Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**GNLP0401**
Address/Grid Ref.	Former EEB site (Dukes' Wharf), Duke Street/622902/308793
Area	0.82ha
Current land use	Car park and industrial buildings
Proposed land use	Residential led mixed use
Sources of flood risk	
Location of site within catchment	The site is contained within 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 near the site.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 0% **FZ2 –** 40% **FZ1 –** 60% *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:** The modelled River Wensum presents fluvial flooding which impacts a significant area to the north and north west of the site. The site access point from Westwick Street remains unaffected by flooding. 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 deepest in the north western part of the site and range between 1.8m and 2.4m in this area. Flood depths in the northern, western and the centre of the site are shallower and range from 0.2m-1m in depth. The modelled flood hazard rating shows that the north western part of the site has been categorised as 'Dangerous for most people'. The area in the centre of the site and along the northern boundary of the site has a lower flood hazard risk and is categorised as 'Dangerous for some' and 'Caution'.
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** – 3% Max depth 0.9m-1.2m Max velocity <0.25m/s **1% AEP** – 6% Max depth 0.9m-1.2m Max velocity <0.25m/s **0.1% AEP** –14% Max depth 0.9m-1.2m Max velocity <0.25m/s *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:** The northern portion of the site is affected by surface water flooding to a greater extent than the southern portion, where modelling shows a small surface water flow path during the lower risk event from a pool in the centre of the site flowing towards the north west corner. In the 3.3% AEP event, a small area of surface water pooling is modelled along the edge of the existing buildings, located to the north of the site. During this event, the flood depths are largely between 0.15 and 0.6m, with a very small areas reaching up to 1.2m in depth. In the 1% AEP event, more extensive surface water flooding is seen along the edge of the buildings to the north of the site. During this event, flood depths are again largely below 0.3m, with isolated areas on the site boundary reaching 0.3 to 1.2m in depth. In the 0.1% AEP event, there is a flow path that flows north from St John Maddermarket towards the site, and ponds in the south of the site. Surface water flood extents within the site itself are not significantly larger than in the 1% AEP event, however larger areas could have depths of 0.3 to 0.9m.
Reservoir	The site is not shown to be at risk of reservoir flooding from the available online maps.
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 two incidences of 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 existing buildings on the site are in the Environment Agency's 'Riverside properties on the River Wensum, through Norwich' flood warning area. A small proportion of the area to the south of the existing buildings is in the 'River Wensum, through Norwich flood warning area'. The north western part of the site is in the Environment Agency's 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' flood alert area.
Access and egress	The site is currently accessed from Westwick Street, located along the southern boundary of the site. Access and egress to the site is unlikely to be affected by fluvial flooding. This is because flooding associated with the River Wensum during the 0.1% AEP flood event only affects the north and north western part of the site where the site currently isn't accessible. The Risk of Flooding from Surface Water dataset shows that the southern portion of the site is affected by flooding during the 0.1% AEP event, which could affect access and egress to the site. The flow path flows north from St John Maddermarket towards the site, and ponds in the south of the

	site. Flooding remains largely below 0.3m in depth during this event, access and egress are likely to be impacted. Access and egress to the site via the south and west are likely to remain unaffected in the future, considering the Upper End (+65%) climate change scenario and a shelter in situ policy should not be necessary, provided an appropriate flood warning and evacuation plan is in place. 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	
Implications for the site	• The site is highly sensitive to climate change, causing increased in fluvial flows in the River Wensum. • 43% of the site is in future Flood Zone 3a. Flood depths during the 1% AEP plus the Upper End (65%) scenario range between 0.2m and 2.4m across the site. The site has a flood hazard rating of 'Dangerous for most' for in the north western part of the site, with lower hazard ratings in the north eastern part of the site. Even for the less severe scenarios, the 1% AEP 1% AEP plus the Higher Central (35%) climate change scenario results in flooding across the site, with depths of between 1.5m and 2m present on a large part of site. The highest depth areas are in the west of the site. During this scenario, the flood hazard rating is 'Dangerous for most' for most 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 in future Flood Zone 2. Flood depths during all the 0.1% AEP climate change scenarios do not increase significantly between each of the climate change scenarios however the extent of flooding increases across the eastern part of the site. The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across the northern part of the site with depths of between 2.2m and 2.8m present in the west of the site. During this scenario, the flood hazard rating is '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 – none recorded
	
	SuDS
	
	• Soils at the site are unclassified.
	
	• 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 may be required to prevent the egress of groundwater. • Filtration techniques are 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 it should be located where the depth to the water table is >1m, additionally a liner may be 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. • Developers should investigate and consider in full all SuDS options and demonstrate that SuDS are not appropriate where they are not implemented. • 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.
Opportunities for wider sustainability benefits and integrated flood risk management	• The surface water flow route presents an opportunity for a green corridor through the site, which presents wider opportunities to improve biodiversity and amenity, as well as reducing flood risk. • 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.
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 development is classified as 'Less Vulnerable Development. 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 if a development is located within Flood Zones 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 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 using a sequential approach. Development should be steered away from areas of fluvial flood risk and surface water flow routes, preserving these spaces as green infrastructure. Development must be in line with Table 3: flood risk vulnerability and flood zone compatibility of the NPPG. • Where development cannot be located outside Flood Zone 2, the site 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:** • 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). • Flood resilient design is essential for this 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 4.2m.

- Safe access and egress will need to be demonstrated in the 1 in 1% AEP plus climate change, considering climate change (upper end scenario), using the depth, velocity and hazard outputs. 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. Alternatively, risk could be managed by inclusion of a higher refuge and a flood response plan that meets the requirements of the Local Council and their Emergency Planner.
- 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.
- 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.
- New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. This should include allowance for climate change.
- 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:

- New development is limited to the 60% of the site located within fluvial Flood Zone 1.
- 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 for all occupants to evacuate from the site during an extreme fluvial flood event (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.
- New developments should adopt exemplar source control SuDS techniques to reduce the risk of frequent low impact flooding due to post-development runoff. Assessment for runoff should include allowance for climate change effects.
- The site discharges 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).
- The only site access point would be from Westwick Street. A safe access route should be provided from 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 for present day has been taken from the existing River Wensum model, and future depth and hazards results are from modelling completed as part of 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.