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

Site details

Site Code	**GNLP0068**
Address/ Grid Ref.	Duke St, central Norwich/ 622989,308909
Area	0.12ha
Current land use	Car Park
Proposed land use	Residential led mixed use

Sources of flood risk

Location of site within catchment	The site is in the River Wensum catchment. The River Wensum is an Environment Agency designated main river and flows in an easterly direction under Duke Street Bridge, through Norwich, towards its confluence with the River Yare.
Existing drainage features	The site is located on the edge of the River Wensum. 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 in close proximity to the site.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 0% **FZ2 –** 92% **FZ1 –** 8% *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%).* **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. Limitations of the modelling are summarised in the Mapping Information section at the end of this table. Further modelling was undertaken to apply recent climate change uplifts to the fluvial model of the Wensum. **Flood characteristics:** Fluvial flooding associated with the River Wensum is wide in extent and is modelled to flood the majority of the site in an extreme event. The low-lying topography of the site means that flood water flows onto the site. The site is not at risk of flooding during the 20- and 1% AEP flood events. In the 1000-year flood event, flood depths on the site are significant and are up to 3.5m in depth in the east of the site and up to 2.4m in the centre of the site, with shallower levels of less than 0.2m along the western edge of the site. The modelled flood hazard shows that the majority of the site (apart from a small part around the boundary) is at 'Significant- Dangerous for most people' flood hazard risk. A small area in the east of the site has a flood hazard rating of 'Dangerous for all'
Coastal and Tidal	The site is not at risk from coastal or tidal flooding.

Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 0% Max depth 0 m Max velocity 0 m/s **1% AEP** – 9% Max depth 0.3-0.9m Max velocity 0m/s **0.1% AEP** – 73% Max depth >0.9m Max velocity >0.25m *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 %)* **Description of surface water flow paths:** There is significant surface water ponding on the site at the 1000-year flood event. The site is not at risk of surface water flooding during the 3.3% AEP event. In the 1% AEP event, a narrow area of surface water ponding is present along the eastern edge of the site. Flood depths during this event could reach 0.3 to 0.9m. The 1000-year flood event presents the most significant risk to the site. There is significant surface water pooling that extends over the majority of the site. Flood depths are greatest in the eastern part of the site (over 0.9m) with lower depths seen in the centre and western parts of the site (0.3m-0.9m).
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 4m 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: • The entire site is shown to have a <25% susceptibility to groundwater flood emergence. 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. The site is located in a postcode area which has previously experienced sewer flooding (as identified in the Level 1 SFRA).
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 majority of the site is located within the Environment Agency's 'Riverside properties on the River Wensum' flood warning area. The northern part of the site is located in the 'River Wensum, through Norwich' flood warning area.
Access and egress	The site is only accessible from north of the site, from Duke Street. In terms of fluvial flood risk, the entire site is located in the modelled 0.1% AEP flood extent and modelling shows that it could experience flood depths of up to 2.4m during a flood event. Due the significant flood extent and depths on the site, access and egress from the site may not be possible during a flood event. The site entrance point of Duke Street is not affected during a flood event but access on Duke Street to the north and south is. 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 3.5m in a 1 in 0.1% AEP event considering the highest risk climate change scenario. As the site is already at significant risk in the present day, there is little change to access and egress in future considering climate change and a shelter in situ policy remains necessary. In terms of surface water flood risk, surface water flooding impacts the site and some of the surrounding road network in the 1000-year modelled event.

	In the 0.1% AEP flood event, surface water flooding should not impact access and egress from the site. There is very minor surface water pooling modelled to the north of Duke Street. This flooding is isolated in area and likely to be less than 0.3m in depth.
Dry islands	The site is not located on a dry island.

Climate change

Implications for the site	• The site is highly sensitive to climate change causing increased in fluvial flows in the River Wensum • Almost all of the site is in future Flood Zone 3b which is the 5% AEP plus the Upper End (+65%). Flood depths on the site during this scenario reach up to 2.3m and have a flood hazard rating of 'Dangerous for most'. 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. • Almost all of the site is in future Flood Zone 3a, which is 1% AEP plus the Upper End (65%). Flood depths range between 2.6m and 2.9m and have a flood hazard rating of 'Dangerous for most' for part of the site, and 'danger to some' for the rest of the site. Even for the less severe scenarios, the 100 year plus the Central (25%) climate change scenario results in flooding across the site with depths of between 1.6m and 2.9m present on the site. The highest depth areas are in the east of the site. During this scenario, the flood hazard rating of 'Dangerous for most' for the majority of the site. 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 site is almost entirely in future Flood Zone 2, which is 0.1% AEP plus the Upper End (65%) climate change scenario. Flood depths during all the 0.1% AEP climate change scenarios increase significantly between each of the climate change scenarios by approximately 0.5m. The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across the site with depths of between 3.0m and 3.4m present on the most significant parts of the site. The highest depth areas are in the east of the site. During this scenario, the flood hazard rating of 'Dangerous for all'. • The modelled 1% AEP with 40% Climate Change Surface water flooding does not show a significant increase in surface water flooding on the site. **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

Broad scale assessment of possible SuDS	**Geology & Soils**
	• Geology at the site consists of:
	  ○ 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).
	• Soils at the site consist of:
	  ○ Fen peat soils - peaty, naturally wet, mixed fertility very low to lime-rich
	SuDs
	• Most source control techniques are likely to be suitable. Mapping suggests that slopes may be unsuitable for selective source control techniques.
	• 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.
	• Detention is unlikely to be feasible as mapping suggests mean site slopes are > 5%. Feasibility of such options should be assessed as part of a site-specific assessment. If this feature is feasible a liner maybe required to prevent the egress of groundwater.

	• Infiltration SuDS may not be suitable on the site as mapping suggests mean site slopes are > 5%. Feasibility of such options should be assessed as part of a site-specific assessment. If this feature is feasible it should be located where the depth to the water table is >1m, additionally a liner maybe required to prevent the egress of groundwater. • 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. A liner may be required to prevent the egress of groundwater. • The site is not designated by the Environment Agency as previously being a landfill site. • Given the highly constrained nature of the site, a carefully considered and integrated flood resilience and sustainable drainage design suitable for the urban setting should be considered. For example, the use of rainwater harvesting and floodable areas at the ground flood level (for example outdoor open storage areas/ rain gardens that are usually dry) should be integrated into the overall design of the development. • Developers should investigate and consider in full all SuDS options and demonstrate that SuDS are not appropriate where they are not implemented.
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. • A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level taking into account 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 taking into account 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. Residential development is classified as 'More Vulnerable'. As the site is mostly covered by Flood Zone 2, the Exception Test Is not required for the site. 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:** • At the planning application stage, a site-specific Flood Risk Assessment will be required as the development is located 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. **Guidance for site design and making development safe:** • Flood resilient design is essential for this highly constrained urban site: o A resilient approach to urban design should be taken. Habitable floor levels must be above the 1% AEP flood level taking into account climate change (upper end scenario) with an allowance for freeboard- approximately 4.1m above ground level. o 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 4.6m 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 1000-year 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 prepared based on a policy of shelter in situ.
- 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).
- Compensatory flood storage is required for any land raising and all proposed buildings (unless open and allowed to accept flows) whenever there is built development on land within the 1% +35% climate change flood extent. Compensatory storage will be more challenging to achieve as the site is almost entirely in Future Flood Zone 3.
- 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 greenfield 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 (100 year) taking into account climate change and a facility for all occupants to shelter above the extreme fluvial flood event (1000 year) 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 (taking into account climate change).
- The only site access point would be from Duke Street to the west. 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 allowances were modelled as part of Level 2 SFRA.
Fluvial depth, velocity and hazard mapping	Fluvial depth and hazard mapping has been taken from the River Wensum model for present day, and the modelling completed as part of the Level 2 SFRA for climate change scenarios. 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 Agency's Risk of Flooding from Surface Water mapping.