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Drainage Strategy & Design

Trumpet Road, Cleator Moor

Mr & Mrs A. Casson

Ref: K39288.DS/001

Version	Date	Prepared By	Checked By	Approved By
Original	07 July 2023	T. Melhuish	O. Sugden	O. Sugden

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FIGURES

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GLOSSARY OF TERMS

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CC	Climate Change
CCC	Cumbria County Council
DSM	Digital Surface Model
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
FFL	Finished Floor Level
FRA	Flood Risk Assessment
GIS	Geographical Information System
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
NPPF	National Planning Policy Framework
OS	Ordnance Survey
RGP	RG Parkins & Partners Ltd
SFRA	Strategic Flood Risk Assessment
SuDS	Sustainable Drainage System
UU	United Utilities

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1. INTRODUCTION

1.1 BACKGROUND

This report has been prepared by R. G. Parkins & Partners Ltd (RGP) for Mr & Mrs A. Casson in support of proposals for a residential development on Trumpet Road in Cleator Moor, in accordance with the National Planning Policy Framework [1][2].

Copeland District Council issued outline planning permission for the development in March 2021 (4/20/2043/0O1) and the following report and associated drainage drawing and supporting information is submitted to discharge the following planning conditions.

- **Condition 7**

'No development shall commence until a sustainable surface water drainage scheme including a timetable for implementation has been submitted to and approved in wring by the Local Planning Authority. No surface water shall drain directly or indirectly into the public sewer.'

- **Condition 8**

'Prior to first occupation of the development, a Sustainable Drainage Management and Maintenance Plan shall be submitted to the Local Planning Authority and agreed in writing'.

Please note that a separate document, entitled '*Operations & Maintenance Plan for Sustainable Drainage Systems'* (K39288.OM/002) has been prepared by RGP detailing the requirements for future maintenance of the drainage system.

- **Condition 9**

'No development shall commence until a Construction Surface Water Management Plan including a timetable for implementation has been submitted to and approved in writing by the Local Planning Authority'.

Please note that a separate document, entitled '*Construction Management Plan for Sustainable Drainage Systems'* (K39288.CMP/003) has been prepared by RGP detailing the requirements for future maintenance of the drainage system.

- **Condition 10**

'The development hereby approved shall be completed in accordance with the provisions of Flood Risk Assessment Ref. 17/07/914-FRA. The application for approval of reserved matters following outline approval shall include details of the mitigation of the surface water flood risk on the Application Site'.

- **Condition 15**

'Foul and surface water shall be drained on separate systems'.

2. SITE CHARACTERISATION

2.1 SITE LOCATION

The site is located to the south of Trumpet Road in Cleator Moor at National Grid Co-Ordinates 302515E 514316N (Figure 2.1).

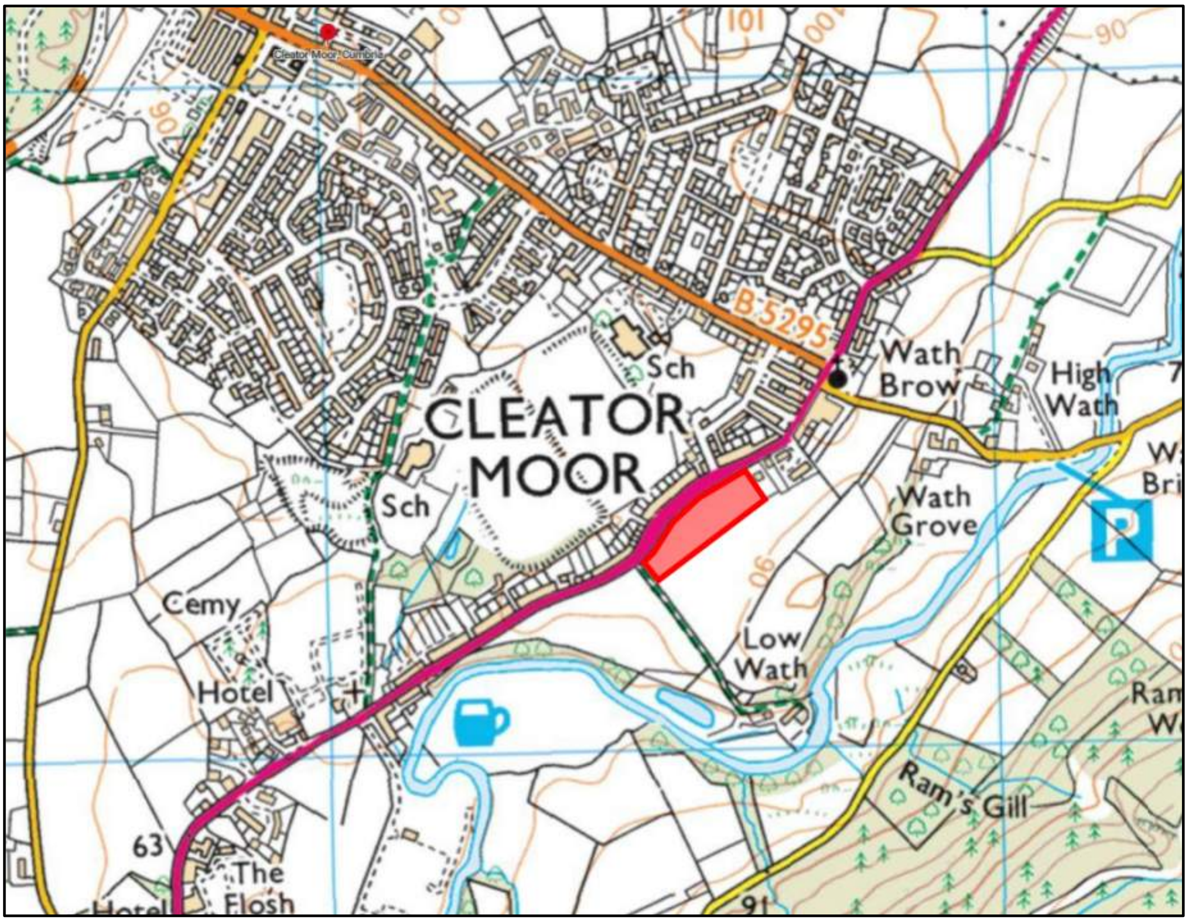

Figure 2.1 Site Location

2.2 SITE DESCRIPTION

The site is currently Greenfield and covers an area of approximately 1.15 ha (c.11,534 m^2), and at present is utilised as grazing pasture. The site is bounded by Trumpet Road and a terrace of existing properties to the north-west, existing dwellings to the north-east, additional agricultural land to the south-east, a farm access track, public right of way and further agricultural fields to the south-west.

Within the site boundary the site falls from the north-east boundary at a max. level of 86.5mAOD to the south-west boundary, with a min. level of 82.3mAOD. However, there is a localised depression located c. 70m from the south-west boundary where a min. level of 81.05mAOD is identified. It is noted from the EA Surface Water Flood Maps that this localised depression is at risk of flooding/ponding as a result of direct run-off from the land beyond the south-eastern boundary which rises up to a max. level of 90mAOD.

There is a parcel of land to the south-west which is intended to be used for an off-site surface water sewer (discussed in Section 3). This land generally falls from the north-east corner (max. level of 84mAOD to south western boundary (72.5mAOD).

2.3 GEOLOGY & HYDROGEOLOGY

British Geological Survey (BGS) [3] and Land Information Systems (LandIS) [4] mapping indicates the site is underlain by the geological sequences outlined in Table 2.1. The Defra Magic Maps [5] indicates that the site has medium-low groundwater vulnerability.

Table 2.1 Site Geological Summary

Geological Unit	Classification	Description	Aquifer Classification
Soil	Soilscape 18	Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils	N/A
Drift	Glacial Till deposits	Diamicton	Secondary
Solid	Buttermere Formation	Mudstone & Sandstone	Secondary B

2.4 HYDROLOGY

The nearest watercourse is the River Ehen c. 170m south-west of the development site.

2.5 EXISTING SEWERS

Reference to the United Utilities sewer records indicates that the nearest public sewer is a 375mm dia. combined sewer located in a paved area just off Trumpet Road. The records indicate the sewer runs in a north-west direction between nos. 19 & 20 Trumpet Road, eventually discharging into an existing 600mm dia. combined sewer. Within this location there is also a 450mm dia. public surface water sewer.

A drainage survey will be undertaken in due course to confirm the depth of the existing public combined sewer at the point of connection for foul water drainage.

2.6 SOIL INFILTRATION TESTING

In-situ soil infiltration testing was undertaken at the site on 9th July 2018 by GEO Environmental Engineering Ltd[6]. GEO were commissioned to carry out soil infiltration tests to determine whether the underlying ground conditions were suitable for infiltration-based SuDS.

The work comprised 3 no. trial pits excavated to a depth of 3 mBGL which encountered topsoil (0.2m-0.25m thick) overlying stiff sandy, gravelly CLAY. The clay generally became very stiff from c.1.5m depth. No groundwater ingress was noted. The trial pits were partially filled with water and the water level recorded on regular occasions over a two-day period. During this time, the water level remained relatively static dropping a maximum of 20mm over a 28 hour period. It was therefore not possible to calculate an infiltration rate and as such it can be concluded that the underlying ground conditions are not suitable for infiltration-based SuDS.

For further details refer to Geo Environmental Engineering Report No. GEO2018-3181[6].

3. SURFACE WATER DRAINAGE STRATEGY & DESIGN

3.1 INTRODUCTION

The principal aim of the drainage strategy is to design the development to avoid, reduce and delay the discharge of rainfall to public sewers and watercourses in order to protect watercourses and reduce the risk of localised flooding, pollution and other environmental damage.

In order to satisfy these criteria this surface water runoff assessment and drainage design has been undertaken in accordance with the following reports and guidance documents:

- SuDS Manual, CIRIA Report C753, 2015 [7]
- Code of Practice for Surface Water Management, BS8582:2013, November 2013[8]
- Rainfall Runoff Management for Developments, Defra/EA, SC030219, October 2013[9]
- Designing for Exceedance in Urban Drainage – Good Practice, CIRIA Report C635, 2006[10]
- Flood Estimation Handbook (FEH)[11]
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993[12]
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983[13]
- Flood Estimation for Small Catchments, Marshall & Bayliss, Institute of Hydrology, Report No. 124 (IoH 124), 1994[14]

The following drainage strategy is based on the latest site layout plan by Alpha Design.

3.2 SITE AREAS

The existing site area covered by the development proposals is 11,534m^2. To support the exploration of options for site drainage, the spatial extent of different types of proposed land cover on the site have been measured. Table 3.1 shows the measured proposed land cover areas.

Table 3.1 Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	Ha	
Housing roof areas	1248.5	0.125	11%
Road area	1195.0	0.120	10%
Driveway areas	823.9	0.082	7%
Paved areas	330.0	0.033	3%
Gardens & landscaped areas	7936.6	0.794	69%

To develop the detailed drainage design, only certain surfaces and areas will be positively drained into the surface water network. Positively drained areas include roof areas, driveways, access road and footways. All other areas (principally gardens & landscaping) will either have a permeable surface or will have no positive drainage. Table 3.2 summarises this and shows that positively drained areas will cover 31% of the site and permeable/undrained areas 69%.

Table 3.2 Summary of drained and undrained areas into surface water drainage system

Land Cover	Area		Percentage of total site area
	m^2	Ha	
Total Positively Drained Area	3597.4	0.358	31%
Remaining Undrained Area	7936.6	0.794	69%

3.3 SURFACE WATER DRAINAGE DESIGN PARAMETERS

The surface water drainage system has been designed on the following basis using the modified rational method and a generated rainfall profile.

3.3.1 CLIMATE CHANGE

Projections of future climate change indicate that more frequent short-duration, high intensity rainfall and more frequent periods of long-duration rainfall are likely to occur over the next few decades in the UK. These future changes will have implications for river flooding and for local flash flooding. These factors will lead to increased and new risks of flooding within the lifetime of planned developments.

The EA have provided a peak rainfall online map showing the anticipated changes in peak rainfall intensity across the UK. Climate change allowances are now provided on a catchment by catchment basis. The site falls within the South West Lakes catchment. Table 3.3 outlines the EA guidance for this catchment, for the anticipated design life of the proposed development.

In line with current guidance and for conservative design, a 50% allowance shall be used within this assessment.

Table 3.3 South West Lakes Management Catchment Peak Rainfall Allowances (1.0 AEP)

South West Lakes (1.0%AEP)	Central Allowance (%)	Upper End Allowance (%)
2050s	30	45
2070s	35	50

3.3.2 URBAN CREEP

BS 8582:2013[8] outlines best practice with regard to Urban Creep. Although not a statutory requirement, future increase in impermeable area due to extensions and introduction of impervious positively drained areas has been considered. An uplift of 10% on impermeable areas associated with dwelling roof areas has been applied to the contributing area used for surface water drainage design. This equates to an additional area of 124.85m^2 which increases the total positively drained area to 3722.25m^2.

3.3.3 PERCENTAGE IMPERMEABILITY (PIMP)

The percentage impermeability (PIMP) for all impermeable areas is modelled as 100%. The entirety of the impermeable areas is to be positively drained.

3.3.4 VOLUMETRIC RUNOFF COEFFICIENT (CV)

The volumetric runoff coefficient describes the volume of surface water which runs off an impermeable surface following losses due to infiltration, depression storage, initial wetting and evaporation. The coefficient is dimensionless. Default industry standard volumetric runoff coefficients are 0.75 for summer and 0.84 for winter and are used for design.

3.3.5 RAINFALL MODEL

The calculations use the REFH2 unit hydrograph methodology in line with best practice as outlined in the SuDS Manual[7]. The calculations use the most up to date available catchment descriptors (2013) provided by the Centre for Ecology and Hydrology Flood Estimation Handbook web service.

3.4 PRE-DEVELOPMENT GREENFIELD RUNOFF ASSESSMENT

As the site covers an area of less than 200 ha the Greenfield calculations have been undertaken in accordance with methodology described in IoH 124[14]. For catchments of less than 50 ha the Greenfield runoff rate is scaled according to the size of the catchment in relation to a 50-hectare site. The calculation has been based on the total proposed positively drained area of 3597.4m^2, as summarised in Table 3.2.

Full details of the calculations and the methodology for deriving the Peak Rate of Runoff are in included in Appendix B, and a summary included in Table 3.4.

Table 3.4 Pre-Development Greenfield Runoff Rates

Rate of Runoff (l/s)	
Event	**Greenfield**
Q1	3.0
QBAR	3.5
Q10	4.8
Q30	5.9
Q100	7.2
Q100 +50% CC	10.8

3.5 SURFACE WATER DISPOSAL

Surface water disposal has been considered in line with the hierarchy outlined in the SuDS Manual[7]. The approach considers infiltration drainage in preference to disposal to watercourse, in preference to discharge to sewer.

3.5.1 DISPOSAL BY INFILTRATION

Infiltration testing undertaken at the site by GEO Environmental Engineering confirmed that the ground is not sufficiently permeable to facilitate soakaway drainage. For further information refer to Section 2.6.

3.5.2 DISPOSAL TO WATERCOURSE

The nearest watercourse is the River Ehen, c. 170m to the south of the site. Direct discharge into the river from within the parcel of land that the development is in is unfeasible, since the ground level rise by c. 8 – 9m towards the southern boundary.

Therefore, an alternative off-site drainage route with discharge towards the River Ehen has been investigated. This culminated in a site visit and walkover survey with the landowner of the neighbouring field to the south-west of the development site on 14th April 2022. As noted in Section 2.2 and photographs included in Appendix C, this neighbouring field has a different topography and slope compared to the development site, with the ground sloping down towards the River Ehen along the southern boundary. Beyond the southern boundary the ground banks down sharply through a woodland area with the river running at the base of the embankment.

It was identified that there was an existing stone culvert land drainage system discharging at the site boundary. A stone headwall was located and discharged into a profiled open channel or gully through the woodland area and down the slope and towards the River Ehen.

3.6 SURFACE WATER DRAINAGE DESIGN

Full details of the drainage proposals are included on the RGP drawings in Appendix A.

3.6.1 GEOCELLULAR ATTENUATION TANK

It is proposed that surface water runoff from all positively drained areas will be attenuated within a single geocellular tank located under the access road to the front of Plots 7 and 8. A silt trap manhole (S04) will be located upstream of the tank, which will provide surface water treatment and access for maintenance. Silt traps isolate silt and other particles by encouraging settlement into removal silt buckets, preventing ingress into the tank. The tank will be founded at a suitable level providing a minimum depth of cover of 825mm over the top.

Geocellular attenuation tanks provide high void ratios (95%), resulting in a high storage volume capacity. They are lightweight, easy to install, robust and are also capable of managing high-flow events.

The tank will be fully accessible via access turrets and a row of inspections cells to facilitate future access and maintenance. A flow control chamber (S07) incorporating a Hydrobrake will be located downstream of the attenuation tank restricting discharge to the greenfield runoff rate (QBAR) of 3.5 lit/sec with the following specification:

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- Ref = SHE-0092-3500-0800-3500
- Max. discharge rate = 3.5 lit/sec
- Design head = 0.8m
- Orifice size = 92mm dia.

3.6.2 STORAGE VOLUME IN TANK

The drainage design has been sized to convey and attenuate runoff during a Q100 event plus a 50% allowance for future climate change to ensure adequate drainage over the design life of the development (100 years).

The drainage system has been modelled using Causeway FLOW using FEH catchment descriptors to model the rainfall and determine the volume of attenuation required. To contain the 100-year design storm, including a 50% climate change design storm flows, the storage volume outlined in Tables 3.5 is required.

Table 3.5 Storage Requirement (Geocellular Storage)

Tank Depth (m)	Discharge Rate (lit/sec)	Tank Dimensions (m)	Storage Requirement (m^3)
0.8	3.5	36 x 8	219

The critical storm event has been calculated to be the 480 min summer storm and under this event the water level within the tank will be 0.8m. A copy of the calculations is included in Appendix B.

3.6.3 HYDRODYNAMIC SEPARATOR

A Hydrodynamic Separator will be installed downstream of the flow control chamber to provide an enhanced level of treatment of flows prior to offsite discharge into the downstream highways drainage network and watercourse.

3.6.4 FILTER DRAINS TO ACCESS ROADS & DRIVEWAYS

The access roads and car parking areas will be constructed using conventional surfacing in the form of asphalt and block paving. The access roads and driveways will fall towards linear filter drains running parallel alongside the areas of hardstanding. The filter drains will comprise a 600mm wide by min. 500mm deep stone filled trench with a perforated 150mm dia. pipe laid in the bottom. The filter drain trench will be wrapped in a permeable geomembrane to prevent silt entering the stone matrix. The filter drains will provide an enhanced level or treatment to contaminated run-off from roads and driveways by helping to trap and remove suspended solids and hydrocarbons. The filter drains will discharge run-off into the surface water drainage network upstream of the main silt trap manhole (S04).

3.6.5 OFFSITE SURFACE WATER PIPELINE

It is proposed that a new c. 220m long by 150mm dia. offsite surface water drainage pipe will be installed through the neighbouring site to convey attenuated surface water runoff from the development towards the existing land drainage outfall at the field boundary. The final 30m section of 150mm dia. pipe will be half-perforated (slots facing up) to enable any existing land drainage to discharge into the outlet pipe. Likewise, any existing land drainage pipes that are encountered during installation will be connected into the new half-perforated 150mm dia. outlet pipe.

3.6.6 OUTLET HEADWALL

A new outlet headwall is proposed at the field boundary and will be constructed in in-situ concrete and finished with stone pitching to the wingwalls and spillway. Precast concrete lintels will be placed over the top of the outlet headwall to enable the structure to be backfilled with topsoil and returned to agricultural land without any loss of land, or risk of livestock falling into the structure.

3.7 DESIGNING FOR LOCAL DRAINAGE SYSTEM FAILURE

In accordance with the general principles discussed in CIRIA Report C635 – Designing for Exceedance in Urban Drainage [10] the proposed surface water drainage, where practical, should be designed to ensure there is no increased risk of flooding to the proposed dwellings on the site or elsewhere as a result of extreme rainfall, lack of maintenance, blockages or other causes. These measures are discussed below.

3.7.1 BLOCKAGE & EXCEEDANCE

The sustainable drainage system has been designed to attenuate a 100-year design storm including a 50% allowance for climate change. The drainage system will also provide capacity for lower probability (greater design storm events) which are not critical duration.

Based on the existing topography, overland flows from the higher land to the south of the development follow the contours towards the existing localised depression (min. level of c.81.05mAOD) near the northern boundary. Uncontrolled surface water run-off then spills directly onto Trumpet Road where the lowest road level is c. 80.895mAOD. There are a series of existing road gullies in this location, presumably installed by the Highways Authority to help deal with this existing problem.

As part of the development proposals, this existing run-off route will be preserved, allowing excess run-off from the undeveloped land to the south of the rear gardens to be directed down the corridor of land between Plots 6 and 7 toward the field access gate and then onto the new access road. The new access road will fall towards Trumpet Road. To prevent upland flows running through rear gardens and towards the rear of the new properties a 300mm high earth bund is proposed at the back of the rear garden fenceline.

Any blockage or exceedance from the geocellular attenuation tank would result in the silt trap manhole (S04) surcharging first as this chamber as the lowest cover level (i.e. 81.382mAOD). Flood flows would then follow the same exceedance route towards the site entrance and Trumpet Road. The lowest proposed finished floor level is 82.000mAOD for Plots 7 & 8 and it can therefore be concluded that none of the new dwellings will be at risk of flooding from overland flows of blockage/exceedance of the surface water drainage system.

3.7.2 PROPOSED EXTERNAL LEVELS & GRADIENTS

The road and driveway gradients and levels have been designed to ensure that flood flows are conveyed away from dwellings should the SuDS and drainage system fail, flood or exceed capacity.

3.7.3 BUILDING LAYOUT & DETAIL

The finished floor levels to the new dwellings have been designed and situated to ensure that they are not at risk of flooding from overland flow. Threshold levels have been set 150mm above external paved areas, and external footpaths and driveways fall away from the thresholds, ensuring that any flood water runs away from, rather than towards the dwellings.

3.8 SURFACE WATER TREATMENT

The treatment of surface water is not a statutory requirement. Water quality remains a material consideration but there are no prescriptive standards to be imposed in terms of treatment train management. In the absence of a design standard, the SuDS manual has been used which outlines best practice.

Pollutants such as suspended solids, heavy metals and organic pollutants may be present in surface water runoff, the quantity and composition of the runoff is highly dependent upon site use. For housing developments, the pollutant load is very low. The SuDS Manual[7] outlines best practice with regards to treatment of surface water by SuDS components prior to discharge to the environment. SuDS components can be effective in reducing the amount of pollutants within the surface water discharged and therefore environmental impact of the development. SuDS components may be installed in series to form a treatment train to treat the runoff.

It is proposed to install a StormCleanser™ hydrodynamic separator by FP McCann downstream of the Hydrobrake chamber to ensure surface water is treated prior to discharge to the highways drainage system, and thereby the River Ehen. Furthermore, the run-off from the access roads and driveways will pass through filter drains first before passing through the attenuation tank and hydrodynamic separator, resulting in two stages of treatment.

Table 3.6 – Table 3.8 summarise the pollution hazard and mitigation indices for each type of runoff.

Table 3.6 Pollution Hazard & Mitigation Indices - Roof Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.2	0.2	0.05
Pollution Mitigation – Hydrodynamic Separator	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

Table 3.7 Pollution Hazard & Mitigation Indices - Driveways Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation 1 – Filter Drain	0.4	0.4	0.4
Pollution Mitigation 2 – Hydrodynamic Separator	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

Table 3.8 Pollution Hazard & Mitigation Indices - Road Areas

Indices	Suspended Solids	Metals	Hydrocarbons
Pollution Hazard	0.5	0.4	0.4
Pollution Mitigation 1 – Filter Drain	0.4	0.4	0.4
Pollution Mitigation 2 – Hydrodynamic Separator	0.5	0.4	0.8
Treatment Suitability	**Adequate**	**Adequate**	**Adequate**

3.9 OPERATIONS & MAINTENANCE RESPONSIBILITY

All on site drainage will remain private and will be maintained by the site owner in the first instance, and then a third-party management company. An '*Operations & Maintenance Plan'* (K39288.OM/002) has been prepared by RGP detailing the requirements for future maintenance of the drainage system.

4. FOUL WATER DRAINAGE STRATEGY

It is proposed that foul water from the development shall be drained via private gravity foul water plot drainage towards a new adoptable foul sewer located within the access road. Off-site discharge will be into the existing public combined sewer system located c.43 down Trumpet Road to the south-west.

Foul water discharge calculations have been undertaken for the 11 no. dwellings, in accordance with the Design and Construction Guidance for Foul and Surface Water Sewers [17], as shown in Table 4.1.

Table 4.1 Peak Foul Flow Rates

Sewerage Sector Design & Construction Guidance Clause B3.1	
Peak Load based on Number of Dwellings, 11 no. units @ 4000 l/day	44,000
Peak Flow Rate from Site (l/s)	0.51

The estimated peak foul flow rate for the development is 0.51 lit/sec. For further details, refer to the Drainage Layout Plan included in Appendix A.

5. CONCLUSIONS AND RECOMMENDATIONS

The proposed Drainage Strategy can be summarised as follows:

- Soil infiltration testing undertaken on 9th July 2023 by GEO Environmental Engineering Ltd concluded that the site is not suitable for infiltration-based SuDS drainage and an off-site surface water drainage solution is required.

- It is proposed that surface water runoff from positively drained areas will be attenuated within a geocellular attenuation tank, measuring 36m x 8m x 0.8m deep, thereby providing 219m^3 of storage within the site.

- A flow control chamber incorporating a Hydrobrake will be located downstream of the geocellular tank restricting discharge to the greenfield development QBAR runoff rate of 3.5 lit/sec.

- The access roads and driveways will be constructed using conventional surfacing in the form of asphalt and block paving respectively. The access roads and driveways will fall towards filter drains which will provide an enhanced level of pre-treatment and convey flows towards the geocellular tank.

- Attenuated discharge from the site shall be via an off-site surface water pipeline through the neighbouring land and into the existing land drainage system that discharges at the boundary into an open channel running through the woodland and into the River Ehen. A site visit with the landowner has confirmed that these proposals will be acceptable.

- Treatment of surface water is proposed by both filter drains (for access roads and driveways) and a proprietary Hydrodynamic Separator, located downstream of the flow control chamber. An upstream silt trap will also help to remove any potential pollutants and silt from entering the tank. The tank will be fully accessible via access turrets and inspections cells to facilitate future access and maintenance.

- A 300mm high earth bund will be formed at the back and sides of the rear gardens of the new dwellings to prevent existing uplands overland flows running into and through new gardens.

- It is proposed foul water drainage shall discharge via a new off-site gravity sewer into the existing downstream public combined water sewer in Trumpet Road. The new foul sewer will be offered for adoption to United Utilities under a S104 Agreement.

6. REFERENCES

[1] Ministry of Housing, Communities and Local Government, National Planning Policy Framework, July 2018.

[2] Ministry of Housing, Communities and Local Government, Planning Practice Guidance to the National Planning Policy Framework, December 2022

[3] British Geological Survey, 2022. Geoindex. http://mapapps2.bgs.ac.uk/geoindex/home.html

[4] Land Information System (LANDIS)- Soilscapes viewer, Accessed December 2022 http://www.landis.org.uk/soilscapes

[5] Defra Magic Maps, 2022. https://magic.defra.gov.uk/MagicMap.aspx.

[6] GEO Environmental Engineering Ltd, July 2018. GEO2018-31811: Trumpet Road, Cleator Moor – BRE365 Permeability Assessment.

[7] CIRIA, The SuDS Manual, Report C753, 2015.

[8] BS8582:2013, Code of Practice for Surface Water Management, November 2013.

[9] DEFRA/EA, Rainfall Runoff Management for Developments, SC030219, October 2013.

[10] CIRIA, Designing for Exceedance in Urban Drainage – Good Practice, Report C635, London, 2006.

[11] Centre for Ecology and Hydrology, Flood Estimation Handbook, Vols. 1 – 5 & FEH CD-ROM 3, 2009.

[12] Institute of Hydrology, Flood Studies Report, Volume 1, Hydrological Studies, 1993.

[13] Institute of Hydrology, Flood Studies Supplementary Report No 14 – Review of Regional Growth Curves, August 1983.

[14] Marshall & Bayliss, 1994. Flood Estimation for Small Catchments, Report No. 124 (IoH 124), Institute of Hydrology.

[15] Department for Environment, Food and Rural Affairs, Non-Statutory Technical Standards for Sustainable Drainage Systems, March 2015

[16] Innovyze, 2022, Micro Drainage Source Control

[17] Water UK, Design and Construction Guidance for Foul & Surface Water Sewers Offered for Adoption Under the Code for Adoption Agreements for Water and Sewage Companies Operating Wholly or Mainly in England, Approved Version 10, October 2019

APPENDIX A

DRAWINGS

Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: Approval

Do not scale from this drawing

R G PARKINS
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Scale @ A1:	1:250
First Issue:	06/07/23
Office of Origin:	Kendal
Drawn by:	SR
Checked by:	TM
Approved:	TM
Client:	Mr & Mrs A. Casson
Project:	Trumpet Road, Cleator Moor
Drawing Title:	Foul & Surface Water Drainage Plan - On-site Layout
Project No:	K39288
Drawing No:	10
Rev:	
BIM No:	

Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: Approval

Do not scale from this drawing

R G PARKINS
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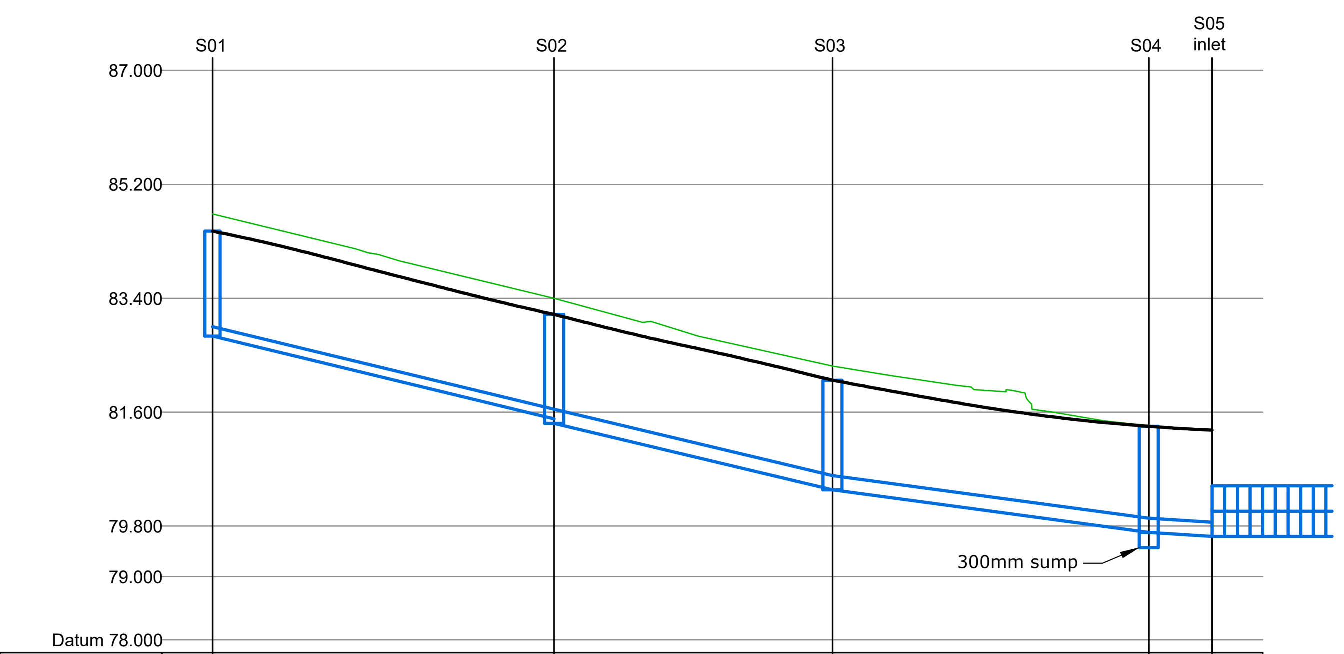
Scale @ A1: 1:250	First Issue: 06/07/23	Office of Origin: Kendal	
Drawn by: SR	Checked by: TM	Approved: TM	
Project No: K39288	Drawing No: 11	Rev:	

Client: Mr & Mrs A. Casson

Project: Trumpet Road, Cleator Moor

Drawing Title: Foul & Surface Water Drainage Plan - Off-site Layout

BIM No:



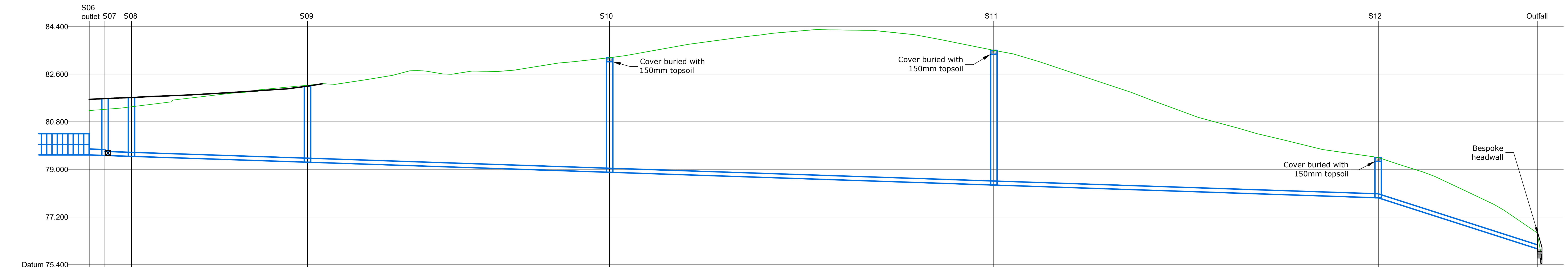
Link Name	PN1.000		PN1.001		PN1.002		PN1.003	
Section Type	150mm		225mm		225mm		225mm	
Slope (1:X)	20.7		21.0		37.2		76.9	
Existing Level	84.734		83.399		82.330		81.390	81.322
Cover Level	84.460		83.144		82.105		81.382	81.316
Invert Level	82.800		81.495 81.420		80.372 80.372		79.700 79.700	79.635
Length	27.000		22.000		25.000		5.000	
Pipe Bedding	Type 7 - Embedment Class S							

Longitudinal Section along Surface Water PN1.000-PN1.003

Scale 1:500 horizontal 1:100 vertical

Pipeline Schedule: Storm Network 1																		
Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth	DS CL (m)	DS IL (m)	DS Depth	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
PN1.000	27.000	20.7	150	Circular	84.460	82.800	1.510	83.144	81.495	1.499	S01	1200	Manhole	PCC	S02	1500	Manhole	PCC
PN1.001	22.000	21.0	225	Circular	83.144	81.420	1.499	82.105	80.372	1.508	S02	1500	Manhole	PCC	S03	1500	Manhole	PCC
PN1.002	25.000	37.2	225	Circular	82.105	80.372	1.508	81.382	79.700	1.450	S03	1500	Manhole	PCC	S04	1500	Manhole	PCC
PN1.003	5.000	76.9	225	Circular	81.382	79.700	1.450	81.316	79.635	1.456	S04	1500	Manhole	PCC	S05 inlet		Junction	
PN2.000	3.000	150.0	225	Circular	81.594	79.545	1.824	81.623	79.525	1.873	S06 outlet		Junction		S07	1200	Manhole	PCC
PN2.001	5.000	151.5	150	Circular	81.623	79.525	1.948	81.687	79.492	2.045	S07	1200	Manhole	PCC	S08	1200	Manhole	PCC
PN2.002	33.500	150.2	150	Circular	81.687	79.492	2.045	82.146	79.269	2.727	S08	1200	Manhole	PCC	S09	1200	Manhole	PCC
PN2.003	57.000	150.0	150	Circular	82.146	79.269	2.727	83.220	78.889	4.181	S09	1200	Manhole	PCC	S10	1200	Manhole	PCC
PN2.004	72.500	150.1	150	Circular	83.220	78.889	4.181	83.500	78.406	4.944	S10	1200	Manhole	PCC	S11	1200	Manhole	PCC
PN2.005	72.500	150.1	150	Circular	83.500	78.406	4.944	79.449	77.923	1.376	S11	1200	Manhole	PCC	S12	1200	Manhole	PCC
PN2.006	30.932	12.6	150	Circular	79.449	77.923	1.376	77.000	75.461	1.389	S12	1500	Manhole	PCC	Outfall		Junction	

Manhole Schedule: Storm Network 1																
Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Node Type	MH Type	Connections		Link	IL (m)	Dia (mm)	Link Type	Manhole DCG code	Cover slab opening	Cover type
S01	302606.193	514392.392	84.460	1.660	1200	Manhole	PCC		0	PN1.000	82.800	150	Circular	Figure B10 Type B	600x750	D400 600x600
S02	302584.273	514376.628	83.144	1.724	1500	Manhole	PCC		1 2 0	PN1.000 Plot PN1.001	81.495 81.495 81.420	150 150 225	Circular Circular Circular	Figure B10 Type B	600x750	D400 600x600
S03	302563.571	514369.184	82.105	1.733	1500	Manhole	PCC		1 2 0	PN1.001 Plot PN1.002	80.372 80.447 80.372	225 150 225	Circular Circular Circular	Figure B10 Type B	600x750	D400 600x600
S04 Silt Trap 300mm sump	302546.015	514351.385	81.382	1.682	1500	Manhole	PCC		1 2 3 4 0	PN1.002 Plot Gully Gully PN1.003	79.700 79.700 79.775 79.775 79.700	225 225 150 150 225	Circular Circular Circular Circular Circular	N/A	600x750	D400 600x600
S05 Tank Inlet	302542.450	514347.879	81.316	1.681		Junction			1	PN1.003	79.635	225	Circular			
S06 Tank outlet	302516.795	514322.645	81.594	2.049		Junction			0	PN2.000	79.545	225	Circular			
S07 Flow Control	302514.656	514320.541	81.623	2.098	1200	Manhole	PCC		1 0	PN2.000 PN2.001	79.525 79.525	225 150	Circular Circular	N/A	600x750	D400 600x600
S08 Hydrodynamic Separator	302511.860	514316.396	81.687	2.195	1200	Manhole	PCC		1 0	PN2.001 PN2.002	79.492 79.492	150 150	Circular Circular	N/A	600x750	D400 600x600
S09	302493.116	514288.640	82.146	2.877	1200	Manhole	PCC		1 0	PN2.002 PN2.003	79.269 79.269	150 150	Circular Circular	Figure B10 Type B	600x750	D400 600x600
S10	302446.346	514256.059	83.220 (83.07)	4.331	1200	Manhole	PCC		1 0	PN2.003 PN2.004	78.889 78.889	150 150	Circular Circular	Figure B6 Type A2	600x750	D400 600x600 Buried
S11	302378.986	514229.246	83.500 (83.35)	5.094	1200	Manhole	PCC		1 0	PN2.004 PN2.005	78.406 78.406	150 150	Circular Circular	Figure B6 Type A2	600x750	D400 600x600 Buried
S12	302311.626	514202.434	79.449 (79.30)	1.526	1200	Manhole	PCC		1 0	PN2.005 PN2.006	77.923 77.923	150 150	Circular Circular	Figure B15 Type C	600x750	D400 600x600 Buried
Outfall	302305.828	514172.050	77.000	1.539		Junction			1	PN2.006	76.000	150	Circular			



Link Name	PN2.000	PN2.001	PN2.002	PN2.003	PN2.004	PN2.005	PN2.006	
Section Type	225	150mm	150mm	150mm	150mm	150mm	150mm	
Slope (1:X)	150	151.5	150.2	150.0	150.1	150.1	16	
Existing Level	81.223	81.269	81.365	82.178	83.220	83.500	79.449	77.000
Cover Level	81.594	81.623	81.687	82.146	83.220	83.500	79.449	77.000
Invert Level	79.545 79.525	79.525	79.492 79.492	79.269 79.269	78.889 78.889	78.406 78.406 72.500	77.923 77.923 30.000	76.000
Length	3.000	5.000	33.500	57.000	72.500			
Pipe Bedding	Type 7 - Embedment Class S							

Longitudinal Section along Surface Water PN2.000-PN2.006

Scale 1:500 horizontal 1:100 vertical

<u>General</u>

1. This drawing should not be scaled - use figured dimensions only. If in doubt, ask.
2. All dimensions are in millimetres unless stated otherwise.
3. This drawing is to be read in conjunction with all relevant Architects drawings as well as all other drawings by RG Parkins (refer to RG Parkins drawing register).
4. The Contractor is responsible for verifying all dimensions on site prior to commencing works.
5. Any specified proprietary products are to be installed in strict accordance with manufacturers guidelines. No specified product should be substituted without gaining approval from RG Parkins.

<u>Drainage</u>

1) All drainage construction is to be in accordance with the following:
   a. Sewer Sector Guidance Appendix C - Design and Construction Guidance (DCG) for foul and surface water sewers offered for adoption under the Code for adoption agreement for water and sewerage companies operating wholly or mainly in England ("the Code")
   b. United Utilities Standard Details
   c. Civil Engineering Specification for the Water Industry (CESWI) 7th Edition
   d. Building Regulations Approved Document Part H 2010
2) Invert levels shown on all incoming and outgoing pipes for manholes indicate the invert levels at the intersection of the pipes within the manhole.
3) CONCRETE BENCHING AND PIPE SURROUND
   Concrete shall be placed in a single continuous operation from top of base slab to top of benching and pipe surround.
4) CONNECTION INTO MANHOLES
   Connections into manholes shall be constructed with the soffits at the same level unless detailed differently on the contract drawings.
5) CONCRETE SURROUND TO MANHOLES
   All manholes to Rigid material construction with 150mm surround of at least 20N/mm2 (GEN3) concrete shall be provided. Any joints should be staggered with pre-cast concrete joints.
6) CUT ENDS OF REINFORCED CONCRETE PIPES
   Shall be treated with epoxy resin paint/mortar.
7) MANHOLE ACCESSES
   For manhole access options and details refer to UU Standard Detail STND/01/013.
   Double steps shall be plastic encapsulated carbon steel to BS EN 1247-2 manhole steps.
   Double steps shall not be used where cover-to-soffit dimension is >3.0m.
8) COVER AND FRAME FOR TYPE A AND TYPE B ACCESS
   150mm deep double triangular covers are to be used in all adopted highways. Frame to be set as per manufacturers specification.

   Manhole cover and frame to be in accordance with BS EN 124 Class D400, class M1 mortar bed and haunch, with minimum clear opening of 600x600 unless noted otherwise.
9) ROCKER PIPES
   Start of rocker pipe to be as close to face of manhole as possible and not greater than 750mm. Rocker pipes to be used until the pipe outside diameter exceeds the effective length of the rocker pipe.
   Rocker pipe effective length shall be as follows:
   600mm for pipes up to 600mm
10) BENCHING WIDTH
   Minimum benching widths shall be as follows:
   For depth to soffit < 1.5m
   225mm min for all pipe sizes
   For depth to soffit ≥ 1.5m
   600mm min for 150mm ø to 375m ø pipes
11) CHANNEL FITTINGS
   Proprietary channel fittings are to be used up to and including 300mm ø pipes, above which granolithic in-situ channels can be used. Incoming and outgoing 'T' junctions, square junctions and 90º bends are not acceptable especially on foul systems, to be replaced by 'Y' junctions, oblique junctions and 2 No. 45º bends respectively.
12) All proposed connections from plot drainage that do not enter a new manhole are to be connected via the installation of an oblique pre-formed junction
13) SEWER PIPES
   Pipes used on main PCC sewer lengths must comply with Sewers for Adoption specification.
   Vitrified clay pipes should comply with requirements BS EN 295 for Foul pipes and BS 65 for surface water pipes.
   Thermoplastic structural walled pipes must comply with Water Industry Standard 4-35-01 and achieve Class 8KN/m^2 nominal short term stiffness.

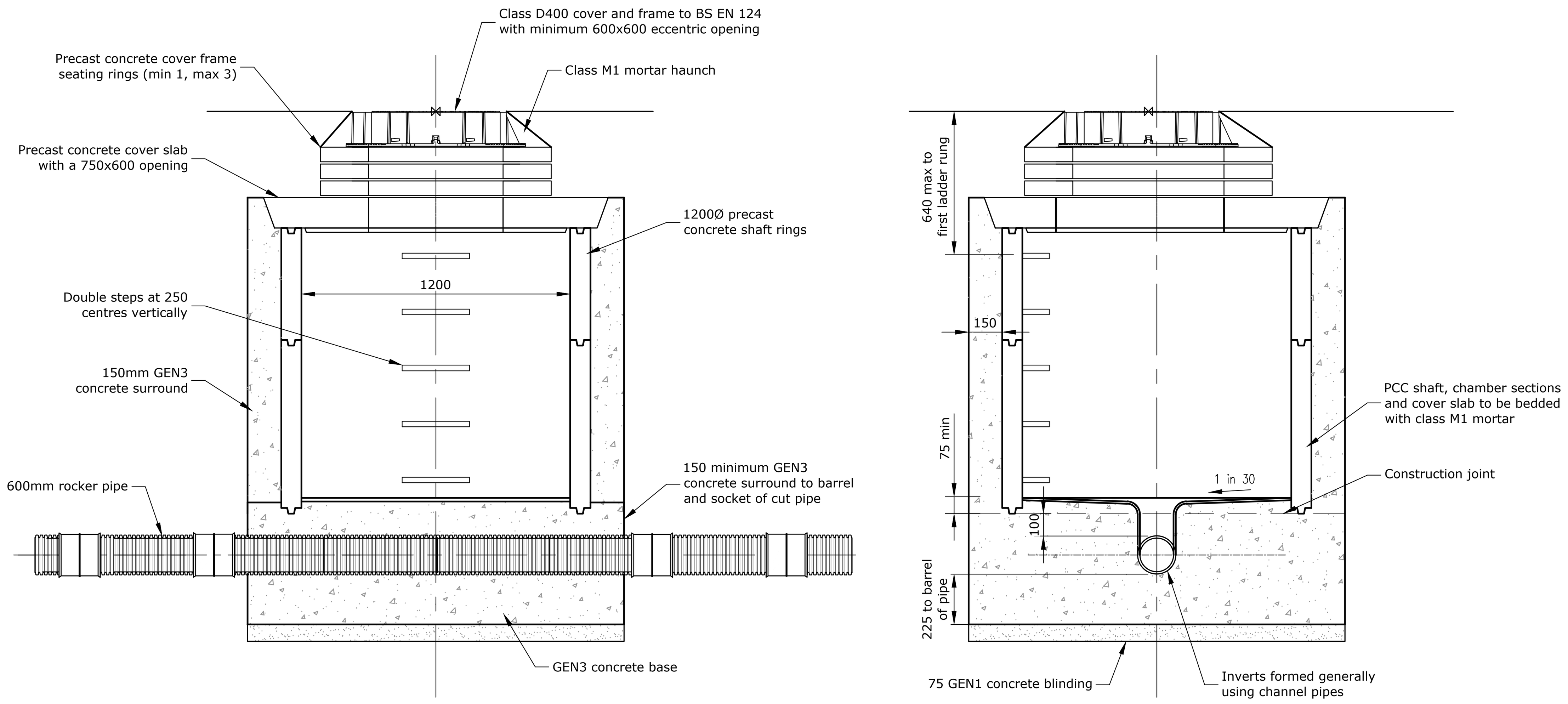
Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: Approval

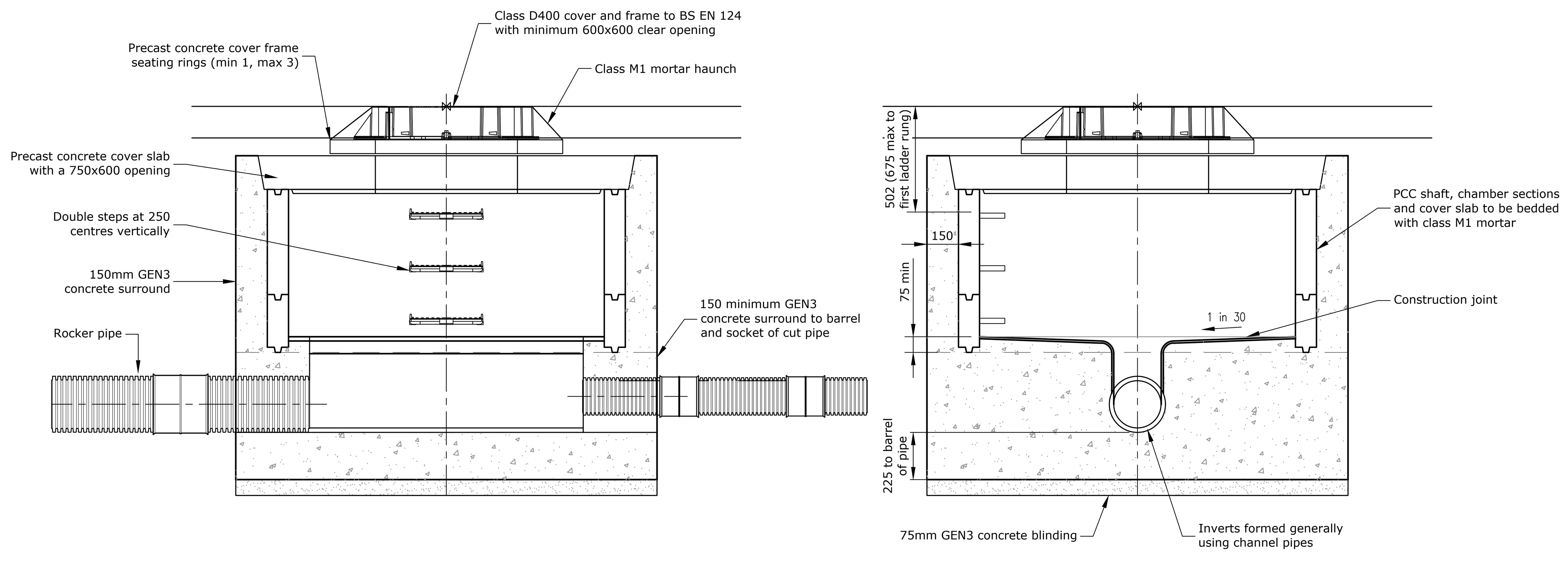
Do not scale from this drawing

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

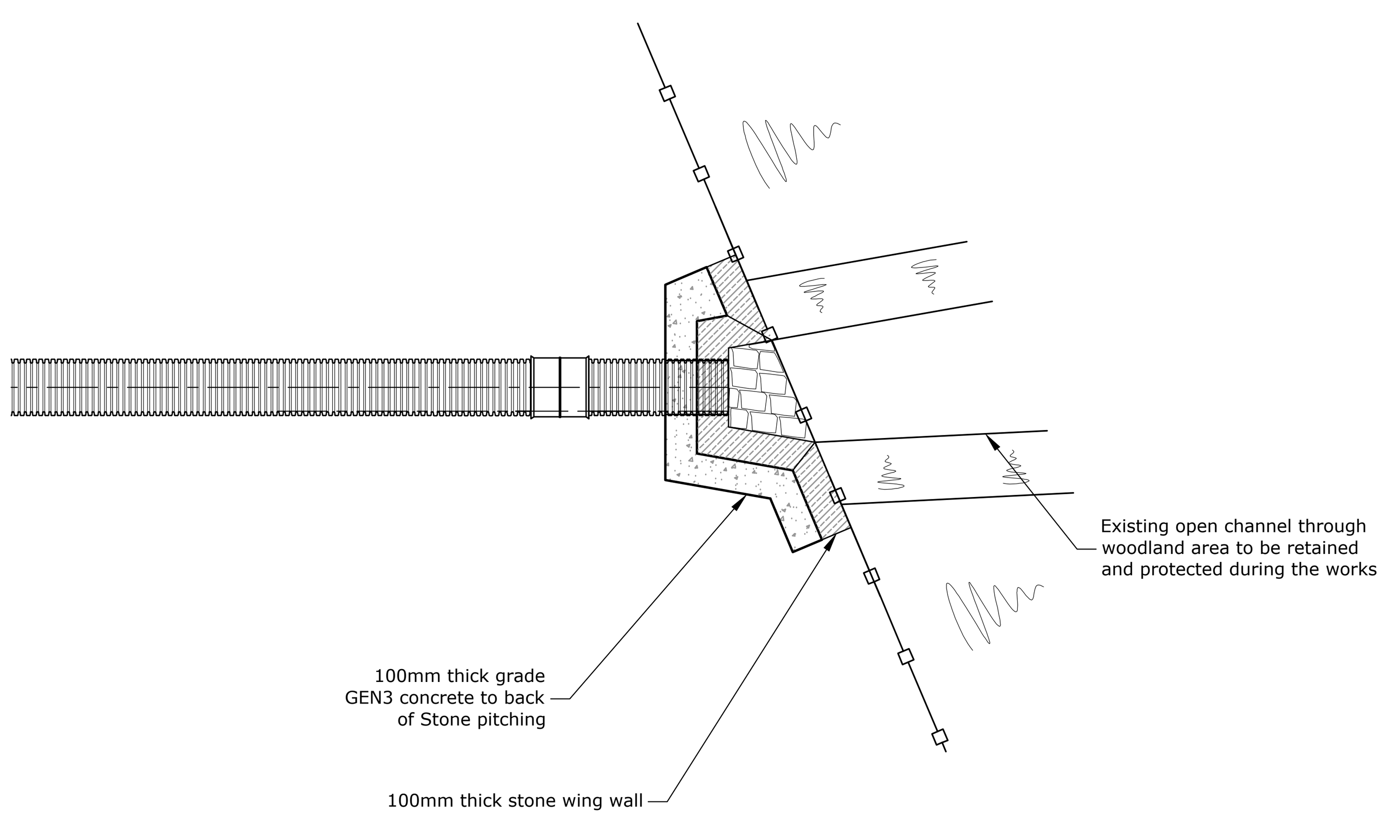
Client: Mr & Mrs A. Casson	Scale @ A1: 1:500	First Issue: 06/07/23	Office of Origin: Kendal
Project: Trumpet Road, Cleator Moor	Drawn by: SR	Checked by: TM	Approved: TM
Drawing Title: Surface Water Drainage Longitudinal Sections and Manhole Schedules	Project No: K39288	Drawing No: 12	Rev:
	BIM No:		



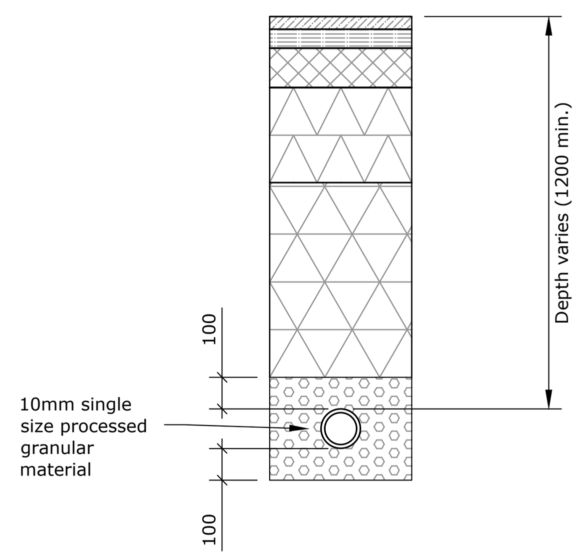
Typical Section Through 1200Ø Manholes > 1.5m to Soffit
SCALE 1:20



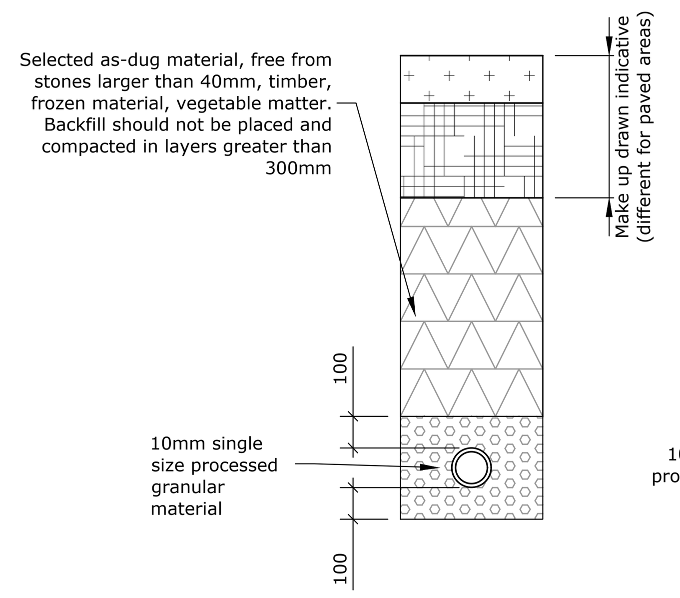
Typical Section Through 1500Ø Manholes > 1.5m to soffit
Scale 1:20



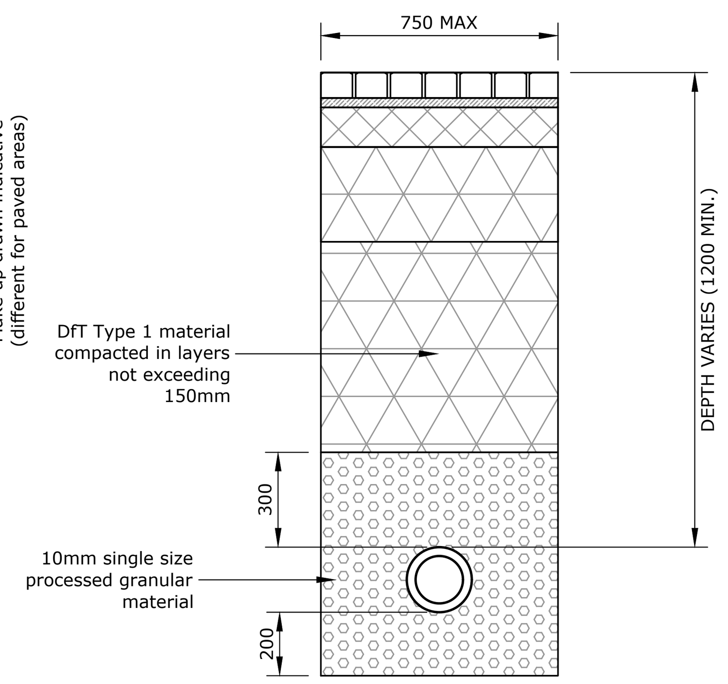
Plan on Headwall
Scale 1:20



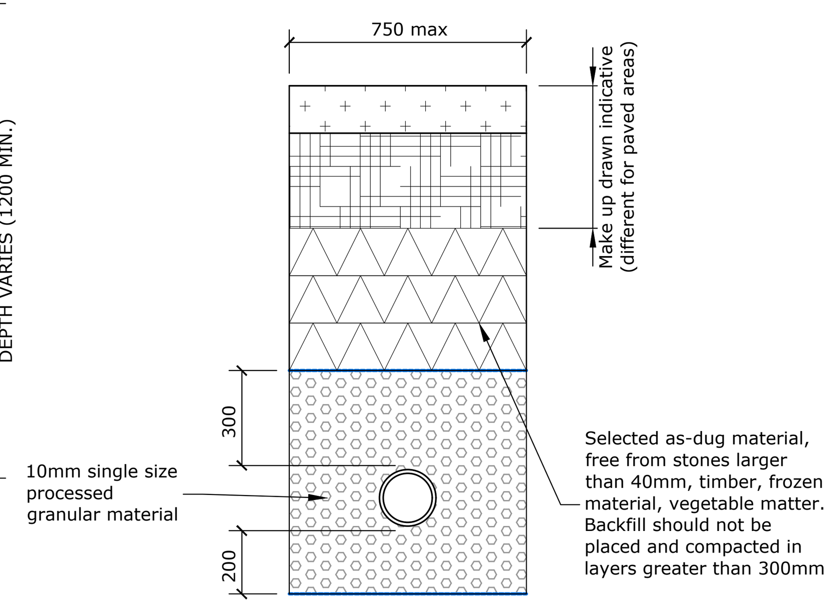
Pipe Bedding For 100Ø Pipes in Hard Landscaped Areas
SCALE 1:20



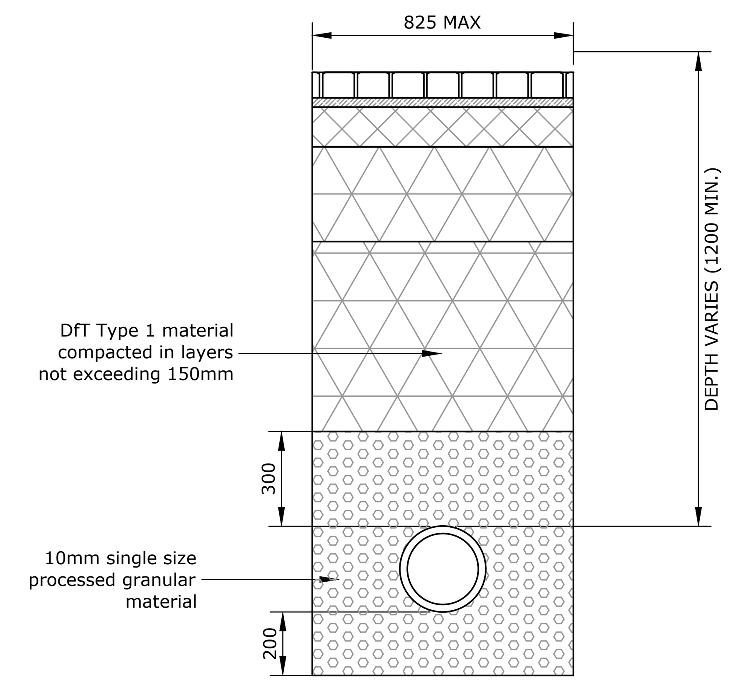
Pipe Bedding For 100Ø Pipes In Soft Landscaped Areas
SCALE 1:20



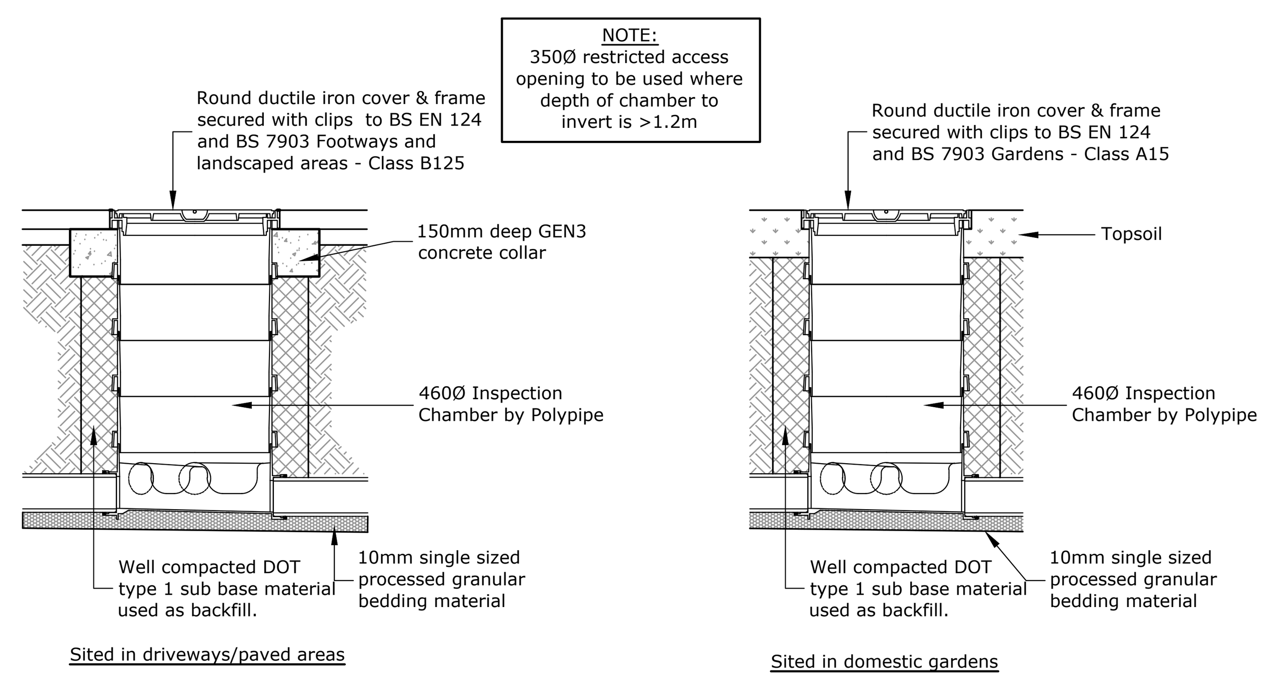
Type 7 Embedment Class S For 150Ø Pipes In Hard Landscaped Areas
SCALE 1:20



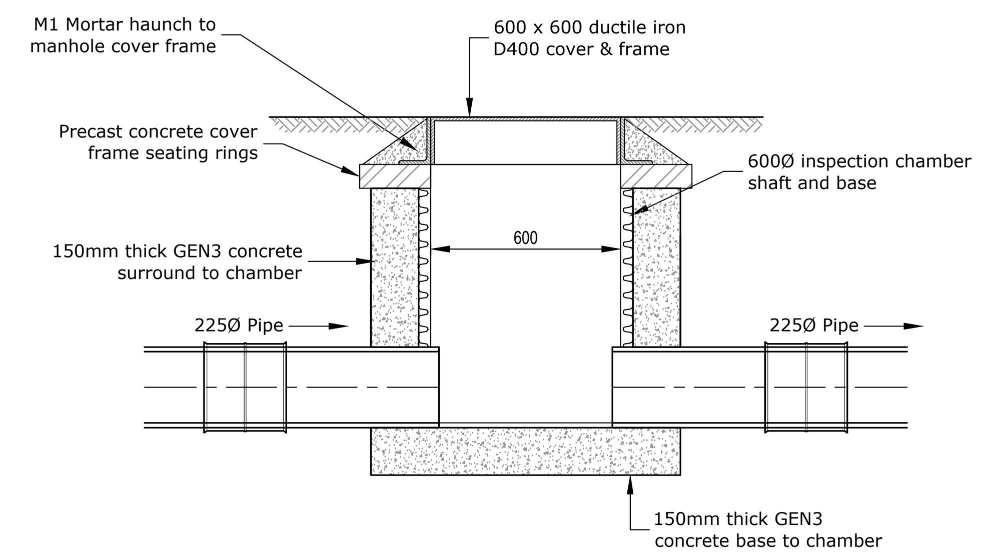
Type 7 Embedment Class S For 150Ø Pipes In Soft Landscaped Areas
SCALE 1:20



Type 7 Embedment Class S For 225Ø Pipes In Hard Landscaped Areas
SCALE 1:20



Typical Inspection Chamber Detail
Scale 1:20

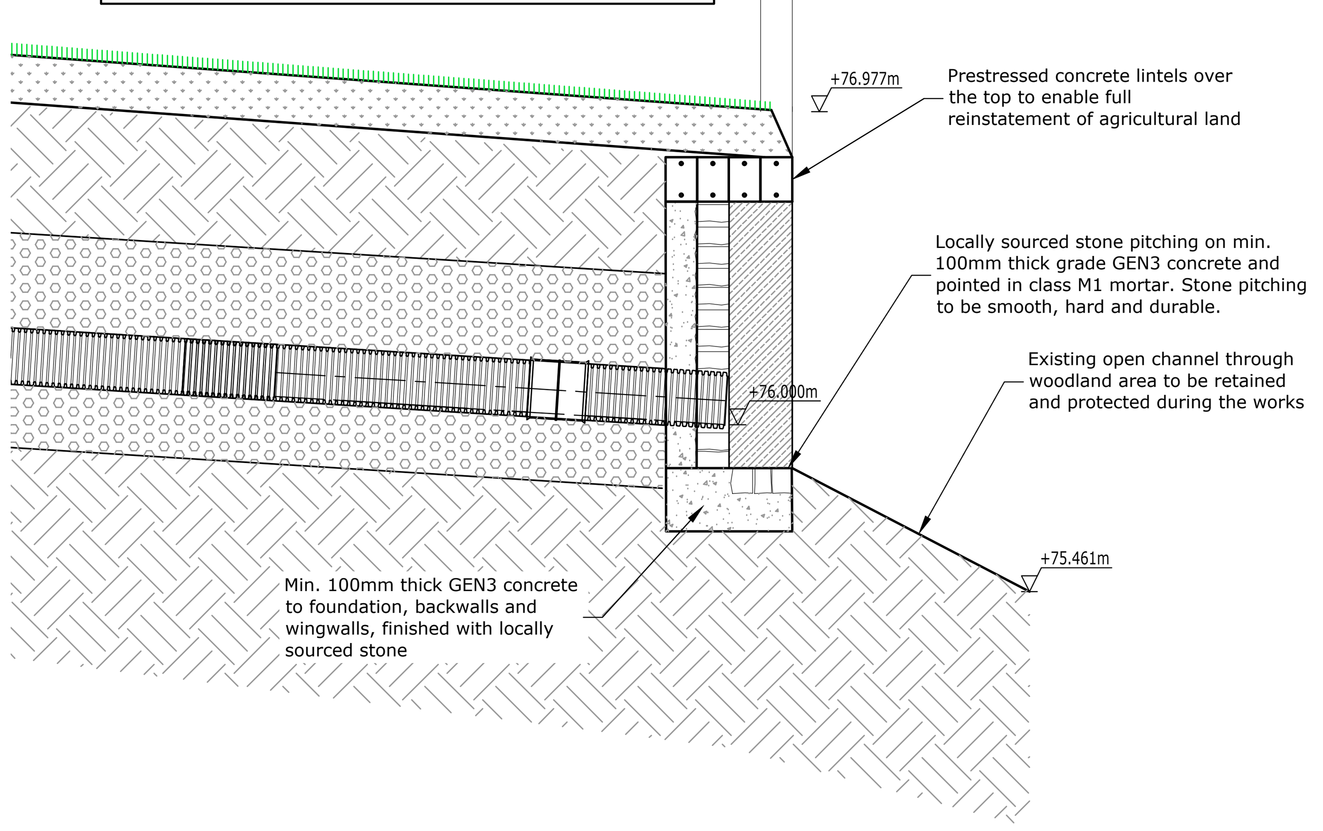


Typical 600Ø Chamber Detail
SCALE 1:20

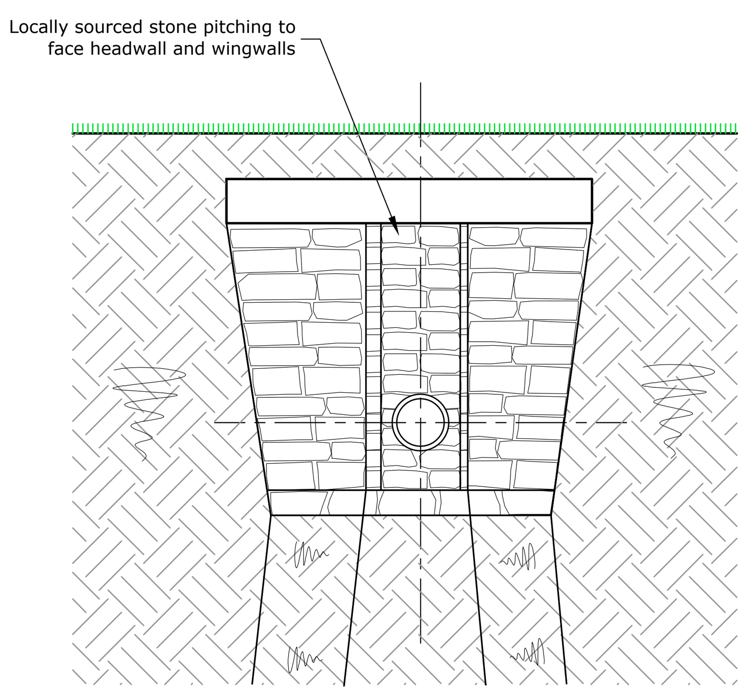
NOTE

Outfall works require Ordinary Watercourse Land Drainage Consent from the LLFA prior to undertaking any site works. Reference should be made to a site specific Risk Assessment and Method Statement to include as minimum the following:

- Minimum disruption/unwanted effects on the watercourse (dry working area/over pumping etc).
- Pollution control (silt/sand/concrete/oil/fuel etc).
- Action to be taken if a pollution incident occurred in or around the watercourse.
- Weather watch details - including action to be taken if increased watercourse flow is experienced or forecasted.
- Site clearance/reinstatement at the end of the works.



Section Through Headwall
Scale 1:20



Elevation on Headwall
Scale 1:20

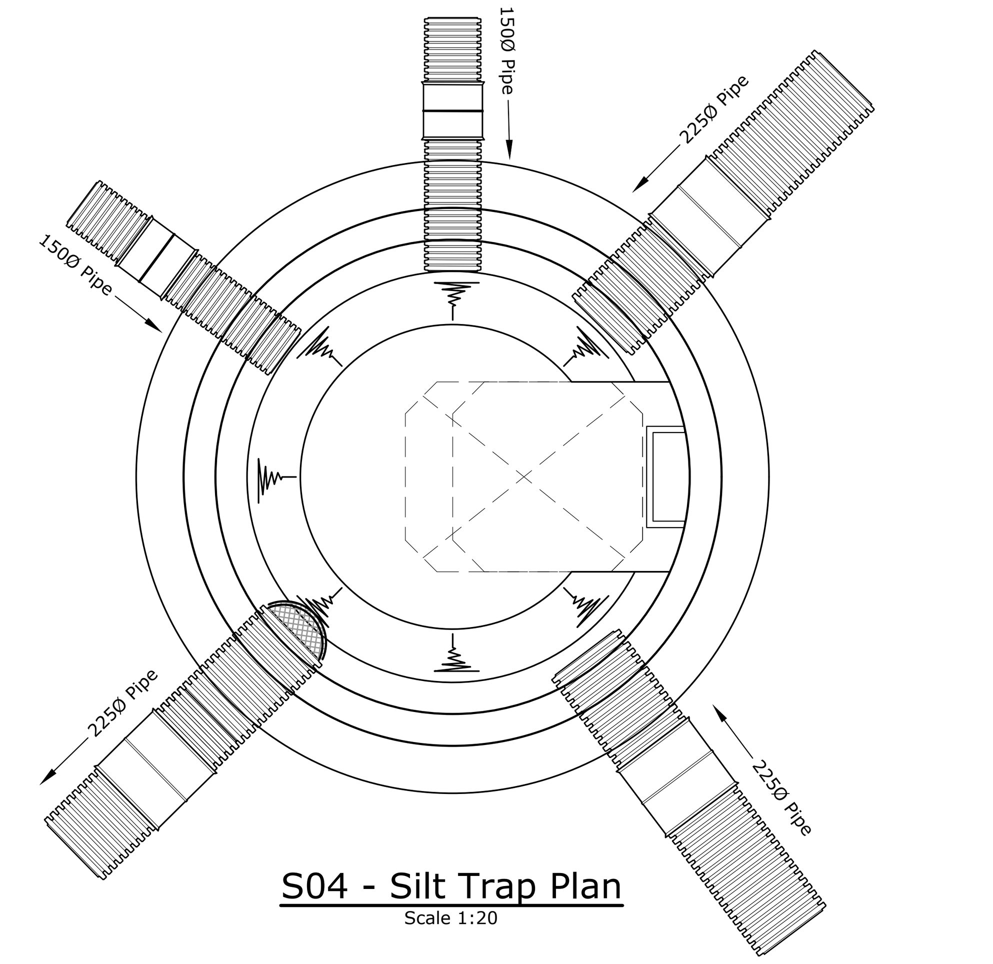
Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: Approval

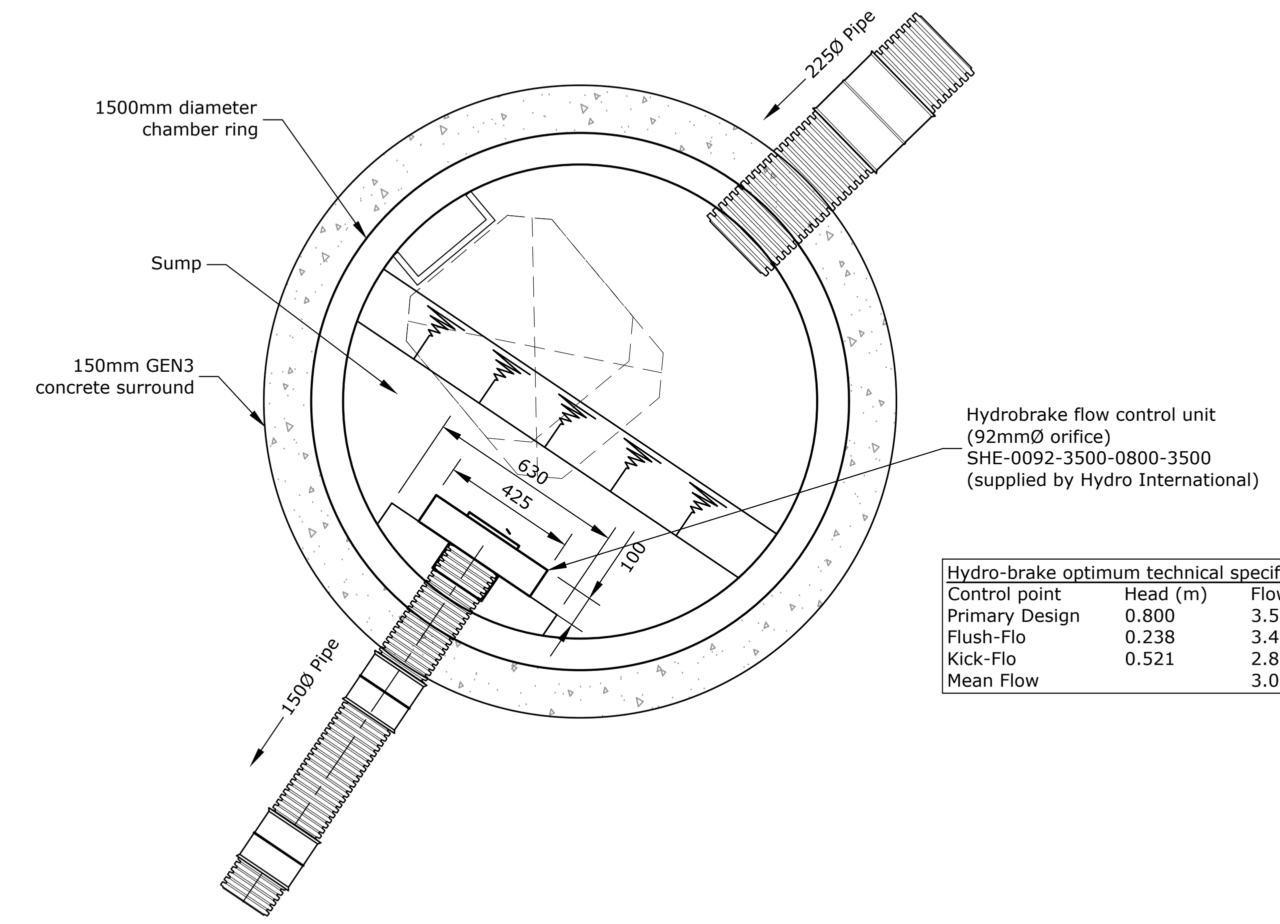
Do not scale from this drawing

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

Scale @ A1: 1:20	First Issue: 06/07/23	Office of Origin: Kendal	
Drawn by: SR	Checked by: TM	Approved: TM	
Client: Mr & Mrs A. Casson			
Project: Trumpet Road, Cleator Moor	Project No: K39288	Drawing No: 13	Rev:
Drawing Title: General Drainage Construction Details	BIM No:		

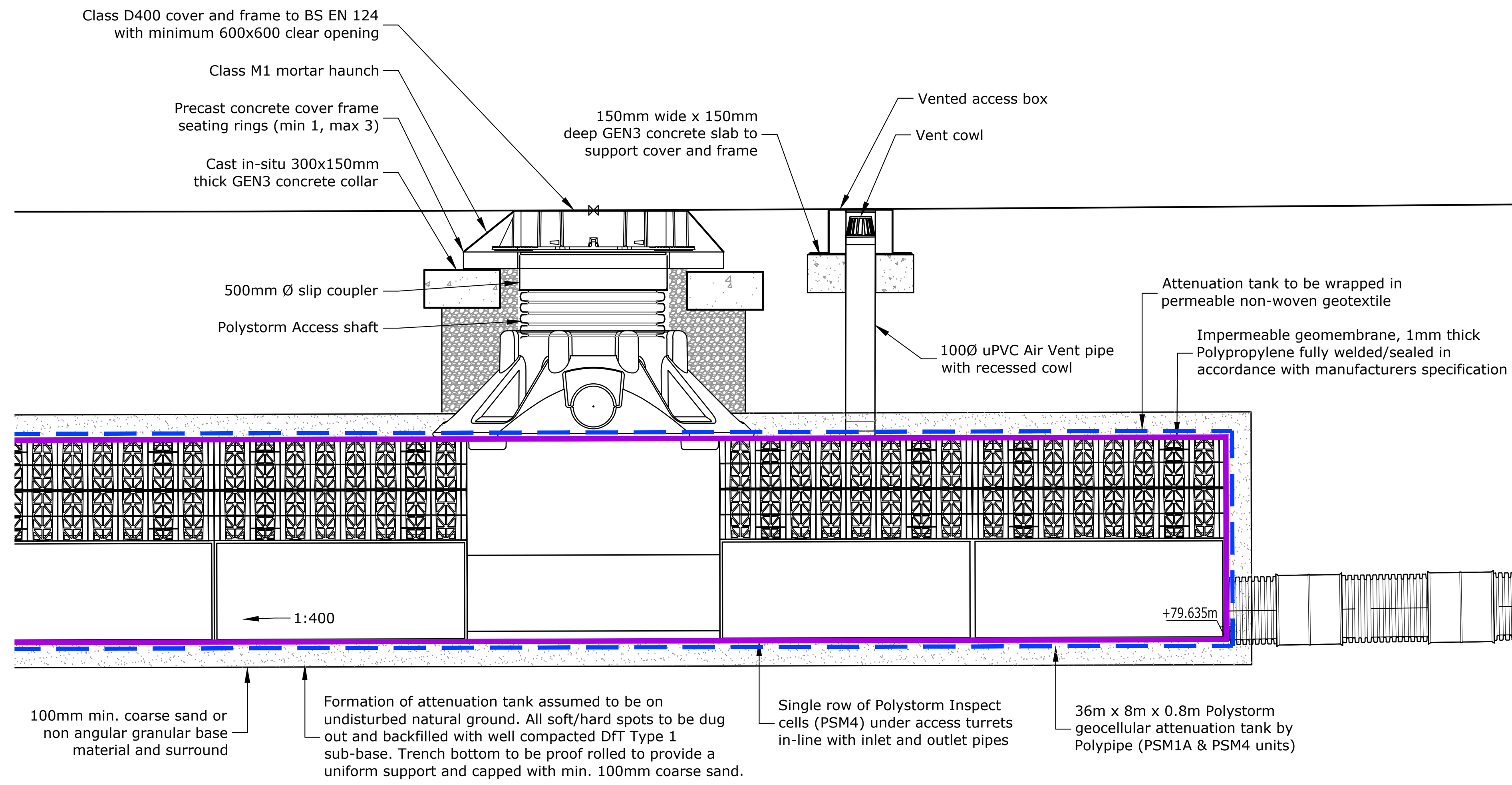


S04 - Silt Trap Plan
Scale 1:20

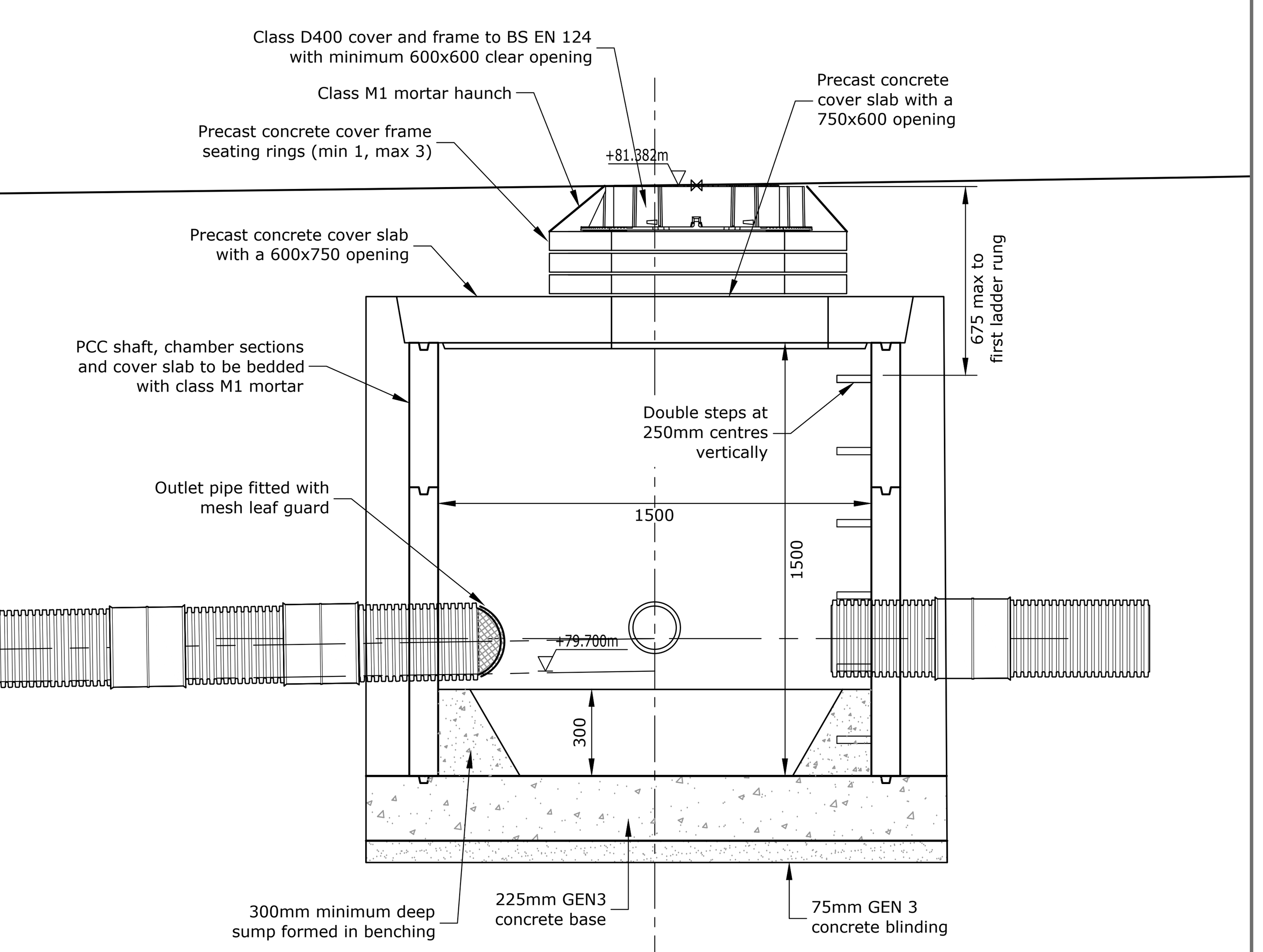


Hydro-brake optimum technical specification		
Control point	Head (m)	Flow (l/s)
Primary Design	0.800	3.500
Flush-Flo	0.238	3.494
Kick-Flo	0.521	2.877
Mean Flow		3.032

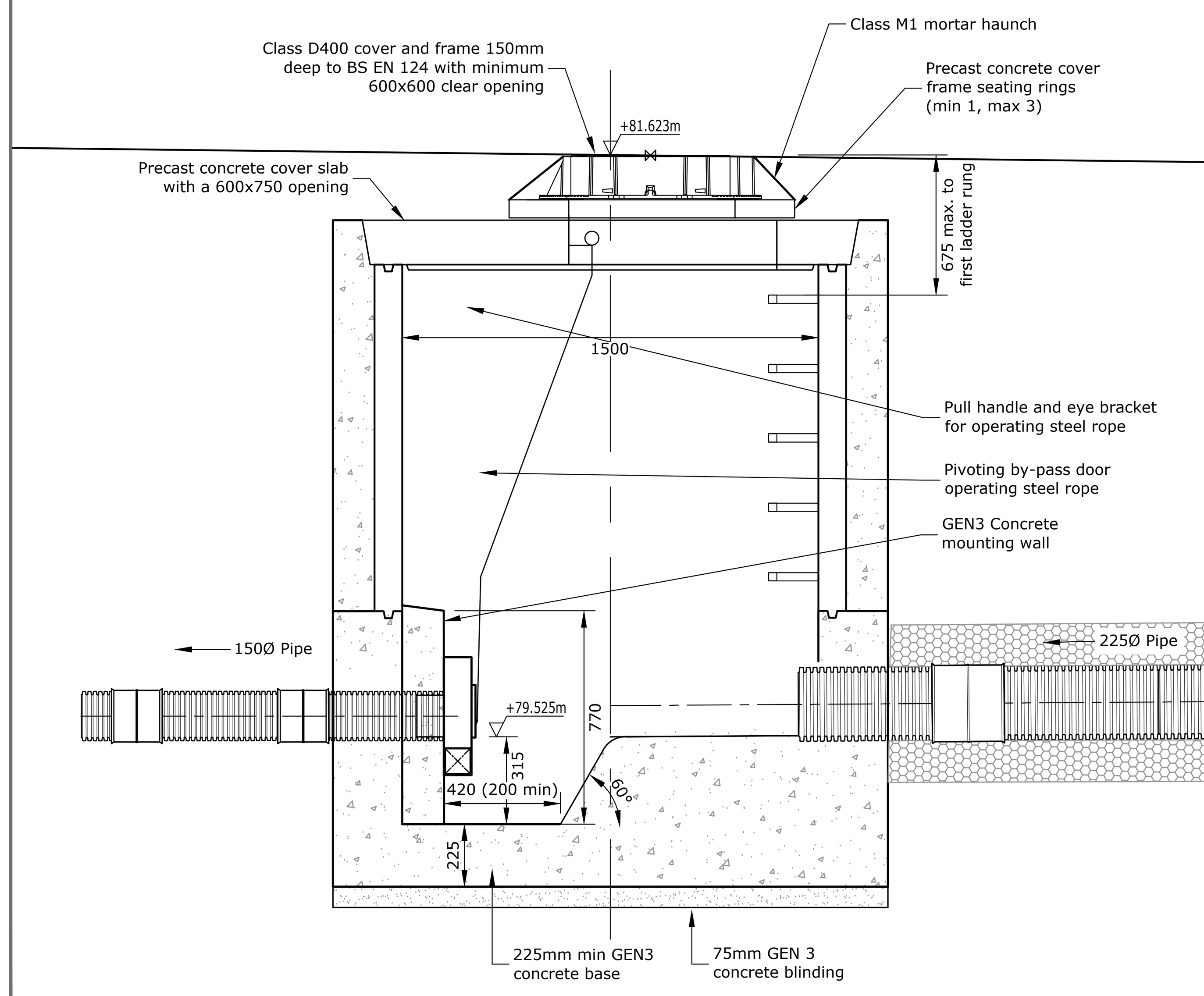
S07 - Flow Control Chamber Plan
Scale 1:20



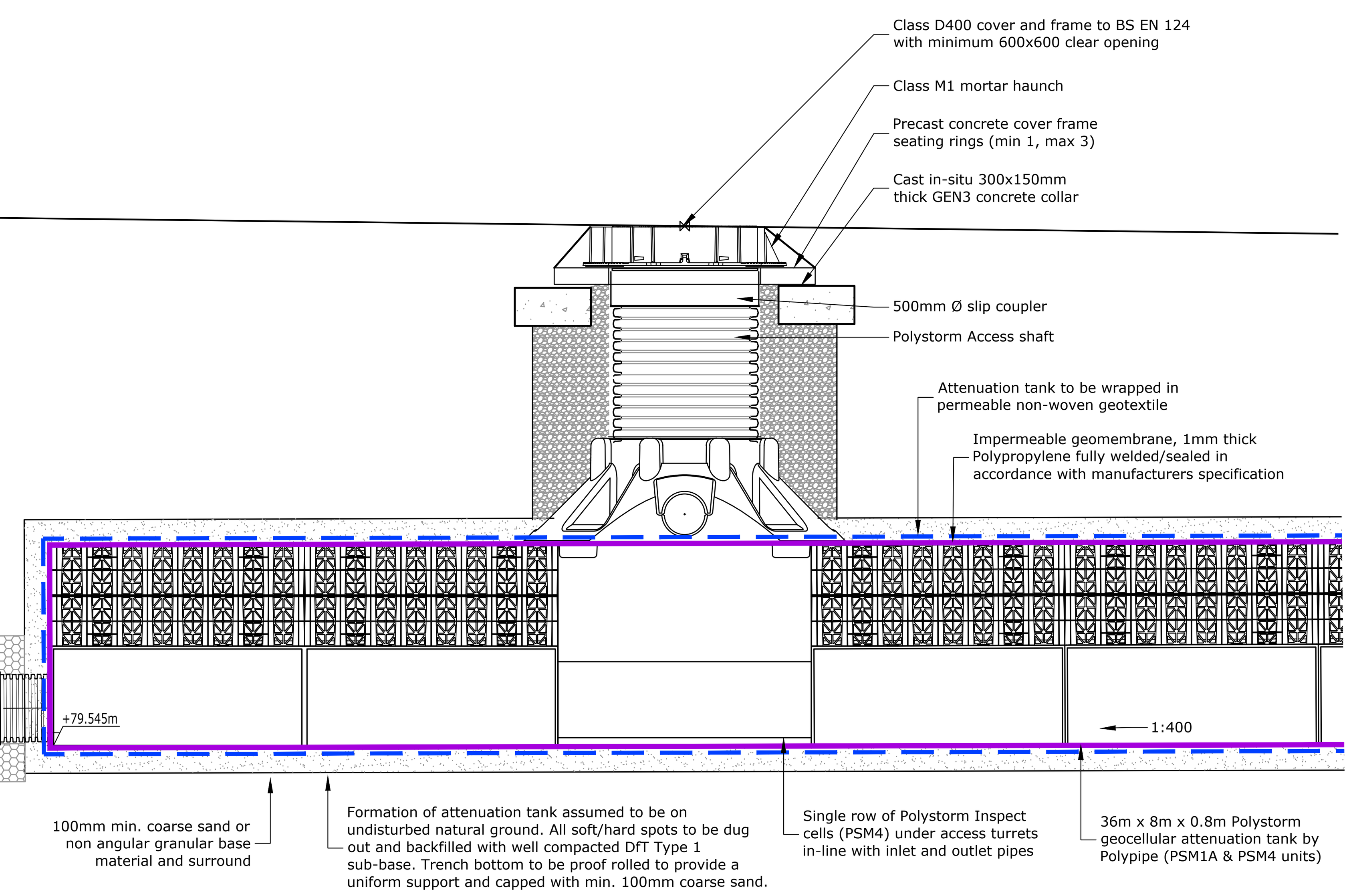
Section Through Geocellular Attenuation Tank
(Upstream)
Scale 1:20



S04 - Silt Trap Section
Scale 1:20



S07 - Flow Control Chamber Section
Scale 1:20



Section Through Geocellular Attenuation Tank
(Downstream)
Scale 1:20

Rev	Description	Date	Revised by	Checked by	Approved

Issue Purpose: **Approval**

Do not scale from this drawing

R G PARKINS
Kendal | 01539 729393 Lancaster | 01524 32548

Client: Mr & Mrs A. Casson
Project: Trumpet Road, Cleator Moor
Drawing Title: Geocellular Attenuation Tank Construction Details

Scale @ A1: 1:20 | First Issue: 06/07/23 | Office of Origin: Kendal
Drawn by: SR | Checked by: TM | Approved: TM
Project No: K39288 | Drawing No: 14 | Rev:
BIM No:

APPENDIX B

CALCULATIONS

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DESIGN BASIS MEMORANDUM - PEAK RATE OF RUN-OFF CALCULATION

Design Brief

The following peak rate of run-off calculations have been undertaken to determine changes in peak flow resulting from the development of a greenfield or brownfield site. These calculations are for the **Peak Rate of Run-Off** requirements only.

Background Information & References

The site area **is less than** 200ha and the Greenfield (pre-development) calculation has been undertaken in accordance with methodology described by Marshall & Bayliss, Institute of Hydrology, Report No. 124, Flood Estimation for Small Catchments, 1994 (IoH 124).

In addition, the following references have been used in the preparation of these calculations:

- Interim Code of Practice for Sustainable Drainage Systems (SUDS), CIRIA, 2004
- CIRIA, The SUDS Manual, Report C753, 2015
- Designing for Exceedance in Urban Drainage - good practice, CIRIA Report C635, 2006
- Flood Estimation Handbook (FEH)
- Flood Studies Report (FSR), Volume 1, Hydrological Studies, 1993
- Flood Studies Supplementary Report No 2 (FSSR2), The Estimation of Low Return Period Floods
- Flood Studies Supplementary Report No 14 (FSSR14), Review of Regional Growth Curves, 1983
- Planning Practice guidance of the National Planning Policy Framework, Recommended national precautionary sensitivity ranges for peak rainfall intensities, peak river flows, offshore wind speeds and wave heights.

Proposed Land Use Changes

Changes to the existing site are as follows: Greenfield Site to housing development

Results Summary

Rate of Run-Off (l/s)	
Event	**Greenfield**
Q1	3.0
QBAR	3.5
Q10	4.8
Q30	5.9
Q100	7.2
Q100 + 50% CC	10.8

R G PARKINS 97 King Street | Lancaster | LA1 1RH Tel:01524 32548 Email: office@rgparkinslancaster.co.uk	**Wallingford Runoff Estimation**	Job Number K39288	Page Number 2 of 4
		Calc by SR	Check by TM
	Trumpet Road Cleator Moor	Date 07/07/2023	Revised

SITE AREAS (LAND COVER AREAS)

Existing Impermeable & Permeable Land Cover

Total Site Area: **1.1534** **ha** **11534** **m²**

Existing Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area		0.000	0%
Remaining permeable area	11534.0	1.153	100%

Proposed Land Cover Areas

Land Cover	Area		Percentage of total site area
	m²	ha	
Total roof area	1248.5	0.125	11%
Roads	1195.0	0.120	10%
Driveways	823.9	0.082	7%
Paved areas	330.0	0.033	3%

Proposed Impermeable & Permeable Land Cover

Land Cover	Area		Percentage of total site area
	m²	ha	
Total impermeable area	3597.4	0.360	31%
Remaining permeable area	7936.6	0.794	69%

ESTIMATION OF QBAR (RURAL) (GREENFIELD RUNOFF RATE)

IoH 124 based on research on small catchments < 25 km2

Method is based on regression analysis of response times
using catchments from 0.9 to 22.9 km^2

$QBAR_{rural}$ is mean annual flood on rural catchment
$QBAR_{rural}$ depends on SOIL, SAAR and AREA most significantly

$QBAR_{rural} = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times SOIL^{2.17}$

For SOIL refer to FSR Vol 1, Section 4.2.3 and 4.2.6 and IoH 124

Contributing watershed area

Area, A	=	500000	m^2	insert 50 ha for EA
	=	0.500	km^2	small catchment method
	=	50.000	ha	
SAAR	=	**1259**	mm	From FEH Web Service (point data)

Soil index based on soil type, SOIL $= \frac{(0.1S1+0.3S2+0.37S3+0.47S4+0.53S5)}{(S1+S2+S3+S4+S5)}$

Where: S1	=		%	
S2	=	**0**	%	
S3	=	**0**	%	
S4	=	**100**	%	
S5	=		%	
		100	%	
So, SOIL	=	**0.47**		

UK Suds website provides a value of 4 based on the equivalent Host value. This seems reasonable based on ground investigation.

Note: for very small catchments it is far better to rely on local site investigation information.

$QBAR_{rural}$	=	0.480	m^3/s
	=	479.7	l/s

Small rural catchments less than 50 ha
The Environment Agency recommends that this method should be used for development sizes from
0 to 50 ha and should linearly interpolate the formula to 50 ha.

So, catchment size	=	**3597**	m^2	Excluding significant open space which would remain disconnected from the positive drainage system during flood events.
	=	0.004	km^2	
	=	0.360	ha	
$QBAR_{rural\ site}$	=	0.00345	m^3/s	
	=	**3.5**	l/s	

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GREENFIELD RETURN PERIOD ORDINATES

QBAR can be factored by the UK FSR regional growth curves for return periods <2 years and for all other return periods to obtain peak flow estimates for required return periods.

These regional growth curves are constant throughout a region, whatever the catchment type and size.

See Table 2.39 for region curve ordinates
Use FSSR2 Growth Curves to estimate Qbar

Reference- Pg 173-FSR V.1, ch 2.6.2

Region = **10**

Use Figure A1.1 to determine region

GREENFIELD RETURN PERIOD FLOW RATES

Return Period	Ordinate	Q (l/s)
1	0.87	3.0
2	0.93	3.2
5	1.19	4.1
10	1.38	4.8
25	1.64	5.7
30	1.7	5.9
50	1.85	6.4
100	2.08	7.2
200	2.32	8.0
500	2.73	9.4
1000	3.04	10.5

Ordinate from FSSR2

Interpolation taken from Figure 24.2 (pg 515) SuDS Manual

Design Settings

Rainfall Methodology	FEH-13
Return Period (years)	100
Additional Flow (%)	0
CV	0.750
Time of Entry (mins)	5.00
Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0

Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	✓
Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S01	0.026	5.00	84.460	1200	302606.193	514392.392	1.660
S02	0.063	5.00	83.144	1500	302584.273	514376.628	1.724
S03	0.087	5.00	82.105	1500	302563.571	514369.184	1.733
S04	0.196	5.00	81.382	1500	302546.015	514351.385	1.682
S05			81.316		302542.450	514347.879	1.681
S06		5.00	81.594		302516.795	514322.645	2.049
S07			81.623	1200	302514.656	514320.541	2.098
S08			81.687	1200	302511.860	514316.396	2.195
S09			82.146	1200	302493.116	514288.640	2.877
S10			83.220	1200	302446.346	514256.059	4.331
S11			83.500	1200	302378.986	514229.246	5.094
S12			79.449	1200	302311.626	514202.434	1.526
S13			77.000		302305.828	514172.050	1.539

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	S01	S02	27.000	0.600	82.800	81.495	1.305	20.7	150	5.20	50.0
1.001	S02	S03	22.000	0.600	81.420	80.372	1.048	21.0	225	5.33	50.0
1.002	S03	S04	25.000	0.600	80.372	79.700	0.672	37.2	225	5.52	50.0
1.003	S04	S05	5.000	0.600	79.700	79.635	0.065	76.9	225	5.58	50.0
2.000	S06	S07	3.000	0.600	79.545	79.525	0.020	150.0	225	5.05	50.0
2.001	S07	S08	5.000	0.600	79.525	79.492	0.033	151.5	150	5.15	50.0
2.002	S08	S09	33.492	0.600	79.492	79.269	0.223	150.2	150	5.83	50.0
2.003	S09	S10	57.000	0.600	79.269	78.889	0.380	150.0	150	6.99	50.0
2.004	S10	S11	72.500	0.600	78.889	78.406	0.483	150.1	150	8.47	50.0
2.005	S11	S12	72.500	0.600	78.406	77.923	0.483	150.1	150	9.95	50.0

Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
1.000	2.224	39.3	3.5	1.510	1.499	0.026	0.0	30	1.380
1.001	2.868	114.0	12.1	1.499	1.508	0.089	0.0	49	1.872
1.002	2.151	85.5	23.9	1.508	1.457	0.176	0.0	81	1.853
1.003	1.492	59.3	50.4	1.457	1.456	0.372	0.0	160	1.668
2.000	1.065	42.3	0.0	1.824	1.873	0.000	0.0	0	0.000
2.001	0.814	14.4	0.0	1.948	2.045	0.000	0.0	0	0.000
2.002	0.817	14.4	0.0	2.045	2.727	0.000	0.0	0	0.000
2.003	0.818	14.5	0.0	2.727	4.181	0.000	0.0	0	0.000
2.004	0.818	14.5	0.0	4.181	4.944	0.000	0.0	0	0.000
2.005	0.818	14.5	0.0	4.944	1.376	0.000	0.0	0	0.000

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)
2.006	S12	S13	30.932	0.600	77.923	75.461	2.462	12.6	150	10.13	50.0

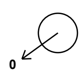
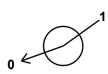
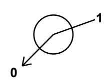
Name	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
2.006	2.857	50.5	0.0	1.376	1.389	0.000	0.0	0	0.000

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	27.000	20.7	150	Circular	84.460	82.800	1.510	83.144	81.495	1.499
1.001	22.000	21.0	225	Circular	83.144	81.420	1.499	82.105	80.372	1.508
1.002	25.000	37.2	225	Circular	82.105	80.372	1.508	81.382	79.700	1.457
1.003	5.000	76.9	225	Circular	81.382	79.700	1.457	81.316	79.635	1.456
2.000	3.000	150.0	225	Circular	81.594	79.545	1.824	81.623	79.525	1.873
2.001	5.000	151.5	150	Circular	81.623	79.525	1.948	81.687	79.492	2.045
2.002	33.492	150.2	150	Circular	81.687	79.492	2.045	82.146	79.269	2.727
2.003	57.000	150.0	150	Circular	82.146	79.269	2.727	83.220	78.889	4.181
2.004	72.500	150.1	150	Circular	83.220	78.889	4.181	83.500	78.406	4.944
2.005	72.500	150.1	150	Circular	83.500	78.406	4.944	79.449	77.923	1.376
2.006	30.932	12.6	150	Circular	79.449	77.923	1.376	77.000	75.461	1.389

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	S01	1200	Manhole	Adoptable	S02	1500	Manhole	Adoptable
1.001	S02	1500	Manhole	Adoptable	S03	1500	Manhole	Adoptable
1.002	S03	1500	Manhole	Adoptable	S04	1500	Manhole	Adoptable
1.003	S04	1500	Manhole	Adoptable	S05		Junction	
2.000	S06		Junction		S07	1200	Manhole	Adoptable
2.001	S07	1200	Manhole	Adoptable	S08	1200	Manhole	Adoptable
2.002	S08	1200	Manhole	Adoptable	S09	1200	Manhole	Adoptable
2.003	S09	1200	Manhole	Adoptable	S10	1200	Manhole	Adoptable
2.004	S10	1200	Manhole	Adoptable	S11	1200	Manhole	Adoptable
2.005	S11	1200	Manhole	Adoptable	S12	1200	Manhole	Adoptable
2.006	S12	1200	Manhole	Adoptable	S13		Junction	

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections		Link	IL (m)	Dia (mm)
S01	302606.193	514392.392	84.460	1.660	1200		0	1.000	82.800	150
S02	302584.273	514376.628	83.144	1.724	1500		1	1.000	81.495	150
							0	1.001	81.420	225
S03	302563.571	514369.184	82.105	1.733	1500		1	1.001	80.372	225
							0	1.002	80.372	225

Manhole Schedule

Node	Easting (m)	Northing (m)	CL (m)	Depth (m)	Dia (mm)	Connections	Link	IL (m)	Dia (mm)
S04	302546.015	514351.385	81.382	1.682	1500	1	1.002	79.700	225
						0	1.003	79.700	225
S05	302542.450	514347.879	81.316	1.681		1	1.003	79.635	225
S06	302516.795	514322.645	81.594	2.049		0	2.000	79.545	225
S07	302514.656	514320.541	81.623	2.098	1200	1	2.000	79.525	225
						0	2.001	79.525	150
S08	302511.860	514316.396	81.687	2.195	1200	1	2.001	79.492	150
						0	2.002	79.492	150
S09	302493.116	514288.640	82.146	2.877	1200	1	2.002	79.269	150
						0	2.003	79.269	150
S10	302446.346	514256.059	83.220	4.331	1200	1	2.003	78.889	150
						0	2.004	78.889	150
S11	302378.986	514229.246	83.500	5.094	1200	1	2.004	78.406	150
						0	2.005	78.406	150
S12	302311.626	514202.434	79.449	1.526	1200	1	2.005	77.923	150
						0	2.006	77.923	150
S13	302305.828	514172.050	77.000	1.539		1	2.006	75.461	150

Simulation Settings

Rainfall Methodology	FEH-13	Skip Steady State	x	Check Discharge Rate(s)	x
Summer CV	0.750	Drain Down Time (mins)	240	Check Discharge Volume	x
Analysis Speed	Detailed	Additional Storage (m³/ha)	20.0		

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	**Climate Change (CC %)**	**Additional Area (A %)**	**Additional Flow (Q %)**
100	50	0	0

Node S07 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	79.525	Product Number	CTL-SHE-0092-3500-0800-3500
Design Depth (m)	0.800	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	3.5	Min Node Diameter (mm)	1200

Node S06 Flow through Pond Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Main Channel Length (m)	36.000
Side Inf Coefficient (m/hr)	0.00000	Invert Level (m)	79.545	Main Channel Slope (1:X)	400.0
Safety Factor	2.0	Time to half empty (mins)		Main Channel n	0.030

Inlets

S05

Depth (m)	**Area (m²)**	**Inf Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf Area (m²)**
0.000	288.0	0.0	0.800	288.0	0.0	0.801	0.0	0.0

Other (defaults)

Entry Loss (manhole)	0.250	Entry Loss (junction)	0.000	Apply Recommended Losses	x
Exit Loss (manhole)	0.250	Exit Loss (junction)	0.000	Flood Risk (m)	0.300

Approval Settings

Node Size	✓	Minimum Full Bore Velocity (m/s)	
Node Losses	✓	Maximum Full Bore Velocity (m/s)	3.000
Link Size	✓	Proportional Velocity	✓
Minimum Diameter (mm)	150	Return Period (years)	
Link Length	✓	Minimum Proportional Velocity (m/s)	0.750
Maximum Length (m)	100.000	Maximum Proportional Velocity (m/s)	3.000
Coordinates	✓	Surcharged Depth	✓
Accuracy (m)	1.000	Return Period (years)	
Crossings	✓	Maximum Surcharged Depth (m)	0.100
Cover Depth	✓	Flooding	✓
Minimum Cover Depth (m)		Return Period (years)	30
Maximum Cover Depth (m)	3.000	Time to Half Empty	x
Backdrops	✓	Discharge Rates	✓
Minimum Backdrop Height (m)		Discharge Volume	✓
Maximum Backdrop Height (m)	1.500	100 year 360 minute (m³)	
Full Bore Velocity	✓		

Results for 100 year +50% CC Critical Storm Duration. Lowest mass balance: 99.48%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S01	10	82.863	0.063	13.7	0.0903	0.0000	OK
30 minute summer	S02	19	81.566	0.146	45.9	0.3650	0.0000	OK
30 minute summer	S03	19	81.411	1.039	88.7	2.8779	0.0000	SURCHARGED
15 minute summer	S04	11	80.698	0.998	177.4	4.0887	0.0000	SURCHARGED
480 minute summer	S05	472	80.345	0.710	39.9	0.0000	0.0000	OK
480 minute summer	S06	472	80.345	0.800	21.7	0.0000	0.0000	SURCHARGED
480 minute summer	S07	472	80.345	0.820	3.6	0.9273	0.0000	SURCHARGED
15 minute summer	S08	10	79.544	0.052	3.5	0.0583	0.0000	OK
15 minute summer	S09	12	79.321	0.052	3.5	0.0590	0.0000	OK
15 minute summer	S10	15	78.941	0.052	3.6	0.0586	0.0000	OK
480 minute summer	S11	480	78.462	0.056	3.5	0.0628	0.0000	OK
480 minute summer	S12	480	77.950	0.027	3.5	0.0305	0.0000	OK
480 minute summer	S13	480	75.488	0.027	3.5	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S01	1.000	S02	13.6	1.988	0.345	0.1975	
30 minute summer	S02	1.001	S03	43.8	1.525	0.384	0.7376	
30 minute summer	S03	1.002	S04	81.9	2.059	0.957	0.9943	
15 minute summer	S04	1.003	S05	175.0	5.444	2.950	0.1968	
480 minute summer	S05	Flow through pond	S06	21.7	0.050	0.004	217.2961	
480 minute summer	S06	2.000	S07	3.6	0.260	0.085	0.1193	
480 minute summer	S07	Hydro-Brake®	S08	3.5				
15 minute summer	S08	2.002	S09	3.5	0.814	0.243	0.1787	
15 minute summer	S09	2.003	S10	3.6	0.798	0.249	0.3027	
15 minute summer	S10	2.004	S11	3.6	0.777	0.250	0.4011	
480 minute summer	S11	2.005	S12	3.5	0.893	0.243	0.2927	
480 minute summer	S12	2.006	S13	3.5	1.640	0.070	0.0662	131.5

APPENDIX C

PHOTOGRAPHS OF OFF-SITE SW DRAINAGE ROUTE

Photo 1 – development site taken from PROW in south-west corner

Photo 2 – start of off-site SW route taken from PROW looking south-west

Photo 3 – off-site SW route running south-west parallel to boundary retaining wall (6 – 8m from wall)

Photo 4 – off-site SW route proceeds south-west, boundary retaining wall tapers down

Photo 5 – off-site SW route proceeds south-west before turning south

Photo 6 – off-site SW route proceeds south toward existing land drainage outfall

Photo 7 – existing stone culvert land drainage outfall

Photo 8 – existing open channel/gully through woodland area running downslope to River Ehen