Appendix A

Supporting Documentation

SOMERSET COUNTY COUNCIL

SWMP ENGAGEMENT PLAN

Reference

Date

20 August 2010

CONTENTS

1 INTRODUCTION

1.1 Purpose

The purpose of this engagement strategy is to improve how Somerset County Council consults and involves citizens and other stakeholders in decision making, and to ensure that their views are used to develop a targeted and appropriate surface water management plan (SWMP) for the Taunton and Minehead areas. This Engagement Plan sets out clear objectives, principles, standards and an action plan for consultation and engagement.

Relationship to other Council operations/engagement strategies?

1.2 Aims

This Engagement Plan aims to:

- to highlight how the engagement of stakeholders will take place in the development of the SWMP
- to identify ways in which the findings of the SWMP can be communicated
- to identify, prior to commencing the project, how all interested parties can be involved in assessing and providing feedback on the SWMP
- to ensure that we make the most of the resources we have

2 CONTEXT

The Summer 2007 floods provided clear evidence that intense rainfall events can occur anywhere, highlighting the need for all those involved in flood risk management to work in partnership to improve the understanding and management of flood risk in urban areas. This need is outlined in the Pitt Report[1] which concludes that

> ‘there is a distinct lack of clarity around the responsibilities of the relevant organisations, resulting in frustration for the public and emergency responders’.

Recommendation 15 of the Pitt Review recommends that ‘Local authorities should positively tackle local problems of flooding by working with all relevant parties, establishing ownership and legal responsibility’.

Sir Michael Pitt also recommended that SWMPs coordinated by local authorities should provide the basis for managing all local flood risk (Recommendation 18).

What this means for Somerset.

Policy

The Flood and Water Management Act 2010 received Royal Assent on 8 April 2010 and takes forward key recommendations from the Pitt Review. The Flood and Water Management Act 2010 and the Flood Risk Regulations 2009 support collaborative working and partnership arrangements and outline the need for Lead Local Flood Authorities (LLFAs) to lead on flood risk management.

Taken from Tender Brief:

SCC is preparing a Flood and Water Management Strategic Business Plan which is intended to provide clarity on the aims, objectives and policy direction of the Council and in turn fulfils the requirement to develop a local flood management plan.

The Plan is currently in draft form. It is intended to publish the Plan after Cabinet approval expected at the end of April 2010.

Notwithstanding, the Strategic Business Plan will be made available and should be referred to in the development of the SWMP to ensure consistency with policy and the strategic aims and objectives of the County Council.

Further context for Somerset

PPS25

PPS25 sets out the Government's national policies for flood risk management in a land use planning context within England.

PPS25 states that developers and local authorities should try to relocate existing development to land in zones with the lowest probability of flooding and to:

> *"reduce the flood risk to and from new development through location, layout and design, incorporating sustainable drainage systems (SUDS)".*

A sequential risk based approach to determine the suitability of land from development in flood risk areas is central to PPS25 and should be applied at all levels within the planning process.

SFRA info for SCC

Surface Water Management

Embedded within the DEFRA Surface Water Management Plan Technical Guidance (Mar 2010) are recommendations for engaging and working with partners. It also suggests that a' plan' is drawn up to engage with not only the SWMP partners but a wider stakeholder group including the community.

Local Flood Forums/Partnerships

Specific for Somerset

The Partnership – SCC, together with Taunton District Borough Council (TDBC), the Environment Agency (EA) and Wessex Water (WW)

3 COLLABORATIVE WORKING

3.1 Benefits

The anticipated benefits of collaborative working on the production of the two SWMPs for SCC include:

- Expertise sharing and innovation to avoid wasted effort and provide a measure of consistency in standards adopted and deliverables produced;
- Data sharing where source data is common and where there may be economies of scale;
- Overall cooperation between partners to ensure that effort is focused on delivery of quality project deliverables on time and to budget, and to promote cooperation between all the Partners. This will include:
  - Improvement in communication between SCC, Wessex Water and the Environment Agency;
  - Improvement in communication within SCC between the key departments who may be involved with monitoring, managing and planning for surface water; for example, Emergency Planners, Spatial Planners, Highways Engineers, Drainage Engineers, Parks and Open Spaces Planners;
  - A standardised way to record surface water flood events (SCC, Wessex Water and Environment Agency);

- A standardised way to record assets (as requirement under the Flood and Water Management Act, 2010) and maintenance regimes; and,
- A clear and transparent approach to the prioritisation of future flood risk investments through the use of a standardised 'prioritisation matrix' to determine where and when funding should be allocated.

- Others?

3.2 Ethos

Given the complex nature of surface water flooding which may have multiple sources and pathways, cross authoritative boundaries and be monitored or managed by multiple organisations, a partnership approach is the most efficient way to co-ordinate flood risk management activities within an area. The Defra guidance for surface water management[2] endorses collaborative working stating that 'Working in partnership is essential to achieving integrated and efficient mitigation measures where multiple organisations are involved.'

To achieve effective collaborative working it is essential to:

1 Create a partnering ethos with a mind set in each individual organisation and the boroughs to work together;

2 Engender a culture of trust between organisations where they are comfortable to cooperate rather than compete with each other; and,

3 Break down barriers between different organisations through good communication.

Anything additional for Somerset?

3.3 Approach

In order for the SWMPs to be successful, it is essential that the relevant partners and stakeholders, who share the responsibility for necessary decisions or actions, work collaboratively to understand existing and future surface water flood risk in Taunton and Minehead and to develop SWMPs and co-ordinated investments to reduce or avoid this risk.

The Partnership has been specifically set up to ensure that partners and stakeholders involved in flood risk management work collaboratively to develop SWMPs that are consistent across the areas of Taunton and Minehead.

Develop a hierarchy diagram

3.4 Obstacles

One of the key components of a shared understanding of flood risk is to anticipate potential barriers and obstacles to data sharing and collaborative working and identify pre-emptive mechanisms to overcome these barriers. To this end, summarised in Table 1 below are potential obstacles as well as proposed management solutions to overcome these obstacles.

No	Anticipated Obstacle	Proposed Management Solution	Lead / Support
1	Intellectual Property Rights		
2	Data Licensing		
3	Commercial sensitivity		
4	Lack of time / resource to provide data		
5	Lack of consultant		

	collaboration
	Others?

4 KEY AUDIENCES

Given the multiple sources and pathways of surface water flooding, multiple organisations need to be involved in the development of SWMPs. This engagement plan deals only with the management of communications and flows of information between the professional audiences who will be directly involved in the SWMPs for Taunton and Minehead.

The key audience groups for this project can be spilt into three levels:

Level 1 - Members of the SWMP delivery team:

- Somerset County Council
- Taunton Deane Borough Council
- Environment Agency
- Wessex Water
- Hyder Consulting

Level 2 - Key Technical Stakeholders:

- Network Rail
- Natural England
- Riparian owners
- Highways Agency
- British Waterways
- Developers or regeneration agencies
- Others

Level 2 - Key Community Stakeholders

- Local flood forums
- Local waterway management groups
- Flood victims

5 ROLES AND RESPONSIBILITIES

Building relationships is fundamental to the success of any engagement plan These relationships need to be based upon clearly defined tasks, roles, expectations and responsibilities in order that informed SWMPs for Taunton and Minehead are actualised.

The SWMP project is led by SCC with support from the Environment Agency, Taunton Dean Borough Council, Wessex Water and Hyder Consulting. The key roles and responsibilities of those involved in the Tier 1 project delivery team are set out below:

Agency	Contact	Role
SSC	Andrew Turner	Project PM

6 ENGAGEMENT PLAN

The following section sets out

6.1 Developing and Agreeing a MOU

To ensure that all Tier 1 Stakeholders involved in the SWMP project fulfil their responsibilities in the collaborative framework, a Memorandum of Understanding (MoU) has been developed which sets out the collaborative working requirements which will be expected of all parties.

A copy of the draft MoU document can be found in ?

Agreeing the Objectives

A key component of the MOU is agreement of the engagement objectives for

1. COMMITMENT TO COOPERATION

In this cross-boundary project, involving multiple partners and stakeholders, cooperation between all consultants is essential to ensure that effort is focused on the delivery of excellent quality project deliverables on time and to budget. This will also promote greater ongoing cooperation between all the stakeholders and partners in the long-term on the delivery of flood risk solutions for Taunton and Minehead area.

2. PROGRESS MEETINGS

A representative from each partner organisation will make themselves available to attend the initial project kick-off meeting and four subsequent gateway review meetings.

The initial meeting will be used to introduce the Project, agree these objectives and the overall deliverables and timescales for the Project. The subsequent gateway meetings will be used to review progress, any problems encountered and agree deliverables for the next phase.

All meetings will be held at the SCC. Any issues raised at the progress meetings will be dealt with through a formal process by the SCC.

3. MODELLING STANDARDS

All consultants working on the project will use Infoworks CS2D or ISIS-TuFLOW.

4. DATA SHARING

??

5.COMMUNITY ENGAGEMENT

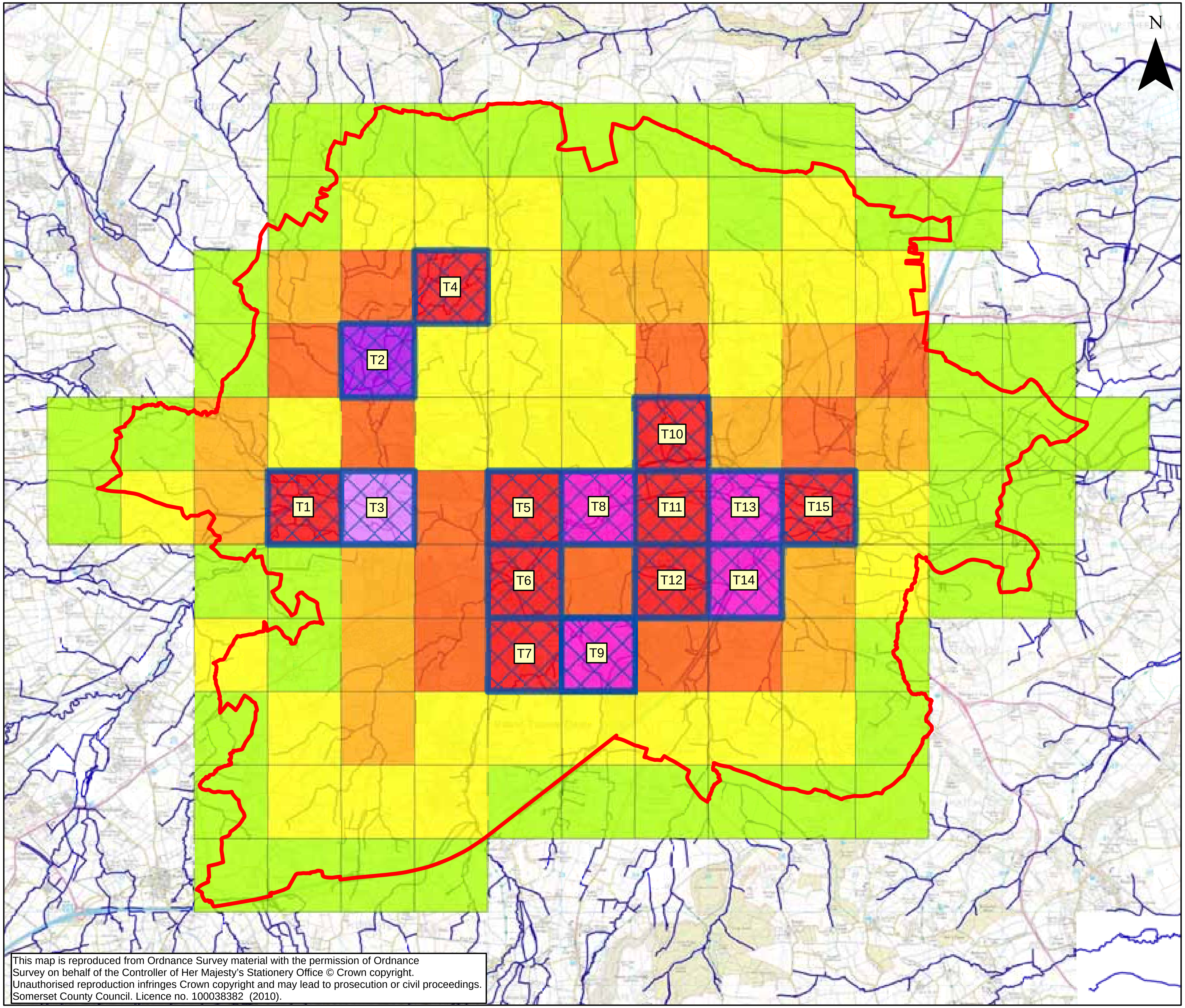
6.2 Performance Management

Key Performance Indicators

To be agreed

Appendix B

Area Prioritisation



Legend

Taunton SWMP Study Area

Further Study Boundaries

EvyDR Grid Calculations

Sum %

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80

Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	14 JUN11

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:50,000	Current Issue Signatures
		Author A.NIMMO
Original Size	A3	Checker R.BEHAN
Height Datum	mAOD	Approver B.SARGENT
Grid	OS	© Copyright reserved

Filename:

Client: SOMERSET County Council

Hyder

HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T3
PRELIMINARY DIRECT RAINFALL
GRID SQUARE CALCULATIONS

Drawing No.	Project No.	Issue
0234	UA001888	01

50mm on Original

V1

Flood Risk Constraints Mapping

Due to the potential for errors within Surface Water modelling, it is necessary to assess the areas against other sources of flooding to ensure that the Wetspots taken forward for detailed study are those at greatest risk and that any flood risk mitigation strategies respond to the inter-related flood risk issues.

The following assessment categories were used to summarise the surface water flood risk and other potential flood risks for the 5 areas identified in Taunton. A summary sheet for each of these squares is presented below and supporting information can be found in Appendix B.

Flood Constraint Mapping Assessment Categories

1. **Preliminary Direct Rainfall Model** – Percentage of Study Square Flooding, represented:

   a 4% AEP > 0.3m (Deep)

   b 0.5% AEP - 0.1m – 0.3m (Shallow)

   c 0.5% AEP > 0.3m (Deep)

Note: Where the extent of modelling has spilled onto the beach beyond the coastline, the grid square calculation does not take into account these points.

2 Areas Susceptible to Surface Water Flooding (ASTSWF) – Comparison to the Flood Map to Surface Water

3 **Fluvial** – Name of Watercourse(s) flooding where given

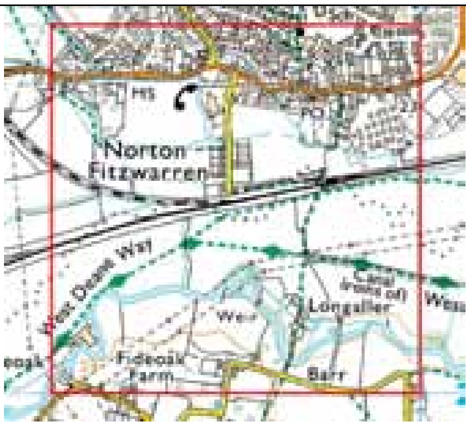
4 **Historic** – Count of number of incidents from Historic Flood Risk Register

5 **Sewer** – Count of 2% AEP Flood Volume Nodes from Wessex Model

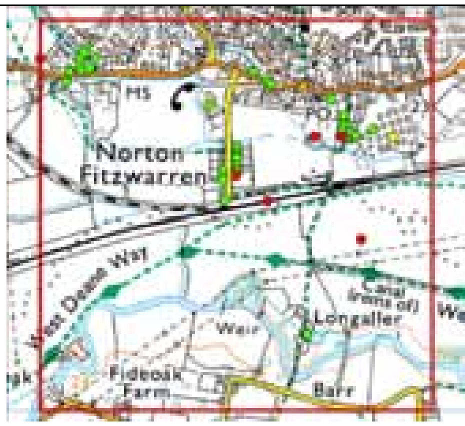
6 **Groundwater** – Yes or None

7 **Reservoir –** None, Intermediate, Major

1.1.1 Location T1



Site Area



Historic Flooding

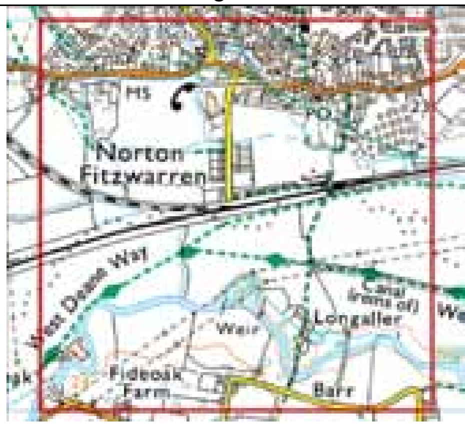
Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

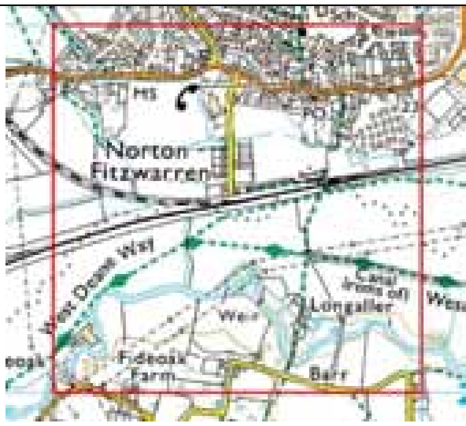
Flood Susceptibility



Wessex Sewer Flooding

Location T1

- Mixed urban & rural area, approximately 103 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Surface Water Flooding shown along parts of the London to Penzance main line.



1 Preliminary Direct Rainfall Model

A: 9% B:21% C:29%

2 Flood Map for Surface Water

Similar zones, reduced extent on northern side of railway.

3 ASTSWF

Similar zones, increased extent on southern side of railway.

4 Fluvial

River Tone, Norton Brook and numerous land drains.

5 Historic

8 Fluvial incidents reported, mostly from Halse Water overtopping its banks, 1 unknown pluvial source, 1 pluvial/fluvial source and 74 of unknown origin.

6 Sewer – 50yr Flood Volume

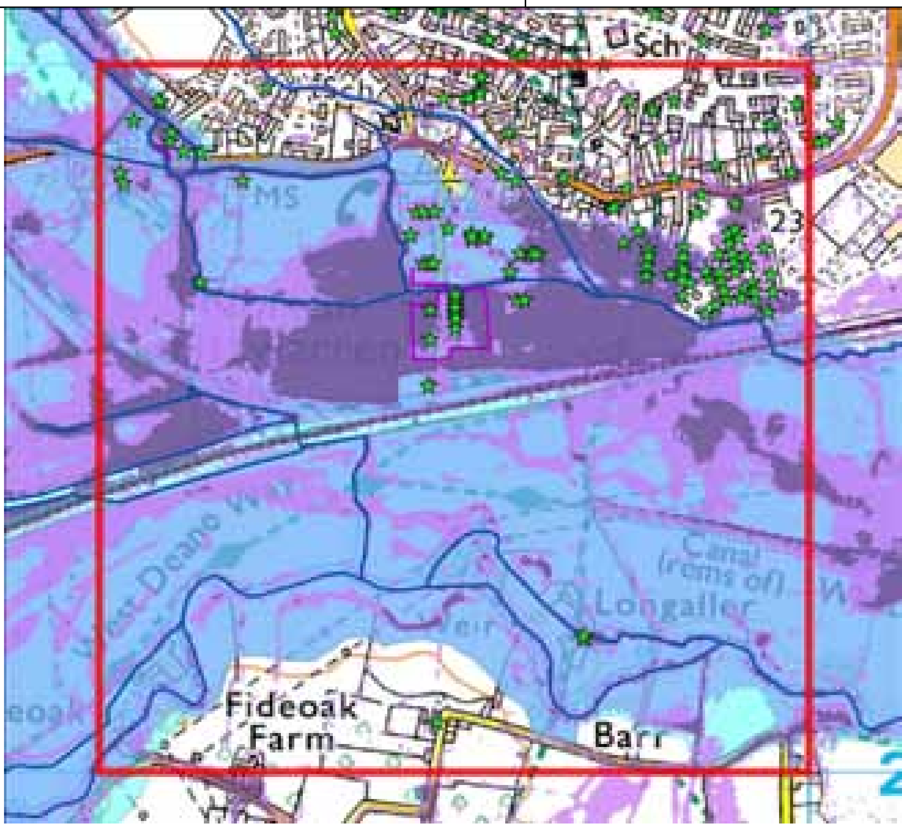
None

7 Reservoir

Intermediate

8 Canal

No record of overtopping or breach. No structures in vicinity



1.1.2 Location T2

Site Area

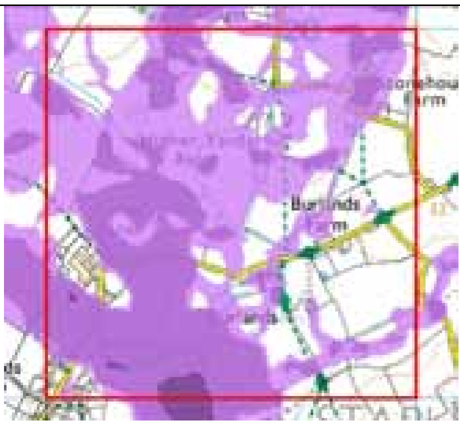
Historic Flooding


Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water


Reservoir Flooding


Flood Susceptibility

Wessex Sewer Flooding

Location T2

- Largely rural area, approximately 1 dwelling at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.

1 Preliminary Direct Rainfall Model

A: 18%   B:27%   C:29%

2 Flood Map for Surface Water

Similar zones, reduced extent of low level flooding.

3 ASTSWF

Similar zones slightly increased low level flooding.

4 Fluvial

Back Stream and numerous minor watercourses/Land Drains.

5 Historic

2 Fluvial incidents reported as flooding of the Back Stream, 1 of unknown origin.

6 Sewer – 50yr Flood Volume

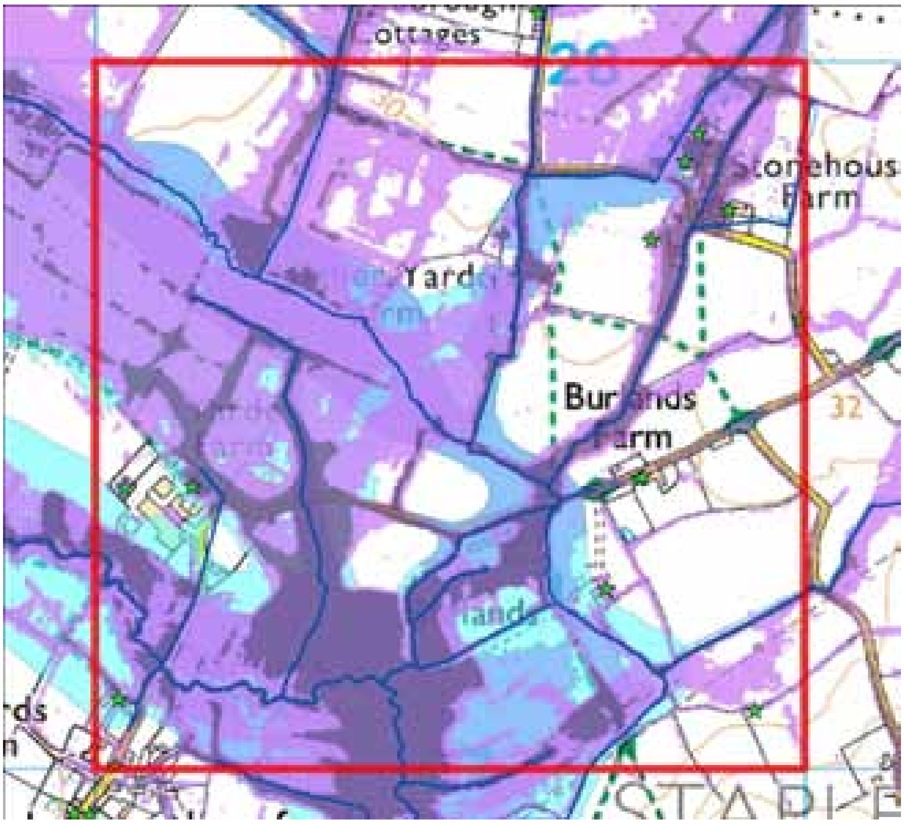
None

7 Reservoir

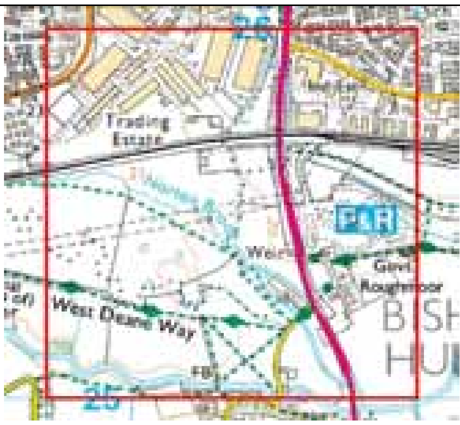
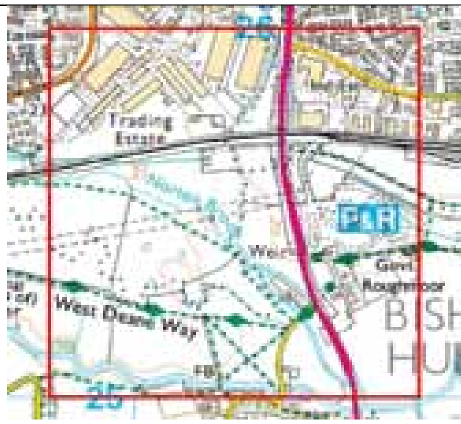
None

8 Canal

No record of overtopping or breach. No structures in vicinity.

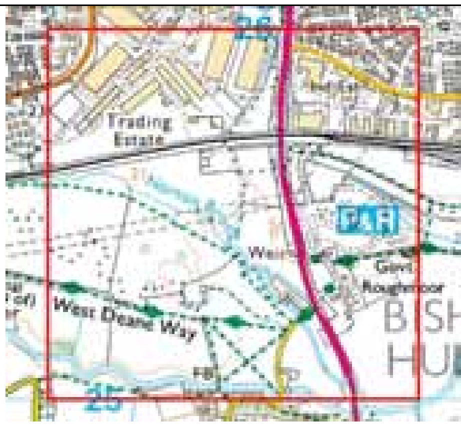


1.1.3 Location T3

 Site Area	 Historic Flooding
 Preliminary Direct Rainfall Modelling	 Fluvial Flood Risk and Defences
 Flood Map for Surface Water	 Reservoir Flooding
 Flood Susceptibility	 Wessex Sewer Flooding

Location T3

- Mixed Urban & Rural area, approximately 24 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Surface Water Flooding shown along parts of the Taunton Railway line.
- Surface water only flooding of the trading estates to the north of the London to Penzance main Line..



9 Preliminary Direct Rainfall Model

A: 11% B:34% C:18%

10 Flood Map for Surface Water

Similar zones, reduced extent of flooding near trading estate.

11 ASTSWF

Similar zones, greater extent of flooding along River Tone and increase flooding to east of A3065.

12 Fluvial

Norton Brook/River Tone.

13 Historic

18 Fluvial incidents reported as flooding of the River Tone, Halse Water and Back Stream, 1 pluvial, 1 pluvial/fluvial and 6 of unknown origin.

14 Sewer – 50yr Flood Volume

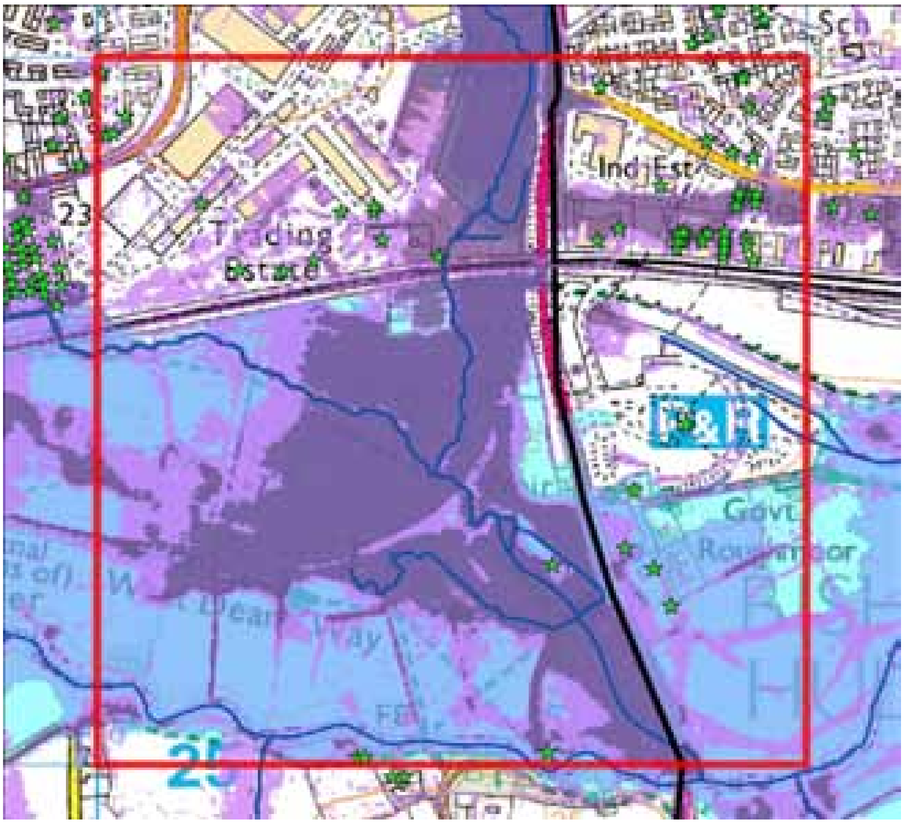
None

15 Reservoir

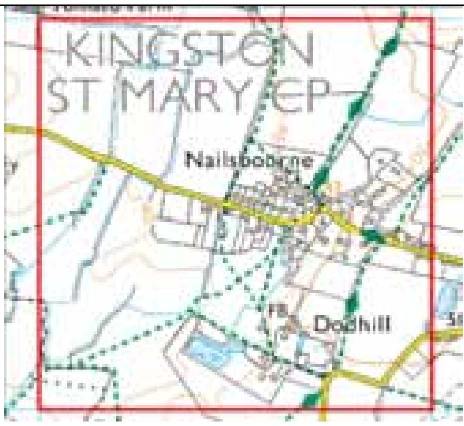
Intermediate

16 Canal

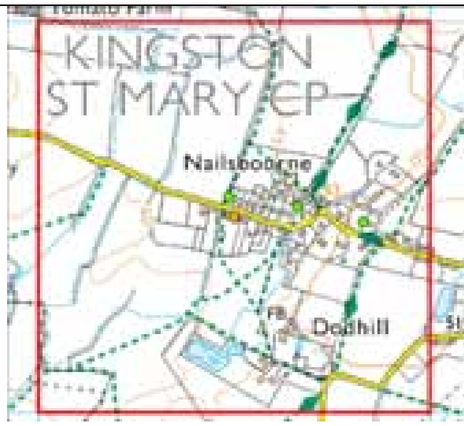
No record of overtopping or breach. No structures in vicinity.



1.1.4 Location T4



Site Area



Historic Flooding

Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

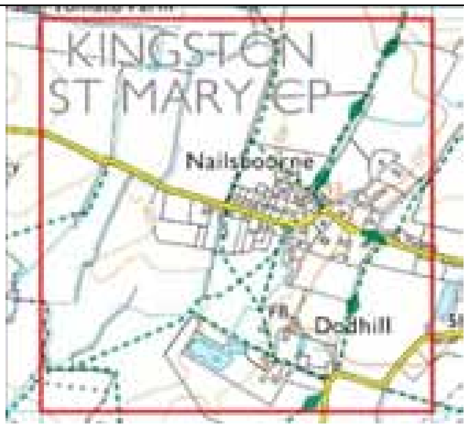
Reservoir Flooding

Flood Susceptibility

Wessex Sewer Flooding

Location T4

- Largely rural area, approximately 2 dwellings at risk of 200yr Shallow Flooding.
- Flooding of Pickney Lane may cause emergency access and egress problems for Nailsbourne.



17 Preliminary Direct Rainfall Model

A: 10% B:14% C:17%

18 Flood Map for Surface Water

Similar zones, reduced extent of low level flooding.

19 ASTSWF

Very similar zones and extent of flooding, slight increase in north east extent.

20 Fluvial

Unknown Stream running through Nailsbourne and numerous Land Drains.

21 Historic

1 pluvial/fluvial incidents reported as inadequate local drain to Back Stream and 3 of unknown origin.

22 Sewer – 50yr Flood Volume

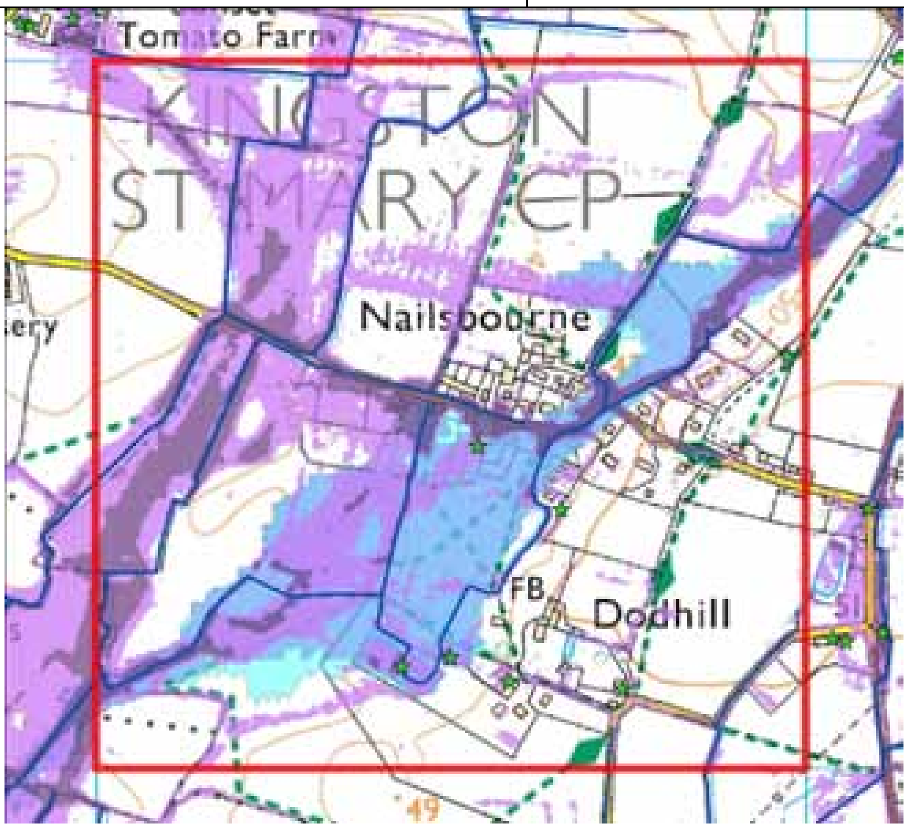
Yes - 1

23 Reservoir

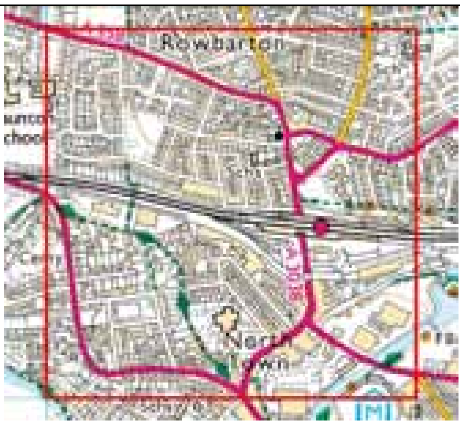
None

24 Canal

No record of overtopping or breach. No structures in vicinity



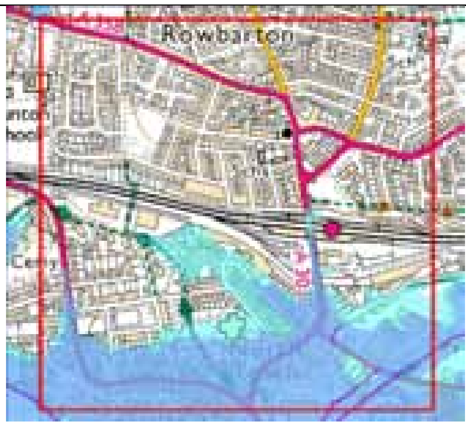
1.1.5 Location T5



Site Area

Historic Flooding

Preliminary Direct Rainfall Modelling

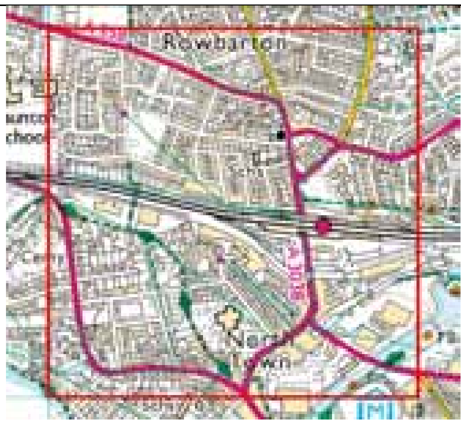


Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

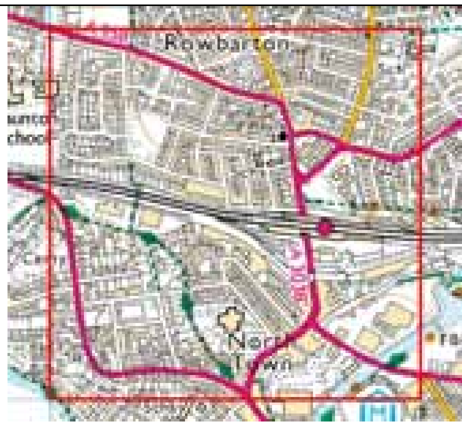
Flood Susceptibility



Wessex Sewer Flooding

Location T5

- Urban area, approximately 184 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue from the River Tone.
- Potentially surface water flooding at Priorswood Primary School, its grounds & the Northern Side of St Andrews C of E Primary School.
- 'Deep' flooding along lower section of Cheddon Road from Wedlands to the A3038.
- Surface Water Flooding shown along the London to Penzance main line and station.



25 Preliminary Direct Rainfall Model

A: 12% B:18% C:13%

26 Flood Map for Surface Water

Similar zones, reduced width of flooding

27 ASTSWF

Similar zones to south east but differences to west side and flow along southern edge of the railway.

28 Fluvial

River Tone to the South.

29 Historic

137 fluvial incidents largely reported as flooding from the River Tone, 1 pluvial flooding Chedder Road and 48 of unknown origin.

30 Sewer – 50yr Flood Volume

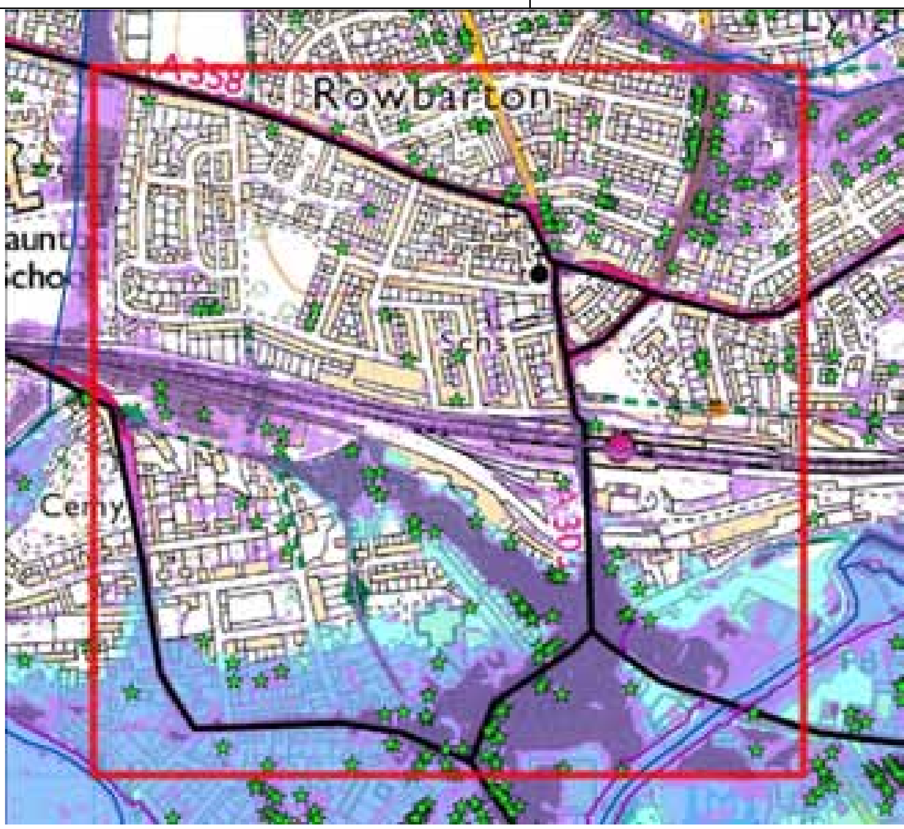
Yes - 3

31 Reservoir

Major

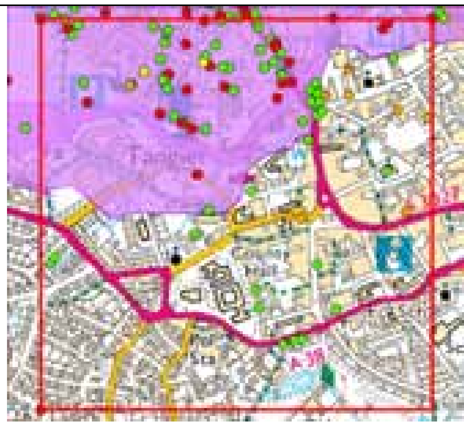
32 Canal

No record of overtopping or breach. No structures in vicinity.



1.1.6 Location T6

Site Area

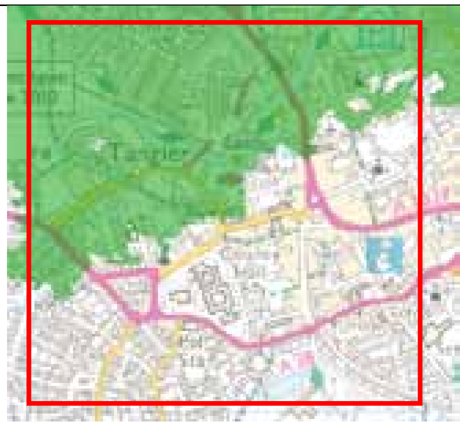


Historic Flooding

Preliminary Direct Rainfall Modelling

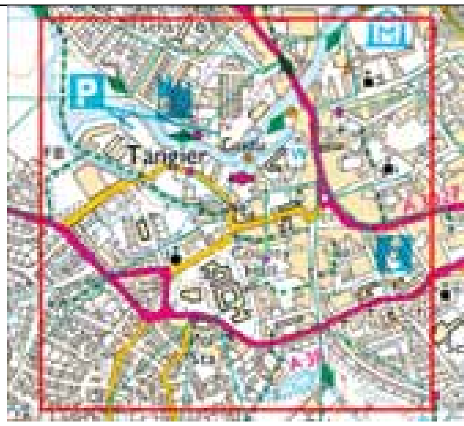
Fluvial Flood Risk and Defences

Flood Map for Surface Water



Reservoir Flooding

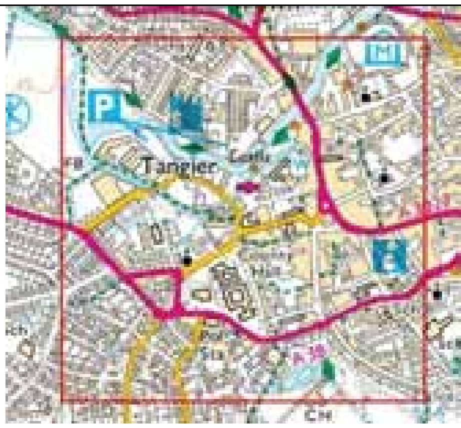
Flood Susceptibility



Wessex Sewer Flooding

Location T6

- Urban area, approximately 314 dwellings at risk of 200yr Shallow Flooding.
- Surface water only flooding of Wood Street and Yarde Place to the north involving 'Deep' flooding.
- Flooding to County Hall ground and buildings indicated.



33 Preliminary Direct Rainfall Model

A: 12%   B:20%   C:17%

34 Flood Map for Surface Water

Similar zones, reduced extent around county hall and south of the A38.

35 ASTSWF

Large increase in flooding in north west corner and along watercourses.

36 Fluvial

River Tone, Gaol Stream and the Galmington Stream.

37 Historic

365 Fluvial incidents of flooding from the River Tone, 9 pluvial relating to blockage and structure failures, 2 pluvial/fluvial and 68 of unknown origin

38 Sewer – 50yr Flood Volume

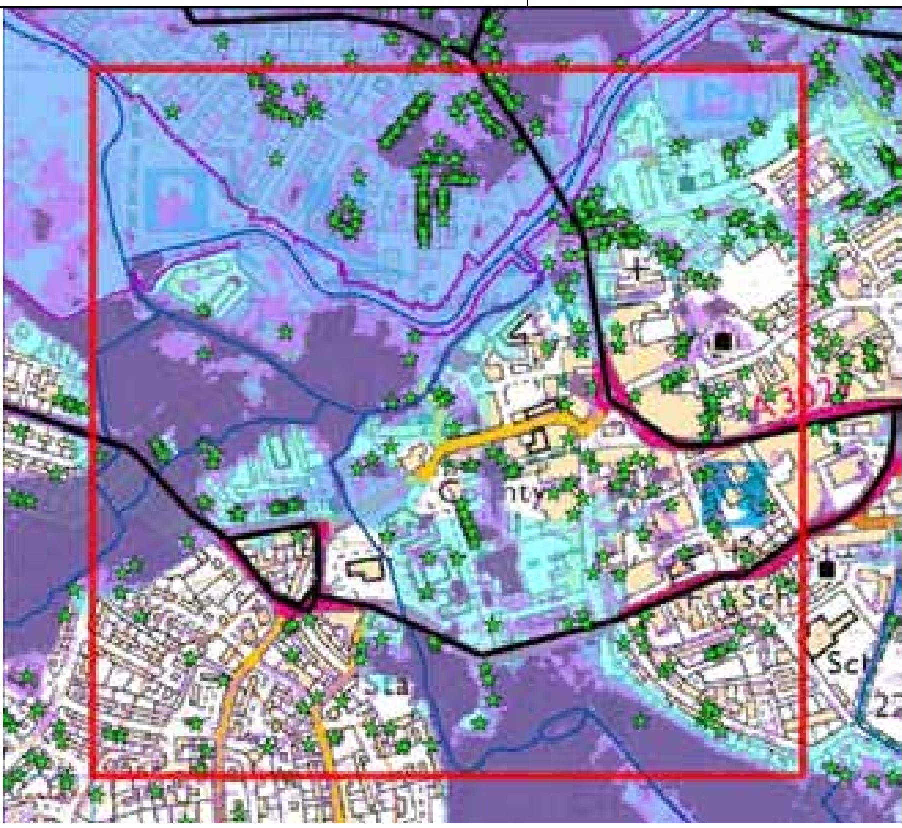
Yes - 9

39 Reservoir

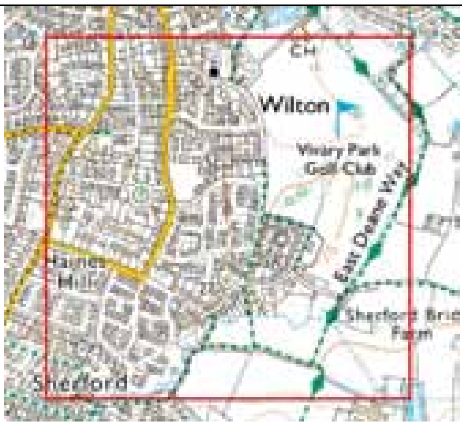
Major

40 Canal

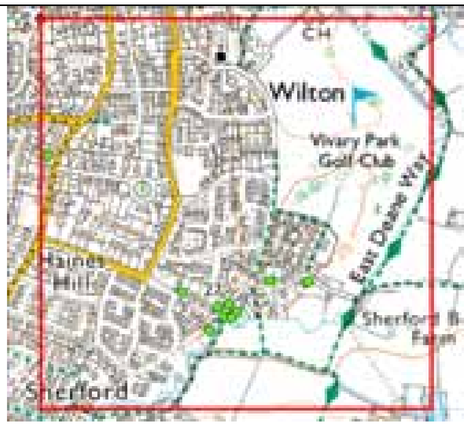
No record of overtopping or breach. 2 french weirs and at least 2 sluices within vicinity.



1.1.7 Location T7



Site Area



Historic Flooding

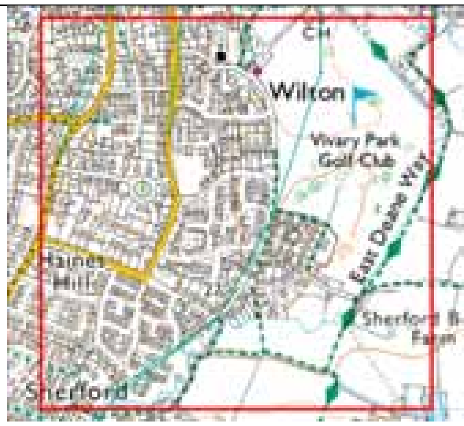
Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

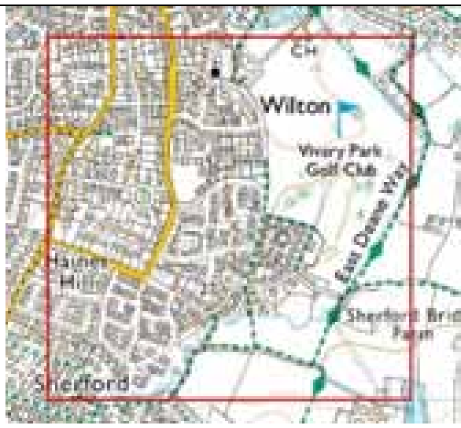
Flood Susceptibility



Wessex Sewer Flooding

Location T7

- Largely urban area, approximately 187 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Minor areas of surface water only flooding across the Wilton/Sherford area.



41 Preliminary Direct Rainfall Model

A: 10% B:18% C:19%

42 Flood Map for Surface Water

Slight decrease in flood extent but similar flood routing.

43 ASTSWF

Similar zones but increased widths of flooding.

44 Fluvial

Sherford Stream.

45 Historic

15 incidents of unknown origin.

46 Sewer – 50yr Flood Volume

Yes - 1

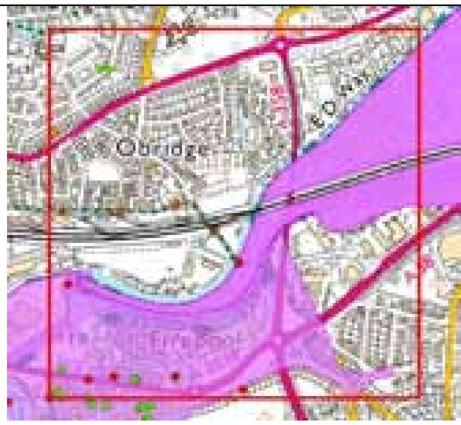
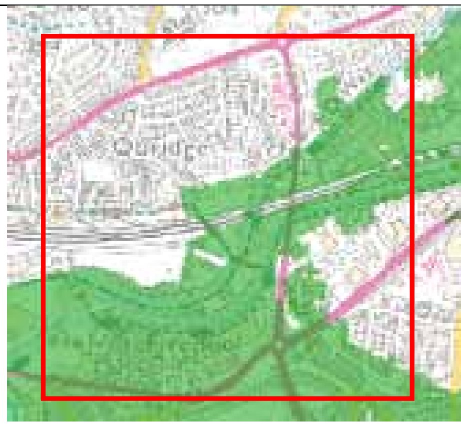
47 Reservoir

None

48 Canal

No record of overtopping or breach. 1 lock, 7 sluices and 3 weirs within vicinity.

1.1.8 Location T8

 Site Area	 Historic Flooding
 Preliminary Direct Rainfall Modelling	 Fluvial Flood Risk and Defences
 Flood Map for Surface Water	 Reservoir Flooding
 Flood Susceptibility	 Wessex Sewer Flooding

Location T8

- Urban area, approximately 248 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue from the River Tone and the Bridgwater and Taunton Canal.
- Surface Water Flooding shown along A38, A358, A3038 & A3259.
- Surface Water Flooding shown along the whole length of the London to Penzance main line.
- Significant Surface Water Flooding Grange Drive & Grange Road housing estate.

49 Preliminary Direct Rainfall Model

A: 16% B:25% C:17%

50 Flood Map for Surface Water

Similar zones, reduced extents in north east corner.

51 ASTSWF

Largely similar areas but increase in flooding along watercourses and Firepool area.

52 Fluvial

River Tone & Bridgwater and Taunton Canal.

53 Historic

199 Fluvial incidents along southern side of River Tone, 2 pluvial relating to highway flooding and blockage, 1 pluvial/fluvial at Baldwin/Lambrook Road and 11 of unknown origin.

54 Sewer – 50yr Flood Volume

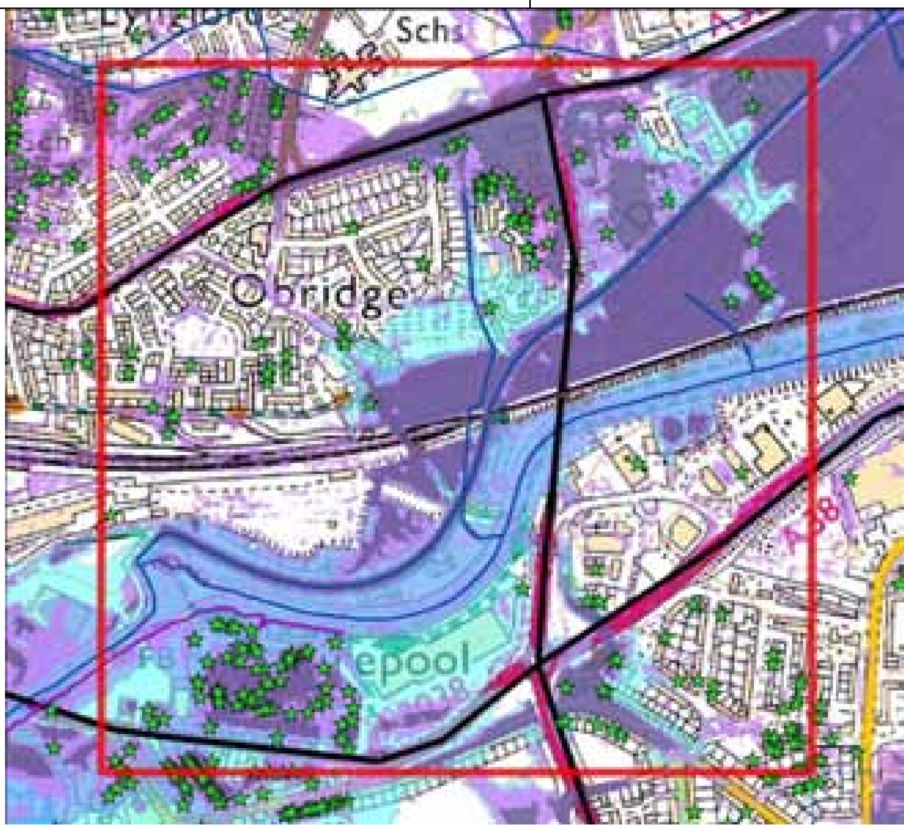
Yes - 1

55 Reservoir

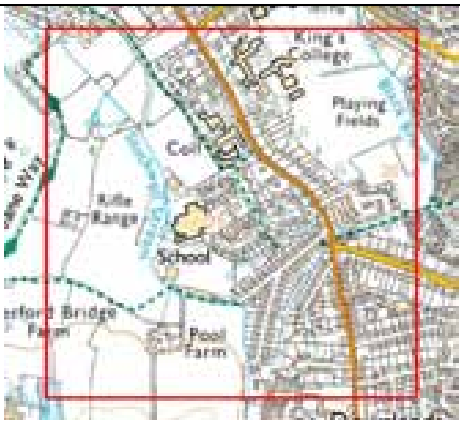
Major

56 Canal

No record of overtopping or breach. No structures in vicinity.



1.1.9 Location T9



Site Area

Historic Flooding

Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

Flood Susceptibility

Wessex Sewer Flooding

Location T9

- Largely urban area, approximately 146 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue from the Blackbrook & Stockwell Stream.
- Potential Surface Water Flood Risk to Richard Huish College and Kings College.

57 Preliminary Direct Rainfall Model

A: 13% B:19% C:20%

58 Flood Map for Surface Water

Similar zones, reduced flooding in Kings College grounds and Bishops Fox Community School.

59 ASTSWF

Very Similar zones and extents.

60 Fluvial

Sherford Stream, Stockwell Stream and the Blackbrook.

61 Historic

3 fluvial incidents, 1 of which is reported as from the Blackbrook and 5 of unknown origin.

62 Sewer – 50yr Flood Volume

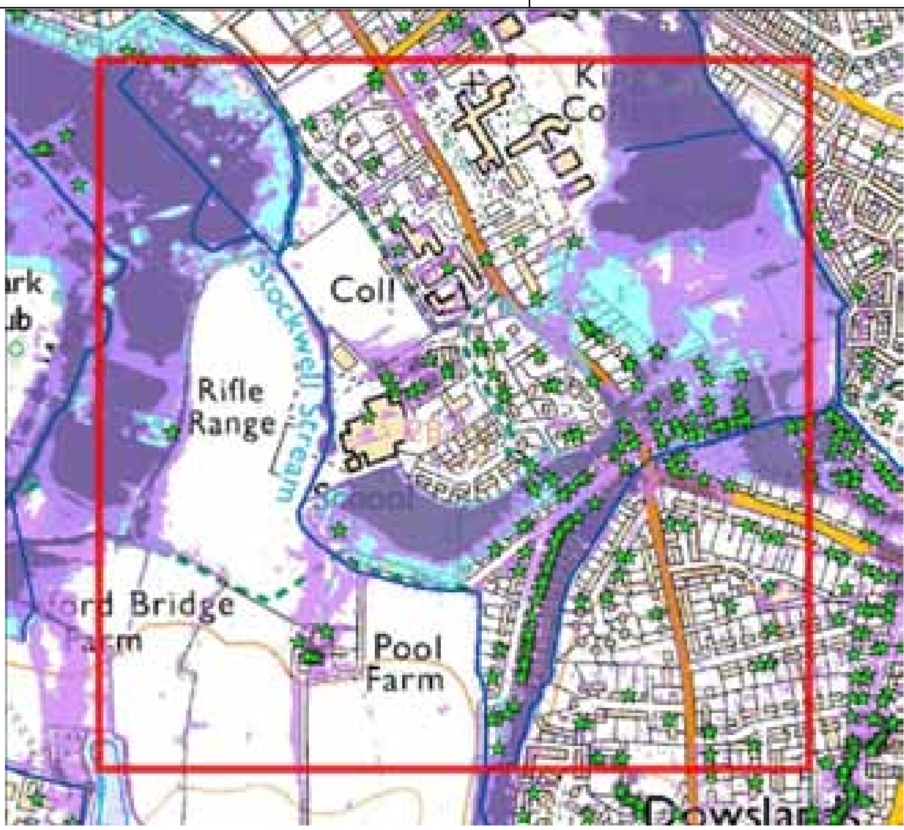
Yes - 2

63 Reservoir

None

64 Canal

No record of overtopping or breach. No structures in vicinity.



1.1.10 Location T10

Site Area

Historic Flooding

Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water


Reservoir Flooding

Flood Susceptibility

Wessex Sewer Flooding

Location T10

- Mixed urban & rural area, approximately 88 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Surface water flooding of the A3259 which a major road exiting the north east of Taunton.
- Surface water flooding only of parts of Maidenbrook near Cranes Close.

65 Preliminary Direct Rainfall Model

A: 16% B:20% C:8%

66 Flood Map for Surface Water

Similar zones, reduced width of flooding along stream adjacent to Maidenbrook lane.

67 ASTSWF

Very similar zones, slight increase at Priory Way to the south west.

68 Fluvial

Kingston Stream, Bridgwater and Taunton Canal, Allen's Brook and numerous Land Drains

69 Historic

3 fluvial incidents likely from the River Tone and 3 of unknown origin.

70 Sewer – 50yr Flood Volume

None

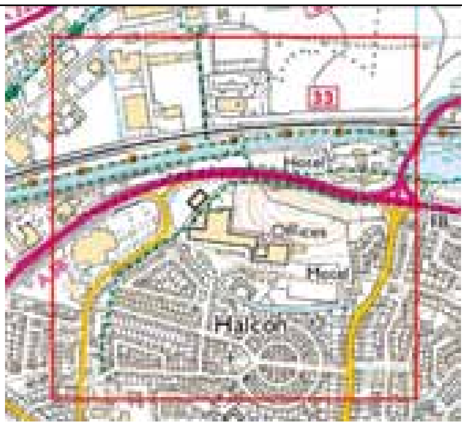
71 Reservoir

Intermediate

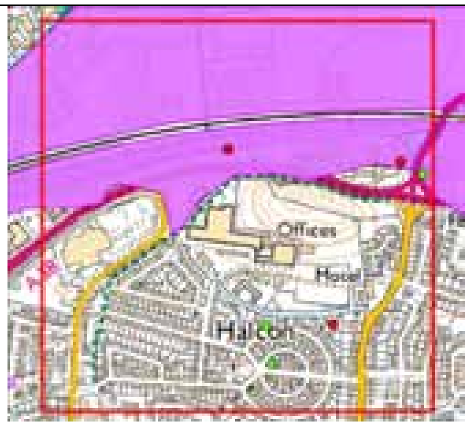
72 Canal

No record of overtopping or breach. No structures in vicinity.

1.1.11 Location T11



Site Area



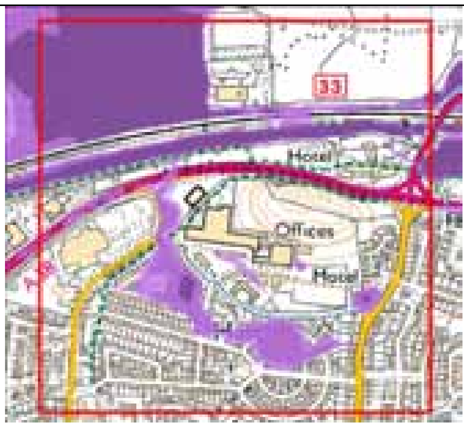
Historic Flooding

Preliminary Direct Rainfall Modelling

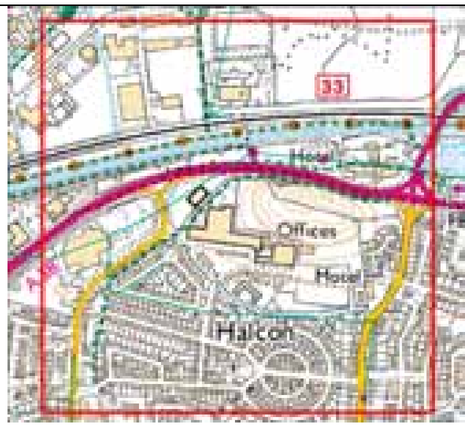
Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding



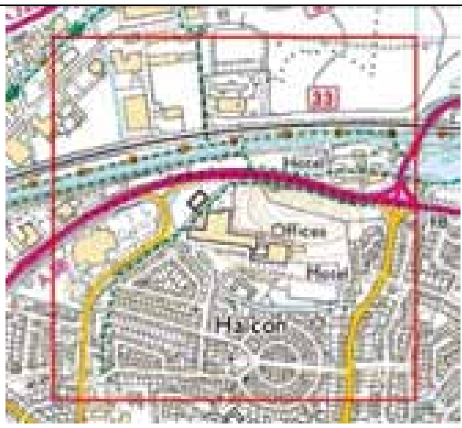
Flood Susceptibility



Wessex Sewer Flooding

Location T11

- Urban area, approximately 192 dwellings at risk of 200yr Shallow Flooding.
- Surface water only flooding of commercial and residential properties.
- Surface water only flooding across the A38.



73 Preliminary Direct Rainfall Model

A: 14% B:19% C:12%

74 Flood Map for Surface Water

Similar zones, reduced extent of flooding to commercial units on south side of Venture Way.

75 ASTSWF

Very Similar zones, increased flooding shown along River Tone.

76 Fluvial

River Tone, River Tone Relief and Drains.

77 Historic

None

78 Sewer – 50yr Flood Volume

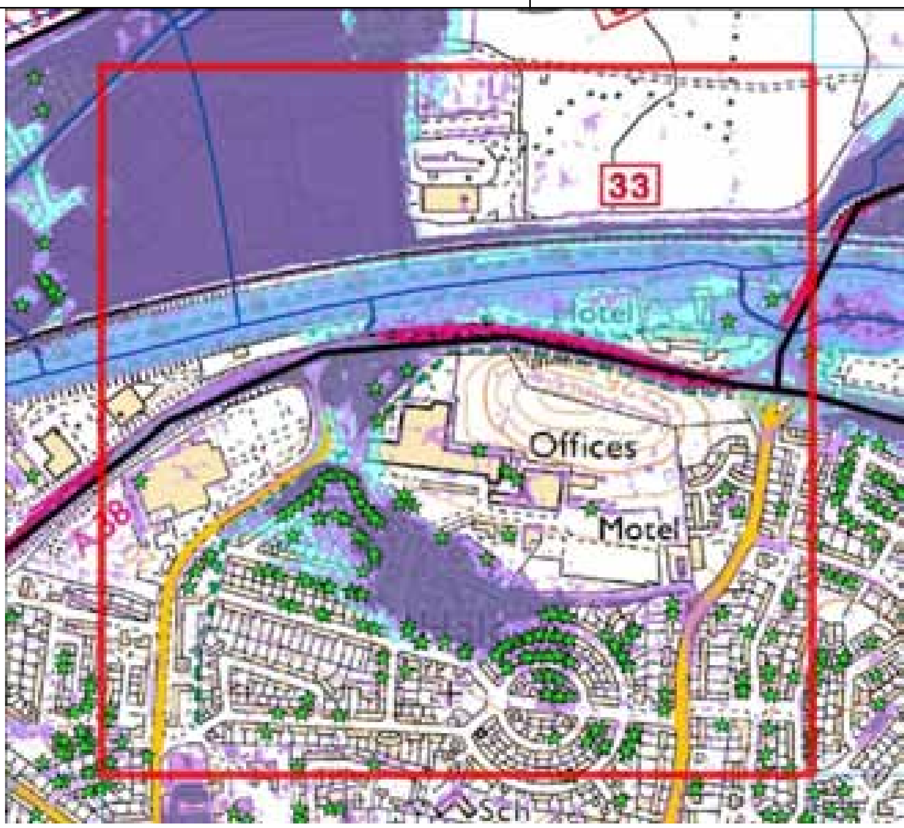
Yes - 4

79 Reservoir

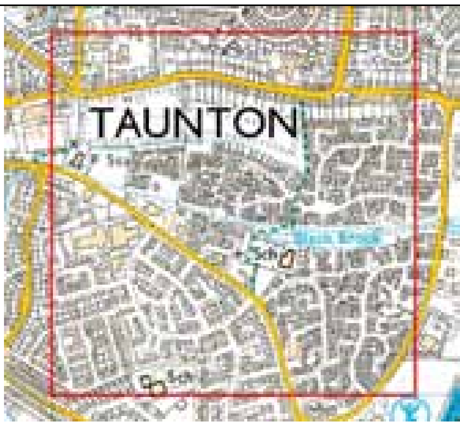
Major

80 Canal

No record of overtopping or breach. No structures in vicinity.



1.1.12 Location T12



Site Area

Historic Flooding

Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

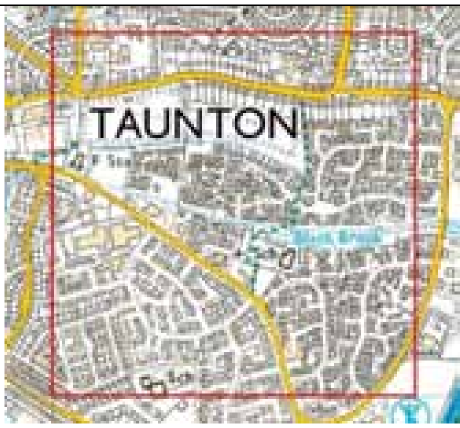
Flood Map for Surface Water

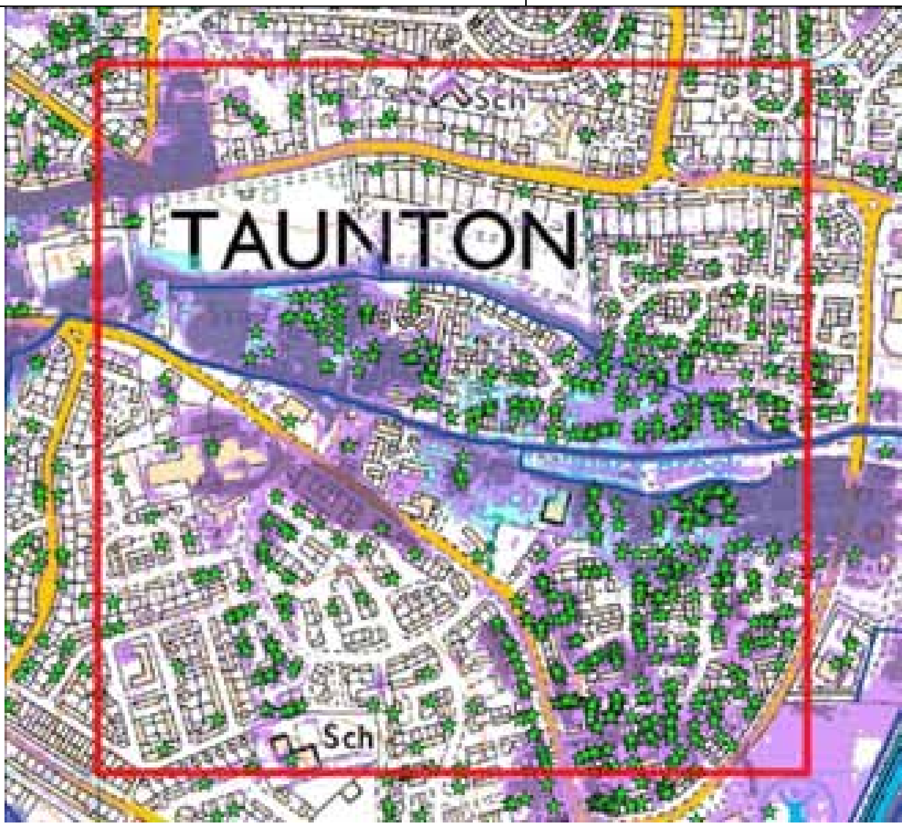
Reservoir Flooding


Flood Susceptibility

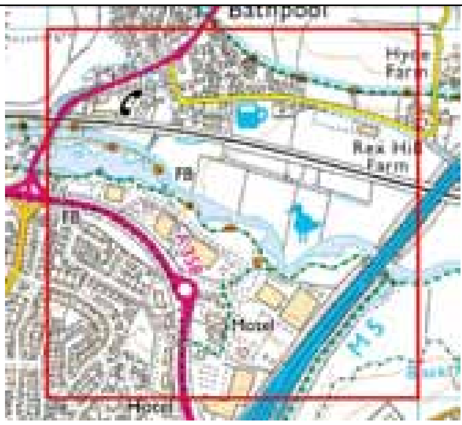
Wessex Sewer Flooding

Location T12

▪ Urban area, approximately 578 dwellings at risk of 200yr Shallow Flooding. ▪ Surface water only flooding of parts of Liseux Way, Ashbourne Crescent and Redlake Drive affecting numerous properties.	
81 Preliminary Direct Rainfall Model A: 5% B:13% C:25% **82 Flood Map for Surface Water** Greatly reduced zones, lesser extent of low level flooding. **83 ASTSWF** Similar zones, increased density of flooding to residential areas. **84 Fluvial** Blackbrook and 2 Drains.	**85 Historic** 1 of unknown origin at Redlake Drive. **86 Sewer – 50yr Flood Volume** None **87 Reservoir** Major **88 Canal** No record of overtopping or breach. No structures in vicinity.

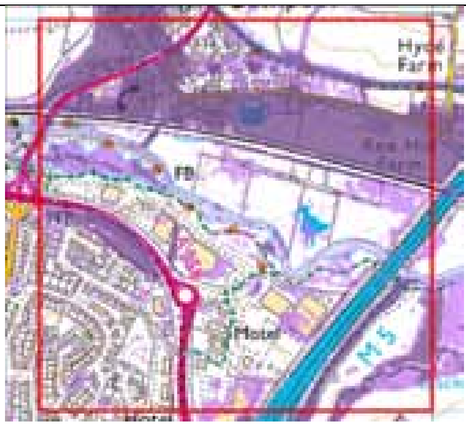


1.1.13 Location T13



Site Area

Historic Flooding



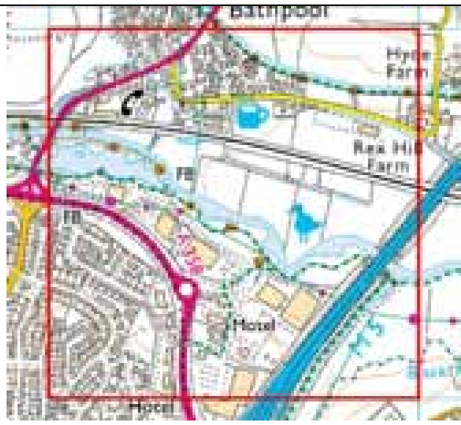
Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

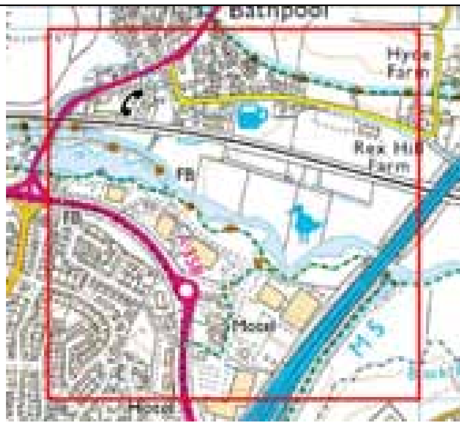
Flood Susceptibility



Wessex Sewer Flooding

Location T13

- Mixed urban & rural area, approximately 92 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Surface water flooding of the A358.



89 **Preliminary Direct Rainfall Model**

A: 17% B:23% C:15%

90 **Flood Map for Surface Water**

Similar zones, reduced extent and depth north of the railway line.

91 **ASTSWF**

Similar zones, increased flooding shown south of the railway line and along the River Tone.

92 **Fluvial**

River Tone, Broughton Brook, Blackbrook, Bridgwater and Taunton Canal, Kingston Stream and Drains.

93 **Historic**

21 fluvial incidents largely reported as from the River Tone, 3 pluvial due to inadequate capacity and blockage, 2 pluvial/fluvial reported in the vicinity of Bridgewater Road and 57 of unknown origin.

94 **Sewer – 50yr Flood Volume**

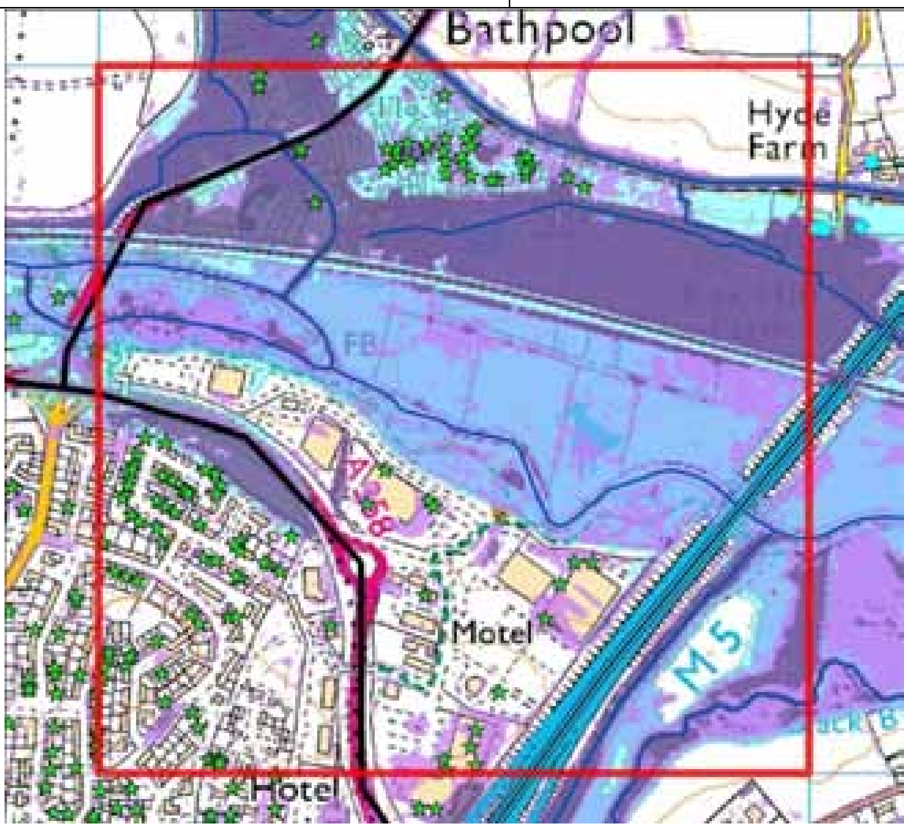
Yes - 8

95 **Reservoir**

Intermediate

96 **Canal**

No record of overtopping or breach. 1 sluice controlling Towpath Culvert 45.



1.1.14 Location T14

Site Area

Historic Flooding

Preliminary Direct Rainfall Modelling

Fluvial Flood Risk and Defences

Flood Map for Surface Water

Reservoir Flooding

Flood Susceptibility

Wessex Sewer Flooding

Location T14

- Largely urban area, approximately 56 dwellings at risk of 200yr Shallow Flooding.
- Flooding appears to be part of a larger fluvial flooding issue.
- Surface water only flooding of parts of Blackbrook Way and Blackbrook Park Avenue.

97 Preliminary Direct Rainfall Model

A: 14% B:24% C:18%

98 Flood Map for Surface Water

Similar zones, reduced extent and depth east of M5.

99 ASTSWF

Largely similar zones, but with reduced extent to south west of the M5.

100 Fluvial

Blackbrook, Broughton Brook and land drains.

101 Historic

2 of unknown origin, likely source being the Blackbrook.

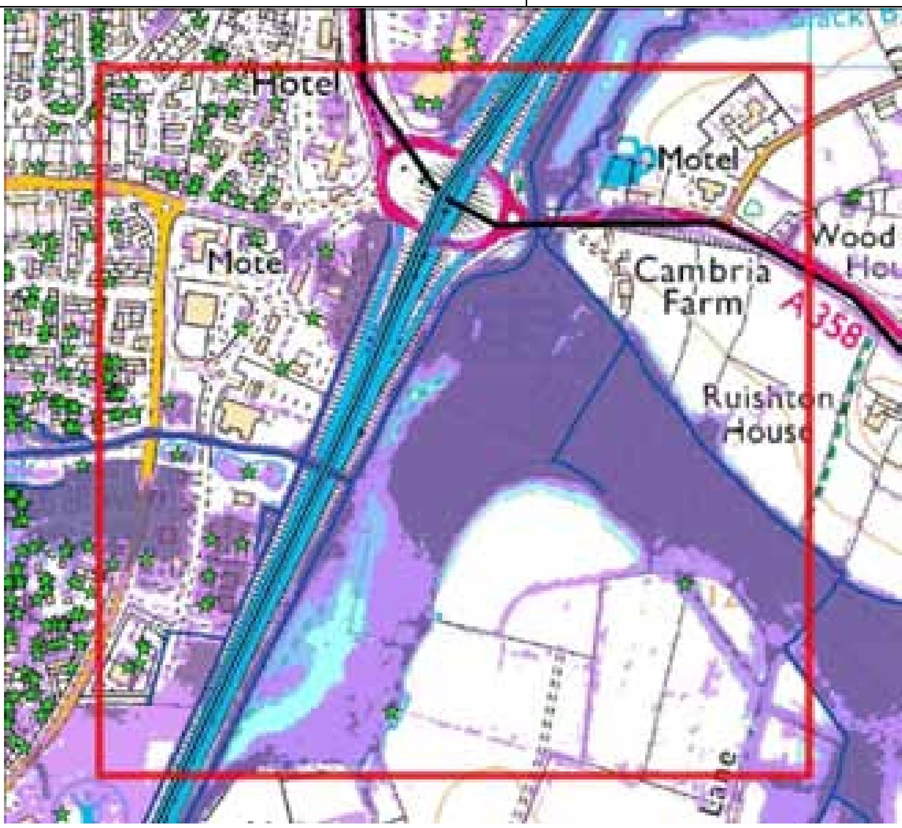
102 Sewer – 50yr Flood Volume

Yes - 7

103 Reservoir

Intermediate

104 Canal



1.1.15 Location T15


Site Area


Historic Flooding


Preliminary Direct Rainfall Modelling


Fluvial Flood Risk and Defences


Flood Map for Surface Water


Reservoir Flooding


Flood Susceptibility


Wessex Sewer Flooding

Location T15

- Largely rural area, approximately 6 dwellings at risk of 200yr Shallow Flooding.
- Surface water flooding of the M5 to the north.

105 Preliminary Direct Rainfall Model

A: 7% B:22% C:18%

106 Flood Map for Surface Water

Greatly reduced extent to the north of the railway and south the River Tone.

107 ASTSWF

Similar zones, increased extent north of the River Tone and along the Blackbrook.

108 Fluvial

River Tone, Blackbrook, Bridgwater and Taunton Canal and numerous Land Drains.

109 Historic

8 fluvial incidents, 1 of which is reported as flooding from the Canal, 3 pluvial due to inadequate road drainage and ditches, 1 pluvial/fluvial reported around the M5 and 38 of unknown origin.

110 Sewer – 50yr Flood Volume

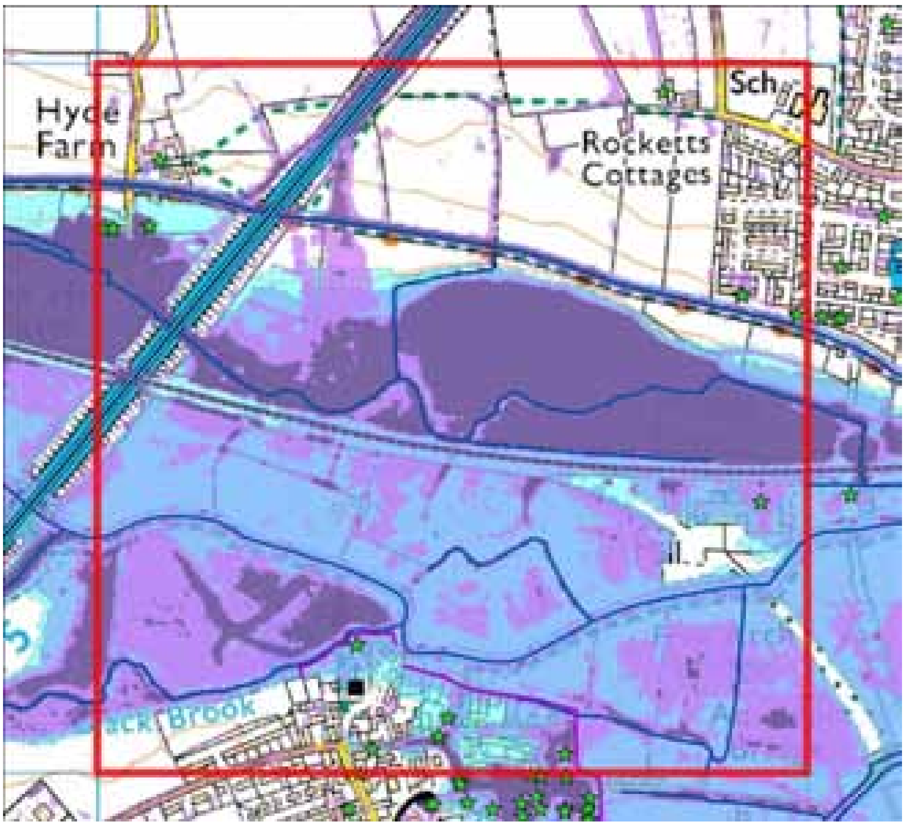
Yes - 1

111 Reservoir

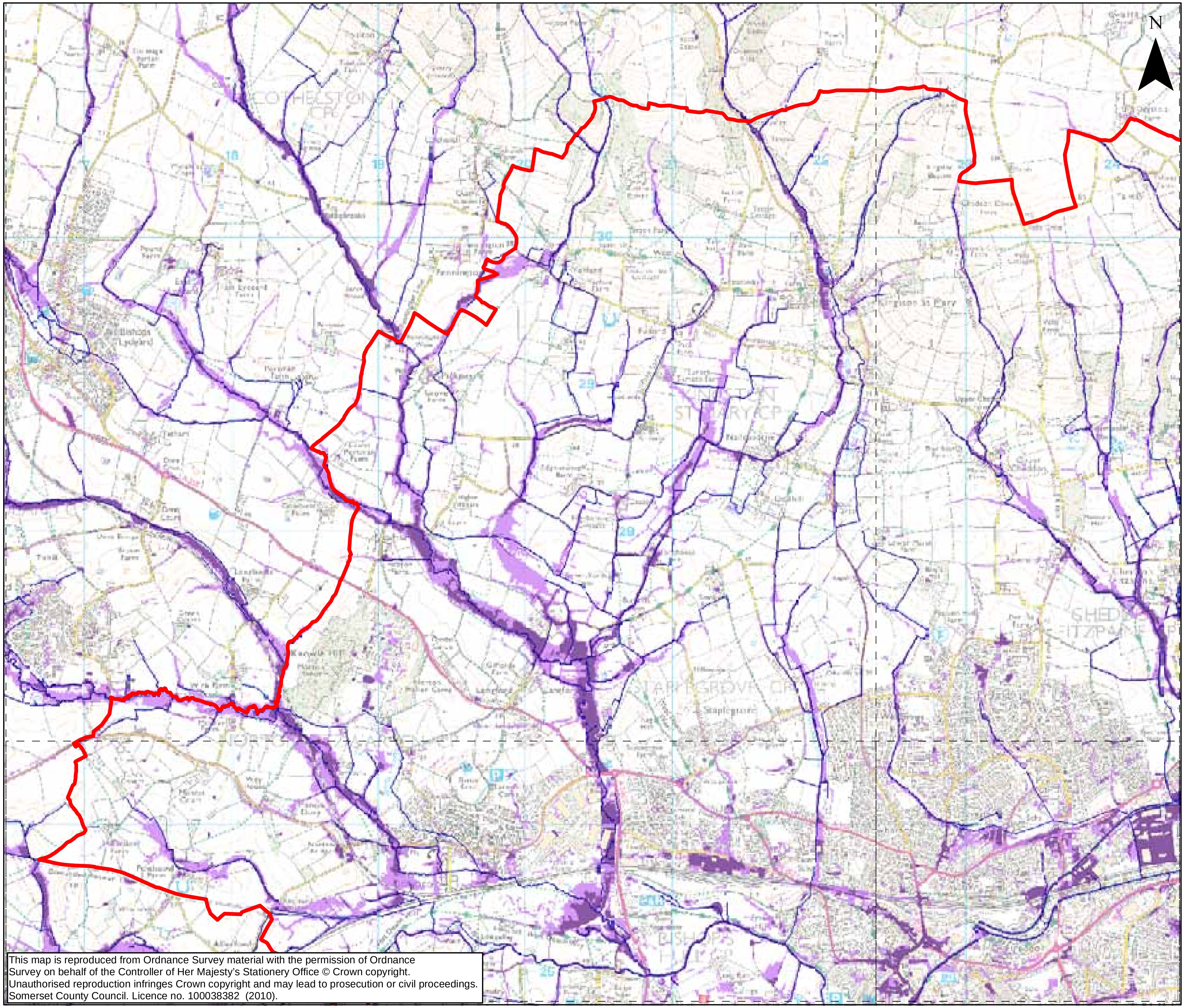
Intermediate

112 Canal

No record of overtopping or breach. No structures in vicinity.



Mapping



Legend

- Taunton SWMP Study Area
- Detailed River Network
- FMfSW-200yr > 0.3m (Deep)
- FMfSW-200yr > 0.1m (Shallow)

Issue	Description	Date
01	FOR INFORMATION	18FEB11

Status: FOR INFORMATION
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Scales	1:25,000	Current Issue Signatures	
		Author A.NIMMO	
Original Size	A3	Checker R.BEHAN	
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England
EX2 5AZ

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Fax: +44 (0)870 000 3912

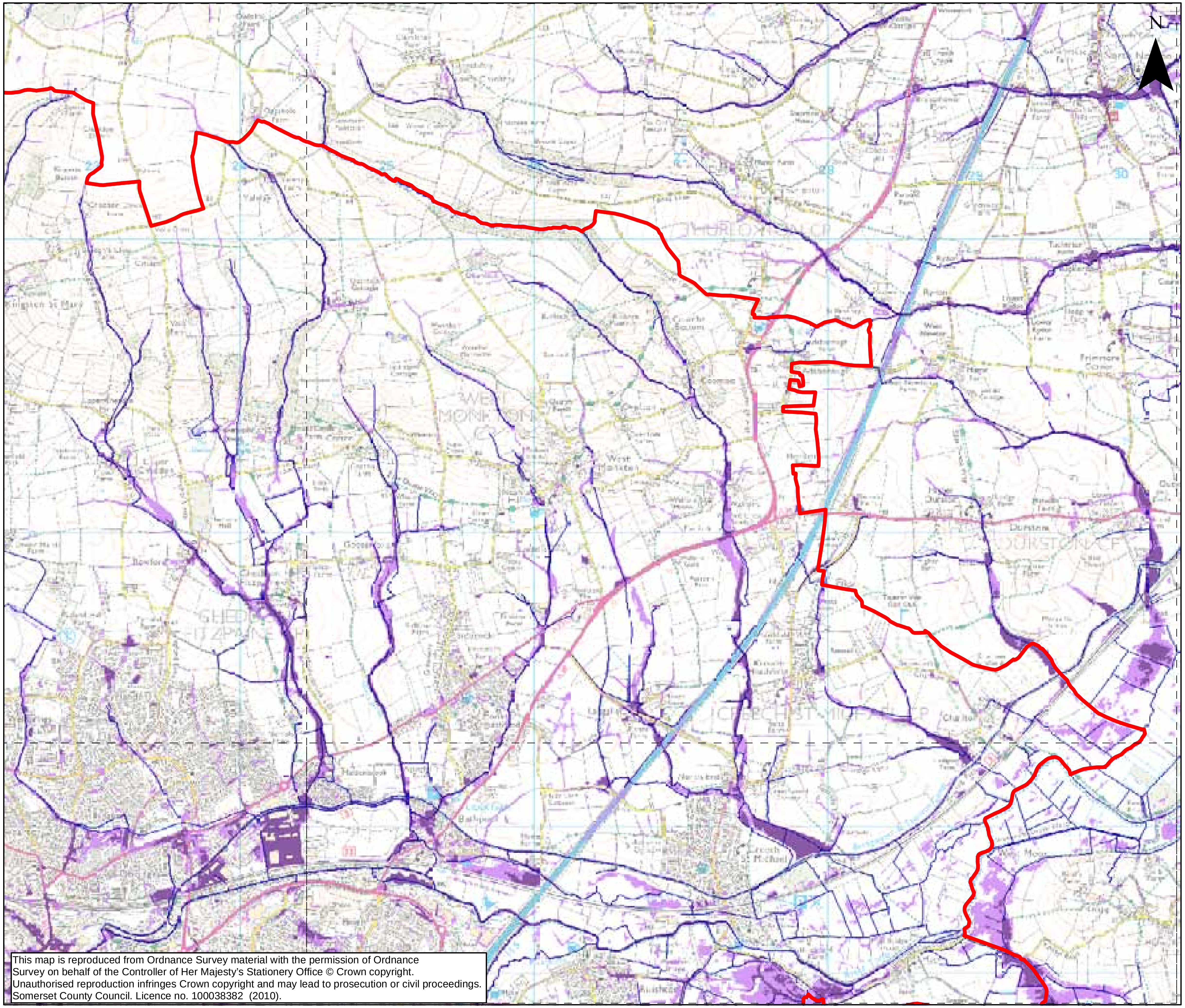
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T1
FLOOD MAP FOR SURFACE WATER 200yr FLOOD EXTENT
SHEET 1 OF 4

Drawing No.	Project No.	Issue
0229	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network
- FMfSW-200yr > 0.3m (Deep)
- FMfSW-200yr > 0.1m (Shallow)

Issue	Description	Date
01	ORIGINAL ISSUE	18FEB11

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EX2 5AZ

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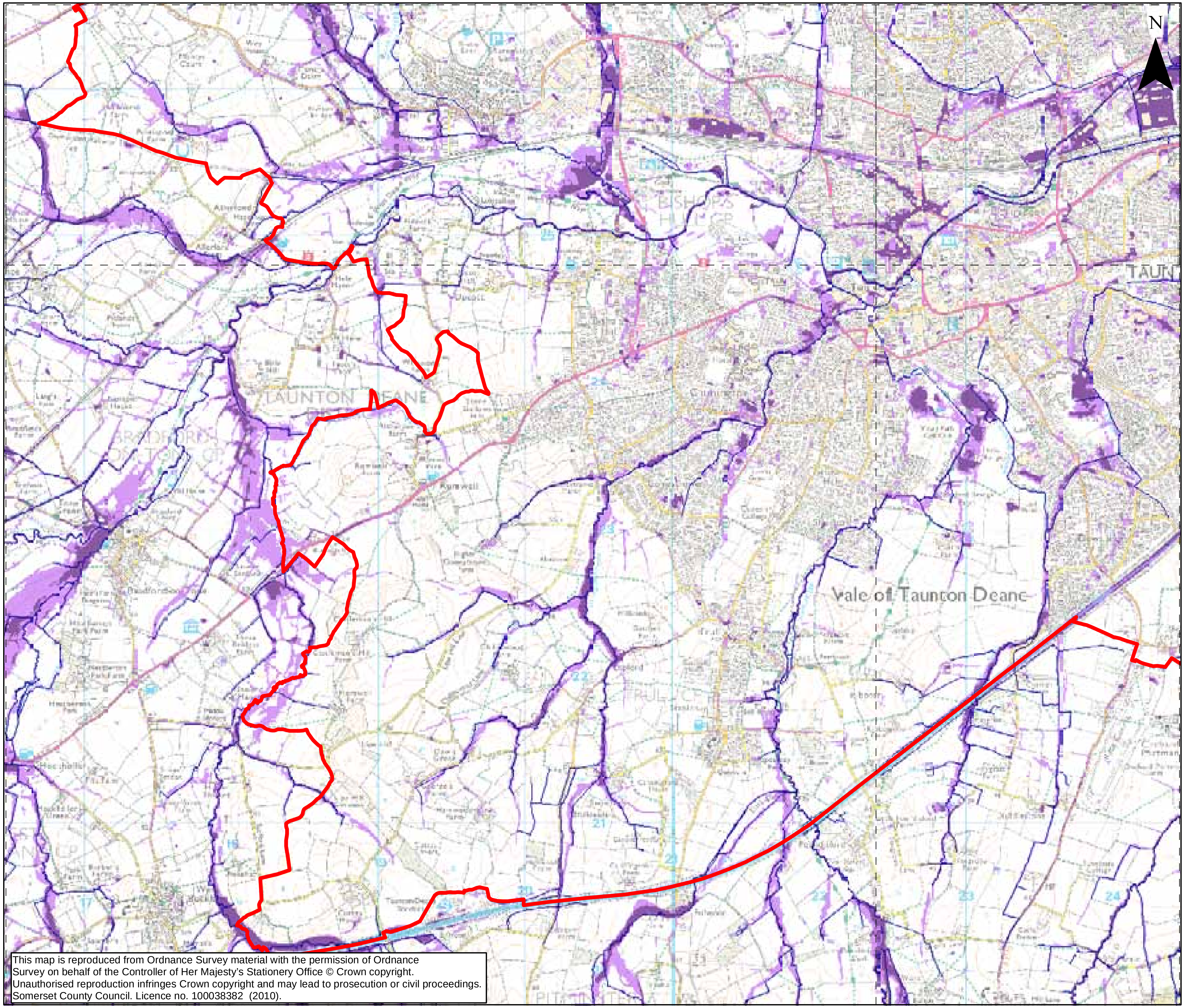
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T1
FLOOD MAP FOR SURFACE WATER 200yr FLOOD EXTENT
SHEET 2 OF 4

Drawing No.	Project No.	Issue
0230	UA001888	01

51mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network
- FMfSW-200yr > 0.3m (Deep)
- FMfSW-200yr > 0.1m (Shallow)

Issue	Description	Date
01	ORIGINAL ISSUE	18FEB11

Status: FOR INFORMATION
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EX2 5AZ

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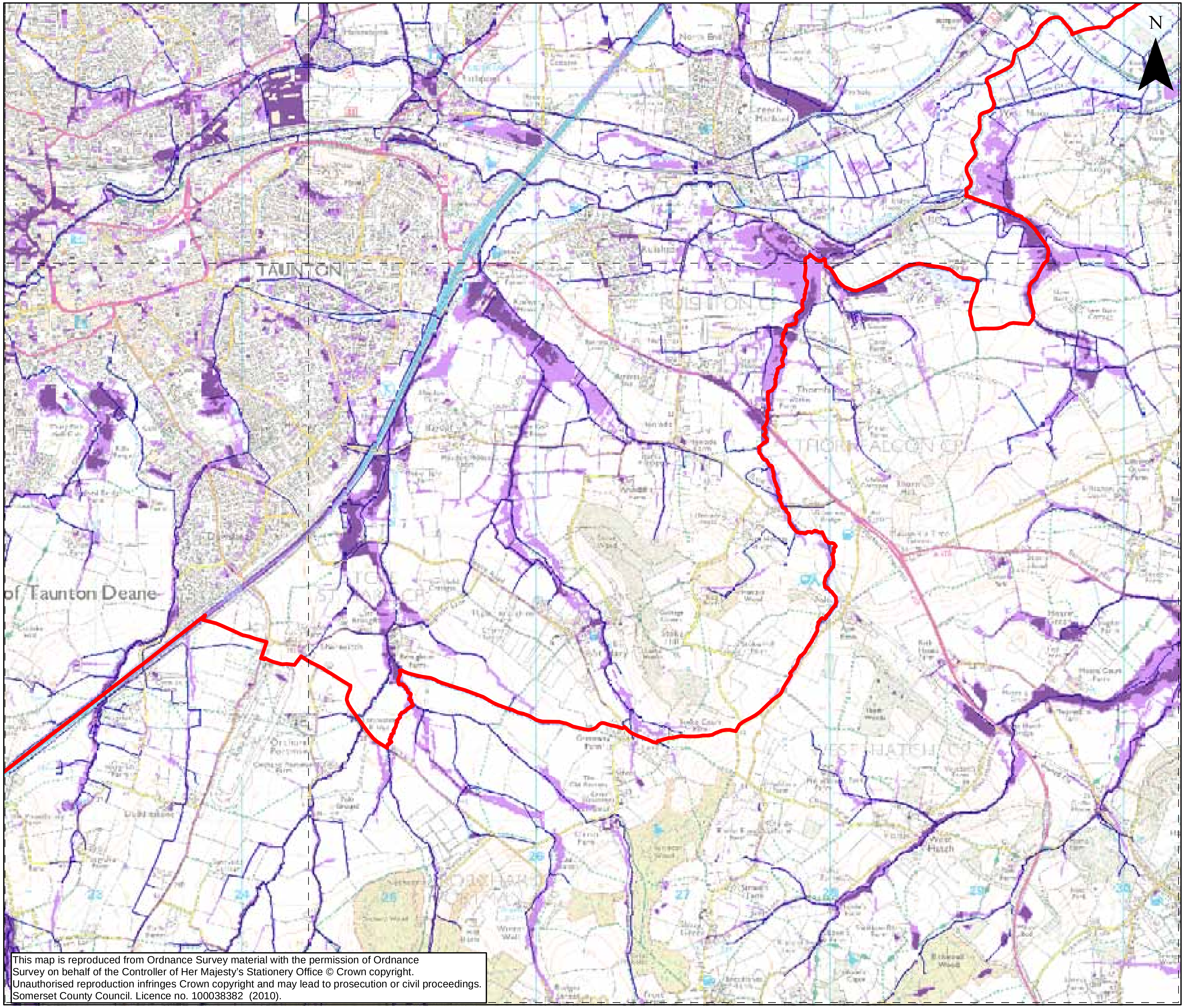
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T1
FLOOD MAP FOR SURFACE WATER 200yr FLOOD EXTENT
SHEET 3 OF 4

Drawing No.	Project No.	Issue
0231	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network
- FMfSW-200yr > 0.3m (Deep)
- FMfSW-200yr > 0.1m (Shallow)

Issue	Description	Date
01	ORIGINAL ISSUE	18FEB11

Status: FOR INFORMATION
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England
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Tel: +44 (0)870 000 3012
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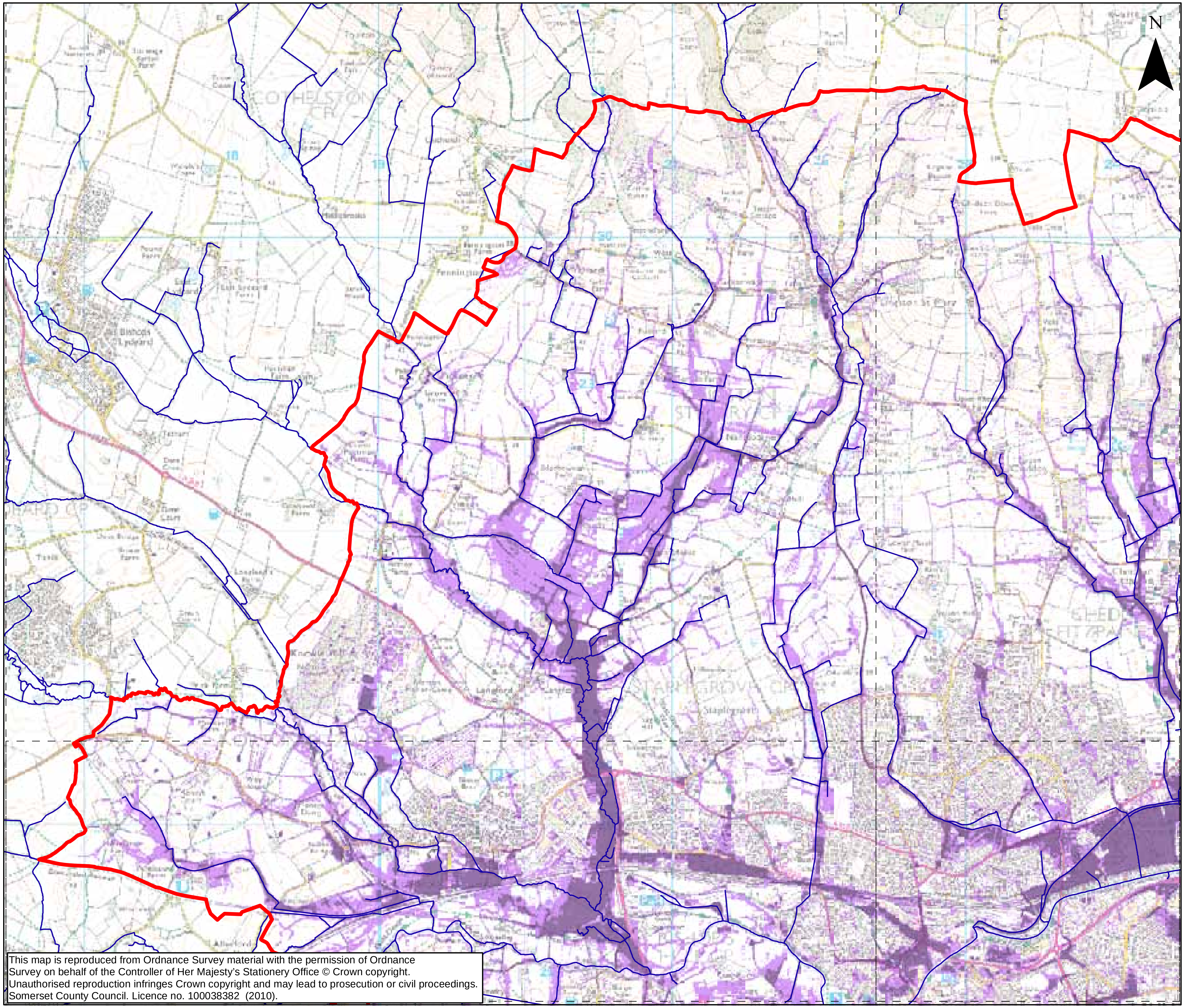
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T1
FLOOD MAP FOR SURFACE WATER 200yr FLOOD EXTENT
SHEET 4 OF 4

Drawing No.	Project No.	Issue
0232	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network

Preliminary Direct Rainfall Modelling

- 0.1m - 0.3m (Shallow)
- >0.3m (Deep)

Issue	Description	Date
01	FOR INFORMATION	14JUN11

Status: FOR INFORMATION
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		Author	A.NIMMO
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England
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Fax: +44 (0)870 000 3912

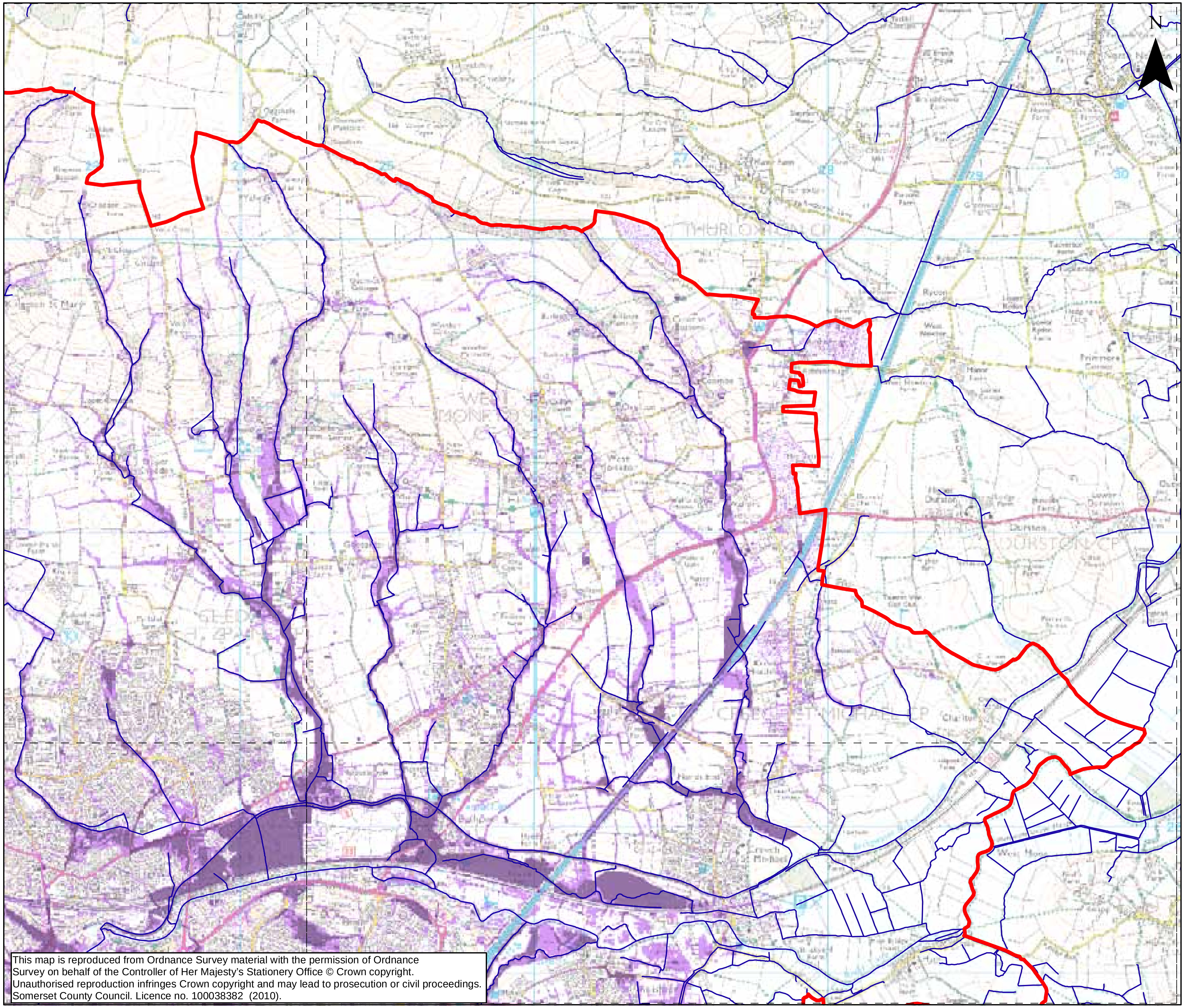
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T2
PRELIMINARY DIRECT RAINFALL
MODELLING 200yr EXTENTS
SHEET 1 OF 4

Drawing No.	Project No.	Issue
0235	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network

Preliminary Direct Rainfall Modelling

- 0.1m - 0.3m (Shallow)
- >0.3m (Deep)

Issue	Description	Date
01	ORIGINAL ISSUE	14JUN11

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:25,000	Current Issue Signatures	
		Author A.NIMMO	
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England
EX2 5AZ

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Fax: +44 (0)870 000 3912

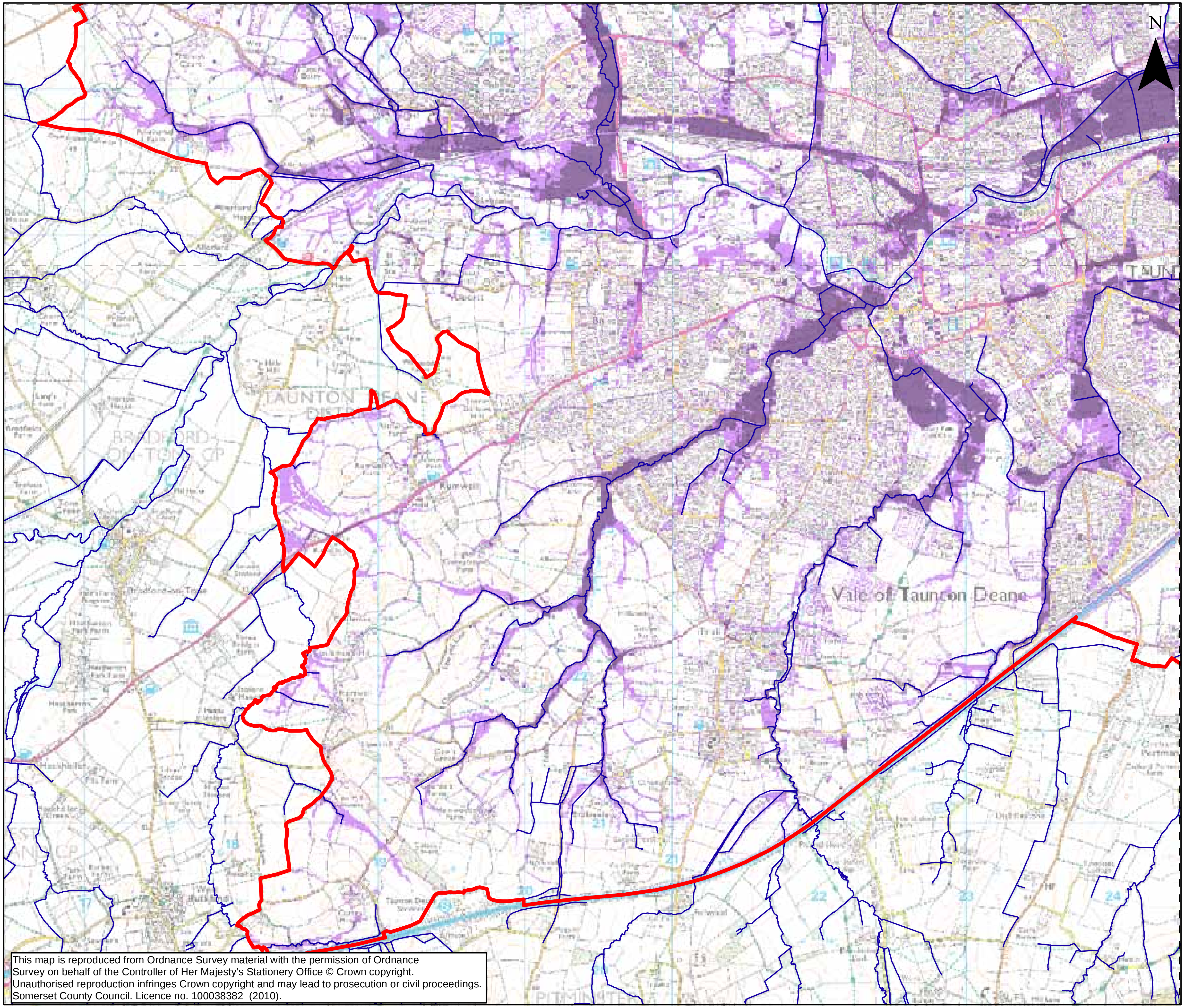
Project: SOMERSET SWMP TAUNTON

Title: FIGURE T2
PRELIMINARY DIRECT RAINFALL
MODELLING 200yr EXTENTS
SHEET 2 OF 4

Drawing No.	Project No.	Issue
0236	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network

Preliminary Direct Rainfall Modelling

- 0.1m - 0.3m (Shallow)
- >0.3m (Deep)

Issue	Description	Date
01	ORIGINAL ISSUE	14JUN11

Status: FOR INFORMATION
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3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

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Fax: +44 (0)870 000 3912

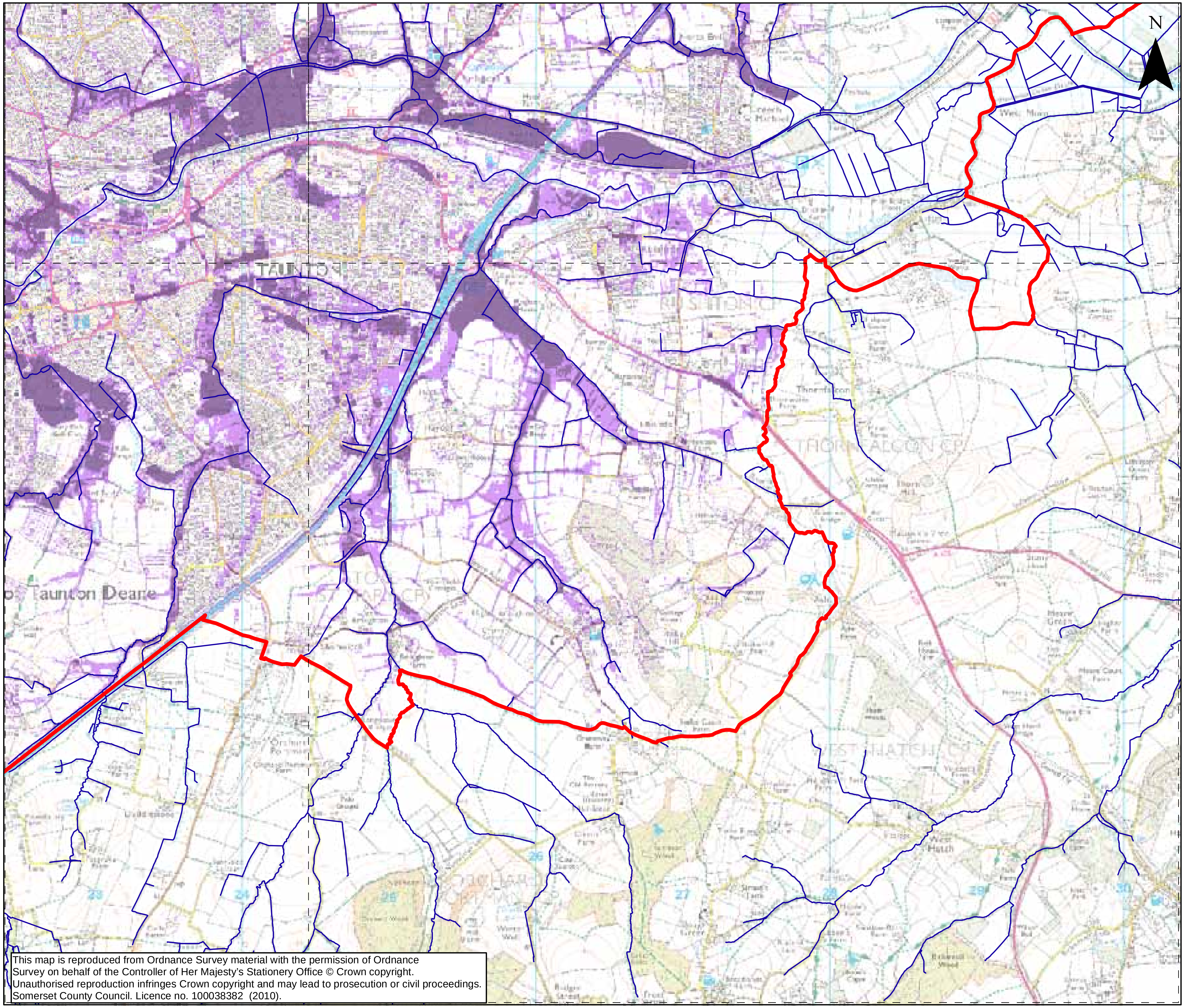
Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T2
PRELIMINARY DIRECT RAINFALL MODELLING 200yr EXTENTS
SHEET 3 OF 4

Drawing No.	Project No.	Issue
0237	UA001888	01

50mm on Original

V1



Legend

- Taunton SWMP Study Area
- Detailed River Network

Preliminary Direct Rainfall Modelling

- 0.1m - 0.3m (Shallow)
- >0.3m (Deep)

Issue	Description	Date
01	ORIGINAL ISSUE	14 JUN 11

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3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T2
PRELIMINARY DIRECT RAINFALL MODELLING 200yr EXTENTS
SHEET 4 OF 4

Drawing No.	Project No.	Issue
0238	UA001888	01

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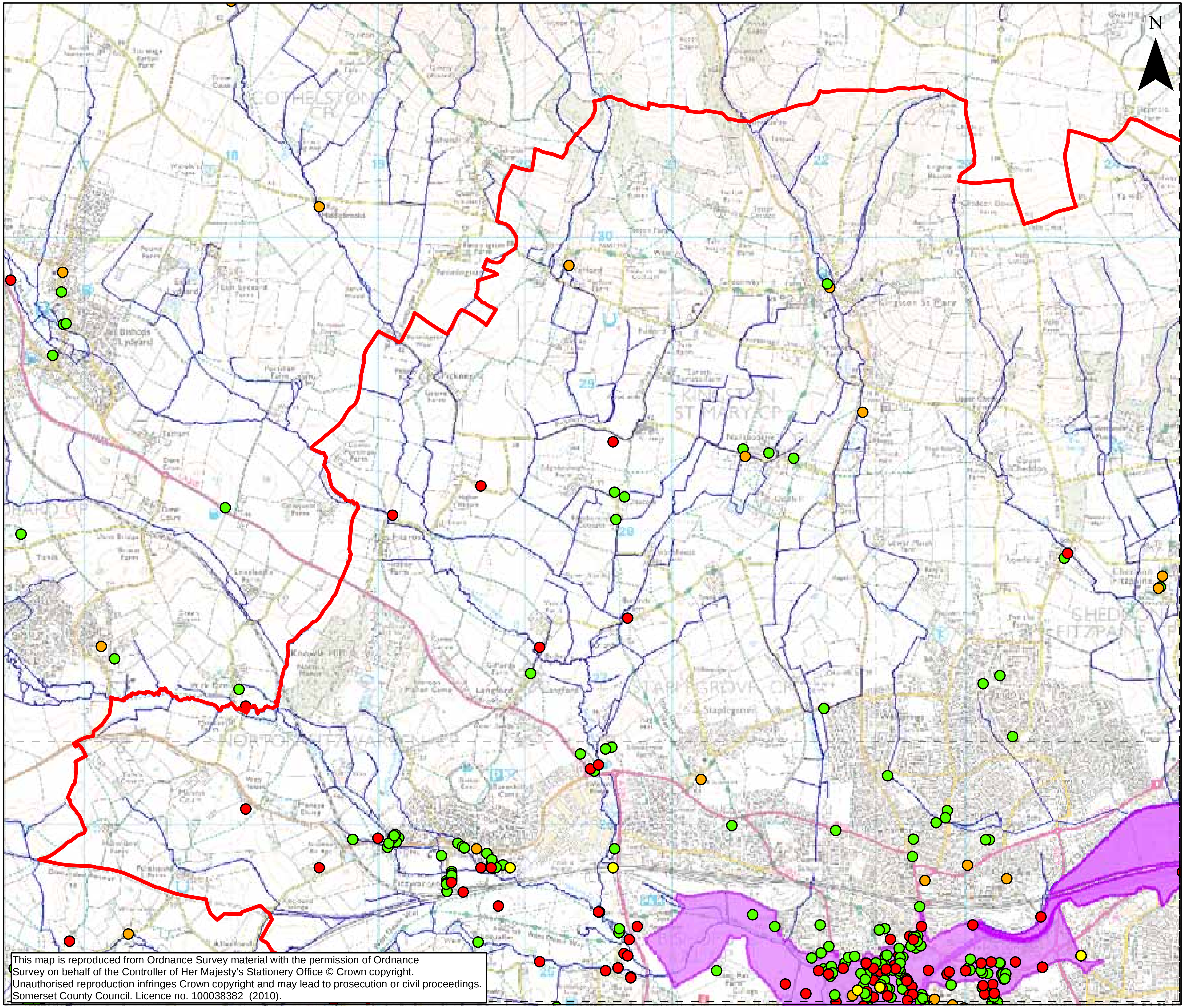
V1



Legend

Taunton SWMP Study Area

Historic Flood Incident Database

Flood Source

- Fluvial
- Pluvial
- Pluvial/Fluvial
- Unknown
- Historic Flood Areas
- Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:25,000	Current Issue Signatures	
		Author	A.NIMMO
Original Size	A3	Checker	R.BEHAN
Height Datum	mAOD	Approver	B.SARGENT
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HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP TAUNTON

Title: FIGURE T4
POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK
SHEET 1 OF 4

Drawing No.	Project No.	Issue
0213	UA001888	01

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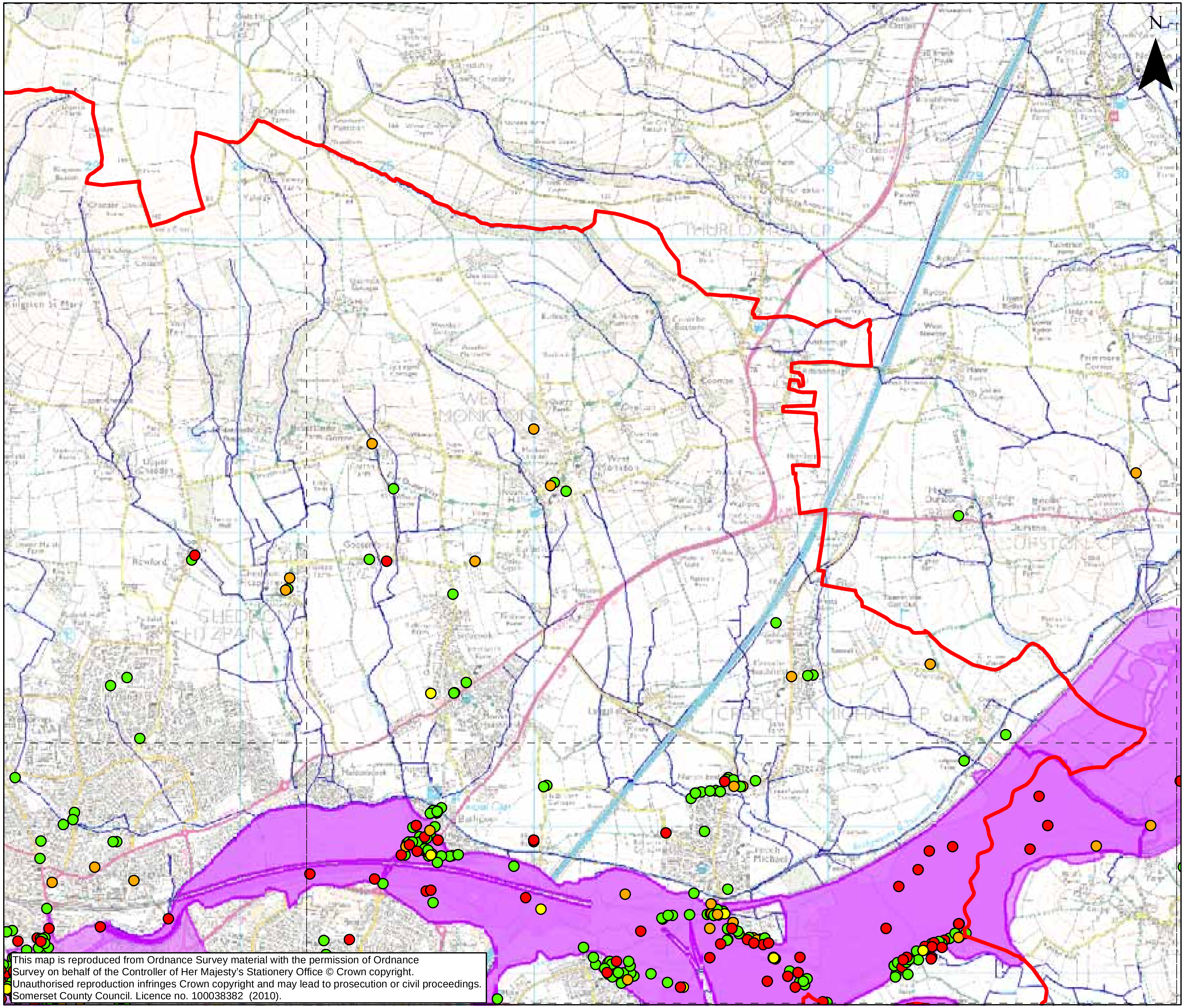
V1



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Taunton SWMP Study Area

Historic Flood Incident Database

Flood Source

- Fluvial
- Pluvial
- Pluvial/Fluvial
- Unknown

Historic Flood Areas

Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:25,000	Current Issue Signatures	
		Author A.NIMMO	
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Hyder
HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T4
POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK
SHEET 2 OF 4

Drawing No.	Project No.	Issue
0214	UA001888	01

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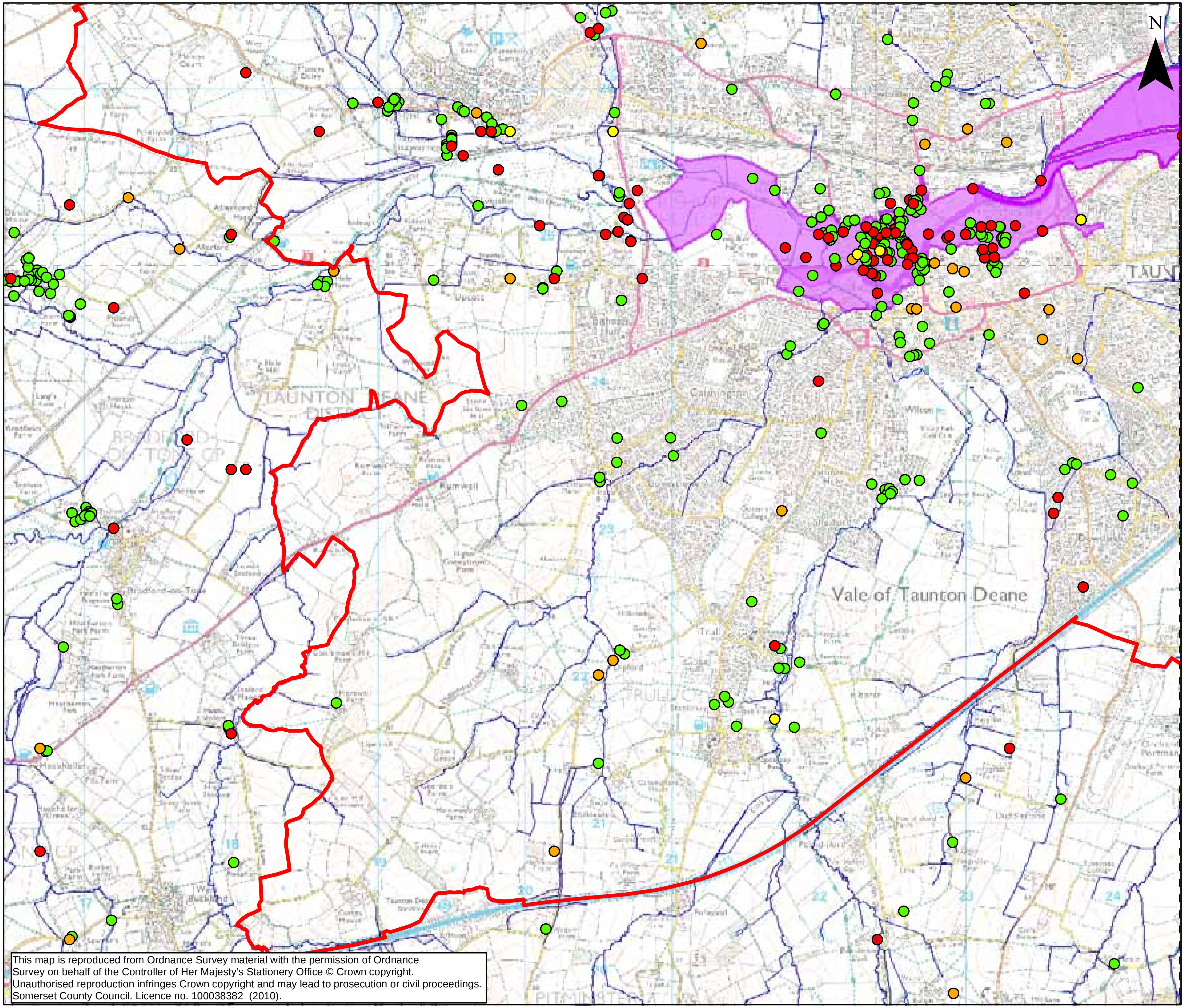
V1



Legend

Taunton SWMP Study Area

Historic Flood Incident Database

Flood Source

- Fluvial
- Pluvial
- Pluvial/Fluvial
- Unknown

Historic Flood Areas

Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION
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Client: SOMERSET County Council

Hyder
HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
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Title: FIGURE T4
POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK
SHEET 3 OF 4

Drawing No.	Project No.	Issue
0215	— UA001888 —	01

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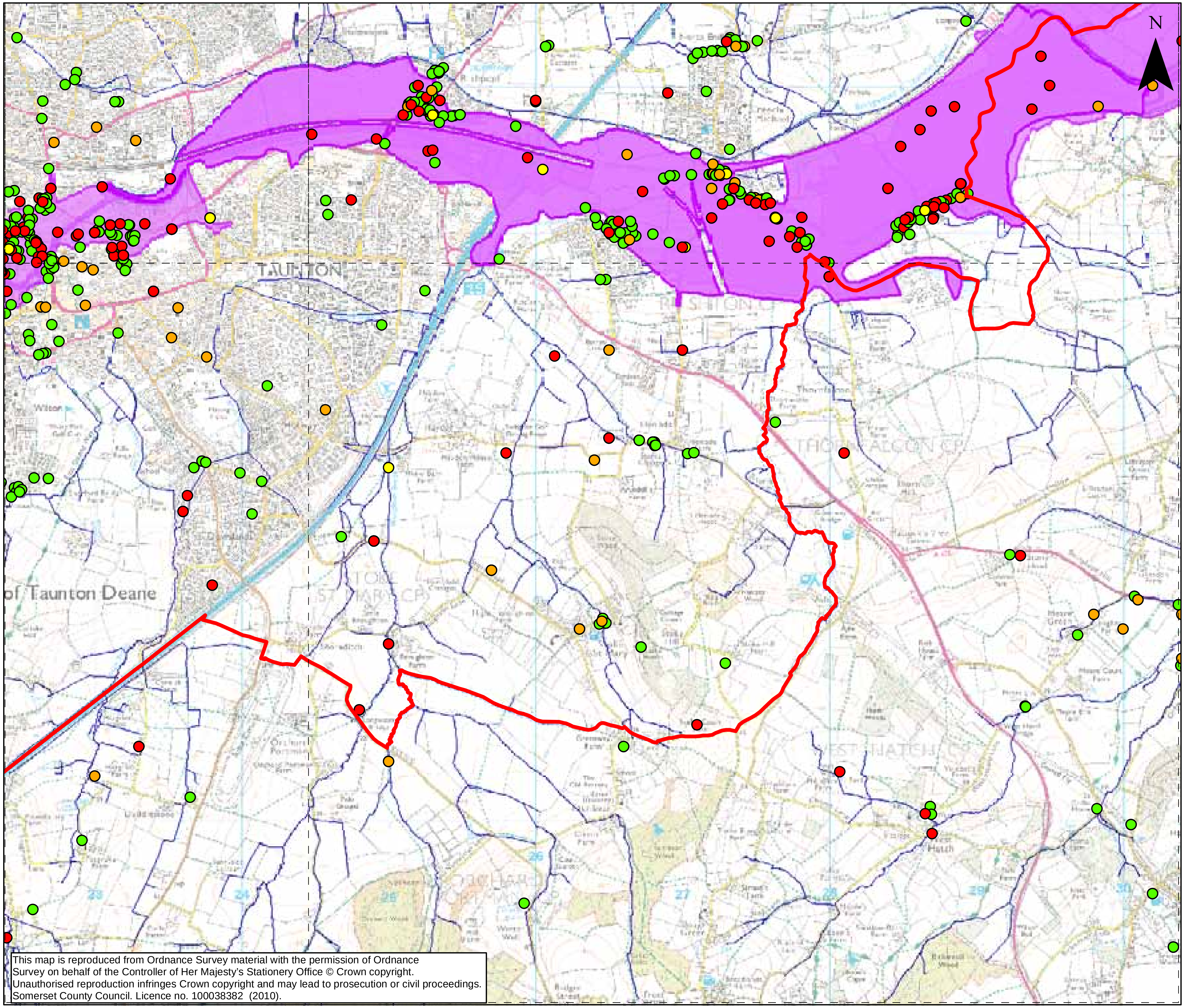

Legend

Taunton SWMP Study Area

Historic Flood Incident Database

Flood Source

- Fluvial
- Pluvial
- Pluvial/Fluvial
- Unknown
- Historic Flood Areas
- Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION
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Client: SOMERSET County Council

Hyder
HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T4
POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK
SHEET 4 OF 4

Drawing No.	Project No.	Issue
0216	UA001888	01

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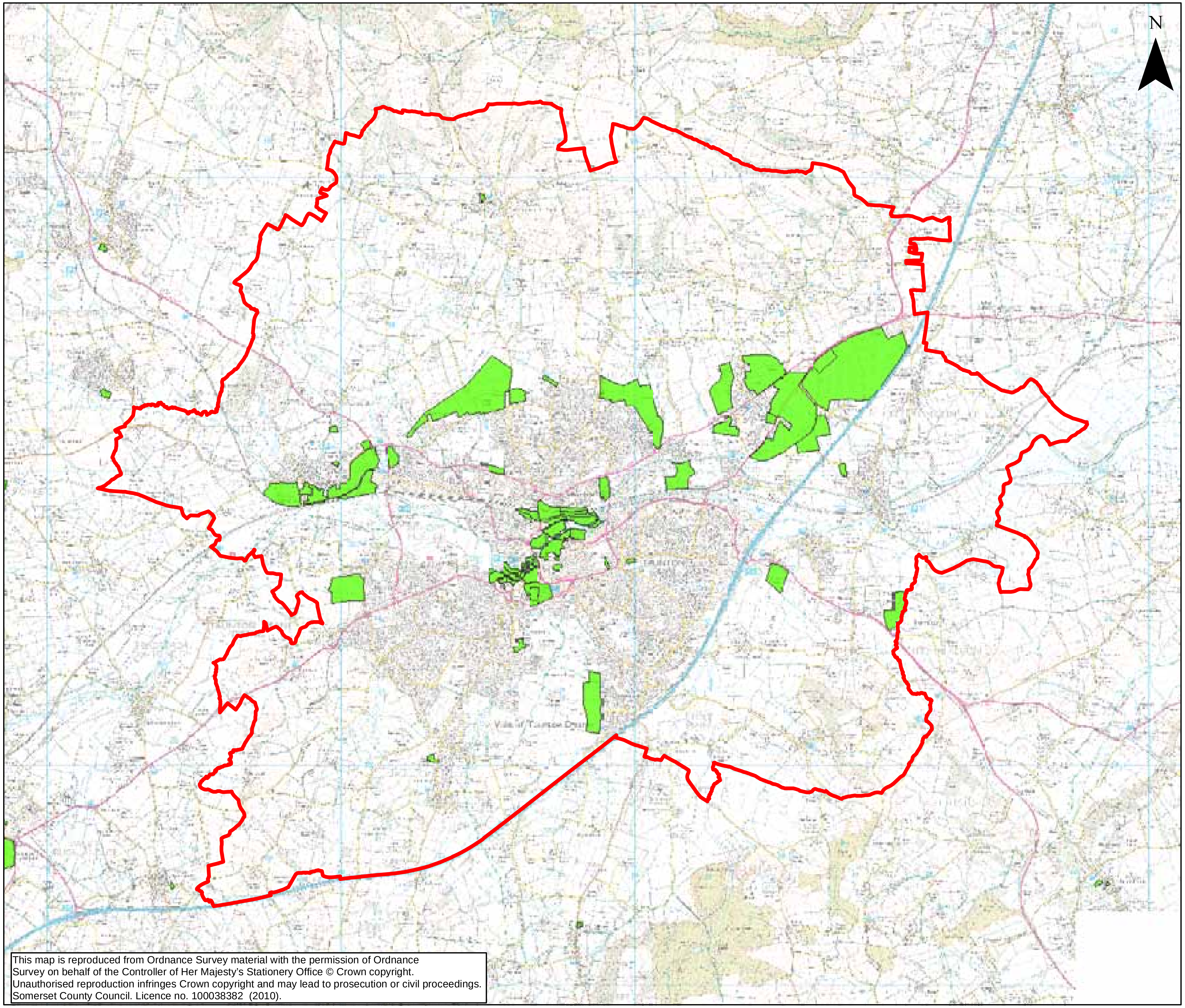
V1



Legend

- Taunton SWMP Study Area
- All Proposed Development Areas

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:50,000	Current Issue Signatures	
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Hyder
HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ
Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
TAUNTON

Title: FIGURE T5
PREFERRED DEVELOPMENT
SITES

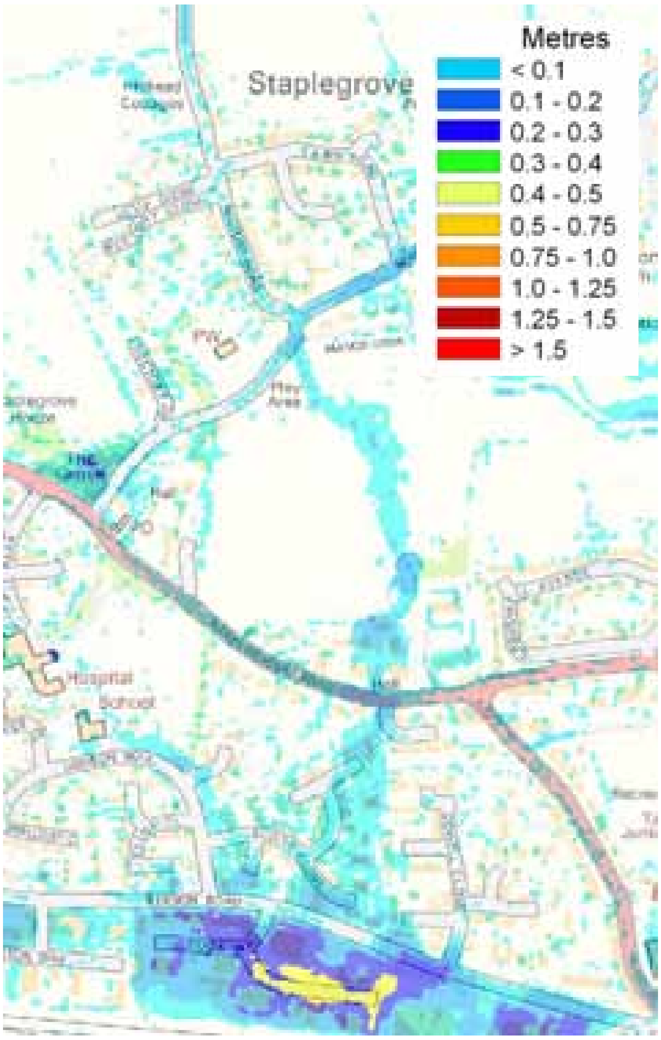
Drawing No.	Project No.	Issue
0217	UA001888	01

50mm on Original

V1

Stage 3 Wetspots

Staplegrove



Flooding Mechanism

Overland flow on Manor Way and Rectory Road results in overland flow to Staplegrove Road with flooding to properties to the south of the highway. This includes Scott Way and Binder Road. In addition, members of the workshop did consider that flooding could be a problem at this location. Also Information received from Wessex Water indicates that the combined foul / surface water system in the area has limited capacity to address surface water flooding.

Approximate Number of Properties Affected

- 40 Domestic and Commercial properties.

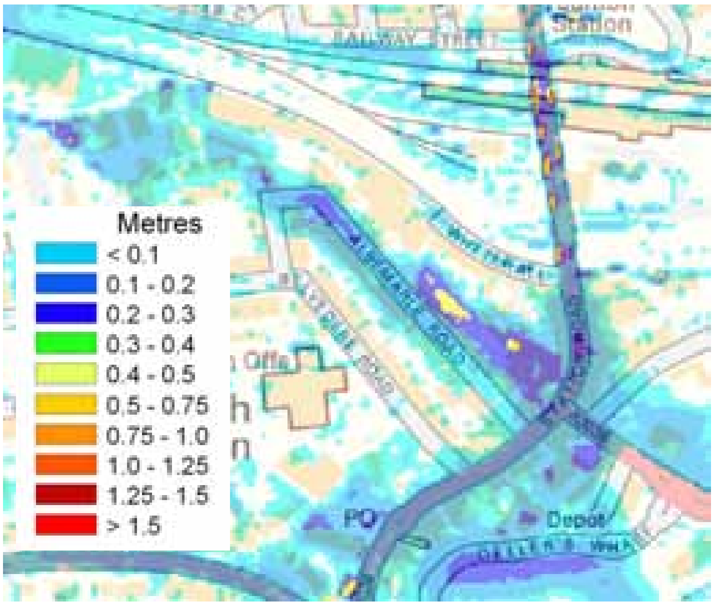
Possible Options

- Attenuation pond in fields to the north of Staplegrove Road.
- Improvements to the surface water drainage system.

Recommendation

- Undertake modelling of options at this location.

Northtown



Flooding Mechanism

Overland flow from north Taunton results in flooding to properties south of the railway line. This includes Albermarle Road, and Chip Lane. Flooding may well be exacerbated by blockage to culverts and / or high water levels in the Tone. However, members of the workshop doubted that there were problems with flooding in this area. This may be due to the storm water system is not being well represented in the hydraulic model, particularly in the vicinity of the railway.

Approximate Number of Properties Affected

- 60 Domestic and Commercial properties.

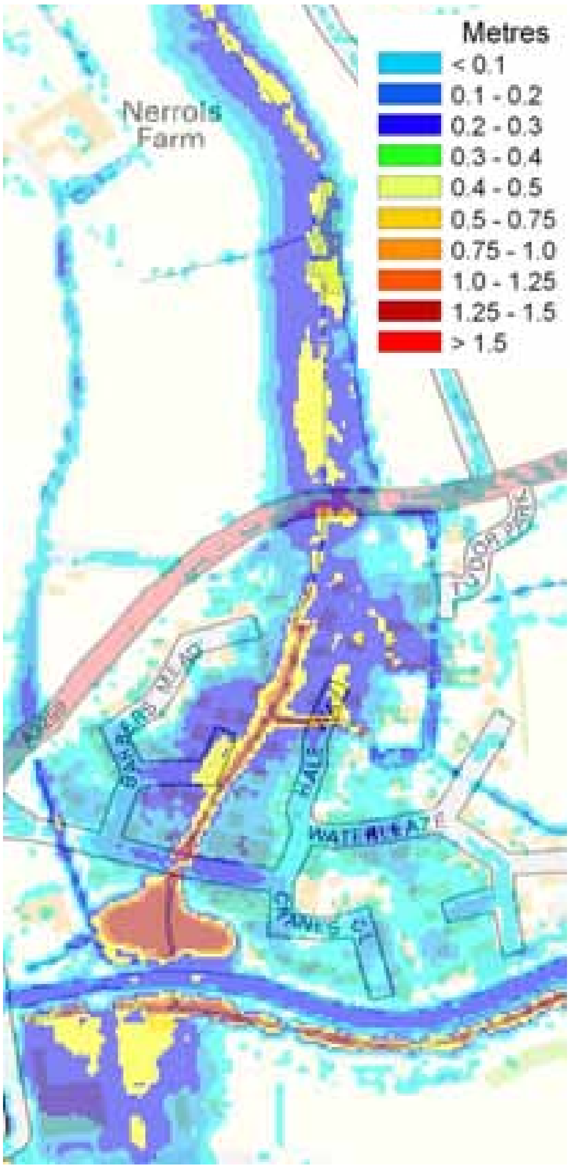
Possible Options

- Installation of trash screens (if blockage of the storm water system is considered to be a problem).
- Improvements to the surface water drainage system.

Recommendation

- Review representation of surface water system in the model.
- Set aside and monitor possible problems with flooding in the area.

Barbers Mead & Hale Way



Flooding Mechanism

Fluvial flooding from the Maiden Brook results in flooding to properties on Barbers Mead and Hale Way. However, members of the workshop did not indicate that there were flood issues and there are no records of historical flooding in this area.

Approximate Number of Properties Affected

- 40 Domestic and Commercial

Possible Options

- Installation of trash screens (if blockage of the storm water system is considered to be a problem.
- Improvements to the surface water drainage system.

Recommendation

- Review representation of surface water and fluvial system in the model.
- Set aside and monitor possible problems with flooding in the area.

Lyngford

Flooding Mechanism

- Fluvial and overland flow from the Kingston Stream results in flooding to properties on Cheddon Road, Wellesley Street and Grange Drive. However, members of the workshop doubted that there were problems with flooding in this area.

Approximate Number of Properties Affected

- 60 mainly domestic properties and a school.

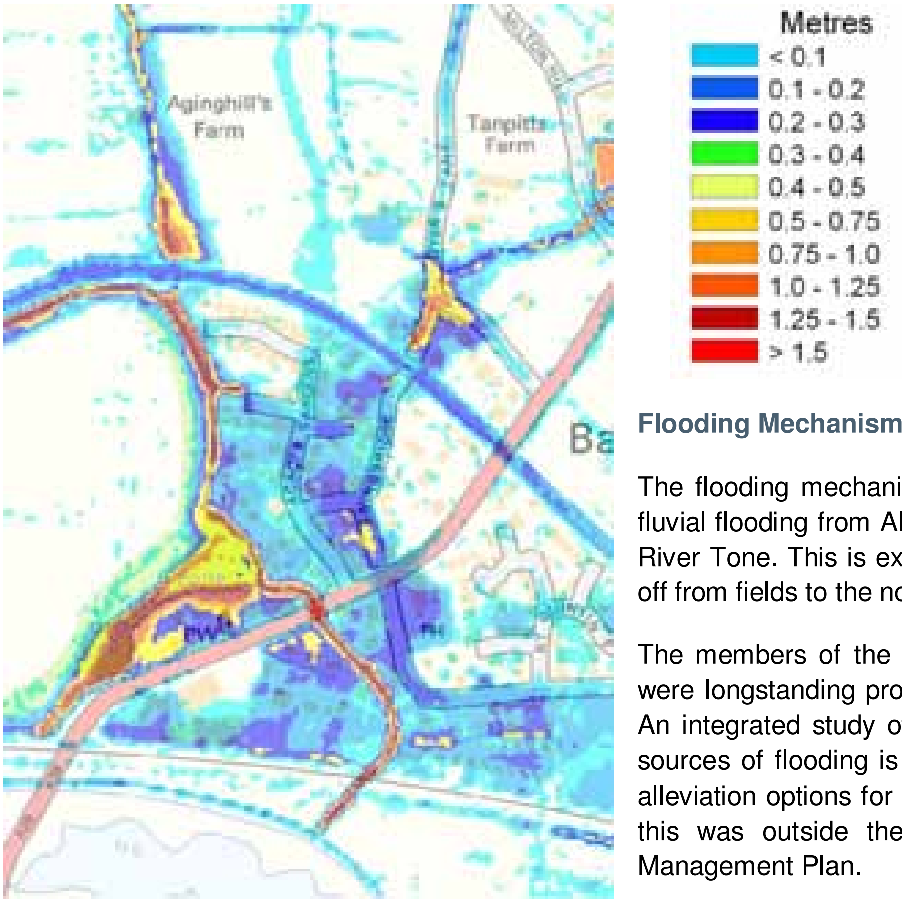
Possible Options

- Installation of trash screens (if blockage of the storm water system is considered to be a problem).
- Improvements to the surface water drainage system.

Recommendation

- Review representation of surface water and fluvial system in the model.
- Set aside and monitor possible problems with flooding in the area.

Bathpool



Flooding Mechanism

The flooding mechanism in Bathpool is complex with fluvial flooding from Allen's and Dyer's Brooks and the River Tone. This is exacerbated by surface water run-off from fields to the north of Bathpool.

The members of the workshop recognised that there were longstanding problems with flooding in this area. An integrated study of flooding which incorporates all sources of flooding is required to drive potential flood alleviation options for Bathpool. It was considered that this was outside the scope of the Surface Water Management Plan.

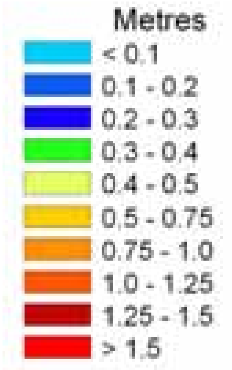
Approximate Number of Properties Affected

- 90 mainly domestic properties

Recommendations

- Undertake comprehensive study of flooding in Bathpool.

Creech St Michael



Flooding Mechanism

Fluvial flooding occurs to the north of the village affecting a number of properties in the left bank of the watercourse to the north of the village. Wessex Water has also reported problems associated with foul / combined surface water flooding in the centre of the village.

Approximate Number of Properties Affected

- Hydraulic modelling indicates twenty, mainly domestic properties could be affected by fluvial flooding to the north of the village.
- The highway within the centre of the village is vulnerable to flooding from foul / combined sewer systems.

Possible Options

- Construction of formal flood defences to the north.
- Reduction in surface water run-off to the watercourse through the installation of SuDS features in proposed developments to the North West of Creech St Michael.
- Separation of foul and surface water in the centre of the village.

Recommendation

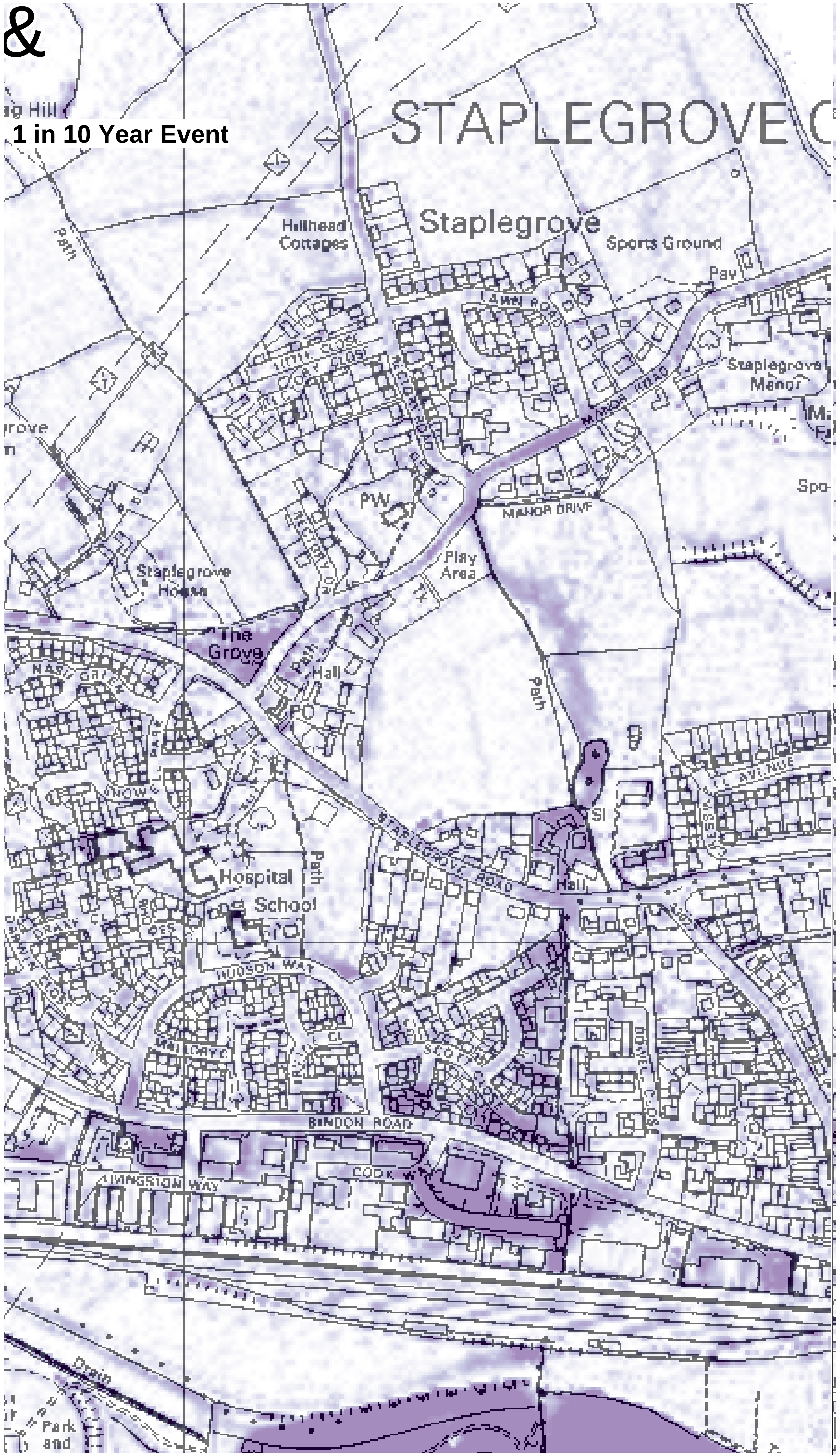
- Wessex Water has indicated that separation of surface and foul water may exacerbate risk of flooding to Creech St Michael.

Monitor possible problems with fluvial flooding in the area and encourage implementation of SuDS systems in new development areas which would reduce discharge to the watercourses.

Modelled Outputs

&

1 in 10 Year Event



1 in 200 Year Event

Legend

> 0.1 m

> 0.3 m

Hyder

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

Taunton Surface Water Management Plan

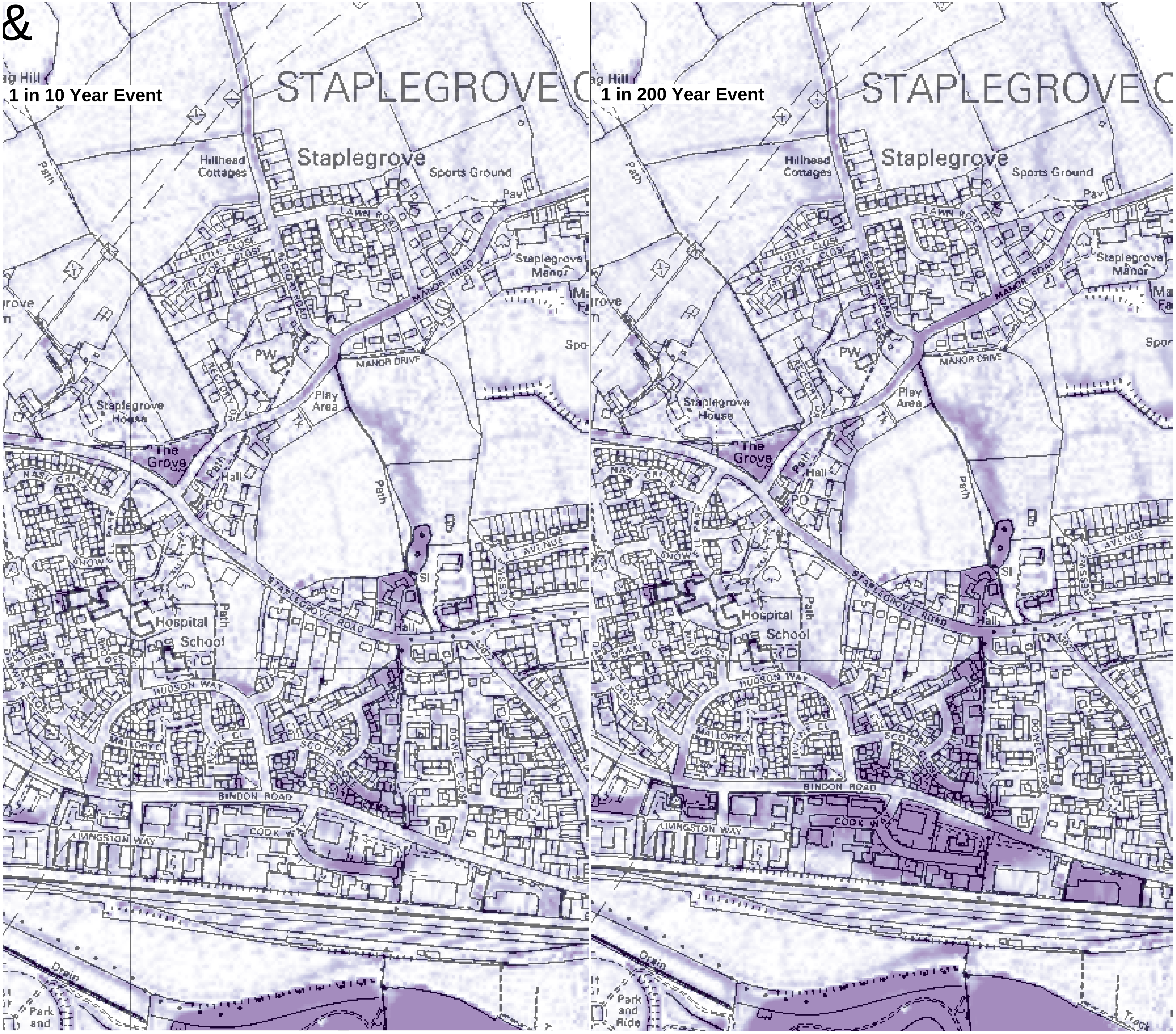
Flood Mapping- Do Nothing

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.

0239-UA001888-DVD-01



Legend

> 0.1 m

> 0.3 m

Somerset County Council

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Taunton Surface Water Management Plan

Flood Mapping- Do Minimum

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0240-UA001888-DVD-01

Legend

- > 0.1 m
- > 0.3 m

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

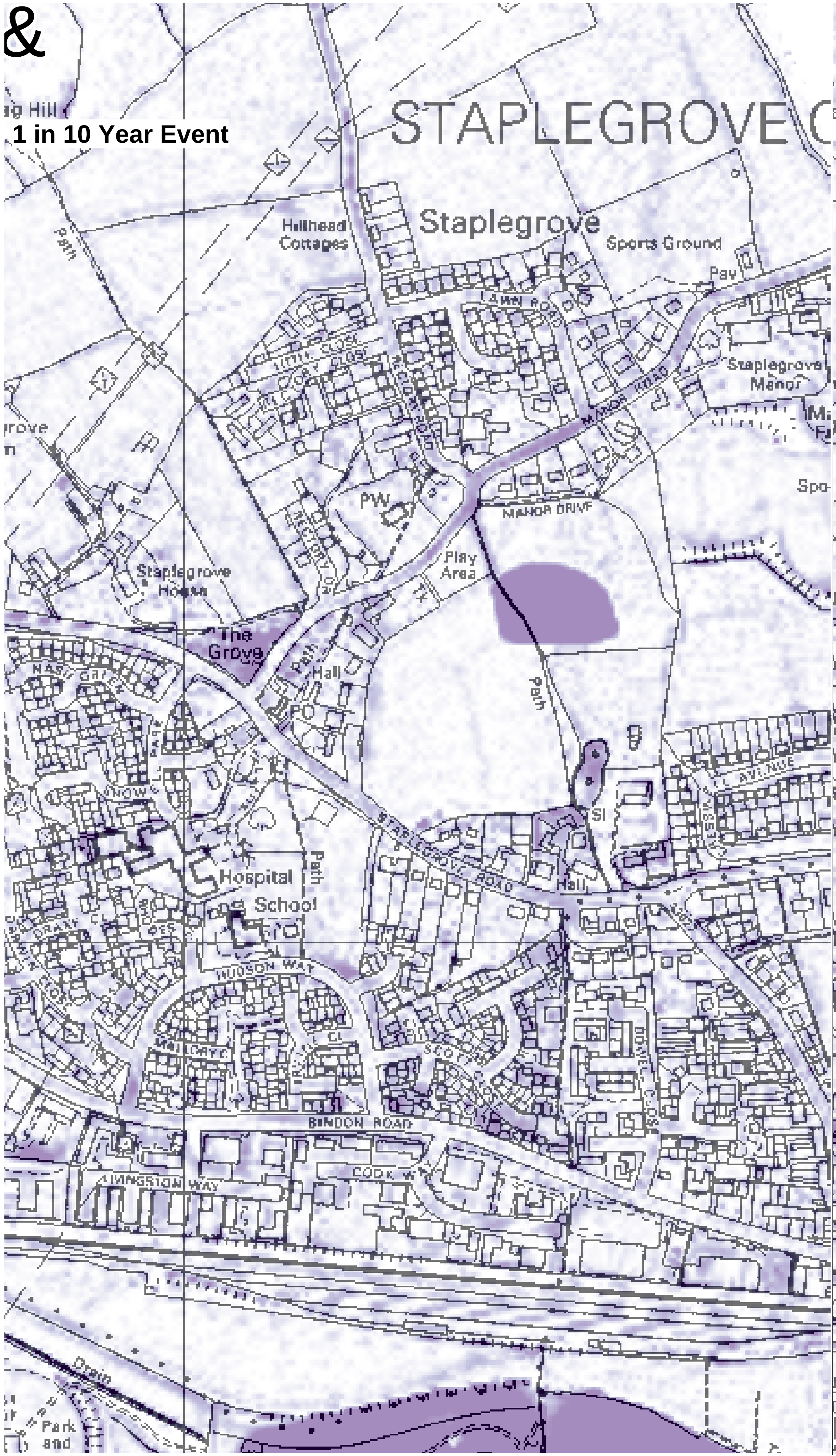
Taunton Surface Water Management Plan

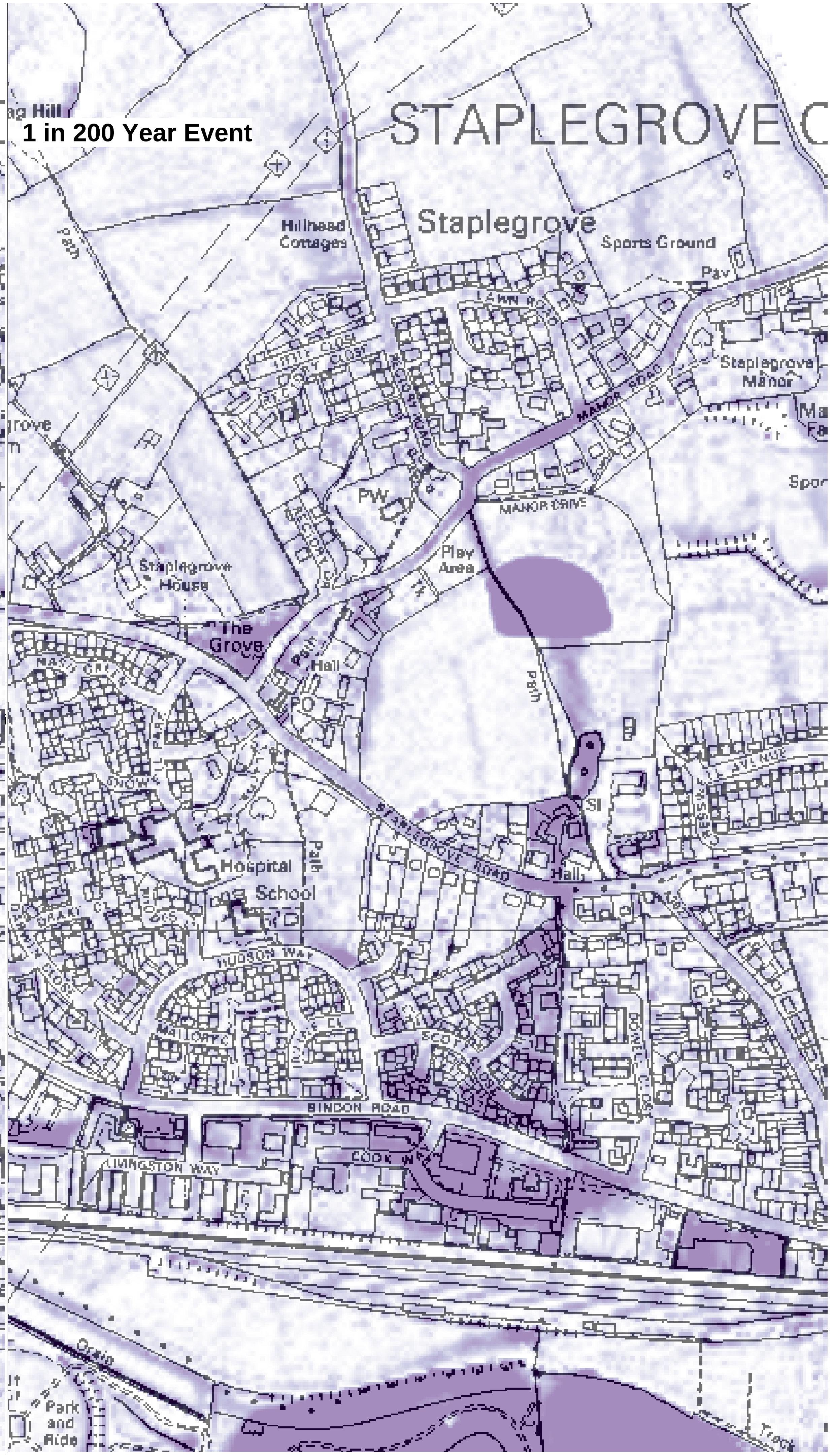
Flood Mapping- Option H 'Minimum Intervention'

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0241-UA001888-DVD-01





Legend

> 0.1 m

> 0.3 m

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

Taunton Surface Water Management Plan

Flood Mapping- Option I 'Medium Intervention'

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0242-UA001888-DVD-01

Legend

- Danger For Some >0.75
- Danger For Most >1.25
- Danger For All >2

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

Taunton Surface Water Management Plan

Flood Hazard Mapping- Do Minimum

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0243-UA001888-DVD-01

Legend

Danger For Some >0.75

Danger For Most >1.25

Danger For All >2

Hyder

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

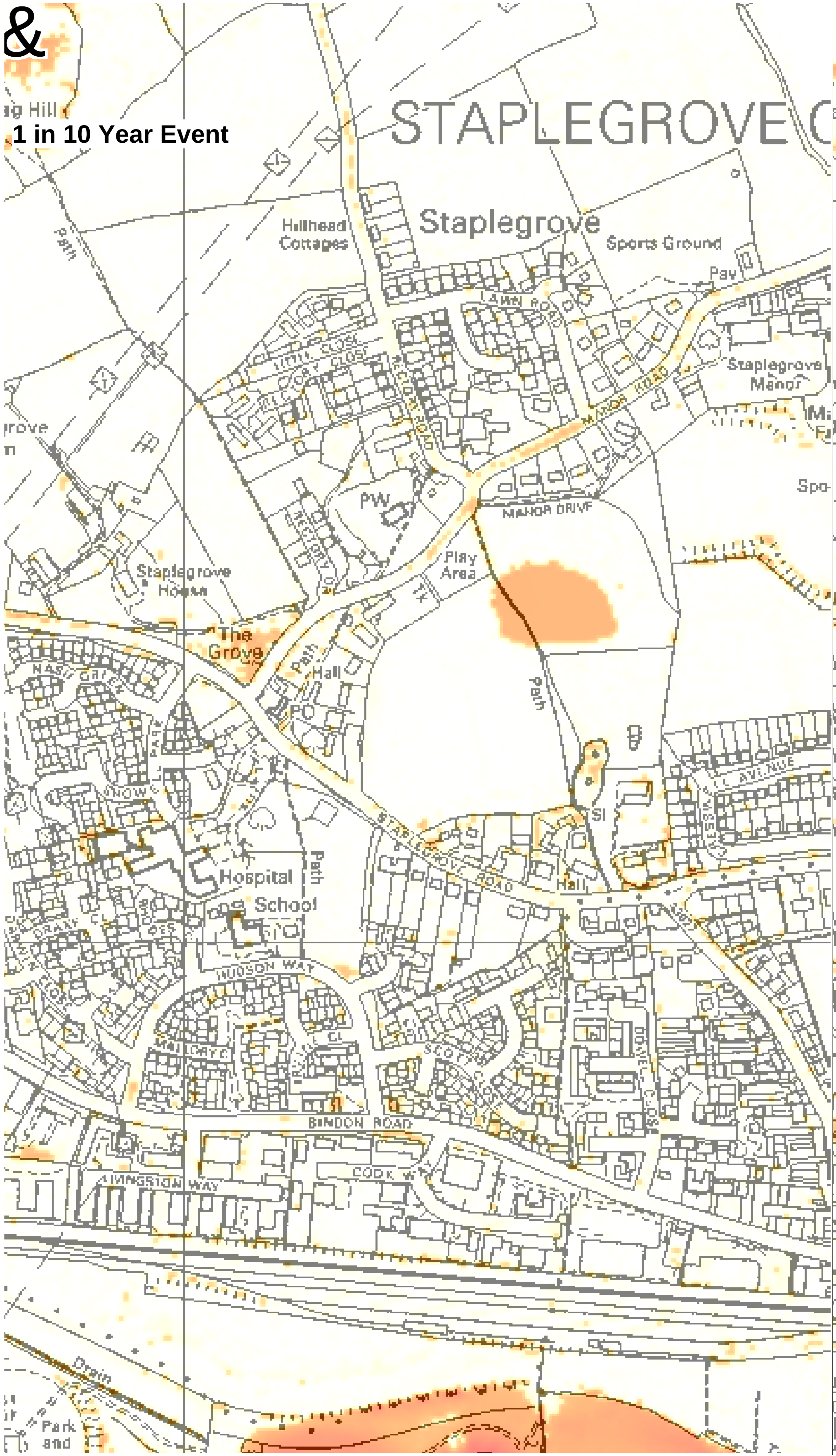
Taunton Surface Water Management Plan

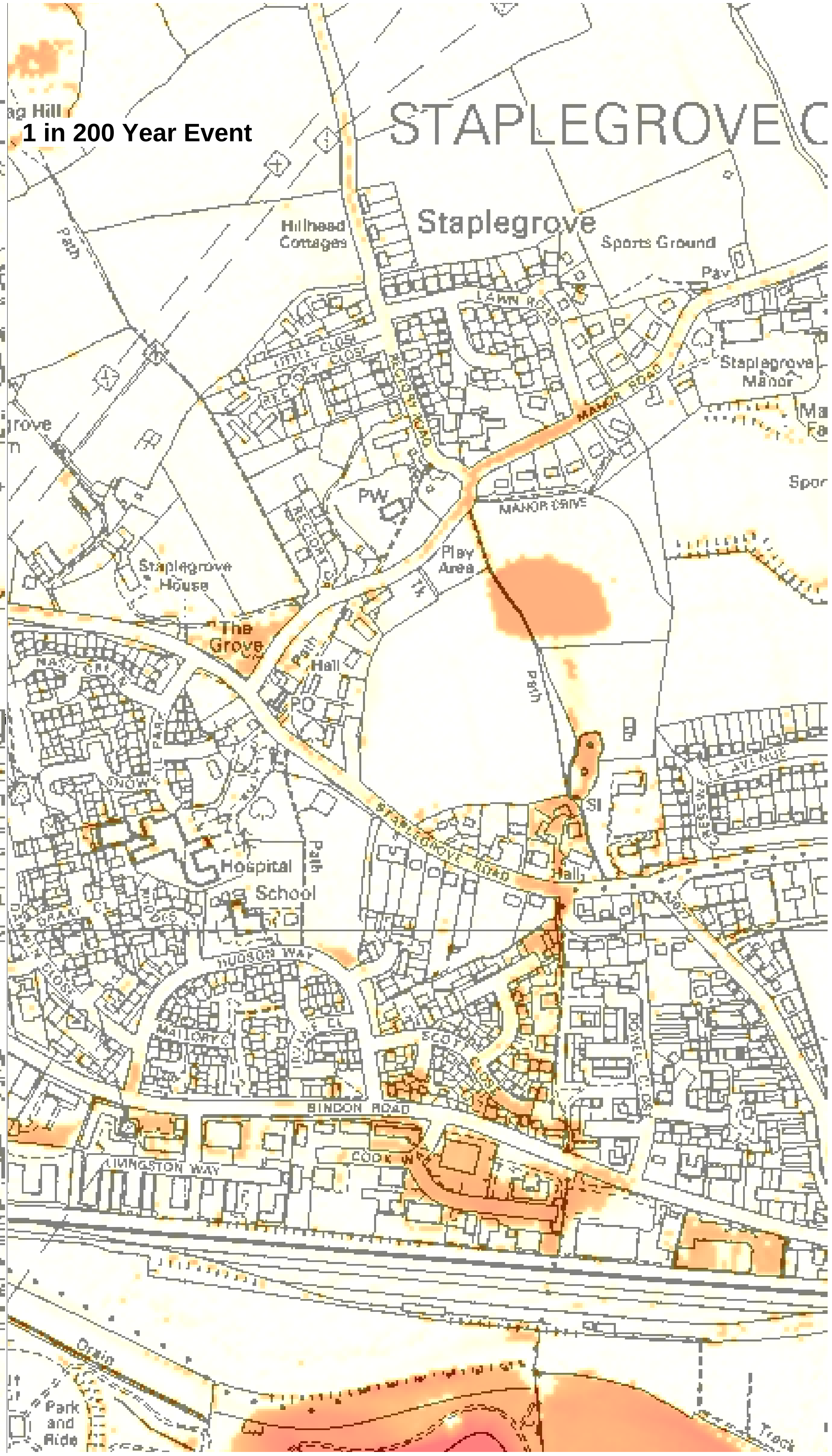
Flood Hazard Mapping- Option H 'Minimum Intervention'

Scale NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0244-UA001888-DVD-01





Legend

	Danger For Some >0.75
	Danger For Most >1.25
	Danger For All >2

Somerset County Council

County Hall, Taunton, Somerset, TA1 4DY

Taunton Surface Water Management Plan

Flood Hazard Mapping- Option I 'Medium Intervention'

Scale
NTS

Produced	VB	22-11-12
Checked	AH	26-11-12
Approved	HT	26-11-12

DRAWING NO.
0245-UA001888-DVD-01

Appendix F

SuDS

Engineering Options Details

Source

Green Roofs

Green roofs are designed to intercept rainfall and slow down its entry into the ground level drainage system. Vegetation such as grass and small shrubs are added to residential, commercial or shed roofs (Figure F1-1). The green roof systems can improve the quality of the runoff before it enters the drainage system.

Figure F1-1 Example of a residential green roof (Ecotips, 2010[i])

The advantages and disadvantages of green roofs are shown below.

	Advantage/Disadvantage
Advantage	Green roofs are effective at managing and reducing rainfall runoff from property.
	Low maintenance once installed as hardy vegetation is used.
	Management of potential flooding at the source, ‘upstream’ of any high risk areas.
	Water treatment by pollutant removal.
	Does not require extra land space on new development, good for constrained areas.
	Reduces net annual volume required by the storm sewer system.
Disadvantage	Construction on existing properties is disruptive.
	Storage Capacity within green roof can be full prior to commencement of storm
	High associated construction cost on existing properties.
	Challenging to encourage existing homeowners to consider this option.

Table F1-1 Advantages/Disadvantages of Green Roofs

Soakaways

Soakaways are designed to provide an alternative infiltration route for storm water to prevent overburdening the sewerage system. There are several different soakaway options; Figure F1-2 below illustrates a small scale soakaway system within a residential development.

Figure F1-2 Example of a soakaway within a residential development (BCProfiles, 2011[ii])

The advantages and disadvantages of soakaways are shown below.

	Advantage/Disadvantage
Advantage	Management of potential flooding at the source, 'upstream' of any high risk areas.
	Reduces likelihood of property flooding as alternative storm water infiltration route.
	Reduces net volume required by the storm sewer system.
Disadvantage	Installation is disruptive in existing residential areas.
	Not useable in areas underlain by thick clay.
	High associated construction cost.
	Can only be constructed on highways with low traffic volumes where speed restrictions not exceeding 30mph are present.

Table F1-2 Advantages/Disadvantages of Soakaways

Water Butts and Rainwater Harvesting

Water butts are designed to be a low maintenance, easy to install rain water collection receptacle. A large barrel is connected up to a residential property down pipe to collect water for use in the resident’s garden (Figure F1-3).

Figure F1-3 Example of a water butt (Water Features Online, 2011[iii])

	Advantage/Disadvantage
Advantage	Management of potential flooding at the source, ‘upstream’ of any high risk areas.
	Easy to implement on a property level.
	Minimal maintenance required to the water butt once it is in place.
	Reduces net volume required by the storm sewer system.
Disadvantage	May require incentives to encourage residents to install a water butt
	Cannot be guaranteed storage as may be full at the time of a storm.
	In densely urbanised areas may not be applicable if properties do not have gardens as they may not have a use for the water collected.

Table F1-3 Advantages/Disadvantages of Water Butts

Rainwater harvesting is a more comprehensive system that is designed to allow for the re-use of ‘grey’ water within a property for non-potable purposes (Figure F1-4).

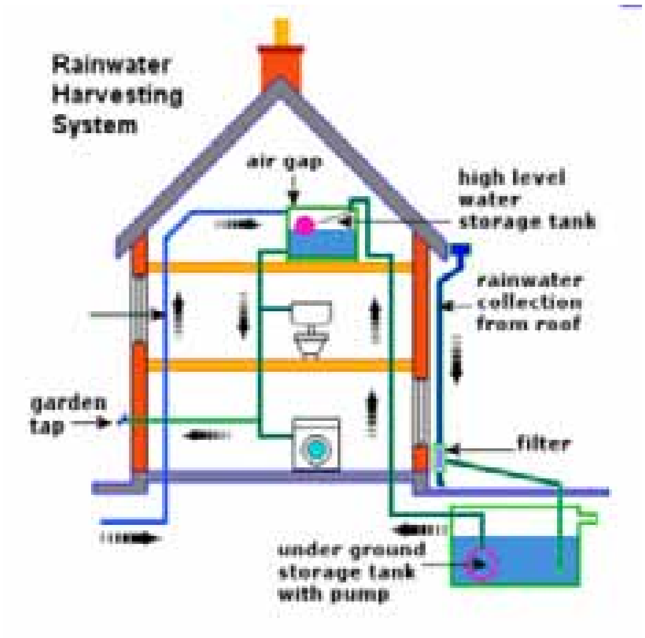


Figure F1-4 Example of a rainwater harvesting system (lowenergyhouse.com, 2011[iv])

	Advantage/Disadvantage
Advantage	Management of potential flooding at the source, ‘upstream’ of any high risk areas.
	Reduces mains water usage at a property level.
	Reduces net volume required by the storm sewer system.
Disadvantage	Expensive to install this system into an existing residential property.
	Disruptive to install this system into an existing property.
	Maintenance costs would be high.

Table F1-4 Advantages/Disadvantages of Rainwater Harvesting

Permeable Paving

Permeable paving systems are designed to allow water to infiltrate to the underlying granular sub-grade material and eventually provide local groundwater recharge (Figure F1-5). They provide significant benefits in relation to rainfall interception as well an option for removal of surface water volume.

Figure F1-5 Example of permeable paving

The advantages and disadvantages of permeable paving, in combination with filter drains, are shown below.

	Advantage/Disadvantage
Advantage	Permeable paving surfaces have been demonstrated as effective in managing and reducing runoff from paved surfaces.
	Management of potential flooding at the source, ‘upstream’ of any high risk areas.
	Sustainable alternative to creating a larger capacity sewer network.
	Encourage natural groundwater recharge.
	Water treatment by pollutant removal.
	Allows multi-functional use of space.
	Reduces net volume required by the storm sewer system.
Disadvantage	Construction within the road will lead to temporary road closures.
	High associated construction cost
	Can only be constructed on highways with low traffic volumes where speed restrictions not exceeding 30mph are present.
	Annual inspection of permeable pavement will be required.

Table F1-5 Advantages/Disadvantages of Permeable Paving

Roadside Rain Garden

The purpose of the road side rain gardens system is to create a chain of surface water storage areas each connected with a filter/French drain. Surface water is temporarily stored in the soil and granular layer at the base of the structure before being gradually released into the groundwater through infiltration into the ground. Intentionally situated in roadside verges, this will provide areas of storm water infiltration and planting in the smallest area. Roadside rain gardens typically contain hydrophilic flowers, grasses, shrubs and trees.

Figure F1-6 Typical example of a roadside rain garden in Seattle USA[v]

The advantages and disadvantages of using road side rain gardens are shown in the table below.

	Advantage/Disadvantage
Advantage	Roadside rain gardens have been demonstrated as effective in managing and reducing runoff conveyed by highway surfaces.
	Sustainable alternative to creating a larger capacity sewer network.
	Encourage natural groundwater recharge.
	Reduces net volume required by the storm sewer system.
	Contribution to aesthetic appeal and habitat in urbanised areas.
	Flexible for use in areas of various shapes and sizes.
Disadvantage	Regular maintenance of vegetation, such as weeding, soil replacement and watering during dry periods.
	Inspection following large rainfall events. This includes clearing of the access channel from the road to the soil.
	Periodic replacement of planting is required.
	Retrofitting costs are high and would be disruptive in heavily urbanised areas

Table F1-6 Advantages/Disadvantages of Roadside Rain Gardens

Swales

Swales are landscape features designed to remove silt and pollution from surface water runoff (Figure F1-7) constructed with shaped sloped sides and filled with vegetation. The water's flow path, along with the wide and shallow ditch, is designed to maximize the time water spends in the swale, which traps pollutants and silt. Depending upon the geometry of land available, a swale may have a meandering or almost straight channel. A common application is around car parks or alongside roads, where substantial automotive pollution is collected by the paving and then flushed by rain. The swale treats the runoff before releasing it to the watershed or storm sewer.

Figure F1-7 Example of swale under construction (completed swale shown in background)

	Advantage/Disadvantage
Advantage	A decreased conveyance of overland flow of flood water toward an area with historical records of flooding.
	Manage the rate of runoff and reduce flooding caused by urbanisation.
	Encourage natural groundwater recharge
Disadvantage	Temporary closure of the areas during construction.
	Swales to route flow in to structures will need regular maintenance.

Table F1-7 Advantages/Disadvantages of Swales

Detention Basins

A detention basin is a large area of ground laid to grass which is dry for the majority of the time and fills up with water during periods of heavy rainfall, which it releases slowly. Permanent ponds may be incorporated towards inlets and outlets for visual amenity and settlement of silts. They can also act as offline storage structures when positioned alongside existing watercourses, which fill when river levels are high. This can help to alleviate pressure on the drainage network elsewhere in the catchment.

Figure F1-8 Example of Detention Basin © Copyright BJ Smur[vi]

The following Figure shows an offline basin during construction.

Figure F1-9 Example of an offline storage structure under construction

The advantages and disadvantages of providing this form of flood mitigation measure are as follows:-

	Advantage/Disadvantage
Advantage	Attenuation of storage of flood water when water levels are high
	Manage the rate of runoff and reduce flooding caused by urbanisation.
	Encourage natural groundwater recharge
Disadvantage	Potential health and safety implications of adding flood storage areas in and around schools without significant costs associated with education and warning requirements. However the CIRIA W12 Sustainable Water Management in Schools provides guidance on overcoming these health and safety issues.
	Temporary closure of parkland/open space during construction and when water levels are high.

Table F1-8 Advantages/Disadvantages of Detention Basins

Ponds and Wetlands

Ponds and wetlands can be used to manage storm water runoff, prevent flooding and downstream erosion. They can also be used to improve water quality in an adjacent river, watercourse or lake and to encourage biodiversity through the creation of new habitats. They can vary in size but they are essentially areas that are designed to accommodate and intercept storm water slowing their entry into nearby watercourses and/or drainage systems. They can be designed to discharge into watercourses with overflow structures pipes or weirs that only operate during flood conditions.

	Advantage/Disadvantage
Advantage	A decreased conveyance of overland flow of flood water toward an area with historical records of flooding.
	Manage the rate of runoff and reduce flooding caused by urbanisation.
	Encourage biodiversity and habitat creation.
Disadvantage	Temporary closure of the areas during construction.
	Usage dependent on underlying ground conditions/soil type.
	Swales to route flow in to structures will need regular maintenance.

Table F1-9 Advantages/Disadvantages of Ponds and Wetlands

Pathway

Improved Maintenance Regimes

This option involves the implementation of an effective maintenance regime to ensure that blockage by vegetation or deposition will not reduce the hydraulic capacity of the existing drainage infrastructure including the public drains, ordinary watercourses, highway gullies, storm and foul sewers. Maintenance would include regular inspection, treeworks, jetting and clearance of debris, gravel and silt where required.

In the context of blockage by trees, the “maintaining to a better standard” option would entail implementing good arbori-cultural practice including:

- surveys for root-plate stability of the larger specimens,
- selective thinning and coppicing of the developing scrub to increase vigour,
- thinning for better specimens,
- removal of non-native species,
- improvement of the stand for amenity, bank stability and biodiversity purposes,
- removal of major fallen dead-wood, obstacles and other debris.

The objective of these works would be to reduce the amount of woody debris liberated in flood conditions which could accumulate on bridges or in sewers.

Maintenance also assumes enforcement of notices served under the Land Drainage Act[vii]. It would be beneficial to identify assets that are more at risk of blockage than others to allow for a more pragmatic approach to setting maintenance regimes. Therefore if an asset is considered at greater risk then it should be maintained more frequently than others in the borough.

The advantages and disadvantages of providing an effective maintenance regime are:

	Advantage/Disadvantage
Advantage	Clearance of drains and swale networks will ensure that water drains freely and to the best of its design capacity.
	Regular and effective maintenance and record keeping could help to support flood defence funding decisions.
Disadvantage	Inspection of the flood defence systems and assets should take place prior to and after potential significant rainfall events, representing a burden on the asset owners, both in terms of cost and time.

Table F1-10 Advantages/Disadvantages of Maintaining Existing System

Increase Capacity in Drainage System

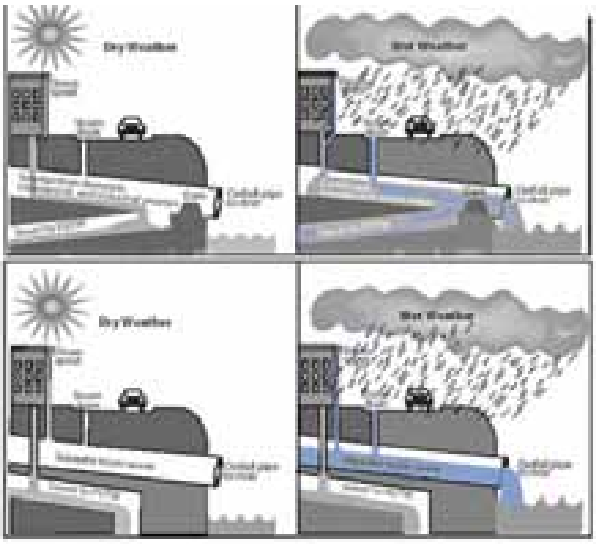
Drainage network improvements involve upsizing of sewer pipes, increased gully entry point locations, construction of off/on-line storage tanks etc. Their advantages and disadvantages are shown below.

	Advantage/Disadvantage
Advantage	Manage the rate of runoff and reduce flooding caused by urbanisation.
Advantage	Reduce the risk of manhole surcharging.
Disadvantage	Temporary closure of the roads during construction causing disruption.
Disadvantage	Network improvements are generally expensive to carry out.
Disadvantage	Could lead to an increase in flood risk downstream of the system improvements.

Table F1-11 Advantages/Disadvantages of Network Drainage Improvements

Separation of Foul & Surface Water Sewers

Historically foul and surface water sewer networks were combined into one piped system. In areas where urbanisation has significantly increased along with the expanse of impermeable surface this combined network is not always capable of dealing with the associated increase in surface water runoff. This can lead to an increase of sewer surcharging events resulting in effluent spilling above ground which poses a significant risk to public health. The separation of the two networks ensure that if the surface water network does surcharge there is no effluent mixed with the overflow (Figure F1-10).



F1-10 Example of a combined sewer system at the top and a separated sewer system at the bottom (Department for Environmental Protection, 2011[viii])

The advantages and disadvantages of sewer separation are provided below.

	Advantage/Disadvantage
Advantage	Manage the rate of runoff and reduce flooding caused by urbanisation.
	Significant reduction in the likelihood of effluent flooding.
	Reduce the risk of manhole surcharging.
Disadvantage	Temporary closure of the roads during construction causing disruption.
	Network improvements are generally expensive to carry out.

Table F1-12 Advantages/Disadvantages of Sewer System Separation

Managing Overland Flows

This option involves the installation of raised features to manage overland flow through an area. Raised features such as high kerbs and full width speed humps can be used to divert flow along carriageways when the sewer system is overburdened (Figure F1-11).

F1-11 Example of a speed hump (Geograph, 2011[ix]) and of raised kerbing (Barkingside, 2009[x])

The advantages and disadvantages of overland flow management are provided below.

	Advantage/Disadvantage
Advantage	Contain surface water runoff in the road carriageway preventing property flooding.
	Speed humps will also have a traffic calming effect.
	Would be quick to implement, depending on scale of management required.
Disadvantage	This setup can cause the temporary closure of the roads during a flood event.
	Disruption caused during the initial installation of both overland flow options.
	Depending on the scale of management required this can be quite an expensive option to implement.

Table F1-13 Advantages/Disadvantages of Overland Flow Management

Land Management Practices

Through the masterplanning of strategic growth areas or large development sites, modification of land contours, profiles and ground levels may be used to channel surface water flows away from property and infrastructure. The advantages and disadvantages of land management practices are provided below.

	Advantage/Disadvantage
Advantage	Highly effective method for surface water flooding of property and/or infrastructure.
Disadvantage	This can be a disruptive option to implement particularly in areas where there is existing occupied development.
	This will be a costly option to implement and may require on-going management to ensure modifications which adversely affect the effectiveness of the measure are not subsequently made by occupiers.

Table F1-14 Advantages/Disadvantages of Land Management Practices

Receptor

Improved Weather Warning

In key flood risk areas this could be a beneficial option to ensure that residents with temporary/demountable defences have time to prepare their properties prior to an event. Monitoring stations could be put in place by both the EA and WW in areas that are particularly prone to flooding. An alarm system or call centre contact approach could be used to alert residents prior to an event.

The advantages and disadvantages of weather warning are provided below.

	Advantage/Disadvantage
Advantage	Will give local residents more time to prepare their property for an event.
	Will allow for better monitoring of frequency of flood events and may allow for the identification of key causes.
	Would be relatively straight forward to put the monitors in place.
Disadvantage	Requires a system to be in place for contacting the local residents, this can be costly and disruptive depending on the system.
	Can be a costly option depending on the number of monitors required.

Table F1-15 Advantages/Disadvantages of Improved Weather Warning

Planning Policy

In preparing this Surface Water Management Plan consideration has been given to the potential of policy as well as engineering interventions to contribute to flood risk mitigation. In developing its Development Management and other local planning policies, in support of the Local Flood Risk Management Strategy, it is recommended that SCC give consideration to the following matters:

- the need to avoid 'urban creep';
- using redevelopment opportunities to improve the drainage characteristics of the site over those which currently exist;
- using water corridors to achieve sustainability and where appropriate public access benefits;
- deculverting of watercourses; and
- improving the surface water management through the design and layout of development.

Urban creep is the term used to refer to the cumulative impact on towns and cities of gradual increases of impermeable areas. The Pitt Review discussed the risks relating to urban creep and through Recommendation 9 expressed the view that urban creep should be minimised. Recommendation 9 of the Pitt Review recommended that: "Householders should no longer be able to lay impermeable surfaces as of right on front garden and the Government should consult on extending this policy to back gardens and business premises". To date this has not been extended to back gardens and business premises but this study highlights the importance of considering such initiatives within the Wetspots assessed.

As a minimum all new development in Taunton that go through a Flood Risk Assessment process must provide betterment to greenfield run off rates in the existing site. The SWMP can be used as part of the Local Development Framework evidence base to support local policies and provide additional evidence base for the wetspots identified. Local policies should be developed to deculvert sections of local watercourses and safeguard river corridors from future development to reduce flood risk and maximise environmental benefits.

Development design and layout should be considered in terms of making efficient use of land and ensuring that the resulting urban form achieves sustainable management of surface water. There are opportunities to work with the natural topography for cost effective and sustainable developments that minimise engineering land movement.

There are opportunities to provide new outdoor amenity space, areas of biodiversity, and new recreational uses within areas of higher flood risk. The key SuDS features such as swales, detention and wetlands areas should be located within public open spaces. Where this is not possible due to the extent of current urbanisation, suitable easement land strips should be incorporated within the design layout development and land covenants to avoid potential access and riparian ownership issues to safeguard long-term maintenance.

It is also considered that flood risk can be mitigated through a progressive policy on planning and urban design. This would include rolling out design policies associated with:

- The use of SuDS on all new developments to reduce overall flood risk and to remove surface water from the storm sewer system.
- Encouraging the use of green roofs in new development.
- Incorporation of SUDS and highway source control measures within highway, traffic calming and community schemes.
- Minimisation of the use of hard landscaping in conjunction with the use of positive drainage systems to remove surface water.

Social Change, Education and Awareness

As part of education and awareness, it is important that residents within key flood risk areas are made aware of what to do when a flood occurs, who they should contact and the information that they should provide. It is also important that Council staff can respond swiftly and appropriately when alerted to a flood event. SCC in conjunction with WW and the EA could hold meetings in key risk areas and/or produce information leaflets for local residents to outline this information.

Within SCC any staff that may possibly be contacted by the general public should be made aware of the most appropriate method for recording a flood incident within the borough. Staff should be made aware of what key information is required to ensure that the event is fully logged and that it is passed onto the relevant person within SCC for resolution. Even if the flooding incident is not from a source within the administrative area of SCC, staff should still record the incident and refer the member of the public to the relevant body responsible.

Collaboration between SCC, WW and the EA to educate local residents to make them more aware of the impact small property level changes can have on local flood risk. Introducing property level options that residents could implement themselves such as green roofs, water butts and permeable paving to reduce localised flood risk would be beneficial. Informing local residents of the available property level protection measures will improve general awareness and may encourage residents to make their own preparations to protect their properties against future floods.

Improved Resilience and Resistance Measures

Property resistance measures are those which prevent flood water from entering a property. Resistance measures include:

- Flood resistant gates
- Periscope air vents
- Waterproof wall renders and facings
- Non return valves in waste pipes and outlets
- Temporary measures such as free standing barriers, door boards, flood skirts and airbrick covers
- Water resistant external doors and windows

The advantages and disadvantages of this option are outlined below.

	Advantage/Disadvantage
Advantage	Installation of these measures will help to minimise the likelihood of flow entry into property.
	Allows for faster community recovery following an event.
	Gives residents peace of mind at low return period events.
Disadvantage	Many of these measures are temporary so need to be fitted by the residents prior to a flood so require the resident to be at home to put up/install the resistance measures.
	Sufficient warning needs to be provided to ensure the residents have time to respond.
	To be most effective several resistance measures need to be implemented which can be quite costly.
	Only provides protection to property for low return period events.

Table F1-16 Advantages/Disadvantages of Property Resistance Measures

Property resilience measures are those that are carried out within a property to minimise internal floodwater damage. Resilience measures include:

- Tanking
- Concrete floors
- Raised electrical sockets
- Horizontal plasterboard replacement
- Flood resilient kitchens – plastic, stainless steel, free standing removable units
- Water resistant internal walls (rendered or tiled)
- Plastic skirting boards
- Pump and sump systems in place
- Water resistant internal doors
- The advantages and disadvantages of this option are outlined below:

	Advantage/Disadvantage
Advantage	Minimises property damage during a flood event
	Quicker recovery of property after an event
	Gives peace of mind to residents during an event
Disadvantage	This is a costly option for a property owner to have to implement
	Relies on all adjoining properties implementing resilience measures to ensure the scheme is effective

Table F1-17 Advantages/Disadvantages of Property Resilience Measures

Raising Doorway/Access Thresholds

This is a permanent resistance measure which involves the raising of property access points through the incorporation of steps or a ramped access.

The advantages and disadvantages of this option are outlined below.

	Advantage/Disadvantage
Advantage	Installation of these measures will help to minimise the likelihood of flow entry into property.
	Allows for faster community recovery following an event.
	Permanent measure so there is no need for the resident to be in place to install the measure.
	Gives residents peace of mind at low return period events.
Disadvantage	This is a costly measure to implement into existing residential properties.
	This option alone will not completely protect a property other measures may also be necessary.
	Only provides protection to property for low return period events.

Table F1-18 Advantages/Disadvantages of Raising Doorway/Access Thresholds

Temporary or Demountable Flood Defences

This option involves the installation of fittings to allow for the placement of temporary/demountable flood defences at a property level.

The advantages and disadvantages of this option are outlined below.

	Advantage/Disadvantage
Advantage	Installation of these measures will help to minimise the likelihood of flow entry into property.
	Allows for faster community recovery following an event.
	Gives residents peace of mind at low return period events.
Disadvantage	Sufficient warning needs to be provided to ensure the residents have time to respond.
	This measure is temporary so needs to be fitted by the residents prior to a flood which requires the resident to be at home to put up/install the resistance measures.
	To be most effective several resistance measures need to be implemented which can be quite costly.
	Only provides protection to property for low return period events.

Table F1-19 Advantages/Disadvantages of Temporary/Demountable Flood Defences

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[i] Ecotips (2010), http://www.4ecotips.com/eco/article_show.php?aid=2235&id=243

[ii] BCProfiles (2011), http://www.bcprofiles.co.uk/aco-soakaway/cat_49.html

[iii] Water Features Online (2011), http://www.google.co.uk/imgres?imgurl=http://www.oak-barrel.com/plastic_water_butts/child_safe_water_butt.jpg&imgrefurl=http://www.oak-barrel.com/plastic_water_butts/227litre_child_safe_water_butt.htm&usg=__cU8xels-tj1p8QtxpW4Kmors9FQ=&h=272&w=200&sz=19&hl=en&start=0&zoom=1&tbnid=sQej9C4PW7JmTM:&tbnh=134&tbnw=95&ei=tezQTc-vFYuwhAffreypDQ&prev=/search%3Fq%3Dwater%2Bbutts%26um%3D1%26hl%3Den%26biw%3D1259%26bih%3D839%26tbm%3Disch&um=1&itbs=1&iact=hc&vpx=135&vpy=165&dur=218&hovh=217&hovw=160&tx=96&ty=111&page=1&ndsp=32&ved=1t:429,r:0,s:0

[iv] Lowenergyhouse.com (2011), http://www.lowenergyhouse.com/rainwater-harvesting.html

[v] http://www.myballard.com/2010/05/12/roadside-raingardens-coming-to-ballard/

[vi] http://www.geograph.org.uk/photo/1817340 © Copyright BJ Smur and licensed for reuse under this Creative Commons Licence

[vii] Land Drainage Act 1991

[viii] Department for Environmental Protection (2011), http://water.ky.gov/permitting/Pages/CombinedSewerOverflows.aspx

[ix] Geograph (2011), http://www.geograph.org.uk/photo/19466

[x] Barkingside (2009) http://barkingside21.blogspot.com/2009_06_01_archive.html

Appendix G

Economics

Economic Appraisal

Introduction

Aims and Objectives

This appendix presents the methodology and results of the economic appraisal carried out to support the Taunton Surface Water Management Plan (SWMP). This appendix is intended to accompany the SWMP and describes in detail the methodology and results of the economic appraisal. The appraisal has resulted in the calculation of benefits associated with potential surface water flooding mitigation measures. These have been incorporated into the option appraisal and decision process detailed in the main SWMP document. It is important to note that any assessment of costs and benefits associated with flood risk management options is affected by a range of assumptions and limitations, associated with both the method of simulating extreme flood events using a hydraulic and the approach to applying this modelled flood information to an economic assessment of property damages. This appendix is designed to document these assumptions and limitations.

Background

The Staplegrove study area was selected for assessment by the stakeholders during the development of the SWMP. The study area selected is a suburb of Taunton, located on the northern-eastern edge of the town. This area is mainly residential and includes private homes, some commercial buildings and recreational facilities.

Options Considered

The following options to alleviate or manage surface water flooding have been selected by the stakeholders and assessed for the study area.

Do Nothing. The option assumes that no maintenance, clearance or other intervention is made to interfere with the natural fluvial processes or sewer network. The evaluation of the "Do Nothing" option is a technical requirement to enable comparisons to be made between the "Do Minimum" and "Do Something" options. Should maintenance cease, it has been assumed that the surface water drainage network would fail within a short timeframe. Somerset County Council (SCC) indicated that failure of the surface water system would be expected, under such circumstances, within 10 years.

Do Minimum. This option assumes the continuation of existing maintenance of the storm sewers, ordinary watercourses and highway drainage including: gully cleaning; jetting; removal of debris / vegetation; treeworks; and periodic removal of deposition and sediments. It is assumed that this maintenance is sufficient to result in the preservation of the existing drainage network throughout the assessment period.

Following an option long-listing process, to which the stakeholder group contributed, a set of potential Do Something options specific to the study area were identified. These are detailed in the main SWMP document, and summarised as follows:

Option B - Water diverted from Staplegrove Rd- 15,500m³. A 15,500m³ partly-bunded attenuation pond with a bed elevation of 25m AOD. The attenuation pond would be located along Staplegrove Road, south of Westerkirk Gate. Water would be diverted from Staplegrove Road by a 0.75m diameter gully drain discharging into the pond.

Figure 1 – Option B

Option C - Water intercepted at Rectory Rd- 15,500m³. Option C would channel surface water from Manor Road (south of Manor Road-Rectory Road junction) to discharge into a partly-bunded attenuation pond with the same specification as Option B without the drainage from Staplegrove Road. The water would be diverted into the attenuation pond via a 350m long, 0.75m diameter culvert.

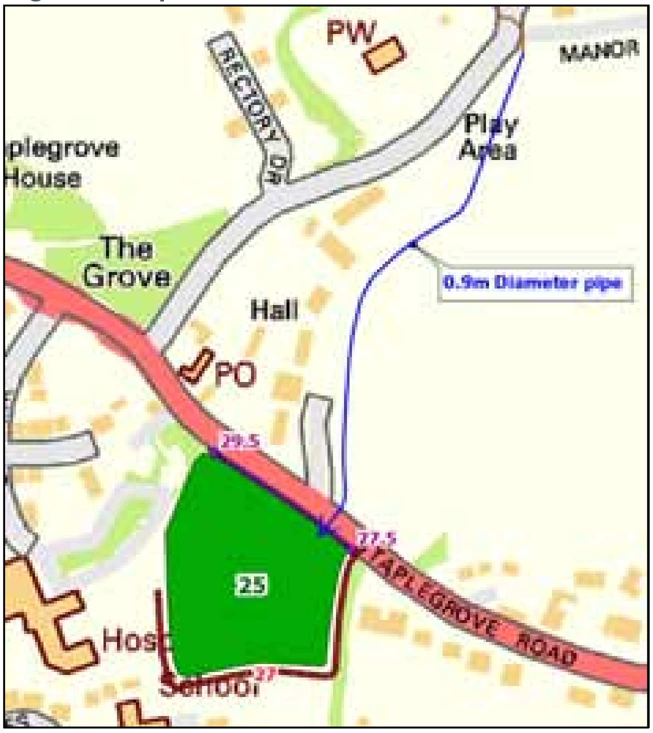
Figure 1 – Option C

Option D - Water diverted off Staplegrove Rd- 25,700m³. Option D is the same as Option B with a greater storage capacity of 25,700m³, achieved through higher embankments and a larger plan area of the attenuation pond.

Figure 3 – Option D

Option E - Water intercepted at Rectory Rd- 25,700m³. Option E is the same as Option C with a greater storage capacity of 25,700m³, achieved through higher embankments and a larger plan area of the attenuation pond.

.Figure 4 – Option E

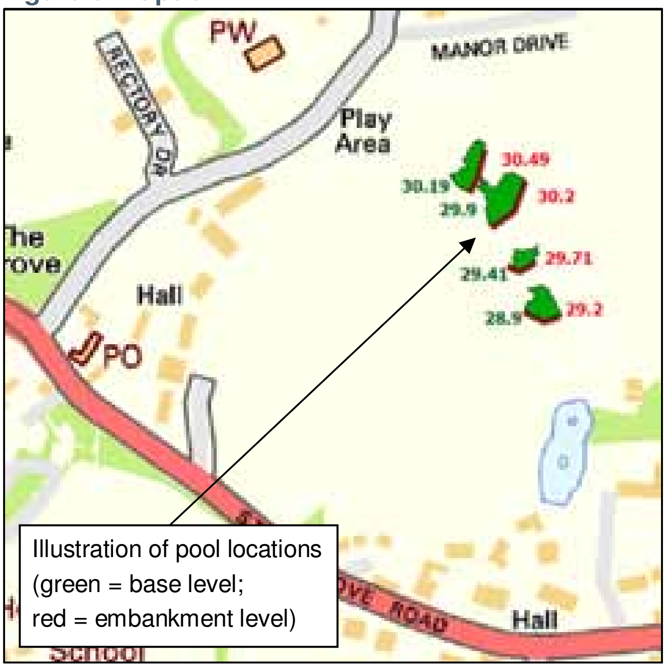


Option G - Water intercepted at Rectory Rd, "maximum intervention" 27,500m³. Option G is a large-scale attenuation feature that has been termed the "maximum intervention option" at Rectory Road since it is designed to provide complete attenuation of a flow pathway which results in flooding to the south. The volume of water within the attenuation area would be approximately 27,500m³, but this option would be designed without raised embankments, with the entire volume provided through excavation below existing ground levels..

Figure 5 – Option G

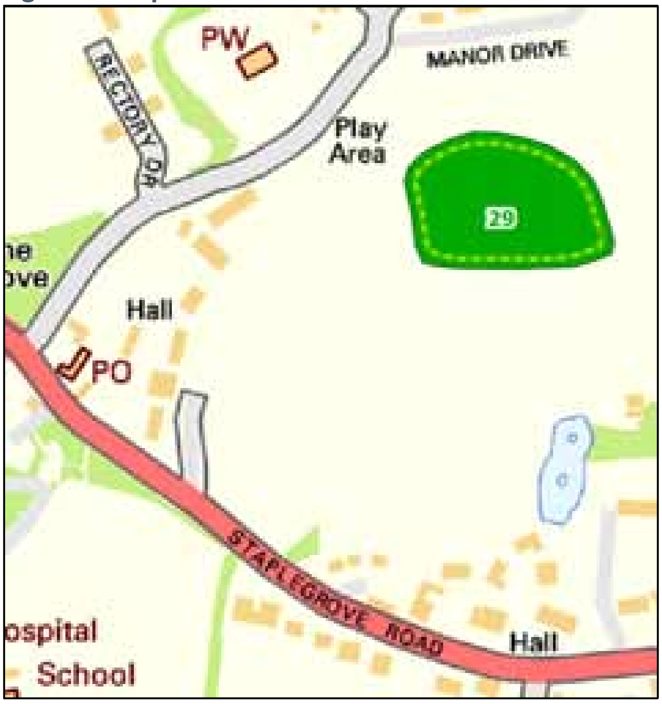
Option H - Water intercepted at Rectory Rd "minimum Intervention" 800m³. In contrast to Option G, Option H is a series of low-level scrapes designed to maximise existing undulations and provide additional attenuation, although not elimination, of the main flow route. It is therefore termed the 'minimum intervention option' in comparison to Option G. The maximum depth of the attenuation would be 300mm to keep the attenuation shallow, with small local embankments used to simply accentuate existing areas where larger pools would form following heavy rain.

Figure 6 – Option H



Option I - Water intercepted at Rectory Rd, "medium Intervention" 4,300m³. Option I is designed to sit between Options G and H, dealing with the same flood flow pathway, but striking a balance between small scrapes and a significant volume of storage. The volume of water within the attenuation area would be approximately 4,300m³.

Figure 7 – Option I



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Appraisal Methodology

Overview

This section provides details of the economic analysis carried out in support of the SWMP. Details of the economic appraisal methodology are presented along with the results of the cost-benefit analyses. The methodology used in this appraisal follows the principles of the Flood and Coastal Erosion Risk Management Appraisal Guidance (FCERM-AG; Environment Agency, 2010a) the Multicoloured Manual (MCM; Flood Hazard Research Centre, 2005), the Multicoloured Handbook (Flood Hazard Research Centre, 2010) and the Treasury Green Book (HM Treasury, 2003).

A 100 year appraisal period has been used and future damages, costs and benefits have been discounted using HM Treasury discount rates beginning at 3.5%. The appraisal has been carried out using a base date for estimates of October 2012, the most recent date for which inflation information (based on the Retail Prices Index, RPI) was available at the time of appraisal.

Flood damages from the MCM Handbook (price date January 2010) have been updated to the appraisal base date using RPI.

Property List

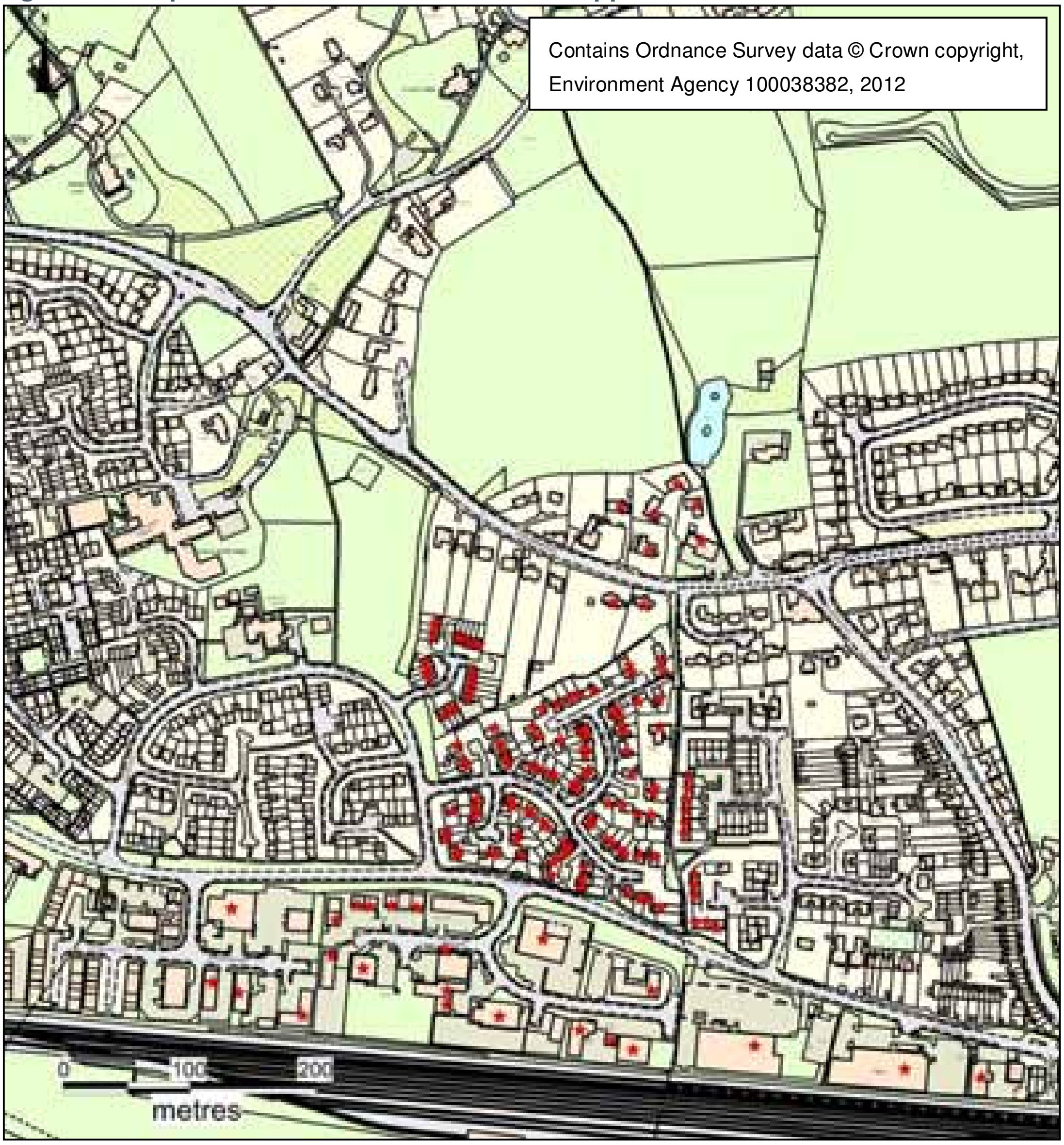
Somerset County Council (SCC) provided the National Receptor Dataset (NRD) for use in this study. NRD data contains information on property type, floor area and floor level (differentiating between upper and ground flood properties, for example).

The NRD dataset includes a large number of property entries with '900' MCM codes, identified, for example, as 'electricity substations' and 'tanks'. Given the difficulties with estimating the value and assigning MCM depth-damage data to these types of 'property' within a large strategic study area, all those with '900' codes were removed from the assessment.

The NRD was mapped for Taunton and properties located outside of the Staplegrove study area were removed from the assessment. All properties recorded as upper floor were also removed from the assessment. In order to focus the appraisal and ensure that baseline damage values were proportionate, the study area for Staplegrove was refined based on the area that would directly benefit from the proposed options that address a particular flood pathway and area of ponding. A total of 157 properties were included in the edited NRD dataset for Staplegrove.

Properties were assigned a standard threshold level of 150mm above a ground level extracted from LiDAR data. This threshold was applied to each property, in common with best practice when utilising LiDAR data to inform estimates of property floor levels. Since there is a level of uncertainty regarding the threshold level of properties, this assumed threshold level is explored further in the sensitivity analysis section. In practice, since the nature of the direct rainfall modelling undertaken means that every cell in the flood model experiences a depth of rainfall, thresholds were incorporated by subtracting the 150mm from the flood depth values assigned to each property.

Figure 8 – Properties included in the economic appraisal



Property Valuation and Capping

As standard in this type of assessment, properties were assigned a market value in order that individual property present value damages (PVd) were 'capped' if necessary, to prevent then exceeding that property's market value over the appraisal period. These 'capping values' were derived according to Environment Agency best practice (Environment Agency, 2008). Distributional impacts (DI) were considered, in order to remove social class bias from the property value estimates. A DI factor was calculated using Approximate Social Grade data for Staplegrove (UV50) ward area, available from neighbourhood.statistics.gov.uk. This method is presented in Table 1 below.

Table 1 – Derivation of Distributional Impact Factor, West Somerset

Social Class	DI Weighting Factor	Count	%	Weighting x %
AB	0.74	777	23.3	0.19
C1	1.12	956	32.4	0.36
C2	1.22	442	15.0	0.18
DE	1.64	779	26.4	0.43
Total		**2,954**	**100.0**	**1.17**

Residential property valuations were based on regional average property sale prices for Taunton for August 2012 (source: Home.co.uk), using the latest data available, multiplied by the DI factor of 1.17. This resulted in the capping values listed in Table 2 below. It is important to note, however, that capping is unlikely when surface water flooding is under consideration, since the depth of flooding is often insufficient to result in significant enough damages to exceed a property market values unless flooding occurs very frequently.

Table 2 – Residential Capping Values

Property Type	Capping Value including DI factor
All	£227,068
Detached	£344,334
Semi-detached	£230,604
Terraced	£184,654
Bungalow	£344,334
Flat/Maisonette	£140,657

Flood Levels and Representation of Scenarios

The long list of options described above has have been analysed in a high-level review considering technical, economic and environmental factors to determine which options were appropriate to short-list for further consideration. This is in line with the approach detailed in the FCERM-AG, which aims to ensure that appraisal work is not abortively spent pursuing options which could be ruled out based on a considered analysis without detailed appraisal. This review is summarised and presented in Table 3 below.

Table 3 – Summary of High Level Option Review

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
Option A- Do Minimum	Undertake maintenance works to existing surface water sewer system. It is assumed that, with regular maintenance, the drainage network will continue to operate as it currently does.	Outline assessment indicates that this option currently prevents a maximum of nine properties from flooding. Costs would remain as under the current maintenance regime.	No impacts predicted as this option maintains the current maintenance regime.	**Yes**
Option B- Water diverted off Staplegrove Rd- 15,500m³	A 15,500m³ attenuation pond with a bed elevation of 25m AOD. The attenuation would be located along Staplegrove Road, south of Westerkirk Gate. Attenuation would be contained within an embankment with an elevation of 27mAOD tying into higher ground in the north-west corner of the attenuation pond. There would be a further bund along the Staplegrove Road boundary to reduce the rate of surface water inundation discharging into the pond. Water would be diverted from Staplegrove Road by a gully drain discharging into the attenuation area. Once the relevant part of the Flood and Water Management Act are enacted, the resultant pond would require classification and management as a reservoir under the Reservoirs Act 1975 and amendments.	Outline assessment indicates that this option would remove a maximum of only 20 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This would be a large scale intervention, likely to result in high capital and maintenance costs, including those associated with classification as a reservoir.	Large-scale attenuation in a school playing field would give rise to potential health and safety issues with water depths approaching 1m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	**No** – significant long term commitment required to maintain and preserve safety associated with significant storage option. Health and Safety implications could render it unachieveable, especially given the magnitude of flooding it is designed to protect against and the disproportionate nature of this as a proposed solution.
Option C- Water intercepted at Rectory Rd- 15,500m³	Option C would channel surface water from Manor Road (south of Manor Road-Rectory Road junction) to discharge into an attenuation pond with the same specification as Option B minus the drainage from Staplegrove Road. The water would be diverted into the attenuation pond via a 350m long, 0.75m diameter culvert. Once the relevant part of the Flood and Water Management Act are enacted, the resultant pond would require classification and management as a reservoir under the Reservoirs Act 1975 and amendments.	Outline assessment indicates that this option would remove a maximum of 25 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs.	This option would actually increase flood risk on Manor Road and in the vicinity of the school building. Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 1.4m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	**No** – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachieveable.

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
Option D- Water diverted off Staplegrove Rd- 25,700m³	Option D is the same as option B with a greater storage capacity of 25,700m³. This would mean that the storage area would be considered a reservoir under the current Reservoirs Act and amendments, regardless of the implementation of the Flood and Water Management Act.	Outline assessment indicates that this option would remove a maximum of 21 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs.	Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 0.50m. This attenuation area would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	**No** – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachieveable.
Option E- Water intercepted at Rectory Rd- 25,700m³	Option E is the same as Option C with a greater storage capacity of 25,700m³.	Outline assessment indicates that this option would remove a maximum of 26 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. As Option B, this would be a large scale intervention likely to result in high capital and maintenance costs.	This option would actually increase flood risk on Manor Road and in the vicinity of the school building. Large scale attenuation in a school playing field would give rise to potential health and safety issues with flood depths up to 1.0m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	**No** – as option B, this would be a costly option that would require a long-term commitment to maintain and would be subject to significant health and safety considerations which could render it unachieveable.
Option G- Water intercepted at Rectory Rd- Maximum intervention 27,500m³.	Option G is a large-scale attenuation feature which has been termed the “maximum intervention option” at Rectory Road since it is designed to provide complete attenuation of a flow pathway which results in flooding to the south. The attenuation would be located on the flow path running north-south through the fields between Manor Road and Staplegrove Road. The attenuation feature would be situated where existing terrain had the least incline to make use of the existing elevations. The attenuation area would result in the land being excavated to an elevation of 27m AOD, 4-2m below ground level. The volume of water within the attenuation area would be approximately 27,500m³.	Outline assessment indicates that this option would remove a maximum of only 20 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This would be a large scale intervention, likely to result in high capital and maintenance costs, including those associated with classification as a reservoir.	Large-scale attenuation in a school playing field would give rise to potential health and safety issues with water depths approaching 1m. Due to the volume of water attenuated it is likely the storage would be classified as a reservoir. It would be expected that additional onerous heath and safely requirements would result from the location in a residential area.	**No** – significant long term commitment required to maintain safety associated with significant storage option. Health and Safety implications could render it unachievable, especially given the magnitude of flooding it is designed to protect against and the disproportionate nature of this as a proposed solution.

Option	Technical Details	Economic Factors	Environmental Factors	Shortlisted
Option H- Water intercepted at Rectory Rd- Minimum Intervention- 800m³	In contrast to Option G, Option H is a series of low-level scrapes designed to maximise existing undulations and provide additional attenuation, although not elimination, of the main flow route. It is therefore termed the 'minimum intervention option' in contrast to Option G. A series of four small attenuation areas would be located in the same location as the proposed storage area in Option G, designed to 'hold up' the flow of surface water without storing large volumes. The maximum depth of the attenuation would be 300mm to keep the attenuation shallow and just accentuating existing areas where larger puddles would form.	Outline assessment indicates that this option would remove a maximum of 11 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. This option is likely to be less costly, in tandem with a reduction in benefits, but its appearance may be more proportionate to the risk of flooding and the historic records in the local area.	Series of small scrapes could be achieved through landscaping and would not represent a large-scale engineering option. Health and safety implications would be minimised by simply augmenting existing areas of ponding during heavy rainfall.	**Yes** – by augmenting existing areas of ponding, it may be possible to reduce the intensity of flooding experienced "down-slope". Further investigation warranted.
Option I- Water intercepted at Rectory Rd- Medium Intervention 4,300m³	Option I is designed to sit between Options G and H, dealing with the same flood flow pathway, but striking a balance between small scrapes and significant volume of storage. The attenuation area has been located on the flow path running north-south through the fields between Manor Road and Staplegrove Road. The scrape was situated where existing terrain had the least incline and makes use of the existing elevations. The attenuation area above has a constant elevation of 29m AOD, the elevation is tied into existing ground elevations (approximately 1-2m below ground level). The volume of water within the attenuation area would be approximately 4,321m³.	Outline assessment indicates that this option would remove a maximum of 17 properties from flood risk. Wider benefits would be attributed to reductions in flood risk at other properties still flooded for equivalent events. Although not as intrusive as Options B-G, this option would still involve creation of storage requiring high capital and maintenance costs.	Location of the attenuation area to capture flow would result in three field boundaries being crossed. A footpath is located through the proposed attenuation area.	**Yes** – by providing storage but avoiding the onerous requirements associated with large volumes, it may be possible to reduce the intensity of flooding experienced "down-slope". Further investigation warranted.

Options Selected Following High Level Option Review

Do Minimum

Continuing with the current maintenance regime has been taken forward for detailed assessment against the Do Nothing baseline.

Option H - Water intercepted at Rectory Rd - Minimum Intervention

The option would be hydraulically-connected to the flow path and affect the progress of flood flow. The option would comprise a series of four small scrapes. It could be considered a 'minimum intervention' in terms of attempts to impact on this flow path since the scrapes would be dry features for the majority of the time, simply increasing natural ground undulation to provide some small degree of attenuation. The maximum depth in the attenuation features would be around 300mm to keep flooding shallow and proportionate. This is not a whole-scale solution designed to store or attenuate extreme events, rather a more nuanced scheme to reduce regular flooding and limit the need for time-consuming and costly future maintenance. The total volume of water that would be attenuated over the four attenuation ponds is approximately 800m^3.

Option I- Water intercepted at Rectory Rd - Medium Intervention

The option would be hydraulically-connected to the flow path and capture flood flows. The attenuation would be located in fields, not adjacent to residential areas. To capture the existing flow path, the attenuation area would have to be located in the route of an existing footpath, which would most likely require diversion. There would, however, be potential for additional benefits in terms of landscaping to form an attractive feature alongside the diverted footpath subject to land-use. This option could be considerd a "medium intervention" option since it would provide 4,300m^3 of potential storage and as such sits between the smaller and larger options G and H respectively. It would provide greater attenuation than the also short-listed Option H, but does not involve storage of such a significant amount of water as Option G, which was ruled out from further consideration because of its disproportionate size and onerous long-term maintenance and safety requirements.

Property Damages

Property damages were calculated using the MCM depth-damage data from the 2010 Multi-coloured Handbook (Flood Hazard Research Centre, 2010). Depth-damage data without basements was used. In line with the modelled results, depth-damage data for flood durations of less than 12 hours was used. Flood depths for individual properties were extracted using a point analysis of the modelling outputs.

Property annual average damages (AAD) were calculated and discounting applied to result in a single value of present value damages (PVd) for each scenario. It was assumed that present-day conditions remain throughout the appraisal period. The potential for climate change to impact on the appraisal results is considered in the sensitivity section.

Emergency Services

Emergency services costs were incorporated in the assessment by adding 5.6% to all calculated property damages. This is as stated in the Multi-coloured Handbook, and is lower than used in previous assessment prior to 2010, reflecting the economies of scale found when providing emergency services provision to built-up areas as informed by data from the 2007 floods.

Assumptions

The following are considered the three assumptions of most importance in the economic assessment:

Assumption 1 – Property thresholds across the study area are 0.15m and no below floor level flooding of properties will occur. The number of properties in the study area means that it would not be possible to survey threshold levels for each property nor estimate these using site observations or photographs. As such, an assumed threshold level of 0.15m at all properties has been incorporated. Furthermore it has been assumed that no damage occurs to property when the flood level at the property is between 0 - 0.15m (below the threshold). It is possible that flood water can still enter properties below the threshold level via airbricks but this is not considered in this damages assessment. This decision has been taken in part based on the direct rainfall modelling approach that has been applied, which means that all cells within the hydraulic model experience a depth of flooding (associated with rainfall landing on all areas modelled). In practice, this approach cannot account for the fact that sloping roofs and drainage systems serve to direct rainfall initially away from properties, such that flooding causing damages should only occur when ponded rainfall reaches a property.

Assumption 2 – Damage to property does not occur for flood events more frequent than a 1 in 10 event. The smallest flood event modelled was a 1 in 10 event. Whilst it is possible within the flood damage equations to interpolate flood damages for more frequent event, these damages would not be based on any modelled outputs and as such are subject to significant uncertainty. Furthermore, since they occur more frequently within the appraisal process, they have a disproportionate impact on present value damages. As such, and in keeping with the approach set out in FCERM-AG, it has been assumed that no damages occur to property within the study area at for more frequent flood events than the 1 in 10 event modelled..

Assumption 3 – Failure of the surface water drainage network under the Do Nothing Option occurs in year 10. Somerset County Council has advised that the surface water drainage network would be likely to have failed within 10 years, without any maintenance or capital works. To represent gradual failure of the surface water network the Do Nothing Present Value damages are constructed by beginning with the Do Minimum damages at Year 0 and gradually moving to Do Nothing by Year 10 by interpolating between the damage values.

Exclusions

The following key items were excluded from the assessment, in keeping with the approach in the FCERM-AG that appraisal should be targeted at those items which are likely to influence the decision-making process:

Transport disruption: flooding within Staplegrove has the potential to impact on transport systems and networks, which could add to the economic impact of flooding. Since appraising such disruption would require modelled outputs and additional appraisal time, this was not investigated further, and is an example of an exclusion that can be assumed to result in a potential underestimation of total damages.

Recreational losses: In keeping with the scope of appraisal work available, investigation of any recreational benefits has not been progressed. Surface water flooding, while disruptive and damaging to property, is not necessarily considered to result in loss or damage to recreation in the way that fluvial or coastal flooding can in certain areas..

Environmental Benefits: Consideration of environmental benefits associated with preventing surface water flooding has not been progressed in this appraisal. Whilst some environmental benefit can be attributed to surface water flooding measures such as retrofitting SUDS or providing flood storage, this was not assessed at this stage.

Human intangible benefits: these perceived benefits attributable to Do Something options were not included. This is because it is unlikely that the general public would feel any benefit for being 'protected' from surface water flooding (as may be the case alongside a flood wall, for example), especially as there is a limited history of flooding from surface water in Staplegrove.

Risk to life: Although surface water flooding can occur rapidly and without significant warning, it is highly unlikely that depths or velocities would be observed that could lead to a significant risk to life, as may be the case for fluvial or coastal flooding. Therefore this has not been considered further in this assessment.

Temporary accommodation: Costs can be incorporated into economic assessments by allowing for an average rental cost, post-flood, of £5.7k per property flooded. This figure was determined in a review of the summer 2007 floods (Environment Agency, 2010b). The shallow depths associated with the majority of surface water flooding in this assessment, and the potential for the number of properties to be disproportionate to the amount of damage caused, mean that temporary accommodation has been excluded in this assessment. The effects of this exclusion of temporary accommodation costs are discussed further in the sensitivity analysis section.

Option Costs

Costs for each option were developed in the form of a capital construction costs (at year 0 and a future construction cost at year 50) and annual maintenance costs. High-level capital costs for each of the Do Something options were calculated using experience from similar studies, reference to unit cost databases and price books (e.g. SPONS). It is important to note that these costs have been developed to a level of detail suitable for high-level comparison in a strategic study.

The existing maintenance costs for Staplegrove were provided by Wessex Water and deemed appropriate to use in this study by Somerset County Council. The suggested annual maintenance cost for the Staplegrove study area for use in the assessment was **£10,000**. The present value costs are show in Table 4, along.

Table 4 – Option Cost Estimates

Option	Capital Costs	Annual Maintenance Costs
Do Minimum	-	£10,000
Option H- Water intercepted at Rectory Rd- Minimum Intervention	£64,500	£10,500
Option I- Water intercepted at Rectory Rd- Medium Intervention	£359,000	£12,000

Option H involves small-scale landscaping works and, as such, the option relates to the ongoing maintenance of the existing drainage network, and does not introduce any new significant assets to the maintenance schedule. However, it is anticipated that additional low level maintenance will be required to check that the shallow 'hollows' have not been in filled with vegetation and to account for routine clearing of the areas. The Do Minimum maintenance costs have been increased by 5% to account for the additional maintenance. For Option H the additional maintenance budget covers tending to the small scrapes and clearing any obvious debris from the areas.

Option I is a larger-scale engineered option and therefore it is anticipated that the option will incur higher maintenance costs compared to the existing regime. This assumption is due to the option involving the creation of a large storage area requiring additional and more frequent maintenance than Option H. The Do Minimum maintenance costs have been increased by 20% to account for this additional maintenance. For Option I the additional maintenance budget covers tending to a larger landscaped storage area, clearing any obvious debris, maintaining signage/safety and repairing any defects to flow exit point (e.g. reinforced bank on downstream side).

The FCERM-AG recommends that, for strategies, as detailed design will not have been carried out, unit rates can be used to give an indication of the scale of the costs. Unit rates and the experience of the project team are required to be able to assign indicative costs for options. Sufficient allowance for error should be made for the uncertain nature of cost estimates at the strategic level. The cost estimates reflect the strategic nature of the assessment. The costs are outline and provide indicative costs of the potential works. The costing of both the attenuation options would need to be subject to further investigation at further stages in the development of any potential options. The estimated costs should not be used for detailed assessment and would need refinement for any future studies investigating similar options.

Optimism bias is a risk-based contingency approach, which should be used to ensure that the tendency for early assessments of project costs to be overly optimistic. Optimism bias of 60% has been applied to option costs, since the SWMP is equivalent to a strategy, in line with HM Treasury Green Book policy, restated in 2010 in the Environment Agency FCERM-AG. Future costs have been discounted accordingly.

Results

Property Counts

The economic appraisal resulted in the following counts of properties affected by flooding. Within the assessment area there are 131 residential properties and 26 commercial properties. Table 5 presents the property counts for all options. Table 5 shows the number of properties the modelling has predicted will flood for each option and per return period. It should be noted that a standard allowance for property threshold levels of 0.15m has been used in the assessment.

Table 5 –Properties accruing flood damages (flood depths outside property > 0.15m)

Annual Probability	***10***	***2***	***1.3***	***1***	***0.5***
Annual Chance	***10***	***50***	***75***	***100***	***200***
Do Nothing	15	22	28	30	43
Do Minimum	11	17	18	20	34
Option H - Water intercepted at Rectory Rd (Minimum Intervention)	10	17	18	20	32
Option I - Water intercepted at Rectory Rd (Medium Intervention)	1	17	18	18	26

The results show that the Do Something Options H and I are reducing flood risk by attenuating water in the location of the flow path which runs through the fields north to south. Option H does reduce flood risk, however the reduction is very marginal, and properties flooded either remain the same or are marginally reduced. Option I is effective for the 1 in 10 event but is less effective when attenuating larger magnitude events.

Table 6 presents the option comparison table, where present value damages (PVd) for the Do Something options are compared to generate benefits against the Do Nothing scenario. The benefit-cost ratio (BCR) is the ratio of the present value benefits provided by an option to the present value costs of providing that option. The incremental benefit-cost ratio (IBCR) compares each option to the previous option, when listed in terms of increasing cost, and indicates the value provided by an increase in expenditure. The Net present Value (NPV) is the discounted benefits minus the discounted costs.

Table 6 – Option Costs and Benefits (all values in £k)

Option number	Baseline	Option 1	Option 2	Option 3
Option name	Do Nothing	Opt A- Do Minimum	Opt H- - Minimum Intervention	Opt I- Medium Intervention
COSTS:				
PV capital costs		0	65	359
PV maintenance costs		298	313	356
PV future construction		0	77	430
Optimism bias adjustment		179	273	687
PV negative costs (e.g. sales)				
PV contributions				
Total PV Costs £k excluding contributions		477	727	1,831
Total PV Costs £k taking contributions into account				
BENEFITS:				
PV monetised flood damages	1,121	595	583	372
PV monetised flood damages avoided		526	538	749
Total PV damages £k	1,121	595	583	372
Total PV benefits £k		526	538	749
DECISION-MAKING CRITERIA: ***Based on total PV benefits***				
Net Present Value **NPV**		49	-189	-1,082
Average benefit/cost ratio **BCR**		1.10	0.74	0.41
Incremental benefit/cost ratio **IBCR**			-1.5	-0.1

Based on the high-level appraisal undertake as part of the SWMP, the Do Minimum option, maintaining existing maintenance, is the preferred option. This is shown to result in present value benefits of £526k over the appraisal period and an average BCR of 1.1:1, indicating that maintaining the existing drainage network is economically viable by a small margin.

The benefits of the Do Something Options H and I are £538k and £749k respectively. Both options include capital works, the costs of which are likely to exceed the benefits of both options and therefore both options have negative NPV. Both of the Do Something options have a benefit cost ratio of less than 1, indicating that the options are not likely to be economically feasible, with costs outweighing any expected benefit.

The results of the direct rainfall modelling show that both Do Something options have a limited effect on reducing flood risk in the study area. Table 5 shows that, when compared to the Do Minimum option, the number of properties flooded under the Do Something options remain the same or decrease slightly. This could be due to the uncertainties of the application of direct rainfall modelling results to properties and the sensitivity of the model to the shallow flood depths. It is likely that a larger scale engineered option would be more effective in reducing flood risk from the flow path which runs north-south from Rectory Road. However, it is likely that the cost of such an option would be prohibitive and is likely to be economically unfeasible.

Sensitivity Tests

To reflect those areas of the appraisal where assumptions were made or uncertainty was high, and to provide an assessment of the consequences for the decision rule applied in the SWMP, a number of sensitivity tests were carried out on the economic appraisal results. These are summarised in Table 7.

Table 7 – Sensitivity Test Results

No	Sensitivity Test	Preferred Option PVb	Do Nothing (PVd)	Preferred Option BCR
	Preferred Appraisal Values	**£526K**	**£1.1M**	**1.10:1**
1	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 150mm allowance for threshold level	£526K	£1.1M	1.10:1
2	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 100mm allowance for threshold level	£898K	£2.6M	1.88:1
3	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 300mm allowance for threshold level	£9K	£9K	0.02:1
4	Inclusion of temporary accommodation costs for residential property	£551K	£1.4M	1.15:1
5	Assuming Do Nothing damages occur at year 0	£686K	£1.3M	1.44:1
6	Assuming Do Nothing damages occur at year 20	£357K	£950K	0.75:1
7	Decrease in Option Bias to 30% (with test 2)	No change	No change	1.36:1

There are 131 residential properties in the study area and residential properties contribute the majority of the damages.

The sensitivity tests show that the results are heavily dependent on the threshold level which is used to apply depth values to properties. Since surface water flooding is typically characterised by rapid flood mechanisms and shallow flood depths, it is considered reasonable to ignore below floor level damages, associated with more prolonged exposure of the building fabric to flood waters (as following fluvial or coastal flooding). This does not suggest that surface water flooding does not result in this type of damage, but when considering a large study area, there are likely to be far more properties where below floor level damages overestimate total damage than accurately reflect it.

There is an inherent uncertainty regarding the application of direct rainfall modelling results to properties, as in reality buildings can act as pathways to rainfall as well as receptors. When rainfall falls onto a building the slope of the roof and the guttering has an effect of directing rainfall to the ground and towards the surface water drainage network. Properties only begin to flood when the capacity of the drainage network or local topography is exceeded and the level of ponded flood water exceeds the threshold level of buildings. Using the direct rainfall approach, can, however, mean that water immediately ponds on the flat surface representing the bare earth of the building, resulting in a perceived depth of flooding at that property.

Given this uncertainty, and the fact that surface water flooding typically occurs in rapid, short-duration events, below floor level damages were excluded from the assessment.

The standard 0.15m threshold level has been selected to use as the final appraisal value as it is an in common with best practice and the 0.15m value provides a conservative assessment when compared to sensitivity test 2. Increasing the threshold level to 300mm dramatically reduces flood damages in sensitivity text 3, which confirms that the flooding is generally shallow in depth.

The sensitivity analysis indicates that including temporary accommodation costs would result in a minimal increase in damages, with damages for the preferred option increasing by £25k. As detailed previously, the shallow depths associated with the majority of surface water flooding mean that it is reasonable to exclude temporary accommodation costs from this assessment.

Increasing and decreasing the market value of properties has a negligible effect on the damages. This is due to the limited number of properties being capped in the assessment.

The sensitivity tests indicate that damages are heavily dependent on the threshold level selected. It is recommend that if there were to be a reason to progress this study further then consideration should be given to a threshold level survey of the most at risk properties to confirm the benefits.

Summary

This appendix has detailed the methodology and results of the economic appraisal for the surface water flooding mitigation options for the Taunton SWMP. The appraisal can be concluded as follows:

- Following a long-listing and short-listing process which considered and ruled out a series of intervention options to address surface water flood risk in the Staplegrove Area, two potential options have been appraised at a high-level, using the SWMP Stage 3 model. The options aim to address the flow route running north-south from Rectory Road, which the SWMP modelling predicts will result in flooding of 11 properties in a 1 in 10 flood event and 20 properties in a 1 in 100 event.
- The FCERM-AG guidance recommends that, for strategic studies, unit rates can be used to give an indication of the scale of option costs. The estimated costs for Do Something options presented in this assessment should not be used for detailed assessment and would need refinement for any future studies investigating similar options. Maintenance costs have been provided by Wessex Water and confirmed by Somerset County Council.
- Property damages were calculated using the MCM depth damage-data from the 2010 Multi-coloured Handbook (Flood Hazard Research Centre, 2010). Below floor level damages were excluded from the assessment and a standard 0.15m threshold level has been selected for use in the final appraisal.
- Economically, there is no justification for undertaking the two Do Something options investigated. In order to increase the benefit provided by options, a larger scale option would be required, which would only increase costs and, as indicated in the short-listing process, result in a disproportionately large option requiring onerous future commitment to maintain. Were there historic records to back-up the predicted baseline model results, then further consideration of options may be justified. Sensitivity testing of the economic assessment, however, indicates that the number of properties flooded is heavily dependent on the threshold levels used in the assessment. Combined with known assumptions and limitations of the modelling approach, this suggests that further assessment of options is unlikely to be justified at the present time.

References

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APPENDIX

Project Summary Sheet

Client/Authority		Prepared (date)	19/11/2012
Somerset County Council		Printed	23/11/2012
Project name		Prepared by	AH
Taunton SWMP		Checked by	IJ
Project reference	UA001888	Checked date	20/11/2012
Base date for estimates (year 0)	Oct-2012		
Scaling factor (e.g. £m, £k, £)	£k		
Year	0		
Discount Rate	3.5%		
Optimism bias adjustment factor	60%		

Costs and benefits of options

	Costs and benefits £k			
Option number	Baseline	Option 1	Option 2	Option 3
Option name	Do Nothing	Opt A- Do Minimum	Opt H- Water intercepted at Rectory Rd- Minimum Intervention	Opt I- Water intercepted at Rectory Rd- Medium Intervention
COSTS:				
PV capital costs		0	65	359
PV maintenance costs		298	313	356
PV future construction		0	77	430
Optimism bias adjustment		179	273	687
PV negative costs (e.g. sales)				
PV contributions				
Total PV Costs £k excluding contributions		477	727	1,831
Total PV Costs £k taking contributions into account				
BENEFITS:				
PV monetised flood damages	1,121	595	583	372
PV monetised flood damages avoided		526	538	749
Total PV damages £k	1,121	595	583	372
Total PV benefits £k		526	538	749
DECISION-MAKING CRITERIA:				
Based on total PV benefits				
Net Present Value **NPV**		49	-189	-1,082
Average benefit/cost ratio **BCR**		1.10	0.74	0.41
Incremental benefit/cost ratio **IBCR**			-1.5	-0.1

Brief description of options:

Option 1	Opt A- Do Minimum
Option 2	Opt H- Water intercepted at Rectory
Option 3	Opt I- Water intercepted at Rectory

Comments and assumptions:

Client/Authority
Somerset County Council
Project name
Taunton SWMP
Project reference UA001888
Base date for estimates (year 0) Oct-2012
Scaling factor (e.g. £m, £k, £) £
Initial discount rate 3.5%

Prepared (date)	19/11/2012
Printed	23/11/2012
Prepared by	AH
Checked by	IJ
Checked date	20/11/2012

		Option 1	Opt A- Do Minimum			TOTALS:	PV	PV	PV	PV
year	Discount Factor	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs
	cash sum	0	1000000	0	0	1,000,000	0	298,125	0.00	0.00
0	1.000		10000			10000.00	0.00	10000.00	0.00	0.00
1	0.966		10000			10000.00	0.00	9661.84	0.00	0.00
2	0.934		10000			10000.00	0.00	9335.11	0.00	0.00
3	0.902		10000			10000.00	0.00	9019.43	0.00	0.00
4	0.871		10000			10000.00	0.00	8714.42	0.00	0.00
5	0.842		10000			10000.00	0.00	8419.73	0.00	0.00
6	0.814		10000			10000.00	0.00	8135.01	0.00	0.00
7	0.786		10000			10000.00	0.00	7859.91	0.00	0.00
8	0.759		10000			10000.00	0.00	7594.12	0.00	0.00
9	0.734		10000			10000.00	0.00	7337.31	0.00	0.00
10	0.709		10000			10000.00	0.00	7089.19	0.00	0.00
11	0.685		10000			10000.00	0.00	6849.46	0.00	0.00
12	0.662		10000			10000.00	0.00	6617.83	0.00	0.00
13	0.639		10000			10000.00	0.00	6394.04	0.00	0.00
14	0.618		10000			10000.00	0.00	6177.82	0.00	0.00
15	0.597		10000			10000.00	0.00	5968.91	0.00	0.00
16	0.577		10000			10000.00	0.00	5767.06	0.00	0.00
17	0.557		10000			10000.00	0.00	5572.04	0.00	0.00
18	0.538		10000			10000.00	0.00	5383.61	0.00	0.00
19	0.520		10000			10000.00	0.00	5201.56	0.00	0.00
20	0.503		10000			10000.00	0.00	5025.66	0.00	0.00
21	0.486		10000			10000.00	0.00	4855.71	0.00	0.00
22	0.469		10000			10000.00	0.00	4691.51	0.00	0.00
23	0.453		10000			10000.00	0.00	4532.86	0.00	0.00
24	0.438		10000			10000.00	0.00	4379.57	0.00	0.00
25	0.423		10000			10000.00	0.00	4231.47	0.00	0.00
26	0.409		10000			10000.00	0.00	4088.38	0.00	0.00
27	0.395		10000			10000.00	0.00	3950.12	0.00	0.00
28	0.382		10000			10000.00	0.00	3816.54	0.00	0.00
29	0.369		10000			10000.00	0.00	3687.48	0.00	0.00
30	0.356		10000			10000.00	0.00	3562.78	0.00	0.00
31	0.346		10000			10000.00	0.00	3459.01	0.00	0.00
32	0.336		10000			10000.00	0.00	3358.27	0.00	0.00
33	0.326		10000			10000.00	0.00	3260.45	0.00	0.00
34	0.317		10000			10000.00	0.00	3165.49	0.00	0.00
35	0.307		10000			10000.00	0.00	3073.29	0.00	0.00
36	0.298		10000			10000.00	0.00	2983.78	0.00	0.00
37	0.290		10000			10000.00	0.00	2896.87	0.00	0.00
38	0.281		10000			10000.00	0.00	2812.49	0.00	0.00
39	0.273		10000			10000.00	0.00	2730.58	0.00	0.00
40	0.265		10000			10000.00	0.00	2651.05	0.00	0.00
41	0.257		10000			10000.00	0.00	2573.83	0.00	0.00
42	0.250		10000			10000.00	0.00	2498.87	0.00	0.00
43	0.243		10000			10000.00	0.00	2426.08	0.00	0.00
44	0.236		10000			10000.00	0.00	2355.42	0.00	0.00
45	0.229		10000			10000.00	0.00	2286.82	0.00	0.00
46	0.222		10000			10000.00	0.00	2220.21	0.00	0.00
47	0.216		10000			10000.00	0.00	2155.54	0.00	0.00
48	0.209		10000			10000.00	0.00	2092.76	0.00	0.00
49	0.203		10000			10000.00	0.00	2031.81	0.00	0.00
50	0.197		10000			10000.00	0.00	1972.63	0.00	0.00
51	0.192		10000			10000.00	0.00	1915.17	0.00	0.00
52	0.186		10000			10000.00	0.00	1859.39	0.00	0.00
53	0.181		10000			10000.00	0.00	1805.23	0.00	0.00
54	0.175		10000			10000.00	0.00	1752.65	0.00	0.00
55	0.170		10000			10000.00	0.00	1701.61	0.00	0.00
56	0.165		10000			10000.00	0.00	1652.04	0.00	0.00
57	0.160		10000			10000.00	0.00	1603.93	0.00	0.00
58	0.156		10000			10000.00	0.00	1557.21	0.00	0.00
59	0.151		10000			10000.00	0.00	1511.85	0.00	0.00
60	0.147		10000			10000.00	0.00	1467.82	0.00	0.00
61	0.143		10000			10000.00	0.00	1425.07	0.00	0.00
62	0.138		10000			10000.00	0.00	1383.56	0.00	0.00
63	0.134		10000			10000.00	0.00	1343.26	0.00	0.00
64	0.130		10000			10000.00	0.00	1304.14	0.00	0.00
65	0.127		10000			10000.00	0.00	1266.15	0.00	0.00
66	0.123		10000			10000.00	0.00	1229.28	0.00	0.00
67	0.119		10000			10000.00	0.00	1193.47	0.00	0.00
68	0.116		10000			10000.00	0.00	1158.71	0.00	0.00
69	0.112		10000			10000.00	0.00	1124.96	0.00	0.00
70	0.109		10000			10000.00	0.00	1092.20	0.00	0.00
71	0.106		10000			10000.00	0.00	1060.38	0.00	0.00
72	0.103		10000			10000.00	0.00	1029.50	0.00	0.00

	Option 7	Opt H- Water intercepted a			TOTALS:	PV	PV	PV	PV
year	Capital	Maint.	Future Cons	Other	Cash	Capital	Maint	Future Cons	Other
cash sum	64500	1049500	64500	0	1178500.00	64500.00	312531.73	77223.45	0.00
0	64,500	10,000			74500.00	64500.00	10000.00	64500.00	0.00
1		10,500			10500.00	0.00	10144.93	0.00	0.00
2		10,500			10500.00	0.00	9801.86	0.00	0.00
3		10,500			10500.00	0.00	9470.40	0.00	0.00
4		10,500			10500.00	0.00	9150.14	0.00	0.00
5		10,500			10500.00	0.00	8840.72	0.00	0.00
6		10,500			10500.00	0.00	8541.76	0.00	0.00
7		10,500			10500.00	0.00	8252.91	0.00	0.00
8		10,500			10500.00	0.00	7973.82	0.00	0.00
9		10,500			10500.00	0.00	7704.18	0.00	0.00
10		10,500			10500.00	0.00	7443.65	0.00	0.00
11		10,500			10500.00	0.00	7191.93	0.00	0.00
12		10,500			10500.00	0.00	6948.72	0.00	0.00
13		10,500			10500.00	0.00	6713.74	0.00	0.00
14		10,500			10500.00	0.00	6486.71	0.00	0.00
15		10,500			10500.00	0.00	6267.35	0.00	0.00
16		10,500			10500.00	0.00	6055.41	0.00	0.00
17		10,500			10500.00	0.00	5850.64	0.00	0.00
18		10,500			10500.00	0.00	5652.79	0.00	0.00
19		10,500			10500.00	0.00	5461.63	0.00	0.00
20		10,500			10500.00	0.00	5276.94	0.00	0.00
21		10,500			10500.00	0.00	5098.49	0.00	0.00
22		10,500			10500.00	0.00	4926.08	0.00	0.00
23		10,500			10500.00	0.00	4759.50	0.00	0.00
24		10,500			10500.00	0.00	4598.55	0.00	0.00
25		10,500			10500.00	0.00	4443.04	0.00	0.00
26		10,500			10500.00	0.00	4292.80	0.00	0.00
27		10,500			10500.00	0.00	4147.63	0.00	0.00
28		10,500			10500.00	0.00	4007.37	0.00	0.00
29		10,500			10500.00	0.00	3871.86	0.00	0.00
30		10,500			10500.00	0.00	3740.92	0.00	0.00
31		10,500			10500.00	0.00	3631.96	0.00	0.00
32		10,500			10500.00	0.00	3526.18	0.00	0.00
33		10,500			10500.00	0.00	3423.47	0.00	0.00
34		10,500			10500.00	0.00	3323.76	0.00	0.00
35		10,500			10500.00	0.00	3226.95	0.00	0.00
36		10,500			10500.00	0.00	3132.96	0.00	0.00
37		10,500			10500.00	0.00	3041.71	0.00	0.00
38		10,500			10500.00	0.00	2953.12	0.00	0.00
39		10,500			10500.00	0.00	2867.11	0.00	0.00
40		10,500			10500.00	0.00	2783.60	0.00	0.00
41		10,500			10500.00	0.00	2702.52	0.00	0.00
42		10,500			10500.00	0.00	2623.81	0.00	0.00
43		10,500			10500.00	0.00	2547.39	0.00	0.00
44		10,500			10500.00	0.00	2473.19	0.00	0.00
45		10,500			10500.00	0.00	2401.16	0.00	0.00
46		10,500			10500.00	0.00	2331.22	0.00	0.00
47		10,500			10500.00	0.00	2263.32	0.00	0.00
48		10,500			10500.00	0.00	2197.40	0.00	0.00
49		10,500			10500.00	0.00	2133.40	0.00	0.00
50		10,500	64,500		75000.00	0.00	2071.26	12723.45	0.00
51		10,500			10500.00	0.00	2010.93	0.00	0.00
52		10,500			10500.00	0.00	1952.36	0.00	0.00
53		10,500			10500.00	0.00	1895.49	0.00	0.00
54		10,500			10500.00	0.00	1840.29	0.00	0.00
55		10,500			10500.00	0.00	1786.69	0.00	0.00
56		10,500			10500.00	0.00	1734.65	0.00	0.00
57		10,500			10500.00	0.00	1684.12	0.00	0.00
58		10,500			10500.00	0.00	1635.07	0.00	0.00
59		10,500			10500.00	0.00	1587.45	0.00	0.00
60		10,500			10500.00	0.00	1541.21	0.00	0.00
61		10,500			10500.00	0.00	1496.32	0.00	0.00
62		10,500			10500.00	0.00	1452.74	0.00	0.00
63		10,500			10500.00	0.00	1410.43	0.00	0.00
64		10,500			10500.00	0.00	1369.35	0.00	0.00
65		10,500			10500.00	0.00	1329.46	0.00	0.00
66		10,500			10500.00	0.00	1290.74	0.00	0.00
67		10,500			10500.00	0.00	1253.15	0.00	0.00
68		10,500			10500.00	0.00	1216.65	0.00	0.00
69		10,500			10500.00	0.00	1181.21	0.00	0.00
70		10,500			10500.00	0.00	1146.81	0.00	0.00
71		10,500			10500.00	0.00	1113.40	0.00	0.00
72		10,500			10500.00	0.00	1080.97	0.00	0.00

	Option 8	Opt I- Water intercepted a			TOTALS:	PV	PV	PV	PV
year	Capital	Maint.	Future Cons	Other	Cash	Capital	Maint	Future Cons	Other
cash sum	359000	1198000	359000	0	1916000.00	359000.00	355,751	429817.32	0.00
0	359,000	10,000			369000.00	359000.00	10000.00	359000.00	0.00
1		12,000			12000.00	0.00	11594.20	0.00	0.00
2		12,000			12000.00	0.00	11202.13	0.00	0.00
3		12,000			12000.00	0.00	10823.31	0.00	0.00
4		12,000			12000.00	0.00	10457.31	0.00	0.00
5		12,000			12000.00	0.00	10103.68	0.00	0.00
6		12,000			12000.00	0.00	9762.01	0.00	0.00
7		12,000			12000.00	0.00	9431.89	0.00	0.00
8		12,000			12000.00	0.00	9112.94	0.00	0.00
9		12,000			12000.00	0.00	8804.77	0.00	0.00
10		12,000			12000.00	0.00	8507.03	0.00	0.00
11		12,000			12000.00	0.00	8219.35	0.00	0.00
12		12,000			12000.00	0.00	7941.40	0.00	0.00
13		12,000			12000.00	0.00	7672.85	0.00	0.00
14		12,000			12000.00	0.00	7413.38	0.00	0.00
15		12,000			12000.00	0.00	7162.69	0.00	0.00
16		12,000			12000.00	0.00	6920.47	0.00	0.00
17		12,000			12000.00	0.00	6686.45	0.00	0.00
18		12,000			12000.00	0.00	6460.33	0.00	0.00
19		12,000			12000.00	0.00	6241.87	0.00	0.00
20		12,000			12000.00	0.00	6030.79	0.00	0.00
21		12,000			12000.00	0.00	5826.85	0.00	0.00
22		12,000			12000.00	0.00	5629.81	0.00	0.00
23		12,000			12000.00	0.00	5439.43	0.00	0.00
24		12,000			12000.00	0.00	5255.49	0.00	0.00
25		12,000			12000.00	0.00	5077.76	0.00	0.00
26		12,000			12000.00	0.00	4906.05	0.00	0.00
27		12,000			12000.00	0.00	4740.15	0.00	0.00
28		12,000			12000.00	0.00	4579.85	0.00	0.00
29		12,000			12000.00	0.00	4424.98	0.00	0.00
30		12,000			12000.00	0.00	4275.34	0.00	0.00
31		12,000			12000.00	0.00	4150.82	0.00	0.00
32		12,000			12000.00	0.00	4029.92	0.00	0.00
33		12,000			12000.00	0.00	3912.54	0.00	0.00
34		12,000			12000.00	0.00	3798.59	0.00	0.00
35		12,000			12000.00	0.00	3687.95	0.00	0.00
36		12,000			12000.00	0.00	3580.53	0.00	0.00
37		12,000			12000.00	0.00	3476.24	0.00	0.00
38		12,000			12000.00	0.00	3374.99	0.00	0.00
39		12,000			12000.00	0.00	3276.69	0.00	0.00
40		12,000			12000.00	0.00	3181.26	0.00	0.00
41		12,000			12000.00	0.00	3088.60	0.00	0.00
42		12,000			12000.00	0.00	2998.64	0.00	0.00
43		12,000			12000.00	0.00	2911.30	0.00	0.00
44		12,000			12000.00	0.00	2826.50	0.00	0.00
45		12,000			12000.00	0.00	2744.18	0.00	0.00
46		12,000			12000.00	0.00	2664.25	0.00	0.00
47		12,000			12000.00	0.00	2586.65	0.00	0.00
48		12,000			12000.00	0.00	2511.31	0.00	0.00
49		12,000			12000.00	0.00	2438.17	0.00	0.00
50		12,000	359,000		371000.00	0.00	2367.15	70817.32	0.00
51		12,000			12000.00	0.00	2298.21	0.00	0.00
52		12,000			12000.00	0.00	2231.27	0.00	0.00
53		12,000			12000.00	0.00	2166.28	0.00	0.00
54		12,000			12000.00	0.00	2103.18	0.00	0.00
55		12,000			12000.00	0.00	2041.93	0.00	0.00
56		12,000			12000.00	0.00	1982.45	0.00	0.00
57		12,000			12000.00	0.00	1924.71	0.00	0.00
58		12,000			12000.00	0.00	1868.65	0.00	0.00
59		12,000			12000.00	0.00	1814.23	0.00	0.00
60		12,000			12000.00	0.00	1761.38	0.00	0.00
61		12,000			12000.00	0.00	1710.08	0.00	0.00
62		12,000			12000.00	0.00	1660.27	0.00	0.00
63		12,000			12000.00	0.00	1611.92	0.00	0.00
64		12,000			12000.00	0.00	1564.97	0.00	0.00
65		12,000			12000.00	0.00	1519.39	0.00	0.00
66		12,000			12000.00	0.00	1475.13	0.00	0.00
67		12,000			12000.00	0.00	1432.17	0.00	0.00
68		12,000			12000.00	0.00	1390.45	0.00	0.00
69		12,000			12000.00	0.00	1349.95	0.00	0.00
70		12,000			12000.00	0.00	1310.64	0.00	0.00
71		12,000			12000.00	0.00	1272.46	0.00	0.00
72		12,000			12000.00	0.00	1235.40	0.00	0.00

		Option 1	Opt A- Do Minimum			TOTALS:	PV	PV	PV	PV
		Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs
73	0.100		10000			10000.00	0.00	999.51	0.00	0.00
74	0.097		10000			10000.00	0.00	970.40	0.00	0.00
75	0.094		10000			10000.00	0.00	942.14	0.00	0.00
76	0.092		10000			10000.00	0.00	919.16	0.00	0.00
77	0.090		10000			10000.00	0.00	896.74	0.00	0.00
78	0.087		10000			10000.00	0.00	874.87	0.00	0.00
79	0.085		10000			10000.00	0.00	853.53	0.00	0.00
80	0.083		10000			10000.00	0.00	832.71	0.00	0.00
81	0.081		10000			10000.00	0.00	812.40	0.00	0.00
82	0.079		10000			10000.00	0.00	792.59	0.00	0.00
83	0.077		10000			10000.00	0.00	773.26	0.00	0.00
84	0.075		10000			10000.00	0.00	754.40	0.00	0.00
85	0.074		10000			10000.00	0.00	736.00	0.00	0.00
86	0.072		10000			10000.00	0.00	718.05	0.00	0.00
87	0.070		10000			10000.00	0.00	700.53	0.00	0.00
88	0.068		10000			10000.00	0.00	683.45	0.00	0.00
89	0.067		10000			10000.00	0.00	666.78	0.00	0.00
90	0.065		10000			10000.00	0.00	650.51	0.00	0.00
91	0.063		10000			10000.00	0.00	634.65	0.00	0.00
92	0.062		10000			10000.00	0.00	619.17	0.00	0.00
93	0.060		10000			10000.00	0.00	604.07	0.00	0.00
94	0.059		10000			10000.00	0.00	589.33	0.00	0.00
95	0.057		10000			10000.00	0.00	574.96	0.00	0.00
96	0.056		10000			10000.00	0.00	560.94	0.00	0.00
97	0.055		10000			10000.00	0.00	547.25	0.00	0.00
98	0.053		10000			10000.00	0.00	533.91	0.00	0.00
99	0.052		10000			10000.00	0.00	520.88	0.00	0.00

		Option 7	Opt H- Water intercepted a			TOTALS:	PV	PV	PV	PV
		Capital	Maint.	Future Cons	Other	Cash	Capital	Maint	Future Cons	Other
73	0.100		10,500			10500.00	0.00	1049.49	0.00	0.00
74	0.097		10,500			10500.00	0.00	1018.92	0.00	0.00
75	0.094		10,500			10500.00	0.00	989.24	0.00	0.00
76	0.092		10,500			10500.00	0.00	965.12	0.00	0.00
77	0.090		10,500			10500.00	0.00	941.58	0.00	0.00
78	0.087		10,500			10500.00	0.00	918.61	0.00	0.00
79	0.085		10,500			10500.00	0.00	896.21	0.00	0.00
80	0.083		10,500			10500.00	0.00	874.35	0.00	0.00
81	0.081		10,500			10500.00	0.00	853.02	0.00	0.00
82	0.079		10,500			10500.00	0.00	832.22	0.00	0.00
83	0.077		10,500			10500.00	0.00	811.92	0.00	0.00
84	0.075		10,500			10500.00	0.00	792.12	0.00	0.00
85	0.074		10,500			10500.00	0.00	772.80	0.00	0.00
86	0.072		10,500			10500.00	0.00	753.95	0.00	0.00
87	0.070		10,500			10500.00	0.00	735.56	0.00	0.00
88	0.068		10,500			10500.00	0.00	717.62	0.00	0.00
89	0.067		10,500			10500.00	0.00	700.12	0.00	0.00
90	0.065		10,500			10500.00	0.00	683.04	0.00	0.00
91	0.063		10,500			10500.00	0.00	666.38	0.00	0.00
92	0.062		10,500			10500.00	0.00	650.13	0.00	0.00
93	0.060		10,500			10500.00	0.00	634.27	0.00	0.00
94	0.059		10,500			10500.00	0.00	618.80	0.00	0.00
95	0.057		10,500			10500.00	0.00	603.71	0.00	0.00
96	0.056		10,500			10500.00	0.00	588.98	0.00	0.00
97	0.055		10,500			10500.00	0.00	574.62	0.00	0.00
98	0.053		10,500			10500.00	0.00	560.60	0.00	0.00
99	0.052		10,500			10500.00	0.00	546.93	0.00	0.00

		Option 8	Opt I- Water intercepted a			TOTALS:	PV	PV	PV	PV
		Capital	Maint.	Future Cons	Other	Cash	Capital	Maint	Future Cons	Other
73	0.100		12,000			12000.00	0.00	1199.42	0.00	0.00
74	0.097		12,000			12000.00	0.00	1164.48	0.00	0.00
75	0.094		12,000			12000.00	0.00	1130.57	0.00	0.00
76	0.092		12,000			12000.00	0.00	1102.99	0.00	0.00
77	0.090		12,000			12000.00	0.00	1076.09	0.00	0.00
78	0.087		12,000			12000.00	0.00	1049.84	0.00	0.00
79	0.085		12,000			12000.00	0.00	1024.24	0.00	0.00
80	0.083		12,000			12000.00	0.00	999.25	0.00	0.00
81	0.081		12,000			12000.00	0.00	974.88	0.00	0.00
82	0.079		12,000			12000.00	0.00	951.11	0.00	0.00
83	0.077		12,000			12000.00	0.00	927.91	0.00	0.00
84	0.075		12,000			12000.00	0.00	905.28	0.00	0.00
85	0.074		12,000			12000.00	0.00	883.20	0.00	0.00
86	0.072		12,000			12000.00	0.00	861.65	0.00	0.00
87	0.070		12,000			12000.00	0.00	840.64	0.00	0.00
88	0.068		12,000			12000.00	0.00	820.14	0.00	0.00
89	0.067		12,000			12000.00	0.00	800.13	0.00	0.00
90	0.065		12,000			12000.00	0.00	780.62	0.00	0.00
91	0.063		12,000			12000.00	0.00	761.58	0.00	0.00
92	0.062		12,000			12000.00	0.00	743.00	0.00	0.00
93	0.060		12,000			12000.00	0.00	724.88	0.00	0.00
94	0.059		12,000			12000.00	0.00	707.20	0.00	0.00
95	0.057		12,000			12000.00	0.00	689.95	0.00	0.00
96	0.056		12,000			12000.00	0.00	673.12	0.00	0.00
97	0.055		12,000			12000.00	0.00	656.71	0.00	0.00
98	0.053		12,000			12000.00	0.00	640.69	0.00	0.00
99	0.052		12,000			12000.00	0.00	625.06	0.00	0.00

AH- Staplegrove Options
Based on sheet- IJ - 25/09/2012

Option I- Medium		
CAPITAL		
Excavation	294,000	
Embankment	0	
OTHER		
Feasibility-PAR	20,000	
Consents/Licences/Compen	15,000	
Design Works	5,000	
Site Investigations	5,000	
Site Costs	10,000	3%
Diversion of footpath	10,000	
TOTAL COST	**359,000**	

Option H- Minimum		
CAPITAL		
Excavation	8,000	
Embankments	9,000	
OTHER		
Feasibility-PAR	20,000	
Consents/Licences/Comp	15,000	
Design Works	5,000	
Site Investigations	5,000	
Site Costs	2,500	15%
	64,500	

Recommend these as absolute bare minimum for consideration in SWMP (note 60% Optimism Bias Applied) - IJ