Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**GNLP0360 (East Norwich Regeneration Area)**
Address/Grid Ref.	Bracondale, Deal Ground, May Gurney site and Trowse Pumping Station/ 624699,307338
Area	21.35ha
Current land use	Open land, residential and commercial
Proposed land use	Residential led mixed use
Sources of flood risk	
Location of site within catchment	The site is in the catchments of the River Wensum and the River Yare, just upstream of the confluence of the two rivers. The site is situated to the north of the River Yare on predominantly greenfield with some brownfield land use to the west and access from Carrow Bridge. 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. The River Yare rises near Garvestone and flows eastward, around the southern edge of Norwich, towards its confluence with the River Wensum, just downstream of the city centre.
Existing drainage features	The downstream extent of the River Yare flows in a north easterly direction through the southern section of the site (to the north of the commercial buildings off Bracondale), and along the eastern boundary of the site. Two branches of the River Yare approach the site from the south, with the main channel crossing through the southern section of the site and the second skirting the easterly boundary of the site. These channels merge shortly downstream and continue in a northerly direction along the east boundary of the site. The river has not been artificially modified and flows in open channel. The River Wensum flows from west to east along the northern boundary of the site before its confluence with the River Yare. The river has been artificially modified through Norwich and the banks of the river have been enforced with steel and concrete, including along the north edge of the site. Several small drainage channels are present in the centre of the site. These channels are small and flow east into the River Yare.
Fluvial	**Proportion of site at risk:** **FZ3b –** 39% **FZ3a –** 44% **FZ2 –** 62% **FZ1 –** 38% *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 exists for the River Wensum and the downstream extent of the River Yare (from Trowse Newton Weir to Kirby Marsh) 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 existing fluvial model. The H++ scenario was also run for extreme climate change scenarios due to the site being classed as significant urban development. For fluvial, an 80% increase was applied to existing modelled flows and a 1.9m rise applied to current day sea levels (at the coast).

	Flood characteristics: The site is significantly affected by fluvial flooding and most of the site is within the most extreme event extent . In the 5% AEP flood event, flooding occurs across the south east section of the site adjacent to the River Yare, and to the north of the site. The 5% AEP event shows the extent of the functional floodplain along the banks of the River Wensum in the north of the site Flood depths in this area are between 0.1m and 0.4m and have a flood hazard rating of 'Caution' to 'Dangerous for some'. In the 5% AEP event, the area at risk of flooding adjacent to the River Yare is significantly lower in topography than the rest of the site, resulting in the large extent of flooding. Flood depths in this area range between 0.1m-0.9m and have a flood hazard rating of 'Caution' to 'Dangerous for most'. During the 1% AEP flood event, the extent of flooding in comparison to the 5% AEP flood event is increased in the north of the site, and a marginal increase is seen in the centre of the site. Flood depths in the central part of the site range between 0.1m and 1.1m and have a flood hazard rating of 'Dangerous for most' for the majority of the site, with lower flood hazard ratings around the edge of the floodplain. Flood depths in the north of the site marginally increase and are between 0.1-0.6m in depth, and have a flood hazard rating of 'Caution' to 'Dangerous for most'. In the 0.1% AEP flood event, the extent of flooding in the north of the site is significantly increased. Flood depths in this area are significant and are up to 1.1m in depth. This area has a maximum flood hazard rating of 'Dangerous for most'. In the centre of the site, flood depths are a maximum of 1.5m. The area has a flood hazard rating of 'Dangerous for most' with lower flood hazard ratings around the edge of the floodplain.
Coastal and Tidal	The site is not at risk from coastal or tidal flooding. For the Level 2 SFRA, modelling was undertaken to determine whether a coastal breach would affect sites in the east of Norwich at extreme climate change scenarios, although the 0.1% AEP plus 80+ (H++) scenario does affect these sites.
Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 0% Max depth 0m, Max velocity 0m/s **1% AEP** –1% Max depth 0m Max velocity 0m/s **0.1% AEP** – 4% 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:** The site is not at risk of surface water flooding during the 3.3% AEP event. In the 1% AEP event, three small areas of surface water ponding are present in the western part of the site. Flood depths during this event could reach 0.15m to 0.9m with a flood hazard rating of 'dangerous for some'. For the 0.1% AEP flood event, additional areas of surface water ponding are located around the site, as well as a minor increase in extent of the areas of ponding in the 1% AEP flood event. Flood depths are up to 0.9m in most of the surface water ponding areas with lower depths in some parts of the site (0.15m-0.6m).
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 majority of the site has a >75% susceptibility to groundwater flood emergence from superficial deposits. • The southern part of the site has a >50%- <75% susceptibility to groundwater flood emergence from superficial deposits. 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 from the great flood of 1912. Given the topography of the site it is likely to have been affected by lower level events more recently.

	Flood history information provided in the Level 1 SFRA identifies one incidence of external historic flooding 300m south-west of the site however the source was not recorded. The site is in a postcode area which has previously experienced 1 incidence 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 majority of site is located within the Environment Agency's 'The River Yare from the A11 at Cringleford to Trowse Newton' flood warning area. The northern part of the site is in the 'The River Wensum, through Norwich' flood warning area and the 'Riverside properties on the River Wensum, through Norwich'. The entire site is in the 'The River Yare at Norwich, from Cringleford to Trowse Newton' Environment Agency's flood alert area.
Access and egress	The main area of the site is only accessible from an unnamed access road along the western boundary of the site. The two areas in the south of the site are currently accessible from two small unnamed access roads from Bracondale. In terms of fluvial flood risk, a significant part of the site is at risk of flooding during all flood events and modelling shows that it could experience flood depths of up to 1.1m in some areas of the site during a flood event. The access road along the western boundary of the site remains unaffected during all flood events. The access roads for the two areas in the south of the site also remain unaffected by flood water and access to Bracondale is still possible during a flood event. Flood depths in this area remain shallow (below 0.4m) for all flood events, therefore access is unlikely to be significantly affected. Due to the significant flood extent and depths in the main part of the site, access and egress from the site may not be possible for development in the east of the site 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 3.1m above ground level in a 1 in 0.1% AEP event considering the highest risk climate change scenario. In terms of surface water flood risk, surface water flooding impacts the site and some of the surrounding road network in the 1% AEP and 0.1% AEP modelled events. Neither surface water flooding scenario should impact access and egress from the site. There is very minor surface water pooling modelled in isolated areas around the site and this will not restrict access.
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 fluvial flows in the River Wensum and the River Yare. • The future functional floodplain is the 20 year plus the Upper End (65%) climate change event. 60% of the site is in future Functional Floodplain (Flood Zone 3b). Flooding occurs across most of the site, including the south of the site towards Bracondale which was not at risk during the present-day flood risk scenarios. Flood depths in the central part of the site are the most significant and range from 0.1m-1.4m. This area has a flood hazard rating of 'dangerous for most' for the majority of the site. Flood water in the northern and southern parts 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. For the least severe climate change scenario, the 20 year plus the Central (25%) event results in a significant increase in flooding in the north of the site (in comparison to the current day scenario) with depths of up to 0.7m. This area has a maximum flood hazard rating of 'Dangerous for most'. • The future flood zone 3a is the 1% AEP plus the Upper End (65%) climate change event. 73% of the site is in future Flood Zone 3a. Flooding occurs across most of the site with a significant increase in flood extent in the area in the north of the site in comparison to the present day 100 year flood extent. Flood depths in the north and centre of the site are the most significant and range from 0.2m-1.6m with a maximum flood hazard rating of 'dangerous for most'. Flood depths across the rest of the site range between 0.1m-1.3m and have a maximum flood hazard rating of 'dangerous for most'.

	• 81% of he future Flood Zone 2 is the 0.1% AEP plus the Upper End (65%) climate change event.The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across most of the site with depths of up to 2.2m. The highest depth areas are in the centre of the site. During this scenario, the site has a flood hazard rating of 'dangerous for most' for most of the site with an area in the centre of the site rated as 'dangerous for all'. • The H++ climate change scenario has been applied to this site as it is considered significant urban development. The 0.1% AEP plus 80% climate change poses the most significant risk to the site. Flood depths from this scenario range between 0.3m-2.3m for most of the site. Applying this extreme scenario results in a flood hazard rating of 'dangerous for most' for most of the site with several areas rated as '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).
	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.
	• Mapping suggests that there is a high risk of groundwater flooding at this location, therefore it is likely infiltration techniques will not be suitable. This should be confirmed via site investigations to assess the potential for infiltration. As the site is located within a Source Protection Zone, if infiltration is possible and permitted, it should only be used where there are suitable levels of treatment. 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 feature. If the site has contamination or groundwater issues, a liner will be required.
	• Filtration is 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.
	• An asphalt plant is located alongside the west of the site. When preparing drainage strategy, it will need to be confirmed that surface water flow paths from the asphalt plant do not contaminate surface water on the site.
	• 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.
	• 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	• Space on the site should be made for green infrastructure, which presents wider opportunities to improve biodiversity and amenity as well as climate change adaptation. • It is recommended that areas of green space are retained in areas of higher flood risk to accept surface water flow routes from the site, store water and provide amenity and habitat benefits. • It is recommended that areas of hard paving are permeable, and that community level sustainable drainage is considered. • 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).

	• **To enable development in the East Norwich Regeneration Area, a carefully considered flood risk and sustainable drainage strategy covering sites GNLP0360, GNLP3053 and R10 must support early master planning and feasibility work. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of sites to be defended against fluvial flooding. There should be no overall loss of floodplain storage and the risk of flooding should not be increased up or downstream of the sites. The most suitable site in flood risk terms is GNLP3053.**
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' and commercial is classed as 'Less Vulnerable'. As the site is in Flood Zone 3, the Exception Test is required for the site. Given the significant degree of flood risk to this site it must be proved that the site provides significant wider sustainability benefits within the East Norwich Regeneration Area that outweigh the significant costs that would be associated with major reprofiling, flood defences and sustainable drainage work required to bring forward such as high flood risk site.
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. This should be informed by an overall strategy for flood risk and sustainable drainage for the East Norwich Regeneration Area. • 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 site due to the potential extent and depths of flooding: ○ Where possible, more vulnerable development should be located to the outside of the area at risk in the west of the site with the area at risk of flooding used for greenspace. Across the East Norwich Regeneration Area, the most vulnerable development should be located on site GNLP3053. ○ A resilient approach to design should be taken for any development within the floodplain. Habitable floor levels must be above the 1% AEP flood level considering climate change (upper end scenario) with an allowance for freeboard- approximately 2.4m. ○ A shelter in situ for an extreme fluvial event must be designed into any buildings in the fluvial flood plain 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 3.2m. ○ **Major reprofiling, flood defences and sustainable drainage work would be required to bring forward such as high flood risk site. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of the site to be defended against fluvial flooding.** ○ **The residual risk should such work take place must be taken into account so that residents still have a safe place to shelter in an extreme event and so habitable flood levels are above the level that might be reasonably expected should any future flood defences breach. Hence flood resilient urban design will still be essential in any such areas defended against fluvial flooding in future.** • 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. This will be challenging given the majority of the site is within Future Flood Zone 3.

- 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 or contribute to loss of floodplain storage. 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, although access should still be available for emergency services.
- 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 and the River Yare, it is suggested that a water entry strategy is used for development within the floodplain (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.
- The surface water drainage strategy should also consider any contaminated surface water flows from the west of the site boundary.
- Plans to address both fluvial and surface water flooding should integrate 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). Development on greenfield land should discharge at rates no greater than the existing greenfield rates for the 100% and the 1% rainfall events.
- 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

To enable development in the East Norwich Regeneration Area, a carefully considered flood risk and sustainable drainage strategy covering sites GNLP0360, GNLP3053 and R10 must support early master planning and feasibility work. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of sites to be defended against fluvial flooding. There should be no overall loss of floodplain storage and the risk of flooding should not be increased up or downstream of the sites. The most suitable site in flood risk terms is GNLP3053.

Major reprofiling, flood defences and sustainable drainage work would be required to bring forward such as high flood risk site. This will involve sacrificing some areas as functional floodplain and increasing flood storage to allow other areas of the site to be defended against fluvial flooding. This is likely to affect the amount of land available for development.

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. Residual risk from an extreme flood or breach scenario must be considered if areas of the site are defended in future.

- 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). Development on greenfield land should discharge at rates no greater than the existing greenfield rates for the 100% and the 1% rainfall events.
- 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 site access points would be from the three unnamed existing access roads that currently serve the site. A Flood Warning and Evacuation Plan should be prepared for the site.
- The most vulnerable development should be located on site GNLP3053.

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 and River Yare 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 the Level 2 SFRA strategic 2D modelling for the 2080s. This included Central (+25%), Higher central (+35%) and Upper end (+65%). Level 1 SFRA surface water climate change scenario model results were used to assess the risk of surface water flooding in the future.
Fluvial depth, velocity and hazard mapping	Fluvial depth, velocity and hazard mapping for present day has been taken from the existing River Wensum Model. For the River Yare and for the future River Wensum depth, hazard and velocity, this has been modelled 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 from the Environment Agency's Risk of Flooding from Surface Water mapping.