



Wolverhampton City Council

Level 2 Strategic Flood Risk Assessment

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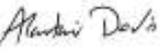
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1 Introduction

The Black Country Core Strategy has identified 16 Regeneration Corridors within Sandwell, Walsall, Dudley and Wolverhampton. Five of these Regeneration Corridors fall within Wolverhampton. The Council is now progressing Area Action Plans (AAP's) for four of these Regeneration Corridors. The Stafford Road AAP has now reached Issues consultation stage, and the Bilston Corridor AAP will soon follow.

A number of potential strategic sites have been identified for initial consultation, however the extent and land use associated with each of these sites has yet to be finalised.

To assist in the decision making process, and in accordance with the requirements of Planning Policy Statement 25: Development and Flood Risk (PPS25), and the associated Practice Guide, this Level 2 Strategic Flood Risk Assessment (SFRA) has been commissioned by the Council for the Bilston Corridor and Stafford Corridor. Regeneration is also proposed for Wolverhampton City Centre, but the City Centre AAP has been omitted from the Level 2 SFRA process as the degree of flood risk is low.

The primary purpose of the Level 2 SFRA is to build upon the findings of the recent Black Country Level 1 SFRA, and to assess in further detail the potential risk of flooding to each potential development site. This will determine whether it is feasible that the sites can be developed safely, without increasing the risk of flooding elsewhere.

To aid the planning process, each individual development site within the Bilston Corridor and Stafford Road Corridor AAP areas has been assessed separately. This assessment has included an analysis of the risks associated with all sources of flooding highlighted in PPS25. Recommendations for Spatial Planning, Development Control and site specific flood risk assessment (FRA) have also been included for the individual sites / development areas.

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2.1 Assessment of Flood Risks

The flood risks to each potential development area have been assessed individually. This approach has been taken as it will allow planners, developers and other interested parties to focus upon the area in question. Consultation with the Environment Agency has confirmed the suitability of the approach.

The methodology used to identify the risk (probability and consequence) of flooding is described below. The results of the assessment are contained in Section 3.

2.1.1 Flooding from Rivers

The assessment of fluvial flood risk was carried out by building on the work conducted during the Black Country Level 1 SFRA. In the Level 1 document, PPS25 Flood Zones were identified based on flood risk mapping undertaken by the Environment Agency. These Flood Zones have been used as the basis of the Level 2 assessment.

According to the PPS25 Practice Guide¹ the Level 2 SFRA should contain the following information in relation to fluvial flooding:

- *Flood Probability*
- *Flood Depth*
- *Flood Velocity*
- *Rate of Onset of Flooding*

Flood Probability has already been identified as an integral part of the Level 1 SFRA. Consultation with the Environment Agency confirmed that no further flood risk modelling has been undertaken in the study area. No further work to determine the frequency of flooding in flood risk areas has been carried out.

Depth of flooding has been identified through interrogation of the Digital Terrain Model² (DTM) and the extents of flooding (See Appendix A). A conservative approach was used and the maximum depth of flooding has been reported in the individual site reports using the 0.1% Annual Exceedance Probability (AEP) i.e. 1 in 1000 year flood levels.

Velocity of flooding has been worked out using the Manning’s Equation. This equation provides a simple, yet robust, estimation of flows using hydraulic parameters such as flood depths, slope and surface roughness (the results and a more detailed explanation of the methodology is included in Appendix B). In all instances, surface roughness characteristics have been assumed to be ‘smooth’. This will generate faster flows and represents a precautionary approach, as advocated by PPS25.

Rate of Onset (and period of inundation) has been determined through an analysis of catchment hydrology. Information on the catchment hydrology was taken from the Flood Estimation Handbook (FEH) CD-ROM and flood hydrology characteristics

¹ Para 3.51, Page 49

² The Digital Terrain Model has been created from SAR data.

were generated for the Q100 (1% AEP or 1 in 100 year) event. The hydrological characteristics for the three principal watercourses in the study are shown in Appendix C.

It should be noted that the approach described above represents an *indicative* overview of the potential characteristics of flooding for each site considered. The flooding characteristics obtained do not represent detailed modelling and should not be used as part of a detailed design. If development is planned within an area affected by fluvial flooding detailed modelling of the flood risk will be required.

Culvert Capacity

During the Black Country Level 1 SFRA an assessment of the culvert capacities of a number of culverts within the study area was carried out. Many of these culverts were found to have capacities significantly greater than the 1% AEP (1 in 100 year) flood event represented by the Environment Agency Flood Zone 3. In these cases the Flood Zones were amended and an 'overland flow path' was substituted. This has been retained within this study and in these cases the risk of blockage has been assumed to be low in the short to medium term.

Climate change is likely to lead to an increased likelihood of intense rainfall and greater flood flows. Older culverts often have not taken into account the impacts of climate change and therefore may not have an adequate capacity in the long term which could significantly increase flood risk to future developments.

The Environment Agency have stated during consultation that **site specific analysis via a FRA will be required for culverts on proposed development sites**. The structural integrity of culverts should also be checked as part of the site specific analysis.

2.1.2 Flooding From Land

The risk of flooding to the proposed development sites has been assessed using information on geology, soil type, land use characteristics, historic incidents and topography.

A Geographical Information System (GIS) analysis using the DTM identified potential overland flow routes. These routes give a good indication of where there could be large volumes of flows generated following a rainfall event. A map showing topography and calculated overland flow routes is contained in Appendix D.

However, it is important to note that overland flow routes can be heavily influenced by surface features that are not represented on a DTM, such as walls, kerbs, drainage ditches and underpasses. Overland surface flow can also accumulate or 'pond' in topographic depressions. Therefore, the generated overland flow paths should be viewed with a degree of caution.

It should be noted that techniques are evolving which will enable a more comprehensive assessment of overland flow and surface water flood risk to be made in future. Guidance on appropriate techniques is currently being trialled and we would recommend that the assessment of flooding from 'land' and surface water flood risk is reviewed and a Surface Water Management Plan prepared (as discussed in Section 4) when formal guidance becomes available.

2.1.3 Groundwater Flooding

The potential for groundwater flooding has been identified using geological and Ordnance Survey maps, historical data and soil data. It should be noted that the risk of groundwater flooding is difficult to predict. In recent years there are examples of areas across the UK being affected from this source of flooding without any warnings or indication that they could be at risk. This is due to the complex long term behaviour of local and regional water tables related to rates of groundwater recharge (climatic) and water abstraction rates.

2.1.4 Flooding from Sewers

The risk of flooding to the development from sewers was identified from information obtained from Severn Trent Water and local knowledge held by the Environment Agency and Wolverhampton City Council Drainage Engineers. Information from the Black Country Level 1 SFRA was updated with additional details received following further consultation as part of the Level 2 SFRA.

The assessment of the potential effect of future development on the risk of sewer flooding elsewhere was also based on this information. If historic incidents of flooding were noted in the vicinity of the development, particularly immediately downhill, the sewer network was identified as having a potential capacity problem. Severn Trent Water was contacted for comment on this type of flood risk, but it was unable to comment on individual areas due to the high level, long-term and strategic nature of the study (see Appendix E).

2.1.5 Flooding from Artificial Sources

Waterbodies which could pose a potential risk to future development in the study area were identified from Ordnance Survey maps. From this review, canals were the only significant risk identified. Information was obtained through consultation with British Waterways on the level of risk in the study area (see Appendix E).

Note that whilst no large reservoirs were identified in the immediate vicinity of the study areas the risk of flooding that might be associated with a dam breach situation should be kept under review. Due to stringent reservoir safety regulations such a risk is extremely unlikely but not impossible. Further information on potential sources of dam breach flood risk may become available in the future.

2.2 Planning Related Recommendations

2.2.1 Spatial Planning Recommendations

Spatial Planning recommendations have been provided on a site by site basis. The recommendation is based on the whole site and no attempt was made to split the site up into sub-sites based on flood risk.

The 'flood risk vulnerability classification' for the proposed land-use was identified using PPS25 descriptions (see Table 2-A). As the planning process is still at a relatively high (strategic) level, there was only limited information on the types of development planned for the AAP sites.

Based on PPS25 vulnerability classifications, employment land-use has been determined as ‘less vulnerable’ and housing land-use as ‘more vulnerable’. It should be noted that these flood risk vulnerability classifications may change depending on the final nature of each individual development.

Essential Infrastructure
<ul style="list-style-type: none"> • Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Highly Vulnerable
<ul style="list-style-type: none"> • 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.
More Vulnerable
<ul style="list-style-type: none"> • Hospitals. • Residential institutions such as residential care homes, children’s homes, social services homes, prisons and hostels. • Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. • Non–residential uses for health services, nurseries and educational establishments. • Landfill and sites used for waste management facilities for hazardous waste. • Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable
<ul style="list-style-type: none"> • 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 (except landfill and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment plants. • Sewage treatment plants (if adequate pollution control measures are in place).
Water Compatible
<ul style="list-style-type: none"> • Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel workings. • Docks, marinas and wharves. • Navigation facilities. • MOD defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 2-A Development Vulnerability (from PPS25 Table D2)

Once the vulnerability of the development has been identified, its suitability for the area and the level of flood risk present was assessed in accordance with Table 2-B.

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1 <0.1% Annual Probability	✓	✓	✓	✓	✓
	Zone 2 0.1% to 1% Annual Probability	✓	✓	Exception Test required	✓	✓
	Zone 3a >1% Annual Probability	Exception Test required	✓	x	Exception Test required	✓
	Zone 3b 5% Annual Probability	Exception Test required	✓	x	x	x

Table 2-B Flood Risk Vulnerability and Flood Zone ‘Compatibility’ (based on PPS25 Table D3)

It is important to note that this identification of Flood Zone ‘compatibility’ does not represent application of the PPS25 Sequential Test. The Sequential Test, in simple terms, is the requirement of Local Planning Authorities to consider locating developments in reasonably available sites at the lowest levels of risk.

The Test has been undertaken as a separate exercise, see Jacobs’ Report: ‘Application of the Sequential Test’ (April 2009).

2.3 Recommendations for Site Specific Flood Risk Assessment

The PPS25 Practice Guide states the Level 2 SFRA should contain guidance on the preparation of FRAs, including information about the use of SUDS techniques. The Environment Agency considers some of this guidance to be mandatory. This has been made explicit where possible but consultation with the Environment Agency should be carried out prior to the carrying out of a FRA to ensure that the assessment is fit for purpose.

The site specific flood risk assessment (FRA) recommendations have been included in the individual development area reports (see Section 3). They are based upon the key flood risks identified during the Level 2 assessment. The site specific recommendations should give planners and developers an indication of the amount and detail of work that will be required in future, if the site is to be developed.

Where appropriate, a methodology for assessing the risk at FRA level has been included within the individual report. The methodology is based upon existing experience of FRA projects and approaches recommended by Environment Agency Officers across England.

The Black Country SFRA Level 1 states that post development surface water runoff rates and volumes should be reduced to match green field runoff rates and volumes. Consultation with the Environment Agency has revealed that this is a greater reduction than is considered mandatory by the Environment Agency who state that a 20% reduction in pre-development surface water runoff rates is required.

A reduction in surface water runoff to green field levels will lead to a significant reduction in flood risk and developers should be encouraged to aim for reductions greater than the 20% required by the Environment Agency.

The application of SUDS techniques for the management of surface water runoff is mandatory for all new developments. Recommendations on appropriate SUDS techniques have been given at a strategic level. PPS25 states that the LPA should ensure their policies and decisions should support and complement the Building Regulations.

The Building Regulations give priority to the use of infiltration drainage systems over discharge to the watercourse and the sewers. Consequently, soil and geological information has been used to assess whether infiltration based SUDS techniques are appropriate at each site. If soil conditions indicate that infiltration is not suitable, then attenuation measures have been highlighted as those most appropriate for the development area. Details on soil types and geology are contained in Appendix F.

3 Assessment Results

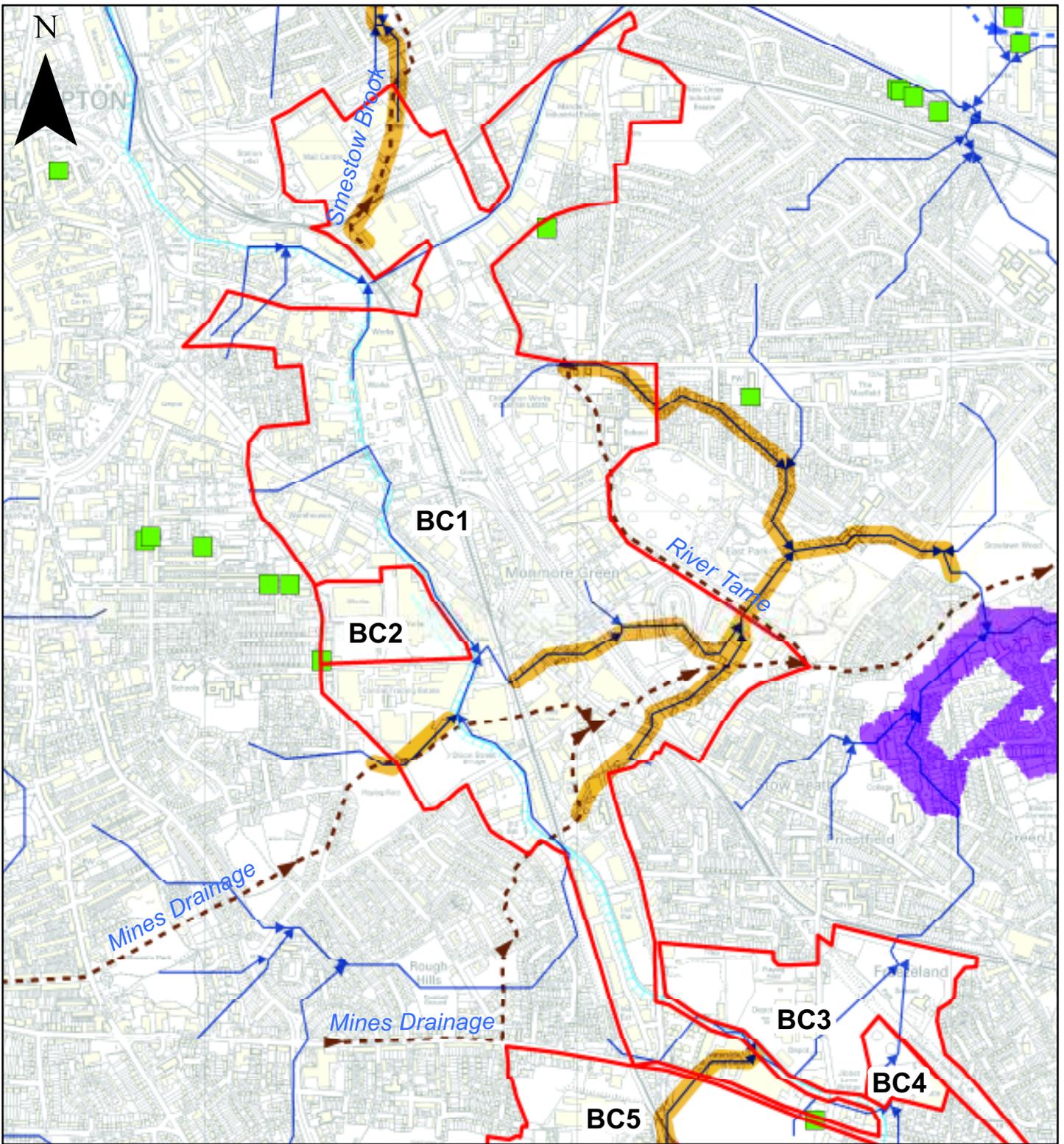
This section provides an assessment of flood risk for each individual site identified and assessed, as listed below:

AAP Area	Site Ref	Site Name
Bilston Corridor	BC1	Rail Corridor Wednesfield Road to Ettingshall Road
	BC2	Cable Street / Steelhouse Lane
	BC3	Ward Street
	BC4	Reliance Trading Estate
	BC5	South of Ettingshall Road
	BC6	East of Spring Road
	BC7	Spring Vale Avenue
	BC8	Spring Vale Industrial Park
	BC9	Withy Road Industrial Area
	BC10	North of Anchor Lane
	BC11	South of Anchor Lane
	BC12	Bilston Urban Village
	BC13	Barton Industrial Estate (adjoining Bilston Town Centre)
	BC14	Bankfield Works / Greenway Road
	BC15	Northcott Road
	BC16	Salop Street
	BC17	Loxdale Industrial Area (including Citadel Junction site)
Stafford Road Corridor	SR1	Wolverhampton Business Park
	SR2	Fordhouses
	SR3	Headway Road
	SR4	Pendeford Business Park
	SR5	Usam Trading Estate
	SR6	Fordhouses Road / Bushbury Lane
	SR7	Goodyear (Housing)
	SR8	Goodyear (Employment)
	SR9	Bushbury Lane
	SR10	Wolverhampton Science Park
	SR11	Foxes Lane
	SR12	Dunstall Hill Trading Estate
	SR13	Wulfrun Trading Estate
	SR14	Crown Street / Cross Street
	SR15	Park Village
	SR16	Bluebird and Fallings Park Industrial Estate
	SR17	Dunstall Racecourse Park

Table 3-A List of Sites Appraised

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Development Area: Bilston Corridor
Site Reference: BC1
Site Name: Rail Corridor Wednesfield Road to
Ettingshall Road



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surcharge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 115 230 460 Meters</p>	<p>Scale @ A4: 1:15,000</p>	<p>Drawing Title: Site BC1</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/BC1</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Site Details

Site Area :	178 ha	Proposed Land Use:	Residential and Commercial
Approximate Grid Reference:	392859, 297662	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The headwaters of Smestow Brook are located in the northern part of the site. The watercourse is entirely in culvert through the development area.
- The headwaters of the River Tame are located in the eastern part of the site. This watercourse is also entirely in culvert as it passes through the development area. The culvert flows along eastern border of the development area, under Hickman Road.
- The Mines Drainage (watercourse) and its link to the River Tame, passes under the south of the site in culvert.
- As these watercourses are in the very upper reaches of their respective catchments, they have not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flows through the culverts will be relatively low.
- Consultation has not revealed any instances of localised flooding in this development area. This suggests that the culverts are of sufficient capacity in this area.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culverts present on site. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan). However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- Wide-scale re-development on this site, without appropriate mitigation, could increase fluvial flood risk elsewhere.
- Much of the site is already developed. However, any the replacement of any currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil, thus increasing the rate and volume that surface water is discharged into local watercourses.
- This could shorten the responsiveness to rainfall events and increase the volume of water in the channel. and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing fluvial flood risk.
- Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- The greatest risk will be to the western part of the site as the Birmingham Canal and a railway embankment protects the eastern half of the development from surface water runoff.
- An analysis of potential overland flow paths indicates that there are surface water flow routes directly through the site.
- The development site is considered to be at high risk of surface water flooding.

Potential Impact from Proposed Development

- Much of the site is already developed, but changes to the surface water drainage system has the potential to alter the existing drainage regime and could increase the risk from surface water flooding.
- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. This will increase the potential for surface water runoff to affect adjacent areas of land, primarily to the east.
- The land to the east of the site is heavily developed and the consequences of increased runoff could be high.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding in some locations outside of the development site.

Flooding from Groundwater:*Risk to Proposed Development*

- The solid geology of the site is permeable sandstone and coal measures. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of Groundwater flooding at this site.
- The site is considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:*Risk to Proposed Development*

- Consultation with Severn Trent Water has not revealed any records of sewer flooding at this site.
- There are records from the Black Country Level 1 SFRA of several sewer flooding incidents close to the site. There is no information available on the specific cause or severity of the flooding.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent Water are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding elsewhere and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes through the site on a broadly to north to south alignment.
- Consultation with British Waterways has not revealed any specific flooding issues relating to this canal at this location.
- Due to the length of the canal passing through the site, the canal has been assessed as having a medium level of risk to the site. Any development within this site will need to investigate the potential for flooding from the canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site in accordance with PPS25.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.

- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water/groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Assess the flow capacity of the culverted watercourses and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the PPS25 Flood Zones.
- Evaluate the potential for, and consequences of, culvert blockage.
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration may not be a viable option due to the poor drainage characteristics of the soil.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

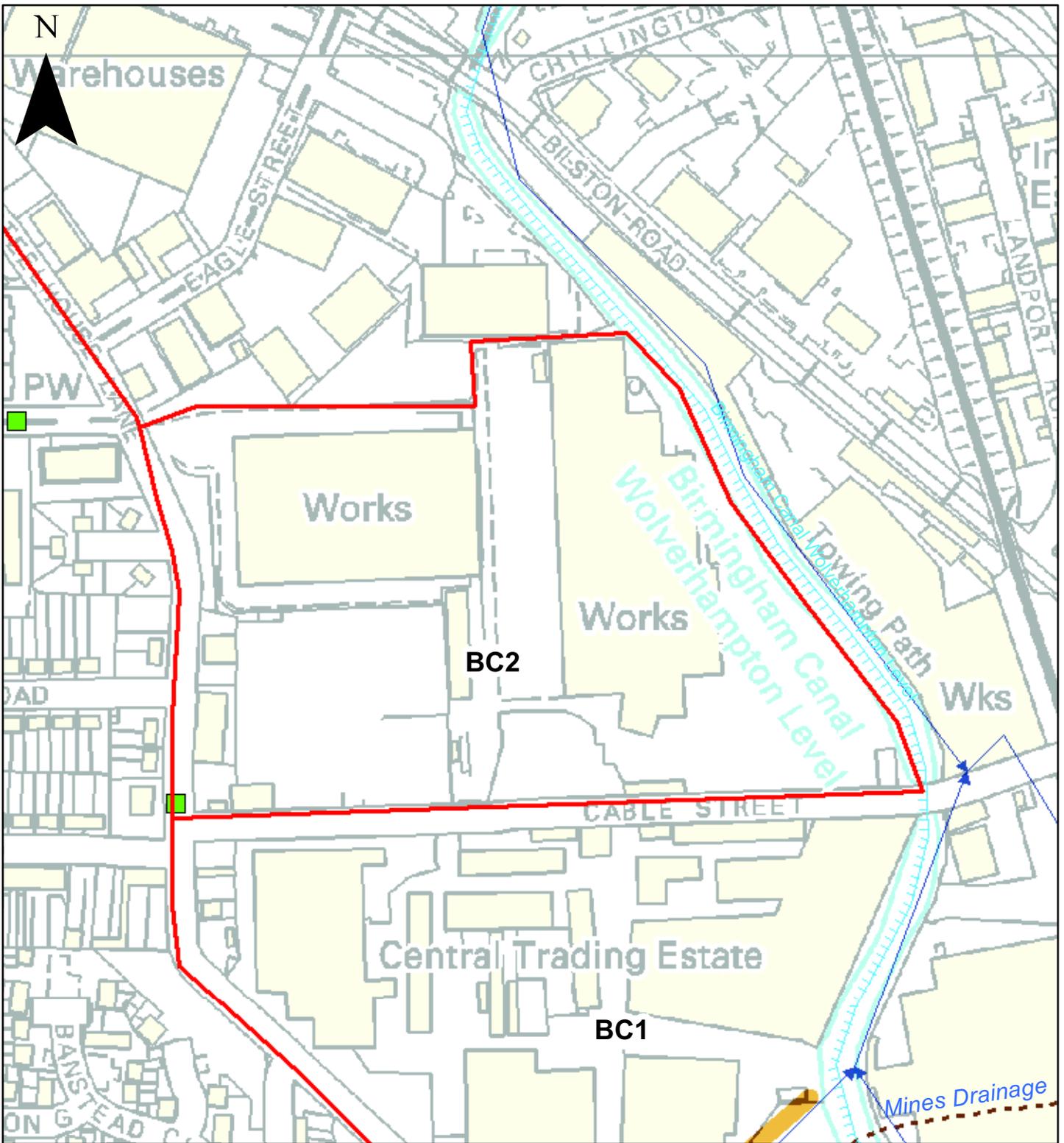
- Investigate the causes of sewer flooding close to the site boundary to ascertain whether they are indicative of a risk to the development area.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

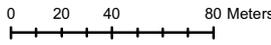
Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC2
Site Name: Rail Cable Street / Steelhouse Lane



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert SurchARGE Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> ➔ Indicative Surface Water Runoff Routes <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 20 40 80 Meters</p> 	<p>Scale @ A4: 1:3,000</p>	<p>Drawing Title: Site BC2</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/BC2</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Checked	DRD	April 2009									
Approved	KD	April 2009									

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Site Details

Site Area :	7.3 ha	Proposed Land Use:	Residential
Approximate Grid Reference:	392475, 297709	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- Re-development on this site, without appropriate mitigation, could increase fluvial flood risk elsewhere.
- Much of the site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing fluvial flood risk.

Flooding from Land:

Risk to Proposed Development

- The development site is considered to be at high risk of surface water flooding.
- There is high ground to the west of the site, which, as the area is heavily urbanised and impermeable, is likely to generate surface water flows during heavy rainfall events which would flow towards the development area.
- Severn Trent Water has a record of surface water related flooding on the western border of the site.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has not revealed any records of sewer flooding at this site.
- There are records from the Black Country Level 1 SFRA of several sewer flooding incidents close to the site. There is no information available on the specific cause or severity of the flooding.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes along the eastern border of the development site.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.
- The canal is not considered to be a risk to this development site.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Surface Water Runoff Management**

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration may not be a viable option due to the poor drainage characteristics of the soil.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.

- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

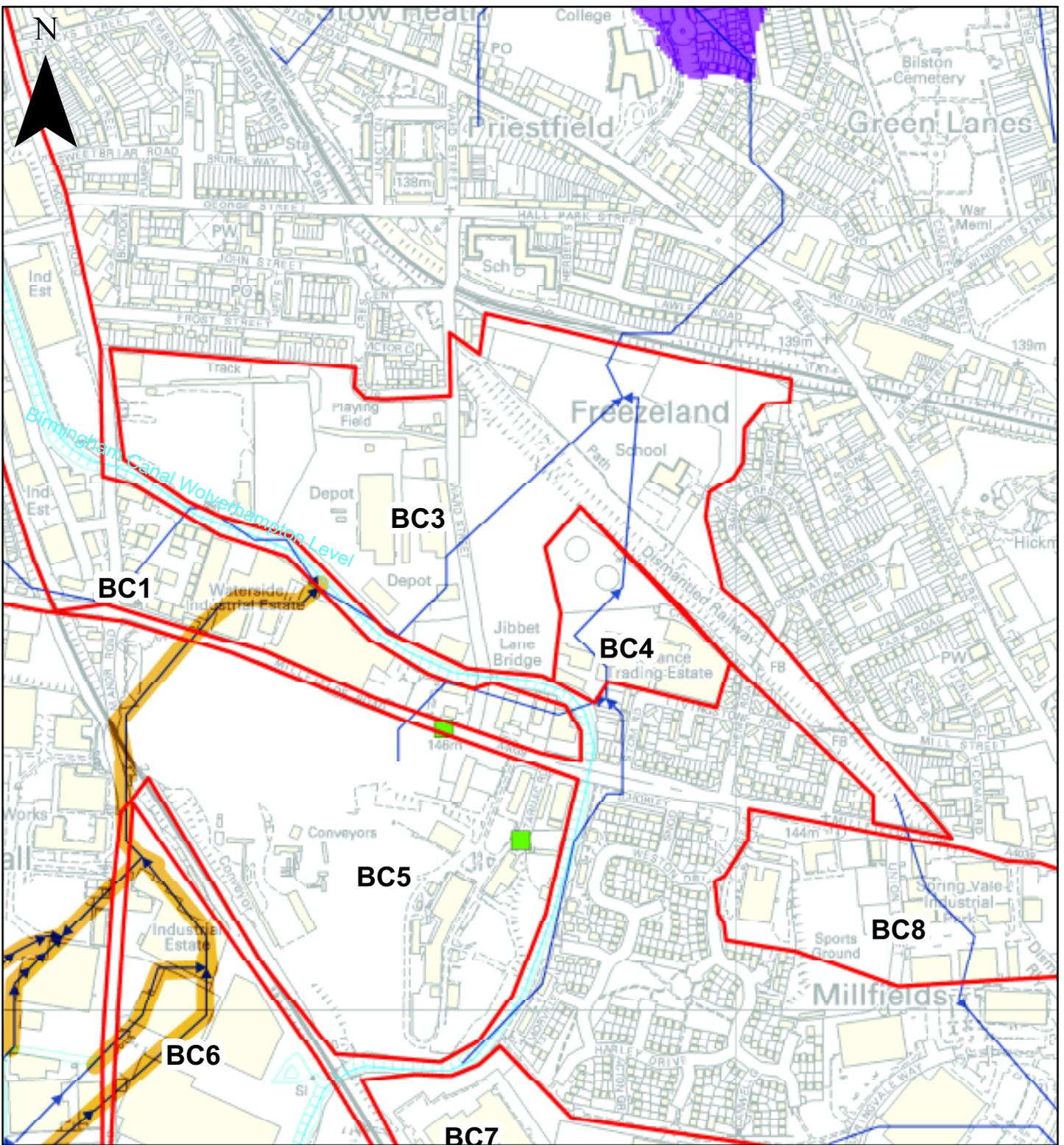
- Investigate the causes of sewer flooding close to the site boundary to ascertain whether they are indicative of a risk to the development area.
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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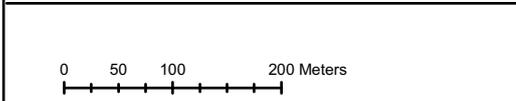
Development Area: Bilston Corridor
Site Reference: BC3
Site Name: Ward Street



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surge Flow Paths		Culvert
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Open Channel
	Groundwater Flooding Incidents		Flood Zone 3a		Canal
			Flood Zone 2		

Client:

Project: **Wolverhampton SFRA Level 2**



Scale @ A4: 1:7,000

Drawing Title: **Site BC3**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: **B0536900/L2SFRA/BC3**

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009

Site Details

Site Area :	24 ha	Proposed Land Use:	Residential
Approximate Grid Reference:	393629, 296647	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing fluvial flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high ground to the southwest of the site, which, as the area is urbanised and impermeable (due to roads etc), is likely to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there are surface water flow routes directly through the site.
- However, the Birmingham Canal and railway embankments cross these potential overland flow paths and will prevent flows onto the site.
- The site is considered to be at low risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. This will increase the potential for surface water runoff to affect adjacent areas of land, primarily to the north. However, runoff routes to the north are crossed by infrastructure which should significantly reduce the probability that surface will be able to flow freely into adjacent areas.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has not revealed any records of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes to the south of this site.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Surface Water Runoff Management**

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration may not be a viable option due to the poor drainage characteristics of the soil.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

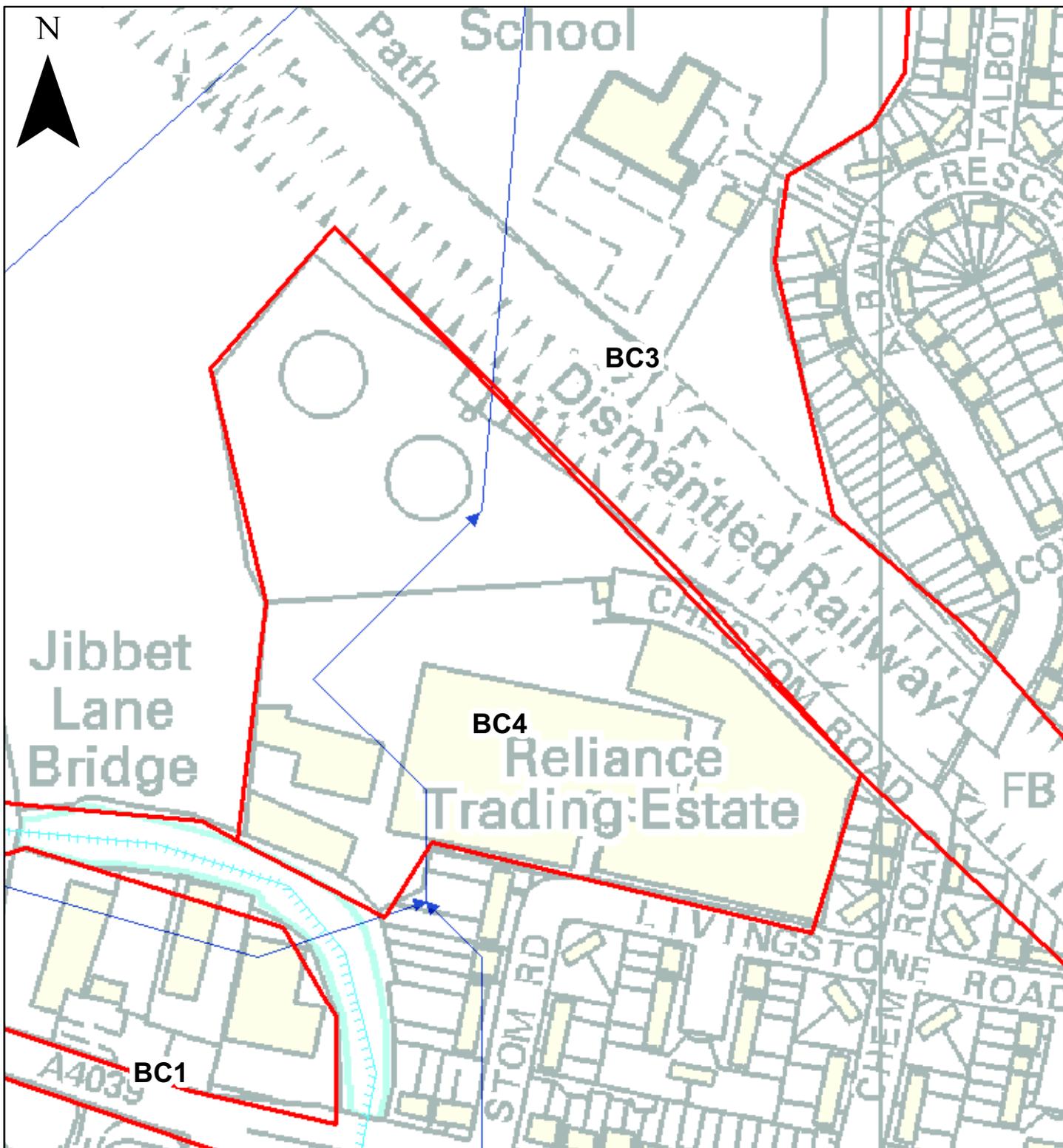
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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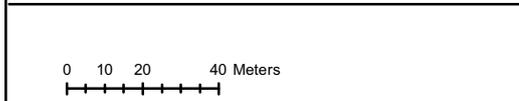
Development Area: Bilston Corridor
Site Reference: BC4
Site Name: Reliance Trading Estate



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surcharge Flow Paths	Watercourse	
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**



Scale @ A4: 1:2,000

Drawing Title: **Site BC4**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: B0536900/L2SFRA/BC4

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009

Site Details

Site Area :	3.3 ha	Proposed Land Use:	Residential and Employment
Approximate Grid Reference:	393855, 296490	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- Re-development on this site, without appropriate mitigation, could increase fluvial flood risk elsewhere.
- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high ground to the southwest of the site, which, as the area is heavily urbanised and impermeable, is likely to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there are surface water flow routes directly through the site. However, the Birmingham Canal will prevent surface water runoff onto the site.
- The site is considered to be at low risk from surface water runoff.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has not revealed any records of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes to the south of this site.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this

canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
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- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration may not be a viable option due to the poor drainage characteristics of the soil.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
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Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

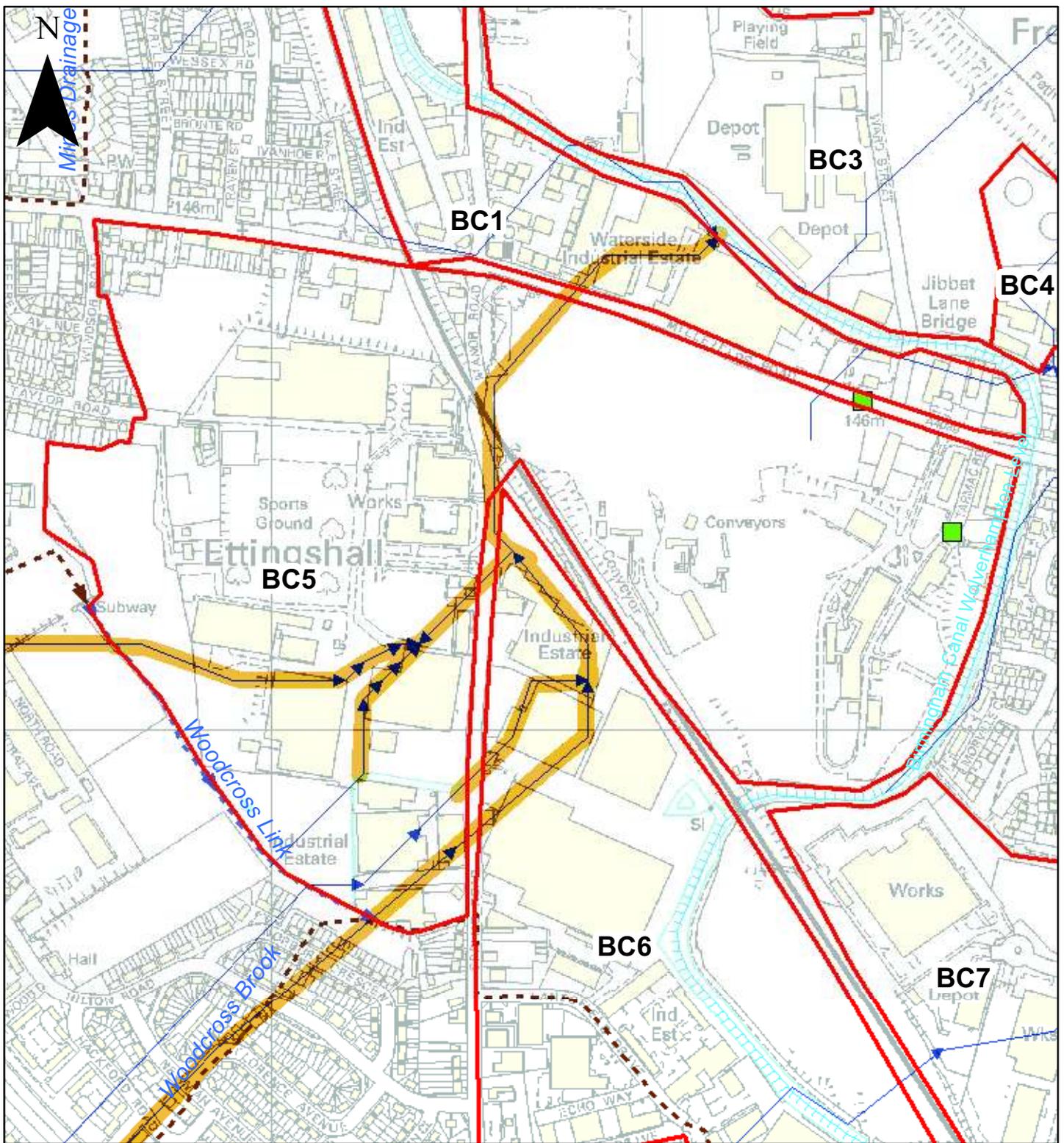
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

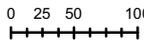
Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account.

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Development Area: Bilston Corridor
Site Reference: BC5
Site Name: South of Ettingshall Road



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents ■ Overland Flow Paths Level 1 SFRA ■ Indicative Culvert Surge Flow Paths ■ Flood Zone 3b ■ Flood Zone 3a ■ Flood Zone 2 	<ul style="list-style-type: none"> → Indicative Surface Water Runoff Routes Watercourse Culvert Open Channel Canal 	<p>Client: </p>									
<p>0 25 50 100 Meters</p> 	<p>Scale @ A4: 1:6,000</p>	<p>Project: Wolverhampton SFRA Level 2</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Title: Site BC5</p> <p>Drawing Number: B0536900/L2SFRA/BC5</p>									
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Approved	KD	April 2009									

Site Details

Site Area :	45 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	393191, 296356	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The Ettingshall to Woodcross Link (watercourse) flows along the south eastern border of the development area. It enters the site from a culvert and flows in an open channel before passing into another culvert at the downstream border of the site.
- Woodcross Brook passes in culvert along the southern border of development area. The inlet to the culvert is approximately 500m south west of the site.
- Because of the location at the head of the catchment, it is likely that the volume of flows in this watercourse will be relatively low.
- Environment Agency Flood Zones are not produced in the very upper reaches of watercourses.
- Consultation has not revealed any instances localised flooding in this development area. This suggests that the culverts are of sufficient capacity in this area.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culverts within the vicinity of the development area. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan). These flow routes pass through a significant portion of the site. However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert.
- Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the south west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there are surface water flow routes directly through the site.
- The site is dominated by a low area of ground at its centre, to the east of Ettingshall Sports Ground. Several overland flow paths converge here whilst the outflow is limited by a railway embankment. This could lead to surface water ponding, possibly to significant depth, depending on the capacity of existing surface water drainage infrastructure
- The site is considered to be at high risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. This will increase the potential for surface water runoff to affect adjacent areas of land, primarily to the north.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered high.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has revealed that there are several incidences of sewer flooding within the development.
- There is no information on the cause or the severity of the flooding.
- Without specific information the site is considered to be at high risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes along the eastern border of the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way reduces that the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Assess the flow capacity of the culverted watercourses and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the PPS25 Flood Zones.
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement)
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

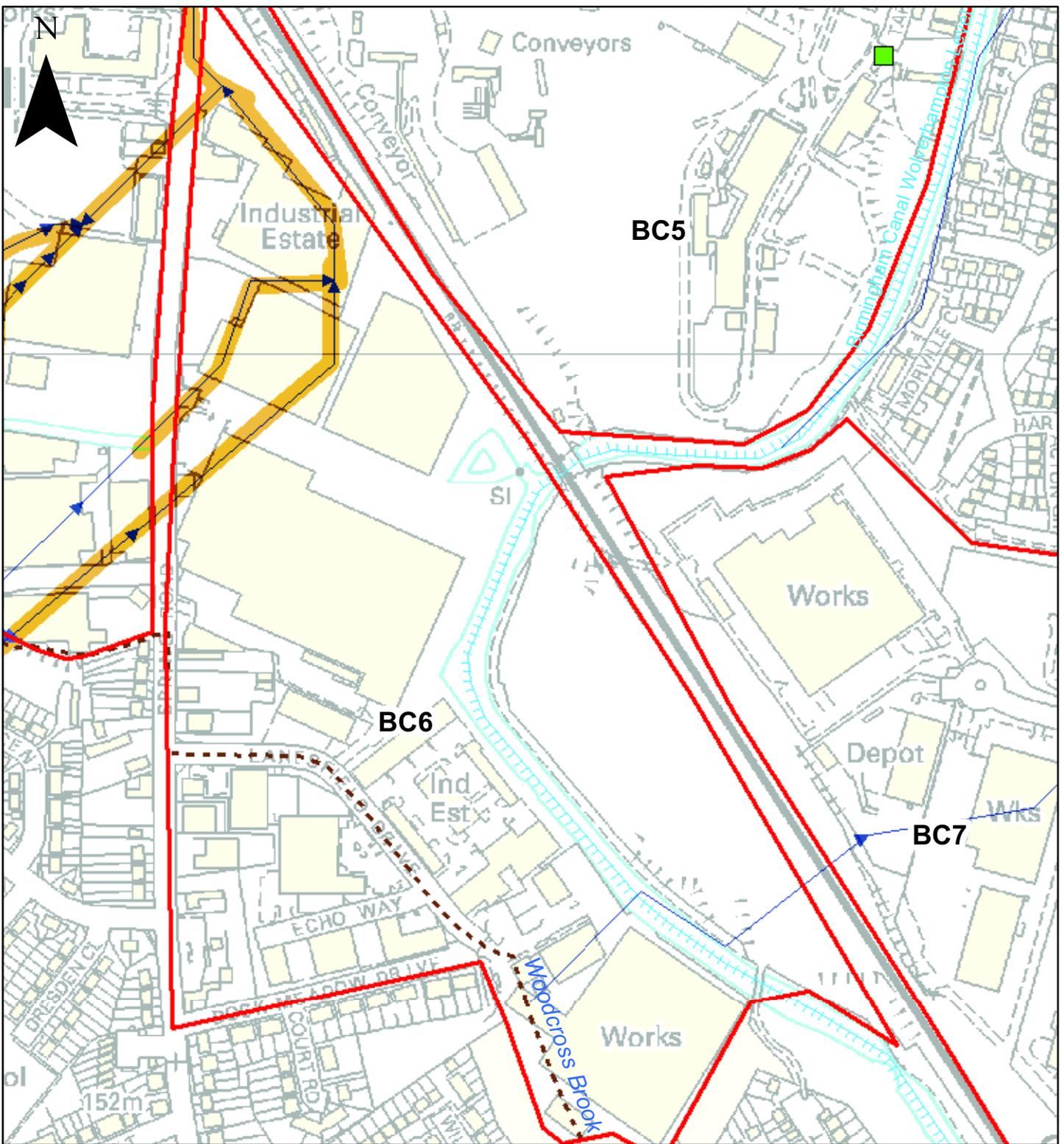
- Investigate the causes of sewer flooding to ascertain whether they are indicative of a risk to the development area.
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

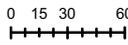
Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC6
Site Name: East of Spring Road



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> ➔ Indicative Surface Water Runoff Routes <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 15 30 60 Meters</p> 	<p>Scale @ A4: 1:4,000</p>	<p>Drawing Title: Site BC6</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/BC6</p>									
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Produced	EDR	April 2009									
Checked	DRD	April 2009									
Approved	KD	April 2009									

Site Details

Site Area :	21 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	393410, 295755	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Woodcross Brook flows in culvert along the south eastern border of the development area. The inlet to the culvert is approximately 500m south west of the site.
- As this watercourse is in the very upper reaches of its catchment, it has not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flow through the culvert will be relatively low.
- Consultation has not revealed any instances of localised flooding in this development area. This suggests that the culvert is of sufficient capacity.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culverts present on site. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan) and part the site is affected. However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.
- If surface waters are discharged into the culverted watercourses, fluvial flood risk could increase both upstream and downstream of the culvert.
- Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the south and south west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there is a surface water flow route directly through the site.
- The site is considered to be at high risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- However, the overland flow path out of the site is in an easterly direction and this flow path is blocked by railway infrastructure and the Birmingham Canal which crosses through the site.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:*Risk to Proposed Development*

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has not revealed any incidences of sewer flooding within the development.
- The site is considered to be at low risk of sewer flooding.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density equivalent could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes through the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Fluvial Flood Risk**

- Assess the flow capacity of the culverted watercourse and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the PPS25 Flood Zones.

- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

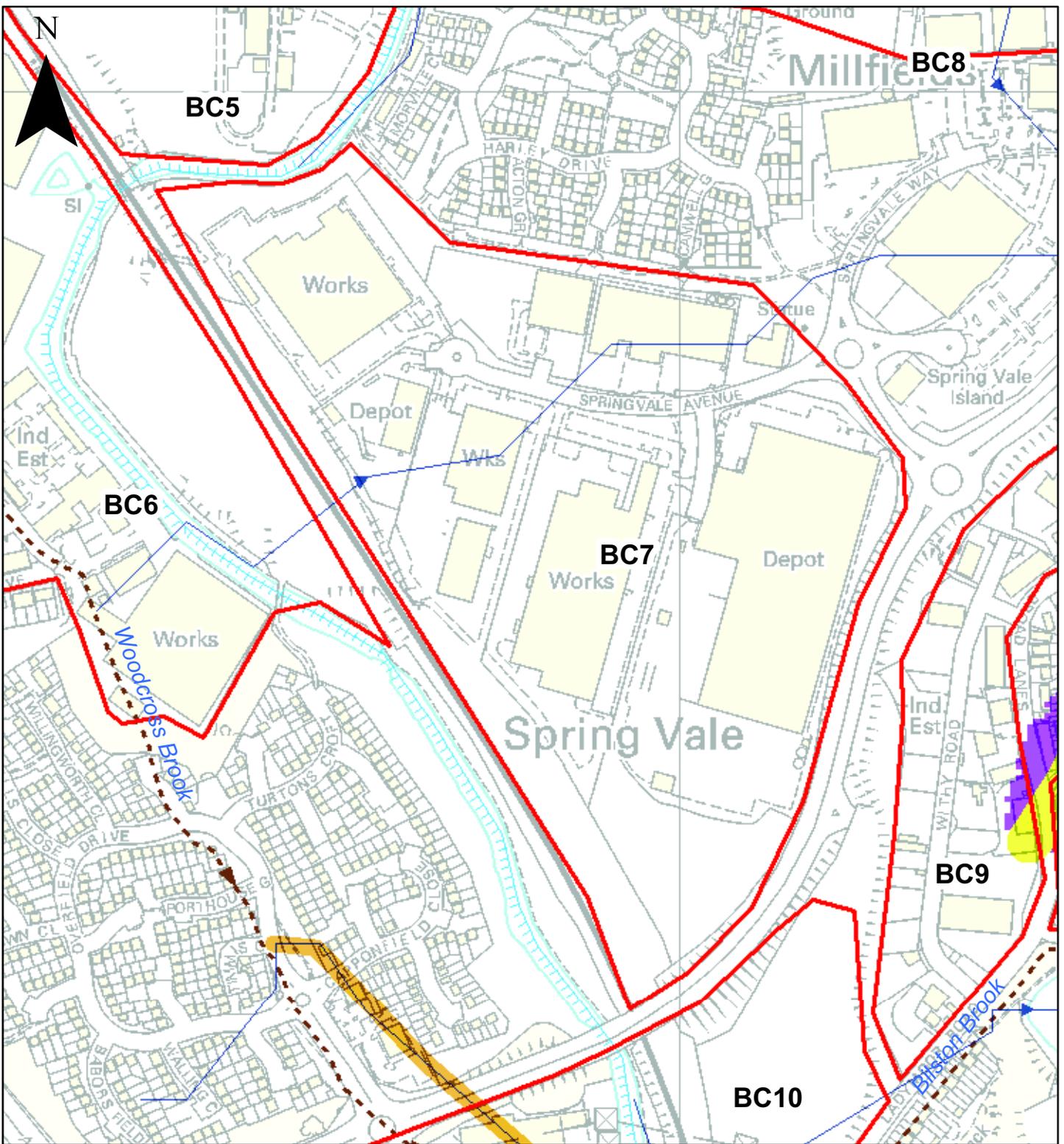
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

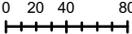
Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC7
Site Name: Spring Vale Avenue



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surcharge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> ➔ Indicative Surface Water Runoff Routes Watercourse Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 20 40 80 Meters</p> 	<p>Scale @ A4: 1:5,000</p>	<p>Drawing Title: Site BC7</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/BC7</p>									
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Site Details

Site Area :	21 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	393410, 295755	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the south and south west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there is a surface water flow route directly through the site. However, the Birmingham Canal and infrastructure are likely to prevent overland flows reaching the development area.
- The site is considered to be at low risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered medium.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has not revealed any incidences of sewer flooding within the development.
- The site is considered to be at low risk of sewer flooding.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density equivalent could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes along the western border of the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Surface Water Runoff Management**

- Show how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

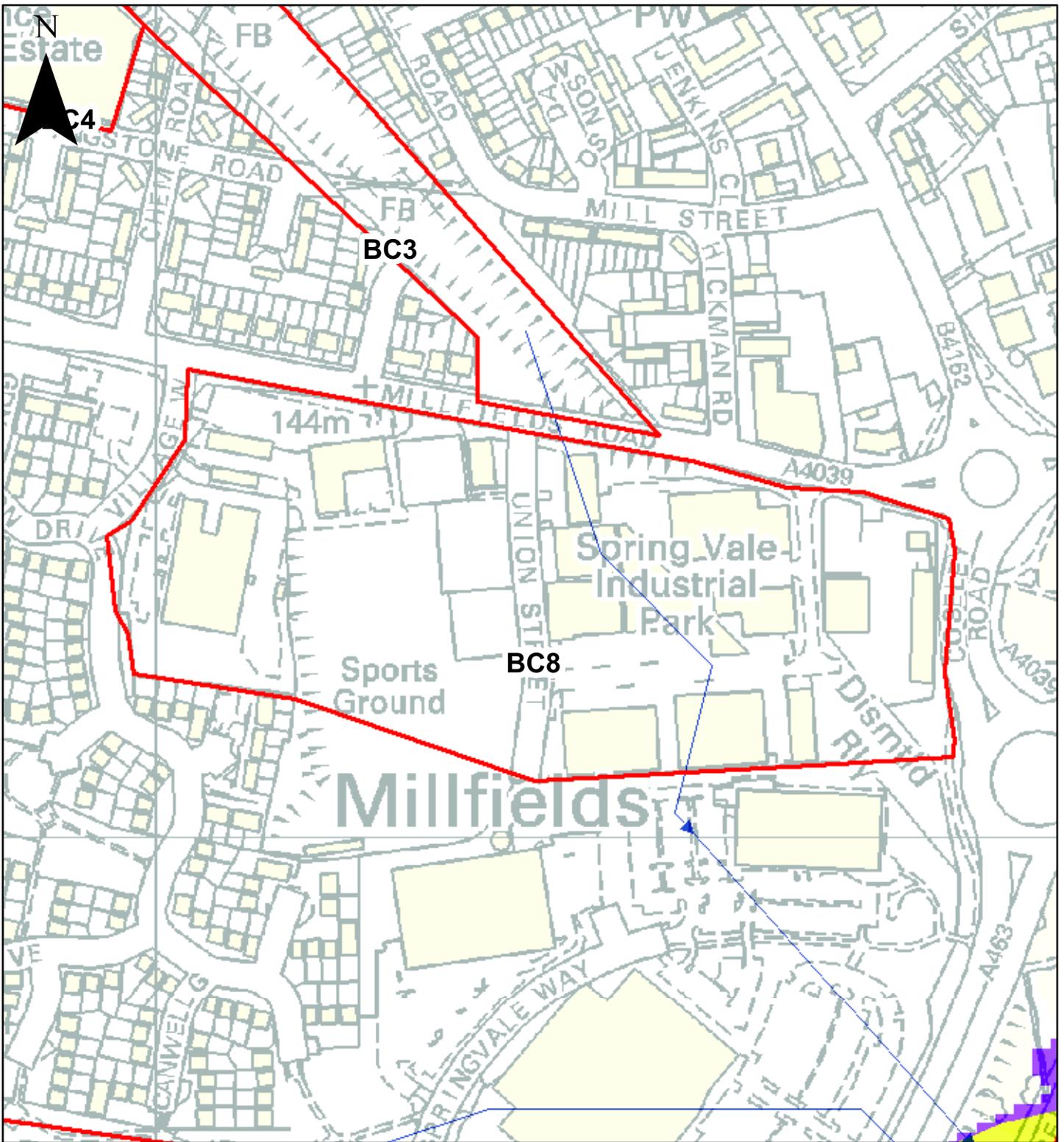
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

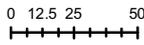
Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC8
Site Name: Sping Vale Industrial Park



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents ■ Overland Flow Paths Level 1 SFRA ■ Indicative Culvert Surge Flow Paths ■ Flood Zone 3b ■ Flood Zone 3a ■ Flood Zone 2 	<ul style="list-style-type: none"> → Indicative Surface Water Runoff Routes <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client:</p> 									
<p>0 12.5 25 50 Meters</p> 	<p>Scale @ A4: 1:3,000</p>	<p>Project:</p> <p>Wolverhampton SFRA Level 2</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Title:</p> <p style="text-align: center;">Site BC8</p> <p>Drawing Number:</p> <p style="text-align: center;">B0536900/L2SFRA/BC8</p>									
<p><small>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</small></p>	<p>Office:</p> <p style="text-align: center;">Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Produced</td> <td style="width: 33%;">EDR</td> <td style="width: 33%;">April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
Produced	EDR	April 2009									
Checked	DRD	April 2009									
Approved	KD	April 2009									

Site Details

Site Area :	7.2 ha	Proposed Land Use:	Housing and Employment
Approximate Grid Reference:	394185, 296127	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the north of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there is a surface water flow route directly through the site.
- The site is considered to be at high risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered medium.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has not revealed any incidences of sewer flooding within the development.
- The site is considered to be at low risk of sewer flooding.

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density equivalent could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- No sources of this type of flooding have been identified.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Surface Water Runoff Management**

- Show how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

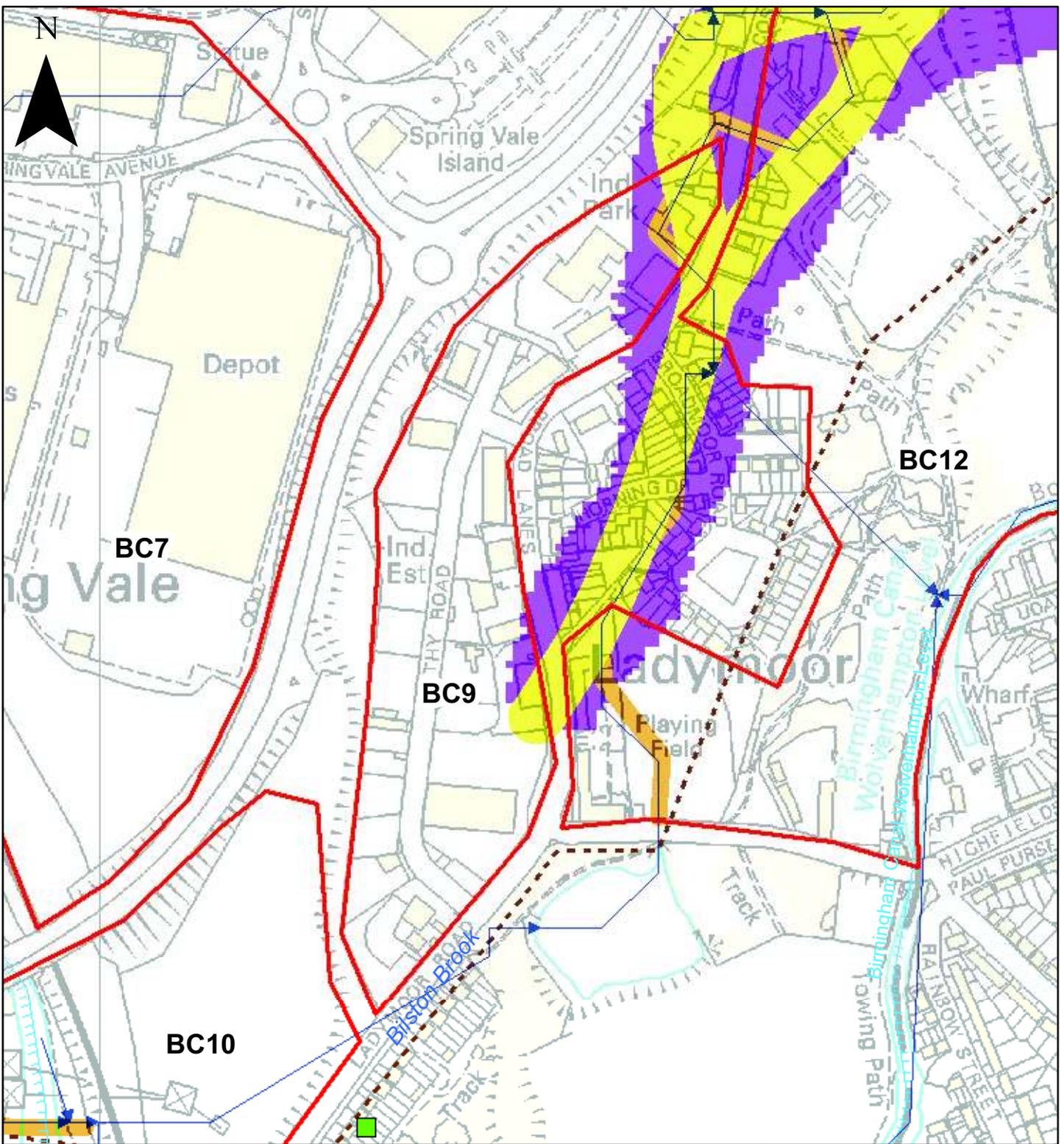
Sewer Flooding

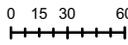
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding

elsewhere.

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Development Area: Bilston Corridor
Site Reference: BC9
Site Name: Withy Road Industrial Area



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 15 30 60 Meters</p> 	<p>Scale @ A4: 1:4,000</p>	<p>Drawing Title: Site BC9</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/BC9</p>									
<p>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</p>	<p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<table border="1"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Checked	DRD	April 2009									
Approved	KD	April 2009									

	Level 2 Strategic Flood Risk Assessment	Site Reference: BC9 Withy Road Industrial Area
Site Details		
Site Area : 6.3 ha Approximate Grid Reference: 394249, 295455.	Proposed Land Use: Housing and Employment PPS25 Vulnerability Classification: More Vulnerable and Less Vulnerable	
Assessment of Flood Risks		
<p>Flooding from Rivers</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> • A culverted section of the minor watercourse; Bilston Brook runs passes a short distance south and east of the site. It does not pass through the site itself. • During the Black Country SFRA Level 1, Bilston Brook culvert was assessed as being capable of conveying 1 in 500 year flows and Flood Zone 3a High Probability, was removed from the Environment Agency Flood Maps for this area. • The Flood Zone 3a High Probability was replaced with a possible overland flow route due to culvert blockage or collapse. This pathway follows the original route of Flood Zone 3a and affects a small area of the east and north of the site • Flood Zone 2 Medium Probability relating to Bilston Brook extends to the east of the site, affecting small areas of the east of the site and the northern tip (approximately 10%). • The estimated flood characteristics are: <ul style="list-style-type: none"> – Time to peak: 2 hours – Duration of flooding: 4 hours – Maximum flood depth (Q1000): 0.4m – Velocity of flows (Q1000): 1.1m/s <p><i>Potential Impact from Proposed Development</i></p> <ul style="list-style-type: none"> • The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk. • Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site. • If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert. 		
<p>Flooding from Land:</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> • The site is bordered by heavily urbanised high ground to the west and south of the site which could potentially generate surface flows onto the site. • The Birmingham Canal is to the west and south of the site. A railway embankment is also to the west. These features are likely to impede surface flows onto the site. • The development area is assessed as being at medium risk of surface water runoff. <p><i>Potential Impact from Proposed Development</i></p> <ul style="list-style-type: none"> • The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff. • Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the potential for development in this area to increase the risk of surface water flooding elsewhere is considered low. 		
<p>Flooding from Groundwater:</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> • The Black Country SFRA level 1 states that the Wolverhampton area is experiencing increasing groundwater levels due to the reduction of commercial abstraction. • However, consultation with the EA has not revealed any localised groundwater flooding issues near the 		

site.

- The site is considered to be at low risk of groundwater flooding based on the information available.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal flows approximately 300m to the west, south and east of the site. Consultation with British Waterways has revealed no specific localised flooding issues related to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 10% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Sewer Flooding

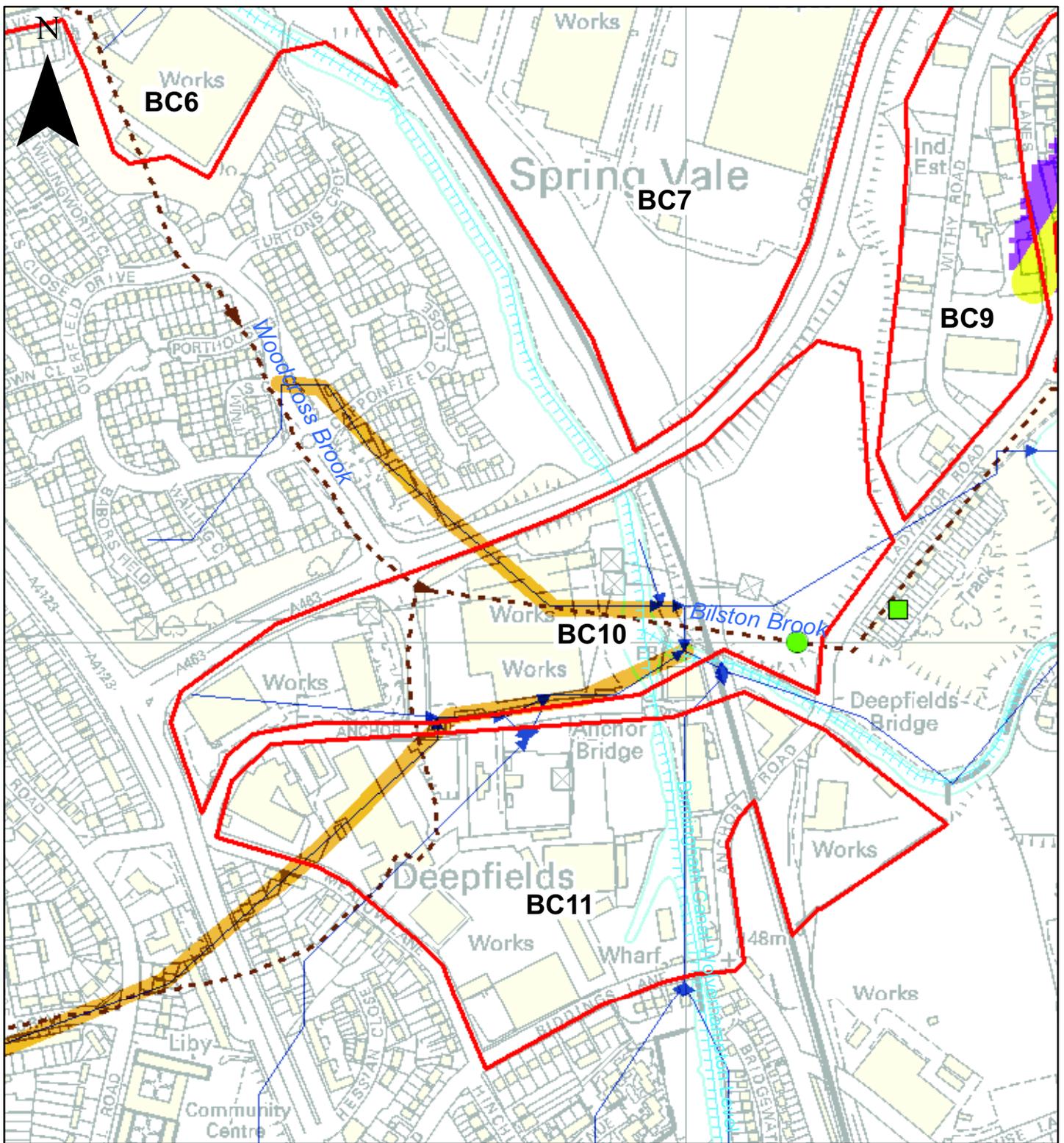
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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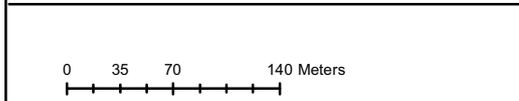
Development Area: Bilston Corridor
Site Reference: BC10
Site Name: North of Anchor Lane



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surge Flow Paths	Watercourse	
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**



Scale @ A4: 1:5,000

Drawing Title: **Site BC10**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: B0536900/L2SFRA/BC10

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009

Site Details

Site Area :	21 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	393848, 295018	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Bilston Brook flows in culvert through the development area.
- During the Black Country Level 1 SFRA, the capacity of the Bilston Brook culvert was checked and found to have a capacity of 1 in 500 year flows.
- Woodcross Brook joins Bilston Brook within the development area. This watercourse is also in culvert. Its flow capacity is not known.
- As these watercourses are in the very upper reaches of their respective catchments, they have not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flows through the culverts will be relatively low.
- Consultation has not revealed any instances of localised flooding in this development area. This suggests that the culverts are of sufficient capacity in this area.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culverts present on site. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan). However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.
- Changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there are several surface water flow routes that pass directly through the site.
- The site is considered to be at high risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- However, the overland flow path out of the site is in an easterly direction and this flow path is blocked by railway infrastructure and the Birmingham Canal which crosses through the site.
- Runoff from the eastern part of the site could affect land to the east.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered medium.
- Local surface water runoff paths could also be affected by development in this area.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has revealed an incidence of sewer flooding within the development.
- The frequency and severity of the flooding event is unknown.
- The site is considered to be at high risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density equivalent could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes through the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and in accordance with PPS25 there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
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- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Assess the flow capacity of the culverted watercourses and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the PPS25 Flood Zones.
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

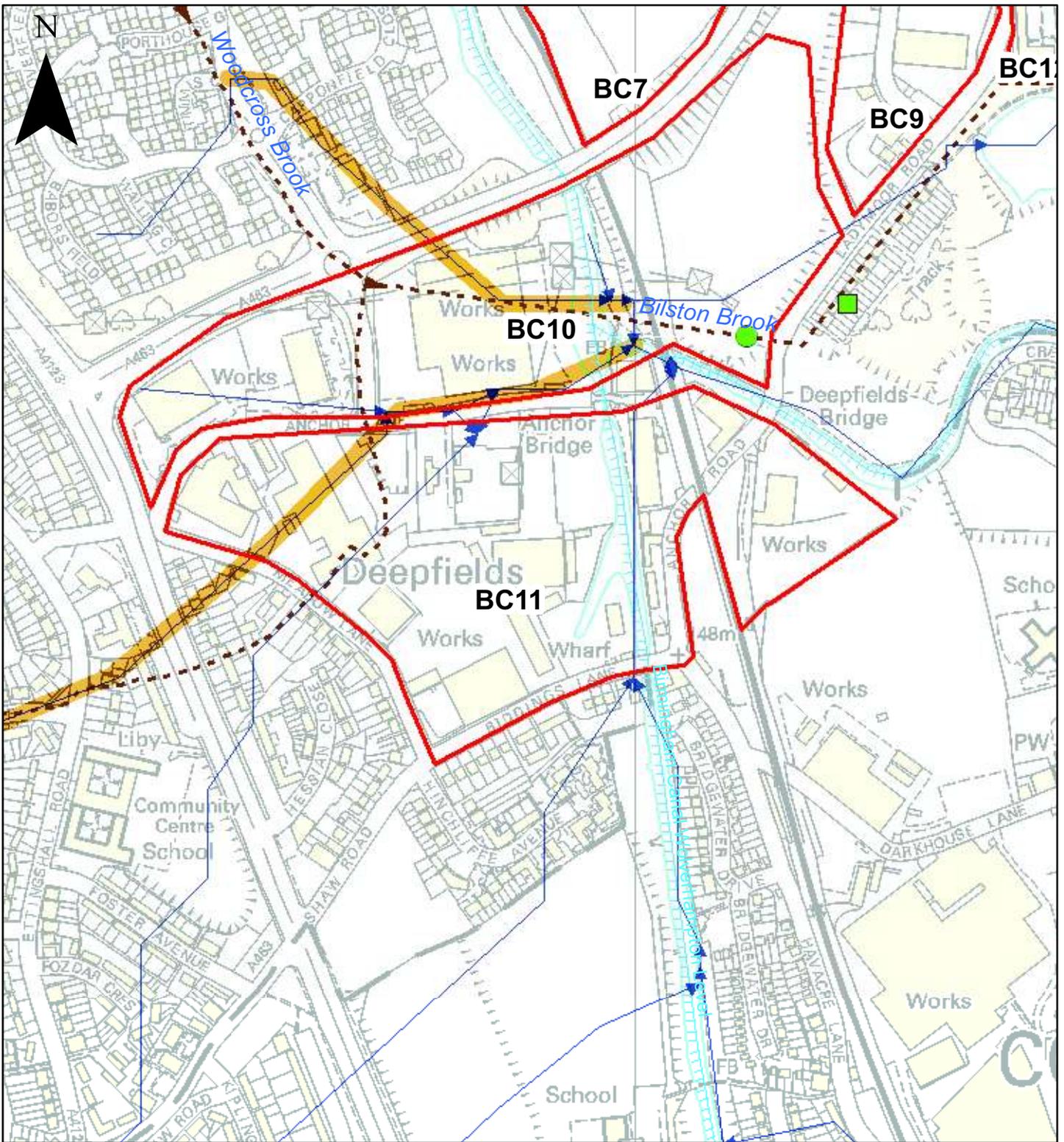
- Investigate the causes of sewer flooding to ascertain whether they are indicative of a risk to the development area.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC11
Site Name: South of Anchor Lane



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> → Indicative Surface Water Runoff Routes <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 35 70 140 Meters</p>	<p>Scale @ A4: 1:5,000</p>	<p>Drawing Title: Site BC11</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/BC11</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Produced</td> <td style="width: 33%;">EDR</td> <td style="width: 33%;">April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Site Details

Site Area :	11.4 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	393908, 294829	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Woodcross Brook flows, in culvert, through the development area. Its flow capacity is not known.
- As this watercourse is in the very upper reaches of its catchment, it has not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flow through the culvert will be relatively low.
- Consultation has not revealed any instances of localised flooding in this development area. This suggests that the culvert is of sufficient capacity.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culverts present on site. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan) and part the site is affected. However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert.
- Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site.

Flooding from Land:

Risk to Proposed Development

- There is urbanised high ground to the south and south west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- An analysis of potential overland flow paths indicates that there are several surface water flow routes that pass directly through the site.
- The site is considered to be at high risk from surface water runoff.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the overland flow path out of the site is in an easterly direction and this flow path is blocked by railway infrastructure and the Birmingham Canal which crosses through the site.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:*Risk to Proposed Development*

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- The Wolverhampton Level of the Birmingham Canal passes through the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted,
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Fluvial Flood Risk**

- Assess the flow capacity of the culverted watercourse and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the PPS25 Flood Zones.
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).

- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

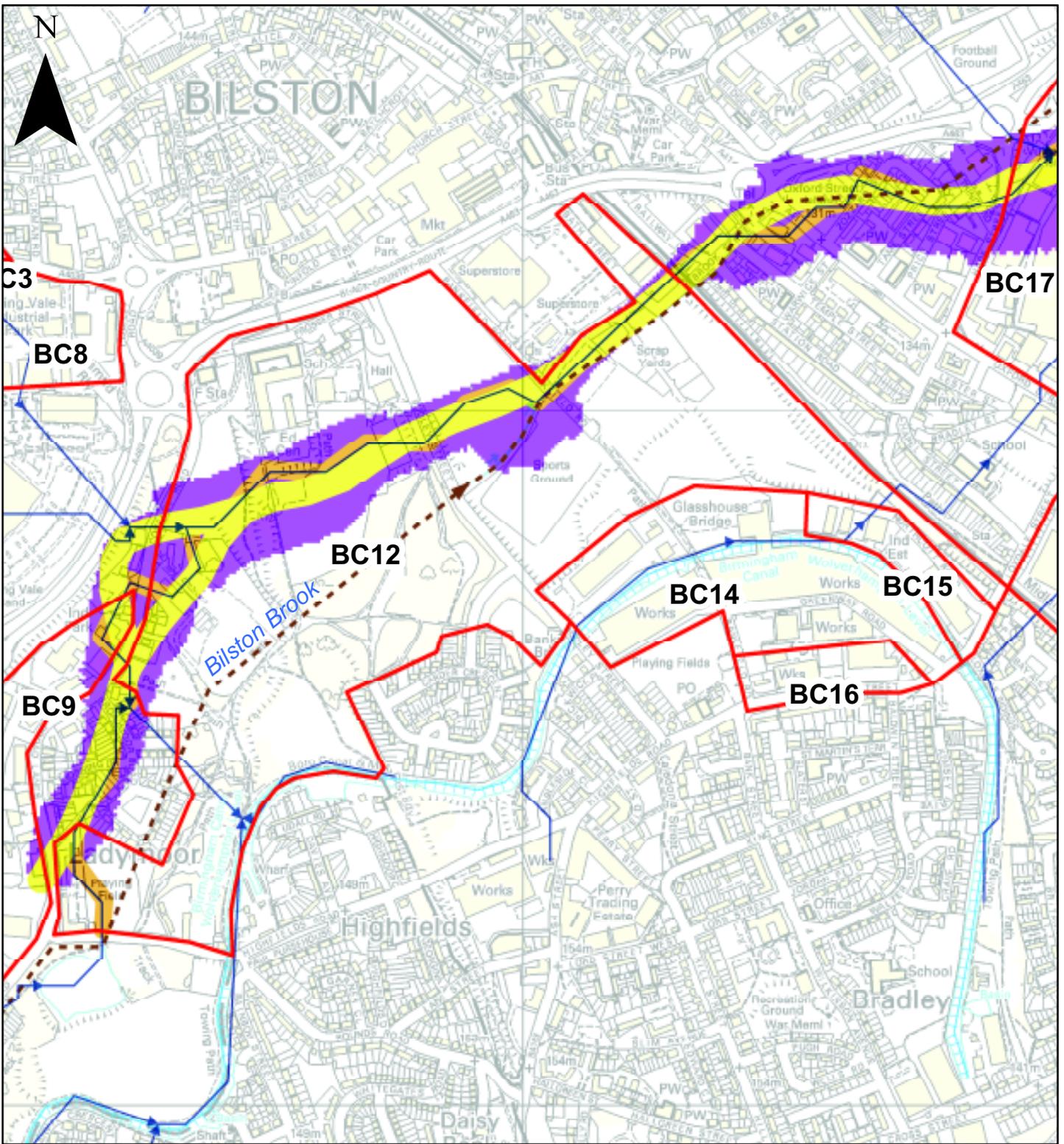
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC12
Site Name: Bilston Urban Village



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3a Flood Zone 2 Flood Zone 3b 	<p>➔ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>										
<p>0 55 110 220 Meters</p>	<p>Scale @ A4: 1:8,000</p>		<p>Drawing Title: Site BC12</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>		<p>Drawing Number: B0536900/L2SFRA/BC12</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Produced</td> <td style="width: 33%;">EDR</td> <td style="width: 33%;">April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Level 2 Strategic Flood Risk Assessment

Site Reference:
BC12
Bilston Urban Village

Site Details

Site Area :	48 ha	Proposed Land Use:	Housing
Approximate Grid Reference:	394827, 295850	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The minor watercourse Bilston Brook runs, in culvert, through the majority of the site. There is a small section of open watercourse towards the east.
- Approximately 20% of the site is classified as Flood Zone 2 Medium Probability (i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event).
- During the Black Country SFRA Level 1, Bilston Brook culvert was assessed as being capable of conveying 1 in 500 year flows and Flood Zone 3a High Probability, was removed from the Environment Agency Flood Maps for this area.
- The Flood Zone 3a High Probability was replaced with a possible overland flow route due to culvert blockage or collapse. This pathway follows the original route of Flood Zone 3a High Probability, a natural topographic depression.
- The Bilston Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: 2 hours
 - Duration of flooding : 4 hours
 - Maximum flood depth (Q1000): 1.1m
 - Velocity of flows (Q1000): 1.1m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert. The impact of any development at this site on fluvial flood risk could be high.
- Changes to topography and new structures/buildings following re-development could alter overland flow routes and could increase the risk of flooding at some locations outside of the development site.

Flooding from Land:

Risk to Proposed Development

- The development area is situated in the valley of Bilston Brook, which is now mostly in culvert. Consequently there is higher land to the north, south and west. The highest land is to the south and west.
- The surrounding areas are heavily urbanised, and will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- The site is bordered on the south by the Birmingham Canal which may impede surface flows onto the site.
- An analysis of potential overland flow paths indicates that there are several potential surface water flow routes directly through the development area.
- Surface water flows are likely to be concentrated into the topographic low point representing the old course of Bilston Brook which flows across the centre of the site. There is potential for surface water ponding of significant depth to occur here. The railway embankment bordering the eastern end of the site may represent a significant impediment to flow, also potentially leading to ponding of considerable depth.
- The site should be considered to be at high risk from surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the volume and rate of flows

from the land.

- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered high.

Flooding from Groundwater:

- The Black Country SFRA Level 1 states that the Wolverhampton area is experiencing increasing groundwater levels due to the reduction of commercial abstraction.
- However, consultation with the EA has not revealed any localised groundwater flooding issues near the site and groundwater flooding is normally most common in topographic low points not at the relatively high location of the site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal flows along the southern border of the site.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 20% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event

above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.

- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Sewer Flooding

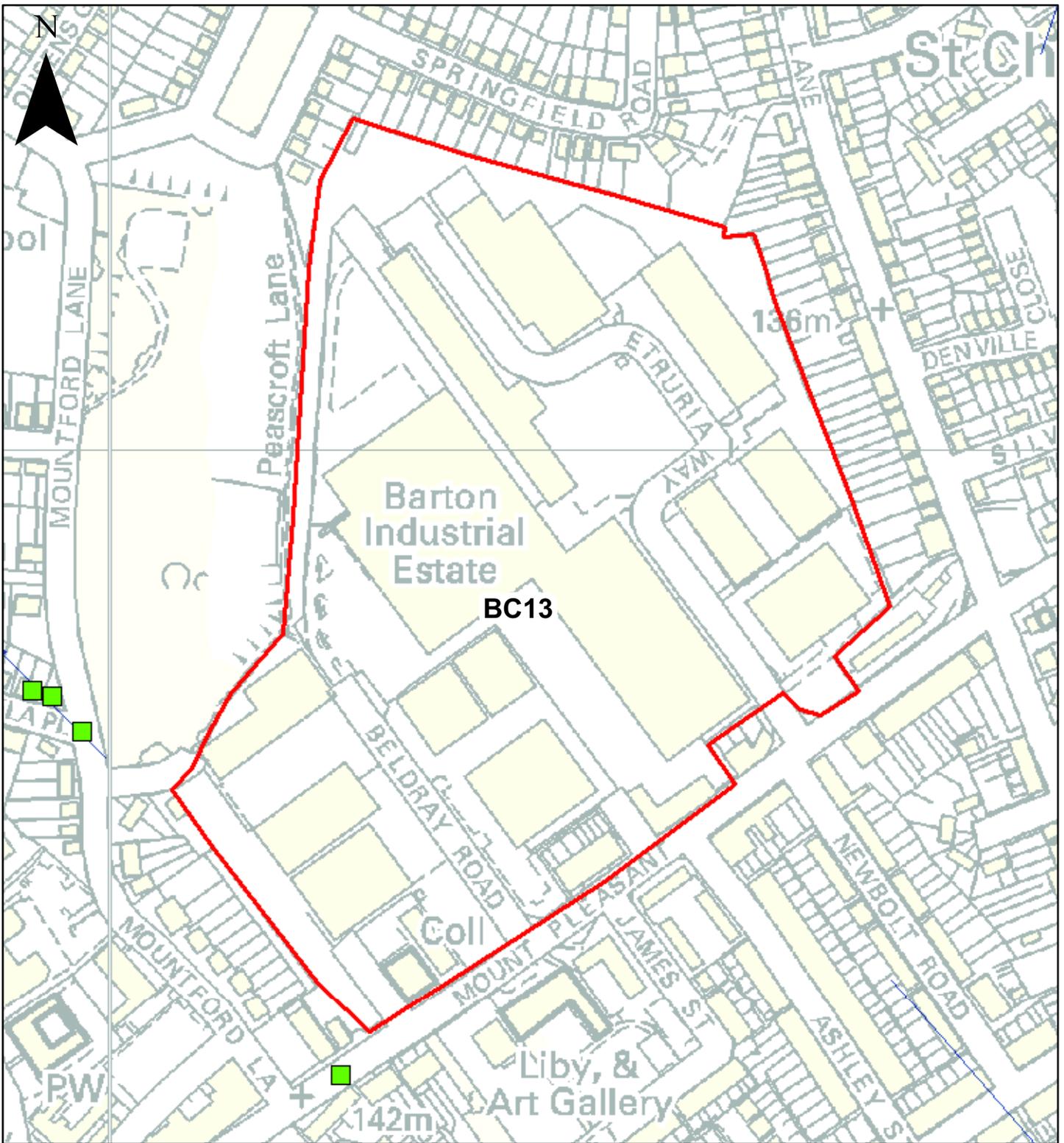
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

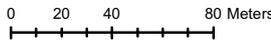
Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC13
Site Name: Barton Industrial Estate
(adjoining Bilston Town Centre)



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surcharge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 20 40 80 Meters</p> 	<p>Scale @ A4: 1:3,000</p>	<p>Drawing Title: Site BC13</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/BC13</p>									
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Level 2 Strategic Flood Risk Assessment

Site Reference:
BC13
Barton Industrial Estate
(adjoining Bilston town
centre)

Site Details

Site Area :	11.4 ha	Proposed Land Use:	Housing and Employment
Approximate Grid Reference:	395227, 296931	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing fluvial flood risk.

Flooding from Land:

Risk to Proposed Development

- The development area is situated on localised topographic high point and is unlikely to be at risk from surface water runoff.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has revealed some instances of sewer flooding in close proximity to the development area.
- The cause, frequency and severity of the sewer flooding are not known.
- Re-development of this site could increase the loading on the foul water network and increase risk of sewer flooding elsewhere.
- As the surrounding area already has a history of sewer flooding, the redevelopment of this site could potential have a high impact on the level of risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- No sources of this type of flooding have been identified.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

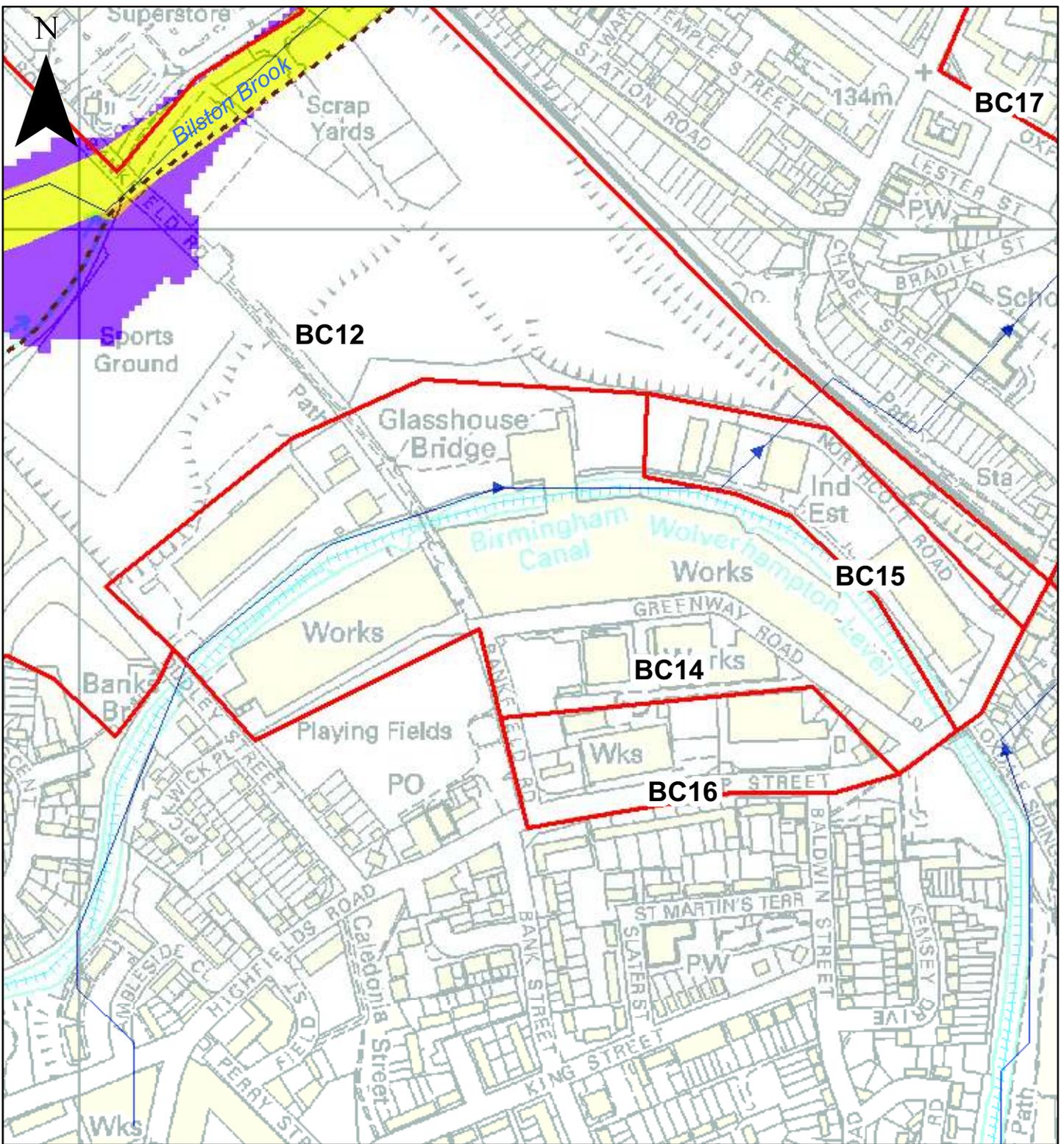
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Bilston Corridor
Site Reference: BC14
Site Name: Bankfield Works / Greenway Road



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Charge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 25 50 100 Meters</p>	<p>Scale @ A4: 1:4,000</p>	<p>Drawing Title: Site BC14</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/BC14</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Site Details

Site Area :	9.5 ha	Proposed Land Use:	Housing
Approximate Grid Reference:	393323, 295769	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high ground to the south of the site, which, as the area is heavily urbanised and impermeable, is likely to generate surface water flows during heavy rainfall events.
- An analysis of overland flow routes does *not* show overland flow routes towards the site.
- The site is considered to be at medium risk from surface water runoff.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the overland flow path out of the site is in a north easterly direction and this flow path is blocked by railway infrastructure and the Birmingham Canal which crosses through the site.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes through the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this

canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

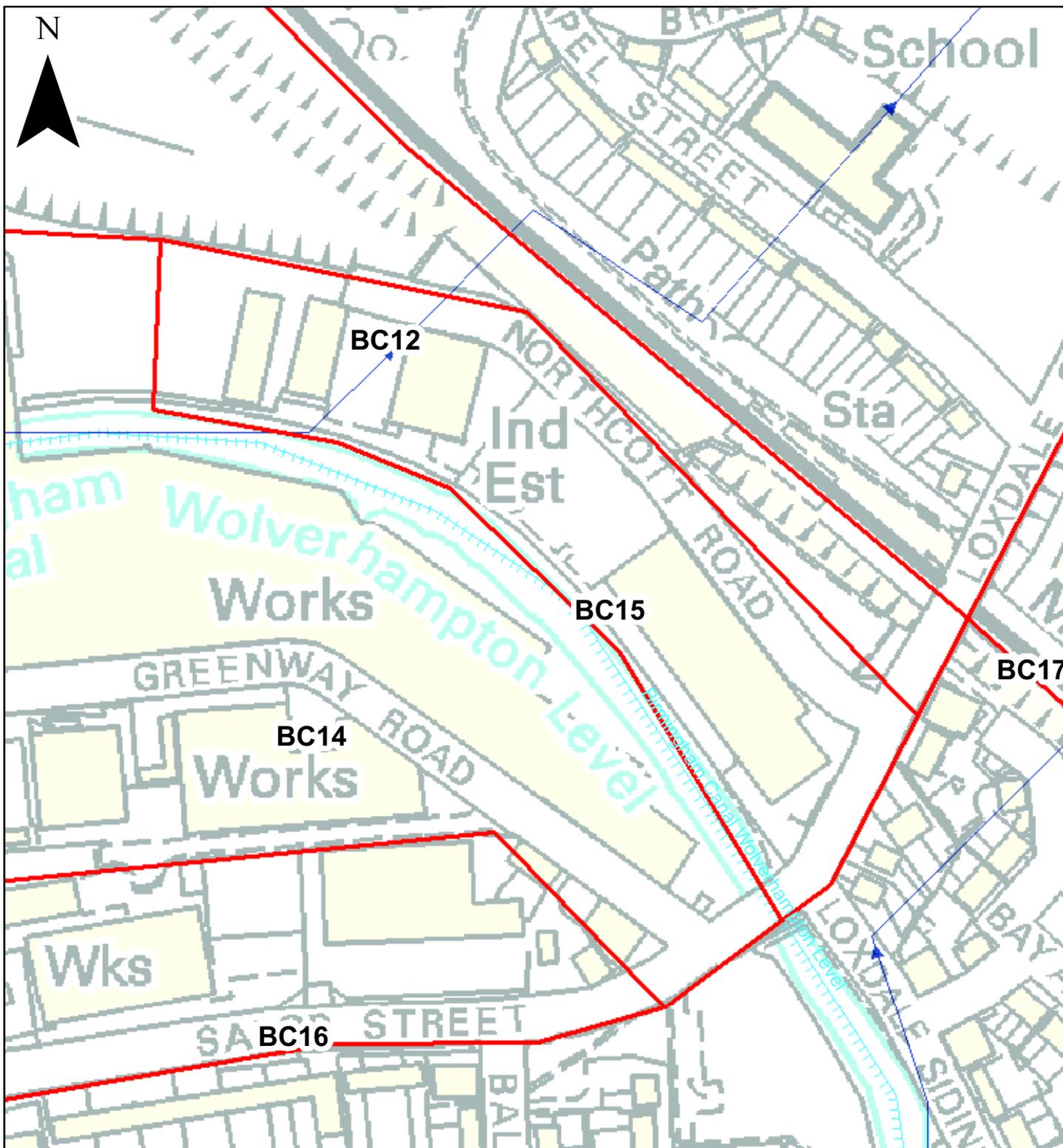
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC15
Site Name: Northcott Road



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surcharged Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 12.5 25 50 Meters</p>	<p>Scale @ A4: 1:2,000</p>	<p>Drawing Title: Site BC15</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/BC15</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Site Details

Site Area :	2.1 ha	Proposed Land Use:	Housing and Employment
Approximate Grid Reference:	395561, 295790	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high ground to the south west of the site. This area will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- The Birmingham Canal (Wolverhampton Level) is likely to intercept any overland flows into the site, therefore the level of risk is considered to be low.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the overland flow path out of the site is in a north easterly direction and this flow path is blocked by railway infrastructure.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at low to medium risk of groundwater flooding

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes to the south of the development area.

- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

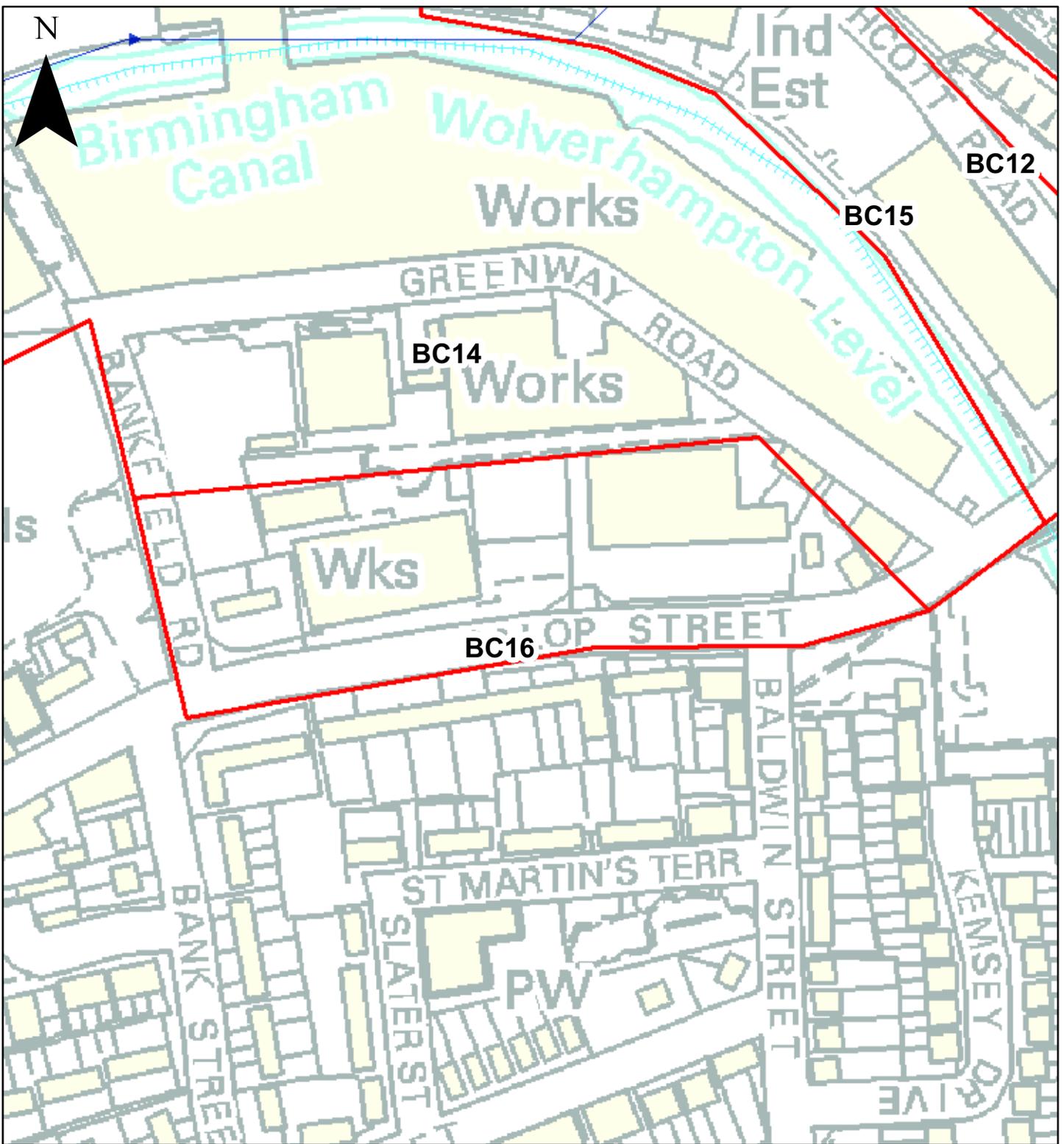
- Consult Severn Trent water to asses the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.

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Development Area: Bilston Corridor
Site Reference: BC16
Site Name: Salop Street



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA Groundwater Flooding Incidents ■ Overland Flow Paths Level 1 SFRA ■ Indicative Culvert Surge Flow Paths ■ Flood Zone 3b ■ Flood Zone 3a ■ Flood Zone 2 	<p>➔ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 12.5 25 50 Meters</p>	<p>Scale @ A4: 1:2,000</p>										
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>										
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Site Details

Site Area :	1.8 ha	Proposed Land Use:	Housing and Employment
Approximate Grid Reference:	3954351, 295618	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high ground to the south west of the site, which, as the area is heavily urbanised and impermeable, is likely to generate surface water flows during heavy rainfall events.
- The site is considered to be at medium risk from surface water runoff.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The development area is considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Wolverhampton Level of the Birmingham Canal passes to the east of the development area.
- Consultation with British Waterways has not revealed any specific localised flooding issues relating to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and, in accordance with PPS25, there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
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Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
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- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

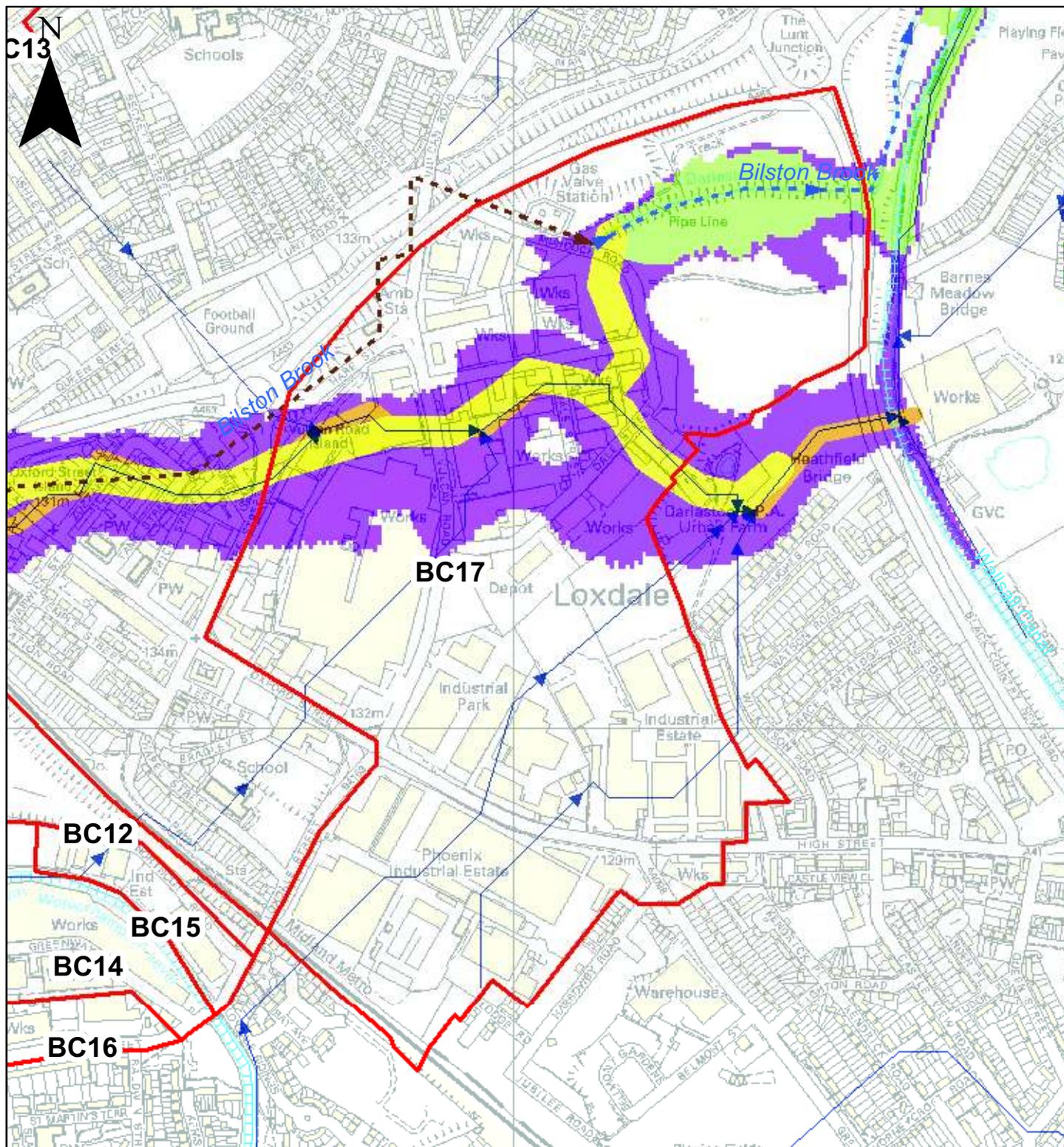
Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.

- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Bilston Corridor
Site Reference: BC17
Site Name: Loxdale Industrial Area
(including Citadel Junction site)

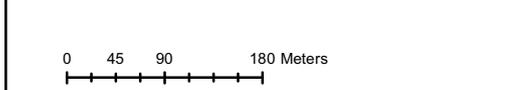


Legend

- Localised Flooding Incidents
- Sewer Flooding Incidents Level 2 SFRA
- Sewer Flooding Incidents Level 1 SFRA
- ⊗ Groundwater Flooding Incidents
- Overland Flow Paths Level 1 SFRA
- Indicative Culvert Surge Flow Paths
- Flood Zone 3b
- Flood Zone 3a
- Flood Zone 2
- Indicative Surface Water Runoff Routes
- Watercourse**
- Culvert
- Open Channel
- Canal

Client:

Project: **Wolverhampton SFRA Level 2**



Scale @ A4: 1:7,000

Drawing Title: **Site BC17**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: B0536900/L2SFRA/BC17

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Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009



Level 2 Strategic Flood Risk Assessment

Site Reference:
BC17
Loxdale Industrial Area
(including Citadel
Junction site)

Site Details

Site Area :	57 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	395979, 296289	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The minor watercourse, Bilston Brook runs, in culvert, along the north western edge of the site and emerges into open channel in the north east corner of the site.
- Approximately 20% of the site is classified as Flood Zone 2 Medium Probability (i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event).
- During the Black Country SFRA Level 1 the capacity of the Bilston Brook culvert was assessed as capable of conveying 1 in 500 year flow, consequently Flood Zone 3a High Probability was removed from the Flood Maps for this area.
- The Flood Zone 3a High Probability was replaced with probable overland flow route in the event of culvert blockage or collapse. The overland flow route follows local topography rather than the route of the culvert. Culverting appears to have diverted the watercourse northwards.
- Where Bilston Brook emerges from culvert Flood Zone 3a High Probability has been retained and this affects an area of approximately 5% of the site.
- The Bilston Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: 2.0 hours
 - Duration of flooding : 4 hours
 - Maximum flood depth (Q1000): 0.9m
 - Velocity of flows (Q1000): 1.8m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert. The impact of any development at this site on fluvial flood risk could be high.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the high ground to the north, west and south.
- These areas are heavily urbanised, and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- Preliminary analysis has identified several possible surface water flow paths onto the site from the north-west and south-west.
- It is likely that surface water will follow the topographic low points associated with the path of Bilston Brook followed before it was placed in culvert (the identified overland flow paths). There is the potential for significant depths of ponding in this area if this flow path was to be impeded or blocked, or if the drainage infrastructure was inadequate.
- The site itself has a west to east slope which could lead to onsite generated surface runoff. It is therefore likely that any surface water generated on the site would flow in this direction.
- The site should be considered to be at high risk from surface water flooding during high intensity rainfall events.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the volume and rate of flows from the land. However, the prevailing slope of the land is towards the Walsall Canal, and the presence of the canal structure will limit any surface water flows onto adjacent areas of land.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site consists of sedimentary rocks (mainly coal measures). Sedimentary rocks can act as a natural aquifer leading to high ground water level in the underlying strata.
- Consultation with the EA has not revealed any localised Groundwater flooding issues relating to this site.
- The Black Country SFRA Level 1 states that the Wolverhampton area is experiencing increasing groundwater levels due to the reduction of commercial abstraction.
- Parts of the site are topographically low compared to the surrounding area and there is a greater risk of groundwater emerging in such locations.
- It is considered that there is a medium risk of groundwater flooding in this area.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Walsall Canal flows along the north-eastern edge of the site. Consultation with British Waterways has revealed no specific localised flooding issues related to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 5% of the site is classified as Flood Zone 3a High Probability and 20% is Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk.
- It will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'Less Vulnerable' developments are classified as being compatible with Flood Zone 3a.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the

river(s) should be heavily promoted.

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration could be a viable option due to the poor drainage characteristics.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

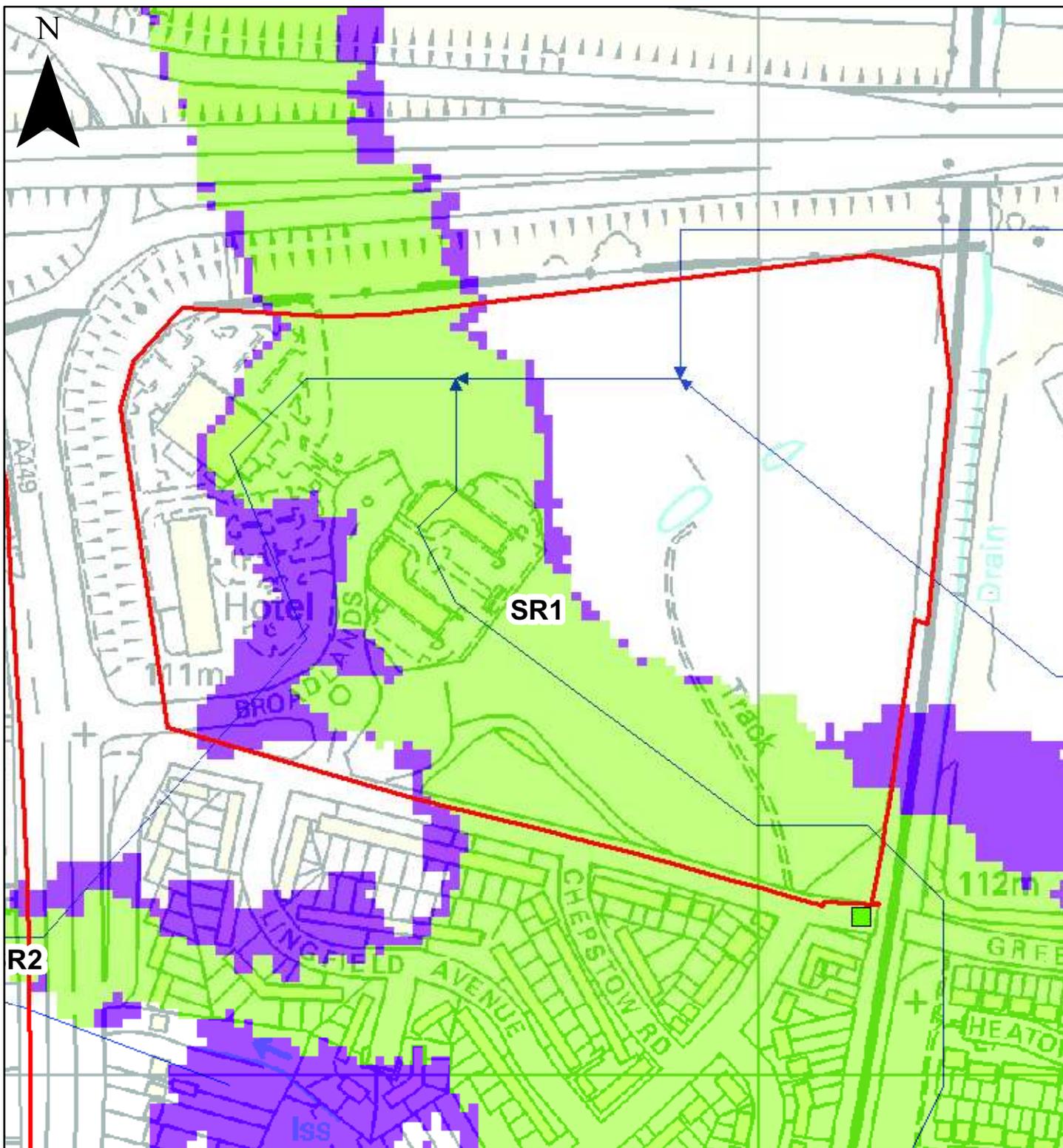
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR1
Site Name: Wolverhampton Business Park



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents ■ Overland Flow Paths Level 1 SFRA ■ Indicative Culvert Surge Flow Paths ■ Flood Zone 3b ■ Flood Zone 3a ■ Flood Zone 2 	<p>➔ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 12.5 25 50 Meters</p> 	<p>Scale @ A4: 1:3,000</p>	<p>Drawing Title: Site SR1</p>									
<p>Notes:</p> <p>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</p>	<p>JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/SR1</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
Produced	EDR	April 2009									
Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR1
**Wolverhampton Business
Park**

Site Details

Site Area :	11.9 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391873, 304285	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Waterhead Brook flows in open channel approximately 300m south of development site.
- Approximately 40% of the site is classified as Flood Zone 3a High Probability due to flooding from Waterhead Brook. Another 10% (approximately) is Flood Zone 2 Medium Probability.
- The Waterhead Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Onset of flooding: 1 hour
 - Time to peak: 2 hours
 - Duration of flooding: 2 hours
 - Maximum flood depth (Q1000): 0.6m
 - Velocity of flows: 1.85m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the higher ground to the east and south east.
- The area to the south east is urbanised, and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- The largely undeveloped land to the east has a till diamicton superficial geology which is largely impermeable in and may also generate runoff.
- An analysis of overland flow routes based upon topography suggests that there are number of potential flow paths through the site. These appear to be concentrated into a single flow path, and directed around the northern edge of the site, by the area of the high ground represented by the road embankment. Inadequate drainage of this area, or the introduction of flow impedance, could lead to significant depths of surface water ponding on this site.
- In addition several small ponds are shown in the OS coverage of this site but are not represented on SAR; these may represent localised topographic low points which could lead to surface water ponding.
- Information obtained from the Black Country Level 1 SFRA, from Severn Trent Water, indicates that there is an instance of surface water flooding from local highways on the south east border of the site.
- The site should be considered to be at medium to high risk from surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the volume and rate of flows from the land, which will increase the risk of surface water flooding to existing development to the west and south.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered high.

Flooding from Groundwater:

Risk to Proposed Development

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- According to Ordnance Survey data there is a pond in the centre of the development area. Ponds can be indicative of high water levels in the underlying strata.
- The site should be considered to be at high risk of groundwater flooding, as a precautionary measure.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed one instance of sewer flooding at this site. This is believed to be surface water flooding from localised highway runoff.
- As this is a confirmed instance of sewer related flooding the risk to the development is considered high.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- Ordnance Survey data shows a drainage channel east of the site.
- There are no reported instances of flooding from this drain.
- The risk from this feature is considered low, but further investigation will be needed to clarify the potential for flooding in future.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 15% of the site is classified as Flood Zone 2 Medium Probability or Flood Zone 3a. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment

Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.

- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2 or 3a, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDS to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

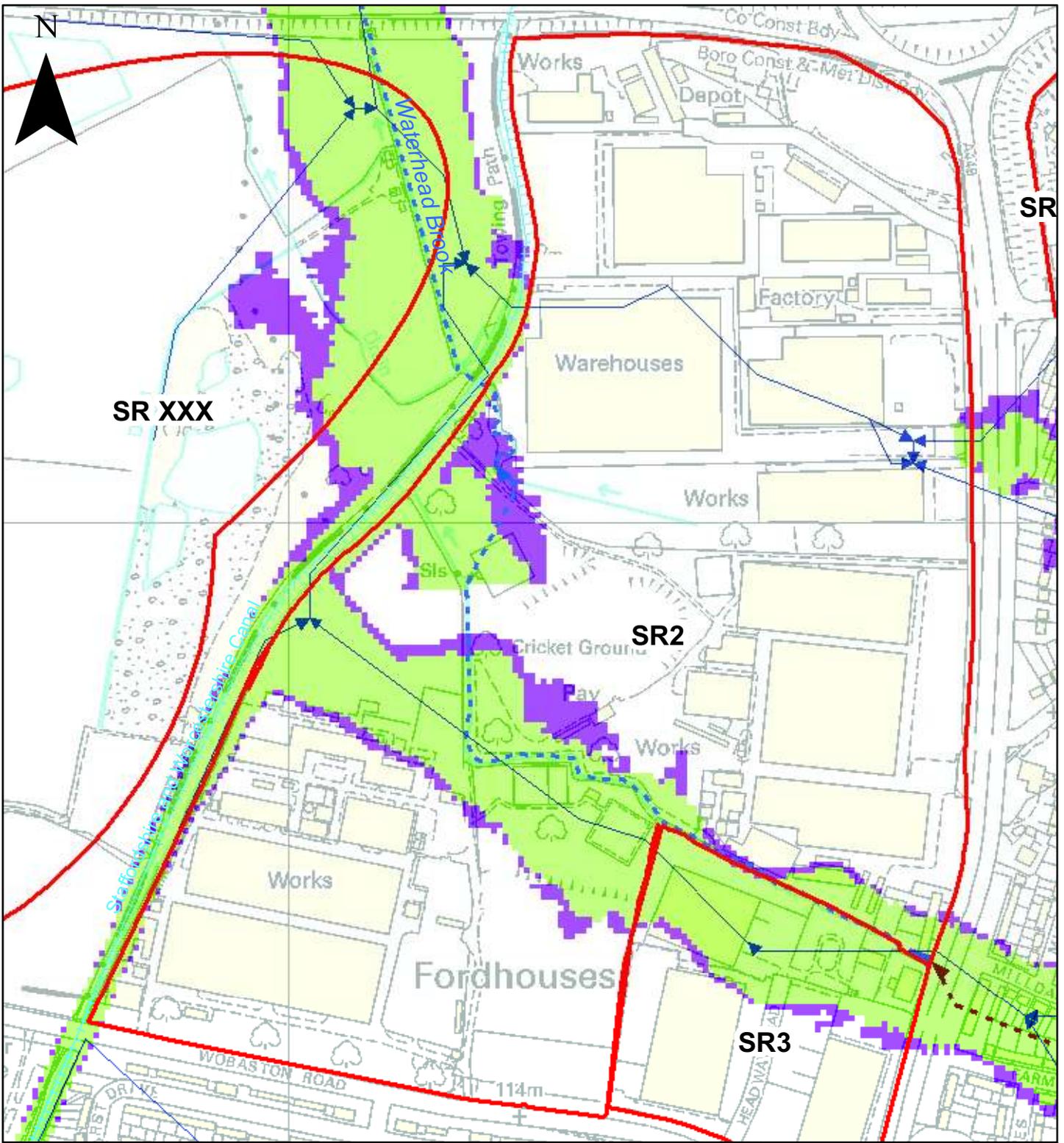
- Investigate the cause of sewer related flooding to the south east of the development area.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Determine the risk of flooding from the unnamed drain shown on OS mapping east of the site.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Stafford Road Corridor
Site Reference: SR2
Site Name: Fordhouses



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surge Flow Paths		Watercourse
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**

0 1020 40 Meters

Scale @ A4: 1:5,000

Drawing Title: **Site SR2**

Notes:

JACOBS
 Jacobs Engineering UK Ltd

Drawing Number: **B0536900/L2SFRA/SR2**

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009



**Level 2 Strategic
Flood Risk
Assessment**

**Site Reference:
SR2
Fordhouses**

Site Details

Site Area :	47 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391302, 303977	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Waterhead Brook flows through the development site. It flows in a short section of culvert at the downstream end of the site where it passes under the Staffordshire and Worcestershire Canal.
- Approximately 10% of the site is classified as Flood Zone 3a High Probability due to flooding from Waterhead Brook. Another 5% (approximately) is Flood Zone 2 Medium Probability.
- The Waterhead Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: 2 hours
 - Duration of flooding: 4 hours
 - Maximum flood depth (Q1000): 0.6m
 - Velocity of flows (Q1000): 2.5m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the high ground to the east. These areas are heavily urbanised and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- The overland flow routes to the site are limited by rail infrastructure to the east and existing watercourses that will capture surface flows.
- The impermeable nature of the superficial geology (till diamicton) underlying some of the site may lead to localised ponding issues and generate runoff.
- The site should be considered to be at low risk from surface water flooding.
- There may be a risk of surface water ponding to a significant depth during intense rainfall periods especially at topographic low points adjacent to the canal (at the western boundary).

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the volume and rate of flows from the land. However, the prevailing slope of the land is towards undeveloped areas of land.
- The presence of the canal structure will prevent any surface water flows onto adjacent areas of land.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The superficial geology of the site is impermeable till diamicton, which may impede groundwater rise from deep underground sources but may also lead to perched groundwater issues.
- Investigation of the Ordnance Survey data shows ponds in the general area of the site. This may be

evidence of high ground water levels in the area.

- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent Water are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The site is bordered to the west by the Staffordshire and Worcestershire Canal
- Ordnance Survey data shows a drainage channel towards the centre of the site.
- There are no reported instances of flooding associated with these features.
- The risk from these features is considered low but the further investigation will be needed to clarify the potential for flooding in future.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 15% of the site is classified as Flood Zone 2 Medium Probability or Flood Zone 3a. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.

- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2 or 3a, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

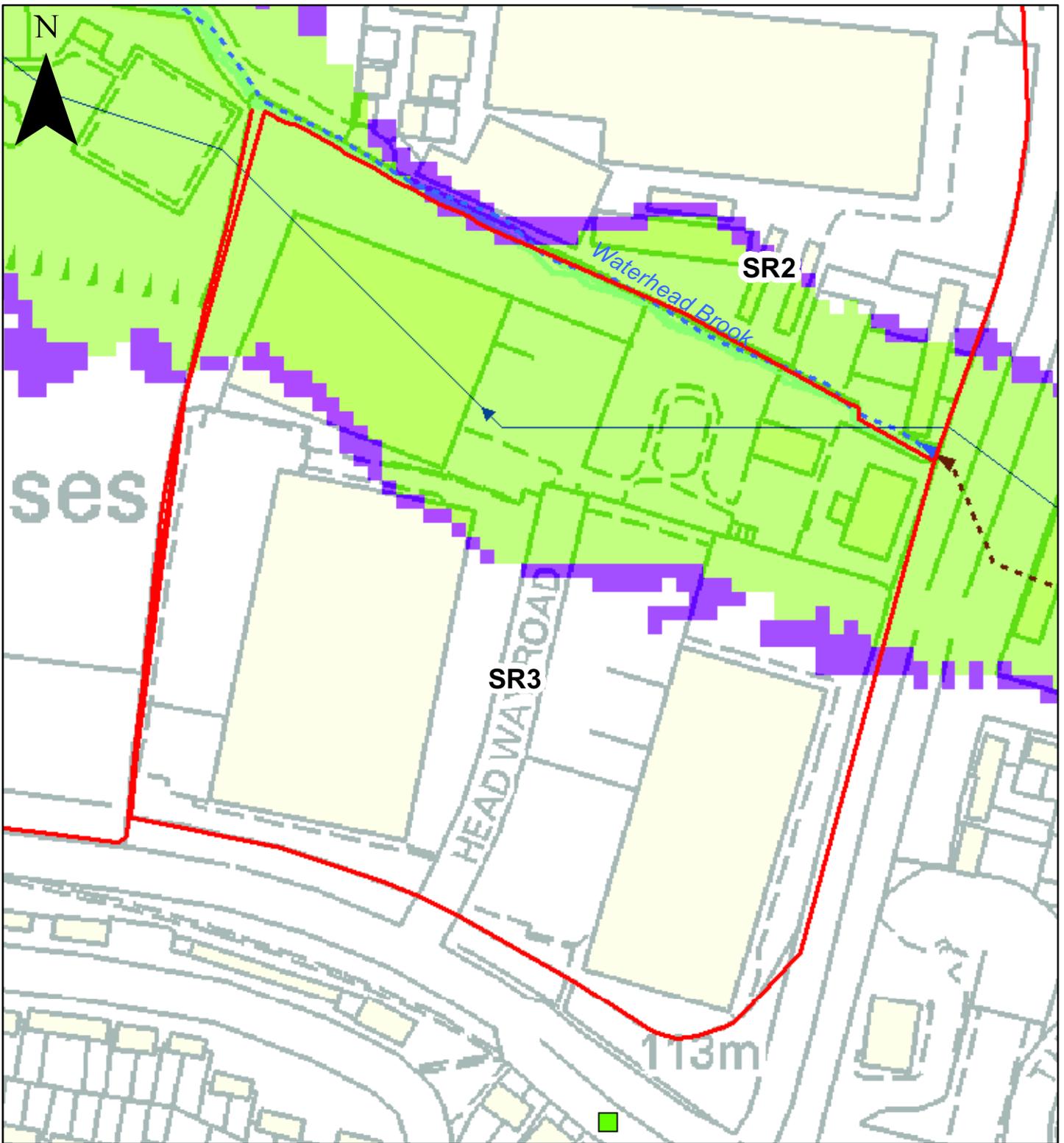
Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.

- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account
- Determine the risk of flooding from the unnamed drain shown on OS mapping in the centre of the site.

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Development Area: Stafford Road Corridor
Site Reference: SR3
Site Name: Headway Road



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surge Flow Paths		Culvert
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Open Channel
	Groundwater Flooding Incidents		Flood Zone 3a		Canal
			Flood Zone 2		

Client:

Project: **Wolverhampton SFRA Level 2**

03.57 14 Meters

Scale @ A4: 1:2,000

Drawing Title: **Site SR3**

Notes:

JACOBS
 Jacobs Engineering UK Ltd

Drawing Number: **B0536900/L2SFRA/SR3**

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009



Level 2 Strategic Flood Risk Assessment

**Site Reference:
SR3
Headway Road**

Site Details

Site Area :	6.1ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391302, 303977	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Waterhead Brook flows along the northern boundary of the development site. It flows into the area from a culvert underneath Stafford Road on the eastern boundary of the site.
- Approximately 35% of the site is classified as Flood Zone 3a High Probability due to flooding from the watercourse. Another 5% (approximately) is Flood Zone 2 Medium Probability.
- The Waterhead Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: 2 hours
 - Duration of flooding: 4 hours
 - Maximum flood depth (Q1000): 0.7m
 - Velocity of flows: *To be confirmed*

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed.
- Any changes to the surface water drainage system has potential to alter the existing drainage regime. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the high ground to the east. These areas are heavily urbanised, and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- The overland flow routes to the site are limited by rail infrastructure to the east and existing watercourses that will capture flows.
- The impermeable nature of the superficial geology (till diamicton) underlying some of the site may lead to localised ponding issues and generate runoff.
- The site should be considered to be at low risk from surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The superficial geology of the site is impermeable till diamicton, which may impede groundwater rise from deep underground sources but may also lead to perched groundwater issues.
- Investigation of the Ordnance Survey data shows some evidence of ponds in the general area of the site. This may be evidence of high ground water levels in the area.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.

- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.
- There are records from the Black Country Level 1 SFRA of several sewer flooding incidents close to the site. There is no information available on the specific cause or severity of the flooding.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Staffordshire and Worcestershire Canal is approximately 400m west of the site. Consultation with British Waterways has not revealed any specific incidents or risks associated to this stretch of canal.
- The risk from this feature is considered low.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 40% of the site is classified as Flood Zone 2 Medium Probability or Flood Zone 3a. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a

safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2 or 3a, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

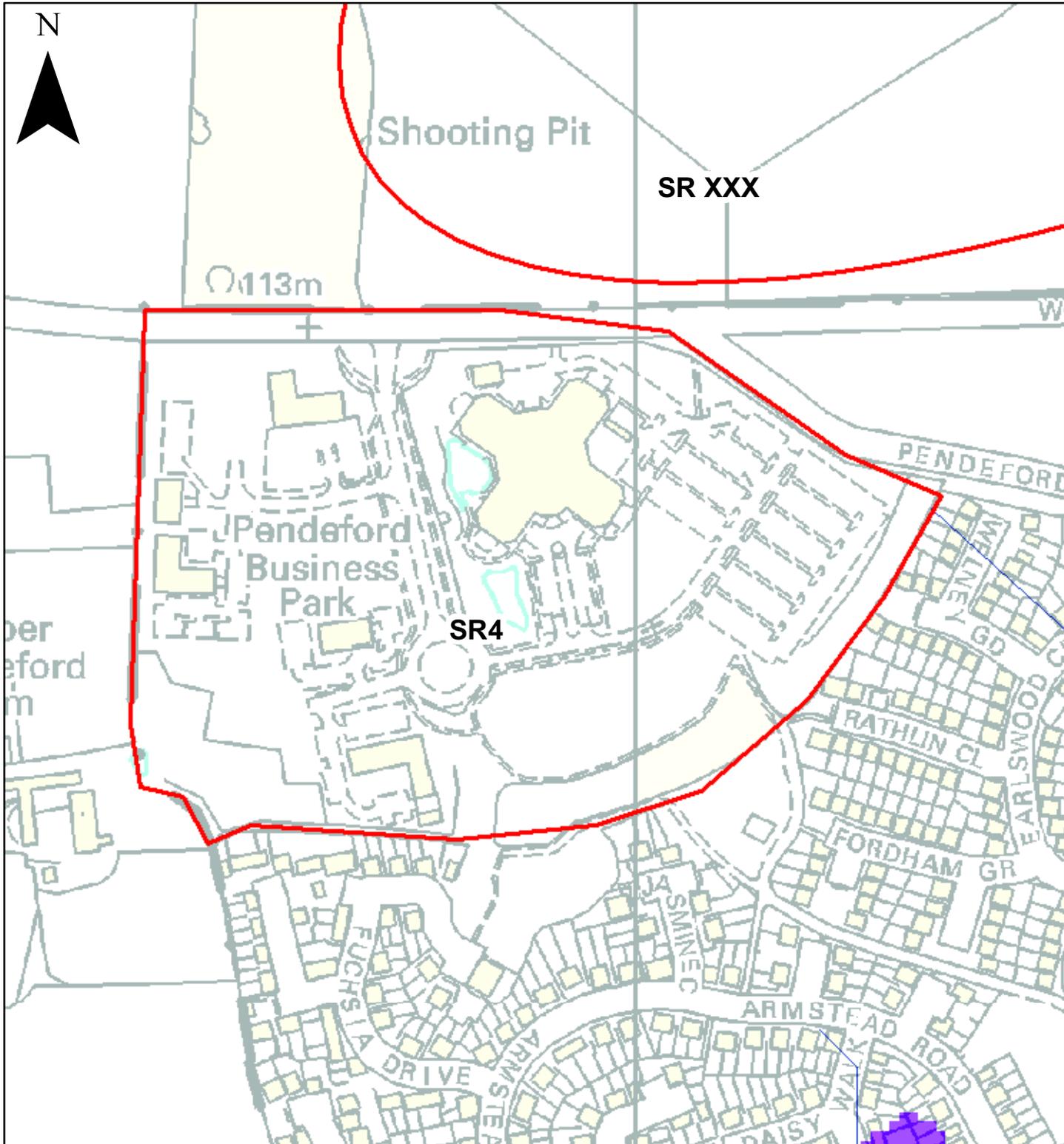
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR4
Site Name: Pendeford Business Park



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents ■ Overland Flow Paths Level 1 SFRA ■ Indicative Culvert Surchage Flow Paths ■ Flood Zone 3b ■ Flood Zone 3a ■ Flood Zone 2 	<p>➔ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>Scale @ A4: 1:3,000</p>	<p>Drawing Title: Site SR4</p>										
<p>Notes:</p>	<p>Drawing Number: B0536900/L2SFRA/SR4</p>										
<p>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</p>	<p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<table border="1"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR4
Pendeford Business Park

Site Details

Site Area :	9.8 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	389907, 303414	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is a small area of raised ground to the immediate west of site which may cause small volumes surface water flow onto the site.
- The site should be considered to be at low risk from surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- Three small ponds are shown on OS data for this site. No instances of flooding are reported for these features.
- Two of the ponds appear to be SUDS related features and are unlikely to represent a risk to development.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

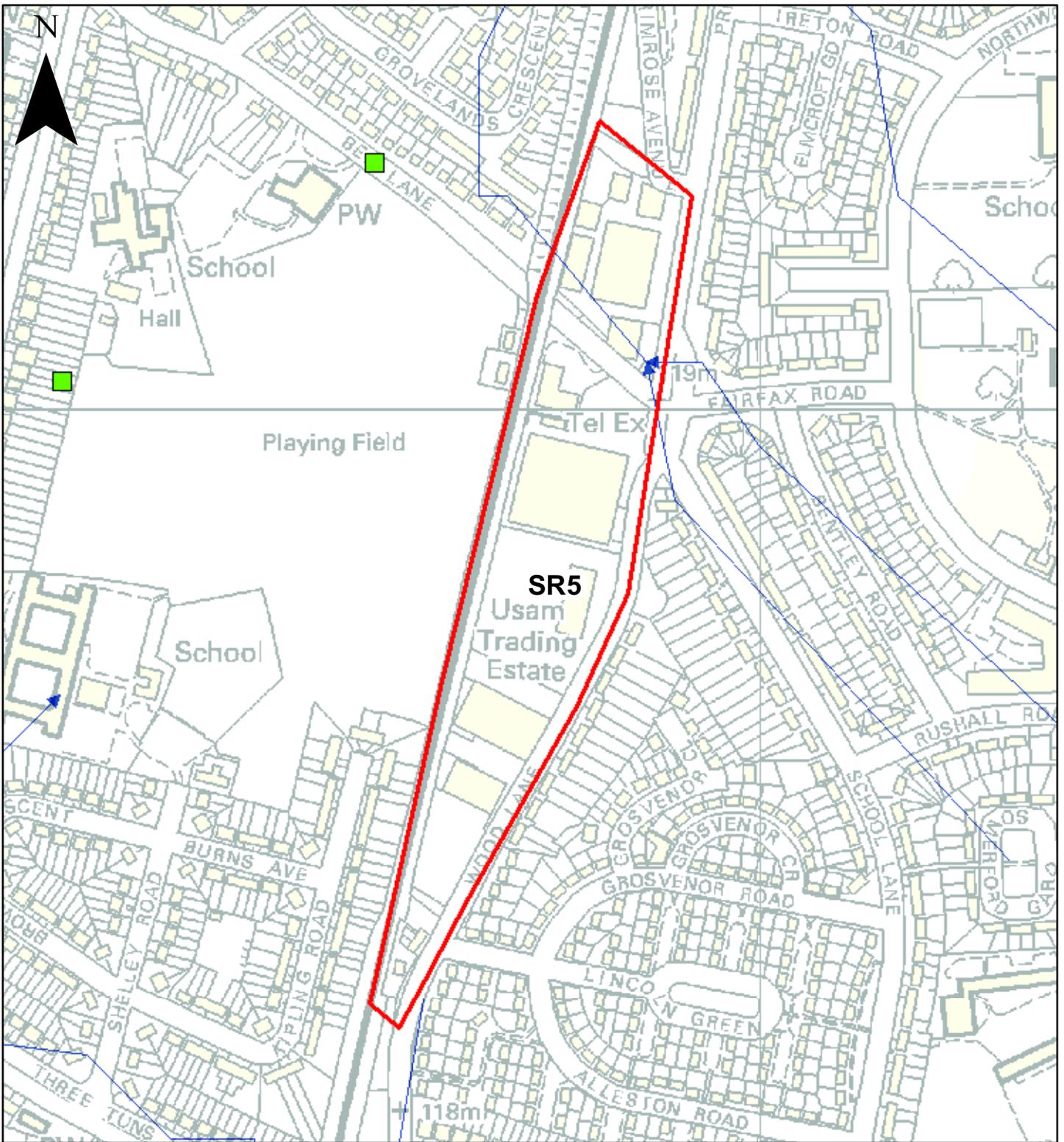
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR5
Site Name: Usam Trading Estate



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert SurchARGE Flow Paths	Watercourse	
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**

0.51020 Meters

Scale @ A4: 1:4,000

Drawing Title: **Site SR5**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: B0536900/L2SFRA/SR5

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Produced	EDR	April 2009
Checked	DRD	April 2009
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Level 2 Strategic Flood Risk Assessment

**Site Reference:
SR5
Usam Trading Estate**

Site Details

Site Area :	5.5 ha	Proposed Land Use:	Housing
Approximate Grid Reference:	391856, 302884	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- The site sits at the base of an area of high ground immediately to the east of the site, 'Bushbury Hill'
- Although the area is underlain by permeable sandstones, with no superficial geology recorded, the steep and urbanised nature of the ground suggests that surface water flooding is a risk to this site.
- An analysis of overland flow routes based upon topographic data suggests that there is an overland flow route directly through the northern section of the site.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
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Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology,

superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.

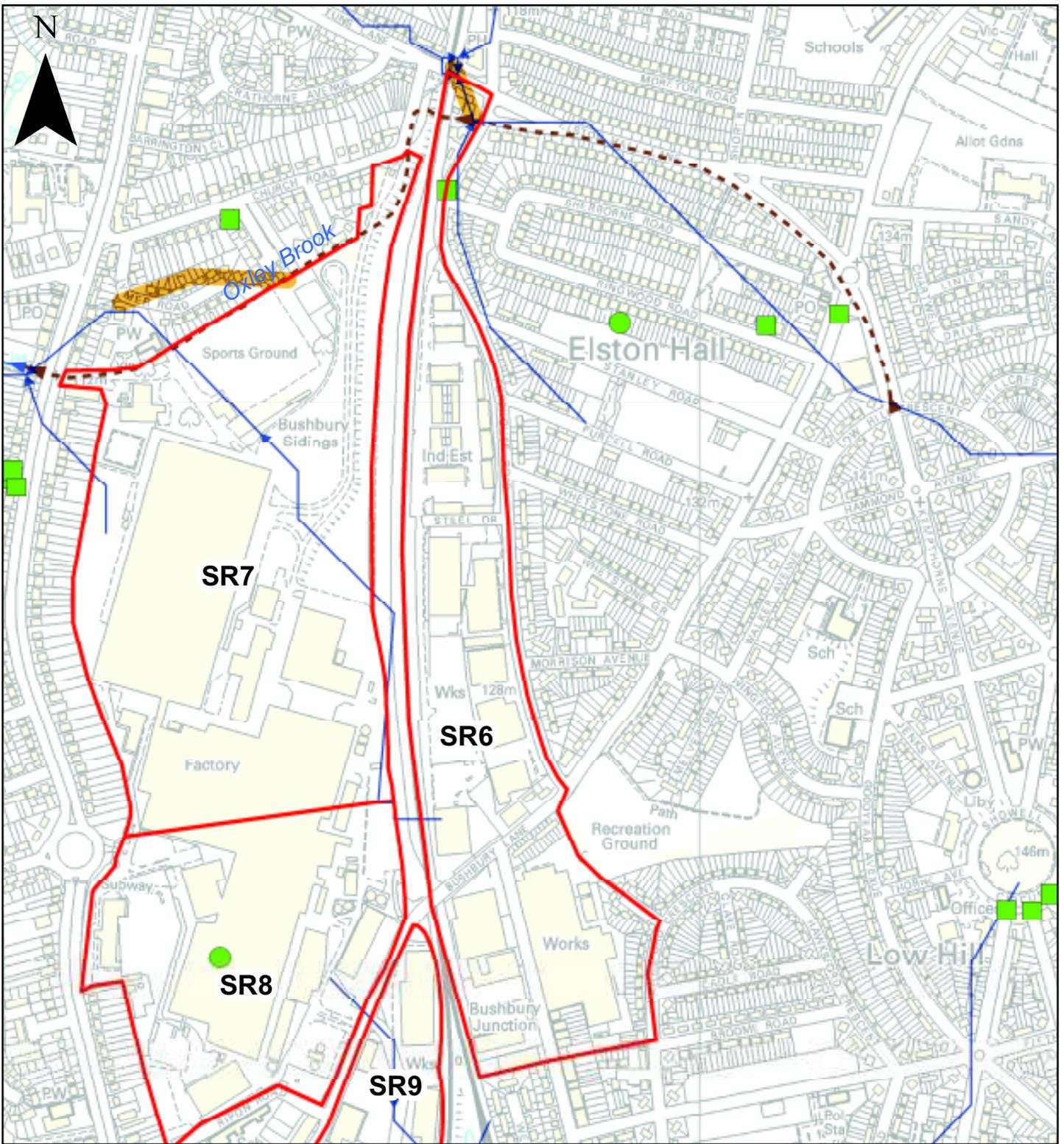
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR6
Site Name: Fordhouses Road / Bushbury Lane



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Charge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> - - - Culvert - - - Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 50 100 200 Meters</p>	<p>Scale @ A4: 1:7,000</p>										
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>										
<p>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</p>	<p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<table border="1"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

**Site Reference:
SR6
Fordhouses
Road/Bushbury Lane**

Site Details

Site Area :	16.9 ha	Proposed Land Use:	Housing
Approximate Grid Reference:	391715, 301650	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Oxley Brook flows, in culvert, through the northern part of the site.
- As this watercourse is in the very upper reaches of its catchment, it has not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flows through the culvert will be relatively low.
- Consultation has not revealed any instances of flooding associated with this watercourse, which suggests that the culvert is of sufficient capacity.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culvert. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan). However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system have the potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- The site sits at the base of an area of high ground immediately to the east of the site, 'Bushbury Hill'
- Although the area is underlain by permeable sandstones, with no superficial geology recorded, it is urban and will contain a high proportion of impermeable surfaces, such as roads and pavements, which have a high potential to generate surface water flows during heavy rainfall events.
- The steep and urbanised nature of the ground suggests that surface water flooding is a risk to this site.
- An analysis of overland flow routes based upon topographic data suggests that there is an overland flow route directly through the northern section of the site.
- The level of risk to the site is considered high.

Potential Impact from Proposed Development

- The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff.
- New development and landscaping could alter overland flow paths, and increase the risk elsewhere.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- There are records from the Black Country Level 1 SFRA of a sewer flooding incident within the development area. There is no information available on the specific cause or severity of the flooding but is believed to be related to surface water / highway drainage.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Assess the flow capacity of the Oxley Brook culvert and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Determine the Flood Zones.

- Evaluate the potential for, and consequences of, culvert blockage along Oxley Brook (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration could be a viable option due to the poor drainage characteristics.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

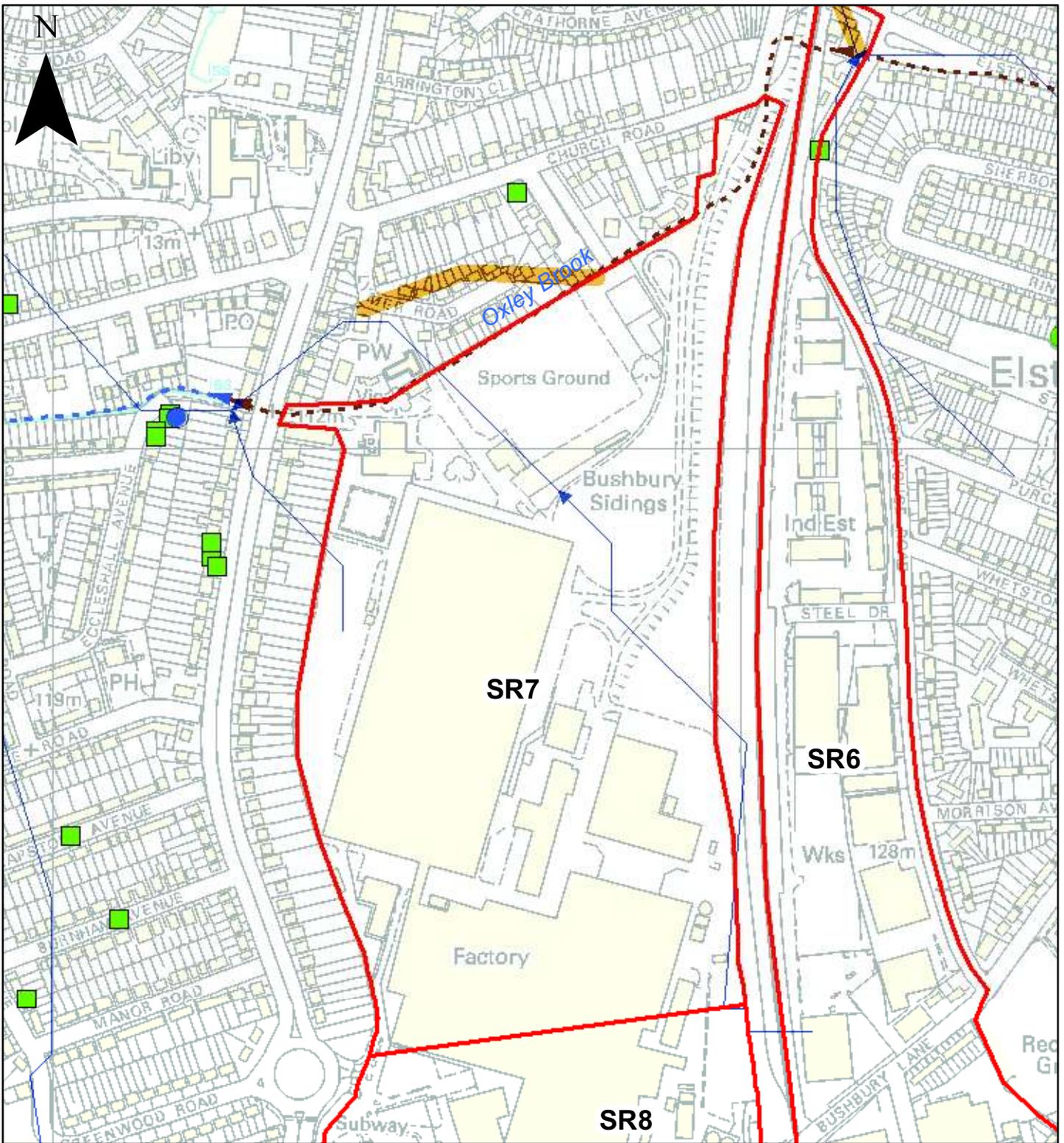
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Investigate the causes of sewer flooding to ascertain whether they are indicative of a risk to the development area.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR7
Site Name: Goodyear (Housing)



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Charge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>250 Meters </p>	<p>Scale @ A4: 1:5,000</p>	<p>Drawing Title: Site SR7</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/SR7</p>									
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Level 2 Strategic Flood Risk Assessment

Site Reference:
SR7
Goodyear (Housing)

Site Details

Site Area :	24 ha	Proposed Land Use:	Housing
Approximate Grid Reference:	391431, 301788	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Oxley Brook flows, in culvert, along the northern boundary of the site.
- As this watercourse is in the very upper reaches of its catchment, it has not been captured by existing Environment Agency Flood Zone Mapping.
- Because of the location at the head of the catchment, it is likely that the volume of flows through the culvert will be relatively low.
- Consultation has not revealed any instances of flooding associated with this watercourse, which suggests that the culvert is of sufficient capacity.
- There is a degree of fluvial risk to the development area due to the potential for problems with the culvert. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan) and they appear to flow away from the site. However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has the potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- The site sits at the base of an area of high ground immediately to the east of the site, 'Bushbury Hill'
- Although the area is underlain by permeable sandstones, with no superficial geology recorded, the steep and urbanised nature of the ground suggests that surface water flooding is a risk to this site.
- An analysis of overland flow routes based upon topographic data suggests that there is an overland flow route directly through site.
- The level of risk to the site is considered medium.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- New development and landscaping could alter overland flow paths, and increase the risk elsewhere.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However information contained in the Black Country Level 1 SFRA shows numerous instances of foul water flooding downhill (west) of the proposed development area. This may be indicative of capacity problems within the receiving foul water sewer network
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.
- Proposed development within this area has been assessed as having a potentially high impact on sewer flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted,
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Assess the flow capacity of the Oxley Brook culvert and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).

- Determine the Flood Zones.
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR8
Site Name: Goodyear (Employment)

	Level 2 Strategic Flood Risk Assessment	Site Reference: SR8 Goodyear (Employment)
Site Details		
Site Area : 24 ha Approximate Grid Reference: 391431, 301788	Proposed Land Use: Employment PPS25 Vulnerability Classification: Less Vulnerable	
Assessment of Flood Risks		
Flooding from Rivers <i>Risk to Proposed Development</i> <ul style="list-style-type: none"> The site is not considered to be at risk of fluvial flooding. No watercourses flow through this site. The development area is not affected by any Flood Zones. <i>Potential Impact from Proposed Development</i> <ul style="list-style-type: none"> The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk. 		
Flooding from Land: <i>Risk to Proposed Development</i> <ul style="list-style-type: none"> The site is situated on area of land that is a little higher than most the surrounding sites and development. Consultation with the Environment Agency and Wolverhampton City Council drainage engineers suggests that there are no records of surface water flooding at this site. The overall level or risk is considered low. <i>Potential Impact from Proposed Development</i> <ul style="list-style-type: none"> The site is already heavily developed, so it is unlikely that there will be an increase in the amount of impermeable area and an associated increase in surface water runoff. Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding. However, the potential for development in this area to increase the risk of surface water flooding elsewhere is considered low. 		
Flooding from Groundwater: <i>Risk to Proposed Development</i> <ul style="list-style-type: none"> The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata. The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site. The site should be considered to be at medium of groundwater flooding. <i>Potential Impact from Proposed Development</i> <ul style="list-style-type: none"> It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere. 		
Flooding from Sewers: <i>Risk to Proposed Development</i> <ul style="list-style-type: none"> Consultation with Severn Trent Water has revealed that there is a record of sewer flooding at this site. There is no information available on the frequency or severity of the flooding. Without specific information the site is considered to be at high risk of sewer flooding (as a precautionary approach). <i>Potential Impact from Proposed Development</i> <ul style="list-style-type: none"> Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. Re-development of this site with a different land use and an increased population density could increase 		

loading on the sewer system and heighten flood risk elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

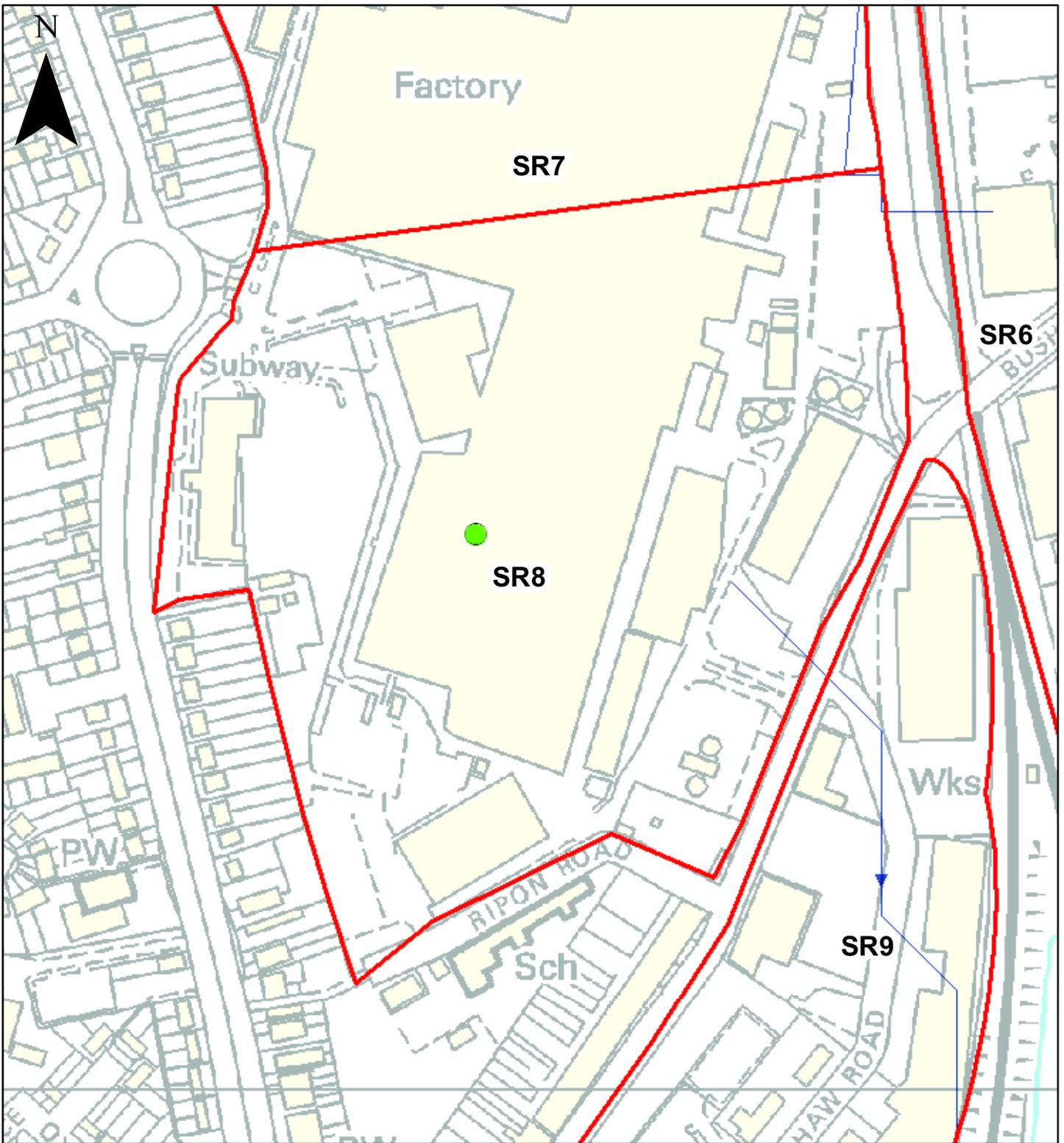
- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration could be a viable option due to the poor drainage characteristics.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

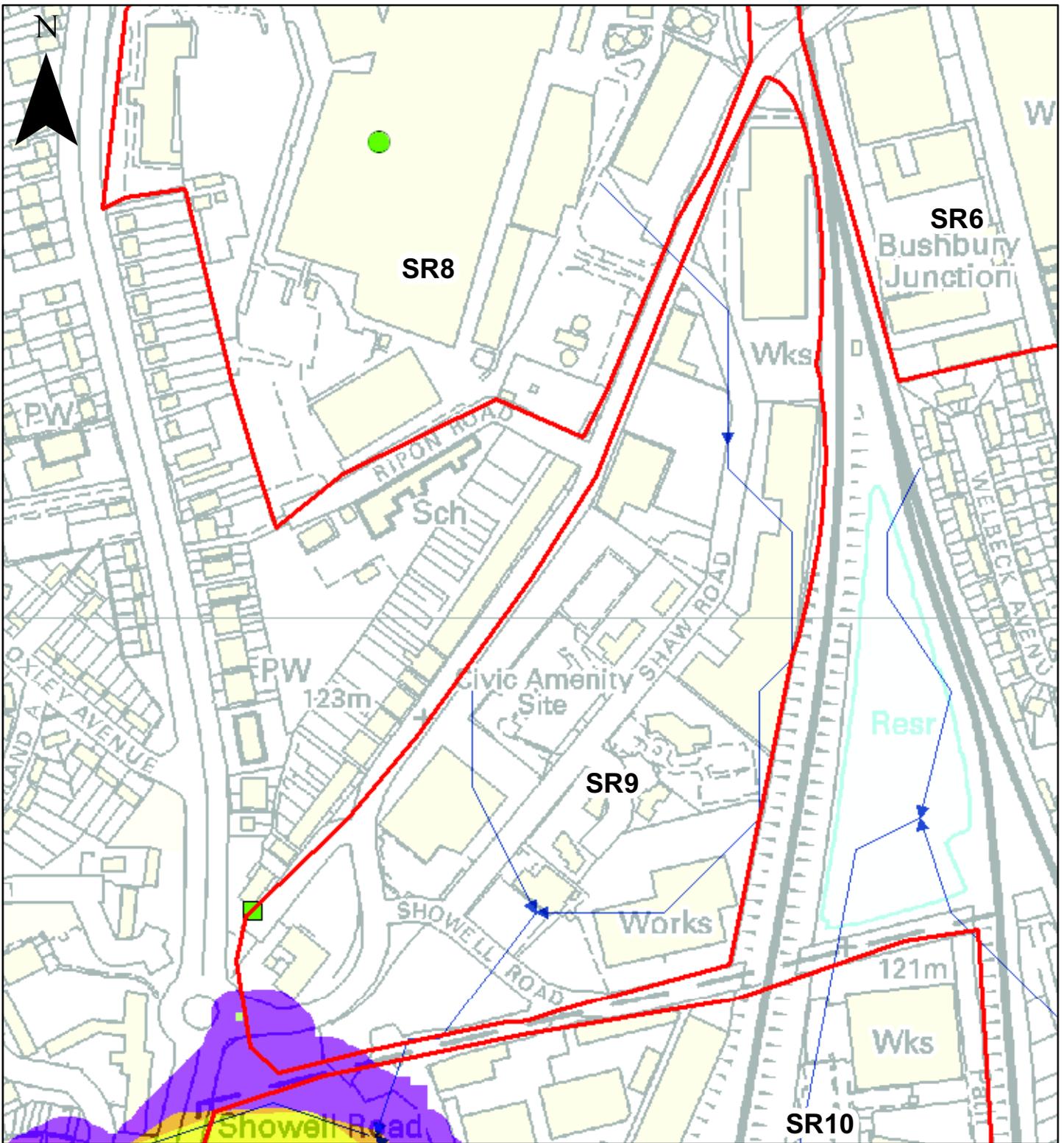
- Consult Severn Trent about the nature of the sewer flooding issue and the level of risk posed to the site. Provide mitigation measures if appropriate.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>➔ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 8 Meters </p>	<p>Scale @ A4: 1:3,000</p>	<p>Drawing Title: Site SR8</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/SR8</p>									
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Development Area: Stafford Road Corridor
Site Reference: SR9
Site Name: Bushbury Lane



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert SurchARGE Flow Paths		Culvert
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Open Channel
	Groundwater Flooding Incidents		Flood Zone 3a		Canal
			Flood Zone 2		

Client:

Project: **Wolverhampton SFRA Level 2**

Scale @ A4: 1:3,500

Drawing Title: **Site SR9**

Notes:

JACOBS
Jacobs Engineering UK Ltd

Drawing Number: **B0536900/L2SFRA/SR9**

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Office: **Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009



Level 2 Strategic Flood Risk Assessment

**Site Reference:
SR9
Bushbury Lane**

Site Details

Site Area :	10 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391539, 300939	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- No watercourses flow through this site, but Smestow Brook flows, in culvert, 300m to the south.
- Approximately 2% of the site is within Flood Zone 2 Medium Probability i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event), associated with Smestow Brook.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is high land to the north and east of the site.
- A raised railway embankment runs to the east of the site which is likely to impede flows onto the site from this direction.
- The land to north of the development is developed and will contain a large proportion of permeable surfaces.
- An assessment of overland flow routes based upon topography suggests that the site is at high risk from surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding in locations previously unaffected.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has revealed that there is a single record of sewer flooding at this site.
- There is no information on the cause or the severity of the flooding.
- Without specific information the site is considered to be at high risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a different land use and an increased population density could increase loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is a small reservoir immediately east of the development site. The reservoir is separated from the site by a railway embankment.
- There are no records of flooding from this feature and the level of risk is considered low.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 2% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk.
- Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed. *Although, due to the very small area of Flood Zone 2 Medium Probability it may be possible to re-define the development boundary of the site not to include the area at risk of flooding.*
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

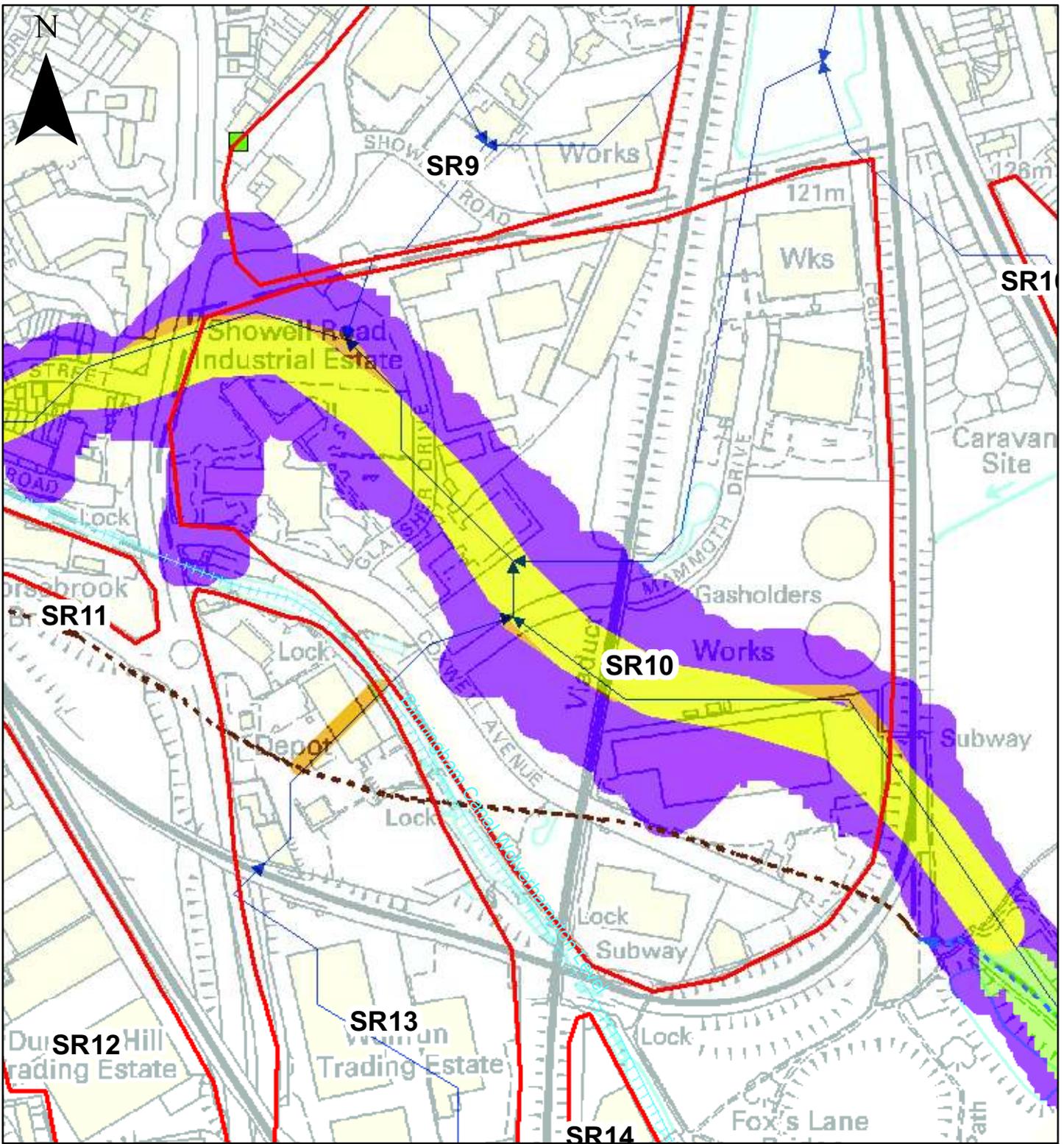
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent about the nature of the sewer flooding issue and the level of risk posed to the site. Provide mitigation measures if appropriate.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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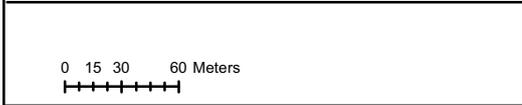
Development Area: Stafford Road Corridor
Site Reference: SR10
Site Name: Wolverhampton Science Park



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert SurchARGE Flow Paths	Watercourse	
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**



Scale @ A4: 1:4,000

Drawing Title: **Site SR10**

Notes:

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Drawing Number: B0536900/L2SFRA/SR10

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Produced	EDR	April 2009
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Level 2 Strategic Flood Risk Assessment

Site Reference:
SR10
Wolverhampton Science
Park

Site Details

Site Area :	21 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391576, 300529	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

- Smestow Brook runs in culvert, across the southern section of the development area. The watercourse enters into culvert an estimated 150m east of the site.
- Approximately 35% of the site is classified as Flood Zone 2 Medium Probability (i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event).
- During the Black Country SFRA Level 1 the capacity of the Smestow Brook culvert was assessed as capable of conveying 1 in 500 year flow, consequently Flood Zone 3a High Probability was removed from the Flood Maps for this area.
- The Flood Zone 3a High Probability was replaced with probable overland flow route in the event of culvert blockage or collapse. The overland flow route follows local topography rather than the route of the culvert.
- The potential for culvert blockage and collapse is dependant on a number of factors (such as age, debris loading) and this has not been assessed as part of this investigations.
- The Smestow Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: <0.5 hours
 - Duration of flooding : 1 hour
 - Maximum flood depth (Q1000): 1.0m
 - Velocity of flows (Q1000): 2.0m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed.
- Any changes to the surface water drainage system has potential to alter the existing drainage regime Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the high ground to the east. These areas are heavily urbanised, and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- The embanked railway line running across the northern edge of the site could represent a significant obstacle to surface flows from the south potentially leading to significant depths of surface water ponding in this area.
- There is a degree of uncertainty on the presence of potential flow paths into the site due to potential flow routes from subways and other drainage infrastructure.
- The impermeable nature of the superficial geology (till diamicton) underlying some of the site may lead to localised ponding issues and generate runoff.
- The site should be considered to be at medium risk from surface water flooding. This is a risk that needs clarification.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- There are three ponds on site, which can be an indication of high water levels.
- The site is situated in a topographic low point relative to the land to the east.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The superficial geology of the site is split. Approximately 50% of the site permeable sands and gravels and 50% impermeable till. The presence of permeable sands and gravels could provide a flow route for groundwater into the site.
- The site should be considered to be at high risk of groundwater flooding (as a precautionary measure)

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.
- Higher density development and/or further new development could increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Birmingham Canal is flows along the south-west border of the site. Consultation with British Waterways has not revealed any specific incidents or risks associated to this stretch of canal. The risk from this feature is considered low.
- Three small ponds are shown on OS data for this site. No instances of flooding are reported for these features.
- OS mapping shows a small drainage ditch to the east of the site. Local flood risk is unknown from this feature.
- There is a small reservoir immediately north of the development site. There are no records of flooding from this feature and the level of risk is considered low. However, there is a degree of uncertainty as little information in relation to the feature is available.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 35% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event

above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information

- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

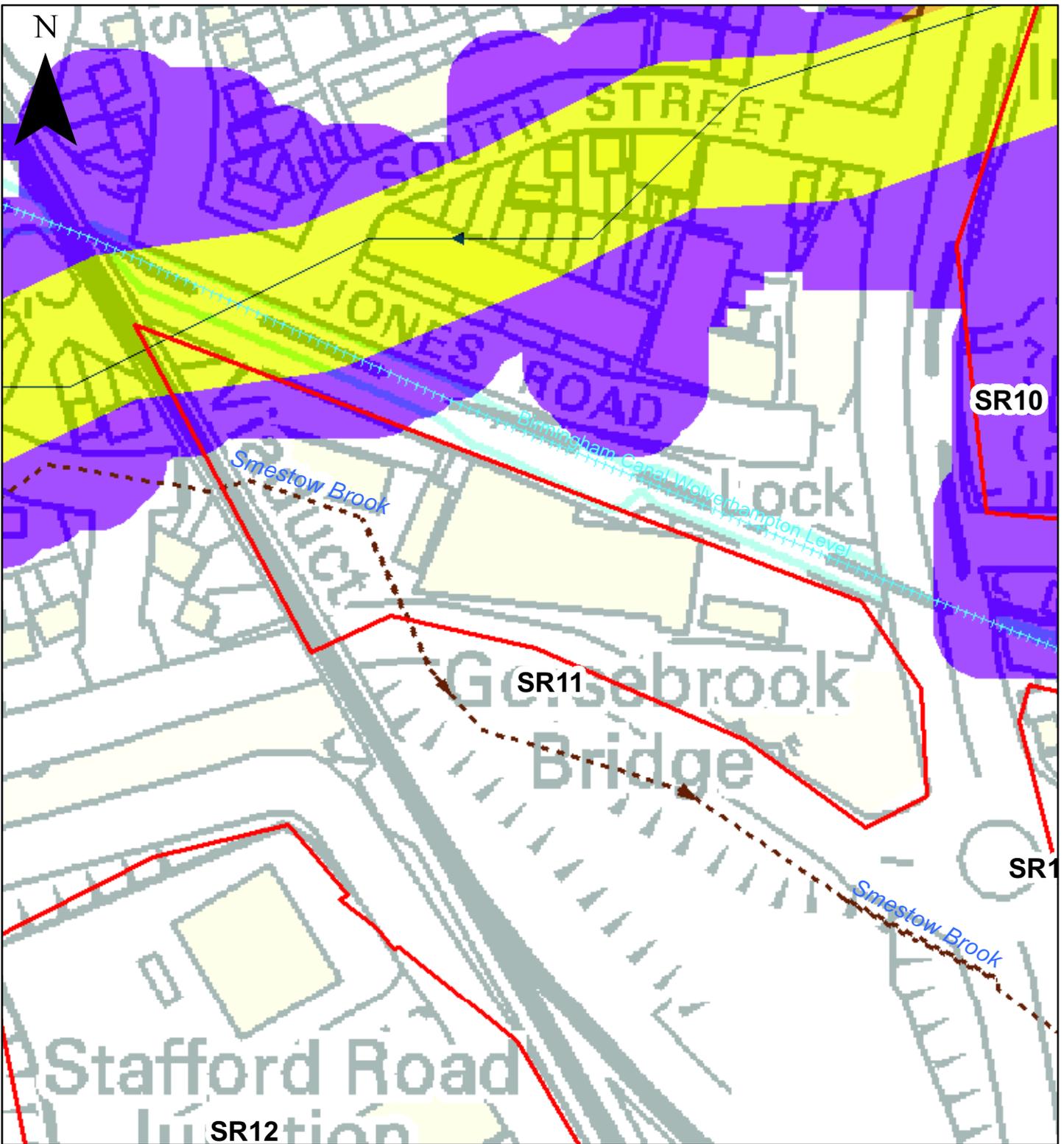
- Consult Severn Trent about the nature of the sewer flooding issue and the level of risk posed to the site. Provide mitigation measures if appropriate.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

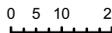
Flooding from Reservoirs, Canals and Other Artificial Sources

- Determine the risk of flooding from the unnamed drain shown on OS Mapping east of the site.
- Investigate the reservoir north of the development site.
- Examine the risk from the canal on the south-west border of the site.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Stafford Road Corridor
Site Reference: SR11
Site Name: Foxes Lane



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surcharge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 5 10 20 Meters</p> 	<p>Scale @ A4: 1:1,500</p>	<p>Drawing Title: Site SR11</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/SR11</p>									
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Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR11
Foxes Lane

Site Details

Site Area :	1 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391155, 300529	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

- Smestow Brook runs in culvert, across the western section of the site.
- Approximately 10% of the site is classified as Flood Zone 2 Medium Probability (i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event).
- During the Black Country SFRA Level 1 the capacity of the Smestow Brook culvert was assessed as capable of conveying 1 in 500 year flow, consequently Flood Zone 3a High Probability was removed from the Flood Maps for this area.
- The Flood Zone 3a High Probability was replaced with probable overland flow route in the event of culvert blockage or collapse. The overland flow route follows local topography rather than the route of the culvert.
- The potential for culvert blockage and collapse is dependant on a number of factors (such as age, debris loading) and this has not been assessed as part of this investigation.
- The extents of Flood Zone 2 and the overland flow route are likely to be effected presence of the Brimingham Canal to the north of the site. The level of risk to the site from fluvial flooding could be reduced.
- The Smestow Brook catchment at this location is relatively small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Time to peak: <0.5 hours
 - Duration of flooding : 1 hour
 - Maximum flood depth (Q1000): 1.3m
 - Velocity of flows (Q1000): 3.6m/s

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert.

Flooding from Land:

Risk to Proposed Development

- There is a small area of raised ground to the immediate south of site which may cause surface water flow onto the site.
- The overland flow routes to the site from the east are limited by the Birmingham Canal.
- The site should be considered to be at low risk from surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.

- The superficial geology of the site is split. Approximately 50% of the site permeable sands and gravels and 50% impermeable till. The presence of permeable sands and gravels could provide a flow route for groundwater into the site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.
- Higher density development and/or further new development could increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Birmingham Canal is flows along northern border of the site. Consultation with British Waterways has not revealed any specific incidents or risks associated to this stretch of canal. The risk from this feature is considered low.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 10% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not

adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

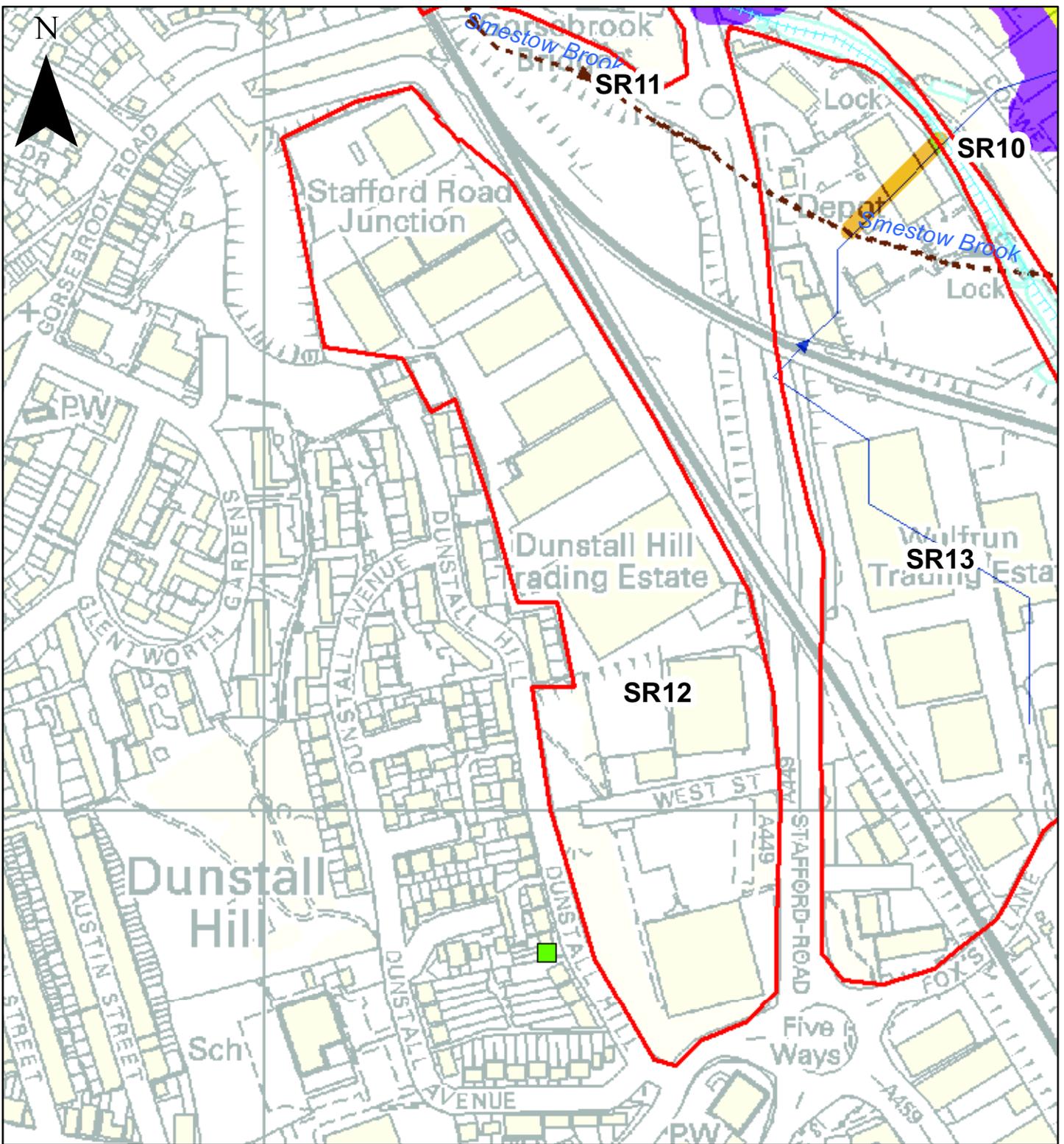
- Consult Severn Trent water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Consider the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dam breach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Stafford Road Corridor
Site Reference: SR12
Site Name: Dusntall Hill trading Estate



Legend

- Localised Flooding Incidents
- Sewer Flooding Incidents Level 2 SFRA
- Sewer Flooding Incidents Level 1 SFRA
- ⊗ Groundwater Flooding Incidents
- Overland Flow Paths Level 1 SFRA
- Indicative Culvert Surge Flow Paths
- Flood Zone 3b
- Flood Zone 3a
- Flood Zone 2
- Indicative Surface Water Runoff Routes
- Watercourse**
- Culvert
- Open Channel
- Canal



Project: **Wolverhampton SFRA Level 2**

Drawing Title: **Site SR12**

Drawing Number: **B0536900/L2SFRA/SR12**

0 12.5 25 50 Meters

Scale @ A4: 1:3,500

Notes:

JACOBS
Jacobs Engineering UK Ltd

Office:
**Fairbairn House, Ashton Lane, Sale
Manchester, M33 6WP**

Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009

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**Level 2 Strategic
Flood Risk
Assessment**

**Site Reference:
SR12
Dunstall Hill Trading Est.**

Site Details

Site Area :	7.8 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391213, 300158	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- The site is located near the top of a small hill and the risk of the site being affected by significant surface water flooding is considered low.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding in locations previously unaffected.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The superficial geology of the site is permeable sands and gravels which would allow groundwater to pass through to the surface relatively easily. However, as the site is on a hill it is unlikely to cause significant ponding as water will flow away.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:*Risk to Proposed Development*

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has revealed that there is a single record of sewer flooding near to the site (dated 1997).
- There is no information on the cause or the severity of the flooding.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network but the instance of sewer flooding may indicate that there are problems within the receiving infrastructure.
- Re-development of this site could increase the population equivalent loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:*Risk to Proposed Development*

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)**Surface Water Runoff Management**

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).

- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

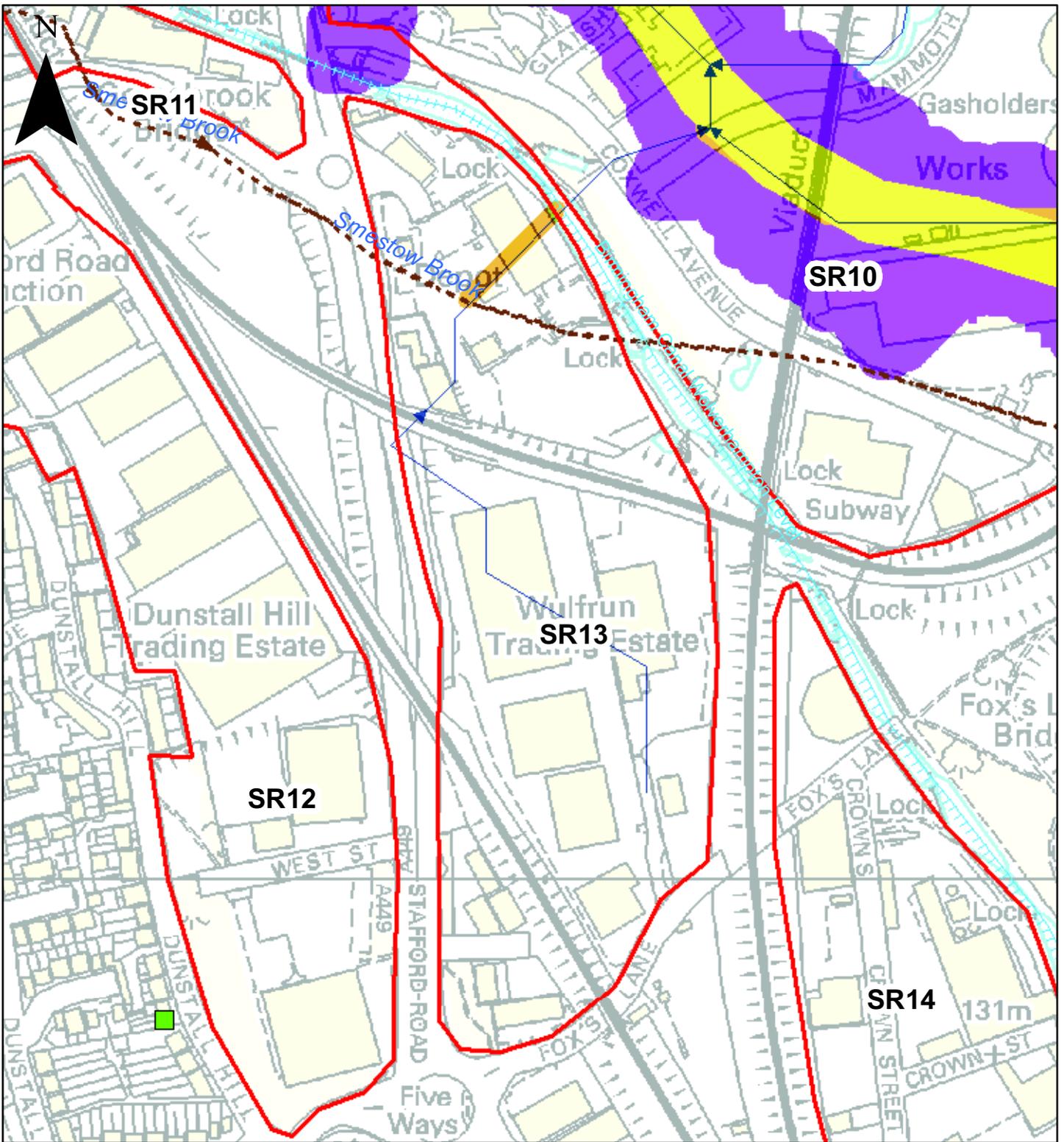
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water about the nature of the sewer flooding issue and the level of risk posed to the site. Provide mitigation measures if appropriate.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR13
Site Name: Wulfrun Trading Estate



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>Scale @ A4: 1:3,500</p>	<p>Drawing Title: Site SR13</p>										
<p>Notes:</p>	<p>Drawing Number: B0536900/L2SFRA/SR13</p>										
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Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR13
Wulfrun Trading Est.

Site Details

Site Area :	8.7 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391431, 300189	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is a small hill to the west and south of the site which could generate surface water flows towards the site.
- An assessment of overland flow routes based upon topography suggests that there is a flow path crossing the site
- The railway embankment running across the northern edge of the site may represent an obstacle to this flow path potentially leading to ponding to significant depth in this area.
- The site is considered to be at medium risk of surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding in locations previously unaffected. However, the Birmingham Canal represents a barrier to flows to areas downhill.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The superficial geology of the site is partially permeable sands and gravels which would allow groundwater to pass through to the surface relatively easily. However, as the site is on a hill it is unlikely to cause significant ponding as water will flow away.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that this any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water as part of the Black Country Level 1 SFRA has revealed that there is a single record of sewer flooding near to the site (adjacent to development area SR12 and dated 1997).
- There is no information on the cause or the severity of the flooding.
- Without specific information the site is considered to be at medium risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network but the instance of sewer flooding may indicate that there are problems within the receiving infrastructure.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Birmingham Canal passes along the eastern border of the development site.
- Consultation with British Waterways has revealed no specific localised flooding issues related to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).

- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
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- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

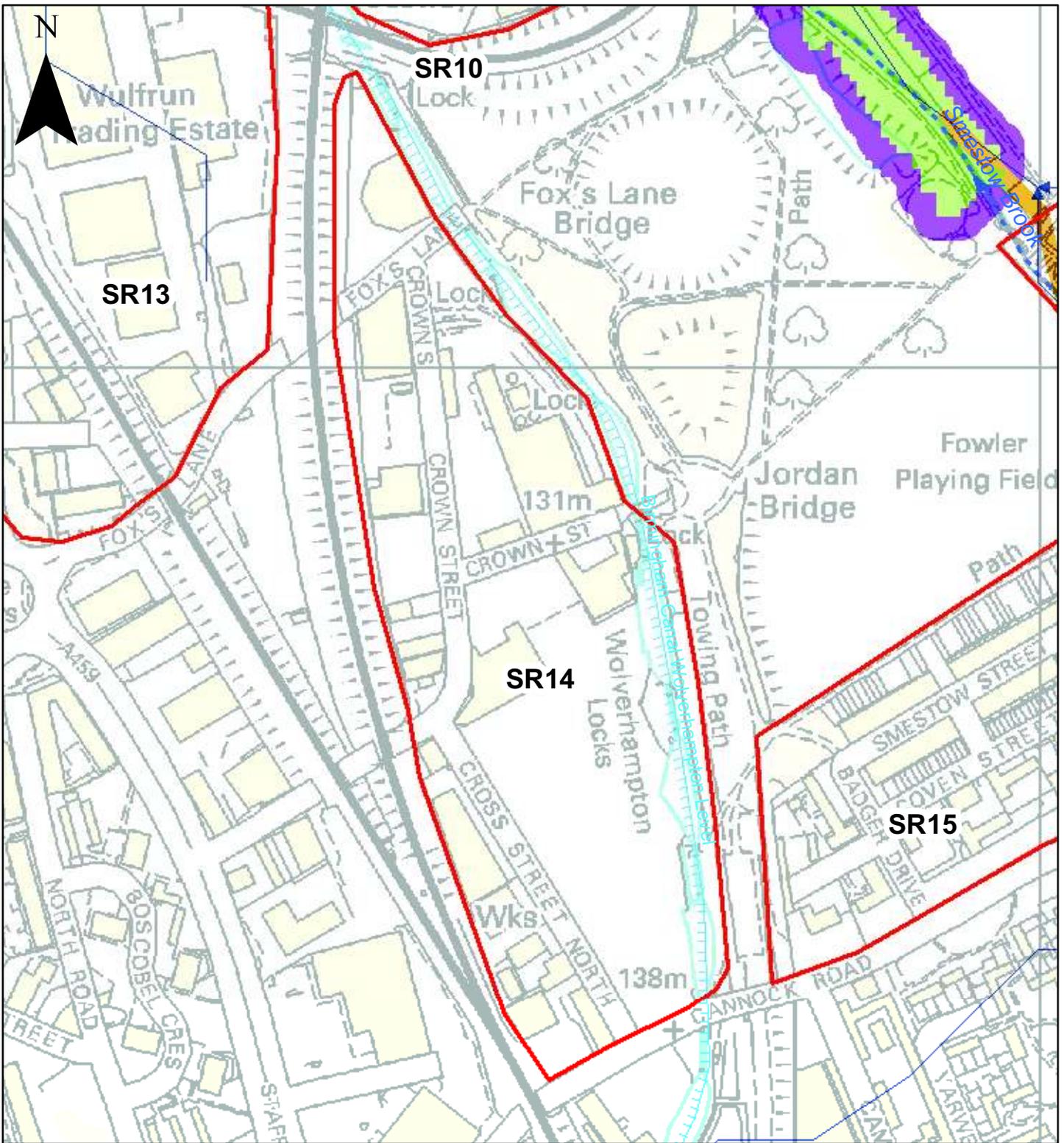
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Stafford Road Corridor
Site Reference: SR14
Site Name: Crown Street / Cross Street



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert SurchARGE Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<p>→ Indicative Surface Water Runoff Routes</p> <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 10 20 40 Meters +++++</p>	<p>Scale @ A4: 1:3,500</p>	<p>Drawing Title: Site SR14</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Number: B0536900/L2SFRA/SR14</p>									
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Produced	EDR	April 2009									
Checked	DRD	April 2009									
Approved	KD	April 2009									



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR14
Crown Street/Cross Street

Site Details

Site Area :	8.4 ha	Proposed Land Use:	Employment
Approximate Grid Reference:	391681, 299833	PPS25 Vulnerability Classification:	Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- The site is not considered to be at risk of fluvial flooding.
- No watercourses flow through this site.
- The development area is not affected by any Flood Zones.

Potential Impact from Proposed Development

- The site is already heavily developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.

Flooding from Land:

Risk to Proposed Development

- There is a small hill to the south-west which could generate surface water flows towards the site.
- Railway infrastructure on the site's boundary should offer protection to the site from surface water flooding from the west.
- The site is considered to be at low risk of surface water flooding.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- Changes to topography and new structures/buildings could alter overland flow routes and could increase the risk of surface water flooding in locations previously unaffected. However, the Birmingham Canal represents a barrier to flows to areas downhill.
- The potential for development in this area to significantly increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is primarily permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The Birmingham Canal passes along the eastern border of the development site.
- Consultation with British Waterways has revealed no specific localised flooding issues related to this canal.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
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Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
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given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.

- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

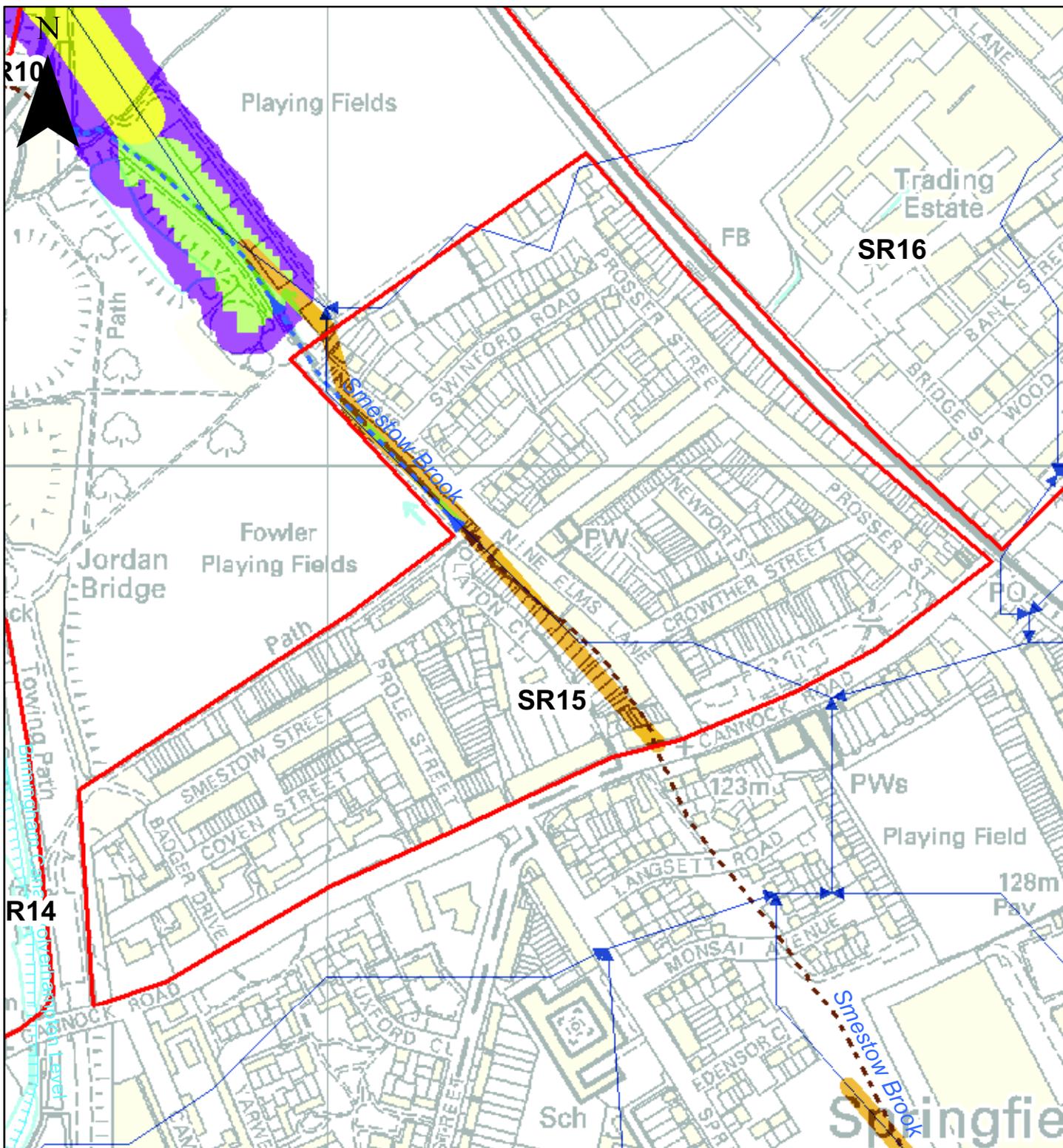
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Investigate the potential for flooding from the canal in more detail.
- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account

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Development Area: Stafford Road Corridor
Site Reference: SR15
Site Name: Park Village



Legend					
	Localised Flooding Incidents		Overland Flow Paths Level 1 SFRA		Indicative Surface Water Runoff Routes
	Sewer Flooding Incidents Level 2 SFRA		Indicative Culvert Surge Flow Paths	Watercourse	
	Sewer Flooding Incidents Level 1 SFRA		Flood Zone 3b		Culvert
	Groundwater Flooding Incidents		Flood Zone 3a		Open Channel
			Flood Zone 2		Canal

Client:

Project: **Wolverhampton SFRA Level 2**

0 10 20 40 Meters

Scale @ A4: 1:4,000

Drawing Title: **Site SR15**

Notes:

JACOBS
 Jacobs Engineering UK Ltd

Drawing Number: B0536900/L2SFRA/SR15

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Produced	EDR	April 2009
Checked	DRD	April 2009
Approved	KD	April 2009



Level 2 Strategic Flood Risk Assessment

Site Reference:
SR15
Park Village

Site Details

Site Area :	16.5 ha	Proposed Land Use:	Residential
Approximate Grid Reference:	392184, 299909	PPS25 Vulnerability Classification:	More Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Smestow Brook flows through the centre of the site. The upper reaches are culverted, but it emerges from the culvert within the site and flows in an open channel.
- Environment Agency Flood Zone Mapping begins a short distance downstream (north) of the site. The site is not affected by any of the Flood Zones.
- Because of the location near the head of the catchment, it is likely that the volume of flow through the and through the watercourse will be relatively low.
- Consultation has not revealed any instances of localised flooding in this development area. This suggests that the culvert and the open channel are of sufficient capacity.
- The watercourse is likely to pose a degree of risk to the development but this risk cannot be quantified without further modelling of the watercourse.
- There is also a degree of fluvial risk to the development area due to the potential for problems with the culvert present on site. For example capacity problems associated with blockage and structural collapse (over the long term) can cause overland flows.
- Indicative overland flow routes in the event of culvert blockage or collapse have been identified (see site plan) and part the site is affected. However, a full appraisal of the risk should be undertaken as part of a detailed FRA.

Potential Impact from Proposed Development

- The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert. The impact of any development at this site on fluvial flood risk could be high.

Flooding from Land:

Risk to Proposed Development

- The site sits in a small valley and is therefore bordered on the west and east by high ground.
- The highly developed nature of the surrounding catchment, which contains a high degree of impermeable surfaces, suggests that high intensity rainfall events could generate a significant amount of surface water runoff.
- An analysis of potential surface water flow routes based on topographic data indicates that there are a number of routes that converge on this location from the south and east.
- The site's position means that it is highly likely to be affected by externally generated surface water runoff.

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment.
- The area immediately downhill of the development site is occupied by playing fields and gardens. The consequences of runoff from this site are likely to be low.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site.

Potential Impact from Proposed Development

- Consultation with Severn Trent Water has not revealed any known capacity issues in the existing sewer network.
- Re-development of this site with a similar land use and density is unlikely to increase the risk of sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging

Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- Model the flood risk from Smestow Brook. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details. culvert and compare this to the flows in the watercourse for a range of return periods (Q2, Q25, Q100, Q100 + climate change and Q1000).
- Evaluate the potential for, and consequences of, culvert blockage along Smestow Brook (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

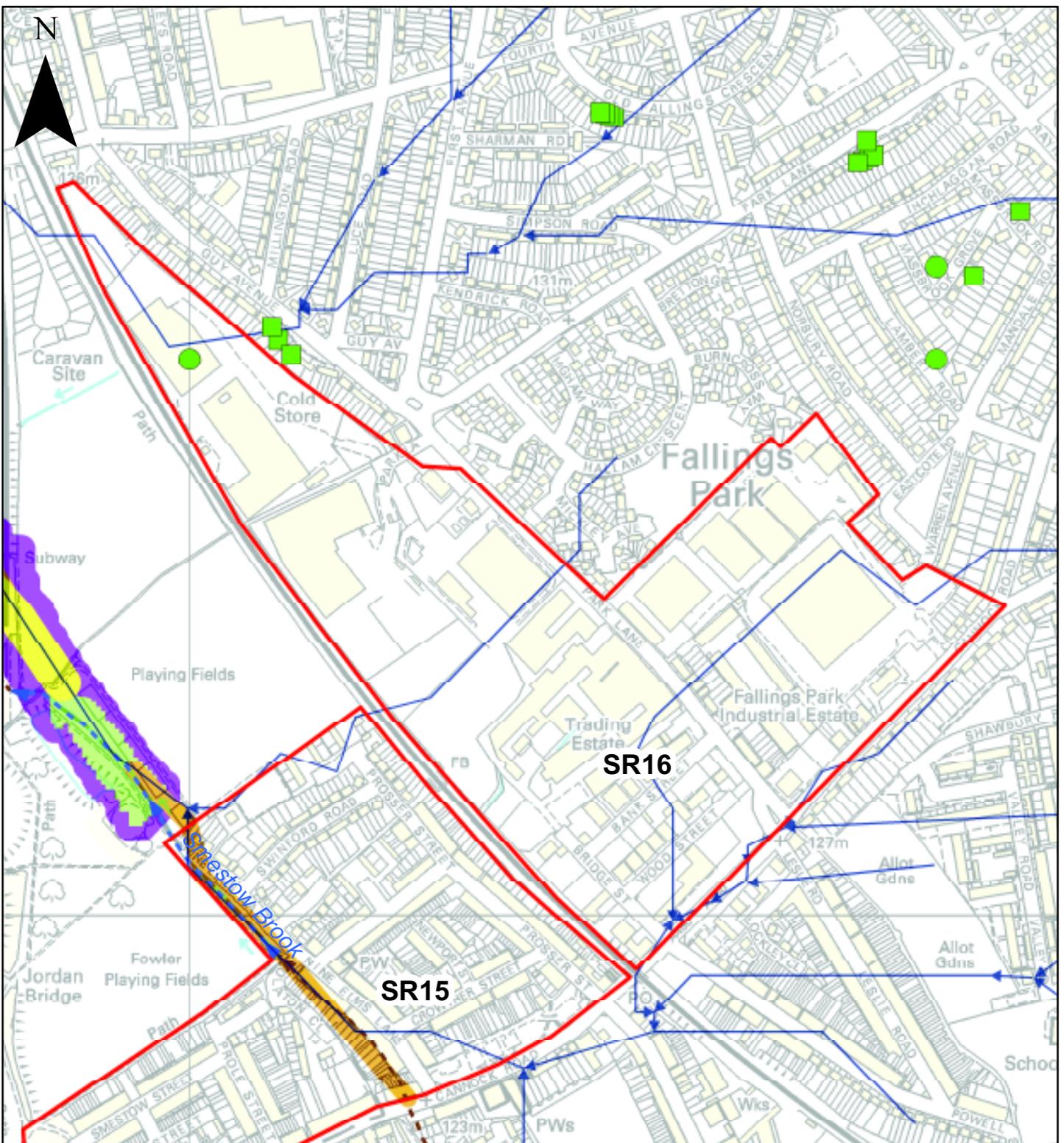
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR16
Site Name: Bluebird and
Fallings Park Industrial Estate



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Charge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> → Indicative Surface Water Runoff Routes Watercourse Culvert Open Channel Canal 	<p>Client:</p> 									
<p>0 40 80 160 Meters</p>	<p>Scale @ A4: 1:6,000</p>	<p>Project:</p> <p>Wolverhampton SFRA Level 2</p>									
<p>Notes:</p>	<p>JACOBS Jacobs Engineering UK Ltd</p>	<p>Drawing Title:</p> <p>Site SR16</p> <p>Drawing Number:</p> <p>B0536900/L2SFRA/SR16</p>									
<p>This map is reproduced from Ordnance Survey material with the permission of Ordnance Survey on behalf of the Controller of Her Majesty's Stationery Office © Crown copyright. Unauthorised reproduction infringes Crown copyright and may lead to prosecution or civil proceedings. Environment Agency, 100019537, 2009</p>	<p>Office:</p> <p>Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<table border="1"> <tr> <td>Produced</td> <td>EDR</td> <td>April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Approved	KD	April 2009									

	Level 2 Strategic Flood Risk Assessment	Site Reference: SR16 Bluebird and Fallings Park Industrial Estate
Site Details		
Site Area : 27 ha Approximate Grid Reference: 392398, 300215	Proposed Land Use: Residential PPS25 Vulnerability Classification: More Vulnerable	
Assessment of Flood Risks		
<p>Flooding from Rivers</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> The site is not considered to be at risk of fluvial flooding. No watercourses flow through this site. The development area is not affected by any Flood Zones. <p><i>Potential Impact from Proposed Development</i></p> <ul style="list-style-type: none"> The site is already developed, but changes to the surface water drainage system has potential to alter the existing drainage regime and could increase the rate and volume that surface water is discharged into the receiving watercourse(s), thus increasing flood risk. 		
<p>Flooding from Land:</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> The site is surrounded to the northeast, east and southeast by high ground. The highly developed nature of the surrounding catchment, which contains a high degree of impermeable surfaces, suggests that high intensity rainfall events could generate a significant amount of surface water runoff. An analysis of potential surface water flow routes based on topographic data indicates that there are a number of routes that converge on this location from the east and north east. The site's position means that it is highly likely to be affected by externally generated surface water runoff. <p><i>Potential Impact from Proposed Development</i></p> <ul style="list-style-type: none"> The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. However, much of the site is already developed and it is unlikely that there would be a significant increase in runoff following redevelopment. There are areas of existing development immediately downhill of the proposed development site, therefore the consequences of a change in runoff characteristics could be high. New development has the potential to change surface water flow routes through the placement of new buildings and landscaping. This could increase the risk of flooding in some locations and decrease it in others. The potential for development in this area to increase the risk of surface water flooding elsewhere is considered medium. 		
<p>Flooding from Groundwater:</p> <p><i>Risk to Proposed Development</i></p> <ul style="list-style-type: none"> The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata. The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of groundwater flooding at this site. The site should be considered to be at medium risk of groundwater flooding. <p><i>Potential Impact from Proposed Development</i></p> <ul style="list-style-type: none"> It is unlikely that development in this area will increase the risk of groundwater flooding elsewhere. 		

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water, as part of the Black Country Level 1 SFRA, revealed that there are several instances of flooding near the north eastern border of the site.
- Another instance of sewer flooding has been recorded within the northern part of the development site.
- There is no information on the cause or the severity of the flooding.
- Without specific information the site is considered to be at high risk of sewer flooding (as a precautionary approach).

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network but the instances of sewer flooding may indicate that there are problems within the receiving infrastructure.
- Re-development of this site could increase the population equivalent loading on the sewer system and heighten flood risk elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- There is no evidence to suggest that the site is at risk of flooding from these sources.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- The site is situated in entirely in Flood Zone 1 and there are no planning restrictions for this site.

Recommended Development Control Measures

- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.
- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).

- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

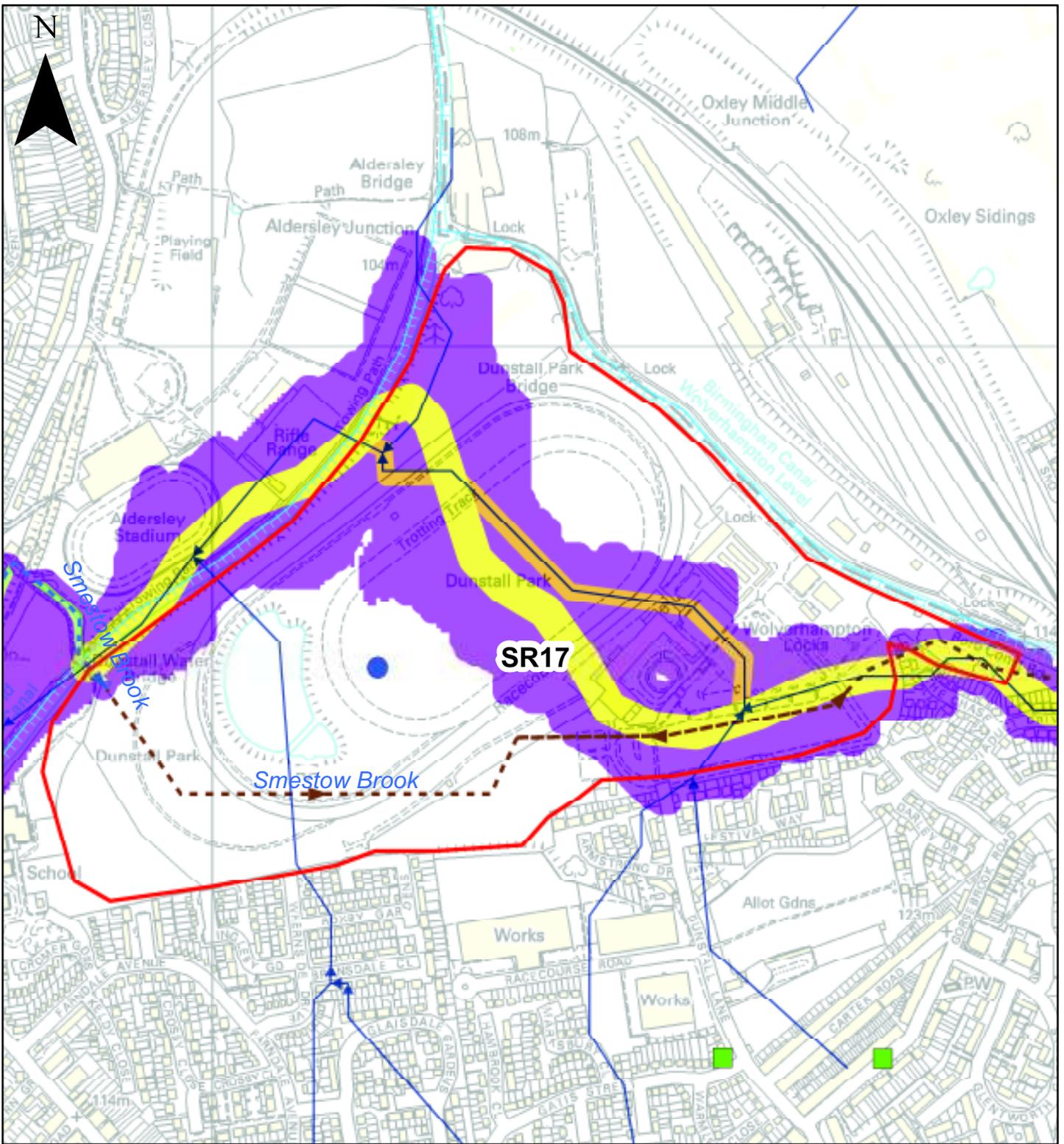
- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

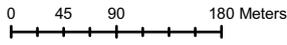
Sewer Flooding

- Consult Severn Trent about the nature of the sewer flooding issue and the level of risk posed to the site. Provide mitigation measures if appropriate.
- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

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Development Area: Stafford Road Corridor
Site Reference: SR17
Site Name: Dunstall Park Racecourse



<p>Legend</p> <ul style="list-style-type: none"> ● Localised Flooding Incidents ● Sewer Flooding Incidents Level 2 SFRA ■ Sewer Flooding Incidents Level 1 SFRA ⊗ Groundwater Flooding Incidents Overland Flow Paths Level 1 SFRA Indicative Culvert Surge Flow Paths Flood Zone 3b Flood Zone 3a Flood Zone 2 	<ul style="list-style-type: none"> → Indicative Surface Water Runoff Routes <p>Watercourse</p> <ul style="list-style-type: none"> Culvert Open Channel Canal 	<p>Client: </p> <p>Project: Wolverhampton SFRA Level 2</p>									
<p>0 45 90 180 Meters</p> 	<p>Scale @ A4: 1:6,500</p>	<p>Drawing Title: Site SR17</p>									
<p>Notes:</p>	<p style="text-align: center;">JACOBS Jacobs Engineering UK Ltd</p> <p>Office: Fairbairn House, Ashton Lane, Sale Manchester, M33 6WP</p>	<p>Drawing Number: B0536900/L2SFRA/SR17</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Produced</td> <td style="width: 33%;">EDR</td> <td style="width: 33%;">April 2009</td> </tr> <tr> <td>Checked</td> <td>DRD</td> <td>April 2009</td> </tr> <tr> <td>Approved</td> <td>KD</td> <td>April 2009</td> </tr> </table>	Produced	EDR	April 2009	Checked	DRD	April 2009	Approved	KD	April 2009
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Site Details

Site Area :	41 ha	Proposed Land Use:	Leisure
Approximate Grid Reference:	390299, 300700	PPS25 Vulnerability Classification:	More Vulnerable and Less Vulnerable

Assessment of Flood Risks

Flooding from Rivers

Risk to Proposed Development

- Approximately 30% of the site is classified as Flood Zone 2 Medium Probability (i.e. at risk during the 0.1% AEP (1 in 1000 year) flood event).
- The flood risk is related to Smestow Brook which runs in culvert underneath most of the site. The culvert is estimated as having a flow capacity equal to the 0.2 % AEP (1 in 500 year) flood event.
- The probable overland flow route from the culvert in the event of a collapse or blockage of the culvert was identified as part of the Black Country Level 1 SFRA based on topography. The culvert is relatively new and the probability of blockage or collapse is considered low in the short to medium term.
- The Smestow Brook catchment at this location is small and the watercourse will respond quickly to high intensity rainfall events. The estimated flood characteristics are:
 - Onset of flooding: <1/2 hour
 - Duration of flooding : 1hour
 - Maximum flood depth (Q1000): 0.6m
 - Velocity of flows (Q1000): 1.88m/s

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil. Without mitigation, the proposed development has the potential to increase the rate and volume that surface water is discharged into local watercourses, thus increasing flood risk.
- If surface waters are discharged into the culverted watercourse, flood risk could increase both upstream and downstream of the culvert. The impact of any development at this site on fluvial flood risk could be high.

Flooding from Land:

Risk to Proposed Development

- Heavy rainfall events could lead to surface water runoff towards the site from the high ground to the east and north. These areas are heavily urbanised, and will therefore contain a high proportion of impermeable surfaces such as roads and pavements which can exacerbate the risk of surface water runoff.
- Several overland flow paths are identified running across the site. The greatest risk of surface water runoff is likely to be from the area south-east of the site as the Birmingham Canal Wolverhampton Level is likely to impede flows from the northeast.
- The site itself is largely flat and it is therefore unlikely that significant surface water runoff flows will be generated within the site. The impermeable nature of the superficial geology (till diamicton) underlying some of the site may lead to localised ponding issues.
- The surface water runoff routes across this site are predominantly directed to the northwest and into the Birmingham canal. However, there is an area of low ground between the site and the canal in the north-western area of the site. If this area was not provided with adequate drainage, or if flow paths into the canal were blocked, there is the potential for significant depths of ponding to occur here.
- The site should be considered to be at high risk from surface water flooding

Potential Impact from Proposed Development

- The replacement of currently undeveloped areas of land with hard standing surfaces could reduce the amount of natural infiltration of rainwater into the subsoil.
- Without mitigation, the proposed development has the potential to increase the volume and rate of flows from the land. However, the prevailing slope of the land is towards the canal, and the presence of the canal structure will limit any surface water flows onto adjacent areas of land.
- The potential for development in this area to increase the risk of surface water flooding elsewhere is considered low.

Flooding from Groundwater:

Risk to Proposed Development

- The solid geology of the site is permeable sandstone. Sandstone can act as a natural aquifer, leading to high groundwater levels in the underlying strata.

- The superficial geology of the site is split between impermeable till diamicton and permeable glacial sands and gravels. The impermeable superficial geology may impede groundwater rise from deep underground sources but may also lead to perched groundwater issues.
- Investigation of the Ordnance Survey data shows some evidence of ponds in the general area of the site. This may be evidence of high ground water levels in the area.
- The Black Country Level 1 SFRA notes that the Wolverhampton area is experiencing increasing levels of high groundwater due to reductions in commercial abstraction. However, consultation with the Environment Agency has revealed no particular instances of Groundwater flooding at this site.
- The site should be considered to be at medium risk of groundwater flooding.

Potential Impact from Proposed Development

- It is unlikely that any development in this area will increase the risk of groundwater flooding elsewhere.

Flooding from Sewers:

Risk to Proposed Development

- Consultation with Severn Trent Water has revealed no existing instances of sewer flooding at this site

Potential Impact from Proposed Development

- Consultation with Severn Trent has not revealed any known capacity issues in the existing sewer network. However, large developments have the potential to substantially increase the loading on infrastructure and could increase the risk of sewer flooding. Without specific details and plans for development Severn Trent are unable to comment on the risk.
- The level of risk has been assessed as medium, as development here has the potential to increase the likelihood of sewer flooding and will require further investigation.

Flooding from Reservoirs, Canals and Other Artificial Sources:

Risk to Proposed Development

- The site is bordered to the west by the Staffordshire and Worcestershire Canal and to the north by the Wolverhampton Level of the Birmingham Canal. Consultation with British Waterways has revealed that in 1989 flooding from the site caused embankment failure of the Staffordshire and Worcestershire Canal, impeding flows and leading to localised flooding. The problem has been rectified and the residual risk of flooding is considered low.
- Ordnance Survey data shows two large ponds which occupy a section of the centre of the site. There are no reported instances of flooding associated with these features. The risk from these features is considered low at this stage of investigation.

Potential Impact from Proposed Development

- Development is unlikely to impact flooding from these sources elsewhere.

Spatial Planning Recommendations

- Approximately 30% of the site is classified as Flood Zone 2 Medium Probability. According to PPS25, new development should be allocated in Flood Zone 1 Low Probability in preference to areas of higher risk. Therefore, it will need to be demonstrated that there are no reasonably available sites at lower probability of flooding for the type of development proposed.
- If there are no other reasonably available sites, then in accordance with PPS25 Table D.3, 'More Vulnerable' and 'Less Vulnerable' developments are classified as being compatible with Flood Zone 2.

Recommended Development Control Measures

- Finished floor levels should be a minimum of 600mm above 1% AEP (1 in 100 year) plus climate change fluvial flood level.
- As an integral part of the government's "Making Space for Water" agenda, the Environment Agency is actively seeking the re-naturalisation of culverted watercourses as part of any future development. Realistic opportunities to reinstate the natural open waterway within existing culverted reaches of the river(s) should be heavily promoted.
- The site must be developed in a way that reduces the impacts of extreme rainfall events (i.e. an event above the capacity of surface water drainage system) on people and property both in the development itself and in the surrounding area. See report 'Designing for exceedance in urban drainage - good practice (CIRIA Report C635)' for further information.
- Implement SUDS to ensure that runoff from the site (post-redevelopment) is controlled. The Environment Agency requires that post-development runoff rates should be reduced by 20% from pre-development levels. However, the Black Country Level 1 SFRA states that runoff rates should not exceed Greenfield runoff rates (refer Section 6.6.3 of the Black Country Level 1 SFRA). The Buildings Regulations 2000 state that infiltration techniques should be used as the first option for SUDS where possible. Any SUDS design must take due account of groundwater, soil and geological conditions and should be located in open space areas.

- The use of basements should be discouraged due to the potential for surface water and/or groundwater flooding. Basements should only be permitted if a FRA clearly shows that the risk of surface water and/or groundwater flooding is low and/or that the basement is of a waterproof construction to avoid seepage during high groundwater conditions. It must be demonstrated that any below ground construction does not adversely increase the risk of groundwater flooding to adjoining properties. All basements must provide a safe evacuation route in time of flood, providing an access point that is situated above the 1% AEP (100 year) peak design plus climate change flood level.
- Dry access is to be provided (above flood level) to enable the safe evacuation of residents and/or employees in case of flooding. In exceptional circumstances where this is not achievable, and for non-residential uses, safe access must be provided at all locations, defined in accordance with the emerging Defra research as outlined in "Flood Risks to People" (FD2320 and FD2321). It is essential to ensure that the nominated evacuation route does not divert evacuees onto a 'dry island' upon which essential supplies (i.e. food, shelter and medical treatment) will not be available for the duration of the flood event.

Recommendations for Site Specific Flood Risk Assessment (FRA)

Fluvial Flood Risk

- If development is planned within Flood Zone 2, the level of fluvial flood risk will need to be determined in more detail. Modelling is likely to be required to assess this risk. The approach to be undertaken should be agreed in advance by the Environment Agency. See Environment Agency document 'Using computer river modelling as part of a flood risk assessment, Best Practice Guidance - Version 1 April 2006' for further details.
- Determine the fluvial flood level of the 1 in 100 year plus climate change (additional 20% to fluvial flows).
- Evaluate the potential for, and consequences of, culvert blockage (The EA considers this to be a mandatory requirement).
- Assess the impacts of the proposed development on fluvial flood risk elsewhere. This should include potential changes to overland flow routes as well as the displacement of flood water.

Surface Water Runoff Management

- Show clearly how surface water management is functioning on site at present and how it will function in the new development.
- Demonstrate clearly that, following development, there has been at least a 20% reduction in the volume and rate of surface water runoff discharging into local watercourses for all events up to the 1% AEP (1 in 100 year) plus climate change. Developers should aim to reduce runoff rates and volumes to the Greenfield rate in line with the Black Country Level 1 SFRA (refer Section 6.6.3 of the Black Country Level 1 SFRA).
- Greenfield, pre development and post development runoff rates and volumes should be calculated. Refer to the Environment Agency and Defra document W5-074 'Preliminary Rainfall Management for Developments' version D (PRRMD v. D) for guidance.
- The use of SUDs to manage surface waters is mandatory. Preference should be given to infiltration techniques where these are appropriate. Where they are not deemed appropriate, justification should be given for not using them. Refer to CIRIA publication C609 – The SUDS Manual for further guidance on appropriate SUDS techniques. Note that an assessment of soil types on this site suggests that infiltration could be a viable option due to the poor drainage characteristics.
- Initial investigation into the potential for infiltration techniques suggests that the local soils may contain groundwater at shallow depth (perched) and is unlikely to be suitable. Attenuation techniques will likely be the primary method of delivering SUDS.
- Assess surface water flow paths into and through the site and ponding areas during an extreme rainfall event. This assessment should be based on detailed topography (LiDAR or ground survey).
- Identify the impact of the development and any associated landscaping on surface water flow paths and ponding areas.
- Surface water assessment and management should be undertaken in accordance with relevant guidance current at the time and take into account any Surface Water Management Plan that might be prepared.

Groundwater Flooding

- The risk of groundwater flooding should be identified as clearly as possible based upon solid geology, superficial geology and soil characteristics. Historic maps should also be consulted to identify features indicative of high groundwater.
- Measures to mitigate any identified risk should also be included where necessary.

Sewer Flooding

- Consult Severn Trent Water to assess the impact of the proposed development on sewer flooding elsewhere.

Flooding from Reservoirs, Canals and Other Artificial Sources

- Any mapping of potential reservoir dambreach flood risk should be consulted if available and any advice associated with such mapping taken into account.

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4.1 Flooding from Rivers

From a review of the information available it is clear that there is a degree of fluvial flood risk across the study area. However, this risk is relatively minor as the most of the watercourses responsible for the flood risk are near their headwaters, in the upper part of the catchment. This means that the volumes of flows in the watercourses are low and that flooding is unlikely to be deep or prolonged in most instances.

Conversely, lead times (i.e. the delay between rainfall events and the onset of flooding) will be short. The upper parts of river catchments respond quickly to rainfall and flood warnings cannot be issued effectively. It is unlikely that people will have sufficient time to evacuate areas affected by flooding. Therefore, it is imperative the developments in areas potentially at risk of flooding are 'safe by design' and that vulnerable buildings are protected from flooding and access routes can function effectively during a flood event.

It is also apparent that there are a number of culverted watercourses within areas highlighted for future development. From the analyses undertaken as part of the Level 1 SFRA it appears as though the culverts within Wolverhampton are of sufficient hydraulic capacity to pass flood events well in excess of the Q100 (1% AEP or 1 in 100 year) flows.

Nevertheless, it is recommended that during redevelopment all opportunities to re-open these watercourses are taken. All culverted sections of watercourses have the potential to collapse and block, a risk that will increase over time as the structural condition deteriorates and the amount of debris in the channel builds up. Regular maintenance can reduce this risk (but not remove it completely); although this can be costly and dangerous due to the health and safety implications of working in confined spaces.

Opening up culverts can significantly increase the sustainability of any future development by reducing flood risks, decreasing maintenance costs and improving ecological habitats. Note that the Council may have obligations to do this under the EU Water Framework Directive, which states that all watercourses should have 'good ecological potential'.

From a spatial planning perspective, this Level 2 SFRA has not found any evidence to suggest that the risk of fluvial flooding would prevent development in the areas identified provided that the principals of PPS25 are applied on a site by site basis i.e. that vulnerable development is located in areas at lowest risk of flooding and that risk of flooding is mitigated through appropriate development control measures.³

4.2 Flooding from Land

Flooding from land (surface water runoff) has been identified as a high risk in many areas through a GIS based analysis. It could be argued that this source of flooding represents the greatest risk to the development areas in general as it is likely to become a more frequent occurrence with climate change.

³ Note that this is not the application of the Sequential Test.

A review of the localised drainage issues indicates a good correlation between known events and the overland flow routes. As stated in Section 2, overland flow routes can be significantly influenced by small features such as kerbs and walls, which will not be represented in a strategic level investigation. Overland surface flow can also accumulate or 'pond' in topographic depressions. Therefore, it is recommended that a more detailed Surface Water Management Plan (SWMP) is undertaken for the Wolverhampton City Council area once formal guidance for the preparation of such plans becomes available.

Flooding from land can be mitigated once the risk has been identified. If a surface water flood risk is identified this would not necessarily prevent an area from being redeveloped.

4.3 Groundwater Flooding

This Level 2 SFRA has identified that there may be a risk of groundwater flooding across the Wolverhampton area due to the 'groundwater rebound' following cessation of abstraction for industrial purposes. A review of currently available information does not at this stage suggest any strong pattern from which high risk and low risk areas can be identified.

As a precautionary measure, the risk has been assessed as medium across many of the development areas. Further investigations will be required on a site by site basis to determine the level of risk more accurately.

4.4 Flooding from Sewers

The information available suggests that there are numerous instances of sewer flooding across the study area, which is primarily based upon the DG5 register from Severn Trent Water (a record of known instances of sewer flooding). However, the DG5 register may contain 'out of date' information as many problems may have been rectified. Furthermore, the risk of sewer flooding to a development can often be mitigated.

Nonetheless, it is still possible that redevelopment could increase the risk of sewer flooding elsewhere, as identified in the site by site appraisal in Section 3. As Severn Trent Water was unable to comment on specific developments, no assessment can be made which could have an impact on the spatial planning process at this stage. It is noted that there is a Water Cycle Strategy in development and that this may reveal further information at a later date.

4.5 Flooding from Artificial Sources

There are number of small drainage ditches that could affect several development sites. However, flooding from this source can often be readily mitigated and is unlikely to present a serious problem in terms of spatial planning.

A more significant source of flood risk are the canals present throughout Wolverhampton. The volume of water contained within these structures is large and has the potential to cause extensive flooding if a canal is breached. Furthermore, this flooding could be rapid and deep, with little warning.

Consultation with British Waterways suggests that the risk of a major breach is low (see Appendix E), and the most common source of flooding from canals is

overtopping due to high volumes of flow into the canal. Overtopping of canal banks is less of a risk as the onset of flooding is generally slower and the volumes of water involved is much lower. However overtopping could lead to a breach.

The actual level of risk will depend on site specific factors, which cannot be determined as part of the SFRA process, such as method of construction of the canal, typical water levels relative to local ground levels and the location of overflows into the canal system.

The location of a site in close proximity of a canal should not necessarily affect the siting of a development area as rigorous inspection procedures aim to ensure that the level of risk of flooding from canals is low – this includes the Wolverhampton area. Nevertheless, it is imperative that where the individual site report (produced as part of this Level 2 SFRA) has identified a potential risk from the canal that this risk is investigated as part of the site specific FRA.

4.6 Further Recommendations for the FRA

The individual site assessments undertaken in Section 3 contain recommended investigations to be carried out as part of the FRA. However, before a site specific FRA is undertaken the local Environment Agency Development Control Officer must be consulted. This consultation should confirm the scope of the FRA and approach(es) to be taken. Failure to do this may result in wasted investigations or the production of a FRA that does not meet the requirements of Local Development Control Officers. Consultation will also give the Environment Agency the opportunity to let developers know of any new information, which may have come to light since completion of this Level 2 SFRA.

Wolverhampton City Council is progressing a series of Area Action Plans (AAP) for regeneration areas. These areas include Bilston and Stafford Road.

To assist in the decision making process, and in accordance with the requirements of PPS25, and the associated Practice Guide, this Level 2 SFRA was commissioned by the Council.

This Level 2 SFRA has built upon the findings of the recent Black Country Level 1 SFRA, and assessed in further detail the potential risk of flooding to each potential development site.

The assessments have identified a number of flood risks associated with the potential developments. However, none of these risks are deemed to be sufficient to prevent allocation of the sites at this stage of the planning process. It is likely that mitigation measures will be available to reduce any risks to a level acceptable under PPS25.

It is also likely that it is feasible that the sites can be developed safely, without increasing the risk of flooding elsewhere. Nonetheless, it is essential that site specific FRAs are undertaken where appropriate that address the risks identified within this document. In addition, the Environment Agency should be consulted early within the FRA process to determine the scope and level of detail required.