Flood Risk Assessment (FRA) Update

DOCUMENT 12

June 2009

New Settlement at Curborough

Flood Risk Assessment Update

June 2009

Note

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Document History

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Contents

Appendices

Glossary of Terms

Abbreviation	Description
EIA	Environmental Impact Assessment
FRA	Flood Risk Assessment
PPS25	Planning Policy Statement 25
EA	Environmental Agency
STW plc	Severn Trent Water
BW	British Waterways
SUDS	Sustainable Drainage Systems
FEH	Flood Estimation Handbook

Executive Summary

This Flood Risk Assessment (FRA) has been prepared as an update to the previously submitted FRA that was prepared on behalf of the Curborough Consortium to accompany the planning application 08/00342/OUT that was submitted to Lichfileld District Council 28 March 2008 for the development of a new settlement at Curborough (formerly known as Fradley).

Following the objections letter received from the Environment Agency (EA) dated 8 May 2008 a meeting was held between the EA and various Consortium Consultants to discuss the objections raised. Of particular significance were the needs to address the issues raised in connection with surface waters / flooding, infrastructure failure, groundwater flooding, surface water drainage strategy (SUDS) and surface water control strategy (construction phases).

The comments contained within this update relate solely to addressing the matters concerning the original Flood Risk Assessment (FRA). The aspects that required further work are summarised below:

- Surface Waters / Flooding: The Curborough/Pyford Brook requires modelling of the floodplain extent to be overlain with the proposed masterplan to ensure built areas are not subject to flood risk. Clarification is also required to demonstrate that Mare Brook and Business Brook will not flood the development, as the development will be built sufficiently far away so that it does not pose a significant flood risk.
- Provide correspondence from British Waterways confirming that the canals adjacent to the site are stable and level.
- Groundwater: Flooding as a result of groundwater was not recorded within the Fradley/Lichfield area. Site investigations should seek to identify the groundwater depth across the site. Due to varying sandstone/clay substrata percolation tests will be important to inform the drainage strategy of percolation method suitability.
- Drainage strategy: The use of SUDS must be considered as they are promoted not only for surface water attenuation but improved water quality benefits. Source control measures should be employed throughout the development and relate to designed sub-catchments within the development. Comments should be made regarding the continued maintenance of lakes/swales.
- Construction: Surface water and flood control during construction should be considered, particularly in regard to soil erosion and wash off.
- Phasing: The two areas of attenuation lakes should be delivered in the first phase of the development and this should be identified in the strategy.

The issues raised in the EA objections are revised and the outcomes of the re-assessment are summarised below:

- The hydraulic model demonstrated that Curborough/Pyford Brook does not pose a significant risk to the development in either 1 in 100 year and 1 in 1000 year events which coincides with the EA Flood Map Zones. All development will be built 8-10m back from Mare Brook and Business Brook to avoid risks of flooding, as agreed with the Environment Agency at the consultation meeting. There will also be no development to be constructed on the floodplain of these areas.
- Correspondence with British Waterways has confirmed the integrity of the canal is in good condition and they are not aware of any events of overtopping from the canal.
- Percolation tests and groundwater depth testing will be undertaken during Ground Investigations in the detailed design phases of the development. This will strategically assess different areas of different geological character within the development site to measure rates of drainage.
- SUDS design and applications will be incorporated at all appropriate locations across the site. The designs will be reviewed alongside the Ground Investigation data and detailed infrastructure designs

to ensure compatibility and functional success. For example infiltration techniques may not be appropriate within some parts of the site from a geological and a contamination perspective.

- Attenuation pond systems alongside sediment basins and traps, buffer strips, swales, soakaways, bunds and interception channels will be constructed, where appropriate, to manage surface waters across the site during the establishment of each construction phase depending on the ground conditions and area characteristics. In the post-construction, the attenuation ponds will continue to manage surface waters and where possible enhanced to provide wetland habitats and improve local biodiversity within the new development area.

1. Introduction

This Flood Risk Assessment (FRA) has been prepared as an update to the original Curborough Development FRA (Document 12) that was prepared on behalf of the Curborough Consortium following the objections made by the Environment Agency and must be read in conjunction with the original FRA. This FRA is to accompany the planning application 08/00342/OUT that was submitted to Lichfileld District Council 28 March 2008 for the development of a new settlement at Curborough (formerly known as Fradley). Appendix A of this update refers to the objections letter from the EA.

Following receipt of these objections, a meeting was arranged (on 1st August 2008) between the EA and various Consortium Consultants to discuss the issues raised. The required areas of work are summarised below:

- Surface Waters / Flooding: The Curborough/Pyford Brook requires modelling of the floodplain extent to be overlain with the proposed masterplan to ensure built areas are not subject to flood risk. Clarification is also required to demonstrate that Mare Brook and Business Brook will not flood the development, as the development will be built sufficiently far away so that it does not pose a significant flood risk.
- Provide correspondence from British Waterways confirming that the canals adjacent to the site are stable and level.
- Groundwater: Flooding as a result of groundwater was not recorded within the Fradley/Lichfield area. Site investigations should seek to identify the groundwater depth across the site. Due to varying sandstone/clay substrata percolation tests will be important to inform the drainage strategy of percolation method suitability.
- Drainage strategy: The use of SUDS must be considered as they are promoted not only for surface water attenuation but improved water quality benefits. Source control measures should be employed throughout the development and relate to designed sub-catchments within the development. Comments should be made regarding the continued maintenance of lakes/swales.
- Construction: Surface water and flood control during construction should be considered, particularly in regard to soil erosion and wash off.
- Phasing: The two areas of attenuation lakes should be delivered in the first phase of the development and this should be identified in the strategy.

2. Assessment of EA Objections

2.1 Surface Waters / Flooding

The original FRA prepared in March 2008 addressed flooding from all local sources of flooding using readily available EA Flood Zone mapping and concluded that the risk of fluvial flooding was 'low', as all the built development area was situated within Flood Zone 1. The FRA identified through data gathering and consultations with the EA that in the past there had been localised floods within the floodplain areas of Curborough and Mare Brooks. Therefore, no development would be proposed within these floodplain areas that could otherwise be retained for green space and habitat enhancements.

The Environment Agency reviewed the FRA in May 2008 (Reference – UT/2008/103670/01-L01) and requested during a subsequent meeting (1st August 2008) that the FRA should develop a hydraulic model for the Curborough/Pyford Brook to identify any flood risks within the proposed development boundaries. This further work is provided in Appendices B (Hydraulic Modelling) and C (Hydraulic Modelling Flood Zone Mapping) while a brief outline of the main findings is detailed below:

- To investigate the flood risks posed by the Curborough/Pyford Brook through the development of a HECRAS hydraulic model, topographical surveys were conducted and Digital Terrain data purchased.
- The hydrological analysis used the FEH as an overarching approach while considering additional methods to more fully understand the hydrological regime (refer to Appendix B for further details).
- The HECRAS hydraulic model and hydrological analysis determined design flood flows and inundation areas for the 1 in 100 year flood, 1 in 100 year plus 20% for climate change, and 1 in 1000 year flood events.
- The fluvial modelling of the 1 in 100 year event was also used to inform:
    - the proposed drainage discharge location;
    - the proposed minimum floor levels for development buildings;
    - potential affects of flooding on any proposed, nearby surface water attenuation systems; and
    - potential management issues along the Curborough/Pyford Brook systems in respect of the proposed development.
- The model demonstrated that Curborough/Pyford Brook does not pose a significant risk to the development site during either a 1 in 100 year event (+ climate change) or a 1 in 1000 year event. The majority of the development area was deemed to be situated within Flood Zone 1, with little or no risk of fluvial flooding. Those areas that were deemed to be situated within Flood Zone 2 were not posing flood risk issues to the development, as these were planned to remain undeveloped and provide a habitat for wildlife or green spaces.
- The estimated flooding areas along the brook are detailed in Figure A3 of the Hydraulic Model Build and Validation Report of Appendix B. When the proposed locations of nearby buildings are superimposed upon the flood zone mapping, it can clearly be seen that all buildings are at least 50m away from the 1 in 100 year flood zones, as shown in the diagram for Appendix C (Figure 11c). However, it is important to note for future users that the Flood Zones shown to the west of the modelled brook (outside the development area) are indicative only as topographical data was not available for this area.
- Flow sensitivity tests for the area revealed that water levels in Curborough/Pyford Brook around Stowe Pools and between the Trent & Mersey Canal to Alrewas Hayes Farm are more sensitive to

changes in channel roughness (i.e. encroachment of vegetation into the channel area could lead to reduced flow conveyance within these reaches).

The recommendations from the hydrological modelling were:

- The Curborough/Pyford Brook should be maintained to ensure debris does not block structures local to the site, as this would increase the risk of flooding at the site;
- The finished floor levels of buildings within the development area should be built to a minimum height relevant to those given in Table 6.6, provided in Appendix B, for different site areas, plus an additional freeboard of 600mm.
- The development should avoid altering the existing natural floodplain. If the proposals were to change or ground levels be altered, the loss of floodplain storage volumes must be compensated for on a 'like-for-like' basis in terms of volume and quantity within specified elevation bands (following Environment Agency guidelines and Planning Policy Statement 25).
- The drainage strategy for the site should also promote the use of Sustainable Urban Drainage Systems (SUDS) to maximise source control through infiltration and attenuation and minimise the impact of urban development on the current hydrological regime.
- At detailed design stage, the proposed drainage discharge location must be designed to accommodate flow levels during a 1 in 100 year (+ climate change) event and be set to cope with a water level of 57.16m AOD (located at Hay End Lane Road Bridge).

As shown in the masterplan in the Curborough Design and Access Statement[1] all development will be built 8-10m back from Mare Brook and Business Brook to avoid the risks of flooding, as agreed with the Environment Agency at the consultation meeting. The attenuation ponds will also be located a similar distance from the Mare Brook to avoid direct flooding interaction between the brook and the ponds. Specific details of ponds and building locations will be finalised in the detailed design.

2.2 Assessment of Infrastructure failure and flooding

Section 4.5.1 of the original FRA identified that the risk of flooding from infrastructure failure was considered low due to local topography and the good condition and maintenance status of the existing infrastructure (canals). However, to investigate and satisfy the objections made by the EA further consultation with British Waterways has been undertaken. Correspondence from British Waterways regarding these issues is included in Appendix E and is summarised below:

In terms of structural condition of the canal systems, correspondence has confirmed that British Waterways are not aware of any instances of flooding or overtopping from the canal reaches adjacent to the site. The canal structure is made up of brickwork, steel piles and natural banks which are in a serviceable state of repair at present for British Waterways use, though sections of the offside canal (the side without a defined towpath) may not be owned by British Waterways so they cannot comment on the state of these sections.

All works that may affect British Waterways' property should adhere to the requirements outlined within the BW Code of Practice documentation.

If reaches of the canals within the development area are not owned by British Waterways, further enquiries would be needed to identify, contact and liaise with the relevant landowners.

2.3 Groundwater Flooding

The original FRA deemed the site to be of 'low' to 'moderate' risk of flooding from groundwater, given the recorded local geology of the site. This document also highlights the fact that further geological studies and

[1] Curborough Design and Access Statement, Document 5, October 2008, Author: RPS

ground investigations would be required to fully understand the drainage implications for the site and the development (FRA Section 5.1.2).

Ground investigations will take the form of groundwater depth testing and 'percolation tests' that will strategically assess areas of different geological character within the development site to measure rates of drainage and the potential influence of groundwater flooding. These will be conducted as part of, and to inform, the detailed design phase of the development. This information will be used not only to inform the drainage strategy for the development but also to inform the overland flood risks and dictate the suitability of surface water 'source control' designs where infiltration techniques for SUDS could be incorporated in various development areas and whether alternate surface water management strategies will be required.

2.4 Surface Waters Drainage Strategy - SUDS

The original FRA outlined the principles of reducing the potential overland flood risk and the reduction of potential surface water pollution entering the local watercourses and highlighted that these issues would be addressed as far as practicable through the use of Sustainable Urban Drainage Systems (SUDS).

To further promote the implementation of SUDS practices as part of the development process for Curborough, SUDS will be implemented throughout the detailed design stage, subject to obtaining further information regarding ground conditions and finalised site layout.

The impacts of surface water drainage from impermeable areas of the Curborough development will be controlled and managed to reduce the risk of flooding and control pollutants, whilst maximising the principles of more natural drainage mechanisms and cycles across the site and improve amenity benefits.

Impermeable areas within the proposed development include roads, pavements, car parks, playgrounds and roof areas of residential buildings, industrial units, schools and offices. Runoff from all of these areas could affect the quantity and quality of water entering local watercourses by carrying sediments, synthetic particles, litter and a wide range of soluble pollutants (e.g. hydrocarbons from fuel and vehicle exhausts).

Flood risk and water quality management of surface waters will be achieved through incorporating, wherever possible, Sustainable Drainage Systems (SUDS), which are designed to manage surface water by retention, attenuation and infiltration. An increasing range of SUDS designs and applications are widely used in modern development strategies. For example, soakaways, permeable pavements, swales and infiltration trenches, wetlands, ponds, storm water attenuation systems, green roof systems, rainwater harvesting and even the use of household water butts.

Throughout all design stages, construction phases and linking across many different aspects of the development, the use and incorporation of SUDS will be applied at all appropriate locations across the site, and, where appropriate, follow other pollution control structures such as oil interceptors and silt traps.

Designs will apply the main principles of the 'SUDS Management Train' to maximise the control and treatment of water at its first point of contact with the ground within the site (source control) and continue to manage surface water flows across the larger site catchment (site control). This should improve the management of water flows leaving the development area and entering receiving watercourses or other treatment systems (regional control).

Section 4.3 of the FRA modelled various overland flood risks that could be generated from the development and demonstrated that the maximum estimated surface water volume of 85,000m^3 generated by the development could be managed by using recommended SUDS designs.

The development area of the proposed Curborough expansion has been designed with several specific types of land use in certain areas of the site. This 'subcatchment' design for different land uses will allow for the design and implementation of specifically appropriate SUDS with targeted source control measures that are designed to link, where appropriate or necessary, to larger site control strategies.

The design will be based on various sub-catchment areas within the site, as determined by proposed land use, settlement character or by population density parameters. These sub-catchments are detailed in the Curborough Design and Access Statement.

Each phase of the various development sub-catchments will be reviewed in terms of site information and data, masterplan reviews, compatibility with other infrastructure, hydraulic and water quality requirements, feasibility assessments for all stages, conveyance linkages between sub-catchments and future operation issues to ensure hydraulic, water quality, amenity and ecological requirements are addressed (following principles outlined in the SUDS Manual (CIRIA c697).

As part of the SUDS design process, account must be made for existing local factors such as the geology and ground conditions, the natural drainage character, existing soil or water-borne pollutants (e.g. historical MOD use of the site) and current water drainage functioning. This is contained in the Environmental Statement previously submitted to the Environment Agency. In addition, SUDS designs should incorporate principles of safety, compatibility with other proposed structures (e.g. buildings and pipelines, both above and below ground) and potential new sources of pollution (e.g. traffic-related pollutants, litter, other waste waters not sent to sewer). This will ensure that all opportunities for SUDS are investigated and wherever possible, effectively utilised.

Much of the information required to plan and design effective SUDS will not be available until later in the development process. Detailed, specific surveys, ground work and ground investigations will be required to inform other aspects of the development (e.g. percolation tests for groundwater interactions, further geological studies required for land use and geological information, soil assessments for potential contamination). Section 3.3.8 of the FRA discussed the need for further geological investigations to be conducted at the detailed design stage to identify constraints or opportunities for the inclusion of suitable SUDS designs in the development.

SUDS designs that utilise infiltration techniques may not be appropriate within some parts of the site (both from a geological and a contamination perspective), but this can not be clarified until tests have been carried out as part of the detailed design stage.

A few of the examples that will be considered include ‘green roof’ designs that will be applied to schools and larger buildings within the Local Centre where structural requirements, safety and designs will allow. Swales (broad, shallow vegetated channels) will be incorporated where land space is sufficient along roads and adjacent to other paved areas. Water harvesting systems will be considered in high density, public or school areas (e.g. water butts for gardens and underground systems to augment WC supplies). The concept of a ‘SUDS Corridor’ will be incorporated to allow for the conveyance of exceedence flows and make space for water. Permeable paving and drainage will be applied to appropriate parking areas and all designs will incorporate considerations for climate change and maintenance.

Several attenuation ponds will be constructed for controlling surface sediments and run off during construction phases and will form part of the continued SUDS management train after construction is completed, whilst also providing additional wetland habitat and amenity areas. The precise size and locations for these ponds will be given at the detailed design stage, but they will be located beyond the flooding zones of the adjacent watercourses (e.g. Mare Brook) and will not be placed where there may be concerns for existing local wildlife areas or areas of archaeological importance. Attenuation ponds will also be smaller in size than those shown in the Design and Access Statement (within the Site Wide Masterplan diagram), as additional SUDS techniques will be introduced across the site to reduce the size of attenuation ponds required to control surface waters prior to release into receiving watercourses. Surface waters discharged from the site will not be released into canal systems or into existing natural wetland/pond areas.

The design, construction, adoption, ownership and maintenance of SUDS, such as those already mentioned, will be more fully incorporated as part of the detailed design phase of the Curborough Development. Design and implementation will be undertaken in accordance with recognised best practice and SUDS guidelines (e.g. PPS25: Development & Flood Risk (HMSO); PPS23: Planning & Pollution Control (HMSO); Drainage of Development Sites (CIRIA/HR Wallingford); SUDS – A Guide for Developers (EA); The SUDS Manual C697 (CIRIA); Making Space for Water (DEFRA), DMRB Guidance - Volume 11 (Highways Agency)).

In addition, the ideas and principles of ‘Making Space for Water’ (as outlined by Defra and other Government departments since 2004 and 2005 and being strategically implemented by the Environment Agency through its SUDS Policy EAS/0102/1/3) will be adopted across the development area to minimise flood risk, maximise surface water and pollutant control.

Future management and maintenance will require further liaison with all stakeholders, STW, Lichfield DC, local businesses, schools and other potential private management schemes in conjunction with the Open Space management scheme, once the extent, location and designs of the SUDS are finalised for the detailed design. The maintenance and ownership issues will follow the guidelines for 'Model Agreements for Sustainable Water Management Systems - Model agreement for rainwater and greywater use systems' (CIRIA C626). This is particularly important as, for example, permeable pavements need regular cleaning to unblock pores or replacing every 8-10 years (Zhang, 2006[2]) and underground stormwater chambers may need de-silting to continue to provide adequate surface water control across the site.

At this stage there is nothing to preclude the successful use and implementation of SUDS across the development site, provided ground conditions, sub-catchments and structural designs are reviewed alongside sustainable drainage concepts and designs.

2.5 Surface Waters Control Strategy – Construction Phases

The development will seek to incorporate the principles of PPS23 (Planning and Pollution Control) and PPS25 (Development and Flood Risk). In addition, technical guidance will be sought from various other publications including the Site Handbook for the construction of SUDS (CIRIA c698) and Control of water pollution from constructions sites (CIRIA SP156 & C532).

Throughout the development and construction phases, the control of surface waters and mobilised sediments will be carefully reviewed and preventative measures strategically developed to minimise exposed sediments, reduce the risks of flooding and prevent pollution of receiving watercourses. Three main phases of development will include secondary and tertiary access links; secondary school and park and ride areas; mixed use local centre developments. This is detailed in the Curborough Design & Access Statement - Phasing Parameter Plan diagram ACD5257.14.11.

Localised areas of ground disturbance will be reviewed with each proposed phase and area of construction to assess how surface waters and potential sediment release, or pollutants will be controlled, both on a small, localised scale and on a larger, site-wide scale.

Through modelling of the floodplain and associated streams (as already undertaken as part of the FRA), attenuation pond systems can be incorporated in the early detailed design stages, located in areas not already subject to local flooding. This will serve to reduce and control surface water quantities and quality as a priority within the first phase of construction works and such approaches will be applicable or adapted for the construction phases that follow.

Sediment basins and traps, buffer strips, swales, soakaways, bunds and interception channels will be constructed to manage surface waters across the site during the establishment of each construction phase, depending on ground conditions and area characteristics.

Protection zones where there should be no or minimal disturbance by construction will be identified. Careful planning for the timing of works, storage of materials and remedial works once works are completed will form an important part of the detailed design stages.

Post-construction, the attenuation ponds and lakes will be re-assessed and, where possible, enhanced to provide wetland habitats and improve local biodiversity within the new development area, whilst maintaining their effective role as surface water attenuation systems as part of the integrated SUDS management across the site.

The maintenance and ownership issues will follow the guidelines for 'Model Agreements for Sustainable Water Management Systems - Model agreement for rainwater and greywater use systems' (CIRIA C626).

[2] Zhang, J (2006) A laboratory scale study of infiltration from Pervious Pavements. Thesis for Master of Engineering, RMIT University, Australia.

3. Conclusions

This Flood Risk Assessment update has been produced to address the EA objections on the previously submitted FRA. The conclusions of this FRA update are summarised as follows:

Surface Waters / Flooding: The hydraulic model has demonstrated that Curborough/Pyford Brook does not pose a significant risk to the development in either a 1 in 100 year event (plus 20% for climate change) or a 1 in 1000 year event (Figure A.3 of the Hydraulic Model Build and Validation Report – Appendix B). The development area is therefore within Flood Zone 1, with little or no risk of flooding. This coincides with the Hydraulic Modelling Flood Zone maps (Appendix C) which concluded all the proposed development area would be within Flood Zone 1.

It has been established through consultations and various data gathering that there would be potentially localised flooding within the floodplain areas of Mare Brook and Business Brook. Therefore, no development is proposed within the agreed 8-10m set back of development from the watercourses. Where attenuation ponds will be built, this will not encroach Flood Zone 3, as all development will be built sufficient distances away from Mare Brook and Business Brook to avoid risks of flooding.

Assessment of infrastructure failure and flooding: British Waterways have certified that the structural integrity of the canal is reported to be in the good condition and there are no events of overtopping or breaches resulting from the canal. However, sections of the offside canal (the side without a defined towpath) may not be owned by British Waterways so they cannot comment on the state of these sections.

Groundwater Flooding: Groundwater investigations will incorporate groundwater depth testing and 'percolation tests' that will strategically assess areas of different geological background within the development. These will be conducted as part of, and to inform the detailed design phase of the development.

Surface Water Drainage Strategy – SUDS: The principles of SUDS will be used and incorporated at all appropriate locations within the site and continue to manage surface water flows across the larger site catchment which subsequently should improve the receiving watercourses or other treatment systems (see also Design and Access Statement, page 133, refer to footnote 1). For example, soakaways, permeable pavements, swales and infiltration trenches, wetlands, ponds, storm water attenuation systems, green roof systems, rainwater harvesting and even the use of household water butts. SUDS designs and applications are widely used in modern development strategies and have wider benefits including sustainable development, improved water quality and biodiversity.

Future management and maintenance will require further liaison with all stakeholders, STW, Lichfield DC, local businesses, schools and other potential private management schemes in conjunction with the Open Space management scheme, once the extent, location and designs of the SUDS are finalised for the detailed design.

Surface Water Control Strategy - Construction Phases: Attenuation ponds will be constructed for controlling surface sediments and run off during construction phases and will be part of the SUDS management train after construction is completed (see also Design and Access Statement, page 133, as referenced in footnote 1). The precise size and locations for these ponds will be given at the detailed design stage but they will be located beyond the flooding zones of the adjacent watercourses (e.g. Mare Brook). These ponds also will be a smaller in size as SUDS techniques will be introduced across the site to reduce the size of attenuation ponds required to control surface waters prior to release into receiving watercourses.

4. References

Curborough Design and Access Statement, Document 5, October 2008, Author: RPS

Zhang, J (2006) A laboratory scale study of infiltration from Pervious Pavements. Thesis for Master of Engineering, RMIT University, Australia.

Appendix A

Environment Agency Objections Letter

Appendix B

B.1 Model Schematic

B.2 Example of Extended Cross Section

B.3 Flood Map for the Curborough/Pyford Brook along Development Site

B.4 LiDAR Coverage

B.5 Calculations of Mannings *n*

Appendix C

Hydraulic Modelling Flood Zone Mapping

Appendix D

Correspondence with British Waterways