SuDS strategy report

For the proposed development at

Station House, Station Road, Gedney, Spalding

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1 Executive Summary

A All surface water arising can be managed on site.

B All surface water arising from roofed areas is controlled by direct infiltration through soakaways.

C A water butt will provide additional SuDS on site.

D All areas of hard standing on the site will be constructed using a permeable medium.

E There is no design exceedence outfall away from the site.

F All SuDS on site will be installed with full consideration to long term maintenance.

G Exceedence flows and flows arising from system failure can be accommodated on site.

H The use of SuDS techniques on site will mitigate and treat the run-off volumes.

2 Introduction

2.1 Site location

The development is at Station House, Station Road, Gedney, Spalding, PE12 0DD (see Figure 1).



Figure 1: Site location plan, (just South of Mimosa House). North to top (source: EA flood mapping)

2.2 Approved development description

The Approval is for a storage compound, storage buildings and office in old station house. Approved plans at Appendix A.

2.2.1 Condition 16 of Approval H06-0643-17

> "No development shall take place until a surface water drainage scheme for the site, based on sustainable urban drainage principles and an assessment of the hydrological and hydrogeological context of the development, has been submitted to and approved in writing by the Local Planning Authority. The scheme shall: a) Provide details of how run-off will be safely

conveyed and attenuated during storms up to and including the 1 in 100 year critical storm event, with an allowance for climate change, from all hard surfaced areas within the development into the existing local drainage infrastructure and watercourse system without exceeding the run-off rate for the undeveloped site; b) Provide attenuation details and discharge rates which, unless agreed with the surface water receiving body, shall be restricted to 1.4 litres per second per hectare; c) Provide details of the timetable for and any phasing of implementation for the drainage scheme; and d) Provide details of how the scheme shall be maintained and managed over the lifetime of the development, including any arrangements for adoption by any public body or Statutory Undertaker and any other arrangements required to secure the operation of the drainage system throughout its lifetime."

2.2.2 Over view

The curtailment of the entire site encloses an area of approximately 6412m^2 of which, pre-development, 200m^2 is classed as being impermeable (200m^2 roofs, 0m^2 impermeable hard-standing and paths), with the remaining 6212m^2 classed as permeable planting. The new development increases the impermeable area from 200m^2 to 724m^2 (724m^2 roof area).

2.3 Site geology

With reference to BGS data, the site lays on Tidal Flat Deposits - Clay And Silt.

2.3.1 Infiltration rates

Infiltration rates for the site have been calculated to BRE 365 as 1.4 x 10^{-5}ms^{-1}, see Appendix

2.3.2 Water table

Ground water is not found during the on site testing to 1.9m b.g.l.

2.4 Existing flow paths

The existing site is considered as brownfield. All areas of loose surface finishes on the site all drain to ground via natural process. There is no formal drainage provision on

the site for Surface Water. These are being retained with no changes made.

It is also evident from site images that other structures on the site drain direct to the ground via eaves drop without formal drainage.

There is no known (identified) existing surface water outfall from the site to a network drain.

2.5 Estimation of existing run-off rates

2.5.1 Variables

i_1 = 50.4[1] mm hr^{-1}

i_{100} = 153 mm hr^{-1}

A = 200 m^2

2.5.2 Impermeable area run-off rate for pre-developed site

$$Q_{BF1} = \frac{0.95 * 50.4 * 200}{3600}$$
$$= 2.7 ls^{-1}$$

$$Q_{BF100} = \frac{0.95 * 153 * 200}{3600}$$
$$= 8.1 ls^{-1}$$

2.5.3 Variables

i_1 = 50.4[2] mm hr^{-1}

i_{100} = 153 mm hr^{-1}

A = 200 m^2

2.5.4 Impermeable area run-off rate for pre-developed site

$$Q_{BF1} = \frac{0.95 * 50.4 * 200}{3600}$$
$$= 2.7 ls^{-1}$$

[1] 50.4mm hr^{-1} is the mean intensity of a 1 in 1yr 6min duration summer storm, calculated to be the worst case, using standard IDF formula.

[2] 50.4mm hr^{-1} is the mean intensity of a 1 in 1yr 6min duration summer storm, calculated to be the worst case, using standard IDF formula.

$$Q_{BF100} = \frac{0.95 * 153 * 200}{3600}$$
$$= 8.1 ls^{-1}$$

2.6 Estimation of Green field rates

This site is less than 50 ha therefore runoff rate calculations have been carried out in accordance with the IH Report 124 'Flood estimation for small catchments'[1]. The pro rata method on the size of catchment detailed in table 4.2 of the SuDS manual[2] has been used.

2.6.1 Formula

For catchments less than 50ha:

$$Q_{BAR50ha} = 1.08\,(50/100)^{0.89} * SAAR^{1.17} * SPR^{2.17} \tag{1}$$

$$Q_{BAR} = Q_{BAR50ha} * \frac{A}{50} \tag{2}$$

$$Q_{1yr} = Q_{BAR} * 0.85 \tag{3}$$

$$Q_{100yr} = Q_{BAR} * GC_{100} \tag{4}$$

2.6.2 Variables

Qbar/Qmed =0.85

SAAR = 580mm

Hydrological Region 5

Growth curve factors: 30 yr = 2.45; 100 yr = 3.56

SPR = 0.3

2.6.3 Calculations

$$\begin{aligned} Q_{BAR50ha} &= 1.08 * 0.5^{0.89} * 580^{1.17} * 0.3^{2.17} \\ &= 0.58 * 1710.85 * 0.07 \\ &= 73.13 \end{aligned}$$

Using Equation 2:

$$\begin{aligned} Q_{BAR} &= \frac{73.13 * 0.64}{50} \\ &= 0.94 ls^{-1} \end{aligned}$$

Using Equation 3:

$$\begin{aligned} Q_1 &= 0.94 * 0.85 \\ &= 0.80 ls^{-1} \end{aligned}$$

Using Equation 4:

$$\begin{aligned} Q_{100} &= 0.94 * 3.56 \\ &= 3.34 ls^{-1} \end{aligned}$$

2.6.4 Peak run-off rates

For the 1 year Return Period event the peak runoff calculates to 0.80 ls^{-1}
For the 30 year Return Period event the peak runoff calculates to 2.30 ls^{-1}
For the 100 year Return Period event the peak runoff calculates to 3.34 ls^{-1}

3 SuDS Principles

In line with the SuDS management train, the following hierarchy has been considered in applying the use of SuDS into the proposed development scheme.

3.1 SuDS design philosophy

The CIRIA SuDS[2] manual provides the design philosophy:

"SuDS design should, as much as possible, be based around the following:

- using surface water runoff as a resource
- managing rainwater close to where it falls
- managing runoff at the surface
- allowing rainwater to soak into the ground
- promoting evapotranspiration
- slowing and storing run-off to mimic natural runoff characteristics
- reducing contamination of runoff through pollution prevention and controlling the runoff at source
- treating runoff to reduce the risk of urban contaminants causing environmental pollution."

3.2 Source control

- Sedum roofing.
- Infiltration devices. Typically soakaways.
- Rainwater harvesting.
- Bio-retention planting, rain gardens.
- Permeable paving, porous asphalt. These provide both infiltration and short term storage volumes thus reducing overall un-mitigated run-off volumes.

3.3 "End of pipe" solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means to limiting discharge rates and volumes to discharge to existing SW flow pathways.

Sections 4.2 to 4.7 consider the viability of a range of these SuDS devices.

4 Appraisal of SuDS options

The primary aim is to meet the requirements of the Local Plan core policies and the SuDS hierarchy so as to manage SW on site.

4.1 Site constraints impacting on SuDS

- Pitched roof design.
- Relatively small site hence small Green field rates.
- Small, 1.4ls^{-1}ha^{-1} acceptable outfall rates if required to IDB.
- Commercial site.

4.2 Infiltration devices

With reference to Section 3.1, soakaways promote the following SuDS design criteria:

- manages rainwater close to where it falls
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural run-off characteristics
- treats run-off to reduce the risk of urban contaminants causing environmental pollution.

Due to the reasonable infiltration rates expected with the local geology, Section 2.3, infiltration devices appear suited for this site and can be designed to accommodate design rainfall events (designed in line with BRE365 and Part H of the Building Regulations and at least 5m away from any structure).

4.3 Bio-retention devices

Due to site constraints, Section 4.1, these are not found suitable for this site.

4.4 Permeable hard standing

With reference to Section 3.1, permeable paving promotes the following SuDS design criteria:

- manages rainwater close to where it falls
- manages runoff at the surface
- allows rainwater to soak into the ground
- slows and stores run-off to mimic natural runoff characteristics
- treats runoff to reduce the risk of urban contaminants causing environmental pollution.

4.4.1 Permeable paving

A 30% void ratio is assumed through a 350mm sub-base. This is appropriate for a DOT Type 3 Sub-base hence the storage capacity equates to circa 105mm per $1m^2$ therefore based on a M6 100hr + cc storm of 87mm rainfall the paving offers, without any allowance for infiltration, a circa 1:1.2 drained volume:storage volume capacity. Hence there is no anticipated exceedence flow from the areas of permeable paving.

Note: where attenuation cells or soakaways are located under areas of permeable paving the perimeter of each attenuation tank or soakaway will be bunded within the sub-base with an appropriate up-stand or kerbing so as to prevent the sub-base draining directly into the attenuation tanks or soakaways.

TSS 0.7, Metals 0.6, Hydrocarbons 0.7 = suitable for trafficked areas

All permeable paving offers sufficient storage volume to accommodate the 5mm event.

4.5 Rainwater harvesting

With reference to Section 3.1, Rainwater harvesting promotes the following SuDS design criteria:

- uses surface water runoff as a resource
- manages rainwater close to where it falls

and in line with B.C.C guidance:

- stores rainwater for later use

4.5.1 For external use

Rain water harvesting / water butts: These provide additional, "off line[3]" SuDS, and are deemed a suitable SuDS component for small plots[2], extract at Figure 2. The image shows a water butt in "off-line" configuration using a standard diverter.

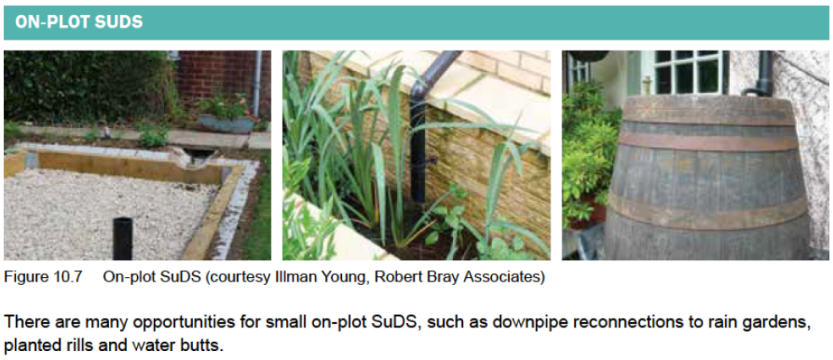


Figure 2: Use of water butts as provided in the SuDS manual

The collection and re-use of water can reduce run off volumes arising from roofs. The collected water, via readily available diverters (e.g. Web link: Standard diverter example, as per Figure 3), being used for external uses.



Figure 3: Standard rainwater diverter

Rainwater butts can, in part, accommodate the 5mm event dependent on manual drawdown and evaporation.

[3]The term "off-line" refers to the fact that a water butt is a harvesting device that is not "in-line" in the same manner that a pipe is in-line. Water is collected (harvested) until the water butt is full. When full, the rainwater continues down the rainwater pipe. Outflow from the tank is not "automatic" since this would negate the reason to harvest rainwater. Instead, manual drawdown occurs with the harvested water being used for external uses. Since a water butt may be full, the useful volume is not accounted for in storage and run-off calculations.

4.6 Sedum/green roofs.

Due to site constraints, Section 4.1, these are not found suitable for this site.

4.7 "End of pipe" solutions

To be considered only after implementation of the above options.

- Retention tanks with outfall controlled by hydraulic means (e.g. hydrobrakes, pipe sizing, orifice plate etc.) to limiting rates and volumes to discharge to existing flow pathways.

5 Proposed surface water disposal strategy

The following sections consider the strategy for water arising from the roof areas, hard standing and areas of landscaping.

5.1 Roofs.

5.1.1 Soakaways

Surface water arising from each building's roof drained area will be conveyed to a individual soakaway.

Station House

All surface water arising from roofed areas is controlled by direct infiltration through a soakaway. Notes:

- For this report the drained area to the soakaway(s) arises from the area of roof plus a 1 allowance for urban creep.
- The soakaway is designed for all events up to and including the M100 6hr event.
- An allowance of x1.4 is made for climate change in line with current best practice.

Designed to BRE365, and to accommodate all surface water arising from a drained area of 150m^2 requires 3 , open void (i.e. 95%), soakaway(s) of 1.6m wide x 1.7m long with a 1.2m effective depth. See Table 1.

Permeability	1.40E-05	ms^{-1}
Urban Creep	1	
Drained area	150	m^2
Designed drained area	150	m^2
Return Period	100	yr
% voids	95	%
Climate change	1.4	

Design Width, m	1.6
Design $Depth_{eff}$, m	1.2
Design Qty	3

Duration, mins	5	10	15	30	60	120	240	360	600	1440
Rainfall, mm	19.1	28.6	34.5	45.4	56.7	68.5	80.3	87.5	97.4	116.1
Volume in, m^3	1	1.4	1.7	2.3	2.8	3.4	4	4.4	4.9	5.8
Length req'd, m	0.5	0.8	0.9	1.2	1.4	1.6	1.7	1.7	1.6	1.1

Crit Length, m	1.7
Crit Duration, mins	240
Empty to 50%, hrs	7.87

Table 1: BRE 365 Calculation results

5.1.2 Sedimentation risk

Roofing carries a very low sediment loading. Worst case 216 $kg.ha^{-1}yr^{-1}$ - so for this site that equates to circa 16.2$kg.yr^{-1}$ in the worst case. Generally this would reduce the attenuation capacity by circa 2% over 50yrs (all data from the SuDS maunual). The design allows for this amount with extra capacity provided to a 100yr design life. The BRE 365 method acknowledges this sedimentation and hence the base area is not considered in the sizing calculations.

5.1.3 Minimising sedimentation risk

However, the developer will fit accessible sumped rainwater gulleys at the base of all RWP's so as to reduce the amount of any sediment entering the soakaway.

The developer will also fit downpipe leaf guards to all outfalls from the roof (or "hedge-hog" gutter guards).

254m^2 roof area Building

All surface water arising from roofed areas is controlled by direct infiltration through a soakaway. Notes:

- For this report the drained area to the soakaway(s) arises from the area of roof plus a 1 allowance for urban creep.
- The soakaway is designed for all events up to and including the M100 6hr event.
- An allowance of x1.4 is made for climate change in line with current best practice.

Designed to BRE365, and to accommodate all surface water arising from a drained area of 254m^2 requires 1 , open void (i.e. 95%), soakaway(s) of 2.4m wide x 7.0m long with a 1.2m effective depth. See Table 2.

Permeability	1.40E-05	ms^{-1}
Urban Creep	1	
Drained area	254	m^2
Designed drained area	254	m^2
Return Period	100	yr
% voids	95	%
Climate change	1.4	

Design Width, m	2.4
Design $Depth_{eff}$, m	1.2
Design Qty	1

Duration, mins	5	10	15	30	60	120	240	360	600	1440
Rainfall, mm	19.1	28.6	34.5	45.4	56.7	68.5	80.3	87.5	97.4	116.1
Volume in, m^3	4.9	7.3	8.8	11.5	14.4	17.4	20.4	22.2	24.7	29.5
Length req'd, m	1.8	2.6	3.2	4.1	5.1	6	6.7	6.9	7	6.2

Crit Length, m	7.0
Crit Duration, mins	600
Empty to 50%, hrs	16.82

Table 2: BRE 365 Calculation results

270m^2 roof area Building

All surface water arising from roofed areas is controlled by direct infiltration through a soakaway. Notes:

- For this report the drained area to the soakaway(s) arises from the area of roof plus a 1 allowance for urban creep.
- The soakaway is designed for all events up to and including the M100 6hr event.
- An allowance of x1.4 is made for climate change in line with current best practice.

Designed to BRE365, and to accommodate all surface water arising from a drained area of 270m^2 requires 1 , open void (i.e. 95%), soakaway(s) of 2.4m wide x 7.4m long with a 1.2m effective depth. See Table 3.

Permeability	1.40E-05	ms^{-1}
Urban Creep	1	
Drained area	270	m^2
Designed drained area	270	m^2
Return Period	100	yr
% voids	95	%
Climate change	1.4	

Design Width, m	2.4
Design $Depth_{eff}$, m	1.2
Design Qty	1

Duration, mins	5	10	15	30	60	120	240	360	600	1440
Rainfall, mm	19.1	28.6	34.5	45.4	56.7	68.5	80.3	87.5	97.4	116.1
Volume in, m^3	5.2	7.7	9.3	12.3	15.3	18.5	21.7	23.6	26.3	31.3
Length req'd, m	1.9	2.8	3.4	4.4	5.4	6.4	7.1	7.3	7.4	6.6

Crit Length, m	7.4
Crit Duration, mins	600
Empty to 50%, hrs	17.1

Table 3: BRE 365 Calculation results

Design

A typical soakaway section at Figure 4.

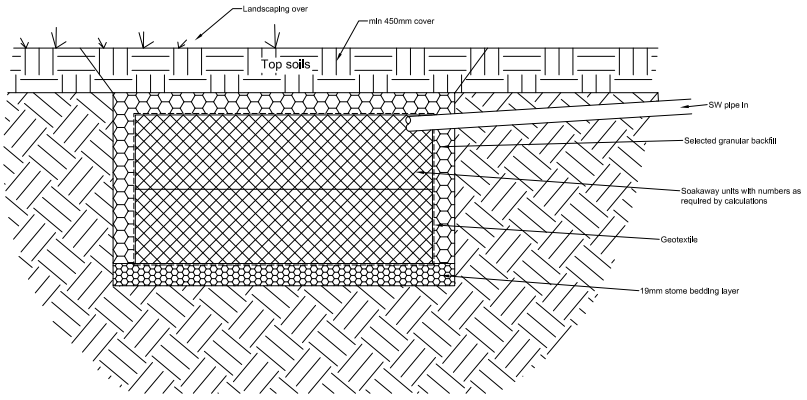


Figure 4: Soakaway section

5.2 Rainwater Harvesting

The project team have detailed an "off line" rainwater butt to collect water for external use primarily to reduce potable water demand. This also serves however as an ad-

ditional SuDS feature. Since this is in off-line configuration any exceedence flows are automatically directed back to the downpipes.

5.3 New parking area's hard standing

All new areas of hard standing on the site will be constructed using a permeable medium on a DOT/MOT 3 sub-base of 350mm depth (refer to Section 4.4).

The perimeter of these areas will be considered for expansive planting to accommodate any exceedence flows. Residual exceedence will be surface channelled onwards towards the rear soakaway cells.

For a check on the capacity of the permeable paving to function an infiltration rate of 10mm.hr^{-1} has been used below. Infiltration rates on the site have been estimated at 1.4 x 10^{-5} ms^{-1} which equals 50mm.hr^{-1}hence the rate of 10mm.hr^{-1} is considered very conservative being circa 5 times lower. A nominal 100m^2 is checked here but the results can be scaled pro rata.

Over 100m^2 plan area, 5mm.hr^{-1} equates to a total outflow rate of 0.138ls^{-1}

Designed to accomodate all surface water arising from a design drained area of 100m^2 requires a minimum attenuation volume of 6 m^3. This can be achieved using an overall storage volume of 35.0 m^3 formed within a 100m^2 x 0.35m deep 30% void ratio sub-base. See Table 4.

Drained area	$100m^2$	
Urban Creep	1	
Designed drained area	$100m^2$	
Return periods considered	1yr, 30yr, 100yr	
Storm profiles used	50% Summer	75% Winter
Storm coeffs	a = 0.1, b = 0.815	a = 0.06, b = 1.026
Storm range, storm increments	From 5 minutes duration in further 5 min. intervals until critical storm reached	
M5-60	20mm	
r	0.4	
Rainfall model	FSR	
Critical design storm	220 mins, Winter	
Climate change	1.4	
Storm mean intensity	$15.1mm.hr^{-1}$	
Design mean intensity	$21.1mm.hr^{-1}$	
Storm peak intensity	$40.5mm.hr^{-1}$	
Design peak intensity	$56.7mm.hr^{-1}$	
Design maximum head	0.25m	
Calculated maximum head	0.20m	
Minimum attenuation volume required	$5.99m^3$	
Void ratio	30%	
Design attenuation volume	$8m^3$	(0.3 x $100m^2$ x 0.25m)
Provided attenuation volume	$11m^3$	(0.3 x $100m^2$ x 0.35m)
Factor of Safety	1.40	
1 in 1yr maximum outfall rate	$0.1ls^{-1}$	(See Figure 5.)
1 in 30yr maximum outfall rate	$0.1ls^{-1}$	(See Figure 6.)
1 in 100yr maximum outfall rate	$0.1ls^{-1}$	(See Figure 7.)
1 in 100yr Time to peak	210 mins	
Design head: Time to drop to 50%	6.03 hrs	
Time to 50% total capacity	4.53 hrs	
Outfall control method	Nominal GF outflow	

Table 4: Storage volume design summary

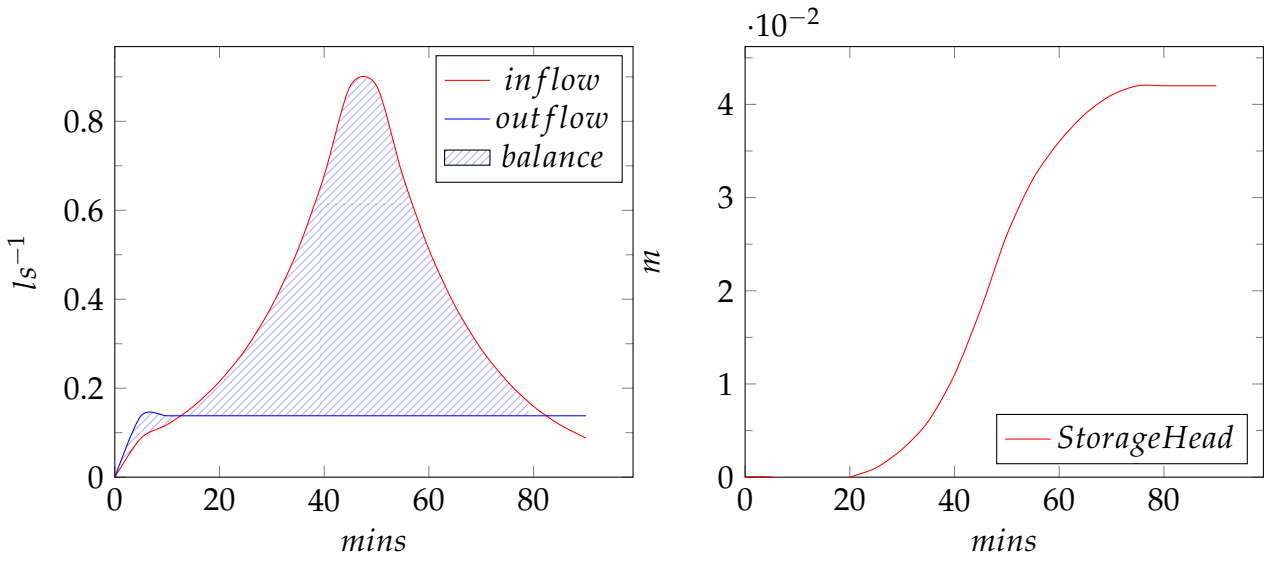


Figure 5: 1 in 1 year critical storm event

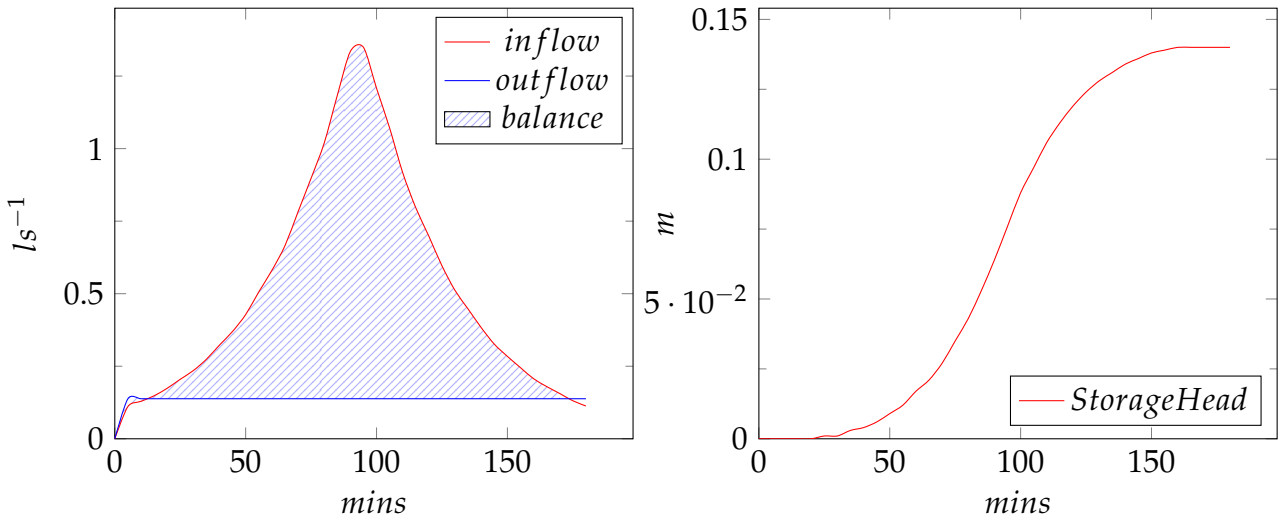


Figure 6: 1 in 30 year critical storm event

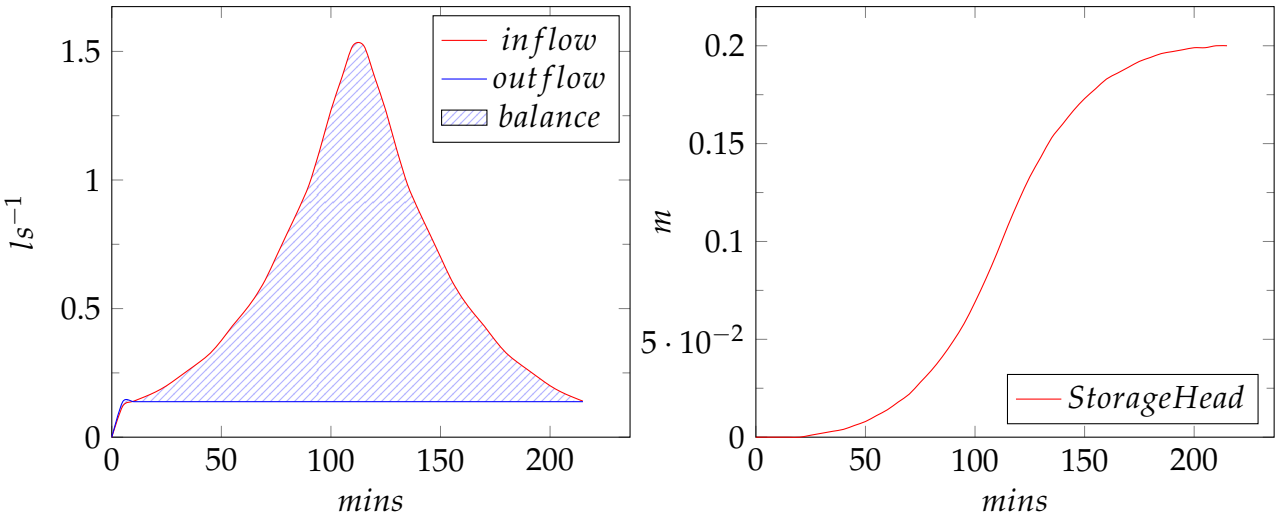


Figure 7: 1 in 100 year critical storm event

The areas of permeable paving are primarily disconnected from the proposed SW network on site, i.e. they are not primarily designed to drain to the soakaway. Surface water retained in the sub-base matrix is lost through evaporation and infiltration at or greater than 1.4 x 10^{-5} ms^{-1}, at shallow depths, into the surrounding naturally fissured sub-soils (due to action of freeze-thaw, roots, earthworms and the proposed local re-grading following any site clearance). In doing so it mimics as close as possible the natural hydrological process of water falling onto the ground and finding natural flow paths for dispersion.

Exceedence flows only (flows over the 1.2 x M1006hr + CC event) will be conveyed at the surface via channels (e.g. ACO channels) to the proposed soakaway.

5.4 Landscaped areas

Typical landscape planting.

5.5 Indicative drainage layout

Please refer to the indicative drainage layout showing SuDS features at Appendix A.

1 in 100yr max mean intensity storm = 153mmhr^{-1}

Drained area to one pipe = 140m^2

Required pipe capacity = 140 x 0.153 / 3.6 = 6.0 ls^{-1}

Water from the roofs will be conveyed at gutter level to RWPs. Flow from the RWPs will be conveyed to the soakaway via 100mm diam UPVC drainage runs laid at no less than 1:80 fall giving a minimum design capacity of 7ls^{-1}(Part H design chart, Figure 8).

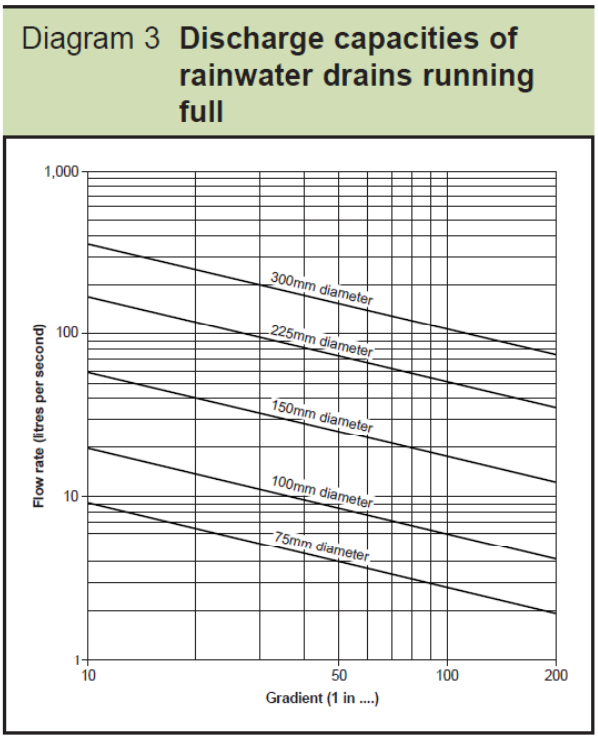


Figure 8: Part H drainage design chart

5.6 Timetable for implementation

5.6.1 Construction phase

Soakaways/attenuation cells will be installed early in the project under the remit of the ground-works operations.

Areas of landscaping and boundary planting will be undertaken as the project nears completion.

Permeable paving will only be installed when all construction activities are either complete, or near completion so as to minimise blockage of the surface.

5.6.2 Post construction phase

Water butts will be installed prior to final completion as part of the final landscaping.

Soakaway cells pumped and cleaned out.

6 Maintenance of SuDS

Ultimate responsibility for the long term maintenance with SuDS in this environment lay with the land owner/management company.

All SuDS on site will be installed with full consideration to long term maintenance. The following guidance applies:

6.1 Soakaways (and pre treatment sediment sumps)

Figure 9[2] provides details maintenance operations required for a soakaway system.

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

Figure 9: Maintenance operations for soakaway

6.2 Permeable pavements

The maintenance plan for permeable paving will include:

- Monthly litter removal;
- Bi-Annual suction sweeping.
- Annual inspection and repairs as/if required.

6.3 Summary

All surface water arising can be managed on site using SuDS. There is no design exceedence outfall away from the site. Exceedence flows and flows arising from system failure can be accommodated on site within areas of the basin/bio retention, soakaway crates and the sub-base to the hard standing.

The use of SuDS techniques on site, as detailed above and when installed in line with best practice (I.e. CIRIA 753 & CIRIA 768), will reduce and treat the run-off volumes in line with the core policies.

Signed: 

Dr Robin Saunders C. Build E, MCABE, BEng(Hons), PhD

Date: 21st June, 2019

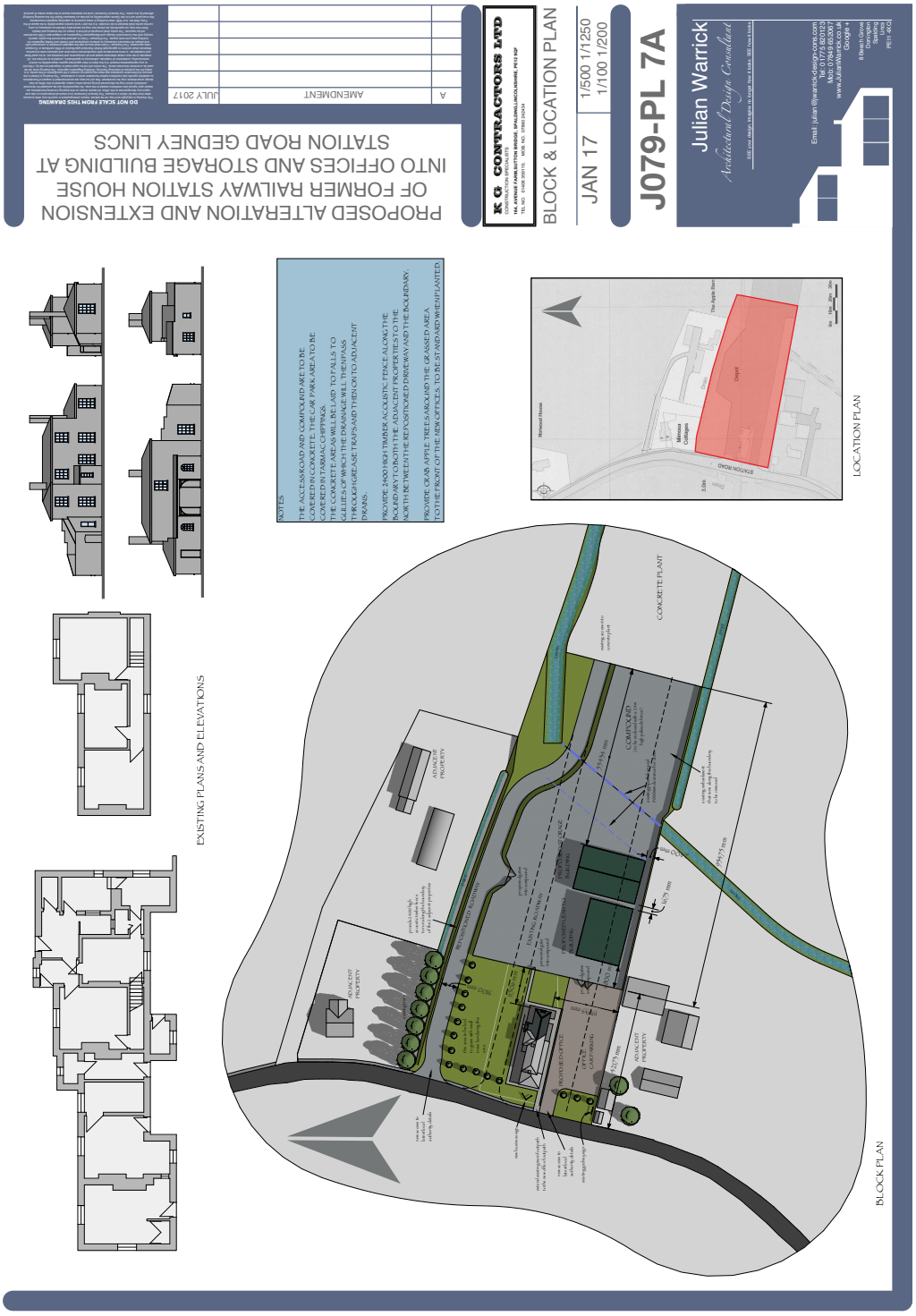
References

[1] DCW Marshall & AC Bayliss. Flood estimation for small catchments. Technical Report No. 124, Institute of Hydrology, June 1994.

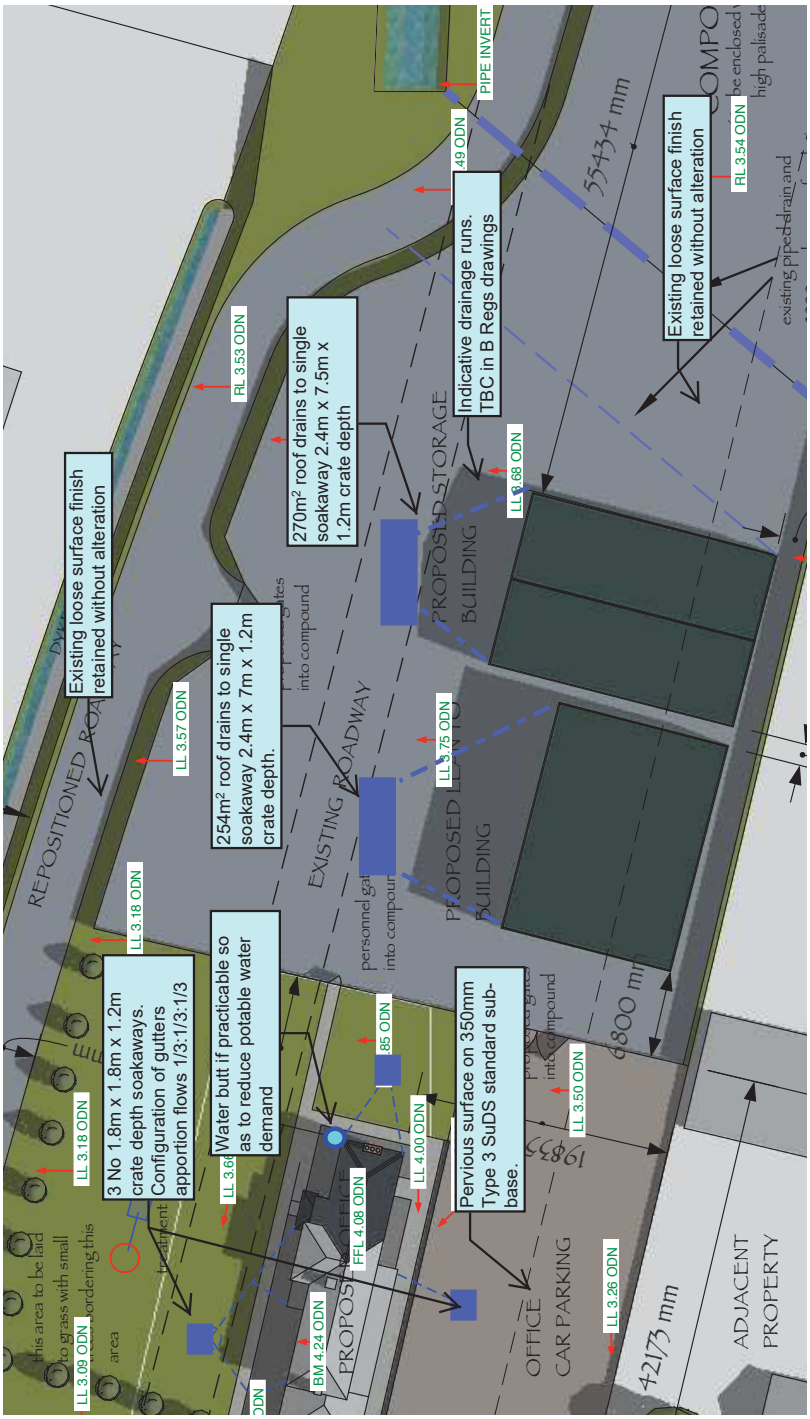
[2] CIRIA. The SUDS manual. Technical report, CIRIA, 2015.

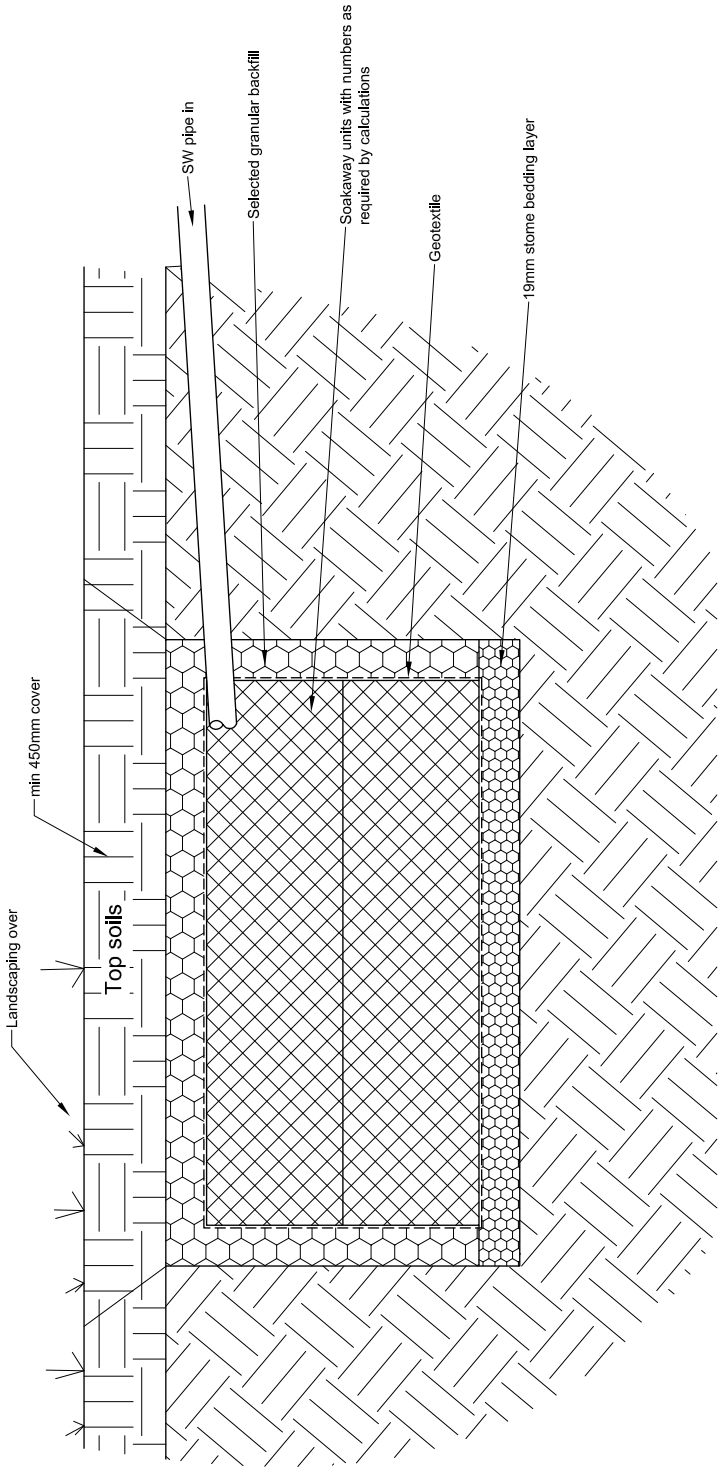
A Proposal plans

A.1 Approved plans

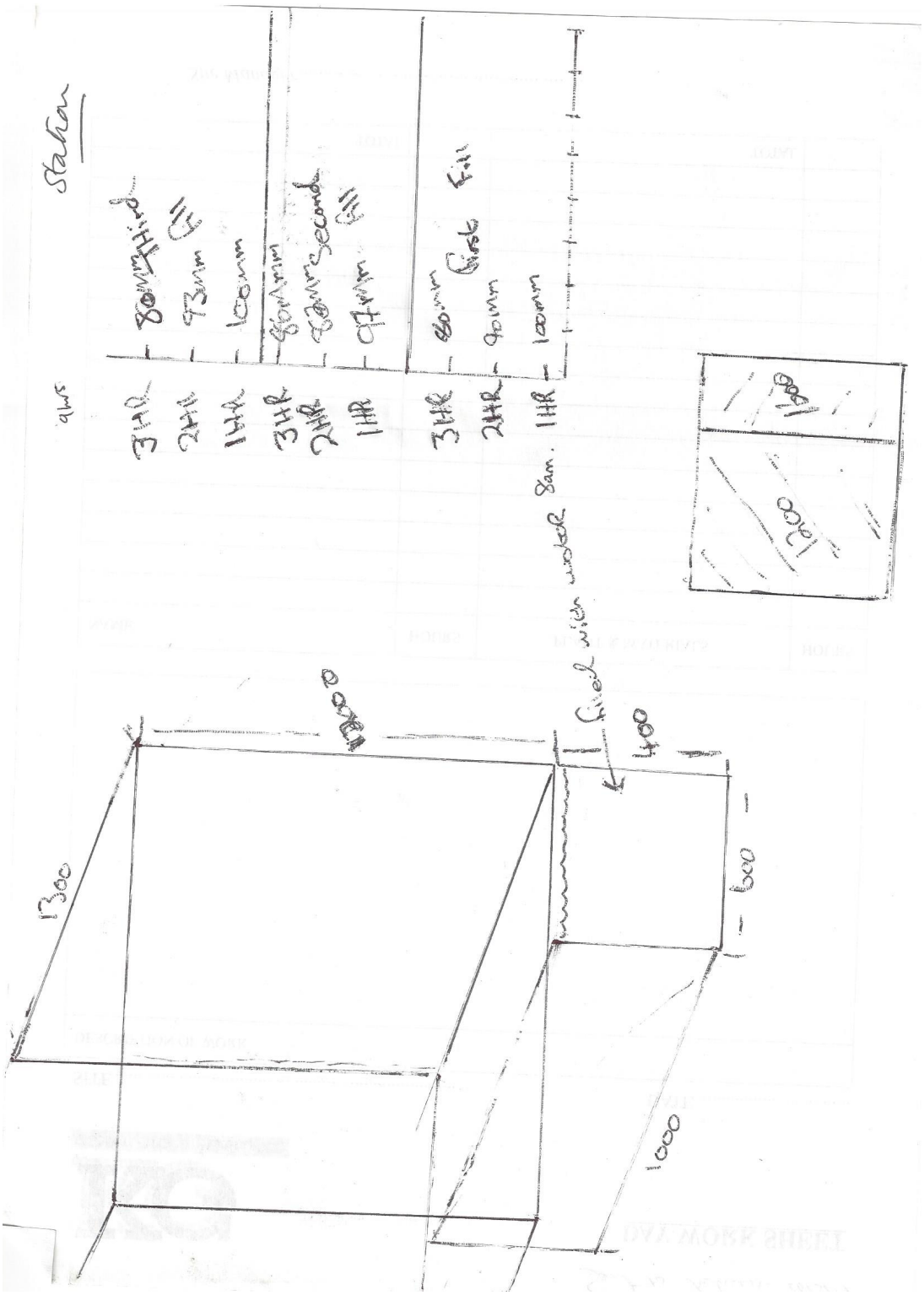


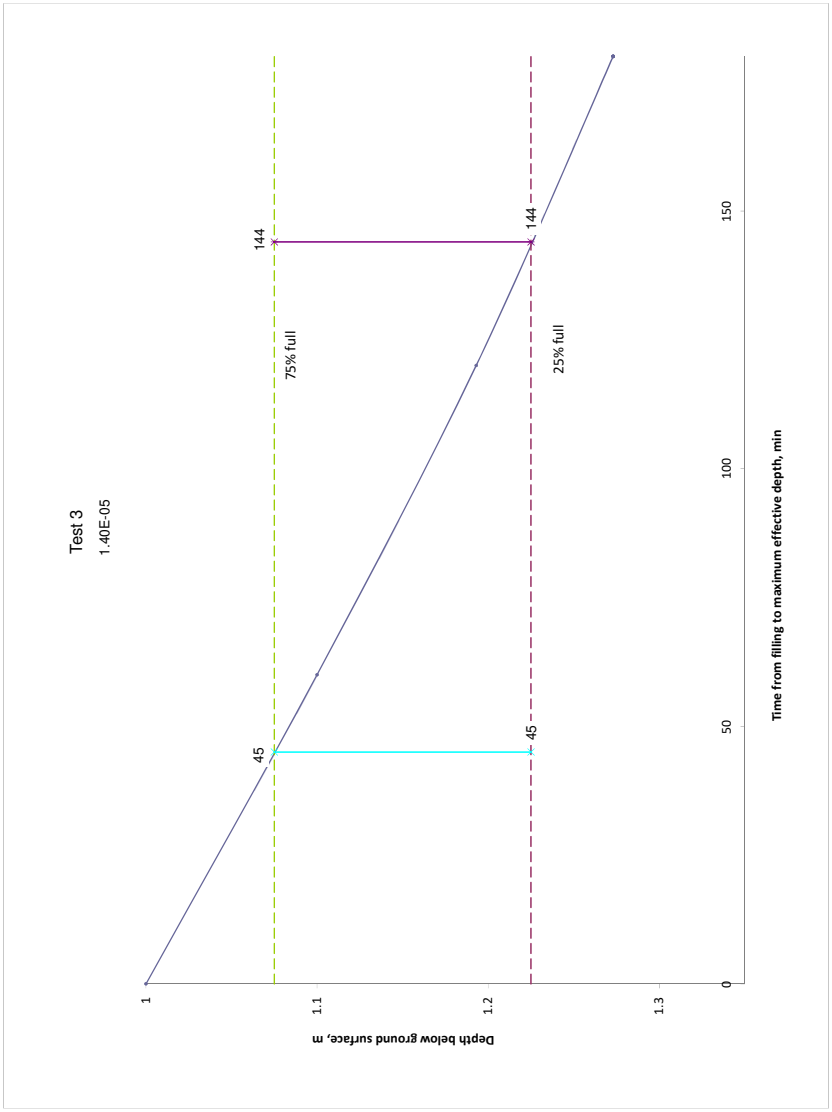
A.2 Indicative SuDS layout




SW pipe in
Selected granular backfill
Soakaway units with numbers as required by calculations
Geotextile
19mm stome bedding layer
min 450mm cover
Top soils
Landscaping over

B Infiltration testing




Test 3
1.40E-05
144
144
75% full
25% full
45
45
1
1.1
1.2
1.3
Depth below ground surface, m
0
50
100
150
Time from filling to maximum effective depth, min