Sunderland City Council

Flooding and Coastal Team

Dining Room Extension Barnes School

FLOOD RISK ASSESSMENT AND DRAINAGE STRATEGY

Date: July 2021

Version 1.0

Scheme Reference: NF085

Flooding and Coastal
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Revision History

Version	Date	Amendments	Issued to
1.0	12th July 2021	N/A	Wayne Barron (Sunderland City Council)

Quality Control

Action	Signature	Date
Prepared	Paul Armin (Flood and Coastal Group Engineer)	July 2021
Checked	Chris Graham (Flood and Coastal Engineer)	July 2021
Approved	Paul Armin (Flood and Coastal Group Engineer)	July 2021

Contents

1.0 EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) has been prepared as part of the planning application for a new dining room extension to Barnes primary and Junior school. The Planning Application must provide a FRA and Drainage Strategy to be in accordance with the National Planning Policy Framework (NPPF) as the development is creating more than 1000m² of floor area and is classed as a major planning application.

It is assessed that the development is acceptable from a flood risk perspective in accordance with the NPPF with the changes proposed as part of the new design.

2.0 INTRODUCTION

The Flood and Coastal team from Sunderland City Council have been instructed to carry out a Flood Risk Assessment and Drainage Strategy for a proposed dining room extension at Barnes School, Sunderland.

A new surface water system is to be installed as part of the new development to meet the requirements of the Lead Local Flood Authority regarding discharge of surface water.

The NPPF requires an assessment to be made of any flood risks relating to proposed developments, i.e. whether the development is at risk of being flooded or whether the development would increase the risk of flooding elsewhere.

The new extension will be located within the Barnes Burn CDA which has been identified within the councils SFRA (2018). The SFRA requires the following:

- SCC should avoid allocating any developments in flood risk areas and should carry out the Sequential Test;
- FRAs are required for developments sites with areas greater than 0.5 ha that are within Critical Drainage Areas.

3.0 SITE DESCRIPTION

The development will be on a brownfield site occupied by barnes Primary and Junior schools. The centre of the site is located at Grid Ref: 437931, 555953 approximately 1850m southwest of Sunderland City centre and is shown in Figure 1. The site covers a total area of 450m². However due to the development being over 1000m² in floor area the proposals are classed as a major planning application.

There are terraced houses in all directions around the development site.

The site is located between the existing primary and junior schools and the site falls from west to east (64.600m to 61.500m).

The proposed red line boundary of the scheme is shown in Appendix A.

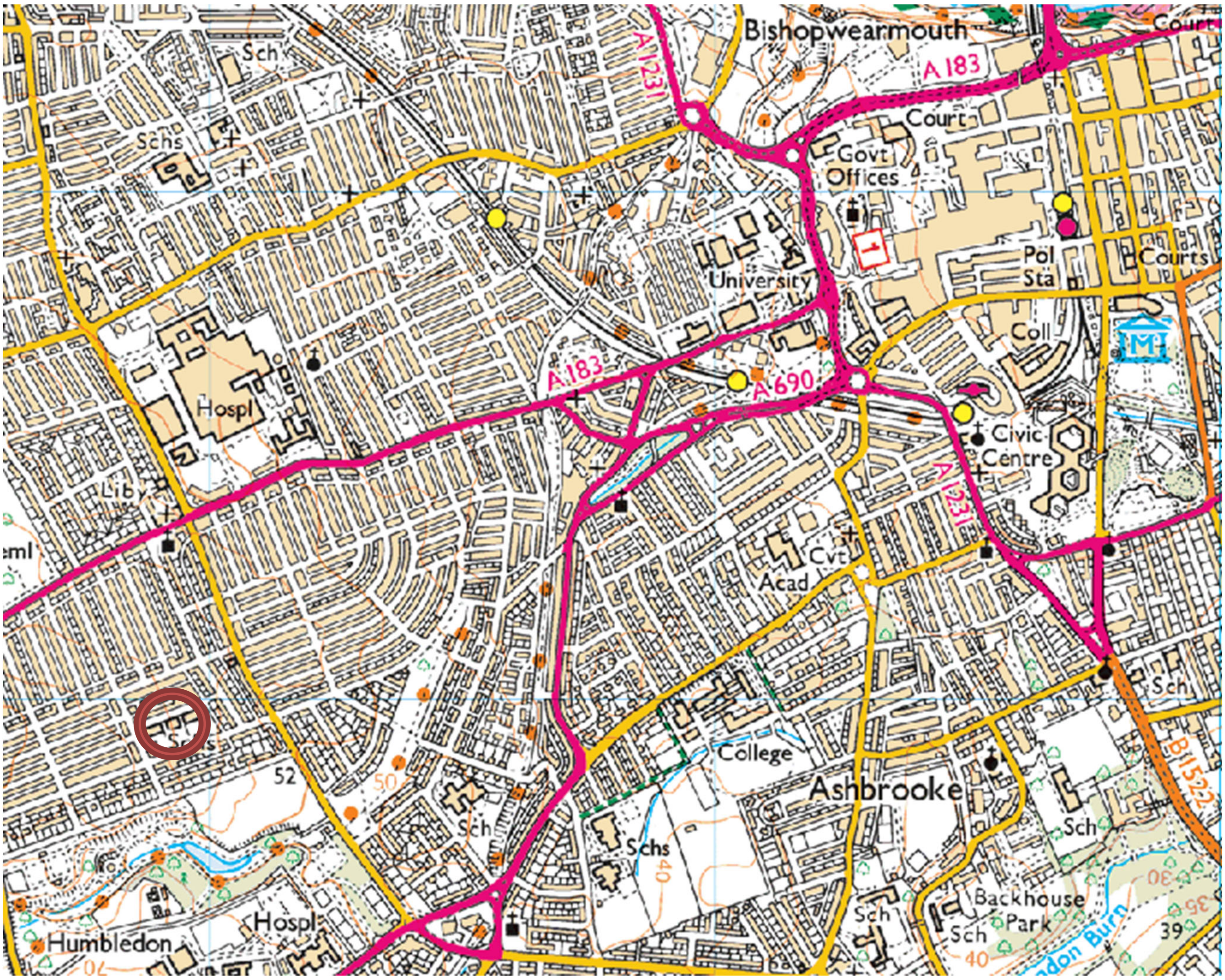


Figure 1. Site Location Plan

4.0 SOURCES OF FLOOD RISK

4.1 Fluvial Flooding

The proposed site area is identified as in flood zone 1 as shown in Figure 2. Flood risk from fluvial sources is considered low.

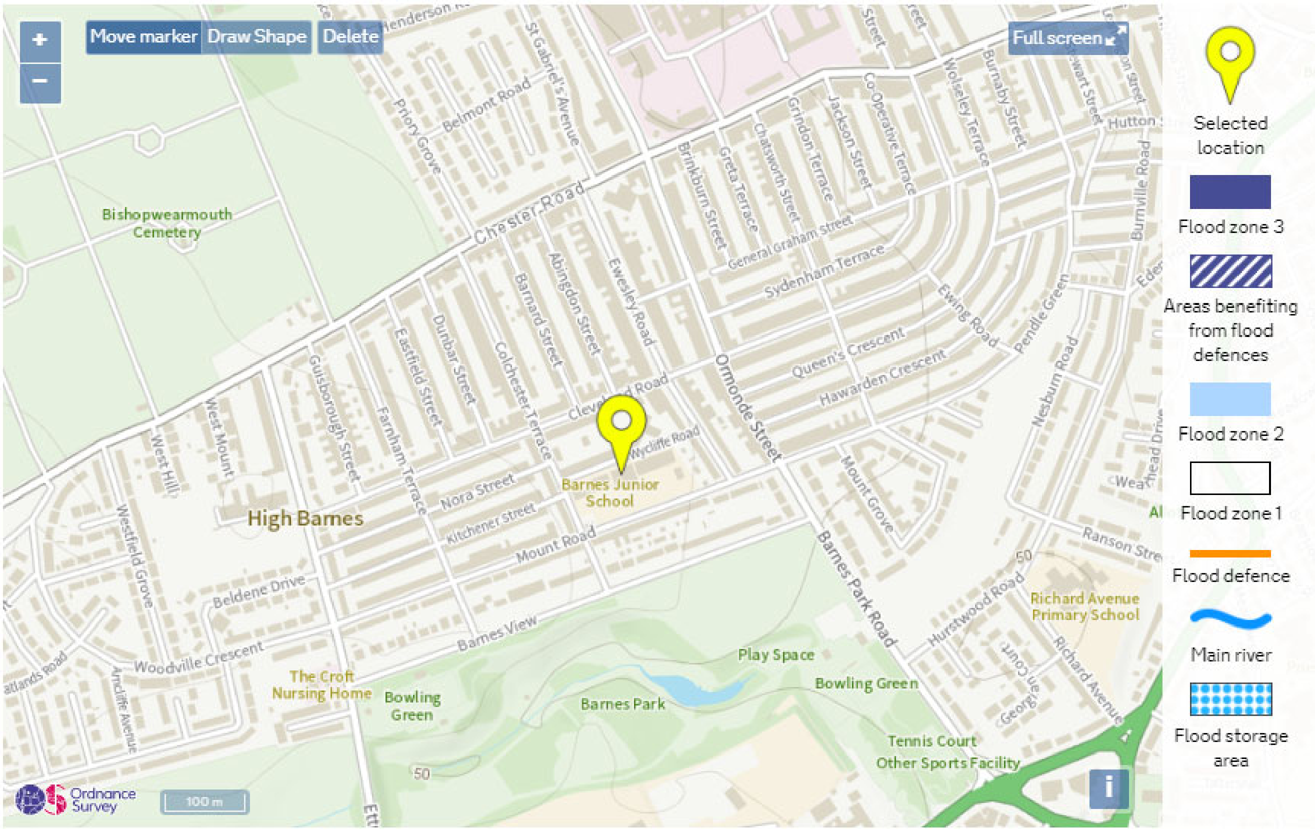


Figure 2. Flood zone map. © Environment Agency 2020

4.2 Surface Water Flooding

The Environment Agency surface water flood risk map in Figure 3 shows that the site is at a very low surface water flood risk. No flooding on a less than 1 in 1000-year event. There are small areas of low risk to the south of the site.

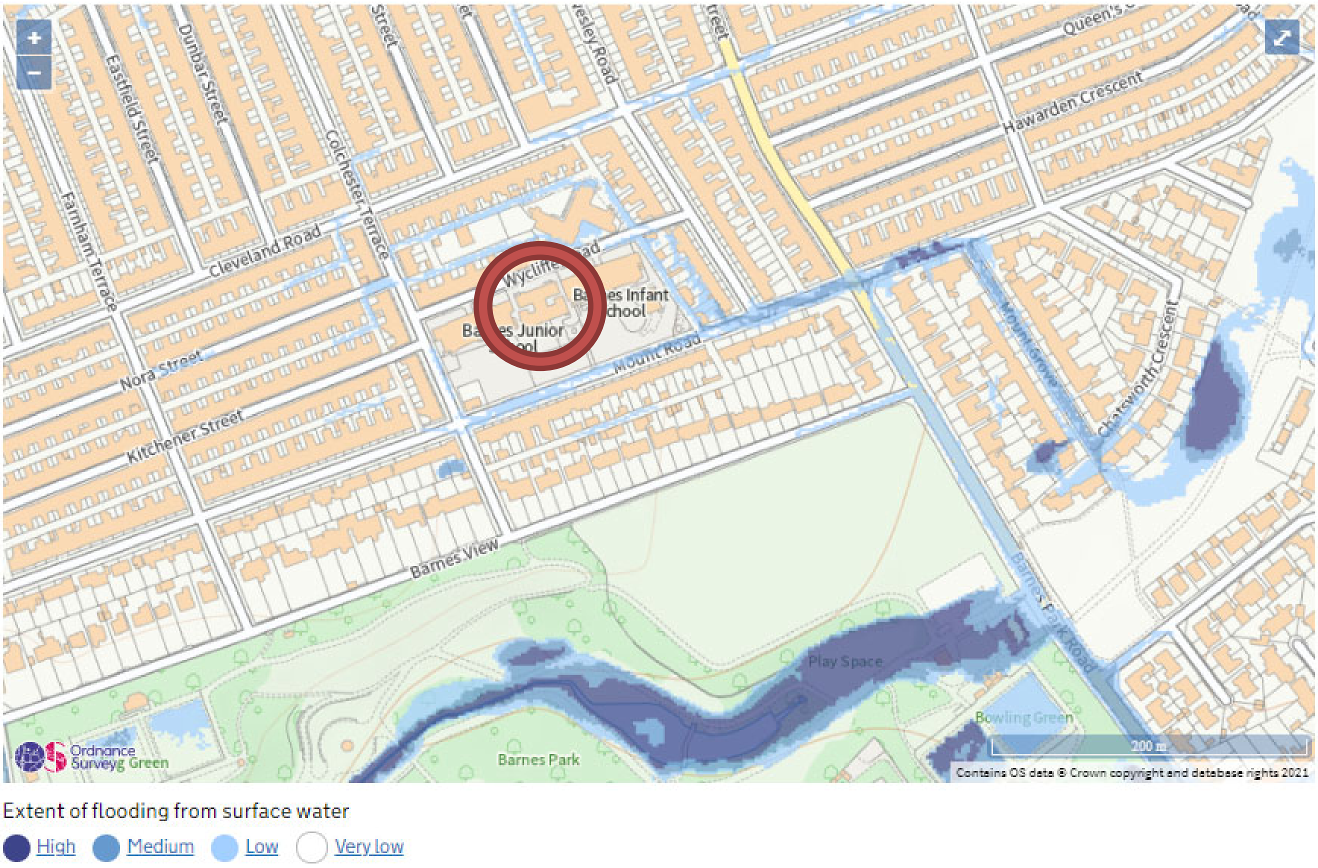


Figure 3. Surface water flood risk map. © Environment Agency 2019

Surface water flooding is not shown to occur adjacent to the proposed site. To prevent surface water flooding outside of the site boundary SuDS will be implemented within the school. Therefore associated flood risk from surface water will not be increased off site due to this development and is therefore considerer low risk.

4.3 Groundwater Flooding

A phase 1 Site Investigation report has been completed by Dunelm Geotechnical (report no. D10341) for the development. No ground water was encounted on site.

It is considered flood risk from ground water is very low.

4.4 Flooding from Existing Sewers / Drains

There are no sewers on site only existing combined drains, these drains have been CCTV surveyed and are in very good condition for the age. Therefore the risk of flooding from the existing on-site drains is considered very low.

4.5 Other sources of flood risk

There are no known reservoirs in the catchment. The risk of flooding from reservoirs is considered very low. The site is located further than 3km from the sea and the risk of flooding from the sea is considered very low.

5.0 PROPOSED DEVELOPMENT

The development covers a total of 450m². This includes the construction of a new dining room between the existing junior and primary school. The total impermeable area is 0.045 hectares.

The development includes the construction of a new surface water and foul water drains to serve the new dining room. Surface water will be attenuated on site with the use of oversized pipes and a green roof and conveyed via a traditional pipe system to the existing combined drains.

To be in accordance with the LLFAs requirements, source control must be included in the development ensuring that the first 5mm of rainfall is kept on site. The layout and calculation for source control are included within the associated drainage strategy for this scheme.

The proposed scheme is shown in Appendix C.

6.0 MAINTENENCE

The school management will be responsible for the ongoing maintenance of the proposed development including the SUDS components. Maintenance will be based on Ciria C753 best practice guidance. Further details of the maintenance schedule are included within the associated Drainage Strategy.

7.0 CONCLUSIONS

The risk of flooding from all sources is low / very low.

8.0 DRAINAGE STRATEGY

8.1 Existing Drainage

The existing combined drainage from the site connects into a Northumbrian Water (NWL) combined sewer to the rear of Ewesley Road on pipe length NZ37559003. See appendix B for existing drainage layout.

8.2 Flood Risk

Please refer to the associated Flood Risk Assessment, which accompanies this report as part of the planning submission.

9.0 PROPOSED DRAINAGE STRATEGY

All Surface water will be designed and installed in accordance with Building Regulations Part H (2015 Edition).

9.1 Surface Water Discharge

The hierarchy for discharge of surface as per Non-statutory Standards for Sustainable Drainage states the following: -

'*Generally, the aim should be discharge surface runoff as high up the hierarchy of drainage options as reasonably practicable'*

1. *Into the ground (infiltration)*
2. *To a surface water body*
3. *To a surface water sewer, highway drain or another drainage system*
4. *To a combined sewer*

9.2 Infiltration

Effective infiltration allows surface water to infiltrate into the ground over a period, reducing the volume of runoff during a rainfall event. In addition, it can help replenish local aquifers and support river base flows, wetland systems and support local moisture levels and vegetation.

To evaluate if a site is suitable for infiltration, several constraints must be considered such as the rate at which infiltration might occur, contributing catchment area, ground water connectivity and the volume of temporary storage required.

To determine suitability for infiltration the soil type and capacity must be identified via field tests. Site Investigation undertaken have confirmed the following: -

- The site's ground conditions shows clay and gravel underlain by hard stony clay to 6.0m bgl underlain by limestone. The limestone is interbedded with marl to a depth of 32.3m bgl where shale was recorded.
- No soakaway tests have been carried out due to the presence of the stiff clay. A letter from Dunelm Geotechnical to confirm unsuitability can be seen in Appendix F.

9.3 Surface Water Body

The closest water course to the development is around 250m away but due to the topography it is not possible to drain the site there.

9.4 To a Surface Water Sewer

No Surface Water Sewers are nearby.

9.4 To a Combined Sewer

The foul and surface water will drain to the existing combined Sewer via the existing connection.

10.0 PROPOSED DRAINAGE

The site is to be drained via a combination of a green roof, 600mm oversized pipes and traditional 100mm dia. piped system.

The system will be designed to prevent any flooding in a 1in100 year event + 40% climate change (six-hour storm duration) leaving the site and will be constructed in accordance with current standards. Existing drainage will be utilised as part of the proposed development to relay flows to the existing combined sewer to the rear of Ewesley Road. As the new building is required to drain at greenfield runoff rates or as close as possible peak flows will be reduced coming from the development area.

11.0 LLFA REQUIREMENTS

Consultation was undertaken with the LLFA to gain their discharge and SuDS requirements for this development.

To comply with Sunderland City Council's Local Flood Risk Management Strategy, source control should be included as part of the proposed drainage design. Discharge into receiving bodies shall be at greenfield runoff rate.

11.1 Greenfield Run off Rates

The greenfield run off rate for this site has been obtained using IH124 UKSuDS tool (see appendix D) based on a total site area of 0.1 ha (minmimum value) using a soil type 4 classification. This is the soil type for the area and is backed up by the site investigation report.

Sunderland LLFA accepts QBAR discharge rate, this shows a discharge rate of 0.43 l/s which is very low and is unachieavable with a flow control. It is therefore proposed to use a 75mm hydrobrake which will give a discharge of 3.1 l/s for all storms, this will meet the minimum maintenance requirements.

11.2 Storage Requirements

Attenuation will be required on site to accommodate a volume of water at various rainfall events, a green roof and 600mm oversized pipe ill be used to accommodate these flows.

11.3 Source Control

A requirement of the LLFA is to retain the first 5mm of rainfall on site of the majority of all rainfall events. Source control can be met through a number of measures such as rainwater harvesting, permeable paving etc. or evapotranspiration.

The source control requirements for this project will delivered using infiltration in accordance with Ciria C753. The breakdown of hardstanding areas of this scheme is as follows:-

Contributing hardstanding area	Area(m2)
Building roof	450
Total	450

A simple calculation of $450m^2 \times 0.005m$ (rainfall) = $2.25m^3$ of storage required within the green roof below the outlet.

This can be achieved with 150mm of open graded stone below the outlet. $57m^2$ (green roof) x 0.150 (depth) x 30% (void) = $2.565m^3$

11.4 Water Quality

The LLFA and LASOO stipulate that water quality should be considered as part of a major application.

The proposed drainage system has been designed to retain the first 5mm of rainfall on site as described in section 11.3. Where water contaminants are being washed into the drainage network and offsite the total pollutant load to the receiving surface water body is potentially high.

By applying the simple index approach stated in Ciria C753 the potential hazard indices for the proposed development is: -

Land use	Pollution hazard level	Total suspended solids	Metals	Hydro Carbons	Site land use.
Other roofs (typically commercial / industrial roofs)	Low	0.3	0.2	0.05	School building Roof

The measures being utilised for this project are green roofs, see table 26.15 in the SuDS manual (Ciria C753) for mitigation indices values.

	Mitigation Indices		
Types of SUDS component	TSS	Metals	Hydrocarbons
Green Roof	0.8	0.7	0.9

By comparing the SUDS mitigation indices for the proposed SUDS components to the potential hazard indices for this development it is shown that water quality has been considered and mitigated in accordance with CIRIA C753.

12.0 Development Management and Construction

The construction of the development will be undertaken in a single phase. The construction phase of the development will be constructed in accordance with Ciria C532, C732 and C648.

As the development is the demolision of the existing building and construction of the new building in the same place surface water runoff will be minimal, however precautions should be taken to prevent building material from entering the existing drainage system which could cause bloackages. Bungs / caps should be installed on any open pipework with silt socks installed to prevent debris entering the system.

13.0 Operation and Maintenance Plan

Green Roof

TABLE 12.5 Operation and maintenance requirements for green roofs		
Maintenance schedule	**Required action**	**Typical frequency**
Regular inspections	Inspect all components including soil substrate, vegetation, drains, irrigation systems (if applicable), membranes and roof structure for proper operation, integrity of waterproofing and structural stability	Annually and after severe storms
	Inspect soil substrate for evidence of erosion channels and identify any sediment sources	Annually and after severe storms
	Inspect drain inlets to ensure unrestricted runoff from the drainage layer to the conveyance or roof drain system	Annually and after severe storms
	Inspect underside of roof for evidence of leakage	Annually and after severe storms
Regular maintenance	Remove debris and litter to prevent clogging of inlet drains and interference with plant growth	Six monthly and annually or as required
	During establishment (ie year one), replace dead plants as required	Monthly (but usually responsibility of manufacturer)
	Post establishment, replace dead plants as required (where > 5% of coverage)	Annually (in autumn)
	Remove fallen leaves and debris from deciduous plant foliage	Six monthly or as required
	Remove nuisance and invasive vegetation, including weeds	Six monthly or as required
	Mow grasses, prune shrubs and manage other planting (if appropriate) as required – clippings should be removed and not allowed to accumulate	Six monthly or as required
Remedial actions	If erosion channels are evident, these should be stabilised with extra soil substrate similar to the original material, and sources of erosion damage should be identified and controlled	As required
	If drain inlet has settled, cracked or moved, investigate and repair as appropriate	As required

REFERENCES

EA 2009 Wear Catchment Flood Risk Plan

SCC 2018 Strategic Flood Risk Assessment.

SCC 2016 Local Flood Risk Management Strategy.

Dunelm Geoenvironmental Appraisal for Barnes Junior and Infant Schools, Sunderland (Report No D10341).

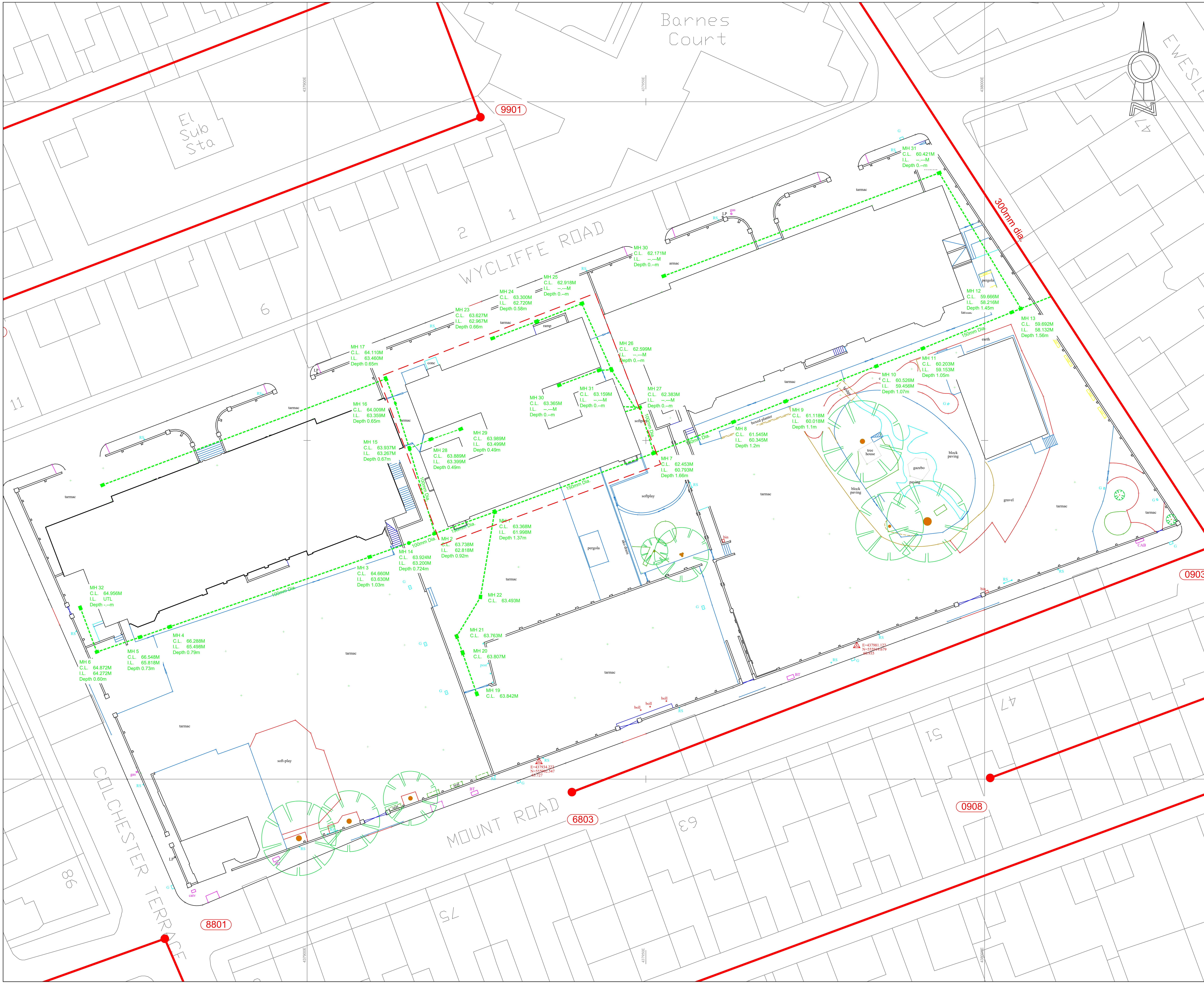
National Planning Policy Framework (NPPF)

Local Authority Suds Officer Organisation (LASSO) – Non-statutory Technical Standards for SUDS

Appendix A
Topographical Survey

Court
EWESLEY ROAD
WYCLIFFE ROAD
MOUNT ROAD
COLCHESTER TERRACE
El Sub Sta
LEGEND
tarmac
softplay
soft-play
pergola
ramp
cobbles
tree house
gazebo
block paving
gravel
concrete
earth
boxed planter
DAVID BRIEN SURVEYING Ltd
57 PARK LEA, SUNDERLAND, SR3 3SZ
Tel: 0191 5202091 email: davidbrien@sky.com
BARNES SCHOOLS
Scale: 1:1 metric - 1:250 @ A1 - (2D POINTS)
Date: December 2020
Datum: Ordnance Survey Origins
Jan 2020 - REV B - Final deliverable

Appendix B
Existing Drainage Layout



KEY

- Redline Boundary
- Existing Combined Sewers (NWL) (0903)
- Existing Private Combined Drains

FOR PLANNING

Rev.	Date	Description	Drawn	Approved

Sunderland City Council

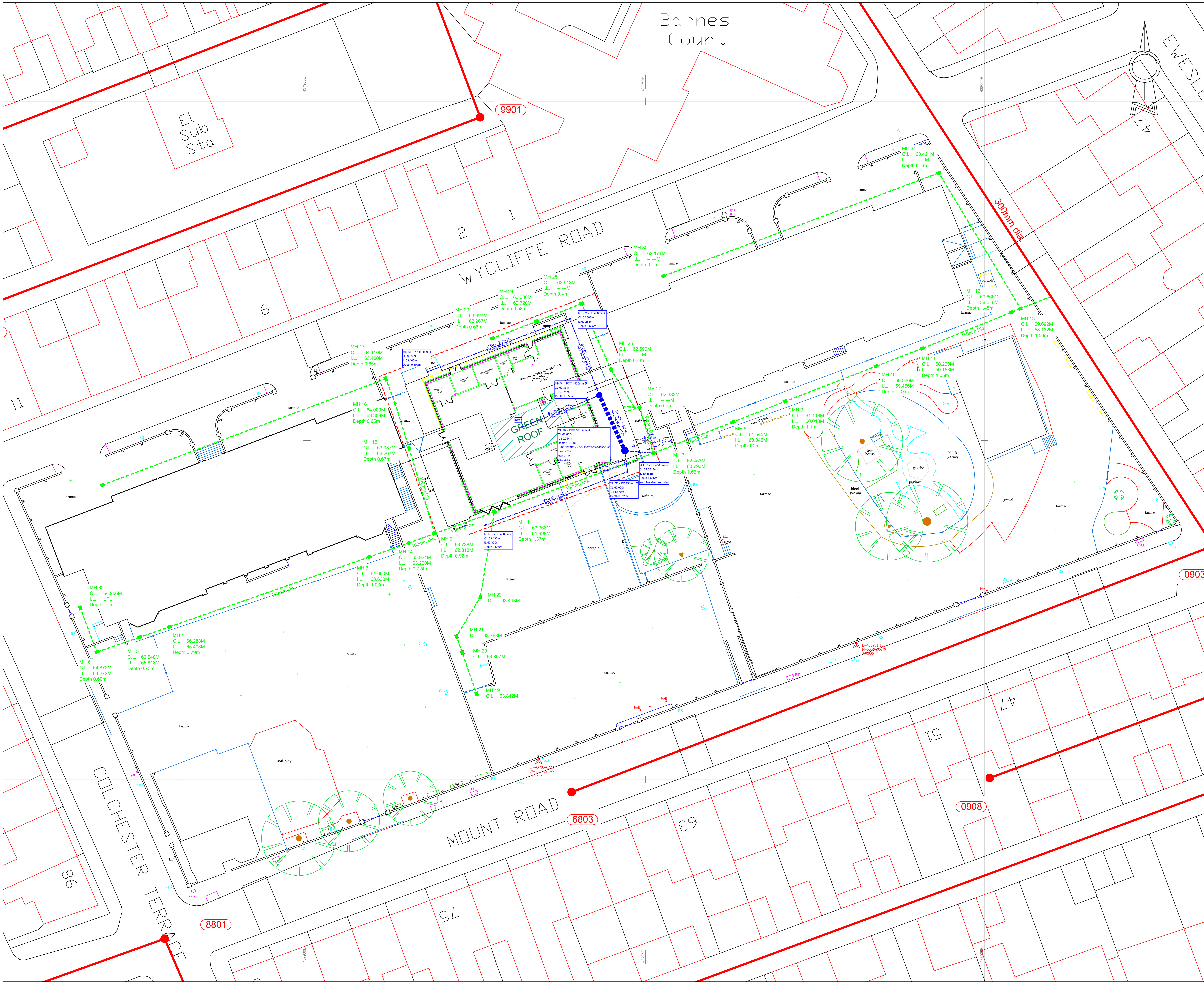
City Development Directorate
Civic Centre,
Burdon Road
Sunderland
SR2 7DN

Tel. (0191) 520 5555

Client	CITY DEVELOPMENT DIRECTORATE
Project	Barnes Schools
Subject	Existing Drainage Layout

Drawn by	P. Armin	Date	July 2021
Checked by	C. Graham	Scale	1:250
Approved by	P. Armin	Sheet size	A1
Drawing No.	BDS-SCC-00-DR-CH-0502		

Appendix C
Proposed Surface Water Layout



KEY

red dashed line	Redline Boundary
red line with dot	Existing Combined Sewers (NWL)
green dashed line with square	Existing Private Combined Drains
blue dashed line with dot	Proposed S.W. Drains

Notes:-

1. Information regarding existing drainage is given without prejudice to any rights or responsibilities. No guarantee is given of its accuracy and is intended for general guidance only. The Contractor must take whatever steps necessary to establish the precise position and depth of any apparatus. Private connections are not shown but their presence must be anticipated. Exact positions of gullies, manholes and exact line of gully connections to be agreed with the Project Manager on site prior to commencement of drainage work.
2. Drains to be in accordance with Building Regs Part H & Specification Series 500 of the Specification for Highway Works - Highways Agency as referenced.
3. Internal down comers to have a bend no greater than 45° from the edge of the pad foundation into a surface water manhole or inspection chamber.
4. Connections of new pipes to existing drains and manholes to be approved by the Project manager.
5. All pipes to have approved flexible joints. All surface water carrier pipes to have watertight joints.
6. Joints must be capable of retaining the line of the pipeline during backfilling operations and prevent the ingress of concrete or laitance into the pipes.
7. See standard detail for trench details for the surface water drain runs.
8. Each connection between the gully and the main pipe or manhole is to be 150mm diameter and supplied complete with all necessary fittings and have 150mm concrete surround (GEN 3/ST4) where cover is less than 1200mm .
9. Gully connections may be in pipe materials differing from the main run subject to the prior agreement of the Project Manager.
10. For details of drains, gullies and manholes see Standard Details.
11. All pipes in carriageway and vehicular trafficked areas to have Type Z 150mm concrete surround protection where cover to crown is less than 1200mm.
12. All drainage downcomers, pipe runs, gullies and manholes are to be located to avoid conflict with tree pits, service ducts/pipes/cables/chambers/manholes and also foundations to lighting columns, traffic signs/signals and other street furniture.
13. All new drains are to be inspected by CCTV and reports provided to the Project Manager.
14. Invert and cover levels are shown in metres. Manhole and pipe sizes are shown in millimetres.
15. Before commencing the drainage the Contractor shall check that the proposed drain routes and the locations of proposed manholes are clear of existing services and if necessary agree revised drain routes and manhole locations with the designer.
16. All Rainwater Pipes to be 100mm Ø.

FOR PLANNING

Rev.	Date	Description	Drawn	Approved

Sunderland City Council

City Development Directorate
Civic Centre,
Burdon Road
Sunderland
SR2 7DN

Tel. (0191) 520 5555

Client: CITY DEVELOPMENT DIRECTORATE

Project: Barnes Schools

Subject: Proposed S.W. Drainage Layout

Drawn by	P. Armin	Date	July 2021
Checked by	C. Graham	Scale	1:250
Approved by	P. Armin	Sheet size	A1

Drawing No. BDS-SCC-00-DR-CH-0503

Appendix D
Greenfield Runoff Calculations

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Paul Armin
Site name:	Barnes School
Site location:	Sunderland

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance “Rainfall runoff management for developments”, SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	54.89686° N
Longitude:	1.40977° W
Reference:	2530629658
Date:	Jul 09 2021 10:38

Runoff estimation approach: IH124

Site characteristics

Total site area (ha):	0.1

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	2	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	636	636
Hydrological region:	3	3
Growth curve factor 1 year:	0.86	0.86
Growth curve factor 30 years:	1.75	1.75
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.16	0.43
1 in 1 year (l/s):	0.14	0.37
1 in 30 years (l/s):	0.29	0.76
1 in 100 year (l/s):	0.34	0.9
1 in 200 years (l/s):	0.39	1.02

Appendix E
Microdrainage Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.100	Add Flow / Climate Change (%)	0
Ratio R	0.350	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.600
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	22.341	1.117	20.0	0.022	4.00	0.0	0.600	o	100	Pipe/Conduit	
S1.001	12.134	0.809	15.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
S2.000	12.199	0.610	20.0	0.006	4.00	0.0	0.600	o	100	Pipe/Conduit	
S1.002	9.011	0.060	150.2	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S3.000	22.420	1.121	20.0	0.018	4.00	0.0	0.600	o	100	Pipe/Conduit	
S3.001	3.127	0.156	20.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
S1.003	4.226	0.106	39.9	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	4.21	63.400	0.022	0.0	0.0	0.0	1.73	13.6	3.0
S1.001	50.00	4.32	62.283	0.022	0.0	0.0	0.0	2.00	15.7	3.0
S2.000	50.00	4.12	62.749	0.006	0.0	0.0	0.0	1.73	13.6	0.8
S1.002	50.00	4.39	60.974	0.028	0.0	0.0	0.0	1.98	561.2	3.7
S3.000	50.00	4.22	62.800	0.018	0.0	0.0	0.0	1.73	13.6	2.5
S3.001	50.00	4.25	61.679	0.018	0.0	0.0	0.0	1.73	13.6	2.5
S1.003	50.00	4.45	60.914	0.046	0.0	0.0	0.0	1.22	9.6	6.2

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Storage Structures	0
Number of Online Controls	1	Number of Time/Area Diagrams	1
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.100	Storm Duration (mins)	30
Ratio R	0.350		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S7, DS/PN: S1.003, Volume (m³): 7.0

Unit Reference	MD-SHE-0075-3100-1650-3100
Design Head (m)	1.650
Design Flow (l/s)	3.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	75
Invert Level (m)	60.914
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.650	3.1
Flush-Flo™	0.327	2.6
Kick-Flo®	0.669	2.1
Mean Flow over Head Range	-	2.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.1	1.200	2.7	3.000	4.1	7.000	6.1
0.200	2.4	1.400	2.9	3.500	4.4	7.500	6.3
0.300	2.5	1.600	3.1	4.000	4.7	8.000	6.5
0.400	2.5	1.800	3.2	4.500	4.9	8.500	6.7
0.500	2.5	2.000	3.4	5.000	5.2	9.000	6.9
0.600	2.3	2.200	3.5	5.500	5.4	9.500	7.0
0.800	2.2	2.400	3.7	6.000	5.7		
1.000	2.5	2.600	3.8	6.500	5.9		

Time Area Diagram for Green Roof at Pipe Number S2.000 (Storm)

Area (m³)	57	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.001036	20	24	0.000381	40	44	0.000140	60	64	0.000052
4	8	0.000848	24	28	0.000312	44	48	0.000115	64	68	0.000042
8	12	0.000694	28	32	0.000255	48	52	0.000094	68	72	0.000035
12	16	0.000568	32	36	0.000209	52	56	0.000077	72	76	0.000028
16	20	0.000465	36	40	0.000171	56	60	0.000063	76	80	0.000023

Time Area Diagram for Green Roof at Pipe Number S2.000 (Storm)

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
80	84	0.000019	92	96	0.000010	104	108	0.000006	116	120	0.000003
84	88	0.000016	96	100	0.000009	108	112	0.000005			
88	92	0.000013	100	104	0.000007	112	116	0.000004			

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Storage Structures 0
Number of Online Controls 1 Number of Time/Area Diagrams 1
Number of Offline Controls 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.350
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 17.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 100
Climate Change (%) 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	15 Winter	100	+40%					63.473
S1.001	S2	60 Winter	100	+40%	100/30 Winter				62.571
S2.000	S3	15 Summer	100	+40%					62.767
S1.002	S4	60 Winter	100	+40%	100/15 Summer				62.560
S3.000	S5	15 Winter	100	+40%					62.864
S3.001	S6	60 Winter	100	+40%	100/15 Summer				62.563
S1.003	S7	60 Winter	100	+40%	1/15 Summer				62.559

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.027	0.000	0.89			11.7	OK	
S1.001	S2	0.188	0.000	0.41			6.1	SURCHARGED	
S2.000	S3	-0.082	0.000	0.05			0.7	OK	
S1.002	S4	0.986	0.000	0.01			4.5	FLOOD RISK	
S3.000	S5	-0.036	0.000	0.73			9.7	OK	
S3.001	S6	0.784	0.000	0.46			5.0	FLOOD RISK	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.003	S7	1.545	0.000	0.38			3.1	FLOOD RISK	

Appendix F
Geotechnical Latter

Foundation House
St.John's Road
Meadowfield Industrial Estate
Durham
DH7 8TZ

Wayne Barron
Sunderland City Council
Commercial Road
Hendon
Sunderland
Tyne and Wear
SR2 8QR

Our Ref.: D10341/SA
Date: 14th June 2021

Dear Wayne,

Proposed Dining Hall, Barnes Junior and Infant School, Sunderland– Soakaway Testing

Dunelm Geotechnical and Environmental Limited (Dunelm) have been appointed by Sunderland City Council (the Client) to undertake a review of the feasibility of soakaway testing for a new dining hall at Barnes Junior and Infant School.

Dunelm have previously undertaken a Preliminary Geoenvironmental Appraisal for the site, Ref. D10341/0, dated March 2021, reference should be made to this report for details of the historical, geological and environmental setting.

1.0 Anticipated Ground Conditions

The site is shown to be underlain by drift deposits comprising glacial clay.

The solid geology underlying the site comprises the Ford Formation of the Magnesian Limestone. No faults are shown in the vicinity of the site.

There is a BGS borehole located 10m north of the site at the former laundry. The log records clay and gravel underlain by hard stony clay to 6.0m bgl underlain by limestone. The limestone is interbedded with marl to a depth of 32.3m bgl where shale was recorded.

BGS report, "Surface Collapse Features in the Magnesian Limestone of the Seaham Area, County Durham, report number CR/06/225" undertaken on behalf of District of Easington Council indicates evidence of ground dissolution features in the surrounding area of the site however, the site itself appears to fall out of the areas of concern identified within the report.

2.0 Solution Features.

Solution features can be caused by several factors which can act separately or cumulatively including:

- Magnesium Limestone strata are naturally more susceptible to solution features due to its chemical compositions,
- The infiltration of acid rain, dissolving the rock and the by the action of CO_2 and humic acids in association with a cover of soils and vegetation,

- Faulted rocks will commonly be heavily fractured, making them more susceptible to dissolution, and the formation of solution features.
- Where rock is shallow, it will be more susceptible to dissolution by acid rain.
- Solution features can also be increased by rising mine waters. When pumping of groundwater from deep mines has stopped the groundwater level can rise, leading to dissolution of the overlying rock at depth. In addition collapse of mine workings at depth may also cause the rock strata above to collapse thereby allowing greater infiltration/movement of water through broken strata and subsequent possible dissolution of the strata.
- Shallow mobile groundwater may also be a contributing factor to the formation of solution features.

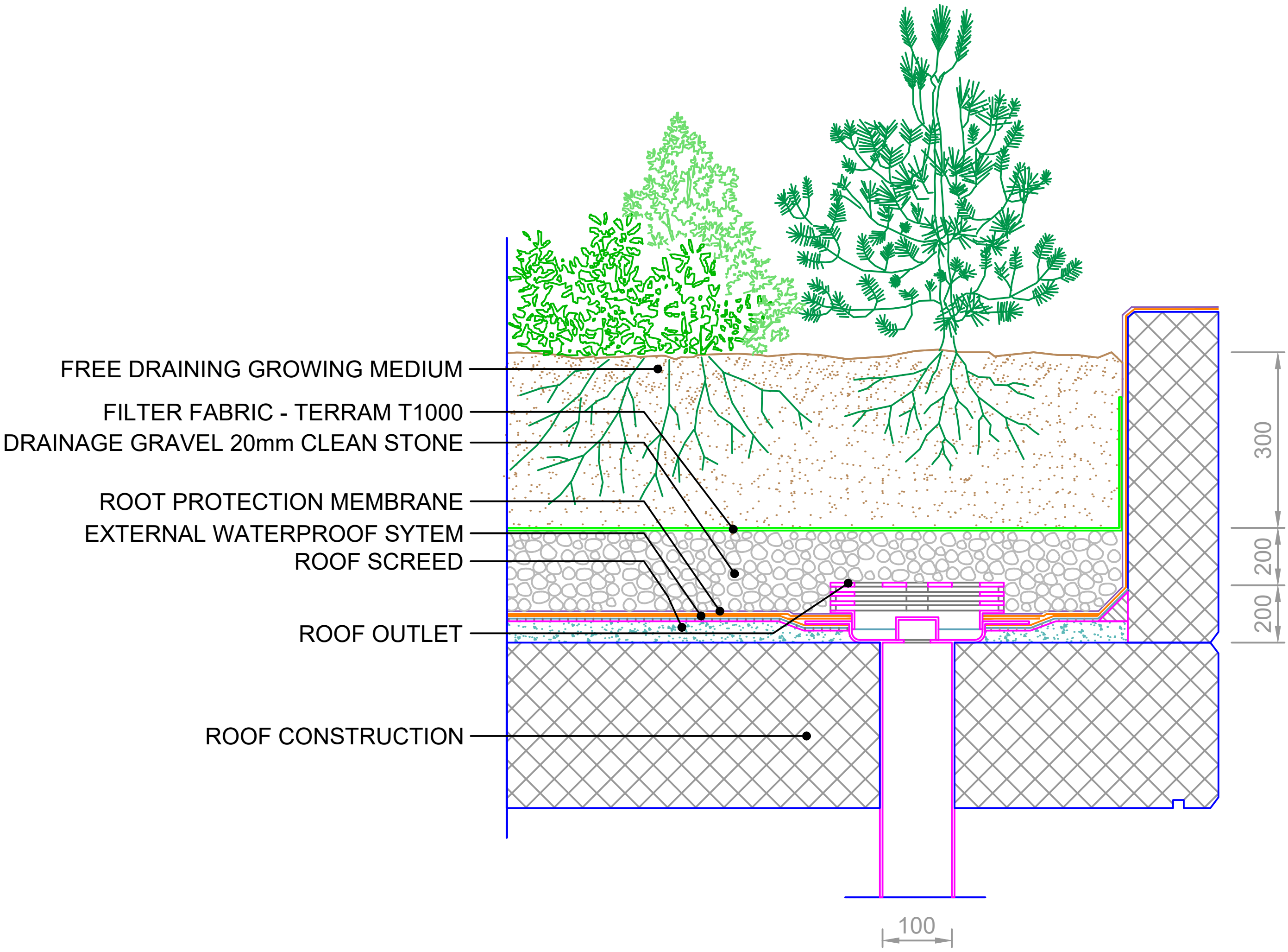
Although no surface evidence of existing solution features in the form of collapsed strata was present at the time of the site walkover, the possibility of solution features forming cannot be ruled out. It is therefore recommended that no surface water should be taken into soakaway drainage. In addition, all new drainage should be a closed system with flexible jointing or should contain impervious linings to prevent infiltration of water onto the underlying deposits and loose or completely weathered limestone should be inspected by a suitably competent person prior to construction.

Kind Regards,

Katie Dresser

For and behalf of Dunelm Geotechnical and Environmental

Appendix G
Green Roof Specification



Sunderland City Council
City Development Directorate,
Civic Centre,
Burdon Road,
Sunderland,
SR2 7DN

Tel. (0191) 520 5555

Client CITY DEVELOPMENT DIRECTORATE

Project Barnes Schools

Subject Green Roof Typical Detail

Drawn by PA	Checked by CG	Scale NTS
Date July 2021	Approved by PA	Sheet size A4

Drawing No. BDS-SCC-00-DR-CH-0504

Revision