Modelled floodplain flood levels

THM102057

The modelled flood levels for the closest most appropriate model grid cells for your site are provided below:

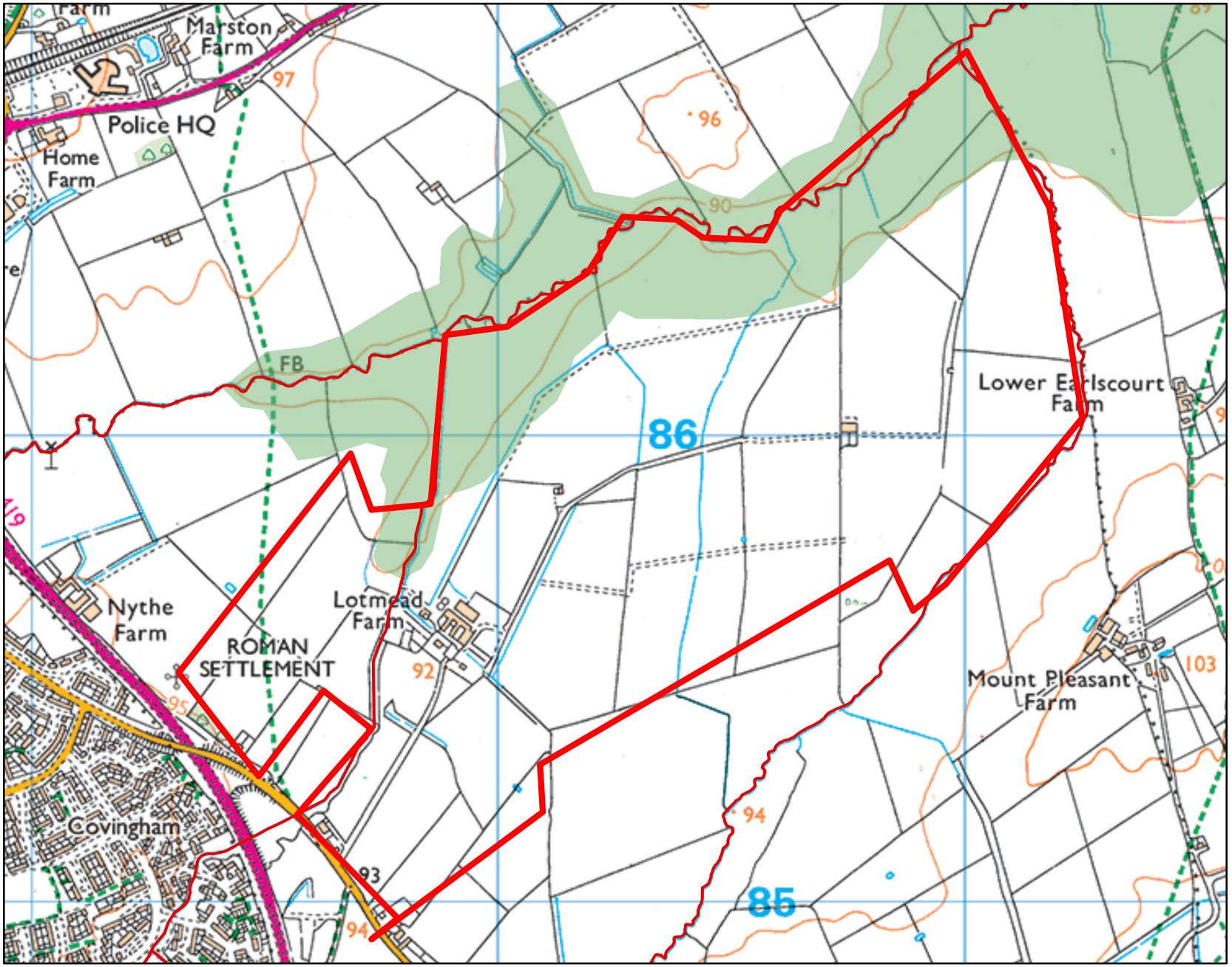
				flood levels (mAOD)							
2D grid cell reference	Model	Easting	Northing	20% AEP	5% AEP	1% AEP	1% AEP (+20% increase in flows)	1% AEP (+25% increase in flows)	1% AEP (+35% increase in flows)	1% AEP (+70% increase in flows)	0.1% AEP
Floodplain 1	Cole EDA (A419 to South Marston Brook) 2011	419,565	185,122	No data	No data	No data	No data	No data	No data	No data	93.32
Floodplain 2	Cole EDA (A419 to South Marston Brook) 2011	419,784	185,614	No data	No data	No data	No data	No data	No data	No data	91.99
Floodplain 3	Cole EDA (A419 to South Marston Brook) 2011	420,314	185,478	No data	No data	No data	No data	No data	No data	No data	92.16
Floodplain 4	Cole EDA (A419 to South Marston Brook) 2011	420,359	186,344	No data	No data	90.03	90.08	No data	No data	No data	90.33
Floodplain 5	Cole EDA (A419 to South Marston Brook) 2011	421,019	186,221	No data	89.85	89.91	89.91	No data	No data	No data	89.94

This flood model has represented the floodplain as a grid.
The flood water levels have been calculated for each grid cell.

Note:
Due to changes in guidance on the allowances for climate change, the 20% increase in river flows should no longer to be used for development design purposes. The data included in this Product can be used for interpolation of levels as part of an intermediate level assessment.

For further advice on the new allowances please visit
https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

Historic Flood Map centred on SN4 0UY
Created on 18/10/18 REF:THM102057



Environment Agency

Kilometres

0 0.3 0.6

Legend

Main River

year

2007

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 03708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Historic flood data

THM102057

Our records show that the area of your site has been affected by flooding.
Information on the floods that have affected your site is provided in the table below:

Flood Event Code	Flood Event Name	Start Date	End Date	Source of Flooding	Cause of Flooding
ea061070003	Bourton_Fluvial Water	19/07/2007	29/07/2007	main river	channel capacity exceeded (no raised defences)

Please note the Environment Agency maps flooding to land not individual properties. Floodplain extents are an indication of the geographical extent of a historic flood. They do not provide information regarding levels of individual properties, nor do they imply that a property has flooded internally.

Start and End Dates shown above may represent a wider range where the exact dates are not available.

Product 4 (Detailed Flood Risk) for Area off Wanborough Road to the south west of Swindon
Our Ref: OX_0327_01

Product 4 is designed for developers where Flood Risk Standing Advice FRA (Flood Risk Assessment) Guidance Note 3 Applies. This is:

i) "all applications in Flood Zone 3, other than non-domestic extensions less than 250 sq metres; and all domestic extensions", and
ii) "all applications with a site area greater than 1 ha" in Flood Zone 2.

Product 4 includes the following information:

Ordnance Survey 1:25k colour raster base mapping;
Flood Zone 2 and Flood Zone 3;
Relevant model node locations and unique identifiers (for cross referencing to the water levels, depths and flows table);
Model extents showing *defended* scenarios;
FRA site boundary (where a suitable GIS layer is supplied);
Flood defence locations (where available/relevant) and unique identifiers; (supplied separately)
Flood Map areas benefiting from defences (where available/relevant);
Flood Map flood storage areas (where available/relevant);
Historic flood events outlines (where available/relevant, not the Historic Flood Map) and unique identifiers;
Statutory (Sealed) Main River (where available within map extents);

A table showing:

i) Model node X/Y coordinate locations, unique identifiers, and levels and flows for *defended* scenarios.
ii) Flood defence locations unique identifiers and attributes; (supplied seperately)
iii) Historic flood events outlines unique identifiers and attributes; and
iv) Local flood history data (where available/relevant).

Please note:

If you will be carrying out computer modelling as part of your Flood Risk Assessment, please read the enclosed guidance which sets out our requirements and best practice for computer river modelling.

This information is based on that currently available as of the date of this letter. You may feel it is appropriate to contact our office at regular intervals, to check whether any amendments/ improvements have been made. Should you re-contact us after a period of time, please quote the above reference in order to help us deal with your query.

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

This letter is not a Flood Risk Assessment. The information supplied can be used to form part of your Flood Risk Assessment. Further advice and guidance regarding Flood Risk Assessments can be found on our website at

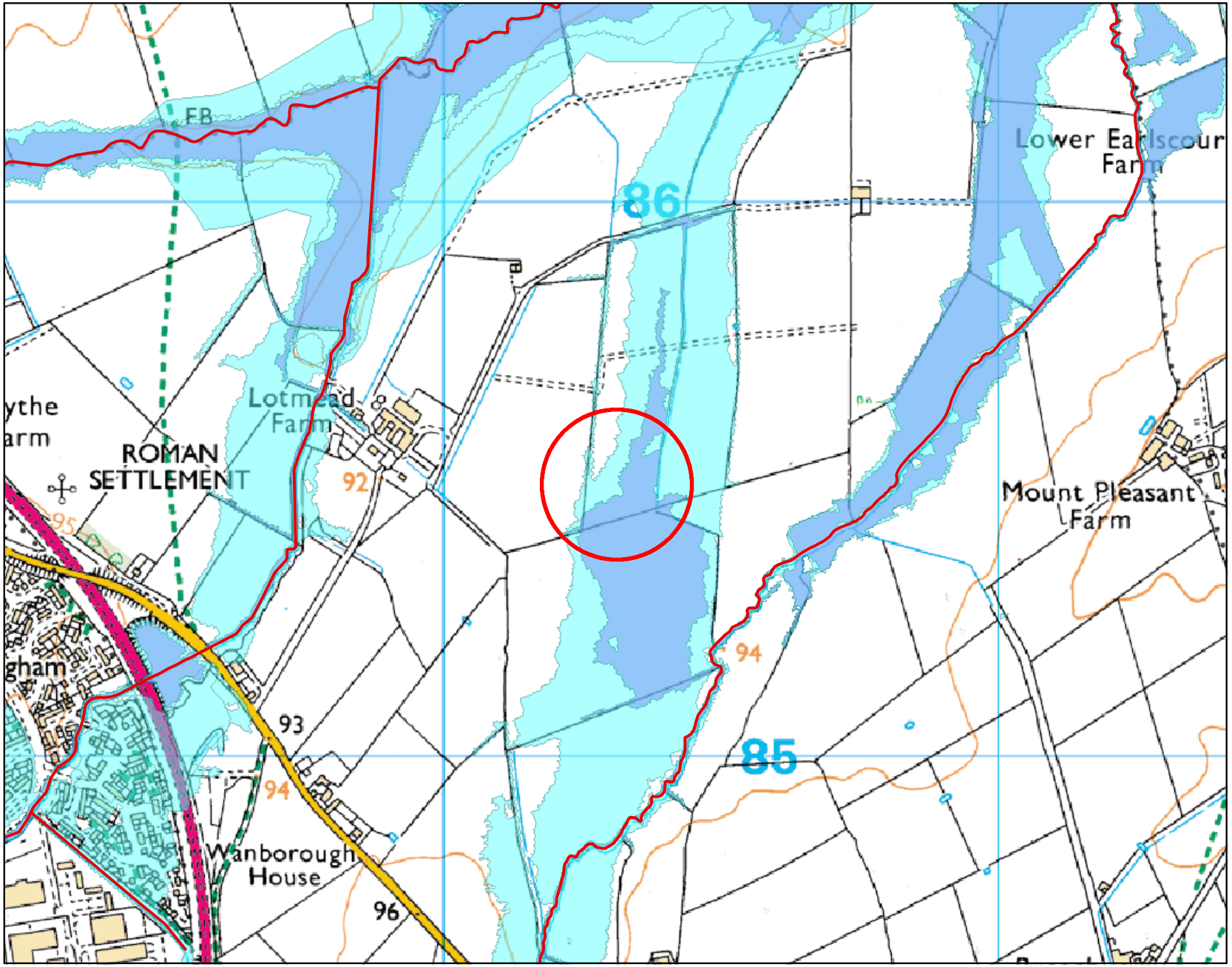
http://www.environment-agency.gov.uk/research/planning/82584.aspx

If you would like advice from us regarding your development proposals you can complete our pre application enquiry form which can be found at

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

Red Kite House, Howbery Park, Wallingford, Oxon OX10 8BD
Customer services line: 08708 506 506
Email: WTenquiries@environment-agency.gov.uk

Flood Map centred on Area off Wanborough Road to the south west of Swindon
Created 11/06/2013 - REF: OX_0327_01



Environment Agency

Kilometres

0 0.15 0.3

Legend

- Main River
- Flood defences
- Areas benefiting from flood defences
- Flooding from rivers or sea (FZ3)
- Extent of extreme flood (FZ2)
- Flood Map - flood storage areas

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

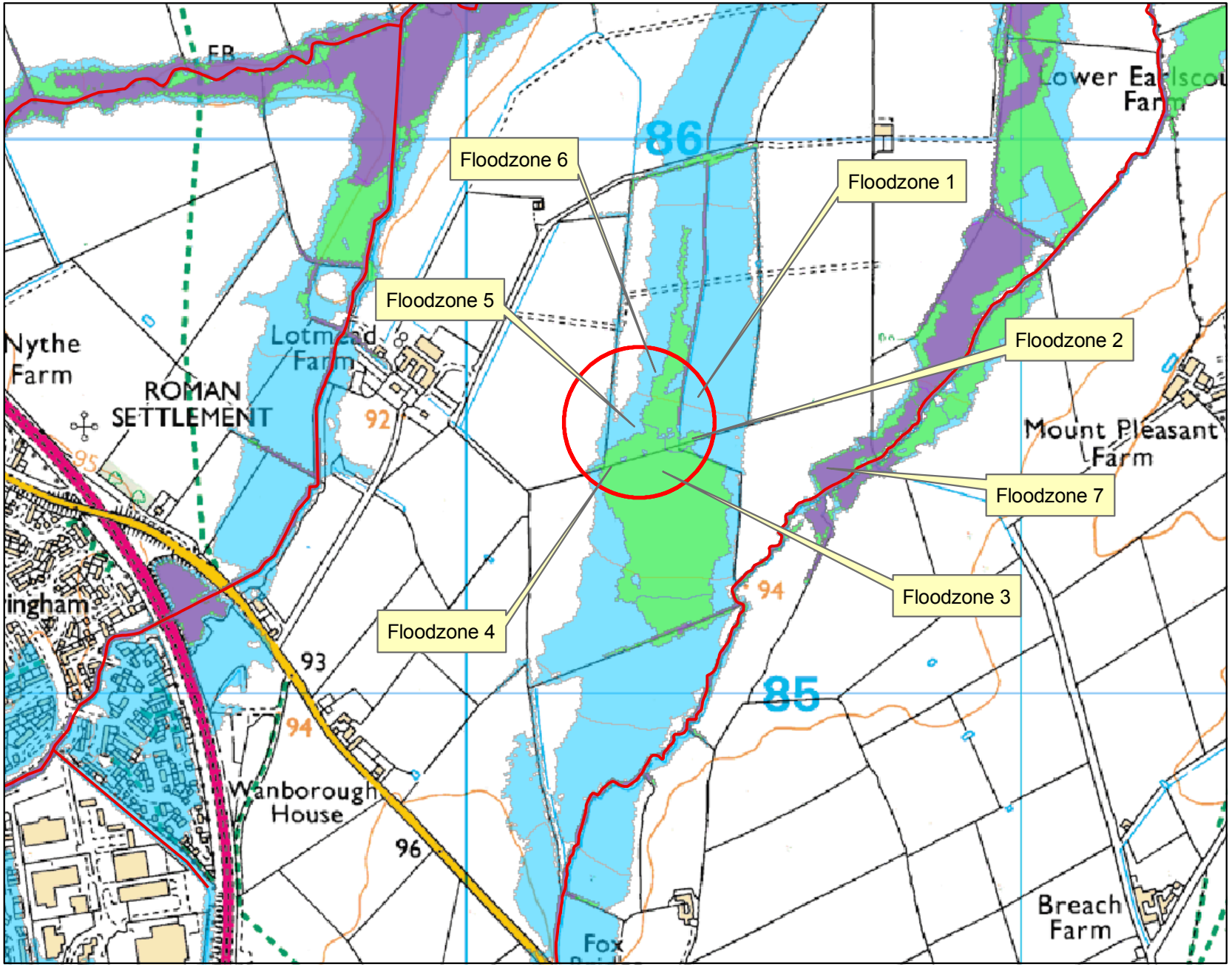
Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Defence information

OX_0327_01

Defence Location:	Swindon - Dorcan Brook
Description:	There are main river defences in the locality but we cannot currently say which properties benefit from these or what is the standard of protection. We are however modelling these defences in order to identify the standard of protection and update the Flood Map here by the end of 2013.

Model Flood Map centred on Area off Wanborough Road to the south west of Swindon
Created 11/06/2013 - REF: OX_0327_01



Environment Agency

Kilometres

0 0.15 0.3

Legend

- Main River
- 5% AEP Modelled Flood Extent
- 1% AEP Modelled Flood Extent
- 0.1% AEP Modelled Flood Extent

AEP = Annual Exceedance Probability
The probability of a flood of a particular magnitude, or greater, occuring in any given year

1%CC = 1% Climate Change extent
This is the 1% AEP event with an allowance for climate change (+20% on river flows)

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Model information

OX_0327_01

Model: Cole EDA (A419 to South Marston Brook) 2011

Description: The information provided is taken from the River Cole modelling completed in March 2011 as part of the Eastern Development Area Flood Risk Assessment. The study was carried out using 2D modelling in ISIS/TUFLOW software.

Model design runs:
1 in 20 / 5% AEP; 1 in 100 / 1% AEP and 1 in 1000 / 0.1% AEP

Mapped Outputs:
1 in 20 / 5% AEP; 1 in 100 / 1% AEP and 1 in 1000 / 0.1% AEP

Model accuracy:
Levels ± 250mm

Modelled floodplain flood levels

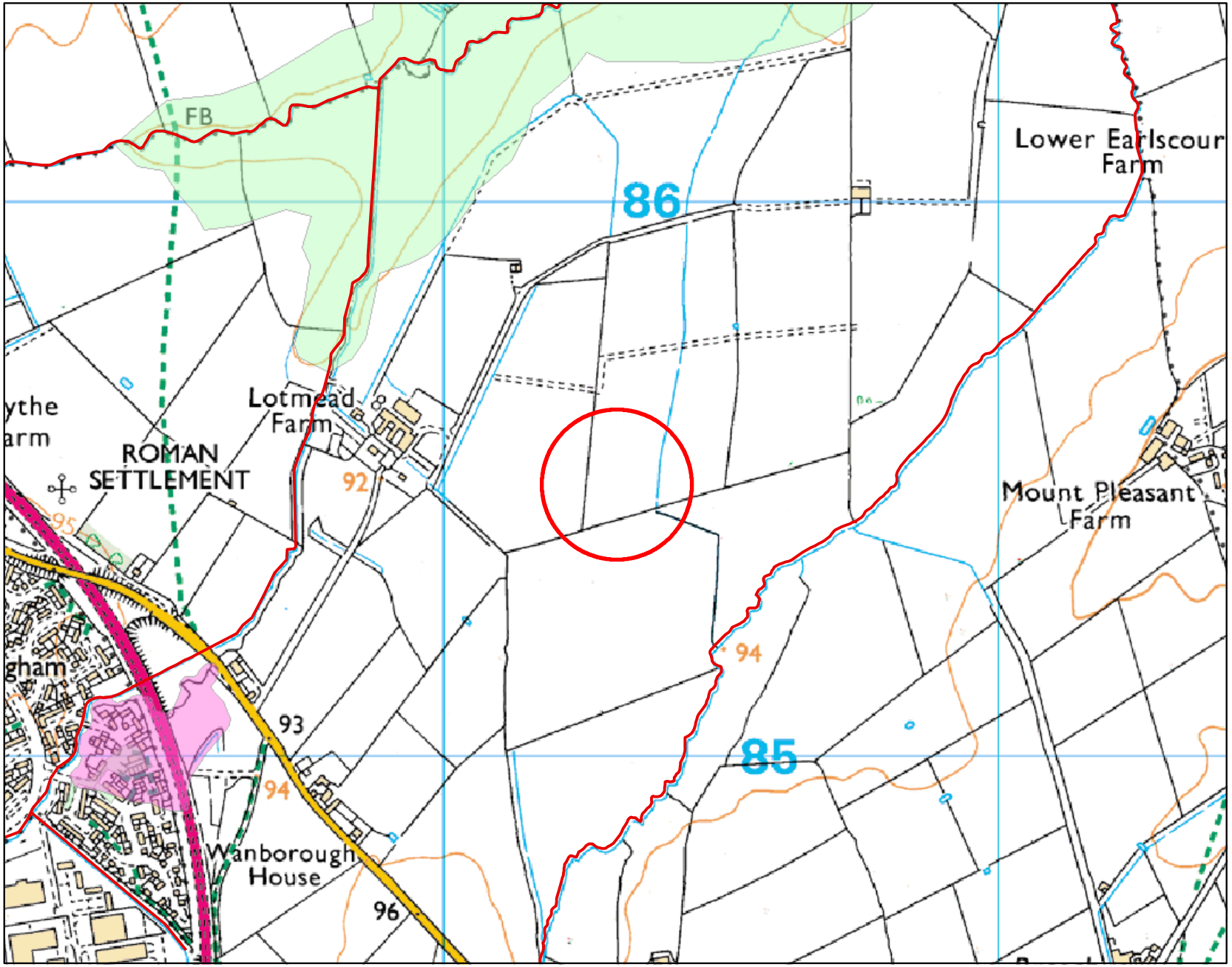
OX_0327_01

The modelled flood levels for the closest most appropriate model grid cells for your site are provided below:

				flood levels (mAOD)				
2D grid cell reference	Model	Easting	Northing	20% AEP	5% AEP	1% AEP	1% AEP with climate change allowance (+20% on river flows)	0.1% AEP
Floodzone 1	Cole EDA (A419 to South Marston Brook) 2011	420,421	185,532					91.95
Floodzone 2	Cole EDA (A419 to South Marston Brook) 2011	420,410	185,455			91.91		92.16
Floodzone 3	Cole EDA (A419 to South Marston Brook) 2011	420,354	185,401			92.17		92.32
Floodzone 4	Cole EDA (A419 to South Marston Brook) 2011	420,263	185,409			92.37		92.37
Floodzone 5	Cole EDA (A419 to South Marston Brook) 2011	420,306	185,479					92.15
Floodzone 6	Cole EDA (A419 to South Marston Brook) 2011	420,344	185,575					91.9
Floodzone 7	Cole EDA (A419 to South Marston Brook) 2011	420,652	185,403		92.22	92.31		92.38

This flood model has represented the floodplain as a grid.
The flood water levels have been calculated for each grid cell.

Historic Flood Map centred on Area off Wanborough Road to the south west of Swindon
Created 11/06/2013 - REF: OX_0327_01



Environment Agency

Kilometres

0 0.15 0.3

Legend

Main River

Flood Event Outlines selection

Year

1968

2007

Flooding from rivers or sea without defences (Flood Zone 3) shows the area that could be affected by flooding:
- from the sea with a 1 in 200 or greater chance of happening each year
- or from a river with a 1 in 100 or greater chance of happening each year.

The Extent of an extreme flood (Flood Zone 2) shows the extent of an extreme flood from rivers or the sea with up to a 1 in 1000 chance of occurring each year.

Contact Us: National Customer Contact Centre, PO Box 544, Rotherham, S60 1BY. Tel: 08708 506 506 (Mon-Fri 8-6). Email: enquiries@environment-agency.gov.uk

Historic flood data

OX_0327_01

Our records show that the area of your site has been affected by flooding.
Information on the floods that have affected your site is provided in the table below:

Flood Event Code	Flood Event Name	Start Date	End Date	Source of Flooding	Cause of Flooding
EA0619680900146	06SeptemberAutumn1968	01/01/1968	12/12/1968	main river	channel capacity exceeded (no raised defences)
ea061071086	Covingham CP_Fluvial Water	19/07/2007	29/07/2007	main river	channel capacity exceeded (no raised defences)

Please note the Environment Agency maps flooding to land not individual properties. Floodplain extents are an indication of the geographical extent of a historic flood. They do not provide information regarding levels of individual properties, nor do they imply that a property has flooded internally.

Start and End Dates shown above may represent a wider range where the exact dates are not available.

Using ‘Flood risk assessments: climate change allowances’ following publication of new climate projections in UKCP18

Who are these messages for?

These messages are for local planning authorities and developers preparing Strategic Flood Risk Assessments (SFRAs) and site specific flood risk assessments (FRAs).

How to use these messages

These messages advise developers who need to prepare site specific flood risk assessments and all local planning authorities how to use ‘Flood risk assessments: climate change allowances’ (published 2016) to account for the impact of climate change on flood risk now UKCP18 has been published.

Main messages

- UKCP18 was published on 26th November 2018.
- UKCP18 is the official source of information on how the climate of the UK may change over the rest of this century. The UKCP18 projections replace the UKCP09 projections.
- The allowances in ‘Flood risk assessments: climate change allowances’ (published Feb 2016) are still the best national representation of how climate change is likely to affect flood risk for:
    - peak river flow
    - peak rainfall intensity
- Research that is due to be published in 2019 may result in changes to these allowances[1]. We will provide customers with more information regarding the need to update peak river flow and peak rainfall intensity allowances in due course.
- The climate change allowances for sea level rise in ‘Flood risk assessments: climate change allowances’ will be updated and published as early as possible in 2019. Until then, it is reasonable to continue to use the sea level rise allowances in ‘Flood risk assessments: climate change allowances’ (published in 2016) for planning decision making, because the allowances that have been used to date represent the high end of the range of sea level rise projected by UKCP18.

[1] High resolution mapping providing peak river flow allowances at 1km grid resolution due to be published Spring 2019. We do not expect the peak river flow allowances provided at a regional scale in ‘Flood risk assessments: climate change allowances’ to change as a result of this information, however, planners and developers may need to take account of this information where it shows a significant difference to the regional allowances. High resolution (daily and sub daily) rainfall projections is due to be published in the second half of 2019. These are used to understand the impact of climate change on peak rainfall. Following this, the peak rainfall allowances in ‘Flood risk assessments: climate change allowances’ may need to be updated, but this will not be until late 2019 at the earliest.

- However, in exceptional cases where developments are very sensitive to flood risk and have a lifetime of at least 100 years[2], we recommend you assess the impact of both the current allowance in 'Flood risk assessments: climate change allowances' and the 95th percentile of UKCP18 'RCP 8.5' scenario (high emissions scenario) **standard method** sea level rise projections of UKCP18, and plan according to this assessed risk. You will need to calculate sea level rise allowances beyond 2100 by extrapolating the UKCP18 dataset. The Environment Agency will check your extrapolation methodology and provide advice.
- UKCP18 provides sea level rise projections for 2100 – 2300. The update of 'Flood risk assessments: climate change allowances' will include advice on using these projections. In the meantime, for development with a longer than 100 year lifetime e.g. large urban extensions, new settlements, major infrastructure, you should contact your local the Environment Agency office for advice on how to calculate such allowances.
- Where it is appropriate to use the sea level rise information in UKCP18 as described in this briefing note, planning decisions should do so from now onwards, in order to ensure planning decisions are in line with policies in the National Planning Policy Framework. However, where local plans or development proposals and associated flood risk assessments are well advanced, it will usually be acceptable make decisions based on the allowances and advice in 'Flood risk assessments: climate change allowances' (published Feb 2016) in the following circumstances:
    - local plan has been submitted for examination (before or on the day UKCP18 is published); or
    - development proposals are well advanced or where a valid planning application has already been submitted to the local planning authority (before or on the day UKCP18 is published).
- When the climate change allowances are updated, the supporting guidance will be updated at the same time to address user feedback collated since Feb 2016.
- Once 'Flood risk assessments: climate change allowances' has been updated, over time we will update our flood risk modelling to reflect the revised climate change projections. This modelling work is principally done to inform our flood risk management activities, but we will continue to share this work with planners (for SFRAs) and developers (for site-specific FRAs) when it becomes available. Where the modelling needed by planners and developers has not yet been undertaken, we may be able to work together to do this work more quickly and to share the costs. Where this is not possible, the onus will be on planners and developers to undertake the necessary work at their own cost. Contact your local Environment Agency office to find out when they plan to update their flood risk modelling and to discuss working together.

[2] Such as infrastructure projects or developments that significantly change existing settlement patterns including urban extensions and new settlements

Appendix D PBA Hydraulic Modelling

PBA Hydraulic Modelling Report (doc ref *27970_Swindon_Expansion_Area_modelling_Report_RevA,* dated March 2015)

PBA Technical Note *Updated modelling to consider February 2016 Climate Change Allowances (doc ref: TN_CC001,* dated April 2017)

Lotmead Farm Villages

Hydraulic Modelling Report

On behalf of **Ainscough Strategic Land**

Project Ref: 27970/016 | Rev: A | Date: March 2015

Office Address: Caversham Bridge House, Waterman Place, Reading, Berkshire RG1 8DN
T: +44 (0)118 950 0761 F: +44 (0)118 959 7498 E: reading@peterbrett.com

Document Control Sheet

Project Name: **Lotmead Farm Villages**
Project Ref: **27970/016**
Report Title: **Hydraulic Modelling Report**
Doc Ref: **27970_Swindon_Expansion_Area_modelling_Report_RevA**
Date: **03/03/15**

	Name	Position	Signature	Date
Prepared by:	Shumol Bari	Assistant Modeller		12/12/14
Reviewed by:	Amy Hensler	Associate		12/12/14
Approved by:	Paul Jenkin	Partner		12/12/14
For and on behalf of Peter Brett Associates LLP				

Revision	Date	Description	Prepared	Reviewed	Approved
–	12/12/2014	Submitted to EA as part of Model Review	SB	AH	PJ
A	03/03/2015	Changed Title for inclusion in FRA and ES Appendixes	SB	AH	AH

Contents

Figures

Tables

Appendices

1 Introduction

1.1 Site location

1.1.1 Peter Brett Associates (PBA) has been commissioned by Ainscough Strategic Land to undertake the hydraulic modelling for their landholding within the Eastern Villages (formerly known as Swindon East Villages) development area.

1.1.2 The area being modelled represents the largest parcel of the Eastern Villages site and is associated with Lotmead Farm. (Appendix A)

Figure 1: Site Boundary

1.2 Site Boundary

1.2.1 The site boundary is shown in Figure 1 and is bounded by Wanborough Road to the southwest. The north western boundary extends perpendicular to Wanborough Road and extends for around 550m, before following the Dorcan Stream to the confluence with the River Cole. The River Cole forms the northern boundary through to the confluence with the Liden Brook, which itself forms the entire 1.7km long, eastern boundary. The southern boundary connects across from the Liden Brook, back along field boundaries to Wanborough Road.

1.2.2 The site is predominantly agricultural pasture associated with the dairy farm at Lotmead; as such, the site is grazed grassland with a few associated farm buildings (milking room, pens, barns etc.). Some of the existing brick farm buildings have been converted to commercial units forming a small commercial business park, but these are buildings located outside the floodplain.

1.3 Main watercourses

1.3.1 The watercourses affecting the site (Figure 2) are the River Cole, the Liden Brook, the Lenta Brook and the Dorcan Stream. There are also two significant land drains across the site, which discharge to the River Cole. A network of land drainage gullies and ditches along the field boundaries on the site also exists.

Figure 2: Watercourses in model and through site

1.3.2 The River Cole flows downstream in a north east direction, along the north boundary of the site. The River Cole is the principal receptor for flows from the site with all the other significant watercourses tributing it from the south. Of the other watercourses, the Dorcan Stream tributes the River Cole the furthest upstream at the western edge of the site; the next watercourses to join the River Cole are the two land drains through the site, with the Liden Brook joining the River Cole at the eastern edge of the site. The Lenta Brook tributes the River Cole downstream to the east of the site, upstream of the A420 crossing over the River Cole at Acorn Bridge.

2 Existing Model

2.1 Swindon Eastern Development Area Group model

2.1.1 The Environment Agency (EA) has provided a 1D/2D Estry-TUFlow model covering the site area. This model was created for the Swindon Eastern Development Area Group in 2010, and was purchased from the EA for use with this assessment.

2.2 Model reports

2.2.1 The model provided to PBA by the EA included two reports;

- Flood Mapping Study Volume 1: Hydrology Report for the River Cole (February 2010) (referred to in this report as the EA hydrology report);
- Flood Mapping Study Volume 2: Hydraulic modelling report for the River Cole (August 2010) (referred to in this report as the EA modelling report).

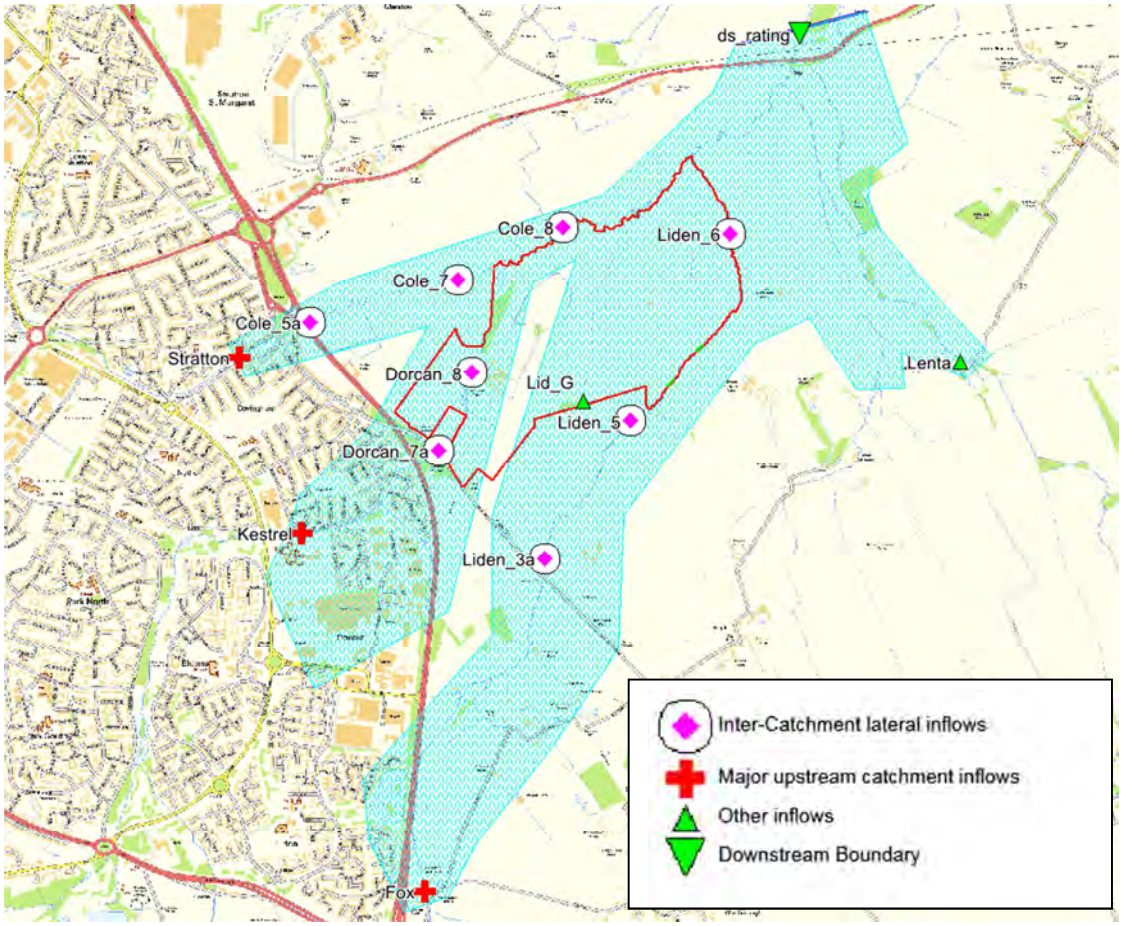
2.3 Modelled watercourses

2.3.1 The model includes the River Cole, Liden Brook, Lenta Brook and Dorcan Stream and one of the significant land drains (Drainage Ditch B) as the main watercourses modelled in Estry. The land drain is labelled as a 'preferential flowpath' in the EA modelling report for spills from the Liden Brook. The other major land drain (Drainage Ditch A) was included as a 2d 'gully line'. The other drains across the field boundaries on site are also included as 2d 'gully' lines in TUFlow.

2.4 Model extent and boundary conditions

2.4.1 The model extent and inflow locations are shown in Figure 3; the model domain is the light blue shaded area, and the red crosses are the major inflows for the upper catchments of the River Cole and the Liden Brook and Dorcan Stream.

Figure 3: Model extent (*light blue)*, Ainscough Land Holding (*red line)* and inflows in Current Model



2.4.2 The upstream boundary of the model is at the west of the model on the edge of Swindon, with inflows for the River Cole, the Dorcan Stream and the Liden Brook applied at Stratton Bridge. Kestrel Bridge and Fox Bridge respectively. These flows are labelled Stratton, Kestrel and Fox and are shown in Figure 3.

2.4.3 The inter-catchment flows for the River Cole, Liden Brook and Dorcan Stream are distributed along each catchment with each inflow location representing the flow from the catchment area between that location and the previous inflow upstream.

2.4.4 The model inflows are all specified as flow vs. time boundaries (QT).

2.4.5 The downstream end of the model was located to the north at Acorn Bridge where a head vs. flow (HQ) boundary was applied (labelled ds_rating in figure 2).

2.4.6 The model inflows were generated using ReFH (para 4.8.1 EA hydrology report).

2.5 Missing/Incomplete model data

2.5.1 The data provided by the EA included flood extents and the model result data but did not include any TUFlow .tlf log files. The model files did not include a .tab or .mif file for the model zpts which contains the topographic level data. The model data did include the zpt .mid file, which allowed the TUFlow model to be run, but the topographic data could not be inspected in Mapinfo. In order to resolve this issue the model from the EA was rerun and the zpts .mif and

.tab files recreated, so that the raw baseline topographic level data could be imported into MapInfo to be scrutinised.

2.6 TUFlow run version

2.6.1 The model was rerun to generate the omitted .tlf files in the data provided by the EA. The model was initially run by PBA using the 2006-06-DB version as that version was closest to the 2006-06-AA version stated as being used in the EA modelling report (the DB version accommodates a change in TUFlow license dongle hardware rather than the TUFlow software so should not affect the model results).

2.6.2 Upon rerunning the model, the results were found to have large discrepancies with the results provided with the EA model. Upon further investigation it was found that the original model had been run using the 2007-07-BF version (found by opening one of the supplied model result data .sup file in a text editor), which included changes to underlying default modelling parameters compared to the 2006-07-AA version.

2.6.3 Subsequently, the models were rerun using the 2007-07-DB version of TUFlow and the results were found to be appropriately comparable. All subsequent model runs have been undertaken in the 2007-07-DB (DB version for dongle compatibility).

3 PBA Modelling

3.1 Updates to Base model

3.1.1 PBA updated the existing model using new topographic and channel survey data. The survey data included channel sections for the reach of the River Cole through the site as well as the two land drains on site.

3.1.2 In the current model, only one of these land drains was modelled in Estry, with the second, shorter drain (easternmost of the two land drains) modelled in 2D as a gully line in TUFlow. For this study both drains were re-schematised into Estry using the updated channel survey to redraw the channel cross-sections and the 1d_nwk files.

3.1.3 Several small culverts were located along these drains and were included in the model, with the sizes of these culverts taken from the topographic survey.

3.1.4 The land drain would have an influence on the modelled flood routing, and representing the channel in the 1d represents an improvement over the existing schematisation as a 2d gully.

3.1.5 The model also updated the topographic levels on site to improve the accuracy of the ground model. The current model used EA aerial photogrammetry to create the floodplain topography (para 4.4.1 EA modelling report). According to Table 1 of the EA modelling report, the aerial photogrammetry was flown in 1997 so is relatively old and photogrammetry has inherent inaccuracies, which are not as significant for an accurate topographic survey.

3.1.6 No other changes to the base model were undertaken.

3.2 Hydrology

3.2.1 In general no changes were made to the existing hydrology as the methodology used in the EA model was considered sound. However, for the 1 in 1000 year return period scenario, an inconsistency in the inflows at Lid_3a and Lid_G was found when compared to the inflows at these locations for the smaller return periods.

3.2.2 Lid_3a is an inter-catchment flow on the Liden Brook and Lid_G is the upstream inflow boundary along the 'preferential flowpath' land drain. In the model these two flow locations split a flow generated at the location of Lid_3a in the model. For the smaller return periods this flow split was 80:20 in favour of Lid_3a and the model used separate inflow hydrographs for each location in the model bc_dbase in TUFlow.

3.2.3 This inflow was very small, ranging between 0.05 - 0.19 m^3/s for the 1 in 5 year to 1 in1000 year return period events (Table 2, para 5.2.1, EA modelling report). However in the 1 in 1000 year model a much larger flow was used when compared to the figure in the EA modelling report and compared relative to the other return periods modelled.

3.2.4 Following investigation of this inconsistency, it is thought that an error was made in the 1 in 1000 year hydrology, leading to the flow used at Lid_3a being larger than the inflow for the entire upstream Liden Brook catchment at Fox Bridge.

Investigation of the 1 in 1000 year return period hydrology

3.2.5 The total inflow split between Lid_3a and Lid_G in the model was stated as being 0.19 m^3/s for 1 in 1000 year return period event (Table 2, para 5.2.1, EA modelling report). The reports included with the model did not include the calculations of this figure, but the figure bore

comparison with the figures stated for the smaller return periods modelled and used, in the models for these lower return period events.

3.2.6 However, the 1000 year model did not split the peak flow of 0.19m^3/s as indicated in the EA modelling report; and instead split a peak inflow of 8.14m^3/s between Lid_3a and Lid_G.

3.2.7 In terms of magnitude, the combined 8.14 m^3/s peak inflow was larger than the model inflow at Fox Bridge (7.75 m^3/s), which represented the inflow generated from the entire upper catchment of the Liden Brook at that point.

3.2.8 The potential source of this 8.14 m^3/s flow was investigated and a ReFH flow was calculated using the FEH Catchment Descriptors for the catchment at Lid_3a, to compare with the 8.14m^3/s flow.

3.2.9 Using the catchment descriptors at Lid_3a (taken from Appendix H in the EA hydrology report); a flow of 8.17 m^3/s was generated using the ReFH method, similar to the 8.14m^3/s flow used in the model. On the basis of this investigation, it was thought that the suspect flow on the Liden Brook at location Lid_3a included the entire upstream catchment to this point, rather than the flow from the inter-catchment between the inflow at Fox Bridge and the location of Lid_3a.

3.2.10 As this catchment area was already included in the model as the inflow at Fox Bridge; the 1000 year return period model double counted the upstream catchment up to Fox Bridge. Consequently the 8.14m^3/s is a significant overestimation for the inflow between Lid_3a and Lid_G.

3.2.11 It was decided to readjust the 8.14 m^3/s 1000 year flow at Lid_3a and Lid_G to match the peak flow of 0.19m^3/s for Liden 3a in Table 2, para 5.2.1,of the EA modelling report.

3.2.12 The existing 1000 year hydrographs provided with the model included a separate flow for the Lid_G inflow at the head of the 'preferential flowpath'. This was not used in the 1000 year model as it was not referenced in the 1000 year bc_dbase, but was found to be the 20% split of the 0.19m^3/s peak flow stated in the EA hydrology report for Lid_3a.

3.2.13 The unused Flow_G_Lid hydrograph for the 1000 year model was scaled by 4 to generate the new Flow_Lid3a hydrograph (scaling the 20% flow to 80% flow split for Lid_3a). The combined peak flow for the new Lid_3a and Lid_G were then checked against the peak flow in Table 2 of the EA modelling report to ensure they matched.

3.2.14 These flows were then used at locations Lid_3a and Lid_G for the inflows for the 1000 year return period model.

4 PBA Baseline Results

4.1 PBA baseline model runs

4.1.1 The updates to the model floodplain topography and channel, the inclusion of additional Estry channels and the alterations to the 1000 year hydrology required that a new set of models were run to create a new baseline for the existing site.

4.1.2 This baseline will be used to inform the masterplan and for later modelling of specific mitigation schemes or design options.

4.1.3 The new baseline was rerun for the 100 year, 100 year plus climate change and the 1000 year return period events.

4.2 Baseline model results

4.2.1 The baseline model extents are included in Appendix B.

4.2.2 These flood extents and water levels represent the baseline for assessing the potential detriment and betterment for our potential mitigation schemes.

5 Development Floodplain Restoration Scheme

5.1 Existing flood routes

5.1.1 The existing flood routes on the site are from overtopping of banks on the Liden Brook, with the overtopping flows following the low ground along the existing land drains into the River Cole and flowing north.

5.1.2 The flow routes along the major land drains divide the site, creating isolated 'islands' of Flood Zone 1 (above the 1 in 1000 year flood level) surrounded by corridors of shallow flooding in Flood Zones 2 and 3, as such, the Liden Brook is detached from its floodplain. It is considered that a mitigation scheme could be designed which would consolidate these 'islands' of Flood Zone 1 into a single developable area.

5.2 Floodplain Restoration Option

5.2.1 Several design options were assessed and initial model runs were made to inform a suitable scheme which would integrate with the existing features on site. These options focussed on limiting the floodplain flow from the Liden Brook to the River Cole through the centre of the site and included potential 2-stage channels along the Liden Brook through the site and compensation storage area along the preferential flow path.

5.2.2 The chosen scheme channels the floodplain flow along the existing land drains onto a 'flood corridor' re-establishing a floodplain alongside the Liden Brook. In this way, the chosen scheme offered an improvement in downstream flood levels and could be incorporated into the existing landscape, drainage gullies and flowpaths on site.

5.2.3 The grading and position of this flood corridor would be at a 'natural' shallow gradient, and would be landscaped as a 'soft' engineering solution. The flood corridor will integrate into existing ground levels and create a flood corridor alongside the Liden Brook which would also act as a floodplain in other flood events, potentially offering benefits downstream.

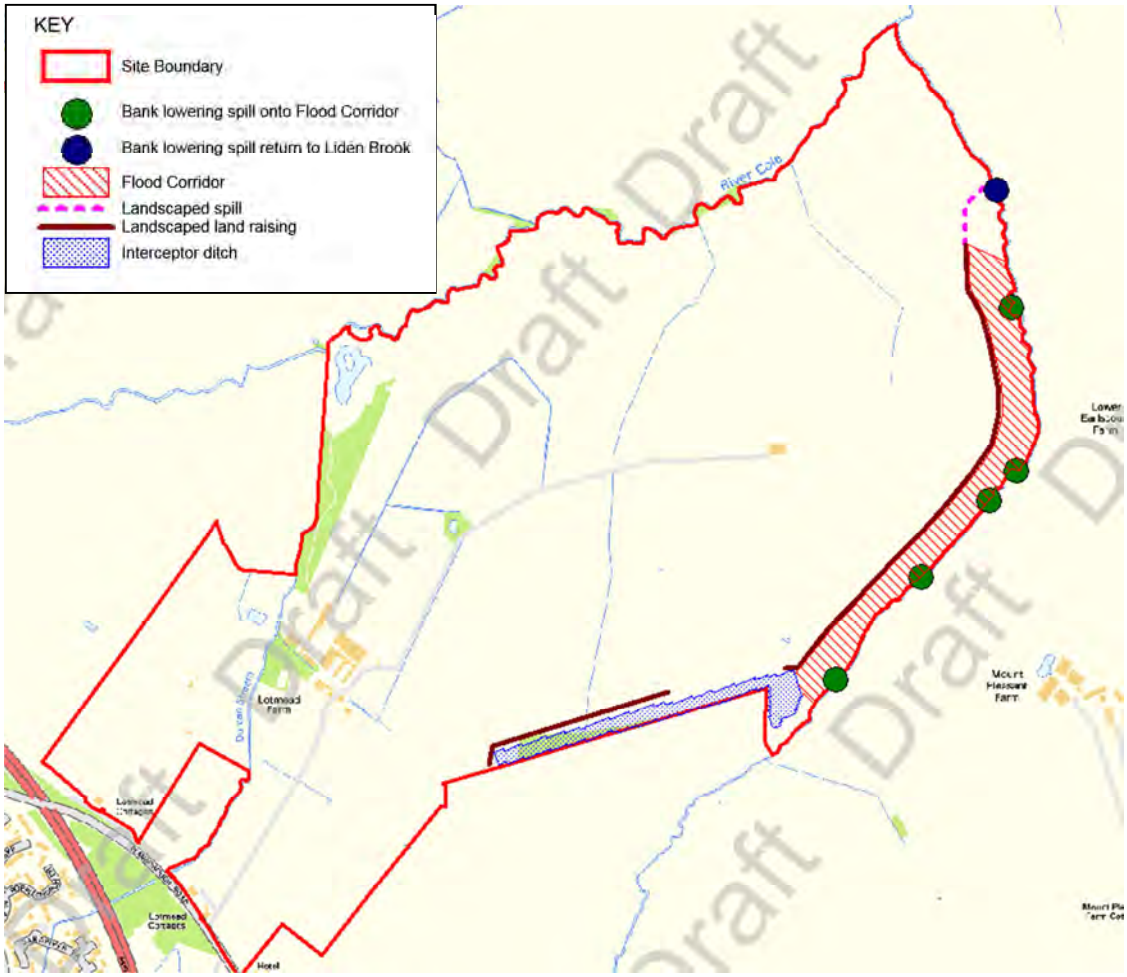
5.2.4 The preferred option will use an existing land drainage ditch to act as an 'interceptor ditch' across the 'preferential flowpath'. This interceptor ditch will be extended across the width of existing modelled floodplain and use shallow ground raising to create a landscaped rise of high ground to separate it from the development area and prevent flow circumventing the interceptor ditch, onto the development areas on the site.

5.2.5 The floodplain restoration scheme extends east beyond the existing drainage ditch towards the Liden Brook. The floodplain restoration scheme will be graded to form a shallow slope integrated into the existing landscape, and remain separate to the main Liden Brook channel. This floodplain restoration scheme follows the Liden Brook towards the River Cole floodplain before allowing the diverted flow to either rejoin the Liden Brook or spill onto the existing River Cole floodplain on site.

5.2.6 The scheme includes short lengths of bank lowering along the Liden Brook to encourage flow out of the main channel in flood events. The bank lowering will also allow the return of any water in the floodplain restoration scheme to return to the Liden Brook and River Cole, maintaining the existing flow mechanism on site.

5.2.7 A schematic indicating the proposed land raising and line of flow from the interceptor ditch to the floodplain restoration scheme is shown below, and a more detailed schematic is included in Appendix C.

Figure 4: Schematic of PBA scheme



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5.3 Floodplain Restoration scheme model

5.3.1 The interceptor ditch used the levels of the existing ditch on site and used two parallel gully lines to create a wider profile of the channel in 2d representing the wider and shallower sloped interceptor ditch. Similarly a 2d ridge line was used to generate the landscaping behind the ditch, used to divert flow towards the flood corridor. The interceptor ditch is notionally modelled as being at a 1:5 or shallower slope.

5.3.2 As the EA model was calibrated in an earlier version of TUFlow which does not support the use of 2d_zsh files; the floodplain restoration scheme was created as a set of zpts. The zpts were created using a 2d_zsh, in a later version of TUFlow (2013 version) to create a set of zpts which included the natural landscaped slopes of the relief corridor. This zpt file was read into the model to add the floodplain restoration scheme along the Liden Brook into the model.

5.3.3 The areas of low bank along the Liden Brook were created by amending the 2d_zln along the Liden Brook used for the bank levels.

6 Floodplain Restoration Scheme Model Results

6.1 Summary of model results

6.1.1 The proposed floodplain restoration option model was simulated for the 1000 year return period event. The results (Appendix D) indicated that the scheme worked for the 1000 year event and diverted the flow along the floodplain restoration scheme as intended.

6.1.2 The results showed a small reduction in flood risk downstream along the River Cole floodplain at Acorn Bridge and at the interceptor ditch. The areas of detriment were on site and associated with the diverted flow from the Liden Brook. The model did not show any detriment off-site.

6.1.3 The proposed scheme also removed flooding from a significant offsite area on the right bank of the Liden Brook, opposite the site. This betterment caused by the scheme represents the removal of flooding along an existing flow route around Lower Earlscourt Farm; indicating that the floodplain restoration scheme also has a beneficial impact on the water levels in the Liden Brook, lowering the flood level to prevent the overtopping of the right bank of the Liden Brook in the 1 in 1000 year event.

6.1.4 The current masterplan for the scheme has not been finalised and other constraints may impact on the initial alignment of the restoration scheme. If any of these constraints impact the restoration scheme, then the scheme can be modified as part of more detailed design as the masterplan becomes better defined.

6.2 Flood betterment/detriment

6.2.1 A plan indicating level differences across the model is included in Appendix D. In general the difference in flood level between the baseline and the floodplain restoration option models are negligible; Figure 4 below indicates the areas where differences in flood depths greater than 5mm occur. Figure 5 and Table 1 indicate the largely negligible differences in the modelled flood levels on the main watercourses from the proposed scheme.

Figure 4: Areas of betterment (blue) and detriment (red) greater than 5mm.

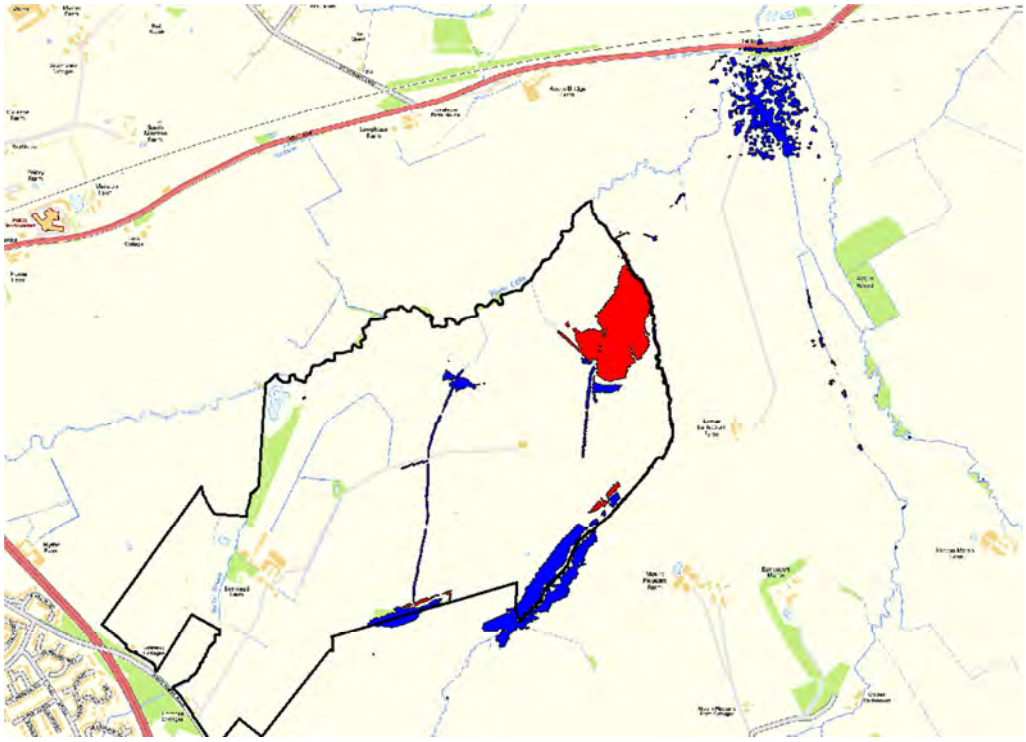
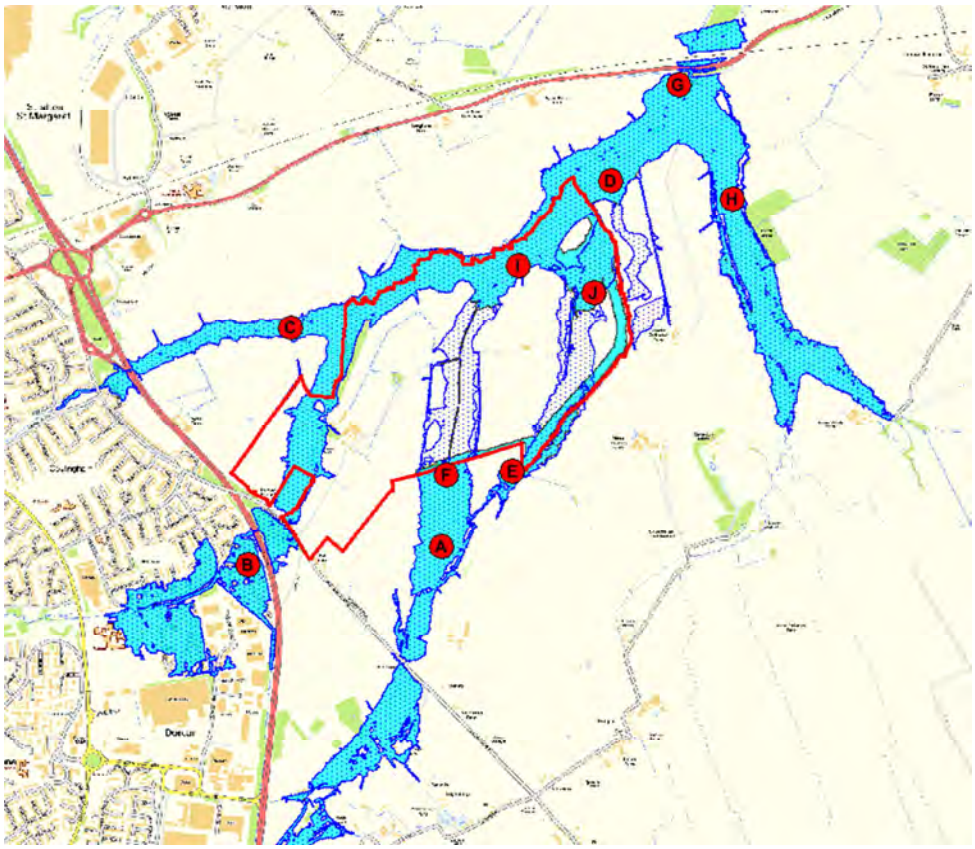


Figure 5: Location plan for levels in Table 1



Location Label	Difference in Flood Level between baseline and floodplain restoration scheme model
A (Liden Brook at preferential flow route upstream of site)	0.00m
B (Dorcan Stream upstream of site)	0.00m
C (River Cole upstream of site)	0.00m
D (River Cole downstream of confluence with Liden Brook)	0.00m
E (Liden Brook upstream of site)	-0.01m
F (Land Drain B at interceptor ditch)	0.00m
G (River Cole downstream of site at Acorn Bridge)	-0.01m
H (Lenta Brook downstream of site)	0.00m
I (River Cole floodplain on site)	0.00m
J (Floodplain restoration scheme on site)	0.08m

Table 1: Difference in modelled flood level at selected locations *(see Figure 5 for locations)*.

6.3 Sensitivity testing

6.3.1 No additional sensitivity testing was carried out within the model as sensitivity tests were undertaken for the base model provided by the EA. The details of the sensitivity testing undertaken are included in; Flood Mapping Study Volume 2: Hydraulic modelling report for the River Cole (August 2010).

6.3.2 The sensitivity testing undertaken in the EA modelling report included:

- Flow
- Channel Manning's n Roughness coefficients

- Floodplain Manning's n Roughness coefficients
- Channel and Structure Losses
- Downstream Boundary Conditions and;
- Blockages

6.3.3 The summary of the sensitivity testing undertaken on the original model concluded that the model was insensitive to changes to the floodplain roughness, downstream boundary condition, channel losses and structure losses. The model also demonstrated no disproportionate responses to changes in flow or blockages.

6.3.4 The model was considered to be robust and appropriate for our use. Our improvements and amendments to the model are not considered to invalidate any of the sensitivity testing previously undertaken. No further parameters were considered for sensitivity testing in the PBA modelling.

Appendix A Land Holding Location

LDĀDESIGN

PROJECT TITLE
EASTERN VILLAGES, SWINDON

DRAWING TITLE
Land Ownership Plan

DWG. NO3502_SK_001

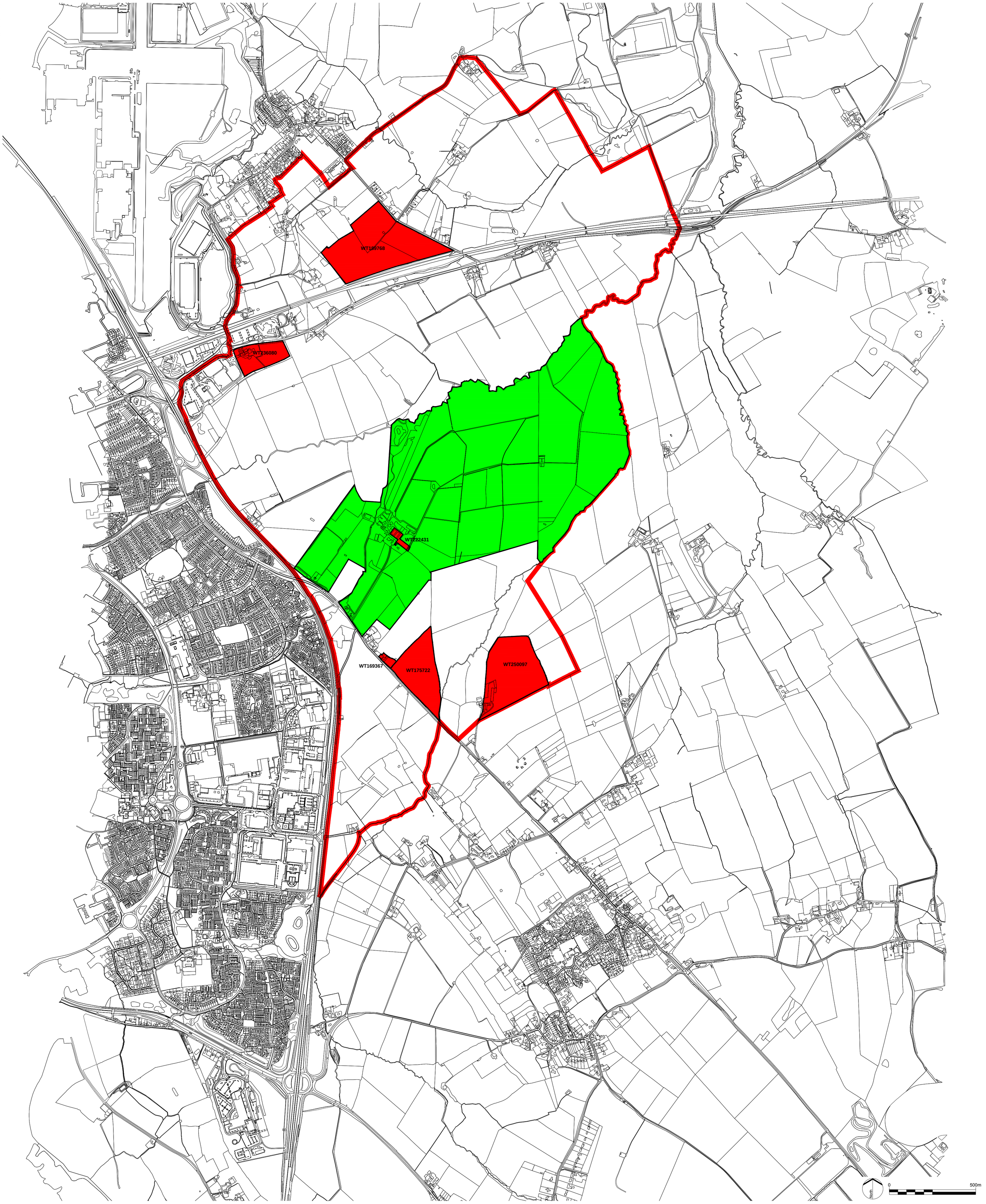
REV.	DESCRIPTION	APP.	DATE
A	Minor amendments	ChC	24/01/1□

ISSUED BY	Peterborough	T: 017□□ □10471	
DATE	17 □an 201□	DRAWN	MEv
SCALE@A1	1:10,000	CHECKED	ChC
STATUS	Preliminary	APPROVED	ChC

No dimensions are to be scaled from this drawing.
All dimensions are to be checked on site.
Area measurements for indicative purposes only.

Sources Ordnance Survey

□□O S:□502 SWINDON 7CAD DRAWINGS□502 S□ 001.DWG



LEGEND

- Ainscough landholding
- HM Land Registry titles □where plans available□ - refer to schedule for details
- Extent of Eastern Villages SUE