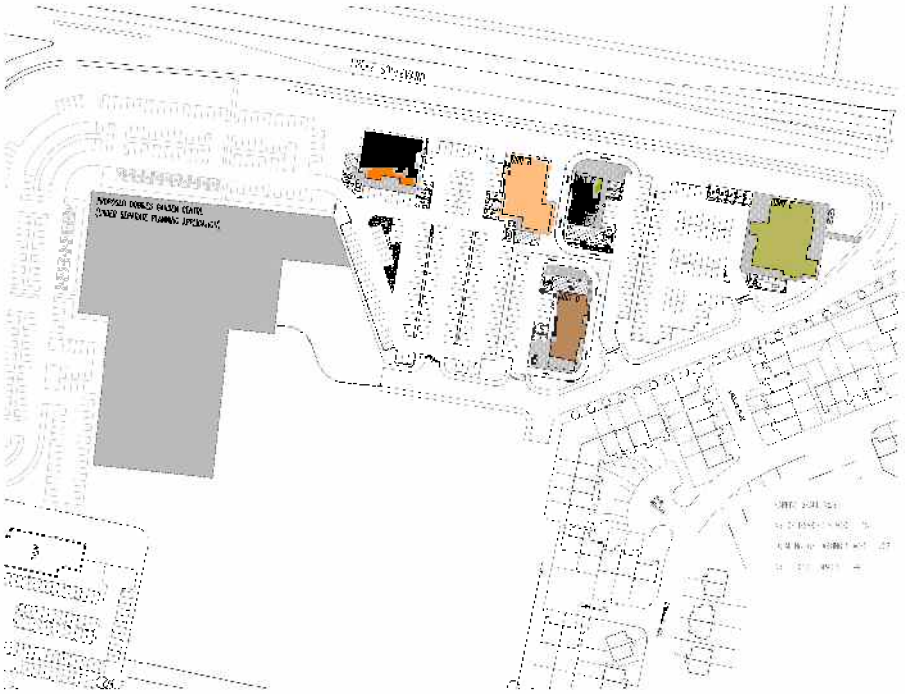
Wings Business Park

Flood Risk Assessment

Final
September 2010



Prepared for

Peel Holdings (Land & Property) Limited

Revision Schedule

Wings Business Park
Flood Risk Assessment
June 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
D01	May 2010	Draft	**Ene Adanu** Graduate Engineer	**Michael Gartside** Civil Engineer	**Annette Lardeur** Associate
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1 Introduction

1.1 Commission

1.1.1 Scott Wilson has been commissioned to undertake a Flood Risk Assessment (FRA) to support an outline planning permission, submitted on behalf Peel Holdings (Land & Property) LTD, for 5 proposed food and drinks units at Wings Business Park, Speke. The FRA also covers future development land to the south of the outline planning application area.

1.1.2 The FRA has been prepared in accordance with Planning Policy Statement 25: Development and Flood Risk (PPS25) and its accompanying Practice Guide, to provide information on flood risk and related constraints for the development as well as recommendations for the proposed redevelopment.

1.2 Terms of Reference

1.2.1 This FRA has been prepared in line with the agreed terms of reference set out in Scott Wilson's proposal, dated 9th June 2010.

1.2.2 The Objectives of the Flood Risk Assessment are as stated in the fee proposal of 9th June 2010:

- Determine potential sources of flooding to and from the site in line with PPS25 and the associated Practice Guide and suggest appropriate mitigation measures;
- Undertake a walkover survey of the site, in liaison with an Environment Agency representative if possible, to establish potential mechanisms of flooding, current surface water management and potential constraints to SUDS implementation;
- Propose an outline drainage strategy in accordance with PPS25 requirements. This will include the following elements:
  - Identification of a suitable receptor for surface water;
  - Calculation of pre and post development runoff rates, including the anticipated effects of climate change;
  - Provision of outline attenuation or soakaway volumes for the proposed site. This will be undertaken using industry computing software – Microdrainage WinDes.
- Produce a Level 2 FRA report that outlines the flood risk at the site and surface water management considerations. The report will be prepared in line with the recommendations of PPS25.

1.3 Background

1.3.1 The proposed development, which is described in Section 3 is being submitted for outline planning permission.

1.3.2 The Environment Agency Flood Zone Maps show the site to be located within Flood Zone 1 and therefore considered to be at low risk of flooding from fluvial and tidal sources (See figure 5.1). The development site covers approximately 2.93 ha and Planning Policy Statement 25: Development and Flood Risk (PPS25) requires that an FRA is undertaken for any site in Flood Zone 1 that exceeds 1 ha in size considering flooding from all potential sources.

1.3.3 PPS25 advocates the consideration of flood risk issues early in the development process. The preparation of this FRA would aid the identification of potential flood risk issues, from all sources of flooding, affecting the site and the subsequent incorporation of mitigation measures if necessary, into the design of the proposed developments to eliminate or reduce these risks.

1.4 Flood Risk Assessment Methodology

Source-Pathway-Receptor Model

1.4.1 An FRA aims to assess the risk from all sources of flooding to and from a development. PPS25 emphasises the need for a risk-based approach to be adopted by planning authorities through the application of the **Source-Pathway-Receptor** model and the Sequential Test.

1.4.2 The Source-Pathway-Receptor model firstly identifies the causes or '**sources**' of flooding to and from a development. The identification is based on a review of local conditions and consideration of the effects of climate change. The nature and likely extent of flooding arising from any one source is considered, for example whether such flooding is likely to be localised or widespread.

1.4.3 The presence of a flood source does not always infer a risk. The exposure '**pathway**' (or 'flooding mechanism) determines the risk to the receptor and the effective consequence of exposure.

1.4.4 The varying effect of flooding on the '**receptors**' depends largely on the sensitivity of the target. Receptors include people or buildings within the range of the flood source, which are connected to the source by a pathway.

1.4.5 In order for there to be a flood risk all the elements of the Source-Pathway-Receptor model must be present. Furthermore effective mitigation can be provided by removing one element of the model, for example by removing the pathway or receptor.

Scope of the FRA

1.4.6 PPS25 guidelines suggest three levels of FRA as shown in Table 1-1.

Table 1-1: Levels of Flood Risk Assessment FRA

FRA Level	Scope of work
Level 1	**Screening Study** Identification of any flooding or surface water management issues related to the development of the site that may need further investigation. Should be based on readily available existing information, including: • SFRA • Environment Agency Flood Maps • Standing Advice This Level will identify whether a FRA is required.
Level 2	**Scoping Study** Produced if the Level 1 FRA identifies the site as lying within an area at risk of flooding or development of the site may increase flood risk due to increased runoff. Report will confirm sources of flooding which may affect the site. Study will include: • Appraisal of availability and adequacy of existing information. • Qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site. • An appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. This Level may identify that sufficient quantitative information is already available to complete a Level 3 FRA appropriate to the scale and nature of the development.
Level 3	**Detailed Study** Undertaken if the Level 2 FRA concludes that further quantitative analysis is required in order to assess flood risk issues related to the development site. This Level should include: • Quantitative appraisal of the potential flood risk to the development. • Quantitative appraisal of the potential impact of development on the site under investigation on flood risk on and off the site. • Quantitative demonstration of the effectiveness of any proposed mitigation measures.

1.4.7 Having considered the available information on the site, the vulnerability of the developments and after consultation with the Environment Agency, it has been concluded that a Level 2 FRA is required for the planning application.

1.4.8 The methodology adopted for this Level 2 FRA involves a desk-based review of available information to establish the likely flooding sources, mechanisms of flooding and mitigation measures relevant to the site. This methodology is adopted from the PPS25 Practice Guide.

1.4.9 The scope of the Level 2 assessment excludes hydrological and hydraulic river modelling, but includes conceptual drainage assessment.

1.4.10 This report documents the methodology and findings of the Level 2 FRA.

2 Site and Surrounding Area

2.1 Site Location

2.1.1 The location of the site and its surrounding are shown on Figure 2-1.

2.1.2 The site is located approximately 1.1km north of the Liverpool John Lennon Airport and approximately 11km form the City centre. It occupies an area of about 2.93 ha and is located in Speke in south Liverpool.

2.1.3 To the North of the site is the Speke Boulevard and Speke Hall Avenue lie to the west. The east is mainly occupied by residential developments and assorted industrial units are further south and east of the site.

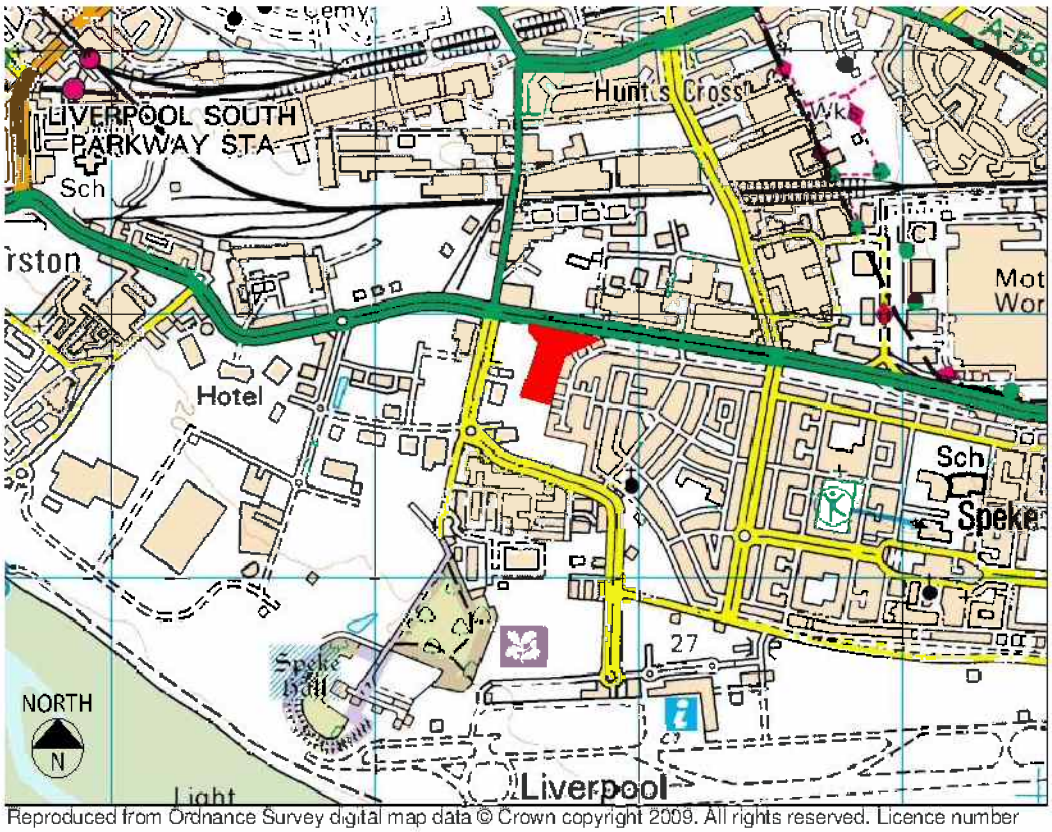


Figure 2-1: Location of the site

2.2 Existing Land Use

2.2.1 Figure 2-2 shows an aerial photograph of the site.

2.2.2 The site is currently undeveloped. A ground investigation carried out in 2001 indicated that the site was undeveloped at the time and there have been no developments since then.

2.2.3 The site is largely covered with grass with small shrubs scattered around. There are a few large trees forming the Northern boundary and a few small trees within the site.

Figure 2-2: Aerial view of the site

2.3 Site Levels

2.3.1 Existing levels have been obtained from the topographical survey carried out by Edmund Kirby Land Surveyors in 2001. The site is generally level with a gentle slope from north to south. The site levels fall from an average of 29.73m AOD to 25.30m AOD. The north east corner of the site is slightly higher rising to 32.52m AOD midway through the section and falling back to 29.07m AOD forming a small hill.

2.3.2 The Topographical Survey plan is attached as Appendix C

2.4 Site Geology

2.4.1 Allied Exploration and Geotechnics Ltd (AEG) undertook a ground investigation of the site in 2001. The results of the investigation have been reviewed as part of this study. The top 1.5m of the site is described as grass over Made ground and top soil mainly consisting of soft brown / black very sandy clay and slightly clayey sand. Below this is a layer of loose light brown very silty sand lying above firm brown sandy gravelly clay.

2.4.2 Ground water was encountered at a depth of 2.10m.

2.5 Identification of Surrounding Water Features

2.5.1 No main rivers have been identified within 500m of the site. The nearest major watercourse and main river in the area is the River Mersey Estuary which is located approximately 1.5km south of the proposed development. There is one small embankment/dam, Speke Dam, which is located over 1.0km south from the site.

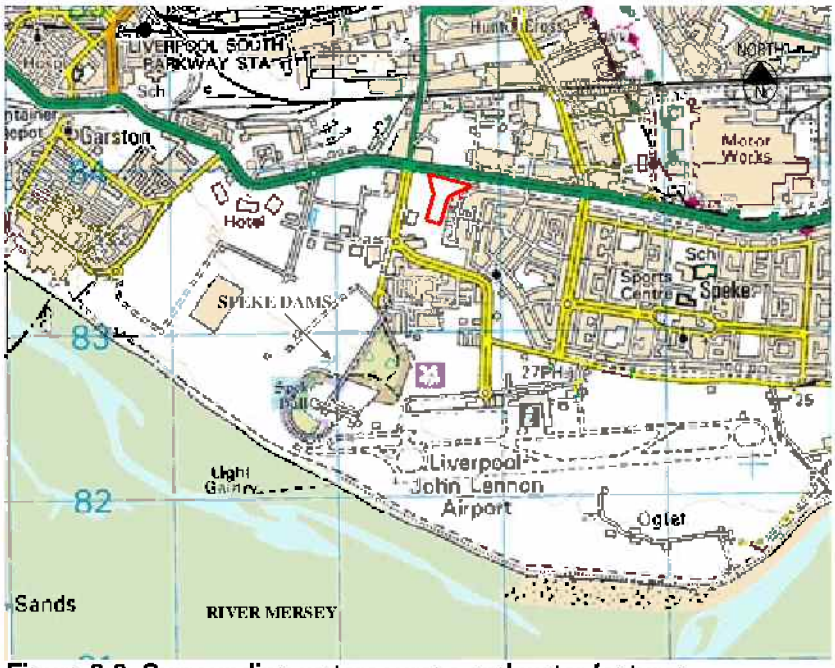


Figure 2-3: Surrounding watercourses and water features

2.5.2 The Liverpool Strategic Flood Risk Assessment (SFRA) identifies 3 non-main rivers to the south of the site, Oglet Brook, Speke Hall drain (incorporated into sewerage system) and Old Garston River. These watercourses drain into the Mersey via culverts and are also not within 500m of the proposed development.

2.5.3 The Flood Screening Report obtained from Landmark shows the Environment Agency's detailed River network Map and is included as Appendix B.

3 Proposed Development

3.1 Description of the Proposed Development

3.1.1 The proposed development proposals comprises a retail development of 5 proposed food and drink units and a new access road from Speke Boulevard. The development is on two distinct parcels of land separated by the proposed access road. Parcel 1 lies to the north of the access road that splits the site and covers an area of 1.73 ha while Parcel 2, located to the south of the access road covers 0.71 ha. The two parcels are separated by the proposed access road which covers an area of approximately 0.465 ha.

It is currently envisaged that parcel 1 will contain 5 food and drink outlets while Parcel 2 will be future development land.

The proposed outline development plan for parcel 1 and the proposed access road is included as Appendix A.

The development plan for Parcel 2 is still under consideration, although it is likely to be of a similar retail nature. Due to the uncertainty on the final design, when the proposed runoff is considered from this parcel, a high ratio of impermeable to permeable area has been assumed.

This development area is included within the FRA as it is more efficient and cost effective to design a drainage solution for both parcels of land at the same time.

3.2 Site Areas

3.2.1 Using topographical survey, aerial photography and the site layout plan, the pre- and post-development permeable and impermeable site areas have been established and presented in Table 3-1.

Table 3-1: Existing and proposed areas

Surface Type	Existing area	Proposed area
Roofing (assumed 100% impermeable)	0	17076
Hardstanding (assumed 100% impermeable)	0	8981
Grass / open ground (assumed 100% permeable)	29000	2943
TOTAL	**29000**	**29000**

4 Regulatory Position

4.1 Planning Policy Statement 25: Development and Flood Risk

4.1.1 Planning Policy Statement 25: Development and Flood Risk (PPS25) and its accompanying Practice Guide set out the requirements and criteria for assessing flood risk. Planning Authorities and regulators should apply the Sequential Test, and where appropriate the Exception Test, to decide on the appropriateness of any planned development from a flood risk point of view in accordance with PPS25.

4.1.2 In allocating land for development planning authorities should consider both the probability of flooding and vulnerability of the proposed development. PPS25 recommends a system of classification based on the probability of a flood event being exceeded and type and use of developments. Flood zones are defined according to PPS25 based on Annual Exceedance Probability (AEP) or probability of occurrence of flood events as shown in Table 4-1 below.

Table 4-1: Flood Zone Definitions (from Table D.1 of PPS25)

Flood Zone	Definition	Description
1	Low Probability	Land having less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%)
2	Medium Probability	Land having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5 – 0.1%) in any year
3a	High Probability	Land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year
3b	Functional Floodplain	Land where water has to flow or be stored in times of flood. Land which would flood with an annual probability of 1 in 20 year (5 %) or greater in any year or is designed to flood in an extreme (0.1 %) flood.

4.1.3 The Sequential Test and Exception Test are discussed in the following section.

4.2 The Sequential Test and Exception Test

4.2.1 The Sequential Test is a risk-based approach for determining the suitability of land for development in flood risk areas. The Sequential Test should be applied at all levels of the planning process. It aims at steering new development to areas with the lowest probability of flooding (i.e. Flood Zone 1) and only permits development in areas of higher risk (i.e. Flood Zone 2 and Flood Zone 3) where the development is of low vulnerability and/or giving due regard to sustainability considerations.

4.2.2 The Exception Test is an additional test to be applied by decision-makers following application of the Sequential Test. It is required when a development application is made for

a site within Flood Zones 2 & 3 and no other site of lower flood risk is available. The Exception Test involves a series of three criteria as shown below, all of which must be satisfied for development in a flood risk area to be considered acceptable.

a). It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a SFRA;

b). The development should be on developable previously developed land or, if not, it must be demonstrated there is no such alternative land available; and

c). A FRA must demonstrate that the development will be safe, without increasing flood risk elsewhere, and, where possible, reducing flood risk overall.

4.2.3 PPS25 defines each flood zone according to the probability of flooding and further clarifies for each zone, the appropriate land use and type of development, FRA requirements and Policy aims. Table 4-2 below, which is an excerpt from PPS25 (Table D.3 in PPS25), provides a summary of the types of development appropriate in each zone.

Table 4-2: Flood Risk Vulnerability and Flood Zone 'Compatibility' (PPS25, Annex D, Table D.3)

Flood Risk Vulnerability Classification		Essential Infrastructure	Water Compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	1	✓	✓	✓	✓	✓
	2	✓	✓	Exception Test Required	✓	✓
	3a	Exception Test Required	✓	x	Exception Test Required	✓
	3b	Exception Test Required	✓	x	x	x

✓ Development is appropriate x Development should not be permitted

4.2.4 Table 4-3 shows the Vulnerability Classification according to PPS25.

Table 4-3: Flood Risk Vulnerability Classification (PPS25, Annex D, Table D.2)

Class	Description
Essential Infrastructure	*Essential transport infrastructure (including mass evacuation routes), which has to cross the area at risk, and strategic utility infrastructure, including electricity generating power stations and grid and primary substations.
Water-Compatible Development	*Flood control infrastructure. *Water transmission infrastructure and pumping stations. *Sewage transmission infrastructure and pumping stations. *Sand and gravel workings. *Docks, marinas and wharves. *Navigation facilities. *MOD defence installations. *Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. *Water-based recreation (excluding sleeping accommodation). *Lifeguard and coastguard stations. *Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. *Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.
Highly Vulnerable	*Police stations, Ambulance stations and Fire stations and Command Centres and telecommunications installations required to be operational during flooding. *Emergency dispersal points. *Basement dwellings. *Caravans, mobile homes and park homes intended for permanent residential use. *Installations requiring hazardous substances consent.
More Vulnerable	*Hospitals. *Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels. *Buildings used for: dwelling houses; student halls of residence; drinking establishments; nightclubs; and hotels. *Non–residential uses for health services, nurseries and educational establishments. *Landfill and sites used for waste management facilities for hazardous waste. *Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.
Less Vulnerable	*Buildings used for: shops; financial, professional and other services; restaurants and cafes; hot food takeaways; offices; general industry; storage and distribution; non–residential institutions not included in 'more vulnerable'; and assembly and leisure. *Land and buildings used for agriculture and forestry. *Waste treatment (except landfill and hazardous waste facilities). *Minerals working and processing (except for sand and gravel working). *Water treatment plants. *Sewage treatment plants (if adequate pollution control measures are in place).

4.2.5 The proposed development falls under the category of 'Less Vulnerable' under Annex D of PPS25 and is appropriate for Flood Zone 1. The proposals meet the requirements of the Sequential Test and the Exception Test is therefore not required.

4.3 Surface Water Management

4.3.1 PPS25 states that all developments, including developments in Flood Zone 1, should consider:

- Their vulnerability to flooding from other sources as well as from river and sea flooding,
- Their potential to increase flood risk elsewhere through the addition of hard surfaces,
- The effect of the new development on surface water run-off.

4.3.2 In addition, PPS25 also outlines that:

'Developers and local authorities should seek opportunities to:

- *Reduce the overall level of flood risk in the area and beyond through the layout and form of the development,*
- *Mitigate the potential to increase flood risk elsewhere through the appropriate application of sustainable drainage techniques.'*

4.3.3 According to Annex F of PPS25, the surface water strategies for any development site should be such that the volumes and peak flow rates of surface water from a developed site are no greater than those prior to the proposed development, unless specific off-site arrangements are made and result in the same net effect.

4.3.4 Annex F of PPS25 promotes the use of SUDS in new developments. SUDS aim to mimic natural systems whereby water is held close to the source then released slowly over time. This has the effect of both reducing peak discharge and promoting the settlement of sediment thereby improving the water quality of any resulting discharge.

Strategic Flood Risk Assessment

4.3.5 The sustainability appraisals, land allocations and development control policies of Local Authorities are all informed by a SFRA carried out in liaison with the Environment Agency. The SFRA provides guidance on flood risk policies and how FRAs should be conducted and should be consulted when FRAs are undertaken.

4.3.6 Liverpool City Council Planning Policy Department completed the SFRA for Liverpool City Council in 2008 fulfilling the requirement set out in Planning Policy Statement (PPS) 25. This SFRA is a tool that plays an important role in delivering sustainable development for the City of Liverpool, taking account of flood risk issues and climate change.

4.3.7 The main objectives of the SFRA are to:

- Identify land at risk of flooding in Liverpool and the degree of risk from river, sea and other sources
- Reduce flood risk from and to new development through location, design and mitigation measures
- Inform policy formulation and the Sustainability Appraisal for the emerging Local Development Framework concerning land use in flood risk areas
- Provide a framework for development control officers and developers for dealing with the flood risk in development proposals.

4.4 United Utilities Requirements

4.4.1 Following examination of United Utilities records, it could be seen that there was no existing drainage present on the site. There are both surface and foul water sewers, installed along the central reservation of Speke Boulevard which drain the existing developments around the site

4.4.2 The proposed drainage for the Wings Business park development is designed to discharge into a privately owned sewer to the west of the development installed along Speke Hall Avenue. The Sewer is owned by the Northwest Regional Development Agency (NWDA) and Peel Holdings (Lands and Property) Ltd has obtained discharge permission for the sewer.

A copy of the discharge consent is included in Appendix D.

4.4.3 In addition, agreement has also been reached with United Utilities / Liverpool City Council that a maximum surface water flow of 9 l/s can be discharged into the existing surface water public sewer within Speke Boulevard.

A copy of the discharge consent is included in Appendix E.

5 Assessment of Flood Risk

5.1 Potential Sources of Flooding

5.1.1 PPS25 advises that an FRA should consider all potential sources of flood risk to the site in question. Table 5-1 summarises the range of potential flood sources, pathways and the relevance of these flood sources to the site.

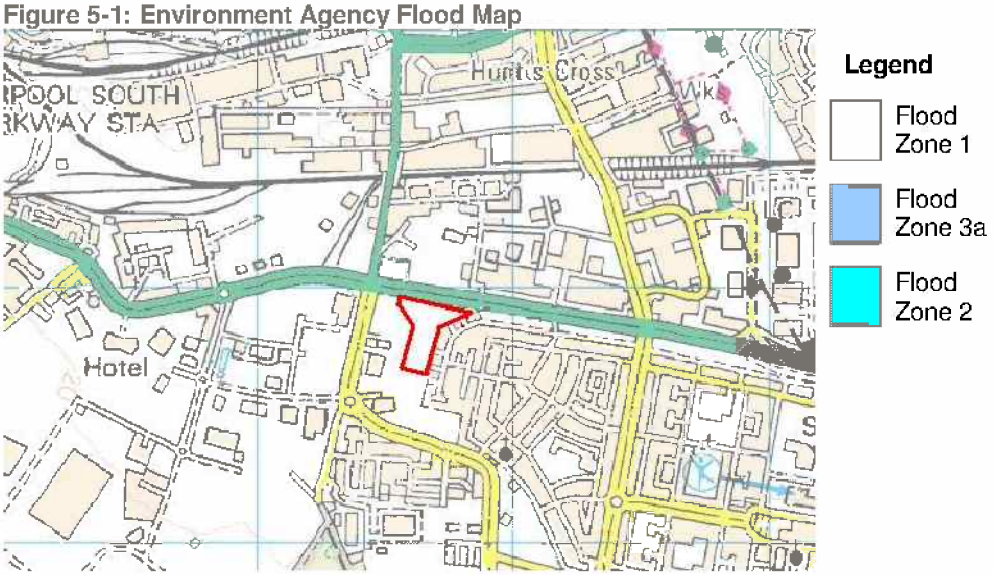
Table 5-1: Flood Sources

Flood Mechanism	Source	Pathway	Further Consideration Required?
Fluvial	Main rivers and ordinary watercourses	None – there are no Fluvial sources within the vicinity of the site	No
Tidal	None	None – there are no tidal sources within the vicinity of the site	No
Overland Flow	Runoff from surrounding hard standing surfaces	From surrounding hard standing and Greenfield surfaces	Yes
Drainage	Surrounding public / private drainage systems	Existing drainage system	Yes
Groundwater	Underlying geology	Permeable bedrock	Yes
Reservoirs	Releases from Reservoirs or breach	Connected watercourse. There are no reservoirs within the vicinity	No

5.2 Flooding from Fluvial and Tidal Sources

5.2.1 The Environment Agency Flood Zone Map (Figure 5-1) shows that the site is located in Flood Zone 1 i.e. the risk of flooding from fluvial sources is less than 0.1% (1in 1000 year event).

Figure 5-1: Environment Agency Flood Map



5.2.2 The closest watercourses to the site are ordinary watercourses (not main rivers) running south and into the Mersey. These watercourses do not pose a risk to the proposed development site. The Liverpool SFRA shows that there is no risk of flooding from fluvial sources to the site.

Please refer to Appendix B: for the Environment Agency Detailed River Network Map.

5.2.3 There are no tidal sources of flooding local near the site (the Mersey Estuary is located ca 1.5km to the south).

5.3 Overland Flow

5.3.1 Overland flow occurs when runoff from heavy rainfall flows over land. It often occurs when the soil is saturated and natural drainage channels or artificial drainage systems do not have the capacity to absorb the additional flow. Areas affected by overland flooding are generally low-lying areas where overland flows will accumulate.

5.3.2 There is no record of surface water flooding on the site, however the RMS surface water flood risk maps received from Landmark show that sections of the site are vulnerable to surface water flooding from the 1 in 75 year, 1 in 100 and 1 in 1000 year rainfall events. (Appendix B: RMS 75, 100, and 1000 year Return Flood Maps).

5.4 Flooding from Sewers and Drainage System

5.4.1 Sewer flooding has the potential to occur anywhere within the sub-region especially in areas with a high urban density. Storm water drainage systems are typically constructed to accommodate storm events with a return period of 30 years or less. As such, events with a

greater return period would often cause the system to surcharge, resulting in localised flooding. Flooding from artificial drainage systems may occur if:

- the rainfall event exceeds the capacity of the drainage system;
- the system becomes blocked by debris or sediment;
- the system surcharges due to high water levels in rivers.

5.4.2 The Liverpool SFRA suggests that the risk of flooding to the site from the existing sewer system is low. The Environment Agency has not reported any incidents of flooding from the existing sewer network in the site vicinity.

5.4.3 From the site walkover, it was found that surface water runoff from the site discharges via infiltration into the underlying strata.

5.5 Flooding from Groundwater

5.5.1 Groundwater flooding tends to occur after much longer periods of sustained high rainfall, and the areas at most risk are often low-lying where the water table is likely to be at shallow depth. Groundwater flooding is known to occur in areas underlain by major aquifers, although increasingly it is also being associated with more localised floodplain sands and gravels.

5.5.2 The main causes of groundwater flooding are:

- Natural groundwater rising due to exceptionally wet periods leading to rapid recharge.
- Groundwater rebound due to cessation of abstraction and mine dewatering
- Existence of confined aquifers and springs.

5.5.3 There are no known incidents of groundwater flooding at the site or in the surrounding area. The BGS Flood Data Map shows the susceptibility to groundwater flooding within the site is negligible (See Appendix B: BGS flood data).

5.6 Flooding from Reservoirs

5.6.1 The risk of flooding from reservoirs is mainly due to dam / reservoir wall failure and emergency releases into the catchment. As shown in Appendix B (Environment Agency Detailed River Network Map) there are no reservoirs within the vicinity of the site.

6 Assessment of Existing and Proposed Drainage

6.1 Existing Drainage

6.1.1 Examination of United Utilities records shows that the only drainage system present is located in the central reservation of Speke Boulevard to the north of the site serving the industrial, retail and residential developments surrounding the site. There are no records of any adopted surface water drainage on the site.

6.2 Proposed Drainage

6.2.1 The site layout plan for the outline planning stage and the topographic survey provided by the Peel Holdings (Land & Property) LTD have been used to calculate the post-development and existing run-off rates and volumes for the site. The run-off rates for the site were determined using the Institute of Hydrology Report 124 method in WinDes Microdrainage.

6.2.2 An indicative drainage layout proposed is shown on drawing D128603/ER/002 Option 1 in Appendix G. It should be noted that this layout was produced at an earlier stage in the design development and while there will be some alterations to the upstream end of the drainage scheme to accommodate the revised layout, the storage and discharge principles remain the same.

6.2.3 It is proposed that all the surface water runoff from the site will drain to the private sewer located in Speke Hall Avenue to the east of the site. As previously discussed, there is already a discharge consent in place for 1200l/s for the entire site, however following previous discussions with Peel Holdings, it is intended to limit the discharge rate to 208 l/s, which is an approximate pro-rata of the proposed development area against the wider development area.

6.3 Surface Water Runoff

6.3.1 PPS25 requires that the peak runoff rate and total runoff volume from a development do not exceed current values. As highlighted in PPS25, climate change is expected to result in more frequent, shorter duration, higher intensity rainfall events and more frequent periods of long duration rainfall, of the type responsible for the summer 2007 floods.

6.3.2 To comply with the requirements of PPS25, the peak surface water flows generated on site for the existing and post-development scenarios have been calculated and compared for various return periods and rainfall durations, considering an allowance of 30% for Climate Change.

Existing Runoff Rates

6.3.3 As the proposed development area is currently classed as Greenfield, the existing runoff rate was calculated using the Institute of Hydrology (IOH) 124 method and this calculation is

included in Appendix H. The following runoff rates were calculated based on an annual peak flow rate of (QBARRURAL) of 6.06 l/s/h:

Table 6-2: Summary of peak runoff pre-development

	Peak Runoff Rate (l/s)			
	Parcel 1 (1.73 Ha)	Parcel 2 (0.705 Ha)	Link Road (0.465 Ha)	Total
Peak runoff rate	10.5	4.3	2.8	17.6

Runoff Rates from the Proposed Developments

6.3.4 Using the existing and proposed site plans, existing areas of roofing, hardstanding (roads, footpaths and driveways) and open ground have been calculated below.

Table 6-2: Summary of post-development impermeable areas

Surface Type	Area (m^2)			
	Parcel 1	Parcel 2	Link Road	Total
Roofing (assumed 100% impermeable)	1861	2120	0	3981
Hardstanding (assumed 100% impermeable)	10990	2829	3257	17076
TOTAL	**12851**	**4949**	**3257**	**21057**

6.3.5 WinDes Micro Drainage software was used to estimate the runoff rates for the post-development scenarios and the resulting flows are presented in Table 6-3.

Table 6-3: Summary of peak runoff post-development

Return Period Event	Peak Runoff Rate (l/s)			
	Parcel 1	Parcel 2	Link Road	Total
10 year (10% AEP)	28.4	11.6	7.9	47.9
30 year (3.3% AEP)	31.2	12.7	8.5	52.4
50 year (2% AEP)	32.2	13.1	8.7	54.0
100 year (1% AEP)	33.9	13.8	9.2	56.9
100 year (1% AEP) + 30% allowance for climate change	44.1	18.0	12.0	74.1

6.3.6 The runoff calculations show that the proposed development will increase the risk of surface water flooding due to the increased runoff rate. However, this can be mitigated by providing surface water attenuation as discussed below.

6.4 Introduction to Sustainable Drainage Systems

6.4.1 PPS25 recommends that suitable surface water mitigation measures are incorporated into proposed development plans in order to reduce and manage the surface water flood risk and to attenuate the runoff from the site to Greenfield values. Ideally, this should be achieved by incorporating SUDS in the drainage design.

6.4.2 There are many complex issues surrounding the management of storm water at any site, such as: the physical characteristics of the catchment (e.g. slope), the nature of the rainfall event, the hydrology of the catchment, and the presence of pollutants. Each site is different, thus individual and unique solutions need to be designed. The incorporation of approved SUDS systems to manage runoff is particularly important for large development sites such as this one.

6.4.3 There are a number of different SUDS techniques that can be used individually or in combination in order to manage surface water for any specific site. It is suggested that individual SUDS be used in a management train in order to mimic the natural pattern of drainage as far as possible, this is outlined below (National SUDS Working Group 2004).

Table 6-4: SUDS techniques hierarchy

Hierarchy of Techniques	Description	Examples
Prevention	Use of good site design and housekeeping on site	Minimised paved areas and the use of sweeping to remove surface dust from car parking areas
Source Control	Runoff control at or near the source	Rainwater harvesting, previous pavements, green roofs or soakaways
Site Control	Water management from several sub-catchments	Routing water from roofs and car parks to one large soakaway or infiltration basin for the whole site
Regional Control	The management of runoff from several sites, in detention ponds or wetlands	Not applicable for a single site

6.4.4 Management practices specific to the site should be adopted but a holistic approach is needed, where all components are investigated with respect to the specific site under consideration.

6.4.5 An integrated strategy should be determined for the whole proposed development area, combining different SUDS mechanisms. To identify the most suitable drainage solution at detailed design stage, the area and use of the site, underlying physical characteristics and nature of the surrounding area must be taken into account.

6.4.6 The type of SUDS system adopted should take into account the future adoption and maintenance of the scheme. Adoption and maintenance agreements must be reached at

detailed drainage design stage once more information is available to determine the most suitable method of SUDS for the site.

6.4.7 We would recommend that consideration is given to the inclusion of SUDS such as underground storage tanks / pipes or permeable paving at detail design stage.

7 Flood Mitigation Measures

7.1.1 The proposed redevelopment site is located within Flood Zone 1, outside the floodplain of the nearest watercourse. The risk of flooding from other sources is also low. As a result, the proposed development will not require mitigation measures to reduce the risk of flooding to the proposed development from fluvial and other sources of flooding, although mitigation measures are required to attenuate runoff from the development.

7.1.2 The proposed redevelopment will result in a net increase in impermeable area and without mitigation measures the peak flow rates and total runoff volume from the site will increase. However, prior approval has already been obtained to discharge to the private sewer in Speke Hall Avenue, therefore runoff rates and attenuation volumes were calculated for a range of flood durations using a discharge rate to the private sewer of 208l/s. Allowances for the effects of climate change were included by assuming a 30% increase in rainfall intensity on the 100-year return storm event.

7.1.3 The attenuation volumes required for the critical duration for each proposal is summarized in Table 7-1. The total volume (considering Climate Change) for the two phases of proposed development considered is 475m^3. A limiting discharge rate of 208l\s was used to determine the attenuation volume calculations.

Table 7-1: Indicative storage requirements

Return Period Event	Attenuation Volume (m^3)
	Total
100 year (1% AEP) + 30% allowance for climate change	475

7.1.4 The road and hardstanding drainage will be designed to store excess runoff during extreme rainfall events and discharge to the private sewer at a rate of 208l/s.. An indicative surface water drainage design illustrating the storage principles is included in Appendix G.

7.1.5 Other SUDS methods, such as permeable paving, may be considered at detail design stage if necessary.

8 Conclusions and Recommendations

8.1 Conclusions

8.1.1 The flood risk assessment was undertaken in accordance with the requirements of PPS25, considering flood risk from all sources and the vulnerability of the proposed development. The FRA conclusions are summarised below:

- The proposed development is a retail development of 5 food and drink units and an area of future development land on two distinct parcels separated by an access road and is classified as "Less Vulnerable" development according to PPS25.
- Both proposed parcels are located in a low risk area, with an annual exceedance probability of less than 0.1 % (return period of 1 in 100 years). This meets the requirements of the Sequential Test so the Exception Test is not required.
- The risk of flooding from all other sources to both proposed developments is low.
- The proposed development will increase the runoff rates from the site during extreme rainfall events if no mitigation measures are implemented. However, the FRA has demonstrated that the runoff from the proposed development sites can be mitigated to maintain the agreed discharge consents after construction of the proposed developments. An indicative surface water management arrangement has been developed to demonstrate that surface water attenuation can be achieved by storage of excess volumes from the proposed development.

8.1.2 It is therefore concluded that the overall flood risk associated with the site and development proposals are low and that flood risk issues should not preclude planning consent being granted.

8.2 Recommendations

8.2.1 The following recommendations are made with respect to the development of scheme:

- Giving due regard to sustainability considerations, it is recommended that attenuation is provided to reduce peak flows during extreme events. The exact method of attenuation, which should include the use of SUDS, should be considered in more detail at detail design stage.