LAND SOUTH OF GLAN USK PRIMARY SCHOOL, HERBERT ROAD NEWPORT

ENVIRONMENTAL STATEMENT

VOLUME 2
CHAPTER 10: FLOOD RISK

10. FLOOD RISK

INTRODUCTION

9.1 This chapter presents the Flood Consequences Assessment associated with the proposed development. It has been prepared by Waterman Infrastructure and Environment Ltd (WIE).

9.2 This chapter sets out the hydrological regimes that currently exist and assesses the risk of flooding to the Site. The impact of the proposed development on flood risk to surrounding properties, the proposed flood mitigation measures and the residual risk/compliance with relevant planning policies are also assessed.

9.3 A comprehensive Flood Consequences Assessment (FCA) has been prepared by WIE, which is located in Appendix 10.1. The findings of the FCA are summarised in this chapter.

ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

Data Sources

9.4 The assessment of the Site is based on scheme information included within Appendix A of the FCA, as presented in the description of the development (Chapter 5) and includes a detailed topographic survey of the existing Site and a proposed development layout.

9.5 Information pertaining to the Groundwater regime at the Site was obtained from Natural Resources Wales (NRW) and their National Groundwater datasets which include Groundwater Source Protection Zones, Aquifer Maps-Superficial Deposits Designation, Aquifer Maps-Bedrock Designation, and Groundwater Vulnerability Zones.

9.6 The Welsh Government TAN 15 Development Advice Map (DAM) was assessed to establish the flood risk designation for the Herbert Road Site, alongside the Flood Risk Maps and modelling work completed as part of this study.

9.7 To establish the likely extent of the extreme floodplain the NRW Flood Map was obtained as part of a Request for Information, which is based on the 'Newport SFRM Modelling – Update of Newport Tidal Model v3.1 study'. This data was requested as part of the original ES and has been updated and verified as part of the latest study.

9.8 NRW previously provided the Newport Strategic Flood Risk Mapping (SFRM) model. We have used version 3.1 (Version 3, dated 2011) of the Newport Tidal model for our assessment. We are aware that there have been updates in guidance and the implementation of a number of flood defence schemes being constructed since 2011. However, it has been established that our updated version of the 2011 model produces higher flood levels across the proposed development site in comparison to the current NRW model (Version 6). This is due to fewer flood defences included within the 2011 model (Version 3) compared with the current day situation (Version 6), which allows more floodwater to flow into the area. As a result, NRW have confirmed that using our

model (Version 3) to assess the development platform and finished floor levels against would be acceptable, as it takes a precautionary approach in relation to flood risk from the tidal River Usk.

9.9 The NRW Surface Water Flood Map and Reservoir Flood Map were accessed online (2017).

9.10 Extreme sea levels were also provided by NRW as part of the initial Request for Information – these have been checked and updated using the good practice guidance from NRW. The peak level estimates were derived for England and Wales using a national tidal model calibrated to UK tidal gauge data. 95% confidence bounds for the calculated values were also derived using the confidence intervals for each node location. The baseline estimations are for the year 2008, so climate change (CC) is calculated relative to this year.

9.11 To provide a site-specific assessment of flood risk, the NRW hydrodynamic 1d/2d ESTRY-TUFLOW model for the River Usk was obtained, amended and re-run for the appropriate scenarios using 2017 as a baseline assessment date.

Consultation

9.12 Consultation has been undertaken with NRW (in terms of flood risk), Newport City Council and Dwr Cymru Welsh Water (in terms of existing drainage arrangements at the site) as part of the previous ES, and the data provided has been updated and amended as appropriate for this study.

LEGISLATIVE & PLANNING POLICY FRAMEWORK

National Planning Policy

Planning Policy Wales (November 2016)

9.13 Planning Policy Wales' (2016) (PPW) is the overarching policy document that deals with planning matters in Wales. Chapter 4 of PPW confirms the Welsh Government's commitment to sustainable development. Chapter 12 of PPW deals with Infrastructure and paragraph 12.1.1 explains that adequate and efficient infrastructure is crucial for the economic, social and environmental sustainability of all parts of Wales.

9.14 Planning Policy Wales and its associated Technical Advice Note 15 (TAN 15) requires that consideration be given to the potential for flooding both to and from a proposed development. TAN 15: *Development and Flood Risk*, published in July 2004 by the Welsh Government, provides a framework for managing risks arising from all potential sources of flooding, as well as the potential for an adverse impact on third party flood risk as a result of a proposed development. The redevelopment of existing grass and woodland areas to form hard (impermeable) surfaces such as highways and buildings will cause an increase in surface water runoff rates and volumes unless appropriately mitigated.

9.15 The provision of drainage is fundamental to any development and to comply with general sustainability objectives the proposed type and level of drainage provision for

any development must be sustainable. This has been discussed in Chapter 10 of the ES and the appended drainage study.

Flood Risk Regulations (2009)

9.16 The Flood Risk Regulations came into force in December 2009 and the Flood and Water Management Act became law in April 2010. Under these legislations, Newport City Council has been identified as a Lead Local Flood Authority (LLFA) and has been given a number of key responsibilities including the preparation of a LFRMS. The LFRMS was prepared for Newport in October 2014.

9.17 Other documents required by the FRR were the preparation of a Preliminary Flood Risk Assessment (prepared 2011) and flood risk management plans alongside risk and hazard mapping.

Flood and Water Management Act (2010)

9.18 The act came into law in 2010 and formalised a number of the recommendations of the FRR including the requirement to identify ordinary watercourses and their impact on local flood risk, review surface water flooding issues and update and review groundwater flooding issues that may affect developments.

Local Planning Policy

Newport Unitary Development Plan (UDP) (1996 - 2011)

9.19 The Newport Unitary Development Plan (UDP) 1996 - 2011 was formally adopted by Newport City Council in May 2006.

9.20 UDP Policy SP24 relates to flood risk and seeks to ensure that development does not result in an unacceptable risk of flooding, either on or off the site.

9.21 Policy SP27 sets out the requirement for Flood Consequence Assessments to be prepared to support planning applications where proposals are constrained by flood risk.

9.22 Policy U6 requires that development which could increase the risk of flooding due to additional surface water runoff, includes appropriate and environmentally sympathetic mitigation measures.

Newport Local Development Plan (2011 - 2026)

9.23 The Newport Local Development Plan was formally adopted by Newport City Council on 25th of January 2015 and supersedes the UDP.

9.24 The Newport Local Development Plan (LDP) 2011 – 2026 indicates that the Herbert Road Site has been previously committed and is carried forward into the LDP.

9.25 The proposed Site is located within the 'Glebelands' site H(5), which is designated as a main source of housing land within the Newport Deposit Plan 2011 - 2026. It is detailed in the Deposit Plan that the Glebelands Site has 'existing commitments for residential development', to include 153 dwellings. The replacement primary school has now been constructed. This planning consent has been implemented by virtue of the construction of the primary school.

9.26 The LDP contains a clause "SP3 Flood Risk" which details the authority's requirements in regard to flood risk and mitigation. The special guidance requires the following local policy considerations.

"Watercourses within the Internal Drainage Board (IDB) area must not be culverted and development must avoid obstructing the water course by providing a buffer zone of 12.5m minimum for reens and 7m minimum for field ditches in order to allow on-going maintenance. It is recommended that developers seek advice and information from NRW, the Local Authority and Internal Drainage Board where relevant."

BASELINE CONDITIONS

Baseline Surveys

9.27 Reference to the Welsh Government TAN 15 Development Advice Map (2015), which is included in Appendix B of the FCA, indicates that most of the Site is located within Zone C1. This risk designation suggests that the existing site is at risk from an extreme flood event, namely the 0.5% probability flood event (tidal). However, the Zone C1 designation signifies this part of the Site as being served by significant infrastructure including defences. There are also some areas within the Site which lie within Zone A i.e. considered to be at little or no risk of fluvial or coastal/tidal flooding.

9.28 The NRW Flood Map, which is included in Appendix B of the FCA, also indicates that the southern part of the existing site is at risk of flooding in both 0.5% and 0.1% tidal probability events. However, the affected area of the Site is shown to be located within an Area Benefitting from Defences.

9.29 The site is also inside the maximum extent of flooding in the event of a breach from Llangefedd Reservoir and at low to moderate risk of surface water flooding (high risk within the channel of the ordinary watercourse).

9.30 The Site is located (at least in part) on a former industrial/domestic landfill site. This is reflected in the topography of the main part of the site which varies between 7.0m AOD and 8.0m AOD. The ground running immediately adjacent to the River Usk along the western boundary of the site is generally higher, with levels rising from 9.0m AOD in the north to approximately 10.0m AOD halfway along the Site, before dropping to 9.5m AOD at the southern extent.

9.31 There are no known records of fluvial/tidal flooding at the proposed development site, although the DAM suggests that the area has been subjected to historical flooding as there is evidence of alluvial deposits in the soil strata from historic flood events (Zone B).

Hydrogeology

9.32 Historically, the site was operated as a landfill between the 1930s and 1960s. Imported material is known to have raised this low-lying part of Newport by about four metres.

9.33 The Soilscapes dataset, produced by the National Soil Resources Institute, is a 1:250000 scale simplified soils dataset covering England and Wales. This shows the Site as being located in an area where 'freely draining slightly acid loamy soils' dominate.

9.34 According to NRW data, the made ground at the Site is likely to be sufficiently permeable so as to allow the limited lateral and vertical migration of water to the underlying aquifer and offsite receptors. The underlying strata are both classified as Secondary A Aquifers which may be capable of supporting water supplies at a local rather than strategic scale.

9.35 NRW data confirms the Site is not located within a Groundwater Protection Zone. The Site is deemed to be a Minor Aquifer, according to the Groundwater Vulnerability Zones.

Hydrology

Fluvial Regime

9.36 The site is located within the tidal reaches of the River Usk. This major watercourse rises in the mountains of mid-Wales and flows in a southerly direction through several major urban areas including Monmouth and the eastern valley towns to outfall into the Severn Estuary at Newport. To the north of Newport the River Usk meanders as it flows along the river valley of relatively flat gradient.

9.37 At Newport the natural geological features channel the river between the high ground occupied by Allt yr yn (near Newport Civic Centre) to the west of the river and Summerhill to the east. Downstream of this channel restriction the river again meanders across formerly estuarine mud flats to the Estuary. The former mud flats extend along the coast to Caldicot in the east.

Ordinary Watercourse

9.38 A small watercourse flows through the Herbert Road Site. An assessment of the catchment area of this ordinary watercourse indicates that it drains an area of circa 4.865 ha.

9.39 The catchment area is heavily urbanised and drains the residential area of St Julians to the east of the Herbert Road Site. The watercourse is culverted for a length of some 500m between St Julians Avenue and the Site, to which it enters via a culvert beneath the railway embankment.

9.40 The watercourse flows through the Herbert Road Site in open channel for a length of approximately 180m before discharging into the River Usk via a pipe of 1.0m diameter. Along the open channel section, the watercourse is conveyed beneath the newly constructed pedestrian access route into the Glan Usk School Site via a circular culvert of 2m diameter.

9.41 It is assumed that the area to the north of the Site encompassing the 'Glebelands' and the new Glan Usk School site drains into this watercourse, although the exact location of the connection cannot be established.

Tidal Regime

9.42 The City of Newport is located in the upper part of the Severn Estuary. The coastal geomorphology of the Bristol Channel and Severn Estuary encourages the development of high tidal ranges. Tidal water is constricted as it propagates up the estuary and as such, the tidal range is greater with distance up the estuary.

9.43 In this case, the coastal fringe of Newport is potentially at risk from tidal flooding in the event of a high return period tide.

9.44 Flood defences in the Newport area vary in form and protection level but generally the defences on the west bank of the river are of a higher protection level than on the east.

9.45 The formal defences along the east (left) bank of the River Usk end at the downstream boundary of the proposed Site, adjacent to Courtney Street. However, there is a raised embankment with a formed pathway on top that runs along the left bank of the River Usk from the southern extent of the proposed Site to beyond the M4 Motorway Bridge and Glebelands Park to the north. The crest level of this embankment is circa 9.5m AOD at the downstream extent. This rises to approx. 10.3m AOD for a short section before returning to levels of generally 9.3m to 9.5m AOD. The lowest section of the bank is located at the outfall of the small drainage ditch to the River Usk where ground levels are circa 9.1m AOD.

Hydrological Calculations

9.46 The current NRW Flood Map in this area is derived from the Newport SFRM Modelling-Update of Newport Tidal Model Study v3.1, which is based on a hydrodynamic 1d/2d ESTRY-TUFLOW model completed in December 2011.

9.47 The modelling exercise assessed flood risk from the River Usk and major tributaries, and included the major flood defences as well as the newly constructed east bank defence along the River Usk.

9.48 The hydraulic modelling confirmed that the site will remain unaffected by floodwaters during the extreme fluvial flood in the River Usk.

9.49 The model was also run for the defended tidal flood events as well as the defended scenario with climate change. QMED was applied to the fluvial inflows for all model runs.

9.50 Following consultation with NRW, it was agreed that they would supply the River Usk tidal model in order to inform the site-specific FCA.

Peak Tide Level Estimation

9.51 The NRW model was supplied with the peak tide levels for the 0.5% Annual Exceedance Probability (AEP) and the 0.1% AEP for the current-day scenario when the model was developed (2011).

9.52 There is increasing scientific evidence to suggest that the global climate is changing. It is therefore necessary to consider the potential impacts of Climate Change in terms of tidal flood risk. Global sea level is predicted to rise with the onset of Climate Change.

9.53 In this case, the Department for Environment, Food and Rural Affairs (DEFRA) has produced guidance regarding potential sea level rise. Table 1 provides a summary of the net sea level allowances in the vicinity of the proposed development site.

Table 1: Regional Net Sea Level Rise Allowances:

Administrative Region	Net Sea Level Rise (mm/yr)			
	2009 to 2025	2026 to 2055	2056 to 2085	2085 to 2116
Wales	3.5	8.0	11.5	14.5

9.54 DEFRA carried out a 'Technical Report Design sea levels' study which was designed to produce a nationally consistent set of extreme sea levels. These levels were derived using a tidal model calibrated to UK tidal gauge data, and produced estimates for the extreme tidal events for the baseline year (2008). In order to derive the 0.5% AEP plus CC for the year 2117, 0.1% AEP tidal levels for the year 2017 and the 0.1% AEP plus CC for the year 2117; the 2008 year levels have been extrapolated based on current DEFRA guidance for sea level rise. The tidal levels used to inform this FCA are summarised in Table 2.

Table 2: Peak Tide Level Estimates:

	0.5% AEP+CC (2117)	0.1% AEP (2017)	0.1% AEP+CC (2117)
Tide Level (m AOD)	9.91	9.42	10.50

9.55 DEFRA guidance was formalised by NRW when they released the "Good Practice Guide" in august 2016.

Peak flow estimate for the Ordinary Watercourse

9.56 The peak flow estimate for the ordinary watercourse was derived using ReFH Rainfall-Runoff methods. The flow estimate for the 1% AEP event was calculated as 0.2m^3/s.

9.57 This was applied as a constant inflow throughout the model simulation to give a conservative estimate of the flow passing through the watercourse during a storm event.

Hydraulic Modelling of the River Usk

9.58 In order to investigate the flood mechanisms in more detail and assess the degree of tidal flooding to the proposed development, WIE obtained a copy of the NRW hydraulic model.

9.59 Advice was sought from NRW with regard to the scenarios required for assessing tidal flood risk for the proposed development. The NRW Flood Risk Analysis Team considered the development proposals in line with interim guidance relating to the application of the Upper Bound Confidence Limits to tidal scenarios. With specific reference to the NRW Data Request (Ref Q3_133, dated 14th Nov 2012) and the June 2013 FCA Report (Issue C), the scenarios recommended and subsequently modelled are:

- 0.5% AEP event plus Upper Confidence Limit allowance of climate change plus (DESIGN EVENT)
- 0.1% AEP (present-day) event (SENSITIVITY EVENT)
- 0.1% AEP event plus Upper Confidence Limit allowance for climate change plus (SENSITIVITY EVENT)

9.60 Based on these recommendations, the NRW model was re-run for the 0.5% AEP+CC (2117), the 0.1% AEP in the present day and the 0.1% AEP+CC (2117). This assumes a Lifetime of Development of 100 years in line with Newport City Council current advice. The appropriate values were added to the hydraulic model boundary to account for the anticipated sea level rise.

9.61 The model outputs indicate that the site is affected during the 0.1% AEP in the present day scenario. Peak water levels within the River Usk channel adjacent to the Site are circa 9.4m AOD. Scrutiny of the topographic survey data indicates that the raised embankment along the left bank of the River Usk at this location ranges between 10.38m AOD and 9.12m AOD and therefore the raised embankment was overtopped in places. Flood depths are up to 0.3m in this event.

9.62 The Site was also affected by the 0.5% AEP+CC (2117) in the scenario. The model output data indicates that the modelled peak water levels within the River Usk channel are as high as 9.91m AOD. As a result, the majority of the site is flooded to a depth greater than 1m.

9.63 To provide protection to the residential development, the ground levels have been raised above the 0.5% AEP+CC maximum water level.

9.64 The proposed site layout was therefore simulated through the model for all tidal flood events to test the impact on flood risk of raising the development platform. It was found that the development platform prevented inundation in the 0.5% AEP+CC (2117) and despite small areas of increased flood risk caused an overall decrease in flood risk to the wider area.

9.65 The results of the model can be seen in graphical form in Appendix E of the FCA. These show the existing floodplain for the 0.5% AEP (2117), 0.1% (2017) and 0.1% AEP (2117) events.

Hydraulic Modelling of the Ordinary Watercourse

9.66 Hydraulic modelling of the ordinary watercourse was carried out during the same simulations as the tidal flood risk, to simulate a conservative tide-locked scenario.

9.67 The modelling results before the tidal water levels overtopped the embankments show the likely flooding patterns from the ordinary watercourse. It shows that the floodwater spills out of bank just before the watercourse enters the site, and flows parallel to the railway line along the eastern edge of the site towards the industrial estate to the south.

9.68 As part of an extant permission the existing ordinary watercourse has been reprofiled and extended to increase the capacity of the channel. Modelling shows that in the proposed situation there are no out of bank flows, ensuring protection of the site and surrounding area.

ASSESSMENT OF POTENTIAL IMPACTS

Construction

9.69 Construction impacts are considered to occur because of the actual development (preliminary earthworks and construction operations) itself, and are all considered as being potentially adverse in nature. The following potentially significant impacts are typically associated with construction works and are considered relevant to this site.

- Site drainage;
- Surface water outfalls (existing and proposed);
- Delivery/storage of construction materials;
- Storage/handling of materials/oils/chemicals;
- Siltation;
- Concrete mixing; and
- Cross contamination of geological strata due to piling.

9.70 Site levels have been raised to ensure that the risk of flooding is managed for the lifetime of the development. Modelling shows that peak flood levels for the present day 0.1% AEP event affect the site. There is therefore the possibility of tidal flooding during the construction process affecting the site, prior to ground raising. As a result, there is a **minor adverse** impact.

9.71 Floodwater from the ordinary watercourse is shown to spill out of bank onto the existing site prior to development. By raising the ground levels within the site, floodwaters spilling out of the existing channel are prevented from flowing overland in a southerly direction. Reprofiling and extension of the existing river channel ensures that any ground raising within the existing floodplain would have a **negligible** impact in respect of fluvial flooding from the ordinary watercourse. It is important that the river channel extension occurs within Phase 1, to prevent any adverse impacts on fluvial flooding due to ground raising during construction.

9.72 During construction, there is flood risk associated with the period during which construction works are being undertaken. Sudden rainfall events can mobilise silt and materials held within the site, and if not controlled these could be conveyed to the tidally influenced River Usk and ordinary watercourse. Without mitigation could have a **minor adverse** impact.

9.73 The inappropriate siting of stockpiled material may have an adverse effect on the current hydrological regime by diverting flood water and/or surface water flow

generated from rainfall events (pluvial flooding) into previously unaffected third-party property. Considering the limited flooding associated with the ordinary watercourse the potential impact of this would be **negligible**.

9.74 There are no basements proposed as part of the scheme, which would limit required excavations. However, some works would be required to facilitate ground raising and construct foundations. If excavations are undertaken below the water table there is a potential risk to site workers and/or there could be a delay to works. Taking a worst case scenario, the impact is deemed to be **negligible to minor adverse.**

9.75 The southern part of the site is shown to be at risk of flooding from artificial sources. However, as the northern part of the site any workers would be able to evacuate to this area and the impact would be **negligible**. Furthermore, reservoirs are impacted to a very high standard, and the likelihood of this occurring it low.

9.76 The proposed development would generate additional surface water flows from the increased impermeable areas. The resulting pressure on the downstream system could potentially cause flooding in extreme rainfall events. Notwithstanding this, the ultimate downstream system (River Usk) is tidally dominated, and therefore the impact of the construction phase of the proposed development (i.e. increased impermeable areas and therefore increased rate of runoff) on the existing hydrological regime, without mitigation, would be **negligible**. The conservative estimate of the inflow to the ordinary watercourse is expected to account for the increased flows caused by increased impermeable areas, this will be confirmed at detailed design stage as part of the overall site drainage strategy.

Operation

9.77 In order to comply with the threshold and maximum depth of flooding criteria in TAN 15, ground levels have been raised to form a development plateau set at 10.4m AOD on the north portion of the site, and 9.95m AOD on the south of the site. This will ensure that the development remains protected and flood free during the 0.5% AEP+CC (2117), with the Upper Confidence Interval applied to peak tide level estimates. The potential impact on the development would therefore be **negligible**.

9.78 The site would similarly remain protected in the 0.1% AEP. Version 3 of the model shows that there could be flooding on-site during a highly unlikely 0.1% AEP+CC. However, NRW have agreed than Version 3 of the model over predicts the potential flood depths, with Version 6 showing that the 0.1%+CC water level would be 1m lower, at 9.8m AOD. In this scenario the site would remain safe in all flood scenarios. The potential impact on the development is therefore considered to be **low to negligible**.

9.79 The proposed access/egress arrangement is shown to be affected by floodwaters during the present day 0.1% AEP. However, it is proposed that an alternative existing pedestrian route will be available through the pedestrian link adjacent to the emergency vehicle access route in the north of the Site which will provide dry access/egress. It has been confirmed that the pedestrian link will remain open at all times. Emergency vehicle access will be provided through the vehicle access route and away through Glan Usk primary school and Bank Street to the north. Therefore, the risk to residents is deemed to be **negligible**.

9.80 Modelling shows that there are wide scale tidal flood risk benefits as a result of the development, with flood levels in the area generally reducing. However, there are localised, minor increases in tidal flood depths to the north. It is noted that these small increases (less than 0.04m) are located in areas where the existing tidal flood depth is already severe (up to 0.80m). Furthermore, the Finished Floor Level of the associated building is set at 10.4m AOD, 0.5m above the design flood level ensuring safety. This small increase is therefore considered negligible, and it is deemed that the wider reductions in tidal flood risk provide betterment over the existing situation. It is therefore considered that the proposed development will have a **negligible** impact.

9.81 To accommodate the fluvial floodwater associated with the ordinary watercourse, Phase 1 of the proposed development will extend the ordinary watercourse and re-grade the banks for both environmental benefits and flood storage. As set out above, post development all water has been modelled to remain within bank, with no flood risk to the site or surrounding area. All proposed ground raising is outside the area of the ordinary watercourse. This impacts on fluvial flood risk would therefore be **negligible**.

9.82 There are no basements proposed as part of the scheme, and therefore there would be no impact on the existing groundwater regime post development. Raising ground levels would increase the protection from groundwater flooding, alongside provision of a formation slab. Ground raising would also provide additional protection from flooding from pluvial and artificial sources, however it should be noted that these are not significant risks in the existing situation. The impact on other sources of flooding would therefore be **negligible**.

9.83 The proposed development would result in increased impermeable areas, which in turn would result in higher levels of surface water runoff. The resulting increase in discharge could cause the downstream system to flood in extreme rainfall events.

9.84 Surface water generated from an extreme rainfall event will enter the drainage system for the proposed development, details of which are provided in Chapter 11: Drainage. It is proposed to discharge surface water from the development into the ordinary watercourse via petrol/oil interceptors. The ordinary watercourse outfalls into the tidally dominated River Usk, and therefore there will be a **negligible** impact on third party flooding to downstream properties. The ordinary watercourse has also been modelled to account for the proposed catchment area, to ensure flows remain within channel.

MITIGATION MEASURES

9.85 This section provides a description of the proposed mitigation measures which are required over and above the elements already incorporated within the scheme.

9.86 The general philosophy of approach to the development has been to create proposals which are sympathetic to the site topography and environmental setting. Where specific further mitigation is desirable, such measures are described below.

Construction

9.87 Hydraulic modelling has shown that the Site be affected by the present day 0.1% AEP extreme tidal event. Given the predictable nature of extreme flood events and the 24 hour lead in time allowed prior to the site being flooded by the third tidal cycle (based on the modelling undertaken), it is expected that measures could be taken to limit the negative impacts of potential flooding. It is recommended that the contractor signs up to NRW's flood warnings to be alerted in case an extreme flood is likely. In such an event, operatives should be evacuated from the site and the construction site made safe.

9.88 There is a small fluvial floodplain at the existing site due to the existing ordinary watercourse. This will be mitigated through design by reprofiling and extension of the existing channel to increase capacity. However, this has occured within Phase 1, to prevent any adverse impacts on fluvial flooding due to ground raising during construction.

9.89 The agreed construction protocols will be included as part of the Construction Environment Management Plan, to be approved prior to commencement of the construction works. This would mitigate against the transfer of silts and sediments into the adjacent watercourses.

9.90 Other measures will also be adopted to minimise the impacts of surface water discharges during the construction phase and these will include the following as a minimum:

- Where feasible, site-specific construction techniques will be adopted to ensure that no migration pathways are created to jeopardise groundwater quality. Where deeper foundations are required, proposed appropriate pilling techniques (i.e. non-driven techniques) will be considered to minimise the associated risk;
- The use of appropriate measures as outlined in PPGs to prevent spillage of potentially polluting substances, including:
    - Appropriate storage and handling measures for all hydrocarbon fuels and lubricating oils, including the use of bunded storage areas or the use of double-skinned storage tanks;
    - The use of drip trays for static plant and designated refuelling areas for mobile plant;
    - The implementation of appropriate spillage contingency measures to mitigate the impact of such spillages on the surface water; and
    - Appropriate personnel awareness training of the potential environmental implications of all construction work on site.
- The prevention of silt-laden runoff and mud entering the surrounding surface water drains and watercourses by:
    - Timely site phasing and engineering, thus minimising un-surfaced and un-vegetated areas of the site to as small as practicably possible;
    - The provision of measures to intercept and treat such runoff prior to it leaving the site, including the use of peripheral cut-off ditches, settlement facilities, filtration and/or use of flocculants to effect the removal of water borne particulates; and
    - The provision of wheel-cleaning equipment for site plant to prevent the tracking of mud onto the public highway and therefore into the off-site surface water drainage systems.

9.91 If groundwater is encountered during construction, appropriate de-watering processes will be put in place, and an agreed point of discharge will be agreed with the relevant authority.

Operation

9.92 The modelling proves that the site would remain protected in a tidal and fluvial flood scenario, and all impacts are considered low to negligible. As a result there are no mitigation measures required over and above those elements already incorporated as part of the design. This includes preparation of a Flood Emergency Plan and signing up to the NRW's flood warnings.

RESIDUAL IMPACTS ASSESSMENT

Construction

9.93 Being aware of the potential risks of tidal flooding, and signing up to NRW's flood warning system will ensure that the contractors are aware of the potential tidal and fluvial flood risk to the site. Upon receipt of a flood warning appropriate procedures will be put in place, and safe evacuation carried out prior to the onset of flooding. The construction site will also be made safe, and would result in a **negligible** residual impact.

9.94 Retention of an area of unraised land adjacent to the ordinary watercourse will provide flood storage in the event that an extreme fluvial flood flow in the watercourse coincides with a high tide during the construction works. Reprofiling the ordinary watercourse prior to ground raising will safeguard the storage that could otherwise be offset through construction. It is considered that the residual impacts would therefore be **negligible**.

9.95 Implementation of the construction phase protocols will ensure management of surface water runoff from the site. In this case, the residual impact is deemed to be **negligible.**

9.96 With implementation of dewatering procedures (if required), the residual impact on groundwater will be **negligible**.

Operation

9.97 The scheme has been appropriately designed to remain safe in the event of a design flood and the potential impact to third parties has also been assessed and is considered negligible.

Recommendations

Construction

9.98 The Construction Management Plan should include advice on the risk of tidal flooding and the appropriate actions to take should an extreme tidal event be predicted during the construction process. It should also include locations for the storage of construction materials, so as to avoid the diversion of potential surface water flow.

Operation

9.99 Through ground raising the development would remain safe. However, to enable safe egress it is recommended that an Emergency Flood Plan is compiled in order to identify the risk of flooding posed to the site, and the appropriate course of action should flooding occur in this area. It is also recommended that residents sign up to NRW flood warnings to allow for maximum time to respond to an extreme tidal event.

Summary and Conclusions

Baseline

9.100 The NRW Flood Map and the TAN 15 DAM indicate that the majority of the Site is at risk of tidal and fluvial flooding.

9.101 Hydraulic analysis of the potential mechanisms of flooding has established based on existing ground levels that:

- The site will not be affected by an extreme fluvial flood event in the River Usk;
- An extreme fluvial event in the ordinary watercourse would cause flooding to the eastern extent of the site; and
- A present day 0.1% AEP tidal event in the River Usk Estuary will affect the site in present-day scenario. The Site will also be inundated by the 0.5% AEP+CC (2117).

9.102 Flood risk from pluvial, sewer, groundwater and artificial sources have also been assessed. However, none are considered significant or would cause an impact on the development's design.

9.103 Please refer to Chapter 11: Drainage for discussion of surface water drainage.

Development Options and Mitigation Measures

9.104 In order to ensure that the proposed site remains dry during the 0.5% AEP+CC (2117) design event, even with the Upper Confidence Interval applied, it is proposed to raise site levels to 10.40m AOD for areas of the site north of the ordinary watercourse , and 9.95m AOD for areas of the site south of the ordinary watercourse.

9.105 Pedestrian access/egress routes is available through the gated pedestrian link adjacent to the emergency vehicle access route in the north of the site. It has been confirmed that the pedestrian link will remain open at all times. Pedestrians can then head through the underpass beneath the railway embankment that provides access onto Charnwood Road and higher ground to the east.

9.106 An alternative option for emergency access/egress is to remain on-site until flood waters recede, and to seek safe refuge above the high water level. This may be an option to be used in conjunction with a flood warning system.

9.107 The channel of the existing ordinary watercourse would be reprofiled and extended to increase the capacity. This would reduce fluvial flood risk post development, and ensure no off-site fluvial flooding.

9.108 Reprofiling the ordinary watercourse generally results in a beneficial impact on land elsewhere. Although there are some localised areas where tidal flood depths increase as a result of raised ground levels (by 0.03m), these areas are already subject to tidal flood depths of greater than 1m, and therefore any impact is considered negligible.

9.109 Ground raising would also reduce the risk of flooding from other sources (pluvial, sewer, groundwater and artificial sources).

9.110 Details pertaining to the proposed on-site drainage system are dealt with in Chapter 11: Drainage.

Likely Significant Effects

9.111 Table 9.3 below, contains a summary of the likely significant effects of the proposed development.

Table 9.3: Table of Significance – Flood Risk

Potential Effect	**Nature of Effect** (Permanent/ Temporary)	**Significance** (Major/ Moderate/ Minor) (Beneficial/ Adverse/ Negligible)	**Mitigation/ Enhancement Measures**	**Geographical Importance***							**Residual Effects** (Major/ Moderate/ Minor) (Beneficial/ Adverse/ Negligible)
				I	UK	W	R	C	D	L	
Construction											
Risk of tidal flooding to site operatives	Temporary	Minor Adverse	Contractor to sign up to NRWs flood warning system. Advance warning expected so that appropriate procedures can be put in place to ensure safety of workers, and safety of the construction site							L	Negligible
Fluvial flooding due to the on-site ordinary watercourse impacting site operatives and the construction site. Site phasing ensures channel enhanced prior to ground raising	Temporary	Negligible	The channel reprofiling and extension would be undertaken within Phase 1, to ensure that the storage potentially required is in place prior to ground raising being undertaken							L	Negligible
Risk of groundwater flooding due to excavation beneath the groundwater table.	Temporary and potentially Permanent	Negligible to Minor Adverse	Careful consideration in the design of drainage/sub-structures prior to the construction phase will be carried out such that deep excavations are minimised. De-watering system to be employed where necessary							L	Negligible
Accidental spillages of contaminants and increase in concentrations of pollutants such as suspended solids during earthworks and heavy plant movement during construction, affecting	Temporary	Minor Adverse	Introduction and enforcement of construction phase protocols to enhance surface water management and to mitigate the potential for accidental spillages, etc							L	Negligible

groundwater and quality of surface water (overland flow)											
Risk to site operatives due to flood risk from artificial sources	Temporary	Negligible	The northern part of the site would remain safe in the existing situation, providing a place of safe refuge in the unlikely event of flooding from the nearby reservoir							L	Negligible
Current risk of flooding to off-site properties by overland flow from the site could be exacerbated by the increase in surface water runoff, or the diversion of overland flows elsewhere due to inappropriate stockpiling	Temporary	Negligible	Programme construction/completion of drainage works early in the construction programme. Contractor method statement to include temporary site drainage proposals and require approval prior to site start							L	Negligible

Completed Development												
Risk of Tidal Flooding to the proposed Site and its main vehicular access. Ground raising to provide protection above the 0.5% AEP+CC. Emergency Flood Plan to be prepared to set out access and egress routes in the event of flooding	Permanent	Negligible	Inherent ground raising as part of the proposals ensures protection of the development Preparation of an Emergency Flood Plan and signing up to NRW's flood warnings will ensure that any exceedance events are appropriately mitigated, ensuring safety to occupants.							L	Negligible
Adverse effect on third party flood risk for tidal flooding due to the requirement to raise ground levels within the Site	Permanent	Negligible	Hydraulic modelling has shown that ground raising within this area will generally result in a reduction in flood flows. Where there are some minor increases in flood depths these are negligible in comparison to the existing flood depth present							L	Negligible
Risk of Fluvial Flooding from the ordinary watercourse to the proposed site. Reprofiling and extension of the existing channel to provide additional storage and protect development	Permanent	Negligible	Inherent alteration to the existing watercourse provides additional storage and ensures flows remain in bank. No risk to development							L	Negligible
Adverse effect on third party flood risk for fluvial flooding for the ordinary watercourse due to the requirement to raise ground levels within the site. Existing channel to be reprofiled to compensate and provide additional storage	Permanent	Negligible	Hydraulic modelling shows that inherent reprofiling and extension of the existing ordinary watercourse provides sufficient storage to contain fluvial flows within the watercourse, with no out of bank flooding							L	Negligible
Groundwater flooding to the development due to elevated water table. Controlled through proposed	Permanent	Negligible	Provision of an impermeable slab alongside ground raising reduces the risk of groundwater flooding to the development. No basements proposed which							L	Negligible

foundation slab			could alter the movement of groundwater beneath the site								
Potential to increase flood risk from pluvial and artificial sources	Permanent	Negligible	Ground raising required to protect the development from tidal flooding would also reduce the risk of flood risk from these sources due to the site's elevated level							L	Negligible
Increased surface water runoff from impermeable areas could (without mitigation) cause an increased flooding to downstream property	Permanent	Negligible	Discharge into the tidally dominated waters of the ordinary watercourse and River Usk. Catchment allowed for within ordinary watercourse. Please refer to Chapter 10: Drainage for further information							L	Negligible

*** Geographical Level of Importance**

I = International; UK = United Kingdom; W = W; R = Regional; C = County; D = District; L = Local

Appendix 10.1 – Flood Consequences Assessment