26A WILBRAHAM ROAD, MANCHESTER

SUSTAINABLE DRAINAGE STRATEGY

Job Number: FRA 23 1092
Date: January 2024
Client: Creative Property People Ltd

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LK Consult Document Verification			
Site Address	26a Wilbraham Road, Fallowfield, Manchester, M14 6JX		
Report Title	Sustainable Drainage Strategy		
Job Number	FRA 23 1092	**Document Ref.**	FRA 23 1092 - SUD - R0
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Prepared By	Jenna Lowe – Flood Risk Engineer	**Reviewed By**	Paul Quimby

Revision Record			
Revision No.	**Date**	**Nature of Revision**	**Approved By**

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EXECUTIVE SUMMARY

Scope and Background

This Sustainable Drainage (SuDS) Strategy has been undertaken by LK Consult Ltd (LKC) to support a planning application for the redevelopment of 26a Wilbraham Road, Manchester. The development comprises the demolishment and replacement of the existing building with a residential apartment block and associated soft landscaping and car parking.

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

Consultations

Manchester City Council – Lead Local Flood Authority (LLFA) and United Utilities (UU) have been contacted during preparation of this report.

The Environment Agency (EA) website has been utilised to assess if there are any limitations that may affect the form of SuDS that may be appropriate to this site. The records show that the site is within Flood Zone 1.

Drainage Strategy

The ground conditions beneath the site are recorded as Till, Devensian superficial deposits that mainly consist of silty sandy Clay with occasional fine to coarse subrounded Gravel over Sandstone bedrock which have been confirmed by British Geological Survey (BGS) borehole records.

There is a slight slope from the south east towards the north eastern boundary.

The outline drainage strategy considers the use of an infiltration-based SuDS to be not feasible. It is assumed that surface water runoff arising from the development will discharge into the combined sewer on the southern boundary of the site.

The most effective strategy, in line with the SuDS management train, would be to have a detention facility at the southern boundary.

The estimated volume to be retained on site for the 1 in 30-year storm event including an allowance for climate change is **21.6m^3.**

The estimated volume to be retained on site for the 1 in 100-year storm event including an allowance for climate change is **34.3m^3.**

The flows from the site should be restricted to an acceptable level to the Lead Local Flood Authority and UU.

The proposed development will marginally decrease the proportion of the site covered by impermeable surfaces and will therefore generate less runoff. Attenuation will be required to allow for climate change.

The estimated volume can be stored within the site boundary.

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1 Introduction

1.1 Background

LK Consult Ltd (LKC) were commissioned by Creative Property People Ltd to carry out a Sustainable Drainage Strategy for 26a Wilbraham Road, Manchester. The report was undertaken in support of a future planning application to redevelop the site for residential use.

The report will consider the impact of the development on surface water runoff accounting for climate change. The sustainable drainage assessment in Section 4 will provide an overview of the SuDS techniques which could be considered on the site.

This preliminary SuDS assessment complies with the principles presented in the Draft National Standards for Sustainable Drainage Systems (Defra, 2015)[1] and the Planning Practice Guidance (PPG) March 2014[2]. The sustainable drainage assessment is presented with reference to the hydrological and hydrogeological context of the development.

The report findings are based upon professional judgement and are summarised below. The report includes baseline data from the Environment Agency (EA), rainfall data from the Wallingford Studies and Hydrogeological information from the British Geological Survey (BGS). The assessment will summarise and refer to these datasets in the text.

Drainage on the site has been assessed by considering the following key constraints:

- Topography of the site.
- Local water features and hydrological context.
- Underlying geology, soil types and permeability.
- Layout and geometry of the proposed development.

[1] Non-statutory Technical Standards for Sustainable Drainage Systems – DEFRA March 2015
[2] Planning Practice Guidance – Department for Communities and Local Government July 2021

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. Figure 1 indicates the site location and boundary. Figure 2 indicates the proposed development.

Site Details	
Location	26a Wilbraham Road, Fallowfield, Manchester, M14 6JX. Centred at approximate National Grid Reference 385065E, 394132N.
Area	Approximately 0.25 Ha.
Topography	36.40 metres above ordnance datum (AOD) in the south east of the site and 35.00m AOD in the north east of the site. The site is sloping down from the south east towards the north east.
Current Land Use	Site Former language school in the north and rough grassland, shrubbery and established trees in the south and east. Surrounding Area/ Boundary Treatment North: Fields and lake beyond. East: Residential properties. South: Wilbraham Road and residential properties beyond. West: Residential properties.
Proposed Development	Demolishment and replacement of the existing building with a residential apartment block and associated soft landscaping and car parking. Access will be from Wilbraham Road.

Table 1-1: Summary of site details.

2 Site Setting

2.1 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		Till, Devensian (Diamicton).
	Bedrock		Chester Formation (Sandstone).
	BGS Boreholes		BH Ref: SJ89SE457, 245m N: Firm to stiff light brown silty sandy Clay to 0.90m and firm to stiff light orangish silty Clay with occasional fine to coarse subrounded gravel to 1.60m. BH Ref: SJ89SW741, 610m SW: fairly compact Sand and Gravel to 2.50m and weathered Sandstone to 3.00m. (Groundwater struck at 3.00mbgl).
	Defra Soilscape Mapping		Type 17: Slowly permeable seasonally wet acid loamy and clayey soils.
Hydrogeology	Aquifer Designation	Superficial	Secondary Undifferentiated Aquifer.
		Bedrock	Principal Aquifer.
	Source Protection Zone (SPZ)		Total Catchment (Zone 3).
Flood Zone (EA)	The site is within Fluvial Flood Zone 1. Flood Zone 1: Very Low risk, with annual probability of flooding from rivers and the sea of less than 0.1% (1 in 1000).		
Hydrology	All adjacent and internal surface water		There are no open or culverted watercourses within the site boundary. There is a lake approximately 95m north of the site. There is a culverted watercourse (Platt Brook) approximately 245m north west of the site.
Site History			The earliest historical mapping indicates that the site consisted of pasture land from 1891. From 1922 the site and surrounding area consisted of residential and commercial properties.

Table 2-1: Summary of the Environmental Setting.

2.2 Site 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 elevation ranges from 35.00m AOD in the north east to 36.40m AOD in the south east. The site is sloping down from the south east towards the north eastern boundary.

3 Consultation

Information from consultees is summarised in Table 3-1 below.

Relevant correspondence is provided in Appendix C.

Source	Details	
Manchester City Council (LLFA)	No information provided at the time of writing. In line with statutory for Brownfield sites surface water discharge should be limited to greenfield run-off rates. Where this is not achievable the surface water discharge rate should be in line with the Manchester, Salford, and Trafford SFRA User Guide which states: "Developments should aim for a minimum reduction in surface water runoff rates of 50% for Brownfield sites, with an aim of reducing runoff to Greenfield rates up to a 1 in 100-year storm event, considering climate change". Foul drainage from developments should be in line with Approved Document H of the Building Regulations. The site is located within a Critical Drainage Area.	
United Utilities (UU)	Sewer Map	There is a 300mm diameter public combined sewer south west of the site in Hart Road flowing in a south easterly direction. This connects to a 575 x 875mm diameter public combined sewer south of the site in Wilbraham Road flowing in a westerly direction.
	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. All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80 of the National Planning Practice Guidance. Surface water runoff generated from this development should discharge to the ground via infiltration system where feasible. If not feasible, UU will consider a connection to the 300mm diameter public combined sewer located in Hart Road at a pass forward flow to be agreed by the Lead Local Flood Authority. UU request that any agreed rate does not exceed 5l/s. Foul flow from this site will be allowed to drain into the public combined sewer system. UU's preferred point of discharge would be to the 300mm diameter public combined sewer within Hart Road south east of the site at an unrestricted rate. 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.

Table 3-1: Summary of Consultee Information.

4 Sustainable Drainage Strategy

4.1 Introduction

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 development is a material planning consideration in determining proposals for the development and use of land.

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 H3[3] 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 2010[4].

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.

4.2 Sustainable Drainage Hierarchy

4.2.1 Infiltration

The Groundwater Source Protection Zone mapping from the EA website shows that the site is within SPZ3 (total catchment). A summary of the BGS superficial and bedrock aquifer descriptions and classifications supplemented by local records is shown in Table 4-1 below:

[3] Building Regulations part H3 2010: Approved Document, Drainage and Waste Disposal.
[4] Flood and Water Management Act 2010: UK Government.

Classification	Description	Recorded Water Table Depth	Soakaway Potential
Glacial Till Deposits	Silty, sandy Clay with occasional subrounded Gravel	Approx. 3mbgl	Poor
Chester Formation Bedrock	Sandstone	N/A	Moderate

Table 4-1: Geological and Hydrogeological Setting.

Infiltration methods such as soakaways are unlikely to be feasible given the silty sandy Clay and shallow groundwater levels recorded in nearby borehole records, but this may be investigated further at the detailed design stage, if required.

4.2.2 Watercourses

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

4.2.3 Public Sewer

There is a combined sewer running adjacent to the site in Wilbraham Road and a further combined sewer running adjacent to the site in Hart Road.

4.3 Surface Water Drainage Strategy

Following the assessment of the site settings and existing constraints to the development. The drainage options relating to the final discharge of surface water for this section of the site are listed in Table 4-2 in order of priority within the NPPF:

Option No:	Drainage Solution	Most feasible solution	Reasoning
a	Soakaway/Infiltration	2	Not likely to be feasible as the site is constrained by the proximity of the adjacent properties and roads. The impermeable ground conditions and shallow water table level also make the use of infiltration unlikely.
b	Connection to Watercourse	N/A	Not feasible as there are no known watercourses within or adjacent to the site.
c	Discharge into a sewer	1	A connection into the 300mm diameter combined sewer in Hart Road would be possible – subject to approval from LLFA and connection consent from UU.

Table 4-2: Drainage options.

Table 4-3 provides a summary of the SuDS options appraisal with consideration of CIRIA C753 (The SUDS Manual)[5] for the development:

SuDS Option	Appropriate to Development	Comments	Benefits	Description
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	X	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	X	Engineered filters that use vegetation to remove and treat runoff. The filter strip is sloped to allow sheet flow across the vegetated strip. May not 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 4-3: Summary of the SuDS options appraisal.

SuDS Option	Appropriate to Development	Comments	Benefits	Description

[5] CIRIA C753 - The SUDS Manual. London 2015.

Retention & Detention				
Detention basin	X	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	X	Attenuation ponds can be used to offset the increase in surface water flows attributable to increased area of hard standing, in order to minimise the risk of flooding to and from the proposed development.	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 4-3 (continued): Summary of the SuDS options appraisal.

SuDS Option	Appropriate to Development	Comments	Benefits	Description
Swales & conveyance channels				
Swales	X	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	X	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	X	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 4-3 (continued): Summary of the SuDS options appraisal.

SuDS Option	Appropriate to Development	Comments	Benefits	Description
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	X	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 contaminates by facilitating adhesion to vegetation and aerobic decomposition. They also provide significant ecological benefits.

Table 4-3 (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

X Not suitable

4.4 Surface Water Attenuation Requirements

In accordance with the non-statutory guidance, the flow from this development should aim for a minimum reduction in surface water runoff rates of 50% for Brownfield sites as the site is located within a Critical Drainage Area, with an aim of reducing runoff to Greenfield rates up to a 1 in 100-year storm event, considering climate change.

It is estimated from the supplied plan (see Appendix A) that the site will have the following designated areas (Table 4-4).

Designated Areas	Plot Area
Total area (ha)	0.25
Existing Impermeable Area (ha)	0.12
Green Infrastructure (ha)	0.13
Contributing Catchment	
Catchment Area (ha)	0.25
Impermeable Area (ha)	0.08
Permeable Area (ha)	0.17

Table 4-4: Assumed plot areas.

It can be seen that there is a reduction 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 UU, including an allowance for climate change.

4.4.1 Attenuation Estimate

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

For the contributing catchment an estimate has been produced assuming a developable area of 0.08ha and a greenspace of 0.17ha. This gives the following runoff rates and attenuation requirements for this section based on the Wallingford method:

- Q_{bar}: 15.40 l/s
- 1 in 1-year peak runoff rate: 10.70 l/s
- 1 in 30-year peak runoff rate: 27.30 l/s
- 1 in 100-year peak runoff rate: 34.60 l/s

This reduced by 50% would give the following rates:

- Q_{bar}: 7.70 l/s
- 1 in 1-year peak runoff rate: 5.35 l/s
- 1 in 30-year peak runoff rate: 13.65 l/s
- 1 in 100-year peak runoff rate: 17.30 l/s

4.4.2 Discharge Rate

Where the drainage system discharges to a surface water body that can accommodate uncontrolled surface water discharges without any impact on flood risk from that surface water body (e.g., the sea or a large estuary) the peak flow control standards (S2 and S3 below) and volume control technical standards (S4 and S6 below) need not apply.

<u>Peak flow control</u>

S3 For developments which were previously developed, the peak runoff rate from the development to any drain, sewer or surface water body for the 1 in 1 year rainfall event and the 1 in 100 year rainfall event must be as close as reasonably practicable to the greenfield runoff rate from the development for the same rainfall event, but should never exceed the rate of discharge from the development prior to redevelopment for that event.

Volume control

S5 Where reasonably practicable, for developments which have been previously developed, the runoff volume from the development to any highway drain, sewer or surface water body in the 1 in 100 year, 6 hour rainfall event must be constrained to a value as close as is reasonably practicable to the greenfield runoff volume for the same event, but should never exceed the runoff volume from the development site prior to redevelopment for that event.

UU has specified an allowable discharge rate of 5l/s to their adjacent combined sewer.

The following attenuation has been estimated for the development using 5l/s runoff rates and utilises the FSR methodology[6] as:

- Attenuation storage volume: **21.6 m^3** (1 in 30 year event + 35% Climate Change)
- Retention on site volume: **34.3 m^3** (1 in 100 year + 40% Climate Change)

Attenuation storage aims to limit the peak rate of runoff from the development to the 5l/s runoff for a range of annual flow rate probabilities before discharging into a sewer. As the flow from the development would be restricted there should be little change in the flows that enter the public sewer and thus the risk of flooding as a result from the development should be negligible.

The attenuation required for a 1 in 30-year storm event, requires a storage volume of **21.6 m^3**. For the 1 in 100-year event, a storage capacity of **34.3 m^3** 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 adjacent sewer.

4.5 Site Specific SuDS

The use of attenuation SuDS are deemed to be the most feasible and practical option for the development. The attenuation tank or similar will provide the 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.

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.

[6] Flood Studies Report Wallingford NERC 1975.

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.

4.6 Foul Drainage

The potential foul drainage strategy is considered elsewhere.

5 Conclusion

The site is currently a vacant building to the north and rough grassland, shrubbery and established trees in the south and east. The proposal is the demolishment and replacement of the existing building with a residential block and associated soft landscaping and car parking.

An assessment of the site settings and existing constraints in conjunction with the development proposals have resulted in the following recommendations for the safe development of the site:

- The site is considered to be too constrained due to the existing topography and proximity of the adjacent properties for the use of soakaway.
- The recorded geology on site would indicate that infiltration may not be practical. This may be investigated at the detailed design stage by means of undertaking permeability testing.
- The attenuation required for a 1 in 30 year event, requires a storage volume of **21.6 m^3** and for the 1 in 100-year event, a storage capacity of **34.3 m^3** will be required from on-site storage as well as SuDS systems.
- The suitability and depth of a potential connection into the adjacent combined sewer should be confirmed on site.
- A pre-development advice enquiry received from United Utilities considered that a flow rate of 5l/s would be acceptable if infiltration proved to be impractical.
- All proposed outflow connections from the development should be agreed with the Lead Local Planning Authority and United Utilities.

APPENDIX A

FIGURES, PLANS AND DRAWINGS

Client: Creative Property People Limited	Title: Site Location & Boundary Plan			LK CONSULT
Site: 26a Wilbraham Road, Manchester	Scale (see scale bar): 1:125,00 & 1:1,250 @ A4	Figure: 1	Revision:	
Job No.: FRA 23 1092 / Drawn By: JL / Checked By: CC / Drawn: Dec 2023				

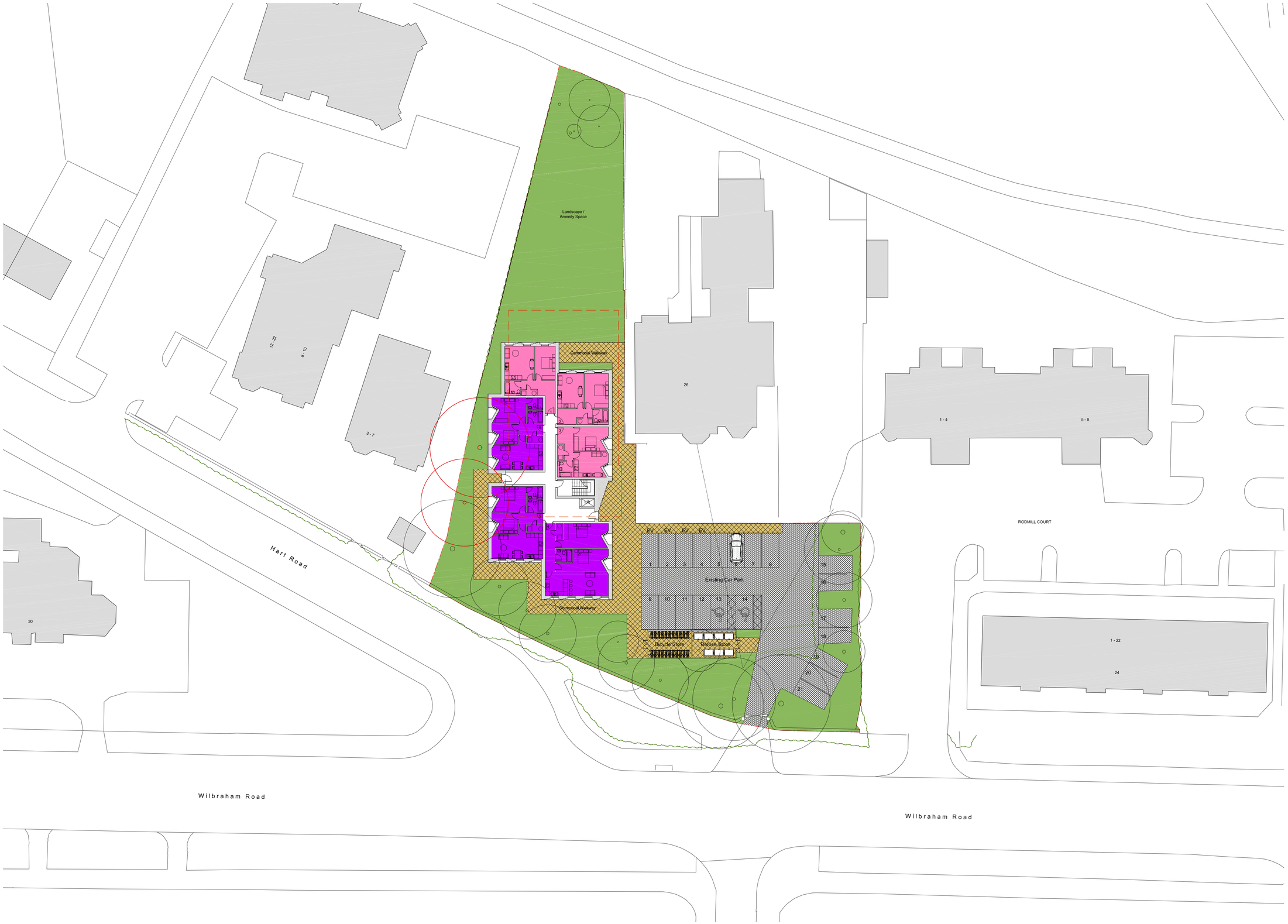
All dimensions are to be checked on site, any discrepancies are to be reported to the Architect before work commences, Do not scale from this drawing.

This drawing is to be read in conjunction with all relevant consultants and specialists drawings / documents, any discrepancies are to be reported to the Architect before the affected work commences.

All structural components shown are indicative only. Details / calculations of structural members are to be provided by the Structural Engineer.

This drawing is copyright.

A	First Issue	20/10/2022
B	Amendments following client's comments 20/10/2022	26/10/2022
C	Amendments following client's comments 27/10/2022	28/10/2022
D	Amendments following receipt of pre-application comments 16/11/2022	12/12/2022
E	Amendments following client's comments 14/12/2022	14/12/2022
F	Amendments following client's comments 17/01/2023	14/02/2023
G	Amendments following receipt of pre-application comments received on 17/01/2023	28/02/2023



N

Proposed Site Plan 1:250
Scale Bar 1:250

0 12.5 25m

Demolition

Trees to be removed

Tang & Associates Ltd
Chartered Architects

Tel : 0161 877 9587
e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester M14 6JU

Drawing Title:
Proposed Site Plan

Scale: 1:250@ A1

Date: October 2022

Drawing No: 9792/102

Revision: G

APPENDIX B

SITE INFORMATION

All dimensions are to be checked on site, any discrepancies are to be reported to the Architect before work commences. Do not scale from this drawing.

This drawing is to be read in conjunction with all relevant consultants and specialists drawings / documents, any discrepancies are to be reported to the Architect before the affected work commences.

All structural components shown are indicative only. Details / calculations of structural members are to be provided by the Structural Engineer.

This drawing is copyright.

A	First Issue	20/10/2022

N

Existing Site Plan 1:250
Scale Bar 1:250

0 12.5 25m

Demolition

Trees to be removed

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Chartered Architects

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e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester
M14 6JU

Drawing Title:
Existing Site Plan

Scale:	Date:
1:250@ A1	October 2022

Drawing No:	Revision:
9792/002	A

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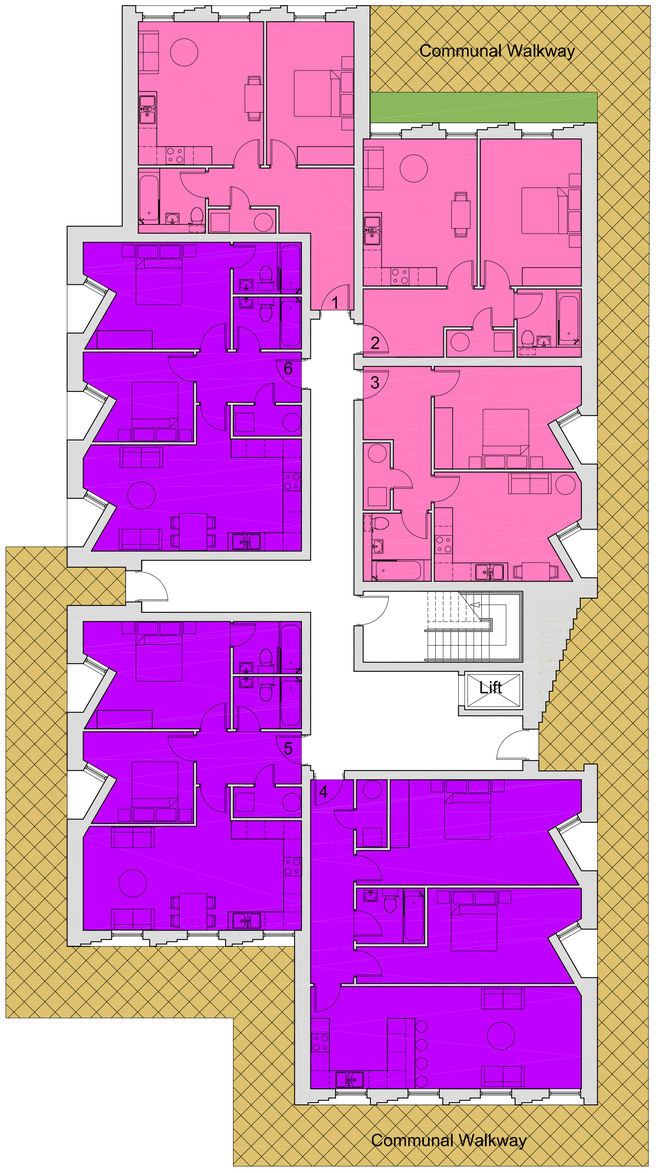
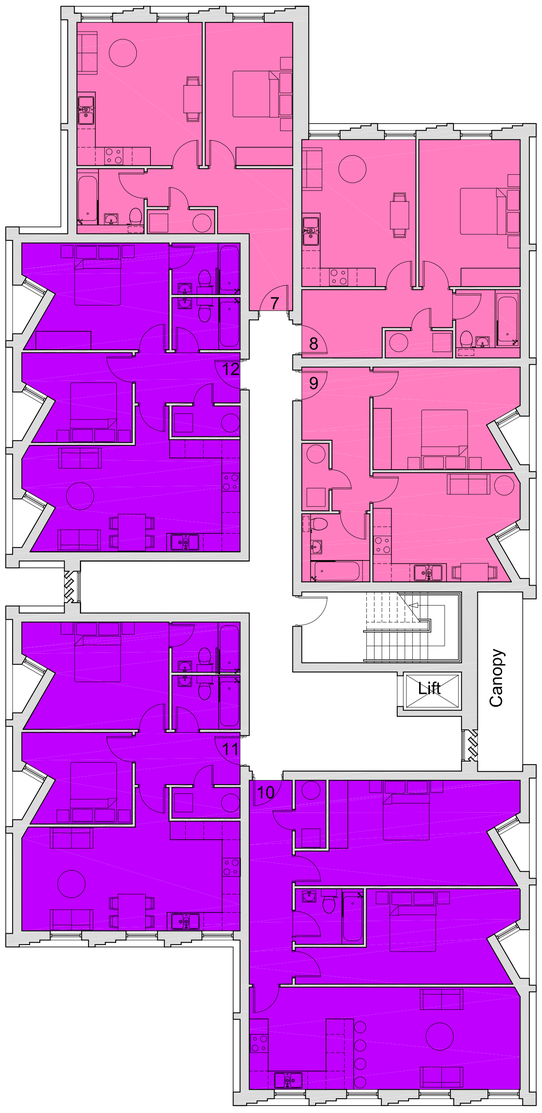
A	First Issue	20/10/2022
B	Amendments following client's comments 20/10/2022	26/10/2022
C	Amendments following client's comments 27/10/2022	28/10/2022
D	Amendments following receipt of pre-application comments 16/11/2022	12/12/2022
E	Amendments following receipt of pre-application comments 16/11/2022	14/12/2022
F	Amendments following receipt of pre-application comments 17/01/2023	14/02/2023
G	Amendments following receipt of pre-application comments received on 17/01/2023	28/02/2023
H	Amendments following receipt of Light easement conditions pertaining the site received on 17/04/2023	17/04/2023



1-bed Apartment

2-bed Apartment



N

Proposed G/F Plan 1:100

Scale Bar 1:100

0 5 10m

Proposed 1/F Plan 1:100

Tang & Associates Ltd
Chartered Architects

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e-mail: barrytang@tangassociates.co.uk

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Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester
M14 6JU

Drawing Title:
Proposed G/F and 1/F Plans

Scale: 1:100@ A1

Date: October 2022

Drawing No: 9792/111

Revision: H

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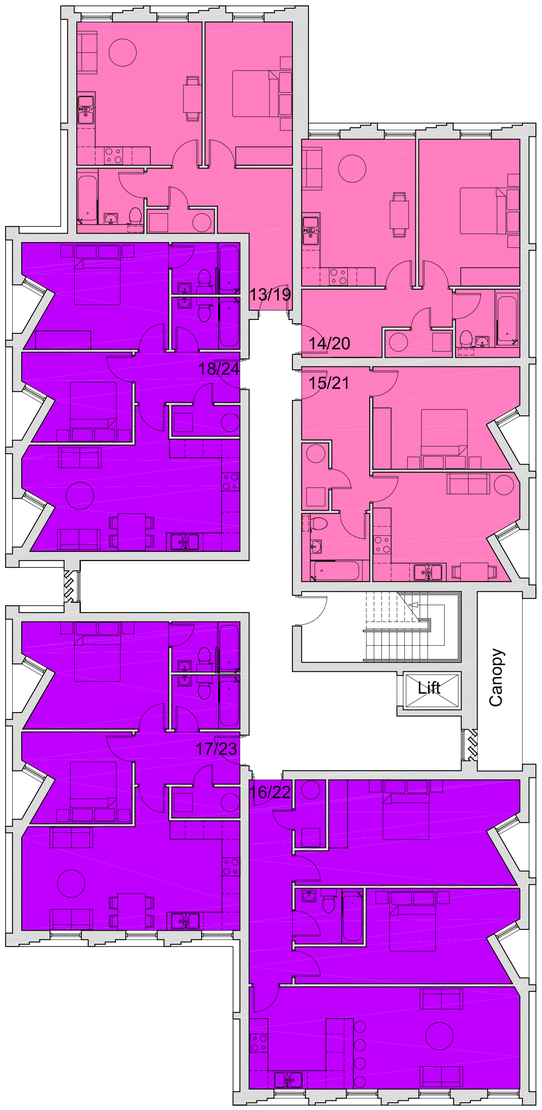

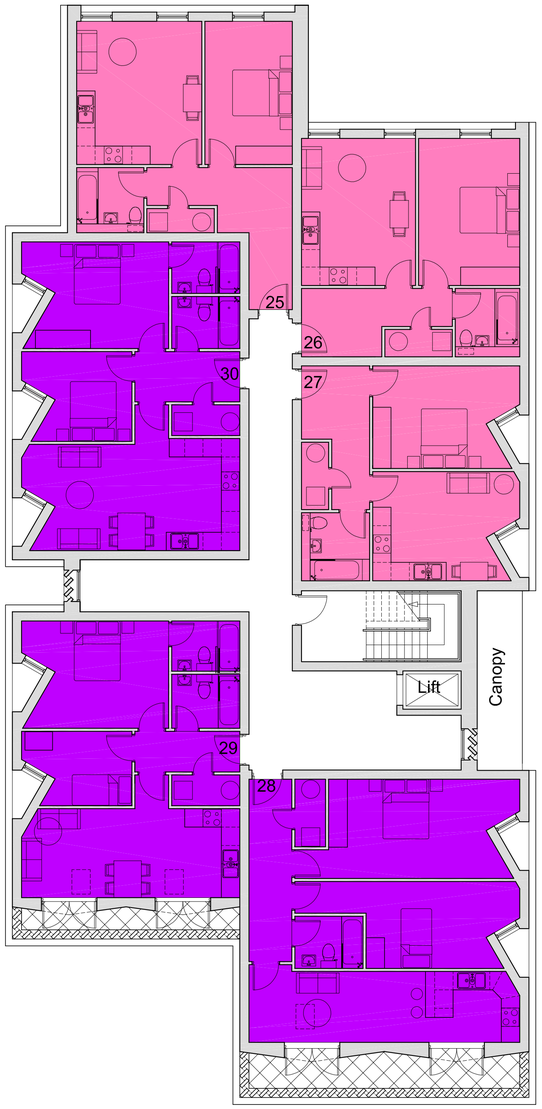

1-bed Apartment

2-bed Apartment

N

Proposed 2/F - 3/F Plan 1:100

Scale Bar 1:100

0 5 10m

Proposed 4/F Plan 1:100

Tang & Associates Ltd
Chartered Architects

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e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester
M14 6JU

Drawing Title:
Proposed 2/F-3/F and 4/F Plans

Scale: 1:100@ A1

Date: February 2023

Drawing No: 9792/112

Revision: C

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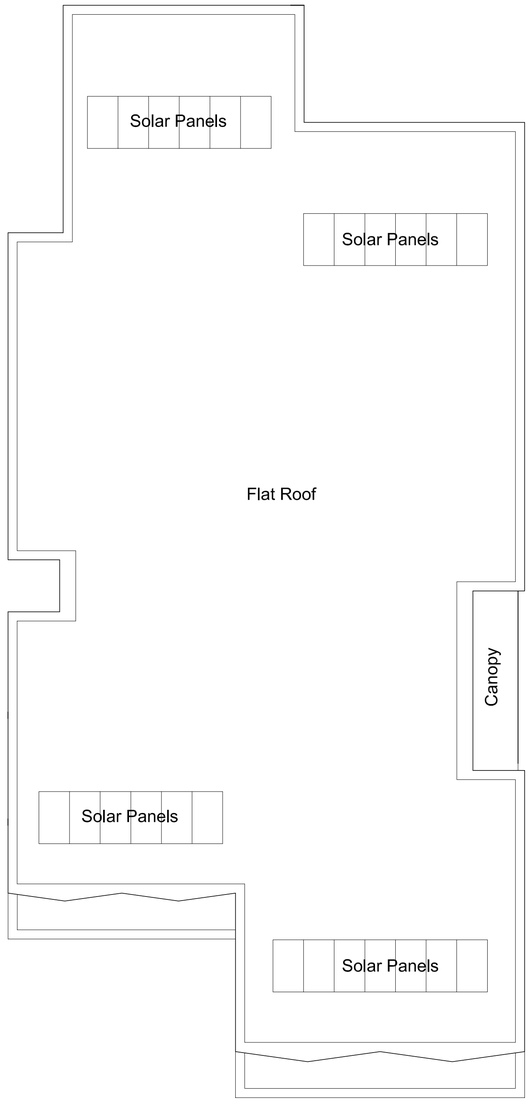
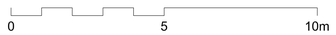


Proposed Roof Plan 1:100

Scale Bar 1:100



Tang & Associates Ltd
Chartered Architects

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10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester
M14 6JU

Drawing Title:
Proposed Roof Plans

Scale:	Date:
1:100@ A1	February 2023

Drawing No:	Revision:
9792/113	C

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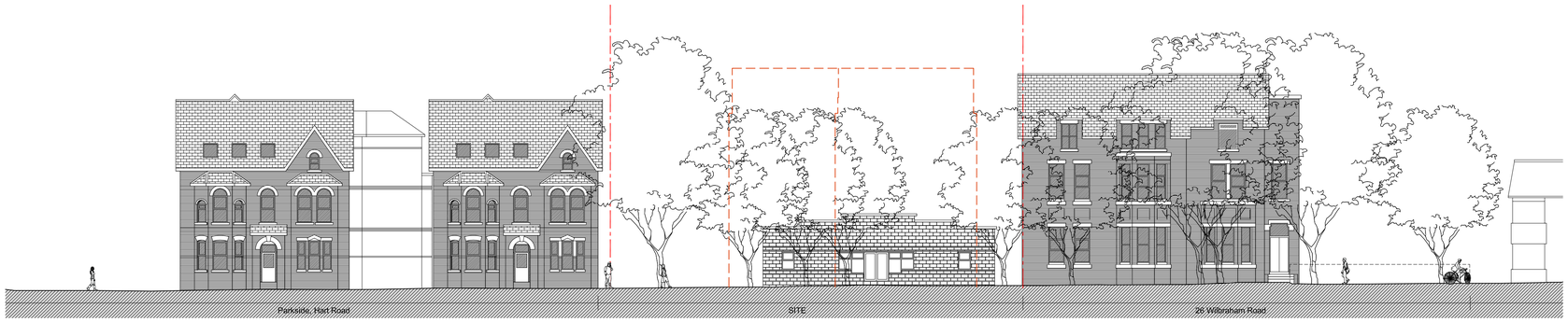
C	Amendments following receipt of client's comments	14/12/2022
D	Amendments following receipt of pre-application comments received on 17/01/2023	28/02/2023

Proposed Wilbraham Road and Hart Road Street-scene 1:200



Existing Wilbraham Road and Hart Road Street-scene 1:200

Scale Bar 1:200

0 10 20m

Tang & Associates Ltd
Chartered Architects

Tel : 0161 877 9587
e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester M14 6JU

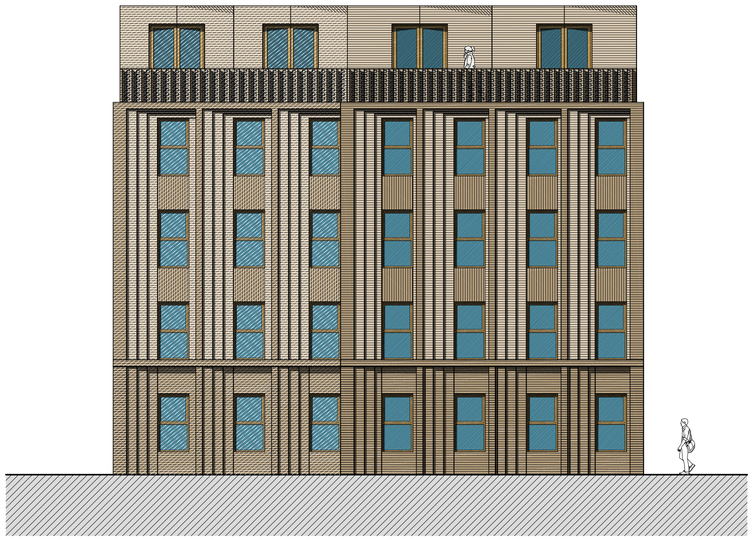
Drawing Title:
Existing and Proposed Wilbraham Road Street-scene

Scale: 1:200@ A1

Date: October 2022

Drawing No: 9792/122

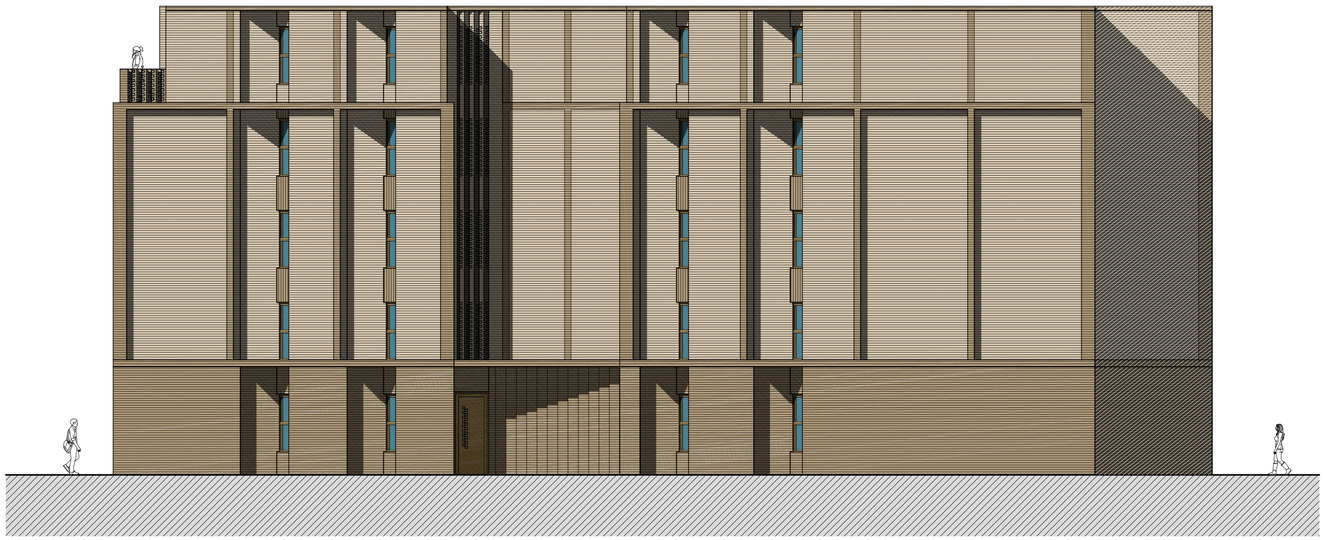
Revision: D



Proposed Wilbraham Road Elevation 1:100

Scale Bar 1:100

0 5 10m



Proposed East Elevation 1:100

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A	First Issue	28/02/2023
B	Amendments following receipt of Light easement conditions pertaining the site received on 17/04/2023	17/04/2023

Tang & Associates Ltd
Chartered Architects

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e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester
M14 6JU

Drawing Title:
Proposed Wilbraham Road Elevation &
Proposed East Elevation

Scale:	Date:
1:100@ A1	February 2023

Drawing No:	Revision:
9792/123	B

All dimensions are to be checked on site, any discrepancies are to be reported to the Architect before work commences. Do not scale from this drawing.

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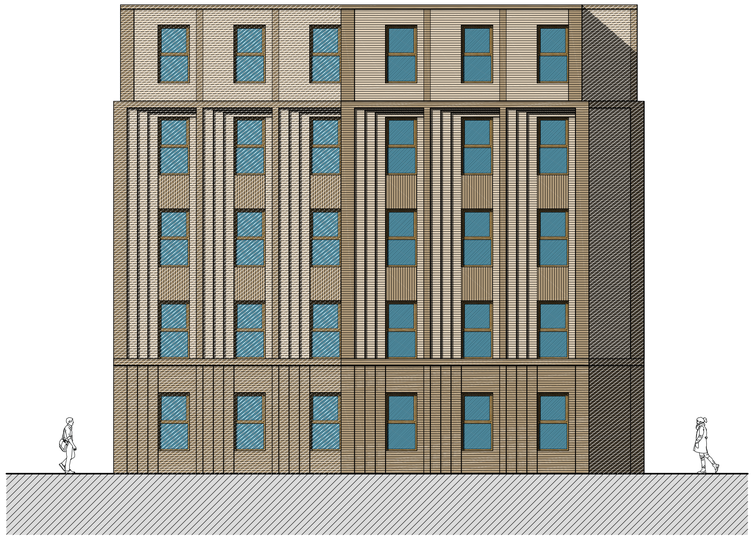
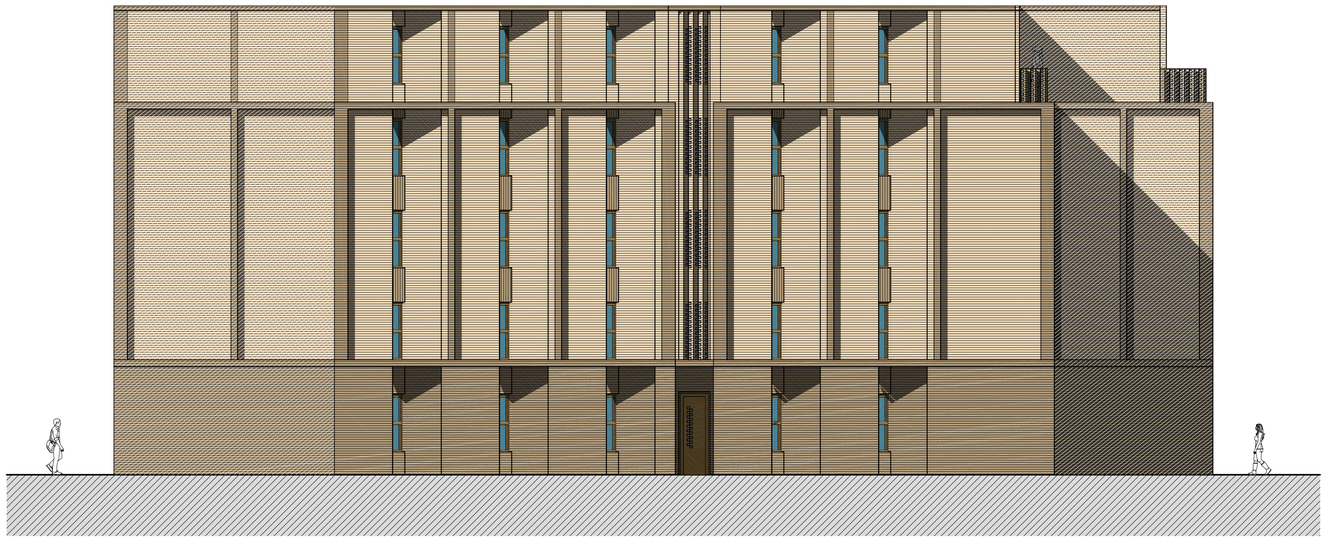
B	Amendments following receipt of Light easement conditions pertaining the site received on 17/04/2023	17/04/2023



Proposed Rear Elevation 1:100

Scale Bar 1:100

0 5 10m



Proposed West Elevation 1:100

Tang & Associates Ltd
Chartered Architects

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e-mail: barrytang@tangassociates.co.uk

10/F, 1 City Approach, Albert Street,
Eccles,
Manchester, M30 0BG, UK

Client:
Creative Property People Limited

Project:
26A Wilbraham Road, Fallowfield, Manchester M14 6JU

Drawing Title:
Proposed Rear Elevation & Proposed West Elevation

Scale: 1:100@ A1

Date: February 2023

Drawing No: 9792/124

Revision: B

Status
Draft1
Date 12/2/93

SJ 89 SE 457

Norwest Holst Soil Engineering Ltd.

TRIAL PIT LOG

Trial Pit No.
TP102
Sheet 1 of 1

Contract No.	F9638	Method	Machine Dug	Coords.	8505 9444
Project	Chorlton Brook	Equipment	JCB 3CX		
				Ground Level	36.42
Client	National Rivers Authority			Date Started	11/11/92
Consultant	Manstock			Date Completed	11/11/92
Logged by	EM				

Description of Strata	Legend	Depth below G.L.	O.D. Level	Sampling			Cu (kPa)	Notes
TOPSOIL with occasional roots and rootlets.		0.30	36.12					
MADE GROUND:Firm to stiff light brown and orangish brown mottled occasionally light green silty sandy clay locally very sandy (fine and medium) with occasional fine to coarse subrounded gravel and lenses of topsoil with occasional rootlets.		0.90	35.52	BD	0.30	0.70		HV at 0.60m x 1.346 113/27
MADE GROUND:Reworked topsoil.		1.00	35.42					
Firm to stiff light orangish and blue grey mottled silty CLAY with occasional fine to coarse subrounded gravel. (Fluvial/Glacial)		1.60	34.82	BD	1.00	1.60		
Trial Pit Complete at 1.60m.								HV on block at 1.60m 126/32

REMARKS

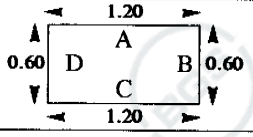
All Dimensions in Metres.

Shoring / Stability: None/Slight spalling from 0.30 to 0.90m.

Groundwater: Dry

General Notes: Photos: 2 x sidewall
1 x spoil
2 x access
2 x finish

PLAN



Bearing 350°

KEY TO ABBREVIATIONS

D	Small Disturbed Sample	W	Water Sample
B	Bulk Disturbed Sample	( )V	Cu - Hand Vane, Peak
LB	Large Bulk Disturbed Sample	( )VR	Cu - Hand Vane, Residual
U	Undisturbed U100 Sample	( )P	Cu - Pocket Penetrometer
BK	Block Sample	*	Estimated Relative Density
NR	No Recovery		

Form G221
Version 1.03
Revised 21.09.92

WILBRAHAM SMALLHOLDINGS

T.H.1. SJ89SW741 8443 9392

0 - 2.50m	Fill : soil, brick rubble, ash and organic clay
2.50 - 3.00	Fairly compact sand and gravel
3.00 -	Weathered sandstone
	Water entry : 3.00m

T.H.2. SJ89SW742 8441 9388

0 - 0.50m	Fill : topsoil and brick rubble
0.50 - 1.40	Stiff yellow brown mottled clay
1.40 - 2.00	Stiff mottled boulder clay
	No ground water

T.H.3. SJ89SW743 8437 9389

0 - 2.50m	Fill : mainly clay with inclusions of brick rubble - occasional large concrete obstructions
2.50 -	Concrete obstruction
	No ground water

T.H.4. SJ89SW744 8435 9385

0 - 0.85m	Fill : brick rubble, ash, clay and soil
0.85 - 1.75	Stiff yellow born mottled clay
	No ground water

T.H.5. SJ89SW745 8429 9388

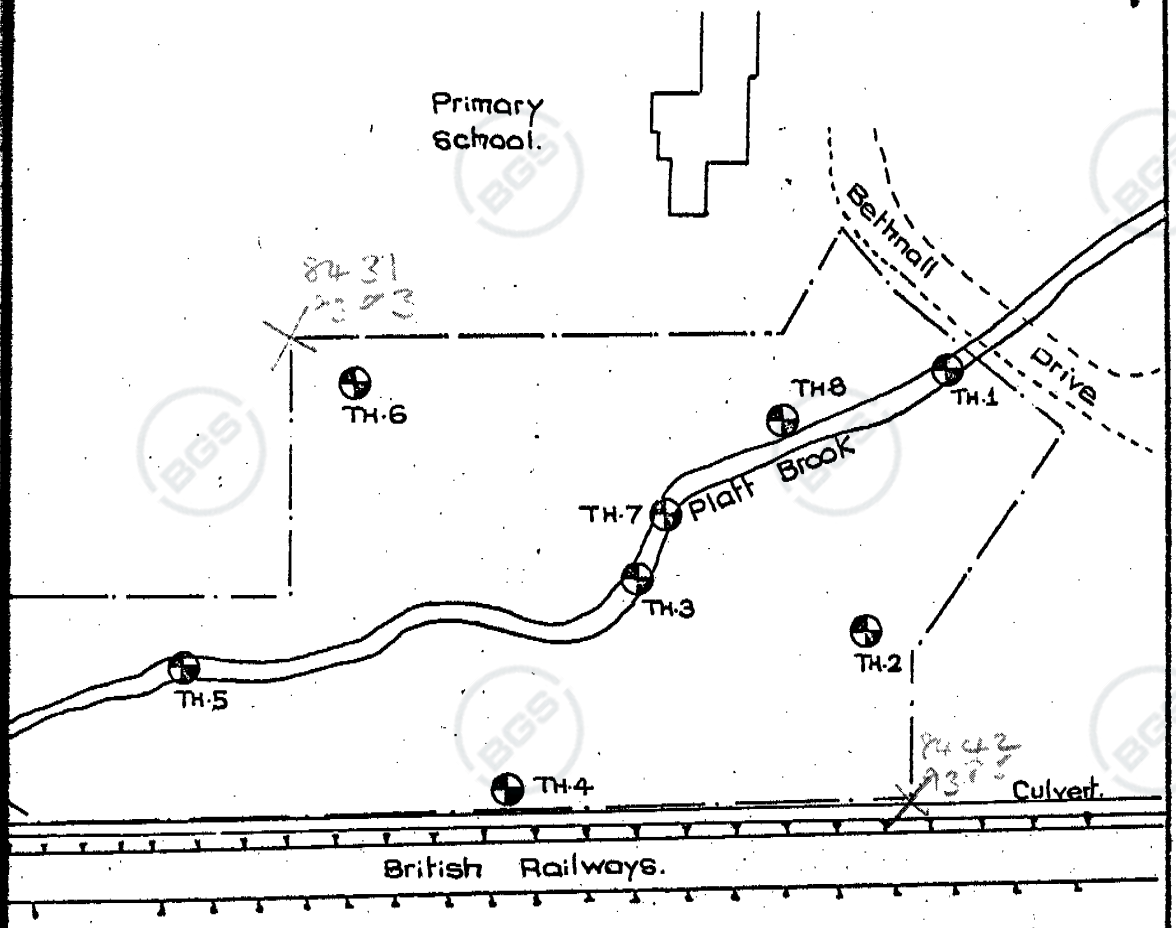
0 - 0.50m	Fill : topsoil, brick rubble and clay
0.50 - 1.00	Stiff yellow brown mottled clay
1.00 - 2.00	Stiff brown boulder clay
	No ground water

British Geological Survey
BGS ID: 865620 : BGS Reference: SJ89SW741
British National Grid (27700) : 384430,393920

SJ89SW741 - 748

e. WILBRAHAM SMALL HOLDINGS Job No. S.I.

ent City Architect - Manchester Date Feb./Mar. 1978



SJ89SW741-748

NGDC ACCESSION NUMBER 39956

KEYPLAN

Showing trialhole positions

Scale : 1:1250

NORTHERN FOUNDATIONS LIMITED

Contact BGS: ngdc@bgs.ac.uk

KEY

Site Location

Till, Devensian

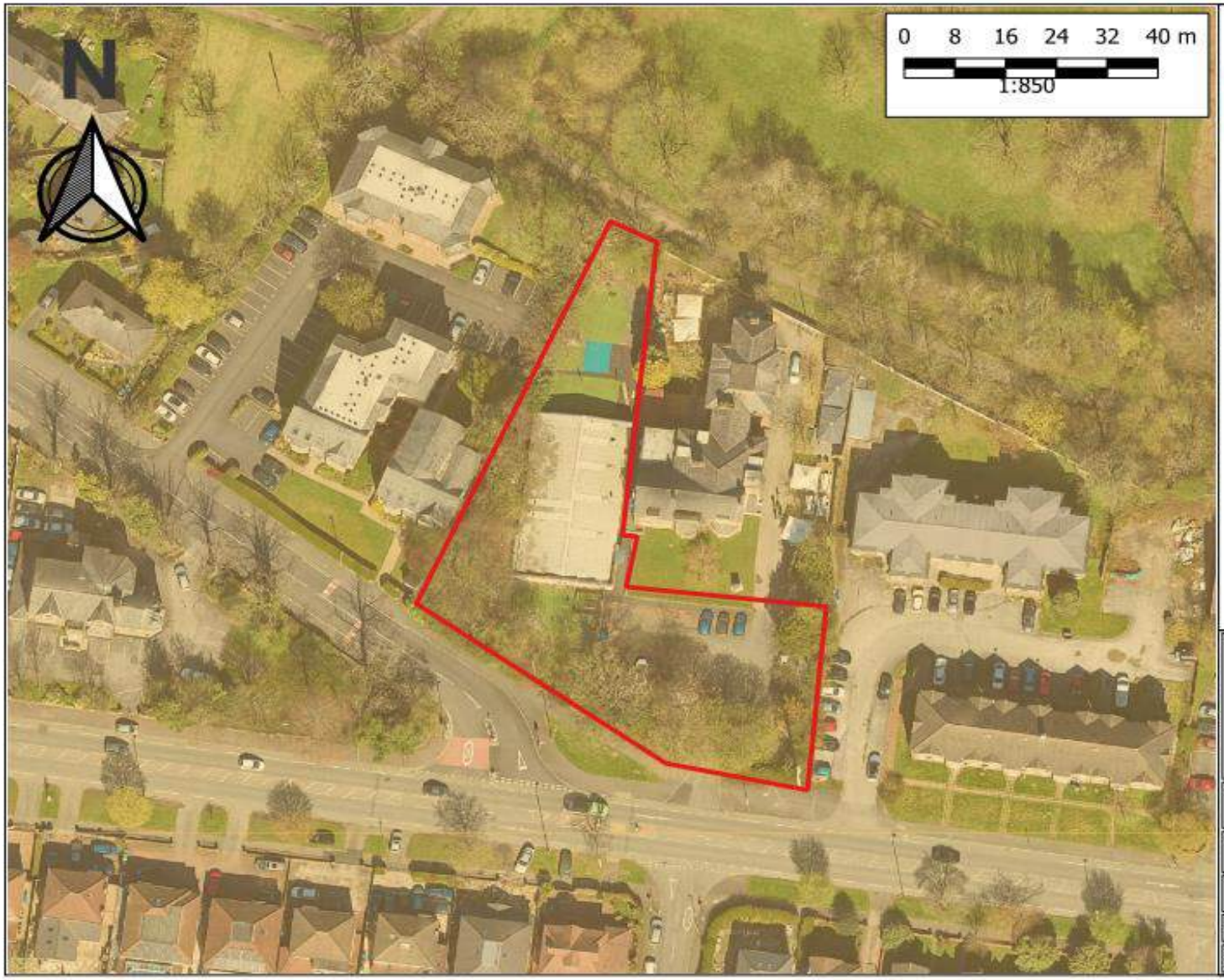
LK CONSULT LIMITED

26a Wilbraham Rd

Superficial Geology

FRA 23 1092	1:850 @ A4		
JL	CC	Jan 2024	

BGS Superficial Geology - Contains British Geological Survey Materials © UKRI 2024



KEY

Site Location

Chester Formation (Sandstone)

LK CONSULT LIMITED

26a Wilbraham Rd

Bedrock Geology

FRA 23 1092		1:850 @ A4	
JL	CC	Jan 2024	

BGS Bedrock Geology - Contains British Geological Survey Materials © UKRI 2024

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LANCASHIRE, MANCHESTER, SHEET CXI. S. 13.
FALLOWFIELD
Owens College Athletic Ground

PLATT FIELDS PARK
FALLOWFIELD
RUSHOLME WARD
Athletic Ground
Pavilion
Drinking Fountain
Allotment Gardens
Grangethorpe
Grangethorpe Road
Cromwell Range
Old Hall Lane
Ashburne Hall
Rusholme Lodge
Oldenbury House
Westbourne
Oak Lawn
Birch Hays
Birchfield
Ashley Lodge
Lodge
Gorton Road
Wilbraham Road
Fallowfield Brook
Thirlmere Aqueduct
(Manchester Corporation Water Works)
G.C.R.
MANCHESTER CENTRAL STATION LINE
Fallowfield Station
Nurseries
Holy Innocents Church
Sunday School
Synagogue
Tennis Ground
Cricket Ground
Portland Street
Langley Road
Mayfield Road
Lancaster Road
Oak House
The Oaks
The Acorns
Oak Bank
The Hollies
Oak Mount
Nursery
School
Lodge
Stand
Munchener Athletic Gr
Hulme Grammar Farm
Allotment Ground
Pavilion
Stoughton House
Hulme Lawn
Airlie
Holmfield
Cricket Ground
Pavilion
Pump House
Air Valve
Bridge
Footbridge
Weir
Cottage
Bank House
Bowling Green
Tennis Ground
Stand
The Fire
Lake

APPENDIX C

CONSULTEE CORRESPONDENCE

Jenna Lowe

From: wastewaterdeveloperservices@uuplc.co.uk
Sent: 07 December 2023 10:59
To: Jenna Lowe
Subject: RE: Automatic reply: 05017058 SuDS QUERY - FRA 23 1092 - 26a Wilbraham Road, Manchester

Good morning Jenna,
Pre Development Enquiry for: 26a Wilbraham Road, M14 6JU UU Reference Number : 05017058

We have carried out an assessment of your application which is based on the information provided. This pre-development advice on your drainage strategy will be valid for 12 months. Your drainage strategy will need to be reviewed by other competent authorities as part of the planning process, and we advise that you carry out the necessary site investigations to confirm the viability of your proposals.
If your investigations require access to our public sewer network, we ask that you contact our network engineers with a request for an access certificate via our main contact telephone number 0345 6723 723 or refer to the link below:
https://www.unitedutilities.com/builders-developers/working-near-our-assets/

Foul Water
Foul flow from this site will be allowed to drain into the public foul water/combined sewer system.
Our preferred point of discharge would be to the 300mm diameter public combined sewer within Hart Road located to the South of your proposed development at an unrestricted rate.
If you are able to identify an alternative, more suitable point of discharge, we request that you contact us at your earliest convenience so that we can assess suitability.
In accordance with our infrastructure plans we may ask you to change your point of connection. Therefore please contact us when you are ready to formalise your drainage proposals, we would suggest before you submit for Full Planning.

Surface Water
All surface water flow from the proposed development should drain in-line with the drainage hierarchy, as outlined in Paragraph 80, (Reference ID: 7-080-20150323), of the National Planning Practice Guidance. We also recommend you prioritise the use of multi-functional sustainable drainage systems for the management of surface water in accordance with national planning policy.
Generally, the aim should be to discharge surface run off as high up the following hierarchy of drainage options as reasonably practicable.
This is outlined as follows, in order of priority:

1. **into the ground (infiltration);**
2. **to a surface waterbody;**
3. **to a surface water sewer or highway drain;**
4. **to a combined sewer.**

For guidance, The **North West SuDS Pro-Forma** provides information on the appropriate evidence required at each stage of the hierarchy, to demonstrate how each level has been discounted.
The Lead Local Flood Authority has responsibility for all surface water drainage concerns and their input to your proposal is critical. You should also consider whether it is necessary to discuss your proposal with the Environment Agency, or Internal Drainage Board (if operating in your area).
The Local Planning Authority are the determining authority for any application for planning permission and the appropriate authority for determining cost viability of a proposed drainage scheme, such assessments are outside of the jurisdiction of United Utilities.

Infiltration
Thank you for discounting infiltration on this scheme.

Highway Drainage
If an evidence based assessment has been carried out and confirms that infiltration is not feasible, we recommend that you investigate the possibility of draining surface water to the highway drain where this ultimately discharges to a watercourse, by contacting the relevant Highway Authority.

Public Sewer
In accordance with the hierarchy of drainage options within the National Planning Practice Guidance, both discharge to ground via infiltration and discharge to a waterbody should be discounted prior to consideration of discharging surface water to the public sewer system. Evidence should be provided to demonstrate how these have been discounted, as outlined in the North West SuDS pro-forma.
Once evidence is provided as outlined above, United Utilities will consider a connection to the 300mm diameter public combined sewer within Hart Road located South of the proposed site at a pass forward flow to be agreed by the Lead Local Flood Authority. United Utilities request that any agreed rate does not exceed 5l/s.
As a Water Company, we have no obligation to accept highway drainage into our public sewer network. However, should your proposals include runoff from highways, we would request that consideration is given to SuDS components that deliver source control are incorporated within the design of the scheme to reduce the volume and frequency of discharges of these flows to the public sewer.

Levels
For low-lying sites, (where the ground level of the site or the level of a basement is below the ground level at the point where the drainage connects to the public sewer), care should be taken to ensure that the property is not at increased risk of flooding. If these circumstances exist, we recommend that you contact us to discuss further. It could affect the detailed design of your site and result in the need to incorporate appropriate mitigating measures in your drainage scheme.

Land drainage / Overland flows / track drainage
United Utilities have no obligation, and furthermore we do not accept land drainage, overland flows or track drainage into the pubic sewerage network under any circumstances

Existing Wastewater Assets Crossing the Site
We have reviewed our records and can confirm that there does not appear to be any charted public sewers located within the boundary of proposed development. However, due to the accuracy of the records and the public sewer transfer legislation in 2011, not all public sewers are shown on our records so we would ask that you proceed with caution and carry out your own site investigation works. If any uncharted sewers are identified while carrying out your works we would ask that you contact United Utilities at the earliest opportunity so that we can offer guidance and update our records

Surcharge Risk
I can confirm that we have no current record of sewer flooding on our DG5 register within the vicinity of the proposed development. The DG5 register is a register of properties that have flooded as a result of hydraulic inadequacy of the public sewer network.
Please note that United Utilities Water Limited (UUW) can only record and check flooding events which are reported to us and we have to comply with our Regulators instructions on the qualification of flooding events to place on the register.
Our response does not include:

- any sewer flooding events caused by blockages or collapses which are the result of third party actions, natural events or other actions over which UUW has no control and not a facet of sewer capacity; or
- any historical sewer flooding events that have been removed from the register as a result of investment in our infrastructure.

Existing Water Assets Crossing the Site
It is the developer responsibility to identify utilities on-site. Where clean water assets are shown on our records, we recommend that you contact our Water Pre-Development Team, via the following email address:

DeveloperServicesWater@uuplc.co.uk. Further information for this service can be found on our website via the link below:
https://www.unitedutilities.com/builders-developers/larger-developments/pre-development/water-pre-dev/

Connection Application
Although we may discuss and agree discharge points and 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:
https://www.unitedutilities.com/builders-developers/wastewater-services/sewer-connections/sewer-connection/
We recommend that the detailed design should confirm the locations of all utilities in the area and ensure that any proposed drainage solution considers routing and clash checks where required.
If we can be of any further assistance please don't hesitate to contact us further.
Kind Regards

Lewis Barr
Assistant Developer Engineer
Developer Services & Metering
Customer Services
07827286541
unitedutilities.com

If you have received a great service today why not tell us?
Visit: unitedutilities.com/wow

---------- Original Message ----------
From: Jenna Lowe [j.lowe@thelkgroup.com]
Sent: 06/12/2023 09:07
To: wastewaterdeveloperservices@uuplc.co.uk
Subject: Automatic reply: 05017058 SuDS QUERY - FRA 23 1092 - 26a Wilbraham Road, Manchester

I am currently on annual leave until 7th December.

If your query is urgent please contact the main office at 0161 7637200.

The information contained in this e-mail is intended only for the individual to whom it is addressed. It may contain legally privileged or confidential information or otherwise be exempt from disclosure. If you have received this Message in error or there are any problems, please notify the sender immediately and delete the message from your computer. You must not use, disclose, copy or alter this message for any unauthorised purpose. Neither United Utilities Group PLC nor any of its subsidiaries will be liable for any direct, special, indirect or consequential damages as a result of any virus being passed on, or arising from the alteration of the contents of this message by a third party.

United Utilities Group PLC, Haweswater House, Lingley Mere
Business Park, Lingley Green Avenue, Great Sankey,
Warrington, WA5 3LP
Registered in England and Wales. Registered No 6559020

www.unitedutilities.com
www.unitedutilities.com/subsidiaries

United Utilities
Water for the North West

How to contact us:

United Utilities Water Limited
Property Searches
Haweswater House
Lingley Mere Business Park
Great Sankey
Warrington
WA5 3LP

Telephone: 0370 7510101

E-mail: propertysearches@uuplc.co.uk

LKGroup

Unit 29 Eton Business Park
Unit 29, Eton Business Park,
Radcliffe, Greater Manchester
M26 2ZS

FAO:

Your Ref: FRA 23 1092
Our Ref: UUPS-ORD-536157
Date: 07/12/2023

Dear Sirs

Location: 26A WILBRAHAM ROAD, MANCHESTER, M14 6JU

I acknowledge with thanks your request dated 05/12/2023 for information on the location of our services.

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

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

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

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

If you have any queries regarding this matter please contact us .

Yours Faithfully,

Karen McCormack
Property Searches Manager

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

Water for the North West

TERMS AND CONDITIONS - WASTEWATER AND WATER DISTRIBUTION PLANS

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

TERMS AND CONDITIONS:

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

United Utilities Water Limited
Registered In England & Wales No. 2366678
Registered Office Haweswater House, Lingley Mere Business Park,
Lingley Green Avenue, Great Sankey, Warrington, WA5 3LP

FALLOWFIELD
Bowling Lake
Car Park
Tennis Courts
Sports Court
Skatepark
Allotment Gardens
Union Chapel
Cedar Court
Rudehill Court
Fallowfield Brook
Path (Un)
Cycle Way
Footpath
Cycle Stop
Bus Stop
Bus Shelter
Seat
Bollards
Play Area
Landing Stage
Pitch Barrier
Pitch Barrier 1.2m @ 1:x
Sub Stn
Electricity Sub Station
Gas Govn
Gas Govn Area
Pump
Fountain
Sculpture
Cycle Parking
Cycle Rack
Cycle Shelter
Cycle Stand
Cycle Bay
Bus Stop Clearway
Bus Stop Flag
Bus Stop Pole
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Bus Stop Post

Jenna Lowe

From: Jenna Lowe
Sent: 05 December 2023 09:09
To: floodriskmanagement@manchester.gov.uk
Subject: SuDS QUERY - FRA 23 1092 - 26a Wilbraham Road, Manchester
Attachments: FRA 23 1092 - Figure 1 Location and Boundary.pdf

Dear Sir/Madam,

LK Consult Ltd. has been commissioned to undertake a Sustainable Drainage Systems (SuDS) Strategy, for a site located at 26a Wilbraham Road, Manchester. Nearest Postcode M14 6JU, centred at approximate National Grid Reference 385047E, 394135N.

The area of interest appears to be within Flood Zone 1.

BGS data indicates that the site is within an area underlain by Till, Devensian - Diamicton superficial deposits and Chester Formation - Sandstone bedrock.

The site location is attached to this email.

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

- 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.
- Any restrictions applied to ordinary watercourses and sewers in the area.
- Highway drainage restrictions and records.
- Indications if the site is within the Critical Drainage Area.
- Policies that may relate to Sustainable Drainage Systems (SuDS).

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

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

Any advice or recommendations you may have regarding the potential discharges from the development of this site would also be appreciated.

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

Regards
Jenna

Jenna Lowe MSc, BSc. (Hons)
Flood Risk Engineer
0161 763 7200 | 07467 957756
Manchester | London | Swindon | Liverpool | Glasgow
www.thelkgroup.com

APPENDIX D

CALCULATIONS

MasterDrain SW	**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 08/01/24
	Project **QBAR EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**		By / Checked / Reviewed
	Title **QBAR EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**		

Area data:-

FSR data

M5-60 = 18.5
r = 0.37
Soil index = 0.45
SAAR = 850
WRAP value = 4
Nat grid = SJ 8594

Site data:-

Ret. period (yrs) = 2.33
ToC = 7.0 mins
Time of entry = 7.00
Overland flow time = 0.0 mins
Impervious area drained = 1200 m²
Pervious area drained = 1300 m²
Site slope = Mild <2% (1:50)
Soil type = Clay
Length of overland flow = 0.00
Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%
UCWI = 89.1
Rainfall rate= 59.8 mm/Hr
Runoff rate (gross)= 15.4 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7
where
PIMP = Impervious Area*100/(Impervious Area+Pervious Area)
UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program

MasterDrain SW	**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 08/01/24
	Project **1 YEAR EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**		By / Checked / Reviewed
	Title **1 YEAR EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**		

Area data:-

FSR data

M5-60 = 18.5 r = 0.37

Soil index = 0.45 SAAR = 850

WRAP value = 4 Nat grid = SJ 8594

Site data:-

Ret. period (yrs) = 1 ToC = 10.0 mins

Time of entry = 10.00 Overland flow time = 0.0 mins

Impervious area drained = 1200 m² Pervious area drained = 1300 m²

Site slope = Mild <2% (1:50) Soil type = Clay

Length of overland flow = 0.00 Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0% UCWI = 89.1

Rainfall rate= 41.8 mm/Hr Runoff rate (gross)= 10.7 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program

MasterDrain SW	**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 08/01/24		
	Project **30 YEARS EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**		By	Checked	Reviewed
	Title **30 YEARS EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER**				

Area data:-

FSR data

M5-60 = 18.5 r = 0.37

Soil index = 0.45 SAAR = 850

WRAP value = 4 Nat grid = SJ 8594

Site data:-

Ret. period (yrs) = 30 ToC = 6.0 mins

Time of entry = 6.00 Overland flow time = 0.0 mins

Impervious area drained = 1200 m² Pervious area drained = 1300 m²

Site slope = Mild <2% (1:50) Soil type = Clay

Length of overland flow = 0.00 Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0% UCWI = 89.1

Rainfall rate= 106.2 mm/Hr Runoff rate (gross)= 27.3 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7

where

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

UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program

MasterDrain SW	**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 08/01/24		
	Project 100 YEARS EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER		By	Checked	Reviewed
	Title 100 YEARS EXISTING RUNOFF 26A WILBRAHAM RD, MANCHESTER				

Area data:-

FSR data

M5-60 = 18.5
r = 0.37
Soil index = 0.45
SAAR = 850
WRAP value = 4
Nat grid = SJ 8594

Site data:-

Ret. period (yrs) = 100
ToC = 6.0 mins
Time of entry = 6.00
Overland flow time = 0.0 mins
Impervious area drained = 1200 m²
Pervious area drained = 1300 m²
Site slope = Mild <2% (1:50)
Soil type = Clay
Length of overland flow = 0.00
Climate change factor = 0.0 %

Calculated data:-

Calculated runoff factor = 40.0%
UCWI = 89.1
Rainfall rate= 134.5 mm/Hr
Runoff rate (gross)= 34.6 l/s

Methods

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7
where
PIMP = Impervious Area*100/(Impervious Area+Pervious Area)
UCWI = Calculated value for Wetness Index

Calculations produced by MasterDrain Surface Water design program

MasterDrain SW	**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 08/01/24
	Project 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT		By / Checked / Reviewed
	Title 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT		

Data:-

FSR Hydrology:-

Location = WILBRAHAM RD
M5-60 (mm) = 18.5
Soil index = 0.45
Return period = 30
UCWI = 91.2

Grid reference = SJ 8594
r = 0.37
SAAR (mm/yr) = 850
WRAP = 4
Climate change = 35

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

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7
where
PIMP = Impervious Area*100/(Impervious Area+Pervious Area)
UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 800 m²
Total area (TA) = 2500 m²
Mean disch. rate = 5.000 l/s
Additional flow = 0.00 l/s

Pervious area = 1700 m²
Equiv area = 1000 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 35

Calculated data:-

Time to max = 38.0 mins
Rainfall at max = 52.16 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 21.6 m³
Allowed discharge rate = 5.000 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 10.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

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

Diam	Len	Diam	Len
100	2754.8	1125	21.8
150	1224.3	1200	19.1
225	544.2	1275	16.9
300	306.1	1350	15.1
375	195.9	1425	13.6
450	136.0	1500	12.2
525	99.9	1575	11.1
600	76.5	1650	10.1
675	60.5	1725	9.3
750	49.0	1800	8.5
825	40.5	1875	7.8
900	34.0	1950	7.2
975	29.0	2025	6.7
1050	25.0	2100	6.2

Ovoid	Len
400 x 600	120.2
600 x 900	52.3
800 x 1200	29.4

Box culvert	Len
500 x 500	86.5
500 x 750	57.7
500 x 1000	43.3
750 x 1000	28.8
750 x 1200	24.0
750 x 1500	19.2
1000 x 1000	21.6
1000 x 1200	18.0
1000 x 1500	14.4
1000 x 1800	12.0
1000 x 2000	10.8
1500 x 1500	9.6
1500 x 1800	8.0
1500 x 2000	7.2

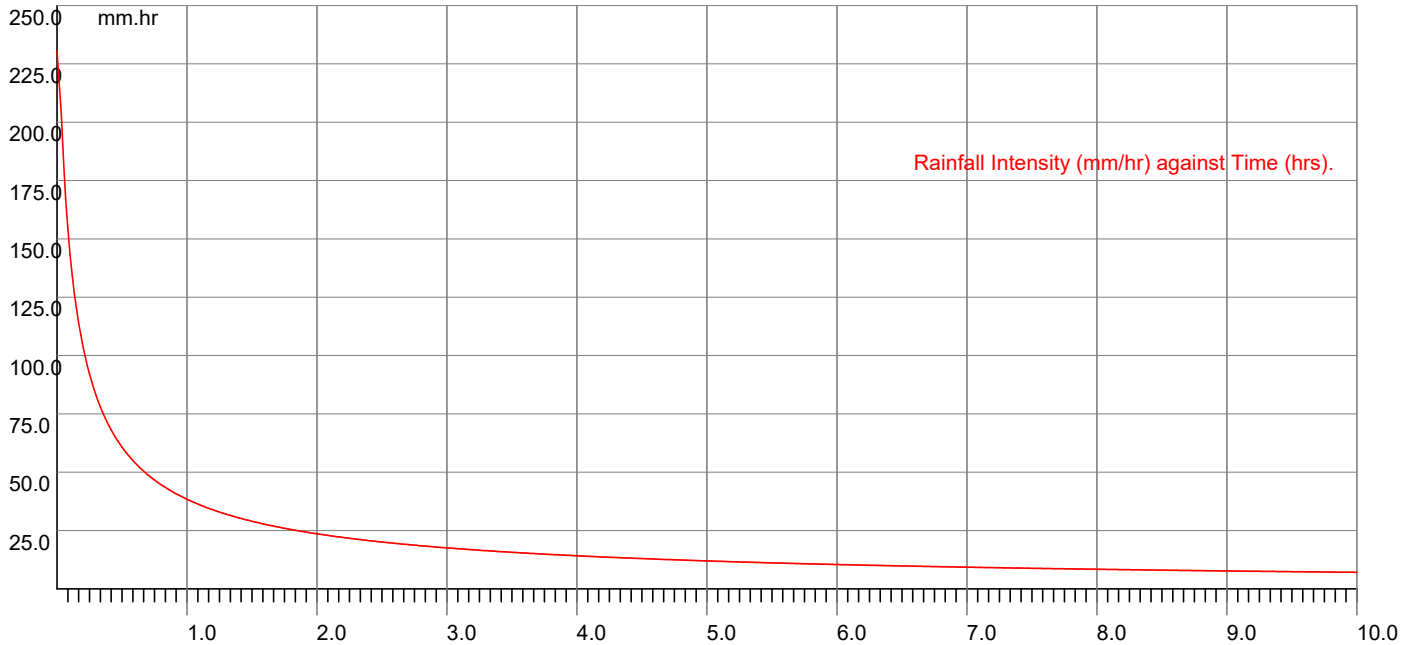
The LK Group	Eton Business Park, Eton Hill Road, Radcliffe M26 2ZS Tel: 0161 763 7200 email: m.jones@thelkgroup.com	Job No.	
www.thelkgroup.com		Sheet no.	2
		Date	08/01/24
MasterDrain SW	Project 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT	By	Checked / Reviewed
	Title 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT		

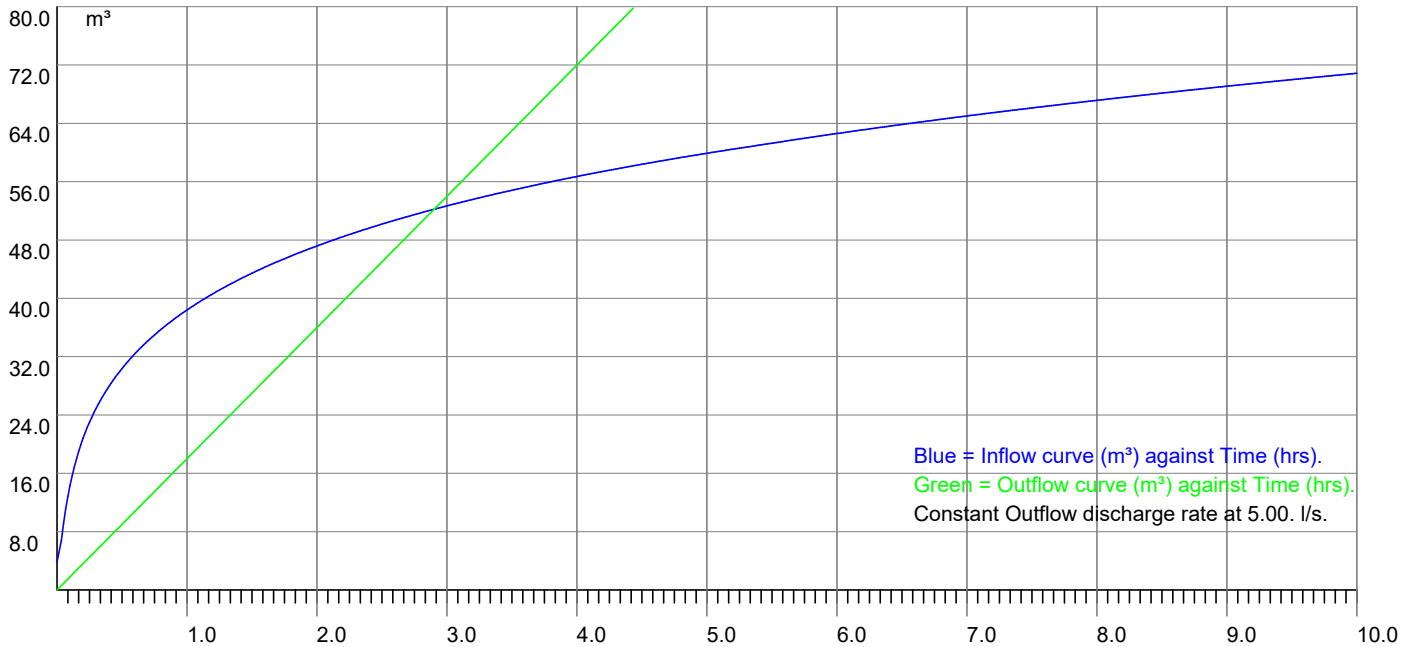
Data:-

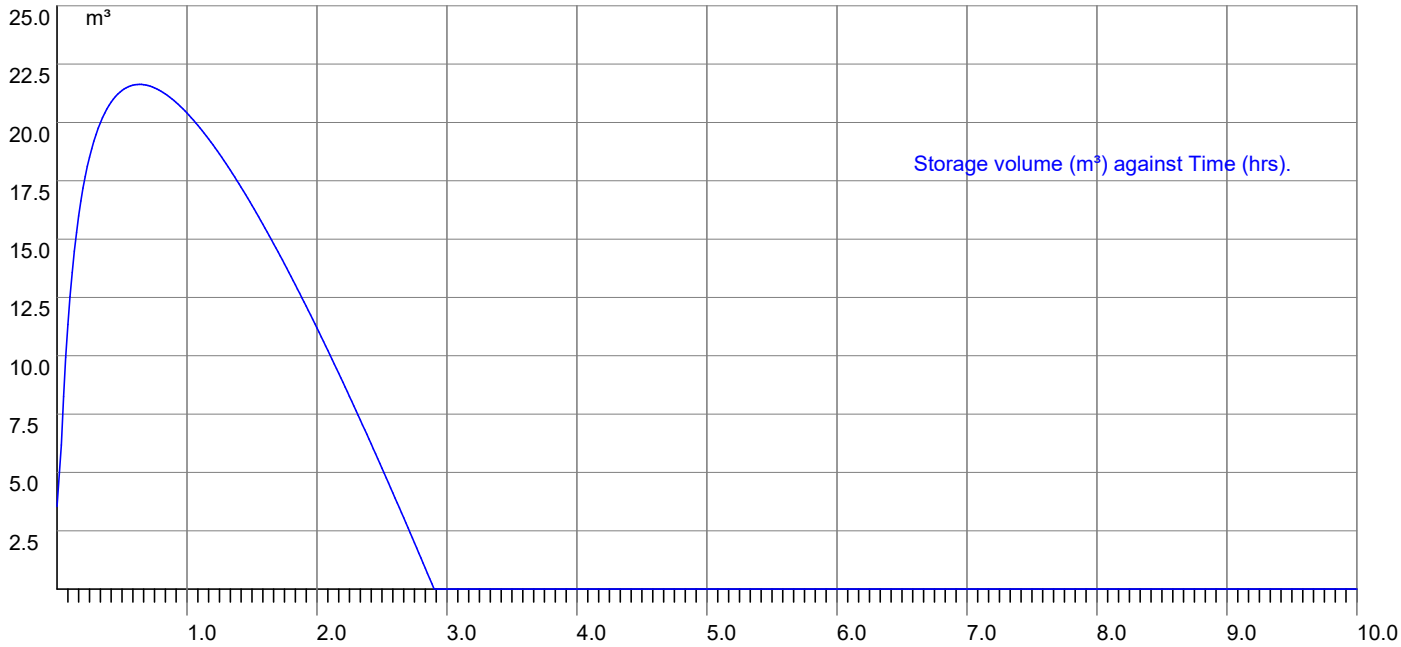
Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	114.0	18.995	3.000	15.995
20	78.0	25.988	6.000	19.988
30	61.0	30.372	9.000	21.372
40	50.0	33.619	12.000	21.619
50	43.0	36.221	15.000	21.221
60	38.0	38.403	18.000	20.403
70	35.0	40.289	21.000	19.289
80	31.0	41.953	24.000	17.953
90	29.0	43.446	27.000	16.446
100	27.0	44.800	30.000	14.800
110	25.0	46.041	33.000	13.041
120	24.0	47.187	36.000	11.187
130	22.0	48.251	39.000	9.251
140	21.0	49.246	42.000	7.246
150	20.0	50.179	45.000	5.179
160	19.0	51.059	48.000	3.059
170	18.0	51.890	51.000	0.890
180	18.0	52.679	54.000	0.000
190	17.0	53.429	57.000	0.000
200	16.0	54.144	60.000	0.000
210	16.0	54.828	63.000	0.000
220	15.0	55.482	66.000	0.000
230	15.0	56.109	69.000	0.000
240	14.0	56.711	72.000	0.000
250	14.0	57.290	75.000	0.000
260	13.0	57.848	78.000	0.000
270	13.0	58.386	81.000	0.000
280	13.0	58.906	84.000	0.000
290	12.0	59.408	87.000	0.000
300	12.0	59.894	90.000	0.000
310	12.0	60.365	93.000	0.000
320	11.0	60.821	96.000	0.000
330	11.0	61.264	99.000	0.000
340	11.0	61.729	102.000	0.000
350	11.0	62.171	105.000	0.000
360	10.0	62.603	108.000	0.000
370	10.0	63.025	111.000	0.000
380	10.0	63.439	114.000	0.000
390	10.0	63.843	117.000	0.000
400	10.0	64.240	120.000	0.000
410	9.0	64.628	123.000	0.000
420	9.0	65.009	126.000	0.000
430	9.0	65.383	129.000	0.000
440	9.0	65.750	132.000	0.000
450	9.0	66.110	135.000	0.000
460	9.0	66.464	138.000	0.000
470	9.0	66.812	141.000	0.000
480	8.0	67.154	144.000	0.000
490	8.0	67.490	147.000	0.000
500	8.0	67.820	150.000	0.000
510	8.0	68.146	153.000	0.000
520	8.0	68.466	156.000	0.000
530	8.0	68.782	159.000	0.000
540	8.0	69.092	162.000	0.000
550	8.0	69.399	165.000	0.000
560	7.0	69.700	168.000	0.000
570	7.0	69.998	171.000	0.000
580	7.0	70.291	174.000	0.000
590	7.0	70.580	177.000	0.000
600	7.0	70.866	180.000	0.000

Storage volume (m^3) = 21.6 m^3

MasterDrain SW	**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. 3 Date 08/01/24
	Project 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT		By / Checked / Reviewed
	Title 26a WILBRAHAM ROAD. MANCHESTER 30 YEARS + 35% CC STORAGE EVENT		







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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	Project 26a WILBRAHAM ROAD. MANCHESTER 100 YEARS + 40% CC STORAGE EVENT		By / Checked / Reviewed
	Title 26a WILBRAHAM ROAD. MANCHESTER 100 YEARS + 40% CC STORAGE EVENT		

Data:-

FSR Hydrology:-

Location = WILBRAHAM RD
M5-60 (mm) = 18.5
Soil index = 0.45
Return period = 100
UCWI = 91.2

Grid reference = SJ 8594
r = 0.37
SAAR (mm/yr) = 850
WRAP = 4
Climate change = 40

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

Runoff factor (RF) = 40.0, calculated from:-

Runoff factor = (0.829*PIMP)+(25*SOIL)+(0.078*UCWI)-20.7
where
PIMP = Impervious Area*100/(Impervious Area+Pervious Area)
UCWI = Calculated value for Wetness Index

Design data:-

Imperv. area = 800 m²
Total area (TA) = 2500 m²
Mean disch. rate = 5.000 l/s
Additional flow = 0.00 l/s

Pervious area = 1700 m²
Equiv area = 1000 m² (TA x RF).
Areal reduction factor = 1.000
Climate change factor = 40

Calculated data:-

Time to max = 56.0 mins
Rainfall at max = 54.80 mm/hr
Pipeline storage = 0.0 m³
Offline storage = 0.0 m³

Calculated storage volume = 34.3 m³
Allowed discharge rate = 5.000 l/s
Available MH storage = 0.0 m³

Fixed 6 hour data:-

Rainfall event = 6 hours
Rainfall rate = 14.00 mm/hr

Calculated storage volume = 0.0 m³
Allowed discharge rate = 5.000 l/s

Rainfall intensities calculated using the Wallingford Procedure

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

Diam	Len	Diam	Len
100	4373.7	1125	34.6
150	1943.8	1200	30.4
225	863.9	1275	26.9
300	486.0	1350	24.0
375	311.0	1425	21.5
450	216.0	1500	19.4
525	158.7	1575	17.6
600	121.5	1650	16.1
675	96.0	1725	14.7
750	77.8	1800	13.5
825	64.3	1875	12.4
900	54.0	1950	11.5
975	46.0	2025	10.7
1050	39.7	2100	9.9

Ovoid	Len
400 x 600	190.8
600 x 900	83.1
800 x 1200	46.7

Box culvert	Len
500 x 500	137.4
500 x 750	91.6
500 x 1000	68.7
750 x 1000	45.8
750 x 1200	38.2
750 x 1500	30.5
1000 x 1000	34.3
1000 x 1200	28.6
1000 x 1500	22.9
1000 x 1800	19.1
1000 x 2000	17.2
1500 x 1500	15.3
1500 x 1800	12.7
1500 x 2000	11.4

The LK Group

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Job No.	
Sheet no.	2
Date	08/01/24
By	
Checked	
Reviewed	

MasterDrain SW

Project: 26a WILBRAHAM ROAD. MANCHESTER 100 YEARS + 40% CC STORAGE EVENT

Title: 26a WILBRAHAM ROAD. MANCHESTER 100 YEARS + 40% CC STORAGE EVENT

Data:-

Time (mins)	Rain mm/hr	Inflow (m3)	Outflow (m3)	Balance (m3)
10	152.0	25.267	3.000	22.267
20	105.0	34.993	6.000	28.993
30	82.0	41.110	9.000	32.110
40	68.0	45.642	12.000	33.642
50	59.0	49.267	15.000	34.267
60	52.0	52.299	18.000	34.299
70	47.0	54.910	21.000	33.910
80	43.0	57.207	24.000	33.207
90	40.0	59.258	27.000	32.258
100	37.0	61.112	30.000	31.112
110	34.0	62.803	33.000	29.803
120	32.0	64.358	36.000	28.358
130	30.0	65.796	39.000	26.796
140	29.0	67.134	42.000	25.134
150	27.0	68.384	45.000	23.384
160	26.0	69.557	48.000	21.557
170	25.0	70.660	51.000	19.660
180	24.0	71.702	54.000	17.702
190	23.0	72.688	57.000	15.688
200	22.0	73.624	60.000	13.624
210	21.0	74.514	63.000	11.514
220	21.0	75.362	66.000	9.362
230	20.0	76.171	69.000	7.171
240	19.0	76.944	72.000	4.944
250	19.0	77.685	75.000	2.685
260	18.0	78.395	78.000	0.395
270	18.0	79.076	81.000	0.000
280	17.0	79.730	84.000	0.000
290	17.0	80.360	87.000	0.000
300	16.0	80.966	90.000	0.000
310	16.0	81.550	93.000	0.000
320	15.0	82.114	96.000	0.000
330	15.0	82.658	99.000	0.000
340	15.0	83.261	102.000	0.000
350	14.0	83.823	105.000	0.000
360	14.0	84.372	108.000	0.000
370	14.0	84.909	111.000	0.000
380	13.0	85.433	114.000	0.000
390	13.0	85.946	117.000	0.000
400	13.0	86.448	120.000	0.000
410	13.0	86.940	123.000	0.000
420	12.0	87.422	126.000	0.000
430	12.0	87.895	129.000	0.000
440	12.0	88.358	132.000	0.000
450	12.0	88.813	135.000	0.000
460	12.0	89.259	138.000	0.000
470	11.0	89.697	141.000	0.000
480	11.0	90.128	144.000	0.000
490	11.0	90.551	147.000	0.000
500	11.0	90.967	150.000	0.000
510	11.0	91.376	153.000	0.000
520	11.0	91.779	156.000	0.000
530	10.0	92.175	159.000	0.000
540	10.0	92.565	162.000	0.000
550	10.0	92.949	165.000	0.000
560	10.0	93.327	168.000	0.000
570	10.0	93.699	171.000	0.000
580	10.0	94.066	174.000	0.000
590	10.0	94.428	177.000	0.000
600	9.0	94.785	180.000	0.000

Storage volume (m^3) = 34.3 m^3

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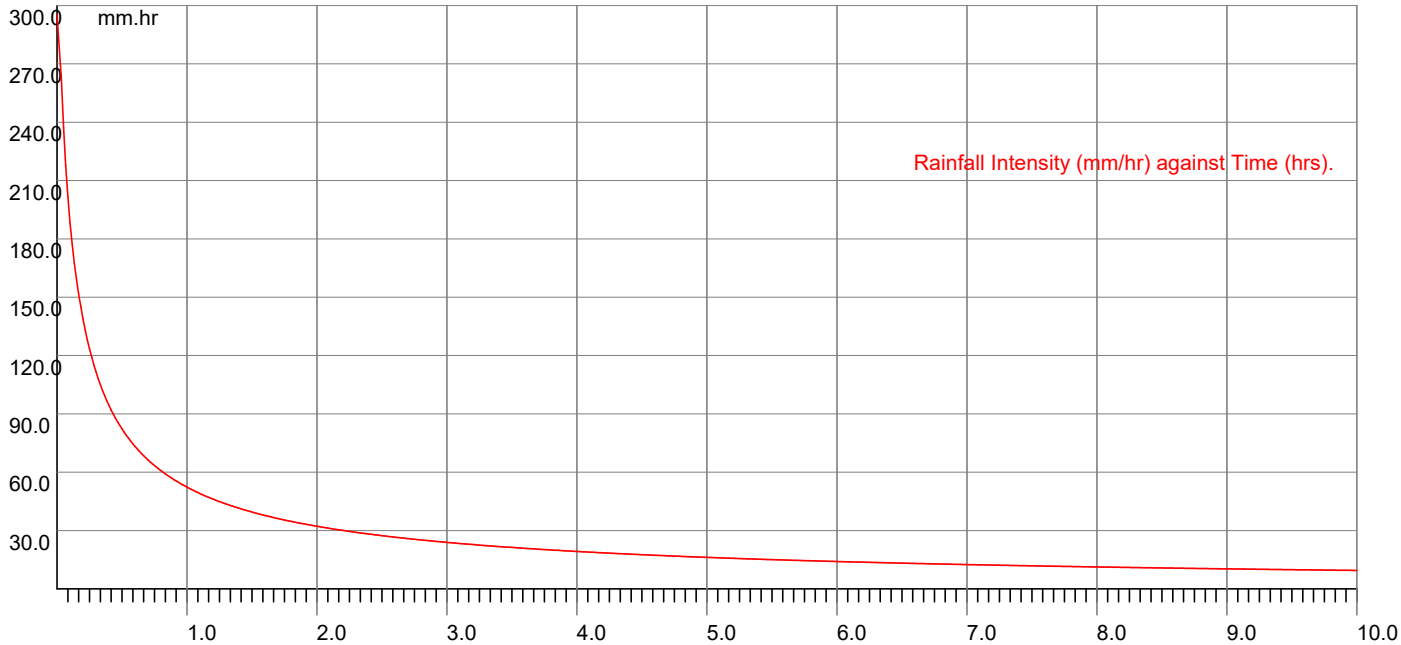

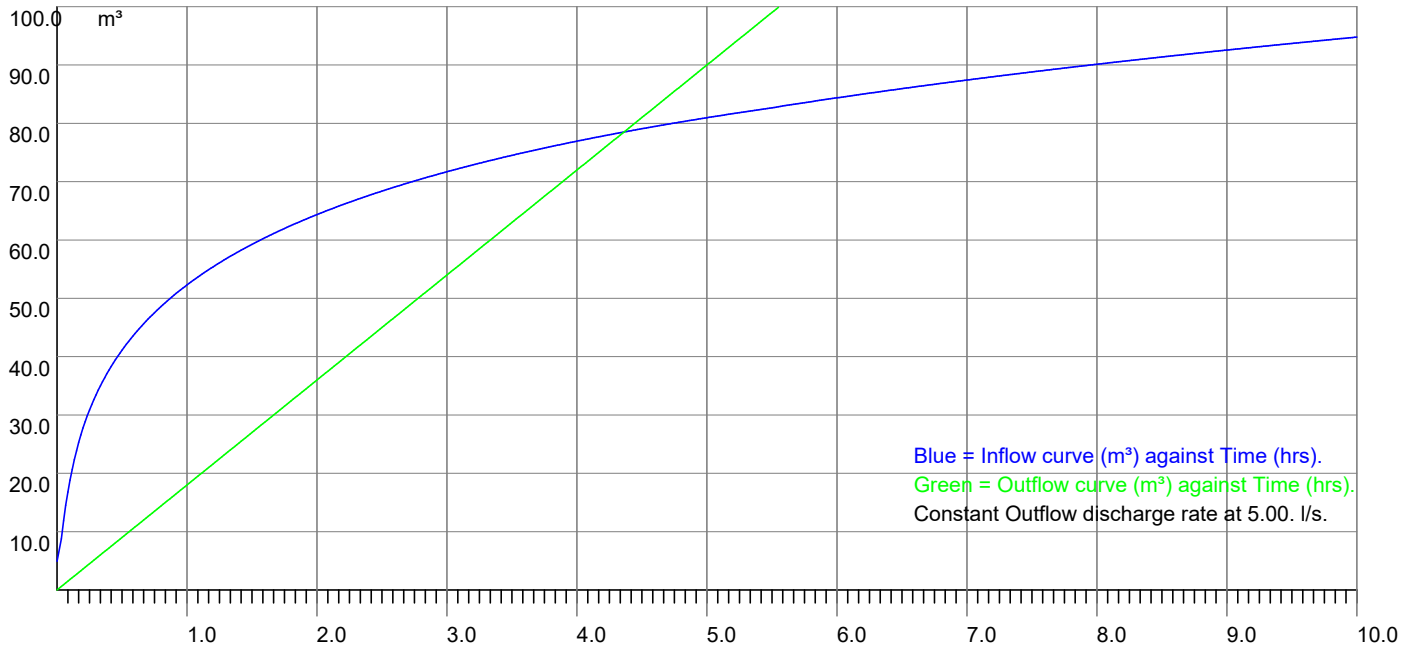

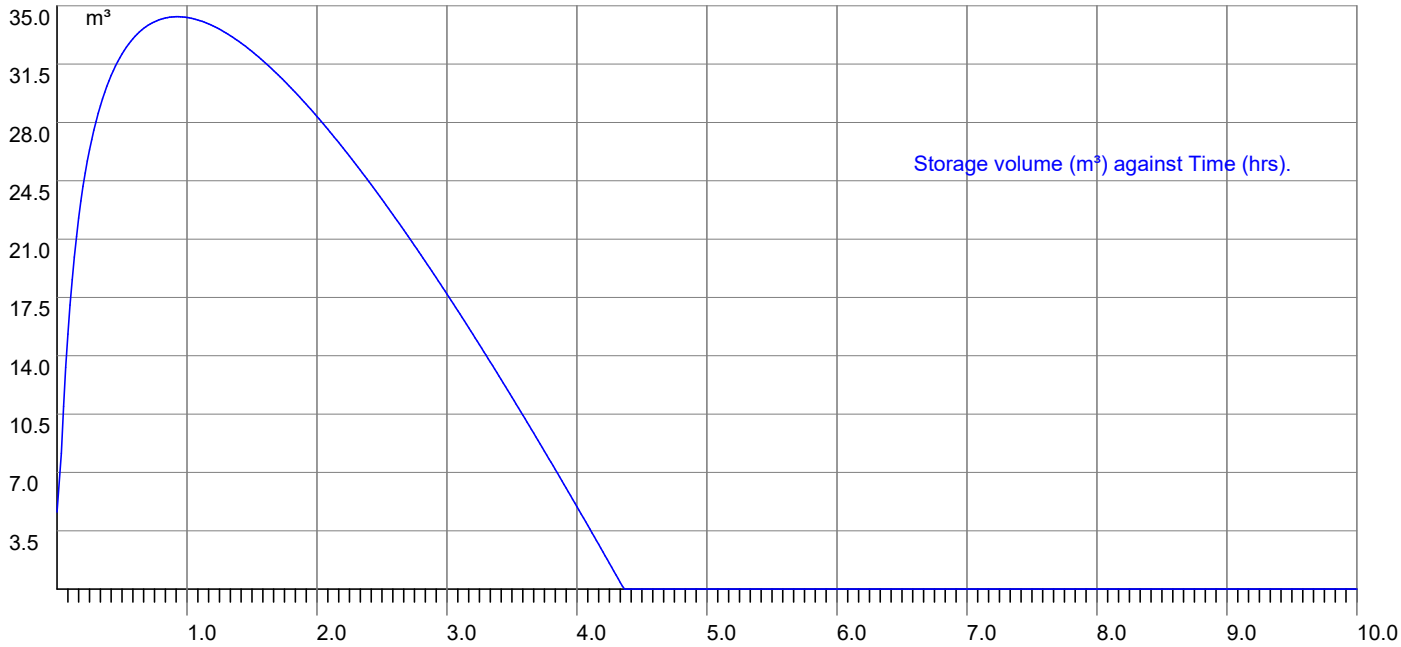

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