GHBullard & Associates LLP
Civil and Traffic Engineering Consultants

Land West of Norwich Road,

Tacolneston

FLOOD RISK AND DRAINAGE STRATEGY
INITIAL ASSESSMENT

Date:

June 2021

GHB Reference:

173/2021/FRADS

Revision:

D1

Status:
D – Draft
P – Planning
C - Construction

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1.0 INTRODUCTION

1.1. This flood risk and drainage strategy initial assessment is produced to explain how the site is affected by various forms of flooding and how the proposed development can mitigate the potential impact on flooding. A location plan is shown in **Appendix A**.

1.2. The report is produced for the sole use by Earlswood Homes.

1.3. The information provided within this report is based on the best available data currently recorded or provided by a third party. The accuracy of this report is therefore not guaranteed and does not obviate the need to make additional appropriate searches, inspections and enquiries.

1.4. An illustrative site layout plan (refer to **Appendix B**) showing how this quantum of development can be accommodated on the site. It is an indicative layout only and does not form part of the application as such. However, this initial flood risk assessment and drainage strategy has been prepared on the basis of the illustrative site layout to demonstrate that this development can be undertaken without it being at risk from flooding on site or off site.

1.5. The National Planning Policy Framework (NPPF, February 2019), Section 14 (Meeting the challenge of climate change, flooding and coastal change), Paragraph 155 states that:

"Inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk, but where development is necessary, making it safe without increasing flood risk elsewhere."

1.6. The NPPF recommends the Environment Agency (EA) Flood Maps as a starting point for Flood Risk Assessment. An extract from the EA Flood maps is reproduced in Figure 1.1 below.

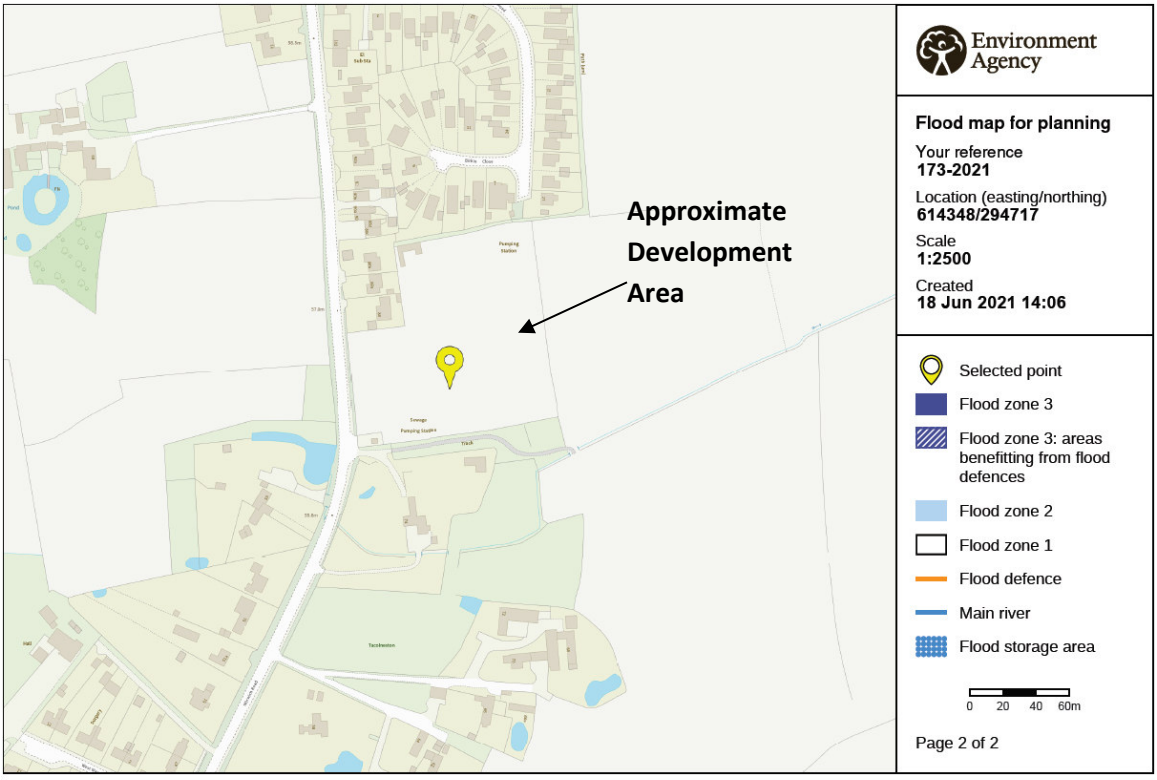

Figure 1.1 – EA Flood Map (Rivers and Seas)

1.7. Industry best practice requires assessment of all flooding sources to be carried out. Despite this document having now been superseded by the NPPF, Figure 3.2 of the "PPS25: Development and Flood Risk" (PPS25) Practice Guide lists five key sources of flooding:

i. Fluvial;
ii. Tidal;
iii. Pluvial;
iv. Groundwater; and
v. Infrastructure Failure.

2. FLUVIAL FLOODING

2.1. Fluvial flooding is the flooding associated with rivers. This can take the form of:

i. Inundation of floodplains from rivers and watercourses;
ii. Inundation of areas outside the floodplain due to influence of bridges, embankments and other features that artificially raise water levels;
iii. Overtopping of defences;
iv. Breaching of defences;
v. Blockages of culverts;
vi. Blockages of flood channels or corridors.

2.2. Figure 1.1 shows that the site is located within Flood Zone 1 where the risk is greater than 1 in 1000 (0.1% AEP).

2.3. Environment Agency Mapping shows that the site is at low risk of flooding.

3. TIDAL FLOODING

3.1. Tidal flooding is a risk of water levels from the sea or an estuary exceeding the normal tidal range. This can take the form of:

i. Overtopping of defences;
ii. Breaching of defences;
iii. Other flows (fluvial surface water) that could pond due to tide locking;
iv. Wave action.

3.2. The Environment Agency Flood Map for Rivers and Seas shows the site is located within Flood Zone 1, where the likelihood of fluvial flooding is greater than 0.1% AEP (1in1000). However, the site is located too far from the sea to be affected by tidal flooding.

4. PLUVIAL FLOODING

4.1. Pluvial flooding is a risk of overland flows and ponding associated with extreme rainfall events. This can take the form of:

i. Sheet run-off from adjacent land (urban or rural)
ii. Surcharged sewers

4.2. As rain falls everywhere within the United Kingdom, there will always be a residual risk of flooding from extreme rainfall events.

4.3. The Environment Agency has produced maps with risk classifications that show the risk of flooding from surface water run-off. The maps show that the site is at medium risk of surface

water flooding, 1 in 100 (1% AEP). Therefore, consideration has to be given location of residential units in order to maintain a safe access during times of flood and also to ensure the flow path is not impeded.

4.4. An extract for the area showing the extent of flooding from all forms of flooding is reproduced in Figure 4.1 below, with the following risk;

High risk means that each year this area has a chance of flooding of **greater than 3.3%.** Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding;

Medium risk means that each year this area has a chance of flooding of between **1% and 3.3%.** Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.

Low risk means that each year this area has a chance of flooding of between **0.1% and 1%.** Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.

Very low risk means that each year this area has a chance of flooding of **less than 0.1%.** Flooding from surface water is difficult to predict as rainfall location and volume are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding.

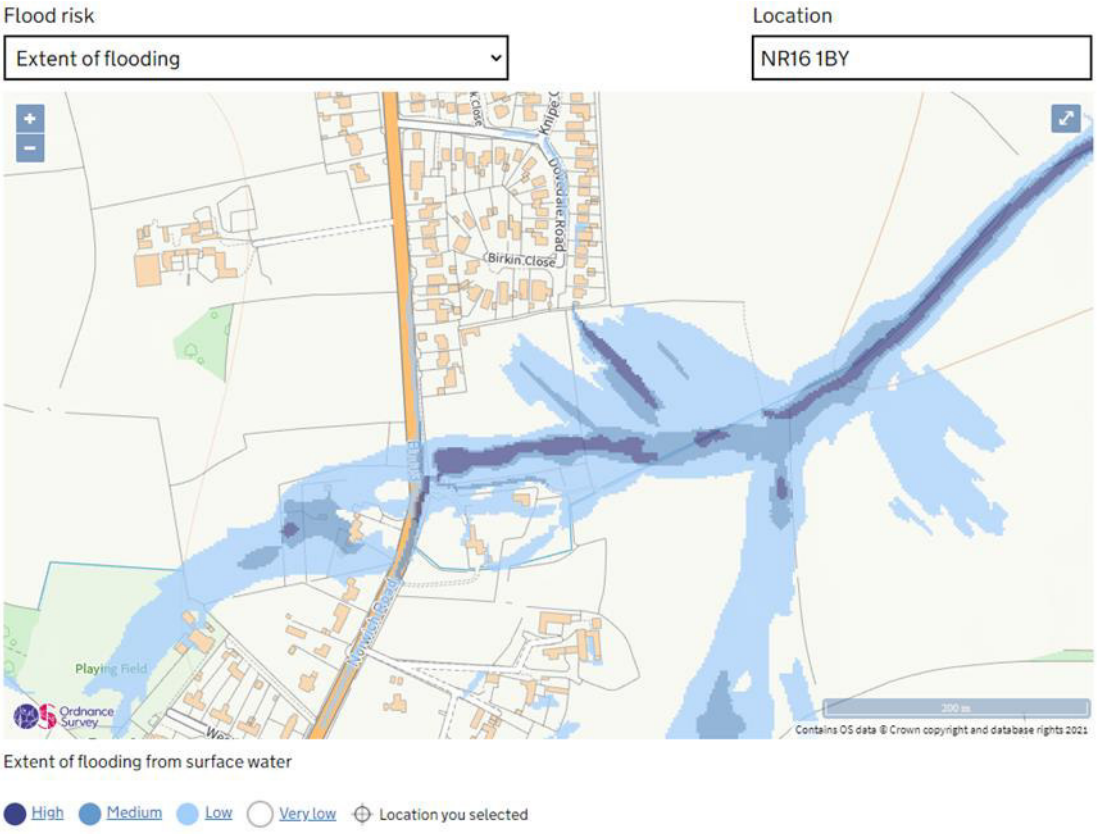

Figure 4.1 – Surface water flooding extents High to Very Low Risk.

4.5. An extract for the area showing the extent of flooding in the Medium Risk Scenario is reproduced in Figure 4.2 below. The flood depth on the site is between zero to 300mm flood depth.

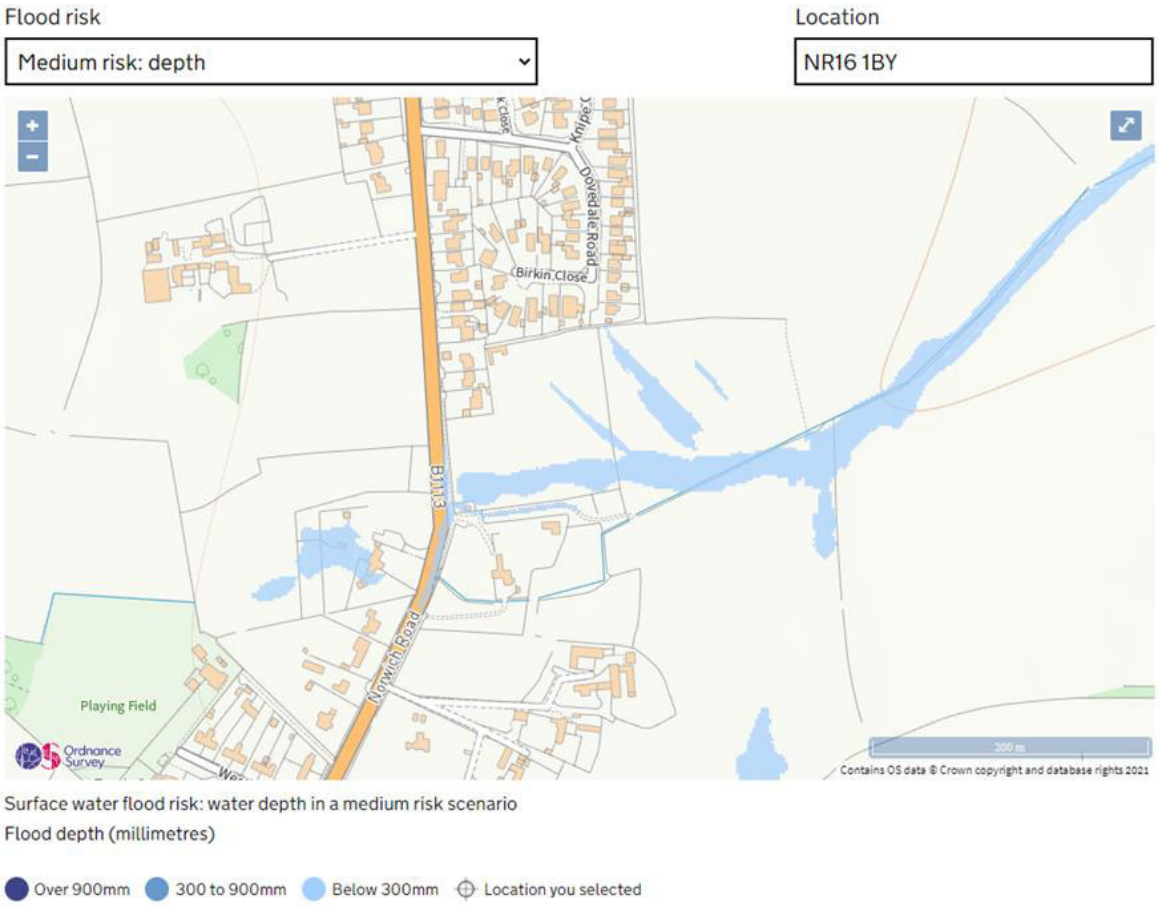

Figure 4.2 – Surface water flooding extents 1% to 3.33%

4.6. The flood map appears to show some anomalies within the field of development. These appear not to coordinate with the contours on the site, as shown by the two images below.

Figure 4.2: Surface water medium risk map and LiDAR generated contour map.

4.7. It can be seen that predicted surface water flooding set at 45 degrees does not follow any natural depression, whereas the flood water shown along the bottom of the image does follow a natural depression as shown by the contours. This surface water will be mostly generated from rain

falling within the site. As the site will be managing the surface water that falls within, this risk can be mitigated.

4.8. It should be noted that to the north of the development site, there is a residential area served by a surface water public sewer. This will reduce the inflow to the site. This public sewer discharges into a watercourse to the east.

4.9. A plan of the existing features is shown in **Appendix C** and identifies that mentioned above and also identifies other constraints of the site.

5. GROUNDWATER FLOODING

5.1. Groundwater flooding is a risk of the water table rising after prolonged rainfall to emerge above ground level remote from a watercourse. It is most likely to occur in low lying areas underlain by aquifers of high vulnerability.

5.2. The Environment Agency has mapped groundwater vulnerability and Figure 7.1 below shows the site is not located over a vulnerable aquifer.

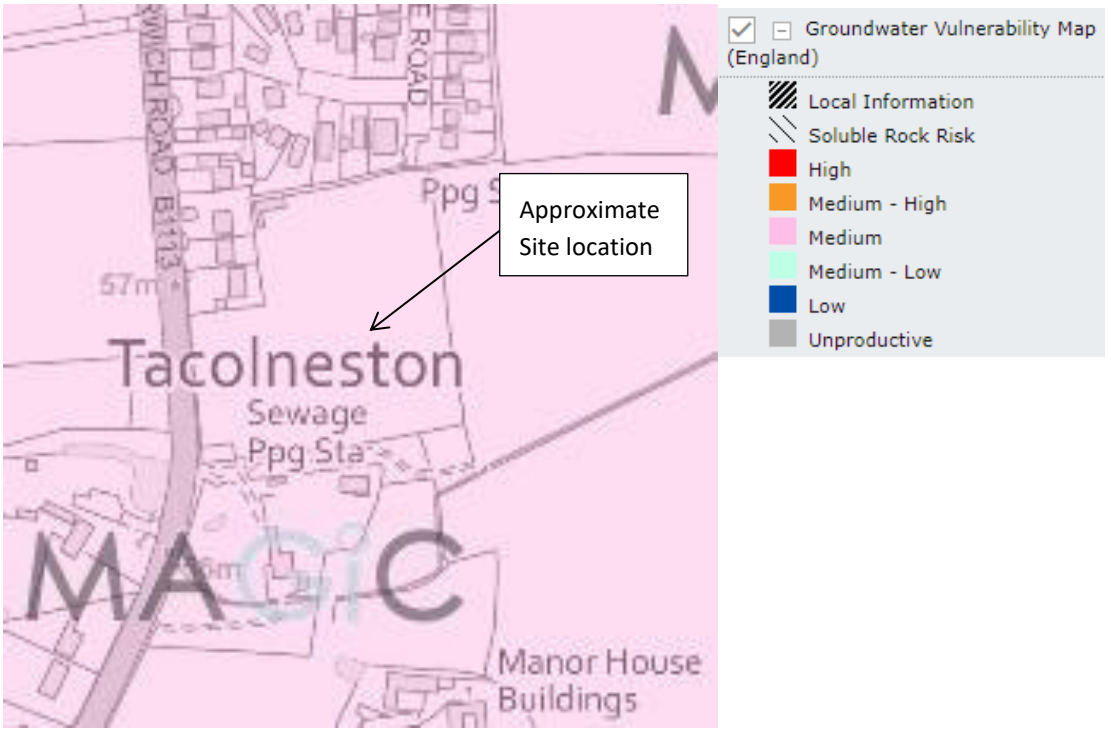

Figure 7.1 – EA Groundwater Vulnerability Zones

5.3. Given the soil type and the proximity of the watercourses, allowing an outlet for groundwater, the risk of water coming up to the surface through the ground is considered to be Low. Any water that does come up through the surface would drain to the watercourses near to the site.

6. INFRASTRUCTURE FAILURE FLOODING

6.1. Infrastructure failure flooding is a risk of collapse, failure or surcharging of man-made structures and drainage systems. This could take the form of:

i. Reservoirs;
ii. Canals;
iii. Burst water mains;
iv. Blocked sewers;
v. Failed pumping stations;

6.2. The Environment Agency have mapped failure of reservoirs, and this indicates there are no near effects of reservoir failure impacting the site, therefore the risk to the site is low.

6.3. The risk of flooding from blocked sewers is considered to be medium as any flood water would flow to the existing watercourses located at the site boundary.

7. SEQUENTIAL TEST

7.1. The local planning authority (LPA) may require this test to see if there are any reasonably available sites in the area at a lower flood risk on which the development could take place.

7.2. The scope of the sequential test is set by the LPA, unless this site is allocated within the local development plan.

7.3. The layout has taken the sequential approach within the proposed site boundaries, buy locating the development on the higher ground.

DRAINAGE STRATEGY

8. PROPOSED DRAINAGE

8.1. The proposed development comprises of a residential development with associated access road and open spaces. The layout takes the sequential approach, by placing the residential units outside the predicted pluvial flood areas. Refer to **Appendix B** for the development plan.

8.2. Site characteristics:

- Total development area is 1.2ha
- Proposed impermeable area is 0.5ha
- The greenfield rate based on the proposed impermeable area is Q_{bar} = 1.6 l/s, Refer to the Micro-Drainage calculations in **Appendix D**.

Surface Water Disposal

8.3. In accordance with Government and Local Plan Policies and the requirements of the Building Regulations, surface water run-off from the development will be drained at source in a sustainable way by making full use of Sustainable Drainage Systems (SuDS) where possible.

8.4. The SuDS hierarchy dictates that infiltration at source is considered first. After infiltrating at source has been considered, the next stage is to deal with run-off in individual catchments, followed finally by site wide drainage solutions. Run-off from the development should not adversely impact upon drainage systems outside of the site boundary.

8.5. Detailed surface water drainage design should take into account all three key SuDS principles in equal measure:

i. Reducing peak quantity;
ii. Improving quality; and
iii. Providing amenity and biodiversity value.

8.6. The geology is superficial deposits of Lowestoft formation; Diamicton. A BGS borehole describes the upper lays as clay. Therefore, it is unlikely that infiltration techniques will work.

8.7. It is proposed to discharge the runoff from the site to the existing watercourse to the south-east, at a controlled peak rate of 1.6l/s, utilising on-site attenuation in the form of a swale and detention basin to achieve this. The proposed drainage arrangement is shown on plan in **Appendix E**.

8.8. Micro-Drainage has been used to design the detention basin, assessing the volumes associated with the 1 in 100 year event plus an allowance for 40% climate change and 10% creep. The calculations are attached in **Appendix F**.

8.9. The quality of water has to be considered and although the run-off from the road is a low hazard, this will still pass through two stages of treatment, the first being the swale and the second being the basin. These in combination will provide sufficient cleansing for all the water.

Exceedance

8.10. In an exceedance event in which rainfall surpasses the design capacity, there should be no vulnerable buildings at risk of flooding.

8.11. The exceedance flow paths have been shown on both plans in **Appendix C & E**.

8.12. Site ground levels will be locally contoured to deflect water away from building thresholds, with floor levels being set at least 150mm above surrounding ground levels. The exceedance flow path will be directed around the building and towards the existing watercourses, mimicking the current flow path.

9. ADOPTION & MAINTENANCE

9.1. It is important to establish the adopting authorities at an early stage to define the requirement and how these meet the standards. In accordance with the new Sewage Sector Guidance, the water authority will be adopted the majority of the surface water system.

10. FOUL WATER DISPOSAL

10.1. The foul water from the site will gravity fall to the pumping station in the southwest corner, via a piped network. Capacity will be available via the infrastructure charge mechanism supported by the water authority.

10. SUMMARY

10.1. It has been demonstrated that the site is located within Flood Zone 1.

10.2. Table 12.1 summarises the probability of the site flooding from the five key sources as listed in PPS25.

Source	Description	Risk	
Fluvial	Rivers	Flood Zone 1	**(<0.1%)**
Tidal	Seas		
Pluvial	Surface Water	Medium	**(3.3% to 1%)**
Groundwater	Aquifers	Low	**-**
Infrastructure failure	Reservoirs Blocked Sewers	Outside maximum extent of flooding Very Low	**(Very Low)**

Table 12.1 – Flood Risk Summary

10.3. The sequential approach has been taken to locate the units away from the predicted flood flow path.

10.4. Run-off from this development will be discharged to a watercourse at a restricted flow rate, utilising a detention basin for attenuation.

10.5. The exceedance flow is directed away from vulnerable buildings and infrastructure and outflows along its original path.

10.6. It is considered that the risk of flooding to the site has been adequately considered and therefore development of the site with the proposed drainage system does not pose an unacceptable flood risk either to occupants of the site or to others off site.

11. LIST OF APPENDICES

Appendix A - Location Plan
Appendix B - Proposed Layout Plan
Appendix C - Existing Drainage Features Plan
Appendix D - Greenfield Rate Calculations
Appendix E - Proposed Drainage Layout
Appendix F - Micro-Drainage Pond Design Calculations

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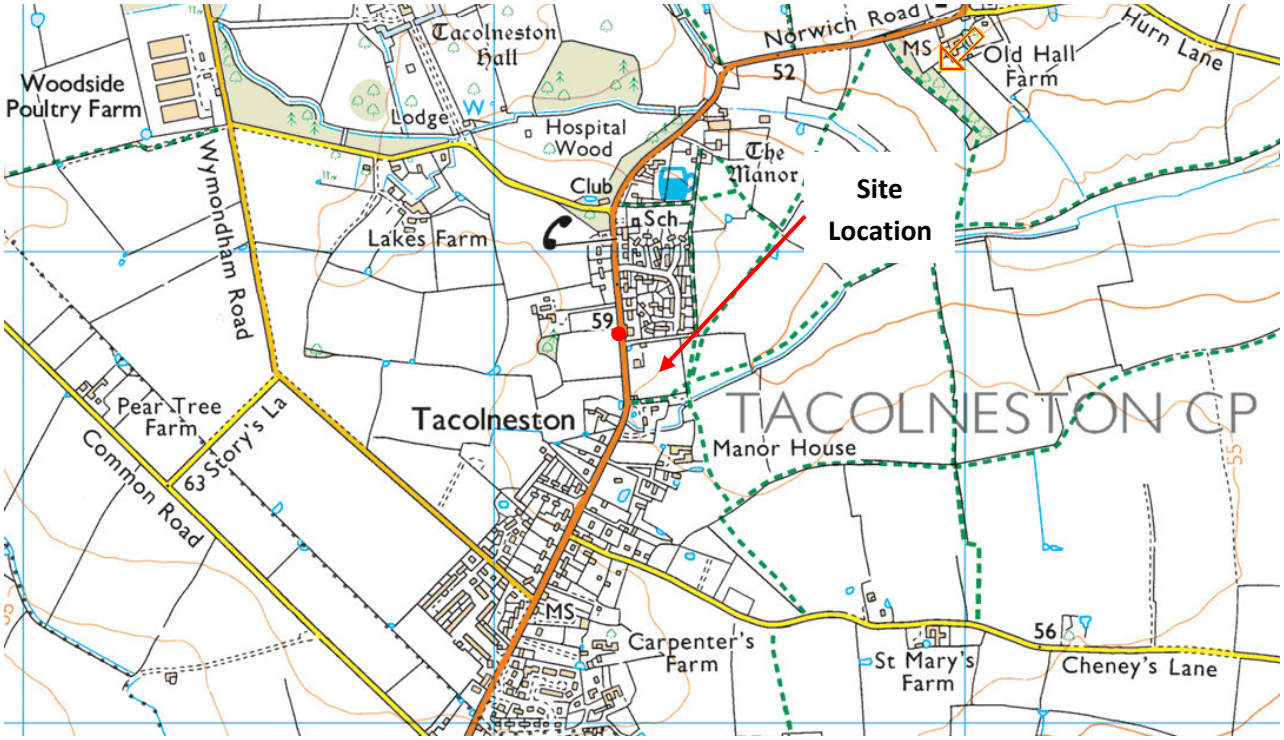
APPENDIX A

Location Plan



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APPENDIX B

Proposed Layout Plan

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Scheme Summary

Site Area	1.24 ha
Total plots	15
Comprising:	
Open Market	10
Affordable	5
Housing Mix:	
Open Market	3no. 2 bed
	5no. 3 bed
	2no. 4 bed
Affordable	5no. 2 bed
Total parking:	
Open Market	26 spaces
Affordable	10 spaces
Visitor	3 spaces

Key

- Denotes affordable housing.
- Visibility splay (2.4m x 43m).
- Flood zone line.

Rev.	Date	Details	Drawn	Checked

Issued for:

FEASIBILITY

Project/Client:

Land off Norwich Road
Tacolneston, Norfolk
(Earleswood Homes)

Project No: 0494

Dwg No: Sk001 Rev: B

Scale: 1:1000 @ A4

Drawing:

Proposed Site Layout

North:

Drawn By: Date:

Checked By: Date:

APPENDIX C

Existing Drainage Features Plan

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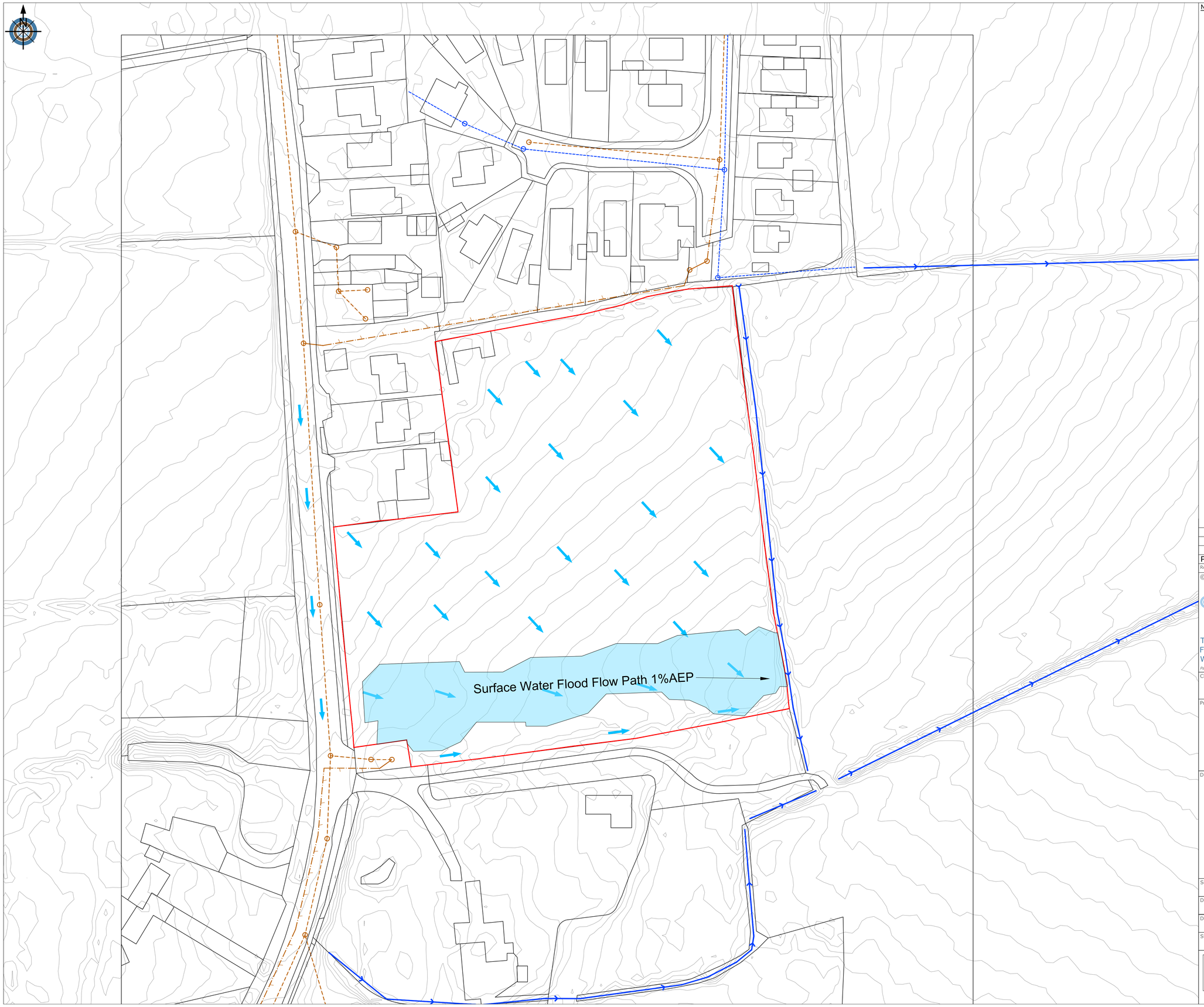

NOTES:

1. This drawing is to be read in conjunction with GHB series 000/2021 drawings and documents and any other relevant project team documents.
2. Preliminary Issue - This drawing is not to be used for construction or detailed pricing purposes. Any work undertaken before approvals are received (in writing) are at risk of abortive works.
3. This drawing has been prepared solely for the purpose of obtaining a Planning Consent based on information available and planning requirements at the date of issue only.

Legend-

- Site Boundary- Area: 12,360m^2
- Existing Open Channel Watercourse
- Overland Flowpaths
- Greenfield: Greenfield run-off rate: 1.6 l/s $\bar{Q}$= 3.3 l/s/ha
- Geology: Lowestoft Formation - Clay.
- Existing Foul water Sewer
- Existing Surface Water Network

Revision	Date	Description
P1	21/06/21	Initial Issue

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Partnership No. OC383830, Registered in England and Wales

Client: Earlswood Homes Ltd.

Project: Norwich Road, Tacolneston

Drawing Title: Existing Site Plan Layout

Scale: 1:500 @ A1

Date: JUNE 2021 | Drawn: JWT | Checked: JAH

DWG Reference: 173-2021.DWG

Status: FOR INFORMATION

Drawing Number: 173/2021/01 | Revision: P1

P# = Preliminary, C# = Construction, AB# = As Built

APPENDIX D

Greenfield Rate Calculations

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ICP SUDS Mean Annual Flood

Input

Return Period (years)	100	Soil	0.400
Area (ha)	1.000	Urban	0.000
SAAR (mm)	675	Region Number	Region 5

Results l/s

QBAR Rural	3.3
QBAR Urban	3.3
Q100 years	11.6
Q1 year	2.8
Q30 years	7.8
Q100 years	11.6

APPENDIX E

Proposed Drainage Plan

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NOTES:

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Legend-

- Site Boundary- Area: 1.2 ha
- Proposed Flowpath
- Attenuation Basin- Volume: 405m³ 1% AEP+40%cc
- Swale
- Flow Control- Discharge rate: 1.6 l/s
- 2m Service Strip/Maintenance Easement
- LIDAR Contours (0.2m)

Revision	Date	Description
P1	21/06/21	Initial Issue

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Client: Earlswood Homes Ltd.

Project: Norwich Road, Tacolneston

Drawing Title: Indicative Surface Water Drainage Site Plan Layout

Scale:		
1:500 @ A1		
Date: JUNE 2021	Drawn: JWT	Checked: JAH

DWG Reference: 173-2021.DWG

Status: FOR INFORMATION

Drawing Number:	Revision:
173/2021/02	P1

P# = Preliminary, C# = Construction, AB# = As Built

APPENDIX F

Micro Drainage Basin Calculations

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Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	53.427	0.227	1.1	131.7	O K
30 min Summer	53.490	0.290	1.2	170.1	O K
60 min Summer	53.550	0.350	1.3	208.5	O K
120 min Summer	53.607	0.407	1.4	245.5	O K
180 min Summer	53.638	0.438	1.4	265.5	O K
240 min Summer	53.657	0.457	1.5	278.2	O K
360 min Summer	53.680	0.480	1.5	294.0	O K
480 min Summer	53.695	0.495	1.5	304.1	O K
600 min Summer	53.705	0.505	1.5	310.5	O K
720 min Summer	53.710	0.510	1.5	314.5	O K
960 min Summer	53.716	0.516	1.6	318.0	O K
1440 min Summer	53.711	0.511	1.5	315.0	O K
2160 min Summer	53.696	0.496	1.5	304.6	O K
2880 min Summer	53.680	0.480	1.5	294.1	O K
4320 min Summer	53.649	0.449	1.5	272.7	O K
5760 min Summer	53.618	0.418	1.4	252.6	O K
7200 min Summer	53.592	0.392	1.4	235.5	O K
8640 min Summer	53.569	0.369	1.4	220.2	O K
10080 min Summer	53.547	0.347	1.3	206.4	O K
15 min Winter	53.453	0.253	1.2	147.6	O K
30 min Winter	53.523	0.323	1.3	190.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	141.917	0.0	84.3	27
30 min Summer	91.958	0.0	93.7	42
60 min Summer	56.713	0.0	180.5	72
120 min Summer	33.812	0.0	196.5	130
180 min Summer	24.675	0.0	204.8	190
240 min Summer	19.628	0.0	209.9	250
360 min Summer	14.150	0.0	216.2	368
480 min Summer	11.224	0.0	220.0	488
600 min Summer	9.372	0.0	222.3	606
720 min Summer	8.084	0.0	223.6	726
960 min Summer	6.399	0.0	224.2	964
1440 min Summer	4.596	0.0	220.8	1434
2160 min Summer	3.296	0.0	400.1	1756
2880 min Summer	2.602	0.0	399.0	2132
4320 min Summer	1.862	0.0	381.9	2944
5760 min Summer	1.467	0.0	528.0	3752
7200 min Summer	1.219	0.0	548.3	4608
8640 min Summer	1.047	0.0	565.3	5376
10080 min Summer	0.921	0.0	579.9	6168
15 min Winter	141.917	0.0	88.3	27
30 min Winter	91.958	0.0	98.3	41

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	53.590	0.390	1.4	233.9	O K
120 min Winter	53.653	0.453	1.5	275.7	O K
180 min Winter	53.687	0.487	1.5	298.5	O K
240 min Winter	53.709	0.509	1.5	313.3	O K
360 min Winter	53.736	0.536	1.6	331.7	O K
480 min Winter	53.753	0.553	1.6	343.8	Flood Risk
600 min Winter	53.764	0.564	1.6	351.8	Flood Risk
720 min Winter	53.772	0.572	1.6	357.1	Flood Risk
960 min Winter	53.780	0.580	1.6	362.8	Flood Risk
1440 min Winter	53.780	0.580	1.6	363.0	Flood Risk
2160 min Winter	53.764	0.564	1.6	351.2	Flood Risk
2880 min Winter	53.745	0.545	1.6	338.6	O K
4320 min Winter	53.708	0.508	1.5	312.7	O K
5760 min Winter	53.669	0.469	1.5	286.2	O K
7200 min Winter	53.631	0.431	1.4	261.2	O K
8640 min Winter	53.598	0.398	1.4	239.1	O K
10080 min Winter	53.568	0.368	1.3	219.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	56.713	0.0	191.2	70
120 min Winter	33.812	0.0	208.1	128
180 min Winter	24.675	0.0	216.7	186
240 min Winter	19.628	0.0	222.1	246
360 min Winter	14.150	0.0	228.6	362
480 min Winter	11.224	0.0	232.5	478
600 min Winter	9.372	0.0	234.8	596
720 min Winter	8.084	0.0	236.0	712
960 min Winter	6.399	0.0	236.5	940
1440 min Winter	4.596	0.0	232.4	1386
2160 min Winter	3.296	0.0	427.6	1996
2880 min Winter	2.602	0.0	425.4	2252
4320 min Winter	1.862	0.0	405.7	3164
5760 min Winter	1.467	0.0	591.1	4088
7200 min Winter	1.219	0.0	614.0	4968
8640 min Winter	1.047	0.0	633.0	5800
10080 min Winter	0.921	0.0	631.6	6656

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.432	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.500

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.167	4	8	0.167	8	12	0.167

Model Details

Storage is Online Cover Level (m) 53.800

Tank or Pond Structure

Invert Level (m) 53.200

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	550.0	0.600	709.8

Orifice Outflow Control

Diameter (m) 0.031 Discharge Coefficient 0.600 Invert Level (m) 53.100