

16-0177

FLOOD RISK ASSESSMENT AND SUSTAINABLE DRAINAGE ASSESSMENT

FOR

CREASE DROVE

AT

CROWLAND

REVISION 1.0

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Revision

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PREFACE

- a) This Flood Risk Assessment and/or opinion has been prepared for the specific purpose stated therein.
- b) The Flood Risk Assessment has been prepared for the exclusive use by:-
- Messrs Adcocks and their agents Barker Storey Matthews
 - Local Authority (South Holland District Council)
 - Environment Agency (EA)
- c) This document is issued only to the persons stated above and on the understanding that this Practice is not held responsible for the actions of others who obtain any unauthorised disclosure of its contents, or place reliance on any part of its findings, facts or opinions, be they specifically stated or implied.
- d) This study is a risk based assessment of potential flooding issues at the study site and the information presented and the conclusions drawn are for guidance only and provide no guarantee against flooding.

1.0 INTRODUCTION

This Flood Risk Assessment has been prepared on behalf of Barker Storey Matthews to support an outline planning application for the proposed redevelopment of the former Adcocks drink company site off Crease Drove Crowland and to assess the Flood Risk impact of the development on the surrounding area. It also incorporates a SuDS strategy for the proposed drainage to the site to provide sufficient information on the design for the site to gain approval by Lincolnshire County Council (LCC) as Lead Local Flood Authority.

This report has been written and formatted generally in accordance with the requirements outlined in National Planning Policy Framework (NPPF) and its technical guidance. To further assist the checking process included in Appendix F is an EA checklist identifying its location within the report.

2.0 SITE SUMMARY

The proposed development is located to the south of Crowland in the district of South Holland. It is bounded by Crease Drove to the west, Alderlands Close dwellings to the north, Beccelm Drive dwellings to the east and open fields to the south. The approximate total site area is 1.54Ha. The grid reference for the centre of the site is as follows,

Description	Grid Reference	X	Y	Latitude	Longitude	Postcode
Crowland	TF23739 09663	523739	309663	52.670559	-0.1714977	PE6 0BN

A Location plan of the site is included in Appendix A.

3.0 SITE LEVELS – EXISTING AND PROPOSED

3.1 EXISTING LEVELS

From a review of information available, the site levels across the site fall generally in an easterly direction. The existing parking area and building are generally level at approximately 2.50m and this falls to the east to a level of 1.21 in the south east corner.

The existing levels are indicated in Appendix C within the background of the proposed levels plan.

3.2 PROPOSED LEVELS

The proposed site levels (and Floor Levels) for the proposed development will be dictated by the existing ground levels within and surrounding the site together with the proposed drainage strategy. This will allow the current above ground surface water flow routes to be maintained in a direction beyond the buildings to the east.

The proposed level plan is included in Appendix C

4.0 EXISTING SITE DRAINAGE SYSTEM

The existing site consists of a substantial paved and roof area in excess of 3000m² and therefore the potential for a substantial peak flow. Also a previous building which similarly would have had a substantial peak flow has recently been removed. From the Anglian Water (AW) Asset information, the topographical survey and information obtained from North Level District Internal Drainage Board, the existing site drainage appears to drain into the adjacent field drain to the north of the site and also towards the east of the site into a board Drain. However there does not appear to be any positive connections and water will tend to run-off from the hardstanding areas and roofs onto the ground and into the drain. It has also been determined that the North Level Drain to the East of the site has been culverted within the back gardens of the properties on Beccelm Drive and the field drain to the south of the site, identified on OS maps is not visible from site inspection and appears to have been filled in.

Refer to Appendix B for details of the existing drainage to the site.

5.0 EXISTING FLOOD ALLEVIATION MEASURES

The site is within a defended floodplain, as defined in Appendix 1 of the Environment Agency's 'Policy and Practice for the Protection of Floodplains' and is considered to be passive until such time as a flood greater than that for which the defences were designed occurs. The likelihood of flooding due to overtopping or failure of a flood defence embankment is considered to be small.

The North Level drainage area is protected by flood embankments of the Folly River, the River Welland and the Crowland and Cowbit Washes against a flood return period event of 1 in 100 years plus climate change.

The site and adjoining agricultural land is located within the North Level Internal Drainage Board district with the nearest 'main drain' open watercourse identified beyond the eastern boundary of the site. The existing site level varies between 1.20m and 2.90m AOD.

The existing standard of drainage for the Newborough district of the North Level Internal Drainage Board area is a minimum of 1 in 50 years return period, compatible with the Department of the Environment, Food and Rural Affairs Target level of service for rural drainage and flood defence works. Freeboard of a minimum 900mm is provided to the lowest land levels offering further storage in channel against higher return period flood events.

The site and surrounding land drains by gravity to the Board's Newborough Pumping Station to discharge into the River Welland.

Current maintenance standards within the North Level Internal Drainage Board district are very good.

During the operation and maintenance of its pumping stations, associated structures and channel systems, particularly those that could affect property, the Board seeks to maintain a general standard capable of providing flood protection to its district. A routine maintenance programme is in place to ensure that the Boards assets are commensurate with the standard of protection that is sought. However, bank slips, blocked culverts etc may occur from time to time and these matters are usually dealt with promptly.

The flood defences of the Folly River and River Welland are similarly well maintained by the Environment Agency and their asset condition regularly inspected.

The Crowland & Cowbit Washes are located some 1.00km north west of the site and provide protection against the 1 in 100 year flood event.

6.0 EXISTING FLUVIAL FLOOD RISKS

Included in Appendix D is the Environment Agency's flood plain map and correspondence. This identifies that the site is contained within flood zones 2 and 3 but this is based on the assumption that the flood defences do not exist. The flood levels associated with the in channel levels of the Crowland and Cowbit Washes are indicated as 4.43 and 5.37 for the 1% and 0.1% Annual Exceedance Probability respectively. Refer to section 9.0 for further discussion.

7.0 IDENTIFICATION OF POTENTIAL FLOODING SOURCES

7.1 TIDAL/COASTAL

Due to the sites location, Tidal or coastal flooding is not considered to be an issue.

7.2 WATER COURSES

Four potential sources of flooding have been identified as a result of this assessment:

- a) Local blockages to IDB main drain
- b) Storm return period of 1 in 50 years being exceeded
- c) Failure of Newborough Pumping Station
- d) Breaching of fluvial flood embankments to the River Welland

The probability of flooding from source a) is low due to the maintenance standards already achieved and managed by the IDB.

The probability of flooding from b) is also low due to the Newborough main drain design standard incorporating a minimum 900mm freeboard to the lowest land level which provides adequate storage in events greater than 1 in 50 years.

Failure of Newborough Pumping Station may occur due to long term mechanical breakdown or power supply being disrupted. However in these circumstances, if conditions were such as to put properties and land at risk of flooding, the Internal Drainage Board would take emergency action to maintain the drainage level of service by utilising temporary pumping equipment. The probability of such an occurrence is also considered to be low.

The River Welland between Peakirk and Spalding is protected by fluvial embankments as part of the Environment Agency 'main river' under the terms of the Water Resources Act 1991. The Crowland and Cowbit Washes are also located alongside the River Welland and combined together offer protection of a minimum 1 in 100 year return period plus climate change.

The last time any breaching of flood defences occurred in this particular section of river was 1947, since when substantial investment has been made to improve the standard of protection.

The Crowland and Cowbit Washes flood embankment is a designated structure under the Reservoirs Act 1975. A flood study has been carried out by the Environment Agency to meet the legislation requirements and one small recommendation to review and update the current flood operational procedures has been completed.

The Folly River upstream of Peakirk Pumping Station is similarly protected by fluvial embankments. The Pumping Station operated by the Environment Agency is part electrical, part diesel powered and with the fluvial embankments offer protection against a 1 in 100 year return period event.

The risk of a breach or overtopping occurring to the River Welland and Folly River defences is considered remote.

7.3 GROUNDWATER

The ground conditions indicated on the BGS geology survey indicate that the site is underlain by the Oxford Clay formation which is predominantly impermeable.

Groundwater flooding is not known to be an issue historically with no previous indications of groundwater flooding and therefore groundwater flooding is considered unlikely to be an issue.

7.4 PONDS/ LAKES

The nearest ponds/lakes to the site are those within the Crowland washes to the north west of Crowland. This is within the River Welland and Crowland and Cowbit washes which is protected by the existing embankment and is therefore unlikely to be an issue to the site. The potential for reservoir flooding is contained in Appendix D and indicates that the site is within the zone of influence although this is explained in more detail in section 9.

7.5 ARTIFICIAL SOURCES

The Indicative surface water flooding map contained in Appendix D identifies minor flooding potential within the site. Due to the topography this would be directed towards the field boundary ditches. However due to the relatively flat nature of the site, localised ponding may occur which will dissipate following a storm event.

8.0 ANALYSIS OF PROPOSED DEVELOPMENT AND SITE DRAINAGE SYSTEM

8.1 PROPOSED DEVELOPMENT

The proposed development will consist of residential units including an access road and parking areas. The existing and proposed site plan is indicated in Appendix E.

The proposals will necessitate additional roof and hard surface areas and will thus have the potential to increase surface water runoff from the existing site.

8.2 PRELIMINARY SURFACE WATER DRAINAGE ASSESSMENT

In discussions with Lincolnshire county council the proposed drainage strategy has been developed to generate the current site plan. This provides sufficient space for a swale to convey the highway drainage and also a balancing pond to provide suitable surface water balancing for the site. Private surface water drainage is also directed through permeable paving and restricted discharges to adjacent drainage systems. The discharge into the North Level IDB drainage system will require approval during the detailed drainage design process.

8.3 PRELIMINARY DRAINAGE/SUDS DESIGN

The preliminary drainage design below is split into quantity (flow and volume) and quality in accordance with the latest Ciria and EA guidance.

8.3.1 Design to limit flow and volume

The proposed drainage strategy has been split into several areas each with independent outfalls to the existing drain to the north of the site. These are split into 3 separate areas A,B and C as follows, (Refer to Appendix E for the location of these areas)

- Area A incorporates several houses and a private access road to the north west of the site
- Area B incorporates several Houses and a private access road to the north east of the site
- Area C incorporates the access road and all the houses to the south of the access road

8.3.1.1 Area A

Area A incorporates several houses and a private drive and parking bays. It is proposed to utilise a permeable paving system which will be deep enough to accommodate the external run-off and roof run-off from the houses. The impermeable area is approximately 1040m² and the approximate permeable paving extent is 330m². Drainage calculations indicated in Appendix E identify that the area can be restricted to a nominal flow using an orifice flow control to a nominal 0.7 l/s with the use of 750mm depth of sub-base. This could be reduced during the detailed design process by either increasing the area of paving or providing a void replacement storage system (ie Permavoid) in lieu of the granular material.

8.3.1.2 Area B

Area B incorporates several houses and a private drive and parking bays. It is proposed to utilise a permeable paving system which will be deep enough to accommodate the external run-off and roof run-off from the houses. The impermeable area is approximately 1740m² and the approximate permeable paving extent is 510m². Drainage calculations indicated in Appendix E identify that the area can be restricted to a nominal flow using an orifice flow control to a nominal 0.7 l/s with the use of 900mm depth of sub-base. This could be reduced during the detailed design process by either increasing the area of paving or providing a void replacement storage system (ie Permavoid) in lieu of the granular material. Also the two separate areas adjacent to the access road could be restricted into the storage system which could also reduce the depth of storage required.

8.3.1.3 Area C

Area C incorporates the southern side of the site, the access road, the north side of Crease Drove and the houses in the north east corner of the site. The access road is designed with a single crossfall into the proposed swale on the northern side of the road. This falls in an easterly direction towards the proposed balancing pond in the north east corner of the site. It is proposed to incorporate a piped drainage system to accept the eastern side of flows from Crease Drove carriageway via trapped gullies and restricted flows from the individual housing/parking blocks to the north east and south side of the access road. The impermeable area draining into the balancing pond is approximately 5720m² and the calculations in Appendix E identify the balancing pond size required to accommodate this impermeable area is 340m² to the base and 570 m² to the top with a restricted flow of 2.8 l/s.

8.3.2 Design to ensure water quality

In accordance with the Ciria Guidance SuDS manual C753, table 26.2, the pollution hazard level for the site is as follows,

Land Use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydrocarbons
Residential roofs	Very low	0.2	0.2	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads)	Low	0.5	0.4	0.4

Therefore based on the use of permeable paving for external runoff from private areas, together with the swale for the proposed carriageway, the indicative SuDS mitigation indices as identified in table 26.3 of the SuDS manual, for discharges to surface waters are as follows,

SuDS feature	TSS	Metals	Hydrocarbons
Permeable paving	0.7	0.6	0.7
Swale	0.5	0.6	0.6
Pond	0.7	0.7	0.5

With regards to the roof runoff mitigation it is recommended that where possible this is directed towards the permeable paving. The use of permeable paving, a swale and balancing pond would therefore satisfy the water quality criteria of C753.

8.3.3 Climate change and Dilapidation

National Planning Policy Framework (which sets out the government requirements for the management and reduction of flood risk in the land use planning process) requires the investigation of climate change on the proposed development. The guidance identifies that the storm intensity could be increased by between 20 and 40% by 2115 (Table 2). An average 30% climate change allowance should be used within the detailed drainage design for the development to accommodate this principal together with a freeboard to ensure the higher value could be accommodated. A dilapidation factor should also be applied to the storage system in accordance with best practice which will need to be considered during the detailed design process.

8.3.4 Maintenance of drainage features

The proposed external drainage system will consist of permeable paving within the parking areas, a swale for the carriageway and a balancing pond for the majority of the surface water storage. The private drainage system will be maintained by the property owners, the swale will be maintained by Lincolnshire County Council as part of the Highway and the main drainage network will be adopted by Anglian Water. The pond adoption will be either local authority as part of the open space or Management Company.

The recommended maintenance regime is set out in Appendix F.

9.0 ASSESSMENT, PROBABILITY AND RATE OF POTENTIAL FLOODING

9.1 PROBABILITY OF FLOODING

The probability of this brownfield development flooding from localised drainage systems is very low because of the existing standards of drainage within the IDB system. A sustainable drainage system will be designed to meet the requirements of North Level IDB and Building Regulations approval.

The probability of the site flooding with water from any main river system or from the arterial drainage system is less than 0.5% because of the standards of the existing flood defence systems and the location of the site.

If under very extreme events, levels of floodwater from Main River or arterial systems rose to such an extent that the site was affected, the situation would not be sudden. It is highly probable that sufficient time would be available to take precautionary actions to limit the extent and potential impacts of flooding.

The water levels in the drainage channels and main river systems will tend to rise as a result of the impacts of climate change. However, the existing systems and defences are such that the standard of protection to the site will be appropriate for the design life of the development (100 years). Finished floor levels will be at a minimum of 300mm above existing ground levels.

The site is located approximately 1.00km distance from the main river flood embankments and any overtopping or breaching of the defences is considered to have little effect on the development site. The site is shown in Flood Zone 1 of the South Holland Strategic Flood Risk Assessment in year 2115.

9.2 IMPACTS OF FLOODING

No significant impacts of flooding are anticipated.

Floor levels of the development will be at a minimum of 300mm above existing ground level offering additional protection against impacts arising from any extreme short duration, localised events.

The developer will ensure that the occupiers of the dwellings are sufficiently aware of the risk of flooding and the standard of the existing defences. The Environment Agency provides a Flood Warning Service which includes Flood Warning Codes and uses direct warning methods where the risks and impacts of flooding are high. Indirect warnings are provided to all flood risk areas, even those at low risk of flooding. The main method is media broadcasts via local radio and also by television. In addition to direct and indirect flood warnings, the Environment Agency operates a 24 hour a day Floodline Service providing advice and information on flooding, contact tel. no: 0845 988 1188.

The occupiers of the dwellings should register with the Environment Agency Floodline Direct Warnings Service to receive any future flood warnings.

Safe access and egress to the site is available onto Crowland Road towards the centre of Crowland which is identified at a higher level. Safe refuge is also available at first floor level of all the dwellings with no sleeping accommodation at ground floor level.

9.3 RESIDUAL RISK

The residual risk from extreme events is very low on this site, because of its location within an IDB drainage area and protection offered by existing flood defences.

Although shown in either Flood Zone 1 or Flood Zones 2 and 3 according to NPPF classification, the site has a very low risk of flooding due to the current standards of flood defence and surface water drainage with existing land levels. The site is not located within a Functional Flood Plain of any 'main river' or 'main drain'. The Environment Agency Flood Zone Maps have been produced irrespective of existing flood defences and standards of protection.

The risk of flooding is not increased in terms of probability by the proposed development.

In the extreme event of a serious blockage occurring to the IDB main drains coinciding with a high intensity, short duration storm, and protection will be afforded by the finished floor levels being at a minimum of 300mm above existing ground level.

The existing drainage system and proposed permeable paving will ensure surface water is conveyed below ground for storms up to the proposed design event. For events greater than this, the proposed site will direct surface water flows above ground beyond the new dwellings, following the proposed (and existing) topography. Local flooding will be limited to areas adjacent to new and existing kerbs and at low points in external areas which would be at an approximate maximum depth of 0.25m. Due to the relatively flat nature of the ground, the flow of flood water beyond these lower areas would be slow. These scenarios would place it in the category of low risk in accordance with figure 3.2 in document Flood Risks to People Phase 2 FD2321/TR1, which is identified below.

Velocity Coefficient C (V+C) * D		Depth									
Velocity		0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50
0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00	1.13	1.25	
0.50	0.25	0.50	0.75	1.00	1.25	1.50	1.75	2.00	2.25	2.50	
1.00	0.38	0.75	1.13	1.50	1.88	2.25	2.63	3.00	3.38	3.75	
1.50	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	
2.00	0.63	1.25	1.88	2.50	3.13	3.75	4.38	5.00	5.63	6.25	
2.50	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75	7.50	
3.00	0.88	1.75	2.63	3.50	4.38	5.25	6.13	7.00	7.88	8.75	
3.50	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	
4.00	1.13	2.25	3.38	4.50	5.63	6.75	7.88	9.00	10.13	11.25	
4.50	1.25	2.50	3.75	5.00	6.25	7.50	8.75	10.00	11.25	12.50	
5.00	1.38	2.75	4.13	5.50	6.88	8.25	9.63	11.00	12.38	13.75	

	From	To	
Class 1	0.75	1.25	Danger for some
Class 2	1.25	2.50	Danger for most
Class 3	2.50	20.00	Danger for all

Figure 3.2: Velocity, depth and flood hazard matrix

10.0 CONCLUSION

In conclusion, this Flood Risk Assessment and SuDS appraisal has been undertaken in accordance with National Planning Policy in relation to development and Flood Risk and LCC requirements in respect of the proposed development at Crease Drove Crowland.

The proposed development is not in a Functional Floodplain. It is in the Passive Floodplain of the River Welland and North Level IDB protected by defences to meet the 1 in 100 year return period fluvial event plus climate change.

Although the site is shown in either Flood Zone 1 or Flood Zones 2 and 3 the actual risk of the site flooding from Main River is very low (less than 0.5%).

The recommended mitigation measures are as follows,

- Proposed finished levels are set preferably 300mm above surrounding ground levels to suit practical access arrangements and no sleeping accommodation at ground floor.
- External levels should be arranged to direct any overland flows away from proposed buildings
- Ground conditions should be analysed (and permeability tests undertaken) to confirm the understanding that infiltration techniques will not be suitable for the site.
- The discharge of surface water from the site should be limited to pre-development flows and volumes utilising permeable paving for the private parking areas, a swale for the carriageway run off and a balancing pond for surface water storage, subject to detailed design and approval from North Level IDB.

Subject to the mitigation measures proposed, the development should not be subject to significant flood risk and furthermore should not increase the flood risk to the surrounding area.

In order to indicate NPPF and PCC compliance, Appendix G indicates a copy of the EA guidance note checklist and PCC planning SuDS checklist and its location within the report.

11.0 REFERENCES

- National Planning Policy Framework (NPPF) dated March 2012 by Communities and Local Government.
- Planning Practice Guidance – Flood Risk and Coastal Change dated April 2015 by Communities and Local Government.
- South Holland District Council Update of Strategic Flood Risk Assessment – Final Report , dated January 2010 by Royal Haskoning
- FRA Guidance Note 1 by the EA
- EA/DEFRA document W5-074/A/TR/1 revision E 'preliminary rainfall runoff management for new developments' dated January 2012
- EA/DEFRA document Flood Risks to People Phase 2 FD2321/TR1 dated March 2006

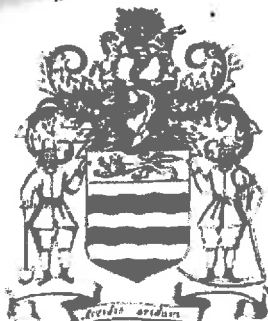
APPENDIX A - LOCATION PLAN



**APPENDIX B - EXISTING SITE DRAINAGE INFORMATION, NORTH LEVEL IDB AND
ANGLIAN WATER**

DRAFT

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NORTH LEVEL DISTRICT INTERNAL DRAINAGE BOARD

Drainage Office, Station Road, Thorney, Peterborough, PE6 0QE.

Telephone: 01733 270333 Facsimile: 01733 270231 Email: enq@northlevelidb.org Web: northlevelidb.org

Paul Sharman
Chief Executive

Edward Johnson
Operations Engineer

When calling or telephoning on this matter please ask for:

Our ref: **KT/F4**

Your ref:

Miss K. Tizzard

k.tizzard@northlevelidb.org

14th March 2016

Mr S. Pentlow,
Rolt Group Limited,
The Charles Parker Building,
Midland Road,
Higham Ferrers,
Northants,
NN10 8DN

Dear Mr Pentlow,

Flood Risk Assessment Information for Crease Drove, within the Newborough Catchment

I can confirm that Crease Drove, Crowland, falls within my Board's Newborough Pumping Station catchment area.

The North Level District Internal Drainage Board is a land drainage authority responsible for the drainage and evacuation of surplus water from 33,000 hectares of land bounded on the south by the River Nene and on the west by the River Welland. The Board is responsible for the improvement and maintenance of some 613 kilometres of watercourses and for the operation of 12 pumping stations.

Please find attached a plan highlighting in red the drains which my Board is responsible for in the Newborough Pumping Station catchment, however, please be aware that we do not own the freehold for the majority of these drains. I have enclosed a further plan indicating maximum design water levels at various points on the Board's network of drains. We are currently working on a hydraulic model of the entire catchment, but would suggest that my Board offers a standard of protection of greater than 1 in 50 years. To the best of my knowledge there is no known history of flooding in this area.

The Board's watercourses have been designed to provide a freeboard (the distance between land level and the level of water in the watercourse) of 0.9 metres above the water level of a 1 in 20 year flood event to the lowest general land levels in the District.

The Board's Newborough Pumping Station, which discharges into the River Welland through pipelines some 140 metres in length, was constructed in 1973 as part of the North Level Major Improvement Scheme. Evacuating surplus water from an area of 3320 hectares of predominantly agricultural land, the station also serves the expanding villages of Newborough, Crowland and Eye. The station consists of three 900 mm diameter mixed flow pumps powered by Brush VTQHA748, 200HP electric motors and has a total capacity of 273T/min or 6.64 cumecs. The pumps and motors are of all weather type, the electrical switch gear being housed in a brick built control building.

The drainage network is maintained annually with flail mowing and weed cutting of all watercourses carried out between August and December. The drains are also de-silted as and when required, usually on a five to ten year cycle.

The Board's byelaws stipulate a nine metre buffer zone from the brink of any Board's watercourse to the nearest part of any structure, and this will be strictly enforced. This applies to all structures including temporary and permanent structures, solar panels and wind turbines.

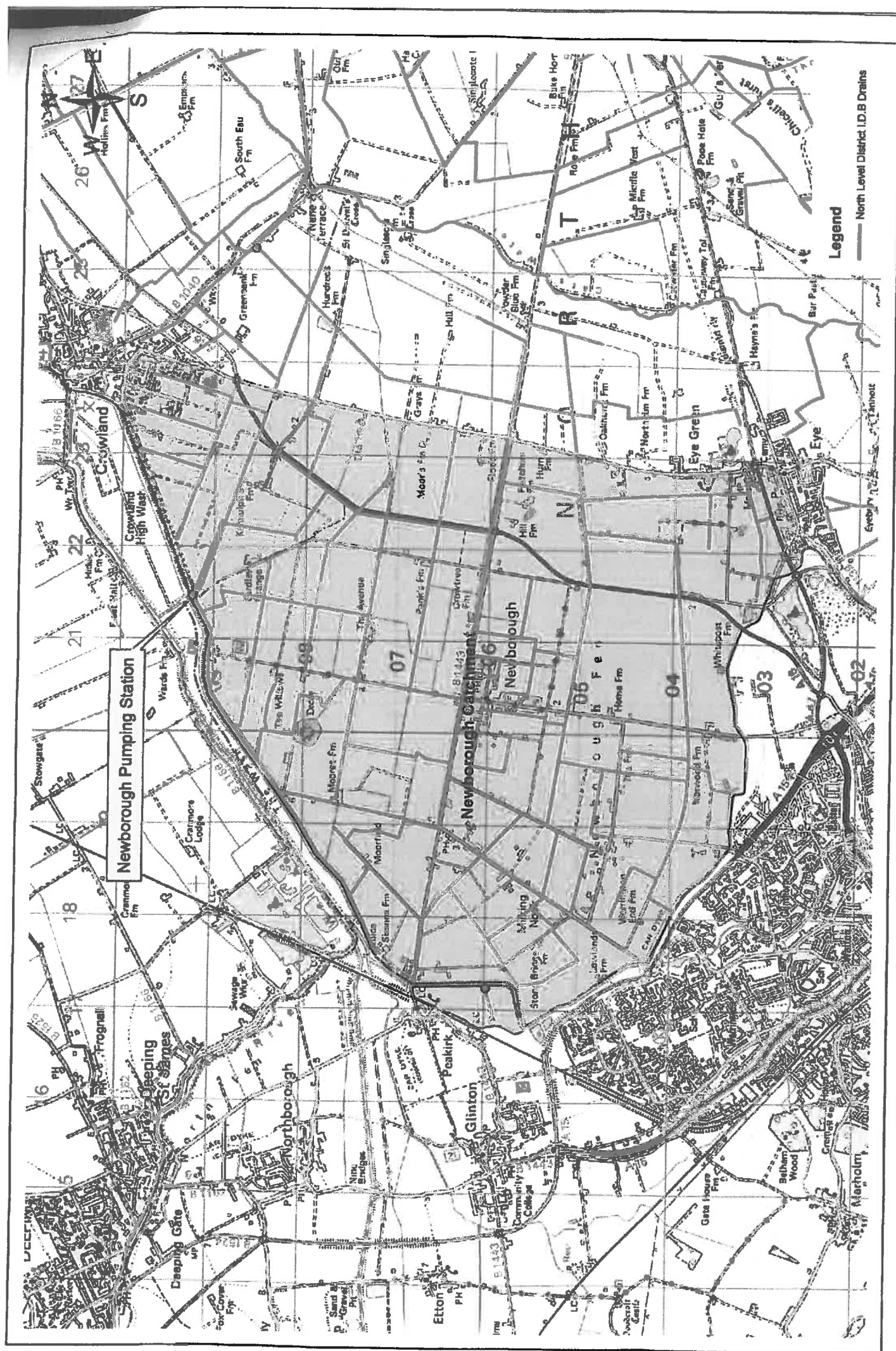
I hope the above is useful to you.

Yours sincerely,



Miss K. Tizzard BSc (Hons)
Engineering Technician

Enc: Newborough Catchment Plan
MDWL Map
Newborough Lane Pumping Station Location Map
Newborough Drain Flow Map



North Level District Internal Drainage Board
 1:50,000 K.Tizzard 2016

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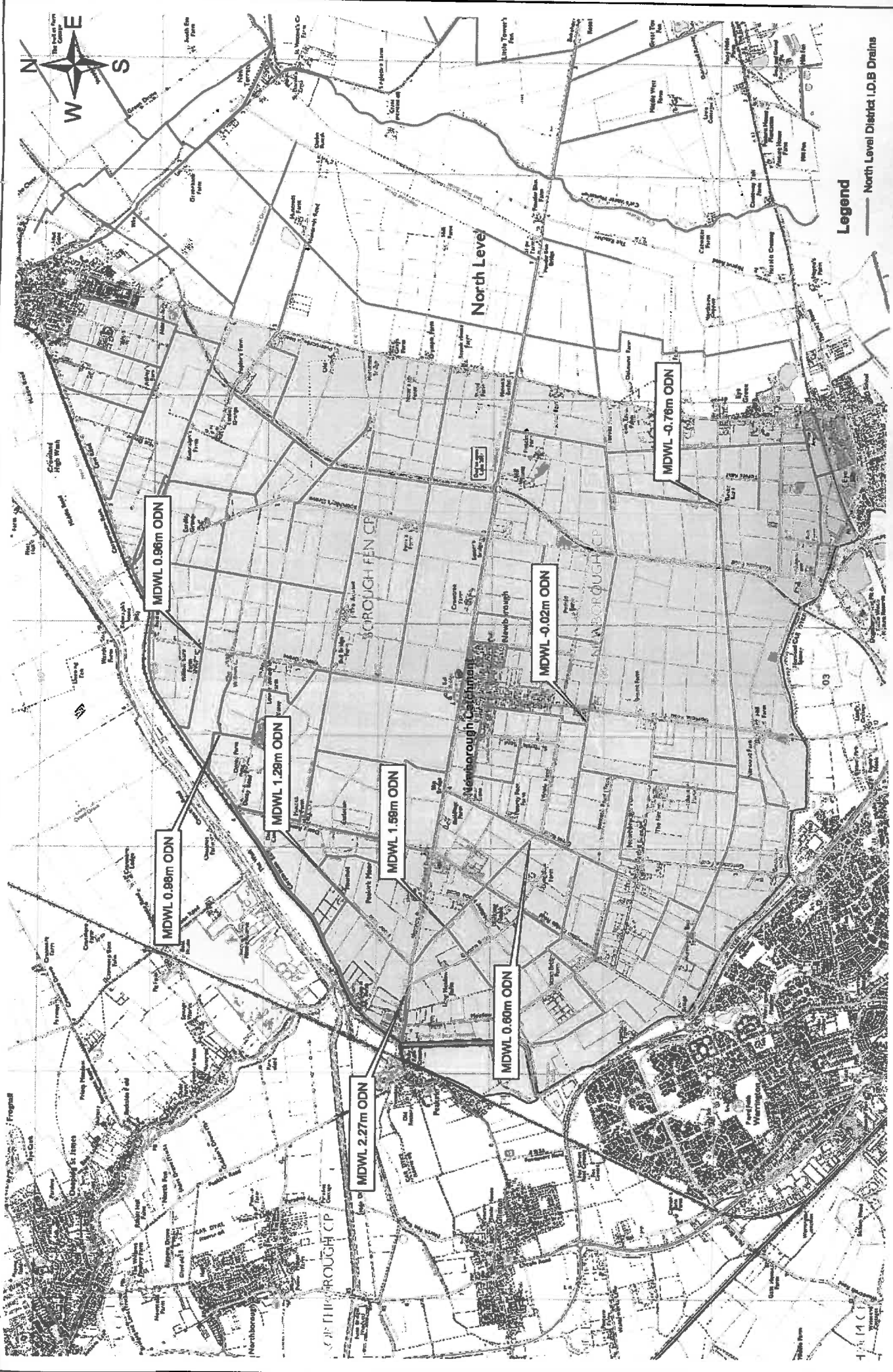


North Level District Internal Drainage Board

1:50,000 K. Tizzard 2016



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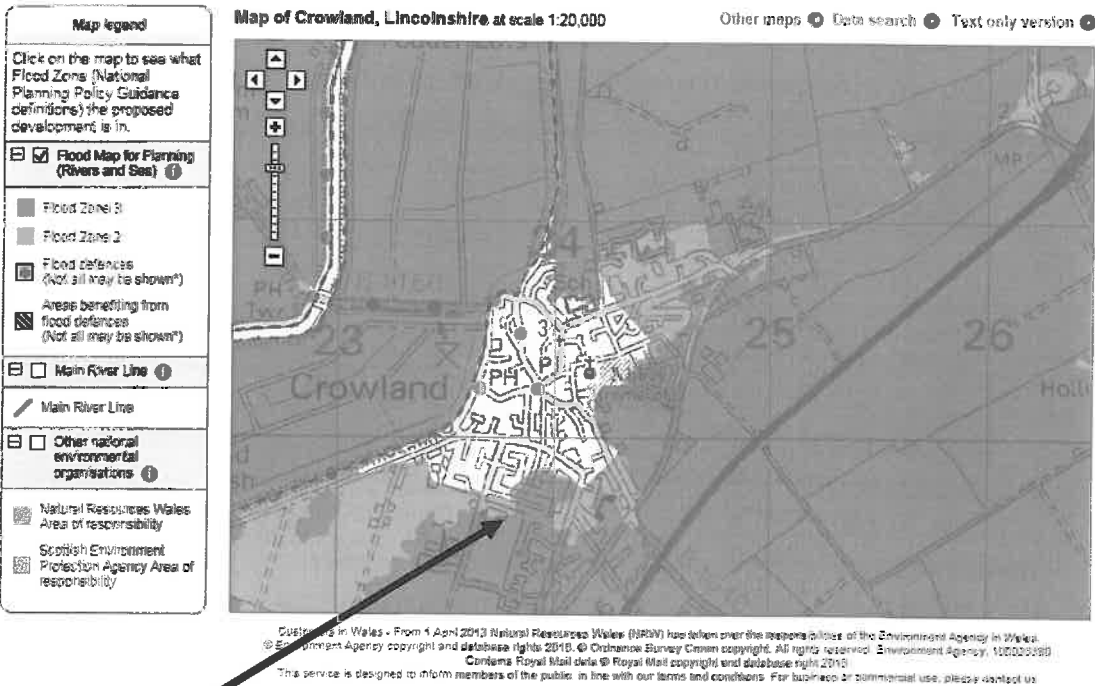


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APPENDIX C - PROPOSED AND EXISTING LEVELS

DRAFT

APPENDIX D - ENVIRONMENT AGENCY'S INDICATIVE FLOOD PLAIN MAP, RESERVOIR FLOODING MAP AND FLOODING INFORMATION AND PCC CORRESPONDANCE



Site Location

More about flooding:

Understanding the Flood Map for Planning (Rivers and Sea)

A more detailed explanation to help you understand the flood map shown above.

Current flood warnings

We provide flood warnings online 24 hours a day. Find out the current flood warning status in your local area.

* **Legend Information:** Flood defences and the areas benefiting from them are gradually being added through updates. Please contact your local environment agency office for further details.

Risk of Flooding from Reservoirs

Reservoir flooding is extremely unlikely to happen.

The shading on the map shows the area that could be flooded if a large reservoir were to fail and release the water it holds. A large reservoir is one that holds over 25,000 cubic metres of water, equivalent to approximately 10 Olympic sized swimming pools. Since this is a worst case scenario, it's unlikely that any actual flood would be this large.

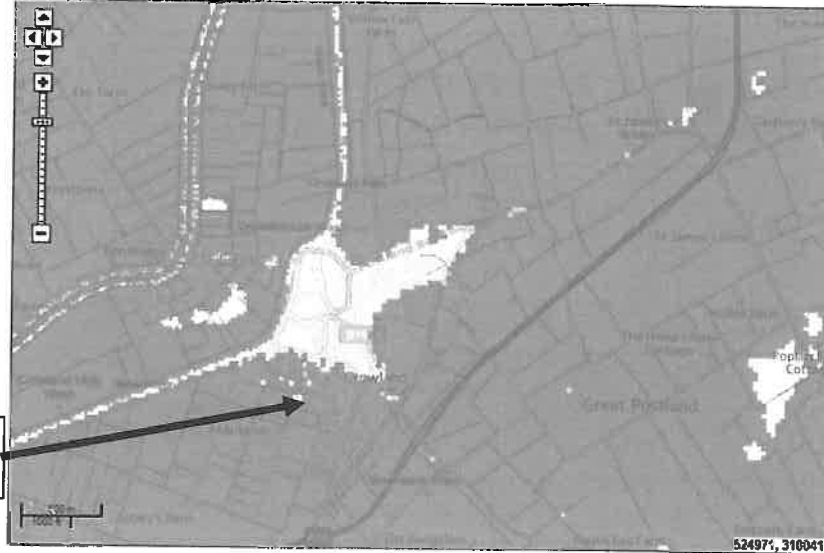
Click on the shading to see details of reservoirs that could cause flooding in this area.

Map of X: 524,500; Y: 310,600 at scale 1:20,000

Data search

Map legend	
☒	Risk of Flooding from Reservoirs
	Maximum extent of flooding
☒	Other national environmental organisations
	Natural Resources Wales Area of responsibility
	Scottish Environment Protection Agency Area of responsibility

Site Location



Customers in Wales - From 1 April 2013 Natural Resources Wales (NRW) will take over the responsibilities of the Environment Agency in Wales.
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Risk of Flooding from Surface Water

Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soaks into the ground, but lies on or flows over the ground instead.

The shading on the map shows the risk of flooding from surface water in this particular area.

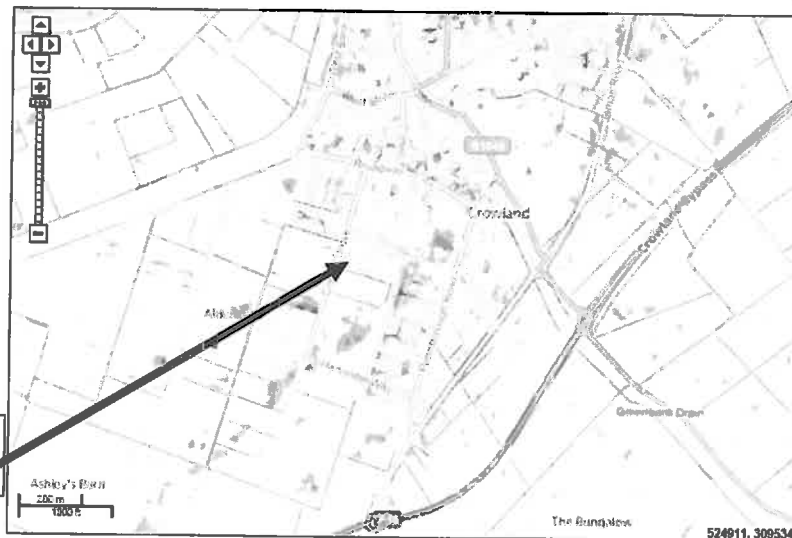
Click on the map for a more detailed explanation.

Map of X: 523,902; Y: 309,618 at scale 1:10,000

Data search

Map legend	
☒	Risk of Flooding from Surface Water
	High
	Medium
	Low
	Very Low
☒	Other national environmental organisations
	Natural Resources Wales Area of responsibility
	Scottish Environment Protection Agency Area of responsibility

Site Location



Customers in Wales - From 1 April 2013 Natural Resources Wales (NRW) will take over the responsibilities of the Environment Agency in Wales.
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Ms C Nimmo
<charlotte.nimmo@rolton.com>

Our ref: CCN/2016/3748
Your ref:

Date: 10 March 2016

Dear Charlotte

Basic Flood Risk Assessment Data Request for Crease Drove, Crowland. Grid Ref: TF 23779 09661

Thank you for your request of 22 February 2016 to use Environment Agency data, Product 3, in the development of the Flood Risk Assessment (FRA) for the above site. The information is attached.

If you have requested this information to help inform a development proposal, then you should note the detail in the attached advisory text on the use of Environment Agency Information for Flood Risk Assessments.

Flood Map

The attached map includes the current Flood Map for your area. The Flood Map indicates the area at risk of flooding, **assuming no flood defences exist**, for a flood event with a 0.5% chance of occurring in any year for flooding from the sea, or a 1% chance of occurring for fluvial (river) flooding. It also shows the extent of the Extreme Flood Outline which represents the extent of a flood event with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

The Flood Map only indicates the extent and likelihood of flooding from rivers or the sea. It should also be remembered that flooding may occur from other sources such as surface water sewers, road drainage, etc.

Fluvial Flood Levels

The most relevant fluvial flood level for the above site are the water levels within the Crowland and Cowbit Washes. These are set out in the table below and all levels are measured in metres above Ordnance Datum Newlyn (mODN).

	Annual Exceedance Probability - Maximum Water Levels (mODN)	
	1% (1 in 100) inc Climate Change and Wave Run Up	0.1% (1 in 1000) inc Climate Change and Wave Run Up
Crowland and Cowbit Washes	4.43	5.37

These levels are taken from the Crowland and Cowbit Flood Storage Area Reservoir Flood Study (March 2008) and are the most up-to-date currently available. We aim to review our models on a regular basis, so if you are using these levels more than twelve months from the date of this letter, please contact us again to check that they are still valid.

Please note that these levels are "in-channel" levels and therefore may not represent the flood level on the floodplain, particularly where the channel is embanked or has raised defences.

Climate Change

Flood risk data requests including an allowance for climate change will be based on the 1% annual probability flood including an additional 20% increase on peak flows to account for climate change impacts, unless otherwise stated. You should refer to 'Flood risk assessments: climate change allowances' to check if this allowance is still appropriate for the type of development you are proposing and its location. You may need to undertake further assessment of future flood risk using different allowances to ensure your assessment of future flood risk is based on best available evidence.

Fluvial Defence Information

The fluvial defences protecting this site consist of The Crowland and Cowbit flood storage reservoir. They are in good condition and provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). We inspect these defences regularly to ensure that any potential defects are identified early.

Historic Flood Extent Map

A copy of the Historic Flood Extent Map for your area is enclosed. This shows the extent of previous recorded flooding in your area, notably March 1947. It is possible that other flooding may have occurred that we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Land Drainage

The information provided is limited to flood risk from the sea and rivers with catchment areas greater than 3km². The property is in an area of extensive land drainage which may pose an additional risk of flooding. Further information should be sought from the North Level Internal Drainage Board (tel: 01733 270333).

Other Information Requested

The South Holland Strategic Flood Risk Assessment (SFRA) (Update 2010) is available at: <http://www.sholland.gov.uk/environment/plandev/localplan/background/ifraupdatefinal2010.htm>. You may wish to review the hazard mapping during the development of your Flood Risk Assessment.

The SFRA has not considered the residual risk if the banks of the Crowland and Cowbit Washes were to fail. Given the proximity of the site to the Washlands, it is likely that in such an event the development site would be affected. Any FRA should also assess the likely consequences for the site if the banks of the Washlands were to fail.

Further details about the Environment Agency information supplied can be found on the GOV.UK website:

<https://www.gov.uk/browse/environment-countryside/flooding-extreme-weather>

If you have requested this information to help inform a development proposal, then you should note the information on GOV.UK on the use of Environment Agency Information for Flood Risk Assessments

<https://www.gov.uk/planning-applications-assessing-flood-risk>

<https://www.gov.uk/government/publications/pre-planning-application-enquiry-form-preliminary-opinion>

Supporting Information

This information is provided subject to the enclosed notice which you should read.

I hope that we have correctly interpreted your request. Please see the attached Standard Notice or licence for details of permitted use.

We respond to requests for recorded information that we hold under the Freedom of Information Act 2000 (FOIA) and the associated Environmental Information Regulations 2004 (EIR).

If you are not satisfied with our response to your request for information you can contact us within 2 calendar months to ask for our decision to be reviewed.

If you have any queries or would like to discuss the content of this letter further please contact Rebecca Bristow at the Environment Agency.

Yours sincerely

Rebecca Bristow

Rebecca Bristow
FOR Alastair Windler
Partnership and Strategic Overview Team Leader
Lincolnshire & Northamptonshire Area

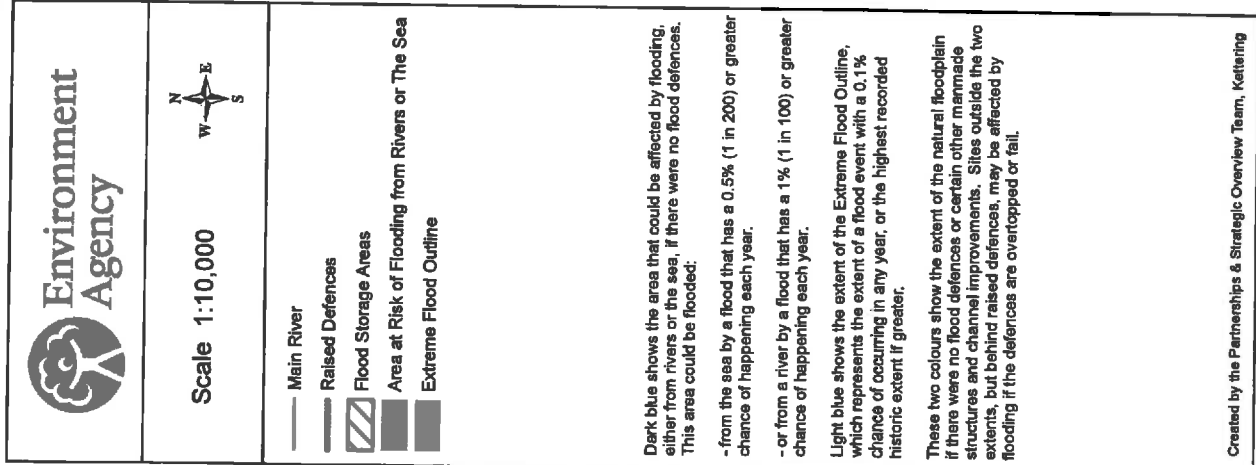
Direct dial 02030 253516
e-mail psown@environment-agency.gov.uk



Awarded to Lincolnshire & Northamptonshire Area

Enc.
Basic FRA Map
Historic Flood Map
FRA Advisory Text
Standard Notice

Map centred on TF 23779 09661 - created February 2016 [Ref: CCN-2016-3748]



Map 2. Historic Flood Extent Map
Map centred on TF 23779 09661 - created February 2016 [Ref: CCN-2016-3748]



Scale 1:10,000

N
W E
S

- Main River
- March 1947 on the River Welland near Cowbit

Created by the Partnership & Strategic Overview Team,
 Kettering

Use of Environment Agency Information for Flood Risk / Flood Consequence Assessments

Important

If you have requested this information to help inform a development proposal, then we recommend that you undertake a formal pre-application enquiry using the form available from our website:-

<http://www.environment-agency.gov.uk/research/planning/33580.aspx>

Depending on the enquiry, we may also provide advice on other issues related to our responsibilities including flooding, waste, land contamination, water quality, biodiversity, navigation, pollution, water resources, foul drainage or Environmental Impact Assessment.

In **England**, you should refer to the Environment Agency's Flood Risk Standing Advice, the technical guidance to the National Planning Policy Framework and the existing PPS25 Practice Guide for information about what flood risk assessment is needed for new development in the different Flood Zones. These documents can be accessed via:

<http://www.environment-agency.gov.uk/research/planning/82587.aspx>

<http://www.communities.gov.uk/publications/planningandbuilding/nppftechnicalguidance>

<http://www.communities.gov.uk/publications/planningandbuilding/pps25guideupdate>

You should also consult the Strategic Flood Risk Assessment produced by your local planning authority.

In **Wales**, you should refer to TAN15 for information about what flood consequence assessment is needed for new development in the different flood zones

<http://new.wales.gov.uk/splash;jsessionid=8yIGTfGZthmB0t2vhp6hS1GcB1LXvZzB3Ylczf20Xn7LK3zK0nMk!981825250?orig=/topics/planning/policy/tans/tan15/>

You should also consult the Strategic Flood Consequence Assessment if one has been produced by your local planning authority.

In both **England and Wales** you should note that:

1. Information supplied by the Environment Agency may be used to assist in producing a Flood Risk / Consequence Assessment (FRA / FCA) where one is required, but does not constitute such an assessment on its own.
2. This information covers flood risk from main rivers and the sea, and you will need to consider other potential sources of flooding, such as groundwater or overland runoff. The information produced by the local planning authority referred to above may assist here.
3. Where a planning application requires a FRA / FCA and this is not submitted or deficient, the Environment Agency may well raise an objection.
4. For more significant proposals in higher flood risk areas, we would be pleased to discuss details with you ahead of making any planning application, and you should also discuss the matter with your local planning authority.

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- internal use for any purpose, or offering a product or service based on the Information for indirect commercial advantage, by an organisation that is primarily engaged in trade, commerce or a profession.

APPENDIX E - PROPOSED SITE PLAN, DRAINAGE LAYOUT AND CALCULATIONS

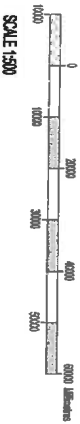
DRAFT



CREASE DROVE, CROWLAND Site Feasibility / Sketch Layout Plan

PROJECT No: 2201 SCALE: 1:100@A1
DRAWING No: AK0001_P03 DATE: April 2016

NOTES:
1. This drawing is a site feasibility / sketch layout plan only.
2. The site is shown as a general guide only.
3. The site is shown as a general guide only.
4. The site is shown as a general guide only.



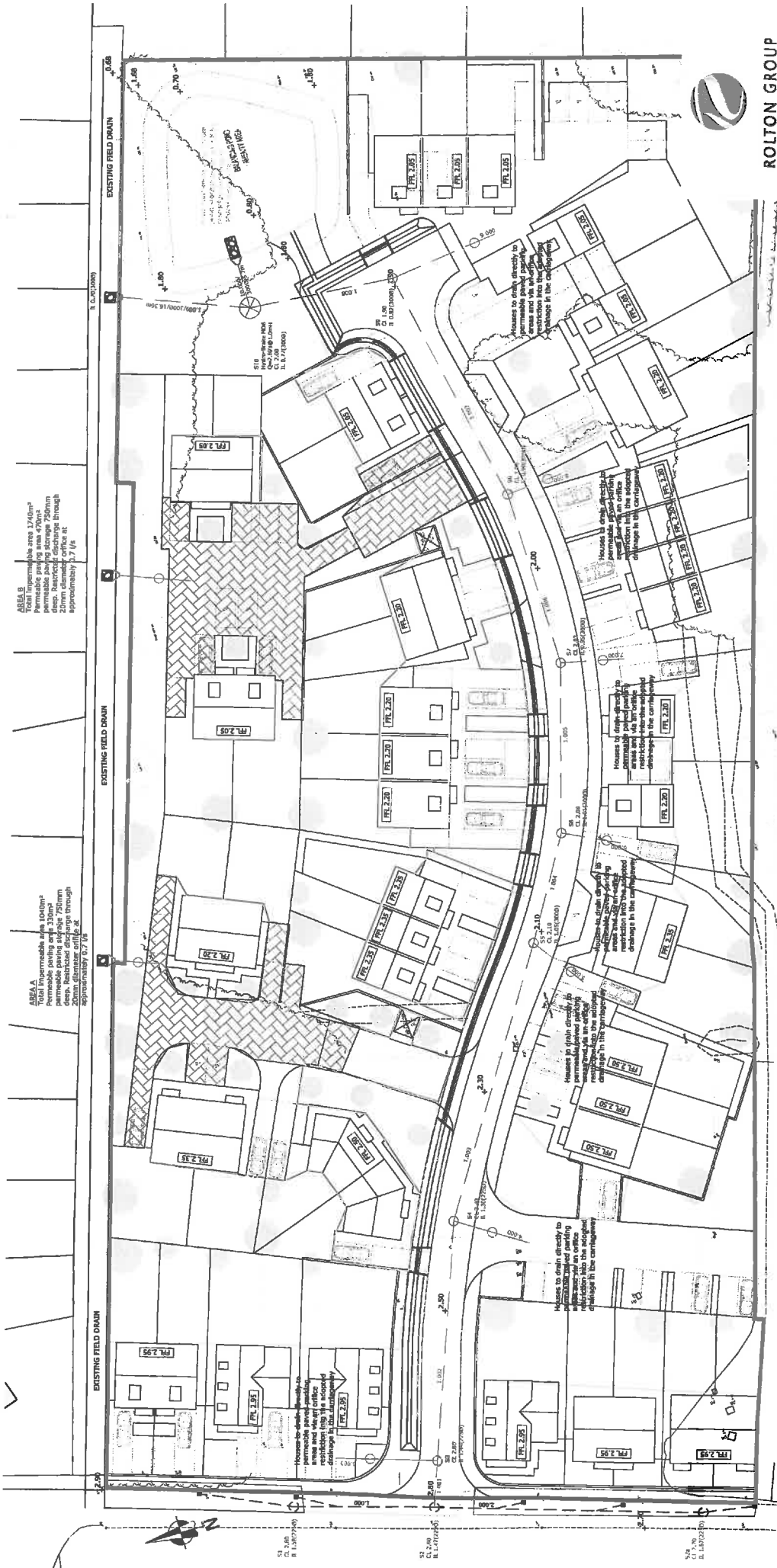
TOTAL
NO. BUILDINGS
= 47

HOUSE TYPE KEY	
X12	TYPE A 2 bed - 4 bedrooms
X9	TYPE A2 3 bed - 4 bedrooms
X4	TYPE B1 3 bed - 4 bedrooms
X11	TYPE B2 3 bed - 4 bedrooms
X2	TYPE B3 3 bed - 4 bedrooms
X3	TYPE M1 4/5 bed - 4 bedrooms
X6	TYPE C1 4 bed - 4 bedrooms
	SHRUB
	OPEN SPACE AREA

• TOTAL SITE AREA
 = 10,000 sqm (2.5 acres)
 • 10% Public Open Space Area
 • 30% Affordable Housing
 • Final layout plan to be agreed at reserved planning stage

DAVID TURNOCK ARCHITECTS

Dayn House 3 Commerce Road
Lynch Wood Peterborough PE2 6LR
Phone 01733 393010 Fax 01733 393013
Email info@dtarchitects.co.uk



ROLT GROUP
ENGINEERING THE FUTURE[®]
www.rolt.com 01933 410009

Project: Grease Drive Crowland	
Drawing Title: Proposed SW & FW Drainage Scheme Layout	Date: 01 May 16

Drawn By: CS	Checked By: SDP	Scale: 1:500	Sheet: 043
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Alt. Project Ref: 16-0177	Superintendent: PRELIMINARY
-------------------------------------	---------------------------------------

CDC	RGL	00	00	DR
Project	Originator	Zone	Level	Type
D	120	0001	\$1	P1
Rule	Classification	Number	Subsidiary	Revision

DO NOT SCALE	Copyright Rolton Group Ltd 2016
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	WARNING
This drawing is a preliminary design and is not to be used for construction. It is for guidance only. It may be subject to change without notice.	

New	Date	Revision Description	Drawn By
P1	16/05/16	Preliminary Issue	SD

Sewer Type Key:

- Proposed adoptable surface water gravity sewer
- Proposed private surface water sewer
- Proposed adoptable road gully
- Proposed Highway gully
- Proposed Sewer crossing
- Proposed Highway manhole
- Proposed adoptable manhole
- Proposed private manhole

NOTES

- This drawing is to be read in conjunction with all the relevant contract documents.
- All dimensions are in mm unless otherwise stated. Any discrepancies reported to the Rolton Group Engineer.
- Drawings marked Preliminary are for guidance approval only, i.e. NOT for Construction.

Rolton Group		Page 1
The Charles Parker Building	Crease Drove Crowland	
Midland Road		
Northants NN10 8DN	16-0177	
Date 26.05.16	Designed by SDP	
File Permeable paving storag...	Checked by	
Micro Drainage	Source Control 2016.1	

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1726 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.403	0.403	0.0	0.5	0.5	61.7	O K
30 min Summer	1.465	0.465	0.0	0.6	0.6	71.1	O K
60 min Summer	1.534	0.534	0.0	0.6	0.6	81.6	O K
120 min Summer	1.608	0.608	0.0	0.6	0.6	93.0	O K
180 min Summer	1.653	0.653	0.0	0.7	0.7	99.9	O K
240 min Summer	1.684	0.684	0.0	0.7	0.7	104.7	O K
360 min Summer	1.726	0.726	0.0	0.7	0.7	111.0	Flood Risk
480 min Summer	1.751	0.751	0.0	0.7	0.7	115.0	Flood Risk
600 min Summer	1.768	0.768	0.0	0.7	0.7	117.5	Flood Risk
720 min Summer	1.778	0.778	0.0	0.7	0.7	119.1	Flood Risk
960 min Summer	1.789	0.789	0.0	0.7	0.7	120.7	Flood Risk
1440 min Summer	1.789	0.789	0.0	0.7	0.7	120.7	Flood Risk
2160 min Summer	1.782	0.782	0.0	0.7	0.7	119.6	Flood Risk
2880 min Summer	1.769	0.769	0.0	0.7	0.7	117.6	Flood Risk
4320 min Summer	1.699	0.699	0.0	0.7	0.7	106.9	O K
5760 min Summer	1.637	0.637	0.0	0.7	0.7	97.5	O K
7200 min Summer	1.584	0.584	0.0	0.6	0.6	89.3	O K
8640 min Summer	1.537	0.537	0.0	0.6	0.6	82.1	O K
10080 min Summer	1.496	0.496	0.0	0.6	0.6	75.9	O K
15 min Winter	1.453	0.453	0.0	0.6	0.6	69.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	198.109	0.0	36.6	27
30 min Summer	114.036	0.0	39.9	42
60 min Summer	65.642	0.0	70.9	72
120 min Summer	37.785	0.0	78.4	130
180 min Summer	27.353	0.0	82.8	190
240 min Summer	21.750	0.0	85.9	250
360 min Summer	15.745	0.0	89.9	368
480 min Summer	12.520	0.0	92.4	488
600 min Summer	10.480	0.0	94.0	608
720 min Summer	9.063	0.0	95.0	726
960 min Summer	7.219	0.0	96.0	964
1440 min Summer	5.239	0.0	94.9	1244
2160 min Summer	3.802	0.0	161.4	1608
2880 min Summer	3.028	0.0	163.9	2020
4320 min Summer	2.109	0.0	154.4	2820
5760 min Summer	1.632	0.0	195.2	3640
7200 min Summer	1.337	0.0	198.5	4464
8640 min Summer	1.137	0.0	200.7	5264
10080 min Summer	0.991	0.0	201.4	6048
15 min Winter	198.109	0.0	39.4	27

Rolton Group		Page 2
The Charles Parker Building	Crease Drove Crowland	
Midland Road		
Northants NN10 8DN	16-0177	
Date 26.05.16	Designed by SDP	
File Permeable paving storag...	Checked by	
Micro Drainage	Source Control 2016.1	

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	1.523	0.523	0.0	0.6	0.6	80.0	O K
60 min Winter	1.600	0.600	0.0	0.6	0.6	91.8	O K
120 min Winter	1.684	0.684	0.0	0.7	0.7	104.7	O K
180 min Winter	1.736	0.736	0.0	0.7	0.7	112.5	Flood Risk
240 min Winter	1.771	0.771	0.0	0.7	0.7	118.0	Flood Risk
360 min Winter	1.819	0.819	0.0	0.8	0.8	125.4	Flood Risk
480 min Winter	1.850	0.850	0.0	0.8	0.8	130.0	Flood Risk
600 min Winter	1.870	0.870	0.0	0.8	0.8	133.1	Flood Risk
720 min Winter	1.884	0.884	0.0	0.8	0.8	135.2	Flood Risk
960 min Winter	1.900	0.900	0.0	0.8	0.8	137.7	Flood Risk
1440 min Winter	1.903	0.903	0.0	0.8	0.8	138.2	Flood Risk
2160 min Winter	1.888	0.888	0.0	0.8	0.8	135.8	Flood Risk
2880 min Winter	1.868	0.868	0.0	0.8	0.8	132.9	Flood Risk
4320 min Winter	1.775	0.775	0.0	0.7	0.7	118.5	Flood Risk
5760 min Winter	1.692	0.692	0.0	0.7	0.7	105.8	O K
7200 min Winter	1.619	0.619	0.0	0.7	0.7	94.8	O K
8640 min Winter	1.557	0.557	0.0	0.6	0.6	85.2	O K
10080 min Winter	1.502	0.502	0.0	0.6	0.6	76.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	114.036	0.0	42.9	41
60 min Winter	65.642	0.0	77.3	70
120 min Winter	37.785	0.0	85.2	128
180 min Winter	27.353	0.0	89.8	188
240 min Winter	21.750	0.0	93.0	246
360 min Winter	15.745	0.0	97.2	362
480 min Winter	12.520	0.0	99.8	480
600 min Winter	10.480	0.0	101.5	594
720 min Winter	9.063	0.0	102.5	710
960 min Winter	7.219	0.0	103.5	934
1440 min Winter	5.239	0.0	102.2	1362
2160 min Winter	3.802	0.0	177.1	1696
2880 min Winter	3.028	0.0	179.2	2164
4320 min Winter	2.109	0.0	168.3	3072
5760 min Winter	1.632	0.0	219.7	3928
7200 min Winter	1.337	0.0	223.5	4760
8640 min Winter	1.137	0.0	226.0	5616
10080 min Winter	0.991	0.0	225.9	6368

Rolton Group		Page 3
The Charles Parker Building	Crease Drove Crowland	
Midland Road		
Northants NN10 8DN	16-0177	
Date 26.05.16	Designed by SDP	
File Permeable paving storag...	Checked by	
Micro Drainage	Source Control 2016.1	

Model Details

Storage is Online Cover Level (m) 2.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	51.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	141.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.000	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 1.000

Rolton Group		Page 1
The Charles Parker Building Midland Road Northants NN10 8DN		
Date 26/05/2016 18:52	Designed by Shaun Pentlow	
File Pond storage 5720sqm.srcx	Checked by	
Micro Drainage		Source Control 2016.1

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	1.032	0.532	2.1	210.1	O K
30 min Summer	1.099	0.599	2.2	240.8	O K
60 min Summer	1.170	0.670	2.3	274.7	O K
120 min Summer	1.243	0.743	2.4	310.8	Flood Risk
180 min Summer	1.285	0.785	2.5	331.7	Flood Risk
240 min Summer	1.312	0.812	2.5	346.0	Flood Risk
360 min Summer	1.347	0.847	2.6	363.9	Flood Risk
480 min Summer	1.366	0.866	2.6	373.9	Flood Risk
600 min Summer	1.376	0.876	2.6	379.5	Flood Risk
720 min Summer	1.381	0.881	2.6	382.1	Flood Risk
960 min Summer	1.382	0.882	2.6	382.4	Flood Risk
1440 min Summer	1.367	0.867	2.6	374.8	Flood Risk
2160 min Summer	1.342	0.842	2.6	361.6	Flood Risk
2880 min Summer	1.316	0.816	2.5	347.8	Flood Risk
4320 min Summer	1.230	0.730	2.4	304.1	Flood Risk
5760 min Summer	1.158	0.658	2.3	268.7	O K
7200 min Summer	1.093	0.593	2.2	238.2	O K
8640 min Summer	1.035	0.535	2.1	211.5	O K
10080 min Summer	0.981	0.481	2.0	187.4	O K
15 min Winter	1.088	0.588	2.2	235.5	O K
30 min Winter	1.161	0.661	2.3	270.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	198.109	0.0	162.0	30
30 min Summer	114.036	0.0	164.4	44
60 min Summer	65.642	0.0	276.0	74
120 min Summer	37.785	0.0	314.2	132
180 min Summer	27.353	0.0	335.5	192
240 min Summer	21.750	0.0	347.0	250
360 min Summer	15.745	0.0	354.1	370
480 min Summer	12.520	0.0	357.1	488
600 min Summer	10.480	0.0	359.6	608
720 min Summer	9.063	0.0	361.8	726
960 min Summer	7.219	0.0	364.7	964
1440 min Summer	5.239	0.0	363.7	1216
2160 min Summer	3.802	0.0	583.6	1588
2880 min Summer	3.028	0.0	616.7	1996
4320 min Summer	2.109	0.0	604.3	2816
5760 min Summer	1.632	0.0	671.6	3640
7200 min Summer	1.337	0.0	687.9	4464
8640 min Summer	1.137	0.0	701.4	5200
10080 min Summer	0.991	0.0	712.2	6048
15 min Winter	198.109	0.0	164.1	30
30 min Winter	114.036	0.0	169.8	44

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	1.239	0.739	2.4	308.4	Flood Risk
120 min Winter	1.319	0.819	2.5	349.4	Flood Risk
180 min Winter	1.365	0.865	2.6	373.7	Flood Risk
240 min Winter	1.396	0.896	2.6	390.3	Flood Risk
360 min Winter	1.436	0.936	2.7	411.8	Flood Risk
480 min Winter	1.459	0.959	2.7	424.6	Flood Risk
600 min Winter	1.473	0.973	2.8	432.3	Flood Risk
720 min Winter	1.481	0.981	2.8	436.8	Flood Risk
960 min Winter	1.487	0.987	2.8	440.3	Flood Risk
1440 min Winter	1.476	0.976	2.8	433.8	Flood Risk
2160 min Winter	1.445	0.945	2.7	416.8	Flood Risk
2880 min Winter	1.412	0.912	2.7	398.8	Flood Risk
4320 min Winter	1.301	0.801	2.5	340.3	Flood Risk
5760 min Winter	1.204	0.704	2.3	291.3	Flood Risk
7200 min Winter	1.117	0.617	2.2	249.2	O K
8640 min Winter	1.037	0.537	2.1	212.2	O K
10080 min Winter	0.961	0.461	2.0	178.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	65.642	0.0	306.9	72
120 min Winter	37.785	0.0	343.6	130
180 min Winter	27.353	0.0	356.7	188
240 min Winter	21.750	0.0	361.4	246
360 min Winter	15.745	0.0	368.5	364
480 min Winter	12.520	0.0	374.4	480
600 min Winter	10.480	0.0	379.0	594
720 min Winter	9.063	0.0	382.4	708
960 min Winter	7.219	0.0	386.3	932
1440 min Winter	5.239	0.0	385.1	1352
2160 min Winter	3.802	0.0	651.7	1680
2880 min Winter	3.028	0.0	682.7	2144
4320 min Winter	2.109	0.0	640.9	3036
5760 min Winter	1.632	0.0	752.2	3928
7200 min Winter	1.337	0.0	770.4	4760
8640 min Winter	1.137	0.0	785.6	5624
10080 min Winter	0.991	0.0	798.1	6448

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Model Details

Storage is Online Cover Level (m) 1.500

Tank or Pond Structure

Invert Level (m) 0.500

Depth (m)	Area (m ²)	Depth (m)	Area (m ²)
0.000	340.0	1.000	564.4

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md6 SW Only Invert Level (m) 0.500
Design Flow (l/s) 2.8 Diameter (mm) 70

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.7	1.200	3.1	3.000	4.8	7.000	7.4
0.200	1.9	1.400	3.3	3.500	5.2	7.500	7.7
0.300	1.8	1.600	3.5	4.000	5.6	8.000	7.9
0.400	1.9	1.800	3.8	4.500	5.9	8.500	8.2
0.500	2.0	2.000	4.0	5.000	6.3	9.000	8.4
0.600	2.2	2.200	4.1	5.500	6.6	9.500	8.6
0.800	2.5	2.400	4.3	6.000	6.8		
1.000	2.8	2.600	4.5	6.500	7.1		

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Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 1024 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	1.370	0.370	0.0	0.5	0.5	36.6	O K
30 min Summer	1.425	0.425	0.0	0.5	0.5	42.1	O K
60 min Summer	1.486	0.486	0.0	0.6	0.6	48.2	O K
120 min Summer	1.550	0.550	0.0	0.6	0.6	54.5	O K
180 min Summer	1.586	0.586	0.0	0.6	0.6	58.1	O K
240 min Summer	1.610	0.610	0.0	0.6	0.6	60.4	O K
360 min Summer	1.637	0.637	0.0	0.7	0.7	63.1	O K
480 min Summer	1.650	0.650	0.0	0.7	0.7	64.3	O K
600 min Summer	1.654	0.654	0.0	0.7	0.7	64.8	O K
720 min Summer	1.654	0.654	0.0	0.7	0.7	64.7	O K
960 min Summer	1.652	0.652	0.0	0.7	0.7	64.6	O K
1440 min Summer	1.645	0.645	0.0	0.7	0.7	63.8	O K
2160 min Summer	1.624	0.624	0.0	0.7	0.7	61.8	O K
2880 min Summer	1.598	0.598	0.0	0.6	0.6	59.2	O K
4320 min Summer	1.518	0.518	0.0	0.6	0.6	51.2	O K
5760 min Summer	1.453	0.453	0.0	0.6	0.6	44.8	O K
7200 min Summer	1.400	0.400	0.0	0.5	0.5	39.6	O K
8640 min Summer	1.356	0.356	0.0	0.5	0.5	35.3	O K
10080 min Summer	1.320	0.320	0.0	0.5	0.5	31.7	O K
15 min Winter	1.416	0.416	0.0	0.5	0.5	41.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	198.109	0.0	30.2	27
30 min Summer	114.036	0.0	33.4	41
60 min Summer	65.642	0.0	48.6	72
120 min Summer	37.785	0.0	55.9	130
180 min Summer	27.353	0.0	60.5	190
240 min Summer	21.750	0.0	63.8	248
360 min Summer	15.745	0.0	68.4	368
480 min Summer	12.520	0.0	71.4	486
600 min Summer	10.480	0.0	73.6	604
720 min Summer	9.063	0.0	75.1	690
960 min Summer	7.219	0.0	77.2	796
1440 min Summer	5.239	0.0	78.3	1044
2160 min Summer	3.802	0.0	103.1	1456
2880 min Summer	3.028	0.0	109.0	1856
4320 min Summer	2.109	0.0	111.5	2684
5760 min Summer	1.632	0.0	116.5	3464
7200 min Summer	1.337	0.0	118.4	4248
8640 min Summer	1.137	0.0	119.9	5016
10080 min Summer	0.991	0.0	120.8	5752
15 min Winter	198.109	0.0	32.9	27

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Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max E Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	1.479	0.479	0.0	0.6	0.6	47.4	O K
60 min Winter	1.548	0.548	0.0	0.6	0.6	54.2	O K
120 min Winter	1.620	0.620	0.0	0.7	0.7	61.4	O K
180 min Winter	1.662	0.662	0.0	0.7	0.7	65.5	O K
240 min Winter	1.689	0.689	0.0	0.7	0.7	68.2	O K
360 min Winter	1.722	0.722	0.0	0.7	0.7	71.5	Flood Risk
480 min Winter	1.739	0.739	0.0	0.7	0.7	73.2	Flood Risk
600 min Winter	1.747	0.747	0.0	0.7	0.7	73.9	Flood Risk
720 min Winter	1.749	0.749	0.0	0.7	0.7	74.1	Flood Risk
960 min Winter	1.744	0.744	0.0	0.7	0.7	73.7	Flood Risk
1440 min Winter	1.730	0.730	0.0	0.7	0.7	72.3	Flood Risk
2160 min Winter	1.698	0.698	0.0	0.7	0.7	69.1	O K
2880 min Winter	1.659	0.659	0.0	0.7	0.7	65.3	O K
4320 min Winter	1.550	0.550	0.0	0.6	0.6	54.4	O K
5760 min Winter	1.463	0.463	0.0	0.6	0.6	45.8	O K
7200 min Winter	1.394	0.394	0.0	0.5	0.5	39.0	O K
8640 min Winter	1.338	0.338	0.0	0.5	0.5	33.5	O K
10080 min Winter	1.293	0.293	0.0	0.4	0.4	29.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	114.036	0.0	36.3	41
60 min Winter	65.642	0.0	54.5	70
120 min Winter	37.785	0.0	62.5	128
180 min Winter	27.353	0.0	67.3	186
240 min Winter	21.750	0.0	70.7	244
360 min Winter	15.745	0.0	75.4	360
480 min Winter	12.520	0.0	78.5	474
600 min Winter	10.480	0.0	80.7	586
720 min Winter	9.063	0.0	82.3	694
960 min Winter	7.219	0.0	84.3	896
1440 min Winter	5.239	0.0	85.2	1112
2160 min Winter	3.802	0.0	115.8	1568
2880 min Winter	3.028	0.0	122.4	2024
4320 min Winter	2.109	0.0	124.1	2860
5760 min Winter	1.632	0.0	131.1	3696
7200 min Winter	1.337	0.0	133.4	4472
8640 min Winter	1.137	0.0	135.2	5264
10080 min Winter	0.991	0.0	136.5	5960

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Micro Drainage	Source Control 2016.1	

Model Details

Storage is Online Cover Level (m) 2.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	33.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	91.7	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	1.000	Membrane Depth (m)	0

Orifice Outflow Control

Diameter (m) 0.020 Discharge Coefficient 0.600 Invert Level (m) 1.000

APPENDIX F - RECOMMENDED MAINTENANCE REGIME

DRAFT

Geocellular storage system

Regular maintenance	Inspect and identify any areas that are not operating correctly. If required, take remedial action.	Monthly for 3 months, then six monthly
	Debris removal from catchment surface (where may cause risks to performance)	Monthly
	Where rainfall infiltrates into blocks from above, check surface of filter for blockage by silt, algae or other matter. Remove and replace surface infiltration medium as necessary.	Monthly (and after large storms)
	Remove sediment from pre-treatment structures	Annually, or as required
Remedial actions	Repair/rehabilitation of inlets, outlet, overflows and vents.	As required
Monitoring	Inspect/check all inlets, outlets, vents and overflows to ensure that they are in good condition and operating as designed.	Annually and after large storms

Control Structures

Regular maintenance	Litter and debris removal.	Monthly (or as required).
Occasional maintenance	Removal of sediment, oil, grease and floatables	
Remedial actions	Replacement of malfunctioning parts	As required.
Monitoring	Inspect for evidence of poor operation	Monthly, or as required
	Inspect inlets for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly, or as required

Pervious pavements

Regular maintenance	Brushing and vacuuming.	Three times/year at end of winter, mid-summer, after autumn leaf fall, or as required based on site-specific observations of clogging or manufacturers' recommendations
Occasional maintenance	Stabilise and mow contributing and adjacent areas.	As required.
	Removal of weed.	As required.
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level of the paving.	As required.
	Remedial work to any depressions, rutting and cracked or broken blocks considered detrimental to the structural performance or a hazard to users.	As required.
	Rehabilitation of surface and upper sub-structure.	As required (if infiltration performance is reduced as a result of significant clogging).
Monitoring	Initial inspection.	Monthly for 3 months after installation
	Inspect for evidence of poor operation and/or weed growth. If required take remedial action.	3-monthly, 48h after large storms.
	Inspect silt accumulation rates and establish appropriate brushing frequencies.	Annually.
	Monitor inspection chambers.	Annually.

Balancing ponds

Regular maintenance	Litter and debris removal.	Monthly (or as required).
	Grass cutting – for spillways and access routes.	Monthly (during growing season), or as required.
	Grass cutting – meadow grass in and around basin.	Half yearly (spring – before nesting season, and autumn) or as required.
	Manage other vegetation and remove nuisance plants.	Monthly (at start, then as required).
	Tidy all dead growth before start of growing season.	Annually.
	Remove sediment from inlets and outlet.	Annually (or as required).
Occasional maintenance	Re-seed areas of poor vegetation growth.	Annually, or as required.
	Prune and trim trees and remove cuttings.	2 years, or as required.
	Remove sediment from forebay, when 50% full and from micropools if volume reduced by > 25%.	3 – 10 years (or as required).
Remedial actions	Repair of erosion or other damage by re-seeding or re-turfing.	As required.
	Realignment of inlet/outlet protection	As required.
	Repair/rehabilitation of inlets, outlets and overflows.	As required.
	Re-level uneven surfaces and reinstate design levels.	As required.
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required.	After large storms and as required
	Inspect banksides, structures, pipework, etc for evidence of physical damage.	After large storms and as required
	Inspect inlets and pond surface for silt accumulation. Establish appropriate silt removal frequencies.	As required
	Check penstocks and other mechanical devices.	Half yearly or as required

APPENDIX G - FRA GUIDANCE: LOCATION WITHIN THE REPORT

Flood Risk Assessment (FRA) Guidance	
	LOCATION WITHIN THE REPORT
Plans	
A location plan that includes geographical features, street names and identifies the catchment, watercourses or other bodies of water in the vicinity.	Appendix A and D
A plan of the site showing:	
• existing site	Appendix B
• development proposals	Appendix B
• identification of any structures (e.g. embankments), which may influence local flood flow overland or in any watercourses (e.g. culverts) present on the site.	Section 5 and Appendix C
Surveys	
Site levels - both existing and proposed. Reference to Ordnance Datum may be required where details of context of the site to its surroundings is needed.	Appendix B
Assessments	
The Applicant should submit:	
• Proposals for surface water management that aims to not increase, and where practicable reduce the rate of runoff from the site as a result of the development (in accordance with sustainable drainage principles, and the Local Planning Authority's published SFRA).	Section 8
• Information about the surface water disposal measures already in place and their state of maintenance.	Section 4
• An assessment of the volume of surface water run-off likely to be generated from the proposed development.	Section 8
• Allowance in design for how the increased frequency and intensity of rainfall that is predicted as a result of climate change will affect the proposal (see Annex B of PPS25).	Section 8.3
• Information about other potential sources of flooding, if any, that may affect the site e.g. streams, surface water run-off, sewers, groundwater, reservoirs, canals and other artificial sources or any combination of these; including details on how these sources of flooding will be managed safely within the development proposal.	Section 5 and 6
• Confirmation as to whether Environment Agency consent is needed for any aspect of the work, and whether this has been applied for or not.	Not applicable

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