

ENVIRONMENT

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Royal Hill Road
Spondon
Flood Risk Assessment

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Flood Risk Assessment

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EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (PPG). It has been produced on behalf of Miller Homes Ltd in respect of a planning application for the proposed residential development located at Royal Hill Road, Spondon (approximate grid reference: SK 39627 36680).

This report demonstrates that the proposed development is at an acceptable level of flood risk, subject to the recommended flood mitigation strategies being implemented.

The Environment Agency (EA) Flood Map for Planning shows the site is located entirely within Flood Zone 1 (land at low risk of flooding from rivers and the sea). The nearest EA Main River to the site is the Chaddesden Brook located approximately 840m northwest of the site. The nearest fluvial flood extents are located approximately 320m north of the site attributed to the ordinary watercourse known as the Lees Brook. EA Light Detection and Ranging (LiDAR) data shows the site is elevated at least 10m above the nearest Flood Zone attributed to the Lees Brook.

An Unnamed Ordinary Watercourse (UOW) is located adjacent to the southern site boundary. To understand the risk associated with this watercourse, BWB Consulting have undertaken a direct rainfall hydraulic modelling exercise. The modelling shows that the predominant risk to the site is a pluvial flow route which flows across the southern site boundary that is offset from the watercourse.

EA Risk of Flooding from Surface Water Mapping shows the site as a whole to be at an overall very low risk of pluvial flooding, with no surface water ponding shown within the site. Mapping also shows the presence of a low to high risk pluvial flow route along the southern site boundary. The direct rainfall hydraulic modelling undertaken supersedes the EA mapping as it is specific to the application site. The results from the modelling exercise show the south of the site to be at risk of pluvial flooding for all modelled storm events.

Post-development modelling was undertaken to understand the impact the development would have on flood risk to the site and surrounding areas. Across all post-development modelled events, there is shown to be no change (within model tolerances) in modelled flood levels across the majority of the model domain, with flood levels shown to slightly decrease downstream of the site. Therefore, the development is not expected to lead to a detriment in flood risk both on-site and downstream.

To mitigate the pluvial flood risk to the site, it is recommended that finished floor levels of the proposed dwellings are raised 600mm above the 1 in 100-year +40% climate change level or 150mm above surrounding ground levels, whichever is greater.

The site's access and egress route via Royal Hill Road is shown to be subject to surface water flood depths of up to 400mm which presents a significant (Danger for Most) hazard, for an approximate 6m stretch, during the 1 in 100-year +40% climate change design scenario. In the event of flooding, alternative safe pedestrian access and egress can be achieved via the footpath to the north of the site onto Longley Lane. It should be noted that the emergency

service vehicles can still cross this area of significant hazard to reach the site during a flood event.

The site has been assessed against other sources of flood risk including canals, groundwater, reservoirs and large waterbodies, and sewers. The overall risk posed by these sources is considered low and therefore these sources do not preclude development. The raising of finished floor levels will provide mitigation for any residual flood risks. Furthermore, ground levels should be profiled to encourage pluvial runoff and overland flows away from the built development and towards the nearest drainage point.

The site has been sequentially arranged to locate all proposed residential development outside of the 1 in 100-year +40% climate change pluvial flood extent. Derby City Council have confirmed that a Sequential Test is therefore not required.

The development will increase the area of impermeable surfaces, increasing the rate of runoff from the site. To mitigate the development's impact on the current runoff regime it is proposed to incorporate surface water attenuation and storage as part of the development proposals. It is proposed to drain used water from the development separately to surface water.

In compliance with the requirements of the NPPF, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site.

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1. INTRODUCTION

- 1.1 This Flood Risk Assessment (FRA) has been prepared in accordance with the requirements set out in the National Planning Policy Framework (NPPF) and the associated Planning Practice Guidance (PPG). The FRA has been produced on behalf of Miller Homes Ltd in respect of a planning application for the proposed residential development located at Royal Hill Road, Spondon.
- 1.2 This FRA is intended to support an outline planning application, the level of detail included is commensurate and subject to the nature of the proposals at the planning stage. Summary information is included as **Table 1.1**.

Table 1.1: Site Summary

Site Name	Royal Hill Road
Location	Spondon
NGR (approx.)	SK 39627 36680
Application Site Area (ha)	4.5 (approx.)
Development Type	Residential
Flood Zone Classification	Flood Zone 1
NPPF Vulnerability	More Vulnerable
Anticipated Development Lifetime	100+ years
Environment Agency Office	East Midlands
Lead Local Flood Authority	Derby City Council
Local Planning Authority	Derby City Council

Sources of Data

- i. Topographical Survey by BWB Consulting Ltd (reference: RHR-BWB-00-ZZ-DR-G-0001)
- ii. Environment Agency (EA) Risk of Flooding from Surface Water Data
- iii. Derby City Council Strategic Flood Risk Assessment
- iv. Derby City Council Preliminary Flood Risk Assessment
- v. Derby City Council Preliminary Flood Risk Assessment Addendum
- vi. Derby City Council Local Flood Risk Management Strategy
- vii. Humber River Basin District Flood Risk Management Plan

- viii. Derby City Council Surface Water Management Plan
- ix. Derby City Council Section 19 Flood Investigation Reports
- x. Derby City Council Local Plan – Part 1 Core Strategy
- xi. 2022 1m spatial resolution EA Light Detection and Ranging (LiDAR) data
- xii. Lead Local Flood Authority (LLFA) Consultation
- xiii. EA Consultation
- xiv. Hydraulic modelling of Unnamed Ordinary Watercourse (UOW) to the south of the site undertaken by BWB Consulting (reference: RHR-BWB-ZZ-XX-RP-YE-0002_HMR)
- xv. Severn Trent Water (STW) Sewer Records
- xvi. British Geological Survey (BGS) Drift & Geology Maps

Existing Site

- 1.3 The site is situated within Spondon, located approximately 4.5km east of Derby City Centre. The site is bound by Royal Hill Road and existing residential development to the east, and predominantly greenfield land to the north and west. A UOW is located along the southern boundary of the site. Access to the site is obtained via Royal Hill Road to the southeast of the site. The site's location is illustrated within **Figure 1.1**.
- 1.4 A topographical survey has been undertaken and is included as **Appendix 1**. The survey shows the site generally falls from north to south, falling from a high point of approximately 91.2 mAOD in the north, to a low point of approximately 76.1 mAOD in the southwest corner of the site. A small portion of the site to the north falls from the high point in a northerly direction.
- 1.5 The survey also shows that a small land drainage feature is present to the south of the site which appears to outfall to the UOW.
- 1.6 The site is currently undeveloped greenfield land and predominantly comprises arable fields.

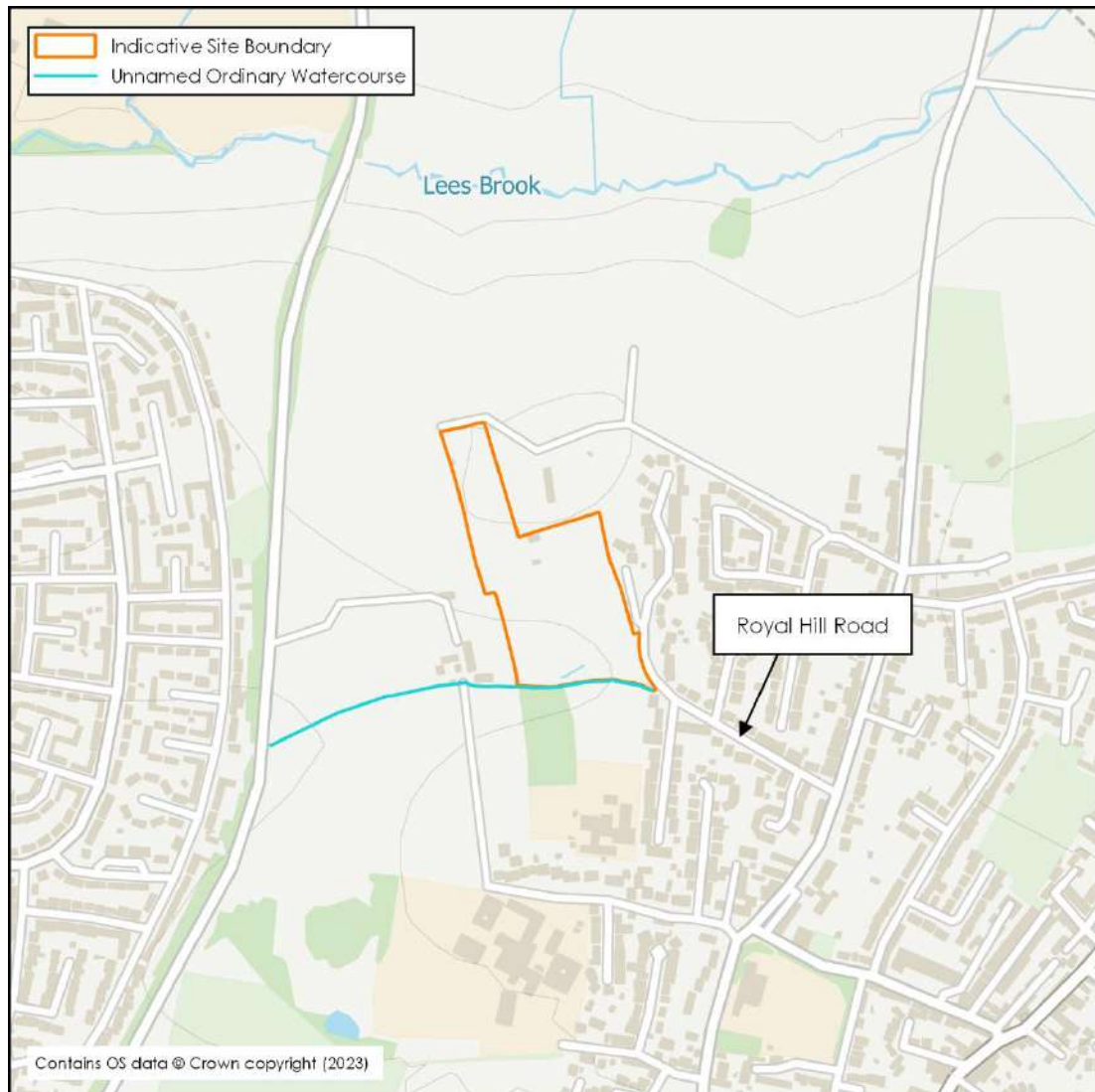


Figure 1.1: Site Location

Proposed Development

- 1.7 The proposed development is understood to comprise a residential development including related infrastructure, landscaping and open space. The proposed access will be from Royal Hill Road in the southeast of the site.
- 1.8 The proposed site layout plan is included as **Appendix 2**.

2. FLOOD RISK PLANNING POLICY & GUIDANCE

National Planning Policy Framework

- 2.1 The NPPF¹ sets out the Government's national policies on different aspects of land use planning in England in relation to flood risk. The PPG is also available online².
- 2.2 The PPG sets out the vulnerability to flooding of different land uses. It encourages development to be located in areas of lower flood risk where possible and stresses the importance of preventing increases in flood risk off site to the wider catchment area.
- 2.3 The PPG also states that alternative sources of flooding, other than fluvial (river flooding), should be considered when preparing an FRA.
- 2.4 The PPG includes a series of tables that define Flood Zones (Table 1), the flood risk vulnerability classification of development land uses (Table 2) and 'compatibility' of development within the defined Flood Zones (Table 3). Table 2 and Table 3 are recreated within **Appendix 3** of this report for reference.
- 2.5 This FRA is written in accordance with the NPPF and the PPG.

Flood Map for Planning

- 2.6 With particular reference to planning and development, the Flood Map for Planning identifies Flood Zones in accordance with Table 1 of the PPG. Further details on the Flood Zone classifications are outlined in **Table 2.1**.

Table 2.1: Flood Zone Classifications

Flood Zone	Description
Flood Zone 1 (Low Probability)	Land having less than a 1 in 1000 annual probability of river or sea flooding (<0.1% Annual Exceedance Probability). All land outside of Flood Zone 2 and 3.
Flood Zone 2 (Medium Probability)	Land having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% - 0.1% AEP); or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5% - 0.1% AEP).
Flood Zone 3a (High Probability)	Land having a 1 in 100 or greater annual probability of river flooding (>1% AEP); or land having a 1 in 200 or greater annual probability of flooding from the sea (>0.5% AEP). This is represented by "Flood Zone 3" on the Flood Map for Planning.
Flood Zone 3b (The Functional Floodplain)	Flood Zone 3b (The Functional Floodplain) is defined as land where water must flow or be stored in times of flood. This is not identified or separately distinguished from Zone 3a on the Flood Map for Planning.

¹ Revised National Planning Policy Framework, Ministry of Housing, Communities & Local Government, amended 2021

² Planning Practice Guidance: <https://www.gov.uk/government/collections/planning-practice-guidance>

2.7 The site is shown to be located within Flood Zone 1, as shown in **Figure 2.1**.

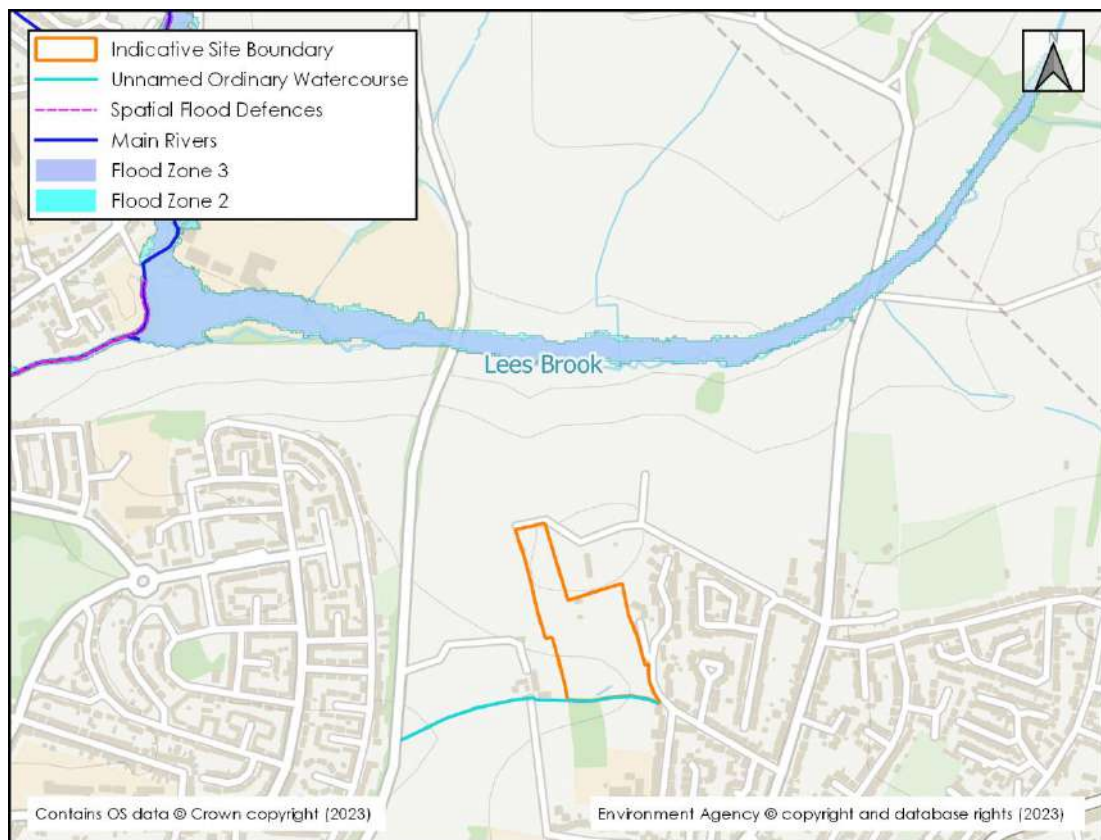


Figure 2.1: Flood Map for Planning

The Design Flood

- 2.8 The PPG identifies that new developments should be designed to provide adequate flood risk management, mitigation, and resilience against the 'design flood' for their lifetime.
- 2.9 This is a flood event of a given annual flood probability, which is generally taken as fluvial (river) and surface water (pluvial) flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year), or tidal flooding with a 0.5% annual probability (1 in 200 chance each year), against which the suitability of a proposed development is assessed and mitigation measures, if any, are designed.

Climate Change

Peak River Flow

- 2.10 Predicted future changes in peak river flows caused by climate change are provided by the EA³, with a range of projections applied to regionalised 'River Basin Districts', which are further subdivided into Management Catchments.

³ Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>. Last Accessed June 2023.

- 2.11 The site falls within the Derwent Derbyshire Management Catchment of the Humber River Basin District. **Table 2.2** identifies the relevant peak river flow climate change allowances from this Management Catchment.

Table 2.2: Peak River Flow Climate Change Allowances for the Derwent Derbyshire Management Catchment within the Humber River Basin District

Allowance Category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2125)
Upper End	29%	38%	63%
Higher Central	18%	23%	39%
Central	13%	17%	29%

- 2.12 When determining the appropriate allowance for use in an FRA the Flood Zone classification, flood risk vulnerability and the anticipated lifespan of the development should be considered. **Table 2.3** provides a matrix summarising the EA's guidance on determining the appropriate allowance(s).

Table 2.3: Application of Appropriate Peak River Flow Climate Change Allowances

Flood Zone	Essential Infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
1	Use the central allowance where a location may fall within Flood Zone 2 or 3 in the future.				
2	Use the higher central allowance	Use the central allowance			
3a	Use the higher central allowance	Development should not be permitted	Use the central allowance		
3b	Use the higher central allowance	Development should not be permitted			Use the central allowance
If development is considered appropriate by the local authority when not in accordance with Flood Zone vulnerability categories, then it would be appropriate to use the higher central allowance.					

- 2.13 There is no future Flood Zone mapping included within the Derby City Council Level 1 Strategic Flood Risk Assessment⁴ (SFRA). EA LiDAR data shows the site is raised at least 10m above the nearest Flood Zones attributed to the Lees Brook.
- 2.14 Therefore, the site is not expected to be in a location which may fall into Flood Zone 2 or 3 within the anticipated lifetime of the proposed development. It is expected that the site will remain safe from fluvial flood risk for its lifetime and additional peak river flow

⁴ Derby City Council Level 1 Strategic Flood Risk Assessment (Derby City Council, June 2010)

climate change allowances do not need to be considered further within this FRA. Due to the pluvial risk shown to the south of the site, rainfall allowances will instead be used, and more detail is provided below.

Peak Rainfall

- 2.15 Predicted future changes in peak rainfall intensity caused by climate change are provided by the EA⁵, with a range of projections also applied to River Basin District Management Catchments.
- 2.16 **Table 2.4** identifies the relevant peak rainfall climate change allowances from the site's Management Catchment.

Table 2.4: Peak Rainfall Climate Change Allowances for the Derwent Derbyshire Management Catchment

Allowance Category	Total potential change anticipated for the '2050s' epoch (2022 to 2060)		Total potential change anticipated for the '2070s' epoch (2061 to 2125)	
	1 in 30-Year	1 in 100-Year	1 in 30-Year	1 in 100-Year
Upper End	35%	40%	35%	40%
Central	20%	20%	25%	30%

- 2.17 The future increase in rainfall will need to be considered when designing a development to ensure its drainage system is sufficient for its lifetime and that it does not increase flood risk elsewhere. When determining the appropriate allowance(s) the anticipated lifespan of the development should be considered. **Table 2.5** provides a summary of the EA's guidance on determining the appropriate allowance(s).

⁵ Environment Agency, Flood risk assessments: climate change allowances: Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>. Last Accessed June 2023.

Table 2.5: Application of Appropriate Peak Rainfall Climate Change Allowances – new Development Drainage Design

Area Assessed	Anticipated Development Life Span		
	up to 2060	between 2061 and 2100	up to or beyond 2100*
Development Sites[^] Assess the 1 in 30-year and 1 in 100-year storm events with the respective climate change allowance(s) applied. Development to be designed so that with the climate change allowance applied to the 1 in 100-year storm: • there is no increase in flood risk elsewhere • the development will be safe from surface water flooding	Use the Central Allowance for the 2050s	Use the Central Allowance for the 2070s ⁺	Use the Upper End Allowance for the 2070s ⁺

*Includes all residential developments

[^]the Lead Local Flood Authority may have local standards that also need to be considered.

⁺unless the 2050s allowance is greater

- 2.18 The development site has an anticipated lifespan of 100+ years. Therefore, the Upper End allowance for the '2070s' epoch will need to be considered when assessing surface water flood risk and in the design of the associated drainage infrastructure.

Strategic Flood Risk Assessment

- 2.19 A 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.
- 2.20 The Derby City Council Level 1 SFRA has been reviewed in the production of this FRA. The SFRA provides information relating to Main Rivers, other watercourses, and allocated development sites. It also includes flood risk policy and guidance for the area. Information from the Level 1 SFRA will be referenced within **Section 3** and **Section 4** where applicable.
- 2.21 A Level 1 SFRA Explanatory Note⁶ was released in 2013 and states that more detailed data was released following the Level 1 SFRA. As a result, the SFRA mapping was amended to reflect changes to the EA Flood Zones. The Note also outlines the inclusion of Potential Overland Flow Routes within the SFRA mapping. These are areas extracted from Derbyshire Surface Water mapping undertaken by the EA and Derbyshire County Council which are considered to be at elevated risk of surface water flooding. The flood maps have been reviewed and will be referenced within **Section 3** where applicable.
- 2.22 The Derby City Council Level 2 SFRA⁷ was produced to facilitate the application of Sequential and Exception Tests to screen allocated development sites in the North

⁶ Level 1 Strategic Flood Risk Assessment Explanatory Note (Derby City Council, October 2013)

⁷ Level 2 Strategic Flood Risk Assessment (Derby City Council, January 2011)

Riverside, Castleward and Derwent Triangle areas. Therefore, the proposed application site is not referenced within the Level 2 SFRA.

Preliminary Flood Risk Assessment

- 2.23 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 LLFAs.
- 2.24 The Derby City Council PFRA⁸ considers flooding from surface water runoff, groundwater, ordinary watercourses and canals. It also references the historical river flooding which occurred in the local area in 1931, 1932, 1965, 1981, 2000, 2001, and 2002. However, no historical instances of flooding at the site are specifically referenced. Information from the PFRA will be referenced within **Section 3** where applicable.
- 2.25 The Derby City Council PFRA Addendum⁹ has also been reviewed in the production of this FRA. The PFRA Addendum provides an update to the 2011 PFRA and information from the PFRA Addendum will be referenced within **Section 3** where applicable.
- 2.26 Key findings from the PFRA Addendum include:
- i. "A large flooding incident occurred on July 19th 2014 that impacted the north-eastern area of the City. [...] The event lead to widespread flooding across north east of Derby in particular Oakwood and Spondon. This has led to concerns on the capacity of the surface water drainage system in these areas".

Local Flood Risk Management Strategy

- 2.27 A Local Flood Risk Management Strategy (LFRMS) is prepared by an LLFA to help understand and manage flood risk at a local level.
- 2.28 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.
- 2.29 The Derby City Council LFRMS¹⁰ has been reviewed and no applicable information in relation to flood risk at the site was identified.

River Basin Flood Risk Management Plan

- 2.30 Flood Risk Management Plans (FRMPs) explain the risk of flooding from rivers, the sea, surface water, groundwater and reservoirs. FRMPs set out how risk management authorities will work with communities to manage flood and coastal risk. Risk management authorities include the EA, Natural Resources Wales, local councils, internal drainage boards, Highways England and LLFAs.

⁸ Preliminary Flood Risk Assessment (Derby City Council, August 2011)

⁹ Preliminary Flood Risk Assessment Addendum (Derby City Council, December 2017)

¹⁰ Local Flood Risk Management Strategy (Derby City Council, March 2017)

- 2.31 The first FRMPs were published in March 2016. They describe actions to manage flood risk across England between 2015 to 2021. A series of updated reports were subsequently published at the end of 2022 which cover the period of 2021 to 2027.
- 2.32 The site is located within the Humber River Basin District, and the Humber FRMP¹¹ has been reviewed. However, there are no relevant objectives which relate to the site.

Surface Water Management Plan

- 2.33 Surface Water Management Plan (SWMPs) are non-statutory plans which preceded the introduction of the Flood and Water Management Act 2010. They can provide an important evidence base of local flood risk issues which can include surface water drains, groundwater and small watercourses.
- 2.34 The Derby City Council SWMP¹² plan has been reviewed and will be referenced within **Section 3** where applicable.

Section 19 Flood Investigation Reports

- 2.35 Under their duties of the Flood and Water Management Act 2010, LLFAs have a responsibility to publish reports of investigations of flood incidents. A section 19 flood investigation report is a public statement of the circumstances of a historical flood event and what parties have a role in managing the risks. The investigation does not always give an in-depth analysis of the flood risk or mechanisms, but it can provide a valuable record of past events.
- 2.36 Derby City Council have published five Section 19 reports on their website, which document the flooding that occurred in 2012, 2014, and 2019. The reports have been reviewed in relation to the site's location, and the findings will be discussed within **Section 3**.

Local Plan

- 2.37 The Derby City Local Plan – Part 1 Core Strategy¹³ has been reviewed in the production of this FRA.
- 2.38 The Core Strategy outlines the city's development strategy, plans, and policies until 2028, and is used to determine all future planning applications submitted to the council. The document is separated into two parts: Core strategy and Site Allocations.
- 2.39 The Derby City Local Plan has 22 core principles, including flood risk. Key policies are summarised below.

¹¹ Humber River Basin District Flood Risk Management Plan 2021 to 2027 (Environment Agency, December 2022)

¹² Surface Water Management Plan (Derby City Council, July 2011)

¹³ Derby City Local Plan – Part 1 Core Strategy (Derby City Council, January 2017)

CP2 - Responding to Climate Change:

- 2.40 The Council is committed to tackling the causes and effects of climate change, including ensuring that development provides access to watercourses, properties are flood resilient and resistant, the development does not increase flood risk elsewhere, and encourages the use of Sustainable Drainage Systems (SuDS).

Other Relevant Policy and Guidance

- 2.41 This FRA has considered the following document when assessing sources of flood risk and when recommending mitigation and resilience measures.

Flood Risk to People and New Developments

- 2.42 The Flood Risk to People (FD2321/TR1)¹⁴ document was prepared as a research project considering flood hazard and factors that affect it.
- 2.43 Flood Risk Assessment Guidance for New Development (FD2320/TR2)¹⁵ provides a framework and guidance for assessing and managing flood risks for new developments and sets flood hazard thresholds.
- 2.44 Hazard ratings are derived using the following equation in line with the above:

$$\text{Hazard Rating} = D * (V+0.5) + DF$$

Where:

D = depth

V = velocity

DF = debris factor

- 2.45 A supplementary note¹⁶ provides clarification of the hazard rating thresholds which should be used for development planning and control use. **Table 2.6** identifies the thresholds of the flood hazard categories.

¹⁴ Flood Risk to People Methodology (FD2321/TR1), Defra/Environment Agency, 2006

¹⁵ Flood Risk Assessment Guidance for New Development (FD2320/TR2), Defra/Environment Agency, 2005

¹⁶ Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purpose – Clarification of the Table 13.1 of FD2320/TR2 and Figure 3.2 of FD2321/TR1. (http://randd.defra.gov.uk/Document.aspx?Document=FD2321_7400_PR.pdf)

Table 2.6: Hazard to People¹⁷

Threshold for Flood Hazard Rating	Degree of Flood Hazard	Description
< 0.75	Low	Caution "Flood zone with shallow flowing water or deep standing water"
0.75 - 1.25	Moderate	Danger for some (i.e.: children, the elderly and the infirm) "Danger: Flood Zone with deep or fast flowing water"
1.25 - 2.0	Significant	Danger for most (includes the general public) "Danger: Flood Zone with deep fast flowing water"
2.0 >	Extreme	Danger for all (includes the emergency services) "Extreme Danger: Flood Zone with deep fast flowing water"

¹⁷ 2008, DEFRA. Supplementary Note on Flood Hazard Ratings and Thresholds for Development Planning and Control Purposes.

3. POTENTIAL SOURCES OF FLOOD RISK

- 3.1 Flooding can occur from a variety of sources, or combination of sources, which may be natural or artificial. **Table 3.1** below identifies the potential sources of flood risk to the site in its current condition, and the impacts which the development could have in the wider catchment, prior to mitigation. These are discussed in greater detail in the forthcoming section. The mitigation measures proposed to address flood risk issues and ensure the development is appropriate for its location are discussed within **Section 4**.

Table 3.1: Pre-Mitigation Sources of Flood Risk

Flood Source	Potential Risk				Description
	High	Medium	Low	None	
Fluvial			X		The site is located in Flood Zone 1 which is land at low risk of flooding.
			X		Direct rainfall modelling shows the UOW itself to the south of the site poses a low risk.
Canals				X	The Trent and Mersey Canal is located approximately 7.3km southeast of the site.
Groundwater			X		The site is shown to fall within an area predicted to be at a low susceptibility to groundwater flooding.
Reservoirs and waterbodies			X		The site is shown to fall outside of the area at risk of reservoir failure.
Pluvial runoff		X			Direct rainfall modelling shows the site is at an overall medium risk of pluvial flooding.
Sewers			X		The site is considered to be at low risk of sewer flooding. If sewers within the site vicinity are exceeded, flows would be conveyed towards the site and to the UOW to the south of the site.
Effect of Development on Wider Catchment			X		Development will not result in displacement of floodplain or impedance of surface water flow routes.
		X			The development will increase the area of impermeable surfaces leading to a potential increase in runoff.

Fluvial Flood Risk

- 3.2 Flooding from watercourses occurs when flows exceed the capacity of the channel, or where a restrictive structure is encountered, which leads to water overtopping the banks into the floodplain. This process can be exacerbated when debris is mobilised by high flows and accumulates at structures.

Main Rivers

- 3.3 The site is shown to be located entirely in Flood Zone 1, which is land at low risk of flooding. The nearest EA Main River to the site is the Chaddesden Brook located approximately 840m northwest of the site. Following a review of EA LiDAR data, the site is shown to be elevated at least 25m above the nearest Flood Zone attributed to the Chaddesden Brook.
- 3.4 Therefore, the site is considered to be at low risk of flooding from Main Rivers.

Ordinary Watercourses

- 3.5 The nearest fluvial flood extents attributed to an ordinary watercourse are located approximately 320m north of the site attributed to the Lees Brook, a tributary of the Chaddesden Brook. EA LiDAR data shows the site is elevated at least 10m above the nearest Flood Zone attributed to the Lees Brook.
- 3.6 An UOW is shown to be present adjacent to the southern site boundary. Derby City Council SFRA mapping shows the potential floodplain associated with this UOW, an extract of mapping is included as **Figure 3.1**.

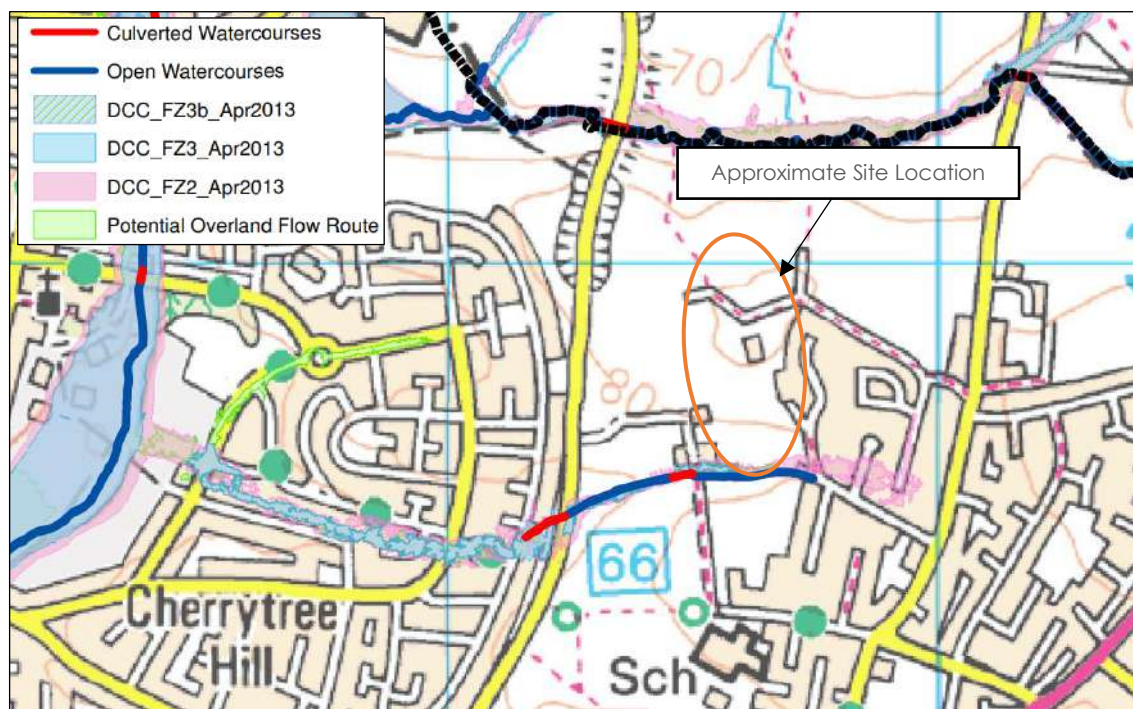


Figure 3.1: Extract from Derby City SFRA

- 3.7 The mapping suggests the site is partially at risk from the UOW. The floodplain extents are relatively confined in line with the local topography, however, the southern extent of the site and its access route via Royal Hill Road appear to be located in Flood Zone 2 based on the SFRA mapping.
- 3.8 The EA Flood Map for Planning does not identify watercourses with catchment areas of less than 3km², therefore, the EA Risk of Flooding from Surface Water (RoFSW) mapping can be used as a proxy for assessing fluvial flood risk to the site, as this dataset provides an indication of the potential floodplain associated with the UOW. An extract of mapping is included as **Figure 3.2**.

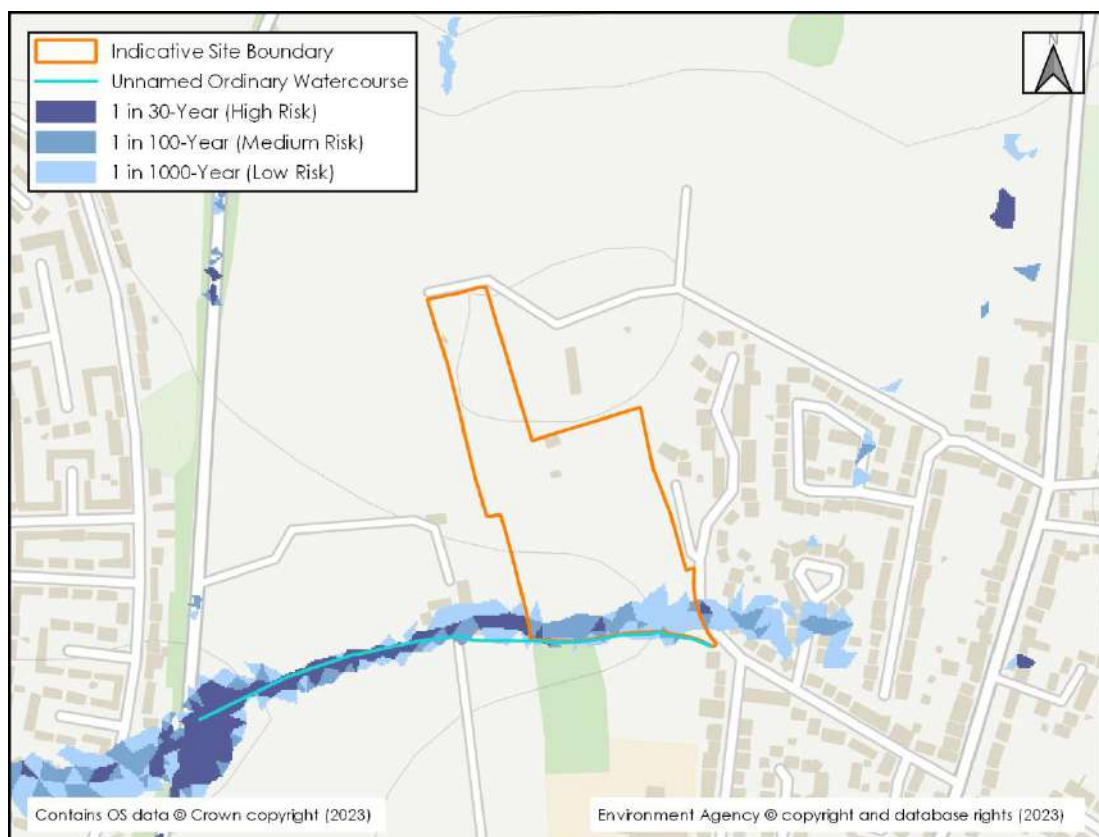


Figure 3.2: EA RoFSW Mapping

- 3.9 The site is shown to be at low to high risk of pluvial flooding, with a low to high risk pluvial flow route present along the southern site boundary. This flow route is broadly aligned with the UOW and provides an indicative floodplain associated with this watercourse.
- 3.10 The LLFA have confirmed that the EA RoFSW mapping was recently updated based on an integrated drainage model which incorporates surface water, ordinary watercourses and sewers for Derby. This information is strategic scale and is therefore not expected to be appropriate to inform a site-specific FRA.
- 3.11 The EA have been consulted and confirm that they do not hold any model information for this area. Therefore, to determine the flood risk posed to the site from this UOW, a hydraulic modelling exercise has been undertaken.

BWB Hydraulic Model – Royal Hill Road, Spondon (2023)

- 3.12 A bespoke modelling exercise of the UOW to the south of the site has been undertaken. In brief, a one-dimensional (1D) – two-dimensional (2D) (ESTRY-TUFLOW) direct rainfall model has been prepared using standard practice in line with the Flood Estimation Handbook (FEH) and EA guidelines. The UOW channel was modelled in the 1D domain with a 2D representation of the rainfall catchment and floodplain. The hydraulic modelling report, included as **Appendix 4**, provides further detail on the hydrology and modelling approach.
- 3.13 The baseline (existing conditions) maximum flood extents at the site are shown in **Figure 3.3**. The floodplain outlines have been trimmed to remove areas of very shallow depths (<0.03m) to help identify the main flow pathways.

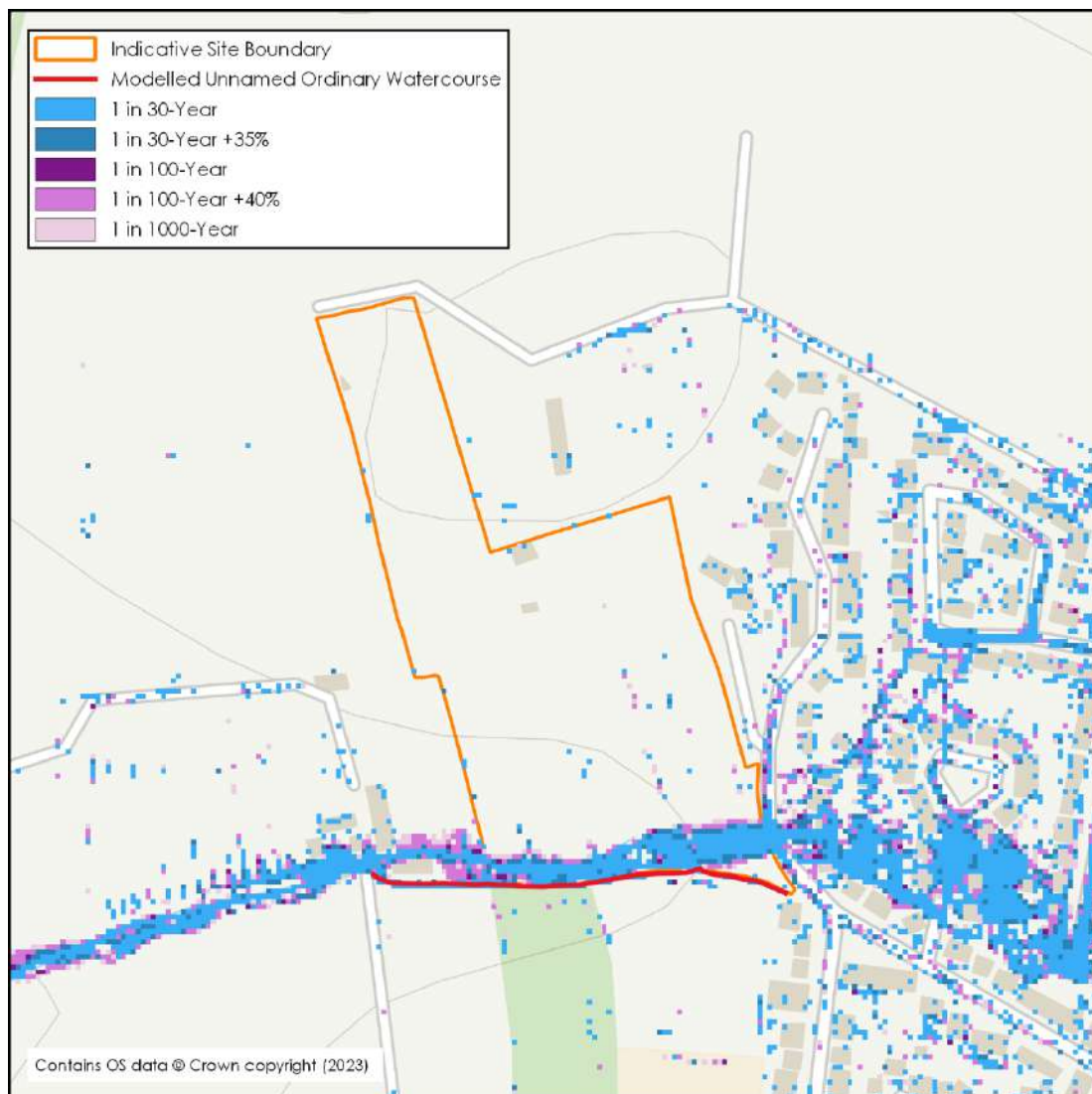


Figure 3.3: Modelled Baseline Floodplain Extents

- 3.14 The modelling demonstrates that the baseline flood extents broadly align with the EA RoFSW Mapping, with flood extents attributed to the UOW shown to be relatively constrained to the channel. This shows that the predominant flood risk to the site is in

fact the overland flow route which appears to be generated at a topographical low point on Royal Hill Road to the southeast of the site.

- 3.15 Based on these results, the site is considered to be at low risk of fluvial flooding attributed to the UOW, as the mechanism is in fact pluvial flooding/overland flow in nature, as opposed to water spilling out of the banks of the UOW and onto the site.

Historical Flood Risk

- 3.16 The EA Historical Flood Map shows there are no previously recorded flood outlines which have impacted the site or immediate surrounding area.
- 3.17 The 'Summary of Historic Flooding' Map included within the Derby City Council PFRA shows there are no previously recorded fluvial flood events which have impacted the site.
- 3.18 The Derby City Council Level 1 SFRA does not report any historical fluvial flood events which have impacted the site or surrounding area.
- 3.19 Overall, the site is considered to be at low risk of fluvial flooding.

Pluvial Flood Risk

- 3.20 Pluvial flooding can occur during prolonged or intense storm events when the infiltration potential of soils, or the capacity of drainage infrastructure is overwhelmed leading to the accumulation of surface water and the generation of overland flow routes.
- 3.21 RoFSW mapping has been collated and published by the EA, this shows the potential flooding which could occur when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. An extract from the mapping is included as **Figure 3.2**.
- 3.22 The site is shown to be predominantly at very low risk of pluvial flooding, with no surface water ponding shown within the site. As outlined within the 'Fluvial Flood Risk' section, the surface water flood map shows a low to high risk pluvial flow route present along the southern site boundary. This appears to be generated at a topographical low point on Royal Hill Road to the southeast of the site.
- 3.23 The hydraulic modelling undertaken by BWB (RHR-BWB-ZZ-XX-RP-YE-0002_HMR, **Appendix 4**) includes site-specific information and therefore supersedes the EA surface water extents associated with this flow route. The model extents, included as **Figure 3.3**, shows the south of the site to be at risk of pluvial flooding for all modelled storm events, up to and including the 1 in 1000-year event.
- 3.24 The results show that the south of the site is generally at risk of relatively shallow pluvial flood depths of between 0.05m to 0.3m during all modelled events. Maximum flood depths during the 1 in 100 year +40% design flood event are shown in **Figure 3.4**.

- 3.25 The Derby City Council Level 1 SFRA does not report any historical surface water flood events which have impacted the site or surrounding area.
- 3.26 The 'Summary of Historic Flooding' Map included within the Derby City Council PFRA shows there are no previously recorded surface water flood events which have impacted the site.
- 3.27 The Derby City Council PFRA Addendum reports a large flooding incident occurred on July 19th 2014 which impacted areas of Spondon. These events have since been reported in two Section 19 Flood Investigation Reports.
- 3.28 The two Section 19 Flood Investigation Reports detail pluvial flooding which impacted Sandringham Drive and Willow Croft Road in Spondon, located approximately 1.35km southeast and approximately 1km south of the site respectively. There is no reference of flooding impacting the site location.

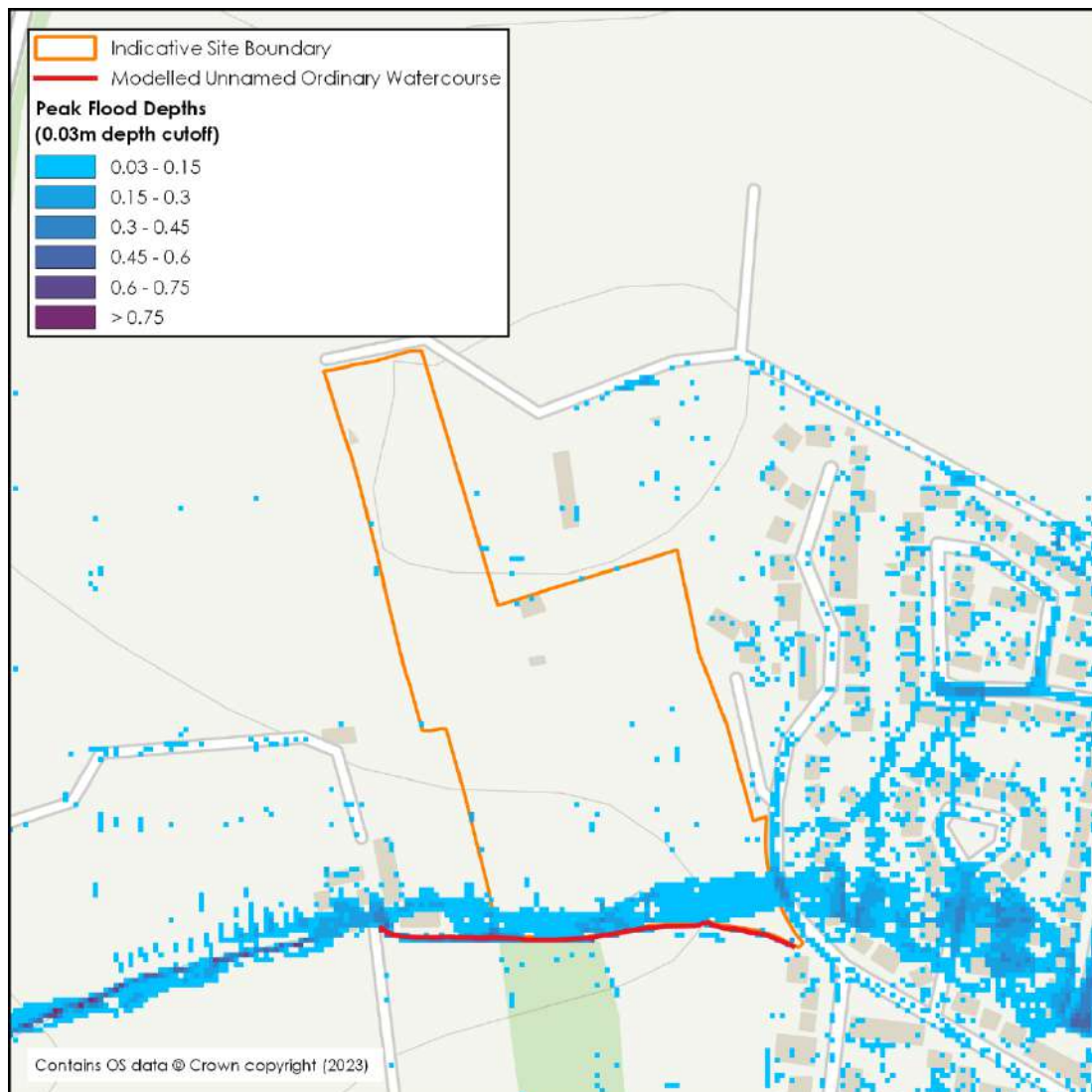


Figure 3.4: 1 in 100-year +40% Maximum Flood Depths (<0.03m cut-off depth)

- 3.29 The pluvial flow route present along the southern site boundary poses a medium risk to the site and corresponding access and egress routes. Therefore, appropriate measures to mitigate this risk are discussed in **Section 4**.

Flood Risk from Canals

- 3.30 The Canal and River Trust (CRT) generally maintains canal levels using reservoirs, feeders and boreholes and manages water levels by transferring it within the canal system.
- 3.31 Water in a canal is typically maintained at predetermined levels by control weirs. When rainfall or other water enters the canal, the water level rises and flows out over the weir. If the level continues rising it will reach the level of the storm weirs. The control weirs and storm weirs are normally designed to take the water that legally enters the canal under normal conditions. However, it is possible for unexpected water to enter the canal or for the weirs to become obstructed. In such instances the increased water levels could result in water overtopping the towpath and flowing onto the surrounding land.
- 3.32 Flooding can also occur where a canal is impounded above surrounding ground levels and the retaining structure fails.
- 3.33 The nearest canal to the site is the Trent and Mersey Canal located approximately 7.3km southeast of the site. Due to the significant distance between the site and the Trent and Mersey Canal, canals are not expected to pose a flood risk to the site.

Groundwater Flood Risk

- 3.34 Groundwater flooding occurs when the water table rises above ground elevations, or it rises to depths containing basement level development. It is most likely to happen in low lying areas underlain by permeable geology. This is most common on regional scale chalk aquifers, but there may also be a risk on sandstone and limestone aquifers or on thick deposits of sands and gravels underlain by less permeable strata such as that in a river valley.
- 3.35 The BGS mapping shows the site is entirely underlain by Tarporley Siltstone Formation (Mudstone and Siltstone). The EA class this geology as a Secondary B Aquifer. Secondary B Aquifers comprise lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin cracks and openings or eroded layers.
- 3.36 The site is also partially underlain by Thrussington Member (Diamicton) Superficial Deposits. The EA class these superficial deposits as Secondary (Undifferentiated) aquifers. Secondary (undifferentiated) aquifers occur where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value. There are no superficial deposits mapped within the southeastern portion of the site.
- 3.37 The Derby City Council Level 1 SFRA and PFRA do not report any historical groundwater flood records which have impacted the city. The 'Areas Susceptible to Groundwater Flooding' map included within the PFRA shows the site is situated within an area that is considered to be at a 25% susceptibility to groundwater flooding.

- 3.38 It should be noted that Groundwater Susceptibility mapping is based on strategic scale mapping that uses a kilometre square grid. It identifies areas susceptible to flooding from groundwater at a broad scale on the basis of geological and hydrogeological conditions, and therefore, the classification could potentially be based on another area within the cell.
- 3.39 The BGS holds historical records of borehole samples across the UK which include measurements of groundwater levels taken during the sample. These are measurements taken at one point in space and time and are not a substitute for a long-term record of groundwater levels. However, they can provide an indication of groundwater levels that could potentially be experienced.
- 3.40 There are no borehole records located within the site, however, one borehole record taken in 1988 is located approximately 290m south of the site and underlain by the same geology (reference: SK33NE534). The borehole record does not report a water strike up to 3m Below Ground Level (bgl).
- 3.41 Overall, based on the geology underlying the site, the site is considered to be at a low risk of groundwater flooding.

Flood Risk from Reservoirs & Large Waterbodies

- 3.42 Flooding can occur from large waterbodies or reservoirs if they are impounded above the surrounding ground levels or are used to retain water in times of flood. Although unlikely, reservoirs and large waterbodies could overtop or breach leading to rapid inundation of the downstream floodplain.
- 3.43 To help identify this risk, reservoir failure flood risk mapping has been prepared and included as **Figure 3.5**, this shows the largest area that might be flooded if a reservoir were to fail and release the water it holds. The map displays a worst-case scenario and is only intended as a guide.
- 3.44 There are two flooding scenarios shown on the reservoir flood maps: a 'dry-day' and a 'wet-day'. The dry-day scenario predicts the flooding that would occur if the dam or reservoir failed when rivers are at normal levels. The wet-day scenario predicts how much worse the flooding might be if a river is already experiencing an extreme flood.



Figure 3.5: Reservoir Failure Flood Risk Map

- 3.45 **Figure 3.5** shows the site to be located outside of the reservoir failure extents for both 'dry-day' and 'wet-day' scenarios. The nearest failure extent is located approximately 260m north of the site attributed to the Locko Park Lake.
- 3.46 A Severn Trent Water covered reservoir borders the north-eastern site boundary and is not represented within the reservoir failure extents. The covered reservoir is reinforced with concrete and is not considered to pose risk to the site.
- 3.47 The reservoirs and large waterbodies are operated and maintained by the responsible authority who have ultimate responsibility for the safety of their assets within Locko Park. Their responsibilities include regular safety inspections, any necessary design or repairs undertaken where required and an annual statement produced on the operation and maintenance regime.
- 3.48 Based on the safety legislation in place and the maintenance and repair responsibilities of the responsible authority, the actual probability of a significant failure is considered

to be low. Therefore, the risk of flooding at the site from this source is also considered to be low.

Flood Risk from Sewers

- 3.49 Sewer flooding can occur when the capacity of the infrastructure is exceeded by excessive flows, or as a result of a reduction in capacity due to collapse or blockage, or if the downstream system becomes surcharged. This can lead to the sewers flooding onto the surrounding ground via manholes and gullies, which can generate overland flows.
- 3.50 The local sewerage undertaker is STW and a copy of their asset plans is included as **Appendix 5**.
- 3.51 The records show the presence of a 375mm diameter public surface water sewer which traverses the south eastern corner of the site, flowing in a southerly direction from Royal Hill Road. This surface water sewer forms part of a wider network located within the existing residential development to the east of the site and is shown to outfall to the UOW located to the south of the site.
- 3.52 A public foul water sewer network is also shown to be located within the existing residential development to the east of the site. Pipe diameters range from 150mm to 300mm and is shown to reach a pumping station located to the south of the site.
- 3.53 For the surface water and foul water sewer networks, the records indicate an average depth to invert of 1.3m and 1.5m-2.4m respectively. Due to the shallow depth of surface water sewers, the site may be at residual risk of flooding from this source.
- 3.54 In the event of exceedance of the assets located within Royal Hill Road, flows are expected to be conveyed in a southerly direction towards the site and to the UOW, following the general topography of the area.
- 3.55 The 'Summary of Historic Flooding' Map included within the Derby City Council PFRA shows there are no previously recorded sewer flood events which have impacted the site.
- 3.56 The large flood event which impacted Spondon in 2014, referenced within the Derby City Council PFRA Addendum, suggests there may be a residual risk of surface water sewer flooding, with issues surrounding the capacity of the surface water drainage systems in Spondon.
- 3.57 Surface water sewerage assets located to the east of the site were modelled as part of the hydraulic modelling undertaken by BWB (RHR-BWB-ZZ-XX-RP-YE-0002_HMR, **Appendix 4**). The results show that the sewers located within Royal Hill Road do not become surcharged during all modelled scenarios including the 1 in 1000-year event.
- 3.58 Overall, the site is considered to be at low risk of sewer flooding. However, there is a potential residual risk of sewer flooding to site due to the shallow depth of surface water

sewers and previous flood events within the area. Appropriate measures to mitigate this residual risk are discussed in **Section 4**.

- 3.59 This residual risk should be mitigated by Severn Trent Water who have maintenance responsibilities associated with their assets. Appropriate inspection and repair should be applied by Severn Trent Water where blockages and exceedance events occur in order to limit potential future failure of the system which may lead to flooding.

Effect of Development on Wider Catchment

Displacement of Floodplain

- 3.60 There is an area of 1 in 100-year +40% climate change design event floodplain present across the south of the site. The proposed development has the potential to displace this prior to mitigation. Appropriate mitigation measures are set out in **Section 4**.

Impedance of Flood Flows

- 3.61 There is a flow route generated across the south of the site during the 1 in 100-year +40% climate change design event. The proposed development has the potential to impede or re-direct this flow route prior to mitigation. Appropriate mitigation measures are set out in **Section 4**.

Development Land Use/Drainage Considerations

- 3.62 The development will increase the area of impermeable surfaces, increasing the rate of runoff from the site. Therefore, mitigation measures will be necessary, as discussed in **Section 4**.

4. FLOOD RISK MITIGATION

- 4.1 **Section 3** has identified the sources of flooding which could potentially pose a risk to the site and the proposed development. This section of the FRA sets out the mitigation measures which are to be incorporated within the proposed development to address and reduce the risk of flooding to within acceptable levels.

Surface Water and Foul Water Drainage

- 4.2 To mitigate the development's impact on the current runoff regime it is proposed to incorporate surface water attenuation and storage as part of the development proposals.
- 4.3 In brief, the development will continue to discharge surface water to the UOW at the equivalent greenfield QBAR rate. Attenuated surface water storage will be provided in the form of a SuDS detention basin with capacity for the 1 in 100-year storm with an allowance for climate change.
- 4.4 The development should be designed with exceedance in mind and the road network should be used to convey excess overland flows towards the attenuation points.
- 4.5 It is proposed to drain used water from the development separately to surface water.
- 4.6 Further information on the drainage approach is provided within the accompanying Sustainable Drainage Statement, reference (reference: RHR-BWB-ZZ-XX-RP-CD-0001_SDS).

Post-Development Pluvial Flood Risk

- 4.7 As part of the hydraulic modelling, a post-development scenario was undertaken to understand the impact that the development could have on flood risk to the site and surrounding areas.
- 4.8 The hydraulic model was updated to consider the proposed development area and the restricted runoff rate as a result of the proposed surface water drainage strategy. The post-development conditions were run across all key return periods, and the results are presented within **Figure 4.1** with peak modelled flood depths compared to baseline depths within **Table 4.1**.

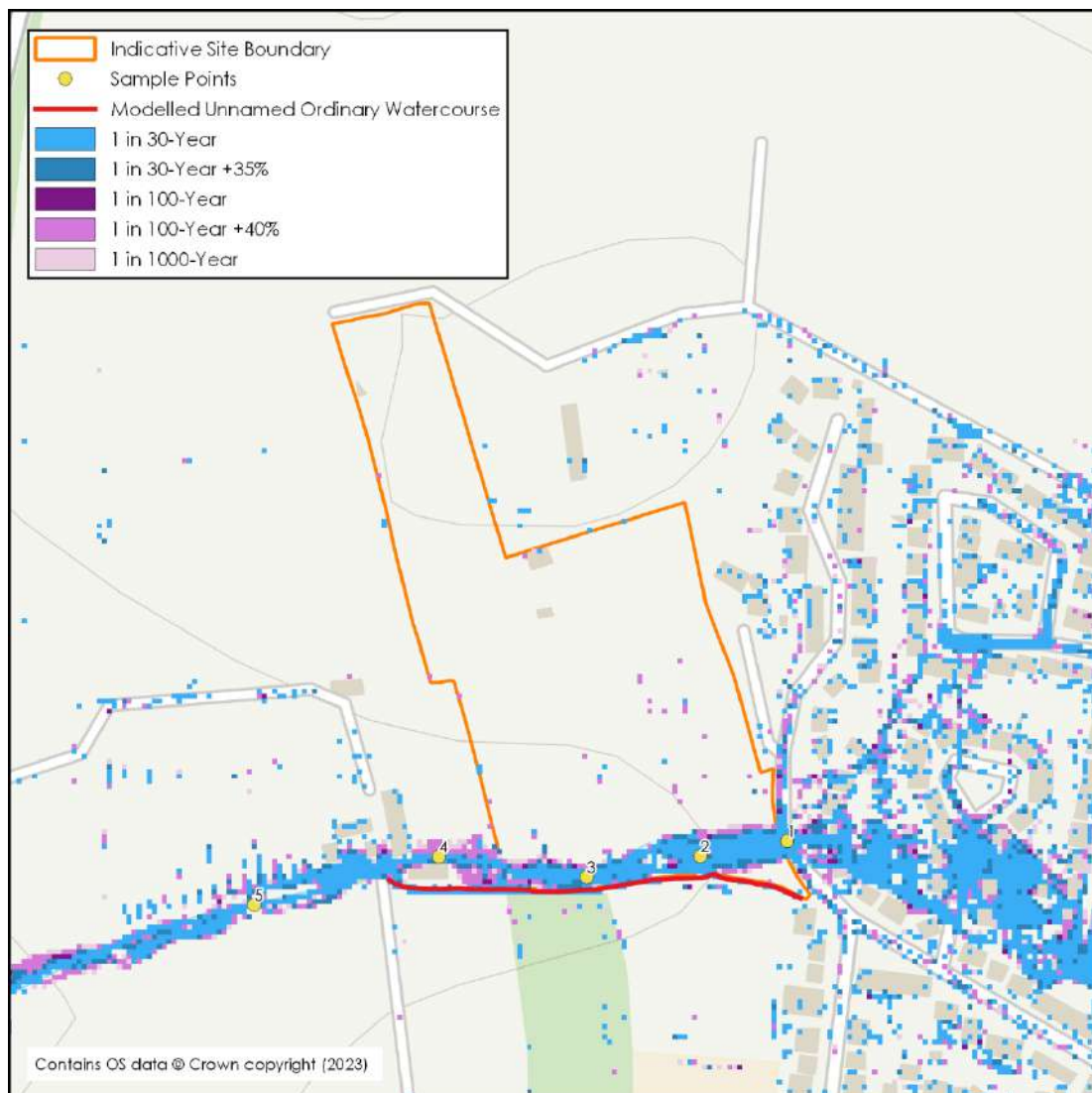


Figure 4.1: Post-Development Floodplain Extents (<0.03m cut-off depth)

Table 4.1: Post-Development Peak Modelled Flood Depth Comparison (m)

Node	1 in 30-Year			1 in 30-year +35%			1 in 100-Year			1 in 100-Year +40%			1 in 1000-Year		
	Post – Development Flood Depth	Baseline Flood Depth	Difference with Baseline	Post – Development Flood Depth	Baseline Flood Depth	Difference with Baseline	Post – Development Flood Depth	Baseline Flood Depth	Difference with Baseline	Post – Development Flood Depth	Baseline Flood Depth	Difference with Baseline	Post – Development Flood Depth	Baseline Flood Depth	Difference with Baseline
1	0.28	0.28	0	0.31	0.31	0	0.31	0.31	0	0.34	0.34	0	0.36	0.36	0
2	0.04	0.04	0	0.05	0.05	0	0.05	0.05	0	0.07	0.07	0	0.07	0.07	0
3	0.10	0.10	0	0.12	0.12	0	0.13	0.13	0	0.16	0.16	0	0.18	0.18	0
4	0.10	0.10	0	0.11	0.12	-0.01	0.12	0.12	0	0.17	0.17	0	0.19	0.19	0
5	0.43	0.44	-0.01	0.51	0.52	-0.01	0.52	0.53	-0.01	0.63	0.63	0	0.66	0.67	-0.01

- 4.9 The post-development results are similar to the baseline extents, with the site shown to be partially at risk in all modelled scenarios. The predominant flood risk to the site is still the pluvial flow route generated at the topographical low point on Royal Hill Road.
- 4.10 To assess the potential impact on third-party flood risk, the post-development modelled peak flood levels and flood extents were compared to the equivalent baseline conditions for the 1 in 100-year +40% climate change scenario. The comparison mapping is included as **Figure 4.2**.

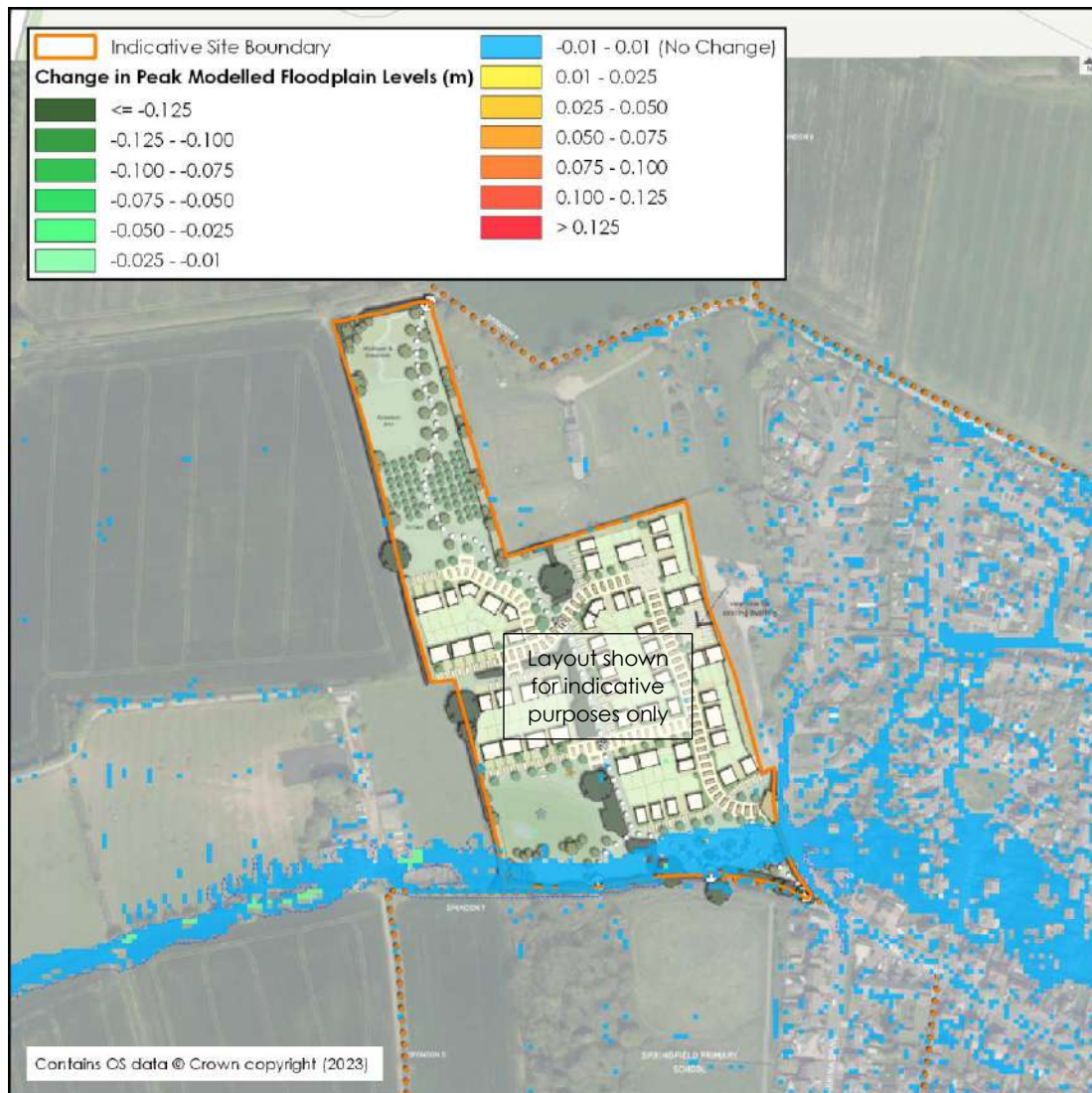


Figure 4.2: Baseline and Post-Development Floodplain Comparison - 1 in 100-year +40% (<0.03m cut-off depth)

- 4.11 Across all modelled events there is shown to be no change (within model tolerances) in modelled flood levels across the majority of the model domain. Flood levels are shown to decrease downstream of the site where the proposed attenuation basin will outfall to the UOW.
- 4.12 The development therefore is not expected to lead to a detriment in flood risk both on-site and downstream.

Sequential Arrangement

- 4.13 Flood flows across all modelled flood events are shown to remain in channel, therefore the site is located outside of fluvial flood risk.
- 4.14 The proposed site layout has been sequentially arranged so all housing is located outside of the 1 in 100-year +40% climate change pluvial flood extent, as shown in **Figure 4.2**. Derby City Council have confirmed that a Sequential Test is therefore not required.

Development Levels

- 4.15 Finished floor level requirements are not outlined within the Derby City Council Level 1 SFRA. Therefore, in line with national design requirements, finished floor levels should be raised at least 600mm above the 1 in 100-year plus an allowance for climate change flood level.
- 4.16 It is recommended that the proposed dwellings have finished floor levels set 600mm above the nearest peak 1 in 100-year +40% flood level or 150mm above surrounding ground levels, whichever is greater. This is considered to provide a level of mitigation from any other residual sources of flood risk.
- 4.17 Ground levels should be profiled to encourage pluvial runoff and overland flows away from the built development and towards the nearest drainage point.

Floodplain Compensation

- 4.18 There should be no changes to existing ground levels within the 1 in 100-year +40% climate change design event floodplain extent. This will ensure no net loss of the design event floodplain. The current site layout has been sequentially arranged so that all built development is located outside of the 1 in 100-year +40% climate change design event floodplain (**Figure 4.2**).

Safe Access and Egress

- 4.19 While the site has been sequentially arranged so that the built development and proposed access point are located outside of the 1 in 100-year +40% climate change pluvial flood extent, there is a residual risk posed to Royal Hill Road to the southeast of the site access point. During consultation, the LLFA accepted the general principle that this is a residual off-site risk and that measures have been undertaken within the proposed development site to mitigate this.
- 4.20 Surface water hazard mapping for the 1 in 100-year +40% scenario has been included as **Figure 4.3**. The mapping shows a minor area of Royal Hill Road (approximately 6m) to be subject to depths of up to 400mm which presents a significant (Danger for Most) hazard, as per definitions within **Table 2.6**. It should be noted that **Section 2** confirms the emergency services can still cross this area of significant hazard to reach the site during a flood event.

- 4.21 To mitigate this residual risk, it is recommended that residents sign up to the Met Office UK weather warnings to be aware of potential extreme rainfall events which may lead to compromised access on Royal Hill Road. If an extreme weather warning is issued or an extreme rainfall event were to occur, it is recommended that alternative pedestrian access and egress is achieved via the footpath to the north of the site onto Longley Lane.
- 4.22 Furthermore, the raising of finished floor levels above the 1 in 100-year +40% design event flood level including an appropriate freeboard will mean that safe refuge is available within the built development during a flood event.

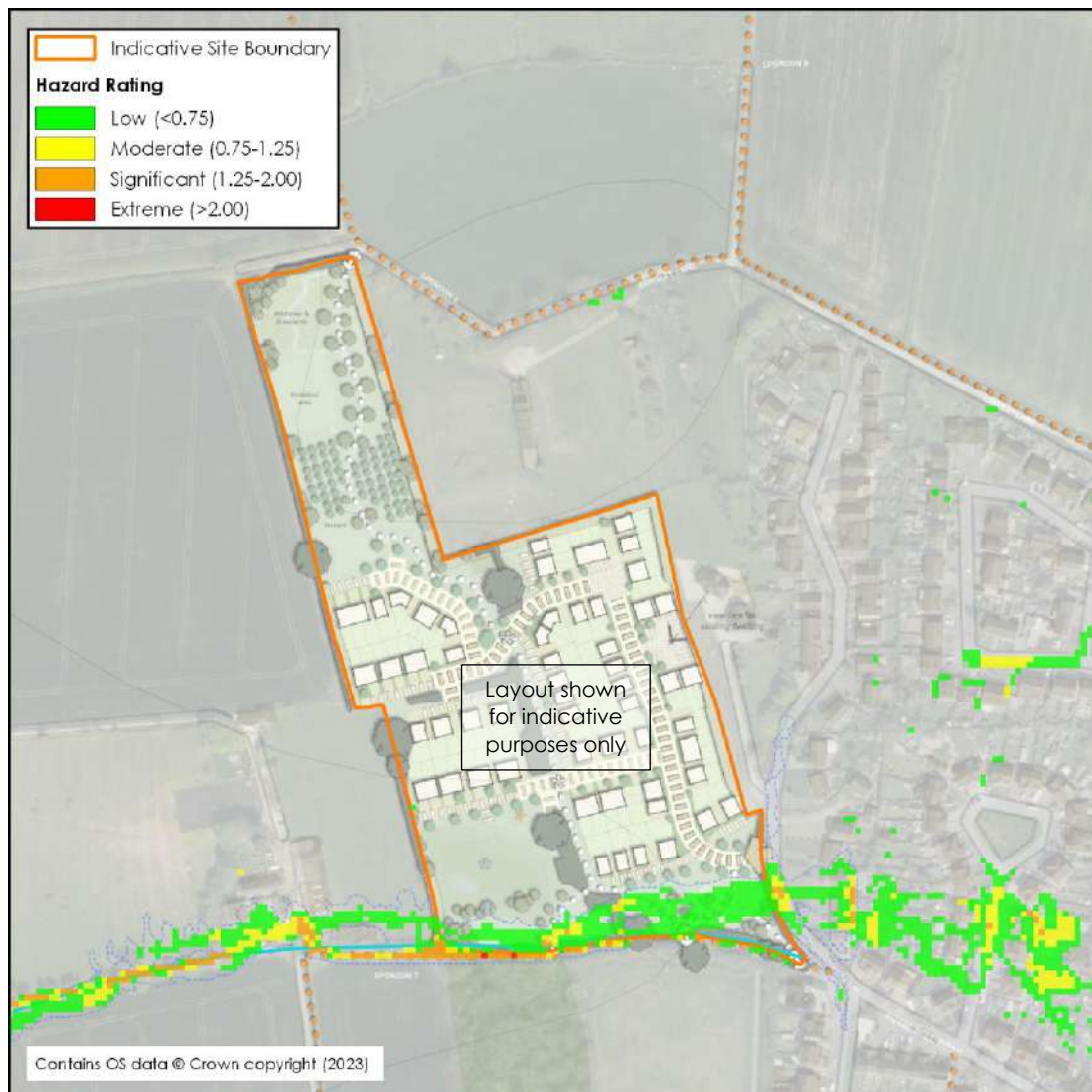


Figure 4.3: Post-Development Hazard Mapping - 1 in 100-year +40%

5. CONCLUSIONS AND RECOMMENDATIONS

- 5.1 This FRA has been prepared in accordance with requirements set out in the NPPF and the associated PPG. The FRA has been produced on behalf of Miller Homes Ltd in respect of a planning application for the proposed residential development located at Royal Hill Road, Spondon.
- 5.2 This FRA is intended to support an outline planning application, the level of detail included is commensurate and subject to the nature of the proposals at the planning stage.
- 5.3 This report demonstrates that the proposed development is at an acceptable level of flood risk, subject to the recommended flood mitigation strategies being implemented. The identified risks and mitigation measures are summarised within **Table 5.1**:

Table 5.1: Summary of Flood Risk Assessment

Flood Source	Risk & Proposed Mitigation Measures
Fluvial	The site is located entirely within Flood Zone 1. The nearest fluvial flood extents are located approximately 320m north of the site attributed to the Lees Brook. EA LiDAR data shows the site is elevated at least 10m above the nearest Flood Zone attributed to the Lees Brook. An UOW is located adjacent to the southern site boundary. To understand the risk associated with this watercourse, BWB Consulting have undertaken a direct rainfall hydraulic modelling exercise. The modelling shows that all flood extents associated with the UOW remain in channel, and the predominant risk to the site is a pluvial overland flow route which is generated at a topographical low point on Royal Hill Road. Overall, the site is considered to be at a low risk of fluvial flooding.
Pluvial runoff	The site is shown to be at predominantly a very low risk of pluvial flooding, with no surface water ponding shown within the site. EA RoFSW Mapping shows the presence of a low to high risk pluvial flow route along the southern site boundary. The direct rainfall hydraulic modelling undertaken supersedes the generalised EA RoFSW to inform flood risk for the site-specific FRA. The results from the modelling exercise show the south of the site to be at risk of pluvial flooding for all modelled storm events. Post-development modelling was undertaken to understand the impact the development would have on flood risk to the site and surrounding areas. Across all post-development modelled events, there is shown to be no change (within model tolerances) in modelled flood levels across the majority of the model domain, with flood levels shown to decrease downstream of the site. Therefore, the development is not expected to lead to a detriment in flood risk both on-site and downstream. It is recommended that finished floor levels of the proposed dwellings are raised 600mm above the 1 in 100-year +40% climate change level or 150mm above surrounding ground levels, whichever is greater.

	The site's access and egress route via Royal Hill Road is shown to be subject to surface water flood depths of up to 400mm which presents a significant (Danger for Most) hazard, for an approximate 6m stretch, during the 1 in 100-year +40% climate change design scenario. In the event of flooding, alternative safe pedestrian access and egress can be achieved via the footpath to the north of the site onto Longley Lane.
Other Sources	The site has been assessed against other sources of flood risk including canals, groundwater, reservoirs and large waterbodies, and sewers. The overall risk posed by these sources is considered low and therefore these sources do not preclude development. The raising of finished floor levels will provide mitigation for any residual flood risks. Furthermore, ground levels should be profiled to encourage pluvial runoff and overland flows away from the built development and towards the nearest drainage point.
Impact of the Development	The site has been sequentially arranged to locate all proposed residential development outside of the 1 in 100-year +40% climate change floodplain extent and the associated overland flow route. The development will increase the area of impermeable surfaces, increasing the rate of runoff from the site. To mitigate the development's impact on the current runoff regime it is proposed to incorporate surface water attenuation and storage as part of the development proposals. It is proposed to drain used water from the development separately to surface water.
This summary should be read in conjunction with BWB's full report. It reflects an assessment of the Site based on information received by BWB at the time of production.	

- 5.4 In compliance with the requirements of NPPF, and subject to the mitigation measures proposed, the development could proceed without being subject to significant flood risk. Moreover, the development will not increase flood risk to the wider catchment area subject to suitable management of surface water runoff discharging from the site.

APPENDICES

Appendix 1: Topographical Survey

Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. No scale factor has been applied to this survey, therefore the os coordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
8. OS license number: 10002432

Key Plan

Legend

OS Buildings

Surveyed Buildings

Building

Wall

Kerb Channel Line

Top of Kerb

Top of Bank

Edge of Surface

Bottom of Bank

Canopy / Overhang

Line Marking

Centre Line

Watercourse

Centre Line

Barrier

Fence

Gate

Overhead Powerline

Overhead Utilities

Contour Lines

Inspection Chamber

Flow direction and pipe-diameter

Station and Name

Monitoring Borehole

Tree / Bush / Sapling

Area of Vegetation/ Extent of Tree Canopy

Hedge

Body of Water

Body of Water from OS

Spot Level

Assumed Surface

Water Drainage Line

Surface Water Drainage Line

AP Anchor Point

BO Back Gully

BT British Telecom

C Crest

CL Cover Level

CMP Cable Marker

P Post

CCTV/Security Camera

CTV Cable TV

DC Drainage

DK Drop Kerb

DP Down Pipe

ELC Electric

EP Electricity Post

ER Earth Road

FL Floodlight

FBW Fence Barbed Wire

FOB Fence Closed Board

FCL Fence Chain Link

FEL Fence Electric

FMP Fence Metal Panel

FOB Fence Open Board

FWW Fence Post & Wire

FWM Fence Wire Mesh

FFL Finished Floor Level

FP Flagpole

OV Gas Valve

HS Height

IC Inspection Chamber

IFL Internal Floor Level

IL Invert Level

LB Litter Bin

LP Lamp Post

MH Manhole

MS Service Marker

PS Post Box

PT Post

RE Roadside Eye

SP Sign Post

ST Stop Sign

SV Stop Valve

TGB Telephone Call Box

THL Threshold Level

TL Traffic Light

TS Telegraph Post

TS Traffic Signal

UTS Unable to Survey

WL Water Level

WM Water Meter

WO Wash Out

P2	08.04.22	Middle Field Added	IR	DS
P1	26.11.20	First Issue	IR	DS
Rev	Date	Details of issue / revision	Dw	Rev

Issues & Revisions

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Client

Miller Homes Ltd

Project Title

Land At
Royal Hill Road
Spondon

Drawing Title

Existing Site Plan

Drawn:	LRiley	Reviewed:	D.Smith
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BWB Ref:	BMW 3087	Date:	26.11.20	Scale@A0:	1:500
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Drawing Status

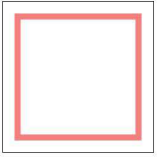
Information

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
RHR-BWB-00-ZZ-DR-G-0001	S2	P2

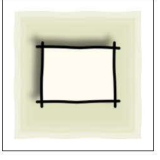
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Appendix 2: Proposed Site Layout

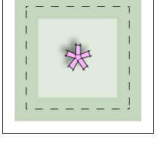




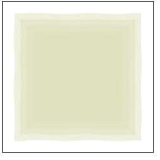
Site Boundary
4.51Ha



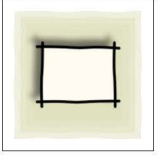
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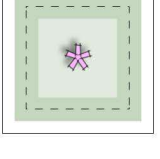
Equipped Play Space
LEAP



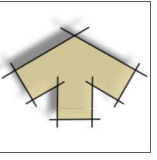
Residential Development Area
2.19Ha = Circa 90 dwellings
Dependent on housing mix



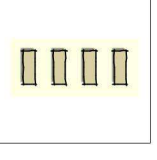
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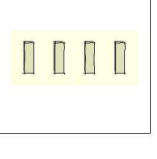
Equipped Play Space
LEAP



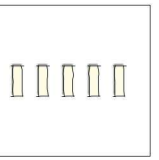
Site Access
Vehicle and Pedestrian



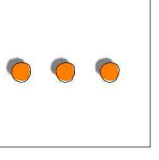
Streets



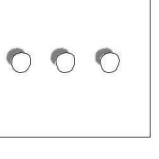
Lanes



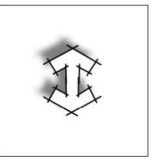
Shared Private Drives



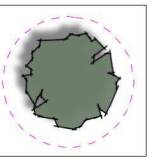
Public Rights of Way



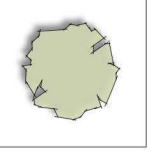
Footpaths &/or Cycleways
Infrastructure to connect to the wider existing network of routes and PRoWs to adjacent schools



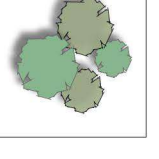
Pedestrian Connections at Site Boundary



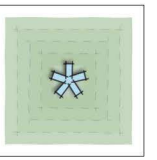
Retained Trees & Hedgerows
With associated RPAs



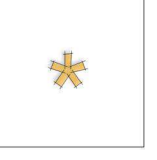
Structural Landscaping
Planting buffer along eastern boundary



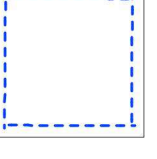
Illustrative Landscape Strategy
Includes opportunities for a kickabout area, orchard and grasslands (to be agreed as part of detailed applications)



Drainage Basin



Illustrative Location of Pumping Station



Flood Zones

Appendix 3: NPPF Flood risk Vulnerability and Flood Zone Compatibility

Flood Risk Vulnerability Classifications (recreated from the NPPF Planning Practise Guidance)

Vulnerability Classification	Description
Essential infrastructure	• Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk. • Essential utility infrastructure which has to be located in a flood risk area for operational reasons, including infrastructure for electricity supply including generation, storage and distribution systems; including electricity generating power stations, grid and primary substations storage; and water treatment works that need to remain operational in times of flood. • Wind turbines. • Solar farms.
Highly Vulnerable	• Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding. • Emergency dispersal points. • Basement dwellings. • Caravans, mobile homes and park homes intended for permanent residential use. • Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure'.)
More Vulnerable	• 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.
Less Vulnerable	• Police, ambulance and fire stations which are not required to be operational during flooding. • Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure. • Land and buildings used for agriculture and forestry. • Waste treatment (except landfill* and hazardous waste facilities). • Minerals working and processing (except for sand and gravel working). • Water treatment works which do not need to remain operational during times of flood. • Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place. • Car parks.
Water-Compatible Development	• Flood control infrastructure. • Water transmission infrastructure and pumping stations. • Sewage transmission infrastructure and pumping stations. • Sand and gravel working. • Docks, marinas and wharves. • Navigation facilities. • Ministry of Defence installations. • Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location. • Water-based recreation (excluding sleeping accommodation). • Lifeguard and coastguard stations. • Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms. • Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Flood Zone Compatibility (recreated from the NPPF Planning Practise Guidance)

Flood Zone	Vulnerability Classification				
	Essential infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 1 (Low Probability)	Development is appropriate	Development is appropriate	Development is appropriate	Development is appropriate	Development is appropriate
Flood Zone 2 (Medium Probability)	Development is appropriate	To be deemed appropriate an exception test is required to demonstrate: - The development will be safe for its life time without increasing flood risk elsewhere, and where possible reduce overall flood risk - the sustainability benefits of the development to the community outweigh the flood risk.	Development is appropriate	Development is appropriate	Development is appropriate
Flood Zone 3a (High Probability)	To be deemed appropriate an exception test is required to demonstrate: The development will be safe for its life time without increasing flood risk elsewhere, and where possible reduce overall flood risk the sustainability benefits of the development to the community outweigh the flood risk. Additionally, essential infrastructure should be designed and constructed to remain operational and safe in times of flood.	Development should not be permitted	To be deemed appropriate an exception test is required to demonstrate: - The development will be safe for its life time without increasing flood risk elsewhere, and where possible reduce overall flood risk - the sustainability benefits of the development to the community outweigh the flood risk.	Development is appropriate	Development is appropriate

Flood Zone	Vulnerability Classification				
	Essential infrastructure	Highly Vulnerable	More Vulnerable	Less Vulnerable	Water Compatible
Flood Zone 3b (The Functional Floodplain)	To be deemed appropriate an exception test is required to demonstrate: - The development will be safe for its life time without increasing flood risk elsewhere, and where possible reduce overall flood risk - the sustainability benefits of the development to the community outweigh the flood risk. Additionally, development should be designed and constructed to: - remain operational and safe for users in times of flood; - result in no net loss of floodplain storage; - not impede water flows and not increase flood risk elsewhere.	Development should not be permitted	Development should not be permitted	Development should not be permitted	Development is appropriate if designed and constructed to: - remain operational and safe for users in times of flood; - result in no net loss of floodplain storage; - not impede water flows and not increase flood risk elsewhere.

Appendix 4: Hydraulic Modelling Report

ENVIRONMENT

Miller Homes Ltd
Royal Hill Road
Spondon
Hydraulic Model Report

ENVIRONMENT

Miller Homes Ltd
Royal Hill Road
Spondon
Hydraulic Model Report

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July 2023

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P02	18/07/23	S2	Update to include post- development conditions modelling	Alex Eaton BSc (Hons)	Rachel Meredith BSc (Hons) MCIWEM	Alex Petrakis BSc (Hons)MCIWEM C.WEM

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The information presented, and conclusions drawn, are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

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GLOSSARY & NOTATION

1D – one-dimensional hydraulic model, good for representing the hydraulics of a definitive channel or flow pathway and hydraulic structure.

2D – two-dimensional hydraulic model, good for representing complex flow routing present within the floodplain.

Annual Exceedance Probability (AEP) - the probability (%) of a flood event occurring in any year.

Catchment - the land area that drains (normally naturally) to a given point on a river, drainage system or body of water.

DTM – Digital Terrain Model

EA – Environment Agency

ESTRY - a 1D hydraulic modelling software package published by BMT.

Flood Estimation Handbook (FEH) – industry standard guidance on rainfall and river flood frequency estimation across the UK.

Floodplain - any area of land over which water flows or is stored during a flood event.

Hydraulic Model - a mathematical (generally computer based) model of a water/sewer/storm system which is used to analyse the system's hydraulic behaviour.

LiDAR – Light Detection and Ranging aerial survey data

mAOD – metres above Ordnance Datum

OS – Ordnance Survey

ReFH – Revitalised Flood Hydrograph rainfall-runoff hydrological model

Return period - a statistical term defining the probability of occurrence of a flood event. Thus a 1 in 50-year flood is one likely to be equalled or exceeded on average only once in a 50-year period: a flood with a 2.0% AEP.

TUFLOW – a 2D fixed grid hydraulic modelling software package published by BMT.

UOW – Unnamed Ordinary Watercourse

Watercourse – a natural or man-made open channel for the conveyance of water.

Z-Shape – a layer in TUFLOW which can be used to manipulate the 2D model geometry.

1. INTRODUCTION

- 1.1 BWB Consulting Ltd has been commissioned by Miller Homes Ltd (the client) to undertake a site-specific hydraulic modelling exercise of the minor UOW to the south of a site located at Royal Hill Road, Spondon (NGR: SK 39631 36706). This exercise has been undertaken in order to inform and support masterplan production for the site.

Site Description

- 1.2 The site is situated within Spondon, located approximately 4.5km east of Derby City Centre. The site is bound by Royal Hill Road and existing residential development to the east, and predominantly greenfield land to the north and west. A UOW is located along the southern boundary of the site. Access to the site is obtained via Royal Hill Road to the southeast of the site. The site location is shown in **Figure 1.1**.

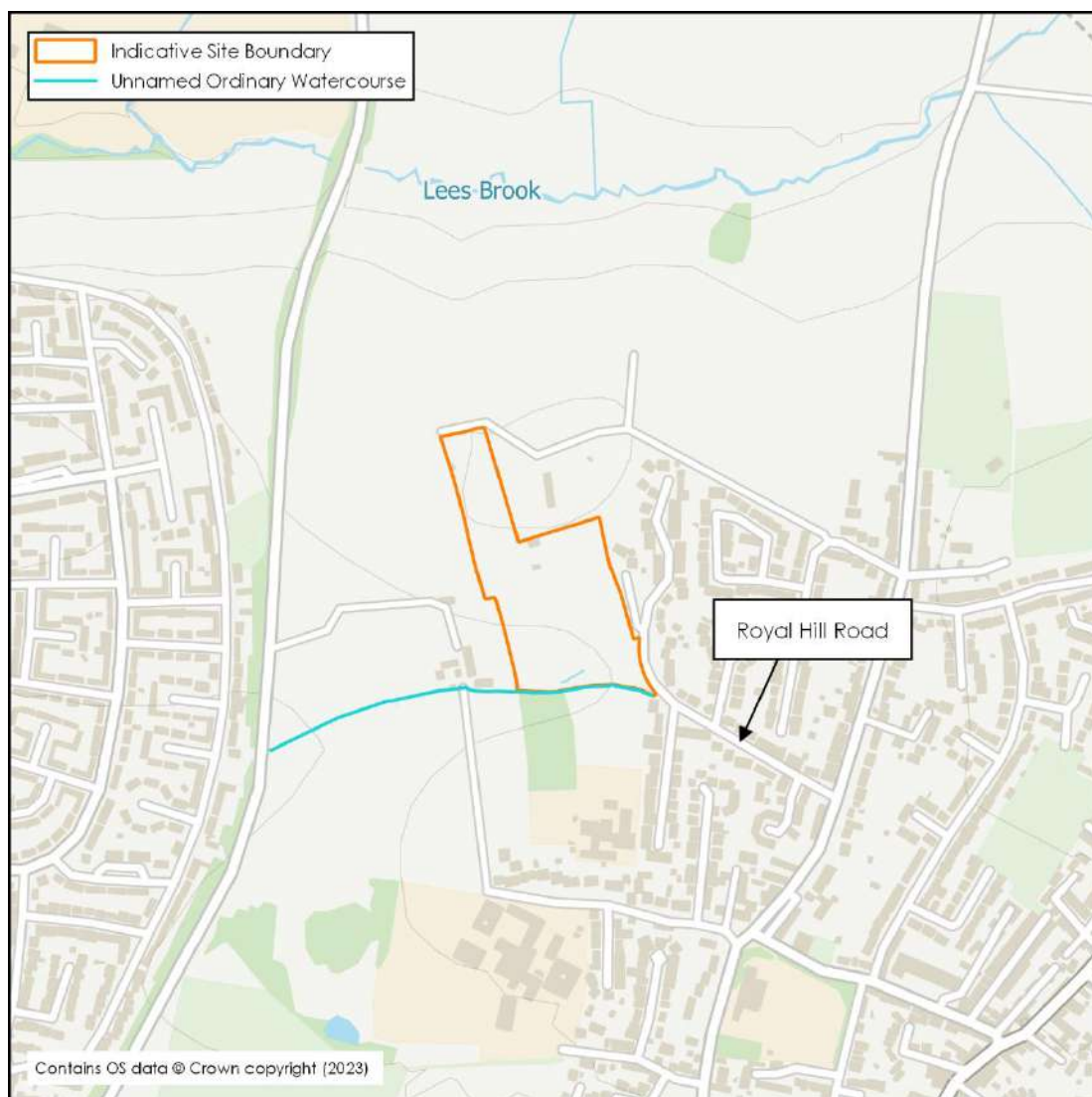


Figure 1.1: Site location

- 1.3 A topographical survey has been undertaken and is included as **Appendix 1**. The survey shows the site generally falls from north to south, falling from a high point of

approximately 91.2 mAOD in the north, to a low point of approximately 76.1 mAOD in the southwest corner of the site. A small portion of the site to the north falls from the high point in a northerly direction.

- 1.4 The survey also shows that a small land drainage feature is present to the south of the site which appears to outfall to the UOW.
- 1.5 The site is currently undeveloped and predominantly comprises arable fields. Precipitation falling on the site is expected to either drain by infiltration into the underlying ground or by overland flows into the UOW.

Previous Studies & Available Data

EA Flood Maps

- 1.6 As shown in **Figure 1.2**, the site sits in Flood Zone 1. As the UOW's catchment area is considered too small to be included within the national mapping programme, explicit hydraulic modelling is required to determine the risk from this watercourse.

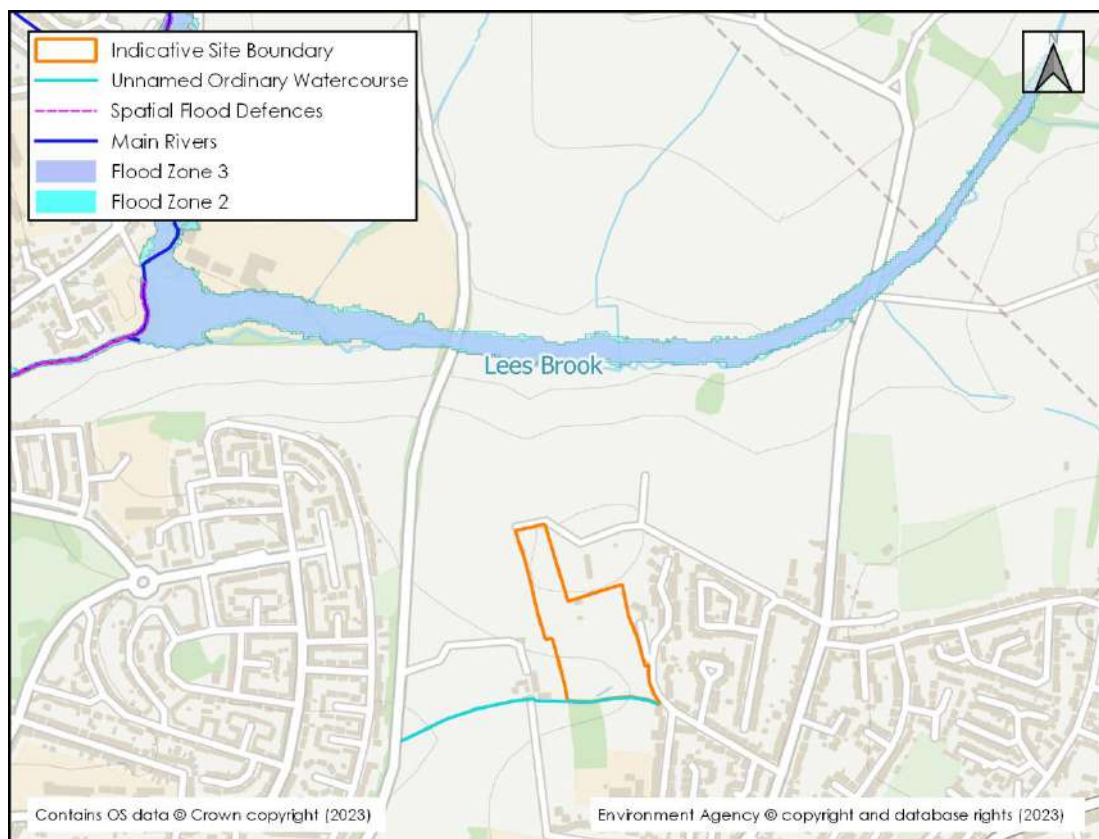


Figure 1.2: EA Flood Map for Planning

- 1.7 The EA Flood Map for Planning does not identify watercourses with catchment areas of less than 3km², therefore, the EA Surface Water Flood Map can be used as a proxy for assessing fluvial flood risk to the site, as this dataset provides an indication of the potential floodplain associated with the UOW. An extract of mapping can be seen in **Figure 1.3**.

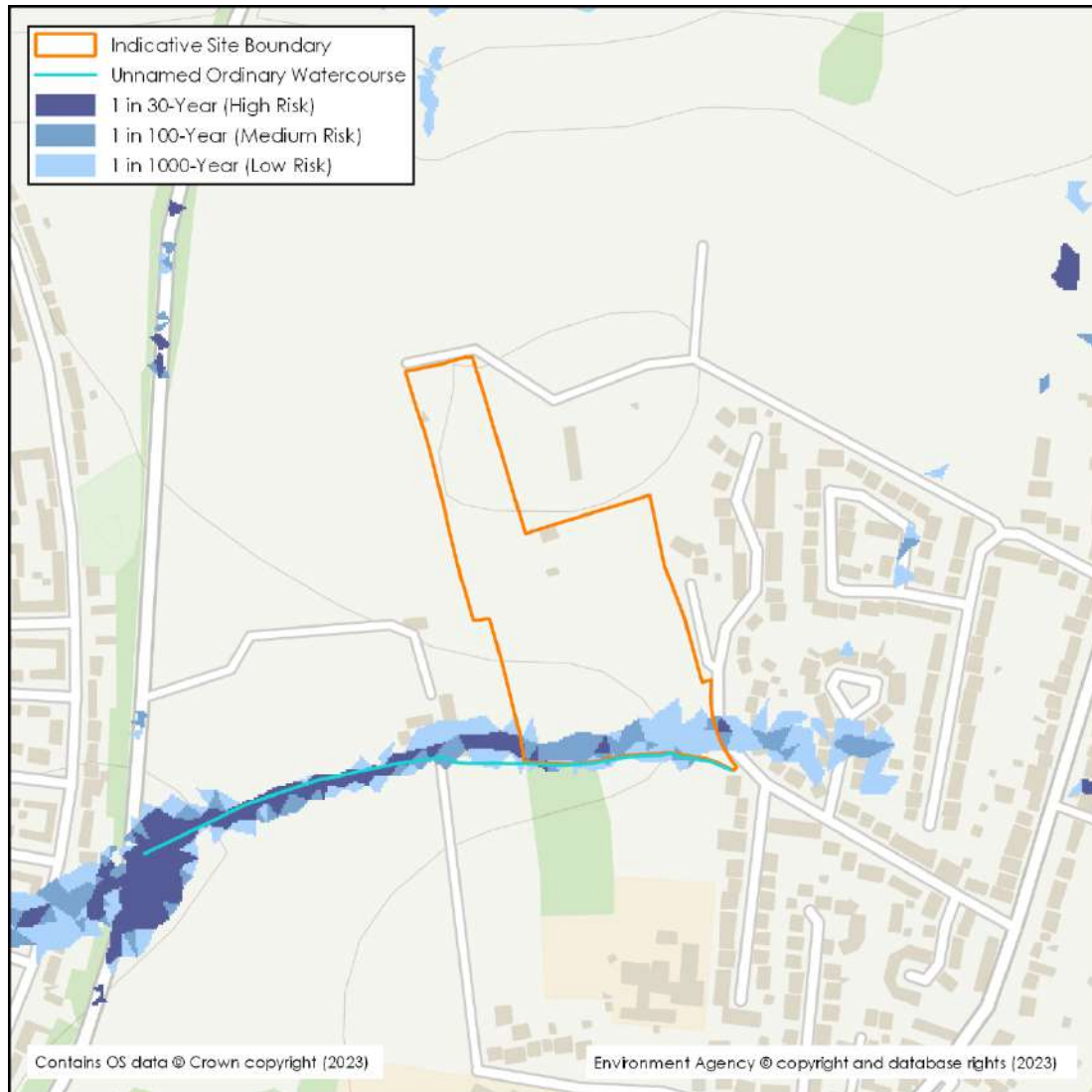


Figure 1.3: EA Surface Water Flood Map

- 1.8 The Surface Water Flood Map shows that the south of the site is at risk of flooding, with a low to high risk pluvial flow route present along the southern site boundary. Mapping suggests that this flood risk may be related to the UOW. It is also noted that a number of surface water sewers serving the nearby residential development outfall to the watercourse which may have implications for flood risk to the site.
- 1.9 Therefore, to determine the risk to the site from this UOW, and due to the mapped surface water flood risk, a direct rainfall modelling exercise has been undertaken for this study.

BWB Site Visit

1.10 A site visit was undertaken by BWB in September 2022 to walk the local watercourse reach and observe any key features that either needed surveying or needed to be considered during the hydraulic modelling process. The key considerations have been summarised below:

- The UOW is heavily vegetated in certain sections.
- The UOW is culverted in a number of locations.
- There are a number of outfalls into the UOW, expected to be associated with sewer outfalls.
- Surrounding land and fields to the north and south fall towards the UOW.
- There is a topographically low point on Royal Hill Road on the southeastern site boundary (**Figure 1.4**).



Figure 1.4: Looking south on Royal Hill Road towards Low Point at Site Access

Aims and Objectives

1.11 The baseline modelling exercise will be used to identify the extent and depth of possible flooding that could affect the development site for a range of return periods. These outputs will be used to support masterplan production for a future development at the site. The following objectives have been identified:

- i. Undertake a hydrological assessment of the local catchment to derive rainfall hyetographs for the study area.
- ii. Construct a 1D-2D hydraulic model of the site and upstream catchment using TUFLOW.
- iii. Undertake sensitivity testing to determine the critical storm duration for the local catchment (CSD).
- iv. Undertake simulations of the baseline conditions and analyse the results to understand the flooding mechanisms and the predicted flood risk at the site.
- v. Undertake sensitivity testing of key parameters including Manning's n roughness coefficients.
- vi. Undertake post-development conditions modelling and confirm any mitigation requirements.

Approach

- 1.12 In order to achieve the objectives identified above, a new 1D-2D ESTRY-TUFLOW model was constructed, based on a watercourse survey completed by BWB Consulting Ltd in September 2022 (Reference: RHR-BWB-01-ZZ-M2-G-0060, see **Appendix 2**).
- 1.13 The direct rainfall model has been produced using standard practice in line with the FEH and EA guidelines.
- 1.14 Watershed analysis using LiDAR data has been completed to determine the UOW catchment boundary.

Sources of Data

- 1.15 The following additional datasets were used within the hydraulic modelling exercise:
 - i. EA 2020 LiDAR 1m resolution composite DTM.
 - ii. Topographical survey of the study site, undertaken in November 2020 (reference: RHR-BWB-00-ZZ-DR-G-0001, included as **Appendix 1**).
 - iii. Cross-sectional watercourse survey, undertaken in September 2022 (included as **Appendix 2**).
 - iv. Photographs and observations from site visit undertaken in September 2022 by BWB Consulting.
 - v. Severn Trent Water sewer records (included as **Appendix 3**).
 - vi. FEH13 catchment descriptors.
 - vii. ReFH2 rainfall hyetographs.
 - viii. OS MasterMap data.

Assumptions and Limitations

- 1.16 Several assumptions were made during the study which may lead to implications on the modelled results. However, the study has been based on the data available at the time of writing. The key assumptions and limitations are as follows:

- The modelling exercise has made use of the available data at the time of construction and simulation. The model represents the floodplain and channel conditions at the time of survey.
- The model contains no formal representation of the conveyance within minor watercourses or ditches other than that captured by the model grid and within the 1D model domain.
- The 1m resolution of the model may negate any small-scale topographic features, although all the significant features are believed to have been captured.
- The floodplain levels are derived from LiDAR which has limited accuracy (+/- 0.15m). however, this is considered to be sufficient for the purpose of this study.
- The bare earth DTM does not include for the presence of walls, buildings, or other structures. Buildings have been modelled at 150mm above ground level with an elevated roughness in line with best practice. Roads have been lowered by 100mm in line with best practice.
- The modelling exercise has been undertaken to produce a good representation of flood risk mechanisms in and around the study site. It has not been designed to accurately map flooding in the wider catchment.
- Infiltration losses have been represented by runoff coefficients applied within the model based on variation in land use. This approach and the values used are in line with industry guidance however, no additional sensitivity testing of these coefficients has been undertaken at this time.
- Manholes without known invert levels have been assumed to have the same depth to invert level as the closest known manhole. This has been calculated based on the elevation of the unknown manhole (mAOD) and the difference between the nearest known manhole invert and cover level.
- It is assumed that all sewers are clear of blockages or sedimentation.
- Any private drainage, or highway road drainage, has not been explicitly included within the model, however, adjustment to infiltration coefficients have been applied to account for any losses to these networks.
- The survey included the upstream section of the farm access culvert however the downstream section could not be accessed due to land ownership. As a conservative approach, the structure was not included in the model and therefore is theoretically represented as fully blocked.

2. HYDROLOGICAL MODELLING

Climate Change

- 2.1 Rainfall hyetographs are required to support the hydraulic modelling exercise. To determine the predicted peak rainfall intensities necessary for the model, the appropriate climate change allowances must be applied.
- 2.2 Predicted future changes in peak rainfall intensity caused by climate change are provided by the EA within their online guidance¹, with a range of projections applied to regionalised River Basin District Management Catchments. The study area falls within the Derwent Derbyshire Management Catchment. **Table 2.1** displays the allowances for peak rainfall intensity for the 1 in 30-year (3.3% AEP) and 1 in 100-year (1% AEP) events.

Table 2.1: Peak Rainfall Allowance for the Derwent Derbyshire Management Catchment

Allowance Category	Total potential change anticipated for the '2050s' epoch (2022 to 2060)		Total potential change anticipated for the '2070s' epoch (2061 to 2125)	
	1 in 30-Year	1 in 100-Year	1 in 30-Year	1 in 100-Year
Upper End	35%	40%	35%	40%
Central	20%	20%	25%	30%

- 2.3 When determining the appropriate allowance to assess the catchment size, catchment urbanisation, and anticipated lifespan of the development should be considered.
- 2.4 The development site has an anticipated lifespan of 100+ years. Therefore, based on the EA's guidance and to promote a precautionary approach, the Upper End allowances for the '2070s' epoch for the 1 in 30-year (+35%) and 1 in 100-year (+40%) have been applied to the rainfall hyetographs.

¹ Environment Agency, Flood risk assessments: climate change allowances: <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#table-1>

Rainfall Hyetographs

- 2.5 The FEH catchment for the UOW at the site was extracted to the west of Acorn Way.
- 2.6 Rainfall hyetographs were derived in ReFH2 version 3.2 software using the industry standard FEH Depth Duration Frequency (DDF) model.
- 2.7 ReFH2 software recommended a storm duration of 3.25 hours for the catchment. Rainfall hyetographs were also extracted for the 2.25 hour and 4.25 hour storm durations to allow analysis and confirmation of the CSD at the site. Rainfall hyetographs for the three different storm durations tested are shown in **Figure 2.1**.

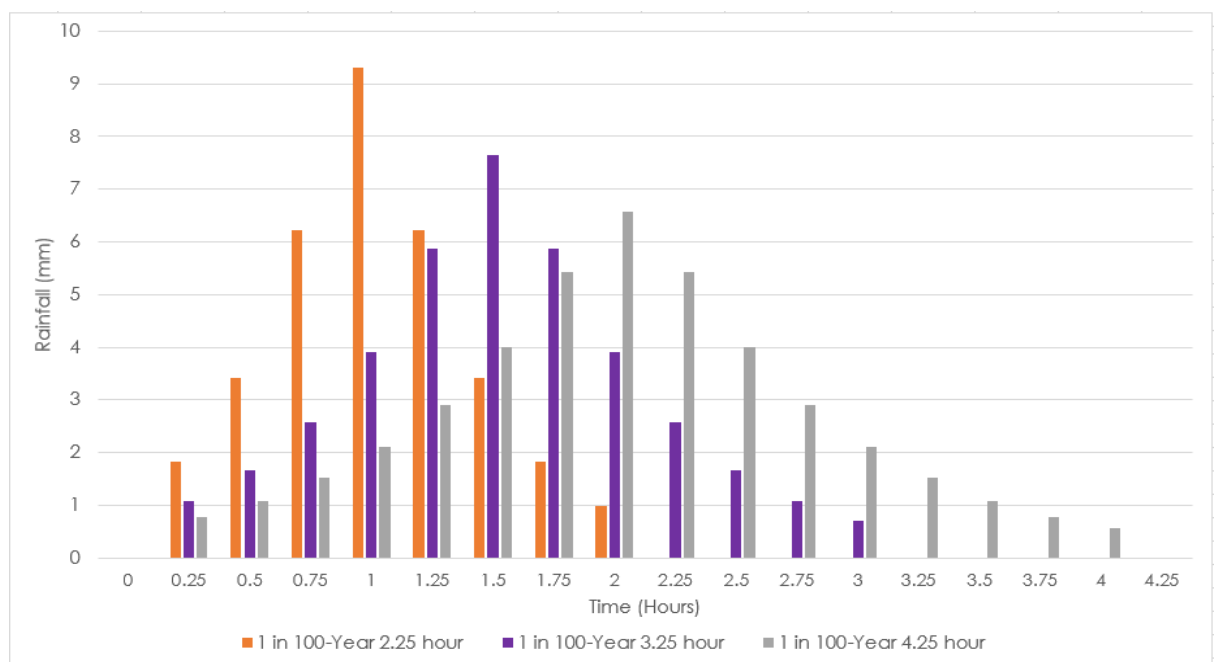


Figure 2.1: ReFH2 Hyetographs for the 1 in 100-year Event

- 2.8 CSD testing was undertaken to determine the appropriate storm duration for the study. The 2.25 hour, 3.25 hour, and 4.25 hour storms were compared, and the CSD test showed that the 2.25 hour and 3.25 hour storms resulted in the greatest depth of flooding at the site. However, the differences in flood depths were minimal ($\leq 3\text{mm}$) between the 2.25 hour and 3.25 hour storm durations.
- 2.9 Therefore, the ReFH2 recommended 3.25 hour storm duration was confirmed as the CSD for the catchment and has therefore been used within this study.
- 2.10 Rainfall hyetographs were subsequently derived for the following hydrological events:
- 1 in 30-year
 - 1 in 30-year +35% climate change
 - 1 in 100-year
 - 1 in 100-year +40% climate change
 - 1 in 1000-year

3. HYDRAULIC MODELLING

Software and Solver

- 3.1 TUFLOW version 2020-AD-iSP-w64 was used for all model runs. The Heavily Paralysed Compute (HPC) solver was used within a Graphics Processing Unit (GPU) environment. This uses an adaptive timestep to solve the equations.
- 3.2 TUFLOW's built in 1D component, ESTRY, was used to model the 1D domain.

The 1D Domain

Extent

- 3.3 The 1D domain comprises the UOW and the selected elements of Severn Trent Water sewer network.
- 3.4 The 1D channel domain includes the surveyed length of the UOW, from the upstream extent to the west of Royal Hill Road, to the downstream extent circa 70m west of the site. The two surveyed culverts have been represented within the channel.
- 3.5 Using the EA LiDAR data for the area, watershed analysis was undertaken to the east of Acorn Way to determine the catchment of the UOW. The 1D sewer domain includes sewers within the watershed catchment which have a diameter of $\geq 225\text{mm}$ or sewers which outfall to the UOW. Where sewers were shown to be directed outside of the watershed analysis catchment, these were excluded from the modelling.
- 3.6 The extent of the 1D channel domain can be seen in **Figure 3.1** and a model schematic including the sewer network and catchment area is shown in **Figure 3.2**.

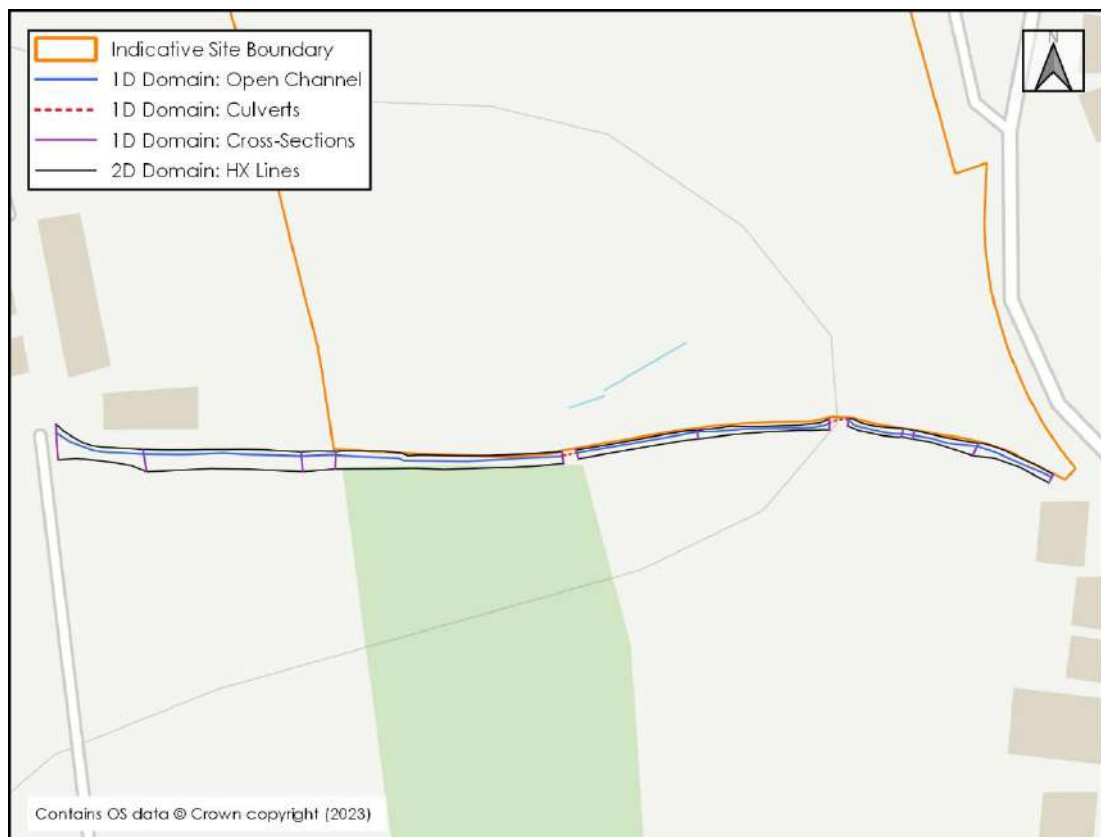


Figure 3.1: 1D Channel Domain

- 3.7 The extent of the 1D sewer domain can be seen in the model schematic, included as **Figure 3.2**.

Channel Geometry

- 3.8 The river channel geometry is based on a new watercourse survey carried out by BWB Consulting Ltd in September 2022. The survey also captured hydraulic structures that were present such as bridges and culverts.
- 3.9 The maximum distance between cross sections is 56m. However, sections are more generally spaced approximately 3m-39m apart. The watercourse channel survey is included as **Appendix 2**.
- 3.10 The channel sections were truncated at top-of-bank based on the survey data at what would be the interface with the 2D domain. The top of bank lines were used to delineate the 2D HX lines and these can be seen in **Figure 3.2**.

Hydraulic Roughness

- 3.11 Hydraulic roughness has been represented using the Manning's n coefficient. The values applied are based on those stipulated in the literature, using Chow (1959)². This

² http://www.fsl.orst.edu/geowater/FX3/help/8_Hydraulic_Reference/Mannings_n_Tables.htm

study documents appropriate values based on channel bed material, sinuosity, and presence of vegetation.

- 3.12 The guideline values are chosen using engineering judgement, based on photographs of the channel condition taken at the time of survey. Each cross section has a Manning's roughness value applied in the same way as the channel geometry and is read into TUFLOW within a CSV file.
- 3.13 For the 1D sewer network, a value of 0.015 was used. As per Chow (1959), this is representative of "Conduit; Sewer with manholes, inlet, etc., straight".

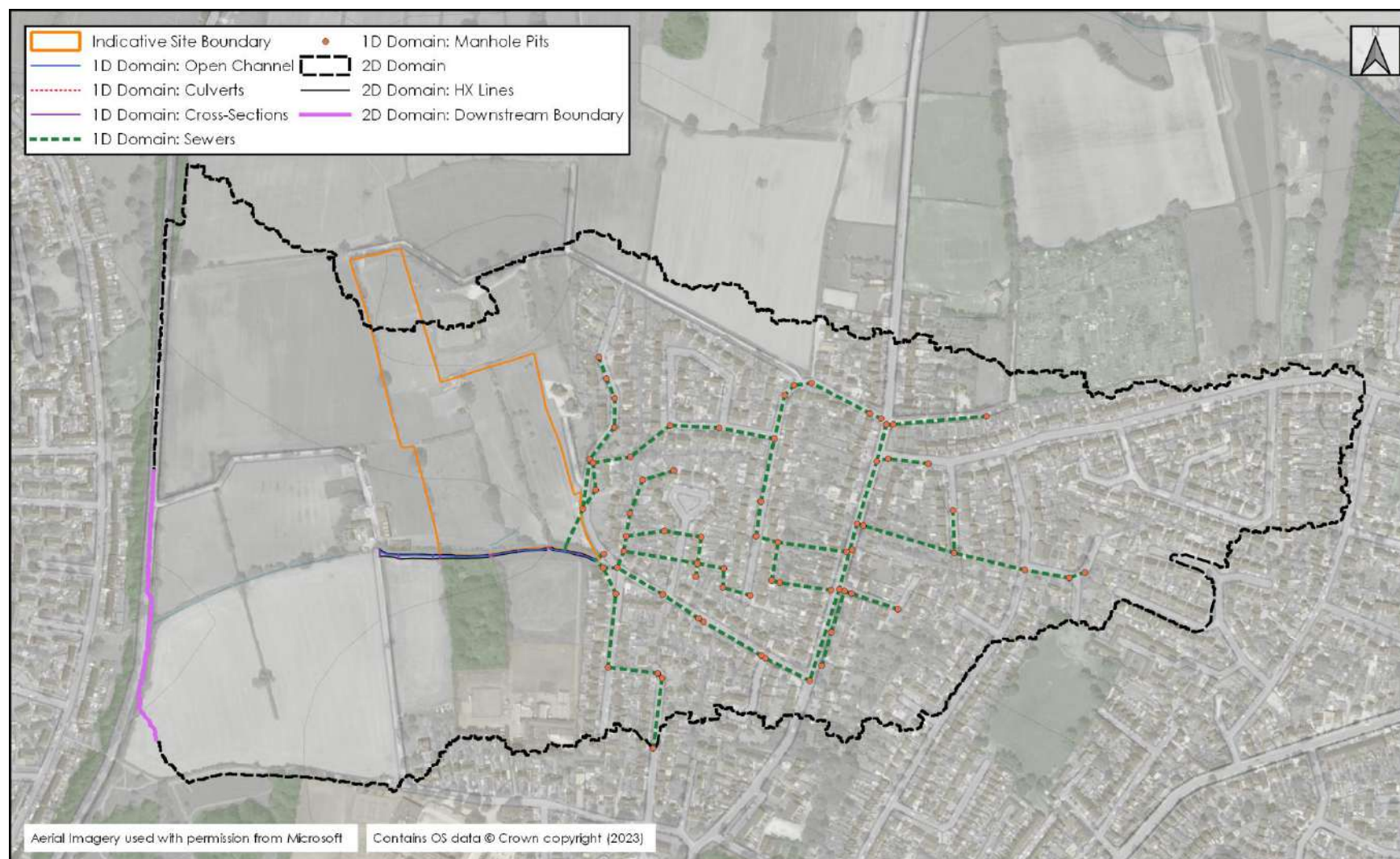


Figure 3.2: Model Schematic

Hydraulic Structures

- 3.14 A number of hydraulic structures were represented in the 1D domain, the data for which was collected during the watercourse survey.
- 3.15 In total, two culverts were included in the modelled reach. The survey included the upstream section of the farm access culvert, however, the downstream section could not be accessed due to land ownership. As a conservative approach, the structure was not included in the model and therefore is theoretically represented as fully blocked.
- 3.16 Details on the modelled culverts are highlighted in **Table 3.1**.

Table 3.1: Hydraulic Structures

Cross Section ID	Model Details	Photograph
R1_00198	Unit Type: Culvert U/S IL: 78.87m AOD D/S IL: 78.61 AOD Width: 0.28m Length: 4.84m Manning's 'n': 0.014	
R1_00131	Unit Type: Culvert U/S IL: 76.82m AOD D/S IL: 76.66m AOD Width: 0.29m Length: 3.69m Manning's 'n': 0.020	

Initial Conditions

- 3.17 The initial water levels measured during the watercourse survey were applied to the model as 1D points at respective cross-section locations.

1D-2D Links

- 3.18 The 1D channel was linked to the floodplain using 2D HX lines. These transfer the calculated water level from the 1D cross-sections into the 2D floodplain, providing that the water level is above the level of the cell that the HX line is located in. The HX lines were digitised along the top of bank of the watercourse visible in the survey and LiDAR data, as shown in **Figure 3.2**.
- 3.19 The average modelled width of the channel was approximately 3.52m, with a maximum modelled width of 8.87m, and a minimum modelled width of 1.95m.
- 3.20 In order to represent the interaction between the 1D drainage network and the 2D domain, manholes were represented in the model using 1d_nwke points with a "SXZ" command. This allows water to spill from the manhole into the 2D domain and vice versa.

The 2D Model Domain

Extent and Active Area

- 3.21 A watershed analysis was undertaken to determine the extent of the UOW catchment, and this defined the 2D domain for the direct rainfall model. After a review of the Severn Trent Water sewer records, the 2D domain was reduced towards the eastern extent of the catchment to be consistent with the draining sewer network. The model extent is displayed in **Figure 3.2**.
- 3.22 The watercourse channel was deactivated to ensure that it was modelled in the 1D domain. This deactivated area may appear fragmented where the decks of the two culverts are modelled in the 2D domain.

Grid Size and Orientation

- 3.23 The grid cell size should be chosen in order to sufficiently represent the average width of the modelled channel and its ability to capture key floodplain topographic features.
- 3.24 The selected grid size of 1m provides a high enough resolution to capture the capacity of the watercourse channel and allows for identification of overland flow routes. This therefore offers confidence in the flood mechanisms and flow routes seen across the site.
- 3.25 The orientation of the grid is important for flow routing as flow cannot pass to the neighbouring cell via its corner, only via the cell sides. Therefore, the location line (2d_loc) was drawn to orientate the grid in the predominant direction of flow (east to west).

Floodplain Topography and Amendments

- 3.26 The general floodplain topography is based on the latest available LiDAR data, which was downloaded from the DEFRA Open Survey website at a 1m resolution.

- 3.27 The topographical survey was converted to a Digital Elevation Model (DEM) surface and was used to represent the study site topography in greater detail. This has been incorporated into the floodplain topography where appropriate.
- 3.28 Roads and building footprints were adjusted in line with EA surface water modelling guidance. TUFLOW 'Z-Shape' layers representing roads were lowered by 100mm to allow for surface water flows to be effectively conveyed and building footprints were raised by 150mm.

Floodplain Roughness

- 3.29 Floodplain roughness is defined by the Manning's n coefficient, as per the 1D domain. However, the method in which it is applied differs.
- 3.30 A global roughness value is set based on the predominant land use (Long Grass) in the catchment. Each OS MasterMap land use type has a designated ID label which is then used as the 'Material' field value within the '2d_mat' layer. These are linked to the materials roughness CSV and read into TUFLOW.
- 3.31 Buildings were represented as having depth-varying Manning's n values. For this study, buildings are represented as having a roughness coefficient of 0.015 for depths of up to 300mm. For greater depths, a more obstructive coefficient of 0.50 is used. The lower coefficient is used to represent shallow flow paths over building roofs and through building drainage.

Boundary Conditions

- 3.32 The rainfall hyetographs discussed in **Section 2** of this report were applied across the entirety of the model domain. Suitable runoff coefficients were applied to the rainfall hyetographs within the hydraulic model based on land use to represent the losses to interception and infiltration. In addition, an 11mm/hr continuing loss to ground was applied along the road network throughout the simulation to represent the effects of any highway drainage system.
- 3.33 Boundary conditions within the 2D domain are often used to prevent "glass walling" at the downstream end of the model through use of a "HQ" boundary. This is a flow vs stage relationship automatically defined in TUFLOW when the user inputs a slope value, to allow water to flow out of the model. A single HQ boundary was used at the downstream extent of the model at Acorn Way using an average slope from the LiDAR in this location. This is shown in **Figure 3.2**.

Calibration/Verification

- 3.34 A lack of detailed flow data, level data, or rain gauge data for the catchment meant that there was limited opportunity to calibrate the model.
- 3.35 Due to the lack of documentation on previous historical instances of flooding, the model cannot be verified against historic events. A conservative approach adopted to the model build mitigates this.

Simulation Parameters

- 3.36 A timestep of 0.5 seconds was applied for the 2D domain. This is $\frac{1}{2}$ of the model grid size and is in line with industry guidance. A timestep of 0.25 seconds was used for the 1D domain. This is $\frac{1}{2}$ of the 2D timestep and is in line with industry guidance.
- 3.37 The simulations were run for 8 hours to ensure there was sufficient time for runoff to be distributed throughout the system. This was sufficient for the different storm durations and allowed the overland flows to pass through the model and to recede.
- 3.38 All TUFLOW default model parameters for pluvial models were used for this study.

Stability, Warnings and Messages

- 3.39 TUFLOW has a number of indicators available to assess the stability of a model. These differ slightly between the Classic and HPC solver (the HPC solver was used for this model). The following indicators were checked for both baseline and post-development runs to ensure the model was performing as expected:
- **Stage and flow time series** – A number of spot checks should be completed to ensure that conveyance through the channel is as expected and that both the stage and flow time series are reasonably smooth, particularly around the study area.
 - **1D negative depths** – Significant negative depths indicate that instabilities are present.
 - **Cumulative Mass Error** – A value of +/-5% is considered acceptable for pluvial models.
 - **Velocities** – Unusually high velocities or circulating vectors are usually a sign of instabilities.
 - **Minimum Timestep** – or “dt” shows the timestep used to reach a solution over the duration of the model, as the HPC simulation used an adaptive timestep. A timestep lower than $\frac{1}{10^{\text{th}}}$ of the 2D domain timestep is considered to indicate instabilities.
 - **Nu values** – 1.0 or greater may indicate unusually high velocities.
 - **Nc values** – Higher than 1.0 might indicate unusually high-water depths caused by a low cell elevation.
 - **Nd values** – 0.3 or higher might suggest poor boundary setup.
 - **High Control Numbers** – or HCN will require timesteps to be repeated if there is an instability.
- 3.40 The time series graphs were reviewed along the modelled reaches and no significant issues were present that could compromise results at the site.
- 3.41 There are no negative depths reported within TUFLOW and all runs experience mass error within the accepted tolerance for pluvial models ($\pm 5\%$).
- 3.42 No HCN's, repeated timesteps, or 1D or 2D negative depths were reported. There were no warnings recorded during the simulation.

- 3.43 The minimum timestep (dt) dropped to below 1/10th of the TUFLOW timestep on 16 instances during the model simulations undertaken. However, these instances occurred towards the end of the simulation and were not identified in close proximity to the site area. Therefore, these small timesteps are not considered to be significant.
- 3.44 The remaining values highlighted above were considered acceptable.

Model Runs

3.45 In order to achieve the study objectives, the simulations summarised in **Table 3.2** were completed.

Table 3.2: Model Runs

Model Geometry	Return Periods	Comments
Baseline Conditions	1 in 30-year 1 in 30-year +35% CC 1 in 100-year 1 in 100-year +40% CC 1 in 1000-year	Modelled return periods in 'as surveyed' conditions.
Roughness +20%	1 in 100-year	Floodplain, channel, and structure roughness increased by 20% for Baseline Conditions.
Roughness -20%	1 in 100-year	Floodplain, channel, and structure roughness decreased by 20% for Baseline Conditions.
Post-Development Conditions	1 in 30-year 1 in 30-year +35% CC 1 in 100-year 1 in 100-year +40% CC 1 in 1000-year	Modelled return periods in 'as surveyed' conditions with the rainfall polygons within the site boundary excluded and additional inflow added to represent post-development site drainage.

4. BASELINE RESULTS

Baseline Flood Extents

- 4.1 Pluvial floodplain extents within the study area are illustrated within **Figure 4.1**. The floodplain outlines have been trimmed to remove areas of very shallow depths (<0.03m) to help identify the main flow pathways.
- 4.2 The floodplain extents for these baseline simulations broadly align with the EA Surface Water Flood Mapping shown in **Figure 1.3**. It indicates that the main flood risk to the site is the pluvial flow route which appears to be generated at a low point on Royal Hill Road to the southeast of the site. The site is at risk of pluvial flooding to the south of the site for all modelled storm events, including the 1 in 30-year event.

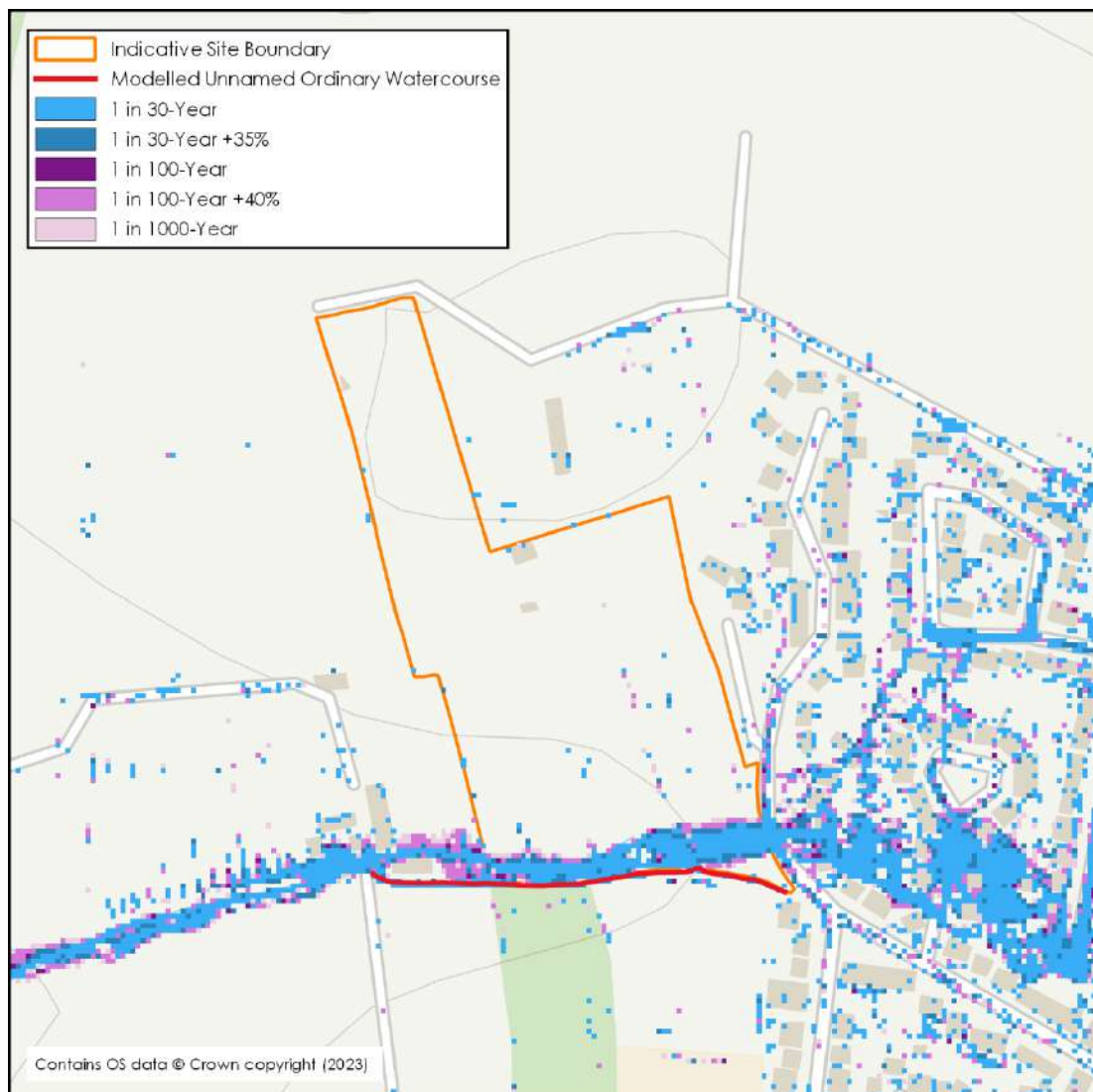


Figure 4.1: Baseline Floodplain Extents

Baseline Flood Depths

- 4.3 A review of the results shows that the south of the site is generally at risk of relatively shallow flood depths of between 0.05m to 0.3m during all modelled events.
- 4.4 Maximum flood depths during the 1 in 100 year + 40% flood event can be seen in **Figure 4.2**.

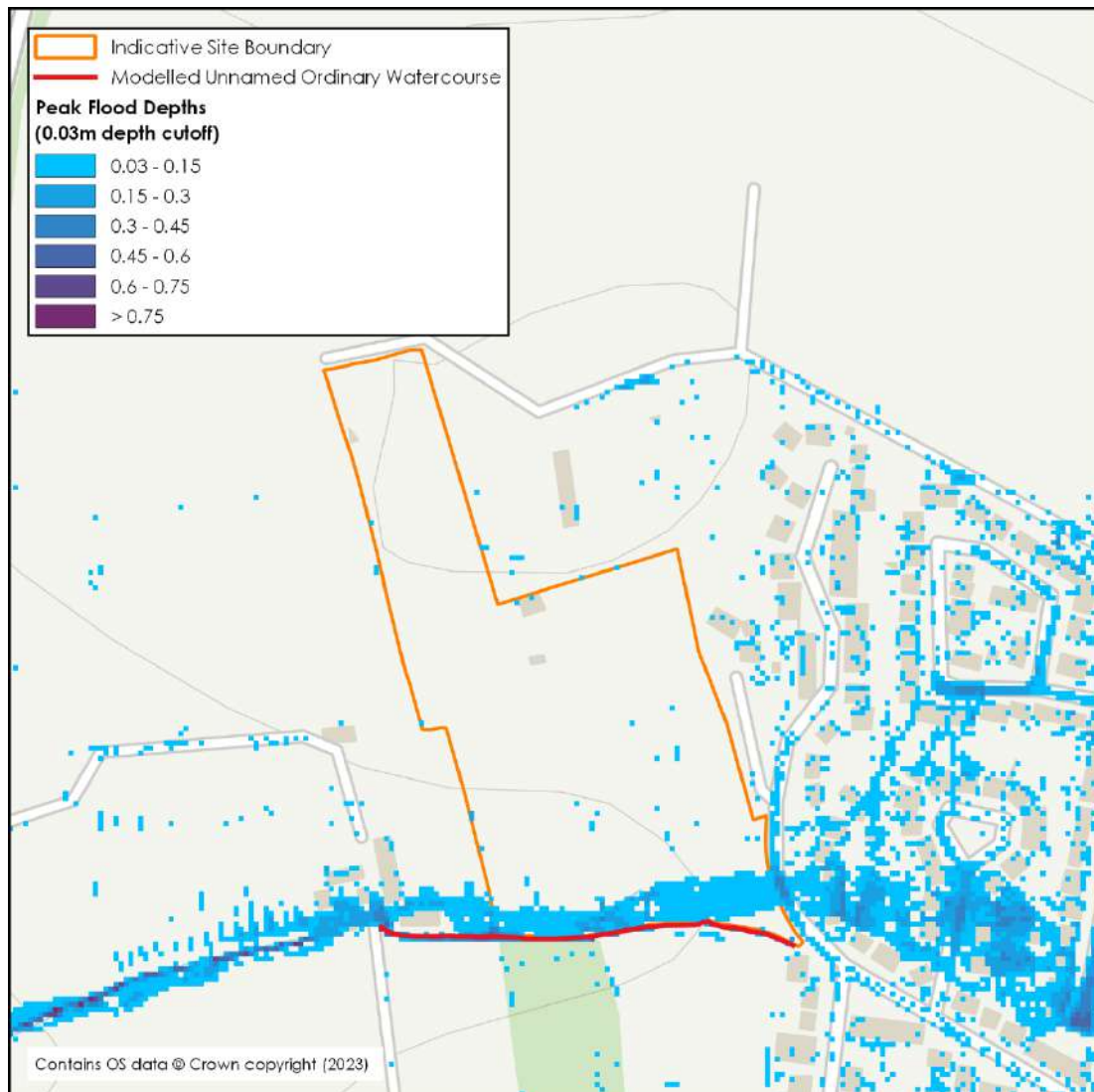


Figure 4.2: 1 in 100-year +40% Maximum Flood Depths (<0.03m cut-off depth)

5. SENSITIVITY TESTING

- 5.1 Robust sensitivity analysis provides improved confidence in the model outputs, particularly in absence of calibration data. Sensitivity testing has been undertaken on the baseline 1 in 100-year return period event.

Flow Estimates

- 5.2 As a climate change allowance has been assessed, it was not considered necessary to test further variations on the rainfall hyetographs being applied to the model.

Blockage

- 5.3 As the culvert at the farm access track at the downstream extent of the surveyed channel was excluded from the model this was theoretically modelled as fully blocked. Therefore, sensitivity testing of culvert blockage is not considered necessary.

Roughness

- 5.4 To account for seasonal variations in vegetation and maintenance periods, sensitivity tests were conducted on the roughness coefficients.
- 5.5 The modelling has shown that a 20% reduction in channel and floodplain roughness (representative of winter seasonal conditions or channel conditions following maintenance) results in a general decrease of in-channel and pluvial flood depths of up to 45mm. The impact on floodplain extents on the site was negligible.
- 5.6 Similarly, a 20% increase in Manning's 'n' (representative of summer seasonal conditions or a period without maintenance) is shown to result in a general increase of in-channel flood levels of up to 40mm. The impact on floodplain extents on the site was negligible.

6. POST-DEVELOPMENT MODEL RESULTS

Development Proposals

- 6.1 The proposed development is understood to comprise a residential development including related infrastructure, landscaping and open space. The proposed site layout is included as **Appendix 4**.
- 6.2 A Sustainable Drainage Statement (SDS) has been developed for the site (reference: RHR-BWB-ZZ-XX-RP-CD-0001_SDS). This outlines that surface water from the proposed development will be stored within an attenuation basin located in the southwestern corner of the site and will outfall to the UOW to the south of the site at a restricted rate of 8l/s.

Representation in Hydraulic Model

- 6.3 The baseline model was updated to exclude the site boundary from the 2D model domain.
- 6.4 A QT (flow vs time) boundary was added to represent the outfall from the attenuation basin. This consisted of a point inflow added to the modelled UOW at the nearest cross-section to the proposed attenuation basin. A constant flow rate of $0.008\text{m}^3/\text{s}$ was applied for the entire model duration; this is considered to be conservative as in reality flows would be distributed over time. A schematic is included as **Figure 6.1**.



Figure 6.1: Additional Point Inflow for Post-Development Site Drainage

Model Results

- 6.5 The results of the post-development modelling extents are shown in **Figure 6.2** with peak modelled flood levels shown within **Table 6.1**.
- 6.6 Similar to the baseline conditions, the site is shown to be at risk of pluvial flooding in the south for all modelled storm events. The primary flood mechanism still appears to be associated with the low point at Royal Hill Road.

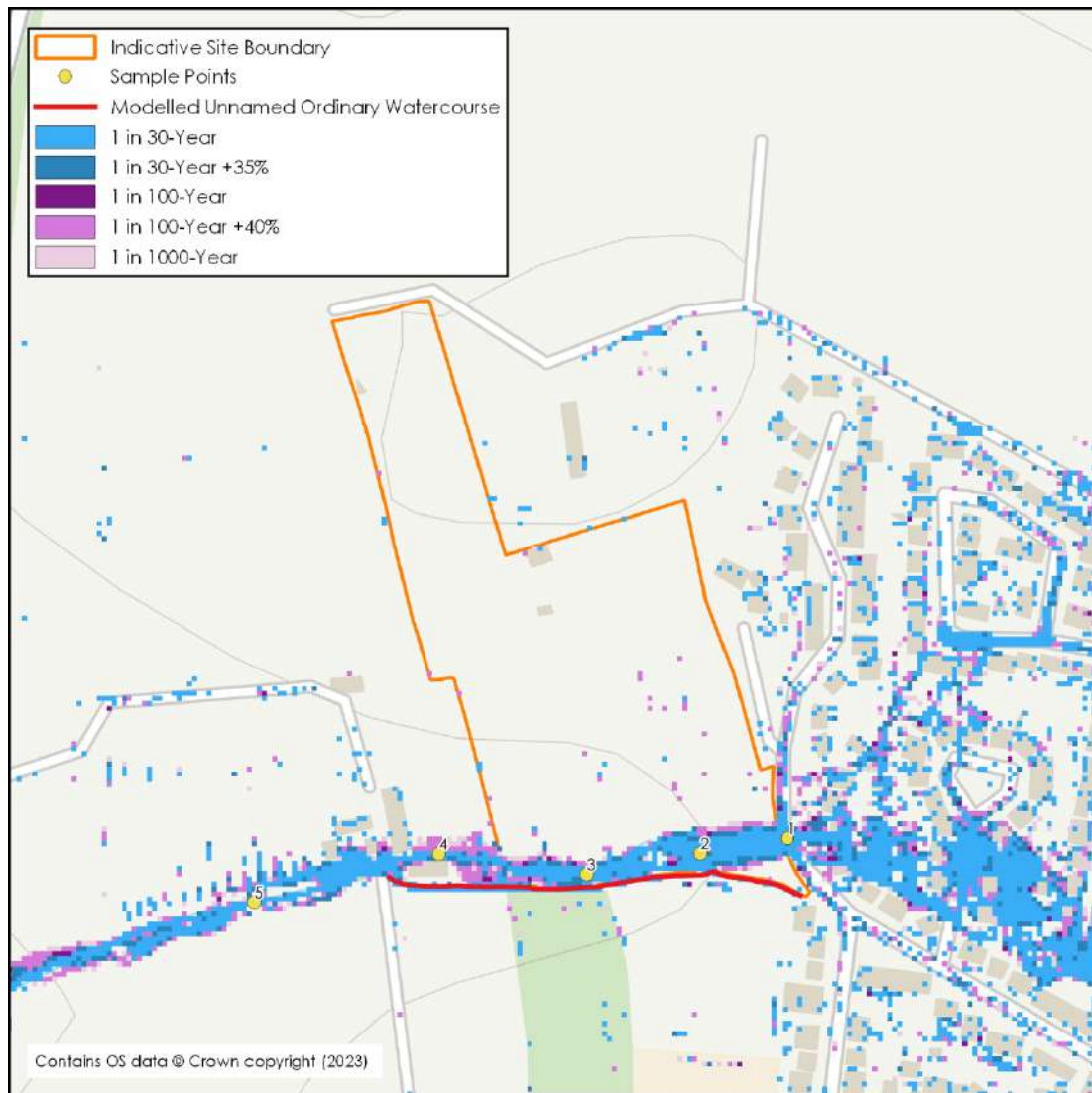


Figure 6.2: Post-Development Floodplain Extents (<0.03m cut-off depth)

Table 6.1: Post-Development Peak Modelled Flood Depths (m)

Node	1 in 30-Year			1 in 30-year +35%			1 in 100-Year			1 in 100-Year + 40%			1 in 1000-Year		
	Post – Development Flood Depth (m)	Baseline Flood Depth (m)	Difference with Baseline (m)	Post – Development Flood Depth (m)	Baseline Flood Depth (m)	Difference with Baseline (m)	Post – Development Flood Depth (m)	Baseline Flood Depth (m)	Difference with Baseline (m)	Post – Development Flood Depth (m)	Baseline Flood Depth (m)	Difference with Baseline (m)	Post – Development Flood Depth (m)	Baseline Flood Depth (m)	Difference with Baseline (m)
1	0.28	0.28	0	0.31	0.31	0	0.31	0.31	0	0.34	0.34	0	0.36	0.36	0
2	0.04	0.04	0	0.05	0.05	0	0.05	0.05	0	0.07	0.07	0	0.07	0.07	0
3	0.1	0.1	0	0.12	0.12	0	0.13	0.13	0	0.16	0.16	0	0.18	0.18	0
4	0.1	0.1	0	0.11	0.12	-0.01	0.12	0.12	0	0.17	0.17	0	0.19	0.19	0
5	0.43	0.44	-0.01	0.51	0.52	-0.01	0.52	0.53	-0.011	0.63	0.63	0	0.66	0.67	-0.01

Impact Analysis

- 6.7 The post-development modelled peak flood levels have been compared to the equivalent baseline conditions peak flood levels to establish on and off-site impacts. **Figure 6.3** shows the comparison for the 1 in 100-year +40% climate change scenario against the proposed development layout.

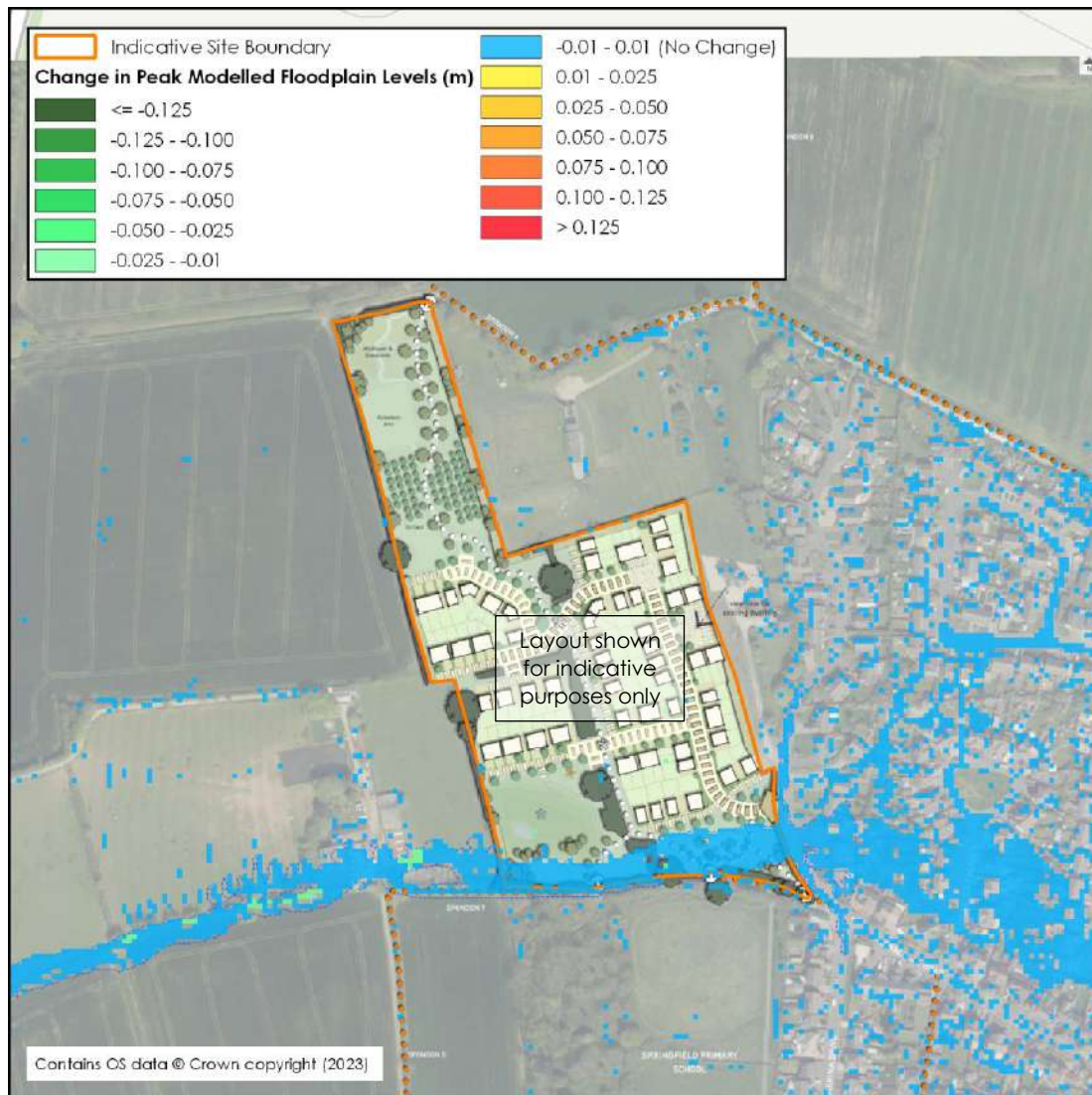


Figure 6.3: Baseline and Post-Development Floodplain Comparison - 1 in 100-year +40% (<0.03m cut-off depth)

- 6.8 Across all model events there is shown to be no change (within model tolerances) in modelled flood levels across the majority of the model. Flood levels are shown to decrease downstream of the site where the proposed attenuation basin will outfall to the UOW. This is due to the proposed attenuation basin restricting the rate of flow from the site into the UOW.
- 6.9 The development is therefore not expected to lead to a detriment in flood risk, both on-site and downstream of the site.

7. SUMMARY & RECOMMENDATIONS

- 7.1 This Hydraulic Modelling Report has been prepared on behalf of Miller Homes Ltd by BWB Consulting Ltd to determine the risk of the UOW to the south of the Royal Hill Road, Spondon site, and to help inform and support masterplan production for the site.
- 7.2 The site is located in Flood Zone 1, and the main flood risk to the site on the EA surface water flood mapping appears to be unclear as to whether it is associated with an overland flow route or the floodplain from the UOW.
- 7.3 A 1D-2D modelling exercise has been undertaken to determine the flood risk associated with the UOW and the surface water flow routes through the site.
- 7.4 The 1D-2D hydraulic model has been built using ESTRY-TUFLOW based on a watercourse survey completed by BWB Consulting Ltd in September 2022 and rainfall hyetographs derived in ReFH2 version 3.2. A CSD test confirmed the 3.25 hour storm duration as the most critical for the catchment, and the one used within this study.
- 7.5 The model has been simulated for both baseline and post-development conditions for the 1 in 30-year, 1 in 30-year+35% CC, 1 in 100-year, 1 in 100-year+40% CC, and 1 in 1000-year storm events.
- 7.6 Maximum flood extents taken from this hydraulic model show a general alignment with the EA Surface Water Flood Maps. This shows the main flood risk to the site is the pluvial flow route generated at the low point on Royal Hill Road which flows through the south of the site. There is considered to be a low risk attributed to the UOW.
- 7.7 Baseline maximum flood depth results show the south of the site is generally at risk of relatively shallow overland flows of between 0.05m to 0.3m during all modelled events.
- 7.8 Post-development modelling has also been undertaken to understand the potential impacts of the development on flood risk on and offsite. Comparative analysis between key return periods demonstrates there to be no change (within model tolerances) in modelled flood levels across the majority of the model. Flood levels are shown to decrease downstream of the site where the proposed attenuation basin will outfall to the UOW. The development is therefore not expected to lead to a detriment in flood risk both on-site and downstream of the site.

APPENDICES

Appendix 1: Topographical Survey

Notes

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. No scale factor has been applied to this survey, therefore the os coordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
8. OS license number: 10002432

Key Plan

Legend

OS Buildings

Surveyed Buildings

Building

Wall

Kerb Channel Line

Top of Kerb

Top of Bank

Edge of Surface

Bottom of Bank

Canopy / Overhang

Line Marking

Centre Line

Watercourse

Centre Line

Barrier

Fence

Gate

Overhead Powerline

Overhead Utilities

Contour Lines

Inspection Chamber

Flow direction and pipe diameter

Station and Name

Monitoring Borehole

Tree / Bush / Sapling

Area of Vegetation/ Extent of Tree Canopy

Hedge

Body of Water

Body of Water from OS

Spot Level

Assumed Surface

Water Drainage Line

Surface Water Drainage Line

AP Anchor Point

BO Back Gully

BT British Telecom

C Crest

CL Cover Level

CMP Cable Marker

P Post

CCTV/Security Camera

CTV Cable TV

DC Drainage

DK Drop Kerb

DP Down Pipe

ELC Electric

EP Electricity Post

ER Earth Road

FL Floodlight

FBW Fence Barbed Wire

FOB Fence Closed Board

FCL Fence Chain Link

FEL Fence Electric

FMP Fence Metal Panel

FOB Fence Open Board

FWW Fence Post & Wire

FWM Fence Wire Mesh

FPL Finished Floor Level

FP Flagpole

OV Gas Valve

HS Height

IC Inspection Chamber

IFL Internal Floor Level

IL Invert Level

LB Litter Bin

LP Lamp Post

MH Manhole

MS Service Marker

PS Post Box

PT Post

RE Roadside Eye

SP Sign Post

SV Stop Valve

TGB Telephone Call Box

THL Threshold Level

TL Traffic Light

TP Telegraph Post

TS Traffic Signal

UTS Unable to Survey

WL Water Level

WM Water Meter

WO Wash Out

P2	08.04.22	Middle Field Added	IR	DS
P1	26.11.20	First Issue	IR	DS
Rev	Date	Details of issue / revision	Dw	Rev

Issues & Revisions

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Client

Miller Homes Ltd

Project Title

Land At
Royal Hill Road
Spondon

Drawing Title

Existing Site Plan

Drawn:	LRiley	Reviewed:	D.Smith
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BWB Ref:	BMW 3087	Date:	26.11.20	Scale@A0:	1:500
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Drawing Status

Information

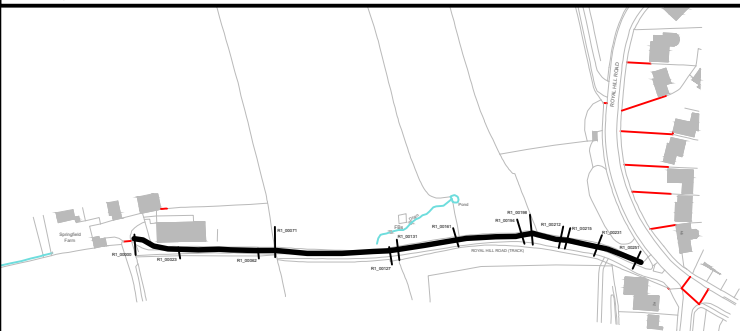
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
RHR-BWB-00-ZZ-DR-G-0001	S2	P2

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C:\Users\ian.rey\Documents\BLS FILES\08082022 2385\BMW3087 Royal Hill Road\RHR-BWB-00-ZZ-DR-G-0001_Existing_Site_P2.dwg

Appendix 2: Watercourse Survey

- Notes**
1. Do not scale this drawing. All dimensions must be checked/verified on site. If in doubt ask.
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 7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
 8. OS license number: 100022432

Key Plan



Legend

- OS Buildings
 - Surveyed Buildings
 - Building
 - Wall
 - Kerb Channel Line
 - Top of Kerb
 - Edge of Surface
 - Top of Bank
 - Bottom of Bank
 - Canopy / Overhang
 - Line Marking
 - Centre Line
 - Watercourse
 - Centre Line
 - Barrier
 - Fence
 - Gate
 - Overhead Powerline
 - Overhead Utilities
 - Contour Lines
 - Inspection Chamber
 - Flow direction and pipe diameter
 - Station and Name
 - Monitoring Borehole
 - Tree / Bush / Sapling
 - Area of Vegetation/ Extent of Tree Canopy
 - Hedge
 - Body of Water
 - Body of Water from OS
 - Spot Level
 - *50.00
 - Assumed Surface
 - Water Drainage Line
 - Surface Water Drainage Line
- AP Anchor Point
BO Back Gully
BO Bollard
BS Bus Stop
BT British Telecom
C Crest
CL Cover/Lid
CMP Cable Marker
P Post
CCTV/Security Camera
CTV Cable TV
DC Drainage
Channel
DK Drop Kerb
DP Down Pipe
Elec Electric
EP Electricity Post
ER Earth Road
FH Fire Hydrant
FL Floodlight
- FBW Fence Barbed Wire
FOB Fence Chain Board
FCL Fence Chain Link
FEL Fence Electric
FMP Fence Metal Panel
FMR Fence Metal Rolling
FOW Fence Open Wood
FWW Fence Post & Wire
FWM Fence Wire Mesh
FVL Finished Floor Level
FP Flagpole
Gas
OV Gas Valve
Gully
Height
IC Inspection Chamber
IFL Internal Floor Level
IL Invert Level
Lamp Post
LH Lamp Post
LP Lamp Post
MH Manhole
PS Post Box
PS Post Box
PT Post
RE Roadside Level
ST Stop Sign
SV Stop Valve
TCS Telephone Call Box
THL Threshold Level
TL Traffic Light
TP Telegraph Post
TS Traffic Signal
UTS Unable to Survey
VL Water Level
WM Water Meter
WO Wash Out

AP	Anchor Point	FBW	Fence Barbed Wire	LB	Litter Bin
BO	Back Gully	FOB	Fence Chain Board	LP	Lamp Post
BO	Bollard	FCL	Fence Chain Link	MH	Manhole
BS	Bus Stop	FEL	Fence Electric	MV	Service Marker
BT	British Telecom	FMP	Fence Metal Panel	PS	Post Box
C	Crest	FMR	Fence Metal Rolling	PT	Post
CL	Cover/Lid	FOW	Fence Open Wood	RE	Roadside Level
CMP	Cable Marker	FWW	Fence Post & Wire	SP	Sign Post
P	Post	FWM	Fence Wire Mesh	SV	Stop Valve
CCTV/Security Camera		FVL	Finished Floor Level	TCS	Telephone Call Box
CTV	Cable TV	FP	Flagpole	THL	Threshold Level
DC	Drainage	Gas	Gas	TL	Traffic Light
Channel		OV	Gas Valve	TP	Telegraph Post
DK	Drop Kerb	Gully	Gully	TS	Traffic Signal
DP	Down Pipe	Height	Height	UTS	Unable to Survey
Elec	Electric	IC	Inspection Chamber	VL	Water Level
EP	Electricity Post	IFL	Internal Floor Level	WM	Water Meter
ER	Earth Road	IL	Invert Level	WO	Wash Out
FH	Fire Hydrant				
FL	Floodlight				

P1	23.09.22	First Issue	IR	DS
Rev	Date	Details of issue / revision	Dwn	Rev

Issues & Revisions

BWB Birmingham | 0121 233 3322
London | 020 7407 3879
Manchester | 0161 233 4260
Nottingham | 0115 924 1100
www.bwbconsulting.com

Client

Miller Homes Ltd

Project Title

**Land At
Royal Hill Road
Spondon**

Drawing Title

**Watercourse Survey
Reach 1 Sections
Sheet 1 Of 2**

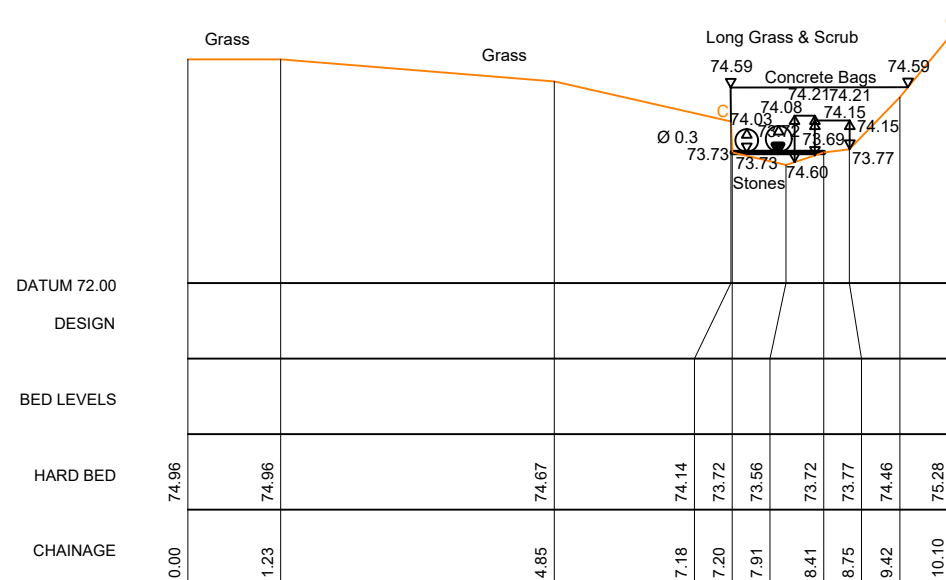
Drawn: IRILEY Reviewed: D.SMITH

BWB Ref: BMW 3087 Date: 23.09.22 Scale: A0: 1:100

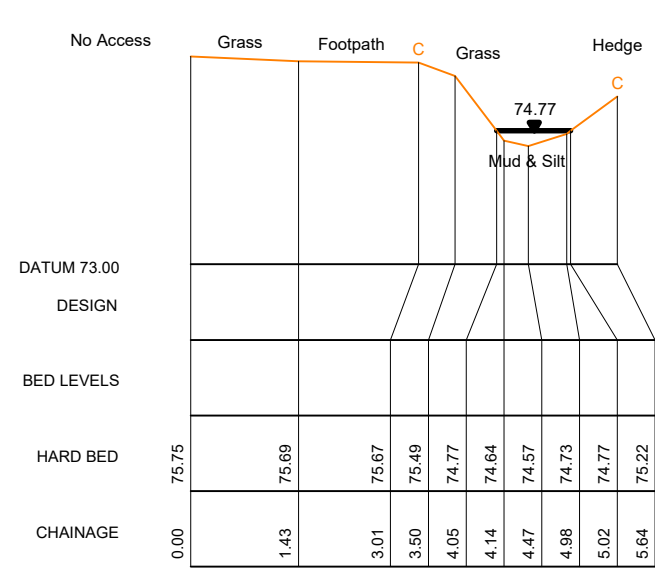
Drawing Status

INFORMATION

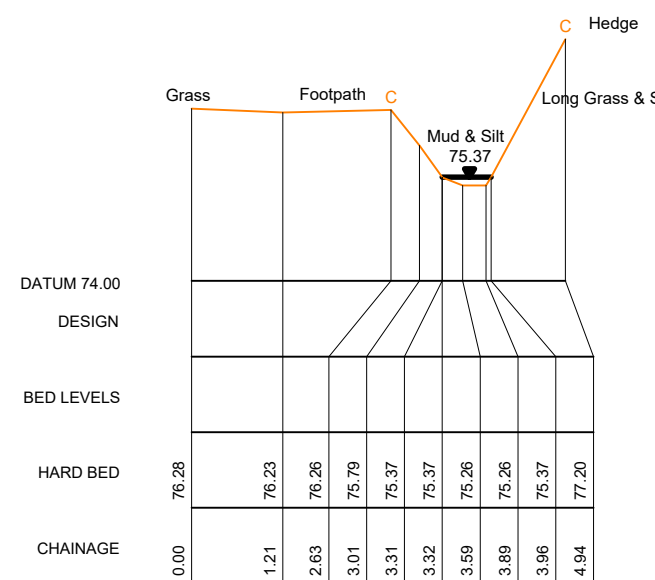
Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
RHR-BWB-01-ZZ-M2-G-0060	S2	P1



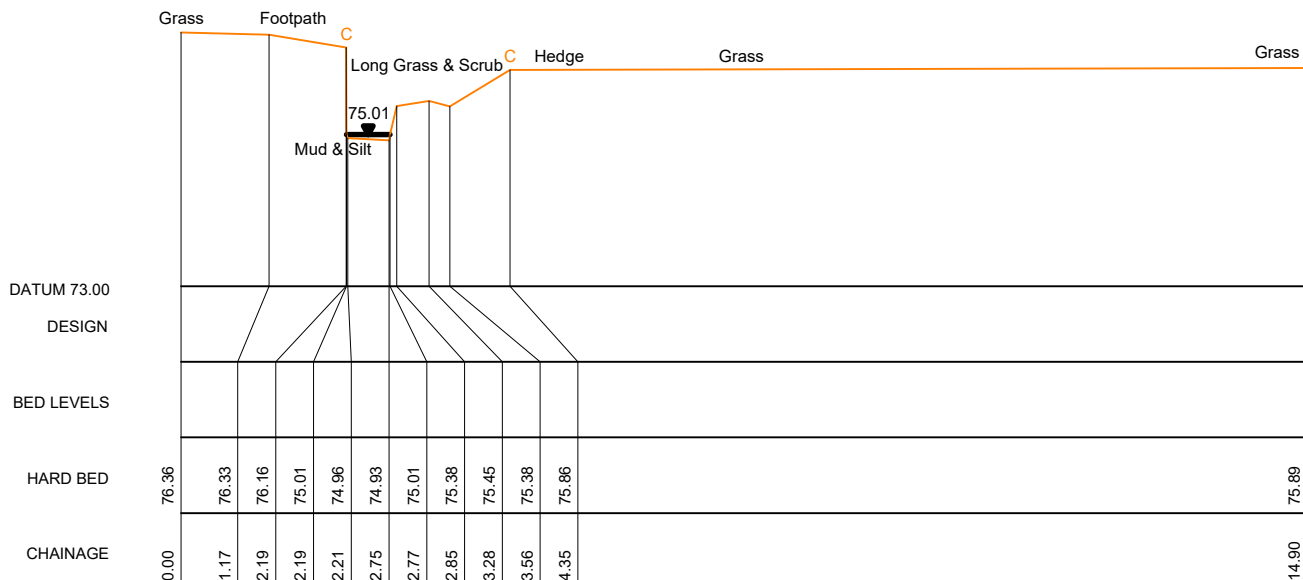
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0.342 M
Culvert



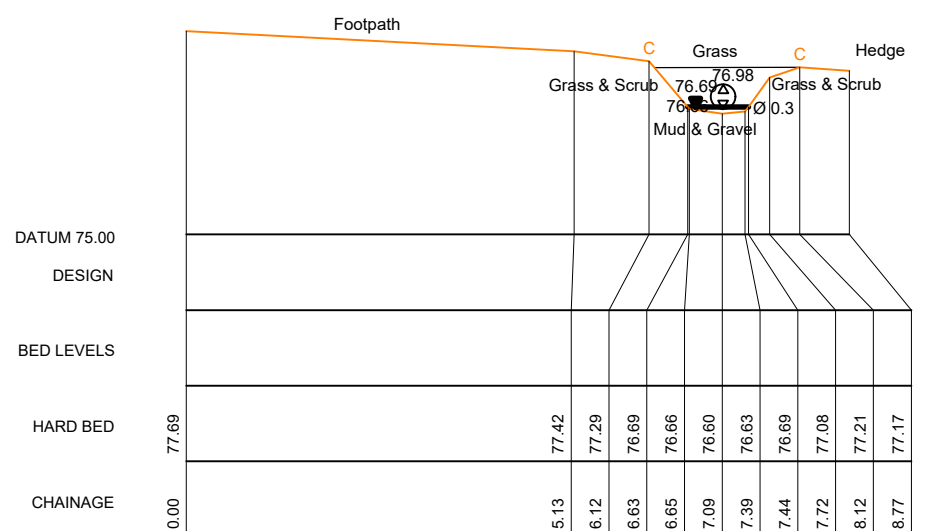
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Open Channel



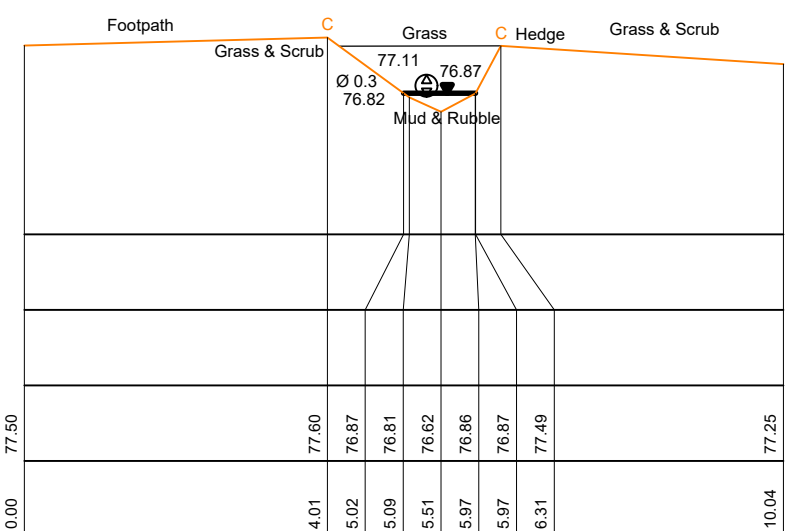
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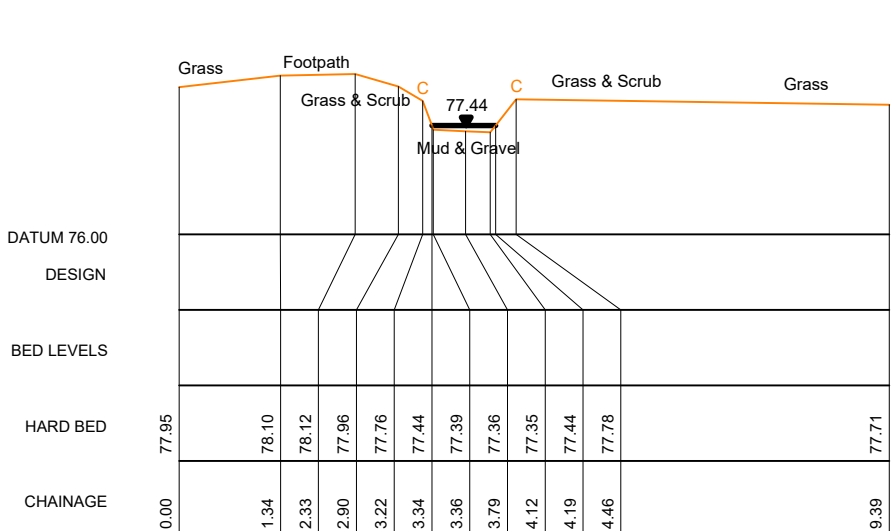
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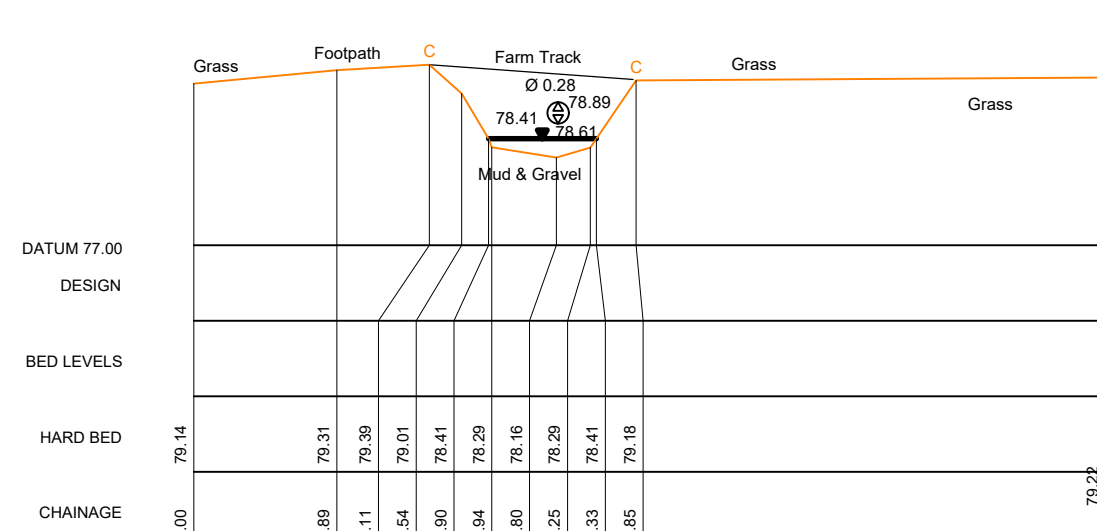
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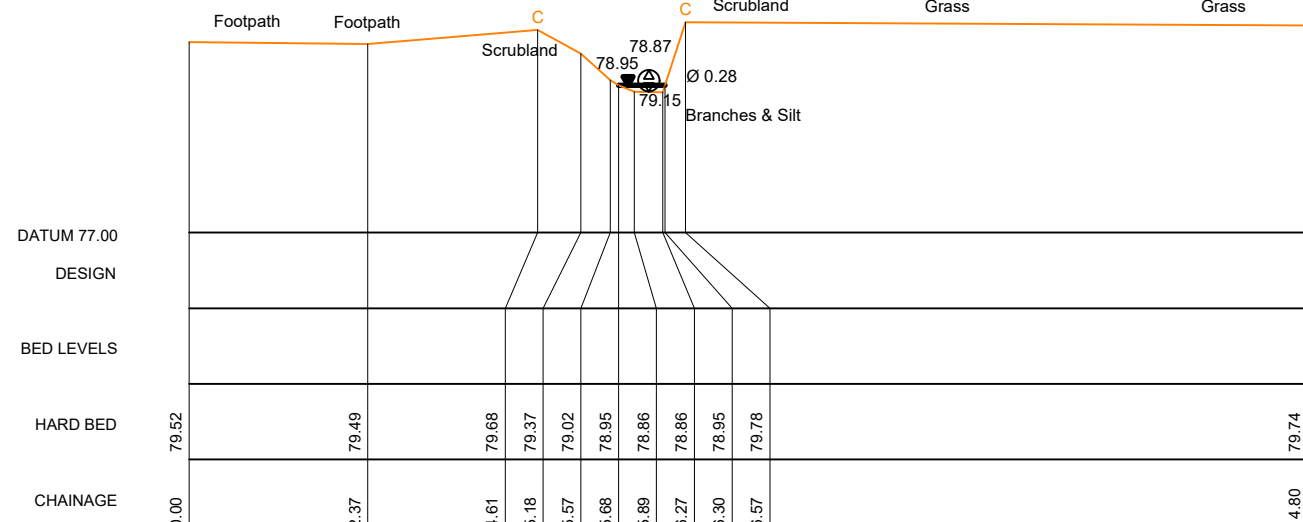
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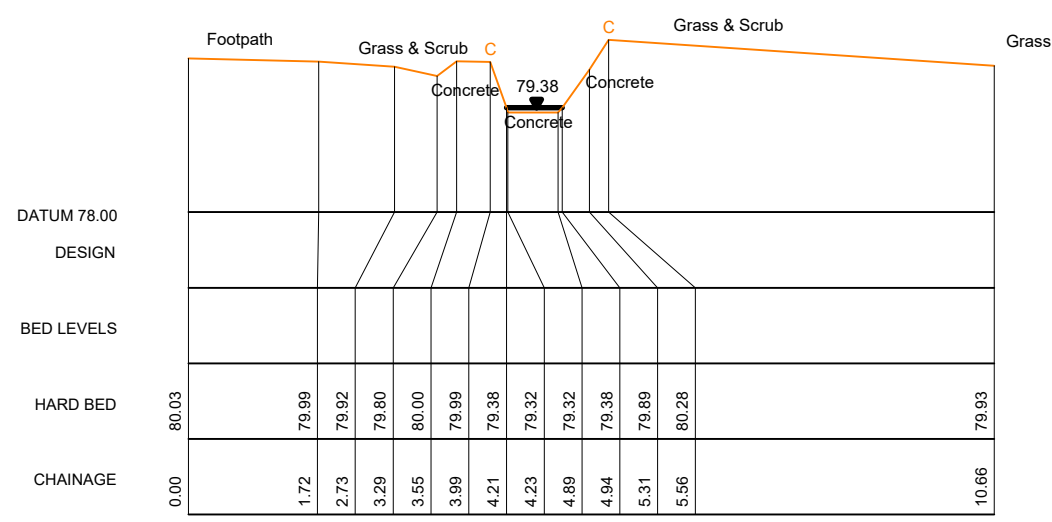
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Open Channel



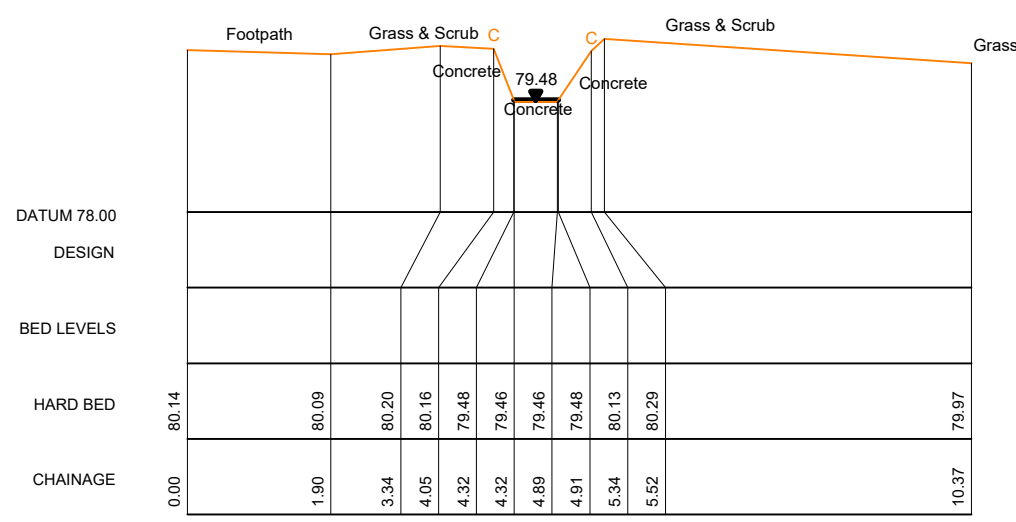
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Farm Access



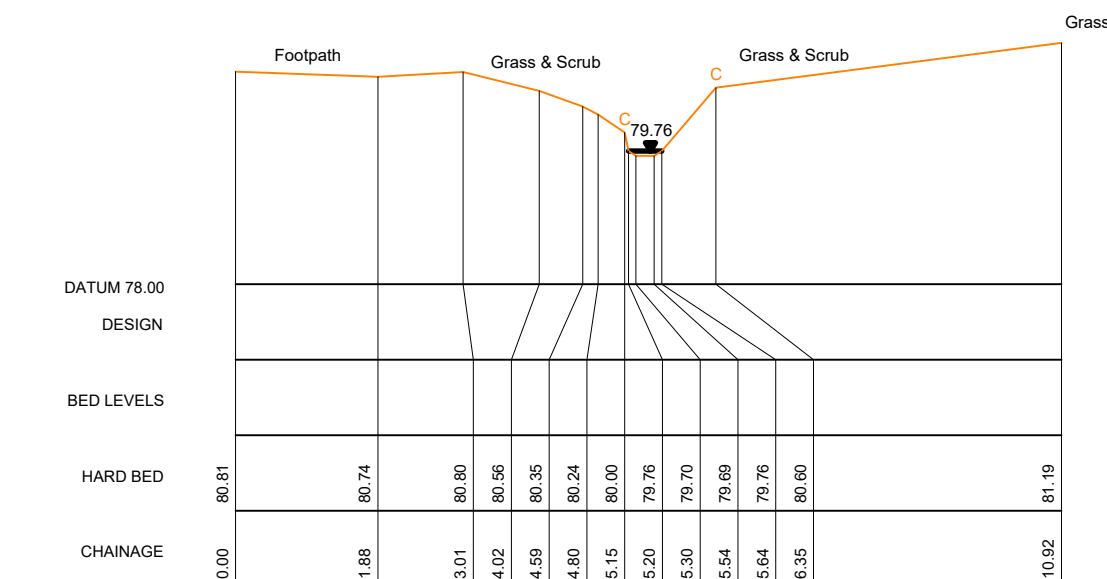
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Farm Access



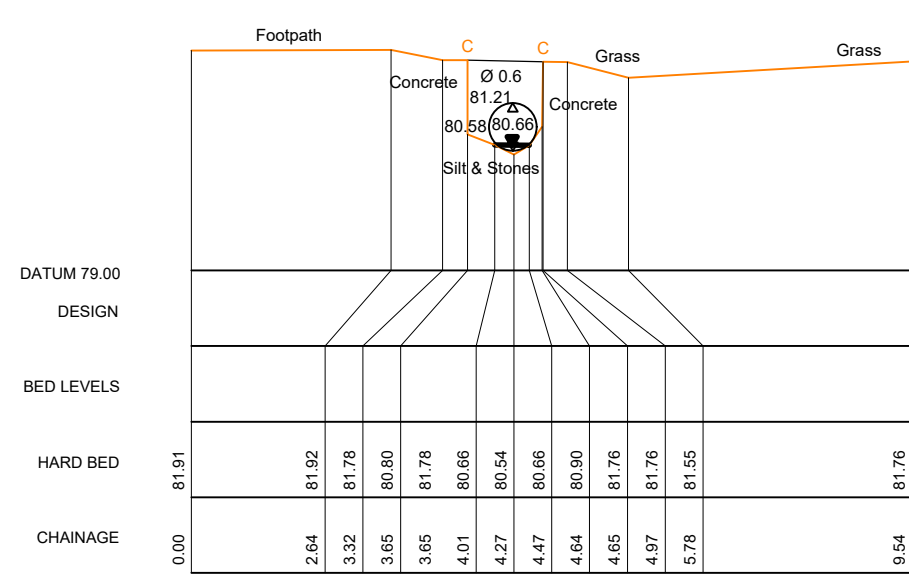
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Concrete Channel



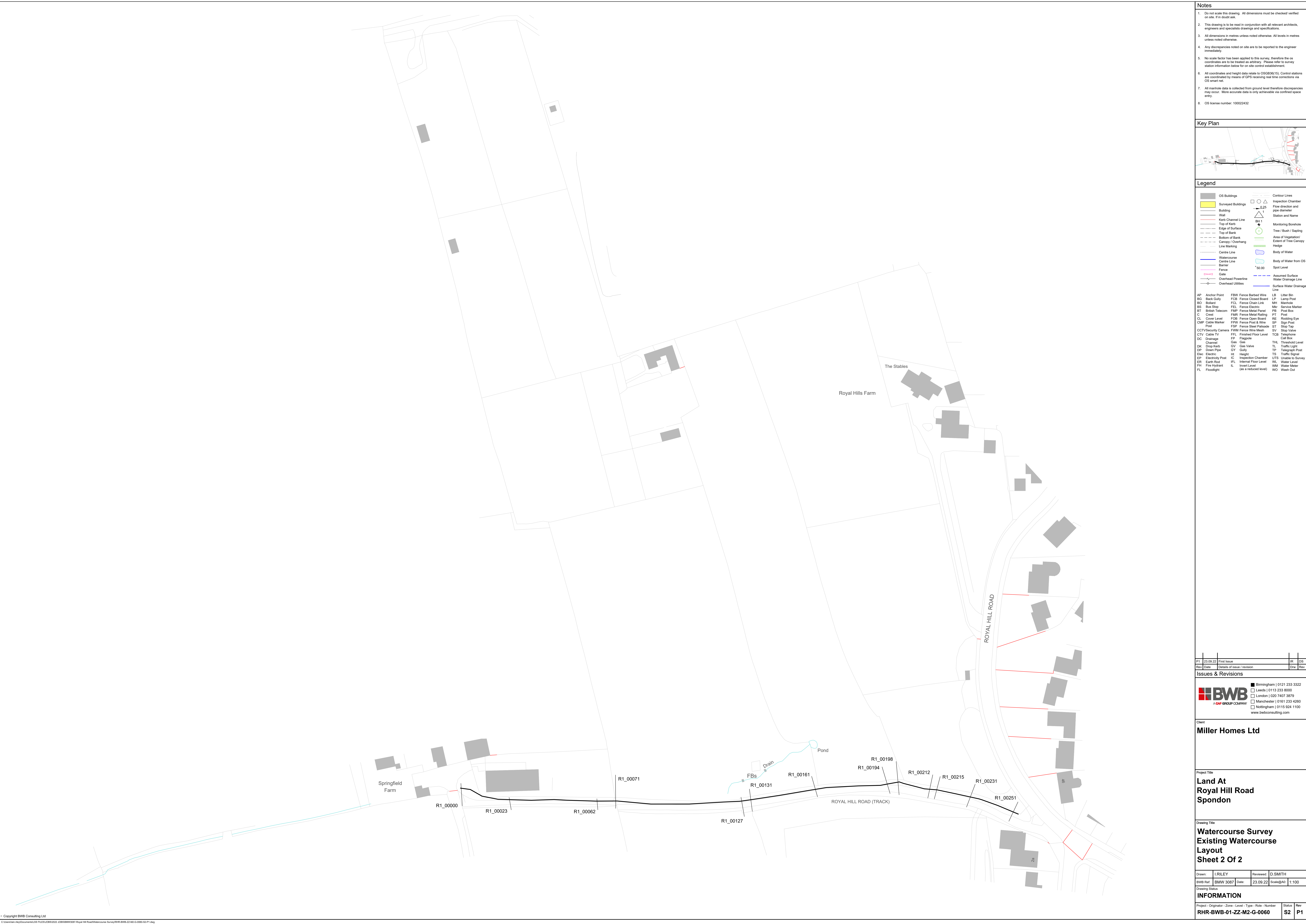
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Concrete Channel



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230.705 M
Open Channel



R1_00251
439746.27Em 336563.67Nm BEARING 025Dgr
250.859 M
Culvert



- Notes**
1. Do not scale this drawing. All dimensions must be checked/verified on site. If in doubt ask.
 2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
 3. All dimensions in metres unless noted otherwise. All levels in metres unless noted otherwise.
 4. Any discrepancies noted on site are to be reported to the engineer immediately.
 5. No scale factor has been applied to this survey, therefore the coordinates are to be treated as arbitrary. Please refer to survey station information below for on site control establishment.
 6. All coordinates and height data relate to OSGB36(15). Control stations are coordinated by means of GPS receiving real time corrections via OS smart net.
 7. All manhole data is collected from ground level therefore discrepancies may occur. More accurate data is only achievable via confined space entry.
 8. OS license number: 100022432

Key Plan



Legend

- | | | |
|--------------------|--------------------|---|
| OS Buildings | Contour Lines | Inspection Chamber |
| Surveyed Buildings | Building | Flow direction and pipe diameter |
| Wall | Kerb Channel Line | Station and Name |
| Top of Kerb | Edge of Surface | Monitoring Borehole |
| Top of Bank | Bottom of Bank | Tree / Bush / Sapling |
| Canopy / Overhang | Line Marking | Area of Vegetation/ Extent of Tree Canopy |
| Centre Line | Watercourse | Body of Water |
| Barrier | Gate | Body of Water from OS |
| Overhead Powerline | Overhead Utilities | Spot Level |
| | | Assumed Surface |
| | | Water Drainage Line |
| | | Surface Water Drainage Line |
- AP - Anchor Point
BO - Back Gully
BS - Bus Stop
BT - British Telecom
C - Crest
CL - Cover Level
CMP - Cable Marker
CCTV - Cable TV
DC - Drainage
DK - Drop Kerb
DP - Down Pipe
Elec - Electric
EP - Electricity Post
ER - Earth Road
FH - Fire Hydrant
FL - Floodlight
FBW - Fence Barbed Wire
FCS - Fence Chain Board
FCL - Fence Chain Link
FEL - Fence Electric
FMP - Fence Metal Panel
FOS - Fence Open Board
FPW - Fence Post & Wire
FWM - Fence Wire Mesh
FPL - Finished Floor Level
FP - Flagpole
Gas - Gas
GV - Gas Valve
GY - Gully
HS - Height
IC - Inspection Chamber
IL - Invert Level
LB - Litter Bin
LP - Lamp Post
MH - Manhole
Mx - Service Marker
PS - Post Box
PT - Post
RE - Roadside Eye
SP - Sign Post
SV - Stop Valve
TCB - Telephone Call Box
THL - Threshold Level
TL - Traffic Light
TS - Traffic Signal
TP - Telegraph Post
UTS - Unable to Survey
WL - Water Level
WM - Water Meter
WO - Wash Out

P1	23.09.22	First Issue	IR	OS
Rev	Date	Details of issue / revision	Dw	Rev

Issues & Revisions

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Client

Miller Homes Ltd

Project Title

**Land At
Royal Hill Road
Spondon**

Drawing Title

**Watercourse Survey
Existing Watercourse
Layout
Sheet 2 Of 2**

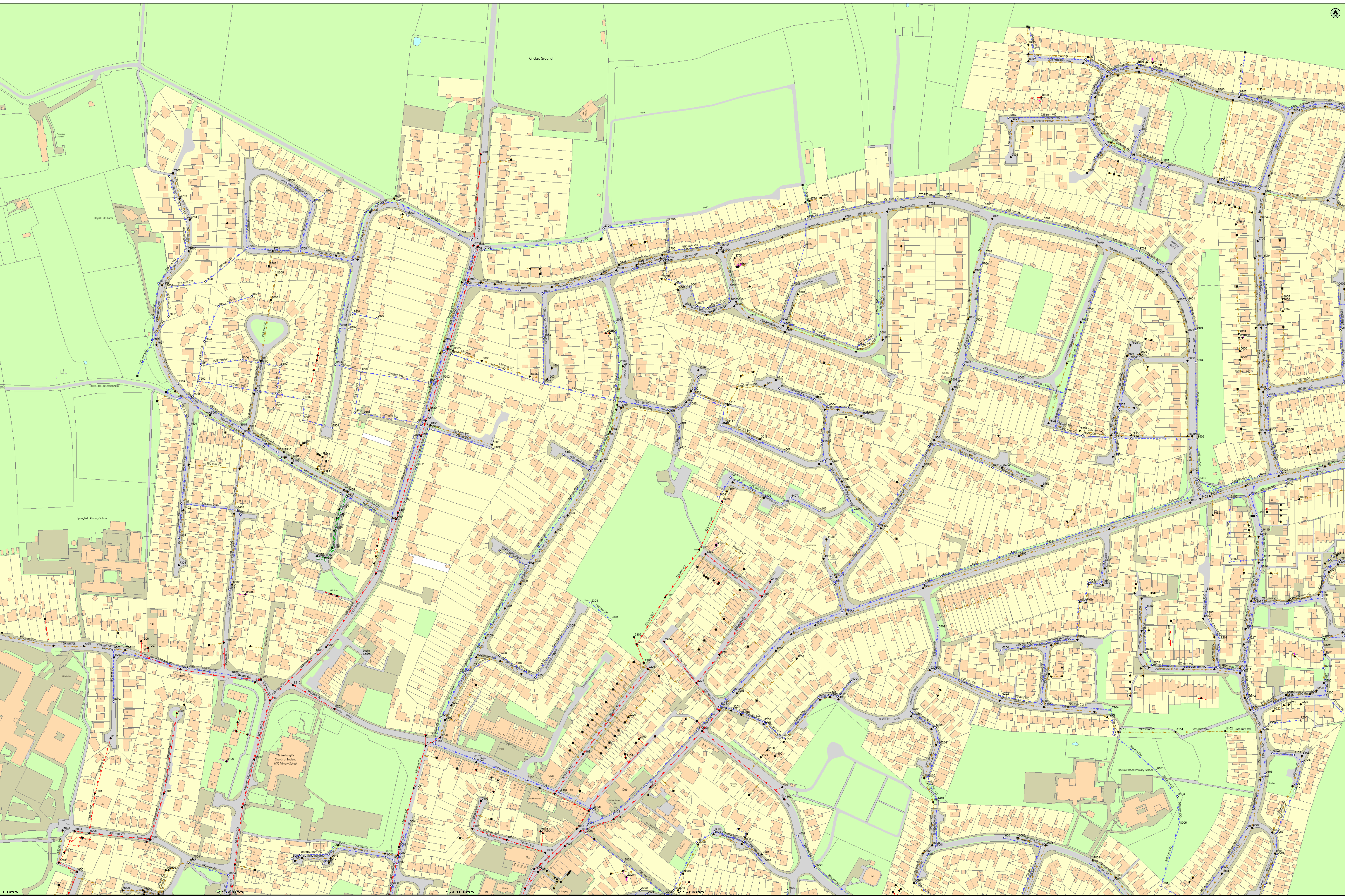
Drawn:	I.RILEY	Reviewed:	D.SMITH
BWB Ref:	BMW 3087	Date:	23.09.22
Scale@A0:	1:100		

Drawing Status

INFORMATION

Project - Originator - Zone - Level - Type - Role - Number	Status	Rev
RHR-BWB-01-ZZ-M2-G-0060	S2	P1

Appendix 3: Severn Trent Water Sewer Records



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Date: 06/10/22

Scale: 1:1250

Map Centre: 440296,336504

Data updated: 14/09/22

Our Ref: 969951 - 1

Wastewater Plan A0

[illegible]

jurgita.v@bwbconsulting.com
BMW3087 RHR Spondon

SEVERN
TRENT



GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on: **0800 783 4444 (24 hours)**

- a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.
- b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.
- c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.
- d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.
- e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).
- f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants.
14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

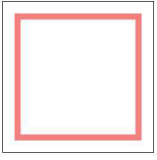
There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

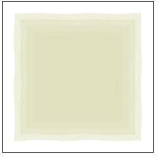
Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert	Manhole Reference	Liquid Type	Cover Level	Invert Level	Depth to Invert
C		0	0		F		0	0		8513	F	83.66	82.05	1.61	2002	S	77.64	76.73	0.91	7510	S	99.39	96.36	3.03										
C		0	0		F		0	0		8514	F	76.76	82.35	1.41	2003	S	74.16	72.98	2	7512	S	99.39	96.36	3.03										
C		0	0		F		0	0		8602	F	101.17	97.67	3.5	2005	S	75.81	74.04	1.77	7512	S	99.64	0	0										
C		0	0		F		0	0		8603	F	84.29	82.76	1.53	2006	S	76	74.19	1.81	7601	S	83.42	80.93	2.49										
C		0	0		F		0	0		8603	F	100.73	99.56	1.17	2007	S	79.52	0	0	7601	S	100.16	98.94	1.22										
C		0	0		F		0	0		8604	F	101.29	97.61	3.68	2009	S	74.82	73.49	1.33	7602	S	82.49	80.4	2.09										
C		0	0		F		0	0		8605	F	83.7	82.47	1.23	2102	S	80.44	0	0	7603	S	83	81.91	1.09										
C		0	0		F		0	0		8606	F	95.7	93.74	1.96	2103	S	79.80	0	0	7604	S	83.24	81.78	1.46										
C		0	0		F		0	0		8606	F	100.94	97.48	3.46	2105	S	80.02	0	0	7604	S	81.31	79.99	1.32										
C		0	0		F		0	0		8607	F	100.9	97.84	3.06	2303	S	88.41	87.87	0.54	7605	S	100.29	99.02	1.27										
C		0	0		F		0	0		8702	F	101.22	100.31	0.91	2304	S	87.9	0	0	7606	S	100.41	99.32	1.09										
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C		0	0		F		0	0		8704	F	84.98	83.26	1.72	2501	S	92.69	91.55	1.14	7608	S	84.07	81.19	2.88										
C		0	0		F		0	0		8801	F	100.57	98.49	2.08	2502	S	91.7	90.33	1.37	7701	S	93.77	85.46	8.31										
C		0	0		F		0	0		8803	F	97.71	95.75	1.96	2505	S	91.06	89.68	1.38	7701	S	100.6	98.57	2.03										
C		0	0		F		0	0		8901	F	96.69	94.62	2.07	2509	S	92.19	91.08	1.11	7702	S	84.68	83.15	1.53										
C		0	0		F		0	0		8904	F	95.88	93.99	1.89	2601	S	92.23	90.9	1.33	7706	S	86.07	84.45	1.62										
C		0	0		F		0	0		9002	F	85.91	84.08	1.83	2602	S	93.7	92.15	1.55	7801	S	86.63	84.94	1.69										
C		0	0		F		0	0		9004	F	85.21	83.03	2.18	2604	S	94.25	92.6	1.65	7801	S	100.22	97.59	2.63										
C		0	0		F		0	0		9007	F	85.93	83.77	2.16	2605	S	92.63	91.6	1.03	7803	S	100.13	98.27	1.86										
C		0	0		F		0	0		9015	F	82.17	81.12	1.05	3004	S	95.1	92.23	2.87	7804	S	99.93	97.38	2.55										
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C		0	0		F		0	0		9018	F	81.39	79.25	2.14	2706	S	94.53	92.61	1.92	7903	S	96.43	93.44	2.99										
C		0	0		F		0	0		9104	F	89.91	88.27	1.64	3002	S	80.91	79.35	1.56	7905	S	96.28	93.3	2.98										
C		0	0		F		0	0		9107	F	88.76	86.43	2.33	3003	S	79.36	77.58	1.78	8001	S	100.1	97.7	2.4										
C		0	0		F		0	0		9108	F	88.77	86.67	2.1	3004	S	78.76	77.24	1.52	8002	S	83.11	81.37	1.74										
C		0	0		F		0	0		9109	F	90.86	87.71	3.15	3005	S	0	0	0	8004	S	81.27	79.8	1.47										
C		0	0		F		0	0		9201	F	0	0	0	3012	S	76.3	74.72	1.58	8005	S	85.66	83.32	2.34										
C		0	0		F		0	0		9203	F	93.18	90.22	2.96	3102	S	81.8	0	0	8008	S	83.14	82.11	1.03										
C		0	0		F		0	0		9205	F	92.1	89.46	2.64	3202	S	84.07	0	0	8009	S	83.02	81.9	1.12										
C		0	0		F		0	0		9206	F	91.98	90.25	1.73	3203	S	82.81	0	0	8101	S	88.97	85.82	3.15										
C		0	0		F		0	0		9207	F	92.13	90.5	1.63	3206	S	85.93	84.06	1.87	8103	S	87.64	84.79	2.85										
C		0	0		F		0	0		9208	F	0	0	0	3207	S	85.26	83.77	1.49	8202	S	84.96	84.2	0.76										
C		0	0		F		0	0		9209	F	91.54	89.22	2.32	3208	S	83.27	80.65	2.62	8203	S	93.35	91.95	1.4										
C		0	0		F		0	0		9212	F	0	0	0	3401	S	93.41	91.91	1.5	8206	S	93.21	91.5	1.71										
C		0	0		F		0	0		9215	F	93.34	91.72	1.62	3404	S	93.11	91.54	1.57	8208	S	94.53	92.88	1.65										
C		0	0		F		0	0		9220	F	92.14	90.54	1.6	3501	S	93.83	92.6	1.23	8209	S	93.85	92.3	1.55										
C		0	0		F		0	0		9221	F	0	0	0	3503	S	93.57	92.49	1.08	8301	S	93.67	95.18	1.49										
C		0	0		F		0	0		9222	F	0	0	0	3504	S	94.38	93.01	1.37	8302	S	95.19	92.82	2.37										
C		0	0		F		0	0		9301	F	97.08	95.57	1.51	3505	S	93.29	0	0	8305	S	95.39	93.81	1.58										
C		0	0		F		0	0		9303	F	95.95	93.37	2.58	3506	S	92.97	91.76	1.21	8306	S	96.85	95.42	1.43										
C		0	0		F		0	0		9304	F	95.71	93.9	1.81	3508	S	94.04	93.25	0.79	8403	S	86.18	84.27	1.91										
C		0	0		F		0	0		9305	F	95.63	94.32	1.51	3514	S	92.85	91.83	1.02	8404	S	86.22	84.34	1.88										
C		0	0		F		0	0		9306	F	93.99	92.74	1.25	3601	S	94.35	0	0	8405	S	99.34	95.42	3.92										
C		0	0		F		0	0		9307	F	0	0	0	3604	S	94.8	93.35	1.45	8408	S	84.87	82.83	2.04										
C		0	0		F		0	0		9308	F	0	0	0	3605	S	95.11	93.58	1.53	8501	S	83.77	82.74	1.03										
C		0	0		F		0	0		9308	F	94.88	92.62	2.26	3606	S	95.62	94.1	1.52	8502	S	83.7	82.66	1.04										
C		0	0		F		0	0		9408	F	85.78	81.2	4.58	3608	S	95.88	94.51	1.37	8502	S	99.86	95.86	4										
C		0	0		F		0	0		9409	F	97.92	96.09	1.83	3701	S	95.8	94.76	1.04	8503	S	0	0	0										
C		0	0		F		0	0		9414	F	99.51	0	0	4001	S	83.23	81.21	2.02	8504	S	101.07	97.79	3.28										
C		0	0		F		0	0		9415	F	99.72	82.41	17.31	4002	S	92.41	80.93	11.48	8505	S	0	0	0										
C		0	0		F		0	0		9417	F	99.83	0	0	4004	S	83.06	81.49	1.57	8507	S	0	0	0										
C		0	0		F		0	0		9452	F	0	0	0	4104	S	85.71	84.27	1.44	8511	S	84.73	82.69	2.04										
C		0	0		F		0	0		9453	F	0	0	0	4201	S	89.55	88.05	1.5	8515	S	83.98	81.89	2.09										
C		0	0		F		0	0		9454	F	0	0	0	4202	S	88.61	86.87	1.74	8516	S	84.57	83.31	1.26										
C		0	0		F		0	0		9455	F	0	0	0	4203	S	8																	

Appendix 4: Proposed Site Layout

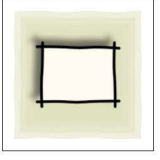




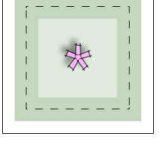
Site Boundary
4.51Ha



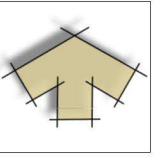
Residential Development Area
2.19Ha = Circa 90 dwellings
Dependent on housing mix



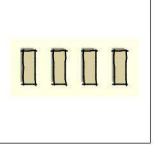
Illustrative Built Form



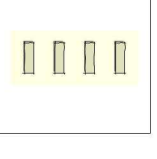
Equipped Play Space
LEAP



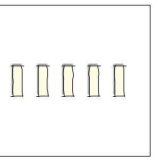
Site Access
Vehicle and Pedestrian



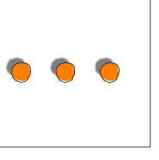
Streets



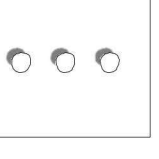
Lanes



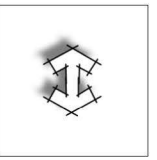
Shared Private Drives



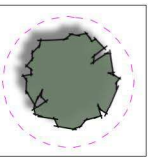
Public Rights of Way



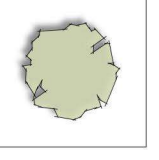
Footpaths &/or Cycleways
Infrastructure to connect to the wider existing network of routes and PRowTs to adjacent schools



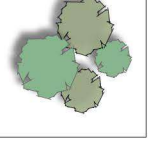
Pedestrian Connections at Site Boundary



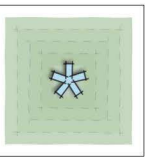
Retained Trees & Hedgerows
With associated RPAs



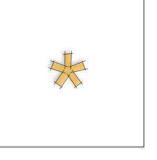
Structural Landscaping
Planting buffer along eastern boundary



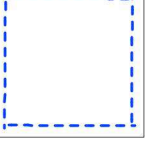
Illustrative Landscape Strategy
Includes opportunities for a kickabout area, orchard and grasslands (to be agreed as part of detailed applications)



Drainage Basin



Illustrative Location of Pumping Station

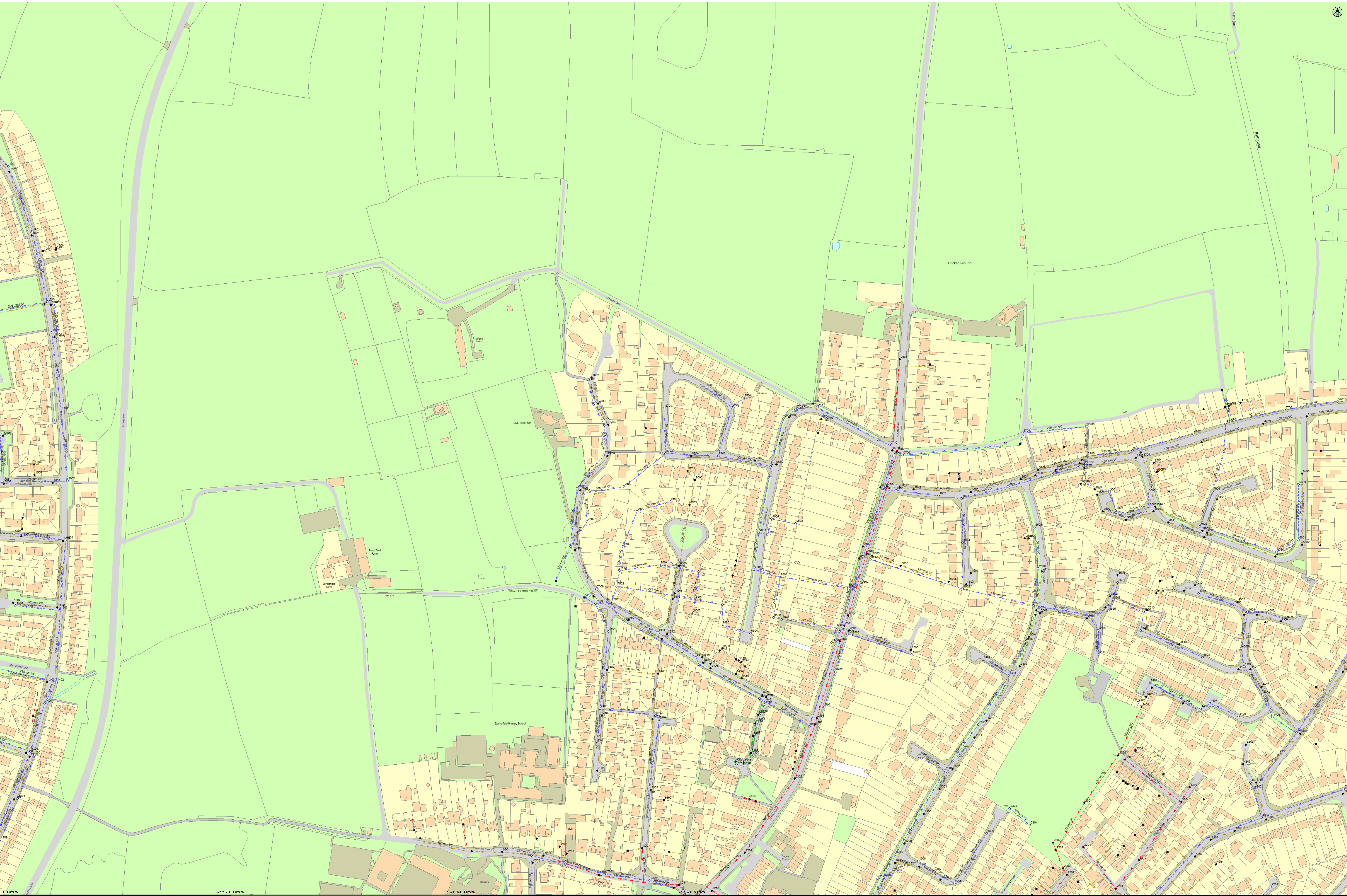


Flood Zones



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Appendix 5: Severn Trent Water Sewer Records



Do not scale of this Map. This plan and any information supplied with it is furnished as a general guide, is only valid at the date of issue and no warranty as to its correctness is given or implied. In particular this plan and any information shown on it must not be relied upon in the event of any development or works. It is the responsibility of the user to ensure that the plan and any information shown on it is up to date and correct. It is the responsibility of the user to ensure that the plan and any information shown on it is up to date and correct. It is the responsibility of the user to ensure that the plan and any information shown on it is up to date and correct.

Public Foul Gravity/Lateral Drain	Highway Drain	Manhole Foul
Public Combined Gravity/Lateral Drain	Overhead Pipe	Manhole Surface
Public Surface Water Gravity/Lateral Drain	Drapped Pipe	Abandoned Pipe
Pressure Foul	Quarantine Water	Character
Pressure Combined	Pumping Station	Section 104 sewers are shown in green
Pressure Surface Water	Filling	Private sewers are shown in magenta

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BMV0087 Spondon





GENERAL CONDITIONS AND PRECAUTIONS TO BE TAKEN WHEN CARRYING OUT WORK ADJACENT TO SEVERN TRENT WATER'S APPARATUS

Please ensure that a copy of these conditions is passed to your representative and/or your contractor on site. If any damage is caused to Severn Trent Water Limited (STW) apparatus (defined below), the person, contractor or subcontractor responsible must inform STW immediately on: **0800 783 4444 (24 hours)**

- a) These general conditions and precautions apply to the public sewerage, water distribution and cables in ducts including (but not limited to) sewers which are the subject of an Agreement under Section 104 of the Water Industry Act 1991(a legal agreement between a developer and STW, where a developer agrees to build sewers to an agreed standard, which STW will then adopt); mains installed in accordance with an agreement for the self-construction of water mains entered into with STW and the assets described at condition b) of these general conditions and precautions. Such apparatus is referred to as "STW Apparatus" in these general conditions and precautions.
- b) Please be aware that due to The Private Sewers Transfer Regulations June 2011, the number of public sewers has increased, but many of these are not shown on the public sewer record. However, some idea of their positions may be obtained from the position of inspection covers and their existence must be anticipated.
- c) On request, STW will issue a copy of the plan showing the approximate locations of STW Apparatus although in certain instances a charge will be made. The position of private drains, private sewers and water service pipes to properties are not normally shown but their presence must be anticipated. This plan and the information supplied with it is furnished as a general guide only and STW does not guarantee its accuracy.
- d) STW does not update these plans on a regular basis. Therefore the position and depth of STW Apparatus may change and this plan is issued subject to any such change. Before any works are carried out, you should confirm whether any changes to the plan have been made since it was issued.
- e) The plan must not be relied upon in the event of excavations or other works in the vicinity of STW Apparatus. It is your responsibility to ascertain the precise location of any STW Apparatus prior to undertaking any development or other works (including but not limited to excavations).
- f) No person or company shall be relieved from liability for loss and/or damage caused to STW Apparatus by reason of the actual position and/or depths of STW Apparatus being different from those shown on the plan.

In order to achieve safe working conditions adjacent to any STW Apparatus the following should be observed:

1. All STW Apparatus should be located by hand digging prior to the use of mechanical excavators.
2. All information set out in any plans received from us, or given by our staff at the site of the works, about the position and depth of the mains, is approximate. Every possible precaution should be taken to avoid damage to STW Apparatus. You or your contractor must ensure the safety of STW Apparatus and will be responsible for the cost of repairing any loss and/or damage caused (including without limitation replacement parts).
3. Water mains are normally laid at a depth of 900mm. No records are kept of customer service pipes which are normally laid at a depth of 750mm; but some idea of their positions may be obtained from the position of stop tap covers and their existence must be anticipated.
4. During construction work, where heavy plant will cross the line of STW Apparatus, specific crossing points must be agreed with STW and suitably reinforced where required. These crossing points should be clearly marked and crossing of the line of STW Apparatus at other locations must be prevented.
5. Where it is proposed to carry out piling or boring within 20 metres of any STW Apparatus, STW should be consulted to enable any affected STW Apparatus to be surveyed prior to the works commencing.
6. Where excavation of trenches adjacent to any STW Apparatus affects its support, the STW Apparatus must be supported to the satisfaction of STW. Water mains and some sewers are pressurised and can fail if excavation removes support to thrust blocks to bends and other fittings.
7. Where a trench is excavated crossing or parallel to the line of any STW Apparatus, the backfill should be adequately compacted to prevent any settlement which could subsequently cause damage to the STW Apparatus. In special cases, it may be necessary to provide permanent support to STW Apparatus which has been exposed over a length of the excavation before backfilling and reinstatement is carried out. There should be no concrete backfill in contact with the STW Apparatus.
8. No other apparatus should be laid along the line of STW Apparatus irrespective of clearance. Above ground apparatus must not be located within a minimum of 3 metres either side of the centre line of STW Apparatus for smaller sized pipes and 6 metres either side for larger sized pipes without prior approval. No manhole or chamber shall be built over or around any STW Apparatus.
9. A minimum radial clearance of 300 millimetres should be allowed between any plant or equipment being installed and existing STW Apparatus. We reserve the right to increase this distance where strategic assets are affected.
10. Where any STW Apparatus coated with a special wrapping is damaged, even to a minor extent, STW must be notified and the trench left open until the damage has been inspected and the necessary repairs have been carried out. In the case of any material damage to any STW Apparatus causing leakage, weakening of the mechanical strength of the pipe or corrosion-protection damage, the necessary remedial work will be recharged to you.
11. It may be necessary to adjust the finished level of any surface boxes which may fall within your proposed construction. Please ensure that these are not damaged, buried or otherwise rendered inaccessible as a result of the works and that all stop taps, valves, hydrants, etc. remain accessible and operable. Minor reduction in existing levels may result in conflict with STW Apparatus such as valve spindles or tops of hydrants housed under the surface boxes. Checks should be made during site investigations to ascertain the level of such STW Apparatus in order to determine any necessary alterations in advance of the works.
12. With regard to any proposed resurfacing works, you are required to contact STW on the number given above to arrange a site inspection to establish the condition of any STW Apparatus in the nature of surface boxes or manhole covers and frames affected by the works. STW will then advise on any measures to be taken, in the event of this a proportionate charge will be made.
13. You are advised that STW will not agree to either the erection of posts, directly over or within 1.0 metre of valves and hydrants.
14. No explosives are to be used in the vicinity of any STW Apparatus without prior consultation with STW.

TREE PLANTING RESTRICTIONS

There are many problems with the location of trees adjacent to sewers, water mains and other STW Apparatus and these can lead to the loss of trees and hence amenity to the area which many people may have become used to. It is best if the problem is not created in the first place. Set out below are the recommendations for tree planting in close proximity to public sewers, water mains and other STW Apparatus.

15. Please ensure that, in relation to STW Apparatus, the mature root systems and canopies of any tree planted do not and will not encroach within the recommended distances specified in the notes below.
16. Both Poplar and Willow trees have extensive root systems and should not be planted within 12 metres of a sewer, water main or other STW Apparatus.
17. The following trees and those of similar size, be they deciduous or evergreen, should not be planted within 6 metres of a sewer, water main or other STW Apparatus. E.g. Ash, Beech, Birch, most Conifers, Elm, Horse Chestnut, Lime, Oak, Sycamore, Apple and Pear. Asset Protection Statements Updated May 2014
18. STW personnel require a clear path to conduct surveys etc. No shrubs or bushes should be planted within 2 metre of the centre line of a sewer, water main or other STW Apparatus.
19. In certain circumstances, both STW and landowners may wish to plant shrubs/bushes in close proximity to a sewer, water main of other STW Apparatus for screening purposes. The following are shallow rooting and are suitable for this purpose: Blackthorn, Broom, Cotoneaster, Elder, Hazel, Laurel, Privet, Quickthorn, Snowberry, and most ornamental flowering shrubs.

