OMEGA ZONE 8, ST HELENS

Omega St Helens Ltd / T. J. Morris Limited

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11. WATER

11.1. INTRODUCTION

11.1.1. This chapter reports the outcome of the assessment of likely significant effects arising from the Proposed Development upon the upon hydrology, flood risk, water resources and Water Framework Directive (WFD) from the construction and operation of the Proposed Development.

11.1.2. The assessment of hydrology, flood risk, water resources and WFD has established that the following additional mitigation measures are required:

- For the channel diversion and WFD compliance, the following secondary mitigation is required for the design of the proposed watercourse diversion:
  - Creation of a riffle-pool sequence through the length of the diversion;
  - Inset alternating berms to create a degree of low flow channel sinuosity and flow type variation; and
  - Two-stage channel design to both provide low-level berms for habitat variability, which could be planted with wetland species, and to increase channel capacity to accommodate design flood events.
- Marginal and riparian planting to create a well-structured riparian buffer zone, where tree and shrub planting would contribute towards off-setting tree loss as a result of the Proposed Development.
- Production of a Construction Environmental Management Plan (CEMP) that includes management of flood risk and groundwater interaction during construction, particularly in relation to flood risk from rivers and surface water.
- Consideration of groundwater seepage into the surface water runoff attenuation ponds.

11.1.3. The following residual effects have been identified:

- For flood risk, no residual risks have been identified providing the mitigation is appropriately implemented into the Proposed Development design.
- Residual flood risk still remains with regard to rare events, such as flood events greater than the 1% annual probability event occurring, but these events are considered to be unlikely.
- For WFD, no residual risks have been identified providing the mitigations outlined above are appropriately implemented into the Proposed Development design.
- For groundwater, no residual risks have been identified providing the mitigations outlined above are appropriately implemented into the Proposed Development design.

11.1.4. The following monitoring requirements have been identified:

- For groundwater, the continuance (magnitude and duration) of groundwater level rebound within the Primary Sherwood Sandstone underlying the application site is unknown. Therefore, it recommended that groundwater level monitoring is continued for at least five years of operations to better gauge the significance of this phenomena. Currently, it is not thought to be significant but the matter does currently entail some element of uncertainty.
- For the channel diversion and WFD compliance, monitoring requirements include: aquatic ecology surveys and River Habitat Survey of the existing channel prior to construction; repeat of these surveys post-construction, after high magnitude events; and, after five years to monitor

both change and to determine whether the objectives of the diversion design have been met and to confirm no deterioration in WFD status or deterioration in any of the WFD quality elements.

11.1.5. The following enhancement opportunities have been identified:

- Flood risk and the channel diversion have been assessed and modelled assuming the use of attenuation storage to achieve water quality and runoff rates. The use of infiltration Sustainable Drainage Systems (SuDS) options would enhance the performance of the proposed strategies however (refer to **Chapter 14: Land and Soils**) the current condition of the application site is such that the observed waterlogging would exclude these options and have therefore not been put forward.
- For WFD compliance and the channel diversion, there is opportunity for additional enhancement of the riparian zone by the planting of more trees, and, potentially, the creation of some patches of wet woodland. This would provide both enhancement and a degree of net gain.

11.1.6. The remainder of this chapter describes the assessment methodology and the baseline conditions relevant to the assessment, which have been used to reach these conclusions, as well as a summary of the likely significant effects leading to the additional mitigation measures required to avoid, prevent, reduce or, if possible, offset any likely significant adverse effects, and the likely residual effects and any required monitoring after these measures have been employed. Opportunities for enhancement, where such opportunities exist, are also discussed.

11.1.7. This chapter (and its associated figures and appendices) is intended to be read as part of the wider ES, with particular reference to **Chapters 9:** Biodiversity**, Chapter 14: Land and** Soils, and the Flood Risk Assessment and Drainage Strategy (**OPP DOC.1.1**).

11.1.8. The Flood Risk Assessment has been undertaken based on data provided by the Environment Agency, St. Helens Council and Warrington Borough Council.

11.1.9. The assessment in relation to potential impacts on flood risk has focused on flood risk from rivers, flood risk from land (surface water overland flow paths and associated ponding), management of surface water runoff from the Proposed Development and flood risk from groundwater.

11.1.10. Potential significant impacts include the following:

- Increased flood risk due to development on a greenfield site.
- Increased surface water runoff rates and volumes from impermeable and hardstanding areas.
- Increased flood risk from groundwater.
- Increased flood risk from realignment of the Whittle Brook.

11.1.11. The assessment in relation to potential impacts on WFD compliance has focused on the proposed diversion of the Whittle Brook, which forms part of the Outline Planning Application component of the Hybrid Planning Application.

11.1.12. Potential significant impacts may arise due to the proposed diversion of the Whittle Brook.

11.1.13. The WFD has been applied to inform the optioneering of the proposed channel diversion to arrive at a proposed diversion that would be WFD compliant. In addition, fluvial form and function high-level design principles are applied to the assumed channel design and used to inform the WFD compliance assessment. The design principles applied are to ensure the proposed watercourse diversion would be WFD compliant.

11.2. CONSULTATION, SCOPE, METHODOLOGY AND SIGNIFICANCE CRITERIA

CONSULTATION UNDERTAKEN TO DATE

11.2.1. **Table 11-1** provides a summary of the consultation activities undertaken in support of the preparation of this assessment.

Table 11-1 - Summary of consultation undertaken

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
Environment Agency	Enquiries Unit at Environment Agency	10/10/2019 - Request of data (email)	Request of appropriate hydraulic model and GIS information to support water resources assessments including products 4-7.
Environment Agency	Anne Ball, Customer and Engagement Officer	31/10/2019 – Response to data request (email)	▪ Discharge Consents within 3km of Proposed Development show no ongoing water environment issues in surrounding area. ▪ One historic landfill site with limited information ▪ No flood defences within application site ▪ Confirmation that Catchment Flood Management Plans are still valid ▪ No information on contamination ▪ No information on hygrometry and telemetry ▪ No surface water or groundwater abstractions within 2km of Proposed Development ▪ No information on groundwater flooding
Environment Agency	Anne Ball, Customer and Engagement Officer	31/10/2019 – Outlining misaddressed/outstanding information (email)	▪ No hydraulic model received ▪ Floodplain compensation requirements ▪ Products 4-7 not received ▪ Discharge rates to Environment Agency main river ▪ Water quality or hydrochemistry data for

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
			surface water and groundwater ▪ Geological/hydrogeological logs
St. Helens Council	Environmental Health and Planning at St. Helens Council	31/10/2019 – Request of data as acting Lead Local Flood Authority (email)	▪ Abstractions within Proposed Development ▪ Lead Local Flood Authority requirements of flood risk management ▪ Information around surface water and groundwater. Information on groundwater including any landfills
Environment Agency	Anne Ball, Customer and Engagement Officer	04/11/2019 – Response to re-addressed data request (email)	▪ Received hydraulic model from 2008, deemed fit for purpose and climate change allowances confirmed ▪ Floodplain compensation query forwarded to Sustainable Places team. ▪ No historic flooding outlined in the area
Environment Agency	Sylvia Whittingham	23/10/2019	▪ Attempted to arrange WFD consultation meeting to discuss the required scope for the WFD assessment. It was not possible to arrange a consultation meeting within the programme timescale, thus the WFD team had to proceed at risk based upon assumptions surrounding the scope of the assessment. The Environment Agency has confirmed that a WFD assessment is expected for the channel diversion.
United Utilities	United Utilities	13/11/2019 – Online service for ordering sewer record drawings (online service)	▪ Request of sewer record drawings for foul and surface water systems

Body / organisation	Individual / stat body / organisation	Meeting dates and other forms of consultation	Summary of outcome of discussions
United Utilities	Karen Mc Cormack, Property Searches Manager, United Utilities	13/11/2019 – Plans received highlighting approximate locations of assets (.pdf)	▪ Received plans highlighting the approximate locations of United Utilities assets within the Proposed Development ▪ Shown for the wastewater and surface water networks
United Utilities	Developer services mailbox at United Utilities	19/11/2019 – Pre-development sewer enquiry	▪ Pending

SCOPE OF THE ASSESSMENT

11.2.2. The scope of this assessment has been established through an ongoing scoping process submitted to St. Helens Council. Further information can be found in **Chapter 5: Approach to EIA**.

11.2.3. This section provides an update to the scope of the assessment and re-iterates the evidence base for scoping out elements following further iterative assessment.

11.2.4. In addition, further enquiries have been made to relevant stakeholders to build on this assessment including:

- Environment Agency – current information on the catchment including hydraulic models, water quality issues, other environmental schemes in the catchment area and information on abstraction licences; and
- United Utilities – sewage treatment works, sewer record plans, pre-development sewer enquiries.

11.2.5. The Scoping Report indicated that a detailed Flood Risk Assessment would be conducted. Following consultation with the Environment Agency an existing 1D model has been utilised in the assessment and the review of Whittle Brook realignment options.

WFD Assessment Scoping

11.2.6. The need for a WFD assessment for the proposed diversion of the Whittle Brook was confirmed in the scoping response from the Environment Agency. Other aspects of the Proposed Development were considered during initial WFD screening and scoping, with the outcomes summarised below.

11.2.7. The WFD screening exercise identified the extent to which the Proposed Development may affect WFD water bodies that lie within the zone of influence. A summary of this screening exercise is provided below:

- The Whittle Brook (Mersey Estuary) (GB112069060990) WFD water body, would be directly impacted by the Proposed Development due to the proposed diversion of this watercourse. Therefore, this WFD water body is screened in for further assessment.
- The downstream water body is Mersey (GB531206908100) (a transitional water body). This is considered sufficiently far downstream from the Proposed Development to avoid any impacts and is therefore scoped out of further assessment.

- The groundwater body that the study area sits within is the Lower Mersey Basin and North Merseyside Permo-Triassic Sandstone Aquifers (GB41201G101700). Activities relating to development of the Proposed Development have been assessed in terms of their potential impact upon this groundwater water body. There are no anticipated impacts at the water body scale, therefore assessment of impacts to groundwater is scoped out.

ELEMENTS SCOPED OUT OF THE ASSESSMENT

11.2.8. The elements shown in **Table 11-2** are not considered to give rise to likely significant effects as a result of the Proposed Development and have therefore not been considered within this assessment:

Table 11-2 - Elements scoped out of the assessment

Element scoped out	Justification
Flood risk from reservoirs	This element was scoped out as investigations highlighted that there was no risk of flooding from reservoirs within or near to the Proposed Development site
Flood risk from sewers	This element was scoped out as sewer record plans highlighted no assets within the Proposed Development which were at risk of flooding
Flood risk from other artificial sources	This element was scoped out as desk studies showed there was no risk of flooding from artificial sources including canals.
Flood risk from the sea	This element was scoped out of the assessment as the application site is not within a coastal location and is not influenced by tidal activity.
Water Framework Directive: Full Planning Application	
Full Planning: Construction of a B8 warehouse (78, 832 sq. m), with ancillary office space, parking access and landscaping proposals	No anticipated direct impact upon the Whittle Brook WFD water body. Construction activities that may impact upon the watercourse due to proximity would be managed and mitigated through standard best practice and pollution prevent methods.
Two outfalls	The outfalls are assumed to discharge into the watercourse at equivalent greenfield runoff rates. The flows within Whittle Brook are also being modelled to ensure no adverse impacts. The embedded design would ensure outfall design follows best practice and are angled in line with flow within the channel to mitigate the risk of localised bed scour. Water quality assessments would ensure that discharge meets required water quality standards. Therefore, with embedded mitigation in place, it is anticipated that there would be no impact upon the WFD water body. Therefore, outfalls and their discharge have been screened out of further assessment.

Element scoped out	Justification
Three attenuation ponds	The proposed attenuation ponds are assumed to accommodate a comparable volume of surface water as the existing application site, which would be discharged back to the channel at an appropriate rate. Therefore, attenuation ponds have been scoped out of further assessment.
Water Framework Directive: Outline Planning Application	
Outline Planning: Construction of up to 124,000 sq.m of manufacturing (B2) and logistics (B8) development with ancillary offices and associated access infrastructure works	No anticipated direct impact upon the Whittle Brook WFD water body. Construction activities that may impact upon the watercourse due to proximity would be managed and mitigated through standard best practice and pollution prevent methods.
Attenuation ponds	The proposed attenuation ponds are assumed to accommodate a comparable volume of surface water as the existing application site, which would be discharged back to the channel at an appropriate rate. Therefore, attenuation ponds have been scoped out of further assessment.
Outfalls	The outfalls are assumed to discharge into the watercourse at equivalent greenfield runoff rates. The flows within Whittle Brook are also being modelled to ensure no adverse impacts. The embedded design would ensure outfall design follows best practice and are angled in line with flow within the channel to mitigate the risk of localised bed scour. Water quality assessments would ensure that discharge meets required water quality standards. Therefore, with embedded mitigation in place, it is anticipated that there would be no impact upon the WFD water body. Therefore, outfalls and their discharge have been screened out of further assessment.
Water Framework Directive: Specific WFD Quality Elements	
Thermal conditions	Due to the small width of Whittle Brook, steep banks and the length of the proposed works it is unlikely this would affect thermal conditions. In addition, considerate planting would also limit any changes arising due to the Proposed Development. Therefore, this WFD quality element is scoped out of further assessment.
Salinity	Salinity is not included in the WFD cycle 2 classification for this water body. It is unlikely the Proposed Development would affect salinity within this water body and likely that the proximity of the water body to the Mersey Estuary will have a greater effect. Therefore, salinity is scoped out of further assessment.

Element scoped out	Justification
Acidification Status	It is unlikely the Proposed Development would affect acidification within this water body. Cement works would occur away from the watercourse and managed using best practice and appropriate mitigation. Therefore, acidification status is scoped out of further assessment.
Connection to Groundwater	A thick layer of drift geology (till and clay deposits) would ensure that the groundwater body is protected from activities associated with the Proposed Development. Therefore, assessment of Connection to Groundwater is scoped out of further WFD assessment. A specific WFD assessment of the Groundwater water body is also scoped out of the assessment.

ELEMENTS SCOPED INTO THE ASSESSMENT

Construction Phase

11.2.9. The following elements are considered to have the potential to give rise to likely significant effects during construction of the Proposed Development and have therefore been considered within this assessment:

- Diversion of the Whittle Brook, fluvial flood risk during construction and WFD compliance;
- Surface water runoff; and
- Groundwater flood risk whilst carrying out groundworks

11.2.10. For the surface water WFD assessment, all biological, physico-chemical and hydromorphological quality elements are scoped into the assessment, except for this listed within **Table 11-2**.

Operation Phase

11.2.11. The following elements are considered to have the potential to give rise to likely significant effects during operation of the Proposed Development and have therefore been considered within this assessment:

- Fluvial flood risk;
- Diversion of the Whittle Brook for WFD compliance;
- Surface water runoff; and
- Groundwater flooding.

11.2.12. For the surface water WFD assessment, all biological, physico-chemical and hydromorphological quality elements are scoped into the assessment, except for this listed within **Table 11-2**.

EXTENT OF THE STUDY AREA

11.2.13. The study area for the Flood Risk Assessment, groundwater and WFD assessment was identified by the application site boundary for the Proposed Development.

METHOD OF BASELINE DATA COLLATION

DESK STUDY

11.2.14. A desk based assessment was undertaken to highlight the baseline conditions at the application site. Information was gathered from the following sources:

- Environment Agency Web Based Data;
- OS and MAGIC Mapping;
- Geology and soil maps;
- Current aerial photography;
- Environment Agency ecology data; Historic maps;
- Environment Agency Site Specific Information;
- United Utilities Asset Location Plans;
- River Basin Management Plan – North West River Basin;
- Mersey Estuary Catchment Flood Management Plan;
- St. Helens Council Preliminary Flood Risk Assessment;
- St. Helens Council Strategic Flood Risk Assessment;
- St. Helens Council Local Flood Risk Management Strategy;
- Warrington Strategic Flood Risk Assessment; and
- Warrington Surface Water Management Plan (SWMP)

SITE VISIT AND SURVEYS

11.2.15. A site visit was undertaken to the application site to look at the existing watercourse (Whittle Brook) on the 16th September 2019. This was a geomorphological walkover survey to gain an understanding of the baseline conditions of the study area and to evaluate the potential impacts of both the construction (including enabling works) and operational impacts.

11.2.16. The site visit was attended by an experienced geomorphologist and an experienced aquatic ecologist to gain understanding of baseline ecological functioning of the channel.

11.2.17. Field notes and maps of the study area were annotated to capture the key geomorphological features and prevailing fluvial processes. During the site visit, weather conditions were fair and water levels were low to moderate.

11.2.18. The survey covered approximately 1.1km of the Whittle Brook WFD waterbody.

11.2.19. No further topographic survey was gathered along the Whittle Brook specifically for this project, topographic data was extracted from the survey for the hydraulic model provided by the Environment Agency. The cross sections within this model were not changed and cross sections used for the proposed realignment of the Whittle Brook channel were estimated.

11.2.20. Topographic survey for ground levels was also carried out.

11.2.21. A further site visit was carried out on Monday 2nd December 2019 to gain further understanding of the direction of flow and connectivity in the north east of the application site.

ASSESSMENT METHODOLOGY

11.2.22. This section of the ES chapter discusses the methodology used to determine the environmental impact on:

- Groundwater resources;

- Surface water resources;
- Flood risk from fluvial, surface water and groundwater; and
- WFD compliance.

11.2.23. The methodology aims to analyse the potential impact of the Proposed Development based on a source-pathway-receptor approach, as dictated by best practice EIA guidance. The main receptors outlined in the scoping report are:

- Floodplain associated with the Whittle Brook;
- The Whittle Brook watercourse (WFD water body);
- The Principal Aquifer and Secondary Groundwater aquifers; and
- Future occupiers of the Proposed Development and adjacent landowners.

SIGNIFICANCE CRITERIA

11.2.24. The significance level attributed to each effect has been assessed based on the sensitivity/value of the affected receptor(s) and the magnitude of change arising from the Proposed Development, as well as a number of other factors that are outlined in more detail in **Chapter 5: Approach to EIA**. The sensitivity of the affected receptor is assessed on a scale of high, medium, low and negligible, and the magnitude of change is assessed on a scale of large, medium, small, negligible and no change, as set out in **Chapter 5: Approach to EIA** and outlined below in **Table 11-3**.

Table 11-3 - Generic criteria used to evaluate Receptor Sensitivity/Value

Sensitivity/Value	Generic Criteria
Very High	Attribute with a high quality and rarity on an international or national scale
High	Attribute with a high quality and rarity on a regional scale
Medium	Attribute with a medium quality and rarity on a local scale
Low	Attribute with a low quality and rarity on a local scale

11.2.25. Determination of the magnitude of change to the receptors as a result of the development has been undertaken based on the criteria shown in **Table 11-4**.

Table 11-4 - Magnitude of impact

Magnitude of Impact	Description/ Examples
Large	Results in a loss of attribute and/or quality and integrity of the attribute: ▪ Significant change in ecological and/or chemical status of the surface water; ▪ Significant change in quantitative and/or chemical status of groundwater; ▪ Proposal significantly compromises key Programme of Measures under the WFD; ▪ Significant loss of flood storage/ increased flood risk

Magnitude of Impact	Description/ Examples
	▪ Large change in: • National Planning Policy Framework (NPPF) Flood Risk Vulnerability Classification; • Surface Water Flood Risk; • Fluvial Flood Risk; • Groundwater Flood Risk; and • WFD status or deterioration of one or more WFD quality elements.
Medium	Results in impact on integrity of attribute, or loss of part of attribute: ▪ Notable deterioration in ecological and/or chemical condition of a surface water without changing status; ▪ Notable deterioration in quantitative and/or chemical condition of groundwater without changing status; ▪ Proposal notably compromises defined Programme of Measures under the WFD; ▪ Moderate change in: • NPPF Flood Risk Vulnerability Classification; • Surface Water Flood Risk; • Fluvial Flood Risk; • Groundwater Flood Risk; and • Causes deterioration within a WFD quality element class but no change overall WFD status.
Small	Results in some measurable change in attribute's quality or vulnerability: ▪ Small deterioration in ecological and/or chemical condition of a surface water without changing status; ▪ Small deterioration in quantitative and/or chemical condition of a groundwater without changing status; ▪ Proposal leads to small compromise of defined Programme of Measures under the WFD; ▪ Small change in: • NPPF Flood Risk Vulnerability Classification; • Surface Water Flood Risk; • Fluvial Flood Risk; • Groundwater Flood Risk; and • WFD (no change in status class and no deterioration in status of any WFD quality element; i.e. any changes would be within the bands of current classification).
Negligible	No discernible, or relatively insignificant, change in environmental conditions:

Magnitude of Impact	Description/ Examples
	▪ Discharges to watercourse but no significant loss in quality or biodiversity no significant impact on the economic value of the feature; ▪ Very little or a barely perceptible change in: • NPPF Flood Risk Vulnerability Classification; • Surface Water Flood Risk; • Fluvial Flood Risk; • Groundwater Flood Risk; and • WFD (no deterioration)
No Change	No change in environmental condition

11.2.26. The significance of a specific potential impact is derived from both the sensitivity of the receptor and the magnitude of the change. The significance of the impact is then determined using the matrix below (**Table 11-5**):

Table 11-5 - Impact Significance Matrix

		Value/Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Magnitude	**Large**	Major	Moderate to Major	Minor to Moderate	Negligible
	Medium	Moderate to Major	Moderate	Minor	Negligible
	Small	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible
	No change	No change	No change	No change	No change

EFFECT SIGNIFICANCE

11.2.27. The following terms have been used to define the significance of the effects identified and apply to both beneficial and adverse effects:

- **Major effect**: where the Proposed Development could be expected to have a substantial improvement or deterioration on receptors;
- **Moderate effect**: where the Proposed Development could be expected to have a noticeable improvement or deterioration on receptors;
- **Minor effect**: where the Proposed Development could be expected to result in a perceptible improvement or deterioration on receptors; and
- **Negligible**: where no discernible improvement or deterioration is expected as a result of the Proposed Development on receptors.

- **No Change**: where no change is confidently predicted as a result of the Proposed Development on receptors.

11.2.28. As set out in **Chapter 5: Approach to EIA**, effects that are classified as **moderate or above** are considered to be **significant**. Effects classified as below **moderate** are considered to be **not significant**.

11.3. BASELINE CONDITIONS

GROUNDWATER BASELINE CONDITIONS

11.3.1. The geology of the application site comprises several metres, or more, of superficial Boulder Clay (Till) overlying Pebble Beds (bedrock), now referred to as the Chester Formation (BGS lexicon), forming the lowest component within the Sherwood Sandstone Group.

11.3.2. The application site has been subject to a GI (WSP, 2019, GI Report (Ref 11.6)) revealing;

- Boulder Clay (Till) cover ranging from 7.6 to 14.2 m thickness across the site typically incorporating firm to stiff brown slightly sandy/gravelly clay characteristics; and,
- Bed rock, where encountered, being the Chester Formation (previously known as the Pebble Beds) and, typically comprising a 1 to 3m weathered zone at sub-crop surface overlying a more competent fine to medium grained sandstone with occasional clasts of quartz or mudstone.

11.3.3. The 1:50K BGS geology map (Runcorn, sheet 97, Solid Edition) reveals the underlying bedrock geology at the application site is subject to North-South orientated block faulting as shown in **Figure 11.1a**. An extract, as pertinent to this project, of an East-West solid geological cross section interpreted by BGS which coincidentally transects the application site is shown in **Figure 11.1b**. This shows that bedrock generally dips to the east and that the block fault at the application site;

- Is bounded, to the east, by the Roaring Meg Fault; and,
- Reveals progressive down-throws going westwards.

11.3.4. The Boulder Clay (Till) is classified as a Secondary (undifferentiated) aquifer and has little, if any, groundwater resource value. Groundwater levels monitored in the Till (WSP, 2019, GI Report (Ref 11.6)) fall in the range 0.08 to 5.90m bgl (or 18.33 to 25.05m AOD) being significantly higher and hydraulically decoupled from those in the underlying sandstone aquifer. The variable nature of the groundwater level regime in the Till suggests little hydrogeological continuity or relationship/interaction with the on-site surface water regime.

11.3.5. The Sherwood Sandstone Group, which sub-crops below the application site, forms a Principal (major) aquifer and Regional scale groundwater resource significantly exploited for Public Water Supplies and privately operated industrial/agricultural water supplies.

11.3.6. The underlying aquifer falls within the Lower Mersey Basin and North Merseyside Permo-Triassic Aquifers groundwater body under the WFD (ref. GB41201G101700). Under the 2016 WFD assessment, the most recent assessment published, this groundwater body was assessed as being in poor status as it has been consistently under Cycle 2 of the WFD from 2013 to 2016. This arises as both component conditions, being quantitative and chemical, determining overall status for a groundwater body are assessed as poor respectively. The main criterion determining poor quantitative condition is saline intrusion though this is not thought to be highly relevant proximal to the site. There are various criteria effecting a poor chemical condition and it is not known if any of these are relevant proximal to the site.

11.3.7. The Environment Agency has provided groundwater level data for the Sherwood Sandstone aquifer at two of their monitoring stations. Their locations are included in **Figure 11.1a** and resulting hydrographs shown in **Figure 11.2** which reveal approximately 30 years of rising (rebounding) groundwater levels with;

- A rise from approximately -56m AOD (in 1988) to -11m AOD (in 2019) at Bold ETW Replacement located west of the site; and,
- A rise from approximately -24m AOD (in 1988) to +8m AOD (in 2019) at Park Farm located south of the site.

11.3.8. The above groundwater rise appears to be currently ongoing. Two investigation boreholes (WSP, 2019, GI Report (Ref 11.6)) were drilled into, and incorporate monitoring completions, within the Chester Formation at the application site including BHA803 and BHB803 located in the far west and in the eastern portion of the site respectively. In November 2019 respective groundwater levels were 8.13m AOD and 6.13m AOD comparable to levels recorded at the EAs Park Farm monitor.

11.3.9. Currently, groundwater levels within the Principal aquifer underlying the application site remain unconfined and completely decoupled from perched water level regimes in the overlying Till although they are rebounding. The final equilibrium levels that will be attained in the Principal aquifer are unknown.

11.3.10. The application site falls in the Sankey groundwater management unit (GMU) of the Lower Mersey Basin and North Merseyside Permo-Triassic Aquifers groundwater body. According to the EA licensing strategy (February 2013) for the Lower Mersey and Alt this GMU has restricted water availability being over-licensed (in terms of both water balance and Saline Intrusion).

11.3.11. The application site lies at the margins of Source Protection Zone 3 (SPZ3) for a licensed groundwater abstraction by United Utilities near Burtonwood, located approximately 3.5km north-east of the site, serving Public Water Supply. The extent of SPZ3 is shown on **Figure 11.3a** set on a BGS geological base map (Runcorn, sheet 97, Drift Edition). An extract, as pertinent to this project, of an East-West drift geological cross section interpreted by BGS which coincidentally transects the site is shown in **Figure 11.3b** though it should be noted that the alignment for this section is not identical to the one given for the solid geology (see **Figures 11,1a and 11.1b**).

11.3.12. There are no licensed groundwater abstractions located within 2km of the application site.

11.3.13. There are no known and significant groundwater dependant/influenced ecological sites/features in the vicinity of the site. There may be significant groundwater dependant/influenced archaeological/heritage sites/features within 200 – 300m of the site.

11.3.14. Local Authority Strategic Flood Risk Assessments and flood strategies do not recognise groundwater mediated flood risk as being significant. This assertion is considered appropriate at present and is probably appropriate for the future but rebounding groundwater levels within the Principal aquifer are ongoing and may potentially pose a long-term future risk to the application site.

FUTURE GROUNDWATER BASELINE

11.3.15. Under the WFD there is a commitment to improve the status of the Primary (major) aquifer to Good Status requiring corresponding elevation of both its component quantitative and quality conditions. However, there are no definitive Programmes of Measures identified before 2027 for achieving these improvements citing disproportionate financial burdens and/or insufficient understanding of causes as the main reasons.

11.3.16. It is evident that long term groundwater level rebound is occurring and continuing in the Primary (major) aquifer locally and underlying the application site and this probably reflects an aim towards achieving sustainable levels of groundwater abstraction and overall aims of improving groundwater status under the WFD. There is a need to be cognisant of this changing regime regarding the Proposed Development.

SURFACE WATER AND FLOOD RISK BASELINE CONDITIONS

11.3.17. The Whittle Brook, classed as Main River, passes through and drains much of the application site generally flowing south-easterly. The Whittle Brook is joined by a tributary, known as the Union Bank Brook, some 300m south of the southern boundary to the site (**Figure 11.4**). At their confluence and beyond the onward Whittle Brook generally flows south-eastwards and into the Sankey Brook immediately upstream of where it joins the tidal River Mersey.

11.3.18. Part of the application site is drained by the Barrow Brook which flows through the site in its north-east corner (**Figure 11.4**). The Barrow Brook is much altered generally flowing south-eastwards and joins the Whittle Brook south of Lingley Mere Business Park some 800m from the south-east corner of the site. At the eastern boundary to the site the Barrow Brook used to exit the site and enter a south-east orientated culverted section, approximately 500m in length, under what is now the Omega East development. However, at the eastern boundary of the site, the Barrow Brook has been re-routed and now flows northward along the site boundary towards the M62 where it is culverted under the motorway. Beyond, on the northern side of the Motorway, its pathway back into the original course of the Barrow Brook is unknown. Up until Lingley Mere Business Park the Barrow Brook is classed as an Ordinary Watercourse.

11.3.19. On the eastern side of the application site and to the south of the Barrow Beck are two sets of unclassified drains (**Figure 11.4**). The first generally flows south-eastwards until reaching the eastern site boundary where it runs southwards and then eastwards offsite into a culverted section. Further east the culvert daylights and the open drain continues eastwards where it classified as an Ordinary Water Course, north of Lingley Mere Business Park, and joins the Barrow Brook. The second includes a limited series of small interconnected drains though no positive outlet for these drains has been identified to date.

11.3.20. A number of minor drains feed into the Whittle Brook across the application site. None of these are identified as WFD surface water bodies. Perhaps the most significant of these is the west-east flowing drain forming much of the southern boundary to the site.

11.3.21. The application site also includes several small pond features. None of these appear to be contiguous with the main drainage systems flowing across and/or serving the site. Ponds are therefore not considered further within this chapter. For further information, see **Chapter 9: Biodiversity**.

11.3.22. There are no licensed surface water abstractions located within 2km of the application site.

11.3.23. Consented discharges located within 2km of the application site are shown on and summarised in **Figure 11.4**.

11.3.24. The location of Environment Agency surface water quality monitoring locations is shown in **Figure 11.5** and temporal plots for selective physico chemical determinands are shown **Figures 11.6a to 11.6e** and for selective heavy metals in **Figure 11.6f**. Findings from these plots are summarised below;

- **Figure 11.6a** (DO) gives values in the range 60 to 120% and reveals a predominantly high DO condition, achieving an overall good condition, with occasional seasonal values falling to a moderate condition;
- **Figure 11.6b** (Ammonia) gives values in the range 0.1 to 1.0 mg/l (N) and reveals a predominantly high condition, achieving an overall good condition, with occasional seasonal values peaking to a moderate condition. The available data suggests the seasonal peaks increase going downstream;
- **Figure 11.6c** (BOD) gives values in the range 1.0 to 8.0 mg/l (O) and reveals a predominantly high condition, achieving an overall good condition, with occasional seasonal values peaking to a moderate condition;
- **Figure 11.6d** (ortho-phosphate) gives values in the range 0.3 to 0.6 mg/l (P) and reveals a predominantly good/moderate condition, achieving an overall moderate condition, with occasional seasonal values peaking to a poor condition;
- **Figure 11.6e** (Nitrate) gives values in the range 0.5 to 15.0 mg/l (N). Nitrate is not normally assessed as a water quality indicator under the WFD. Under previous GQA criteria the river would have achieved Class 3 (moderately low). The upper part of the Whittle Brook, which probably reflects the condition at the application site is not so bad and may have achieved a moderate (Class 4) condition. However, seasonal peaks are more severe in the Union Bank Brook tributary and in the lower Whittle Brook below their confluence; and,
- **Figure 11.6f** (Cu & Zn) gives Cu and Zn values in the range 4 to 13 µg/l (Cu) and 10 to 50 µg/l (Zn) respectively though an extremely high and suspect Zn level was singly recorded late in 2010. This level of metals, recorded on the lower stretch of the Whittle Brook, means very poor and poor conditions are achieved respectively. These conditions probably reflect the urban nature of the catchment and the influence of major trunk roads including the M62.

11.3.25. The existing flood risk from rivers and the sea within the Proposed Development is mostly located within Flood Zone 1 (low probability): land having less than 1 in 1,000 annual probability of river and sea flooding (shown as clear on the Flood Risk for Planning map).

11.3.26. There are some areas within the application site located within Flood Zone 2 (medium risk): land which is assumed to have between a 1 in 100 and 1 in 1,000 annual probability of river flooding or land between a 1 in 200 and 1 in 1,000 annual probability of flooding from the sea (shown as light blue on the Flood Risk for Planning map).

11.3.27. There are further Flood Zone 2 designations immediately west of the application site.

11.3.28. Environment Agency web-based mapping shows flood risk from surface water indicates areas of overland flow paths throughout the application site as well as areas likely to be at risk from ponding of surface water.

11.3.29. Areas of land to the east of the application site show low risk of flooding from surface water (between 0.1% and 1% annual probabilities) with small areas of medium (between 1% and 3.3% annual probabilities) and high (greater than 3.3% annual probability) risk of flooding from surface water contained within the low risk area. Areas at risk of surface water flooding are generally indicated as having depths under 300mm, with small patches of land shown with depths up to 900mm. According to utility record plans provided by United Utilities there are no existing sewer networks within the application site.

11.3.30. Based on the information available from the British Geological Survey website, Environment Agency MAGIC website and previous studies, a medium risk has been highlighted for groundwater flooding. The bedrock geology at the Proposed Development is underlain with sandstone and the superficial geology is underlain with unsorted till. This gives a permeable geological characteristic.

FUTURE BASELINE

11.3.31. Climate change within the UK over the upcoming decades is likely to result in changes to observed weather patterns, subject to regional variation. This could include milder, wetter winter periods and hotter, drier summers. Short duration, high intensity rainfall and more periods of long duration rainfall are expected, in addition to rising sea levels. These factors are likely to result in increased flood risk from greater surface water run-off and larger watercourse flows for the application site.

WFD BASELINE

11.3.32. The Whittle Brook, including the Union Bank Brook (but not the Barrow Brook) tributary, is recognised as a surface water body under the WFD (Whittle Brook (Mersey Estuary), ref. GB112069060990) falling within the Sankey operational catchment and the Lower Mersey management catchment. within the North West River Basin District. A summary of this WFD water body is provided in **Table 11-6**.

Table 11-6 - WFD Status of the (Whittle Brook (Mersey Estuary) potentially impacted by the Proposed Development (source Environment Agency, 2019)

	Current WFD Baseline Status
Water Body ID	GB112069060990
Water Body Name	Tributary of Whittle Brook (Mersey Estuary)
Water Body Type	River
Water Body area*	1459.43 ha (for Whittle Brook)
Hydromorphological Designation	Heavily Modified
Reason for Designation	The reasons cited include Food protection works and urbanisation.
Overall Ecological Status/Potential	Moderate
Current Overall Status/Potential	Moderate
Status Objective (overall)	Good by 2027 (disproportionate burdens)
Justification for not Achieving Good Status by 2015 (from 2009 Whittle Brook (Mersey Estuary) RBMP	Physical modifications to the channel resulting from flood defence works and urbanisation as well as poor nutrient management, poor soils management and misconnections occurring within the catchment.

	Current WFD Baseline Status
Protected Area Designation	The following nitrate vulnerable zones within the Whittle Brook water body are: NVZ12SW016390; NVZ12SW016370; and NVZ12SW016400.
Biological Quality Elements	
Overall Biological Quality Element Status Objective	Poor
Fish	Not assessed
Invertebrates	Poor
Macrophytes and phytobenthos combined	Not assessed
Physico-chemical Quality Elements	
Overall Physico-Chemical Quality Element Status Objective	Moderate
Specific pollutants	Triclosan - High
Priority substances	Does not require assessment
Priority hazardous substances	Good
Dissolved inorganic Nitrogen	Moderate
Dissolved Oxygen	High
Overall Chemical Status	Good
Overall Chemical Quality Element Status Objective	Good by 2015
Hydromorphological Quality Elements	
Hydromorphology Supporting Elements Status	Supports Good
Hydrological regime	Supports Good
Mitigation Measures Assessment	
Current	Achieving Moderate or less 480104 – Flood protection; 480105 - Urbanisation

WFD HYDROMORPHOLOGY QUALITY ELEMENTS

11.3.33. Due to the proposed diversion of the Whittle Brook; further information is provided below specifically relating to the WFD hydromorphology quality elements as they provide the physical habitat template for the ecological status.

Quantity and Dynamics of Flow

11.3.34. The Whittle Brook is a low gradient, low energy, pool-riffle system within a single-thread channel and a straight planform due to historical modification. Riffles and pools were observed throughout the study reach. Silt accumulation was observed within the middle reach of the study area.

River Continuity

11.3.35. Within the study reach, Whittle Brook is disconnected from its floodplain due to channel over-deepening with a homogenous, rectangular cross-sectional form. Longitudinal connectivity throughout the study reach, however, is essentially unimpeded. No major in-channel structures were noted during the walkover survey; thus, there is no significant disruption to sediment transport processes and hydrological connectivity (and therefore ecological connectivity) in terms of physical barriers.

River Depth and Width Variation

11.3.36. The channel predominantly has a uniform cross-sectional profile and is over-deepened. A riffle-pool channel bed morphology was observed, which provides some variability in cross-sectional profile through the reach. Siltation is a pressure on the watercourse, resulting in choking of the channel due to vegetation growth.

Structure and Substrate of the River Bed

11.3.37. Small to medium gravels dominate the substrate mix through the study reach, with sand and cobbles also present. Silt accumulations are present, with the source being from adjacent agricultural land, from agricultural land in the upstream catchment and from other diffuse sources.

Structure of the Riparian Zone

11.3.38. Stands of deciduous woodland are present along the Whittle Brook providing a well-structured riparian zone. The middle reach of the study area lies within agricultural land, and, therefore, has a degraded riparian zone with limited buffer between the banktop and the cultivated fields. The riparian zone is also impacts by extensive stands of Himalayan balsam, which were noted throughout the study reach.

FUTURE WFD BASELINE

11.3.39. The Whittle Brook has an objective to achieve GEP by 2027 due to disproportionate burdens. Flood protection, urbanisation, poor nutrient and land/soil management and misconnections within the catchment being the key reasons for not currently achieving its status objective.

11.3.40. Assuming that improved land management practices within the catchment will occur within the next few years, there could be a future improvement in the physico-chemical status of the Whittle Brook water body. Changes in land management could result in reduced levels of dissolved inorganic nitrogen within the catchment, thus enabling the achievement of Good for this WFD quality element. Such resulting improvements in water quality could lead to an ecological response and improvement in the WFD status of invertebrates.

11.4. SENSITIVE RECEPTORS

11.4.1. The following sensitive receptors have been assessed for Water Environment (including Flood Risk) and WFD and presented in **Table 11-7**.

Table 11-7 - Assessment of sensitive receptors

Feature	Summary	Sensitivity/ Value	Sensitive Receptors
Fluvial Flood Risk (Main River)	Environment Agency Main River flowing directly through the application site although there is little flood risk associated with the Whittle Brook. There are areas of Flood Zone 2 within the Proposed Development site but no immediate risk was determined.	Low	Floodplain extent Building structures and above ground infrastructure Site end users
Fluvial Flood Risk (Ordinary Watercourses)	Small field drains run through application site but are not associated with fluvial flood risk.	Low	Floodplain extent Building structures and above ground infrastructure Site end users
Surface Water Flood Risk Areas	Areas immediately surrounding small field drains and other areas of surface water flooding have been identified as a low to medium risk.	Medium	Areas of surface water ponding Building structures and above ground infrastructure Site end users
Groundwater Flood Risk (Secondary Till)	The Proposed Development is underlain with permeable geology. Previous studies indicate a risk of groundwater flooding due to the flat low-lying areas.	Low	Building structures, underground infrastructure and above ground infrastructure Site end users
Groundwater Flood Risk (Primary Sherwood Sandstone Group)	The Proposed Development is underlain by the Chester Formation (part of the Sherwood Sandstone Group). This aquifer serves Public Water Supply abstractions (albeit remotely) and groundwater level regimes therein are subject to long term rebound.	High	Building structures, underground infrastructure and above ground infrastructure Site end users The Primary aquifer
Water Resources (Secondary Till)	The Proposed Development is underlain with permeable geology.	Low	Groundwater levels
Water Resources (Primary Sherwood Sandstone Group)	The Proposed Development is underlain by the Chester Formation (part of the Sherwood Sandstone Group). This aquifer serves Public Water Supply abstractions (albeit remotely) and groundwater level regimes therein are subject to long term rebound.	High	The Primary aquifer
WFD water body (Whittle Brook (Mersey Estuary))	EA Main River and WFD water body (Whittle Brook) flowing directly through the site would	High	Whittle Brook WFD water body

Feature	Summary	Sensitivity/ Value	Sensitive Receptors
	be directly impacted by the Proposed Development.		

11.5. LEGISLATIVE FRAMEWORK, POLICY AND GUIDANCE

LEGISLATIVE FRAMEWORK

11.5.1. The applicable legislative framework is summarised as follows:

- The Water Resources Act 1991 as amended;
- Land Drainage Act 1994;
- The Water Act 2003 as amended;
- Flood Risk Regulations 2009;
- The Flood and Water Management Act 2010;
- Water Framework Directive (WFD) (2000/60/EC); and
- Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

POLICY

11.5.2. This chapter has been prepared out in accordance with the Government's National Planning Policy Framework (Ref 11.2).

11.5.3. For Flood Risk the National Planning Policy Framework promotes the use of the risk-based sequential test (which recognises that risk is a function of probability and consequence), in which new development is preferentially steered towards the areas at lowest probability of flooding.

GUIDANCE

11.5.4. The following guidance documents have been used during the preparation of this chapter:

- Planning Policy Guidance (Ref 11.3);
- Sustainable Drainage Systems (SuDS) Manual C753 (Ref 11.5); and
- St. Helens Council Sustainable Drainage Systems Design and Technical Guidance (Ref 11.4), and
- Environment Agency Guidance for Climate Change (Ref 11.1).

11.5.5. In addition to the relevant guidance WSP's professional experience and judgement was used.

11.6. ASSESSMENT OF POTENTIAL EFFECTS, MITIGATION AND RESIDUAL EFFECTS

11.6.1. The area of impermeable surfacing will increase from the current scenario to 55% of the application site area. However, this will not increase flood risk off site as it is proposed that surface water will be intercepted and attenuated with a restricted discharge of 5.81l/s/ha (greenfield Qbar) to the existing watercourses within or adjacent to the site to mitigate the effects of the increased surface water runoff. The proposed mitigation is described in the Flood Risk Assessment **(OPP DOC.1.1**).

11.6.2. The Proposed Development has the potential to impact both the surface and groundwater resource environment plus hydrologically dependant/influenced receptors. Accordingly, all project designs and works will accord with relevant policies and good working practice to minimise associated risks.

CONSTRUCTION PHASE

Table 11-8 – Assessment of potential effects, additional mitigation, residual effects and monitoring during construction

Sensitive receptor	Fluvial Flood Risk (Main River)
Potential effects	Potential impact from runoff (quantity and quality) until SuDS in operation.
Additional mitigation	Implementing temporary standard practices for controlling runoff (quantity and quality) from construction sites. The Principal Contractor will produce a CEMP.
Residual effects and monitoring	The sensitivity of main rivers is Low, and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on Main Rivers (**not significant**).

Sensitive receptor	Fluvial Flood Risk (Ordinary Watercourses)
Potential effects	Incorporated into site SuDS and drainage system.
Additional mitigation	None
Residual effects and monitoring	The sensitivity of ordinary watercourses is Low, and the magnitude of change, following integration with the SUDS mitigation, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on Ordinary Watercourses (**not significant**)

Sensitive receptor	Surface Water Flood Risk Areas
Potential effects	Potential impact from runoff until SuDS system in operation.
Additional mitigation	Implementing temporary standard practices for controlling runoff from construction sites. The Principal Contractor will produce a CEMP.
Residual effects and monitoring	The sensitivity of surface water flood risk (occupiers and adjacent land users/owners) is Medium, and the magnitude of change, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on occupiers and adjacent Land Users (**not significant**).

Sensitive receptor	Ground Water Flood Risk (Secondary Till and Primary Sherwood Sandstone Group)
Potential effects	Potential impact from infiltration in deep excavations (below superficial deposits of clay).
Additional mitigation	The Principal Contractor will produce a CEMP.
Residual effects and monitoring	The sensitivity of the Secondary Till aquifer is Low, and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on the Secondary Till aquifer (**not significant**).
	The sensitivity of the Primary Sherwood Sandstone aquifer is High, and the magnitude of change, following mitigation, is negligible (if not barely discernible). Therefore, there is likely to be a **negligible adverse** residual effect on the Primary Sherwood Sandstone aquifer (**not significant**).

Sensitive receptor	Ground Water Resources (Secondary Till and Primary Sherwood Sandstone Group)
Potential effects	Potential impact from proposed groundworks.
Additional mitigation	The Principal Contractor will produce a CEMP.
Residual effects and monitoring	The sensitivity of the Secondary Till aquifer is Low, and the magnitude of change, following mitigation, is small. Therefore, there is likely to be a **minor adverse** residual effect on the Secondary Till aquifer (**not significant**).
	The sensitivity of the Primary Sherwood Sandstone aquifer is High, and the magnitude of change, following mitigation, is negligible (if not barely discernible). Therefore, there is likely to be a **negligible adverse** residual effect on the Primary Sherwood Sandstone aquifer (**not significant**).

Sensitive receptor	WFD water body (Whittle Brook (Mersey Estuary))
Potential effects	The diversion of the Whittle Brook (approximately 570m long diversion) would result in the loss of aquatic habitats and the physical form and function of the current Whittle Brook watercourse, which has been flowing as a stable channel in its current planform since historical records began. The diversion would result in the mortality of any invertebrates or macrophytes within the channel through the diverted reach. The proposed diversion would cause a disruption to the longitudinal and lateral connectivity of the channel. Construction activities would also impact upon the Whittle Brook water body, including increased fine sediment supply to the channel, which may impact upon the sediment regime by introducing fine sediment, which not only increases silt loading within the watercourse, but also affects biological and physico-chemical quality elements by smothering aquatic habitats, increasing turbidity and reducing oxygen levels within the watercourse.
Additional mitigation	Fish surveys would be required to determine whether a fish rescue would be required prior to the commencement of any works to divert the watercourse. Sediment sampling would also be required to determine the substrate mix that would need to be reinstated to form a natural structure and composition of the channel substrate within the diverted watercourse. The diverted channel would need to be designed to incorporate natural form and function, which would provide the habitat template for the WFD biological quality elements (fish, macrophytes and phytobenthos and macroinvertebrates). The design would include a low-flow channel, riffle and pool sequences and inset and lateral berms to improve habitat heterogeneity. The diverted channel would be designed as a two-stage channel with alternating low-level berms to provide some channel sinuosity, whilst ensuring the channel length remains as similar as possible to the current channel length to maintain a similar channel gradient. Riparian planting would be implemented as part of the channel design to provide channel shading, improved structure of the riparian zone and good quality riparian habitat. To manage fine sediment input to the channel from construction activities, the following mitigation would be required and included in the CEMP: ▪ Off-line construction of the diverted channel with newly created banks seeded prior to diverting the flow into the new channel;

Sensitive receptor	WFD water body (Whittle Brook (Mersey Estuary))
	▪ The diversion of flow into the newly created channel should ideally be done in spring/summer when vegetation may establish and the likelihood of high flows is less; ▪ Best practice pollution prevention guidelines would be adhered to for managing fine sediment; ▪ Silt fences would be installed to prevent fine sediment from reaching the watercourse; ▪ Construction activities should, where practicable, maintain an 8m buffer from the watercourse bank top; ▪ Vegetation clearance for enabling works should be minimised as far as practicable within 8m of a watercourse; ▪ Pollution spill kits should be kept on site; in the event of an incident these will be used. ▪ Any soils contaminated will be removed immediately to a suitable landfill site. ▪ Bins should be provided on site for debris. ▪ Cleaning of tools and shuttering will be carried out in water not draining directly to the watercourse; and, ▪ In any event of expected heavy rain, pouring concrete and other activities which increase the risk of contaminating runoff should not be undertaken.
Residual effects and monitoring	The sensitivity of the Whittle Brook (Mersey Estuary WFD water body is High, and the magnitude of change, following mitigation, is Negligible. Therefore, there is likely to be a direct, temporary, medium-term **negligible adverse** residual effect on the Whittle Brook (Mersey Estuary) WFD water body (**not significant**) following the implementation of mitigation measures. Post-construction, monitoring is recommended for a period of 5-years to ensure that the channel diversion has met its design objectives. Monitoring should include aquatic ecology surveys, such as macroinvertebrates and fish, if fish were present pre-construction, and River Habitat surveys to record the diversity of natural features present in the diverted watercourse. Surveys should occur soon after construction, following any high magnitude flow event and after 5-years. This monitoring should be arranged by the Contractor.

OPERATIONAL PHASE

Table 11-9 – Assessment of potential effects, additional mitigation, residual effects and monitoring during operation

Sensitive receptor	Fluvial Flood Risk (Main River)
Potential effects	Potential impact from runoff.
Additional mitigation	Operational & Management of SuDS system.
Residual effects and monitoring	The sensitivity of main rivers is Low, and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on Main Rivers (**not significant**).

Sensitive receptor	Fluvial Flood Risk (Ordinary Watercourses)
Potential effects	Incorporated into site SUDS and drainage system.
Additional mitigation	None

Sensitive receptor	Fluvial Flood Risk (Ordinary Watercourses)
Residual effects and monitoring	The sensitivity of ordinary watercourses is Low, and the magnitude of change, following integration with the SUDS mitigation, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on Ordinary Watercourses (**not significant**).

Sensitive receptor	Surface Water Flood Risk Areas
Potential effects	Potential impact from runoff.
Additional mitigation	Operational & Management of SuDS system. Consideration of groundwater seepage into the surface water runoff attenuation ponds.
Residual effects and monitoring	The sensitivity of surface water flood risk (occupiers and adjacent land users/owners) is Medium, and the magnitude of change, is negligible. Therefore, there is likely to be a **negligible adverse** residual effect on occupiers and adjacent Land Users is negligible (**not significant**).

Sensitive receptor	Groundwater Flood Risk (Secondary Till and Primary Sherwood Sandstone Group)
Potential effects	None (in presence of proposed Drainage Strategy & SuDS)
Additional mitigation	None.
Residual effects and monitoring	The sensitivity of the Secondary Till aquifer is Low, and the magnitude of change, following mitigation, is negligible. Therefore, there is likely to be a negligible adverse residual effect on the Secondary Till aquifer ('not significant').
	The sensitivity of the Primary Sherwood Sandstone aquifer is High, and the magnitude of change, following mitigation, is negligible (if not barely discernible). Therefore, there is likely to be a **negligible adverse** residual effect on the Primary Sherwood Sandstone aquifer (**not significant**). The continuance (magnitude and duration) of groundwater level rebound within the Primary Sherwood Sandstone underlying the site is unknown. Therefore, it recommended that groundwater level monitoring is continued for at least 5 years of operations to better gauge the significance of this phenomena. Currently, it is not thought to be significant but the matter does currently entail some element of uncertainty.

Sensitive receptor	WFD water body (Whittle Brook (Mersey Estuary))
Potential effects	The diversion of the Whittle Brook (approximately 570m long diversion) would result in the relocation of the Whittle Brook thus disrupting the longitudinal and lateral connectivity of the watercourse. In addition, there would be mortality of macroinvertebrates as a direct result of the diversion, thus these species would need to recovery within the watercourse to reinstate the macroinvertebrate status for the WFD waterbody (currently achieving Poor status for macroinvertebrates) Without appropriate channel design and mitigation, there is a risk of deterioration in one or more of the WFD quality elements, and potential overall WFD status, thus preventing the water body from achieving its WFD status objective for 2027.

Sensitive receptor	WFD water body (Whittle Brook (Mersey Estuary))
Additional mitigation	The operational design of the diverted channel would need to incorporate natural form and function, which would provide the habitat template for the WFD biological quality elements (fish, macrophytes and phytobenthos and macroinvertebrates). The design would include the following design principles: riffle-pool sequence; alternating inset berms; two-stage channel; low-level berms; and marginal and riparian planting with a native species mix (including wetland species on the low-level berms). The diverted channel would be designed as a two-stage channel with alternating low-level berms to provide some channel sinuosity, whilst ensuring the channel length remains as similar as possible to the current channel length to maintain a similar channel gradient. The riffle-pool sequence and natural substrate making up the bed would provide geomorphological diversity, encourage natural form and process, and provide the habitat template for aquatic species for natural recruitment of the expected species assemblages. Riparian planting would be implemented as part of the channel design to provide channel shading, improved structure of the riparian zone and good quality riparian habitat
Residual effects and monitoring	The sensitivity of the Whittle Brook (Mersey Estuary) WFD water body is High, and the magnitude of change, following mitigation, is Negligible. Therefore, there is likely to be a direct, temporary, medium-term **negligible adverse** residual effect on the Whittle Brook (Mersey Estuary) WFD water body (**not significant**) following the implementation of mitigation measures. However, once the watercourse diversion is functioning as designed, there could potentially be an ultimate beneficial impact upon some of the WFD quality elements, which would be confirmed through monitoring. Operational monitoring is recommended for a period of 5-years to ensure that the channel diversion has met its design objectives. Monitoring should include aquatic ecology surveys, such as macroinvertebrates and fish, if fish were present pre-construction, and River Habitat Surveys to record the diversity of natural features present in the diverted watercourse. Surveys should occur soon after construction, following any high magnitude flow event and after 5-years. This monitoring should be arranged by the Contractor.

ASSESSMENT AGAINST FUTURE BASELINE

11.6.3. Schedule 4(3) of the EIA Regulations 2017 requires consideration of the likely evolution of the current state of the environment (baseline scenario) in the absence of the Proposed Development, as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge (future baseline).

11.6.4. Whilst there are considerable limitations to the predictions that can be made about natural baseline conditions at a future point of time, some assessments require projections to account for future change.

11.6.5. The future baseline of the application site is likely to remain unchanged as arable land, with the existing areas of woodland becoming more mature. The flood extents may have increased with climate change in a future baseline condition. Additional changes could include background traffic growth or change in population of certain species.

11.6.6. Due to the afore-mentioned limitations, necessary assumptions and lack of evidence associated with the future baseline (i.e. it cannot be accurately measured), a detailed consideration of the effects of the Proposed Development against the future baseline would generally not result in a robust assessment.

11.6.7. In terms of Flood Risk, unless there are significant improvements in land and soil management, for example to improve the permeability of the site, the current conditions are considered to provide the most reasonable basis for assessment.

11.6.8. In terms of the groundwater level regime in the underlying Primary Sherwood Sandstone Group aquifer this is currently substantially decoupled from perched groundwater in the overlying Till (Boulder Clay) and in an unconfined state. However, the Primary aquifer is subject to long term groundwater level rebound which is currently ongoing. The final equilibrium state for this aquifer is unknown but it is almost inevitable the groundwater level regime will become confined and may, in future, equilibrate with the perched water in the overlying Till (Boulder Clay).

11.6.9. In terms of the WFD, assuming the successful implementation of WFD mitigation measures set for the Whittle Brook water body, the water body could potentially be achieving good ecological potential by 2027. This is assuming that there would be significant improvements in land and soil management, for example, which would rectify the current issues impacting upon the water body. Therefore, in the future, the water body, in the absence of the Proposed Development, could be achieving good ecological potential.

CUMULATIVE EFFECTS

11.6.10. It is assumed that other developments within the area have adequately considered and mitigated for potential impacts upon the Whittle Brook (Mersey Estuary) WFD water body. The proposed design principles for the channel diversion would provide some habitat improvements to mitigate and neutralise impacts along with creating an improved riparian zone to offer further protection and habitat improvement to the channel.

11.7. OPPORTUNITIES FOR ENHANCEMENT

11.7.1. Flood Risk and Channel Realignment have been assessed and modelled assuming the use of attenuation storage to achieve water quality and runoff rates. The use of permeable SuDS options would enhance the performance of the proposed strategies however (refer to **Chapter 14: Land and Soils**) the current condition of the application site is such that the observed waterlogging would exclude these options and have therefore not been put forward.

11.7.2. In relation to the channel diversion, there is opportunity for additional enhancement of the riparian zone by the planting of more trees, and, potentially, the creation of some patches of wet woodland. This would provide both enhancement and a degree of net gain.

11.8. LIMITATIONS AND ASSUMPTIONS

11.8.1. There are several limitations associated with the updated 1D model used in assessing Flood Risk and channel diversion. It is recommended that a full model review is undertaken with associated improvements and updates made to the model at the detailed design stage. The main limitations are listed below:

- The hydrology data has not been reviewed since the original Environment Agency model was developed in 2008. It is recommended that a full review and update is made to the hydrology
- Update the model from steady mode to unsteady using full flow hydrographs
- Extend the cross sections with glass-walling at the baseline model, check if the floodplain needs to be represented in a 2D domain by converting the model to 1D-2D Flood modeller – Tuflow or trim the model at the downstream part to avoid a 2D model

- Check if the possible flooding at the area downstream of the realignment has any impact at the Proposed Development with the updated model

11.8.2. A Technical Note with full details from the hydraulic modelling can be found in the Flood Risk Assessment Report (**OPP DOC.1.1**).

11.8.3. The hydraulic model received from the Environment Agency was built in 2008 and the topographic survey used within the model is over 10 years old and this may not be representative of the current watercourses and future conditions. New climate change allowances have been provided to the Environment Agency model but this was applied to old hydrology which does not include new and updated rainfall or flow gauges. As no new hydrology was applied to the model, old methods have been relied upon and new methods including ReFH2 and WINFAP have not been utilised.

11.8.4. The drainage scheme for the Proposed Development needs to accommodate a small provision for the potential effect of groundwater level rebound in the Primary aquifer underlying the site giving rise to a minor impact, and additional burden, on its future functioning. This is very minor in relation to provision currently required to accommodate possible uplift from potential Climate Change scenarios.

11.8.5. Within the tight programme, it was not possible to arrange a consultation meeting with the Environment Agency to confirm the methodology and design principles applied to the WFD assessment. The scoping response from the Environment Agency does, however, confirm the need for a WFD assessment of the proposed watercourse diversion.

11.8.6. In the absence of a meeting with the Environment Agency, the WFD assessment has been undertaken based upon a set of design principles and using professional judgement. It is assumed that these design principles would be acceptable to the Environment Agency.

11.8.7. It is assumed that detailed surveys, such as sediment sampling and analysis, fish and macroinvertebrate surveys will not be required for the Outline Planning Application. The need for detailed surveys is deferred to support the subsequent Full Planning Application for this phase of the development.

11.8.8. Observations recorded during the site visits represent a snap-shot of that moment in time; for example, the site visit was conducted during a period of low flow and fair-weather conditions, following a benign winter and summer, i.e. with no significant flood events.

11.8.9. Much of the evidence that was visible and acquired on the days of survey reflects the weeks and months leading up to the survey: the channel may exhibit other morphological phenomena during particularly high flow events, or following an extreme flow event. Thus, in the absence of time series data for the watercourse, inferences have been made based upon field data and a desk study exercise.

11.9. SUMMARY

11.9.1. Overall, given the current understanding of the Proposed Development and the baseline condition of the water environment, it is not believed that there will be any significant impacts to mitigate for the water environment in terms of risk to surface water, groundwater and WFD receptors over and above those already included in the proposed design.

11.9.2. The impact study was completed based on the relevant legislation and planning policies, such as national catchment management and local development plans. Construction work is expected to be completed in line with Best Practice guidance the relevant pollution prevention guidelines.

11.9.3. The application site will not increase flood risk off site as it is proposed that surface water will be intercepted and attenuated with a restricted discharge of 5.81l/s/ha (greenfield Qbar) to the existing watercourses within or adjacent to the site to mitigate the effects of the increased surface water runoff.

11.9.4. The main potential impacts during construction would be spills or runoff events directly affecting the perched groundwater environment associated with the Till (Boulder Clay) and directly or indirectly affecting the surface water environment. Mitigation through a CEMP will negate this impact and no significant residual effects are expected in the construction phase.

11.9.5. The main potential impact during the operational phase of the scheme will be a change in the infiltration and drainage patterns on the application site, which could directly affect groundwater recharge patterns to the Secondary Till (Boulder Clay) aquifer and indirectly affect surface water flow via groundwater baseflow in to nearby watercourses. Implementation of SuDS would manage potential impacts arising from the Proposed Development.

11.9.6. A Flood Risk Assessment has been prepared in accordance with the NPPF, demonstrating that future occupants of the Proposed Development will be safe from flooding and that the proposals will not increase flood risk elsewhere.

11.9.7. On the basis of the proposed mitigation works, the effect has been reduced to a negligible (not significant) level. Residual risks still remain with regards to rare events, such as flood events greater than the 1% annual probability event occurring but these events are considered to be unlikely and represent a negligible risk.

11.9.8. Groundwater levels in the Primary aquifer underlying the site will continue to rebound but their final equilibrium is uncertain both quantitatively and temporally. In future the new groundwater level regime may have a minor bearing on the drainage scheme for the Proposed Development. Accordingly, additional provision in the drainage design should be accommodated to allow for this possible, albeit minor component from a drainage perspective, in future.

11.9.9. The proposed diversion of the Whittle Brook is assessed as being WFD compliant and would not result in deterioration in either the classification of any of the WFD quality elements or deterioration in WFD status.

11.9.10. **Table 11-10** provides a summary of the findings of the assessment (all aspects).

Table 11-10 - Summary of water environment effects

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Construction Phase				
Fluvial Flood Risk (Main River)	Runoff until SuDS in operation	Implementing temporary standard practices for controlling runoff from construction sites. The Principal Contractor will produce a CEMP.	**Negligible adverse (not significant)** T / D / ST	None
Fluvial Flood Risk (Ordinary Watercourses)	Runoff until SuDS in operation	Implementing temporary standard practices for controlling runoff from construction sites. The Principal Contractor will produce a CEMP	**Negligible adverse (not significant)** T / D / ST	None
Surface Water Flood Risk	Runoff until SuDS in operation.	Implementing temporary standard practices for controlling runoff from construction sites. The Principal Contractor will produce a CEMP.	**Negligible adverse (not significant)** T / D / ST	None
Ground Water Flood Risk (Secondary Till and Primary Sherwood Sandstone Group)	Earthworks associated with the Proposed Development.	The Principal Contractor will produce a CEMP.	**Negligible adverse (not significant)** T / D / ST	None

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Ground Water Resource Risk	Earthworks and other construction activities associated with the Proposed Development.	The Principal Contractor will produce a CEMP.	**Minor adverse (not significant)** on the Secondary Till aquifer. **Negligible adverse (not significant)** on Primary Sherwood Sandstone Group aquifer T / D / ST	None
WFD water body (Whittle Brook (Mersey Estuary))	The channel diversion would result in the mortality of aquatic invertebrates and disruption of connectivity Construction effects include increase in fine sediment supply to the channel with potential effects on the biological and physico-chemical quality elements by smothering aquatic habitats, increasing turbidity and reducing oxygen levels within the watercourse.	Aquatic ecology surveys prior to construction: fish and macroinvertebrates. Sediment sampling to determine the substrate mix for the diverted channel. Incorporation of pool-riffle sequences, inset berms and low-level berms within a two-stage channel design. Riparian planting with a native species mix. Adherence to the mitigation within the CEMP is required.	**Negligible adverse (not significant)** T / D / ST	Monitoring is recommended for a period of five years to record aquatic ecology and morphological recovery of the channel. Surveys should occur soon after construction, following any high magnitude flow event and after five years. This monitoring should be arranged by the Contractor.

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
Operational Phase				
Fluvial Flood Risk (Main River)	Runoff	Operational & Management of SuDS.	**Negligible adverse (not significant)** P / D / LT	None
Fluvial Flood Risk (Ordinary Watercourses)	Runoff	Operational & Management of SuDS.	**Negligible adverse (not significant)** P / D / LT	None
Surface Water Flood Risk	Runoff and groundwater seepage into the attenuation ponds	Operational & Management of SuDS.	**Negligible adverse (not significant)** P / D / LT	None
Ground Water Flood Risk (Secondary Till and Primary Sherwood Sandstone Group)	Groundwater mediated loading on site drainage scheme is very minor but may become slightly more significant in future with groundwater level rebound in the underlying Primary aquifer.	Incorporate minor provision in drainage scheme design for Proposed Development to allow for a slightly enhanced contribution from groundwater in future to mitigate against uncertainties associated with this issue.	**Negligible adverse (not significant)** P / D / LT	Incorporate long term groundwater level monitoring of the Primary aquifer regime underlying the site and register how this may manifest in terms of impact on site drainage.

Receptor	Potential Effects	Additional Mitigation	Residual Effects	Monitoring
WFD water body (Whittle Brook (Mersey Estuary))	The diversion of the Whittle Brook would disrupt connectivity of the watercourse temporarily until a new equilibrium is established. Without appropriate channel design and mitigation, there is a risk of deterioration in one or more of the WFD quality elements, and potential overall WFD status, thus preventing the water body from achieving its WFD status objective for 2027.	Channel design would need to include the following design principles: riffle-pool sequence; alternating inset berms; two-stage channel; low-level berms; and marginal and riparian planting with a native species mix (including wetland species on the low-level berms).	**Negligible adverse (not significant)** T / D / ST	Operational monitoring is recommended for a period of five years to record aquatic ecology and morphological recovery of the channel. This monitoring should be arranged by the Contractor.

Key to table:

P / T = Permanent or Temporary, D / I = Direct or Indirect, ST / MT / LT = Short Term, Medium Term or Long Term, N/A = Not Applicable

11.10. REFERENCES

- Ref. 11.1: Environment Agency Guidance for Climate Change. [Online] Accessed via https://www.gov.uk/government/collections/environment-agency-and-climate-change-adaptation, 29 November 2019
- Ref. 11.2: National Planning Policy Framework. [Online] Accessed via https://www.gov.uk/government/publications/national-planning-policy-framework--2, 29 November 2019
- Ref. 11.3: Planning Practice Guidance. [Online] Accessed via https://www.gov.uk/government/collections/planning-practice-guidance, 29 November 2019
- Ref. 11.4: St. Helens Council Sustainable Drainage Systems Design. Online] Accessed via http://moderngov.sthelens.gov.uk/mgConvert2PDF.aspx?ID=89588, 29 November 2019
- Ref. 11.5: Sustainable Drainage Systems (SuDS) Manual C753. [Online] Accessed via https://www.susdrain.org/resources/SuDS_Manual.html, 29 November 2019
- Ref. 11.6: WSP (2019) Group Investigation Report.