



NPPF: Flood Risk Assessment

Monarchs Quay, Liverpool – Application 1B

YPG Developments

SHF.1380.001.HY.R.003.B



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Monarchs Quay, Liverpool – Application 1B

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Executive Summary

This report presents an FRA in accordance with the NPPF and PPG ID: 7 guidance, for the construction of an office/contact centre, on land located at Monarchs Quay, off Queens Road, Liverpool (hereafter referred to as 'the Site').

The report has included an assessment of the surface water drainage requirements of the Site, and details the flood risk and how this could be managed and mitigated to allow the Site to be developed in support of a full planning application.

The FRA has demonstrated the following:

- The Site totals 0.64ha in area, and is located within a 5.5 ha wider Site. The proposed development forms the second stage of a phased development within the wider Site. The wider Site is currently occupied by areas of brownfield land, hardstanding car park and metalled roads. The Site has a current land use of car parking, metalled road, paved hardstanding and grassed areas.
- Development is proposed within two areas of the Site, referred to as Plots 2 and 4 in this FRA.
- The River Mersey estuary is located to the west of the wider Site. To the east of the wider Site, are a series of hydrologically linked docks.
- The Environment Agency online flood map shows the Site to be located entirely within Flood Zone 1; outside the 1 in 1000-year probability of tidal flooding (0.1% AEP) and as being at 'low' risk of tidal flooding. Most of the wider Site is located within Flood Zone 1; outside the 1 in 1000-year probability of fluvial (river) and tidal flooding (0.1% Annual Exceedance Probability [AEP]). A small area in the south west of the wider Site is shown to be located within Flood Zones 2 and 3. Environment Agency flood zones are representative of tidal flooding within the wider Site.
- Updated tidal flood outlines show that the Site would be largely located within Flood Zone 1; outside the 1 in 1000-year probability of fluvial (river) and tidal flooding (0.1% Annual Exceedance Probability [AEP]). An area to the east of the Queens Wapping Bridge, which forms Plot 2 of the Site, is shown to be inundated during the 1 in 200-year return period tidal event (Flood Zone 3).
- When climate change is considered for the 1 in 200-year event for the year 2115, the south-western area of the Site is shown to be inundated.
- The Site and wider Site has isolated areas of surface water ponding with low to medium risk, primarily located in the entirety of Plot 2, the access road west to Plot 4 and the western extent of Plot 4. No overland flow pathways originating outside of the wider Site are shown.
- Flood risk from all other sources is considered 'Low'
- Flood risk from tidal and surface water sources will be mitigated through the following measures:
 - Ensure finished floor levels are above 7.28 mAOD to ensure the development remains flood free from tidal sources, for the entirety of its lifetime (to the year 2115).
 - Adoption of a surface water management strategy.
 - Incorporate flood resilient construction measures into the proposed buildings
 - Register the Site with the Environment Agency Floodline Warnings Direct service.

- Prepare a Flood Plan to ensure all onsite staff and visitors can exit the Site and move to a place within Flood Zone 1 (low risk).
- Subject to mitigation measures, the Sequential Test will be passed and the Exception Test would not be required.
- The proposed development will not increase the impermeable surfaces and therefore the amount of runoff will remain unchanged.
- A drainage scheme is proposed to connect to an existing surface water network within the wider Site, with subsequent connection to the public surface water network and the River Mersey Estuary. It is proposed to maintain the current surface water discharge for areas that currently diffusely discharge to the Docks.

The FRA has considered the potential impact of the development on surface water runoff rates. These rates have been calculated, and it has been demonstrated that surface water can be managed, such that flood risk to and from the Site following development will not increase.

The FRA demonstrates that the proposed development would be operated with minimal risk from flooding, and would not increase flood risk elsewhere. The development should therefore not be precluded on the grounds of flood risk and surface water drainage.

1.0 Introduction

1.1 Background

- 1.1.1 Enzygo Ltd was commissioned by YPG Developments to carry out a site-specific Flood Risk Assessment (FRA) including a surface water drainage strategy in support of a full planning application for a proposed mixed-use development, located on land at Monarchs Quay off Queens Road, Liverpool (hereafter referred to as 'the wider Site').
- 1.1.2 A phased development is proposed within the wider Site, as follows:
- Application 1a: Full Planning application
- Application 1b: Full Planning application
- Application 2: Outline Planning application.
- 1.1.3 This FRA considers the proposed development for **Application 1b only**, (hereafter referred to as 'the Site').
- 1.1.4 The proposal is for the development of three buildings, located within three separate plots within the application redline boundary. The proposed buildings will have office, retail, commercial and residential use with associated access, landscaping and hardstanding. A copy of the proposed layout for the wider Site is included in Appendix 1 along with the proposed layout for Application 1b (the Site).
- 1.1.5 Planning applications for development in England require an FRA¹, when:
- In Flood Zone 2 or 3 including minor development and change of use.
 - More than 1 hectare (ha) in Flood Zone 1.
 - Less than 1 ha in Flood Zone 1, including a change of use in development type to a more vulnerable class (for example from commercial to residential), where they could be affected by sources of flooding other than rivers and the sea (for example surface water drains, reservoirs).
 - In an area within Flood Zone 1 which has critical drainage problems as notified by the Environment Agency.
- 1.1.6 The Site is more than 1 hectare (ha) in area (approximately 0.64 ha) and represents a change of use to a more vulnerable class. As such, an FRA is required.
- 1.1.7 The purpose of this FRA is to provide sufficient flood risk information to demonstrate that the future users of the development remain safe throughout its lifetime, that the development would not increase flood risk on Site and elsewhere and, where practicable, that the development would reduce flood risk overall.

¹ <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

1.2 Scope of the Assessment

- 1.2.1 Government policy on development and flood risk is set out in the National Planning Policy Framework (NPPF)² and the supporting Planning Practice Guidance: Flood Risk and Coastal Change [PPG ID7]³.
- 1.2.2 NPPF paragraphs 99-104 set out the need for an appropriate assessment of flood risk at all levels of the planning process and requires the application of a sequential risk-based approach to assess the suitability of land for development in flood risk areas.
- 1.2.3 The FRA should also consider the effects of climate change⁴. The climate change allowances are predictions of anticipated change for:
- Peak river flow by river basin district;
 - Peak rainfall intensity;
 - Sea level rise; and
 - Offshore wind speed and extreme wave height.
- 1.2.4 They are based on climate change projections and different scenarios of carbon dioxide emissions to the atmosphere. There are different allowances for different periods of time over the next century.
- 1.2.5 Site-specific FRAs provide an assessment of the flood risk to and from a development site, over its lifetime, to satisfy the requirements of the local planning authority. They are categorised as Level 1 Screening studies to give a general indication of the potential flood risk to a site and identify whether more detailed Level 2 scoping assessment is required. A Level 2 assessment is a qualitative appraisal to develop understanding of flood risk to a site and the effects of the site on flooding elsewhere including recommended mitigation measures. Level 2 reporting is the minimum required to accord with the NPPF. Level 3 assessments are more detailed quantitative studies, for example modelling to establish flood levels at a site in the absence of Environment Agency data, or providing detailed outline drainage designs.
- 1.2.6 This report is a Level 2 qualitative FRA but includes a Level 3 assessment of the surface water drainage requirements for the proposed development.

1.3 Aims

- 1.3.1 This FRA aims to provide sufficient flood risk information to satisfy the requirements of the NPPF, PPG ID7 and regional/local government plans and policies. It describes the potential for the Site to be impacted by flooding, the impacts of the proposed development on flooding elsewhere near the Site, and the proposed measures that could be incorporated into the development to mitigate the identified risks.

² Department for Communities and Local Government (2012) National Planning Policy Framework.

³ Department for Communities and Local Government (2014) Planning Practice Guidance ID7-030-20140306; Flood Risk & Coastal Change.

⁴ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

1.4 Planning Context

National Policy

- 1.4.1 The FRA was prepared in accordance with the **NPPF** and **PPG ID7**.

Regional/Local Policy

- 1.4.2 The FRA also considers the following policies from the Liverpool City Local Plan, September 2016:

Policy STP2: Sustainable Growth Principles and managing Environmental Impacts

- 1.4.3 New development should seek to avoid negative impacts on the environment through adoption of best practice:

- 1(g) Avoid areas at risk of flooding and demonstrate it will not exacerbate potential sources of flood risk;
- 1(h) Improve and protect water and groundwater quality, including the River Mersey, Leeds & Liverpool Canal, and other inland rivers and watercourses, and where appropriate and feasible the opening up of watercourses to assist in flood risk management.

Policy STP2: Sustainable Growth Principles and managing Environmental Impacts

- 1.4.4 Sensitive areas where development may have an impact, and which would therefore require avoidance or careful assessment and mitigation measures, include:

- 2(a) Areas at risk from coastal, river and surface water flooding, including small areas along the River Mersey and on the north east and south-east fringes of the City, and North Docks and Garston Docks which provide access to processing and trans-shipment facilities for mineral resources from the Mersey Estuary, Liverpool Bay and other sources.

Policy R3: Flood Risk and Water Management

- 1.4.5 Flood risk will be reduced, water efficiency measures will be promoted, and water quality will be protected and enhanced through the following mechanisms:

- R3 (1); All proposals for development must follow the sequential approach to determining the suitability of land for development, directing new development to areas at the lowest risk of flooding and where necessary apply the exception test, as outlined in national planning policy;
- R3 (2): Developers will be required to demonstrate, where necessary, through an appropriate Flood Risk Assessment (FRA) at the planning application stage, that development proposals will not increase flood risk on site or elsewhere, and should seek to reduce the risk of flooding. New development will be required to include or contribute to flood mitigation, compensation and/or protection measures, where necessary, to manage flood risk associated with or caused by the development. Unless appropriate alleviation or mitigation measures are carried out, planning permission will not be granted for development.

Policy R4: The Coast

- R4 (1); All proposals for development must follow the sequential approach to determining the suitability of land for development, directing new development to areas at the lowest

risk of flooding and where necessary apply the exception test, as outlined in national planning policy:

- Increase the risk of tidal flooding or coastal erosion through their impact on coastal processes
- Impair the capacity of the coast to form a natural sea defence or adjust to changes in conditions without risk to life or property
- Adversely affect the integrity of sites of international nature conservation importance, taking into account appropriate mitigation, or as a last resort, compensation in accordance with Policy GI 5 of the Local Plan.

1.5 Report Structure

1.5.1 This report is structured as follows:

- Section 2 identifies the sources of information that were consulted;
- Section 3 describes the Site and the existing and proposed development;
- Section 4 outlines the flood risk to the existing site and proposed development;
- Section 5 details the proposed mitigation measures against identified flooding sources;
- Section 6 assesses the potential impacts of the proposed development on surface water drainage and proposes mitigation for those effects; and
- Section 7 presents a summary and conclusions.

2.0 Sources of Information

2.1 Sources of Information

The following information was used in preparation of this FRA:

- Ordnance Survey 1:25,000 mapping (Explorer 275: Liverpool, St Helens, Widnes and Runcorn).
- Environment Agency online flood maps (Flood Map for Planning⁵, Long Term Flood Risk Assessment for Locations in England⁶ and Environment Agency – What’s in Your Backyard?⁷).
- River Basin District (RBD) Maps⁸ (North West RBD) together with guidance on climate change allowances⁹
- National River Flow Archive¹⁰
- Liverpool City Council Level 1 Strategic Flood Risk Assessment (SFRA) January 2008 (Appendix 2).
- Flood Risk Assessment conducted for Planning Application 13F/0531 (Exhibition Centre Liverpool) in 2013 (Appendix 9)
- Mersey Estuary Catchment Flood Management Plans (2009) (CFMP)
- Liverpool City Council Preliminary Flood Risk Assessment Report (PFRA) (Appendix 2)
- North West England and North Wales Shoreline Management Plan SMP2
- National Soils Resources Institute: Soilsdapes online mapping¹¹
- British Geological Survey [BGS] online mapping: Geology of Britain Viewer¹²
- Landmark’s Promap: Flood Data package: Additional flood mapping
- Geosmart 1 in 100-year groundwater flood risk map
- United Utilities sewer asset plans.
- DEFRA’s Magic Map¹³ for identifying Designated Sites.

2.2 Consultation and Discussion with Regulators

2.2.1 Consultation and discussions were undertaken with the Environment Agency, the Local Planning Authority (LPA)/Lead Local Flood Authority (LLFA), and Water Utilities.

⁵ <https://flood-map-for-planning.service.gov.uk/>

⁶ <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>

⁷ http://maps.environment-agency.gov.uk/wiyby/wiybyController?ep=maptopics&lang=_e

⁸ <https://www.gov.uk/government/publications/flood-risk-assessments-river-basin-district-maps>

⁹ <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

¹⁰ <http://nrfa.ceh.ac.uk>

¹¹ <http://www.landis.org.uk/soilsdapes/>

¹² <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

¹³ <http://www.natureonthemap.naturalengland.org.uk/>

Environment Agency

- 2.2.2 The Environment Agency is a statutory consultee on flood risk and planning and is directly responsible for the prevention, mitigation and remediation of flood damage for main rivers and coastal areas; and it has a strategic overview for all forms of flooding.
- 2.2.3 Environment Agency Standing Advice and the NPPF/PPG ID: 7 was consulted and reviewed.
- 2.2.4 Correspondence with the Environment Agency is included in Appendix 3.

Lead Local Flood Authority

- 2.2.5 Liverpool City Council, as the LLFA responsible for surface water, groundwater and ordinary watercourses, was consulted on flood risk issues at this Site. The consultation response is included in Appendix 4.

Water Utility

- 2.5.2 All Water Companies have a statutory obligation to maintain the DG5 Flood Register of properties which are at risk of flooding from the public sewerage system.
- 2.5.3 United Utilities is responsible for the disposal of wastewater within the area. A copy of the asset plan is in Appendix 5.

Canal and River Trust

- 2.5.4 The Canal and River Trust are responsible for the Liverpool docks from Wapping Dock to Brunswick Dock, which form the eastern boundary of the Site.
- 2.5.5 Correspondence with the Canal and River Trust is included as Appendix 6.

2.3 Site Walkover

- 2.3.1 Enzygo staff conducted a walkover of the Site on the 10th January 2017 and 26th September 2017. Observations made were used to inform the Site description.

3.0 Site Location and Description

3.1 Location

- 3.1.1 The wider Site is located on land at Monarchs Quay off Queens Wharf, Liverpool, L3 4FP.
- 3.1.2 The wider Site is centred on National Grid Reference (NGR) 334367, 389182.
- 3.1.3 The wider Site location is shown in Drawing 001 and in more detail in Drawing 002, which shows the blue line boundary enclosing an area of approximately 5.5ha.
- 3.1.4 The Site comprises of a single redline boundary and is located within the eastern and south-eastern area of the wider Site. The redline boundary encloses an area of 0.64 ha.

3.2 Existing Use

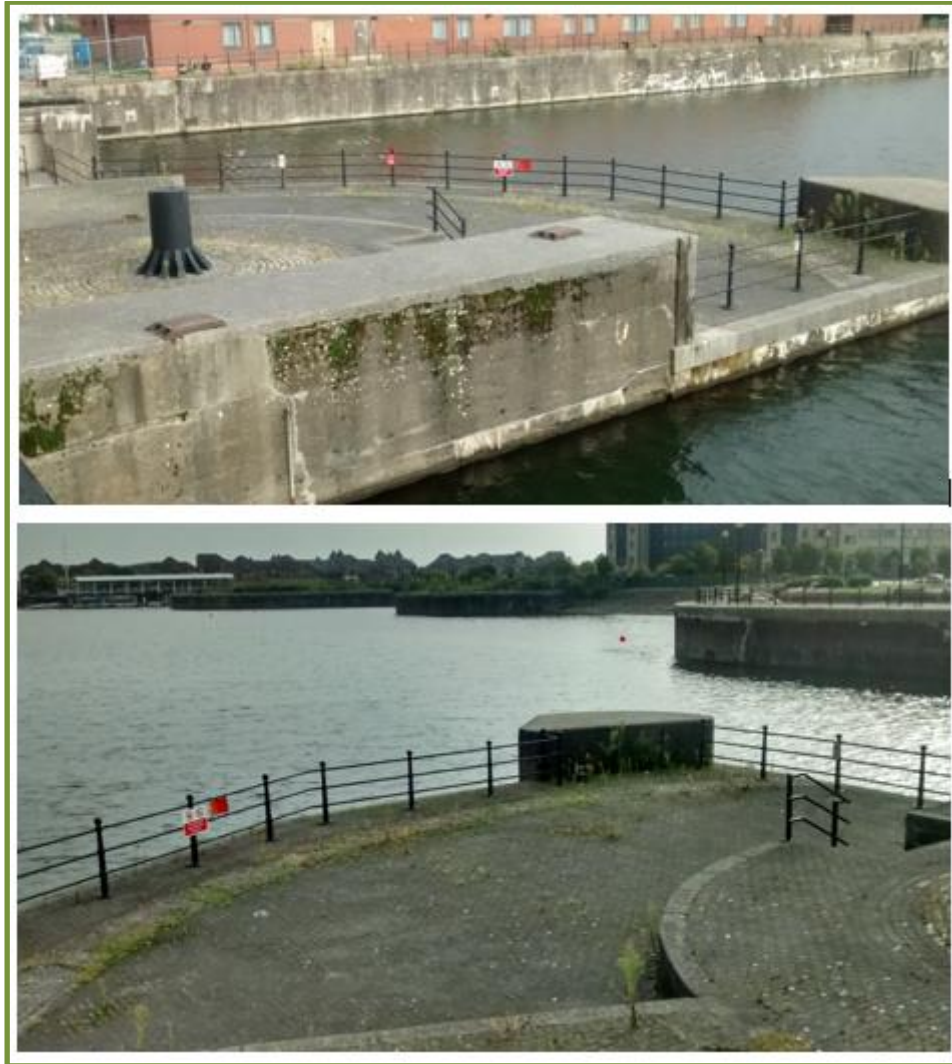
- 3.2.1 The wider Site is located on land between the Queens and Wapping Docks and the right (eastern) bank of the tidal River Mersey. The wider Site is currently occupied by areas of brownfield land, hardstanding car park and metalled roads. The land upon which the proposed development Site is located could be considered an 'island' and is linked to the 'mainland' via a number of bridges and control structures.
- 3.2.2 The island on which the wider Site is located is significantly urbanised with very little of what could be termed greenfield areas. The 'built up' nature of the island also means the perimeter is encased in high concrete walls and sloping masonry abutments.
- 3.2.3 The wider Site is accessed via the Queens Wapping bridge, which falls within the Site Redline boundary and links the island to the A562 to the East of Wapping and Queens Dock. The Queens Wapping bridge is the primary access and egress route to the Site and wider Site. An existing metalled road infrastructure is located within, and bounding, the wider Site, namely; Queens Wharf, Keel Wharf, Monarchs Quay, Kings parade and Half Tide wharf. Approximately (~) 2 Ha of the Site is currently laid to tarmac in the form of car parking. The remaining ~3.5 Ha comprises the existing metalled road network, brownfield land and areas of various hardstanding.
- 3.2.4 The wider Site has been subject to significant development, in the form of road networks and service infrastructure, in preparation for future Site development.
- 3.2.5 Preparatory development within the Site has divided the wider Site into a number of development 'Plots', bounded by the existing road network and docks.

Figure 3.1: Photograph of the wider Site



Top Left: Pan of middle of the Site **Top Right:** **Bottom Left:** **Bottom Right:** Looking along Monarchs Quay to the north.

- 3.2.6 The wider Site is bounded by the River Mersey and Liverpool Exhibition Centre to the west, existing office buildings to the north, Queens and Wapping docks to the east and existing office buildings to the south.
- 3.2.7 The Site comprises two development plots; Plots 2 and 4, located within a single redline boundary within the eastern area of the wider Site and is approximately 0.64 ha in area. Plots 2 and 4 corresponds to Buildings 2 and 4 as shown within the development plan provided within Appendix 1.
- 3.2.8 **Plot 2:** Comprises a hardstanding promontory of approximately 0.056 ha in area. The Plot is bounded on its southern and western sides by Queens Dock, on its northern boundary by Queens Wharf and eastern boundary by further hardstanding associated with the eastern extent of the Queens Wapping road bridge. The Plot was historically part of the pivot infrastructure for the Queens Wapping bridge when it was operated a swing bridge. The area is currently used as a viewpoint area with steps linking it to Queens Wharf (Figure 3.2).

Figure 3.2: Photograph of Plot 2.

Top: Looking east from Queens Wapping bridge towards Plot 2 Bottom: Looking south west across Plot 2 towards Queens Dock.

3.2.9 **Plot 4:** Plot 4 is L shape in plan has a current land use of car parking, metalled road, paved hardstanding and grassed areas (Figure 3.4). Plot 4 area is approximately 0.48 ha. Grassed areas currently account for 0.12 ha (33% of the Plot Area) (Drawing 007). An electrical substation, with a footprint of 0.04 ha is located immediately to the south west of the Plot. To the east of Plot 4 is Queens Dock. To the north of Plot 4 is Queens Wharf. To the west of Plot 4 is Monarchs Quay and to the south of Plot 4 is Half Tide Wharf and Keel Dock.

Figure 3.4: Photographs of Plot 4



Top: Looking north across Plot 4 from Keel Wharf **Bottom:** Looking south west across Plot 4 from Queens Wharf

3.3 Proposed Use

3.3.1 Development of the wider Site is proposed to be undertaken in three phases/applications. This FRA considers application 1b only and consists of:

- **Application 1b: Plot 2:** 5 Storey Interpretation Centre /Office use with ground floor Cafe (Less Vulnerable Use). Proposed building footprint is 0.017 ha
- **Application 1b: Plot 4:** Ground floor Commercial, Food Hub and 120 apartments (More Vulnerable Use). Proposed building footprint is 0.36 ha

3.4 Topographic Information

3.4.1 A topographic survey was carried out during July 2017 and a copy is included in Appendix 7.

Wider Site

3.4.2 The survey shows that the wider Site has a topographic high of 8.4 m above Ordnance Datum (mAOD) at both the centre of the Queens Wapping bridge deck and roundabout at the junction of Queens Wharf and Monarchs Quay. The Site has a topographic low of 4.25 mAOD

at the eastern extent of a slipway, which links Queens Dock with the south-east area of the Site.

- 3.4.3 Roadway elevations within the wider Site, namely Monarchs Quay, Keel Wharf and Half Tide Wharf ranges between 6.7 mAOD and 7.4 mAOD.
- 3.4.4 The majority of the wider Site is between 6.6 and 7.5 mAOD with a fall to the south over a distance of approximately 260 metres (m). This gives a slope gradient of 1:290
- 3.4.5 The Mersey estuary frontage (Kings Parade), which partially forms the western boundary of the wider Site has elevations of between 7.5 and 7.6 mAOD.

Primary Access/Egress

- 3.4.6 The Queens Wapping bridge, which forms the primary vehicular access to the wider Site, has an elevation of 7.10 mAOD at its eastern extent, 7.9 mAOD at its western extent and 8.38 mAOD within the centre of the bridge Deck.

Site

- 3.4.7 **Plot 2:** Plot was not surveyed as part of the topographical survey. However, 1 metre LIDAR data was utilised to determine existing elevations. The plot comprises various 'stepped' levels that are linked via masonry stairs. The majority of the Site is at an elevation of between 4.5 and 5.3 mAOD. No discernible slope is present within Plot 2, however, the stepped nature of the Plot drops towards the western and southern boundaries, which front the Docks. Plot is located immediately to the south and west of high ground with elevation between 7.5 and 8 mAOD.
- 3.4.8 **Plot 4:** The Site ranges from a topographical high of 8.2 mAOD within its north-eastern corner to a topographical low of 7.3 mAOD within the centre of the Site. The Site slopes towards the existing Site entrance with gradients ranging between 1:43 and 1:186.

3.5 Catchment Hydrology

- 3.5.1 Environment Agency online flood mapping and Ordnance Survey mapping (Drawing 005 and 002 respectively) identifies the River Mersey (a 'main river' where flood risk work is carried out by the Environment Agency) conveying flow west, adjacent to the southwestern boundary of the Site (Figure 3.2). The River Mersey's main river designation terminates at Warrington, approximately 36km upstream of the Site. The River Mersey adjacent to the Site classified as tidal/estuarine and is in the region of 1.2 km wide.

Figure 3.2: Photograph of The River Mersey



View South West Across the River Mersey from Canning Dock, to the north of the Site.

- 3.5.2 The River Mersey channel was observed to be free flowing and at low tide (Figure 3.2) at the time of visit.
- 3.5.3 To the east of the wider Site, are a series of hydrologically linked docks, namely; Brunswick Dock, Coburn Dock, Queens Dock, Wapping Dock, Wapping basin, Salthouse Dock, Canning Dock and Canning Half Tide Dock (Figure 3.3). Along with the tidal River Mersey, these docks encapsulate the land upon which the proposed development Site is located. The docks are currently operated by the Canal and River Trust.
- 3.5.4 **Plot 2:** Is located within Queens Dock, as a promontory from the Queens Wapping Road Bridge. As such, Plot 2 is immediately adjacent to the Queens Dock and is approximately 345m from the Mersey Estuary.
- 3.5.5 **Plot 4:** Plot 4 is located immediately adjacent to Queens Dock and is approximately 245m from the Mersey Estuary.

Figure 3.3: Photographs of the Docks

Top Left: Looking South at Queens Dock from Queens Wapping Bridge. **Top Right:** Looking North at Wapping Dock from Queens Wapping Bridge. **Bottom Left:** Queens Wapping Bridge **Bottom Right:** Looking east from the Site to Wapping Dock

- 3.5.6 A significant variation between the River Mersey and Docks water level was observed during the Site walkover. This indicates that the docks do not mirror water levels within the River Mersey with water levels maintained by control structures (Figure 3.4).
- 3.5.7 Control and lock structures within the docks are operated by the Canal and River Trust.

Figure 3.4: Photograph of Dock Control Structure*Brunswick Dock Control Structure*

3.6 Sewerage Assets

Public Sewers

- 3.6.1 United Utilities Water asset plans (Appendix 5) show that there is a private surface water main sewer located within an area occupied by the Liverpool Exhibition Centre, which is located to the west of the Site.
- 3.6.2 No public sewers are shown within the Site (Plots 2 or 4)
- 3.6.3 To the south west of the wider Site, running parallel with the River Mersey frontage (Kings Parade), is a $\varnothing 150\text{mm}$ surface water public sewer which conveys south east before discharging to the River Mersey to the south of the Site. The sewer is shown to be approximately 280 m in length with a single outfall to the River Mersey Estuary at its centre.
- 3.6.4 Running parallel with the River Mersey frontage (Kings Parade), to the south west of the Site, is a $\varnothing 400\text{mm}$ foul sewer, which conveys flow in a north-westerly direction.
- 3.6.5 A $\varnothing 1580\text{mm}$ and $1030 \times 1580 \text{ mm}$ combined sewer is shown to be located approximately 75m to the east of Plot 2 which conveys flow in a north westerly direction. This sewer is shown to accept flows, as part of a combined system, from Liverpool City centre via numerous connections.

Private Sewers

- 3.6.6 A culvert tracing survey, undertaken in July 2017 (Drawing 8 and Appendix 7) was conducted to determine existing drainage arrangements within the wider Site.
- 3.6.7 The survey found that an existing, separate surface water and foul network is located within the wider Site (Figure 3.5).

Figure 3.5: Photographs of the existing private sewer network within the wider Site.



Top Left: Foul manhole SW19 looking west along Half Tide Wharf **Top Right:** Surface Water Manhole SW10 looking north to Queens Wharf Roundabout **Bottom Left:** Manhole SW12 looking North **Bottom Right:** Inside of Manhole SW10 showing connection spurs

3.6.8 Drawing 008 shows the surveyed, existing network to be primarily located beneath the existing road network.

- 3.6.9 The surface water network, within the wider Site, is shown to drain to the River Mersey via a connection to the United Utilities ø150mm surface water sewer where Half Tide Wharf joins Kings Parade on the wider Sites southern boundary. The ø150mm surface water sewer discharges to the River Mersey Estuary, via a ø1200mm flapped outfall, approximately 45 m to the south of Half Tide Wharf
- 3.6.10 The foul network, within the wider Site, is shown to connect to the United Utilities ø400mm public foul sewer on the wider Site southern boundary (Kings Parade).
- 3.6.11 The existing surface and foul networks, as per Drawing 008, are not shown on the United Utilities asset plans (Appendix 5).
- 3.6.12 The culvert tracing survey (Drawing 008) shows:
- Plot 2:** No private surface water or foul sewers are located within Plot 2. A ø150mm surface water sewer is shown to originate at manhole SW31, approximately 15 m to the north of the Plot. The surface water sewer conveys flow in a north easterly direction with assumed connection to the public combined sewer network located approximately 75 m to the east of the Plot. Approximately 50 m to the west of Plot 2 is the head of the surface water and foul network within the wider Site to the west of the Queens Wapping bridge. A ø600mm surface water and ø225mm foul sewer originate at manholes SW30 and FW29 respectively before conveying in a westerly direction along Queens Wharf.
- 3.6.13 **Plot 4:** ø300mm and ø225mm surface water seers are located within Queens Wharf and Keel wharf, to the north and west of Plot 4 respectively. These sewers join within Queens Wharf, approximately 20 m to the north west of Plot 4, before continuing westerly as a ø600mm along Queens Wharf. ø150mm foul sewers are shown to the north a and west of Plot 4, before joining in Queens Wharf and continuing westerly on Queens Wharf as a ø225mm foul sewer.
- 3.6.14 The drainage network within the Site and wider Site appears to have been built to an adoptable standard in preparation for development of the wider Site, but at this time, may not have been formally adopted by United Utilities.
- 3.6.15 It is unknown whether the surveyed network, within the Site, accepts surface and foul water from developments located outside the wider Site redline boundary.
- 3.6.16 Appendix 9, which contains extracts from the Flood Risk Assessment conducted for Planning Application 13F/0531 (Exhibition Centre Liverpool) in 2013, shows that historically, both surface water and foul drainage routed westward from Queens Wharf (within the centre of the wider Site), to a ø600mm public surface water sewer located within Kings Parade, to the west of the Exhibition Centre.
- 3.6.17 A comparison of the surveyed drainage within Appendix 7 and Appendix 9 shows that as part of the Exhibition Centre development, both surface water and foul assets were diverted from Queens Wharf to Half Tide Wharf (southwards along the eastern boundary of the exhibition centre) with subsequent connection to the ø150mm public surface water sewer and ø400mm foul sewer in Kings Parade.
- 3.6.18 Queries were raised with the LLFA (Liverpool City Council) (Appendix 4) with regards to design details of the existing drainage network within the wider Site. Through correspondence, the LLFA have stated that Liverpool City Council do not hold information regarding the drainage network within the Site or drainage catchment of the area.
- 3.6.19 Correspondence has been sent to ISG Construction Ltd, who were the client for the flood risk assessment conducted for the Exhibition Centre Liverpool requesting further information

regarding the design, calculations and correspondence relating to the existing drainage network within the wider Site (Appendix 9).

- 3.6.20 A further CCTV survey is proposed for the Site, wider Site and areas surrounding the wider Site. The survey is proposed to be undertaken during detailed drainage design stage to ensure that sewer modelling utilises the most detailed information possible.

3.7 Soils and Geology

- 3.7.1 The Soilscape online soils map viewer shows that the wider Site is underlain by 'loamy and clayey floodplain soils with naturally high groundwater'.
- 3.7.2 The Geology of Britain online map viewer shows that the underlying geology beneath the Site are of the 'Chester Pebble Beds Formation', comprised of sandstone, pebbly and gravelly in nature. These rocks were formed from rivers depositing mainly sand and gravel detrital material to form river terrace deposits.
- 3.7.3 The Geology of Britain online map viewer shows no superficial deposits located within the Site.
- 3.7.4 The Site is brownfield and includes 'Made Ground' of variable composition, location and depth as shown within borehole logs (Appendix 7). Made ground is shown to a depth of between 3.00 to 4.65 m.
- 3.7.5 Borehole SJ38NW962, located within the north of the wider Site, shows dark silty material, with an 'oily/tarry smell' to a depth of 6 m.
- 3.7.6 Correspondence from both the Environment Agency (Appendix 3) and United Utilities (Appendix 5) show areas to the north of the wider Site as being contaminated.

3.8 Designated Sites

- 3.8.1 The DEFRA Magic Map (England and Wales)¹⁴ shows there are designated sites close to the Site including downstream (from a flood risk and drainage perspective).
- Mersey Estuary RAMSAR Site
 - New Ferry Site and North Wirral Foreshore Site of Special Scientific Interest
 - Mersey Estuary Special Protection Area (Marine)
 - Mersey Narrows and North Wirral Foreshore Ramsar Site
 - Mersey Narrows Site of Special Scientific Interest
 - SSSI Impact Zone
 - Mersey Narrows and North Wirral Foreshore Special Protection Area (Marine)

¹⁴ <http://www.natureonthemap.naturalengland.org.uk/MagicMap.aspx>

4.0 Flood Risk Assessment

4.1 Potential Sources of Flooding

- 4.1.1 A summary of the potential sources of flooding and the potential risk posed by each source at the Site is presented in Table 4.1. Each source of flooding and level of risk is then assessed in further detail.

Table 4.1: Potential Risk Posed by Flooding Sources

| Flooding Source | Potential Flood Risk at Application Site (Yes/No) | Potential Source | Data Sources |
|------------------------|---|-----------------------|--|
| Fluvial | No | None Identified | Environment Agency flood mapping (Drawing 005), |
| Tidal | Yes | River Mersey Estuary | Environment Agency flood mapping (Drawing 005), JBA coastal flooding (Drawing 004.2) |
| Groundwater | Yes | Aquifer | BGS mapping (Drawing 003) PRFA Mapping (Appendix 2) |
| Surface Water | Yes | Poor permeability | Environment Agency online flood mapping, SFRA extract, JBA surface water mapping (Drawing 004.1) PRFA Mapping (Appendix 2) |
| Sewer | Yes | Public/private sewers | Asset plans (Appendix 5), SFRA extract (Appendix 2), Culvert Survey (Appendix 7) |
| Infrastructure Failure | Yes | Liverpool Docks | JBA coastal flooding (Drawing 004.2) |

4.2 Fluvial Flooding

Environment Agency

- 4.2.1 The Flood Zones are the current best information on the extent of the extremes of flooding from rivers or the sea that would occur without the presence of flood defences, since these can be breached, overtopped and may not be in existence for the lifetime of a development.
- 4.2.2 The River Mersey, to the south of the wider Site, is classed as tidal, as such, Environment Agency flood zones are not representative of fluvial sources. No fluvial sources of flooding have been identified (Drawing 002).
- 4.2.3 The Environment Agency online flood map shows most of the wider Site is located within Flood Zone 1; outside the 1 in 1000-year probability of fluvial (river) flooding (0.1% Annual Exceedance Probability [AEP]). A small area in the south-west of the wider Site, and outside the redline boundary of the Site, is shown to be located within Flood Zones 2 and 3. As described above, Environment Agency flood zones are representative of tidal flooding.
- 4.2.4 The wider Site is assessed as being at 'low' risk of fluvial flooding.

Historic Flooding

- 4.2.5 The LLFA consultation (Appendix 4) confirms they have no recorded history of flooding at the Site.
- 4.2.6 PFRA mapping 'Summary of past Flooding' which shows areas of historical flooding (Appendix 2) shows no flooding in the vicinity of the wider Site.

Flood Defences

- 4.2.7 Environment Agency online flood mapping and SFRA mapping show that the wider Site and Site does not benefit from flood defences.
- 4.2.8 Defences are located on the left-hand bank of the River Mersey opposite the wider Site. Although the defences do not offer benefit to the wider Site, the defences may be influential upon flood levels affecting the Site.

Flood Warning

- 4.2.9 Environment Agency online flood mapping shows the wider Site is located within an area that receives flood warnings and alerts.
- 4.2.10 The wider Site is located within the 'Irish Sea and Mersey Estuary from the Head of the Wirral to Runcorn' tidal flood warning area.

Residual Risk

- 4.2.11 The LLFA confirmed that the wider Site has no history of flooding and there are no watercourses, either culverted, open or historic that cross or are close to the wider Site (Appendix 4).

4.3 Tidal Flooding

Environment Agency Flood Map

- 4.3.1 The wider Site is located close to tidally affected flooding sources and so the flood risk from this source is assessed as high.
- 4.3.2 The Environment Agency online flood map shows most of the wider Site is located within Flood Zone 1; outside the 1 in 1000-year probability of tidal flooding (0.1% AEP) and as being at 'low' risk of tidal flooding.
- 4.3.3 An area in the south west of the wider Site is shown to be located within Flood Zones 2 and 3; within the 1 in 1000-year probability of tidal flooding (0.1% AEP) and within the 1 in 200-year probability of tidal flooding (0.5% AEP). This area of the wider Site is assessed as being at 'medium and high' risk of tidal flooding respectively.
- 4.3.4 The Site (inclusive of plots 2, 3 and 4) is shown to be located entirely within Flood Zone 1; outside the 1 in 1000-year probability of tidal flooding (0.1% AEP) and as being at 'low' risk of tidal flooding.

JBA Coastal Flood Mapping

- 4.3.5 JBA coastal flood mapping (Drawing 004.2) shows flooding within the wider Site is restricted to the eastern and southern areas, in particular, the sloping abutments alongside Wapping and Queens Dock. Inundation is also shown, with a 1 in 75-year return period, within the slipway area and also the eastern extent of Half Tide Wharf. Inundation with a 1 in 1000-year return period is shown within the central and eastern areas of Half Tide Wharf. No flooding is shown from the Mersey Estuary with all inundation occurring from the Wapping and Queens Docks.
- 4.3.6 JBA coastal flood mapping shows inundation within the Site and inundation is shown within Plots 2, 3 and 4. Plot 2 is shown to be entirely inundated during the 1 in 75-year event and above. A limited area of flooding, within the 1 in 75-year event, is shown within the southern area of Plot 4. Half Tide wharf, which is located south-west of the Site, is shown to be inundated during the 1 in 1000-year tidal event.
- 4.3.7 JBA coastal flood mapping shows inundation of the Queens Wapping bridge within the 1 in 75-year return period event. This mapping does not take the bridge deck into account. A comparison of the Environment Agency tidal data (Appendix 3) and topographical data for the bridge deck shows freeboard of over 1 metre above the climate change scenario level of 7.28 mAOD.

Environment Agency Modelled levels

- 4.3.8 Through consultation, the Environment Agency have supplied modelled tidal levels (Appendix 3), derived as part of a modelling study conducted in 2016. The Environment Agency have confirmed that the 2016 modelled levels are acceptable for use in support of an FRA.
- 4.3.9 The Environment Agency have confirmed that Flood Zones (Drawing 005 and Appendix 3) are not derived from the 2016 River Mersey modelling study results, and as such, do not represent the latest tidal levels for the Mersey estuary.
- 4.3.10 Draft flood outlines have been provided by the Environment Agency which are derived from the 2016 Mersey modelling study, (Appendix 3). The supplied map is of low resolution with an unknown source of ground elevations within the wider Site.
- 4.3.11 In order to ensure that tidal flood risk, within this FRA, considers the latest modelled levels and flood outlines, supplied model levels have been compared to the wider Site topographical survey to derive updated flood Zones (Drawing 009).
- 4.3.12 Based upon 2016 modelled levels and topographical survey, tidal Flood Zones 2 and 3 within the wider Site, are restricted to the eastern area of the Site and are generally representative of the slipway and sloping abutments from Queens dock. Flooding of this area is sourced from the docks, not the Mersey Estuary.
- 4.3.13 Based upon drawing 009, Plot 2 is inundated during the 200 year and 1000 year tidal events. Maximum depths are in the region of 1.35 and 1.48 m for the 200 year and 1000 year events respectively. No inundation of Plots 3 and 4 is shown.
- 4.3.14 No flooding is shown within the west of the wider Site and no flooding of the wider Site is shown to occur directly from the Mersey Estuary through overtopping of the Mersey frontage.
- 4.3.15 Updated flood outlines have also been produced which represent the 0.5% AEP (1 in 200-year) tidal event with sea level rise (climate change) to the year 2115. The most significant area of inundation is within the southern area of the wider Site in the vicinity of Monarchs Quay and Half Tide Wharf, where maximum depths are in the region of 0.6 m. Isolated areas of

inundation are also seen within Keel Wharf, to the north of the Keel Wharf and Queens Wharf junction, and also at the eastern extent of the Queens Wapping bridge.

- 4.3.16 When sea level rise to the year 2115 (climate change) is considered, Plot 2 is shown to be entirely inundated with a maximum depth in the region of 1.98 m. No inundation of Plot 4 is shown during the climate change scenario.
- 4.3.17 The primary vehicular access routes of Queens Wharf and Monarchs Quay, to Plots 2 and 4 remain flood free during all tidal events, including the year 2115 sea level rise scenario. However, inundation during the 2115 sea level rise scenario is shown within the eastern extent of the Queens Wapping bridge. Based upon a tidal level of 7.28 mAOD, maximum depths would in the region of 0.17 to 0.28 m.
- 4.3.18 Queens Wharf, immediately to the north of Plot 2, is shown to reside within Flood Zone 1 (Low Risk) with an elevation in the region of 8 mAOD. The primary access/egress to the proposed building within Plot 2, will be directly from Queens Wharf to the 1st floor. The proposed building design allows safe, dry access/egress directly to an area of Flood Zone 1.
- 4.3.19 The updated tidal flood outlines have not been sent to the Environment Agency at the time of writing.

4.4 Groundwater Flooding

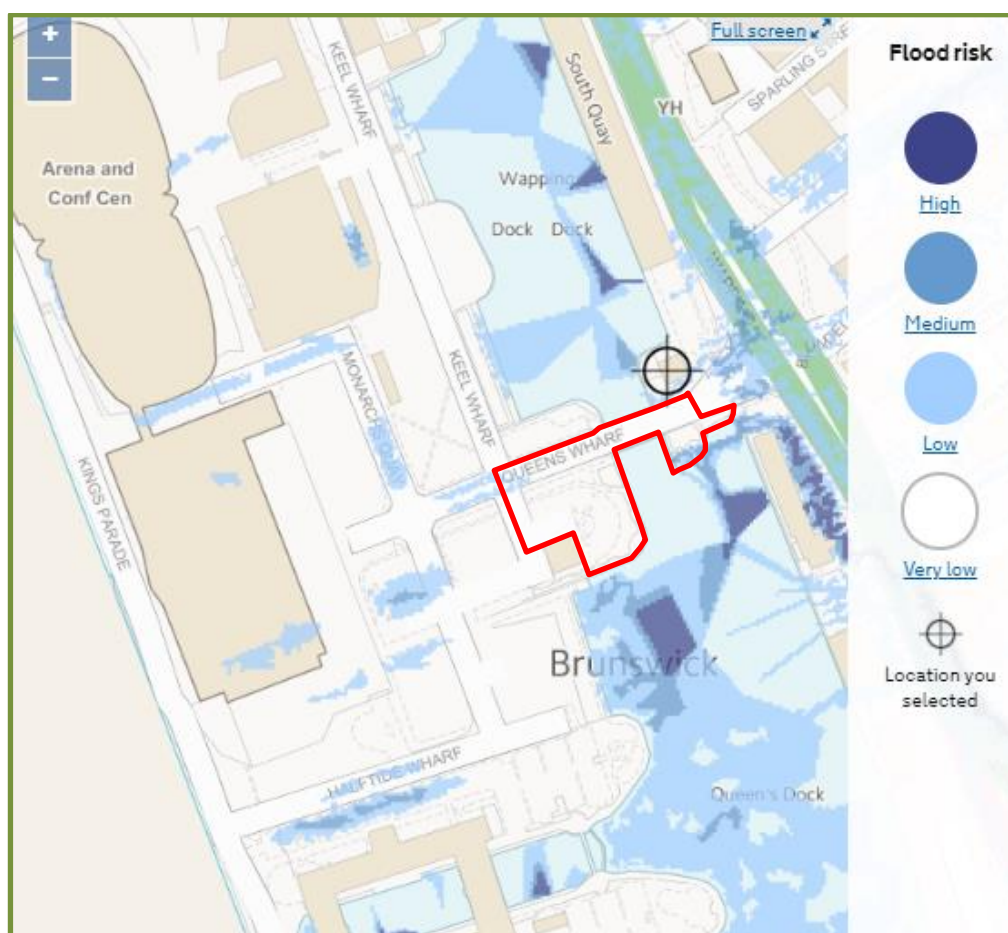
- 4.4.1 Groundwater flooding occurs when subsurface water emerges either at surface or in made ground or in subsurface structures such as basements and services ducts. It occurs as diffuse seepage, emergence from new point source springs or an increase in flow from existing springs. It results from aquifer recharge from infiltrating rainfall, from sinking streams entering aquifers from adjacent non-aquifers, or from high river levels or tides driving water through near surface deposits. It tends to occur with a delay following rainfall and can last for several weeks or months. Groundwater flooding or shallow water tables also prevent or reduce infiltration and so can worsen surface water flooding.
- 4.4.2 The BGS Groundwater Flooding Susceptibility Map (Drawing 003) shows that the Site is within the mapped extent of susceptibility to ground water flooding, with limited potential for flooding to occur. The low risk of groundwater flooding is likely to be linked to the Sites encapsulation by, and elevation above, the Mersey Estuary and docks.
- 4.4.3 PFRA mapping 'Areas Susceptible to groundwater flooding' (Appendix 2) shows the Site is not located in an area susceptible to groundwater flooding.
- 4.4.4 The LLFA also confirmed that the area is not susceptible to high groundwater levels (Appendix 4).
- 4.4.5 Mitigation measures against residual groundwater flooding are discussed in Section 5.

4.5 Surface Water Flooding

- 4.5.1 Surface water flooding occurs following rainfall on ground where infiltration rates are less than the rainfall precipitation rate. This can occur when either:
- Soils or ground materials are naturally of low permeability or have been compacted (infiltration excess runoff);
 - Soils or ground materials are saturated from previous rainfall either directly or from upslope (saturation excess runoff and return flow).

- 4.5.2 The JBA Surface Water Flood Map (Drawing 004.1) shows that most of the wider Site is located outside the mapped extent of surface water flooding. There are, however, isolated ponded areas of 'medium to low' risk surface water flooding located within the wider Site. The ponded areas of surface water flooding appear to be associated with topographic low spots within the existing road network and not with active overland flow paths.
- 4.5.3 Surface water ponding within the wider Site is associated with the 75-year, 200-year and 1000-year events. 1 in 1000-year flooding is shown for the entirety of Plot 2 and the western area of Plot 4 (representing the current entrance). Ponding during the 1 in 200-year surface water flooding event is shown within Keel Wharf to the west of Plot 4.
- 4.5.4 Environment Agency online surface water mapping¹⁵ (Figure 4.1), shows similar surface water flooding as the JBA mapping, with isolated areas of low to medium risk ponding, primarily located within the existing road network. No overland flow pathways originating outside of the wider Site are shown. Medium risk of surface water flooding is shown within Plot 2. No surface water flooding is shown within Plot 4.

Figure 4.1: Environment Agency Online Surface Water Mapping with Site Redline Boundary



¹⁵ <https://flood-warning-information.service.gov.uk/long-term-flood-risk/map?easting=391184&northing=304837&address=100031815131>

- 4.5.5 Both the JBA surface water mapping and Environment Agency online surface water mapping shows inundation of Plot 2. However, the built nature of Plot 2, and location within Queens Wharf means any rainfall to this area will diffusely runoff to Queens Docks. Surface water flow pathways into Plot 2, and the ponding of surface water within Plot 2 is considered highly unlikely.
- 4.5.6 PRFA mapping (areas susceptible to surface water flooding) (Appendix 2) shows that Site is in an area of 'less to intermediate' susceptibility.
- 4.5.7 Mitigation measures against surface water flooding are discussed in Section 5.

4.6 Sewer Flooding

- 4.6.1 Sewer flooding occurs when urban drainage networks become overwhelmed after heavy or prolonged rainfall due to restrictions or blockage in the sewer network or if the volume of water draining into the system exceeds the sewer design capacity.
- 4.6.2 New sewers are built to the guidelines within Sewers for Adoption¹⁶ and have a design standard to the 1 in 30-year flood event. Older sewers were not designed to any particular standard. Modern sewer systems will only surcharge during rainstorm events with a return period greater than 30-years (e.g. 100-years).
- 4.6.3 Two public sewers are shown to be located on Kings Parade, on and just inside, the western Site boundary.
- 4.6.4 The Kings Parade public surface water sewer is approximately 280 m in length, with a single outfall to the River Mersey Estuary at its centre. The limited network, catchment entering the sewer and ability to discharge to the River Mersey at atmospheric pressure significantly reduces the likelihood of manhole surcharging.
- 4.6.5 If discharge to the River Mersey estuary is restricted through tidal locking, it is expected that surface water could enter the wider Site, in particular, Half Tide Wharf, where ground levels are lower than the manhole cover levels, within Kings Parade, of 7.46 and 7.5 mAOD.
- 4.6.6 From a review of SFRA incidences of sewer flooding (Appendix 2), there are no recorded sewer flooding incidents located within postcode L3, in which the Site is located.
- 4.6.7 LLFA consultation (Appendix 4) confirms they have no recorded history of flooding for the Site.
- 4.6.8 The risk of flooding from sewers is therefore assessed as Low. Mitigation measures against sewer water flooding are discussed in Section 5.

4.7 Flooding from Infrastructure Failure

Reservoirs

- 4.7.1 The Environment Agency online flood mapping shows the Site is located outside the extent of flooding sourced from reservoirs. The risk of flooding from reservoirs is assessed as negligible.

Liverpool Docks

- 4.7.2 The docks, which form the eastern boundary of the Site, and wider Site, are hydraulically linked to the River Mersey Estuary, however, water levels within the Docks are maintained at

¹⁶ WRC (2012) Sewers for Adoption 7th Edition.

an artificial level through locks and control structures. Water levels within the docks do not rise and fall with the tide.

- 4.7.3 Flood risk from the docks will occur from tidal sources through overtopping, or failure of, control structures. As such, tidal water levels within the docks will mirror those within the Mersey Estuary. Flooding from the docks has been considered within the 'tidal flooding' section.

5.0 Flood Risk Mitigation Measures

5.1 Introduction

5.1.1 The following sources of flooding were identified:

- Tidal flooding
- Surface water flooding
- Groundwater flooding
- Sewer flooding

5.2 Mitigation Measures

Tidal Flooding

- Ensure finished floor levels are above 7.28 mAOD, for developments proposed within Plot 4, to ensure the development remains flood free from tidal sources, for the entirety of its lifetime (to the year 2115).
- A finished floor level at, or above 7.28 mAOD, within Plot 2 is not considered feasible. In this instance, the building should mitigate flood risk through the use of flood resilient construction and completion of a Flood Evacuation Management Plan (FEMP), discussed below.
- High ground, in excess of the 1 in 200 year 2115 climate change tidal event is located immediately to the north and east of Plot 2 allowing direct access to Flood Zone 1 from the primary building on the first floor.
- Register all proposed development within Site with the Environment Agency Floodline Warnings Direct service. It is noted that the Site is located within the mapped coverage of receiving flood warnings (Irish Sea and Mersey Estuary from the Head of the Wirral to Runcorn).
- As the primary flood risk to the Site is from tidal sources, long lead times before significant flooding events are usually available which provides timescales for the evacuation of the Site or prohibition of access to the Site. The published standard from the Environment Agency for a tidal flood warning is 1-day notice. A **SEVERE FLOOD WARNING** usually follows a **FLOOD WARNING**.
- Prepare a Flood Evacuation Management Plan (FEMP), at an individual building/development level, to ensure all onsite staff and visitors can exit the Site and move to a place within Flood Zone 1 (low risk).
- Incorporate flood resilient construction measures into the onsite buildings. Construction measures may include:
 - Electricity supply cables to enter building from a high level and wired downwards; electric sockets to be positioned +600mm above finished floor level.
 - Use water resilient floor and wall coverings.
 - Use anti-flood valves on internal building drainage

Surface Water Flooding

- Adoption of a surface water management strategy.
- Set finished floor levels as per above.

Groundwater Flooding

- No below surface buildings (i.e. basements).
- Adoption of a surface water management strategy.
- Set finished floor levels as per above.

Sewer Flooding

- Adoption of a surface water management strategy.
- Set finished floor levels as per above.

5.3 Summary of Flood Risk

5.3.1 Table 5.1 summarises the probability and level of risk, both with and without mitigation measures.

Table 5.1: Probability and consequences of all sources of flooding

| Flooding Source | Potential Source | Probability | Consequence & Impact Without Mitigation | Consequence & Impact with Mitigation |
|------------------------|------------------------------------|---------------|---|--------------------------------------|
| Fluvial | None | Low | Low | Negligible |
| Tidal | Mersey Estuary. Liverpool Docks | High | High | Negligible |
| Groundwater | Aquifer | Low | Low | Negligible |
| Surface Water | Poor Permeability | Low to Medium | Low to Medium | Negligible |
| Sewer | Public sewers | Low | Low | Negligible |
| Infrastructure Failure | Reservoir Failure | Negligible | Negligible | Negligible |

Key: Green - Negligible, Yellow - Low, Orange - Medium and Red - High; based on consequence and impact with mitigation from each flooding source.

5.4 Flood Guidance and Sequential Test

- 5.4.1 The proposal is for a mixed-use development, comprising 'Less Vulnerable' development in the form of retail/commercial and office use and 'More Vulnerable' use in the form of residential apartments. Table 2 of PPG ID: 7 (not included in this report) classifies the proposed office use as 'Less vulnerable'.
- 5.4.2 The Environment Agency Flood Zones and acceptable development types are listed in Table 5.2. All development types (including More vulnerable uses) are acceptable in Flood Zone 1 (Low risk). Less vulnerable uses are acceptable within Flood Zones 2 and 3. As such, the Sequential Test would be passed and the Exception Test would not be required as indicated in Table 5.3.

Table 5.2: Environment Agency Flood Zones and Appropriate Land Use

| Flood Zone | Probability | Explanation | Appropriate Land use |
|------------|-------------------------|--|---|
| Zone 1 | Low | Less than 1 in 1000 annual probability of river or sea flooding in any year (<0.1%). | All development types generally acceptable. |
| Zone 2 | Medium | 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. | Most development type are generally acceptable. |
| Zone 3a | High | 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. | Some development types not acceptable. |
| Zone 3b | 'Functional Floodplain' | Land where water must flow or be stored in times of flood. SFRAs should identify this zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1% flood, or at another probability to be agreed between the LPA and the Environment Agency, including water conveyance routes). | Some development types not acceptable. |

Note: The Flood Zones are the current best information on the extent of the extreme flood from rivers or the sea that would occur without the presence of flood defences, because these can be breached, overtopped and may not be in existence for the lifetime of the development. The identified risk of fluvial flooding is highlighted green.

Table 5.3: Vulnerability and Flood Zone ‘Compatibility’ as identified in Table 3 of PPG ID: 7

| Flood Risk Vulnerability classification (see Table 1 of PPG ID: 7) | Essential Infrastructure | Water Compatible | Highly Vulnerable | More Vulnerable | Less Vulnerable |
|--|--------------------------|------------------|-------------------------|-------------------------|-----------------|
| Zone 1 | Yes | Yes | Yes | Yes | Yes |
| Zone 2 | Yes | Yes | Exception test required | Yes | Yes |
| Zone 3a | Exception test required | Yes | No | Exception test required | Yes |
| Zone 3b ‘Functional Floodplain’ | Exception test required | Yes | No | No | No |

Key: Yes: Development is appropriate, No: Development should not be permitted.
The identified risk of fluvial flooding is highlighted green.

6.0 Site Drainage

6.1 Surface Water Drainage

- 6.1.1 Consideration of flood issues is not confined to the floodplain. This is recognised in the NPPF and associated guidance where all proposed development of 1ha or more in Flood Zone 1 and so outside the floodplain nevertheless requires an FRA. The alteration of natural surface water flow patterns through developments can lead to problems elsewhere in a catchment, particularly flooding downstream and replacing permeable vegetated areas with low permeability roofs, roads and other paved areas will increase the speed, volume and peak flow of surface water runoff.
- 6.1.2 A surface water management strategy for the development is proposed to manage and reduce the flood risk posed by surface water runoff from the Site. The developer will be required to ensure that any scheme for surface water should build in sufficient capacity for the entire Site.
- 6.1.3 The surface water drainage arrangements for any development Site should be such that the volume and peak flow rates of surface water leaving a developed Site are no greater than the rates prior to the proposed development, unless specific off-Site arrangements are made and result in the same net effect.
- 6.1.4 An assessment of the surface water runoff rates was undertaken to determine the surface water options and attenuation requirements for the Site.

6.2 Existing Drainage System

- 6.2.1 The wider Site is 5.5 ha in area and current land use comprises areas of brownfield land, hardstanding car park and metalled roads.
- 6.2.2 The Site is 0.64ha in area and currently comprises car parking, associated hardstanding and metalled roads.
- 6.2.3 As established in Section 3, the Site is predominantly hardstanding/impermeable area underlain by pebbly and gravelly sandstone. Although the underlying bedrock may offer some permeability, the predominant surface hardstanding means that drainage is predominantly via overland flow to the existing surface water drainage network with diffuse discharge to the Queens dock from Plot 2 without any formal drainage network routing this flow.
- 6.2.4 Existing Site drainage has been determined through a culvert tracing survey conducted in July 2017 (Appendix 7) and described at length in Section 3.
- 6.2.5 The topographic survey (Appendix 7) show a drain/gully, with a north-east to south-west orientation, within the centre of Plot 4. Gully elevations within Plot 4 range from 7.24 mAOD at the eastern extent to 7.22 mAOD at the western extent, indicating positive drainage to the surface water network within Keel Wharf (Drawing 008 and Appendix 7).
- 6.2.6 The existing surface water drainage network (Drawing 008), located within the wider Site, appears to have been developed as part of ongoing upgrades to the wider Site in preparation for development. The survey determined that the wider Site has separate surface water and foul systems that are located within the road network and connect to the public sewer network on the wider Site southern boundary (Kings Parade).
- 6.2.7 The survey shows the wider Site surface water drainage network connects to a ø600mm surface water sewer within Half Tide Wharf before connection to a public ø150mm surface

water sewer (Appendix 5), located within Kings Parade, which subsequently discharges into the River Mersey via a ø1200mm flapped outfall.

- 6.2.8 A query was raised with United Utilities to confirm the diameter of the receiving surface water sewer within Kings Parade. United Utilities have confirmed that the diameter of the receiving surface water sewer (ø150mm) is the information held on record. (Appendix 5).
- 6.2.9 A detailed CCTV sewer survey, proposed to be undertaken as part of the detailed design stage, will determine the exact dimensions of the receiving United utilities surface water sewer in Kings Parade.
- 6.2.10 A pre-application enquiry has been submitted to United Utilities for confirmation of the connection to the public sewer network, connection agreements and permitted discharge rates from the wider Site existing network (Appendix 5).
- 6.2.11 Based on the above, the United Utilities surface water sewer, located on Kings Parade, is currently receiving unattenuated runoff, at the brownfield rate from the wider Site, via the existing surface water drainage network and ø600mm surface water sewer located on Half Tide Wharf.
- 6.2.12 There is currently no foul water discharging from the undeveloped Site.

6.3 Proposed Development

- 6.3.1 The proposal is for the development of three Plots within a single redline boundary as part of Application 1b. The development forms the second stage of a phased development of the wider Site. This FRA considers application 1b only and consists of:
 - **Application 1b: Plot 2:** 5 Storey Interpretation Centre /Office use with ground floor café. Proposed building footprint is 0.017 ha
 - **Application 1b: Plot 4:** Ground floor Commercial, Food Hub and 120 apartments. Proposed building footprint is 0.36 ha
- 6.3.2 Areas of grassed landscaping are proposed, which represent a decrease of 0.09 ha (14% of Site area) when compared to existing (Appendix 1 and Drawing 007)). It is assumed that the grassed areas will be engineered and will provide little in the way of storage and infiltration. Based upon this assumption, a worst-case scenario of 100% impermeable surfaces will be carried forward.
- 6.3.3 A figure of 100% impermeable area was applied to the 0.64 ha developable area. The existing and proposed impermeable areas are shown in Table 6.1 and Drawing 007.
- 6.3.4 The 5.5 ha wider Site is proposed to be developed through a number of phases/applications. All phases/applications will form part of an overall drainage strategy as part of a holistic approach to the wider Site to assess the potential load on, and the capacity of, the existing drainage network.

Table 6.1: Impermeable Area

| Area | Existing Buildings and Hardstanding | Proposed Buildings and Hardstanding | Difference |
|-----------------------------------|-------------------------------------|-------------------------------------|------------|
| Area (ha) | 0.64 | 0.64 | +0.00 |
| Percentage of Total Site Area (%) | 100 | 100 | +0 |

6.3.5 The proposed development will maintain the existing area of impermeable surfaces and therefore maintain the existing amount of runoff.

6.4 Runoff Rates

6.4.1 Through consultation with the LLFA, it was stated that *'Maximum discharge will be based on the 1:2-year runoff from the existing impermeable area. However, if the development had a direct discharge to either the River Mersey or Queens or Wapping dock, then this will not apply and unrestricted discharge will be acceptable'* (Appendix 4).

6.4.2 The LLFA also stated that *'If the proposed drainage connects to an existing surface water drainage system that in turn discharges to the River Mersey or Queens or Wapping dock, then this may be viewed the same as above. There would need to be a high level of confidence that any flows for the 1:100 with allowance for 30% climate change would not cause flooding to properties connected to the upstream drainage network.'*

6.4.3 Based on the above, and existing wider Site drainage to the public sewer and subsequently, the River Mersey, unrestricted flows, at the brownfield rate of 50mm per hour are proposed.

6.4.4 The Site has a total area of 0.64 ha.

6.4.5 The ability to discharge at the unrestricted brownfield rate will be subject to existing drainage network capacity and permitted rates to the public sewer network.

6.4.6 The following parameters were used in the runoff calculations:

- Developable Area: 0.64 ha
- Brownfield Runoff rate: 50mm per hour (approximate 1 in 30-year rainfall rate)

6.4.7 Based on the above, a brownfield runoff rate of 89 l/s would be expected from the Site redline boundary.

6.4.8 Queens Wharf, to the east of the centre of the Queens Wapping Bridge, will drain via the existing surface water sewer network to the public combined sewer 75 m to the east. No development is proposed within this area, and drainage will be maintained as existing. This area measures 0.072 ha, and would produce 10 l/s based on a 50mm per hour runoff rate.

6.4.9 Plot 2 measures 0.056 ha in area, and based upon the 50mm per hour runoff rate, would produce 8 l/s. This volume would diffusely discharge into the Queens Dock.

6.4.10 Based on the above areas and runoff, 200 l/s would be expected to enter the existing, private surface water network to the west of Queens Wapping bridge with subsequent discharge to the Mersey estuary via the public sewers on Kings parade.

6.4.11 A brownfield rate of 763 l/s would be expected from the wider Site, with a total area of 5.5 ha.

6.5 Sustainable Drainage Options (SUDS)

i. Feasibility of SuDS

- 6.5.1 Soakaway testing has not been undertaken. The desk-based study and consultation with the Environment Agency have shown the Site maybe contaminated. Findings show that infiltration-based SUDS would not be feasible due to possible contamination within the Site and wider Site.

ii. Choice of SuDS Options

- 6.5.2 Sustainable water management measures should be used to control the surface water runoff from the proposed development Site, thereby managing the flood risk to the Site and surrounding areas from surface water runoff. These measures will also improve the quality of water discharged from the Site.
- 6.5.3 Current guidance promotes sustainable water management using SuDS. Options applicable to this Site are identified in Table 6.2, if required.

Table 6.2: SUDS Options

| | |
|----------------------|---------------------|
| Green roofs | Infiltration basins |
| Water butts | Detention basins |
| Permeable paving | Oversized pipes |
| Rainwater harvesting | Brown roofs |
| Filter strips | Swales |
| Wetland Areas | Cellular Storage |

Note: SUDS appropriate to the development are highlighted green.

- 6.5.4 A hierarchy of SuDS techniques is identified¹⁷:
- 1. Prevention** – the use of good Site design and housekeeping measures on individual Sites to prevent runoff and pollution (e.g. minimise areas of hard standing).
 - 2. Source Control** – control of runoff at or very near its source (such as the use of rainwater harvesting).
 - 3. Site Control** – management of water from several sub-catchments (including routing water from roofs and car parks to one/several large soakaways for the whole Site).
 - 4. Regional Control** – management of runoff from several Sites, typically in a detention pond or wetland.
- 6.5.5 The implementation of SUDS as opposed to conventional drainage systems provides several benefits by:

¹⁷ CIRIA (2004) Report C609, Sustainable Drainage Systems – Hydraulic, Structural and Water Quality advice.

- reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses or sewers from developed Sites;
- improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources;
- reducing potable water demand through rainwater harvesting;
- improving amenity through the provision of public open spaces and wildlife habitat; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

iii. SuDS Maintenance

- 6.5.6 Cellular Storage and Oversized pipework will form the main attenuation feature within the development Site, if determined to be necessary during detailed drainage design.
- 6.5.7 Maintenance of the SUDS features would be in line with the SUDS Manual (CIRIA C753, 2015)
- 6.5.8 SUDS should be designed to adoptable standards with United Utilities or the LLFA. If not adopted, the maintenance would be undertaken by a private maintenance company.
- 6.5.9 Details of SUDS features and maintenance would be considered further at detailed design, following capacity checks on the existing surface water network within the wider Site. The level of detail provided within this FRA should be sufficient to demonstrate that SUDS would be deliverable.

6.6 Surface Water Management Strategy

i. Hierarchy of Discharge

- 6.6.1 In accordance with requirement H3 of the Building Regulations 2010¹⁸ rainwater runoff must discharge to one of the following, listed in order of priority:
- 1. An adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable:** The use of infiltration based SUDs is not feasible due to the presence of contaminated ground within the Site and wider Site.
 - 2. A watercourse; or where that is not reasonably practicable:** The River Mersey estuary is located immediately to the west of the wider Site boundary
 - 3. A sewer:** An existing surface water network is located within the wider Site which connects to a ø150m public surface water sewer is located within Kings Parade, to the west of the wider Site. The public surface water sewer discharges to the River Mersey approximately 45 m to the south of the wider Site boundary on Kings Parade.

The potential route to discharge from the Site will be through a connection to the existing surface water network and maintaining the existing connection to public surface water sewer with subsequent outfall to the River Mersey estuary.

¹⁸ Office of the Deputy Prime Minister, The Building Regulations 2010.

ii. Drainage Design

- 6.6.2 Surface water runoff would be directed to the existing drainage system through drainage gullies located around the perimeter of the buildings and through contouring of the hardstanding areas.
- 6.6.3 A holistic approach to drainage design is required that considers all proposed phases of development within the wider Site along with assessment of the design and capacity of the existing surface water drainage network.
- 6.6.4 An existing surface water network is shown within Queens Wharf, Monarchs Quay and Keel Wharf which bound the Site (Drawing 008 and Appendix 7). It is proposed to maintain positive connections to the existing network.
- 6.6.5 Information gained from the Pre-Application enquiry (Appendix 5) to United Utilities and correspondence to ISG Construction Ltd (Appendix 9) will be used to inform the detailed drainage design.
- 6.6.6 United utilities, in response to the Pre- Application enquiry, have stated that surface water discharge rates are a matter for the LLFA (Appendix 5). The LLFA have stated that unrestricted discharge rates to the Docks and River Mersey would be acceptable.
- 6.6.7 A further CCTV survey is proposed for the Site, wider Site and areas surrounding the wider Site. The survey is proposed to be undertaken during detailed drainage design stage to ensure that sewer modelling utilises the most detailed information possible.
- 6.6.8 It is proposed to maintain diffuse discharge at unrestricted rates, into Queens Dock, from Plot 2, as per existing. It is proposed to consult with the Canal and Rivers Trust during the detailed drainage design stage, as per correspondence provided in Appendix 6,
- 6.6.9 The detailed drainage design is requested to be submitted as part of suitably worded planning condition.

iii. Attenuation Requirements

- 6.6.10 The requirement for attenuation storage will be determined during detailed drainage design.
- 6.6.11 Through consultation, the LLFA have stated that unrestricted discharge to the Docks and River Mersey estuary would be permitted. However, unrestricted discharge may be constrained by:
- The existing surface water network capacity
 - Permitted discharge rates to the United Utilities Kings Parade sewer
- 6.6.12 The detailed drainage design should:
- Determine the design standard and capacity of the existing surface water drainage network within the wider Site.
 - Undertake further consultation with United Utilities with regards to the proposed drainage design.
 - Undertake consultation with the Canal and Rivers Trust with regards to proposed surface water discharge from Plot 2.
 - Determine the attenuation required, in order to meet discharge constraints, on a phase by phase basis, as part of a holistic approach to drainage design for the wider Site.

- Ensure that the existing design standard, or existing design standard with attenuation, is sufficient to accommodate the 1 in 30-year event and ensure that the 1 in 100-year event with 30% climate change allowance and does not cause flooding to properties connected to the upstream drainage network, as stated by the LLFA (Appendix 4)

6.6.13 The detailed drainage design is requested to be submitted as part of suitably worded planning condition.

6.7 Foul Drainage

6.7.1 The wider Site is currently served by an existing foul water drainage network (Drawing 008 and Appendix 7).

6.7.2 It is proposed that a foul connection is made from Plot 2 to the combined public sewer network located approximately 75m to the east. This will be confirmed at detailed drainage design stage.

6.7.3 It is proposed that foul flow connection from Plot 4 is made to the existing private foul network located within Queens Wharf, Keel Wharf and Half Tide Wharf. The private foul network has an existing connection to the public foul sewer network at the junction of Half Tide Wharf and Kings Parade, to the west of the Site. This will be confirmed at detailed design stage.

6.7.4 As per surface water, detailed drainage design will:

- Assess the capacity of the existing foul network
- Consult with United Utilities to determine permitted rate of foul discharge to the public sewer network.

6.7.5 **Plot 2: 5 Storey Interpretation Centre /Office use with ground floor Cafe:** In accordance with British Flows and Loads-4¹⁹, peak foul water discharge from an office/factory, with canteen, is 100 litres per person per day. Using this method, peak foul flows have been estimated for a range of employee numbers within Building 2 (Plot 2) (Table 6.3). In accordance with British Flows and Loads-4²⁰, peak foul water discharge from a restaurant (Luxury Catering), is 100 litres per cover. Using this method, peak foul flows have been estimated for a range of covers within the proposed café. The calculated foul flow rate will be reviewed at detailed drainage design stage

Table 6.3: Foul Flow Volumes for Plot 2 (Building 2)

| Number of Employees (Office Use) | Total Volume (Litres) | Peak Flow (l/s) |
|-------------------------------------|-----------------------|-----------------|
| 50 | 5000 | 0.06 |
| 150 | 15000 | 0.17 |
| Number of Covers (Restaurants) | Total Volume (Litres) | Peak Flow (l/s) |

| | | |
|-----|------|------|
| 50 | 1500 | 0.02 |
| 150 | 4500 | 0.05 |

6.7.6 **Plot 4: Ground floor Commercial, Food Hub and 120 apartments:** In accordance with British Flows and Loads-4 ²¹, peak foul water discharge for 'Standard residential is 150 litres per person per day. A maximum of 4 persons per apartment has been assumed. These loads have been used to assess the foul flows from the proposed residential apartments. In accordance with British Flows and Loads-4 ²², peak foul water discharge for 'Snack bars and bar meals' is 15 litres per cover. These loads have been used to assess the foul flows from the proposed food hub. Using this method, peak foul flows have been estimated for foul flows from Building 4. (Table 6.5). The calculated foul flow rate will be reviewed at detailed drainage design stage

Table 6.5: Foul Flow Volumes Plot 4 (Building 4)

| Number of Persons (based on 4 people per apartment) | Total Volume (Litres) | Peak Flow (l/s) |
|---|-----------------------|-----------------|
| 480 | 72000 | 0.83 |
| Number of Food Hub Covers | Total Volume (Litres) | Peak Flow (l/s) |
| 100 | 1500 | 0.02 |
| 250 | 3750 | 0.04 |
| 500 | 7500 | 0.09 |

6.7.7 Based on the above, foul flows have been calculated to be a maximum of 1.14 l/s based on an estimate of employee, residents and covers within the proposed development.

6.7.8 All foul sewerage should be designed in accordance with Building Regulations Part H. In areas where sewers are to be adopted by United Utilities, an application to enter into a Section 104 agreement for sewer adoption must be made in writing to United Utilities prior to any works commencing on Site. A connection point should be agreed with United Utilities.

7.0 Summary and Conclusions

7.1 Introduction

- 7.1.1 A site-specific Flood Risk Assessment (FRA) has been undertaken for a proposed office development, located on a 0.64 ha Site on land off Monarchs Quay, Liverpool.

7.2 Flood Risk

- 7.2.1 The risk of fluvial flooding is 'Low'.
- 7.2.2 The risk of tidal flooding is 'High'.
- 7.2.3 The risk of surface water flooding is 'Low to Medium'
- 7.2.4 The risk of sewer flooding is 'Low'
- 7.2.5 The risk of groundwater flooding is 'Low'
- 7.2.6 The risk of flooding from all other sources is 'Low'.

7.3 Mitigation Measures

- 7.3.1 Tidal, surface water and sewer flood risk can be mitigated to a negligible level through the following approach:
- A finished floor level at, or above 7.28 mAOD, within Plot 2 is not considered feasible. In this instance, the building should mitigate flood risk through the use of flood resilient construction and completion of a Flood Evacuation Management Plan (FEMP), discussed below.
 - Ensure finished floor levels are above 7.28 mAOD, for development proposed within Plot 4, to ensure the development remains flood free from tidal sources, for the entirety of its lifetime (to the year 2115).
 - High ground, in excess of the 1 in 200 year 2115 climate change tidal event is located immediately to the north and east of Plot 2 allowing direct access to Flood Zone 1 from the primary building on the first floor.
 - Register all proposed development within Site with the Environment Agency Floodline Warnings Direct service. It is noted that the Site is located within the mapped coverage of receiving flood warnings (Irish Sea and Mersey Estuary from the Head of the Wirral to Runcorn).
 - As the primary flood risk to the Site is from tidal sources, long lead times before significant flooding events are usually available which provides timescales for the evacuation of the Site or prohibition of access to the Site. The published standard from the Environment Agency for a tidal flood warning is 1-day notice. A **SEVERE FLOOD WARNING** usually follows a **FLOOD WARNING**.
 - Prepare a Flood Evacuation Management Plan (FEMP), at an individual building/development level, to ensure all onsite staff and visitors can exit the Site and move to a place within Flood Zone 1 (low risk).
 - Incorporate flood resilient construction measures into the onsite buildings. Construction measures may include:

- Electricity supply cables to enter building from a high level and wired downwards; electric sockets to be positioned +600mm above finished floor level.
- Use water resilient floor and wall coverings.
- Use anti-flood valves on internal building drainage

7.4 Flood Guidance

7.4.1 The proposed development is classified as:

- **Application 1b: Plot 2:** 5 Storey Interpretation Centre /Office use with ground floor Cafe (Less Vulnerable Use).
- **Application 1b: Plot 4:** Ground floor Commercial, Food Hub and 120 apartments (More Vulnerable Use).

7.4.2 Less vulnerable development is acceptable within Flood Zone 3.

7.4.3 All development, including 'More Vulnerable Use', is acceptable within Flood Zone 1. As such, the Sequential Test will be passed and the Exception Test would not be required.

7.5 Site Drainage

Surface Water

7.5.1 The proposed development will not increase the impermeable surfaces and therefore the amount of runoff will remain unchanged.

7.5.2 A drainage scheme is proposed to connect to an existing surface water network within the wider Site, with subsequent connection to the public surface water network and the River Mersey Estuary.

7.5.3 It is proposed to maintain existing diffuse surface water runoff, at impermeable rates, from Plot 2, into Queens Dock.

7.5.4 It is proposed to discharge at the unrestricted, brownfield rate based on 50mm per rainfall.

7.5.5 A holistic detailed drainage design for all development phases within the wider Site, to be subject to a suitably worded planning condition, will determine the existing network design, capacity and determine if attenuation is required to meet capacity constraints from the existing network.

7.5.6 The detailed drainage design is requested to be submitted as part of suitably worded planning condition.

Foul Water

7.5.7 It is proposed that foul flows will discharge to the existing foul network within the wider Site with maintenance of the existing foul connection to the public sewer network. Foul flows have been calculated to be a maximum of 1.14 l/s based on an estimate of employees, residents and covers within the proposed development.

7.5.8 The detailed drainage design is requested to be submitted as part of suitably worded planning condition.

Conclusion

- 7.5.9 This FRA demonstrates that the proposed development would be operated with minimal risk from flooding, would not increase flood risk elsewhere and is compliant with the requirements of national policy and guidance.
- 7.5.10 The development should not therefore be precluded on the grounds of flood risk and surface water and foul drainage.