Land North of Dark Lane, Alrewas

Flood Risk Assessment & Drainage Strategy

Lioncourt Homes

31 October 2013

Plan Design Enable

Notice

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This document has 40 pages including the cover.

Document history

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Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
Rev 1.0	First issue	PJB	CJCB	TNB	CJCB	23/09/13
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Rev 3.0	Redline boundary and masterplan updated.	PJB	CJCB	KMR	CJCB	31/10/13

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1. Introduction

Atkins was commissioned by Lioncourt Homes to prepare a Flood Risk Assessment and Drainage Strategy to support a full planning application for a proposed residential development on land north of Dark Lane, Alrewas, Staffordshire.

This Flood Risk Assessment has been prepared in accordance with the National Planning Policy Framework[1] (NPPF) and associated Technical Guidance[2]. The scope of this Assessment has been established through consultations with the Environment Agency, Staffordshire County Council and Severn Trent Water. Comments and information provided by local residents at a public consultation event have also informed the content of this document.

[1] National Planning Policy Framework, March 2012, Department for Communities & Local Government.
[2] Technical Guidance to the National Planning Policy Framework, March 2012, Department for Communities & Local Government.

2. Background Information

2.1. Environment Agency

Consultations with the Environment Agency have been ongoing over a number of years prior to the preparation of this Assessment. An enquiry was submitted to confirm the outcomes of previous discussions and to obtain some further information. The response is summarised below and shown in full in **Appendix B**:

- The previous proposals relating to floodplain compensation to smooth out the boundary of Flood Zone 3 within the proposed development site are acceptable in principle.
- The 2005 River Trent Strategic Model upon which all previous work has been based remains the current model for this area.
- The site is shown to be potentially prone to surface water flooding which may be due to local topography.
- There may be capacity issues associated with the local sewerage network.
- The Flood Risk Assessment must assess the risk of flooding from all sources, and where necessary, include details of how the development will seek to reduce flood risk both on the site and in the surrounding area.
- There are no restrictions relating to the use of infiltration in the area. Permeability testing will need to be undertaken to confirm the viability of infiltration as a means of surface water disposal.
- The surface water discharge rate from the proposed development must be limited to the greenfield run-off rate using sustainable drainage systems (SUDS) for all events up to and including the 1 in 100-year +30% rainfall event.
- The surface water drainage strategy must demonstrate that there is a viable surface water outfall for the proposed development. If the strategy relies on any existing drainage systems to should also be included in any calculations.
- There are no specific records of historic fluvial flooding on this site.

2.2. Severn Trent Water

A Development Enquiry Request was submitted to Severn Trent Water. A copy of the response received is included in **Appendix B** and summarised below:

- There are known flood and capacity problems on the local sewerage network and at Dark Lane pumping station immediately to the south of the proposed development.
- Severn Trent Water is currently reviewing options for improving the capacity of the local network to allow for future development.
- If infiltration is not proposed as a means of surface water drainage for this site, evidence should be provided to demonstrate why this is not possible.
- Should infiltration not be viable or only capable of managing a proportion of the total run-off from the proposed development, surface water should be discharged to a local watercourse at 5l/s/ha or another rate determined by the Environment Agency or Local Authority.

2.3. Local Authority

Staffordshire County Council, as Lead Local Flood Authority, was consulted regarding the proposed development. The response received is summarised below and shown in full in **Appendix B**:

- There are 4 no. records of flooding in the vicinity of the site on the A38 service road and Main Street.
- The land to the south and north of the proposed development site has experienced flooding in the past, notably in 2007.
- The proposed development site is located within an area at risk of surface water flooding. This must be taken into consideration by the proposed development to ensure that either development is not placed within affected areas or that the risk is mitigated in a manner that does not negatively affect any third-party.
- The proposed surface water drainage system should be analysed to ensure that it remains operational during periods of high flow within the River Trent.

3. Site Description

3.1. Location

The proposed development site is located on the northern edge of Alrewas, Staffordshire. It is bounded to the south by Dark Lane and is located to the east of the A38. The River Trent lies to the north and the Trent & Mersey canal runs immediately to the west. Only the south-western section of the site immediately adjacent to Dark Lane and the Canal is proposed for development. The site location is illustrated in Figure 3–1.

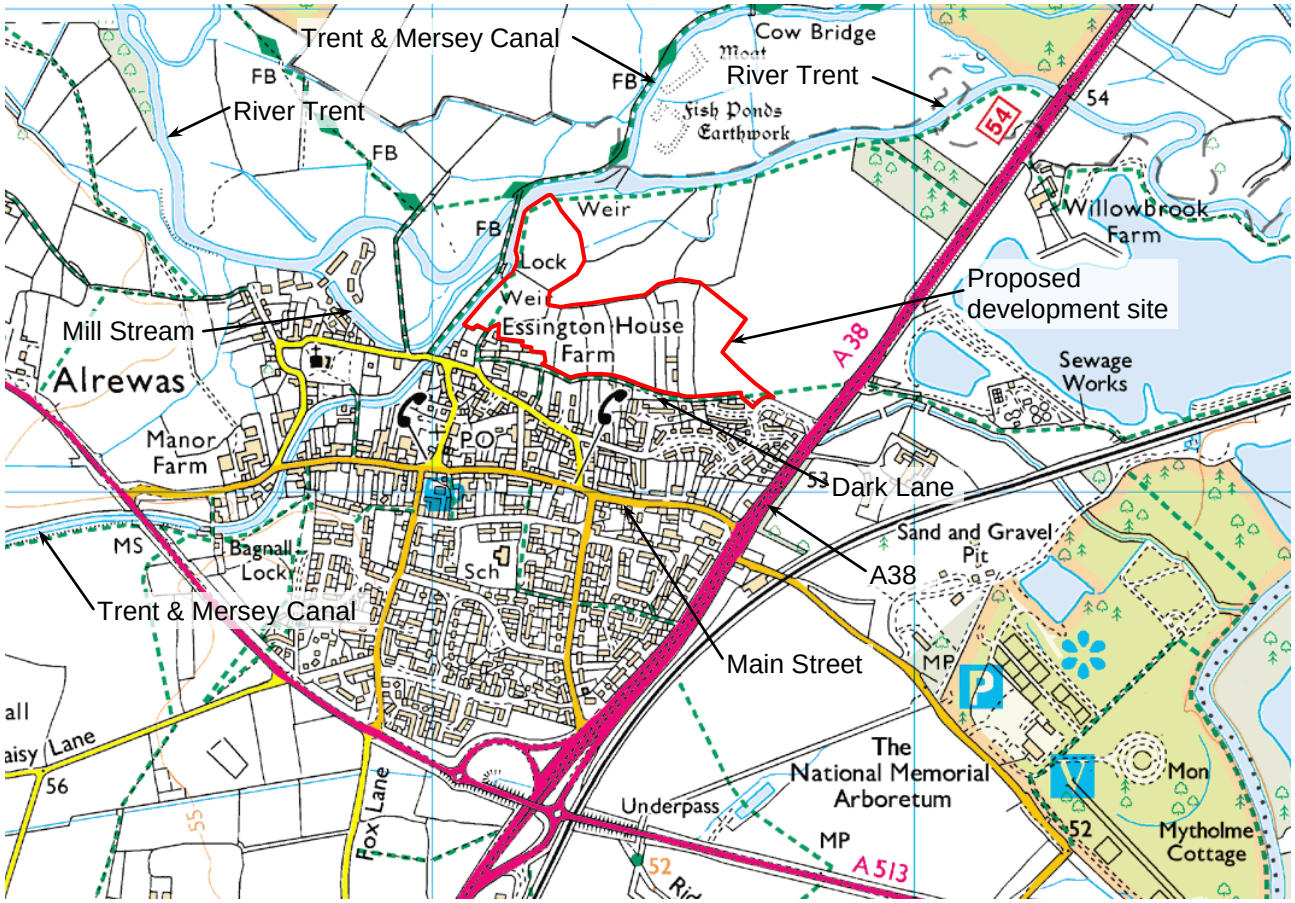


Figure 3–1 Site location (Not to scale)

3.2. Topography

The proposed development site has a total area of approximately 11.67ha. Due to the floodplain that occupies part of the site, the area proposed for development is approximately 6.71ha.

The proposed development site generally falls in a northerly direction towards the River Trent. There is also a slight fall from west to east. Surface gradients are generally shallow. The highest point on the site is located in the south-west corner and has a level of approximately 54.5m AOD. The riverbank downstream of the weir is at a level of approximately 52.0m AOD, which is the lowest level on the site.

The fields in the south-western quadrant of the site are located on a plateau with ground levels generally between approximately 53.8m AOD and 54.1m AOD. Beyond this area, levels fall over a short distance to between 52.8m AOD and 53.0m AOD.

A topographical survey of the proposed development site is shown on drawing number 5117802/001 in **Appendix C**.

3.3. Land Use

3.3.1. Historic

A review of old Ordnance Survey maps shows that the site has remained undeveloped since the late 19th century. At this time, the Trent & Mersey Canal is present as is Dark Lane and a number of dwellings immediately to the south-west of the site. Development to the south of Dark Lane continued through until the 1970's when the current layout was reached.

The single private dwelling with the site was constructed between the 1920's and the 1950's.

3.3.2. Current

The proposed development site is currently agricultural land. The western half of the site is primarily used for grazing while the remainder to the east is arable land.

The grazing land to the west is divided up by a number of well established hedgerows along the field boundaries. These include a number of mature trees. The arable land is a single large field.

There is a high pressure gas main running through the site from south-east to north-west. This does not pass through the area of the site proposed for development.

3.4. Ground Conditions

Intrusive ground investigations were undertaken by Ian Farmer Associates and Atkins Ltd. on 24 July 2013. These comprised the excavation of 4 no. trial pits within the proposed development site and infiltration testing in each. Copies of the trial pit logs are included in **Appendix D**. The site investigations undertaken to date are presented in the *Phase 1 Contaminated Land Preliminary Geo-environmental Desk Study Report* (reference: 5117802-R.002-1; date: 17 September 2013), prepared by Atkins Ltd.

3.4.1. Soil

According to Soilscapes, the soils beneath the proposed development site are divided into two types. The soils on the southern half of the site are described as *freely draining, slightly acid, loamy soils*. To the north, closer to the River Trent and the Trent & Mersey Canal, the soils are described as *loamy and clayey floodplain soils with naturally high groundwater*.

The trial pits logs show that the site is overlain by topsoil to a depth of between 0.1m and 0.5m. The sub-soil varies in thickness between 0.6m and 0.8m and is formed by the upper layers of the River Terrace Deposits which comprise the superficial deposits beneath the site.

Small amounts of Made Ground were identified in a number of locations across the site that appeared to be associated with demolished and semi-collapsed structures. The composition of the Made Ground was not investigated.

3.4.2. Geology

The British Geological Survey GeoIndex shows that the proposed development site is underlain by superficial deposits of Alluvium (clay, silt, sand and gravel) to the north, and River Terrace Deposits (sand and gravel) to the south. The bedrock beneath the site is shown to be the Mercia Mudstone Group.

The trial pit logs confirm the presence of River Terrace Deposits beneath the site. These comprise fine to medium sands and gravels. This stratum extends to depths exceeding 1.6m to 1.8m. The depth to bedrock was not established.

As underlying geology is potentially suitable for surface water disposal via infiltration, testing in accordance with BRE Digest 365 *Soakaway Design* was undertaken. The results are summarised in Table 3-1. The calculations are shown in **Appendix D**.

Table 3-1 Infiltration test results

Location	Infiltration rate (m/s)		
	Test 1	Test 2	Test 3
1	7.54×10^{-5}	6.05×10^{-5}	5.03×10^{-5}
2	1.10×10^{-4}	1.08×10^{-4}	1.15×10^{-4}
3	6.10×10^{-5}	4.88×10^{-5}	-
4	9.22×10^{-5}	6.44×10^{-5}	5.60×10^{-5}

3.4.3. Contamination

The *Phase 1 Contaminated Land Preliminary Geo-environmental Desk Study Report* states that the Made Ground may include some contaminating materials. The contamination status of the site must be confirmed by appropriate intrusive testing.

3.5. Water Environment

3.5.1. Drainage

3.5.1.1. Private Drainage

To date, no information has been received regarding the presence of any private surface or foul water drainage within the proposed development site. It is anticipated that there may be foul water sewer connections from the private dwelling within the site boundary and from Essington House Farm adjacent to the south-western corner of the site.

Any private surface water drainage within the site is anticipated to either discharge via infiltration or into the River Trent.

3.5.1.2. Land Drainage

There is no evidence of a piped land drainage network; however, it is possible that pipework may be present. If any land drainage pipework is encountered during construction, it must be diverted and/or reconnected to ensure continued drainage.

There are a number of ditches running along the field boundaries and hedgerows within the proposed development site. It is believed that this perform a land drainage function and may also provide some drainage for Dark Lane to the south of the site. The topographical survey does not show any pipes discharging into these ditches.

3.5.1.3. Public Sewerage

Sewer records supplied by Severn Trent Water, included in **Appendix B**, show that there are no public gravity sewers within the site boundary. The 100mm diameter rising main from Dark Lane pumping station runs along Dark Lane before crossing the south-eastern corner of the site. The rising main runs underneath the A38 towards a wastewater treatment works approximately 300m further to the east.

There are no public surface water sewers within Alrewas. The whole sewerage system is shown to comprise small diameter combined sewers all of which fall towards Dark Lane pumping station. The maximum pipe diameter is 300mm with the majority of the system being either 150mm or 225mm diameter. Dark Lane pumping station also receives flows from two other pumping stations to the west and south-west via a rising main that runs along Dark Lane from the west.

3.5.2. Watercourses

The River Trent is the most significant watercourse close to the proposed development site and is designated Main River. The configuration of channels to the west of the site is complex with a loop from the main channel of the River Trent, known as the Mill Stream, and the Trent & Mersey Canal combining. A short section of the river along the western and north-western boundary of the site is navigable. Immediately adjacent to the northern site boundary, the Canal leaves the main river channel and continues in a northerly

direction while the river flows over a large weir in an easterly direction along the site boundary. The weir is required to maintain water levels in the navigable section of the river.

The Trent & Mersey Canal flows through Alrewas from the west. Before entering the River Trent, there is a lock immediately adjacent to the western boundary of the site. The level difference between the river and canal is approximately 1.5m. Water levels within the canal are generally approximately 0.2m below adjacent levels within the site boundary; however, in the south-western corner of the site, ground levels fall to approximately 0.5m below the canal water level.

Sewer records, shown in **Appendix B**, indicate a culverted watercourse flowing along Park Road and Mickleholme Drive in an easterly direction. The watercourse emerges into a short channel adjacent to the junction between Mickleholme Drive and the A38 service road before running through a culvert beneath the A38. It then enters a channel flowing in an easterly direction towards the River Tame upstream of its confluence with the River Trent. An examination of old Ordnance Survey maps shows that this watercourse was originally open and extended further west along Park Road. It is likely that this watercourse historically provided surface water drainage for Alrewas. As the village developed the channel was progressively shortened until eventually the last section was culverted into its current form.

3.5.3. Waterbodies

There are no waterbodies present within the site boundary. The closest features are flooded gravel pits to the east of the A38 and isolated ponds within the floodplain on the northern side of the River Trent.

3.5.4. Groundwater

According to the Environment Agency website, the proposed development site is located outside of any groundwater Source Protection Zones. The bedrock is designated a *Secondary B*[3] aquifer while the superficial deposits are identified as a *Secondary A*[4] aquifer. Both are classified as *Minor* aquifers of *intermediate* vulnerability.

During the excavation of the trial pits and the infiltration testing, no groundwater was encountered. The pits were excavated to a depth of up to 1.8m below ground level.

[3] Predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering (Environment Agency).
[4] Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers (Environment Agency).

4. Development Proposals

4.1. Description

The development proposals comprise 151 residential properties with associated access roads, private parking areas, landscaping and public open space. The site will be served by a positive surface water drainage system with SuDS features located within the public open space. Details of the surface water drainage strategy are provided in section 6.

The proposed development layout prepared by Studio REAL (reference: 1425-201-01 revision K; date: 31 October 2013) is shown in **Appendix C**.

4.2. Sequential Test

A Sequential Test for the proposed development site was prepared by JMP Consultants (reference: MID1025-ET0001-R.001; date: 14 January 2011). This document was based on a different site layout but the same development footprint as the current proposals; therefore, the results are considered to remain valid. A copy of the Sequential Test is included in **Appendix E**.

The proposed development is shown to pass the Sequential Test.

5. Flood Risk Assessment

5.1. Flooding History

The Environment Agency does not have any specific records of flooding in the immediate vicinity of the site; however, the land to the north of the part of the site to be developed is known to flood from the River Trent.

Staffordshire County Council provided details of four records of flooding in the vicinity of the site. These are listed below and indicated on Figure 5–1:

- **Location 1**: Near the service road drainage outfall. Frequency: ~1-2 years
- **Location 2**: Main Street, flooding outside properties. Frequency: ~2-5 years
- **Location 3**: Main Street. Frequency: ~1 -2 years
- **Location 4**: Main Street. Frequency: ~1-2 years

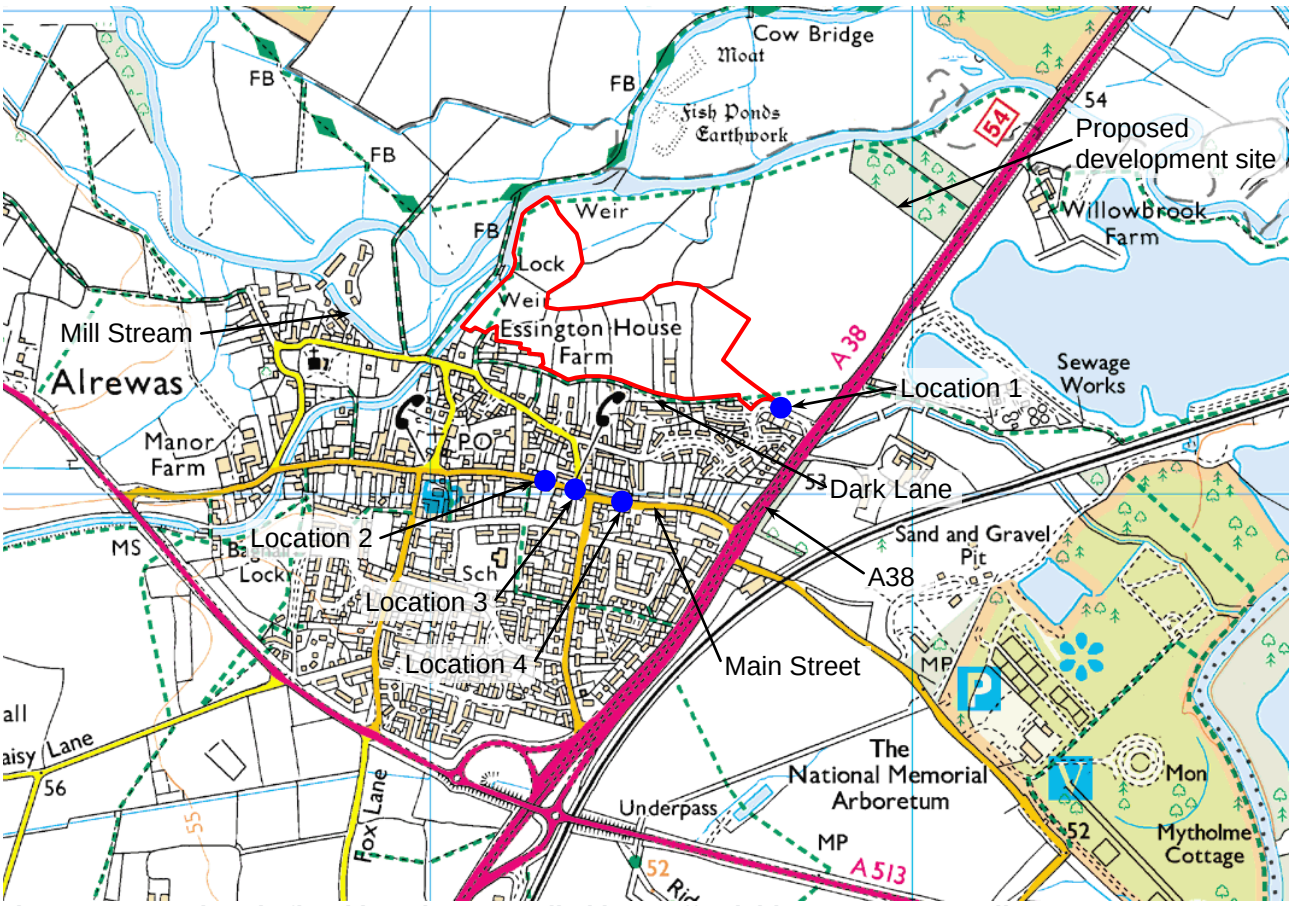


Figure 5–1 Historic flood locations supplied by Staffordshire County Council

Further information, both new and supporting the flooding locations described above was provided by local residents at a public consultation event held on 20 July 2012. They also provided information relating to flooding within Alrewas itself. There are no records or reports of the section of the site proposed for development being affected by flooding.

The flooding reported by local residents took place at an unspecified time in the past, although it is believed to be 20 to 30 years ago based on information supplied by the land owner of the proposed development site. No official records of this flooding could be located and it is possible that these events pre-date any formal recording of flooding. According to anecdotal evidence, the flooding affected Main Street and Dark Lane. The depth of the flooding was reportedly sufficient for canoes to be used on Main Street. The source of this flooding is unknown. As a result, there is local concern regarding possible flooding in the future.

An investigation into the historic flooding has been undertaken to establish the likely source and confirm the area that was affected. Details of this are set out below.

5.1.1. Potential Flooding Sources

The primary sources of flooding that could affect Alrewas are:

- Fluvial – from the River Trent
- Surface water
- Sewers

Groundwater in the area within the sands and gravels alongside the River Trent is known to be high; however, according to the Lichfield District Council Strategic Flood Risk Assessment, there are no known problems related to groundwater flooding within the District. On this basis, it is concluded that groundwater flooding is not a matter of concern for Alrewas.

The Environment Agency website shows that the whole of Alrewas lies within the area that would be affected in the event of a failure of the dam at Blithefield Reservoir to the north-west. Further detail relating to this source of flooding is provided in section 5.3.4. The reported flood events are of insufficient scale to have been attributable to a reservoir failure; therefore, this source of flooding was discounted as being associated with the reported historic flooding.

5.1.2. Local Topography

Local topography plays a significant role in the flood mechanisms affecting a particular location. LIDAR data for the whole of Alrewas was obtained and merged with the topographical survey of the proposed development site to understand the topography of the village and the surrounding area. A contour map of Alrewas (drawing number 5117802/002) is shown in **Appendix C**.

In general, ground levels within Alrewas fall in a northerly direction towards the River Trent. The lowest area within Alrewas is its north-eastern corner covering an area including Main Street, Park Road and Mickleholme Drive. This area comprises a small valley falling from west to east. The bottom of the valley is occupied by Park Road and Mickleholme Drive. From the valley, ground levels rise again towards Dark Lane to the north. The area of the site proposed for development occupies higher land north of Dark Lane before ground levels once again fall towards the River Trent.

A review of local topography in conjunction with archaeological information suggests that the landform as it is currently is natural. The exception to this is an area of raised ground on the island between the Mill Stream and the main River Trent channel. This is occupied by dwellings off Cotton Close which crosses the Mill Stream past the old mill which has been converted to residential properties. From an examination of old Ordnance Survey maps, it is believed that the raising of this piece of land was undertaken originally to provide space for buildings associated with the mill above flood levels rather than being a recent action to facilitate the residential development. This area creates an obstruction within the natural floodplain that forces flood flows to split in order to pass around it.

5.1.3. Fluvial Flooding

The primary source of fluvial flooding within Alrewas is the River Trent and the Mill Stream. In addition, according to Severn Trent Water sewer records shown in **Appendix B** and as described in section 3.5.2, there is a culverted watercourse running beneath Mickleholme Drive.

Flood levels for the River Trent have been obtained from the Environment Agency *Fluvial Trent Strategy* (April 2004). These have been plotted against the digital terrain data for Alrewas to obtain the 1 in 100-year flood outline (drawing number 5117802/003) which is shown in **Appendix C**. This shows that it is possible for flood water from the River Trent to pass around the end of the high ground upon which the proposed development will be constructed and affect the area surrounding Park Road and Mickleholm Drive. Main Street is also affected. The depths of flooding on Park Road and Main Street are generally between 0.3m and 0.5m. Mickleholme Drive is at a lower level and consequently the potential depths of flooding are between 0.7m and 1.0m.

For this area of Alrewas to be affected, flood levels from the River Trent must reach a level of at least 52.50m AOD. According to the flood levels stated in the Environment Agency Fluvial Trent Strategy, a 1 in 5-

year flood event on the River Trent would be just sufficient for flood water to begin to affect Mickleholm Drive. Park Road and Main Street become vulnerable to flooding during the 1 in 10-year and 1 in 25-year flood events, respectively.

There is also a possibility that the culverted watercourse could provide a pathway for floodwater from further downstream beyond the A38 to reach Alrewas; however, it is anticipated that this will only happen if a very high flood water level were to occur downstream. Local topography is such that it is considered unlikely that a depth of water sufficient to enable this flow path to be used will occur.

5.1.4. Surface Water

Surface water flood maps for Alrewas have been obtained from the Environment Agency and are included in **Appendix B**. The pattern of surface water flooding largely follows the local topography. The maps show Post Office Road and Mickleholme Drive to be the most affected areas in terms of depth and extents respectively during the 1 in 30-year rainfall event. Small areas of Park Road and Main Street are also affected.

During the 1 in 200-year rainfall event, the flooding is much more extensive with Post Office Road, Mickleholme Drive and Park Road, together with the number of side streets, affected. The depths of flooding on Post Office Road and Mickleholme Drive are shown to exceed 0.3m. Short lengths of Main Street are predicted to flood to depths of between 0.1m and 0.3m.

There are a number of anecdotal reports, subsequently confirmed by Severn Trent Water and Staffordshire County Council, of the drainage systems within Alrewas having capacity issues. This would increase the susceptibility of the area to surface water flooding. The surface water flood maps show that surface water flooding has the potential to affect the areas reported by residents as having been flooded in the past. There is no information available regarding the conditions preceding the past flooding so it is not currently possible to confirm whether surface water flooding was indeed the source.

The pattern of flooding, and the frequency of events, described in the Staffordshire County Council records, reflects that which would be expected from surface water flooding rather than fluvial events.

5.1.5. Sewers

As described in section 3.5.1.3, the public sewers within Alrewas are small diameter, 300mm or less, and drain to a series of pumping stations located along the northern edge of the village. While the size of pipes is likely to be sufficient to convey foul flows, the capacity for any surface water is likely to be very limited. Both Severn Trent Water and Staffordshire County Council have advised that flooding associated with the local sewerage network has occurred in the past. It is possible that the flooding recorded by Staffordshire County Council could relate to sewer flooding either in isolation or in combination with surface water flooding.

There are no connections from the local public sewerage system into the River Trent or any other watercourse in the area. This means that it is not possible for the river to affect the performance of the sewerage system or to use it as a flow path thereby causing surface flooding. It is possible that there may be some small, private outfalls to the local watercourses; however, these are anticipated to be of insufficient size to cause flooding on the scale reported.

The small size of the majority of the local sewerage network and the lack of large outfalls into nearby watercourses indicates that it is unlikely that the volumes of water needed to cause the reported flooding could have originated solely from the sewers.

5.1.6. Investigation Conclusions

The investigation results suggest that the flooding reported by local residents was either associated with a flood event from the River Trent or surface water flooding exacerbated by poor sewerage capacity. Both these flood mechanisms have the potential to affect Main Street as reported, in addition to Park Lane and Mickleholme Drive.

Dark Lane is at a higher level than Main Street, Mickleholme Drive and Park Lane; therefore, if it had been flooded by the same source as the other streets, a substantially larger area of Alrewas would also have been affected. This has never been recorded. However, it is possible that shallow surface water flooding could have affected Dark Lane without other areas at a similar level being flooded.

5.2. Identification of Flooding Sources

The NPPF Technical Guidance[2] requires that the risk of flooding from the following sources be considered:

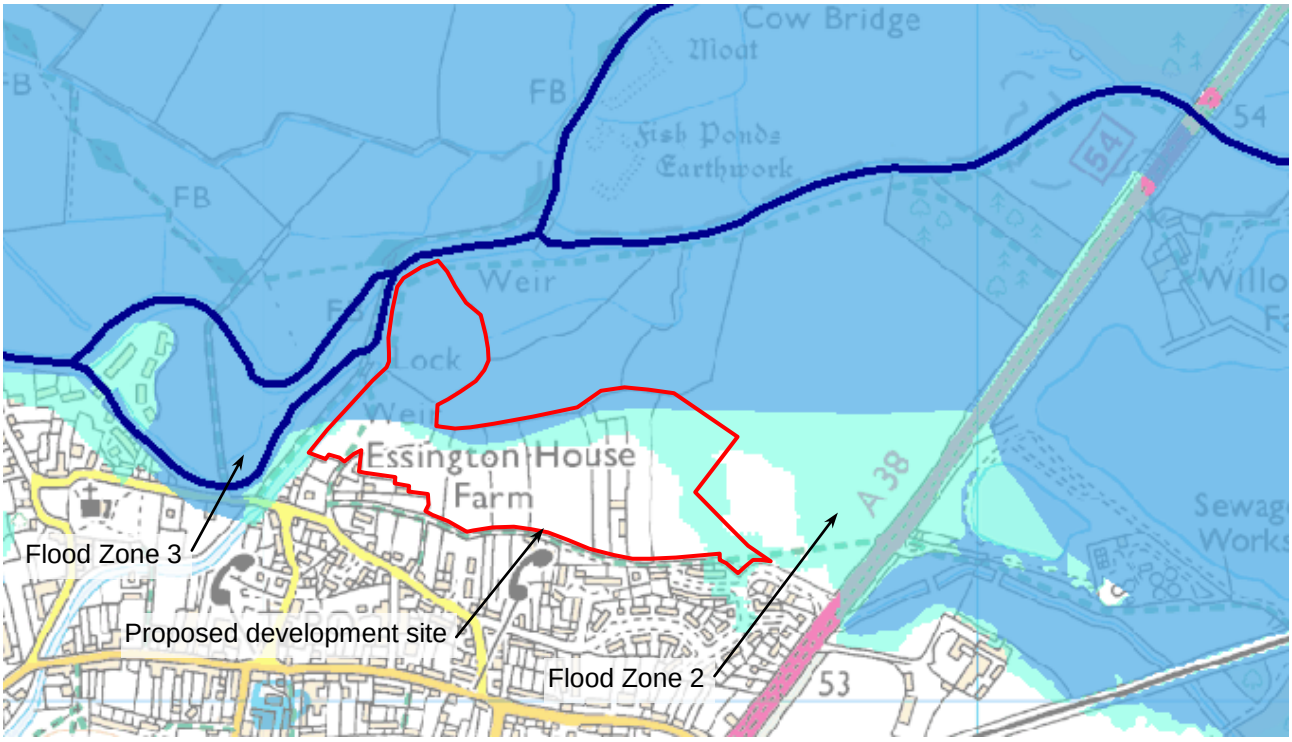
- **Fluvial (river)** – the proposed development site contains areas of Flood Zones 2 and 3 associated with the River Trent; therefore, further consideration of this flooding source is required.
- **Coastal, tidal and estuarine** – the proposed development site is remote from coastal, tidal and estuarine waters hence the risk associated with this source is negligible.
- **Surface water** – both the Environment Agency and Staffordshire County Council have advised that the site and its surrounding area are potentially at risk from surface water flooding; therefore, the risks associated with this source will be considered further.
- **Groundwater** – intrusive ground investigations have established that the ground is permeable; however, groundwater was not encountered at depths of up to 1.8m. The risk from groundwater flooding is considered to be low and hence not required further assessment.
- **Sewers** – information supplied by Severn Trent Water and Staffordshire County Council refer to flooding from sewers within Alrewas hence this flooding source requires further assessment.
- **Artificial sources** – the Environment Agency website shows the proposed development site to lie within an area at risk of flooding in the event of a reservoir failure; therefore, this source will be considered further.

On the basis of the above, the risk assessment section below will establish the risks associated with fluvial (river), surface water, sewers and artificial sources.

5.3. Risk Assessment

5.3.1. Fluvial (River)

The Environment Agency Flood Map, shown in Figure 5–2, indicates that the proposed development site contains areas of Flood Zones 1, 2 and 3. There are, however, some concerns regarding whether the Flood Map reflects reality as the Flood Zone 3 boundary does not match the topography of the site. This is indicated by the almost straight zone boundary on the eastern side of the site.



Source: Environment Agency. (c) Environment Agency copyright and database rights 2013. (c) Ordnance Survey Crown copyright. All rights reserved. Environment Agency, 100026380.

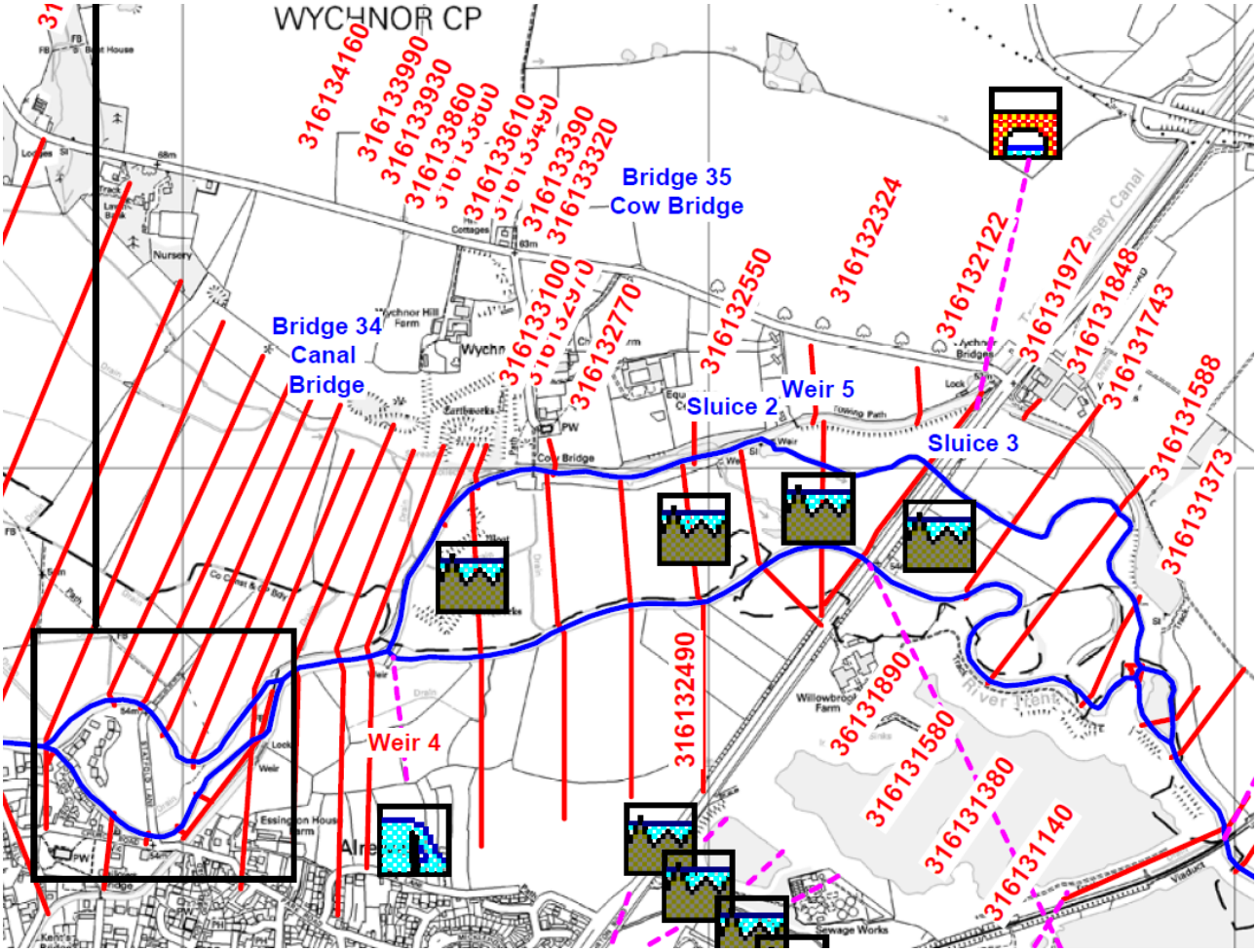
Figure 5–2 Environment Agency Flood Map

In order to obtain Flood Zone boundaries that are more realistic, flood level information was obtained from the 2005 River Trent Strategic Model and merged with the topographical survey of the proposed development site. The flood levels used are shown in Table 5-1 with the associated model node location plan shown in Figure 5-3. The resultant flood outline is shown on drawing number 5117802/004 in **Appendix C**.

Table 5-1 River Trent modelled flood levels adjacent to the proposed development site

Node	Flood levels (m AOD)		
	1 in 25-year	1 in 100-year	1 in 200-year
316133490	53.42	53.60	53.71
316133390	53.38	53.56	53.67
316132902	53.29	53.48	53.58
316132765	53.00	53.20	53.31
316132627	52.88	53.11	53.23
316132490	52.82	53.06	53.19
316132350	52.73	52.99	53.12
316132240	52.57	52.86	53.00
316132160	52.55	52.84	52.99

Source: Environment Agency. 2005 River Trent Strategic Model



Source: Environment Agency. 2005 River Trent Strategic Model

Figure 5-3 Model node location plan

The model results did not include flood levels for the 1 in 20-year or 1 in 100-year +20% flood events; therefore, following a conservative approach, the 1 in 25-year flood levels were assumed to equate to the 1 in 20-year levels. The 1 in 200-year flood levels have been assumed to equate to the 1 in 100-year +20% flood event.

The Flood Zones generated from the modelled flood levels show that the current extents of Flood Zone 3a shown on the Flood Map are incorrect. The actual extents within the site boundary are greater; however, the area of Flood Zone 1 in the south-western corner of the site remains largely the same. The development intention for the site is to only develop this area of Flood Zone 1.

As can be seen from the flood extents shown on drawing number 5117802/004 in **Appendix C**, there are a number of areas where a small area of floodplain encroaches into the proposed development area. These are generally attributable to existing land drainage ditches or locally low areas. In order to create a suitable boundary for the proposed development area, a small scale floodplain compensation scheme is proposed to "smooth" the floodplain extents. The principle of this proposal has been agreed with the Environment Agency (see letter UT/2011/109713/02-L01; date: 08 January 2013 in **Appendix B**).

5.3.1.1. Floodplain Compensation

The floodplain compensation scheme has been designed in accordance with the current Environment Agency requirement for level-for-level, volume-for-volume replacement of lost floodplain volume. It is usual for compensation schemes to be designed using 0.2m thick horizontal slices; however, due to the relatively flat topography on the site and the surrounding area, the decision was made to increase the resolution of the compensation scheme design by using 0.1m thick slices instead. The design of the floodplain compensation is based on the flood level data described above and a three-dimensional topographical survey of the site.

The floodplain compensation scheme was designed by measuring the area of each contour defining the top and bottom of each horizontal slice that was lost as a result of the fill thereby allowing the volume within each slice to be calculated using the trapezium rule. The replacement floodplain was determining by ensuring that the reduction in each contour area is offset elsewhere thereby ensuring that the floodplain volume is fully replaced.

Table 5-2 shows details of the floodplain volume that is lost as a result of the fill together with information relating to the replacement of this volume through cut in specific areas. Drawing number 5117802/005 in **Appendix C** illustrates the areas of proposed cut and fill required by the floodplain compensation scheme.

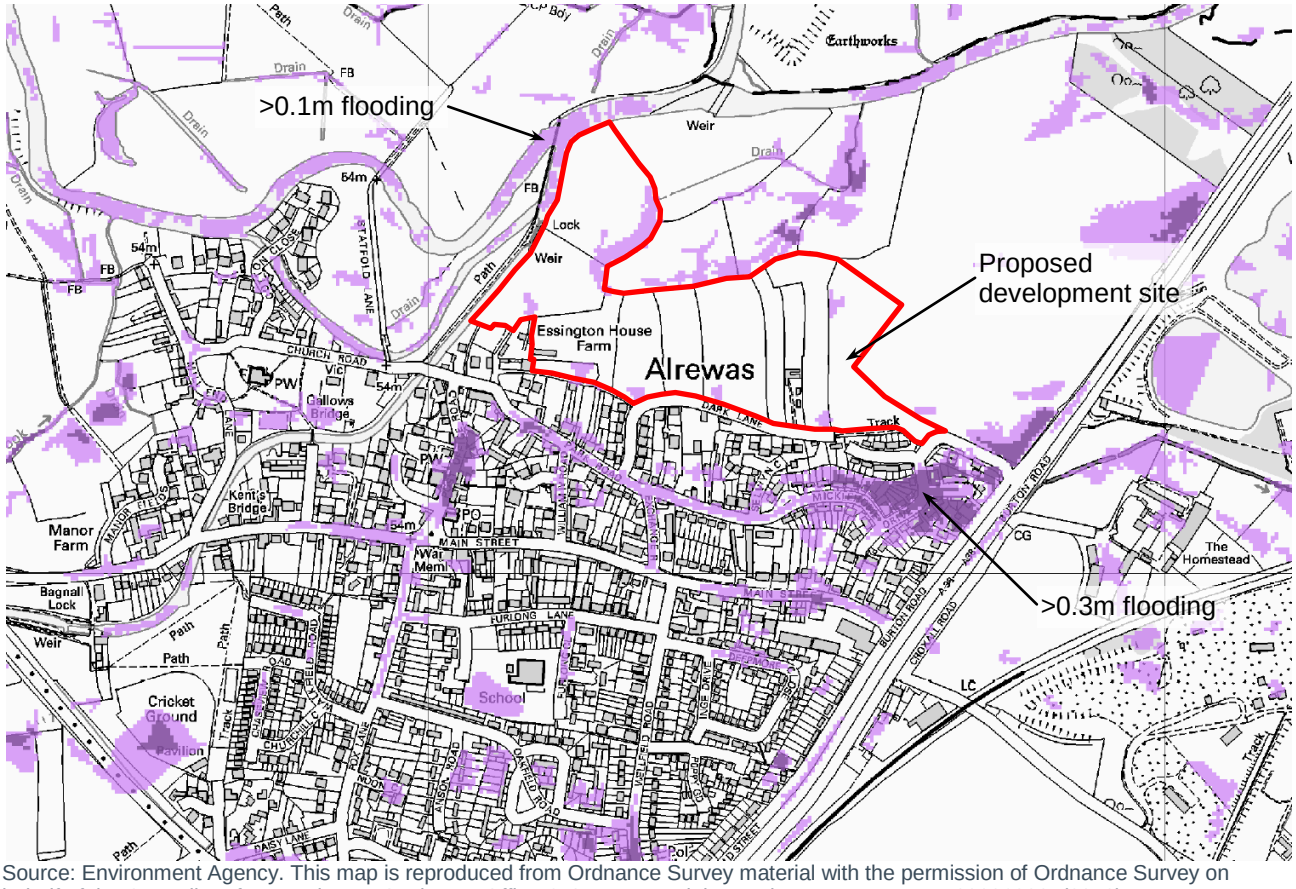
Table 5-2 Floodplain compensation scheme design results

Level slice (m AOD)	Lost floodplain			Replaced floodplain			
	Contour area lost (m^2)		Slice volume (m^3)	Contour area gained (m^2)		Slice volume (m^3)	Difference (m^3)
	Bottom	Top		Bottom	Top		
52.9 - 53.0	5	42	2	93	750	42	+40
53.0 - 53.1	42	113	8	750	508	63	+55
53.1 - 53.2	113	285	20	508	443	48	+28
53.2 - 53.3	285	928	61	443	830	64	+3
53.3 - 53.4	928	1313	112	830	3384	211	+99
53.4 - 53.5	1313	378	85	3384	1581	248	+164
53.5 - 53.6	378	598	49	1581	1007	129	+81
53.6 - 53.7	598	131	36	1007	494	75	+39
53.7 - 53.8	131	26	8	494	260	38	+30
Total			**380**			**917**	**+537**

The results show that the floodplain compensation scheme replaces the lost floodplain volume at all levels. For all slices extra floodplain volume is created. This is primarily due to over-excavation at higher levels to enable volume replacement at lower levels to be achieved. In total, the floodplain compensation scheme generates an additional 537m^3 of floodplain storage hence the fill required by the proposed development will not adversely affect the performance of the floodplain in surrounding area.

5.3.2. Surface Water

Surface Water Flood Maps for Alrewas have been obtained from the Environment Agency and are included in **Appendix B**. The 1 in 200-year Surface Water Flood Map is shown in Figure 5-4, indicates that there are some isolated areas within the proposed development site that will flood to a depth exceeding 0.1m but less than 0.3m. These are generally located immediately adjacent to Dark Lane and relate to shallow depressions in the ground. There is no indication of any surface water flow paths through the area of the site designated for development.



Source: Environment Agency. 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. Environment Agency, 100026380, (2010).

Figure 5-4 1 in 200-year Surface Water Flood Map

The scale of surface water flooding within the proposed development site is such that the associated risks are considered to be low. The re-profiling of the site needed to ensure satisfactory elevation of finished floor levels above the 1 in 100-year +20% fluvial flood level is likely to infill the depressions that are shown to flood hence the risk of surface water flooding will be further reduced.

As described in section 3.5.1.2, there are a number of existing land drainage ditches within the proposed development site. Of these, four originate immediately adjacent to Dark Lane and flow in a northerly direction towards the River Trent. It is believed that these may provide some drainage for run-off generated by Dark Lane. There is a possibility that the proposed development could block these existing drainage paths; therefore, in order to reduce the risk of flooding both the proposed development, Dark Lane and existing adjacent properties, measures must be put in place to ensure continuity of drainage from Dark Lane to the River Trent. These are described further in section 5.4.

5.3.3. Sewers

Severn Trent Water has advised in their Development Enquiry response that there are known flooding and capacity problems on both the local sewerage network and at the Dark Lane pumping station. The Lichfield District Council Level 1 Strategic Flood Risk Assessment states that there are currently two properties within Alrewas that are identified on Severn Trent Water's DG5 register as being at risk of sewer flooding. Sewer flooding was also identified as an issue by local residents during a consultation event held on 20 July 2012.

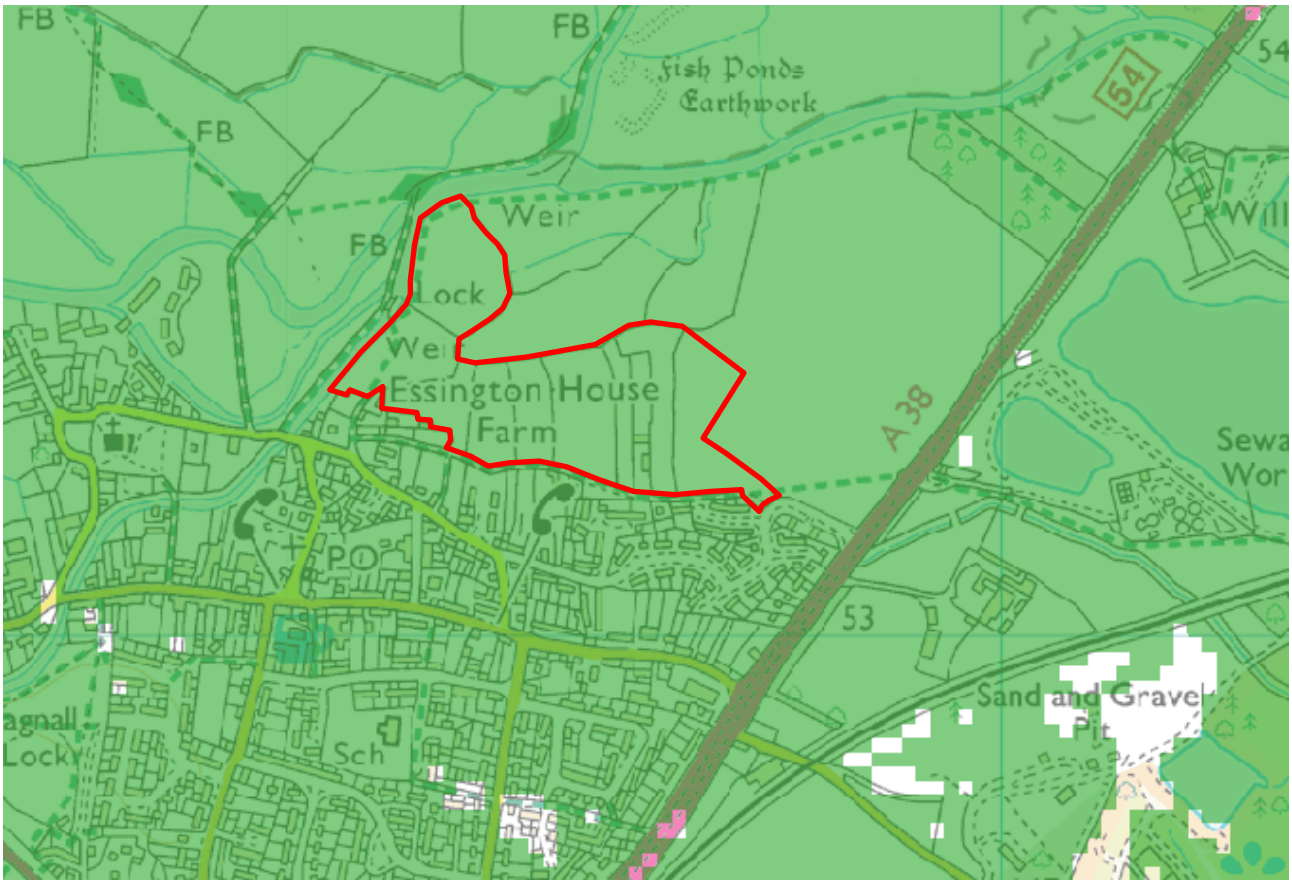
The exact locations of the sewer flooding are not known; however, from information supplied by local residents, it is believed that locations on Main Street and Park Road are affected. As described in section 5.1.2, Main Street and Park Road are located in a shallow valley which is below the level of the proposed development site hence any sewer flooding in this area is unlikely to be able to affect the site. If flooding were to occur on Dark Lane, there is a possibility that this would flow onto the proposed development site in its current condition; however, post-development, ground levels on the site will be slightly raised which will prevent any sewage that escapes from the local system affecting the proposed development. On this basis, the risk to the proposed development from sewer flooding is considered low.

5.3.4. Artificial Sources

According to the Environment Agency Risk of Flooding from Reservoirs map, shown in Figure 5–5, the proposed development site is located in an area potentially at risk of flooding should the dam impounding an upstream reservoir fail. The area of flooding is associated with two separate reservoirs:

- Stowe Pool
- Blithfield Reservoir

Stowe Pool is owned by Lichfield District Council and is located in the centre of Lichfield approximately 7.5km to the south-west of the proposed development site. South Staffordshire Water own Blithfield Reservoir which is located approximately 13km to the north-west. The flood extents illustrated are a worst-case scenario assuming simultaneous failure of both reservoirs when they are both at maximum capacity.



Source: Environment Agency

Figure 5–5 Risk of Reservoir Flooding Map

It is not possible to assign a probability to failure of an artificial structure. The risk of flooding from reservoirs is considered to be very low by virtue of the rigorous regulatory framework for inspections and other maintenance; however, the possibility of such an event remains. In this situation, the management of the hazards during a flood event becomes the priority.

In the event of a reservoir failure, the potential scale and rate of onset of the flooding is such that the preservation of life takes priority over property. The distance between the two reservoirs and the proposed development site is such that sufficient time is likely to be available to issue evacuation warnings for residents before the flood water arrives. There a number of roads in the immediate vicinity of the proposed development site that can be used as emergency evacuation routes should the need arise. There are safe zones within 2km of the site.

It is concluded that the risk of the proposed development site being affected by flooding attributed to the failure of an artificial structure is extremely low; however, should such an event occur, it is anticipated that will be sufficient time for evacuation via the local road network.

5.4. Flood Risk Management

The proposed development will incorporate the following flood risk management measures to mitigate the risks identified above:

- The minimum finished floor level of any dwelling within the proposed development will be at least 0.6m above the 1 in 100-year +20% flood level on the adjacent watercourse. This is achieved as part of the floodplain compensation scheme described in section 5.3.1.1.
- The finished floor level of all dwellings will be at least 0.15m above adjacent external ground levels in order to reduce the risk of overland flows entering the property. Where flush thresholds are required, these must be ramped up to the finished floor level to maintain the required level difference.
- Wherever possible, the external ground profile around buildings will ensure that surface water is directed away from the building.
- The proposed development will incorporate a positive surface water drainage system, described further in section 6, that will intercept run-off from roofs and paved areas rather than allowing it to flow unchecked through the proposed development.
- The existing land drainage ditches, and any other land drainage features, originating from near Dark Lane that may be interrupted by the proposed development must be diverted as necessary through the proposed development, either in pipework or as open channels, to ensure continuity of existing drainage paths.

5.5. Residual Risks

Residual risks are the risks that remain once the flood risk management measures described above have been implemented. These are typically associated with extreme events that overwhelm drainage systems exceed the flood levels used to design any mitigation measures.

The primary residual risks that will affect this development are:

- An extreme rainfall event which exceeds the capacity of the proposed surface water drainage system to both intercept and convey flows. During such an event, water that is unable to enter the formal drainage system will flow over the ground surface through the proposed development. The risk to properties can be reduced by designing site levels to direct any run-off towards the highways or other corridors running through the site towards the watercourse.
- A rainfall event that exceeds the capacity of off-site drainage networks could result in run-off and/or sewage entering the site. This may result in some proposed dwellings being flooded to a shallow depth.
- An extreme fluvial flood event on the River Trent exceeding the 1 in 100-year +20% flood could overtop the fill placed on the site and causing flooding of properties.

If during an extreme event, it is necessary to evacuate the proposed development or for emergency services to access the site, the proposed accesses onto Dark Lane are anticipated to remain safe and dry. This will allow access and egress for both vehicles and pedestrians in an emergency situation.

6. Surface Water Drainage Strategy

6.1. Existing Drainage Regime

The proposed development site, as described in section 3.5.1, does not have a piped positive drainage system. According to the topographical survey, any run-off from the site drains via a series of field drains into the River Trent to the north. Infiltration is also a significant means of surface water drainage on the site.

The existing run-off flow rate generated by the site in its current condition has been calculated using IH124 *Flood Estimation for Small Catchments* with modifications as described in the *Interim Code of Practice for Sustainable Drainage Systems*. The calculations were undertaken using MicroDrainage Source Control with the following parameters:

- Area: 6.71ha
- SAAR (Standard Annual Average Rainfall): 700mm
- Soil: 0.4
- Urban: 0
- Region: 4

The results are presented in Table 6–1.

Table 6–1 Existing surface water run-off rates

Return period	Flow rate (l/s)	Run-off rate (l/s/ha)
1 in 1-year	18.6	2.8
1 in 2-years	20.5	3.1
QBAR* (1 in 2.33-years)	22.8	3.4
1 in 30-years	44.7	6.7
1 in 100-years	58.7	8.7

** QBAR: Annual average flow rate*

6.2. Proposed Outfall

Surface water run-off from the proposed development will be discharged via two routes. The ground conditions beneath the site are favourable for infiltration hence this will be used as a means of surface water disposal. In order to ensure that extreme rainfall events can be managed and to continue the current drainage regime, an outfall into the River Trent will also be maintained.

As described in section 3.4.2 and shown in Table 3-1, infiltration testing has demonstrated that this is a viable means of surface water disposal. The infiltration rates measured show a variation in ground permeability across the site. For the purposes of soakaway design for the site, following a conservative approach, the lowest recorded infiltration rate of 4.88×10^{-5}m/s (0.176m/hr) has been used.

The location of the outfall into the River Trent is indicated on drawing number 5117802/006 in **Appendix C**. This is an existing ditch running through the fields to the north. It is anticipated that some minor re-grading and clearing of this ditch may be required to ensure an adequate drainage path to the river. As these ditches are likely to be designated Ordinary Watercourses, it is possible that this may require a Land Drainage Consent application to the local land drainage authority, Lichfield District Council. Re-grading of the ditches must also take into consideration any ecological issues that may be present on the site.

6.3. Maximum Permitted Discharge Rate

In accordance with Environment Agency requirements, the maximum permitted discharge rate from the proposed development into the River Trent will be limited to the annual average existing run-off rate (QBAR) of 22.8l/s. This flow rate will apply for all rainfall events up to and including the 1 in 100-year +30% event.

There is no restriction applied to the flow rate of water disposed of via infiltration into the ground.

6.4. Use of SuDS

The Environment Agency requires SuDS to be considered for inclusion within the drainage strategy for proposed developments such as this. The SuDS techniques suitable for this development have been identified using the selection process defined in CIRIA C697 *The SuDS Manual*[5].

The proposed development is wholly residential. According to CIRIA C697[5], Table 5.2 (reproduced in **Appendix F**), all SuDS techniques with the exception of perimeter sand filters, are considered acceptable.

As described in section 6.2, surface water from the proposed development will be discharged into the River Trent and into the ground via infiltration. According to the Environment Agency website, the Water Framework Directive assessment of the River Trent states that the current and predicted future quality status is poor. Groundwater quality is currently good and predicted to remain good into the future. There are no areas with environmental designations downstream of the site. On this basis, both the River Trent and groundwater are considered to be *medium* sensitivity receptors. According to CIRIA C697[5], Table 5.6, between 1 and 2 treatment train components are required for residential development.

The parameters for the initial selection of SuDS components for this site using CIRIA C697[5], Table 5.4, reproduced in **Appendix F**, are as follows:

- Soils: Permeable
- Area draining to a single SuDS component: 0 – 2ha
- Minimum depth to watertable: >1m
- Site slope: 0 – 5%
- Available head: 0 – 1m
- Available space: High

Based on this initial selection process, the following SuDS techniques are identified as being potentially suitable for this site:

- All types of retention
- All types of wetland
- All types of infiltration
- Bio-retention/filter strips
- Filter trenches
- All types of open channels/swales
- Green roofs
- Rainwater harvesting
- Permeable paving

Retention is anticipated to provide the majority of surface water storage for the proposed development. Some additional storage may also be provided within open channel features such as swales. These retention features will also be used for infiltration. All roof areas within the proposed development will be drained directly to soakaways rather than the piped drainage system. Only flows from hardstanding and highway areas will be drained via the proposed pipe network.

Wetlands require a continuous through-flow of water or high groundwater levels. Neither of these conditions is present on the site hence wetlands are not considered to be viable for the proposed development.

[5] C697 The SuDS Manual, CIRIA, 2007

Green roofs and rainwater harvesting are not proposed for the proposed development due to doubts regarding ongoing future maintenance and hence the performance of such systems. All properties will be fitted with a rainwater butt.

Permeable paving is proposed for all driveways, shared parking areas and other private hardstanding areas. This will facilitate infiltration across the whole of the proposed development in addition to providing water treatment. At this time, permeable paving on the sections of public highway has been omitted as the use of such paving in these areas subject to the agreement of the Highway Authority which has not yet been established.

6.5. Strategy

The proposed surface water drainage strategy comprises two distinct elements:

- Roof run-off disposal via individual house soakaways.
- Run-off from hardstanding and highway areas drained using a combination of infiltration and a pipe system discharging into the River Trent.

The performance requirements for the proposed surface water drainage system are as follows:

- No flooding permitted up to and including the 1 in 30-year rainfall event.
- For all events up to and including the 1 in 100-year +30% rainfall event, the maximum discharge rate into the River Trent must be limited to 22.8l/s during free outfall conditions.
- Any flooding occurring within the proposed development for up to and including the 1 in 100-year +30% event must be contained within the site boundary in a safe manner and allowed to discharge when downstream capacity permits.
- All individual soakaways must half drain within 24 hours.

The surface water drainage strategy for the proposed development is illustrated on drawing number 5117802/006 in **Appendix C**.

6.5.1. Roof Areas

The surface water drainage strategy involves the disposal of all roof run-off into individual house soakaways rather than a pipe network. There are a wide range of different size houses and associated garages on the site; therefore, rather than individually determining the soakaway details for each house, the soakaway needed to drain the largest individual roof area on the site has been designed. All other soakaways will either be equal to this in size or smaller. The exact size and position of each soakaway will be determined during detailed design.

The largest individual roof area on the site is associated with a block of four proposed dwellings with a combined area of 183m^2. The largest individual properties on the site, with their associated double garages, have a total roof area of 161m^2. The design parameters for the soakaway are set out below:

- Infiltration rate: 0.176m/hr (see section 6.2 for details) base and sides
- Maximum depth: 3.0m (assuming an average ground level of ~54.0m AOD and base level of ~51.0m AOD to reach the permeable stratum)
- Ring size: 1800mm diameter (perforated pre-cast concrete)
- Surround: Min. 0.3m granular material with min. 30% voids
- Excavation: 2.4m x 2.4m square
- Infiltration depth: 1.0m (in recognition that ground surrounding the upper sections of the soakaway will be fill rather than natural ground)
- Factor of safety: 2.0

The soakaway was designed using MicroDrainage Source Control. Calculations are shown in **Appendix G**. These show that a soakaway designed using the parameters set out above is adequate to drain a roof area of 183m^2 (0.018ha) during the 1 in 100-year +30% event. The critical rainfall event is the 180 minute winter event during which the maximum water depth within the soakaway is 2.55m and the maximum volume is 7.4m^3. The half drain time is 173 minutes (2.88 hours), which is compliant with the performance requirements stated above.

The soakaway design was tested to establish the maximum area that could be drained to it before flooding occurred. The calculations showed that the maximum roof area that can be accommodated is 200m^2 (0.020ha).

6.5.2. Hardstanding and Highway Areas

The proposed hardstanding and highway areas within the proposed development will be drained via a pipe network which outfalls, via ditches, into the River Trent. Due to the need to keep pipe sizes to a minimum and the system as shallow as possible, there are two outfalls from the proposed system into existing ditches to the north. The maximum permitted discharge rate from the whole development site of 22.8l/s has been divided between the two outfall points based on the proportion of the total site area draining to each outfall. The resultant maximum permitted discharge rates, applicable up to and including the 1 in 100-year +30% rainfall event, are as follows:

- Western outfall: 9.4l/s
- Eastern outfall: 13.4l/s

A vortex flow control (e.g. Hydrobrake) is proposed for each outfall to ensure that these flow rates are not exceeded. These flow rates are applicable when free outfall conditions are present (when the River Trent is not in flood). The surface water drainage system must also be capable of managing the scenario when the River Trent is flooding and hence the outfalls are fully submerged. Under such circumstances the discharge rate from the system will be at least limited if not reduced to zero. Both free and surcharged outfall scenarios have been simulated and the results are described below.

As described in section 6.4, all private driveways, shared parking areas and other areas of private hardstanding are proposed to be surfaced using permeable paving. The areas of permeable paving will be configured to facilitate infiltration and will include collector pipework to link to the surface water pipe network. This arrangement provides for interception of run-off, filtration and water treatment, infiltration of run-off into the ground and resilience during extreme events that may exceed infiltration capacity. The exact configuration of the permeable paving is subject to detailed design; however, it has been incorporated into the model of the surface water system so its performance can be evaluated. The areas included are indicated on drawing number 5117802/006 in **Appendix C**.

In addition to the areas of permeable paving, further storage is required within the surface water system. This is provided by a swale/open channel on the western half of the site, and by a shallow basin within public open space on the eastern side of the site. Both of these features provide further opportunities to utilise infiltration for surface water disposal.

A MicroDrainage WinDes model of the proposed system serving the highway and other hardstanding areas has been developed. This includes the flow controls, permeable paving and other storage areas. Design calculations are shown in **Appendix G**.

The simulation results for the free outfall scenario are included in **Appendix G**. These show that there is no flooding for all events up to and including the 1 in 100-year +30% rainfall event. The maximum discharge rates for the western and eastern outfalls are 5.6l/s and 9.9l/s respectively giving a total peak discharge rate of 15.5l/s.

The analysis of the surcharged outfall scenario used a water level of 53.71m AOD, which is the 1 in 100-year +20% flood level on the River Trent. The simulation results are shown in **Appendix G**. The results show that there is no discharge from the proposed development site when the outfall is surcharged. A non-return valve will be required on each outfall to ensure that flood water does not inundate the system water system and remove storage capacity to manage run-off from the development. The results also demonstrate that no flooding occurs from the surface water drainage system under surcharged outfall conditions during the 1 in 100-year +30% rainfall event. Maximum water levels are higher than those which occur under free outfall conditions; however, the use of infiltration limits the impact of surcharged outfall conditions.

It should be noted that the probability of a simultaneous 1 in 100-year +20% flood on the River Trent and a 1 in 100-year +30% rainfall event on the site is very small (1 in 10,000; 0.01% in any one year period).

The simulation results show that the proposed surface water drainage system is fully compliant with the performance requirements set out above. The use of infiltration enables the run-off flow rate into the River Trent to be reduced below existing rates. The requirement to handle surcharged outfall conditions results in a greater degree of resilience within the system than would otherwise be provided if only free outfall conditions were considered.

6.6. Extreme Rainfall Events

There is a possibility that a rainfall event exceeding the capacity of the surface water drainage system, in particular the collection systems, may occur. This was identified as a residual flood risk in section 5.5. If such an event were to occur, run-off is anticipated to remain on the surface rather than entering the proposed drainage system. Under such circumstances, it is important to ensure that any run-off is directed in a northerly direction towards the River Trent rather than south towards the properties on Dark Lane.

The finished surface level of the site generally falls from west to east. There are also a number of green corridors proposed within the site layout which maintain existing trees and adjacent ditches. These flow in a northerly direction. Under extreme conditions, these ditches will intercept run-off from the site and direct away from existing properties towards the River Trent; therefore, the risk to existing properties from the proposed development will be minimised. The risk to the proposed development during extreme conditions will be minimised through the implementation of the flood risk management measures set out in section 5.4.

6.7. Adoption & Maintenance

It is anticipated that the underground pipework within the proposed surface water drainage system will be offered to Severn Trent Water for adoption. The individual house soakaways and areas of permeable paving will remain in private ownership.

The storage ponds and other SuDS within the proposed development will be offered for adoption to Staffordshire County Council who is anticipated to become the local SuDS Approval Body (SAB). There is no timescale in place at this moment in time for the formation of the SAB and hence when adoption of the SuDS can take place.

7. Foul Water Drainage Strategy

7.1. Foul Water Flow Rates

As described in section 4.1, the proposed development comprises 151 dwellings. Based on Sewers for Adoption (7th Edition), each dwelling generates 4,000 l/dwelling/day; therefore the peak foul water flow rate generated by the proposed development will be 7.0l/s (based on 6 dry weather flow (DWF)).

7.2. Proposed Outfall

Foul water flows from the proposed development will be discharged directly to the pumping station located off Dark Lane, immediately adjacent to the site.

It is known that there are current capacity issues at the pumping station which will need to be addressed to accommodate the proposed development. Severn Trent Water is currently being consulted regarding the necessary works.

7.3. Strategy

Foul water flows from the proposed development will be conveyed to the outfall via a gravity pipe network. At this time, the invert level of the existing pumping station is not known; therefore, it is possible that a small pumping station may be required within the site to lift flows so they can then drain by gravity to the existing pumping station. This is subject to confirmation during the detailed design process.

7.4. Adoption & Maintenance

It is anticipated that all parts of the proposed foul water drainage system will be offered to Severn Trent Water for adoption.

8. Conclusions & Recommendations

8.1. Conclusions

There are areas of Flood Zones 1, 2 and 3 within the planning boundary associated with the River Trent to the north. The proposed development footprint has been designed to ensure that all the proposed dwellings are located on land outside of Flood Zone 3. A small scale floodplain compensation scheme will be used to smooth the existing floodplain boundary and create a uniform boundary to the development platform. This has previously been approved in principle by the Environment Agency. The floodplain compensation scheme presented in this document creates approximately 140% more floodplain volume than is lost as a result of fill being placed on the site.

Other sources of flooding identified as potentially affecting the proposed development site are surface water, sewers and artificial sources. Surface water flood risk is considered to be low as a result of changes in ground levels within the site that will occur during development. Similarly, the risk of sewer flooding encroaching onto the site is low for the same reason. The proposed development site is located within the area that could be affected in the event of a failure of the dams impounding Stowe Pool and Blithfield Reservoir. The risk of such an occurrence is considered to be very low.

Alrewas has flooded occasionally in Main Street and Park Road. There are also reports of Dark Lane flooding in some locations. The cause of this flooding is uncertain; however, it is believed to result from a combination of surface water, sewer and fluvial flooding as the locations reported to have flooded are in the lowest part of Alrewas. Local residents have previously expressed their concern that the proposed development would exacerbate the existing flooding issues. Following an investigation, it has been concluded that the development will not divert flood flows towards or introduce additional run-off into the affected areas; therefore, the existing risk of flooding will remain unchanged.

The proposed development will include a range of flood risk management measures primarily associated with fluvial and surface water flood risk. To provide additional protection from fluvial flooding into the future, fill will be placed across the whole site to ensure that the minimum finished floor levels of all properties are at least 0.6m above the 1 in 100-year +20% flood level from the River Trent. External ground profiling, ensuring finished floor levels are 0.15m above external levels and a positive surface water drainage system will all contribute towards reducing the risks associated with surface water flooding. Existing land drainage routes through the proposed development will either be maintained or diverted to ensure continuity of drainage for Dark Lane and adjacent areas.

The residual flood risks affecting the proposed development are primarily associated with extreme rainfall events exceeding the capacity of the on- or off-site drainage systems. Similarly, a flood event exceeding the 1 in 100-year +20% event on the River Trent could also present a risk to the proposed development. Should an extreme event occur, safe access/egress routes exist onto Dark Lane immediately to the south.

Site investigations have established that the ground conditions beneath the site are sufficiently permeable for infiltration to be a viable means of surface water disposal. The proposed surface water drainage strategy uses a combination of positive drainage and infiltration to dispose of surface run-off. All roof areas are drained solely to soakaways. Highway and other hardstanding areas drain to outfalls into the River Trent via a pipe network that also includes permeable paving and other features to facilitate infiltration and storage. Other SuDS features may also be included within the proposed development. Rainwater harvesting and green roofs are not proposed for the site due to uncertainty regarding ongoing future maintenance; however, all properties will be fitted with rainwater butts.

The configuration of house soakaways is subject to confirmation during detailed design; a design for a soakaway suitable for managing the run-off from the largest property is presented in this document. The scale of this soakaway design can be reduced as appropriate to suit smaller properties or several properties can be connected to a single soakaway, provided that the total roof area does not exceed 200m^2.

The surface water drainage system serving the highways and hardstanding areas has a maximum discharge limit of 22.8l/s up to and including the 1 in 100-year +30% rainfall event. As there are two outfalls from the site into ditches to the north, this allowable flow rate is split proportionately based on the area draining to each outfall. Flow control will be achieved using a vortex flow control or equivalent. Downstream of the

outfalls, run-off will be conveyed to the River Trent via existing field ditches. These may require clearing or re-grading to ensure an adequate drainage path is provided for the proposed development.

A model of the proposed drainage system has been developed using MicroDrainage WinDes. This includes the pipe network, areas of permeable paving and other infiltration features. Simulation results show that the system operates within the required performance parameters in terms of maximum discharge rates and flooding. It is possible that the site outfalls may be surcharged by flooding from the River Trent. This situation has been simulated with a 1 in 100-year +20% rainfall event on the site and the results show that, while no flow is able to leave the site, infiltration enables the proposed drainage system to continue to operate correctly.

The proposed development will generate a peak foul water flow rate of 7.0l/s (based on 6 DWF). All flows will be transferred, either by gravity or via a new pumping station, into the existing Dark Lane pumping station. Severn Trent Water are being consulted regarding the proposed development and whether any specific works are required to provide sufficient capacity for the scheme.

It is anticipated that the piped sections of the surface water system and the whole of the foul water system will be offered to Severn Trent Water for adoption. The storage and infiltration areas together with other SuDS features will be offered to Staffordshire County Council for adoption once the SAB has been established. The areas of permeable paving in private areas will remain privately owned.

8.2. Recommendations

This document is suitable for submission in support of a full planning application for the proposed development.

The detailed design of the proposed surface and foul water drainage systems must comply with the parameters and principles defined within this document.

The ditches downstream of the proposed development site should be investigated to establish the extents of any clearing and/or re-grading that may be required to provide a good outfall into the River Trent. The need for Land Drainage Consent for this work should be confirmed with Lichfield District Council and any possible ecological issues identified.

Discussions with Severn Trent Water regarding local foul water sewerage capacity, with particular reference to Dark Lane pumping station, should be concluded to establish the scale of any works that are required.

Appendices

Appendix A. General Information

This appendix provides background general information relating to flood risk and probability, and national policies and guidance relating to the assessment and management of flood risks.

A.1. Flood Risk and Flood Probability

Flooding is a natural process that can present a range of different risks depending on its form. Flood practitioners and professionals define the risks presented by flooding according to an *annual exceedance probability* (AEP), or a *return period*.

Flood risk includes the statistical probability of an event occurring and the scale of the potential consequences. Flood risk is estimated from historical data and expressed in terms of the expected frequency of a flood of a given magnitude. The 1 in 10-year, 1 in 50-year and the 1 in 100-year floods have a 10%, 2% and 1% chance of occurring in any one year period, respectively. Over a longer period the probability of a particular flood event occurring is considerably greater. For example, the chance of a 1 in 100-year flood occurring or being exceeded is:

- 1% in any 1-year period
- 26% in any 30-year period
- 51% in any 70-year period

Table A–1 shows how each AEP corresponds to a particular return period:

Table A–1 Definition of AEP and return period flood events

AEP (%)	Return period (Years)
100%	1 in 1-year
10%	1 in 10-years
2%	1 in 50-years
1%	1 in 100-years
0.5%	1 in 200-years
0.1%	1 in 1,000-years

A.2. National Planning Policy Framework (NPPF)

The National Planning Policy Framework[1] and its associated Technical Guide[2] were introduced in March 2012, and included the government's spatial planning policy with regard to development and flood risk. These documents superseded are broad range of Planning Policy Statements including PPS25 *Development & Flood Risk*[6]. The NPPF[1] and its associated Technical Guide[2] retain many of the previous design principles and standards included in PPS25 and its related Practice Guide[7].

The NPPF[1] aims to ensure that flood risk is taken into account by all relevant statutory bodies from regional to local authority planning departments to avoid inappropriate development in areas at risk of flooding and to direct development away from areas of highest risk. Where new development is, exceptionally, necessary in high risk areas, the policy framework aims to make it safe, ensure that it will not increase flood risk elsewhere and, where possible, reduce overall flood risk in the local area.

[6] Planning Policy Statement 25: Development and Flood Risk, Department for Communities and Local Government, March 2010
[7] Planning Policy Statement 25: Development and Flood Risk: Practice Guide, Department for Communities and Local Government, December 2009

Local authorities should only consider development in flood risk areas as appropriate where it is informed by a site-specific Flood Risk Assessment, based upon the Environment Agency's Standing Advice[8] on flood risk. The Assessment should identify and assess the risks of all forms of flooding to and from the development and demonstrate how flood risks will be managed so that the development remains safe throughout its lifetime, taking climate change into account.

Within the NPPF Technical Guide[2], there is a hierarchy that should be applied for flood risk management, with avoidance or prevention being the preferred first measure to reduce flood risk. Table A–2 presents the flood risk management hierarchy.

Table A–2 Flood risk management hierarchy

Approach	What it means
1 Assess	Undertake studies to collect data at the appropriate scale and level of detail to understand the level of flood risk.
2 Avoidance/Prevention	Allocate development to areas of least risk and apportion development types vulnerable to the impact of flooding to areas of least flood risk.
3 Substitution	Substitute less vulnerable development types for those incompatible with the degree of flood risk present.
4 Control	Implement flood risk management measures to reduce the impact of new development on flood frequency and use appropriate design.
5 Mitigation	Implement measures to mitigate residual risks.

The NPPF[1] and its Technical Guide[2] define spatial flood risk zones based on the annual probability of fluvial flooding occurring:

- Flood Zone 1 Low probability <0.1% AEP fluvial and sea flooding
- Flood Zone 2 Medium probability 0.1-1.0% AEP fluvial flooding; 0.5-0.1% AEP sea flooding
- Flood Zone 3a High probability 1-5% AEP fluvial flooding; >0.5% AEP sea flooding
- Flood Zone 3b Functional floodplain >5% AEP fluvial flooding or designed to flood in 0.1% event

Development should be directed as far as is practicable towards Flood Zone 1 areas to avoid flood risks wherever possible. For development proposed in any flood zone, if the development area is greater than 1ha, a Flood Risk Assessment will still be required to address design issues related to the control of surface water runoff and climate change, as well as considering any other potential sources of flood risk for the development site.

[8] Flood Risk Standing Advice, Environment Agency, http://www.environment-agency.gov.uk/research/planning/82584.aspx (Last accessed: 15 February 2012)

Appendix B. Correspondence

Mr Paul Birkenshaw
J M P Consulting
85-89 Colmore Row
Birmingham
West Midlands
B3 2BB

Our ref: UT/2011/109713/02-L01
Your ref: Alrewas residential dev

Date: 08 January 2013

Dear Mr Birkenshaw

PRE-APPLICATION PROPOSALS FOR FLOODPLAIN COMPENSATION

LAND NORTH OF DARK LANE ALREWAS

Thank you for your pre-application enquiry received on 19 December 2012, regarding proposed residential development to the north of Dark Lane, Alrewas.

We have addressed the points raised in your email, below:

· The previous proposals to provide floodplain compensation in order to smooth out the flood zone 3 extent on the site are acceptable in principle.

· The 2005 River Trent Strategic model is the current model available and included within our published Flood Map, we note that your e-mail refers to a 2008 model, we are not aware of this, and is a typing error.

· We are not aware of any restrictions on the use of infiltration in this area. Infiltration tests will need to be carried out to determine the site's suitability for infiltration. Restriction of surface water discharge to the Greenfield run-off rate using SuDS methodology (in line with the Ciria 697 SuDS Manual hierarchy) will be required.

· We do not hold any specific records of historic fluvial flooding for this site. Our surface water flood risk maps show potential flooding in this area. This may be due to topography, and there may also be capacity issues in the public sewer.
Severn Trent Water PLC or the Lead Local Flood Authority may hold further information about sewer capacity issues and flood events.

· The flood risk assessment should assess the risk of flooding from all sources in line with the NPPF and supporting guidance. The flood risk assessment must provide sufficient drainage detail to demonstrate that the scheme has a viable surface water

Cont/d..

discharge point(s). Surface water discharge should be restricted to at the greenfield rate incorporating SuDS attenuation to the 1:100 30% climate change standard.
The flood risk assessment should include an assessment of the existing & proposed drainage with calculations where appropriate to support the proposed drainage scheme.

· Please note that if any details of flooding in the area can be ascertained, the flood risk assessment should include measures of how the development should seek to reduce flood risk both to the site and surrounding area.

Yours sincerely

Mrs Laura Perry
Planning Liaison Team Leader

Please ask for: Mrs Becky Clarke

Direct Dial: 01543 404945
Direct Fax: 01543 444161
Direct email: becky.clarke@environment-agency.gov.uk

End

SEVERN
TRENT
WATER

Severn Trent Water
Severn Trent Water Ltd
Regis Road
Tettenhall
Wolverhampton
WV6 8RU

Tel: 01902 793871
Fax:01902 793971

www.stwater.co.uk
net.dev.west@severntrent.co.uk

Contact: Dave Hadley

Your ref: 5117802-L.001/pjb
Our ref: WT32106

15 January 2013

29 JAN 2013

Atkins Ltd
The Axis
10 Holliday Street
Birmingham
B1 1TF
FAO Paul Birkenshaw

Dear Mr Birkenshaw,

Proposed Residential Development, Land off Dark Lane, Alrewas, Staffordshire DE13 7AP

I refer to your Development Enquiry Request in respect of the above. Please find enclosed the sewer records that are included in the fee together with Supplementary Guidance Notes referred to herein.

Foul Water Drainage

There are known flooding and capacity problems both on the sewer network and at the Dark Lane pumping station to the immediate south of the development. Severn Trent is presently considering options to accommodate growth in the area and we will undertake an appropriate scheme to increase capacity in the system to allow for future development.

In the meantime it would be useful to know details of your preferred connection points and anticipated dates for planning permission and developers programme so that we can plan ahead for this and other developments in the area.

Surface Water Drainage

There is a river, canal and several watercourses in the area and I have marked some of these on the sewer records enclosed. In the event that following comprehensive testing, it is demonstrated that soakaways would not be possible, evidence should be submitted. This would satisfy SGN1 (enclosed). In the interests of sustainability a connection to one or several of the watercourses would be necessary in accordance with SGN3 at 5 l/s/ha or such other rate and attenuation as determined by the Environment Agency and Local Authority.

SEVERN TRENT WATER

Severn Trent Water

For any new connections (including the re-use of existing connections) to the public sewerage system, the developer will need to submit Section 106 application forms. Our New Connections department are responsible for handling all such enquiries and applications. To contact them for an application form and associated guidance notes please call 0800 7076600 or download from www.stwater.co.uk.

Please quote WT32106 in any future correspondence (including e-mails) with STWL. Please note that Developer Enquiry responses are only valid for 6 months from the date of this letter.

Yours sincerely

D. J. Hadley

D J Hadley
Asset Protection West
Waste Water Services

SUPPLEMENTARY GUIDANCE NOTES

In 2006 the Government issued national advice in the form of "Planning Policy Statement 25: Development and Flood Risk" that seeks to reduce the impact of development on surface water runoff. This advice is generally followed by Local Authorities through both the Building Regulations (Approved Document H) and the imposition of appropriate planning conditions. Severn Trent welcomes this advice and supports such planning conditions that impose flow restrictions. It is considered that in accordance with current guidance disposal of storm runoff from the development should be dealt with as follows:

1. By soakage into the site's subsoil, subject to suitable ground soakage capacity and any contamination present. If ground soakage proves inadequate, evidence should be submitted to Severn Trent Water. The evidence should be either percolation test results or a statement from the SI consultant (extract from report or a supplementary letter) stating that soakaways would be ineffective. **A connection to public sewerage (existing or adoptable) would then be considered reasonable with flows as:**

2. Brown field development site: If storm runoff from the existing development is connected to the public sewerage system, then peak storm flows from the proposed development up to that generated from the previous connected impermeable area may be connected to the network subject to the details of the existing storm connection arrangements being submitted to Severn Trent Water. Existing flows should be assessed as the lower of $Q=2.78x50xA_{imp}$ l/s (A_{imp} ha), based on a 2 year storm return period, and the unsurcharged capacity of the outfall pipe(s).

   In addition to this restriction, for Brownfield developments, the Company would also suggest a reduction in surface water flow to the public sewerage systems of 20%. It should be noted that the Company would like to see any flow attenuation based on a 30 year critical duration storm design in accordance with 'Sewers for Adoption' current edition.

   For existing storm connections to the public foul sewerage system, any new storm connection to the public storm sewerage system (if available) should be limited to 5 litres/sec/ha (option A) OR a peak flow to be determined by the Company from its developer-funded hydraulic modelling of the public storm sewerage system (option B). The developer may choose either option.

3. Green field development site: If the site is a green field development i.e. not involving any demolition of buildings or paved areas connected to the public sewerage system, then the storm runoff from the proposed development may be connected to the public sewerage system subject to peak storm flows (30 year storm return period) being limited to a green field runoff of 5 litres/sec/ha (subject to a minimum of 5 litres/sec for Adoptable systems), applied to the gross area of the site, subject to sufficient capacity in the network.

No assets within north part of the site.
Please see letter for more information as standard.

SEVERN TRENT WATER Ltd
Asset Data Management
GISmapping Team
PO Box 5344
Coventry
CV3 9FT
Tel 0845 601 6616
Fax 02477 715862
Contact Nicholas Westcott
Our Ref 40172

29 July 2013

Apparatus Location Enquiry

ATKINS CHECKED
SAT

Further to your enquiry re: Alrewas, Staffordshire, DE13 7AW (Your ref: 26861)

Enclosed is a copy of the plans showing the approximate positions of the **public sewers** situated within the vicinity of the land/property which is the subject of your enquiry.

The GISmapping Team has no record of any underground apparatus within the northern part of the site for which you have requested information and so the plans provided cover all known Severn Trent assets within your given site.

The area covered by your plan for **clean water** does not fall within the Severn Trent region. For details of existing water mains you may need to contact:

South Staffordshire Water Company
Green Lane
Walsall
WS2 7PD
Tel: 01922 638282 Ext 3320

Asset Data Management can only provide plans of the location of the Company's underground assets. Therefore service pipes and drains are the responsibility of the property owner and should be anticipated during any excavation.

However, we wish to inform you that although most private lateral drains and sewers were transferred to Severn Trent Water's ownership on 1st October 2011, the Company does not possess complete records of these assets and therefore they may not be shown on these maps.

Enquiry received by GISmapping:
29 July 2013

TERMS AND CONDITIONS AND GENERAL PRECAUTIONS

These general terms and conditions and precautions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the Agreement for the self construction of water mains) (STW Apparatus) of Severn Trent Water Limited (STW) and are not to be taken as exhaustive.

TERMS AND CONDITIONS:

1. This plan and any information supplied with it is issued subject to these terms and conditions.

2. This plan and any information supplied with it is furnished as a general guide only and no representation or warranty as to its accuracy is given or implied.

3. In particular, the position and depth of STW Apparatus shown on the plan are approximate only. It is strongly recommended that a survey is carried out to determine the precise location of STW Apparatus. The exact positions and depths should be obtained by excavation trial holes.

4. The position of private drains, private sewers and service pipes to properties are not normally shown on this plan but their presence must be anticipated and you are strongly advised to carry out your own enquiries and investigations to locate them.

5. The position and depth of STW Apparatus may change and therefore this plan is issued subject to any such change. The onus is entirely upon you to confirm whether any changes to the plan have been made subsequent to issue and prior to any works being carried out.

6. This plan and any information shown on it must not be relied upon in the event of any development or other works (including but not limited to excavations) in the vicinity of STW Apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or distribution systems.

7. No person or company shall be relieved from liability for any damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan and any information supplied with it.

8. If any provision of these terms is or becomes invalid or unenforceable, it will be taken to be removed from the rest of these terms to the extent that it is invalid or unenforceable. No other provision of these terms shall be affected.

9. These terms shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts.

PRECAUTIONS:

STW staff will visit any site at reasonable notice to assist in the location of our apparatus and advise of any precautions necessary to avoid damage.

In order to achieve safe working conditions adjacent to any apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.

2. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.

3. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

4. Where it is proposed to carry out piling or boring within 15 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.

5. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.

6. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.

7. No apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within 5.0 metres either side of the centre line of STW Apparatus without prior approval. A minimum of radial clearance of 300 millimetres should be allowed between any plant being installed and existing STW Apparatus. No manhole or chamber shall be built over or around any STW Apparatus.

8. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged.

9. With regard to any proposed resurfacing works, you are required to contact STW on the number given below to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken.

10. Trees or shrubs - please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not encroach within the recommended distances specified in the notes overleaf.

Sewer Node / Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SK16159001	53.76	50.72	50.66	C	VC	C	225	nil	600.71	nill
SK17140801	54.70	52.92	52.11	C	VC	C	225	nil	82.81	nill
SK17140901	54.23	51.90	51.14	C	VC	C	150	nil	99.96	nill
SK17140902	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK17140903	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK17140904	nil	nil	53.86	C	VC	C	100	nil	0.00	nill
SK17140905	54.44	53.83	nil	C	VC	C	150	nil	0.00	nill
SK17141901	54.49	52.71	51.90	C	VC	C	150	nil	108.15	nill
SK17141902	54.52	52.27	52.03	C	VC	C	150	nil	296.08	nill
SK17142901	54.30	52.00	51.36	C	VC	C	150	nil	89.36	nill
SK17142902	54.49	53.93	nil	C	VC	C	100	nil	0.00	nill
SK17142903	54.48	54.01	53.95	C	VC	C	100	nil	33.33	nill
SK17142904	54.48	54.00	nil	C	VC	C	100	nil	0.00	nill
SK17142905	nil	nil	nil	C	VC	C	150	nil	0.00	nill
SK17142906	54.54	54.18	54.12	C	VC	C	100	nil	33.33	nill
SK17142907	54.54	54.11	53.87	C	VC	C	100	nil	41.88	nill
SK17142908	54.43	53.84	nil	C	VC	C	150	nil	0.00	nill
SK17142909	54.66	54.05	nil	C	VC	C	100	nil	0.00	nill
SK17142910	54.62	53.82	nil	C	VC	C	100	nil	0.00	nill
SK17142911	54.60	nil	nil	C	VC	C	100	nil	0.00	nill
SK17142912	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK17143802	54.15	51.24	51.15	C	VC	C	150	nil	226.67	nill
SK17143803	54.08	51.12	50.64	C	VC	C	150	nil	99.33	nill
SK17143901	53.94	50.24	50.19	C	VC	C	225	nil	458.04	nill
SK17143904	53.79	50.18	49.53	C	VC	C	225	nil	98.55	nill
SK17143905	53.29	49.50	49.20	C	VC	C	225	nil	261.00	nill
SK17144803	54.01	52.00	51.42	C	VC	C	150	nil	115.41	nill
SK17144804	54.03	51.41	51.28	C	VC	C	150	nil	203.69	nill
SK17144903	52.97	49.19	48.94	C	VC	C	225	nil	418.08	nill
SK17144904	53.09	49.37	49.21	C	VC	C	225	nil	332.88	nill
SK17145902	53.10	49.62	49.38	C	VC	C	225	nil	389.33	nill
SK17146805	53.82	nil	nil	C	VC	C	nil	nil	0.00	nill
SK17146903	53.24	50.20	49.98	C	VC	C	225	nil	277.82	nill
SK17146904	53.46	49.98	49.63	C	VC	C	225	nil	254.17	nill
SK17150001	54.03	50.63	50.24	C	VC	C	225	nil	205.15	nill
SK17150002	53.69	50.90	50.86	C	VC	C	150	nil	466.40	nill
SK17150004	53.50	50.96	50.91	C	VC	C	150	nil	494.00	nill
SK17150101	53.37	51.26	50.96	C	VC	C	150	nil	119.13	nill
SK17150102	53.46	51.81	51.66	C	VC	C	150	nil	118.13	nill
SK17150103	53.36	51.62	51.26	C	VC	C	150	nil	110.27	nill
SK17150201	54.06	52.26	51.83	C	VC	C	150	nil	144.98	nill
SK17150202	54.29	52.99	51.79	C	VC	C	225	nil	55.63	nill
SK17150205	53.35	51.67	51.53	C	VC	C	225	nil	252.00	nill
SK17150208	54.13	53.72	52.29	C	VC	C	100	nil	14.07	nill
SK17150209	53.52	52.29	nil	C	VC	C	100	nil	0.00	nill
SK17151003	53.49	50.22	50.03	C	VC	C	225	nil	400.32	nill

MATERIALS

-	- NONE	PE	- POLYETHLENE
AC	- ASBESTOS CEMENT	PF	- PITCH
BR	- BRICK	PP	- POLYPROPYLENE
CC	- CONCRETE BOX CULVERT	PSC	- PLASTIC STEEL COMPOSITE
CI	- CAST IRON	PVC	- POLYVINYL CHLORIDE
CO	- CONCRETE	RPM	- REINFORCED PLASTIC MATRIX
CSB	- CONCRETE SEGMENTS (BOLTED)	SI	- SPUN (GREY) IRON
CSU	- CONCRETE SEGMENTS (UNBOLTED)	ST	- STEEL
DI	- DUCTILE IRON	U	- UNKNOWN
GRC	- GLASS REINFORCED CONCRETE	VC	- VITRIFIED CLAY
RP	- GLASS REINFORCED PLASTIC	XXX	- OTHER
MAC	- MASONRY IN REGULAR COURSES		
MAR	- MASONRY RANDOMLY COURSED		

SHAPE

C	- CIRCULAR
E	- EGG SHAPED
O	- OTHER
R	- RECTANGLE
S	- SQUARE
T	- TRAPEZOIDAL
U	- UNKNOWN

PURPOSE

C	- COMBINED
E	- FINAL EFFLUENT
F	- FOUL
L	- SLUDGE
S	- SURFACE WATER

TABULAR KEY

A. Sewer pipe data refers to downstream sewer pipe.

B. Where the node bifurcates (splits) X and Y indicates downstream sewer pipe.

C. Gradient is stated a 1 in...

SEVERN TRENT WATER

Severn Trent Water Limited
Asset Data Management
PO Box 5344
Coventry
CV3 9FT
Telephone: 0845 601 6616

SEWER RECORD DATA TABLE

O/S Map scale:	1:5000	**This map is centred upon: O / S Grid reference:**	
Date of issue:	29.07.13	**x:**	417453
Sheet No.	2 of 3	**y :**	315385

Sewer Node — Sewer Pipe Data

REFERENCE	COVER LEVEL	INV LEVEL UPSTR	INV LEVEL DOWNSTR	PURP	MATL	SHAPE	MAX SIZE	MIN SIZE	GRADIENT	YEAR LAID
SK17151004	53.16	50.73	50.03	C	VC	C	150	nil	64.27	nill
SK17151005	53.39	50.02	nil	C	VC	C	225	nil	0.00	nill
SK17151102	53.17	51.57	51.21	C	VC	C	150	nil	252.78	nill
SK17151102	53.17	51.24	50.87	C	VC	C	225	nil	197.91	nill
SK17151201	53.18	51.50	51.25	C	VC	C	225	nil	339.80	nill
SK17152001	nil	nil	49.61	C	VC	C	225	nil	0.00	nill
SK17152101	52.98	50.56	50.21	C	VC	C	225	nil	216.83	nill
SK17152102	52.97	50.86	50.75	C	VC	C	225	nil	146.55	nill
SK17152103	52.96	50.73	50.58	C	VC	C	225	nil	225.60	nill
SK17152104	53.11	51.21	50.76	C	VC	C	150	nil	38.80	nill
SK17153002	53.06	50.94	50.61	C	VC	C	150	nil	189.00	nill
SK17153003	53.15	49.58	49.50	C	VC	C	225	nil	411.71	nill
SK17153004	52.92	50.22	50.02	C	VC	C	225	nil	213.05	nill
SK17153101	53.00	52.70	nil	C	VC	C	100	nil	0.00	nill
SK17153102	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK17153103	nil	nil	52.37	C	VC	C	100	nil	0.00	nill
SK17153104	53.06	52.34	nil	C	VC	C	100	nil	0.00	nill
SK17153105	nil	nil	nil	C	VC	C	100	nil	0.00	nill
SK17154001	52.74	48.58	nil	C	VC	C	300	nil	0.00	nill
SK17154002	52.75	48.90	48.59	C	VC	C	300	nil	149.42	nill
SK17154101	53.11	51.73	51.71	C	VC	C	150	nil	2662.22	nill
SK17155001	52.46	49.82	49.64	C	VC	C	225	nil	228.50	nill
SK17155002	52.70	nil	nil				nil	nil	0.00	nill
SK17155003	52.71	nil	nil				nil	nil	0.00	nill
SK17155006	nil	nil	nil				nil	nil	0.00	nill
SK17155102	52.61	49.64	49.27	C	VC	C	225	nil	109.22	nill
SK17155103	52.59	49.26	nil	C	VC	C	225	nil	0.81	nill
SK17155104	nil	nil	nil	C	VC	C	300	nil	0.00	nill
SK17156001	52.55	50.08	49.82	C	VC	C	225	nil	162.27	nill
SK17156002	52.76	nil	nil				nil	nil	0.00	nill
SK17156003	nil	nil	nil				nil	nil	0.00	nill
SK17156101	53.11	51.31	51.01	C	VC	C	225	nil	110.27	nill
SK17156102	52.39	50.53	50.10	C	VC	C	225	nil	153.53	nill
SK17156103	52.35	50.93	50.57	C	VC	C	225	nil	80.36	nill
SK17156104	nil	nil	nil				nil	nil	0.00	nill
SK17157001	52.87	50.49	50.23	C	VC	C	225	nil	383.46	nill
SK17157101	nil	nil	nil				nil	nil	0.00	nill
SK17157102	53.26	nil	nil				nil	nil	0.00	nill

MATERIALS

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