

The Market Bosworth School, Back Lane,
Market Bosworth, Nuneaton CV13 0JT

Flood Risk Assessment and SuDS Drainage
Strategy for New Sports Facilities and Car
Park Extension

Client: The Market Bosworth School

Report Ref: CWC363-RP-01 Rev 1

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Quality assurance record

Contributors for Corner Water Consulting:

Name	Role
Alan Corner	Project Director

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The methodologies adopted plus the sources of information used by Corner Water Consulting Ltd (CWC) in providing its services are outlined within this Report. Any information provided by third parties and referred to herein has not been checked or verified by CWC, unless otherwise expressly stated within this Report. This Report was checked and approved for issue on the date of issue shown, all data, parameters and methodology are valid on this date.

1. Introduction

1.1 Purpose of this Report

This report provides an assessment of the drainage provision for new sports facilities plus car park at The Market Bosworth School (TMBS), Back Lane, Market Bosworth, Nuneaton, Leicestershire CV13 0JT. The planning proposal is for the construction of a new Multi Use Games Area (MUGA) to the west of the current one, extension of a car park, plus upgrade works to one grass sports pitch including regrading the playing surface.

The site location is shown in Figure 1, being to the west of the existing school building, car park and MUGA. An aerial view is shown in Figure 2, with the local ordnance survey data provided in Figure 3 including local watercourses to the northeast.

The planning layout proposed for the new MUGA, car park extension and updated grass pitch are shown in Figure 4, with the current and proposed levels/contours also provided. The levels show that the site slopes down to the northeast and the car park extension is in the low point. It is thus proposed to have attenuation SuDS in the car park and limit the flow off site into existing drainage facilities. Infiltration will be allowed and encouraged at the base of all the large footprint SuDS elements proposed in this school scheme.

The proposed site plan areas are detailed in Figure 4. The new MUGA is set out at 73m x 46m and thus covers 3,358 sqm. The grass pitch is 73.2m x 45.7m and thus covers 3,345 sqm. The car park extension is set out as 72m x 18m and thus covers 1,296 sqm. Thus the 'constructed areas' total up to 0.8ha, of which 4,654 sqm is permeable hard surfaced.

This report provides a Flood Risk Assessment (FRA), plus a Surface Water Management Plan (SWMP) including the surface water and SuDS design including an attenuation sustainable drainage element to deal with rainfall events up to the 1 in 100-year plus allowances for Climate Change (CC). This report seeks to provide the standard information required for a planning application plus any site-specific council comments received to date.

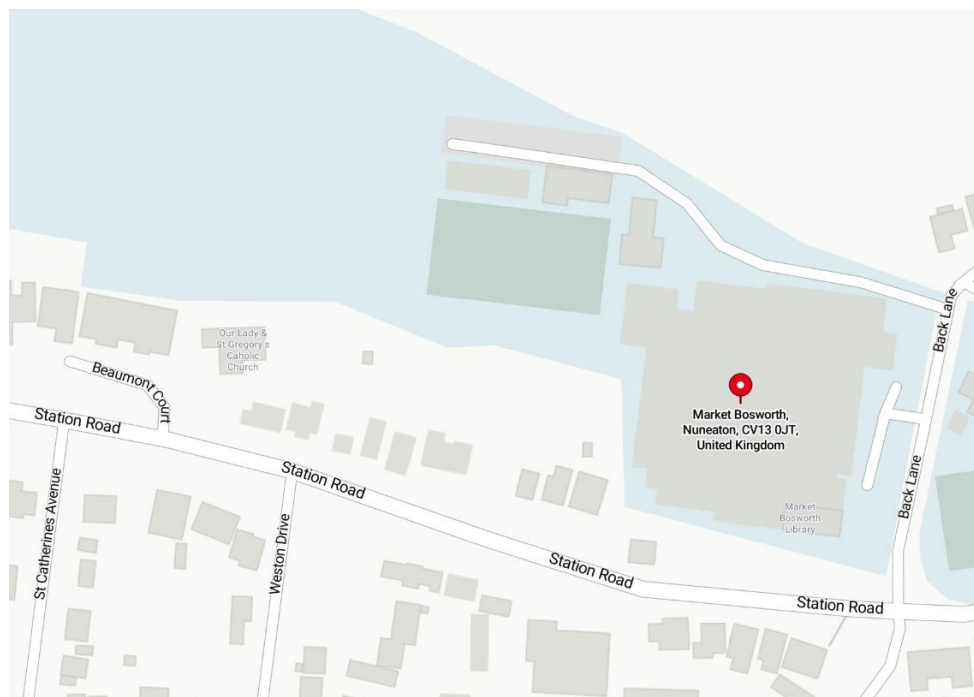


Figure 1: Site Location at West of Existing MUGA – Source Bing Maps
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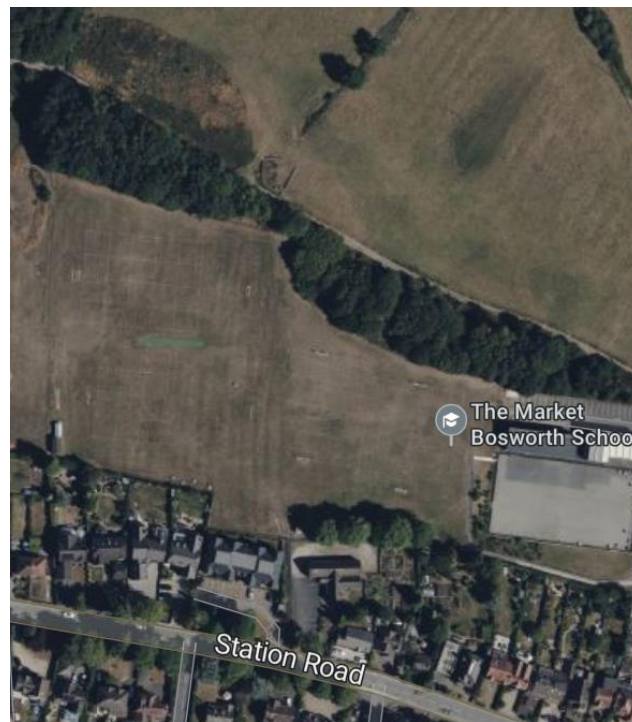


Figure 2: Aerial View of Site Location West of Existing MUGA – Source Bing Maps
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Figure 3: Ordnance Survey of Area – Source Bing Maps
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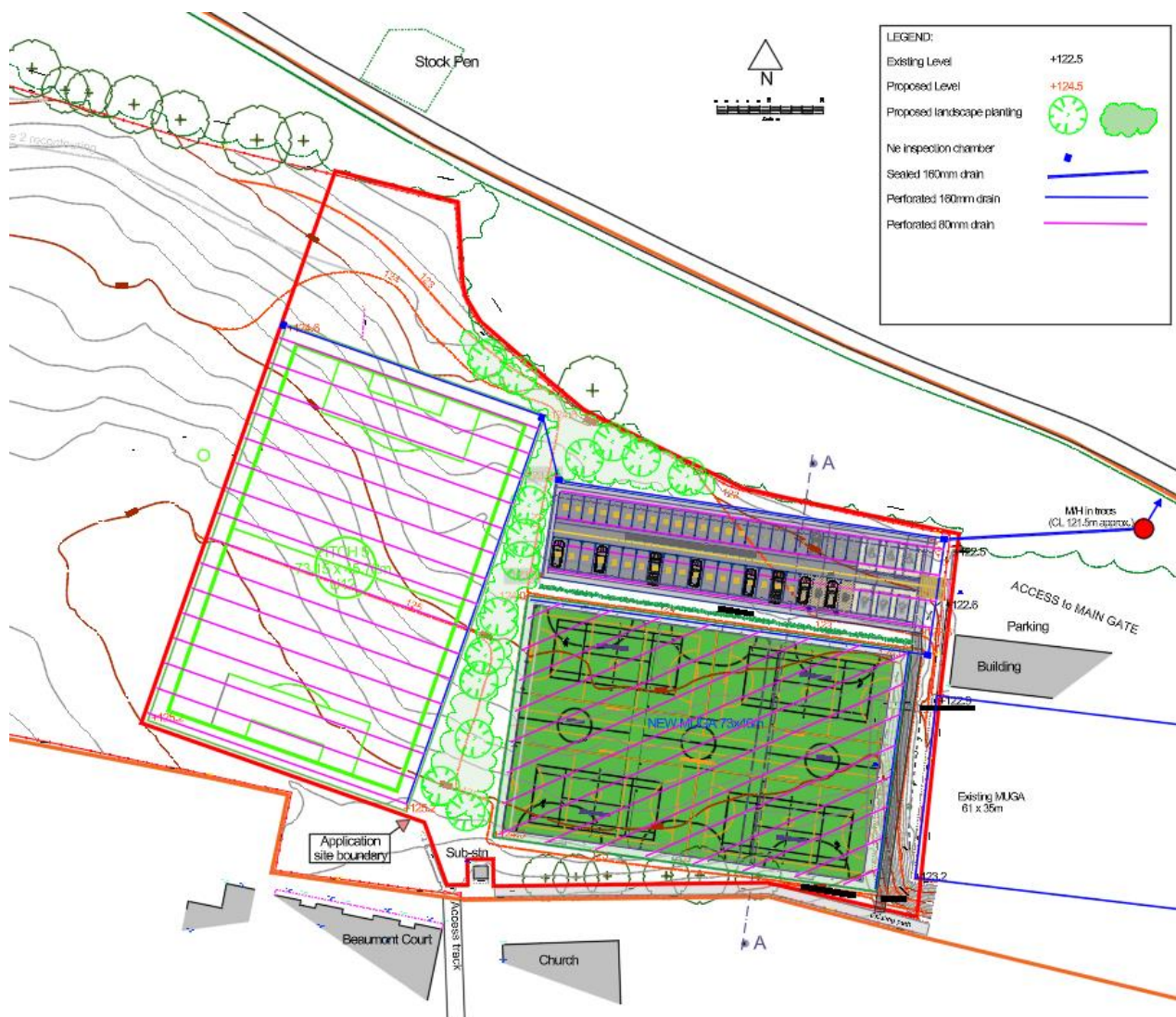


Figure 4: Proposed Facilities

1.2 Sources of Information

This Report has been informed by the following site information:

- Site location;
- Drawings of the scheme;
- Site plan areas from the site plan;
- Hemstock Design Limited report entitled Technical Assessment Report on the Proposed MUGA & Associated Work;
- LLLFA comments dated 3 July 2024.

Plus, the following local and National guidance and policies:

- CIRIA 'SuDS manual' and Leicestershire County Council Sustainable Drainage Guide 2015;
- The National Planning Policy Framework.

2. Site Details and Data

2.1 Existing Site Details

The school land ownership includes a number of grass pitches. The proposed site area is currently some of these existing grass sports pitches, see Figure 5. The site development area, plus planning Red-Line boundary are shown in Figure 4.



*Figure 5: Aerial View of Local Area Showing Various Pitches – Source Bing Maps
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The southern edge of the site is basically level from East to West, being along a contour. The overall area around the site slopes from Southwest to Northeast as shown by the Ordnance Survey mapping details and contours in Figure 3, plus the existing site levels in Figure 4.

The existing site drains off to the northeast and an existing drainage system, which has been located and reviewed.

There is a local watercourse around 115m to the northeast of the site which is directly downslope from the low point at the northeastern end of the proposed car park. This watercourse flows away from the site in a Southeast to Northwest direction.

The Hemstock Design Technical Assessment Report shows that planning was previously given, detailing:

“1.1 (4) TMBS previously obtained planning consent from Hinckley & Bosworth Borough Council for a car-park extension and new ‘astro-turf’ pitch in March 2019, Application Number 19/00305/FUL. The consent included particular conditions stating:

- *No development shall commence until the permeable drainage system details of the astro turf pitch with or without attenuation storage, depending on ground strata permeability, have been submitted.*
- *The astro turf pitch hereby permitted shall not be constructed other than in accordance with Sport England's design guidance note 'Artificial Surfaces for Outdoor Sport'.*
- *No development shall take place until a scheme for playing field quality improvements for the site is submitted to and approved in writing by the Local Planning Authority. The scheme shall be carried out in full accordance with the approved scheme.*

1.1 (5) The consent is now out of time, so a new application is now to be made for the proposed MUGA and additional parking. Since the original application, a new building has been constructed adjacent to and north of the existing MUGA in 2021, reducing parking capacity.

2.2 Ground Conditions

The current site usage is grass sports pitches. The Hemstock Design report notes that:

“The grass pitches, particularly to the east, or school building-end of the playing field area, are waterlogged and mostly unusable from the end of October through to early April each year. This has led to all pupils being affected by an inability to play sport and partake in physical exercise in both core PE lessons and free time (break and lunchtime) due to the inadequate facilities.”

Some soil investigations have been undertaken and are detailed in the Hemstock Design report. The key parts of that information are repeated below for ease of reference.

The proposed site for the new MUGA has been filled at some point in the past with material from an old canteen building, it is understood. Trial pits have been excavated to assess the soil profile to a depth of around 1.2m.

2.1 Soil Profile Investigation

1) The new MUGA must be laid over a firm subsoil base, so all topsoil is to be stripped before construction. A topsoil survey was carried out to estimate depths and volume to be stripped from the existing grass area. This topsoil is to be deposited on the adjacent grass pitch for releveling.

2) The topsoil was found to be variable in depth, between 100mm on the filled zones to over 200mm on the unfilled areas, being a wet to waterlogged clay-loam, no water table, the wetness was from surface water only. The topsoil varied from a dark-brown to a light brown clay loam.

Below the topsoil layer was a filled made-ground profile of hard soil/stone/debris, which included pieces of metal, glass, pottery, tile, brick and stone. To the north of the area, where the car park is proposed to be, and to the west on the adjacent grass pitch, the subsoil was a light brown clay loam with stone inclusions, wet to very wet.

No obvious contaminant material was found, but it is a possibility that other materials exist in the profile under the proposed location of the MUGA.

3) The ground was too hard to use a hand-auger on the initial visit. A further examination was subsequently carried out to a maximum of 1.2m depth with a mini-digger, general results outlined below.

The majority of the ground in which the new MUGA and car park extension are due to cover has been filled with a mixture of rubble and clay, finished with topsoil.

Soilscapes information by Cranfield University supported by DEFRA shows that the entire site and surrounding area is underlain by loamy and clayey soils described as “Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils.”, see Figure 6.

Therefore, a low rate of soakage into the soil has been included in the SuDS design by using a design infiltration rate of 1×10^{-6} m/s or 0.0036 m/hr in the hydraulic modelling software to represent a nominal amount of soakage.

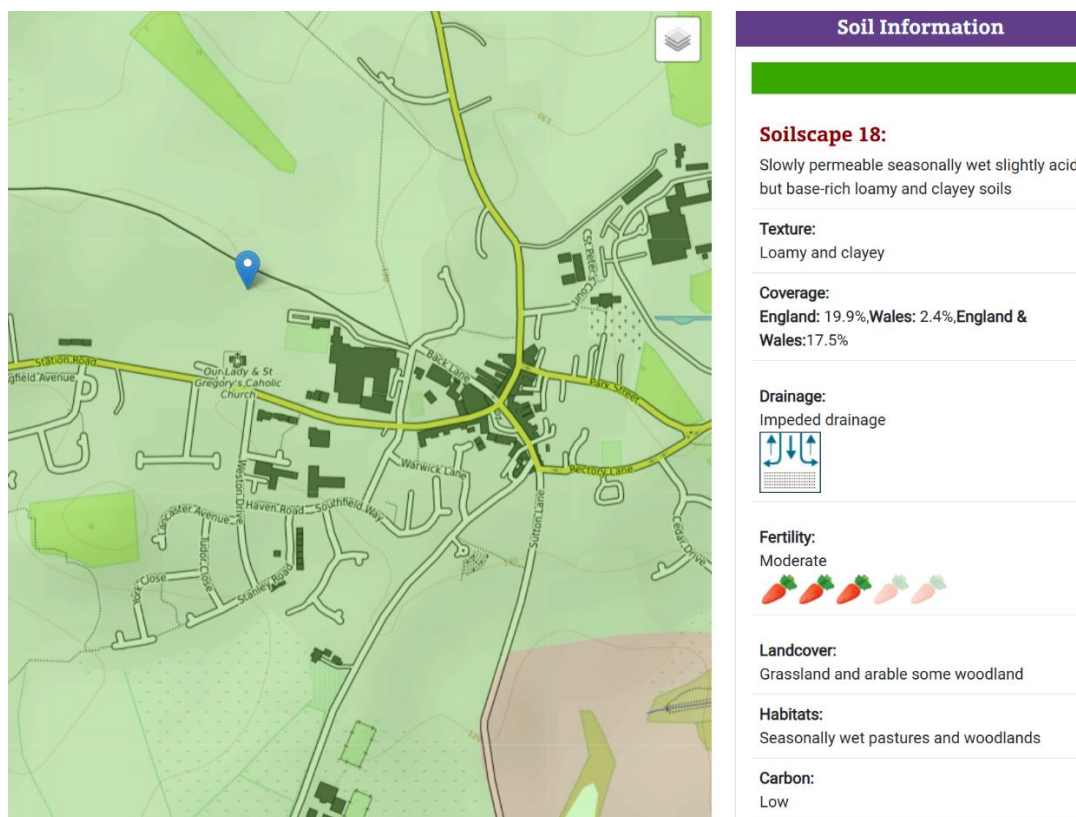


Figure 6: Soilscapes Soil Data

2.3 Flood Risk

The site is located entirely within Flood Zone 1 for river and sea flooding as defined and detailed in the Flood Map for Planning, as also confirmed by the LLFA - so there is no external river flood risk and sporting development is appropriate. The flood map for planning is included in Figure 7.

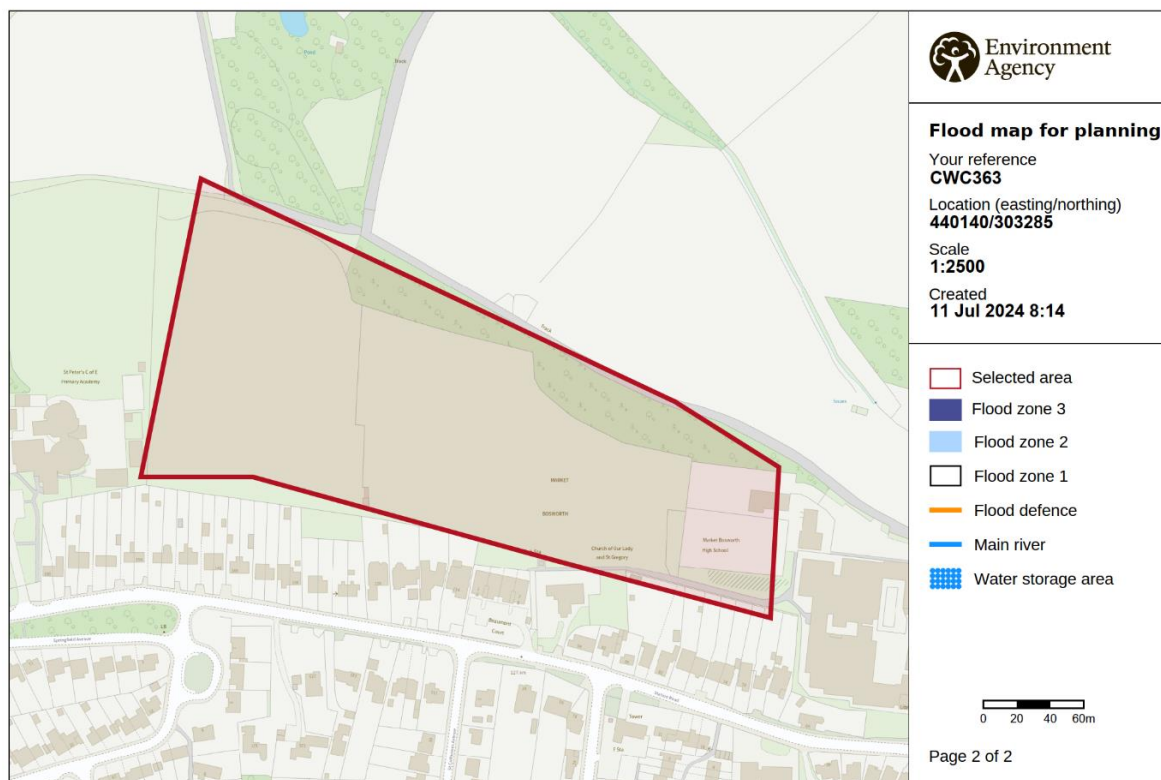


Figure 7: Flood Map for Planning – Source EA

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Environment Agency data shows that the site is unlikely to be affected by groundwater flooding. This is logical as the site is on a constant slope off to the north so there is no reason for groundwater to collect in the vicinity of the site. Also, with the soil type there is unlikely to be much shallow groundwater.

There is no mapped 1 in 100-year or Medium Risk Scenario surface water flood risk within the school. Further there is no mapped 1 in 1000-year or extremely unlikely Low Risk Scenario surface water flood risk within the application site.

However there is some Low Risk Scenario surface water flood risk to the East of the existing MUGA and around the existing school building on the applicant's wider land ownership - see EA published website details in Figure 8 and the close up view in Figure 9.

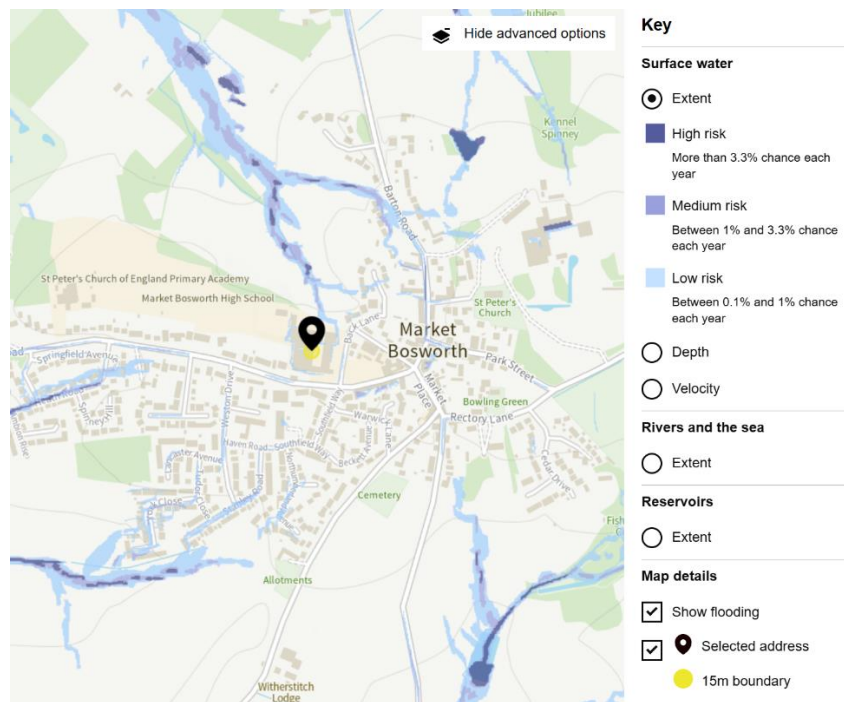


Figure 8: EA Medium Risk of Surface Water Flooding or 1 in 100-year RP.



Figure 9: Close up EA Medium Risk of Surface Water Flooding or 1 in 100-year.

The Government estimate that Climate Change will increase rainfall by as much as 40% by 2061 at this site and so the current situation to the East inside the school, plus to the North off the site, will likely become worse.

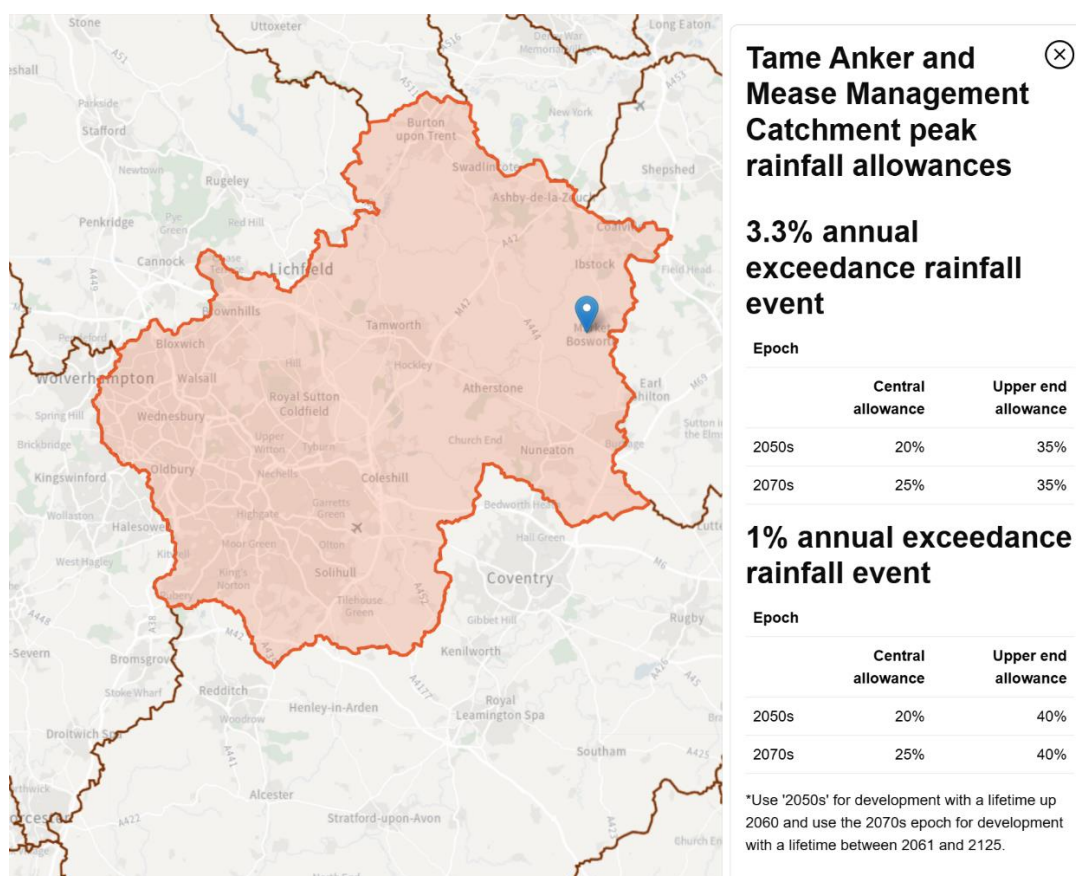


Figure 10: Climate Change Allowances

To maintain the impact of this development at a maximum of current Greenfield Rates, plus absorb the additional rainfall due to climate change, the proposal includes a SuDS drainage scheme that deals with extreme rainfall events of up to the 1 in 100-year plus the additional 40% due to Climate Change. Since the site does not include any housing or impermeable surfacing there is no allowance in this design for urban creep.

The grassed pitch, the MUGA and the car park will all provide Interception Storage and Treatment which means the site will contain the first 5mm of rainfall – which is especially useful to improving water quality during summer rainfall. Complete surface water drainage and SuDS details are provided in Section 3.

2.4 Proposed Site Details

The planning proposal is for the construction of a new MUGA, plus the extension of a car park to provide additional spaces and replace capacity lost due to previous changes at the school, see Figure 4. To create these features there will be some cut and fill earthworks with any spare soil being used to seek to address the waterlogging and poor surface drainage problems that are evident on the adjacent existing grass pitch – identified as number 5. Regrading of this pitch and adding land drainage should increase the times when it is useable by the pupils, which is urgently required as the school have had to cancel and manage sports access, see the Hemstock Design report. Regrading is also required as the pitch is too steep versus sports pitch guidance.

All roadways and parking would be permeable surfacing or paving. Therefore pre-development the site is 100% permeable and post-development the grass pitch remains a grass pitch but at a flatter slope which will reduce runoff, with the rest of the site being permeable hard surfaced. The site will discharge at Greenfield Rates.

The MUGA and the grass pitch will have some under drainage, so they will gradually pass forward collected rainfall. The car park will be permeable surfaced and contain a porous sub-base stone providing structural strength plus rainwater attenuation. The sub-base will have a flat formation to provide attenuation storage, i.e. it will not follow the slope of the parking surface.

The developed part of the planning proposal comprises the MUGA at 73m x 48m or 3,500 sqm, the grass pitch at 73.2m x 45.7m or 3,345 sqm, plus the car park at 73m x 18m or 1,314 sqm. Thus, the total of the 'developed area' is 8,159 sqm or 0.816ha, of which 4,654 sqm is permeable hard surfaced.

To achieve a Biodiversity Net Gain (BNG) overall effect there will be some planting and landscaping added to the grassed areas to the west of the proposed regraded grass pitch and the other construction works detailed in this report. This does not change the land for drainage purposes and any trees plus large bushes in hedges will intercept rainfall in their canopies before it reaches the ground, plus they will take more rainwater out of the soil than the current arrangement. These changes are thus assessed as drainage positive and the BNG area of the site has been excluded from the SuDS assessment as it is effectively unchanged.



Figure 11: Total Red-Line Boundary Including BNG Zone

3. Surface Water Drainage

3.1 Surface Water Management Plan

The site development, or Red-Line area is shown in Figure 4. The proposal includes a SuDS drainage scheme that deals with extreme rainfall events of up to the 1 in 100-year plus the additional maximum required Climate Change of 40%. The Standard Percentage Runoff (SPR) for the site is 47%, therefore the grass pitch has been assumed to have a runoff coefficient post regrading equalling the SPR value.

The remainder of the Red-Line area includes the under drained MUGA which has a stone sub-base; plus a permeable surfaced car park with a stone sub-base. The MUGA has an orifice flow control to limit the pass forward rate to the attenuation under the car park. The car park is underlain by a 35% voided stone sub-base. This drainage system takes rainfall off all the space inside the Red-Line.

As this is a sports facility there is no allowance added to the catchment areas to accommodate future urban creep.

The UK Government publishes climate change allowances and states that designers should “Use ‘2050s’ for development with a lifetime up to 2060 and use the 2070s epoch for development with a lifetime between 2061 and 2125.” At this site the proposal is sport/recreation, with an estimated 100-year lifespan, therefore the climate change values for 2070 have been used. As the site is sport/recreation the Central Allowances would be appropriate. However, to be conservative the design has used the Upper End Allowance values. At this site the UK Government climate change allowances are 35% for the 3.3%AEP event and 40% for the 1%AEP event.

The drainage SuDS system design settings are given in Figure 12 with the Simulation Settings and runoff rates in Figure 13.

<u>Design Settings</u>			
Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	1.000
CV	0.750	Preferred Cover Depth (m)	0.250
Time of Entry (mins)	8.00	Include Intermediate Ground	x
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	250.0		

Figure 12: SuDS Design Settings

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	2 year (l/s)	1.9
Summer CV	0.750	Drain Down Time (mins)	2400	30 year (l/s)	4.1
Winter CV	0.840	Additional Storage (m ³ /ha)	20.0	100 year (l/s)	5.4
Analysis Speed	Normal	Check Discharge Rate(s)	✓	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	35	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.99
Greenfield Method	IH124	Growth Factor 100 year	2.57
Positively Drained Area (ha)	0.482	Betterment (%)	0
SAAR (mm)	637	QBar	2.1
Soil Index	4	Q 2 year (l/s)	1.9
SPR	0.47	Q 30 year (l/s)	4.1
Region	4	Q 100 year (l/s)	5.4
Growth Factor 2 year	0.89		

Figure 13: SuDS Assessment and Simulations Settings

3.2 Surface Water SuDS Design

The site areas have been measured off the scheme drawings. The developed area covers 8,159 sqm, and this equates to the pre-development greenfield runoff rates shown in Table 1. This table also details the post-development SuDS discharge rates showing that the development provides betterment and removes the effect of more runoff due to Climate Change that would occur if the site was left unchanged.

Table 1: Pre- and Post-Development Runoff Rates

RETURN PERIOD	Pre-Development Rate (l/s)	Post-Development Rate (l/s)
2-year	1.9	1.9
30-year	4.1	2.1
100-year	5.4	4.3

The catchment areas have been highlighted green in Figure 14. This also shows the drainage network and the SuDS attenuation elements.



Figure 14: Indicative Masterplan with SuDS Catchment

The SuDS drainage solution has been designed to meet or better the current scenario on the site, assuming that the entire site area is Greenfield. The grass pitch has been designed taking a 47% runoff rate post development and this is the amount of rainfall that enters the SuDS. This is assumed to be a conservative assumption given the lessening of the slope after regrading, plus the additional topsoil being added alongside the land drainage that is to be installed.

The Greenfield rates have been determined within the Flow by Causeway software – see Appendix 1, plus also cross checked with the UKSuDS.com tools by HR Wallingford.

The characteristics of the various voided stone sub-bases forming the attenuation storage have been analysed using the Flow module of the industry leading Causeway Drainage Design suite of software developed by Causeway Technologies Ltd. The following conservative assumptions and design parameters were applied within the design process.

- FEH-22 point rainfall data was obtained from the FEH Webservice website, as this is the most up to date hydrological information.
- To account for climate change the design flows and simulation testing includes 40% rainfall uplift during the 100-year events, in line with the requirements of NPPF and SuDS theory.
- The catchment areas proposed on site are taken from the scheme drawings.
- The area of the car park and MUGA have been included in the catchments as they accept direct incident rainfall.

Node 2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.002	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0073-1900-0500-1900
Invert Level (m)	121.700	Min Outlet Diameter (m)	0.100
Design Depth (m)	0.500	Min Node Diameter (mm)	1200
Design Flow (l/s)	1.9		

Node MUGA Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.040
Downstream Link	1.000	Invert Level (m)	123.400	Discharge Coefficient	0.600

Node 2 Offline Orifice Control

Flap Valve	x	Invert Level (m)	122.380	Discharge Coefficient	0.600
Loop to Node	3	Diameter (m)	0.090		

Node CAR PARK Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00360	Safety Factor	2.0	Invert Level (m)	121.900
Side Inf Coefficient (m/hr)	0.00360	Porosity	0.35	Time to half empty (mins)	1380

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	1300.0	1300.0	0.600	1300.0	1350.0

Node MUGA Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00360	Safety Factor	2.0	Invert Level (m)	123.650
Side Inf Coefficient (m/hr)	0.00360	Porosity	0.35	Time to half empty (mins)	784

Depth (m)	Area (m ²)	Inf Area (m ²)	Depth (m)	Area (m ²)	Inf Area (m ²)
0.000	2000.0	2000.0	0.300	2000.0	2000.0

Figure 15: Flow Controls and Attenuation Details

Full hydraulic modelling has been undertaken in Flow by Causeway with a design output report included in Appendix 1. The flow rate off the site for all required rainfall events is as per the current Greenfield runoff rates or less.

The SuDS system performance results in the 100-year event are given in Figure 16, showing that the peak water level in the car park is 122.443m versus a cover level of 122.50m AOD.

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	MUGA	360	123.943	0.543	30.6	212.0508	0.0000	FLOOD RISK
600 minute winter	CAR PARK	585	122.443	0.543	22.0	253.3476	0.0000	FLOOD RISK
600 minute winter	2	585	122.442	0.742	7.2	0.8396	0.0000	FLOOD RISK
600 minute winter	3	585	121.042	0.042	4.3	0.0119	0.0000	OK
600 minute winter	To Off-site	585	120.941	0.041	4.3	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)
360 minute winter	MUGA	Orifice	CAR PARK	2.4				
360 minute winter	MUGA	Infiltration		1.0				
600 minute winter	CAR PARK	1.001	2	7.2	0.258	0.102	0.4284	
600 minute winter	CAR PARK	Infiltration		0.7				
600 minute winter	2	Hydro-Brake®	3	2.3				
600 minute winter	2	Orifice	3	2.1				30.5
600 minute winter	3	1.003	To Off-site	4.3	0.863	0.074	0.0390	376.9

Figure 16: SuDS Results During 100 year & 40%CC Storms

Due to the low Greenfield Rates the car park half-drains in 1,380 minutes for the 30-year events, which is slightly below the target 1,440 minutes or 24 hours.

3.3 Surface Water Operation and Maintenance

The owners of the dwellings would be responsible for the management and maintenance of the surface water drainage systems. This requires simple but regular attention as detailed within Table 2.

Table 2: Pervious Pavements Maintenance

TABLE 20.15 Operation and maintenance requirements for pervious pavements		
Maintenance schedule	Required action	Typical frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial Actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50 mm of the level of the paving	As required
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users, and replace lost jointing material	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Initial inspection	Monthly for three months after installation
	Inspect for evidence of poor operation and/or weed growth – if required, take remedial action	Three-monthly, 48 h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

4. Summary

The site is currently a series of grass covered sports pitches.

The remainder of the applicant's land holding to the West is other grass sports pitches that may be reconfigured for different sports in the future but are essentially unchanged apart from the planting of some vegetation to achieve the required BNG outcome. As such the other area does not change in drainage terms, plus it may be slightly better due to the interception of rainfall before it reaches the ground. As such the BNG area has been excluded from this assessment.

The SuDS proposal follows National plus Council SuDS policy by collecting rainwater then attenuating it for all events up to a 1 in 100-year storm plus 40% Climate Change allowance to ensure in the future only Greenfield runoff rates occur to the north.

Any rainfall in excess of the design storm, or during the emptying phase of the soakaway SuDS elements, will initially fill the stone sub-bases to ground level. If additional rainfall occurs, then overland flow will occur into the remainder of the site and off to the northeast, as it currently would following the natural slope.

All surface water SuDS drainage is dealt with inside the site boundary to meet Greenfield runoff rates.

5. References

Author	Date	Title/Description
HM Government		The Flood Map for Planning website Flood map for planning - GOV.UK (flood-map-for-planning.service.gov.uk)
HM Government		Long Term Flood Risk for England website https://check-long-term-flood-risk.service.gov.uk
CIRIA	2015	The SUDS Manual – CIRIA Report C753.
Leicestershire County Council	February 2015	Sustainable Drainage Guide
Leicestershire County Council	2018	LLFA Checklist and Interim LLFA Guidance Note
DCLG	March 2012	Technical Guidance to the National Planning Policy Framework.
Ministry of Housing, Communities and Local Government		National Planning Policy Framework

APPENDIX 1 – Surface Water Drainage Modelling



Design Settings

Rainfall Methodology	FEH-22	Minimum Velocity (m/s)	1.00
Return Period (years)	100	Connection Type	Level Soffits
Additional Flow (%)	0	Minimum Backdrop Height (m)	1.000
CV	0.750	Preferred Cover Depth (m)	0.250
Time of Entry (mins)	8.00	Include Intermediate Ground	x
Maximum Time of Concentration (mins)	30.00	Enforce best practice design rules	x
Maximum Rainfall (mm/hr)	250.0		

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
MUGA	0.348	30.00	124.000		173.119	86.048	0.600
CAR PARK	0.339	30.00	122.500		175.308	107.247	0.600
2			122.500	1200	186.710	116.987	0.800
3			121.500	600	225.178	118.799	0.500
To Off-site			121.500		228.558	125.630	0.600

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	MUGA	CAR PARK	18.290	0.600	123.400	121.950	1.450	12.6	150	30.00	64.8
1.001	CAR PARK	2	10.771	0.600	121.900	121.700	0.200	53.9	225	30.00	64.8
1.002	2	3	38.045	0.600	121.700	121.000	0.700	54.4	225	30.00	64.8
1.003	3	To Off-site	7.737	0.600	121.000	120.900	0.100	77.4	225	30.00	64.8

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	2.852	50.4	61.2	0.450	0.400	0.348	0.0	150	2.905
1.001	1.786	71.0	120.7	0.375	0.575	0.687	0.0	225	1.819
1.002	1.778	70.7	120.7	0.575	0.275	0.687	0.0	225	1.810
1.003	1.488	59.2	120.7	0.275	0.375	0.687	0.0	225	1.515

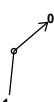
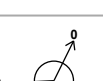
Pipeline Schedule

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	18.290	12.6	150	Circular	124.000	123.400	0.450	122.500	121.950	0.400
1.001	10.771	53.9	225	Circular	122.500	121.900	0.375	122.500	121.700	0.575
1.002	38.045	54.4	225	Circular	122.500	121.700	0.575	121.500	121.000	0.275
1.003	7.737	77.4	225	Circular	121.500	121.000	0.275	121.500	120.900	0.375

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	MUGA		Junction		CAR PARK		Junction	
1.001	CAR PARK		Junction		2	1200	Manhole	HCD Manhole
1.002	2	1200	Manhole	HCD Manhole	3	600	Manhole	HCD Manhole
1.003	3	600	Manhole	HCD Manhole	To Off-site		Junction	



Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)	
MUGA	173.119	86.048	124.000	0.600			0	1.000	123.400	150
CAR PARK	175.308	107.247	122.500	0.600			1	1.000	121.950	150
							0	1.001	121.900	225
2	186.710	116.987	122.500	0.800	1200		1	1.001	121.700	225
							0	1.002	121.700	225
3	225.178	118.799	121.500	0.500	600		1	1.002	121.000	225
							0	1.003	121.000	225
To Off-site	228.558	125.630	121.500	0.600			1	1.003	120.900	225

Simulation Settings

Rainfall Methodology	FEH-22	Skip Steady State	x	2 year (l/s)	1.9
Summer CV	0.750	Drain Down Time (mins)	2400	30 year (l/s)	4.1
Winter CV	0.840	Additional Storage (m³/ha)	20.0	100 year (l/s)	5.4
Analysis Speed	Normal	Check Discharge Rate(s)	✓	Check Discharge Volume	x

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
2	0	0	0
30	35	0	0
100	40	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.99
Greenfield Method	IH124	Growth Factor 100 year	2.57
Positively Drained Area (ha)	0.482	Betterment (%)	0
SAAR (mm)	637	QBar	2.1
Soil Index	4	Q 2 year (l/s)	1.9
SPR	0.47	Q 30 year (l/s)	4.1
Region	4	Q 100 year (l/s)	5.4
Growth Factor 2 year	0.89		

Node 2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Downstream Link	1.002	Sump Available	✓
Replaces Downstream Link	✓	Product Number	CTL-SHE-0073-1900-0500-1900
Invert Level (m)	121.700	Min Outlet Diameter (m)	0.100
Design Depth (m)	0.500	Min Node Diameter (mm)	1200
Design Flow (l/s)	1.9		

Node MUGA Online Orifice Control

Flap Valve	x	Replaces Downstream Link	✓	Diameter (m)	0.040
Downstream Link	1.000	Invert Level (m)	123.400	Discharge Coefficient	0.600

Node 2 Offline Orifice Control

Flap Valve	x	Invert Level (m)	122.380	Discharge Coefficient	0.600
Loop to Node	3	Diameter (m)	0.090		

Node CAR PARK Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00360	Safety Factor	2.0	Invert Level (m)	121.900
Side Inf Coefficient (m/hr)	0.00360	Porosity	0.35	Time to half empty (mins)	1380

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1300.0	1300.0	0.600	1300.0	1350.0

Node MUGA Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00360	Safety Factor	2.0	Invert Level (m)	123.650
Side Inf Coefficient (m/hr)	0.00360	Porosity	0.35	Time to half empty (mins)	784

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	2000.0	2000.0	0.300	2000.0	2000.0

Approval Results

The network has been designed using IDF rainfall
 It contains 5 nodes (1 outfall) and 4 links
 The total impermeable area is 0.687 ha
 2 online controls have been defined
 1 offline loop has been defined
 2 structures have been defined, providing 171m³ of storage below the flood risk level
 Infiltration based on BRE 365 has been applied at 2 of the structures
 Simulations have been completed using FEH-22 summer and winter storms from 15 to 1440 minute duration

The node size test has not been completed

1 connection has combined exit and entry losses less than the recommended total

Node	US Link	DS Link	US Exit Loss	DS Entry Loss	Angle (degrees)	Recommended Node Losses
3	1.002	1.003	0.250	0.250	61	0.900

No circular links have diameters < 100mm

No links have lengths > 100.000m

2 links have lengths that differ from their coordinated length by more than 1.000m

US Node	DS Node	Link	Length (m)	Coordinate Length (m)
MUGA	CAR PARK	1.000	18.290	21.312
CAR PARK	2	1.001	10.771	14.996

No links cross one or more other links

No links have cover depth outside the range 0.250-3.000m

No nodes have backdrops outside the range 1.000-1.500m

No links have full bore velocity outside the range 1.000-3.000m/s

The proportional velocity test has not been completed

1 link has a surcharged depth greater than 0.100m during the 100 year return period

US Node	DS Node	Link	Surcharged Depth (m)	Event
CAR PARK	2	1.001	0.318	100 year +40% CC 600 minute winter

No nodes flood during the 30 year return period

No infiltrating structures failed to half empty in 1440 minutes during the 30 year return period

No outfalls have a discharge rate greater than 1.9l/s during the 2 year return period

No outfalls have a discharge rate greater than 4.1l/s during the 30 year return period

No outfalls have a discharge rate greater than 5.4l/s during the 100 year return period

The discharge volume test has not been completed

Results for 2 year Critical Storm Duration. Lowest mass balance: 99.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute winter	MUGA	204	123.704	0.304	11.4	41.9660	0.0000	FLOOD RISK
600 minute winter	CAR PARK	600	122.049	0.149	10.7	69.6420	0.0000	OK
480 minute winter	2	496	122.055	0.355	9.1	0.4014	0.0000	SURCHARGED
480 minute summer	3	984	121.028	0.028	1.9	0.0079	0.0000	OK
480 minute summer	To Off-site	984	120.928	0.028	1.9	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)
240 minute winter	MUGA	Orifice	CAR PARK	1.8				
240 minute winter	MUGA	Infiltration		1.0				
600 minute winter	CAR PARK	1.001	2	6.2	0.253	0.088	0.3649	
600 minute winter	CAR PARK	Infiltration		0.7				
480 minute winter	2	Hydro-Brake®	3	1.9				
480 minute winter	2	Orifice	3	0.0				0.0
480 minute summer	3	1.003	To Off-site	1.9	0.678	0.032	0.0217	97.9

Results for 30 year +35% CC Critical Storm Duration. Lowest mass balance: 99.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	MUGA	352	123.863	0.463	23.7	154.5209	0.0000	FLOOD RISK
960 minute winter	CAR PARK	960	122.345	0.445	12.4	207.5730	0.0000	FLOOD RISK
960 minute winter	2	945	122.354	0.654	7.8	0.7391	0.0000	FLOOD RISK
960 minute winter	3	930	121.030	0.030	2.1	0.0084	0.0000	OK
960 minute winter	To Off-site	975	120.929	0.029	2.1	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)
360 minute winter	MUGA	Orifice	CAR PARK	2.2				
360 minute winter	MUGA	Infiltration		1.0				
960 minute winter	CAR PARK	1.001	2	7.8	0.258	0.110	0.4284	
960 minute winter	CAR PARK	Infiltration		0.7				
960 minute winter	2	Hydro-Brake®	3	2.1				
960 minute winter	2	Orifice	3	0.0				0.0
960 minute winter	3	1.003	To Off-site	2.1	0.703	0.036	0.0236	311.0

Results for 100 year +40% CC Critical Storm Duration. Lowest mass balance: 99.34%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
360 minute winter	MUGA	360	123.943	0.543	30.6	212.0508	0.0000	FLOOD RISK
600 minute winter	CAR PARK	585	122.443	0.543	22.0	253.3476	0.0000	FLOOD RISK
600 minute winter	2	585	122.442	0.742	7.2	0.8396	0.0000	FLOOD RISK
600 minute winter	3	585	121.042	0.042	4.3	0.0119	0.0000	OK
600 minute winter	To Off-site	585	120.941	0.041	4.3	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)
360 minute winter	MUGA	Orifice	CAR PARK	2.4				
360 minute winter	MUGA	Infiltration		1.0				
600 minute winter	CAR PARK	1.001	2	7.2	0.258	0.102	0.4284	
600 minute winter	CAR PARK	Infiltration		0.7				
600 minute winter	2	Hydro-Brake®	3	2.3				
600 minute winter	2	Orifice	3	2.1				30.5
600 minute winter	3	1.003	To Off-site	4.3	0.863	0.074	0.0390	376.9

Corner Water Consulting

Registered office:

1 Cricklade Court
Cricklade Street
Swindon SN1 3EY

Registered in England

13675352

Contact

info@cornerwaterconsulting.co.uk