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**Bellway Homes (East Midlands) Ltd**

**Proposed Residential Development  
Land off Ashland Road West  
Sutton in Ashfield  
Nottinghamshire**

**Flood Risk Assessment  
Prepared by EWE Associates Ltd  
Final RevD November 2020**



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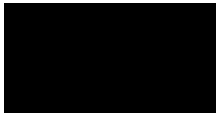
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## CLIENT DETAILS

Bellway Homes (East Midlands) Ltd
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## CONTRACT

This report describes work commissioned by Bellway Homes (East Midlands) Ltd following written instruction by their representative during May 2019. Bellway Homes Ltd representative for the contract was Jo Althorpe of DLP Planning Ltd. Lea Favill of EWE Associates Ltd carried out the work.

Date:	11 <sup>th</sup> November 2020
Prepared by:	.....  ... Lea Favill Director

## REVISION HISTORY

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## **EXECUTIVE SUMMARY**

The existing development site consists of a single large agricultural field which has a single hedgerow running south to north through the centre. The site is located to the north of Ashland Road West and to the north west of the centre of Sutton in Ashfield which is to the north of Mansfield. The ground levels in this area are at a level of between 159.64mOD at the north east corner of the site adjacent to the local watercourse up to 182.72mOD at the south west corner of the site adjacent to Ashland Road West. There is existing residential development located to the south, east and west of the site. Brierley Forest Park and a local watercourse are located to the north. The total area of the site is 10.137 hectare and is considered to be 100% permeable as the whole of the site is grassland/agricultural. There are no roofed or paved areas within the site. The site presently drains in a northerly direction towards the local watercourse. The proposal is to construct a residential housing development which also includes associated driveways, access courts and access roads within the site. It is estimated that the impermeable area following completion of the development will be increased to approximately 4.23 hectares which is 41% of the total site.

The existing site is elevated sufficiently above the nearest Main River watercourses, as such, lies within Flood Zone 1 of the Environment Agency Flood Map (version 2.8.2). However, there is a local watercourse to the north of the site which is controlled by a culvert under a large soil heap, which, if it became blocked could result in localised flooding to the north of the site. It is considered that the flood water could overtop the headwall and reach a level of 160.159mOD. As such, it is recommended that the internal ground floor levels of the dwellings within the site are elevated at least 600mm above the estimated flood level, hence a level of 160.759mOD. The area where the dwellings are proposed are at 161.50mOD and above. As such, the raising of ground floor levels will be easily achieved within the site. It is also recommended that the internal ground floor levels of all the dwellings within both parcels of land are elevated at least 150mm above the adjacent proposed roads within the site to reduce the risk of flooding from overland flows.

Consideration has been given to the hierarchy for surface water disposal which recommends the SUDs approach which includes infiltration as the first tier. Further investigation is required to confirm that infiltration drainage will be a practical solution for the site.

However, other SUDs techniques can be used within the site and they have been considered. The second tier is to discharge to a watercourse. The existing site is considered to be 100% permeable. Following the proposed development, the impermeable area will be significantly increased to approximately 41% of the total site area. It is considered that the site currently discharges runoff via a combination of infiltration, evaporation and overland flow to the local watercourse to the north of the site.

Using software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (40%) event. The site will discharge into the existing culvert and local watercourse system to the north of the site at a peak discharge rate of 46.9l/s. The primary attenuation will be provided within a single balancing pond. The balancing pond will be 1.5m deep with a top area of approximately 4000m<sup>2</sup>.

The balancing pond will be used to accommodate the storage during 1 in 1 year, 30 year, 100 year and 100 year +CC storms (worst case scenario).

The proposal is to provide a hydro-brake to restrict flows from the site. The hydro-brake will reduce the runoff from the development site during higher return periods, hence, there will be a significant reduction in runoff and as such the development will provide significant betterment in terms of runoff being passed forward from the site into the local watercourse.

It is concluded that the proposed development lies within flood zone 1 low risk and the current drainage feasibility study utilises sustainable drainage techniques where practically possible.

## **CONTENTS**

<b>1.</b>	<b>INTRODUCTION -----</b>	<b>7</b>
	Terms of Reference .....	7
	Approach to the Assessment .....	7
	Application of Sequential & Exceptions Test .....	9
<b>2.</b>	<b>DETAILS OF THE SITE -----</b>	<b>10</b>
	Site Location .....	10
	Site Details .....	10
	Site Description .....	11
	Site Photographs.....	11
<b>3.</b>	<b>INITIAL ASSESSMENT -----</b>	<b>12</b>
	Environment Agency Flood Map .....	12
	Environment Agency Reservoir Flood Map.....	12
	Environment Agency Surface Water Flood Map .....	13
	Past Flooding History.....	13
	Environment Agency Flooding History .....	13
	SFRA Flooding History .....	13
	Possible Flooding Mechanisms .....	13
<b>4.</b>	<b>FLOOD RISK ASSESSMENT -----</b>	<b>15</b>
	Requirements of the Environment Agency .....	15
	Local Watercourse .....	15
	Increased Runoff due the Development .....	19
	Existing Drainage.....	19
	Proposed Drainage Strategy .....	20
	Sustainable Urban Drainage.....	22
	Adoption and Maintenance .....	23
	Overland Flow.....	24
	Foul Drainage.....	24
<b>5.</b>	<b>MITIGATION MEASURES -----</b>	<b>25</b>
	Raising Floor Levels/Land Raising.....	25
	Emergency Access & Egress.....	25
	Control of Runoff.....	25
<b>6.</b>	<b>CONCLUSION -----</b>	<b>27</b>

### **APPENDICES:**

**APPENDIX A: - EXISTING GROUND LEVELS WITHIN SITE**

**APPENDIX B: - PROPOSED LAYOUT DRAWING**

**APPENDIX C: - REFH CALCULATION SHEET**

**APPENDIX D: - CULVERT CAPACITY CALCULATION SHEET**

**APPENDIX E: - ICP SUDS CALCULATION SHEET**

**APPENDIX F: - DRAINAGE STRATEGY DRAWING**

**APPENDIX G: - WINDES 100YR+CC 480MIN**

**APPENDIX H: - STW DEVELOPER ENQUIRY**

**LIST OF FIGURES**

Figure 2-1: Aerial Photograph of Existing Site .....	11
Figure 4-1: 1300mm diameter culvert entrance .....	16
Figure 4-2: Cross Section In line with Site .....	17
Figure 4-3: Cross Section at 1300mm diameter culvert.....	18

**LIST OF TABLES**

Table 2-1: Location Plan.....	10
Table 2-2: Site Details.....	10
Table 4-1: Runoff Estimates from site 10.137 ha.....	19

## **1. INTRODUCTION**

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### **Terms of Reference**

This report was commissioned by Bellway Homes (East Midlands) Ltd to support a planning application for the development of an area of land to the north of Ashland Road West, Sutton in Ashfield to provide residential units. The site can presently be accessed from the south off Ashland Road West. The location of the site is shown on Table 2-1.

The whole of the development site lies within Zone 1 of the Environment Agency Flood Map (version 2.8.2), being the zone with risk of 1 in 1,000 year (0.1% AEP) or less for river flooding. The overall size of the development is greater than 1 hectare.

It is usual for the Agency to raise an objection to development applications within the floodplain or Zone 2 or 3 of the flood map until the question of flood risk has been properly evaluated. The Agency will also object to developments where the total site area is in excess of 1 hectare until suitable consideration has been given to surface water runoff.

### **Approach to the Assessment**

As there two sources of flood risk – Local Watercourses and Surface water runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from this source. Consideration has also been given to the site flooding from either overland flow or ponding of localised rainfall within the site.

Ashfield District Council undertook a level 1 in-house Strategic Flood risk Assessment (SFRA). The work was completed in February 2009.

There is a single local watercourse located to the north of the site within the Brierley Forest Park. In line with the site the watercourses enter a series of culverts. There are no modelled flood levels which may assist in predicting the design flood level for the watercourses adjacent to the proposed development site. An assessment of the flood level will be made by simple channel capacity calculations using the Manning's 'n' equation and pipe tables.

There is a single local watercourse located within the western boundary of the site which flows south to north into the local watercourse located within Brierley Forest Park. The watercourse is small with a bed width of 0.5m and depth of 0.4m with a bed slope of 1 in 19. The capacity of the watercourse is estimated at approximately 800l/s (0.8m<sup>3</sup>/s) using the Manning's Equation. The catchment area is approximately 1.2 hectares of domestic gardens and a small part of the site. Based on a 1 in 100 year plus climate change greenfield runoff rate of 25 l/s/ha the peak flow rate entering the watercourse is only 30 l/s. it is therefore considered that the capacity of the local watercourse is adequate to convey the peak 1 in 100 year plus climate change flow. The developer should not encroach onto the watercourse or impede its conveyance route. As such, no further consideration will be given to this watercourse.

In line with the site the watercourses enter a series of culverts. There are no modelled flood levels which may assist in predicting the design flood level for the watercourses adjacent to the proposed development site. An assessment of the flood level will be made by simple channel capacity calculations using the Manning's 'n' equation and pipe tables.

The proposed development will significantly increase the paved and roofed area within the site. As such, the existing method of draining the site will be appraised. EWE Associates Ltd has undertaken a drainage feasibility study for the site and will provide indicative storage volumes estimated using Micro Drainage Source Control Software.

The storage volumes needed to attenuate surface water flow from the development to accommodate the required 1 in 100 year plus 40% climate change event, have therefore been calculated, using the proposed drainage strategy, as outlined above. However, the volume balance requirements should be recalculated during the detailed design stage to reflect the actual development proposal, the extent of impermeable areas and runoff to be generated.

A walk over of the site was conducted by Mr Lea Favill, Principal Engineer during February 2020; during the visit a photograph survey of the site was undertaken. During the site visit an investigation into the existing drainage route from the site was also undertaken. A topographical survey of the development site was provided by the client's representative. The survey has been calibrated to OS GPS. The surveyed levels have been used within this report.

The requirements for flood risk assessments are generally as set out in National Planning Policy Framework (NPPF). The detail and complexity of the study required should be appropriate to the scale and potential impact of the development. For the purposes of this study, the following have been considered: -

- Available information on historical flooding in the area.
- Site level information.
- Details of structures, which may influence hydraulics of the watercourse and consideration of the effect of blockage of structures.
- Estimates of design levels, equivalent to a 200-year (coastal/tidal) and a 100-year (fluvial) return period flood event.
- Allowances for increased flows resulting from the effects of climate change.
- Allowances for sea level rise resulting from the effects of climate change.

Assess the existing runoff characteristics and the potential impact the proposed development will have on the runoff.

Further guidance is also provided in the CIRIA Research Project 624 "Development and Flood Risk: Guidance for the Construction Industry".



## Application of Sequential & Exceptions Test

The whole of the development site lies within Zone 1 of the Environment Agency Flood Map (version 2.8.2), being the zone with risk of 1 in 1,000 year (0.1% AEP) or less for tidal/river flooding. The SFRA completed in 2009 estimates that the whole of the site is within flood zone 1, low risk. The Environment Agency flood maps also show the whole of the site to be within flood zone 1, low risk. The proposed development is residential, as such, is more vulnerable.

**Table 1: Flood Risk Vulnerability and Flood Zone ‘Compatibility’**

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

✓ Development is appropriate

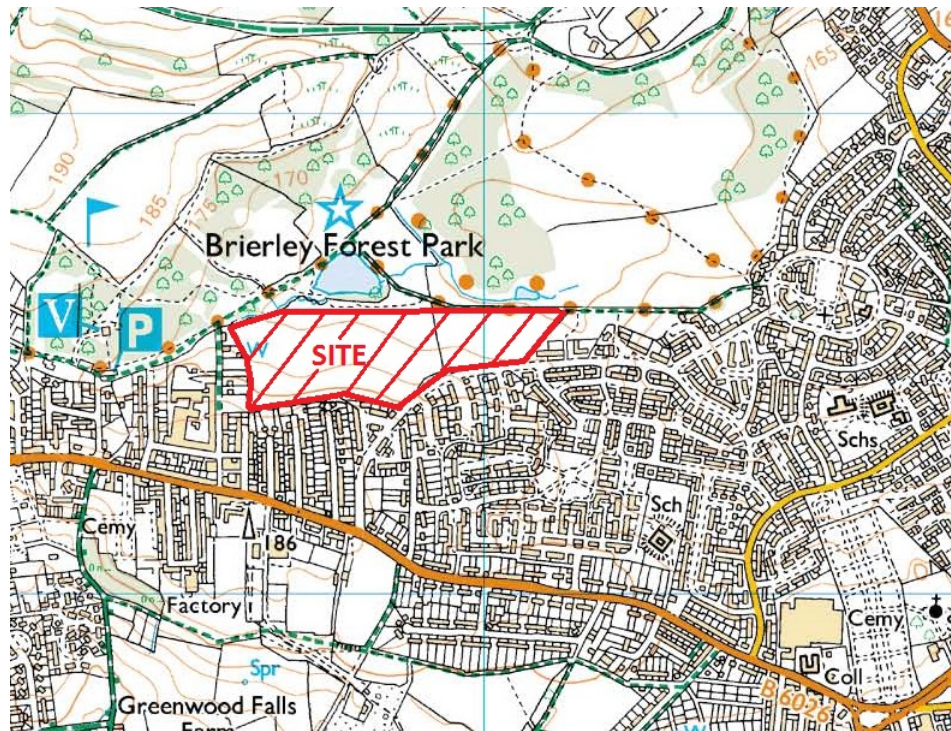
✗ Development should not be permitted

It is therefore considered that the exceptions test is not required for the development. Furthermore, it is considered that the site is sequentially preferable as there are no alternative sites available at a lower flood risk within the district.

## 2. DETAILS OF THE SITE

### Site Location

**Table 2-1: Location Plan**



Ordnance Survey Licence no.: WL1005160

### Site Details

**Table 2-2: Site Details**

<b>Site Name</b>	Land off Ashland Road West, Sutton in Ashfield
<b>Existing Land Use</b>	Agricultural
<b>Proposed Development</b>	Residential Development
<b>Grid Reference (centre of site)</b>	SK 48193 59641
<b>County</b>	Nottinghamshire
<b>Local Planning Authority</b>	Ashfield District Council
<b>Internal Drainage Board</b>	Not Applicable
<b>Post code</b>	NG17 2GG

## Site Description

The existing development site consists of a single large agricultural field which has a single hedgerow running south to north through the centre. The site is shown on the aerial photograph in Figure 2.1 below. The site is located to the north of Ashland Road West and to the north west of the centre of Sutton in Ashfield which is to the north of Mansfield.

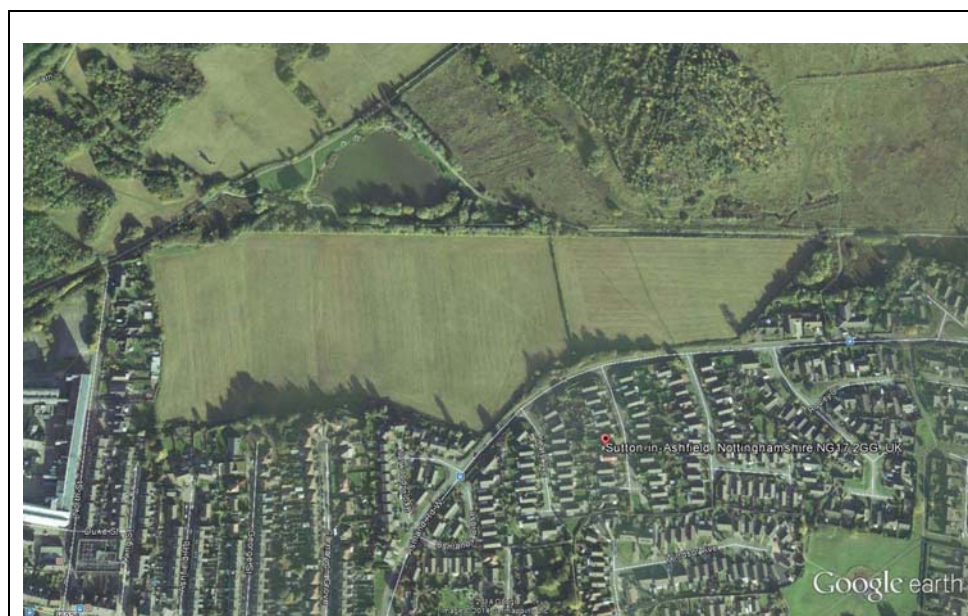
The ground levels in this area are at a level of between 159.64mOD at the north east corner of the site adjacent to the local watercourse up to 182.72mOD at the south west corner of the site adjacent to Ashland Road West. The ground levels within the site are illustrated at Appendix A of this report. There is existing residential development located to the south, east and west of the site. Brierley Forest Park and a local watercourse are located to the north.

The total area of the site is 10.137 hectare and is considered to be 100% permeable as the whole of the site is grassland/agricultural. There are no roofed or paved areas within the site. The site presently drains in a northerly direction towards the local watercourse.

The proposal is to construct a residential housing development which also includes associated driveways, access courts and access roads within the site. Indicative layout plan for the development is shown at Appendix B of this report. It is estimated that the impermeable area following completion of the development will be increased to approximately 4.23 hectares which is 41% of the total site.

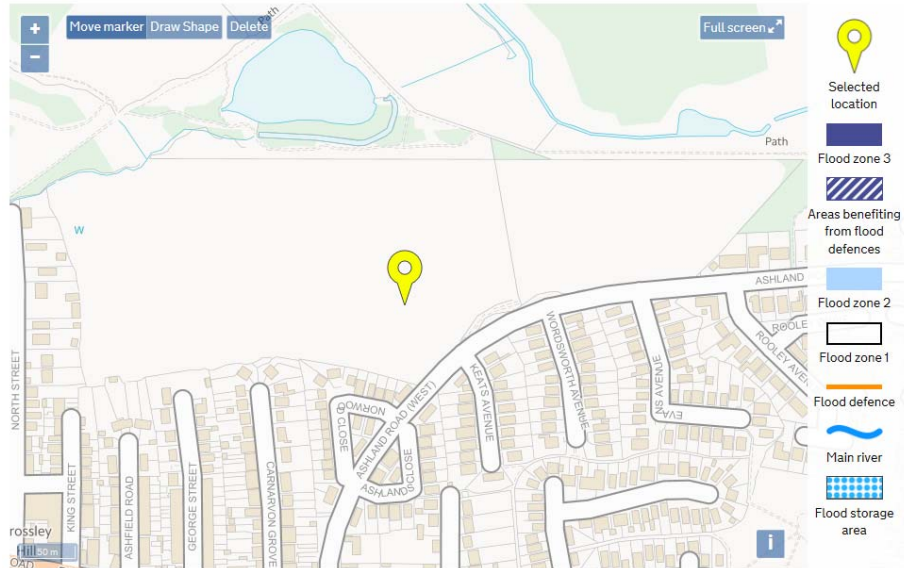
## Site Photographs

**Figure 2-1: Aerial Photograph of Existing Site**

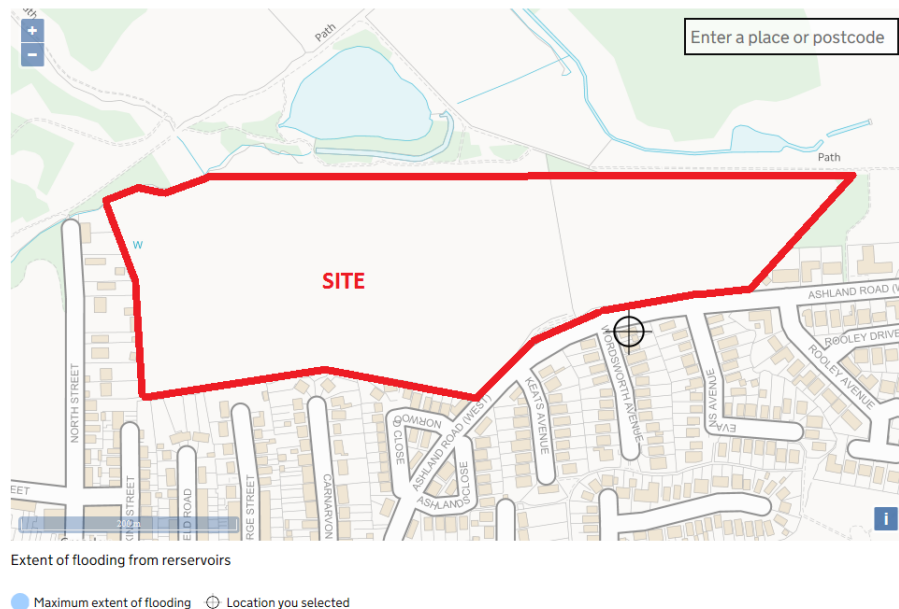


### 3. INITIAL ASSESSMENT

#### Environment Agency Flood Map



#### Environment Agency Reservoir Flood Map





## Environment Agency Surface Water Flood Map



## Past Flooding History

A search on the British Hydrological Society Chronology of British Hydrological Events website<sup>1</sup> found no records of past flooding within Sutton in Ashfield local to the site.

Undertaking an internet based search for flooding in the area provided no further information.

## Environment Agency Flooding History

The Environment Agency did not provide any references to flooding close to the site.

## SFRA Flooding History

The SFRA did not provide any references to flooding close to the site.

## Possible Flooding Mechanisms

As there two sources of flood risk – Local watercourses and Surface water runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from these sources.

The Local watercourse is not defended by earth embankments or flood walls which extend above the natural ground level. As such, consideration will only need to be given to overtopping.

<sup>1</sup> <http://www.dundee.ac.uk/geography/cbhe/>

The proposed development will significantly increase the impermeable area and subsequently the runoff from the site will also be increased. An initial drainage strategy has been completed as part of this assessment based on available data.

Ashland Road West is elevated above the site. Therefore, this flood mechanism has been considered further.

There are no depressed areas within the site which could promote ponding. Therefore, this flood mechanism has not been considered further.

Information on groundwater flooding is limited within the Ashfield District Council. The SFRA makes no comment regards the potential for ground water flooding in the district. In addition, reference to the Groundwater Vulnerability Map and Source Protection Zones produced by the Environment Agency indicate that the district is not underlain by an aquifer, as such, groundwater is unlikely to be source of significant flood risk.

Severn Trent Water is the statutory water undertaker and is responsible for the public sewer systems within the Sutton in Ashfield area. Severn Trent Water maintains a register of historical sewer flooding events (DG5 Register) within the area. There are no report incidents close to the site.

## **4. FLOOD RISK ASSESSMENT**

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### **Requirements of the Environment Agency**

The Environment Agency, as part of its development control procedures, generally require finished floor levels to be set above the 1% AEP plus climate change flood water level at the site. The development is residential in nature, as such, it is considered that access and egress from the development site will be essential during times of extreme floods.

The Environment Agency will request that the runoff from the proposed development is restricted to the existing peak runoff rate. None of the existing site is considered to be 'brownfield development' hence a further 30% reduction will not need to be applied to the estimated peak run off rate in order to accommodate climate change over the lifetime of the development. The whole of the site is Greenfield development which will not require a 30% reduction. They will further insist that the proposed 1 in 2 year runoff can be maintained and also insist that the 1 in 30 year event is not allowed to flood the surface; hence, the water must remain within the pipes, manholes, and storage systems (the proposed balancing ponds). The 1 in 100 year plus climate change event will be allowed to flood the surface but flood water will not be permitted to enter any of the buildings within the site. The 1 in 100 year plus climate change flood must also be limited to the development boundary and must not be allowed to migrate to adjacent properties.

### **Local Watercourse**

There is a local watercourse which flows from the west to the east through the Brierley Forest Park approximately 30m to the north of the site. Upstream and in line within the site the local watercourse passes through the Brierley Forest Park collecting flows from within the park and the urbanised area of Huthwaite. Within the Brierley Forest Park there is a large pond which is used for fishing which is controlled by a weir and a 900mm diameter culvert directly downstream which conveys flows beneath an access track before discharging into an open channel section for the local watercourse. At the downstream end of the site the local watercourse passes through a 1300mm diameter culvert which flows under a soil heap before emerging in a small valley to the south of the Brierley Park Industrial Estate. The watercourse generally collects flows from a catchment area of 0.87 km<sup>2</sup>.

The Environment Agency was unable to provide any estimated or historical flood data which may assist in predicting the 1 in 100 year flood at the site. Therefore, an estimate of the 1 in 100 year flood level has been made simplistically.

Local watercourse is approximately 460m in length between the 1300mm diameter culvert at the downstream end of the site. It is considered that the section of the open watercourse directly in line with the downstream end of the site is the most likely point which the watercourse could flood and affect the site due to the constriction caused by the 1300mm diameter culvert. The invert level of the 1300mm diameter culvert has been estimated at 157.806mOD and the soffit of the 1300mm diameter culvert is 159.106mOD. Directly upstream of the 1300mm diameter culvert the minimum open channel cross section has a bed width is 1m and the top width of 4m. The bed slope in line with the site is 1 in 122 (3.763m fall in 460m). The culvert entrance is shown overleaf at Figure 4-1.

Due to the catchment size it is considered that the FEH technique is not appropriate for such a small catchment. The catchment is also considered to be predominantly rural and therefore the ReFH Rainfall Runoff Method has been adopted. From the site visit and ordnance survey mapping of the area it is estimated that the catchment area to the downstream end of the site is approximately 0.87km<sup>2</sup>. As such a peak 1 in 100 year flow of 1.3m<sup>3</sup>/s (1300l/s) has been estimated. The peak 1 in 1,000 year flow of 2.5m<sup>3</sup>/s (2500l/s) has been estimated. The results and calculations are provided at Appendix C of this report. The Manning's calculations used to calculate the channel capacity is shown below.

**Figure 4-1: 1300mm diameter culvert entrance**



The channel capacity in line with the site has been estimated at 14.4m<sup>3</sup>/s. The 1 in 100 year flow has been estimated at 1.3m<sup>3</sup>/s which is considerably less than the channel capacity.

The climate change allowances were modified during February 2016 by the Environment Agency. The increases are now provided for eleven different river basins within the country and for varying confidence levels depending on the proposed development. The proposed development falls within the Humber basin and as the development is residential the 2070 to 2115 banding is relevant as the design life of the development is 100 years. As the development is residential the upper and higher central bandings should also be considered. This provides two climate change increases at 30% and 50%.

Therefore, an increase of 50% has been applied to the 1 in 100 year flow for future climate change; hence, a flow of 1.95m<sup>3</sup>/s has been estimated. The 1 in 1,000 year flow has been estimated at 2.5m<sup>3</sup>/s which is considerably less than the channel capacity. Therefore, the 1 in 100 year, 1 in 100 year plus climate change and extreme 1 in 1,000 year flows are less than the channel capacity. As such, out of bank flooding is not expected during any of the flood events.



### **Manning's Equation: $Q = (A \cdot r^{2/3} \cdot s^{1/2}) / n$**

A = Cross sectional area of channel = 8.25m<sup>2</sup>

P = Wetted perimeter of channel = 5.24m

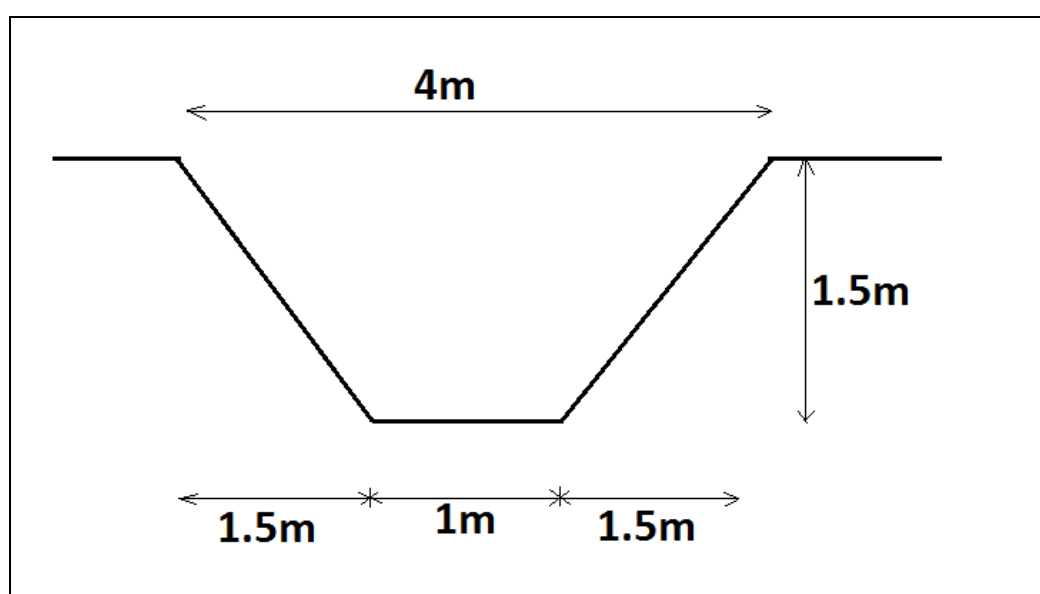
r = A/P = 1.57

s = average channel slope = 3.763m fall over 460m = 0.0082

n = Manning's coefficient of roughness = 0.070 (straight channel, with some stones and weeds).

Q = 14.4m<sup>3</sup>/s

**Figure 4-2: Cross Section In line with Site**



### **Culvert Capacity**

Directly in line with the downstream end of the site there is a 1300mm diameter culvert under the soil heap. The invert level at the culvert entrance is 157.806mOD. The culvert is several hundred metres in length. The gradient of the local watercourse upstream of the culvert entrance is 1 in 122 (0.0082). As such, a pipe gradient of 1 in 122 has been adopted for this assessment. The peak 1 in 100 year plus climate change flow has been estimated at 1.95m<sup>3</sup>/s. The peak capacity of the culvert has been estimated using the Colebrook White pipe tables. A peak flow of 4.25m<sup>3</sup>/s has been estimated. The calculation sheet is provided at Appendix D of this report. This is considerably greater than the estimated 1 in 100 year plus climate change flow of 1.95m<sup>3</sup>/s. Due to the size of the culvert and the amount of vegetation located directly upstream of the headwall that it is highly probable that the culvert could become blocked. Therefore, flows will back up from the headwall and overtop the headwall during the design flood events.

Adopting the criteria set by the Environment Agency a 75% blockage is considered. Therefore, reducing the culvert capacity by 75% reduces the culvert capacity at the entrance to 1.06m<sup>3</sup>/s. This is less than the estimated 1 in 100 year plus climate change flow of 1.95m<sup>3</sup>/s and the extreme 1 in 1,000 year flow of 2.5m<sup>3</sup>/s, as such, it is considered that the water level will exceed the soffit level of the culvert (159.106mOD). It is likely that the flood water will overtop the headwall which is at a level of 159.559mOD. It is therefore estimated that during a 1 in 1,000 year extreme flood event that 1.44m<sup>3</sup>/s will overtop the headwall.

Therefore assuming the flood water is limited to a channel width of 4m it is estimated that the flood depth will not exceed 0.6m. The Manning's calculations used to calculate the overflow channel capacity is shown overleaf. Therefore, the peak flood level during the extreme 1 in 1,000 year flood event has been estimated at 160.159mOD (159.559mOD + 0.6m).

**Manning's Equation:  $Q = (A \cdot r^{2/3} \cdot s^{1/2}) / n$**

A = Cross sectional area of channel = 2.4m<sup>2</sup>

P = Wetted perimeter of channel = 5.2m

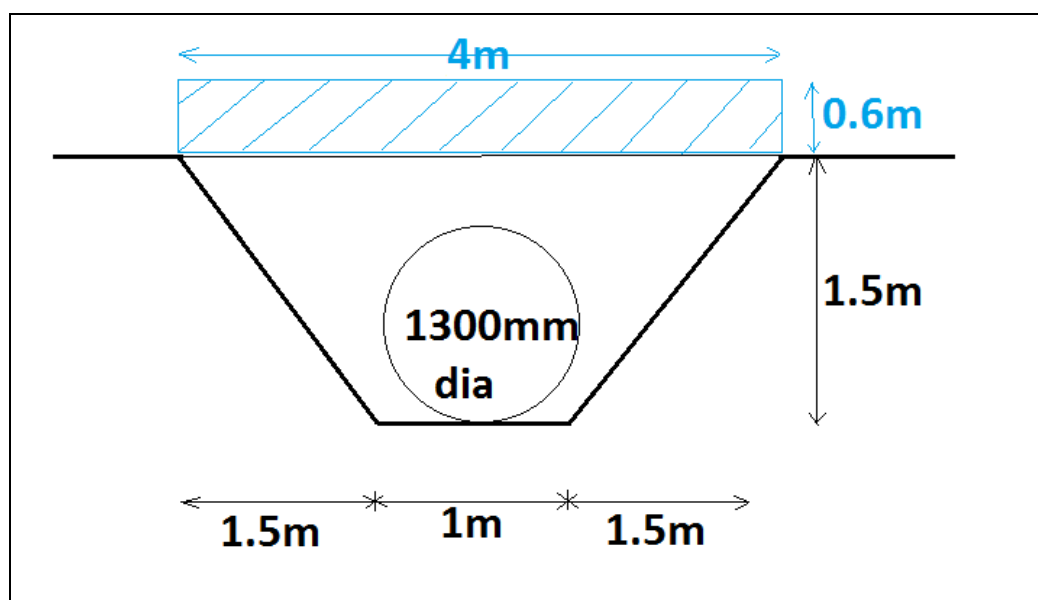
$r = A/P = 0.462$

s = average channel slope = 3.763m fall over 460m = 0.0082

n = Manning's coefficient of roughness = 0.070 (straight channel, with some stones and weeds).

Q = 1.55m<sup>3</sup>/s

**Figure 4-3: Cross Section at 1300mm diameter culvert**



## Increased Runoff due the Development

### Existing Drainage

The site consists of a single large agricultural field which slopes south from Ashland Road West towards the north where the local watercourse within Brierley Forest Park is located. As such, the whole of the site is considered to be 100% permeable. There is a single hedgerow running south to north approximately midway within the site. However, there are no ditches or dikes within the site.

GRM Development Solutions undertook site investigations during December 2012 and concluded that soakaways are not a practical solution for the site. Following the drainage hierarchy consideration has been given to discharging to a watercourse. There is an ordinary watercourse located to the north of the site which is accessible. Therefore, a discharge to the local watercourse has been assessed. As the watercourse is non main river it is assumed that the LLFA will be responsible for consenting any discharges into the watercourse.

For the purpose of this assessment the peak discharge rates from the site below in Table 4-1 have been conservatively adopted. The ICP SUDS Method has been used to calculate the runoff from the site. The estimate assumes a 100% permeable area. The calculation sheet is provided at Appendix E of this report. Any discharge from the site into the local watercourse will require the consent of the appropriate water authority/riparian owner and as such they will also need to be approached to agree the discharge restriction from the site. There is a 600mm diameter culvert which flows south to north past the north east corner of the site which outfalls into the local watercourse directly adjacent to the downstream end of the site. It is possible that a connection could be made into this culvert from the site if the owners are in agreement.

For the purpose of this assessment a peak discharge rate of 46.9l/s has been adopted.

**Table 4-1: Runoff Estimates from site 10.137 ha**

<b>Return Period</b>	<b>Flow in litres per second (l/s)</b>	<b>Flow in litres per second per hectare (l/s/ha)</b>
Qbar	46.9	4.50
1 in 2 year	42.0	4.04
1 in 30 year	91.9	8.83
1 in 100 year	120.5	11.58

Intrusive investigation work will be needed to determine whether any areas of the site are suitable for the use of soakaways. If soakaways are determined to be unsuitable then roof and pavement drainage will need to discharge into the existing local watercourse located to the north of the site.

## Proposed Drainage Strategy

It is proposed to ultimately discharge any surface water flows generated by the development of the site which cannot drain via infiltration to the local watercourse located to the north of the site.

The proposed impermeable area for the development site has been calculated to be approximately 4.23 ha which is 41% of the total site area, with the remainder of the site proposed as gardens, landscaping and open space.

The drainage strategy utilises an appropriately sized hydro brake to restrict the flows to a peak rate of 46.9l/s. As such, it is expected that during the more extreme return periods there will be a considerable betterment as the hydro brake is likely to restrict flows to a lesser rate than estimated at present.

Based upon the assumption that the EA will agree to the maximum discharge of 46.9l/s, a preliminary surface water strategy has been developed and attenuation has been sized using MicroDrainage software. Attenuation volumes have been calculated for the 1 in 100 year plus 40% climate change event. The proposed drainage strategy is shown at Appendix F of this report.

It is proposed that a single pond is provided adjacent to the northern boundary of the site at the lowest end of the site (east corner) which will discharge to the 600mm diameter culvert which crosses the site and then into the local watercourse.

The model data for the proposed surface water drainage network has been obtained from the proposed development layout drawing and the drainage strategy drawing is provided at Appendix F of this report. A model has been developed to represent the main drainage runs within the proposed drainage network and contributing drainage areas within the development.

Overall, the hydraulic models include the following;

- 50 pipes to represent the proposed system
- 1 hydro-brake (46.9l/s 1.5m head)
- 1 attenuation pond
- 1 outfall into the ditch watercourse with no surcharging

Impermeable area contributions have been based on those supplied on the proposed layout drawing, considered to be 100% impermeable, comprising of roofed and paved areas.

The models have been set up as a fixed runoff model assuming 100% runoff coefficient for roofed and paved areas. The rainfall characteristics for Sutton in Ashfield have been utilised with a value for M5-60 given as 20mm (the depth of rain in a once in five years one hour duration event); and  $r$  given as 0.40 (the ratio of the M5-60 rainfall to the M5-2day rainfall). For durations over 60 minutes the FEH runoff data for Sutton in Ashfield has been used.

The volume balance requirements should be recalculated during the detailed design stage to reflect the actual development proposal, agreed discharge rate and the extent of impermeable areas and runoff to be generated.

## Hydraulic Modelling Results

The proposed MicroDrainage models have been simulated with the 1 in 100 year plus climate change (40%) return period design storm events with durations of 15, 45, 60, 180, 360, 420, 480, 540, 600, 900 and 1440 minutes. At the request of the Environment Agency seven day 10080 minute duration was also undertaken. The durations were run in both Winter and Summer profiles. It was found that the Winter profile was critical.

The table overleaf shows a summary of the 1 in 100 year plus climate change model runs and the impact on the drainage system in terms of peak depth within the pond and flow through the hydro-brake.

The 480 minute duration produced the largest flow through the hydro-brake (46.3 l/s) which is less than the restricted runoff rate (46.9l/s). The modelled result for the 480 minute Winter model run is provided at Appendix G. There was no flooding during this event.

Return Period	Profile	Duration (min)	Peak water level in pond	Peak flow into ditch	Status
100 year+CC	Winter FSR	15min	160.954	46.3	OK
100 year+CC	Winter FSR	45min	161.146	46.2	OK
100 year+CC	Winter FEH	60min	161.194	46.1	OK
100 year+CC	Winter FEH	180min	161.401	46.2	OK
100 year+CC	Winter FEH	360min	161.463	46.3	OK
10.8100 year+CC	Winter FEH	420min	161.472	46.3	OK
100 year+CC	Winter FEH	480min	161.476	46.2	Surcharge
100 year+CC	Winter FEH	540min	161.474	46.2	OK
100 year+CC	Winter FEH	600min	161.473	46.3	OK
100 year+CC	Winter FEH	900min	161.461	46.3	OK
100 year+CC	Winter FEH	1440min	161.424	46.3	OK
100 year+CC	Winter FEH	10080min	160.766	29.3	OK

## **Sustainable Urban Drainage**

With regard to water quality considerations for the site, it is recommended that 1 treatment train is provided for building roofs and 2 treatment trains are provided for roads and hard-standing areas in line with CIRIA C697 recommendations. For the building roof, it is proposed to use trapped drainage outlets to provide 1 treatment train.

It is proposed that the attenuation will be provided in the form of a single large pond, designed in accordance with the recommendations of CIRIA C697 Table 5.7. This is considered to be the most appropriate type of attenuation facility for a development of this type. The current drainage strategy is to direct the whole of the site to an online pond. As such, flows will constantly be running through the pond prior to discharging to the watercourse. The pond will have been designed to provide the following 4 treatment techniques which are all considered to be high quality.

- Detention Basin
- Shallow wet land – two areas have been provided within the pond
- Wet open channel linking the two shallow wet lands
- Filtration within the basin – although percolation of the subsoil's is poor, which results in infiltration devices failing to meet the half empty time criteria, infiltration will still occur within the wet land areas.

Additionally, the following SUDS techniques shown overleaf within Table 4-2 have been considered. The precise combination of methods used will be dependent upon the site constraints identified at the final design stage.

**Table 4-2: SUDS Techniques and Suitability of Use**

Method	Description	Potential for use at site
Filter drains	Drainage trench filled with gravel and provided with a pipe	Poor infiltration not suitable.
Swales	Shallow grass ditch	Maybe used to control overland flows
Permeable surfaces	Pavement surfaces that allow water to pass through into underlying storage in sub base e.g. permeable concrete block paving or porous asphalt.	Poor infiltration not suitable.
Ponds and basins	Open areas that are used to store and treat rainwater. Ponds are permanent bodies of water and basins are generally dry and occasionally store water.	Pond Proposed for higher return period storms
Green roofs	Roof system that is vegetated with plants (note sedum plants rather than grass so no mowing is required)	Not incorporated into design
Infiltration devices	Methods that allow rainwater to soak into the ground, e.g. soakaways.	Poor infiltration not suitable.
Storage tanks	Underground tanks that temporarily store water in the drainage system.	Not incorporated into design

### Adoption and Maintenance

The piped drainage system will be adopted and maintained by STW. The attenuation pond will be the responsibility of a private management company. All private drainage will be the responsibility of the individual owners. Any source control within adoptable highway will be the responsibility of the highway's agency. Any source control measures within private drives or access roads will be the responsibility of private landowners or management company.

## **Overland Flow**

The southern boundary of the site is formed by the existing Ashland Road West which is generally elevated above the development site. The highway and the adjacent residential dwellings are all supported by a formalised drainage system which is believed to provide at least the 1 in 30 year design standard. As such, any rainfall event which exceed this are likely to flood the highway which could potentially be encouraged towards the new development. It is envisaged that the flows will be shallow, say 100mm in depth.

## **Foul Drainage**

There is a foul sewer located within Ashland Road West to the south of the site. It is proposed that a foul pumping station will be required to lift foul sewerage into the public sewer system.

STW were approached and provided a developer enquiry response which is shown at Appendix H. Once planning is approved STW will need to undertake additional sewerage modelling of their existing system.



## **5. MITIGATION MEASURES**

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### **Raising Floor Levels/Land Raising**

The existing site is elevated sufficiently above the nearest Main River watercourses, as such, lies within Flood Zone 1 of the Environment Agency Flood Map (version 2.8.2). However, there is a local watercourse to the north of the site which is controlled by a culvert under a large soil heap, which, if it became blocked could result in localised flooding to the north of the site. It is considered that the flood water could overtop the headwall and reach a level of 160.159mOD.

As such, it is recommended that the internal ground floor levels of the dwellings within the site are elevated at least 600mm above the estimated flood level, hence a level of 160.759mOD. The area where the dwellings are proposed are at 161.50mOD and above. As such, the raising of ground floor levels will be easily achieved within the site.

It is also recommended that the internal ground floor levels of all the dwellings within both parcels of land are elevated at least 150mm above the adjacent proposed roads within the site to reduce the risk of flooding from overland flows.

### **Emergency Access & Egress**

As the development is residential, it is considered that dry access and egress from the development site will be essential during extreme flood events.

It is considered that the proposed development is located outside of the 1 in 1,000 year extreme flood envelope and will be a safe area during flood events. As such, dry access and egress will be available at all times onto Ashland Road West to the south of the site.

### **Control of Runoff**

Consideration has been given to the hierarchy for surface water disposal which recommends the SUDs approach which includes infiltration as the first tier. Further investigation is required to confirm that infiltration drainage will be a practical solution for the site.

However, other SUDs techniques can be used within the site and they have been considered. The second tier is to discharge to a watercourse. The existing site is considered to be 100% permeable. Following the proposed development, the impermeable area will be significantly increased to approximately 41% of the total site area. It is considered that the site currently discharges runoff via a combination of infiltration, evaporation and overland flow to the local watercourse to the north of the site.

Using software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (40%) event. The site will discharge into the existing culvert and local watercourse system to the north of the site at a peak discharge rate of 46.9l/s. The primary attenuation will be provided

within a single balancing pond. The balancing pond will be 1.5m deep with a top area of approximately 4000m<sup>2</sup>.

The balancing pond will be used to accommodate the storage during 1 in 1 year, 30 year, 100 year and 100 year +CC storms (worst case scenario).

The proposal is to provide a hydro-brake to restrict flows from the site. The hydro-brake will reduce the runoff from the development site during higher return periods, hence, there will be a significant reduction in runoff and as such the development will provide significant betterment in terms of runoff being passed forward from the site into the local watercourse.

It is recommended that during the detailed phase of the development the following items are considered.

- The proposed surface water drainage system should be modelled using Micro Drainage WinDes or similar. The model should be used to analyse the possibility that the design for surface water may fail or becomes blocked and as such should design a backup plan. Overland floodwater should be routed away from vulnerable areas. Acceptable depths and rates of flow are contained in EA and Defra document FD2320/TR2 "Flood Risk Assessment Guidance for New Development Phase 2".
- The maintenance and adoption regimes for all elements of the development should be considered for the lifetime of the development.
- Consenting will be required from the Water Authority for any connections/outfalls into the local watercourse.

## **6. CONCLUSION**

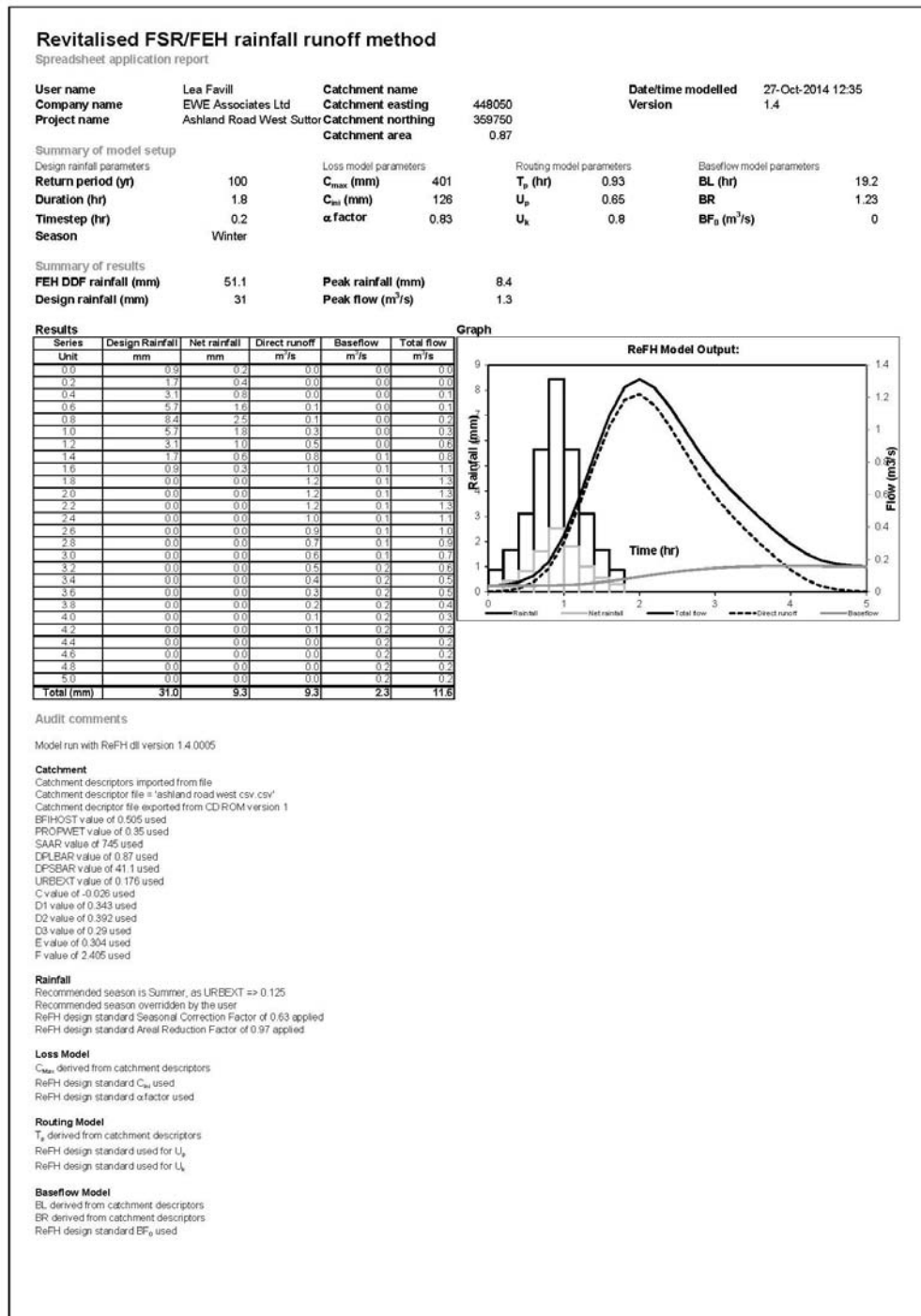
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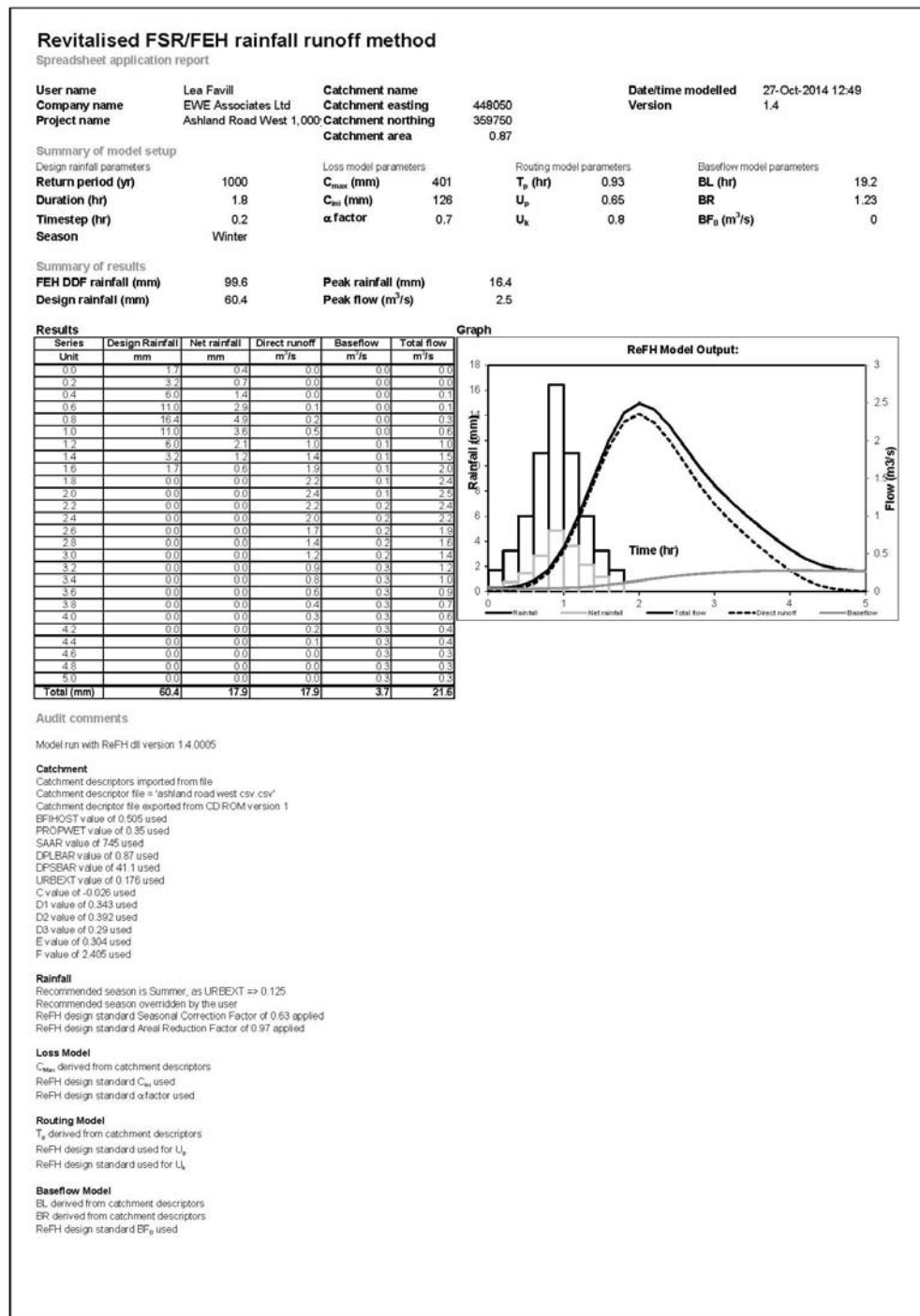
It is concluded that the proposed development lies within flood zone 1 low risk and the current drainage feasibility study utilises sustainable drainage techniques where practically possible.

## **Appendix A: - Existing Ground Levels within Site**

## **Appendix B: - Proposed Layout Drawing**

## Appendix C: - ReFH Calculation Sheet





## Appendix D: - Culvert Capacity Calculation Sheet

COLEBROOK WHITE							
Roughness	1.5	mm	U/S level	161.569	m		
Diam(mm)	1300	mm	D/S level	157.806	m		
Length	460	m	Gradient	0.00818043		122.242891	
PROPOR'N DEPTH	WETTED PERIMETER	AREA OF FLOW	HYDRAULIC MEAN DEPTH	VELOCITY (m/s)	DISCHARGE (l/s)	DEPTH (mm)	SURFACE WIDTH (mm)
FULL	4.08407045	1.327322896	0.3250000	3.20	4,240.80	1300	
0.01	0.2604353	0.002246561	0.0086262	0.28	0.63	13	259
0.02	0.36893234	0.006335011	0.0171712	0.46	2.92	26	364
0.03	0.45261583	0.011602714	0.0256348	0.61	7.07	39	444
0.04	0.52353059	0.017808777	0.0340167	0.74	13.16	52	509
0.05	0.58633486	0.024811696	0.0423166	0.86	21.26	65	567
0.1	0.83655144	0.069079218	0.0825762	1.33	92.08	130	780
0.15	1.03401848	0.12484826	0.1207408	1.71	212.87	195	928
0.2	1.20548378	0.18898223	0.1567688	2.02	380.99	260	1,040
0.25	1.36135682	0.259493099	0.1906136	2.28	592.42	325	1,126
0.3	1.50706332	0.334904522	0.2222233	2.52	842.62	390	1,191
0.35	1.64593477	0.414017008	0.2515391	2.72	1,126.54	455	1,240
0.4	1.78026993	0.495794973	0.2784943	2.90	1,438.30	520	1,274
0.45	1.91181758	0.579302493	0.3030114	3.06	1,771.51	585	1,293
0.5	2.04203522	0.663661448	0.3250000	3.20	2,120.40	650	1,300
0.55	2.17225287	0.748020403	0.3443524	3.31	2,478.19	715	1,293
0.6	2.30380052	0.831527923	0.3609375	3.41	2,837.17	780	1,274
0.65	2.43813568	0.913305888	0.3745919	3.49	3,188.35	845	1,240
0.7	2.57700712	0.992418374	0.3851050	3.55	3,525.07	910	1,191
0.75	2.72271363	1.067829797	0.3921932	3.59	3,836.71	975	1,126
0.8	2.87858667	1.138340667	0.3954512	3.61	4,110.55	1040	1,040
0.85	3.05005197	1.202474636	0.3942473	3.60	4,333.72	1105	928
0.9	3.24751901	1.258243678	0.3874477	3.57	4,486.90	1170	780
0.95	3.49773559	1.3025112	0.3723870	3.48	4,531.44	1235	567
1	4.08407045	1.327322896	0.3250000	3.20	4,240.80	1300	0



EWE Associates Ltd  
7 Waveney Close, Burton upon Stather, North Lincolnshire, DN15 9DT  
T: 07875 972270

**Appendix F: - Drainage  
Strategy  
Drawing**

**Appendix G: - WINDES  
100yr+CC  
480min**

## Appendix H: - STW Developer Enquiry

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EWE Associates Ltd  
7, Waveney Close  
Burton upon Stathor  
Scunthorpe  
DN15 9DT

FAO: Lea Favill

Severn Trent Water Ltd  
Leicester Water Centre  
Gorse Hill  
Anstey  
Leicester  
LE7 7GU

Tel: 024 777 16843

[www.stwater.co.uk](http://www.stwater.co.uk)  
[net.dev.east@severntrent.co.uk](mailto:net.dev.east@severntrent.co.uk)

Contact: Asset Protection  
East (waste water)

Our Ref: 8431002

6<sup>th</sup> October 2020

Dear Sir / Madam,

**Ashlands Road West, Sutton in Ashfield, Notts. NG17 2GG**  
**Proposed 300 dwellings (447835, 359510)**

I refer to your 'Development Enquiry Request' in respect of the above named site. Please find enclosed the sewer records that are included in the fee together with the Supplementary Guidance Notes (SGN) which refer to surface water disposal from development sites.

### Protective Strips

There are no public sewers, as shown on the records, located within the development site boundaries.

Due to recent change in legislation, there could be sewers, which have transferred over to the Company that are not shown on the statutory sewer records, but may be located on your clients land. These sewers will have protective strips that we will not allow to be built over. The sewers could be identified whilst the land is being surveyed. If this is the case, please contact us for further guidance upon discovery.

Please note: there is no guarantee that you will be able to build over or close to any Severn Trent sewers, and where a diversion is required there is no guarantee that you will be able to undertake those works

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on a self-lay basis. Every approach to build near to or divert our assets has to be assessed on its own merit and the decision of what is or isn't permissible is taken based on the risk to the asset and the wider catchment it serves. It is vital therefore that you contact us at the earliest opportunity to discuss the implications of our assets crossing your site. Failure to do so could significantly affect the costs and timescales of your project if it transpires diversionary works need to be carried out by Severn Trent.

### Foul Water Drainage

A foul discharge by pumping into the 150mm dia public foul sewer in Ashland Road West will need to be modelled due to there being several areas downstream where flooding has occurred and the foul network eventually joins into a combined system. Modelling will be needed to determine the impact of a pumped discharge from the proposed development, a suitable pump rate and whether any network improvements are required in the downstream network to take the developments foul flows.

Sewer modelling is paid for by Severn Trent and will take between 4 – 8 weeks to complete subject to current workloads. Where an improvement scheme is required, this is paid for by Severn Trent, however this can take several years to complete. We may require some limited first phase and reduced pump rates to suit until any required scheme has been completed.

### Surface Water Drainage

Under the terms of Section H of the Building Regulations 2010, the disposal of surface water by means of soakaways should be considered as the primary method. If this is not practical and no watercourse is available as an alternative, the use of sewerage should be considered. In addition, other sustainable drainage methods should also be explored before a discharge to the public sewerage system is considered.

If ground conditions are not suitable, for soakaways and other SUDs techniques, evidence should be submitted. The evidence should be either percolation test results or by the submission of a statement from the SI consultant (extract or a supplementary letter). This would satisfy the SGN (enclosed).

Subject to the above, Severn Trent would not wish to accept pumped surface water flows to our network wherever possible. Looking at your

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site plan it would seem that the far west of the site either includes the watercourse within its boundaries or the watercourse is the boundary of the site. Therefore the site owner will have riparian ownership and responsibilities. This means that a surface water discharge to this

length of the watercourse would be possible under the riparian ownership. Although not all the site (from the far east) may be able to drain by gravity to this point (see attached plan 8431002 – Watercourse boundary) much of the site could do. Severn Trent would prefer to see any necessary pumped flows go to the watercourse and not the public sewerage system where this is physically possible.

I looked at the possibility of a gravity sewer requisition to the east to the sw sewers in The Oval but these invert levels would appear to be too high at around 167m. The nearer sewers are either too high also or are not accessible due to private housing.

Therefore, a gravity sw discharge to the watercourse to the west that bounds your site may be the best option. This should be discussed with the LLFA for their comments and views on the most suitable surface water strategy for this development. Where there are difficulties in terms of gravitating the whole site, there may be a requirement for a part of the site to pump to the watercourse. This would be preferable to pumping sw to the public sw sewers, for which modelling would also need to be carried out.

Please contact me to notify me of any requirement to model any surface water flows to the public sewers if all the above has been proven to be not workable.

Any flows generated by the site in excess of the permitted discharge rate will have to be attenuated within the development site.

### Connections

For any new connections including the use, reuse and indirect to the public sewerage system, the developer will need to submit Section 106 application. Our Developer Services department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 707 6600 or download from [www.stwater.co.uk](http://www.stwater.co.uk)

Please quote the above reference number in any future correspondence (including e-mails) with STW Limited. Please send **all correspondence** to the [net.dev.east@severntrent.co.uk](mailto:net.dev.east@severntrent.co.uk) email inbox address, a response will be made within 15 days.

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If you require a VAT receipt for the application fee please email  
MISCINCOME.NC@SEVERNTRENT.CO.UK quoting the above  
Reference Number.

Please note that Developer Enquiry responses are only valid for 6  
months from the date of this letter.

Yours sincerely,

A handwritten signature in black ink, appearing to read "K Baker".

Keith Baker  
**Senior Evaluation Technician**  
**Asset Protection East (wastewater)**  
**Asset Strategy & Planning**  
**Chief Engineer**