RichardJackson
Engineering Consultants

Our Ref: 49455/JE/MJD
Your Ref:

05 October 2018

Mr D Piper
Abel Homes Ltd
Neaton Business Park
Norwich Road
Watton
Norfolk
IP25 6JB

Dear Mr Piper,

Re: Land at Horsham St Faith - Site Allocation – Assessment of Flood Risk and Drainage

I refer to our instructions to assess the preliminary surface water drainage strategy for the above site as indicated on **Figure 1**.

The site compromises of greenfield land and is approximately 15ha in size. The main access is likely to be located off the road to the north of the site (currently unnamed continuation of Church Street). Our assessment for a surface water strategy on the land at Horsham St Faith, has been made on the basis of up to approximately 400 proposed dwellings.

The Flood Risk and Drainage Strategy has been carried out in accordance with the National Planning Policy Framework (NPPF) – Planning Practice Guidance on Flood Risk and Coastal Change, published by the Department for Communities and Local Government (DCLG). Reference is also made to the Norfolk County Council, Lead Local Flood Authority (LLFA) Guidance, dated April 2017.

From the OS contours the topography of the site falls north, with the potential to flow both north easterly and north westerly, with an approximate range in elevations from 28m AOD along the south west boundary to 23m AOD along the eastern boundary adjacent to West Lane and also the north west corner near to the A140.

Proposed Development

The site is proposed for residential development and the total site area is approximately 15Ha. There are currently no public rights of way across the site that we are aware of.

For the purposes of establishing the likely drainage parameters for the site, the site area of 15Ha, with a density of impermeable area at 40% to 50%, will be used to provide a range of necessary water attenuation and/or storage. An area of 10% of the overall site area will be assumed to be highways, where an assessment for highway drainage is to be made as a standalone parameter.

Cont'd.../

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Existing Flood Sources

When assessing any development site, there are four potential sources of flooding which need to be considered both in terms of their effect on the development itself and its end users and that caused to others. The main sources of flooding that need to be considered are as follows:

- Fluvial and/or tidal flooding;
- Ground water;
- Overloading of the existing drainage network;
- Surface water flooding.

Fluvial and Tidal Sources of Flooding

From investigation of the existing watercourses and the Environment Agency (EA) floodplain maps, there are no identified influences of fluvial or tidal flooding at the site and the site is in Flood Risk Zone 1, see the Environment Agency – 'Flood Map for Planning'. Therefore this has not been investigated further. An indication of the associated Government Flood Maps are shown on **Figure 2**.

Groundwater Vulnerability

The British Geological Survey (BGS) mapping was used to provide an indicative assessment for the proposed development. The BGS records contain a borehole record located at the low point of the proposed site dated 23/09/1983 and was undertaken by T. W. Page & Son Ltd. This record states that the soil conditions are predominantly sand and stone to a depth of 8.8m, then a section of marl for 4.9m and finally chalk. Chalk was encountered at a depth of 13.7m and groundwater was encountered at a depth of 20' (6m). Note, all depths are approximate.

The mapping indicates that the groundwater will be at approximately 17 metres above ordnance survey datum. Therefore, it is believed that the groundwater will be approximately 6m – 11m below ground level across the site.

The EA defines groundwater Source Protection Zone around all major groundwater abstraction points. Source Protection Zones (SPZ) are defined to protect areas of groundwater that are used for potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks. The proposed site is within groundwater source protection zone 3 (Total catchment). This zone is defined as the total area needed to support the abstraction or discharge from the protected groundwater source. For the EA groundwater source protection zones of the site, see **Figure 3.**

In addition, the Groundwater Vulnerability Zone Maps see **Figure 4** show that the site is in the high risk for groundwater vulnerability as the site is located above a major aquifer.

If soluble rocks, such as chalk, are present within the site (as indicated by the BGS borehole record) then further consideration will be required for distances of any infiltration methods and their proximity to permanent buildings. This does not preclude the use of soakaways, however, further precautions may need to be made during design and construction.

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Existing Surface Water System and Ground Conditions

The borehole record from the BGS discussed above provided data indicating a ground water depth of approximately 6m, thus, soakaways or other infiltration devices could be utilised on the site.

As discussed, the soil at the site should be suitable for the use of soakaways, however as no ground investigations have taken place yet, the permeability rate of 5.5×10^{-6} m/s will be adopted for the purpose of this study. The rate of 5.5×10^{-6} m/s or 0.0198 m/hr is based on a rate likely to be consistent with the soil types identified within the borehole log mentioned earlier. This is also ratified by the rates used in the 'Norwich Northern Distributor Road (NNDR) Application for Development Consent Order, Document Reference 5.2 Flood Risk Assessment'. In table 4.1 of this document rates for the infiltration basins for the NNDR are stated at 0.028, 0.028 and 0.021 m/hr for the nearby lagoons, thus, this provides a good indication of the likely results to be expected on the development site.

The existing surface water flooding for the 1 in 30, 1 in 100 and 1 in 1000 year events (High Risk, Medium Risk and Low Risk respectively) have been investigated and are shown on **Figure 5, Figure 6** and **Figure 7** respectively. The mapping for all three risk scenarios indicates no risk of surface water flooding within the proposed site.

Any new systems of drainage should consider the flow from the site and suitable SuDS to accommodate storage before discharging into the ground.

Flood Risk Impact

It has been determined using the Ordnance Survey level information available, that surface water runoff from the site will potentially occur in a north easterly or north westerly direction.

A proportion of rainfall falling across the existing site will also infiltrate into the soils of the site given the current ground conditions. A proportion of this infiltrating surface water will also contribute to any groundwater recharge.

To determine the rainfall data for the site when undertaking the detail design, the Flood Estimation Handbook (FEH) data would be used for establishing the critical rainfall scenario where this is greater than 1 hour. The FEH data will be used and only Rainfall Studies Report (FSR) rainfall used for storms of less than 1 hour.

If the drainage calculations show a need for critical storms under 1 hour, then the FSR will be used. The FEH data normally provides higher rainfall intensity parameters however, for the assessment at this stage the FEH rainfall data will provide a strategic level of storage or attenuation required for the development sites.

Soil Types and SuDS Suitability

The NPPF and appropriate guidance indicates that the FRA should identify the risks of flooding and manage those risks to ensure the site remains safe. One way to manage the flood risk is to incorporate Sustainable Drainage Systems (SuDS) within proposals for new sites. There is a general requirement that SuDS be installed where appropriate, in order to limit the amount of surface water runoff entering drainage systems and to return surface water into the ground to follow its natural drainage path. This advice is also replicated in the SuDS Manual C753 (2015).

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The details of the ground conditions have yet to be determined through a full ground investigation but advice on the use of SuDS/soakaways is such that they could be used. The permeability of the site for the purpose of this report is 5.5 x 10^{-6} m/s as discussed previously, in absence of any data from within the site.

SuDS Assessment

The suitability of the use of SuDS on the site is based on the criteria as set out in the Ciria document C753 dated November 2015, where in Chapter 26 the appropriateness of SuDS can be established. The table below suggests the potential SuDS selection for Highways and Private Drives and also for Private Roofs.

Table A – SuDS Selection

Type of SuDS	Highways & Private Drives TSS=0.5 Metal=0.4 Hydrocarbons=0.4	Private Roofs TSS=0.2 Metals=0.2 Hydrocarbons=0.05
Filter Strip		✓
Filter Drain		✓
Swale	✓	✓
Permeable Paving	✓	✓
Detention Basin	✓	✓
Pond	✓	✓
Wetland	✓	✓
Soakaway (surrounded with infiltration materials)		✓
Infiltration Trench		✓

Using the **Table A** above which is derived from **Table 26.3** and **26.4** of Ciria C753 then it can be concluded that the better SuDS' choices for the site are as set out below;

Private Drives – Permeable paving or soakaway
Residential Roofs – To soakaway or permeable paving
Highways – To Swales or Infiltration Basin or Detention Basin

A surface water strategy is therefore proposed to utilise the permeable paving and soakaways for the drives and private roof areas and swales and/or infiltration basins for the highway water for events up to the 1 in 100 year storm event, plus climate change at 40%. This strategy is based on the SuDS management train assuming favourable soakage rates as previously indicated.

Flood Risk Management

Having determined that the soils across the site possess sufficient infiltration capacity for the use of infiltration devices, the methods of surface water disposal have been investigated, to determine the feasibility of discharging and treating the water prior to it entering the ground.

To determine the appropriate use of the SuDS features, the pollution indices were used to determine the type of SuDS to be used. For the purposes of the design

Cont'd.../

for the site, which has yet to be detailed and is only at masterplan stage, a selection of likely solutions have been prepared for different house types, drive areas and widths of highway.

The private drives will provide permeable paving to act as a pollution treatment and then the water can be collected and drain towards the soakaway proposed for the private dwelling. The permeability rate of 5.5 x 10^{-6}m/s or 0.0198 m/hr as indicated previously for a robust assessment. Suggested sizes for the private dwelling drainage are indicated on **Table B** below:

Table B – Indicative Crated Soakaway Storage Sizes

Dwelling Type	Dwelling Area (m^2)	Garage Area (m^2)	Private Drive Area (m^2)	Total Area (m^2)	1 in 100 year plus 40% CC Storage (LxWxH)m
A	48	N/A	42	90	2.5 x 2.0 x 1.6 Vol = 6.8m^3
B	56	23	29	106	3.0 x 3.0 x 1.2 Vol = 8.3m^3
C	65	45	19	129	4.0 x 3.0 x 1.2 Vol = 9.7m^3
D	116	45	98	259	6.0 x 5.0 x 0.8 Vol = 19.4m^3

The dwelling, garage and drive areas have been based on a previous development parameters for similar sites.

If dwelling soakaways or permeable paving is used then, the highway water will be directed towards the swales and/or infiltration basins which are to be positioned in the Public Open Space in the north east / north west areas of the site, or adjacent to the road. The size will be determined by the exact dimensions of the roads and footways going to the swales/infiltration basin but an indication of the sizes are given in this Chapter. For purposes of being robust, a permeability rate of 5.5 x 10^{-6} m/s or 0.0198m/hr will be used. For an estimated Highways SuDS sizing see **Table C** below which shows swales and **Table D** shows catchments of larger areas in infiltration basins:

Table C – Highway Swale/Infiltration Design for smaller areas

Overall Highway Width (m)	Length of Highway (m)	Swale Profile*	1 in100 year storm plus 40% CC	
			Depth (m)	Volume (m^3)
4.8 + 1.0 = 5.8m	10m	Side Slope = 1 in 4 Base Width = 1.0m	0.454	3.8
4.8 + 1.5 + 1.5 = 7.8m	10m	Side Slope = 1 in 4 Base Width = 1.0m	0.550	5.2
6.0 + 1.8 + 1.8 = 9.6m	10m	Side Slope = 1 in 4 Base Width = 1.0m	0.636	6.7

*The width of swale is required due to the lower rate of permeability. The parameters could be reduced if a greater permeability rate is found though on site ground investigations.

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For an estimated Highways SuDS sizing see **Table D** below:

Table D – Highway Infiltration Basin Design for Larger areas

Overall Highway Width (m)	Length of Highway (m)	Basin Profile	1 in100 year storm plus 40% CC	
			Depth (m)	Volume (m^3)
5.8m	250m	Side Slope = 1 in 4 Area = 243m^2	0.677	103
7.8m	250m	Side Slope = 1 in 4 Area = 291m^2	0.850	145
9.6m	250m	Side Slope = 1 in 4 Area = 300m^2	0.990	182

Alternatively, drainage for whole areas of development could be addressed as indicated in **Table E** below, where;

Table E – Development Infiltration Basins/Detention Basins

Overall Development Area	Imp. Area @ 50%	Area of Basin	1 in100 year storm plus 40% CC	
			Depth (m)	Volume (m^3)
0.50 Ha	0.25 Ha	339m^2	0.769	186
2.0 Ha	1.0 Ha	1360m^2	0.623	755
7.0 Ha	3.5 Ha	5610m^2	0.533	2805

Please note that all calculations are indicative and subject to a layout and detailed drainage design.

For the scenarios of drainage and areas required for the SuDs as outlined in Tables C & D, an indicative strategy is shown on Drawing **49455-PP-002**. For the whole site scenario outlined in Table E, an indicative strategy is shown on Drawing **49455-PP-003**.

Summary

It can be seen from the indicative ground conditions taken from the historic BGS borehole record for the site that infiltration is likely to be suitable. Further intrusive investigations are required in order to determine infiltration rates for the proposed, and confirm the underlying geology within the site boundary. If chalk is present within the site then, an easement distance from soakaways to buildings will have to be agreed with the LLFA.

An infiltration strategy, with above ground storage, would be in accordance with National and Local planning policy, by treating the water for quality and quantity on site, thus not creating a detrimental effect downstream of the site.

Cont'd.../

The sizes of the soakaways for the houses might be a little large to fit into back gardens, so if this is the case, then alternative arrangements for the water in line with the areas and volumes indicated for the highways could be introduced for the water from the private dwellings. Sufficient land must be set aside for accommodating the swales / infiltration facilities.

An indicative area of drainage needed for the highways is shown on drawing **49455-PP-002** showing the infiltration basins and locations, subject to further masterplanning processes, alternatively drawing **49455-PP-003** indicates a strategy for the whole development if soakaways within the dwellings rear gardens is not desirable.

Matters	Comment	Satisfactory	Needs some Upgrade	Not Satisfactory
Flood Risk Zone	The site is in Flood Risk Zone 1. Suitable for residential development			
High Risk Surface Water Flooding	There are no existing surface water flooding issues of High Risk			
Medium Risk Surface Water Flooding	There are no existing surface water flooding issues of Medium Risk.			
Low Risk Surface Water Flooding	There are no existing surface water flooding issues of Low Risk.			
Proposed Surface Water Drainage	The proposals are likely to conform to the SuDS Manual and LLFA guidance for use of infiltration devices which are dependent upon a detailed site investigation to determine the permeability rate for the site			

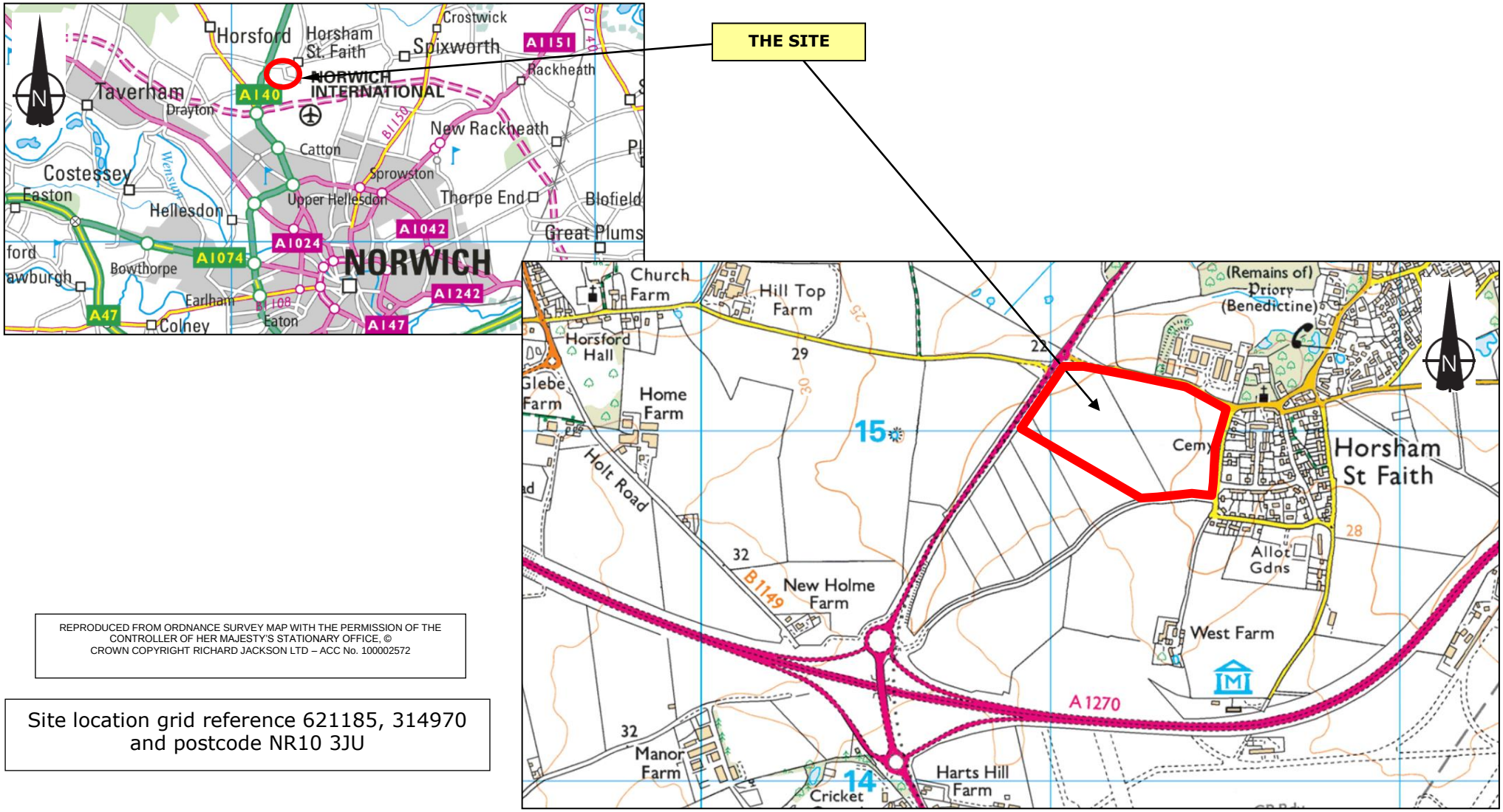
I trust the foregoing is satisfactory but if we can be of any further assistance, please do not hesitate to contact us.

Yours sincerely

Martin Doughty BEng (Hons), CEng, FCIHT, FICE, MAPM
Director on behalf of Richard Jackson Limited

Enc

Figures 1, 2, 3, 4, 5, 6 & 7
Environment Agency – 'Flood Map for Planning'
49455-PP-002 – Preliminary Surface Water Drainage Strategy (Highways)
49455-PP-003 – Preliminary Surface Water Drainage Strategy
(For whole development)



Site location grid reference 621185, 314970 and postcode NR10 3JU

Client:	Drawing Title:		
Abel Homes Ltd	**Site Location Plan**		
Job Title:	Date:	Job No:	Dwg No:
Land east of A140, Horsham St Faith	**1.10.18**	**49455**	**Fig. 1 (NTS)**

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www.richardjackson.uk.com

Flood map for planning

Your reference	Location (easting/northing)	Created
49455	**621213/314960**	**5 Oct 2018 11:29**

Your selected location is in flood zone 1, an area with a low probability of flooding.

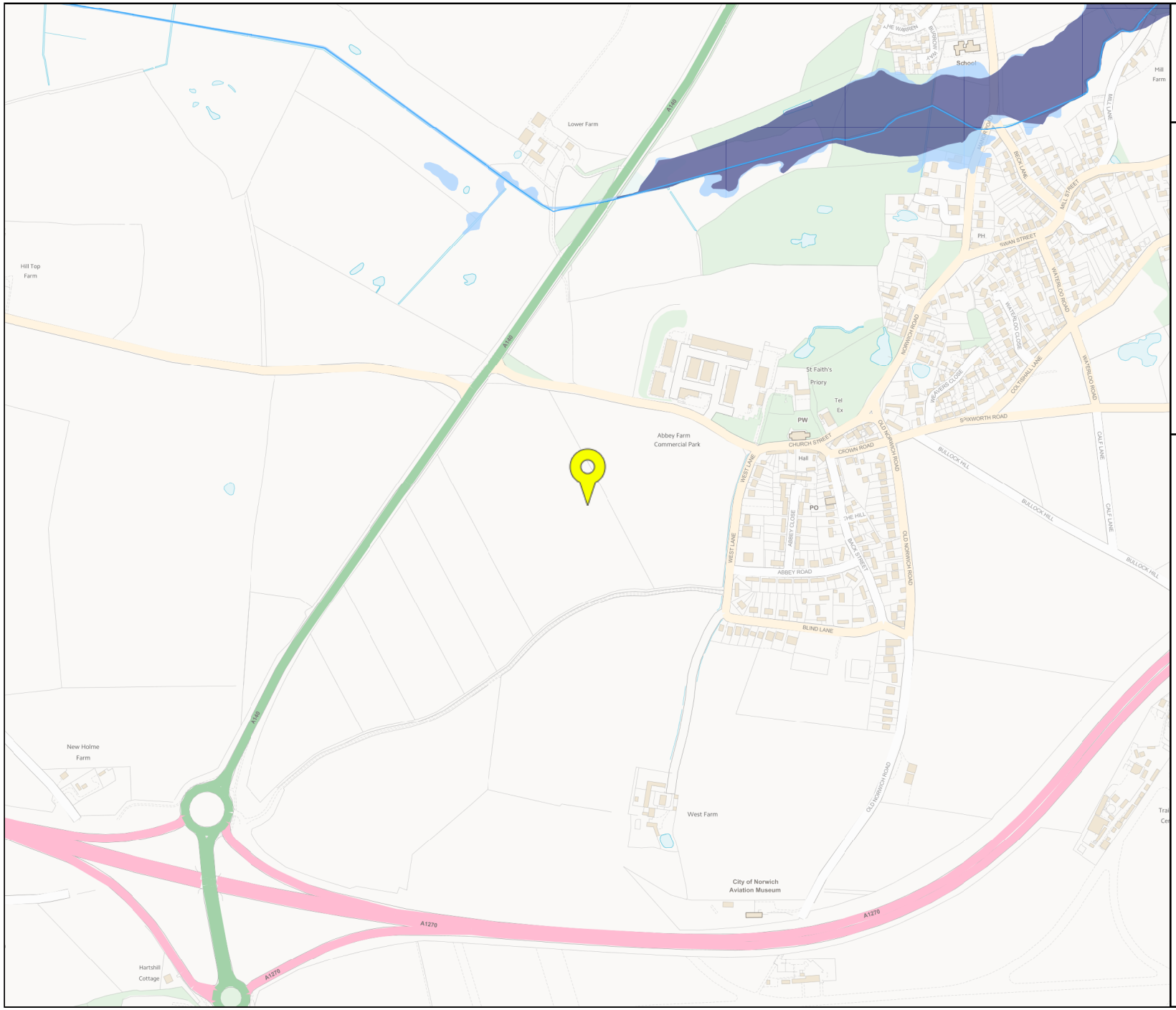
This means:

- you don't need to do a flood risk assessment if your development is smaller than 1 hectare and not affected by other sources of flooding
- you may need to do a flood risk assessment if your development is larger than 1 hectare or affected by other sources of flooding or in an area with critical drainage problems

Notes

The flood map for planning shows river and sea flooding data only. It doesn't include other sources of flooding. It is for use in development planning and flood risk assessments.

This information relates to the selected location and is not specific to any property within it. The map is updated regularly and is correct at the time of printing.



Environment Agency

Flood map for planning

Your reference
49455

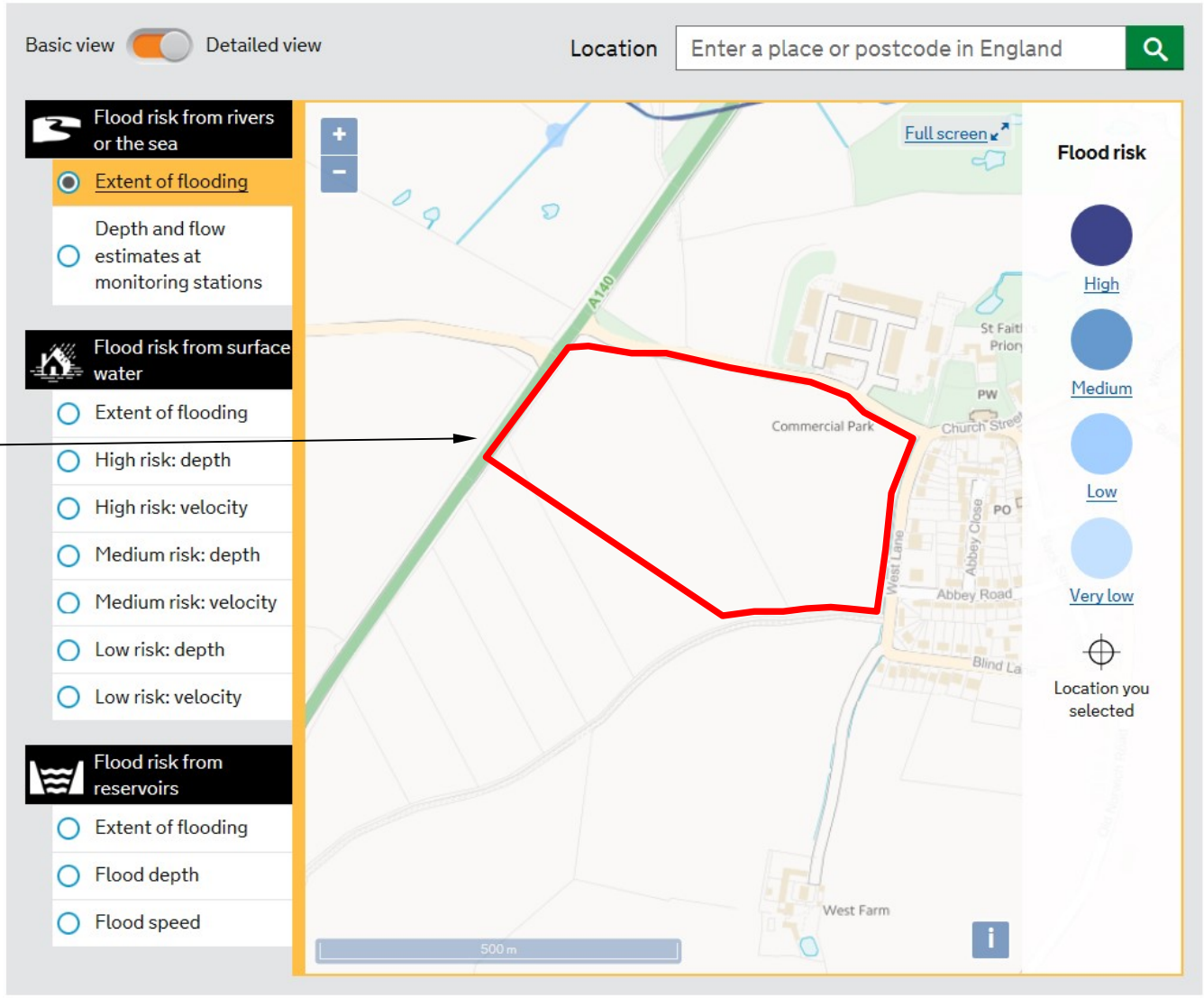
Location (easting/northing)
621213/314960

Scale
1:10000

Created
5 Oct 2018 11:29

- Selected point
- Flood zone 3
- Flood zone 3: areas benefitting from flood defences
- Flood zone 2
- Flood zone 1
- Flood defence
- Main river
- Flood storage area

0 100 200 300m



THE SITE

Client:	Drawing Title:		
Abel Homes Ltd	**Environment Agency Flood Plan (Rivers and Sea)**		
Job Title:	Date:	Job No:	Dwg No:
Land at Horsham St Faith, Norwich	**03.10.18**	**49455**	**Fig. 2 (NTS)**

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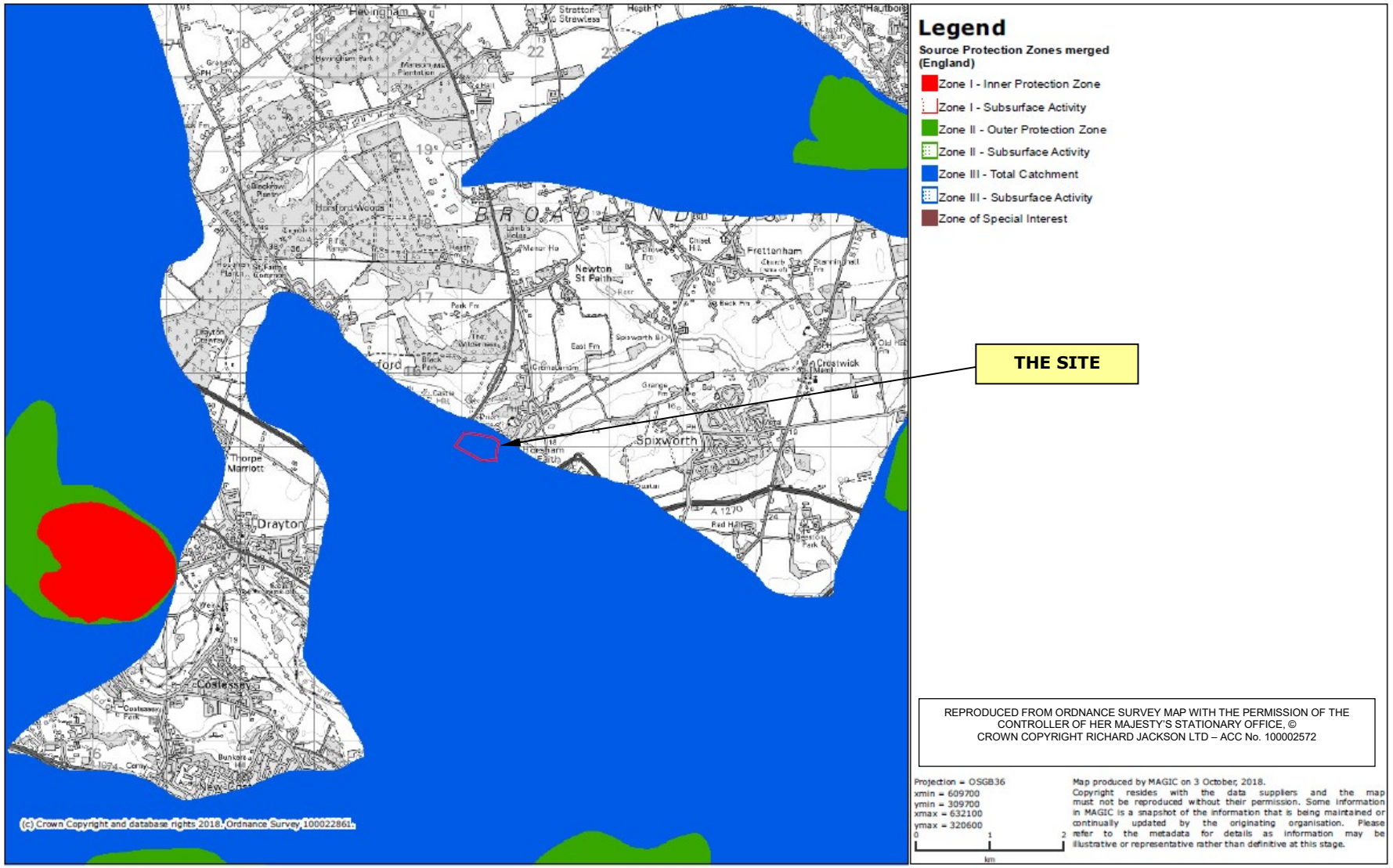

Client: **Abel Homes Ltd**	Drawing Title: **Environment Agency Source Protection Zones (Groundwater)**		
Job Title: **Land at Horsham St Faith, Norwich**	Date: **03.10.18**	Job No: **49455**	Dwg No: **Fig. 3 (NTS)**

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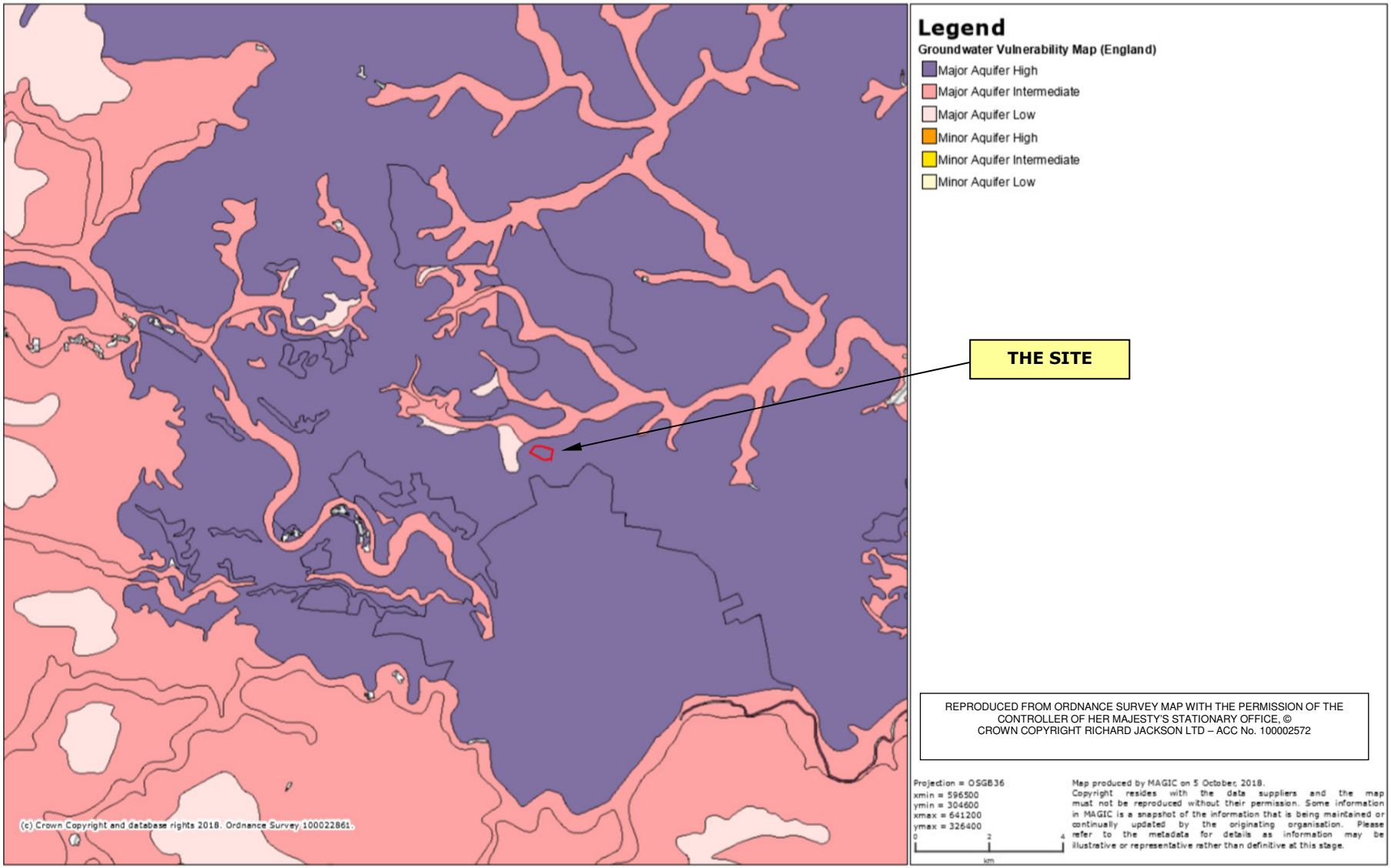

Client:	Drawing Title:		
Abel Homes Ltd	**Environment Agency Flood Plan (Groundwater)**		
Job Title: **Land at Horsham St Faith, Norwich**	Date: **03.10.18**	Job No: **49455**	Dwg No: **Fig. 4 (NTS)**

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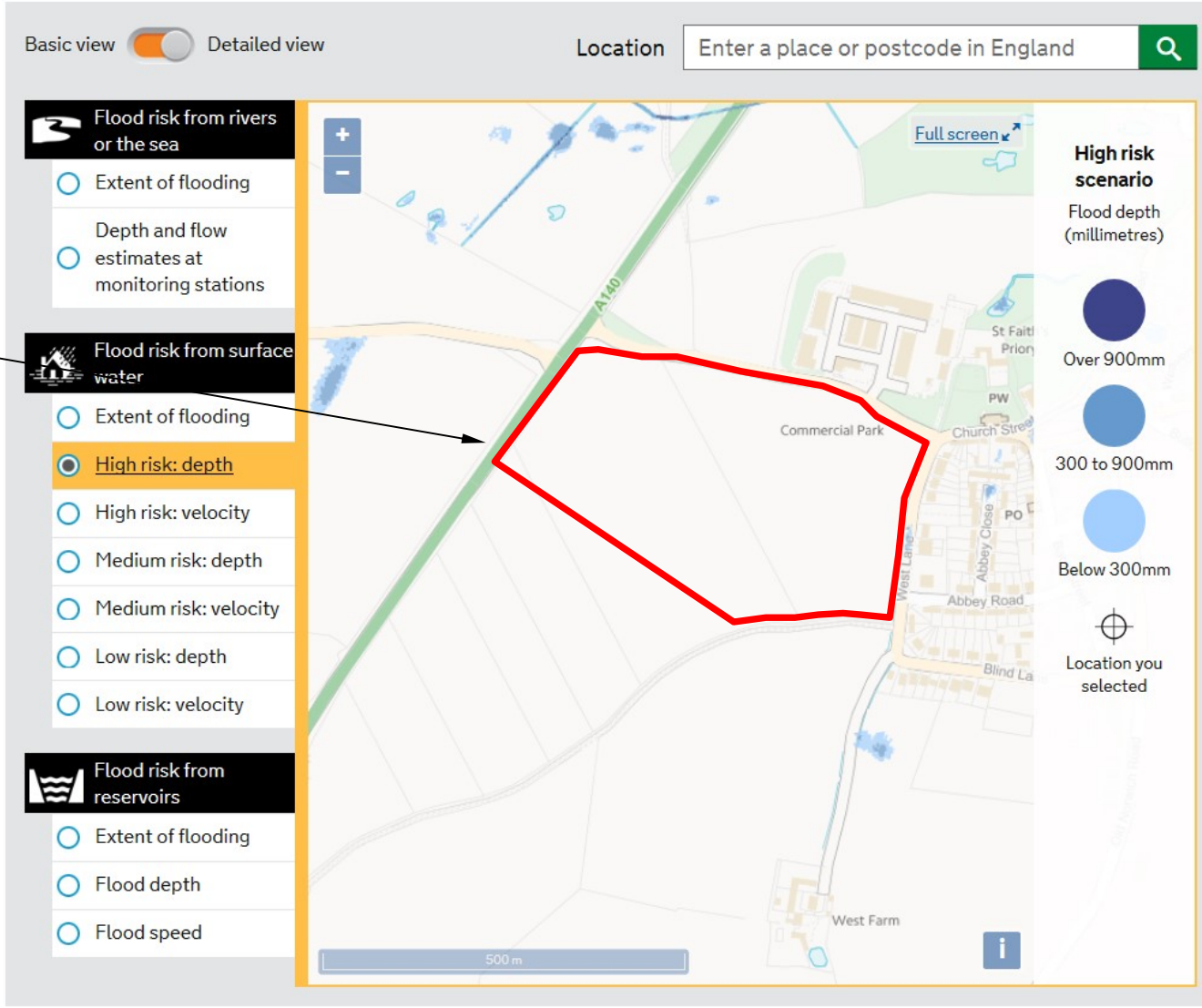
THE SITE



Client:	Drawing Title:		
Abel Homes Ltd	**Surface Water Flood Mapping (High Risk)**		
Job Title:	Date:	Job No:	Dwg No:
Land at Horsham St Faith, Norwich	**03.10.18**	**49455**	**Fig. 5 (NTS)**

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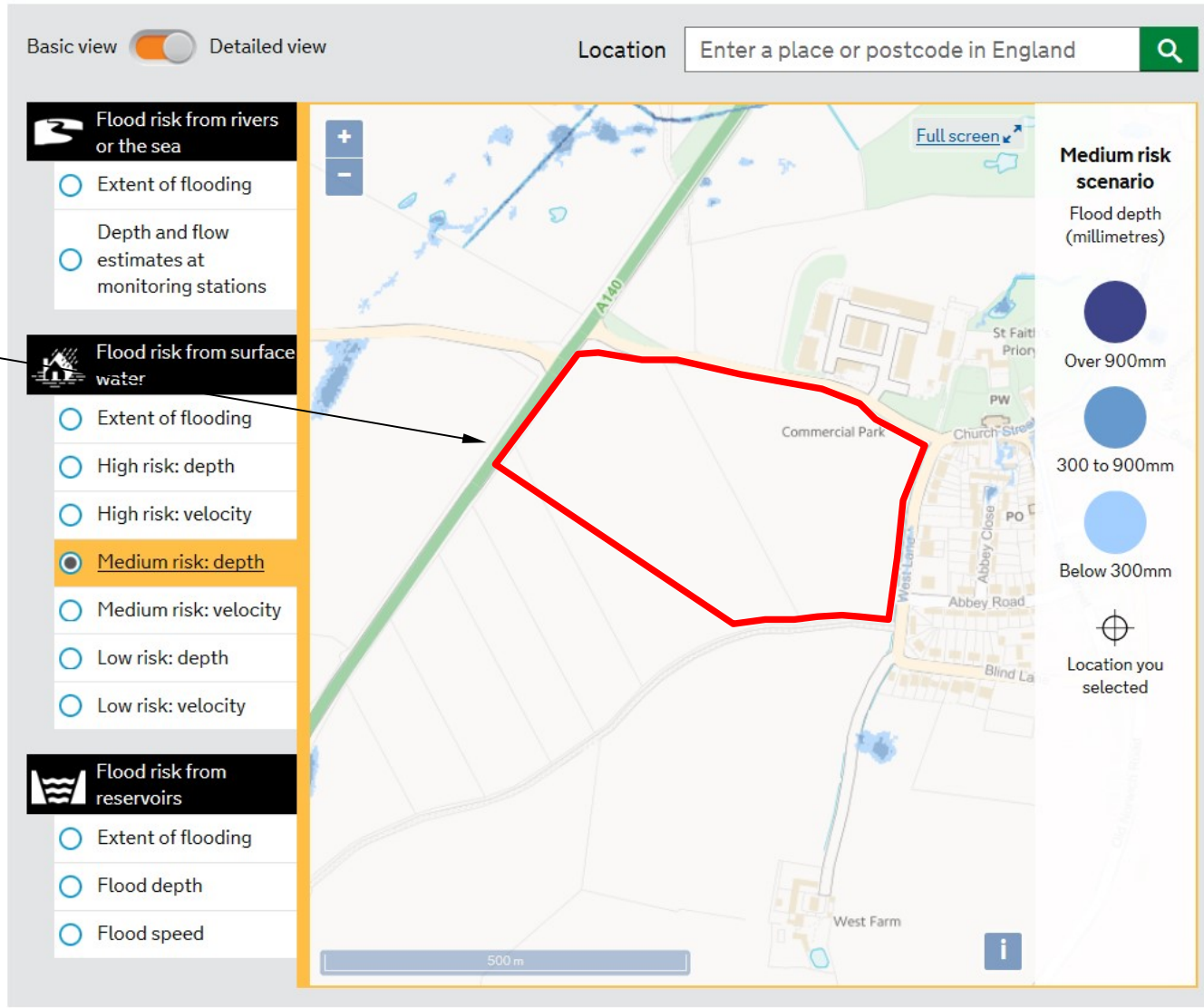
THE SITE



Client:	Drawing Title:		
Abel Homes Ltd	**Surface Water Flood Mapping (Medium Risk)**		
Job Title:	Date:	Job No:	Dwg No:
Land at Horsham St Faith, Norwich	**03.10.18**	**49455**	**Fig. 6 (NTS)**

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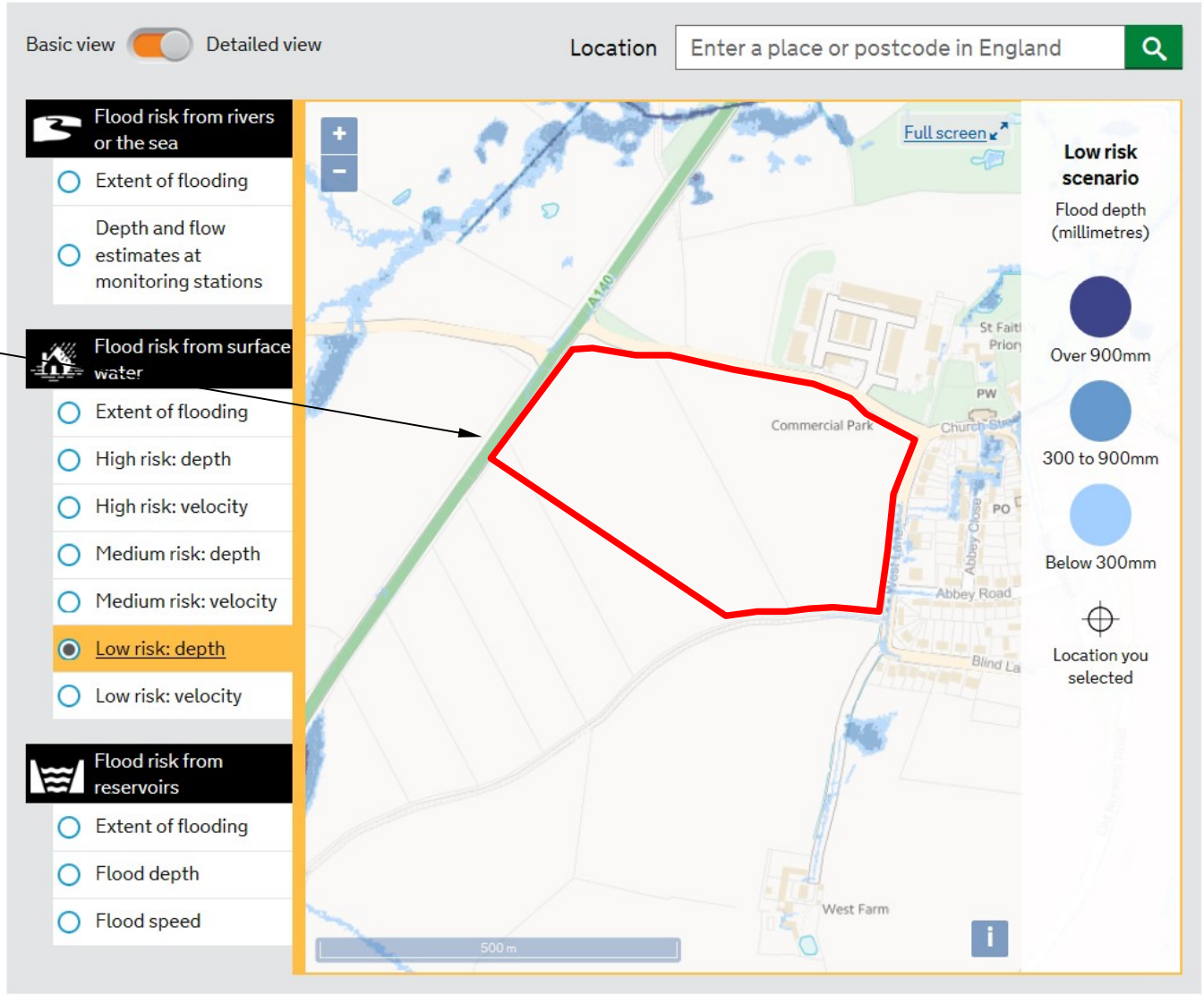

THE SITE

Client:	Drawing Title:		
Abel Homes Ltd	**Surface Water Flood Mapping (Low Risk)**		
Job Title:	Date:	Job No:	Dwg No:
Land at Horsham St Faith, Norwich	**03.10.18**	**49455**	**Fig. 7 (NTS)**

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DO NOT SCALE

KEY:

- SITE BOUNDARY
- INDICATIVE SPINE ROAD
- INDICATIVE SWALE POSITION
- EXCEEDENCE/TOPOGRAPHY FLOW DIRECTION

NOTES:

1. ALL LEVELS ARE IN METRES ABOVE ORDNANCE SURVEY DATUM.
2. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE STATED.
3. NOT ALL UTILITIES ARE SHOWN FOR CLARITY.
4. INDICATIVE HIGHWAY DRAINAGE BASINS HAVE BEEN SIZED ON A SUGGESTED INFILTRATION RATE OF 0.0198 m/hr, FROM IMPERICAL DATA FROM LOCAL SOURCES.
5. THE INDICATION OF SWALES AND/OR INFILTRATION BASINS COULD BE USED. IF SWALES ARE USED FOR THE HIGHWAY DRAINAGE THEN THE INFILTRATION BASINS ARE NOT REQUIRED AND VICE VERSA, IF THE INFILTRATION BASINS ARE USED FRO HIGHWAY DRAINAGE THEN THE SWALES ARE NOT NEEDED.
6. THE ASSUMPTIONS ARE MADE ON THE BASIS THAT THE DRAINAGE IS FOR THE HIGHWAY ONLY AND THAT DWELLINGS WILL HAVE THEIR OWN INDIVIDUAL PERMEABLE PAVING OR SOAKAWAYS. THIS MEANS THE DWELLINGS ARE SELF CONTAINED AND DO NOT CONTRIBUTE TO THE SWALES OR INFILTRATION BASINS.

PRELIMINARY

REV	DATE	DESCRIPTION	DRAWN	CHKD

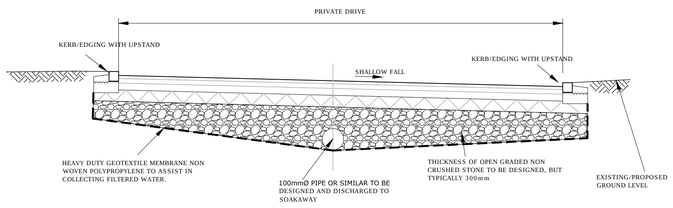
REVISIONS

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

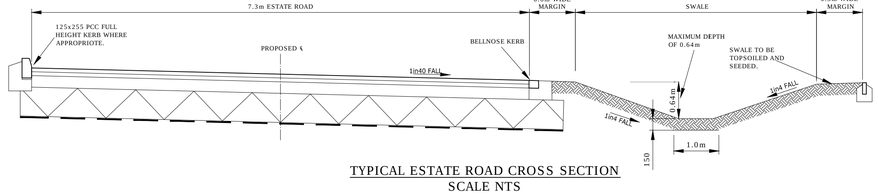
Project
LAND EAST OF A140
HORSHAM ST FAITH

Title
PRELIMINARY SURFACE WATER DRAINAGE DESIGN (HIGHWAYS)

Client
ABEL HOMES LTD



TYPICAL CROSS SECTION OF THE PRIVATE DRIVE AND PERMEABLE PAVING
SCALE NTS



TYPICAL ESTATE ROAD CROSS SECTION
SCALE NTS

Scale	Drawn	Date
1:1,000 @ A1	J.EVERITT	03/10/18
Job Manager	Checked	Approved
M. DOUGHTY	M. DOUGHTY	M. DOUGHTY

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3rd Floor, Rennie House, 57-60 Aldgate High Street, London EC3N 1AL Tel: 020 7448 9910
5 Queen House, Mill Court, Great Shelford, Cambs CB22 5LD Tel: 01223 314794
4 The Old Church, St. Matthews Road, Norwich, Norfolk NR1 1SP Tel: 01603 230240
The Wheelhouse, Bonds Mill, Stonehouse, Gloucestershire GL10 3RF Tel: 01172 020070
Email Address: mail@rj.uk.com Website: http://www.rj.uk.com

Drawing No. 49455/PP/002
Revision

Drawing Status
- [X] INFORMATION
- [ ] APPROVAL
- [ ] COSTING
- [ ] TENDER
- [ ] CONSTRUCTION
- [ ] AS CONSTRUCTED

A1

DO NOT SCALE

KEY:

- SITE BOUNDARY
- INDICATIVE SPINE ROAD
- EXCEEDENCE/TOPOGRAPHY FLOW DIRECTIONS

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5. THE ASSUMPTIONS ARE MADE ON THE BASIS THAT THE DRAINAGE IS FOR THE DEVELOPMENT (DWELLINGS) AND HIGHWAY AREAS. DWELLINGS COULD HAVE THEIR OWN INDIVIDUAL PERMEABLE PAVING FOR POLLUTION CONTROL, BUT ALL DISCHARGE IS COLLECTED IN THE INFILTRATION BASINS AND STORED IN THESE LOCATIONS UNTIL THE WATER DISCHARGES. A GREATER NUMBER OF SMALLER INFILTRATION BASINS COULD BE USED ACROSS THE DEVELOPMENT INSTEAD TO PROVIDE THE SAME VOLUMEN OF STORAGE AS AN ALTERNATIVE.

PRELIMINARY

REV	DATE	DESCRIPTION	DRAWN	CHKD

REVISIONS

This drawing is to be read in conjunction with all other Engineer's drawings and all other project information. Any discrepancy between the Engineer's drawings and other project information is to be reported to the Engineer immediately.

Project
LAND EAST OF A140
HORSHAM ST FAITH

Title
PRELIMINARY SURFACE WATER DRAINAGE DESIGN
(FOR WHOLE DEVELOPMENT)

Client
ABEL HOMES LTD

Scale	Drawn	Date
1:1,000 @ A1	J.EVERITT	05/10/18
Job Manager	Checked	Approved
M. DOUGHTY	M. DOUGHTY	M. DOUGHTY

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847 The Crescent, Colchester, Essex CO4 9YQ Tel: 01206 228800
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5 Queen House, Mill Court, Great Shelford, Cambs CB22 5LD Tel: 01223 314794
4 The Old Church, St. Matthews Road, Norwich, Norfolk NR1 1SP Tel: 01603 230240
The Wheelhouse, Bonds Mill, Stonehouse, Gloucestershire GL10 3RF Tel: 01172 020070
Email Address: mail@rj.uk.com Website: http://www.rj.uk.com

Drawing No.	Revision
49455/PP/003	

Drawing Status
[X] INFORMATION [ ] APPROVAL [ ] COSTING
[ ] TENDER [ ] CONSTRUCTION [ ] AS CONSTRUCTED

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