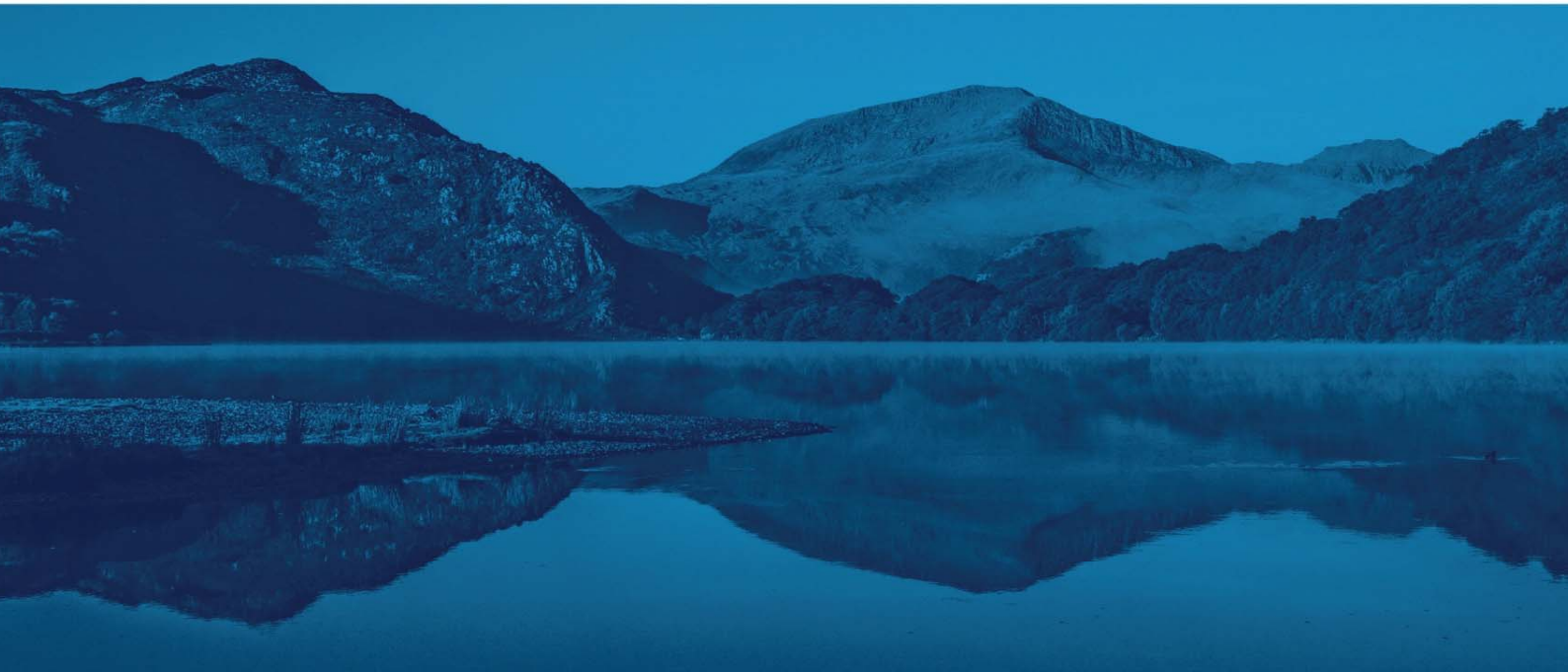




Lidl, Mercia Road, Gloucester

Flood Risk Assessment & Drainage Strategy

July 2017



Assessment / Modelling / Design

waterco.co.uk

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Contents

Introduction	1
Existing Conditions	1
Development Proposals	3
Planning Policy & Flood Zone Classification	4
Consultation	6
Sources of Flooding and Probability	8
Mitigation Measures	13
Flood Warnings and Evacuation	14
Impact on Flood Risk Elsewhere	14
Other considerations	15
Surface Water Management	15
Maintenance	20
Foul Drainage	21
Sequential Test and Exception Test	21
Recommendations	24

Appendices

Appendix A – Location Plan & Aerial Image

Appendix B – Topographical Data

Appendix C – Sewer Plan and Drainage Survey

Appendix D – Development Plan

Appendix E – Correspondence

Appendix F – EA Flood Maps & Product 4 Flood Level Data

Appendix G – SFRA Flood Maps

Appendix H – ReFH2 Runoff Rates & MicroDrainage Storage Volumes

Appendix I – Drainage Sketch

Appendix J – Maintenance Schedules

Tables

Table 1 – EA Estimated Fluvial/Tidal Flood Levels	11
Table 2 – Existing Brownfield Runoff Rates	16
Table 3 – Pollution Hazard Indices	20
Table 4 – SuDS Mitigation Indices.....	20

Introduction

Waterco Consultants have been commissioned to undertake a Flood Risk Assessment and Drainage Strategy to support the planning application in respect of a proposed development of a Lidl store at Mercia Road, Gloucester, GL1 2SQ.

The purpose of this report is to outline the potential flood risk to the site, the impact of the proposed development on flood risk elsewhere, and the proposed measures which could be incorporated to mitigate the identified risk. This report has been prepared in accordance with the guidance contained in the National Planning Policy Framework (NPPF) and the National Planning Practice Guidance (NPPG).

From April 2015, Gloucestershire County Council as a Lead Local Flood Authority (LLFA) is a statutory consultee for major planning applications in relation to surface water drainage, requiring that all planning applications are accompanied by a Sustainable Drainage Strategy. The aim of the Sustainable Drainage Strategy is to identify water management measures, including Sustainable Drainage Systems (SuDS), to provide surface water runoff reduction and treatment.

Existing Conditions

The 1.04 hectare (ha) development site is located at National Grid reference: 383174E 219334N. A location plan and an aerial image are included in Appendix A.

The site currently consists of an operational HGV/LGV hire and repair centre with associated car parking and service yards. The site is bordered by parkland to the north, residential gardens and properties to the east, industrial/commercial units to the south, Mercia Road with commercial units beyond to the south-west and St Oswalds Road with St.Oswalds Retail Park beyond to the north-west. Access to the site is provided via Mercia Road west of the site. The site is currently 100% hardstanding.

Local Topography

A Topographical Survey has been undertaken by EDI Surveys LTD (Drawing Number: 16350/T&S/01-01) in April 2017 and is included in Appendix B. The Topographical Survey shows that the site slopes from 11.33metres Above Ordnance Datum (m AOD) in the west to 10.31m AOD in the south eastern extent of the site.

The Topographic Survey identifies the finished floor levels of the existing buildings on site. The northernmost building has finished floor levels ranging between 11.09m AOD and 10.40m AOD. Finished floor levels of the southernmost building range from 11.3m AOD and 11.2m AOD.

Topographic levels to m AOD have also been derived from a 1m resolution Environment Agency (EA) composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). The LiDAR data shows the topography of the wider area which generally reflects the Topographic Survey. A LiDAR extract is included in Appendix B.

Ground Conditions

British Geological Survey online mapping (1:50,000 scale) indicates that the western extent of the site is underlain by superficial Alluvium deposits generally comprising Clay, Silt, Sand and Gravel. No superficial deposits are identified to the eastern extent of the site. The superficial deposits are identified as being underlain by the Blue Lias Formation and the Charmouth Mudstone Formation consisting Mudstone. According to the Environment Agency's online Landfill Mapping, the site is underlain by the former Gloucester Cattle Market landfill, no further details have been provided.

There are no historic boreholes within the vicinity of the site available to review on the British Geological Survey website.

According to the Environment Agency's online Groundwater Vulnerability Mapping, the Blue Lias Formation and the Charmouth Mudstone Formation bedrock is classified as a 'Secondary Undifferentiated Aquifer' which are assigned in cases where it has not been possible to attribute either category A or B to a rock type.

The Environment Agency's online 'Groundwater Source Protection Zones' map indicates that the site is not located within a Groundwater Source Protection Zone.

The Cranfield University 'Soilscapes' map indicates that the site is underlain by 'Lime-rich loamy and clayey soils with impeded drainage.'

Local Drainage

Public sewer records have been obtained from Severn Trent Water in May 2017 and are included in Appendix C. The sewer records show that two 300mm public surface water sewers converge at manhole 1201, within Mercia Road and form a 450mm public surface water sewer south of the site. The 450mm sewer flows east along the southern boundary of the site and discharges into the

culverted River Twyver at manhole 2201. The culverted River Twyver flows north adjacent to the eastern boundary of the site. Manhole 2201 indicates that the 450mm sewer has a cover level of 11.28m AOD and an upstream invert level of 9.06m AOD.

The sewer records identify a 300mm public surface water sewer which flows north within Dean's Way, east of the site, before flowing west and discharging into the culverted River Twyver north of the site.

An un-surveyed public sewer is identified within Mercia Road south-west of the site which discharges into a 225mm public foul water sewer at manhole 1202 south of the site. Manhole 1202 indicates that the sewer has a cover level of 11.18m AOD and an upstream invert level of 9.07m AOD.

A culvert survey was undertaken by Invek Surveys in May 2017 to determine the positioning of the culvert identified within the eastern extent of the site. The 'Culvert Layout' (drawing ref. A1_1197/01_Rev_00) from the Drainage Survey (Appendix C) identifies the culvert as a 1000mm x 1000mm concrete box culvert. The drawing indicates that surface water from the site is drained by a network of 150mm surface water sewers to the culverted River Twyver at an unrestricted rate. Foul flows from the site are drained by a 100mm foul sewer which appears to discharge into the un-surveyed sewer within Mercia Road.

Development Proposals

The proposed development is for the demolition of the HGV/LGV hire and repair centre and replacement with a Lidl Food Store with associated access road, car parking, delivery area and peripheral soft landscaping. A development plan is included in Appendix D.

The proposed development will result in a decrease in hardstanding area on the site through the introduction of peripheral soft landscaping. Hardstanding will occupy approximately 8,936m² or 85% of the total site area. The remaining permeable soft landscaped areas will occupy 1,564m² or 15% of the total site area.

Planning Policy & Flood Zone Classification

The Environment Agency (EA) 'Flood Map for Planning – Rivers and Sea' (Appendix F), shows that the majority of the site is located within Flood Zone 3 – an area considered to be at flood risk with a 1% (1 in 100) or greater annual probability of fluvial flooding and / or a 0.5% (1 in 200) or greater annual probability of tidal flooding. The western boundary of the site is shown to be within Flood Zone 2 – an area considered to be at flood risk with between a 1% (1 in 100) and 0.1% (1 in 1000) annual probability of fluvial flooding and / or between a 0.5% and 0.1% annual probability of tidal flooding.

In accordance with Table 2 of the NPPG: Flood Risk and Coastal Change, commercial development is classified as 'less vulnerable'. Table 3 of the NPPG: Flood Risk and Coastal Change, states that less vulnerable developments are considered appropriate in Flood Zones 2 and 3. Therefore, the application of the Exception Test is not necessary.

This report details the flood risk to the site and the mitigation measures which could be implemented to ensure that the development will be safe for its lifetime.

Local Policy

The 'Pre-submission Joint Core Strategy' for Gloucester City, Cheltenham Borough and Tewkesbury Borough Council's (June 2014) contains the following policies relating to flood risk and drainage;

Policy INF3: Flood Risk Management:

1. Development proposals must avoid areas at risk of flooding, in accordance with a risk- based sequential approach. Proposals must not increase the level of risk to the safety of occupiers of a site, the local community or the wider environment either on the site or elsewhere. For sites of strategic scale, the cumulative impact of the proposed development on flood risk in relation to existing settlements, communities or allocated sites must be assessed and effectively mitigated.
2. Minimising the risk of flooding and providing resilience to flooding, taking into account climate change, will be achieved by:
 - I. *Requiring new development to, where possible, contribute to a reduction in existing flood risk*
 - II. *Applying a sequential test for assessment of applications for development giving priority to land in Flood Zone 1, and, if no suitable land can be found in Flood Zone 1, applying the exception test*
 - III. *Requiring new development that could cause or exacerbate flooding to be subject to a flood risk assessment which conforms to national policy and incorporates the latest available*

modelling and historic data and information and guidance contained in the authorities' Strategic Flood Risk Assessments and Supplementary Planning Documents, in order to demonstrate it will be safe, without increasing flood risk elsewhere

- IV. *Requiring new development to incorporate suitable Sustainable Drainage Systems (SuDS) where appropriate in the view of the local authority to manage surface water drainage: to avoid any increase in discharge into the public sewer system; to ensure that flood risk is not increased on-site or elsewhere; and to protect the quality of the receiving watercourse and groundwater. Where possible, the authorities will promote the retrofitting of SuDS and encourage development proposals to reduce the overall flood risk through the design and layout of schemes which enhance natural forms of drainage. Developers will be required to fully fund such mitigation measures for the expected lifetime of the development including adequate provision for on-going maintenance.*
- V. *Working with key partners, including the Environment Agency and Gloucestershire County Council, to ensure that any risk of flooding from development proposals is appropriately mitigated and the natural environment is protected in all new development.*

The following Local guidance documents have been reviewed to inform this report:

- The Gloucestershire City Council Level 1 Strategic Flood Risk Assessment (SFRA) (September 2008).
- The Gloucestershire County Council Level 1 Strategic Flood Risk Assessment (SFRA) (September 2008).
- The Gloucestershire County Council Preliminary Flood Risk Assessment (PFRA) (June 2011).
- The Gloucestershire County Council Local Flood Risk Management Strategy (LFRM) (Summer 2014).
- The Central Gloucester SWMP (October 2014).
- The Gloucester, Cheltenham & Tewkesbury Joint Core Strategy Strategic Flood Risk Assessment for Local Development Framework Level 2 (October 2011).
- The EA River Twyver Strategic Flood Risk Mapping Draft Report (July 2006).

Consultation

A pre-planning opinion request was submitted to the LLFA (Gloucestershire County Council) in April 2017. A response was received in April 2017 and is included in Appendix E. The LLFA stated;

'For brownfield developments we would ideally like to see the post development discharge rate equal to the greenfield runoff rate for each return period up to and including the 1 in 100 year event plus climate change. If this is not reasonably practicable then we would expect to see a betterment of 40% over the existing discharge rate. There should also be a reduction of 40% in the runoff volume from the site during the 1 in 100 year, 6 hour rainfall event plus climate change or as close as reasonably practicable to the greenfield runoff volume for the same event. The discharge rate and volume should not exceed the pre development values. We ask for 40% for climate change to be used in calculations (not 30% as mentioned in our guidance which needs to be updated). These calculations should be included in the application with the drainage strategy.'

There should be evidence the SuDS hierarchy has been used in the design so we would require a valid reason for not infiltrating or discharging into the River Twyver, which appears to be nearby the site. If this was possible then it may require consent from the Environment Agency as the River Twyver is designated main river. The design should also take into account the principles of SuDS and consider water quality, water quantity, amenity and biodiversity.'

Regarding flood risk and historic flooding, the site lies within flood zone 3 so the Environment Agency would need to be consulted on the application. We have a record of flooding on our Flood Data Register approximately 200m south of the site and reports that 98 in the Dean's Walk/Serlo Road/St Catherine Street area flooded from the River Twyver. Unfortunately the record doesn't have a date of flooding but I would imagine it is likely to be July 2007.'

A pre-planning opinion request was submitted to the Environment Agency (EA) in May 2017. A full response is included in Appendix E. The EA highlighted that:

'The site may be subject to contamination from previous historic uses and current uses (previously a depot that may have included petrol/oil/fuel storage tanks, and current use as a HGV/LGV hire and repair centre) ...'

A meeting was held with the EA, Waterco and client in attendance on the 22nd June 2017. Following the meeting the EA provided additional flood level data for what is considered to be the most hydraulically relevant node on the River Severn (node ref. PUMPUS). The additional Product 4 Flood

Level Data is included in Appendix E. The EA also stated that tidal flooding is considered to be the primary source of flood risk to the site.

A developer enquiry was submitted to Severn Trent Water. A response was received in April 2017 and is included in Appendix E. Severn Trent Water stated that:

'Public Sewer in Site – Required Protection

Our records show a 450mm surface water sewer crossing the site. We will require a 10m protection strip, 5m on each side from the centre line.

Records indicate a culverted watercourse running along the site. Whilst Severn Trent does not own this asset, I would advise contacting the Lead Local Flood Authority and the EA to get necessary permission before any work commences.

Foul Water Drainage

The site will have an existing indirect foul connection. It might be possible to utilise the existing connection if this is in a convenient location and in good condition.

Alternatively, foul sewers on Mercia Road (MH 1202) can accommodate the foul flows from your development.

Your site plan which shows most of the development will be sales area with customer and staff WC's. The foul flows anticipated from the development will be nominal and will have little impact to the network.

I confirm that a gravity foul flows from your development (will) [sic] not have an adverse hydraulic impact on our network...

Surface Water Drainage

Under the terms of Section H of the Building Regulations 2000, the disposal of surface water by means of soakaways should be considered as the primary method.

If these are found to be unsuitable, satisfactory evidence will need to be submitted. The evidence should be either percolation test results or by the submission of a statement from the SI consultant. (extract of a supplementary letter).

If soakaways is [sic] not practical then usage of a nearby watercourse should be explored. Records show a culverted watercourse running along the site.

If the above options are proven to be unsuitable then a connection to wherever the existing development drains to would be appropriate with attenuation and restricted flows in accordance with the Lead Local Flood Authority's requirements. A detailed connectivity survey will be required and we would expect to see at least a 30% reduction in flows to our network. Please refer to the guidance notes for further information.

Subject to the above, Severn Trent Water expects all surface water from the development to be drained in a sustainable way to the nearest watercourse or land drainage channel, subject to the developer discussing all aspects of the developments surface water drainage with the Local Lead Flood Authority (LLFA). Any discharge rate to a watercourse or drainage ditch will be determined by the LLFA/EA...'

Sources of Flooding and Probability

Fluvial & Tidal

The nearest watercourse is the culverted River Twyver. The River Twyver becomes culverted approximately 114m south-east of the site before flowing northward beneath the eastern extent of the site. The River Twyver emerges from the culvert approximately 258m north of the site, before discharging into the River Severn approximately 758m west of the site. The River Severn is tidally influenced in this location. There are no formal flood defences identified within the area.

Fluvial flooding could occur if the culverted River Twyver became blocked and surcharge during or following an extreme rainfall/tidal event or tide locked during higher flow events in the River Severn. Fluvial/tidal flooding could also occur if the River Severn overtopped its banks during or following an extreme rainfall/tidal event.

The EA 'Historic Flood Map' (Appendix F) indicates that the site has been flooded in the past. However, no information regarding the dates or source of the flooding is available.

Correspondence from Gloucestershire County Council (Appendix E) states that; *'We have a record of flooding on our Flood Data Register approximately 200m south of the site and reports that 98 in the Dean's Walk/Serlo Road/St Catherine Street area flooded from the River Twyver. Unfortunately, the record doesn't have a date of flooding but I would imagine it is likely to be July 2007.'*

The Joint Core Strategy Level 2 SFRA states; *'Historically flooding from the River Twyver has been experienced on a number of occasions including 1968, 1997, 2001 and 2003... Localised flooding is known to have occurred at the Rugby Club car park which is thought to be the consequence of culvert blockage. A combined sewer overflow (CSO) which discharges into the Twyver underneath Deans Way brought extra flow to an already blocked culvert and the water therefore backed up the culvert, and out into the car park.'*

...properties and roads are at risk from flooding in the area between rugby club and the confluence of the Rivers Twyver and Severn from water spilling from the watercourse adjacent to the rugby club. This area is bounded by the railway line, the A40, Tewkesbury Road and Kingsholm Road (SO 8309 1940). The Flood Zone maps at the confluence of the River Twyver with the River Severn indicate that flooding from the River Severn can reach a considerable distance upstream during peak flows. Flood Zone maps for the River Severn extend as far upstream as the rugby club near Deans Walk. The accumulation of silt in the river channel and tide locking are both common problems experienced by the River Twyver and flood relief channel. De-silting of the river channel is conducted by Gloucester City Council every 2-3 years, but silt blockage continues to be a problem for this watercourse...

Within the lower reaches of the River Twyver, the influence of the River Severn on the watercourse can be clearly seen. During peak flows, the River Severn backs up along the River Twyver as far upstream as Walham Lane Culvert (SO 8320 1969) and the Rugby Club near Deans Walk. It is thought that the accumulation of silt within the River Twyver channel exacerbate the risk of flooding from this watercourse. The areas affected by fluvial flooding along the River Twyver are generally classified with a higher flood hazard (significant to extreme) within the lower reaches where flood levels are also influenced by the River Severn...

The Joint Core Strategy Level 2 SFRA includes modelling of the 1 in 20 year, 1 in 100 year, 1 in 100 year plus climate change and 1 in 1000 year fluvial flood events and the 1 in 200 year, 1 in 200 year climate change and 1 in 1000 year tidal event scenarios. Relevant flood mapping including (b1) Flood Extent Maps, (b2) Flood Hazard Maps and (b3) Blockage Maps are included within Appendix G. Site specific flood levels are not provided within the report.

The flood extent mapping indicates that the site is partially within Flood Zone 3b, and wholly within the Flood Zone 3a with allowance for climate change flood extent. The SFRA states that; *'For the 1 in 20 year event, ... There is ...a small section of open channel to the south of the Rugby Ground (SO 8328 1919) where the modelling results indicate that the culvert has insufficient capacity to convey the 1 in*

20 year flow and subsequently surcharges. This flood water flows overland through the city, following a flow route along Deans Walk affecting a number of properties adjacent to St Oswalds Road, Mount Street, Clare Street, Priory Road, Deans Walk, Deans Way and Serlo Way. In general, the flood hazard classification is moderate to significant, 'danger for most', for the 1 in 20 year event. During the 1 in 100 year, 1 in 100 year climate change and 1 in 1000 year events, the extent of flooding increases, affecting a larger area adjacent to St Catherine's Meadow and the area to the west of St Oswald's Road. The flood hazard classification also increases to predominantly significant, 'danger for most, 'during the 1 in 1000 year event.'

The identified flood extent shows a convoluted flood flow path from the inlet of the culvert south of the Rugby Club along Dean's Way, west onto the parkland north of the site and toward the site. Given there are no specific records of the site flooding as a result of culvert surcharging, the site should not be considered to be within the functional floodplain.

The modelling undertaken has indicated that large parts of the Gloucester City Urban area are at risk from fluvial, tidal, canal and surface water flooding. In general, the flood risk areas associated with the River Severn are restricted to the low lying rural areas adjacent to the watercourse. Within these areas the flood hazard is significant to extreme, 'danger for all', for the range of modelled events.

Within the lower reaches of the River Twyver, the influence of the River Severn on the watercourse can be clearly seen. During peak flows, the River Severn backs up along the River Twyver as far upstream as Walham Lane Culvert (SO 8320 1969) and the Rugby Club near Deans Walk. It is thought that the accumulation of silt within the River Twyver channel exacerbate the risk of flooding from this watercourse. The areas affected by fluvial flooding along the River Twyver are generally classified with a higher flood hazard (significant to extreme) within the lower reaches where flood levels are also influenced by the River Severn.

Given the above and following discussion with the EA, it can be concluded that the River Twyver is heavily influenced by the River Severn during extreme tidal/fluvial events. Therefore, the River Severn and surcharging of the upstream inlet of the River Twyver are considered the main risk of flooding to the site with a residual risk of culvert blockage upstream of the site at the Rugby Club.

EA Estimated Flood Levels

Estimated flood levels for the River Severn were obtained from the EA in June 2017 and are included in Appendix F. The flood levels are taken from the EA Tidal Severn model released in 2007. The node identified as most hydraulically relevant to the site by the EA is 'PUMPUS', located approximately

730m west of the site. The node location is shown on the EA 'Mercia Rd Gloucester Model Node Locations' map in Appendix F. A summary of the flood levels for the most hydraulically relevant node point are provided in Table 1 below.

Table 1 – EA Estimated Fluvial/Tidal Flood Levels

Node reference	Maximum Water Level (m AOD)					
	20% Fluvial 1% Tidal	20% Fluvial 0.5% Tidal	20% Fluvial 0.5% Tidal +CC*	1% Fluvial 50% Tidal	1% Fluvial 50% Tidal +CC*	0.1% Fluvial 50% Tidal
PUMPUS	10.48	10.50	11.10	11.00	11.60	11.84

*In accordance with the Climate Change allowances for planning (SHWG Area) document (Appendix F), an additional 600mm flood depth has been applied to account for Climate Change. The 600mm figure is provided for the 35%-45% climate change allowance within the 'Table of Nominal Allowances'. The 35%-45% band climate change allowance has been utilised in accordance with the 'higher central' allowance for less vulnerable development in Flood Zone 3a in the Severn basin district.

A conservative estimation of the onsite flood depths has been undertaken, through a comparison of the in-channel flood levels and the recorded site levels. A comparison of the in-channel levels in Table 1, with the minimum level on site (10.31m AOD) indicates that the site is estimated to flood by depths of up to approximately 1.29m during the 1% Fluvial / 50% Tidal AEP + 600mm CC event. The western extent of the site is situated at a maximum of 11.33m AOD and would experience flood depths of approximately 270mm during the same event.

It can be concluded that the site is at high risk of flooding from the River Severn and the culverted River Twyver. There is also a residual risk from the blockage of the River Twyver culvert inlet south of the Rugby Club.

Surface Water

Surface water flooding occurs when rainwater does not drain away through the normal drainage system or soak into the ground. It is usually associated with high intensity rainfall events, but can also

occur with lower intensity rainfall or melting snow where the ground is saturated, frozen or developed, resulting in overland flow and ponding in depressions in topography. Surface water flooding can occur anywhere without warning. However, flow paths can be determined by consideration of contours and relative levels.

The EA 'Flood Map for Surface Water' (Appendix F) indicates that the western boundary of the site is identified at very low risk of surface water flooding, meaning it has a less than 0.1% annual probability of flooding. The majority of the site is identified at low risk of surface water flooding, meaning it has between a 1% and 0.1% annual probability of flooding. A small proportion of the site towards the eastern extent is identified at medium risk of surface water flooding, meaning it has between a 3.3% and 1% annual probability of flooding.

The SFRA and PFRA contain no historic flooding events from surface water at or near the site.

There are no distinct flow routes in the area which would direct any potential surface water flooding towards the site.

It can therefore be concluded that the site is at low risk of surface water flooding.

Sewer Flooding

Flooding from sewers can occur when a sewer is overwhelmed by heavy rainfall, becomes blocked, is damaged, or is of inadequate capacity. Flooding is mostly applicable to combined and surface water sewers.

Any potential flooding arising from the sewers south-west of the site within Mercia Road would be contained within the road by kerbs heights. There is potential for sewer flooding within Mercia Road south-west of the site to enter the site should flood depths within the road exceed the kerb heights.

The SFRA indicates that the site's postcode area (GL1 2) is located within a 'high' risk area of flooding from sewers. The table indicates that 40 properties have previously been affected by flooding from sewers.

It can therefore be concluded that the risk of sewer flooding is moderate.

Groundwater Flooding

Groundwater flooding occurs when water levels underneath the ground rise above normal levels. Prolonged heavy rainfall soaks into the ground and can cause the ground to become saturated. This results in rising groundwater levels which leads to flooding above ground.

The SFRA states that *'there are no records of groundwater flooding in Gloucester'*.

Hardstanding will continue to cover the majority of the development area and no basement levels are proposed. It can therefore be concluded that the risk of groundwater flooding is low.

Artificial Sources of Flooding

There are no canals within the vicinity of the site. The EA 'Flood Risk from Reservoirs' map (Appendix F) shows that the site is not at risk of flooding from reservoirs.

The nearest Canal to the site is the Gloucester and Sharpness Canal located approximately 980m south of the site. The SFRA states that *'One canal, the Gloucester and Sharpness Canal, is located in Gloucester. There are no recorded incidents of breaches or overtopping, or any other local flood risk instances associated with this canal...There are no records of breaching/overtopping of reservoirs within Gloucester'*.

It can therefore be concluded that the risk of flooding from artificial sources is very low.

Summary of Potential Flooding

It can be concluded that tidal / fluvial flooding from the River Severn and its combined effect on the culverted River Twyver is the main potential source of flood risk to the site. The site is also at moderate risk of sewer flooding. The associated risk has been used to inform mitigation design as discussed further in this report.

Mitigation Measures

The site is identified at risk of tidal / fluvial flooding from the River Severn. Finished floor levels should be set above the 1% Fluvial / 50% Tidal AEP + CC event where feasible (11.60m AOD) Where this is not feasible, finished floor levels should be set as high as practical.

In order to minimise the impact of flooding during extreme flood events / an undefended tidal event, the following flood resilience and resistance measures should be applied where practical:

- Use robust construction materials (engineering bricks)
- Raise electronic control units and sockets
- Use solid flooring (tiled, resin, concrete) at ground floor level
- Install smart air bricks or air brick covers
- Use non-hygroscopic renders, where applicable
- Use plastic and stainless-steel fixtures and fittings and avoid wooden alternatives.

Flood Warnings and Evacuation

The Flood Alert service covers this area. The Flood Alert service is a free service that provides prior warning of a fluvial / tidal flood event.

The site owner should prepare a flood plan to inform site users of the flood risk and to provide advice on what to do in the event of a flood. The flood plan should include details of a safe access / egress route to be used during a flood event. Safe access / egress is available on St Oswalds Road via Mercia Road. St Oswalds Road, west of the site is situated at 11.7m AOD and is therefore located above the flood level during the 1% Fluvial / 50% Tidal AEP + CC event.

Given the nature of the proposed development, normal opening hours should apply with minimal staffing levels during out of hours. Therefore, any evacuation process could be undertaken given adequate warning to ensure the site is not occupied during a flood event. However, should insufficient warning time be received. Site users should not evacuate the building into flood water unless instructed to do so otherwise by the emergency services.

Impact on Flood Risk Elsewhere

The combined footprints of the existing buildings are approximately 2,458m². The proposed Lidl food store has a reduced footprint of approximately 2,125m². The proposed development will therefore not result in a loss of floodplain storage and will not increase fluvial/ tidal flood risk elsewhere.

Other considerations

The culverted River Twyver flows beneath the eastern extent of the site. The proposed development plan (Appendix D) indicates that it is intended to locate the building over the existing culvert. The proposed layout is dictated by the requirement to have the car parking area in full view of the adjacent roads to minimise potential antisocial behaviour. As a result, there are two potential development options for the site;

- 1) Build over the culvert. The building could be constructed over the culvert with appropriate foundation design and improved access provided for on-going maintenance of the culvert at the upstream and downstream ends.
- 2) Divert the culvert. The existing culvert could be diverted around the proposed building.

The EA have indicated that they would object to any proposed development which includes construction of the building above the culvert. Further consultation with the local planning authority should be undertaken to determine whether the potential benefits of construction over the culvert outweigh the potential issues, and whether the potential issues can be appropriately mitigated. Should it be proposed to divert the culvert it is likely that hydraulic modelling will need to be undertaken to ensure that the proposed diversion does not impact flooding offsite. A plan indicating the potential line of the culvert diversion is included as Appendix I, this is indicative and subject to detailed design.

Surface Water Management

The proposed development is for the demolition of the HGV/LGV hire and repair centre and replacement with a new Lidl Food Store with associated access road, car parking, delivery area and peripheral soft landscaping.

The proposed development will decrease the total hardstanding on site to approximately 8,936m² (85% of the total site area) compared to the existing site which is 100% hardstanding.

As stated in Council Correspondence (Appendix E), in the first instance, developers should aim to achieve a greenfield discharge rate. Existing greenfield runoff rates have been estimated using the Revitalised Flood Hydrograph Model (ReFH2) method (see Appendix H). The 1 in 2 year storm event (equivalent to QMED) greenfield rate for the 1.05ha development site is 1.5 l/s.

A minimum flow rate of 5 l/s should be utilised to ensure the drainage system is self-cleansing.

Attenuation Storage – Greenfield Discharge Rate

In order to achieve a discharge rate of 5 l/s, attenuation storage will be required. A storage estimate is included in Appendix H. An estimated storage volume of 244m³ will be required to accommodate the 1 in 30 year event. An estimated storage volume of 565m³ will be required to accommodate the 1 in 100 year plus 40% Climate Change (CC) event. The storage estimates are based on storage within a tank or pond structure, an impermeable drainage area of 0.8936ha, a design head of 1m and hydro-brake flow control.

Where it is not feasible to achieve a greenfield discharge rate, Gloucestershire County Council 'request a betterment of 40%' over the existing runoff rate.

The existing brownfield runoff rates have been estimated using the Revitalised Flood Hydrograph Model (ReFH2) method. The impermeable catchment area for the existing site is 1.05ha. The existing runoff rates are shown in Table 2 below:

Table 2 – Existing Brownfield Runoff Rates

Return Period (yr)	Runoff Rate (l/s)
1 in 2	14.2
1 in 30	32.4
1 in 100	44.0

In accordance with Gloucester County Council requirements, discharge rates will be limited to the existing runoff rate for a 1 in 2 year rate plus 40% betterment. This rate equates to 8.5 l/s.

Attenuation Storage – Brownfield Discharge Rate

In order to achieve a discharge rate of 8.5 l/s, attenuation storage will be required. An attenuation storage estimate has been provided using MicroDrainage and is included in Appendix H. An estimated storage volume of 203m³ will be required to accommodate the 1 in 30-year event and a storage volume of 485m³ will be required to accommodate the 1 in 100 year plus 40% CC event. The attenuation volumes are based on a flow rate of 8.5 l/s, storage within a tank or pond structure, hydro-brake flow control and an impermeable drainage area of 0.8936 ha.

The attenuation volumes are based on the Proposed Site Plan (Mistral, Ref. 1237-004, July 2017) and should be verified during the detailed drainage design.

Discharge Method

Paragraph 080 of the NPPG: Flood Risk and Coastal Change sets out the following hierarchy of drainage options: into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain or another drainage system; to a combined sewer.

Infiltration

The first consideration for the disposal of surface water is infiltration (soakaways and permeable surfaces). As described above the site is underlain by superficial Alluvium deposits generally comprising Clay, Silt, Sand and Gravel. Given the impermeable nature of the superficial deposits, the industrial nature of the existing site and the identified historic landfill, infiltration is not considered a feasible method of surface water disposal for the site.

It can be concluded that soakaways are not suitable for the discharge of surface water runoff.

Watercourse

The nearest watercourse is the culverted River Twyver which flows beneath the eastern extent of the site. Discharge to the River Twyver, at a limited discharge rate of 5 l/s, appears to be feasible. The 'Culvert Layout' drawing included within Appendix C identifies the culvert invert level within the site as 8.52m AOD. Therefore, a gravity connection to the existing culvert or a diverted section of the culvert appears feasible.

Sewer

As described above, a connection to the culverted River Twyver is feasible and therefore a connection to the public surface water sewer is not required.

Sustainable Drainage Systems

Attenuation storage should be provided in the form of Sustainable Drainage Systems (SuDS) where practical. The following SuDS options have been considered:

Soakaways

As described above, the use of soakaways is not considered to be feasible.

Swales, detention basins and ponds

The proposed building, car park and access roads take up the majority of the site area. As such there is insufficient space to incorporate a swale, detention basin or pond on site. Furthermore, an open water attenuation features such as a pond or a swale in an urban area presents a significant safety risk.

Rainwater Harvesting

The attenuation benefits provided through the use of rainwater harvesting are considered to be limited, and would only be realised when the tanks were not full. However, rainwater harvesting techniques could be incorporated within the final design.

Green Roofs

Green roofs are not identified on development plans. Given the nature of the proposed development, the significant additional cost involved in installing and maintaining green roofs and the additional works required to allow for the additional loading on the building, green roofs are not considered a practical option. The benefits achieved through installing a green roof would be disproportionate to the significant ongoing maintenance and construction costs involved.

Porous / Permeable Paving

The internal central access road leading to the eastern extent of the building will be trafficked with frequent HGV movements. The surfacing material required to support such HGV activity is not considered suitable for accommodating the use of permeable / porous surfacing.

Restricting porous paving to the car parking bays provides a potential porous paved area of approximately 2,385m². Based on a sub-grade depth of 0.3m with a void ratio of 30%, there is potential to accommodate up to 214.65m³ of attenuation within the permeable paving sub-grade. Further investigation into the use of porous paving will be undertaken at the detailed design stage.

Underground Attenuation Tanks

Storage could be provided within an underground attenuation tank or oversized pipes. Sufficient space for an underground tank or oversized pipes is provided within the car parking area.

Concept Surface Water Drainage Scheme

Surface water runoff will continue to be discharged to the culverted River Twyver currently located within the eastern extent of the site at a rate of 5 l/s. Surface water runoff up to the 1 in 100 year plus 40% climate change allowance event will be attenuated on site. A total attenuation volume of 565m³ will be required to achieve the discharge rate. There is potential to provide the full balance of the required surface water attenuation within an underground attenuation tank (modular storage) measuring 60m x 10m x 1m deep within the car parking area in the northern extent of the site. A tank of this size including a 95% void ratio provides a total attenuation volume of 570m³. A plan indicating the potential location of the underground 1m deep tank is included in Appendix I. The plan illustrates a sketch proposal only and as such is subject to detailed site investigation.

Permeable paving could be incorporated within the access road and car parking areas within the development.

The proposed surface water drainage scheme will ensure no increase in runoff over the lifetime of the development and will create betterment over the existing situation.

Exceedance Event

Storage will be provided for the 1 in 100 year plus 40% CC event. Storm events in excess of the 1 in 100 year plus 40% CC event should be permitted to produce temporary shallow depth flooding within the car park / access road. Finished floor levels should be set above the 1% Fluvial / 50% Tidal AEP + CC event where practical, ensuring exceedance flooding will not affect the buildings.

Surface Water Treatment

In accordance with the CIRIA C753 publication 'The SuDS Manual (2015)', 'other roofs' (applicable to commercial premises) have a 'low' pollution hazard level. Commercial yards, delivery areas, all roads except low traffic roads and non-residential parking have a 'medium' pollution hazard level. Table 3 overleaf shows the pollution hazard indices for each land use.

Table 3 – Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other roofs	Low	0.3*	0.2	0.05
Commercial yard and delivery areas, non-residential car parking with frequent change (e.g. retail), all roads except low traffic roads...	Medium	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

* Indices values range from 0-1.

Where practical, runoff from roofs and roads will be directed to permeable paving or an underground tank located within the car parking area. Table 4 below demonstrates that permeable paving provides sufficient treatment.

Table 4 – SuDS Mitigation Indices

Type of SuDS	Mitigation Indices		
	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavement	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

It can be concluded that the inclusion of permeable paving will provide sufficient treatment. Where attenuation is provided in a below ground system (tank storage), treatment will need to be provided by a suitably sized separator.

Maintenance

Maintenance of communal drainage features accommodating storm events up to and including the 1 in 100 year plus 40% CC event such as permeable paving or attenuation tanks will be the responsibility of the site owner. Maintenance of shared surface water drainage systems can be arranged through

appointment of a site management company. Maintenance schedules for an attenuation tank and permeable paving are included in Appendix J.

Foul Drainage

Foul flows should be discharged to the un-surveyed sewer which discharges into the 300mm foul water sewer in Mercia Road as per the existing situation. The 300mm foul water sewer has a upstream invert level of 9.07m AOD, therefore a gravity connection appears feasible.

Correspondence from Severn Trent Water (Appendix E) states that; *'The site will have an existing indirect foul connection. It might be possible to utilise the existing connection if this is in a convenient location and in good condition.'*

Sequential Test and Exception Test

Sequential test

The NPPF requires the Local Authority to apply the Sequential Test in consideration of new development. The aim of the Test is to steer new development to areas at the lowest probability of flooding.

The site is situated within Flood Zone 3 associated with both that tidal/fluviial flooding from the River Severn and its combined effect on the culverted River Twyver, The SFRA states that the upstream inlet of the Twyver culvert can only convey flows from the 1 in 20 year event and the resulting surcharged floodwater is predicted to follow a convoluted flow route along Dean's Way, west onto the parkland north of the site and toward the site. Given that there are no specific records of flooding impacting the site, and the convoluted nature of the identified flow path the site should not be considered functional floodplain.

It is proposed to set finished floor levels above the 1% Fluvial / 50% Tidal AEP + CC event where feasible. Where this is not feasible, finished floor levels will be set as high as practical. Flood resilience measures will be incorporated into the final design and a flood management plan will be produced to ensure the safe operation of the site.

Given the extent of flood risk to Central Gloucester and the potential to redevelop an existing brownfield site within a wider commercial area, there are unlikely to be sequentially preferable sites available and suitable that could accommodate the application proposal. On the basis of the subject site's brownfield credentials and, importantly, its potential to deliver a 'sustainable economic development' as favoured in the NPPF, we conclude that Lidl's regeneration proposal satisfies a sensible interpretation of the sequential test.

This Flood Risk Assessment demonstrates that the development will be safe, without increasing flood risk elsewhere through a reduction in the overall building footprint, and will reduce flood risk overall given the reduction in surface water runoff following redevelopment.

The site is not considered to be functional floodplain and less vulnerable development is considered appropriate within Flood Zone 3. As such Exception Test does not need to be applied for the site.

Conclusions

The proposed development is for the demolition of the HGV/LGV hire and repair centre and replacement with a Lidl Food Store with associated access road, car parking and delivery area.

The Environment Agency (EA) 'Flood Map for Planning – Rivers and Sea' shows that the site is located within Flood Zone 3 – an area considered to be at flood risk with a 1% (1 in 100) or greater annual probability of fluvial flooding and / or a 0.5% (1 in 200) or greater annual probability of tidal flooding.

The site is identified at flood risk during the 1% Fluvial / 50% Tidal AEP + climate change event. The estimated in channel flood level during this event is 11.6m AOD. Finished Floor Levels should be raised above the above the 1% Fluvial / 50% Tidal AEP + CC event where feasible. Where this is not feasible, Finished Floor Levels should be set as high as practical and flood resilience measures will be included within the site construction. This will provide betterment in terms of flood risk over the existing scenario.

The proposed Lidl food store layout is shown to be above the culverted River Twyver. Further consultation with the local planning authority is required to determine whether this is an acceptable option for the site. If construction of the building over the existing culvert is not considered acceptable, diversion of the culvert is considered to be feasible subject to detailed hydraulic modelling to establish impact on flood risk elsewhere.

In accordance with Gloucester County Council requirements, the greenfield surface water runoff rate should be utilised where feasible. Given the low greenfield discharge rate calculated for the site, a minimum discharge rate of 5 l/s has been used to ensure a self-cleansing drainage network. A limited discharge rate will be achieved through flow control and attenuation storage. Attenuation storage will be provided on site to accommodate storm events up to and including the 1 in 100 year plus 40% climate change event.

All methods of surface water discharge have been assessed. Surface water discharge to the culverted River Twyver as per the existing situation appears to be a feasible option.

Attenuation will be required on site in order to restrict surface water discharge to 5 l/s. Attenuation could be provided within the sub-grade of porous paving or within a below ground attenuation tank.

The site owner will be responsible for the maintenance of the surface water drainage system.

Recommendations

1. Submit this Flood Risk Assessment and Drainage Strategy to the Planning Authority in support of the Planning Application;
2. Verify the attenuation volumes included in this report when undertaking detailed drainage design.
3. Confirm with Local Planning Authority potential to build over the existing culvert.