

AS Whitaker & Sons

**Proposed Light Industrial Units
Stephenson Avenue
Pinchbeck
Spalding
Lincolnshire**

**Flood Risk Assessment
Prepared by EWE Associates Ltd
Final RevA April 2020**



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CLIENT DETAILS

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PE11 3TZ

FAO Mr Phil Whitaker

CONTRACT

This report describes work commissioned by AS Whitaker & Sons following written instruction on 12th February 2020. AS Whitaker & Sons representative for the contract was Mr Alastair Plant of Parkin Gerry Limited. Lea Favill of EWE Associates Ltd carried out the work.

Date: 9th April 2020

Prepared by:



..... Lea Favill
Director

REVISION HISTORY

Draft Report Rev0 issued 1st April 2020
- 1No copy issued to Mr Alastair Plant

Final Report RevA issued 9th April 2020
- 1No copy issued to Mr Alastair Plant

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1. INTRODUCTION

Terms of Reference

This report was commissioned by AS Whitaker & Sons to consider the flood risk implication of a light industrial development within a commercial area off Stephenson Avenue, Pinchbeck, Spalding. The site is located to the east of Stephenson Avenue and to the north of the centre of Spalding. The location of the site is shown on Table 2-1.

The whole of the development site lies within Zone 3 of the Environment Agency Flood Map (version 2.8.2). The site is within Flood Zone 3a, being the zone with risk of 1 in 100 year (1% Annual Exceedance Probability) or greater for river flooding and 1 in 200 year (0.5% AEP) or greater for tidal/coastal flooding. The development site is within an existing developed area and is less than 1 hectare.

It is usual for the Agency to raise an objection to development applications within the floodplain or Zone 2 or 3 of the flood map until the question of flood risk has been properly evaluated. The Agency will also object to developments where the total site area is in excess of 1 hectare until suitable consideration has been given to surface water runoff.

Approach to the Assessment

As there are four local sources of flood risk – River Welland, Vernatts Drain, local watercourses and surface water runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from the four sources. Consideration has also been given to the site flooding from either overland flow or ponding of localised rainfall within the site.

South Holland SFRA completed by Royal Haskoning DHV Consulting Engineers during February 2017. References have been taken from the assessment which includes hazard mapping and flood depth mapping.

The River Welland is Main River; the Environment Agency holds modelled flood data which may assist in predicting the design flood level for the River Welland in line with the proposed development site.

Vernatts Drain is located approximately 300m to the south of the site. The drain is the responsibility of the Welland & Deeping Internal Drainage Board. The drain is not defended by any elevated flood defences. The drain flows north past the site and eventually discharges into the River Welland at Surfleet which is 5km north of the site. Large Sluice Gates at Surfleet control the flows from the Vernatts Drain into the River Welland. The gates will also control flows backing up the drain from the River Welland. There is also a small ditch watercourse within the eastern boundary of the site which conveys flows north into Scraggs Dyke which is the responsibility of the Welland & Deeping Internal Drainage Board. Flows pass through a number of drainage board drains before eventually discharging into the River Glen and then the River Welland at Surfleet. Sluice gates control the discharge from the drainage board drain into the River Glen. There is no flood level data for the Vernatts Drain and the local watercourses. However, it is considered that the River Welland is the primary flood risk

mechanism in the Spalding area. The SFRA includes flood hazard mapping and flood depth mapping for the combination of watercourses in the Spalding area. As such, no further consideration has been given to the Vernatts Drain and the local watercourses.

The proposed development will increase the overall paved and roofed area within the site. The site is currently a grassed area with no formalised drainage. The existing method of draining the site will be appraised. EWE Associates Ltd have undertaken a drainage feasibility study for the proposed development.

The storage volumes needed to attenuate surface water flow from the development to accommodate the required 1 in 100 year plus 30% climate change event, have therefore been calculated, using the proposed drainage strategy, as outlined above. However, the volume balance requirements should be recalculated during the detailed design stage to reflect the actual development proposal, the extent of impermeable areas and runoff to be generated.

A walk over of the site was conducted by Mr Lea Favill, a senior river engineer during March 2020; during the visit, a photograph survey of the site and adjacent river was undertaken. Stephenson Avenue in line with the site is at a similar level to the site and is at a level of 3.2mOD. Therefore, for the purpose of this assessment the average ground level within the site has been assumed to be 3.2mOD.

The requirements for flood risk assessments are generally as set out in National Planning Policy Framework (NPPF) dated July 2018. For the purposes of this study, the following policies have been considered: -

- Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future). Where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere.
- Strategic policies should be informed by a strategic flood risk assessment and should manage flood risk from all sources. They should consider cumulative impacts in, or affecting, local areas susceptible to flooding, and take account of advice from the Environment Agency and other relevant flood risk management authorities, such as lead local flood authorities and internal drainage boards.
- When determining any planning applications, local planning authorities should ensure that flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood-risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated that:

a) within the site, the most vulnerable development is located in areas of lowest flood risk, unless there are overriding reasons to prefer a different location;

b) the development is appropriately flood resistant and resilient;

c) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;

d) any residual risk can be safely managed; and

e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.

Further guidance is also provided in the CIRIA Research Project 624 “Development and Flood Risk: Guidance for the Construction Industry”.

Application of Sequential & Exceptions Test

The development site lies within Zone 3 of the Environment Agency Flood Map (version 2.8.2), being the zone with risk of 1 in 100 year (1% AEP) or greater for river flooding and 1 in 200 year (0.5% AEP) or greater for tidal/coastal flooding. The proposed development is industrial, as such considered to be less vulnerable.

Table 1-1: Flood Risk Vulnerability and Flood Zone ‘Compatibility’

Flood Risk Vulnerability classification		Essential Infrastructure	Water compatible	Highly Vulnerable	More Vulnerable	Less Vulnerable
Flood Zone	Zone 1	✓	✓	✓	✓	✓
	Zone 2	✓	✓	Exception Test required	✓	✓
	Zone 3a	Exception Test required	✓	✗	Exception Test required	✓
	Zone 3b	Exception Test required	✓	✗	✗	✗

- ✓ Development is appropriate
- ✗ Development should not be permitted

2. DETAILS OF THE SITE

Site Location

Table 2-1: Location Plan



Site Details

Table 2-2: Site Details

Site Name	Stephenson Avenue, Pinchbeck, Spalding
Existing Land Use	Grass
Proposed Development	Light Industrial
Grid Reference	TF 25228 24386
County	Lincolnshire
Local Planning Authority	South Holland District Council
Internal Drainage Board	Not Applicable
Others	Not Applicable
Post Code	PE11 3SW

Site Description

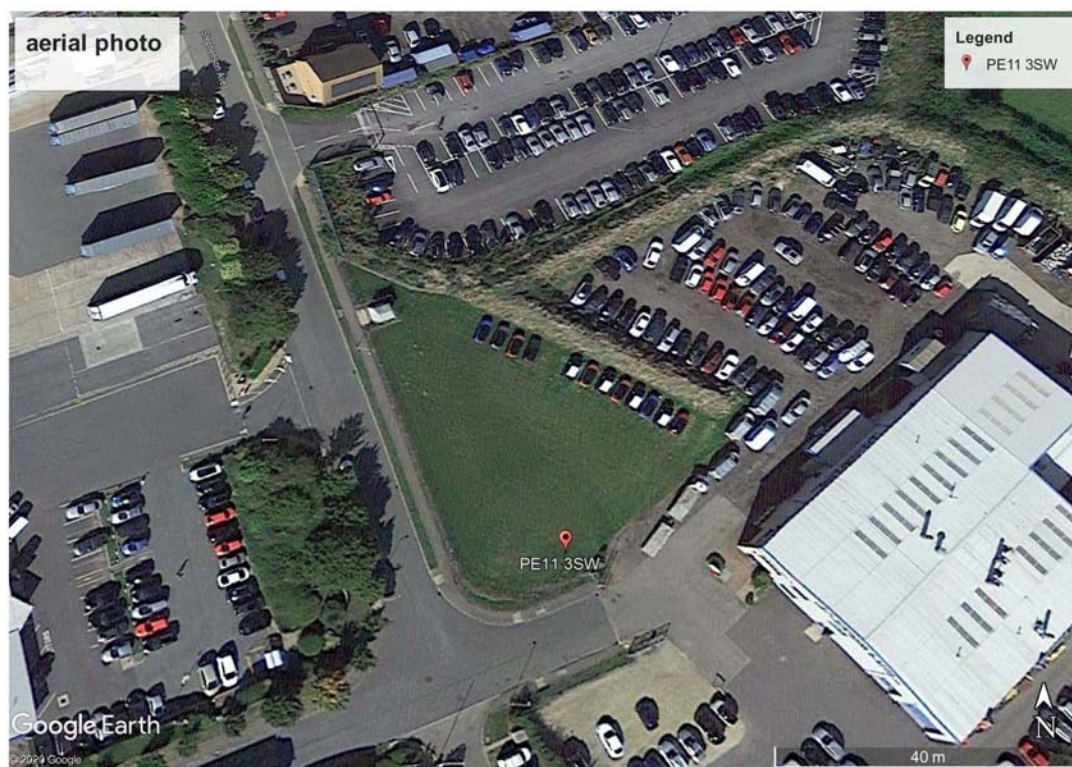
The proposed development site is currently a grass field which is 100% permeable. The site is located to the south of Stephenson Avenue and to the north of the centre of Spalding. An aerial photograph of the existing site is provided below.

The existing site has an area of 1942m². The area proposed for the development is at a level of approximately 3.2mOD. The existing site plan and levels are provided at Appendix A of this report.

There is existing commercial development to the north of the proposed development site. The Vernatts Drain and the River Welland are to the south of the site. There is a small watercourse located within the site.

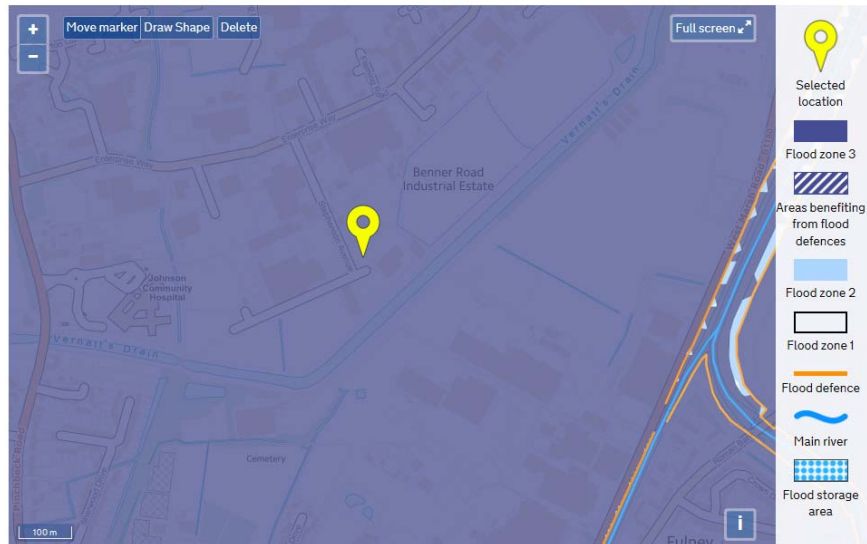
The proposal is to provide three light industrial units. The impermeable area will be increased by approximately 1260m² due to the development. The proposed layout plan is provided at Appendix B of this report.

Site Photographs



3. SCOPING FLOOD RISK ASSESSMENT

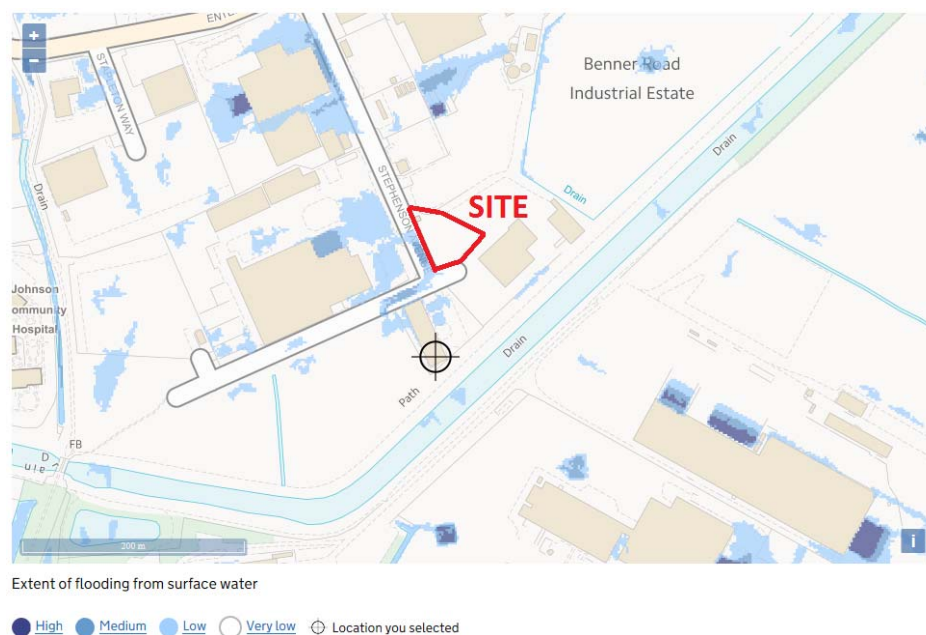
Environment Agency Flood Map



Environment Agency Reservoir Flood Map



Environment Agency Surface Water Flood Map



Past Flooding History

A search on the British Hydrological Society Chronology of British Hydrological Events website¹ found no records of past flooding within the Spalding area close to the site. Undertaking an internet based search for flooding in the area provided no further information.

SFRA Flooding History

The SFRA contained no references to the site being flooded.

Environment Agency Flooding History

The Environment Agency did not provide any references to the site being flooded.

Overland Flow

There is no higher ground adjacent to the site which could promote overland flow of water across the site. Consequently, further consideration will not be given to this mechanism.

¹ <http://www.dundee.ac.uk/geography/cbhe/>

Ponding

The site is generally at a similar level to adjacent boundaries. The surface water flood map shows the ditch watercourse within the site which is within a low risk area. However, the maps do not consider the full capacity of the adjacent surface water drainage system and is therefore highly conservative.

Groundwater

Information on groundwater flooding is limited within the area. The SFRA makes no comment regards the potential for ground water flooding in the district. In addition, reference to the Groundwater Vulnerability Map and Source Protection Zones produced by the Environment Agency indicate that the district is not underlain by an aquifer, as such, groundwater is unlikely to be source of significant flood risk.

Sewer Flooding

Anglian Water is the statutory water undertaker and is responsible for the public sewer systems within the Spalding area. Anglian Water maintains a register of historical sewer flooding events (DG5 Register) within the area. There are no reported incidents close to the site. The SFRA provided no further information.

Possible Flooding Mechanisms

As there are two remaining sources of flood risk to consider – River Welland and onsite runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from these sources.

The River Welland is to the south of the proposed development. The River Welland is defended by earth embankments and flood walls which are elevated above the adjacent natural ground level. As such, consideration will only need to be given to overtopping and a breach of the defences.

The proposed development will increase the impermeable area within the site; therefore, consideration will need to be given to the existing drainage route and the drainage characteristics in order to evaluate the impact that surface water runoff from the site will have on the site and elsewhere.

4. FLOOD RISK ASSESSMENT

Requirements of the Environment Agency

The Environment Agency, as part of its development control procedures, generally require finished floor levels to be set above the 1% AEP plus climate change flood water level at the site. The development is commercial in nature, as such, it is considered that access and egress from the development site will be desirable during times of extreme floods.

River Welland

Directly to the south of the site is the main channel of the River Welland. Within Spalding the River Welland main channel splits to form the Spalding Channel which provides additional flow capacity within Spalding.

The River Welland is defended by earth embankments which are quoted by the Environment Agency to give a 1 in 100-year standard of protection. The 1 in 100-year flood level for the River Welland in line with the site has been estimated at 4.52mOD. The flood data provided by the Environment Agency is provided at Appendix C of this report.

The embanked defences are well maintained by the Environment Agency. The defences undergo periodic maintenance such as grass cutting, weed control and vermin control. The river toe is regularly inspected for bank slips and erosion.

It is therefore considered that during a 1 in 100 year flood event that the flows will be maintained within the main channel and the site will remain dry. The South Holland SFRA provided a model scenario during a 1 in 100 year event which assumed a 1% fluvial flow and a 0.5% tidal level. The resulting hazard map and flood depth map shows that the site will remain dry.

Increase in estimated flood level due to Climate Change

As the proposed development includes a commercial land use (less vulnerable), consideration has therefore been given to take into account the potential effects of climate change over the next 75 years in accordance with NPPF.

Climate change increase will need to be considered for the present day plus 75 years, hence the year 2094.

The 1 in 100-year plus climate change flood level for the River Welland in line with the site has been estimated at 4.68mOD. The River Welland is defended by earth embankments which are quoted by the Environment Agency to give a 1 in 100-year standard of protection. The 1 in 100-year flood level for the River Welland in line with the site has been estimated at 4.52mOD. Therefore, during this event the flood embankments could be overtopped by 0.14m. Although, the site is close to the river it is considered that the flood banks overtopping by only 0.14m will only have a minor impact on the site.

Overtopping of the defences during Extreme flood events

Consideration has been given to the extreme flood event and its likely impact on the site and its occupants.

The 1 in 1,000-year plus climate change flood level for the River Welland in line with the site has been estimated at 4.56mOD. The River Welland is defended by earth embankments which are quoted by the Environment Agency to give a 1 in 100-year standard of protection. The 1 in 100-year flood level for the River Welland in line with the site has been estimated at 4.52mOD. Therefore, during this event the flood embankments could be overtopped by 0.04m. Although, the site is close to the river it is considered that the flood banks overtopping by only 0.04m will only have a minor impact on the site.

Breach Failure of the defences

The South Holland SFRA provided a model scenario during a 1 in 100 year plus climate change event which assumed a 1%+CC fluvial flow and a 0.5% tidal level. The resulting hazard map and flood depth map shows that the site could be within the danger to most category (brown) and estimated flood depths of between 0.5m and 1m.

Increase in Surface Water Runoff due to Development

A drainage feasibility study for the proposed development has been undertaken by EWE Associates Ltd based on available information. The proposed Drainage Feasibility drawing is provided within Appendix F of this report.

Existing Drainage

The existing development site is currently unused grassland. Therefore, the site is considered to be 100% permeable. The total site area has been estimated at 0.194 hectares and is relatively flat.

Based on the SPR value of 40% for the area local to the site it is assumed that infiltration is not practically possible within the site. There is an Anglian Water 825mm diameter surface water sewer located within Stephenson Avenue adjacent to the site. The sewer is at least 1.5m deep in line with the site.

The existing site plan which shows the impermeable area is provided at Appendix A of this report.

Table 4-1: ICPSUDs Method flows from existing site 0.194 hectares

Return Period	Flow in litres per second (l/s)
Qbar	0.5
1 in 1 year	0.4
1 in 30 year	1.2
1 in 100 year	1.8

The ICPSUDs Method has been used to calculate the existing runoff from the permeable site. The calculation sheet is provided at Appendix E of this report. It is considered impractical to restrict to less than 1l/s. Therefore, a practical minimum of 1l/s into the adjacent Anglian Water sewer has been adopted for the development.

Any discharge from the site will require the consent of the appropriate water authority/riparian owner, as such, they will also need to be approached to agree the discharge restriction from the site.

Proposed Drainage Strategy

For the purpose of this assessment the peak discharge rate from the site of 1 l/s has been adopted. An assessment of the required balance volume has been made using the estimated post development impermeable area of 0.126 hectares. Using WinDes Source Control software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (30%) event.

Reference should be made to Appendix G where the calculation sheets are provided. The attenuation size has been tabulated below in Table 4-1. It is estimated that during the 1 in 100 year plus climate change (30%) event that 89.3m³ of storage will be required. This will be provided within a single crate tank within the site. The drainage strategy drawing provided at Appendix F shows the initial drainage strategy for the site which includes a crate tank.

Table 4-1: WinDes 1 in 100 year+CC Storage Volume

Return Period	Required Attenuation	Approx Volume (m³)
1 in 100year + CC	Crate tank 100m ² by 0.8m deep	89.3

It is normal practice to ensure that the 1 in 30 year event is maintained below the ground in the form of storage and the difference between the 1 in 100 year and the 1 in 30 year is permitted to flood the surface as long as there is no flooding to buildings and the flood volume is contained within the site boundary. Alternatively, if the development is sensitive, the client can choose to store the full 1 in 100 year plus climate change balance volume below ground.

The volume balance requirements should be recalculated during the detailed design stage to reflect the actual development proposal, agreed discharge rate and the extent of impermeable areas and runoff to be generated.

5. MITIGATION MEASURES

Raising Floor Levels/Land Raising

There are several fluvial watercourses including the Vernatts Drain, River Glen and several local watercourses which could potentially cause minor flooding to the local area and the site. However, it is considered that the River Welland is the primary flood risk mechanism in the area.

The River Welland is defended to the appropriate 1 in 100 year standard and therefore the site is not at risk from the defences overtopping. However, during the 1 in 100 year plus climate change and the extreme 1 in 1,000 year flood events the defences could be overtopped by a maximum of 0.14m resulting in minor flooding of the site.

During a 1 in 100 year plus climate change breach event within the River Welland the breach level at the site has been estimated at between 0.5m and 1m deep. Hence, a maximum flood level of 4mOD based on the lowest existing ground level of 3mOD.

It is therefore recommended that the ground floor level of the building is 3.5mOD. A further 500mm of flood resilience measures should be introduced.

Emergency Access & Egress

A breach failure of the River Welland is likely to result in a maximum flood level of 4mOD within the site.

It is likely that the whole of the site and the local area could be inundated to between 0.5m and 1m in depth.

As such, a flood warning evacuation plan should be developed to ensure that all the occupants have left the site prior to a flood reaching the development.

Flood Resilience Measures

Consideration should be given to flood proofing the building to a level equivalent to the proposed ground floor level plus 0.5m to reduce the residual damages if an extreme flood was to occur. Flood proofing is a technique by which buildings are designed to withstand the effects of flooding. There are two main categories of flood proofing, which are dry proofing and wet proofing.

Dry proofing methods are designed to keep water out of the building, and wet proofing methods are designed to improve the ability of the property to withstand the effects of flooding once the water has entered the building. Both would be required in this case, due to the possible failure of the dry proofing methods.

Where wet proofing is required it is important that a flood response plan should be prepared and practised regularly, so that any contents of the building can be moved to design flood level if required or are built to withstand immersion in water or are designed to be easily replaceable.

The differential pressures across load bearing walls and the flotation effect that will occur during flood events should be taken into account when considering dry proofing techniques. For most existing properties, this means that dry flood proofing should only be considered if the expected flood depth is under 0.6m, which in this particular case

during more extreme flood events is expected to be less than 0.5m depth within the building and as such dry proofing is likely to be successful. The following table summarises the recommendations for flood proofing measures which can be incorporated within the design of buildings²:

Feature	Considerations To Improve Flood Proofing
External Walls	Careful consideration of materials: use low permeability materials to limit water penetration if dry proofing required. Avoid using timber frame and cavity walls. Any cavity walls should include solid insulation materials and the outer skin includes a water resistant coating. Provide fitting for flood boards or other temporary barriers across openings in the walls.
Internal Walls	Avoid use of gypsum plaster and plasterboards; use more flood resistant linings (e.g. hydraulic lime, ceramic tiles). Avoid use of stud partition walls.
Floors	Avoid use of chipboard floors. Use concrete floors with integrated and continuous damp proof membrane and damp proof course. Solid concrete floors are preferable; if a suspended floor is to be used, provide facility for drainage of sub-floor void. Use solid insulation materials.
Fitting, Fixtures and Services	If possible, locate all fittings, fixtures and services above design floor level. Avoid chipboard and MDF. Consider use of removable plastic fittings. Use solid doors treated with waterproof coatings. Use solid wood staircases. Avoid fitted carpets. Locate electrical, gas and telephone equipment and systems above flood level. Fit anti-flooding devices to drainage systems.

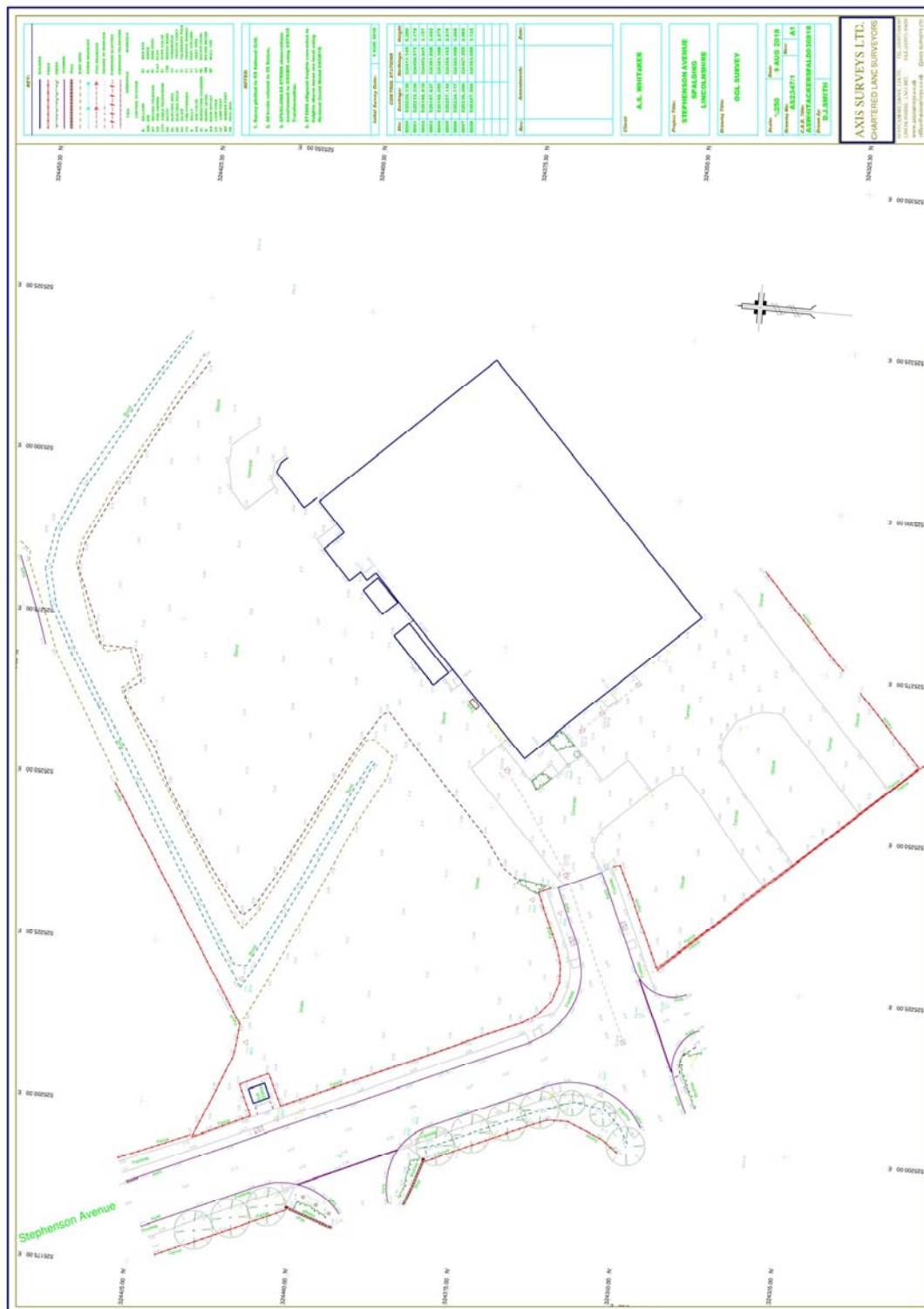
² Development and Flood Risk Guidance for the Construction Industry, CIRIA C624, London 2004

6. CONCLUSION

It is concluded that there is a risk of flooding to the site especially if the defences were to breach. The latest breach hazard mapping shows the site is within an area which is considered to be danger to most when the effects of climate change are considered.

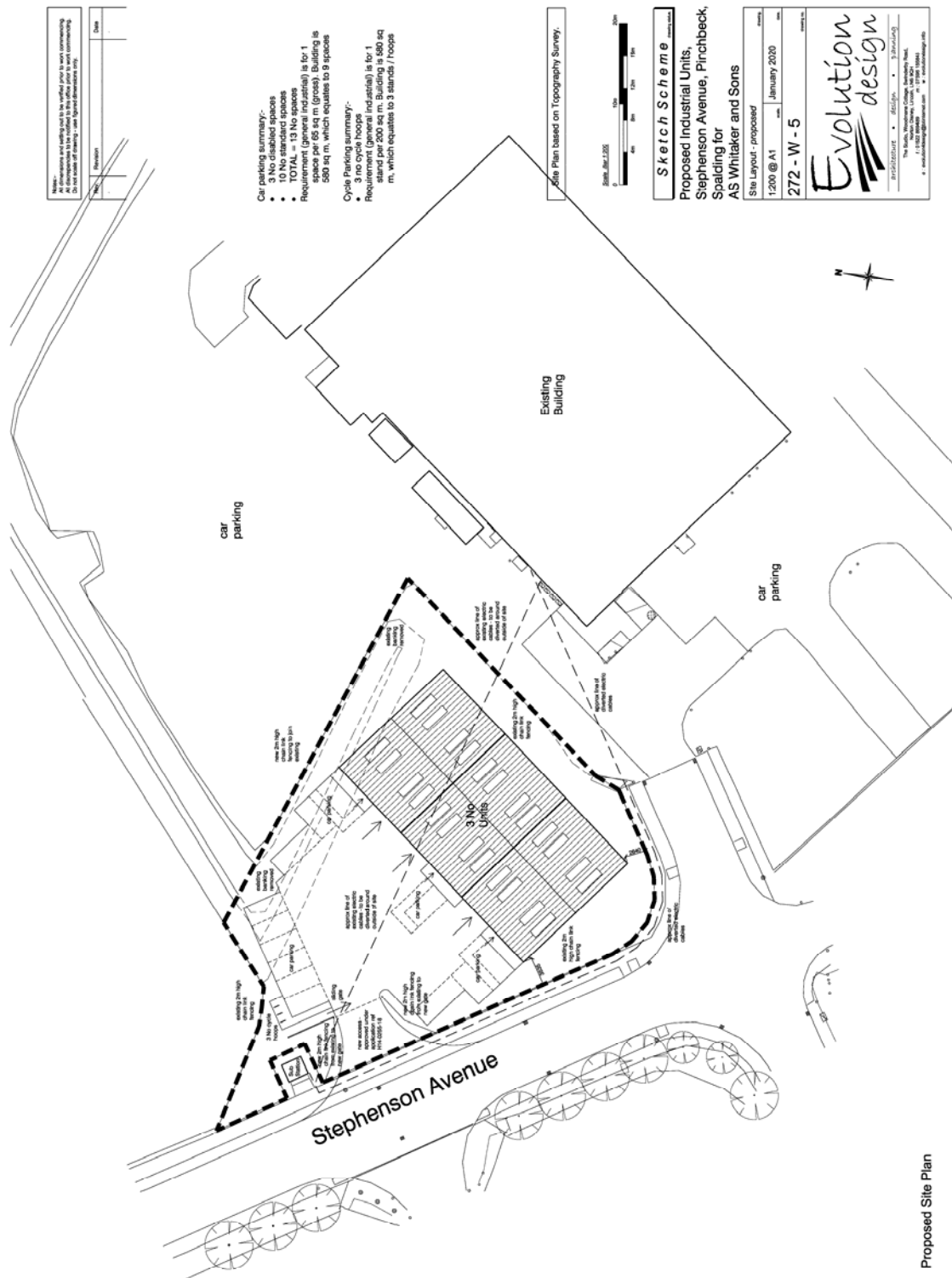
It is therefore considered at this stage based on currently available information that the flood risk within the site can be managed to an acceptable level through appropriate mitigation in line with the NPPF and best practices. It is also considered that the development will not increase flood risk to adjacent third-party users.

Appendix A: - Existing Site



Appendix B: -

Layout Plan



Appendix C: - Environment Agency Flood Data



Lea Favill
lea.favill@eweassociates.com

Our ref: CCN/2019/122806
Date: April 2019

Dear Lea

Provision of Flood Risk Information for Spalding, PE11 3UG

Thank you for your request to use our flood risk information in the development of the Flood Risk Assessment (FRA) for the above site. The information is set out below and attached. It is important you read any contextual notes on the maps provided.

We aim to review our information on a regular basis, so if you are using this data more than twelve months from the date of this letter, please contact us again to check it is still valid.

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 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 with a 0.1% chance of occurring in any year, or the highest recorded historic extent if greater.

In some locations, such as around the fens and the large coastal floodplains, showing the area at risk of flooding assuming no defences may give a slightly misleading picture in that if there were no flood defences, water would spread out across these large floodplains. This flooding could cover large areas of land but to relatively shallow depths and could leave pockets of locally slightly higher land as isolated dry islands. It is important to understand the actual risk of the flooding to these dry islands, particularly in the event of defence failure.

The Flood Map also shows the location of formal raised flood defences and flood storage reservoirs. It represents areas at risk of flooding for present day only and does not take account of climate change.

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

History of Flooding

With regards to the history of flooding I can advise we do not have any records of flooding in this area. It is possible other flooding may have occurred we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Fluvial Flood Risk Information

Fluvial Defence Information

The fluvial defences reducing the risk of flooding to this site consist of earth embankments. They are in fair condition and reduce the risk of flooding to a 1% (1 in 100) chance of occurring

Ceres House, Searby Road, Lincoln, LN2 4DW
Customer services line: 03708 506 506
Email: enquiries@environment-agency.gov.uk
www.gov.uk/environment-agency



in any year. We inspect these defences routinely to ensure potential defects are identified.

Modelled Levels and Flows

Available modelled fluvial flood levels and flows for the model nodes shown on the attached map are set out in the data table attached. This data is taken from the model named on the data table, which is the most up-to-date model currently available.

Please note 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.

Tidal Flood Risk Information

Tidal Defence Information

The tidal defences protecting this site consist of earth embankments. They are in fair condition and reduce the risk of flooding to a 1% (1 in 100) chance of occurring

Tidal/Breach Flood Levels

The attached table shows our current best estimate for extreme tide levels.

Levels for the Humber Estuary have an assessment date of 2014, with others having an assessment date of 2006, which should be used in any consideration of future increases due to climate change.

Modelled Hazard Mapping

Please refer to South Holland District Council's hazard mapping undertaken for their Strategic Flood Risk Assessment (SFRA). Please use the following website for the updated 2016 maps: <http://www.southeastlincslocalplan.org/2016-update-of-south-holland-strategic-flood-risk-assessment/>

Development Planning

If you would like local guidance on preparing a flood risk assessment for a planning application, please contact our Sustainable Places team at inplanning@environment-agency.gov.uk. It will help if you mention this data request and attach your site location plan.

We provide free preliminary advice; additional/detailed advice, review of draft FRAs and meetings are chargeable at a rate set to cover our costs, currently £100 (plus VAT) per hour of staff time. Further details are available on our website at <https://www.gov.uk/guidance/developers-get-environmental-advice-on-your-planning-proposals>.

General advice on flood risk assessment for planning applications can be found on GOV.UK at <https://www.gov.uk/guidance/flood-risk-assessment-for-planning-applications>

Climate change will increase flood risk due to overtopping of defences. Please note the climate change data included has an allowance for 20% increase in flow. Updated guidance on how climate change could affect flood risk to new development - 'Flood risk assessments: climate change allowances' was published on GOV.UK in February 2016. The appropriate updated climate change allowance should be applied in a Flood Risk Assessment.

Ceres House, Searby Road, Lincoln, LN2 4DT
Customer services line: 03708 506 506
Email: enquiries@environment-agency.gov.uk
www.gov.uk/environment-agency

FLOODS
DESTROY
BE PREPARED

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

Supporting Information

Please see the Standard Notice or licence for details of permitted use. The Standard Notice can be found at the link below.

<http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/>

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

Further information on flood risk can be found on the GOV.UK website at:

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

Other Flood Risk Management Authorities

The information provided with this letter relates to flood risk from main river or the sea. Additional information may be available from your Lead Local Flood Authority (ie county council or unitary authority) or, where they exist, the Internal Drainage Board.

Further Contact

I hope we have correctly interpreted your request. If you are not satisfied with our response to your request for information, you can contact us within two 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 Rachael Storey using the details below.

Yours sincerely,



FOR Alastair Windler
Partnerships and Strategic Overview Team Leader - Welland and Nene

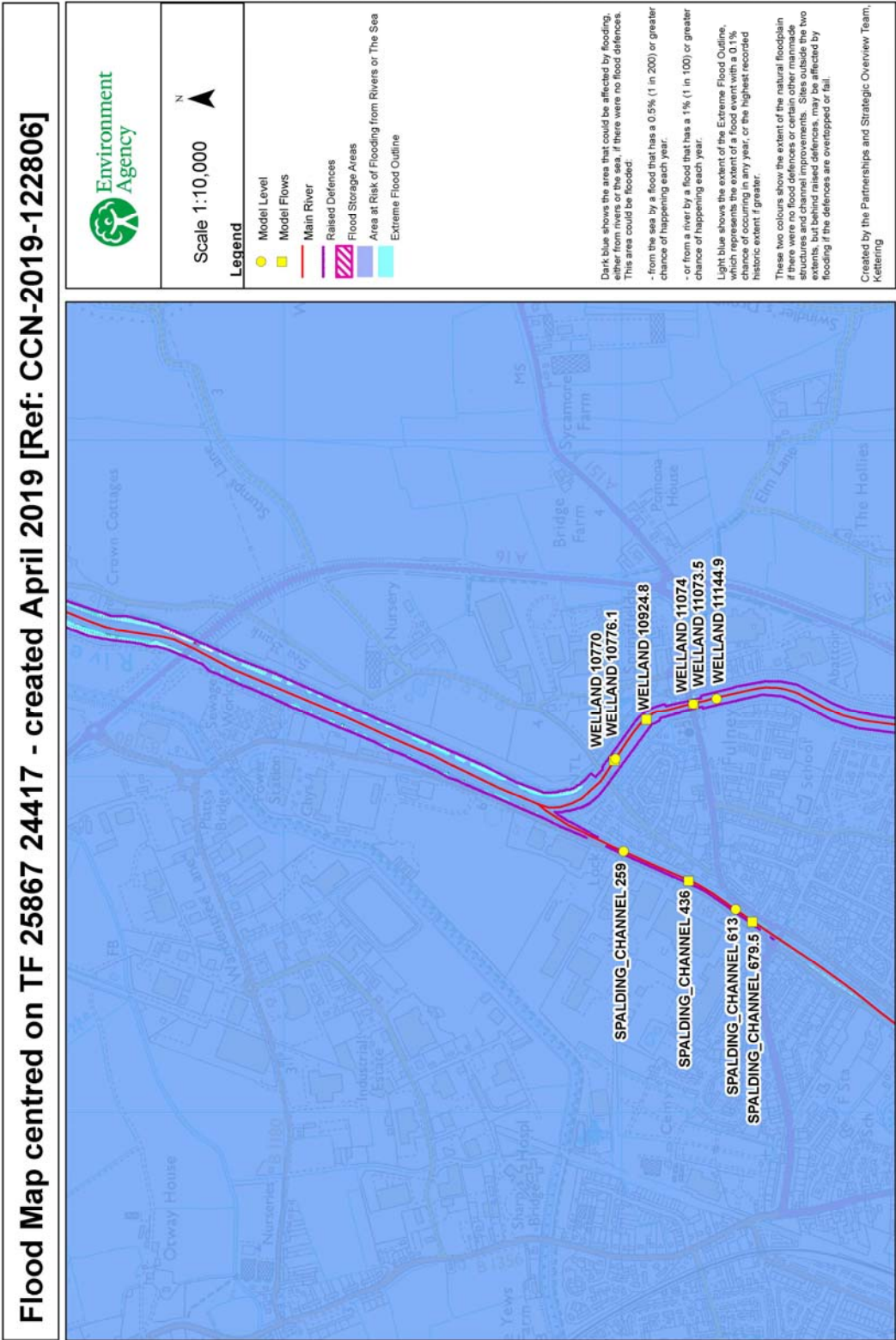
Direct dial 02030253535

Direct e-mail PSOWN@environment-agency.gov.uk

Enc.
Flood Map
Modelled Fluvial Levels and Flows Data Sheet
Estimated Tide Levels

Ceres House, Searby Road, Lincoln, LN2 4DT
Customer services line: 03708 506 506
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FLOODS
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Model Date: 2016

Model Name: Welland

Datasheet [Ref: CCN-2019-122806]

Fluvial Flood Levels (mODN)

The fluvial flood levels for the model nodes shown on the attached map are set out in the table below. They are measured in metres above Ordnance Datum Newlyn (mODN).

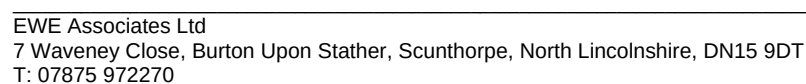
Node Label	Easting	Northing	Annual Exceedance Probability - Maximum Water Levels (mODN)										
			50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
SPALDING CHANNEL 259	525779	323995	3.70	4.00	4.17	4.45	4.51	4.52	4.52	4.68	4.53	4.56	4.68
SPALDING CHANNEL 613	525605	323662	3.70	4.00	4.17	4.45	4.51	4.52	4.52	4.68	4.53	4.55	4.68
WELLAND 10776.1	526053	324019	3.64	3.90	4.10	4.36	4.38	4.41	4.41	4.68	4.44	4.45	4.68
WELLAND 11073.5	526216	323788	3.65	3.91	4.10	4.36	4.38	4.41	4.43	4.68	4.44	4.45	4.68
WELLAND 11144.9	526232	323719	3.65	3.91	4.10	4.36	4.39	4.42	4.44	4.68	4.45	4.46	4.68

Fluvial Flood Flows (m³/s)

The fluvial flood flows for the model nodes shown on the attached map are set out in the table below. They are measured in metres cubed per second (m³/s).

Node Label	Easting	Northing	Annual Exceedance Probability - Maximum Flows (m³/s)										
			50% (1 in 2)	20% (1 in 5)	10% (1 in 10)	5% (1 in 20)	2% (1 in 50)	1.33% (1 in 75)	1% (1 in 100)	1% (1 in 100) inc 20% Climate Change	0.5% (1 in 200)	0.1% (1 in 1000)	0.1% (1 in 1000) inc 20% Climate Change
SPALDING CHANNEL 436	525690	323802	0.71	1.06	0.91	1.06	1.03	1.15	1.17	1.65	1.10	1.07	1.93
SPALDING CHANNEL 679.5	525567	323613	1.30	1.99	1.77	2.06	1.93	2.24	2.31	3.19	2.18	2.06	3.61
WELLAND 10770	526048	324023	74.58	91.64	102.46	116.08	121.43	121.70	123.79	124.12	122.86	123.37	236.17
WELLAND 10924.8	526170	323927	74.06	89.60	100.87	115.72	118.85	119.81	121.38	123.20	120.56	120.49	119.34
WELLAND 11074	526216	323788	73.88	89.28	100.54	115.25	118.58	119.51	123.31	124.59	121.86	124.52	119.07

April 2019



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Appendix E: - ICPSUDs Runoff Calculation

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Windy Ridge Barn		
Thealby Lane		
Winterton DN15 9TG		
Date 01/04/2020 15:03	Designed By Windows7	
File	Checked By	
Micro Drainage	Source Control W.12.4	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.400
Area (ha)	0.194	Urban	0.000
SAAR (mm)	563	Region Number	Region 5

Results 1/s

QBAR Rural	0.5
QBAR Urban	0.5
Q1 year	0.4
Q1 year	0.4
Q30 years	1.2
Q100 years	1.8

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Appendix F: - Drainage Strategy Drawing



Appendix G: - Storage Calculation

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Windy Ridge Barn

Thealby Lane

Winterton DN15 9TG

Date 01/04/2020 15:07

File 100yr+CC30% tank ...

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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
15 min Summer	2.161	0.461	0.7	46.1	O K
30 min Summer	2.229	0.529	0.7	52.9	O K
60 min Summer	2.302	0.602	0.8	60.2	O K
120 min Summer	2.376	0.676	0.8	67.6	O K
180 min Summer	2.417	0.717	0.9	71.7	O K
240 min Summer	2.442	0.742	0.9	74.2	O K
360 min Summer	2.470	0.770	0.9	77.0	O K
480 min Summer	2.480	0.780	0.9	78.0	O K
600 min Summer	2.480	0.780	0.9	78.0	O K
720 min Summer	2.476	0.776	0.9	77.6	O K
960 min Summer	2.467	0.767	0.9	76.7	O K
1440 min Summer	2.443	0.743	0.9	74.3	O K
2160 min Summer	2.402	0.702	0.8	70.2	O K
2880 min Summer	2.362	0.662	0.8	66.2	O K
4320 min Summer	2.265	0.565	0.8	56.5	O K
5760 min Summer	2.189	0.489	0.7	48.9	O K
7200 min Summer	2.126	0.426	0.7	42.6	O K
8640 min Summer	2.073	0.373	0.6	37.3	O K
10080 min Summer	2.028	0.328	0.6	32.8	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Summer	198.187	27
30 min Summer	114.287	41
60 min Summer	65.905	70
120 min Summer	38.005	128
180 min Summer	27.541	188
240 min Summer	21.916	246
360 min Summer	15.882	364
480 min Summer	12.638	482
600 min Summer	10.586	600
720 min Summer	9.159	654
960 min Summer	7.290	768
1440 min Summer	5.285	1028
2160 min Summer	3.832	1440
2880 min Summer	3.050	1852
4320 min Summer	2.135	2676
5760 min Summer	1.658	3464
7200 min Summer	1.363	4248
8640 min Summer	1.161	5016
10080 min Summer	1.014	5752

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Windy Ridge Barn

Thealby Lane

Winterton DN15 9TG

Date 01/04/2020 15:07

File 100yr+CC30% tank ...

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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
15 min Winter	2.217	0.517	0.7	51.7	O K
30 min Winter	2.293	0.593	0.8	59.3	O K
60 min Winter	2.375	0.675	0.8	67.5	O K
120 min Winter	2.461	0.761	0.9	76.1	O K
180 min Winter	2.509	0.809	0.9	80.9	O K
240 min Winter	2.545	0.845	0.9	84.0	O K
360 min Winter	2.598	0.898	1.0	87.4	O K
480 min Winter	2.634	0.934	1.0	88.9	O K
600 min Winter	2.648	0.948	1.0	89.3	O K
720 min Winter	2.640	0.940	1.0	89.1	O K
960 min Winter	2.603	0.903	1.0	87.7	O K
1440 min Winter	2.557	0.857	0.9	84.9	O K
2160 min Winter	2.493	0.793	0.9	79.3	O K
2880 min Winter	2.436	0.736	0.9	73.6	O K
4320 min Winter	2.302	0.602	0.8	60.2	O K
5760 min Winter	2.198	0.498	0.7	49.8	O K
7200 min Winter	2.116	0.416	0.7	41.6	O K
8640 min Winter	2.049	0.349	0.6	34.9	O K
10080 min Winter	1.992	0.292	0.5	29.2	O K

Storm Event	Rain (mm/hr)	Time-Peak (mins)
15 min Winter	198.187	26
30 min Winter	114.287	41
60 min Winter	65.905	70
120 min Winter	38.005	126
180 min Winter	27.541	184
240 min Winter	21.916	242
360 min Winter	15.882	356
480 min Winter	12.638	470
600 min Winter	10.586	580
720 min Winter	9.159	686
960 min Winter	7.290	806
1440 min Winter	5.285	1096
2160 min Winter	3.832	1560
2880 min Winter	3.050	1996
4320 min Winter	2.135	2856
5760 min Winter	1.658	3688
7200 min Winter	1.363	4472
8640 min Winter	1.161	5272
10080 min Winter	1.014	6056

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Micro Drainage	Source Control W.12.4	

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	522450 325450 TF 22450 25450
C (1km)	-0.022
D1 (1km)	0.307
D2 (1km)	0.308
D3 (1km)	0.222
E (1km)	0.313
F (1km)	2.486
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+30

Time / Area Diagram

Total Area (ha) 0.126

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.042	4-8	0.042	8-12	0.042

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Model Details

Storage is Online Cover Level (m) 3.200

Tank or Pond Structure

Invert Level (m) 1.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	100.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	100.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	100.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	100.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	100.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	0.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Hydro-Brake® Outflow Control

Design Head (m) 1.000 Hydro-Brake® Type Md4 Invert Level (m) 1.700
Design Flow (l/s) 1.0 Diameter (mm) 36

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.5	1.200	1.1	3.000	1.8	7.000	2.7
0.200	0.5	1.400	1.2	3.500	1.9	7.500	2.8
0.300	0.6	1.600	1.3	4.000	2.1	8.000	2.9
0.400	0.7	1.800	1.4	4.500	2.2	8.500	3.0
0.500	0.7	2.000	1.5	5.000	2.3	9.000	3.1
0.600	0.8	2.200	1.5	5.500	2.4	9.500	3.2
0.800	0.9	2.400	1.6	6.000	2.5		
1.000	1.0	2.600	1.7	6.500	2.6		

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