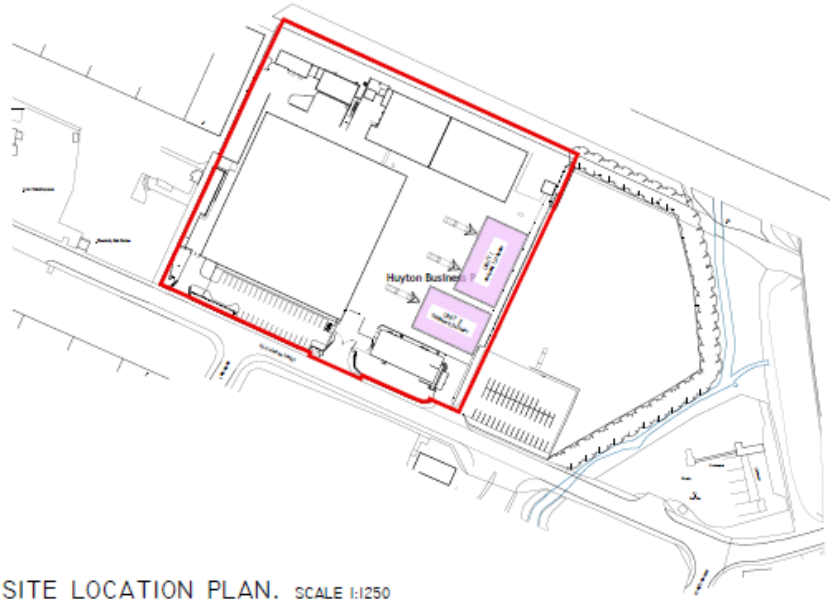
STL

CONSULTING STRUCTURAL ENGINEERS

Surface Water Drainage Strategy and Drainage Design

Project: Hardwood Holdings Ltd
Site: Hardwood Holdings Ltd
Ellis Ashton Street
Huyton, Liverpool.



SITE LOCATION PLAN. SCALE 1:1250

Client: Hardwood Holdings Ltd
Architect: Aspire Design Studio Ltd
Date: 25/09/25

Job Ref: 25-6488
Prepared by: MR
Checked by:

Revisions:

The Institution of Structural Engineers

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Standard documents.

Documents used:

Building Regulation Approved Documents	Part A	Structure
	Part B	Fire
	Part C	Site Preparation
	Part H	Drainage
British Codes of Practice	BS8110 Part 1	Concrete
	BS5950 Part 1	Steel
	BS5628 Part	Unreinforced masonry
	BS5977	Lintel design
	BS5268 Part	Timber
	BS6399 Parts	Dead & Imposed loads
Euro Codes	EC1	Actions on structures
	EC2	Concrete design
	EC3	Steel Design
	EC5	Timber design
	EC6	Masonry design
NHBC Standards 2011	Chapter 4.3	Building near Trees

Construction (Design & Management) Regulations 2015.

Under the C(D&M) Regs the designer's responsibility is limited to the reasonably foreseeable risks to persons involved in the construction, maintenance and repair of a structure from hazards that arise from the design. Therefore, this DRA only assesses the possible hazards that may arise from the specific structural design at this stage of the project. Should any alterations to the structure be carried out without the knowledge of the designer then no responsibility can be attributed.
It is the Contractors responsibility to use this document for the construction and future maintenance of the building as designed at this stage. This is not a Method Statement.

Under the C(D&M) Regulations 2015 it is the clients responsibility to ensure that every person designing the structure and every contractor who has been or may be appointed to work on the project is promptly provided with sufficient pre-construction information to ensure so far as is reasonably practicable the health and safety of all persons engaged in the construction work, liable to be affected by the way in which it is carried out, and who will use the structure in future.

Designers Risk Analysis.

Considerations to be given are:

During initial construction.

Noise and vibrations. Not only consider the effects these may have on workers but also neighbours.
Contamination. Where ground may be contaminated may need to consider substructure works that do not allow leaching through surface etc.
Falls from height, generally over 2m. These include around edges of deep excavations, upper floor and roof edges.
Collapse of the structure under both temporary and permanent imposed loads.
Handling of structural elements. Consideration must be given to the weight of elements specified and whether mechanical handling is feasible. Otherwise consider splicing beams and columns etc or the use of lightweight masonry if acceptable.
Fire. Although on site welding may be necessary, using this near combustible materials is not wise.

Long term.

Falls from height, generally over 2m. Consideration should be given for the future maintenance of the building such as ladder restraint to upper walls.
Collapse of the structure under the permanent imposed loads. The structural elements should be clearly marked on the drawings.

Hazard ref	Hazard Source	Risk Category	Preventative/Control Measures	Residual Risk
1	Manual handling	MEDIUM	Use lighter sections/material where possible and keep lengths to minimum. Where necessary allow for splicing longer, heavier sections and provide details	LOW
2	Competence	HIGH	Consideration to be given during design of persons undertaking building works. Where complicated structural works are to be carried then suitable design information is to be produced and risks highlighted	MEDIUM
3	Structural stability of building	HIGH	Design is to consider the temporary (during works) and permanent stability of the building Unless we have been instructed to provide the temporary works design, it is the contractors responsibility to design all temporary works to facilitate the structural alterations. Any element where risk is possible to be highlighted in our design information	MEDIUM
4	Noise/ vibration	MEDIUM	The design is to consider the effects of any recommended works on the workforce and/or neighbours. Risks to be advised on design information	LOW
5	Working at height	MEDIUM	The design is to consider any unnecessary height issues such as foundation/excavation depths and working overhead. Ultimately, this is the contractors' responsibility to provide all temporary support and platforms	LOW

Risk Category/Residual Risk

Low	Medium	High
No further action required	Risk to be highlighted to contractor/end user	Action required within design to mitigate risk

Standard Construction Notes.

These calculations have been produced for the sole purpose of obtaining Building Regulations Approval for the structural elements of the proposed scheme as per our terms of instruction. These calculations are based on the structural alterations required and either as shown on the Architects' drawings or in the design brief. These calculations should be read in conjunction with such information. Due care and attention has been given in the production of these calculations, however, it is the Contractors' responsibility to advise STL of any discrepancies prior to commencing on site.

Any dimensions shown in these calculations are purely for design purposes only and must not be used for ordering lengths of members. All measurements must be taken on site and lengths of required bearings added.

Unless specifically stated, STL have not undertaken any ground investigations or survey of the existing structure and the suitability of such is presumed to be structurally sound for the purpose of these calculations. All supporting walls are presumed to have suitable foundations and it is the Contractors' responsibility to ensure such before creating new load paths. These calculations do not constitute a structural appraisal of the building, and it is the Clients responsibility to employ an experienced Contractor who has full knowledge and understanding of current building practice.

We also recommend that Building Regulation Approval is obtained for any structural works. The design calculations should be provided as part of any such approval, however STL take no responsibility applying for such approval unless specifically instructed. Additional fees may be charged for such work in addition to Building Control Fees.

All attempts have been made to simplify the design of any supports and reduce the risks and hazards associated with the implementation of such. It is the contractor's responsibility to ensure that he is satisfied with the scheme and design and install all the necessary temporary support of the existing structure and ensure the safety of all persons involved in the construction and secure the site.

Where we have not been asked to undertake any ground investigations we cannot advise on the required foundations for the new project. Therefore, all new foundations are to be of adequate width and taken down to a suitable depth to be confirmed on site with the Engineer or Building Inspector. Where posts or piers are specified then we will provide approximate pad foundation sizes based upon presumed safe bearing capacities of the substrata. These will need to be confirmed on site. Should specialist foundations be required then STL are more than happy to design these but at extra cost. Where new foundations pass over existing or new drain runs they should be taken down below the invert level of the drains and pre cast concrete lintels used to span over.

All steel specified in these calculations is to be of minimum grade S275 to Standard British sections to BS5950. All steelwork is to be protected from corrosion by standard 2 coats of zinc rich primer and being touched up on site as necessary. Where steel is in external exposed conditions, then we recommend shot blasting and hot dip galvanising plus the use of cavity trays etc where applicable. All bearings for beams supporting the structure over new openings should be a minimum of 100mm, sat on 440x100x215mm deep C35 concrete padstones built into the new/existing masonry walls. Where increased bearing is required these will be specified in the calculations/drawings. All steel to steel connections are to be made with M16 Grade 8.8 bolts minimum or 6mm full penetration fillet welds all round.

All lintels are to be installed in accordance with the manufacturers' recommendations, with a minimum bearing of 150mm unless specified otherwise.

All new load bearing masonry should be of minimum 7N/mm^2 block or 10N/mm^2 brickwork bed in class iii mortar to BS5628 unless advised otherwise in the calculations.

All new timber sections are to be of structural graded timber as specified in the calculations to BS5268. All timber delivered to site should be marked with the grade and this should be checked with the calculations for compatibility. All timber should be kept covered, off the ground and out of the elements. Any special timber trusses or floor joists should be stored in accordance with the manufacturer's instructions.

It should be noted that any structural works to the existing building fabric may cause some damage to adjacent plastered/decorated areas and this should be taken into consideration with respect to any redecoration costs.

Where any of the structure is built into or adjacent a Party Wall Structure, you have a legal requirement under the Party Wall etc Act 1996, to notify the owner such structure before undertaking any work. We recommend that a condition survey is undertaken of the affected area as any damage that may occur during the work is your responsibility to correct. Sometime disputes can arise and you will need the services of a Party Wall Surveyor.

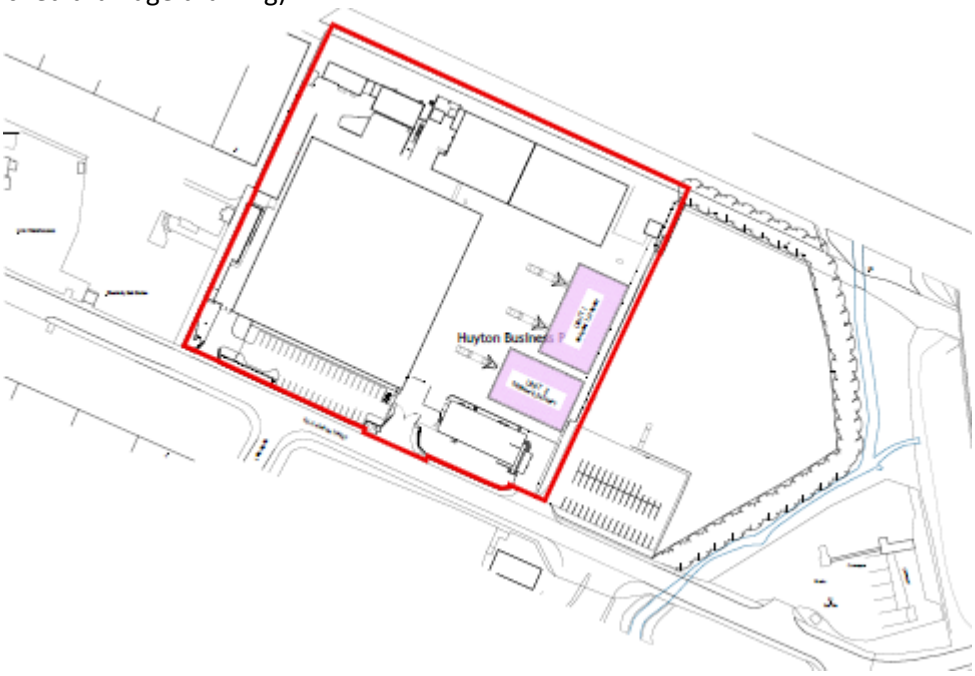
Drainage strategy.

Proposed development

The project includes construction of two industrial/ storage warehouses on the above site, along the eastern boundary of the industrial site. The new buildings are to be constructed with metal clad walls and roof over a steel portal frame with solid concrete ground floors over traditional concrete foundations.

The buildings are to be constructed on what is currently concrete and tarmac hardstanding used by delivery vehicles, vehicle car parking, materials storage and Porta-cabins.

A new industrial unit was constructed recently (2016/ 2017) along the northern boundary with investigations confirming impermeable clay subsoil. The surface water from this development is attenuated and discharges into the Logwood Mill Brook, which runs along the south east corner and eastern boundary at a rate of 5.0 L/sec. (see attached drainage drawing)



Ground Conditions/ site investigations

British geological survey data confirms superficial deposits consist of Till, Devensian- Diamicton, sedimentary superficial deposit, with underlying solid geology comprises Pennine Middle Coal Measures formation - mudstone, siltstone and sandstone sedimentary bedrock.

Site investigations for the previous extension and industrial unit prepared by REC Ltd in Nov 2011 confirmed shallow depths of made ground to a maximum depth of 1.8m underlain by firm to stiff high strength gravelly clay proved to a maximum depth of 4.6m with high strength Marl to a maximum depth of 4.6m and soild geology comprising grey mudstone between 3.3m and 4.7m below ground level. Ground water was encountered at depths of 1.02 to 1.74m in four boreholes with no water encountered in two boreholes.

Drainage proposals/ design

The proposed for the surface water are as follows-

- Infiltration to ground is not feasible due to the presence of impermeable stiff gravelly clay which was proved for the previous development.
- The surface water discharge for the previous development was attenuated and discharges into Logwood Mill Brook on the south east corner of the site with flow restricted to 5 L/sec using a Hydro-brake.
- It is proposed to connect the surface water discharge from the proposed building into the existing drainage system for the previous industrial unit, with attenuation tanks to store stormwater and flow control to restrict the discharge into the existing drainage system.
- The final discharge will be into Logwood Mill Brook via the existing outfall with no increase in discharge rate.
- This is a commercial site and so the use of water retaining features and water butts etc is not feasible.
- There is no landscaping proposed and so it is not feasible to install tree pits and rain gardens.

The proposal is to provide attenuation tanks to store stormwater for a 1 year/ 30 year and 100 year storm. The attenuation tanks are to be designed to allow for a 40% storage volume increase for climate change.

Calculate the pre-development surface water discharge rate for existing hardstanding area/ proposed building area and reduce/ restrict surface water discharge to max 50 % of the calculated pre-development discharge rate.

Calculate attenuation tanks required for the proposed buildings (694 m^2 and 580 m^2) allowing for a 40% volume increase/ uplift for climate change.

Undertake Causeway Flow Drainage analysis for a 1 year/ 30 year and 100 year storm with 40% climate change uplift for 15min/ 30min/ 60 min (1hr)/ 180min (3hrs)/ 240min (4hrs)/ 360min (6hrs) storm duration.

It is assumed the existing and remaining hardstanding and paving will discharge into existing gullies and surface water drainage system.

Proposed site areas

Proposed roof area Unit 1	= 694 m^2
Proposed roof area Unit 2	= 580 m^2
Existing Hardstanding area	= 1274 m^2

Drainage Maintenance and Management plan.

Maintenance of the drainage will be undertaken by the Contractor until adopted and/or transferred to a management company or owners of the properties.
Documents to be prepared when the lease is prepared for the new industrial units which define responsibilities for the drainage system serving the new buildings.

The management document will include the following terms-

1- All drainage on site to be maintained regularly with agreement written into the lease documents
2- All costs associated with the maintenance of the drainage system on site to be included within the service charges for all owners.
3 Service charges and maintenance costs to be administered by the Landlords or Property Management company.

The Drainage Maintenance Agreement to include and is not restricted to the following-

1- Cleaning and checking gullies and silt trap manholes within the site boundaries- 6 month intervals
2- Inspecting soak-away tanks and if required clearing silt from the tanks- 12 month intervals
3 Inspecting Flor control chamber and flow restrictor- 12 month intervals
4- Defining responsibility for reporting defects or blockages and responsibility for arranging repairs accordingly
5- Emergency procedures specified and set out to deal with spillages of hazardous liquids (petrol/ diesel/ turpentine etc).

Existing Surface Water Discharge rate

Calculate discharge rate for the area of hardstanding / proposed building area.

DESIGN RAINFALL

In accordance with the Wallingford Procedure

Tedds calculation version 2.0.00

Design rainfall intensity

Location of catchment area;	Liverpool
Storm duration;	D = **15** min
Return period;	Period = **100** yr
Ratio 60 min to 2 day rainfall of 5 yr return period;	r = **0.400**
5-year return period rainfall of 60 minutes duration;	M5_60min = **19.0** mm
Increase of rainfall intensity due to global warming;	$p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure);	Z1 = **0.63**
Rainfall for 15min storm with 5 year return period;	$M5_15min_i$ = Z1 × M5_60min = **12.0** mm
Factor Z2 (Wallingford procedure);	Z2 = **1.94**
Rainfall for 15min storm with 100 year return period;	M100_15min = Z2 × $M5_15min_i$ = **23.4** mm
Design rainfall intensity;	I_{max} = M100_15min / D = **93.5** mm/hr

Maximum surface water runoff

Catchment area;	A_{catch} = **1274** m^2
Percentage of area that is impermeable;	p = **90** %
Maximum surface water runoff;	Q_{max} = A_{catch} ´ p ´ I_{max} = **29.8** l/s

Maximum discharge for the existing hardstanding area/ proposed building area	= 29.8L/sec
Allowable discharge (50% of pre development discharge)	= 14.9 L/sec
Restrict discharge to current used of the previous building	**= 5 L/sec**

Attenuation Storage – Unit 1 – 694 m2

ATTENUATION DESIGN

In accordance with CIRIA publication C697 - The SUDS Manual

Tedds calculation version 1.0.02- Library item: Calculation title

EA_Defra method

Library item: Header output

Site characteristics

Location;	Liverpool
Hydrological region;	10
Soil type (Wallingford Procedure W.R.A.P map);	4
Standard percentage runoff;	SPR = **0.47**
Average annual rainfall;	SAAR = **820** mm
5 year return period rainfall of 60 minute duration;	M5_60min = **19.0** mm
Ratio 60-minute to 2 day rainfalls of 5 year return;	r = **0.40**
Rainfall intensity increase due to global warming;	$p_{climate}$ = **40**%
Impervious area req. attenuation storage;	α = **90.0** %

Catchment details

Subcatchment	Name	Area (ha)	PIMP (%);	Impermeable. area (ha)
1;	Prop roof;	0.07;	90.0;	0.06;
	Total	0.07;	90.0;	0.06;

Greenfield runoff rates

Catchment area;	AREA = **50.00** hectare
Greenfield runoff rate (50 hectare site);	$\bar{Q}_{rural} = 0.00108 m^3/s \times (AREA/1km^2)^{0.89} \times (SAAR/1mm)^{1.17} \times SPR^{2.17}$ = **290.5** l / s
Greenfield runoff rate;	$\bar{Q} = \bar{Q}_{rural} / AREA \times A$ = **0.4** l / s
Greenfield runoff rate per unit area;	$\bar{Q}_A = \bar{Q} / A$ = **5.8** l / s / hectare

Estimated site discharges

FSR growth rate (1 year);	FSR_{1yr} = **0.87**
Discharge (1 year);	$Q_{1yr} = \bar{Q} \times FSR_{1yr}$ = **0.4** l/s
FSR growth rate (30 year);	FSR_{30yr} = **1.70**
Discharge (30 year);	$Q_{30yr} = \bar{Q} \times FSR_{30yr}$ = **0.7** l/s
FSR growth rate (100 year);	FSR_{100yr} = **2.08**
Discharge (100 year);	$Q_{100yr} = \bar{Q} \times FSR_{100yr}$ = **0.8** l/s

Estimated attenuation volume - 1 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{1yr}$ = **106.6** m^3 / hectare
Basic storage volume ;	$BSV_{1yr} = Uvol_{1yr} \times \alpha \times A$ = **6.66** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{1yr} = **1.00**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{1yr} = **1.56**
Adjusted storage volume;	$ASV_{1yr} = SVR_{1yr} \times BSV_{1yr}$ = **10.39** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{1yr} = **1.00**
Final estimated attenuation storage;	$Vol_{1yr} = HR_{1yr} \times ASV_{1yr}$ = **10.41** m^3

Library item: Estimated attenuation output

Estimated attenuation volume - 30 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{30yr}$ = **253.8** m^3 / hectare
Basic storage volume ;	$BSV_{30yr} = Uvol_{30yr} \times \alpha \times A$ = **15.85** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{30yr} = **0.95**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{30yr} = **1.68**
Adjusted storage volume;	$ASV_{30yr} = SVR_{30yr} \times BSV_{30yr}$ = **26.64** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{30yr} = **1.09**
Final estimated attenuation storage;	$Vol_{30yr} = HR_{30yr} \times ASV_{30yr}$ = **28.97** m^3

Library item: Estimated attenuation output

Estimated attenuation volume - 100 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{100yr}$ = **321.2** m^3 / hectare
Basic storage volume ;	$BSV_{100yr} = Uvol_{100yr} \times \alpha \times A$ = **20.06** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{100yr} = **0.95**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{100yr} = **1.68**
Adjusted storage volume;	$ASV_{100yr} = SVR_{100yr} \times BSV_{100yr}$ = **33.71** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{100yr} = **1.13**
Final estimated attenuation storage;	$Vol_{100yr} = HR_{100yr} \times ASV_{100yr}$ = **38.11** m^3

Library item: Estimated attenuation output

Attenuation storage required

Vol. increase due to head-discharge relationship;	p_{hydro} = **1.25**
Maximum attenuation storage required;	$V_{req_max} = Vol_{30yr} \times p_{hydro}$ = **36.2** m^3

Interception storage

Interception rainfall depth;	d_{int} = **5** mm
Volume of interception storage required;	$V_{int_req} = 0.8 \times A_{imp} \times d_{int}$ = **2.50** m^3

Long term storage

Proportion of paved area draining in to network; α = 0.9

Proportion of pervious area draining in to network; β = 0.5

Rainfall depth for 100years, 6 hour event; RD = M100_360 = 79.7 mm

Extra runoff vol of dev.runoff over greenfield runoff; $Vol_{xs} = \max(RD \times A \times (PIMP \times \alpha \times 0.8 + ((1 - PIMP) \times \beta \times SPR) - SPR), 0m^3)$ = 11.15 m^3

Treatment volume

Treatment volume (assume 80% runoff);	$T_{vol} = 0.8 \times A \times 15mm \times PIMP$ = **7.50** m^3

<u>Provide min 11.15m³ attenuation tanks for unit 1- Use min Brett Martin Stormcrate 55 or Wavin Aqua-core tanks.</u>

<u>Attenuation tanks to be installed in accordance with manufacturer's specifications</u>

Attenuation Storage – Unit 2 – 580 m2

ATTENUATION DESIGN

In accordance with CIRIA publication C697 - The SUDS Manual

Tedds calculation version 1.0.02- Library item: Calculation title

EA_Defra method

Library item: Header output

Site characteristics

Location;	Liverpool
Hydrological region;	10
Soil type (Wallingford Procedure W.R.A.P map);	4
Standard percentage runoff;	SPR = **0.47**
Average annual rainfall;	SAAR = **820** mm
5 year return period rainfall of 60 minute duration;	M5_60min = **19.0** mm
Ratio 60-minute to 2 day rainfalls of 5 year return;	r = **0.40**
Rainfall intensity increase due to global warming;	$p_{climate}$ = **40**%
Impervious area req. attenuation storage;	α = **90.0** %

Catchment details

Subcatchment	Name	Area (ha)	PIMP (%);	Impermeable. area (ha)
1;	Prop roof;	0.06;	90.0;	0.05;
	Total	0.06;	90.0;	0.05;

Greenfield runoff rates

Catchment area;	AREA = **50.00** hectare
Greenfield runoff rate (50 hectare site);	$\bar{Q}_{rural} = 0.00108 m^3/s \times (AREA/1km^2)^{0.89} \times (SAAR/1mm)^{1.17} \times SPR^{2.17}$ = **290.5** l / s
Greenfield runoff rate;	$\bar{Q} = \bar{Q}_{rural} / AREA \times A$ = **0.3** l / s
Greenfield runoff rate per unit area;	$\bar{Q}_A = \bar{Q} / A$ = **5.8** l / s / hectare

Estimated site discharges

FSR growth rate (1 year);	FSR_{1yr} = **0.87**
Discharge (1 year);	$Q_{1yr} = \bar{Q} \times FSR_{1yr}$ = **0.3** l/s
FSR growth rate (30 year);	FSR_{30yr} = **1.70**
Discharge (30 year);	$Q_{30yr} = \bar{Q} \times FSR_{30yr}$ = **0.6** l/s
FSR growth rate (100 year);	FSR_{100yr} = **2.08**
Discharge (100 year);	$Q_{100yr} = \bar{Q} \times FSR_{100yr}$ = **0.7** l/s

Estimated attenuation volume - 1 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{1yr}$ = **106.6** m^3 / hectare
Basic storage volume ;	$BSV_{1yr} = Uvol_{1yr} \times \alpha \times A$ = **5.56** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{1yr} = **1.00**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{1yr} = **1.56**
Adjusted storage volume;	$ASV_{1yr} = SVR_{1yr} \times BSV_{1yr}$ = **8.69** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{1yr} = **1.00**
Final estimated attenuation storage;	$Vol_{1yr} = HR_{1yr} \times ASV_{1yr}$ = **8.70** m^3

Library item: Estimated attenuation output

Estimated attenuation volume - 30 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{30yr}$ = **253.8** m^3 / hectare
Basic storage volume ;	$BSV_{30yr} = Uvol_{30yr} \times \alpha \times A$ = **13.25** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{30yr} = **0.95**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{30yr} = **1.68**
Adjusted storage volume;	$ASV_{30yr} = SVR_{30yr} \times BSV_{30yr}$ = **22.26** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{30yr} = **1.09**
Final estimated attenuation storage;	$Vol_{30yr} = HR_{30yr} \times ASV_{30yr}$ = **24.22** m^3

Library item: Estimated attenuation output

Estimated attenuation volume - 100 year

Attenuation storage vol (fig A7.1 - A7.8);	$Uvol_{100yr}$ = **321.2** m^3 / hectare
Basic storage volume ;	$BSV_{100yr} = Uvol_{100yr} \times \alpha \times A$ = **16.76** m^3
FEH rainfall factor (figs A11.1, A6.1.1 - A6.3.4);	FF_{100yr} = **0.95**
Storage volume ratio (fig A8.1 - A8.8);	SVR_{100yr} = **1.68**
Adjusted storage volume;	$ASV_{100yr} = SVR_{100yr} \times BSV_{100yr}$ = **28.17** m^3
Hydrological regional volume ratio (fig A9.1);	HR_{100yr} = **1.13**
Final estimated attenuation storage;	$Vol_{100yr} = HR_{100yr} \times ASV_{100yr}$ = **31.85** m^3

Library item: Estimated attenuation output

Attenuation storage required

Vol. increase due to head-discharge relationship;	p_{hydro} = **1.25**
Maximum attenuation storage required;	$V_{req_max} = Vol_{30yr} \times p_{hydro}$ = **30.3** m^3

Interception storage

Interception rainfall depth;	d_{int} = **5** mm
Volume of interception storage required;	$V_{int_req} = 0.8 \times A_{imp} \times d_{int}$ = **2.09** m^3

Long term storage

Proportion of paved area draining in to network; α = 0.9

Proportion of pervious area draining in to network; β = 0.5

Rainfall depth for 100years, 6 hour event; RD = M100_360 = 79.7 mm

Extra runoff vol of dev.runoff over greenfield runoff; $Vol_{xs} = \max(RD \times A \times (PIMP \times \alpha \times 0.8 + ((1 - PIMP) \times \beta \times SPR) - SPR), 0m^3)$ = 9.31 m^3

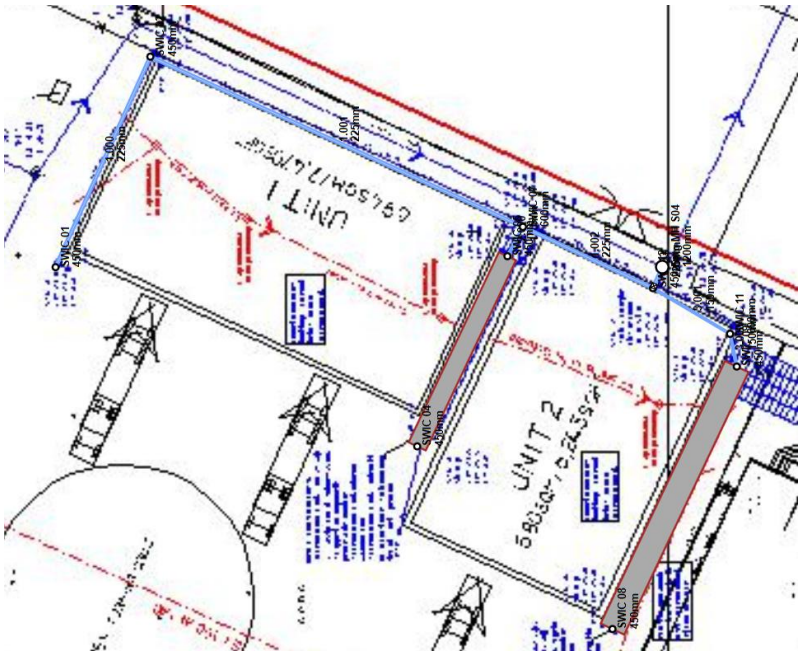
Treatment volume

Treatment volume (assume 80% runoff);	$T_{vol} = 0.8 \times A \times 15mm \times PIMP$ = **6.26** m^3

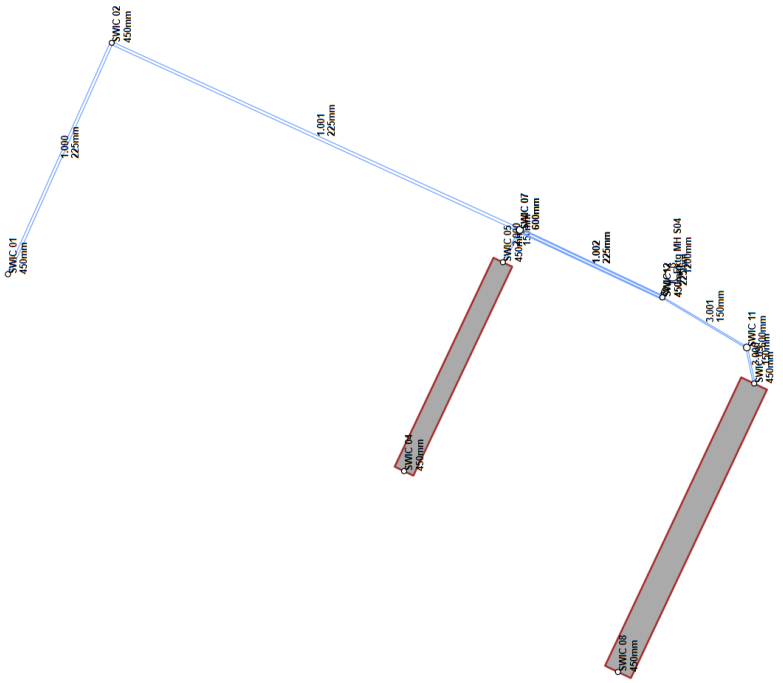
<u>Provide min 9.31m³ attenuation tanks for unit 2- Use min Brett Martin Stormcrate 55 or Wavin Aqua-core tanks.</u>

<u>Attenuation tanks to be installed in accordance with manufacturer's specifications</u>

Causeway Flow drainage analysis (summary).



Site plan with surface water drainage (nts)



Surface water drainage- Schematic plan (nts)

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	30	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	England and Wales	Connection Type	Level Soffits
M5-60 (mm)	19.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.400	Preferred Cover Depth (m)	0.600
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Add Inflow (l/s)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
SWIC 01	0.018	5.00		29.900	450	345840.400	390357.800	0.825
SWIC 02	0.018	5.00	0.0	29.600	450	345860.408	390348.792	0.894
SWIC 05	0.033	5.00		28.900	450	345841.440	390314.841	0.750
SWIC 07				28.900	600	345844.232	390313.370	0.879
SWIC 09	0.015	5.00		28.800	450	345830.954	390293.036	1.350
SWIC 11				28.800	600	345834.065	390293.672	1.450
SWIC12				28.600	450	345838.400	390301.000	1.425
Extg MH S04				28.400	1200	345840.418	390300.123	1.234
SWIC 04	0.033	5.00		29.250	450	345823.371	390323.420	1.100
SWIC 08	0.015	5.00		28.700	450	345806.011	390304.853	1.250

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Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	SWIC 01	SWIC 02	21.942	0.600	29.075	28.706	0.369	59.5	225	5.22	50.0
1.001	SWIC 02	SWIC 07	38.941	0.600	28.706	28.050	0.656	59.4	225	5.60	50.0
2.000	SWIC 05	SWIC 07	3.156	0.600	28.150	28.096	0.054	58.4	150	5.04	50.0
1.002	SWIC 07	SWIC12	13.676	0.600	28.021	27.200	0.821	16.7	225	5.67	50.0
3.000	SWIC 09	SWIC 11	3.175	0.600	27.450	27.400	0.050	63.5	150	5.04	50.0
3.001	SWIC 11	SWIC12	8.514	0.600	27.350	27.250	0.100	85.1	150	5.17	50.0
1.003	SWIC12	Extg MH S04	2.200	0.600	27.175	27.166	0.009	244.5	225	5.71	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	1.699	67.5	2.4	0.600	0.669	0.018	0.0	29	0.815
1.001	1.700	67.6	4.9	0.669	0.625	0.036	0.0	41	0.998
2.000	1.318	23.3	4.5	0.600	0.654	0.033	0.0	44	1.017
1.002	3.221	128.1	9.4	0.654	1.175	0.069	0.0	41	1.896
3.000	1.264	22.3	2.0	1.200	1.250	0.015	0.0	31	0.791
3.001	1.090	19.3	2.0	1.300	1.200	0.015	0.0	33	0.712
1.003	0.832	33.1	11.4	1.200	1.009	0.084	0.0	91	0.756

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Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	21.942	59.5	225	Circular	29.900	29.075	0.600	29.600	28.706	0.669
1.001	38.941	59.4	225	Circular	29.600	28.706	0.669	28.900	28.050	0.625
2.000	3.156	58.4	150	Circular	28.900	28.150	0.600	28.900	28.096	0.654
1.002	13.676	16.7	225	Circular	28.900	28.021	0.654	28.600	27.200	1.175
3.000	3.175	63.5	150	Circular	28.800	27.450	1.200	28.800	27.400	1.250
3.001	8.514	85.1	150	Circular	28.800	27.350	1.300	28.600	27.250	1.200
1.003	2.200	244.5	225	Circular	28.600	27.175	1.200	28.400	27.166	1.009

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	SWIC 01	450	Manhole	Adoptable	SWIC 02	450	Manhole	Adoptable
1.001	SWIC 02	450	Manhole	Adoptable	SWIC 07	600	Manhole	Adoptable
2.000	SWIC 05	450	Manhole	Adoptable	SWIC 07	600	Manhole	Adoptable
1.002	SWIC 07	600	Manhole	Adoptable	SWIC12	450	Manhole	Adoptable
3.000	SWIC 09	450	Manhole	Adoptable	SWIC 11	600	Manhole	Adoptable
3.001	SWIC 11	600	Manhole	Adoptable	SWIC12	450	Manhole	Adoptable
1.003	SWIC12	450	Manhole	Adoptable	Extg MH S04	1200	Manhole	Adoptable

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
SWIC 01	345840.400	390357.800	29.900	0.825	450		0	1.000	29.075	225
SWIC 02	345860.408	390348.792	29.600	0.894	450		1	1.000	28.706	225
							0	1.001	28.706	225

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Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
SWIC 05	345841.440	390314.841	28.900	0.750	450	0	2.000	28.150	150
SWIC 07	345844.232	390313.370	28.900	0.879	600	1	2.000	28.096	150
						2	1.001	28.050	225
						0	1.002	28.021	225
SWIC 09	345830.954	390293.036	28.800	1.350	450	0	3.000	27.450	150
SWIC 11	345834.065	390293.672	28.800	1.450	600	1	3.000	27.400	150
						0	3.001	27.350	150
SWIC12	345838.400	390301.000	28.600	1.425	450	1	3.001	27.250	150
						2	1.002	27.200	225
						0	1.003	27.175	225
Extg MH S04	345840.418	390300.123	28.400	1.234	1200	1	1.003	27.166	225
SWIC 04	345823.371	390323.420	29.250	1.100	450				
SWIC 08	345806.011	390304.853	28.700	1.250	450				

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Simulation Settings

Rainfall Methodology	FSR	Summer CV	0.750	Additional Storage (m³/ha)	20.0
Rainfall Events	Singular	Winter CV	0.840	Starting Level (m)	
FSR Region	England and Wales	Analysis Speed	Normal	Check Discharge Rate(s)	x
M5-60 (mm)	19.000	Skip Steady State	x	Check Discharge Volume	x
Ratio-R	0.400	Drain Down Time (mins)	240		

Storm Durations

15	30	60	120	180	240	360

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)	Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	40	0	0	100	40	0	0
30	40	0	0				

Node SWIC12 Online Orifice Control

Flap Valve	x	Replaces Downstream Link	x	Design Depth (m)	1.000	Diameter (m)	0.049
Downstream Link	1.003	Invert Level (m)	27.175	Design Flow (l/s)	5.0	Discharge Coefficient	0.600

Node SWIC 05 Tank Storage Structure

Invert Level (m)	28.150	Time to half empty (mins)	25	Analyse flow through structure	x

Inlets

SWIC 04

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	30.0	0.400	30.0

Node SWIC 09 Tank Storage Structure

Invert Level (m)	27.450	Time to half empty (mins)	55	Analyse flow through structure	x

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Inlets

SWIC 08

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	56.0	0.400	56.0

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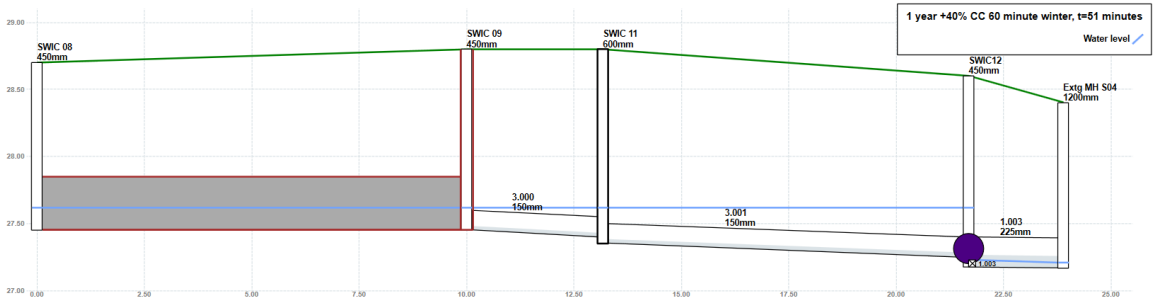
Results for 1 year +40% CC Critical Storm Duration. Lowest mass balance: 99.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 01	10	29.109	0.034	3.4	0.0202	0.0000	OK
15 minute winter	SWIC 02	11	28.754	0.048	6.8	0.0268	0.0000	OK
15 minute winter	SWIC 05	12	28.224	0.074	9.8	2.4498	0.0000	OK
15 minute winter	SWIC 07	12	28.073	0.052	14.8	0.0146	0.0000	OK
60 minute winter	SWIC 09	51	27.615	0.165	7.4	9.0221	0.0000	SURCHARGED
60 minute winter	SWIC 11	51	27.615	0.265	6.1	0.0749	0.0000	SURCHARGED
15 minute winter	SWIC12	12	27.623	0.448	14.8	0.0713	0.0000	SURCHARGED
15 minute winter	Extg MH S04	12	27.211	0.045	3.2	0.0000	0.0000	OK
15 minute winter	SWIC 04	12	28.234	0.084	6.2	0.0000	0.0000	OK
60 minute winter	SWIC 08	54	27.615	0.165	4.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 01	1.000	SWIC 02	3.4	0.690	0.050	0.1075	
15 minute winter	SWIC 02	1.001	SWIC 07	6.6	1.080	0.097	0.2367	
15 minute winter	SWIC 05	2.000	SWIC 07	8.8	1.114	0.379	0.0250	
15 minute winter	SWIC 07	1.002	SWIC12	14.8	0.972	0.116	0.3187	
60 minute winter	SWIC 09	3.000	SWIC 11	-6.0	0.627	-0.270	0.0559	
60 minute winter	SWIC 11	3.001	SWIC12	-6.1	0.473	-0.318	0.1499	
15 minute winter	SWIC12	1.003	Extg MH S04	3.2	0.515	0.095	0.0135	11.2



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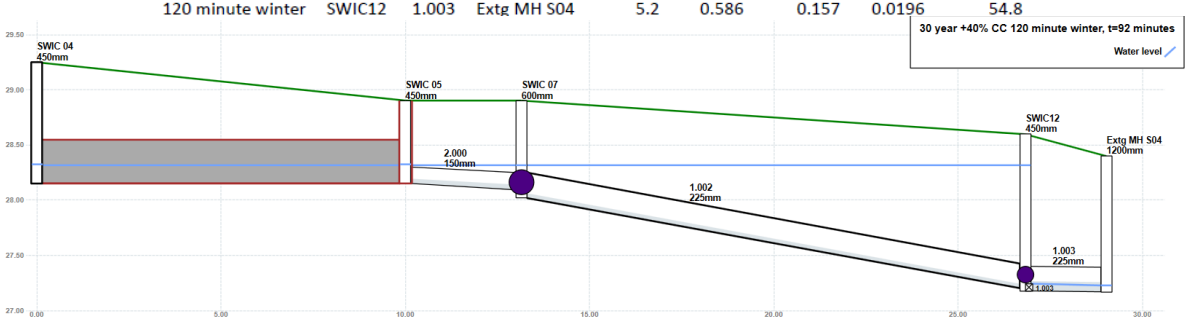
Results for 30 year +40% CC Critical Storm Duration. Lowest mass balance: 99.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 01	10	29.128	0.053	8.3	0.0314	0.0000	OK
15 minute winter	SWIC 02	10	28.782	0.076	16.5	0.0426	0.0000	OK
120 minute winter	SWIC 05	92	28.320	0.170	9.4	5.3665	0.0000	SURCHARGED
120 minute winter	SWIC 07	92	28.319	0.298	14.5	0.0844	0.0000	SURCHARGED
120 minute winter	SWIC 09	92	28.319	0.869	12.2	22.7380	0.0000	SURCHARGED
120 minute winter	SWIC 11	92	28.319	0.969	10.2	0.2741	0.0000	SURCHARGED
120 minute winter	SWIC12	92	28.318	1.143	14.5	0.1817	0.0000	FLOOD RISK
120 minute winter	Extg MH S04	92	27.224	0.058	5.2	0.0000	0.0000	OK
120 minute winter	SWIC 04	92	28.326	0.176	4.8	0.0000	0.0000	OK
120 minute winter	SWIC 08	92	28.323	0.873	7.1	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 01	1.000	SWIC 02	8.2	0.879	0.122	0.2065	
15 minute winter	SWIC 02	1.001	SWIC 07	16.4	1.379	0.242	0.5777	
120 minute winter	SWIC 05	2.000	SWIC 07	9.3	1.130	0.401	0.0556	
120 minute winter	SWIC 07	1.002	SWIC12	14.5	0.730	0.113	0.5439	
120 minute winter	SWIC 09	3.000	SWIC 11	-10.0	0.623	-0.446	0.0559	
120 minute winter	SWIC 11	3.001	SWIC12	-10.2	-0.581	-0.531	0.1499	
120 minute winter	SWIC12	1.003	Extg MH S04	5.2	0.586	0.157	0.0196	54.8



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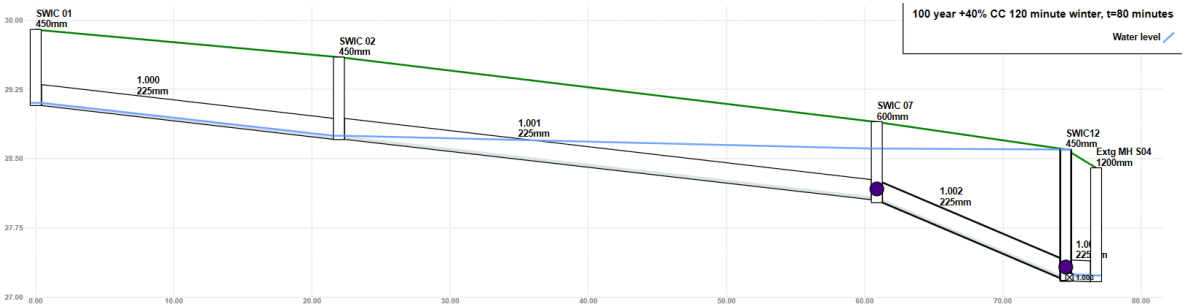
Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.62%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute winter	SWIC 01	10	29.135	0.060	10.7	0.0357	0.0000	OK
15 minute winter	SWIC 02	10	28.792	0.086	21.3	0.0484	0.0000	OK
60 minute winter	SWIC 05	44	28.624	0.474	19.5	12.5991	0.0000	FLOOD RISK
60 minute winter	SWIC 07	44	28.615	0.594	29.9	0.1681	0.0000	FLOOD RISK
60 minute winter	SWIC 09	44	28.616	1.166	26.4	23.2249	0.0000	FLOOD RISK
60 minute winter	SWIC 11	44	28.612	1.262	22.4	0.3572	0.0000	FLOOD RISK
120 minute winter	SWIC12	80	28.600	1.425	19.1	0.2266	3.9664	FLOOD
60 minute winter	Extg MH S04	45	27.228	0.062	5.8	0.0000	0.0000	OK
60 minute winter	SWIC 04	44	28.637	0.487	11.9	0.0000	0.0000	OK
60 minute winter	SWIC 08	44	28.619	1.169	15.4	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute winter	SWIC 01	1.000	SWIC 02	10.6	0.951	0.157	0.2462	
15 minute winter	SWIC 02	1.001	SWIC 07	21.3	1.424	0.314	1.0149	
60 minute winter	SWIC 05	2.000	SWIC 07	19.2	1.316	0.824	0.0556	
60 minute winter	SWIC 07	1.002	SWIC12	28.1	0.913	0.219	0.5439	
60 minute winter	SWIC 09	3.000	SWIC 11	-21.9	-1.244	-0.981	0.0559	
60 minute winter	SWIC 11	3.001	SWIC12	-22.4	-1.273	-1.164	0.1499	
120 minute winter	SWIC12	1.003	Extg MH S04	5.8	0.604	0.176	0.0213	68.0



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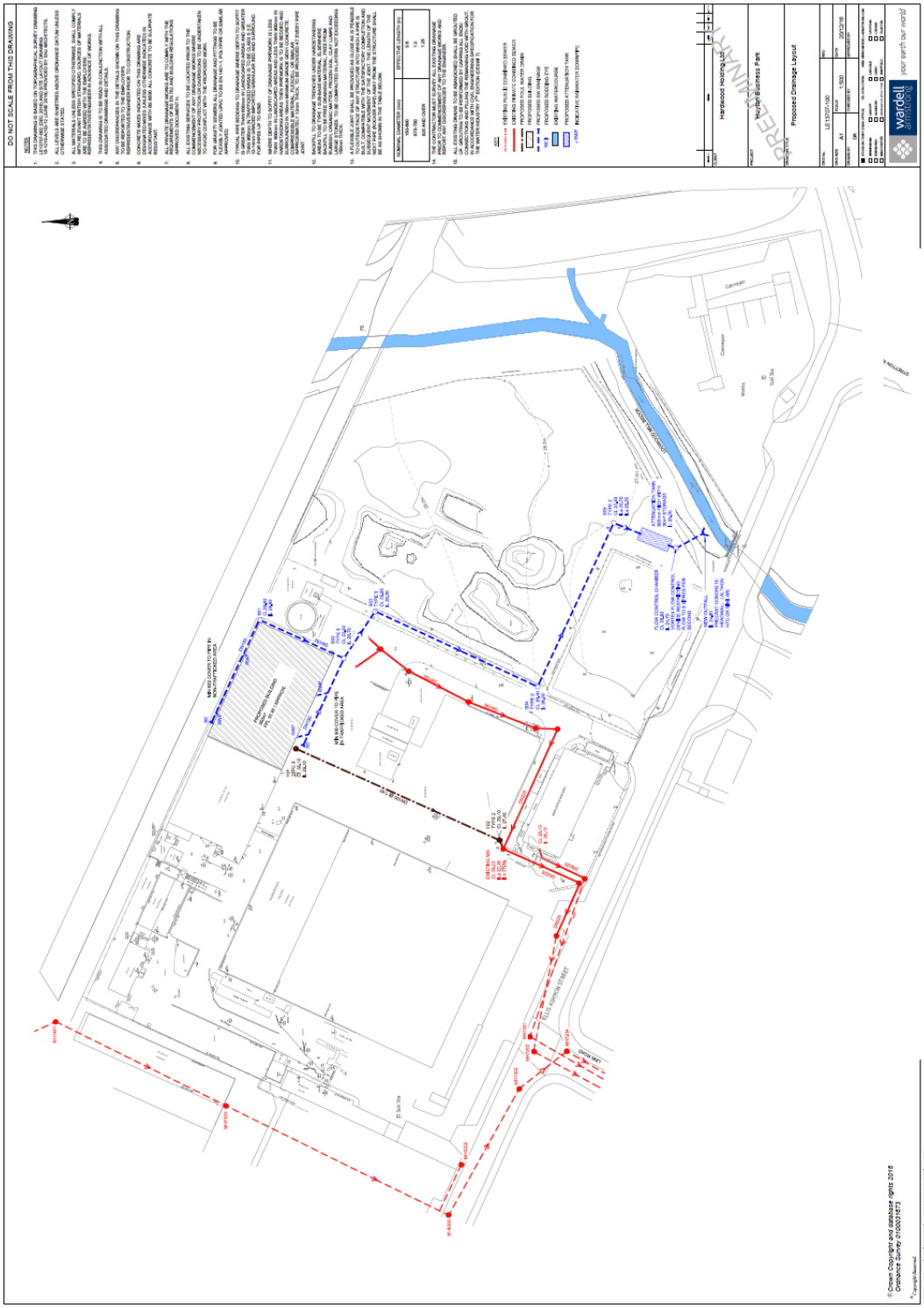
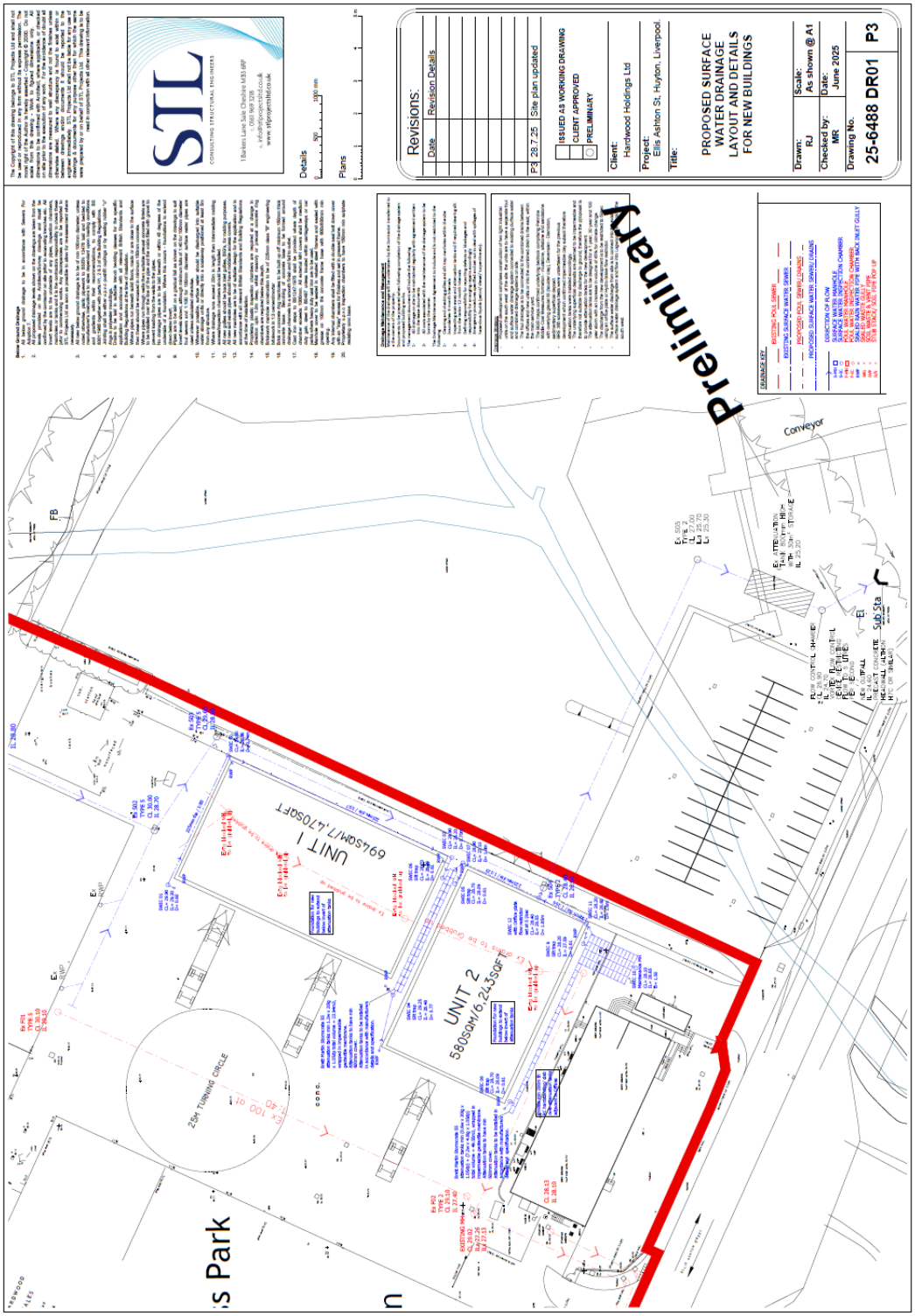
Surface Water Drainage summary

- Previous site investigation confirmed the presence of impermeable stiff clay subsoil which is not suitable for infiltration to ground.
- The surface water from the previous development is therefore stored in attenuation tanks and discharges into Logwood Mill Brook on the south-east corner of the site with flow restricted to 5 L/sec.
- The existing site of the proposed industrial units comprises concrete/ tarmac hard standing with calculated pre-development stormwater discharge being 29.8 L/sec, reducing the discharge to 50 % of the pre-development rate would permit a discharge of 14 9 L/sec, however, in order to reduce the risk of surcharging the existing drainage system **restrict the discharge rate to 5 L/sec.**
- Provide attenuation tanks on site to cater for a **1 year/ 30 year and 100 year storm** with a **volume increase/ uplift of 40%** to allow for climate change.
- Provide an Orifice plate or Hydro-brake flow restrictor in the last MH (SWIC 12) before connection into the existing drainage system.
- Drainage calculation have been undertaken for a **1 year, 30 year and 100 year storm return period** and for a **15min/ 30min/ 60min/ 120min/ 180min/ 240min and 360min (6 hour) storm duration.**
- The drainage analysis confirms manholes SWIC 09/ SWIC 11 and SWIC 12 will be surcharged during a 1 year 60 min winter event.
- The drainage analysis confirms manholes SWIC 05/ SWIC 07/ SWIC 09 and SWIC 11 will be surcharged and SWIC 12 will have a flood risk during a 30 year 120 min winter event.
- The drainage analysis confirms manholes SWIC 05/ SWIC 07/ SWIC 09 and SWIC 11 will have a flood risk with SWIC 12 flooding during a 100 year 120 min winter event.
- The cover level of SWIC 12 is 28.60m which the anticipated/ proposed finished floor slab for the building being 29.10m (0.50m difference in height), therefore flooding from SWIC 12 will not affect the proposed building.
- SWIC 12 is located adjacent to the car park/ lorry park for the site which gently falls towards Logwood Mill Brook (level difference in the order of 1.3m).
- The flood volume for a 100year 120min event is 3.96m^3 , the area of the car park is 1400m2 therefore the depth of water over the car park will be in the order of 3mm which is an acceptable risk.
- The surface water drainage on site is to be private and the responsibility for maintenance to be the owners/ leaseholders.
- The drainage Maintenance and Management plan is to be written into the lease agreement for the property.

Existing Surface water drainage – Previous development



Surface Water Drainage Drawing 25-6488- DR01 P3