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Quality Assurance Record

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Limitation of Liability and Use

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1. INTRODUCTION

1.1 Purpose of this Report

Townsend Water Engineering Ltd. has been appointed by Partner Construction Ltd./ Torus 62 Ltd. for a Flood Risk Assessment (FRA) for the development of 88 residential dwellings with associated landscaping and access roads (Grid Ref: 346095, 392048). This report has been prepared in support of the planning permission for the aforementioned development.

The report is based on the available flood risk information for the site detailed in Section 1.2 and prepared in accordance with the planning policy requirements set out in Section 1.3. The scope of the FRA is consistent with the 'Site Specific Flood Risk Assessment Checklist' from the *National Planning Policy Framework (NPPF)* and *accompanying Planning Practice Guidance (PPG)*:

<https://www.gov.uk/guidance/flood-risk-and-coastal-change#Site-Specific-Flood-Risk-Assessment-checklist-section>

It is also in accordance with Policy CS24 (Managing Flood Risk) of the Knowsley Local Plan Core Strategy (2016)

1.2 Sources of Information and Consultation

This Report has been informed by:

- Existing Site Plan drawings and respective topographic plan delivered by *United Living*;
- The *EA* online flood maps;
- <https://flood-map-for-planning.service.gov.uk/>;
- <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>;
- [Knowsley-Sustainable-Drainage-Completing-your-Pro-Forma-Feb-2019.pdf](#) ; and
- *EP3* Phase I & II Geo-environmental Report, February 2021.

1.3 Policy Context

This report has been prepared in accordance with the relevant national, regional and local planning policy and statutory guidance as follows:

- National policy contained within the *National Planning Policy Framework (NPPF)* dated July 2021, issued by Communities and Local Government with reference to Section 14 'Meeting the challenge of climate change, flooding and coastal change'; and
- The Planning Practice Guidance (PPG) released in March 2014 ('Flood Risk and Coastal Change' section) and updated in February 2016 to incorporate the *EA 'Flood Risk Assessments: Climate Change Allowances'* guidance;
- Knowsley Local Plan Core Strategy (2016).

1.4 Structure of this Report

The Report has been prepared based on the following structure:

- Section 2 refers to spatial planning considerations by reference to the proposed land use, flood zoning and *NPPF* vulnerability;
- Section 3 presents the assessment of existing flood risk at the site;
- Section 4 presents the proposed development and findings of flooding;
- Section 5 presents the drainage strategy (Undertaken by *REFA*); and
- Section 6 provides a summary of the assessments.

Additional Appendices are provided that deal with the following:

- Appendix A: Topographical Survey;
- Appendix B: EP3 Geo-Environmental Site Assessment;
- Appendix C: Environment Agency Levels
- Appendix D: Sewer Maps
- Appendix E: Location Plan;
- Appendix F: *REFA* Drainage Strategy; and

2. SPATIAL PLANNING CONSIDERATION

2.1 Location and Background

The location of the proposed development site is shown in Figure 1 and Figure 2, with location details found in Table 1. The site is located at Carr Lane, Prescott, Huyton, Knowsley, Liverpool City Region, L34 1AX (Grid Ref: 346095, 392048). (Table 1: Site Details). The site is a greenfield site.

The development involves the building of 88 residential dwellings. The entire development site is approximately 2.31ha and is currently a field.

Prescot Brook runs along the site's Western boundary, *Prescot Brook* is a main river under the Flood and Water Management Act 2012. Therefore, any works within 8m of the top of bank or toe of the landward side of the river defence will require a flood permit from the *Environment Agency*.

To the North of the site is *Carr Lane*, further North are fields. To the East is a public right of way, then a residential area. To the South is the M57, followed by fields. To the West of the site is the main river *Prescot Brook*, further to that is a pond called *The Fishing Pond*; *The Carr Lane Woods* surrounds the pond to the West of the site.

Please see Figure 1 and Figure 2 indicating these features.

Table 1: Site Details

Reference	Value
OS X (Easting)	346095
OS Y (Northing)	392048
Nearest Post Code	L34 1NS
Nat. Grid	SJ460920

Grid reference details taken from the site Grid Reference Finder



Figure 1: Site Location (Source: Bing Ordnance Survey Map)



Figure 2: Aerial View of the Site (Source: Grid Reference Finder)

2.2 Topography

The existing ground elevations on site is shown in the topographic drawing (Appendix A). It indicates that the ground falls from East to West, towards the watercourse *Prescot Brook*. Ground levels range between 45.23mAOD in the East to 38.66mAOD in the West.

Please see Figure 3 below.

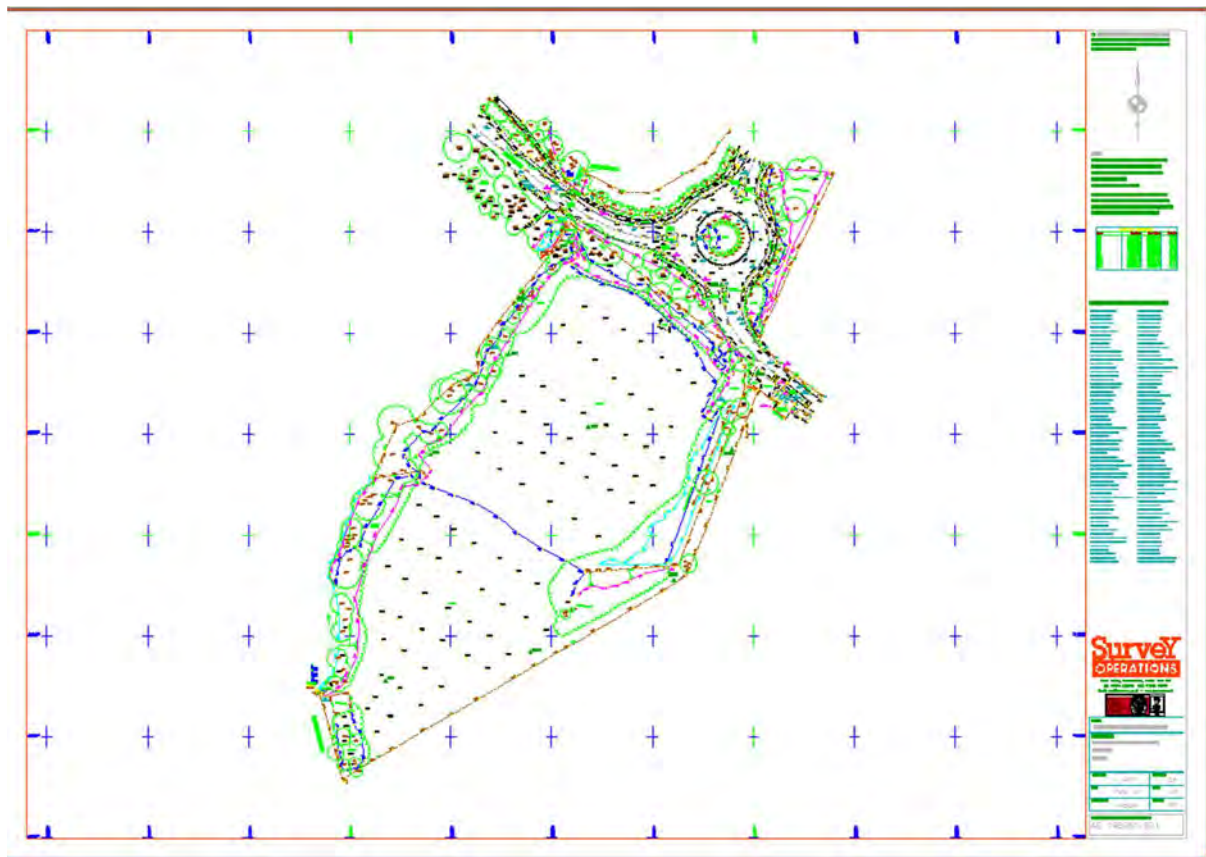


Figure 3: Topographical Survey (Source: United Living)

2.3 Geology and Soil

The geology at the site has been obtained from the *British Geological Survey* (BGS) website. The bedrock beneath the site is described as '*Pennine Lower Coal Measures Formation - Mudstone, siltstone and sandstone*' (Figure 4: Bedrock underneath the Site (Source: BGS Bedrock Geology Mapping)). The superficial deposits are described as '*Till, Devensian - Diamicton*'.

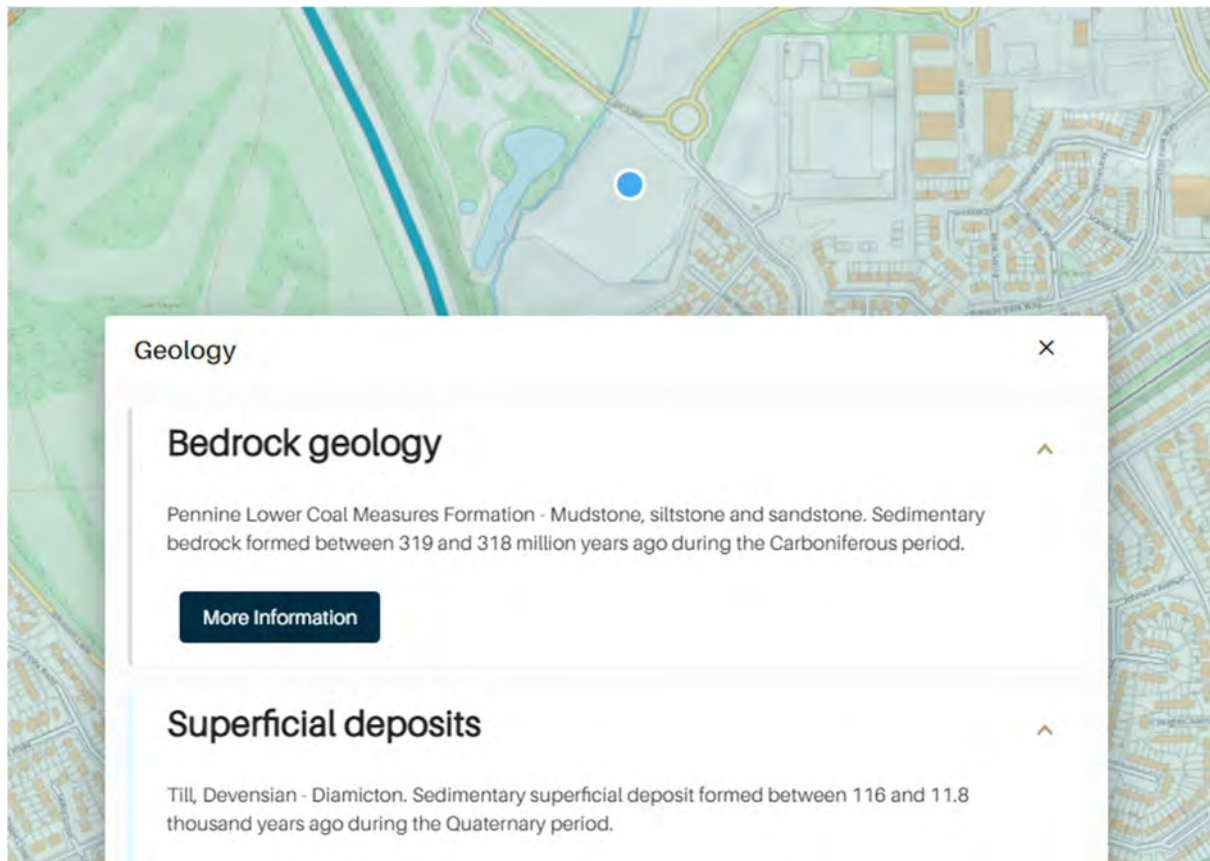


Figure 4: Bedrock underneath the Site (Source: BGS Bedrock Geology Mapping)

Soils at the site are described on the *Cranfield University 'Soilscapes'* website mostly as, '*Slightly acid, loamy and clayey soils with impeded drainage*' (Figure 4). This suggest that the site is likely to be unsuitable for infiltration.

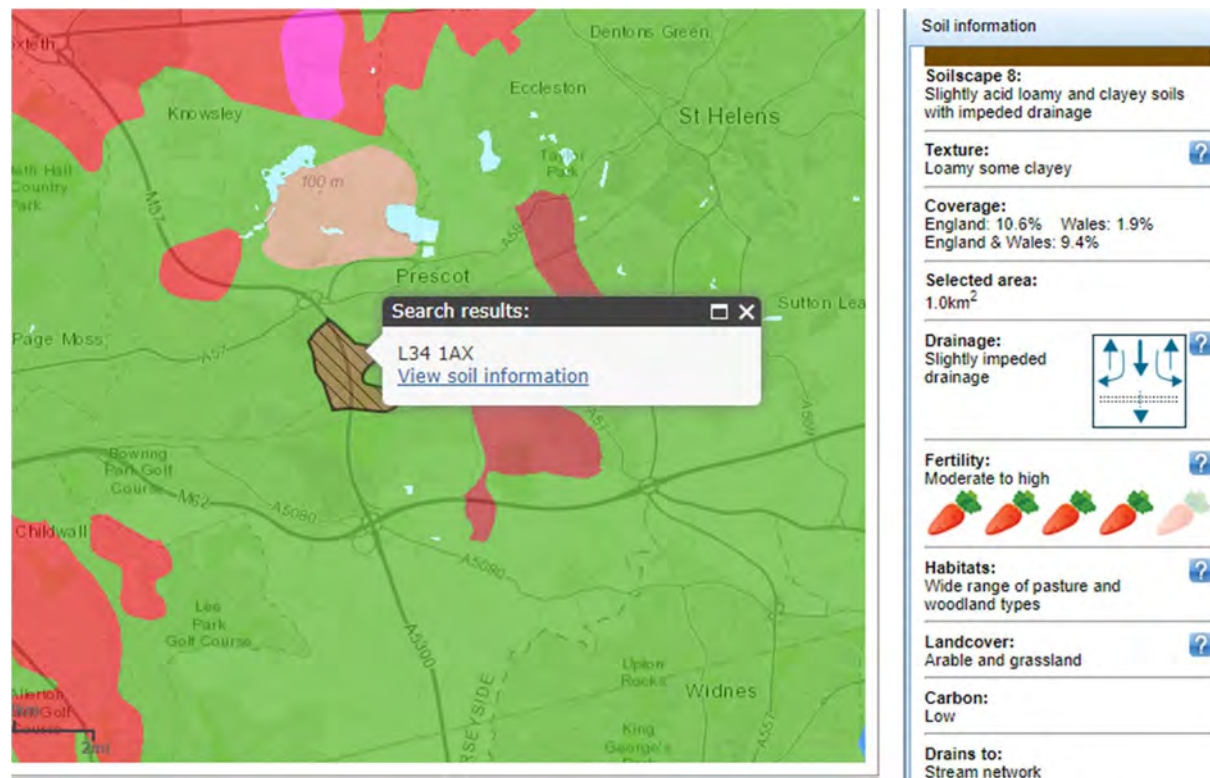


Figure 5: Soil Map of the Site (Source: Cranfield University Soil Mapping)

In February 2021 EP3 Published A 'Phase I and II Geoenvironmental Site Assessment' for Carr Lane, Prescott (Reference:14-245-R1). 'Made ground' was encountered throughout the site.

Soakaway tests were undertaken over a 48-hour period within trial pits SA101–SA104; the ground did not infiltrate.

Therefore, infiltration is not suitable for this site due to the failure of the soakaway testing. Please see Figure 6 and Figure 7 below (an extract of the Geo-environmental report can be found in appendix B).

TABLE 8.3 SUMMARY VISUAL AND OLFACTORY EVIDENCE OF CONTAMINATION

LOCATION	DEPTH (m)	STRATUM	NOTES
TP102	1.90	Made Ground	Organic odour
TP104	0.70	Made Ground	Ash and clinker
TP105	2.80	Made Ground	Ash and clinker
TP106/SA104	1.20	Made Ground	Slight hydrocarbon odour
TP107	0.50	Made Ground	Ash and clinker
TP110	2.00	Made Ground	Slight hydrocarbon odour
TP111	0.50	Made Ground	Ash and clinker
TP112	1.40	Made Ground	Ash and clinker
TP114	0.70	Made Ground	Ash and clinker
TP120	0.70	Made Ground	Ash and clinker
TP121	0.00	Made Ground	Ash
TP121	2.00	Made Ground	Hydrocarbon odour
TP122	0.00	Made Ground	Ash and clinker
TP122	0.50	Made Ground	Menthol odour
TP123	0.00	Made Ground	Ash and clinker
WS101	0.00	Made Ground	Ash and clinker
WS102	1.50	Made Ground	Ash and clinker
WS103	0.00	Made Ground	Ash
WS106	0.00	Made Ground	Ash and clinker
WS108	0.50	Made Ground	Ash and clinker
WS109	0.00	Made Ground	Ash and clinker and foul odour
WS110	0.00	Made Ground	Ash and clinker
WS111	2.50	Made Ground	Ash and clinker
WS112	0.00	Made Ground	Ash and clinker

Figure 6: EP3 Geo-environmental Report Extract (Evidence of Ground Contamination)

TABLE 8.8 BRE365 SOAKAWAY TESTING RESULTS

LOCATION	DEPTH (m)	MATERIAL	TEST No.	SOIL INFILTRATION RATE (m/s)
TP101/SA101	3.00	sandy CLAY	1	N/A
TP103/SA102	2.10	MADE GROUND: Gravelly sand	1	N/A
TP104/SA103	3.10	MADE GROUND: Gravelly sand	1	2.71E-02**
TP106/SA104	3.20	silty SAND	1	N/A

**Due to the significant depths of Made Ground through the site SA103 was completed within the Made Ground stratum – Whilst granular Made Ground can be used to support SUDS careful consideration of the chemical nature of the soils and the site controlled waters sensitivity should be carefully considered in any design.

Figure 7: EP3 Geo-environmental Report BRE365 Soakaway Testing Results

2.4 Flood Zone

The existing site is mostly within a Flood Zone 1, please see Figure 8 below. Flood Zone 1 is an area with a less than a 0.1% chance of flooding (1 in 1000 year event plus climate change). Parts of the site are in Flood Zone 2 & 3, however, these areas run along the Western boundary, following the watercourse *Prescot Brook*. The proposed development will be built within the Flood Zone 1 areas, therefore, the proposed development is at low risk of flooding.

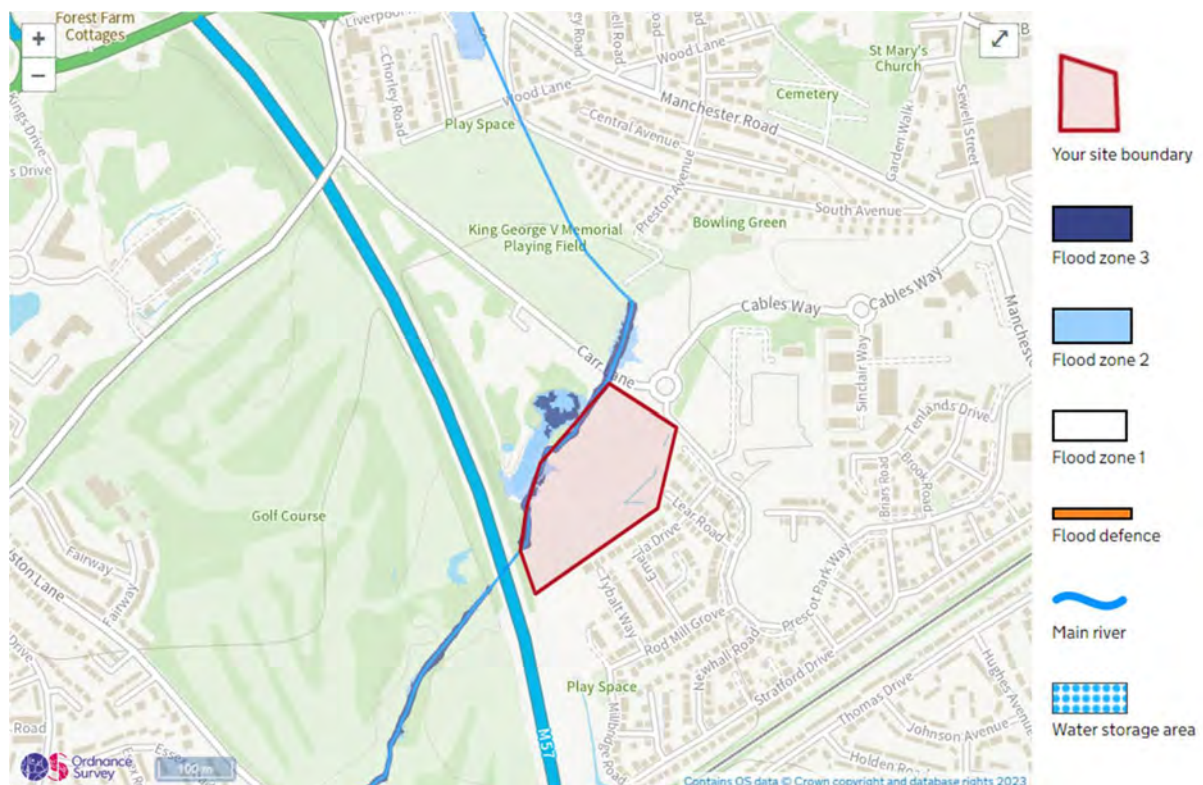


Figure 8: Flood Risk Maps

The existing site has areas at a medium to high risk of surface water flooding. However, when reviewing the topographical survey, the areas indicated to have medium to high levels of flooding are not low points in the topography. This suggests that in high rainfall events, water will not collect here. Please see Figure 9 below. Therefore, we believe the site is at low risk of surface water flooding.

There will be a decrease in surface water flooding with the planned installation of the drainage infrastructure.



Figure 9: Flood Risk Maps: Surface Water

2.5 NPPF Vulnerability

Table 3:Flood Risk Vulnerability and flood zone compatibility (Source NPPF Technical Guide). As noted in Section 2.4, the proposed development is within Flood Zone 1, protected according to the EA flood risk map for planning.

Table 2:Flood Risk Vulnerability Classification (Source: NPPF Technical Guide)

More vulnerable (MV)
Hospitals, residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels
Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
Non-residential uses for health services, nurseries and educational establishments.
Landfill and sites used for waste management facilities for hazardous waste.
Sites used for holiday or short let caravans and camping, subject to a specific warning and evacuation plan.

Table 3:Flood Risk Vulnerability and flood zone compatibility (Source NPPF Technical Guide)

Flood Zone	Definition	Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
1	$T > 1,000$	✓	✓	✓	✓	✓
2	$100 < T_{fluv} < 1,000$ $200 < T_{tidal} < 1,000$	✓	✓	Exc. Test	✓	✓
3a	$T_{fluv} < 100$ $T_{tidal} < 200$	Exc. Test	✓	✗	Exc. Test	✓
3b (functional floodplain)	$T_{fluv} < 20$	Exc. Test	✓	✗	✗	✗

Table 3:Flood Risk Vulnerability and flood zone compatibility (Source NPPF Technical Guide).

2.6 Climate Change Allowances for Peak Rainfall Intensity

The *Environment Agency* and *NPPF* require a consideration of the impacts of climate change in Flood Risk Assessments (FRA). In May 2022, the *Environment Agency* updated the climate change allowances required in Flood Risk Assessments (*Environment Agency*, 2022); this advice updates previous climate change allowances to support the *NPPF* (DCLG, 2021).

Figure 10 shows anticipated changes in small catchments, recommending a progressive increase, reaching 45% for the 'Upper End' allowance by 2070. This allowance would be recommended for this proposed development, which is classified as 'More Vulnerable' and has been taken to have a 100-year design life. The 45% climate change allowance is based on the 90th percentile, meaning that there is a 90% chance that rainfall will not increase by more than the 45% increment.

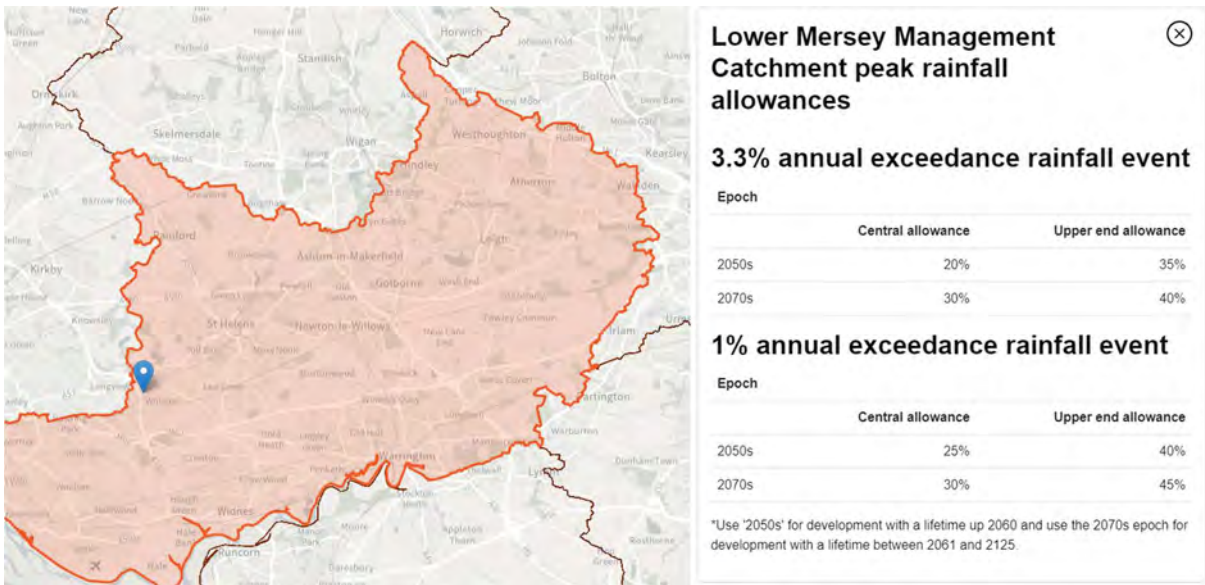


Figure 10: Peak Rainfall Climate Change Allowances

2.7 Climate Change Allowances for Peak River Flow

The river flow guidance recommends a progressive increase, reaching 44% for the ‘Central’ allowance by 2080 in this area. This allowance would be recommended for this proposed development, which is classified as ‘More Vulnerable’ and has been taken to have a 100-year design life. The 44% climate change allowance is based on the 90th percentile, meaning that there is a 90% chance that rainfall will not increase by more than the 44% increment. Please see Figure 11 below.

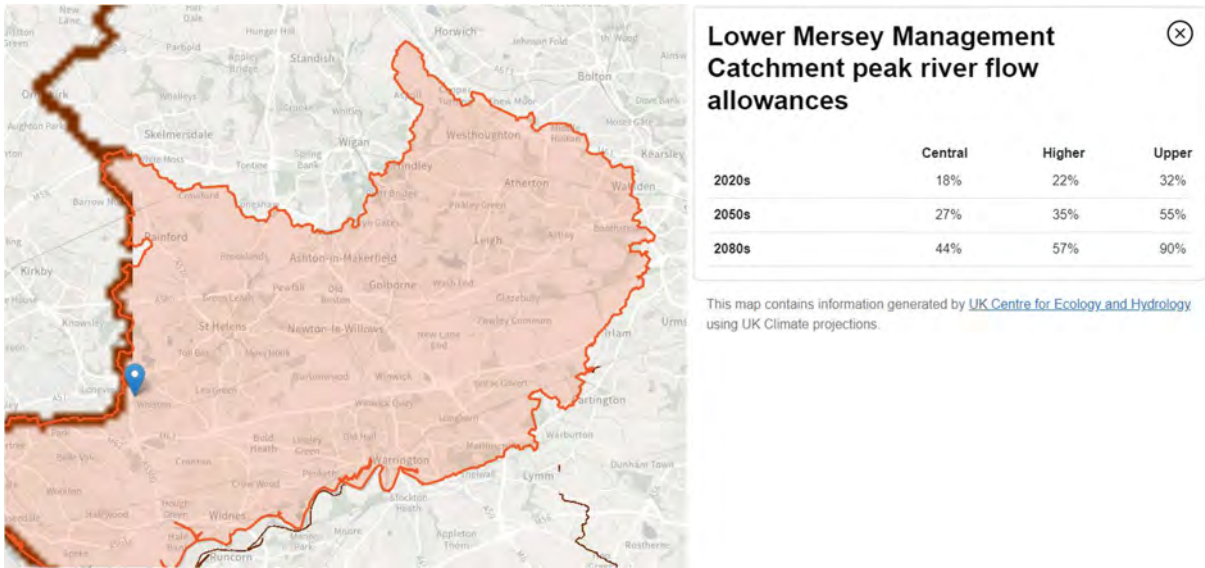


Figure 11: Peak River flow Climate Change Allowances

3. FLOOD HAZARD FOR EXISTING SITE

3.1 Source of Flood Risk

Flood sources and their possibilities at the site are further described below.

3.1.1 Flood Risk from Fluvial Sources

The proposed development is within a Flood Zone 1. *Prescot Brook* is to the West of the site. An embankment lies along the North-West boundary of the site between the site area and *Prescot Brook*. Levels on the top of the embankment range between 42.8m and 43.1m AOD. *Prescot Brook* levels are shown between 41.0m to 41.8m AOD. This means that *Prescot Brook* is approximately 1m lower than the site. Therefore, the proposed development is considered to be at low risk of fluvial flooding. Please see in appendix C the full results.

3.1.2 Prescot Brook Flood Levels

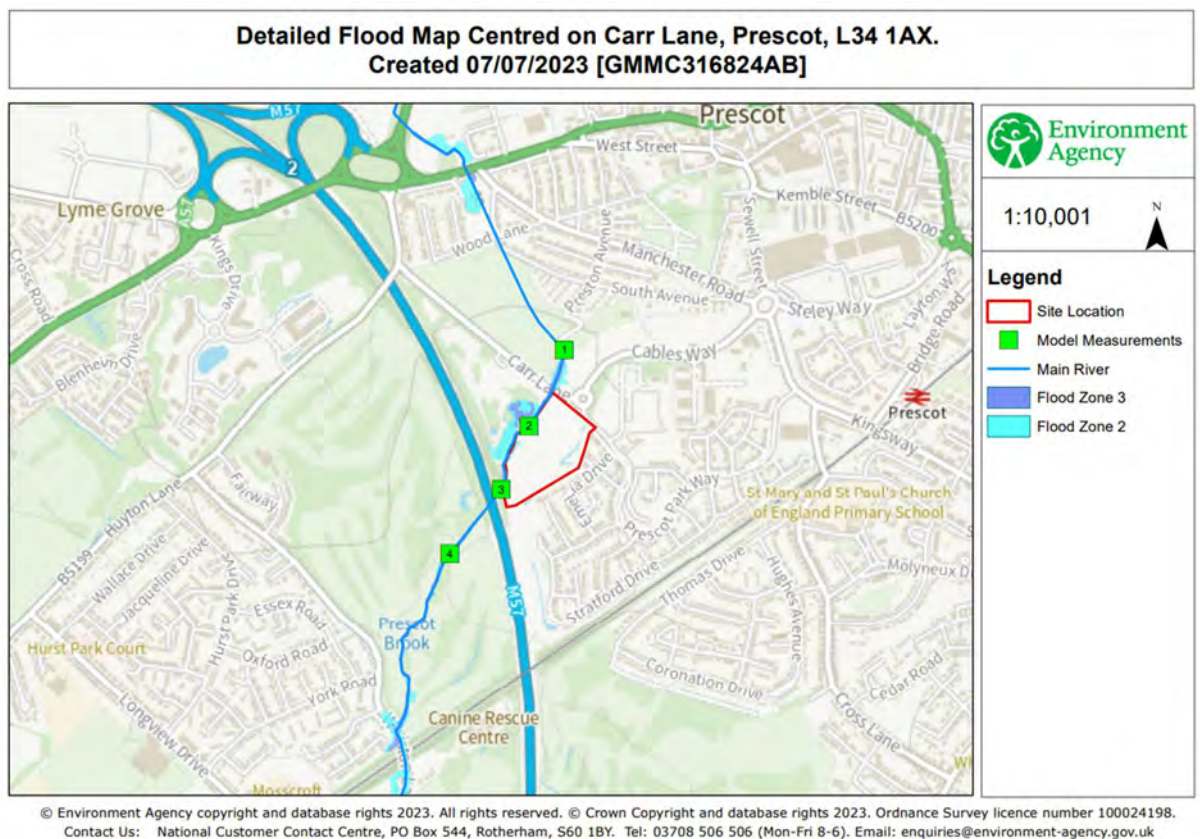


Figure 12: EA Flood Map for Prescot Brook

The points that are affecting the site are points 2 and 3 from the *Prescot Brook* model, which is shown above in Figure 12.

Table 4: EA Flood Level for Prescott Brook

Points Taken From Prescott Brook Model Supplied by EA	EA Flood Levels (1 in 100yr +35%) (mAOD)	EA Flood Levels (1 in 100yr plus 70%CC) (mAOD)	EA Flood Levels (1 in 1000yr) (mAOD)
2	40.35	40.42	40.42
3	39.75	39.87	39.89

The 1 in 1000 year flood levels have been compared to the proposed developments topographical levels, the topographical levels in this area of the proposed development are all above 41.3mAOD, while the highest flood level for this area in the 1 in 1000 year event is 40.42mAOD (point 2 from Table 4 above). Therefore, the topographical levels are higher than the flood levels. In conclusion, the proposed development is *outside* of the 1 in 1000 year fluvial flooding event for *Prescott Brook*.

The 1 in 100 year fluvial plus 70% climate change is 40.42mAOD with a further 600mm for freeboard the level would be 41.02mAOD. The minimum finished floor level of the houses is 42.80mAOD which is above 41.3mAOD therefore the houses and development are outside of the 1 in 100 year event plus climate change plus freeboard as well.

3.1.3 Surface Water

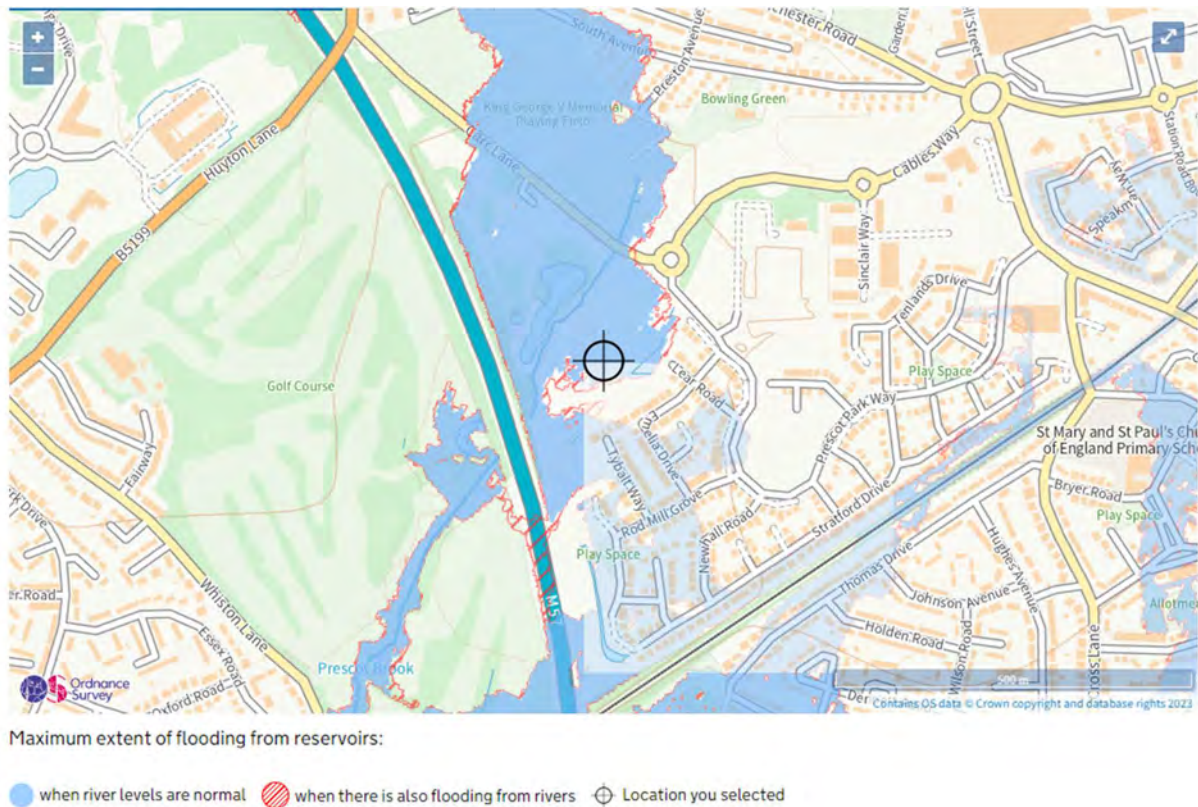
The site has areas of medium to high of surface water flooding according to the Surface Water Flood Map. However, when reviewing the topographical survey, the areas indicated to have medium to high levels of flooding are not low points in the topography. This suggests that in high rainfall events, water will not collect here. Therefore, we believe the site is at low risk of surface water flooding.

There will be a decrease in surface water flooding with the planned installation of the drainage infrastructure. Please see Figure 9.

3.1.4 Flood Risk from Reservoir /Canals / Other Artificial Sources

The EA Extent of Flooding from Reservoirs map (Figure 13:Extent of Flooding from Reservoirs (Source; EA Flood Warning Information Service)), based only on large reservoirs (over 25,000 m³ of water), shows that the site is not as risk of flooding from reservoirs. Flooding from reservoir is considered to be extremely unlikely and the risk of flooding to the site considered to be low.

There is no flood risk from canals and other artificial sources as there are no canals or other artificial sources within the vicinity of the site.



3.1.5 Flood Risk from Groundwater

According to the EP3 'Phase I & II Geo-environmental Site Assessment', groundwater was encountered between 1mbg and 4mbg. Please see Figure 14 below.

8.6. GROUNDWATER

Groundwater strikes were encountered as seepages. The depth of the seepages are shown on the exploratory hole records in Appendix V and are summarised in Table 8.2.

TABLE 8.2 SUMMARY GROUNDWATER STRIKES

LOCATION	DEPTH TO STRIKE (m)	NOTES
TP101/SA101	1.00	Slow seepage
TP102	2.50	Rapid ingress
WS104/TP105	4.00	Slow seepage
TP112	1.90	Slow seepage
TP114	1.40	Rapid ingress
TP115	2.00	Moderate seepage
TP117	1.60	Rapid ingress
WS101	2.00	Perched at base of MG
WS102	2.00	Perched at base of MG
WS103	2.00	Perched above cohesive stratum
WS105	3.00	Perched in cohesive stratum
WS106	1.00	Perched in MG
WS108	3.00	Perched in cohesive stratum
WS110	4.00	Perched above cohesive stratum
WS111	3.00	Perched above cohesive stratum
CP101	3.00	Perched above cohesive stratum
CP102	3.50	Perched above cohesive stratum
CP103	3.60	Perched above cohesive stratum

Monitoring was undertaken using an electronic dip meter and interface probe to record the depth to groundwater and the thickness of any free-phase hydrocarbon product, if present. These results are summarised in Table 8.12.

Figure 14: EP3 Geo-environmental Reports Summary of Groundwater Strikes

The risk of groundwater flooding is 1m below ground level for this site. None of the proposed buildings will have basements and therefore the risk of groundwater flooding to the site is believed to be low.

3.1.6 Flood Risk from Sewers

According to *United Utilities* sewer maps, there is a combined sewer running along the sites Western boundary, flowing South. There is also an abandoned public sewer running along the sites Eastern boundary, crossing the Northern area of the site from East to West. Please see Figure 15 below. Any buildings placed on the site will need a 4m easement from the combined sewer. It is our understanding from the client, that the abandoned sewer will be filled in or removed. We recommend that a CCTV survey is undertaken to ensure that the abandoned sewer has no live discharges into it. If the combined sewer requires moving, a section 185 application will need to be made to the water company for approval. Please see appendix D for the sewer maps

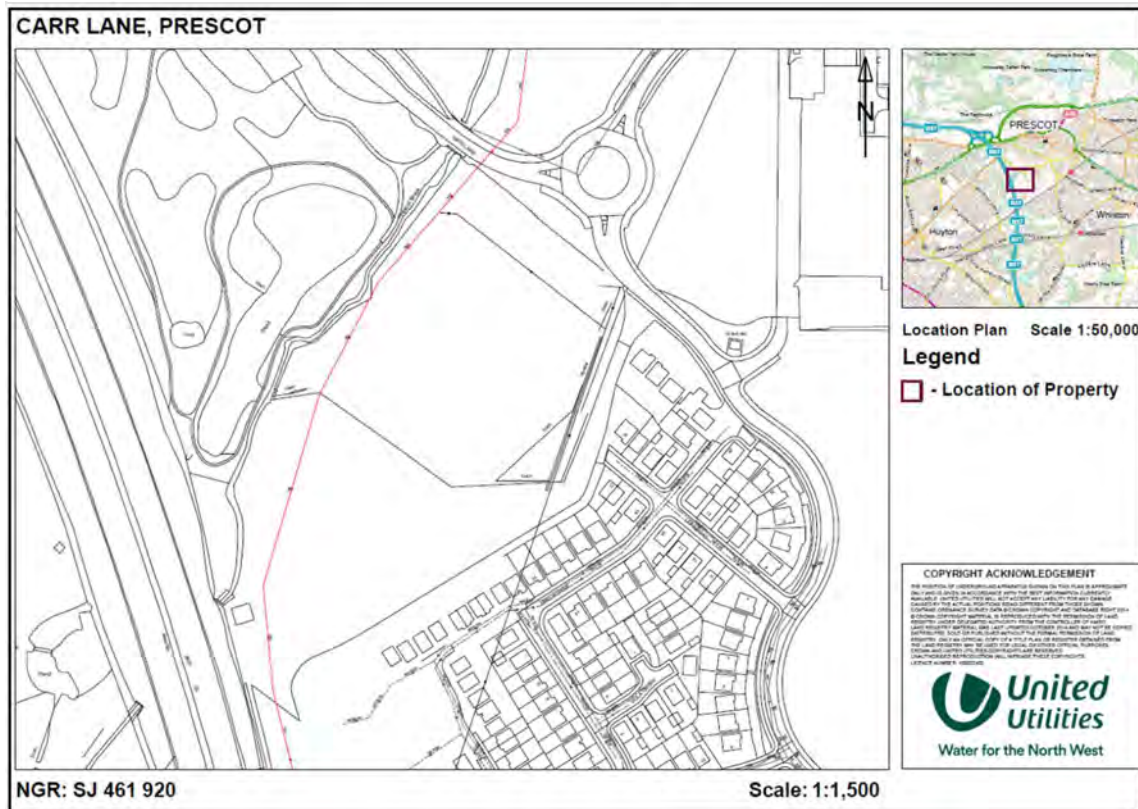


Figure 15: United Utilities (UU) Sewer Map

There is also a live distribution water main running along the sites Northern border. This may need to be investigated, but is outside the scope of this report. Please see Figure 16 below.



Figure 16: United Utilities Water Main Records

4. ASSESSMENT OF FLOOD RISK FOR PROPOSED DEVELOPMENT

4.1 Development Proposals

It is proposed to build 88 residential dwellings with associated landscaping and access roads at Carr Lane, Prescott, L34 1AX, as shown on the indicative masterplan Figure 17. Access will be via *Carr Lane*. Please see appendix E.

The development area is 2.31ha according to the client. The impermeable area of the site is 1.173ha.



4.2 Fluvial Flood Management

The proposed development is mostly within a Flood Zone 1. There are areas of medium to high fluvial flood risk to the West of the site that follow the watercourse *Prescot Brook*. However, the watercourse is 1m lower than the embankment that lies between the watercourse and the site, therefore, it is believed that fluvial flooding is at a low risk.

The finished floor levels are set above 41.3mAOD and the 1 in 100 year event plus climate change is 40.42mAOD and therefore the houses are above the flood level. The houses and development have been placed outside the 1 in 1000 year event flood envelope.

There is no development within 8m of the brook please see the dashed purple line on the layout and the drainage strategy.

5. DRAINAGE STRATEGY

5.1 Existing Drainage Arrangements

5.1.1 Surface Water

The existing site is a greenfield site. The surface water is assumed to discharge into *Prescot Brook* to the West.

5.2 Infiltration Rates

It is considered that infiltration is unlikely to be feasible. According to the *EP3* report, soakaway testing was terminated within all locations due to the water level remaining constant over a prolonged period or increasing due to weather.

5.3 Run-off

Recommended discharge rates have been calculated based on Knowsley Councils 'Sustainable Drainage Systems Completing your Pro-Forma: Advice Note' ([Knowsley-Sustainable-Drainage-Completing-your-Pro-Forma-Feb-2019.pdf](#)). Please see below:

Greenfield Site: Proposed discharge rates from the development are to be limited to the equivalent pre-development greenfield runoff rate for ALL rainfall events up to and including the 1 in 100 year event (plus climate change allowance).

Figure 18: Sustainable Drainage Systems: Completing Your Pro-Forma: Advice Note (Section 4 Extract)

Please see below for the allowable discharge rates off the site, the calculations are within Appendix D:

Table 5: Variable Greenfield Allowable Discharge Rates

Return Period (Years)	Discharge (l/s)
1 in 1	13.4
1 in 30	26.1
1 in 100	32.0

5.4 Surface Water Drainage Strategy

5.4.1 Hierarchy of Discharge

As detailed in section 3.3, infiltration is not feasible at this site. As noted previously, there is a main watercourse on the Western border. Therefore, the surface water from the site will discharge to *Prescot Brook*.

5.4.2 Sizing of SUDS Features

As discussed in section 4.1 of this report, the proposed impermeable surface area of the dwellings and associated features is 1.173ha. It is intended that the proposed surface water system will be adopted by the *United Utilities*. Infiltration SUDS systems have been discounted as the ground does not infiltrate.

A detention basin has been placed in a public open space and permeable pavements have been used in parking bays and shared parking areas.

The entire discharge for the site will be restricted to a total of 32l/s (in the 1 in 100 year event plus climate change), 26.1 or less for the 1 in 30 year event, 13.4l/s for the 1 in 1 event via Hydrobreaks up to and including the 1 in 100 year event plus climate change (45%). The storage will be held in oversized pipes and a detention basin, up to and including the 1 in 100 year event plus 45% climate change.

Modelling of the surface water runoff to the design parameters was carried out using the Source Control of Info Drainage, an industry leading software which allows design and analysis of SuDS features. Micro Drainage modelling results. Appendix F. The following conservative assumptions and design parameters have been set within the Hydraulic model for the housing section of the site:

- Dwellings, walkways, parking spaces and access roads area equals 1.173ha.
- Rainfall intensity was obtained using the Flood Studies Report (FSR) methodology, and increased by 45%, the upper end allowance for climate change over the 100 years design life of the proposed residential development, in line with the requirements of the *NPPF*;
- No runoff loss has been assumed in the modelling, therefore, all the design rainfall landing on the impermeable surfaces is expected to reach the detention basin and oversized pipes;
- As per the conclusions in Section 3.3, the soil has been modelled with an infiltration rate of zero (0.0) m/hr;
- A Hydro-Break has been used to restrict the total discharge from the site to the variable greenfield rate as stated in section 5.3; and
- The required storage will be 740m³ up to and including the 1 in 100 year event plus climate change of 45%.

Please see below the drainage strategy a full drawing and calculations are in appendix F.



Figure 19: Proposed Drainage Strategy

5.4.3 Maintenance Plan

Structures which manage surface water runoff require little maintenance, however a regular maintenance schedule e.g., after heavy rainfall, should be established by the site owners to reduce the risk of blockage within the drainage system and ensure the design remains in good working order. It is proposed to offer this up for adoption:

Table 6: Operation and Maintenance Requirements for Oversize Pipes (attenuation Storage Tanks)

TABLE 21.3	Operation and maintenance requirements for attenuation storage tanks		
	Maintenance schedule	Required action	Typical frequency
	Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually
		Remove debris from the catchment surface (where it may cause risks to performance)	Monthly
		For systems where rainfall infiltrates into the tank from above, check surface of filter for blockage by sediment, algae or other matter; remove and replace surface infiltration medium as necessary.	Annually
		Remove sediment from pre-treatment structures and/or internal forebays	Annually, or as required
	Remedial actions	Repair/rehabilitate inlets, outlet, overflows and vents	As required
	Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed	Annually
		Survey inside of tank for sediment build-up and remove if necessary	Every 5 years or as required

Table 7: Operation & Maintenance Plan for Detention Basins

TABLE 22.1	Operation and maintenance requirements for detention basins		
	Maintenance schedule	Required action	Typical frequency
Regular maintenance		Remove litter and debris	Monthly
		Cut grass – for spillways and access routes	Monthly (during growing season), or as required
		Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
		Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
		Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
		Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
		Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
		Check any penstocks and other mechanical devices	Annually
		Tidy all dead growth before start of growing season	Annually
		Remove sediment from inlets, outlet and forebay	Annually (or as required)
		Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter 23)
Occasional maintenance		Reseed areas of poor vegetation growth	As required
		Prune and trim any trees and remove cuttings	Every 2 years, or as required
		Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial actions		Repair erosion or other damage by reseeding or re-turfing	As required
		Realignment of rip-rap	As required
		Repair/rehabilitation of inlets, outlets and overflows	As required
		Relevel uneven surfaces and reinstate design levels	As required

The detailed drainage strategy will be undertaken by *REFA*, please see Appendix D for a full Drainage Strategy Report.

6. SUMMARY & CONCLUSIONS

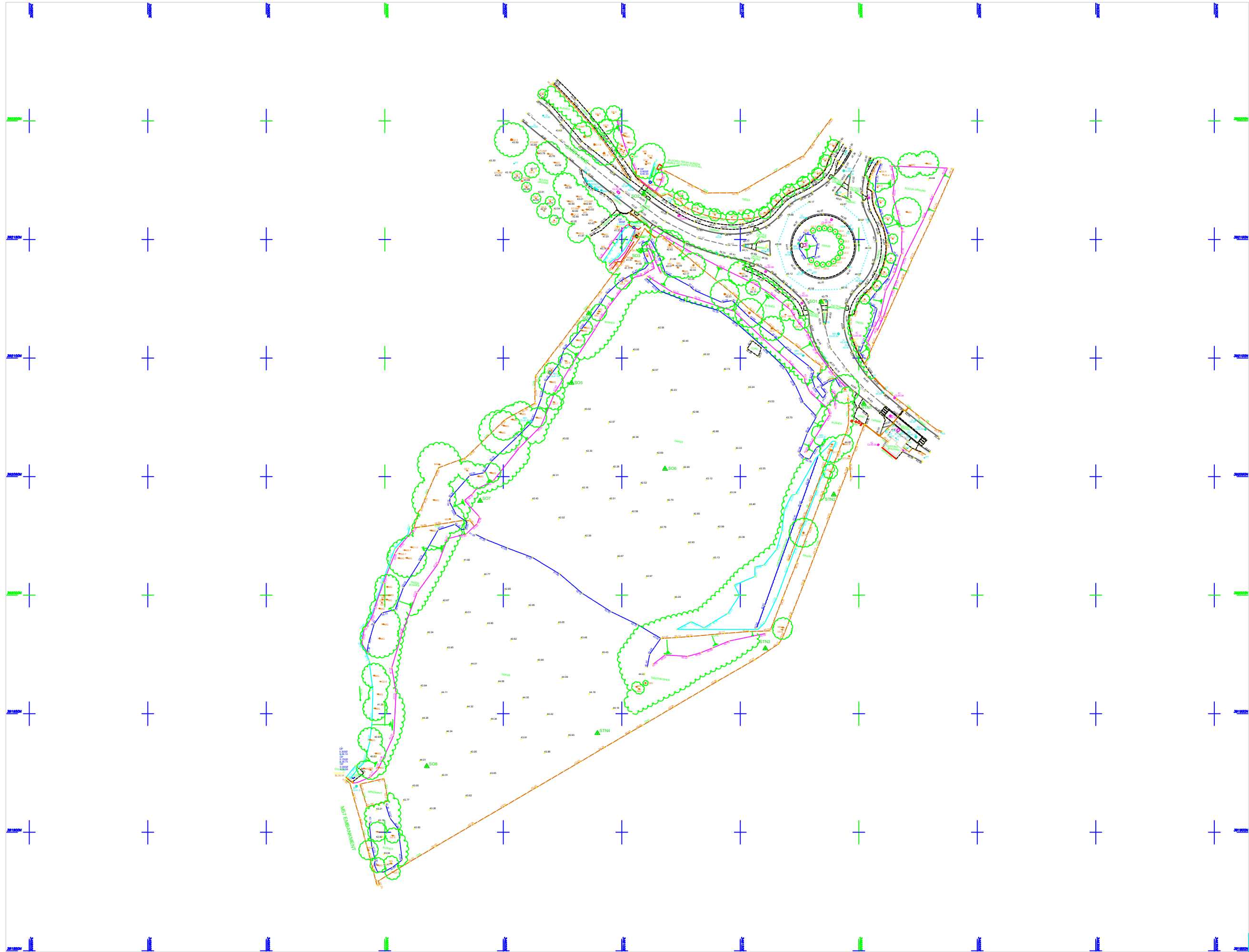
A summary of the main conclusions for the FRA is presented below:

- Development proposals are for a development of 88 residential dwellings at Carr Lane, Prescott, L34 1AX;
- The development site is approximately 2.31ha. The impermeable area is 1.173ha;
- The proposed development is within a Flood Zone 1, an area at low risk of fluvial flooding. There are some areas of medium to high fluvial flooding to the West of the site, however, these areas follow the watercourse *Prescot Brook*, which is 1m lower than the embankment that lies between the site and the watercourse. No houses will be placed in these areas; therefore, the risk of fluvial flooding is believed to be low;
- The proposed development passes the sequential test;
- The finished floor levels have been set above 41.3mAOD, this is above the 1 in 100 year event plus 70% climate change level of 40.42mAOD.
- The site is not suitable for infiltration;
- *Prescot Brook* runs along the site's Western boundary, this is a main river and, therefore, any works within 8m of the top of bank or toe of the landward side of the river defence will require a flood permit from the *Environment Agency*. No buildings or development have been situated within the 8m easement of the river.
- There is a combined *UU* sewer and an abandoned *UU* sewer on the site, the abandoned sewer will be filled in and the combined sewer requires a 4m easement on either side;
- The site is at low risk of surface water flooding;
- The site is at low risk of groundwater flooding;
- *REFA* have undertaken the drainage design; and
- The proposed development will have storage up to and including the 1 in 100 year event plus climate change of 45%.

7. REFERENCES

Author	Date	Title/Description
Department for Communities and Local Government	Mar 2012	Technical Guidance to the National Planning Policy Framework
Ministry of Housing, Communities and Local Government.	Feb 2019	National Planning Policy Framework
EP3	Feb 2021	Phase I & II Geo-environmental Report

Appendix A: Topographical Survey



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Survey Operations Limited.

Note:
The survey is plotted on a plane local
Grid. Orientation to National Grid.
All levels relate to Ordnance Datum,
achieved using the
OS National GPS Network.
Survey Control Markers established for
Mapping purposes only and should not be
used for Construction without the written
approval of Survey Operations Ltd.

SURVEY STATIONS	
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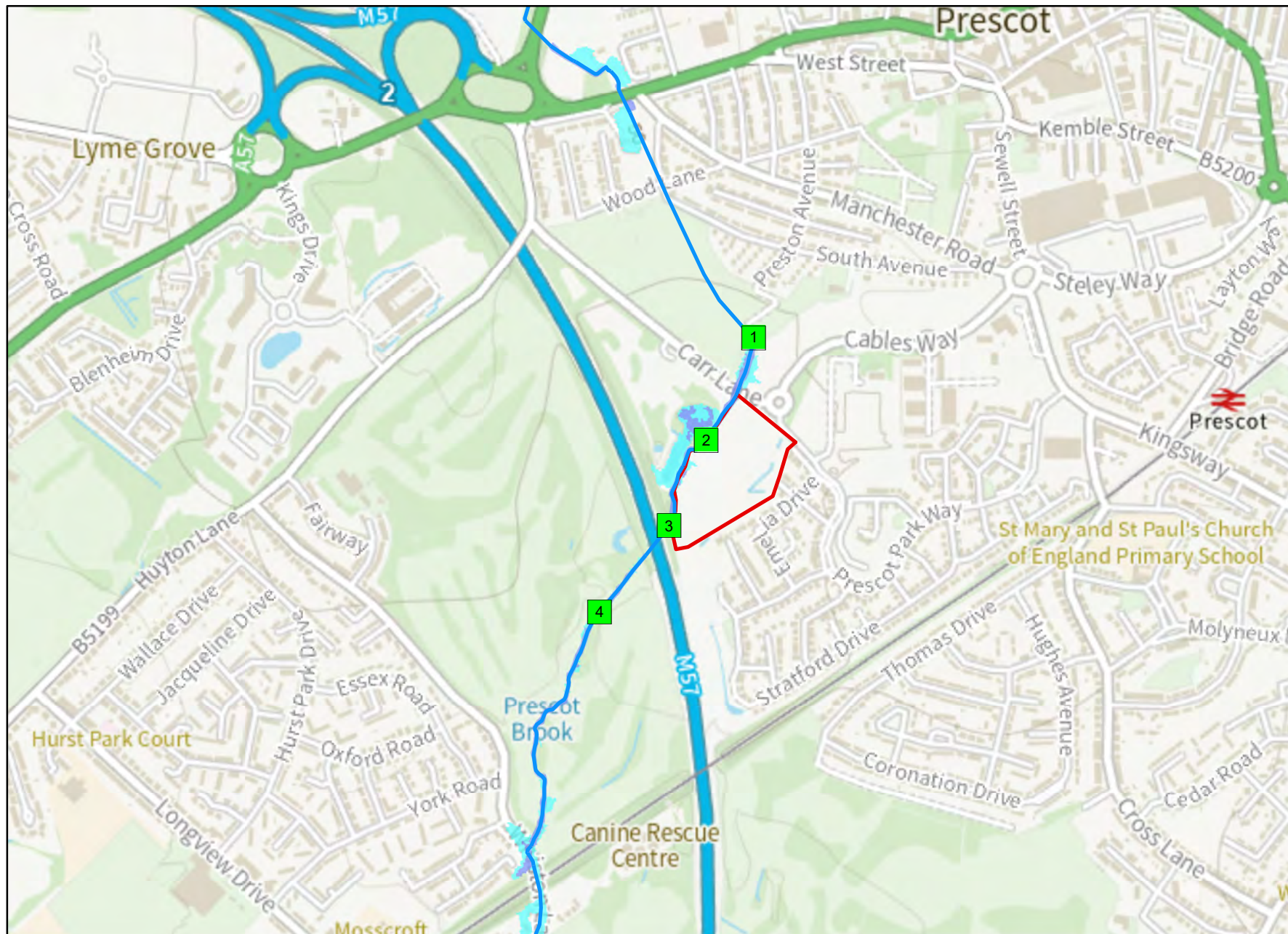
Appendix B: EP3 Geo-Environmental Site Assessment

Building Floor Slabs	Ground-bearing floor slabs are unlikely to be viable given the anticipated depths of Made Ground > 600 mm and shallow cohesive soils. Where a cast in situ slab is incorporated the detailed design will be required to include the use of a suitably deep granular subbase to manage any settlement in the underlying stratum.
Heave Precautions	Given that the underlying clay is of medium volume change potential, heave precautions will be required to the internal face of a foundation less than 1.50 m in depth (in the conjectured zone of tree influence). Heave precautions will be required to the underside of floor slabs (where there is no 200 mm void) and pile ground beams are required within the modelled influencing distance of trees.
Soakaway Drainage	BRE365 soakaways testing has been completed across the site within designated locations to assess the effective permeability for sustainable drainage. Testing was terminated within all locations due to the water level remaining constant over a prolonged period or increasing due to weather conditions, therefore it is not recommended that soakaways are utilised within the proposed development.
Sulphate Assessment	The soils at the site generally meet Class DS-1, Aggressive Chemical Environment for Concrete Classification (ACEC) AC-1s in accordance with BRE Special Digest 1 (2005). However elevated sulphate concentrations meeting Class DS-2, AC-2 and DS-3, AC-3 were noted within the Made Ground deposits in TP117 at 1.00 m and TP116 at 2.20 m bgl, respectively. Following the remediation works and given than only isolated higher sulphate classification has been identified, the concrete classification will in all likelihood be DS-1 AC-1s.
CBR Design %	Granular soils can be re-engineered to ensure 5% within the subgrade during favourable climatic conditions. Natural clay soils will provide a CBR in the order of 3–5% during drier climatic periods; however, if water is allowed to shed onto the formation, the CBR will reduce to < 2%, which will require specialist engineering of the subgrade.
Cut/Fill	Development levels unknown at this time; however, significant cut-and-fill works are anticipated. Where fill is required and materials added to the existing material consideration of the settlement and applied surcharge loadings should be considered. A geotechnical engineering specification will be required in consideration of the materials, foundation solution and loadings.
Civil Engineering Excavations	The E3P Intrusive Ground Investigation has identified the presence of weathered bedrock at a shallow depth between 6.00 m and in excess of 9.70 m bgl, becoming deeper in the northern sector of the site., the presence of which may impede the excavation materials to form sewerage and drainage infrastructure and foundations. A high groundwater table has also been identified at the site with levels from 1.20 m bgl. Dewatering may be required in order to advance excavations.



Appendix C: Environment Agency Flood Levels

Detailed Flood Map Centred on Carr Lane, Prescott, L34 1AX. Created 07/07/2023 [GMMC316824AB]



1:10,001



Legend

-  Site Location
-  Model Measurements
-  Main River
-  Flood Zone 3
-  Flood Zone 2

Undeveloped													
Map Reference	Model Node Reference	Easting	Northing	Data	10 % AEP (1 in 10 year)	4 % AEP (1 in 25 year)	1.33 % AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + 30% increase in flow	1 % AEP (1 in 100 year) + 35% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)
1	ea013_0168_Logwood_027	346136	392266	Modelled Water Level (m aodN)	41.70	41.78	42.37	42.58	43.39	43.41	43.44	43.16	43.45
				Modelled Flow (cumecs)	1.01	1.18	1.57	1.70	2.17	2.20	2.28	1.99	2.31
2	ea013_0168_Logwood_033	346052	392081	Modelled Water Level (m aodN)	40.06	40.13	40.24	40.26	40.32	40.35	40.42	40.30	40.42
				Modelled Flow (cumecs)	1.34	1.59	2.05	2.13	2.32	2.34	2.32	2.26	2.19
3	ea013_0168_Logwood_034	345986	391925	Modelled Water Level (m aodN)	39.38	39.46	39.58	39.61	39.70	39.75	39.87	39.66	39.89
				Modelled Flow (cumecs)	1.66	1.99	2.53	2.64	3.06	3.28	3.92	2.86	4.07
4	ea013_0168_Logwood_036	345857	391766	Modelled Water Level (m aodN)	38.13	38.21	38.31	38.32	38.39	38.41	38.53	38.36	38.56
				Modelled Flow (cumecs)	1.90	2.29	2.90	3.04	3.48	3.72	4.53	3.33	4.74

Model data taken from Logwood Mill Brook 2012

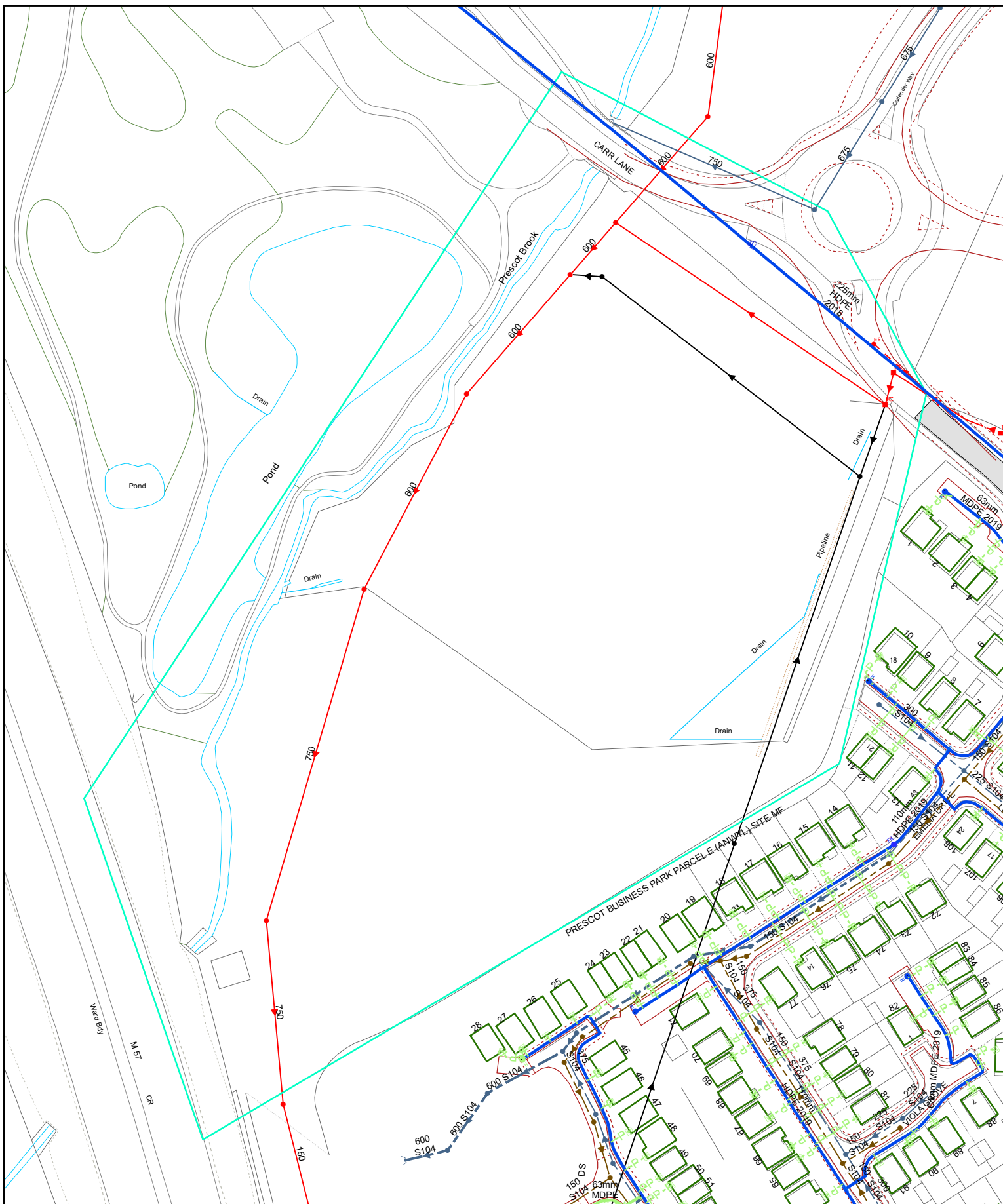
AEP - Annual Exceedence Probability

m aodN - metres above ordnance datum Newlyn

cumecs - cubic metres per second

Notes: *Climate Change Scenario - 30%, 35% and 70% increases in flow calculated for the 2080's (2070 - 2115). Please see <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances> for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment.

Appendix D: Sewer Maps



Date: 12/02/2021

Extract from maps of public sewers and water mains

Printed By:
Property Searches

Site off Carr Lane Prescott



The position of underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded. United Utilities Water PLC will not accept any liability for any damage caused by the actual positions being different from those shown.

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WASTE WATER SYMBOLOGY



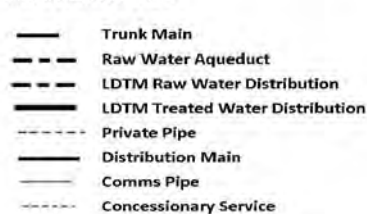
Legend			
MANHOLE FUNCTION		SEWER SHAPE	
FO	Foul	CI	Circular
SW	Surface Water	EG	Egg
CO	Combined	OV	Oval
OV	Overflow	FT	Flat Top
		RE	Rectangular
		SQ	Square
		TR	Trapezoidal
		AR	Arch
		BA	Barrel
		HO	HorseShoe
		UN	Unspecified
SEWER MATERIAL			
AC	Asbestos Cement	DI	Ductile Iron
BR	Brick	VC	Vitrified Clay
CO	Concrete	PP	Polypropylene
CSB	Concrete Segment	PF	Pitched Fibre
CSU	Concrete Segment	MA	Masonry, Coursed
CC	Concrete Box Culverted	MA	Masonry, Random
PSC	Plastic / Steel	RP	Reinforced Plastic
GR	Glass Reinforced	CI	Cast Iron
GRP	Glass Reinforced	SI	Spun Iron
PVC	Polyvinyl Chloride	ST	Steel
PE	Polyethylene	U	Unspecified

CLEAN WATER SYMBOLOGY

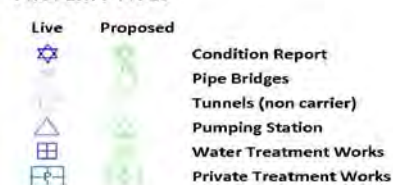
PIPE WORK



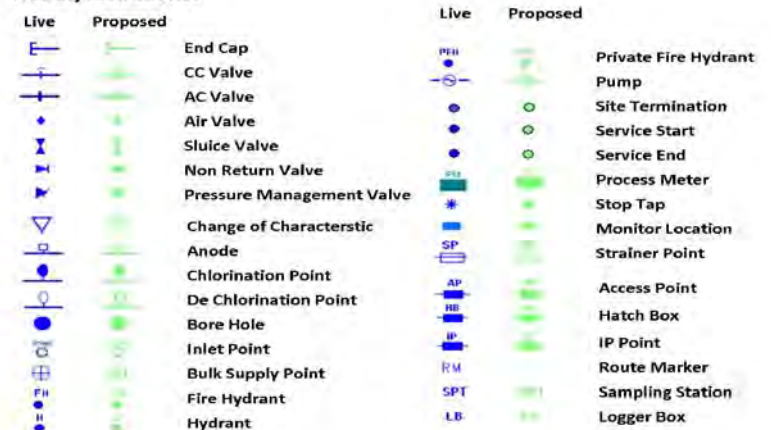
ABANDONED PIPE



PROPERTY TYPES

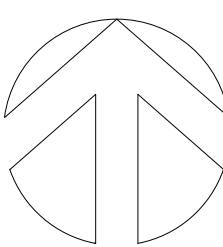


NODES/FURNITURES



Legend	
MATERIAL TYPES	LINING TYPES
AC	ASBESTOS CEMENT
CI	CAST IRON
CU	COPPER
CO	CONCRETE
DI	DUCTILE IRON
GI	GALVANISED IRON
GR	GREY IRON
OT	OTHERS
PB	LEAD
PV	UPVC
SI	SPUN IRON
ST	STEEL
UN	UNKNOWN
PE	POLYETHYLENE
CL	CEMENT LINING
TB	TAR OR BITUMEN
ERL	EPOXY RESIN
INSERTION TYPES	
DD	DIE DRAWN
DR	DIRECTIONAL DRILLING
MO	MOLING
PI	PIPELINE
SL	SLIP LINED

Appendix E: Location Plan



IMPORTANT NOTE:
ALL DIMENSIONS AND LEVELS SHOWN ON THIS DRAWING ARE TO BE CHECKED BY THE CONTRACTOR MANUFACTURER PRIOR TO THE COMMENCEMENT OF ANY WORKS ON SITE OR THE MANUFACTURE OF ANY SITE COMPONENTS.
THIS DRAWING IS NOT TO BE SCALED.
DIMENSIONS ARE INDICATED IN MILLIMETRES UNLESS CLEARLY STATED OTHERWISE.
COPYRIGHT OF THIS DRAWING BELONGS SOLELY TO BALDWIN DESIGN CONSULTANCY LTD.

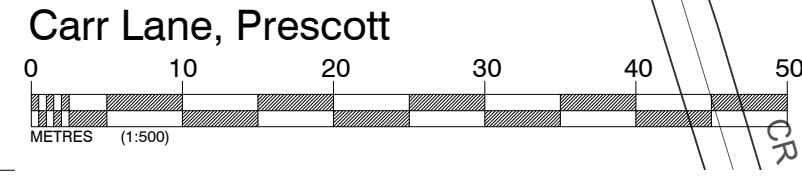
SITE PLAN

Legend

- Access / Door To dwelling.
- 1800mm high close boarded fence.
- Line to delineate application site boundary.
- Lockable Timber gates to be erected to rear gardens (as indicated on site layout).
- Proposed tree planting. (Refer to Landscape Layout for further details).
- Indicates trees to be retained. Category B/C trees.
- Indicates Sewer Easement.
- Indicates river top of bank standoff
- Indicates mineshaft
- Indicates acoustic Bund
- Indicates proposed relocated PROW

Revision:	By:	Date:
D - Updated house types	BG	23.08.2

	Client:
	Partner CONSTRUCTION LTD
	Project Title:
	Residential Development
	Address:
	Carr Lane Prescot Knowsley
	Drawing Title:
	CAD Site Layout
	Drawing No:
	UL/CL/SL/01
	Dwn: Bg Ckd: ST Date: 09/08/23
	Scale: 1:500 Paper Size: A1 Rev: D



Appendix F: REFA Drainage Strategy

UK and Ireland Rural Runoff Calculator

ICP SUDS / IH 124 ADAS 345 FEH ReFH2 Greenfield Volume

Method ☒ ICP SUDS ☐ IH 124

Area (ha)

SAAR (mm)

Soil

Region

Additional Options

Urban

Return Period (years)

Growth Curve

Results

Region	QBAR Rural (L/s)	QBAR Urban (L/s)	Q 1 (years) (L/s)	Q 30 (years) (L/s)	Q 100 (years) (L/s)
Region 10	15.4	15.4	13.4	26.1	32.0

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	200.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	20.000	Minimum Backdrop Height (m)	1.200
Ratio-R	0.400	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	x

D AND CG Manhole Type

Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)	Max Width (mm)	Diameter (mm)
299	1200	899	1800	1801	3000
449	1350	1199	2100		
599	1500	1799	2700		

>1801 Link+900 mm

SW CIRCULAR Link Type

Shape	Circular	Auto Increment (mm)	75
Barrels	1	Follow Ground	x

Available Diameters (mm)

225	375	525	750	900	1200	1500
300	450	600	825	1050	1350	1800

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
1	0.051	5.00	43.000	1800	346102.762	392109.425	1.200
2	0.051	5.00	42.966	2700	346098.176	392097.020	2.529
3	0.051	5.00	42.988	2700	346085.434	392078.413	2.608
4	0.051	5.00	42.813	2700	346095.193	392071.028	2.464
5	0.051	5.00	42.708	2700	346101.232	392056.160	2.400
6	0.051	5.00	42.919	2700	346114.230	392045.495	2.654
7	0.051	5.00	43.850	2700	346157.248	392074.082	3.526
8	0.051	5.00	43.640	2700	346147.614	392065.484	3.349
9	0.051	5.00	43.422	2700	346139.928	392050.218	3.174
10	0.051	5.00	43.225	2700	346134.539	392035.405	3.017
11	0.051	5.00	43.163	2700	346129.174	392022.188	2.991
12	0.051	5.00	43.426	2700	346121.565	392001.128	3.311
13	0.051	5.00	43.580	2700	346117.986	391990.663	3.493
14	0.051	5.00	43.721	2700	346111.023	391982.683	3.661
15	0.051	5.00	42.587	2700	346057.347	392004.922	2.443
16	0.051	5.00	42.825	2700	346074.847	391999.883	2.727
17	0.051	5.00	43.100	2700	346084.243	391992.670	3.032
18	0.051	5.00	43.942	2700	346094.580	391973.657	3.929
19	0.051	5.00	44.383	2700	346064.865	391956.081	4.457
20	0.051	5.00	44.523	2700	346053.232	391949.800	4.630
21	0.051	5.00	44.520	2700	346045.238	391949.126	4.647

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
22	0.051	5.00	44.303	2700	346027.025	391954.225	4.478
HB1	0.051	5.00	44.400	2700	346020.388	391934.978	4.627
OF			40.800	1350	345993.110	391935.836	1.146

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	1	2	13.226	0.600	41.800	41.337	0.463	28.6	300	5.07	69.8
1.001	2	3	22.552	0.600	40.437	40.380	0.057	395.0	1200	5.28	68.7
1.002	3	4	12.238	0.600	40.380	40.349	0.031	395.0	1200	5.38	68.1
1.003	4	5	16.048	0.600	40.349	40.308	0.041	395.0	1200	5.53	67.3
1.004	5	6	16.813	0.600	40.308	40.265	0.043	395.0	1200	5.68	66.5
1.005	6	10	22.677	0.600	40.265	40.208	0.057	395.0	1200	5.88	65.5
2.000	7	8	12.913	0.600	40.324	40.291	0.033	395.0	1200	5.11	69.6
2.001	8	9	17.092	0.600	40.291	40.248	0.043	395.0	1200	5.27	68.7
2.002	9	10	15.763	0.600	40.248	40.208	0.040	395.0	1200	5.41	67.9
1.006	10	11	14.264	0.600	40.208	40.172	0.036	395.0	1200	6.00	64.8
1.008	11	12	22.392	0.600	40.172	40.115	0.057	395.0	1200	6.20	63.9
1.009	12	13	11.060	0.600	40.115	40.087	0.028	395.0	1200	6.30	63.4
1.010	13	14	10.591	0.600	40.087	40.060	0.027	395.0	1200	6.40	63.0
1.011	14	18	18.757	0.600	40.060	40.013	0.047	395.0	1200	6.56	62.2
3.000	15	16	18.211	0.600	40.144	40.098	0.046	395.0	1200	5.16	69.3
3.001	16	17	11.845	0.600	40.098	40.068	0.030	395.0	1200	5.27	68.7
3.002	17	18	21.641	0.600	40.068	40.013	0.055	395.0	1200	5.46	67.6
1.012	18	19	34.524	0.600	40.013	39.926	0.087	395.0	1200	6.87	60.9
1.013	19	20	13.220	0.600	39.926	39.893	0.033	395.0	1200	6.99	60.4
1.014	20	21	8.022	0.600	39.893	39.873	0.020	395.0	1200	7.06	60.1

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	2.952	208.7	9.7	0.900	1.329	0.051	0.0	44	1.528
1.001	1.876	2121.6	19.0	1.329	1.408	0.102	0.0	78	0.608
1.002	1.876	2121.6	28.2	1.408	1.264	0.153	0.0	94	0.682
1.003	1.876	2121.6	37.2	1.264	1.200	0.204	0.0	108	0.741
1.004	1.876	2121.6	46.0	1.200	1.454	0.255	0.0	119	0.790
1.005	1.876	2121.6	54.3	1.454	1.817	0.306	0.0	129	0.829
2.000	1.876	2121.6	9.6	2.326	2.149	0.051	0.0	57	0.494
2.001	1.876	2121.6	19.0	2.149	1.974	0.102	0.0	78	0.608
2.002	1.876	2121.6	28.2	1.974	1.817	0.153	0.0	94	0.682
1.006	1.876	2121.6	89.6	1.817	1.791	0.510	0.0	164	0.958
1.008	1.876	2121.6	97.1	1.791	2.111	0.561	0.0	171	0.982
1.009	1.876	2121.6	105.2	2.111	2.293	0.612	0.0	178	1.003
1.010	1.876	2121.6	113.1	2.293	2.461	0.663	0.0	185	1.026
1.011	1.876	2121.6	120.4	2.461	2.729	0.714	0.0	190	1.043
3.000	1.876	2121.6	9.6	1.243	1.527	0.051	0.0	57	0.494
3.001	1.876	2121.6	19.0	1.527	1.832	0.102	0.0	78	0.608
3.002	1.876	2121.6	28.1	1.832	2.729	0.153	0.0	94	0.682
1.012	1.876	2121.6	151.4	2.729	3.257	0.918	0.0	213	1.114
1.013	1.876	2121.6	158.6	3.257	3.430	0.969	0.0	218	1.129
1.014	1.876	2121.6	166.1	3.430	3.447	1.020	0.0	224	1.145

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.015	21	22	18.913	0.600	39.873	39.825	0.048	395.0	1200	7.23	59.4
1.016	22	HB1	20.359	0.600	39.825	39.773	0.052	395.0	1200	7.41	58.7
1.017	HB1	OF	27.291	0.600	39.773	39.654	0.119	230.0	300	7.85	57.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.015	1.876	2121.6	172.4	3.447	3.278	1.071	0.0	228	1.157
1.016	1.876	2121.6	178.4	3.278	3.427	1.122	0.0	231	1.167
1.017	1.032	73.0	181.2	4.327	0.846	1.173	0.0	300	1.046

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	13.226	28.6	300	SW CIRCULAR	43.000	41.800	0.900	42.966	41.337	1.329
1.001	22.552	395.0	1200	SW CIRCULAR	42.966	40.437	1.329	42.988	40.380	1.408
1.002	12.238	395.0	1200	SW CIRCULAR	42.988	40.380	1.408	42.813	40.349	1.264
1.003	16.048	395.0	1200	SW CIRCULAR	42.813	40.349	1.264	42.708	40.308	1.200
1.004	16.813	395.0	1200	SW CIRCULAR	42.708	40.308	1.200	42.919	40.265	1.454
1.005	22.677	395.0	1200	SW CIRCULAR	42.919	40.265	1.454	43.225	40.208	1.817
2.000	12.913	395.0	1200	SW CIRCULAR	43.850	40.324	2.326	43.640	40.291	2.149
2.001	17.092	395.0	1200	SW CIRCULAR	43.640	40.291	2.149	43.422	40.248	1.974
2.002	15.763	395.0	1200	SW CIRCULAR	43.422	40.248	1.974	43.225	40.208	1.817
1.006	14.264	395.0	1200	SW CIRCULAR	43.225	40.208	1.817	43.163	40.172	1.791
1.008	22.392	395.0	1200	SW CIRCULAR	43.163	40.172	1.791	43.426	40.115	2.111
1.009	11.060	395.0	1200	SW CIRCULAR	43.426	40.115	2.111	43.580	40.087	2.293
1.010	10.591	395.0	1200	SW CIRCULAR	43.580	40.087	2.293	43.721	40.060	2.461
1.011	18.757	395.0	1200	SW CIRCULAR	43.721	40.060	2.461	43.942	40.013	2.729
3.000	18.211	395.0	1200	SW CIRCULAR	42.587	40.144	1.243	42.825	40.098	1.527
3.001	11.845	395.0	1200	SW CIRCULAR	42.825	40.098	1.527	43.100	40.068	1.832
3.002	21.641	395.0	1200	SW CIRCULAR	43.100	40.068	1.832	43.942	40.013	2.729

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1800	Manhole	D AND CG	2	2700	Manhole	D AND CG
1.001	2	2700	Manhole	D AND CG	3	2700	Manhole	D AND CG
1.002	3	2700	Manhole	D AND CG	4	2700	Manhole	D AND CG
1.003	4	2700	Manhole	D AND CG	5	2700	Manhole	D AND CG
1.004	5	2700	Manhole	D AND CG	6	2700	Manhole	D AND CG
1.005	6	2700	Manhole	D AND CG	10	2700	Manhole	D AND CG
2.000	7	2700	Manhole	D AND CG	8	2700	Manhole	D AND CG
2.001	8	2700	Manhole	D AND CG	9	2700	Manhole	D AND CG
2.002	9	2700	Manhole	D AND CG	10	2700	Manhole	D AND CG
1.006	10	2700	Manhole	D AND CG	11	2700	Manhole	D AND CG
1.008	11	2700	Manhole	D AND CG	12	2700	Manhole	D AND CG
1.009	12	2700	Manhole	D AND CG	13	2700	Manhole	D AND CG
1.010	13	2700	Manhole	D AND CG	14	2700	Manhole	D AND CG
1.011	14	2700	Manhole	D AND CG	18	2700	Manhole	D AND CG
3.000	15	2700	Manhole	D AND CG	16	2700	Manhole	D AND CG
3.001	16	2700	Manhole	D AND CG	17	2700	Manhole	D AND CG
3.002	17	2700	Manhole	D AND CG	18	2700	Manhole	D AND CG

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.012	34.524	395.0	1200	SW CIRCULAR	43.942	40.013	2.729	44.383	39.926	3.257
1.013	13.220	395.0	1200	SW CIRCULAR	44.383	39.926	3.257	44.523	39.893	3.430
1.014	8.022	395.0	1200	SW CIRCULAR	44.523	39.893	3.430	44.520	39.873	3.447
1.015	18.913	395.0	1200	SW CIRCULAR	44.520	39.873	3.447	44.303	39.825	3.278
1.016	20.359	395.0	1200	SW CIRCULAR	44.303	39.825	3.278	44.400	39.773	3.427
1.017	27.291	230.0	300	SW CIRCULAR	44.400	39.773	4.327	40.800	39.654	0.846

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.012	18	2700	Manhole	D AND CG	19	2700	Manhole	D AND CG
1.013	19	2700	Manhole	D AND CG	20	2700	Manhole	D AND CG
1.014	20	2700	Manhole	D AND CG	21	2700	Manhole	D AND CG
1.015	21	2700	Manhole	D AND CG	22	2700	Manhole	D AND CG
1.016	22	2700	Manhole	D AND CG	HB1	2700	Manhole	D AND CG
1.017	HB1	2700	Manhole	D AND CG	OF	1350	Manhole	D AND CG

Simulation Settings

Rainfall Methodology	FSR	Drain Down Time (mins)	240
FSR Region	England and Wales	Additional Storage (m³/ha)	20.0
M5-60 (mm)	20.000	Check Discharge Rate(s)	✓
Ratio-R	0.400	1 year (l/s)	13.4
Summer CV	0.750	30 year (l/s)	26.1
Winter CV	0.840	100 year (l/s)	32.0
Analysis Speed	Detailed	Check Discharge Volume	x
Skip Steady State	✓		

Storm Durations

15 | 30 | 60 | 120 | 180 | 240 | 360 | 480 | 600 | 720 | 960 | 1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	0	0	0
30	0	0	0
100	45	10	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Node HB1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	39.773	Product Number	CTL-SHE-0169-1340-0800-1340
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	13.4	Min Node Diameter (mm)	1200

Node HB1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	40.400	Product Number	CTL-SHE-0126-9100-1900-9100
Design Depth (m)	1.900	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	9.1	Min Node Diameter (mm)	1500

Node 1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	41.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	28.5	0.0	1.200	243.5	0.0

Node 19 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	41.500
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	72.0	0.0	0.800	72.0	0.0	0.801	0.0	0.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 15 minute summer	109.521	30.991
1 year 15 minute winter	76.857	30.991
1 year 30 minute summer	71.439	20.215
1 year 30 minute winter	50.133	20.215
1 year 60 minute summer	48.435	12.800
1 year 60 minute winter	32.179	12.800
1 year 120 minute summer	30.053	7.942
1 year 120 minute winter	19.966	7.942
1 year 180 minute summer	23.233	5.979
1 year 180 minute winter	15.102	5.979
1 year 240 minute summer	18.475	4.882
1 year 240 minute winter	12.274	4.882
1 year 360 minute summer	14.169	3.646
1 year 360 minute winter	9.210	3.646
1 year 480 minute summer	11.185	2.956
1 year 480 minute winter	7.431	2.956
1 year 600 minute summer	9.182	2.511
1 year 600 minute winter	6.274	2.511

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year 720 minute summer	8.203	2.199
1 year 720 minute winter	5.513	2.199
1 year 960 minute summer	6.768	1.782
1 year 960 minute winter	4.483	1.782
1 year 1440 minute summer	4.949	1.326
1 year 1440 minute winter	3.326	1.326
30 year 15 minute summer	268.706	76.035
30 year 15 minute winter	188.566	76.035
30 year 30 minute summer	174.929	49.499
30 year 30 minute winter	122.757	49.499
30 year 60 minute summer	116.589	30.811
30 year 60 minute winter	77.459	30.811
30 year 120 minute summer	70.438	18.615
30 year 120 minute winter	46.797	18.615
30 year 180 minute summer	53.298	13.715
30 year 180 minute winter	34.645	13.715
30 year 240 minute summer	41.604	10.995
30 year 240 minute winter	27.641	10.995
30 year 360 minute summer	31.221	8.034
30 year 360 minute winter	20.295	8.034
30 year 480 minute summer	24.324	6.428
30 year 480 minute winter	16.160	6.428
30 year 600 minute summer	19.756	5.404
30 year 600 minute winter	13.498	5.404
30 year 720 minute summer	17.490	4.687
30 year 720 minute winter	11.754	4.687
30 year 960 minute summer	14.215	3.743
30 year 960 minute winter	9.416	3.743
30 year 1440 minute summer	10.161	2.723
30 year 1440 minute winter	6.829	2.723
100 year +45% CC +10% A 15 minute summer	505.670	143.087
100 year +45% CC +10% A 15 minute winter	354.856	143.087
100 year +45% CC +10% A 30 minute summer	332.000	93.944
100 year +45% CC +10% A 30 minute winter	232.982	93.944
100 year +45% CC +10% A 60 minute summer	222.268	58.739
100 year +45% CC +10% A 60 minute winter	147.669	58.739
100 year +45% CC +10% A 120 minute summer	134.215	35.469
100 year +45% CC +10% A 120 minute winter	89.169	35.469
100 year +45% CC +10% A 180 minute summer	101.219	26.047
100 year +45% CC +10% A 180 minute winter	65.795	26.047
100 year +45% CC +10% A 240 minute summer	78.690	20.795
100 year +45% CC +10% A 240 minute winter	52.280	20.795
100 year +45% CC +10% A 360 minute summer	58.701	15.106
100 year +45% CC +10% A 360 minute winter	38.157	15.106
100 year +45% CC +10% A 480 minute summer	45.550	12.038
100 year +45% CC +10% A 480 minute winter	30.262	12.038
100 year +45% CC +10% A 600 minute summer	36.875	10.086
100 year +45% CC +10% A 600 minute winter	25.195	10.086
100 year +45% CC +10% A 720 minute summer	32.556	8.725
100 year +45% CC +10% A 720 minute winter	21.879	8.725
100 year +45% CC +10% A 960 minute summer	26.340	6.936
100 year +45% CC +10% A 960 minute winter	17.448	6.936

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
100 year +45% CC +10% A 1440 minute summer	18.700	5.012
100 year +45% CC +10% A 1440 minute winter	12.567	5.012

Results for 1 year Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	12	41.835	0.035	7.2	1.2271	0.0000	OK
15 minute winter	2	11	40.500	0.063	12.2	0.3864	0.0000	OK
15 minute winter	3	11	40.463	0.083	18.7	0.5086	0.0000	OK
15 minute winter	4	12	40.443	0.094	24.8	0.5748	0.0000	OK
15 minute winter	5	12	40.413	0.105	30.7	0.6428	0.0000	OK
15 minute winter	6	12	40.379	0.114	36.1	0.6941	0.0000	OK
15 minute winter	7	10	40.373	0.049	7.2	0.2969	0.0000	OK
15 minute winter	8	12	40.362	0.071	14.1	0.4276	0.0000	OK
15 minute winter	9	12	40.358	0.110	20.6	0.6657	0.0000	OK
15 minute winter	10	12	40.356	0.148	58.1	0.9004	0.0000	OK
60 minute winter	11	58	40.345	0.173	39.2	1.0475	0.0000	OK
60 minute winter	12	59	40.345	0.230	42.6	1.3875	0.0000	OK
60 minute winter	13	59	40.345	0.258	44.8	1.5511	0.0000	OK
60 minute winter	14	59	40.344	0.284	46.4	1.7079	0.0000	OK
60 minute winter	15	59	40.345	0.201	7.9	1.2355	0.0000	OK
60 minute winter	16	58	40.346	0.248	10.0	1.5114	0.0000	OK
60 minute winter	17	62	40.345	0.277	12.2	1.6792	0.0000	OK
60 minute winter	18	58	40.344	0.331	51.6	1.9835	0.0000	OK
60 minute winter	19	60	40.345	0.419	49.3	2.4954	0.0000	OK
60 minute winter	20	60	40.345	0.452	40.4	2.6889	0.0000	OK
60 minute winter	21	60	40.345	0.472	36.4	2.8068	0.0000	OK
60 minute winter	22	60	40.345	0.520	30.8	3.0931	0.0000	OK
60 minute winter	HB1	61	40.345	0.572	21.4	3.4000	0.0000	SURCHARGED

Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	5.7	1.279	0.028	0.0594	
15 minute winter	2	1.001	3	11.9	0.428	0.006	0.6323	
15 minute winter	3	1.002	4	18.0	0.488	0.009	0.4525	
15 minute winter	4	1.003	5	24.3	0.554	0.011	0.7036	
15 minute winter	5	1.004	6	30.4	0.604	0.014	0.8495	
15 minute winter	6	1.005	10	35.8	0.542	0.017	1.5139	
15 minute winter	7	2.000	8	6.9	0.348	0.003	0.2648	
15 minute winter	8	2.001	9	13.4	0.438	0.006	0.6656	
15 minute winter	9	2.002	10	17.6	0.372	0.008	1.0325	
15 minute winter	10	1.006	11	57.7	0.717	0.027	1.1490	
15 minute winter	11	1.008	12	62.4	0.714	0.029	1.9621	
15 minute winter	12	1.009	13	67.1	0.698	0.032	1.0840	
15 minute winter	13	1.010	14	71.9	0.742	0.034	1.2877	
15 minute winter	14	1.011	18	76.4	0.767	0.036	2.9278	
30 minute summer	15	3.000	16	-10.0	0.323	-0.005	1.8606	
30 minute summer	16	3.001	17	-17.1	0.410	-0.008	1.5774	
15 minute winter	17	3.002	18	-25.0	0.387	-0.012	3.3427	
15 minute winter	18	1.012	19	86.9	0.787	0.041	7.6722	
15 minute summer	19	1.013	20	68.1	0.688	0.032	3.4298	
15 minute winter	20	1.014	21	59.9	0.669	0.028	2.5655	
15 minute winter	21	1.015	22	48.1	0.554	0.023	6.8465	
15 minute summer	22	1.016	HB1	28.6	0.323	0.013	7.8816	
30 minute summer	HB1	Hydro-Brake®	OF	13.4				88.9

Results for 1 year Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	OF	1	39.654	0.000	13.4	0.0000	0.0000	OK
Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	HB1	Hydro-Brake®	OF	0.0				0.0

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	41.858	0.058	17.6	2.1399	0.0000	OK
120 minute winter	2	98	40.678	0.241	10.9	1.4768	0.0000	OK
120 minute winter	3	98	40.678	0.298	16.4	1.8226	0.0000	OK
120 minute winter	4	100	40.678	0.329	21.0	2.0188	0.0000	OK
120 minute winter	5	100	40.678	0.370	25.8	2.2747	0.0000	OK
120 minute winter	6	100	40.678	0.413	28.8	2.5234	0.0000	OK
120 minute winter	7	114	40.679	0.355	5.5	2.1331	0.0000	OK
120 minute winter	8	114	40.678	0.387	9.7	2.3363	0.0000	OK
120 minute winter	9	114	40.678	0.430	13.4	2.6015	0.0000	OK
120 minute winter	10	114	40.678	0.470	40.7	2.8509	0.0000	OK
120 minute winter	11	114	40.678	0.506	41.7	3.0694	0.0000	OK
120 minute winter	12	100	40.678	0.563	41.3	3.3957	0.0000	OK
120 minute winter	13	100	40.678	0.591	39.8	3.5559	0.0000	OK
120 minute winter	14	100	40.678	0.618	39.8	3.7100	0.0000	OK
120 minute winter	15	114	40.678	0.534	5.5	3.2810	0.0000	OK
120 minute winter	16	98	40.678	0.580	7.8	3.5398	0.0000	OK
120 minute winter	17	114	40.678	0.610	9.2	3.6983	0.0000	OK
120 minute winter	18	100	40.678	0.665	38.8	3.9787	0.0000	OK
120 minute winter	19	100	40.678	0.752	28.3	4.4770	0.0000	OK
120 minute winter	20	100	40.678	0.785	24.3	4.6674	0.0000	OK
120 minute winter	21	100	40.678	0.805	23.7	4.7854	0.0000	OK
120 minute winter	22	100	40.678	0.853	24.5	5.0769	0.0000	OK
120 minute winter	HB1	100	40.678	0.905	23.9	5.3790	0.0000	SURCHARGED
Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	15.5	1.695	0.074	0.1210	
15 minute winter	2	1.001	3	31.7	0.511	0.015	1.6421	
15 minute winter	3	1.002	4	47.2	0.570	0.022	1.2707	
15 minute winter	4	1.003	5	62.3	0.645	0.029	2.1202	
15 minute winter	5	1.004	6	76.6	0.679	0.036	2.8125	
15 minute winter	6	1.005	10	89.3	0.629	0.042	4.8149	
15 minute summer	7	2.000	8	14.2	0.382	0.007	1.5222	
15 minute winter	8	2.001	9	26.4	0.467	0.012	3.1418	
15 minute winter	9	2.002	10	39.4	0.397	0.019	3.4543	
15 minute winter	10	1.006	11	140.9	0.814	0.066	3.6456	
15 minute winter	11	1.008	12	150.9	0.799	0.071	6.9168	
15 minute winter	12	1.009	13	150.2	0.785	0.071	3.9774	
15 minute winter	13	1.010	14	159.3	0.828	0.075	4.1341	
15 minute winter	14	1.011	18	159.7	0.876	0.075	8.0887	
15 minute summer	15	3.000	16	-22.3	0.393	-0.011	5.4902	
15 minute winter	16	3.001	17	-44.2	0.478	-0.021	4.4927	
15 minute winter	17	3.002	18	-78.9	0.432	-0.037	9.2535	
15 minute winter	18	1.012	19	149.6	0.851	0.070	17.5272	
15 minute winter	19	1.013	20	111.4	0.685	0.052	7.6723	
15 minute summer	20	1.014	21	88.9	0.657	0.042	4.6338	
15 minute summer	21	1.015	22	73.3	0.562	0.035	11.7510	
15 minute summer	22	1.016	HB1	33.2	0.327	0.016	13.8923	
120 minute winter	HB1	Hydro-Brake®	OF	14.2				266.9

Results for 30 year Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	OF	1	39.654	0.000	13.4	0.0000	0.0000	OK
Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute winter	HB1	Hydro-Brake®	OF	8.3				64.8

Results for 100 year +45% CC +10% A Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	1	11	41.887	0.087	36.5	3.4672	0.0000	OK
180 minute winter	2	172	41.716	1.279	17.0	7.8885	0.0000	SURCHARGED
180 minute winter	3	172	41.716	1.336	19.5	8.2219	0.0000	SURCHARGED
180 minute winter	4	172	41.716	1.367	19.6	8.4465	0.0000	SURCHARGED
180 minute winter	5	172	41.716	1.408	21.0	8.7167	0.0000	SURCHARGED
180 minute winter	6	172	41.716	1.451	22.1	8.9183	0.0000	SURCHARGED
180 minute winter	7	172	41.716	1.392	8.5	8.4130	0.0000	SURCHARGED
180 minute winter	8	172	41.716	1.425	13.1	8.6366	0.0000	SURCHARGED
180 minute winter	9	172	41.716	1.468	14.1	8.9234	0.0000	SURCHARGED
180 minute winter	10	172	41.716	1.508	27.6	9.1936	0.0000	SURCHARGED
180 minute winter	11	172	41.716	1.544	28.5	9.4203	0.0000	SURCHARGED
180 minute winter	12	172	41.716	1.601	30.7	9.7103	0.0000	SURCHARGED
180 minute winter	13	172	41.716	1.629	32.7	9.8524	0.0000	SURCHARGED
180 minute winter	14	172	41.716	1.656	34.5	9.9902	0.0000	SURCHARGED
180 minute winter	15	172	41.715	1.571	8.5	9.7191	0.0000	SURCHARGED
180 minute winter	16	172	41.715	1.617	12.6	9.9265	0.0000	SURCHARGED
180 minute winter	17	172	41.716	1.648	13.8	10.0437	0.0000	SURCHARGED
180 minute winter	18	172	41.716	1.703	38.4	10.2356	0.0000	SURCHARGED
180 minute winter	19	176	41.716	1.790	39.7	26.2836	0.0000	SURCHARGED
180 minute winter	20	176	41.716	1.823	26.9	10.8798	0.0000	SURCHARGED
180 minute winter	21	176	41.716	1.843	27.7	10.9973	0.0000	SURCHARGED
180 minute winter	22	176	41.716	1.891	29.2	11.3005	0.0000	SURCHARGED
180 minute winter	HB1	176	41.716	1.943	30.2	11.5953	0.0000	SURCHARGED
Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	1	1.000	2	33.6	2.085	0.161	0.2132	
15 minute winter	2	1.001	3	63.6	0.532	0.030	10.2444	
15 minute winter	3	1.002	4	91.2	0.595	0.043	6.1593	
15 minute winter	4	1.003	5	118.2	0.682	0.056	8.6775	
15 minute summer	5	1.004	6	139.3	0.719	0.066	8.2095	
15 minute summer	6	1.005	10	158.0	0.669	0.074	12.2079	
15 minute winter	7	2.000	8	27.7	0.384	0.013	7.2743	
15 minute winter	8	2.001	9	-50.4	0.484	-0.024	10.3429	
15 minute winter	9	2.002	10	68.5	0.426	0.032	10.1509	
15 minute winter	10	1.006	11	237.0	0.851	0.112	9.7548	
15 minute winter	11	1.008	12	245.0	0.831	0.115	16.4300	
15 minute summer	12	1.009	13	237.1	0.805	0.112	7.7072	
15 minute summer	13	1.010	14	240.4	0.874	0.113	7.7958	
15 minute winter	14	1.011	18	226.4	0.901	0.107	16.1392	
30 minute winter	15	3.000	16	38.0	0.326	0.018	18.0616	
30 minute winter	16	3.001	17	70.0	0.430	0.033	12.1345	
15 minute winter	17	3.002	18	-118.1	0.466	-0.056	18.8045	
15 minute winter	18	1.012	19	177.6	0.855	0.084	32.0435	
15 minute summer	19	1.013	20	130.0	0.693	0.061	12.2663	
15 minute winter	20	1.014	21	119.0	0.663	0.056	8.1395	
15 minute winter	21	1.015	22	101.2	0.562	0.048	19.7215	
15 minute summer	22	1.016	HB1	47.1	0.317	0.022	21.1052	
180 minute winter	HB1	Hydro-Brake®	OF	20.4				402.9

Results for 100 year +45% CC +10% A Critical Storm Duration. Lowest mass balance: 98.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	OF	1	39.654	0.000	15.3	0.0000	0.0000	OK
Link Event (Outflow)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
30 minute summer	HB1	Hydro-Brake®	OF	9.0				107.3

