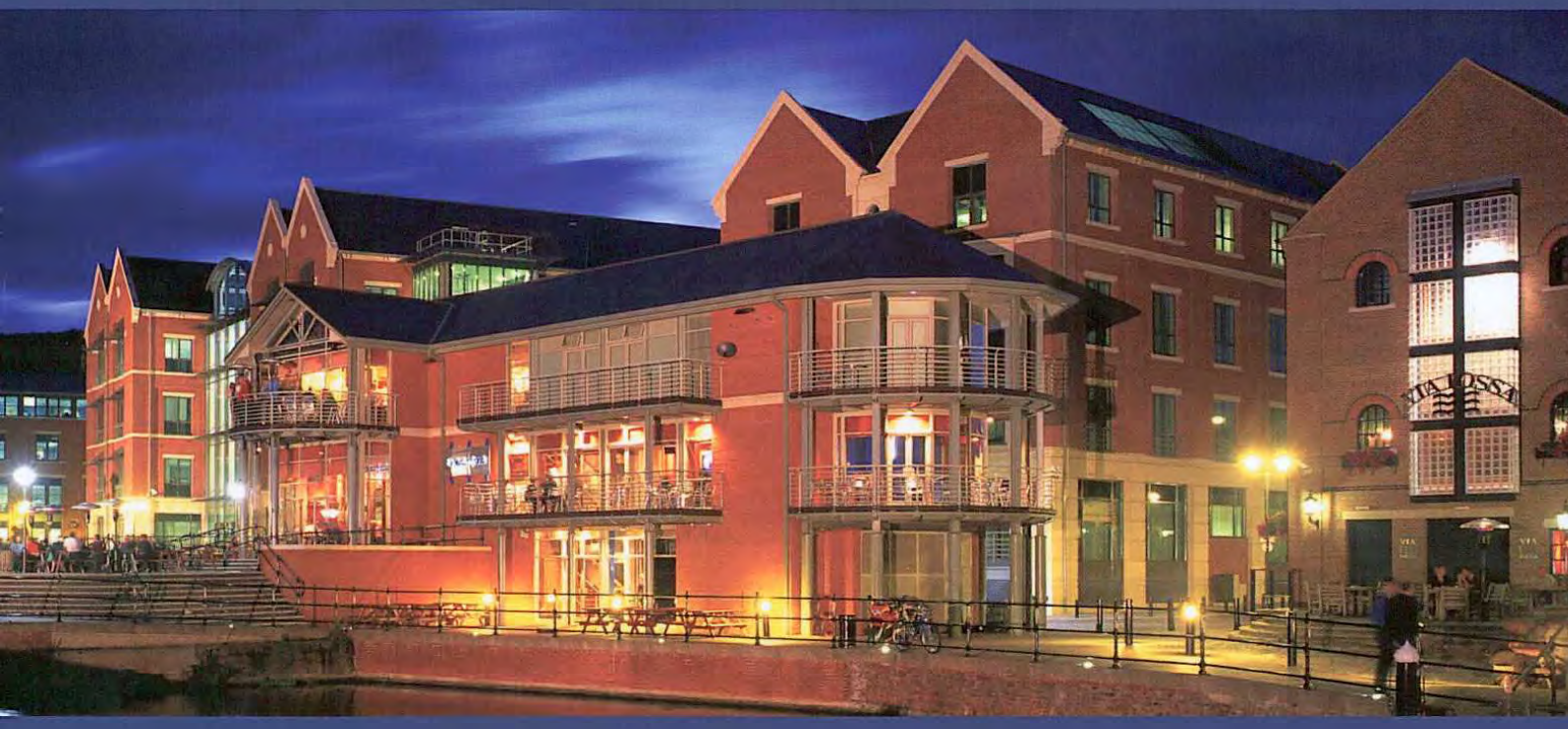
WATER ENGINEERING

South Holland District Council
Crease Drove
Crowland

Flood Risk Assessment



Integrated Engineering and Environmental Consultants

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WATER ENGINEERING

South Holland District Council
Crease Drove
Crowland

Flood Risk Assessment

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FIGURES

1 Site Location Plan
2 Indicative Flood Zone Mapping

APPENDICES

A Topographical Survey
B Proposed Site Layout
C Existing Run-off
D Storage Volumes

All comments and proposals contained in this report, including any conclusions, are based on information available to BWB Consulting during investigations. The conclusions drawn by BWB Consulting could therefore differ if the information is found to be inaccurate or misleading. BWB Consulting accepts no liability should this be the case, nor if additional information exists or becomes available with respect to this scheme.

Except as otherwise requested by the client, BWB Consulting is not obliged to and disclaims any obligation to update the report for events taking place after:-

(i) The date on which this assessment was undertaken, and
(ii) The date on which the final report is delivered

BWB Consulting makes no representation whatsoever concerning the legal significance of its findings or the legal matters referred to in the following report.

The information presented and conclusions drawn are based on statistical data and are for guidance purposes only. The study provides no guarantee against flooding of the study site or elsewhere, nor of the absolute accuracy of water levels, flow rates and associated probabilities.

EXECUTIVE SUMMARY

This Flood Risk Assessment (FRA) is compliant with the requirements set out in Planning Policy Statement 25 – Development and Flood Risk (PPS25). It has been produced on behalf of South Holland District Council in respect of a planning application for Crease Drove, Crowland.

The existing site is located at the end of Crease Drove, Crowland, roughly where the junction of Harvester Way meets Crease Drove, and approximately 1.0km south of the centre of Crowland. The existing site is currently surrounded by open fields with the Crease Drove Industrial Estate to the north of the site.

The site covers 0.42 ha of allocated land by South Holland District Council. This is one section of three areas to be developed. Levels on the site range from 0.5m AOD and 2.0m AOD. The River Welland runs northwards approximately 1.6km to the west of the site and local North Level District Internal Drainage Board drains are located in the vicinity of the site.

The proposals are for a development comprising of workspace units ranging in size up to approximately 2200ft² per unit. The proposed development will occupy 0.42 ha of an allocated employment plot owned by South Holland District Council.

Indicative Flood Zone mapping for the area was extracted from the Environment Agency website and indicates that the site lies within Flood Zone 3a (High Probability). This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) from the sea.

However, with reference to information provided by North Level District Internal Drainage Board and the South Holland District Council Strategic Flood Risk Assessment, there is not considered to be significant risk of direct flooding. Mitigation measures including setting appropriate finished levels and flood warning considerations can address the residual risk of flooding.

It is recommended that finished floor levels are set based on operational considerations and in accordance with best construction practice to set the finished floor levels 150mm above external levels. External finished levels should also be designed to direct pluvial run-off away from buildings.

The proposed development will introduce an increase in impermeable area on site which will lead to an increase in the surface water run-off rate. For run-off restricted to existing greenfield rates, the maximum volume of storage required to be retained onsite would be in the order of approximately 145m³ for the 100-year+20% (climate change) rainfall event. Drainage arrangements will be finalised at detailed design stage and will require consent from North Level District Internal Drainage Board.

Subject to the implementation of recommended mitigation measures, the proposed development can proceed in accordance with the considerations of Planning Policy Statement 25 Development and Flood Risk (PPS 25).

1.0 SUMMARY INFORMATION

Introduction

1.1 This Flood Risk Assessment (FRA) is compliant with the requirements set out in Planning Policy Statement 25 – Development and Flood Risk (PPS25). The FRA has been produced on behalf of South Holland District Council in respect of a planning application for the proposed employment development comprising 5 work space units.

Site Name	Crease Drove
Address	Land off Crease Drove, Crowland
NGR	523508,309260
Site Area (ha)	0.42 ha
Development Type	Employment Development
EA Development Control Area	Anglian Region, Northern Area Office
Local Planning Authority	South Holland District Council
Planning Application Ref	-

Table 1 – Site Summary

1.2 The report is based on the following information:

(i) Site Layout Plan
(ii) OS Explorer Series Mapping
(iii) South Holland District Council Strategic Flood Risk Assessment
(iv) Topographical Survey by Surveyline Geomatics UK Ltd, reference SL2151/1
(v) Proposed Site Plan by Place: Architecture, reference P391-P100
(vi) North Level District Internal Drainage Board consultation

Existing Site

1.3 The existing site is located at the end of Crease Drove, Crowland, roughly where the junction of Harvester Way meets Crease Drove. This is approximately 1.0km south of the centre of Crowland. A Site Location Plan is enclosed as **Figure 1.**

1.4 The site is adjacent to both existing well established business units and smaller starter business units; these are located to the north of the site. These units belong to the Crease Drove Industrial Estate and are owned and run by South Holland District Council. The majority of the site surrounds is open undeveloped land.

1.5 The River Welland runs northwards approximately 1.6km to the west of the site boundary.

1.6 The site will be situated in 0.42 ha of allocated employment land and the existing levels generally range from 0.5m to 2.0m. A Topographical Survey of the site is included as **Appendix A.**

Proposed Development

1.7 The proposals are for a development comprising of workspace units ranging in size up to approximately 2200ft² per unit. The proposed development will occupy 0.42 ha of an allocated employment plot owned by South Holland District Council.

1.8 A new access road is proposed to allow access from Crease Drove to the development. The access road will be approximately 130m long and will run along the north side of the site. A proposed site plan is included as **Appendix B.**

Flood Zone Classification

1.9 Indicative Flood Zone mapping for the area was extracted from the Environment Agency (EA) website. This mapping indicated areas that might be at risk from flooding without taking account of existing flood defences. Printed extracts of the EA website are shown in **Figure 2.**

1.10 The mapping indicates that the site lies within Flood Zone 3a (High Probability). This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%) or a 1 in 200 or great annual probability of flooding from the sea (>0.5%) from the sea.

1.11 All development proposals in this Flood Zone should be accompanied by a Flood Risk Assessment. The purpose of this document is to assess the risk of flooding posed to the development and potential impacts of the development on flood risk on the wider catchment.

2.0 SOURCES OF FLOOD RISK

2.1 This section identifies the *potential* sources of flood risk to the site. The significance of these sources of flood risk is investigated further in Section 4.0 of this report.

Flood Source	Presence	Description
Fluvial	**ü**	The River Welland, Local IDB Drains
Tidal	X	Not Present
Canals	X	Not Present
Groundwater	X	No History
Sewers	X	Not Present
Reservoirs	X	Not Present
Pluvial runoff	**ü**	Could Impact on Development
Development Drainage	**ü**	Could increase flood risk to wider catchment

Table 2 – Potential Flood Sources

2.2 The River Welland poses flood risk to the development and runs adjacent to the western side of the site and flows northwards. The River is approximately 1.6km from the site and the site is upstream of the tidal extent at this point.

2.3 There are local Internal Drainage Board (IDB) drains in the area which also pose a risk of flooding. The closest drain runs to the western side of the site.

2.4 The indicative Flood Zone maps show that the site could be affected by floodplain attributed to these watercourses, although this mapping does not take into account existing flood defences.

2.5 Pluvial run-off from adjacent land has potential to impact on the site.

2.6 If the impermeable area on site increases, this will lead to an increase in surface water run-off which may have adverse impacts in the wider catchment.

3.0 SEQUENTIAL TEST

3.1 According to table D2 of PPS25 (which categorises land use) the development site and proposed use is categorised as 'Less Vulnerable'.

3.2 From the flood zone maps the site is identified as being within Flood Zone 3a. This flood zone is described as being:

Zone 3a – High Probability
This zone comprises land assessed as having a 1 in 100-year or greater annual probability of river flooding (>1%)

Appropriate Uses – water compatible and less vulnerable uses of land are appropriate in this zone. Highly vulnerable not permitted in this zone. More vulnerable and essential infrastructure should only be permitted in this zone if the Exception Test is passed. Essential infrastructure permitted in this zone should be designed and constructed to remain operational and safe for users in times of flood.

3.3 With reference to the flood zone mapping, an extensive area surrounding the site is also shown to be within Flood Zone 3a due to the nature of the landform in this region. It can therefore be considered that in the immediate surrounds there would not be any similar development sites in a lower risk flood zone.

3.4 As the site lies within Zone 3a and the proposed use is classed as 'less vulnerable' the development is considered 'acceptable'. The development is also taking place on land allocated for employment use.

3.5 Based on the above information, the development is therefore considered to be sequentially preferable.

4.0 FLOOD RISK ASSESSMENT

Risk of Flooding to Proposed Development

Local IDB Drains

4.1 As previously stated there are drains in the area around the site which present a source of flood risk to the site. The system is managed and maintained by the North Level District IDB.

4.2 The North Level District IDB is responsible for the drainage and evacuation of surplus water from the surrounding area. The board is also responsible for the improvement and maintenance of the drains and pumping stations.

4.3 With reference to the South Holland District Council Strategic Flood Risk Assessment (SFRA), it is stated that the IDBs within the study area generally consider that there should be no flooding problems associated with their systems even up to the 100-year return period and the drains normally operate with considerable freeboard between water level and land level.

4.4 There is therefore not considered to be a significant risk of flooding from the IDB drains. Any residual risk should be addressed by providing mitigation in the form of raised finished floor levels.

The River Welland

4.5 As previously stated the River Welland is located approximately 1.6km to the west of the site and the South Holland District Council SFRA provides relevant flood level information. Both the site and Crowland are upstream of the tidal extent of the River Welland.

4.6 Table 6R within the SFRA provides modelled flood levels and existing defence levels. With reference to this, a freeboard of approximately 2.5m is available in this case for the 100-year return period event. Taking into account the potential effects of climate change, a freeboard of approximately 2.0m is available.

4.7 With reference to text within the SFRA it is stated that the rapid inundation area on the east side (right bank) of the River Welland is applicable in the event of breach failure, in the South Barrier Bank. The general ground levels in and around Crowland are generally high and substantial enough that a breach failure is not plausible. For this reason Crowland is outside the rapid inundation zone.

4.8 There is therefore not considered to be a significant risk of flooding from the River Welland. Mitigation measures, particularly flood warning should be implemented to enable effective emergency response to be taken if required.

Pluvial Run-off

4.9 There may be risk of pluvial/surface flows entering the site from adjacent land or sewers.

4.10 With reference to the Topographical Survey, existing site levels are generally lower than the surrounding site boundaries. Any pluvial flows in the vicinity, which are likely to be minor in nature, may encroach on the site.

4.11 Within the proposed development, external finished levels should be designed to convey flows away from the buildings to provide mitigation for the residual risk of pluvial/surface flows.

Effect of Development on Wider Catchment

4.12 The proposed development will introduce an impermeable area to the site. This would result in an increase in surface water run-off rates when compared to the existing situation.

4.13 Mitigation is required to ensure that there are no adverse impacts elsewhere as a result of flood flows from development drainage. North Level District IDB has provided preliminary recommendations with regard to surface water flows within their site.

5.0 MITIGATION MEASURES

Finished Levels

5.1 Typically, the finished floor level of buildings should be set with a freeboard above the design flood levels to mitigate the risk of flooding. However based on available information there is not considered to be significant risk from flood levels.

5.2 In accordance with best construction practice, finished floor levels are generally set 150mm above the external finished levels. The external finished levels should also be designed to direct pluvial run-off from buildings. The levels may have to be raised further to allow drainage connections to existing drains.

5.3 The raised floor levels will also provide mitigation against the residual risk of flooding from the River Welland and IDB drains.

Safe Access and Egress

5.4 The site and surrounds will generally be unaffected by flood levels related to watercourses in the vicinity. Safe access and egress is therefore available up to and including the 100-year return period.

5.5 Prompt evacuation of the site would ensure safe access and egress in the event of a flood warning in an extreme case.

Flood Warning

5.6 It is recommended that buildings/occupants within the development are registered with the Environment Agency Floodline Warnings Direct scheme to address the residual risk of flooding from the major watercourse in an extreme flood event. This is a free service which can be set up to produce automated flood warnings direct to telephone, mobile, e-mail or fax.

5.7 With reference to the Environment Agency website, the site is within the “River Welland from Stamford to Spalding and seepage in areas of Stamford, the Deepings and Spalding” flood warning area. Flood warning updates are also shown to be available on local radio stations.

5.8 The area also lies within the larger geographical catchment which is also covered by general Flood Watch warnings for early alert to possible flooding. This area is called “Lower Welland”.

Drainage Arrangements

5.9 The proposed development will introduce an impermeable area on the site which would lead to an increase in the surface water run-off rate. Mitigation is typically achieved by attenuating surface water run-off to a restricted rate and providing an on-site storage volume.

5.10 There is scope to connect to the IDB drains with a free discharge rate. However, this should not be pursued as the primary option and this arrangement would be subject to the payment of a development levy per impervious hectare to be drained.

5.11 It is proposed that runoff is restricted to the existing greenfield rate and storage provided. WinDes software was used to estimate the existing Greenfield run-off rates. The total site area is approximately 0.42 ha in extent which would result in an allowable discharge rate of 1.4l/s per hectare in a 30-year storm and 2.1l/s in a 100-year storm. WinDes extracts are included as **Appendix C.**

5.12 These run-off rates and an estimated impermeable area of 0.3 ha based on the proposed site layout have been used to undertake a storage calculation, also using WinDes software. Extracts from WinDes are included as **Appendix D** and the results are summarised in Table 5.1 below.

Return Period	Discharge Rate (l/s)	Volume Required (m^3)
30-Year	1.4	92.3
100-Year	2.1	115.4
100-Year+20% (climate change)	2.1	144.8

Table 5.1 – Indicative Storage Volumes

5.13 To assist in the reduction of surface water run-off and to improve the quality of the flows, sustainable drainage systems (SuDS) should be in incorporated within the drainage arrangements where possible.

5.14 Based on the current layout, permeable paving systems may be the most suitable sustainable drainage feature to use.

5.15 Drainage arrangements will be finalised at detailed design stage and will require the consent of North Level District IDB. The recommended mitigation measures will ensure that there are no adverse effects in the wider catchment.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 With reference to the information that was provided by North Level IDB and the South Holland District Council SFRA, there is not considered to be a significant risk of direct flooding to the site. Appropriate mitigation measures including setting finished levels and flood warning considerations are considered suitable to address the residual risk of flooding.

6.2 There is no significant risk of flooding from surrounding watercourses and finished floor levels should be set based on operational considerations. It should be taken into account that generally, finished floor levels are set 150mm higher than external levels and levels may have to be raised further so that connections to existing IDB drains can be established.

6.3 It is recommended that buildings/occupants within the development are registered with the Environment Agency Floodline Warnings direct scheme to address the residual risk of flooding from the major watercourse in an extreme flood event. This service can be set up to produce automated flood warnings direct to telephone, mobile, email or fax.

6.4 The site and surrounds are generally shown to be unaffected by flood levels related to watercourses in the vicinity and safe access and egress is therefore available up to and including the 100-year return period. Prompt evacuation of the site would ensure safe access and egress in the event of a flood warning in an extreme case.

6.5 It is proposed to limit run-off to the existing greenfield rates and provide a storage volume on-site. The maximum volume of storage required to be retained onsite would be in the order of approximately 145m^3 for the 100-year+20% (climate change) rainfall event. SuDs should be incorporated to assist in the storage of volume and treatment of flows.

6.6 Drainage arrangements will be finalised at detailed design stage and will require the consent of North Level District IDB.

6.7 Subject to the implementation of recommended mitigation measures, the proposed development can proceed in accordance with the considerations of Planning Policy Statement 25 Development and Flood Risks (PPS 25).

Figure 1

Site Location Plan

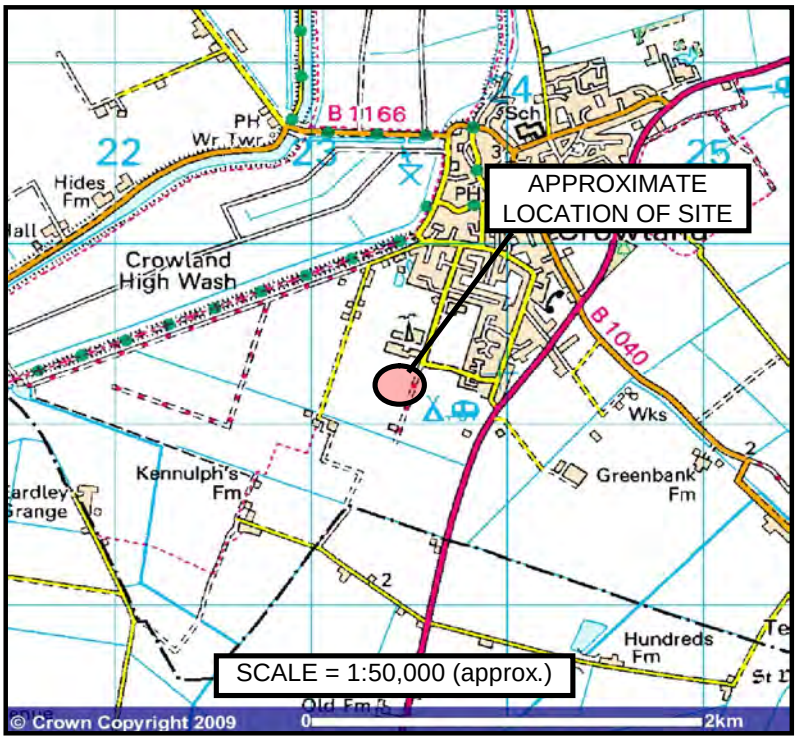
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Project Title	CREASE DROVE, CROWLAND	
Drawing Title	SITE LOCATION PLAN	
Drawing Status	FOR REPORT PURPOSES	Date: April 2009
Drawing No.	NTW/300/FIGURE 1	Scale: AS SHOWN

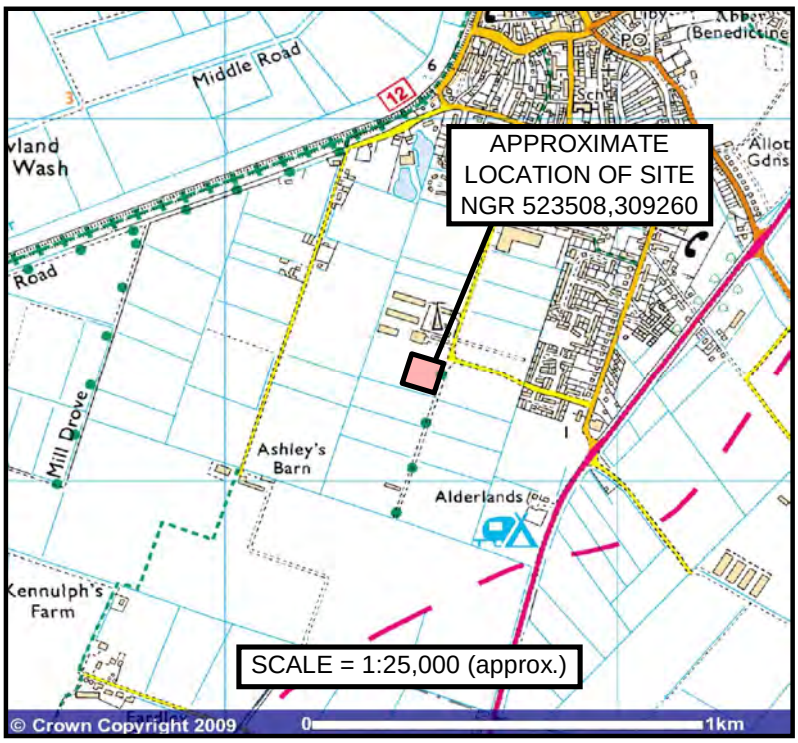
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Figure 2

Indicative Flood Zone Mapping

Client	SOUTH HOLLAND DISTRICT COUNCIL
Project Title	CREASE DROVE, CROWLAND
Drawing Title	INDICATIVE FLOOD ZONE MAPPING
Drawing Status	FOR REPORT PURPOSES ONLY
Date	April 2009
Drawing No.	NTW/300/FIGURE 2
Scale	AS SHOWN

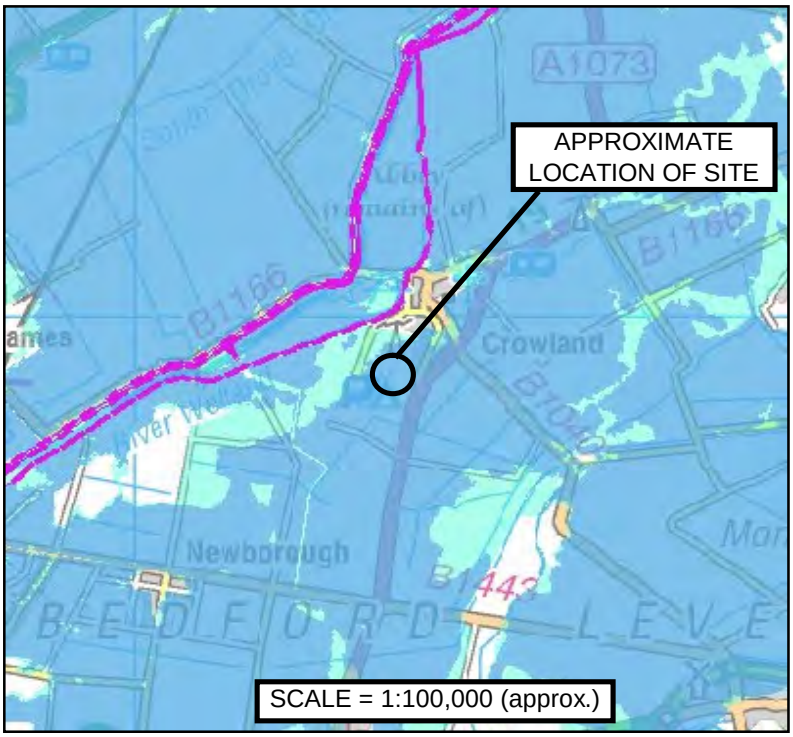
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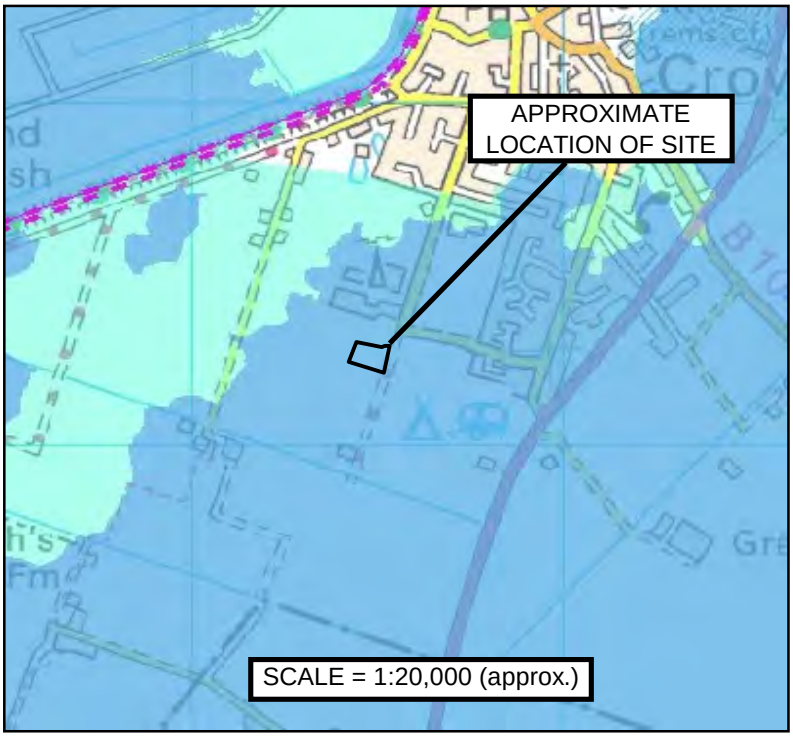
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Extracted From Environment Agency Website, April 2009



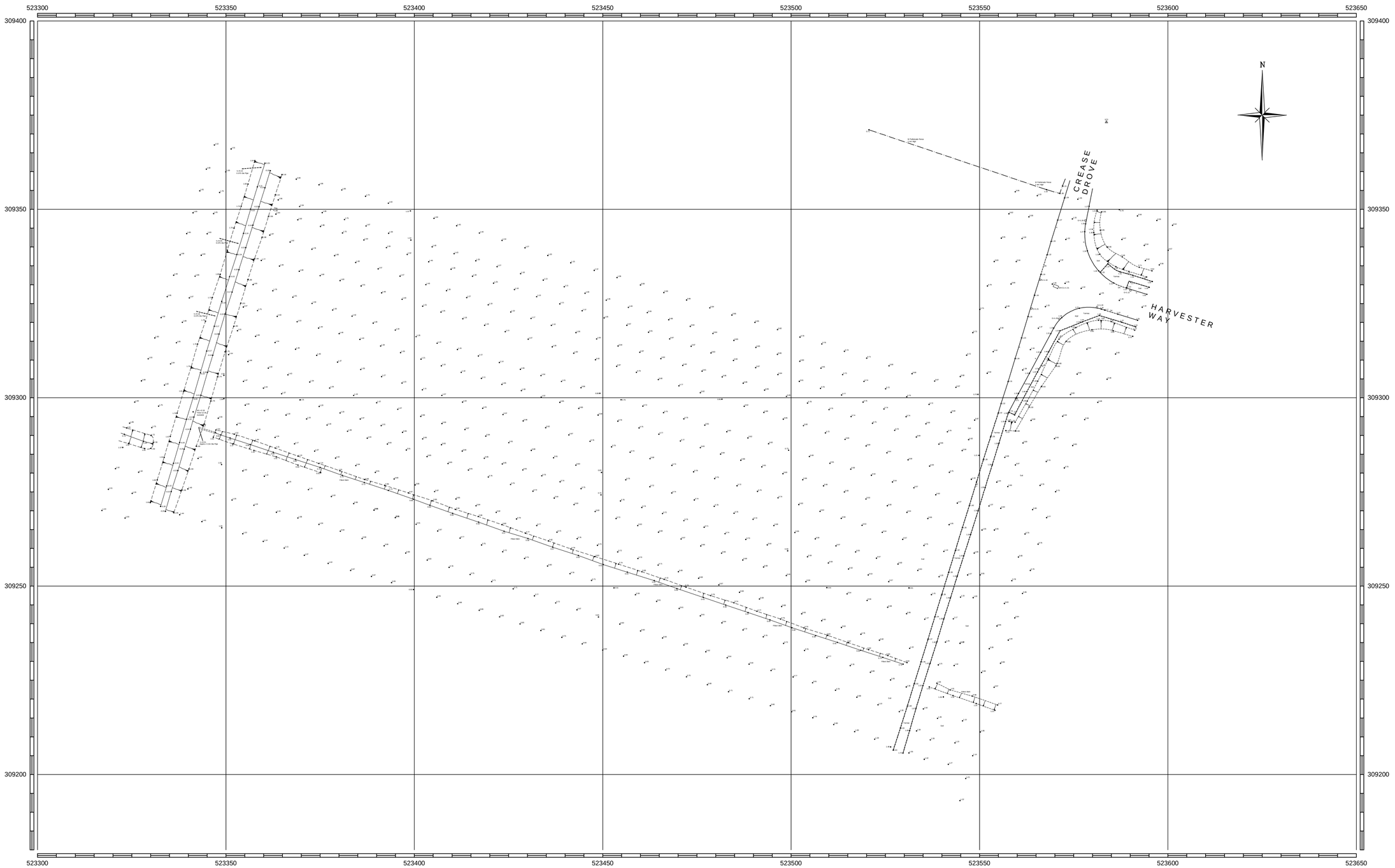


Key

- Flooding from rivers or sea without defences
- Extent of extreme flood
- Flood defences
- Areas benefiting from flood defences

Appendix A

Site Survey



NOTES

1. All co-ordinates are shown relative to Ordnance Survey National Grid System, established using GPS. (Global Positioning System).
2. All levels are shown relative to Ordnance Survey datum, established using GPS.

SURVEY STATIONS

Station Ref	Easting (m)	Northing (m)	Height (m)	
ST1	523559.757	309299.878	1.465	Nail
ST2	523583.670	309373.148	1.480	Nail

Fenceline Abbreviations

TP	Timber Post	R	Rail	WM	Wire Mesh
MP	Metal Post	P	Railing	CL	Chain Link
CP	Concrete Post	CB	Close Boarded	W	Wire
CI	Corrugated Iron	IR	Iron Railing	HM	Hit & Miss

- Top / Bottom of Bank
- Building / Overhead Canopy Line
- Wall
- Change of Surface
- Kerb / Dropped Kerb Line
- Drainage Channel
- Fence Line
- Hedge Line
- Tree / Scrub Canopy Line
- T — O/H Telephone Cable
- E — O/H Electricity Cables
- Rock Face

- CL= Cover Level
- 10.15 Spot Level
- UTL Unable to Lift
- BH 26.55 Borehole (with level)
- FFL= Finished Floor Level
- IL= Invert Level
- T.PIT 22.55 Trial Pit (with level)

- Survey Station
- MH Manhole
- CP Catchpit
- IC Inspection Cover
- UTS Unable to Survey
- SC Service Cover
- FH Fire Hydrant
- GAS Gas Cover
- WM Water Meter
- SV Stop Valve
- WV Water Valve
- Mrk Marker Post
- ER Earth Rod Cover
- RE Rodding Eye
- EL Electricity Cover
- BT British Telecom
- CTV Cable
- TP Telephone Post
- EP Electricity Post
- LC Lamp Column
- SP Sign Post
- RS Road Sign
- TL Traffic Light
- BB Balisha Beacon
- G= Gulley
- KO Kerb Offset
- RWP Rain Water Pipe
- TCB Telephone Call Box
- LB Litter Bin
- Tree

Rev	Description	Date	Signed

Revisions

Client : **South Holland District Council**

Project :

PROPOSED DEVELOPMENT,
CREASE DROVE,
SPALDING,
LINCOLNSHIRE.

Title : **Topographical Survey**

Drawn **S.D.S.**	Checked **C.A.G.**		
Date **Mar 2009**	Scale **1:500**	Original Size A1	

Drawing No. SL2151/1

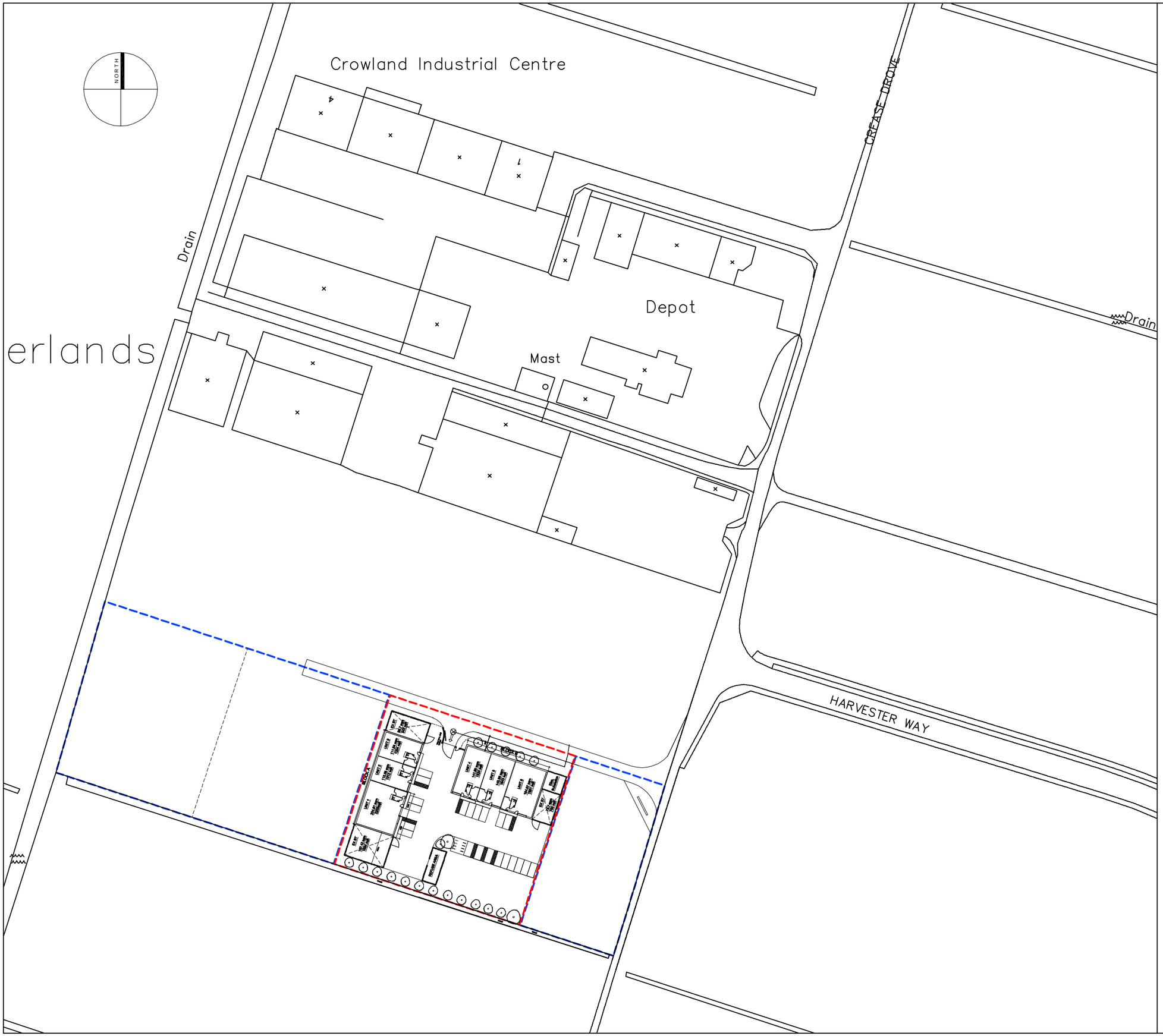
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Appendix B

Proposed Site Layout



Notes

Dimensions to be verified on site. Figured dimensions to take preference to those scaled; do not scale from drawings. All discrepancies to be clarified with project Architect.

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Revisions

Rev	Date	Text

Client	South Holland DC
Project	Crease Drove, Crowland
Drawing	Site Plan

Date	February 2009
Scale	1:1250 @ A3
Dwg. no.	P391 - P100

place : architecture

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t: 01522 546362 e: info@place-architecture.co.uk

Appendix C

Exiting Run-off

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.300
Area (Ha)	0.420	Urban	0.000
SAAR (mm)	550.000	Region Number	5

Results l/s

QBAR Rural	0.6
QBAR Urban	0.6
Q 1 year	0.5
Q 1 year	0.5
Q 30 years	1.4
Q 100 years	2.1

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Appendix D

Storage Volumes

Variables | Result | Design | Overview 2D | Overview 3D | Vt

Region: England & Wales

Return Period (years): 30

Map

M5-60 (mm): 19.000

Ratio R: 0.427

Cv (Summer): 0.750

Cv (Winter): 0.840

Impermeable Area (ha): 0.3

Maximum Allowable Discharge (l/s): 1.4

Infil Coefficient (m/hr):

Safety Factor: 2

Climate Change %: 0

Apply

Done

Help

Variables | **Result** | Design | Overview 2D | Overview 3D | Vt

Global Variables require approximate storage of between 83 m³ and 114 m³.

These values are estimates only and should not be used for design purposes.

Done

Help

Variables | Result | Design | Overview 2D | Overview 3D | Vt

Region: England & Wales

Return Period (years): 100

Map

M5-60 (mm): 19.000

Ratio R: 0.427

Cv (Summer): 0.750

Cv (Winter): 0.840

Impermeable Area (ha): 0.3

Maximum Allowable Discharge (l/s): 2.1

Infil Coefficient (m/hr):

Safety Factor: 2

Climate Change %: 0

Apply

Done

Help

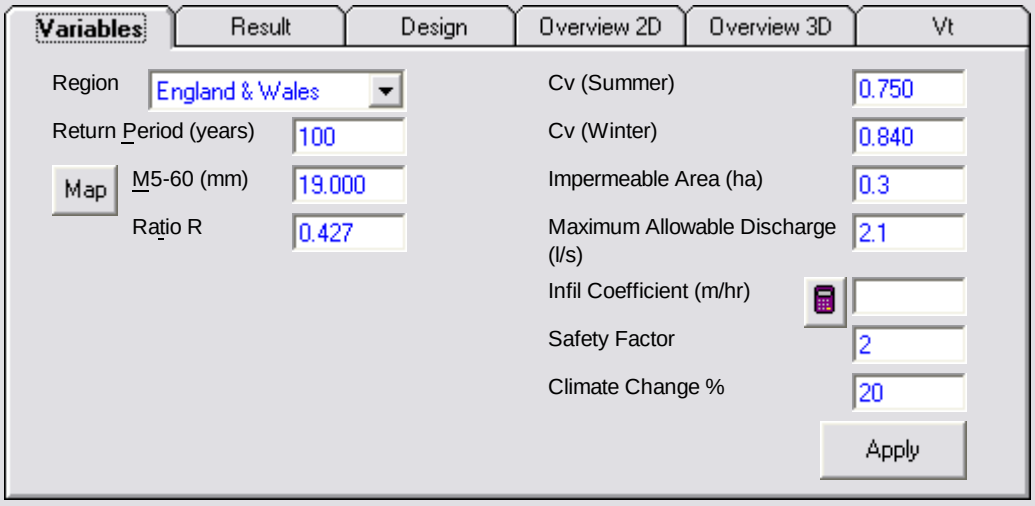
Variables | **Result** | Design | Overview 2D | Overview 3D | Vt

Global Variables require approximate storage of between 106 m³ and 142 m³.

These values are estimates only and should not be used for design purposes.

Done

Help


Variables
Result
Design
Overview 2D
Overview 3D
Vt
Region
England & Wales
Return Period (years)
100
Map
M5-60 (mm)
19.000
Ratio R
0.427
Cv (Summer)
0.750
Cv (Winter)
0.840
Impermeable Area (ha)
0.3
Maximum Allowable Discharge (l/s)
2.1
Infil Coefficient (m/hr)
Safety Factor
2
Climate Change %
20
Apply
Done
Help

Variables | **Result** | Design | Overview 2D | Overview 3D | Vt

Global Variables require approximate storage of between 133 m³ and 177 m³.

These values are estimates only and should not be used for design purposes.

Done | Help

Summary of Results for 30 year Return Period

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m³)	Maximum Volume (m³)	Status
15 Summer	0.9	0.0	0.9	0.4392	0.4392	0.0	40.7	O K
30 Summer	1.1	0.0	1.1	0.5607	0.5607	0.0	51.9	O K
60 Summer	1.2	0.0	1.2	0.6773	0.6773	0.0	62.7	O K
120 Summer	1.3	0.0	1.3	0.7818	0.7818	0.0	72.4	O K
180 Summer	1.3	0.0	1.3	0.8308	0.8308	0.0	76.9	FLOOD RISK
240 Summer	1.3	0.0	1.3	0.8553	0.8553	0.0	79.2	FLOOD RISK
360 Summer	1.3	0.0	1.3	0.8703	0.8703	0.0	80.6	FLOOD RISK
480 Summer	1.3	0.0	1.3	0.8653	0.8653	0.0	80.1	FLOOD RISK
600 Summer	1.3	0.0	1.3	0.8583	0.8583	0.0	79.5	FLOOD RISK
720 Summer	1.3	0.0	1.3	0.8493	0.8493	0.0	78.6	FLOOD RISK
960 Summer	1.3	0.0	1.3	0.8288	0.8288	0.0	76.7	FLOOD RISK
1440 Summer	1.3	0.0	1.3	0.7828	0.7828	0.0	72.5	O K
2160 Summer	1.2	0.0	1.2	0.7158	0.7158	0.0	66.3	O K
2880 Summer	1.2	0.0	1.2	0.6548	0.6548	0.0	60.6	O K
4320 Summer	1.1	0.0	1.1	0.5497	0.5497	0.0	50.9	O K
5760 Summer	1.0	0.0	1.0	0.4627	0.4627	0.0	42.9	O K
7200 Summer	0.9	0.0	0.9	0.3887	0.3887	0.0	36.0	O K
8640 Summer	0.8	0.0	0.8	0.3237	0.3237	0.0	30.0	O K
10080 Summer	0.8	0.0	0.8	0.2622	0.2622	0.0	24.3	O K
15 Winter	1.0	0.0	1.0	0.4927	0.4927	0.0	45.6	O K
30 Winter	1.1	0.0	1.1	0.6293	0.6293	0.0	58.3	O K
60 Winter	1.2	0.0	1.2	0.7618	0.7618	0.0	70.5	O K
120 Winter	1.3	0.0	1.3	0.8823	0.8823	0.0	81.7	FLOOD RISK
180 Winter	1.4	0.0	1.4	0.9398	0.9398	0.0	87.0	FLOOD RISK
240 Winter	1.4	0.0	1.4	0.9713	0.9713	0.0	90.0	FLOOD RISK
360 Winter	1.4	0.0	1.4	0.9953	0.9953	0.0	92.2	FLOOD RISK
480 Winter	1.4	0.0	1.4	0.9968	0.9968	0.0	92.3	FLOOD RISK
600 Winter	1.4	0.0	1.4	0.9863	0.9863	0.0	91.3	FLOOD RISK
720 Winter	1.4	0.0	1.4	0.9728	0.9728	0.0	90.1	FLOOD RISK
960 Winter	1.4	0.0	1.4	0.9483	0.9483	0.0	87.8	FLOOD RISK
1440 Winter	1.3	0.0	1.3	0.8858	0.8858	0.0	82.0	FLOOD RISK
2160 Winter	1.3	0.0	1.3	0.7883	0.7883	0.0	73.0	O K
2880 Winter	1.2	0.0	1.2	0.6998	0.6998	0.0	64.8	O K
4320 Winter	1.1	0.0	1.1	0.5517	0.5517	0.0	51.1	O K
5760 Winter	0.9	0.0	0.9	0.4332	0.4332	0.0	40.1	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	73.62	19
30 Summer	47.45	34
60 Summer	29.24	64
120 Summer	17.51	122
180 Summer	12.85	182
240 Summer	10.27	242
360 Summer	7.46	360
480 Summer	5.94	448
600 Summer	4.98	500
720 Summer	4.31	562
960 Summer	3.43	692
1440 Summer	2.48	966
2160 Summer	1.79	1384
2880 Summer	1.42	1788
4320 Summer	1.03	2592
5760 Summer	0.81	3352
7200 Summer	0.68	4112
8640 Summer	0.59	4848
10080 Summer	0.52	5640
15 Winter	73.62	19
30 Winter	47.45	33
60 Winter	29.24	62
120 Winter	17.51	120
180 Winter	12.85	178
240 Winter	10.27	236
360 Winter	7.46	350
480 Winter	5.94	458
600 Winter	4.98	560
720 Winter	4.31	584
960 Winter	3.43	732
1440 Winter	2.48	1040
2160 Winter	1.79	1492
2880 Winter	1.42	1928
4320 Winter	1.03	2764
5760 Winter	0.81	3568

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Summary of Results for 30 year Return Period

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m^3)	Maximum Volume (m^3)	Status
7200 Winter	0.8	0.0	0.8	0.3312	0.3312	0.0	30.7	O K
8640 Winter	0.8	0.0	0.8	0.2287	0.2287	0.0	21.2	O K
10080 Winter	0.8	0.0	0.8	0.1303	0.1303	0.0	12.1	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
7200 Winter	0.68	4392
8640 Winter	0.59	5104
10080 Winter	0.52	5552

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Summary of Results for 100 year Return Period

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m³)	Maximum Volume (m³)	Status
15 Summer	1.5	0.0	1.5	0.4552	0.4552	0.0	52.6	O K
30 Summer	1.6	0.0	1.6	0.5842	0.5842	0.0	67.5	O K
60 Summer	1.8	0.0	1.8	0.7068	0.7068	0.0	81.6	O K
120 Summer	1.9	0.0	1.9	0.8113	0.8113	0.0	93.7	FLOOD RISK
180 Summer	2.0	0.0	2.0	0.8543	0.8543	0.0	98.7	FLOOD RISK
240 Summer	2.0	0.0	2.0	0.8713	0.8713	0.0	100.6	FLOOD RISK
360 Summer	2.0	0.0	2.0	0.8688	0.8688	0.0	100.3	FLOOD RISK
480 Summer	2.0	0.0	2.0	0.8553	0.8553	0.0	98.8	FLOOD RISK
600 Summer	2.0	0.0	2.0	0.8408	0.8408	0.0	97.1	FLOOD RISK
720 Summer	1.9	0.0	1.9	0.8258	0.8258	0.0	95.4	FLOOD RISK
960 Summer	1.9	0.0	1.9	0.7948	0.7948	0.0	91.8	O K
1440 Summer	1.8	0.0	1.8	0.7328	0.7328	0.0	84.6	O K
2160 Summer	1.7	0.0	1.7	0.6488	0.6488	0.0	74.9	O K
2880 Summer	1.6	0.0	1.6	0.5753	0.5753	0.0	66.4	O K
4320 Summer	1.5	0.0	1.5	0.4512	0.4512	0.0	52.1	O K
5760 Summer	1.3	0.0	1.3	0.3457	0.3457	0.0	39.9	O K
7200 Summer	1.3	0.0	1.3	0.2492	0.2492	0.0	28.8	O K
8640 Summer	1.3	0.0	1.3	0.1763	0.1763	0.0	20.4	O K
10080 Summer	1.3	0.0	1.3	0.1288	0.1288	0.0	14.8	O K
15 Winter	1.5	0.0	1.5	0.5102	0.5102	0.0	58.9	O K
30 Winter	1.7	0.0	1.7	0.6563	0.6563	0.0	75.8	O K
60 Winter	1.9	0.0	1.9	0.7958	0.7958	0.0	91.9	O K
120 Winter	2.0	0.0	2.0	0.9168	0.9168	0.0	105.9	FLOOD RISK
180 Winter	2.1	0.0	2.1	0.9693	0.9693	0.0	111.9	FLOOD RISK
240 Winter	2.1	0.0	2.1	0.9928	0.9928	0.0	114.7	FLOOD RISK
360 Winter	2.1	0.0	2.1	0.9993	0.9993	0.0	115.4	FLOOD RISK
480 Winter	2.1	0.0	2.1	0.9853	0.9853	0.0	113.8	FLOOD RISK
600 Winter	2.1	0.0	2.1	0.9648	0.9648	0.0	111.4	FLOOD RISK
720 Winter	2.1	0.0	2.1	0.9473	0.9473	0.0	109.4	FLOOD RISK
960 Winter	2.0	0.0	2.0	0.9073	0.9073	0.0	104.8	FLOOD RISK
1440 Winter	1.9	0.0	1.9	0.8208	0.8208	0.0	94.8	FLOOD RISK
2160 Winter	1.8	0.0	1.8	0.7003	0.7003	0.0	80.9	O K
2880 Winter	1.7	0.0	1.7	0.5958	0.5958	0.0	68.8	O K
4320 Winter	1.4	0.0	1.4	0.4212	0.4212	0.0	48.7	O K
5760 Winter	1.3	0.0	1.3	0.2592	0.2592	0.0	30.0	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	95.44	19
30 Summer	62.03	33
60 Summer	38.41	64
120 Summer	23.03	122
180 Summer	16.87	182
240 Summer	13.46	242
360 Summer	9.72	358
480 Summer	7.71	408
600 Summer	6.45	470
720 Summer	5.56	532
960 Summer	4.41	666
1440 Summer	3.17	940
2160 Summer	2.28	1360
2880 Summer	1.80	1760
4320 Summer	1.29	2552
5760 Summer	1.02	3296
7200 Summer	0.85	4032
8640 Summer	0.73	4664
10080 Summer	0.64	5248
15 Winter	95.44	19
30 Winter	62.03	33
60 Winter	38.41	62
120 Winter	23.03	120
180 Winter	16.87	178
240 Winter	13.46	236
360 Winter	9.72	346
480 Winter	7.71	450
600 Winter	6.45	488
720 Winter	5.56	562
960 Winter	4.41	714
1440 Winter	3.17	1022
2160 Winter	2.28	1452
2880 Winter	1.80	1876
4320 Winter	1.29	2720
5760 Winter	1.02	3456

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Summary of Results for 100 year Return Period

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m^3)	Maximum Volume (m^3)	Status
7200 Winter	1.3	0.0	1.3	0.1368	0.1368	0.0	15.8	O K
8640 Winter	1.3	0.0	1.3	0.0953	0.0953	0.0	11.0	O K
10080 Winter	1.1	0.0	1.1	0.0843	0.0843	0.0	9.7	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
7200 Winter	0.85	3968
8640 Winter	0.73	4416
10080 Winter	0.64	5144

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m³)	Maximum Volume (m³)	Status
15 Summer	1.4	0.0	1.4	0.4367	0.4367	0.0	63.3	O K
30 Summer	1.6	0.0	1.6	0.5622	0.5622	0.0	81.5	O K
60 Summer	1.8	0.0	1.8	0.6833	0.6833	0.0	99.0	O K
120 Summer	1.9	0.0	1.9	0.7903	0.7903	0.0	114.5	O K
180 Summer	2.0	0.0	2.0	0.8393	0.8393	0.0	121.6	FLOOD RISK
240 Summer	2.0	0.0	2.0	0.8628	0.8628	0.0	125.0	FLOOD RISK
360 Summer	2.0	0.0	2.0	0.8738	0.8738	0.0	126.6	FLOOD RISK
480 Summer	2.0	0.0	2.0	0.8663	0.8663	0.0	125.5	FLOOD RISK
600 Summer	2.0	0.0	2.0	0.8553	0.8553	0.0	123.9	FLOOD RISK
720 Summer	2.0	0.0	2.0	0.8438	0.8438	0.0	122.2	FLOOD RISK
960 Summer	1.9	0.0	1.9	0.8188	0.8188	0.0	118.7	FLOOD RISK
1440 Summer	1.9	0.0	1.9	0.7678	0.7678	0.0	111.3	O K
2160 Summer	1.8	0.0	1.8	0.6958	0.6958	0.0	100.8	O K
2880 Summer	1.7	0.0	1.7	0.6308	0.6308	0.0	91.4	O K
4320 Summer	1.5	0.0	1.5	0.5202	0.5202	0.0	75.4	O K
5760 Summer	1.4	0.0	1.4	0.4262	0.4262	0.0	61.8	O K
7200 Summer	1.3	0.0	1.3	0.3432	0.3432	0.0	49.7	O K
8640 Summer	1.3	0.0	1.3	0.2647	0.2647	0.0	38.4	O K
10080 Summer	1.3	0.0	1.3	0.1997	0.1997	0.0	28.9	O K
15 Winter	1.5	0.0	1.5	0.4897	0.4897	0.0	71.0	O K
30 Winter	1.7	0.0	1.7	0.6313	0.6313	0.0	91.5	O K
60 Winter	1.9	0.0	1.9	0.7683	0.7683	0.0	111.3	O K
120 Winter	2.0	0.0	2.0	0.8913	0.8913	0.0	129.2	FLOOD RISK
180 Winter	2.1	0.0	2.1	0.9493	0.9493	0.0	137.6	FLOOD RISK
240 Winter	2.1	0.0	2.1	0.9793	0.9793	0.0	141.9	FLOOD RISK
360 Winter	2.1	0.0	2.1	0.9993	0.9993	0.0	144.8	FLOOD RISK
480 Winter	2.1	0.0	2.1	0.9978	0.9978	0.0	144.6	FLOOD RISK
600 Winter	2.1	0.0	2.1	0.9853	0.9853	0.0	142.8	FLOOD RISK
720 Winter	2.1	0.0	2.1	0.9678	0.9678	0.0	140.2	FLOOD RISK
960 Winter	2.1	0.0	2.1	0.9388	0.9388	0.0	136.1	FLOOD RISK
1440 Winter	2.0	0.0	2.0	0.8713	0.8713	0.0	126.2	FLOOD RISK
2160 Winter	1.9	0.0	1.9	0.7688	0.7688	0.0	111.4	O K
2880 Winter	1.8	0.0	1.8	0.6758	0.6758	0.0	97.9	O K
4320 Winter	1.5	0.0	1.5	0.5192	0.5192	0.0	75.2	O K
5760 Winter	1.4	0.0	1.4	0.3867	0.3867	0.0	56.1	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	114.53	19
30 Summer	74.43	34
60 Summer	46.10	64
120 Summer	27.63	122
180 Summer	20.24	182
240 Summer	16.15	242
360 Summer	11.66	360
480 Summer	9.26	458
600 Summer	7.73	510
720 Summer	6.68	570
960 Summer	5.29	696
1440 Summer	3.81	970
2160 Summer	2.73	1384
2880 Summer	2.16	1792
4320 Summer	1.55	2596
5760 Summer	1.22	3400
7200 Summer	1.02	4112
8640 Summer	0.87	4840
10080 Summer	0.77	5456
15 Winter	114.53	19
30 Winter	74.43	33
60 Winter	46.10	62
120 Winter	27.63	120
180 Winter	20.24	178
240 Winter	16.15	236
360 Winter	11.66	350
480 Winter	9.26	460
600 Winter	7.73	564
720 Winter	6.68	600
960 Winter	5.29	740
1440 Winter	3.81	1052
2160 Winter	2.73	1492
2880 Winter	2.16	1932
4320 Winter	1.55	2768
5760 Winter	1.22	3576

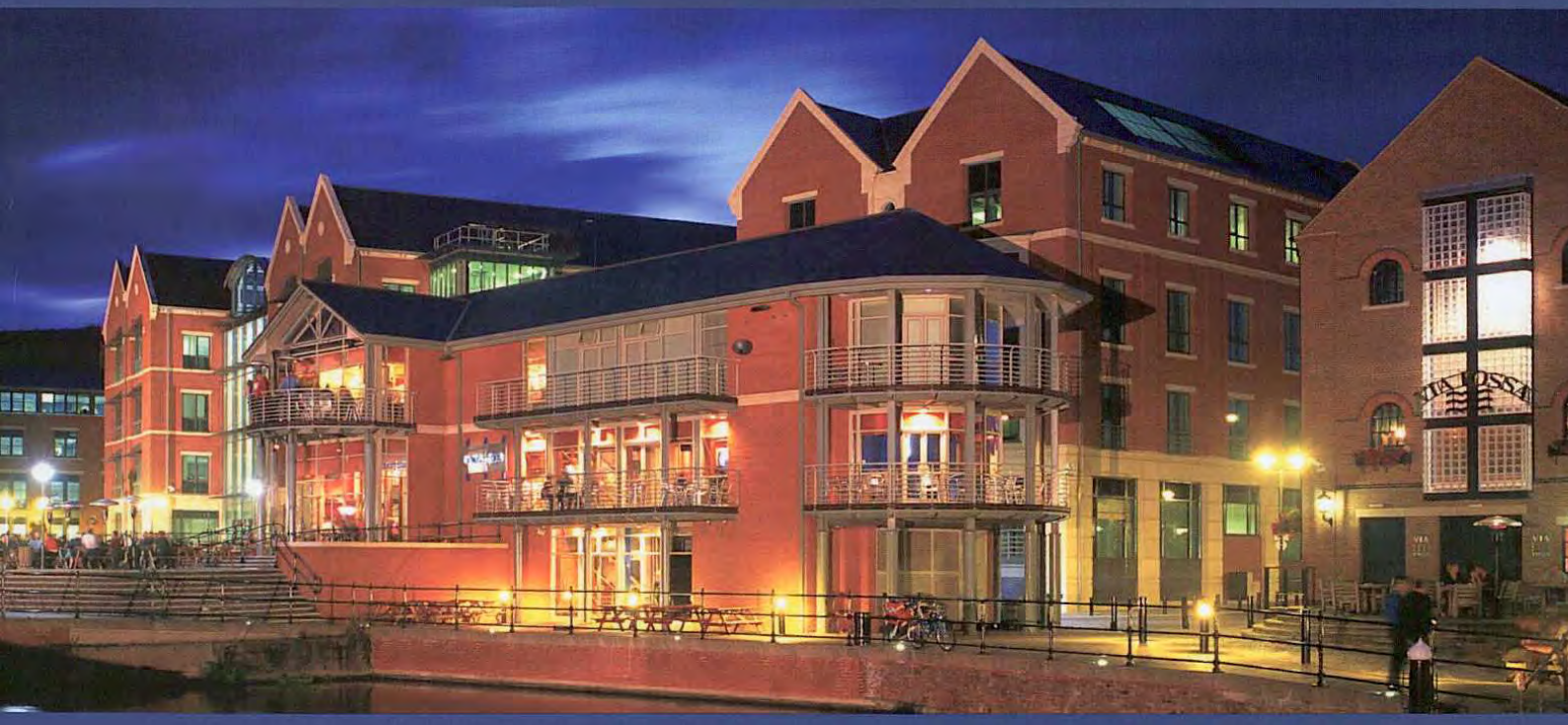
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Summary of Results for 100 year Return Period (+20%)

Storm Duration (mins)	Maximum Control (l/s)	Maximum Overflow (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Overflow Volume (m^3)	Maximum Volume (m^3)	Status
7200 Winter	1.3	0.0	1.3	0.2567	0.2567	0.0	37.2	O K
8640 Winter	1.3	0.0	1.3	0.1533	0.1533	0.0	22.2	O K
10080 Winter	1.3	0.0	1.3	0.1008	0.1008	0.0	14.6	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
7200 Winter	1.02	4320
8640 Winter	0.87	4848
10080 Winter	0.77	5240

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