

**Greater Norwich
Level 2
Strategic Flood
Risk Assessment
Detailed Site
Summary Tables**



Site details

Site Code	GNLP0409AR (previously GNLP0409R)
Address/Grid Ref.	Land at Whitefriars/ 623536,309344
Area	1.61ha
Current land use	Car park and disused industrial site
Proposed land use	Residential led mixed use

Sources of flood risk

Location of site within catchment	The site is in the catchment of the River Wensum. The River Wensum rises in northwest Norfolk and flows through central Norwich to its confluence with the River Yare.
Existing drainage features	The site is located on the edge of the River Wensum. The River Wensum is an Environment Agency designated main river and flows in an easterly direction under Duke Street Bridge. The river has been artificially modified through Norwich and the banks of the river have been enforced with steel and concrete. There are no additional watercourses within the site boundary or near the site.

Fluvial	<p>Proportion of site at risk: FZ3b – 0% FZ3a – 0% FZ2 – 44% FZ1 – 56%</p> <p><i>The % Flood Zones quoted show the % of the site at flood risk from that particular Flood Zone/event, including the percentage of the site at flood risk at a higher risk zone, e.g. FZ2 includes the FZ3 %. FZ1 is the remaining area outside FZ2 (FZ2 + FZ1 = 100%).</i></p> <p>Available data: Modelling has been completed for the River Wensum using TUFLOW. Both defended and undefended scenarios have been modelled and the defended scenarios have been used to assess the risk of flooding to the site. Further modelling was undertaken to apply recent climate change uplifts to the fluvial model of the Wensum.</p> <p>Flood characteristics: Fluvial flooding associated with the River Wensum modelling shows that the eastern part of the site is affected in an extreme event. The low-lying topography of this part of the site means that flood water flows onto the site.</p> <p>The site is not at risk of flooding during the 5% AEP and 1% AEP flood events. In the 0.1% AEP flood event, flood depths on the site are significant and are up to 1.1m in depth. The south eastern corner of the site experiences the deepest flooding with levels of between 0.2m and 1.1m present in this area. Flood depths across the rest of the eastern half of the site are shallower but wider spread and range between 0.1m and 0.6m. The modelled flood hazard shows that the south east of the site has a flood hazard rating of 'Dangerous for most people'. The rest of the site has a hazard rating of 'dangerous for some' with small areas in the north and around the site rated as 'Caution'.</p>
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Coastal and Tidal	The site is not at risk from coastal or tidal flooding.
Surface Water	<p>Proportion of site at risk (RoFfSW): 3.3% AEP – 2% Max depth 0.3-0.6m, Max velocity >0.25m/s 1% AEP – 7% Max depth 0.3-0.6m Max velocity <0.25m/s 0.1% AEP – 32% Max depth 0.9-1.2m Max velocity <0.25m/s</p> <p><i>The % SW extents quoted show the % of the site at surface water risk from that particular event, including the percentage of the site at flood risk at a higher risk zone (e.g. 1% AEP includes the 3.3% AEP %)</i></p> <p>Description of surface water flow paths: The site is impacted by surface water flooding in all modelled events.</p> <p>In the 3.3% AEP event, flood water from surface water ponding along Barrack Street (along the northern boundary of the site) flows onto the site from a flow path on Silver Road. The extent of flooding is minimal on the site itself, and depths range from 0.15m to 0.6m. The flow path from Silver Road along Barrack Street has a flood hazard rating between 'caution' and 'dangerous for some'.</p> <p>In the 1% AEP event, the flow path from Silver Road increases in extent, resulting in larger areas of ponding on Barrack Street. Flood water from these areas of ponding flow onto the site at two locations, the first opposite Silver Road and the second further east along Barrack Street.</p> <p>The flow path from Silver Road is minimal in extent and depths range from 0.15m to 0.6m. The area of ponding further east along Barrack Street is intersected by a flow path flowing south from Brewers Cut, which increases the extent in the north east corner of the site with flood depths of 0m to 0.3m and a flood hazard rating of 'Caution'.</p> <p>In the 0.1% AEP event, surface water flooding is more extensive and affects approximately a third of the site, to the north and east of the site. Flood depths across the site range from 0m-0.9m with the deepest flooding located in the south-eastern corner of the site. Across most of the site, flood depths are between 0m and 0.3m. The flood hazard rating for the south-eastern part of the site is between 'dangerous for some' and 'dangerous for most'. Most of the site has a flood hazard rating of 'caution' with higher flood hazard ratings along the northern boundary of the site where surface water flows onto the site.</p>
Reservoir	The southern part of the site is shown to be at risk of reservoir flooding from the available online maps . This is the edge of the site bordering the Wensum, encroaching around 5m into the site.
Groundwater	<p>The Environment Agency Areas Susceptible to Groundwater Flooding dataset, provided as 1km grid squares, shows the susceptibility of an area to groundwater flood emergence. The following comments can be made about groundwater flood risk:</p> <ul style="list-style-type: none"> The entirety of the site has a >25%- <50% susceptibility to groundwater flood emergence from superficial deposits. <p>This assessment does not negate the requirement that an appropriate assessment of the groundwater regime should be carried out at the site-specific FRA stage.</p>
Flood history	<p>The Environment Agency's historic flooding and recorded flood outlines dataset has a record of flooding on the site. The source of flooding was attributed to the River Wensum and flooding occurred in 1912.</p> <p>Flood history information provided in the Level 1 SFRA does not identify any historic flooding on or near the site.</p>
Flood risk management infrastructure	
Defences	This site is not protected by any formal flood defences.
Residual risk	There is no residual risk to the site from flood risk management structures.
Emergency planning	

<p>Flood warning</p>	<p>The site is located within the Environment Agency's 'River Wensum, through Norwich' flood warning area.</p> <p>The site is also located in 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' flood alert area.</p>
<p>Access and egress</p>	<p>The site is only accessible from north of the site, from Barrack Street.</p> <p>In terms of fluvial flood risk, the site is partially located in the modelled 0.1% AEP flood extent and modelling shows that it could experience flood depths of up to 1.1m during a flood event.</p> <p>Due to significant flood extent and depths on the site and access road, access and egress from the site may not be possible during a flood event for the part of the site at risk of fluvial flooding. The site entrance point of Barrack Street is affected during a fluvial flood event. A Flood Warning and Evacuation Plan should be prepared for the site, with a policy of shelter in situ on a level above the maximum water level of 2m in a 1 in 0.1% AEP event considering the highest risk climate change scenario.</p> <p>The Risk of Flooding from Surface Water dataset shows that part of the site and Barrack Street are affected by flooding during the 1% AEP and 0.1% AEP flood events. Surface water flooding could therefore affect access and egress to the site. Although flooding remains largely below 0.3m in depth at the access point during this event, access and egress are likely to be impacted.</p> <p>The depths, velocities, hazards, durations and speeds of onset of surface water and fluvial flooding along access/ egress routes should be investigated further in a site-specific assessment, to confirm whether access for emergency vehicles could still be obtained.</p>
<p>Dry islands</p>	<p>The site is not located on a dry island.</p>
<p>Climate change</p>	
<p>Implications for the site</p>	<ul style="list-style-type: none"> • The site is highly sensitive to climate change causing increased in fluvial flows in the River Wensum, with a significant increase in the extent of Flood Zone 3a with Upper-End climate change allowances • A small area of the site is in future Functional Flood Zone 3b. The 5% AEP plus the Upper End (65%) climate change results in flooding in a small area of the site along the eastern boundary. Flood depths from this scenario are very shallow, up to 0.4m. This area has a flood hazard rating of 'caution' with a higher hazard rating of 'dangerous for some' in the southern part of the site. This scenario presents a significant increase in risk to the site as during the present day 5% AEP flood event, the site is not at risk of flooding. • Over half of the site is in future Flood Zone 3a. The 1% AEP plus the Upper End (65%) climate change results in flooding across the east of the site. Flood depths are deepest along the south eastern and northern boundaries of the site with depths of 0.6m to 1.2m present in these areas. Flood depths across the rest of the site range between 0.1-0.6m. Most of the site has a flood hazard rating of 'dangerous for most' with the central part of the site having a flood hazard rating of 'dangerous for some' and 'caution'. Even for the less severe scenarios, the 100 year plus the Central (25%) climate change scenario results in flooding across the eastern part of the site however flood depths are shallow, between 0.1m and 0.4m. During this scenario, the site has a flood hazard rating of 'caution' for most of the site with the southern part of the site having a flood hazard rating of 'dangerous for some' and 'dangerous for most'. This scenario presents a significant increase in risk to the site as during the present day 1% AEP flood event, the site is not at risk of flooding. • The entire site is in future Flood Zone 2. The extent of flooding from all the 0.1% AEP climate change scenarios results in flooding across the site. The Upper End (65%) climate change scenario results in flooding across the site with depths of up to 1.6m present on the site. The highest depth areas are in the eastern part of the site with significantly lower depths seen in the western part of the site. During this scenario, the entire site has a flood hazard rating of 'Dangerous for most'. • The modelled 1% AEP with 40% Climate Change Surface water flooding does not show a significant increase in surface water flooding on the site. • <p>Proportions of the site in Future Flood Zones can be found in Table 6-2 of the Greater Norwich Level 2 SFRA Report</p>
<p>Requirements for drainage control and impact mitigation</p>	
<p>Broad scale assessment of possible SuDS</p>	<p>Geology & Soils</p> <ul style="list-style-type: none"> • Geology at the site consists of:

	<ul style="list-style-type: none"> ○ Bedrock – Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation, Portsdown Chalk Formation (undifferentiated) – Chalk. ○ Superficial – Alluvium (Clay, Silt, Sand and Gravel). <p>SuDS</p> <ul style="list-style-type: none"> • Most source control techniques are likely to be suitable. Mapping suggests that permeable paving may have to use non-infiltrating systems given the possible risk both to and from groundwater. • Infiltration may be suitable. Mapping suggests a medium risk of groundwater flooding and underlying soils may be permeable. Further site investigation should be carried out to assess potential for drainage by infiltration. If infiltration is suitable it should be avoided in areas where the depth to the water table is <1m. As the site is located within a Source Protection Zone, infiltration techniques should only be used where there are suitable levels of treatment although it is possible that infiltration may not be permitted. Additionally, proposed SuDS should be discussed with relevant stakeholders (LPA, LLFA and EA) at an early stage to understand possible constraints. • Developers should investigate and consider in full all SuDS options and demonstrate that SuDS are not appropriate where they are not implemented. • Detention may be feasible provided site slopes are <5% at the location of the detention feature. If the site has contamination or groundwater issues, a liner will be required. • Filtration techniques are probably suitable provided site slopes are <5% and the depth to the water table is >1m. If the site has contamination or groundwater issues, a liner will be required. • All forms of conveyance are likely to be suitable. Where the slopes are >5% features should follow contours or utilise check dams to slow flows. If the site has contamination issues, a liner will be required. • The site is not designated by the Environment Agency as previously being a landfill site.
<p>Opportunities for wider sustainability benefits and integrated flood risk management</p>	<ul style="list-style-type: none"> • Due to the size of the site, there is likely to be limited space for green infrastructure. It is recommended that areas of hard paving are designed to ensure that flood water can be stored during a flood event alongside the use of green features such as rain gardens and tree pits. • A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level considering climate change upper end scenario with an allowance for freeboard. • A shelter in situ for an extreme fluvial event must be designed into the building and supported by a flood warning and evacuation plan. Suitable shelter for all occupants of any buildings must be above the 0.1% AEP flood level considering climate change (upper end scenario).
<p>NPPF and planning implications</p>	
<p>Exception Test requirements</p>	<p>The Local Authority will need to confirm that the sequential test has been carried out. The Sequential Test will need to be passed before the Exception Test is applied. The NPPF classifies residential development as 'More Vulnerable' and commercial is classed as 'Less Vulnerable'. As the site is mostly covered by Flood Zone 2, the Exception Test is not required for the site.</p> <p>The site however is in Future Flood Zone 3 and it is recommended that a precautionary approach is taken, and the Exception Test is applied.</p>
<p>Requirements and guidance for site-specific Flood Risk Assessment</p>	<p>Flood Risk Assessment:</p> <ul style="list-style-type: none"> • At the planning application stage, a site-specific Flood Risk Assessment will be required as the development is in Flood Zone 2. • All sources of flooding, particularly the risk of fluvial and surface water should be considered as part of a site-specific flood risk assessment. • The site-specific FRA should be carried out in line with the National Planning Policy Framework; Flood Risk and Coastal Change Planning Practice Guidance, Norwich City Council's Local Plan policies, and the Norfolk County Council Lead Local Flood Authority's Statutory Consultee for Planning Guidance Document. • Consultation with the Local Authority, Lead Local Flood Authority and the Environment Agency should be undertaken at an early stage. • The development should be designed to ensure that mitigation measures are in place to ensure the development does not flood, or that ground level space is used for less vulnerable parts of the development. <p>Guidance for site design and making development safe:</p> <ul style="list-style-type: none"> • Flood resilient design is essential for this highly constrained urban site:

- A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level considering climate change (upper end scenario) with an allowance for freeboard- approximately 1.6m above ground level.
- A shelter in situ for an extreme fluvial event must be designed into the building and supported by a flood warning and evacuation plan. Suitable shelter for all occupants of any buildings must be above the 0.1% AEP flood level taking into account climate change (upper end scenario)- approximately 1.9m above ground level.
- The developer will need to show, through an FRA, that future users of the development will not be placed in danger from flood hazards throughout its lifetime. It is for the applicant to show that the development meets the objectives of the NPPF's policy on flood risk. For example, how the operation of any mitigation measures can be safeguarded and maintained effectively through the lifetime of the development. (Para 048 Flood Risk and Coastal Change PPG).
- Safe access and egress will need to be demonstrated in the 1 in 0.1% AEP plus climate change fluvial and rainfall events, using the depth, velocity and hazard outputs. Ideally, the access route should be situated 300mm above the designed flood level and waterproofing techniques should be used where necessary. Raising of access routes must not impact on surface water flow routes or contribute to loss of floodplain storage. Consideration should be given to the siting of access points with respect to areas of surface water flood risk. Due to the significant fluvial risk posed to the site, a Flood Warning and Evacuation Plan must be prepared based on a policy of shelter in situ.
- Compensatory flood storage is required for any land raising and all proposed buildings (unless they are left open and allowed to accept flows) whenever there is built development on land within the 1% +35% climate change flood extent.
- Due to the highly constrained nature of the site, resilience measures will be required if buildings are situated in the flood risk area. Due to the significant depths of flooding on the site and its proximity to the River Wensum, it is suggested that a water entry strategy is used for the site (i.e. measures to reduce flood damage once water gets inside rather than trying to keep the water out)
- The risk from surface water flow routes should be quantified as part of a site-specific FRA, including a drainage strategy, to ensure that runoff from the development is not increased by development across any ephemeral surface water flow routes. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current rates.
- Areas at risk from surface water flooding should ideally be integrated into green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. An integrated flood risk management and sustainable drainage scheme for the site is advised. It is essential that a detailed model of surface water flooding, using the existing drainage system, topographical and asset survey is constructed at the FRA stage. This will determine the risk from surface water flooding further and to ensure that overland flows do not overwhelm future sustainable drainage features.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA).
- Developers should refer to Norfolk County Council's 'Norfolk County Council Lead Local Flood Authority Statutory Consultee for Planning Guidance Document' and the Level 1 SFRA for information on SuDS for guidance on the information required by the LLFA from applicants to enable it to provide responses to planning applications.

Key messages

The development is likely to be able to proceed if:

- A carefully considered and integrated flood resilient and sustainable drainage design is put forward, with habitable floor levels above the fluvial design flood event (1% AEP) taking into account significant sensitivity to climate change and a facility for all occupants to shelter above the extreme fluvial flood event (0.1% AEP) taking into account climate change
- If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another)
- Space for surface water to be stored on the site is provided and rainwater harvesting should be considered.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA, IDB or Anglian Water). Safe access and egress routes must not be in the areas of high surface water risk or the 1% AEP fluvial design flood event (considering climate change).

- The only site access point would be from Barrack Street. A Flood Warning and Evacuation Plan should be prepared for the site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the broadscale 2D modelling outputs from the Environment Agency's Flood Map for Planning, River Wensum Flood Model and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones 2 and 3 have been taken from the Environment Agency's Flood Map for Planning mapping.
Climate change	Climate change was modelled as part of Level 2 SFRA strategic 2D modelling. Allowances were based on the 2080s category, including Central (+25%), Higher central (+35%) and Upper end (+65%).
Fluvial depth, velocity and hazard mapping	Fluvial depth and hazard mapping has been taken from the River Wensum model for present day, and for future flood zones this was modelling produced for the Level 2 SFRA. This should be explored further at site-specific stage.
Surface Water	The Risk of Flooding from Surface Water map has been used to define areas at risk from surface water flooding.
Surface water depth, velocity and hazard mapping	The surface water depth, and hazard mapping for the 1 in 0.1% AEP event is taken Environment Agency's Risk of Flooding from Surface Water mapping.