Greater Norwich Level 2 Strategic Flood Risk Assessment Detailed Site Summary Tables	
Site details	
Site Code	**R31**
Address/ Grid Ref.	Heigham water Treatment Works, Waterworks Road/ 621528,309765
Area	1.37ha
Current land use	Brownfield
Proposed land use	Carried forward residential/mixed use allocation
Sources of flood risk	
Location of site within catchment	The site is in the River Wensum catchment, just upstream of Mile Cross Bridge. The River Wensum is an Environment Agency designated main river and flows from the site 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 on the south bank adjacent the site, having been reinforced enforced with steel and concrete. The north bank opposite the site remains unreinforced, however it is reinforced further downstream as the river flows through Norwich. On the north bank there a number of minor watercourses crossing the Nature reserve and running alongside the main river. There is an artificial water storage area on the site, owing to its previous usage as a waterworks. Currently this area is significantly raised and surrounded by embankments. Should this be altered during any development, a site-specific FRA will be required to assess any changes to the surface water and fluvial flood risk as a result.
Fluvial	**Proportion of site at risk:** **FZ3b –** 0% **FZ3a –** 11% **FZ2 –** 44% **FZ1 –** 56% *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 undefended 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:** Modelling shows that the fluvial extent for an extreme 0.1% AEP event of flooding from the River Wensum covers a wide area (44%) of the site. Furthermore, a small part (11%) of the site is modelled to flood during a 1% AEP event along the northern edge. Less than 1% of the site is at risk during the 5-year event. In the 1% AEP event, the flood extent stretches in a thin and along the northern edge of the site. Flood depths reach up to 0.6m and the modelled flood hazard gives a maximum classification of 'Dangerous for Some'.

	In the 0.1% AEP scenario, a significant minority (44%) of the site is flooded with flood depths of up to 1.9m in the north of the site and up to 0.7m in the centre. The modelled hazard across the flooded areas is dangerous for all, with significant depths and fast flows. The raised area to the southeast of the site remains dry. Currently, there is an artificial water storage feature sided by embankments present on the site as a result of its' history as a water works- this feature is likely to be altered as a result of development and new modelling will be needed to assess the impact on fluvial flooding on the site
Coastal and Tidal	The site is not at risk from coastal or tidal flooding.
Surface Water	**Proportion of site at risk (RoFfSW):** **3.3% AEP** – 0% **1% AEP** – 8% Max depth 0.15-0.3m Max velocity <0.25m/s **0.1% AEP** – 28% Max depth 0.3-0.6mm 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:** From available surface water modelling, the site is at minor risk of surface water entering the site from Heigham street to the west. Flows are low and depths shallow (0-0.15m) and the maximum modelled flood hazard for this area is categorised as 'Low'. Currently, surface water is modelled to pond in the existing water storage area- this feature is likely to be altered as a result of development and new modelling will be needed to assess the impact on surface water flows It is also unclear from available modelling whether a flow from Heigham street to the west enters and crosses the site. Currently modelling appears to show a significant surface water flow passing through a wall opposite Hotback Road and passing west of the site- the actual flow route is unknown. The developer should undertake further modelling, potentially including topographic survey, to determine flow routes across the site.
Reservoir	From available online maps, the entire northern part of the site is shown to be at risk from reservoir flooding to between a depth of 0.3 and 2m, with speeds of 0.5-2m/s across most of the site and over 2m/s in some areas.
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 25% and 50% 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 across 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 historic 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 located within the Environment Agency's 'Riverside properties on the River Wensum, through Norwich, including Bishopgate and Norwich City Football Ground' flood warning area. The site is also located within the Environment Agency's 'The River Wensum form New Costessey to Thorpe Bridge at Norwich' flood alert area.
Access and egress	There is currently one road access point to the site via Heigham Street into the northeast corner of the site. Whilst the site itself is substantially affected, access/egress via Heigham Street remains unaffected even in the 0.1% AEP event. This access route remains unaffected during the 0.1% AEP event under the Upper End (+65%) climate change scenario. A Flood Warning and Evacuation Plan should be prepared for the site.
Dry islands	The site is not located on a dry island.

Climate change

Implications for the site	• The site is extremely sensitive to climate change causing increased in fluvial flows in the River Wensum, particularly around more frequent flood events. The southern section of the site is significantly raised to be unaffected during even the most extreme events however the northern section is at a high risk of flooding in the future. Modelled flood extents do not however change significantly between the Central (+35%) and Upper End (+65%) Scenarios. • The northern section of the site, with the exception of the raised area, is in Future Functional Flood Zone 3b which is the 5% AEP flood plus the Upper End (+65%) climate change scenario. This results in 22% of the site being flooded up to a maximum depth of 1.1m. The highest depths are seen along the northern edge of the site, adjacent the river. Flood depths across the rest of the site are shallower, reaching up to 0.8m, generally decreasing away from the river towards the south of the site. This represents a significant increase from the present-day risk, as under present day conditions, the site is not at risk of fluvial flooding during the 5% AEP event. • There is a significant expansion in flood extent between the 5% AEP Upper End (+65%) and the 1% AEP Upper End (+65%) scenarios. 44% of the site is in Future Flood Zone 3a, compromising most of the site excluding the raised water storage area. Flood depths are also significantly higher under this scenario, reaching up to 1.0m in the south, and up to 1.8m in the north adjacent the river. The modelled flood hazard for the majority of the flooded area is dangerous for all. • There is no significant change in flood extent on the site between the 1% AEP Upper End (+65%) and 0.1% AEP Upper End (+65%) scenarios, meaning 72% of the site is in Future Flood Zone 2. Again, this comprises the entire northern section of the site with the exception of the raised water storage area. Flood depths across the site are significantly greater under this scenario, reaching up to 2.4m in the north of the site adjacent the river and up to 1.3m away from the river to the south. The modelled flood hazard across the flooded area is dangerous for all. **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 – River Terrace Deposits - Sand and Gravel; Alluvium - Clay, Silt, Sand and Gravel (northern third).
	
	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 where site slopes are <5% at the location of the detention feature. If the site has contamination or groundwater issues, a liner will be required. In the southern third of the site, mapping suggests slopes are >5% therefore detention is unlikely to be feasible here. Feasibility should be assessed as part of a site-specific assessment. • Filtration is probably suitable where 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. In the southern third of the site, mapping suggests slopes are >5% therefore filtration is unlikely to be feasible here. • 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 opportunities 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. For the northern portion of the site, this is approximately 2.1m above ground level at the greatest. • Access/egress should be via Heigham Street and the detail set out in a flood warning and evacuation plan.
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 Exception Test will apply at this site. • The NPPF classifies residential development as 'More Vulnerable'. As the north of the site is mostly covered by Flood Zones 3a and 3b, the Exception Test is required for the site. • A significant portion majority of the site is covered by Future Flood Zone 3, highlighting the need for a precautionary approach including application of the Exception Test.
Requirements and guidance for site-specific Flood Risk Assessment	**Flood Risk Assessment:** • At the planning application stage, a site-specific Flood Risk Assessment will be required as the development is located in Flood Zone 3a and 3b. • 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 vulnerable urban site: o A resilient approach to urban design should be taken. Habitable floor levels in the north of the site must be above the 1% AEP flood level taking into account climate change (upper end scenario) with an allowance for freeboard- approximately 2.1m above ground level. o Access/egress should be via Heigham Street and the detail set out in a flood warning and evacuation plan. o 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, supported by a Flood Warning and Evacuation plan. 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. 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.

- 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).
- 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. Current surface water mapping indicates that a significant surface water flow exists through the site, however the exact route and flow depths are not clear. Any development should be accompanied by a site-specific assessment of surface water flood risk, including a topographic survey. A drainage strategy should help inform site layout and design to ensure there is no increase in runoff beyond current rates.
- 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.
- 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).
- There is an existing artificial water storage feature on the site, as a result of its' history as a waterworks. The structure is raised and is sided by embankments- should this structure be altered by development, a site specific FRA will need to identify and mitigate any changes to fluvial and surface water flood risk as a result.
- 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 may 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 flood evacuation and warning plan put in place.
- The most vulnerable region of the site, the northwest adjacent the river is left undeveloped.
- If flood mitigation measures are implemented then they are tested to ensure that they will not displace water elsewhere (for example, if land is raised to permit development on one area, compensatory flood storage will be required in another)
- Space for surface water to be stored on the site is provided and rainwater harvesting should be considered.
- Brownfield sites should discharge surface water at the original pre-development (greenfield) runoff rate. If this is not possible, a significant reduction in the current rate of discharge should be achieved and agreed with the relevant drainage body (LLFA, IDB or Anglian Water). Safe access and egress routes must not be in the areas of high surface water risk or the 1% AEP fluvial design flood event (taking into account climate change).
- The only site access point would be from Heigham Street to the east. A Flood Warning and Evacuation Plan should be prepared for the site.

Mapping Information

The key datasets used to make planning recommendations regarding this site were the broadscale 2D modelling outputs from the Environment Agency's Flood Map for Planning, River Wensum Flood Model and the Risk of Flooding from Surface Water map. More details regarding data used for this assessment can be found below.

Flood Zones	Flood Zones 2 and 3 have been taken from the Environment Agency's Flood Map for Planning mapping.
Climate change	Climate change allowances (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.