SUPERSEDED

Keigar Homes Ltd

Proposed Residential Development
Land off Dartmouth Road
Scunthorpe
North Lincolnshire

Flood Risk Assessment
Prepared by EWE Associates Ltd
Final Report RevB January 2019

EWE Associates Ltd
7 Waveney Close
Burton Upon Stather
Scunthorpe
North Lincolnshire
DN15 9DT
t: 01724 721099
M: 07875 972270
e: lea.favill@eweassociates.com

CLIENT DETAILS

Keigar Homes Ltd
Keigar Lodge
Canberra View
Barton Upon Humber
North Lincolnshire
DN18 5GR

CONTRACT

This report describes work commissioned by Keigar Homes Ltd following written instruction by their representative during September 2018. Keigar Homes Ltd representative for the contract was Mr Mark Snowden. Lea Favill of EWE Associates Ltd carried out the work.

Date: 14th January 2019

Prepared by: …… [redacted] …… Lea Favill
Director

REVISION HISTORY

Draft Report Rev0 issued 22nd October 2018 - 1No copy issued to Mr Mark Snowden (Keigar Homes Ltd)
Final Report RevA issued 29th October 2018 - 1No copy issued to Mr Mark Snowden (Keigar Homes Ltd)
Final Report RevB issued 14th January 2019 – amended DS - 1No copy issued to Mr Mark Snowden (Keigar Homes Ltd)

EXECUTIVE SUMMARY

The proposed development site is currently a grass field with no ditch or watercourse within the site or its boundaries. The total site covers an area of 2.5 hectares and is considered to be 100% permeable as there are no roofed or paved areas within the site. The land within the site boundary lies between 6.113mOD at the northern west corner and 8.100mOD at the south east corner.

The site is located to the south west of the centre of Scunthorpe. There is existing residential development to the south and west of the proposed development site. There is the crematorium to the east and a leisure area to the north.

The proposal is to provide a residential development. The proposed impermeable area is estimated at 50% of the site area, hence, approximately 1.25 hectares.

The flood risk from tidal, fluvial, and ordinary watercourses is considered to be low. The ground floor level should also be elevated at least 150mm above the adjacent external ground level to reduce the risk of flooding from localised flooding.

It is considered that dry access and egress will be available at all times from the development.

Consideration has been given to the hierarchy for surface water disposal which recommends the SUDs approach which includes infiltration as the first tier. Site investigation has identified clay and silts which is unlikely to provide any infiltration.

However, other SUDs techniques can be used within the site and they have been considered. The second tier is to discharge to a watercourse. There are no watercourses located within or adjacent to the site. There is a surface water sewer located to the west of the site within Weymouth Crescent which is proposed as the point of discharge from the site. Following the proposed development, the impermeable area will be increased to 1.25 hectares. It is considered that the site currently discharges runoff via a combination of infiltration, evaporation and overland flow to the west of the site where the sewer is located.

Using software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (40%) event. The site will discharge into the surface water sewer to the north west corner of the site at a peak discharge rate of 9.4l/s. The primary attenuation will be provided within oversized pipes, crate tanks and a dry basin.

The balancing pond will be used to accommodate the storage during 1 in 1 year, 30 year, 100 year and 100 year +CC storms (worst case scenario).

The proposal is to provide a hydro-brake to restrict flows from the site. The hydro-brake will reduce the runoff from the development site during higher return periods, hence, there will be a significant reduction in runoff and as such the development will provide significant betterment in terms of runoff being passed forward from the site into the receiving combined sewer.

It is concluded that there is a low risk of flooding from tidal and fluvial sources. The proposed drainage strategy discharges runoff to surface water sewer and uses sustainable drainage systems where appropriate.

CONTENTS

LIST OF TABLES

1. INTRODUCTION

Terms of Reference

This report was commissioned by Keigar Homes Ltd to support a planning application for the construction of a residential development off Dartmouth Road in Scunthorpe. The site is located to the north of Dartmouth Road and to the east of Weymouth Crescent. The centre of Scunthorpe is to the north east of the site. The location of the site is shown on Table 2-1.

The development site lies within Zone 1 of the Environment Agency Flood Map (version 2.8.2), being the zone with risk of 1 in 1,000 year (0.1% Annual Exceedance Probability) or less for river and tidal/coastal flooding. The development site is within an existing developed area and is greater 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 is a single source of flood risk – onsite surface water runoff – it is necessary to determine flood water levels at the site for the desired return periods emanating from this source. Consideration has also been given to the site flooding from either overland flow or ponding of localised rainfall within the site.

The closest tidal watercourse is the River Trent which is 3.2km to the west of the site. The site is at a minimum level of 6mOD and based on the Environment Agency flood maps is not within the extreme tidal flood level within the River Trent. The Environment Agency provided the flood maps for both overtopping and breach which concluded that the site is not within the extreme flood envelope. It is therefore concluded that the River Trent represents a low flood risk to the site.

The closest fluvial watercourses are located to the west of Scunthorpe in an area which is generally at a level of 3mOD and below in line with the site. The watercourses are a mixture of Internal Drainage Board drains and riparian drains which are predominantly rural runoff. It is therefore concluded that the fluvial watercourses represent a low flood risk to the site.

The proposed development will increase the paved and roofed area within the site. The site is currently open grass land with no roofed or paved areas. 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 40% 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 October 2018; during the visit a photograph survey of the site was undertaken. A spot level survey of the site was provided by the client. The survey was related to ordnance survey datum.

The requirements for flood risk assessments are generally as set out in National Planning Policy Framework (NPPF). The detail and complexity of the study required should be appropriate to the scale and potential impact of the development. For the purposes of this study, the following have been considered: -

- Available information on historical flooding in the area.
- Site level information.
- Details of structures, which may influence hydraulics of the watercourse and consideration of the effect of blockage of structures.
- Estimates of design levels, equivalent to a 200-year (coastal/tidal) and a 100-year (fluvial) return period flood event.
- Allowances for increased flows resulting from the effects of climate change.
- Allowances for sea level rise resulting from the effects of climate change.

Assess the existing runoff characteristics and the potential impact the proposed development will have on the runoff.

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 partly within Zone 1 of the Environment Agency Flood Map (version 2.8.2), being the zone with risk of 1 in 1,000 year (0.1% AEP) or less for river and tidal/coastal flooding. The proposed development is residential, as such considered to be more 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

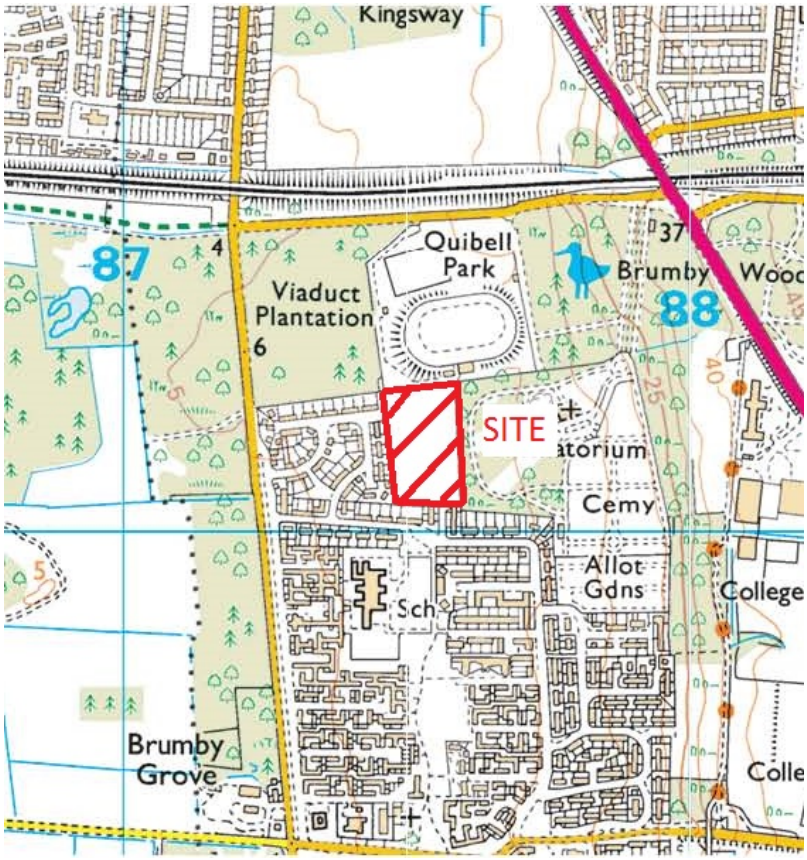
× Development should not be permitted

It is considered therefore, that a sequential test and exceptions test will not be required for this development project.

2. DETAILS OF THE SITE

Site Location

Table 2-1: Location Plan



Site Details

Table 2-2: Site Details

Site Name	Land off Dartmouth Road Scunthorpe
Existing Land Use	Grassland
Proposed Development	Residential
Grid Reference	SE 87525 10141
County	North Lincolnshire
Local Planning Authority	North Lincolnshire Council
Internal Drainage Board	Not Applicable
Others	Not Applicable
Post Code	DN17 1TU

Site Description

The proposed development site is currently a grass field with no ditch or watercourse within the site or its boundaries. An aerial photograph of the existing site is provided below. The total site covers an area of 2.5 hectares and is considered to be 100% permeable as there are no roofed or paved areas within the site. The land within the site boundary lies between 6.113mOD at the northern west corner and 8.100mOD at the south east corner.

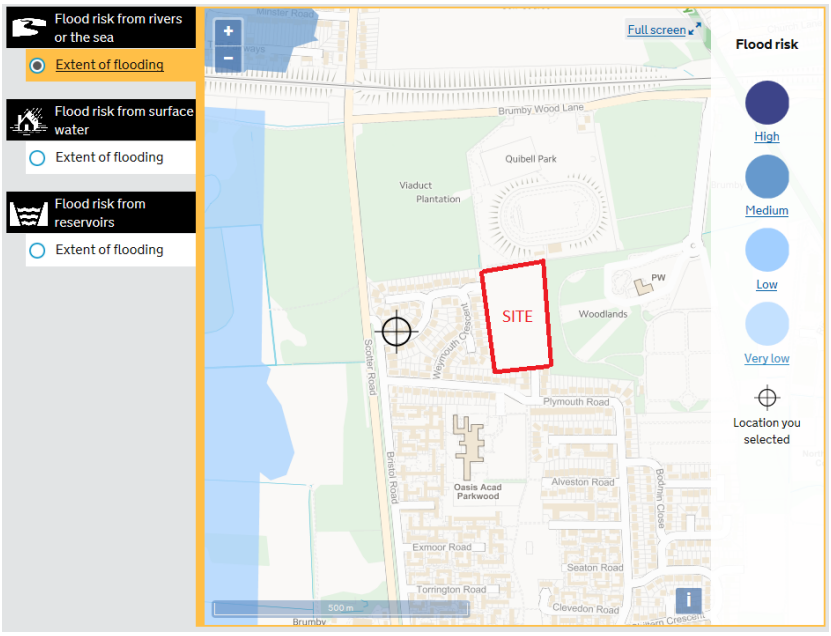
The site is located to the south west of the centre of Scunthorpe. There is existing residential development to the south and west of the proposed development site. There is the crematorium to the east and a leisure area to the north.

The proposal is to provide a residential development. The proposed impermeable area is estimated at 50% of the site area, hence, approximately 1.25 hectares.

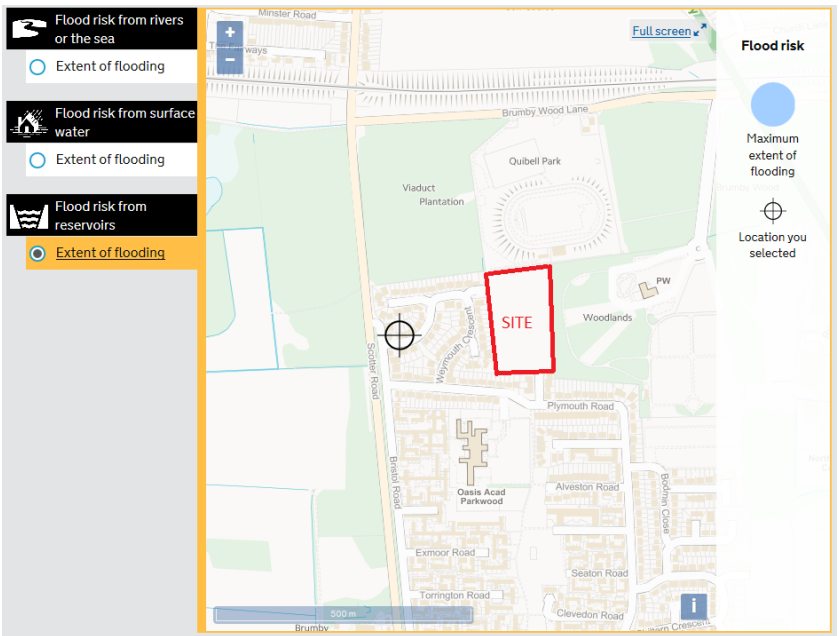
Site Photographs

3. INITIAL ASSESSMENT

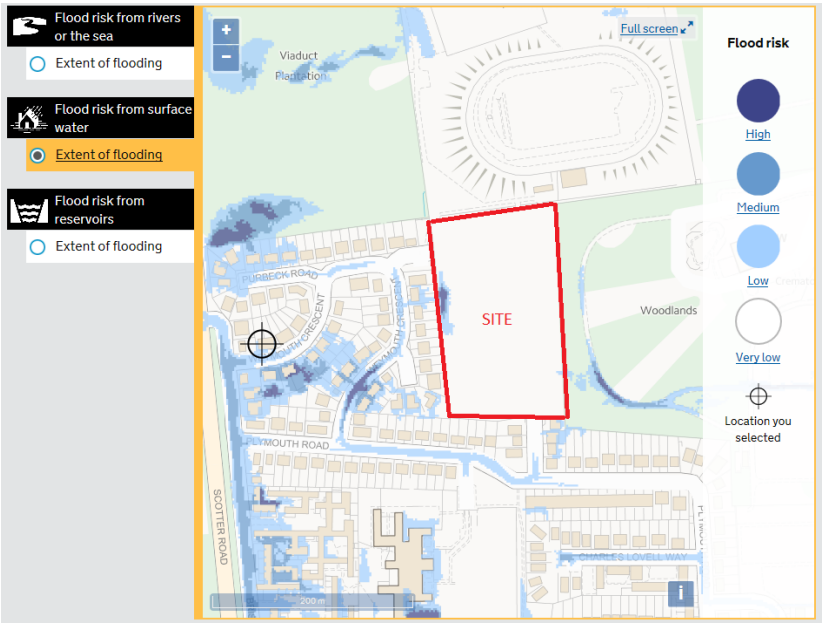
Environment Agency Flood Map



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 website[1] found no records of past flooding within the Scunthorpe 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 provided no further information.

Environment Agency Reservoir Flood Risk

The Environment Agency reservoir risk map shows that the site and Scunthorpe are not located in an area which could be affected by a reservoir failure. As such, the probability of a flooding is extremely low.

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

Environment Agency Surface Water Flood Risk

The Environment Agency surface water flood risk map shows there is a single area of low risk flooding within the western boundary of the existing site where the lowest ground levels. Estimated flood depths during a 1 in 100 year event are likely to be less than 300mm and is located away from buildings within the site.

Overland Flow & Ponding

There is no higher ground adjacent to the site which could promote overland flow of water across the site from the residential area. Consequently, no further consideration will be given to this mechanism.

There are no depressed areas within the site which could encourage ponding, therefore, this flood mechanism has not been considered further.

Groundwater Flooding

Information on groundwater flooding is limited within the area. The SFRA makes no comment regards the potential for ground water flooding in the district. As such, risk from ground water flooding is low.

Sewer Flooding

Severn Trent Water is the statutory water undertaker and is responsible for the public sewer systems within the Scunthorpe area. There are existing surface water and foul sewers within the development site.

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 is a single source of flood risk – onsite runoff– it is necessary to determine flood water levels at the site for the desired return periods emanating from this source.

The proposed development will increase the impermeable area within the site. 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 residential in nature, as such, it is considered that access and egress from the development site will be essential during times of extreme floods.

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 D of this report.

Existing Drainage

The existing development site consists of a grass fields with sparse vegetation. The total site area has been estimated at 2.5 hectares. The site currently drains east to west towards the sewers located within Weymouth Crescent. The subsoils consist of clays and silts with a low permeability.

Table 4-1: ICPSUDs flows from existing site 2.5 hectares

Return Period	Flow in litres per second (l/s)
Qbar	9.4
1 in 1 year	7.8
1 in 30 year	18.4
1 in 100 year	24.1

For the purpose of this assessment the peak discharge rates from the site above in **Table 4-1** have been conservatively adopted. The ICPSUDs Method has been used to calculate the existing runoff from the site. The calculation sheet is provided at Appendix C of this report. Any discharge from the site into the sewer 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.

Therefore, for this assessment the peak discharge rate from the site has been restricted to 9.4l/s.

Proposed Drainage Strategy

For the purpose of this assessment the peak discharge rate from the site of 9.4 l/s has been conservatively adopted.

It is proposed to ultimately discharge any surface water flows generated by the development of the site which cannot drain via infiltration to the surface water sewer within Weymouth Crescent.

The proposed impermeable area for the development site has been calculated to be approximately 1.25 ha which is 50% of the total site area, with the remainder of the site proposed as gardens, landscaping and open space.

The drainage strategy utilises an appropriately sized hydro brake to restrict the flow rate to a maximum of 9.4l/s. As such, the flow will vary for each of the design storms shown above and it is expected that during the more extreme return periods there will be a considerable betterment as the hydro brake is likely to restrict flows to a lesser rate than estimated at present.

Based upon the assumption that the drainage authority will agree to the maximum discharge rates of 9.4l/s, a preliminary surface water network has been developed and attenuation has been sized using MicroDrainage software.

The model data for the proposed surface water drainage network has been obtained from the proposed development layout drawing and the drainage strategy drawing is provided at Appendix D of this report. A model has been developed to represent the main drainage runs within the proposed drainage network and contributing drainage areas within the development.

Overall, the hydraulic models include the following;

- 12 pipes to represent the proposed system
- 1 hydro-brake (9.4l/s 1.8m head)
- 18 attenuation tanks in private areas
- 1 depressed area 0.4m deep for surface storage
- 1 outfall into the surface water sewer with no surcharging

Impermeable area contributions have been based on those supplied on the proposed layout drawing, considered to be 100% impermeable, comprising of roofed and paved areas.

The models have been set up as a fixed runoff model assuming 100% runoff coefficient for roofed and paved areas. The rainfall characteristics for Scunthorpe have been utilised with a value for M5-60 given as 20mm (the depth of rain in a once in five years one hour duration event); and r given as 0.40 (the ratio of the M5-60 rainfall to the M5-2day rainfall). For durations over 60 minutes the FEH runoff data for Scunthorpe has been used.

Hydraulic Modelling Results

The proposed MicroDrainage models have been simulated with the 1 in 100 year plus climate change (40%) return period design storm events with durations of 15, 45, 60, 120, 240, 360, 480, 540, 600, 780, 900, 1140 and 1440 minutes. At the request of the Environment Agency seven day 10080 minute duration was also undertaken. The durations were run in both Winter and Summer profiles. It was found that the Winter profile was critical.

The table below shows a summary of the 1 in 100 year plus climate change model runs and the impact on the drainage system in terms of peak depth within the drainage system and flow through the hydro-brake.

The 480 minute duration produced the largest flow through the hydro-brake (9.4 l/s) which is equivalent to the restricted runoff rate (9.4l/s). The modelled result for the

480 minute Winter model run is provided at Appendix E. There was no flooding during this event.

Return Period	Profile	Duration (min)	Peak water level in system	Peak flow into sewer	Status
100 year+CC	Winter FSR	15min	5.400	8.1	SUR
100 year+CC	Winter FSR	45min	5.587	8.6	SUR
100 year+CC	Winter FEH	60min	5.636	8.8	SUR
100 year+CC	Winter FEH	120min	5.854	9.4	Flood Risk
100 year+CC	Winter FEH	240min	5.949	9.4	Flood Risk
100 year+CC	Winter FEH	360min	5.986	9.4	Flood Risk
100 year+CC	Winter FEH	480min	5.998	9.4	Flood Risk
100 year+CC	Winter FEH	540min	5.996	9.4	Flood Risk
100 year+CC	Winter FEH	600min	5.997	9.4	Flood Risk
100 year+CC	Winter FEH	780min	5.977	9.4	Flood Risk
100 year+CC	Winter FEH	900min	5.960	9.4	Flood Risk
100 year+CC	Winter FEH	1140min	5.928	9.4	Flood Risk
100 year+CC	Winter FEH	1440min	5.881	9.4	Flood Risk
100 year+CC	Winter FEH	10800min	4.852	6.2	SUR

SUDs

The Environment Agency requires that adequate pollution control is incorporated into the proposed drainage system in order to prevent deterioration of the quality of the water environment. However, this is only applicable for surface water originating from access roads and communal parking areas, which needs to be passed through a petrol/oil interceptor or equivalent system prior to discharge into the existing surface water sewer or infiltration system. It is noted however, that this will not apply to surface water originating from roof drainage.

To reduce the impact of surface water runoff from the development in accordance with the requirements of the Environment Agency and Local Authority, the employment of SUDS techniques to limit runoff volumes and rates from the site are recommended. SUDS techniques can also be used to provide an appropriate level of treatment to the runoff.

It is normal practice to ensure that the 1 in 30 year event is maintained within the drainage system and the 1 in 100 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 in specific areas proposed for this purpose.

The following section will provide some possible SUDS techniques which could be employed on the site to balance flows in excess of the 1 in 30 year event. SUDS techniques will also provide treatment to the runoff to remove a proportion of the pollution and protect the quality of the downstream watercourses. Following guidance from CIRIA Report C522 the following levels of treatment will be provided:

- Roofs – 1 level
- Driveways – 1 level
- Roads and communal parking areas – 2 levels.

At this stage it is considered that the site is underlain by clay and silts which are unlikely to allow any infiltration at a reasonable rate.

The following SUDS techniques shown overleaf within Table 4-2. The precise combination of methods used will be dependent upon the site constraints identified at the final design stage

Table 4-2: SUDS Techniques and Suitability of Use

Method	Description	Potential for use at site
Filter drains	Drainage trench filled with gravel and provided with a pipe	Poor infiltration not suitable.
Swales	Shallow grass ditch	Maybe used to control overland flows
Permeable surfaces	Pavement surfaces that allow water to pass through into underlying storage in sub base e.g. permeable concrete block paving or porous asphalt.	Poor infiltration not suitable.
Ponds and basins	Open areas that are used to store and treat rainwater. Ponds are permanent bodies of water and basins are generally dry and occasionally store water.	Dry Basin Proposed for higher return period storms
Green roofs	Roof system that is vegetated with plants (note sedum plants rather than grass so no mowing is required)	Not incorporated into design
Infiltration devices	Methods that allow rainwater to soak into the ground, e.g. soakaways.	Poor infiltration not suitable.
Storage tanks	Underground tanks that temporarily store water in the drainage system.	Proposed attenuation solution for development
Rain Gardens & Filter strips adjacent to adoptable highway	Grassed area draining to stone filled trench with positive outfall into crate storage and borehole	Preferred solution adopted for the site

5. MITIGATION MEASURES

Raising Floor Levels/Land Raising

The flood risk from tidal, fluvial, and ordinary watercourses is considered to be low. The ground floor level should also be elevated at least 150mm above the adjacent external ground level to reduce the risk of flooding from localised flooding.

Emergency Access & Egress

It is considered that dry access and egress will be available at all times from the development.

Control of Runoff

Consideration has been given to the hierarchy for surface water disposal which recommends the SUDs approach which includes infiltration as the first tier. Site investigation has identified clay and silts which is unlikely to provide any infiltration.

However, other SUDs techniques can be used within the site and they have been considered. The second tier is to discharge to a watercourse. There are no watercourses located within or adjacent to the site. There is a surface water sewer located to the west of the site within Weymouth Crescent which is proposed as the point of discharge from the site. Following the proposed development, the impermeable area will be increased to 1.25 hectares. It is considered that the site currently discharges runoff via a combination of infiltration, evaporation and overland flow to the west of the site where the sewer is located.

Using software developed by Microdrainage the required attenuation has been calculated for the 1 in 100 year plus climate change (40%) event. The site will discharge into the surface water sewer to the north west corner of the site at a peak discharge rate of 9.4l/s. The primary attenuation will be provided within oversized pipes, crate tanks and a dry basin.

The balancing pond will be used to accommodate the storage during 1 in 1 year, 30 year, 100 year and 100 year +CC storms (worst case scenario).

The proposal is to provide a hydro-brake to restrict flows from the site. The hydro-brake will reduce the runoff from the development site during higher return periods, hence, there will be a significant reduction in runoff and as such the development will provide significant betterment in terms of runoff being passed forward from the site into the receiving combined sewer.

It is recommended that during the detailed phase of the development the following items are considered.

- The maintenance and adoption regimes for all elements of the development should be considered for the lifetime of the development.
- Consenting will be required from the Water Authority for any connections into the surface water sewer.

6. CONCLUSION

It is concluded that there is a low risk of flooding from tidal and fluvial sources. The proposed drainage strategy discharges runoff to surface water sewer and uses sustainable drainage systems where appropriate.

Appendix A: - Existing Site Levels

Appendix B: - Proposed Layout Plan

Appendix C: - ICPSUDS Site

EWE Associates Ltd		Page 1
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		
Date 13/10/2018 10:45 File	Designed By Windows7 Checked By	
Micro Drainage	Source Control W.12.4	

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.450
Area (ha)	2.500	Urban	0.000
SAAR (mm)	612	Region Number	Region 4

Results	l/s
QBAR Rural	9.4
QBAR Urban	9.4
Q1 year	7.8
Q1 year	7.8
Q30 years	18.4
Q100 years	24.1

Appendix D: - Drainage Strategy Drawing

Appendix E: - WINDES Calculations

EWE Associates Ltd		Page 1
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28	Designed By Windows7	
File 100yr+CC40%Winter...	Checked By	
Micro Drainage	Network W.12.4	

Existing Network Details for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	k (mm)	HYD SECT	DIA (mm)
1.000	47.500	0.190	250.0	0.235	4.00	0.600	o	750
1.001	42.700	0.170	251.2	0.128	0.00	0.600	o	750
1.002	41.700	0.170	245.3	0.117	0.00	0.600	o	750
1.003	50.500	0.410	123.2	0.211	0.00	0.600	o	750
1.004	13.400	0.260	51.5	0.023	0.00	0.600	o	750
2.000	31.000	0.400	77.5	0.102	4.00	0.600	o	750
2.001	12.600	0.100	126.0	0.054	0.00	0.600	o	750
2.002	40.600	0.170	238.8	0.099	0.00	0.600	o	750
2.003	47.200	0.190	248.4	0.142	0.00	0.600	o	750
2.004	48.400	0.200	242.0	0.090	0.00	0.600	o	750
1.005	25.000	0.100	250.0	0.044	0.00	0.600	o	750
1.006	3.000	0.040	75.0	0.000	0.00	0.600	o	750

PN	US/MH Name	US/CL (m)	US/IL (m)	US C.Depth (m)	DS/CL (m)	DS/IL (m)	DS C.Depth (m)	Ctrl	US/MH (mm)
1.000	2	7.200	5.340	1.110	7.100	5.150	1.200		1800
1.001	3	7.100	5.150	1.200	7.000	4.980	1.270		1800
1.002	4	7.000	4.980	1.270	7.000	4.810	1.440		1800
1.003	6	7.000	4.810	1.440	6.200	4.400	1.050		1800
1.004	7	6.200	4.400	1.050	6.100	4.140	1.210		1800
2.000	8	7.000	5.200	1.050	6.600	4.800	1.050		1800
2.001	9	6.600	4.800	1.050	6.500	4.700	1.050		1800
2.002	10	6.500	4.700	1.050	6.400	4.530	1.120		1800
2.003	11	6.400	4.530	1.120	6.300	4.340	1.210		1800
2.004	12	6.300	4.340	1.210	6.100	4.140	1.210		1800
1.005	13	6.100	4.140	1.210	6.000	4.040	1.210		1800
1.006	14	6.000	4.040	1.210	6.003	4.000	1.253	Hydro-Brake®	3000

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006	sewer	6.003	4.000	4.000	0	0

EWE Associates Ltd		Page 2
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Foul Sewage per hectare (l/s)	0.000
PIMP (% impervious)	100	Additional Flow - % of Total Flow	40.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Run Time (mins)	960
Hot Start Level (mm)	0	Output Interval (mins)	8
Manhole Headloss Coeff (Global)	0.500		

Number of Input Hydrographs	0	Number of Storage Structures	8
Number of Online Controls	1	Number of Time/Area Diagrams	0
Number of Offline Controls	0		

Synthetic Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
Site Location	487400 410400 SE 87400 10400
C (1km)	-0.023
D1 (1km)	0.329
D2 (1km)	0.317
D3 (1km)	0.276
E (1km)	0.300
F (1km)	2.469
Summer Storms	No
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.750
Storm Duration (mins)	480

EWE Associates Ltd		Page 3
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Online Controls for Storm

Hydro-Brake® Manhole: 14, DS/PN: 1.006, Volume (m³): 23.8

Design Head (m) 1.800 Hydro-Brake® Type Md4 Invert Level (m) 4.040
Design Flow (l/s) 9.4 Diameter (mm) 95

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	7.7	3.000	12.2	7.000	18.6
0.200	5.6	1.400	8.3	3.500	13.2	7.500	19.3
0.300	4.7	1.600	8.9	4.000	14.1	8.000	19.9
0.400	4.6	1.800	9.4	4.500	14.9	8.500	20.5
0.500	5.0	2.000	9.9	5.000	15.7	9.000	21.1
0.600	5.5	2.200	10.4	5.500	16.5	9.500	21.7
0.800	6.3	2.400	10.9	6.000	17.2		
1.000	7.0	2.600	11.3	6.500	17.9		

EWE Associates Ltd		Page 4
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Storage Structures for Storm

Tank or Pond Manhole: 3, DS/PN: 1.001

Invert Level (m) 5.150

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	4.5	1.400	0.0	2.800	0.0	4.200	0.0
0.200	4.5	1.600	0.0	3.000	0.0	4.400	0.0
0.400	4.5	1.800	0.0	3.200	0.0	4.600	0.0
0.600	4.5	2.000	0.0	3.400	0.0	4.800	0.0
0.800	4.5	2.200	0.0	3.600	0.0	5.000	0.0
1.000	4.5	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: 4, DS/PN: 1.002

Invert Level (m) 4.980

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	9.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	9.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	9.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	9.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	9.0	2.200	0.0	3.600	0.0	5.000	0.0
1.000	9.0	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: 6, DS/PN: 1.003

Invert Level (m) 4.810

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	75.0	1.400	0.0	2.800	0.0	4.200	0.0
0.200	75.0	1.600	0.0	3.000	0.0	4.400	0.0
0.400	75.0	1.800	0.0	3.200	0.0	4.600	0.0
0.600	75.0	2.000	0.0	3.400	0.0	4.800	0.0
0.800	75.0	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		

Tank or Pond Manhole: 7, DS/PN: 1.004

Invert Level (m) 4.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	14.7	0.200	14.7	0.400	14.7	0.600	14.7

EWE Associates Ltd		Page 5
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Tank or Pond Manhole: 7, DS/PN: 1.004

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.800	14.7	2.000	0.0	3.200	0.0	4.400	0.0
1.000	14.7	2.200	0.0	3.400	0.0	4.600	0.0
1.200	0.0	2.400	0.0	3.600	0.0	4.800	0.0
1.400	0.0	2.600	0.0	3.800	0.0	5.000	0.0
1.600	0.0	2.800	0.0	4.000	0.0		
1.800	0.0	3.000	0.0	4.200	0.0		

Tank or Pond Manhole: 9, DS/PN: 2.001

Invert Level (m) 4.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	12.3	1.400	0.0	2.800	0.0	4.200	0.0
0.200	12.3	1.600	0.0	3.000	0.0	4.400	0.0
0.400	12.3	1.800	0.0	3.200	0.0	4.600	0.0
0.600	12.3	2.000	0.0	3.400	0.0	4.800	0.0
0.800	12.3	2.200	0.0	3.600	0.0	5.000	0.0
1.000	12.3	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: 10, DS/PN: 2.002

Invert Level (m) 4.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	14.7	1.400	0.0	2.800	0.0	4.200	0.0
0.200	14.7	1.600	0.0	3.000	0.0	4.400	0.0
0.400	14.7	1.800	0.0	3.200	0.0	4.600	0.0
0.600	14.7	2.000	0.0	3.400	0.0	4.800	0.0
0.800	14.7	2.200	0.0	3.600	0.0	5.000	0.0
1.000	14.7	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

Tank or Pond Manhole: 13, DS/PN: 1.005

Invert Level (m) 4.140

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	63.6	1.400	0.0	2.800	0.0	4.200	0.0
0.200	63.6	1.600	0.0	3.000	0.0	4.400	0.0
0.400	63.6	1.800	0.0	3.200	0.0	4.600	0.0
0.600	63.6	2.000	0.0	3.400	0.0	4.800	0.0
0.800	63.6	2.200	0.0	3.600	0.0	5.000	0.0
1.000	63.6	2.400	0.0	3.800	0.0		
1.200	0.0	2.600	0.0	4.000	0.0		

EWE Associates Ltd		Page 6
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Tank or Pond Manhole: 14, DS/PN: 1.006

Invert Level (m) 5.400

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	482.0	1.400	654.0	2.800	654.0	4.200	654.0
0.200	537.0	1.600	654.0	3.000	654.0	4.400	654.0
0.400	594.0	1.800	654.0	3.200	654.0	4.600	654.0
0.600	654.0	2.000	654.0	3.400	654.0	4.800	654.0
0.800	654.0	2.200	654.0	3.600	654.0	5.000	654.0
1.000	654.0	2.400	654.0	3.800	654.0		
1.200	654.0	2.600	654.0	4.000	654.0		

EWE Associates Ltd		Page 7
Windy Ridge Barn Thealby Lane Winterton DN15 9TG		Micro Drainage
Date 14/01/2019 08:28 File 100yr+CC40%Winter...	Designed By Windows7 Checked By	
Micro Drainage	Network W.12.4	

Summary of Results for 480 minute 100 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	2	6.004	-0.086	0.000	0.02	0.0	15.5	OK
1.001	3	6.003	0.103	0.000	0.03	0.0	20.7	SURCHARGED
1.002	4	6.001	0.271	0.000	0.04	0.0	26.7	SURCHARGED
1.003	6	6.001	0.441	0.000	0.04	0.0	39.2	SURCHARGED
1.004	7	6.000	0.850	0.000	0.05	0.0	39.5	FLOOD RISK
2.000	8	5.999	0.049	0.000	0.01	0.0	6.6	SURCHARGED
2.001	9	5.999	0.449	0.000	0.01	0.0	8.7	SURCHARGED
2.002	10	5.999	0.549	0.000	0.02	0.0	14.1	SURCHARGED
2.003	11	5.999	0.719	0.000	0.03	0.0	22.7	SURCHARGED
2.004	12	5.999	0.909	0.000	0.04	0.0	28.0	SURCHARGED
1.005	13	5.999	1.109	0.000	0.12	0.0	68.0	FLOOD RISK
1.006	14	5.998	1.208	0.000	0.02	0.0	9.4	FLOOD RISK