| Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables |  |
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| **Site details** | |
| **Site Code** | **GNLP0409BR** |
| **Address/Grid Ref.** | Land South of Barrack Street/ 623695,309339 |
| **Area** | 2.17ha |
| **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 between the villages of Colkirk and Whissonsett and flows flows through Fakenham and the Pensthorpe nature reserve, and on through Swanton Morley, Taverham and 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.<br>There are no additional watercourses within the site boundary or near the site. |
| **Fluvial** | **Proportion of site at risk:**<br>**FZ3b – 0**%<br>**FZ3a – 1**%<br>**FZ2 – 85**%<br>**FZ1 –** 14%<br><br>*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%).*<br><br>**Available data:**<br>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.<br><br>**Flood characteristics:**<br>Fluvial flooding associated with the River Wensum is wide in extent and is modelled to flood most of the site in an extreme event. The low-lying topography of the site means that flood water flows onto the site.<br><br>The site is not at risk of flooding during the 5% AEP flood event. During the 1% AEP flood event, a small part of the site is at risk of flooding. Flood depths in this area are very shallow with a maximum depth of flooding of 0.2m.<br><br>In the 0.1% AEP flood event, flood depths on the site are significant and are up to 1.32m in depth. The southern corner of the site experiences the deepest flooding with levels of between 0.4m and 1.3m present in this area. Flood depths across the rest of the site are shallower but wider spread and range between 0.1m and 0.7m. The modelled flood hazard shows that the south 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'. |

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| **Coastal and Tidal** | The site is not at risk from coastal or tidal flooding. |
| **Surface Water** | **Proportion of site at risk (RoFfSW):**<br>**3.3% AEP** – 7%<br>Max depth 0.6-0.9m,<br>Max velocity <0.25m/s<br>**1% AEP** – 16%<br>Max depth 0.6-0.9m<br>Max velocity <0.25m/s<br>**0.1% AEP** – 54%<br>Max depth 0.9-1.2m<br>Max velocity <0.25m/s<br><br>*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 %)*<br><br>**Description of surface water flow paths:**<br>The site is impacted by surface water flooding in all modelled events.<br><br>In the 3.3% AEP event, two areas of isolated surface water pooling are shown in the southern part of the site. Flood depths are shown to be between 0.15m to 0.9m in this area. The flood hazard rating for the larger area of surface water pooling is 'dangerous for some' with a small area rated 'dangerous for most'. The smaller pool has a flood hazard rating of 'caution'.<br><br>In the 1% AEP event, the areas of isolated surface water pooling in the south of the site increase and merge into each other. Flood depths are shown to be between 0.15m to 0.9m in this area. A flow path originating from Silver Road flows onto Barrack Street (along the northern boundary of the site) leads to ponding along the northern boundary of the site. The extent of flooding is increased due to being intersected by a flow path flowing south from Brewers Cut. Flood water from the surface water ponding flows onto the site and ponds in the northern part of the site. Flood depths in this area range from 0m-0.3m and have a flood hazard rating of 'caution'.<br><br>In the 0.1% AEP event, surface water flooding is extensive and affects a significant proportion of the site. Flood depths across the site range from 0m-1.2m with the deepest flooding located in the southern part of the site. Across most of the site, flood depths are between 0m and 0.3m. The flood hazard rating for the southern 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. |
| **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** | 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:<br>• The entirety of the site has a >25%- <50% susceptibility to groundwater flood emergence from superficial deposits.<br><br>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. |
| **Flood history** | 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.<br><br>Flood history information provided in the Level 1 SFRA identifies two incidences of internal historic flooding 140m and 160m east of the site. |
| **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** | |
| **Flood warning** | The site is located within the Environment Agency's 'River Wensum, through Norwich' flood warning area. |

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| | The site is also located in 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' flood alert area. |
| **Access and egress** | The site is only accessible from north of the site, from Barrack Street.<br><br>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 1.3m during a flood event.<br><br>Due the significant flood extent and depths on the site, 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 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 2.2m in a 1 in 0.1% AEP event considering the highest risk climate change scenario.<br><br>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 is likely to be impacted.<br><br>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. |
| **Dry islands** | The site is not located on a dry island |

## Climate change

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| **Implications for the site** | • The site is highly sensitive to climate change causing increased in fluvial flows in the River Wensum.<br><br>• The site is in future Functional Flood Zone 3b. The 5% AEP plus the Upper End (65%) climate change results in flooding across the site. Flood depths in the southern part of the site are the most significant and range from 0.2m-1m. This area has a flood hazard rating of 'dangerous for some' and 'dangerous for most'. Flood water across the rest of the site is shallower and ranges between 0m and 0.4m with a flood hazard rating of 'caution'. 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.<br><br>• The site is in future Flood Zone 3a. The 1% AEP plus the Upper End (65%) climate change results in flooding across most of the site with three small areas in the north of the site not at risk of flooding. Flood depths in the eastern and southern parts of the site are the most significant and range from 0.6m-1.5m with a flood hazard rating of 'dangerous for most'. Flood depths across the rest of the site range between 0.1m-0.5m and have a flood hazard rating of 'caution'. Even for the less severe scenarios, the 1% AEP plus the Central (25%) climate change scenario results in flooding across the site with depths of between 0.1m and 1m present on the site. During this scenario, the flood hazard rating of 'Dangerous for some' for the majority of the site with the north of the site having a flood hazard rating of 'caution'. 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.<br><br>• The site is in future Flood Zone 2. The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across the site with depths of up to 2.1m present on the site. The highest depth areas are in the south of the site. During this scenario, the site has a flood hazard rating of 'Dangerous for most'.<br><br>• The 0.1% AEP plus 80% climate change scenario (H++) poses the most significant risk to the site. Flood depths from this scenario range between 1m-2.2m for the majority of the site. During this scenario, the flood hazard rating of 'Dangerous for most' for the site.<br><br>• The modelled 1% AEP with 40% Climate Change Surface water flooding show a significant increase in surface water flooding on the site.<br><br>**Proportions of the site in Future Flood Zones can be found in Table 6-2 of the Greater Norwich Level 2 SFRA Report** |

## Requirements for drainage control and impact mitigation

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| **Broad scale assessment of possible SuDS** | **Geology & Soils**<br><br>• Geology at the site consists of:<br><br>  ○ Bedrock – Lewes Nodular Chalk Formation, Seaford Chalk Formation, Newhaven Chalk Formation, Culver Chalk Formation, Portsdown Chalk Formation (undifferentiated) – Chalk.<br><br>  ○ Superficial – Alluvium (Clay, Silt, Sand and Gravel). |

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| | **SuDS**<br>• 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.<br>• 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.<br>• 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.<br>• 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.<br>• 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.<br>• Developers should investigate and consider in full all SuDS options and demonstrate that SuDS are not appropriate where they are not implemented.<br>• The site is not designated by the Environment Agency as previously being a landfill site. |
| **Opportunities for wider sustainability benefits and integrated flood risk management** | • 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.<br>• 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.<br>• 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). |
| **NPPF and planning implications** | |
| **Exception Test requirements** | 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.<br>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. |
| **Requirements and guidance for site-specific Flood Risk Assessment** | **Flood Risk Assessment:**<br>• At the planning application stage, a site-specific Flood Risk Assessment will be required as the development is in Flood Zone 2.<br>• All sources of flooding, particularly the risk of fluvial and surface water should be considered as part of a site-specific flood risk assessment.<br>• 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.<br>• Consultation with the Local Authority, Lead Local Flood Authority and the Environment Agency should be undertaken at an early stage.<br>• 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.<br>**Guidance for site design and making development safe:**<br>• Flood resilient design is essential for this highly constrained urban site:<br>  ○ 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 1.5m 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 considering climate change (upper end scenario)- approximately 2.2m 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 whenever there is built development on land within the 1% +35% climate change flood extent. Achieving this may be challenging considering the majority of the site is within Future Flood Zone 3.
- 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 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

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| 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 allowances (for the 2080s) were modelled as part of Level 2 SFRA. This included 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 1% AEP event is taken Environment |