

LAND OFF ORKNEY CLOSE,
REAR 77 BURY ROAD, RADCLIFFE

FLOOD RISK ASSESSMENT
& OUTLINE DRAINAGE STRATEGY

Job Number: FRA 21 1134
Date: August 2021
Client: BCR Estates Ltd



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LK Consult			
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EXECUTIVE SUMMARY

Scope and Background

This Flood Risk Assessment and Outline Drainage Strategy (FRA) has been undertaken by LK Consult Ltd (LKC) to support a planning application for the development of land off Orkney Close to the rear of 77 Bury Street, Radcliffe. The development comprises of a new residential property to the rear garden of the existing property.

LKC has prepared this FRA in line with the NPPF and Technical Guidance where appropriate.

In considering the proposals the following key principles have therefore been applied:

- Identification of flood risks.
- Protection of users of the new development.
- No increased flood risk to third parties.

Consultations

The Environment Agency (EA) has been consulted to inform the preparation of this report. They have provided modelled data for the culverted watercourse.

Bury Council and United Utilities were also consulted concerning flood risk.

All relevant consultees have confirmed that there is a Negligible to Very Low risk of flooding to this site from all sources except Groundwater and Artificial sources which are Low.

Flood Risk

Environment Agency flood maps indicate that the site is potentially vulnerable to fluvial flooding from the culverted Crow Trees Brook to the east of the site.

The site is shown on the Environment Agency's (EA) website Flood Zone Mapping as being in Flood Zones 1 and 2 (PPG Table 1).

The site is in Flood Zone 2 – Low Risk – between a 1 in 100 and 1 in 1000 annual probability of river flooding (1% – 0.1%).

However, comparison of modelled flood level data with the topographic survey shows that the site is wholly in Flood Zone 1 – Very Low Risk – annual probability of flooding less than 0.1% (1 in 1000).

There is a relatively shallow perched groundwater above the clay below the site and there is a Low risk of flooding from a significant failure of Withins Reservoir to the north.

Mitigation

Design

Site falls will be arranged to allow reasonably level access for occupants and visitors and allowing the site to be free-draining in case of local ponding at times of heavy rainfall. Floor levels of dwellings will be set as high as possible above the flood level giving regard to necessary access for the less-able.

The development will not result in any reduction in flood plain storage compared to the existing situation.

In considering the potential drainage options for the site at present it is assumed that surface water runoff arising from the development will discharge into the adjacent existing surface water sewer.

The proposed development will increase the proportion of the site covered by impermeable surfaces and will therefore generate more runoff. Attenuation will therefore be required including an allowance for climate change.

Foul sewage arising from the development will be discharged into the public foul sewer in Orkney Close subject to confirmation.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the adjacent surface water sewer in Orkney Close, the sewer is not shown on the United Utilities revords. The most effective strategy, in line with the SuDS management train, would be to have a detention tank at the southwestern boundary towards the southern corner. The required detention tank or similar has been estimated to be **9.6m³** for the 1 in 30-year flow restriction.

Similarly, the estimated volume to be retained on site for the 1 in 100-year storm event including the allowance for climate change is between **20.3m³** and **26.0m³**.

The site is considered to be at Low risk of flooding. It is recommended that the minimum finished floor levels for the development should be set at a nominal height above the proposed ground levels. This is to allow for overland flow during exceedance flows from an extreme event or a drainage failure.

Access

Access close to the site is elevated above potential flood levels and will always provide safe access to and from the site from Orkney Close. There is the potential for shallow flooding on the adjacent roads for events greater than the 1 in 100 year event.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by BCR Estates Ltd to carry out a Flood Risk Assessment (FRA) and Outline Drainage Strategy for the Land off Orkney Close, Radcliffe. The report was undertaken in support of a future planning application to redevelop the garden land to the rear of 77 Bury Road for a residential care home.

The report will address the vulnerability to flooding from all possible sources and will also consider the impact of the development on surface water runoff accounting for climate change and the potential to increase flood risk elsewhere. The Outline Drainage Strategy in Section 5 will provide an overview of the SuDS techniques which could be considered on the site. The issues of actual flood risk are discussed in Section 4.

Government policy with respect to development in flood risk areas is contained within the Department of Communities and Local Government National Planning Policy Framework¹ and accompanying Technical Guidance of March 2012 (revised to the Planning Practice Guidance (PPG)², which supersedes Planning Policy Statement 25 (PPS25) 'Development and Flood Risk'. The guidance on Climate Change allowance issued by the Environment Agency in February 2016 has also been considered.

LKC has prepared this Flood Risk Assessment (FRA) in line with the NPPF and the PPG where appropriate. The level of detail entered into any flood risk assessment is dependent upon the scale and potential impact of the proposed development, and the vulnerability classification of the proposed land-use.

1.2 Site Details

A summary of the general site details is presented in Table 1-1. Plans, Drawings and Figures are provided in Appendix A. Figures 1 and 2 indicate the site location and boundary.

Site Details	
Location	Land adjacent to Orkney Close, off Bury Road, Radcliffe, Bury, M26 2UT. Centred at approximate National Grid Reference 378950E, 407880N.
Area	Approximately 1300m ² .
Topography	73.5 metres Above Ordnance Datum (AOD) adjacent to the railway embankment. Falling to 72.1mAOD towards the southern corner. Site is generally sloping to the southeast but is mounded with rubble.
Current Land Use	<u>Site</u> Former rear garden, currently storing demolition rubble from the adjacent ongoing development. <u>Surrounding Area/ Boundary Treatment</u> North: Residential Properties and the railway line. East: Metrolink Line. South: Orkney Close and residential properties. West: Bury Road and residential properties.
Proposed Development	Proposed care home including soft landscaping and car parking. Access will be from Orkney Close.

Table 1-1: Summary of site details.

¹ DCLG (2019). "National Planning Policy Framework." Department of Communities and Local Government. July 2021.

² DCLG (2014). "Planning Practice Guidance" <http://planningguidance.communities.gov.uk>, April 2014.

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2 Site Setting

2.1 Vulnerability

As an initial phase in identifying whether a site is potentially at risk of flooding, LKC has consulted the Environment Agency's (EA) website Flood Zone Mapping. This mapping is (often) based on coarse scale modelling and provides only an initial indication of the flood risk to a site. The Environment Agency Flood Zone maps were developed using a very coarse Digital Elevation Map (DEM) and are superseded by a more detailed analysis of modelled flood levels and topographic survey levels.

The Flood Zones divide the floodplain into three categories of flood risk, and do not take flood defences into account. The NPPF defines the Flood Zones as:

- Flood Zone 1 – little or no risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).
- Flood Zone 2 – low risk, with annual probability of flooding of 0.1 to 1.0% from rivers and 0.1 to 0.5% from the sea.
- Flood Zone 3 – medium to high risk of flooding with an annual probability of flooding of 1.0% or greater from rivers, and 0.5% or greater from the sea.

The Flood Zone Mapping indicates the site as being within Flood Zones 1 and 2 in the PPG (paragraph 065, Table 1).

The development site is shown in Flood Zone 2, so under current regulations a Flood Risk Assessment will be necessary to accompany the Planning Application.

The proposed development is for a residential care home end use, and this is classified within the 'More Vulnerable' category in the PPG (paragraph 066, Table 2).

2.2 The Sequential and Exception Tests

The NPPF requires that the Sequential Test be applied to development proposals in Flood Zones 2 or 3 to determine if there are any 'reasonably available' and suitable alternative sites at lower flood risk. The Sequential Test is outside this scope of works and shall be undertaken by others.

Notwithstanding the above, the principles outlined in the Sequential Test guidance should be applied for developments within the site such that, for example, dwellings are situated on a high part of the site when there is a risk of local surface water flooding. The issues of actual flood risk are discussed below. The issues of safety and reduction in flood risk to others required by an Exception Test are also addressed in this document.

The Local Planning Authority (LPA) will make the final decision with regard to any planning application.

2.3 Environmental Setting

LKC have previously undertaken a Preliminary Risk Assessment for the site³ (LKC 20 1743 – October 2020) and pertinent environmental information for the site is summarised in Table 2-1 below.

Summary of the Environmental Setting			
Geology	Superficial		Glaciofluvial sheet deposits (sand and gravel).
	Bedrock		Pennine Middle Coal Measure - Peel Hall Rock (sandstone).
	BGS Boreholes		BH Ref: SD70NE25, 1m east: 2.4m of soil and gravel over Marl to 18.6m.
	Defra Soilscape Mapping		Slowly Permeable Clay based soils.
Hydrogeology	Aquifer Designation	Superficial	Secondary A Aquifer.
		Bedrock	Secondary A Aquifer. Site is not within a SPZ.
Hydrology	All adjacent and internal surface water		Crow Trees Brook/ Crofters Brook is culverted at approximately 60m to the northeast.
Site History			Within Lane Colliery with associated railway sidings present on site by 1889 mapping. No longer present on site by 1909 mapping.

Table 2-1: Summary of the Environmental Setting.

2.4 Site Reconnaissance

A site reconnaissance was undertaken in October 2020 and photographs are provided in Appendix B.

Relevant features identified on site are summarised below:

- Access to site is via metal gates on the east of Orkney Close.
- The majority of the site comprises rough extremely overgrown undulating land comprising shrubs, demolition rubble and household fly tipping are present comprising bricks, pipe, gravel, concrete, wood, carpet, general household waste, plastics, metals.
- An electricity sub-station is present in the southern tip of the site.
- There are sewers within Orkney Close adjacent to the site.
- There is a low railway embankment to the northwest site boundary.

The surrounding area comprises of residential properties and commercial office space with Orkney Close to the southwest of the site.

The site is mounded up with spoil and building rubble at present and is falling slightly to the southeast following the road. There sub-station in the southern corner of the site may affect the route of any drainage connection to the sewer if appropriate.

2.5 Site and Access Levels

A topographic survey of the site has been undertaken to OS GPS datum, and information is included on the drawings in Appendix B. The site falls from 73.5 metres Above Ordnance Datum (AOD) adjacent to the railway to 72.1mAOD towards the southern corner. The final site levels and ground floor levels of dwellings have not yet been determined. The proposed access would join Orkney Close at around 72.4m AOD.

³ Phase 1 Preliminary Risk Assessment: LK Consult Ltd, LKC20 1743, October 2021.

3 Consultation

Information from consultees (Environment Agency (EA), Bury Council - Lead Local Flood Authority and United Utilities is summarised in Table 3-1 below.

Relevant correspondence / information is provided in Appendices C (EA) and D (others).

Source	Details	
Environment Agency	Flood Zone 2: Low risk, with annual probability of flooding of 0.1 to 1.0% from rivers and 0.1 to 0.5% from the sea.	
	Modelled Levels for Crow Trees Farm Brook Nearest Node: 3	Level of 71.29m for 1% annual probability event. Level of 71.39m for 1% annual probability event with 35% climate change allowance. Level of 71.55m for 1% annual probability event with 70% climate change allowance. Level of 71.66m for 0.1% annual probability event.
	Additional Data 2D Levels in Orkney Close	Node 6 Level of 72.40m for the 1% annual probability event +70%. Node 7 Level of 71.24m for 1% annual probability event. Level of 71.25m for 1% annual probability event with 35% climate change allowance. Level of 71.31m for 1% annual probability event with 70% climate change allowance.
	Records of Flooding	No records of flooding.
	Records of Flood Warning Service	Not in a Flood Warning Area.
	Surface Water Flooding	Very low risk of surface water flooding.
	Flooding from reservoirs	There is a risk of flooding from reservoirs along the edges of the site.
	Groundwater Source Protection Zone	Not within Source Protection Zone.

Table 3-1: Summary consultee information.

Source	Details	
Lead Local Flood Authority/LPA	No information provided at the time of writing this report.	
United Utilities	Likely conditions for connecting into their sewerage system	United Utilities would request conditions for a separate system with only foul draining to foul / combined sewers and surface water draining to soakaway/SuDS, watercourse or surface water sewer. UU would also request for a condition to prevent development within 3m either side of the sewer running through the site. All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80 of the National Planning Practice Guidance. Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. If not feasible, UU will consider a connection to the nearby public sewer. It is usual to require a pass forward flow to be agreed by the Lead Local Flood Authority. UU request that any agreed rate does not exceed 5l/s. Foul flow from this site will be allowed to drain into the public combined sewer system at an unrestricted rate.
	Sewer map	The sewer map does not show any public sewers in Orkney Close, but there are existing sewers that are assumed to connect to the 300mm diameter combined sewer in Bury Road.
Strategic Flood Risk Assessment (SFRA)	Level 1 SFRA ⁴	The site has no history of flooding from any source.
	Level 2 SFRA ⁵	The site has no history of flooding from any source. Radcliffe is considered to be in a Critical Drainage Area.
Preliminary Flood Risk Assessment (PFRA) ⁶	The Preliminary Flood Risk Assessment (PFRA)³ for the area indicates that there are no records of flooding for the area which conforms with information supplied by the EA. The PFRA also indicates that the site is in an area susceptible to groundwater flooding.	

Table 3-1 (continued): Summary consultee information.

⁴ Bury, Rochdale and Oldham STRATEGIC FLOOD RISK ASSESSMENT Level 1: JBA Consulting November 2009.

⁵ Bury, Rochdale and Oldham STRATEGIC FLOOD RISK ASSESSMENT Level 2: JBA Consulting November 2009.

⁶ Preliminary Flood Risk Assessment: Bury Council; May 2011, JBA Consulting.

4 Assessment of Flood Risk

4.1 Flood Zones

The detailed flood map provided by the EA indicates that the site is in Flood Zones 1 and 2 (see Appendix C).

A direct comparison was made between the provided EA flood levels at this location and the topographical levels.

The EA design flood levels are marginally lower than the site. It can be reasonably concluded on the evidence above that the site is in Flood Zone 1 for the purposes of this assessment.

The nearest watercourse is a culverted section of Crow Trees Farm Brook to the east.

Comparison of the modelling data and topographical survey indicates that the 1% and 0.1% (100-year and 1000-year) flood level would not affect any part of the site. Therefore, the actual flood position is much better than that indicated by the published flood map.

The only Flood Level data that impinges on the site is the 100 year + 70% 2D flood level for Node 6 which would affect Orkney Close to the south of the development access and the 1 in 1000 year event level is above the existing ground level at the junction of Orkney Close and Bury Road to the south. The extents of the 0.1% (1000-year) flood level do not enter the development site (see Appendix C).

4.2 Sources of Flooding

The risk of flooding from the following flood sources has been considered:

Fluvial – The EA data has confirmed the study area is just within Flood Zone 1. Therefore, the flood risk associated with this source is very low but should be considered further in terms of finished floor levels and flood resilience.

Tidal – The study area is remote from the sea and tidally influenced water bodies. Therefore, the flood risk associated with this source is considered Negligible.

Pluvial (Rainfall) – The surface water flood risk maps show small areas that have the potential to flood during prolonged heavy rainfall. These areas are associated with natural depressions that are likely to be removed/positively drained following the development process. These areas need consideration within the detailed design or there is the potential to have areas of standing water in gardens and landscaped areas not positively drained if overland flow routes are not considered. Therefore, the risk of flooding from surface water flooding is Low but should be considered further during the detailed design.

Surface Water (Overland flow) – This relates to surface water entering the site. The only observed area at a level generally above that of the study area is the adjacent railway embankment to the northwest. Any surface water arising from the embankment is likely to be intercepted by the trackside drainage and therefore pose no threat to the development. If there was a drainage failure causing overland flow it would flow towards the southern corner. Therefore, the flood risk associated with this source is considered Very Low.

Groundwater – The BGS has groundwater records for the study area in the form of mapping. The records show the water table is recorded at just below the surface likely to be at the boundary of the granular material and the clay at about 2.5mbgl. The shallow groundwater potential indicates that water may enter any deep excavations or service trenches during construction and de-watering may be necessary. There are no potential sources of Artesian Pressure to force the water to spring in the area. This makes it unlikely for groundwater flooding to occur at the surface. No evidence of shallow groundwater was observed during the walkover. Therefore, the flood risk associated with this source is considered Low.

Sewers – UU sewer records show that the sewers are the head of systems so flooding from sewers are unlikely. The surrounding roads fall away from the site. Therefore, the flood risk associated with this source is considered Very Low.

Artificial sources – According to the EA online maps, the study area is at risk from reservoir flooding along the outside boundary. The likely risk of an incident occurring if the reservoir is adequately maintained and monitored is low. Therefore, the flood risk associated with this source is considered Low.

4.3 Summary of Flood Risk

Source of Flooding	Risk Assessment Level
Fluvial	Very Low
Pluvial (Rainfall)	Low
Surface Water	Very Low
Tidal	Negligible
Groundwater	Low
Sewers	Very Low
Artificial Sources	Low

Table 4-1: Summary of Existing Risk Level.

The data provided by the EA when compared to the topographical levels for the site is indicated that the site is within Flood Zone 1 and a Low to Very Low risk of flooding from all other sources have been identified for the site. LKC therefore consider that a strategy for surface water management will be required at the site to mitigate the risk to others. The assessments of a range of measures that are feasible for the site are outlined in Section 5.

5 Surface Water Management

The NPPF recognises that flood risk and other environmental damage can be managed by minimising changes in the volume and rate of surface run-off from development sites through the use of Sustainable Drainage Systems (SuDS), this being complementary to the control of development within the floodplain.

SuDS will not alleviate flooding in an area prone to flooding; however, properly designed SuDS have the potential to prevent the surface water runoff from new development worsening the flood risk. The effective disposal of surface water from any new development is a material planning consideration in determining if the proposals for the development and use of land are acceptable.

The accepted principles are that surface water arising from a developed area should, as far as practicable, be managed in a sustainable manner to mimic the surface water flows arising from the site prior to the proposed development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

The Building Regulations Requirement H3⁷ stipulates that rainwater from roofs and paved areas is carried away from the surface to discharge to one of the following, listed in order of priority:

- an adequate soakaway or other adequate infiltration system,
- a watercourse or, where that is not practicable,
- a sewer.

The concept of a sustainable drainage system has been incorporated into the outline drainage strategy for the study area in order to comply with the Flood and Water Management Act 2010⁸.

Suitability of different SuDS will be governed by prevailing site conditions, such as the type and scale of development, topography, ground conditions (soil permeability, ground stability, depth to water table), local hydrogeology and risk of groundwater contamination (presence of sensitive aquifers and source protection zones) etc.

5.1 Infiltration

The Groundwater Source Protection Zone mapping from the EA website shows that the site is not within any identified protection zones.

A summary of the British Geological Survey superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 5-1 below:

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Glacial Till Deposits	Silty, sandy gravel	Secondary A	2.5m	Limited
Pennine Middle Coal Measures	Sandstone	Secondary A	N/A	Limited

Table 5-1: Geological and Hydrogeological Setting.

⁷ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁸ Flood and Water Management Act 2010: UK Government.

Infiltration methods such as soakaways are unlikely to be feasible due to the made ground and the shallow water table, but this may be investigated further at the detailed design stage.

5.2 Surface Water Drainage Strategy

There is a slope over the site and surrounding area which indicates that surface water in the vicinity of the site would drain towards the southeast.

There are no observable watercourses within or near the boundary of the site. Currently surface water from the site runs overland to the southeast.

There is a surface water sewer running adjacent to the site in Orkney Close.

The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 5-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Comments
a	Soakaway/Infiltration	2	Reasoning: made ground and high water table.
b	Connection to Watercourse	N/A	Would require third party access/a road crossing and EA/LLFA consent and would be expensive due to distance between site and watercourse.
c	Discharge into a sewer	1	The depth of the sewer on adjacent to the site and levels at the south east corner indicate that a connection is possible – subject to approval from LLFA/UU.

Table 5-2: Drainage options.

Table 5-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C753 (The SUDS Manual)⁹ for the development

SuDS Option	Appropriate to Development	Comments
Soakaways	X	Due to the nature of the ground conditions, the use of infiltration systems may not be feasible.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May not be appropriate given the ground conditions.
Sand filter	✓	Treatment devices using sand beds as filter media.
Filter drains	✓	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.
Detention basin	X	Dry depressions designed to hold water for a specific retention time.
Swales	X	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses.
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use. When required, the water is pumped to the point of use, thus displacing what would otherwise be a demand for mains-water. In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. Rainwater harvesting systems are currently not included in the development proposals.
Green/blue roofs	*	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Green roofs are not currently included in the development proposals.
Geo-cellular storage systems	✓	Modular block systems can be used to provide an underground storage facility. Any geo-cellular storage systems should be lined with a geo-membrane to provide attenuation storage.
Permeable Pavements – with granular and geo-cellular storage systems	✓	Permeable pavements allow inflow of rainwater into underlying construction. Any geo-cellular storage systems would have to be lined with an impermeable membrane to provide storage rather than infiltration for runoff from highways.
Ponds	X	Attenuation ponds can be used to offset the increase in surface water flows attributable to increased area of hard standing, in order to minimise the risk of flooding to and from the proposed development. Ponds will attenuate the surface water flow prior to discharging to the public surface water sewers. The storage volume afforded by these features should not include any permanent water in the pond.
Oversized Pipes	✓	Oversizing the pipes that make up the on-site drainage network is a cost-effective method for providing attenuation storage within the network. Such systems could be considered on the parts of the development where gradients are relatively flat.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.
Flow control devices	✓	The peak flow rates will be controlled by flow control devices e.g. hydrobrake style flow control systems, and restricted orifices. Flow control devices enable the discharge to be restricted to a constant rate from the development.

Table 5-3: Summary of the SuDS options appraisal.

Notes

✓ Suitable for use given the nature and scale of the development

* Possibly suitable for use – not included in the client and architect design proposal at present

X Not suitable

⁹ CIRIA C753 - The SUDS Manual. London 2015.

5.3 Surface Water Attenuation Requirements

From correspondence with the LPA the flow should be limited to a 'greenfield scenario' for estimating the attenuation volumes required.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 5-4). Table 5-4 shows the assumed split in area included within the calculations.

Designated Areas	Plot Area
Total area (ha)	0.13
Development Area (ha)	0.10
Green Infrastructure (ha)	0.03

Table 5-4: Assumed plot areas.

5.3.1 Attenuation Estimate

Surface water storage and greenfield runoff estimations based on the HR Wallingford procedure (IH 124¹⁰) have been undertaken for the development and the output report is presented in Appendix E.

For the contributing catchment an estimate has been produced assuming a developable area of 0.10ha and an open space of 0.03ha from the 0.13ha plot. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

Q _{bar} :	0.97 l/s
1 in 1-year greenfield runoff rate:	0.82 l/s
1 in 30-year greenfield runoff rate:	1.63 l/s
1 in 100-year greenfield runoff rate:	2.04 l/s

United Utilities will generally accept a maximum flow of 5/s as a practical minimum to their adjacent surface water if infiltration is found to be impractical.

All greenfield runoff estimates, and subsequent storage estimates are included in Appendix E.

The following attenuation has been estimated for the development using a maximum of 5l/s runoff rate and utilises the FSR methodology¹¹ as:

- Attenuation storage volume: **9.60 m³** (1 in 30-year event)
- Retention on site volume: **20.3 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **26.0 m³** (1 in 100 year + 40% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to the corresponding limited runoff for a range of annual flow rate probabilities before discharge to the sewer. As the flow from the development would be restricted to the practical minimum of 5l/s there should be little change in the flows that enter the public sewer and thus the risk of flooding as a result from the development should be not increase the risk of flooding off-site.

The attenuation required for a 1 in 30-year storm event, requires a storage volume of **9.6 m³** as the peak flow for the 30 year event. For the 1 in 100-year event, a storage

¹⁰ IH124 Flood Estimation of Small Catchments.

¹¹ Flood Studies Report Wallingford NERC 1975.

capacity of between **20.3 m³** and **26.0 m³** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary in the proposed drainage. As the flows of surface water and discharges will be limited by flow control devices to the adjacent sewer.

5.4 Site Specific SuDS

The use of attenuation tank or similar deem to be the most feasible and practical option for the development. The attenuation tank will provide required storage volume to limit peak runoff arising from the development.

Utilising of the flow control device at the end of the system will control the peak flow rates.

The use of permeable paving may be viable dependant on the detailed design of the proposed development. If this drainage technique is considered to be feasible then it will reduce the requirement for attenuation as it will reduce the contributing impermeable area. The permeable paving will also provide some level of water treatment reducing effects of pollution in runoff on the environment.

Assuming that the outline drainage strategy is acceptable to the Local Authority, a more detailed design can be presented and agreed with the appropriate regulatory bodies during the detailed design phase.

5.5 Foul Drainage

There are nearby sewers in Orkney Close, but these are not included on the public sewer records. There is a 300mm diameter combined sewer in Bury Road.

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6 Mitigation Measures

6.1 Proposed Site levels and Developments Level

Current Environment Agency guidance recommends that the minimum ground floor levels of residential developments are set at a minimum of 600mm above the 1% annual probability (1 in 100 year) flood level including an additional fluvial allowance for climate change. It is generally accepted that vehicle parking can be accommodated within the flood zone with suitable safeguards. The 'design' flood level for the site should therefore be the 1% annual probability event with allowance for climate change plus an allowance for freeboard.

This and the 0.1% annual probability (1 in 1000-year) is below the lowest existing ground level measured on site by approximately 0.8m. On this basis the finished floor levels (FFL) should be set at a nominal height above the finalised ground levels to allow for any overland flow from a drainage failure. No further mitigation measures are therefore recommended.

6.2 Safe Access

Safe and dry access is available via Orkney Close (72.5m AOD) to the south west at 1.2m above the 1% annual probability event (71.29m AOD). Therefore, no mitigation is proposed.

The proposed vehicular access connects to Bury Road which is within Flood Zone 2 therefore the requirement for a formal evacuation plan should be discussed with the LPA.

6.3 Flood Resistance and Resilience

The development proposed may be subject to groundwater entering excavations for foundations and services due to the potentially shallow water table. Dewatering may be required for excavations and means of limiting flows in service trench bedding be incorporated. However, the risk appears to be sufficiently low that flood resilience measures need not be included into ground floor construction to aid recovery after any event. If utilised, typical measures would include solid floors, use of suitable materials and services fed from upper floors with outlets at high level. The need can be discussed and agreed with building control officers during detailed design.

6.4 Residual Risk

It is impossible to completely guard against flooding since extreme events greater than the design standard event are always possible. However, ground floor levels should be set 600mm above the modelled 1% plus climate change event level adjacent to the flood zones. Proposed finished floor levels above this level across the remainder of the site should provide a nominal freeboard to allow overland flow under exceptional conditions. Overland flow routes should be considered in case of drainage failure and the extreme events.

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7 Conclusions

The site is shown on published mapping to be located within the Environment Agency's Flood Zones 1 & 2. Comparison of topographical data with the EA modelled flood level data indicates that the whole site is in Flood Zone 1 – Very Low Risk of fluvial flooding.

Low risks of flooding from all sources have been identified from information provided by the EA and BGS.

An assessment of these risks in conjunction with the development proposals have resulted in the following recommendations for the safe development of the site:

- » The finished floor level should be set at a nominal height above the finished ground levels to allow for overland flow routes in extreme events and drainage failures.
- » Pedestrian and vehicular safe access to and from the site is achievable under all conditions via the access road off Orkney Close.
- » Potential for soakaway use for rainwater disposal is low; however, this could be investigated further at the detailed design phase.
- » Surface water flow will probably need to be attenuated to the greenfield runoff rate or a rate agreed with the LLFA and UU.
- » Orkney Close appears to be served by a separate sewer system but it is not shown on the sewer records provided. Surface water arising from the site could potentially discharge into a nearby sewer.
- » Foul sewage could be discharged into the existing foul sewer in Orkney Close or the combined sewer in Bury Road, subject to the agreement of UU.
- » The requirement for a formal evacuation plan is not considered to be required but Bury Road is within Flood Zone 2 and may be subject to flooding during an extreme event.

Further details on the proposed mitigation measures are provided in Section 6. All proposed measures should be agreed with the Local Authority prior to commencement of the development.

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Appendix A

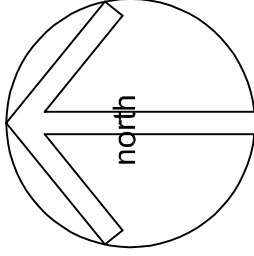
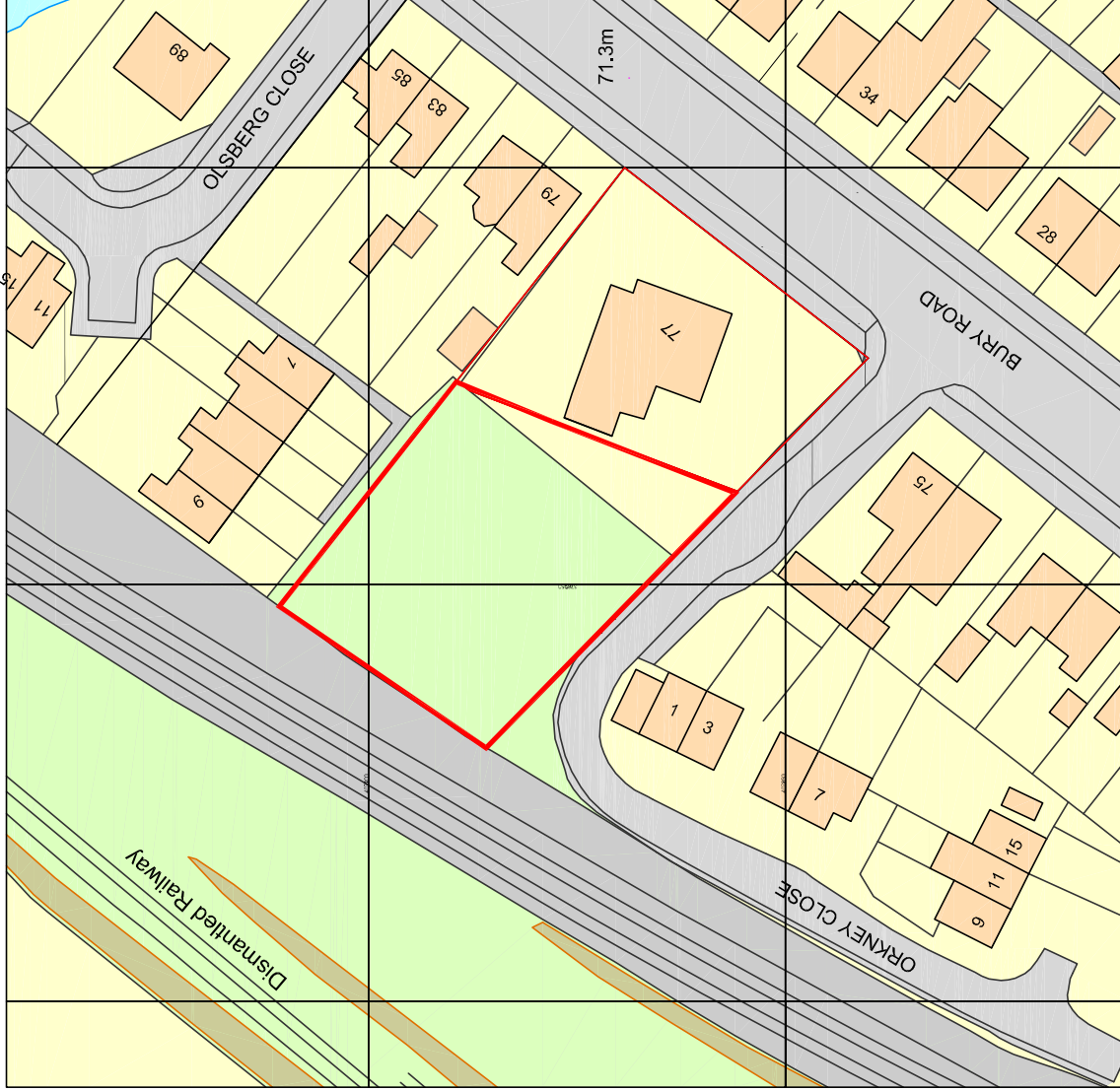
Figures, Plans and Drawings

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Client: BCR Estates Ltd				Title: Site Location & Boundary Plan				
Site: Orkney Close, 77 Bury Road								
Job No.: FRA21 1134		Drawn By: NJ	Checked By: CC	Drawn: August 2021	Scale (see scale bar): 1:25,000 & 1:2,000 @ A4			

- do not scale dimensions from this drawing
- all dimensions to be checked on-site and discrepancies
to be reported to the architects



Client	BCR Estates Limited
Project	Orkney Close, Radcliffe, Manchester M26 2WR
Title	Location Plan
Drawing number	3443:01
Revision	A
Scale	1:500
Date	A3
Drawn by	
Status	



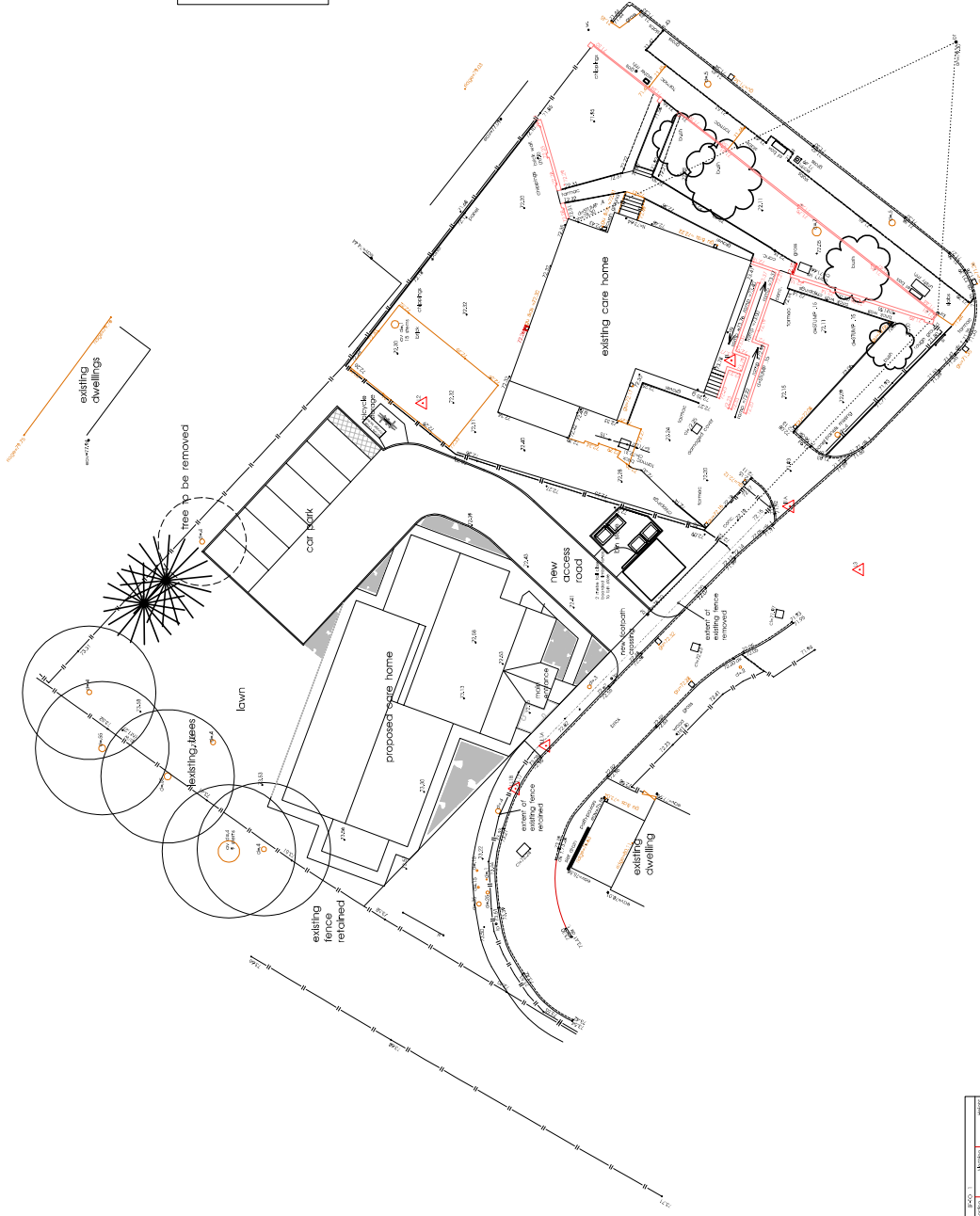
20 charley road, swinton, manchester, m27 5aj
t - 0161 793 5300 e - info@rafisk.co.uk

Appendix B

Site Information

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- do not scale dimensions from this drawing
- all dimensions to be checked on-site and
discrepancies to be reported to the architects



NO.	DATE	BY	CHKD	REV
1	10/10/17	10/10/17	10/10/17	10/10/17
2	10/10/17	10/10/17	10/10/17	10/10/17
3	10/10/17	10/10/17	10/10/17	10/10/17
4	10/10/17	10/10/17	10/10/17	10/10/17
5	10/10/17	10/10/17	10/10/17	10/10/17
6	10/10/17	10/10/17	10/10/17	10/10/17
7	10/10/17	10/10/17	10/10/17	10/10/17
8	10/10/17	10/10/17	10/10/17	10/10/17
9	10/10/17	10/10/17	10/10/17	10/10/17
10	10/10/17	10/10/17	10/10/17	10/10/17

Client	Proposed Care Home
Project	Chiney Close, Rochdale, Manchester M20 2WR
Site	Site Plan
Drawing number	3443.02
Revision	C
Scale	1:200 A1
Drawn by	RH

fisk
& associates
architects

f

20 chorley road, winton, manchester, m27 5jl
t - 0161 793 5300 e - info@fisk.co.uk

Geology 1:50,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	WGR	Worked Ground (Undivided)	Void	Not Supplied - Holocene
	MGR	Made Ground (Undivided)	Artificial Deposit	Not Supplied - Holocene
	SLIP	Landslide Deposit	Unknown/Undassified Entry	Not Supplied - Quaternary

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Not Supplied - Holocene
	GFSDD	Glaciofluvial Sheet Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	TILLD	Till, Devensian	Diamicton	Not Supplied - Devensian
	GFDUD	Glaciofluvial Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	GLLDD	Glaciolacustrine Deposits, Devensian	Clay and Silt	Not Supplied - Devensian
	HMGDD	Hummocky (Moundy) Glacial Deposits, Devensian	Diamicton	Not Supplied - Devensian
	GFICD	Glaciofluvial Ice Contact Deposits, Devensian	Sand and Gravel	Not Supplied - Devensian
	RTD1	River Terrace Deposits, 1	Sand and Gravel	Not Supplied - Quaternary
	HEAD	Head	Clay, Silt, Sand and Gravel	Not Supplied - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	CHES	Chester Formation	Sandstone	Not Supplied - Oldenian
	MM	Manchester Marls Formation	Mudstone	Not Supplied - GUADALUPIAN
	CS	Collyhurst Sandstone Formation	Sandstone	Not Supplied - Cisuralian
	NR	Nob End Rock	Sandstone	Not Supplied - Westphalian
	NHSS	Newton Heath Sandstone	Sandstone	Not Supplied - Westphalian
	PUCM	Pennine Upper Coal Measures Formation	Mudstone, Siltstone and Sandstone	Not Supplied - Westphalian



Geology 1:50,000 Maps

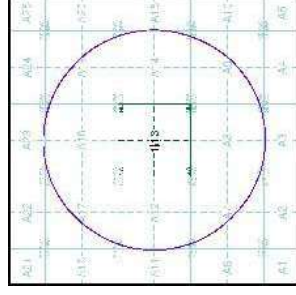
This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.

The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	1
Map Sheet No:	685
Map Name:	Manchester
Map Date:	2010
Bedrock Geology:	Available
Superficial Geology:	Not Available
Artificial Geology:	Not Available
Faults:	Not Supplied
Landslip:	Not Available
Rock Segments:	Not Supplied

Geology 1:50,000 Maps - Slice A



Order Details:

Order Number: 259596715_1_1
Customer Reference: LKC 20 1743_
National Grid Reference: 378950, 407880
Slice: A
Site Area (Ha): 0.13
Search Buffer (m): 1000

Site Details:

77 Bury Road, Radcliffe, M26 2UT



Tel: 0844 844 9652
Fax: 0844 844 9651
Web: www.envisched.co.uk

v15.0 - 29-Sep-2020



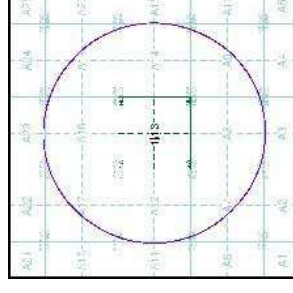
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A

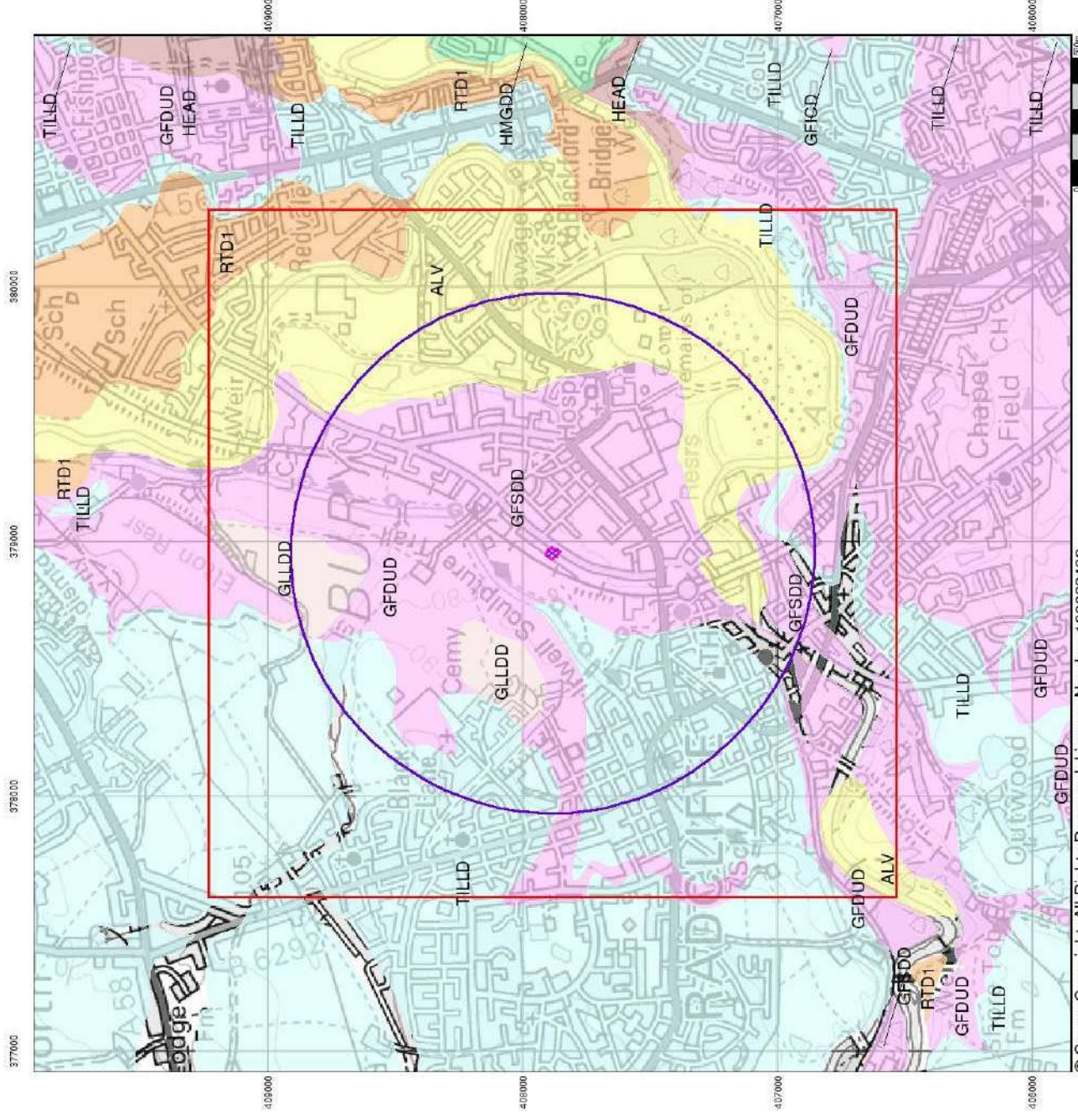


Order Details:

Order Number: 259596715_1_1
Customer Reference: LK20 1743_1
National Grid Reference: 378950, 407880
Slice: A
Site Area (Ha): 0.13
Search Buffer (m): 1000

Site Details:

77 Bury Road, Radcliffe, M26 2UT



Bedrock and Faults

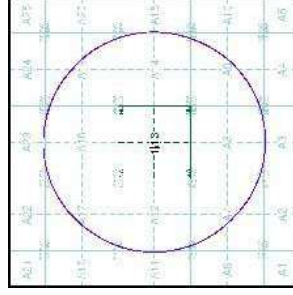
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A

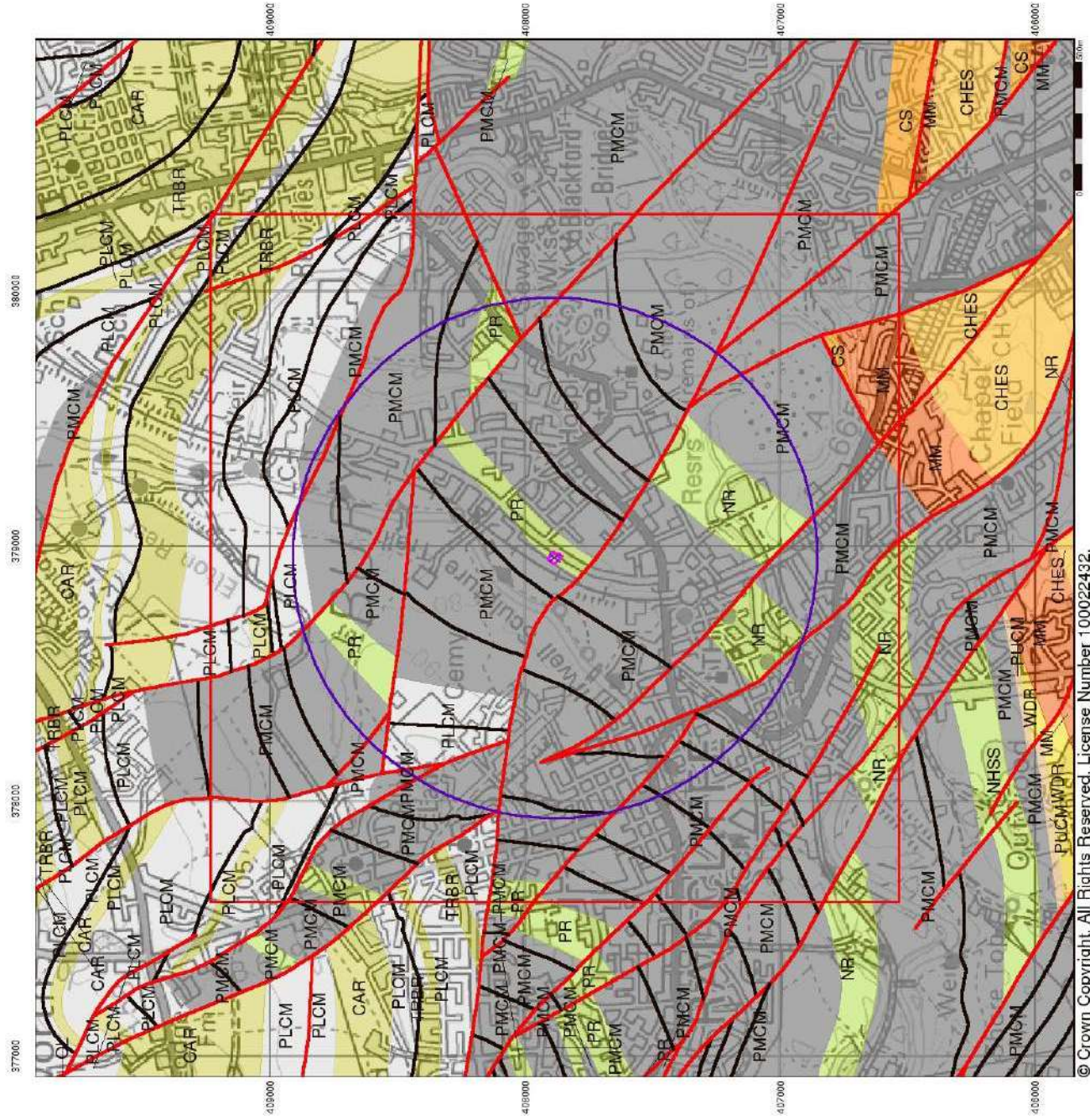


Order Details:

Order Number: 259596715.1.1
 Customer Reference: LK20 1743 -
 National Grid Reference: 378950, 407880
 Slice: A
 Site Area (Ha): 0.13
 Search Buffer (m): 1000

Site Details:

77 Bury Road, Radcliffe, M26 2UT



SD 70 NE/25 Section drawn R.L.S.

Lans. 95 N.E. 12.

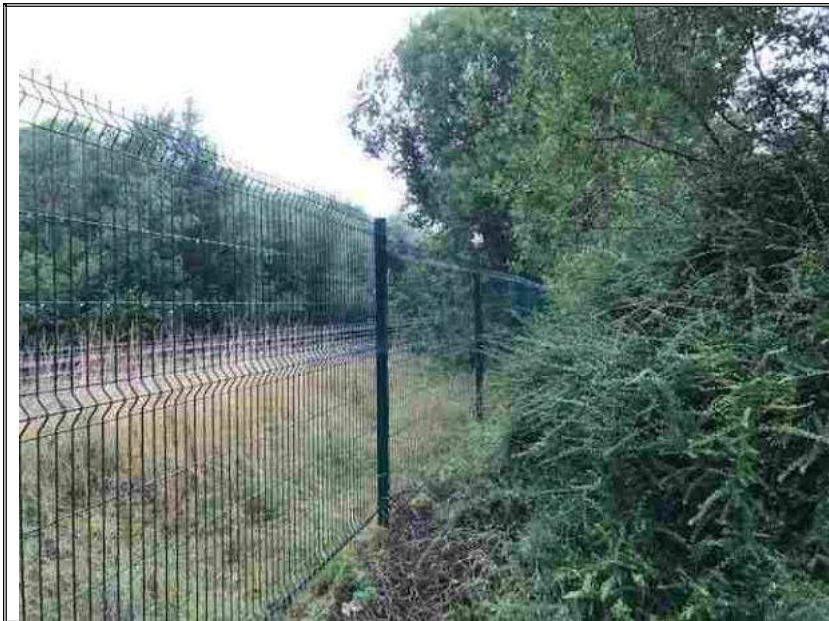
SD 7897 0788

SD 70/161

SD 71

SECTION OF PIT AT WITHINS.

					Ft.	In.	Ft.	In.
1	Soil and gravel	...	...	...	8	0		
2	Marl	...	...	...	53	8		
3	Blue Rock	...	...	...	8	0		
4	Floor	...	...	...	1	2		
5	Blue Rock	...	...	...	5	9		
6	Floor	...	...	...	1	0		
7	Soft Rock	...	...	...	1	9		
8	Metal	...	...	...	8	0		
9	COAL	...	...	...		5		
10	Warrant	...	...	...	2	10		
11	Soft Rock	...	...	...	9	0		
12	COAL	...	...	...	1	1		
13	Warrant	...	...	...	2	5		
14	Rocky Warrant	...	...	...	1	4		
15	Rock	...	...	...	9	6		
16	Strong Metal	...	...	...	4	0		
17	Slate Floor	...	...	...	1	2		
18	COAL	...	...	...	2	0		
19	Warrant	...	...	...	2	8		
20	Strong Rocky Warrant	...	...	...	3	6		
21	Strong Grey Metal	...	...	...	14	0		
	WHITE MINE							
22	COAL	...	...	...		3		
	Warrant	...	...	...	2	4		
	Dark Grey Metal	...	...	...		9		
	COAL	...	...	...	1	6		
23	Soft Doughing	...	...	...		6		
24	Warrant	...	...	...	3	4		
25	Rock Bands	...	...	...	4	9		
26	Rock	...	...	...	3	6		
27	Rock Bands	...	...	...	3	10		
28	Burr	...	...	...	1	0		
29	Flaggy Rock	...	...	...	4	7		
30	Strong Blue Metal	...	...	...	6	0		



Photograph 1
(facing NE):
View of railway
Embankment to
the rear of the site.



Photograph 2
(facing SE):
Orkney Close
towards Bury
Road showing
manhole and gully
locations adjacent
to the site.



Photograph 3
(facing SW):
Spoil tipped within
the site.

	Photograph 4 (facing NE): Spoil and building debris on site.
	Photograph 5 (facing SE): Tipped materials and sub-station.
	Photograph 6 (facing NW): Spoil mound adjacent to the railway line.



Photograph 7
(facing S):
Sub-station
adjacent to the
proposed access
off Orkney Close.

Appendix C

Environment Agency Data

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Mark Jones

From: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>
Sent: 05 August 2021 14:51
To: Mark Jones
Subject: GMMC228188AB Acknowledgement
Attachments: 3443.01 Rev A Location Plan 1.500 A3.pdf

Dear Mark,

Re: Orkney Close, Radcliffe, Manchester, M26 2WR

Thank you for your email which was received by our Customer Contact Centre on 30/7/21.

Your new reference number is: GMMC228188AB.

Please be aware that in light of the current COVID-19 pandemic we are following the Government guidelines on social distancing. We want to assure you that we are still carrying out our regulatory duties, but our staff are now mainly working remotely from home. This may affect our response time to enquiries and correspondence. We apologise for any delay and inconvenience this may cause.

Thank you for your understanding during this unprecedented time. We will be in touch with you as soon as possible.

The Freedom of Information Act and Environmental Information Regulations state that a public authority must respond to requests for information within 20 working days however we always aim to provide an answer as soon as we can.

For further information on what you can expect from us and our full service commitment to you then please visit our website:

<http://www.environment-agency.gov.uk/aboutus/149626.aspx>

Environmental Incident

If your email was to report an environmental incident i.e. pollution, fish in distress, dumping of hazardous waste etc then please call our **freephone 24 hour Incident Hotline** on **0800 80 70 60**.

For more details about incident reporting please see our website: <https://www.gov.uk/report-an-environmental-incident>

If you need to contact me in the meantime, please do not hesitate to do so using the details below and quoting reference number GMMC228188AB.

Yours sincerely,

Anne

Anne Ball - Customer and Engagement Officer

Greater Manchester, Merseyside and Cheshire

Direct email: Inforequests.GMMC@environment-agency.gov.uk

Office address: Richard Fairclough House, Knutsford Road, Latchford, Warrington, WA4 1HT

From: Mark Jones [<mailto:M.Jones@thelkgroup.com>]

Sent: 30 July 2021 15:13

To: Enquiries, Unit <enquiries@environment-agency.gov.uk>

Subject: FRA Enquiry at Orkney Close, Radcliffe, Manchester, M26 2WR

Dear All,

LK Consult Ltd. has been commissioned to undertake an updated Flood Risk Assessment and Outline Drainage Strategy for a site on Orkney Close,, Bank Top Radcliffe, Manchester, M26 2WR, centred at approximate National Grid Reference 37855E, 407890N.

The area of interest appears to be partially within Flood Zone 2.

BGS data indicates that the site is underlain by Glaciofluvial Deposits, Devensian, Sand And Gravel superficial deposits over Hall Rock Sandstone bedrock. The onsite site investigation recorded shallow made ground over Sand and Gravel, therefore the use of soakaway may be feasible.

The red site boundary plan is attached to this email.

To complete the FRA, we would be grateful if you could supply us with the following, if available, for the vicinity of the site:

- (with confirmation of the reference datum used for the levels – i.e. Local OSBM or OSGPS) if available.
- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Proposed defence levels and timescale for implementation.
- Results of any breach analyses for defences in the area which may be relevant.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.
- Any restrictions to infiltration and discharge to the watercourse.
- A copy of your detailed flood zone map and the modelled flood extent plans for the area.

If you have any queries, please do not hesitate to get in touch.

We will be in contact with all other relevant authorities to get a more complete understanding of the issues in the area.

Regards

Mark



Mark Jones

Associate

LK Consult | 0161 763 7200

Manchester | London | Liverpool | Glasgow |

www.thelkgroup.com

I N C R E A S I N G L A N D V A L U E



Disclaimer Information [Here](#)

Mark Jones

From: GMMC Info Requests <InfoRequests.GMMC@environment-agency.gov.uk>
Sent: 16 August 2021 11:19
To: Mark Jones
Subject: GMMC228188AB Response attached from the Environment Agency
Attachments: 3443.01 Rev A Location Plan 1.500 A3.pdf; GMMC228188AB - DFM.PDF; GMMC228188AB - HAZ1.pdf; GMMC228188AB - HAZ2.pdf; GMMC228188AB - HAZ3.pdf; GMMC228188AB - Table.pdf

Dear Mark,

Re: FRA Enquiry at Orkney Close, Radcliffe, Manchester, M26 2WR

Thank you for your enquiry which was received on 30/7/21.

We respond to requests under the Freedom of Information Act 2000 and Environmental Information Regulations 2004.

I enclose the requested data.

In regard to 'restrictions to infiltration and discharge to the watercourse':

The site appears remote from any watercourse and a direct outfall would not appear possible. Options to discharge surface water run-off from development should follow the hierarchy of disposal. From April 2015 Lead Local Flood Authorities became the statutory consultee for surface water flood risk in relation to planning applications. They are now the appropriate body to assess surface water drainage proposals for developments.

We have no records of flooding affecting the site. However, this does not mean flooding has not occurred in the past or that it will not flood in future. We recommend that you also contact United Utilities and Bury District Council who may hold additional information (the former especially in relation to sewer flooding).

There are no flood defences in the vicinity of the site or proposed defences.

There are no 2D levels available for this site, however, we have provided it for the access road.

Please be aware you can check your risk of flooding on our external website <https://flood-warning-information.service.gov.uk/long-term-flood-risk/>

Here are some useful links below:

<https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>

<https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

Our Groundwater team have advised that any infiltration device must include a minimum 1m unsaturated depth of aquifer material between the infiltration surface and the maximum likely groundwater level.

Approved Document Part H of the Building Regulations 2010 establishes a hierarchy for surface water disposal, and encourages a SuDS approach. The first option for surface water disposal should be the use of SuDS, which encourage infiltration such as soakaways or infiltration trenches. In all cases, it should be established that these options are feasible, can be adopted and properly maintained and would not lead to any other environmental problems. For example, using soakaways or other infiltration methods on

contaminated land carries groundwater pollution risks and may not work in areas with a high water table. Where the intention is to dispose to soakaway, these should be shown to work through an appropriate assessment carried out under Building Research Establishment (BRE) Digest 365.

Further information on SuDS can be found in:

- the CIRIA C753 document SuDS manual

A simple index approach should be used to determine what level of treatment is required based on the land use.

Please refer to the [Open Government Licence](#) which explains the permitted use of this information.

Please get in touch if you have any further queries or contact us within two months if you'd like us to review the information we have sent.

Kind regards,

Anne Ball
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
Email: inforequests.gmmc@environment-agency.gov.uk

From: Mark Jones [<mailto:M.Jones@thelkgroup.com>]

Sent: 30 July 2021 15:13

To: Enquiries, Unit <enquiries@environment-agency.gov.uk>

Subject: FRA Enquiry at Orkney Close, Radcliffe, Manchester, M26 2WR

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The area of interest appears to be partially within Flood Zone 2.

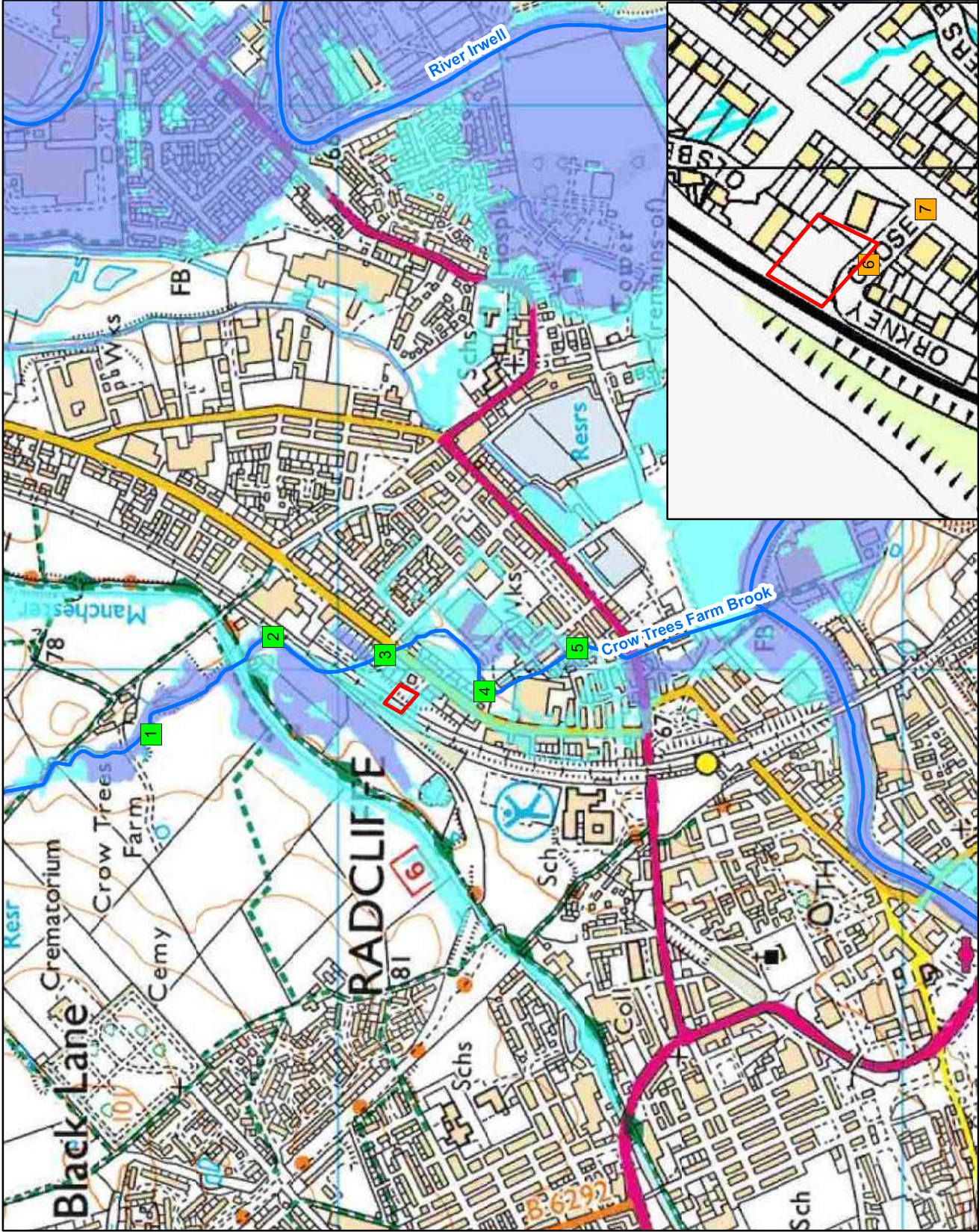
BGS data indicates that the site is underlain by Glaciofluvial Deposits, Devensian, Sand And Gravel superficial deposits over Hall Rock Sandstone bedrock. The onsite site investigation recorded shallow made ground over Sand and Gravel, therefore the use of soakaway may be feasible.

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- Details of any flood defences in the immediate area, including their extent, crest levels (and datum), assumed level of standard, construction and maintenance regime, as well as any other structures which may influence the local hydraulics.
- Proposed defence levels and timescale for implementation.
- Results of any breach analyses for defences in the area which may be relevant.
- Records of any historic flood events and potential sources of flooding from rivers, land drainage, groundwater, foul and surface water sewers on site and in the area.

Detailed Flood Map centred on Orkney Close, Radcliffe, Manchester, M26 2WR.
Created on 10/08/2021 [GMMC228188AB]





Environment
Agency

1:10,001

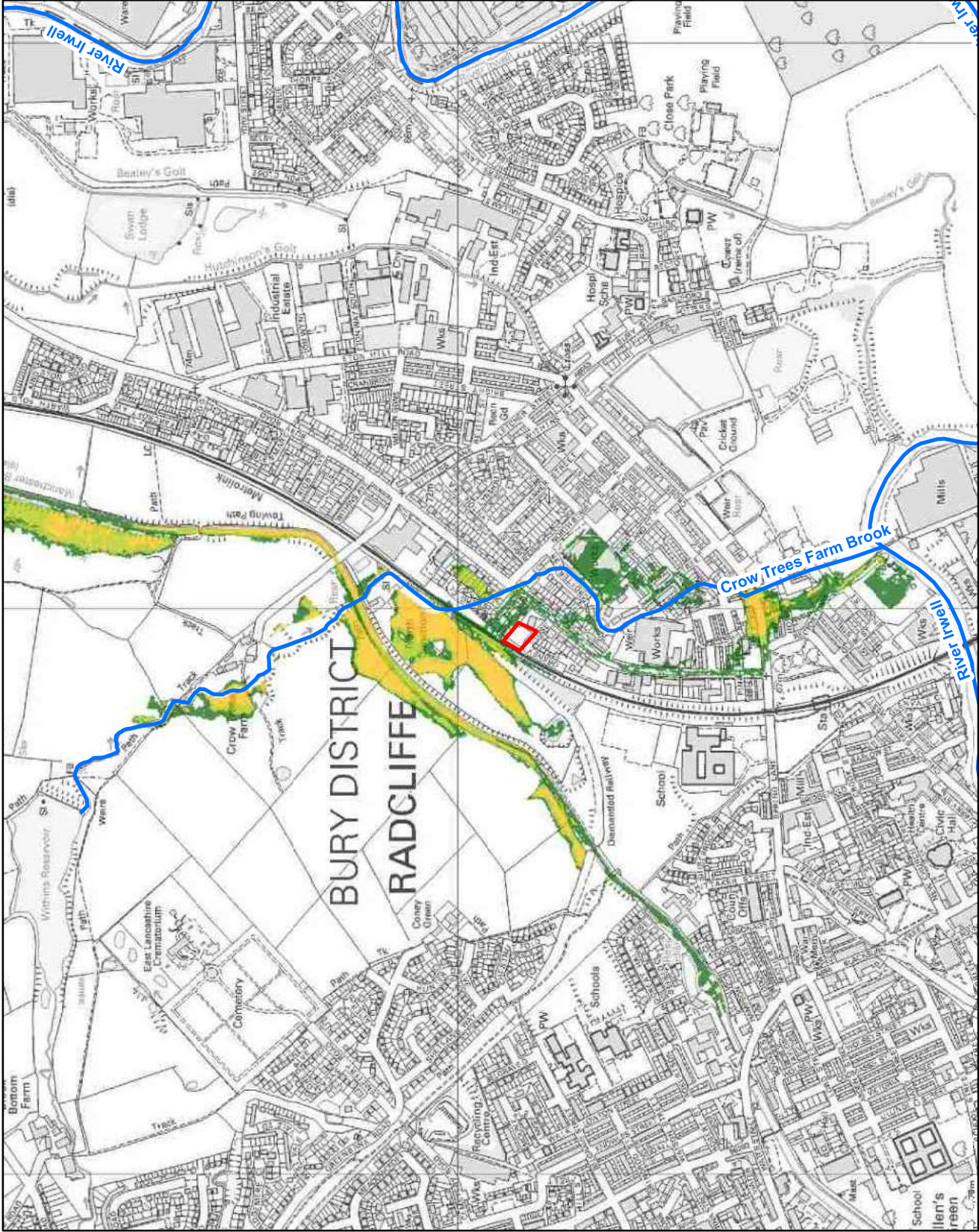
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Legend

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

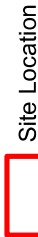
Hazard Flood Map (1 in 100 year + 30% increase in flow) centred on Orkney Close, Radcliffe, Manchester, M26 2WR. Created on 10/08/2021 [GMMC228188AB]



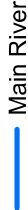
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N

Legend



Site Location



Main River

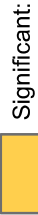
Hazard Risk Rating



Low: <0.75



Moderate: 0.75-1.25

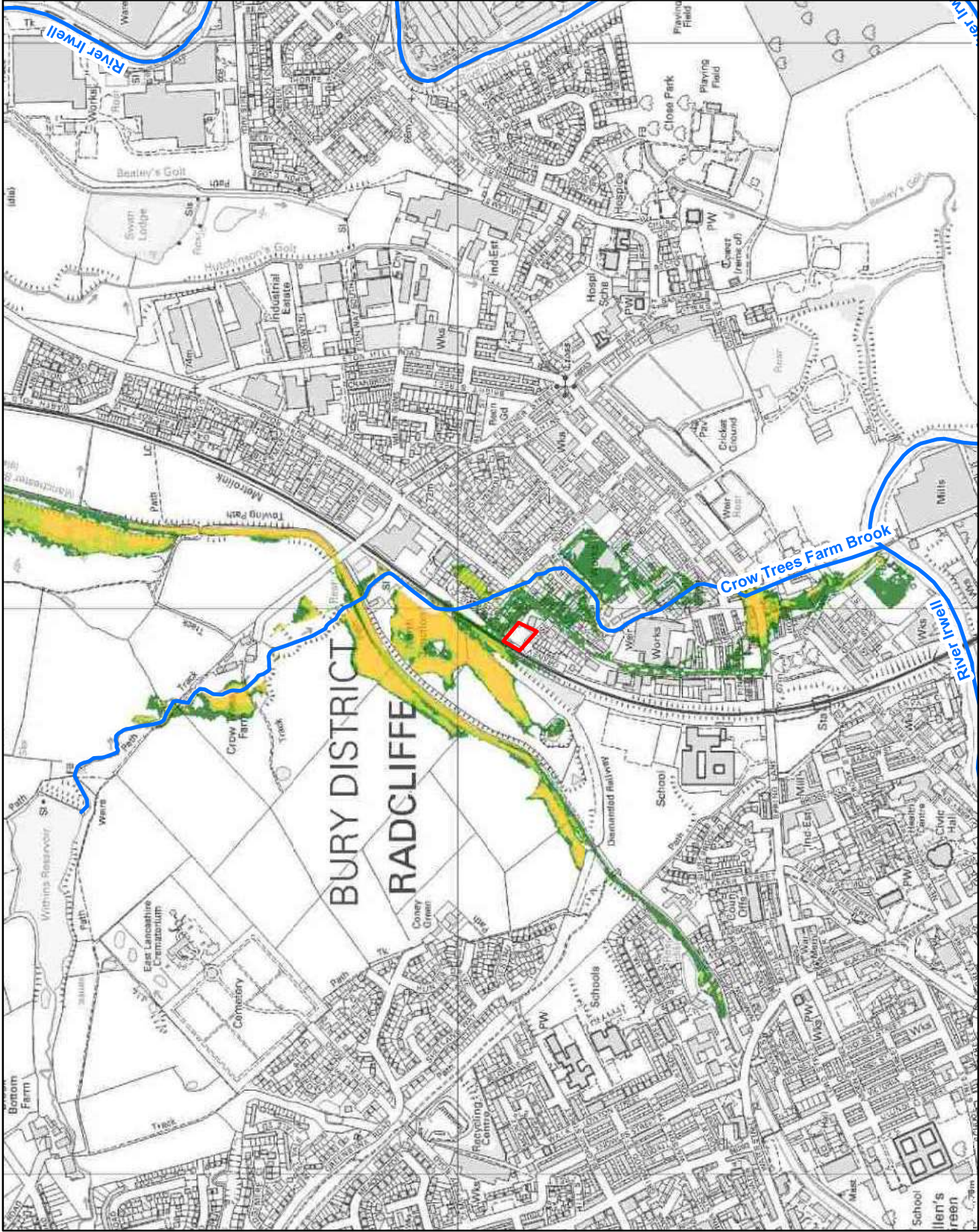


Significant: 1.25 - 2.0



Extreme: >2.0

Hazard Flood Map (1 in 100 year + 35% increase in flow) centred on Orkney Close, Radcliffe, Manchester, M26 2WR. Created on 10/08/2021 [GMMC228188AB]





1:10,001



Legend

 Site Location

 Main River

Hazard Risk Rating

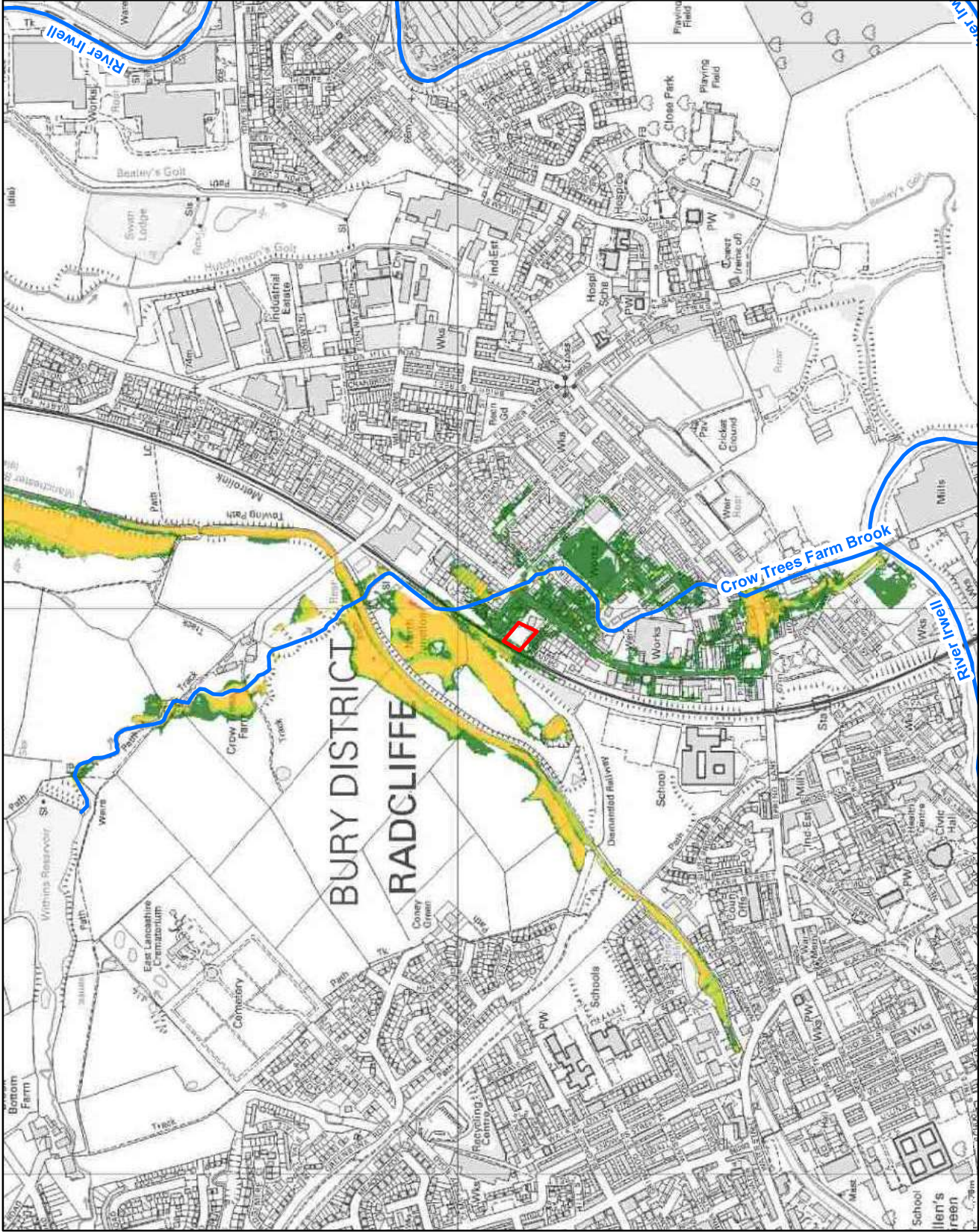
 Low: <0.75

 Moderate: 0.75-1.25

 Significant: 1.25 – 2.0

 Extreme: >2.0

Hazard Flood Map (1 in 100 year + 70% increase in flow) centred on Orkney Close, Radcliffe, Manchester, M26 2WR. Created on 10/08/2021 [GMMC228188AB]





1:10,001



Legend

 Site Location

 Main River

Hazard Risk Rating

 Low: <0.75

 Moderate: 0.75-1.25

 Significant: 1.25 – 2.0

 Extreme: >2.0

Appendix D

Consultee Correspondence

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LKGroup**Unit 29
Eton Hill Road,
Radcliffe,
m26 2zs****FAO:****How to contact us:****United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP****Telephone: 0370 7510101****E-mail: propertysearches@uuplc.co.uk****Your Ref: FRA 21 1134
Our Ref: UUPS-ORD-318110
Date: 23/08/2021****Dear Sirs****Location: Orkney Close**

I acknowledge with thanks your request dated 17/08/2021 for information on the location of our services.

Please find enclosed plans showing the approximate position of United Utilities' apparatus known to be in the vicinity of this site.

The enclosed plans are being provided to you subject to the United Utilities terms and conditions for both the wastewater and water distribution plans which are shown attached.

If you are planning works anywhere in the North West, please read United Utilities' access statement before you start work to check how it will affect our network. <http://www.unitedutilities.com/work-near-asset.aspx>.

I trust the above meets with your requirements and look forward to hearing from you should you need anything further.

If you have any queries regarding this matter please [contact us](#).

Yours Faithfully,



Karen McCormack
Property Searches Manager

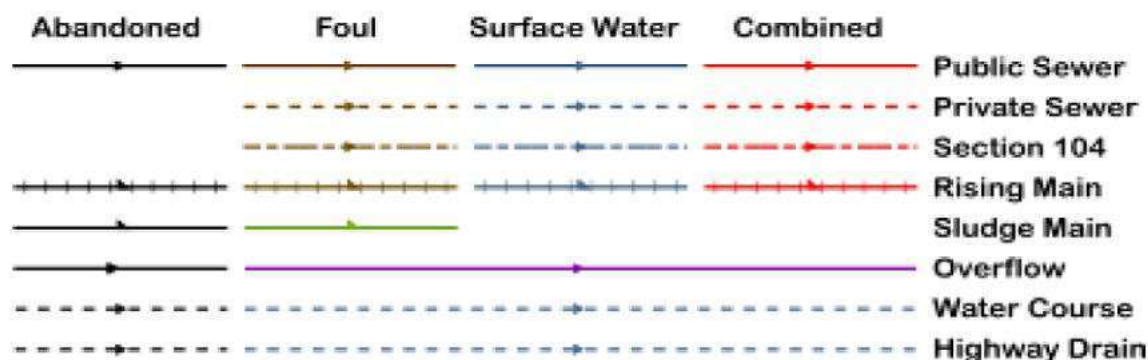
TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

These provisions apply to the public sewerage, water distribution and telemetry systems (including sewers which are the subject of an agreement under Section 104 of the Water Industry Act 1991 and mains installed in accordance with the agreement for the self construction of water mains) (UUWL apparatus) of United Utilities Water Limited "(UUWL)".

TERMS AND CONDITIONS:

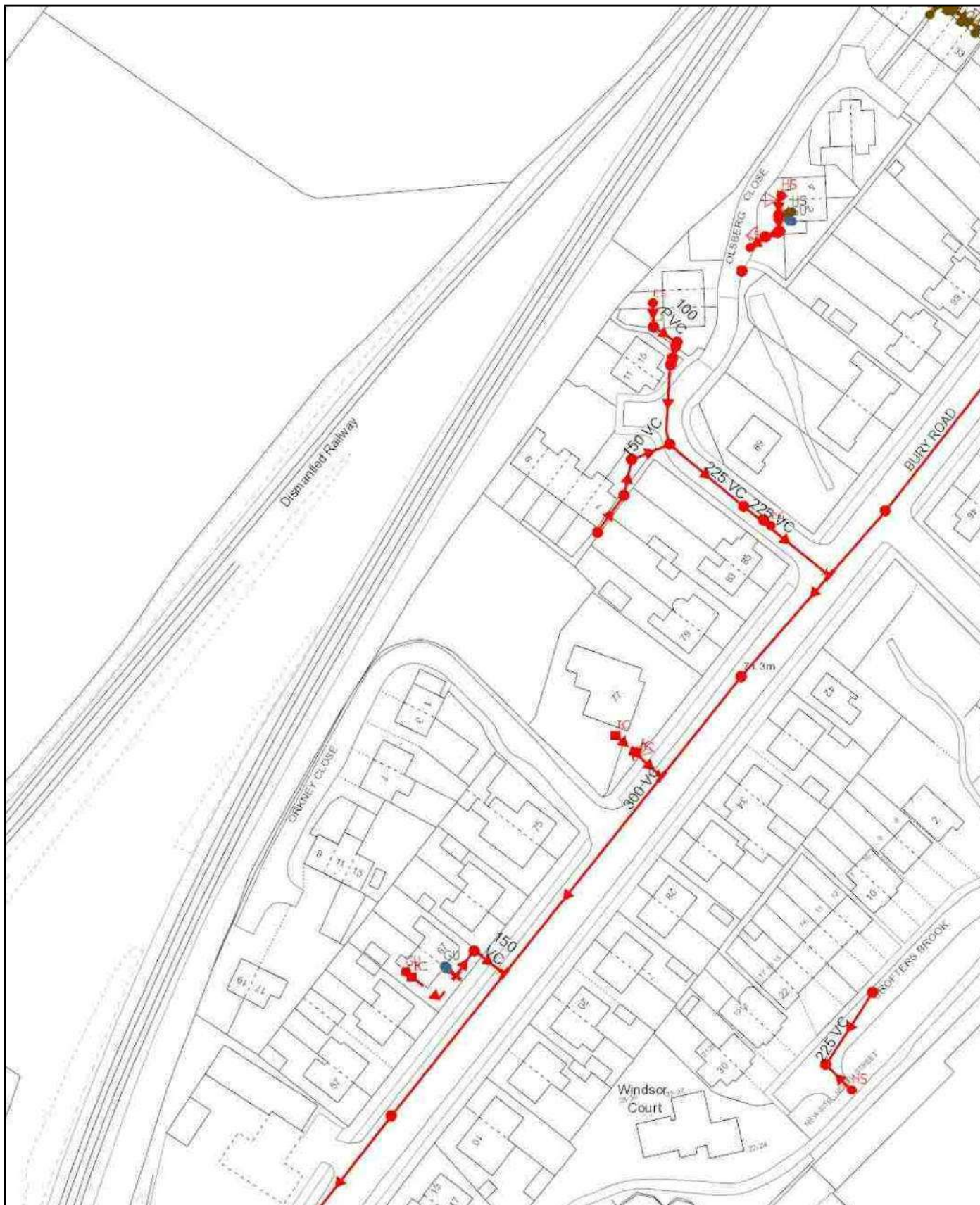
- This Map and any information supplied with it is issued subject to the provisions contained below, to the exclusion of all others and no party relies upon any representation, warranty, collateral contract or other assurance of any person (whether party to this agreement or not) that is not set out in this agreement or the documents referred to in it.
- This Map and any information supplied with it is provided for general guidance only and no representation, undertaking or warranty as to its accuracy, completeness or being up to date is given or implied.
- In particular, the position and depth of any UUWL apparatus shown on the Map are approximate only. UUWL strongly recommends that a comprehensive survey is undertaken in addition to reviewing this Map to determine and ensure the precise location of any UUWL apparatus. The exact location, positions and depths should be obtained by excavation trial holes.
- The location and position of private drains, private sewers and service pipes to properties are not normally shown on this Map but their presence must be anticipated and accounted for and you are strongly advised to carry out your own further enquiries and investigations in order to locate the same.
- The position and depth of UUWL apparatus is subject to change and therefore this Map is issued subject to any removal or change in location of the same. The onus is entirely upon you to confirm whether any changes to the Map have been made subsequent to issue and prior to any works being carried out.
- This Map and any information shown on it or provided with it must not be relied upon in the event of any development, construction or other works (including but not limited to any excavations) in the vicinity of UUWL apparatus or for the purpose of determining the suitability of a point of connection to the sewerage or other distribution systems.
- No person or legal entity, including any company shall be relieved from any liability howsoever and whensoever arising for any damage caused to UUWL apparatus by reason of the actual position and/or depths of UUWL apparatus being different from those shown on the Map and any information supplied with it.
- If any provision contained herein is or becomes legally invalid or unenforceable, it will be taken to be severed from the remaining provisions which shall be unaffected and continue in full force and affect.
- This agreement shall be governed by English law and all parties submit to the exclusive jurisdiction of the English courts, save that nothing will prevent UUWL from bringing proceedings in any other competent jurisdiction, whether concurrently or otherwise.

Wastewater Symbolology



All point assets follow the standard colour convention: **red** – combined **brown** - foul
blue – surface water **purple** - overflow

Manhole	Side Entry Manhole
Head of System	Outfall
Extent of Survey	Screen Chamber
Rodding Eye	Inspection Chamber
Inlet	Bifurcation Chamber
Discharge Point	Lamp Hole
Vortex	T Junction / Saddle
Penstock	Catchpit
Washout Chamber	Valve Chamber
Valve	Vent Column
Air Valve	Vortex Chamber
Non Return Valve	Penstock Chamber
Soakaway	Network Storage Tank
Gully	Sewer Overflow
Cascade	Ww Treatment Works
Flow Meter	Ww Pumping Station
Hatch Box	Septic Tank
Oil Interceptor	Control Kiosk
Summit	
Drop Shaft	Change of Characteristic
Orifice Plate	



Scale: 1:1250
Date: 23/08/2021

SEWER RECORDS



Address or Site Reference: Orkney Close
Printed by: Property Searches

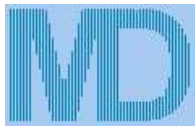
The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.

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Appendix E

Calculations

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HY 11.0

The LK Group

www.thelkgroup.com

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Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 05/08/21		
By	Checked	Reviewed

Project	greenfield
Title	IoH 124 Runoff calcs for Radcliffe

Hydrological Data:-

FSR Hydrology:-

Location = Radcliffe

M5-60 (mm) = 18.9

Soil runoff = 0.45

WRAP = 4

Hydrological area = 10

Grid reference = SD7808

r = 0.32

SAAR (mm/yr) = 1100

Area = England & Wales

Hydrological zone = 7

Soil classification for WRAP type 4

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Design data:-

Area = 0.0013 Km² - 0.13 Ha - 1300 m²

Calculation method:-

Runoff is calculated from:-

$$Q_{BAR(rural)} = 0.00108 \text{ AREA}^{0.89} \cdot \text{SAAR}^{1.17} \cdot \text{SOIL}^{2.17}$$

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

$Q_{BAR(rural)}$ = Runoff (cumecs)

$Q_{BAR(rural)}$ is then multiplied by a growth factor - GC(T) - for different storm return periods derived from EA publication W5-074/A.

Calculated data:-

For areas less than 50Ha, a modified calculation which multiplies the 50Ha runoff value by the ratio of the site area to 50Ha is used
Reducing factor used for these calculations is 0.003

Mean Annual Peak Flow $Q_{BAR(rural)} = 0.97 \text{ l/s}$



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HY 11.0

Project
greenfield

Title **loH 124 Runoff calcs for Raddcliffe**

Job No.	
Sheet no.	2
Date	05/08/21
By	Checked
Reviewed	

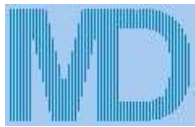
Values for $Q_{\text{BAR(rural)}}$

	Ret. per. 1yr	m^3/hr 2.966	1/s 0.824	1/s/ha 6.337	Ret. per. 100yr+20%	m^3/hr 8.792	1/s 2.442	1/s/ha 18.786
2yr		3.245	0.901	6.933	100yr+30%	9.525	2.646	20.352
5yr		4.222	1.173	9.020	100yr+40%	10.257	2.849	21.917
10yr		4.815	1.337	10.288	200yr	8.373	2.326	17.892
30yr		5.861	1.628	12.524	200yr + 30%	10.885	3.024	23.259
50yr		6.454	1.793	13.791	500yr	9.525	2.646	20.352
100yr		7.327	2.035	15.655	1000yr	10.606	2.946	22.663

Growth factors -

1yr 0.85	2yr 0.93	5yr 1.21	10yr 1.38	30yr 1.68	50yr 1.85	100yr 2.10	200yr 2.40	500yr 2.73	1000yr 3.04
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The above is based on the Institute of Hydrology Report 124
to which you are referred for further details (see Sect 7).
Note that the 200 and above year growth curves were taken from W5-074.



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Job No.		
Sheet no. 1		
Date 05/08/21		
By	Checked	Reviewed

Project	30 yr event
Title	Storage calcs for Radcliffe

Data:-

FSR Hydrology:-

Location = Radcliffe

M5-60 (mm) = 18.9

Soil index = 0.45

Return period = 30

UCWI = 113.8

Grid reference = SD7808

r = 0.32

SAAR (mm/yr) = 1100

WRAP = 4

Climate change = 0

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Runoff factor (RF) = 63.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = Impervious Area * 100 / (Impervious Area + Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²

Total area (TA) = 1300 m²

Mean pump disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 300 m²

Equiv area = 819 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 23.0 mins

Rainfall at max = 52.45 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 9.6 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 8.00 mm/hr

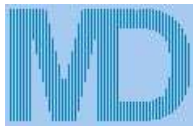
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	1218.2	1125	9.6	400 x 600	53.1	500 x 500	38.3
150	541.4	1200	8.5	600 x 900	23.1	500 x 750	25.5
225	240.6	1275	7.5	800 x 1200	13.0	500 x 1000	19.1
300	135.4	1350	6.7			750 x 1000	12.8
375	86.6	1425	6.0			750 x 1200	10.6
450	60.2	1500	5.4			750 x 1500	8.5
525	44.2	1575	4.9			1000 x 1000	9.6
600	33.8	1650	4.5			1000 x 1200	8.0
675	26.7	1725	4.1			1000 x 1500	6.4
750	21.7	1800	3.8			1000 x 1800	5.3
825	17.9	1875	3.5			1000 x 2000	4.8
900	15.0	1950	3.2			1500 x 1500	4.3
975	12.8	2025	3.0			1500 x 1800	3.5
1050	11.0	2100	2.8			1500 x 2000	3.2



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Data:-

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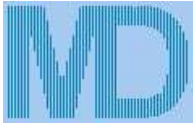
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email: m.jones@thelkgroup.com

Job No.		
Sheet no. 2		
Date 05/08/21		
By	Checked	Reviewed

Project	30 yr event
Title	Storage calcs for Radcliffe

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	81.0	11.075	3.000	8.075
20	57.0	15.501	6.000	9.501
30	45.0	18.373	9.000	9.373
40	38.0	20.548	12.000	8.548
50	33.0	22.316	15.000	7.316
60	29.0	23.816	18.000	5.816
70	26.0	25.123	21.000	4.123
80	24.0	26.284	24.000	2.284
90	22.0	27.329	27.000	0.329
100	21.0	28.282	30.000	0.000
110	19.0	29.157	33.000	0.000
120	18.0	29.967	36.000	0.000
130	17.0	30.721	39.000	0.000
140	16.0	31.427	42.000	0.000
150	16.0	32.089	45.000	0.000
160	15.0	32.714	48.000	0.000
170	14.0	33.305	51.000	0.000
180	14.0	33.865	54.000	0.000
190	13.0	34.398	57.000	0.000
200	13.0	34.906	60.000	0.000
210	12.0	35.390	63.000	0.000
220	12.0	35.854	66.000	0.000
230	12.0	36.298	69.000	0.000
240	11.0	36.724	72.000	0.000
250	11.0	37.133	75.000	0.000
260	11.0	37.555	78.000	0.000
270	10.0	37.958	81.000	0.000
280	10.0	38.349	84.000	0.000
290	10.0	38.730	87.000	0.000
300	10.0	39.101	90.000	0.000
310	9.0	39.463	93.000	0.000
320	9.0	39.815	96.000	0.000
330	9.0	40.159	99.000	0.000
340	9.0	40.496	102.000	0.000
350	9.0	40.824	105.000	0.000
360	8.0	41.146	108.000	0.000
370	8.0	41.460	111.000	0.000
380	8.0	41.768	114.000	0.000
390	8.0	42.070	117.000	0.000
400	8.0	42.366	120.000	0.000
410	8.0	42.657	123.000	0.000
420	7.0	42.942	126.000	0.000
430	7.0	43.221	129.000	0.000
440	7.0	43.496	132.000	0.000
450	7.0	43.766	135.000	0.000
460	7.0	44.032	138.000	0.000
470	7.0	44.293	141.000	0.000
480	7.0	44.549	144.000	0.000
490	7.0	44.802	147.000	0.000
500	7.0	45.051	150.000	0.000
510	7.0	45.296	153.000	0.000
520	6.0	45.537	156.000	0.000
530	6.0	45.774	159.000	0.000
540	6.0	46.009	162.000	0.000
550	6.0	46.240	165.000	0.000
560	6.0	46.467	168.000	0.000
570	6.0	46.692	171.000	0.000
580	6.0	46.913	174.000	0.000
590	6.0	47.132	177.000	0.000
600	6.0	47.348	180.000	0.000

Storage volume (m³) = 9.6 m³



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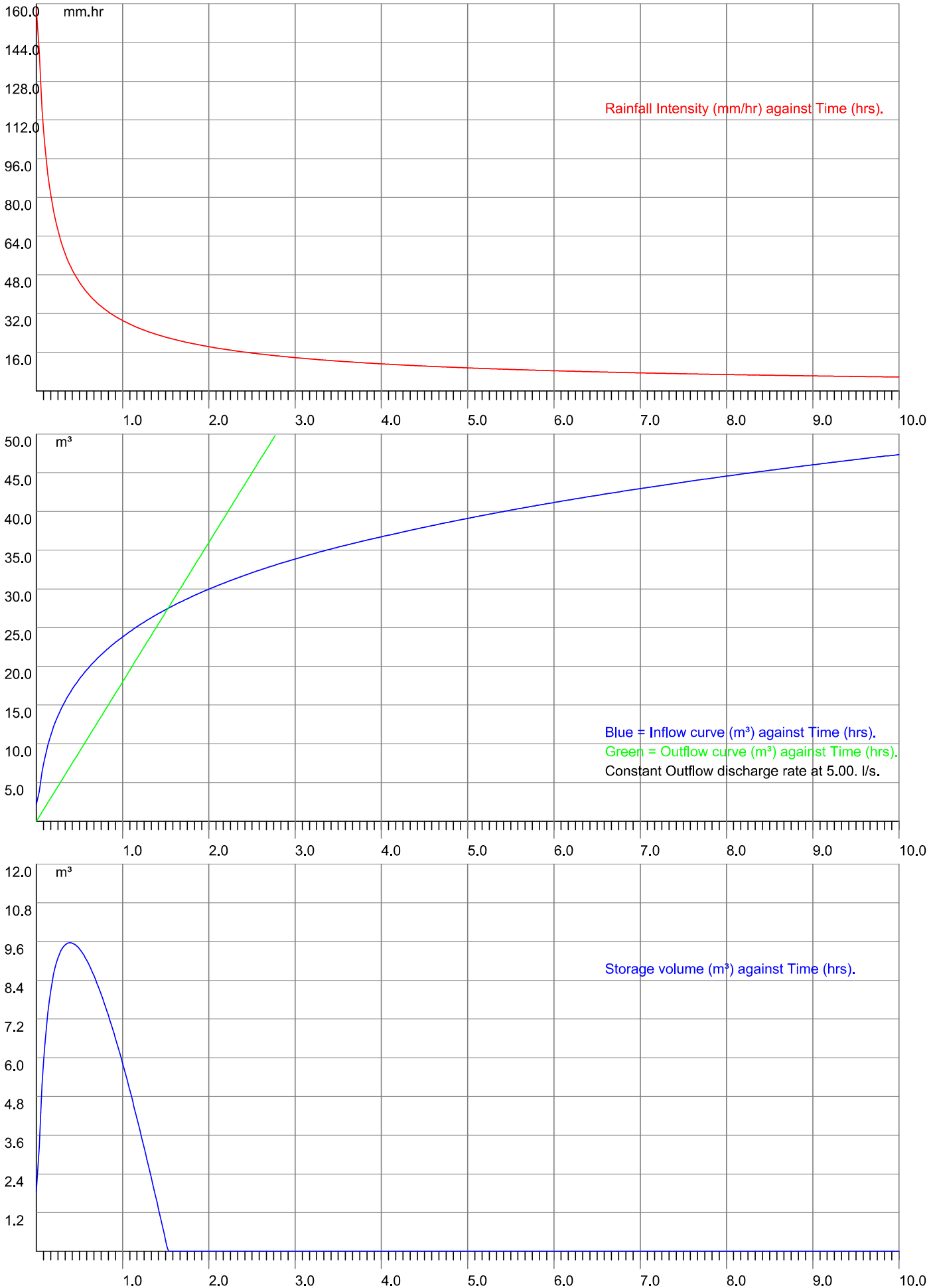
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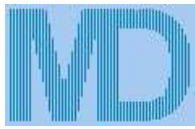
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Job No.		
Sheet no. 3		
Date 05/08/21		
By	Checked	Reviewed

Project **30 yr event**
Title **Storage calcs for Radcliffe**





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Job No.		
Sheet no. 1		
Date 05/08/21		
By	Checked	Reviewed

Project	100yr +20%
Title	Storage calcs for Radcliffe

Data:-

FSR Hydrology:-

Location = Radcliffe

M5-60 (mm) = 18.9

Soil index = 0.45

Return period = 100

UCWI = 113.8

Grid reference = SD7808

r = 0.32

SAAR (mm/yr) = 1100

WRAP = 4

Climate change = 20

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Runoff factor (RF) = 63.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = Impervious Area * 100 / (Impervious Area + Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²

Total area (TA) = 1300 m²

Mean pump disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 300 m²

Equiv area = 819 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 42.0 mins

Rainfall at max = 57.39 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 20.3 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 13.00 mm/hr

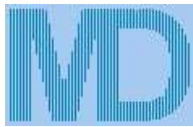
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	2585.2	1125	20.4	400 x 600	112.8	500 x 500	81.2
150	1149.0	1200	18.0	600 x 900	49.1	500 x 750	54.1
225	510.7	1275	15.9	800 x 1200	27.6	500 x 1000	40.6
300	287.2	1350	14.2			750 x 1000	27.1
375	183.8	1425	12.7			750 x 1200	22.6
450	127.7	1500	11.5			750 x 1500	18.0
525	93.8	1575	10.4			1000 x 1000	20.3
600	71.8	1650	9.5			1000 x 1200	16.9
675	56.7	1725	8.7			1000 x 1500	13.5
750	46.0	1800	8.0			1000 x 1800	11.3
825	38.0	1875	7.4			1000 x 2000	10.2
900	31.9	1950	6.8			1500 x 1500	9.0
975	27.2	2025	6.3			1500 x 1800	7.5
1050	23.4	2100	5.9			1500 x 2000	6.8



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SW

Data:-

The LK Group

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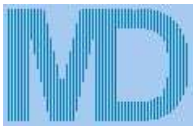
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Eton Hill Road,
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Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 2		
Date 05/08/21		
By	Checked	Reviewed

Project	100yr +20%
Title	Storage calcs for Radcliffe

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	125.0	17.012	3.000	14.012
20	88.0	24.138	6.000	18.138
30	70.0	28.774	9.000	19.774
40	59.0	32.286	12.000	20.286
50	51.0	35.137	15.000	20.137
60	46.0	37.545	18.000	19.545
70	41.0	39.635	21.000	18.635
80	38.0	41.483	24.000	17.483
90	35.0	43.139	27.000	16.139
100	33.0	44.639	30.000	14.639
110	31.0	46.009	33.000	13.009
120	29.0	47.270	36.000	11.270
130	27.0	48.437	39.000	9.437
140	26.0	49.522	42.000	7.522
150	25.0	50.534	45.000	5.534
160	24.0	51.482	48.000	3.482
170	23.0	52.373	51.000	1.373
180	22.0	53.212	54.000	0.000
190	21.0	54.005	57.000	0.000
200	20.0	54.755	60.000	0.000
210	19.0	55.466	63.000	0.000
220	19.0	56.141	66.000	0.000
230	18.0	56.784	69.000	0.000
240	18.0	57.395	72.000	0.000
250	17.0	57.979	75.000	0.000
260	17.0	58.605	78.000	0.000
270	16.0	59.198	81.000	0.000
280	16.0	59.773	84.000	0.000
290	15.0	60.332	87.000	0.000
300	15.0	60.876	90.000	0.000
310	15.0	61.405	93.000	0.000
320	14.0	61.920	96.000	0.000
330	14.0	62.423	99.000	0.000
340	14.0	62.914	102.000	0.000
350	13.0	63.393	105.000	0.000
360	13.0	63.861	108.000	0.000
370	13.0	64.318	111.000	0.000
380	12.0	64.766	114.000	0.000
390	12.0	65.204	117.000	0.000
400	12.0	65.634	120.000	0.000
410	12.0	66.054	123.000	0.000
420	12.0	66.467	126.000	0.000
430	11.0	66.871	129.000	0.000
440	11.0	67.268	132.000	0.000
450	11.0	67.658	135.000	0.000
460	11.0	68.041	138.000	0.000
470	11.0	68.417	141.000	0.000
480	10.0	68.787	144.000	0.000
490	10.0	69.150	147.000	0.000
500	10.0	69.508	150.000	0.000
510	10.0	69.860	153.000	0.000
520	10.0	70.206	156.000	0.000
530	10.0	70.547	159.000	0.000
540	10.0	70.883	162.000	0.000
550	9.0	71.213	165.000	0.000
560	9.0	71.539	168.000	0.000
570	9.0	71.861	171.000	0.000
580	9.0	72.177	174.000	0.000
590	9.0	72.489	177.000	0.000
600	9.0	72.797	180.000	0.000

Storage volume (m³) = 20.3 m³



MasterDrain
SW

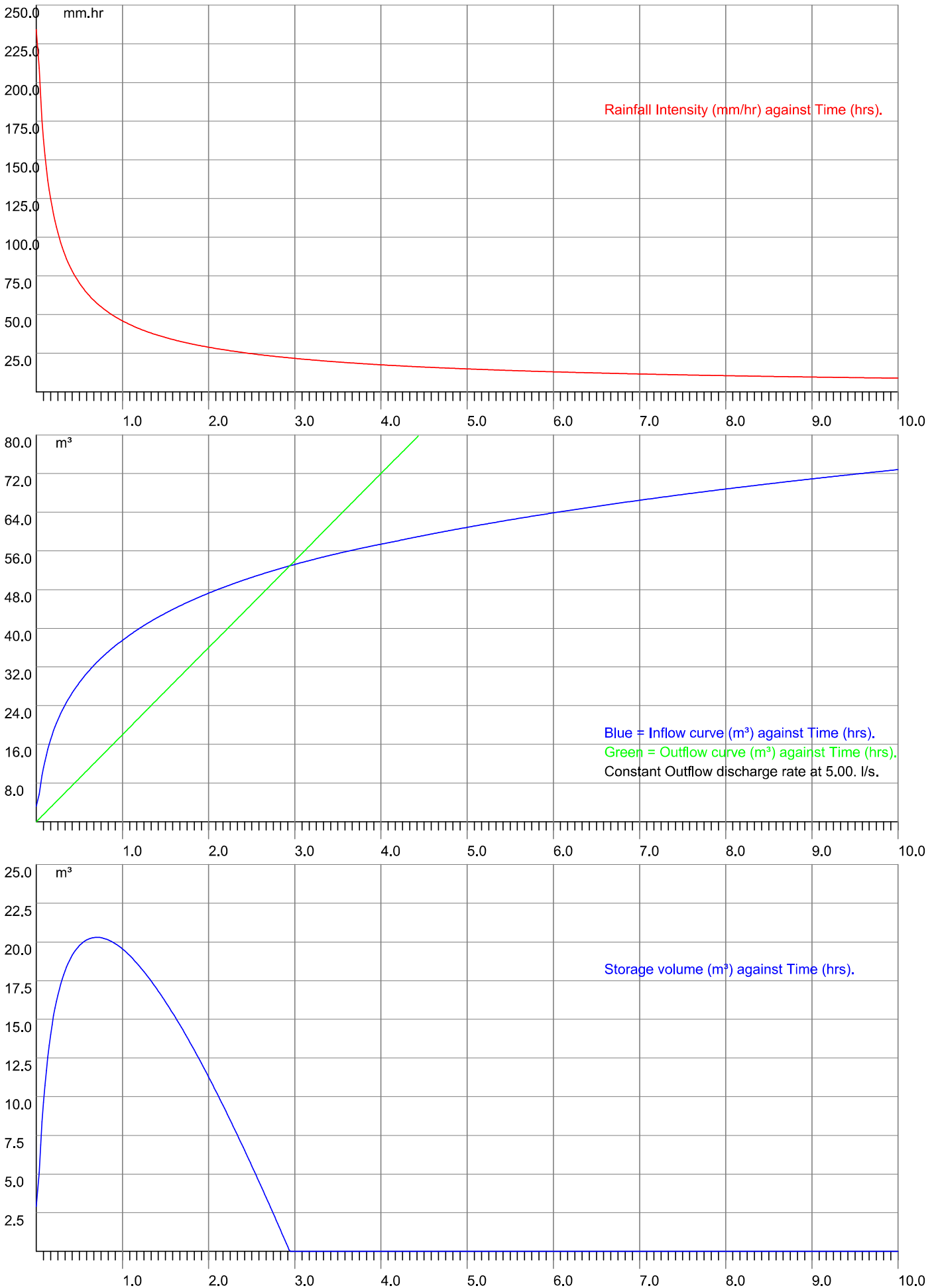
The LK Group

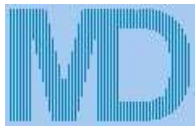
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Job No.		
Sheet no. 3		
Date 05/08/21		
By	Checked	Reviewed

Project 100yr +20%	By	Checked	Reviewed
Title Storage calcs for Radcliffe			





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Job No.		
Sheet no. 1		
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Data:-

FSR Hydrology:-

Location = Radcliffe

M5-60 (mm) = 18.9

Soil index = 0.45

Return period = 100

UCWI = 113.8

Grid reference = SD7808

r = 0.32

SAAR (mm/yr) = 1100

WRAP = 4

Climate change = 40

Clayey, or loamy over clayey soils with an impermeable layer at shallow depth.

Runoff factor (RF) = 63.0, calculated from:-

Runoff factor = $(0.829 \times \text{PIMP}) + (25 \times \text{SOIL}) + (0.078 \times \text{UCWI}) - 20.7$

where

PIMP = Impervious Area * 100 / (Impervious Area + Pervious Area)

UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 1000 m²

Total area (TA) = 1300 m²

Mean pump disch. rate = 5.000 l/s

Additional flow = 0.00 l/s

Pervious area = 300 m²

Equiv area = 819 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 51.0 mins

Rainfall at max = 59.32 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 26.0 m³

Allowed discharge rate = 5.000 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 15.00 mm/hr

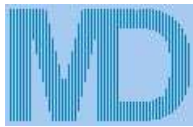
Calculated storage volume = 0.0 m³

Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

Storage lengths for initial calculation (x 1.1, 1.2, 1.3 or 1.5 as above if required) :-

Diam	Len	Diam	Len	Ovoid	Len	Box culvert	Len
100	3310.3	1125	26.2	400 x 600	144.4	500 x 500	104.0
150	1471.2	1200	23.0	600 x 900	62.9	500 x 750	69.3
225	653.9	1275	20.4	800 x 1200	35.4	500 x 1000	52.0
300	367.8	1350	18.2			750 x 1000	34.7
375	235.4	1425	16.3			750 x 1200	28.9
450	163.5	1500	14.7			750 x 1500	23.1
525	120.1	1575	13.3			1000 x 1000	26.0
600	92.0	1650	12.2			1000 x 1200	21.7
675	72.7	1725	11.1			1000 x 1500	17.3
750	58.8	1800	10.2			1000 x 1800	14.4
825	48.6	1875	9.4			1000 x 2000	13.0
900	40.9	1950	8.7			1500 x 1500	11.6
975	34.8	2025	8.1			1500 x 1800	9.6
1050	30.0	2100	7.5			1500 x 2000	8.7



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Data:-

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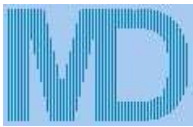
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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	145.0	19.847	3.000	16.847
20	103.0	28.161	6.000	22.161
30	82.0	33.569	9.000	24.569
40	69.0	37.667	12.000	25.667
50	60.0	40.993	15.000	25.993
60	53.0	43.803	18.000	25.803
70	48.0	46.241	21.000	25.241
80	44.0	48.396	24.000	24.396
90	41.0	50.328	27.000	23.328
100	38.0	52.079	30.000	22.079
110	36.0	53.678	33.000	20.678
120	34.0	55.149	36.000	19.149
130	32.0	56.510	39.000	17.510
140	30.0	57.775	42.000	15.775
150	29.0	58.956	45.000	13.956
160	28.0	60.063	48.000	12.063
170	26.0	61.102	51.000	10.102
180	25.0	62.081	54.000	8.081
190	24.0	63.006	57.000	6.006
200	23.0	63.881	60.000	3.881
210	23.0	64.711	63.000	1.711
220	22.0	65.498	66.000	0.000
230	21.0	66.248	69.000	0.000
240	20.0	66.961	72.000	0.000
250	20.0	67.642	75.000	0.000
260	19.0	68.372	78.000	0.000
270	19.0	69.064	81.000	0.000
280	18.0	69.735	84.000	0.000
290	18.0	70.388	87.000	0.000
300	17.0	71.022	90.000	0.000
310	17.0	71.639	93.000	0.000
320	17.0	72.241	96.000	0.000
330	16.0	72.827	99.000	0.000
340	16.0	73.399	102.000	0.000
350	15.0	73.958	105.000	0.000
360	15.0	74.504	108.000	0.000
370	15.0	75.038	111.000	0.000
380	15.0	75.560	114.000	0.000
390	14.0	76.072	117.000	0.000
400	14.0	76.572	120.000	0.000
410	14.0	77.063	123.000	0.000
420	14.0	77.545	126.000	0.000
430	13.0	78.017	129.000	0.000
440	13.0	78.480	132.000	0.000
450	13.0	78.935	135.000	0.000
460	13.0	79.381	138.000	0.000
470	12.0	79.820	141.000	0.000
480	12.0	80.251	144.000	0.000
490	12.0	80.676	147.000	0.000
500	12.0	81.093	150.000	0.000
510	12.0	81.503	153.000	0.000
520	12.0	81.907	156.000	0.000
530	11.0	82.305	159.000	0.000
540	11.0	82.697	162.000	0.000
550	11.0	83.082	165.000	0.000
560	11.0	83.463	168.000	0.000
570	11.0	83.837	171.000	0.000
580	11.0	84.207	174.000	0.000
590	11.0	84.571	177.000	0.000
600	10.0	84.930	180.000	0.000

Storage volume (m³) = 26.0 m³



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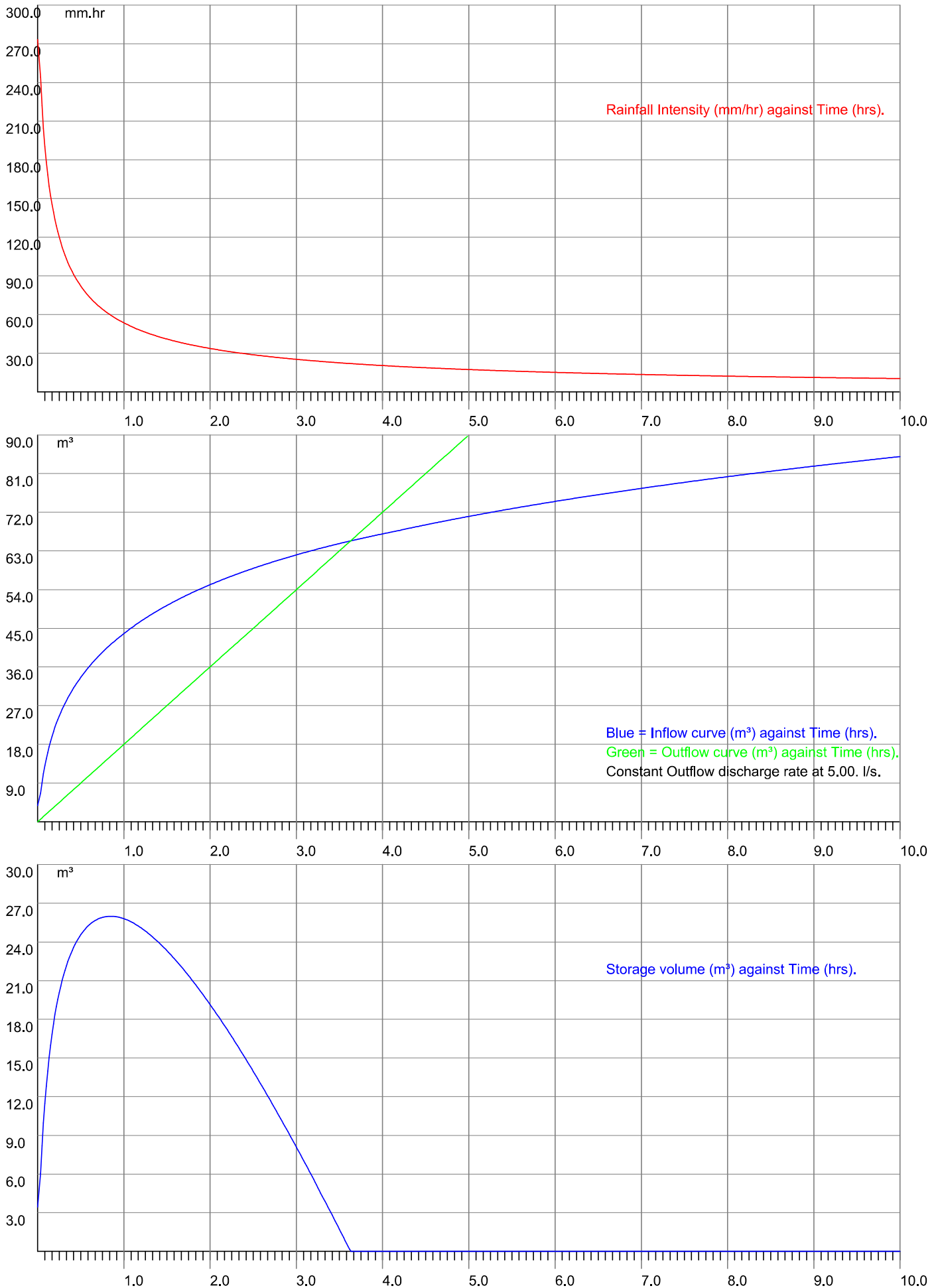
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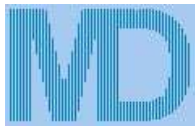
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Explanatory notes for Peak Flow Storage

- 1) This system uses the rainfall intensity/ duration curve calculated using either the Wallingford or FEH method as selected.
- 2) The balance is calculated from the inflow minus the outflow.
- 3) The storage volume is the maximum value of the balance curve.
- 4) This method was described by Davis (1963) - see Butler & Davies, 2nd edition, p294
- 5) References to 'storm duration' relate only to the hydrograph method (qv).
- 6) There are always 600 steps in the calculation process, thus a 'run' time of 10 hours will be sampled every minute,

Explanatory notes for Hydrograph Storage

- 1) The user has the choice of Summer or Winter curves
- 2) The mean intensity varies with the duration of the storm curve
- 3) There are always 120 steps in the calculation process, irrespective of storm duration.
- 4) The balance is calculated from the inflow minus the outflow.
- 5) The storage volume is the sum of the balance values for each step.
- 6) Varying durations should be tried to find the maximum storage value - this can be narrowed down very closely.

*Modelling using the flow characteristics of the restrictor is available using Vortex Control modelling function. Please be aware that this function needs the full design data file to function.

Why do the two methods give different results?

The rainfall characteristics for each method are very different.

The Peak flow (using the Intensity/Duration/Frequency curve) does not model the actual rainfall. This curve is joined points which represent the mean intensity of a storm at a given duration i.e. a value of 19.5 mm/hr for a 60 minute storm indicates that over the sixty minute period, the mean intensity was 19.5 mm/hr. The calculation method samples the IDF curve for a given location and frequency (Return Period) and calculates the storage for that rate and duration less the outflow volume. The maximum value is displayed as the 'worst case' storage. The outflow volume is constant throughout the process at the specified discharge rate.

The hydrograph method uses a standard curve for either Winter or Summer storms. Traditionally these are symmetrical about the central peak. UK rainfall does not fit into this convenient curve, so the calculations are dealing with a stylised set of data. The mean intensity for the storm is calculated from the IDF curve and applied to the curve data, calculating the storage for that step less the outflow volume. The final storage volume is the sum of the storage for all the steps. The outflow volume varies with the hydraulic head on the control device using flow equations provided by the control manufacturer. This is a far more accurate method than the peak flow method and often results in bigger storage volumes.

It can be seen that these two methods are very different, and the user may have the choice of which result to use. This is not an exact science, though is often treated as such by those that do not understand the principles of the calculations.

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