Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**CC04b**
Address/Grid Ref.	Land at Rose Lane and East of Mountergate/ 623752,308407
Area	2.39ha
Current land use	Brownfield
Proposed land use	Carried forward mixed use allocation
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 through Norwich, passing under Foundry Bridge (adjacent the site) 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 to the site.
Fluvial	**Proportion of site at risk:** **FZ3b –** 2% **FZ3a –** 21% **FZ2 –** 80% **FZ1 –** 20% *The % Flood Zones quoted show the % of the site at flood risk from that 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 most of the site in an extreme event. The low-lying topography of the site means that flood water flows onto the site. During the 5% AEP flood event, a limited (<2%) area of the site alongside the river is at risk of flooding up to a depth of 20cm. The modelled flood hazard shows that this area is at risk of shallow flowing water. During the 1% AEP flood event, a significant portion (approx. 20%) of the site is at risk of flooding up to a depth of 0.5m. The most significant flooding during the 1% AEP event is limited to the south west of the site, currently comprising a car park, with limited shallower flooding around the north-west corner of the site. The modelled flood hazard shows that this area is at 'Dangerous for most - Danger - Flood zone with deep fast flowing water' flood hazard risk.

	During the 0.1% AEP event, the majority (80%) of the site is at risk of flooding. Modelled flood depths are greatest at the northwest corner of the site and alongside the river bank, up to 1.12m, and the modelled flood hazard shows that the this area is at ' Dangerous for all - Danger - Flood zone with deep fast flowing water flood hazard risk'. Flood depths are shallower to the east, depth up to 0.3m.
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** – 1.2 Max depth 0.3m, Max velocity <0.25m/s **1% AEP** – 8.25 % Max depth 0.6-0.9m Max velocity <0.25m/s **0.1% AEP** – 29.05% Max depth 0.6-0.9m 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:** During the 3.3% AEP event, the site is not at significant risk of surface water flooding. In the 1% AEP event, there is significant ponding of 0.3-0.6m depth around the buildings to the east of the site but no significant surface water flow routes. The 0.1% AEP event poses the most significant flood risk to the site. Water flows onto the site primarily from Mountergate through 3 main routes along the east of the site. Water then generally flows in a southerly direction across the site towards the river. Flows are fastest through the car park to the south of the site where the three flows converge. Depths from the western edge through to the river are between 0.3-0.6m, whilst the northern section of the site experiences depths of 0.6-0.9m.
Reservoir	The site is not shown to be at risk of flooding from reservoirs.
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 between a 50% and 75% 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 not located in a postcode area which has previously experienced sewer flooding (as identified in the Level 1 SFRA).
Flood risk management infrastructure	
Defences	The 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	Most of the site is located within the Environment Agency's 'Riverside properties on the River Wensum' flood warning area. The eastern part of the site is in the 'River Wensum, through Norwich' flood warning area.
Access and egress	The site is accessible to the east from Mountergate and to the north from Prince of Wales Road. In terms of fluvial flood risk, the majority of the site is located in the modelled 0.1% AEP flood extent and modelling shows it could experience flood depths of up to 1.12m 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. Up to the 0.1% AEP fluvial event, access is unaffected however at the 0.1% AEP event both Mountergate and Prince of Wales Road will be significantly impacted by flood water. Depths on Prince of Wales road may reach up to 0.5m, whilst on Mountergate flood depths are below 0.3m. In terms of surface water flood risk, surface water significantly impacts the site and surrounding roads during the 100- and 0.1% AEP flood events. During the 1% AEP event, surface water should not impact access and egress to the site owing to the low depths and flow rates. During the 0.1% AEP surface water event, depths of up to 0.9m with significant flows along Mountergate and significant depths of up to 0.9m on Prince of Wales road are likely to impede access and egress to the site. 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 1.95m in a 0.1% AEP event considering the highest risk climate change scenario (+65%).
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 • Most of the site is within future Functional Flood Zone 3b. The 20 year plus the Upper End (65%) climate change results in flooding across 58% of the site. Flood depths on the site during this scenario reach 0.9m 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. • The entire site is within future Flood Zone 3a. Flood depths during the 100 year plus the Upper End (65%) scenario range between 1.0m and 1.35m and have a flood hazard rating of 'Dangerous for all' for part of the site, and 'danger to most' 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 0.5m and 0.9m 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 most of the site. This scenario presents a significant increase in risk to the site compared to the present day 1% AEP event. • The entire 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 between 1.6m and 1.9m 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' across most of the site. • The 0.1% AEP plus 80% climate change scenario (H++) poses the most significant risk to the site, however not significantly higher than the Upper End scenario. Flood depths from this scenario range between 1.7m-2.0m. During this scenario, the flood hazard rating of 'Dangerous for all' for most of the site. • 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).
	SuDS
	• 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.
	• 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 or groundwater issues, a liner will be required.
	• Developers should investigate and consider in full all Suds options and demonstrate that SuDS are not appropriate where they are not implemented.
	• 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. • 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 1.7m 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 2.3m above ground level.
NPPF and planning implications	
Exception Test requirements	• The exception test is required. There is a significant increase in flood risk due to climate change and the site is likely to require major flood mitigation work to proceed. A small amount of this site is in the Functional Floodplain which would need to be left open e.g. undeveloped/ for green infrastructure.
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 in Flood Zone 3. • 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:
    - 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 1.7m 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 2.3m 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. This will more challenging given the majority of the site is in 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 (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).
- 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. Flood Zone 3b was produced for the Level 1 SFRA.
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 Agency's Risk of Flooding from Surface Water mapping.