10. Drainage and Flood Risk

Introduction

10.1 This chapter assesses the effects of the proposed development on flood risk and drainage. In particular, it considers the potential effects of the proposed development on existing hydrology and flood risk in the local area.

10.2 The chapter describes the methods used to assess the impacts, the baseline conditions currently existing at the Site and surroundings, the potential direct and indirect impacts of the development, and the mitigation measures required to prevent, reduce, or offset the impacts and the residual impacts. It has been written by BWB Consulting Ltd.

Planning Policy Context

International / National Legislation

Flood and Water Management Act

10.3 The Flood and Water Management Act takes forward some proposals previously published by the UK Government: Future Water, making Space for Water and the UK Government's response to Sir Michael Pitt's Review of the summer 2007 floods.

10.4 The Act gives the Environment Agency the strategic overview of management of flood risk in England. It gives upper tier local authorities in England responsibility for preparing and putting in place strategies for managing flood risk from groundwater, surface water and ordinary watercourses in their areas.

10.5 Local flood authorities, district councils, internal drainage boards and highways authorities have a duty to aim to make a contribution towards sustainable development.

Water Framework Directive

10.6 The Water Framework Directive 2000/60/EC states that the overall requirement of the legislation is that all river basins must achieve 'good ecological status' by 2015 or by 2027, if there are grounds for derogation (essentially if it can be proven that it is not possible to achieve it by 2015). The WFD, for the first time, combines water quantity and quality issues together and, as an umbrella Directive, effectively incorporates and/or supersedes all water related legislation that drives the existing consenting framework.

Groundwater Directive

10.7 Groundwater Directive 80/68/EEC (enacted into English law through the Groundwater (England and Wales) Regulations 2009; subsequently revoked) aims to protect groundwater against pollution by 'List 1 and 2' Dangerous Substances.

The Water Act

10.8 The Water Act 2014 implements changes to the water abstraction management system and regulatory arrangements to make water use more sustainable.

National Planning Policy

National Planning Policy Framework

10.9 Prepared by the Department for Communities and Local Government, the National Planning Policy Framework (NPPF) outlines the Government's planning policies for England.

10.10 Within the context of water quality, climate change, flooding and coastal change, the Government's objective set out in the NPPF is the support of a transition to a low carbon economy in a changing climate, taking full account of flood risk and coastal change. To achieve this objective, the planning system should aim to:

- secure reductions in greenhouse gas emissions;
- minimise vulnerability and provide resilience to effects arising from climate change;
- avoid new development in inappropriate areas at risk of flooding by directing it away from areas at highest risk or where development is necessary, making it safe without increasing flood risk elsewhere (part of the Sequential Test);
- reduce risk from coastal change by avoiding inappropriate development in vulnerable areas or adding to the impacts of physical changes to the coast; and;
- protect and enhance valued landscapes, geological conservation interests and soils; prevent both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of soil, air, water or noise pollution or land instability.

10.11 NPPF Section 10 (Paragraphs 155-169) outlines how planning policy should meet the challenges of climate change, flooding and coastal change. It retains the ethos of steering new development to areas at the lowest risk of flooding.

10.12 The NPPF specifies that planning applications should demonstrate through production of a site-specific flood risk assessment that development in flood prone areas can be made safe and will not increase flood risk elsewhere.

Sequential Test & Exception Test

10.13 As set out in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding. The Flood Zones are the starting point for this sequential approach. Flood Zones 2 and 3 are shown on the Environment Agency Flood Map with Flood Zone 1 being all the land falling outside Zones 2 and 3. These Flood Zones refer to the probability of sea and river flooding only, ignoring the presence of existing defences.

10.14 Flood Zone 3 (High Probability) is defined in the NPPF as land assessed as having a 1 in 100-year or greater annual probability of river flooding and/or a 1 in 200-year probability of flooding from tidal sources. The NPPF also defines Flood Zones 2 and 1. These zones are identified as land assessed as having a 1 in 1000 or greater annual probability of river/tidal flooding and land assessed as having a less than 1 in 1000 annual probability of river/tidal flooding respectively.

10.15 Strategic Flood Risk Assessments refine information on the probability of flooding, taking other sources of flooding and the impacts of climate change into account. They provide the basis for applying the Sequential Test, on account of the Flood Zones.

10.16 The overall aim should be to steer new development to Flood Zone 1. Where there are no reasonably available sites in Flood Zone 1, local planning authorities allocating land in local plans or determining planning applications for development at any particular location should take into account the flood risk vulnerability of land uses and consider reasonably available sites in Flood Zone 2. If, following application of the Sequential Test, it is not possible, consistent with wider sustainability objectives, for the development to be located in zones with a lower probability of flooding, the Exception Test can be applied if appropriate.

10.17 For the Exception Test to be passed:

- It must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment where one has been prepared; and
- A site-specific Flood Risk Assessment must demonstrate that the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall. Both elements of the test will have to be passed for development to be allocated or permitted.

10.18 The Planning Practice Guidance (PPG) to the NPPF provides additional guidance to local planning authorities to guide effective implementation of the NPPF on development in areas at risk of flooding. Table 1 of the PPG classifies each Flood Zone and allocates sequentially appropriate uses to each zone. Table 2 defines the flood risk vulnerability classification of different land uses.

10.19 Further guidance is also provided with regard to appropriate allowances for climate change and ways to manage residual flood risk.

Local Planning Policy

Local Plan

10.20 The Adopted Sheffield Local Plan is split up into The Sheffield Core Strategy and The Sheffield Unitary Development Plan (UDP). The UDP was adopted in March 1998 and has now been partially superseded by the Core Strategy, adopted in March 2009. The Local Plan sets out a spatial vision and strategy for the sustainable growth of Sheffield between 2009 to 2026. The SDF includes policies on climate change, flood risk and drainage across the city.

10.21 Within the UDP, Policy: GE20 - Flood Defence, states:

- "Development will not be permitted where flooding risks to it or to existing development would not be overcome by suitable on-site protective measures. Where necessary, off-site flood prevention measures will be required before a new development takes place."

10.22 Within the Core Strategy, Policy CS67: Flood Risk Management, states:

- "The extent and impact of flooding will be reduced by:

- requiring that all developments significantly limit surface water runoff;
- requiring the uses of Sustainable Drainage Systems or sustainable drainage techniques on all sites where feasible and practicable;
- encouraging the removal of existing culverting;
- not increasing and, where possible, reducing the building footprint in areas of developed functional floodplain;
- not locating or subdividing properties that would be used for more vulnerable uses in areas of developed functional floodplain;
- developing only water-compatible uses in the functional floodplain;
- designating areas of the city with high probability of flooding for open space uses where there is no overriding case for development;
- developing areas with high probability of flooding only for water-compatible uses unless an overriding case can be made and adequate mitigation measures are proposed;
- ensuring any highly vulnerable uses are not located in areas at risk of flooding;
- ensuring safe access to and from the area with a low probability of flooding

- Where an overriding case remains for developing in a zone with high probability of flooding, development will only be permitted if;
  - More Vulnerable uses, including housing, would be above ground floor level and;
  - the lower floor levels of any other development with vulnerable equipment would remain dry in the event of flooding; and
  - the building would be resilient to flood damage; and
  - adequate on and off-site storage protection measures would be provided
- Housing in areas with a high probability of flooding will not be permitted before 2016/17."

Sheffield Development Framework Climate Change and Design Supplementary Planning Document and Practice Guide

10.23 This document (adopted in 2011) seeks to supplement the Core Strategy and is designed to help applicants understand what they must achieve to obtain planning permission. It involves more specific guidelines relating to green roofs, reducing carbon emissions, the definition of a 'conversion' and decommissioning renewable/low carbon energy generating infrastructure. Whilst helpful, these matters will be considered further at the detailed design stage.

Strategic Flood Risk Assessment

10.24 A Strategic Flood Risk Assessment (SFRA) is a study carried out by one or more local planning authorities to assess the risk to an area from flooding from all sources, now and in the future.

10.25 The Sheffield City Council Level 1 SFRA provides information specific to the site location in the form of fluvial, surface water and groundwater flood risk mapping, as well as records of historical flooding.

10.26 The Sheffield City Council Level 2 SFRA was produced to facilitate the application of Sequential and Exception Tests to screen allocated development sites.

Preliminary Flood Risk Assessment

10.27 A Preliminary Flood Risk Assessment (PFRA) is an assessment of floods that have taken place in the past and floods that could take place in the future. It generally considers flooding from surface water runoff, groundwater and ordinary watercourses, and is prepared by the Lead Local Flood Authorities.

10.28 The Sheffield City Council PFRA and PFRA Addendum consider flooding from surface water runoff, groundwater, ordinary watercourses and canals. They also reference the historical river flooding which occurred within the Sheffield area.

Local Flood Risk Management Strategy

10.29 A Local Flood Risk Management Strategy (LFRMS) is prepared by a Lead Local Flood Authority to help understand and manage flood risk at a local level.

10.30 The LFRMS aims to ensure that the knowledge of local flood risk issues is communicated effectively so that they can be better managed. The LFRMS also aims to promote sustainable development and environmental protection.

Other Relevant Policy, Standards and Guidance

10.31 C753 SuDS Manual provides best practice guidance on the planning, design, construction, operation and maintenance of SuDS to facilitate their effective implementation within developments.

10.32 C624 Development and Flood Risk – Guidance for the Construction Industry sets out practical guidance in assessing flood risk as part of the development process. It describes the mechanisms and impacts of flooding, whether caused by rivers, the sea, estuaries, groundwater, overland flow, artificial drainage systems or infrastructure failure. The guidance recommends a tiered approach to flood risk assessment and provides a toolkit to assist practitioners in completion of assessments. It covers UK planning policy guidance for development and flood risk and is aimed at achieving a consistent approach to the implementation of that guidance, which in turn should allow developments to be planned and designed more efficiently.

10.33 C532 Control of Water Pollution from Construction Sites – Guidance for consultants and contractors provides help on environmental good practice for the control of water pollution arising from construction activities. It focuses on the potential sources of water pollution from within construction sites and the effective methods of preventing its occurrence.

10.34 Environment Agency's Pollution Prevention Guidelines were withdrawn in December 2015; however, they provide sound advice and good environmental practice, to help reduce environmental risks from business activities.

Approach

Assessment Methodology

10.35 This assessment identifies the potential impacts of the proposed development on drainage and flood risk. It determines the significance of the identified impacts for the construction and operation phases.

10.36 The impacts are assessed against the Highways Agency's assessment guidance which can be found in the Design Manual for Roads and Bridges (DMRB) Volume 11, Environmental Assessment, Section 3, Part 10, HD54/09 Road Drainage and the Water Environment.

Scope

10.37 This chapter is supported by a Flood Risk Assessment (FRA), presented as **Appendix 10.1**. The purpose of this report is to identify flood risk to the Site in its current condition, and how this may change with the Proposed Development. The FRA is underpinned by a hydraulic modelling exercise (with supporting hydrological assessment) and direct rainfall model, to better reflect the fluvial and pluvial flood risks to the Site respectively.

10.38 This chapter is also supported by a Sustainable Drainage Statement (SDS), presented as **Appendix 10.2**. An SDS outlines the principles of the drainage design, including: consideration of local and national guidance; justification of specific flow rates; volumes of attenuated storage; and the level of treatment to be provided to surface water runoff.

Fluvial Flood Modelling

10.39 The FRA is supported by a bespoke hydrological and hydraulic study of the River Loxley, an Environment Agency Main River bisecting the centre of the Site, and also the Mill Pond and Mill Leat present on the Site, to confirm their floodplain extents.

10.40 The hydraulic model is based on the EA's own model of the River Loxley, but it has been updated to include site specific information. The model is a dynamically linked 1D-2D model, with the following representations incorporated:

- The River Loxley's in-channel conditions and hydraulic structures are incorporated within a one-dimensional (1D) Flood Modeller Pro (FMP) domain;
- The Mill Leat and hydraulic conditions are modelled within a 1D ESTRY domain; and
- The Mill Pond and floodplain are modelled within a two-dimensional (2D) TUFLOW domain.

Peak River Flow

10.41 Flood flow estimates are required to support the hydraulic modelling exercise. The following return periods have been used to inform the assessment work: 1 in 20-year, 1 in 100-year, 1 in 100-year plus climate change, and the 1 in 1000-year.

10.42 The hydrological analysis is based on industry standard methodologies which utilise FEH catchment descriptors: the FEH Statistical Analysis (FEH-Stat) and the ReFH2 (Revitalised Flood Hydrograph) rainfall-runoff model. The IH124 and Modified Rational Methods were dismissed due to the size and nature of the catchment, and the FEH rainfall-runoff and ReFH1 hydrological models have been superseded.

10.43 The River Loxley is gauged at Rowell Bridge (NGR: 430157, 389548), hence used as a donor station to refine flow estimations with real-world observed flows. The station here has an 18-year record of the observed flows, to inform the verification process.

Assessment of Climate Change for Hydraulic Modelling

10.44 Predicted future change in peak river flows caused by climate change are provided by the Environment Agency, with a range of projections applied to regionalised 'river basin districts'.

10.45 The peak river flow allowances applicable to the Humber River Basin District have been applied to the hydrological inputs. To determine the appropriate allowance, consideration should be given to the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of the proposed development.

10.46 Given the parameters applicable to this development, the 'upper end' and 'higher central' allowances applicable to the '2080s' are informing the recommended flood management and resilience strategy (30% and 50% respectively).

Pluvial Flood Modelling

10.47 The FRA is supported by a direct rainfall hydraulic modelling exercise to quantify the overland flows generated by runoff from the hillsides above the proposed development. The catchment upstream of the Site is not served by a single, distinct watercourse, but by a series of artificial drainage channels. The full connectivity and condition of these is currently unknown, but the ultimately outfall into the River Loxley and Mill Pond.

10.48 The modelling exercise is principally 2D in nature, to ensure that rainfall is distributed across the catchment, with flow routes developing for the topography. The Mill Pond and Mill Leat were added in a 1D domain, as these intercept runoff from the north. TUFLOW and ESTRY software packages inform the pluvial modelling.

Characterisation of Impact

10.49 The DMRB assessments are developed for the assessment of highways projects and many of the criteria are developed around the results of highways specific assessment tools in the DMRB. Consequently, the assessment method is not followed in its entirety; only transferrable elements are adapted for use in the assessment. In addition, the DMRB assessments are only required to present the residual significance of impacts of any environmental effects after proposed mitigation, which is only appropriate if the project being assessed is a Highways Agency managed scheme.

10.50 The assessment methodology has been adapted accordingly, as summarised below.

10.51 The sensitivity of the resource is assessed according to

Table 10.1 below and considers the quality, rarity and sensitivity of the resource to change.

10.52 The magnitude of a potential impact is estimated according to the likely impacts and independent of the feature's importance, as shown in **Table 10.2**.

Table 10.1: Sensitivity of Resource

Designation	Definition
High	Resource of high sensitivity to change; with a high quality and rarity on a local scale; and/or medium quality on a regional or national scale with limited potential for substitution.
Medium	Resource with a medium quality and rarity on a local scale; and/or a low quality and rarity on a regional or national scale with limited potential for substitution.
Low	Resource with a low quality and rarity, local scale and limited potential for substitution.
Negligible	Resource of little or no interest.

Table 10.2: Magnitude of Impact

Designation	Definition
Major Beneficial	Results in a large improvement of the attribute's quality.
Moderate Beneficial	Results in a moderate improvement of the attribute's quality.
Minor Beneficial	Results in some beneficial impact on the attribute or a reduced risk of a negative impact occurring.
Negligible	Results in an impact on the attribute, but of insufficient magnitude to affect the use or integrity.
Minor Adverse	Results in some measurable change in the attribute's quality or vulnerability.
Moderate Adverse	Results in impact on integrity of the attribute, or loss of part of the attribute.
Major Adverse	Results in a loss of attribute and/or quality and integrity of the attribute

Significance Criteria

10.53 The assessment of potentially significant effects on receptors will consider the sensitivity of the receptor and the magnitude of change to determine significance, on a scale of high, medium, low and negligible, with impacts of moderate significance or greater considered to be significant, as denoted by the grey shading. This is summarised in

Table 10.3.

Table 10.3: Significance of Effects

		Sensitivity of Resource			
		High	Medium	Low	Negligible
Magnitude of Impact	Major	Major	Major	Moderate	Negligible
	Moderate	Major	Moderate	Minor to Moderate	Negligible
	Minor	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

Assumptions/Limitations

10.54 This assessment is based on available data from the Environment Agency, Yorkshire Water and the British Geological Survey (BGS). This accuracy of the information has not been verified.

10.55 The supporting fluvial hydraulic modelling is based on a theoretical simulation of potential flood events. It is underpinned by the Environment Agency's Upper Don hydraulic model, with the topographical survey of the Site, survey of the Mill Leat and site visit observations incorporated to support a site-specific assessment of flood risk. The purpose of the modelling exercise has been to produce a good representation of fluvial floodplain extents and flood risk mechanisms in and around the Site. It has not been designed to accurately map fluvial flooding in the wider catchments or flooding from other sources within the Site.

10.56 The pluvial modelling does not include a formal representation of the surface water runoff from minor watercourses and ditches within the hillsides, other than any captured by LiDAR DTM. This approach is considered conservative as the capacity and infiltration within the catchment is not considered.

10.57 The survey for the fluvial and pluvial models is based upon ground elevation data derived from digital elevation data (Light Detection and Ranging data, LiDAR). There are accuracy limitations associated with this data as LiDAR is reported to have a +/- 15cm (root mean square error) vertical accuracy across a 1m cell size.

10.58 Where LiDAR coverage is limited, OS NextMap DTM has been used. This is less accurate than LiDAR, but considered preferable to omitting the required data.

10.59 The hydrological estimation is based on best practice methodologies, and sensitivity tests have been carried out using appropriate parameters. The parameters have been validated using the equivalent design flow recorded downstream at the Rowell Bridge gauged catchment. A precautionary approach has been promoted as appropriate.

Consultation

10.60 A summary of the consultations undertaken is included as **Table 10.4**.

Table 10.4: Consultation

Consultee	Date and Time	Comments	Actions
Environment Agency	17th November 2015	Written review of the River Loxley hydraulic model included recommendations for improving how the hydrology is represented within the model.	Update model as identified.
Environment Agency	3rd February 2016, 11:00	Agreed the approach to be taken for the hydrology to be inputted into the model. EA confirmed that they consider the flood risk from the upstream, reservoir to be low. No requirement for the consideration of a breach scenario from a reservoir.	Obtain the latest available hydrology.
Sheffield City Council	21st October 2019, 14:30	Principally a discussion of the principle of development at this located, with limited focus on drainage and flood risk	N/A
Sheffield City Council	8th January 2020	Agreed broad principles of the proposed surface water and flood risk management strategies for the proposed development.	N/A
Environment Agency	Ongoing	Fluvial model submitted for review.	N/A
Yorkshire Water	Ongoing	Discussion about the capacity of the foul network in the vicinity of the site.	N/A

Baseline Conditions

10.61 Baseline conditions at the Site are outlined in the Flood Risk Assessment, and supporting hydraulic modelling, and Sustainable Drainage Statement, but a summary is provided below.

Hydrology

10.62 The existing Site comprises a combination of brownfield and greenfield portions; the latter principally comprises woodland areas at the periphery of the Site.

10.63 A topographical survey of the Site is available. This captures details of manholes across the Site, indicating that the developed proportion of the Site is positively drained. It is expected that the drainage infrastructure directs surface water flows to the River Loxley and, if that system were to be in a poor condition or overtop, flows would be directed overland to the River Loxley.

Water Quality

10.64 It is understood that surface water runoff leaving the Site is currently untreated. Whilst the Site was formerly used for industrial purposes, much of it is currently in a disused state. Some traffic does pass through the Site to the existing residential cottages and tenant businesses – which includes a garage.

10.65 The Site is positioned within the 'Loxley from Strines Dyke to River Don' surface water catchment, as defined by the Environment Agency's Catchment Data Explorer. This is designated as 'heavily modified'. In 2016, its overall water body status was 'Moderate', with its Ecological element rating as 'Moderate' and Chemical element rating as 'Good'.

Flood Risk

10.66 The nearest Environment Agency Main River is the River Loxley, which flows in a south-easterly direction through the Site. Within the Site, the channel bifurcates from the left bank of the River Loxley to form the Mill Leat. The Mill Leat flows into Mill Pond, and the outflow into several smaller channels is controlled by a number of weirs. The Mill Leat narrows downstream before flowing back into the River Loxley. The River Loxley's flow is regulated by a number of reservoirs upstream of the Site which include the Strines, Dale Dike, Agden, and Damflask Reservoirs. These in turn are operated by a network of flow control structures which include sluices, weirs and on-line storage ponds.

10.67 The Site is positioned across Flood Zones 1, 2 and 3. The Flood Zones are associated with the River Loxley. The majority of the Site is within Flood Zone 1, with the Flood Zone 2 and 3 extents positioned in the centre of the Site, associated with the River Loxley, Mill Leat and Mill Pond.

10.68 There are two ordinary watercourses, tributaries of the River Loxley, within the vicinity of the Site; the Skyehouse Brook outfalls into the River Loxley approximately 230m west of the Site and the Storrs Brook outfalls into the River Loxley on the eastern Site boundary.

10.69 There are anecdotal reports of the Site having flooded historically from pluvial and fluvial sources. Rapid surface water runoff from the valley sides is reported to have flowed through the Site on its way to the River Loxley. The Mill Pond and Leat have been observed to overtop into the existing developed areas of the site when the outflow weir from the Pond became blocked with debris. The River Loxley also flood the central developed area of the site when a bridge becomes blocked with debris. This local knowledge of the flooding mechanisms has informed the adopted methodology for assessing the flood risk at the Site: pluvial and fluvial hydraulic modelling. It has also help inform the proposed flood risk management strategy.

10.70 Fluvial hydraulic modelling of the River Loxley and Mill Leat shows the 1 in 20-year and 1 in 100-year events to stay within bank passed the areas of the Site currently developed. The central low-lying developed area immediately to the south of the Mill Pond is shown to be flooded from the River Loxley in events greater than 1 in 100-year. Additionally, in events greater than the 1 in 100-year, the Mill Pond and Mill Leat are shown to spill from its southern banks into the central developed area. This adds to the flooding already present from the Loxley.

10.71 Downstream of the developed areas within the Site, within the woodland, there are several minor channels which connect the Mill Leat with the Loxley. There is predicted to be extensive flooding in this area as flows are exchanged between the Mill Leat and the River Loxley. This flooding is not of great significance, as the area which is affected is undeveloped and is not proposed for redevelopment. However, the model does show there to be a flow route from the wetland area over Rowel Lane, which occurs at all simulated events.

10.72 Blockages of the bridges present on the River Loxley and Mill Leat have been assessed and have been shown to increase flood risk within the developed areas of the Site. This correlates with the observed historic flooding incident on the Site.

10.73 Pluvial hydraulic modelling of the valley has confirmed that there are a number of surface water flow routes present in the valley which flow through the site on their way to the River Loxley. Once the defined flows have descended the valley slopes into the site below, the surface water spreads out across the flatter, existing developed areas before entering the River Loxley. The Mill Pond/Leat are shown to intercept some of the runoff entering the site, but they are predicted to overtop into the development areas before entering the River Loxley, at events greater than the 1 in 100-year. The surface water flooding is shown to occur and dissipate rapidly, correlating with anecdotal reports.

10.74 Public sewer infrastructure near to the Site is limited. The nearest asset is positioned 530m northeast of the Site, and if the capacity of this were to fail flows would follow the local topography, away from the proposed development.

10.75 British Geological Survey mapping shows a proportion of the Site to be underlain by superficial deposits, which overlie the bedrock deposits. These are predominantly formed of alluvium, with boulder deposits recorded in the northern margins of the site further up the valley sides. This alluvium is potentially in continuity with the watercourses present within the site. Therefore, shallow groundwater could potentially pose a flood risk to the Site.

10.76 The three nearest canals to the Site are the Sheffield and Tinsley Canal, the Chesterfield Canal and the Sheffield and South Yorkshire Navigation Canal. Given the distance between these features and the Site, they are considered to pose a low risk.

10.77 The Site is in the failure zone of several reservoirs: the Agden, Dale Syke, Damflask and Strines. These reservoirs are operated and maintained by Yorkshire Water, who have ultimate responsibility for the safety of reservoir assets. Given the management regimes in place, risk from these waterbodies is considered to be low.

10.78 The Site is not considered to be at risk from coastal/tidal sources.

Geology / Hydrogeology

10.79 Online British Geological Survey (BGS) mapping shows the Site to be underlain by multiple geological formations: the Rosendale Formation (undifferentiated mudstones and siltstones), the Rough Rock Formation (sandstone) and the Pennine Lower Coal Measures Formation (undifferentiated siltstones and mudstones). The Environment Agency defines these bedrock geologies as Secondary A Aquifers.

10.80 Part of the northern portion of the Site is underlain by superficial deposits. There is a band of alluvium deposits broadly following the route of the River Loxley, with boulder deposits further to the north. These are also designated as Secondary A Aquifers.

10.81 The Site is not underlain by a Source Protection Zone.

10.82 The Site is positioned a designated ground water catchment, the 'Don & Rother Millstone Grit & Coal Measures'. This is identified to have a 'Poor' overall water body classification, with a 'Good' quantitative classification but 'Poor' chemical classification.

Ecological Designations

10.83 No ecological designations relevant to this Drainage and Flood Risk Chapter have been identified.

Sensitivity of Receptors

10.84 The following receptors to environmental impacts have been identified for the Proposed development and its construction:

- Site users and properties - considered to be of high value and high susceptibility to change.
- Surrounding properties and residents - considered to be of high value and susceptibility to change
- River Loxley – considered to be of high value and susceptibility to change
- Existing surface water drainage network - considered to be of medium value and susceptibility to change
- Groundwater - considered to be of medium value and susceptibility to change
- Public foul water sewer network - considered to be of medium value and susceptibility to change

Embedded Mitigation

10.85 Mitigation measures in accordance with national and local policy have been outlined in the supporting Flood Risk Assessment and Sustainable Drainage Statement. A summary of these measures is presented below.

Demolition and Construction

10.86 No embedded mitigation is proposed for the demolition and construction phase.

Completed Development

10.87 The Proposed Development is cited at least 8m from the River Loxley and 3m from the Mill Pond and Mill Leat, providing access for maintenance as per local and national requirements.

10.88 The Proposed Development is restricted to the existing developed proportion of the Site, thereby avoiding the areas of the Site at the highest flood risk.

10.89 Access routes through the Proposed Development will be set a minimum of 300mm above the design event flood level.

10.90 The finished floor levels of the new buildings will be set a minimum of 600mm above the design event flood level, and also above the flood level generated during a potential blockage of the bridge(s).

10.91 As the Mill Leat and Pond are elevated above the adjacent development parcels, finished levels in these areas cannot be elevated above the flood levels present in the Leat and Pond. Instead, it is proposed that the banks of the Leat and Pond are improved to create a barrier between the flood water and the development. This will include ensuring the structural integrity of the existing impoundment structure and raising of the bank levels to prevent overtopping flows entering the proposed development.

10.92 Where existing buildings are to be retained, water resilience measures will be implemented help minimise the consequence of a potential flood event, and to help in the recovery following a flood event.

10.93 It is proposed that interception ditches are created on the uphill side of the development, intercepting flows from the valley side and safely routing them around the proposed development and into the River Loxley.

10.94 Three out of the four existing bridges over the River Loxley will be removed and replaced with two new vehicular bridges and two new pedestrian and cycle bridges, that will clear span the channel and provide dry access/egress above the design flood event. It is proposed that the one bridge structure retained as part of the development will serve pedestrians and bicycles. The existing culvert on the Mill Leat will also be upgraded to facilitate vehicular access.

10.95 An appropriate floodplain compensation strategy will be implemented to ensure that no detrimental impacts occur to third party land. This will either be achieved by allowing new areas of floodplain to form naturally within the un-developed areas of the wider Site, or through the design of a formal floodplain compensation area in the river corridor. Both options have been assessed in the hydraulic model and shown to result in no third-party detriment. The specifics of the approach are to be determined at the detailed design stage.

10.96 The development has been arranged such that it is generally located only on brownfield areas. The development will result in a net reduction in impermeable areas, naturally altering the Site's surface water runoff regime, reducing the rate and volume of water. This will naturally provide some mitigation in terms of a reduction in runoff rates and volumes via the introduction and landscaped and garden areas.

10.97 Additionally, there will be an engineered alteration in the rate of runoff due to the implementation of a surface water drainage strategy. It is proposed that a 30% betterment over existing runoff rates from the Site is provided post development. Water will be directed to the River Loxley, as currently, via multiple points of discharge.

10.98 Water will be attenuated on Site prior to discharge, with storage provided up to the 1 in 100-year event including an allowance for climate change. Storage will be provided above ground where necessary, supplemented by underground storage where necessary. Appropriate Sustainable Drainage Systems (SuDS) will be provided on Site to provide treatment prior to discharge.

10.99 It is proposed that foul water is ultimately directed to the foul water network, which will alter the existing foul water drainage regime on the site. Appropriate pumping station(s) should be provided on Site. Additional

information on the foul water strategy at the Site area is subject to further correspondence from Yorkshire Water, which is on-going at the time of writing.

Potential Impacts

Demolition and Construction

10.100 The potential impacts from the demolition and construction phase are generally considered to be short to medium term in length.

10.101 The use of heavy machinery on the parcels during the construction phase is likely to compact the soil, although given the current brownfield nature of the site, this will be limited. This can reduce infiltration rates; the movement of construction traffic could disturb the upper portions of the ground, leading to compaction, altering the degree of surface water infiltration. A reduction in infiltration rates may increase the volume and rate of runoff into local watercourses. The effect is considered to be **minor adverse**.

10.102 Suspended soils are one of the most common causes of water pollution from construction sites. They emanate from excavations; exposed ground or stockpiles; plant and wheel washing; build-up of dust and mud on roads; or pumping or contaminated surface waters or groundwater accumulated on the Site. Extreme rainfall events could exacerbate runoff rates and the mobilisation of suspended solids has the potential to affect ecological habitats, impact on the ecological and chemical quality of watercourses, block watercourses and alter flow regimes. Prior to mitigation, runoff containing suspended soils from construction work would have a **moderate adverse** effect on the watercourses in the vicinity of the Site.

10.103 Concrete production taking place on the Site or introduced by ready-mix lorries could cause small particulates to settle in the surrounding area. Wastewater from the batching plant or washing down of lorries/mixing areas could cause particulates to runoff into local watercourses, influencing the chemical quality. This is considered to be **moderate adverse** prior to mitigation.

10.104 Oil, diesel and petrol are common construction site pollutants, caused by either spillages from fuel stored on the Site or vehicles operating during the construction phase. Upon entering a watercourse, hydrocarbons could lead to the build-up of a film on the surface of the water, impacting on the oxygen content and influencing the aquatic ecosystem. Hydrocarbons may impact on the ecological and chemical quality of local watercourses and groundwater and, prior to mitigation, are considered to have a **moderate adverse** effect.

10.105 The uncontrolled release of substances such as solvents, cleaning agents, paints and other chemicals, liquids or solids could lead to further pollution. These could become a hazard if used in the construction process or stored on the Site. These substances can be of high toxicity, thereby having a **moderate adverse** effect on nearby watercourses.

10.106 Due to the size of the development, there will be a heavy presence of construction staff during the development phase. There should be welfare facilities requiring sewage waste disposal, but this is considered to have a **negligible** effect.

Completed Development

10.107 The effects associated with the operation phase of the development are considered to be long term in length. The proposed impacts plus their potential impacts are detailed below, prior to mitigation.

10.108 There is potential for site users and properties to be impacted by the development, due to a potential change in flood risk from the River Loxley as a result of the development. This is considered to be a **major adverse** effect prior to mitigation. However, this will be addressed via the raising of finished floor levels, implementation of appropriately designed bridges, works to increase the capacity of the Mill Pond and Mill Leat. Moreover, the use of interception ditches will safely route flows around the development. Therefore, the effect post mitigation will be negligible.

10.109 Hydraulic modelling has confirmed there will be no change in flood risk to third parties as a result of the development. Therefore, the effect is **negligible**.

10.110 There is potential for the implications on the existing surface water drainage network to be **moderate adverse**, given the potential changes in the rate and quality of runoff leaving the site. Post mitigation, changes to the existing surface water drainage regime will be negligible as there is to be an appropriately designed surface water drainage strategy. This includes the provision of a 30% betterment over runoff rates from the site and the use of SuDS to provide a suitable level of treatment to water.

10.111 There is potential for the development to reduce the rate and quality of groundwater from the site, considered to be a **moderate adverse** effect. However, the surface water drainage strategy will also provide some mitigation for ground water.

10.112 The development will result in an increase in foul water flows to the local sewer network, which is a **moderate adverse** effect. Discussions with Yorkshire Water to establish whether any reinforcement works are required within the network, and appropriate provision for a foul water pumping station has been made on the site.

Mitigation Measures

10.113 The mitigation measures outlined below should be considered alongside the 'Embedded Mitigation' measures detailed above. The measures outlined below are in addition to these.

Demolition and Construction

10.114 It is recommended that a phased approach is adopted for the construction works, with mitigation measures for the operational phase, such as the drainage system, being constructed as a priority to ensure adequate treatment prior to water leaving the Site.

10.115 It is recommended that a detailed Construction Environment Management Plan (CEMP) is prepared which will set out detailed methodologies and monitoring requirements of the measures below to prevent adverse effects on the water environment.

10.116 Construction site security should be considered to reduce potential vandalism which may result in contaminants reaching the water environment.

10.117 The erosion of exposed topsoil (including the erosion of stockpiled materials), caused by either wind or rain, is one of the primary sources of suspended solids and other contaminants. As a result, large areas of exposed topsoil or similar materials should be contained and covered/watered down where possible and when not in use.

10.118 Wheel washing facilities and/or regular sweeping will ensure the build-up of dust and silts on haul roads will be kept to a minimum. Wheel washing facilities should be kept in a designated bunded impermeable area and surplus surface water disposed via the foul water system or adequately treated prior to discharge into a local watercourse. These facilities should be located at least 10m from any surface waterbody and away from the areas identified to be at high risk of flooding.

10.119 Concrete should be mixed off site where possible. Should this not be practical, wastewater from concrete production/wastewater from lorry washing should be limited to a designated area, to be bunded over an impermeable surface to prevent runoff/infiltration elsewhere. Wastewater should either be directed into the foul sewer network or adequately treated prior to discharging into a watercourse.

10.120 To avoid hydrocarbons reaching the water environment from vehicles or the accidental spillage of fuels, vehicles used on the Site should be regularly inspected and maintained to reduce the risk of oil/fuel leakages. Vehicle wash-down areas should be at least 10m from surface water bodies, away from the areas identified to be at high risk of flooding, and take place at bunded areas over impermeable surfacing, with runoff routed through oil interceptors and treated before discharge.

10.121 On-site refuelling activities should be undertaken in a bunded area over impermeable surfaces to prevent runoff and infiltration. Although revoked, the Environment Agency's Pollution Prevention Guidance provide a useful recommendation on best practice, including the regular testing of storage tanks and pipes. Surface water from such areas should be routed through an oil separator prior to disposal.

10.122 Where oils or fuels are stored in bulk quantities on site, the storage facilities should be suitable for above ground oil storage tanks.

10.123 Drip trays under vehicles should be used where appropriate, allowing oil to be collected and contained.

10.124 To reduce the impact that soil compaction may have on surface water rates, the movement of larger vehicles around the Site should be restricted by creating designated pathways, reducing the area impacted.

10.125 Sediment loading within the nearby watercourses should be monitored during construction, in order that additional mitigation measures can be implemented if necessary.

10.126 Guidance on best practice when working near watercourses should be followed, particularly during the bridge construction phase.

10.127 To mitigate the additional loads from construction staff, connections to the public sewers from welfare facilities should be controlled by sewer connection notices to the sewerage undertaker, Yorkshire Water.

Completed Development

10.128 Appropriate foul water pumping stations will be accommodated within the development. Adequate provision is made for this within the masterplan. Further consultation with Yorkshire Water is ongoing and will confirm whether reinforcement works are required to provide sufficient capacity within the system.

Residual Impacts

Table 10.5: Residual Effects Summary

Description of Effect	Potential effect including significance	Mitigation	Residual Effect including significance
Construction and Demolition			
Existing surface water drainage network - compaction of soil due to heavy machinery	Minor adverse, medium susceptibility	Detailed Construction Environment Management Plan (CEMP)	Negligible
Existing surface water drainage network - water pollution emanating from suspended soils	Moderate adverse, medium susceptibility	Detailed Construction Environment Management Plan (CEMP)	Negligible
Existing surface water drainage network - small particulates from concrete pollution of ready-mix lorries	Moderate adverse, medium susceptibility	Detailed Construction Environment Management Plan (CEMP)	Negligible
Existing surface water drainage network - pollution from hydrocarbons or high toxicity substances	Moderate adverse, medium susceptibility	Detailed Construction Environment Management Plan (CEMP)	Negligible
Welfare facilities requiring sewerage waste disposal	Negligible	-	-
Completed Development			
Site users and properties - change in flood risk from the River Loxley	Major adverse, high susceptibility	Raising of finished floor levels; recommended clearing of channels and bridges to clear silts and debris; increasing the capacity of the Mill Pond and Mill Leat;	Negligible

Surrounding properties and residents - change in flood risk to third parties	Negligible	None required – hydraulic modelling has confirmed that there are no off-site impacts because the floodplain lost to the development can be accommodated within the wider ownership	Negligible
Site users and properties - Interruption of existing pluvial flow routes from the valley sides	Moderate adverse, high susceptibility	Implementation of interception ditches to safely route flows around the development	Negligible
Existing surface water drainage network - change in the rate and volume of surface water runoff leaving the site	Moderate adverse, medium susceptibility	Provision of a 30% betterment in runoff rates from the site and provision of on-site storage up to and include the 100-year plus climate change event.	Minor Beneficial
Existing surface water drainage network – change in the quality of discharge to surface receptors	Moderate adverse, medium susceptibility	Implementation of SuDS to provide appropriate treatment to water.	Minor Beneficial
Groundwater - change in the rate and volume of ground water infiltrating to underlying aquifers	Moderate adverse, medium susceptibility	Implementation of SuDS to provide appropriate treatment to water.	Negligible
Groundwater - change in the quality of discharge to ground water receptors	Moderate adverse, medium susceptibility	Implementation of SuDS to provide appropriate treatment to water.	Negligible
Public foul sewer network - increase in the foul water discharge from the site	Moderate adverse, medium susceptibility	Provision of on-site pumping stations; consultation to ascertain appropriate network reinforcement works are on-going.	Negligible

Conclusions

10.129 The ES Chapter is underpinned by a Flood Risk Assessment, in turn supported by fluvial and pluvial hydraulic modelling, and a Sustainable Drainage Statement. These documents have been produced in accordance with local and national policy and best practice, noting the identified assessment assumptions and limitations.

10.130 Where possible, the DMRB methodology has been used to inform the assessment, albeit with appropriate amendments where necessary. Through consideration of a resource's sensitivity and the expected magnitude of change, the potential impacts arising from both the demolition and construction phase and operational phase of the development have been identified. For the purposes of this assessment, these have been identified as having an expected short to medium term influence and long-term influence respectively.

10.131 The following potential Drainage and Flood Risk receptors have been identified within this ES Chapter: site users and properties; surrounding properties and residents; the River Loxley; the existing surface water drainage network; groundwater and the public foul water sewer network. These have been considered in detail, drawing on the current baseline conditions, and identifying the potential impacts which may arise from the proposed development.

10.132 In response, this ES Chapter outlines two forms of mitigation. 'Embedded Mitigation' is required to meet the requirements identified through local and national policy. In the context of Drainage and Flood Risk, these measures are generally evident within the development proposals and associated technical reports; for example, elevated development levels, interception ditches, floodplain compensation and appropriate foul and surface water drainage provision can be accommodated within the development proposals. Further mitigation measures are then identified to address other potential impacts which may arise from the proposed development, but generally combatted through appropriate construction and site management practices.

10.133 Overall, it is considered that any residual effects in the context of Drainage and Flood Risk will be negligible or minor beneficial following the implementation of the appropriate mitigation measures, as outlined in this ES Chapter. This is because the implementation of appropriate mitigation measures will reduce the adverse effect of the development.

Other Information

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