East Boldon

Drainage Strategy

For: Gentoo Homes

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Client:	Gentoo
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Job Number:	1015049

Document Revision History

Revision Ref	Issue Date	Purpose of issue / description of revision
-	13.04.17	Planning Submission

Document Validation (latest issue)

Recoverable Signature

X

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Executive Summary

Cundall have prepared this Drainage Strategy as part of the planning application for the proposed Gentoo Homes residential development at East Boldon, South Tyneside. This report details the drainage strategy for the site.

Cundall have had consultation with both NWL and the LLFA as part of the development proposals. The LLFA confirmed site specific drainage and flood risk requirements with NWL confirming discharge allowance for foul and storm water drainage to their sewer network.

The site is unsuitable for infiltration and a connection to the local watercourse verified impractical by onsite surveys.

The proposed strategy is to connect both storm and foul water to the adjacent NWL sewerage infrastructure in Moor Lane.

The storm water discharge will be restricted to 5 l/s with attenuation provided on site to deal with all storms up to and including the 1 in 100 year plus 40% climate change event.

SuDS have been proposed in the form of swales and permeable paving.

Contents

1. Introduction 1
1.1 Reason for Report and Planning Context 1
2. The Site 2
2.1 Site Description 2
2.2 Proposed Development 2
3. Existing Drainage 4
4. Proposed Drainage 6
4.1 NWL Consultation 6
4.2 LLFA Consultation 6
4.3 Surface Water 7
4.4 Foul Water 14
5. Conclusion 15
5.1 Surface Water 15
5.2 Foul Water 15
6. Appendices 16

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1. Introduction

1.1 Reason for Report and Planning Context

Cundall have prepared this Drainage Strategy to support the planning application for the proposed development of the former Builders Yard site. The site is located near the B1299 Whitburn Road junction with Moor Lane in East Boldon. See Figure 1 for a site location plan.

This report includes;

- An appraisal of the existing site and its current drainage pattern;
- Surface water drainage proposals; and
- Foul water drainage proposals



Figure 1 Site Location

2. The Site

2.1 Site Description

The site is located within the jurisdiction of South Tyneside Council, in the area of East Boldon. See Figure 1 for location.

The site is approximately 0.5ha in size and is currently occupied by a building contractor yard. The site slopes at an approximate grade of 1:40 from the north west to south east.

The site is bounded by Whitburn Road to the north west, Moor Lane to the south west and open grassland to the south east and north east. The surrounding area to the immediate north is open fields. Residential development is found to the north east and east, industrial/commercial is to the north west and the south is predominantly open fields/agricultural land known as Boldon Flats. A watercourse lies approximately 100m south east of the development boundary.

2.2 Proposed Development

The proposals are for a new residential development consisting of a range of house types. See Figure 2 for the proposed layout.



Figure 2 Proposed Development

3. Existing Drainage

The site is served by existing public combined sewers. There is existing drainage on site which served the former builders yard. The existing foul and storm site drainage connects into the NWL combined sewer network within Moor Lane and has been proven by connectivity surveys.

It is estimated that the existing site generates the following surface water flows based upon its existing impermeable area and the average rainfall intensity for the locality;

- 1 in 1 year storm – 36 l/s
- 1 in 30 year storm – 89 l/s
- 1 in 100 year storm – 116 l/s

The entire site is impermeable.

The existing foul flow is estimated at no more than 1 l/s. This is based on the maximum occupancy capacity of the existing buildings and processes and therefore is only an estimate.

The site is located in a Critical Drainage Area according to South Tyneside Council's Strategic Flood Risk Assessment, however there is no known or recorded historical sewer flooding incidents reported directly around the vicinity of the site.

It is also known that upgrading works are ongoing by NWL in the Boldon Flats area on the sewerage infrastructure although this will not directly affect the development site.

There are no public sewers that cross the site, the nearest sewers are located in the surrounding road network, Moor Lane to the west and Whitburn Road to the north which are owned and maintained by Northumbrian Water Limited (NWL) who are the local sewerage undertaker, see Figure 3 NWL Sewer Plan Extract.

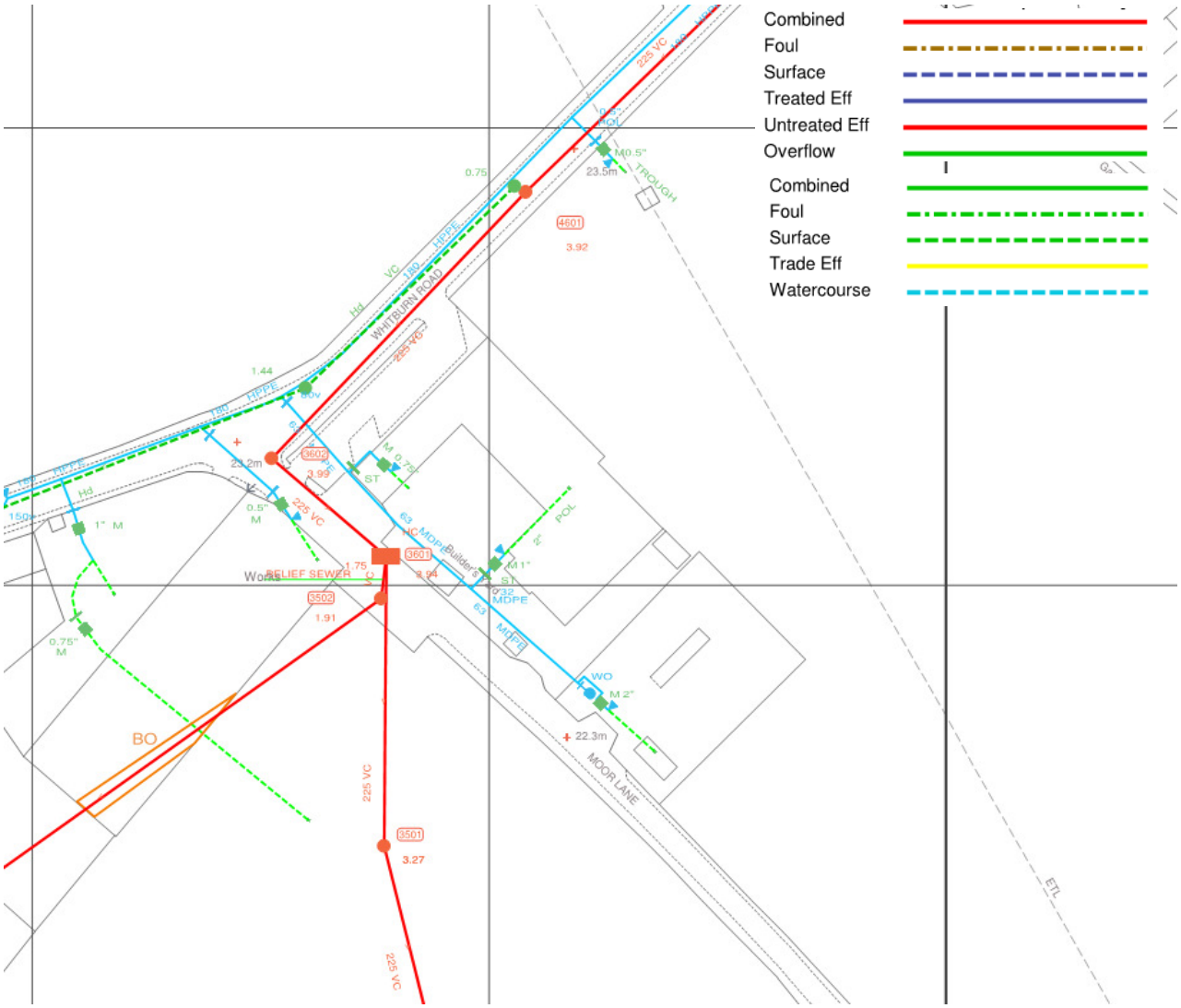


Figure 3 NWL Sewer Plan Extract (Full map in Appendix 2)

4. Proposed Drainage

Refer to Appendix 5 & 6 for proposed drainage drawings and calculations.

Both Northumbrian Water Limited and the South Tyneside Council LLFA were consulted as part of the development proposals.

4.1 NWL Consultation

A pre-development enquiry has been made to Northumbrian Water Limited regarding the disposal of foul and surface water and the response received is in Appendix 3. Summary points from NWL are listed below;

- With regards to storm water discharge, the LLFA should be contacted. The site should first look to discharge storm water direct to the watercourse to the south of the development or look to utilise infiltration methods if possible. If these options are not viable then connection could be made to the NWL combined sewer network in Moor Lane at a restricted rate of 5 l/s (MH 3601 or 3602).

- The estimated foul flow of 0.82 l/s can discharge without restriction into the combined sewer network in Moor Lane (MH 3601 or 3602)

4.2 LLFA Consultation

In addition to the pre-development enquiry to NWL, contact was made with the South Tyneside LLFA to determine specific site requirements for SuDS, surface water runoff from the site and also Flood Risk Assessment criteria. Refer to report 1015049-CL-RPT-001 for additional details. A meeting was held with the LLFA on Thursday 30th April with the following items discussed in relation to the proposed development:

- Storm water should follow a hierarchy of discharge with investigation into first infiltration, second to the watercourse to the south and then to the sewers (pending viability, practicality or reasonableness).

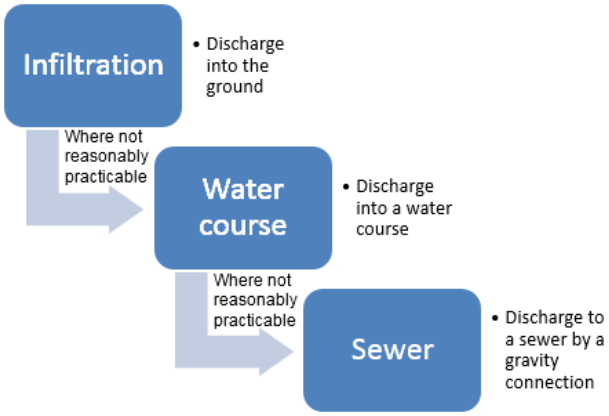
- Greenfield Runoff Rate should be targeted for the storm water discharge offsite, or as low as practicable with a target of 5 l/s.

- SuDS should be incorporated to as close to source as possible.

- Attenuation will be required for up to and including the 1 in 100 year plus 40% climate change design storm.

4.3 Surface Water

Building Regulations Approved Document H gives a hierarchy of how surface water should be disposed of, see hierarchy image to right. Firstly, surface water should be discharged into the ground. If this is not reasonably practicable, to a watercourse and where this is not reasonably practicable, to a surface water sewer and lastly to a combined water sewer.



The site is considered to be unsuitable for soakaways due to the low permeability of the underlying ground (as referenced in the Phase I & Phase II Geo-Environmental Site Investigation and Risk Assessment by Roberts Environmental Ltd, 161107.R.001).

A direct connection to the nearby watercourse was targeted although after investigation it was found that a gravity connection would not be possible. This was verified by a detailed topographical survey, see Figure 4. The watercourse that was identified was 100m to the south of the site boundary although it is only a shallow stream. See the photograph in Figure 5.

In investigating a potential route for the storm water, it would have to route through the Moor Lane carriageway from the site, south towards the watercourse (approximately 100m) prior to connecting into the water body. The centreline road level at the southern boundary is 20.66m AOD. The base of the ditch as it crosses under Moor Lane is 19.23mAOD with a top of ditch/embankment level of approximately 20.30mAOD. A 150mm diameter sewer discharging 5 l/s from the site would need to be laid at a gradient of between 1/60 and 1/100 to achieve required self-cleansing velocities. This would generate a fall of between 1-1.5m in the pipe length of 100m. This required fall and the required depth of sewer in the road render a gravity connection impossible. An extract of the topographical survey at the ditch crossing of Moor Lane is shown in Figure 6.

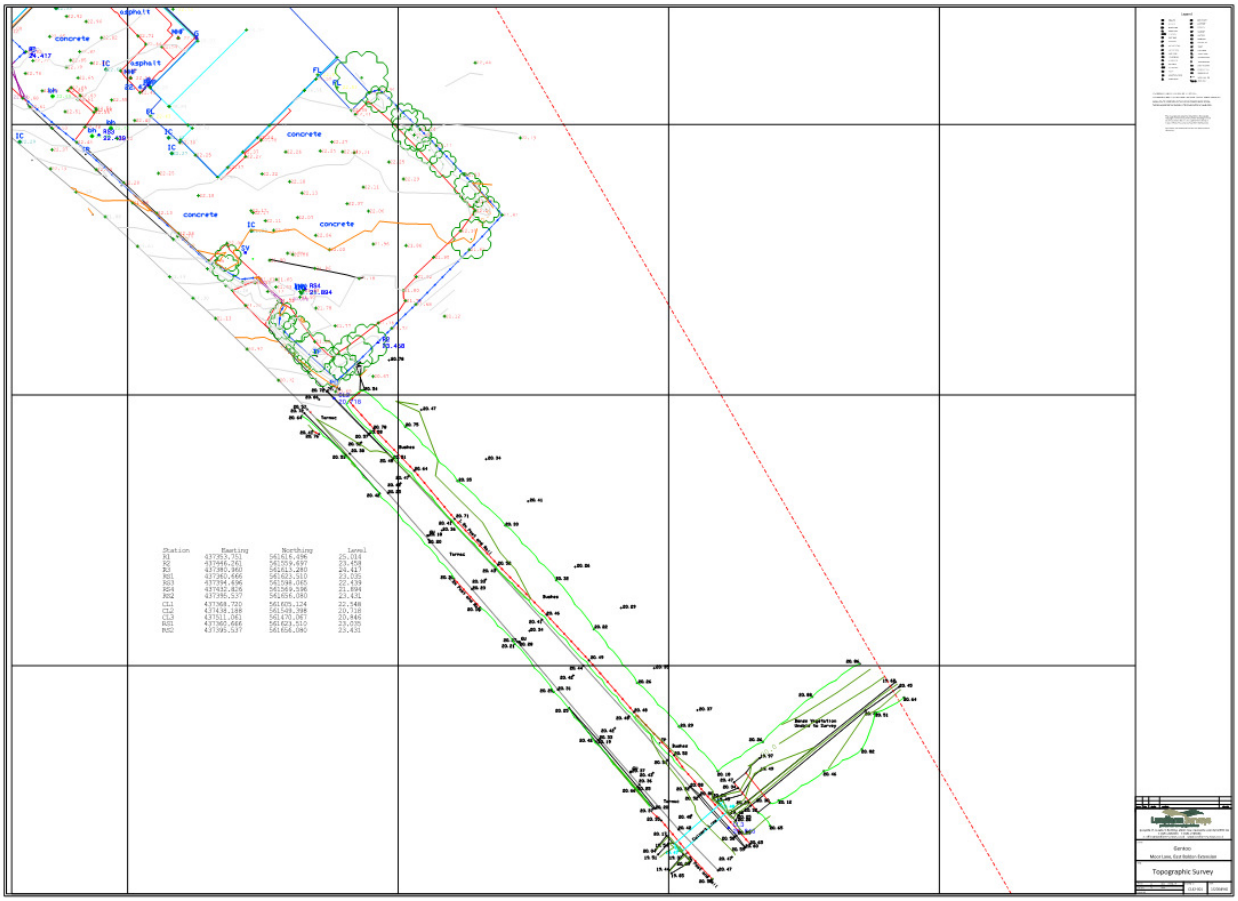


Figure 4 Extended Topographical Survey



Figure 5 Watercourse Photograph

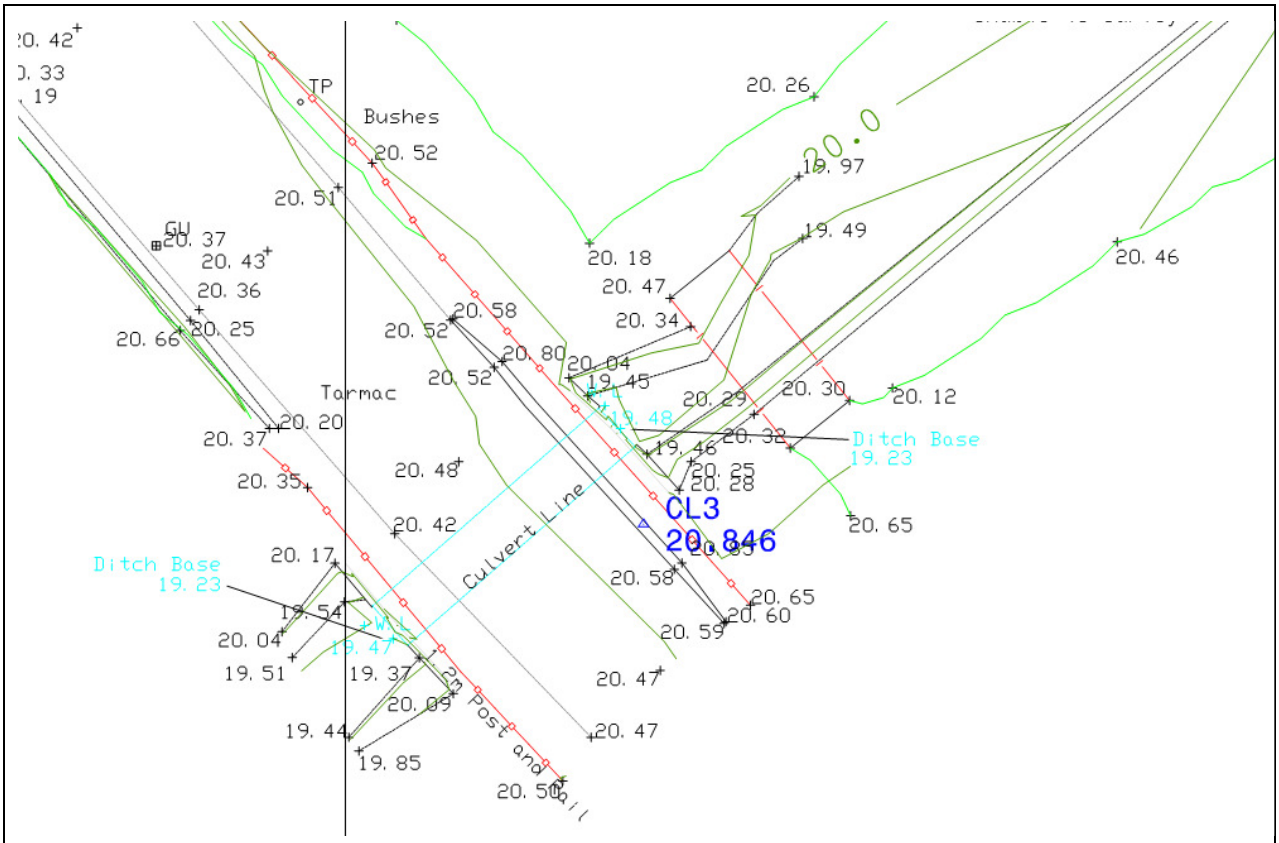


Figure 6 Extract of Topographical Survey at Watercourse Crossing

As there are no surface water sewers in the vicinity of the site, following the hierarchy, it is proposed that the surface water flows will be conveyed to the combined public sewer.

NWL have since confirmed that a storm water connection to the NWL combined sewers is acceptable at a restricted discharge rate of 5 l/s. Refer to Appendix 3.

4.3.1 Storm Water Restrictions & SuDS Strategy

Greenfield runoff for the site was calculated at the following rates using the IH124 method;

- QBar - 0.84l/s
- 1 in 1 - 0.72l/s
- 1 in 30 - 1.47l/s
- 1 in 100 - 1.75l/s

Due to the small nature of the development, the calculated Greenfield Runoff Rate above is unpracticable to restrict due to potential maintenance issues and adoption requirements from NWL. The discharge rate from the development is proposed to be restricted to a minimum practical rate of 5 l/s. This 5 l/s restriction is a massive improvement on the previous development (builders yard) discharge rates which were calculated at:

- 1 in 1 year storm – 36 l/s
- 1 in 30 year storm – 89 l/s
- 1 in 100 year storm – 116 l/s

As a brownfield redevelopment site, this is seen as a major betterment and beneficial impact to the existing sewer infrastructure and also complies with local and national policy.

The 5 l/s restriction requires attenuation to be provided within the site boundary to achieve the Local Authority SuDS Officer Organisation (LASSO, 2015), CIRIA SuDS Manual, Northumbrian Water and NPPF requirements. The on-site storage will cope with all storms up to and including the 1 in 100 year, 6-hour duration with climate change allowance of 40%.

The proposed drainage drawing in shown in Appendix X and the proposed WinDes results in Appendix 6. The WinDes/Microdrainage MDX file will also be sent electronically to the LLFA for model verification purposes.

The proposed storm water connection is to a combined NWL sewer which would generally reduce the need to maximise water quality improvement, however **source control SuDS** have been proposed to improve quality and slow down the rate of inundation.

Permeable paving is proposed to all private driveways within the development site. The permeable pavement system will be lined with an underdrain provided (and connection back to the site drainage) so as not to allow water to infiltrate into the ground. The permeable paving maintenance will be the responsibility of the tenant/home owners and the regime/requirements detailed in Section 4.3.2 will be included within homeowner packs.

Permeable pavements have been selected as they are highly compatible with residential developments and also incorporate an element of source control into the SuDS design.

A swale will be used to collect and convey the road drainage within the development site. Swales are drainage features that are usually linear vegetated depressions in which water can be stored or conveyed. A swale is being considered as not only are they attractive in terms of landscape setting but are also a good source of removing urban pollutants and have good amenity and ecological potential. The swale sides will be a maximum of 1/3 slope. The swale will be lined (by Bentotex or similar) due to the low permeability of the underlying soil but also to seal and act as protection to the neighbouring properties. The swale will sit within the private domain and be the maintenance responsibility of the private management company to the requirements detailed in Section 4.3.2.

The swale and permeable pavements will not have the capacity on their own to store the excess flows over and above the 5 l/s discharge limit. An underground attenuation tank is proposed as the main method of storage. This will be used in conjunction with a flow control device, which will likely be a vortex control which is detailed within the WinDes model. Approximately 100m³ of storage will be required.

The attenuation tank proposed is an underground cellular system which will have CCTV and jet access through pipes with manhole access up and downstream of the main flow pipe through the attenuation.

The tank will sit within the private domain and be a private asset. The tank will be managed by a private management company to the maintenance regime detailed in Section 4.3.2.

4.3.2 Operation and Maintenance Plan

The following operation and maintenance schedules should be followed for the SuDS items with reference to the CIRIA SuDS Manual (2016) for additional guidance on each element.

The permeable paving will require the following maintenance;

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Brushing and vacuuming	Three times/ year at the end of winter, mid-summer, after autumn leaf fall, or as required based on site specific observations of clogging or specific manufacturers' recommendations.
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weed	As required
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm 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	As required
	Rehabilitation of surface and upper sub-structure	As required (if infiltration performance is reduced as a result of significant clogging).
Monitoring	Initial inspection.	Fortnightly for 3 months after installation.
	Inspect for evidence of poor operation and/ or weed growth. If required, take remedial action	3 monthly, 48 hours after large storms
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually

	Monitor inspection chambers	Annually

The swale will require the following maintenance;

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Remove litter and debris	Monthly, or as required
	Cut grass - to retain grass height within the specified design range	Monthly (during growing season), or as required
	Inspect inlets and outlets for blockages and clear if required	Monthly
	Inspect vegetation coverage	Monthly for 6 months, quarterly for 2 years, then half yearly
	Inspect inlets and surface for silt accumulation, establish appropriate silt removal frequencies	Half yearly
Occasional maintenance	Reseed areas of poor vegetation growth, alter plant types to be suit conditions, if required	As required or if bare soil is exposed over 10% or more of the swale area
Remedial actions	Repair erosion or other damage by re-turfing or reseeding	As required
	Relevel uneven surfaces and reinstate design levels	As required
	Remove and dispose of oils or petrol residues using safe standard practices	As required

The attenuation tank will require the following maintenance;

Maintenance Schedule	Required Action	Frequency
Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action	Monthly for 3 months, then annually

	Remove debris from the catchment surface (where it may cause risks to the surface)	Monthly
Remedial actions	Repair/ rehabilitate inlets, outlets and vents	As required
Monitoring	Inspect/check all inlets, outlets and vents to ensure they are in good condition and operating as designed	Annually
	Survey inside of tank for sediment build-up and remove (water jet) if necessary	Every 5 years or as required

4.3.3 Adoption and Implementation Arrangement

SuDS elements were discussed within Section 4.3.1 but are summarised here.

All highway gullies and leads are to be adopted and maintained by the South Tyneside Council Highway Authority.

The road swale is to be maintained by a local private management company.

The sub-surface attenuation (storage tank) is to be maintained by a local private management company.

The permeable paving to the car parking areas are to be maintained by the associated homeowner/tenant.

It is envisioned that the local sewerage authority (Northumbrian Water Limited) will adopt the sewer infrastructure upstream and downstream of the attenuation tank, including the flow control restriction.

NWL will also adopt the foul water sewerage infrastructure.

4.3.4 Health and Safety Audit

The SuDS Manual (CIRIA C753) states that swales are generally applicable to most types of development, and can be used in both residential and non-residential areas.

The side slopes recommended in the SuDS manual are 1 in 4. Generally, 1 in 4 has been adopted in the design of the swale to allow easy access to and from the swale for maintenance and inspections. Grass cutting (should this be required) and maintenance of the slopes are considered practicable on the 1 in 4 slopes given the infrequent and limited extent of the works required.

4.4 Foul Water

The peak foul water flow from the development will be around 0.82 l/s. NWL have confirmed they can accommodate this flow without restriction into manholes 3601 or 3602.

5. Conclusion

5.1 Surface Water

Surface water will be restricted to 5 l/s with discharge to the NWL combined sewer in Moor Lane.

Approval has been granted by NWL for the discharge.

SuDS have been proposed in the form of permeable paving and swales.

Attenuation is proposed in the form of an underground cellular system to provide storage for all events up to and including the 1 in 100 year plus 40% climate change design storm event.

Maintenance schedules for all SuDS elements have been included.

5.2 Foul Water

Foul water will discharge unrestricted into the NWL combined sewer in Moor Lane.

Approval has been granted by NWL for the discharge.

6. Appendices

Appendix 1

UKSuDS Greenfield Runoff Calculations

Appendix 2

Northumbrian Water (NWL) Sewer Plan

Appendix 3

Northumbrian Water (NWL) Pre-development enquiry response

Appendix 4

Topographical Survey

Appendix 5

Proposed Drainage Strategy Drawing

Appendix 6

Proposed Drainage Calculations

Appendix 1 - UKSuDS Greenfield Runoff Calculations

HR Wallingford
Working with water

Greenfield runoff estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by:	Leanne Christie
Site name:	Land at East Boldon
Site location:	East Boldon

This is an estimation of the greenfield runoff rate limits that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site coordinates

Latitude:	54.94781° N
Longitude:	1.41735° W

Reference:	5910618
Date:	2017-03-24T11:57:11

Methodology	IH124

Site characteristics

Total site area (ha)	0.526

Methodology

Qbar estimation method	Calculate from SPR and SAAR
SPR estimation method	Calculate from SOIL type

	Default	Edited
SOIL type	2	2
HOST class	---	---
SPR/SPRHOST	0.3	0.3

Hydrological characteristics

	Default	Edited
SAAR (mm)	627	627
Hydrological region	3	3
Growth curve factor: 1 year	0.86	0.86
Growth curve factor: 30 year	1.75	1.75
Growth curve factor: 100 year	2.08	2.08

Notes:

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

Normally limiting discharge rates which are less than 2.0 l/s/ha 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 consents are usually set at 5.0l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set in which case blockage work must be addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

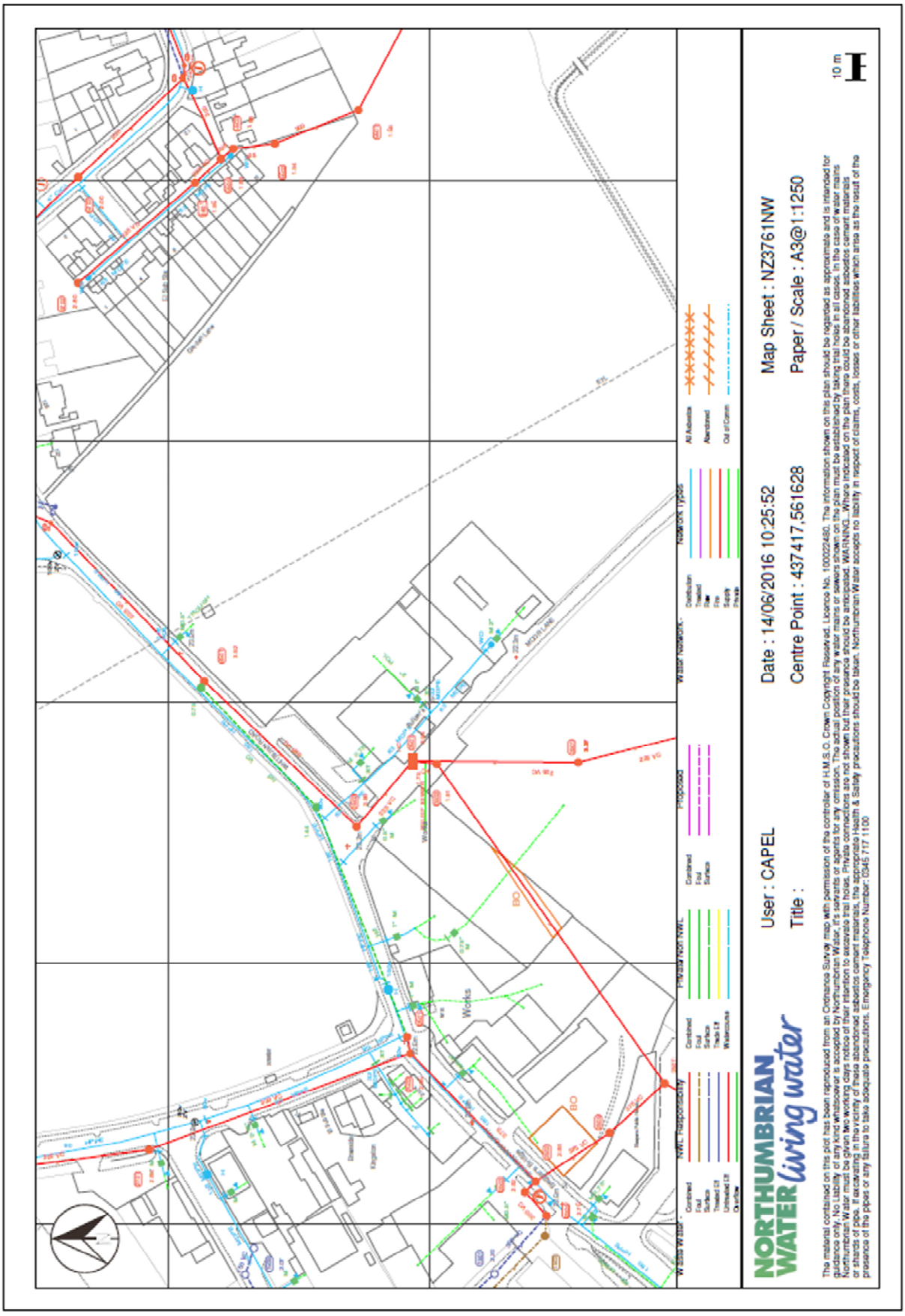
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite may be a requirement for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Qbar (l/s)	0.84	0.84
1 in 1 year (l/s)	0.72	0.72
1 in 30 years (l/s)	1.47	1.47
1 in 100 years (l/s)	1.75	1.75

This report was produced using the greenfield runoff tool developed by HR Wallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for use of this data in the design or operational characteristics of any drainage scheme.

Appendix 2 – Northumbrian Water Limited Sewer Plan



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Appendix 3 – Northumbrian Water (NWL) Pre-development enquiry response

Ext: 36646
Direct Line: 0191 419 6546
Email: developmentenquiries@nwl.co.uk
Our Ref: 17NO456761
Your Ref:

25 January 2017

Chris Leach
Gentoo Homes
Akeler House
1 Emperor Way
Doxford Int Business Prk
Sunderland
SR3 3XR

Dear Mr Leach,

Re: Pre-Development Enquiry – Dunelm House, East Boldon, Tyne & Wear

Further to the Pre-Development Enquiry for the above site, received on 6 January 2017, we are now able to provide the following response.

We have based our response on the information in your application and accompanying correspondence. Therefore, should any of the information now be different, then you must ensure that you inform us of any changes as further Network Modelling may be required and our response may also change, leading to this response being invalid.

Northumbrian Water assesses the impact of the proposed development on our assets and assesses the capacity within our network's to accommodate and treat the anticipated flows arising from the development. We do not therefore offer comment on aspects of planning applications that are outside of our area of control.

Enclosed for your information is a scaled extract showing the approximate position of our water and wastewater networks and associated assets. Please note that the actual position of any of our assets shown on the plan must be established by taking trial holes in all cases.

An appropriate risk assessment and method statement (RAMS) must be provided to us prior to gaining approval for any trial hole investigations, at least 5 working days in advance of starting any work onsite.

Also enclosed is our extract showing locations within the approximate vicinity of this site that have, from our records, experienced flooding. This has been provided to demonstrate the known flood risks within the vicinity which have been considered as part of our assessment on this enquiry.

We have also carried out a review of your application and can confirm the following:

Sewerage and Sewerage Treatment

Northumbrian Water would ask that you separate the foul and surface water flows in accordance with Part H of the Building Regulations prior to the final connection to the public sewer.

All new connections to the public sewerage system must first be approved through the Section 106 of the Water Industry Act 1991 process prior to construction.

Should you decide to proceed with this development, a fully completed Sewer Connection application form will be required. These are available to download from the following link:

https://www.nwl.co.uk/developers/new-connections.aspx

- Foul Water Discharge

The estimated foul flow of 0.82 l/sec can discharge without restriction into manhole 3601 or 3602.

- Surface Water Discharge

In applying for planning permission you will be required to demonstrate to the Local Planning Authority through your flood risk appraisal that you have considered the 3 alternative options for the management of surface water which are listed within Part H of the Building Regulations 2010:

(a) an adequate soakaway or some other adequate infiltration system; or, where that is not reasonably practicable,

(b) a watercourse; or, where that is not reasonably practicable,

(c) a sewer.

Your assessment of this will form an important part in considering our response to the planning consultation.

In this instance we have identified that the surface water flow may be able to discharge directly to the watercourse to the south of the site. We therefore suggest that you contact either the Environment agency or Lead local flood authority, as appropriate, to discuss this in further detail.

- Protection of Existing Sewerage Assets

We wish to draw your attention to the existing combined sewer which may pass through the site. This sewer could be diverted, protected or accommodated within your site layout with an appropriate easement. To discuss this in further detail, please contact Roger Perkins on 0191 419 6621 or roger.perkins@nwl.co.uk

- Sewage Treatment Capacity

The Sewage Treatment Works to which this development finally discharges to is able to accept the additional flows.

Please note that this response is valid for 1 year only and you should resubmit your proposals should this period lapse prior to your development beginning.

Should you require any further assistance or information, then please do not hesitate to contact me laura.king@nwl.co.uk or alternatively on 0191 419 6646, please quote our reference number above in any future correspondence.

Yours sincerely,

Laura King
New Development

Hi Leanne

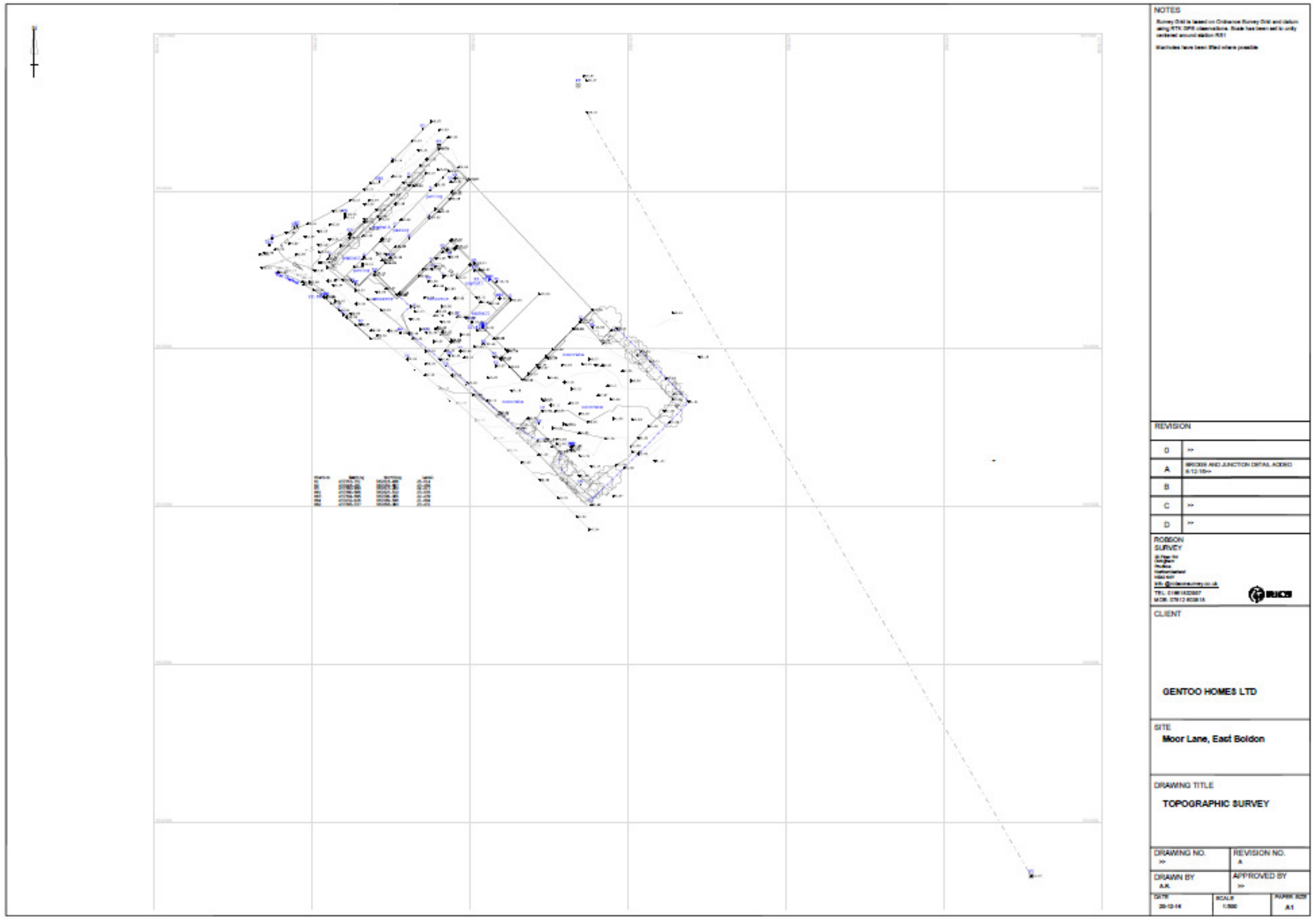
Thank you for your email. If it is not feasible to take the surface water from the site to the watercourse or utilise SuDS onsite then a restricted surface water flow of 5 l/sec could be accommodated in the existing network at manholes 3601 or 3602.

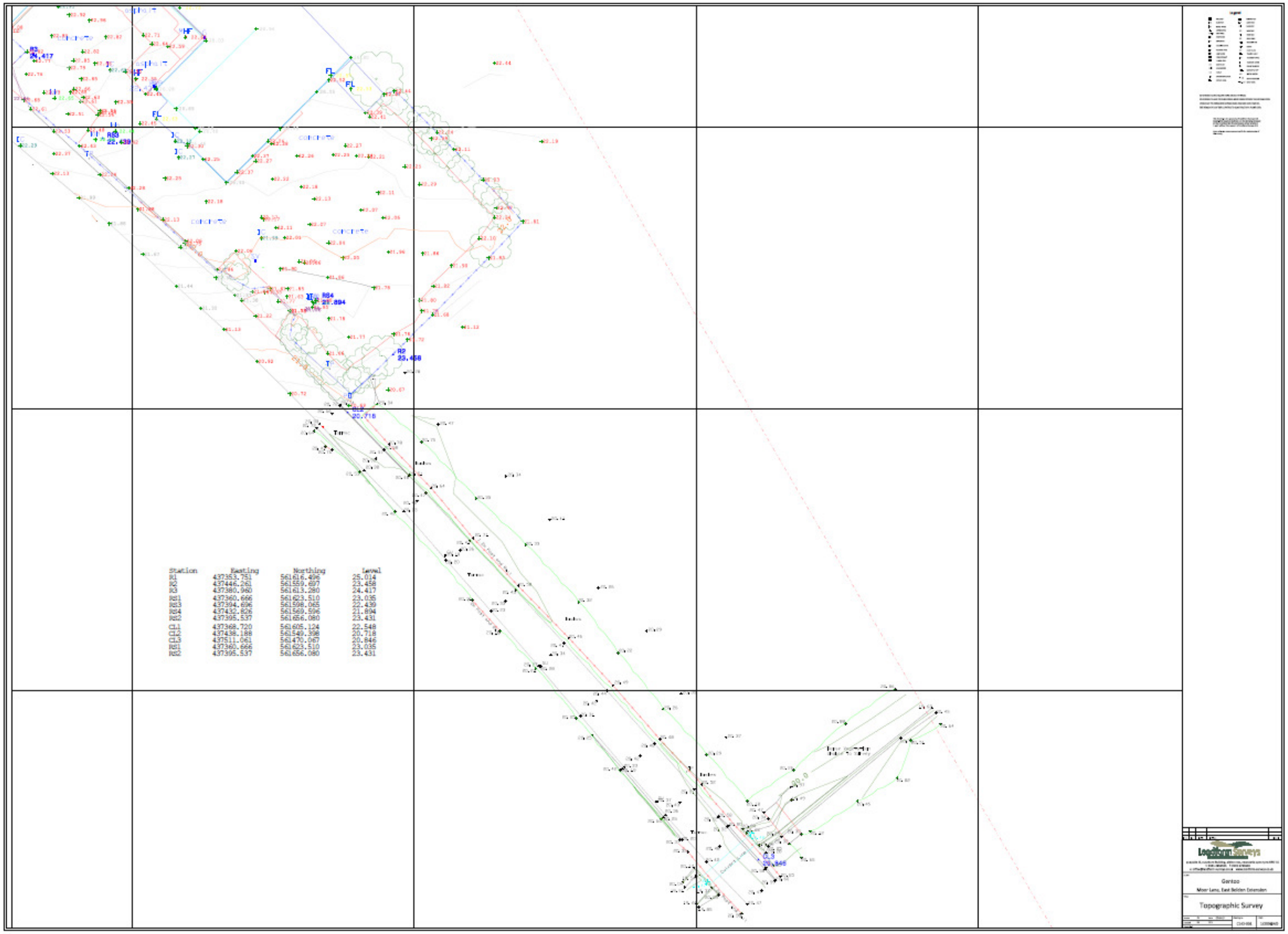
Regards

Laura King
Developer Services

Tel: 0191 4196646
Email: laura.king@nwl.co.uk

Appendix 4 – Topographical Survey





Station	Easting	Northing	Level
R1	437353.751	561616.496	25.014
R2	437446.261	561559.697	23.458
R3	437380.960	561613.280	24.417
Rd1	437360.666	561623.510	23.035
Rd3	437394.696	561598.065	22.439
Rd4	437432.826	561560.596	21.894
Rd2	437395.537	561656.080	23.431
CL1	437368.720	561605.124	22.548
CL2	437438.188	561549.398	20.718
CL3	437511.061	561470.067	20.846
Rd1	437360.666	561623.510	23.035
Rd2	437395.537	561656.080	23.431

Appendix 5 – Proposed Drainage Strategy Plan



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Appendix 6 – Proposed Drainage Calculations

Cundall, Johnston & Partners		Page 1
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

Existing Network Details for Storm

* - Indicates pipe has been modified outside of System 1

	PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
*	1.000	6.400	0.115	55.7	0.030	5.00	0.600	o	225
*	2.000	6.305	0.230	27.4	0.060	5.00	0.600	o	225
*	1.001	10.290	0.055	187.1	0.040	0.00	0.600	o	300
*	1.002	46.544	0.120	387.9	0.060	0.00	0.600	o	300
*	1.003	12.073	0.100	120.7	0.060	0.00	0.600	o	300
*	1.004	8.292	0.050	165.8	0.010	0.00	0.600	o	300
*	1.005	6.690	0.050	133.8	0.000	0.00	0.600	o	150
*	1.006	3.441	0.730	4.7	0.000	0.00	0.600	o	150

	PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
*	1.000	S0	22.250	21.510	0.515	22.100	21.395	0.480		1200
*	2.000	S4	22.200	21.000	0.975	22.100	20.770	1.105		1200
*	1.001	S1	22.100	20.695	1.105	22.260	20.640	1.320		1200
*	1.002	S2	22.260	20.640	1.320	22.960	20.520	2.140		1200
*	1.003	S3	22.960	20.520	2.140	23.000	20.420	2.280		1200
*	1.004	S5	23.000	20.420	2.280	22.850	20.370	2.180		1200
*	1.005	Tank Dummy	22.850	20.370	2.330	22.730	20.320	2.260		1200
*	1.006	S6	22.730	20.320	2.260	22.760	19.590	3.020	Hydro-Brake®	1200

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006	C1	22.760	19.590	19.590	1200	0

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Cundall, Johnston & Partners		Page 2
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	30	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	17.900	Storm Duration (mins)	30
Ratio R	0.350		

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Cundall, Johnston & Partners		Page 3
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

Online Controls for Storm

Hydro-Brake Optimum® Manhole: S6, DS/PN: 1.006, Volume (m³): 2.8

Unit Reference	MD-SHE-0098-5000-1500-5000
Design Head (m)	1.500
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Diameter (mm)	98
Invert Level (m)	20.320
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	5.0	Kick-Flo®	0.878	3.9
Flush-Flo™	0.431	4.9	Mean Flow over Head Range	-	4.3

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	3.2	1.200	4.5	3.000	6.9	7.000	10.3
0.200	4.4	1.400	4.8	3.500	7.4	7.500	10.7
0.300	4.8	1.600	5.1	4.000	7.9	8.000	11.0
0.400	4.9	1.800	5.4	4.500	8.4	8.500	11.3
0.500	4.9	2.000	5.7	5.000	8.8	9.000	11.6
0.600	4.8	2.200	6.0	5.500	9.2	9.500	11.9
0.800	4.3	2.400	6.2	6.000	9.6		
1.000	4.1	2.600	6.5	6.500	10.0		

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Cundall, Johnston & Partners		Page 4
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

Storage Structures for Storm

Tank or Pond Manhole: Tank Dummy, DS/PN: 1.005

Invert Level (m) 20.370

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	66.0	1.500	66.0	1.501	0.0

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Cundall, Johnston & Partners		Page 5
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

1 year Return Period 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 Coefficient	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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 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)	17.900	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 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)
1.000	S0	15 Winter	1	+0%	100/120 Winter				21.551
2.000	S4	15 Winter	1	+0%	100/15 Summer				21.049
1.001	S1	15 Winter	1	+0%	30/60 Winter				20.799
1.002	S2	15 Winter	1	+0%	30/30 Winter				20.771
1.003	S3	15 Winter	1	+0%	30/15 Winter				20.636
1.004	S5	60 Winter	1	+0%	30/15 Summer				20.580
1.005	Tank Dummy	60 Winter	1	+0%	1/15 Winter				20.578
1.006	S6	180 Winter	1	+0%	1/15 Summer				20.605

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S0	-0.184	0.000	0.07		3.5	OK	
2.000	S4	-0.176	0.000	0.11		7.1	OK	
1.001	S1	-0.196	0.000	0.24		14.5	OK	
1.002	S2	-0.169	0.000	0.38		19.8	OK	
1.003	S3	-0.184	0.000	0.32		25.3	OK	
1.004	S5	-0.140	0.000	0.26		16.2	OK	
1.005	Tank Dummy	0.058	0.000	0.34		4.4	SURCHARGED	
1.006	S6	0.135	0.000	0.08		4.2	SURCHARGED	

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Cundall, Johnston & Partners		Page 6
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

30 year Return Period 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 Coefficient	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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 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)	17.900	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 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)
1.000	S0	15 Winter	30	+0%	100/120 Winter				21.575
2.000	S4	15 Winter	30	+0%	100/15 Summer				21.078
1.001	S1	60 Winter	30	+0%	30/60 Winter				21.010
1.002	S2	60 Winter	30	+0%	30/30 Winter				21.002
1.003	S3	120 Winter	30	+0%	30/15 Winter				20.977
1.004	S5	120 Winter	30	+0%	30/15 Summer				20.973
1.005	Tank Dummy	120 Winter	30	+0%	1/15 Winter				20.971
1.006	S6	180 Winter	30	+0%	1/15 Summer				21.048

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S0	-0.160	0.000	0.18		8.7	OK	
2.000	S4	-0.147	0.000	0.26		17.4	OK	
1.001	S1	0.015	0.000	0.33		20.2	SURCHARGED	
1.002	S2	0.062	0.000	0.54		28.6	SURCHARGED	
1.003	S3	0.157	0.000	0.26		20.3	SURCHARGED	
1.004	S5	0.253	0.000	0.34		20.7	SURCHARGED	
1.005	Tank Dummy	0.451	0.000	0.39		5.1	SURCHARGED	
1.006	S6	0.578	0.000	0.09		4.7	SURCHARGED	

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Cundall, Johnston & Partners		Page 7
Horsley House Regent Centre, Gosforth Newcastle upon Tyne NE3 3LU		Micro Drainage
Date 13/04/2017 15:00 File 170413.mdx	Designed by h.ahmed Checked by	
Micro Drainage	Network 2015.1	

100 year Return Period 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 Coefficient	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 Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 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)	17.900	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep Fine Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 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)
1.000	S0	180 Winter	100	+40%	100/120 Winter				21.781
2.000	S4	180 Winter	100	+40%	100/15 Summer				21.781
1.001	S1	180 Winter	100	+40%	30/60 Winter				21.780
1.002	S2	180 Winter	100	+40%	30/30 Winter				21.778
1.003	S3	180 Winter	100	+40%	30/15 Winter				21.773
1.004	S5	180 Winter	100	+40%	30/15 Summer				21.768
1.005	Tank Dummy	180 Winter	100	+40%	1/15 Winter				21.765
1.006	S6	180 Winter	100	+40%	1/15 Summer				21.822

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S0	0.046	0.000	0.09		4.1	SURCHARGED	
2.000	S4	0.556	0.000	0.11		7.3	SURCHARGED	
1.001	S1	0.785	0.000	0.26		16.2	SURCHARGED	
1.002	S2	0.838	0.000	0.45		23.6	SURCHARGED	
1.003	S3	0.953	0.000	0.39		31.2	SURCHARGED	
1.004	S5	1.048	0.000	0.52		32.0	SURCHARGED	
1.005	Tank Dummy	1.245	0.000	0.46		6.0	SURCHARGED	
1.006	S6	1.352	0.000	0.09		4.9	SURCHARGED	

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