Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**R10 (East Norwich Regeneration Area)**
Address/Grid Ref.	Cremorne Lane, Utilities Site parts within Norwich/ 624800,307808
Area	6.92ha
Current land use	Industrial, brownfield and greenfield land
Proposed land use	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 River Wensum rises between the villages of Colkirk and Whissonsett and flows through Fakenham and the Pensthorpe nature reserve, then 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 River Wensum flows in an easterly direction along the southern boundary of the site before its confluence with the River Yare at the edge of the site. The river has been artificially modified through Norwich and the banks of the river have been reinforced with steel and concrete. The bank along the site is more natural than the upstream banks and has not been artificially modified. The River Yare is located 60m south of the site and flows in a north easterly direction to the south of the site. Two small drainage channels are present in the south of the site, the first runs parallel to the River Wensum, flowing from west to east for approximately 125m, in a small manmade channel before flowing into the River Wensum. The drain is approximately 3m wide. The second drain flows across the site and the eastern boundary in an artificially modified channel. The channel appears to be open and is approximately 6m wide.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 4% **FZ2 –** 63% **FZ1 –** 37% *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 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 fluvial model. **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 site is not at risk of flooding from the River Wensum during the 5% AEP flood event. During the 1% AEP flood event, flood water affects the south-western edge of the site, along the banks of the River Wensum and from the manmade channel. A small area of flood water is present in the south-western corner of the site on Hardy Road with flood depths between 0.1m and 1m. This

	area has a maximum flood hazard rating of 'Dangerous for most'. A small area of flooding is present along the manmade channel however flood depths are very shallow (>0.1m). This area has a flood hazard rating of 'caution'. The 0.1% AEP flood event poses the most significant risk to the site. Flood water during this flood event affects a significant proportion of the site including the south of the site and the area along the edge of the unnamed watercourse in the east of the site. Flood depths across the site during this scenario are between 0.1m and 0.7m and flood hazard ratings range between 'Caution' and 'Dangerous for most'.
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% Max depth 0.3-0.6m, Max velocity <0.25m/s **1% AEP** – 3% Max depth 0.3-0.9m Max velocity >0.25m/s **0.1% AEP** – 16% 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:** Areas of surface water ponding are present around the site during all modelled surface water flooding events. In the 3.3% AEP event, two small areas of surface water pooling are modelled in the centre of the site. These areas are small in extent and flood depths are largely between 0.15m and 0.6m. The maximum flood hazard rating in these areas is 'dangerous for some'. A small area of surface water ponding is also present along Hardy Road along the western boundary of the site. Flood depths from this area range between 0.3m and 0.6m and have a flood hazard rating of 'dangerous for some' In the 1% AEP event, the extent of surface water flooding is marginally increased from the 3.3% AEP event. The areas of surface water ponding present during the 3.3% AEP flood event have merged to form a small flow path in the centre of the site. Flood depths in this flow path vary and are between 0.15m and 0.9m. The maximum flood hazard rating on the site is still 'dangerous for some'. Two small areas of surface water ponding are present in the north and south of the site. These areas of ponding have a maximum flood depth of 0.6m and a maximum flood hazard rating of 'dangerous for some'. In the 0.1% AEP event, the risk of flooding across the site significantly increases. Flood water ponds along Hardy Road (located along the northern boundary of the site) and overflows onto the site, leading to ponding. Flood depths in this area are between 0.15m and 0.6m deep and a maximum flood hazard rating of 'dangerous for some'. Additional areas of ponding are also scattered around the south of the site. Flood depths are a maximum of 0.6 and have a flood hazard rating of 'caution'. The area of ponding along the western boundary of the site increases in depth during the 0.1% AEP flood event to between 0.15m-0.9m. This area has a maximum flood hazard rating of 'dangerous for most'.
Reservoir	From available online maps, a small part of the site is shown to be at risk from reservoir flooding to between a depth of below 0.3m with speeds of below 0.5m/s. The water is largely constrained within the banks of the Wensum.
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 has a >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 western part of 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	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 in the 'The River Wensum, through Norwich' and the 'Riverside properties on the River Wensum, through Norwich' Environment Agency flood warning areas. The site is in the 'The River Wensum from New Costessey to Thorpe Bridge at Norwich' Environment Agency's flood alert area.
Access and egress	Currently access and egress routes to the site are limited by the railway lines to the north and east. To the east, an underpass passes under the railway line- during the 3.3% AEP surface water event , depths in the underpass exceed 1.2m and are highly like to impeded access/egress. The access road to the north crosses over the railway line, however Crenmore lane on the other side of the crossing is affected by depths of up to 0.3m in the 3.3% AEP surface water event, and up to 0.6m in the 0.1% AEP event. Under current day scenarios, access and egress to the east is severely impacted during the 100 and 1,000- year fluvial event scenarios, however the access route to the north remains unaffected. In the 100- and 0.1% AEP Upper End (+65%) scenarios, access and egress to the north will also be substantially impacted. Given the high likelihood of access and egress to the site being impacted during an event, and railway lines limiting the opportunities to create additional access, any development should include a flood warning and evacuation plan and also include suitable places for residents to shelter in situ during an extreme event. This should be located above the maximum flood level in an extreme event including climate change (0.1% AEP +80%), with an allowance for freeboard- approximately 2.5m above ground level.
Dry islands	Part of the site is 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. The site is not currently at risk during the 5-year event. During the 5-year central climate change scenario (+35%), significant areas of the western site are at risk with depths of up to 0.6m, and during the 5-year upper end (+65%) estimate areas of flooding extend across most of the site with depths up to 1.2m. • The site is in future Functional Flood Zone 3b, which is the 5% AEP plus the Upper End (65%) climate change scenario. This flood event results in flooding across the entire western half and much of the eastern side of the site. Flood depths across a significant part of the site range from 0.1m-0.6m. This area has a maximum flood hazard rating of 'dangerous for most'. Flood depths in the western corner of the site are deeper than those seen around the rest of the site. In this area, flood depths are between 0.4m-1.3m and has a flood hazard rating of 'dangerous for most'. • The site is in future Flood Zone 3a, which is the 1% AEP plus the Upper End (65%) climate change scenario. This flood event results in flooding across most of the site. Flood depths across the eastern side of the site range from 0.1m-1m. This area has a maximum flood hazard rating of 'dangerous for most'. Flood depths in the western corner of the site range between 0.6m-1.6m and have a flood hazard rating of 'dangerous for most'. • The site is in future Flood Zone 2, which is the 0.1% AEP plus the Upper End (65%) climate change scenario.. The 0.1% AEP plus the Upper End (65%) climate change scenario results in flooding across the site with depths of between 0.1m and 1.5m present across the site. The highest depth areas are in the west of the site. During this scenario, most of the site has

	a flood hazard rating of 'dangerous for most'. A small proportion of the western corner of the site has a flood hazard rating of 'dangerous for all'. • 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 0.3m-2.2mm. During this scenario, most of the site has flood hazard rating of 'dangerous for most'. A small proportion of the western corner of the site has a flood hazard rating of 'dangerous for all'. • The modelled 1% AEP with 40% Climate Change Surface water flooding shows a minor 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 detention 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.
	• 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	• 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 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 considering climate change upper end scenario with an allowance for freeboard, approximately 1.9m 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 2.5m above ground level.. • **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 highly constrained urban site: ○ Across the East Norwich Regeneration Area, the most vulnerable development should be located on site GNLP3053. ○ 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 1.9mAOD. ○ 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 2.5mAOD. ○ **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. • 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).

- 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, although access should still be available for emergency services. Access is a major concern for this site using the current access road which runs alongside the river (Hardy Road). An alternative access may be required, especially given the significant increase in flood risk due to climate change.
- 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). 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, approximately 1.9m above ground level, and a facility for all occupants to shelter above the extreme fluvial flood event (0.1% AEP) taking into account climate change, approximately 2.5m above ground level. 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 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 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 0.1% AEP event is taken from the Environment Agency's Risk of Flooding from Surface Water mapping.