



Powell Tolner & Associates Ltd

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

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1 INTRODUCTION

Powell Tolner and Associates Limited (PTA) have been commissioned by Knowsley (Image Business Park) Ltd to produce a Flood Risk Assessment (FRA) and drainage strategy report in order to support the planning application for a proposed industrial development onto a greenfield site at Acornfield Road, Knowsley.

The National Planning Policy Framework (NPPF) was published in March 2012, and updated in February 2019 by the Department of Communities and Local Government and replaced all planning policy statements including Planning Policy Statement 25 (PPS 25): Development and Flood Risk. The NPPF set out the Government's planning policies for England and how these are expected to be applied. The Planning Practice Guidance (PPG), provides additional guidance and retains key elements of the now superseded PPS 25.

An initial search on the Environment Agency's (EA) website has identified the development site to be located within Flood Zone 1 and is considered to be very low risk of flooding.

The purpose of this report is to provide details of the site Flood Risk and provide a drainage strategy to cope with surface water runoff generated by the proposed development and mitigate any potential downstream impacts.

2 DEVELOPMENT DESCRIPTION

2.1 Location

The site is located within an industrial zone area of Knowsley at OS Grid SJ 43767 98801 (E:343767, N:398801) and sits between Acornfield Road and Perimeter Road, as shown in Figure 1. The northern site boundary is bounded by an existing access road, which provides entry to other industrial units, and the south boundary is aligned with existing industrial units as shown on the aerial map in Figure 2. The site has a plan area of 2.246ha (22,457m²).

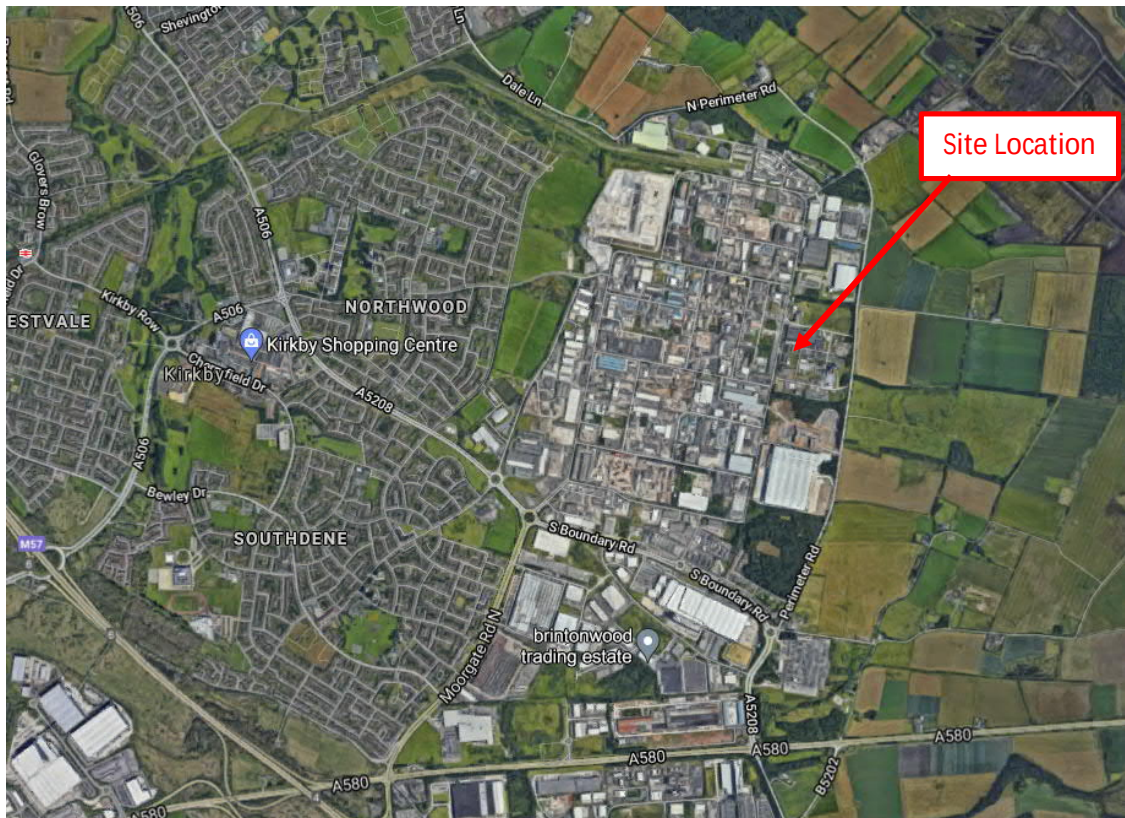


Figure 1: Site Location (Google Maps © Bluesky 2021)

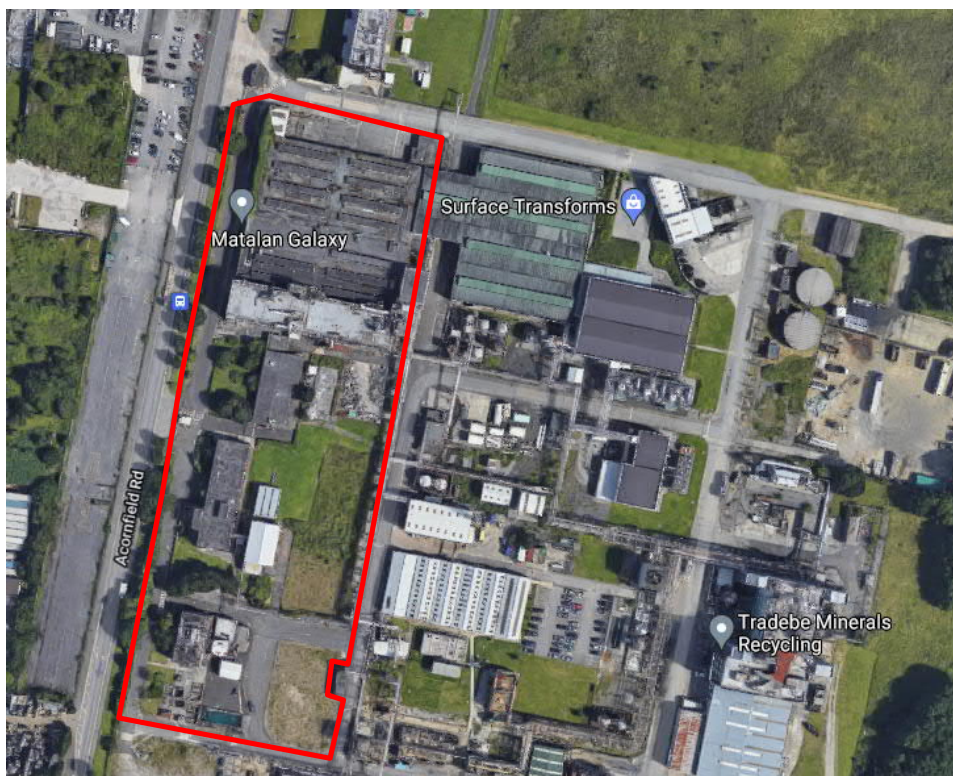


Figure 2: Aerial Photo (Google Maps © Bluesky 2021)

2.2 Existing Site

A pre-development topographical survey was carried out by Survey & Engineering Projects ref. S15946-T, dated April 2018. Based on the survey the site slopes towards the north-western corner, with a highpoint to the north-eastern side. Since the existing structure was demolished, the area mainly consists of the former building slab, associated hardstanding and a small green area. The site topographical survey is shown in Appendix A.

Existing Site Area	
Roof	7,299m ²
Hard Landscaping Area	10,546m ²
Soft Landscaping Area	4,612m ²
Total	22,457m ²

Table 1: Existing Areas

2.3 Proposals

The site covers an area of approximately 22,457m² of which 10,505m² is proposed to be roof area and 9,622m² is external hardstanding. The remaining areas will be soft landscaping. The

proposed development will be made up of an industrial unit as shown on Hale Architect drawing in Appendix B.

Proposed Site Area	
Roof	10,505m ²
Hard Landscaping Area	9,622m ²
Soft Landscaping Area	2,330m ²
Total	22,457m ²

Table 2: Proposed Areas

2.4 Flood Vulnerability Classification

The EA Flood risk map shows the site is located within Flood Zone 1, with a low probability of flooding. This is less than 1 in 1000 (<0.1%) annual probability of flooding from rivers and seas.

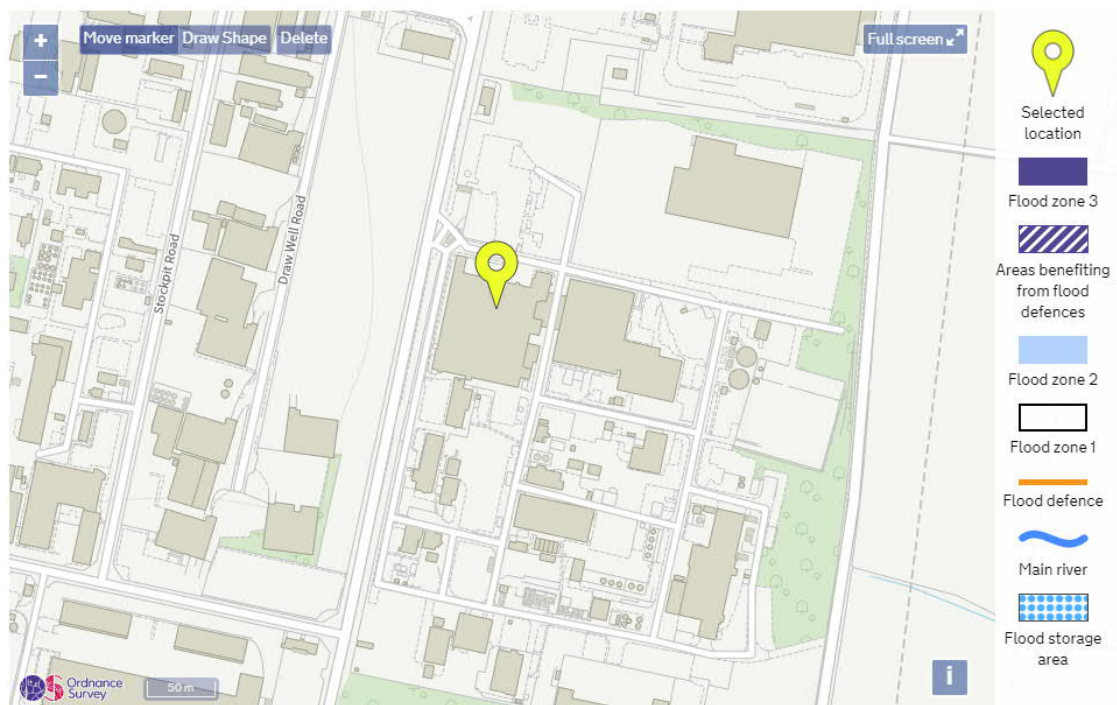


Figure 3: EA Flood Map

2.5 Flood Zone Compatibility

In accordance with the NPPF, there are no restrictions upon the type of development within Flood Zone 1. As such the proposed development is compatible within Flood Zone 1. Also, as the site is in Flood Zone 1 the need for an exception test is not required.

3 FLOOD RISK

In accordance with the NPPF and its Technical Guidance document, the risk of flooding from varying sources needs to be considered.

3.1 Rivers

The site is not within any watercourse influence. The closest recorded watercourse based on the EA maps is approximately 750m to the North away from the site and does not impose any flood risk to the proposed development.



Figure 4: Watercourse Location

3.2 Tidal

The site is not within the tidal influence.

3.3 Ground Water

Groundwater flooding is highly variable and dependant on local conditions. An investigation has been carried out through BGS borehole logs. Based on the boreholes results, the groundwater is at an average depth 2.0m from the existing surface. Boreholes logs are shown in Appendix H.

The figure 5 below shows the location of boreholes available within the site.

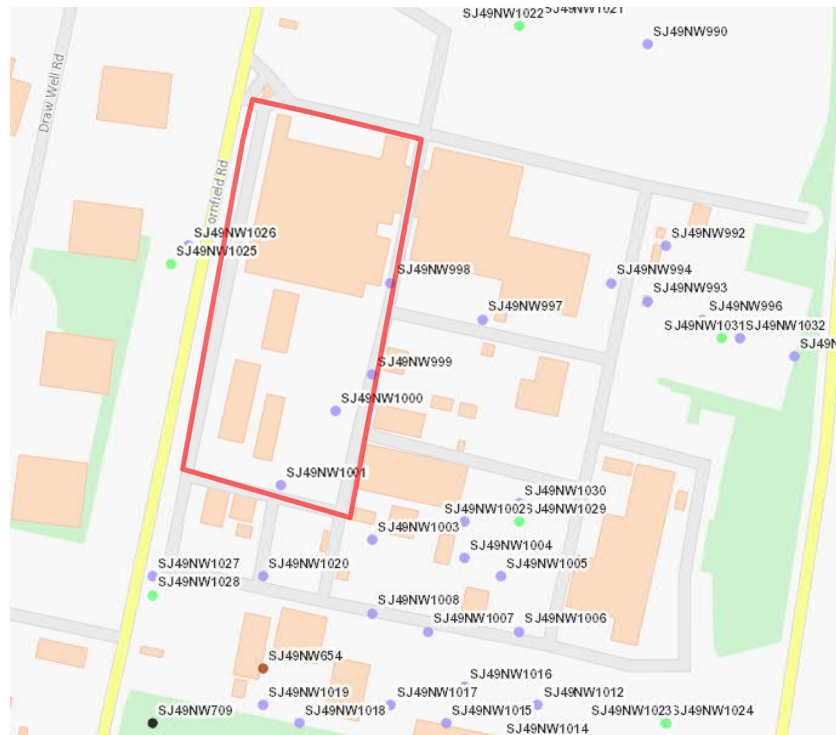
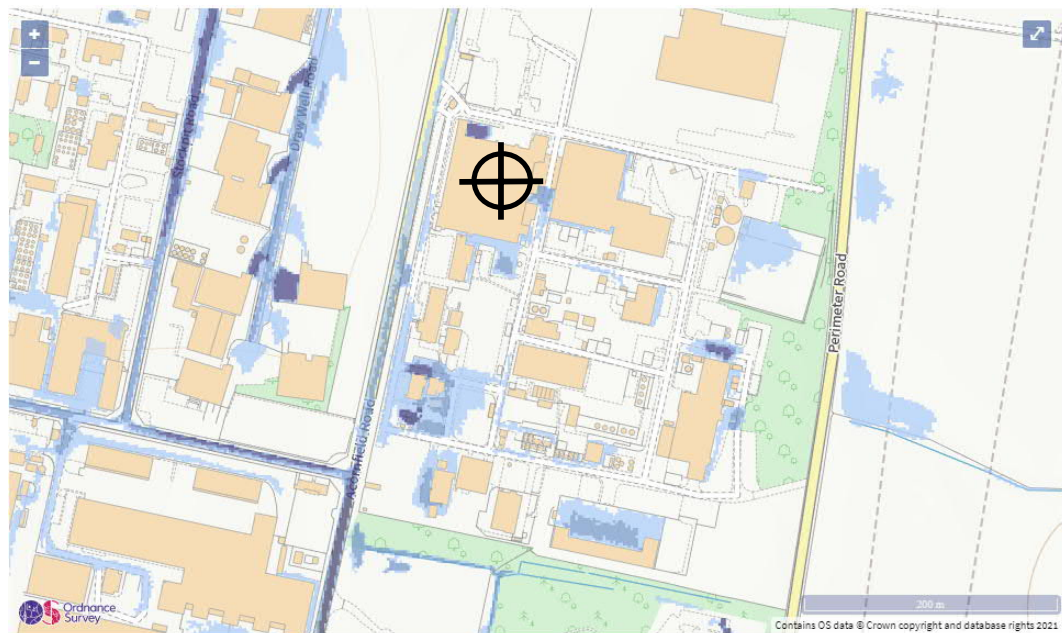


Figure 5: Boreholes' Location

Considering the above, the risk of flooding from groundwater is very low and if any groundwater flooding occurs, it would behave as overland flows and based on the proposed topography of the site it should be directed away from the proposed buildings toward the south boundary.

3.4 Overland Flows

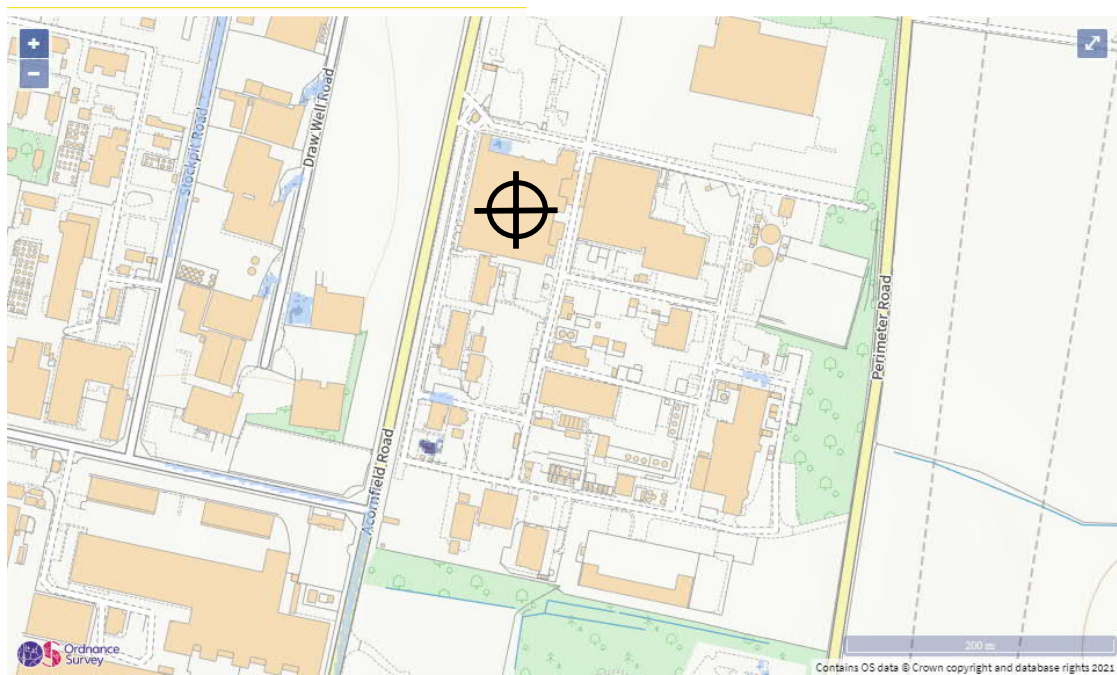
Based on the topographical survey the site levels slope from a high point of 42.820m AOD to the north-east and falls to the south-west, with a low point of 41.390m AOD. The risk of flooding associated within the site areas are shown on the EA surface water flood risk map (Figure 6). The flood depth and velocities in all scenarios, including the high-risk scenario is considered to be very low or negligible as shown in Figures 6, 7 & 8 below.



Extent of flooding from surface water

● High ● Medium ● Low ○ Very low ⊕ Location you selected

Figure 6: EA Surface Water Flood Risk Map



Surface water flood risk: water depth in a high risk scenario

Flood depth (millimetres)

● Over 900mm ● 300 to 900mm ● Below 300mm ⊕ Location you selected

Figure 7: EA Surface Water Flood Risk Map - Flood Depth in High Risk Scenario

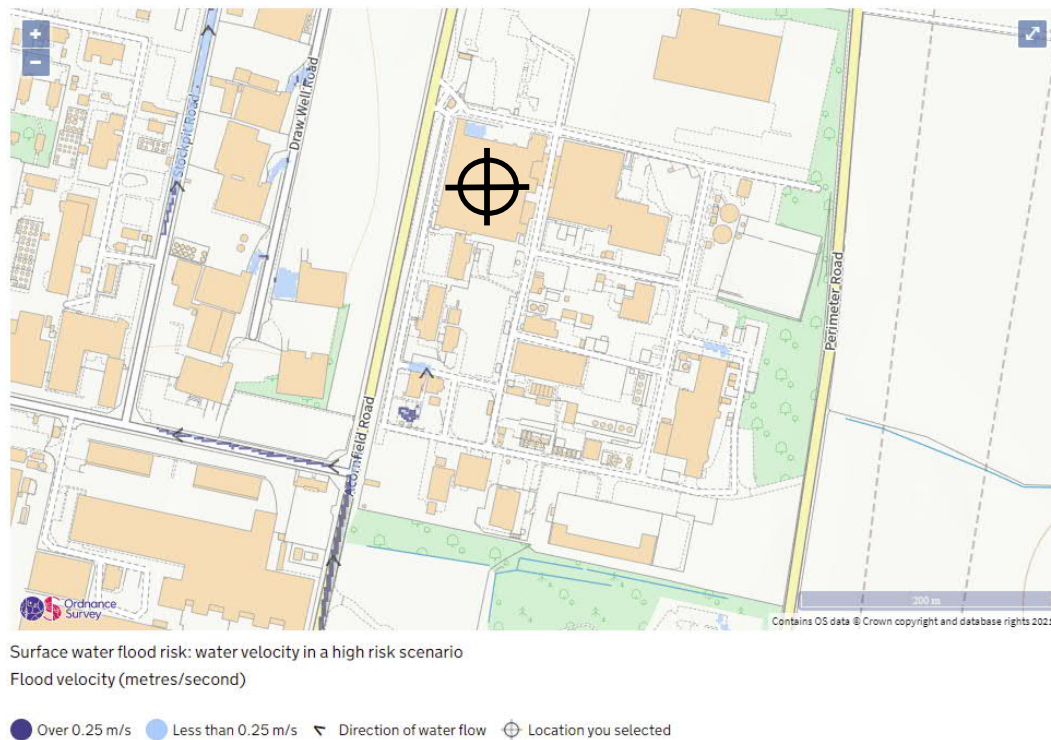


Figure 8: EA Surface Water Flood Risk Map - Flood Velocity in a High-Risk Scenario

3.5 Sewers

The United Utilities Sewer Records (Appendix C) shows no sewers running through the site. There are surface and foul drainage assets to the north-east of the site within Acornfield Road. As the site seeks to reduce the existing brownfield area runoff, the risk of flooding from sewers is very low.

The residual risk when potential blockages within the sewer causes surcharging into the site. In this event of, the surface water exceedance would behave as overland flows, flowing mainly to the south of the site, avoiding the proposed buildings as shown in Appendix D.

3.6 Other Sources

As shown by the EA map below (Figure 9), there is no risk of flooding from reservoirs. There are no other known sources of flooding within the vicinity of the site and the risk of flooding from other sources is considered very low.

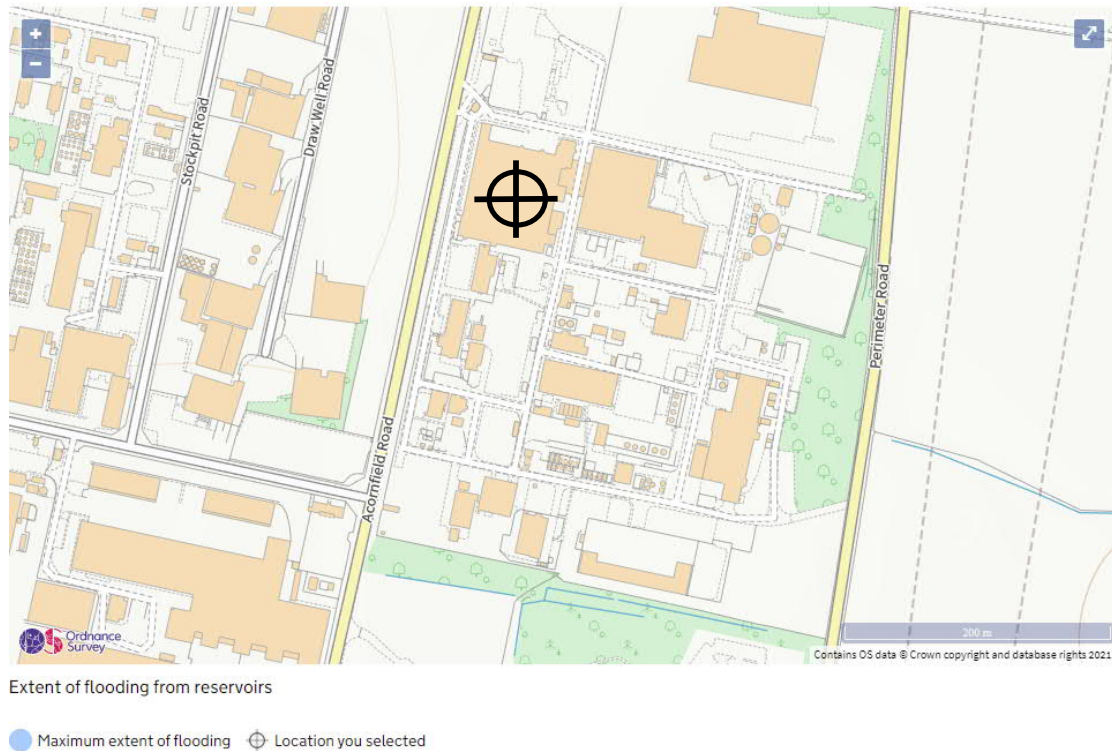


Figure 9: EA Reservoirs Flood Risk Map

3.7 Climate Change

The projected effects of climate change are expected to lead to increased rainfall, increased river flows, raised sea level and tidal fluctuations. The only increases pertinent to this development are from increased rainfall, its effect on drainage systems and potential overland flows.

The EA, as the government's expert on flood risk, has updated these climate change allowances. Following the above, a 40% increase in the peak rainfall intensity (Upper-end category) should be used considering the proposed development lifetime (50 -100 years) and the flood risk due to surface water runoff.

Furthermore, the extreme storm of a 1 in 100-year storm event with a 40% increase in rainfall shall be safely contained on-site, thus preventing any increase in flood risk to adjacent & downstream properties.

As a result of climate change, there would be a slight increase in the risk of flooding by overland flows and sewers; however, the risk would remain low.

4 FLOOD RISK MANAGEMENT

4.1 Floor Levels

To mitigate the flood risk due to surface water, the proposed development levels should be designed to provide flood flow routes within the site away from proposed buildings and access routes in the event of surface water drainage malfunction or during extreme rainfall events falling outside of the design requirements.

4.2 Sustainable Drainage Techniques

The use of various sustainable drainage techniques has been investigated with respect to their potential to be used within the development to control stormwater as close to the source as possible and reduce the potential increased flood risk from the development. They are reviewed in order of Most to Least Sustainable based upon the SuDS Hierarchy table from the EA.

<i>Most Sustainable</i>	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
	Living roofs	✓	✓	✓
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✓	✓	✓
	Filter strips and swales	✓	✓	✓
	Infiltration devices - soakaways - infiltration trenches and basins	✓	✓	✓
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviers	✓	✓	
Least Sustainable	Tanked systems - over-sized pipes/tanks - storms cells	✓		

Table 3: SuDS Hierarchy

4.2.1 Living Roofs

Living / Green roofs are not recommended for this development due to the severe implications of adopting these systems on an industrial warehouse:

- Structural: Even an extensive green roof system with a 100mm thick growing media will impose considerable loading to a typical lightweight roof system used on these units. Thus, increasing substantially the overall structural requirements.
- Slope: Green roofs are typically installed on flat roofs. The proposed lightweight roof system has a significant slope, and as such specific proprietary systems cannot be implemented.
- Maintenance: Any regular or irregular maintenance to the proposed units high roofs are likely to require the mobilization of elevated platforms and trained personnel.
- Damage & leaks: Although these systems are waterproof, extreme weather factors or human error can result in a leak in the roof. In these restricted conditions, finding and repairing such failure in a complex roof system will be a challenging process.

Although a green roof should always be considered, on this development, the complexity and disadvantages of implementing a green roof are far greater than the potential benefits.

4.2.2 Basins and Ponds

The existing and proposed development layouts have a high percentage coverage of hard landscaping and building plan area, the remaining available land would not be large enough to propose a basin or pond feature.

4.2.3 Filter Strips and Swales

The site layout and the proposed arrangement does not allow for the implementation of swales as these systems require a free large soft landscape area.

4.2.4 Infiltration Devices

Based on the borehole data the underlying sub strata is Clays. Therefore, the use of infiltration techniques is not a feasible option for the site.

4.2.5 Attenuation Tank

The use of an attenuation tank will be required on site to the north. The storage volume required from this is 525m³ and will allow the sites discharge rate drop significantly.

4.2.6 Permeable Paving/Porous Asphalt

The site includes a series of car parking areas that may be suitable for the use of porous asphalt. Storage could be provided within the sub-grade material prior to controlled discharge to the public sewer network.

The provision of storage within the sub-grade material would only be feasible in areas with a proposed gradient of less than 1 in 20 as detailed within CIRIA RP992/28 (Design Assessment Checklists for Permeable/Porous Pavement). The amount of storage provided within the drainage blanket is subject to sub-grade depth.

4.2.7 Rainwater Harvesting Systems

The use of rainwater to provide water for re-use within the proposed unit has been reviewed and ruled out as being not feasible for the following reasons;

- The demand for rainwater re-use on a building of this type is extremely low compared to the potential yield generated. Prolonged storage of rainwater can also lead to water “quality” issues in a holding tank, leading to coloration.
- There is an associated significant increase in CO₂ emissions from the rainwater harvesting systems because of the need to pump stored water from a lower level to different parts of the building at higher levels. This is in conflict with the primary objectives of a sustainable system.

4.2.8 Exceedance Event

Storage will be provided for the 1 in 100 years plus 40% CC event. Storm events in excess of the 1 in 100 years plus 40% CC event should be permitted to produce shallow depth flooding within landscaped areas or adjacent to an attenuation feature. Site levels should be designed to ensure that exceedance flooding is contained on-site to eventually drain back into the drainage system. In the event of rainfall intensities and durations outside of the modelled extreme scenarios or in the case of the drainage system malfunction, the exceedance flows will overflow toward the Southern site boundary as shown on the Exceedance Flow Route Drawing— Appendix D.

4.2.9 Surface Water Treatment

In accordance with the CIRIA C753 publication ‘The SuDS Manual’ (2015), other roofs (non-residential) have a ‘low’ pollution hazard level. Roofs are considered to impose a low risk of pollution to the receiving ground and do not require any sort of specific water treatment other than capturing sediments in the catchpit manholes.

For the yard and carpark areas, treatment of the surface water runoff will be provided by proprietary treatment systems.

The delivery / industrial yard is considered to have a medium pollution hazard level which equates to following pollution hazard indices:

Table 4 below shows the pollution hazard indices for each land use.

Pollution Hazard Indices Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Other Roofs	Low	0.3	0.2	0.05
Industrial/delivery yard	Medium	0.7	0.6	0.7

Table 4: SuDS Pollution Indices

(Table extract is taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

** Indices values range from 0-1.)*

The runoff will be directed to permeable paving where practical (subject to site gradients).

Table 5 below demonstrates that permeable paving provides sufficient treatment to runoff.

Type of SuDS	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Permeable Pavements	0.7	0.6	0.7
Swale	0.5	0.6	0.6
Pond	0.7	0.7	0.5

Table 5: SuDS Mitigation Indices

(Table extract is taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

** Indices values range from 0-1)*

4.3 Surface Water Management

4.3.1 Existing Site Runoff

The existing brownfield site's runoff rate has been calculated using the modified rational method, as can be seen below in Table 6.

Site Area	Existing Run-Off Rates			
	1 in 1 Year Storm Event	1 in 30 Year Storm Event	1 in 100 Year Storm Event	1 in 100 + 40% CC Year Storm Event
Brownfield (2.246ha)	185.06 l/s	453.73 l/s	586.20 l/s	820.68 l/s

Table 6: Existing Flow Rates

4.3.2 Post-Development Surface Water Run-off

The nature of the proposed development means that there will be an increase in the impermeable areas of the site, resulting in an increase in both volume and the peak rates of run-off of flows when unrestricted. The proposed impermeable area covers approximately 91% of the site.

The on-site surface water drainage network will be split into two separate drainage systems (north and south of the site) such that surface water runoff from building roof and service yard will be collected and discharged separately from runoff from the carpark area.

The proposed network relies on the use of drainage sumps, pipework, catchpits, tank, manholes, petrol interceptor and a vortex flow control system to discharge the surface water.

The north network treats the roof area and service yard, a tanked system is proposed to store approximately 525m³ of storage. Surface water from the tank and petrol interceptor will flow to the vortex flow control unit, which will discharge the surface water at a rate of 90 l/s.

The south network treats the carpark area only. Surface water will flow through a permeable paving system which creates 285m³ of storage. Water from the permeable paving will flow through diffuser blocks out of the site via an orifice at 8 l/s.

This system results in a total discharge rate of 98 l/s. Below in Table 7 a comparison can be seen between the existing and proposed situation.

Return Period	Run-off Rate		Betterment
	Existing (unmitigated)	Proposed	
Q ₁	185.06 l/s	90 l/s	51.37%
Q ₃₀	453.73 l/s	90 l/s	80.16%
Q ₁₀₀	586.20 l/s	90 l/s	84.65%
Q _{100+40%}	820.68 l/s	90 l/s	89.03%

Table 7: Existing and Proposed Discharge Rates

The proposed new surface water drainage system has been designed using current MicroDrainage analysis software, ensuring all planning requirements, Lead Local Flood Authorities (LLFA) and EA guidelines are satisfied to prevent uncontrolled flooding of the site and surrounding areas. Microdrainage calculations for the design of the surface water network and attenuation requirements on site are included in Appendix F.

The surface water drainage system proposed for the site is shown in Appendix G. The system shall be designed not to flood for the critical 1 in 100 year design storm plus 40% Climate Change.

4.3.3 Proposed Foul Water Drainage

The proposed foul water will discharge by gravity through private drainage into the existing foul water network on site.

A Pre-Planning Enquiry Application to United Utilities would be required to confirm the sewer capacity for the proposed development.

5 OFFSITE IMPACT

The proposed redevelopment of this site results in approximately the same impermeable area as its current use. To reduce the offsite impact, the surface water drainage network will be designed to cater for up to and including the 1 in 100 year return period storm event, with allowances for climate change (40% increase in rainfall). To minimise the risk to downstream properties the runoff from the critical storm event will be kept on the site.

As all the surface water is being controlled and attenuated onsite, the offsite impact is very low.

6 MAINTENANCE STRATEGY

6.1 Manholes, Inspection Chambers, Pipe Work, Drainage Channels & Gullies

The surface water drainage system should be inspected and maintained periodically, primarily to check for silt sedimentation within the system or ingress of any detritus or debris which would decrease system performance. Table 8 sets out the recommended maintenance actions and frequency.

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove manhole and chamber covers to sewers and flow control on network– inspect to ensure water is flowing freely and that the water flow route is unobstructed. Remove debris and silt as required.	Half Yearly Undertake one of these inspections after leaf fall in autumn
Occasional Maintenance	None required	
Remedial Actions	Re-line or replace pipework if unable to clear blockages by jetting.	As required
Monitoring	Inspect chambers for build-up of silt and debris	Half yearly

Table 8: Operation & maintenance requirements for pipe network, manholes & inspection chambers, drainage channels & gullies.

6.2 Vortex Flow Control (Hydrobrake)

The vortex flow control relies typically on its shape to create a vortex within the unit to control the flows to a design point.

These systems have a larger cross-sectional area than that of a comparable orifice that is sized for the same design point, reducing the risk of blockage.

The product specified to be installed is a *Hydrobrake MD-SHE-0363-9000-2200-9000*.

Table 9 sets out the recommended maintenance actions and frequency, refer appendix A for manufacture guidance notes.

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Inspect and identify if it is not operating correctly. If required, take remedial action.	Initially monthly for 3 months, then half yearly.
Remedial Actions	Repair/rehabilitate flow control.	As required.
Monitoring	Inspect chambers for build-up of silt and debris	Half yearly

Table 9 – Operation & maintenance requirements for vortex flow controls

6.3 Proprietary Surface Water Treatment Systems

These are manufactured products to provide a treatment to the surface water by removing specific pollutants.

Table 10 sets out the recommended maintenance actions and frequency. Manufacturer guidance/recommendations should always be used when available.

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Remove litter and debris and inspect for sediment, oil and grease accumulation.	Monthly for 3 months, then annually.
	Change the filter media.	As recommended by manufacturer.
	Remove sediment, oil grease and floatables.	As necessary – indicated by system inspections or immediately following significant spill.
Remedial Actions	Replace malfunctioning parts or structures.	As required.
Monitoring	Inspect for evidence of poor operation.	Biannually
	Inspect filter media and establish appropriate replacement frequencies.	Biannually
	Inspect sediment accumulation rates and establish removal frequencies.	Monthly during first half year of operation, then every six months.

Table 10 – Operation & maintenance requirements for proprietary surface water treatment systems - Based on CIRIA SuDS Manual 2015

6.4 Attenuation Tank

Geocellular attenuation tanks are proposed, they are modular storage systems made with plastic units. These units can be assembled to achieve the required volume and usually on multiple layers.

Generally, the units have 95% of voids content and are used to create an efficient below ground structure to store surface water.

Table 11 sets out the recommended maintenance actions and frequency.

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually.
	Remove debris from the catchment surface (where it may cause risks to performance).	Monthly.
	For systems where rainfall infiltrates into the tank from above, check surface of filter for blockages by sediment, algae or other matter; remove and replace surface infiltration medium as required.	Annually.
	Remove sediments from pre-treatment structures and/or internal forebays.	Annually, or as required.
Remedial Actions	Repair/rehabilitate inlets, outlets, overflows and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually
	Survey inside of tank for sediment build-up and remove if necessary.	Every 5 years or as required.

Table 11 – Operation & maintenance requirements for attenuation storage tanks –
Based on CIRIA SuDS Manual 2015

6.5 Porous Paved Area

The following Table 12 sets out the recommended maintenance actions and frequency for porous paved area.

Maintenance schedule	Required action	Typical frequency
Regular Maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surfaces from adjacent impermeable areas as this are is most likely to collect the most sediment.

Occasional Maintenance	Stabilise and mow contributing and adjacent areas.	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements.
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the surface.	As required
	Remedial works to any depressions, rutting and cracked considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping.	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Inspect for evidence of poor operation and/or weed growth -if required, take remedial action	Three-monthly, 48 hours after large storms in the first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually
	Monitor inspection chambers	Annually

Table 12 – Operation & maintenance requirements for Porous Paved Area - Based on CIRIA SuDS Manual 2015

7 CONCLUSION

The FRA & Drainage Strategy has considered the potential flood risk to the proposed development and its potential impact on flood risk:

- The development is located in Flood Zone 1.
- The site flood risk is considered low or very low from all sources.
- The development drainage system and levels are designed to accommodate the 100-year rainfall event with a 40% allowance for climate change.
- The proposed development's drainage regime will reduce the onsite and offsite flood risk by having a more resilient surface water drainage system and reducing the peak surface water runoff rates.

Therefore, the FRA & Drainage Strategy concludes that overall this development has a low flood risk both on and offsite.

APPENDICES