

Client: Persimmon Homes Thames Valley
Project Title: 19163- Sites A2 & B6 Littlehampton, West Sussex
Rev: - 1st Issue
Date – 14th May 2020

**Drainage Consultee Response for Residential Development at Hampton Park,
Parcels A2 & B6, Toddington Road, Littlehampton. Ref LU/90/20/doc**

1.0 Introduction

1.01 Banners Gate have been commissioned by Persimmon Homes Thames Valley to undertake the drainage design for the development. This design has been issued by the Client to discharge pre-commencement Planning drainage conditions and we have been asked to address the subsequent Arun Council Drainage Consultee response dated 5th May 2020. In addition, Southern Water have raised a query relating to an existing foul pumping main which is located adjacent to the eastern boundary of the A2 development parcel.

1.02 The text of the response is indicated below for referencing purposes. In addition, further correspondence has been received requesting information to address the Surface Water Proposals Checklist published jointly by Arun District Council and Chichester District Council. Specific answers are provided to each point raised in blue text with direction to an expanded explanation, as necessary.

From: Paul Cann
Sent: 05 May 2020 12:21
To: Planning.Responses; Sarah Burrow
Subject: RE: Planning Consultation on LU/90/20/DOC

Comments on surface water drainage.

Has infiltration been ruled out on this site? Provide evidence. Please note that all comments below assume that infiltration has been ruled out. If infiltration was proven not to be feasible, then provide evidence of how this phase fits into the overall North Toddington development strategy, including the agreed allowable/discharge rates from this phase. BG- Please refer to section Sections 2.04 to 2.09 inclusive. Infiltration is not feasible due to underlying clay layer and site is at potential risk of solution features. Leap Geotechnical Report advises there may be a risk of swallow holes that cannot be discounted and that it is essential that all efforts to minimise surface water migration into the ground are adhered to. This precludes the use of infiltration method of surface water disposal. Please refer to sections 2.01 & 2.02 and Appendix A- Mayer Brown Surface Water West of Wetlands Drainage Strategy Extracts.

- 1. Provide groundwater monitoring data. Please refer to cl 2.07 and Appendix B which contains extracts of the Leap Environmental Geotechnical Report April 2020. Also refer to Appendix C which confirms the rainfall and river flow data published by EA for reference.*
- 2. With reference to Southern Waters consultation, listing issues to be addressed, please show the foul rising main on the layout drawing/s. Foul Rising Main indicated on drawing 19163/100S104. Extent of tanked permeable paving amended to be 5m from foul rising main. 3m wide easement both sides of existing foul rising main added.*

3. *Are Southern Water adopting any part of the surface water onsite drainage system? Client entering Section 104 Agreement with ICOSA. See section 4.01*
4. *Indicate allowable discharge rates on the plans and provide hydrobrake technical data sheets from the manufacturer. Allowable discharge rates indicated on drawing no 19163/100S104 at control chambers. Hydrobrake tech data sheets and Construction details are contained within Appendix D.*
5. *Provide hydraulic calculations to confirm that the 1 in 100 year storm event (+40% allowance for climate change) can be stored within the system/on site. Planning Condition 10 states surface water attenuation to accommodate 100 year + 30% for climate change is provided. An allowable surface water discharge of 5 l/s per parcel has been confirmed in the approved Mayer Brown Surface Water Strategy. See section 2.02. Refer to Appendix D for calculations.*
6. *Provide fully detailed construction drawings to include manholes including catchpits & hydrobrake chambers, gullies, channel drains, permeable paving and outlet sumps/diffuser unit, storage tanks, rodding eyes, pipe bedding, etc. Please refer to drawing no's 19163/301 REV B,311,323 REV A,326 REV A,GEOlight 750mm – 500mm Datasheet,& Online Bridged Attenuation Tank-Standard Detail.*
7. *Specify materials of all pipework. Pipe materials currently indicated but may be amended to plastic dependant on Client preference and adoption requirements of ICOSA.*
8. *Specify diameter and gradients of ALL pipework on the network. Noted and added. Please refer to drawings no's 19163/100S104,121 REV H,122 REV H.*
9. *Provide a vent on each tank. Geocomposite high level vent indicated. Please refer to Online Bridged Attenuation Tank-Standard Detail.*
10. *Indicate base levels of permeable paving and outlet invert levels. Noted and added.*
11. *Add note that all pipes are to be connected soffit to soffit. Where pipes of differing diameters are connecting to one another, show the connecting invert level. Noted*
12. *Where connections are not being made to manholes, the oblique 45 degree junctions are to be used. Add note. Saddle connection note added.*
13. *Pipes connecting to the 900mm oversized pipe must connect at soffit to soffit level not invert to invert. Can the storage tank be increased in size to remove the need for the 900mm pipe? Design amended to omit oversized pipe and drainage rationalised in Parcel B6. Please refer to drawings 19163/100S104, 121 REV H & 122 REV*
14. *Can the CS2 tank be online rather than offline? Tank now on-line as requested.*
15. *Gully north of HB2 control chamber is connecting against the flow. Reconfigure the arrangements here to improve the situation. Appreciate comment but the road gully connection is discharging to the sump of the hydrobrake. We have endeavoured to try and produce a practical design and taking into consideration the outfall location and the orientation of the various connections believe it is a more practical arrangement. It would be appreciated if the arrangement could be accepted in this instance.*
16. *Western spur – provide diameter/levels/gradient. Noted and added*
17. *Gullies downstream of S8 – stagger connections so not opposite one another. Gully connections amended as requested.*
18. *Alter colour of permeable paving outline ie. not blue, in order to avoid confusion. Noted and amended.*
19. *Specify manhole S18 as a catchpit. Drainage design has been rationalised in this area but a CP has been added to the connection prior to the cellular storage tank.*
20. *Rather than running pipes under the permeable paving, can they be connected into the paving via diffuser units? The tanked permeable construction has been provided to provide a degree of treatment to the surface water runoff from communal carpark areas. The perception is these areas could be at a marginally higher risk of pollution associated with oil leaks etc. The construction of these has been kept relatively shallow. Outlet sumps have been specified at low points in the tanked car park and their purpose is to*

facilitate maintenance and if there are any issues with the operation of the car park in terms of drainage they will be apparent at these points. We have been questioned on the previous schemes on how distributors such as permovoid etc can be maintained which is not practically possible.

Any queries, please let me know.

Regards

*Paul Cann
Principal Engineer (Drainage)*

Paul Cann | Principal Engineer (Drainage), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre, Maltravers Road, Littlehampton, BN17 5LF

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2.00 Surface Water Drainage Design Strategy

2.01 Overall North Toddington Development Strategy.

2.02 We have been in liaison with Mayer Brown who undertook the overall development strategy for North Toddington. Please find attached an email dated 12/05/2020 confirming the proposed site in context with the overall development drainage strategy. Relevant extracts from the Surface Water West of Wetlands Drainage Strategy have been kindly provided by Mayer Brown. This confirms that an allowable surface water discharge of 5 l/s per second for each parcel has been allowed for within the receiving development infrastructure. Please refer to Appendix A.

2.03 The potential for the use of infiltration as a viable method of surface water disposal is discussed below.

2.04 Groundwater, Infiltration & Solution Features

2.05 The Client has commissioned Leap Environmental to undertake a Geotechnical Investigation on the site. Relevant extracts from the report reference LP2128 dated 9th April 2020 have been appended for reference.

2.06 The report has confirmed the site is underlain by firm becoming stiff silty clays up to depths of 3.1m but generally at depths between 1.7m and 2m begl. These were underlain by a loose to medium dense gravelly fine to coarse sand with gravel of flint and occasional sandy ironstone. The sand layer ranged from 1.7m with deeper deposits proven to 6.2m begl. The sand was underlain by chalk bedrock.

2.07 Groundwater monitoring was undertaken on 6 occasions between 17th January a sewer 18th March 2020 has confirmed that the underlying groundwater levels are 5.25m and 5.62m below existing ground levels. It should be noted that this was over a period of sustained winter storms which occurred in February 2020. On inspection of the Weekly Rainfall and River Flow Bulletin. 19th to 25th February

published by Environment Agency a 131% increase over the long-term average rainfall is noted between November 2019 and January 2020. See attached in Appendix C for information.

2.08 Section 26 on Page 34 of the report advises that the site is an area at potential risk of solution features with the underlying chalk strata. There may be a risk of swallow holes that cannot be discounted and that it is essential that all efforts to minimise surface water migration into the ground are adhered to.

2.09 The taking into consideration the clay superficial near surface layer encountered on the site, which will have poor infiltration characteristics; and the advice relating to solution features the use of infiltration as an appropriate method of surface water disposal has been discounted.

3.00 Southern Water Consultee comments.

3.01 As requested the location of the existing foul pumping rising main has been indicated on the revised drawings as indicated on the attached drawing issue sheet. The extent of the indicated proposed tanked permeable paving has been amended to ensure that it is not within 5m of the existing rising main as requested.

4.00 Parcels A2 & B6 Surface Water Drainage Strategy.

4.01 We can confirm that our Client is entering into a Section 104 Agreement with ICOSA Ltd for the adoption of the on-site drainage system. The extent of the proposed adoption is indicated on drawing no. 19163/100. ICOSA are an OFWAT approved NAV, (New Appointments and Variations); company who provide a water / sewerage service to customers in an area which was previously provided by the incumbent provider.

4.02 The proposed foul drainage from each development parcel will discharge into existing foul sewer infrastructure which has been constructed to accommodate them.

4.03 The on-site surface water systems have been designed to restrict the surface water run-off from each development parcel to 5 l/s and surface water attenuation has been provided to accommodate the 100 year + 30% climate change allowance. This is in accordance with Condition 10 of the Planning approval and the agreed overall development strategy promoted by Mayer Brown.

4.05 In order to provide a degree of water quality treatment communal parking areas will be tanked permeable paving construction.

4.06 The attached civil engineering design drawings as indicated on the attached drawing issue sheet have been amended to reflect the additional information requested by Arun Council, Engineering Services, Drainage Section. Details relating to the hydrobrake controls for each parcel have been appended for information. It should be noted that the cellular storage approved for adoption by ICOSA utilises a through pipe at invert level with the storage volume in the form of crates constructed above. This arrangement prevents silt and detritus accumulating within the storage tank and allows for ready access for jetting and maintenance.

5.00 Conclusion

5.01 The A2 & B6 Parcels development strategy is in accordance with the approved overall development strategy promoted by Mayer Brown.

5.02 As required the potential use of infiltration as a viable means of surface water disposal has been explored and discounted due to the encountered site conditions and the recommendations of the Leap Environmental Geotechnical Report

5.03 An existing groundwater level of 5.25m begl has been confirmed through a monitoring exercise.

5.04 The existing Southern Water foul rising main that crosses the site adjacent to the Parcel A2 boundary has been accommodated within the design.

5.05 The on-site sewerage systems have been offered for adoption by the Client to ICOSA under a Section 104 Agreement under the Water Industries Act.

5.06 The design details have been updated and additional information has been added to reflect Arun Council, Engineering Services, Drainage Section comments.

John Byrne-Director. For and on behalf of Banners Gate Ltd

Enc. Appendices

APPENDIX A

Mayer Brown Surface Water West of Wetlands Drainage Strategy Extracts.

John Byrne

From: john byrne [REDACTED]
Sent: 14 May 2020 10:36
To: John Byrne
Subject: FW: 2020-05-11-19163-PARCELS A2 & B6, Littlehampton - Drainage Drawings 112U.PDF; LU.90.20.DOC - ADC DRAINAGE ENGINEERS RESPONSE.PDF; PHLITTLE_Surface Water Drainage Strategy_West of Wetlands_24.01.2019_Text Only.pdf; Appendix I - Drainage Strategy, West of Wetlands.pdf; Appendix C - Arun DC Drainage Correspondence.pdf

From: Sean Foley [REDACTED]
Sent: 12 May 2020 16:16
To: John Byrne [REDACTED]
[REDACTED]

Subject: RE: 2020-05-11-19163-PARCELS A2 & B6, Littlehampton - Drainage Drawings

Hi John,

Each RM application for individual parcel needs to discharge the relevant outline conditions

The drainage related outline planning conditions are:

- Condition 10 – Surface Water Drainage
- Condition 11 & 12 – Watercourse and associated
- Condition 13 – Foul Water

Lots of parcels on the west of wetlands had been approved & built but the conditions were never discharged. Therefore, we completed catch all documents that encompass the almost the entire west of wetlands areas / parcels. All future / remaining RM applications to the west of wetlands areas need to include or refer to these documents. wetransfer link here: <https://we.l/1-uylytMW7oi>

The approval of the Condition 10 document from the Arun drainage team is located in attached Appendix C.

The salient information that I believe you require now is highlighted on the attached text only part of the report.

We agreed 5 litres /second from parcels A2 & B6 (total combined of 10 litres/sec), **BUT** it is also necessary to prove infiltration drainage is not feasible. See paragraphs 2.66 & 2.72. If infiltration is possible it can be used **in conjunction with** the agreed combined discharge of 5 litres / sec.

We did not offer / suggest this initially but had to agree to it in order to get it over the line with Arun DC.

Please call me on the number below if you wish to discuss.

Regards,

Sean Foley
[REDACTED]

Sean Foley

From: Laura Gibbons <Laura.Gibbons@arun.gov.uk>
Sent: 16 January 2019 11:05
To: Sean Foley
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray; Adam Winstone
Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

Condition 10

I am now happy for you to submit the details formally to planning to discharge condition 10.

Condition 11

I think it would be most practical whilst awaiting consent from the EA to provide us with two potential schemes, i.e. one presuming consent is achievable. And one presuming that consent will not be granted which demonstrates sufficient easement to the watercourse.

Please also speak with Tracey Headley-Smith (copied in) regarding this condition.

Condition 12

Please provide evidence that application for consent has been applied for by the end of tomorrow.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre, Maltravers Road, Littlehampton, BN17 5LF

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Save the environment - think before you print.

From: Sean Foley [REDACTED]
Sent: 11 January 2019 16:42
To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray; Adam Winstone
Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

Please see below in red and attached is a link to the updated DOC report that takes these comments into account:
The wetransfer link is here: <https://we.tl/LeCQnN8oBpT>

With this in mind I believe we are now agreed on surface water condition 10, which will hopefully prevent a temporary stop notice being served.

We will endeavour resolve conditions 11 & 12 asap.

Many thanks

Sean Foley

From: Laura Gibbons [mailto:Laura.Gibbons@arun.gov.uk]

Sent: 11 January 2019 13:19

To: Sean Foley

Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

Thanks for the prompt response.

Comments Regarding Condition 10

- The area at point 11 (PN 31.000) in the model and plan are inconsistent. Within the model you have 0.215 ha impermeable area at PN31.000 and 0.043 ha at PN31.001. This is less than the 0.358 ha on plan. The other areas are okay as you have clarified that they are totals.

MBL Response: You are correct. The modelled figure at PN31.000 did not match the plan. The model was okay but the plan was not. This is now updated on the plan as a 60/40 split between PN31.000 & PN18.000. Has been updated on appendix H

- The attenuation volume on plan at 3.000 is inconsistent to that in the model, 80m³ and 92m³ respectively.

MBL Response: Noted. This has been changed. And is on the drainage plan in Appendix L.

- Please can you confirm if all manholes/ gullies upstream of connections into attenuation tanks and permeable sub bases are catchpits/sumps.

MBL Response:

- We will specify the chambers immediately upstream of the main 1,500m³ attenuation tank under the car park as catch pits, which is good practice
- We expect the attenuation tanks in the future plots will also specify catch pits. We have added a section to the updated DOC report. refer to paragraph 2.34
- Run-off enters the permeable sub-base via large precast concrete catch pit gullies. In order to ensure the sub-base does not become blocked / blinded we have also specified a geotextile wrapped around the perforated pipe feeding into the sub-base. See attached detail that was also in the DOC report.

Comments Regarding Conditions 11 and 12

I still do not believe evidence has been submitted regarding consents from the EA to infill the reservoir and its associated IDB ditch.. Please provide this so that condition 1.1 and 1.2 can be discharged? N.B. This needs to be submitted now as it is within the phase 2 development area.

MBL Response: Noted. We will resolve this asap.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)



From: Sean Foley [REDACTED]
Sent: 11 January 2019 07:56
To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray; Adam Winstone
Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

Excellent news. Please see below.

Attached is an wetransfer link to the updated drainage report which is circa 70MB with appendices. Therefore I have also attached the text only part of the report.

<https://we.tl/t-4uDxtCmiug>

Regards,

Sean Foley
[REDACTED]

From: Laura Gibbons [<mailto:Laura.Gibbons@arun.gov.uk>]
Sent: 10 January 2019 16:29
To: Sean Foley [REDACTED]
[REDACTED]

Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

I have reviewed the information you have provided. To summarise what needs to be resolved:

1. There are numerous inconsistencies between plans and calculations regarding cover levels and invert levels of MHs. Please complete a full review and ensure all inconsistencies are removed.

MBL Response: Noted. We have reviewed the model and removed the inconsistencies in Phase 1. We have re-run the simulations and it make negligible difference to the modelled output. The output network details and simulation results take these changes into account

2. There are inconsistencies between impermeable areas on plan and those modelled at points 11, 18 and 22. Please increase the areas in calculations so that they are consistent with those on plan.

MBL Response: Noted.

- Point 11 coincides with PN 31.000: The modelled at this location is 0.358 hectares, which matches the plan. Therefore no discrepancy. No amendment necessary to model
- Point 18 coincides with PN 40.001: The modelled total area at this location is 0.11 hectares, which matches the plan. Therefore no discrepancy. No amendment necessary to model
- Point 22 coincides with PN 37.002: The modelled total at this location is 0.213 hectares, which matches the plan. Therefore no discrepancy. No amendment necessary to model

3. Your summary of the pipe network doesn't show the very top extent of Phase 2. The A0 drawings do not detail pipe diameters in this area

MBL Response: Noted and amended accordingly in Appendices of the updated DOC report. (Appendix H)

4. Updated drainage strategy report to include flows from unrestricted discharge points.

MBL Response: Noted and amended accordingly in Appendices of the updated DOC report. (Appendices L & S)

5. Updated plans with revised storage volumes.

MBL Response: Noted and amended accordingly in Appendices of the updated DOC report. (Appendix L)

Once you have supplied these details and I have reviewed they are correct we will be at a point where all relevant details can be submitted through planning to discharge the condition.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
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From: Sean Foley [REDACTED]
Sent: 10 January 2019 12:26
To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray; Adam Winstone
Subject: RE: Planning Consultation on LU/345/18/DOC
Importance: High

Laura,

I call earlier but went to voicemail.

The area currently being developed is Phase 2 and the extent of this RM application within the west of wetlands drainage catchment is on the attached PDF, titled "Phase 2 -- Proposed Layout"

- Phase 2 (Parcel C1, Partial C2, Partial B2, Partial B4) -- Full Drainage details have been supplied in Appendix N (MBL Estate Road layout and details) and Appendix O (MJA Plots or sub-catchment layout and details). MJA have not undertaken detailed drainage modelling (microdrainage) of their sub-catchments because it is unnecessary to do this. MJA have however undertaken the detailed design of the plot drainage within these sub-catchments in accordance with Building Regulations Part H & BS EN 752.
- Bovis site (Parcels B3 & B5) -- RM determined. Constructed. I believe the last correspondence on this is attached and I have extracted the condition 10 information below. The Glanville Appendix I is also attached. The Bovis site is within the purple "Sub-Catchment Outfall B", which has a proposed discharge of 221.7 litres / second. By our estimation Parcels B3/B5 takes up approximately 50% of this sub-catchment areas, which explains the peak allowable discharge of 120 litres / second for the Bovis Site. However, the Glanville drainage strategy has now been superseded by MBL's drainage strategy, which is subject to our ongoing discussions

Condition 10: ADC Engineers have asked for confirmation that the total flow from the site is consistent with the proposed flows calculated in the Glanville Site-wide Surface Water Drainage Outfall Strategy of 19 May 2015, specifically appendix 1. They have suggested an overlay of each phase to be shown on the proposed discharge rate catchment layout, showing it as a proportion of the catchment. The same comment was made in relation to application LU/79/16/DOC and additional information was provided. **Please could the same information be submitted in relation to this DOC application.**

- Parcel A1 – RM determined. Constructed. The RM application was accompanied by the attached surface water drainage strategy report and associated calculations produced by Glanville. The final outfall location has now been superseded by MBL's drainage strategy, which is subject to our ongoing discussions

Hopefully this help is what you are looking for in relation to the catchments. If this is correct I believe you now have all the information you require. Please advise if otherwise.

We will now update the DOC Report to take account of what we've discussed / agreed.

Regards,

Sean Foley

From: Sean Foley

Sent: 09 January 2019 18:20

To: 'Laura Gibbons' <Laura.Gibbons@arun.gov.uk>

Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

We have already supplied the details for the areas that are currently being developed. Refer to Appendices N to R of the DOC report dated 07/11/2018.

I have also addressed your comments in green below. If possible I'd like to discuss point b below about the "catchment plan". Before we embark on providing this I'd like to understand exactly what you require

Regards,

Sean

From: Laura Gibbons [mailto:Laura.Gibbons@arun.gov.uk]

Sent: 09 January 2019 16:14

To: Sean Foley

Subject: RE: Planning Consultation on LU/345/18/DOC

Sean,

I think there is some confusion regarding the level of detail I require. I require full drainage details of the areas which are currently being developed without pre-commencement conditions having been discharged. Without this there is

a continued breach of the planning permission and a Temporary Stop Notice will be served. I will require this level of detail for each future parcel and their respective DOC application prior to commencement.

I have provided some comments below in blue. I would like to complete my next review when all details are provided, rather than taking a piecemeal approach which is not time effective.

Look forward to receiving the necessary details.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre, Maltravers Road, Littlehampton, BN17 5LF
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From: Sean Foley [REDACTED]
Sent: 09 January 2019 15:01
To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray
Subject: RE: Planning Consultation on LU/345/18/DOC
Importance: High

Laura,

Thanks. Please see below in red.

With the recent correspondence and attached in mind we have absolute confidence that the proposed surface water network is fit for purpose:

- Peak rate of discharge is a significant improvement when compared to the pre-demolition figure
- There is sufficient storage volume on site to cater for the critical 1in00yr+CC storm event, even with a fully surcharged outfall
- There is no flooding for the 1in30yr event with a fully surcharge outfall
- In the unlikely event the surface water is overwhelmed by a storm event in excess 1in100yr, or the outfall/pipe experience a blockage the resulting floodwater can flow safely within the road network into the wetlands leaving the new properties unaffected

Regards,

Sean Foley
Principal Engineer
Mayer Brown Ltd
[REDACTED]

From: Laura Gibbons [<mailto:Laura.Gibbons@arun.gov.uk>]
Sent: 09 January 2019 11:23
To: Sean Foley [REDACTED]
[REDACTED]

Hi Sean,

I have now managed to complete a more detailed review of the proposals. As we are now a few comments and responses in, I have just started a new comments list (alphabetically referenced), any points which cross over to old points are cross referenced.

- a) (3+6) The storage structures (which are not porous paving) are inconsistent between calculations and plans. With the storage volumes provided in calculations all being greater than those on plan. Please update calculations or drawings so that they match up. Compliance with this on site will need to be checked.

MBL Response:

- The only storage structure that needs to be accurate is the large one underneath the car park because this is subject to the RM application for Phase 2 and provides most of the storage for the drainage network. This has been modelled accurately. This has not been modelled accurately, volumes are incorrect as are invert levels. MBL: The large tank you are referring to is located at PN 24.010. The invert level of the tank in the drawing is 1.70m, and is 1.71m in the model. Apart from this 10mm difference the large tank has been modelled correctly. The tank dimensions of 50m x 21m x 1.5m are the same in the drawing and in the model. We will not change the model and will change the number on the drawing. I'd be grateful
- The other modelled storage structures in the future development plots are indicative and have not been subject to a detailed design. The layout of these sites are not even agreed yet, never mind a detailed drainage design and associated tank dimensions and, as such, the volumes of the tanks are indicative only. The most important piece of information is the peak allowable discharge rate from each of the plots. The follow on RM applications for each of the plots will then provide accurate drainage designs and you will have an opportunity to scrutinise these as they accompany the future applications. I need to see that the modelled details match up with those on plan. When detailed design of the future stages occurs logically they would start by looking at the storage volumes outlined on the plans you are creating. Please update the plans. MBL: Noted and we will do this so the modelled tank dimensions match the plan.

- b) (5) Please provide a catchment area plan for the detailed persimmons parcels, and the time area details for these in a MicroDrainage printout.

MBL Response:

- We don't have a catchment area plan for the detailed persimmon parcels. We have however added the modelled areas to the plan (see point C below), which also shows how far back the model extends into each sub-catchment. You need to fully detail the catchments for the persimmons land where development has already started. MBL: Can we discuss on the phone please in the morning
- On 20th December we explained that we enhanced our micro drainage model so it picks up the individual pots areas / sub catchments identified as Points 1 to 23. We have not extended the model to include the surface water pipes within each sub-catchment. The drainage networks within the 23 sub-catchments are made up with a combination of 100dia, 150dia and 225dia pipes, which are expected for small catchments. Each of these mini catchments have already been designed MJA Consulting and we have 100% confidence that the pipes within these catchments are sized correctly / adequately. I need evidence that the design of the networks is sufficient within the parcels where development is occurring. This level of detail will be required for each subsequent DOC application. MBL: Can we discuss on the phone please in the morning
- We did not feed the areas onto the sub catchment nodes using a time area hydrograph. For example on PN22.000 we added the 710m2 impermeable area as one hit and the time of entry is 2 minutes. I will review this information against the plan provided.

- c) Please provide pipe details on a MicroDrainage printout (list) so that I can review the MicroDrainage model.

MBL Response:

- Please find attached the network details the pipeline schedules for the drainage network. Thank you, I will review this in due course.
- The plan showing pipe numbers is attached again and we have added the hardstanding areas from each of the sub-catchments and the MJA drainage plot networks (as a reminder MJA completed the sub-catchment drainage designs)

- d) (9) Without a flat sub base to permeable areas the water will pool at the lower points, and breach the surface at these points. I would like to either see: slopes modelled in the MicroDrainage inputs (i.e. take account of the 300mm difference in elevation over the relevant distances); or cover levels reduced to the lowest cover elevation within each permeable area. I believe this will result in considerably more flooding,

and therefore evidence the requirement for either a flat sub base to provide greater depths of stone in some areas, or check dams being provided.

MBL Response:

- The permeable sub-base does not need to be laid to be effective. The water will inevitably pool at the low points within the road network and come out of the gullies at these locations. There is 260mm of tarmac above the sub-base stone so when the water comes out of the gullies at the low point almost all the storage volume in the open graded stone will be utilised.
- We have updated the model and added a sloped invert to the sub-base. We have also changed the cover levels at the sub-base nodes (permeable subbase nodes 04 & 05) because these coincide with the gully locations
- Modelling the slope sub-base has a negligible difference when compared to the previous results. The 240minute duration event is still the critical storm:
 - o PN8.001/8.002 decreases from 7.6m³ to 3.9m³
 - o PN14.002 increases from 22.4m³ to 23.50m³
 - o PN1.014/PN1.015 increases from 4.7m³ to 9.5m³ I will review this in due course.

e) (12) I am happy for all free discharge rates to be provided on plan and within the report for the 1 in 1 year event, 1 in 30 year and 1 in 100 year plus cc.

MBL Response:

- Thanks, we will add these figures to the report and the drawing.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
Maltravers Road, Littlehampton, BN17 5LF

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Save the environment - think before you print.

From: Sean Foley [REDACTED]

Sent: 08 January 2019 13:13

To: Laura Gibbons

Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray

Subject: RE: Planning Consultation on LU/345/18/DOC

Importance: High

Laura,

Regarding point 3 below:

Please find attached the phase 2 drainage composite plan. I've sent you the phase 2 information because this is the area that has been designed to a construction standard level of detail.

(The layouts are still being developed for extension of parcels C2 and B2, denotes as unrestricted discharge points 6, 7, 12 & 13)

These A0 plans at 1:250 scale include:

- Finished Road Levels
- House finished floor level
- Proposed levels in parking courts and driveways
- Location of permeable sub-base
- Surface Water sewer and associated invert and cover levels
- Windes Pipe numbers that can be read in conjunction with the supplied Windes simulation results

The only information missing is the formation level of the permeable sub-base. See point 9 below

Regarding point 9 below:

The finished road surface down around this low area of the site ranges generally from 3.8m to 4.1m (apart from in front of plots 64 & 65 where it drops to 3.6m). This is because these properties 61 to 100 are on a relatively flat earthworks platform. The roads cannot be laid flat so we designed crests and sags in order to introduce falls to gullies. The low points are generally 3.8m and the high points are generally 4.1m.

The formation level of the sub base is not constant flat level, and it mirrors the finished surface. The formation level is approximately 720mm below the surface (260mm tarmac over 460mm open graded stone). We have modelled the formation level of the sub-base at 3.08m AOD and allowed for 460mm depth of storage. For your peace of mind we have also just run some figures with the formation level modelled 170mm higher at 3.25 (conservative approach), so in theory the storage becomes effective later in the storm. The volume of flooding increase slightly but not by a significant amount (Attached are the results)

- PN14.002 increases from 22.4m³ to 27.50
- PN1.014 increases from 4.7m³ to 9.9m³

I hope this is acceptable

Regards,

Sean Foley
Principal Engineer
Mayer Brown Ltd


From: Sean Foley

Sent: 07 January 2019 17:30

To: 'Laura Gibbons' <Laura.Gibbons@arun.gov.uk>

Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

Thanks,

Regarding point 10 below, please find attached the free discharge rates from the plots areas. Apologies for not attaching this to my previous e-mail.

Regarding point 12, are we supposed to add the critical 1in1, 1in30 & 1in100yr discharges rate at each of the 23 nodes. Both on the drawing and within the report?

I'll get back to you asap on point 3. We did not have the latest dwg files from MJA previously that contained plot levels and FFLs. We have these now so will be able to produce a composite plan

Regards,

Sean

From: Laura Gibbons [mailto:Laura.Gibbons@arun.gov.uk]

Sent: 07 January 2019 16:31

To: Sean Foley [REDACTED]

Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

Thanks for your email. Just to clarify after we have agreed the drainage details between us they will need to be submitted formally to the planners.

I have provided comments below in purple. Please give me a call if you have any queries.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
Maltravers Road, Littlehampton, BN17 5LF
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From: Sean Foley [REDACTED]

Sent: 04 January 2019 15:38

To: Laura Gibbons

Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray

Subject: RE: Planning Consultation on LU/345/18/DOC

Importance: High

Hi Laura,

Happy new year and I hope you had a good break,

I also hope you agree we're in a pretty good position in relation to the surface water drainage design and the responses below in red, with associated attachments, will enable Condition 10 to be discharged.

Whilst reading the response below please note we have updated our Windes model so it now includes the permeable sub-base. See image below where we've added new nodes and modelled is as a "porous car park" (function within the programme) where the storage within 30% voids of the granular sub-base is recognised. We have distributed it as evenly as possible across the areas where the granular sub-base is located. The addition improves the results significantly and the total flooding volume for the fully surcharged critical 1in100yr+CC storm is now only 35m3 (spread across 4 different locations) that can safely be contained within the site.

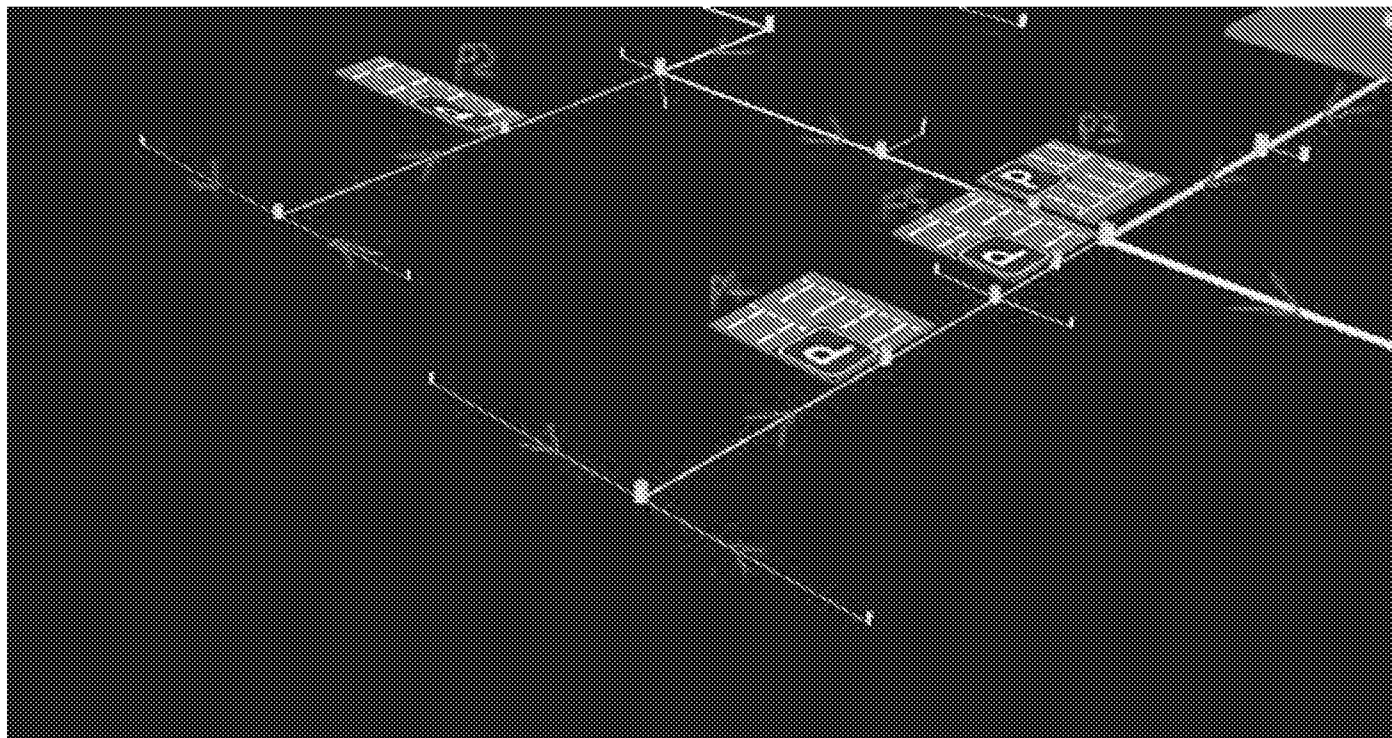
We're confident this will answer your questions, but if not we would be happy to meet you early next week if you feel this would be beneficial. Or alternatively, we're happy to discuss over the phone

I look forward to your response.

Regards,

Sean Foley

Image below: Shows the locations of the permeable sub-base within the Windes model..



From: Laura Gibbons [mailto:Laura.Gibbons@arun.gov.uk]

Sent: 21 December 2018 15:21

To: Sean Foley [redacted]

Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

Thanks for sending me that information. I have the following comments/ queries:

Surcharged outfall simulations

1. Can you please send me the FRA/ modelling report from PBA? I can access an FRA from PBA but it does not detail revised flood levels. Asking for this information from the EA will take quite some time (21 days even for us).

MBL Response:

- We have obtained the EA Product 4 form PBA. It is quite large to the following is a wetransfer link to the zip file: <https://we.tl/t-LIBEpKEWou> okay.

2. If you could also send me the critical storm summary for the 1 in 100year plus climate change allowance surcharged outfall event.

MBL Response:

- Attached is the critical storm summary for the 1in100yr+CC event. The critical storm down at the low end of the catchment where the surface flooding occurs is the 240 minute storm. I will review this once point 3 is resolved.

3. Can I please see a plan showing FFLs (including garages) and the drainage layout on the same drawings, with references to MicroDrainage PN included. Please also indicate kerb levels in the areas of flooding on this drawing.

MBL Response:

- Please find attached the MJA drawings that show the proposed road contours and the building floor levels. We have also identified where the critical 1 in 100yr flooding occurs on the levels plan. I need to see FFLs, finish, and formation levels of permeable paving, kerb levels, drainage network details including PN on the same plan. I do not believe this to be too onerous an ask. Without this my review is very slow and errors can easily be missed. Drawings need to be of a standard that can easily be interpreted, i.e. construction issue quality.
4. Can you please explain the water levels shown on the road cross section, is this just the MicroDrainage level from a specific location (not taking account of the sub base)?

MBL Response:

- Please ignore this. We added this to the drawing last year in order to get an approximation of flood levels within the system, which did not take into account the storage volume of the sub-base. I have removed the information from the drawing and re-issued. See point 7 below. Okay.
5. There is currently a small volume of flooding in the 30 year event simulation, please provide storage/ change pipe sizes to remove this.

MBL Response:

- The simulated flood volume was 0.2m³ for the high intensity 15 minute storm. The addition of the permeable sub-base and adjustment of the hardstanding area has removed this flooding and attached are the revised 1 in 30yr simulation results please can you provide me with an updated catchment area plan.
6. 250mm depth of water is not insubstantial and vehicular movements could result in bow waves and flooding to properties. Therefore, we want to see evidence the vast majority of water is actually stored within the sub base.

MBL Response:

- The addition of the permeable sub-base to the micro drainage model has decreased the flood volume significantly. The simulated volume in front of plots 83/84 & 90/91 has now been reduced from 58m³ to 22.4m³. This is a large open area if approximately 1200m² and 22.4m³ could easily be accommodated within this space (20mm depth of water over a space of 1,200m² works out at approximately to 24m³). I will review this upon completion of point 3.
 - The 250mm depth of water would only occur if a complete blockage / failure of the drainage network occurred in this specific area in front of plots 83/84 & 90/91. Okay.
7. Please can you provide detail on finish and formation level of roads on the same plans as requested in point 3 above.

MBL Response:

- The type of road make-up and finishes are on the attached drawings, which also show the location of the permeable sub-base.
 - The formation level of the roads is based upon the attached drawing that show the road make-up. The depth of the open graded stone is generally 460mm and is located just below the tarmac layers. See point 3.
8. Please also clearly indicate on a plan which roads will have a permeable subbase.

MBL Response:

- The location of the permeable sub-base is also on the road build-up and finishes drawing. (See point 7 above) See point 3
9. Please can you model the permeable sub base roads to demonstrate if the flooded volume can be stored. Check dams etc. may need to be provided.

MBL Response:

- We have added the permeable sub-base to the micro drainage model so the storage within the open graded sub-base is now included. There is no need to include check dams because the volume of the sub-base is utilised / required for the long duration. The site does slope, is subbase of all permeable subbases to be laid flat? Clarification and details of this under point 3 will be required. I will complete a full review of the calculations once point 3 is provided.

Free Discharge Rates

10. For information can you please supply the critical flow rates (critical storm may vary per catchment).

MBL Response:

- Critical Flow rates for the sub-catchment are now attached I cannot see these, can you resend and tell me the file name.

11. On the summary of discharges for plot areas you have got different (greater in some locations) flooded volumes to those provided in the surcharged outfall simulations. Please can you explain this discrepancy.

MBL Response:

- This is because we provided the summary for discharges for plot areas before we added a surcharged outfall. The latest attached figures now include for a surcharged outfall.
- All results provided are now based upon a surcharged outfall, apart from one which is the 1in100+CC 240min and is titled accordingly as "unsurcharged".

12. Please confirm parcel ownerships for the areas with free discharges.

MBL Response:

- Persimmon Homes Thames Valley own all of the parcels where free discharges into the main network are proposed. Okay, I would like to see the surface water drainage strategy updated to reference (maybe in an appendix) the critical flows from each of the free discharge parcels. The main document itself must also reference the criticality of the network design within these regions.

Please note I am on leave from 4pm this afternoon until 2nd January.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
Maltravers Road, Littlehampton, BN17 5LF

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From: Sean Foley [REDACTED]

Sent: 21 December 2018 11:37

To: Laura Gibbons

Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq; Fatima Evernden; Tracey Headley-Smith; Alex Wray

Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

Good news. I had a very useful conversation with PBA yesterday afternoon, the flood risk consultants on the project, who have undertaken the flood compensation analysis for the new residential platforms that extend into the wetland. It turns out the flood level in the wetlands is much lower than we thought so the simulated flood volume resulting from a surcharged outfall reduces significantly.

Revised Flood Level in Wetlands

PBA confirmed we were using an out of date flood levels in the wetland, which accompanied the outline application. The EA have updated their flood model (post outline submission) and the modelled flood levels in the wetlands are as follows:

- 1in1000yr Flood Level: 2.38m AOD
- 1in100yr+20%CC Flood level: Ranges 1.72m to 1.83m AOD
- 1in75yr Flood Level: Ranges 1.56m to 1.72m AOD
- 1in20yr flood level: Ranges 1.49m to 1.59m AOD

This represents a significant reduction when compared old flood levels:

- Superseded 1in100yr flood level: 3.23m AOD
- Current 1in100yr flood level: 1.80m AOD
- **1.43m lower**

Revised Surcharged Outfall Simulation

With the above in mind we have applied a surcharged outfall to our micro-drainage model. A 1in100yr flood level in the wetlands of 1.8m AOD by the outfall will result in the outfall (@ 1.0m AOD) being surcharged by approximately 0.8m. There will be a flap valve on the final headwall to ensure this floodwater will not back up into the drainage network but in this scenario the drainage network can't push open the flap valve until the water level within the site goes above the flood level in the wetlands. Below is an image we have taken from our micro-drainage model where a constant surcharge of 0.8m has been applied.

Critical Storm

Windes allows us to simulate a range of storm events from short duration very intensity events (15min or 30min storms) and much longer low intensity rainfall events (24hrs). A 30 minute duration storm for this site has an average intensity of 57mm/hr. This intensity of storm would be used to size the pipes and other drainage elements for conveyance purposes. A longer 480 minute duration storm has an average intensity of only 8mm/hr (figures obtained from simulated results). However, the 480 minute storm lasts 16 times longer, therefore generating a much greater volume of water and would be used to size the attenuation. The critical storm for this scenario of a surcharge outfall is the 240 minute storm (4 hour storm).

It is worth noting that flooding in the wetlands is effected by the tide so it is unlikely this flood depth of 1.8m AOD will remain constant, and is the peak flood level. It takes approximately 6 hours for the high tide level to go to low tide level so in theory the flood level is likely to subside when this is read in conjunction with the 4 hour critical storm. However, we have taken a conservative approach and simulated a constant surcharged depth of 0.8m for the entire duration of the 4 hour critical storm

Flood Mechanism for surcharged outfall

The 1in100yr+cc 240min storm will generate a low intensity but large volume of water that will drain to the bottom of the network by the outfall. It cannot escape immediately because the flap valve on the outfall would be kept shut by the 1in100yr flood water in the wetlands. The drainage network will start to fill up and on-site water will eventually push open the flap valve. However, on-site storage has been used within this filling up period and, as such, flooding is simulated on site for this critical 4 hour storm. The drainage network at the low end of the site will eventually fill up entirely and flood water would start to escape out of the gullies located at the low points of the roads.

The low points where the flood water will escape from the network, for the 240minute storm, has been highlighted on the attached. The total combined volume across these points for the surcharged outfall is 182m³. This floodwater would follow the exceedance flow route in the channels of the road as shown on the attached appendix N. It would flow in the channel of the roads and would not affect the properties.

The flood depth and velocity in the channel will be low and it is expected that most of the footpaths would still be usable. The maximum depth of flood would occur in front of plots 83/84 & 90/91. The flood water would rise to a maximum level depth of 250mm (low point gullies @ 3.8, spill level of adjacent road table 4.05m) before it flow north along the road and into the wetlands. The flood water in this areas would also be stationary (zero velocity)

Permeable Sub-base Road

There are also permeable sub-base roads located in these low / gully areas. Also identified on the attached pan. This open graded sub-base in the roads has the ability to store water within the voids

The total area of carriageway with permeable sub-base is 1,300m². Based upon the design depth of 460mm open graded sub-base with a void ratio of 30% the volume of storage within these carriageways is approximately 180m³. (Note: it is a coincidence that it matches the surcharged flood volume above)

The permeable sub-base has not been modelled in the drainage network because we've designed it primarily for treatment purposes, but in reality it will have the ability to store water. So in theory it removes the surcharged 1in100yrCC flooding

1in30yr Storm with Surcharged Outfall

The reduced flood level in the wetlands also has the added benefit of removing the flooding for the 1in30yr storm event. Attached are the results.

Flood Compensation – Wetlands

While speaking with PBA yesterday afternoon they informed us that their flood compensation analysis for the wetlands is currently resulting in 500m³ surplus volume for the 1in1000yr analysis. Therefore, spilling floodwater into the wetlands for the extremely rare event of a fully surcharged outfall coinciding with the critical 1in100yr storm event will not have negative impact on downstream or surrounding properties.

Conclusion

With the above and attached in mind we have absolute confidence that the proposed surface water network is fit for purpose:

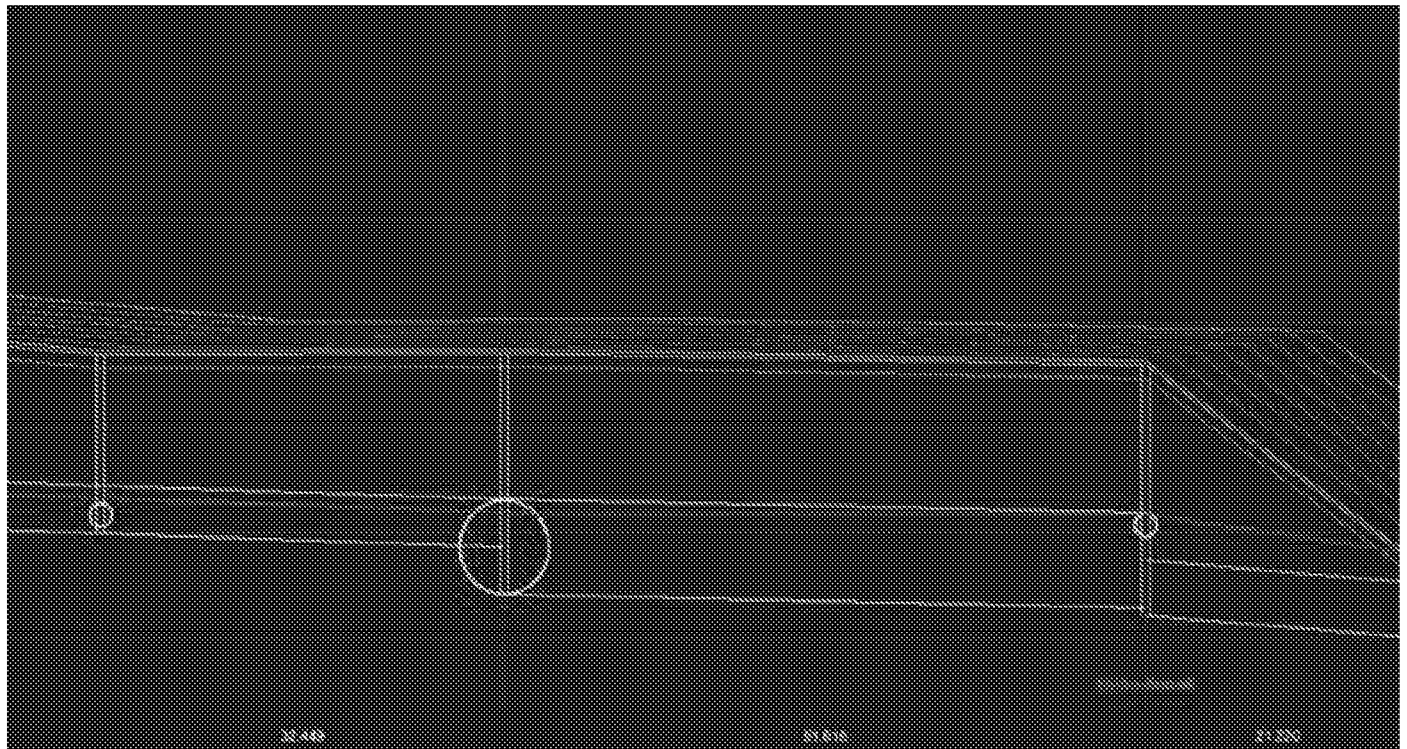
- Peak rate of discharge is a significant improvement when compared to the pre-demolition figure
- There is sufficient storage volume on site to cater for the 1in00yr+CC storm event, even with a fully surcharged outfall
- There is no flooding for the 1in30yr event with a fully surcharge outfall
- In the unlikely event the surface water is overwhelmed by a storm event in excess 1in100yr, or the outfall/pipe experience a blockage the resulting floodwater can flow safely within the road network into the wetlands leaving the new properties unaffected

I hope the above and attached provide sufficient information to facilitate the discharge Condition 10. We would be happy to meet you in the first week to January if you feel this would be beneficial. Or alternatively, we're happy to discuss over the phone

I look forward to your response

Regards,

Sean Foley
Principal Engineer
Mayer Brown Ltd



From: Sean Foley
Sent: 20 December 2018 16:18
To: 'Laura Gibbons' <Laura.Gibbons@arun.gov.uk>

Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

As requested, we have enhanced / increased the microdrainage model so it picks up the individual pots areas / sub catchments. The most notable changes are new branches at points 2, 6, 7, 12, 13, 20 & 21. We have then re-distributed the impermeable areas.

With the above in mind, attached is the following:

- Plans showing 23 different locations / sub-catchments within Parcels B2, Partial B4, C1, C2 & S4. The sub catchment are all feeding into the main carrier sewer as it passes through the site
- Flow rates for the 23 location for the 1in1, 1in30 & 1in100yr return period. We chose the relatively high intensity storm duration of 30 minutes.

Hopefully this information is what you are expecting to receive.

We wish to avoid installing hydro-brakes within each of these sub-catchments because the downstream receiving sewers have already been designed to receive the run-off from each of the sub-catchments. The downstream attenuation volume and final restricted flow into the black ditch have been designed with a free discharge from the sub-catchments. Therefore, free discharges from the sub-catchments into the downstream sewer will not increase the flood risk downstream

Apologies for my piecemeal response, but we're feed the modelling information through to you as I complete it.

Regards,

Sean Foley
Principal Engineer
Mayer Brown Ltd

From: Laura Gibbons [<mailto:Laura.Gibbons@arun.gov.uk>]

Sent: 19 December 2018 12:30

To: Sean Foley

Subject: RE: Planning Consultation on LU/345/18/DOC

Hi Sean,

Thanks for the prompt response.

I am very concerned by the fact that the surcharged outfall scenario results indicate that significant flooding would occur and furthermore I do not believe the joint probability of a rainfall event and tidal event occurring are infinitesimally small. DEFRA research indicates that typically the south coast has a modest correlation between the two. Obviously catchment factors vary this, with some catchments on the south coast having a far greater correlation. I could go into more detail on this, but it really is opening a big can of worms and having done some joint probability analysis in the past I know it isn't a small task. I also believe that flooding will occur for lower probability events.

The important thing is that WSCC policy states that the 1 in 100 year plus climate change event must be contained on site/ not increase flood risk elsewhere. You need to demonstrate that allowing 1750m3 to overflow through the development wouldn't increase flood risk elsewhere. You will also need to demonstrate to me that flood depths and velocities on site are safe.

Furthermore, WSCC policy requires no flooding for the 1 in 30 year plus climate change event, please model this event with a surcharged outfall and ensure that surface water drainage design is modified to provide the required storage to ensure no flooding.

Regarding condition 11, until I have seen consent for the infilling I am not willing to recommend the discharge of this condition.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
Maltravers Road, Littlehampton, BN17 5LF
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From: Sean Foley [REDACTED]
Sent: 18 December 2018 16:09
To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq
Subject: RE: Planning Consultation on LU/345/18/DOC

Laura,

Thanks for your response. I'll come back to you asap on the hydro-brake / modelling issue.

I can however provide a response on the surcharged outfall scenario, which is covered in paragraphs 2.42 to 2.46 of the submitted DOC report (text attached), under the section titled "*Exceedence Flows and Surcharged Outfall*"

We had lengthy discussions earlier this year with Mark Akmenkalns (MA), the Drainage Engineer at West Sussex County Council. The correspondence is contained in Appendix F of the DOC drainage report (attached). A number of issues were addressed including a situation whereby the outfall could potentially be surcharged by the flood water in the Black Ditch. We simulated the surcharged scenario and it ended up with a large volume of flood water escaping from the drainage network. Therefore, It was agreed with WSCC that it is not reasonable keep this flood water on site and the resulting flood water will flow safely through the road network and eventually into the wetlands, as shown in Appendix H.

Condition 11 & 12

We have analysed the wording of these conditions again and perhaps there is some misunderstanding about the specific requirements contained therein.

- Condition 11 – Refers to arrangements for future access to and maintenance of any watercourse or culvert. Section 3 of the DOC report provides clarification that there will no longer be any existing watercourses or ditches within this section of the development, West of Wetlands, that will require future access for maintenance. Therefore, arrangements for future access are not required for the areas to the West of the Westlands. The final headwall at Outfall location B that discharges into existing ditch will be maintained by a Management Company organised by Persimmon Homes. The headwall is located adjacent an estate road turning head so will be easily accessible.
- Condition 12 – Refers to consents for any works effecting watercourses.
 - Outfall B: A nominal length of existing ditch is to be filled in to facilitate the construction of the new 525mm diameter outfall pipe and the new headwall. The 525mm diameter outfall pipe and associated headwall are described / included in the Flood Defence Consent for Outfall B. Therefore, we believe existing flood defence consent for Outfall B should be sufficient for works affecting this particular ditch
 - Lagoon and Overflow ditch: Regarding the irrigation lagoon and overflow ditch, we will find out if a specific application has been submitted to fill this ditch in. If not we will organise for one to be submitted asap.

We will get back to you asap about the hydro-brake / modelling issue

Regards,

Sean Foley

From: Laura Gibbons [mailto:Laura.Gibbons@arun.gov.uk]

Sent: 18 December 2018 13:29

To: Sean Foley

Subject: RE: Planning Consultation on LU/345/18/DOC

Sean,

Thanks for the email.

Condition 10

I have attached a plan, with alterations to the required hydrobrake locations crossed out. This reduces the number to 17 by utilising hydrobrakes within slightly more main sewers, this is just an option. However, I do feel that if we were looking at this from scratch we could have reduced this number down further. In my opinion there is insufficient argument to not reduce the number of hydrobrakes/ construct them.

Within the model you have what are the flow rates you have coming from each of the 26 locations?

I am unwilling to accept the surface water drainage proposals without further information regarding detailed network modelling or installing the required hydrobrakes.

Furthermore, you need to be submitting MicroDrainage results from models with the outfall to the black ditch surcharged to the 1 in 100 year plus climate change flood levels. Ensuring that the surface water drainage network can cope with this event. N.B. This was one of the reasons for refusal given on the decision notice.

Condition 11

I look forward to receiving further information on this.

Condition 12

As you stated in your response below regarding condition 11 you are infilling a ditch. I therefore, I await confirmation from you as to whether consent has been obtained for this.

Kind Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre,
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From: Sean Foley

Sent: 13 December 2018 13:06

To: Laura Gibbons
Cc: Clark, Robert; Michael Eastham; Edgley, Martin; Adrian Barnley; Steven Lecocq
Subject: RE: Planning Consultation on LU/345/18/DOC

Dear Laura,

Thank you for your comments below. Following your initial response our subsequent / updated report (dated 7th November) we did take your comments into account where we believed they were appropriate. (We certainly do not wish to give the impression we've ignored these and apologies if this is how it seems)

The paragraphs where amendments were made are highlighted in yellow on the attached DOC report_07.11.2018_Text only

Condition 10 – Surface Water Drainage Discharge Rates (pre-demolition & proposed)

In the surface water Condition 10 Section:

- We have amended paragraphs 2.14 to 2.16 and 2.23 that cover the pre-development and post development discharge rates.
- We have 2.62 & 2.68 that deals with infiltration within the individual parcels

Restricted Discharges from Parcels

When we met a few months ago you requested that individual parcels are assigned a specific discharge rates. However there are a number of parcels where it is not practicable to achieve this.

Following our meeting we endeavoured to figure out a solution by analysing the micro drainage model but it is almost impossible to assign a specific rate unless individual controls are applied. We have highlighted on the attached pdf where these individual controls would be required before it discharges into the main carrier sewers. A total of 26 controls would be needed, and where controls are applied we then need to potentially add some upstream attenuation.

I believe you accept it is not practicable to apply 26 individual controls, but you requested us to justify the approach by creating individual micro drainage models for each location. We believe creating 26 individual micro drainage models would prove to be a superfluous exercise. The drainage networks within the 26 mini catchments are made up with a combination of 100dia, 150dia and 225dia pipes, which are expected for small catchments of no more than 1,000m². Each of these mini catchments have already been designed MJA Consulting (contained in Appendix O) and we 100% confidence that the pipes within these catchments are sized correctly / adequately and creating an individual model for each one is not a task we would normally undertake.

Modelling the main drainage runs and laterals is absolutely required and we have already created a large and pretty comprehensive microdrainage model of the drainage network that takes into account the drainage areas from each of these 26 locations.

With the above in mind we hope you agree that we do not need to assign specific discharge rates to the parcels in phase 2, which are listed in paragraph 2.26 of the updated report (including B2). Plus, there is no need to undertake additional modelling for the 26 individual catchments.

Condition 11 – Existing Watercourses & Culverts

The only watercourse and ditch affected by the proposed development will be the irrigation lagoon and its overflow, which are no longer required to serve the consented scheme. We understand that the ditch is not yet filled in and the works will form part of the future planning submission for the remaining section of phase 2 that extends into the wetlands.

We will liaise with our Client to find out if a specific application has been submitted to fill this ditch in. If not we will organise for one to be submitted asap.

Condition 12 – Consents

We surprised by this response because we believe the Flood Defence Consent for the new outfall (granted by the Environment Agency) into the ditch would be adequate because it includes a description of the works and information on the new headwall.

Below is an extract from the flood defence consent describing what is allowed and we are at a loss as to why this is not considered adequate?

We'd be very grateful for some advice on how we can overcome this please.

Watercourse: Ordinary Watercourse within the River Arun Internal Drainage District

Location: Land south of Black Ditch, North Littlehampton, West Sussex

NGR: 503413, 104302

Description of works: Construction of 1 no. precast concrete surface water outfall (with railings and flapvalve) to take discharge from new development through 525mm diameter pipe.

For the following activities:

Construction of 1 no. surface water outfall

(1) Construction of 1 no. permanent precast concrete surface water outfall (with railings and flapvalve) to take discharge from new development through 525mm diameter pipe

As detailed on Drawings: 8140927/SK12, CV8140927/SK09 and SFA 10C

Headwall Plan

I trust the above is acceptable and will hopefully be sufficient to contribute towards the discharge to these planning conditions, specifically Condition 10 & 12

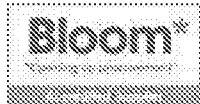
Please contact me if you wish to discuss this further or require additional information.

Regards,

Sean Foley
Principal Engineer
Mayer Brown Ltd

Sean Foley,
Principal Engineer
Mayer Brown Limited
Lion House
Oriental Road
Woking
Surrey
GU22 8AR

www.mayerbrown.co.uk



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From: Clark, Robert [REDACTED]
Sent: 12 December 2018 15:55
To: Sean Foley [REDACTED]
Subject: FW: Planning Consultation on LU/345/18/DOC

Hi Sean

Please see email below. This is getting urgent as the Council have now threatened a Stop Notice. Can you review ASAP and get in touch with Laura Gibbon today. Thanks

Kind Regards

Rob

Robert Clark
Head of Planning
Persimmon Homes Thames Valley
Persimmon House
Knoll Road
Camberley
GU15 3TQ
[REDACTED]

From: Michael Eastham [<mailto:Michael.Eastham@arun.gov.uk>]
Sent: 06 December 2018 15:33
To: Clark, Robert
Subject: FW: Planning Consultation on LU/345/18/DOC

Hi Rob,

Please see the email below from ADC Drainage Engineers to LU/345/18/DOC.

I look forward to receiving the requisite information.

Kind regards,

Michael

From: Laura Gibbons
Sent: 06 December 2018 14:58
To: Planning.Responses
Cc: Michael Eastham
Subject: Planning Consultation on LU/345/18/DOC

Engineers Comments Regarding Condition 10

I cannot see that anything has changed from the Surface Water Drainage Strategy that Mayer Brown provided on the 9th October, in fact the version number is the same. I had the following comments in October:

“Thank you for sending through that information. I have the following comments regarding the pre-demolition rates:

1. No connection between Outfall 5, 6 and 7 the lakes and reservoirs to the Norway ditch was proven in the drainage survey. I would therefore like to see these removed from the 1 in 1 year calculations for the site (we don't know what the capacity of the lakes would have been but I would imagine they'd take a decent volume of water). This equates to 163.5 l/s
2. The pond between catchment 3 and the Toddington ditch was not included in the calculations, therefore the rate of 301.4 l/s is far too great in my opinion.

If we discount the runoff in points 1 and 2 above we get a 1 in 1 year discharge of 340.47l/s. This is greater than what you are proposing. And some discharge from catchment 3 would have occurred, so the figure would be something greater than 340.47l/s.

To summarise, as the pre-development rates are greater than the rates you propose I am happy.

Regarding the discharge rates from individual parcels:

I note that you state that there are no controls in the interlinked parcels B4, C1, C2, C4 and roads and you are using this as justification for allowing an uncontrolled discharge from these parcels. I am not happy with this, it is possible that you are causing a greater flood risk downstream as a result. As discussed in the meeting I am keen to see you stating maximum values from each. If physical controls aren't currently used then I am keen to push for them to be constructed. The only other way I will accept no physical control devices being installed is by you demonstrating that the maximum flow from the networks doesn't exceed the maximum value for that parcel as a result of pipe diameters constricting flow. This will require you modelling the networks in microdrainage and running various return periods and storm durations.

What about parcel B2 where discharge is proposed to be free? What is the justification for this?

Please feel free to give me a call should you have any questions.”

These comments have not been resolved. There are still un restricted flows from B4, C1, C2, C4 and B2 despite my previous comments that this was inappropriate. I will re-iterate that either controls should now be installed or models run to show what the maximum flow from each parcel is based upon pipe diameters that have been constructed. And evidence submitted based on this that the total flow from the complete development does not exceed 285l/s.

Until such a time as this evidence is clearly supplied and the drainage strategy updated to follow this I am unwilling to recommend the discharge of this condition.

Engineers Comments Regarding Condition 11

No evidence has been submitted of formal written acceptance of the proposals to infill the watercourses shown in Figure 3.1 of the drainage strategy. Therefore, I do not recommend the discharge of this condition.

Engineers Comments Regarding Condition 12

A FRAP has been obtained from the Environment Agency to construct a headwall in the Black ditch. However, no evidence of the acceptance of infilling has been provided, nor for any over proposed structures. Therefore, I do not recommend the discharge of this condition.

Regards,

Laura Gibbons, MEng, GMICE
Engineer (Drainage & Coastal)

Laura Gibbons | Engineer (Drainage & Coastal), Engineering Services, Arun District Council | Location: First Floor, Arun Civic Centre, Maltravers Road, Littlehampton, BN17 5LF
Internal: 37818 | External: +44 (0) 1903 737818 | Fax: +44 (0) 1903 716018 | E-mail: laura.gibbons@arun.gov.uk



From:

planning.responses@arun.gov.uk [<mailto:planning.responses@arun.gov.uk>]

Sent: 30 November 2018 11:04

To: Land Drainage

Subject: Planning Consultation on LU/345/18/DOC

To: Engineers (Drainage)

NOTIFICATION FROM ARUN DISTRICT COUNCIL

TOWN AND COUNTRY PLANNING ACT 1990

APPLICATION LU/345/18/DOC
NO:

Registered: 28-NOV-18

Site Address: Land North of Toddington Lane Littlehampton BN17 7PP

Description of Works: Approval of details reserved by condition imposed under ref LU/47/11/ relating to Condition Nos 10 surface water drainage scheme, 11 future access to & maintenance of any watercourse or culvert, 12 discharge of any flows to watercourse, 13 foul water drainage system.

The Council have received the above application to discharge conditions. I shall be pleased to receive any observations you may wish to make in respect of those conditions relating to your field of expertise.

[Click here to view the Discharge of Condition application](#)

[Click here to view conditions on original application - click on decision tab](#)

Should you have any comments to make, these should be sent by replying to this email by 14th December 2018.

www.arun.gov.uk/planning

Please be aware that any comments you may make will be available on our website so please do not insert personal details or signatures on your reply.

In the absence of a reply within the period stated, I shall assume that you have no observations to make.

The officer dealing with this application is Michael Eastham who can be contacted on telephone number 01903 737772.

Thanking you in anticipation

Planning Case Officer
Arun District Council

post_con_email

<http://www.arun.gov.uk>

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<https://www.persimmonhomes.com/corporate/corporate-responsibility/policies>

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**PERSIMMON HOMES THAMES VALLEY
LAND NORTH OF TODDINGTON LANE,
LITTLEHAMPTON**

**DRAINAGE STRATEGY, WEST OF
WETLANDS
(DISCHARGE OF CONDITION 10)**

JANUARY 2019

the journey is the reward

**PERSIMMON HOMES THAMES VALLEY
LAND NORTH OF TODDINGTON LANE,
LITTLEHAMPTON**

**DRAINAGE STRATEGY, WEST OF
WETLANDS
(DISCHARGE OF CONDITION 10)**

JANUARY 2019

Project Code:	A/PHDRAIN.10
Prepared by:	SF
Approved by:	AB
Issue Date:	24th January 2019
Status:	1st Issue

**Persimmon Homes Thames Valley
Land North of Toddington Lane, Littlehampton
Drainage Strategy, West of Wetlands
(Discharge of Condition 10)**

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APPENDIX L: List of Drawings in West of Wetlands Catchment

1 Introduction

- 1.1 Mayer Brown Ltd has been commissioned by Persimmon Homes Thames Valley (PHTV) to compile this report to assist with the discharge of planning condition 10 for their outlined approved development (**Arun DC reference LU/47/11/**) for up to 1,260 residential dwellings, B1 employment use, Class A facilities, a 100 bed hotel, 60 bed care home, primary school, plus many other facilities and improvements to the local infrastructure.

Outline Planning Consent

- 1.2 Outline Planning Consent was granted in 2011, under Arun District Council planning reference LU/47/11, which includes Condition 10 that relates to surface water drainage.

Purpose of this Drainage Report

- 1.3 This drainage report does not cover the entire area that received outline planning approval. It includes the development area of approximately 19.0 hectares to the west of the wetlands as identified Appendix B, titled "Land Uses and Drainage Areas Covered".
- 1.4 There are a total of 18 land parcels and associated road infrastructure identified within this catchment at varying states of progress. The report describes the design philosophy behind the main surface sewers within the road network that will eventually drain the development parcels within this area. It also specifies the proposed connection points and peak allowable surface water discharge from each of the land parcels.
- 1.5 A parcel specific surface and foul water drainage strategy will still be required to accompany the reserved matters (RM) applications from the individual land parcels.
- 1.6 This report is to be used to accompany the RM planning applications for each of the individual parcels in order to demonstrate that the receiving drainage network has been adequately designed and considered.

Previous Consultancy Work

- 1.7 Greencore obtained outlined planning consent for the scheme in 2011, using White Young Green as their drainage consultants, and subsequently sold the site to PHTV.

- 1.8 Glanville Consulting Engineers were employed by PHTV to develop the surface and foul water strategy further. Glanville are no longer working on the project but produced useful information to depict the pre-development scenario, which is contained in a number of Appendices within this report.
- 1.9 Mayer Brown were employed by PHTV as their drainage consultants for the project in September 2017 and where possible will utilise the information produced by previous Consultants.
- 1.10 There are numerous projects, sub-parcels and associated civils and drainage drawings that inform the works within the west of wetlands catchment. It is not practical to include all the drawings for these projects within this report and, as such, they are listed in Appendix L. These drawings can be supplied on request to Mayer Brown Ltd.

2 Condition 10 - Surface Water Drainage

Condition 10: *No development shall begin until a fully detailed surface water drainage scheme for that phase of the development, based on sustainable drainage principles and designed in accordance with the SUDS strategy for the whole development, has been submitted to and approved in writing by the Local Planning Authority. It should be demonstrated how each detailed scheme will contribute to delivering, and link into, the surface water drainage strategy for the site as a whole.*

- *The SUDS shall be designed to attenuate the 1 in 100 year storm event (plus climate change allowance of 30% in accordance with DEFRA's National Standards for Sustainable Drainage Systems).*
- *No infiltration of surface water drainage shall occur within ground affected by contamination unless suitable remediation is undertaken.*
- *Each detailed scheme should include a timetable for its implementation; and provide a management and maintenance plan in the form of a site specific Maintenance Manual for the SUDS system for the lifetime of the development. This shall include the arrangements for adoption by any public authority or statutory undertaker or details of the financial management of the scheme throughout its lifetime.*

Elements of the scheme serving any particular phase shall subsequently be implemented in accordance with the approved details (unless otherwise agreed with the Local Planning Authority) prior to the occupation of any dwellings in that phase and no building in that phase of the development shall be occupied until the surface water drainage scheme has been fully implemented in accordance with the approved details.

Reason: To ensure that the proposed development is satisfactorily drained to prevent the increased risk of flooding, and improve and protect water quality, habitat and amenity, and ensure future maintenance of these in accordance with national guidance and policies GEN7, GEN9 of the Arun District Local Plan.

Pre-Demolition Site

- 2.1 The pre-demolition site was heavily developed comprising large glasshouses with associated outbuildings and areas of hardstanding. Refer to the site location plan in Appendix A that shows the extent of the glasshouses covering the site to the east and west of the wetlands.
- 2.2 A plan illustrating the existing surface water regime, produced by Glanville in 2014, is contained in Appendix H.
- » The former Toddington Nurseries: The western part of the site comprising is understood to have discharged to a combination of soakaways and outfall to the existing ditch system north of the site.
 - » Central West Former Holland Nursery: Discharged to an irrigation pond before discharging to Toddington ditch. It is understood that there was no restriction of flows from the system.

Infiltration

- 2.3 Intrusive ground investigations and soakage testing undertaken by Merebrook have confirmed that infiltration methods for the disposal of surface water runoff are unlikely to be practical across the majority of the site as the underlying material is generally found to comprise of Clay.
- 2.4 Review of these investigative reports appears to indicate only two areas where infiltration drainage were feasible (subject to further testing):
- » Towards the western part of the site at depths of around 1.0m into the localised sand deposits; Parcels B3, B5, B1, Care Home, Enterprise Zone
 - » Towards the western part of the site at depths of around 2.0m into localised Sand deposits; notably Parcels A1, A2, Youth Facility, B6, Waste Recycling Centre, and Commercial Areas.
- 2.5 Other than the locations noted above infiltration methods for the disposal of surface water runoff are unlikely to be feasible due to either the presence of Clay material or high groundwater levels.
- 2.6 Modelled Flood Levels in the Black Ditch are within a metre of ground level in many locations which could restrict depths available to effectively locate SuDS features.

Sustainable Drainage (SuDS) and Drainage Hierarchy

- 2.7 Sustainable Urban Drainage Systems (SuDS) are a range of techniques that aim to mimic the way rainfall drains in natural systems and so reduces the hydraulic and hydrological impact on the local area and downstream catchments. There are a number of options available to impose surface water restrictions on proposed development plots such as oversized sewers, below ground storage tanks, attenuation ponds and basins, swales, permeable paving, or infiltration systems.
- 2.8 To determine the most sustainable method of surface water disposal the hierarchy from approved document part H was used, see below:
- » **An adequate soakaway or some other adequate infiltration system** apart from a few locations across the site infiltration methods for the disposal of surface water runoff are not feasible due to either the presence of Clay material or high groundwater.
 - » **A Watercourse** – The Black Ditch is located to the north of the site within the boundary of the consented scheme. There are ordinary watercourse tributaries that run across the wetlands and connect to the Black Ditch
 - » **A Sewer** – There are no public surface water sewers in the immediate vicinity. The only drains available were those that drained the pre-demolition glasshouses and discharged into the black ditch.

Proposed Surface Water Strategy

- 2.9 Based upon the above hierarchy a high level description of the surface water strategy is that the entire 19 hectare catchment as identified in Appendix B will drain at a restricted rate of run-off into the Black Ditch via a single outfall located at the northern boundary of development parcel C2.
- 2.10 As explained in the introduction this report describes the drainage strategy for the development parcels and associated road network for the consented scheme to the west of the wetlands. (The remaining area to the east of the wetlands is currently under development).

Proposed and Pre-Demolition Discharge Rates

Pre-Demolition Discharge

- 2.11 As described in paragraph 1.9 Glanville Consulting Engineers (GCE) produced useful information to depict the pre-demolition scenario. In order to understand and quantify the existing drainage and associated discharge rates

PHTV commissioned MK Surveys to carry out a drainage survey of the pre-demolition drainage network. The resulting survey is contained in Appendix H of this report (a total of 12 AO drawings covering the whole site).

- 2.12 GCE subsequently reviewed the drainage survey and ascertained there was a total of 10 outfalls, ranging in diameter from 150mm up to 375mm, with run-off eventually ending up in the Black Ditch via the series of smaller upstream ditches.
- 2.13 GCE produced basic micro drainage models in order to quantify the discharge rate from each outfall. They also produced a plan summarising the discharge rates from the individual parcels. Refer to Appendix H of this report.
- 2.14 The resulting total pre-demolition discharge rate from the West of Wetlands is as follows:
- ✦ Outfalls 01, 02, 03 (**Not** including outfalls 04 to 09 or the overland flow)
 - ✦ Combined impermeable area = 8.33 hectares
 - ✦ Peak Pre-demolition 1 in 1 year discharge = **390 Litres / second**
- (The above figure does not account for the run-off from the demolished buildings and unrecorded drainage, as shown on the GCE plan. These areas are hatched on the GCE plan and are referred to as overland flow)
- 2.15 The overall development area of the west of wetlands catchment is 19.0 hectares, which equates to a pre-demolition peak **1 in 1 year** discharge rate of **20 litres / second / hectare**.
- 2.16 It is worth noting that the calculated pre-demolition discharge rate of 20 litres / second / hectare is for the 1 in 1 year return period and, although not calculated, would be significantly larger for the higher 1 in 30 year and 1 in 100 year return periods.

Proposed Discharge Rate

- 2.17 The Arun DC SFRA identifies the site as brownfield and states that development is unlikely to significantly increase run-off but should seek to reduce rates where possible. Therefore, the proposal is to specify a reduced rate of run-off when compared to the pre-demolition run-off described above.
- 2.18 A proposed peak discharge rate has been calculated using Greenfield runoff methods provided in IoH124 using a Soil Type of 5 to make allowance for the possible effect of the previous extensive impermeable area. The resulting 1 in 1 year brownfield rate has been calculated at approximately 15 litres

/second / hectare. A copy of the relevant calculation is contained in Appendix H.

- 2.19 The peak rate of surface water discharge for up to the **1 in 100 year return period + 30% climate change** will be restricted to **15 litres / second / hectare**. This proposed peak rate of surface water discharge will provide significant betterment when compared to the pre-demolition undeveloped scenario.

Calculations and Results

- 2.20 A Micro Drainage model has been created of the drainage network covering the overall catchment area of 19.0 hectares. The pipes have been sized to convey the surface water run-off from each area, and the proposed peak allowable discharge has been specified from each future development plot. The overall network schematic and details are contained in Appendix E.
- 2.21 Outfall B, the final outfall from the overall catchment, will discharge through a headwall into the existing ditch that is also located in a flood plain. There will be a flap valve on the final headwall to ensure floodwater within the floodplain will not back up into the drainage network. However, in this scenario the drainage network can't push open the flap valve until the water level within the site goes above the flood level in the wetlands.
- 2.22 There is a risk that a fully surcharged outfall could coincide with the on-site critical 1in100yr+CC storm so the Micro Drainage model has been simulated with a fully surcharged outfall.
- 2.23 The EA supplied 1in100yr+20%CC modelled flood level within the floodplain ranges from 1.72m AOD to 1.83m AOD. A flood level in the wetlands of 1.8m AOD by the outfall will result in the outfall (@ 1.0m AOD) being surcharged by approximately 0.8m.
- 2.24 There is also permeable sub-base designed beneath some of the Phase 2 roads, which has been incorporated into the Micro Drainage model.
- 2.25 The final peak allowable discharge of **285 litres / second** (19 hectares x 15 litres / second / hectares) has been modelled for the worst case 1 in 100 year storm event + 30% climate change. The simulation results are contained in Appendix F & G.

2.26 The discharge rates will be considerably lower for lower intensity storm events as shown below (discharge rates below are for a surcharged outfall. When the outfall is unsurcharged the full 285 litres / sec discharge is achieved):

- ✧ Critical 1 in 100 year storm (+30% CC): 265 litres / second
- ✧ Critical 1 in 30 year Storm: 207 litres / second
- ✧ Critical 1 in 1 year Storm: 167 litres / second

2.27 The proposed discharge rates represent a significant reduction when compared to the pre-demolition 1 in 1 year discharge rate of 390 litres / second, as follows:

- ✧ Critical 1 in 100 year storm (+30% CC): 32% Reduction
- ✧ Critical 1 in 30 year Storm: 47% Reduction
- ✧ Critical 1 in 1 year Storm: 58% Reduction

2.28 Most of the surface water attenuation will be located within the future car park area in a 1500 cubic metre proprietary storage tank and permeable paving sub-base. There will also be attenuation in the 900mm diameter pipe running from the car park to the outfall.

2.29 A maximum allowable discharge will be imposed on the majority of development parcels and, as such, each parcel will need to contain surface water storage within its respective reserved matters (RM) application boundary. These have been modelled indicatively within the micro drainage network but their design will need to be undertaken to accompany each RM Application.

Existing & Future Development Parcels

2.30 The discharge from each parcel into the main drainage network will be restricted to the following peak rate of run-off:

- ✧ Non-Resi Land (0.91Ha) 5 litres / second
- ✧ Non-Resi Land (0.81Ha) 5 litres / second
- ✧ Non-Resi Land (0.32Ha) 5 litres / second
- ✧ Non-Resi Land (Hotel) 5 litres / second
- ✧ Care Home: 5 litres / second
- ✧ Parking Square: 5 litres / second
- ✧ A1 Parcel (Existing): 34.5 litres / Second
- ✧ A2 Parcel: 5 litres / second
- ✧ B1 Parcel: 5 litres / second

- » B2 Parcel: Free Discharge – See Appendix I & K
- » B3 & B5 Parcel (Existing): 120 litres / second
- » B6 Parcel: 5 litres / second
- » Block B Parcel: 5 litres / second
- » Block A Parcel: 5 litres / second

Free discharge areas below – See paragraph 2.27 to 2.29

- » B4 Parcel (Phase2): Free Discharge – See Appendix I & K
- » C1 Parcel: Free Discharge – See Appendix I & K
- » C2 Parcel: Free Discharge – See Appendix I & K
- » C4 Parcel: Free Discharge – See Appendix I & K
- » Roads Serving Above Free Discharge into Network

Total Peak Discharge: **285 litres / Second**

(1in100yr return period, including climate change)

Free Discharge from Parcels

- 2.31 The surface water network serving the above parcels (C1, C2, C4, B4 Partial, Roads) are interconnected and overlap with each other, and the roads passing through these parcels also drain the upstream and surrounding parcels
- 2.32 There are also no flow controls (ie hydro-brakes) on the surface water sewers within Phase 2 parcels or roads. A total of 23 individual locations / sub-catchments have been identified within Phase 2. The free discharge varies for different return periods and their associated storm durations varying for short durations high intensity storms to longer durations low intensity rainfall events. The critical discharge rates have been identified in
- 2.33 Although there is a free discharge from these sub-catchments the downstream network has been designed to cater for this and the final outfall / discharge rate will not exceed 285 litres / second for the peak 1in100yr return period, including climate change. (The peak discharge rate will be considerably less for lower returns periods as set out above in paragraph 2.27.)
- 2.34 The type of attenuation tanks in the future development plots are to be determined at the time of the RM application. The volumes of tanks identified in Appendix I is approximate only and will need to be designed accurately by the Consultants undertaking the detailed design. Catch pit chambers are to

be specified immediately upstream to the tanks in order to limit the volume of debris / silt entering the tanks.

Modelled Overflow into Future Parcel B4

- 2.35 There is a requirement to add an overflow in the drainage network at the south west corner of the catchment (by SW01). The drainage is exceptionally shallow in this location so there is no scope to add surface water attenuation under the road or adjacent parking areas.
- 2.36 Approximately 226m³ of surface water run-off will overflow into the proposed surface water drainage network that will eventually serve the future development parcel B4. This will only occur for the critical duration storm (120mins) for the 1in100yr return period + climate change.
- 2.37 Therefore, the plan is to increase the size of the future attenuation tank in the adjacent B4 parcel so it will store the 226m³ and release it into the wetlands via a future outfall at the agreed rate of 15 liters / second / hectare.

Surface Water Treatment

- 2.38 Table 26.2 of the SuDS Manual identifies the pollution hazard level associated with the land uses within the Proposed Development as being 'Low'. On a scale from 0-1 a 'Low' pollution hazard level relates to the following pollution hazard indices (See table 26.2 of the SuDS Manual) This is applicable to runoff from residential roofs, driveways, paths, residential parking areas and low traffic roads:
- ✦ Total Suspended Solids = 0.5
 - ✦ Metals = 0.4
 - ✦ Hydrocarbons = 0.4
- 2.39 Table 26.3 of the SuDS Manual sets out the indicative mitigation indices provided by different SuDS features for discharges to surface water.

Permeable Paving

- 2.40 Communal parking and private driveways will be constructed using permeable paving allowing the rainwater falling onto permeable paved areas to be treated by the microorganisms as it passes through drainage medium, see Figure 4.1 below.

- 2.41 Permeable paving provides sufficient pollution mitigation for runoff from low hazard land uses and provides mitigation indices of 0.7, 0.6 and 0.7, which are in excess of the requirement set out in paragraph 2.25.

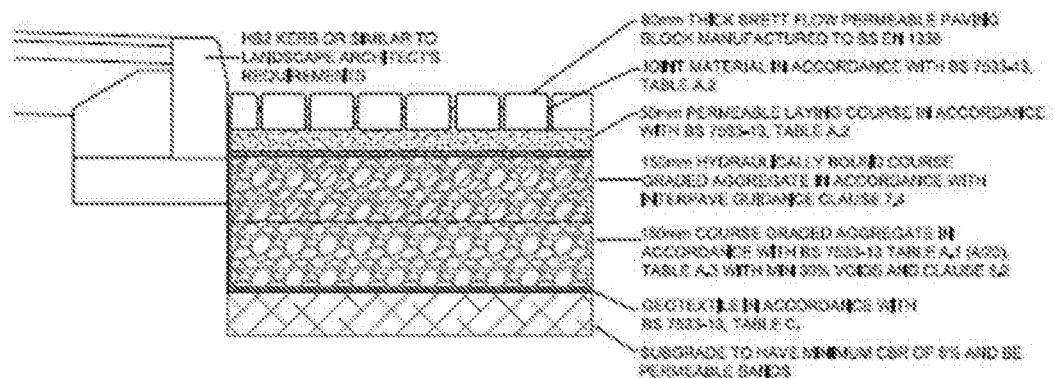


Figure 2.1: Typical Permeable Block Paving Construction

Permeable Sub-base Road

- 2.42 A number of the private roads within C2 Parcel, B2 Parcel and B4 Parcel draining into the drainage network will drain via permeable sub-base located under the road surface. The specific construction is contained in Appendix J.
- 2.43 It is considered that the permeable sub-base provides sufficient pollution mitigation for runoff from low hazard land uses and provides mitigation indices of 0.7, 0.6 and 0.7, which are in excess of the requirement set out in paragraph 2.25

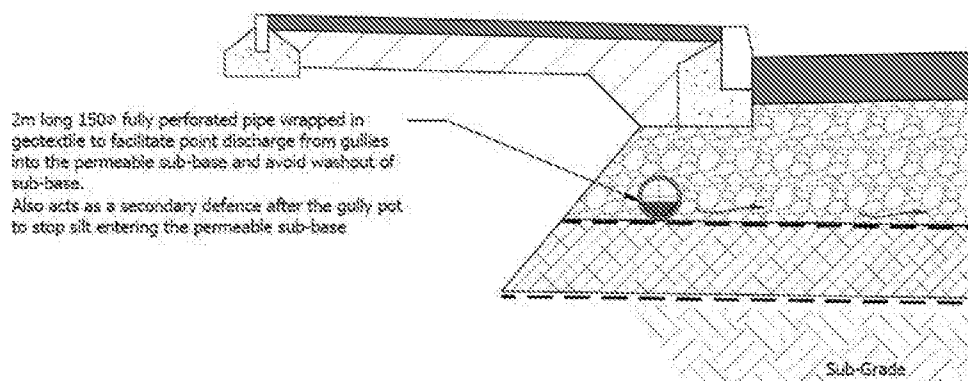


Figure 2.2: Permeable Sub-base Road (refer to Appendix J)

- 2.44 The private roads within C1 Parcel will drain via a filter trench running adjacent the carriageways. The specific construction is contained in Appendix J.
- 2.45 It is considered that the granular material sub-base will provides sufficient pollution mitigation for runoff from low hazard land uses and provides

mitigation indices of 0.7, 0.6 and 0.7, which are in excess of the requirement set out in paragraph 2.25

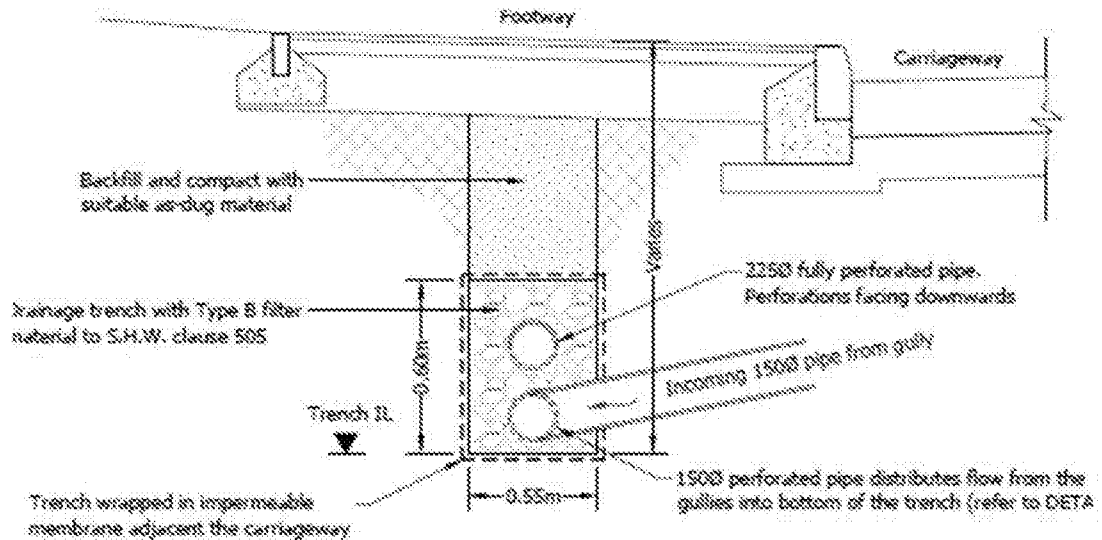


Figure 2.3: Permeable Sub-base Road (refer to Appendix J)

Traditional Gullies

- 2.46 Full size precast concrete gully pots draining the asphalt roads that will act as the first line of defence to trap silt and sediments in the drainage network.

Exceedance Flows & Surcharged Outfall

- 2.47 The drainage network is designed to cope with flooding up to the **1in100yr+30%CC** flood event and this water will be contained on site within the developed areas (not the wetlands)
- 2.48 Appendix D contains drawings that show the route of overland flow in the event of system failure, blockage or overload. This demonstrates that dwellings will be suitably protected in the event of a drainage system failure and resulting overland flow can find its way safely through the road network and into the wetlands.
- 2.49 Discussions have been had with Arun DC to ascertain what would happen if the wetland are flooded and the outfall becomes surcharged. The EA supplied 1in100yr+20%CC modelled flood level within the floodplain ranges from 1.72m AOD to 1.83m AOD. A flood level in the wetlands of 1.8m AOD by the outfall will result in the outfall (@ 1.0m AOD) being surcharged by approximately 0.8m.

- 2.50 The chances of the critical 1in100yr+CC flood level in the wetlands (which is tidal) coinciding with the peak 1in100yr+CC storm event on the site are very small. However, a fully surcharged outfall was simulated and results in a small flood volume escaping from the drainage network that can be safely be contained within the road network (refer to the simulated results for the critical 240 minute storm in Appendix F).

Adoption and Maintenance

- 2.51 The proposed surface water drainage system will be constructed in accordance with Sewers for Adoption 7th edition (SFA7); however it will remain in private ownership and will be maintained by a Management Company organised by the Developer.
- 2.52 Some of the main roads, footpaths and shared areas will be adopted by Mid Sussex District Council under a Section 38 agreement. The remaining private roads and communal parking areas will be maintained by a Management Company, organised by the Developer.
- 2.53 Taking this approach will ensure shared drainage and infrastructure items are properly maintained. This should enable tight control over the operation and maintenance of the drainage / SuDS systems on site.

Attenuation Tank Maintenance

- 2.54 The primary purpose of the attenuation tanks is to attenuate surface water run-off during extreme rainfall events.
- 2.55 Regular inspection and maintenance is required to ensure the effective long-term operation of the below ground storage tanks, see table 2.1 below for details:

Maintenance Schedule	Required Action	Recommended Frequency
Regular Maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then annually
	Debris removal from catchment surface (where may cause risk to performance).	Monthly.
	Remove sediment from pre-treatment structures.	Annually, or as required.
Remedial Actions	Repair/rehabilitation of inlets, outlets, overflows and vents.	As required.
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually and after large storms.

	Survey inside of tank for sediment build-up and remove if necessary.	Annually until evidence this is too regular, every 5 years thereafter.
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Table 2.1: Attenuation Tank Maintenance Requirements

Pervious Pavement Maintenance

2.56 Pervious pavements are pavements that allow for pedestrian and/or vehicular traffic while allowing rainwater to infiltrate through the surface and into underlying structural foundation layers.

2.57 Regular inspection and maintenance is important for the effective operation of pervious pavements as designed, these are described below in table 2.2:

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

Table 2.2: Pervious Pavement Maintenance Requirements

Drainage Network Design Criteria

- 2.58 The positive drainage will be designed in accordance with Sewers for Adoption, and BS EN 752 – Drain and sewer systems outside buildings and the Building Regulations - part H (2002).
- 2.59 The surface water network design and rate of surface water runoff would be based on the Modified Rational method and designed in accordance with the Wallingford Procedure. In order to carry out the design of the networks, a number of Global Variables are used. These Global Variables / parameters are related to the location of the site in the UK and have been obtained from the Flood Estimation Handbook (FEH).
- 2.60 The positive surface water system would be designed such that:
- ✦ The pipes remain unsurcharged during the 1 in 2 year design storm;
 - ✦ The system should not flood during the worst case 1 in 30 year storm with a free outfall;
 - ✦ The surface water run-off from the proposed development would be safely contained on site for up to and including the worst case 1 in 100 year storm event, plus an additional 30% for climate change;
 - ✦ The pipe velocities are such that self-cleansing is achieved at lesser more moderate storm intensities :
 - Pipe roughness (ks) = 0.6
 - Minimum pipe velocity at full flow = 1.0 m/s
 - Cv Value of 0.84 (as agreed with WCSS)
 - Percentage Impermeable areas
 - Buildings = 100%
 - Carriageways and footpaths = 100%
 - Private and Communal Parking = 100%

Micro Drainage Software

- 2.61 The proposed and existing networks have been designed and analysed using the Micro drainage software package that is recognised as one of the industry standard design suites. There are two separate programmes used within the package to firstly generate and then analyse the completed model. These are 'System 1' and 'Simulation'.

- ✧ System 1: The surface water computer model has been generated in “System 1” in using proposed data, such as the cover levels, invert levels and catchment areas. This is used to size the pipes in the proposed network based on the global variable outlined above
- ✧ Simulation: Once the proposed drainage system has been generated it was analysed using ‘Simulation’. This is a full hydrograph method for the determination of flood risk and system failure under extreme conditions. It can be used to analyse system overloads, storage, reverse flow characteristics, surcharging and backwater effects. It can also analyse against a wide variety of critical variables.

Return Periods & Critical Duration Storms

- 2.62 To determine the hydraulic requirements for an element of a drainage system, one must first consider the consequences of that capacity being exceeded and then identify an acceptable frequency for this to occur. This acceptable frequency is termed the return period, the period of time during which the stated rainfall can be expected to be exceeded on average only once, that particular element is then designed to accommodate a storm / flood with this return period.
- 2.63 Once the design return period is established the most critical storm duration for each of the elements is determined. These range in duration from 15 to 1440 minutes. For example;
- ✧ A 1 in 30 year, 30 minute duration storm for the northern catchment has an average intensity of 56.762mm/hr. This intensity of storm would be used to size the pipes and other drainage elements for conveyance purposes.
 - ✧ A 480 minute duration storm has an average intensity of only 8mm/hr (figures obtained from simulated results). However, the 480 minute storm lasts 16 times longer, therefore generating a much greater volume of water and would be used to size the attenuation tanks.

Condition 10 Conclusion

- 2.64 This surface water drainage strategy demonstrates that the west of wetlands catchment site can be drained satisfactorily without increasing flood risk elsewhere.

- 2.65 Intrusive ground investigations and ground water monitoring have determined that infiltration drainage is unlikely to be practical across **much** of the site. Discharge of surface water runoff directly into the chalk, which is designated a principal aquifer, has been discounted due to high recorded groundwater levels within this material and the inability to provide a minimum standoff distance from the saturated zone.
- 2.66 There are, however parcels to the **west** of the site, (as described in paragraph 2.4) that are yet to be developed and where bespoke infiltration drainage might be feasible. Parcel specific infiltration tests will be undertaken to determine the feasibility for each future land parcel where the standing ground water level is found to be in excess of 2.0m below the surface.
- 2.67 Surface water runoff will be discharged to the Black Ditch at a peak allowable discharge of 15 litres / second / hectares for up to the 1 in 100 year return period, plus 30% allowance.
- 2.68 This proposed rate of discharge will provide considerable betterment when compared to the pre-demolition brownfield arrangement. The provision of SuDS and attenuation features will store the balance of surface water runoff.
- 2.69 The proposed discharge rates represent a significant reduction when compared to the pre-demolition 1 in 1 year discharge rate of 390 litres / second, as follows:
- ✦ Critical 1 in 100 year storm (+30% CC): 32% Reduction
 - ✦ Critical 1 in 30 year Storm: 47% Reduction
 - ✦ Critical 1 in 1 year Storm: 58% Reduction
- 2.70 The information contained within this report demonstrates that adequate surface water infrastructure will be provided to enable the consented scheme to be satisfactorily drained, and will enable the future Parcels within the west of the wetlands catchment to make a positive connection into the proposed surface water network.
- 2.71 The reserved matters planning applications for the future parcels will need to be accompanied by an individual surface water drainage strategy and technical note. Each technical note will also include this overall strategy that demonstrates the downstream receiving network has been satisfactory designed in accordance with the relevant standards.

- 2.72 Parcel specific soakaway tests will be undertaken to confirm the feasibility of using infiltration drainage on the future RM planning applications for the remaining land parcels. If feasible the infiltration drainage will be used in conjunction with the positive discharge rates described within this report.
- 2.73 Therefore, it is considered that this evidence base, when read in conjunction with the RM application for the individual parcels, will provide sufficient information to discharge the outline planning Condition 10.

APPENDIX B

LEAP Report Extracts Ref LP2128 Dated 9th April 2020

EXECUTIVE SUMMARY

The investigation areas form part of the wider North Littlehampton Strategic Development Site (NLSDS), which is being developed by the Client and others. Thirteen land parcels (namely A2, B6, Phase 4, D1-D2, E1-E6, F1-F2 and two allotment areas) are to be investigated. This report relates to an area of investigation LEAP have termed Stage 1 Zone 3 and comprises land parcels, A2, B6 and Southern Allotments. Together they cover an area approximately 2.08 hectares in size. All sites are generally flat and level, although A2 and the southern allotment areas were characterised by large open excavation pits, assumed to be related to archaeological work. A plastic newt fence extends around the perimeter of the allotment area. A railway line aligned east to west in a cutting (lower by ~2.0 m) forms the southern boundary of A2 / B6 and Toddlington Lane, also in a cutting (lower by ~1.5 m), aligned east to west forms the northern boundary to A2/B6. Residential developments form the eastern boundary to B6 and the western boundary to A2. A new by-pass road aligned north to south bisects land parcels A2/B6. The boundaries of the allotment areas are formed by residential properties to the east, playing fields and allotments to the west, the railway line to the north and residential developments to the south.

The proposed development in A2 comprises low-rise residential dwellings, with private and public soft landscaped areas including a playground space; B6 includes low-rise residential dwellings and an apartment block with areas of private and public soft landscaping. Hardstanding includes access roads and parking spaces. The southern allotment area is for allotment use only.

A previous Phase I and Phase II investigation covering the NLSDS site boundaries was completed by others in 2014. A2 and B6 are shown to be undeveloped on historical maps dated 1876 until early 2000's when a nursery is labelled on parcel B6 only. Aerial imagery from 2001-2012 shows that majority of B6 is occupied by greenhouses during this period, some related structures also appear on the western boundary of A2. The southern allotment area appears not to have been developed at all during recent history. The desk study has identified a number of potential sources of contamination associated with the site's former use as a nursery. The site is mapped in an area where 1-3% of properties are affected by radon gas, but not in an area where protection measures are required for new buildings.

The site is mapped as being underlain by River Terrace Deposits over the New Pit Chalk Formation. Ground conditions comprise made ground (in one location only) to 0.60 m depth. Firm becoming stiff silty clays were encountered to depths of up to 3.1m but generally to between 1.7 and 2.0m. The clays were noted to become sandier with depth and were locally soft (BH102). They were underlain by a loose to medium dense gravelly fine to coarse sand with gravel of flint and occasional sandy ironstone. The sand was encountered at the shallowest depth of 1.7mbgl in TP139 with deeper deposits proven to 6.2mbgl in BH102. The sands are underlain by chalk bedrock mapped as New Pit Chalk Formation. The chalk was only identified within the two deep boreholes at 3.5m bgl in BH101 and 7.0m bgl in BH102. The upper 1.0m – 2.20m of the chalk is highly weathered comprising structureless Chalk



recovered as very silty chalk gravel. The depth of weathering is noted to be greater within BH102 than BH101. Below 5.8m (BH101) and 8.0m (BH102) the chalk comprises structured high-density Chalk which was recovered as angular chalk gravel and cobbles.

Groundwater strikes were identified during the current investigation at depths of between 5.2 and 7.0m bgl whilst groundwater level monitoring was carried out on 6 occasions between 17th January and 18th March 2020 and found groundwater to be at depths of between 5.25 and 5.62m bgl.

The site is mapped as being located in a flood risk zone 1 by the Environment Agency i.e. land and property have a low probability for flooding.

An allowable bearing capacity of 80kPa is recommended for shallow foundations on the firm to stiff superficial clays. However, foundations will require deepening in the clay soils near trees to NHBC LOW VCP precautions and through any soft/loose soils. Piled foundations may be the preferred option and using the pile design methodology outlined in CIRIA C574, example calculations suggest that a 12m long 300mm diameter cfa pile would have a design compressive resistance of around 360kN whilst a 400mm pile could have around 560kN. The final design must be carried out by the specialist contractor in accordance with their preferred method of formation.

Suspended floor slabs are recommended.

Where a risk of dissolution features has been identified, this must be considered in the pile design. Dissolution features are rarely vertical and may be evident under significant thicknesses of intact chalk. On that basis, care must be taken to not rely on end bearing piles.

The River Terrace Deposits are classified by the BRE as sulphate design class DS-I, and, assuming a mobile groundwater table, the ACEC class is AC-I.

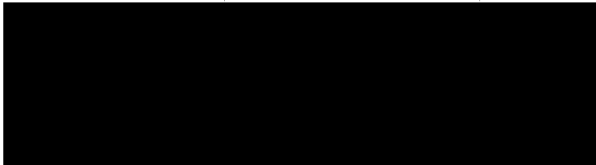
A design CBR value of 0.5% is recommended for a silty clay subgrade.

A geo-environmental risk assessment has been carried out. Contamination testing of the soils did not identify potential contaminants of concern above generic assessment criteria values for the proposed end-uses (residential with home grown produce and allotment land uses). However, further testing is recommended in B6 where shallow made ground is identified.

If it is not possible to undertake further investigation it is recommended that a minimum of 600 mm clean cover (or made ground removal into top of natural soils, whichever is the shallowest) is allowed for in proposed new soft landscaped areas where made ground is present.

As with any redevelopment site, there is always the risk of hitherto undetected contamination, and further investigations should be carried out prior to redevelopment.

Much of the soils on site will be expected to be classified as non-hazardous waste.

Signed :	 Oscar Amelianczyk BSc MSc FGS
Checked :	 Martin Weil BSc MA C.WEM CSci CEnv  Phil Clare BSc CGeol FGS
Countersigned :	 Richard Brinkworth BEng CEng MICE
Date :	9 April 2020
Revision:	Issue 1

Samples were collected with a clean sampling trowel or by hand (using dedicated nitrile gloves for each sampling location). Samples were placed into laboratory supplied sampling containers, specific to the type of analyses required.

All sample containers were sealed and labelled with a unique location identity, depth and date of sampling.

13.2.5 Monitoring Well Installation

One groundwater monitoring wells was installed within the Zone 3 area, although in total three groundwater wells were installed across the Stage 1 investigation areas to target the Chalk Aquifer. The monitoring wells were constructed of 50mm diameter HDPE pipe. The response zone within the cable percussive boreholes were typically targeted to intercept the groundwater surface and was surrounded by washed filter gravel. The plain zone was surrounded with bentonite to provide a seal.

Land gas monitoring wells were not installed within the Zone 3 area, as a potential land gas source was not identified.

Table 6: Stage 1 borehole installation details

Borehole	Zone	Type G-gas W-water	Plain Well Screen (mbgl) and ID (mm)	Slotted Well Screen (mbgl)	Bentonite Seal (mbgl)
LBH101	3	W	GL - 4	4 - 7	GL - 4
LBH104	1	W	GL - 3	3 - 6	GL - 3
LBH106	1	W	GL - 3	3 - 6	GL - 3

13.3 Field Tests

13.3.1 Standard Penetration Tests

Standard penetration tests were undertaken in the boreholes at 1m centres until 5.0m, there after taken every 1.5m and where feasible, alternating with UT100 samples in cohesive soils, in accordance with BS EN ISO 22476-3;2005. Uncorrected blow counts, 'N values', are recorded on the borehole logs in Appendix F.

13.4 Groundwater Monitoring

13.4.1 Groundwater level monitoring

6No. rounds of groundwater monitoring have been undertaken to date. The visits were completed between 17/01/2020 and 18/03/2020. Groundwater monitoring wells were inspected for the presence of water using an electronic dip meter. Field monitoring records are provided in Appendix I.

17 Sulphates

4 No. samples of the River Terrace Deposits and a single sample of chalk were tested for sulphate content and pH. In accordance with the BRE¹³ methodology and the number of samples tested, the site has been classified on the highest measured sulphate content.

Based on the results detailed in Section 15 and the above, the soils are classified by the BRE as sulphate design class DS-I, and, assuming a mobile groundwater table, the ACEC class is AC-I.

18 Groundwater

The groundwater monitoring results/observations are given in Section 15.1. On the basis of these results, groundwater at about 5.2m below ground level should be anticipated.

Shallow seepages from more granular seems within the clay should also be anticipated, however, should this occur, pumping from sumps should suffice to maintain dry working conditions.

19 Bearing Capacity and Foundations

19.1 Shallow Foundations

Areas of soft ground have been identified around the location of BH102 located on the B6 development area and beyond to the north on the proposed bypass.

All loads should be transferred beneath any topsoil, made ground, loose, soft, low strength, desiccated or disturbed soils and transferred onto the firm becoming stiff clays at depth. For low rise housing, based on local experience and BS8103¹⁴ Table 8, an allowable bearing capacity of 80kPa is recommended for shallow foundations. However, foundations will require deepening in the clay soils near trees to NHBC LOW VCP precautions.

Allowance should be made for nominal reinforcement, due to the propensity for foundations to span different soil types.

¹³ Building Research Establishment Special Digest 1: 2005. Concrete in aggressive ground. Part 1: Assessing the aggressive chemical environment.

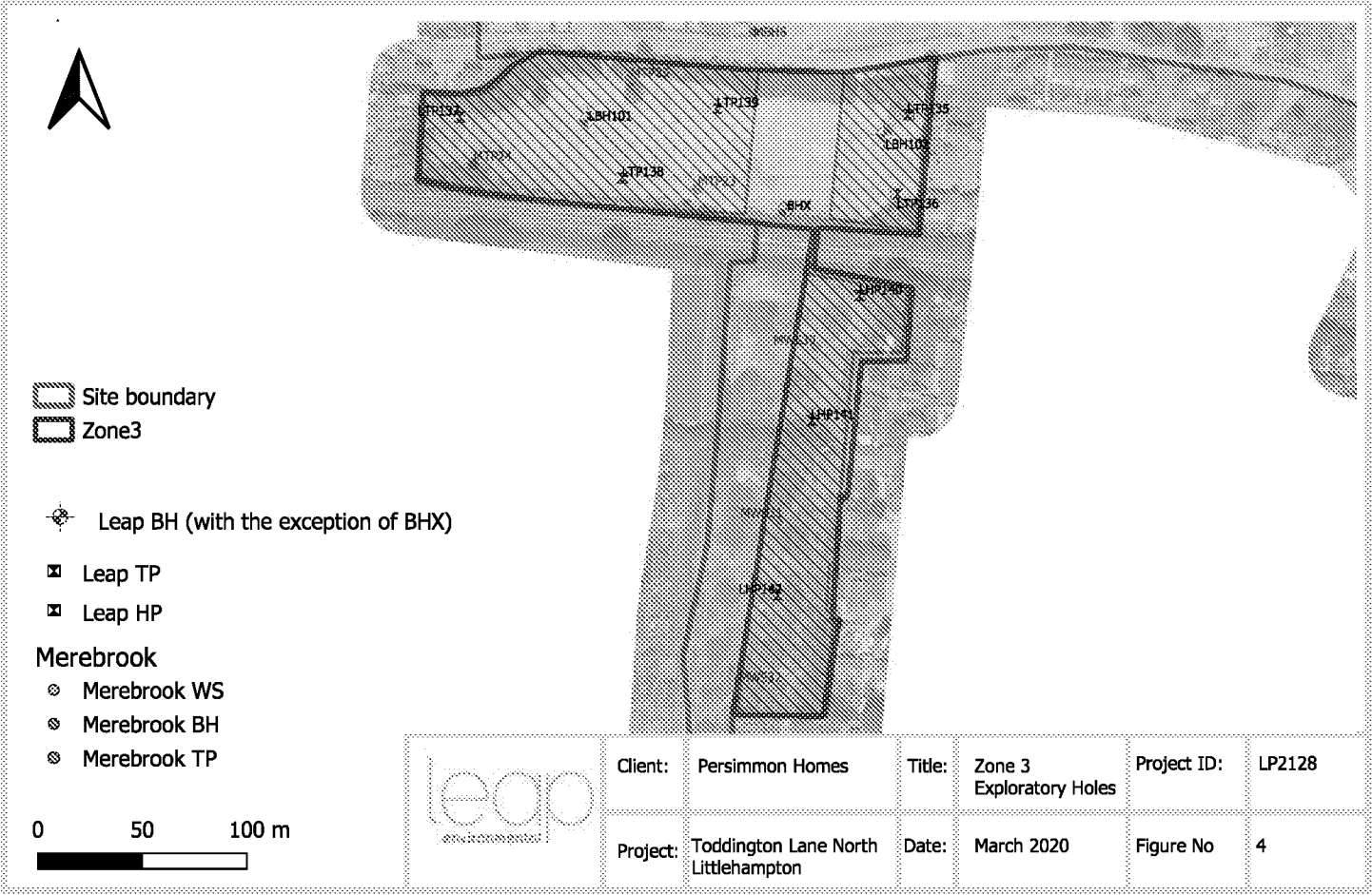
BS8103-1:2011 Structural design of low-rise buildings. Code of practice for stability, site investigations, foundations, precast concrete floors and ground floor slabs for housing

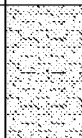
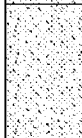
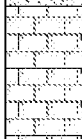
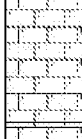
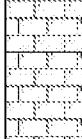
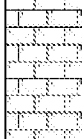
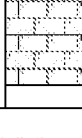
26 Solution Features

The site is situated within an area at potential risk of solution features. The PBA database search found no natural cavities within 2.5km of the site and therefore the site was reported by them to have a low risk from solution features. However, localised soft/loose soils have been found on site (BH102) which extend to the top of the chalk and resemble areas of potential dissolution, possibly relating to inactive or collapsed former features.

This report provides recommendations for precautions for the design and construction of foundations taking account of the current level of risk of solution features and swallow holes. The precautions recommended within this report, if designed and constructed correctly, will minimise the risk to the proposed foundations and structures.

However, the risk of swallow holes opening within the wider site, away from structures, remains the same. As such the potential for swallow holes to occur on site cannot be discounted or designed against and the reputational (and possibly financial) impact of any such occurrence should not be underestimated. It is essential that **all efforts to minimise surface water migration into the ground are adhered to**. In particular, the design of water supply and sewer pipes should take into account the potential for relatively large settlements to occur where ground levels are raised and be designed accordingly. Where possible, ground level raises should be avoided.

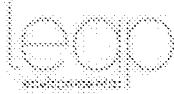
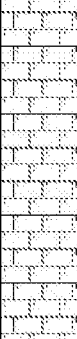


 Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Borehole Log				Borehole No. BH101 Sheet 1 of 2		
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 503034 - 103887		Hole Type CP		
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Level: 7.24		Scale 1:50				
Client: Persimmon Homes Thames Valley				Dates: 20/12/2019 - 23/12/2019		Logged By OA				
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description		
		Depth (m)	Type	Results						
		1.00	D	N=19 (0,1/2,4,6,7)	1.00	6.24		Brown to dark brown sandy gravelly CLAY with gravel of subangular to subrounded fine to coarse flint.	1	
		1.20								Firm brown to reddish brown very sandy gravelly CLAY.
		1.50	B							
			2.20		N=21 (2,4/5,5,5,6)	2.00	5.24		Loose brown to reddish brown gravelly SAND with gravel of sub angular to subrounded fine to coarse flint.	2
			3.20							
			3.20	B	N=8 (1,2/2,2,2,2)	3.50	3.74		Off white to cream weathered structureless high density CHALK recovered as silty chalk gravel.	3
			4.00							
			4.20	B	N=25 (5,7/6,7,5,7)	4.80	2.44		Yellowish off white locally darkly stained structureless high density CHALK recovered as silty chalk gravel.	4
			5.00							
			5.20	D	N=12 (1,2/3,3,3,3)	5.80	1.44		Off white Structured high density CHALK recovered as silty chalk gravel.	5
		6.00								
		6.50	D	N=30 (1,3/7,6,7,10)					6	
		7.50								
		8.00	B	N=50 (6,10/50 for 145mm)					7	
		9.50		N=50 (9,6/50 for 297mm)					8	
		10.00	B						9	
									10	

Continued on next sheet



Remarks
 Groundwater struck at 5.2m. A groundwater monitoring well was installed. The installation comprised a raised steel cover over plain pipe from ground level to 4.0mbgl over slotted pipe from 4.0m to 7.0mbgl. The excavation was reinstated with gravel from 12.5m to 8.0mbgl, bentonite from 8.0m to 7.0m, gravel from 7.0m to 4.0m arisings from 4.0m to 1.0m and bentonite from 1.0m to ground level.

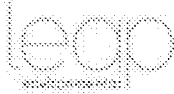
 Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Borehole Log				Borehole No. BH101 Sheet 2 of 2	
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 503034 - 103887		Hole Type CP	
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Level: 7.24		Scale 1:50			
Client: Persimmon Homes Thames Valley				Dates: 20/12/2019 - 23/12/2019		Logged By OA			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50	D	N=50 (25 for 79mm/50 for 85mm)	12.50	-5.26			11
		11.00							12
		12.00	D						13
								End of borehole at 12.50 m	14
									15
									16
									17
									18
									19
									20
Remarks Groundwater struck at 5.2m. A groundwater monitoring well was installed. The installation comprised a raised steel cover over plain pipe from ground level to 4.0mbgl over slotted pipe from 4.0m to 7.0mbgl. The excavation was reinstated with gravel from 12.5m to 8.0mbgl, bentonite from 8.0m to 7.0m, gravel from 7.0m to 4.0m arisings from 4.0m to 1.0m and bentonite from 1.0m to ground level.									

 Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Borehole Log				Borehole No. BH102 Sheet 1 of 2	
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 503176 - 103880		Hole Type CP	
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Level: 7.64		Scale 1:50			
Client: Persimmon Homes Thames Valley				Dates: 18/12/2019 - 19/12/2019		Logged By OA			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30	7.34		Grey to dark grey subrounded medium to coarse rounded gravel MADE GROUND with occasional brick cobbles.	
					0.60	7.04		Brown to dark brown clayey gravel MADE GROUND comprising subangular to subrounded fine to coarse flint and occasional coarse plastic fragments.	
		1.00	D					Soft brown to dark brown very gravelly CLAY with gravel of subangular to subrounded fine to coarse flint.	1
		1.50	B	N=3 (1,0/0,1,1,1)					
		1.50							
		2.00	D		2.10	5.54		Firm orange to orangish brown gravelly very sandy CLAY with gravel of subangular to subrounded fine to coarse flint.	2
		2.50		N=18 (1,3/3,4,6,5)					
		3.00	B		3.10	4.54		Medium dense becoming loose brown to dark brown slightly gravelly medium SAND with occasional gravel of subangular to subrounded fine to coarse flint.	3
		3.50		N=20 (1,3/4,6,5,5)					
		4.50	B	N=7 (1,1/2,2,1,2)	5.00	2.64		Loose brown to dark brown gravelly medium SAND with gravel of subangular to subrounded fine to coarse flint and cobbles of black stained ironstone.	5
	4.50								
	6.00	B	N=8 (1,2/0,2,3,3)	6.20	1.44		Light brown gravelly clayey SILT with gravel of subangular to subrounded fine to coarse flint and chalk.	6	
	6.00								
	6.50	B		7.00	0.64		Off white to brownish cream structureless high density silty clayey CHALK.	7	
			N=15 (1,2/2,3,4,6)						
				8.00	-0.36		Off white structured medium to high density CHALK recovered as silty gravel.	8	
		8.50	D						9
		9.00		N=47 (7,8/10,12,13,12)					
		10.00	B						10

Continued on next sheet



Remarks
 Borehole was terminated due to slow progress through high density chalk. Groundwater was struck at 7.2m. The borehole was reinstated with gravel from 10.8mbgl to 7.0m bentonite from 7.0m to 6.0m and arisings from 6.0m to ground level.

 Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Borehole Log				Borehole No. BH102 Sheet 2 of 2	
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 503176 - 103880		Hole Type CP	
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Level: 7.64		Scale 1:50			
Client: Persimmon Homes Thames Valley				Dates: 18/12/2019 - 19/12/2019		Logged By OA			
Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		10.50		N=50 (25 for 125mm/50 for 115mm)	10.80	-3.16			
								End of borehole at 10.80 m	11
									12
									13
									14
									15
									16
									17
									18
									19
									20
Remarks Borehole was terminated due to slow progress through high density chalk. Groundwater was struck at 7.2m. The borehole was reinstated with gravel from 10.8mbgl to 7.0m bentonite from 7.0m to 6.0m and arisings from 6.0m to ground level.									

Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com		Trial Pit Log			Trialpit No TP135 Sheet 1 of 1	
Project Name: North Littlehampton		Project No. LP2128		Co-ords: 503186 - 103890		Date: 04/12/2019
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP		Dimensions (m):				Scale: 1:25
Client: Persimmon Homes Thames Valley		Depth: 3.00				Logged: OA

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES	N=12	0.30	7.18		Grass over brown to dark brown silty sandy TOPSOIL with frequent rootlets.	1
	0.40	ES		0.50	6.98		Brown to dark brown silty sandy SUBSOIL.	
							Firm brown to dark brown silty CLAY.	
	1.30	D					Hand Pen at 1.5m = 100kPa	
	1.90	B		1.70	5.78		Medium dense brown to orange silty clayey medium SAND.	2
							Closely laminated clay pockets at 2.8m.	
				3.00	4.47		End of pit at 3.00 m	3
								4
								5

Remarks: Trial pit remained dry and stable.	
Stability: Stable	

Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Trial Pit Log				Trialpit No TP136 Sheet 1 of 1	
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 503181 - 103852 Level: 7.39		Date 04/12/2019	
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Dimensions (m):		Scale 1:25		Logged OA	
Client: Persimmon Homes Thames Valley				Depth 3.20					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES	N=14	0.30	7.08		Brown silty clayey TOPSOIL with frequent rootlets, occasional subangular to subrounded coarse flint, rare brick cobbles and frequent rootlets.	1
	0.60	ES					Firm to stiff brown slightly orange silty CLAY.	
	1.00	D					Hand Pen at 1m = 113.3kPa	
	1.70	D					Hand Pen at 1.4m = 96.6kPa	
				1.60	5.78		Firm brown to orange silty sandy CLAY.	2
				2.10	5.28		Medium dense orange brown silty gravelly clayey SAND with gravel of subangular to subrounded fine to coarse flint.	
	2.30	B		3.20	4.18	End of pit at 3.20 m		3
								4
								5

Remarks: Trial pit remained dry and stable.	
Stability: Stable	

Leap Environmental Ltd The Atrium, Curtis Road Dorking, Surrey RH4 1XA Tel: 01306 646510 www.leapenvironmental.com				Trial Pit Log				Trialpit No TP137 Sheet 1 of 1	
Project Name: North Littlehampton				Project No. LP2128		Co-ords: 502972 - 103889 Level: 7.40		Date 04/12/2019	
Location: Land near Wick, North Littlehampton, West Sussex, BN17 7PP				Dimensions (m):		Scale 1:25		Logged OA	
Client: Persimmon Homes Thames Valley				Depth 3.00					

Water Strike	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
	0.20	ES	N=16	0.30	7.10		Grass over reddish dark brown silty clayey TOPSOIL with frequent rootlets.	1
	0.40	ES		0.50	6.90		Dark brown silty clayey SUBSOIL.	
							Firm dark brown occasionally orange grey mottled silty CLAY.	
	1.20	D				Hand Pen at 1.4m = 133.3kPa	2	
				1.80	5.60	Medium dense orange brown silty clayey medium SAND with occasional subangular to subrounded fine flint and pockets of clay.		
	2.50	D			Gravel content increases including weakly cemented sandstone with laminations and flint size range increases from fine to coarse below 2.5m.			
			3.00	4.40	End of pit at 3.00 m	3		
								4
								5

Remarks: Trial pit remained dry and stable.	
Stability: Stable	

APPENDIX I – Groundwater Level Monitoring

**Groundwater Level
Monitoring**

	17/01/2020		29/01/2020		07/02/2020		18/02/2020		04/03/2020		18/03/2020	
	Depth to water	Depth to base	Depth to water*	Depth to base*	Depth to water*	Depth to base*	Depth to water*	Depth to base*	Depth to water*	Depth to base*	Depth to water*	Depth to base*
BH101	5.62	7.23	5.63	7.13	5.36	7.01	5.34	7.10	5.40	7.05	5.25	7.10
BHX	n.r.	n.r.	n.r.	n.r.	5.58	9.95	n.r.	n.r.	5.45	9.95	n.r.	n.r.
WS103	0.80	3.20	0.66	3.01	0.80	3.11	0.45	2.95	0.50	3.00	0.50	3.05
WS104	1.70	1.95	1.58	1.86	1.20	1.55	1.35	1.95	1.20	1.95	1.25	2.00
BH104	5.81	6.00	3.08	6.43	2.50	5.91	n.r.	n.r.	n.r.	n.r.	2.33	5.93
HP101	n.r.	n.r.	Dry	0.96	Dry	0.85	Dry	0.90	Dry	0.85	Dry	0.90
BH106	n.r.	n.r.	2.70	5.77	2.47	5.20	2.60	5.68	2.55	5.70	2.72	5.80
	Measurements from top of well cover		*Measurements from top of pipe		*Measurements from top of pipe		*Measurements from top of pipe		*Measurements from top of pipe		*Measurements from top of pipe	

APPENDIX C

Rainfall & River Flow Summary 19th to 25th February 2020

Weekly rainfall and river flow summary

Weekly bulletin: Wednesday 19 to Tuesday 25 February 2020

Summary: It has been another wet week for England especially in the north. River flows at almost all of the rivers we report on are higher than normal for the time of year, with around two-fifths being exceptionally high.

Rainfall

Rainfall totals for the past week ranged from 18mm in south-east England to 105mm in north-west England (Table 1 and Figure 1). Cumulative rainfall totals for the month to date range from 161% of the monthly long term average (LTA) in south-west England to 333% in north-west England (Table 1).

River flow

River flows increased at all sites we report on in north-west England compared to last week, but decreased on almost two-thirds of the rivers we report on across England as a whole. Almost all of the rivers are classed as above normal or higher for the time of year, with around two-fifths of sites exceptionally high. In east and south-east England, 4 are classed as normal for the time of year (Figure 2).

Outlook

Rain, sleet and snow are expected on Thursday, with showers heaviest in the north-west. From Friday to Saturday, a frontal system will bring rain, heaviest in the west. Further showers are expected on Sunday. From Monday the weather is expected to remain unsettled with showers and frontal rain moving in from the south.

Author: National Water Resources Hydrology Team

Geographic regions	Latest Week: 19 to 25 Feb 2020	Latest month to date: Feb 2020		Last month: Jan 2020		Last 3 months: Nov 2019 to Jan 2020		Last 6 months: Aug 2019 to Jan 2020		Last 12 months: Feb 2019 to Jan 2020	
	Total (mm)	Total (mm)	% LTA	Total (mm)	% LTA	Total (mm)	% LTA	Total (mm)	% LTA	Total (mm)	% LTA
north-west	105	260	333	116	99	356	98	846	119	1,481	124
north-east	52	163	278	55	69	256	104	597	128	1,035	123
central	35	128	250	57	87	262	129	555	142	963	133
east	22	75	199	49	95	206	126	419	131	708	118
south-east	18	108	218	68	94	291	131	531	128	840	115
south-west	27	135	161	104	90	420	124	818	137	1,228	120
England	39	135	233	71	88	290	117	605	129	1,002	121

Table 1 Latest rainfall summary information (Source: Met Office © Crown Copyright, 2020)¹

¹ Notes:

- LTA = long term average rainfall for 1961 – 1990.
- Data for the current month are calculated using MORECS (Met Office Rainfall and Evaporation Calculation System); data for past months are provisional values from the National Climate Information Centre (NCIC).
- The data is rounded to the nearest millimetre or percent (except when values are less than 1).
- Recorded amounts of rainfall are likely to be underestimated during snow events.

All data are provisional and may be subject to revision. The views expressed in this document are not necessarily those of the Environment Agency. Its officers, servants or agents accept no liability for any loss or damage arising from the interpretation or use of the information, or reliance upon views contained herein.

Rainfall

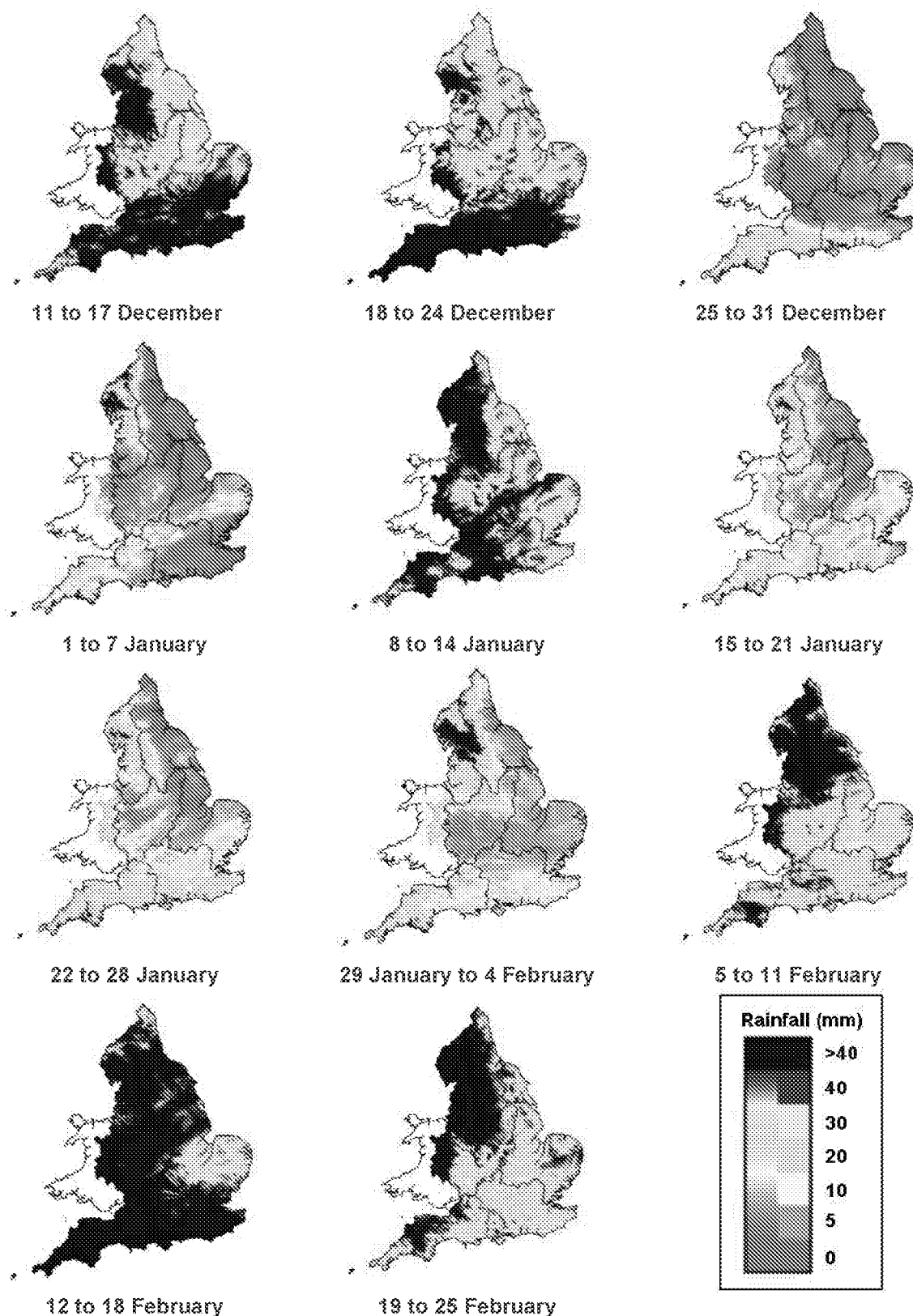
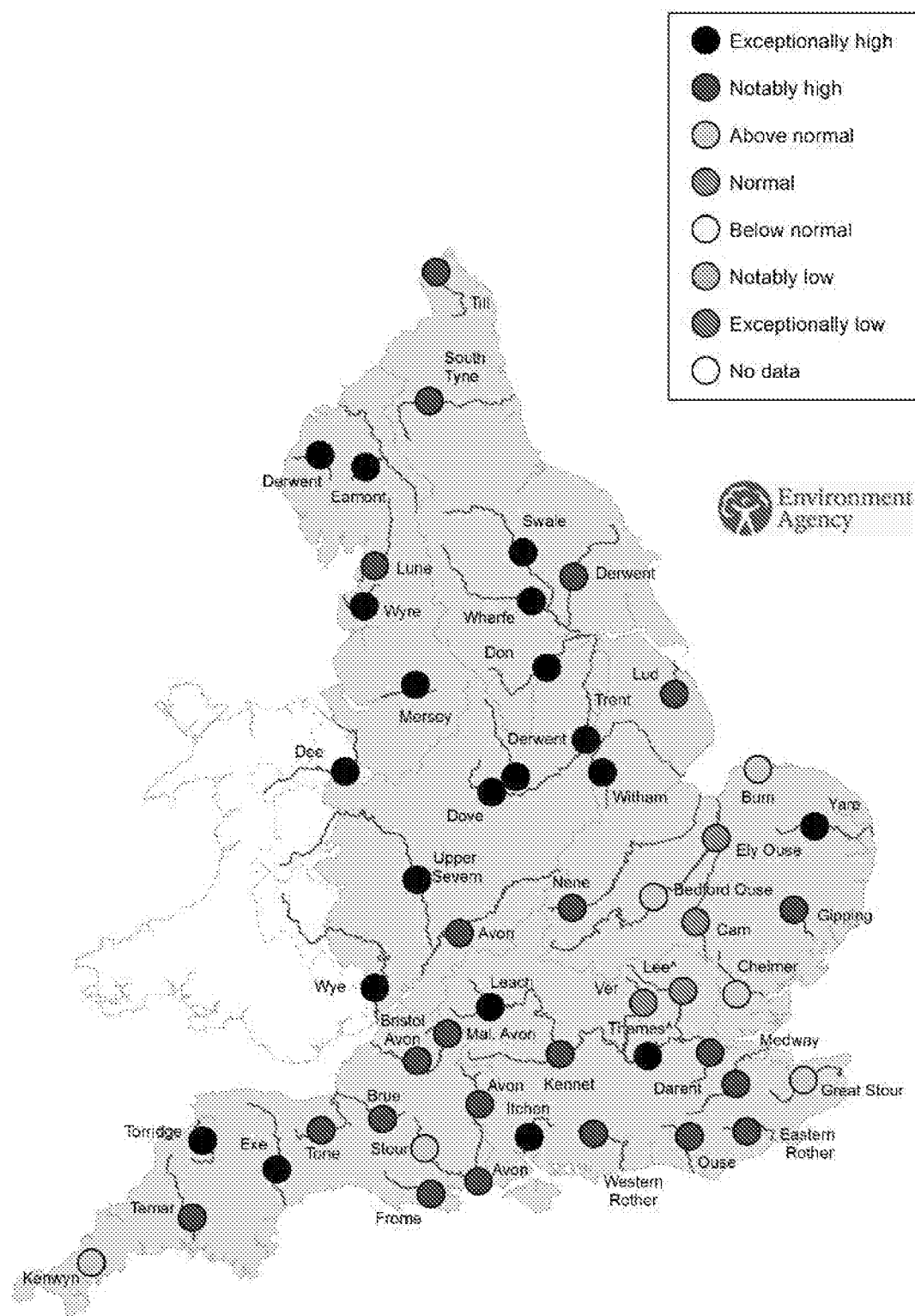


Figure 1 Weekly precipitation across England and Wales for the past 11 weeks. UKPP radar data (Source: Met Office © Crown Copyright, 2020). Note: Images may sometimes include straight lines originating from the centre of the radar, resulting from tall trees and buildings located near the radar installation affecting its performance. This does not reflect actual conditions on the ground. Crown copyright. All rights reserved. Environment Agency, 100024198, 2020.

River flow



'Naturalised' flows are provided for the River Thames at Kingston and the River Lee at Feildes Weir.

Figure 2 Latest daily mean river flow, relative to an analysis of historic daily mean flows, classed by flow percentile for the same time of year² (Source: Environment Agency). Crown copyright. All rights reserved. Environment Agency, 100024198, 2020³.

^aFlow percentiles describe the percentage of time that a particular flow has been equalled or exceeded compared to the historic flow record for that site for the time of year. Flow percentiles presented relate to an analysis for the time of year and not a whole year.

⁵The flow sites in this report are indicator sites providing a National overview and a subset of a wider flow monitoring network.

River flow categories

Exceptionally high	Value likely to fall within this band 5% of the time
Notably high	Value likely to fall within this band 8% of the time
Above normal	Value likely to fall within this band 15% of the time
Normal	Value likely to fall within this band 44% of the time
Below normal	Value likely to fall within this band 15% of the time
Notably low	Value likely to fall within this band 8% of the time
Exceptionally low	Value likely to fall within this band 5% of the time

[Return to summary page](#)

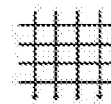
Appendix D

Banners Gate Civil Engineering Design Drawings. Please refer to attached Drawing Issue Sheet for reference.

Microdrainage Hydraulic Calculations

Hydrobrake & Cellular Storage info.

Project No: 19163



BANNERS GATE
CIVIL, STRUCTURAL AND
TRANSPORTATION ENGINEERS

[illegible]

SIZE	SCALE
------	-------

[illegible][illegible]

ISSUE METHOD			
E - Issued by Email	L - Issued by Letter	FT - Issued by File Transfer	U - Uploaded to Online Portal

REASON FOR ISSUE	
PL - Planning	T - Tender
DD - Detailed Design	
FC - For Construction	I - Information
AR - As Requested	

COUNCIL LU/90/20/DOC

S38 - Section 38 S104 - Section 104 S184 - Section 184 S185 - Section 185 S278 - Section 278

AR	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR	AR								
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Notes:



The Contractor is to check and verify in conjunction with the architect details of setting out points, building and site dimensions, levels and sewer invert levels at construction points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standards Specifications, Building Regulations etc, whether or not specifically stated on this drawing.

This drawing is not intended to show details of ground conditions or ground coverings. Each area of ground relied upon to support any structure including drainage must be investigated by the Contractor and areas of potential for subsidence which do not accord with the anticipated conditions as described in the site investigation report are to be immediately notified to the Engineer, where applicable. Any exposed or suspected ground conditions or voids within the ground covered by the site investigation report are to be immediately notified to the Engineer, where applicable. Any earthworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical report. Where existing trees are shown to be retained the contractor should be advised to retain them by a suitable geotechnical report. It is the Contractor's responsibility to ensure that a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

This drawing and the building work depicted are the copyright of Bannerman Gate Ltd and may not be reproduced or amended except by written permission. To liability will be accepted for amendments made by other parties.

GENERAL NOTES

- This drawing is to be read in conjunction with relevant architectural and engineering drawings.
- Levels indicated in blocks are Finished Floor levels and are 150mm above adjacent finished ground levels unless otherwise shown.
- Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the Engineer prior to commencement of works.

ADAPTABLE ROADS AND SEWERS

- Roads, footways and parking bays which form part of the Highway to be adopted under Section 38 of the Highways Act 1980 shall comply with the requirements of the Adopting Authority.
- Sewers to be adopted under Section 104 of the Water Industry Act 1991 shall comply with the Water Authorities Association 'Sewers for Adoption 6th Edition' with any amendments specified by the Adopting Water Authority.
- All pipes to be used in adoptable sewers shall be either clayware to BS EN 285 or concrete to BS EN 1916 and BS EN 117 Part 1 with Class S bedding unless otherwise stated. With approval of the Adopting Authority solid wall concrete external rib reinforced uPVC pipes complying with the relevant provisions of BS EN 14742 may be used.
- Where cover is to be in place for more than 1200mm under adoptable carriageway the trench shall be filled to formation of the carriageway with well compacted CDP Type 1 material.
- Where cover is to be in place for more than 1200mm under adoptable carriageway it shall be provided with concrete protection in accordance with the specification of the adopting authority and back filled to formation of the carriageway with well compacted CDP Type 1 material. Where concrete bed and surround is specified flexibility of joints is to be maintained by using compressible bitumen impregnated fibreboard at each pipe joint.
- All existing drainage invert levels, diameters and locations are to be checked by the Contractor prior to the commencement of any proposed drainage work. Any difference between actual and drawn details is to be reported to the Engineer immediately.
- Positions of existing services/utility underground apparatus adjacent to or crossing proposed sewers is to be checked by the Contractor prior to starting work.
- Infill covers and frames in block paved areas are not to be used (see 2.9.6 S845 p 25).
- Catchpits shall not be adopted.
- Elements at any change in width should be 2.5m to each side of the centre pipe line for pipe size up to 300mm diam and 5m each side of the centre pipeline for pipes 300mm dia greater.
- Where pipe crossing, plastic membrane to be used for protection to eliminate any chances of cross contamination.
- No backflow to be used, deeper gradients are preferred to the use of backdrops.
- Precast concrete manhole rings will not be cut under any circumstances. Other options are preferred, manhole built up with concrete or brick work to the top of the pipe.
- Protective concrete cover slabs to be used on pipes in non traffic area which does not achieve 0.9m/900mm cover level and 1.2m/1200mm cover in traffic area.
- Cover and frames should be kitemarked (Page 15, 1.10).
- Pipes of different diameters entering manholes should be located centrally over the pipe, please refer to S845 Edition figure 2.8 Type E details Page 33.
- Type E manhole the opening cover and frame should be located centrally over the pipe, please refer to S845 Edition figure 2.8 Type E details Page 33.
- The outside of the sewer should be in vehicle carriageway (not footway) and be at least 1m from the kerb line. The outside manholes should be at least 0.5m from the kerb line.
- Trees on the drawing are existing or proposed and adhere to S2.2.3 (Page 33) of S845. The trees specified will be as per Sewers for Adoption and positioned.
- All proposed manhole covers and frames of a minimum of 675x675mm to maintain a clear opening and to comply with Sewers for Adoption and positioned.
- The materials to be used are available for ground conditions.
- In situations where traffic loading is anticipated to be heavier than would occur on a typical residential estate distributor road (i.e. braking or turning near a junction) a higher specification cover (2500) should be used.
- Surface water drainage has been designed to 100yr + 30% allowance for climate change.

Section 104 Legend:

General

- 140.00 Proposed Finished Floor Level
- 140.00 Proposed Garage Slab Level
- Site Boundary

S104 Adoptable Drainage

- S104 Foul Water Sewer & MH
- S104 Storm Water Sewer & MH
- Tanked Impervious Paving
- Existing Rising Main
- S38 Adoptable Drainage
- S38 Gully & Connection
- S104 FMH Reference
- S104 SMH Reference
- Existing Rising Main Easement

Rev.	First Issue	Description	Date	By
1	14.05.20			JJE

Drawing Status

FOR CONSTRUCTION

Client

PERSIMMON
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Project

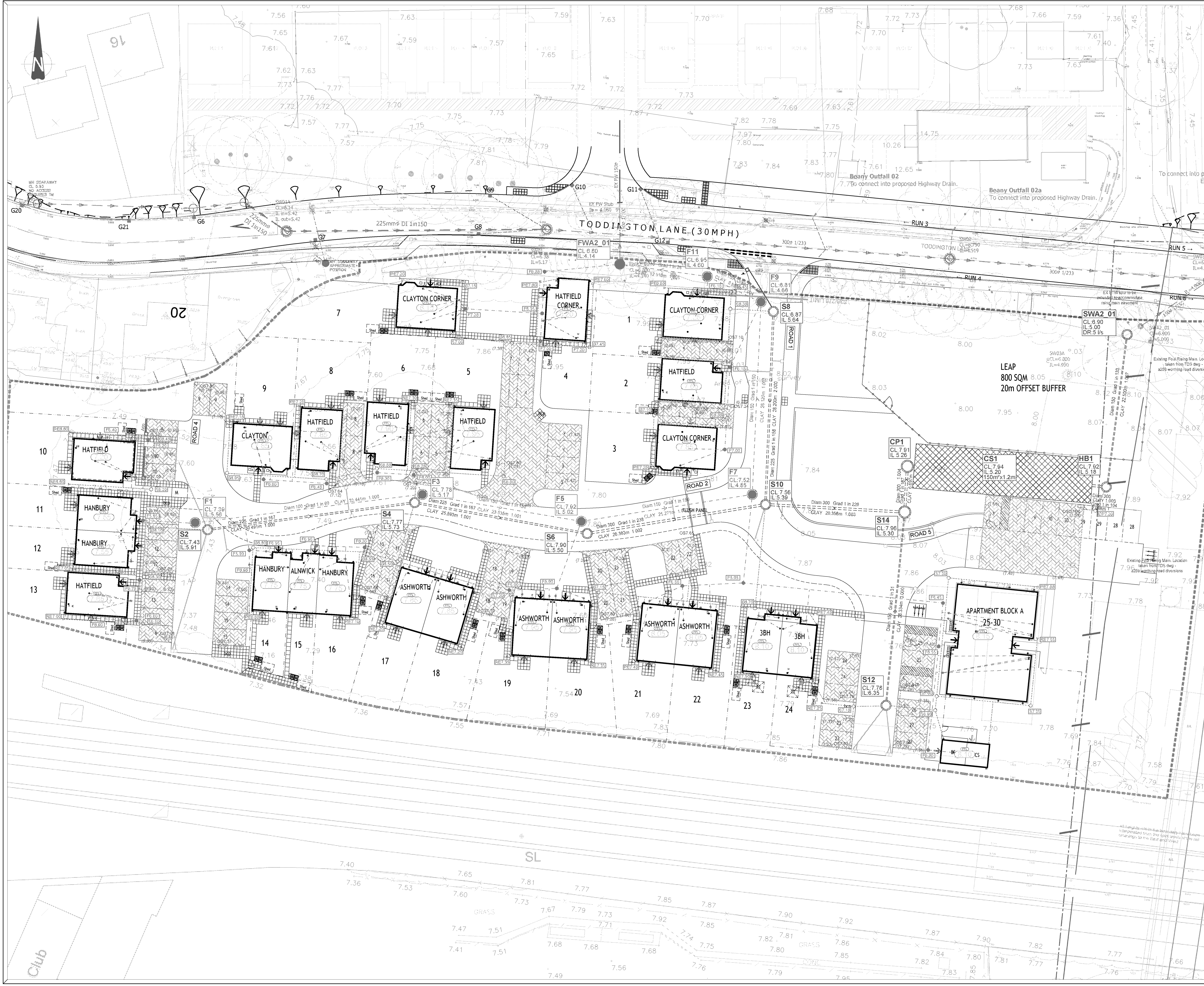
Littlehampton
West Sussex

Title

Section 104 Agreement Plan

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Scale	A1 @ 1: 500	Drawn	JJE
Date	May 2020	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 100S104



GENERAL NOTES

- This drawing is to be read in conjunction with relevant architectural and engineering drawings.
- Levels indicated in brackets are Finished Floor Levels and are 150mm above adjacent finished ground levels unless otherwise stated.
- Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.
- Saddle connections to be 45°

Drainage Legend:

General

- Proposed Finished Floor Level
- Proposed Garage Slab Level
- Site Boundary

Private Drainage

- Foul Water Sewer (1000mm unless otherwise stated)
- Foul Water 525mm Inspection Chamber
- Foul Water 300mm Inspection Chamber (Max. Depth 750mm)
- Acro Drain
- Proposed Outlet Sump and Level
- SW Sewer & MH
- SW Manhole Ref. (Cover & Invert Levels)
- Proposed Road Gully & Connection
- Existing Rising Main
- Storm Water Sewer (1000mm unless otherwise stated)
- Storm Water 525mm Inspection Chamber
- Storm Water Rodding Eye & Level (Max. Depth 750mm)
- Proposed Cellular Storage
- Porous Tanked Paving
- FW Sewer & MH
- FW Manhole Ref. (Cover & Invert Levels)
- Sub Base Levels

H	Private drainage runs amended to suit revised layout.	13.05.20	JE
D	Private drainage lines amended to suit revised layout.	28.02.20	JE
C	Client data added to drawing.	17.01.20	JE
F	Drawings amended to suit 'new' layout.	16.01.20	TB
N	New layout added.	16.01.20	TB
C	New layout inserted.	03.10.19	JE
D	Drawings amended to suit client's request.	19.09.19	TB
A	Plot 11 private storm drainage amended to suit client's comments.	03.09.19	TB
First Issue		13.08.19	CS

Rev.	Description	Date	By
FOR CONSTRUCTION			
Client			
Project Littlehampton West Sussex			
Title Private Drainage Layout Sheet 1 of 2			

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Scale A1 @ 1:250	Drawn CS
Date August 2019	Checked TB
File 19163 / dwgs / civils / current	Drawing 19163 / 121H



The Contractor is checked and aware in conjunction with the Architect details all existing plots, buildings and site dimensions, sewers and sewer lines, i.e. connection points and assumes that they are fully conforming with the conditions and requirements of the applicable laws and regulations and that the existing conditions are in accordance with the applicable laws and regulations. Design: Structural Design. Building Regulations, whether or not specifically stated on this contract. Each area of ground studied in or to support the structure (including drainage) must be investigated by the Contractor any areas of formation for ground levels which do not conform with the applicable laws and regulations and the Contractor shall be responsible for the necessary remedial work. Any suspect hard ground or ground conditions or on within the ground must be further investigated by a suitable expert and the Contractor shall be responsible for the necessary remedial work. The Contractor shall be responsible for the necessary remedial work to ensure that the minimum 5 metres from buildings and 3 metres from drainage and sewers, where applicable. A foundation is required for the structure. The Contractor shall be responsible for the necessary remedial work to ensure that the minimum 5 metres from buildings and 3 metres from drainage and sewers, where applicable. A foundation is required for the structure. The Contractor shall be responsible for the necessary remedial work to ensure that the minimum 5 metres from buildings and 3 metres from drainage and sewers, where applicable. A foundation is required for the structure.

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- Levels of the existing road at the point of tie-in with proposed site must be checked prior to the start of work of construction.
- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the Architect and the Contractor.

Drainage Legend:

General

-
- Private Drainage**
- Legend:**
- Proposed Finished Floor Level
 - Proposed Garage Sub Level
 - Storm Water 525mm Inspection Chamber (Max. Depth 3000mm)
 - Storm Water 300mm Inspection Chamber (Max. Depth 750mm)
 - Acco
 - Proposed Outlet Sump and Level
 - SW Sewer & MH
 - FW Sewer & MH
 - Proposed Road Gully & Connection
 - Existing Rising Main
 - Storm Water 525mm Inspection Chamber (Max. Depth 3000mm)
 - Storm Water Rooding Eye & Level (Max. Depth 750mm)
 - Proposed Cellular Storage
 - Porous Tanked Paving
 - Site Boundary
- Proposed Finished Floor Level**
- Proposed Garage Sub Level**
- Storm Water 525mm Inspection Chamber**
(Max. Depth 3000mm)
- Storm Water 300mm Inspection Chamber**
(Max. Depth 750mm)
- Acco**
- Proposed Outlet Sump and Level**
- SW Sewer & MH**
- FW Sewer & MH**
- Proposed Road Gully & Connection**
(G0 G0)
- Existing Rising Main**
- Storm Water 525mm Inspection Chamber**
(Max. Depth 3000mm)
- Storm Water Rooding Eye & Level**
(Max. Depth 750mm)
- Proposed Cellular Storage**
- Porous Tanked Paving**
- Site Boundary**

H	Private drainage runs amended to suit revised layout.	13.05.05	JE
F	Private drainage runs amended to suit revised layout.	28.02.06	JE
E	OS data added to drawing	17.01.20	TB
D	Drawing amended to suit new layout	16.01.20	TB
C	New layout added.	16.11.10	TB
B	New layout inserted	03.10.10	JE
A	Drawing amended to suit clients request.	19.09.10	TB
	Approximate existing spur location added	03.09.10	TB
	First issue	15.06.10	TB
Rev.	Description	Date	By

	Drawing Status
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FOR CONSTRUCTION

	Client



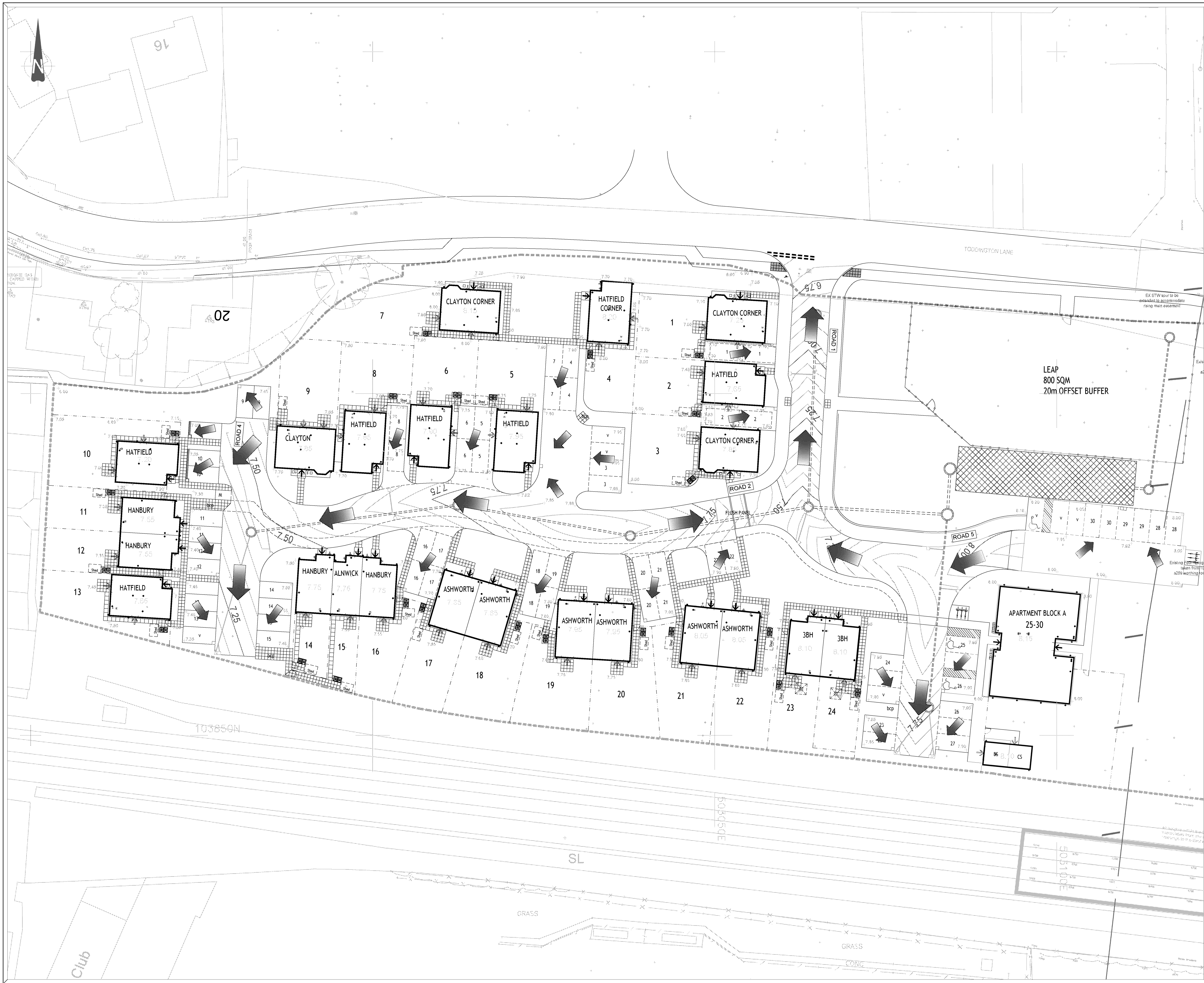
Project	Littlehampton West Sussex
Title	Private Drainage Layout Sheet 2 of 2



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Scale	A1 @ 1 : 250	Drawn	CS
Date	August 2019	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 122H



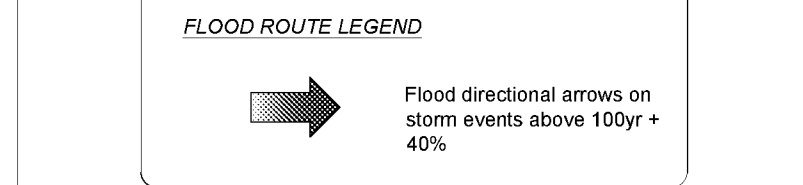
The Contractor is to check and verify in conjunction with the Architects details of setting out points, building and site dimensions, levels and sewer event levels at construction points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standard specifications, Building Regulations etc, whether or not specifically stated on this drawing.

This drawing is not intended to show details of ground conditions or ground contaminants. Each area of ground relied upon to support any structure, including any proposed structure, must be investigated by the Contractor and any areas of concern for safe structure shall be in accordance with the anticipated conditions as detailed in the site investigation report and to be immediately notified to the Engineer, where applicable. Any exposed flat ground or ground contaminants or or within the ground should be further investigated by a suitable expert.

Any structures shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing areas are shown to be retained they should be subject to a full geotechnical inspection for safety. All areas are to be planned so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

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- GENERAL NOTES**
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 - Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
 - Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.



Rev.	Description	Date	By
1	First Issue	14.05.20	JE

Drawing Status

FOR CONSTRUCTION

Client



Project Littlehampton
West Sussex

Title Flood Exceedance Routing Plan
Sheet 1 of 2

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Scale	A1 @ 1 : 250	Drawn	JE
Date	May 2020	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 161

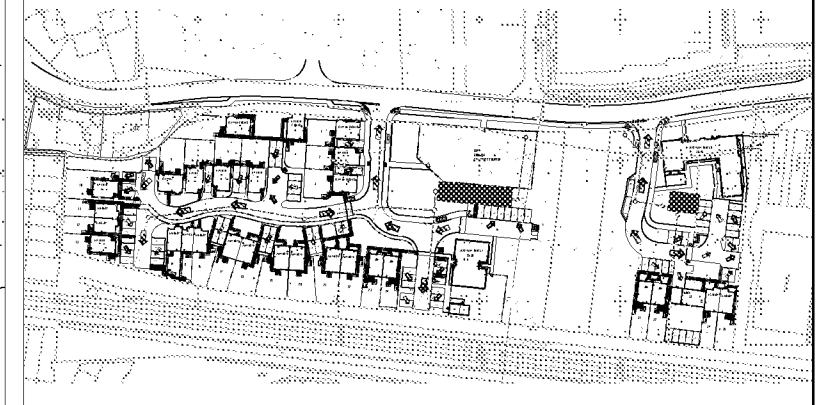


The Contractor is to check and verify in conjunction with the Architects details of setting out points, building and site dimensions, levels and sewer event levels at construction points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standard specifications, Building Regulations etc, whether or not specifically stated on this drawing.

This drawing is not intended to show details of ground conditions or ground contaminants. Each area of ground relied upon to support any structure, including any retaining wall, shall be investigated by the Contractor and any areas of concern for safe structure shall be in accordance with the anticipated conditions as described in the site investigation report and to be immediately notified to the Engineer, where applicable. Any exposed flat ground or ground contaminants or or within the ground should be further investigated by a suitable expert.

Any earthworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing areas are shown to be retained they should be subject to a full geotechnical investigation for safety. All areas are to be planned so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

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FLOOD ROUTE LEGEND

Flood directional arrows on storm events above 100yr + 40%

Rev.	Description	Date	By
1	First Issue	15.08.19	JE

Drawing Status

FOR CONSTRUCTION

Client

PERSIMMON
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Project

Littlehampton
West Sussex

Title

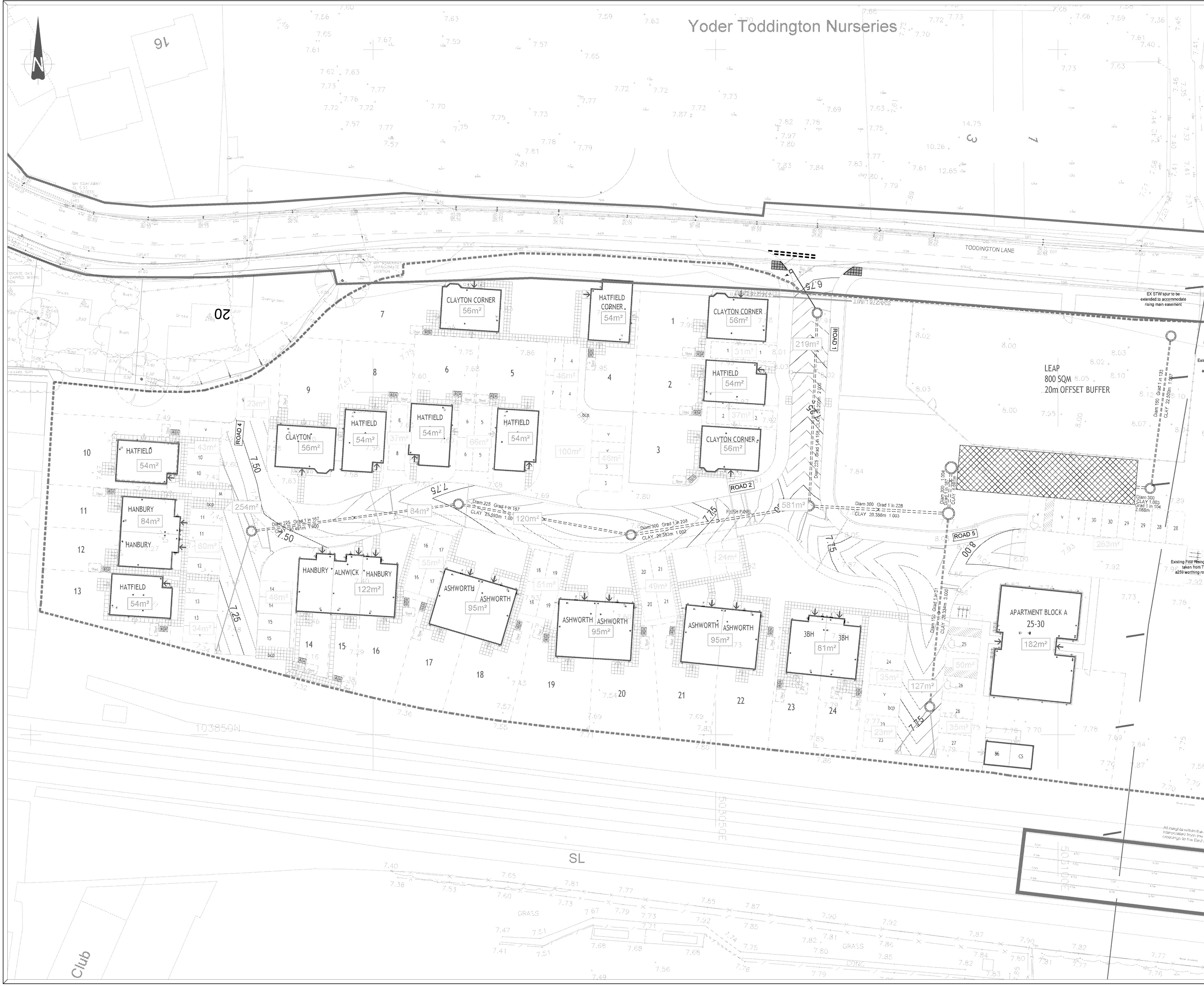
Flood Exceedance Routing Plan
Sheet 2 of 2

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Date	May 2020	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 162



The Contractor is to check and verify in conjunction with the Architects details of setting out points, building and site dimensions, levels and sewer invert levels at construction points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standard specifications, Building Regulations etc, whether or not specifically stated on this drawing.

This drawing is not intended to show details of ground conditions or ground contaminants. Each area of ground relied upon to support any structure, including any structure, must be investigated by the Contractor and any areas of concern for safe operation which do not accord with the anticipated conditions as described in the site investigation report are to be immediately notified to the Engineer, where applicable. Any suspected fluid ground or ground contaminants or or within the ground should be further investigated by a suitable expert. Any earthworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing trees are shown to be retained they should be subject to a full arboricultural inspection for safety. All trees are to be planted so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

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- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.

C	New layout added	14.05.20	TB
S	CS data added to drawing	17.01.20	TB
A	New layout inserted	03.10.19	JE
Rev.	First issue	15.08.19	CS

Rev.	Description	Date	By
Drawing Status			
PRELIMINARY			
Client			
Project			
Title			

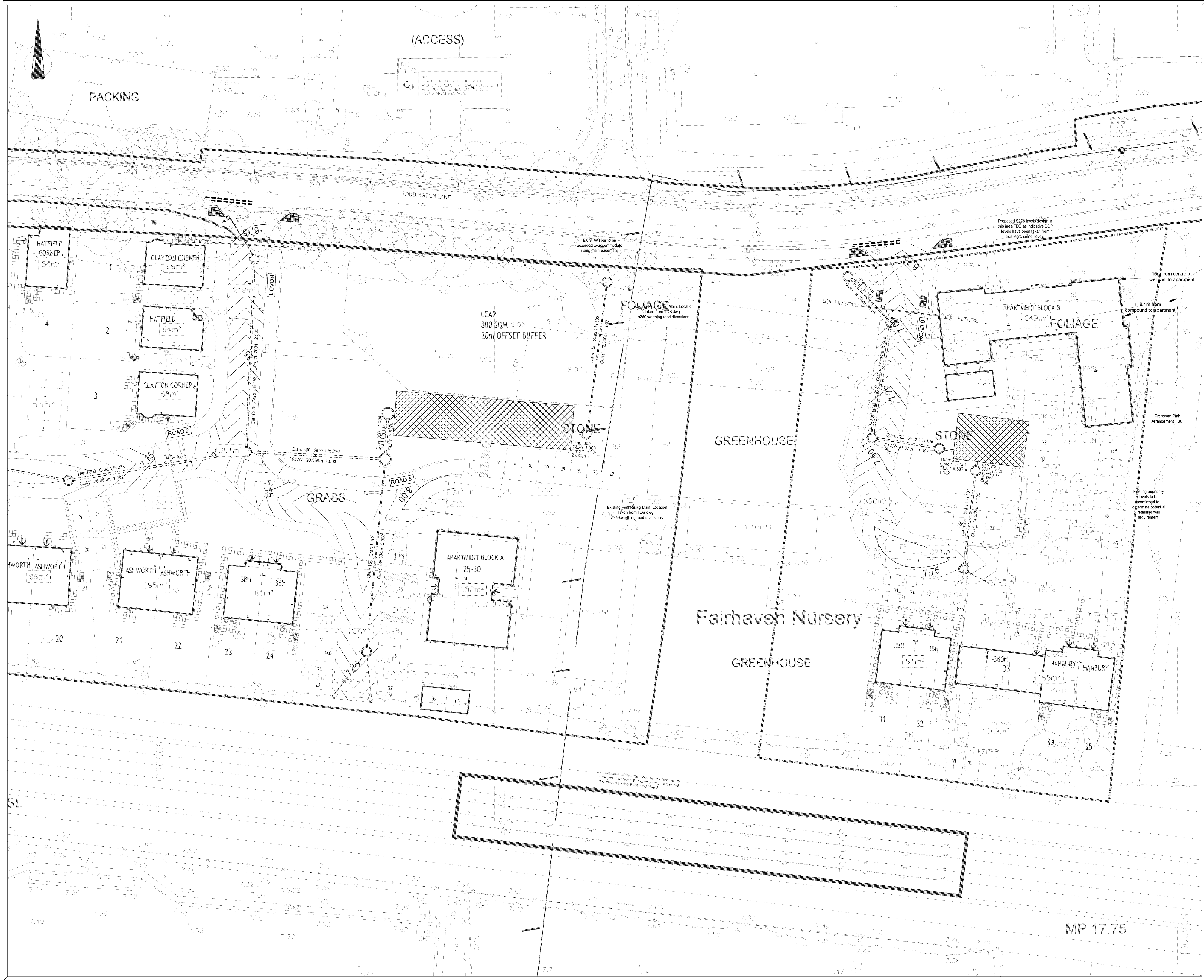
PERSIMMON
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Impermeable Area Plan
Sheet 1 of 2

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Scale	A1 @ 1:250	Drawn	CS
Date	August 2019	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 171 C



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Any overworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing areas are shown to be retained they should be subject to a full geotechnical inspection for safety. All areas are to be planned so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

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- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.



Rev.	Description	Date	By
C	New layout added	14.05.20	TB
B	CS data added to drawing	17.01.20	TB
A	New layout inserted	03.10.19	JE
	First issue	15.08.19	CS

Drawing Status

PRELIMINARY

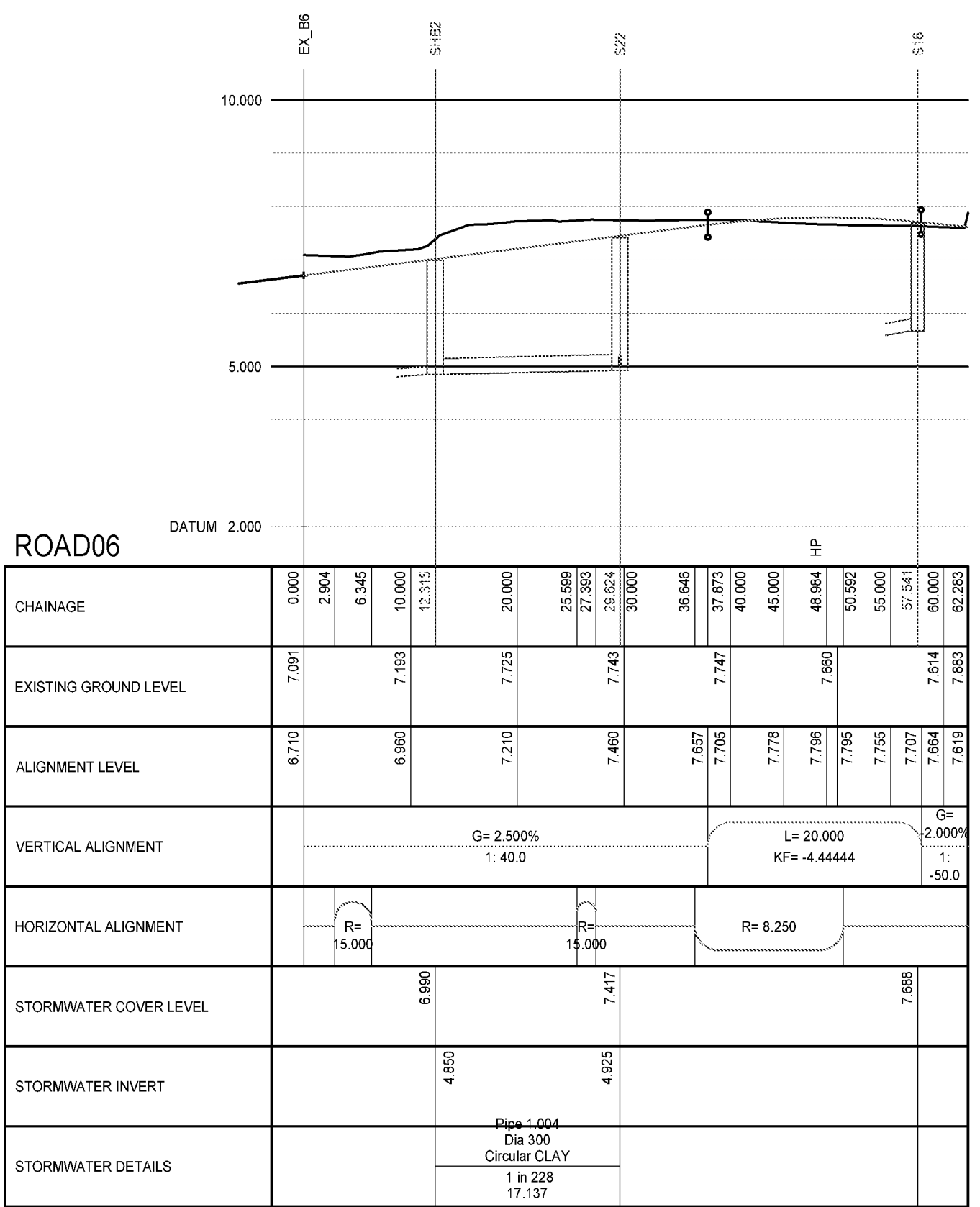
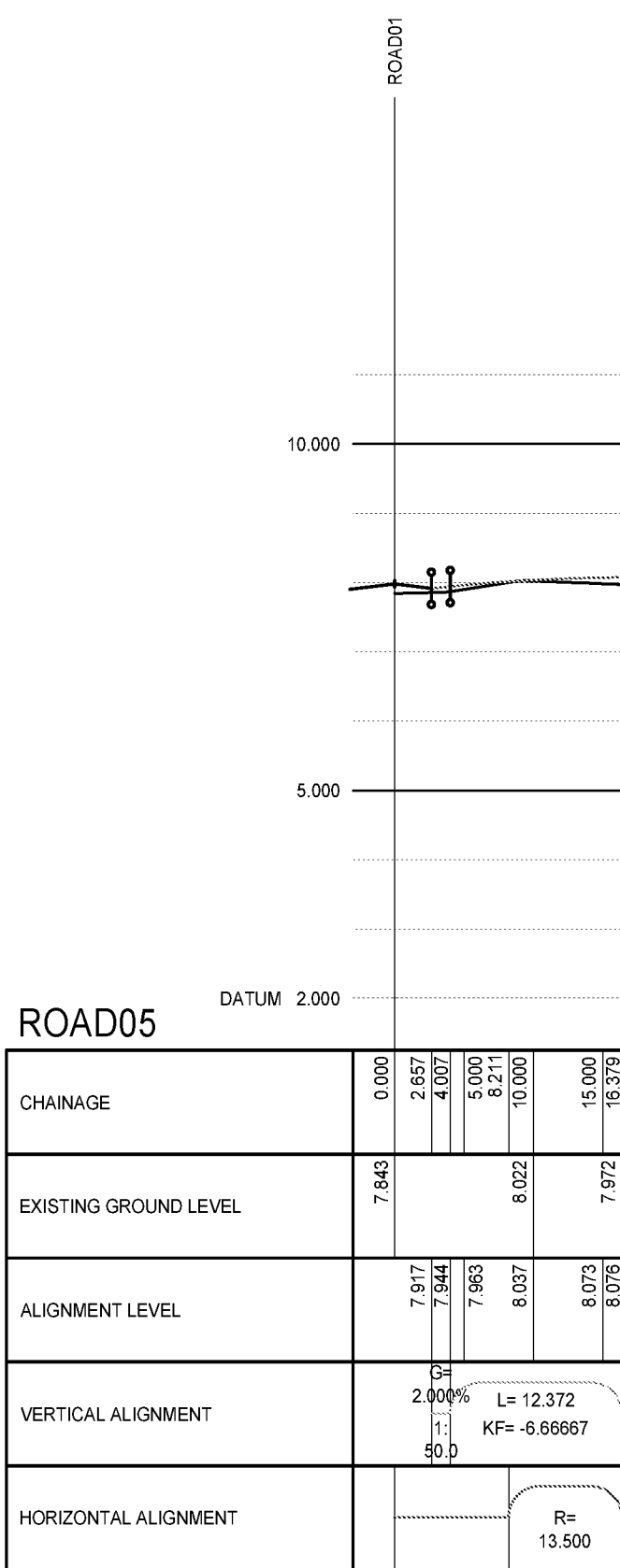
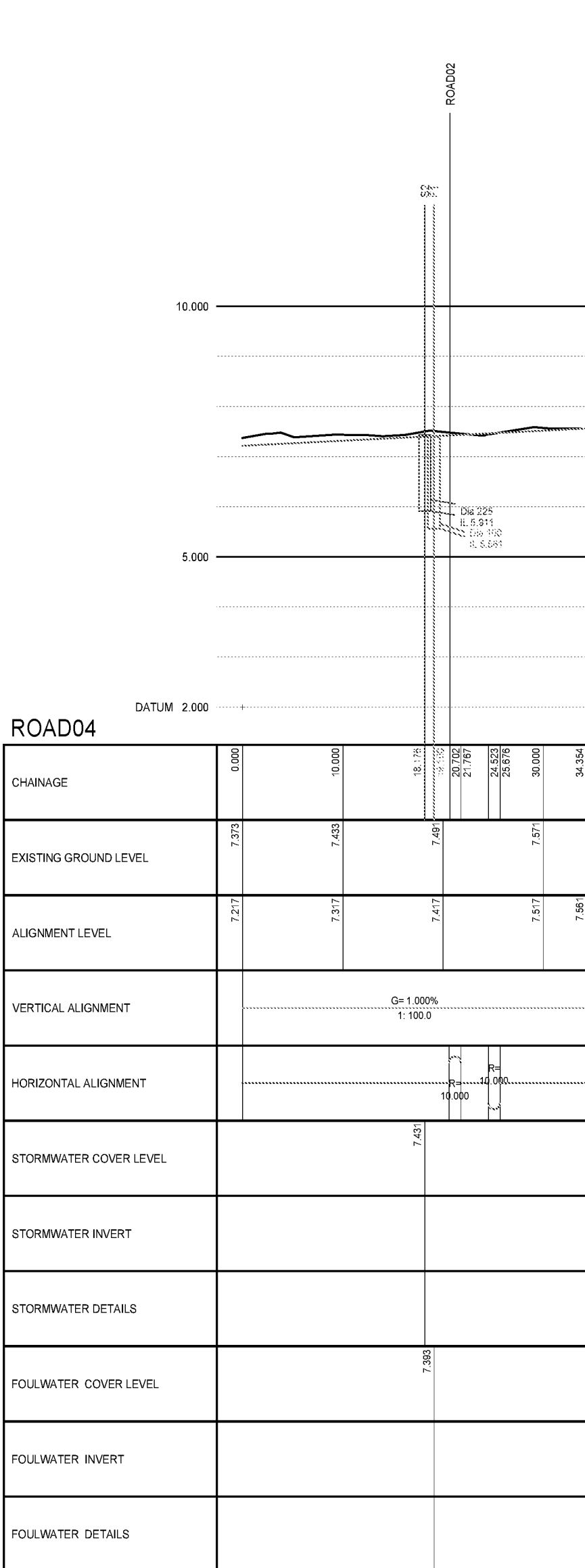
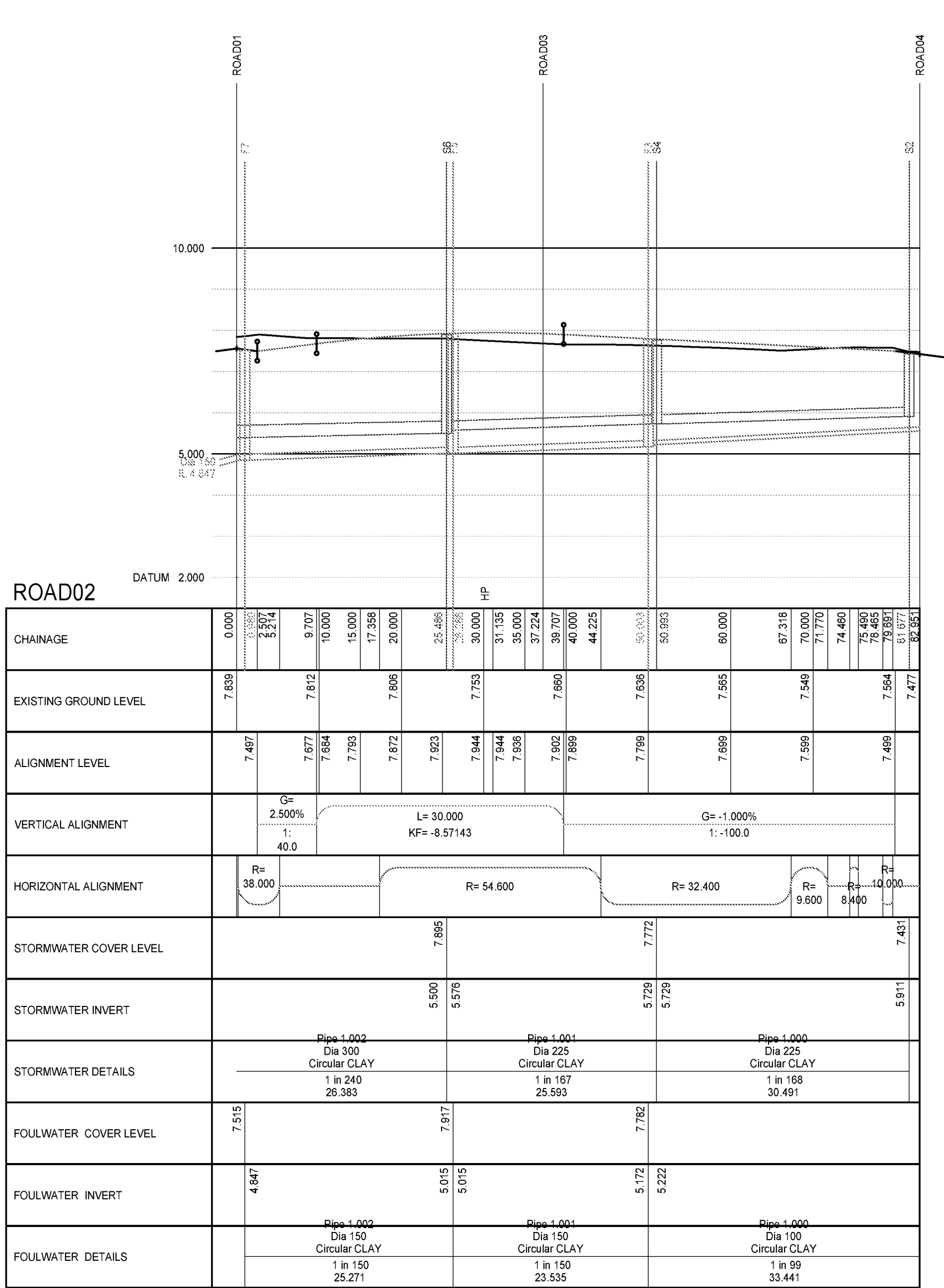
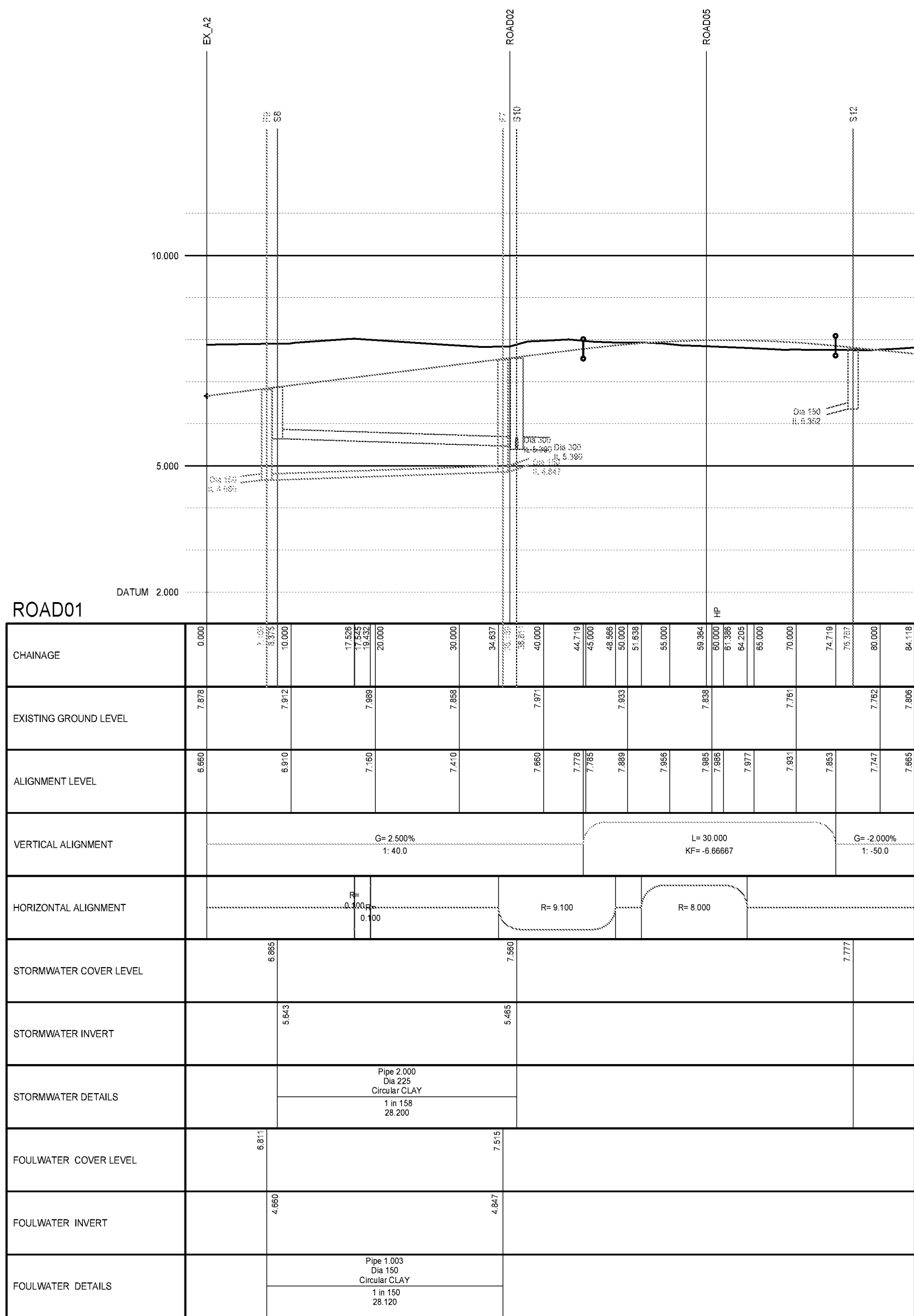
Client
PERSIMMON
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Project
Littlehampton
West Sussex

Title
Impermeable Area Plan
Sheet 2 of 2

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Scale	A1 @ 1:250	Drawn	CS
Date	August 2019	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 172 C



The Contractor is to check and verify in conjunction with the Architects details all setting out points, building and site dimensions, levels and sewer invert levels at connection points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standard specifications, Building Regulations etc, whether or not specifically stated on this drawing.

This drawing is not intended to show details of ground conditions or ground coverings. Each area of ground relied upon to support any structure, including any drainage, must be investigated by the Contractor and any areas of concern for safe installation shall be in accordance with the anticipated conditions as described in the site investigation report and to be immediately notified to the Engineer, where applicable. Any exposed flat ground or ground coverings in or within the ground should be further investigated by a suitable expert. Any overworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing areas are shown to be retained they should be subject to a full geotechnical inspection for safety. All areas are to be planned so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

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- Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
- Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.

ADOPTABLE ROADS AND SEWERS

- Roads, footways and parking bays which form part of the highway to be adopted under Section 36 of the Highways Act 1980 shall comply with the requirements of the Adopting Authority.
- Sewers to be adopted under Section 104 of the Water Industries Act 1991 shall comply with the Water Authorities Association 'Sewers for Adoption 8th or 7th Edition' with any amendments specified by the Adopting Water Authority.
- All pipes to be used in adoptable sewerage shall be either clayware to BS EN 285 or concrete to BS EN 1916 and BS 5911 Part 1 with Class S bedding unless otherwise stated. With approval of the Adopting Authority solid wall concentric external rib reinforced UPVC pipes complying with the relevant provisions of BS EN 15475 may be used.
- Where cover to a pipe is more than 1200mm under adoptable carriageway the trench shall be filled to formation of the carriageway with well compacted DTP Type 1 material.
- Where cover to a pipe is less than 1200mm under adoptable carriageway it shall be provided with concrete protection in accordance with the specification of the adopting authority and back filled to formation of the carriageway with well compacted DTP Type 1 material. Where concrete bed and surround is specified flexibility of joints is to be maintained by using compressible bitumen impregnated fibreglass at each pipe joint.
- All existing drainage invert levels, diameters and locations are to be checked by the Contractor prior to the commencement of any proposed drainage work. Any difference between actual and drawn details is to be reported to the Engineer immediately.
- Portions of existing services/utility underground apparatus adjacent to or crossing proposed sewers is to be checked by the Contractor prior to starting work.

Rev.	Description	Date	By
A	Drawing amended to suit revised drainage strategy	14.05.20	TB
First Issue		15.08.19	CS

Drawing Status

Client

Project

Title

PRELIMINARY

Littlehampton
West Sussex

Road and Drainage Longitudinal Sections

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Scale	A1 @ 1 : 250	Drawn	CS
Date	August 2019	Checked	TB
File	19163 / dwgs / civils / current	Drawing	

19163 / 201 A

Manhole Number	Cover Level	Connections	Pipe			Manhole Size	Types	
Coordinates	Depth To Soffit		Code	Inverts	Diams		Manhole	Cover
SSWA2_01	6.900		1	1.007	5.000	150		
E. 503116.501	1.750					1200	B	D400
N. 103909.217								
CP1	7.907		1	1.004	5.260	300		
E. 503064.405	2.347					1500	B	D400
N. 103888.989			0	1.005	5.260	300		
HB1	7.921		1	1.008	5.180	300		
E. 503113.453	2.591					1200		REFER TO CONSTRUCTION DETAIL
N. 103885.971			0	1.007	5.180	150		
S2	7.431							
E. 502982.229	1.295					1200	E	D400
N. 103879.734			0	1.000	5.911	225		
S4	7.772		1	1.000	5.729	225		
E. 503012.462	1.818					1200	B	D400
N. 103883.694			0	1.001	5.729	225		

Manhole Number	Cover Level	Connections	Pipe			Manhole Size	Types	
Coordinates	Depth To Soffit		Code	Inverts	Diams		Manhole	Cover
S6	7.895		1	1.001	5.578	225		
E. 503037.654	2.095					1200	B	D400
N. 103879.178			0	1.002	5.500	300		
S8	6.855							
E. 503064.846	0.997					1200	D	D400
N. 103911.587			0	2.000	5.643	225		
S10	7.560		1	2.000	5.465	225		
E. 503063.694	1.870		2	1.002	5.390	300		
N. 103883.410			0	1.003	5.390	300		
S12	7.777							
E. 503081.287	1.275					1200	E	D400
N. 103854.101			0	3.000	6.352	150		
S14	7.959		1	1.003	5.300	300		
E. 503084.020	2.359		2	3.000	5.450	150		
N. 103982.303			0	1.004	5.300	300		

Manhole Number	Cover Level	Connections	Pipe			Manhole Size	Types	
Coordinates	Depth To Soffit		Code	Inverts	Diams		Manhole	Cover
SSWB6_01	6.900		1	1.005	4.785	150		
E. 503151.747	1.965					1200	B	D400
N. 103909.025								
CP2	7.808		1	1.000	5.580	225		
E. 503170.485	1.803					1200	B	D400
N. 103880.513			0	1.001	5.580	225		
HB2	6.990		1	1.004	4.850	300		
E. 503158.041	1.990					1500	B	D400
N. 103902.307			0	1.005	4.850	150		
S18	7.688							
E. 503168.718	1.793					1200	B	D400
N. 103869.213			0	1.000	5.670	225		
S20	7.649		1	1.002	5.080	225		
E. 503165.140	2.344					1200	B	D400
N. 103883.872			0	1.003	5.080	225		
S22	7.417		1	1.003	5.000	225		
E. 503155.319	2.192					1500	B	D400
N. 103885.388			0	1.004	4.925	300		

Manhole Number	Cover Level	Connections	Pipe			Manhole Size	Types	
Coordinates	Depth To Soffit		Code	Inverts	Diams		Manhole	Cover
FFWA2_01	6.800		1	1.005	4.140	150		
E. 503042.397	2.510					1200	B	D400
N. 103918.437								
F1	7.393							
E. 502980.409	1.732					1200	B	D400
N. 103880.771			0	1.000	5.561	100		
F3	7.782		1	1.000	5.222	100		
E. 503013.599	2.460					1200	B	D400
N. 103884.879			0	1.001	5.172	150		
F5	7.917		1	1.001	5.015	150		
E. 503036.801	2.752					1200	B	D400
N. 103880.952			0	1.002	5.015	150		
F7	7.515		1	1.002	4.847	150		
E. 503061.764	2.518					1200	B	D400
N. 103884.882			0	1.003	4.847	150		
F9	6.811		1	1.003	4.660	150		
E. 503063.042	2.001					1200	B	D400
N. 103912.973			0	1.004	4.660	150		

Manhole Number	Cover Level	Connections	Pipe			Manhole Size	Types	
Coordinates	Depth To Soffit		Code	Inverts	Diams		Manhole	Cover
F11	7.883		1	1.004	4.600	150		
E. 503055.195	3.133					1200	A	D400
N. 103916.699			0	1.005	4.600	150		

Please note only main sewer information is indicated within MH diagrams. Please refer to drainage layout drawings for lateral connections

The Contractor is to check and verify in conjunction with the Architects details all setting out points, building and site dimensions, levels and sewer invert levels at connection points and ensure that they are fully compliant with the contents and requirements of the site investigation report before work starts. The Contractor is to comply with all aspects with current building regulations, British Standard specifications, Building Regulations etc, whether or not specifically stated on this drawing.
This drawing is not intended to show details of ground conditions or ground coverings. Each area of ground relied upon to support any structure, including drainage, must be investigated by the Contractor and areas of concern for safe structure shall be in accordance with the anticipated conditions as described in the site investigation report are to be immediately notified to the Engineer, where applicable. Any exposed flat ground or ground coverings or within the ground should be further investigated by a suitable expert. Any earthworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert. Where existing areas are shown to be retained they should be subject to a full geotechnical inspection for safety. All areas to be placed on to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.
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- GENERAL NOTES**
- This drawing is to be read in conjunction with relevant architectural and engineering drawings.
 - Levels indicated in brackets are Finished Floor levels and are 150mm above adjacent finished ground levels unless otherwise shown.
 - Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
 - Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.

- ADOPTABLE ROADS AND SEWERS**
- Roads, footways and parking bays which form part of the highway to be adopted under Section 36 of the Highways Act 1980 shall comply with the requirements of the Adopting Authority.
 - Sewers to be adopted under Section 104 of the Water Industries Act 1991 shall comply with the Water Authorities Association "Sewers for Adoption 8th or 7th Edition" with any amendments specified by the Adopting Water Authority.
 - All pipes to be used in adoptable sewerage shall be either clayware to BS EN 286 or concrete to BS EN 1916 and BS 5911 Part 1 with Class B bedding unless otherwise stated. With approval of the Adopting Authority solid wall concentric external rib reinforced uPVC pipes complying with the relevant provisions of BS EN 13476 may be used.
 - Where cover to a pipe is more than 1200mm under adoptable carriageway the trench shall be filled to formation of the carriageway with well compacted DTP Type 1 material.
 - Where cover to a pipe is less than 1200mm under adoptable carriageway it shall be provided with concrete protection in accordance with the specification of the adopting authority and back filled to formation of the carriageway with well compacted DTP Type 1 material. Where concrete bed and surround is specified flexibility of joints is to be maintained by using compressible bitumen impregnated fibreboard at each pipe joint.
 - All existing drainage invert levels, diameters and locations are to be checked by the Contractor prior to the commencement of any proposed drainage work. Any difference between actual and drawn details is to be reported to the Engineer immediately.
 - Positions of existing services/utility underground apparatus adjacent to or crossing proposed sewers is to be checked by the Contractor prior to starting work.

A	Drawing amended to suit revised drainage strategy	19.06.20	TB
Rev.	Description	Date	By

Drawing Status

PRELIMINARY

Client

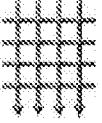
 **PERSIMMON**
Together, we make a home

Project

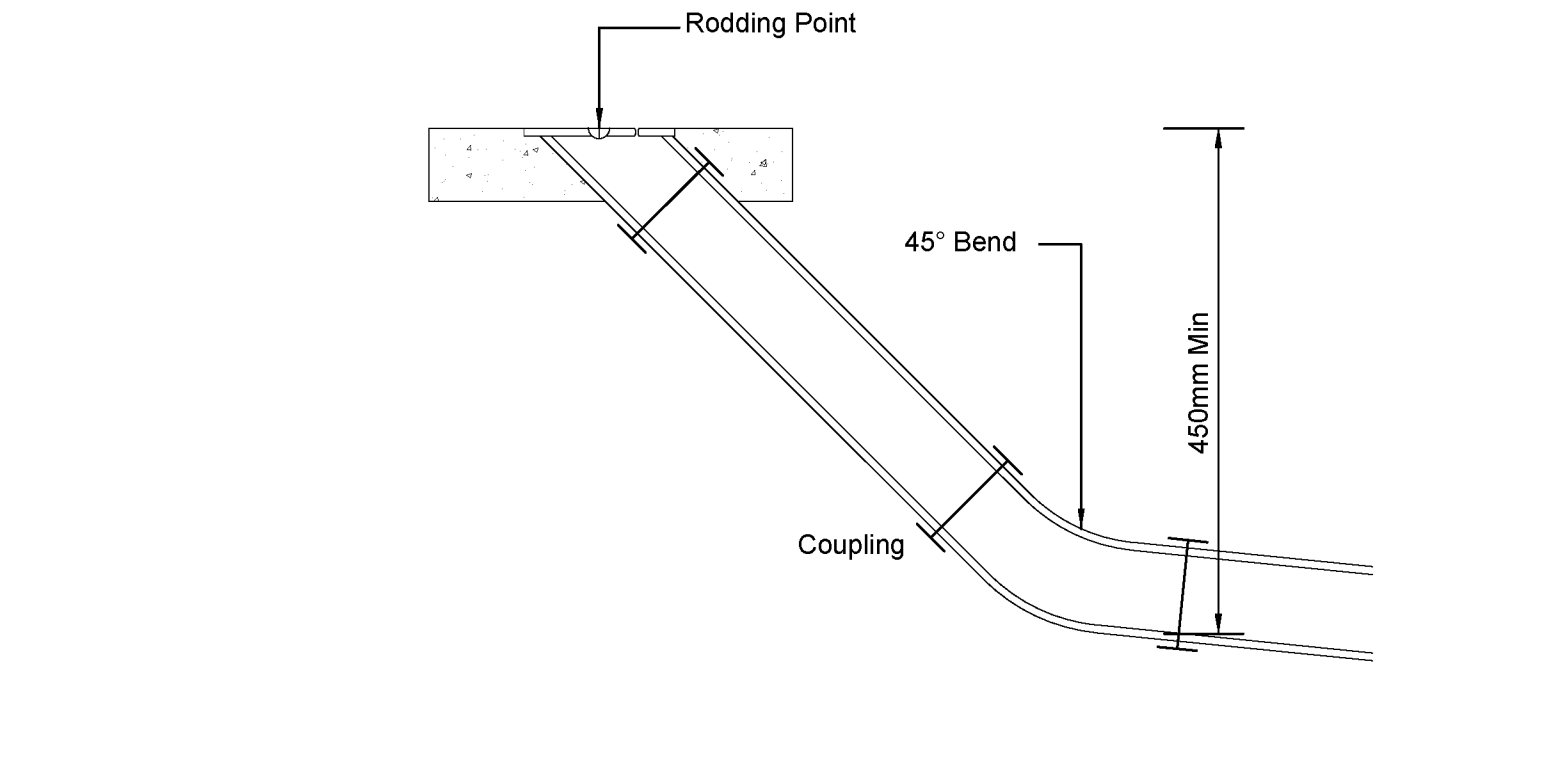
Littlehampton
West Sussex

Title

Storm and Foul Manhole Schedules


BANNERS GATE
CIVIL, STRUCTURAL & ARCHITECTURAL DESIGN SERVICES
10-11 Birmingham Street, Halesowen, West Midlands B63 3HN
Tel: 0121 687 1500 Fax: 0121 687 1501
E-mail: mail@bannersgate.com

Scale	A1 @ 1 : 250	Drawn	CS
Date	August 2019	Checked	TB
File	19163 / dwgs / civils / current	Drawing	19163 / 250 A

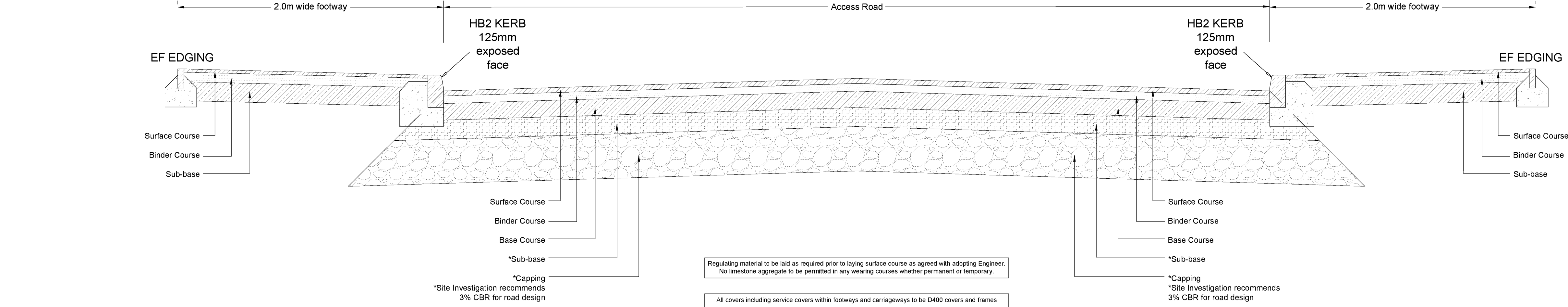


Rodding Eye Detail

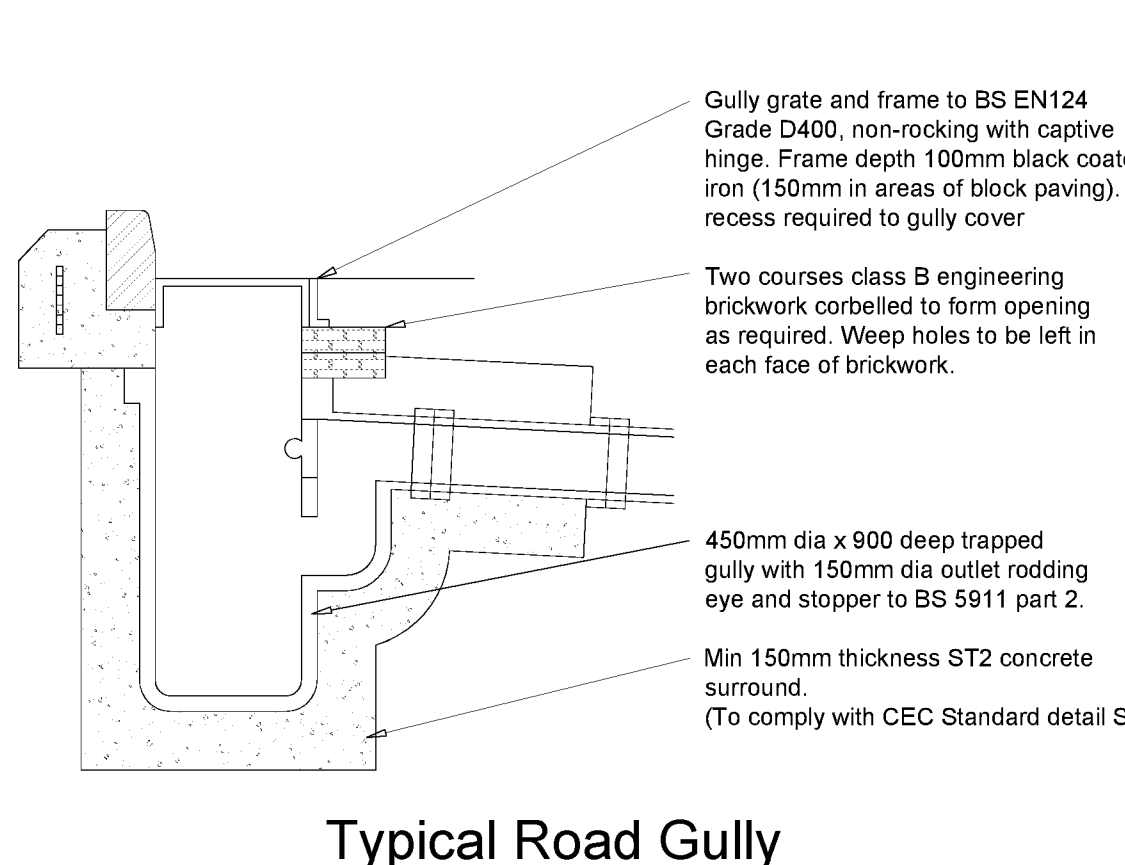
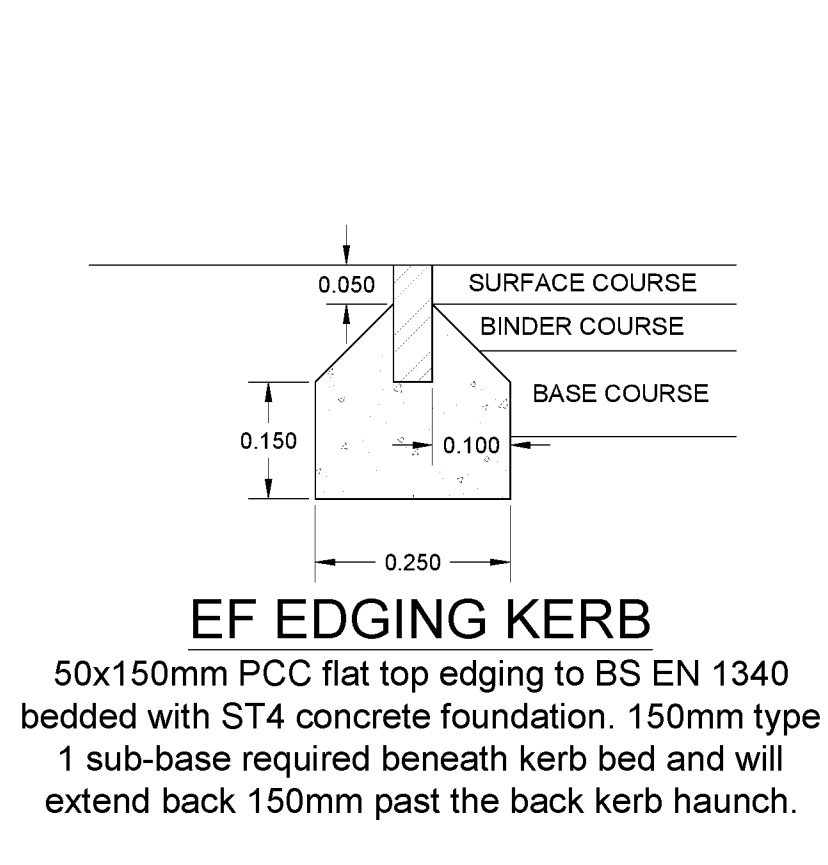
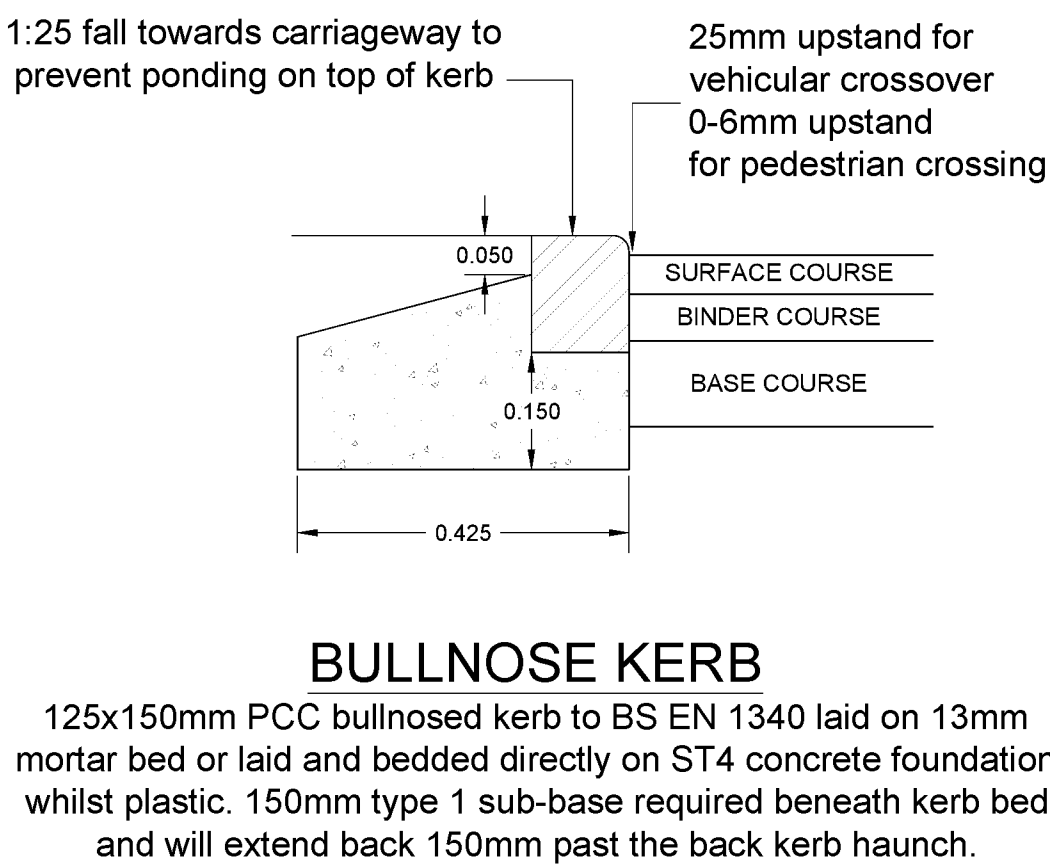
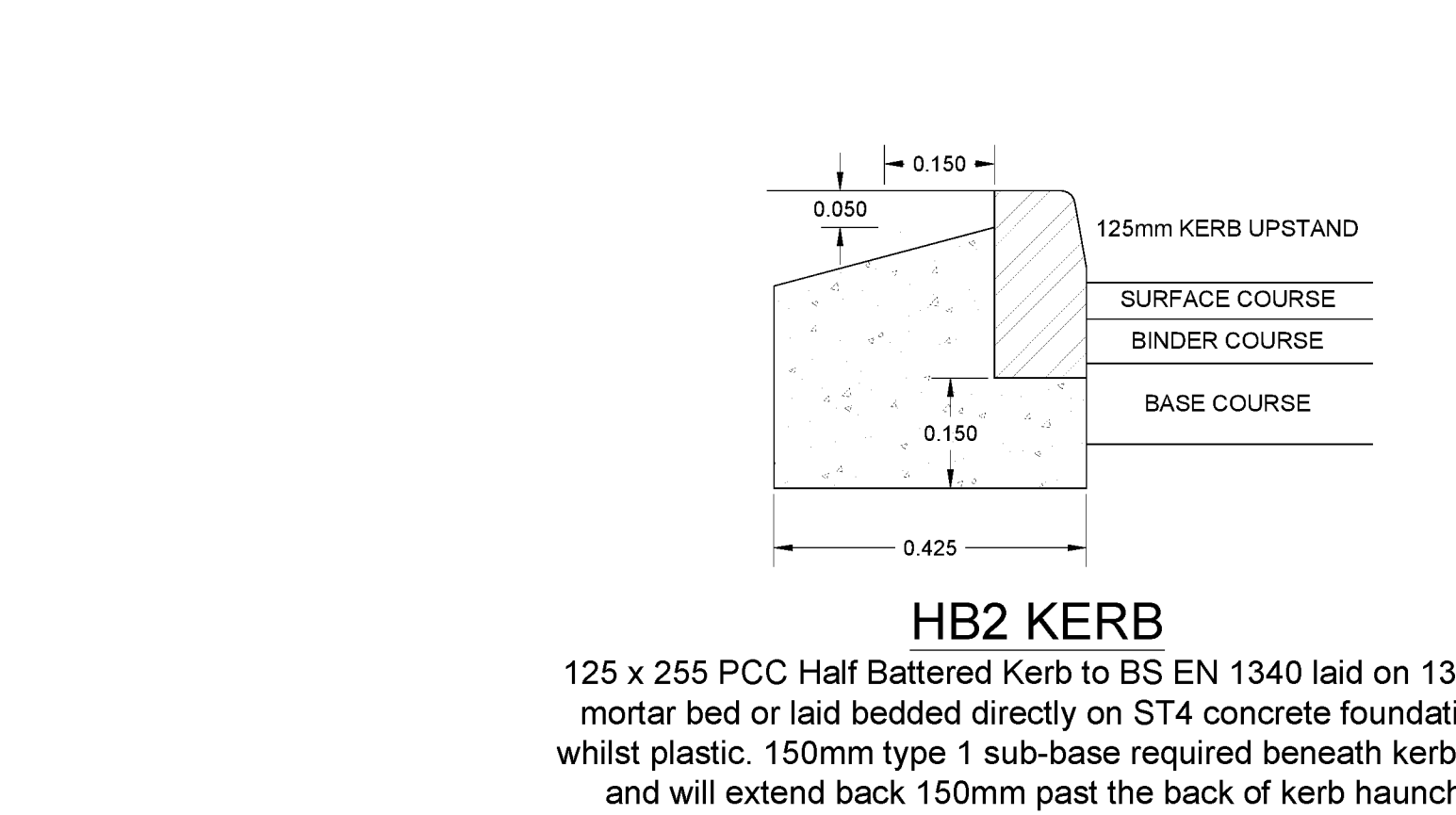
Access Road < 200 dwellings			
Layer	Nom.Size	Matreials	Compacted Thickness
Surface Course	10mm	AC10 Close Graded Asphalt Concrete Surface Course 100/150 to CI 942 PSV 68+ AAV 14	30mm
Binder Course	20mm	AC20 dense bin 100/150 rec to DfT SHW 906	60mm
Base Course	32mm	AC32 dense base 40/60 rec to DfT SHW 906	100mm
Sub Base & Capping	<2%	Type 1 sub base to DfT SHW Clause 803	Bespoke Design
	2-2.5%	Type 1 sub base DfT SHW to Clause 803 6F1 or 6F2 Capping Layer to SHW Clause 613	150mm 600mm
	2.5-5%	Type 1 sub base DfT SHW to Clause 803 6F1 or 6F2 Capping Layer to SHW Clause 613	150mm 350mm
	>5%	Type 1 sub base DfT SHW to Clause 803 6F1 or 6F2 Capping Layer to SHW Clause 613	150mm 100mm

Ground Investigation suggests CBR of 3% may be used for design. TBC during construction as per WSCC requirements.

Footway / Cycleway Construction			
Layer	Nom.Size	Matreials	Compacted Thickness
Surface Course	6mm	AC 6 dense surf 100/150 to DfT SHW Clause 909	20mm
Binder Course	20mm	AC20 dense bin 100/150 rec conforming to DfT SHW 906	50mm
Sub Base		Type 1 / Type 2 sub base DfT SHW to Clause 803	100mm



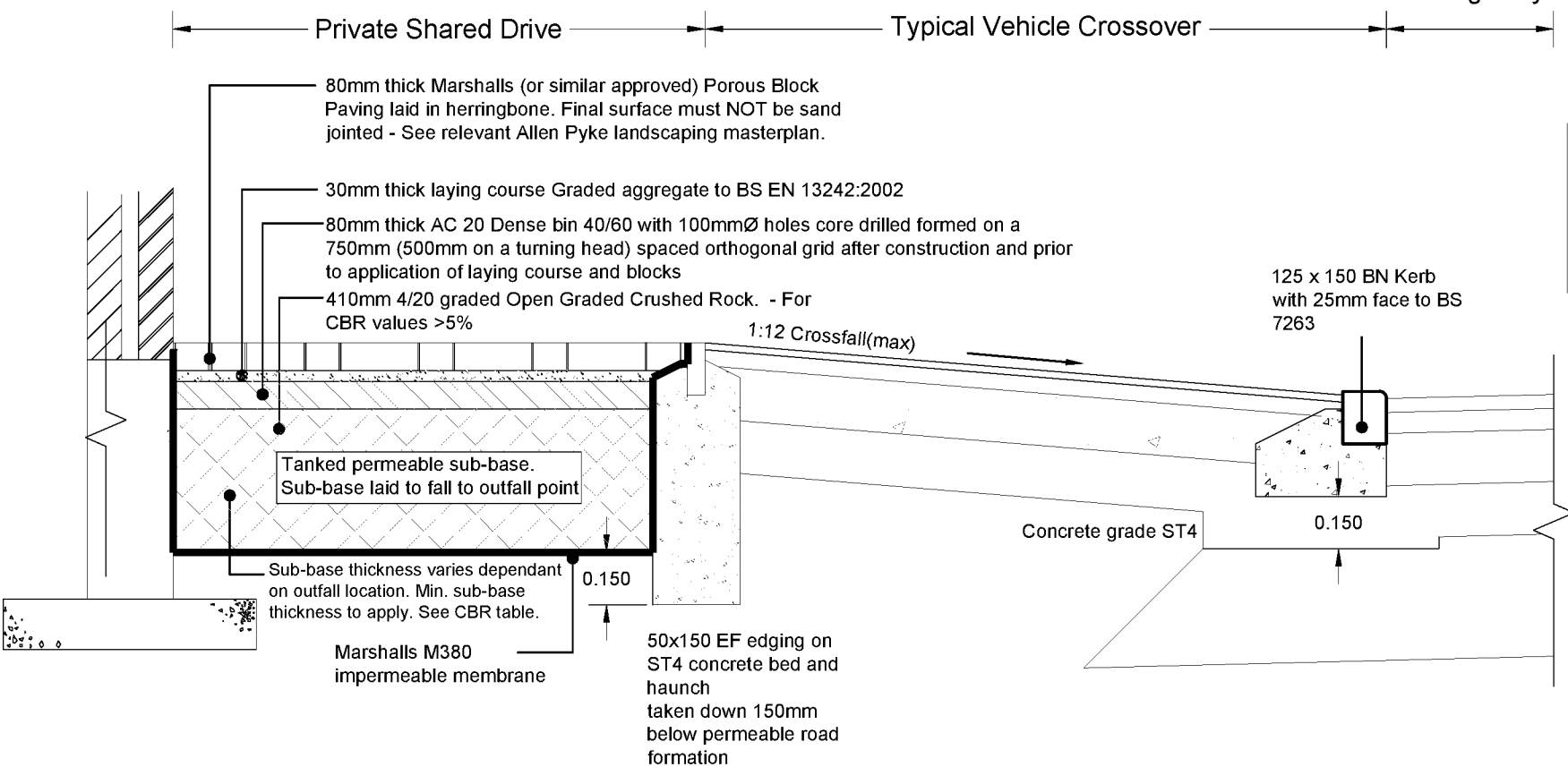
TARMAC ROAD CONSTRUCTION



BULLNOSE KERB

EF EDGING KERB

Typical Road Gully



Porous Block Paved Construction with Tanked Porous Sub-base.

NOTE - Permavoid diffuser requires minimum depth of cover of 260mm based on 12 tonne vehicular loading and CBR value of 5% & to be installed in strict accordance with manufacturers requirements.

Grading for porous granular sub-base material

Sieve size	% passing
100mm	100
63mm	90-100
37.5mm	60-80
20mm	15-30
10mm	0-5

Sub-base for Porous Paving

Note: In car parking and lightly trafficked areas where CBR is less than 5% a capping layer of 200mm thickness is required. In heavily trafficked areas a capping layer is to be provided to ensure that the sub-grade has a CBR of at least 15%.

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This drawing is not intended to show details of ground conditions or ground contaminants. Each area of ground relied upon to support any structure depicted (including drainage) must be investigated by the Contractor any areas of formation for said structures which do not accord with the anticipated conditions as described in the site investigation report are to be immediately notified to the Engineer, where applicable. Any suspected fluid ground or ground contaminants on or within the ground should be further investigated by a suitable expert. Any earthworks shown indicate typical slopes for guidance only and should be investigated further by a suitable geotechnical expert.

Where existing trees are shown to be retained they should be subject to a full Arboricultural inspection for safety. All trees are to be planted so as to ensure they are a minimum of 5 metres from buildings and 3 metres from drainage and services, where applicable. A foundation is to be provided to accommodate the proposed tree planting, where applicable.

- GENERAL NOTES**
- This drawing is to be read in conjunction with relevant architectural and engineering drawings.
 - Levels indicated in blocks are Finished floor levels and are 150mm above adjacent finished ground levels unless otherwise shown.
 - Levels of the existing road at the point of tie-in with proposed site road must be checked prior to commencement of works.
 - Any discrepancies between the details shown and actual on site conditions to be reported immediately to the engineer prior to commencement of works.

- ADOPTABLE ROADS AND SEWERS**
- Roads, footways and parking bays which form part of the highway to be adopted under Section 38 of the Highways Act 1980 shall comply with the requirements of the Adopting Authority.
 - Sewers to be adopted under Section 104 of the Water Industry Act 1991 shall comply with the Water Authorities Association "Sewers for Adoption 6th or 7th Edition" with any amendments specified by the Adopting Water Authority.
 - All pipes to be used in adoptable sewerage shall be either clayware to BS EN 285 or concrete to BS EN 1916 and BS 5911 Part 1 with Class S bedding unless otherwise stated. With approval of the Adopting Authority solid wall concentric external (re-reinforced) sPVC pipes complying with the relevant provisions of BS EN 13476 may be used.
 - Where cover to a pipe is more than 1200mm under adoptable carriageway the trench shall be filled to formation of the carriageway with well compacted DTp Type 1 material.
 - Where cover to a pipe is less than 1200mm under adoptable carriageway it shall be provided with concrete protection in accordance with the specification of the adopting authority and back filled to formation of the carriageway with well compacted DTp Type 1 material. Where concrete bed and surround is specified flexibility of joints is to be maintained by using compressible bitumen impregnated fibreboard at each pipe joint.
 - All existing drainage invert levels, diameters and locations are to be checked by the Contractor prior to the commencement of any proposed drainage work. Any difference between actual and drawn details is to be reported to the Engineer immediately.
 - Positions of existing services/statutory undertakers apparatus adjacent to or crossing proposed sewers is to be checked by the Contractor prior to starting work.

CONTRACTOR SHOULD REFER TO LATEST VERSION OF WEST SUSSEX COUNTY COUNCIL ECONOMY, COMMUNITIES & CORPORATE DIRECTORATE - HIGHWAYS SPECIFICATION FOR NEW DEVELOPMENTS

Rev	Description	Date	By
B	Rodding Eye detail added	14.05.2020	TB
A	Drawing amended to construction issue	19.08.2019	TB
-	First Issue	19.08.2019	CS

Drawing Status

FOR CONSTRUCTION

Client

Project

Title

Private Highway Construction Details

BANNERS GATE

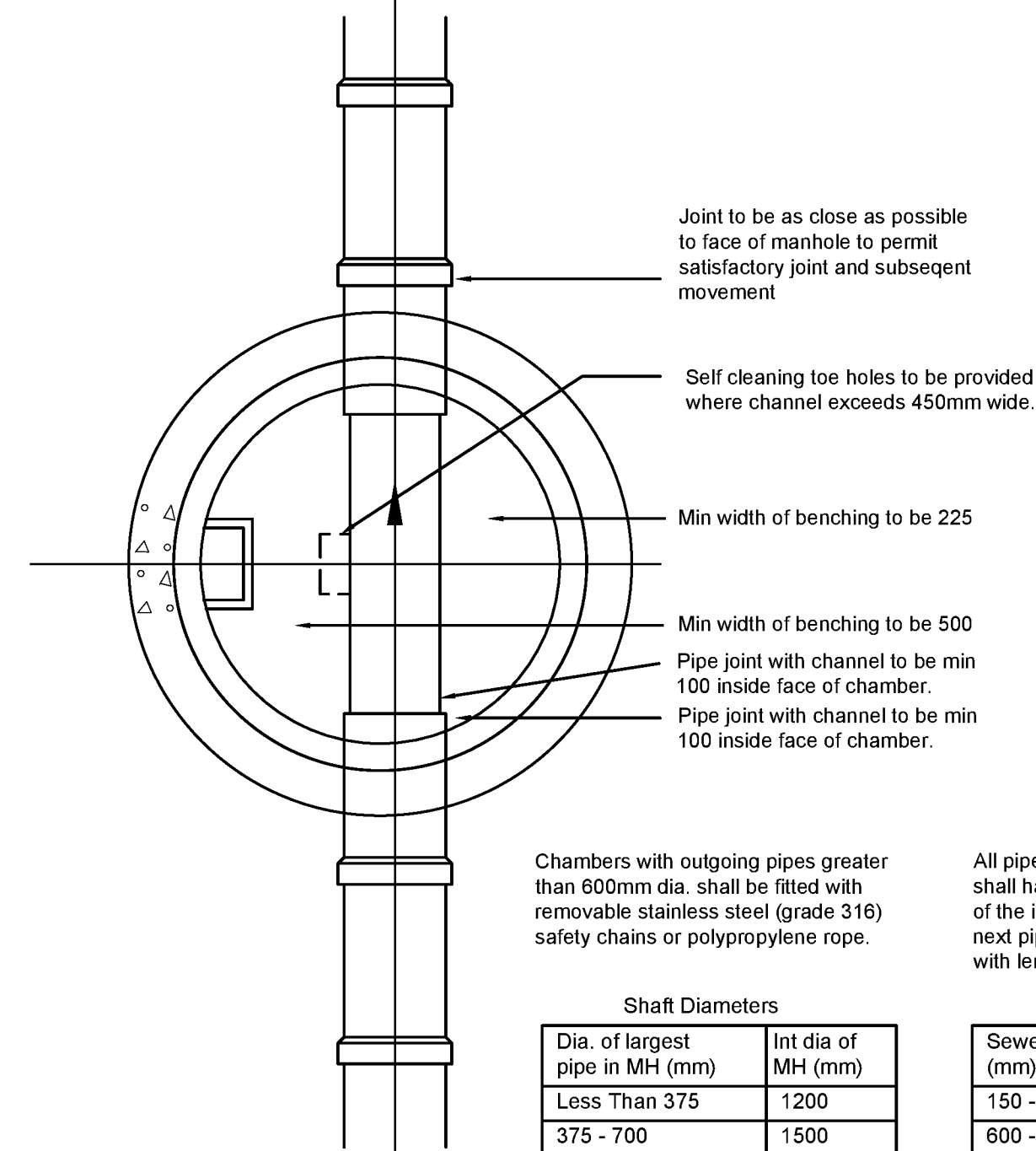
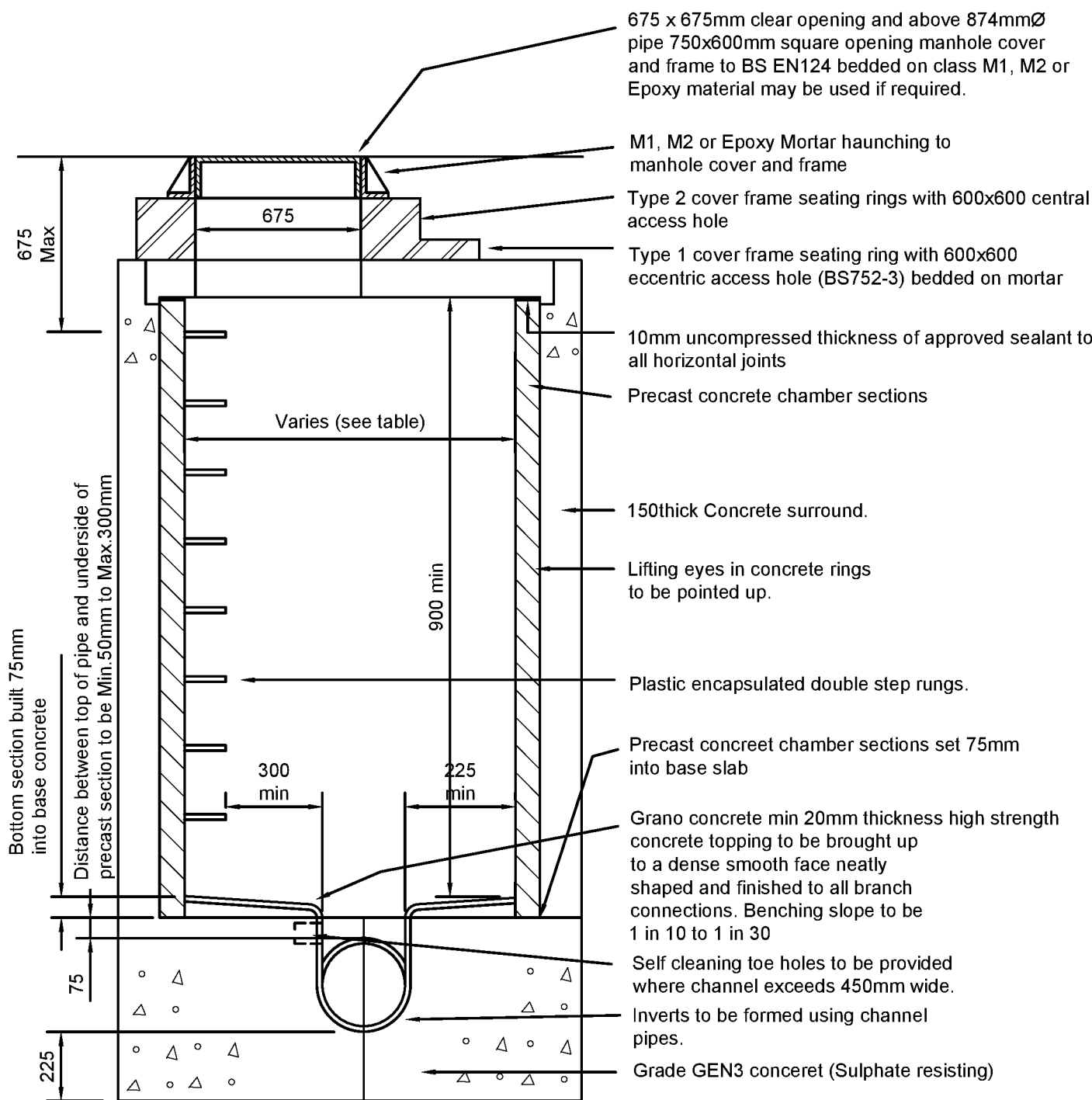
CIVIL, STRUCTURAL & ARCHITECTURAL DESIGN SERVICES

10-11 Birmingham Street, Halesowen, West Midlands B63 3HW

Tel: 0121 687 1500 Fax: 0121 687 1501

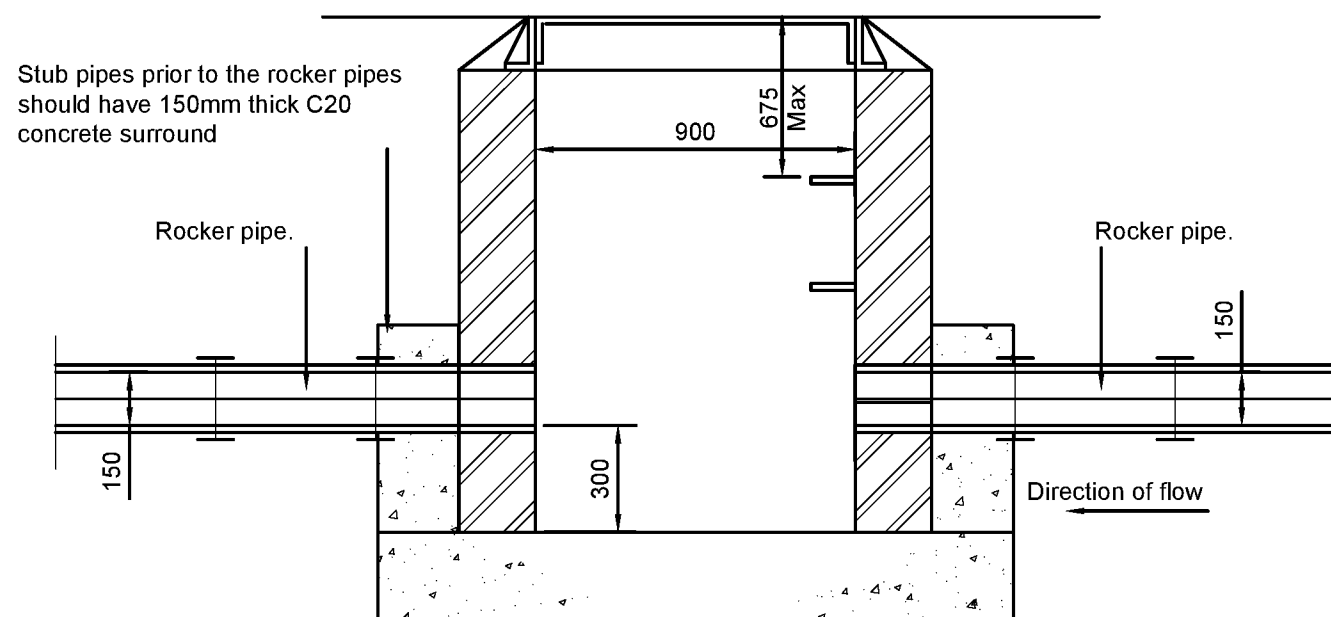
E-mail: mail@bannersgate.com

Scale	Not To Scale @ A1	Drawn	CS
Date	August 2019	Checked	TB
File		Drawing	
19183 / dwgs / civils / current			19163 - 301B

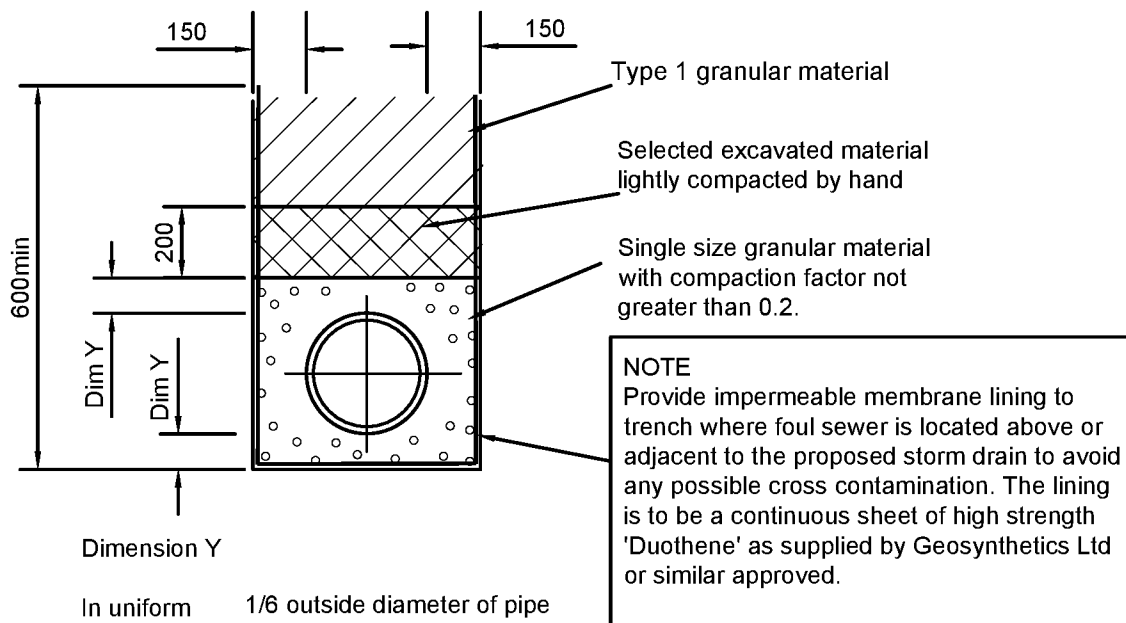


Type B Manhole

Maximum depth from ground level to soffit of pipe 3m



Type C Manhole

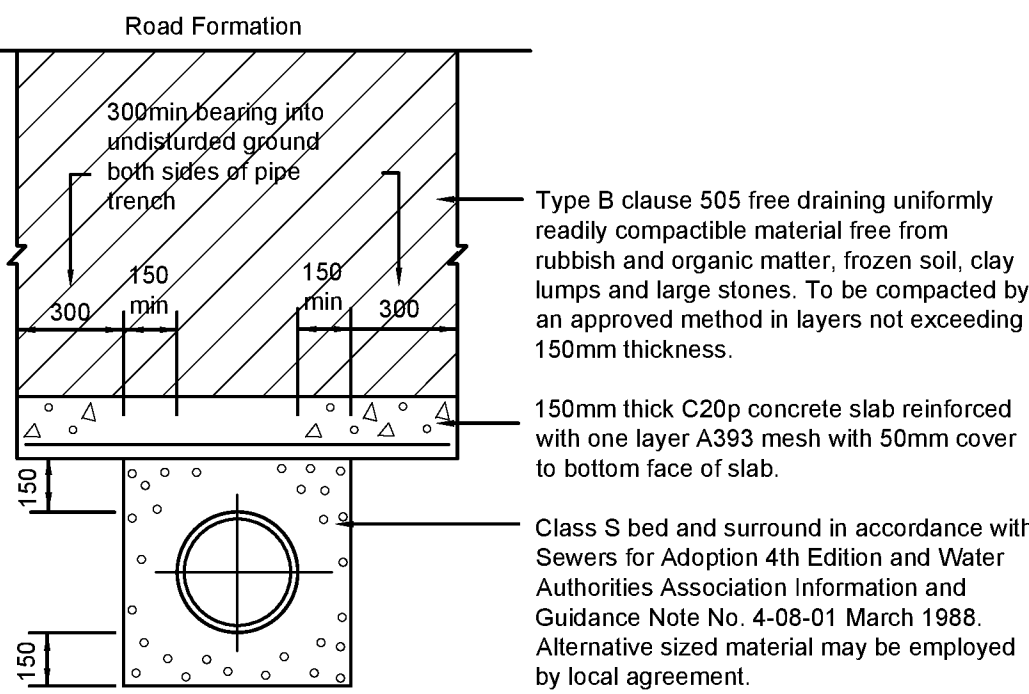
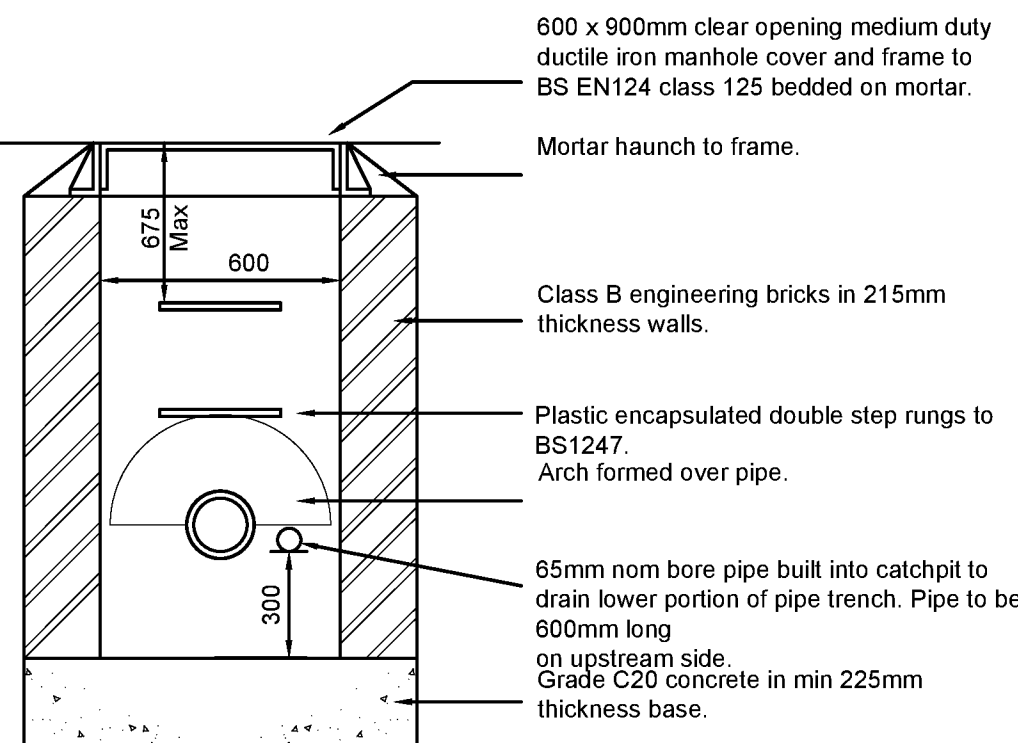


Class S Bedding

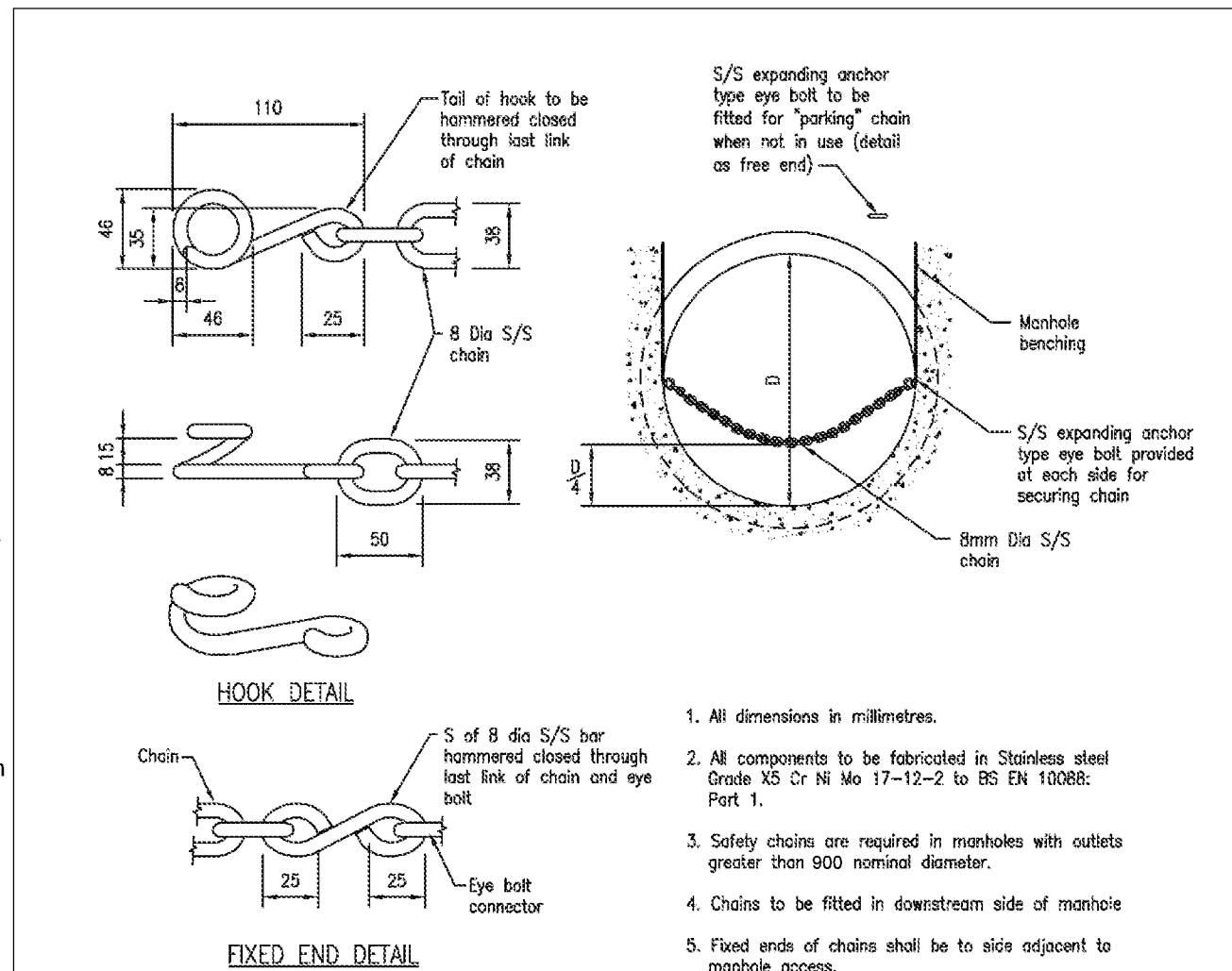
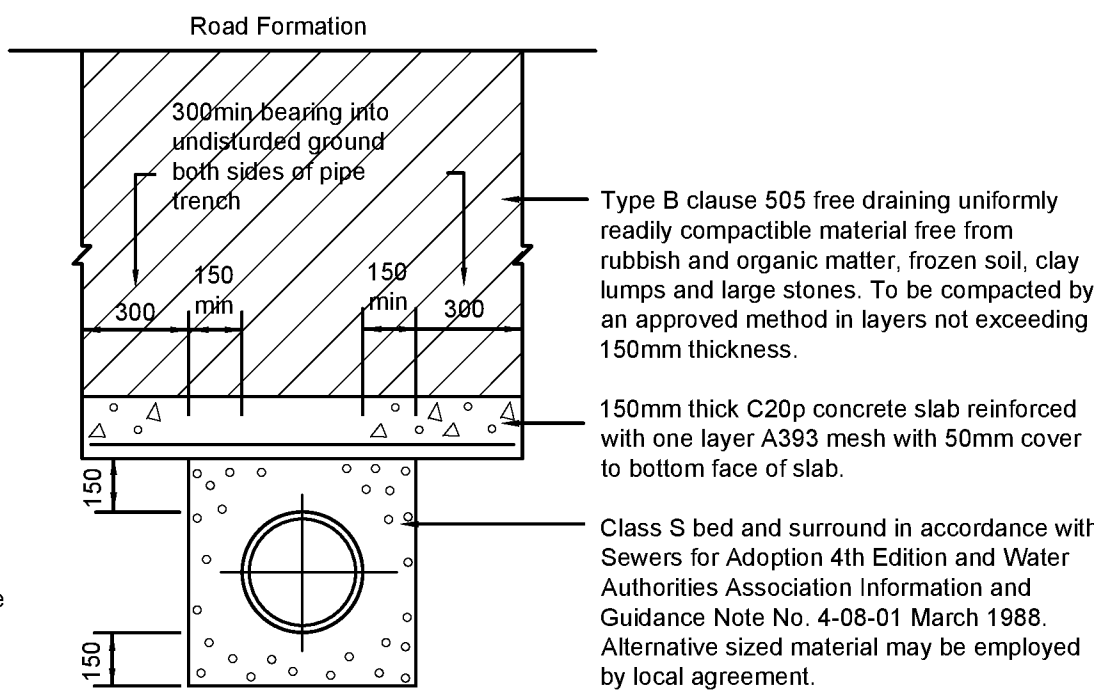
Chambers with outgoing pipes greater than 600mm dia. shall be fitted with removable stainless steel (grade 316) safety chains or polypropylene rope.

Shaft Diameters	
Dia. of largest pipe in MH (mm)	Int dia of MH (mm)
Less Than 375	1200
375 - 700	1500
750 - 900	1800

Rocker Pipes	
Sewer diameter (mm)	Effective Length (mm)
150 - 600	600
600 - 750	1000
750 And Over	1250



Pipe with less than 1200mm cover



Pipe with less than 1200mm cover

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GENERAL NOTES

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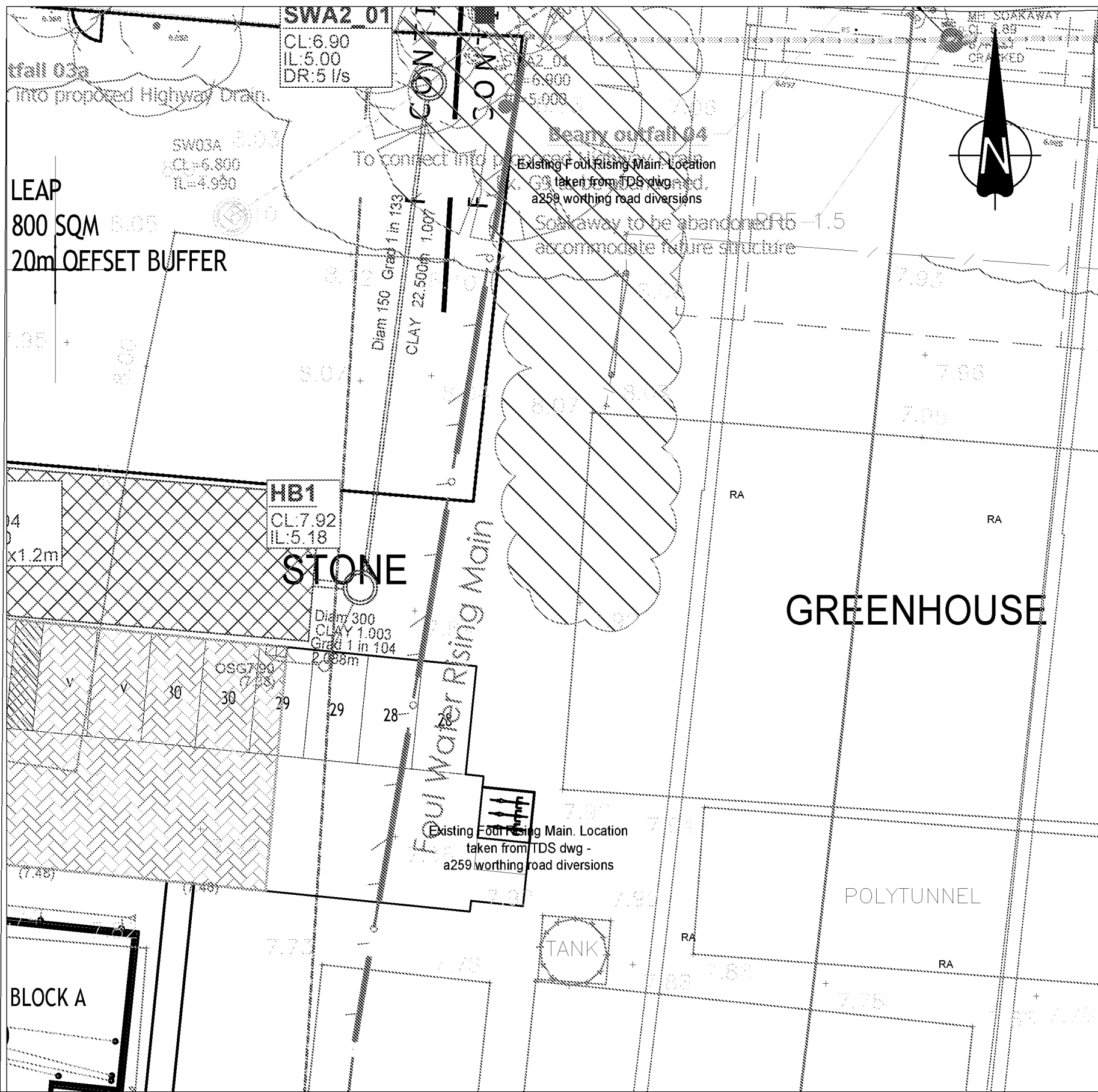
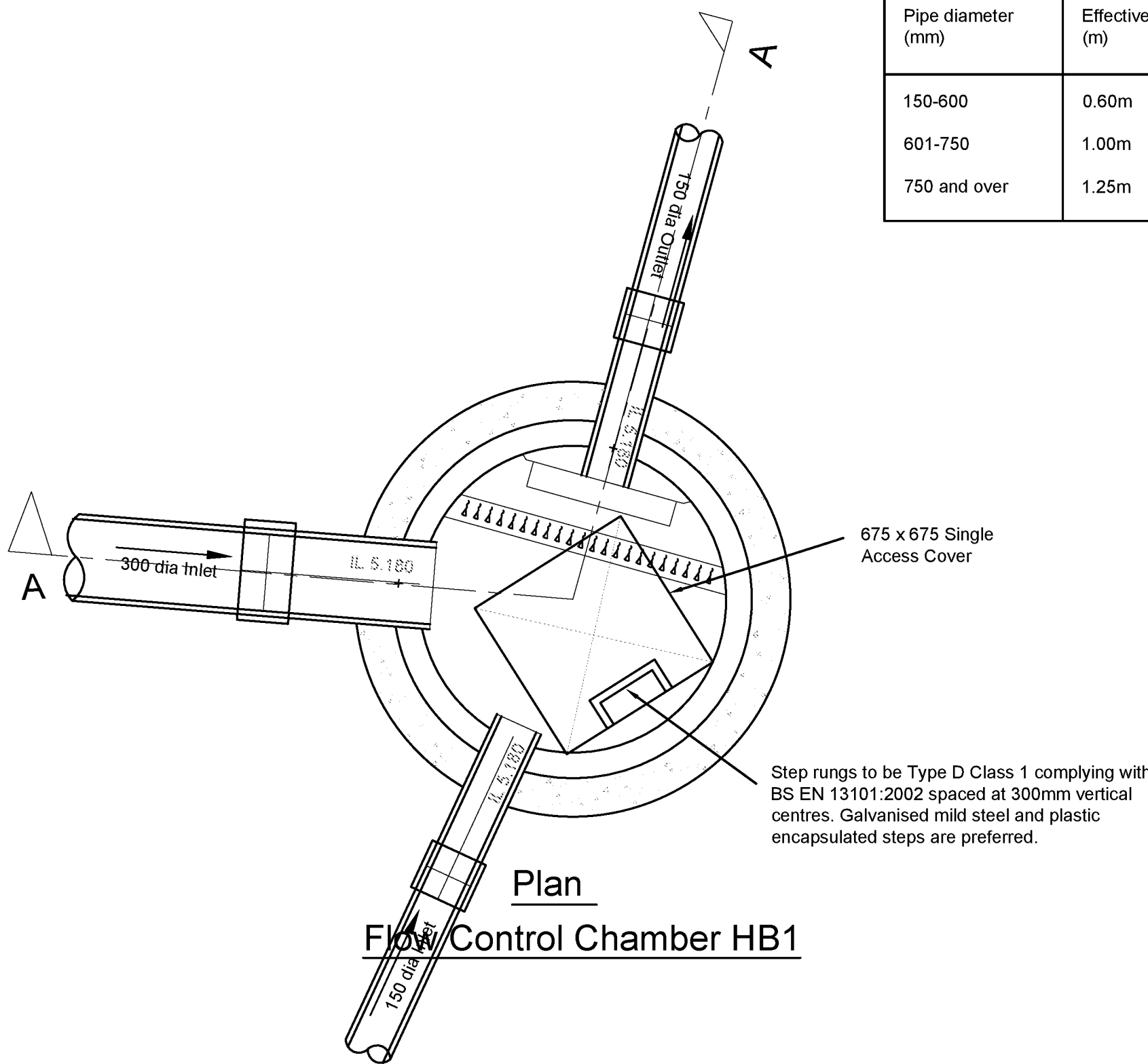
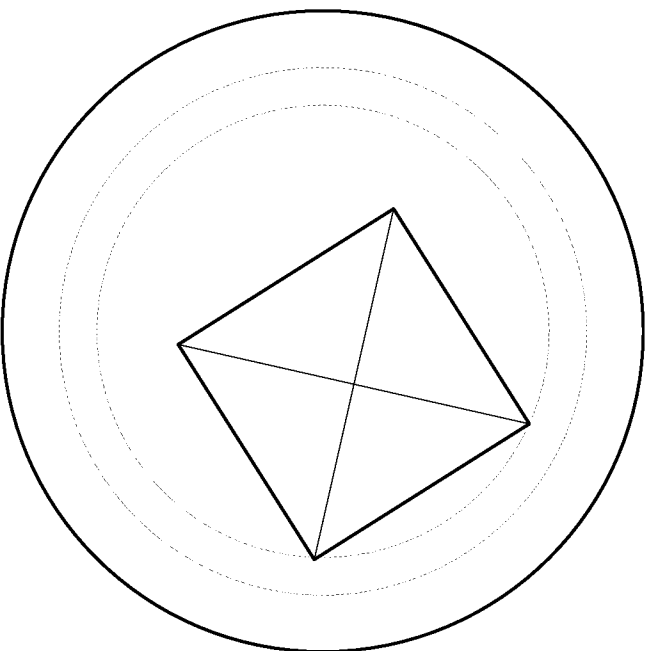
ADOPTABLE ROADS AND SEWERS

- Roads, highways and parking bays which form part of the Highway to be adopted under Section 38 of the Highways Act 1980 shall comply with the requirements of the Adopting Authority.
- Sewers to be adopted under Section 104 of the Water Industries Act 1991 shall comply with the Water Authorities Association 'Sewers for Adoption 6th Edition' with any amendments specified by the Adopting Water Authority.
- All pipes to be used in adoptable sewerage shall be either clayware to BS EN 296 or concrete to BS EN 1916 and BS 5911 Part 1 with Class S bedding unless otherwise stated. With approval of the Adopting Authority solid wall concrete or external rib reinforced uPVC pipes complying with the relevant provisions of BS EN 13476 may be used.
- Where cover to a pipe is more than 1200mm under adoptable carriageway the trench shall be filled to formation of the carriageway with well compacted DTp Type 1 material.
- Where cover to a pipe is less than 1200mm under adoptable carriageway it shall be provided with concrete protection in accordance with the specification of the adopting authority and back filled to formation of the carriageway with well compacted DTp Type 1 material. Where concrete bed and surround is specified flexibility of joints is to be maintained by using compressible bitumen impregnated fibreglass at each pipe joint.
- All existing drainage invert levels, diameters and locations are to be checked by the Contractor prior to the commencement of any proposed drainage work. Any difference between actual and drawn details is to be reported to the Engineer immediately.
- Positions of existing services/statutory undertakers apparatus adjacent to or crossing proposed sewers is to be checked by the Contractor prior to starting work.

First Issue	12.05.20	TB
Rev.	Description	Date By
Drawing Status		
PRELIMINARY		
Client		
PERSIMMON Together, we make a home		
Project		
Littlehampton West Sussex		
Title		
Drainage Construction Details		

BANNERS GATE
CIVIL, STRUCTURAL & ARCHITECTURAL DESIGN SERVICES
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Scale	A1 @ NTS	Drawn	TB
Date	May 2020	Checked	JB
File	19163 / dwgs / civil / current	Drawing	19163 / 311



Drawing Status	PRELIMINARY Subject to Client approval as part of ongoing consultations and design check, amendments may therefore be requested.
Client	PERSIMMON Together, we make a home
Project	Littlehampton West Sussex
Title	HB1 - 1.2m Control Chamber Construction Details



BANNERS GATE

CIVIL, STRUCTURAL & ARCHITECTURAL DESIGN SERVICES

10-11 Birmingham Street, Halesowen, West Midlands B63 3JN
Tel: 0121 687 1500 Fax: 0121 687 1501
E-mail: mail@bannersgate.com

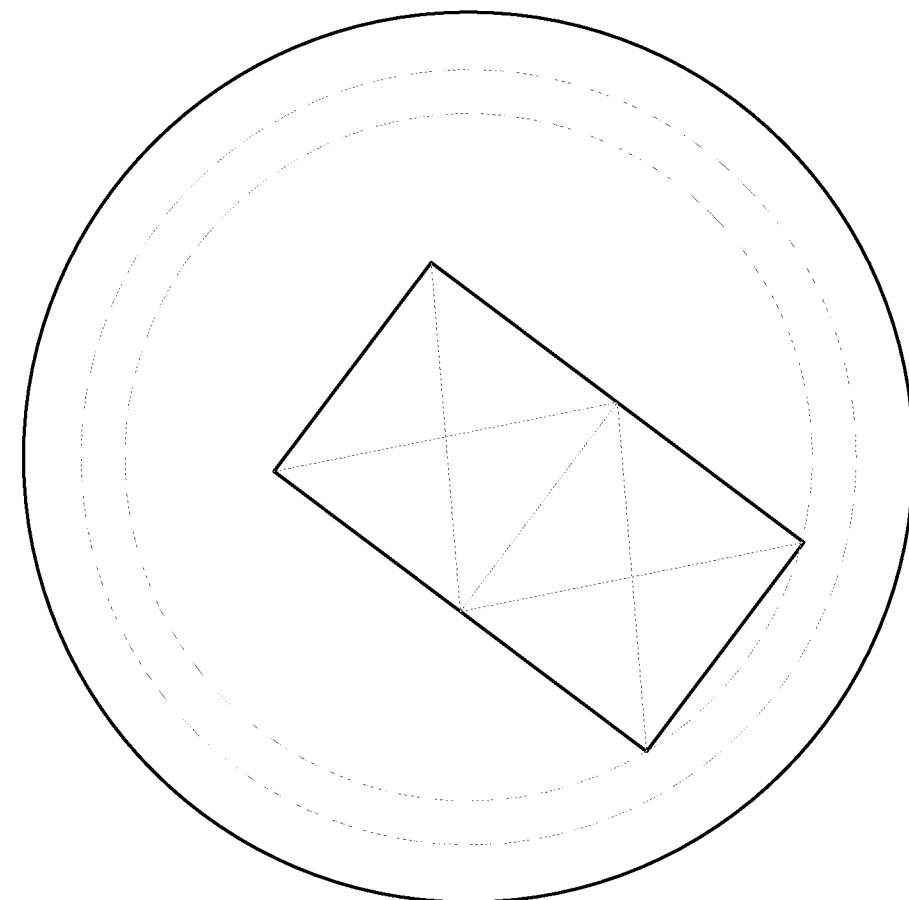
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Date	August 2019	Checked	JB
File	19163/dwgs/civils/current	Drawing	19163 / 323A

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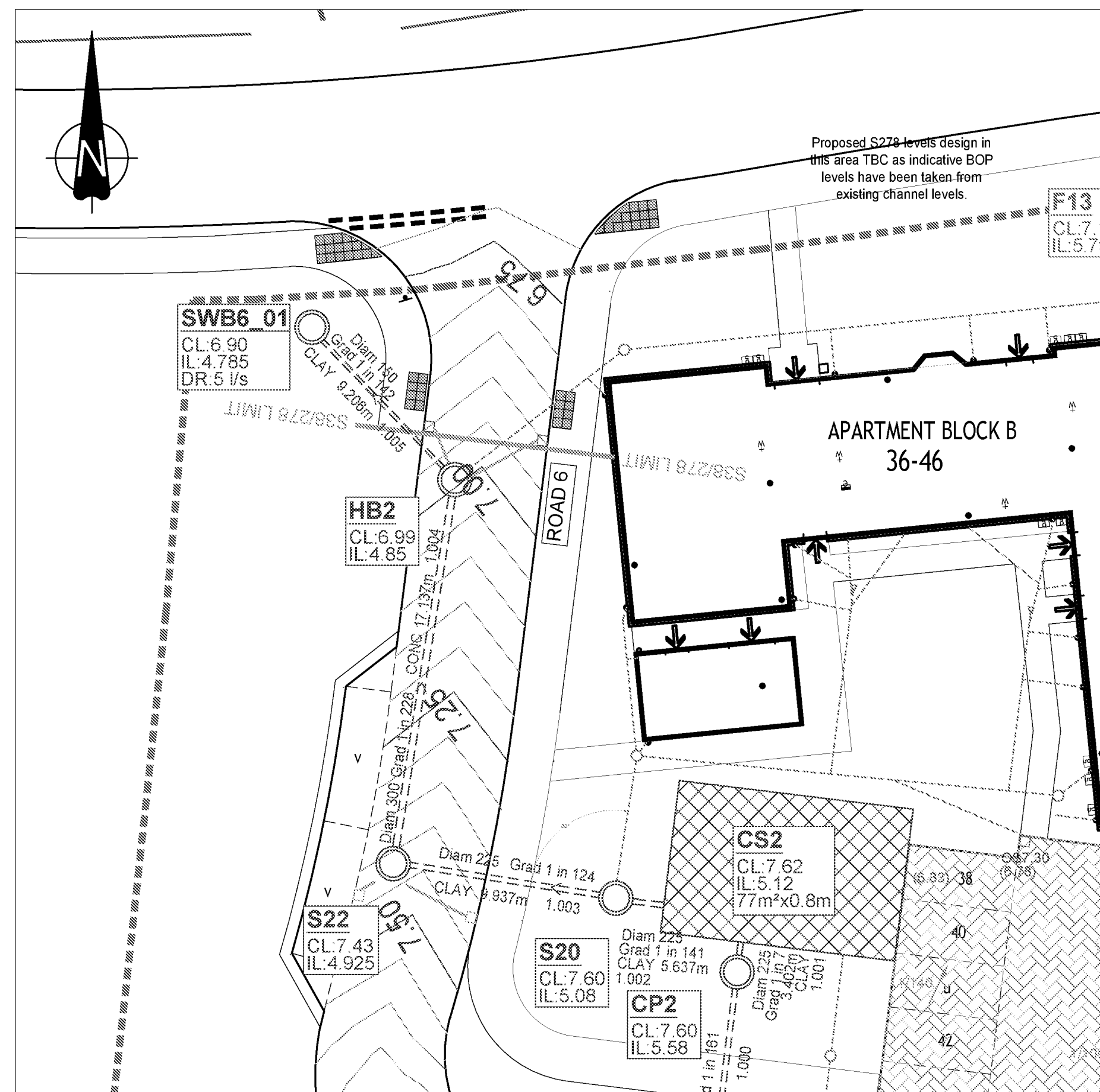
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1. All sewerage to be offered for adoption under Section 104 of the Water Industry Act 1991 shall be constructed in accordance with Sewers for Adoption 8th Edition & Severn Trent Connect requirements.
2. Pipes to have a Class S bed and surround where depths from cover to pipe soffit is greater than 1.2m.
3. Where the manhole cover to pipe soffit is less than 1.2m then concrete protection is to be provided.
4. Where the control chamber is to be constructed in existing highway, the Contractor must notify the Engineer, the cover level and invert level, prior to commencement of works.

- 1) Alternative types of hydrobrakes have different sump configuration & size, always consult the manufacturer.
- 2) Warning signs are to be 40mm high red lettering on a white plastic base. The plastic base dimensions are to be approx 300mm x 6mm.
- 3) The warning sign is to be mounted on a removable safety grid available from cover manufacturer.
- 4) The sign in these manholes are to read "Caution - Hydrobrake located here".
- 5) A sign must be fitted in the upstream MH to read "Caution - Hydrobrake downstream".
- 6) A sign must be fitted in the downstream MH which reads "Caution - Hydrobrake upstream".
- 7) Any difference between actual and drawn details is to be reported immediately.
- 8) The base is to be resistant to attack by sewage.



Plan



Hydro-Brake Control Chamber HB2

Please note while these drawings may be used for tender purposes, drawings are subject to Client approval as part of ongoing consultations and design check.
Amendments may therefore be requested

A	Drawing amended to suit revised drainage strategy First Issue	14.05.2020 20.09.2019	TB
Rev	Description	Date	By
Client			
 PERSIMMON Together, we make a home			
Project			
Littlehampton West Sussex			
Title			
HB2 Control Chamber Construction Details			
 BANNERS GATE CIVIL, STRUCTURAL & ARCHITECTURAL DESIGN SERVICES 10-11 Birmingham Street, Halesowen, West Midlands B63 3HN Tel: 0121 687 1500 Fax: 0121 687 1501 E-mail: mail@bannersgate.com			
Scale	NTS	Drawn	TB
Date	August 2018	Checked	JB
File	19163/dwg/civils/current	Drawing	19163 / 326 A

Banners Gate Ltd		Page 0
Cavendish House 10-11 Birmingham Street Halesowen W.Midlands B63 3HN		
Date 01/01/0001	Designed by tombyrne	
File Foul Network 1 20.05.13...	Checked by	
XP Solutions		Network 2018.1.1

FOUL SEWERAGE DESIGN

Design Criteria for FOUL NETWORK 1 20.05.13.FWS

Pipe Sizes FOUL NETWORK 1 19.08.20 Manhole Sizes FOUL NETWORK 1 19.08.20

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	225.00	Maximum Backdrop Height (m)	0.000
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for FOUL NETWORK 1 20.05.13.FWS

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	33.441	0.339	98.6	0.000	9	0.0	1.500	o	100	Pipe/Conduit	
F1.001	23.535	0.157	149.9	0.000	4	0.0	1.500	o	150	Pipe/Conduit	
F1.002	25.271	0.168	150.4	0.000	2	0.0	1.500	o	150	Pipe/Conduit	
F1.003	28.120	0.187	150.4	0.000	5	0.0	1.500	o	150	Pipe/Conduit	
F1.004	8.686	0.060	144.8	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.005	12.916	0.460	28.1	0.000	5	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	5.561	0.000	0.0	9	0.0	19	0.39	0.67	5.3	0.4
F1.001	5.172	0.000	0.0	13	0.0	23	0.36	0.71	12.6	0.6
F1.002	5.015	0.000	0.0	15	0.0	24	0.38	0.71	12.6	0.7
F1.003	4.847	0.000	0.0	20	0.0	28	0.41	0.71	12.6	0.9
F1.004	4.680	0.000	0.0	20	0.0	28	0.42	0.73	12.8	0.9
F1.005	4.600	0.000	0.0	25	0.0	21	0.80	1.66	29.3	1.2

Free Flowing Outfall Details for FOUL NETWORK 1 20.05.13.FWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.005	FFWA2_01	6.800	4.140	0.000	1200	0

Banners Gate Ltd		Page 1
Cavendish House 10-11 Birmingham Street Halesowen W.Midlands B63 3HN		
Date 01/01/0001	Designed by tombyrne	
File Foul Network 1 20.05.13...	Checked by	
XP Solutions		Network 2018.1.1

Simulation Criteria for FOUL NETWORK 1 20.05.13.FWS

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	0	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	0.000	Storm Duration (mins)	30
Ratio R	0.000		

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SDS GEOLight®

Stormwater Management System

Product Profile

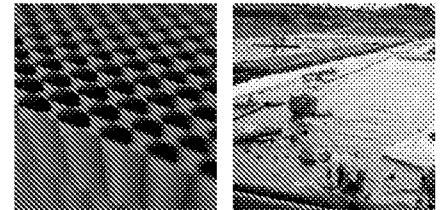
SDS GEOLight® is an ultra lightweight honeycombed modular structure made from recycled PVC. The ready to install units are preformed to provide an underground stormwater storage facility, for the application of stormwater attenuation or infiltration.

The high void rate (>95%), high compressive strength (to 1000KN/m²) and low resistance to water flow makes

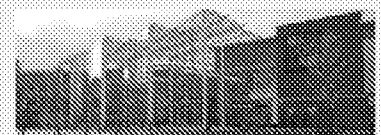
SDS GEOLight® an ideal material for cost efficient and maintainable underground water storage during storm conditions.

SDS GEOLight® Benefits

- High compressive strength – can be located under all roads, car parks and amenity area surfaces.
- Reduced excavation costs – the very high void rate (95%) minimises the required volume of earthworks.
- Speed of installation – 1000m³ reservoir, completed in one week.
- Light and easy to handle.
- Excellent hydraulic characteristics.
- The honeycomb structure is highly permeable, offering low resistance to water flow.
- SDS GEOLight®'s unique lateral and vertical filling arrangement requires a minimum amount of pipework and stone.
- Depth of tank invert reduced by using patented lateral supply.
- Simplified distribution pipe network, easy maintenance – dispensing with costly and complicated pipework configurations.
- Modular format offers design flexibility to overcome topographical constraints and architectural requirements.
- Greatly reduces the risk of flooding when used as stormwater storage.
- Can also be used for water recycling and combining with irrigation systems.
- Can virtually eliminate pollution when used in combination with specialist separation and filtration technology such as SDS Aqua-Swirl™ and SDS Aqua-Filter™.
- Design service available, including calculations.



APPLICATIONS



RETAIL



INFRASTRUCTURE



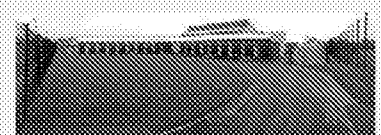
INDUSTRIAL



RESIDENTIAL



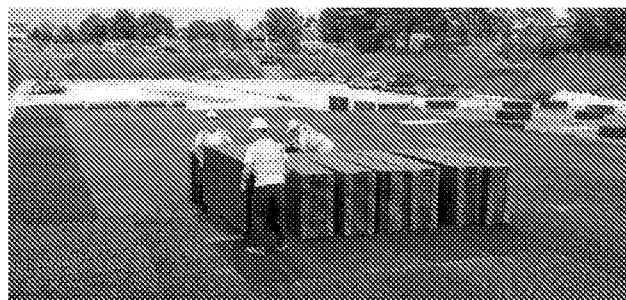
COMMERCIAL



PUBLIC SECTOR

SDS GEOLight®

Cellular Block structure manufactured from recycled PVC.



APPLICATIONS

- Stormwater Management
- Attenuation/Infiltration
- Bacterial filter-bed for biological treatment
- Hydrocarbon Separation
- Filtration and Separation Units

SPECIFICATIONS

Material	Recycled Rigid PVC
Colour	Dark grey to black
Standard length of a block	2000mm
Standard width of a block	500mm
Standard height of a block	750 mm
Other block sizes available on request	
Void Ratio	> 95%
Specific surface area	160 m ² /m ³ ± 5%
Compressive Strength	400kN/m ²

ADVANTAGES

- Highly cost effective
- Reduced excavation costs
- High void capacity
- Good UV resistance
- Good hydrocarbon resistance

SDS GEOLight®

Cellular Block structure manufactured from recycled PVC.



APPLICATIONS

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- Attenuation/Infiltration
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GEO 05/0516

Technical Specification

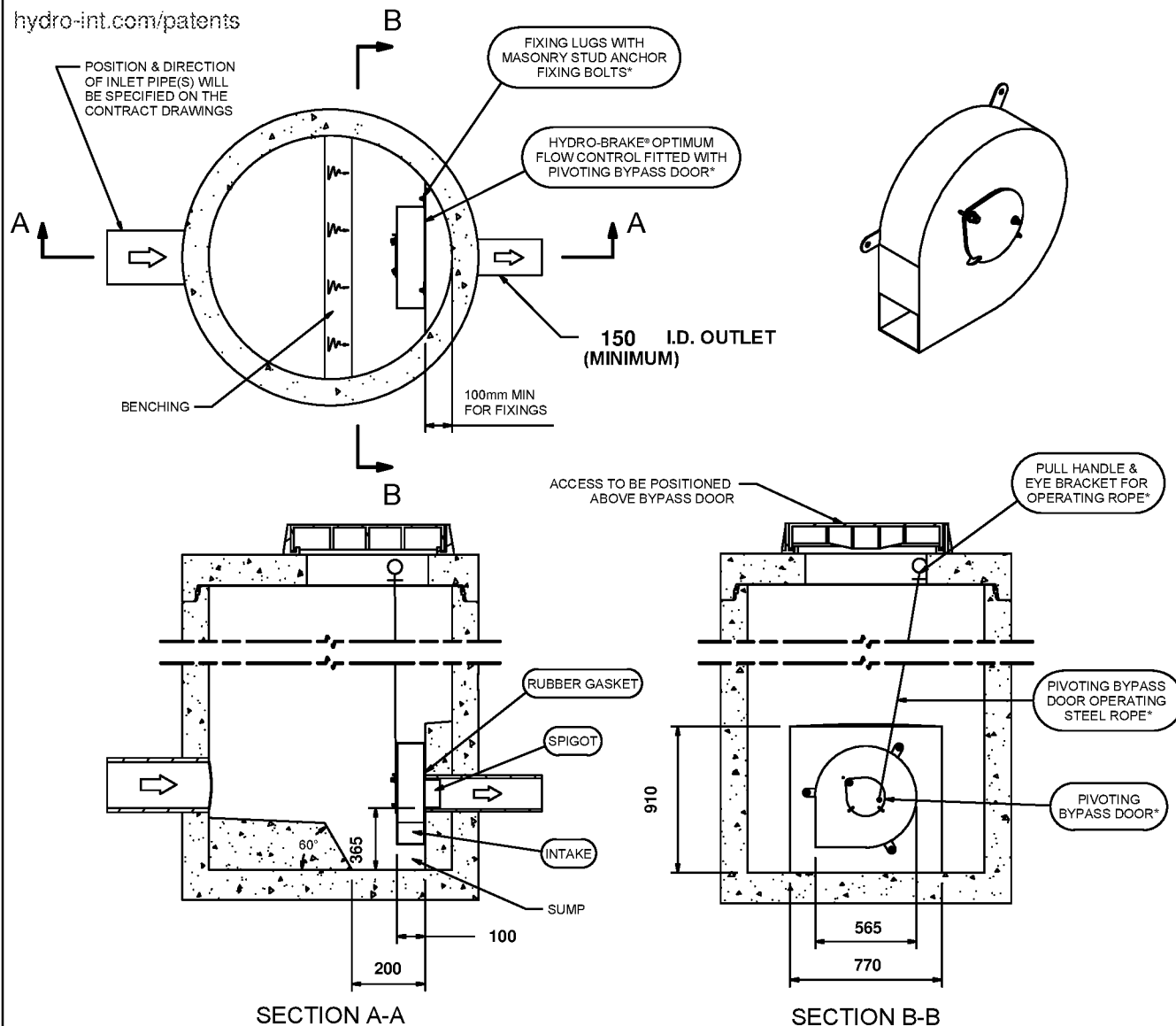
Control Point	Head (m)	Flow (l/s)
Primary Design	1.891	5.000
Flush-Flo™	0.408	4.274
Kick-Flo®	0.832	3.420
Mean Flow		4.014

Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet



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IMPORTANT: LIMIT OF HYDRO INTERNATIONAL SUPPLY
 THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
 FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
 ALL CIVIL AND INSTALLATION WORK BY OTHERS
 * WHERE SUPPLIED
 HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW
 CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE



The head/flow characteristics of this SHE-0093-5000-1891-5000 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro
International

DATE 5/13/2020 4:07 PM

SITE Littlehampton

DESIGNER Liam Hannon

REF 19163

SHE-0093-5000-1891-5000

Hydro-Brake® Optimum

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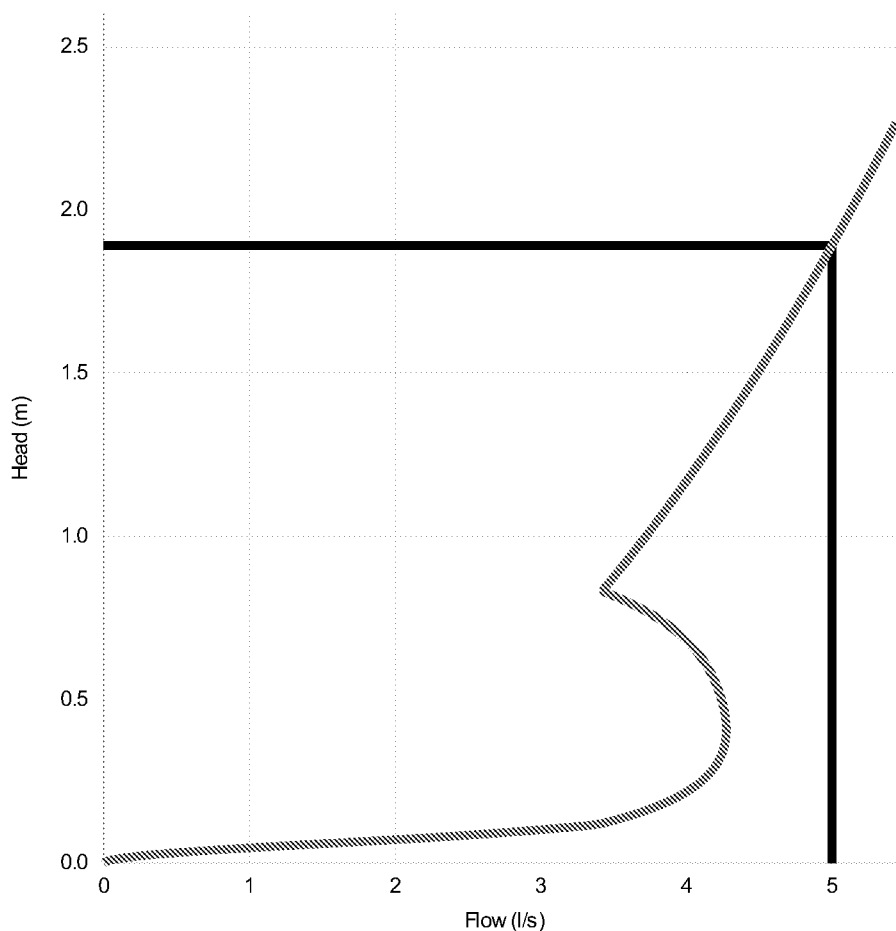
civils@bannersgate.com

Technical Specification

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Flush-Flo	0.408	4.274
Kick-Flo®	0.832	3.420
Mean Flow		4.014



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Head (m)	Flow (l/s)
0.000	0.000
0.065	1.749
0.130	3.501
0.196	3.910
0.261	4.130
0.326	4.237
0.391	4.273
0.456	4.265
0.522	4.227
0.587	4.163
0.652	4.063
0.717	3.910
0.782	3.675
0.848	3.450
0.913	3.569
0.978	3.684
1.043	3.795
1.109	3.903
1.174	4.007
1.239	4.108
1.304	4.207
1.369	4.303
1.435	4.397
1.500	4.488
1.565	4.578
1.630	4.665
1.695	4.751
1.761	4.835
1.826	4.918
1.891	4.999

DESIGN ADVICE



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International

DATE 13/05/2020 16:07

Site Littlehampton

DESIGNER Liam Hannon

Ref 19163

SHE-0093-5000-1891-5000

Hydro-Brake Optimum®

Technical Specification

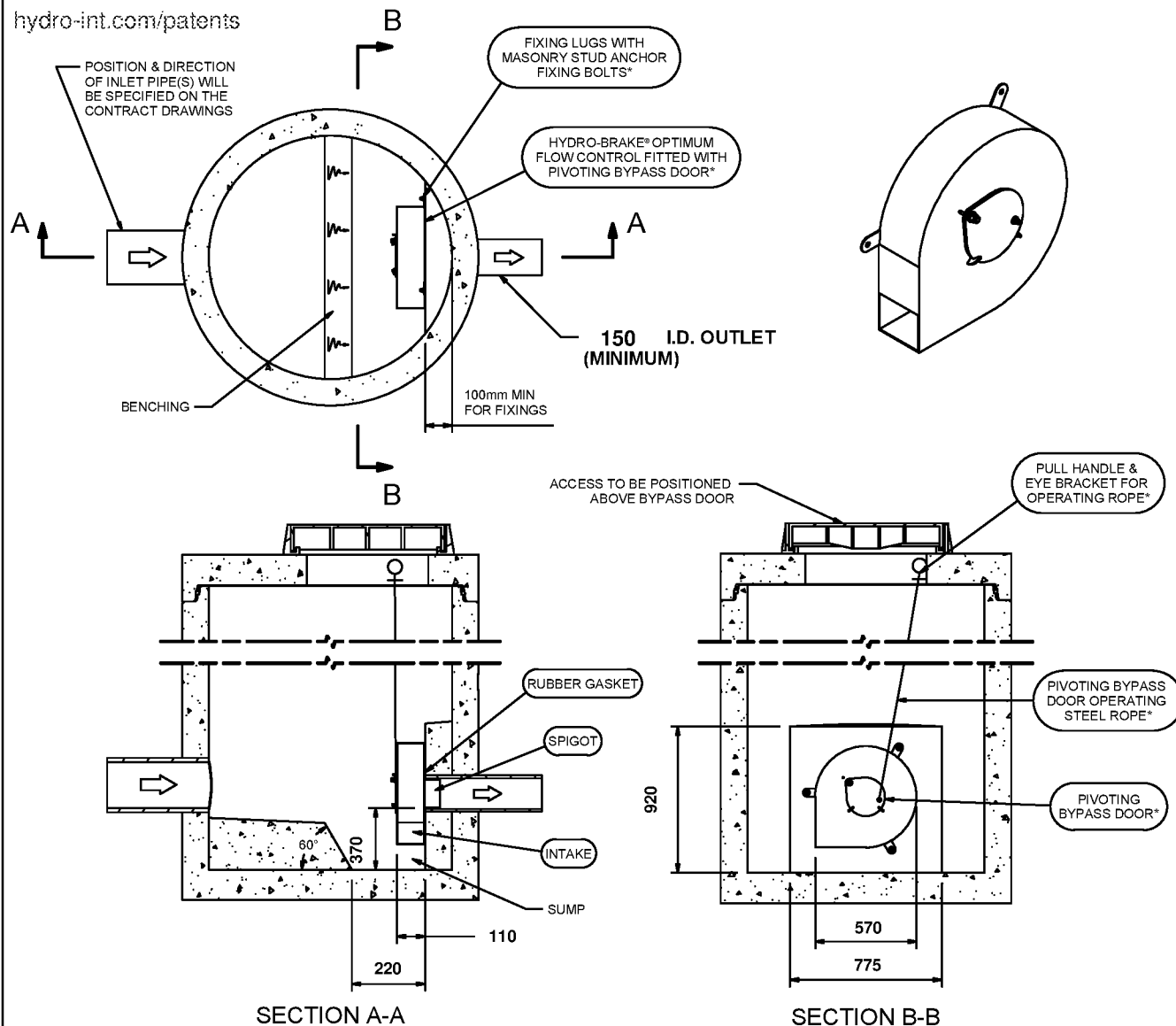
Control Point	Head (m)	Flow (l/s)
Primary Design	1.290	5.000
Flush-Flo™	0.387	4.999
Kick-Flo®	0.802	4.010
Mean Flow		4.381

Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet



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DESIGN ADVICE



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SITE Littlehampton

DESIGNER Liam Hannon

REF 19163

SHE-0101-5000-1290-5000

Hydro-Brake® Optimum

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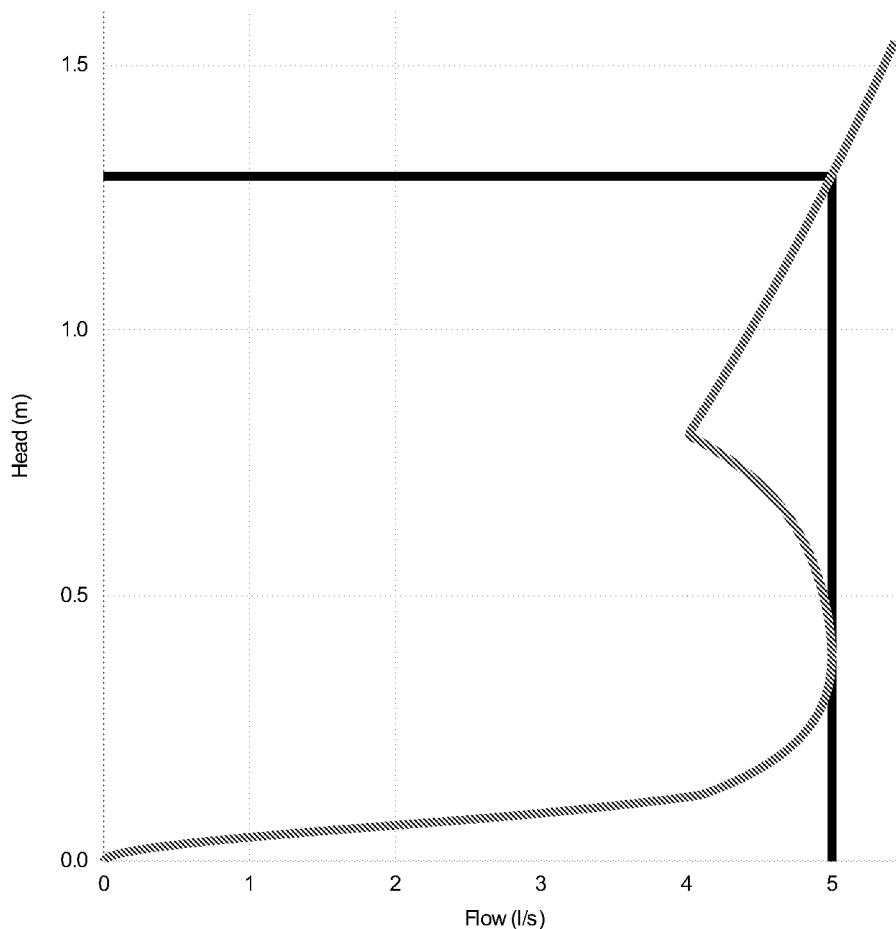
civils@bannersgate.com

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.290	5.000
Flush-Flo	0.387	4.999
Kick-Flo®	0.802	4.010
Mean Flow		4.381



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Head (m)	Flow (l/s)
0.000	0.000
0.044	0.989
0.089	2.959
0.133	4.190
0.178	4.527
0.222	4.745
0.267	4.880
0.311	4.957
0.356	4.992
0.400	4.998
0.445	4.983
0.489	4.951
0.534	4.906
0.578	4.845
0.623	4.764
0.667	4.652
0.712	4.501
0.756	4.297
0.801	4.028
0.845	4.108
0.890	4.206
0.934	4.302
0.979	4.395
1.023	4.486
1.068	4.575
1.112	4.663
1.157	4.748
1.201	4.832
1.246	4.914
1.290	4.995

DESIGN ADVICE



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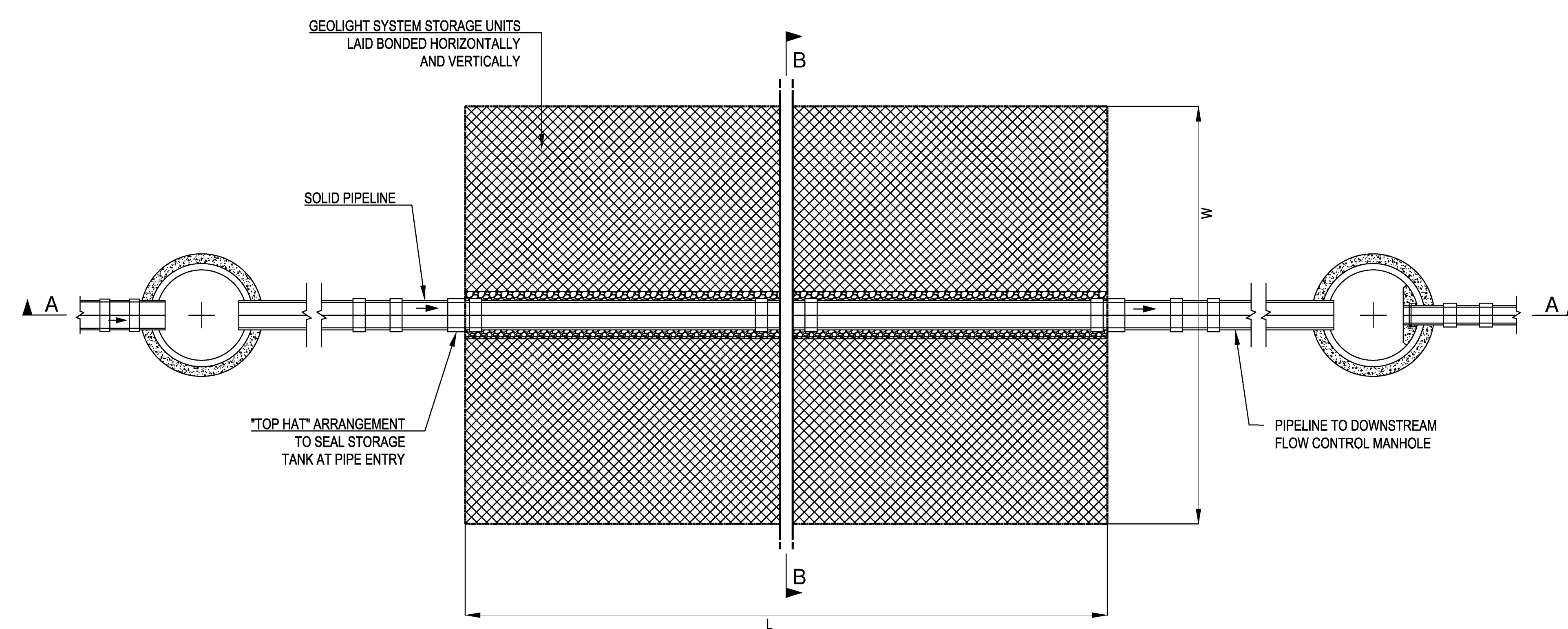
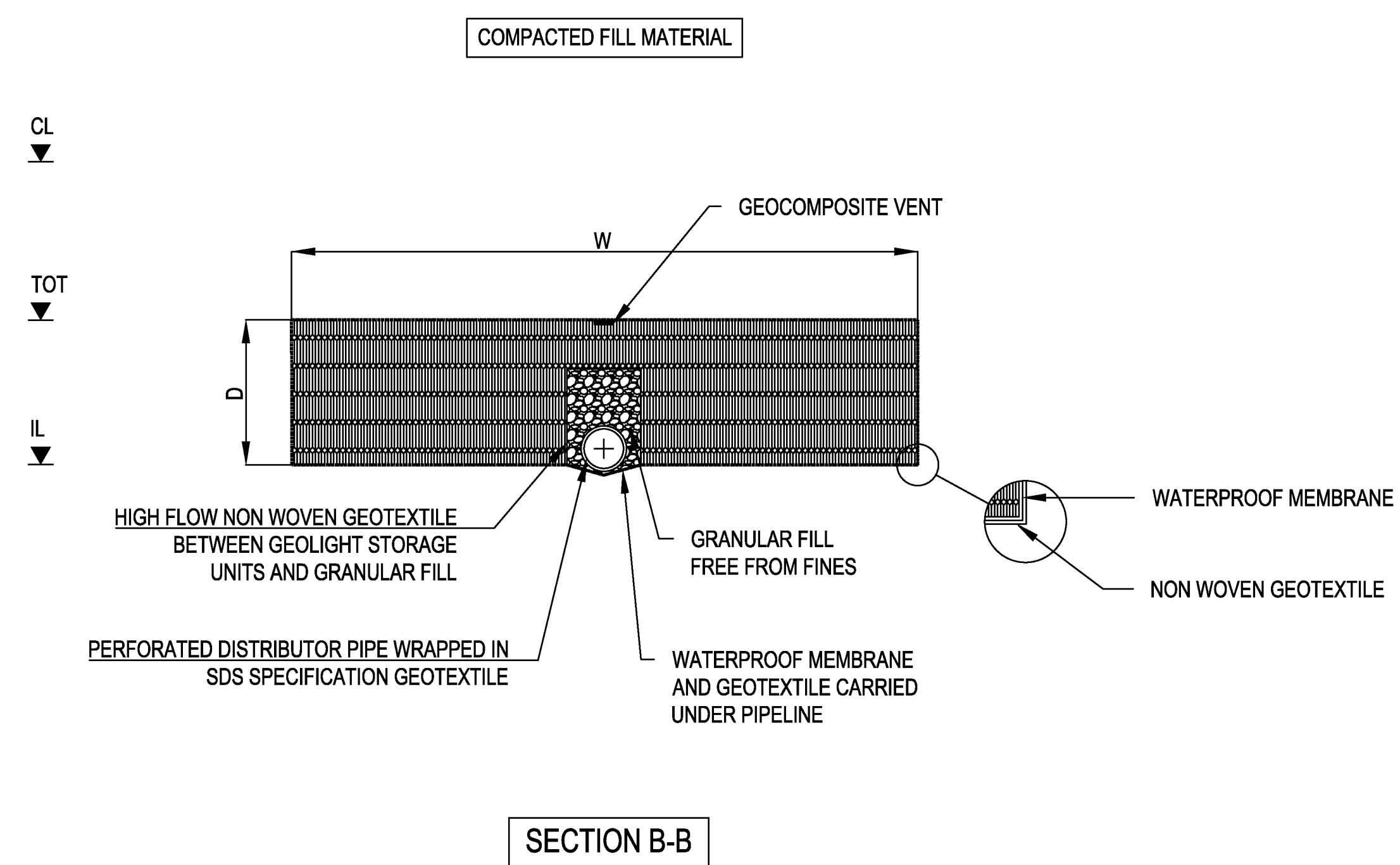
Site Littlehampton

DESIGNER Liam Hannon

Ref 19163

SHE-0101-5000-1290-5000

Hydro-Brake Optimum®



All external Manholes, Access Points, Junctions & Pipe are shown for guidance only and not part of the SDS program unless otherwise agreed.

-	ISSUED FOR APPROVAL	06.10.15
Rev	Comments	Date

Sustainable Drainage Systems Ltd
Clearwater House
Castlemills
Biddisham
Somerset
BS26 2RE

Tel: 01934 751303
Fax: 01934 751304
Web: www.sdslimited.com



Project

	Client
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ONLINE ATTENUATION TANK,
BRIDGED, STANDARD DETAIL

Scale	NTS	Date	06.10.15
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Drawn	SP	Checked By	SP	Rev
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Drawing No. **FOR GUIDANCE ONLY**

Banners Gate Ltd		Page 0
Cavendish House 10-11 Birmingham Street Halesowen W.Midlands B63 3HN	Littlehampton	
Date 17/08/2019 File STORM NETWORK 1 20.05.1...	Designed by TB Checked by	
XP Solutions Network 2018.1.1		

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 1 20.05.13.SWS

Pipe Sizes NETWORK 1 19.08.20 Manhole Sizes NETWORK 1 19.08.20

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 1 20.05.13.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.164	4-8	0.210	8-12	0.014

Total Area Contributing (ha) = 0.388

Total Pipe Volume (m³) = 10.118

Network Design Table for NETWORK 1 20.05.13.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	30.491	0.182	167.5	0.100	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.50	5.911	0.100	0.0	0.0	0.0	1.01	40.1	13.5

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PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design																																																																																																																																																																																																																																						
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Area Summary for NETWORK 1 20.05.13.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.100	0.100	0.100
1.001	-	-	100	0.080	0.080	0.080
1.002	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.045	0.045	0.045
1.003	-	-	100	0.092	0.092	0.092
3.000	-	-	100	0.045	0.045	0.045
1.004	-	-	100	0.026	0.026	0.026
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.388	0.388	0.388

Free Flowing Outfall Details for NETWORK 1 20.05.13.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.007	SSWA2_01	6.900	5.000	0.000	1200	0

Simulation Criteria for NETWORK 1 20.05.13.SWS

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB	503220 103890	Cv (Winter)	0.840
Data Type	Point Storm Duration (mins)		30

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Online Controls for NETWORK 1 20.05.13.SWS

Hydro-Brake® Optimum Manhole: SHB1, DS/PN: S1.007, Volume (m³): 7.4

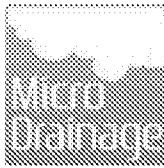
Unit Reference	MD-SHE-0093-5000-1891-5000
Design Head (m)	1.891
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	5.180
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.891	5.0
Flush-Flo™	0.408	4.3
Kick-Flo®	0.832	3.4
Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.0	3.000	6.2	7.000	9.3
0.200	3.9	1.400	4.3	3.500	6.7	7.500	9.6
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.9
0.400	4.3	1.800	4.9	4.500	7.5	8.500	10.2
0.500	4.2	2.000	5.1	5.000	7.9	9.000	10.4
0.600	4.1	2.200	5.4	5.500	8.3	9.500	10.7
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

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Storage Structures for NETWORK 1 20.05.13.SWS

Cellular Storage Manhole: SCS1, DS/PN: S1.006

Invert Level (m) 5.200 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	150.0	150.0	1.201	0.0	208.8
1.200	150.0	208.8			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1
20.05.13.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	2
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S2	15 Winter	2	+0%					6.014
S1.001	S4	15 Winter	2	+0%					5.874
S1.002	S6	15 Winter	2	+0%					5.643
S2.000	S8	15 Winter	2	+0%					5.709
S1.003	S10	15 Winter	2	+0%					5.599
S3.000	S12	15 Winter	2	+0%					6.401
S1.004	S14	15 Winter	2	+0%					5.555
S1.005	SCP1	15 Winter	2	+0%					5.519
S1.006	SCS1	180 Winter	2	+0%	2/120 Winter				5.513
S1.007	SHB1	180 Winter	2	+0%	2/15 Summer				5.511

PN	US/MH Name	Depth (m)	Surcharged Volume (m ³)	Flooded Volume (m ³)	Flow / Cap. (l/s)	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S2	-0.122	0.000	0.42		15.9		OK	
S1.001	S4	-0.080	0.000	0.73		27.0		OK	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 1 20.05.13.SWS

Pipe Sizes NETWORK 1 19.08.20 Manhole Sizes NETWORK 1 19.08.20

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 1 20.05.13.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.164	4-8	0.210	8-12	0.014

Total Area Contributing (ha) = 0.388

Total Pipe Volume (m³) = 10.118

Network Design Table for NETWORK 1 20.05.13.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	30.491	0.182	167.5	0.100	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.50	5.911	0.100	0.0	0.0	0.0	1.01	40.1	13.5

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Area Summary for NETWORK 1 20.05.13.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.100	0.100	0.100
1.001	-	-	100	0.080	0.080	0.080
1.002	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.045	0.045	0.045
1.003	-	-	100	0.092	0.092	0.092
3.000	-	-	100	0.045	0.045	0.045
1.004	-	-	100	0.026	0.026	0.026
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.388	0.388	0.388

Free Flowing Outfall Details for NETWORK 1 20.05.13.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.007	SSWA2_01	6.900	5.000	0.000	1200	0

Simulation Criteria for NETWORK 1 20.05.13.SWS

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB	503220 103890	Cv (Winter)	0.840
Data Type	Point Storm Duration (mins)		30

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Online Controls for NETWORK 1 20.05.13.SWS

Hydro-Brake® Optimum Manhole: SHB1, DS/PN: S1.007, Volume (m³): 7.4

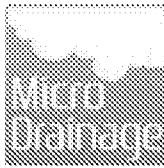
Unit Reference	MD-SHE-0093-5000-1891-5000
Design Head (m)	1.891
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	5.180
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.891	5.0
Flush-Flo™	0.408	4.3
Kick-Flo®	0.832	3.4
Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.0	3.000	6.2	7.000	9.3
0.200	3.9	1.400	4.3	3.500	6.7	7.500	9.6
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.9
0.400	4.3	1.800	4.9	4.500	7.5	8.500	10.2
0.500	4.2	2.000	5.1	5.000	7.9	9.000	10.4
0.600	4.1	2.200	5.4	5.500	8.3	9.500	10.7
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

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Storage Structures for NETWORK 1 20.05.13.SWS

Cellular Storage Manhole: SCS1, DS/PN: S1.006

Invert Level (m) 5.200 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	150.0	150.0	1.201	0.0	208.8
1.200	150.0	208.8			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1
20.05.13.SWS

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	30
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S2	15 Winter	30	+0%	30/15 Summer				6.600
S1.001	S4	15 Winter	30	+0%	30/15 Summer				6.484
S1.002	S6	15 Winter	30	+0%	30/15 Summer				6.186
S2.000	S8	15 Winter	30	+0%	30/15 Summer				6.134
S1.003	S10	15 Winter	30	+0%	30/15 Summer				6.100
S3.000	S12	15 Winter	30	+0%					6.428
S1.004	S14	15 Winter	30	+0%	30/15 Summer				5.934
S1.005	SCP1	180 Winter	30	+0%	30/15 Summer				5.915
S1.006	SCS1	180 Winter	30	+0%	30/15 Summer				5.911
S1.007	SHB1	180 Winter	30	+0%	30/15 Summer				5.909

PN	US/MH Name	Depth (m)	Surcharged Volume (m³)	Flooded Volume (m³)	Flow / Cap. (l/s)	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S2	0.464	0.000	0.84		31.5		SURCHARGED	
S1.001	S4	0.530	0.000	1.37		50.6		SURCHARGED	

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1 20.05.13.SWS								
PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.002	S6	0.386	0.000	0.79		50.8	SURCHARGED	
S2.000	S8	0.266	0.000	0.37		14.2	SURCHARGED	
S1.003	S10	0.410	0.000	1.34		85.8	SURCHARGED	
S3.000	S12	-0.074	0.000	0.52		15.7	OK	
S1.004	S14	0.334	0.000	1.73		107.1	SURCHARGED	
S1.005	SCP1	0.355	0.000	0.62		31.3	SURCHARGED	
S1.006	SCS1	0.411	0.000	0.13		4.9	SURCHARGED	
S1.007	SHB1	0.579	0.000	0.29		4.3	SURCHARGED	
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XP Solutions		Network 2018.1.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 1 20.05.13.SWS

Pipe Sizes NETWORK 1 19.08.20 Manhole Sizes NETWORK 1 19.08.20

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 1 20.05.13.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.164	4-8	0.210	8-12	0.014

Total Area Contributing (ha) = 0.388

Total Pipe Volume (m³) = 10.118

Network Design Table for NETWORK 1 20.05.13.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	30.491	0.182	167.5	0.100	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.50	5.911	0.100	0.0	0.0	0.0	1.01	40.1	13.5

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Area Summary for NETWORK 1 20.05.13.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.100	0.100	0.100
1.001	-	-	100	0.080	0.080	0.080
1.002	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.045	0.045	0.045
1.003	-	-	100	0.092	0.092	0.092
3.000	-	-	100	0.045	0.045	0.045
1.004	-	-	100	0.026	0.026	0.026
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.388	0.388	0.388

Free Flowing Outfall Details for NETWORK 1 20.05.13.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.007	SSWA2_01	6.900	5.000	0.000	1200	0

Simulation Criteria for NETWORK 1 20.05.13.SWS

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB	503220 103890	Cv (Winter)	0.840
Data Type	Point Storm Duration (mins)		30

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Online Controls for NETWORK 1 20.05.13.SWS

Hydro-Brake® Optimum Manhole: SHB1, DS/PN: S1.007, Volume (m³): 7.4

Unit Reference	MD-SHE-0093-5000-1891-5000
Design Head (m)	1.891
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	5.180
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.891	5.0
Flush-Flo™	0.408	4.3
Kick-Flo®	0.832	3.4
Mean Flow over Head Range	-	4.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.0	3.000	6.2	7.000	9.3
0.200	3.9	1.400	4.3	3.500	6.7	7.500	9.6
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.9
0.400	4.3	1.800	4.9	4.500	7.5	8.500	10.2
0.500	4.2	2.000	5.1	5.000	7.9	9.000	10.4
0.600	4.1	2.200	5.4	5.500	8.3	9.500	10.7
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

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Storage Structures for NETWORK 1 20.05.13.SWS

Cellular Storage Manhole: SCS1, DS/PN: S1.006

Invert Level (m) 5.200 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	150.0	150.0	1.201	0.0	208.8
1.200	150.0	208.8			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1
20.05.13.SWS

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013 Cv	(Summer)	0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S2	15 Winter	100	+30%	100/15 Summer	100/15 Summer		
S1.001	S4	15 Winter	100	+30%	100/15 Summer			
S1.002	S6	15 Winter	100	+30%	100/15 Summer			
S2.000	S8	240 Winter	100	+30%	100/15 Summer	100/15 Winter		
S1.003	S10	240 Winter	100	+30%	100/15 Summer			
S3.000	S12	15 Winter	100	+30%	100/15 Summer			
S1.004	S14	240 Winter	100	+30%	100/15 Summer			
S1.005	SCP1	240 Winter	100	+30%	100/15 Summer			
S1.006	SCS1	240 Winter	100	+30%	100/15 Summer			
S1.007	SHB1	240 Winter	100	+30%	100/15 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap. (l/s)	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S2	7.436	1.300	4.677	1.44		54.1	FLOOD	4
S1.001	S4	7.393	1.433	0.000	1.89		69.9	SURCHARGED	

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 1 20.05.13.SWS									
PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.002	S6	6.947	1.147	0.000	1.04		66.7	SURCHARGED	
S2.000	S8	6.867	0.999	2.211	0.12		4.7	FLOOD	3
S1.003	S10	6.875	1.185	0.000	0.53		34.0	SURCHARGED	
S3.000	S12	6.948	0.446	0.000	0.73		22.3	SURCHARGED	
S1.004	S14	6.872	1.272	0.000	0.68		41.6	SURCHARGED	
S1.005	SCP1	6.869	1.309	0.000	0.81		41.1	SURCHARGED	
S1.006	SCS1	6.864	1.364	0.000	0.18		6.8	SURCHARGED	
S1.007	SHB1	6.862	1.532	0.000	0.32		4.7	SURCHARGED	
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 2 20.05.14.SWS

Pipe Sizes NETWORK 2 20.05.13 Manhole Sizes NETWORK 2 20.05.13

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 2 20.05.14.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.109	4-8	0.051

Total Area Contributing (ha) = 0.160

Total Pipe Volume (m³) = 2.705

Network Design Table for NETWORK 2 20.05.14.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	14.508	0.090	161.2	0.090	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.24	5.670	0.090	0.0	0.0	0.0	1.03	40.8	12.2

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<u>Network Design Table for NETWORK 2 20.05.14.SWS</u> <table><tr><th>PN</th><th>Length (m)</th><th>Fall (m)</th><th>Slope (1:X)</th><th>I.Area (ha)</th><th>T.E. (mins)</th><th>Base Flow (l/s)</th><th>k (mm)</th><th>HYD SECT</th><th>DIA (mm)</th><th>Section Type</th><th>Auto Design</th></tr><tr><td>S1.001</td><td>3.402</td><td>0.460</td><td>7.4</td><td>0.000</td><td>0.00</td><td>0.0</td><td>0.600</td><td>o</td><td>225</td><td>Pipe/Conduit</td><td></td></tr><tr><td>S1.002</td><td>5.637</td><td>0.040</td><td>140.9</td><td>0.000</td><td>0.00</td><td>0.0</td><td>0.600</td><td>o</td><td>225</td><td>Pipe/Conduit</td><td></td></tr><tr><td>S1.003</td><td>9.937</td><td>0.080</td><td>124.2</td><td>0.035</td><td>0.00</td><td>0.0</td><td>0.600</td><td>o</td><td>225</td><td>Pipe/Conduit</td><td></td></tr><tr><td>S1.004</td><td>17.137</td><td>0.075</td><td>228.5</td><td>0.000</td><td>0.00</td><td>0.0</td><td>0.600</td><td>o</td><td>300</td><td>Pipe/Conduit</td><td></td></tr><tr><td>S1.005</td><td>9.206</td><td>0.065</td><td>141.6</td><td>0.035</td><td>0.00</td><td>0.0</td><td>0.600</td><td>o</td><td>150</td><td>Pipe/Conduit</td><td></td></tr></table> <u>Network Results Table</u> <table><tr><th>PN</th><th>Rain (mm/hr)</th><th>T.C. (mins)</th><th>US/IL (m)</th><th>Σ I.Area (ha)</th><th>Σ Base Flow (l/s)</th><th>Foul (l/s)</th><th>Add Flow (l/s)</th><th>Vel (m/s)</th><th>Cap (l/s)</th><th>Flow (l/s)</th></tr><tr><td>S1.001</td><td>50.00</td><td>6.25</td><td>5.580</td><td>0.090</td><td>0.0</td><td>0.0</td><td>0.0</td><td>4.84</td><td>192.5</td><td>12.2</td></tr><tr><td>S1.002</td><td>50.00</td><td>6.33</td><td>5.120</td><td>0.090</td><td>0.0</td><td>0.0</td><td>0.0</td><td>1.10</td><td>43.7</td><td>12.2</td></tr><tr><td>S1.003</td><td>50.00</td><td>6.47</td><td>5.080</td><td>0.125</td><td>0.0</td><td>0.0</td><td>0.0</td><td>1.17</td><td>46.6</td><td>16.9</td></tr><tr><td>S1.004</td><td>50.00</td><td>6.75</td><td>4.925</td><td>0.125</td><td>0.0</td><td>0.0</td><td>0.0</td><td>1.04</td><td>73.2</td><td>16.9</td></tr><tr><td>S1.005</td><td>50.00</td><td>6.93</td><td>4.850</td><td>0.160</td><td>0.0</td><td>0.0</td><td>0.0</td><td>0.84</td><td>14.9</td><td>21.7</td></tr></table>												PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design	S1.001	3.402	0.460	7.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit		S1.002	5.637	0.040	140.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit		S1.003	9.937	0.080	124.2	0.035	0.00	0.0	0.600	o	225	Pipe/Conduit		S1.004	17.137	0.075	228.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit		S1.005	9.206	0.065	141.6	0.035	0.00	0.0	0.600	o	150	Pipe/Conduit		PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	S1.001	50.00	6.25	5.580	0.090	0.0	0.0	0.0	4.84	192.5	12.2	S1.002	50.00	6.33	5.120	0.090	0.0	0.0	0.0	1.10	43.7	12.2	S1.003	50.00	6.47	5.080	0.125	0.0	0.0	0.0	1.17	46.6	16.9	S1.004	50.00	6.75	4.925	0.125	0.0	0.0	0.0	1.04	73.2	16.9	S1.005	50.00	6.93	4.850	0.160	0.0	0.0	0.0	0.84	14.9	21.7
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Area Summary for NETWORK 2 20.05.14.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.090	0.090	0.090
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.035	0.035	0.035
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.035	0.035	0.035
				Total	Total	Total
				0.160	0.160	0.160

Free Flowing Outfall Details for NETWORK 2 20.05.14.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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S1.005	SSWB6_01	6.900	4.785	0.000	1200	0
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Simulation Criteria for NETWORK 2 20.05.14.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB 503220 103890		Cv (Winter)	0.840
Data Type	Point Storm	Duration (mins)	30

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Online Controls for NETWORK 2 20.05.14.SWS

Hydro-Brake® Optimum Manhole: SHB2, DS/PN: S1.005, Volume (m³): 4.9

Unit Reference	MD-SHE-0101-5000-1290-5000
Design Head (m)	1.290
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	4.850
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.290	5.0
Flush-Flo™	0.387	5.0
Kick-Flo®	0.802	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	4.8	3.000	7.4	7.000	11.1
0.200	4.6	1.400	5.2	3.500	8.0	7.500	11.4
0.300	4.9	1.600	5.5	4.000	8.5	8.000	11.8
0.400	5.0	1.800	5.8	4.500	9.0	8.500	12.1
0.500	4.9	2.000	6.1	5.000	9.4	9.000	12.5
0.600	4.8	2.200	6.4	5.500	9.9	9.500	12.8
0.800	4.0	2.400	6.7	6.000	10.3		
1.000	4.4	2.600	6.9	6.500	10.7		

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Storage Structures for NETWORK 2 20.05.14.SWS

Cellular Storage Manhole: SCS2, DS/PN: S1.002

Invert Level (m) 5.120 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	77.0	77.0	0.801	0.0	105.1
0.800	77.0	105.1			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 2
20.05.14.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coefficient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013 Cv (Summer)		0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	2
Climate Change (%)	0

	US/MH	Return	Climate	First (X)	First (Y)	First (Z)	Overflow	Water
PN	Name	Storm	Period	Change	Surcharge	Flood	Overflow	Level
							Act.	(m)
S1.000	S18	15 Winter	2	+0%				5.769
S1.001	SCP2	15 Winter	2	+0%				5.638
S1.002	SCS2	60 Winter	2	+0%				5.222
S1.003	S20	30 Winter	2	+0%				5.220
S1.004	S22	30 Winter	2	+0%				5.218
S1.005	SHB2	30 Winter	2	+0%	2/15 Summer			5.215

	US/MH	Surcharged	Flooded	Flow /	Pipe	Level
PN	Name	Depth	Volume	Flow /	Flow	Exceeded
		(m)	(m ³)	Cap.	(l/s)	
S1.000	S18	-0.126	0.000	0.40	14.5	OK
S1.001	SCP2	-0.167	0.000	0.15	14.5	OK
S1.002	SCS2	-0.123	0.000	0.14	4.2	OK
S1.003	S20	-0.085	0.000	0.19	7.4	OK
S1.004	S22	-0.007	0.000	0.08	5.0	OK
S1.005	SHB2	0.215	0.000	0.38	5.0	SURCHARGED

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 2 20.05.14.SWS

Pipe Sizes NETWORK 2 20.05.13 Manhole Sizes NETWORK 2 20.05.13

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 2 20.05.14.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.109	4-8	0.051

Total Area Contributing (ha) = 0.160

Total Pipe Volume (m³) = 2.705

Network Design Table for NETWORK 2 20.05.14.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	14.508	0.090	161.2	0.090	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.24	5.670	0.090	0.0	0.0	0.0	1.03	40.8	12.2

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Area Summary for NETWORK 2 20.05.14.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.090	0.090	0.090
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.035	0.035	0.035
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.035	0.035	0.035
				Total	Total	Total
				0.160	0.160	0.160

Free Flowing Outfall Details for NETWORK 2 20.05.14.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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S1.005	SSWB6_01	6.900	4.785	0.000	1200	0
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Simulation Criteria for NETWORK 2 20.05.14.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB 503220 103890		Cv (Winter)	0.840
Data Type	Point Storm	Duration (mins)	30

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Online Controls for NETWORK 2 20.05.14.SWS

Hydro-Brake® Optimum Manhole: SHB2, DS/PN: S1.005, Volume (m³): 4.9

Unit Reference	MD-SHE-0101-5000-1290-5000
Design Head (m)	1.290
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	4.850
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.290	5.0
Flush-Flo™	0.387	5.0
Kick-Flo®	0.802	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	4.8	3.000	7.4	7.000	11.1
0.200	4.6	1.400	5.2	3.500	8.0	7.500	11.4
0.300	4.9	1.600	5.5	4.000	8.5	8.000	11.8
0.400	5.0	1.800	5.8	4.500	9.0	8.500	12.1
0.500	4.9	2.000	6.1	5.000	9.4	9.000	12.5
0.600	4.8	2.200	6.4	5.500	9.9	9.500	12.8
0.800	4.0	2.400	6.7	6.000	10.3		
1.000	4.4	2.600	6.9	6.500	10.7		

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Storage Structures for NETWORK 2 20.05.14.SWS

Cellular Storage Manhole: SCS2, DS/PN: S1.002

Invert Level (m) 5.120 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	77.0	77.0	0.801	0.0	105.1
0.800	77.0	105.1			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 2
20.05.14.SWS

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	30
Climate Change (%)	0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S18	15 Winter	30	+0%					5.834
S1.001	SCP2	15 Winter	30	+0%					5.669
S1.002	SCS2	60 Winter	30	+0%	30/15 Summer				5.500
S1.003	S20	60 Winter	30	+0%	30/15 Summer				5.497
S1.004	S22	60 Winter	30	+0%	30/15 Summer				5.493
S1.005	SHB2	60 Winter	30	+0%	30/15 Summer				5.489

PN	US/MH Name	Depth (m)	Surcharged Volume (m³)	Flooded Volume (m³)	Flow / Cap. (l/s)	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S18	-0.061	0.000	0.000	0.88		31.4	OK	
S1.001	SCP2	-0.136	0.000	0.000	0.33		31.5	OK	
S1.002	SCS2	0.155	0.000	0.000	0.17		4.9	SURCHARGED	
S1.003	S20	0.192	0.000	0.000	0.19		7.2	SURCHARGED	
S1.004	S22	0.268	0.000	0.000	0.08		5.0	SURCHARGED	
S1.005	SHB2	0.489	0.000	0.000	0.38		5.0	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for NETWORK 2 20.05.14.SWS

Pipe Sizes NETWORK 2 20.05.13 Manhole Sizes NETWORK 2 20.05.13

FEH Rainfall Model	
Return Period (years)	2
FEH Rainfall Version	2013
Site Location	GB 503220 103890
Data Type	Point
Maximum Rainfall (mm/hr)	50
Maximum Time of Concentration (mins)	30
Foul Sewage (l/s/ha)	0.000
Volumetric Runoff Coeff.	0.750
PIMP (%)	100
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	0.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for NETWORK 2 20.05.14.SWS

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.109	4-8	0.051

Total Area Contributing (ha) = 0.160

Total Pipe Volume (m³) = 2.705

Network Design Table for NETWORK 2 20.05.14.SWS

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	14.508	0.090	161.2	0.090	6.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	6.24	5.670	0.090	0.0	0.0	0.0	1.03	40.8	12.2

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Area Summary for NETWORK 2 20.05.14.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.090	0.090	0.090
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.035	0.035	0.035
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.035	0.035	0.035
				Total	Total	Total
				0.160	0.160	0.160

Free Flowing Outfall Details for NETWORK 2 20.05.14.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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S1.005	SSWB6_01	6.900	4.785	0.000	1200	0
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Simulation Criteria for NETWORK 2 20.05.14.SWS

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FEH	Summer Storms	Yes
Return Period (years)	2	Winter Storms	Yes
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location GB 503220 103890		Cv (Winter)	0.840
Data Type	Point Storm	Duration (mins)	30

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Online Controls for NETWORK 2 20.05.14.SWS

Hydro-Brake® Optimum Manhole: SHB2, DS/PN: S1.005, Volume (m³): 4.9

Unit Reference	MD-SHE-0101-5000-1290-5000
Design Head (m)	1.290
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	101
Invert Level (m)	4.850
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.290	5.0
Flush-Flo™	0.387	5.0
Kick-Flo®	0.802	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	4.8	3.000	7.4	7.000	11.1
0.200	4.6	1.400	5.2	3.500	8.0	7.500	11.4
0.300	4.9	1.600	5.5	4.000	8.5	8.000	11.8
0.400	5.0	1.800	5.8	4.500	9.0	8.500	12.1
0.500	4.9	2.000	6.1	5.000	9.4	9.000	12.5
0.600	4.8	2.200	6.4	5.500	9.9	9.500	12.8
0.800	4.0	2.400	6.7	6.000	10.3		
1.000	4.4	2.600	6.9	6.500	10.7		

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Storage Structures for NETWORK 2 20.05.14.SWS

Cellular Storage Manhole: SCS2, DS/PN: S1.002

Invert Level (m) 5.120 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m ²)	Inf. Area (m ²)	Depth (m)	Area (m ²)	Inf. Area (m ²)
0.000	77.0	77.0	0.801	0.0	105.1
0.800	77.0	105.1			

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Summary of Critical Results by Maximum Level (Rank 1) for NETWORK 2
20.05.14.SWS

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model	FEH	Data Type	Point
FEH Rainfall Version	2013	Cv (Summer)	0.750
Site Location	GB 503220 103890	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S18	15 Winter	100	+30%	100/15 Summer				5.986
S1.001	SCP2	60 Winter	100	+30%	100/60 Winter				5.876
S1.002	SCS2	60 Winter	100	+30%	100/15 Summer				5.874
S1.003	S20	60 Winter	100	+30%	100/15 Summer				5.872
S1.004	S22	60 Winter	100	+30%	100/15 Summer				5.867
S1.005	SHB2	60 Winter	100	+30%	100/15 Summer				5.864

PN	US/MH Name	Depth (m)	Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S18	0.091	0.000	1.45		51.9	SURCHARGED	
S1.001	SCP2	0.071	0.000	0.31		30.0	SURCHARGED	
S1.002	SCS2	0.529	0.000	0.14		4.2	SURCHARGED	
S1.003	S20	0.567	0.000	0.18		6.8	SURCHARGED	
S1.004	S22	0.642	0.000	0.08		4.8	SURCHARGED	
S1.005	SHB2	0.864	0.000	0.38		5.0	SURCHARGED	

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