MA10954-FRA-R03

The Paddocks, Holbeach

Ashwood Homes

Flood Risk Assessment

March 2019

millward

- Civil & Structural Engineering
- Environmental & Geotechnical
- Flood Risk & Drainage
- Highways & Infrastructure
- Structural Inspections
- Transportation

INTEGRATED ENGINEERING CONSULTANTS

REVISION

Reference	Revision	Author	Date
MA10954-FRA-R01	Issue for Planning	CMN	February 2019
MA10954-FRA-R02	Drainage Strategy and Calculations updated	CMN	6th March 2019
MA10954-FRA-R03	Site Layout updated along with no. of dwellings	CMN	7th March 2019

CONTENTS

1. INTRODUCTION 4
2 THE SITE 5
3 CONSULTATIONS 6
4 SEQUENTIAL AND EXCEPTION TESTS 7
5 PROPOSED DEVELOPMENT 9
6 PROPOSED DRAINAGE STRATEGY 10
7 FLOOD RISK 13
8 MITIGATION MEASURES 18
9 CONCLUSIONS 20

APPENDICIES

Appendix A – Drawings

Site Location Plan: MA10954/001

Proposed Site Layout: 1247 planning layout Rev A 7.3.19

Proposed Drainage Strategy: MA10954/200A

Topographical Survey: AS2344/1

Appendix B – Consultations

Environment Agency Hazard Mapping

Appendix C – WinDES Calculation Results

Source Control Surface Water Drainage – Provisional Attenuation Volumes required

Appendix D – Ground Investigation

Site Investigation Report: Geodyne, Combined Desk Study and Phase II Exploratory Investigation

1. INTRODUCTION

1.1 Millward have been appointed to undertake a Flood Risk Assessment (FRA) and Drainage Strategy (DS) for a proposed residential development for 84 dwellings on land to the north of Fen Road, Holbeach, PE12 8QG.

1.2 This FRA is undertaken in accordance with the National Planning Policy Framework and associated Technical Guidance 'Flood Risk and Coastal Change March 2014' (NPPF).

1.3 This FRA discusses and provides both a qualitative assessment and quantitative assessment for the residential development in terms of flood risk, future flood risk over the anticipated lifetime of the development and reference to the sequential and exception test using a precautionary and risk based approach.

1.4 As part of the adjacent site development a FRA was submitted as part of planning (ref BSP Consulting 13401:FRA). This FRA will be used in conjunction with the adjacent site FRA in order to provide comparable mitigation measures.

2 THE SITE

2.1 This proposed residential development is located to the north side of Fen Road on Greenfield Land, totalling 2.586 Hectares (25,860m^2) in area. The site is located at grid reference 535861E 323968N South-west of Holbeach, approximately 900m to the South West of Holbeach town centre and approximately 11.3 kilometres to the east of the centre of Spalding. The site location is shown on drawing MA10943/100 contained within Appendix A.

2.2 Vehicular access to the development will be via an access road off Fen Road to the southern boundary of the site and as per the architects drawing 1247-003 Rev C contained within Appendix A.

2.3 This site area is an additional phase to a wider site which has planning permission for development. This wider development is to the north-west and west of the site boundaries and provides vehicular access for the proposed development of this phase.

2.4 Site levels within the development area are relatively flat varying from 2.81mAOD-3.44mAOD to the northern boundary, 2.56mAOD-3.05mAOD in the east, 2.72mAOD-3.17mAOD in the south and 2.9mAOD-3.08mAOD in the west.

2.5 There is an existing IDB maintained ditch to the north-west boundary of the site with top of bank levels ranging from 3.44mAOD to 2.82mAOD. It is envisaged that this drain will be diverted to run parallel to the proposed developments north-western boundary as part of the adjacent development plans. See appendix A for proposed layout.

2.6 The site is currently classed as Greenfield. In terms of this site the IDB apply a discharge rate limit of 1.4l/s/ha to their watercourses. This will be discussed further in section 6.

3 CONSULTATIONS

3.1 Environment Agency (EA)

3.1.1 The EA national flood risk maps available on their web site have been interrogated firstly to define in terms of planning what flood zone the site is contained within.

3.1.2 The development site is located within Flood Zone 3 which in accordance with Table 1 of the NPPF Technical Guidance document, is defined as High Probability having a 1 in 100 or greater annual probability of flooding from rivers (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.

3.1.3 The site and surrounding area benefit from significant tidal and fluvial flood defences.

3.1.4 Therefore information has been obtained from the EA relating to this site in the form of Flood Mapping which is contained within Appendix B.

3.1.5 The assessment of this data is undertaken in Section 7.1.

3.2 Anglian Water (AW)

3.2.1 Liaison with AW will be required through their Planning Engineers who will identify reinforcement requirements either on site or on the existing network relating to the foul sewer connection for this site.

3.2.2 Any foul connections to any existing adoptable sewers are subject to a S106 sewer connection agreement which would be undertaken as part of the detailed design of the drainage for the development.

4 SEQUENTIAL AND EXCEPTION TESTS

4.1 Sequential Test

4.1.1 The site has been assessed in line with the NPPF technical guidance. The site is confirmed to be wholly within Flood Zone 3 (High probability) as defined in Table 1 (Flood zones) of the technical guidance document for the NPPF.

4.1.2 Table 2, (Flood risk vulnerability classification) of the same document confirms that residential development (buildings used for dwelling houses) is classified as 'More Vulnerable' development.

4.1.3 Table 3, (Flood risk vulnerability and flood zone 'compatibility') confirms that development classified as 'More vulnerable' development in Flood Zone 3a requires the exception test' to be carried out.

4.1.4 In terms of Sequential Test the site sits wholly within flood zone 3 which is the case for the vast majority of this borough.

4.1.5 The SFRA states that the EA flood zones will continue to be used by the Borough Council as the basis on which the Sequential Test is applied. The majority of the Borough Councils area is within Flood Zone 3 and the site has land in the 'Danger for Some' category but with a low probability of flooding.

4.1.6 Therefore the EA have been consulted to provide the Hazard Mapping for the site.

4.1.7 Hazard mapping provided in BSP Consulting FRA shows the probability of tidal flooding breach scenario in the 1:200 and 1:1000 (2115) event probability. This report should be read in conjunction with this FRA in order to access the hazards of flooding due to breach or overtopping of the tidal defences.

4.1.8 The mapping for the hazard to people is categorised as Danger to Some. The depths expected in this scenario is up to 0.25m and the velocity of the breached water is up to 0.3m/s. However, this mapping only shows flooding to the north-east of the site and the Southern-western boundaries.

4.1.9 Mitigation measures should therefore be included in the detailed design where the previous FRA recommendations for the adjacent site (BSP Consulting FRA) should be considered also.

4.2 Exception Test

4.2.1 The development site would see a greenfield site be developed for residential use which will provide a contribution to the housing targets for the Borough, in a sustainable location (close to the town centre and current amenities of Holbeach) and as such has a wider benefit to the community as a whole.

4.2.2 The adjacent site to the south/north-west boundaries of the site has received planning permission and this site should be considered as part of the wider development.

4.2.3 This FRA confirms through the assessment of flood risk from all sources that the development by design can be made safe in terms of flood risk and would not increase the risk of flooding elsewhere.

4.2.4 The Exception Test is therefore passed.

5 PROPOSED DEVELOPMENT

5.1 The proposed development proposals consist of 84 no dwellings in total with associated driveways and garages (off road) and garden areas to the rear of the proposed dwellings. The site is to be accessed off Fen Road via the adjacent developments access road and a private shared driveway off Fen Road in line with the current master plan for the site contained within Appendix A.

5.2 The impermeable areas of the proposed site are 1.204ha. This is an increase in impermeable area on the site, as the previous site is greenfield, which therefore will require mitigation measures in terms of surface water drainage to reduce the surface water run off to acceptable levels as stipulated by the IDB.

5.3 The site is essentially split into small housing zones which are served off internal collector roads which will be drained by roadside filter drains which convey water through to the attenuation tank.

5.4 Foul drainage is proposed to drain via gravity into the adopted FWS to the south of the site. This sewer is currently proposed as part of the proposed adjacent development identified as 3MHF01 on drawing MA10954_200 in appendix A.

6 PROPOSED DRAINAGE STRATEGY

6.1 The site topography is relatively flat. However, site constraints dictate the FFL's and levels across the site. One of these constraints is the invert level of the existing FWS in Fen Road to which we would propose the site to connect to. This IL is fairly shallow compared to existing site levels.

6.2 The preliminary drainage strategy shown on drawing MA10954/200 is based upon the current master plan for the site and assumes that private driveways and shared drives will utilise a form of permeable tarmac as part of the strategy.

6.3 Roadside filter drains will take the surface water run-off from the proposed carriageways before outfall into the attenuation tank to the north-west of the site before ultimate outfall into the IDB maintained ditches at restricted discharge rates.

6.4 The attenuation storage structure is proposed to be underground storage under the proposed public open space areas. This form of attenuation has been proposed in this instance to ensure the public open space areas remain usable even in time of rainfall events. This ensures the benefits and amenity provided by these areas is maximised. The roadside filter drains for the highways and permeable tarmac for private driveway areas provide suitable treatment trains for surface water run off before outfall into the IDB watercourse to the west of the site.

6.5 The discharge rate for surface water is not to exceed the 3.6l/s (equivalent to 1.4l/s/ha) limit for the 1 in 100 year event including 40% climate change allowance for this area of the site.

6.6 The surface water drainage system to be designed for the site will ensure that there is no flooding from the site in the 1 in 100 year event including a 40% allowance for climate change whilst maintaining the above rates for the corresponding storm events.

6.7 A provisional Micro drainage network model has been produced to determine the pipe sizes and also the locations and provisional volumes of attenuation required to accommodate the development surface water run-off of 3.6l/s for this site. Within this model a 6% increase in flow is applied to allow for urban creep (in line with LCC specification).

6.8 The volumes at this stage do not take into account the volumes in the undertrained filter drain medium or permeable driveway areas. This would be determined as part of the detailed design process for the drainage of the site.

6.9 The drainage of the site is designed to drain into the IDB maintained watercourse to the western boundary of the site.

6.10 As the site is to be raised above adjacent ground levels (in accordance with the identified mitigation measures in Section 8, consideration of inclusion of perimeter land drains (especially at the boundaries of the existing dwellings which back onto the site which would intercept any water from the gardens of the proposed dwellings and prevent it entering the proposed development to the south-west of the site.

6.11 The surface water drainage strategy provides the required minimum 1 treatment train for roof areas and two treatment trains for the roads / driveways. (All areas flow through 2 treatment trains in line with CIRIA C697).

6.12 The surface water drainage system will be adopted by Anglian Water and Lincolnshire County Council will adopt the filter drain (to be confirmed as part of the detailed design process). The proposed system will be able to be adopted by both authorities but a final decision will be made at the detailed design stage.

6.13 The existing IDB maintained drain will have a 9m easement to the eastern bank which is to be applied for maintenance purposes as shown on drawing MA10943/200 contained within Appendix A.

6.14 The consent of the IDB would be required for any works within 9m of the Old River Drain and any new surface water outfall into the boards system. This would be undertaken as part of the detailed design process for the development proposals.

6.15 BGS data has been collected from their website which shows the sites underlying strata to be Mudstone and siltstone. A site investigation has also been carried out which concludes: *'The results from the programme of in-situ infiltration rate testing have indicated that traditional soakaways and permeable paving are unlikely to be viable for the site'* Therefore, infiltration drainage is not deemed viable for this site.

6.16 In terms of foul drainage it is proposed to have a gravity foul system within the site which is to discharge into the proposed adjacent developments adoptable FWS in the form of a S106 application. This proposed FWS is currently undergoing S104 approval with AW which is to connect into the existing foul manhole 3MHF03 in Fen Road. See appendix A for drawing.

6.17 It is known that the existing foul water sewer in Fen Road may not have capacity. Using AW criteria for the site to calculate peak inflow to the sewer. A peak inflow rate of 0.757l/s (based on 84 units) should be considered. Therefore as part of the development AW will adopt zonal charging to the developer and assess the need for upgrading the existing AW system.

7 FLOOD RISK

7.1 Flooding From Fluvial and Tidal Sources

7.1.1 The residential development area is shown within Flood Zone 3a as having a 1 in 100 or greater annual probability of flooding from rivers (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year. (National Planning Policy Framework Technical Guidance, March 2012).

7.1.2 The South East Lincolnshire Strategic Flood Risk Assessment (March 2017) provides district wide assessment of the flood risk including flood defence breach scenarios which have been assessed. The study area in the SEL SFRA shows the whole site to be within a flood hazard of **Low** and a flood depth of up to 0.25m. This is based on scenario of 1:100 Fluvial and 1:200 Tidal flood probability in the 2115 year (climate change event).

7.1.3 However using the flood mapping from BSP FRA it can be seen that the mapping provides a site specific mapping as well as assessing the 1:200 and 1:1000 tidal breach scenario but does not show flooding from overtopping. The 1:200 probability mapping however both show the same conclusion that there is a **low hazard** and a water depth up to 0.25m.

7.1.4 The site has a watercourse running along the western boundary of the site IDB maintained (Old River Drain). This site is in the catchment of the IDB. This watercourse plays a significant part of the local drainage.

7.1.5 Old River Drain to the west of the site flows from the south of Holbeach and into the wider drain network part of the arterial drainage system in the Holbeach Marsh catchment.

7.1.6 Holbeach is defended by significant tidal flood defences and whilst the Flood Zone is 3a this does not take into account the presence of flood defences.

7.1.7 The use of the Relative Probability of Flooding maps in the SEL SFRA shows that the site is at a low probability of flooding due to these flood defences.

7.1.8 As the risk of flooding is high (Flood Zone 3a) and the probability of flooding (due to the flood defences) low the residual risk of flooding from this source is **MODERATE**.

7.1.9 Upon further interrogation of the maximum depth hazard mapping there is a variation anticipated depth 0-0.25m. Looking at the level differences on the topographical survey the levels on the site are generally flat. However this does not correlate to the high points on site as these are at the western boundary adjacent to the Old River Drain.

7.1.10 Therefore in assessing realistic anticipated depths, whilst part of the site is within the 0-0.25 range (northern-east) with a 0m depth range in the central, north-west, south and western part of the site.

7.1.11 Therefore mitigation measures are required to counteract this which involves raised floor levels in line with the Environment Agencies comments relating to mitigation measures in the South East Lincolnshire SFRA (March 2017). The mitigation measures proposed are discussed further in Section 8. BSP FRA mitigation measures should also be considered as part of this assessment.

7.2 Flooding From Land / Adjacent Development

7.2.1 The main risk of flooding to this site is from the north-east boundaries which are slightly lower in terms of topography. Due to the flat nature of the surrounding land and flooding from overland flow is likely to be slow and shallow site. The Environment Agency long term flood risk mapping confirms some areas of localised low risk surface water flooding in north-east and southern boundaries of the site.

7.2.2 Any overland flow from adjacent development site is likely to be shallow and there are no low points within the site which would create a localised depression in the ground which would be at risk of ponding / pooling water from this source.

7.2.3 Overall the risk of flooding from this source is considered to be **LOW.**

7.2.4 Therefore there are mitigation measures proposed as part of the development layout and levels to mitigate this risk which are discussed in Section 8.

7.3 Flooding From Infrastructure Failure

7.3.1 The site is not within an area deemed to be at risk of flooding from reservoirs (according to the data on the EA website).

7.3.2 As the site is outside the limits of any deemed flood extents from a reservoir failure, the risk of flooding to the site is considered **LOW**.

7.4 Flooding From Groundwater

7.4.1 There are no confirmed records of groundwater flooding in the vicinity of the site in the SFRA.

7.4.2 Overall the risk of flooding from this source is considered to be **LOW**. As there should not be any dwellings in localised low points within the site it is not considered further assessment is required to assess flooding from this source.

7.4.3 However, mitigation measures are proposed as part of measures to counteract other sources of flooding which will essentially further reduce any likelihood of flooding from this source.

7.5 Flooding From Sewers

7.5.1 It is very well documented that the existing sewer network in Holbeach is essentially close to or exceeding capacity. Therefore there is a residual risk of flooding to deal with.

7.5.2 As the topography of the land is quite flat if any sewers to the north and east were to flood then potential flow routes could be towards the site itself. The proposed FFL's are anticipated to be higher than the cover levels of the sewers in Fen Road, hence reducing the risk of flooding from infrastructure.

7.5.3 Flow velocities and depths are expected to be relatively slow and shallow respectively towards the site and likely to be constrained within the carriageways initially then directed into the IDB maintained drains realistically.

7.5.4 Overall taking into account the proximity of the sewers and topography of the area, the risk of flooding from this source is considered to be **LOW**.

7.5.5 However, mitigation measures are proposed as part of measures to counteract other sources of flooding which will essentially reduce any likelihood of flooding of properties on the site from this source.

7.6 Off-Site Flood Risks

7.6.1 The site proposals along with the proposed drainage strategy outlined in Section 6.1 will intercept drainage run off from the development in filter drains, potential perimeter land drains and attenuation tank which will be designed to accommodate the 1 in 100 year event scenario (including 40% allowance for climate change) without flooding of the attenuation features or filter drains.

7.6.2 The drainage system which will serve the development will be designed to accommodate the required volume of storage on site and outflow restricted by a hydrobrake flow control at the outfall point at the flow rate of 3.6l/s.

7.6.3 Consideration at the detailed design stage will be given to either a land drain / land drains to intercept any surface water flow from the site which may approach the adjacent or existing site boundaries where there are adjacent gardens to the site boundary. This would be reviewed at detailed design stage once final proposed floor levels, layout and finished level contours are produced to confirm any flow routes.

7.6.4 With regard to risk to areas off site, the residual risk is considered to be **LOW** as the onsite drainage system will be designed to accommodate the extreme events without flooding and there will be an overflow system in place to ensure any exceedence water does not flow into other land.

7.7 Flooding from Climate Change

7.6.5 The NPPF Technical Guidance Document confirms in Table 5 that peak rainfall intensity is estimated to increase potentially up to 40% over the lifetime of this development (100 years) and peak river flows by 20%. Tidal aspects extreme wave heights could increase between 5% and 10%. Sea level rises in this area over the lifetime of the development would be anticipated to be circa 1.2m (to year 2115).

7.6.6 Hazard mapping provided by the EA included the climate change event in all scenarios. The conclusion to these scenarios was that there was a low hazard to Danger for Some localised to the northern boundary of the site with depths of up to 0.25m. The mitigation measures in section 8 should ensure that properties are above this 1:1000 2115 year event.

7.6.7 The mitigation measures in Section 8 are designed to counteract this increase in risk.

7.6.8 The proposed site drainage will be designed not to flood at the 1 in 100 year event with an allowance of 40% for climate change in line with the NPPF technical guidance document. A further sensitivity test of the developments drainage will be undertaken at 40% climate change allowance to assess the effects and ensure that any flooding within the site itself is kept within the boundaries of the site. The surface water drainage will be designed to be restricted to the run off rates provided in Section 6.

7.6.9 Overall the risk of flooding from the effects of climate change is considered to be **MODERATE.**

8 MITIGATION MEASURES

8.1 Essential Mitigation Measures

8.1.1 The assessment of flood risk in Section 7 of this assessment confirms a **MODERATE** risk of flooding from Fluvial / Tidal, sewers and climate change. There is a **LOW** risk of flooding from all other sources including infrastructure failure, groundwater and off site risks.

8.1.2 Therefore there are several essential mitigation measures to be applied as part of the development.

8.1.3 Flood depths due to a breach scenario are anticipated to be up to 0.25m based upon the Hazard maps provided by the Environment Agency (EA) and the justification in Section 7.1. Therefore, in line with the EA comments on the South East Lincolnshire SFRA, for depths between 0m and 0.25m, finished floor levels are to be raised 500mm above existing ground levels. Due to the surface water drainage design constraints, the minimum finished floor level on this site is 3.600m AOD. This is 500mm above the highest level within the proposed development (3.2mAOD). The north-eastern boundaries of the site have minimum FFL of 4.2mAOD. This again is above the 500mm increase to existing levels in this area where a hazard of flooding would affect properties.

8.1.4 BSP FRA identified that the modelled flood level for the adjacent site is 3.165mAOD. The lowest FFL proposed for our site is 3.7mAOD therefore a free-board of 535mm is given for the site.

8.1.5 Therefore the finished floor levels of the proposed dwellings are above the requirements of the Environment Agency and therefore do not require any other flood mitigation measures. This is also inline with BSP FRA which recommends a minimum FFL of 3.530mAOD.

8.1.6 Surface water drainage for the site must be designed to accommodate the 1 in 100 year event storm scenarios including a 40% allowance for climate change without any flood waters leaving the development site.

8.2 Recommended Mitigation Measures

8.2.1 Permeable tarmac to private driveways and parking areas should be utilised even if infiltration SUDS are not viable as permeable tarmac can be designed into a sealed system before outfall into the drainage ditch to the east of the site. This would form part of a SUDS treatment train in line with CIRIA C753.

8.2.2 It is recommended that FFL to properties should be above any adjacent roads levels.

8.2.3 Where external gradients are flat or towards the dwelling entrances, provision of linear drainage should be provided to all access points.

8.2.4 All properties should be raised a minimum of 500mm above existing levels.

9 CONCLUSIONS

9.1 This Flood Risk Assessment serves to review, assess and quantify (where applicable) the sources, or any potential flooding, the pathways of this flooding and potential receptors within the vicinity of the site.

9.2 The assessment of flood risk in Section 7 of this assessment confirms a **MODERATE** risk of flooding from Fluvial / Tidal, sewers and climate change. There is a **LOW** risk of flooding from adjacent land, infrastructure failure, groundwater and off site.

9.3 The mitigation measures will provide further protection to the development and reduce any residual risk (however low) as far as practicable. It is recommended that compliance with the recommendations of this FRA are conditioned as part of any planning permission (unless otherwise agreed in writing at the time of discharge of the planning conditions)

9.4 This assessment concludes that the site is suitable for development for residential use without unacceptable risk of flooding from all sources to the site itself and elsewhere for the lifetime of the development.

Appendix A – Drawings

Site Location Plan: MA10954/100

Proposed Site Layout: 1247 planning layout Rev A 7.3.19

Proposed Drainage Strategy: MA10954/200

SCHEDULE:

Unit	Beds	Storey	SqFt	Parking	No
Dee	2	2	711	ps	7
Huntingdon	3	2	769	sg	9
Warwick	2	1	802	sg	6
Aire	3	2	902	sg	4
Avon	3	2	910	sg	8
Nene	3	2	1,077	sg	5
Mere	3	2	1,079	sg	7
Lock	3	2	1,079	sg	3
Ribble	4	2	1,283	sg	7
Tay	4	2	1,770	sig	2
Harren	4	2	1,396	dg	1
				Sub-Tot	**59**
Affordable					
A732	2	2	732	ps	15
A902	3	2	902	ps	10
				Sub-Tot	**25**
				Total	**84**

REVISIONS:

Rev A: Garages to plots 57, 58 / 59 moved to avoid drainage easement. 7.3.19

NKW DESIGN
45 York Road
Wollaston
Northamptonshire
NN29 7SG
T: 01933 666130
M: 07957 837164
E: natalie@nkwdesign.co.uk

PROJECT: FEN ROAD, HOLBEACH

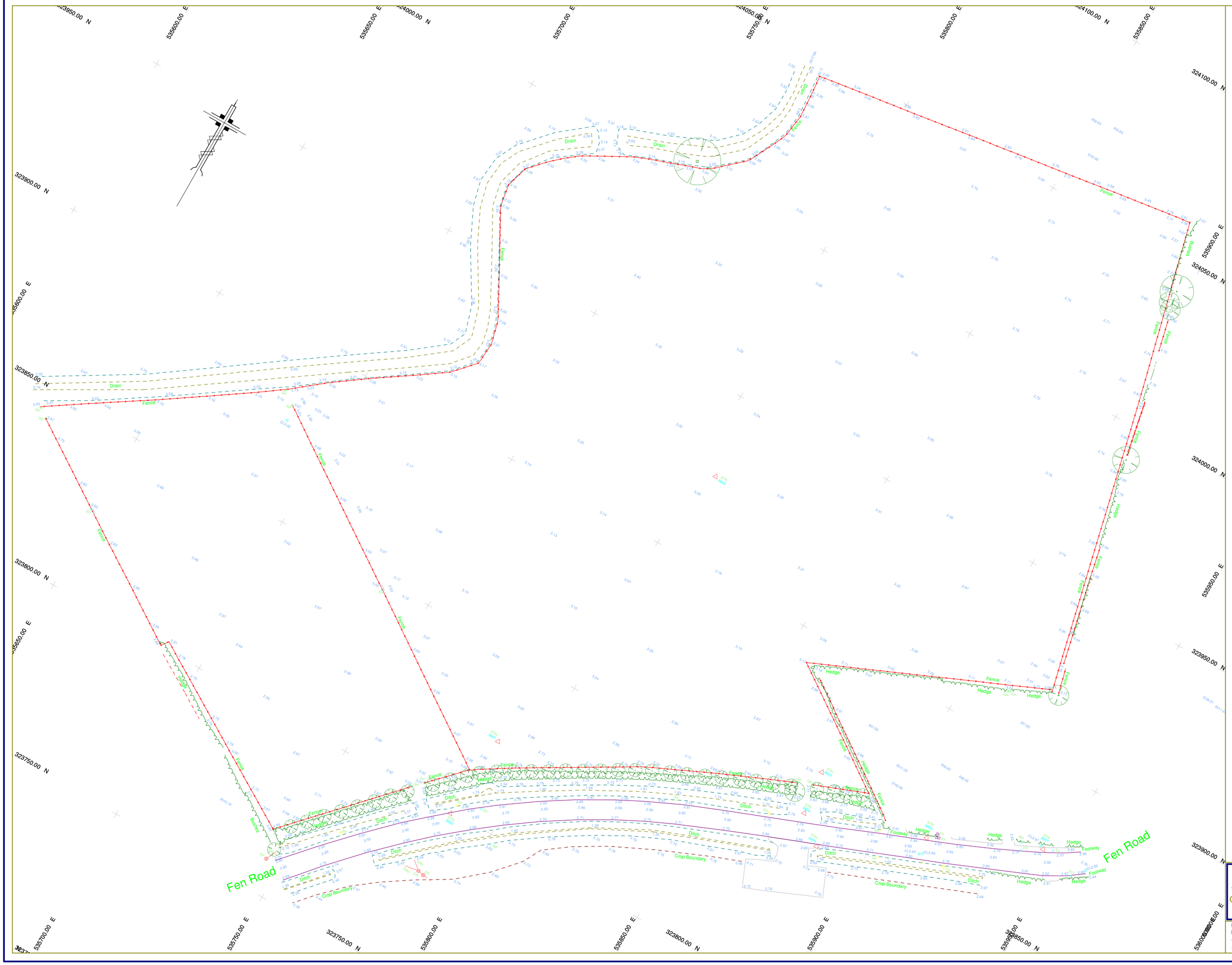
TITLE: PLANNING LAYOUT

CLIENT: ASHWOOD HOMES
1 GOODISON ROAD, LINCS GATEWAY BUSINESS PARK
SPALDING, LINCOLNSHIRE
PE12 6 FY 01406 490590

SCALE	DATE	DRAWN
1:500 @ A1	MARCH 2019	NKW

DRAWING NUMBER: 1247-004

REVISION: A



KEY:

- BUILDING
- FENCE
- HEDGE
- CHANNEL
- WALL
- BANK EDGE
- STORM DRAINAGE
- FOUL DRAINAGE
- CHANGE OF SURFACE
- OVERHEAD ELECTRIC
- OVERHEAD TELEPHONE

TREE BOREHOLE MANHOLE

CONTROL STATION

B	BOLLARD	RE	ROD EYE
BIN	BIN	RI	RIDGE
BT	BRITISH TELECOM	SP	SIGN POST
CR	PIPE CROWN	STAY	STAY
CTV	CABLE TELEVISION	SV	STOP VALVE
EA	EARTH	TBM	BENCH MARK
EL	ELECTRIC BOX	TH	THRESHOLD
EP	ELECTRIC POLE	TL	TRAFFIC LIGHT
EV	EAVES	TP	TELEGRAPH POLE
FH	FIRE HYDRANT	TS	TRAFFIC SIGNAL
G	GULLY	VC	VENT COLUMN
GA	GAS VALVE	VP	VENT PIPE
IC	INSPECTION CHAMBER	WL	WATER LEVEL
IL	INVERT LEVEL	WM	WATER METER
KO	KERB OFFLET	WT	WALL TOP
LH	LAMP HOLE		
LP	LAMP POST		
MP	MARKER POST		
PB	POST BOX		

NOTES:

1. Survey plotted to OS National Grid.
2. All levels related to OS Datum.
3. GPS/GLONASS ETRS89 observations transformed to OSGB36 using OSTN02 Transformation.
4. ETRS89 ellipsoid heights converted to heights above mean sea level using National Geoid Model OSGM02.

Initial Survey Date:	4 JUL 2018

CONTROL STATIONS

Stn:	Eastings:	Northings:	Height:
9900	535805.297	323925.618	3.300
9901	535788.110	323825.023	2.930
9902	535786.337	323799.394	2.834
9903	535876.358	323864.763	2.769
9904	535877.828	323851.583	2.795
9905	535885.900	323844.791	2.615
9906	535913.091	323863.204	2.947
9907	535944.892	323877.414	2.851

Rev:	Amendments:	Date:

Client:
ASHWOOD HOMES

Project Title:
FEN ROAD
HOLBEACH
LINCOLNSHIRE

Drawing Title:
OGL SURVEY

Scale:	Date:
1:500	10 JUL 2018
Drawing No: AS2344/1	Rev: A1
C.A.D. Title: ASHWOODHOLBEACH040718	
Drawn By: D.J.SMITH	

AXIS SURVEYS LTD.
CHARTERED LAND SURVEYORS
10 SYCAMORE DRIVE, LOUTH, LINCOLNSHIRE, LN11 8RT.
TEL (01507) 606397
FAX (01507) 354050
www.axissurveys.co.uk
office@axissurveys.co.uk
©AXIS SURVEYS LTD.

© THIS DRAWING IS THE PROPERTY OF THE MILLWARD PARTNERSHIP AND MUST NOT BE REPRODUCED, WHOLLY OR IN PART, NOR THE INFORMATION THEREIN DISCLOSED TO A THIRD PARTY, WITHOUT THE WRITTEN PERMISSION OF THE OWNERS

Area 275m² Provides 136m³ of storage

Hydrobrake Control Chamber Discharging at 3.6l/s IL 1.685

Ditch culverted for pedestrian access

DITCH DIVERSION + min 2m mown strip each side

Attenuation Tank Provides 624.15m³ storage 136.5x15x1.2m deep) 95% voids CL 3.850 (min) SL 3.250 IL 2.050

Area 355m² Provides 199m³ of storage

Area 478m² Provides 36.9m³ of storage

3MHF01 CL 2.950 IL 2.102

3MHF03 CL 2.898 IL 1.641

REV	DATE	BY	DETAILS	CHK'D
A	06/03/19	CMN	Updated to new site layout	JMcK
A0	AMENDMENTS			

NOTES

TITLE: Drainage Strategy Plan

PROJECT: Paddocks, Holbeach

CLIENT: ASHWOOD HOMES

DATE	CHECKED	APPROVED BY	SCALE	DRAWN	ENGINEER	DRAWING No:	DRAWING STATUS
February 2019	JMcK	JMcK	1:250	CMN	CMN	MA10954_200A	PLANNING

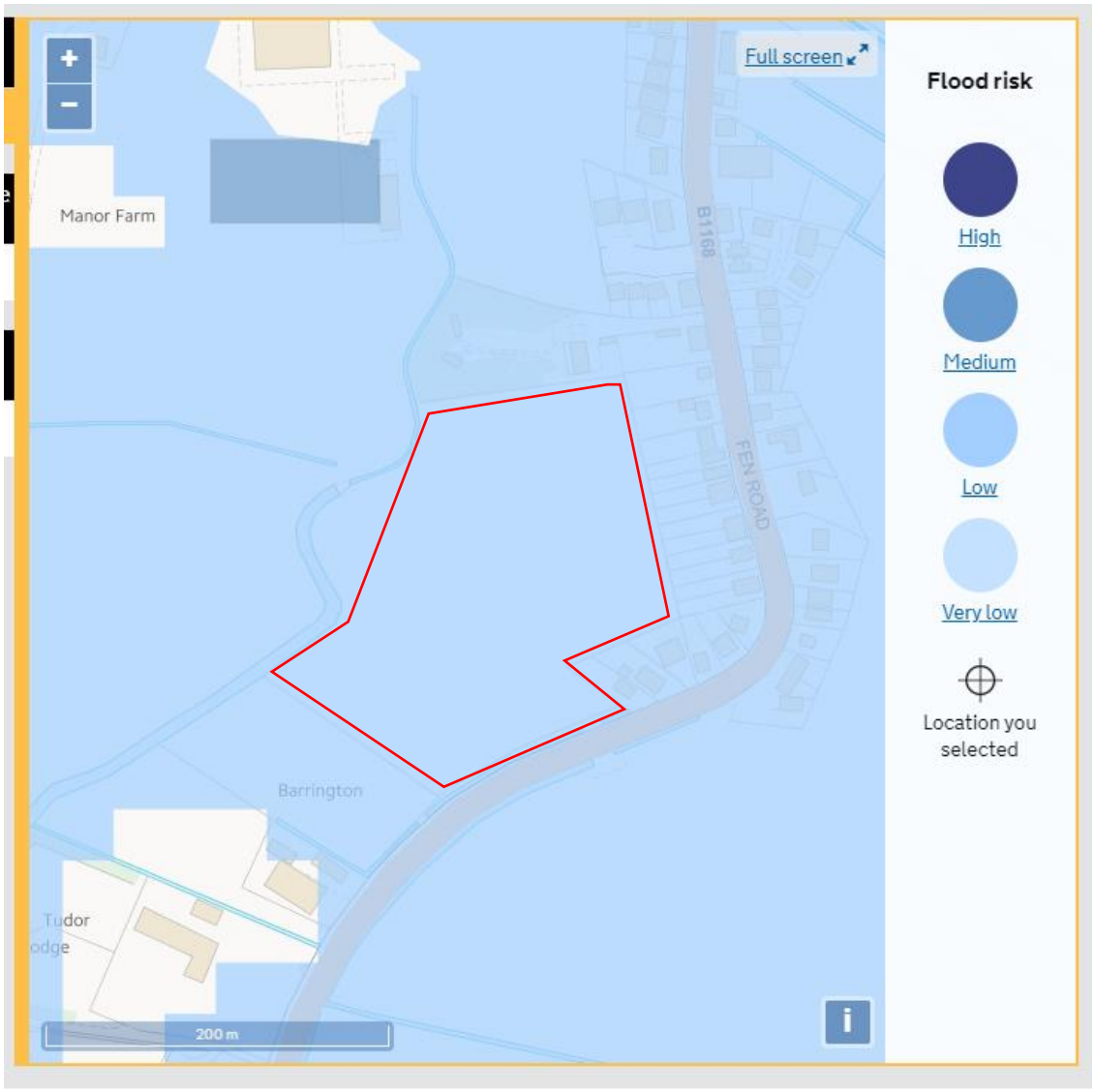
millward
t: 0115 941 4560
no.1 malin hill, nottingham ng1 1jq
e: info@millward.co.uk w: www.millward.co.uk

Appendix B – Consultations

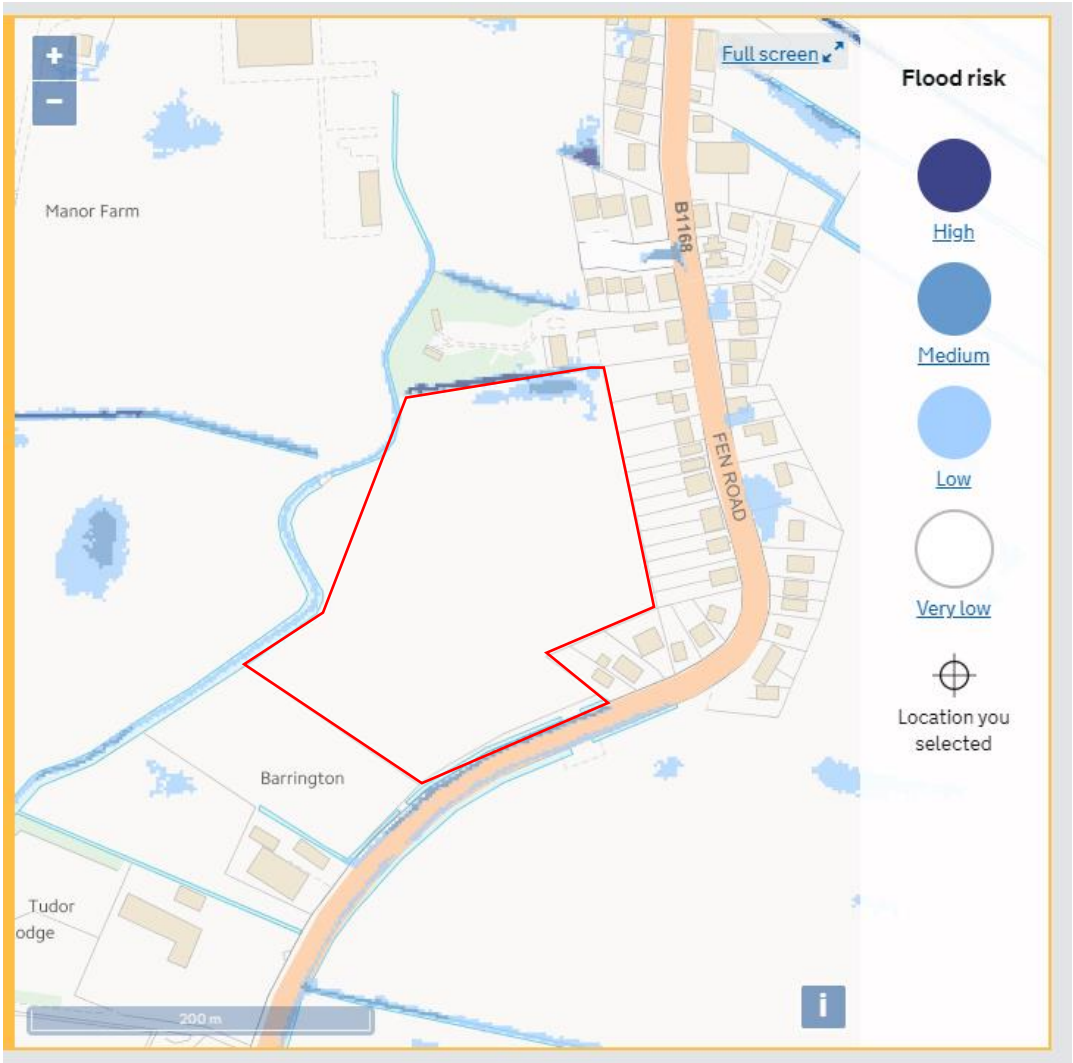
Environment Agency- Flood Mapping

South East Lincolnshire- Hazard Mapping

BSP FRA-Hazard Mapping



Environment Agency- Fluvial Flood Mapping Fen Road, Holbeach



Environment Agency- Surface Water Flood Mapping Fen Road, Holbeach

N

DANGER AREA
The Wash

SOUTH HOLLAND DISTRICT

NOTES

1. The potential flooding consequences shown on this map primarily relate to flooding from the sea and main rivers taking into account the presence of current flood risk management measures such as flood defences.

2. This update only included new flood risk information from River Welland (Fluvial), River Glen (Fluvial) and Tidal hazard mapping (River Welland, River Nene and the Wash sea defences). No new information from the Internal Drainage Boards and associated systems was used for this update.

3. In addition to the potential flood extents shown on this map, there may be shallow flooding in low-lying rural areas

4. The consequences designated as being a Residual Risk arise from direct overtopping of defences, where this would occur, together with breach failure which is assumed could occur at any point along the defences.

5. Functional Floodplain encompasses areas where water is intended to flow or be stored in times of flood.

6. Land outside South Holland District is not considered.

7. This map shows the extents only of the flooding probability bands relevant to the map Title

Map Legend

Max Hazard
(Flood Risk to People : FD2320)

- Less than 0.75 (Low Hazard)
- Between 0.75 and 1.25 (Danger for Some)
- Between 1.25 and 2.0 (Danger for Most)
- Greater than 2.0 (Danger for All)
- Functional Floodplain
- South Holland District Boundary

REV	DATE	REMARKS
2	Feb 17	Modelling and Mapping Update
1	Dec 16	Modelling and Mapping Update

This map is reproduced from the Ordnance Survey map with the permission of the Controller of HM Stationery Office, © Crown Copyright . Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceddings
Licence No: 100018215, 2009

Royal HaskoningDHV
Enhancing Society Together

ROYAL HASKONINGDHV
RIGHTWELL HOUSE
BRETTON
PETERBOROUGH
PE3 8DW
TEL +44 (0)1733 334455
FAX +44 (0)1733 262243

SOUTH HOLLAND DISTRICT COUNCIL
COUNCIL OFFICES
PRIORY ROAD
SPALDING
LINCOLNSHIRE
PE11 2XE

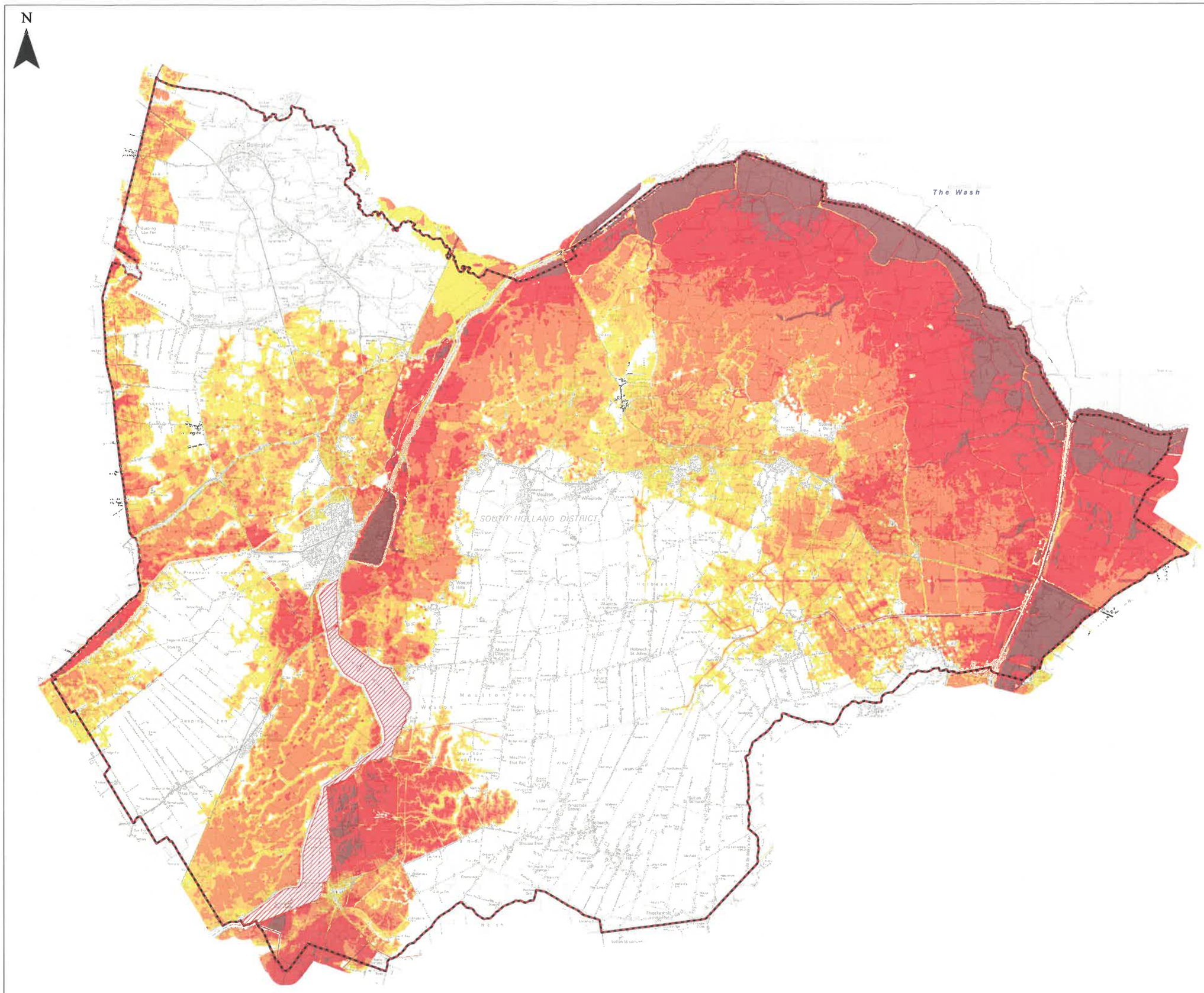
UPDATE OF STRATEGIC FLOOD RISK ASSESSMENT

Residual Flood Hazard District - Year 2115 1% Fluvial / 0.5% Tidal Event Probability

DATE OF ISSUE: Feb 2017 REV NO: 2

SCALE: 1 : 60,000 @ A1

MAP NO:



NOTES

1. The potential flooding consequences shown on this map primarily relate to flooding from the sea and main rivers taking into account the presence of current flood risk management measures such as flood defences.
2. This update only included new flood risk information from River Welland (Fluvial), River Glen (Fluvial) and Tidal hazard mapping (River Welland, River Nene and the Wash sea defences). No new information from the Internal Drainage Boards and associated systems was used for this update.
3. In addition to the potential flood extents shown on this map, there may be shallow flooding in low-lying rural areas
4. The consequences designated as being a Residual Risk arise from direct overtopping of defences, where this would occur, together with breach failure which is assumed could occur at any point along the defences.
5. Functional Floodplain encompasses areas where water is intended to flow or be stored in times of flood.
6. Land outside South Holland District is not considered.
7. This map shows the extents only of the flooding probability bands relevant to the map Title

Map Legend

Peak Depth

- 0m - 0.25m
- 0.25m - 0.5m
- 0.5m - 1m
- 1m - 2m
- 2m +
- Functional Floodplain
- South Holland District Boundary

REV	DATE	REMARKS
2	Feb 17	Modelling and Mapping Update
1	Dec 16	Modelling and Mapping Update

This map is reproduced from the Ordnance Survey map with the permission of the Controller of HM Stationery Office, © Crown Copyright . Unathorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceddings
Licence No: 100018215, 2009

Royal HaskoningDHV
Enhancing Society Together

ROYAL HASKONINGDHV
RIGHTWELL HOUSE
BRETTON
PETERBOROUGH
PE3 8DW
TEL +44 (0)1733 334455
FAX +44 (0)1733 262243

SOUTH HOLLAND DISTRICT COUNCIL
COUNCIL OFFICES
PRIORY ROAD
SPALDING
LINCOLNSHIRE
PE11 2XE

UPDATE OF STRATEGIC FLOOD RISK ASSESSMENT

Residual Peak Depth
District - Year 2115
1% Fluvial / 0.5% Tidal Event Probability

DATE OF ISSUE: Feb 2017 REV NO: 2

SCALE: 1 : 60,000 @ A1

MAP NO:

Appendix C – WinDES Calculation Results

Source Control Surface Water Drainage – Provisional Attenuation Volumes required

FRA/DS Notes

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	6
Ratio R	0.401	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - 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	24.846	0.050	496.9	0.146	5.00	0.0	0.600	o	600	Pipe/Conduit	
S1.001	5.002	0.015	333.5	0.030	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.002	22.023	0.045	489.4	0.104	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.003	9.645	0.020	482.3	0.030	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.004	11.145	0.025	445.8	0.035	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.005	7.583	0.020	379.2	0.027	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.006	22.319	0.045	496.0	0.081	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.007	28.602	0.060	476.7	0.057	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.008	7.144	0.020	357.2	0.058	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.009	17.863	0.040	446.6	0.065	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.010	17.772	0.065	273.4	0.066	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.000	7.600	0.020	380.0	0.121	5.00	0.0	0.600	o	600	Pipe/Conduit	
S2.001	10.769	0.025	430.8	0.009	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.002	17.160	0.035	490.3	0.016	0.00	0.0	0.600	o	600	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	5.38	2.145	0.146	0.0	0.0	1.2	1.09	306.9	21.0
S1.001	50.00	5.44	2.095	0.176	0.0	0.0	1.4	1.33	375.5	25.3
S1.002	50.00	5.78	2.080	0.280	0.0	0.0	2.3	1.09	309.3	40.3
S1.003	50.00	5.93	2.035	0.311	0.0	0.0	2.5	1.10	311.6	44.6
S1.004	50.00	6.09	2.015	0.345	0.0	0.0	2.8	1.15	324.3	49.5
S1.005	50.00	6.19	1.990	0.372	0.0	0.0	3.0	1.24	351.9	53.4
S1.006	50.00	6.53	1.970	0.453	0.0	0.0	3.7	1.09	307.2	65.0
S1.007	50.00	6.96	1.925	0.510	0.0	0.0	4.1	1.11	313.5	73.2
S1.008	50.00	7.05	1.865	0.568	0.0	0.0	4.6	1.28	362.7	81.6
S1.009	50.00	7.31	1.845	0.633	0.0	0.0	5.1	1.15	324.0	90.9
S1.010	50.00	7.52	1.805	0.699	0.0	0.0	5.7	1.47	415.0	100.3
S2.000	50.00	5.10	2.150	0.121	0.0	0.0	1.0	1.24	351.5	17.4
S2.001	50.00	5.26	2.130	0.130	0.0	0.0	1.1	1.17	329.9	18.6
S2.002	50.00	5.52	2.105	0.146	0.0	0.0	1.2	1.09	309.0	20.9

©1982-2017 XP Solutions

Network Design Table for Storm

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
S2.003	8.017	0.020	400.8	0.070	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.004	17.959	0.040	449.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.005	20.887	0.045	464.2	0.186	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.006	26.007	0.055	472.9	0.051	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.007	29.465	0.060	491.1	0.104	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.008	6.853	0.015	456.9	0.046	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.009	19.186	0.040	479.7	0.064	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.010	14.377	0.030	479.2	0.022	0.00	0.0	0.600	o	600	Pipe/Conduit	
S2.011	11.795	0.025	471.8	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.011	12.012	0.025	480.5	0.030	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.012	7.834	0.020	391.7	0.009	0.00	0.0	0.600	o	600	Pipe/Conduit	
S1.013	4.584	0.010	458.4	0.007	0.00	0.0	0.600	o	600	Pipe/Conduit	
S3.000	7.926	0.040	198.2	0.060	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.014	8.852	0.685	12.9	0.000	0.00	0.0	0.600	o	150	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)
S2.003	50.00	5.63	2.070	0.216	0.0	0.0	1.8	1.21	342.2	31.0
S2.004	50.00	5.89	2.050	0.216	0.0	0.0	1.8	1.14	323.1	31.0
S2.005	50.00	6.20	2.010	0.401	0.0	0.0	3.3	1.12	317.7	57.6
S2.006	50.00	6.59	1.965	0.452	0.0	0.0	3.7	1.11	314.7	64.9
S2.007	50.00	7.04	1.910	0.556	0.0	0.0	4.5	1.09	308.8	79.8
S2.008	50.00	7.14	1.850	0.601	0.0	0.0	4.9	1.13	320.3	86.3
S2.009	50.00	7.43	1.835	0.666	0.0	0.0	5.4	1.11	312.5	95.6
S2.010	50.00	7.65	1.795	0.688	0.0	0.0	5.6	1.11	312.6	98.8
S2.011	50.00	7.82	1.765	0.688	0.0	0.0	5.6	1.11	315.1	98.8
S1.011	50.00	8.00	1.740	1.417	0.0	0.0	11.5	1.10	312.2	203.4
S1.012	50.00	8.11	1.715	1.427	0.0	0.0	11.6	1.22	346.2	204.8
S1.013	50.00	8.18	1.695	1.434	0.0	0.0	11.6	1.13	319.7	205.8
S3.000	50.00	5.14	2.100	0.060	0.0	0.0	0.5	0.93	36.8	8.7
S1.014	50.00	8.23	1.685	1.494	0.0	0.0	12.1	2.82	49.8«	214.5

©1982-2017 XP Solutions

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	600	S1	3.945	2.145	1.200	Open Manhole	1800
S1.001	o	600	S2	3.945	2.095	1.250	Open Manhole	1800
S1.002	o	600	S3	3.945	2.080	1.265	Open Manhole	1800
S1.003	o	600	S4	3.945	2.035	1.310	Open Manhole	1800
S1.004	o	600	S5	3.945	2.015	1.330	Open Manhole	1800
S1.005	o	600	S6	3.945	1.990	1.355	Open Manhole	1800
S1.006	o	600	S7	3.945	1.970	1.375	Open Manhole	1800
S1.007	o	600	S8	3.945	1.925	1.420	Open Manhole	1800
S1.008	o	600	S9	3.945	1.865	1.480	Open Manhole	1800
S1.009	o	600	S10	3.945	1.845	1.500	Open Manhole	1800
S1.010	o	600	S11	3.945	1.805	1.540	Open Manhole	1800
S2.000	o	600	S12	3.950	2.150	1.200	Open Manhole	1800
S2.001	o	600	S13	3.950	2.130	1.220	Open Manhole	1800
S2.002	o	600	S14	3.950	2.105	1.245	Open Manhole	1800
S2.003	o	600	S15	3.950	2.070	1.280	Open Manhole	1800
S2.004	o	600	S16	3.950	2.050	1.300	Open Manhole	1800
S2.005	o	600	S17	3.950	2.010	1.340	Open Manhole	1800
S2.006	o	600	S18	3.950	1.965	1.385	Open Manhole	1800
S2.007	o	600	S19	3.950	1.910	1.440	Open Manhole	1800
S2.008	o	600	S20	3.950	1.850	1.500	Open Manhole	1800
S2.009	o	600	S21	3.950	1.835	1.515	Open Manhole	1800
S2.010	o	600	S22	3.950	1.795	1.555	Open Manhole	1800
S2.011	o	600	S23	3.950	1.765	1.585	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	24.846	496.9	S2	3.945	2.095	1.250	Open Manhole	1800
S1.001	5.002	333.5	S3	3.945	2.080	1.265	Open Manhole	1800
S1.002	22.023	489.4	S4	3.945	2.035	1.310	Open Manhole	1800
S1.003	9.645	482.3	S5	3.945	2.015	1.330	Open Manhole	1800
S1.004	11.145	445.8	S6	3.945	1.990	1.355	Open Manhole	1800
S1.005	7.583	379.2	S7	3.945	1.970	1.375	Open Manhole	1800
S1.006	22.319	496.0	S8	3.945	1.925	1.420	Open Manhole	1800
S1.007	28.602	476.7	S9	3.945	1.865	1.480	Open Manhole	1800
S1.008	7.144	357.2	S10	3.945	1.845	1.500	Open Manhole	1800
S1.009	17.863	446.6	S11	3.945	1.805	1.540	Open Manhole	1800
S1.010	17.772	273.4	S12	3.950	1.740	1.610	Open Manhole	1800
S2.000	7.600	380.0	S13	3.950	2.130	1.220	Open Manhole	1800
S2.001	10.769	430.8	S14	3.950	2.105	1.245	Open Manhole	1800
S2.002	17.160	490.3	S15	3.950	2.070	1.280	Open Manhole	1800
S2.003	8.017	400.8	S16	3.950	2.050	1.300	Open Manhole	1800
S2.004	17.959	449.0	S17	3.950	2.010	1.340	Open Manhole	1800
S2.005	20.887	464.2	S18	3.950	1.965	1.385	Open Manhole	1800
S2.006	26.007	472.9	S19	3.950	1.910	1.440	Open Manhole	1800
S2.007	29.465	491.1	S20	3.950	1.850	1.500	Open Manhole	1800
S2.008	6.853	456.9	S21	3.950	1.835	1.515	Open Manhole	1800
S2.009	19.186	479.7	S22	3.950	1.795	1.555	Open Manhole	1800
S2.010	14.377	479.2	S23	3.950	1.765	1.585	Open Manhole	1800
S2.011	11.795	471.8	S12	3.950	1.740	1.610	Open Manhole	1800

©1982-2017 XP Solutions

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.011	o	600	S12	3.950	1.740	1.610	Open Manhole	1800
S1.012	o	600	S13	3.950	1.715	1.635	Open Manhole	1800
S1.013	o	600	S14	3.950	1.695	1.655	Open Manhole	1800
S3.000	o	225	S27	3.950	2.100	1.625	Open Manhole	1800
S1.014	o	150	S15	3.950	1.685	2.115	Open Manhole	2400

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.011	12.012	480.5	S13	3.950	1.715	1.635	Open Manhole	1800
S1.012	7.834	391.7	S14	3.950	1.695	1.655	Open Manhole	1800
S1.013	4.584	458.4	S15	3.950	1.685	1.665	Open Manhole	2400
S3.000	7.926	198.2	S15	3.950	2.060	1.665	Open Manhole	2400
S1.014	8.852	12.9	S	3.950	1.000	2.800	Open Manhole	150

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.014	S	3.950	1.000	1.000	150	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	6.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	0.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.401		

©1982-2017 XP Solutions

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S15, DS/PN: S1.014, Volume (m³): 11.2

Unit Reference	MD-SHE-0081-3600-1600-3600
Design Head (m)	1.600
Design Flow (l/s)	3.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	81
Invert Level (m)	1.685
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	3.6	Kick-Flo®	0.729	2.5
Flush-Flo™	0.356	3.1	Mean Flow over Head Range	-	2.9

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)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.6	2.000	4.0	4.000	5.5	7.000	7.2
0.200	3.0	1.000	2.9	2.200	4.2	4.500	5.8	7.500	7.4
0.300	3.1	1.200	3.1	2.400	4.3	5.000	6.1	8.000	7.6
0.400	3.1	1.400	3.4	2.600	4.5	5.500	6.4	8.500	7.9
0.500	3.1	1.600	3.6	3.000	4.8	6.000	6.7	9.000	8.1
0.600	2.9	1.800	3.8	3.500	5.2	6.500	6.9	9.500	8.3

©1982-2017 XP Solutions

Storage Structures for Storm

Porous Car Park Manhole: S6, DS/PN: S1.005

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	95.6
Max Percolation (l/s)	132.8	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.990	Cap Volume Depth (m)	0.250

Porous Car Park Manhole: S10, DS/PN: S1.009

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	71.0
Max Percolation (l/s)	98.6	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.845	Cap Volume Depth (m)	1.865

Porous Car Park Manhole: S17, DS/PN: S2.005

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.0
Membrane Percolation (mm/hr)	1000	Length (m)	95.6
Max Percolation (l/s)	132.8	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	2.010	Cap Volume Depth (m)	0.250

Cellular Storage Manhole: S23, DS/PN: S2.011

Invert Level (m)	1.765	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.95
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	547.5	0.0	1.200	547.5	0.0	1.201	0.0	0.0

©1982-2017 XP Solutions

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	6.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm) 19.000	Cv (Summer) 0.750
Region England and Wales		Ratio R 0.401	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)	450.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S1	15 Winter	1	+0%	100/15 Winter				2.298	-0.447
S1.001	S2	15 Winter	1	+0%	100/15 Winter				2.274	-0.421
S1.002	S3	15 Winter	1	+0%	100/120 Winter				2.269	-0.411
S1.003	S4	15 Winter	1	+0%	100/60 Summer				2.237	-0.398
S1.004	S5	15 Winter	1	+0%	100/120 Summer				2.209	-0.406
S1.005	S6	30 Winter	1	+0%	100/120 Summer				2.151	-0.439
S1.006	S7	30 Winter	1	+0%	100/60 Winter				2.134	-0.436
S1.007	S8	30 Winter	1	+0%	100/60 Winter				2.093	-0.432
S1.008	S9	360 Winter	1	+0%	100/30 Winter				2.079	-0.386
S1.009	S10	360 Winter	1	+0%	100/30 Winter				2.079	-0.366
S1.010	S11	360 Winter	1	+0%	100/30 Winter				2.080	-0.325
S2.000	S12	15 Winter	1	+0%	100/120 Winter				2.288	-0.462
S2.001	S13	15 Winter	1	+0%	100/15 Winter				2.274	-0.456
S2.002	S14	15 Winter	1	+0%	100/120 Winter				2.255	-0.450
S2.003	S15	15 Winter	1	+0%	100/120 Winter				2.226	-0.444
S2.004	S16	15 Winter	1	+0%	100/120 Winter				2.198	-0.452
S2.005	S17	30 Winter	1	+0%	100/60 Winter				2.172	-0.438
S2.006	S18	30 Winter	1	+0%	100/60 Winter				2.136	-0.429
S2.007	S19	30 Winter	1	+0%	100/60 Winter				2.098	-0.412
S2.008	S20	360 Winter	1	+0%	100/15 Winter				2.078	-0.372
S2.009	S21	360 Winter	1	+0%	100/15 Winter				2.078	-0.357
S2.010	S22	360 Winter	1	+0%	100/60 Summer				2.078	-0.317
S2.011	S23	360 Winter	1	+0%	30/360 Winter				2.078	-0.287
S1.011	S12	360 Winter	1	+0%	30/240 Winter				2.081	-0.259
S1.012	S13	360 Winter	1	+0%	30/180 Winter				2.083	-0.232
S1.013	S14	360 Winter	1	+0%	30/180 Winter				2.085	-0.210
S3.000	S27	15 Winter	1	+0%	30/240 Winter				2.183	-0.142
S1.014	S15	360 Winter	1	+0%	1/15 Summer				2.086	0.251

©1982-2017 XP Solutions

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.08		19.7	OK	
S1.001	S2	0.000	0.10		21.6	OK	
S1.002	S3	0.000	0.15		33.0	OK	
S1.003	S4	0.000	0.23		35.6	OK	
S1.004	S5	0.000	0.23		39.0	OK	
S1.005	S6	0.000	0.14		24.3	OK	
S1.006	S7	0.000	0.13		28.6	OK	
S1.007	S8	0.000	0.12		31.4	OK	
S1.008	S9	0.000	0.06		11.3	OK	
S1.009	S10	0.000	0.05		10.7	OK	
S1.010	S11	0.000	0.04		11.7	OK	
S2.000	S12	0.000	0.09		16.7	OK	
S2.001	S13	0.000	0.10		17.3	OK	
S2.002	S14	0.000	0.10		18.6	OK	
S2.003	S15	0.000	0.15		26.5	OK	
S2.004	S16	0.000	0.12		25.8	OK	
S2.005	S17	0.000	0.12		27.0	OK	
S2.006	S18	0.000	0.12		29.9	OK	
S2.007	S19	0.000	0.14		35.8	OK	
S2.008	S20	0.000	0.06		12.4	OK	
S2.009	S21	0.000	0.07		13.7	OK	
S2.010	S22	0.000	0.08		13.9	OK	
S2.011	S23	0.000	0.08		13.1	OK	
S1.011	S12	0.000	0.09		15.5	OK	
S1.012	S13	0.000	0.07		12.6	OK	
S1.013	S14	0.000	0.04		8.6	OK	
S3.000	S27	0.000	0.28		8.4	OK	
S1.014	S15	0.000	0.07		3.1	SURCHARGED	

©1982-2017 XP Solutions

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	6.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm) 19.000	Cv (Summer) 0.750
Region England and Wales	Ratio R	0.401	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)	450.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S1	15 Winter	30	+0%	100/15 Winter				2.442	-0.303
S1.001	S2	15 Winter	30	+0%	100/15 Winter				2.421	-0.274
S1.002	S3	15 Winter	30	+0%	100/120 Winter				2.416	-0.264
S1.003	S4	360 Winter	30	+0%	100/60 Summer				2.396	-0.239
S1.004	S5	360 Winter	30	+0%	100/120 Summer				2.396	-0.219
S1.005	S6	360 Winter	30	+0%	100/120 Summer				2.396	-0.194
S1.006	S7	360 Winter	30	+0%	100/60 Winter				2.396	-0.174
S1.007	S8	360 Winter	30	+0%	100/60 Winter				2.396	-0.129
S1.008	S9	360 Winter	30	+0%	100/30 Winter				2.396	-0.069
S1.009	S10	360 Winter	30	+0%	100/30 Winter				2.396	-0.049
S1.010	S11	360 Winter	30	+0%	100/30 Winter				2.396	-0.009
S2.000	S12	360 Winter	30	+0%	100/120 Winter				2.393	-0.357
S2.001	S13	360 Winter	30	+0%	100/15 Winter				2.393	-0.337
S2.002	S14	360 Winter	30	+0%	100/120 Winter				2.393	-0.312
S2.003	S15	360 Winter	30	+0%	100/120 Winter				2.393	-0.277
S2.004	S16	360 Winter	30	+0%	100/120 Winter				2.393	-0.257
S2.005	S17	360 Winter	30	+0%	100/60 Winter				2.393	-0.217
S2.006	S18	360 Winter	30	+0%	100/60 Winter				2.393	-0.172
S2.007	S19	360 Winter	30	+0%	100/60 Winter				2.393	-0.117
S2.008	S20	360 Winter	30	+0%	100/15 Winter				2.392	-0.058
S2.009	S21	360 Winter	30	+0%	100/15 Winter				2.392	-0.043
S2.010	S22	360 Winter	30	+0%	100/60 Summer				2.391	-0.004
S2.011	S23	360 Winter	30	+0%	30/360 Winter				2.389	0.024
S1.011	S12	360 Winter	30	+0%	30/240 Winter				2.399	0.059
S1.012	S13	360 Winter	30	+0%	30/180 Winter				2.401	0.086
S1.013	S14	360 Winter	30	+0%	30/180 Winter				2.407	0.112
S3.000	S27	360 Winter	30	+0%	30/240 Winter				2.415	0.090
S1.014	S15	360 Winter	30	+0%	1/15 Summer				2.410	0.575

©1982-2017 XP Solutions

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.20		48.2	OK	
S1.001	S2	0.000	0.26		55.6	OK	
S1.002	S3	0.000	0.39		87.4	OK	
S1.003	S4	0.000	0.09		14.3	OK	
S1.004	S5	0.000	0.09		15.8	OK	
S1.005	S6	0.000	0.07		13.1	OK	
S1.006	S7	0.000	0.07		16.6	OK	
S1.007	S8	0.000	0.07		18.6	OK	
S1.008	S9	0.000	0.11		20.1	OK	
S1.009	S10	0.000	0.07		15.8	OK	
S1.010	S11	0.000	0.06		18.0	OK	
S2.000	S12	0.000	0.03		5.8	OK	
S2.001	S13	0.000	0.03		6.2	OK	
S2.002	S14	0.000	0.04		6.9	OK	
S2.003	S15	0.000	0.06		10.0	OK	
S2.004	S16	0.000	0.05		9.9	OK	
S2.005	S17	0.000	0.07		15.7	OK	
S2.006	S18	0.000	0.07		17.6	OK	
S2.007	S19	0.000	0.09		21.5	OK	
S2.008	S20	0.000	0.12		22.2	OK	
S2.009	S21	0.000	0.12		24.7	OK	
S2.010	S22	0.000	0.14		24.8	OK	
S2.011	S23	0.000	0.08		13.5	SURCHARGED	
S1.011	S12	0.000	0.08		12.5	SURCHARGED	
S1.012	S13	0.000	0.05		9.4	SURCHARGED	
S1.013	S14	0.000	0.03		7.5	SURCHARGED	
S3.000	S27	0.000	0.10		2.9	SURCHARGED	
S1.014	S15	0.000	0.07		3.1	SURCHARGED	

©1982-2017 XP Solutions

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	6.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	0.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm) 19.000	Cv (Summer) 0.750
Region England and Wales	Ratio R	0.401	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm)	450.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	OFF

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

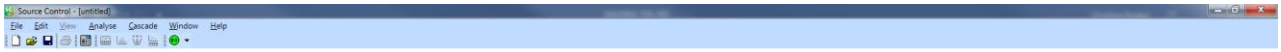
PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S1	360 Winter	100	+40%	100/15 Winter				3.298	0.553
S1.001	S2	360 Winter	100	+40%	100/15 Winter				3.298	0.603
S1.002	S3	360 Winter	100	+40%	100/120 Winter				3.298	0.618
S1.003	S4	360 Winter	100	+40%	100/60 Summer				3.298	0.663
S1.004	S5	360 Winter	100	+40%	100/120 Summer				3.299	0.684
S1.005	S6	360 Winter	100	+40%	100/120 Summer				3.299	0.709
S1.006	S7	360 Winter	100	+40%	100/60 Winter				3.299	0.729
S1.007	S8	360 Winter	100	+40%	100/60 Winter				3.299	0.774
S1.008	S9	360 Winter	100	+40%	100/30 Winter				3.299	0.834
S1.009	S10	360 Winter	100	+40%	100/30 Winter				3.299	0.854
S1.010	S11	360 Winter	100	+40%	100/30 Winter				3.302	0.897
S2.000	S12	360 Winter	100	+40%	100/120 Winter				3.312	0.562
S2.001	S13	360 Winter	100	+40%	100/15 Winter				3.311	0.581
S2.002	S14	360 Winter	100	+40%	100/120 Winter				3.311	0.606
S2.003	S15	360 Winter	100	+40%	100/120 Winter				3.311	0.641
S2.004	S16	360 Winter	100	+40%	100/120 Winter				3.312	0.662
S2.005	S17	360 Winter	100	+40%	100/60 Winter				3.313	0.703
S2.006	S18	360 Winter	100	+40%	100/60 Winter				3.313	0.748
S2.007	S19	360 Winter	100	+40%	100/60 Winter				3.313	0.803
S2.008	S20	360 Winter	100	+40%	100/15 Winter				3.313	0.863
S2.009	S21	360 Winter	100	+40%	100/15 Winter				3.312	0.877
S2.010	S22	360 Winter	100	+40%	100/60 Summer				3.312	0.917
S2.011	S23	360 Winter	100	+40%	30/360 Winter				3.312	0.947
S1.011	S12	360 Winter	100	+40%	30/240 Winter				3.311	0.971
S1.012	S13	360 Winter	100	+40%	30/180 Winter				3.318	1.003
S1.013	S14	360 Winter	100	+40%	30/180 Winter				3.322	1.027
S3.000	S27	360 Winter	100	+40%	30/240 Winter				3.325	1.000
S1.014	S15	360 Winter	100	+40%	1/15 Summer				3.323	1.488

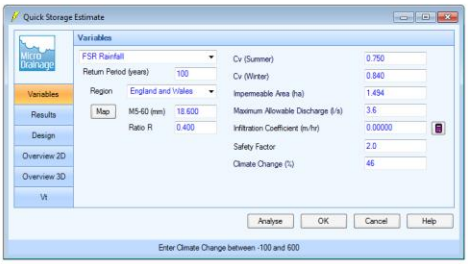
©1982-2017 XP Solutions

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

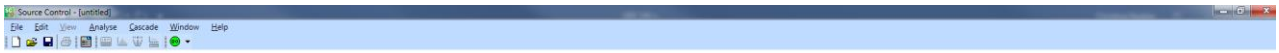
PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.05		12.3	SURCHARGED	
S1.001	S2	0.000	0.07		14.8	SURCHARGED	
S1.002	S3	0.000	0.10		23.5	SURCHARGED	
S1.003	S4	0.000	0.17		26.0	SURCHARGED	
S1.004	S5	0.000	0.17		28.8	SURCHARGED	
S1.005	S6	0.000	0.17		31.1	SURCHARGED	
S1.006	S7	0.000	0.17		37.7	SURCHARGED	
S1.007	S8	0.000	0.17		42.3	SURCHARGED	
S1.008	S9	0.000	0.25		47.1	SURCHARGED	
S1.009	S10	0.000	0.23		50.0	SURCHARGED	
S1.010	S11	0.000	0.18		55.2	SURCHARGED	
S2.000	S12	0.000	0.06		10.0	SURCHARGED	
S2.001	S13	0.000	0.06		10.7	SURCHARGED	
S2.002	S14	0.000	0.06		12.0	SURCHARGED	
S2.003	S15	0.000	0.10		17.7	SURCHARGED	
S2.004	S16	0.000	0.08		17.7	SURCHARGED	
S2.005	S17	0.000	0.14		32.9	SURCHARGED	
S2.006	S18	0.000	0.15		37.1	SURCHARGED	
S2.007	S19	0.000	0.18		45.5	SURCHARGED	
S2.008	S20	0.000	0.26		49.2	SURCHARGED	
S2.009	S21	0.000	0.26		54.2	SURCHARGED	
S2.010	S22	0.000	0.32		54.9	SURCHARGED	
S2.011	S23	0.000	0.15		24.1	SURCHARGED	
S1.011	S12	0.000	0.18		29.4	SURCHARGED	
S1.012	S13	0.000	0.13		23.5	SURCHARGED	
S1.013	S14	0.000	0.08		17.3	SURCHARGED	
S3.000	S27	0.000	0.30		8.8	SURCHARGED	
S1.014	S15	0.000	0.08		3.6	SURCHARGED	

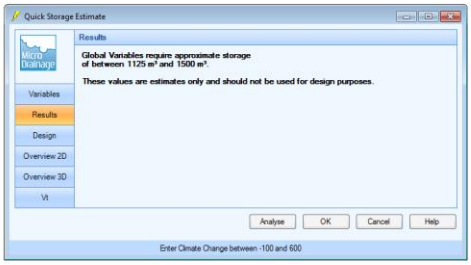
©1982-2017 XP Solutions


Source Control - [untitled]
File Edit View Analyse Cascade Window Help


Quick Storage Estimate
Variables
FSR Rainfall
Return Period (years) 100
Region England and Wales
Map
M5-60 (mm) 18.600
Ratio R 0.400
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 1.494
Maximum Allowable Discharge (l/s) 3.6
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 46
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600

Source Control, A.P.T., CASDeF 2017.1.2
09:49
07/03/2019


Source Control - [untitled]
File Edit View Analyse Cascade Window Help


Quick Storage Estimate
Results
Global Variables require approximate storage
of between 1125 m³ and 1500 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Climate Change between -100 and 600

Source Control, A.P.T., CASDeF 2017.1.2
09:50
07/03/2019

millward
integrated engineering consultants
No. 1 Malin Hill
Nottingham NG1 1JQ
t: 0115 9414560

Project	Job Ref.
Paddocks Holbeach FRA	MA10954
Section	**Sheet no./rev.**
FRA and DS	2
Note by / **Date**	**FILE NOTE**
CMN / 07/03/19	

Total site area – 2.586 ha

Discharge @ 1.4L/s/ha ≈ 3.6 L/s

Storage required 1:100yr + 40% c.c + 6% urban creep = 100m^3

(Based on approx. impermeable area of 1.494ha.)

Volumes provided Approx.

600Ø pipes – 395m ≈ 112m^3

Filter Drains – (2m x 1.2m x 284.1m) x0.3 = 204m^3

∴ 1312.5 – 316 = 997m^3 left to store. (Assume 1000m^3 for DS)

Op1 – Pond

Provides 985m^3 storage
Uses 1200m^2 of area
Loose 5 plots

Op2 – Tank

Provides (36.5 x 15 x 1.2) x0.95 = 624.15m^3 storage
Uses 547.5m^2 of area

\+ Private permeable paving – Provides 371.9m^3 storage
Loose 1 plot
= 996.05m^3

Constraints

- IL of FWS to discharge is too shallow.
  ∴ foul water dictates FFL's.
  Min gradients and shortest pipe runs considered.
- FFL's also need to account for drainage of road into filter strip.
- Low spot south of site i.e needs to drain SW!

millward
integrated engineering consultants

No. 1 Malin Hill
Nottingham NG1 1JQ
t: 0115 9414560

Project		Job Ref.
Section		Sheet no./rev.
Note by	Date	FILE NOTE

Peak Inflow (AW criteria)

$$DWF = \frac{84 \times 235 \times 128 \times 1.25}{86400} = 0.357\ l/s$$

Peak Inflow Rate = $2.12 \times 0.357 = 0.757\ l/s$

Appendix D – Ground Investigation

Geodyne- Combined Desk Study and Phase II Exploratory Investigation

EXECUTIVE SUMMARY

Ground Conditions	TOPSOIL to depths of between 0.20m and 0.40m begl with an average thickness of approximately 0.25m. Slightly clayey slightly sandy SILT to depths of between 0.60m and 1.90m begl. Underlying firm (locally stiff) slightly sandy silty CLAY typically to the base of the exploratory holes. The strength of the Clay typically reduced with depth, becoming soft or very soft in the region of 1.40m begl. Soft slightly sandy very clayey SILT and loose clayey very silty SAND locally encountered in place of the Clay. Rare plant remains locally within the Clay from depths of 2.00m begl.
Foundation Design	Foundations for the proposed development are likely to comprise Engineer designed strip or raft foundations to suit the loading characteristics of the proposed structures. The natural near surface Clay and Silt soils underlying the site at shallow depth appear suitable to support a nett allowable ground bearing pressure of up to 75kN/m². It is recommended that foundations should be advanced to a minimum founding depth of 0.90m and founded within undisturbed suitably competent natural soils. Softening of the soils was observed across the majority of the site at depths generally in excess of 1.40m begl. On the basis of the foregoing, it is important to ensure that all foundation excavations are kept as shallow as possible. The use of a deeper founding solution (i.e. piles, for example) may need to be considered if there is a need to raise site levels and/or where excessive loads from buildings are present
Floor Slab Design	Ground bearing floor slabs may be adopted for the proposed dwellings provided that there is less than 0.60m of suitably compacted geotechnically competent sub-slab fill beneath proposed slabs and subject to the requirements of NHBC Chapter 4.2 *'Building near trees'*. Alternatively, where in excess of 0.60m of sub-slab fill is present, a suspended slab may be adopted.
Ground Gas Precautions	No precautions required.
Building Near Trees	Foundation designs may require locally adjusting due to the presence of shrinkable soils of a medium volume change potential.
Radon	No precautions required.
Water	Foundation excavations are unlikely to require dewatering. However, deeper excavations (i.e. sewers, for example) may encounter water seepage, which should be controllable utilising minor sump pumping techniques, in the first instance. Excavations may be susceptible to standing water following periods of wet weather.
Excavations / Stability	Excavations deeper than approximately 1.40m begl are likely to require trench support for health and safety reasons. The assessment of excavations and provision of support will be the responsibility of the contractor on site.
Sulphate Classification	Design Sulfate Class DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-1s.
Coal Mining	No coal mining precautions or associated investigation works are required at the site.
CBRs	The testing has revealed CBR values for the Natural Strata ranging between 2.6% and 19.4%.
Surface Water Drainage	The results from the programme of in-situ infiltration rate testing have indicated that traditional soakaways and permeable paving are unlikely to be viable for the site and it may be prudent to investigate alternative methods for draining the site, at this stage.
Contamination Assessment	The soils may be considered to be uncontaminated based on a residential with plant uptake end-use. There are considered to be no specific risks posed to Controlled Waters by the findings of the laboratory analysis undertaken.
Remediation Proposals	No specific remediation works will be required other than the provision of existing topsoil in proposed gardens to provide a suitable growing media for plants. The existing topsoil at the site is considered chemically suitable for re-use within the proposed development (based on laboratory testing). The Natural Strata may be regarded as suitable for re-use within proposed gardens or areas of soft landscape as subsoil
Off Site Disposal	If off-site disposal is required, a separate contamination assessment may be required to include bespoke leachate analysis.
Construction Workers	A copy of this report should be included in the site health and safety file, and site workers should be made fully aware of the sites setting.
Utilities	We would recommend that a copy of this report is supplied to the appropriate utility companies, and that their recommendations relating to appropriate supply pipes are adhered to.
Flood Risk	The Landmark Envirocheck report has revealed the site to lie within an area identified as being at risk of flooding. It is recommended that advice be sought from a Drainage Consultant with respect to this matter.
Unforeseen Circumstances	Should any areas of potentially contaminated soil be encountered during site construction works we would recommend consultation with GeoDyne Limited to ensure that our recommendations continue to apply.
Licenses, Permits etc.	The Contractor/Developer is responsible for, and must ensure that, all necessary licenses, permits, plans, registrations and approvals are in place prior to commencing with the earthworks at the site.