# FLOOD RISK ASSESSMENT REPORT

## ON SITE OF FORMER RAILWAY SIDINGS

## DONCASTER ROAD
## STAIRFOOT, BARNSLEY

## ON BEHALF OF

## BLACKSTONE DEVELOPMENTS LTD

## MARCH 2016

| Report No: 800/427r1 | Name | Signature | Date |
|---|---|---|---|
| Prepared By: | A R Poyser BSc CEng MICE FCIHT | A.R. Poyser | 08/03/16 |
| Reviewed By: | A Radcliffe BEng CEng MIStructE | | 08/03/16 |

**ARP ASSOCIATES**
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# C O N T E N T S

## 1.0 INTRODUCTION

1.1 Blackstone Developments Ltd are considering redevelopment of the former railway sidings at Doncaster Road, Stairfoot for new residential dwellings. As part of the viability and to supplement a Planning Application, a Flood Risk Assessment Report was considered to be necessary.

1.2 It is within the general development strategy of the country for development in areas where there is a risk of flooding to be assessed to avoid unnecessary increase in the requirement for flood defence. Under the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG), consultation is required with the Environment Agency, Land Drainage Authority and Water Authority and a Flood Risk Assessment Report should be prepared considering the development proposals and make recommendations for any flood mitigation measures.

1.3 ARP Associates have been appointed to carry out an assessment of the site, implement appropriate consultations and prepare a Flood Risk Assessment Report, in accordance with NPPF, to satisfy the requirements of the Planning Authority.

1.4 The consultations and walkover surveys have been undertaken between January and March 2016.

1.5 This assessment has been prepared for the sole use and reliance of the Client and shall not be relied upon or transferred to any other parties without the written authorisation of ARP Associates. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

## 2.0 WALKOVER SURVEY

General

2.1 The development site is a long rectangular shaped piece of land equating to an area of approximately 0.53ha. The Ordnance Survey Grid Reference is 437450, 405000.

2.2 A site location plan is presented in Appendix A.

Current Use

2.3 The site has been unused for some considerable time, although there is evidence of a former structure in the centre of the site and overgrowth of brambles, bushes and trees has been cleared relatively recently over the main area of the site. There is a pile of site clearance material which needs to be removed from the development. There are also some man-made bunds, particularly to the southeastern corner, to prevent unlawful access onto the site.

2.4 It is known that the site was used as railway sidings in the past.

Boundaries

2.5 The site is now open on to all boundaries, although plant and hedge growth is apparent on the northeastern and northwestern boundaries, which prevents access into the site. To the northwest, there is a steep slope down to Doncaster Road due to a former railway bridge which passes over the highway. The northeastern boundary is adjacent to Sandygate Lane, which slopes down from the southeastern corner to the junction with Doncaster Road and this forms a relatively steep slope on the northeastern side of the site. To the southwest, there is a public footpath and cycleway which runs along the line of the former railway. There is a McDonalds fast food restaurant and other commercial development beyond. To the southeast, the development narrows and there is open woodland present adjacent to the boundary.

Topography and Vegetation

2.6 The site is basically level and raised slightly above the former railway line which is now a public footpath on the southwestern boundary. This creates steep slopes to the northwest and northeast, but is level with the adjacent road at the southeastern corner. A topographical survey is presented in Appendix B.

2.7 The site has self-seed vegetation on the slopes to the northwest and northeast, but the central area has now been cleared to create a plateau for development.

2.8 The building which can be seen to be remaining in the central area of the site may have been a signal box or similar associated with the railway.

Drainage

2.9 There is no obvious positive drainage systems on the site at the present time, and if there has been no use since the former sidings, it is likely that the ash, which can be seen near the surface, just allowed natural infiltration to the below ground strata.

2.10 It should also be noted that the public footpath and cycleway running along the southwestern boundary does not appear to have any positive drainage system and probably runs off to the adjoining land. However, there is a positive drainage system in Sandygate Lane with highway gullies and manholes present, possibly draining the commercial area to the northeast.

2.11 There are no indications of watercourse or similar in the immediate vicinity of the site with the River Dove approximately 1.8km to the south and the River Dearne approximately 1.2km to the north.

## 3.0 CONSULTATIONS

Environment Agency

3.1 A consultation has been requested from the Environment Agency regarding potential flooding, but, at the time of writing the report, no response has been received. However, on viewing the Environment Agency website, the site can be seen to fall within land with less than a 0.1% (1 in 1,000) chance of flooding in any year. Furthermore, on reviewing the surface water flood plan the chance of flooding from this source is considered to be very low risk.

Water Authority

3.2 A consultation was requested from Yorkshire Water, who is the Water Authority for this area, and a copy of their response, dated 2nd February 2016 under reference S000888, is presented in Appendix C for reference.

3.3 Foul water can discharge to the 375mm diameter public sewer recorded in Wombwell Lane at a point to the west of the site. However, to gain access to this location, it will be necessary to undertake a Requisition with Yorkshire Water to gain access across third party land of the public footpath and the car park to McDonalds. The Requisition will need to be undertaken in accordance with an Agreement of the Water Industry Act 1991.

3.4 In respect of surface water, reference is made to Requirement H3 of Building Regulations 2000 and Sustainable Drainage Systems. This establishes the preferred hierarchy for surface water disposal with consideration firstly given to discharge to soakaway, infiltration system and watercourse in that priority order before consideration of connection to sewer. Furthermore, as the proposal site is currently undeveloped, no surface water is known to have previously discharged to the public sewer network. As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. Yorkshire Water understand that a watercourse is located through the site and that this appears to be the obvious place for surface water disposal.

Land Drainage

3.5 A consultation was requested from Barnsley Metropolitan District Council, who is the Land Drainage Authority for this area, and an e-mail response was received on the 3rd March 2016. A copy is presented in Appendix D for reference purposes.

3.6 The Authority have no records of any culverted or open watercourses crossing the site and they are not aware of any flooding issues.

3.7 There should be no increase in surface water run-off from the development, and the management of flood risk should apply to a catchment wide approach. Any balancing facilities should be designed to accommodate a 1 in 30 year flow from the site below ground and a 1 in 100 year flow plus climate change retained within the site without causing flooding to buildings. Furthermore, Sustainable Drainage techniques should be used, wherever possible, on the development.

## 4.0 MATERIAL CONSIDERATION IN RESPECT OF NPPF AND PPG

Flood Classification

4.1 The review of the Environment Agency website has identified that the land is assessed as having less than a 1 in 1,000 annual probability of river or sea flooding in any year (less than 0.1%). In accordance with Table 1 of the PPG, the site falls within Flood Zone 1 "low probability".

4.2 Therefore, all uses of the land are appropriate within this zone, but an assessment of the effect of surface water run-off will need to be incorporated in any Flood Risk Assessment.

End Use

4.3 The development proposal is for the construction of residential dwellings on the site and a copy of the indicative planning layout is presented in Appendix E for reference purposes.

4.4 When applying Table 2 of the PPG, the flood risk vulnerability classification shows that the end use will fall into a "more vulnerable" classification.

Sequential Test

4.5 As set out in the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest probability of flooding (Zone 1).

4.6 When the development site is evaluated in accordance with Table 3 of the PPG, the Sequential Test is satisfied.

Flood Sources

4.7 Flooding from Rivers - There are no rivers maintained by the Environment Agency within the vicinity of the site and flooding from this source is considered to be low risk.

4.8 Flooding from Local Watercourses - There are no watercourses identified within the vicinity of the site and flooding from this source is considered to be low risk.

4.9 Flooding from the Sea - The site is not located near enough to the sea to cause a problem of flooding from this source.

4.10 Flooding from Land - The development site is situated adjacent to commercial buildings to the southwest and this will have a positive drainage system, whilst land to the northwest and northeast is significantly below the level of the site. Land to the southeast is level with the boundaries within the development and, therefore, run-off from outside the site is considered to be low risk.

4.11 Flooding from Groundwater - There has been no intrusive investigation of the ground conditions, but a review of the Geological Survey of Great Britain shows that the site is situated on undifferentiated strata of mudstones, siltstones and sandstones of the Middle Coal Measures. Whilst there is no drift cover shown, it is likely that there has been weathering of the natural soils to a clay subsoil. These soils will prevent issues of groundwater on the site and flooding from this source is considered to be low risk.

4.12 Flooding from Sewer - A new drainage system will need to be introduced onto the site and it is possible that any blockage will result in flooding from the lowest cover level of manholes or gullies. This will need to be considered as part of any proposed development.

4.13 Flooding from Reservoirs, Canals or Artificial Sources - There are no other reservoirs, canals or artificial sources which result in flooding on the site.

Climate Change

4.14 The NPPF and PPG have indicated that the Global sea level will continue to rise, depending on greenhouse gas emissions, and the sensitivity of the climate system and there will be an increase in rainfall across the country. The PPG makes reference to the Environment Agency guidance for Climate Change and Table 2 makes an assessment of the increase in peak rainfall intensity and that this is likely to increase by 20% between 2055 and 2085 and by 30% between 2085 and 2115.

4.15 The land to the southwest is a built-up commercial area and will have a positive drainage system which will prevent run-off into the site. Land to the other boundaries is either lower than or level with the site and, therefore, any run-off from outside the site will be insignificant. On this basis, only rainfall falling within the site boundaries will need to be considered in respect of climate change.

4.16 In accordance with the PPG, the published figures show that, for an expected life of greater than 50 years for any new development, the anticipated increase in rainfall will be around 30%. It will be necessary to design any new positive drainage system with a 30% increase in capacity to accommodate this requirement.

Flood Mitigation

4.17 As the development site falls within Flood Zone 1, the Sequential Test is satisfied and there are no requirements for mitigation measures for this particular site. However, in the event of a catastrophic storm or blockage of the proposed drainage system, then it would be necessary to consider some precautionary flood mitigation measures, as follows:-

4.17.1 Floor levels to the properties shall be raised above external levels by a minimum of 150mm.

4.17.2 Properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.

4.17.3 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from above and not below ground levels.

4.17.4 It will be necessary to ensure there is a flood route through the site by designing external levels to allow water to be directed to non-critical areas.

Sustainable Drainage

4.18 In order to comply with the requirements of NPPF, it will be necessary to consider aspects of Sustainable Drainage techniques for the new development. Whilst no intrusive soil investigation has been carried out, a review of the Geological Survey of Great Britain shows that the site is located on undifferentiated mudstones, siltstones and sandstones of the Middle Coal Measures with no drift cover. However, the natural strata will have weathered to a clay subsoil and it is highly likely these soils will be impermeable and unsuitable for soil infiltration drainage systems. It will be necessary to carry out testing in accordance with BRE Digest 365 'Soakaway Design' to confirm that the upper stratum is impermeable, but, for the purposes of this report, a positive drainage system will be required.

Drainage

4.19 It is a requirement to ensure that surface water run-off from any proposed development has negligible consequence on downstream areas either in sewer capacity or discharge to watercourse.

Existing Surface Water Run-Off

4.20 There has been no development on the existing site for some time and, therefore, a greenfield run-off rate with a maximum discharge of 5l/s would apply.

Proposed Surface Water Drainage

4.21 It will be necessary to carry out percolation testing on the site in accordance with BRE Digest 365 'Soakaway Design' to calculate the infiltration rate of the natural soils and also ensure that the water does not re-emerge downslope to the northwest and northeast. It is anticipated that soakaways will prove to be unsuccessful in this area and there are no suitable watercourses in the vicinity to receive discharge. Therefore, negotiations with Yorkshire Water and the Highway Authority are required to determine a suitable outfall for discharge for surface water from the development. It is noted that there is a surface water sewer to the north of the development which may or may not be accessible by gravity. Correspondence has been entered into with Yorkshire Water regarding the possibility of outfall to this location and this is presented in Appendix F. However, it is also noted that there are gullies and a manhole system in Sandygate Lane and that, as there is no sewer shown on the sewer record plan, that this must be a highway drain. Therefore, a consultation has also been requested from the Highway Authority with a view to confirming the presence of a highway drain and the possibilities of providing a connection to this drain with a view to requesting adoption by Yorkshire Water under a Section 102 Agreement of the Water Industry Act 1991. The correspondence is also presented in Appendix F for reference.

4.22 Assuming that an agreement can be reached to discharge to sewer/drain if soakaways prove to be unsuitable, indicative calculations have been carried out using the WinDES Source Control Computer Program to assess the likely attenuation. Using the sketch layout of the proposed development, the impermeable area will equate to around 0.196ha. The indicative calculations show that an attenuation of 33.9m³ is required for a 1 in 30 year storm with a discharge rate of 5l/s. This can be achieved by several methods, including oversized pipes, underground tanks or balance ponds. As the site is unsuitable for above ground attenuation, one such option would be to provide the attenuation in 13m of 2.1m x 1.2m box culvert or equivalent. However, it will also be necessary to show that the 1 in 100 year storm plus climate change can be accommodated within the site without causing flooding to the buildings or third party land. The indicative calculations show that, in a worst case scenario with the attenuation accommodated underground, a volume of 64.2m³

is required, which can be provided in 25m of 2.1m x 1.2m box culvert or equivalent. The indicative calculations are presented in Appendix G for reference, but detailed calculations and proposals will need to be prepared and submitted to the Planning Authority for approval prior to construction.

Foul Drainage

4.23 Yorkshire Water have confirmed that foul water can discharge to the existing 375mm diameter public combined sewer in Wombwell Lane to the west of the development. This will require a Requisition Agreement with Yorkshire Water to cross the public footpath and the car park to McDonalds to connect to the sewer.

Emergency Egress During Times of Flood

4.24 It is a requirement under the PPG that occupants should be able to egress any building during times of flood, without being trapped by flood conditions.

4.25 As the site falls within Flood Zone 1, no special mitigation measures are required for emergency egress during times of flood.

## 5.0 COMMENT

5.1 The site falls within Flood Zone 1 and the Sequential Test is satisfied. However, in order to accommodate the possibilities of flood from extreme storm or blocked sewers and surcharge of the watercourse, the following precautionary flood mitigation measures are recommended:-

5.1.1 Ground floors to the properties shall be set above external levels by a minimum of 150mm.

5.1.2 The properties shall be designed without any basements and ground floors shall comprise solid concrete slabs or beam and block with screed construction.

5.1.3 Incoming electricity supplies shall be raised above ground floor level and ground floor electric sockets shall be served by loops from above rather than below ground floor level.

5.1.4 The external alignment of the road and hard paved areas shall be designed to direct any floodwater through the site to non-critical areas to prevent flooding to properties or third party land.

5.2 A 30% increase in rainfall shall be incorporated into any new positive drainage system to satisfy the requirements of climate change.

5.3 It will be necessary to undertake percolation testing to determine any suitable infiltration rate for soakaways, but from a study of the geology of the site and its location of the site, it is assumed that these will be impractical and that a positive drainage system is required. A report will be submitted to the Planning Authority on the testing procedure and results.

5.4 Surface water discharge shall be restricted to a maximum greenfield run-off rate of 5l/s to an outfall location to be agreed with the Highway Authority and Water Authority.

5.5 The proposed surface water drainage system shall be restricted to the agreed discharge rate and outfall point with appropriate attenuation for a 1 in 30 year storm underground. The system shall also be checked for a 1 in 100 year storm plus climate change to ensure that any water can be retained on site without flooding of buildings or third party land. The detailed design and calculations shall be submitted to the Planning Authority for approval prior to construction on the development site.

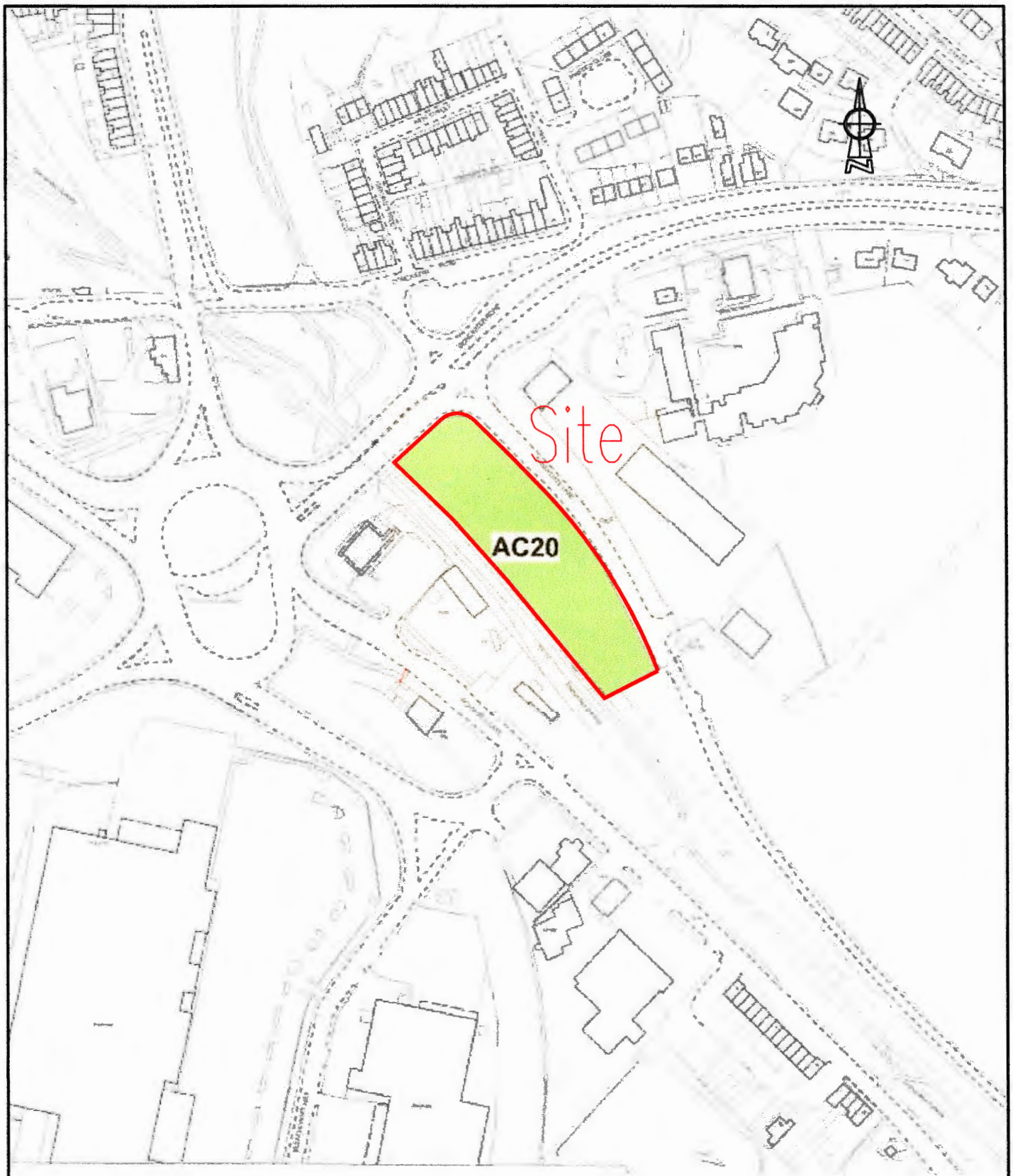
5.6 Foul drainage can discharge to the existing combined sewer in Wombwell Lane via a Requisition Agreement in the Water Industry Act 1991 with Yorkshire Water.

5.7 No special mitigation measures are required for emergency egress during times of flood.

5.8 Subject to compliance with the above, the proposed development can satisfy the requirements of the National Planning Policy Framework and the Planning Practice Guidance in relation to flood risk.

# A P P E N D I X  A

## SITE LOCATION PLAN




| Rev | By | Date | Amendment | Chk |
|---|---|---|---|---|
| / | JMG | 07.03.15 | Issued for approval | ARP |

Title

SITE LOCATION PLAN

Project/Client

DONCASTER ROAD, STAIRFOOT

**BLACKSTONE DEVELOPMENTS LTD**

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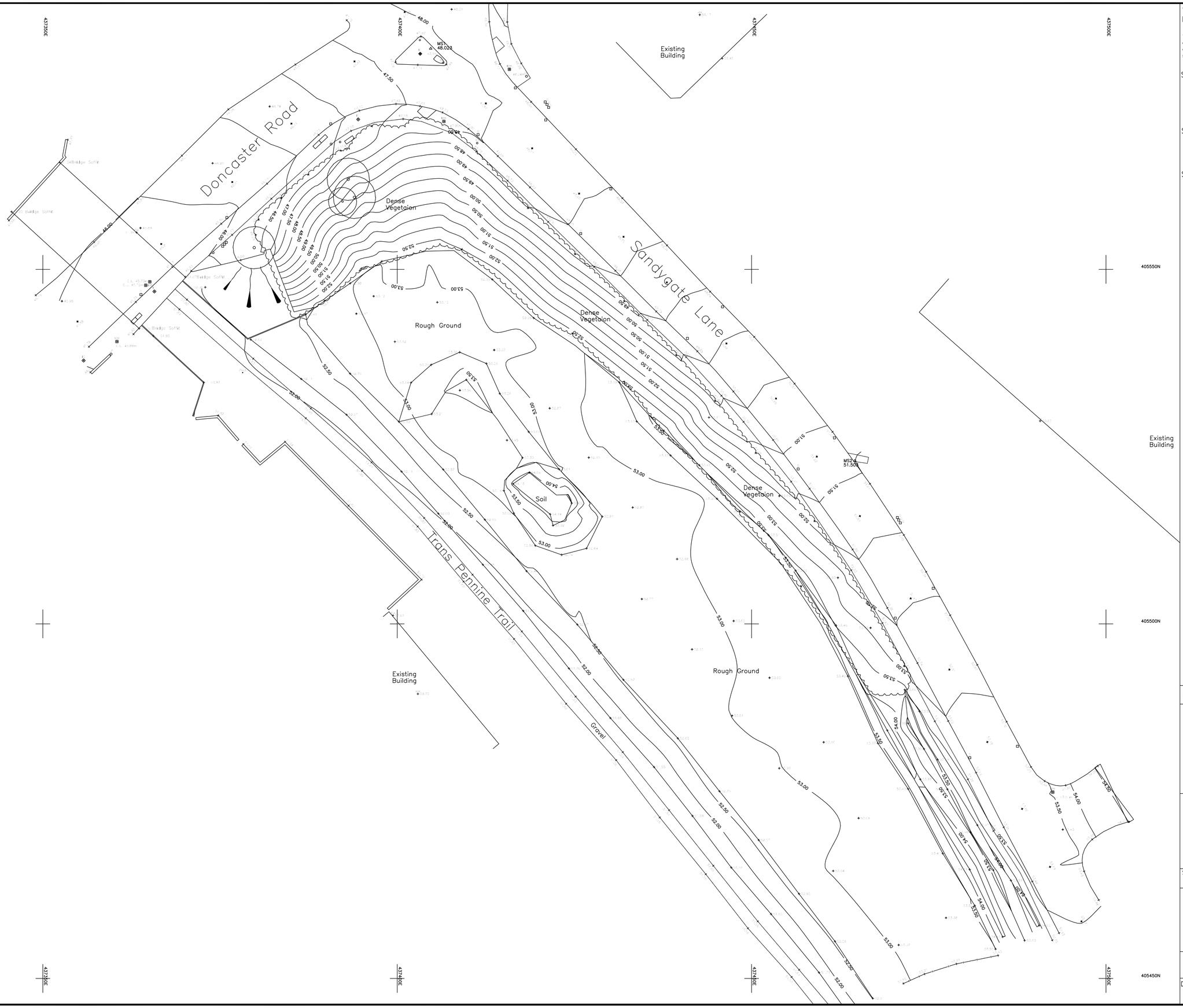
| | |
|---|---|
| Scale: NTS @ A4 | Drawn: JMG |
| Date: MAR 16 | Chk.: ARP |
| Drg. No.: 800/427/FR01 | Rev: / |

# A P P E N D I X  B

# TOPOGRAPHICAL SURVEY






## Notes:

1. The accuracy and content of this drawing are dependent on the surveyed scale and survey specification, care should be taken when working with other plotted scales or from CAD.

## Station Co-Ordinates:

| | | | |
|---|---|---|---|
| MS1 | 437404.722 | 405581.137 | 48.023 |
| MS2 | 437464.567 | 405523.004 | 51.503 |

## Survey Control Data:

Datum for Levels: OS GPS Datum (OSGM02)
Bench Mark: MS1
Value: 48.023m
Grid: Local Grid Based on OSGB36(02) at MS1

## Standard Symbols:

| | |
|---|---|
| MH | Manhole Cover |
| IC | Inspection Cover |
| WOH | Water Outlet Hydrant |
| FH | Fire Hydrant |
| SV | Stop Valve |
| GV | Gas Valve |
| WM | Water Meter |
| UC | Unidentified Cover |
| BT | Telecom Cover |
| LP | Lamp Post |
| TP | Telegraph Pole |
| EP | Electricity Pole |
| SIGN | Sign Post |
| BUS | Bus Stop |
| FP | Flag Pole |
| RTS | Road Traffic Sign |
| TL | Traffic Light |
| CB | Control Box (Traffic) |
| G | Gully |
| RE | Rodding Eye |
| BH | Borehole |
| TrP | Trial Pit |
| JB | Junction Box |
| BOL | Bollard |
| LB | Litter Bin |
| PB | Pillar Box |
| TCB | Telephone Call Box |
| MILE | Milestone |
| MP | Marker Post |
| EC | Electricity Cable |
| GP | Gas Pipe |
| RWP | Rain Water Pipe |
| SVP | Soil and Vent Pipe |
| SP | Soil Pipe |
| VP | Vent Pipe |
| WP | Waste Pipe |
| S/COB | Stone Cobbles |
| SPS | Stone Paving Slabs |
| CPS | Concrete Paving Slabs |
| B/S | Brick Setts |
| ELEC | Electricity Cover |
| OhW | Overhead Wire |
| FL | Floor Level |
| SL | Step Level |
| CL | Cover Level |
| IL | Invert Level |
| B/W | Barbed Wire |
| C/B | Close Boarded |
| C/L | Chain Link |
| W/P | Wood Paling |
| H/R | Hand Rail |
| I/R | Iron Railing |
| I/W | Interwoven |
| O/B | Open Boarded |
| WP/R | Wood Post and Rail |
| CP/R | Concrete Post and Rail |
| CP/T | Concrete Post and Timber Panel |
| P/W | Post and Wire |
| CP/D | Concrete Post and Dropper |
| PAL | Palisade |
| T/S | Tube Steel |
| R/W | Retaining Wall |
| EH | Eaves Height |
| RH | Ridge Height |
| TH | Tree Height |
| SH | Sill Height |
| WH | Wall Height |

Existing Contour
Existing Tree
Tree Stump
Canopy Line

| Rev | Description of revision | Date |
|---|---|---|

**Stamford Geomatics Ltd**
LAND SURVEYING AND VOLUMETRICS
Office 4, The Rear Walled Garden
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Nostell
WF4 1AB
Tel: 01924 862646, 07710 349592
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Site Name:
Stairfoot,
Barnsley,
South Yorkshire.

| Surveyed: | Drawn: | Checked: |
|---|---|---|
| MS | MS | CSm |

Title
Topographical Survey.

| Plotted Scale: | Date: | Sheet Size: |
|---|---|---|
| 1:250 | 18 Jan 16 | A1 |

| Drawing No. | Revision |
|---|---|
| 1908/001 | - |

# A P P E N D I X  C

# WATER AUTHORITY CONSULTATION

YorkshireWater

**Mr A Poyser**
**Arp Associates**
**Unit 5/6 Northwest Business Pk**
**1ST FLR Servia Hill**
**Woodhouse**
**Leeds**
**LS6 2QH**

**Yorkshire Water Services**
**Developer Services**
**Sewerage Technical Team**
**PO BOX 52**
**Bradford**
**BD3 7AY**

**Tel: 0345 120 8482**
**Fax: (01274) 372 834**

**Email:**
**Technical.Sewerage@yorkshirewater.co.uk**

**For telephone enquiries ring:**
**Chris Roberts on 0345 120 8482**

**Your Ref: 800/487**
**Our Ref: S000888**

**2nd February 2016**

Dear Sir,

**Former Railway Sidings, Doncaster Road, Stairfoot, Barnsley - Pre-Planning Sewerage Enquiry on R068758**

Thank you for your recent enquiry. Our charge of £150.00 (plus VAT) will be added to your account with us, reference ARP013. You will receive an invoice for your account in due course.

Please find enclosed a complimentary extract from the Statutory Sewer Map which indicates the recorded position of the public sewers. Please note that as of October 2011 and the private to public sewer transfer, there are many uncharted Yorkshire Water assets currently not shown on our records. The following comments reflect our view, with regard to the public sewer network only, based on a 'desk top' study of the site and are valid for a maximum period of twelve months.

**Existing Infrastructure**

(Please note:- due to the change in legislation on 01/10/2011 there may be public sewers within the site boundary which is not recorded on the Statutory Sewer Map the presence of which should be taken into account in the design of the scheme)

**Foul Water**

Development of the site should take place with separate systems for foul and surface water drainage. The separate systems should extend to the points of discharge to be agreed.

Foul water domestic waste should discharge to the 375 mm diameter public combined sewer recorded in Wombwell Lane, at a point to the West of the site.

**Surface Water**

The developer's attention is drawn to Requirement H3 of the Building Regulations 2000. This establishes a preferred hierarchy for surface water disposal. Consideration should firstly be given to discharge to soakaway, infiltration system and watercourse in that priority order.

Sustainable Drainage Systems (SuDS), for example the use of soakaways and/or permeable hardstanding etc, may be a suitable solution for surface water disposal appropriate in this situation. You are advised to seek comments on the suitability of SuDS in this instance from the appropriate authorities.

As the proposal site is currently undeveloped no surface water is known to have previously discharged to the public sewer network

As such, the local public sewer network does not have capacity to accept any surface water from the proposed site. If SuDS are not viable, the developer is advised to contact the Environment Agency/local Land Drainage Authority with a view to establishing a suitable watercourse for discharge.

It is understood that a watercourse is located through/to the of the site. This appears to be the obvious place for surface water disposal (if SuDS are not viable).

Please note further restrictions on surface water disposal from the site may be imposed by other parties. You are strongly advised to seek advice/comments from the Environment Agency/Land Drainage Authority, with regard to surface water disposal from the site.

**Other Observations**

Any new connection to an existing public sewer will require the prior approval of Yorkshire Water. You may obtain an application form from our website (www.yorkshirewater.com) or by telephoning 0345 120 84 82.

An off-site foul and surface water sewer may be required which may be provided by the developer and considered for adoption under Section 104 of the Water Industry Act 1991. Please telephone 0345 120 84 82 for advice on sewer adoptions. Alternatively, the developer may in certain circumstances be able to requisition off-site sewers under Section 98 of the Water Industry Act 1991 for which an application must be made in writing. For further information, please telephone 0345 120 84 82.

Prospectively adoptable sewers and pumping stations must be designed and constructed in accordance with the WRc publication "Sewers for Adoption - a design and construction guide for developers" 6th Edition as supplemented by Yorkshire Water's requirements, pursuant to an agreement under Section 104 of the Water Industry Act 1991. An application to enter into a Section 104 agreement must be made in writing prior to any works commencing on site. Please contact our Developer Services Team (telephone 0345 120 84 82) for further information.

The public sewer network is for domestic sewage purposes. This generally means foul water for domestic purposes and, where a suitable surface water or combined sewer is available, surface water from the roofs of buildings together with surface water from paved areas of land appurtenant to those buildings. Land and highway drainage have no right of connection to the public sewer network. No land drainage to be connected/discharged to public sewer.

As a last resort, highway drainage may be accepted under certain circumstances. If it can be demonstrated, through satisfactory evidence, that SUDS are not a viable option, there are no watercourses or highway drains available and if capacity is available within the public sewer network, highway drainage discharges to the public sewer network may be permitted. In this event, the developer may be required to enter into a formal agreement with Yorkshire Water Services under Section 115 Water Industry Act 1991 to discharge non-domestic flows into the public sewer network.

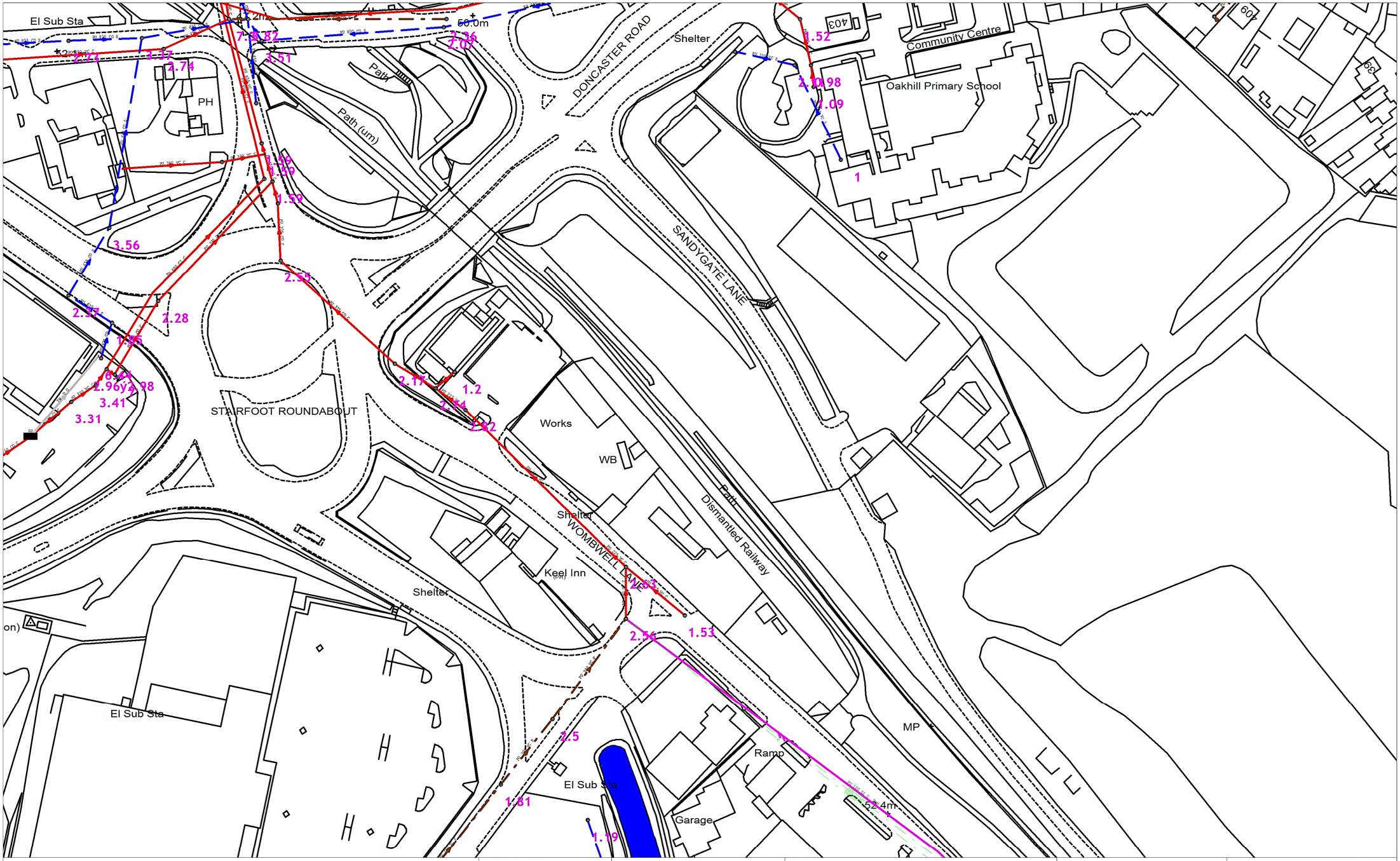
All the above comments are based upon the information and records available at the present time. The information contained in this letter together with that shown on any extract from the Statutory Sewer Map that may be enclosed is believed to be correct and is supplied in good faith.

YorkshireWater

Please note that capacity in the public sewer network is not reserved for specific future development. It is used up on a 'first come, first served' basis. You should visit the site and establish the line and level of any public sewers affecting your proposals before the commencement of any design work.

Yours sincerely

**Chris Roberts**
**Sewerage Technician**
**Developer Services**




| | | | |
|---|---|---|---|
| | 437231 : 405345 | Map Name : SE3705SW | Title |
| | YorkshireWater | Yorkshire Water,<br>PO Box 500,<br>Halifax Road,<br>Bradford BD6 2LZ<br>Contact Name :<br>YorMap Advisor C ROBERTS<br>Contact Tel : 87 2582 | Notes |



Partial Key

Foul Sewer = F
Combined Sewer = C
Surface Water Sewer = SW
Trade Sewer = TD
Partially Separate = PS



Date Req : 02/02/2016, 09:18:53

Date Gen : 02/02/2016, 09:19:26

Source : Sewer Network Enquiry

UPN: Undefined

Originator: C ROBERTS, YorMap, 87 2582

# A P P E N D I X  D

# LAND DRAINAGE AUTHORITY CONSULTATION

## Allan Poyser

**From:** Bell , Derek <DerekBell@barnsley.gov.uk>
**Sent:** Thursday 3 March, 2016 10:12 am
**To:** Allan Poyser
**Subject:** RE: 800/427 Doncaster Road, Stairfoot

Allan,

The Council have no records of any culverted or open watercourses crossing the site indicated on the attached plan.

I am not aware of any flooding issues associated with the site, and would confirm that to my knowledge it is not affected by any flood plains from major watercourses in the area.

The developer's attention is drawn to the following:

There should be no increase in surface water runoff from the new development and the management of flood risk is not simply restricted to flood plains and that a catchment-wide approach should be employed.

There is a combined public sewer adjacent to this site on Wombwell Lane. The developer should contact Yorkshire Water if they wish to discharge to this sewer to discuss allowable discharge rates.

Any balancing facility should be designed to accommodate a 1 in 30 year flow from the site below ground and a 1 in 100 year flow retained within the site (including an allowance of 30% for climate change), without causing any flooding to buildings.

There are alternatives to conventional storage for the control of surface water run-off that are favoured by the authority where ground conditions are suitable. Sustainable Urban Drainage techniques (SUD's) tackle surface water run-off problems at source using features such as soakaways, permeable pavements, grassed swales, infiltration trenches, ponds and wetlands to attenuate flood peak flows, produce water quality improvements and environmental enhancements.

The authority seeks to promote the use of SUD's techniques to this site and the authority expects the developer of the site to submit detailed investigations such that the use of SUD's has been fully explored.

***Regards ~ Derek***

**Derek Bell**
Principal Network Resilience Manager
Environment & Transport
Barnsley Metropolitan Borough Council, Westgate Plaza 1, PO Box 601, Barnsley, S70 9FA*

** Sat Nav Reference - **S70 2DR***

Tel: Ext - 01226 787654 Int - 6654
Mob: 07773 783184
Fax: 01226 772196
E-mail: DerekBell@barnsley.gov.uk

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**From:** Allan Poyser [mailto:AllanPoyser@arpassociates.co.uk]
**Sent:** 03 March 2016 09:49
**To:** Bell , Derek
**Subject:** FW: 800/427 Doncaster Road, Stairfoot

# A P P E N D I X  E

## PROPOSED DEVELOPMENT LAYOUT


## Accommodation Schedule

| | | |
|---|---|---|
| A | TYPE A<br>3 Bed Townhouse | 12no. |
| B | TYPE B<br>3 Bed Townhouse | 2no. |
| | TOTAL UNITS | 14no. |

## Legend

- INDICATIVE LANDSCAPING
- EXISTING LANDSCAPING TO BE RETAINED
- EXISTING LANDSCAPING TO BE REMOVED
- EXISTING TREE TO BE RETAINED
- TURF
- 1800mm SCREEN FENCE
- 1800mm SCREEN WALL/FENCE
- BLOCK PAVING

Client
Blackstone Developments Ltd

Location
Doncaster Road, Stairfoot, Barnsley

Drawing Title
Planning Layout

| | | | |
|---|---|---|---|
| Drg No. | PL/001 | Scale: | 1/500 @ A3 |
| Drawn By: | - | Checked By: | |
| Date : | 03.03.16 | Revision : | 0 |

# A P P E N D I X  F

# CORRESPONDENCE WITH HIGHWAY AND WATER AUTHORITIES

ARP ASSOCIATES
CHARTERED CONSULTING ENGINEERS

Head Office:
5/6 Northwest Business Park
Servia Hill
Leeds LS6 2QH

0113 2458498
0113 2443864
leeds@arpassociates.co.uk
www.arpassociates.co.uk

Barnsley Metropolitan Borough
Council
Highways, Engineering & Waste
PO Box 601
Barnsley
S70 2FA

Our Ref: 800/427/ARPjc

8th March 2016

-- Dear Sirs

Blackstone Developments Ltd
Sandygate Gate Lane/Doncaster Road, Stairfoot, Barnsley

Our Clients are proposing to construct commercial development on land adjacent to Sandygate Lane at the above site. We have enclosed a site location plan and confirmed that the Ordnance Survey Grid Reference is 437450, 405000.

We have held consultations with Yorkshire Water and your Drainage Department, as Land Drainage Authority, for this area and confirm that there are no appropriate watercourses or sewers which would be able to receive surface water discharge from the development. Whilst it will be necessary to carry out percolation testing on the site, in accordance with BRE Digest 365 'Soakaway Design', to calculate the infiltration rate of the natural soils and also ensure that water does not remerge downslope to the northwest and northeast, the general geology on the site is anticipated to show that soakaways will be unsuccessful.

We are aware from the site walkover that there are gullies and manholes in Sandygate Lane, but there are no sewers shown on the sewer record map. We assume, therefore, that there is a highway drain in Sandygate Lane and we would request your comments on the possibility of discharging surface water from the commercial development to the highway drain at a rate of no more than 5l/s. We appreciate that it will be necessary to consult with Yorkshire Water, with a view to requesting that the highway drain is adopted by Yorkshire Water under a Section 102 Agreement of the Water Industry Act 1991, but would appreciate any information that may be pertinent on your records to the size and depth of the highway drain and its outfall location in Sandygate Lane, and any comment on our request for surface water connection from the development.

We thank you in anticipation of your co-operation and early response in this matter.

Yours faithfully
for ARP ASSOCIATES

A R Poyser

Enc

**A R P  A S S O C I A T E S**
**CHARTERED CONSULTING ENGINEERS**

Head Office:
5/6 Northwest Business Park
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☎ 0113 2458498
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🌐 www.arpassociates.co.uk

Mr C Roberts
Yorkshire Water Services
Developer Services
Sewerage Technical Team
PO Box 52
Bradford
BD3 7AY

**BY E-MAIL**

Your Ref: S000888

Our Ref: 800/427/ARPmjs

8th March 2016

-- Dear Chris

Blackstone Developments Ltd
Former Railway Sidings, Doncaster Road, Stairfoot, Barnsley
Pre-planning Sewerage Enquiry on R068758

We refer to your pre-planning sewerage enquiry, received on the 2nd February 2016, in respect of the above site. Your comments on surface water disposal are noted and we have made an assessment on the likely suitability of soakaways on the site and the presence of watercourses in the vicinity.

Whilst it will be necessary to carry out soakaway testing on the site, in accordance with BRE Digest 365 'Soakaway Design', to assess the suitability of soakaways on the site, and also ensure that water does not re-emerge downslope to the northwest and northeast, it is anticipated that infiltration systems to the soils will prove to be unsuccessful. We have also received consultations from Barnsley Metropolitan District Council, as Land Drainage Authority, and they have confirmed that there are no records of culverted or open watercourses crossing the site or within the vicinity.

In these circumstances, you will appreciate that it is likely there is no suitable surface water outfall for the proposed commercial development. We do note, however, that there is a 600mm diameter surface water sewer in Doncaster Road approximately 60m to the northwest and we would request your consideration to a maximum surface water discharge rate of 5l/s from the new development to this location.

We are also aware of gullies and the manholes present on Sandygate Lane and assume that this is a highway drain serving Sandygate Lane, although there is a new development to the east of this highway which may or may not connect to the system. We have written to the Highway Authority with a view to looking into a connection from the development to this location and, if an agreement can be reached, what circumstances would Yorkshire Water consider if they request for a Section 102 Agreement of the Water Industry Act 1991 was requested.

ARP ASSOCIATES

We would appreciate your review and comments on the two options stated above, which are both subject to confirmation that soakaways are inappropriate on this site.

We thank you in anticipation of your co-operation and early response on this matter.

Yours sincerely
for ARP ASSOCIATES

A R Poyser

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# A P P E N D I X  G

# INDICATIVE SURFACE WATER DRAINAGE CALCULATIONS

ARP ASSOCIATES
AND GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

5/6 Northwest Business Park
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Leeds
LS6 2QH
Tel: 0113 245 8498
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E-Mail: leeds@arpassociates.co.uk

| | | |
|---|---|---|
| Client: Blackstone Development | Project No. 800/427 | Sheet 1 of 11 |
| Project: Doncaster Road, Stairfoot | Calc By. ARP | Date. 03/03/16 |
| Element: Surface Water Drainage | Chkd By. | Date. |

## Proposed Impermeable Area ($I_{P\,PROP}$)

Using the proposed layout on page 2

$I_{P\,PROP}$ = $(10.5 \times 8.5 \times 6N°) + (17.5 \times 7.5)$ Units
$+(51.5 \times 6.7) + (8.0 \times 6.7) + (4.5 \times 10.5\,av)$ Road
$+(9.0 \times 10.5)$
$+(5.0 \times 2.4 \times 28N°)$ park spaces.
$(24.0 \times 8.0\,av) + (18.0 \times 7.0\,av)$ access
$+(16.5 \times 6.0)$

= 1960.15 m²

$I_{P\,PROP}$ = 0.196 ha

## Proposed Attenuation

Using WinDES Source Control Computer Program with the following parameters :-

$Q_{PROP}$ = 5 l/s

$I_{P\,PROP}$ = 0.196 ha

Storm Intensity = 1 in 30 years

∴ Attenuation = 33.9 m³

This can be accommodated by 13m of 2.1m x 1.2m Box Culvert or equivalent

Computer Output Sheets are presented on pages 4-7

800/427 2 of 11
ARP 03/03/16

SANDYGATE LANE
SKETCH LAYOUT N° 2.
23.2.16.

ARP ASSOCIATES
AND GEOTECHNICAL LTD
CHARTERED CONSULTING ENGINEERS

5/6 Northwest Business Park
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Leeds
LS6 2QH
Tel: 0113 245 8498
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E-Mail: leeds@arpassociates.co.uk

| | | | |
|---|---|---|---|
| Client: Blackstone Developments | | Project No. 800/427 | Sheet 3 of 11 |
| Project: Doncaster Road, Stairfoot | | Calc By. ARP | Date. 03/03/16 |
| Element: Surface Water Drainage | | Chkd By. | Date. |

Again using the WinDES Source Control Computer Program, using the following parameters

$Q_{peak}$ = 5 l/s.

$I_{peak}$ = 0.196 ha

Storm Intensity = 1 in 100 year

Climate Change = + 30%

∴ Attenuation = 64.2 $m^3$.

This can be accommodated by 25m of 2.1m x 1.2m Box Culvert or equivalent

The Computer Output sheets are presented on pages 8 - 11

## Summary of Results for 30 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 100.802 | 0.802 | 5.0 | 0.0 | 5.0 | 22.3 | O K |
| 30 min Summer | 100.972 | 0.972 | 5.0 | 0.0 | 5.0 | 27.2 | O K |
| 60 min Summer | 101.046 | 1.046 | 5.0 | 0.0 | 5.0 | 29.2 | O K |
| 120 min Summer | 101.025 | 1.025 | 5.0 | 0.0 | 5.0 | 28.7 | O K |
| 180 min Summer | 100.967 | 0.967 | 5.0 | 0.0 | 5.0 | 27.0 | O K |
| 240 min Summer | 100.897 | 0.897 | 5.0 | 0.0 | 5.0 | 25.0 | O K |
| 360 min Summer | 100.736 | 0.736 | 5.0 | 0.0 | 5.0 | 20.5 | O K |
| 480 min Summer | 100.572 | 0.572 | 5.0 | 0.0 | 5.0 | 15.8 | O K |
| 600 min Summer | 100.447 | 0.447 | 5.0 | 0.0 | 5.0 | 12.3 | O K |
| 720 min Summer | 100.352 | 0.352 | 5.0 | 0.0 | 5.0 | 9.6 | O K |
| 960 min Summer | 100.229 | 0.229 | 4.8 | 0.0 | 4.8 | 6.1 | O K |
| 1440 min Summer | 100.127 | 0.127 | 4.2 | 0.0 | 4.2 | 3.2 | O K |
| 2160 min Summer | 100.093 | 0.093 | 3.2 | 0.0 | 3.2 | 2.3 | O K |
| 2880 min Summer | 100.079 | 0.079 | 2.6 | 0.0 | 2.6 | 1.9 | O K |
| 4320 min Summer | 100.064 | 0.064 | 1.9 | 0.0 | 1.9 | 1.5 | O K |
| 5760 min Summer | 100.056 | 0.056 | 1.5 | 0.0 | 1.5 | 1.2 | O K |
| 7200 min Summer | 100.051 | 0.051 | 1.3 | 0.0 | 1.3 | 1.1 | O K |
| 8640 min Summer | 100.047 | 0.047 | 1.1 | 0.0 | 1.1 | 1.0 | O K |
| 10080 min Summer | 100.044 | 0.044 | 1.0 | 0.0 | 1.0 | 0.9 | O K |
| 15 min Winter | 100.909 | 0.909 | 5.0 | 0.0 | 5.0 | 25.4 | O K |
| 30 min Winter | 101.110 | 1.110 | 5.0 | 0.0 | 5.0 | 31.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 70.587 | 0.0 | 25.9 | 0.0 | 21 |
| 30 min Summer | 46.427 | 0.0 | 34.1 | 0.0 | 35 |
| 60 min Summer | 29.238 | 0.0 | 43.0 | 0.0 | 58 |
| 120 min Summer | 17.884 | 0.0 | 52.6 | 0.0 | 92 |
| 180 min Summer | 13.275 | 0.0 | 58.5 | 0.0 | 126 |
| 240 min Summer | 10.697 | 0.0 | 62.9 | 0.0 | 162 |
| 360 min Summer | 7.858 | 0.0 | 69.3 | 0.0 | 230 |
| 480 min Summer | 6.313 | 0.0 | 74.2 | 0.0 | 288 |
| 600 min Summer | 5.324 | 0.0 | 78.3 | 0.0 | 346 |
| 720 min Summer | 4.630 | 0.0 | 81.7 | 0.0 | 402 |
| 960 min Summer | 3.713 | 0.0 | 87.3 | 0.0 | 514 |
| 1440 min Summer | 2.716 | 0.0 | 95.8 | 0.0 | 740 |
| 2160 min Summer | 1.985 | 0.0 | 105.0 | 0.0 | 1104 |
| 2880 min Summer | 1.587 | 0.0 | 112.0 | 0.0 | 1472 |
| 4320 min Summer | 1.158 | 0.0 | 122.5 | 0.0 | 2196 |
| 5760 min Summer | 0.925 | 0.0 | 130.5 | 0.0 | 2936 |
| 7200 min Summer | 0.776 | 0.0 | 136.9 | 0.0 | 3632 |
| 8640 min Summer | 0.673 | 0.0 | 142.4 | 0.0 | 4304 |
| 10080 min Summer | 0.596 | 0.0 | 147.2 | 0.0 | 5032 |
| 15 min Winter | 70.587 | 0.0 | 29.1 | 0.0 | 21 |
| 30 min Winter | 46.427 | 0.0 | 38.2 | 0.0 | 35 |

## Summary of Results for 30 year Return Period

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 60 min Winter | 101.215 | 1.215 | 5.0 | 0.0 | 5.0 | 33.9 | O K |
| 120 min Winter | 101.175 | 1.175 | 5.0 | 0.0 | 5.0 | 32.9 | O K |
| 180 min Winter | 101.085 | 1.085 | 5.0 | 0.0 | 5.0 | 30.3 | O K |
| 240 min Winter | 100.978 | 0.978 | 5.0 | 0.0 | 5.0 | 27.3 | O K |
| 360 min Winter | 100.721 | 0.721 | 5.0 | 0.0 | 5.0 | 20.1 | O K |
| 480 min Winter | 100.477 | 0.477 | 5.0 | 0.0 | 5.0 | 13.1 | O K |
| 600 min Winter | 100.318 | 0.318 | 5.0 | 0.0 | 5.0 | 8.6 | O K |
| 720 min Winter | 100.220 | 0.220 | 4.8 | 0.0 | 4.8 | 5.9 | O K |
| 960 min Winter | 100.127 | 0.127 | 4.2 | 0.0 | 4.2 | 3.3 | O K |
| 1440 min Winter | 100.093 | 0.093 | 3.1 | 0.0 | 3.1 | 2.3 | O K |
| 2160 min Winter | 100.073 | 0.073 | 2.3 | 0.0 | 2.3 | 1.7 | O K |
| 2880 min Winter | 100.064 | 0.064 | 1.8 | 0.0 | 1.8 | 1.4 | O K |
| 4320 min Winter | 100.053 | 0.053 | 1.3 | 0.0 | 1.3 | 1.1 | O K |
| 5760 min Winter | 100.047 | 0.047 | 1.1 | 0.0 | 1.1 | 1.0 | O K |
| 7200 min Winter | 100.042 | 0.042 | 0.9 | 0.0 | 0.9 | 0.8 | O K |
| 8640 min Winter | 100.039 | 0.039 | 0.8 | 0.0 | 0.8 | 0.8 | O K |
| 10080 min Winter | 100.037 | 0.037 | 0.7 | 0.0 | 0.7 | 0.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 29.238 | 0.0 | 48.1 | 0.0 | 62 |
| 120 min Winter | 17.884 | 0.0 | 58.9 | 0.0 | 96 |
| 180 min Winter | 13.275 | 0.0 | 65.6 | 0.0 | 136 |
| 240 min Winter | 10.697 | 0.0 | 70.4 | 0.0 | 174 |
| 360 min Winter | 7.858 | 0.0 | 77.6 | 0.0 | 246 |
| 480 min Winter | 6.313 | 0.0 | 83.2 | 0.0 | 300 |
| 600 min Winter | 5.324 | 0.0 | 87.7 | 0.0 | 354 |
| 720 min Winter | 4.630 | 0.0 | 91.5 | 0.0 | 404 |
| 960 min Winter | 3.713 | 0.0 | 97.8 | 0.0 | 504 |
| 1440 min Winter | 2.716 | 0.0 | 107.3 | 0.0 | 738 |
| 2160 min Winter | 1.985 | 0.0 | 117.6 | 0.0 | 1104 |
| 2880 min Winter | 1.587 | 0.0 | 125.5 | 0.0 | 1460 |
| 4320 min Winter | 1.158 | 0.0 | 137.2 | 0.0 | 2172 |
| 5760 min Winter | 0.925 | 0.0 | 146.1 | 0.0 | 2888 |
| 7200 min Winter | 0.776 | 0.0 | 153.4 | 0.0 | 3632 |
| 8640 min Winter | 0.673 | 0.0 | 159.5 | 0.0 | 4360 |
| 10080 min Winter | 0.596 | 0.0 | 164.9 | 0.0 | 5008 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 30 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.377 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +0 |

## Time Area Diagram

Total Area (ha) 0.196

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.000 | 4 | 8 | 0.196 |

## Model Details

Storage is Online Cover Level (m) 102.500

## Box Culvert Structure

Height (m) 1.200 Slope (1:X) 500.000 Downstream Invert (m) 100.000
Width (m) 2.100 Length (m) 13.000

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0102-5000-1226-5000 |
| Design Head (m) | 1.226 |
| Design Flow (l/s) | 5.0 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Diameter (mm) | 102 |
| Invert Level (m) | 100.000 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.226 | 5.0 |
| Flush-Flo™ | 0.359 | 5.0 |
| Kick-Flo® | 0.756 | 4.0 |
| Mean Flow over Head Range | - | 4.4 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.4 | 1.200 | 4.9 | 3.000 | 7.6 | 7.000 | 11.3 |
| 0.200 | 4.7 | 1.400 | 5.3 | 3.500 | 8.2 | 7.500 | 11.7 |
| 0.300 | 5.0 | 1.600 | 5.6 | 4.000 | 8.7 | 8.000 | 12.1 |
| 0.400 | 5.0 | 1.800 | 6.0 | 4.500 | 9.2 | 8.500 | 12.4 |
| 0.500 | 4.9 | 2.000 | 6.3 | 5.000 | 9.7 | 9.000 | 12.8 |
| 0.600 | 4.7 | 2.200 | 6.6 | 5.500 | 10.1 | 9.500 | 13.1 |
| 0.800 | 4.1 | 2.400 | 6.8 | 6.000 | 10.5 | | |
| 1.000 | 4.5 | 2.600 | 7.1 | 6.500 | 10.9 | | |

## Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.100 Invert Level (m) 101.226

## Summary of Results for 100 year Return Period (+20%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 100.708 | 0.708 | 4.9 | 0.0 | 4.9 | 36.6 | O K |
| 30 min Summer | 100.893 | 0.893 | 4.9 | 0.0 | 4.9 | 46.5 | O K |
| 60 min Summer | 101.025 | 1.025 | 4.9 | 0.0 | 4.9 | 53.5 | O K |
| 120 min Summer | 101.057 | 1.057 | 4.9 | 0.0 | 4.9 | 55.3 | O K |
| 180 min Summer | 101.032 | 1.032 | 4.9 | 0.0 | 4.9 | 53.9 | O K |
| 240 min Summer | 100.993 | 0.993 | 4.9 | 0.0 | 4.9 | 51.8 | O K |
| 360 min Summer | 100.909 | 0.909 | 4.9 | 0.0 | 4.9 | 47.3 | O K |
| 480 min Summer | 100.826 | 0.826 | 4.9 | 0.0 | 4.9 | 42.9 | O K |
| 600 min Summer | 100.737 | 0.737 | 4.9 | 0.0 | 4.9 | 38.1 | O K |
| 720 min Summer | 100.632 | 0.632 | 4.9 | 0.0 | 4.9 | 32.5 | O K |
| 960 min Summer | 100.469 | 0.469 | 4.9 | 0.0 | 4.9 | 23.8 | O K |
| 1440 min Summer | 100.268 | 0.268 | 4.9 | 0.0 | 4.9 | 13.0 | O K |
| 2160 min Summer | 100.144 | 0.144 | 4.4 | 0.0 | 4.4 | 6.4 | O K |
| 2880 min Summer | 100.110 | 0.110 | 3.8 | 0.0 | 3.8 | 4.6 | O K |
| 4320 min Summer | 100.082 | 0.082 | 2.8 | 0.0 | 2.8 | 3.1 | O K |
| 5760 min Summer | 100.070 | 0.070 | 2.2 | 0.0 | 2.2 | 2.4 | O K |
| 7200 min Summer | 100.062 | 0.062 | 1.8 | 0.0 | 1.8 | 2.0 | O K |
| 8640 min Summer | 100.057 | 0.057 | 1.6 | 0.0 | 1.6 | 1.7 | O K |
| 10080 min Summer | 100.053 | 0.053 | 1.4 | 0.0 | 1.4 | 1.5 | O K |
| 15 min Winter | 100.798 | 0.798 | 4.9 | 0.0 | 4.9 | 41.4 | O K |
| 30 min Winter | 101.010 | 1.010 | 4.9 | 0.0 | 4.9 | 52.7 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 15 min Summer | 109.644 | 0.0 | 40.3 | 0.0 | 22 |
| 30 min Summer | 72.786 | 0.0 | 53.5 | 0.0 | 36 |
| 60 min Summer | 46.096 | 0.0 | 67.8 | 0.0 | 66 |
| 120 min Summer | 28.220 | 0.0 | 83.0 | 0.0 | 108 |
| 180 min Summer | 20.893 | 0.0 | 92.1 | 0.0 | 140 |
| 240 min Summer | 16.775 | 0.0 | 98.6 | 0.0 | 174 |
| 360 min Summer | 12.243 | 0.0 | 108.0 | 0.0 | 244 |
| 480 min Summer | 9.795 | 0.0 | 115.2 | 0.0 | 314 |
| 600 min Summer | 8.233 | 0.0 | 121.0 | 0.0 | 384 |
| 720 min Summer | 7.139 | 0.0 | 125.9 | 0.0 | 442 |
| 960 min Summer | 5.697 | 0.0 | 134.0 | 0.0 | 560 |
| 1440 min Summer | 4.138 | 0.0 | 146.0 | 0.0 | 784 |
| 2160 min Summer | 3.000 | 0.0 | 158.8 | 0.0 | 1112 |
| 2880 min Summer | 2.385 | 0.0 | 168.3 | 0.0 | 1472 |
| 4320 min Summer | 1.724 | 0.0 | 182.5 | 0.0 | 2204 |
| 5760 min Summer | 1.368 | 0.0 | 193.0 | 0.0 | 2920 |
| 7200 min Summer | 1.142 | 0.0 | 201.5 | 0.0 | 3672 |
| 8640 min Summer | 0.985 | 0.0 | 208.6 | 0.0 | 4392 |
| 10080 min Summer | 0.870 | 0.0 | 214.8 | 0.0 | 5136 |
| 15 min Winter | 109.644 | 0.0 | 45.1 | 0.0 | 22 |
| 30 min Winter | 72.786 | 0.0 | 59.9 | 0.0 | 36 |

## Summary of Results for 100 year Return Period (+20%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Control (l/s) | Max Overflow (l/s) | Max Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 60 min Winter | 101.173 | 1.173 | 4.9 | 0.0 | 4.9 | 61.5 | O K |
| 120 min Winter | 101.250 | 1.250 | 5.0 | 0.0 | 5.0 | 64.2 | O K |
| 180 min Winter | 101.189 | 1.189 | 4.9 | 0.0 | 4.9 | 62.3 | O K |
| 240 min Winter | 101.137 | 1.137 | 4.9 | 0.0 | 4.9 | 59.5 | O K |
| 360 min Winter | 101.012 | 1.012 | 4.9 | 0.0 | 4.9 | 52.8 | O K |
| 480 min Winter | 100.887 | 0.887 | 4.9 | 0.0 | 4.9 | 46.1 | O K |
| 600 min Winter | 100.751 | 0.751 | 4.9 | 0.0 | 4.9 | 38.8 | O K |
| 720 min Winter | 100.582 | 0.582 | 4.9 | 0.0 | 4.9 | 29.8 | O K |
| 960 min Winter | 100.357 | 0.357 | 4.9 | 0.0 | 4.9 | 17.8 | O K |
| 1440 min Winter | 100.156 | 0.156 | 4.5 | 0.0 | 4.5 | 7.0 | O K |
| 2160 min Winter | 100.101 | 0.101 | 3.5 | 0.0 | 3.5 | 4.1 | O K |
| 2880 min Winter | 100.082 | 0.082 | 2.8 | 0.0 | 2.8 | 3.1 | O K |
| 4320 min Winter | 100.066 | 0.066 | 2.0 | 0.0 | 2.0 | 2.2 | O K |
| 5760 min Winter | 100.057 | 0.057 | 1.6 | 0.0 | 1.6 | 1.7 | O K |
| 7200 min Winter | 100.052 | 0.052 | 1.3 | 0.0 | 1.3 | 1.4 | O K |
| 8640 min Winter | 100.047 | 0.047 | 1.1 | 0.0 | 1.1 | 1.2 | O K |
| 10080 min Winter | 100.044 | 0.044 | 1.0 | 0.0 | 1.0 | 1.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Overflow Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|---|
| 60 min Winter | 46.096 | 0.0 | 75.9 | 0.0 | 64 |
| 120 min Winter | 28.220 | 0.0 | 92.9 | 0.0 | 118 |
| 180 min Winter | 20.893 | 0.0 | 103.2 | 0.0 | 148 |
| 240 min Winter | 16.775 | 0.0 | 110.5 | 0.0 | 186 |
| 360 min Winter | 12.243 | 0.0 | 120.9 | 0.0 | 264 |
| 480 min Winter | 9.795 | 0.0 | 129.0 | 0.0 | 340 |
| 600 min Winter | 8.233 | 0.0 | 135.5 | 0.0 | 416 |
| 720 min Winter | 7.139 | 0.0 | 141.0 | 0.0 | 468 |
| 960 min Winter | 5.697 | 0.0 | 150.1 | 0.0 | 574 |
| 1440 min Winter | 4.138 | 0.0 | 163.5 | 0.0 | 780 |
| 2160 min Winter | 3.000 | 0.0 | 177.8 | 0.0 | 1108 |
| 2880 min Winter | 2.385 | 0.0 | 188.5 | 0.0 | 1472 |
| 4320 min Winter | 1.724 | 0.0 | 204.4 | 0.0 | 2208 |
| 5760 min Winter | 1.368 | 0.0 | 216.2 | 0.0 | 2928 |
| 7200 min Winter | 1.142 | 0.0 | 225.7 | 0.0 | 3624 |
| 8640 min Winter | 0.985 | 0.0 | 233.6 | 0.0 | 4256 |
| 10080 min Winter | 0.870 | 0.0 | 240.5 | 0.0 | 5120 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | England and Wales | Cv (Winter) | 0.840 |
| M5-60 (mm) | 19.000 | Shortest Storm (mins) | 15 |
| Ratio R | 0.377 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +20 |

## Time Area Diagram

Total Area (ha) 0.196

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.000 | 4 | 8 | 0.196 |

## Model Details

Storage is Online Cover Level (m) 102.500

## Box Culvert Structure

Height (m) 1.200 Slope (1:X) 500.000 Downstream Invert (m) 100.000
Width (m) 2.100 Length (m) 25.000

## Hydro-Brake Optimum® Outflow Control

| | |
|---|---|
| Unit Reference | MD-SFP-0099-5000-1250-5000 |
| Design Head (m) | 1.250 |
| Design Flow (l/s) | 5.0 |
| Flush-Flo™ | Calculated |
| Objective | Future Proof |
| Diameter (mm) | 99 |
| Invert Level (m) | 100.000 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.250 | 5.0 |
| Flush-Flo™ | 0.325 | 4.9 |
| Kick-Flo® | 0.718 | 3.9 |
| 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 | 3.4 | 1.200 | 4.9 | 3.000 | 7.5 | 7.000 | 11.2 |
| 0.200 | 4.7 | 1.400 | 5.3 | 3.500 | 8.1 | 7.500 | 11.6 |
| 0.300 | 4.9 | 1.600 | 5.6 | 4.000 | 8.6 | 8.000 | 11.9 |
| 0.400 | 4.9 | 1.800 | 5.9 | 4.500 | 9.1 | 8.500 | 12.3 |
| 0.500 | 4.8 | 2.000 | 6.2 | 5.000 | 9.5 | 9.000 | 12.6 |
| 0.600 | 4.5 | 2.200 | 6.5 | 5.500 | 10.0 | 9.500 | 12.9 |
| 0.800 | 4.1 | 2.400 | 6.7 | 6.000 | 10.4 | | |
| 1.000 | 4.5 | 2.600 | 7.0 | 6.500 | 10.8 | | |

## Weir Overflow Control

Discharge Coef 0.544 Width (m) 2.100 Invert Level (m) 101.250