

Figure 5. Model Node Location Map

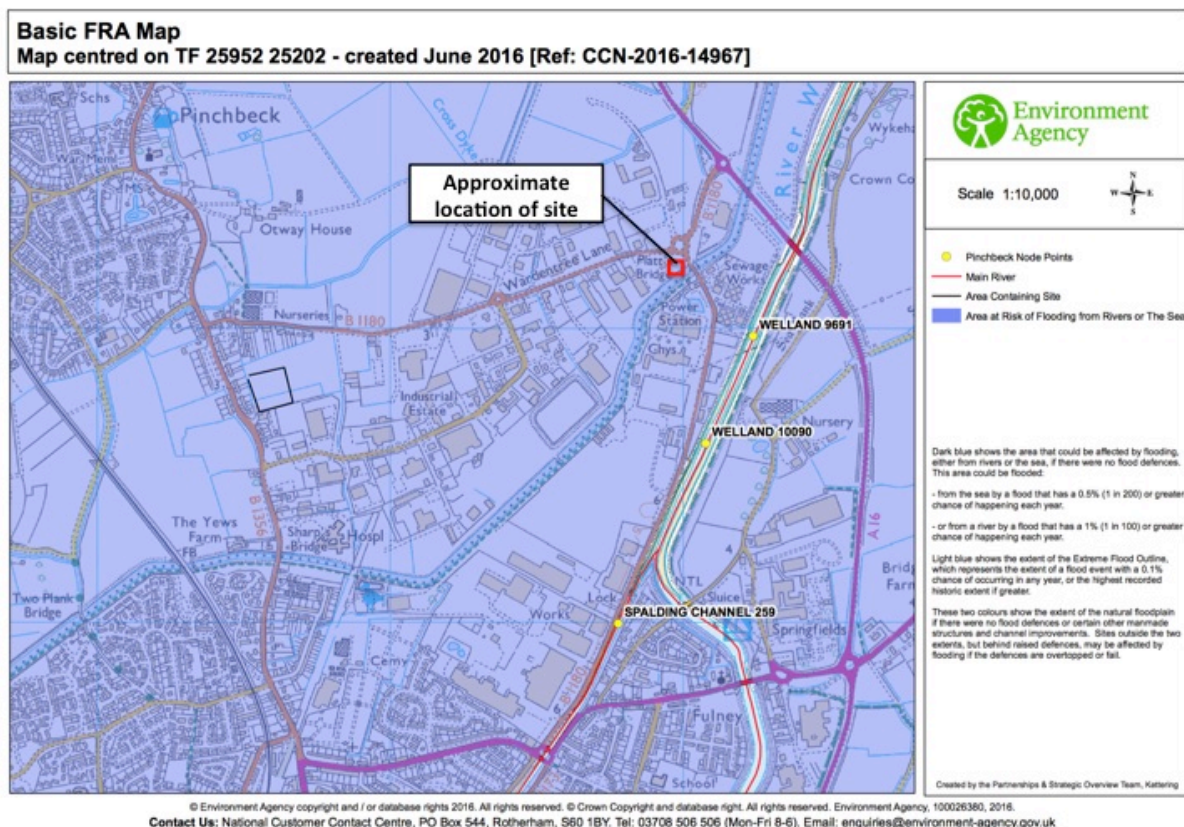


Table 4 –Modelled Water Levels

Node Label	Easting	Northing	Annual Exceedance Probability - Maximum Water Levels (mODN)										
			50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	4% (1 in 25)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
SPALDING CHANNEL 259	525779	323995	4.04	4.23	4.29	4.34	4.40	4.42	4.43	4.68	4.44	4.45	4.69
WELLAND 10090	526078	324609	4.12	4.11	4.15	4.20	4.24	4.25	4.25	5.26	4.26	4.27	5.25
WELLAND 9691	526240	324975	4.11	4.10	4.14	4.19	4.22	4.23	4.23	5.25	4.24	4.25	5.25

Comparison of Modelled Water Levels and Site Levels

The modelled water levels have been compared with the existing site levels (Table 5). The site levels have been derived from the topographic map (Appendix B). Table 5 shows that the site will not be flooded by the 1 in 100 year and 1 in 1000 year events. However, the site is subject to a shallow flooding (maximum flood depth 0.33m) by the 1 in 100 year plus climate change event. As the flood depth is relatively shallow and the site topography is flat where we can expect a relatively low flow velocity, it is reasonable to conclude that the hazard to the people and the property will not be significant.

Table 5 – Comparison of modelled water levels and the site levels

Events	Modelled levels, mAOD	Site Level, mAOD	Potential flood depth, m
1 in 100 year (1% AEP)	4.23	4.92	No flooding
1 in 100 year (1% AEP) plus climate change	5.25	4.92	0.33
1 in 1000 year (0.1% AEP)	4.25	4.92	No flooding

3.4. Tidal Flood Risk

The River Welland at this location is not affected by tidal flood waves. The risk of flooding from this source is therefore low.

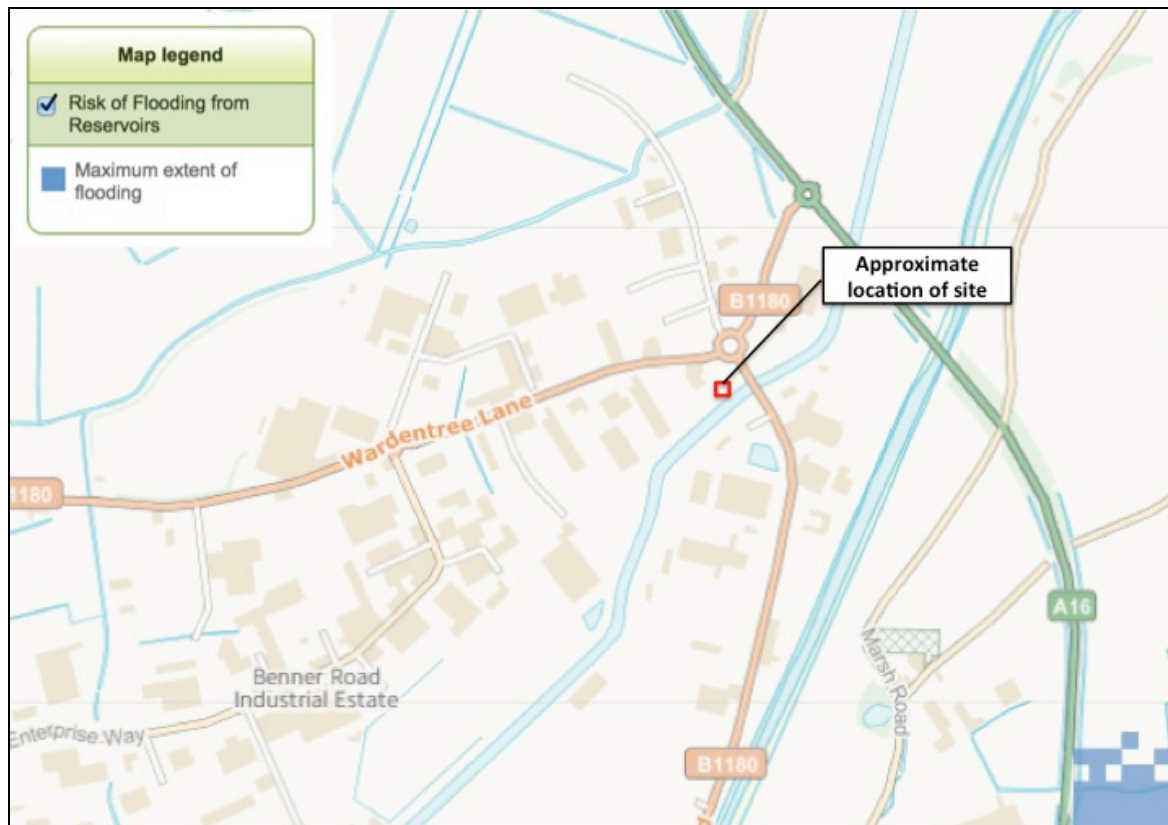
3.5. Flood Risk from Artificial Water Bodies

The Vernatt's Drain flows along the eastern site boundary. There were no records of flooding from this watercourse. The risk of flooding from this watercourse to the proposed development site is low.

3.6. Reservoir Flood Risk

According to the Environment Agency's reservoir flood risk map, the proposed development site is located outside of the maximum extent of flooding (Figure 6). According to the Environment Agency, the reservoir flooding is extremely unlikely to happen. There has been no loss of life in the UK from reservoir flooding since 1925. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the Environment Agency ensure that reservoirs are inspected regularly and essential safety work is carried out.

Figure 6. Reservoir Flood Risk Map



3.7. Groundwater flooding

Groundwater flooding usually occurs following a prolonged period of low intensity rainfall. Predicting groundwater flooding is often complex as groundwater levels are heavily influenced by the underlying geology and the topography and geology of the surrounding catchment areas. Groundwater flooding can occur following extended periods of heavy rainfall (either local or within the aquifer catchment area) and can occur many hours or even days after the precipitation has finished and can remain in-situ for long periods of time. Other factors that can influence groundwater levels include reduced abstraction rates or changes to underground flows.

Groundwater flooding is difficult to apportion as groundwater flooding usually occurs in combination with pluvial and fluvial flooding. As groundwater flooding occurs in low-lying areas, basements of residential housing and commercial buildings are usually impacted by this type of flooding. However, according to the SFRA, no records of historical flooding in this area have been found.

Evidence of historical groundwater flooding within the SFRA is very limited, however it is important to recognise that the risk of groundwater flooding is highly variable and heavily

dependent upon local conditions at any particular time. The future risk from this source is more uncertain than surface water as the climate change predictions indicate that although sea levels will rise, thus possibly raising groundwater levels, overall summer rainfall will decrease, therefore having a long-term effect of lowering the groundwater levels. However, long periods of wet weather are predicted to increase: these are the type of weather patterns that can cause groundwater flooding to occur. According to the information available from the landowner, there were no records of any groundwater flooding incidents around the site. Based on these evidences and information, it is reasonable to consider that the risk of groundwater flooding to the site is low.

3.8. Surface Water Flood Risk

When the infiltration capacity of land or the drainage capacity of a local sewer network is exceeded, excess rainwater flows overland; this water will collect in topographic depressions and at obstructions, and can inundate development downslope. The severity of the rainfall event, the degree of saturation of the soil before the event, the permeability of soils and geology, hill slope steepness and the intensity of land use all contribute to and affect the severity of overland flow.

The Environment Agency most recent flood map for surface water published in December 2013 is freely available online at their website and can be used to see the approximate areas that would experience surface water flooding from a variety of rainfall return periods. The risk is categorised based on annual probability of occurrence. The different risk categories are displayed in Table 6 below.

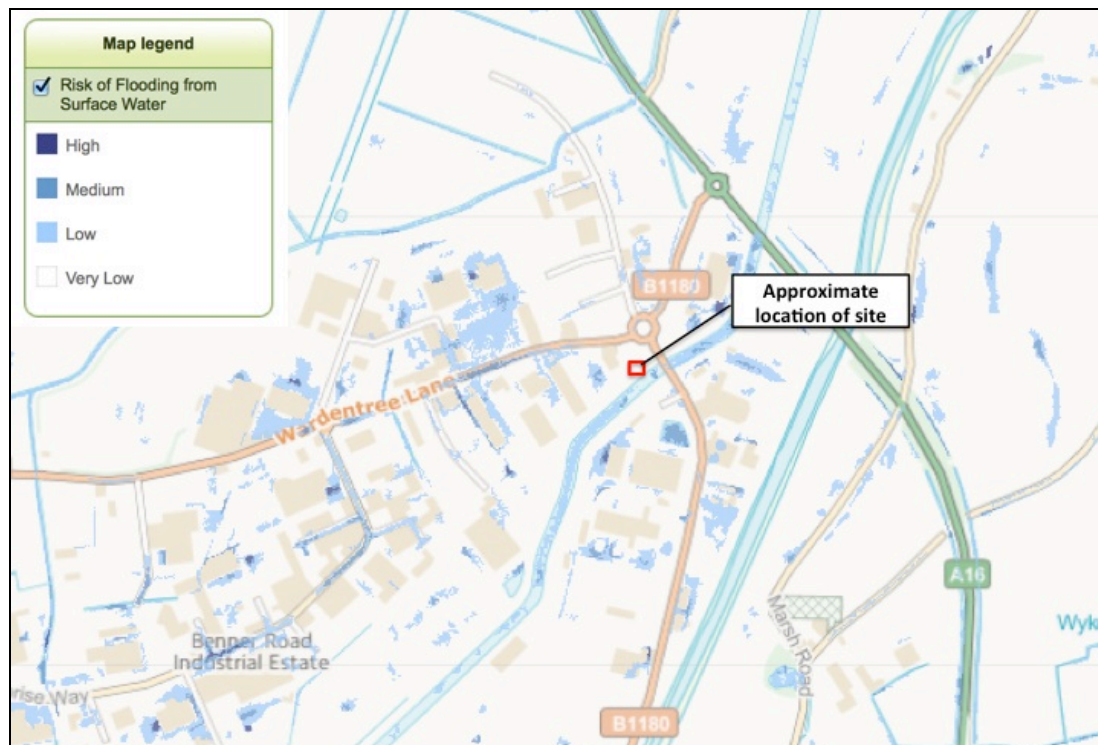
Table 6 - Environment Agency Surface Water Risk Categories

Environment Agency Surface Water Risk Category	Surface water flooding annual probability of occurrence
Very Low	Less than 0.1% (1 in 1000 years)
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	Greater than 3.3% (1 in 30 years)

The Environment Agency's surface water flood map (Figure 7) indicates that the risk of surface water flooding at the site is 'very low'.

As the majority of the area around the site is heavily developed, overland flow typically tends to occur when surface water cannot enter overloaded drainage systems during significant rainfall events. There is therefore an inherent link between sewer flooding and overland flow/surface water flooding.

Figure 7 - Environment Agency's Surface Water Flood Map



3.9. Sewer flooding

Sewer flooding is often caused by excess surface water entering the drainage network causing sewers to surcharge. In lowland areas the topography results in dispersal over a wide area. Local flooding of this kind is often exacerbated by deficiencies in the local surface water drainage system, temporary blockages or saturated ground conditions. These can often be remedied through reactive management once they have been identified in a flooding event.

There were very limited information about sewer flooding incidents in the SFRA. According to the information available from the landowner, there were no sewer flooding incidents around the site.

It is important to note that previous sewer flood incidents or the lack thereof do not indicate the current or future risk to the site as upgrade work could have been carried out to alleviate any issues or conversely in areas that have not experienced sewer flooding incidents the local drainage infrastructure could deteriorate leading to future flooding.

3.10. Climate Change

There is clear scientific evidence that global climate change is happening now. In the UK sea level has risen and more winter rain has fallen in intense wet spells over the past century. Seasonal rainfall is highly variable. It seems to have decreased in summer and increased in

winter, although winter amounts changed little in the last 50 years. Some of the changes might reflect natural variation; however the broad trends are in line with projections from climate models.

The National Planning Policy Framework (NPPF) sets out how the planning system should help minimise vulnerability and provide resilience to the impacts of climate change. NPPF and supporting planning practice guidance on Flood Risk and Coastal Change explain when and how flood risk assessments should be used. This includes demonstrating how flood risk will be managed now and over the development's lifetime, taking climate change into account. Local planning authorities refer to this when preparing local plans and considering planning applications.

The Environment Agency released new climate change guidance for flood risk assessments on 19th February 2016 outlining the allowances for the impact of climate change on peak river flows, peak rainfall intensities, sea level rise, offshore wind speeds and extreme wave height. They are based on climate change projections and different scenarios of carbon dioxide (CO₂) emissions to the atmosphere. There are different allowances for different epochs or periods of time over the next century.

The range of allowances in Table 7 below is based on percentiles. A percentile is a measure used in statistics to describe the proportion of possible scenarios that fall below an allowance level. The 50th percentile is the point at which half of the possible scenarios for peak flows fall below it and half fall above it. The central allowance is based on the 50th percentile, higher central is based on the 70th percentile and the upper end is based on the 90th percentile.

Table 7 - Peak river flow allowances by river basin district (use 1961 to 1990 baseline)

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
Humber	Upper end	20%	30%	50%
	Higher central	15%	20%	30%
	Central	10%	15%	20%
Anglian	Upper end	25%	35%	65%
	Higher central	15%	20%	35%
	Central	10%	15%	25%

South East	Upper end	25%	50%	105%
	Higher central	15%	30%	45%
	Central	10%	20%	35%
Thames	Upper end	25%	35%	70%
	Higher central	15%	25%	35%
	Central	10%	15%	25%
South West	Upper end	25%	40%	85%
	Higher central	20%	30%	40%
	Central	10%	20%	30%
Severn	Upper end	25%	40%	70%
	Higher central	15%	25%	35%
	Central	10%	20%	25%
Dee	Upper end	20%	30%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%
North West	Upper end	20%	35%	70%
	Higher central	20%	30%	35%
	Central	15%	25%	30%
Solway	Upper end	20%	30%	60%
	Higher central	15%	25%	30%
	Central	10%	20%	25%
Tweed	Upper end	20%	25%	45%
	Higher central	15%	20%	25%
	Central	10%	15%	20%

Using peak river flow allowances for flood risk assessments

The guideline suggests to consider the flood zone and the appropriate flood risk vulnerability classification to decide which allowances applies to the development or plan.

In flood zone 2

Essential infrastructure – use the higher central and upper end to assess a range of allowances

Highly vulnerable – use the higher central and upper end to assess a range of allowances

More vulnerable – use the central and higher central to assess a range of allowances

Less vulnerable – use the central allowance

Water compatible – use none of the allowances

In flood zone 3a

Essential infrastructure – use the upper end allowance

Highly vulnerable – development should not be permitted

More vulnerable – use the higher central and upper end to assess a range of allowances

Less vulnerable – use the central and higher central to assess a range of allowances

Water compatible – use the central allowance

In flood zone 3b

Essential infrastructure – use the upper end allowance

Highly vulnerable – development should not be permitted

More vulnerable – development should not be permitted

Less vulnerable – development should not be permitted

Water compatible – use the central allowance

The site is located within the Anglian River Basin District. As the proposed development is categorised as 'less vulnerable and is located in Flood Zone 3a, the guideline recommends to use the central and higher central to assess a range of allowances. The central and higher central allowances for the Anglian River Basin District are 25% and 35% respectively for the period between 2070 and 2115.

All of these allowances are greater than that currently used and incorporated into the Environment Agency's existing Fluvial Flood Model Levels. In order to account for the new climate change allowances, the models should be updated by incorporating the higher peak flow estimates with the central and higher central allowances for the similar development.

4.0 Mitigation Measures

4.1. Flood Resilient Measures

The Communities and Local Government's guideline on 'Improving the Flood Performance of New Buildings' stressed that knowing the characteristics of a particular flood is essential when designing a building to be resilient or resistant to flooding as it enables selection of the most appropriate form of mitigation measures.

A range of flood resilient methods is available as suggested by the guideline. The following flood resilient methods should be adopted where practicable to manage the residual risk of flooding:

- Where possible, all service entries should be sealed (e.g. with expanding foam or similar closed cell material).
- Pipework: Closed cell insulation should be used for pipes which are below the predicted flood level.
- Drainage services: Non-return valves are recommended in the drainage system to prevent back-flow of diluted sewage in situations where there is an identified risk of the foul sewer surcharging. Maintenance of these valves is important to ensure their continued effectiveness.
- Water, electricity and gas meters: should be located above predicted flood level.
- Electrical services: electrical sockets should be installed above flood level for ground floors to minimise damage to electrical services and allow speedy re-occupation. Electric ring mains should be installed at first floor level with drops to ground floor sockets and switches.
- Communications wiring: wiring for telephone, TV, Internet and other services should be protected by suitable insulation in the distribution ducts to prevent damage. Any proposed design solution for flood insulation on all potentially vulnerable wiring should be discussed with the relevant service providers.
- Engineering bricks (Classes A and B) should be used which has 'good' resilience in terms of water penetration, drying ability and retention of pre-flood dimensions and integrity.
- Building materials that are effective for a 'water exclusion strategy' include: engineering bricks, cement-based materials including water retaining concrete and dense stone.
- Building materials that are suitable for a 'water entry strategy' include: facing bricks, concrete blocks, sacrificial or easily removable external finishes or internal linings.

More detailed information about flood resilience can be found on the Environment Agency website (www.environment-agency.gov.uk) and in 'Improving the flood performance of new buildings' (www.planningportal.gov.uk/uploads/br/flood_performance.pdf).

4.2. Flood Warning and Evacuation

As the site is located within a flood zone area, it will be necessary to make sure that the people are fully aware of the flood risk and existing flood warning and evacuation during the extreme event.

4.2.1. Flood Warnings Direct

The Environment Agency operates a free flood warning service called Floodline Warnings Direct (FWD) which can give advance notice of when tidal flooding is likely to happen and time to prepare for a flood event. Property owners on the proposed development site will be able to sign up to FWD online using the following channels (Table 8):

Table 8- Contacts for flood warning services

Channel	Details
Online	https://fwd.environment-agency.gov.uk/app/olr/register
Telephone	0845 988 1188

4.2.2. Flood Warning Service

The Environment Agency provides a Flood Warning Service throughout England and Wales in areas at risk of flooding from rivers or the sea. This is provided using up to date rainfall, river level and sea condition monitoring 24 hours a day to forecast the possibility of flooding. If flooding is forecast, the Environment Agency will issue warnings using a set of three different warning types (Table 9). Many areas of England are covered by the full four stages of the Environment Agency's Flood Warning Service, including the site (Figure 8). The Environment Agency's Flood Warning target lead time; the time between a flood warning being issued and the onset of flooding is approximately two hours. Providing the Environment Agency can meet their target Flood Warning lead time, the occupants of the proposed development will have two hours to ensure that property is relocated to minimise risk and evacuation to safe locations can be carried out.

Figure 8 - Environment Agency's Flood Warning Areas

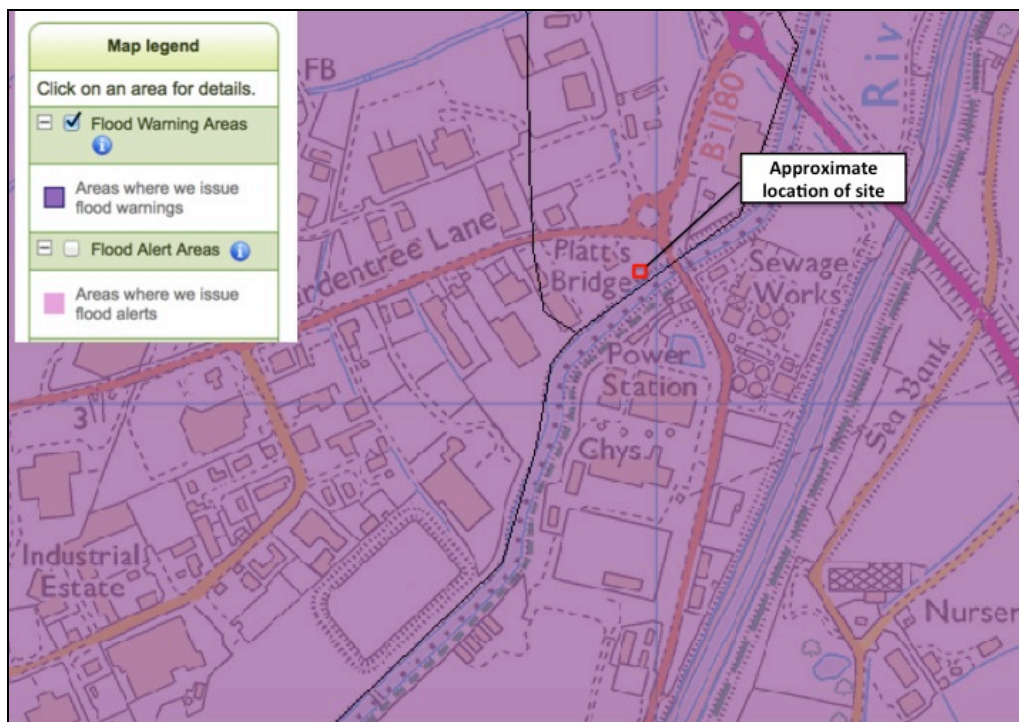


Table 9 - Environment Agency's Flood Warning Codes

Flood Warning Code	What it Means	What To Do
 FLOOD ALERT	Flooding is possible. Be prepared.	Be prepared to act on your flood plan. Prepare a flood kit of essential items. Monitor local water levels and the flood forecast on our website.
 FLOOD WARNING	Flooding is expected. Immediate action required.	Move family, pets and valuables to a safe place. Turn off gas, electricity and water supplies if safe to do so. Put flood protection equipment in place.
 SEVERE FLOOD WARNING	Severe flooding. Danger to life.	Stay in a safe place with a means of escape. Be ready should you need to evacuate from your home. Co-operate with the emergency services. Call 999 if you are in immediate danger.

Warnings no longer in force	No further flooding is currently expected in your area.	Be careful. Flood water may still be around for several days. If you've been flooded, ring your insurance company as soon as possible.

4.3. Surface Water Runoff Management

The surface runoff from the site will be improved by implementing appropriate Sustainable Drainage Systems (SuDS) which have been described in the section below.

4.3.1. Sustainable Urban Drainage Systems (SuDS)

The requirements for SuDS will ensure that any redevelopment or new development does not negatively contribute to the surface water flood risk of other properties and instead provides a positive benefit to the level of risk in the area. It will also ensure that appropriate measures are taken to increase the flood resilience of new properties and developments in surface water flood risk areas, such as those identified as being locally important flood risk areas.

Paragraph 1.3.2 from the SuDS manual (C697) discusses the SuDS 'management train' which is intended to mimic the natural catchment process as closely as possible. The hierarchy of techniques used to achieve the management train are shown in Table 10 below.

Table 10 Hierarchy of SuDS techniques

Technique	Description
Prevention	The use of good site design and housekeeping measures to prevent runoff and pollution (e.g. rainwater harvesting/reuse).
Source control	Control of runoff at or very near its source (e.g. soakaways, porous and pervious surfaces, green roofs).
Site control	Management of water in a local area on site (e.g. routing water to large soakaways, infiltration or detention basins)
Regional control	Management of runoff from a site or several sites (e.g. balancing ponds, wetlands).

There is an opportunity for the application of minimal SuDS techniques (Table 11):

Table 11 Feasible SuDS techniques for the site

Technique	Issues	Feasibility
Prevention Good site design and housekeeping/rainwater harvesting/infiltration devices/education.	Surface runoff can be improved by implementing rainwater harvesting using water butts.	Yes
Source Control Porous and pervious materials/soakaways/green roof/infiltration trenches/disconnect downpipes to drain to lawns or infiltrate to soakaway.	Presence of clay and fine soil means the infiltration measures may not be effective. Feasibility of soakaways or porous pavement will require field infiltration tests.	No
Site and Regional Control Infiltration/detention basins/balancing ponds/wetlands/underground storage/swales/retention ponds.	Balancing ponds/wetlands will not be feasible due to limited space available.	No

5.0 Conclusion

The proposal involves erection of temporary buildings at Scania (Great Britain) Ltd, Warden Tree Lane, Spalding PE11 3UG.

The proposed development is categorised as 'less vulnerable'.

The site is located in close proximity to the River Welland with the risk of fluvial flooding. There were no records of flooding around the site.

The Environment Agency's flood map indicated that the site lies within Flood Zone 3 (high probability flooding) and the risk of flooding is 'medium'.

The Environment Agency's modelling data indicated that the site will not be flooded by the 1 in 100 year and 1 in 1000 year events. However, the site is subject to a shallow flooding (maximum flood depth 0.33m) by the 1 in 100 year plus climate change event. As the flood depth is relatively shallow and the site topography is flat where we can expect a relatively low flow velocity, it is reasonable to conclude that the hazard to the people and the property will not be significant.

There is a low risk of flooding from other sources including surface water, underground water, sewer and reservoir.

As part of the flood risk management, the residents should be made aware of potential flood risk and flood warning services. It is recommended that the residents should utilise the

Environment Agency's Flood Warnings Direct and the Flood Warning Service available in the area.

The surface runoff from the site will be improved by implementing appropriate Sustainable Drainage Systems (SuDS). It is proposed to implement rainwater harvesting system using water butts from the buildings.

This report demonstrates that the proposal will be safe, in terms of flood risk, for its design life and will not impose any flood risk elsewhere.

Appendix A Environment Agency's Data and Information

Appendix B Topographic Map of the Site
