

LAND AT SMITHY BRIDGE ROAD, LITTLEBOUROUGH, ROCHDALE

FLOOD RISK ASSESSMENT & OUTLINE DRAINAGE STRATEGY

Job Number: FRA21 1165

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Client: Taylor Wimpey Strategic Land (North) Ltd



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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 Smithy Bridge Road, Littleborough. The development comprises a residential development with associated landscaping and car parking.

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 a more detailed flood map and modelled flood levels. In addition, a preliminary opinion was provided by the EA and discussions were held and information exchanged with the River Roch Flood Risk Management Team.

Rochdale Borough Council and United Utilities were also consulted concerning flood risk.

All relevant consultees have confirmed that there is a Negligible to Low risk of flooding to this site from all sources except fluvial and surface water, for which there are areas of High Risk.

Flood Risk

Environment Agency flood maps indicate that the lower area of the site is potentially vulnerable to fluvial flooding from the River Roch, south of the site.

The site is shown on the Environment Agency's (EA) website Flood Zone Mapping as being in Flood Zones 1, 2 and 3 (PPG Table 1).

The residential area is completely within Flood Zone 1 – Very Low Risk of fluvial flooding. The site is also partially within Flood Zone 3 – Medium to High Risk - annual probability of flooding of 1.0% or greater from rivers.

There is a moderate risk of groundwater emergence on the lower slopes due to the potential for groundwater to flow along the superficial and bedrock interface and emerge through the variable superficial soil. There is a Low Risk of Surface Water and Pluvial flooding against buildings if flow routes are not considered on the sloping site.

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 floodplain storage compared to the existing situation.

The proposed residential development is at a level at least 7m above the proposed River Roch flood risk management scheme storage levels. The lowest ground level located at the proposed access road location will be a minimum of 1.5m above the management scheme flood storage level.

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 River Roch to the south of the site.

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.

Foul sewage arising from the development will be discharged into the public combined sewer in the south of the site.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the River Roch on the southern boundary of the site. Therefore, the most effective strategy, in line with the SuDS management train, would be to have a number of detention facilities to the south of the development area serving each catchment.

The developed area has been split into two catchments the first is to the west with the remainder to the east.

The outline drainage strategy considers the use of attenuation-based SuDS to be feasible with a discharge to the river on the southern boundary of the development area. Therefore, the most effective strategy, in line with the SuDS management train, would be to have detention facilities towards to the south of the development area.

For the Western Catchment the required detention basin or similar has been estimated to be between **129.9 m³** and **325.8m³** for the 1 in 30-year greenfield 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 **243.6 m³** and **759.4m³**.

For the Eastern Catchment the required detention facility has been estimated to be between **128.9m³** and **363.6 m³** for the 1 in 30-year greenfield 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 **244.1 m³** and **851.5m³**.

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

Safe and dry access is available via Smithy Bridge Road (136.7m AOD) to the east at 1.6m above the 1% annual probability event. There is the existing potential for Smithy Bridge Road to flood to the south of the site access as the roadway levels fall below the 100-year event flood levels. Access to the north should be unaffected.

Flood Compensation

There are proposals for a flood relief scheme to be undertaken on the River Roch within the base of the valley. Following discussions with the EA the proposed level of the storage will reach a level of 136.0m AOD. Based upon the proposed layout of the access road to the development and the alterations to the ground levels adjacent to the cycleway and detention basins there would be a loss of potential storage. The compensatory storage volume has been estimated elsewhere.

This storage could be accommodated outside of the current Flood Zone 3 extents. The location of the compensatory storage should be agreed with the Environment Agency.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by Taylor Wimpey Strategic Land (North) Ltd to carry out a Flood Risk Assessment (FRA) and Outline Drainage Strategy for land at Smithy Bridge Road, Littleborough. The report was undertaken in support of a planning application to redevelop the site for residential use.

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.

SuDS should be designed where practical to maximise the opportunities and benefits that can be secured from surface water management. The strategy will consider the four 'pillars' of SuDS. To maximise these benefits, surface water management should be considered from the beginning of the development planning process and throughout influencing site and wildlife layout and design, and the use and characteristics of open spaces.

The main drivers for SuDS are the controlling water quantity and water quality³ (Plate 1), with an increasing emphasis on amenity and biodiversity benefits where practical.

¹ DCLG (2021). "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.

³ The SuDS Manual (C753) – CIRIA November 2015.

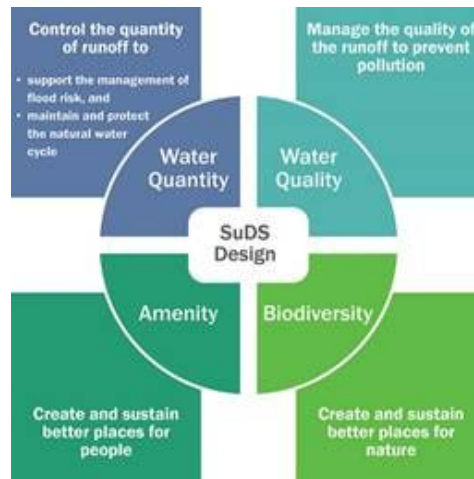


Plate 1: Four 'pillars' of SuDS design as defined by CIRIA in The SuDS Manual.

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	West of Smithy Bridge Road, Littleborough, Rochdale, OL15 8RF. Centred at approximate National Grid Reference 392215E 415425N.
Area	Approximately 14.3ha.
Topography	156.5 metres above ordnance datum (AOD) in the northwest of the site and 130.5m AOD in the southwest. Site is sloping down to the south getting steeper adjacent to the watercourse.
Current Land Use	<u>Site</u> Pastureland with internal boundary stone walls. Large storage tanks to the east of the site operated by United Utilities as a water screening facility for a Combined Sewer Overflow (CSO). The River Roch forms the southern boundary of the site. There are several water features within the site including ponds and ordinary watercourses flowing from north to south. The River Roch is partially retained along its northern edge. <u>Surrounding Area/ Boundary Treatment</u> North: Residential area. East: Smithy Bridge Road; pastureland and residential. South: River Roch; residential area and pastureland. West: Residential area and pastureland.
Proposed Development	Residential housing including soft landscaping and car parking. Access will be from Smithy Bridge Road to the east. Foot access is available at a number of locations to the north of the site.

Table 1-1: Summary of Site Details.

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 – Very Low 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, 2 and 3 in the PPG (paragraph 065, Table 1). The development area is within Flood Zone 1.

The proposed development is for a commercial/non-residential 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 has undertaken a review of public domain information including British Geological Survey data, Environment Agency data, historical mapping and aerial photography to provide a summary of the environmental setting of the site. This is summarised in Table 2-1 below.

Summary of the Environmental Setting			
Geology	Superficial		The majority of Site is Till, Devensian (Gravelly sandy CLAY). To the South of Site - Alluvium (Clay, Silt, Sand and Gravel).
	Bedrock		Milnrow Sandstone across majority of site, with a band of Pennine Lower Coal Measures Formation within the east.
	BGS Boreholes		No BGS boreholes with ground information available, most information relates to pumping water. The nearest records a water level at 2m depth.
Hydro-geology	Aquifer Designation	Superficial	Secondary Undifferentiated with Secondary A to the south.
		Bedrock	Secondary A.
	Source Protection Zone (SPZ)		Site not within an SPZ.
Hydrology	All adjacent and internal surface water		The nearest surface water feature is the River Roch that runs parallel to the southern site boundary. A pond was also noted on site during the site walkover. There is an ordinary watercourse adjacent to the northeast boundary that is collected into a land drain that outfalls to the river. There is also a dry gully within the site that may indicate a seasonal flow path.
Site History			There appears to be one virtually permanent pond towards the west and a couple of wet areas within depressions at the lower edge of the site.

Table 2-1: Summary of the Environmental Setting.

2.4 Geo-Environmental Investigation.

The investigation was undertaken on site by LK Consult Ltd in February 2018⁴.

The investigation involved the drilling of 23 window sample boreholes (referenced WS101 to WS124) to depths of between 1.4 metres below ground level (mbgl) and 5.5mbgl.

The ground conditions beneath the site comprised sandy Clay and clayey Sand. Profile Logs are shown in Appendix B.

Groundwater was recorded at between 1.15mbgl to 3.0mbgl across the site.

⁴ Report Name: LK Consult Ltd, LKC18 10005, February 2018.

2.5 Site Reconnaissance

A site reconnaissance was undertaken in February 2018 and photographs are provided in Appendix B.

The site is falling towards the River Roch at approximately 1 in 12 before steepening further down towards the flood plain.

- » There is a pond within the eastern part of the site that is slightly discoloured.
- » There are land drains crossing the site; some have collapsed.
- » The soil types appeared variable where exposed.
- » There is a Combined Sewer Overflow (CSO) towards the river adjacent to Smithy Bridge Road with a screening facility and storage tanks occupying a significant area.
- » Part of the water course has been retained to alter the path of a meander and protect a combined sewer.
- » There is a large, combined sewer running through the lower area of the site adjacent to the watercourse and a further combined sewer running from the northern boundary towards the CSO at Smithy Bridge Road.
- » There is an abandoned sewer flowing towards the watercourse in the central area.
- » There is a dry gully running from north to south that may be an old watercourse.
- » There is a land drain/culverted watercourse flowing through the site from the eastern end of South View Road. The culverted watercourse is adjacent to the footpath or within existing gardens at a lower level than the adjacent site.
- » There are land drains crossing the site and one entering from the existing allotments.

2.6 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 towards the south and the River Roch. There is a consistent fall over the majority of the site with an average fall of 1 in 12. Towards the watercourse the fall steepens to around 1 in 6 before flattening off adjacent to the watercourse. The final site levels and ground floor levels of dwellings have not yet been determined. The proposed access would join Smithy Bridge Road at around 136.7m AOD.

The lowest ground level for the development area is in the order of 141.5m AOD for the majority of the site, with the lowest property at a ground level of 138.0m AOD. The lowest proposed level for the main access is 136.0m AOD. The preliminary storage level for the River Roch flood risk management scheme is recorded as 134.4m AOD.

3 Consultation

Information from consultees (The Environment Agency (EA), Rochdale Borough Council (RBC) and United Utilities (UU) is summarised in Table 3-1 below.

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

For modelled levels refer to extracted Level table and node location map in Appendix C.

Source	Details	
The Environment Agency	The majority of the site is in Flood Zone 1: Very Low Risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000). There is a limited area of Flood Zone 2: Low Risk, with an annual probability of flooding of 0.1 to 1.0% from rivers towards the southeast. The area of Flood Zone 3: Medium to High Risk of flooding with an annual probability of flooding of 1.0% or greater from rivers, is in an area adjacent to the watercourse and Smithy Bridge Road. A pre-development enquiry with the EA confirmed that the development area is outside of any fluvial flood risk area. There are potential proposals for the EA to create a flood storage area adjacent to the river. These may affect the access from Smithy Bridge Road. The flood storage proposals should not affect the development area but would limit access along Smithy Bridge Road from the south of the access road.	
	Modelled Levels for the River Roch	<u>Node 4 (upstream)</u> Level of 135.08m for 1% annual probability event. Level of 135.15m for 1% event with climate change allowance. Level of 135.24m for 0.1% annual probability event. <u>Node 5 (middle)</u> Level of 133.64m for 1% annual probability event. Level of 133.73m for 1% event with climate change allowance. Level of 133.81m for 0.1% annual probability event. <u>Node 6 (downstream)</u> Level of 132.12m for 1% annual probability event. Level of 132.26m for 1% event with climate change allowance. Level of 132.46m for 0.1% annual probability event.
	Records of Flooding	No records of flooding on site, some flooding recorded on the River Roch upstream of the site.
	Records of Flood Warning Service	The site is not within a flood warning service area but the area adjacent to the watercourse is within a flood alert area.
	Surface Water Flooding	A Very Low Risk of surface water flooding is recorded across the majority of the site with a Low Risk of flooding up to a depth of 300mm in depressions flowing downhill towards the watercourse.
	Flooding from reservoirs	The site is shown to be at risk of flooding from reservoirs.
	Groundwater Source Protection Zone	Not within a Source Protection Zone.

Table 3-1: Summary of Consultee Information.

Source	Details	
Rochdale Borough Council (RBC)	LLFA	RBC does not have any records of any current flooding problems associated with Smithy Bridge Road.
United Utilities (UU)	Likely conditions for connecting into their sewerage system	UU 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. UU was contacted regarding sewer flooding history for the site. UU confirmed that they did not have any record of internal or external sewer flooding of properties in the vicinity of the site as a result of overloaded sewers.
	Sewer map	There is a 1000x2400 surface water sewer running from the CSO towards the River Roch from the filter treatment screen. There is a 600mm diameter combined sewer entering the site from Brooklyn Avenue to the north that flows towards Smithy Bridge Road. It then flows south in a 1950mm diameter combined sewer to connect to the CSO system. The onward flow route from the CSO is a 675mm diameter pipe which connects to a 675mm diameter pipe that enters the site from the northeast crossing Smithy Bridge Road. This pipe continues in a 675mm diameter pipe following the route of the watercourse towards the west.
Strategic Flood Risk Assessment (SFRA)	Level 1 SFRA ⁵	The site has no history of flooding from any source. The majority of the site is within a critical drainage area. The majority of the Flood Zone 3 is within the functional flood plain.
	Level 2 SFRA ⁶	The site has no history of flooding from any source. The River Roch is within an area of indirect flood risk from canals. Groundwater is not considered to be a significant risk within the RBC Area.
Preliminary Flood Risk Assessment (PFRA) ⁷	The Preliminary Flood Risk Assessment (PFRA) ³ for the area is the document titled Volume 1 – SFRA User Guide. This and its subsequent updates indicate that there are no records of flooding for the area which conforms with information supplied by the EA.	

Table 3-1 (continued): Summary of Consultee Information.

⁵ Strategic Flood Risk Assessment: Bury, Rochdale & Oldham Vol 2 – Level 1 JBA Consulting Ltd November 2009.

⁶ Strategic Flood Risk Assessment: Bury, Rochdale & Oldham Vol 3 – Level 2 JBA Consulting Ltd November 2009.

⁷ Strategic Flood Risk Assessment: Bury, Rochdale & Oldham Vol 1 – SFRA User Guide JBA Consulting Ltd December 2009.

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, 2 and 3 (see Appendix C).

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

Comparison of the modelling data and topographical survey indicates that the 1% (100-year) flood extents would closely match the extents shown on the published flood mapping.

The extents of the 0.1% (1000-year) flood level remain outside of the development area.

4.2 Sources of Flooding

Fluvial – The EA has confirmed the lower study area is partially within Flood Zone 3. Therefore, the flood risk associated with this source is considered significant and should be considered further in terms of vulnerability and flood resilience. The area proposed for development is shown within Flood Zone 1. Therefore, the flood risk to the development associated with this source is considered Very Low.

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 adjacent to houses, 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 generally Low but should be considered further during the detailed design. The current layout shows one area where the overland flow route would be through private gardens and may need adjusting during the detailed layout.

Surface Water (Overland flow) - The only observed impermeable area at a level generally above that of the study area is the residential area to the north. Any surface water arising from the north of the study area is likely to be intercepted by the highway drains and therefore pose little threat to the development. If there was a drainage failure causing overland flow it would flow towards the southern boundary. Sources of the potential surface water are the watercourse to the northeast boundary that is partially culverted through the site and the land drain from the allotments. Therefore, the flood risk associated with this source is considered Low.

Groundwater – The local investigations and the BGS have provided groundwater records for the study area in the form of monitoring points/borehole records. The records show the water table is recorded at between 0.75m and 2m below the surface. The shallow groundwater records indicate that water may enter any deep excavations or service trenches during construction and de-watering may be

necessary. There are potential sources of Artesian Pressure to force the water to spring in the area. This makes it possible for groundwater flooding to occur below the surface. No evidence of shallow groundwater was observed during the walkover. Therefore, the flood risk associated with this source is considered Low as the natural topography will cause any groundwater to be shed towards the south of the site.

Sewers – UU sewer records show combined and surface water sewers within the vicinity of the study area within the surrounding housing developments. The Pre-development enquiry states that no incidences of sewer flooding have been recorded in the area. The highway drainage to the north would intercept the majority of any overland flow before it enters the site. there is a culverted land drain flowing southeast across the site from the existing allotments that will need to be diverted into the surface water drainage system. This may be the continuation of the UU surface water drainage from Holland Street to the north. Therefore, the flood risk associated with this source is considered Low.

Artificial sources – According to the EA online maps, the study area is at risk from reservoir flooding; however, the likely risk of an incident occurring if the reservoir is adequately maintained and monitored is Very Low.

There is a small, piped land drain/watercourse adjacent to the eastern boundary. This runs below the sunken footpath or under the existing adjacent residents' gardens. In general, the footpath is 1.5m to 2.5m below the adjacent ground level within the development. The land drain only emerges below the development level to discharge into the marshy area adjacent to the river. Therefore, the flood risk associated with this source is considered Very Low.

4.3 Summary of Flood Risk

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

Table 4-1: Summary of Existing Risk Level.

The site is located within Flood Zones 1, 2 and 3, and a Negligible to Low risk of flooding from all sources have been identified for the development 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 H3⁸ 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 2010⁹.

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 borehole records is shown in Table 5-1 below:

Classification	Description	Aquifer Classification	Recorded Water Table Depth	Soakaway Potential
Glacial Till Deposits	Silty, sand and sandy clay layers	Secondary Undifferentiated	Approx. 0.75 – 2.0m	Poor
Millstone Grit Bedrock	Sandstone Mudstone and Siltstone	Secondary A	N/A	Limited

Table 5-1: Geological and Hydrogeological Setting.

⁸ Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.

⁹ Flood and Water Management Act 2010: UK Government.

Although some sandy bands were encountered infiltration methods such as soakaways are unlikely to be feasible due to the shallow groundwater and the steepness of the site, but this may be investigated further at the detailed design stage if required.

5.2 Surface Water Drainage Strategy

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

The River Roch and an un-named ordinary watercourse currently collect the overland flows of surface water. There are indications of land drainage collecting flow of groundwater.

There are no suitable surface water sewers within the vicinity of the site.

There are combined sewers running through the site and parallel to the main river.

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	3	Some variable low permeability areas and a high-water table.
b	Connection to Watercourse	1	Would require EA/LLFA consent and would have to cross the existing sewers.
c	Discharge into a sewer	2	The depth and invert level of the sewers within the site boundary 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)¹⁰ for the development:

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Infiltration				
Soakaways	X	Due to the nature of the ground conditions, the use of infiltration systems may not be feasible.	Water quantity Water quality	Soakaways provide stormwater attenuation, stormwater treatment and groundwater recharge. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration basin	X	Depressions that store and dispose of water via infiltration. May not be appropriate given the ground conditions.	Water quantity Water quality Biodiversity Amenity	Infiltration basin reduces the volume of runoff from a drainage area, can be very effective at pollutant removal via filtering through the soils, contributes to groundwater recharge and baseflow augmentation. Runoff is treated by physical filtration to remove solids, by absorption into the soil and removal and by biochemical reactions involving micro-organisms growing on the soil.
Infiltration trench	X	Infiltration trenches are shallow excavations with rubble or stone.	Water quantity Water quality Amenity	An Infiltration trench can create temporary subsurface storage of stormwater runoff, thereby enhancing the natural capacity of the ground to store and drain water. Infiltration trenches allow water to dissipate into the surrounding soils from the bottom and sides of the trench where runoff is treated by physical filtration, adsorption and biochemical reactions involving micro-organisms growing in the soil. Infiltration trenches are easy to integrate into a site. They are ideal for use around playing fields, recreational areas or public open space.
Rain gardens	*	Rain gardens are relatively small depressions in the ground that are planted up with native vegetation. Most likely to be implemented on private property close to buildings on relatively flat areas.	Amenity Biodiversity Water quality Water quantity	Attractive features that can help to improve open space. Can be planned as landscaping features. Flexible layout to fit into landscape. Runoff can be treated by physical filtration to remove solids, by absorption and removal by biochemical reactions involving micro-organisms growing on the soil. They can reduce rate of run off and provide some volume reduction.
Filtration				
Filter drain / trench	✓	Linear trenches filled with a permeable granular material, often with a perforated pipe in the base of the trench.	Water quantity Water quality	Filter trenches create temporary subsurface storage of stormwater runoff and provide stormwater treatment. These trenches can be used to filter and convey stormwater to downstream SuDS components.
Filter strip	*	Engineered filters that use vegetation to remove and treat runoff. The filter strip is sloped to allow sheet flow across the vegetated strip. May be appropriate given the site topography.	Water quality Amenity Biodiversity	A filter strip offers no storage and is used solely to remove pollutants from surface water. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. A filter strip features medium amenity potential. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat.

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

¹⁰ CIRIA C753 - The SUDS Manual. London 2015.

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Retention & Detention				
Detention basin	✓	Dry depressions designed to hold water for a specific retention time. Basins tend to be found towards the end of the SuDS management train, so are used if extended treatment of the runoff is required or if they are required for wildlife or landscape reasons.	Water quantity Water quality Biodiversity Amenity	Detention basins provide flow control through attenuation of stormwater runoff for a wide range of rainfall events. Basins treat runoff in a variety of ways: settlement of solids in still or slow moving water, adsorption by the soil, biological activity. Basins offer many opportunities for the landscape designer. Basins should not be built on but can be used for sports and recreation. Basins can be part of public open space.
Attenuation Ponds	✓	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.	Water quantity Water quality Biodiversity Amenity	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. Ponds treat runoff in a variety of ways: settlement of solids in still water (having plants in the water enhances calm conditions and promotes settlement), adsorption by aquatic vegetation, biological activity. Permanently wet ponds can be used to store water for reuse and offer excellent opportunities for the provision of wildlife habitats. Ponds can be part of public open space.
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.	Water quantity	Geo-cellular systems can be used to control and manage rainwater surface water runoff either as a soakaway or as a storage tank. Geo-cellular storage systems provide high storage volume capacity High void ratios (up to 96%). Capable of managing high flow events.
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.	Water quantity	Oversized pipes can reduce rate of run off and provide some volume reduction.
Tanks	✓	Prefabricated underground tanks could be considered at the detailed design stage in order to provide storage to attenuate surface water runoff.	Water quantity	Storage tanks can be used to control and manage rainwater surface water runoff providing high storage volume capacity. Tanks are capable of managing high flow events.

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

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Swales & conveyance channels				
Swales	✓	Swales are shallow grass-lined channels that provide capacity for conveying flows at a controlled rate into ponds and watercourses.	Water quality Biodiversity Amenity Water quantity	Swales are effective at removing polluting suspended solids through filtration and sedimentation. The vegetation traps organic and mineral particles that are then incorporated into the soil, while the vegetation takes up any nutrients. Swales are often integrated into the surrounding land use. Local wild grass and flower species can be introduced for visual interest and to provide a wildlife habitat. Swales are usually designed as conveyance systems but can also be designed with check dams to increase attenuation and, where applicable, infiltration.
Channels & rills	✓	Channels and rills are open surface water channels with hard edges.	Water quality Amenity Water quantity Biodiversity	Effective in water & pollution treatment. Can act as pre-treatment to remove silt before water is conveyed into further SuDS features. Can be visually appealing in urban landscapes. Amenity value for the local community and biodiversity value (design dependant).
Control structures				
Flow control devices	✓	Flow control devices e.g. hydro-brake style flow control systems, and restricted orifices enable the discharge to be restricted to a constant rate from the development.	Water quantity	Control the peak flow. Complex controls can reduce upstream storage requirements.
Inlets, outlets and controls	✓	There are many different designs and variations, including landscaped pipes, perforated pipes, weirs.	Water quality Amenity	Inlets, outlets and other control structures are key elements of well-designed SuDS. Inlet and outlet features allow water to flow into and out of features and also limit the rate at which water flows along and out of the system. There are many different approaches and products available, and they can be easily designed to add interest to the urban landscape. Can provide accurate flow control from one SuDS feature to another.
Source control				
Green roofs	*	Green roofs comprise a multi-layered system that covers the roof of a building or podium structure with vegetation cover/landscaping.	Water quality Water quantity Amenity Biodiversity	Green roof installations can help to reduce surface water runoff from roof areas depending on the system specified. Good removal capability of atmospherically deposited urban pollutants. Ecological, aesthetic and amenity benefits.
Blue roofs	*	A blue roof is a roof design that is explicitly intended to store water, typically rainfall.	Water quantity Amenity Biodiversity	Blue roofs are designed to attenuate and manage stormwater on a flat roof in urban areas where options for ground-based attenuation systems are limited, and in particular, where construction is being carried out within flood sensitive areas. Amenity value for the local community.

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

SuDS Option	Appropriate to Development	Comments	Benefits	Comments
Rainwater harvesting	*	Rainwater harvesting collects the rain which falls onto roofs, then stores it in a tank until required for a non-potable use.	Water quantity	In the process, a volume of water is kept out of the storm-water management system, thereby helping to reduce flooding risks. When required, the water is pumped to the point of use, thus displacing what would otherwise be a demand for mains-water. Reduces demand on mains water.
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.	Water quality Water quantity	Reduced peak flows to watercourses, reducing the risk of flooding downstream. Reduced effects of pollution in runoff on the environment.
Other SuDS				
Wetlands	✗	These comprise of shallow ponds and marshy areas, covered almost entirely in aquatic vegetation.	Water quality Water quantity Amenity Biodiversity	Wetlands provide both stormwater attenuation and treatment. Wetlands detain flows for an extended period to allow sediments to settle, and to remove contaminants by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.

Table 5-3 (continued): 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

✗ Not suitable

5.3 Surface Water Attenuation Requirements

In line with the local guidance, the flow from this development 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)	14.30
Development Area (ha)	8.92
Green Infrastructure (ha)	5.38
West Catchment	
Catchment Area (ha)	4.04
Impermeable split (ha)	2.12
Permeable split (ha)	1.73
Green Infrastructure (ha)	0.19
Eastern Catchment	
Catchment Area (ha)	4.88
Impermeable split (ha)	2.43
Permeable split (ha)	1.98
Green Infrastructure (ha)	0.47

Table 5-4: Assumed plot areas.

It can be seen that there is an increase in impermeable area from the existing usage to the proposed. This is likely to require attenuation to reduce the proposed flow off site to a level which is acceptable to the LLFA and to the EA, including an allowance for climate change.

5.3.1 Attenuation Estimate

Western Catchment

The total greenfield runoff from the western catchment has been estimated to provide a final figure for the greenfield runoff from the area. The split catchment figures have been utilised to estimate the storage that is required for the basin in terms of engineering feasibility.

For the contributing catchment an estimate has been produced assuming a developable area of 3.85ha and a public open space of 0.19ha from the 4.04ha catchment contributions for each catchment may vary as the design progresses but the overall greenfield flow figures should be of a similar order if the overall catchments are similar.

Assuming conservatively that 55% of the developed area comprises roofs and hard surfacing with an allowance for urban creep, the resulting impermeable area would be 2.12ha. All greenfield runoff estimates, and subsequent storage estimates are included in Appendix E. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

➤➤ Q_{bar} :	32.05 l/s
➤➤ 1 in 1 year greenfield runoff rate:	27.24 l/s
➤➤ 1 in 30 year greenfield runoff rate:	53.84 l/s
➤➤ 1 in 100 year greenfield runoff rate:	67.30 l/s

Alternatively, the ADAS 345 Report provides increased estimations from the IH 124 method below due to the steepness of the site:

➤➤ Q_{bar} :	93.23 l/s
➤➤ 1 in 1 year greenfield runoff rate:	75.66 l/s
➤➤ 1 in 30 year greenfield runoff rate:	162.81 l/s
➤➤ 1 in 100 year greenfield runoff rate:	211.04 l/s

The following attenuation has been estimated for the development using IH greenfield runoff rates and utilises the FSR methodology¹¹ as:

- Attenuation storage volume: **325.8 m³** (1 in 30 year event)
- Retention on site volume **595.4 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **759.4 m³** (1 in 100 year + 40% Climate Change)

The following attenuation has been estimated for the development using ADAS 345 greenfield runoff rates and utilises the FSR methodology as:

- Attenuation storage volume: **129.9 m³** (1 in 30 year event)
- Retention on site volume: **243.6 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **330.6 m³** (1 in 100 year + 40% Climate Change)

The attenuation required for a 1 in 30 year storm event, requires a storage volume of between **129.9 m³** and **325.8 m³** and for the 1 in 100 year event, a storage capacity of between **243.6 m³** and **759.8 m³** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the on-site watercourse.

¹¹ Flood Studies Report Wallingford NERC 1975.

Eastern Catchment

For the contributing catchment an estimate has been produced assuming a developable area of 2.37ha and a public open space of 0.92ha from the 3.29ha catchment. Assuming conservatively that 55% of the developed area comprises roofs and hard surfacing with an allowance for urban creep, the resulting impermeable area would be 1.30ha. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford IH 124 method:

- Q_{bar} : 38.71 l/s
- 1 in 1 year greenfield runoff rate: 32.91 l/s
- 1 in 30 year greenfield runoff rate: 65.04 l/s
- 1 in 100 year greenfield runoff rate: 81.29 l/s

Alternatively, the ADAS 345 Report provides increased estimations from the IH 124 method below due to the steepness of the site:

- Q_{bar} : 122.16 l/s
- 1 in 1 year greenfield runoff rate: 98.67 l/s
- 1 in 30 year greenfield runoff rate: 213.12 l/s
- 1 in 100 year greenfield runoff rate: 276.91 l/s

The following attenuation has been estimated for the development using IH greenfield runoff rates and utilises the FSR methodology¹² as:

- Attenuation storage volume: **363.6 m³** (1 in 30 year event)
- Retention on site volume: **666.2 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **851.5 m³** (1 in 100 year + 40% Climate Change)

The following attenuation has been estimated for the development using ADAS 345 greenfield runoff rates and utilises the FSR methodology as:

- Attenuation storage volume: **128.9 m³** (1 in 30 year event)
- Retention on site volume: **244.1 m³** (1 in 100 year + 20% Climate Change)
- Retention on site volume: **335.3 m³** (1 in 100 year + 40% Climate Change)

The attenuation required for a 1 in 30 year storm event, requires a storage volume of between **128.9 m³** and **363.6 m³** and for the 1 in 100 year event, a storage capacity of between **244.1 m³** and **851.5 m³** will be required from on-site storage as well as SuDS systems. All volumes can be stored within the site boundary and discharges will be limited by flow control devices to the on-site watercourse.

Attenuation storage aims to limit the peak rate of runoff from the development to the corresponding greenfield runoff for a range of annual flow rate probabilities before discharging into a watercourse. As the flow from the development would be restricted to the greenfield equivalent there should be little change in the flows that enter the River Roch and thus the risk of flooding and the level of erosion created as a result from the development should not increase the risk of flooding off-site.

¹² Flood Studies Report Wallingford NERC 1975.

5.4 Site Specific SuDS

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

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

There are areas where conveyance systems such as swales may be utilised to intercept overland flow arising from the north and to convey any water to the existing watercourse in the south. This will provide an effective pre-treatment of suspended solids through filtration and sedimentation and will also provide ecological and amenity benefits.

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

A pre-development enquiry to United Utilities confirmed that the foul drainage can be connected to the existing 675mm diameter combined drain within the south of the site at a location convenient to the developer.

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) are below the lowest existing ground level in the developable area by approximately 5.5m. 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 Smithy Bridge Road (136.7m AOD) to the east at 1.6m above the 1% annual probability event (135.08m AOD). The lowest level of the access road surfacing is 136.0m AOD. Therefore, no mitigation is proposed as access to the north will be above the modelled and recorded flood event levels.

There is the potential for Smithy Bridge Road to flood to the south of the site access, as the roadway falls below the 100-year event flood levels. In addition, when considering the River Roch flood risk management scheme, the preliminary storage level for is recorded as 134.40m AOD. It is unlikely this level will increase significantly due to the potential affect upon Smithy Bridge Road. As the flooding of Smithy Bridge Road is an existing regular potential event it is assumed that the emergency services and local emergency planning department are aware of the issue.

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 Risks

It is impossible to completely guard against flooding since extreme events greater than the design standard event are always possible. However, it is likely that with the 1% annual probability flood event with allowance for climate change significantly below the lowest site levels, the relatively elevated position of the development will safeguard it from localised fluvial flooding during extreme rainfall events and fluvial flooding events outside the scope of this assessment. However, ground floor levels should be set above proposed levels across the site and 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.

7 Conclusions

The site is shown on published mapping to be located within the Environment Agency's Flood Zones 1, 2 and 3. Comparison of topographical data with the EA modelled flood level data indicates that the development area of the site is wholly within Flood Zone 1 - Very Low Risk of fluvial flooding. The lower areas of the site are partially within Flood Zone 3 – High to Medium Risk of flooding.

Negligible to Low risks of flooding from all sources have been identified from information provided by the EA, United Utilities and Rochdale Council.

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 Smithy Bridge Road.
- » Potential for soakaway use for rainwater disposal is low; however, this could be investigated further at the detailed design phase.
- » Surface water flow will likely need to be attenuated to the greenfield runoff rate or a rate agreed with the LLFA/EA.
- » Surface water arising from the site could potentially discharge into the River Roch to the south of the site.
- » Foul sewage could be discharged into the existing 675mm diameter public foul sewer within the site boundary subject to the agreement of United Utilities.
- » A formal evacuation plan is not considered to be required but Smithy Bridge Road to the south of the main access may be flooded during an extreme event.
- » Flood compensation will be required where the proposed future flood storage volume will be affected by the works.

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.

Appendix A

Figures, Plans and Drawings

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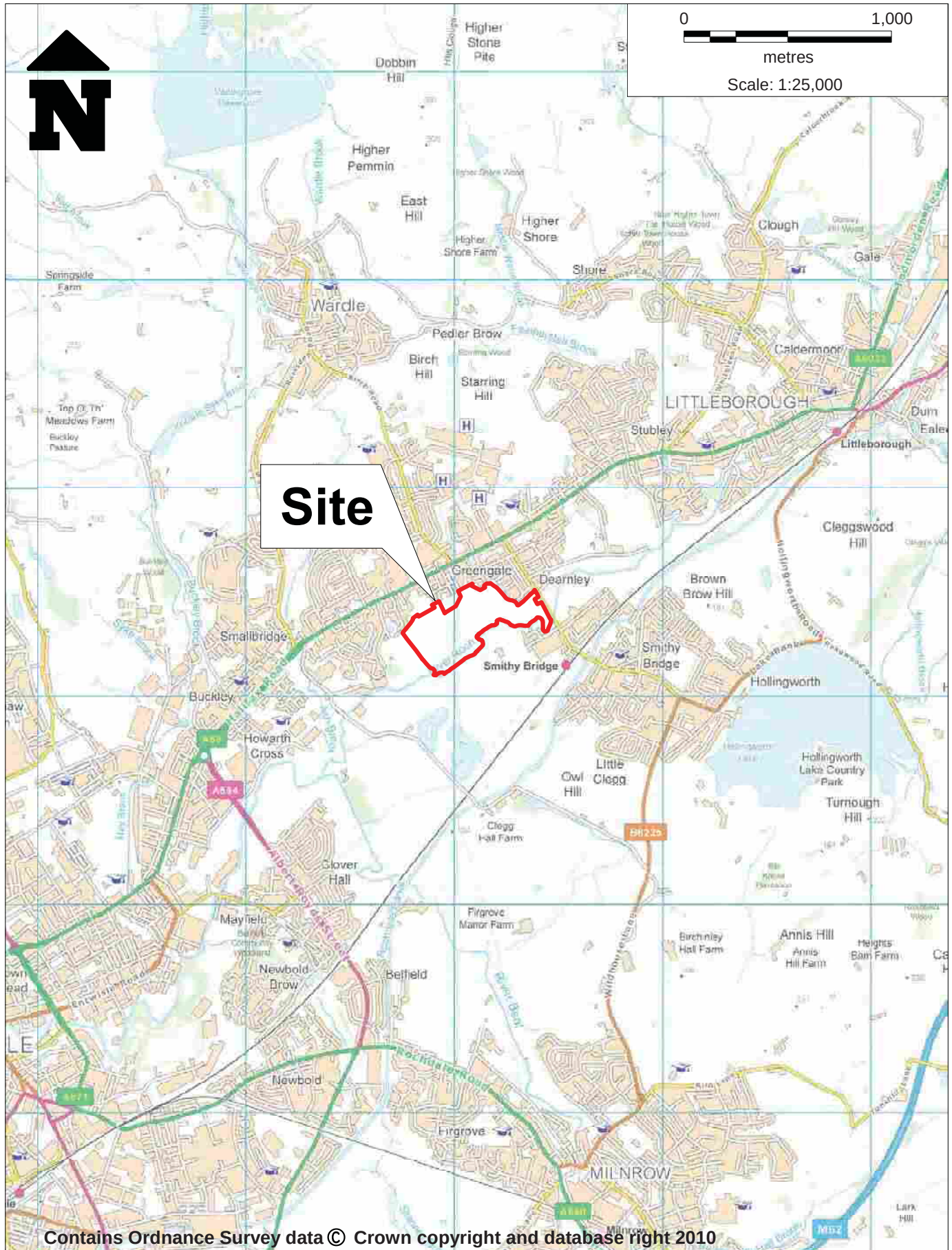


Figure 1: Site Location Plan, Smithy Bridge Road, Littleborough

Drawn: April 2018 Scale: 1:25,000 @ A4 (see scale bar)



KEY

Site Boundary

Sampling Locations and features annotated by LK Consult Ltd are approximate and are based upon observed measurements unless otherwise stated. Do not scale from this drawing and work from marked dimensions only. All dimensions and features should be confirmed on site by the Contractor. Where this drawing includes information provided to LK Consult Ltd by others, LK Consult Ltd gives no warranty, representation or assurance as to the accuracy of such information.



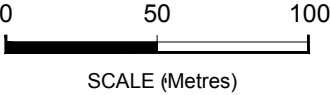
Client:
Taylor Wimpey UK Ltd

Site:
Smithy Bridge Road, Littleborough

Title:
Site Boundary Plan

Job No.: FRA 21 1165	Scale (See Scale Bar): 1:2500 @ A3	Figure: 2	Revision:
Drawn By: AC	Checked By: PW	Drawn: Jul 2022	

Extract from: Plan Supplied by Client
Drawing Ref: Contract Plan, No.02 (June 2017)



APPENDIX B

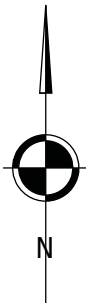
SITE INFORMATION

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SURVEY STATIONS			
Name	Easting	Northing	Height
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SO2	392007.90	415556.32	154.25
SO3	391973.53	415541.06	155.55
SO4	391942.54	415604.90	156.66
SO5	391868.35	415569.64	157.09
SO6	391901.19	415505.86	156.68
SO7	391909.47	415462.87	155.76
SO8	391868.27	415394.71	155.75
SO9	391961.82	415364.73	151.02
SO10	391907.85	415233.20	142.45
SO11	392014.03	415179.81	133.09
SO12	392070.51	415266.00	138.60
SO13	392283.48	415416.37	136.48
SO14	392352.71	415338.55	133.31
SO15	392407.73	415403.53	134.88
SO16	392402.37	415511.28	137.51
SO17	392314.83	415425.48	136.12
SO18	392200.56	415440.54	142.05
SO19	392064.19	415523.03	150.82
DC1	391924.27	415420.84	154.02
DC2	391906.82	415418.88	154.82
WP1	392520.37	415312.96	136.49
WP2	392480.66	415361.34	135.08
WP3	392350.61	415571.59	142.95
WP4	392301.24	415647.48	149.93
WP5	392244.78	415758.13	156.60
WP6	392132.69	415715.53	155.97
WP7	392049.42	416066.77	155.39
SO12	392031.32	415511.21	152.02



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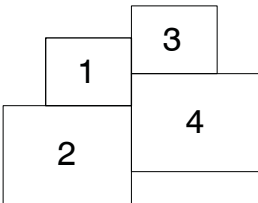
Note:
The survey is plotted on a plane local
Grid. Orientation to National Grid.
All levels relate to Ordnance Datum,
achieved using the
OS National GPS Network.

Survey Control Markers established for
Mapping purposes only and should not be
used for Construction without the written
approval of Survey Operations Ltd.

Drainage information must be verified
with local authority records before use

Levels in parenthesis indicate top of walls.

Areas within bold dashed line surveyed
August 2017 and added to Survey Operations
drawing 14L173.



Sheet Layout

Survey OPERATIONS

Smith Street, Skelmersdale, Lancs. WN8 8LN
Tel: 01695 725662 Fax: 01695 51816
Email: mail@survops.co.uk — www.survops.co.uk

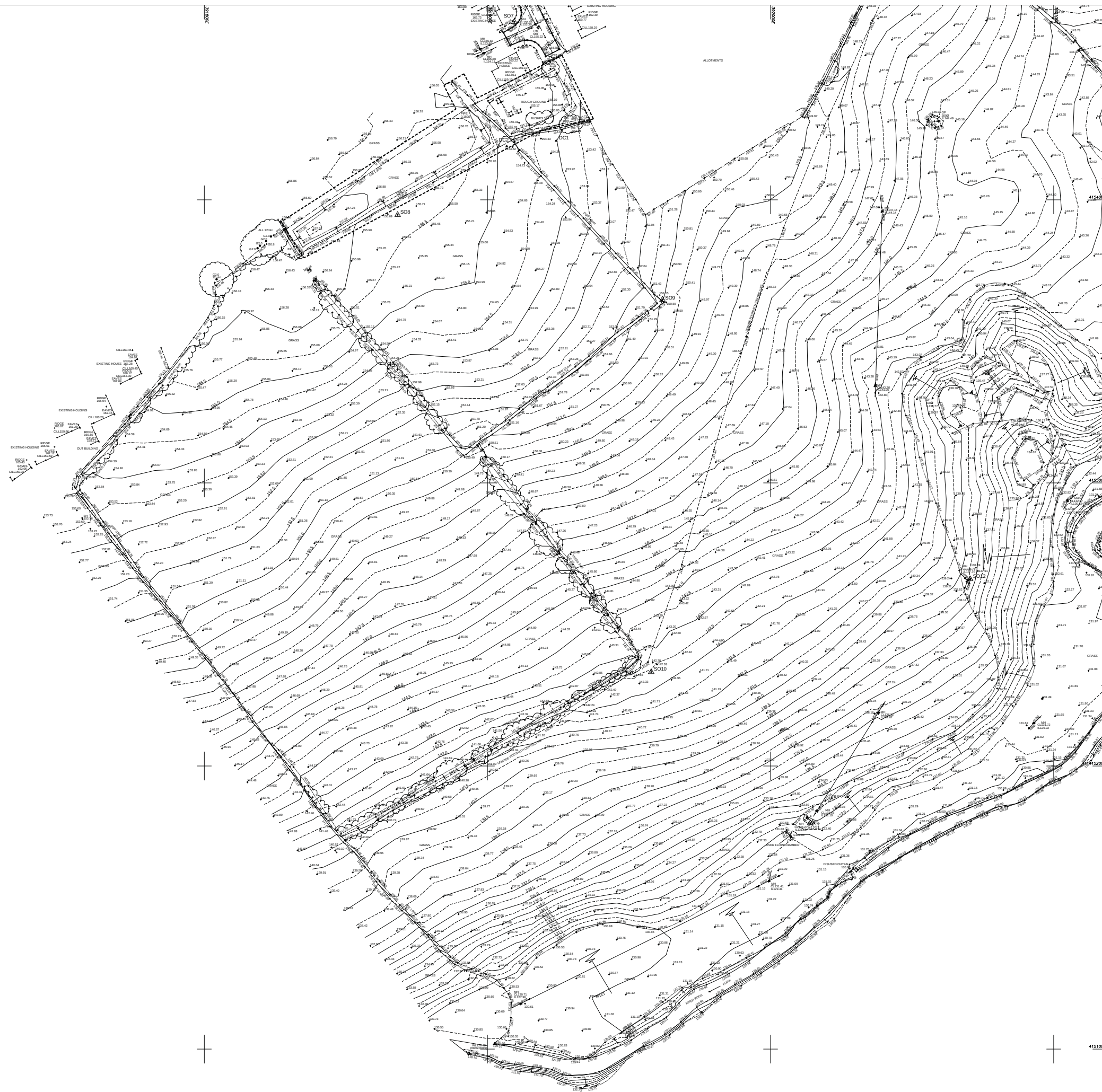
Client
Taylor Wimpey North West

Drawing Title
Topographical Survey of Land at:
Smithy Bridge Additional Areas
Rochdale
Sheet 1 of 4

Scale(s)	1:500	Surveyor	DC/MP
Date	Sep 17	Drawn	AW/NR
Job Number	17H112	Checked	TP/DC

Sheet Size & Drg Number & Revision
A1 17H112/001

SURVEY STATIONS			
Name	Eastings	Northings	Height
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007	391901.47	150505.14	156.66
008	391868.27	151539.74	155.75
009	391868.56	151544.02	155.75
010	391897.85	151523.30	145.45
011	391898.14	151527.58	145.45
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027	391829.07	150446.52	142.09
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051	391848.27	150549.24	142.09
052	391849.07	150553.52	142.09
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054	391850.67	150562.08	142.09
055	391851.47	150566.36	142.09
056	391852.27	150570.64	142.09
057	391853.07	150574.92	142.09
058	391853.87	150579.20	142.09
059	391854.67	150583.48	142.09
060	391855.47	150587.76	142.09
061	391856.27	150592.04	142.09
062	391857.07	150596.32	142.09
063	391857.87	150600.60	142.09
064	391858.67	150604.88	142.09
065	391859.47	150609.16	142.09
066	391860.27	150613.44	142.09
067	391861.07	150617.72	142.09
068	391861.87	150622.00	142.09
069	391862.67	150626.28	142.09
070	391863.47	150630.56	142.09



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Note:
The survey is plotted on a plane local
Grid. Orientation to National Grid.
All levels relate to Ordnance Datum,
achieved using the
OS National GPS Network.

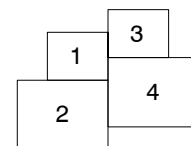
Survey Control Markers established for Mapping purposes only and should not be used for Construction without the written approval of Survey Operations Ltd.

Drainage information must be verified
with local authority records before use

Levels in parenthesis indicate top of walls.

Areas within bold dashed line surveyed
August 2017 and added to Survey Operations
drawing 14L173.

STANDARD REFERENCE & ABBREVIATIONS

[illegible]

Sheet Layout

Survey

Smith Street, Skelmersdale, Lancs. WN8 8LN
Tel: 01695 725662 Fax: 01695 51816
Email: mail@survops.co.uk - www.survops.co.uk

Client
Taylor Wimpey North West

Drawing Title
Topographical Survey of Land at:
Smithy Bridge Additional Areas
Rochdale
Sheet 2 of 4

ON		
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Scale(s)	1:500	Surveyor	DC
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Date	Sep 17	Drawn	AW
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Job Number	17H112	Checked	TP
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Sheet Size & Drg Number & Revision
A0 17H112/002



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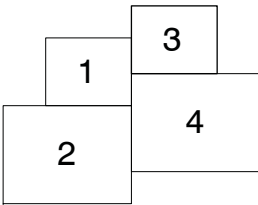
Note:
The survey is plotted on a plane local
Grid. Orientation to National Grid.
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Sheet Layout

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Smith Street, Skelmersdale, Lancs. WN8 8LN
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Client
Taylor Wimpey North West

Drawing Title
Topographical Survey of Land at:
Smithy Bridge Additional Areas
Rochdale
Sheet 3 of 4

Sheet Size & Drg Number & Revision
A1 17H112/003

Geology 1:10,000 Maps Legends

Artificial Ground and Landslip

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	MGR	Made Ground (Undivided)	Artificial Deposit	Holocene - Holocene
	WMGR	Infilled Ground	Artificial Deposit	Holocene - Holocene
	WGR	Worked Ground (Undivided)	Void	Holocene - Holocene
	SLIP	Landslide Deposit	Unknown/Unclassified Entry	Quaternary - Quaternary

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Flandrian - Pleistocene
	TILLD	Till, Devensian	Diamicton	Devensian - Ipswichian
	GFDUD	Glaciofluvial Deposits, Devensian	Sand and Gravel	Devensian - Ipswichian
	LDE	Lacustrine Deposits	Clay	Quaternary - Ryazanian
	PEAT	Peat	Peat [Unlithified Deposits Coding Scheme]	Quaternary - Ryazanian
	HEAD	Head	Diamicton	Quaternary - Ryazanian

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	MLRS	Milnrow Sandstone	Sandstone	Langsettian - Langsettian
	PLCM	Pennine Lower Coal Measures Formation	Mudstone, Siltstone and Sandstone	Langsettian - Langsettian
	DF	Darwen Flags	Sandstone	Langsettian - Langsettian
	GAS	Great Arc Sandstone	Sandstone	Langsettian - Langsettian
	OL	Old Lawrence Rock	Sandstone	Langsettian - Langsettian
	HER	Helpet Edge Rock	Sandstone	Langsettian - Langsettian
	WH	Woodhead Hill Rock	Sandstone	Langsettian - Langsettian
	Rock			
	Fault			

Geology 1:10,000 Maps

This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:10,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around a site. This mapping may be more up to date than previously published paper maps.

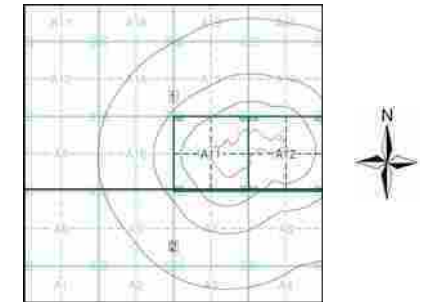
The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page.

Please Note: Not all of the layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:10,000 Maps Coverage

Map ID:	1	Map ID:	2
Map Name:	SD91NW	Map Name:	SD91SW
Map Date:	2007	Map Date:	2007
Bedrock Geology:	Available	Bedrock Geology:	Available
Superficial Geology:	Available	Superficial Geology:	Available
Artificial Geology:	Available	Artificial Geology:	Available
Faults:	Available	Faults:	Available
Landslip:	Available	Landslip:	Available
Rock Segments:	Available	Rock Segments:	Available

Geology 1:10,000 Maps - Slice A



Order Details

Order Number: 133661111_1_1
Customer Ref: 17TAY040
National Grid Reference: 391880, 415320
Slice: A
Site Area (Ha): 14.11
Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP

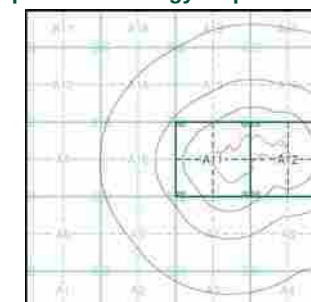
Superficial Geology

BGS 1:10,000 Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, 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

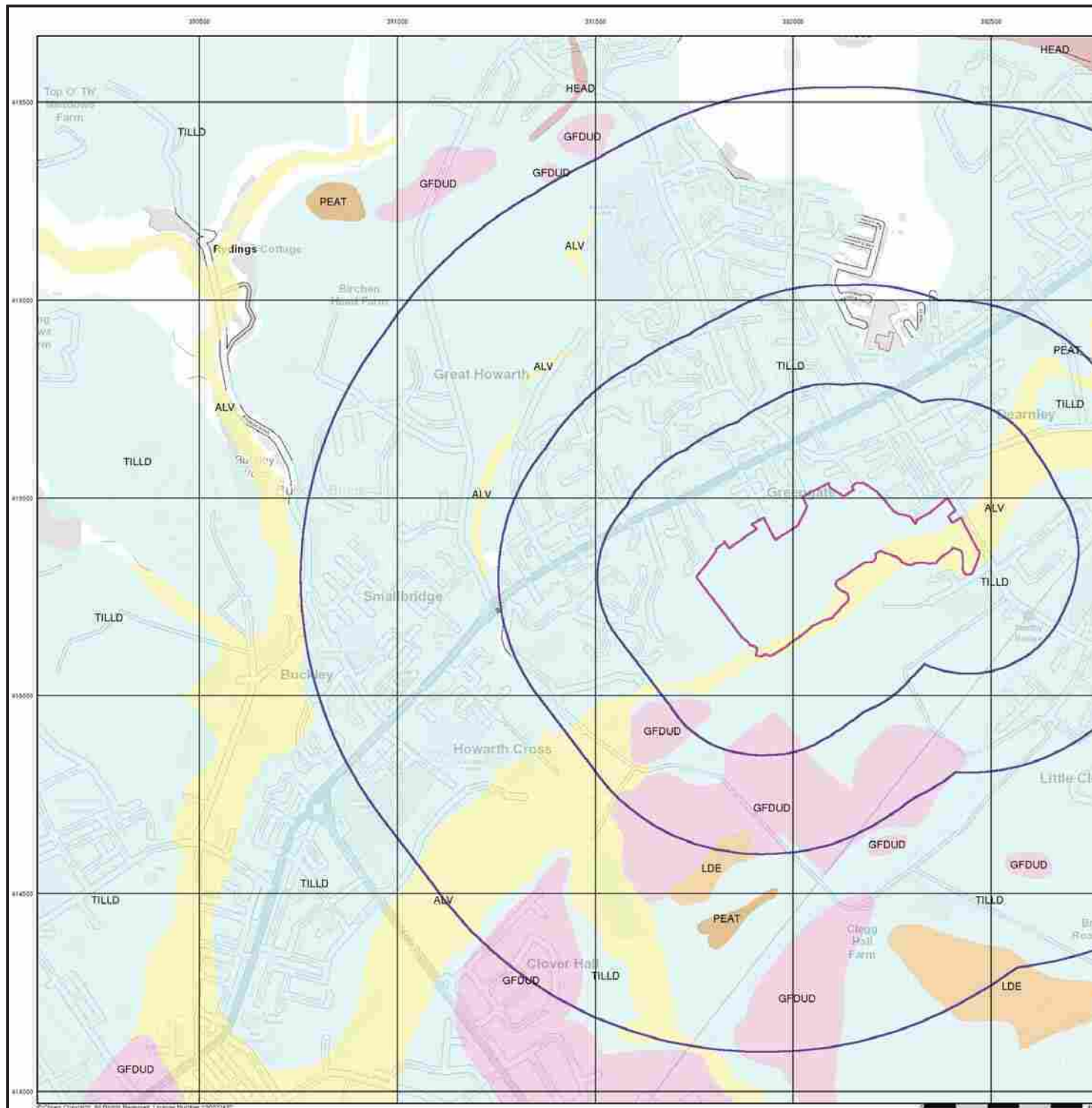


Order Details

Order Number: 133661111_1_1
 Customer Ref: 17TAY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP



Bedrock and Faults

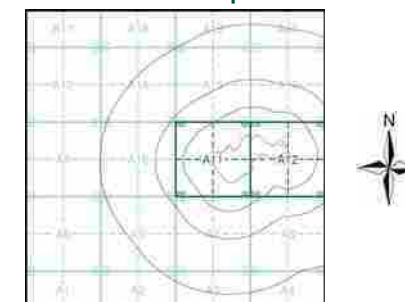
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

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 and thin beds mapped as lines such as coal seams and mineral veins. These are not restricted by age and could relate to features of any of the 1:10,000 geology datasets.

Bedrock and Faults Map - Slice A

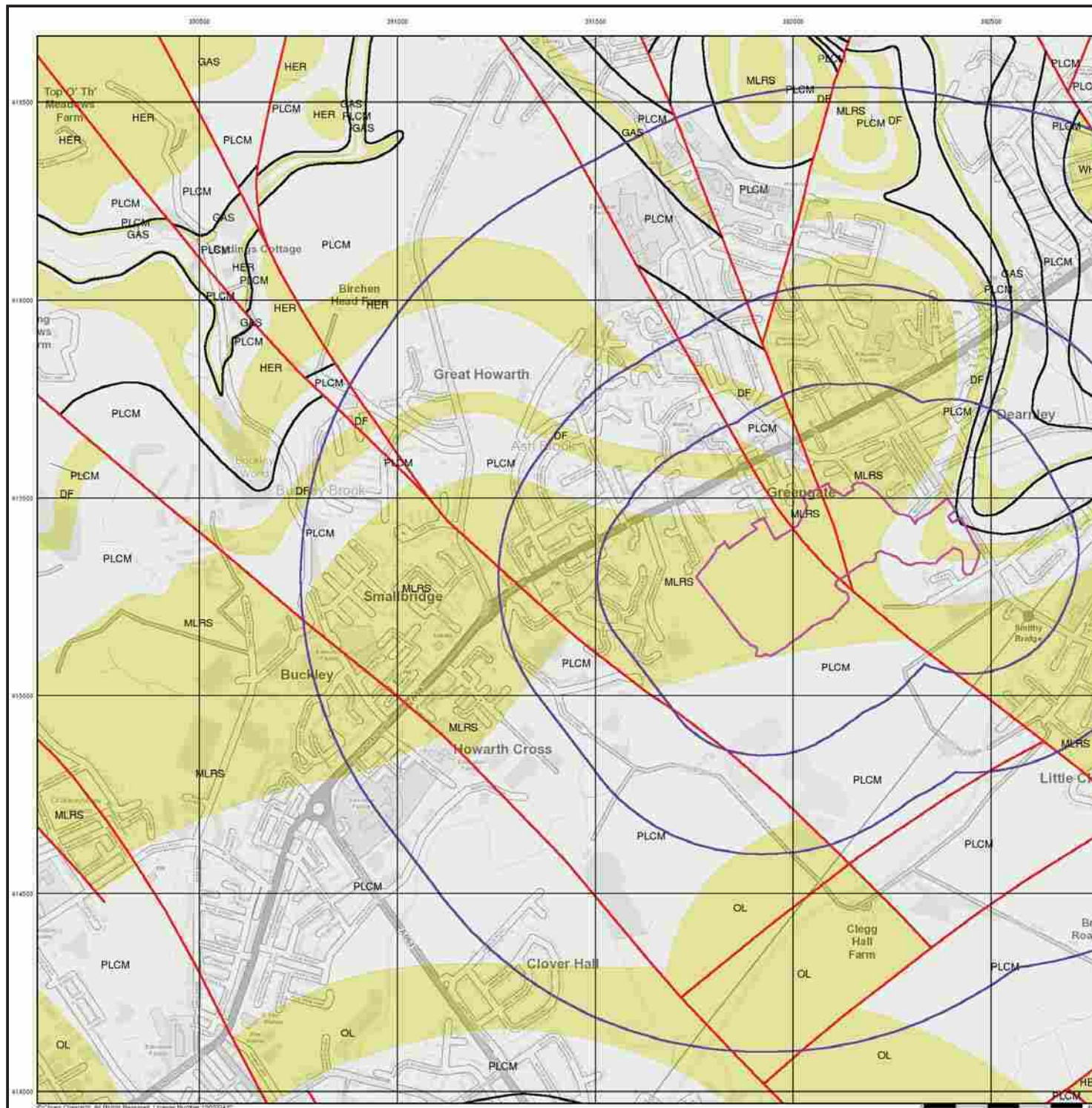


Order Details

Order Number: 133661111_1_1
 Customer Ref: 17TAY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP



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**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS101**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

391943.5 E 415113.6 N

Ground Level (mOD)

131.10

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.35	D1				(0.35)	TOPSOIL: Brown silty SAND with frequent rootlets. Sand is fine to medium.			
0.35-1.70	DB2			130.75	0.35	Very loose orangish brown silty SAND. Sand is fine to medium.			
1.00-1.45	SPT N=0		Water strike(1) at 1.00m. 0,0/0,0,0,0		(1.15)				
1.70-1.89	SPT 25*/90 50/95		20,5/23,27	129.60	1.50	Grey coarse SAND.			
				129.21	(0.39)				
					1.89	Refusal at 1.89mbgl against buff coarse SANDSTONE. Complete at 1.89m			

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS101

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS102**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

131.11

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

392002.2 E 415149.5 N

Dates

19/02/2018

Engineer**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.40	D1				(0.40)	MADE GROUND: Brown very silty SAND with frequent rootlets and rare brick fragments. Sand is fine to medium.		
0.40-1.40	DB2			130.71	0.40	Loose orange and grey mottled clayey silty SAND with occasional organic inclusions. Sand is fine to medium. Sand becomes coarse with depth.		
1.00-1.45	SPT N=8		1,2/1,1,3,3 Water strike(1) at 1.20m.		(1.70)			
2.00-2.44	SPT 50/285		4,6/12,10,10,18	129.01	2.10	Very weak interbedded grey and buff weathered MUDSTONE and SANDSTONE.		
				128.67	2.44	Refusal at 2.44mbgl in competent SANDSTONE. Complete at 2.44m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS102

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS103**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392092.4 E 415210.1 N

Ground Level (mOD)

131.68

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.40	D1				(0.40)	MADE GROUND: Greyish brown clayey SAND with frequent rootlets and rare brick fragments. Sand is fine to medium.			
0.40-1.50	B2			131.28	0.40	Very low strength soft to firm consistency orange and grey mottled very sandy CLAY. Sand is fine to medium			
1.00-1.45 1.00	SPT N=1 SV 12kPa		1,0/0,0,0,1 Water strike(1) at 1.20m.		(1.10)				
1.50-2.50	B3			130.18	1.50	Medium dense to dense grey slightly gravelly clayey SAND with occasional organic inclusions and rare limestone gravel. Sand is fine to coarse. Gravel is fine to coarse, subangular of sandstone. Potentially reworked material.			
2.00-2.45	SPT N=27		4,5/5,6,6,10		(1.91)				
3.00-3.41	SPT 50/255		13,12/12,12,18,8						
				128.27	3.41	Refusal at 3.41mbgl in grey coarse SANDSTONE. Complete at 3.41m			

Remarks

Borehole collapse to 2.30mbgl while installing well.

Scale (approx)

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS103

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS104**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392110.6 E 415249.4 N

Ground Level (mOD)

132.06

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.30	D1				(0.30)	TOPSOIL: Dark brown sandy SILT with frequent rootlets. Sand is fine to medium.			
0.30-1.80	DB2			131.76	0.30	Firm consistency orange and brown mottled very sandy CLAY with thin (<10mm) lenses of PEAT. Soft consistency and higher clay content with depth.			
1.00-1.45	SPT N=0		0,0/0,0,0,0		(1.50)				
2.00-3.00	B3			130.26	1.80				
2.00-2.45	SPT N=24		Water strike(1) at 2.00m. 4,5/6,6,6,6	130.16	(0.10) 1.90	Brown plastic amorphous PEAT.			
						Medium dense grey gravelly SAND. Sand is fine to coarse. Gravel is fine to medium, subrounded of sandstone.		Σ1	
2.70-3.15	SPT N=12		8,7/3,3,3,3		(1.50)				
4.00-4.45	SPT N=8		2,2/2,2,2,2						
4.45-4.90	SPT N=16		3,3/3,4,4,5		(1.95)				
4.90-5.35	SPT N=34		5,6/7,7,10,10						
				128.66	3.40	Loose to dense reddish brown silty SAND. Sand is fine.			

Remarks

On taking the SPT at 4.00mbgl the borehole collapses to 3.00mbgl. SPT is overdriven to 5.35mbgl in an attempt to find bedrock.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS104

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS104**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

132.06

Client

Taylor Wimpey Strategic Land (North)

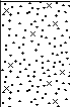
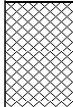
Job
Number
LKC 18 1005**Location**

392110.6 E 415249.4 N

Dates

19/02/2018

Engineer**Sheet**
2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
				126.71	5.35	Complete at 5.35m			

Remarks

On taking the SPT at 4.00mbgl the borehole collapses to 3.00mbgl. SPT is overdriven to 5.35mbgl in an attempt to find bedrock.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS104

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS105

Excavation Method Drive-in Windowless Sampler	Dimensions	Ground Level (mOD) 143.34	Client Taylor Wimpey Strategic Land (North)	Job Number LKC 18 1005
	Location 391990.6 E 415270.4 N	Dates 19/02/2018	Engineer	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1				(0.30)	TOPSOIL: Dark brown sandy SILT with frequent rootlets. Sand is fine to medium.		
0.30-1.30	DB2		Water strike(1) at 0.70m.	143.04	0.30	Firm consistency orange sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium, subangular to subrounded of sandstone. Increasing gravel content with depth.		V1
1.00-1.45	SPT N=9		1,2/2,2,2,3		(2.04)			
2.00-2.34	SPT 50/190		14, 10/16, 20, 14	141.00	2.34	Refusal at 2.34mbgl against competent orange SANDSTONE. Complete at 2.34m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS105

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS106**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

391896.5 E 415228.3 N

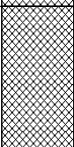
Ground Level (mOD)

144.15

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
1.00-1.45	SPT N=14		4,4/3,3,4,4	143.95	(0.20) 0.20 (0.50) 143.45 0.70	MADE GROUND: Dark brown silty SAND with occasional rootlets and rare brick fragments. Sand is fine to medium. MADE GROUND: Dark brown silty gravelly SAND with rare ash. Sand is fine to medium. Gravel is fine to medium, subangular of sandstone. Medium dense firm consistency brown and orange mottled very clayey gravelly SAND with occasional coal fragments. Sand is fine to coarse. Gravel is fine to coarse, subangular of sandstone. Increasingly sandy with depth.	  	
2.00-2.45	SPT N=16		4,4/4,4,4,4		(3.69)		                     	
3.00-3.45	SPT N=12		Water strike(1) at 3.00m. 4,2/3,3,3,3				                     	
4.00-4.39	SPT 50/240		10,11/12,12,20,6	139.76	4.39	Refusal at 4.39mbgl against brown micaceous iron stained fine to medium SANDSTONE. Complete at 4.39m	                     	

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS106

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS107**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

150.90

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

391906.5 E 415316.8 N

Dates

19/02/2018

Engineer**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
1.00-1.45	SPT N=8		1,2/2,2,2,2	150.60	(0.30)	TOPSOIL: Brown and orange slightly gravelly silty SAND with occasional rootlets. Sand is fine to medium.			
					0.30	Loose to medium dense orangish brown slightly silty SAND with rare rootlets. Sand is fine.			
2.00-2.45	SPT N=21		2,4/6,5,5,5	148.60	(2.00)				
3.00-3.40	SPT 50/245		5,18/20,14,10,6	147.50	2.30	Orangish brown slightly silty gravelly SAND. Sand is fine to coarse. Gravel is fine to medium, subangular to subrounded of sandstone.			
					(1.10)				
					3.40	Refusal at 3.40mbgl against buff micaceous fine to medium SANDSTONE. Complete at 3.40m			
Remarks							Scale (approx)	Logged By	
							1:25	PW	
							Figure No. LKC 18 1005.WS107		

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS108

Excavation Method Drive-in Windowless Sampler	Dimensions	Ground Level (mOD) 149.57	Client Taylor Wimpey Strategic Land (North)	Job Number LKC 18 1005
	Location 391978.3 E 415360.8 N	Dates 20/02/2018	Engineer	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.20	D1				(0.20)	TOPSOIL: Brown clayey silty SAND with frequent rootlets. Sand is fine to medium.		
0.20-1.00	DB2			149.37	0.20	Low strength firm consistency orangish brown sandy gravelly CLAY. Sand is fine to medium. Gravel is fine to medium, subangular of sandstone. Increasing sand content with depth.		
					(0.80)			
1.00-1.45 1.00 1.00-2.00	SPT N=8 SV 35kPa B3		2,1/2,2,2,2	148.57	1.00	Loose to medium dense orangish brown slightly gravelly clayey SAND. Sand is fine to medium. Gravel is fine to coarse, subangular to subrounded of sandstone.		
2.00-2.45	SPT N=26		Water strike(1) at 2.00m. 4,6/8,6,6,6					
					(3.37)			
3.00-3.45	SPT N=23		3,4/5,6,6,6					
4.00-4.37	SPT 50/220		6,10/11,20,19	145.20	4.37	Refusal at 4.37mbgl against weathered dark grey MUDSTONE and micaceous SANDSTONE. Complete at 4.37m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS108

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS109**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392064.1 E 415355.8 N

Ground Level (mOD)

143.40

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.10-0.40	D1			143.30	(0.10)	TOPSOIL: Brown sandy SILT with frequent rootlets. Sand is fine to medium.			
0.40-1.00	B2			143.00	(0.30)	Orange and brown mottled clayey SAND with frequent subrounded cobbles of sandstone.			
1.00-1.45	SPT N=10		1,2/2,2,3,3		0.40	Medium to high strength firm consistency orange and grey mottled sandy CLAY. Sand is fine to medium. Stiff consistency by 2.00mbgl.			
1.00-2.00	SV 45kPa B3								
2.00-2.45	SPT N=14		1,2/3,3,4,4		(2.70)				
2.00	SV 80kPa								
3.00	SV 60kPa		Water strike(1) at 3.00m.						
3.00-3.45	SPT N=17		3,3/4,4,4,5	140.30	3.10	Medium dense orangish brown silty SAND. Sand is fine to medium.			
					(0.50)				
				139.80	3.60	Firm consistency orange and grey mottled sandy CLAY. Sand is fine to medium.			
				139.60	3.80	Brown silty SAND. Sand is fine to coarse.			
4.00-4.40	SPT 50/250		8,10/12,13,13,12		(0.60)				
				139.00	4.40	Refusal at 4.40mbgl against grey coarse SANDSTONE.			
						Complete at 4.40m			

Remarks

Borehole collapse to 4.00mbgl while installing well.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS109

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS110

Excavation Method Drive-in Windowless Sampler	Dimensions	Ground Level (mOD) 139.98	Client Taylor Wimpey Strategic Land (North)	Job Number LKC 18 1005
	Location 392179.1 E 415404.2 N	Dates 20/02/2018	Engineer	Sheet 1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.20	D1				(0.20)	TOPSOIL: Brown silty SAND with frequent rootlets. Sand is fine to medium.		
0.20-1.20	DB2			139.78	0.20	High strength firm consistency orange and grey mottled sandy CLAY. Sand is fine to medium. Increasing clay content with depth.		
1.00-1.45 1.00	SPT N=15 SV 70kPa		2,3/3,4,4,4					
1.50-2.50	B3				(2.70)			
2.00 2.00-2.45	SV 80kPa SPT N=16		Water strike(1) at 2.00m. 2,3/4,4,4,4					V1
3.00-3.45 3.00-4.00	SPT N=26 B4		5,5/5,7,7,7	137.08	2.90	Medium dense to dense orangish brown fine SAND.		
4.00-4.45	SPT N=30		7,7/7,7,8,8		(2.55)			
5.00-5.45	SPT N=31		6,7/7,8,8,8					

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS110

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS110**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

139.98

Client

Taylor Wimpey Strategic Land (North)

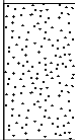
Job Number
LKC 18 1005**Location**

392179.1 E 415404.2 N

Dates

20/02/2018

Engineer**Sheet**
2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				134.53	5.45	Complete at 5.45m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS110

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS111**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392179.1 E 415425.8 N

Ground Level (mOD)

140.38

Dates

20/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job**
Number
LKC 18 1005**Sheet**
1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.30	D1				(0.30)	TOPSOIL: Dark brown silty SAND with occasional rootlets. Sand is fine to medium.			
0.30-1.30	B2			140.08	0.30	Medium dense orangish brown clayey SAND. Sand is fine to medium.			
1.00-1.45	SPT N=27		6,7/8,7,6,6		(1.50)				
1.80-2.80	B3			138.58	1.80	High strength stiff consistency brown gravelly CLAY. Gravel is fine to coarse, subangular of sandstone.			
2.00-2.45 2.00	SPT N=14 SV 100kPa		4,4/3,3,4,4		(1.10)				
3.00-3.45	SPT N=28		Water strike(1) at 2.90m. 4,5/6,7,7,8	137.48	2.90	Medium dense brown slightly silty SAND. Sand is fine to medium.		√1	
4.00-4.45	SPT N=24		5,5/6,6,7		(2.40)				
5.00-5.45	SPT N=26		5,5/6,6,7,7						

Remarks

Borehole collapse to 3.70mbgl while installing well.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS111

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS111**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

140.38

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

392179.1 E 415425.8 N

Dates

20/02/2018

Engineer**Sheet**
2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
				135.08	5.30 (0.15)	Weathered very weak grey shaley MUDSTONE.			
				134.93	5.45	Complete at 5.45m			

Remarks

Borehole collapse to 3.70mbgl while installing well.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS111

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS112**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392327.8 E 415364.6 N

Ground Level (mOD)

134.05

Dates

20/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job**
Number
LKC 18 1005**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.40	D1				(0.40)	MADE GROUND: Dark brown silty SAND with frequent rootlets and rare brick fragments. Sand is fine to medium.			
0.40-1.40	DB2			133.65	0.40	Brown sandy SILT. Sand is fine to medium. Orange with depth.			
1.00-1.45	SPT N=0		1,0/0,0,0,0		(2.10)				
2.00-2.45	SPT N=5		Water strike(1) at 2.00m. 1,1/1,1,2,1	131.55	2.50	Grey slightly silty SAND. Sand is fine to coarse.			
3.00-3.41	SPT 50/260		10,14/10,14,16,10	130.64	3.41	Refusal at 3.41mbgl against light grey micaceous SANDSTONE. Complete at 3.41m			
Remarks							Scale (approx) 1:25	Logged By PW	Figure No. LKC 18 1005.WS112

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS113**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

136.95

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

392353.9 E 415461.9 N

Dates

20/02/2018

Engineer**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.50	D1					MADE GROUND: Black silty gravelly SAND with occasional shale, coal fragments and rare pottery fragments. Sand is fine to medium. Gravel is fine to coarse, subangular.		
0.50-1.00	DB2			136.45	0.50	Stiff consistency orangish brown slightly sandy CLAY. Sand is fine to medium.		
1.00-1.39	SPT 50/235		3,4/10,10,26,4		(0.89)			
				135.56	1.39	Refusal at 1.39mbgl on orange SANDSTONE. Complete at 1.39m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS113

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS114**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392114.4 E 415305.9 N

Ground Level (mOD)

132.54

Client

Taylor Wimpey Strategic Land (North)

Job
Number

LKC 18 1005

Engineer**Sheet**

1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1				(0.30)	MADE GROUND: Dark brown sandy SILT with rare brick fragments and frequent rootlets. Sand is fine to medium.		
0.30-1.30	DB2			132.24	0.30	Medium strength orangish brown sandy clayey SILT. Sand is fine to medium. Increasing clay content with depth.		
1.00-1.45	SPT N=8 SV 60kPa		1,1/1,2,2,3		(1.00)			
1.30-1.90	B3			131.24	1.30	Firm consistency orange and grey slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to coarse, subrounded of sandstone.		
					(0.60)			
2.00-2.45	SPT N=5 SV 30kPa		Water strike(1) at 1.90m. 1,0/1,1,1,2	130.64	1.90	Low strength soft consistency grey very sandy CLAY with occasional coarse sand lenses. Sand is fine to coarse.		
					(2.10)			
3.00-3.45	SPT N=8		1,1/1,1,3,3					
4.00-4.45	SPT N=20		3,3/5,5,5,5	128.54	4.00	Medium dense dark reddish brown fine to medium SAND.		
					(1.45)			
5.00-5.45	SPT N=24		4,4/5,5,7,7					

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS114

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS114**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

132.54

Client

Taylor Wimpey Strategic Land (North)

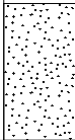
Job
Number
LKC 18 1005**Location**

392114.4 E 415305.9 N

Dates

21/02/2018

Engineer**Sheet**
2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				127.09	5.45	Complete at 5.45m		

Remarks**Scale**
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS114

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS115**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392165.4 E 415341.6 N

Ground Level (mOD)

131.97

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Engineer****Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.80	D1					TOPSOIL: Brown and orange mottled sandy SILT with occasional rootlets. Sand is fine to medium. Potentially reworked topsoil.			
1.00-1.45	SPT N=1		1,0/0,0,0,1	131.17	(0.80)				
1.00-2.00	B2		Water strike(1) at 1.40m.		0.80	Brownish grey silty SAND. Sand is fine to coarse.		V1	
2.00-2.45	SPT N=17		5,6/6,4,4,3	129.97	2.00	Brownish grey silty sandy GRAVEL. Sand is fine to coarse. Gravel is fine to medium, subangular of sandstone.			
				129.77	(0.20)	Brownish grey silty SAND. Sand is fine to coarse.			
3.00-3.45	SPT N=12		3,3/3,3,3,3						
3.45-3.90	SPT N=17		3,4/4,4,4,5		(2.58)				
3.90-4.35	SPT N=22		4,5/5,5,5,7						
4.35-4.78	SPT 50/275		8,10/12,13,15,10	127.19	4.78	Refusal at 4.78mbgl in silty SAND. Complete at 4.78m			

Remarks

On taking the SPT at 3.00mbgl the borehole collapses to 2.00mbgl. SPT is overdriven to 4.78mbgl in an attempt to find bedrock.

Scale
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS115

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS116**Excavation Method**

Window sample undertaken to 5.00mbgl. Continued with DP to 8.95mbgl.

Dimensions**Location**

392186.1 E 415369.9 N

Ground Level (mOD)

132.59

Dates

23/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job Number**
LKC 18 1005**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1				(0.30)	TOPSOIL: Brown silty SAND. Sand is fine to medium.		
0.50-1.50	B2			132.29	0.30	Medium dense firm consistency orange and grey mottled sandy CLAY. Sand is fine to medium. Increasing fine sand content with depth.		
1.00-1.45 1.00	SPT N=8 SV 50kPa		1,2/1,2,2,3		(1.90)			
2.00-2.45 2.00	SPT N=18 SV 50kPa		2,4/4,4,5,5	130.39	2.20	Medium dense brown fine SAND.		
3.00-3.45	SPT N=21		5,5/5,5,5,6		(1.90)			
4.00-4.45	SPT N=18		2,3/3,4,5,6 Water strike(1) at 4.10m.	128.49	4.10	Brown very silty SAND.		▽1
					(0.90)			
				127.59	5.00			

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS116

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS117**Excavation Method**

Window sample undertaken to 5.00mbgl. Continued with DP to 10.00mbgl.

Dimensions**Location**

392213.5 E 415419 N

Ground Level (mOD)

139.97

Dates

23/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job Number**
LKC 18 1005**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1			139.67	(0.30) 0.30	TOPSOIL: Dark brown silty SAND. Sand is fine to medium.		
1.00-1.45 1.00 1.00-1.50	SPT N=12 SV 100kPa B2 2		2,3/3,3,3,3			High strength firm consistency orange and grey mottled sandy CLAY. Sand is fine to medium.		
2.00-2.45 2.00	SPT N=15 SV 120kPa		3,4/4,3,4,4		(4.70)			
3.00-3.45 3.00	SPT N=18 SV 90kPa		3,3/3,5,5,5					
4.00-4.45	SPT N=18		3,4/4,4,5,5	134.97	5.00			

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS117

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS118**Excavation Method**

Window sample undertaken to 5.00mbgl. Continued with DP to 5.38mbgl.

Dimensions**Location**

392194.1 E 415436.2 N

Ground Level (mOD)

141.49

Client

Taylor Wimpey Strategic Land (North)

Job Number
LKC 18 1005**Dates**

23/02/2018

Engineer**Sheet**

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.20	D1				(0.20)	TOPSOIL: Black sandy SILT with frequent rootlets. Sand is fine to medium.		
0.20-1.20	DB2			141.29	0.20	Medium dense firm consistency brown and grey mottled sandy CLAY with rare coal fragments. Sand is fine to medium. Becoming more clayey with depth.		
1.00-1.45	SPT N=13		2,2/3,3,3,4		(2.30)			
1.00	SV 60kPa							
2.00-2.45	SPT N=16		3,4/4,4,4,4		2.50	Medium dense brownish orange fine to medium SAND.		
2.00	SV 65kPa			138.99				
2.00-3.00	B3							
3.00-3.45	SPT N=14		3,4/4,4,3,3		(2.10)			
4.00-4.45	SPT N=27		4,4/6,6,6,9		4.60	Brown and orange mottled gravelly SAND. Sand is fine to coarse. Gravel is fine to medium, subangular. Very iron stained.		
				136.89	(0.40)			
				136.49	5.00			

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS118

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS119**Excavation Method**

Window sample undertaken to 5.45mbgl. Continued with DP to 10.00mbgl.

Dimensions**Location**

392127 E 415343 N

Ground Level (mOD)

141.37

Dates

23/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job**
Number
LKC 18 1005**Sheet**
1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.20	D1				(0.20)	TOPSOIL: Dark brown sandy SILT with frequent rootlets. Sand is fine to medium.			
0.20-1.20	B2			141.17	0.20	Medium dense brown clayey gravelly SAND. Sand is fine to medium. Gravel is fine to coarse, subangular of sandstone.			
1.00-1.45	SPT N=17		4,5/4,4,5,4		(1.70)				
2.00-2.45	SPT N=16		4,5/4,4,4,4	139.47	1.90	Medium dense brown slightly gravelly SAND. Sand is fine to coarse. Gravel is fine to medium, subangular of sandstone. Iron stained.			
3.00-3.45	SPT N=14		4,4/3,3,4,4		(3.10)				
4.00-4.45	SPT N=27		5,5/5,7,7,8						
5.00-5.45	SPT N=12		7,7/3,3,3,3	136.37	5.00				

Remarks**Scale (approx)**
1:25**Logged By**
PW**Figure No.**
LKC 18 1005.WS119

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS119**Excavation Method**

Window sample undertaken to 5.45mbgl. Continued with DP to 10.00mbgl.

Dimensions**Ground Level (mOD)**

141.37

Client

Taylor Wimpey Strategic Land (North)

Job Number
LKC 18 1005**Location**

392127 E 415343 N

Dates

23/02/2018

Engineer**Sheet**
2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS119

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS120**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

391830.1 E 415241.9 N

Ground Level (mOD)

148.65

Client

Taylor Wimpey Strategic Land (North)

Job
Number

LKC 18 1005

Engineer**Sheet**

1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.30	D1				(0.30)	TOPSOIL: Brown silty SAND with frequent rootlets. Sand is fine to medium.			
0.30-1.30	B2			148.35	0.30	Medium dense firm consistency brown and grey mottled slightly gravelly sandy CLAY. Sand is fine to medium. Gravel is fine to coarse, subangular of sandstone.			
1.00-1.45 1.00	SPT N=16 SV 50kPa		3,4/4,4,4,4		(1.90)				
2.00-2.45 2.00	SPT N=29 SV 60kPa		5,5/6,6,7,10	146.45	2.20	Buff weathered fine to medium SANDSTONE recovered as gravel.			
2.60-2.78	SPT 25*/70 50/110		25/30,20	145.87	2.78	Refusal at 2.78mbgl against competent buff coarse SANDSTONE. Complete at 2.78m			

Remarks**Scale**
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS120

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS121**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

155.40

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

391864.3 E 415368.6 N

Dates

26/02/2018

Engineer**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1				(0.30)	MADE GROUND: Dark brown sandy SILT with frequent rootlets and rare brick fragments. Sand is fine to medium.		
0.30-1.30	DB2			155.10	0.30	Medium dense brownish orange silty SAND. Sand is fine to medium.		
1.00-1.45	SPT N=12		3,3/3,3,3,3		(2.30)			
2.00-2.45	SPT N=14		Water strike(1) at 2.00m. 2,3/3,3,3,5					
				152.80	2.60	Firm consistency grey slightly gravelly very sandy CLAY. Sand is fine to medium. Gravel is fine to medium, subangular of sandstone and mudstone.		
3.00-3.45	SPT N=30		5,6/7,7,7,9		(1.10)			
3.70-4.07	SPT 50/220		8,9/15,15,20	151.70	3.70	Grey weathered MUDSTONE.		
					(0.37)			
				151.33	4.07	Refusal at 4.07mbgl against weathered MUDSTONE. Complete at 4.07m		

Remarks**Scale (approx)**

1:25

Logged By

PW

Figure No.

LKC 18 1005.WS121

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS122**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

391958 E 415196 N

Ground Level (mOD)

135.20

Dates

26/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job**
Number
LKC 18 1005**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00-0.30	D1			134.90	(0.30) 0.30	TOPSOIL: Dark brown silty SAND. Sand is fine to medium.		
1.00-1.45 1.00 1.00-2.00	SPT N=18 SV 40kPa B2		3,3/4,4,5,5		(2.84)	Medium strength firm consistency brown and grey mottled sandy gravelly CLAY. Sand is fine to coarse. Gravel is fine to medium, subangular sandstone and mudstone.		
2.00-2.45 2.00	SPT N=14 SV 50kPa		2,2/3,3,4,4					
2.70-3.14	SPT 50/290		7,8/11,12,14,13	132.06	3.14	Refusal at 3.14mbgl in sandy gravelly CLAY. Complete at 3.14m		

Remarks**Scale**
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS122

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS123**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Ground Level (mOD)**

145.28

Client

Taylor Wimpey Strategic Land (North)

Job
Number
LKC 18 1005**Location**

392078.4 E 415446.9 N

Dates

26/02/2018

Engineer**Sheet**
1/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.30	D1			144.98	(0.30) 0.30	TOPSOIL: Brown silty SAND with frequent rootlets. Sand is fine to medium.			
1.00-1.45 1.00-2.00	SPT N=12 B2		3,2/3,3,3,3			Loose to medium dense brown very silty SAND. Sand is fine to medium. Becoming sandier with depth.			
2.00-3.00 2.00-2.45	B3 SPT N=8		Water strike(1) at 2.00m. 3,3/2,2,2,2						
3.00-3.45	SPT N=10		3,2/2,2,3,3		(5.15)				
4.00-4.45	SPT N=12		2,2/3,3,3,3						
5.00-5.45	SPT N=18		3,4/4,4,5,5						

Remarks**Scale (approx)**
1:25**Logged By**
PW**Figure No.**
LKC 18 1005.WS123

Excavation Method Drive-in Windowless Sampler	Dimensions	Ground Level (mOD) 145.28	Client Taylor Wimpey Strategic Land (North)	Job Number LKC 18 1005
	Location 392078.4 E 415446.9 N	Dates 26/02/2018	Engineer	Sheet 2/2

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
				139.83	5.45	Complete at 5.45m			

Remarks	Scale (approx)	Logged By
	1:25	PW
	Figure No. LKC 18 1005.WS123	

**LK CONSULT LTD**Eton Business Park, Eton Hill Road, Radcliffe, M26 2ZS
Tel: 0161 763 7200 web: www.thelkgroup.com**Site**

Smithybridge, Littleborough

Number
WS124**Excavation Method**

Drive-in Windowless Sampler

Dimensions**Location**

392148 E 415489.7 N

Ground Level (mOD)

147.09

Dates

26/02/2018

Client

Taylor Wimpey Strategic Land (North)

Engineer**Job**
Number
LKC 18 1005**Sheet**
1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00-0.40	D1				(0.40)	MADE GROUND: Dark brown silty SAND with frequent rootlets and rare brick fragments. Sand is fine to medium.			
0.40-1.40	B2			146.69	0.40	Soft consistency brownish orange sandy silty CLAY. Sand is fine to medium. Increasing sand and silt content with depth.			
1.00-1.45	SPT N=11		2,2/3,3,3,3		(1.00)				
1.40-2.00	B3			145.69	1.40	Brownish orange fine to medium SAND with occasional coal fragments.			
					(0.60)				
2.00-2.45	SPT N=15		2,3/3,3,4,5	145.09	2.00	Brownish orange sandy SILT. Sand is fine to medium.			
					(0.20)				
				144.89	2.20	Very dense brown sandy GRAVEL with occasional coal fragments. Sand is fine to medium. Gravel is fine to coarse, subangular of sandstone.			
					(1.24)				
3.00-3.44	SPT 50/290		4,7/10,12,13,15						
				143.65	3.44	Refusal at 3.44mbgl in gravel. Complete at 3.44m			

Remarks**Scale**
(approx)

1:25

Logged
By

PW

Figure No.

LKC 18 1005.WS124



Photograph 1
(facing W):
View of lower site area towards development area from Smithy Bridge Road.



Photograph 2
(facing NW):
View across CSO detention tanks and outfall to River Roch.



Photograph 3
(facing W):
View along route of main site access.



Photograph 4
(facing SW):
View of the existing pond in the lower area of the site.



Photograph 5
(facing W):
View of ground sloping down from the development area towards the river.



Photograph 6
(facing NE):
View from NE towards the SW.

		Photograph 7 (facing W): View across the development area from the NE.
		Photograph 8 (facing W): Surface water within pasture area within the central part of the site. Water emergence from blocked land drainage.
		Photograph 9 (facing NW): Land Drainage emerging from the existing Allotment Area to the north.



**Photograph 10
(facing S):**

Location of the final manhole on the combined drain passing through the site, adjacent to the river.



**Photograph 11
(facing N):**

Land drain emergence at the base of the slope.



**Photograph 12
(facing NE):**

Ground sloping down from development area towards the watercourse.



**Photograph 13
(facing NE):**
Ground sloping down from development area towards the watercourse. Showing partially retained section of the watercourse.



**Photograph 14
(facing NE):**
Steeper section of slope with combined drain manhole in the foreground.



**Photograph 15
(facing N):**
Dip in the ground between the upper development area and the lower slope.



**Photograph 16
(facing SW):**
Section of the river retained with stone faced walls.



**Photograph 17
(facing NE):**
Section of the river retained by sheet pile wall. Possibly to protect the combined sewer.



**Photograph 18
(facing E):**
Change in direction of the watercourse due to retained section.

APPENDIX C

THE ENVIRONMENT AGENCY DATA

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From: Cooke, Claire <Claire.Cooke@environment-agency.gov.uk> on behalf of GMMC Info Requests <Inforequests.gmmc@environment-agency.gov.uk>
Sent: 19 April 2018 11:28
To: Matthew Craig
Subject: GMMC82164CC - Response from the Environment Agency
Attachments: GMMC82164CC - DFM.pdf; GMMC82164CC Product 4 Table.pdf; CCA - Area External Guidance v5.pdf

Dear Matthew,

Thank you for your enquiry which was received on 06.04.18

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

Please find attached completed product 4 along with some guidance:

- **The modelled 1% and 0.1% annual probability fluvial flood level, the 1% annual probability plus climate change flood level and any lower order flood levels, in particular the modelled 5% fluvial flood level if relevant for functional floodplain, (with confirmation of the reference datum used for the levels – i.e. Local OSBM or OSGPS) if available;** Please see attached product 4 table.
- **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;** There are no flood defences in the vicinity of the site.
- **Proposed defence levels and timescale for implementation;** Please refer to the pre application guidance response we sent to you under reference SO/2018/118035/01-L01 in February 2018
- **Results of any breach analyses for defences in the area which may be relevant;** Please refer to the pre application guidance response we sent to you under reference SO/2018/118035/01-L01 in February 2018
- **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;** 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 Rochdale Council who may hold additional information (the former especially in relation to sewer flooding).
- **Any restrictions to infiltration and discharge to the watercourse;** Please refer to the pre application guidance response we sent to you under reference SO/2018/118035/01-L01 in February 2018
- **A copy of your detailed flood zone map and the modelled flood extent plans for the area;** please see attached detailed flood map.
- **Please find additional information at the below links;**
- <https://www.gov.uk/guidance/flood-risk-assessment-local-planning-authorities>
- <https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances>

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,

Claire Cooke
Customer and Engagement Officer
Greater Manchester, Merseyside and Cheshire
External: 0203 025 0048
Email: inforequests.gmmc@environment-agency.gov.uk

From: Matthew Craig [<mailto:m.craig@thelkgroup.com>]
Sent: 06 April 2018 12:01
To: Enquiries, Unit <enquiries@environment-agency.gov.uk>
Subject: Ref 180413/JC17 FRA query - Smithy Bridge Road, Littleborough

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of land at Smithy Bridge Road, Littleborough. OL15 8RF.

Centred at approximate National Grid Reference 392216E, 415425N. The area of interest appears to be partially within Flood Zone 3.

The site plans are 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:

- The modelled 1% and 0.1% annual probability fluvial flood level, the 1% annual probability plus climate change flood level and any lower order flood levels, in particular the modelled 5% fluvial flood level if relevant for functional floodplain, (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 get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

We will also contact Rochdale Council and United Utilities for their information and requirements.

Any advice or recommendations you may have regarding the potential discharges from the development of this site?

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

Regards

Matthew Craig

<image001.jpg>

Matthew Craig
Environmental Scientist
LK Consult | 0161 763 7200 |
Manchester | Liverpool | Glasgow | www.thelkgroup.com

<image002.jpg>

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

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<smithy bridge.png>

<GMMC82164CC - DFM.pdf>

<GMMC82164CC Product 4 Table.pdf>

<CCA - Area External Guidance v5.pdf>

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LK Consult
Eton Business Park
Unit 29
Eton Hill Road
Radcliffe
Manchester
M26 2ZS

Our ref: SO/2018/118035/01-L01
Your ref: Mark Jones
Date: 13 March 2018

Dear Sir/Madam

**PRELIMINARY ADVICE ON POTENTIAL RESTRICTIONS TO THE PROPOSED
DEVELOPMENT SITE OFF SMITHY BRIDGE ROAD, LITTLEBOROUGH,
ROCHDALE**

Thank you for referring the above preliminary enquiry (15th February 2018) regarding the above site to the Environment Agency. We would wish to make the following comments.

Environment Agency position

The details submitted (drawing number 590A 08 D) show 7.3 ha of undeveloped and open greenspace area that will be retained along the River Roch corridor as environmental improvements to the River Roch. This would create a key green infrastructure network and also provide flood storage.

We are currently investigating options associated with reducing flood risk in the Rochdale/Littleborough area. One of the options is to store water within the River Roch corridor as part of the overall scheme to reduce risk downstream. The section of the river adjoining the site shown on the submitted plans (WUE/CP/02) has been identified as a key location to store flood water. Current proposals include construction of a control structure within this reach of the river and this would increase flood levels slightly. Rochdale Council are aware of these proposals and are part of the partnership to implement the scheme. We have advised the council that flood plain storage areas within the corridor need to be protected and that if development were allowed to encroach to the edge of the current flood zone areas, the option of increasing flood storage in this reach and reducing flows downstream would be more difficult.

We note the site boundary extends to the river and includes the existing flood plain areas shown by flood zones 2 & 3. The indicative scheme you have shown does avoid these areas and appears to be a sufficient distance from the river to ensure the flood alleviation proposals would not be affected. However, the proposed access to the south of South View Road could be in close proximity to the flood extent and is likely to require more detailed consideration.

The Lead Local Flood Authority will advise on surface water drainage arrangements but we would expect these to be based on sustainable drainage options. Discharge rates should be no more than greenfield run-off and volumetric parity should be sought to ensure increased volumes are not being discharged.

The River Roch is currently failing its ecological objectives under the EU Water Framework Directive (to achieve good ecological status by 2027). WFD waterbody (Ref: River Roch Source to Spodden GB112069064720. The North West River Basin Management Plan (NW RBMP) provides the statutory framework for implementation of the WFD. <https://www.gov.uk/government/publications/north-west-river-basin-district-river-basin-management-plan>). The NW RBMP identifies that the restoration and enhancement of water bodies is needed to prevent further deterioration.

We would recommend that future scheme development looks positively to integrate and where feasible enhance the ecological potential of waterbody and main environmental receptor by:- undertaking an ecological assessment prior to development of detailed plans, carrying these out at appropriate time of year by suitably experienced surveyor, and enabling detailed designs to incorporate recommendations outlined in survey. Sustainable Urban Drainage techniques will have multiple environmental benefits (https://www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx)

The following links refers to other sustainable design techniques that have been achieved elsewhere in UK, such as Kingsbrook (<http://www.kingsbrook-aylesbury.co.uk/proposals>) and Buckshaw Village (<https://www.harrowestates.co.uk/projects/buckshaw-village-chorley/>).

This development may require a permit under the Environmental Permitting (England and Wales) Regulations 2016 from the Environment Agency for any proposed works or structures, in, under, over or within 8m of the bank of the River Roch which, is designated a 'main river'. Some activities are also now [excluded](#) or [exempt](#). A permit is separate to and in addition to any planning permission granted. Further details and guidance are available on the GOV.UK website: <https://www.gov.uk/guidance/flood-risk-activities-environmental-permits>.

We have a voluntary charged for service where we can provide more detailed pre-application advice. As part of this service we can provide a dedicated project manager to act as a single point of contact to coordinate any problems, data requests or review technical documents. Should you wish us to undertake a detailed review of your FRA (or any subsequent revision to take on board our comments above) we can do this as part of our charged service.

Please note that this response is based on the information you have provided at this time and if this changes in the future we would need to consider our position again.

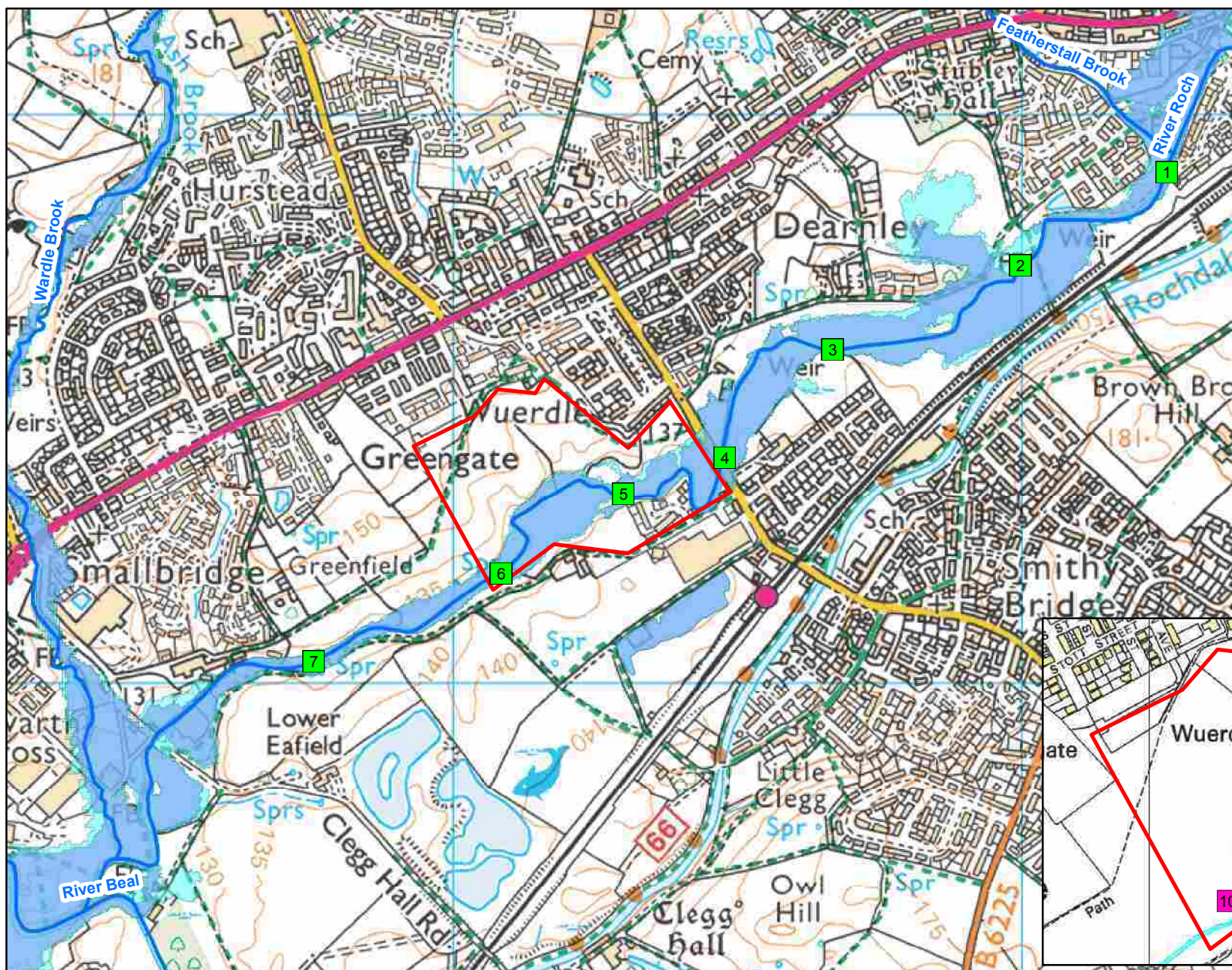
Yours faithfully

Mrs SYLVIA WHITTINGHAM
Planning Advisor

Direct dial 0203 0251059

Direct e-mail sylvia.whittingham@environment-agency.gov.uk

Detailed Flood Map centred on Smithy Bridge Road, Littleborough, OL15 8RF. Created on 17/04/2018 [GMMC82164CC]

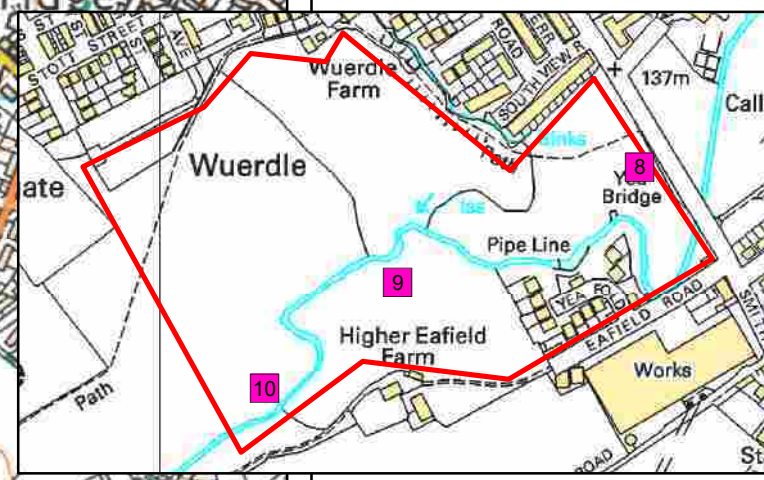


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Legend

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



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Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Sag Reference	Model Water Information	Existing	Proposed	Data	Undershot					Overshot				
					1.10 to AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change	1 % AEP (1 in 100 year) + 20% increase in flow	1 % AEP (1 in 100 year) + 70% increase in flow	0.5 % AEP (1 in 200 year)	0.1 % AEP (1 in 1000 year)	1.10 to AEP (1 in 75 year)	1 % AEP (1 in 100 year)	1 % AEP (1 in 100 year) + Climate Change
1	wd01_model_RCC405_8800	300008	410008	Modelled Water Level (m awhl)	139.51	139.26	139.51	139.57	139.80	139.47	139.47	139.27	139.39	139.45
				Modelled Flow (cumecs)	17.59	17.72	19.47	24.83	40.89	18.19	18.19	17.63	18.09	20.89
2	wd01_model_RCC405_8305	300001	410734	Modelled Water Level (m awhl)	140.76	139.86	139.81	137.61	137.14	139.86	139.81	139.41	139.56	137.19
				Modelled Flow (cumecs)	10.84	17.14	18.53	19.93	31.92	19.08	20.17	18.17	19.36	20.79
3	wd01_model_RCC405_7980	300010	410008	Modelled Water Level (m awhl)	139.89	139.86	139.89	139.89	139.17	139.86	139.89	139.89	139.89	139.89
				Modelled Flow (cumecs)	20.79	21.43	24.04	26.79	31.13	23.14	27.30	20.59	20.48	26.79
4	wd01_model_RCC405_7105	300401	410006	Modelled Water Level (m awhl)	140.09	140.09	140.18	140.18	140.18	140.18	140.18	140.18	140.18	140.18
				Modelled Flow (cumecs)	22.76	22.44	26.23	29.11	33.99	25.26	29.29	22.76	22.97	26.45
5	wd01_model_RCC405_7105	300002	410002	Modelled Water Level (m awhl)	133.61	133.64	133.73	133.79	133.87	133.79	133.81	133.59	133.61	133.69
				Modelled Flow (cumecs)	31.26	30.91	37.79	43.61	52.16	39.92	45.43	32.26	30.11	45.43
6	wd01_model_RCC405_6820	300007	410102	Modelled Water Level (m awhl)	133.09	133.10	133.10	133.10	133.10	133.10	133.10	133.10	133.10	133.10
				Modelled Flow (cumecs)	20.14	20.14	40.29	45.09	53.09	39.44	47.11	20.14	20.14	40.29
7	wd01_model_RCC405_5105	300707	410007	Modelled Water Level (m awhl)	133.08	133.00	133.13	133.10	133.10	133.10	133.10	133.05	133.05	133.05
				Modelled Flow (cumecs)	37.44	39.31	45.11	51.49	60.47	40.74	46.45	39.45	40.39	54.84
8	20 Levels	300006	410017	Modelled Water Level (m awhl)	133.01	133.01	133.01	133.01	133.01	133.01	133.01	133.01	133.01	133.01
9		300014	410016	Modelled Water Level (m awhl)	133.16	133.16	133.16	133.16	133.16	133.16	133.16	133.16	133.16	133.16
10		300003	410007	Modelled Water Level (m awhl)	133.18	133.18	133.18	133.18	133.18	133.18	133.18	133.18	133.18	133.18

Model data taken from Rochdale and Ullenhough 2012 Study
AEP - Annual Exceedance Probability
m awhl - metres above or below datum (Height)
cumecs - cubic metres per second

Notes:
*Climate Change Scenarios - 20% and 70% increases in flow calculated for the 2080's (2070 - 2110). Please see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/281111/2080s-climate-change-scenarios.pdf for more information regarding the new climate change guidance. The location of the site and the type (vulnerability) of development determine the climate change allowances to consider in any flood risk assessment. Note that these levels have not yet been subject to detailed review and therefore should be treated as draft.

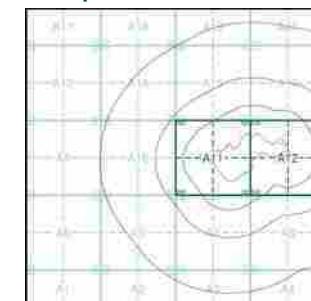
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A

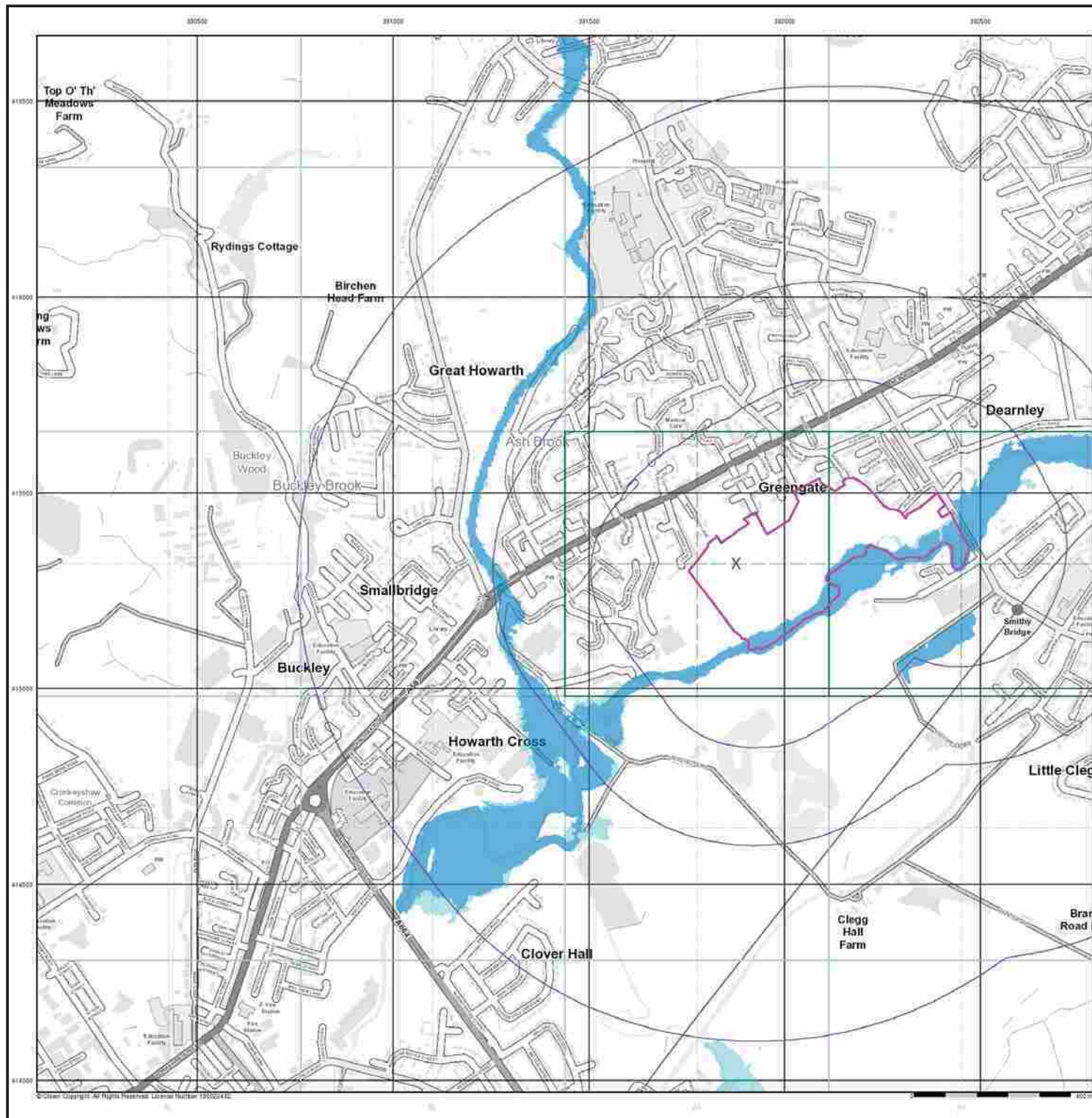


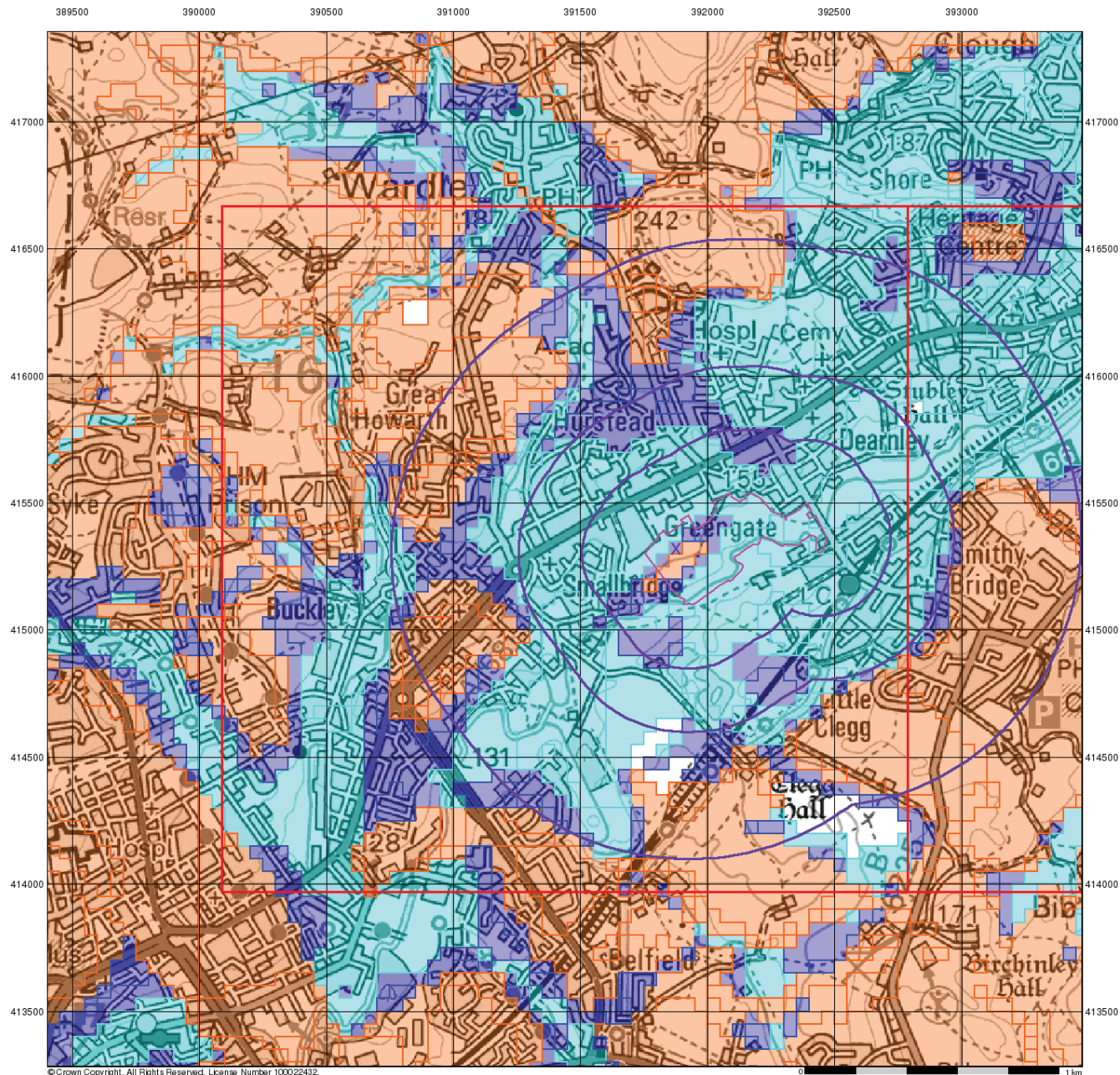
Order Details

Order Number: 133661111_1_1
 Customer Ref: 17TAY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP





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BGS Flood GFS Data

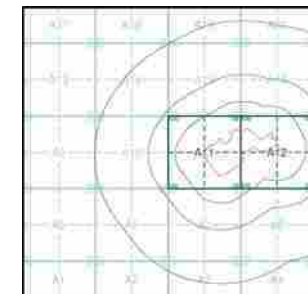
General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point
- Slice

Agency and Hydrological (Flood)

- Limited Potential for Groundwater Flooding to Occur
- Potential for Groundwater Flooding of Property Situated Below Ground Level
- Potential for Groundwater Flooding to Occur at Surface

Site Sensitivity Context Map - Slice A



Order Details

Order Number: 133661111_1_1
 Customer Ref: 177AY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP

Landmark
 INFORMATION GROUP

Tel: 0844 844 9952
 Fax: 0844 844 9951
 Web: www.envirocheck.co.uk

General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

Risk of Flooding from Surface Water

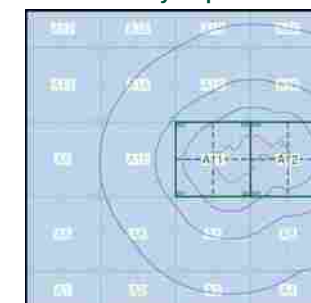
- High - 30 Year Return
- Medium - 100 Year Return
- Low - 1000 Year Return

Suitability

See the suitability map below

- National to county
- County to town
- Town to street
- Street to parcels of land
- Property

EA/NRW Suitability Map - Slice A

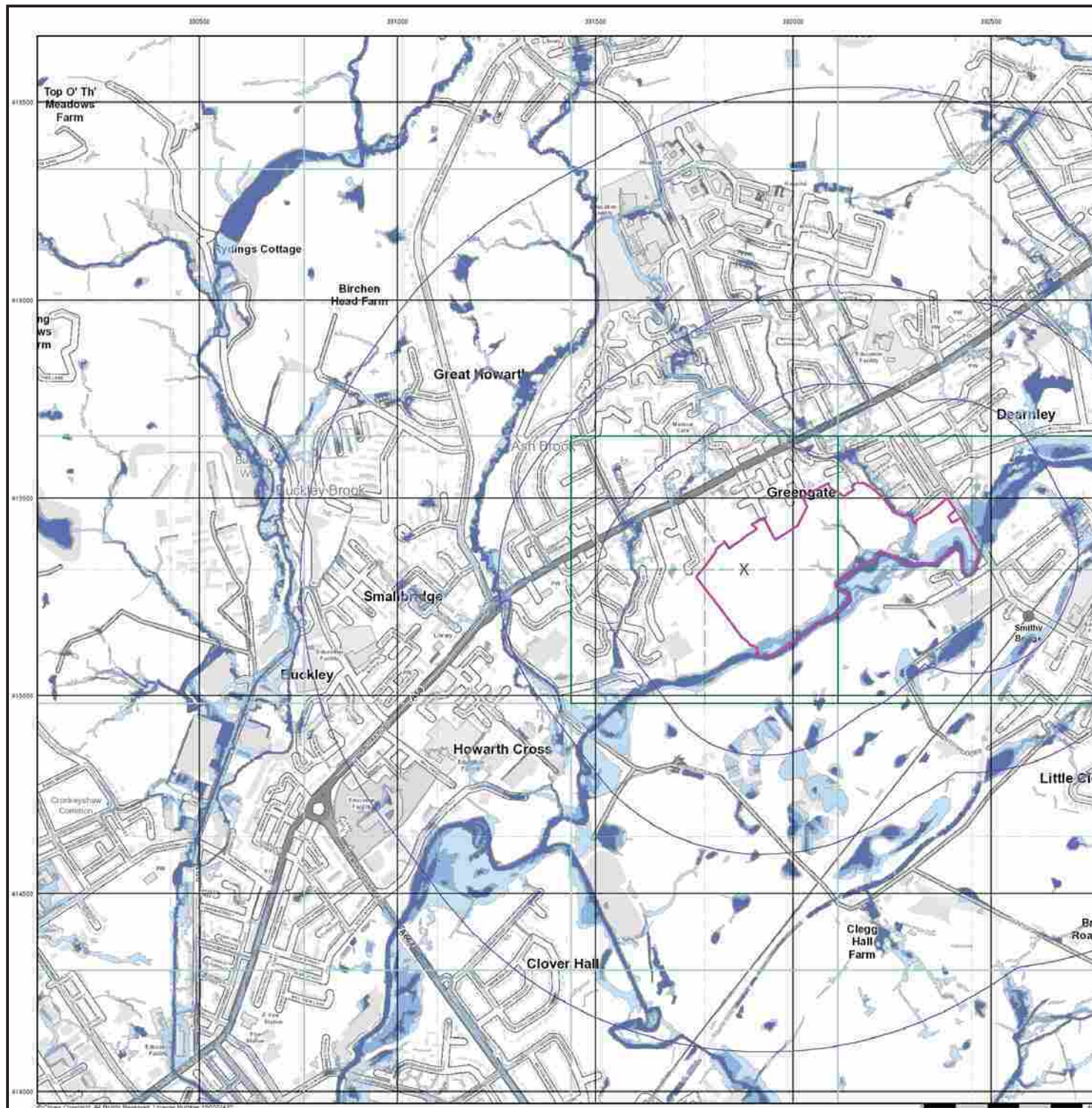


Order Details

Order Number: 133661111_1_1
 Customer Ref: 17TAY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP



General

- Specified Site
- Specified Buffer(s)
- Bearing Reference Point

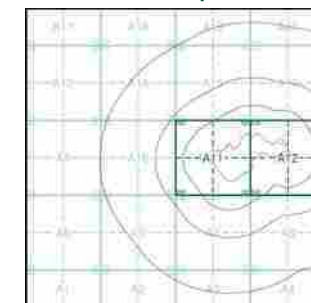
OS Water Network Data

- | | |
|--------------|-------------------------|
| Canal | Drain |
| Reservoir | Other |
| Foreshore | Lake |
| Marsh | Transfer |
| Tidal River | Lock Or Flight Of Locks |
| Inland River | Sea |

Contours (height in meters)

- Standard Contour 105 100 95
- Master Contour 105 100 95
- Spot Height 167.3
- MLW Mean Low Water
- MHW Mean High Water

OS Water Network Map - Slice A



Order Details

Order Number: 133661111_1_1
 Customer Ref: 17TAY040
 National Grid Reference: 391880, 415320
 Slice: A
 Site Area (Ha): 14.11
 Search Buffer (m): 1000

Site Details

8, South View Road, ROCHDALE, OL16 2SP

APPENDIX D

CONSULTEE CORRESPONDENCE

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Matthew Craig

From: Stephen McCann <Stephen.McCann@Rochdale.Gov.UK>
Sent: 26 March 2018 16:07
To: Matthew Craig
Cc: Rachael Dodson-Greaves
Subject: RE: FRA query - Smithy Bridge Road, Littleborough
Attachments: FRA for a large site near to Smithy Bridge Rd.pdf

Dear Mr Craig,

Guidance by Rochdale Borough Council is located on the following link:-

<http://www.rochdale.gov.uk/pdf/2016-01-25-GM-SuDs-Advice.pdf>

It is actually slightly out of date; Government Guidance and EA is now for 40% climate change allowance (not 30%).

As Lead Flood Local Flood Authority, Rochdale council works in partnership with United Utilities. The Applicant may wish to refer to the guidance on the United Utilities webpage:-

<https://www.unitedutilities.com/services/builders-developers/pre-development/site-drainage/>

Because the Smithy Bridge Site is close to another large site, you could download the Flood Risk Assessment done by Others for that site; the attached document points you to the place to download it. Although 2015, it is still relevant. The FRA Engineer obtained River Flood Levels from the EA and included them in their Appendix (also freely downloadable).

Your Queries:

Any existing sewer connections from buildings

- Levels of sewers

These are only obtainable from United Utilities

- 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.

These are obtained from the Environment Agency

- 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.

RBC does not appear to keep any register of historic flood events; the EA is a better source of this information. RBC also do not have any formal records of highway drainage. RBC owned culverts are shown on UU plans (but ownership may not necessarily be marked on these plans)

Kind regards,

Stephen McCann

Drainage & Flooding Engineer
Highways, Property & Strategic Housing



☎ 01706 924606

✉ stephen.mccann@rochdale.gov.uk

Rochdale Borough Council

Floor 2, Number One Riverside
Smith Street, Rochdale, OL16 1XU

From: Rachael Dodson-Greaves **On Behalf Of** Development Management
Sent: 19 March 2018 13:55
To: Francis Comyn
Subject: FW: FRA query - Smithy Bridge Road, Littleborough

Hi,

Would you know who would be best to deal with this please

Regards
Rachael

Rachael Dodson-Greaves
Support Assistant
Planning & Development



☎ 01706 924131
✉ rachael.dodson-greaves@rochdale.gov.uk

Rochdale Borough Council
Floor 3, Number One Riverside
Smith Street, Rochdale, OL16 1XU

From: Matthew Craig [<mailto:m.craig@thelkgroup.com>]
Sent: 19 March 2018 12:41
To: Development Management
Subject: FRA query - Smithy Bridge Road, Littleborough

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of land at Smithy Bridge Road, Littleborough. OL15 8RF.

Centred at approximate National Grid Reference 392216E, 415425N. The area of interest appears to be partially within Flood Zone 3.

The site 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

- Any existing sewer connections from buildings
- Levels of sewers
- 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.
- 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.

If you have any queries please get in touch with me.

Matthew Craig

From: O'Brien, Neil <Neil.O'Brien@uuplc.co.uk>
Sent: 04 April 2018 10:03
To: Matthew Craig; Wastewater Developer Services
Subject: RE: FRA query - Smithy Bridge Road, Littleborough - 4200020242

Dear Customer

We have carried out an assessment of your application which is based on the information provided and have the following comments

United Utilities have no records of hydraulic sewer flooding in the area

To purchase a copy of the sewer records please contact property.searches@uuplc.co.uk

If you require any further guidance please follow <http://www.unitedutilities.com/builders-developers.aspx>

If you need a make further enquiry relating to this matter please send your enquiry to WastewaterDeveloperServices@uuplc.co.uk Please quote your DEXXXX/42XXXXXXX/GEXXXX reference number

Please Note:- enquiries sent to any other United Utilities e-mail address will be deleted.

Connection Application

Although we may discuss and agree discharge points & rates in principle, please be aware that you will have to apply for a formal sewer connection. This is so that we can assess the method of construction, Health & Safety requirements and to ultimately inspect the connection when it is made. Details of the application process and the form itself can be obtained from our website by following the link below

<http://www.unitedutilities.com/connecting-public-sewer.aspx>

Please be aware that on site drainage must be designed in accordance with Building Regulations, National Planning Policy, Planning Conditions and local flood authority guidelines, we would recommend that you liaise and make suitable agreements with the relevant statutory bodies.

Regards

Neil O'Brien

Developer Engineer
Developer Services and Planning

From: Matthew Craig [mailto:m.craig@thelkgroup.com]
Sent: 19 March 2018 14:03
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: FRA query - Smithy Bridge Road, Littleborough

Dear Sir/Madam

LK Consult Ltd. has been commissioned to undertake a Flood Risk Assessment (FRA), of land at Smithy Bridge Road, Littleborough. OL15 8RF.

Centred at approximate National Grid Reference 392216E, 415425N. The area of interest appears to be partially within Flood Zone 3.

The site 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

- Any existing sewer connections from buildings
- Levels of sewers
- 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.
- 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.

If you have any queries please get in touch with me.

We are, of course, happy to pay your reasonable charge for this service. Please let me know by return what information is available and what the charge will be and we will pay the relevant fees by debit card as soon as possible.

We will also contact the EA and Rochdale Council as well for their information and requirements.

Any advice or recommendations you may have regarding the potential discharges from the development of this site?

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

Regards

Matthew Craig



Matthew Craig
Environmental Scientist
LK Consult | 0161 763 7200 |
Manchester | 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: O'Brien, Neil <Neil.O'Brien@uuplc.co.uk>
Sent: 23 April 2018 15:15
To: Mark Jones; Wastewater Developer Services
Subject: REPEAT 1 : Smithy Bridge Road, Littleborough - 4200020242 - GE0824

Dear Customer

Thank you for your email of 9/4/18 in relation to my initial Pre Development Enquiry response.

Foul will be allowed to drain to the public combined sewer network at an unrestricted rate. The connection(s) to the public sewer can be at a point(s) convenient to yourself

If you require any further guidance please follow <http://www.unitedutilities.com/builders-developers.aspx>

If you need a make further enquiry relating to this matter please send your enquiry to WastewaterDeveloperServices@uuplc.co.uk Please quote your reference number

Please Note:- enquiries sent to any other United Utilities e-mail address will be deleted

Please note, should you intend to enter into an adoption agreement with UU and although your proposal may comply with the principal strategy set out in the advice above, we do reserve the right to request changes to any future design proposals put forward for adoption, as we need to be sure that the proposals meet the requirements of Sewers for Adoption and UU Asset Standards. Any design proposals should take in to consideration long term operability whilst also offering cost effectiveness for the life of the assets. Where a developer would like to progress a Section 104 Agreement, it must be emphasised that any works commenced on site on the basis of the Pre-Development Enquiry Advice without an approved S104 technical assessment will be at the Designers/ Developers own risk and may be subject to change. Please be aware that on site drainage must be designed in accordance with Building Regulations, National Planning Policy, Planning Conditions and local flood authority guidelines, we would recommend that you laise and make suitable agreements with the relevant statutory bodies.

Regards,

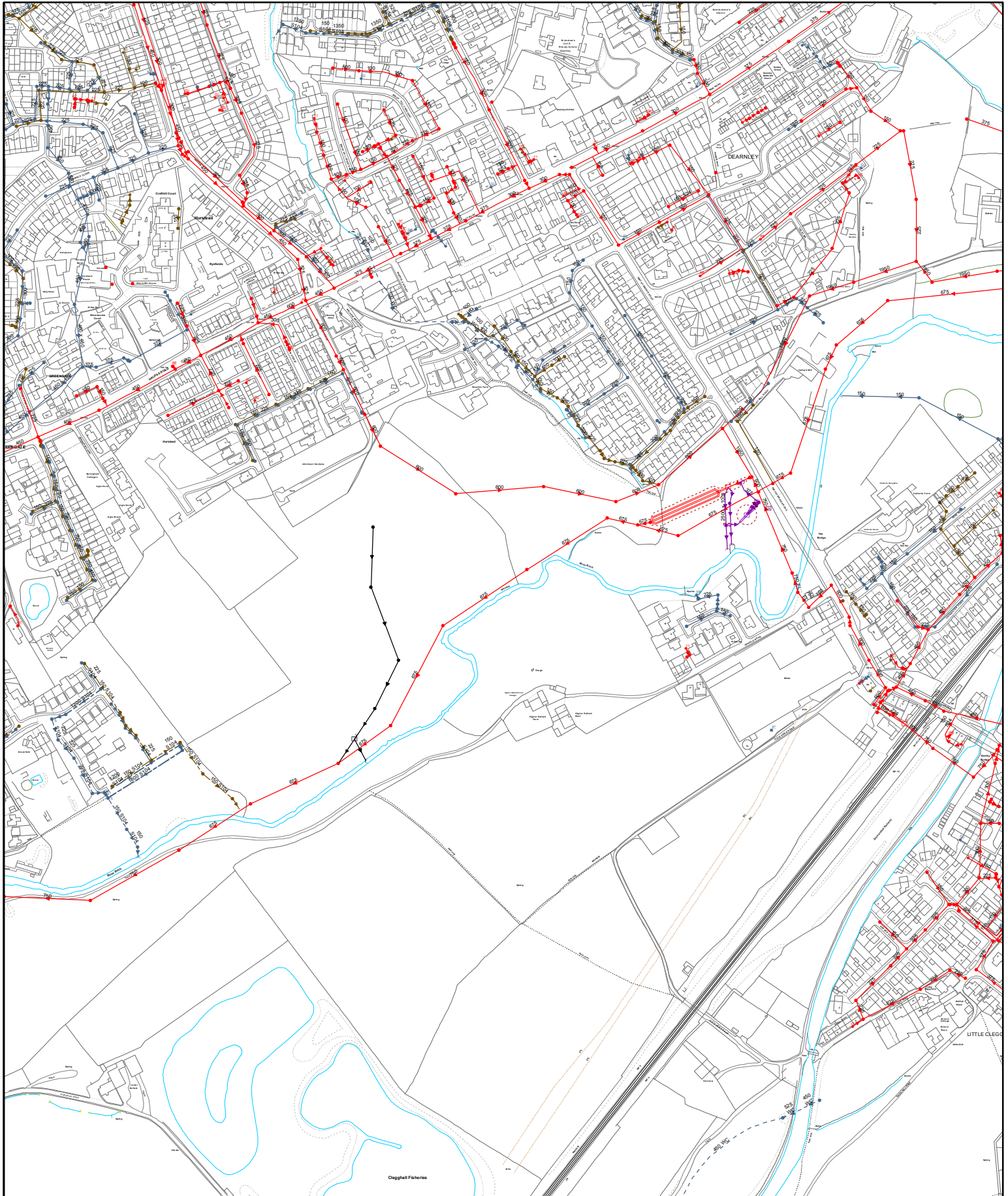
Developer Services

From: Mark Jones [mailto:M.Jones@thelkgroup.com]
Sent: 09 April 2018 16:10
To: Wastewater Developer Services <WastewaterDeveloperServices@uuplc.co.uk>
Subject: Smithy Bridge Road, Littleborough - 4200020242

Neil

Please can you consider a suitable connection points for the foul drainage from the proposed development adjacent to Smithy Bridge Road in principle. There may need to be two connections one to the east and one to the west due to ground undulations and potential service clashes. Will there be any flow restrictions to the foul flow rate. It is anticipated that the surface water will be discharged to the watercourses.

Regards



Date: 14/02/2018

Extract from Map of Public Sewers

Printed By:
Property Searches

Land at Wuerdle Farm, Smithy Bridge Road, Rochdale



The position of this underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. The actual positions may be different from those shown on the plan and private pipes, sewers or drains may not be recorded. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown. Crown copyright and database rights [2016] Ordnance Survey 100022432.

United Utilities Water Limited 2014 The plan is based on the Ordnance Survey Map with the sanction of Controller of H.M. Stationery Office. Crown and Utilities copyrights are reserved. Unauthorised reproduction will infringe these copyrights.

APPENDIX E

CALCULATIONS

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The LK Group www.thelkgroup.com		Eton Business Park, Eton Hill Road, Radcliffe M26 2ZS Tel: 0161 763 7200 email: m.jones@thelkgroup.com		Job No.	
				Sheet no. 1	
				Date 12/07/22	
Project Smithybridge west catchment				By	Checked
Title IoH 124 Runoff calcs for Littleborough					

Hydrological Data:-

FSR Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	r	= 0.26
Soil runoff	= 0.45	SAAR (mm/yr)	= 1160
WRAP	= 4	Area	= England & Wales
Hydrological area	= 10	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 = 0.0404 Km² - 4.04 Ha - 40400 m²

Calculation method:-

Runoff is calculated from:-

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

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

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

$Q_{\text{BAR(rural)}}$ 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 0.081

Mean Annual Peak Flow $Q_{\text{BAR(rural)}}$ = 32.05 l/s

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				Sheet no. 2	
				Date 12/07/22	
	Project Smithybridge west catchment Title loH 124 Runoff calcs for Littleborough			By	Checked Reviewed

Values for $Q_{BAR(rural)}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	98.068	27.241	6.743	100yr+20%	290.742	80.762	19.991
2yr	107.298	29.805	7.377	100yr+30%	314.971	87.492	21.656
5yr	139.602	38.778	9.599	100yr+40%	339.199	94.222	23.322
10yr	159.216	44.227	10.947	200yr	276.897	76.916	19.039
30yr	193.828	53.841	13.327	200yr + 30%	359.967	99.991	24.750
50yr	213.442	59.289	14.676	500yr	314.971	87.492	21.656
100yr	242.285	67.301	16.659	1000yr	350.737	97.427	24.116

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

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 12/07/22		
By	Checked	Reviewed

Project **Smithybridge west catchment 1 in 1 year**
Title **ADAS runoff calculations for Littleborough**

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 1	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.04 Ha	Catchment length	= 202 m
Catchment height	= 13.20 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$
 $M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) =fractional value of the WRAP)
 F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)
 A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.309
Catchment ToC	= 3.85 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 5.85 mm/hr
Flow off site	= 75.66 l/s
Catchment flow	= 18.73 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Job No.		
Sheet no. 1		
Date 12/07/22		
By	Checked	Reviewed

Project **Smithybridge west catchment 1 in 30 year**
Title **ADAS runoff calculations for Littleborough**

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 30	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.04 Ha	Catchment length	= 202 m
Catchment height	= 13.20 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$
 $M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) =fractional value of the WRAP)
 F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)
 A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.309
Catchment ToC	= 3.85 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 12.58 mm/hr
Flow off site	= 162.81 l/s
Catchment flow	= 40.30 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Job No.		
Sheet no. 1		
Date 12/07/22		
By	Checked	Reviewed

Project **Smithybridge west catchment 1 in 100 year**
Title **ADAS runoff calculations for Littleborough**

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 100	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.04 Ha	Catchment length	= 202 m
Catchment height	= 13.20 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$
 $M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) =fractional value of the WRAP)
 F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)
 A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.309
Catchment ToC	= 3.85 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 16.31 mm/hr
Flow off site	= 211.04 l/s
Catchment flow	= 52.24 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Job No.		
Sheet no. 1		
Date 12/07/22		
By	Checked	Reviewed

Project **Smithybridge west catchment**

Title **IoH 124 Runoff calcs for Littleborough**

Hydrological Data:-

FSR Hydrology:-

Location = Littleborough
M5-60 (mm) = 19.4
Soil runoff = 0.45
WRAP = 4
Hydrological area = 10

Grid reference = SD9125
r = 0.26
SAAR (mm/yr) = 1160
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 = 0.0404 Km² - 4.04 Ha - 40400 m²

Calculation method:-

Runoff is calculated from:-

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

where

AREA = Site area in Km²

SAAR = Standard Average Annual Rainfall (mm/yr)

SOIL = Soil value derived from Winter Rainfall Acceptance Potential

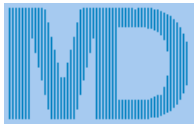
$Q_{\text{BAR(rural)}}$ = Runoff (cumecs)

$Q_{\text{BAR(rural)}}$ 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 0.081

Mean Annual Peak Flow $Q_{\text{BAR(rural)}}$ = 32.05 l/s



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Job No.		
Sheet no. 2		
Date 12/07/22		
By	Checked	Reviewed

Project	Smithybridge west catchment
Title	IoH 124 Runoff calcs for Littleborough

Values for $Q_{BAR(rural)}$

Ret. per.	m ³ /hr	l/s	l/s/ha	Ret. per.	m ³ /hr	l/s	l/s/ha
1yr	98.068	27.241	6.743	100yr+20%	290.742	80.762	19.991
2yr	107.298	29.805	7.377	100yr+30%	314.971	87.492	21.656
5yr	139.602	38.778	9.599	100yr+40%	339.199	94.222	23.322
10yr	159.216	44.227	10.947	200yr	276.897	76.916	19.039
30yr	193.828	53.841	13.327	200yr + 30%	359.967	99.991	24.750
50yr	213.442	59.289	14.676	500yr	314.971	87.492	21.656
100yr	242.285	67.301	16.659	1000yr	350.737	97.427	24.116

Growth factors -

1yr	2yr	5yr	10yr	30yr	50yr	100yr	200yr	500yr	1000yr
0.85	0.93	1.21	1.38	1.68	1.85	2.10	2.40	2.73	3.04

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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HY 11.0

The LK Group

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

Job No.		
Sheet no. 1		
Date 12/07/22		
By	Checked	Reviewed

Project	Smithybridge east catchment 1 in 1 year
Title	ADAS runoff calculations for Littleborough

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 1	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.88 Ha	Catchment length	= 158 m
Catchment height	= 11.00 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$

$L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$

$M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) = fractional value of the WRAP)

F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)

A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.227
Catchment ToC	= 3.42 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 6.31 mm/hr
Flow off site	= 98.67 l/s
Catchment flow	= 20.22 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



MasterDrain
HY 11.0

The LK Group

www.thelkgroup.com

Eton Business Park,
Eton Hill Road,
Radcliffe M26 2ZS
Tel: 0161 763 7200
email: m.jones@thelkgroup.com

Job No.		
Sheet no. 1		
Date 12/07/22		
By	Checked	Reviewed

Project **Smithybridge east catchment 1 in 30 year**
Title **ADAS runoff calculations for Littleborough**

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 30	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.88 Ha	Catchment length	= 158 m
Catchment height	= 11.00 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$
 $M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) =fractional value of the WRAP)
 F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)
 A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.227
Catchment ToC	= 3.42 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 13.64 mm/hr
Flow off site	= 213.12 l/s
Catchment flow	= 43.67 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **Smithybridge east catchment 1 in 100 year**
Title **ADAS runoff calculations for Littleborough**

Data:-

Hydrology:-

Location	= Littleborough	Grid reference	= SD9125
M5-60 (mm)	= 19.4	SAAR (mm/yr)	= 1160
r	= 0.26	Soil	= 0.45
Return period	= 100	Area	= England and Wales

Soil classification for WRAP type 4

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

Site values used in design:-

Catchment area	= 4.88 Ha	Catchment length	= 158 m
Catchment height	= 11.00 m		

Calculations :-

Formula used: $Q = 2.78 \times S_m^2 \times F_a \times A \times \text{Rainfall rate} \times M_f \text{ l/s}$

where

Time of Concentration for rainfall is $ToC = 6.09 \times L_c^{0.39}$
 $L_c = 0.0001 \times (\text{Catchment length}^2 / \text{Height over outfall})$
 $M_f = 4.938 \times S_m^2$ (Soil modification value(S_m) =fractional value of the WRAP)
 F_a = dimensionless annual rainfall factor ($F_a = \{0.00127 \times SAAR\} - 0.321$)
 A = Catchment Area (Ha)

Results :-

Characteristic length L_c	= 0.227
Catchment ToC	= 3.42 hrs
Soil modification factor	= 1.000
Catchment Intensity at ToC	= 17.72 mm/hr
Flow off site	= 276.91 l/s
Catchment flow	= 56.74 l/s/Ha

Calculations derived from formulae in ADAS Land Drainage Service report 5 (1980)
For further information, you are directed to the above document.

N.B. The rainfall rates are calculated using the location specific values above in accordance with the Wallingford procedure.



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Project **30 year event west catchment**

Title **Storage calcs for Littleborough**

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 30

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 0

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 53.840 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 66.0 mins

Rainfall at max = 28.21 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 325.8 m³

Allowed discharge rate = 53.840 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 9.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 53.840 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	41486.2	1125	327.8	400 x 600	1809.8	500 x 500	1303.1
150	18438.3	1200	288.1	600 x 900	788.0	500 x 750	868.7
225	8194.8	1275	255.2	800 x 1200	443.2	500 x 1000	651.5
300	4609.6	1350	227.6			750 x 1000	434.4
375	2950.1	1425	204.3			750 x 1200	362.0
450	2048.7	1500	184.4			750 x 1500	289.6
525	1505.2	1575	167.2			1000 x 1000	325.8
600	1152.4	1650	152.4			1000 x 1200	271.5
675	910.5	1725	139.4			1000 x 1500	217.2
750	737.5	1800	128.0			1000 x 1800	181.0
825	609.5	1875	118.0			1000 x 2000	162.9
900	512.2	1950	109.1			1500 x 1500	144.8
975	436.4	2025	101.2			1500 x 1800	120.7
1050	376.3	2100	94.1			1500 x 2000	108.6



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Data:-

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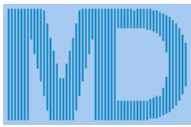
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Project **30 year event west catchment**

Title **Storage calcs for Littleborough**

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	76.0	220.921	32.304	188.617
20	55.0	319.407	64.608	254.799
30	44.0	386.290	96.912	289.378
40	38.0	438.437	129.216	309.221
50	33.0	481.685	161.520	320.165
60	30.0	518.873	193.824	325.049
70	27.0	551.614	226.128	325.486
80	25.0	580.921	258.432	322.489
90	23.0	607.480	290.736	316.744
100	22.0	631.778	323.040	308.738
110	21.0	654.173	355.344	298.829
120	19.0	674.941	387.648	287.293
130	18.0	694.296	419.952	274.344
140	18.0	712.413	452.256	260.157
150	17.0	729.429	484.560	244.869
160	16.0	745.462	516.864	228.598
170	15.0	760.610	549.168	211.442
180	15.0	774.954	581.472	193.482
190	14.0	788.565	613.776	174.789
200	14.0	802.422	646.080	156.342
210	13.0	815.620	678.384	137.236
220	13.0	828.369	710.688	117.681
230	13.0	840.702	742.992	97.710
240	12.0	852.652	775.296	77.356
250	12.0	864.244	807.600	56.644
260	12.0	875.504	839.904	35.600
270	11.0	886.453	872.208	14.245
280	11.0	897.111	904.512	0.000
290	11.0	907.496	936.816	0.000
300	11.0	917.623	969.120	0.000
310	10.0	927.508	1001.424	0.000
320	10.0	937.163	1033.728	0.000
330	10.0	946.600	1066.032	0.000
340	10.0	955.832	1098.336	0.000
350	10.0	964.868	1130.640	0.000
360	9.0	973.718	1162.944	0.000
370	9.0	982.391	1195.248	0.000
380	9.0	990.895	1227.552	0.000
390	9.0	999.236	1259.856	0.000
400	9.0	1007.424	1292.160	0.000
410	9.0	1015.464	1324.464	0.000
420	8.0	1023.361	1356.768	0.000
430	8.0	1031.123	1389.072	0.000
440	8.0	1038.754	1421.376	0.000
450	8.0	1046.260	1453.680	0.000
460	8.0	1053.644	1485.984	0.000
470	8.0	1060.913	1518.288	0.000
480	8.0	1068.069	1550.592	0.000
490	8.0	1075.117	1582.896	0.000
500	7.0	1082.061	1615.200	0.000
510	7.0	1088.904	1647.504	0.000
520	7.0	1095.650	1679.808	0.000
530	7.0	1102.302	1712.112	0.000
540	7.0	1108.862	1744.416	0.000
550	7.0	1115.334	1776.720	0.000
560	7.0	1121.720	1809.024	0.000
570	7.0	1128.024	1841.328	0.000
580	7.0	1134.246	1873.632	0.000
590	7.0	1140.392	1905.936	0.000
600	7.0	1146.461	1938.240	0.000

Storage volume (m³) = 325.8 m³



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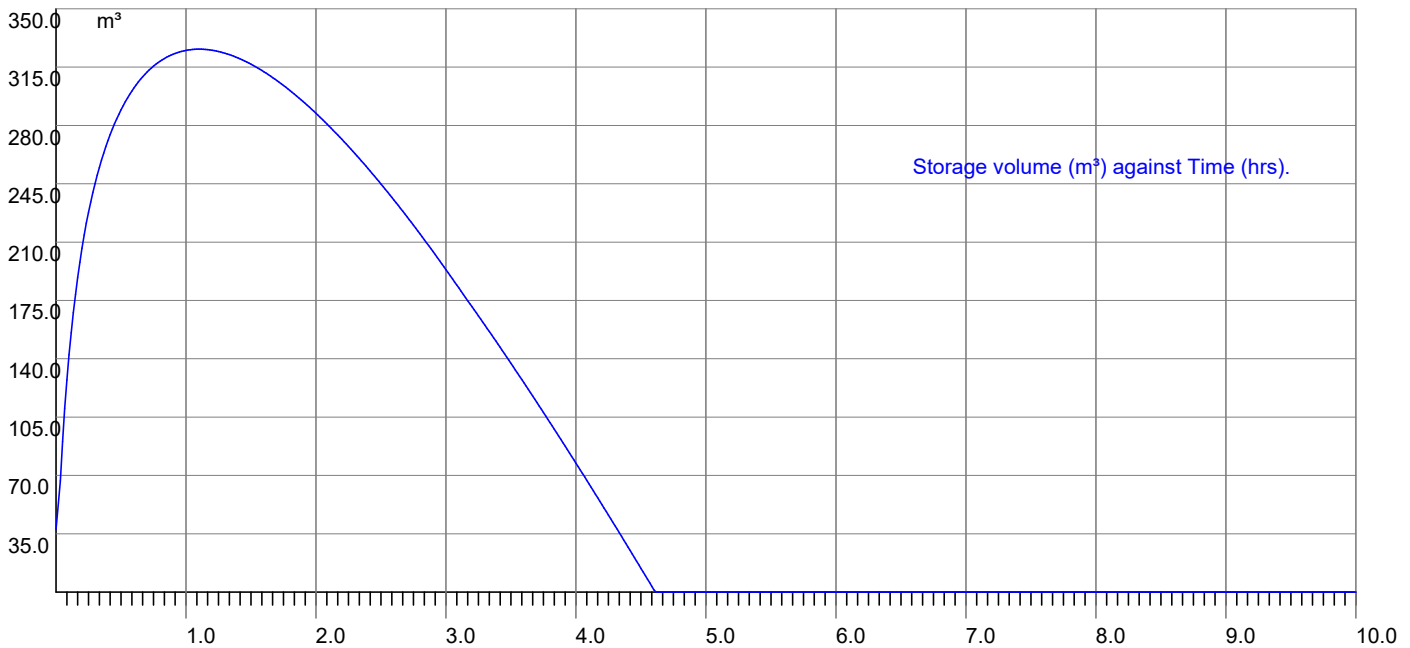
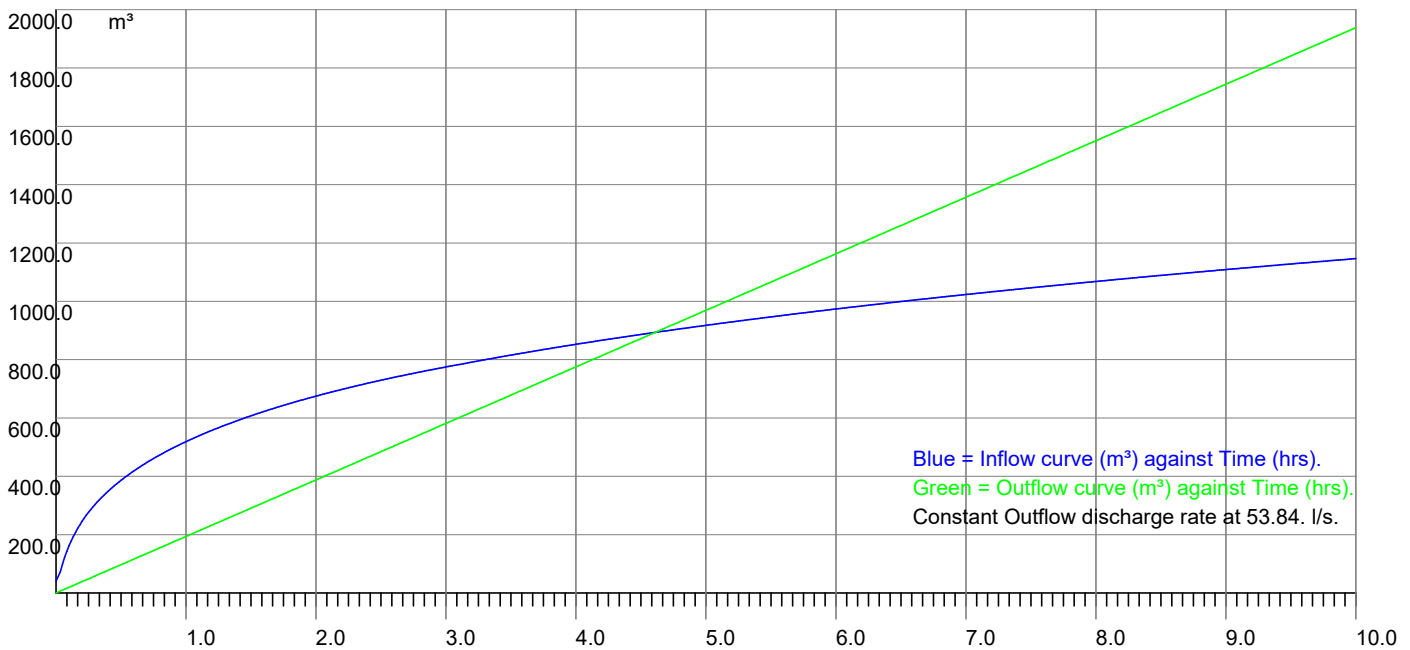
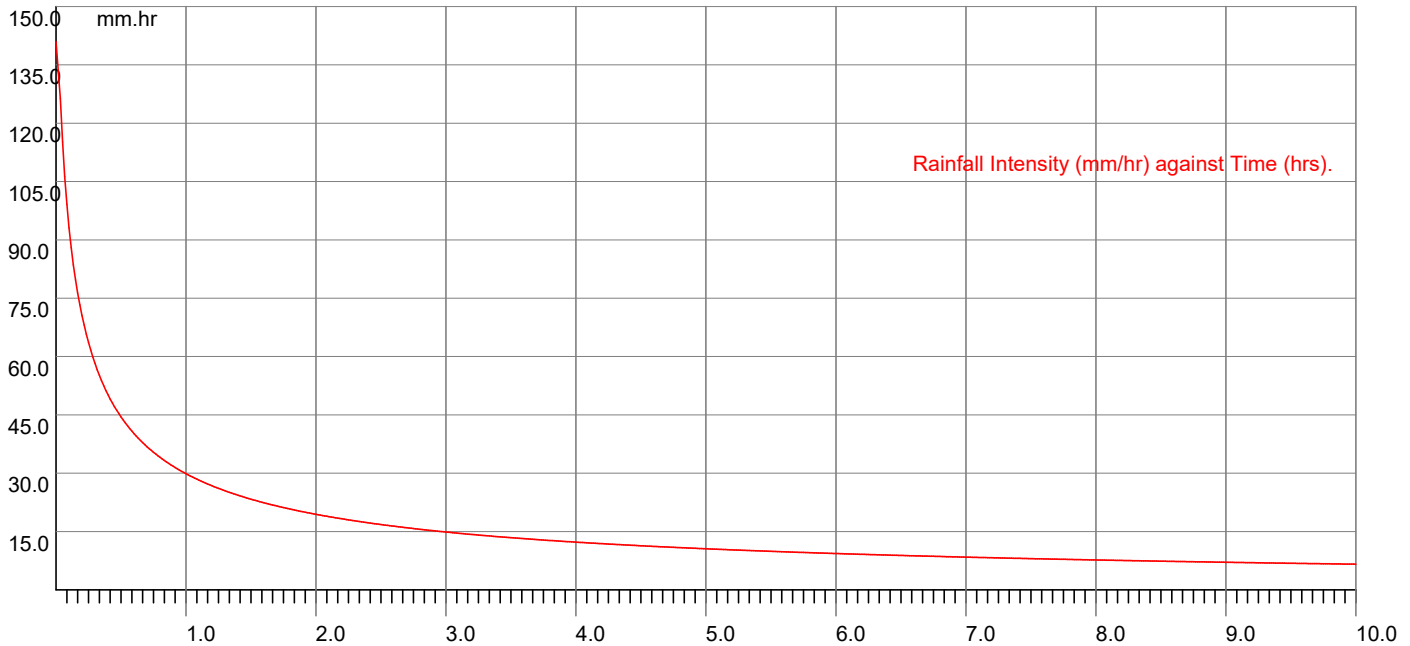
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Project **30 year event west catchment**

Title **Storage calcs for Littleborough**





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Project	30yr event west
Title	Storage calcs for Littleborough ADAS

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 30

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 0

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 162.810 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 15.0 mins

Rainfall at max = 63.65 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 129.9 m³

Allowed discharge rate = 162.810 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 9.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 162.810 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	16540.2	1125	130.7	400 x 600	721.6	500 x 500	519.5
150	7351.2	1200	114.9	600 x 900	314.2	500 x 750	346.4
225	3267.2	1275	101.7	800 x 1200	176.7	500 x 1000	259.8
300	1837.8	1350	90.8			750 x 1000	173.2
375	1176.2	1425	81.5			750 x 1200	144.3
450	816.8	1500	73.5			750 x 1500	115.5
525	600.1	1575	66.7			1000 x 1000	129.9
600	459.4	1650	60.8			1000 x 1200	108.2
675	363.0	1725	55.6			1000 x 1500	86.6
750	294.0	1800	51.0			1000 x 1800	72.2
825	243.0	1875	47.0			1000 x 2000	64.9
900	204.2	1950	43.5			1500 x 1500	57.7
975	174.0	2025	40.3			1500 x 1800	48.1
1050	150.0	2100	37.5			1500 x 2000	43.3



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Date **12/07/22**

Project **30yr event west**

Title **Storage calcs for Littleborough ADAS**

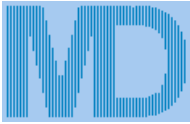
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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	76.0	220.921	97.686	123.235
20	55.0	319.407	195.372	124.035
30	44.0	386.290	293.058	93.232
40	38.0	438.437	390.744	47.693
50	33.0	481.685	488.430	0.000
60	30.0	518.873	586.116	0.000
70	27.0	551.614	683.802	0.000
80	25.0	580.921	781.488	0.000
90	23.0	607.480	879.174	0.000
100	22.0	631.778	976.860	0.000
110	21.0	654.173	1074.546	0.000
120	19.0	674.941	1172.232	0.000
130	18.0	694.296	1269.918	0.000
140	18.0	712.413	1367.604	0.000
150	17.0	729.429	1465.290	0.000
160	16.0	745.462	1562.976	0.000
170	15.0	760.610	1660.662	0.000
180	15.0	774.954	1758.348	0.000
190	14.0	788.565	1856.034	0.000
200	14.0	802.422	1953.720	0.000
210	13.0	815.620	2051.406	0.000
220	13.0	828.369	2149.092	0.000
230	13.0	840.702	2246.778	0.000
240	12.0	852.652	2344.464	0.000
250	12.0	864.244	2442.150	0.000
260	12.0	875.504	2539.836	0.000
270	11.0	886.453	2637.522	0.000
280	11.0	897.111	2735.208	0.000
290	11.0	907.496	2832.894	0.000
300	11.0	917.623	2930.580	0.000
310	10.0	927.508	3028.266	0.000
320	10.0	937.163	3125.952	0.000
330	10.0	946.600	3223.638	0.000
340	10.0	955.832	3321.324	0.000
350	10.0	964.868	3419.010	0.000
360	9.0	973.718	3516.696	0.000
370	9.0	982.391	3614.382	0.000
380	9.0	990.895	3712.068	0.000
390	9.0	999.236	3809.754	0.000
400	9.0	1007.424	3907.440	0.000
410	9.0	1015.464	4005.126	0.000
420	8.0	1023.361	4102.812	0.000
430	8.0	1031.123	4200.498	0.000
440	8.0	1038.754	4298.184	0.000
450	8.0	1046.260	4395.870	0.000
460	8.0	1053.644	4493.556	0.000
470	8.0	1060.913	4591.242	0.000
480	8.0	1068.069	4688.928	0.000
490	8.0	1075.117	4786.614	0.000
500	7.0	1082.061	4884.300	0.000
510	7.0	1088.904	4981.986	0.000
520	7.0	1095.650	5079.672	0.000
530	7.0	1102.302	5177.358	0.000
540	7.0	1108.862	5275.044	0.000
550	7.0	1115.334	5372.730	0.000
560	7.0	1121.720	5470.416	0.000
570	7.0	1128.024	5568.102	0.000
580	7.0	1134.246	5665.788	0.000
590	7.0	1140.392	5763.474	0.000
600	7.0	1146.461	5861.160	0.000

Storage volume (m³) = 129.9 m³



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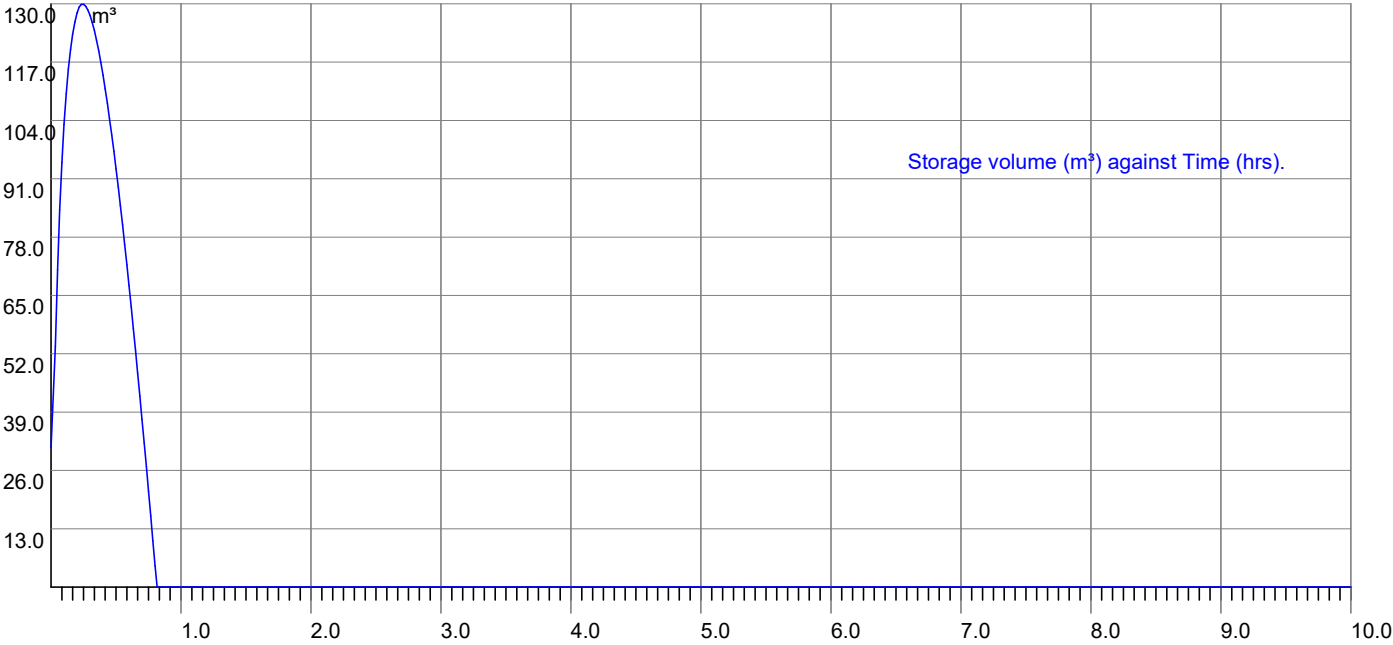
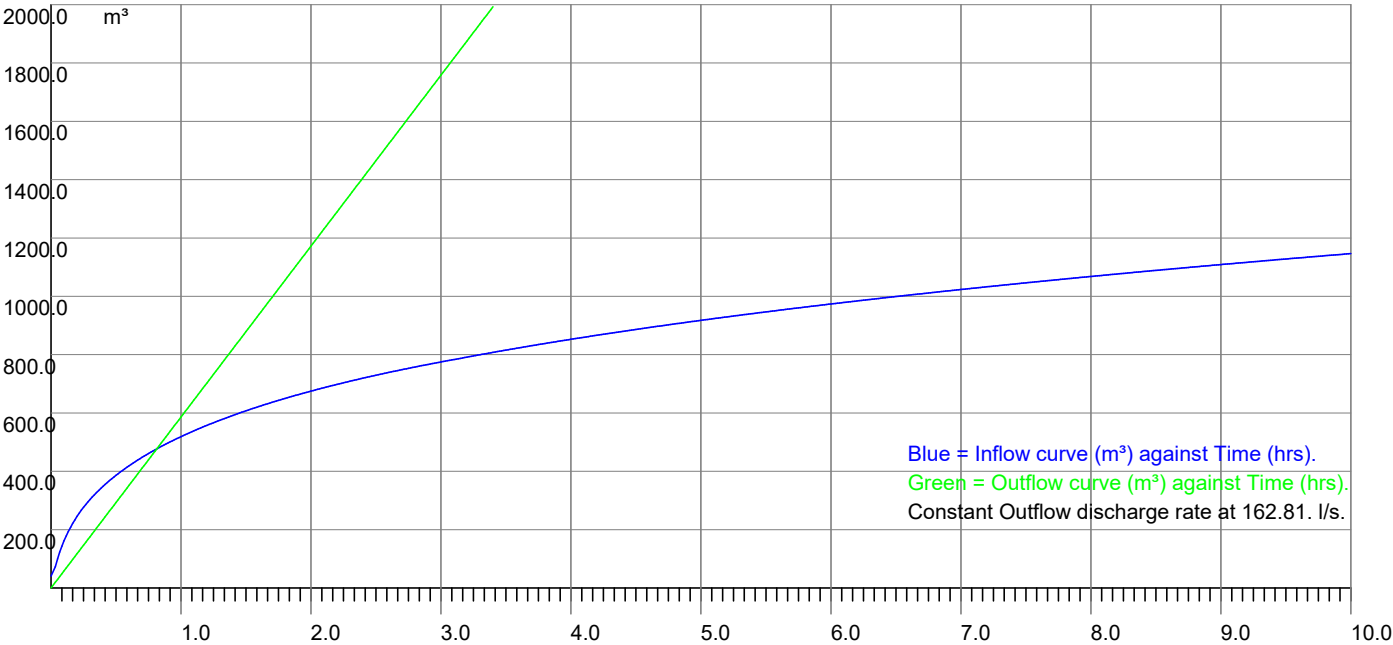
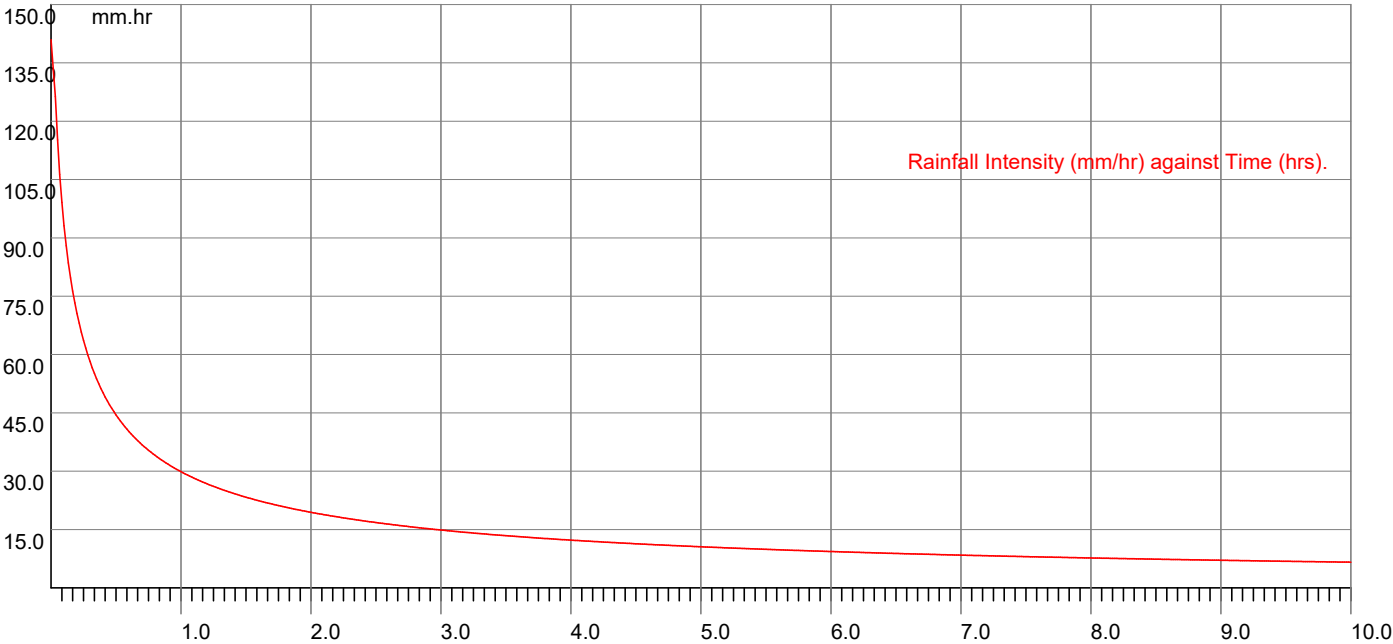
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Project 30yr event west
Title Storage calcs for Littleborough ADAS





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Project	West 100yr+20% event
Title	Storage calcs for Littleborough

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 67.300 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 88.0 mins

Rainfall at max = 37.31 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 595.4 m³

Allowed discharge rate = 67.300 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 18.7 m³

Allowed discharge rate = 67.300 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	75819.6	1125	599.1	400 x 600	3307.6	500 x 500	2381.5
150	33697.6	1200	526.5	600 x 900	1440.2	500 x 750	1587.7
225	14976.7	1275	466.4	800 x 1200	810.0	500 x 1000	1190.7
300	8424.4	1350	416.0			750 x 1000	793.8
375	5391.6	1425	373.4			750 x 1200	661.5
450	3744.2	1500	337.0			750 x 1500	529.2
525	2750.8	1575	305.6			1000 x 1000	595.4
600	2106.1	1650	278.5			1000 x 1200	496.1
675	1664.1	1725	254.8			1000 x 1500	396.9
750	1347.9	1800	234.0			1000 x 1800	330.8
825	1114.0	1875	215.7			1000 x 2000	297.7
900	936.0	1950	199.4			1500 x 1500	264.6
975	797.6	2025	184.9			1500 x 1800	220.5
1050	687.7	2100	171.9			1500 x 2000	198.5



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Data:-

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Project

West 100yr+20% event

Title

Storage calcs for Littleborough

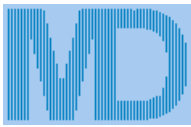
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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	117.0	338.362	40.380	297.982
20	86.0	496.864	80.760	416.104
30	70.0	604.800	121.140	483.660
40	59.0	689.013	161.520	527.493
50	52.0	758.679	201.900	556.779
60	47.0	818.321	242.280	576.041
70	43.0	870.534	282.660	587.874
80	40.0	916.967	323.040	593.927
90	37.0	958.742	363.420	595.322
100	34.0	996.659	403.800	592.859
110	32.0	1031.318	444.180	587.138
120	31.0	1063.176	484.560	578.616
130	29.0	1092.595	524.940	567.655
140	28.0	1119.866	565.320	554.546
150	26.0	1145.227	605.700	539.527
160	25.0	1168.876	646.080	522.796
170	24.0	1190.980	686.460	504.520
180	23.0	1211.681	726.840	484.841
190	22.0	1231.101	767.220	463.881
200	22.0	1251.683	807.600	444.083
210	21.0	1271.073	847.980	423.093
220	20.0	1289.765	888.360	401.405
230	20.0	1307.816	928.740	379.076
240	19.0	1325.272	969.120	356.152
250	19.0	1342.178	1009.500	332.678
260	18.0	1358.570	1049.880	308.690
270	18.0	1374.484	1090.260	284.224
280	17.0	1389.949	1130.640	259.309
290	17.0	1404.994	1171.020	233.974
300	16.0	1419.643	1211.400	208.243
310	16.0	1433.919	1251.780	182.139
320	16.0	1447.844	1292.160	155.684
330	15.0	1461.436	1332.540	128.896
340	15.0	1474.713	1372.920	101.793
350	15.0	1487.690	1413.300	74.390
360	14.0	1500.383	1453.680	46.703
370	14.0	1512.806	1494.060	18.746
380	14.0	1524.970	1534.440	0.000
390	14.0	1536.888	1574.820	0.000
400	13.0	1548.571	1615.200	0.000
410	13.0	1560.029	1655.580	0.000
420	13.0	1571.271	1695.960	0.000
430	13.0	1582.307	1736.340	0.000
440	13.0	1593.144	1776.720	0.000
450	12.0	1603.791	1817.100	0.000
460	12.0	1614.254	1857.480	0.000
470	12.0	1624.542	1897.860	0.000
480	12.0	1634.660	1938.240	0.000
490	12.0	1644.614	1978.620	0.000
500	11.0	1654.411	2019.000	0.000
510	11.0	1664.056	2059.380	0.000
520	11.0	1673.553	2099.760	0.000
530	11.0	1682.909	2140.140	0.000
540	11.0	1692.127	2180.520	0.000
550	11.0	1701.212	2220.900	0.000
560	11.0	1710.168	2261.280	0.000
570	10.0	1718.999	2301.660	0.000
580	10.0	1727.710	2342.040	0.000
590	10.0	1736.303	2382.420	0.000
600	10.0	1744.783	2422.800	0.000

Storage volume (m³) = 595.4 m³



MasterDrain
SW

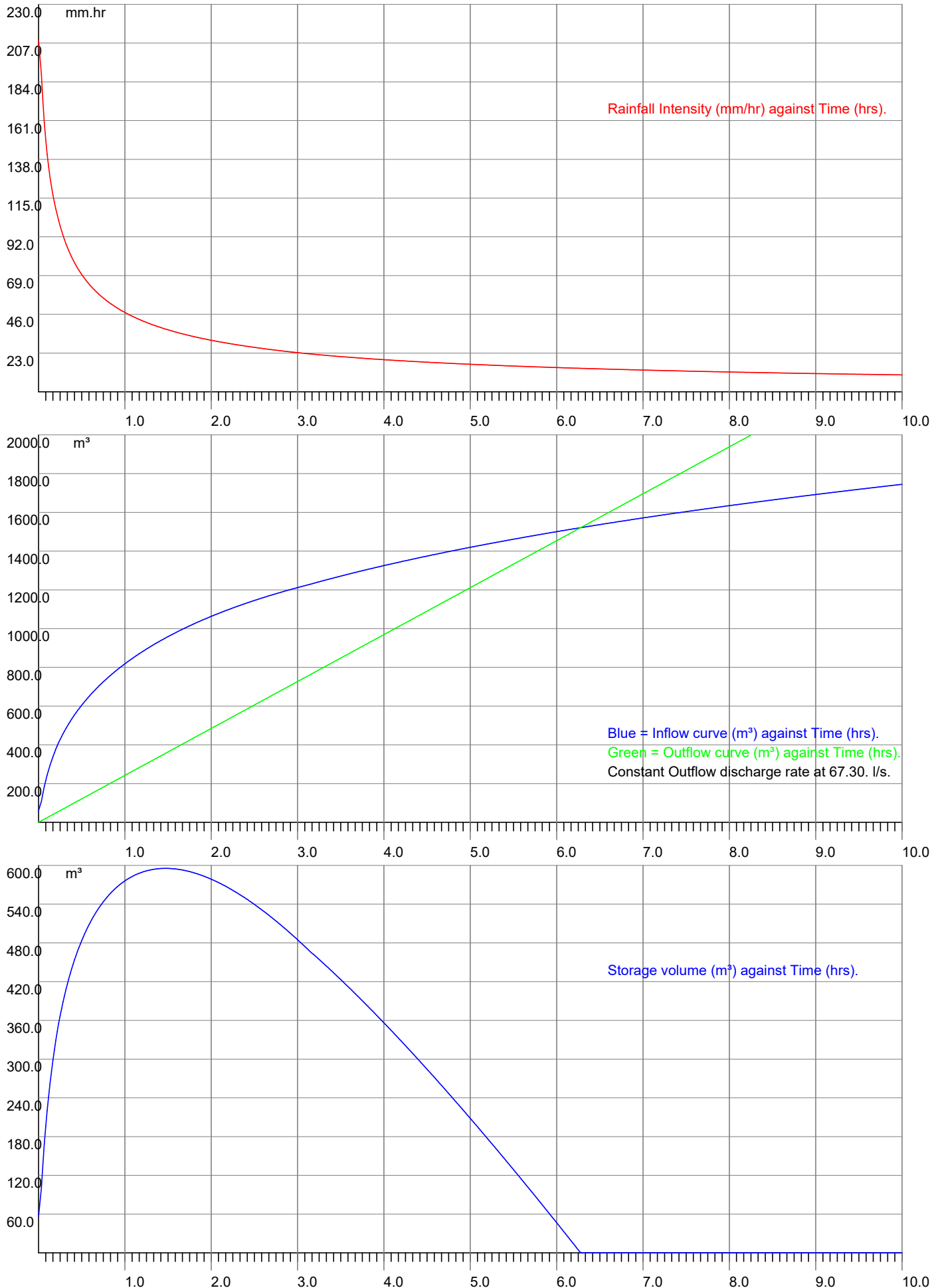
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Job No.		
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Project **West 100yr+20% event**
Title **Storage calcs for Littleborough**





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Sheet no. **1**

Date **12/07/22**

Project **100yr+20% ADAS west**

Title **Storage calcs for Littleborough**

By

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Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 211.040 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 20.0 mins

Rainfall at max = 85.80 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 243.6 m³

Allowed discharge rate = 211.040 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 211.040 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	31024.0	1125	245.1	400 x 600	1353.4	500 x 500	974.5
150	13788.5	1200	215.4	600 x 900	589.3	500 x 750	649.6
225	6128.2	1275	190.8	800 x 1200	331.4	500 x 1000	487.2
300	3447.1	1350	170.2			750 x 1000	324.8
375	2206.2	1425	152.8			750 x 1200	270.7
450	1532.1	1500	137.9			750 x 1500	216.5
525	1125.6	1575	125.1			1000 x 1000	243.6
600	861.8	1650	114.0			1000 x 1200	203.0
675	680.9	1725	104.3			1000 x 1500	162.4
750	551.5	1800	95.8			1000 x 1800	135.3
825	455.8	1875	88.2			1000 x 2000	121.8
900	383.0	1950	81.6			1500 x 1500	108.3
975	326.4	2025	75.7			1500 x 1800	90.2
1050	281.4	2100	70.3			1500 x 2000	81.2



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Data:-

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Sheet no.

2

Date

12/07/22

Project **100yr+20% ADAS west**

Title **Storage calcs for Littleborough**

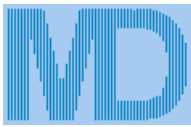
By

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Reviewed

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	117.0	338.362	126.624	211.738
20	86.0	496.864	253.248	243.616
30	70.0	604.800	379.872	224.928
40	59.0	689.013	506.496	182.517
50	52.0	758.679	633.120	125.559
60	47.0	818.321	759.744	58.577
70	43.0	870.534	886.368	0.000
80	40.0	916.967	1012.992	0.000
90	37.0	958.742	1139.616	0.000
100	34.0	996.659	1266.240	0.000
110	32.0	1031.318	1392.864	0.000
120	31.0	1063.176	1519.488	0.000
130	29.0	1092.595	1646.112	0.000
140	28.0	1119.866	1772.736	0.000
150	26.0	1145.227	1899.360	0.000
160	25.0	1168.876	2025.984	0.000
170	24.0	1190.980	2152.608	0.000
180	23.0	1211.681	2279.232	0.000
190	22.0	1231.101	2405.856	0.000
200	22.0	1251.683	2532.480	0.000
210	21.0	1271.073	2659.104	0.000
220	20.0	1289.765	2785.728	0.000
230	20.0	1307.816	2912.352	0.000
240	19.0	1325.272	3038.976	0.000
250	19.0	1342.178	3165.600	0.000
260	18.0	1358.570	3292.224	0.000
270	18.0	1374.484	3418.848	0.000
280	17.0	1389.949	3545.472	0.000
290	17.0	1404.994	3672.096	0.000
300	16.0	1419.643	3798.720	0.000
310	16.0	1433.919	3925.344	0.000
320	16.0	1447.844	4051.968	0.000
330	15.0	1461.436	4178.592	0.000
340	15.0	1474.713	4305.216	0.000
350	15.0	1487.690	4431.840	0.000
360	14.0	1500.383	4558.464	0.000
370	14.0	1512.806	4685.088	0.000
380	14.0	1524.970	4811.712	0.000
390	14.0	1536.888	4938.336	0.000
400	13.0	1548.571	5064.960	0.000
410	13.0	1560.029	5191.584	0.000
420	13.0	1571.271	5318.208	0.000
430	13.0	1582.307	5444.832	0.000
440	13.0	1593.144	5571.456	0.000
450	12.0	1603.791	5698.080	0.000
460	12.0	1614.254	5824.704	0.000
470	12.0	1624.542	5951.328	0.000
480	12.0	1634.660	6077.952	0.000
490	12.0	1644.614	6204.576	0.000
500	11.0	1654.411	6331.200	0.000
510	11.0	1664.056	6457.824	0.000
520	11.0	1673.553	6584.448	0.000
530	11.0	1682.909	6711.072	0.000
540	11.0	1692.127	6837.696	0.000
550	11.0	1701.212	6964.320	0.000
560	11.0	1710.168	7090.944	0.000
570	10.0	1718.999	7217.568	0.000
580	10.0	1727.710	7344.192	0.000
590	10.0	1736.303	7470.816	0.000
600	10.0	1744.783	7597.440	0.000

Storage volume (m³) = 243.6 m³



MasterDrain
SW

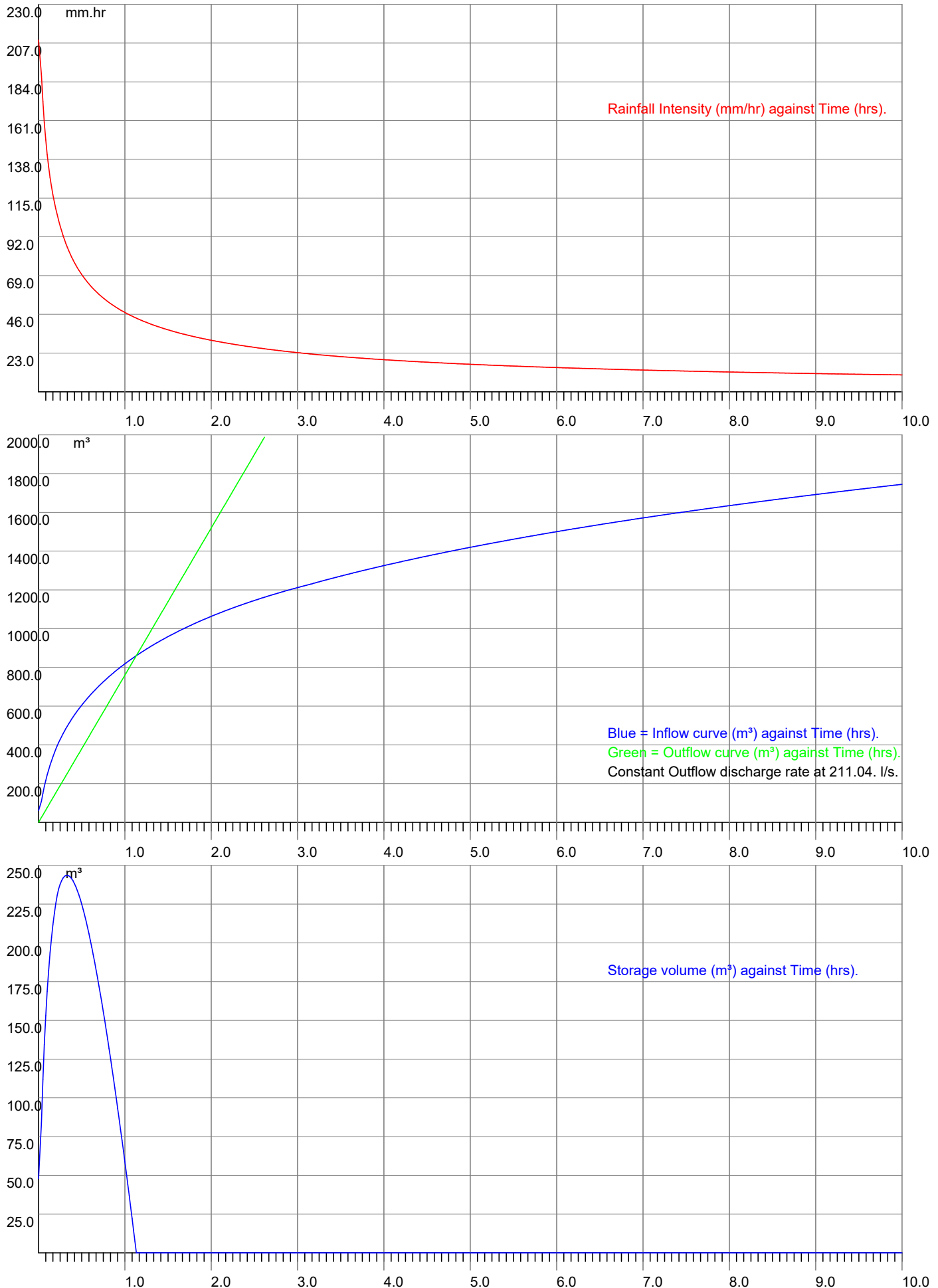
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Project **100yr+20% ADAS west**
Title **Storage calcs for Littleborough**





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Project **100yr+40% west**

Title **Storage calcs for Littleborough**

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 67.300 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 105.0 mins

Rainfall at max = 38.93 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 759.4 m³

Allowed discharge rate = 67.300 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 16.00 mm/hr

Calculated storage volume = 270.9 m³

Allowed discharge rate = 67.300 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	96712.5	1125	764.1	400 x 600	4219.1	500 x 500	3037.7
150	42983.4	1200	671.6	600 x 900	1837.0	500 x 750	2025.2
225	19103.7	1275	594.9	800 x 1200	1033.2	500 x 1000	1518.9
300	10745.8	1350	530.7			750 x 1000	1012.6
375	6877.3	1425	476.3			750 x 1200	843.8
450	4775.9	1500	429.8			750 x 1500	675.1
525	3508.8	1575	389.9			1000 x 1000	759.4
600	2686.5	1650	355.2			1000 x 1200	632.9
675	2122.6	1725	325.0			1000 x 1500	506.3
750	1719.3	1800	298.5			1000 x 1800	421.9
825	1420.9	1875	275.1			1000 x 2000	379.7
900	1194.0	1950	254.3			1500 x 1500	337.5
975	1017.4	2025	235.8			1500 x 1800	281.3
1050	877.2	2100	219.3			1500 x 2000	253.1



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SW

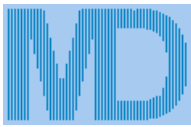
Project **100yr+40% west**

Title **Storage calcs for Littleborough**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	136.0	394.755	40.380	354.375
20	100.0	579.675	80.760	498.915
30	81.0	705.600	121.140	584.460
40	69.0	803.848	161.520	642.328
50	61.0	885.126	201.900	683.226
60	55.0	954.707	242.280	712.427
70	50.0	1015.623	282.660	732.963
80	46.0	1069.795	323.040	746.755
90	43.0	1118.532	363.420	755.112
100	40.0	1162.769	403.800	758.969
110	38.0	1203.204	444.180	759.024
120	36.0	1240.372	484.560	755.812
130	34.0	1274.694	524.940	749.754
140	32.0	1306.510	565.320	741.190
150	31.0	1336.098	605.700	730.398
160	29.0	1363.689	646.080	717.609
170	28.0	1389.477	686.460	703.017
180	27.0	1413.628	726.840	686.788
190	26.0	1436.285	767.220	669.065
200	25.0	1460.297	807.600	652.696
210	24.0	1482.918	847.980	634.938
220	24.0	1504.726	888.360	616.366
230	23.0	1525.785	928.740	597.045
240	22.0	1546.151	969.120	577.031
250	22.0	1565.874	1009.500	556.374
260	21.0	1584.998	1049.880	535.118
270	21.0	1603.564	1090.260	513.304
280	20.0	1621.607	1130.640	490.967
290	20.0	1639.159	1171.020	468.139
300	19.0	1656.250	1211.400	444.850
310	19.0	1672.906	1251.780	421.126
320	18.0	1689.151	1292.160	396.991
330	18.0	1705.009	1332.540	372.469
340	17.0	1720.498	1372.920	347.578
350	17.0	1735.639	1413.300	322.339
360	17.0	1750.447	1453.680	296.767
370	16.0	1764.940	1494.060	270.880
380	16.0	1779.132	1534.440	244.692
390	16.0	1793.036	1574.820	218.216
400	16.0	1806.666	1615.200	191.466
410	15.0	1820.033	1655.580	164.453
420	15.0	1833.150	1695.960	137.189
430	15.0	1846.024	1736.340	109.684
440	15.0	1858.668	1776.720	81.948
450	14.0	1871.089	1817.100	53.989
460	14.0	1883.297	1857.480	25.817
470	14.0	1895.299	1897.860	0.000
480	14.0	1907.103	1938.240	0.000
490	14.0	1918.717	1978.620	0.000
500	13.0	1930.146	2019.000	0.000
510	13.0	1941.398	2059.380	0.000
520	13.0	1952.479	2099.760	0.000
530	13.0	1963.394	2140.140	0.000
540	13.0	1974.148	2180.520	0.000
550	12.0	1984.747	2220.900	0.000
560	12.0	1995.196	2261.280	0.000
570	12.0	2005.499	2301.660	0.000
580	12.0	2015.661	2342.040	0.000
590	12.0	2025.687	2382.420	0.000
600	12.0	2035.580	2422.800	0.000

Storage volume (m³) = 759.4 m³



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SW

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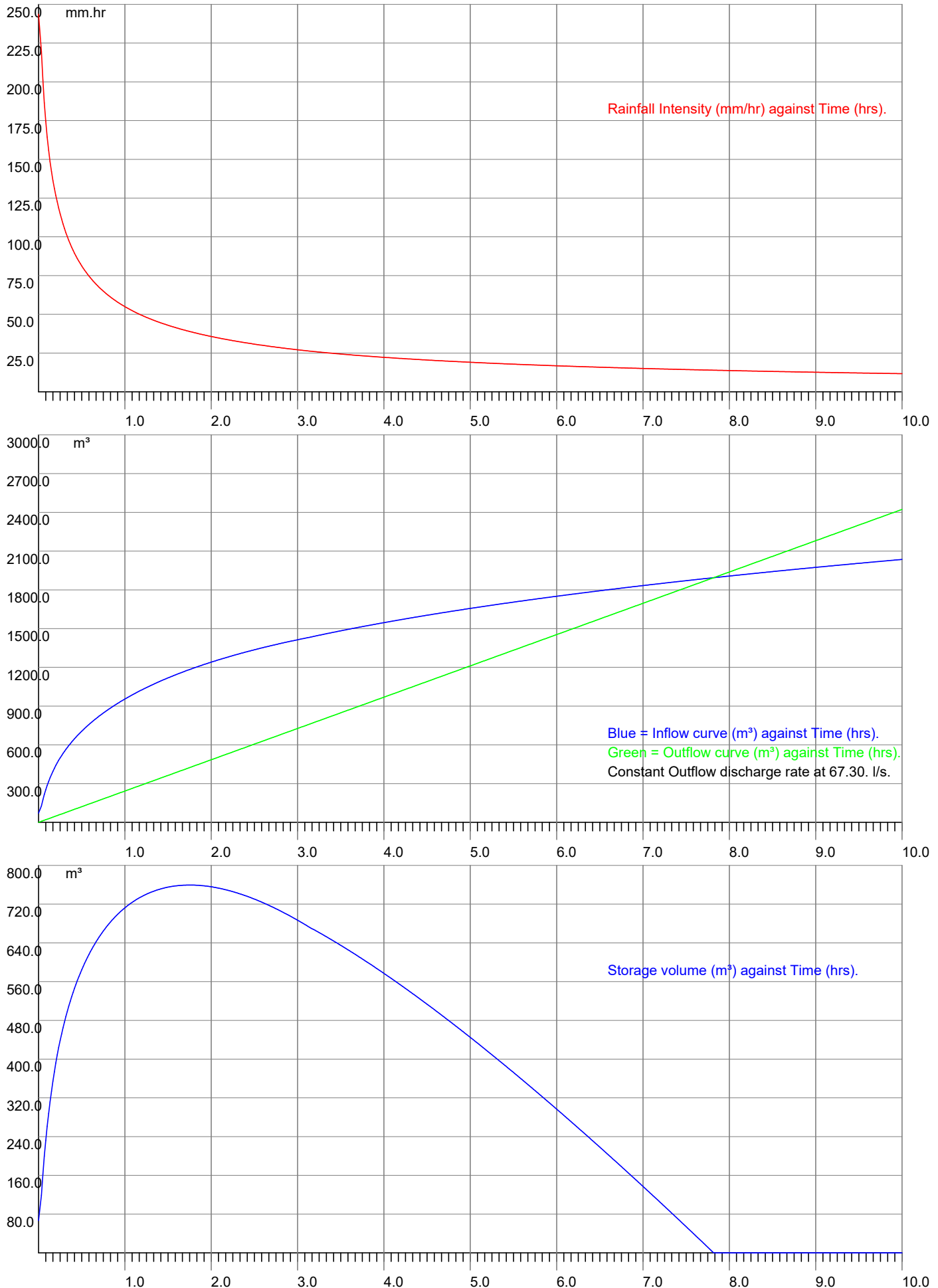
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Project **100yr+40% west**

Title **Storage calcs for Littleborough**





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Sheet no. **1**

Date **12/07/22**

Project **100yr+40% west ADAS**

Title **Storage calcs for Littleborough**

By

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Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 43.0, 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 = 21200 m²

Total area (TA) = 40400 m²

Mean disch. rate = 211.040 l/s

Additional flow = 0.00 l/s

Pervious area = 19200 m²

Equiv area = 17372 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 25.0 mins

Rainfall at max = 89.41 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 330.6 m³

Allowed discharge rate = 211.040 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 16.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 211.040 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	42102.8	1125	332.7	400 x 600	1836.7	500 x 500	1322.4
150	18712.4	1200	292.4	600 x 900	799.7	500 x 750	881.6
225	8316.6	1275	259.0	800 x 1200	449.8	500 x 1000	661.2
300	4678.1	1350	231.0			750 x 1000	440.8
375	2994.0	1425	207.3			750 x 1200	367.3
450	2079.2	1500	187.1			750 x 1500	293.9
525	1527.5	1575	169.7			1000 x 1000	330.6
600	1169.5	1650	154.6			1000 x 1200	275.5
675	924.1	1725	141.5			1000 x 1500	220.4
750	748.5	1800	129.9			1000 x 1800	183.7
825	618.6	1875	119.8			1000 x 2000	165.3
900	519.8	1950	110.7			1500 x 1500	146.9
975	442.9	2025	102.7			1500 x 1800	122.4
1050	381.9	2100	95.5			1500 x 2000	110.2



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Data:-

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Date **12/07/22**

Project **100yr+40% west ADAS**

Title **Storage calcs for Littleborough**

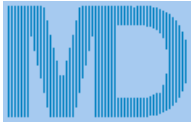
By

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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	136.0	394.755	126.624	268.131
20	100.0	579.675	253.248	326.427
30	81.0	705.600	379.872	325.728
40	69.0	803.848	506.496	297.352
50	61.0	885.126	633.120	252.006
60	55.0	954.707	759.744	194.963
70	50.0	1015.623	886.368	129.255
80	46.0	1069.795	1012.992	56.803
90	43.0	1118.532	1139.616	0.000
100	40.0	1162.769	1266.240	0.000
110	38.0	1203.204	1392.864	0.000
120	36.0	1240.372	1519.488	0.000
130	34.0	1274.694	1646.112	0.000
140	32.0	1306.510	1772.736	0.000
150	31.0	1336.098	1899.360	0.000
160	29.0	1363.689	2025.984	0.000
170	28.0	1389.477	2152.608	0.000
180	27.0	1413.628	2279.232	0.000
190	26.0	1436.285	2405.856	0.000
200	25.0	1460.297	2532.480	0.000
210	24.0	1482.918	2659.104	0.000
220	24.0	1504.726	2785.728	0.000
230	23.0	1525.785	2912.352	0.000
240	22.0	1546.151	3038.976	0.000
250	22.0	1565.874	3165.600	0.000
260	21.0	1584.998	3292.224	0.000
270	21.0	1603.564	3418.848	0.000
280	20.0	1621.607	3545.472	0.000
290	20.0	1639.159	3672.096	0.000
300	19.0	1656.250	3798.720	0.000
310	19.0	1672.906	3925.344	0.000
320	18.0	1689.151	4051.968	0.000
330	18.0	1705.009	4178.592	0.000
340	17.0	1720.498	4305.216	0.000
350	17.0	1735.639	4431.840	0.000
360	17.0	1750.447	4558.464	0.000
370	16.0	1764.940	4685.088	0.000
380	16.0	1779.132	4811.712	0.000
390	16.0	1793.036	4938.336	0.000
400	16.0	1806.666	5064.960	0.000
410	15.0	1820.033	5191.584	0.000
420	15.0	1833.150	5318.208	0.000
430	15.0	1846.024	5444.832	0.000
440	15.0	1858.668	5571.456	0.000
450	14.0	1871.089	5698.080	0.000
460	14.0	1883.297	5824.704	0.000
470	14.0	1895.299	5951.328	0.000
480	14.0	1907.103	6077.952	0.000
490	14.0	1918.717	6204.576	0.000
500	13.0	1930.146	6331.200	0.000
510	13.0	1941.398	6457.824	0.000
520	13.0	1952.479	6584.448	0.000
530	13.0	1963.394	6711.072	0.000
540	13.0	1974.148	6837.696	0.000
550	12.0	1984.747	6964.320	0.000
560	12.0	1995.196	7090.944	0.000
570	12.0	2005.499	7217.568	0.000
580	12.0	2015.661	7344.192	0.000
590	12.0	2025.687	7470.816	0.000
600	12.0	2035.580	7597.440	0.000

Storage volume (m³) = 330.6 m³



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Sheet no.

3

Date

12/07/22

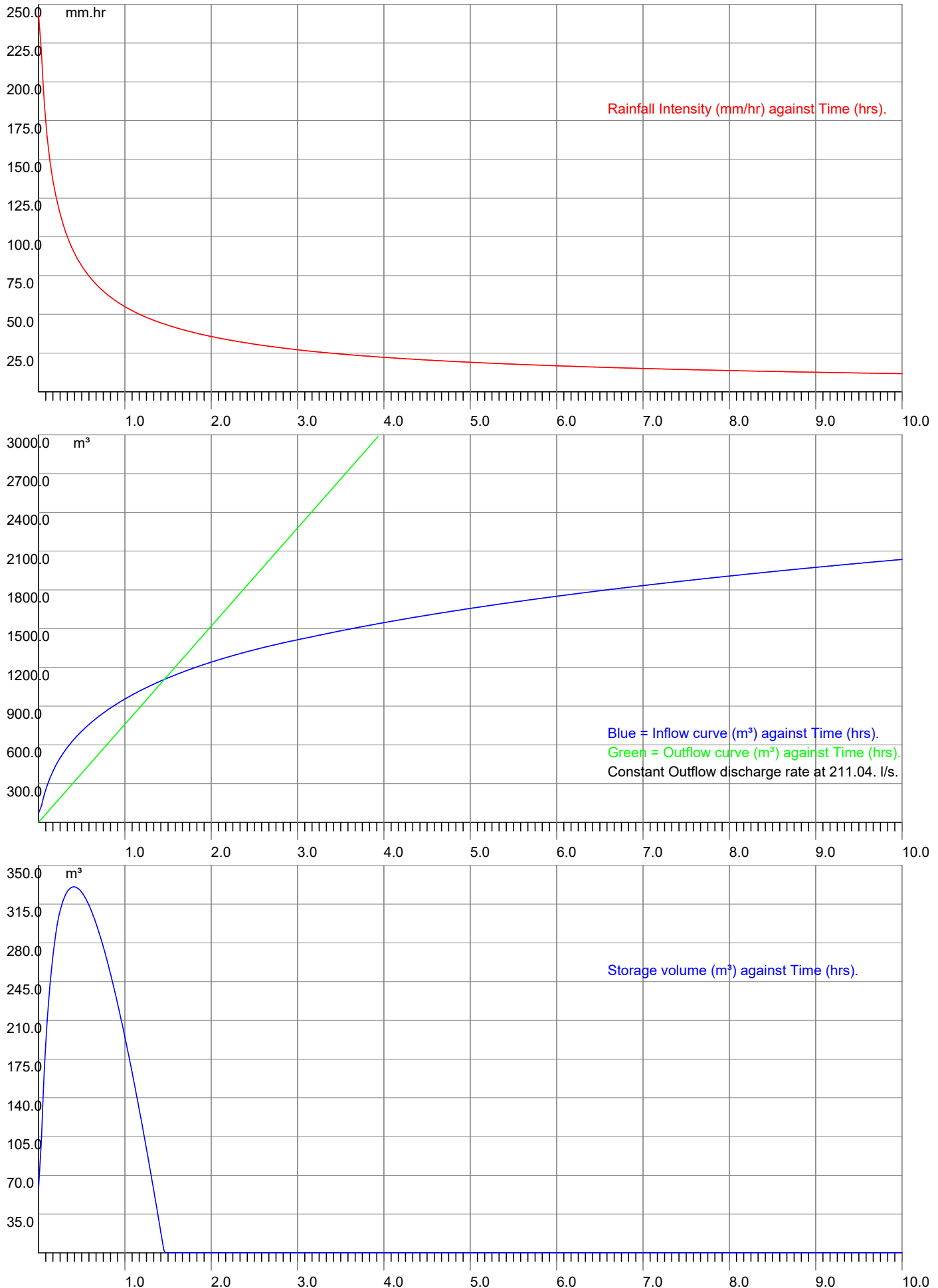
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Project
100yr+40% west ADAS

Title
Storage calcs for Littleborough





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Project **100yr+40% west ADAS**
Title **Storage calcs for Littleborough**

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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Job No.

Sheet no. **1**

Date **12/07/22**

Project **30yr event east IH**

Title **Storage calcs for Littleborough**

By

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Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 30

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 0

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean disch. rate = 65.040 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 62.0 mins

Rainfall at max = 29.29 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 363.6 m³

Allowed discharge rate = 65.040 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 9.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 65.040 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	46299.2	1125	365.8	400 x 600	2019.8	500 x 500	1454.3
150	20577.4	1200	321.5	600 x 900	879.4	500 x 750	969.5
225	9145.5	1275	284.8	800 x 1200	494.6	500 x 1000	727.1
300	5144.4	1350	254.0			750 x 1000	484.8
375	3292.4	1425	228.0			750 x 1200	404.0
450	2286.4	1500	205.8			750 x 1500	323.2
525	1679.8	1575	186.6			1000 x 1000	363.6
600	1286.1	1650	170.1			1000 x 1200	303.0
675	1016.2	1725	155.6			1000 x 1500	242.4
750	823.1	1800	142.9			1000 x 1800	202.0
825	680.2	1875	131.7			1000 x 2000	181.8
900	571.6	1950	121.8			1500 x 1500	161.6
975	487.0	2025	112.9			1500 x 1800	134.7
1050	419.9	2100	105.0			1500 x 2000	121.2



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Data:-

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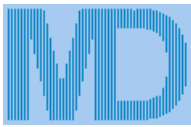
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Project	30yr event east IH
Title	Storage calcs for Littleborough

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	76.0	254.443	39.024	215.419
20	55.0	367.874	78.048	289.826
30	44.0	444.905	117.072	327.833
40	38.0	504.964	156.096	348.868
50	33.0	554.775	195.120	359.655
60	30.0	597.606	234.144	363.462
70	27.0	635.315	273.168	362.147
80	25.0	669.069	312.192	356.877
90	23.0	699.658	351.216	348.442
100	22.0	727.643	390.240	337.403
110	21.0	753.436	429.264	324.172
120	19.0	777.355	468.288	309.067
130	18.0	799.648	507.312	292.336
140	18.0	820.513	546.336	274.177
150	17.0	840.112	585.360	254.752
160	16.0	858.578	624.384	234.194
170	15.0	876.023	663.408	212.615
180	15.0	892.544	702.432	190.112
190	14.0	908.221	741.456	166.765
200	14.0	924.180	780.480	143.700
210	13.0	939.381	819.504	119.877
220	13.0	954.064	858.528	95.536
230	13.0	968.269	897.552	70.717
240	12.0	982.032	936.576	45.456
250	12.0	995.383	975.600	19.783
260	12.0	1008.352	1014.624	0.000
270	11.0	1020.962	1053.648	0.000
280	11.0	1033.238	1092.672	0.000
290	11.0	1045.198	1131.696	0.000
300	11.0	1056.862	1170.720	0.000
310	10.0	1068.246	1209.744	0.000
320	10.0	1079.366	1248.768	0.000
330	10.0	1090.236	1287.792	0.000
340	10.0	1100.869	1326.816	0.000
350	10.0	1111.276	1365.840	0.000
360	9.0	1121.469	1404.864	0.000
370	9.0	1131.458	1443.888	0.000
380	9.0	1141.251	1482.912	0.000
390	9.0	1150.859	1521.936	0.000
400	9.0	1160.289	1560.960	0.000
410	9.0	1169.548	1599.984	0.000
420	8.0	1178.644	1639.008	0.000
430	8.0	1187.584	1678.032	0.000
440	8.0	1196.373	1717.056	0.000
450	8.0	1205.017	1756.080	0.000
460	8.0	1213.522	1795.104	0.000
470	8.0	1221.894	1834.128	0.000
480	8.0	1230.136	1873.152	0.000
490	8.0	1238.254	1912.176	0.000
500	7.0	1246.251	1951.200	0.000
510	7.0	1254.133	1990.224	0.000
520	7.0	1261.902	2029.248	0.000
530	7.0	1269.563	2068.272	0.000
540	7.0	1277.119	2107.296	0.000
550	7.0	1284.573	2146.320	0.000
560	7.0	1291.928	2185.344	0.000
570	7.0	1299.188	2224.368	0.000
580	7.0	1306.355	2263.392	0.000
590	7.0	1313.433	2302.416	0.000
600	7.0	1320.423	2341.440	0.000

Storage volume (m³) = 363.6 m³



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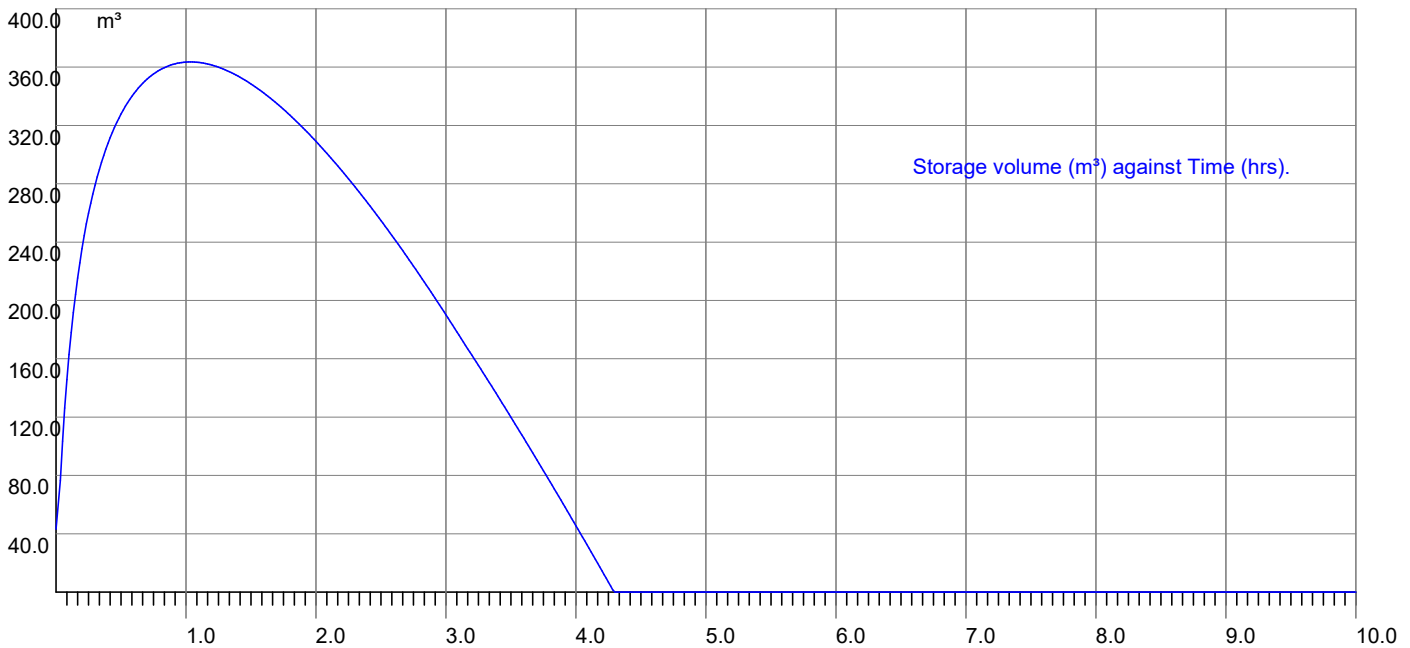
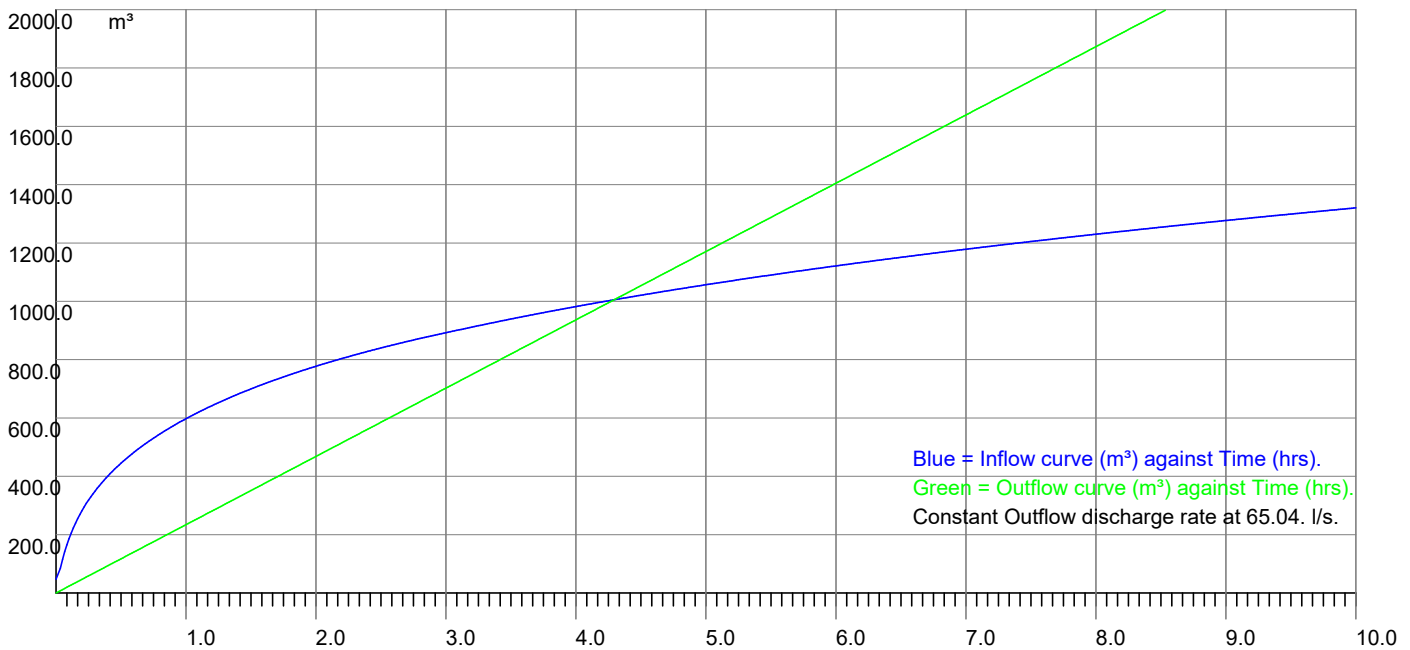
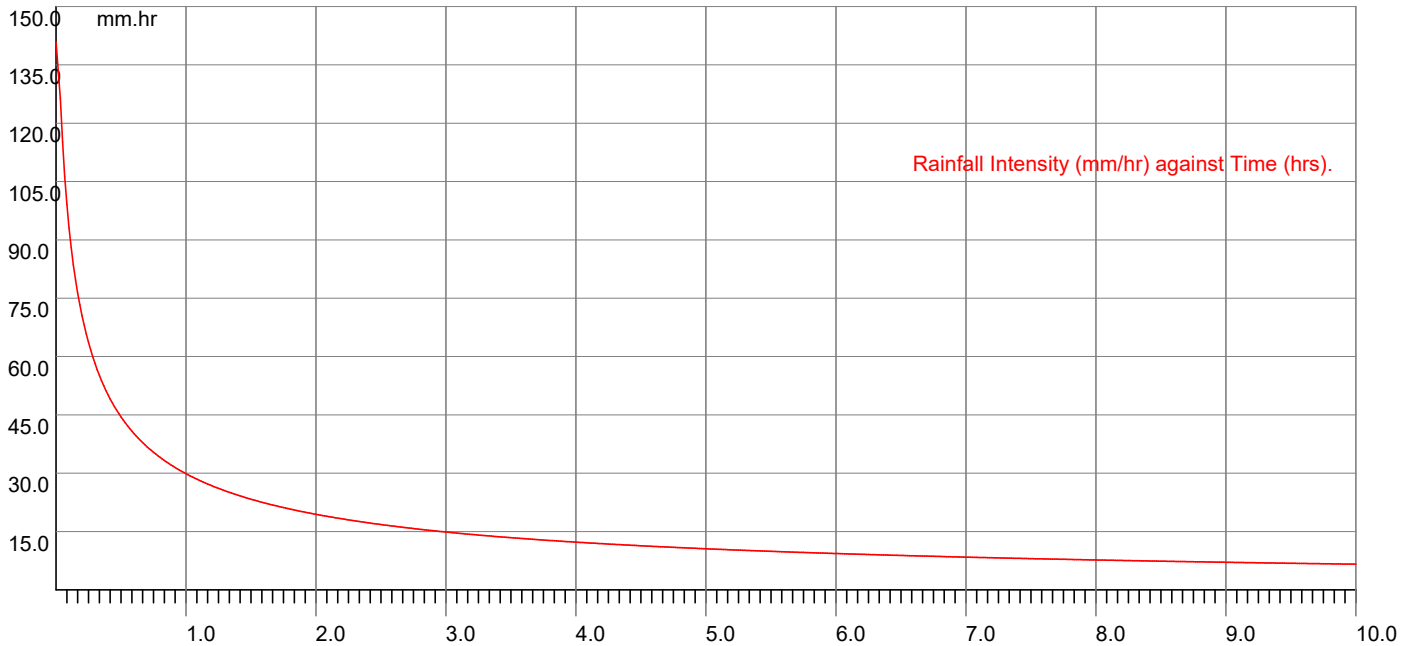
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Project **30yr event east IH**

Title **Storage calcs for Littleborough**





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Date 12/07/22		
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Project	30yr event ADAS east
Title	Storage calcs for Littleborough

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 30

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 0

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean disch. rate = 213.120 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 0

Calculated data:-

Time to max = 13.0 mins

Rainfall at max = 68.09 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 128.9 m³

Allowed discharge rate = 213.120 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 9.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 213.120 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	16420.0	1125	129.7	400 x 600	716.3	500 x 500	515.8
150	7297.8	1200	114.0	600 x 900	311.9	500 x 750	343.8
225	3243.5	1275	101.0	800 x 1200	175.4	500 x 1000	257.9
300	1824.4	1350	90.1			750 x 1000	171.9
375	1167.6	1425	80.9			750 x 1200	143.3
450	810.9	1500	73.0			750 x 1500	114.6
525	595.7	1575	66.2			1000 x 1000	128.9
600	456.1	1650	60.3			1000 x 1200	107.4
675	360.4	1725	55.2			1000 x 1500	86.0
750	291.9	1800	50.7			1000 x 1800	71.6
825	241.2	1875	46.7			1000 x 2000	64.5
900	202.7	1950	43.2			1500 x 1500	57.3
975	172.7	2025	40.0			1500 x 1800	47.8
1050	148.9	2100	37.2			1500 x 2000	43.0



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Data:-

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Sheet no. **2**

Date **12/07/22**

Project **30yr event ADAS east**

Title **Storage calcs for Littleborough**

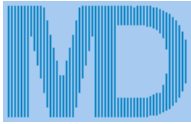
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Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	76.0	254.443	127.872	126.571
20	55.0	367.874	255.744	112.130
30	44.0	444.905	383.616	61.289
40	38.0	504.964	511.488	0.000
50	33.0	554.775	639.360	0.000
60	30.0	597.606	767.232	0.000
70	27.0	635.315	895.104	0.000
80	25.0	669.069	1022.976	0.000
90	23.0	699.658	1150.848	0.000
100	22.0	727.643	1278.720	0.000
110	21.0	753.436	1406.592	0.000
120	19.0	777.355	1534.464	0.000
130	18.0	799.648	1662.336	0.000
140	18.0	820.513	1790.208	0.000
150	17.0	840.112	1918.080	0.000
160	16.0	858.578	2045.952	0.000
170	15.0	876.023	2173.824	0.000
180	15.0	892.544	2301.696	0.000
190	14.0	908.221	2429.568	0.000
200	14.0	924.180	2557.440	0.000
210	13.0	939.381	2685.312	0.000
220	13.0	954.064	2813.184	0.000
230	13.0	968.269	2941.056	0.000
240	12.0	982.032	3068.928	0.000
250	12.0	995.383	3196.800	0.000
260	12.0	1008.352	3324.672	0.000
270	11.0	1020.962	3452.544	0.000
280	11.0	1033.238	3580.416	0.000
290	11.0	1045.198	3708.288	0.000
300	11.0	1056.862	3836.160	0.000
310	10.0	1068.246	3964.032	0.000
320	10.0	1079.366	4091.904	0.000
330	10.0	1090.236	4219.776	0.000
340	10.0	1100.869	4347.648	0.000
350	10.0	1111.276	4475.520	0.000
360	9.0	1121.469	4603.392	0.000
370	9.0	1131.458	4731.264	0.000
380	9.0	1141.251	4859.136	0.000
390	9.0	1150.859	4987.008	0.000
400	9.0	1160.289	5114.880	0.000
410	9.0	1169.548	5242.752	0.000
420	8.0	1178.644	5370.624	0.000
430	8.0	1187.584	5498.496	0.000
440	8.0	1196.373	5626.368	0.000
450	8.0	1205.017	5754.240	0.000
460	8.0	1213.522	5882.112	0.000
470	8.0	1221.894	6009.984	0.000
480	8.0	1230.136	6137.856	0.000
490	8.0	1238.254	6265.728	0.000
500	7.0	1246.251	6393.600	0.000
510	7.0	1254.133	6521.472	0.000
520	7.0	1261.902	6649.344	0.000
530	7.0	1269.563	6777.216	0.000
540	7.0	1277.119	6905.088	0.000
550	7.0	1284.573	7032.960	0.000
560	7.0	1291.928	7160.832	0.000
570	7.0	1299.188	7288.704	0.000
580	7.0	1306.355	7416.576	0.000
590	7.0	1313.433	7544.448	0.000
600	7.0	1320.423	7672.320	0.000

Storage volume (m³) = 128.9 m³



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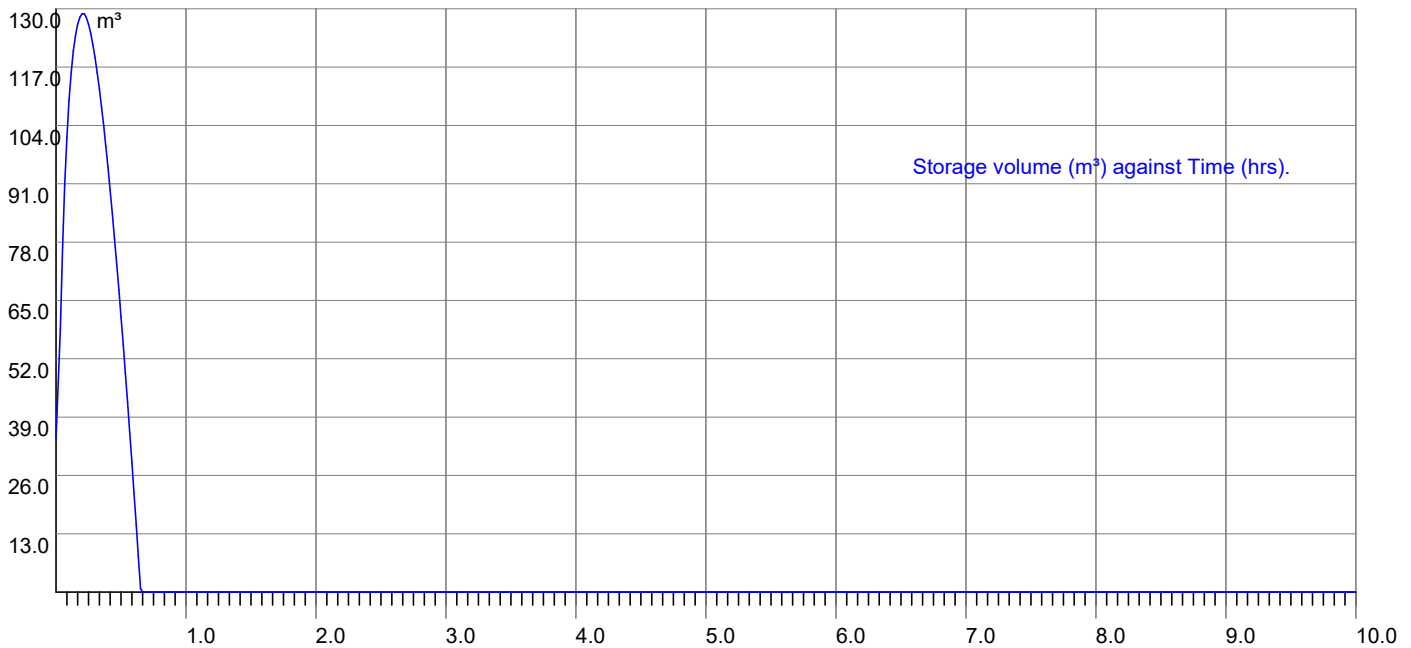
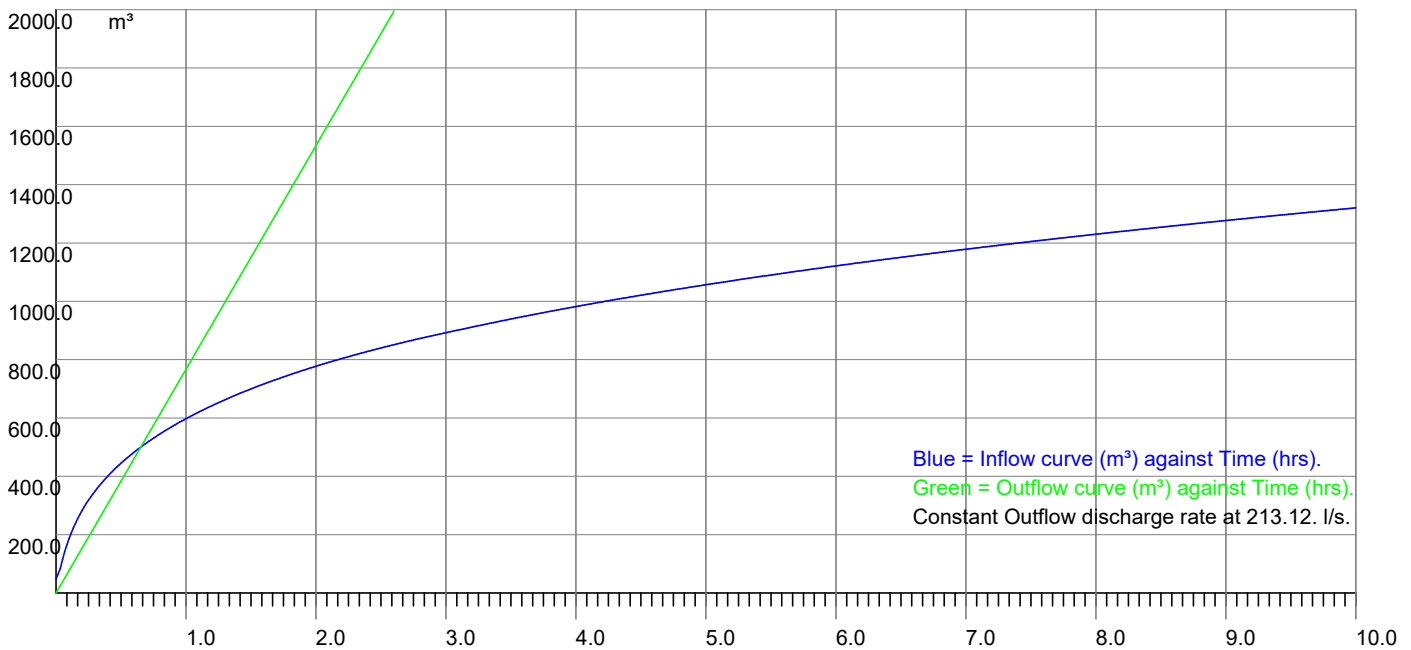
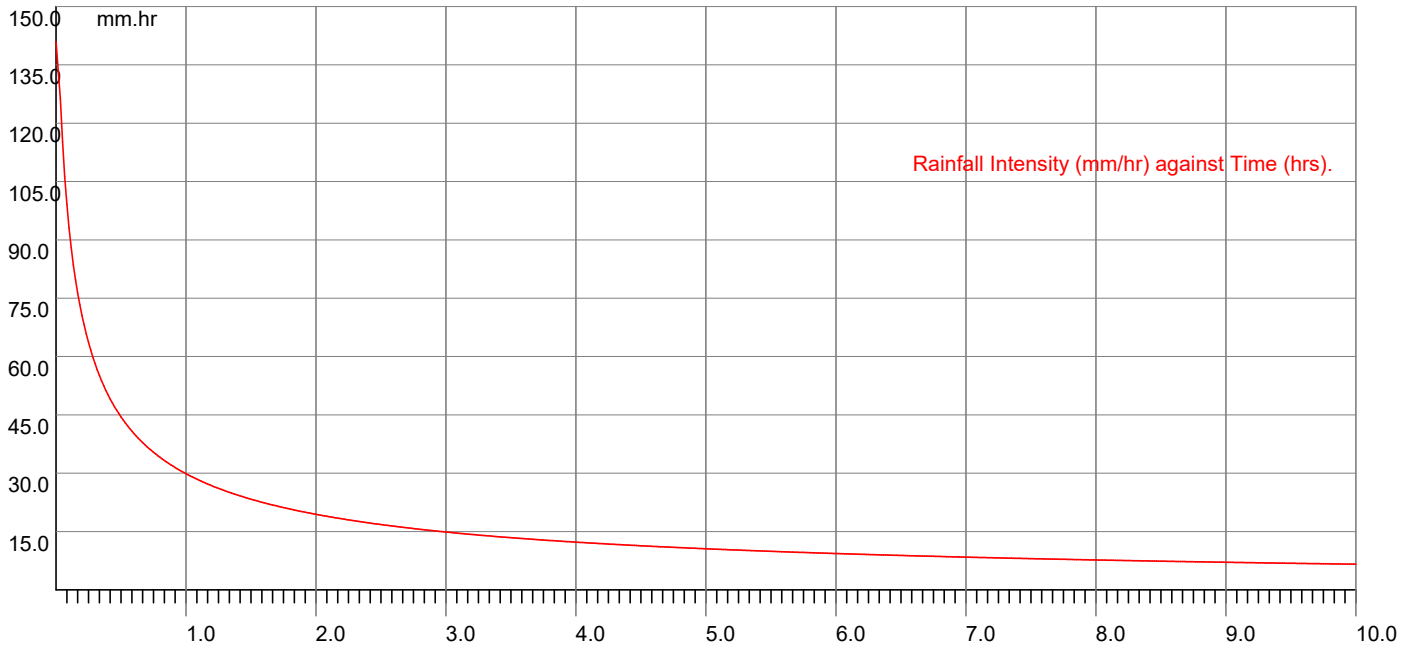
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Project **30yr event ADAS east**

Title **Storage calcs for Littleborough**





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Project **100yr + 20% IH east**

Title **Storage calcs for Littleborough**

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean disch. rate = 81.290 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 84.0 mins

Rainfall at max = 38.41 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 666.2 m³

Allowed discharge rate = 81.290 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 81.290 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	84843.8	1125	670.4	400 x 600	3701.3	500 x 500	2664.9
150	37708.3	1200	589.2	600 x 900	1611.6	500 x 750	1776.6
225	16759.3	1275	521.9	800 x 1200	906.4	500 x 1000	1332.5
300	9427.1	1350	465.5			750 x 1000	888.3
375	6033.3	1425	417.8			750 x 1200	740.3
450	4189.8	1500	377.1			750 x 1500	592.2
525	3078.2	1575	342.0			1000 x 1000	666.2
600	2356.8	1650	311.6			1000 x 1200	555.2
675	1862.1	1725	285.1			1000 x 1500	444.2
750	1508.3	1800	261.9			1000 x 1800	370.1
825	1246.6	1875	241.3			1000 x 2000	333.1
900	1047.5	1950	223.1			1500 x 1500	296.1
975	892.5	2025	206.9			1500 x 1800	246.8
1050	769.6	2100	192.4			1500 x 2000	222.1



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SW

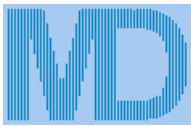
Project **100yr + 20% IH east**

Title **Storage calcs for Littleborough**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	117.0	389.704	48.774	340.930
20	86.0	572.257	97.548	474.709
30	70.0	696.571	146.322	550.249
40	59.0	793.562	195.096	598.466
50	52.0	873.800	243.870	629.930
60	47.0	942.491	292.644	649.847
70	43.0	1002.627	341.418	661.209
80	40.0	1056.106	390.192	665.914
90	37.0	1104.219	438.966	665.253
100	34.0	1147.891	487.740	660.151
110	32.0	1187.808	536.514	651.294
120	31.0	1224.500	585.288	639.212
130	29.0	1258.384	634.062	624.322
140	28.0	1289.793	682.836	606.957
150	26.0	1319.002	731.610	587.392
160	25.0	1346.240	780.384	565.855
170	24.0	1371.698	829.158	542.540
180	23.0	1395.540	877.932	517.608
190	22.0	1417.906	926.706	491.201
200	22.0	1441.611	975.480	466.131
210	21.0	1463.943	1024.254	439.689
220	20.0	1485.472	1073.028	412.444
230	20.0	1506.262	1121.802	384.460
240	19.0	1526.367	1170.576	355.791
250	19.0	1545.838	1219.350	326.488
260	18.0	1564.717	1268.124	296.593
270	18.0	1583.046	1316.898	266.148
280	17.0	1600.858	1365.672	235.186
290	17.0	1618.185	1414.446	203.739
300	16.0	1635.057	1463.220	171.837
310	16.0	1651.500	1511.994	139.506
320	16.0	1667.538	1560.768	106.770
330	15.0	1683.192	1609.542	73.650
340	15.0	1698.484	1658.316	40.167
350	15.0	1713.430	1707.090	6.340
360	14.0	1728.049	1755.864	0.000
370	14.0	1742.357	1804.638	0.000
380	14.0	1756.367	1853.412	0.000
390	14.0	1770.093	1902.186	0.000
400	13.0	1783.549	1950.960	0.000
410	13.0	1796.745	1999.734	0.000
420	13.0	1809.693	2048.508	0.000
430	13.0	1822.403	2097.282	0.000
440	13.0	1834.885	2146.056	0.000
450	12.0	1847.147	2194.830	0.000
460	12.0	1859.199	2243.604	0.000
470	12.0	1871.047	2292.378	0.000
480	12.0	1882.701	2341.152	0.000
490	12.0	1894.166	2389.926	0.000
500	11.0	1905.449	2438.700	0.000
510	11.0	1916.557	2487.474	0.000
520	11.0	1927.496	2536.248	0.000
530	11.0	1938.271	2585.022	0.000
540	11.0	1948.887	2633.796	0.000
550	11.0	1959.351	2682.570	0.000
560	11.0	1969.666	2731.344	0.000
570	10.0	1979.838	2780.118	0.000
580	10.0	1989.870	2828.892	0.000
590	10.0	1999.767	2877.666	0.000
600	10.0	2009.533	2926.440	0.000

Storage volume (m³) = 666.2 m³



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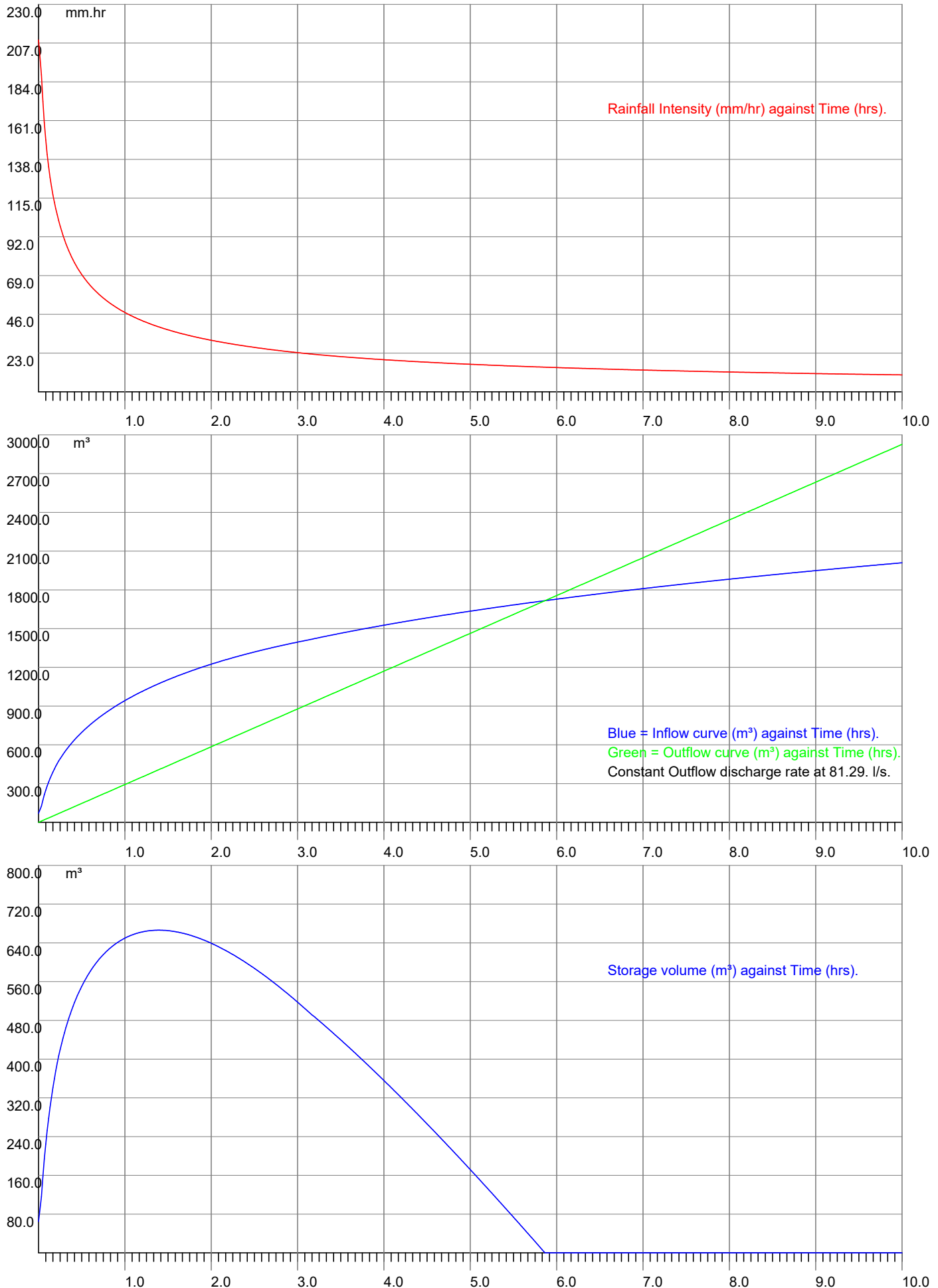
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Project **100yr + 20% IH east**

Title **Storage calcs for Littleborough**





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Project	100yr+20% ADAS east
Title	Storage calcs for Littleborough

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 20

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean pump disch. rate = 276.910 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 20

Calculated data:-

Time to max = 16.0 mins

Rainfall at max = 95.57 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 244.1 m³

Allowed discharge rate = 276.910 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 14.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 276.910 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	31082.8	1125	245.6	400 x 600	1356.0	500 x 500	976.3
150	13814.6	1200	215.9	600 x 900	590.4	500 x 750	650.9
225	6139.8	1275	191.2	800 x 1200	332.1	500 x 1000	488.2
300	3453.6	1350	170.6			750 x 1000	325.4
375	2210.3	1425	153.1			750 x 1200	271.2
450	1535.0	1500	138.1			750 x 1500	217.0
525	1127.7	1575	125.3			1000 x 1000	244.1
600	863.4	1650	114.2			1000 x 1200	203.4
675	682.2	1725	104.5			1000 x 1500	162.7
750	552.6	1800	95.9			1000 x 1800	135.6
825	456.7	1875	88.4			1000 x 2000	122.0
900	383.7	1950	81.7			1500 x 1500	108.5
975	327.0	2025	75.8			1500 x 1800	90.4
1050	281.9	2100	70.5			1500 x 2000	81.4



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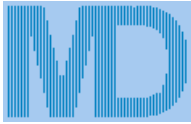
MasterDrain
SW

Project	100yr+20% ADAS east
Title	Storage calcs for Littleborough

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	117.0	389.704	166.146	223.558
20	86.0	572.257	332.292	239.965
30	70.0	696.571	498.438	198.133
40	59.0	793.562	664.584	128.978
50	52.0	873.800	830.730	43.070
60	47.0	942.491	996.876	0.000
70	43.0	1002.627	1163.022	0.000
80	40.0	1056.106	1329.168	0.000
90	37.0	1104.219	1495.314	0.000
100	34.0	1147.891	1661.460	0.000
110	32.0	1187.808	1827.606	0.000
120	31.0	1224.500	1993.752	0.000
130	29.0	1258.384	2159.898	0.000
140	28.0	1289.793	2326.044	0.000
150	26.0	1319.002	2492.190	0.000
160	25.0	1346.240	2658.336	0.000
170	24.0	1371.698	2824.482	0.000
180	23.0	1395.540	2990.628	0.000
190	22.0	1417.906	3156.774	0.000
200	22.0	1441.611	3322.920	0.000
210	21.0	1463.943	3489.066	0.000
220	20.0	1485.472	3655.212	0.000
230	20.0	1506.262	3821.358	0.000
240	19.0	1526.367	3987.504	0.000
250	19.0	1545.838	4153.650	0.000
260	18.0	1564.717	4319.796	0.000
270	18.0	1583.046	4485.942	0.000
280	17.0	1600.858	4652.088	0.000
290	17.0	1618.185	4818.234	0.000
300	16.0	1635.057	4984.380	0.000
310	16.0	1651.500	5150.526	0.000
320	16.0	1667.538	5316.672	0.000
330	15.0	1683.192	5482.818	0.000
340	15.0	1698.484	5648.964	0.000
350	15.0	1713.430	5815.110	0.000
360	14.0	1728.049	5981.256	0.000
370	14.0	1742.357	6147.402	0.000
380	14.0	1756.367	6313.548	0.000
390	14.0	1770.093	6479.694	0.000
400	13.0	1783.549	6645.840	0.000
410	13.0	1796.745	6811.986	0.000
420	13.0	1809.693	6978.132	0.000
430	13.0	1822.403	7144.278	0.000
440	13.0	1834.885	7310.424	0.000
450	12.0	1847.147	7476.570	0.000
460	12.0	1859.199	7642.716	0.000
470	12.0	1871.047	7808.862	0.000
480	12.0	1882.701	7975.008	0.000
490	12.0	1894.166	8141.154	0.000
500	11.0	1905.449	8307.300	0.000
510	11.0	1916.557	8473.446	0.000
520	11.0	1927.496	8639.592	0.000
530	11.0	1938.271	8805.738	0.000
540	11.0	1948.887	8971.884	0.000
550	11.0	1959.351	9138.030	0.000
560	11.0	1969.666	9304.176	0.000
570	10.0	1979.838	9470.322	0.000
580	10.0	1989.870	9636.468	0.000
590	10.0	1999.767	9802.614	0.000
600	10.0	2009.533	9968.760	0.000

Storage volume (m³) = 244.1 m³



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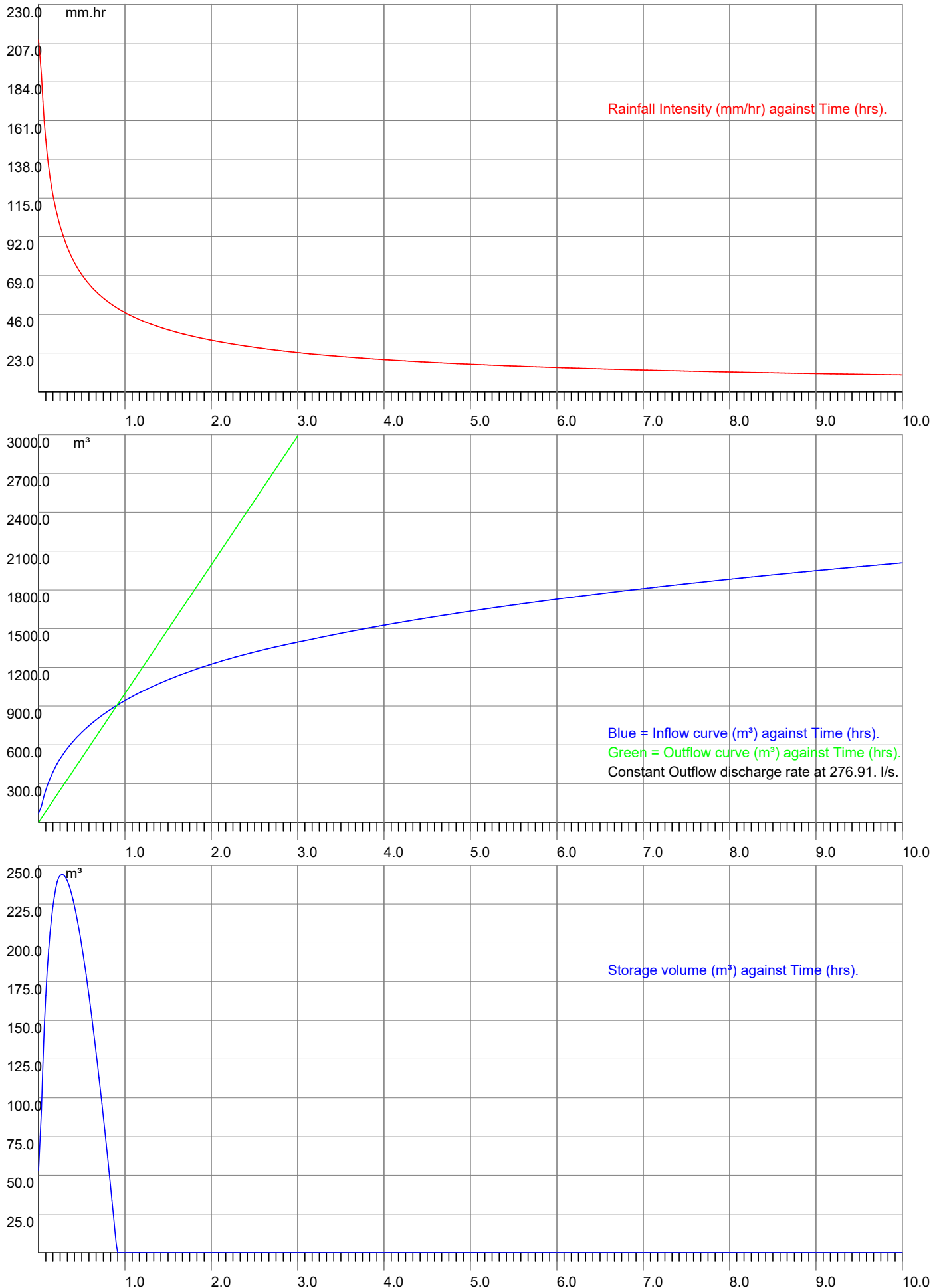
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Project **100yr+20% ADAS east**
Title **Storage calcs for Littleborough**





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Sheet no. **1**

Date **12/07/22**

Project **100yr+40% IH east**

Title **Storage calcs for Littleborough**

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Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean disch. rate = 81.290 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 100.0 mins

Rainfall at max = 40.16 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 851.5 m³

Allowed discharge rate = 81.290 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 16.00 mm/hr

Calculated storage volume = 228.1 m³

Allowed discharge rate = 81.290 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	108432.5	1125	856.8	400 x 600	4730.4	500 x 500	3405.9
150	48192.2	1200	753.0	600 x 900	2059.7	500 x 750	2270.6
225	21418.8	1275	667.0	800 x 1200	1158.4	500 x 1000	1702.9
300	12048.1	1350	595.0			750 x 1000	1135.3
375	7710.8	1425	534.0			750 x 1200	946.1
450	5354.7	1500	481.9			750 x 1500	756.9
525	3934.1	1575	437.1			1000 x 1000	851.5
600	3012.0	1650	398.3			1000 x 1200	709.6
675	2379.9	1725	364.4			1000 x 1500	567.6
750	1927.7	1800	334.7			1000 x 1800	473.0
825	1593.1	1875	308.4			1000 x 2000	425.7
900	1338.7	1950	285.2			1500 x 1500	378.4
975	1140.6	2025	264.4			1500 x 1800	315.4
1050	983.5	2100	245.9			1500 x 2000	283.8



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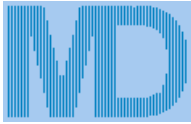
Project **100yr+40% IH east**

Title **Storage calcs for Littleborough**

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	136.0	454.655	48.774	405.881
20	100.0	667.634	97.548	570.086
30	81.0	812.666	146.322	666.344
40	69.0	925.823	195.096	730.727
50	61.0	1019.433	243.870	775.563
60	55.0	1099.573	292.644	806.929
70	50.0	1169.732	341.418	828.314
80	46.0	1232.124	390.192	841.932
90	43.0	1288.256	438.966	849.290
100	40.0	1339.206	487.740	851.466
110	38.0	1385.776	536.514	849.262
120	36.0	1428.584	585.288	843.296
130	34.0	1468.114	634.062	834.052
140	32.0	1504.758	682.836	821.922
150	31.0	1538.835	731.610	807.225
160	29.0	1570.613	780.384	790.229
170	28.0	1600.314	829.158	771.156
180	27.0	1628.130	877.932	750.198
190	26.0	1654.224	926.706	727.518
200	25.0	1681.880	975.480	706.400
210	24.0	1707.934	1024.254	683.680
220	24.0	1733.051	1073.028	660.023
230	23.0	1757.305	1121.802	635.503
240	22.0	1780.762	1170.576	610.186
250	22.0	1803.477	1219.350	584.127
260	21.0	1825.504	1268.124	557.380
270	21.0	1846.886	1316.898	529.988
280	20.0	1867.667	1365.672	501.995
290	20.0	1887.883	1414.446	473.437
300	19.0	1907.567	1463.220	444.347
310	19.0	1926.750	1511.994	414.756
320	18.0	1945.461	1560.768	384.693
330	18.0	1963.724	1609.542	354.182
340	17.0	1981.564	1658.316	323.248
350	17.0	1999.002	1707.090	291.912
360	17.0	2016.057	1755.864	260.193
370	16.0	2032.749	1804.638	228.111
380	16.0	2049.094	1853.412	195.682
390	16.0	2065.109	1902.186	162.923
400	16.0	2080.807	1950.960	129.847
410	15.0	2096.202	1999.734	96.468
420	15.0	2111.309	2048.508	62.801
430	15.0	2126.137	2097.282	28.855
440	15.0	2140.699	2146.056	0.000
450	14.0	2155.005	2194.830	0.000
460	14.0	2169.065	2243.604	0.000
470	14.0	2182.889	2292.378	0.000
480	14.0	2196.484	2341.152	0.000
490	14.0	2209.860	2389.926	0.000
500	13.0	2223.024	2438.700	0.000
510	13.0	2235.983	2487.474	0.000
520	13.0	2248.745	2536.248	0.000
530	13.0	2261.316	2585.022	0.000
540	13.0	2273.702	2633.796	0.000
550	12.0	2285.909	2682.570	0.000
560	12.0	2297.944	2731.344	0.000
570	12.0	2309.811	2780.118	0.000
580	12.0	2321.515	2828.892	0.000
590	12.0	2333.062	2877.666	0.000
600	12.0	2344.455	2926.440	0.000

Storage volume (m³) = 851.5 m³



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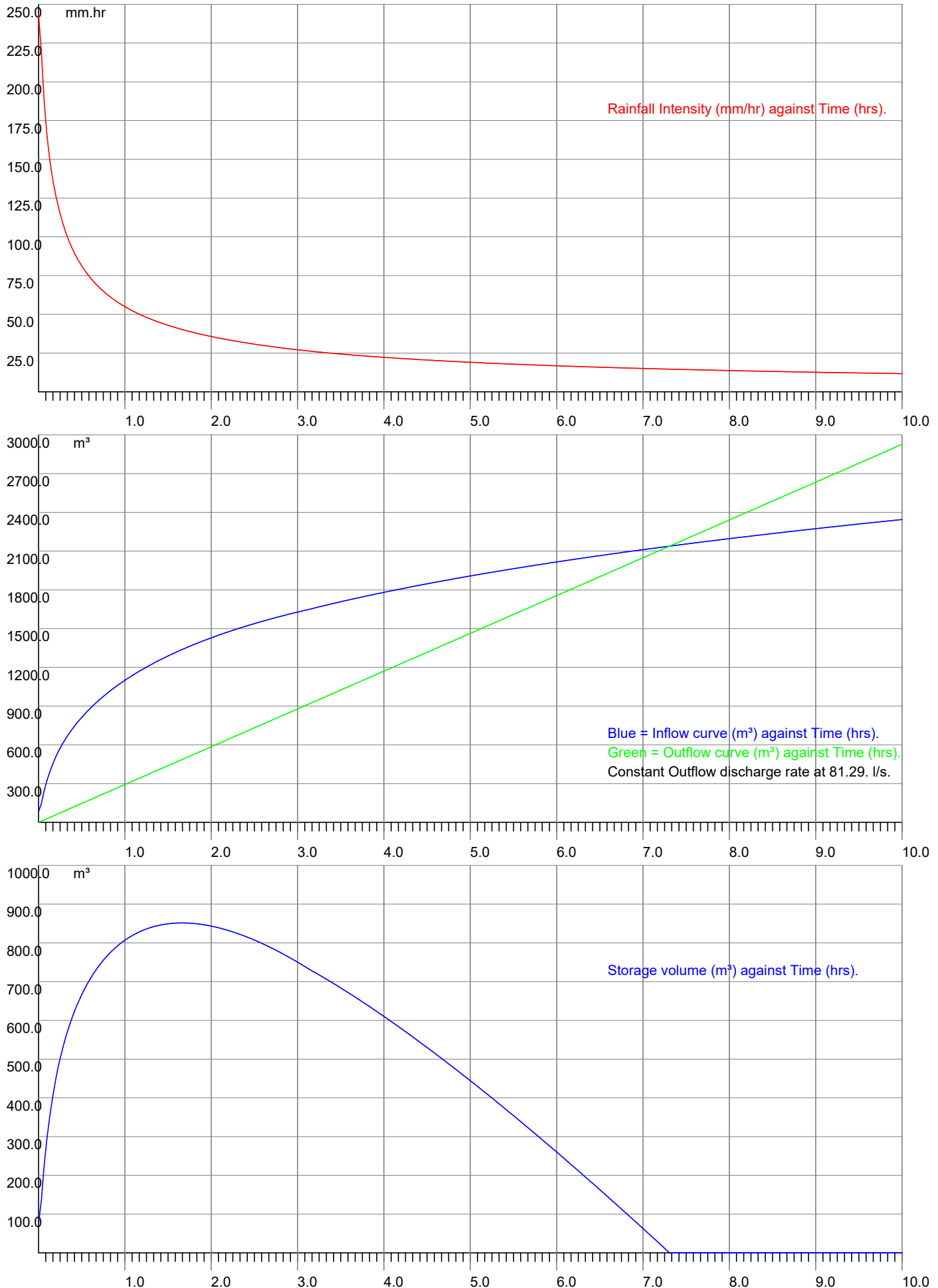
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Project **100yr+40% IH east**

Title **Storage calcs for Littleborough**





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Project	100yr+40% ADAS east
Title	Storage calcs for Littleborough

Data:-

FSR Hydrology:-

Location = Littleborough

M5-60 (mm) = 19.4

Soil index = 0.45

Return period = 100

UCWI = 118.5

Grid reference = SD9125

r = 0.26

SAAR (mm/yr) = 1160

WRAP = 4

Climate change = 40

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

Runoff factor (RF) = 41.0, 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 = 24300 m²

Total area (TA) = 48800 m²

Mean disch. rate = 276.910 l/s

Additional flow = 0.00 l/s

Pervious area = 24500 m²

Equiv area = 20008 m² (TA x RF).

Areal reduction factor = 1.000

Climate change factor = 40

Calculated data:-

Time to max = 20.0 mins

Rainfall at max = 100.11 mm/hr

Pipeline storage = 0.0 m³

Offline storage = 0.0 m³

Calculated storage volume = 335.3 m³

Allowed discharge rate = 276.910 l/s

Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours

Rainfall rate = 16.00 mm/hr

Calculated storage volume = 0.0 m³

Allowed discharge rate = 276.910 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	42705.1	1125	337.4	400 x 600	1863.0	500 x 500	1341.4
150	18980.0	1200	296.6	600 x 900	811.2	500 x 750	894.2
225	8435.6	1275	262.7	800 x 1200	456.2	500 x 1000	670.7
300	4745.0	1350	234.3			750 x 1000	447.1
375	3036.8	1425	210.3			750 x 1200	372.6
450	2108.9	1500	189.8			750 x 1500	298.1
525	1549.4	1575	172.2			1000 x 1000	335.3
600	1186.3	1650	156.9			1000 x 1200	279.5
675	937.3	1725	143.5			1000 x 1500	223.6
750	759.2	1800	131.8			1000 x 1800	186.3
825	627.4	1875	121.5			1000 x 2000	167.7
900	527.2	1950	112.3			1500 x 1500	149.0
975	449.2	2025	104.1			1500 x 1800	124.2
1050	387.3	2100	96.8			1500 x 2000	111.8



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Data:-

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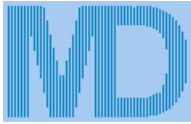
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Title	Storage calcs for Littleborough

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	136.0	454.655	166.146	288.509
20	100.0	667.634	332.292	335.342
30	81.0	812.666	498.438	314.228
40	69.0	925.823	664.584	261.239
50	61.0	1019.433	830.730	188.703
60	55.0	1099.573	996.876	102.697
70	50.0	1169.732	1163.022	6.710
80	46.0	1232.124	1329.168	0.000
90	43.0	1288.256	1495.314	0.000
100	40.0	1339.206	1661.460	0.000
110	38.0	1385.776	1827.606	0.000
120	36.0	1428.584	1993.752	0.000
130	34.0	1468.114	2159.898	0.000
140	32.0	1504.758	2326.044	0.000
150	31.0	1538.835	2492.190	0.000
160	29.0	1570.613	2658.336	0.000
170	28.0	1600.314	2824.482	0.000
180	27.0	1628.130	2990.628	0.000
190	26.0	1654.224	3156.774	0.000
200	25.0	1681.880	3322.920	0.000
210	24.0	1707.934	3489.066	0.000
220	24.0	1733.051	3655.212	0.000
230	23.0	1757.305	3821.358	0.000
240	22.0	1780.762	3987.504	0.000
250	22.0	1803.477	4153.650	0.000
260	21.0	1825.504	4319.796	0.000
270	21.0	1846.886	4485.942	0.000
280	20.0	1867.667	4652.088	0.000
290	20.0	1887.883	4818.234	0.000
300	19.0	1907.567	4984.380	0.000
310	19.0	1926.750	5150.526	0.000
320	18.0	1945.461	5316.672	0.000
330	18.0	1963.724	5482.818	0.000
340	17.0	1981.564	5648.964	0.000
350	17.0	1999.002	5815.110	0.000
360	17.0	2016.057	5981.256	0.000
370	16.0	2032.749	6147.402	0.000
380	16.0	2049.094	6313.548	0.000
390	16.0	2065.109	6479.694	0.000
400	16.0	2080.807	6645.840	0.000
410	15.0	2096.202	6811.986	0.000
420	15.0	2111.309	6978.132	0.000
430	15.0	2126.137	7144.278	0.000
440	15.0	2140.699	7310.424	0.000
450	14.0	2155.005	7476.570	0.000
460	14.0	2169.065	7642.716	0.000
470	14.0	2182.889	7808.862	0.000
480	14.0	2196.484	7975.008	0.000
490	14.0	2209.860	8141.154	0.000
500	13.0	2223.024	8307.300	0.000
510	13.0	2235.983	8473.446	0.000
520	13.0	2248.745	8639.592	0.000
530	13.0	2261.316	8805.738	0.000
540	13.0	2273.702	8971.884	0.000
550	12.0	2285.909	9138.030	0.000
560	12.0	2297.944	9304.176	0.000
570	12.0	2309.811	9470.322	0.000
580	12.0	2321.515	9636.468	0.000
590	12.0	2333.062	9802.614	0.000
600	12.0	2344.455	9968.760	0.000

Storage volume (m³) = 335.3 m³



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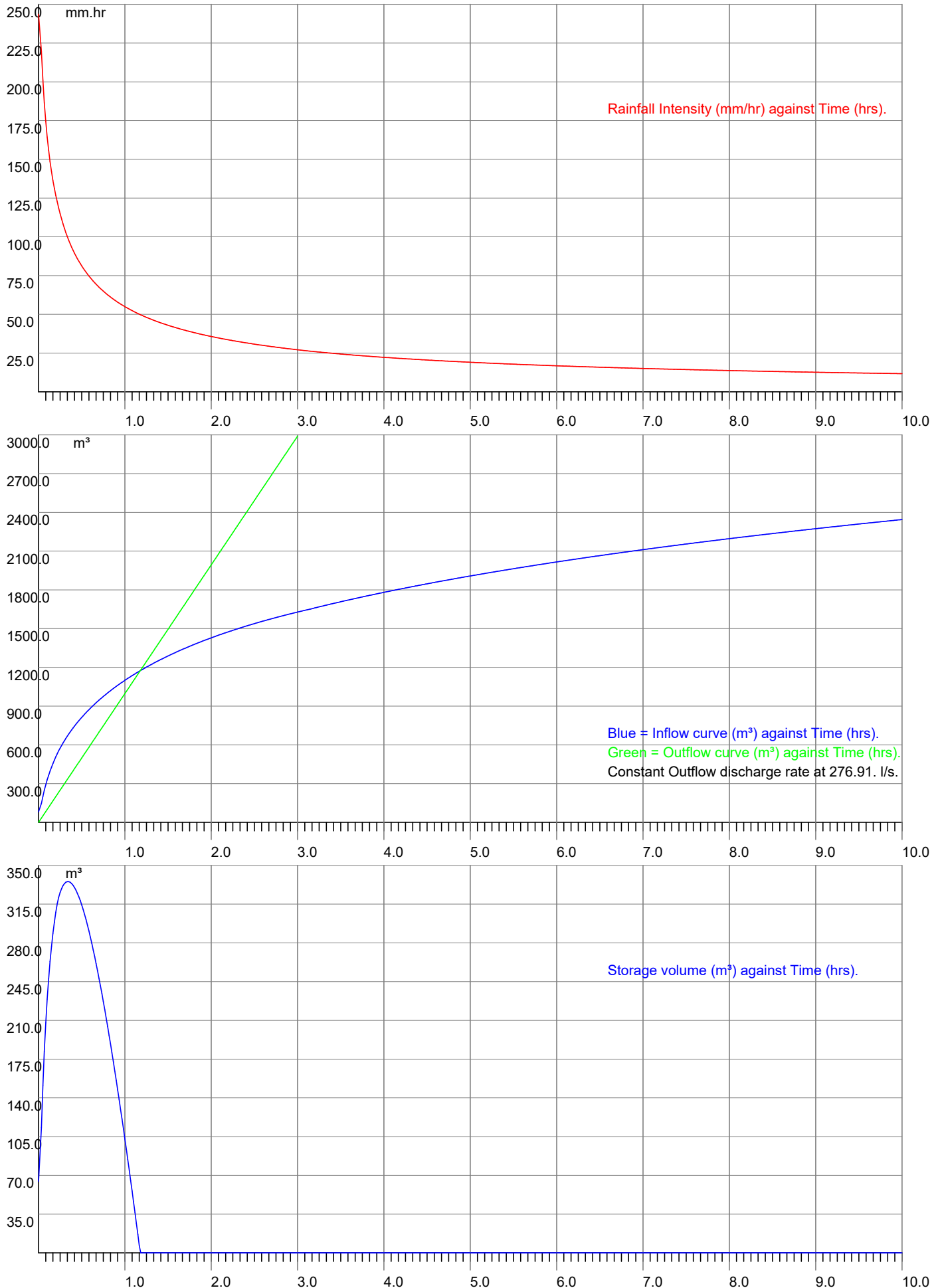
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Explanatory notes for Peak Flow Storage

- 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.

Appendix F

Drainage Layout