URS

Cheddleton Way North

Flood Risk Assessment

July 2014

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Prepared for:
Wainhomes (North West) Ltd

UNITED KINGDOM & IRELAND

REVISION SCHEDULE

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EXECUTIVE SUMMARY

URS Infrastructure & Environment UK Limited (URS) was commissioned by Wainhomes (North West) Ltd to undertake a Flood Risk Assessment (FRA) for the construction of a residential development on the parcel of land to the north of Leek Brook off Cheadle Road, south of Leek. The site is centred on Ordnance Survey National Grid Reference (OSNGR) 398234, 353929 with the development footprint covering an area of approximately 15,500 m^2 (1.55 ha).

This assessment considers the existing flood risk posed to the site from all sources, along with the impact of the development on flood risk both to the proposed development itself and elsewhere. The potential impacts of climate change on flood risk over the lifetime of the development are also considered. In summary:

- The site lies within Flood Zones 2 and 3 based on URS hydraulic modelling carried out in 2014,
- The site is currently undeveloped and as such has no formal surface water drainage system or land drainage outfalls. The current risk of flooding from surface water is considered to be high,
- The site has, historically, been occupied by Baird Fabrics Ltd. Although, currently, not in use the site contains a number of contaminated areas, as evidenced in correspondence between Wainhomes and Joynes Pike and Associates Ltd dated 27th June 2003. The presence of old sludge lagoons and rubble and industrial waste from previous facilities and plant is evidence of contamination. This is likely to prohibit the use of infiltration methods for surface water disposal as this may cause the mobilisation and dispersion of these pollutants into the groundwater and the nearby watercourses,
- The existing flood risk from groundwater and all other sources is considered to be low,
- Current guidance states developers should reduce surface water runoff to Greenfield runoff rates post development where practical. This will also help contribute to reducing flood risk in the areas surrounding the development,
- As the ground conditions on the site are not considered to be suitable to support surface water infiltration techniques, a provision must be made for the reduction of runoff rates. The proposed mitigation measure is to increase the capacity of the flood storage area to the north east of the development site to provide approximately 1,450 m^3 of surface water storage. The increase in impermeable area of 8400 m^2 due to the development will require approximately 450 m^3 of storage for a 1% annual exceedance probability (AEP) plus climate change event and the controlled runoff will discharge to River Churnet at greenfield runoff rate of 7.5 l/s. The existing surface water discharge into the currently disused flood storage basin from the adjoining industrial estate will remain. However, the discharge from the proposed remediated basin will be controlled by a hydrobrake to Greenfield runoff for both sites. Once the available surface water storage has been taken up, the excess flow will discharge to Leek Brook via the proposed 600 mm diameter flood return culvert. Storage above this level is for fluvial floodwater from Leek Brook which enters the basin via the high level side weir but only during extreme events,
- Raising Leek Brook left bank levels to 141.19 mAOD as agreed with the Environment Agency (EA) and the development site ground levels to a minimum of 400 mm above the 1% AEP plus climate change fluvial event flood level i.e. 142.30 mAOD will mitigate the risk of fluvial flooding to an acceptable level, and
- There is a residual risk of local surface water flooding in the event of a significant storm occurring which generates runoff in excess of the capacity of the surface water drainage collection system. The raising of finished floor levels to 200 mm above the raised site ground levels would protect properties from surface water flooding. Excess runoff would remain on site roads and gardens before draining into the surface water system. There are no other sites nearby that would be affected by surface water overland flows generated on the development site. It is therefore not anticipated that exceedance of the surface water drainage system would cause a significant flood risk.

1 INTRODUCTION

1.1 Background

URS Infrastructure & Environment UK Limited (URS) was commissioned by Wainhomes (North West) Ltd to undertake a Flood Risk Assessment (FRA) for a proposed development for the construction of a residential development comprising 48 properties and associated infrastructure including a new bridge crossing, situated north of Leek Brook off Cheadle Road, south-west of Leek. The development site is centred on Ordnance Survey National Grid Reference (OSNGR) 398234, 353929 and the development covers an area approximately 15,500 m^2 (1.55 ha).

The site is situated within Flood Zones 2 and 3 and is therefore at a high risk of flooding from fluvial sources[1] with a 1% annual exceedance probability (AEP) or greater.

A FRA is required to support a planning application for the development of the site under the guidance of the National Planning Policy Framework[2] (NPPF). The FRA primarily considers the risk of fluvial flooding to the site and the management of surface water runoff, as per the recommendations of the Standing Advice[3] of the EA. The FRA also considers the risk of flooding from other sources, such as groundwater and overland flow, and where appropriate, recommends appropriate mitigation measures.

1.2 Aims and Objectives

The aim of this study is to undertake an FRA that is appropriate to the nature and scale of the proposed development. The study is considered sufficient to meet the necessary requirements of current planning guidance, and support an application for planning permission for the proposed development.

The objectives of this report are to:

- Review existing information relating to the flood risk posed to the site from all sources (e.g. fluvial, surface water, sewer flooding),
- Consult Staffordshire Moorlands District Council (SMDC), Staffordshire County Council (SCC) and the Environment Agency (EA) regarding flood risk to the proposed development and the requirements of the NPPF,
- Assess the flood risk to the site under existing and future conditions (taking into account climate change), and
- Outline flood risk mitigation measures needed to meet the requirements of the NPPF.

1.3 Data Sources References

Data collected in preparation of this FRA is presented in the Table 1-1, which also identifies the source of the data and its application.

[1] Environment Agency. (2013) *What's in Your Backyard? 'Risk of Flooding from Rivers and Sea map.* Available at www.environment-agency.gov.uk

[2] Department for Communities and Local Government (2012) National Planning Policy Framework

[3] Flood Risk Standing Advice for England (1995) Available at www.environment-agency.gov.uk/research/planning

Table 1-1: Sources of Data Reviewed

Purpose	Data and Source	Comments
Identification of Hydrological Features	Ordnance Survey mapping	Identifies the position of the site and local hydrological features
	Site Survey (Total Surveys Ltd)	Watercourse sections and land survey
Identification of Existing Flood Risk	LIDAR data, Site Survey (Total Surveys Ltd)	Site topographic levels
	EA Indicative Flood Zone Map	Identification of fluvial/ tidal inundation extents and historical flooding
	EA Flood Inundation Mapping	Information on the risk of flooding from reservoirs (artificial sources)
	Staffordshire Preliminary Flood Risk Assessment (PFRA), Tamworth, Lichfield, Stafford and Staffordshire Moorlands Level 1 Strategic Flood Risk Assessment (SFRA)	Assess flood risk across Staffordshire. Includes flood risk from fluvial/tidal, sewers, overland flow, groundwater
	Ground Investigation (Joynes Pike & associates Ltd)	Details of historic use and ground conditions
Identification of Historical Flooding	Tamworth, Lichfield, Stafford and Staffordshire Moorlands Level 1 SFRA	Details of historical flooding
	Environment Agency flood maps, historic maps.	Details of historical flooding
Development Plans	Plans supplied by Wainhomes North West Ltd	Layout of the Proposed Development
Surface Water Drainage	Site visit undertaken by URS	Identified existing site drainage, public drainage system near the site and contains details of proposed management of surface water runoff from proposed development.

2 DESCRIPTION AND LOCATION

2.1 Type of Development and Location

The proposed development is located to the north of Leek Brook off Cheadle Road, south-west of Leek (Figure 2-1). The development sits within a wider site of approximately 5.9 ha, which includes an existing residential development to the south with Leek Brook dividing the two areas.

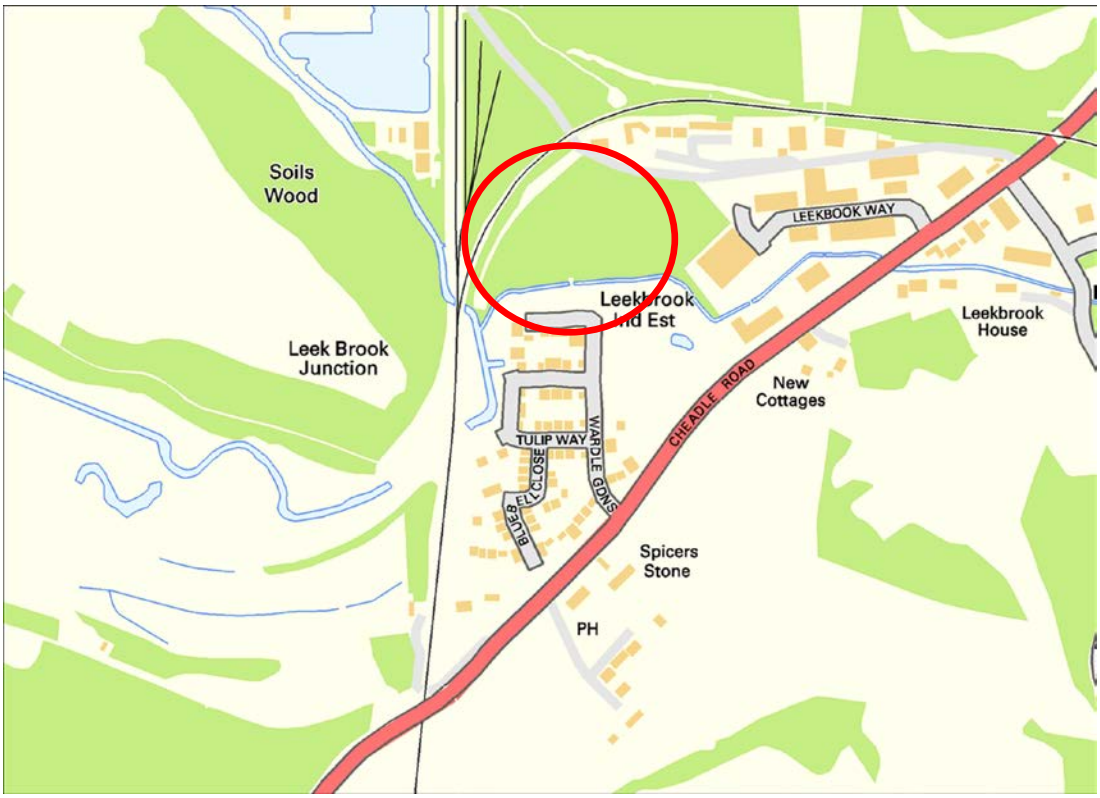

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Figure 2-1: Site Location

The site is bordered along its north-western extent by a Severn Trent Water (ST) access track and a railway embankment. The eastern edge of the site is bordered by a council owned flood detention basin constructed in 1993 which is currently in disrepair, beyond which is an industrial development. A 600 mm diameter outfall pipe from the existing Flood Storage Area (FSA) runs south-westerly across the site to the River Churnet. A 400 mm diameter surface water sewer discharges into the FSA from the industrial estate to the north east of the FSA.

Along its southern boundary, Leek Brook watercourse meanders in an east-westerly direction to its confluence with the River Churnet which runs from north to south to the west of the site. A ST sewage pumping station is situated in the south west corner between the site and Leek Brook.

A site layout plan of the proposed development and typical cross section through the site is presented in Appendix A.

EA Landfill Information

An EA planning decision letter to SMDC dated 11 November 2003 regarding the outline planning application for the Joshua Wardle site states:

> *"The site has historically been known as Baird Fabrics Ltd, Leekbrook, Leek. A waste disposal licence reference 9999/9955 was issued to the site operators, Joshua Wardle Ltd in April 1977 giving permission for the deposit of sludges resulting from the prior treatment of water borne waste from the main effluent treatment plant in Lagoons 1 and 2, and bricks and concrete, hardcore, excavated materials soils and subsoils in lagoons 3 and 4. The EA are not aware of any permanent landfill gas monitoring or control measures at this site. However, elevated levels of methane and carbon dioxide have been detected at the site during spike test surveys".*

Figure 2-2 below shows a historic map of the Leekbrook Industrial Estate taken from 1977 to 1993 Ordnance Survey (OS) mapping which shows the extent of previous development on the proposed development site i.e. the lagoons/sludge beds.

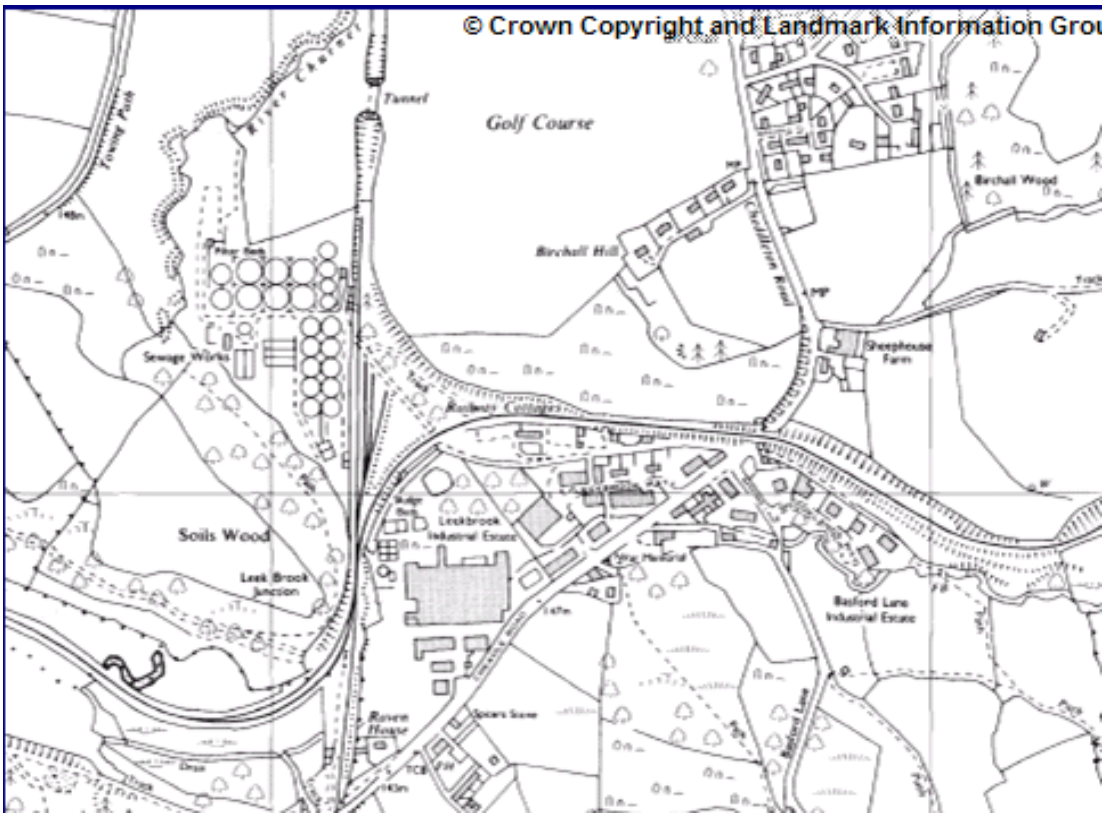

Figure 2-2: Historic map of the area (1971-1993)

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The site is currently undeveloped comprising soil and demolition rubble, and remnants of infrastructure related to the previous site uses. The topographic survey (see Appendix B) shows that the existing site slopes in a south-westerly direction. Ground levels range from approximately 144 mAOD, along the site's northern boundary, to approximately 140 mAOD at the site's south-eastern corner within the vicinity of the ST sewage pumping station.

The proposed development is for the construction of 48 residential properties and associated infrastructure. This includes a proposed road access bridge (see Appendix A) which will provide the site with access from the existing residential development to the south across Leek Brook. The proposed access bridge will be of a clear span design (6m width) with a deck soffit level 600 mm above the 1% AEP plus climate change flood level. The proposed development will occupy an area of approximately 15,500 m^2 (1.55 ha).

2.2

2.2 Development Vulnerability Classification

Table 2 of the NPPF Technical Guidance states that residential development is classed as 'More Vulnerable'.

2.3 Sequential and Exception Test

Due its 'More Vulnerable' land use classification combined with the majority of the site being located in Flood Zones 2 and 3a, the proposed development is considered appropriate within the NPPF statutory guidance relating to Flood Risk Vulnerability and Flood Zone Compatibility (Table 2.1). Based on this classification and areas lying within Flood Zone 3, the Sequential Test and Exception Test are required.

Table 2.1: Flood Risk Vulnerability and Flood Zone Compatibility

Flood risk Vulnerability classification	Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone 1	✓	✓	✓	✓	✓
Flood Zone 2	✓	✓	Exception test required	✓	✓
Flood Zone 3a	Exception test required	✓	×	Exception test required	✓
Flood Zone 3b 'Functional Floodplain'	Exception test required	✓	×	×	×

The Sequential Test is a simple decision making tool designed to ensure that sites at little or no risk of flooding are developed in preference to areas at higher risk. Where new development is necessary in high flood risk areas, it should be directed to sites with the lowest probability of flooding and the flood vulnerability of the intended use should be matched to the flood risk of the site, e.g. higher vulnerability uses located on parts of the site at lowest probability of flooding. The Sequential Test should be applied before moving onto the Exception Test.

Evidence provided by the SFRA allows the application of the Sequential Test with regard to Flood Risk, as set out in the NPPF and the associated guidance, in the allocation of development sites.

2.4 Is the Proposed Development Consistent with the Local Development Documents?

Relevant planning documents have been reviewed including Tamworth, Lichfield, Stafford and Staffordshire Moorlands Level 1 SFRA, Staffordshire Moorlands Core Strategy Development Plan, and the NPPF have all been reviewed to determine the proposed development's consistency with Local Development Documents.

The Tamworth, Lichfield, Stafford and Staffordshire Moorlands Level 1 SFRA

A Level 1 SFRA provides sufficient data and information to enable a planning authority to apply the Sequential Test to land use allocations and can therefore identify, where necessary, the Exception Test needs to be applied.

As stated in the document, the main aims of the SFRA are to allow the local planning authority to:

- Prepare appropriate policies for the management of flood risk,
- Inform the Sustainability Appraisal (SA) so that flood risk is taken account of, when considering options and in the preparation of strategic land use policies,
- Identify the level of detail required for site-specific FRAs,
- Determine the acceptability of flood risk in relation to emergency planning capability.

The areas of assessment required with regards to proposed developments within high probability Flood Zone 3a are listed in the SFRA as:

- The vulnerability of the development to flooding from other sources as well as from river flooding,
- The vulnerability of the development to flooding over the lifetime of the development within the property and surrounding area,
- The potential of the development to increase flood risk elsewhere through the addition of hard surfaces, the effect of the new development on surface water runoff, and the effect of the new development on depth and speed of flooding to adjacent and surrounding property,
- A demonstration that residual risks of flooding (after existing and proposed flood management and mitigation measures are taken into account) are acceptable,
- Details of existing site levels, proposed site levels and proposed ground floor levels.

The SFRA guidance on raised floor levels and basements states:

> *"Wherever possible, floor levels should be situated a minimum of 600 mm above the 1% probability peak flood level plus climate change flood level (plus 20% flows), determined as an outcome of the site based FRA. Additional freeboard may be required because of the risk of blockages to the channel, culvert or bridge. The height that the floor level is raised above the flood level is referred to as the 'freeboard', and is determined as a measure of residual risks.*
>
> *There are a number of flood risk objectives, and the most relevant to this FRA include:*
>
> - *Ensure development is 'safe'. For residential developments to be classed as 'safe', dry pedestrian egress out of the floodplain and emergency vehicular access should be possible.*
> - *Above ground attenuation, such as balancing ponds, should be considered in preference to below ground attenuation, due to the water quality and biodiversity benefits they offer.*
> - *Those proposing development should look for opportunities to undertake river restoration and enhancement as part of a development to make space for water".*

Staffordshire Moorlands Core Strategy Development Plan

The Staffordshire Moorlands Local Development Framework (LDF) is a District wide development plan which replaces the Staffordshire Moorlands Local Plan to provide a framework for delivering development to 2026.

The LDF states:

> *"Sustainable use of resources will be achieved by giving encouragement to development on previously developed land in sustainable locations in allocating land for development and determining planning applications,*
>
> *Development deemed acceptable within areas at risk of flooding due to national or other policies or other material considerations, must be subject to a flood risk assessment".*

3 FLOOD RISK

A review of the relevant OS, EA and British Geological Survey[4] (BGS) data was undertaken to establish the hydrology, drainage and ground conditions of the site.

Hydraulic modelling based on updated survey data was carried out by URS. The model was based on a trimmed version of the EA 2013 hazard mapping model incorporating topographic levels and sections from a 2014 survey. The URS Hydraulic Modelling Technical Note included in Appendix D provides more details of the modelling approach and conditions, and a full suite of mapped modelling outputs. The proposed road bridge was also tested on the mitigation model to check that the afflux of the bridge was not significant in flood flow conditions in the watercourse. The modelling approach adopted was agreed with the EA through consultation using this document.

The dominant feature of the catchment is rapid-runoff from the Peak District and Staffordshire moorlands which can lead to rapid rises in water levels in Leek Brook. The Leek Brook and River Churnet (at Leek Brook) catchments drain areas of approximately 7 km^2 and 78 km^2 respectively.

The River Churnet is located to the west of the site flowing southerly and Leek Brook flows in a westerly direction forming the southern border of the proposed development site. **Potential Sources of Flooding**

3.1.1 *Tidal Flooding*

Tidal flooding occurs through inundation from the sea or estuarine waters. There is no risk of tidal flooding to the site and it is not considered further in this assessment.

3.1.2 *Fluvial Flooding*

Fluvial flooding occurs through inundation from rivers and watercourses.

As part of this assessment, information was sought from the EA as to the source of fluvial flood risk to the site as suggested by the flood map (see Figure 3-1). The information provided by the EA indicates the principal source of flood risk to the site is from a combination of Leek Brook which runs along the south of the site, the River Churnet and the interaction between the two watercourses.

Results of the EA model and all other previous models for the area have been superseded by the URS hydraulic modelling of 2014. As such the Flood Zone classifications of some areas within the site have changed.

The proposed development is situated within Flood Zones 2, 3a and 3b.

The River Churnet rises in the north of the Staffordshire Moorlands District, flowing around the town of Leek in a well-defined floodplain.

The Leek Brook catchment drains an area of approximately 7 km^2. Its predominant characteristic is its rapid time to peak and rapid response to rainfall events.

The model report concludes that when flood levels on Leek Brook coincide with flood events on the River Churnet, flood levels are controlled by the River Churnet levels and the backing up these levels cause on the lower section of Leek Brook. The baseline maximum modelled 1% AEP plus climate change flood level on Leek Brook is 141.82 mAOD.

[4] British Geological Survey, (2012): Geology of Britain Viewer – 1:50, 000 scale mapping. Available at http://www.bgs.ac.uk/opengeoscience/home.html

A comparison of the modelled flood levels with the as surveyed levels of the site and Leek Brook bank levels indicates that a 5% AEP event would cause flooding to a small part of the site along its western boundary (formerly believed to have been a ditch) and the access track to the ST pumping station alongside but outside the site boundary.

The FSA comprises a low level weir diverting flow from Leek Brook along a trapezoidal concrete lined channel to an excavated area north-east of the site. The outfall to the FSA consists of a large headwall with a 600 mm diameter culvert which runs south-westerly across the proposed development site outfalling into the River Churnet adjoining the ST pumping station.

The FSA became redundant as a storage basin following the construction of the Leek Brook diversion channel in 2004. However, the basin remained in operation though not maintained by the council and baseline hydraulic models have been produced that both include and exclude the FSA. With the current side inlet weir to the FSA (located on Leek Brook) modelled at its current level of 141.24 mAOD, the baseline runs indicate that this level is exceeded during a 5% AEP event.

The mechanisms of flooding of the site are from overtopping of the Leek Brook bank and overflow from the FSA when it fills in a 5% AEP event.

A culvert (approximate 400 mm diameter on the topo survey) discharges onto the site from under the ST access track and railway embankment to the north-west. No information was available with regards to the catchment area at the time this FRA being produced. It is thought that it was constructed to direct surface water runoff from the railway embankment on the north side of the railway through the embankment and probably originally discharged into the River Churnet via a ditch along the western boundary of the development site.

There is no detailed information on any other drains local to the site and as such it is not possible to fully quantify the level of risk at this point in time.

In consideration of the baseline model results, data reviewed including design flood and site topographic levels along with the historic flooding information, the fluvial flood risk from main rivers is considered to be high.

3.1.3 *Groundwater Flooding*

Groundwater flooding can occur when the sub-surface water levels are high and groundwater emergence occurs.

BGS mapping and EA Aquifer Designation Maps indicate that the site is underlain by a principal aquifer and situated in a high groundwater vulnerability zone which consists of a Chester Pebble Beds Formation of Sandstone. At surface level the superficial deposits are formed of Alluvium consisting of a Clay, Silt, Sand and Gravel.

The Tamworth, Lichfield, Stafford and Staffordshire Moorlands SFRA does not consider groundwater flooding to be an issue within the area of the development site. Furthermore there are no recorded instances of historical groundwater flooding within the vicinity of the proposed development site.

The EA groundwater vulnerability zone map is included in Appendix C.

3.1.4 *Overland \Flow*

Flooding due to overland flow can occur as a result of high intensity rainfall falling directly or indirectly onto the ground. The majority of the site is undeveloped and as such there are currently no arrangements for the removal of surface water from the site.

3.1.5 ***Sewer Flooding***

Sewer and surface water flooding are often interconnected, where insufficient drainage capacity in the sewer network can result in surface water flooding. By the same rationale, large volumes of surface water can overload the sewers, causing the sewer network to surcharge and flood. There are no public surface water or combined sewers located within the site. A public foul sewer is present along the southern boundary adjacent to Leek Brook. As such, the likelihood of a public sewer causing surface water flooding to the site is considered to be very low.

As described in section 2, the site is undeveloped and is not served by a land drainage system. The 600mm diameter culvert that crosses the site is the present outfall for surface water sewers that discharge into the disused storage basin and drain a part of the Leekbrook Industrial Estate. There are no records that flooding of the site has occurred directly from this culvert.

3.1.6 ***Artificial Waterbodies***

There are no canals located nearby which could be a flood risk. The EA risk of flooding from reservoirs map shows that the site may be at risk from Tittesworth and Rudyard reservoirs, however at the time of writing; the EA designation of the risk posed was yet to be determined.

The Level 1 SFRA stated that due to the high level of inspection and maintenance required by the Reservoirs Act 1975 which governs the water impoundments aforementioned, the risk to the site is considered to be low from these sources and they are not considered any further in this assessment.

The EA Risk of Flooding from Reservoirs map is included in Appendix C of this report.

3.2 Surface Water

The NPPF states that new developments should not increase the risk of flooding to their site and elsewhere. As such, the proposed development must manage surface water to ensure that runoff volumes leaving the site will replicate Greenfield runoff rates.

The site is currently undeveloped, and as such under the proposals there will be a significant decrease in the permeable area. The development proposals will therefore result in an increase in the volume of surface water leaving the site, and therefore potentially increase the flood risk to and downstream of the site.

It is therefore recommended that flood risk management measures are incorporated into the development. The management of surface water is discussed in Section 5 of this report.

4 CLIMATE CHANGE

4.1 Impact of Climate Change on Flood Risk

Table 4 and Table 5 in the Technical Guidance to the NPPF state that climate change is likely to have an impact on river flows and rainfall intensity. Therefore, the risk of flooding to and from the proposed development could potentially increase in the future. Precautionary climate sensitivity ranges adopted from the NPPF are shown in Table 4-1.

Table 4-1: Recommended National Precautionary Sensitivity Ranges for Peak Rainfall Intensities and River Flows

Parameter	1990 to 2025	2025 to 2055	2055 to 2085	2085 to 2115
Peak rainfall intensity	+5%	+10%	+20%	+30%
Peak river flow	+10%	+20%		

The outputs of the UK Climate Projections (UKCP09) climate change scenarios are indicative of a shift towards wetter winters over the whole of England by as much as 20% by the 2050s[5]. Shifts in seasonal patterns of rainfall are also expected, with summer and autumn becoming much drier than at present. Snowfall amounts are anticipated to decrease significantly throughout the UK, but the number of rain-days and the average intensity of rainfall are expected to increase.

4.1.1 *Fluvial Flooding*

The present detailed hydraulic model provided modelled flood extents and flood depths for a range of events at the site. One of the modelled events includes a flood outline of the 1% AEP event with an allowance for climate change. Outputs from this modelled event indicate that the flood extent encroaches onto the site at current levels. The maximum water level in Leek Brook alongside the site is 181.82 mAOD. As a result, it is expected that climate change will increase the extent and depth of fluvial flooding on the site at current ground levels.

4.1.2 *Groundwater*

Climate change may increase groundwater flood risk over time; higher rainfall over outcrop areas of the shallow aquifers may cause groundwater levels to rise.

However, given there is currently no evidence of shallow groundwater, the level of groundwater is unlikely to rise to the point at which it becomes a flood risk to the proposed development.

4.1.3 *Surface Water Runoff Generation and Overland Flow*

An increase in rainfall intensity may increase surface water runoff rates and consequently runoff volumes. As a result, the future drainage arrangements at the site will be need to be designed to take into account the likely impacts of climate change. This is discussed in more detail in Section 5.

[5] Murphy *et al.*,(2009) UK Climate Projections Science Report: Climate change projections. Met Office Hadley Centre, Exeter.

5 SURFACE WATER AND FLUVIAL FLOOD RISK MANAGEMENT

5.1 Surface Water Runoff Generation

The proposed development will result in the creation of impermeable areas on the site. Therefore, the development will cause an increase in the volume of runoff from the site. Advice from the EA specifies that for brownfield development sites a reduction in the amount of runoff from the site is expected, where practical. As there is no record of previous buildings or roads on the site, it has been agreed with the EA that the site be treated as a greenfield undeveloped site.

Development site runoff rates are to be reduced to a greenfield runoff rate of 5.0 l/s/ha during the 1% AEP plus climate change event. To meet with this requirement, a surface water management strategy is required to detail how the reduction would be achieved.

Exact details of runoff rates or the catchment of the industrial estate to the east of the site were not unavailable at the time this FRA was being prepared. The area of the industrial estate that we have assessed as draining to the disused FSA has been estimated to be 3.5 ha. . The total impermeable area of the proposed development and industrial estate is 5.05 ha. Applying a greenfield runoff rate of 5 l/s/ha, the greenfield runoff rate for the two areas is 25 l/s. The current discharge rates leaving the disused FSA are significantly greater than this as there is no flow control in evidence on the 600 mm outlet pipe which conveys the flows to the River Churnet.

5.2 Fluvial Mitigation

As was outlined in Section 3, the proposed development boundary encroaches into the modelled floodplain and lies in Flood Zones 2 and 3.

The proposed principal mitigation for the development against fluvial flood risk is to raise the entire site up to a minimum level of 142.30 mAOD. The increase in ground level varies across the site from 0 m to 2.5 m, with an average typically of around 1.25 m. The finished ground level will generally slope south-westerly towards the south west corner. The minimum finished floor levels for the houses on the site is to be 142.50 mAOD meeting the 600 mm requirement above the River Churnet 1% AEP plus climate change flood level.

Fluvial compensation storage is to be combined with the surface water attenuation proposals as outlined below.

The proposed high level side weir on Leek Brook would only pass floodwater from Leek Brook into the ‘dual use’ FSA during extreme events. The first 650 mm depth of water in the basin above the minimum water level (139.50 mAOD) up to a level of 140.15 mAOD would be utilised for surface water attenuation storage from both the proposed residential development and the existing industrial estate to the north east which has an existing outfall into this area. The remaining storage volume in the basin, up to a top water level of 142.0 mAOD would be utilised for fluvial compensation storage. This arrangement has been modelled for the 1% AEP and 1% AEP plus climate change flood events and the results show that there is a slight reduction in flood levels on Leek Brook with the mitigation proposals included.

The embankment on the left bank of Leek Brook is to be raised to 142.19 mAOD as agreed with the EA to provide a 1% AEP plus climate change level of protection to the existing development.

The soffit level of the access road bridge is to be set 600 mm above the modelled 1% AEP plus climate change levels. It will be a 6 m wide clear span design. This will ensure safe

access and egress during flood events and reduce the risk of blockages under the bridge during extreme events.

5.3 Proposed Surface Water Management Strategy

Guidance dictates that where possible, source control should be given preference over site control measures. Under this arrangement, surface water generated by the impermeable areas on-site would be managed through a soakaway or similar structure. For the proposed building the roof drainage might be expected to be discharged to soakways via water butts with an overflow connection to the surface water sewer in the road. This would be the ideal way of managing the surface water. On the basis that infiltration methods are not suitable at the site, alternative provisions will be required for the disposal of the surface water runoff.

There is a high likelihood that the ground underlying the site (at least in part) is contaminated. This is based on its historic use as an industrial site and anecdotal evidence such as the presence of sludge lagoons which are believed to contain hazardous waste such as dye processing sludge and buried rubble from industrial facilities and plant.

The use of infiltration methods is therefore considered not to be appropriate as this could cause these contaminants to become mobilised and dispersed.

It must be stressed that the conclusion with regards to site contamination is based on information available at this stage and not a detailed ground investigation report. Further investigation of ground conditions is required at the detailed design stage to determine whether or not infiltration can be used anywhere in the final designed scheme.

Taking into consideration the topography of the site, hydraulic modelling results, the exclusion of infiltration methods due to the presence of contaminants, and other evidence highlighted in this report, the following flood risk management measures are proposed:

- Raising the ground levels on the site to a minimum level of 142.30 mAOD i.e. 400 mm above the 1% AEP plus climate change flood level in Leek Brook adjacent to the site,
- Constructing the development finished floor levels above the modelled 1% AEP plus climate change flood level by at least 600 mm, i.e. to a minimum finished floor level of 142.50 mAOD,
- Increasing the storage capacity of the existing FSA and through the provision of a “sweetening flow”, converting it into a “wet pond” with a surface area of approximately 2,500 m^2,
- Raising the level of the side spill feeder weir on Leek Brook to 141.90 mAOD.

The basin would be deepened creating a permanent lake with water depths varying typically between 0.6 m and 1.2 m. This is to maintain open areas of water to prevent it from becoming overgrown with reeds etc.

The low water level would be set at approximately the same level as the original ‘dry’ basin bed level at 139.50 mAOD. A small pipe (nominally 100 mm) would be inserted into the side weir on Leek Brook at low level to allow a small continuous ‘sweetening flow’ to pass through the lake at all times. The basin would function as a surface water flow attenuation facility and a water treatment facility (to improve water quality) to surface water discharges from the adjoining developments Treatment would be achieved through the inclusion of reed beds around the shallower sections along the margins of the basin.

The total volume available for surface water storage is to be approximately 1,450 m^3 allowing for approximately 950 m^3 for inflows from the industrial estate.

The surface water outfall will utilise the existing structure but a new control chamber would be constructed immediately downstream of the headwall where surface water flows discharging from the lake would be restricted by a hydrobrake.

A new 300 mm diameter pipe will follow the northern boundary of the site and then be laid under the access track along the western boundary. The pipe will then pick up the drain from under the railway embankment. At this connection, it then becomes a 450 mm diameter pipe running south to connect into the existing 600 mm diameter outfall pipe which discharges to the River Churnet.

The presence of the ST sewage pumping station and the access path falling under its ownership, works around these features will require agreement with ST.

A flood return culvert approximately 600 mm in diameter will be installed connecting the existing concrete lined inlet channel and the Leek Brook Channel. This is to be set at an invert level of 140.70 mAOD which would return floodwater from the basin back into Leek Brook once flood levels in the watercourse start to recede. The remaining water in the basin below this level would discharge through the surface water control structure returning water levels to the basin's bottom (normal) water level.

5.4 Surface Water Storage Volumes

The proposed development has an impermeable surface area of approximately 8400 m^3. As part of the drainage strategy element of this FRA, a provisional calculation of the storage volume requirements for the proposed development has been undertaken. The complete surface water drainage strategy and associated attenuation volumes should be confirmed during the detailed design stage. These initial calculations are purely indicative at this stage and are based on restricting the post-development runoff rate to a Greenfield rate of 5 l/s/ha.

In accordance with the NPPF, the storage volumes have been factored to accommodate an increase in rainfall intensity of 20% over the lifetime of the development to account for the impacts of climate change.

The initial assessment of the required attenuation volumes for the site and the wider area including the assumed industrial estate catchment is presented in Table 5-2. The calculations are included in Appendix E.

Table 5-2: Storm Water Attenuation Volumes

Design Event - 1% AEP+CC + 20%	
Proposed Development	**Proposed Development and Existing Industrial Site**
500 m^3	2,700 m^3

It must be noted that the diversion of Leek Brook in 2003 into an open channel was designed to remove the requirement of the FSA with respect to the industrial estate. Although an outfall exists there is currently no flow control structure on this outlet, so discharge is assumed to be uncontrolled from the basin.

Once the initial storage in the basin has been used up water will begin to return to Leek Brook via the floodwater return culvert unless the water level in the watercourse is higher than in the

basin. This culvert will have a non-return flap valve on its downstream invert to prevent flood water from entering the basin from downstream of the raised side weir.

5.5 Residual Risks

There is a residual risk of localised surface water flooding occurring from a rainfall event which produces runoff rates that are in excess of the design capacity of the drainage collection and conveyance system. Blockage of a gravity-based outfall increases in levels of the River Churnet or reduced capacity of Leek Brook due to sedimentation could result in backflow of water in the site's drainage system.

Surface water flooding would follow the site topography over the ground and onto site roads where it would be temporarily be stored until it could discharge via the site drainage system.. The raised site ground levels would mean that the development would be protected from fluvial flooding up to in excess of the 1% AEP plus climate change event levels and the finished floor levels with 600 mm provision for freeboard above this flood level would provide protection to properties to levels well above those of the general site.

Regular maintenance of the FSA, drainage system and watercourse should be undertaken to ensure that the systems continue to perform as designed. The owners of the site (or Staffordshire County Council as the SUDS Approval Body) will ultimately be responsible for ensuring that the regular maintenance will be instructed and undertaken by themselves or a management company.

Flood risk from reservoirs located upstream on the catchment that are registered under the Reservoirs Act is considered to be low. It is not possible to forecast or feasible to design for reservoir failure events. The proposals outlined in this report address the risk of flooding as far as is reasonably practical. The residual risks are considered to be acceptable.

6 CONCLUSIONS

- The site lies within Flood Zone 2, Flood Zone 3a and a small area of Flood Zone 3b,
- The existing and future flood risk from groundwater sources is considered to be low, with a high risk of flooding from surface water flooding and overland flow,
- The development will increase the extent of impermeable surfaces at the site by approximately 8500 m^2.The discharge from the site will be restricted to greenfield runoff at a maximum rate of 5 l/s/ha. In order to help reduce flooding elsewhere, a reduction in the current runoff rate from the industrial estate to the east will be provided. This is to be achieved through the enlargement and utilisation of the disused storage basin along the sites north-east border to attenuate the runoff,
- An initial estimate for potential attenuation storage required for the proposed development site suggests that an attenuation volume of approximately 450 m^3 is required for a critical duration 1% AEP event with an additional 20% allowance for climate change,
- The proposed 'wet pond' will have a surface water capacity of approximately 1,450 m^3 and provide further storage for surface water flows from the industrial estate. This has been assessed based on the 1% AEP fluvial event with a 20% allowance for climate change,
- Further investigation of ground conditions is required at a detailed design stage to determine whether or not infiltration through a compensatory permeable area can be used, or if reinstating the FSA will be required. This will be subject to review of the contamination of any proposed area for a compensatory permeable area,
- The wider site will be raised to minimum ground levels of 142.30 mAOD and finished floor levels of the development of 142.50 mAOD, 600 mm above the 1% AEP plus climate change flood levels as per the SFRA guidance,
- The embankments of Leek Brook are to be raised to a min. of 142.19 mAOD as agreed with the EA,
- The proposed design of the access road bridge is of a clear span design with a soffit level 600 mm above 1% AEP plus climate change event. A residual risk of flooding is associated with exceedance of the drainage system design capacity. Due to the site topography however it is not anticipated this would lead to significant flood depths at the development site and as such it is not anticipated this would generate any unacceptable risk. Overland flow would be contained within the roadways on the site.

APPENDIX A – OUTLINE DEVELOPMENT PROPOSALS

APPENDIX B – SITE LIDAR DATA

APPENDIX C – ENVIRONMENT AGENCY MAPS

APPENDIX D – HYDRAULIC MODELLING TECHNICAL NOTE

APPENDIX E – MICRODRAINAGE STORAGE CALCULATIONS

APPENDIX F – WAINHOMES CORRESPONDENCE