Environment Agency
- Severn Trent Water
- Canal and River Trust
- Neighbouring local authorities including
    - Birmingham City Council
    - Bromsgrove District Council
    - Coventry City Council
    - North Warwickshire Borough Council
    - Stratford-on-Avon District Council
    - Warwick District Council

1.6 Use of SFRA data

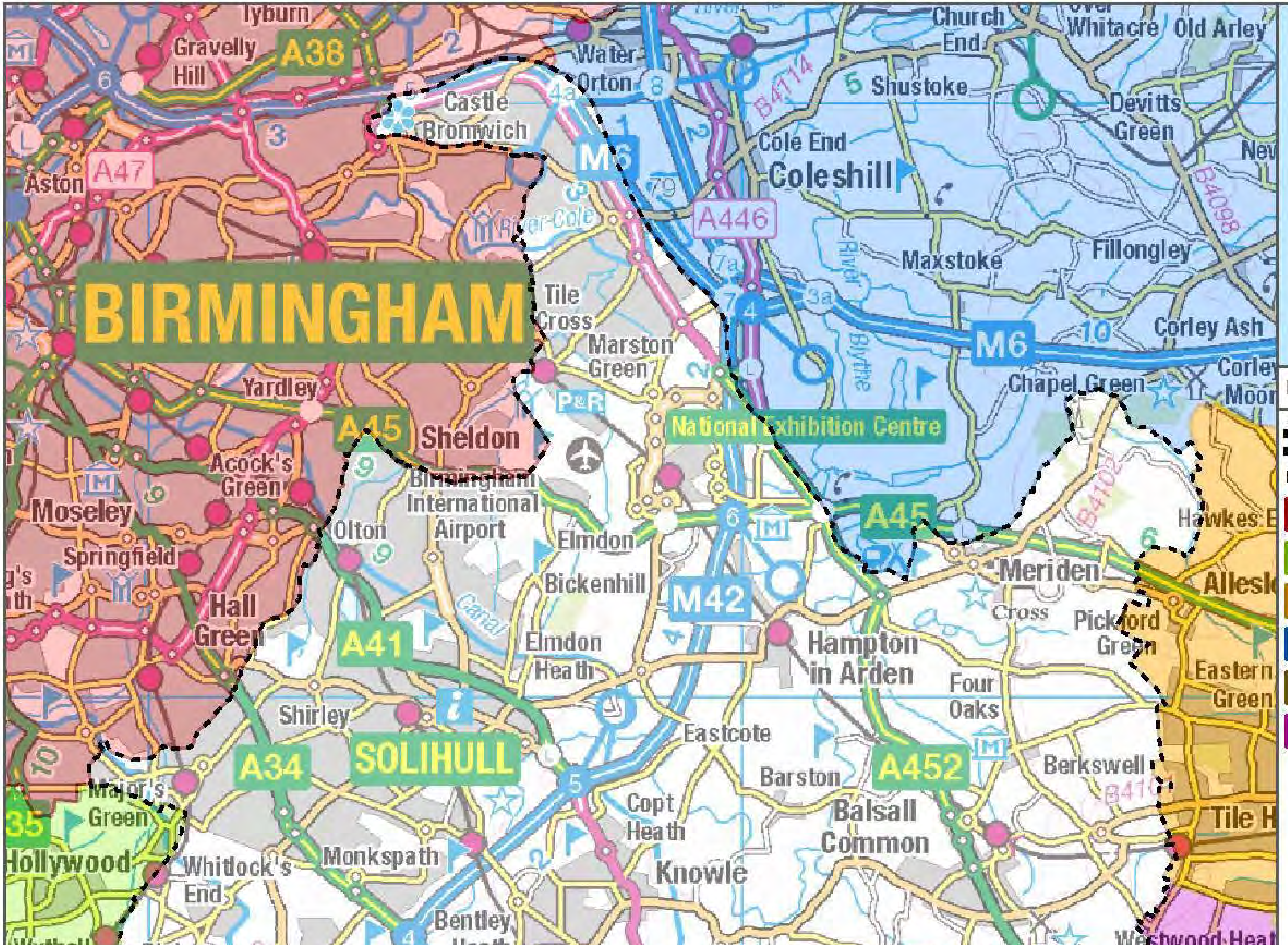
It is important to recognise that SFRAs are high level strategic documents and, as such, do not go into detail on an individual site-specific basis. The SFRA has been developed using the best available information at the time of preparation. This relates both to the current risk of flooding from rivers, and the potential impacts of future climate change.

SFRAs should be a 'living document', and as a result should be updated when new information on flood risk, new planning guidance or legislation becomes available. New information on flood risk may be provided by Solihull Metropolitan Borough Council, the Highways Authority, Severn Trent Water and the Environment Agency. Such information may be in the form of:

- New hydraulic modelling results
- Flood event information following a flood event
- Policy/ legislation updates
- Environment Agency flood map updates
- New flood defence schemes etc.

The Environment Agency regularly reviews their flood risk mapping, and it is important that they are approached to determine whether updated (more accurate) information is available prior to commencing a detailed Flood Risk Assessment. It is recommended that the SFRA is reviewed internally, in line with the Environment Agency's Flood Zone map updates to ensure latest data is still represented in the SFRA, allowing a cycle of review and a review of any updated data by checking with the above bodies for any new information.

Solihull Metropolitan Borough Council



2 The Planning Framework and Flood Risk Policy

2.1 Introduction

The overarching aim of development and flood risk planning policy in the UK is to ensure that the potential risk of flooding is taken into account at every stage of the planning process. This section of the SFRA provides an overview of the planning framework, flood risk policy and flood risk responsibilities.

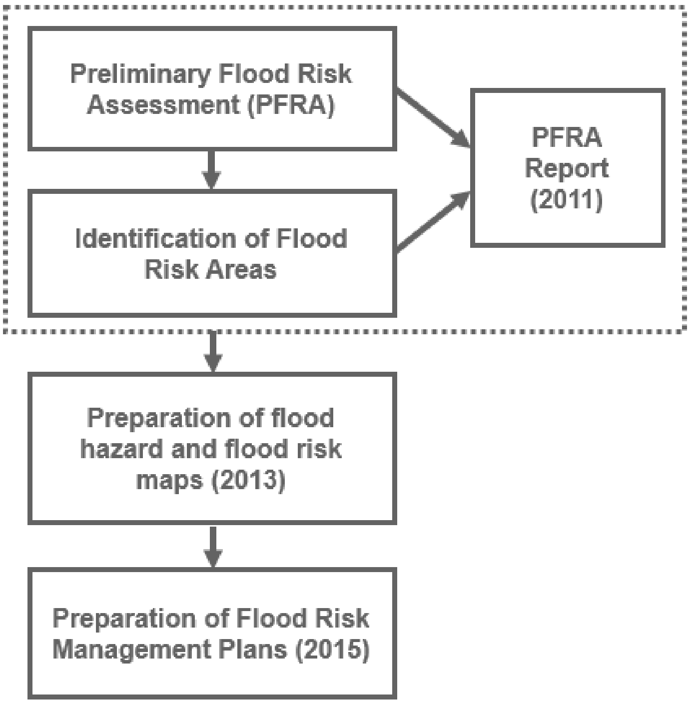
2.2 Flood Risk Regulations (2009) and Flood and Water Management Act (2010)

2.2.1 Flood Risk Regulations, 2009

The Flood Risk Regulations (2009) translate the current EU Floods Directive into UK law and place responsibility upon all Lead Local Flood Authorities (LLFAs) to manage localised flood risk. Under the Regulations, the responsibility for flooding from rivers, the sea and reservoirs lies with the Environment Agency; however, responsibility for local and all other sources of flooding rests with LLFAs. In the instance of this SFRA, the LLFA is Solihull Metropolitan Borough Council. Detail on the responsibilities of LLFAs is provided in Sections 2.2.4 to 2.2.6.

Figure 2-1 illustrates the steps that have / are being taken to implement the requirements of the EU Directive in the UK via the Flood Risk Regulations.

Figure 2-1: Flood Risk Regulation Requirements



2.2.2 Preliminary Flood Risk Assessments (PFRAs)

Under this action plan and in accordance with the Regulations, LLFAs had the task of preparing a Preliminary Flood Risk Assessment (PFRA) report.

PFRAs report on significant past and future flooding from all sources except from Main Rivers and reservoirs, which are covered by the Environment Agency, and sub-standard performance of the adopted sewer network (covered under the remit of Severn Trent Water). PFRAs are a high-level screening exercise and co2.2.6nsider floods which have significant harmful consequences for human health, economic activity, the environment and cultural heritage. The PFRA document that covers the study area was published by Solihull Metropolitan Borough Council in 2011. The Regulations require the LLFA to identify significant Flood Risk Areas.

Ten national indicative Flood Risk Areas were identified by the Defra/Environment Agency; the majority of the western, urban area of Solihull is included within an indicative Flood Risk Area.

Due to significant historic flood events, the indicative Flood Risk Area was extended to include nationally important infrastructure of Birmingham International Airport, the National Exhibition Centre (NEC), and the A45. The primary source of flood risk to these locations, identified in the PFRA, is surface water.

2.2.3 Flood Risk Management Plans (FRMPs)

Under the Regulations the Environment Agency exercised an 'Exception' and did not prepare a PFRA for risk from rivers, reservoirs and the sea. Instead they had to prepare and publish a FRMP. The FRMP summarises the flooding affecting the area and describes the measures to be taken to address the risk in accordance with the Flood Risk Regulations.

The majority of the borough falls within the Humber river basin. However; the upper reaches of ordinary watercourses in the far eastern part of the borough, flow into the Severn river basin.

The final Humber River Basin District Flood Risk Management Plan (FRMP) and the final Severn River Basin District FRMP were issued in March 2016 and covers the period of 2015 to 2021[1]. The FRMP draws on policies and actions identified in Catchment Flood Management Plans (section 2.6) and also incorporates information from Local Flood Risk Management Strategies (Section 2.2.5).

2.2.4 Flood and Water Management Act (FWMA), 2010

Following the 2007 floods, Sir Michael Pitt was appointed to chair an independent review into the floods. The final report was published in June 2008. The Flood and Water Management Act (2010)[2] implements Sir Michael Pitt's recommendations and aims to create a simpler and more effective means of managing both flood risk and coastal erosion.

The FWMA established Lead Local Flood Authorities (LLFAs). Duties for LLFAs include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.

2.2.5 Solihull Local Flood Risk Management Strategy (2015)[3]

The LFRMS is used as a means by which the LLFA co-ordinates flood risk management on a day to day basis. The LFRMS also sets measures to manage local flood risk i.e. flood risk from surface water, groundwater and ordinary watercourses.

The high-level objectives proposed in the LFRMS for managing flood risk are:

1. Improving the understanding and communication of flood risk in Solihull
2. Managing the likelihood of flooding and impacts of flooding
3. Helping Solihull's citizens to manage their own risk
4. Guiding appropriate development in Solihull
5. Improving flood prediction, warning and post flood recovery
6. Working in partnership with others to deliver the Local Strategy

1 Humber and Severn FRMPs (2016)
2 Flood and Water Management Act (2010): http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf
3 http://www.solihull.gov.uk/Portals/0/CrimeAndEmergencies/Final_LFRMS.pdf

The LFRMS also sets out an action plan of how the LLFA intends to achieve these objectives. The LFRMS should be updated regularly or when key triggers are activated. An example of a key trigger would be issues such as amendments to partner responsibilities, updates to legislation, alterations in the nature or understanding of flood risk or a significant flood event.

2.2.6 LLFAs, surface water and SuDS

On 18 December 2014 a Written Ministerial Statement laid by the Secretary of State for Communities and Local Government set out changes to the planning process that would apply for major development from 6 April 2015. When considering planning applications, local planning authorities should consult the LLFA on the management of surface water in order to satisfy that:

- the proposed minimum standards of operation are appropriate
- there are clear arrangements for on-going maintenance over the development's lifetime, through the use of planning conditions or planning obligations.

In March 2015 the LLFA was made a statutory consultee which came into effect on 15 April 2015. As a result, Solihull Metropolitan Borough Council, will be required to provide technical advice on surface water drainage strategies and designs put forward for new major developments.

Major developments are defined as

- residential development: 10 dwellings or more, or residential development with a site area of 0.5 hectares or more where the number of dwellings is not yet known; and
- Non-residential development: provision of a building or buildings where the total floor space to be created is 1,000 square metres or more or, where the floor area is not yet known, a site area of 1 hectare or more.

2.2.7 The National Flood and Coastal Erosion Risk Management Strategy for England (2011)

The National Flood and Coastal Erosion Risk Management Strategy for England provides the overarching framework for future action by all risk management authorities to tackle flooding and coastal erosion in England. It was prepared by the Environment Agency with input from Defra.

This strategy builds on existing approaches to flood and coastal risk management and promotes the use of a wide range of measures to manage risk. It describes how risk should be managed in a co-ordinated way within catchments and along the coast and balance the needs of communities, the economy and the environment.

The strategy encourages more effective risk management by enabling people, communities, business, infrastructure operators and the public sector to work together to:

- ensure a clear understanding of the risks of flooding and coastal erosion, nationally and locally, so that investment in risk management can be prioritised more effectively;
- set out clear and consistent plans for risk management so that communities and businesses can make informed decisions about the management of the remaining risk;
- manage flood and coastal erosion risks in an appropriate way, taking account of the needs of communities and the environment;
- ensure that emergency plans and responses to flood incidents are effective and that communities are able to respond effectively to flood forecasts, warnings and advice;
- help communities to recover more quickly and effectively after incidents.

2.3 National Planning Policy and Guidance

The National Planning Policy Framework (NPPF)[4] was issued in 2012 to replace the previous documentation as part of reforms to make the planning system less complex and more accessible, and to protect the environment and promote sustainable growth. It replaces most of the Planning Policy Guidance Notes (PPGs) and Planning Policy Statements (PPSs) that were referred to in the previous version of the SFRA. The NPPF sets out the Government's requirements for the planning system and provides a framework within which local people and councils can produce distinctive local and neighbourhood plans to reflect the needs and properties of their communities. The NPPF must be taken into account by local planning authorities when preparing Local Plans and for applicants preparing planning submissions.

4 National Planning Policy Framework (Department for Communities and Local Government, March 2012)

National Planning Practice Guidance (NPPG) was published in 2014 and sets out how the NPPF should be implemented. NPPG: Flood Risk and Coastal Change advises on how planning can account for the risks associated with flooding and coastal change in plan making and the application process. It sets out Flood Zones, the appropriate land uses for each zone, flood risk assessment requirements, including the Sequential and Exception Tests and the policy aims for developers and authorities regarding each Flood Zone. Further details on Flood Zones and associated policy is provided in Table 3-1 and throughout this report. The Sequential and Exception tests are covered in greater detail in Section 3.

The Sequential Test

"The Sequential Test ensures that a sequential approach is followed to steer new development to areas with the lowest probability of flooding. The flood zones, as refined in the Strategic Flood Risk Assessment for the area, provide the basis for applying the Test. The aim is to steer new development to Flood Zone 1 (areas with a low probability of river or sea flooding). Where there are no reasonably available sites in Flood Zone 1, local planning authorities in their decision making should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2 (areas with a medium probability of river or sea flooding), applying the Exception Test if required. Only where there are no reasonably available sites in Flood Zones 1 or 2 should the suitability of sites in Flood Zone 3 (areas with a high probability of river or sea flooding) be considered, taking into account the flood risk vulnerability of land uses and applying the Exception Test if required".

(National Planning Practice Guidance, paragraph 019)

The Exception Test

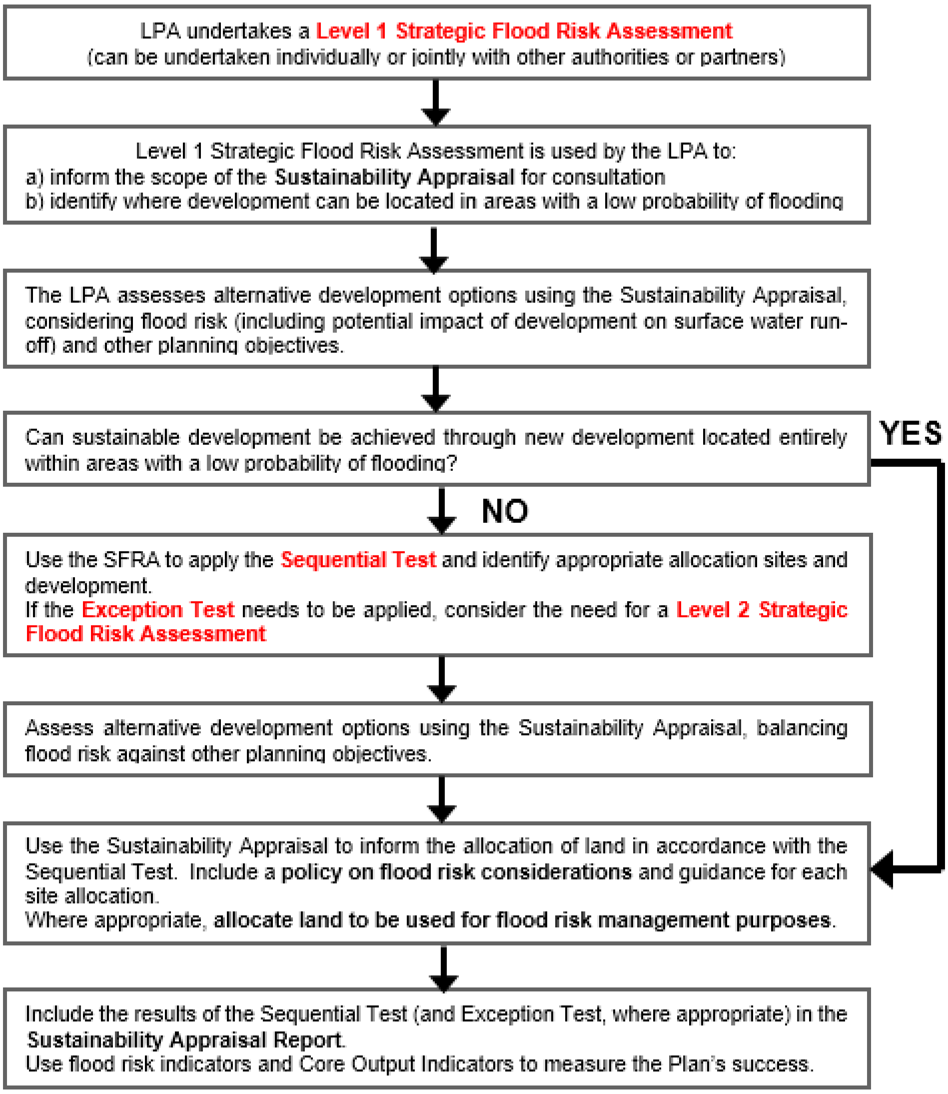
"The Exception Test, as set out in paragraph 102 of the NPPF, is a method to demonstrate and help ensure that flood risk to people and property will be managed satisfactorily, while allowing necessary development to go ahead in situations where suitable sites at lower risk of flooding are not available.

Essentially, the two parts to the Test require proposed development to show that it will provide wider sustainability benefits to the community that outweigh flood risk, and that it will be safe for its lifetime, without increasing flood risk elsewhere and where possible reduce flood risk overall.".

(National Planning Practice Guidance, paragraph 023)

A description of how flood risk should be taken into account in the preparation of Local Plans is outlined in Diagram 1 contained within the Planning Practice Guidance (Figure 2-2).

Figure 2-2: Flood risk and the preparation of Local Plans†



† Diagram 1 of NPPG: Flood Risk and Coastal Change (paragraph 004, Reference ID: 7-005-20140306) March 2014

2.4 Water Cycle Studies

Climate Change is predicted to present unprecedented new challenges, such as more frequent and extreme rainfall events and rising global temperatures, which are expected to exert greater pressure on the existing infrastructure. Planning for water management therefore has to take these potential challenges into account. A large number of new homes for instance may cause the existing water management infrastructure to be overwhelmed which would result in adverse effects on the environment, both locally and in wider catchments.

Water Cycle Studies assist Local Authorities to select and develop sustainable development allocations so that there is minimal impact on the environment, water quality, water resources, and infrastructure and flood risk. This can be achieved in areas where there may be conflict between any proposed development and the requirements of the environment through the recommendation of potential sustainable solutions.

A Water Cycle Study for Solihull Metropolitan Borough Council is being prepared in parallel to this SFRA.

2.5 Surface Water Management Plans

Surface Water Management Plans (SWMPs) outline the preferred surface water management strategy in a given location. SWMPs are undertaken by LLFAs in consultation with key local partners who are responsible for surface water management and drainage in their area. SWMPs establish a long-term action plan to manage surface water in a particular area and are intended to influence future capital investment, drainage maintenance, public engagement and understanding, land-use planning, emergency planning and future developments.

Solihull Metropolitan Borough Council is preparing a SWMP for the borough. The SWMP is likely to include recommendations regarding the management of surface water in the borough; once published, developers will be required to consult the SWMP, when preparing site-specific flood risk assessments. Any Critical Drainage Areas (CDAs) in the borough will also be identified as part of the SWMP.

2.6 Catchment Flood Management Plans

Catchment Flood Management Plans (CFMPs) are a high-level strategic plan providing an overview of flood risk across each river catchment. The Environment Agency use CFMPs to work with other key-decision makers to identify and agree long-term policies for sustainable flood risk management.

There are six pre-defined national policies provided in the CFMP guidance and these are applied to specific locations through the identification of 'Policy Units'. These policies are intended to cover the full range of long-term flood risk management options that can be applied to different locations in the catchment.

The six national policies are:

1. No active intervention (including flood warning and maintenance). Continue to monitor and advise.
2. Reducing existing flood risk management actions (accepting that flood risk will increase over time).
3. Continue with existing or alternative actions to manage flood risk at the current level (accepting that flood risk will increase over time from this baseline).
4. Take further action to sustain the current level of flood risk (responding to the potential increases in risk from urban development, land use change and climate change).
5. take action to reduce flood risk (now and/or in the future)
6. Take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment.

2.6.1 River Trent CFMP (2009)

The majority of the study area is covered by the River Trent CFMP[5]. The primary policy unit for Solihull is 'Sub Area 10'. The area is covered by Policy Option 5, which is for areas of moderate to high flood risk where the Environment Agency are generally taking further action to reduce flood risk. The proposed actions to implement this policy, applicable to the borough, are the following:

- Provide a more accurate and community focused flood warning service.
- Conclude River Tame flood risk management strategy.
- Reduce the incidence of foul water flooding by involving Severn Trent Water Ltd more in flood risk management.
- Investigate and promote opportunities to create green corridors along watercourses through Birmingham and the Black Country.
- Produce and implement an integrated urban drainage strategy.
- Identify locations where flood storage ponds or wetland areas could be developed within the urban areas, with associated habitat creation.
- Produce an integrated flood defence asset management strategy.

The upper reaches of ordinary watercourses in the far eastern part of the borough, flow into the Severn river basin; this is covered by the River Severn CFMP[6].

5 River Trent CFMP https://www.gov.uk/government/publications/river-trent-catchment-flood-management-plan
6 River Severn CFMP https://www.gov.uk/government/publications/river-severn-catchment-flood-management-plan

2.7 River Basin Management Plans

River Basin Management Plans (RBMPs) are prepared under the Water Framework Directive (WFD) and assess the pressure facing the water environment in River Basin Districts. The majority of the borough falls within the Humber river basin. The updated 2015 Humber RBMP[7]identified a number of pressures on the water environment and significant water management issues.

The RBMP describes how development and land-use planning needs to consider a number of issues relevant to the RBMP including Sustainable Drainage Systems, urban diffuse pollution, water efficiency measures, green and blue infrastructure, reducing the impact of pesticides, managing pollution from mine waters and sewage treatment options. The RBMP provides a summary of measures to protect and improve the water environment in the river basin district.

The upper reaches of ordinary watercourses in the far eastern part of the borough, flow into the Severn river basin; this is covered by the updated 2015 Severn RBMP[8].

2.8 Roles and responsibilities of Risk Management Authorities in Solihull Metropolitan Borough

The roles and responsibilities of Risk Management Authorities (RMAs) in Solihull Metropolitan Borough are summarised below.

2.8.1 Solihull Metropolitan Borough Council

As a Local Planning Authority, Solihull Metropolitan Borough Council assess, consult on and determine whether development proposals are acceptable, ensuring that flooding and other, similar, risks are effectively managed.

The council will consult relevant statutory consultees as part of planning application assessments and may, in some cases, also contact non-statutory consultees, such as Severn Trent Water, that have an interest in the planning application.

In addition to the Local Planning Authority role, Solihull Metropolitan Borough Council is also a LLFA. As a LLFA, Solihull Metropolitan Borough Council duties include:

- Local Flood Risk Management Strategy (LFRMS): LLFAs must develop, maintain, apply and monitor a LFRMS to outline how they will manage flood risk, identify areas vulnerable to flooding and target resources where they are needed most.
- Flood Investigations: When appropriate and necessary LLFAs must investigate and report on flooding incidents (Section 19 investigations).
- Register of Flood Risk Features: LLFAs must establish and maintain a register of structures or features which, in their opinion, are likely to have a significant effect on flood risk in the LLFA area.
- Designation of Features: LLFAs may exercise powers to designate structures and features that affect flood risk, requiring the owner to seek consent from the authority to alter, remove or replace it.
- Consenting: When appropriate LLFAs will perform consenting of works on ordinary watercourses.

Solihull Metropolitan Borough Council is also the Local Highway Authority and manages highway drainage, carrying out maintenance and improvement works on an on-going basis, as necessary, to maintain existing standards of flood protection for highways, making appropriate allowances for climate change. It also has the responsibility to ensure road projects to no increase flood risk.

2.8.2 Environment Agency

The Environment Agency is responsible for protecting and enhancing the environment and contributing to the government's aim of achieving sustainable development in England and Wales.

7 Humber River Basin Management Plan (2015) https://www.gov.uk/government/publications/humber-river-basin-district-river-basin-management-plan

8 Severn River Basin Management Plan (2015) https://www.gov.uk/government/publications/severn-river-basin-district-river-basin-management-plan

The Environment Agency has powers to work on Main Rivers to manage flood risk. These powers are permissive, which means they are not a duty, and they allow the Environment Agency to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on main rivers and the coast.

The EA also has powers to regulate and consent works to Main Rivers. Prior written consent is required from the Environment Agency for any work in, under, over or within nine metres of a Main River or between the high water line and the secondary line of defence e.g. earth embankment. The Environment Agency also has a strategic overview role across all types of flooding as well as other types of water management matters.

2.8.3 Water and wastewater providers

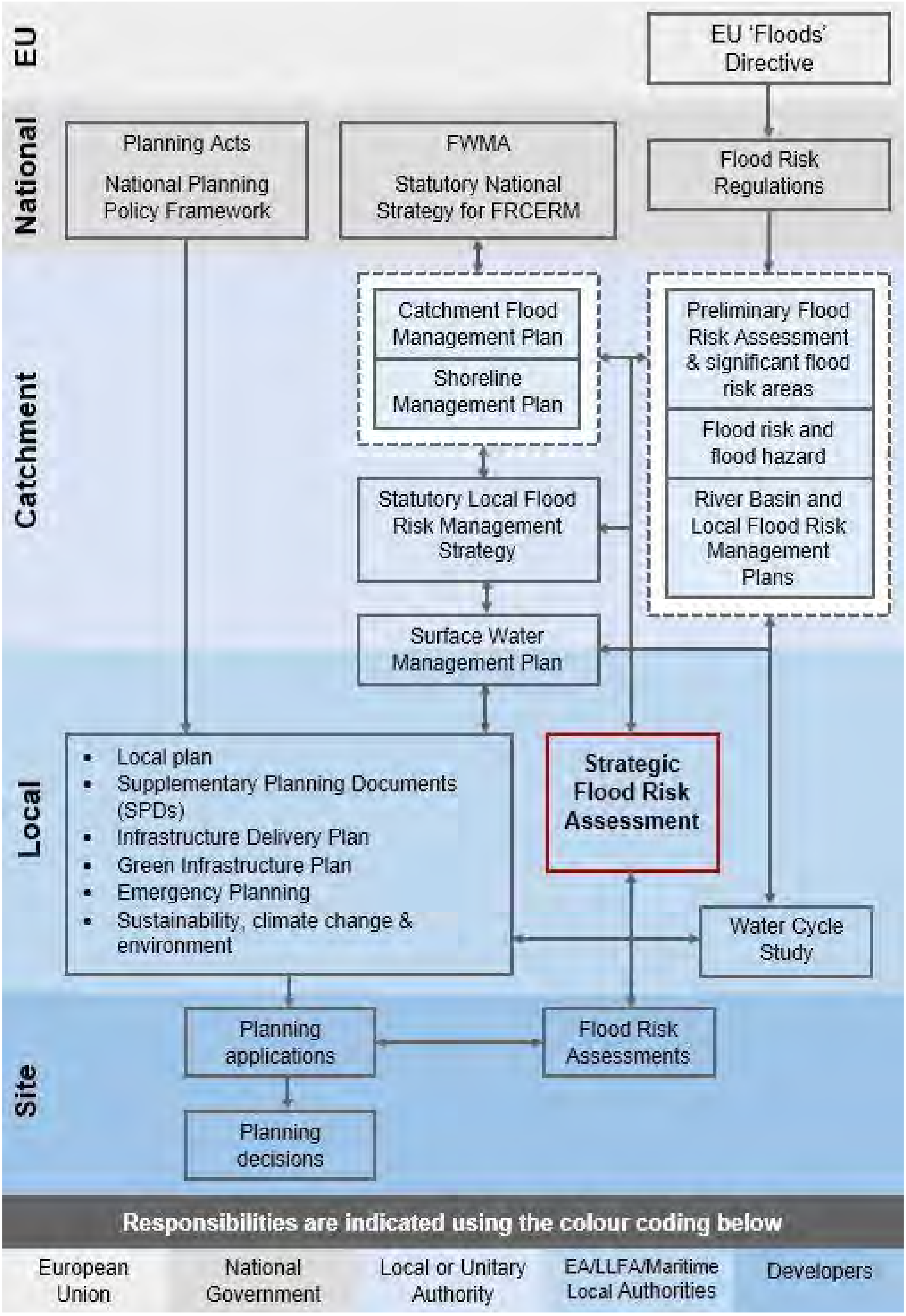
Severn Trent Water is the sewerage undertaker for Solihull Metropolitan Borough. They have the responsibility to maintain surface, foul and combined public sewers to ensure the area is effectively drained. When flows (foul or surface water) are proposed to enter public sewers, Severn Trent Water will assess whether the public system has the capacity to accept these flows as part of their pre-application service. If there is not available capacity, they will provide a solution that identifies the necessary mitigation. Severn Trent Water also comments on the available capacity of foul and surface water sewers as part of the planning application process. Further information can be found on their website.

Consent, prior to commencing work, is required from the relevant provider if installing water systems, or altering existing systems, is intended.

2.9 Key strategic planning links

Figure 2-3 outlines the key strategic planning links for flood risk management and associated documents. It shows how the Flood Risk Regulations and Flood and Water Management Act, have introduced a wider requirement for the mutual exchange of information and the preparation of strategies and management plans.

Figure 2-3: Strategic planning links and key documents for flood risk



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3 The sequential, risk-based approach

3.1 The sequential, risk-based approach

This approach is designed to ensure areas with little or no risk of flooding (from any source) are developed in preference to areas at higher risk, with the aim of keeping development outside of medium and high flood risk areas (Flood Zones 2 and 3) and other sources of flooding, where possible.

When drawing up a local plan, it is often the case that it is not possible for all new development to be allocated on land that is not at risk from flooding. In these circumstances the Flood Zone maps (that show the extent of inundation assuming that there are no defences) are too simplistic and a greater understanding of the scale and nature of the flood risks is required

3.1.1 Flood Zones

Table 1 of NPPG Flood Risk and Coastal Change identifies the following Flood Zones. These apply to both Main River and ordinary watercourses. Flood risk vulnerability and flood zone compatibility is set out in Table 3 of the NPPG. Table 3-1 summarises this information and also provides information on when an FRA would be required.

Table 3-1: Flood Zone descriptions

Zone	Probability	Description
Zone 1	Low	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%).
		All land uses are appropriate in this zone.
		For development proposals on sites comprising one hectare or above the vulnerability to flooding from other sources as well as from river and sea flooding, and the potential to increase flood risk elsewhere through the addition of hard surfaces and the effect of the new development on surface water run-off, should be incorporated in a flood risk assessment.
Zone 2	Medium	This zone comprises land assessed as having between a 1 in 100 and 1 in 1,000 annual probability of river flooding (0.1% - 1%) or between 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.1% – 0.5%) in any year.
		Essential infrastructure, water compatible infrastructure, less vulnerable and more vulnerable land uses (as set out by NPPF) are appropriate in this zone. Highly vulnerable land uses are allowed as long as they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3a	High	This zone comprises land assessed as having a greater than 1 in 100 annual probability of river flooding (>1.0%) or a greater than 1 in 200 annual probability of flooding from the sea (>0.5%) in any year. Developers and the local authorities should seek to reduce the overall level of flood risk, relocating development sequentially to areas of lower flood risk and attempting to restore the floodplain and make open space available for flood storage.
		Water compatible and less vulnerable land uses are permitted in this zone. Highly vulnerable land uses are not permitted. More vulnerable and essential infrastructure are only permitted if they pass the Exception Test.
		All developments in this zone require an FRA.
Zone 3b	Functional Floodplain	This zone comprises land where water has to flow or be stored in times of flood. Local planning authorities should identify, in their SFRA, areas of functional floodplain, in agreement with the Environment Agency. The identification of functional floodplain should take account of local circumstances.
		Only water compatible and essential infrastructure are permitted in this zone and should be designed to remain operational in times of flood, resulting in no loss of floodplain or blocking of water flow routes. They must also be safe for users and not increase flood risk elsewhere. Essential Infrastructure will only be permitted if it passes the Exception Test.
		All developments in this zone require an FRA.

3.1.2 Surface water flood risk information

In 2016, the Environment Agency, working with LLFAs, produced the Risk of Flooding from Surface Water (RoFfSW) dataset. This superseded the previous Flood Map for Surface Water and Areas Susceptible to Surface Water Flooding maps. The RoFfSW is a national scale map and assesses flooding scenarios as a result of rainfall with the following chance of occurring in any given year. It is intended to provide a consistent standard of assessment for surface water flood risk across England and Wales in order to help LLFAs, the Environment Agency and any potential developers to focus their management of surface water flood risk.

The RoFfSW is derived primarily from identifying topographical flow paths of existing watercourses or dry valleys that contain some isolated ponding locations in low lying areas. They provide a map which displays different levels of surface water flood risk depending on the annual probability of the land in question being inundated by surface water (Table 3-2).

Table 3-2: RoFfSW risk categories

Risk	Definition
High	Probability of flooding greater than 1 in 30 (3.3%) each year.
Medium	Probability of flooding between 1 in 100 (0.1%) and 1 in 30 (3.3%) each year.
Low	Probability of flooding between 1 in 1,000 (0.1%) and 1 in 100 (1%) each year.
Very Low	Probability of flooding of less than 1 in 1,000 (0.1%) each year

Although the RoFfSW offers improvement on previously available datasets, the results should not be used to understand flood risk for individual properties. The results should be used for high level assessments such as SFRAs for local authorities. If a particular site is indicated in the Environment Agency mapping to be at risk from surface water flooding, a more detailed assessment should be considered to more accurately illustrate the flood risk at a site specific scale. Such an assessment will use the RoFfSW in partnership with other sources of local flooding information to confirm the presence of a surface water risk at that particular location.

The surface water map is available via the Long term flood risk information page on the government's website, and is also provided in Appendix A of this SFRA. In addition to showing the extent of surface water flooding, there are depth and velocity maps for each risk category. These maps should be used when considering other sources of flooding when applying the Sequential and Exception tests.

3.2 Applying the Sequential Test and Exception Test in the preparation of a Local Plan

When preparing a local plan, the local planning authority should demonstrate it has considered a range of site allocations, using SFRAs to apply the Sequential and Exception Tests where necessary.

The Sequential Test should be applied to the whole local planning authority area to increase the likelihood of allocating development in areas not at risk of flooding. It is recommended that the Council considers using the SFRA climate change maps when applying the Sequential Test for site allocations and windfall sites. The Sequential Test can be undertaken as part of a local plan sustainability appraisal. Alternatively, it can be demonstrated through a free-standing document, or as part of strategic housing land or employment land availability assessments. NPPG for Flood Risk and Coastal Change describes how the Sequential Test should be applied in the preparation of a local plan (Figure 3-1).

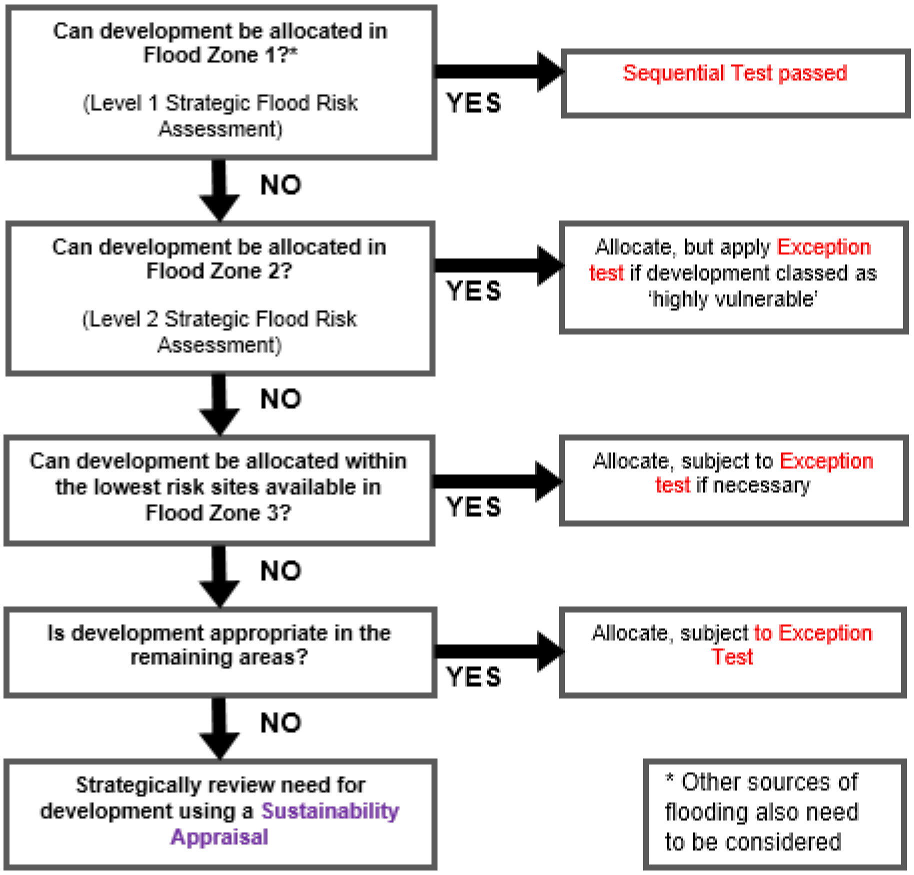

Figure 3-1: Applying the Sequential Test in the preparation of a local plan

The Exception Test should only be applied following the application of the Sequential Test and as set out in Table 3 of the NPPG Flood Risk and Coastal Change. The NPPG describes how the Exception Test should be applied in the preparation of a Local Plan

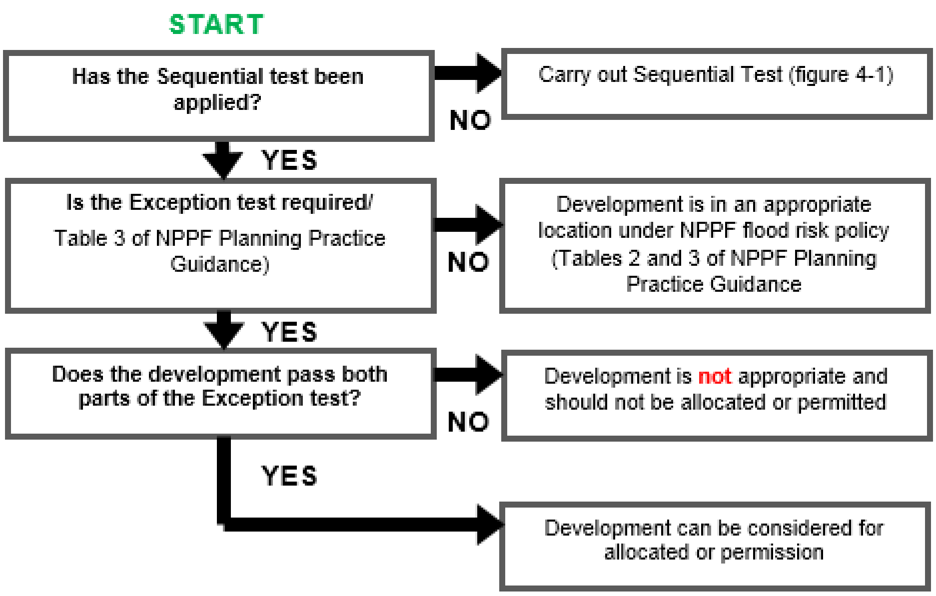

Figure 3-2: Applying the Exception Test in the preparation of a local plan

3.3 Applying the Sequential Test and Exception Test to individual planning applications

3.3.1 Sequential Test

Local circumstances must be used to define the area of application of the Sequential Test (within which it is appropriate to identify reasonably available alternatives). The criteria used to determine the appropriate search area relate to the catchment area for the type of development being proposed. For some sites this may be clear, in other cases it may be identified by other local plan policies. A pragmatic approach should be taken when applying the Sequential Test.

Solihull Metropolitan Borough Council, with advice from the Environment Agency, are responsible for considering the extent to which Sequential Test considerations have been satisfied, and will need to be satisfied that the proposed development would be safe and not lead to increased flood risk elsewhere.

The Sequential Test does not need to be applied for individual developments under the following circumstances:

- The site has been identified in development plans through the Sequential Test
- Applications for minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site)

It is normally reasonable to presume and state that individual sites that lie in Zone 1 satisfy the requirements of the Sequential Test. However, consideration should be given to risks from all sources, areas with critical drainage problems and critical drainage areas.

3.3.2 Exception Text

If, following application of the Sequential Test it is not possible for the development to be located in areas with a lower probability of flooding the Exception Test must then be applied if deemed appropriate. The aim of the Exception Test is to ensure that more vulnerable uses, such as residential development can be implemented safely and are not located in areas where the hazards and consequences of flooding are inappropriate. For the test to be satisfied, the following two elements have to be accepted for development to be allocated or permitted:

1. It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA where one has been prepared.

   Local Planning Authorities will need to consider what criteria they will use to assess whether this part of the Exception Test has been satisfied, and give advice to enable applicants to provide evidence to demonstrate that it has been passed. If the application fails to prove this, the Local Planning Authority should consider whether the use of planning conditions and / or planning obligations could allow it to pass. If this is not possible, this part of the Exception Test has not been passed and planning permission should be refused[9].

2. A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime, taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall.

   The site-specific Flood Risk Assessment should demonstrate that the site will be safe and the people will not be exposed to hazardous flooding from any source. The following should be considered[10]:

   - The design of any flood defence infrastructure
   - Access and egress
   - Operation and maintenance
   - Design of the development to manage and reduce flood risk wherever possible
   - Resident awareness

9 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 037, Reference ID: 7-056-20140306) March 2014
10 NPPF Planning Practice Guidance: Flood Risk and Coastal Change (paragraph 038, Reference ID: 7-056-20140306) March 2014

- Flood warning and evacuation procedures
- Any funding arrangements required for implementing measures

The NPPG provides detailed information on how the Test can be applied

3.4 Actual flood risk

If it has not been possible for all future development to be situated in Zone 1 then a more detailed assessment is needed to understand the implications of locating proposed development in Zones 2 or 3. This is accomplished by considering information on the "actual risk" of flooding. The assessment of actual risk takes account of the presence of flood defences and provides a picture of the safety of existing and proposed development. It should be understood that the standard of protection afforded by flood defences is not constant and it is presumed that the required minimum standards for new development are:

- residential development should be protected against flooding with an annual probability of river flooding of 1% (1 in 100-year chance of flooding) in any year; and
- residential development should be protected against flooding with an annual probability of tidal (sea) flooding of 0.5% (1 in 200-year chance of flooding) in any year.

The assessment of the actual risk should take the following issues into account:

- The level of protection afforded by existing defences might be less than the appropriate standards and hence may need to be improved if further growth is contemplated
- The flood risk management policy for the defences will provide information on the level of future commitment to maintain existing standards of protection. If there is a conflict between the proposed level of commitment and the future needs to support growth, then it will be a priority for the Flood Risk Management Strategy to be reviewed
- The standard of safety must be maintained for the intended lifetime of the development. Over time the effects of climate change may reduce the standard of protection afforded by defences, due to increased river flows and levels, and so commitment is needed to invest in the maintenance and upgrade of defences if the present day levels of protection are to be maintained and where necessary land secured that is required for affordable future flood risk management measures
- The assessment of actual risk can include consideration of the magnitude of the hazard posed by flooding. By understanding the depth, velocity, speed of onset and rate of rise of floodwater it is possible to assess the level of hazard posed by flood events from the respective sources. This assessment will be needed in circumstances where a) the consequences of flooding need to be mitigated or b) where it is proposed to place lower vulnerability development in areas of flood risk.

3.5 Residual flood risk

Residual risk refers to the risks that remain after measures have been taken to alleviate flooding (such as flood defences). It is important that these risks are quantified to confirm that the consequences can be safely managed. The residual risk can be

- the effects of a flood with a magnitude greater than that for which the defences or management measures have been designed to alleviate (the 'design flood'). This can result in overtopping of flood banks, failure of flood gates to cope with the level of flow or failure of pumping systems to cope with the incoming discharges; and/or
- failure of the defences or flood risk management measures to perform their intended duty. This could be breach failure of flood embankments, failure of flood gates to operate in the intended manner, or failure of pumping stations.

The Environment Agency AIMS database identified no formal, raised, flood defences within Solihull Metropolitan Borough and, therefore, no further assessment of flood defences and residual risk was required.

However, there is still potential residual risk in the borough from reservoirs and canals. The residual risk from these sources is discussed further in Section 6.

3.6 Impact of additional development on flood risk

When allocating land for development, consideration must be given to the potential cumulative impact of development on flood risk. The increase in impermeable surfaces and resulting increase in runoff increases the chances of surface water flooding if suitable mitigation measures, such as SuDS, are not put in place. Additionally, the increase in runoff may result in more flow entering watercourses, increasing the risk of fluvial flooding downstream.

Consideration must also be given to the potential cumulative impact of the loss of floodplain as a result of development. The effect of the loss of floodplain storage should be assessed, at both the development and elsewhere within the catchment and, if required, the scale and scope of appropriate mitigation should be identified.

Whilst the increase in runoff, or loss in floodplain storage, from individual developments may only have a minimal impact on flood risk, the cumulative effect of multiple developments may be more severe without appropriate mitigation measures.

The cumulative impact of development should be considered at the planning application and development design stages and the appropriate mitigation measures undertaken to ensure flood risk is not exacerbated, and in many cases the development should be used to improve the flood risk.

4 Climate change

4.1 Climate change and the NPPF

The NPPF sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and NPPG describe how FRAs should demonstrate how flood risk will be managed over the lifetime of the development, taking climate change into account.

4.2 Revised climate change guidance

The Environment Agency published updated climate change guidance on 19 February 2016, which supports the NPPF and must now be considered in all new developments and planning applications. The document contains guidance on how climate change should be taken into account when considering development, specifically how allowances for climate change should be included with FRAs. The Environment Agency can give a free preliminary opinion to applicants on their proposals at pre-application stage. There is a charge for more detailed pre-application planning advice.

4.3 Climate change allowances

By making an allowance for climate change it will help reduce the vulnerability of the development and provide resilience to flooding in the future.

The 2016 climate change guidance includes climate change predictions of anticipated change for peak river flow and peak rainfall intensity. There allowances are based on climate change projections and difference scenarios of carbon dioxide emissions to the atmosphere.

Due to the complexity of projecting climate change, there are uncertainties attributed to climate change allowances. As a result, the guidance presents a range of possibilities to reflect the potential variation in climate change impacts over three periods.

4.4 Peak river flows

Climate change is expected to increase the frequency, extent and impact of flooding, reflected in peak river flows. Wetter winters and more intense rainfall may increase fluvial flooding and surface water runoff and there may be increased storm intensity in summer. Rising river levels may also increase flood risk.

The peak river flow allowances provided in the guidance show the anticipated changes to peak flow for the river basin district within which the subject watercourse is located. Once the river basin district has been identified, guidance on uplift in peak flows are provided for three allowance categories, Central, Higher Central and Upper End which are based on the 50th, 70th and 90th percentiles respectively. The allowance category to be used is based on the vulnerability classification of the development and the flood zones within which it is located.

These allowances (increases) are provided, in the form of figures for the total potential changed anticipated, for three climate change periods:

- The ‘2020s’ (2015 to 2039)
- The ‘2050s’ (2040 to 2069)
- The ‘2080s’ (2070 to 2115)

The time period used in the assessment depends upon the expected lifetime of the proposed development. Residential development should be considered for a minimum of 100 years, whilst the lifetime of a non-residential development depends upon the characteristics of that development. Further information on what is considered to be the lifetime of development is provided in the NPPG.

The allowances for the Humber River Basin District are provided in Table 4-1.

Table 4-1: Peak river flow allowances for the Humber river basin district

Allowance category	Total potential change anticipated for '2020s' (2015 to 39)	Total potential change anticipated for '2050s' (2040 to 2069)	Total potential change anticipated for '2080s' (2070 to 2115)
Upper end	20%	30%	50%
Higher central	15%	20%	30%
Central	10%	15%	20%

The upper reaches of ordinary watercourses in the far eastern part of the borough, flow into the Severn river basin; the allowances for the Severn River Basin District should be used in this area.

4.4.1 High++ allowances

High++ allowances only apply in assessments for developments that are very sensitive to flood risk, for example large scale energy generating infrastructure, and that have lifetimes beyond the end of the century. H++ estimates represent the upper limit of plausible climate projections and would not normally be expected for schemes of plans to be designed to or incorporate resilience for the H++ estimate. Further information is provided in the Environment Agency publication, Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.

4.4.2 Which peak river flow allowance to use?

The flood zone and flood risk vulnerability classification should be considered when deciding which allowances apply to the development or the plan. Vulnerability classifications are found in the NPPG. The guidance states the following:

Flood Zone 2

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure		✓	✓
Highly vulnerable		✓	✓
More vulnerable	✓	✓	
Less vulnerable	✓		
Water compatible	None		

Flood Zone 3a

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable		✓	✓
Less vulnerable	✓	✓	
Water compatible	✓		

Flood Zone 3b

Vulnerability classification	Central	Higher Central	Upper end
Essential infrastructure			✓
Highly vulnerable	Development not permitted		
More vulnerable			
Less vulnerable			
Water compatible	✓		

4.5 Peak rainfall intensities

Climate change is predicted to result in wetter winters and increased summer storm intensity in the future. This increased rainfall intensity will affect land and urban drainage systems, resulting in surface water flooding, due to the increased volume of water entering the systems. The table below shows anticipated changes in extreme rainfall intensity in small and urban catchments. These allowances should be used for small catchments and urban drainage sites. For catchments, larger than 5km², the guidance suggests the peak river flow allowances should be used.

For flood risk assessments, both the central and upper end allowances should be assessed to understand the range of impact.

Table 4-2: Peak rainfall intensity allowance in small and urban catchments

Applies across all of England	Total potential change anticipated for 2010 to 2039	Total potential change anticipated for 2040 to 2059	Total potential change anticipated for 2060 to 2115
Upper end	10%	20%	40%
Central	5%	10%	20%

4.6 Using climate change allowances

To help decide which allowances to use to inform the flood levels that the flood risk management strategy will be based on for a development or development plan allocation, the following should be considered:

- likely depth, speed and extent of flooding for each allowance of climate change over time considering the allowances for the relevant epoch (2020s, 2050s and 2080s)
- vulnerability of the proposed development types or land use allocations to flooding
- 'built in' resilience measures used, for example, raised floor levels
- capacity or space in the development to include additional resilience measures in the future, using a 'managed adaptive' approach

4.7 Groundwater

The effect of climate change on groundwater flooding problems, and those watercourses where groundwater has a large influence on winter flood flows, is more uncertain. Milder wetter winters may increase the frequency of groundwater flooding incidents in areas that are already susceptible, but warmer drier summers may counteract this effect by drawing down groundwater levels to a greater extent during the summer months.

4.8 The impact of climate change in Solihull Metropolitan Borough

Climate change modelling for the watercourses in Solihull has been undertaken based on the new climate change guidance. Existing Environment Agency hydraulic models have been run for the 2080s period for all three allowance categories. As part of this SFRA, additional 2D modelling, using Jflow+, was undertaken for those watercourses where no detailed hydraulic models exist but the watercourse is shown in the Environment Agency Flood Zone mapping.

The Flood Zone 2 extent is comparatively similar to the 100-year plus 20% allowance for climate change across Solihull. Due to the nature of the topography, the flood zones are largely confined and subsequently, the flood extent is not significantly different when a 20% or 30% or 50% allowance for climate change is used. Whilst the flood extent may not increase significantly, the flood depth and hazard may in areas where the floodplain is more constrained. The Hatchford Brook, Low Brook and Kingshurst Brook appear to be more sensitive to increases in the climate change allowances used.

The climate change modelling indicates where areas currently shown to be in Flood Zone 1, may be affected by climate change. These include, but are not limited to:

- Residential areas around the vicinity of Conway Road and Chelmsley Road in Solihull town, near the Kingshurst Brook
- Residential areas around the vicinity of Cambridge Drive, Liverpool Croft and Holly Lane in Marston Green, near the Kingshurst and Low Brooks
- Residential areas around the vicinity of Brook Croft in Marston Green, near the Low Brook
- Upper reaches of the Low Brook, around the vicinity of Birmingham International Airport
- Commercial and residential areas along Station Road and Truggist Lane in Balsall Common, near an un-named watercourse
- Residential areas around the vicinity of Riverside Drive in Solihull town, near the River Blythe
- Residential and commercial areas around the vicinity of the Prince's Way roundabout, including Alderwood Place, Prince's Way and Church Hill Road in Solihull town, near an un-named watercourse
- Residential and commercial areas around the vicinity of Cheswick Way and Willow Drive in Cheswick Green, near the Mount Brook and River Blythe
- Residential areas around the vicinity of Corley Close, Eversleigh Crescent, Colebrook Road and Nethercote Gardens in Shirley, near the River Cole.

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5 Sources of information used in preparing the SFRA

5.1 Summary of SFRA mapping for all sources of flood risk

5.1.1 Fluvial

The data used to prepare the fluvial mapping for this study is based on Flood Zones and the results from hydraulic models either provided by the Environment Agency or prepared for the purposes of this SFRA. Hydraulic models used include:

- River Blythe
- River Cole
- Cheswick Green.

5.1.2 Surface Water

Mapping of surface water flood risk in Solihull Metropolitan Borough Council has been taken from the Risk of Flooding from Surface Water (RoFfSW) published online by the Environment Agency.

5.1.3 Groundwater

Mapping of groundwater flood risk has been based on the Areas Susceptible to Groundwater (AStGWF) dataset. The AStGWF dataset is a strategic-scale map showing groundwater flood areas on a 1km square grid. It shows the proportion of each 1km grid square, where geological and hydrogeological conditions indicate that groundwater might emerge. It does not show the likelihood of groundwater flooding occurring and does not take account of the chance of flooding from groundwater rebound. This dataset covers a large area of land, and only isolated locations within the overall susceptible area are actually likely to suffer the consequences of groundwater flooding.

The AStGWF data should be used only in combination with other information, for example local data or historical data. It should not be used as sole evidence for any specific flood risk management, land use planning or other decisions at any scale. However, the data can help to identify areas for assessment at a local scale where finer resolution datasets exist.

5.1.4 Sewers

Historical incidents of flooding are detailed by Severn Trent Water through their HFRR register. The HFRR database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding.

5.1.5 Canals

Historical incidents of over-topping or a breach of canals in the borough, is stored by the Canal and Rivers Trust.

5.1.6 Reservoirs

The risk of inundation as a result of reservoir breach or failure of a number of reservoirs within the area has been mapped using the outlines produced as part of the National Inundation Reservoir Mapping (NIRIM) study.

5.1.7 Suite of Maps

All of the mapping can be found in the appendices to this SFRA and is presented in the following structure:

- Appendix A: Mapping of all sources of flood risk across the borough. These are a series of interactive maps that show all sources of flooding in Solihull Metropolitan Borough, as well as other supporting map layers.

  Clicking on a grid square in the Index Map will open a separate interactive PDF map that has options for turning on and off the map layers of interest.
- Appendix B: Environment Agency Flood Warning coverage

5.2 Other relevant flood risk information

Users of this SFRA should also refer to other relevant information on flood risk where available and appropriate. This information includes:

- River Trent Catchment Flood Management Plan (2009) and River Severn Catchment Flood Management Plan (2009)
- Solihull Metropolitan Borough Council Local Flood Risk Management Strategy (2015)
- Solihull Metropolitan Borough Council Surface Water Management Plan (once published)
- Solihull Metropolitan Borough Council Water Cycle Study (once published)
- Humber Flood Risk Management Plan (March 2016) and Severn Flood Risk Management Plan (March 2016)
- Environment Agency's Asset Information Management System (AIMS) – users should note that recently completed schemes may not yet be included in this dataset. Provides information on assets in the area. Can be used to identify where residual risk should be assessed.

6 Understanding flood risk in Solihull Metropolitan Borough

6.1 Historic flooding

Solihull Metropolitan Borough has a history of documented flood events with the main source being from 'fluvial' sources i.e. Main Rivers including the River Cole and River Blythe. However, information from the council indicates the blockages of undersized culverts have also been an issue throughout the borough.

The main historical fluvial flood event took place in July 2007 where over 20 houses were flooded in Nethercote Gardens and Cheswick Green. The estimated return period for this event was 1 in 75-year, for both the River Cole and the River Blythe. It is noted that the flooding along the River Blythe was exacerbated due to localised surface water and ordinary watercourse flooding.

Solihull News reported on a surface water flash flood event in Solihull town, in June 2012, which caused external flooding to many properties.

Rail services were disrupted by flooding in Hampton in Arden and 10 properties were flooded in Dickens Heath, in November 2012. The incident was suspected to be caused by a blockage of a culvert inlet which has since had works undertaken to reduce the risk of a blockage reoccurring here. Multiple properties in the village of Meridan also flooded during this event due to high sediment loads blocking a trash screen.

Data was provided for this SFRA from Solihull Metropolitan Borough Council, as LLFA. The supplied database recorded over 200 incidences of property flooding grouped into distinct flood events

- September 2016 had one incidence of internal flooding and seven incidences of external flooding, four of which were confirmed to be from fluvial sources.
- June 2016 had 45 incidences of flooding spread across northern and western parts of the borough but gave no detail on the source or extent of flooding.
- 119 records of flooding were recorded on 01/09/2015 of which 68 were noted to be internal flooding. There were also 18 records of external flooding, including garages, gardens highways and driveways; two of these incidences were confirmed to be flooding from surface water sources.
- A single incidence of flooding was recorded on 06/02/2016.

6.2 Topography, geology and soils

The topography, geology and soil are all important in influencing the way the catchment responds to a rainfall event. The degree to which a material allows water to percolate through it, the permeability, affects the extent of overland flow and therefore the amount of run-off reaching the watercourse. Steep slopes or clay rich (low permeability) soils will promote rapid surface runoff, whereas more permeable rock such as limestone and sandstone may result in a more subdued response.

6.2.1 Topography

The topography of the study area can be seen in Figure 6-1 and is primarily comprised of higher elevations in the north east and south west with lower lying areas in the central and northern areas of the borough. In the north east, elevations reach approximate 180 metres Above Ordnance Datum (m AOD) with steep gradient slopes to central areas where the lowest elevations can be found in the vicinity of Hampton in Arden. The north of the borough is defined by relatively lower, flatter topography. West of the River Blythe, elevations gradually rise in a south westerly direction towards Dickens Heath, over Solihull and Dorridge.

6.2.2 Geology and soils

The geology of the catchment can be an important influencing factor on the way that water runs off the ground surface. This is primarily due to variations in the permeability of the surface material and bedrock stratigraphy.

Figure 6-2 shows the bedrock (solid permeable) formations in the borough and Figure 6-3 shows the superficial (permeable, unconsolidated (loose) deposits). These are classified as the following:

- Principal: layers of rock or drift deposits with high permeability and, therefore, provide a high level of water storage
- Secondary A: rock layers or drift deposits capable of supporting water supplies at a local level and, in some cases, forming an important source of base flow to rivers
- Secondary B: lower permeability layers of rock or drift deposits which may store and yield limited amounts of groundwater
- Secondary (undifferentiated): rock types where it is not possible to attribute either category a or b.
- Unproductive Strata: rock layers and drift deposits with low permeability and therefore have negligible significant for water supply or river base flow.

The bedrock in the borough is predominately Secondary B, associated with mudstone, siltstone and sandstone. These bedrocks have lower permeability which have minimal interaction with groundwater and often produce high levels of runoff. In central areas where there are lower elevations, outcrops of Secondary A superficial deposits overlay the bedrock. Outcrops of Secondary A bedrock can also be found in the southern part of the borough. To the east, there is a large area of principle bedrock, which provide high levels of permeability and water storage. The high ground to the east and west are overlaid with a mixture of Secondary (undifferentiated) and unproductive superficial strata.

The underlying geology and aquifer designation also has implications for what sustainable drainage solutions may be suitable for a site. For example, infiltration SuDS will be dependent on the permeability of the underlying deposits. Further information on geology can be found via the British Geological Society's Geology of Britain website.

The British Geological Society have also produced an Infiltration SuDS map which gives a preliminary indication of the suitability of the ground for infiltration SuDS

Figure 6-1: Solihull Topography

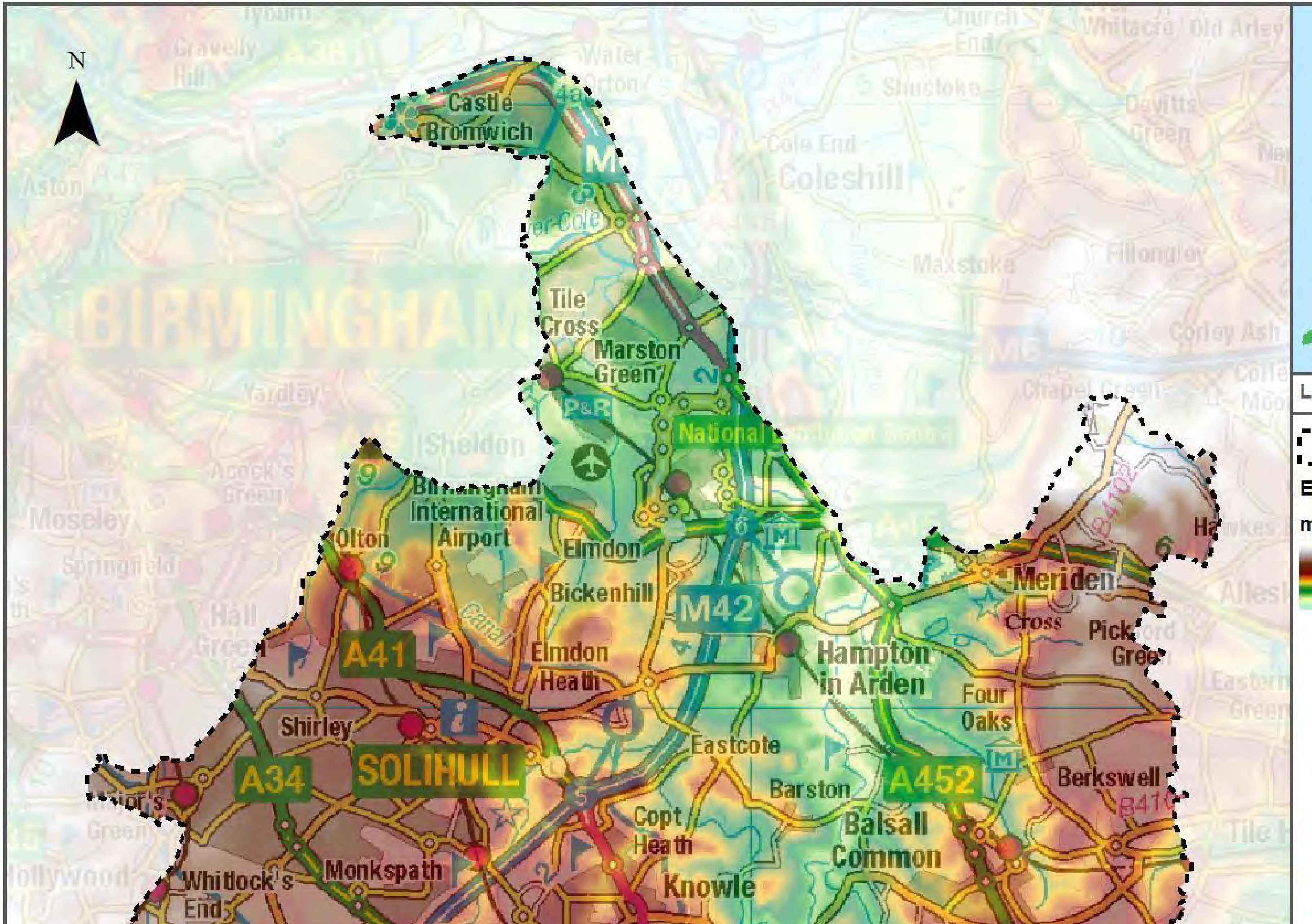

Figure 6-2: Bedrock aquifer classification in the Solihull Metropolitan Borough

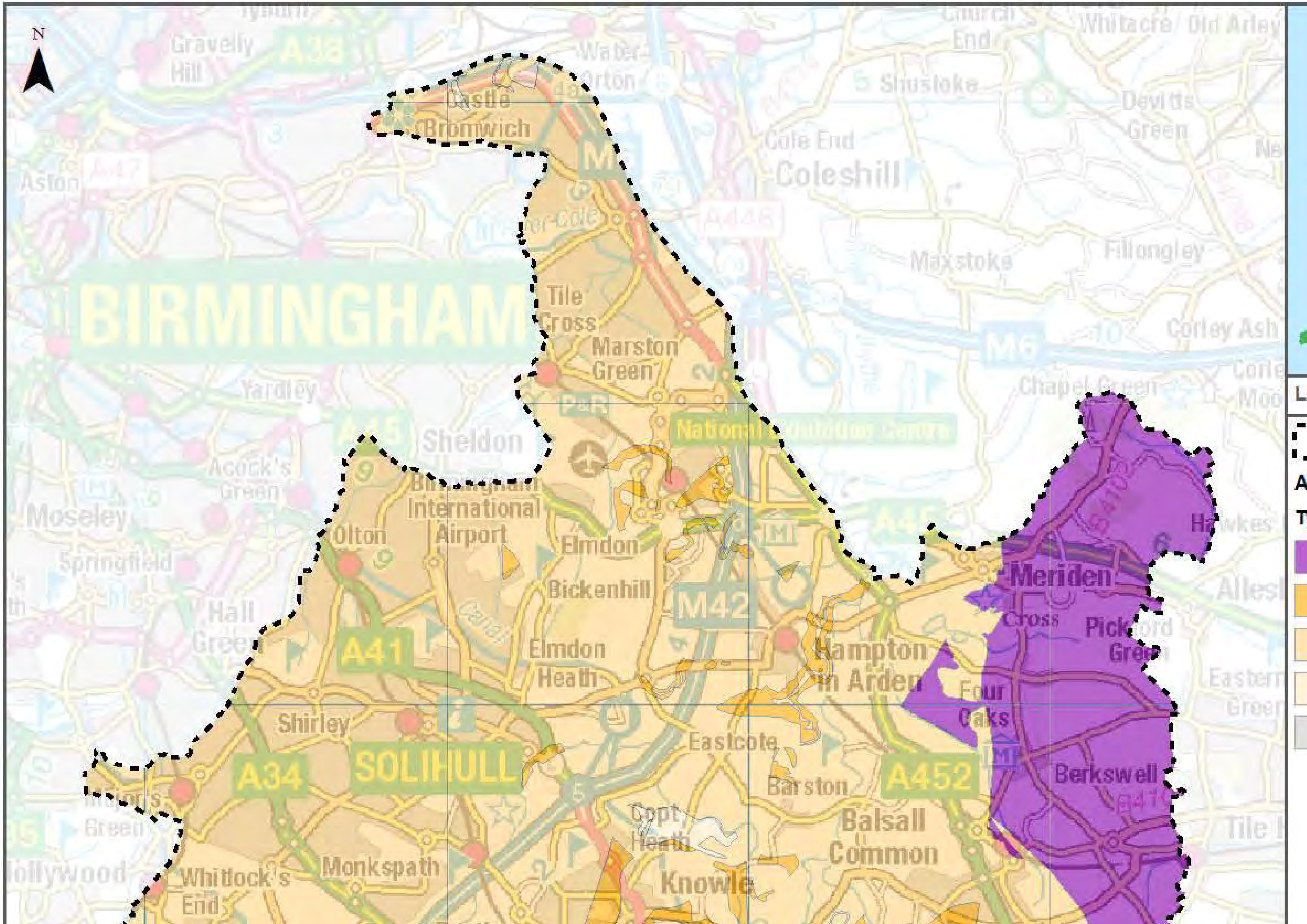

Figure 6-3: Superficial aquifer classification in the Solihull Metropolitan Borough

6.2.3 Hydrology

The principle watercourses flowing through the SFRA area are the River Blythe and its tributaries including the River Cole. Tributaries of these watercourses include other Main Rivers as well as smaller Ordinary Watercourses. A summary of the principal watercourses in the SFRA is provided in Table 6-1. Mapping indicating the location of the principal watercourses can be found in Appendix A.

Table 6-1: Watercourses in the study area

Watercourse	Classification	Description
Alder Brook	Main River	A 2.9km long tributary of the River Blythe flowing east through Solihull to its confluence with the River Blythe west of junction five of the M42.
Cuttle Brook	Ordinary watercourse	A tributary of the River Blythe that flows in an easterly direction for 3.8km, through predominately rural land, from Dorridge close to the southern boundary.
Hatchford Brook	Main River	Originating from the Olton Reservoir in Kineton Green, Solihull, the Hatchford Brook flows in a northerly direction to the A45 and the borough boundary. Here it leaves the borough boundary for 1.5km and re-enters north of the Sheldon Golf course. The Hatchford Brook then flows along north western boundary until Alocott Wood in Marston Green where it merges with Kingshurst Brook.
Hollywell Brook	Main River / Ordinary watercourse	Flowing from Pendigo Lake, the Hollywell Brook is classed as ordinary watercourse until it passes under the M42. From here, it is classed as Main River and flows in an easterly direction until its confluence with the River Blythe.
Kingshurst Brook	Main River	A short 1.4km stretch of Main River flowing in a north easterly direction, after the confluence of the Hatchford Brook and low Brook, to its confluence with the River Cole between Chelmsley Wood and Fordbridge.
Low Brook	Main River / Ordinary watercourse	Low Brook rises east of Elmdon Heath as an ordinary watercourse, flowing northerly through rural land until it passes culverted under the A45. It emerges classified as a Main River and continues north passed Marston Green until its confluence with the Kingshurst Brook.
Mount Brook	Main River	A tributary of the River Blythe, the Mount Brook flows for 1.7km from Tamworth Lane to its confluence with the River Blythe south west of Cheswick Green
Pickford Brook	Ordinary watercourse	A tributary of the River Sherbourne (located out of the borough boundary), the Pickford Brook rises north of Hollyberry End and flows in a southerly direction for 2.9km along the borough boundary until Harvest Hill where is leaves the borough.
Purnell's Brook	Main River / Ordinary watercourse	The Purnell's Brook is classed as ordinary watercourse for 0.6km from its source in Knowle in Dorridge. After passing under Longdon Road it is classified as a Main River, flowing in a north easterly direction until its confluence with the River Blythe 2.1km downstream.
River Blythe	Main River	The River Blythe enters the borough, north of Earlswood and Earlswood Lakes and flows in a north easterly direction along the eastern extent of Cheswick Green, Hillfield and Solihull's, Lode Heath. After crossing the M42, it flows south east towards Temple Balsall. At Temple Balsall, it turns to flow northwards, through predominately rural land towards the A45/A452 roundabout in the north of the borough.

Watercourse	Classification	Description
River Cole	Main River	The River Cole rises in the Bromsgrove district and flows along the south west boundary of the borough. At Solihull Lodge, it enters the borough for a short distance, before leaving the borough and entering Birmingham. Here, it continues to flow in a predominantly north easterly direction until Stechford Bridge, where it flows in an easterly direction and re-enters, at the northern part of the borough, around Kinghurst and Fordbridge. Flowing for 3.3km it then leaves the borough, at the junction with the M6. The River Cole then flows to its confluence with the River Blythe.
Shadow Brook	Main River / Ordinary watercourse	The Shadow Brook flows in a predominately north eastern direction to its confluence with the River Blythe on the northern borough boundary near Diddington Hill. The shadow Brook is classified as an ordinary watercourse, east of the M42.
Westly Brook	Main River	The Westly Brook flows through a predominately urban area from Kineton Green, through Olton in Solihull for approximately 2.9km.

6.3 Fluvial flood risk

The primary fluvial flood risk in Solihull is associated with the River Blythe and its tributaries. Tributaries of the River Blythe include, but are not limited to the River Cole, Mount Brook, Alder Brook, Purnell's Brook, Shadow Brook, and Hollywell Brook. The River Blythe flows through the majority of the borough. However, the areas it flows through are predominantly rural and the fluvial flood risk from the River Blythe to property in this area is minimal.

The River Cole, a tributary of the Blythe, flows through Kingshurst in the north and south east of Solihull. Whilst the River Cole has relatively narrow floodplains, it flows through areas that are heavily urbanised and as such, produces a higher flood risk to properties.

Locations with associated fluvial flood risk from Solihull (as well as other sources of flooding) are detailed in Table 6-4.

A review of the Environment Agency's AIMS dataset and flood storage area GIS layer indicates there are currently no formal flood defences in the borough. However, as part of the Trent Regional Flood and Coastal Committee six-year programme, Solihull Metropolitan Borough Council, submitted a bid for improvements to Dickens Heath balancing pond. This pond is located to the sough of Dickens Heath, off Rumbush Brook, a tributary of Mount Brook. The council are also in the very early stages of looking to see whether the Dickens Heath scheme could be expanded to benefit Cheswick Green.[11]

6.4 Surface water flood risk

Flooding from surface water runoff (or 'pluvial' flooding) is usually caused by intense rainfall that may only last a few hours and usually occurs in lower lying areas, often where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage, or drainage blockage by debris, and sewer flooding.

The Risk of Flooding from Surface Water (RoFfSW) predominantly follows topographical flow paths of existing watercourses or dry valleys with some isolated ponding located in low lying areas.

A summary of surface water flood risk to key locations in Solihull (as well as other sources of flooding) are detailed in Table 6-4.

The RoFfSW mapping for the borough can be found in Appendix A.

6.5 Groundwater flood risk

In comparison to fluvial flooding, current understanding of the risks posed by groundwater flooding is limited and mapping of flood risk from groundwater sources is in its infancy. Under

[11] https://cllrkenhawkins.co.uk/2016/03/31/flood-defence-grant-in-aid-bid-dickens-heath/

the Flood and Water Management Act (2010), LLFAs have powers to undertake risk management functions in relation to groundwater flood risk. Groundwater level monitoring records are available for areas on Major Aquifers. However, for lower lying valley areas, which can be susceptible to groundwater flooding caused by a high water table in mudstones, clays and superficial alluvial deposits, very few records are available. Additionally, there is increased risk of groundwater flooding where long reaches of watercourse are culverted as a result of elevated groundwater levels not being able to naturally pass into watercourses and be conveyed to less susceptible areas.

Mapping of the borough has been provided showing the AStGW dataset and can be found in Appendix A.

6.6 Flooding from artificial sources

6.6.1 Flooding from sewers

Sewer flooding occurs when intense rainfall overloads the sewer system capacity (surface water, foul or combined), and/or when sewers cannot discharge properly to watercourses due to high water levels. Sewer flooding can also be caused when problems such as blockages, collapses or equipment failure occur in the sewerage system. Infiltration or entry of soil or groundwater into the sewer system via faults within the fabric of the sewerage system, is another cause of sewer flooding. Infiltration is often related to shallow groundwater, and may cause high flows for prolonged periods of time.

Since 1980, the Sewers for Adoption guidelines have meant that the newest surface water sewers have been designed to have capacity for a rainfall event with a 1 in 30 chance of occurring in any given year, although until recently this did not apply to smaller private systems. This means that, even where sewers are built to current specification, they are likely to be overwhelmed by larger events of the magnitude often considered when looking at river or surface water flooding (e.g. a 1 in 100 chance of occurring in a given year). Existing sewers can also become overloaded as new development adds to the discharge to their catchment, or due to incremental increases in roofed and paved surfaces at the individual property scale (urban creep). Sewer flooding is therefore a problem that could occur in many locations across the study area.

Historical flood events provided by Solihull Metropolitan Borough Council included records from possible sewer flooding events. For confidentiality reasons this data has been displayed on a 4-digit postcode basis.

Table 6-2: Solihull Metropolitan Borough Council flood database

Post Code	**Locality**	**Recorded Flood Incidents**
B37 6	Kingshurst	1
B37 7	Marston Green	1
B90 2	Hasluck’s Green	3
B91 1	Blossomfield	2
B91 2	Lode Heath	9
B91 3	Tippets Field	3
B92 0	Hampton in Arden	2
B92 8	Ulverly Green	3
B92 9	Elmdon Heath	8
B93 9	Knowle	1
CV7 7	Basall Common	1
Unknown		1
		Total = 35

A total of 35 recorded flood incidences where listed in the Solihull Metropolitan Borough Council flooding database. The most frequently flooded post codes are B91 2, (Lode Heath) and B92 9, (Knowle).

Historical incidents of flooding are detailed by Severn Trent Water through their HFRR registers (see Table 6-3). This database records incidents of flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons this data has been supplied on a postcode basis. The dataset was exported on 06/03/2017.

Table 6-3: Severn Trent Water HFRR (sewer flood risk register)

Locality	Post Code	Recorded Flood Incidents	Locality	Post Code	Recorded Flood Incidents
Balsall Common	CV7 7	5	Hockley Heath	B94 6	7
Bentley Heath	B93 8	2	Kingshurst	B37 6	14
Berkswell	CV7 7	2	Knowle	B93 9	6
				B93 0	7
Birmingham	B36 0	2	Meriden	CV7 7	15
	B27 6	3			
Carol Green	CV7 7	1	Olton	B92 8	5
Castle Bromwich	B36 9	3	Sheldon	B92 9	1
Dorridge	B93 8	16	Shirley	B90 1	10
	B94 6	9		B90 2	5
				B90 4	1
Hampton-in-Arden	B92 0	24	Solihull town	B90 1	2
				B90 2	4
				B91	1
				B91 1	12
				B92 2	13
				B92 7	10
				B92 9	4
				B93 8	4
				B94 6	3
					Total = 185

A total of 185 recorded flood incidents in the Solihull Metropolitan Borough were listed in the HFRR register. The most frequently flooded localities are

- Solihull town, accounting for 29% of all recorded incidents;
- Dorridge, accounting for 14% of all recorded incident; and,
- Hampton-in-Arden, accounting for 13% of all recorded incidents.

20 incidents were recorded during June and July 2007. A further 12 incidents were recorded in August 1999, 9 incidents were recorded in November 2012 and August 2004. July 2007 and November 2012 are also recorded historical fluvial and blockages indicating that there may be some interaction between the fluvial and surface water drainage networks. However, the majority of the dates do not correlate to significant fluvial or surface water flood events noted in Section 6.1; indicating that the events listed in the HFRR are possibly isolated incidents.

It is important to recognise the HFRR does not contain information about properties and areas at risk of sewer flooding caused by operational issues such as blockages. Also the register represents a snapshot in time. As such the sewer flooding flood risk register is not a comprehensive 'at risk register'.

6.7 Flooding from reservoirs

Reservoirs with an impounded volume greater than 25,000 cubic metres are governed by the Reservoir Act 1975 and are listed on a register held by the Environment Agency. The level and standard of inspection and maintenance required under the Act means that the risk of flooding from reservoirs is relatively low. Recent changes to legislation under the Flood and Water Management Act require the Environment agency to designate the risk of flooding from these reservoirs. The Environment agency is currently progressing a 'Risk Designation' process so that the risk is formally determined.

Reservoir flooding is very different from other forms of flooding. It may happen with little or no warning and evacuation will need to happen immediately. The likelihood of such flooding is difficult to estimate, but it is less likely than flooding from rivers or surface water. It may not be possible to seek refuge upstairs from floodwater as buildings could be unsafe or unstable due to the force of water from the reservoir breach or failure.

There is a residual risk of inundation to the borough because of reservoir breach or failure of reservoirs both within and outside the borough. The risk was assessed as part of the National Inundation Reservoir Mapping (NIRIM) study. The results from the NRIM study show inundation outlines follow the River Blythe corridor, from where it enters the borough at Dickens Heath, to where it leaves the borough, at the A45 / A452 roundabout. There are also reservoir inundation outlines from the lakes east of Hampton in Arden, south of Meriden, to Pickford Green, east of the borough as well as from Pendigo Lake, south of the NEC. Maps of the flood extent can be found on the Environment Agency's 'Long term flood risk information' website.

The Environment Agency maps represent a credible worst case scenario. In these circumstances, it is the time to inundation, the depth of inundation, the duration of flooding and the velocity of flood flows that will be most influential.

The risk to development from reservoirs is residual but developers should consider reservoir flooding during the planning stage.

- Developers should seek to contact the reservoir owner to obtain information which may include
  - reservoir characteristics: type, dam height at outlet, area/volume, overflow location;
  - operation: discharge rates / maximum discharge;
  - discharge during emergency drawdown; and
  - inspection / maintenance regime.
- Developers should apply the sequential approach to locating development within the site. The following questions should be considered
  - can risk be avoided through substituting less vulnerable uses or by amending the site lay-out?
  - can it be demonstrated that less vulnerable uses for the site have been considered and reasonably discounted? and
  - can layout be varied to reduce the number of people or flood risk vulnerability or building units located in higher risk parts of the site?
- Consult with relevant authorities regarding emergency plans in case of reservoir breach
- In addition to the risk of inundation those considering development in areas affected by breach events should also assess the potential hydraulic forces imposed by the rapid

flood event and check that the proposed infrastructure fabric can withstand the loads imposed on the structures by a breach event.

6.8 Flooding from canals

Canals do not generally pose a direct flood risk as they are a regulated waterbody. The residual risk from canals tends to be associated with lower probability events such as overtopping and embankment failure (breach and sudden escape of the water retained in the canal channel).

There are two canals in Solihull (see Figure 6-4). The Grand Union Canal cuts through the south west of the borough and flows as a navigable canal for over 14km through the centre of the borough. There are a series of five locks on the Grand Union Canal, known as "Knowle Locks"; these are located south of the B4104 Kenilworth road bridge, south east of Knowle. Several unnamed drains have the potential to interact with the Grand Union Canal as well as the River Blythe which the Grand Union Canal flows over as an aqueduct.

The **Stratford-on-Avon Canal** crosses the River Cole and River Blythe as is flows along the south-western boundary of the borough and is navigable along its entire length.

The residual risk associated with canals is more difficult to determine as it depends on a number of factors including, for example, the source and magnitude of surface water runoff into the canal, the size of the canal, construction materials and level of maintenance. The probability of the risk of a breach is managed by continued maintenance.

6.8.1 Overtopping and breach

The level of water in canals is normally controlled by the level and size of weirs. When surface water enters a canal, the level of water rises. The water level may then reach a point in which it discharges from the canal through control structures such as weirs. If the capacity of these control structures is exceeded, or should they become blocked, overtopping may occur.

Breaches or embankment failure may be caused by a number of factors including:

- Culvert collapse
- Overtopping
- Animal burrowing

Flooding from a breach of a canal embankment is largely dictated by canal and ground levels, canal embankment construction, breach characteristics and the volume of water within the canal that can discharge into the lower lying areas behind the embankment. The volume of water released during a breach is dependent on the upstream pound length (i.e. the distance between locks) and how quickly the operating authorities can react to prevent further water loss, for example by the fitting of stop boards to restrict the length of the canal that can empty through the breach, or repair of the breach.

6.8.2 Recorded flood incidents from canals in the borough

There is one record of a canal breach with in the borough on the Grand Union Canal, in November 1997, by Copt Heath, thought to be caused by a farmer excavating an embankment which resulted in a 65m slope failure.

Any development proposed adjacent to a canal should include a detailed assessment of how a canal breach would impact the site, as part of a site-specific flood risk assessment.

Figure 6-4: Canal locations in the Solihull Metropolitan Borough