Appendix A

Supporting Documentation

SOMERSET COUNTY COUNCIL

SWMP ENGAGEMENT PLAN

Reference

Date

20 August 2010

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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

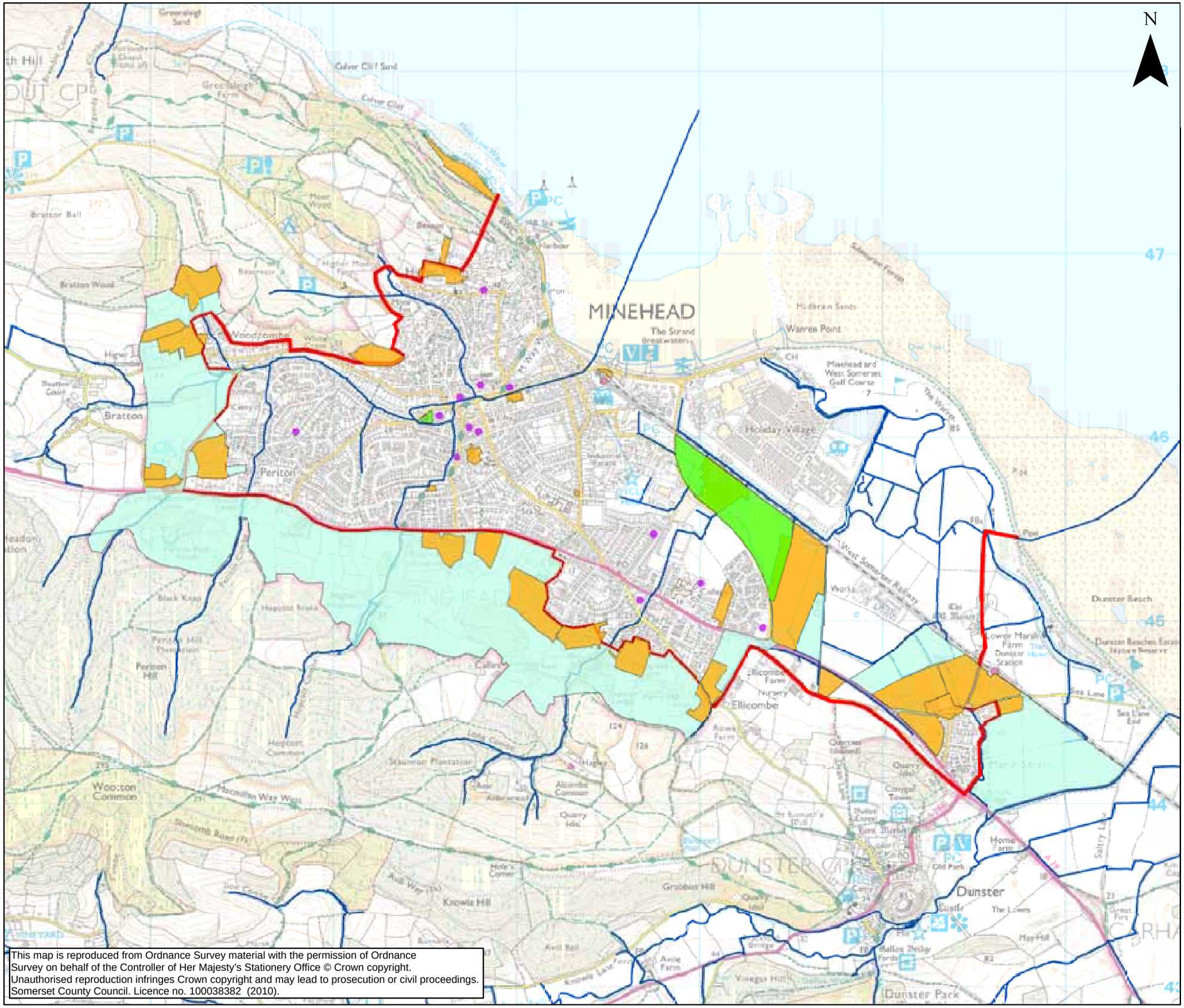
??

5.COMMUNITY ENGAGEMENT

6.2 Performance Management

Key Performance Indicators

To be agreed



Legend

- Employment Land Review
- SHLAA - Future Development Areas
- SHLAA - Future Development Areas - Approx
- SHLAA - Broad Areas for Growth
- Scoping Boundary
- Detailed River Network

Issue	Description	Date
02	SHLAA FUTURE DEVELOPMENT SITES ADDED	15OCT10
01	ORIGINAL ISSUE	04OCT10

Status: FOR INFORMATION NOT TO BE USED FOR CONSTRUCTION

Scales	1:20,000	Current Issue Signatures	
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Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M5
PREFERRED DEVELOPMENT SITES

Drawing No.	Project No.	Issue
0108	— UA001888 —	02

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V1

Information extracted from:

- **West Somerset CFMP (2008)**
- **West Somerset Council and Exmoor National Park Authority SFRA Level 1 (Scott Wilson, 2009)**

	Minehead
Soils	
Conservation designations	
Future growth	(West Somerset CFMP) High demand for development sites around Minehead. West Somerset Local Plan (2006) – Minehead will be sustained as the main growth area; new housing will be apportioned primarily to Minehead.
Flood risk vulnerability	(West Somerset CFMP) Minehead has a high social vulnerability
Transport	
Groundwater	(West Somerset CFMP) The Environment Agency is not aware of any records of groundwater flooding in the West Somerset CFMP area (WSC SFRA) The nature of the underlying geology within the study area means that groundwater flooding is not significant
Surface water runoff *(before water enters drainage network/cannot enter because network full)*	(WSC SFRA) The SFRA notes that there are surface water/drainage issues (WSC SFRA) Manor Road – combined fluvial and surface water (West Somerset CFMP) Surface water flooding is a significant issue in the catchment. It currently affects people and property throughout the catchment, and particularly in Minehead, Williton and Porlock (West Somerset CFMP) The number of people and properties affected by surface water flooding is also likely to increase in Minehead in the future. However, given that the surface water problem in this area is largely as a result of the urban nature of Minehead, increases are not expected to be as significant as in other areas where surface water flooding is as a result of the local geography and land management practices. This is because any future development in Minehead should be compliant with PPS25 and as such incorporate appropriate techniques to prevent or minimise surface water impacts.
Sewer flooding *(network capacity exceeded due to heavy rainfall; sewer flows impeded by high downstream river/tide levels)*	(West Somerset CFMP) The Environment Agency is not aware of any records of sewer flooding in the West Somerset CFMP area (WSC SFRA) No problems on the DG5 register. Historical record of sewer flooding – western end of The Parks
Flooding from open channel and culverted watercourses *(which receive most of their flow from inside urban area and perform urban drainage function)*	(West Somerset CFMP) Victorian culvert beneath Minehead **Bratton Stream** discharges into the sea via a flapped outfall. There is a significant risk of tide locking and therefore a combined river- tidal event causing increased out of channel flows, a greater flood extent and more hazardous flooding to people and property. In addition, the urban nature of the lower Bratton Stream means that surface water flooding is likely to be an issue in Minehead. Whilst the EA has no records of surface water flood events here, its spatial analysis indicated a high likelihood of surface water flooding in Minehead. Relatively fast response due to the urban nature of the catchment and small catchment area. The upper catchment is very steep and due to the impermeable geology the response time of the catchment is relatively fast. High velocities (0.92m/s) occur through this sub-catchment, with low flood depth. This leads to a medium flood hazard. The overall risk of flooding is assessed as high. The current peak velocities (0.92 m/s) that occur in Minehead during the 1% AEP flood event increase in the future to estimated peak velocities of greater than 1m/s. This leads to a high flood hazard. Flood depths in these communities are also significant, 0.22m in the future 1% AEP flood event compared to 0.07m currently In dense urban areas where residential gardens extend up to the edge of the watercourse, **blockages** can also happen when the watercourse is in flood and it can easily pick up debris. This factor is one of the main reasons for the risk of blockages in Minehead. (WSC SFRA) During a combined river and tidal event the potential flood risk posed by the Bratton Stream is likely to increase.
Pollution	

Information extracted from:

- **West Somerset CFMP (2008)**
- **West Somerset Council and Exmoor National Park Authority SFRA Level 1 (Scott Wilson, 2009)**

Measures	Sustainable land use management: To utilise the opportunity to promote land management techniques to reduce soil erosion and compaction, and surface water run-off in the rural areas behind Minehead West Somerset CFMP Policy Appraisal Objectives include 'reduce the number of people susceptible to surface water flooding in Minehead.' Minehead = Policy Unit 6 – policy option 5 applies to this policy unit, i.e. take further action to reduce flood risk Minehead Pre-feasibility Study likely to include the following recommendations: 1) Development of a new culvert on the Holloway Stream plus a new control structure at the flow split location on the Bratton Stream. 2) Creation of a flood storage reservoir on the Bratton Stream at the upstream end of Minehead 3) Installation of a rain gauge and flow monitoring equipment to provide data on the catchment's response to rainfall and the hydraulic performance of the main culvert Action 6.2 of the West Somerset Action Plan: Provide development control advice and promote Sustainable Drainage Systems to ensure no increase in surface water run-off from new developments in Minehead. Monitor the implementation of advice/planning conditions Action 6.3: Promote the provision of a SWMP In order to reduce flood risk from surface water flooding the Environment Agency will work with West Somerset District Council and Somerset County Council Highway department to provide a surface water management plan which will look to both reduce the current surface water flood risk, and ensure it does not increase in the future. In addition, the Agency will continue to work with West Somerset District County Council to ensure that SUDs are implemented both retrospectively and on all new developments Due to the urban nature of this policy unit, the development pressures and the fact that much of the Bratton Stream is already culverted it is harder to reduce flooding from rivers below the current level. However we will look to reduce the residual risk of river flooding by investigating the feasibility of a flood warning service for Minehead, which would give a 2 hour warning to the local population and enable them to be more prepared in a flood event
SUDS	(WSC SFRA) Suitable SUDS techniques dependent on bedrock geology

Appendix B

Area Prioritisation

1.1.1 Location M1

Site Area

Fluvial Flood Risk and Defences

Edenvale Young Direct Rainfall Modelling

Reservoir Flooding

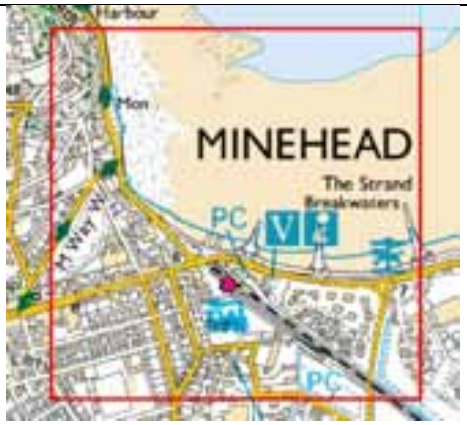
Flood Susceptibility

Groundwater Flooding

Historic Flooding

Wessex Sewer Flooding

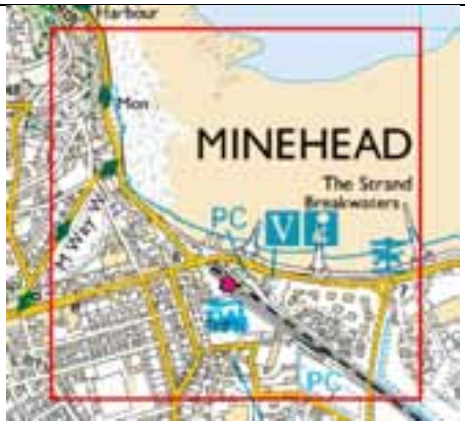
1.1.2 Location M2



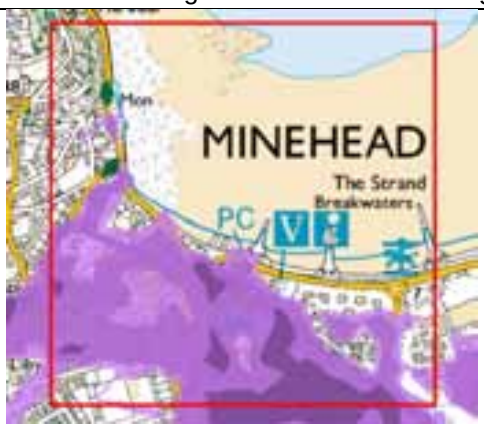
Site Area

Fluvial Flood Risk and Defences

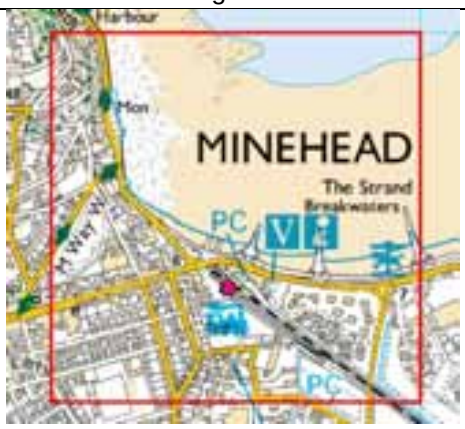
Edenvale Young Direct Rainfall Modelling



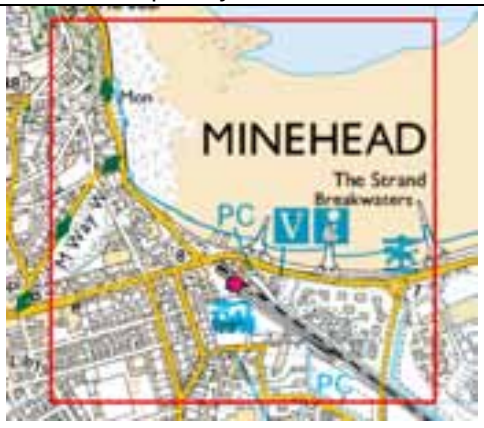
Reservoir Flooding



Flood Susceptibility



Groundwater Flooding



Historic Flooding

Wessex Sewer Flooding

1.1.3 Location M3

Site Area

Fluvial Flood Risk and Defences

Edenvale Young Direct Rainfall Modelling

Reservoir Flooding

Flood Susceptibility

Groundwater Flooding

Historic Flooding

Wessex Sewer Flooding

1.1.4 Location M4

Site Area


Fluvial Flood Risk and Defences


Edenvale Young Direct Rainfall Modelling

Reservoir Flooding


Flood Susceptibility

Groundwater Flooding

Historic Flooding

Wessex Sewer Flooding

1.1.5 Location M5

Site Area

Fluvial Flood Risk and Defences

Edenvale Young Direct Rainfall Modelling

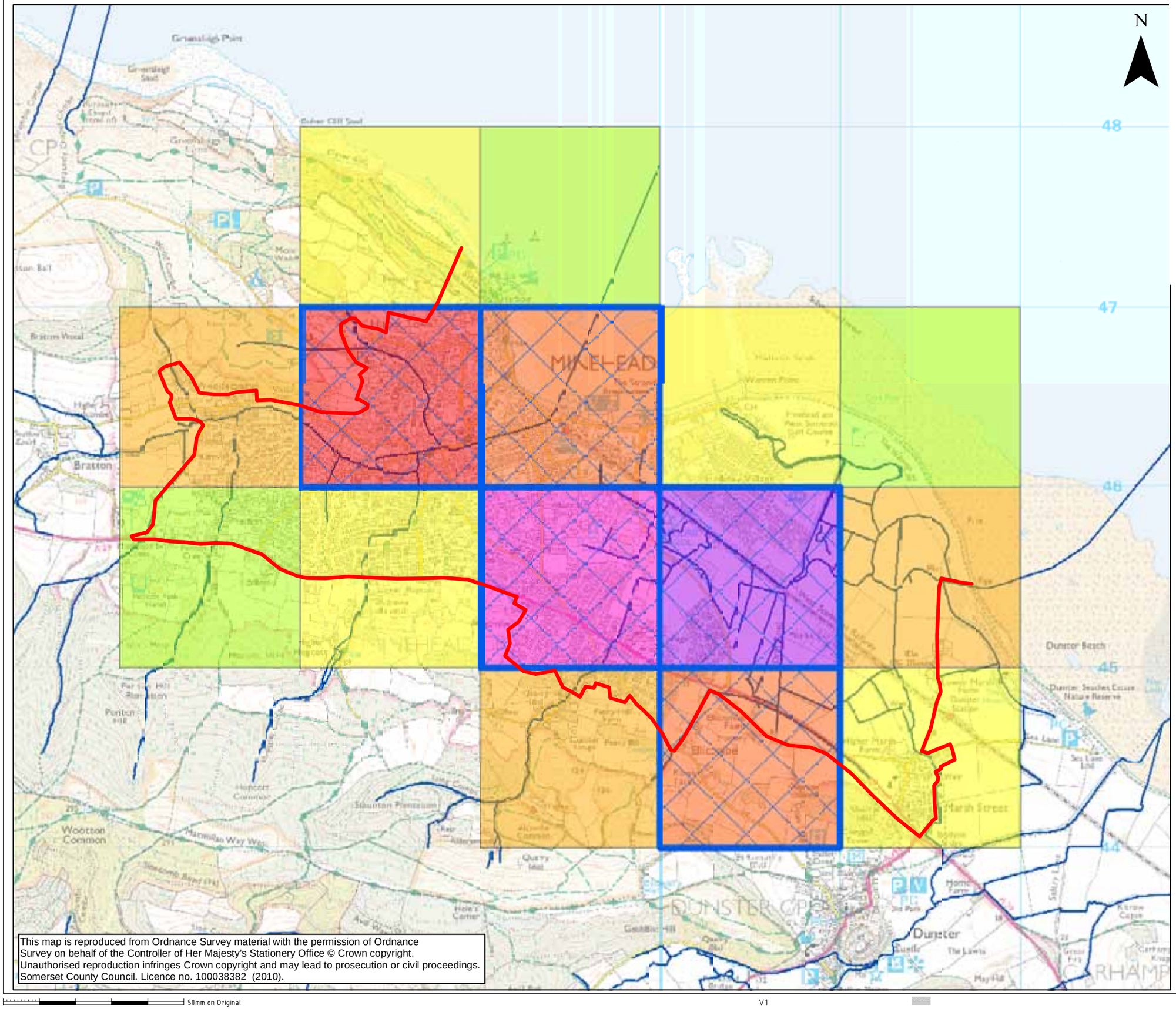
Reservoir Flooding

Flood Susceptibility

Groundwater Flooding

Historic Flooding

Wessex Sewer Flooding



Legend

- Minehead SWMP Study Area
- Further Study Boundaries

EVYDR Grid Calculations

Sum %

- 0 - 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	01MAR11

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Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M3
PRELIMINARY DIRECT RAINFALL GRID SQUARE CALCULATIONS

Drawing No.	Project No.	Issue
0120	— UA001888 —	01

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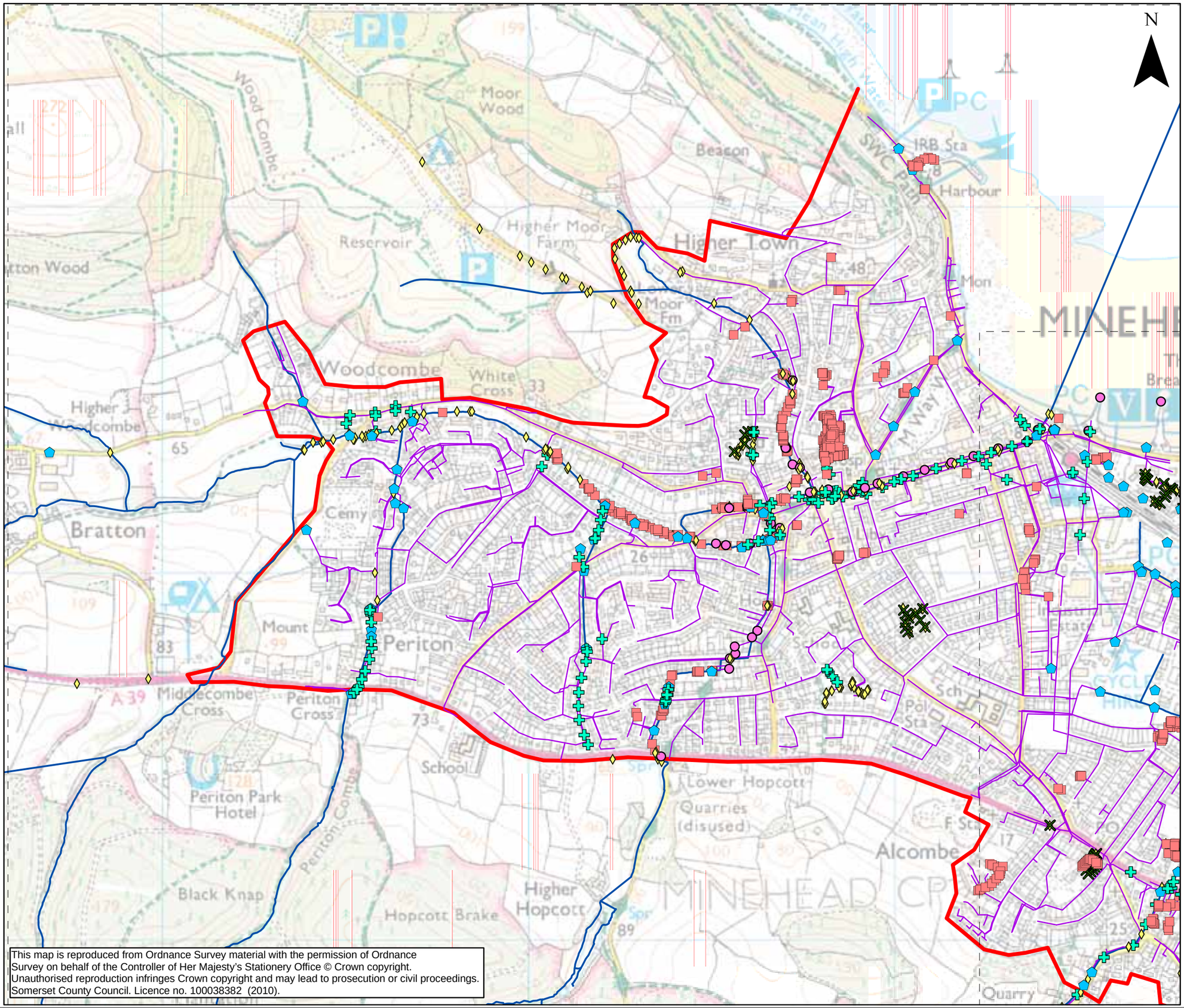
V1

Appendix C

Mapping



LEGEND

- PARRETT INTERNAL DRAINAGE BOARD
- ENVIRONMENT AGENCY
- SOMERSET COUNTY COUNCIL
- WEST SOMERSET COUNCIL
- PRIVATE
- UNKNOWN
- WESSEX WATER
- WESSEX WATER SEWER
- DETAILED RIVER NETWORK
- STUDY BOUNDARY

NOTE:
WESSEX WATER SEWER & MANHOLE AND SOMERSET COUNTY COUNCIL PIPE & GULLY DATA POINTS OMMITED FOR CLARITY.

Issue	Description	Date
02	AMMENDMENTS TO ASSETS DATA	15OCT10
01	ORIGINAL ISSUE	04OCT10

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Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M1
ASSET OVERVIEW
BY OWNER
SHEET 1 OF 2

Drawing No.	Project No.	Issue
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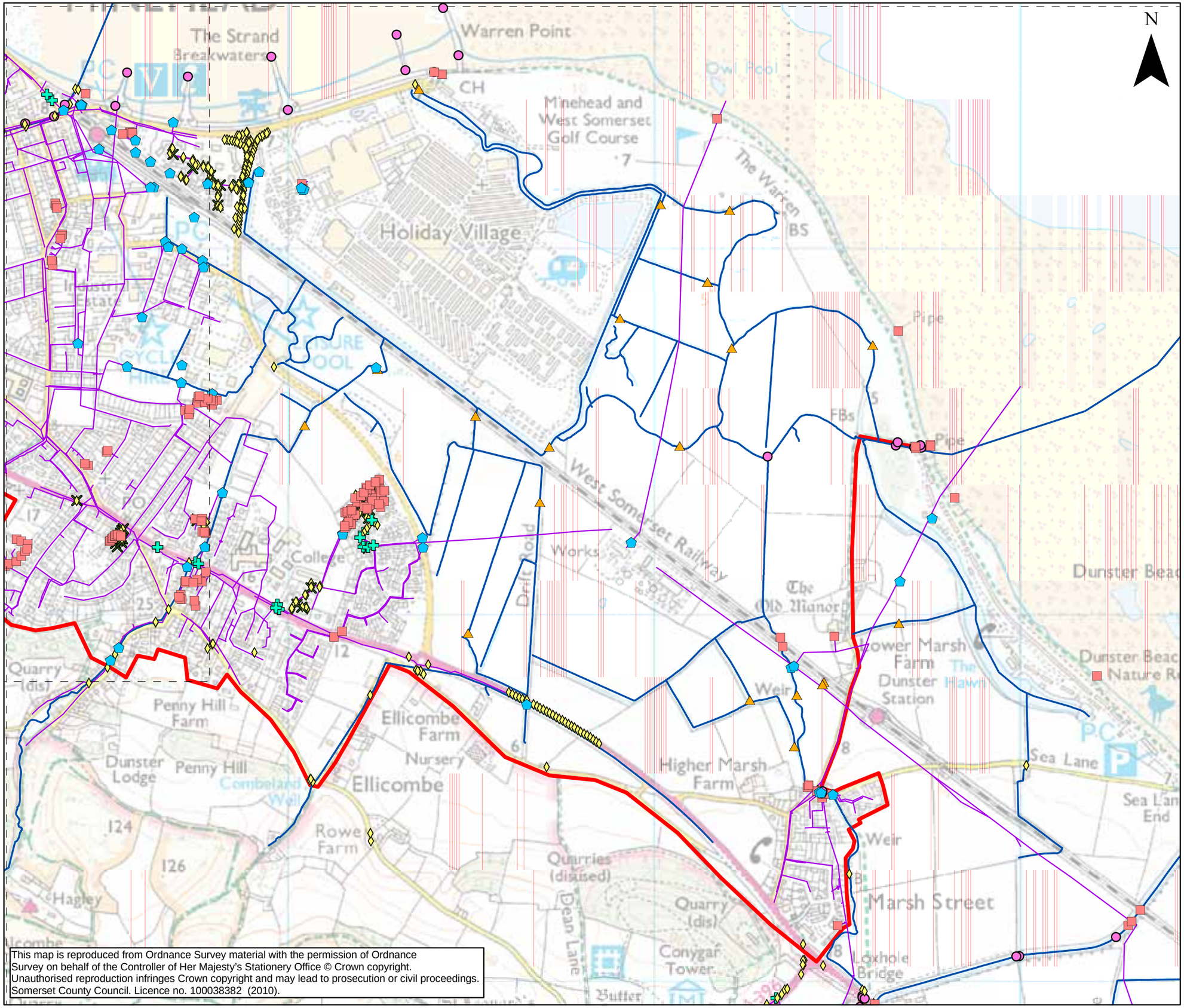

LEGEND

- PARRETT INTERNAL DRAINAGE BOARD
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Issue	Description	Date
02	AMMENDMENTS TO ASSET DATA	15OCT10
01	ORIGINAL ISSUE	04OCT10

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Project
SOMERSET SWMP
MINEHEAD

Title
FIGURE M1
ASSET OVERVIEW
BY OWNER
SHEET 2 OF 2

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0102	— UA001888 —	02

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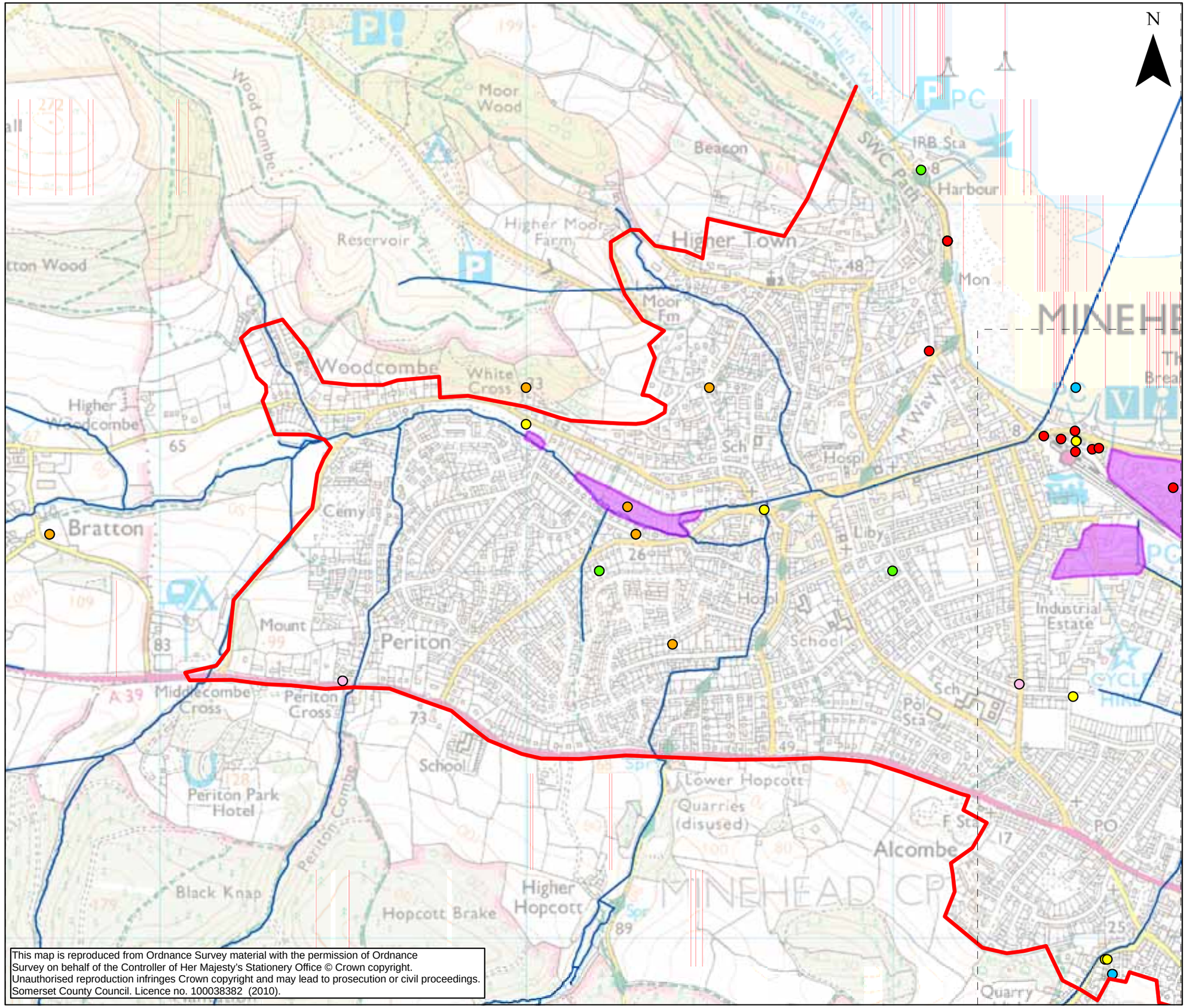

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Legend

- Scoping Boundary

Historic Flood Incident Database

Flood Source

- Coastal
- Fluvial
- Pluvial
- Fluvial, Coastal
- Fluvial, Pluvial
- Pluvial, Coastal
- Unknown
- Historic Flood Areas
- Detailed River Network

Issue	Description	Date
01	ORIGINAL ISSUE	04OCT10

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Project: SOMERSET SWMP MINEHEAD

Title: FIGURE M4 POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK SHEET 1 OF 2

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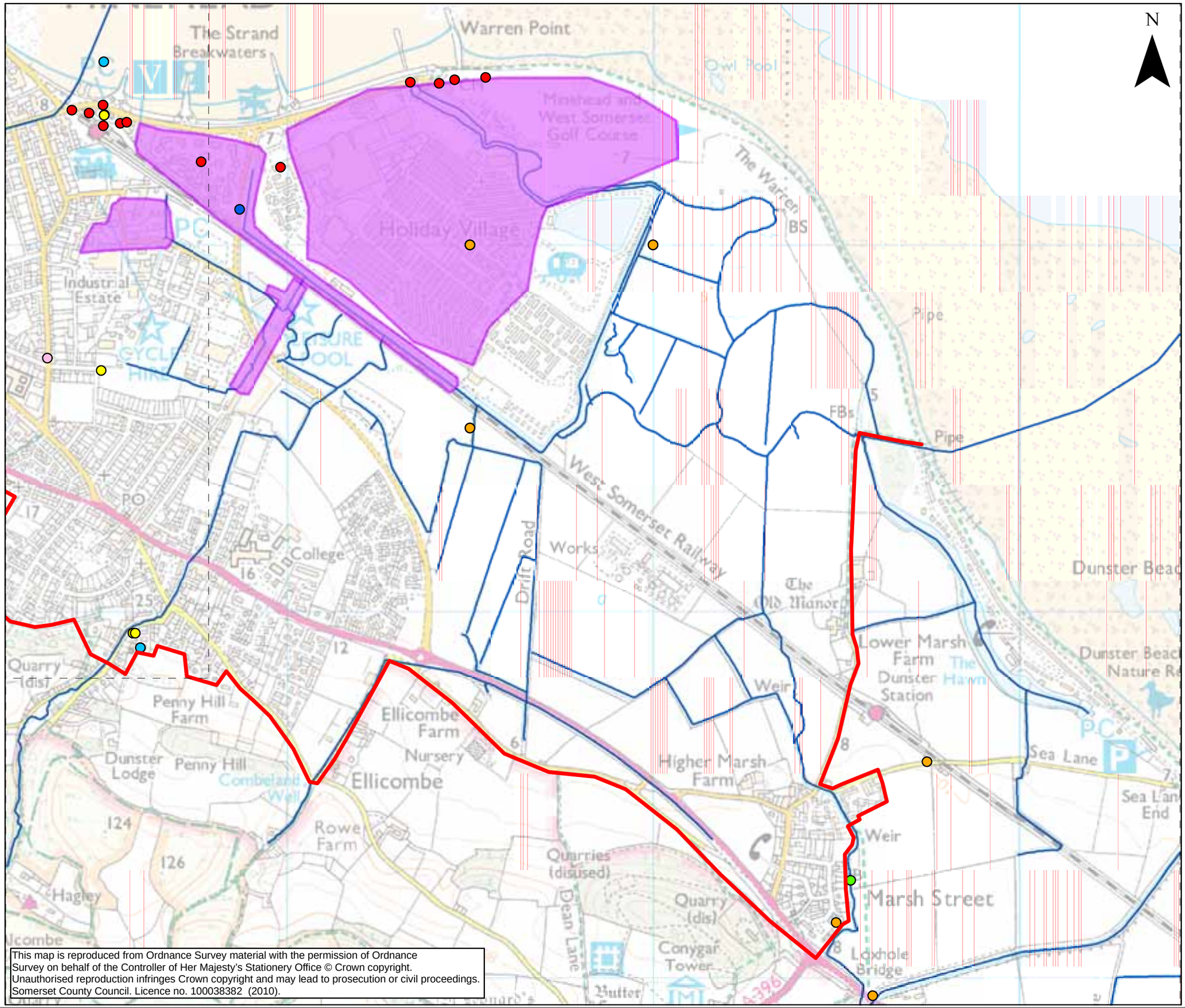
0106	— UA001888 —	01



Legend

- Scoping Boundary

Historic Flood Incident Database

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Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M4
POTENTIAL INDICATORS OF SURFACE WATER FLOOD RISK
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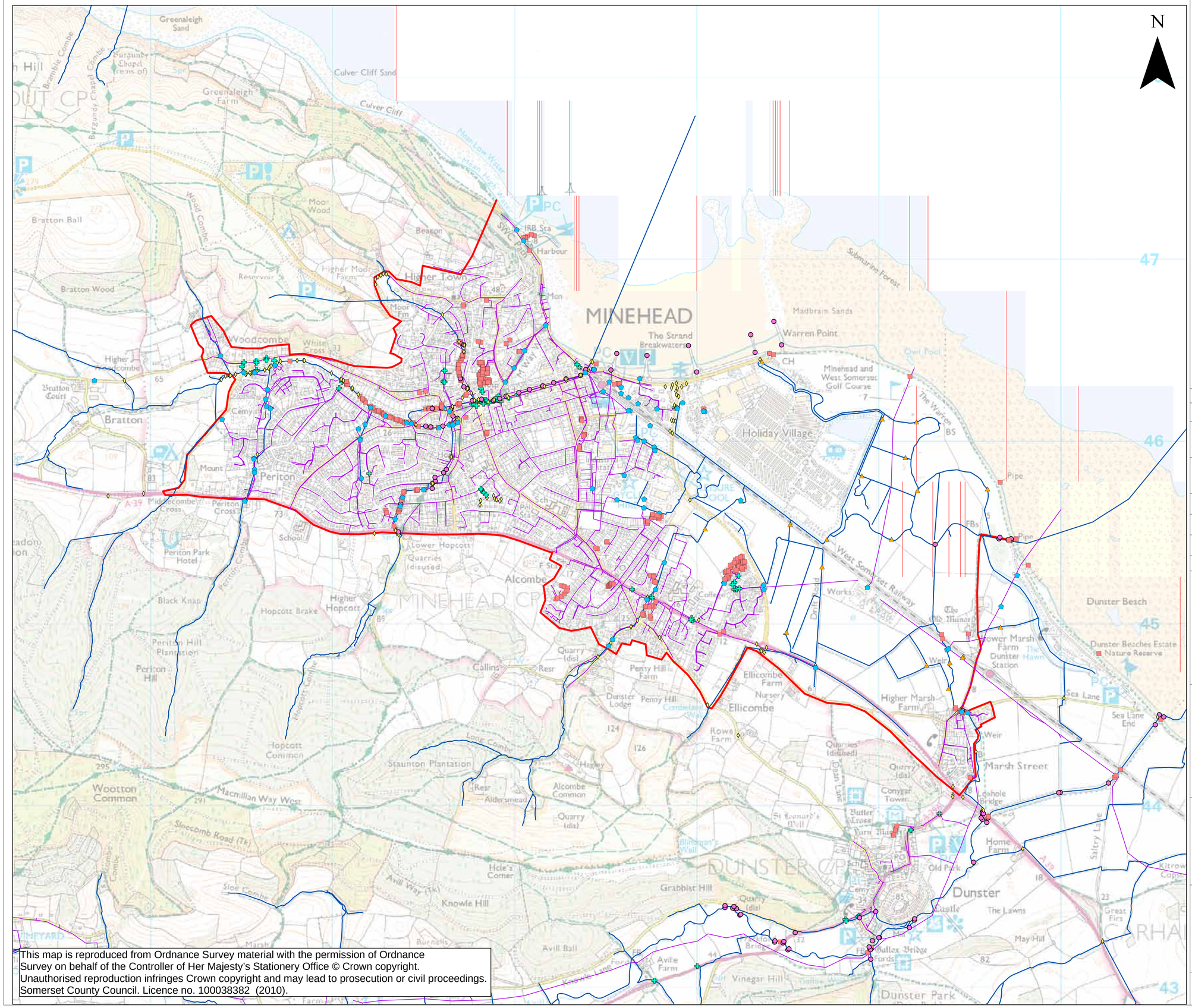


LEGEND

- PARRETT INTERNAL DRAINAGE BOARD
- ENVIRONMENT AGENCY
- SOMERSET COUNTY COUNCIL
- PRIVATE
- UNKNOWN
- WESSEX WATER
- WESSEX WATER SEWER
- DETAILED RIVER NETWORK
- STUDY BOUNDARY

NOTE:
WESSEX WATER SEWER & MANHOLE AND SOMERSET COUNTY COUNCIL PIPE & GULLY DATA POINTS OMMITED FOR CLARITY.

Issue	Description	Date
01	ORIGINAL ISSUE	11OCT11

Status: FOR INFORMATION NOT TO BE USED FOR CONSTRUCTION

Scales	1:10,000	Current Issue Signatures	
		Author A.NIMMO	
Original Size	A1	Checker R.BEHAN	
Height Datum	mAOD	Approver B.SARGENT	
Grid	OS	© Copyright reserved	

Filename:

Client: SOMERSET County Council

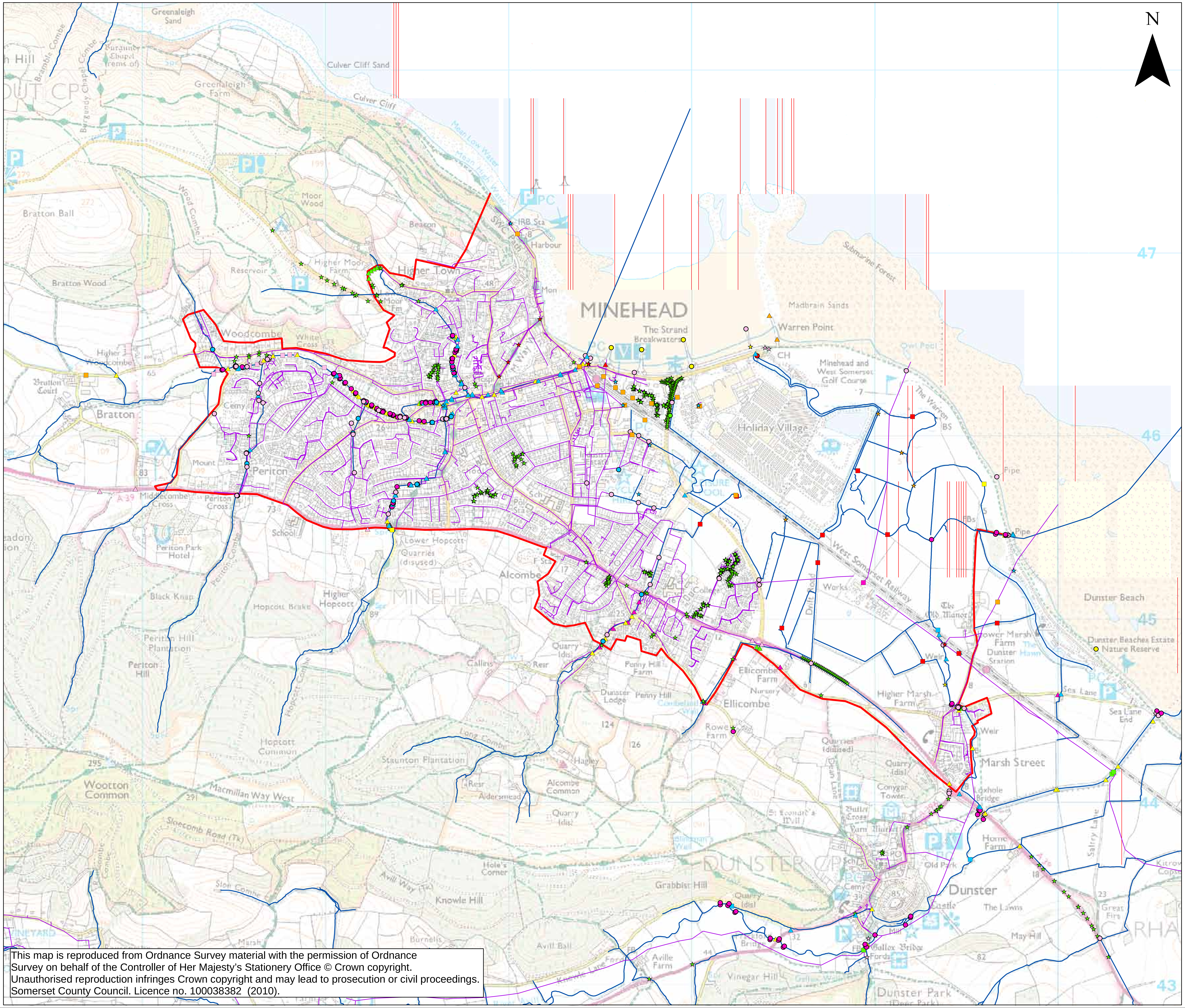
HYDER CONSULTING (UK) Ltd
3 Kew Court
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

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

Project: SOMERSET SWMP MINEHEAD

Title: FIGURE M1 ASSET OVERVIEW BY OWNER

Drawing No.	Project No.	Issue
0109	— UA001888 —	01



Legend

UA001888-Asset Register V01

Type

- Beach
- Breakwater
- Bridge
- Catchpit
- Culvert
- Ditch
- Filter Drain
- Flap & screen
- Grill
- Groyne
- Headwall
- Inlet
- Open Channel
- Outfall
- Overflow
- Penning boards
- Penstock
- Pipe
- Pumping Station
- Rain Gauge
- Raised Defence
- Rhyne
- Rising Main
- Screen
- Service Crossing
- Sluice
- Wastewater Treatment Works
- Weir
- Detailed River Network
- Sewers
- Scoping Boundary

NOTE:
SEWER, MANHOLE AND GULLY DATA POINTS OMMITED FOR CLARITY.

Issue	Description	Date
01	ORIGINAL ISSUE	11OCT10

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:10,000	Current Issue Signatures	
		Author	A NIMMO
Original Size	A1	Checker	R BEHAN
Height Datum	mAOD	Approver	B SARGENT
Grid	OS	© Copyright reserved	

Filename:

Client: SOMERSET County Council

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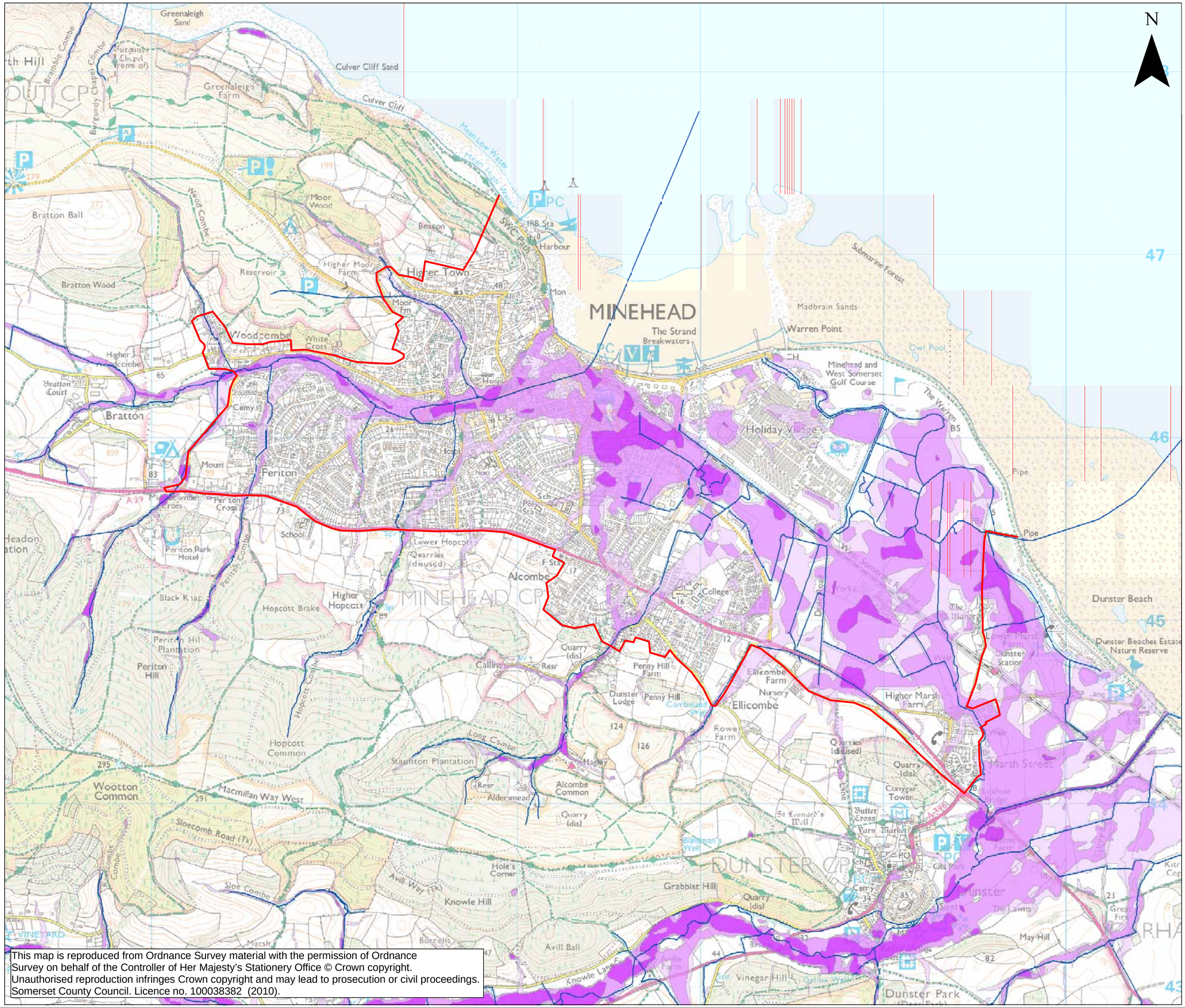
Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ
Tel: +44 (0)870 000 3012
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M2
ASSET OVERVIEW
BY TYPE

Drawing No.	Project No.	Issue
0110	UA001888	01

V1



Legend

- Scoping Boundary
- Detailed River Network
- Surface Water Susceptibility - More
- Surface Water Susceptibility - Intermediate
- Surface Water Susceptibility - Less

Issue	Description	Date
01	ORIGINAL ISSUE	11OCT10

Status: FOR INFORMATION NOT TO BE USED FOR CONSTRUCTION

Scales	1:10,000	Current Issue Signatures	
		Author A.NIMMO	
Original Size	A1	Checker R.BEHAN	
Height Datum	mAOD	Approver B.SARGENT	
Grid	OS	© Copyright reserved	

Filename:

Client: SOMERSET County Council

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England
EX2 5AZ

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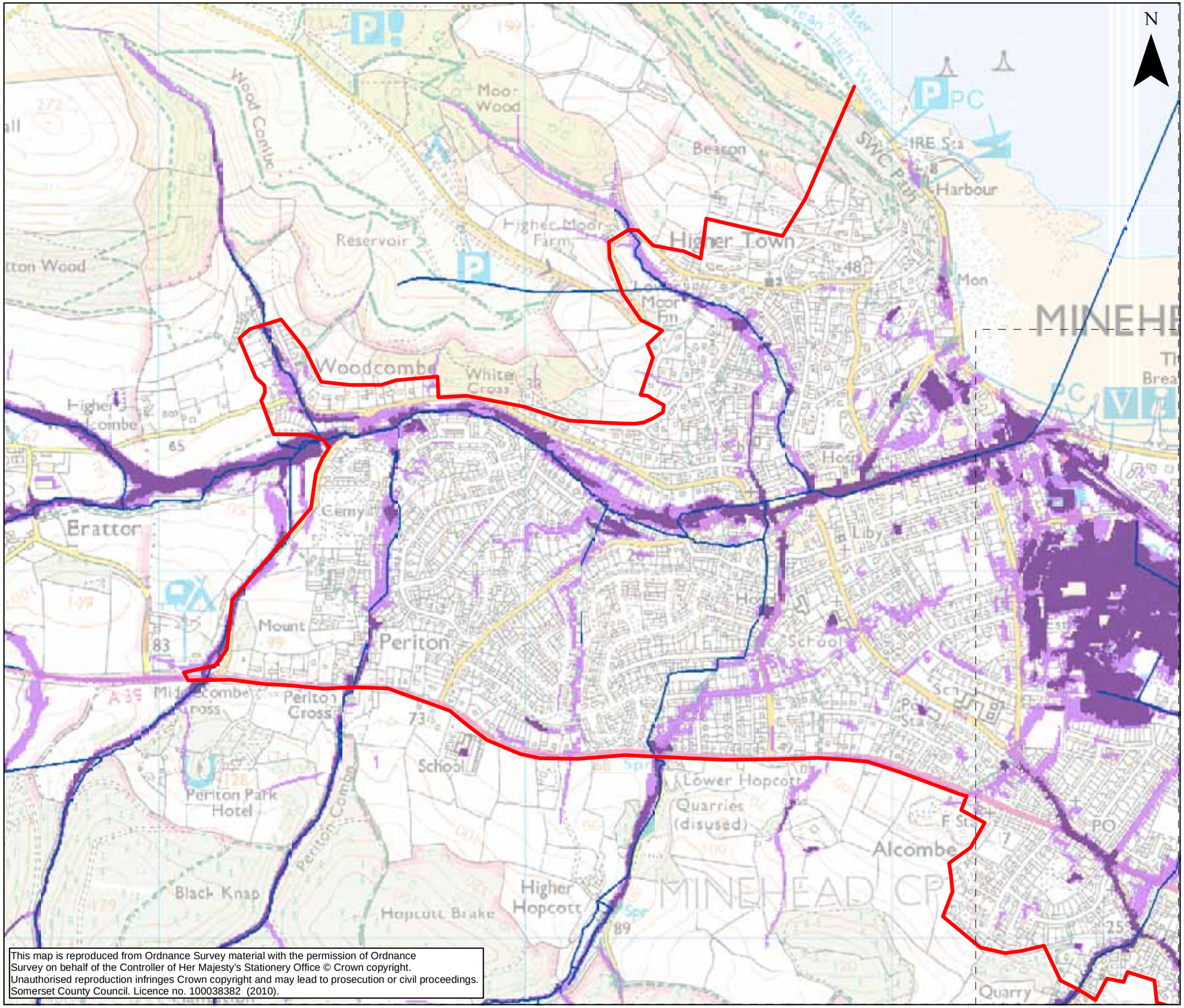
Fax: +44 (0)870 000 3912

Project: SOMERSET SWMP MINEHEAD

Title: FIGURE M3 EA SURFACE WATER SUSCEPTIBILITY MAPPING

Drawing No.	Project No.	Issue
0111	— UA001888 —	01

V1



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Legend

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

Issue	Description	Date
01	ORIGINAL ISSUE	01MAR11

Status: FOR INFORMATION NOT TO BE USED FOR CONSTRUCTION

Scales	1:10,000	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

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Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

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

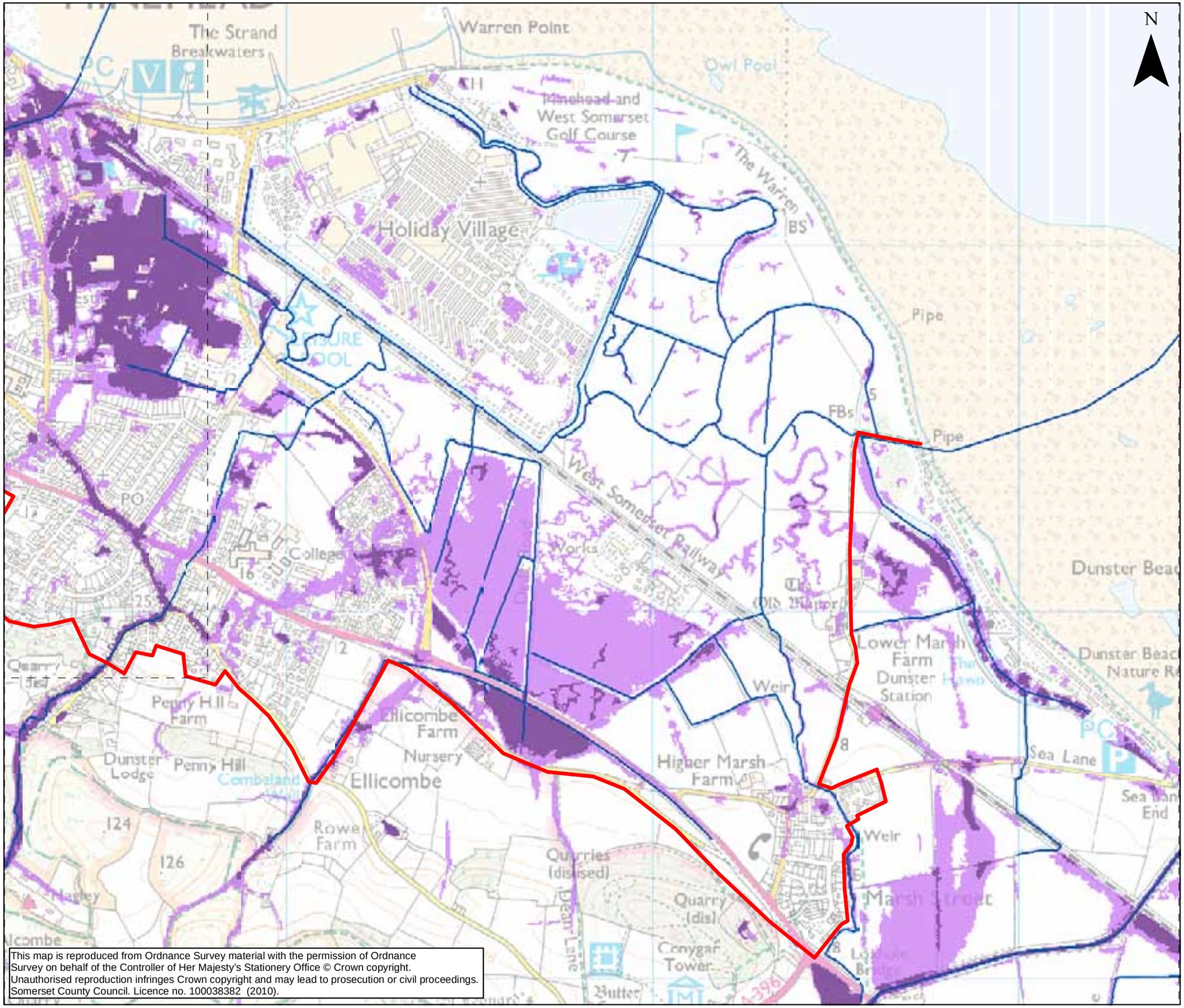
Project: SOMERSET SWMP MINEHEAD

Title: FIGURE M1 FLOOD MAP FOR SURFACE WATER 200yr EXTENTS SHEET 1 OF 2

Drawing No.	Project No.	Issue
0116	— UA001888 —	01

50mm on Original

V1



Legend

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

Issue	Description	Date
01	ORIGINAL ISSUE	01MAR11

Status: FOR INFORMATION
NOT TO BE USED FOR CONSTRUCTION

Scales	1:10,000	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

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Pynes Hill, Rydon Lane
Exeter, Devon
England
EX2 5AZ

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

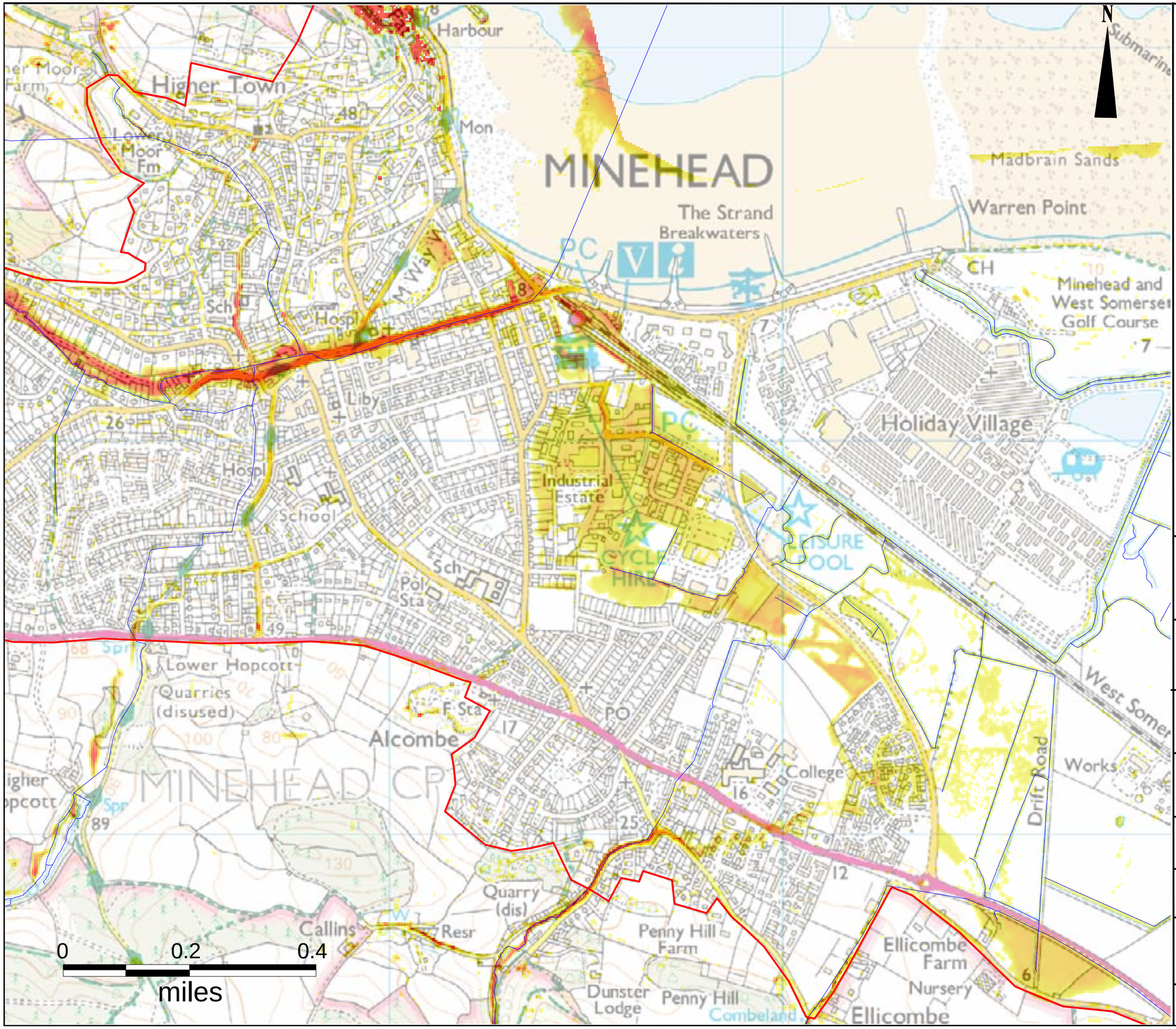
Project: SOMERSET SWMP
MINEHEAD

Title: FIGURE M1
FLOOD MAP FOR SURFACE WATER 200yr EXTENTS
SHEET 2 OF 2

Drawing No.	Project No.	Issue
0117	— UA001888 —	01

Appendix D

Modelled Outputs



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

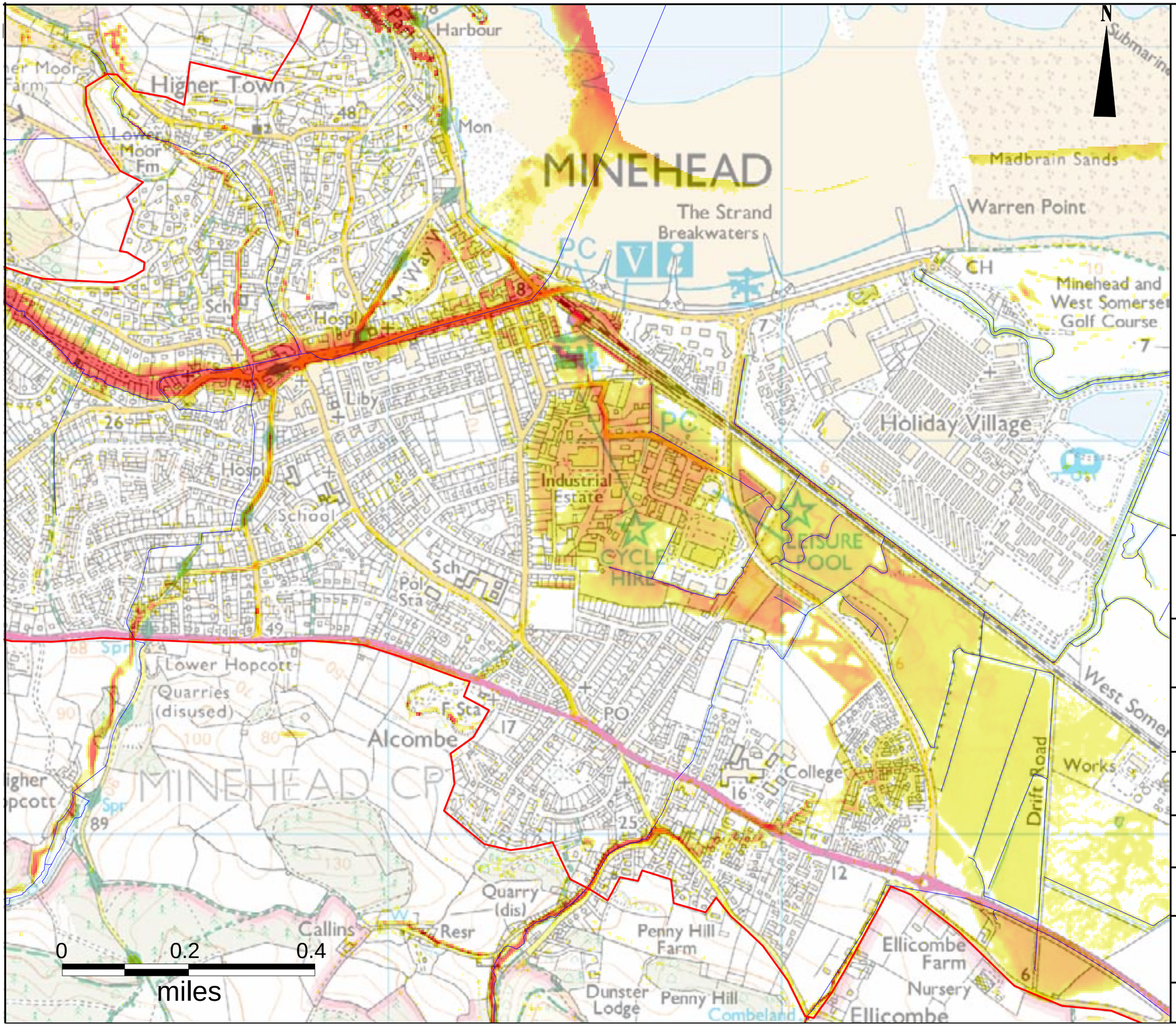
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Do Nothing- 1 in 25 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0133-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

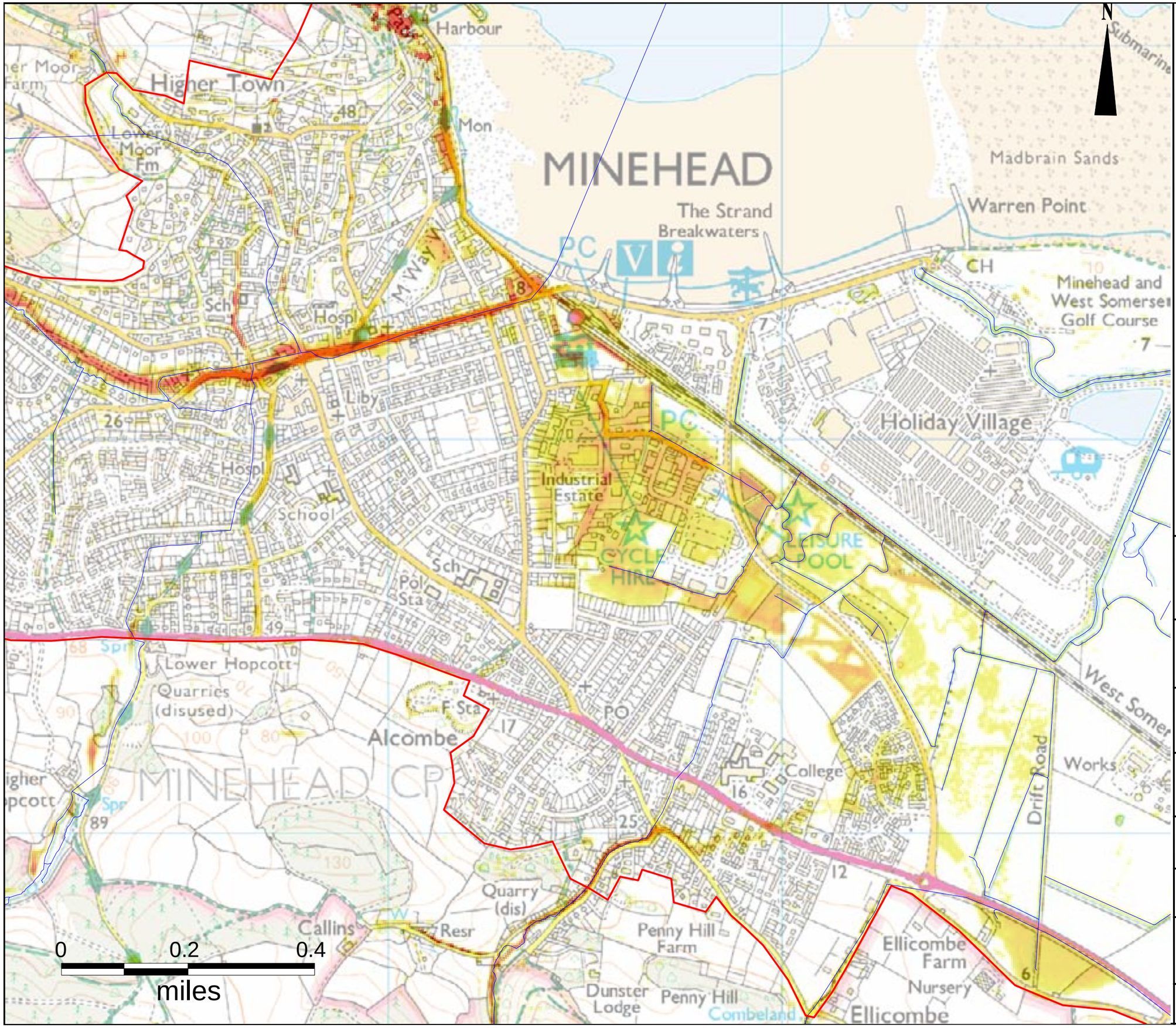
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Do Nothing- 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0134-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

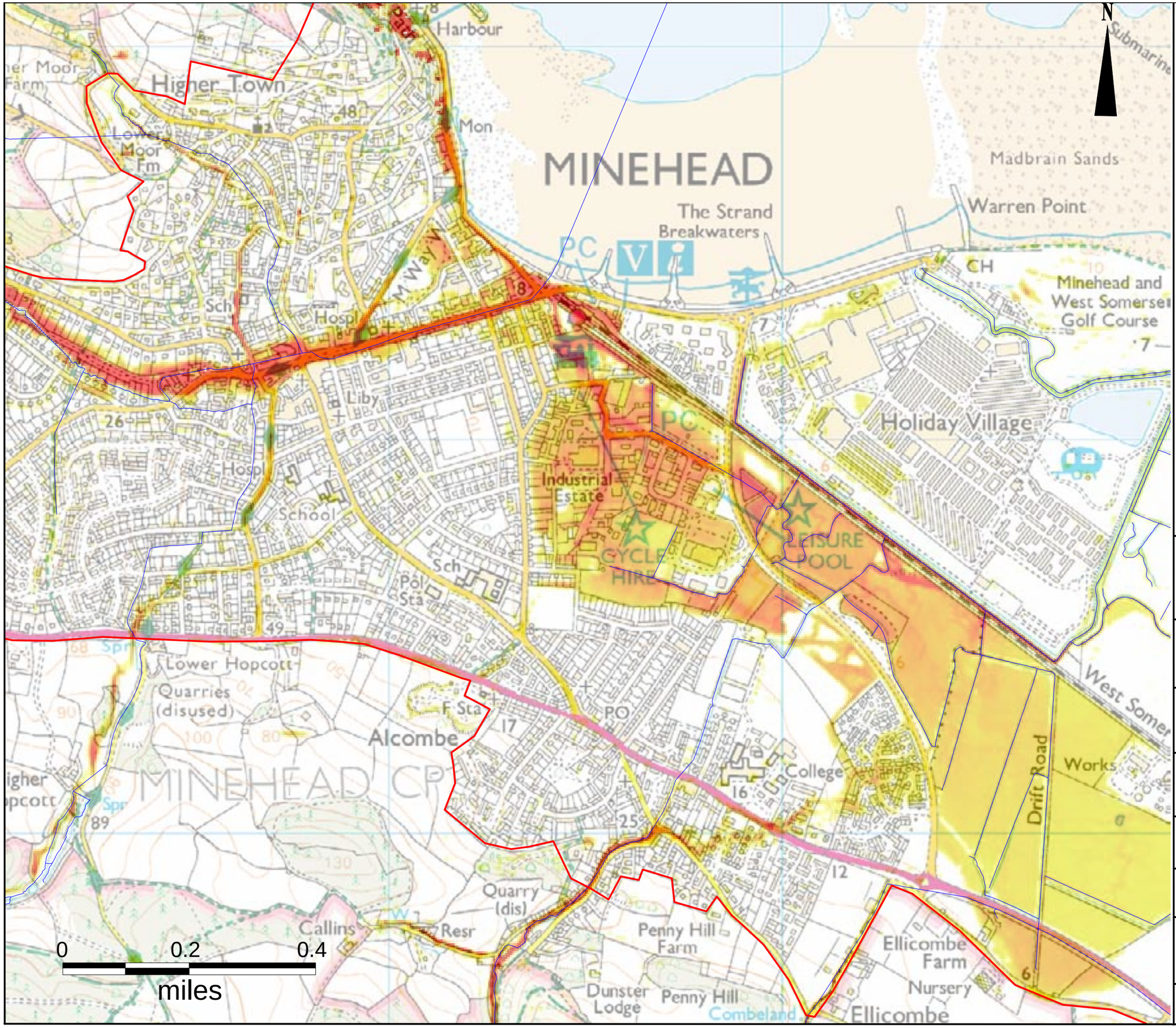
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Do Minimum- 1 in 25 year

Scale NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0135-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

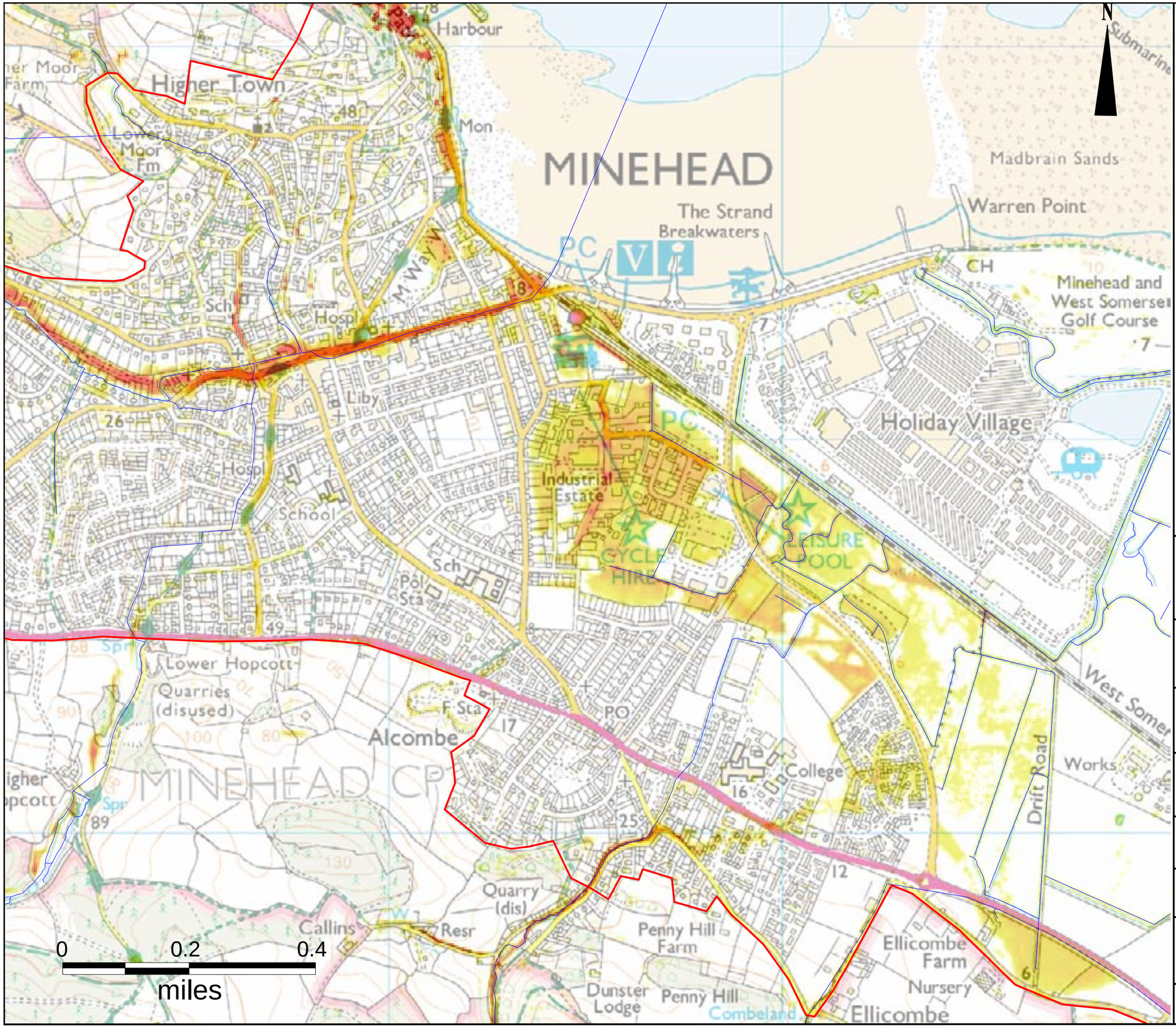
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Do Minimum- 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0136-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

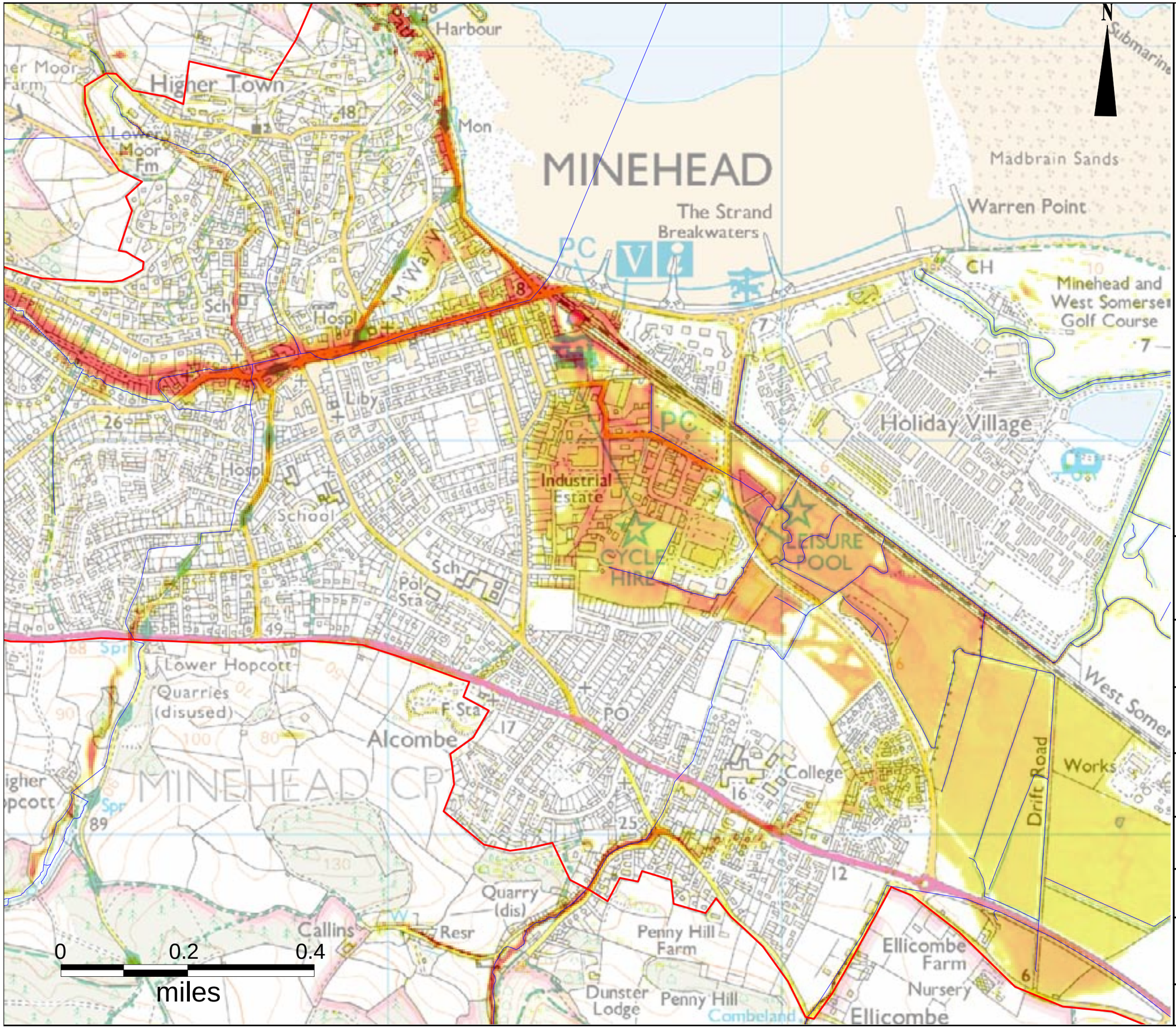
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Option 1- 1 in 25 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0137-UA001888-DVD-01



Legend

Hazard Rating

- Danger for Some > 0.75
- Danger for Most > 1.25
- Danger for All > 2
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

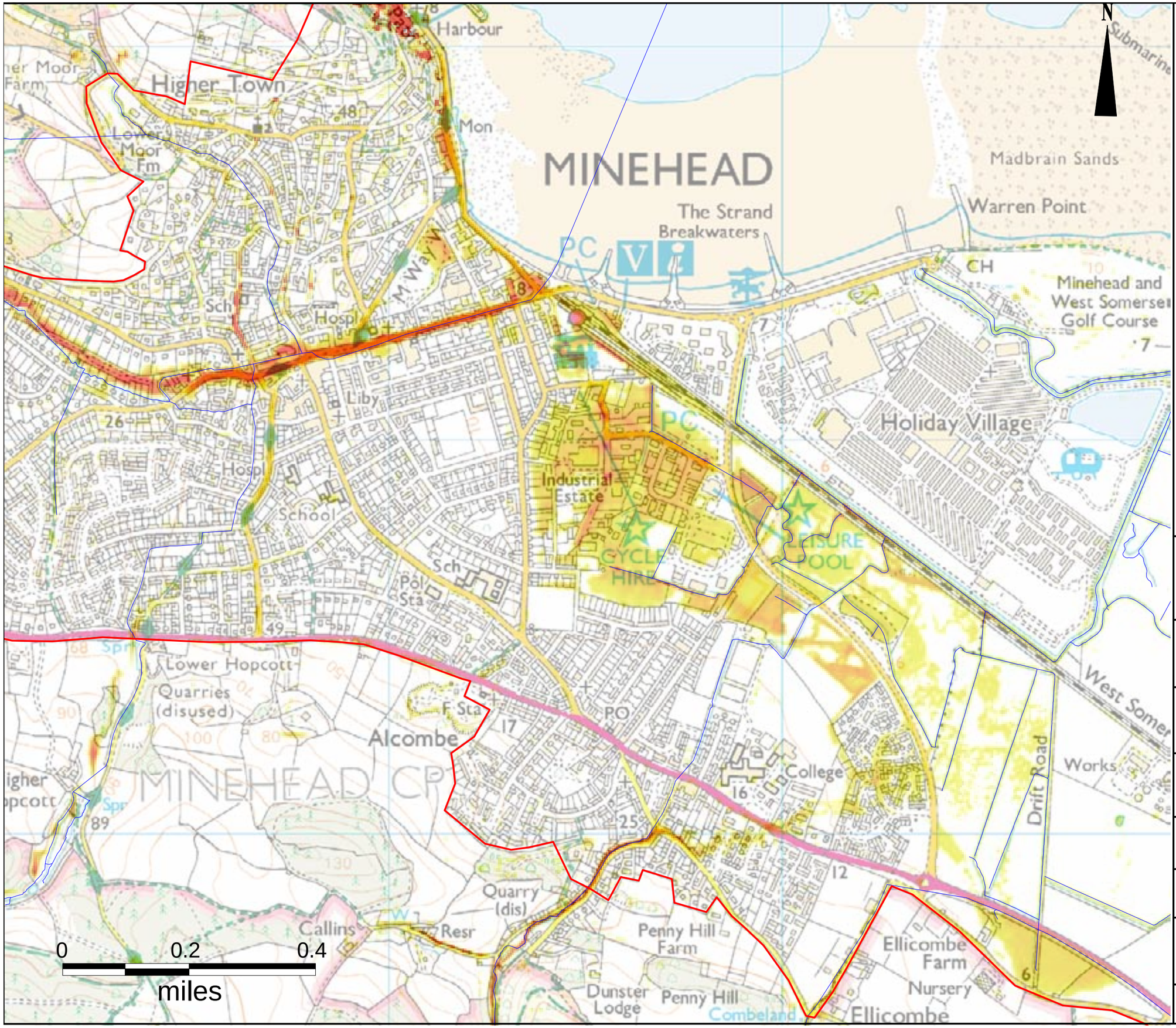
Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Option 1- 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0138-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

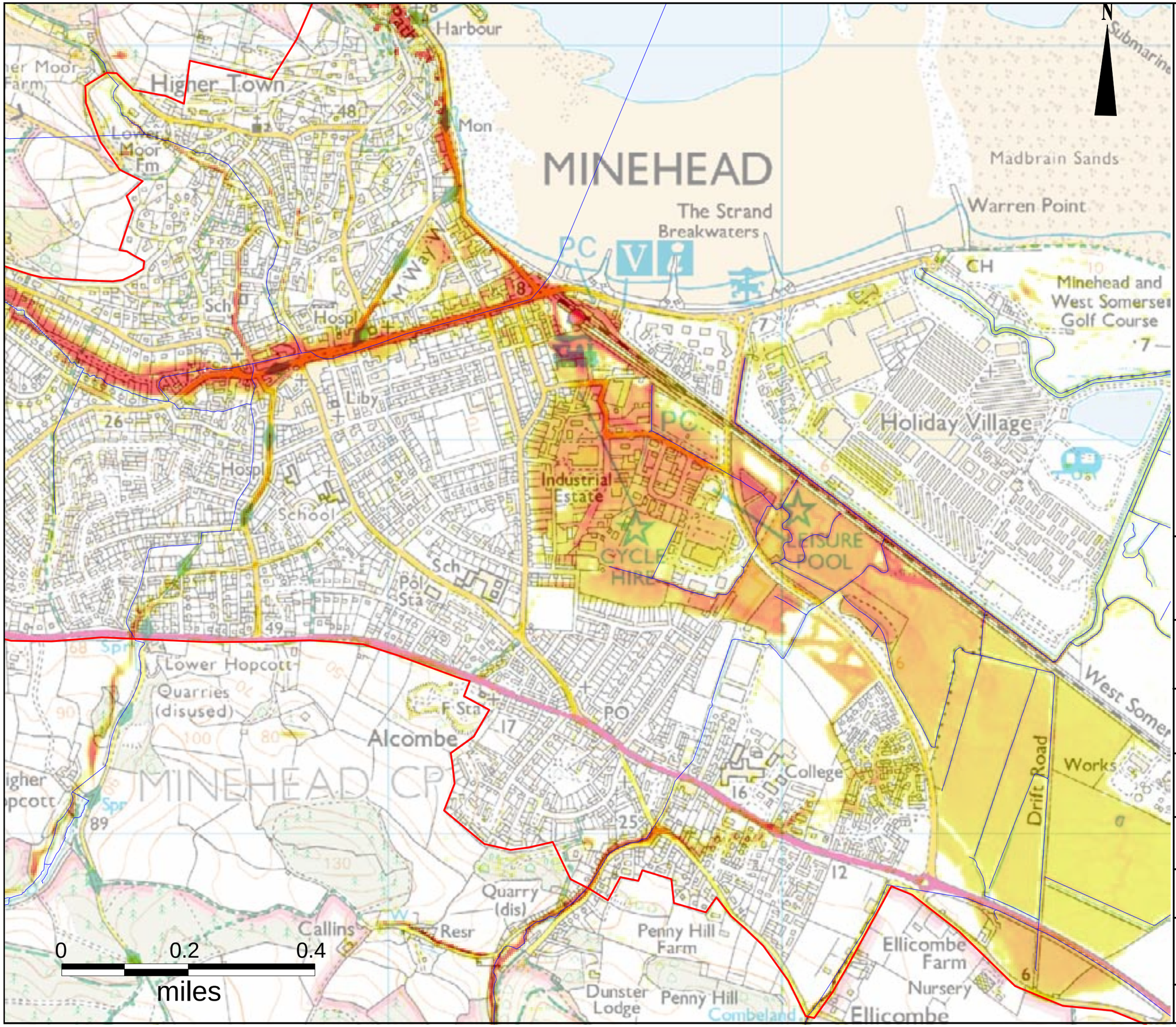
Minehead
Surface Water Management Plan

Modelled Outputs Hazard Rating
Option 2- 1 in 25 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0139-UA001888-DVD-01



Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Option 2- 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0140-UA001888-DVD-01

N

0 0.2 0.4
miles

Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

Somerset SWMP
Minehead

Modelled Outputs Hazard Rating
Option 3- 1 in 25 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0141-UA001888-DVD-01

Legend

Hazard Rating

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

- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

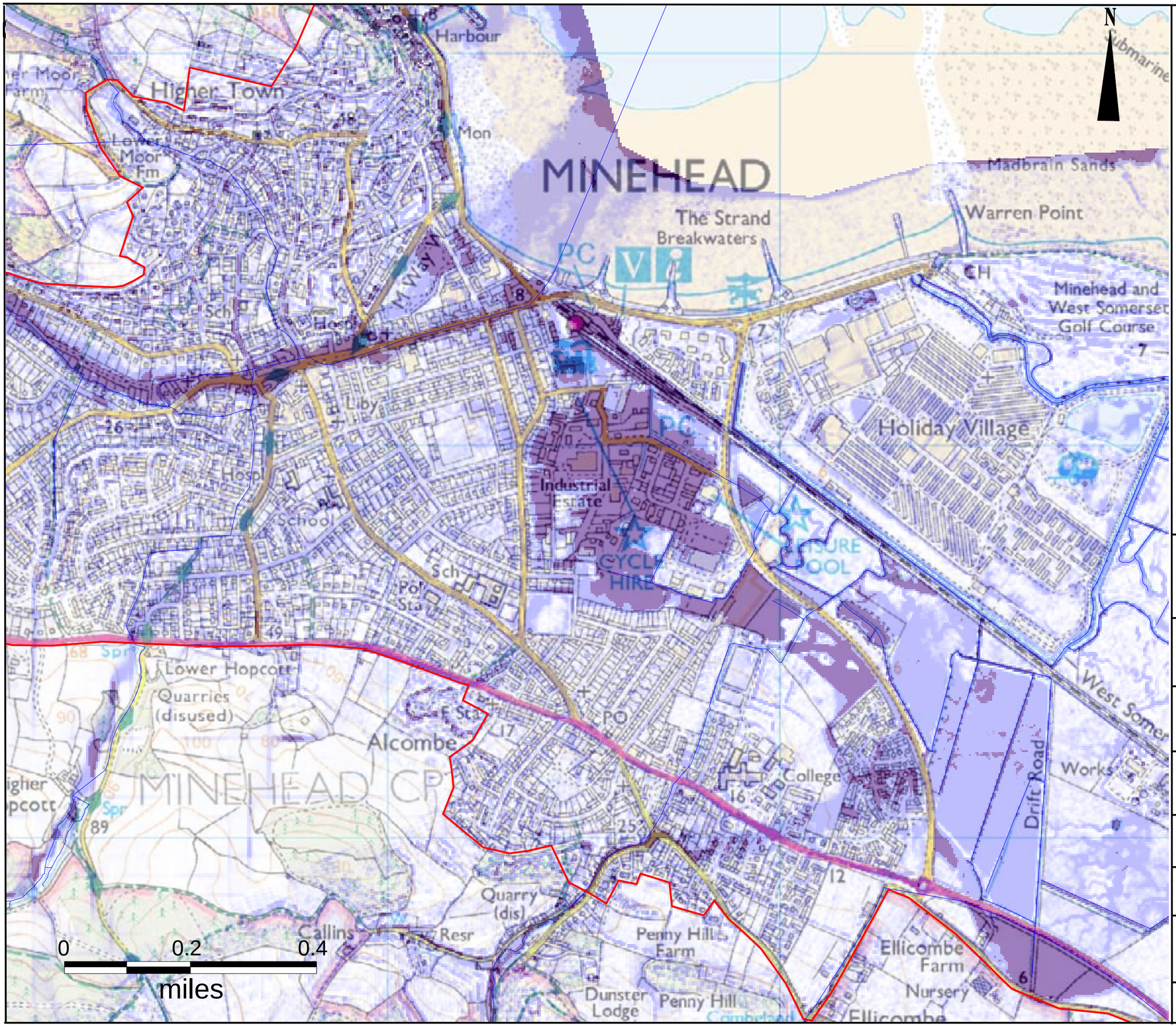
Minehead
Surface Water Management Plan

Figure M4. Modelled Outputs Hazard Rating Option 3- 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0142-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

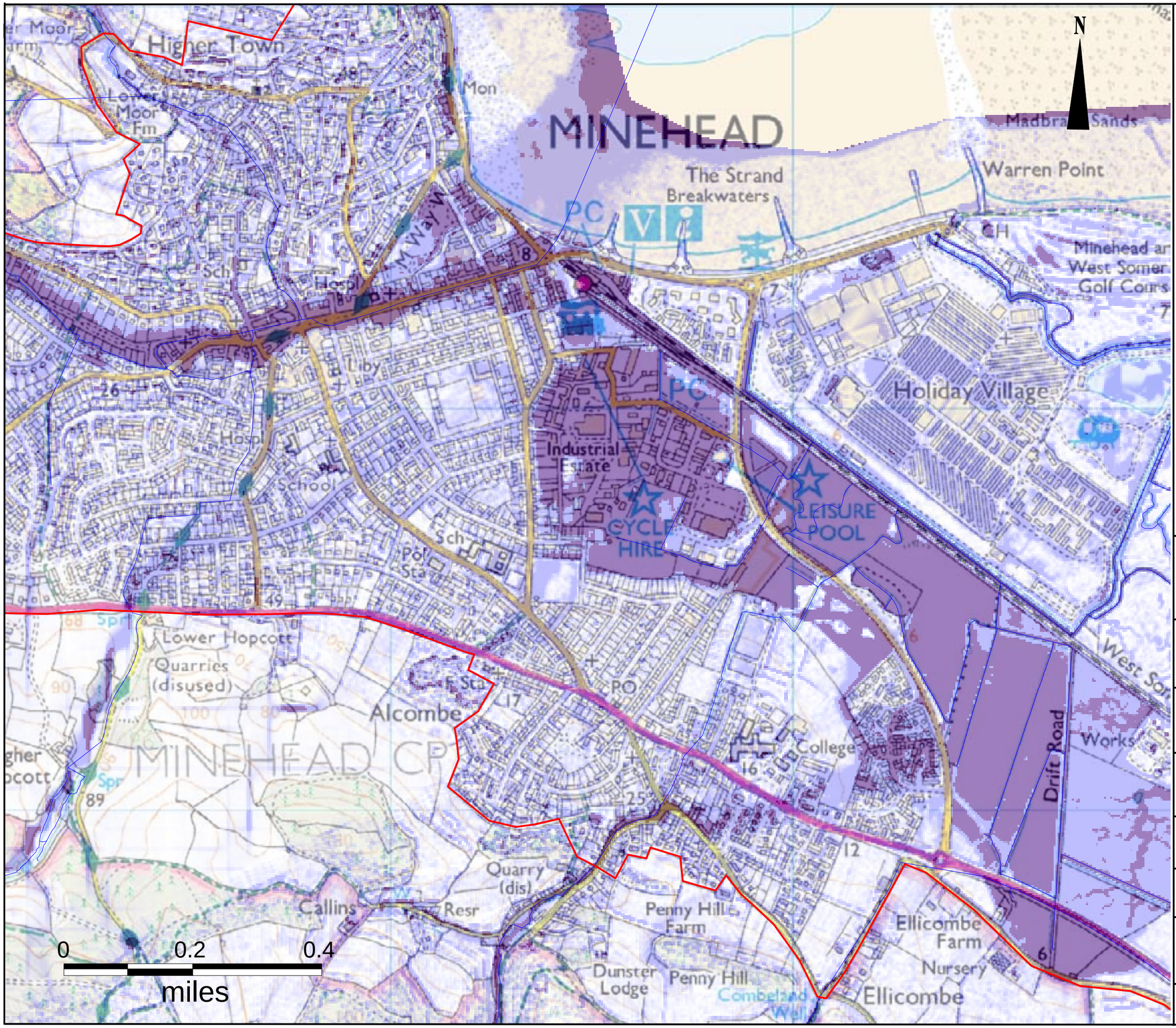
Somerset SWMP
Minehead

Modelled outputs
Do Nothing - 1 in 25 year.

Scale
NTS

Produced	AH	13-04-12
Checked	LF	13-04-12
Approved	LF	13-04-12

DRAWING NO.
0121-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

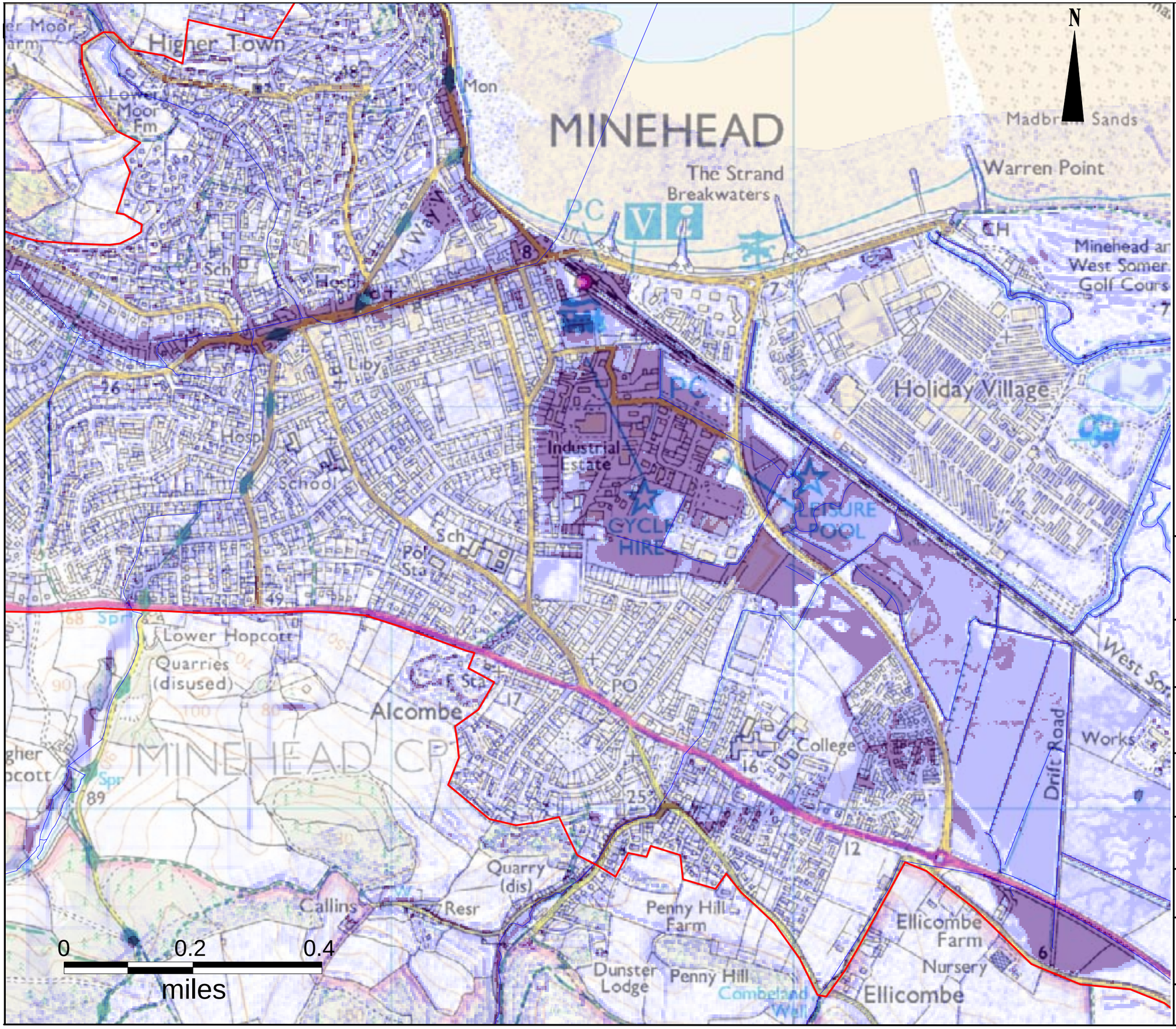
Somerset SWMP
Minehead

Modelled outputs
Do Nothing- 1 in 200 year.

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0122-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

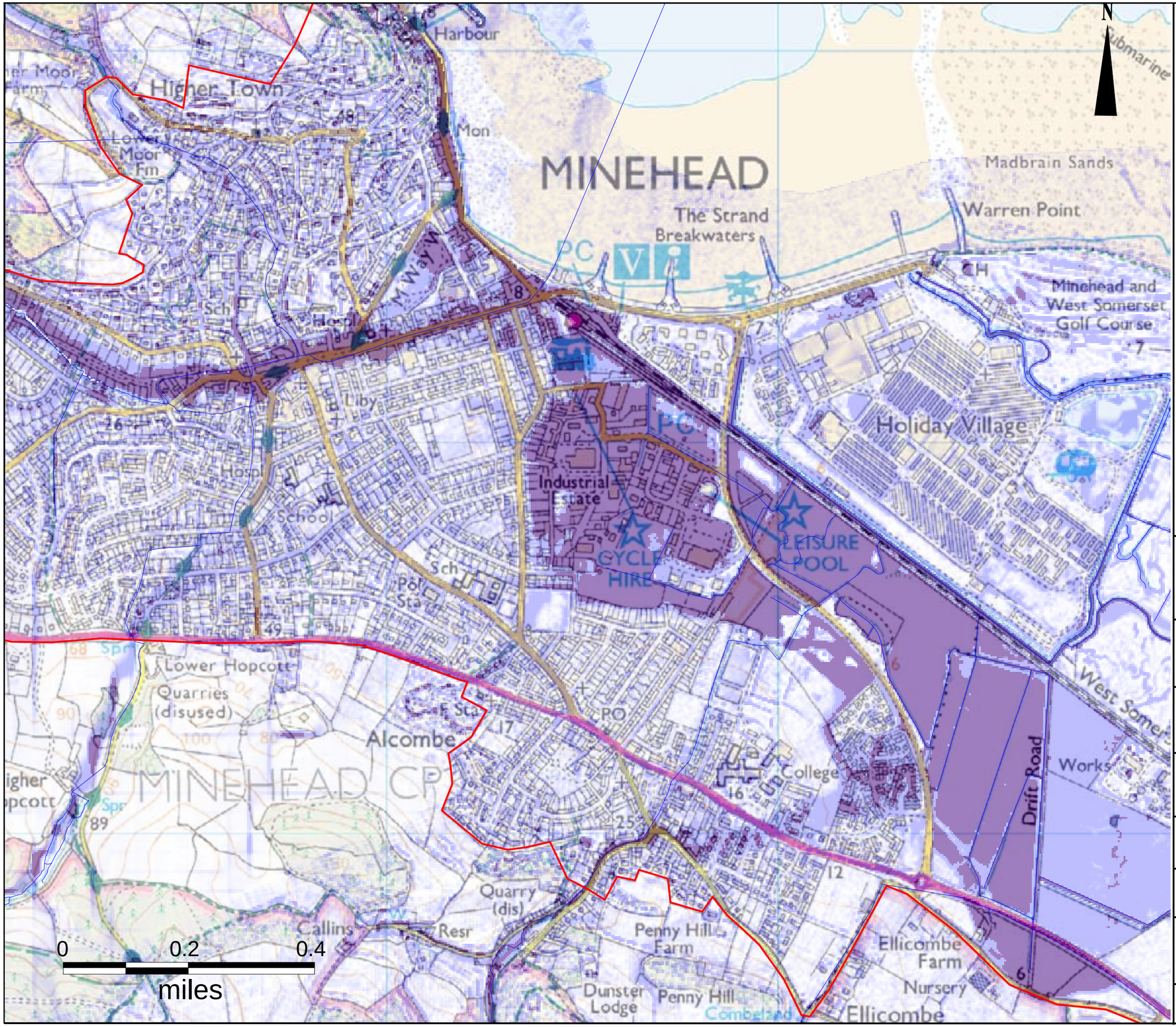
Somerset SWMP
Minehead

Modelled outputs
Do Minimum- 1 in 25 year.

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0123-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

Somerset SWMP
Minehead

Modelled outputs
Do Minimum- 1 in 100 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0130-UA001888-DVD-01

N

0 0.2 0.4 miles

Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

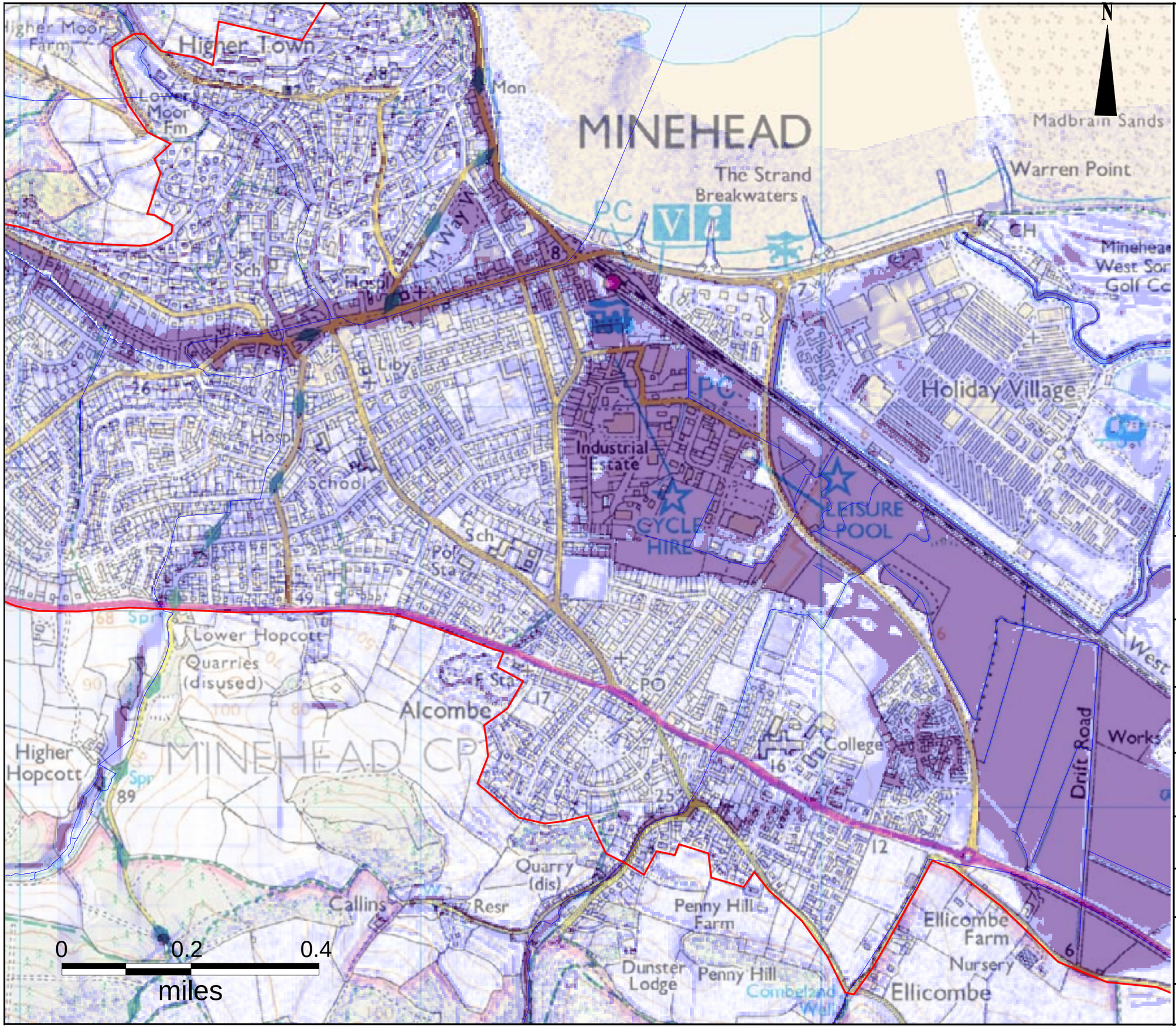
Somerset SWMP
Minehead

Modelled outputs
Do Minimum- 1 in 100 year with 6.5m Tide

Scale
NTS

	Produced	AH	14-04-12
	Checked	LF	14-04-12
	Approved	LF	14-04-12

DRAWING NO.
0129-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

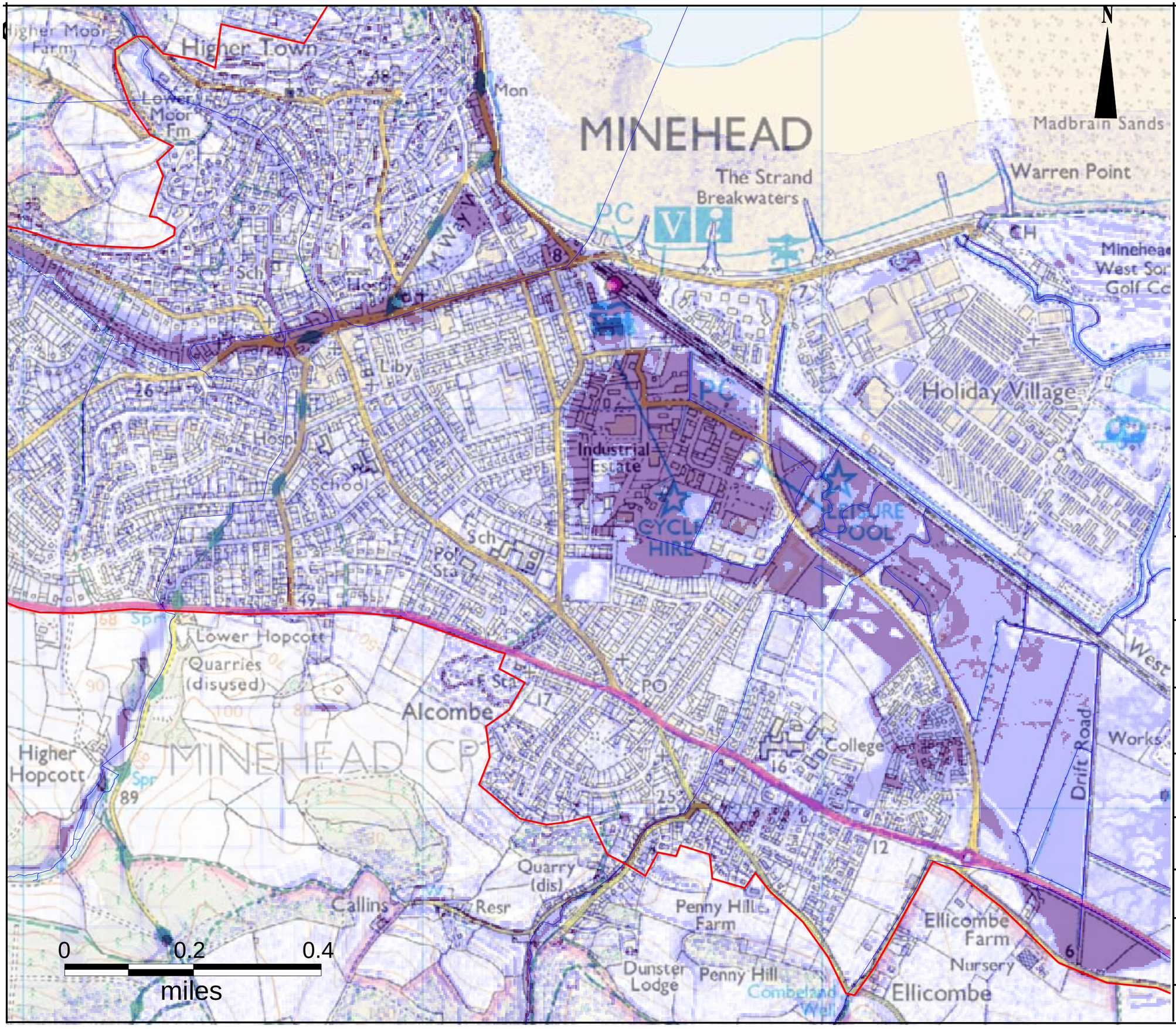
Somerset SWMP
Minehead

Modelled outputs
Do Minimum- 1 in 200 year.

Scale NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0124-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

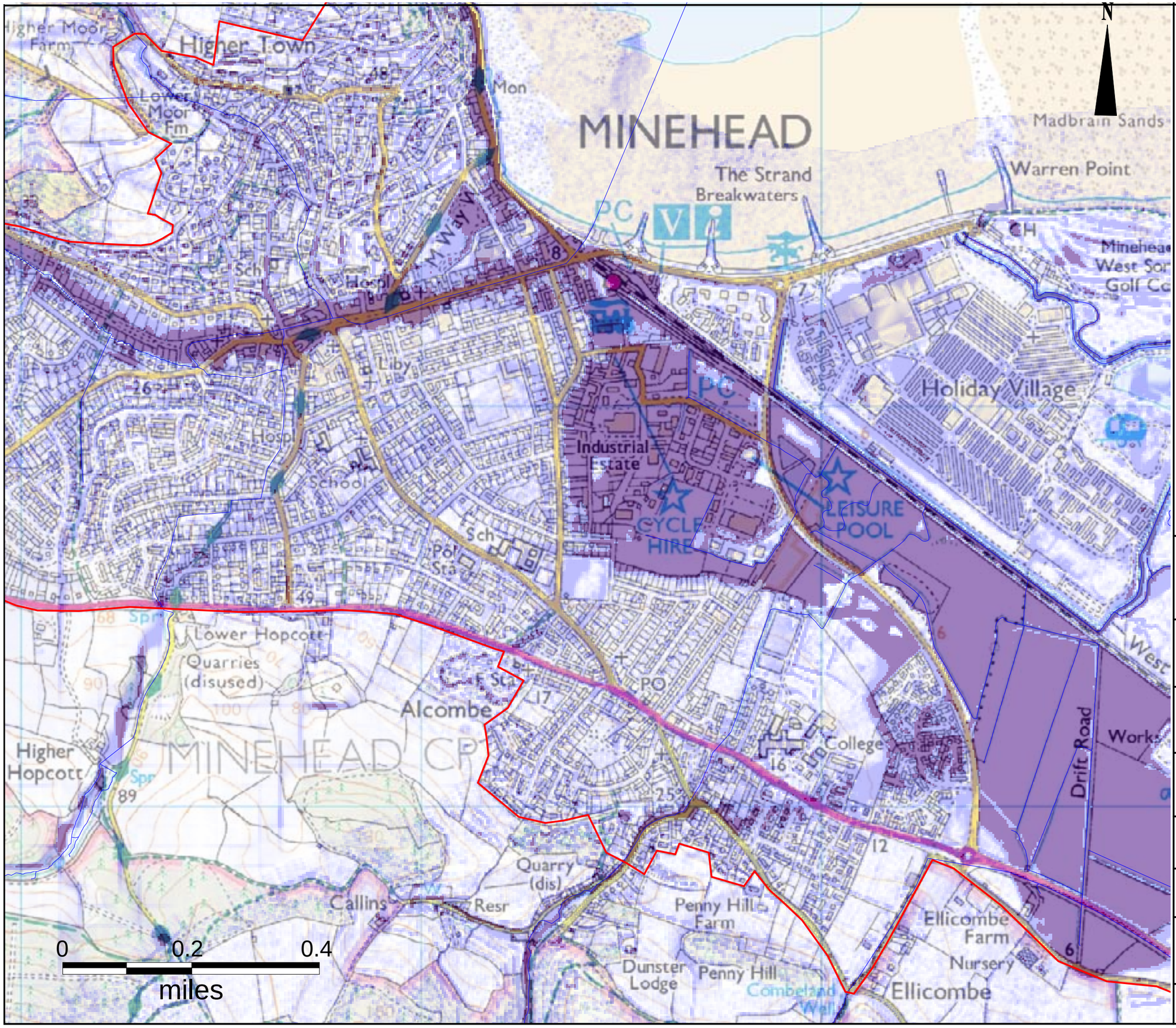
Somerset SWMP
Minehead

Modelled outputs
Option 1- 1 in 25 year.

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0127-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

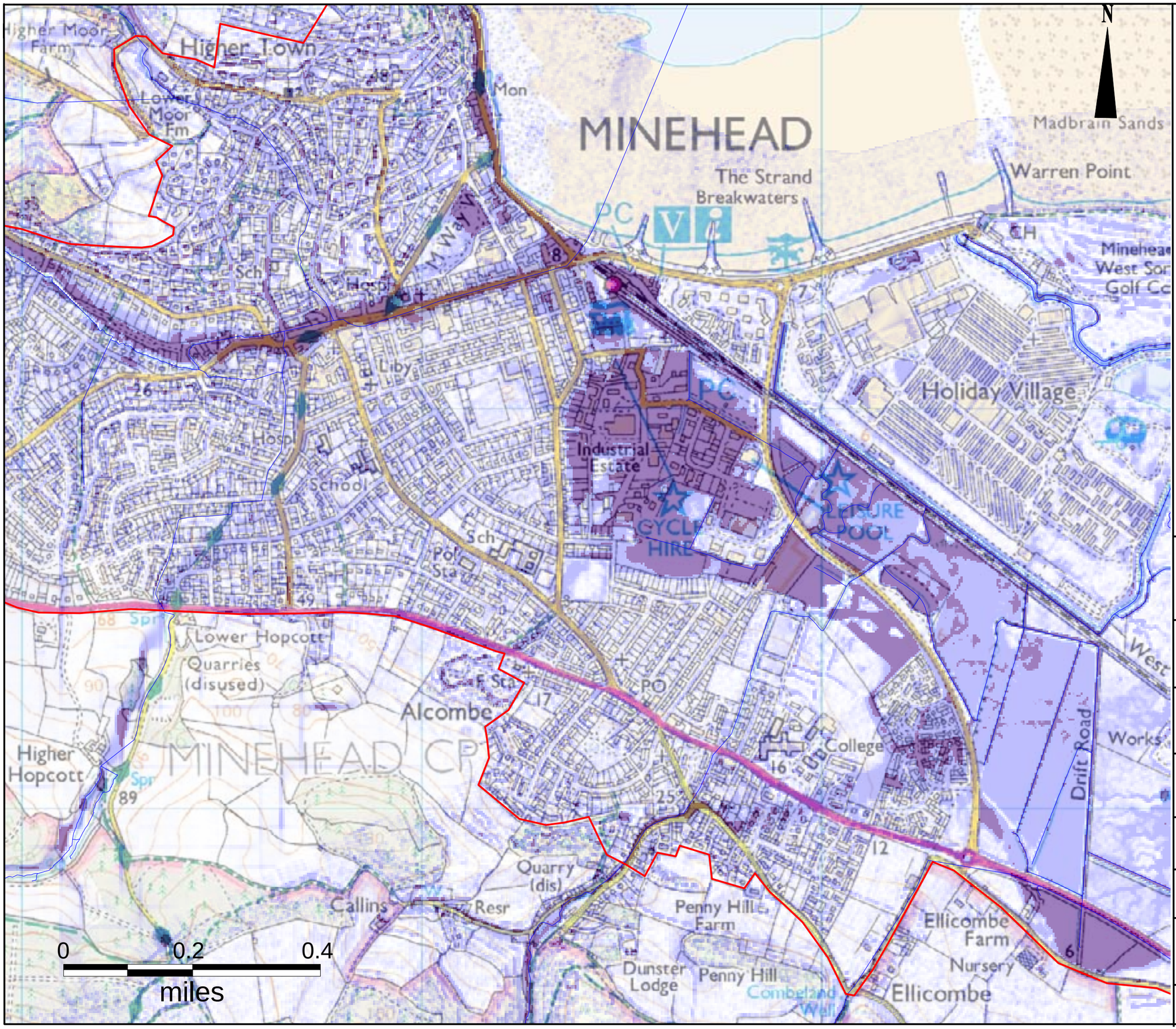
Somerset SWMP
Minehead

Modelled outputs
Option 1- 1 in 200 year.

Scale NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0128-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

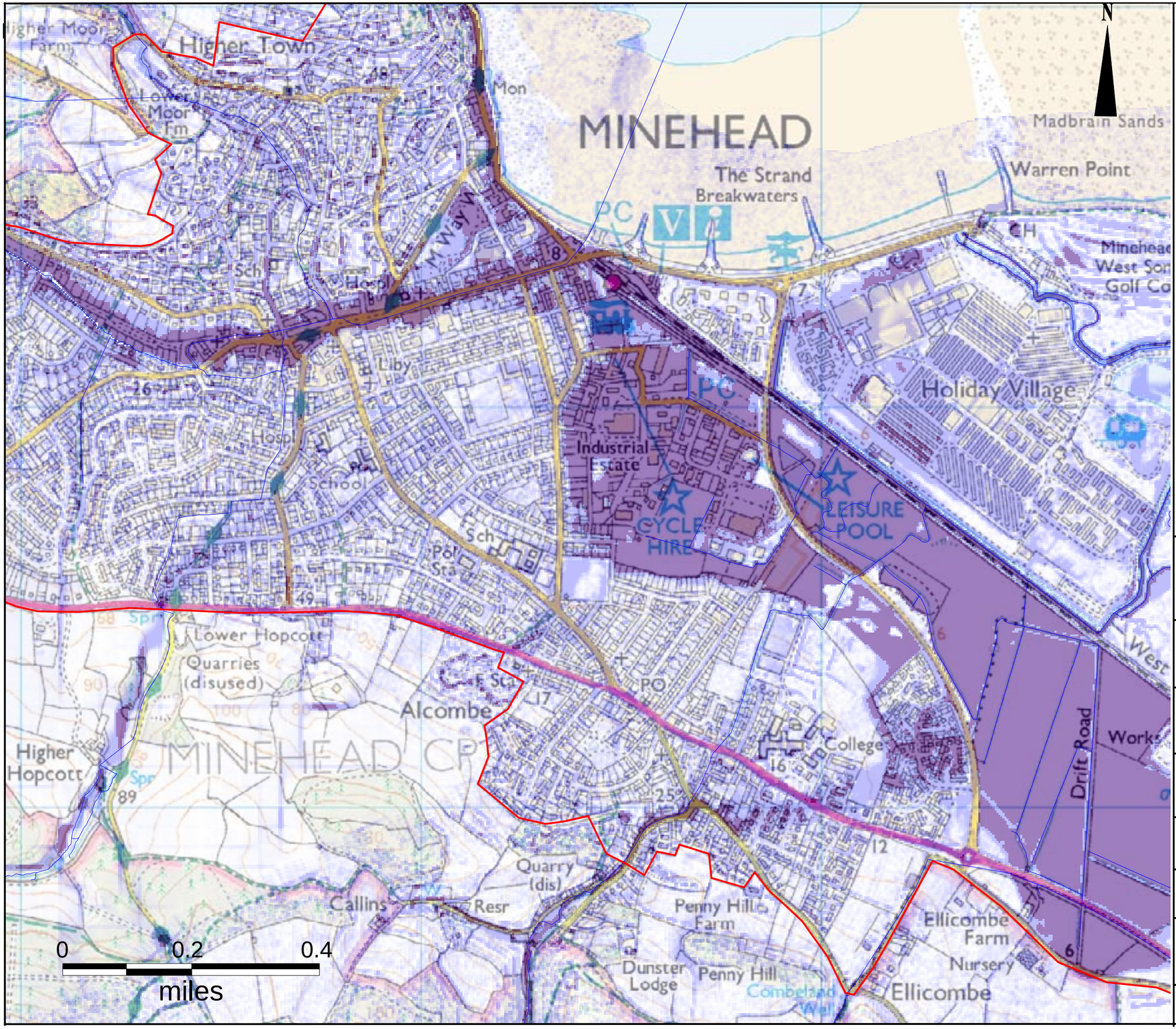
Somerset SWMP
Minehead

Modelled outputs
Option 2- 1 in 25 year.

Scale
NTS

Produced	AH	14-04-04
Checked	LF	14-04-04
Approved	LF	14-04-04

DRAWING NO.
0125-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

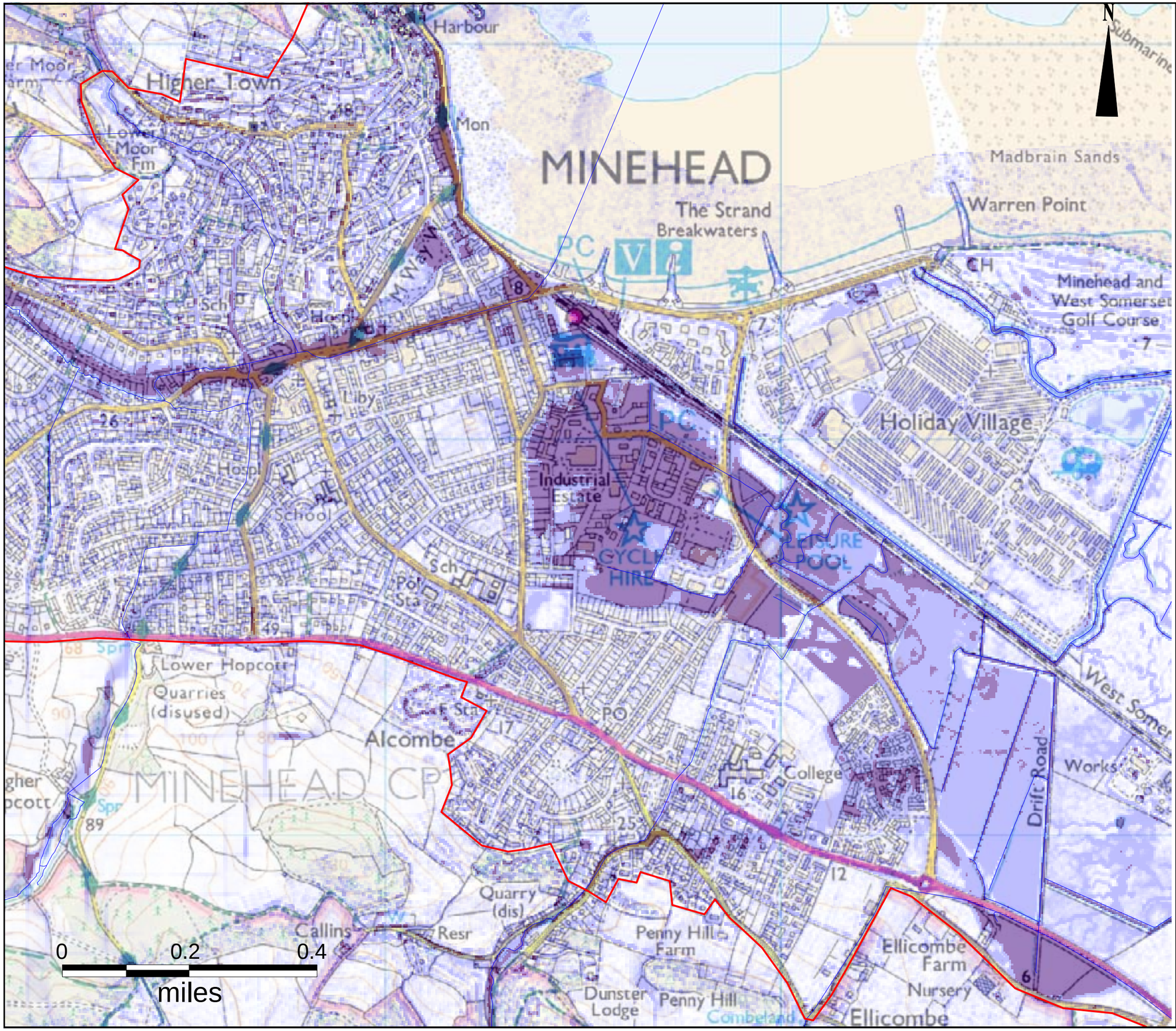
Somerset SWMP
Minehead

Modelled outputs
Option 2- 1 in 200 year.

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0126-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

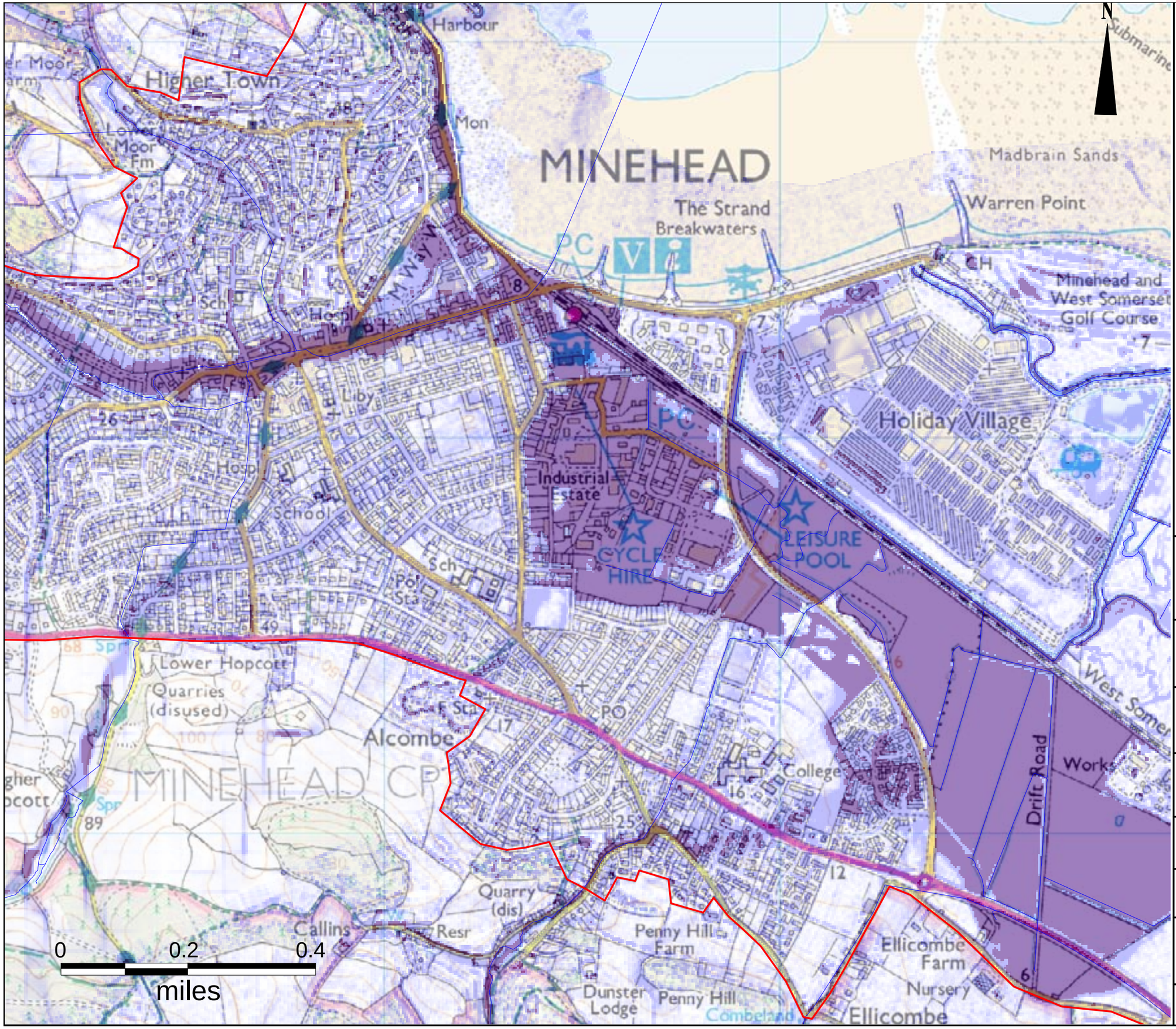
Somerset SWMP
Minehead

Modelled outputs
Option 3 - 1 in 25 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0131-UA001888-DVD-01



Legend

- > 0.1 m
- > 0.3 m
- Minehead SWMP Boundary
- Detailed River Network

Somerset County Council
County Hall, Taunton, Somerset, TA1 4DY

Somerset SWMP
Minehead

Modelled outputs
Option 3 - 1 in 200 year

Scale
NTS

Produced	AH	14-04-12
Checked	LF	14-04-12
Approved	LF	14-04-12

DRAWING NO.
0132-UA001888-DVD-01

Appendix E

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).

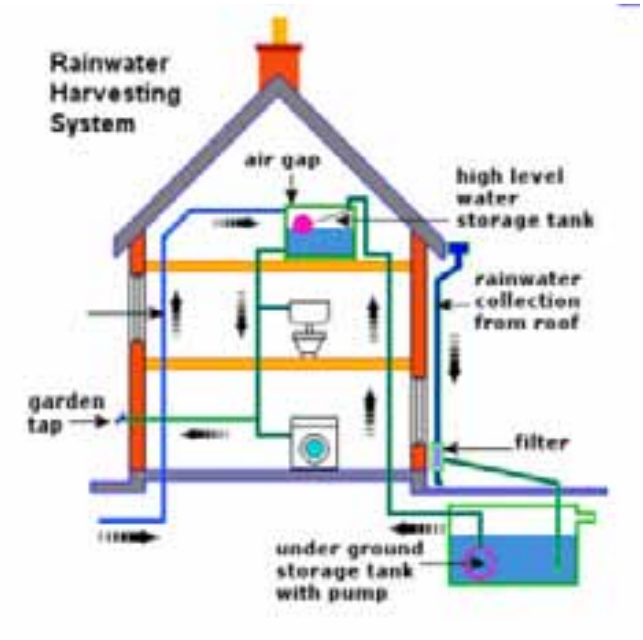


Figure F1-4 Example of a rainwater harvesting system (lowenergyhouse.com, 2011[iv])

	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

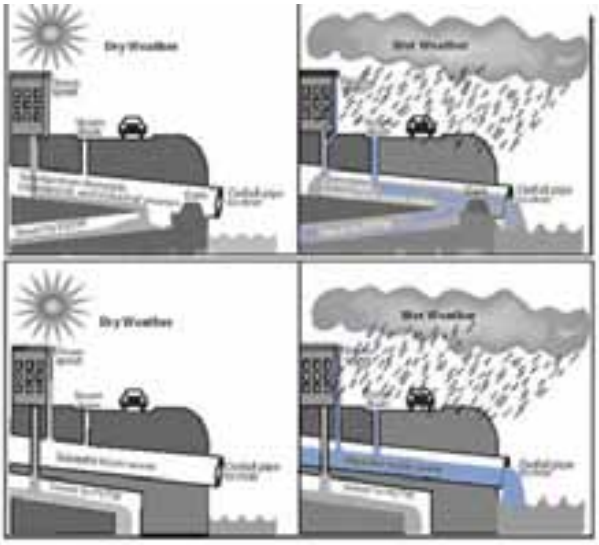
Drainage network improvements involve upsizing of sewer pipes, increased gully entry point locations, construction of off/on-line storage tanks etc. Their advantages and disadvantages are shown below.

	Advantage/Disadvantage
Advantage	Manage the rate of runoff and reduce flooding caused by urbanisation.
	Reduce the risk of manhole surcharging.
Disadvantage	Temporary closure of the roads during construction causing disruption.
	Network improvements are generally expensive to carry out.
	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 AWS 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 CCC 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 Girton 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. CCC in conjunction with AWS and the EA could hold meetings in key risk areas and/or produce information leaflets for local residents to outline this information.

Within CCC 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 CCC for resolution. Even if the flooding incident is not from a source within the administrative area of CCC, staff should still record the incident and refer the member of the public to the relevant body responsible.

Collaboration between CCC, AWS 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 F

Economics

Economic Appraisal

Introduction

Aims and Objectives

This appendix presents the methodology and results of the economic appraisal carried out to support the Minehead 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.

Background

The study area includes the town of Minehead. This large area incorporates the commercial centre of the town and includes residences, commercial buildings and recreational facilities.

Options Considered

Following a short-listing process, the options considered in this appraisal are detailed in the main SWMP document, and summarised here:

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 required by the Treasury in order to enable comparisons to be made between the "Do Minimum" and "Do Something" options. The surface water drainage network would fail within a short timeframe, with a predicted failure at 10 years. Somerset County Council (SCC) indicated that with no maintenance the surface water drainage network would fail in 10 years time.

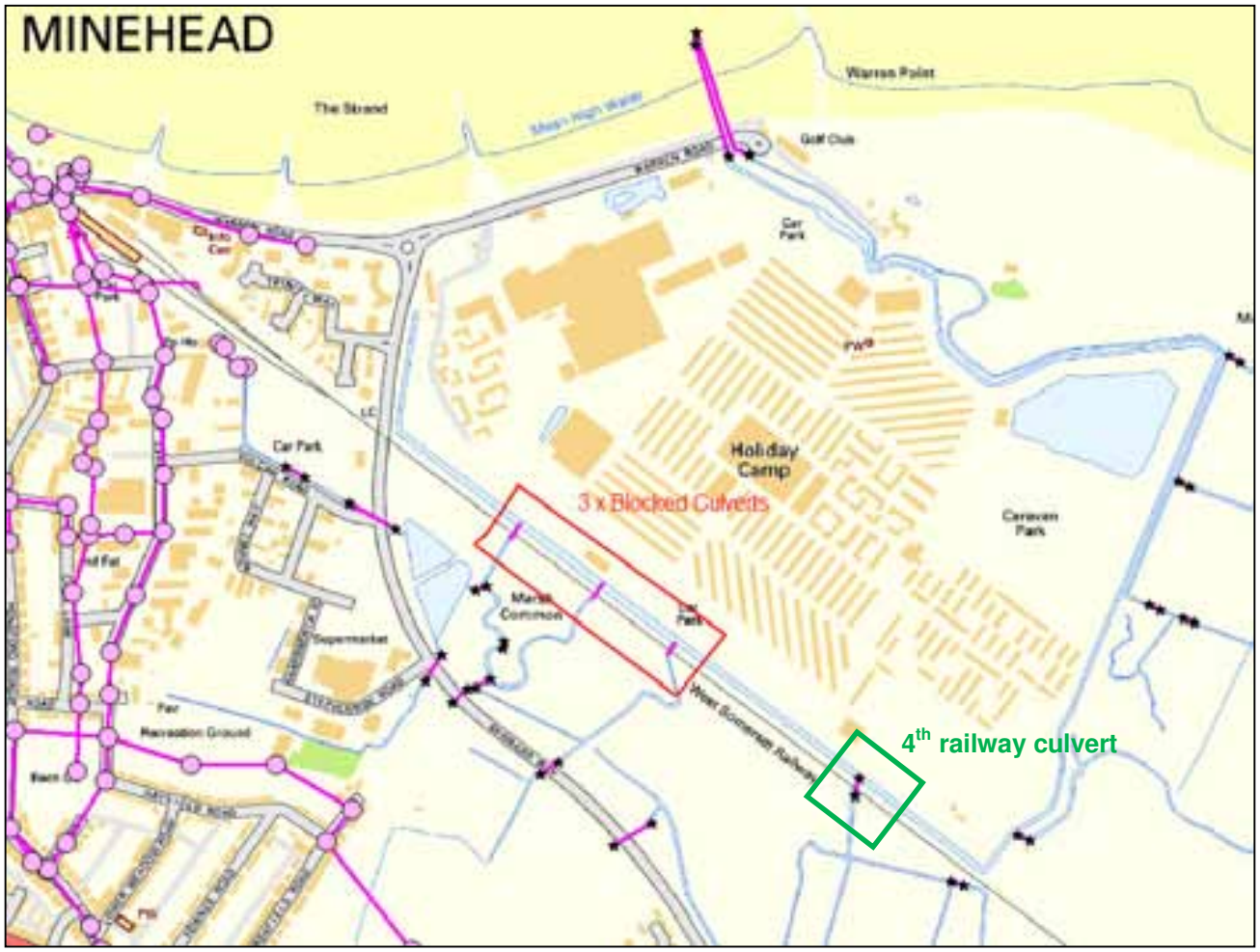
Do Minimum. This option assumes the continuation of existing maintenance of the storm sewers, ordinary watercourses and highway drainage including: gully cleaning; jetting; removal of debris / vegetation; treeworks; and periodic removal of deposition and sediments. It is assumed that this maintenance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

Do Something Option 1 – This option involves blocking the three existing railway culverts and increasing in size the existing fourth railway culvert to 1.5m x 3m.

Do Something Option 2 – This option involves increasing the size of all four railway culverts to 1m x 2.4m.

Do Something Option 3 – This option involves blocking the three existing railway culverts and increasing the size of the existing fourth railway culvert to as large as possible to define the flow path connection between the railway culverts and the Marsh rhyne area to the east of Butlins. Proposed dimensions of the fourth culvert are 1m x 10m.

Figure 1 – Location of the culverts included in the Do Something Options



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 recent 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 February 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).

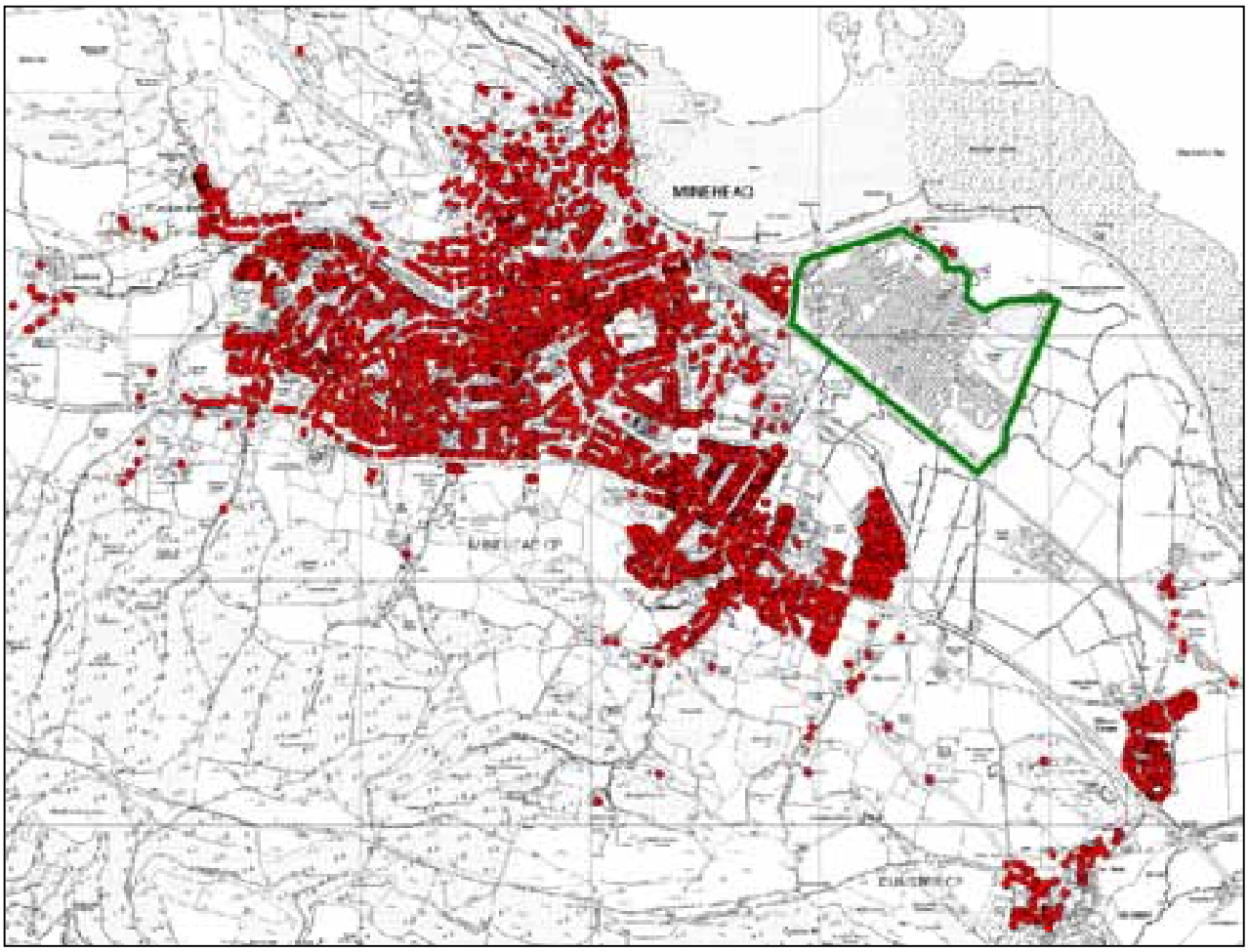
The NRD dataset includes a large number of property entries with '900' MCM codes, identified, for example, as 'electricity substations' and 'tanks'. Given the difficulties with estimating the value and assigning MCM depth-damage data to these types of 'property' within a large strategic study area, all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

All potential receptors within the Minehead Butlins site were excluded from the NRD dataset. A key factor for exclusion was that 409 out of the 423 receptors within the Butlins site had an un-surveyed MCM code of '999' or a '900' code. It was considered that verifying each receptor by means of a separate survey would be disproportionate to the level of assessment. In addition the holiday park has a large number of caravans. The FCERM-AG guidance recommends that caravans should be treated as moveable assets, assuming that if regular flooding occurs at the site the caravans can be moved and monetary damages avoided. Using this rationale the Dunster Beach holiday park has also been removed from the assessment. Furthermore, both areas were excluded as it was considered inclusion of the sites may lead to an overestimation of benefits associated with the proposed options, not least because typically caravans would be sufficiently elevated to be immune to the impacts of surface water flooding unless sufficient depth was experienced to lift/move them, as may be associated with fluvial or coastal flooding.

The NRD was mapped for Minehead and properties located outside of the study area were removed from the assessment. All properties recorded as upper floor were also removed from the assessment. A total of 4,763 properties were included in the edited NRD dataset.

Properties were assigned a standard threshold level of 150mm above ground level. 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 depth of flooding at each property.

Figure 2 – Properties included in the economic appraisal (the excluded Butlins holiday park is outlined in green)



Property Valuation and Capping

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 West Somerset 001D lower layer super output 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	240	18.6	0.14
C1	1.12	498	38.7	0.43
C2	1.22	171	13.3	0.16
DE	1.64	378	29.4	0.58
Total		**1,287**	**100.0**	**1.22**

Residential property valuations were based on regional average property sale prices for Somerset for December 2011 (source: Land Registry), using the latest data available, multiplied by the DI factor of 1.22. This resulted in the capping values listed in Table 2 below.

Table 2 – Residential Capping Values

Property Type	Capping Value including DI factor
All	£199,681
Detached	£327,826
Semi-detached	£186,577
Terraced	£152,928
Bungalow	£327,826
Flat/Maisonette	£107,065

Flood Levels and Representation of Scenarios

After a meeting with SCC and the IDB the Option Elements were combined into 'Do Something', which includes 'Do Minimum' and Option 1, 2 and 3. The 'Do Something' Options are listed below:-

Do Nothing

The "Do Nothing" 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 required by the Treasury in order to enable comparisons to be made between the "Do Minimum" and "Do Something" options. The flood loss damages associated with the "Do Nothing" option are the benefits of the economic assessment. A bare earth model for this analysis will provide the 'Baseline' model for this study.

Do Minimum

Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments (Figure 4.7).

Figure 4.7 Representation of the drainage network under the Do Minimum scenario

Do Something 1

Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Three Railway Culverts (3 No.) are blocked and keep the fourth southern culvert is increased to 1.5m (y) and 3.0m (x) (Figure 4.8).

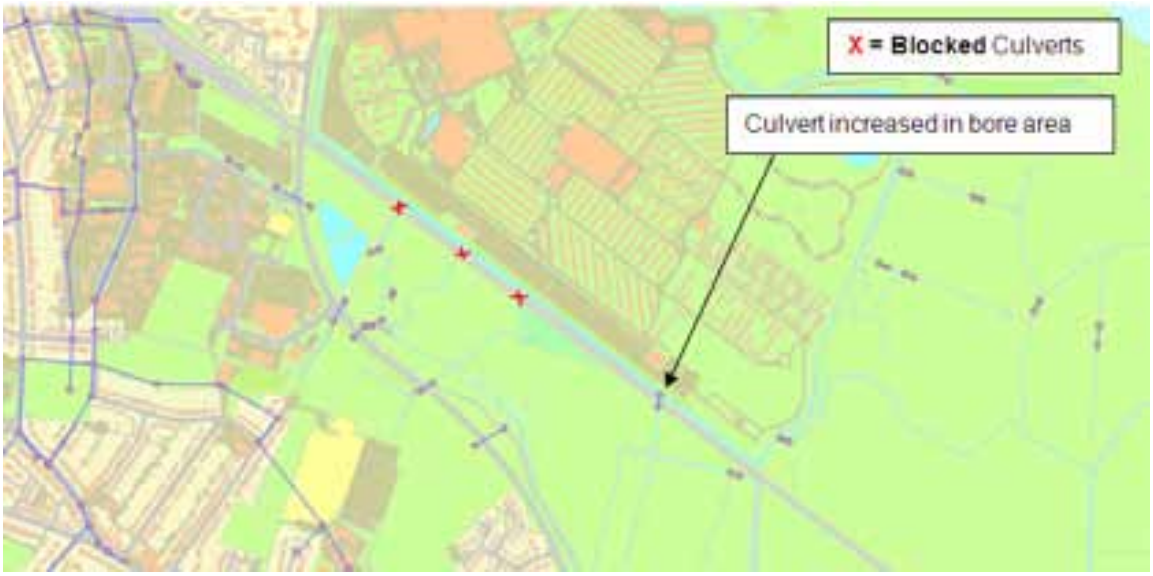


Figure 4.8 Representation of the drainage network under Option 1

Do Something 2

Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Four Railway Culverts (4 No.) increased to 1.0m (y) and 2.4m (x) (Figure 4.9).

Figure 4.9 Representation of the drainage network under Option 2

Do Something 3

Maintenance of the existing storm sewer, ordinary watercourse and highway drainage including, gully cleaning, jetting, removal of debris / vegetation; treeworks and periodic removal of deposition and sediments. Lock out Railway Culverts (3 No.) and keep the fourth southern culvert open, increasing the size to 1m (y) and 10m (x). An embankment on the northern side of the railway embankment is introduced to encourage flood waters onto the Marsh region east of Butlins.

Figure 4.10 Representation of the drainage network under Option 3

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. Flood duration of less than 12 hours was used in the assessment. Flood depths for individual properties were extracted using a point analysis of the modelling outputs.

Property Damages were capped if present value damages exceeded property market values.

Property annual average damages were calculated and discount factors 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.

The flooding problem assessed in this appraisal is not tidal in nature and thus an increase in flood damages to account for the impacts of salt water (a factor of 1.22 on damages) was not included in the appraisal.

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.

Assumptions

Assumption 1 – Property thresholds across the study area are 0.15m and no below floor level flooding of properties will occur. Due to the number of properties across the study area it would not be possible to estimate threshold levels for each property. As such an assumption of a threshold level of 0.15m at all properties has been made. 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 at return periods lower than 10 year. The lowest return period modelled was the 10 year rainfall event. Whilst it is possible within the flood damages equations to interpolate flood damages for return periods below the lowest return period modelled, these damages are not 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 flood events lower than the 10 year return period.

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 is likely to have failed in 10 years time, 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 Do

Minimum at Year 0 and gradually moving to Do Nothing by Year 10 by interpolating between the damages for the two options.

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 a town such as Minehead has the potential for an 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 resulting in a potential underestimation of potential benefits.

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 may.

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, the options considered in the SWMP did not include this 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, especially as there is a limited history of flooding from surface water in the town.

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 measurable 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). Due to 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, 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. The capital costs for each of the Do Something options were calculated using the sources detailed in Table 3. Detailed breakdowns of the option costs are contained within the appendix of the technical note.

The maintenance costs for Minehead were provided by Somerset County Council. The suggested annual maintenance cost for the Minehead study area for use in the assessment was **£2,000**. The maintenance cost is for the entirety of Minehead. The calculations of the annual maintenance costs are show in Table 3.

Table 3 –Maintenance Costs

Option	Present Value Maintenance Costs	Present Value Capital Costs	Source
Do Minimum	£59.7K	NA	Somerset County Council
Option 1- Block railway culverts (3 No.) and increase the fourth southern culvert to 1.5m x 3m.	£59.7K	£348.3K	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010) and SPONS Civil Engineering and Highway Works Price Book (2009)
Option 2- Increase all 4 railway culverts to 1m x 2.4m.	£59.7K	£772.8K	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010) and SPONS Civil Engineering and Highway Works Price Book (2009)
Option 3- Block railway culverts (3 No.) and increase the fourth southern culvert to 1m x 10m.	£59.7K	£748.1K	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010) and SPONS Civil Engineering and Highway Works Price Book (2009)

As all of the Do Something options relate to the ongoing maintenance of the four culverts, and the options do not introduce any new assets to the maintenance schedule the Do Minimum costs have been applied to all Do Something options. It has been assumed that the blocked culverts and the new upsized culverts will need replacing after 50 years and therefore a cost for future construction has been included at year 50.

The FCERM-AG guidance 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 proposed works to the culverts. As the culverts are located under a railway an additional cost allowance of 60% has been built into the costs, to account for potential complications associated with construction under a railway line. This item would need to be subject to further investigation at further stages in the development of 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 were discounted accordingly.

Results

Property Counts

The economic appraisal resulted in the following counts of properties affected by flooding. Below floor level damages have been excluded from this assessment (this is discussed in more detail in the sensitivity section). Within the assessment area there are 4,300 residential properties and 463 commercial properties. Table 4 presents the property counts for all options.

Table 4 –Properties accruing flood damages (flood depths > 0.15m)

Annual Probability	Annual Chance	Count of properties affected				
		Do Nothing	Do Minimum	Option 1	Option 2	Option 3
10%	1 in 10	649	588	594	589	591
4%	1 in 25	733	706	704	702	709
2%	1 in 50	835	797	799	798	798
1.3%	1 in 75	896	870	873	872	871
1%	1 in 100	933	919	918	919	920
0.5%	1 in 200	1,015	1002	1002	1,002	1,001
0.2%	1 in 500	1,131	1,122	1,125	1,125	1,121
0.1%	1 in 1,000	1,232	1,206	1,206	1,187	1,210

Table 5 below 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 5 – Option Comparison Table

	Costs and benefits £k				
Option number	**Do Nothing**	**Do Minimum**	**Option 1**	**Option 2**	**Option 3**
COSTS:					
PV capital costs	0	0	291	645	625
PV maintenance costs	0	60	60	60	60
PV future construction	0	0	57	127	123
Optimism bias adjustment	0	36	245	500	485
PV negative costs (e.g. sales)	0	0	0	0	0
PV contributions					
Total PV Costs £k excluding contributions	0	96	653	1,332	1,292
Total PV Costs £k taking contributions into account	0	96	653	1,332	1,292
BENEFITS:					
PV monetised flood damages	40,441	40,116	40,303	39,984	40,356
PV monetised flood damages avoided		324	138	457	85
Total PV damages £k	40,441	40,116	40,303	39,984	40,356
Total PV benefits £k		324	138	457	85
DECISION-MAKING CRITERIA:					
Based on total PV benefits					
Net Present Value **NPV**		229	-515	-875	-1,207
Average benefit/cost ratio **BCR**		3.4	0.2	0.3	0.1
		Highest bcr			
Brief description of options:					
1	Do Nothing				
2	Do Minimum				
3	Option 1- Block Railway Culverts (3 No.) and increase size of 4th culvert to 1.5m x 3m dimensions				
4	Option 2- Increase all 4 Railway Culverts to 1m x 2.4m dimensions				
5	Option 3- Block Railway Culverts (3 No.) and increase size of 4th culvert to 1m x 10m dimensions				

The Do Minimum Option is the preferred option, as the option is shown to result in present value benefits of £324K over the appraisal period and an average BCR of 3.4:1.

The benefits of the Do Something Options 1, 2 and 3 are £138K, £457K and £85K respectively. All options include capital works, the cost of which exceeds the benefits of all options and therefore all options have negative NPV. All 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 blocking off of the three existing railway culverts under Option 1 and 3 have the lowest benefit and actually increase flood risk within the study area when compared to the Do Minimum. The increase in flood risk under Option 1 and 3 could be due to water backing up behind the blocked culverts, which impacts on the wider study area. Option 2, which increases the flow capacity of all four railway culverts has the highest benefit of £457K, however the costs of constructing the engineered option exceed the benefits.

The results of the direct rainfall modelling show that all Do Something Options have a limited effect on reducing flood risk in the study area. Table 4 shows that, when compared to the Do Minimum Option, the properties flooded under the Do Something options increase or remain the same. This indicates that the Do Something options have no affect on reducing flood risk and actually increases the flood risk to some properties. 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 which occur over this large study area.

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 6.

Table 6 – Sensitivity Test Results

No	Sensitivity Test	Preferred Option PVb	Do Nothing (PVd)	Preferred Option BCR
	Final Appraisal Values	**£324K**	**£40.4M**	**3.4:1**
1	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 150mm allowance for threshold level	£324K	£40.4M	3.4:1
2	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 100mm allowance for threshold level	£468K	£54.5M	4.9:1
3	Removing all below floor level damages accrued 300mm below floor level from the MCM dataset with a 300mm allowance for threshold level	£-424K	£20.6M	-3.4:1
4	25% increase in market value estimates for all property	£321K	£40.1M	3.4:1
5	25% decrease in market value estimates for all property	£325K	£40.1M	3.4:1
6	Inclusion of temporary accommodation costs for residential property	£344K	£49.6M	3.6:1
7	Assuming Do Nothing damages occur at year 0	£1.8M	£41.9M	19.3:1
8	Assuming Do Nothing damages occur at year 20	£-2.1M	£38.1	-21.4:1
9	Increase in total option costs (PVc) by 50% (with test 2)	No change	No change	1.7:1

There are 4,300 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 method which is used to apply depth values to properties, and whether or not below-floor level damages are included. 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 guidance and the 0.15m value provides a conservative assessment when compared to sensitivity test 3.

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 £20K. 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.

Summary

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

- Three potential options have been identified, modelled and costed for the study area. Option 1 involves blocking the three existing railway culverts and increasing in size the existing fourth railway culvert. Option 2 involves increasing the size of all four railway culverts. Option 3 involves blocking the three existing railway culverts and increasing the size of the existing fourth railway culvert to as large as possible.
- The FCERM-AG guidance recommends that for strategies unit rates can be used to give an indication of the scale of the costs. The estimated costs for Options 1, 2 and 3 should not be used for detailed assessment and would need refinement for any future studies investigating similar options. Maintenance costs have been provided 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 to use as the final appraisal value.

  Economically the preferred option is to continue with the current schedule of maintenance under the Do Minimum scenario. The option is shown to result in present value benefits of £324K over the appraisal period and an average BCR of 3.4:1.

- The results indicate that all of the Do Something options have a negligible impact on reducing flooding in the study area. The blocking off of the three existing railway culverts under Option 1 and 3 have the lowest benefit and increase flood risk within the study area. Option 2 has the highest benefit of £457K, however the costs of constructing the engineered option exceed the benefits. Therefore, it is not recommended that any of the Do Something options are taken forward for further analysis.

References

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APPENDIX

Project Summary Sheet

Client/Authority		Prepared (date)	02/11/2011
Somerset County Council		Printed	20/04/2012
Project name		Prepared by	AH
Minehead SWMP		Checked by	IJ
Project reference	UA001888	Checked date	16/11/2011

Base date for estimates (year 0)	Feb-2012		
Scaling factor (e.g. £m, £k, £)	£k	(used for all costs, losses and benefits)	
Year	0	30	75
Discount Rate	3.5%	3.00%	2.50%
Optimism bias adjustment factor	60%		

Costs and benefits of options

Option number	Costs and benefits £k				
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**
Option name	Do Nothing	Do Minimum	Option 1- Lock out Railway Culverts (3 No.) and increase size of 4th culvert to 1.5m x 3m dimensions	Option 2- Increase all 4 Railway Culverts to 1m x 2.4m dimensions	Option 3- Lock out Railway Culverts (3 No.) and increase size of 4th culvert to 1m x 10m dimensions
COSTS:					
PV capital costs	0	0	291	645	625
PV maintenance costs	0	60	60	60	60
PV future construction	0	0	57	127	123
Optimism bias adjustment	0	36	245	500	485
PV negative costs (e.g. sales)	0	0	0	0	
PV contributions					
Total PV Costs £k excluding contributions	0	96	653	1,332	1,292
Total PV Costs £k taking contributions into account	0	96	653	1,332	1,292
BENEFITS:					
PV monetised flood damages	40,441	40,116	40,303	39,984	40,356
PV monetised flood damages avoided		324	138	457	85
Total PV damages £k	40,441	40,116	40,303	39,984	40,356
Total PV benefits £k		324	138	457	85
DECISION-MAKING CRITERIA:					
Based on total PV benefits					
Net Present Value **NPV**		229	-515	-875	-1,207
Average benefit/cost ratio **BCR**		3.4	0.2	0.3	0.07
Incremental benefit/cost ratio **IBCR**			0	0	0
		Highest bcr			

Brief description of options:

Option 1	Do Nothing
Option 2	Do Minimum
Option 3	Option 1- Lock out Railway Culverts (3 No.) and increase size of 4th culvert to 1.5m x 3m dimensions
Option 4	Option 2- Increase all 4 Railway Culverts to 1m x 2.4m dimensions
Option 5	Option 3- Lock out Railway Culverts (3 No.) and increase size of 4th culvert to 1m x 10m dimensions

Present Value Costs for all options

Sheet Nr. 10

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

Results £

	Do Nothing	Do Minimum	Option 1	Option 2	Option 3
			/erts (3 No.) and increase size of 4th	crease all 4 Railway Culverts to 1m x 2.4n	Culverts (3 No.) and increase size of 4th culv
PV total costs	0	59,727	408,007	832,506	807,796

Prepared (date)	02/11/2011
Printed	20/04/2012
Prepared by	AH
Checked by	IJ
Checked date	16/11/2011

		Option 1	Do Nothing			TOTALS:	PV	PV	PV	PV	Option 2	Do Minimum			TOTALS:	PV	PV	PV	PV	Option 3	Option 1- Lock out Railway			TOTALS:	PV	PV	PV	PV	Option 4	Option 2- Increase all 4 Ra			TOTALS:	PV	PV	PV	PV	Option 4	Option 3- Lock out Rai			TOTALS:	PV	PV	PV	PV
year	Discount Factor	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs	Capital	Maint.	Other	Negative costs	Cash	Capital	Maint	Other	Negative costs
	cash sum	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0	202000	0	0	202,000	0	59,727	0	0	290,897	202,000	290,897	0	783,795	290,897	59,727	57,383	0	645455.2	202000	645455.2	0	1492910.40	645,455	59,727	127,324	0.00	624816	202000	624816.4	0	1451632.89	624,816	59,727	123,253	0.00
																											348,281									772,779									748,069	
0	1.000					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	2000.00	0.00	0.00	290897	2000			292897.37	290897.37	2000.00	0.00	0.00	645455	2000			647455.20	645455.20	2000.00	0.00	0.00	624816	2000			626816.45	########	2000.00	0.00	0.00
1	0.966					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1932.37	0.00	0.00		2000			2000.00	0.00	1932.37	0.00	0.00		2000			2000.00	0.00	1932.37	0.00	0.00		2000			2000.00	0.00	1932.37	0.00	0.00
2	0.934					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1867.02	0.00	0.00		2000			2000.00	0.00	1867.02	0.00	0.00		2000			2000.00	0.00	1867.02	0.00	0.00		2000			2000.00	0.00	1867.02	0.00	0.00
3	0.902					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1803.89	0.00	0.00		2000			2000.00	0.00	1803.89	0.00	0.00		2000			2000.00	0.00	1803.89	0.00	0.00		2000			2000.00	0.00	1803.89	0.00	0.00
4	0.871					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1742.88	0.00	0.00		2000			2000.00	0.00	1742.88	0.00	0.00		2000			2000.00	0.00	1742.88	0.00	0.00		2000			2000.00	0.00	1742.88	0.00	0.00
5	0.842					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1683.95	0.00	0.00		2000			2000.00	0.00	1683.95	0.00	0.00		2000			2000.00	0.00	1683.95	0.00	0.00		2000			2000.00	0.00	1683.95	0.00	0.00
6	0.814					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1627.00	0.00	0.00		2000			2000.00	0.00	1627.00	0.00	0.00		2000			2000.00	0.00	1627.00	0.00	0.00		2000			2000.00	0.00	1627.00	0.00	0.00
7	0.786					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1571.98	0.00	0.00		2000			2000.00	0.00	1571.98	0.00	0.00		2000			2000.00	0.00	1571.98	0.00	0.00		2000			2000.00	0.00	1571.98	0.00	0.00
8	0.759					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1518.82	0.00	0.00		2000			2000.00	0.00	1518.82	0.00	0.00		2000			2000.00	0.00	1518.82	0.00	0.00		2000			2000.00	0.00	1518.82	0.00	0.00
9	0.734					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1467.46	0.00	0.00		2000			2000.00	0.00	1467.46	0.00	0.00		2000			2000.00	0.00	1467.46	0.00	0.00		2000			2000.00	0.00	1467.46	0.00	0.00
10	0.709					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1417.84	0.00	0.00		2000			2000.00	0.00	1417.84	0.00	0.00		2000			2000.00	0.00	1417.84	0.00	0.00		2000			2000.00	0.00	1417.84	0.00	0.00
11	0.685					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1369.89	0.00	0.00		2000			2000.00	0.00	1369.89	0.00	0.00		2000			2000.00	0.00	1369.89	0.00	0.00		2000			2000.00	0.00	1369.89	0.00	0.00
12	0.662					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1323.57	0.00	0.00		2000			2000.00	0.00	1323.57	0.00	0.00		2000			2000.00	0.00	1323.57	0.00	0.00		2000			2000.00	0.00	1323.57	0.00	0.00
13	0.639					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1278.81	0.00	0.00		2000			2000.00	0.00	1278.81	0.00	0.00		2000			2000.00	0.00	1278.81	0.00	0.00		2000			2000.00	0.00	1278.81	0.00	0.00
14	0.618					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1235.56	0.00	0.00		2000			2000.00	0.00	1235.56	0.00	0.00		2000			2000.00	0.00	1235.56	0.00	0.00		2000			2000.00	0.00	1235.56	0.00	0.00
15	0.597					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1193.78	0.00	0.00		2000			2000.00	0.00	1193.78	0.00	0.00		2000			2000.00	0.00	1193.78	0.00	0.00		2000			2000.00	0.00	1193.78	0.00	0.00
16	0.577					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1153.41	0.00	0.00		2000			2000.00	0.00	1153.41	0.00	0.00		2000			2000.00	0.00	1153.41	0.00	0.00		2000			2000.00	0.00	1153.41	0.00	0.00
17	0.557					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1114.41	0.00	0.00		2000			2000.00	0.00	1114.41	0.00	0.00		2000			2000.00	0.00	1114.41	0.00	0.00		2000			2000.00	0.00	1114.41	0.00	0.00
18	0.538					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1076.72	0.00	0.00		2000			2000.00	0.00	1076.72	0.00	0.00		2000			2000.00	0.00	1076.72	0.00	0.00		2000			2000.00	0.00	1076.72	0.00	0.00
19	0.520					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1040.31	0.00	0.00		2000			2000.00	0.00	1040.31	0.00	0.00		2000			2000.00	0.00	1040.31	0.00	0.00		2000			2000.00	0.00	1040.31	0.00	0.00
20	0.503					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	1005.13	0.00	0.00		2000			2000.00	0.00	1005.13	0.00	0.00		2000			2000.00	0.00	1005.13	0.00	0.00		2000			2000.00	0.00	1005.13	0.00	0.00
21	0.486					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	971.14	0.00	0.00		2000			2000.00	0.00	971.14	0.00	0.00		2000			2000.00	0.00	971.14	0.00	0.00		2000			2000.00	0.00	971.14	0.00	0.00
22	0.469					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	938.30	0.00	0.00		2000			2000.00	0.00	938.30	0.00	0.00		2000			2000.00	0.00	938.30	0.00	0.00		2000			2000.00	0.00	938.30	0.00	0.00
23	0.453					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	906.57	0.00	0.00		2000			2000.00	0.00	906.57	0.00	0.00		2000			2000.00	0.00	906.57	0.00	0.00		2000			2000.00	0.00	906.57	0.00	0.00
24	0.438					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	875.91	0.00	0.00		2000			2000.00	0.00	875.91	0.00	0.00		2000			2000.00	0.00	875.91	0.00	0.00		2000			2000.00	0.00	875.91	0.00	0.00
25	0.423					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	846.29	0.00	0.00		2000			2000.00	0.00	846.29	0.00	0.00		2000			2000.00	0.00	846.29	0.00	0.00		2000			2000.00	0.00	846.29	0.00	0.00
26	0.409					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	817.68	0.00	0.00		2000			2000.00	0.00	817.68	0.00	0.00		2000			2000.00	0.00	817.68	0.00	0.00		2000			2000.00	0.00	817.68	0.00	0.00
27	0.395					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	790.02	0.00	0.00		2000			2000.00	0.00	790.02	0.00	0.00		2000			2000.00	0.00	790.02	0.00	0.00		2000			2000.00	0.00	790.02	0.00	0.00
28	0.382					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	763.31	0.00	0.00		2000			2000.00	0.00	763.31	0.00	0.00		2000			2000.00	0.00	763.31	0.00	0.00		2000			2000.00	0.00	763.31	0.00	0.00
29	0.369					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	737.50	0.00	0.00		2000			2000.00	0.00	737.50	0.00	0.00		2000			2000.00	0.00	737.50	0.00	0.00		2000			2000.00	0.00	737.50	0.00	0.00
30	0.356					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	712.56	0.00	0.00		2000			2000.00	0.00	712.56	0.00	0.00		2000			2000.00	0.00	712.56	0.00	0.00		2000			2000.00	0.00	712.56	0.00	0.00
31	0.346					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	691.80	0.00	0.00		2000			2000.00	0.00	691.80	0.00	0.00		2000			2000.00	0.00	691.80	0.00	0.00		2000			2000.00	0.00	691.80	0.00	0.00
32	0.336					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	671.65	0.00	0.00		2000			2000.00	0.00	671.65	0.00	0.00		2000			2000.00	0.00	671.65	0.00	0.00		2000			2000.00	0.00	671.65	0.00	0.00
33	0.326					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	652.09	0.00	0.00		2000			2000.00	0.00	652.09	0.00	0.00		2000			2000.00	0.00	652.09	0.00	0.00		2000			2000.00	0.00	652.09	0.00	0.00
34	0.317					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	633.10	0.00	0.00		2000			2000.00	0.00	633.10	0.00	0.00		2000			2000.00	0.00	633.10	0.00	0.00		2000			2000.00	0.00	633.10	0.00	0.00
35	0.307					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	614.66	0.00	0.00		2000			2000.00	0.00	614.66	0.00	0.00		2000			2000.00	0.00	614.66	0.00	0.00		2000			2000.00	0.00	614.66	0.00	0.00
36	0.298					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	596.76	0.00	0.00		2000			2000.00	0.00	596.76	0.00	0.00		2000			2000.00	0.00	596.76	0.00	0.00		2000			2000.00	0.00	596.76	0.00	0.00
37	0.290					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	579.37	0.00	0.00		2000			2000.00	0.00	579.37	0.00	0.00		2000			2000.00	0.00	579.37	0.00	0.00		2000			2000.00	0.00	579.37	0.00	0.00
38	0.281					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	562.50	0.00	0.00		2000			2000.00	0.00	562.50	0.00	0.00		2000			2000.00	0.00	562.50	0.00	0.00		2000			2000.00	0.00	562.50	0.00	0.00
39	0.273					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	546.12	0.00	0.00		2000			2000.00	0.00	546.12	0.00	0.00		2000			2000.00	0.00	546.12	0.00	0.00		2000			2000.00	0.00	546.12	0.00	0.00
40	0.265					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	530.21	0.00	0.00		2000			2000.00	0.00	530.21	0.00	0.00		2000			2000.00	0.00	530.21	0.00	0.00		2000			2000.00	0.00	530.21	0.00	0.00
41	0.257					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	514.77	0.00	0.00		2000			2000.00	0.00	514.77	0.00	0.00		2000			2000.00	0.00	514.77	0.00	0.00		2000			2000.00	0.00	514.77	0.00	0.00
42	0.250					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	499.77	0.00	0.00		2000			2000.00	0.00	499.77	0.00	0.00		2000			2000.00	0.00	499.77	0.00	0.00		2000			2000.00	0.00	499.77	0.00	0.00
43	0.243					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	485.22	0.00	0.00		2000			2000.00	0.00	485.22	0.00	0.00		2000			2000.00	0.00	485.22	0.00	0.00		2000			2000.00	0.00	485.22	0.00	0.00
44	0.236					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	471.08	0.00	0.00		2000			2000.00	0.00	471.08	0.00	0.00		2000			2000.00	0.00	471.08	0.00	0.00		2000			2000.00	0.00	471.08	0.00	0.00
45	0.229					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	457.36	0.00	0.00		2000			2000.00	0.00	457.36	0.00	0.00		2000			2000.00	0.00	457.36	0.00	0.00		2000			2000.00	0.00	457.36	0.00	0.00
46	0.222					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	444.04	0.00	0.00		2000			2000.00	0.00	444.04	0.00	0.00		2000			2000.00	0.00	444.04	0.00	0.00		2000			2000.00	0.00	444.04	0.00	0.00
47	0.216					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	431.11	0.00	0.00		2000			2000.00	0.00	431.11	0.00	0.00		2000			2000.00	0.00	431.11	0.00	0.00		2000			2000.00	0.00	431.11	0.00	0.00
48	0.209					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	418.55	0.00	0.00		2000			2000.00	0.00	418.55	0.00	0.00		2000			2000.00	0.00	418.55	0.00	0.00		2000			2000.00	0.00	418.55	0.00	0.00
49	0.203					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	406.36	0.00	0.00		2000			2000.00	0.00	406.36	0.00	0.00		2000			2000.00	0.00	406.36	0.00	0.00		2000			2000.00	0.00	406.36	0.00	0.00
50	0.197					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	394.53	0.00	0.00		2000	290897		292897.37	0.00	394.53	57383.21	0.00		2000	645455		647455.20	0.00	394.53	127324.25	0.00		2000	624816		626816.45	0.00	394.53	123252.99	0.00
51	0.192					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	383.03	0.00	0.00		2000			2000.00	0.00	383.03	0.00	0.00		2000			2000.00	0.00	383.03	0.00	0.00		2000			2000.00	0.00	383.03	0.00	0.00
52	0.186					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	371.88	0.00	0.00		2000			2000.00	0.00	371.88	0.00	0.00		2000			2000.00	0.00	371.88	0.00	0.00		2000			2000.00	0.00	371.88	0.00	0.00
53	0.181					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	361.05	0.00	0.00		2000			2000.00	0.00	361.05	0.00	0.00		2000			2000.00	0.00	361.05	0.00	0.00		2000			2000.00	0.00	361.05	0.00	0.00
54	0.175					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	350.53	0.00	0.00		2000			2000.00	0.00	350.53	0.00	0.00		2000			2000.00	0.00	350.53	0.00	0.00		2000			2000.00	0.00	350.53	0.00	0.00
55	0.170					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	340.32	0.00	0.00		2000			2000.00	0.00	340.32	0.00	0.00		2000			2000.00	0.00	340.32	0.00	0.00		2000			2000.00	0.00	340.32	0.00	0.00
56	0.165					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	330.41	0.00	0.00		2000			2000.00	0.00	330.41	0.00	0.00		2000			2000.00	0.00	330.41	0.00	0.00		2000			2000.00	0.00	330.41	0.00	0.00
57	0.160					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	320.79	0.00	0.00		2000			2000.00	0.00	320.79	0.00	0.00		2000			2000.00	0.00	320.79	0.00	0.00		2000			2000.00	0.00	320.79	0.00	0.00
58	0.156					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	311.44	0.00	0.00		2000			2000.00	0.00	311.44	0.00	0.00		2000			2000.00	0.00	311.44	0.00	0.00		2000			2000.00	0.00	311.44	0.00	0.00
59	0.151					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	302.37	0.00	0.00		2000			2000.00	0.00	302.37	0.00	0.00		2000			2000.00	0.00	302.37	0.00	0.00		2000			2000.00	0.00	302.37	0.00	0.00
60	0.147					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	293.56	0.00	0.00		2000			2000.00	0.00	293.56	0.00	0.00		2000			2000.00	0.00	293.56	0.00	0.00		2000			2000.00	0.00	293.56	0.00	0.00
61	0.143					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	285.01	0.00	0.00		2000			2000.00	0.00	285.01	0.00	0.00		2000			2000.00	0.00	285.01	0.00	0.00		2000			2000.00	0.00	285.01	0.00	0.00
62	0.138					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	276.71	0.00	0.00		2000			2000.00	0.00	276.71	0.00	0.00		2000			2000.00	0.00	276.71	0.00	0.00		2000			2000.00	0.00	276.71	0.00	0.00
63	0.134					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	268.65	0.00	0.00		2000			2000.00	0.00	268.65	0.00	0.00		2000			2000.00	0.00	268.65	0.00	0.00		2000			2000.00	0.00	268.65	0.00	0.00
64	0.130					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	260.83	0.00	0.00		2000			2000.00	0.00	260.83	0.00	0.00		2000			2000.00	0.00	260.83	0.00	0.00		2000			2000.00	0.00	260.83	0.00	0.00
65	0.127					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	253.23	0.00	0.00		2000			2000.00	0.00	253.23	0.00	0.00		2000			2000.00	0.00	253.23	0.00	0.00		2000			2000.00	0.00	253.23	0.00	0.00
66	0.123					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	245.86	0.00	0.00		2000			2000.00	0.00	245.86	0.00	0.00		2000			2000.00	0.00	245.86	0.00	0.00		2000			2000.00	0.00	245.86	0.00	0.00
67	0.119					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	238.69	0.00	0.00		2000			2000.00	0.00	238.69	0.00	0.00		2000			2000.00	0.00	238.69	0.00	0.00		2000			2000.00	0.00	238.69	0.00	0.00
68	0.116					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	231.74	0.00	0.00		2000			2000.00	0.00	231.74	0.00	0.00		2000			2000.00	0.00	231.74	0.00	0.00		2000			2000.00	0.00	231.74	0.00	0.00
69	0.112					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	224.99	0.00	0.00		2000			2000.00	0.00	224.99	0.00	0.00		2000			2000.00	0.00	224.99	0.00	0.00		2000			2000.00	0.00	224.99	0.00	0.00
70	0.109					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	218.44	0.00	0.00		2000			2000.00	0.00	218.44	0.00	0.00		2000			2000.00	0.00	218.44	0.00	0.00		2000			2000.00	0.00	218.44	0.00	0.00
71	0.106					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	212.08	0.00	0.00		2000			2000.00	0.00	212.08	0.00	0.00		2000			2000.00	0.00	212.08	0.00	0.00		2000			2000.00	0.00	212.08	0.00	0.00
72	0.103					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	205.90	0.00	0.00		2000			2000.00	0.00	205.90	0.00	0.00		2000			2000.00	0.00	205.90	0.00	0.00		2000			2000.00	0.00	205.90	0.00	0.00
73	0.100					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	199.90	0.00	0.00		2000			2000.00	0.00	199.90	0.00	0.00		2000			2000.00	0.00	199.90	0.00	0.00		2000			2000.00	0.00	199.90	0.00	0.00
74	0.097					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	194.08	0.00	0.00		2000			2000.00	0.00	194.08	0.00	0.00		2000			2000.00	0.00	194.08	0.00	0.00		2000			2000.00	0.00	194.08	0.00	0.00
75	0.094					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	188.43	0.00	0.00		2000			2000.00	0.00	188.43	0.00	0.00		2000			2000.00	0.00	188.43	0.00	0.00		2000			2000.00	0.00	188.43	0.00	0.00
76	0.092					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	183.83	0.00	0.00		2000			2000.00	0.00	183.83	0.00	0.00		2000			2000.00	0.00	183.83	0.00	0.00		2000			2000.00	0.00	183.83	0.00	0.00
77	0.090					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	179.35	0.00	0.00		2000			2000.00	0.00	179.35	0.00	0.00		2000			2000.00	0.00	179.35	0.00	0.00		2000			2000.00	0.00	179.35	0.00	0.00
78	0.087					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	174.97	0.00	0.00		2000			2000.00	0.00	174.97	0.00	0.00		2000			2000.00	0.00	174.97	0.00	0.00		2000			2000.00	0.00	174.97	0.00	0.00
79	0.085					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	170.71	0.00	0.00		2000			2000.00	0.00	170.71	0.00	0.00		2000			2000.00	0.00	170.71	0.00	0.00		2000			2000.00	0.00	170.71	0.00	0.00
80	0.083					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	166.54	0.00	0.00		2000			2000.00	0.00	166.54	0.00	0.00		2000			2000.00	0.00	166.54	0.00	0.00		2000			2000.00	0.00	166.54	0.00	0.00
81	0.081					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	162.48	0.00	0.00		2000			2000.00	0.00	162.48	0.00	0.00		2000			2000.00	0.00	162.48	0.00	0.00		2000			2000.00	0.00	162.48	0.00	0.00
82	0.079					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	158.52	0.00	0.00		2000			2000.00	0.00	158.52	0.00	0.00		2000			2000.00	0.00	158.52	0.00	0.00		2000			2000.00	0.00	158.52	0.00	0.00
83	0.077					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	154.65	0.00	0.00		2000			2000.00	0.00	154.65	0.00	0.00		2000			2000.00	0.00	154.65	0.00	0.00		2000			2000.00	0.00	154.65	0.00	0.00
84	0.075					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	150.88	0.00	0.00		2000			2000.00	0.00	150.88	0.00	0.00		2000			2000.00	0.00	150.88	0.00	0.00		2000			2000.00	0.00	150.88	0.00	0.00
85	0.074					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	147.20	0.00	0.00		2000			2000.00	0.00	147.20	0.00	0.00		2000			2000.00	0.00	147.20	0.00	0.00		2000			2000.00	0.00	147.20	0.00	0.00
86	0.072					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	143.61	0.00	0.00		2000			2000.00	0.00	143.61	0.00	0.00		2000			2000.00	0.00	143.61	0.00	0.00		2000			2000.00	0.00	143.61	0.00	0.00
87	0.070					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	140.11	0.00	0.00		2000			2000.00	0.00	140.11	0.00	0.00		2000			2000.00	0.00	140.11	0.00	0.00		2000			2000.00	0.00	140.11	0.00	0.00
88	0.068					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	136.69	0.00	0.00		2000			2000.00	0.00	136.69	0.00	0.00		2000			2000.00	0.00	136.69	0.00	0.00		2000			2000.00	0.00	136.69	0.00	0.00
89	0.067					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	133.36	0.00	0.00		2000			2000.00	0.00	133.36	0.00	0.00		2000			2000.00	0.00	133.36	0.00	0.00		2000			2000.00	0.00	133.36	0.00	0.00
90	0.065					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	130.10	0.00	0.00		2000			2000.00	0.00	130.10	0.00	0.00		2000			2000.00	0.00	130.10	0.00	0.00		2000			2000.00	0.00	130.10	0.00	0.00
91	0.063					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	126.93	0.00	0.00		2000			2000.00	0.00	126.93	0.00	0.00		2000			2000.00	0.00	126.93	0.00	0.00		2000			2000.00	0.00	126.93	0.00	0.00
92	0.062					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	123.83	0.00	0.00		2000			2000.00	0.00	123.83	0.00	0.00		2000			2000.00	0.00	123.83	0.00	0.00		2000			2000.00	0.00	123.83	0.00	0.00
93	0.060					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	120.81	0.00	0.00		2000			2000.00	0.00	120.81	0.00	0.00		2000			2000.00	0.00	120.81	0.00	0.00		2000			2000.00	0.00	120.81	0.00	0.00
94	0.059					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	117.87	0.00	0.00		2000			2000.00	0.00	117.87	0.00	0.00		2000			2000.00	0.00	117.87	0.00	0.00		2000			2000.00	0.00	117.87	0.00	0.00
95	0.057					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	114.99	0.00	0.00		2000			2000.00	0.00	114.99	0.00	0.00		2000			2000.00	0.00	114.99	0.00	0.00		2000			2000.00	0.00	114.99	0.00	0.00
96	0.056					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	112.19	0.00	0.00		2000			2000.00	0.00	112.19	0.00	0.00		2000			2000.00	0.00	112.19	0.00	0.00		2000			2000.00	0.00	112.19	0.00	0.00
97	0.055					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	109.45	0.00	0.00		2000			2000.00	0.00	109.45	0.00	0.00		2000			2000.00	0.00	109.45	0.00	0.00		2000			2000.00	0.00	109.45	0.00	0.00
98	0.053					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	106.78	0.00	0.00		2000			2000.00	0.00	106.78	0.00	0.00		2000			2000.00	0.00	106.78	0.00	0.00		2000			2000.00	0.00	106.78	0.00	0.00
99	0.052					0.00	0.00	0.00	0.00	0.00		2000			2000.00	0.00	104.18	0.00	0.00		2000			2000.00	0.00	104.18	0.00	0.00		2000			2000.00	0.00	104.18	0.00	0.00		2000			2000.00	0.00	104.18	0.00	0.00

Option 1

Details	Lock out Railway Culverts (3 culverts measuring a total of 65m). Keep the fourth southern culvert open and increase the capacity to 1.5x3m rectangular culvert.

Source	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010)

Assumptions	Price based on the grouting up of the 3 existing culverts entire length. Risk value of 60% used due to uncertainty of construction under railway.

Details	***Under Road. Price per m***	**Assumptions**
Grout up 450 pipe	£68	Original cost of £54.33 for construction under the road increased by 25% to account for construction under railway.
Total length of 3 culverts (m)	65	Total length of 3x culverts measured from OS 10k mapping is 63m. 2 m additional added for uncertainty in measurement.
New 1.5x3 box culvert	£141,900	SPONS Pipe Jacking. Cost for thrust pit = £30K, reception pit =£22K, mob/demob =£44K- Total site set up (£96K). Thrust jacking of 21m of 1800mm pipe at £2185.5/m is £45.9K. Total = £141.9K. Total plus 6% inflation on 2010.
Capital Cost	£146,314	
Preliminaries	£36,579	From CESMM3- generally for estimating purposes add 20% where total cost is £0-25k.
Risk	£87,789	Assumed very high risk of 60% as construction is under a railway
Day works	£1,250	From CESMM3- Add £1250 to construction total when total cost is £0-25k.
Network Rail licenses		Not required as not network rail line
Land aquisition	2500	Assumed land aquisition cost for works is required
TOTAL	£274,431	CESMM3 prices are not updated to include inlflation. Advised 3% per annum inflation is used.
TOTAL Plus Inflation	**£290,897**	Base date 2010, so 6% used in assessment.

NOTE- Area of 1.5m x 3m box culvert is most similar to that of an 1.8m dia circular culvert. Due to time restrictions and level of assessment the cost of a 1.8m dia culvert used. 60% risk considered suitable to cover any additional costs associated with box culvert.

Option 2

Details	Increase the capacity of the 4 existing 450mm culverts to 1m x 2.4m culverts. Culverts are located under the railway line.

Source	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010) and SPONS (2009) used for pipe jacking estimate (technique approved by network rail)

Assumptions	Conservative price based on 4 new 1800mm culverts, not upgrading existing. Risk value of 60% used due to uncertainty of construction under railway.

Details		**Assumptions**
Total length of 4 new culverts	88m	Total length of 4x culverts measured from OS 10k mapping is 84m. 4 m additional added for uncertainty in measurement.
Capital Cost	£314,300	SPONS Pipe Jacking. Cost for thrust pit (£30K increased by 50% as 4 locations = £45K), reception pit (£22K increased by 50% as 4 locations so £33K), mob/demob (£44K)- Total site set up (£122K). Thrust jacking of 88m of 1800mm pipe at £2185.5/m is £192.3K. Total = £314.3K. Total plus 6% inflation on 2010.
Preliminaries	£94,290	From CESMM3- generally for estimating purposes add 30% where total cost is £75-250k.
Risk	£188,580	Assumed very high risk of 60% as construction is under a railway
Day works	£9,250	From CESMM3- Add £9250 to construction total when total cost is £150-200k.
Network Rail licenses		Not required as not network rail line
Land aquisition	£2,500	Assumed land aquisition cost for works is required
TOTAL	£608,920	CESMM3 prices are not updated to include inlflation. Advised 3% per annum inflation is used. Base date 2010,
TOTAL Plus Inflation	**£645,455**	so 6% used in assessment.

NOTE- Area of 1m x2.4m box culvert is most similar to that of an 1.8m dia circular culvert. Due to time restrictions and level of assessment the cost of a 1.8m dia culvert used. 60% risk considered suitable to cover any additional costs associated with box culvert.

Option 3

Details	Lock out Railway Culverts (3 culverts measuring a total of 65m). Keep the fourth southern culvert open and increase the capacity to as large as it can feasibly go under the railway 1m x 10m.

Source	CESMM3 ~ Civil Engineering Standard Method of Measurement 3rd Edition (2010)

Assumptions	Price based on the grouting up of the 3 existing culverts entire length. Risk value of 60% used due to uncertainty of construction under railway.

Details	***Under Road. Price per m***	**Assumptions**
Grout up 450 pipe	£68	Original cost of £54.33 for construction under the road increased by 25% to account for construction under railway.
Total length of 3 culverts (m)	65	Total length of 3x culverts measured from OS 10k mapping is 63m. 2 m additional added for uncertainty in measurement.
New 1.5x3 box culvert	£312,180	Based on Option 1- SPONS Pipe Jacking. Cost for thrust pit = £30K, reception pit =£22K, mob/demob =£44K- Total site set up (£96K). Thrust jacking of 21m of 1800mm pipe at £2185.5/m is £45.9K. Total = £141.9K. Total plus 6% inflation on 2010. Costs multiplied by 2.2 to account for larger area of Option 3 culvert.
Capital Cost	£316,594	
Preliminaries	£79,149	From CESMM3- generally for estimating purposes add 20% where total cost is £0-25k.
Risk	£189,957	Assumed very high risk of 60% as construction is under a railway
Day works	£1,250	From CESMM3- Add £1250 to construction total when total cost is £0-25k.
Network Rail licenses		Not required as not network rail line
Land aquisition	2500	Assumed land aquisition cost for works is required
TOTAL	£589,449	CESMM3 prices are not updated to include inlflation. Advised 3% per annum inflation is used.
TOTAL Plus Inflation	**£624,816**	Base date 2010, so 6% used in assessment.

NOTE- Option 1 = Area of 1.5m x3m box culvert is 4.5m². Option 3 = area of 1m x 10m box culvert is 10m². As option 3 is the same as option 1, apart from the culvert being 2.2x the size the costs of the new box culvert for Option 1 have simply been multiplied by 2.2. This methodology has been selected as there is no readily availavle data for sizing 1m x 10m culverts. 60% risk considered suitable to cover any additional costs associated with box culvert.

Appraisal Summary Table																
Project Name	Minehead Surface Water Management Plan															
Project Description	Investigation of surface water flooding mitigation options in Minehead.															
Option	**Baseline**			**Do Minimum**			**Option 1**			**Option 2**			**Option 3**			
Overview/Description	Do Nothing			Do Minimum to maximise the residual life of the surface water drainage network.			Continue to maintain the existing surface water drainage network as present and increase the size of one railway culvert.			Continue to maintain the existing surface water drainage network as present and increase the size of four railway culverts.			Continue to maintain the existing surface water drainage network as present and increase the size of one railway culvert to as large as feasibly possible.		
Technical Issues	None			Maintain and repair the sewer system and surface water drainage network and replace as existing when failed.			This option involves blocking the three existing railway culverts and increasing in size the existing fourth railway culvert to 1.5m x 3m			This option involves increasing the size of all four railway culverts to 1m x 2.4m			This option involves blocking the three existing railway culverts and increasing the size of the existing fourth railway culvert to as large as possible to 1m x 10m.		
Assumptions and Uncertainties	No intervention, no maintenance or operational activities, resulting in failure of the sewer and surface water drainage system in year 11 (2021).			Surface water drainage system not predicted to fail. Annual maintenance cost of £2000 per annum remains the same throughout 100 year assessment period.			Surface water drainage system not predicted to fail. Annual maintenance cost of £2000 per annum remains the same throughout 100 year assessment period.			Surface water drainage system not predicted to fail. Annual maintenance cost of £2000 per annum remains the same throughout 100 year assessment period.			Surface water drainage system not predicted to fail. Annual maintenance cost of £2000 per annum remains the same throughout 100 year assessment period. Assumed a culvert 1m x 10m is feasible under the railway line.		
Approaches to Adaption	None			None			None			None			None			
Costs	£0			£100K (PV over 100 years)			£650K (PV over 100 years)			£1.3M (PV over 100 years)			£1.3M (PV over 100 years)			
Category	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	
Economic Impacts																
Properties	**649** properties are flooded during the 1 in 10 year event (10% AEP). **733** properties are flooded during the 1 in 25 year event (4% AEP). **835** properties are flooded during the 1 in 50 year event (2% AEP). **896** properties are flooded during the 1 in 75 year event. (1.3% AEP). **933** properties are flooded during the 1 in 100 year event (1% AEP). **1015** properties are flooded during the 1 in 200 year event (0.5% AEP). **1131** properties are flooded during the 1 in 500 year event (0.2% AEP). **1232** properties are flooded during the 1 in 1000 year event (0.1% AEP).	PV damages: £40.4M	Property numbers flooded are based on flooding over 0.15m i.e. above threshold level. A direct rainfall runoff model has been used to model the catchment with no sewer network. It has been assumed that the sewer/drainage network fails at year 11. From years 0-10 damages have been interpolated between Do Nothing and Do Minimum.	**588** properties are flooded during the 1 in 10 year event (10% AEP). **706** properties are flooded during the 1 in 25 year event (4% AEP). **797** properties are flooded during the 1 in 50 year event (2% AEP). **870** properties are flooded during the 1 in 75 year event (1.3% AEP). **919** properties are flooded during the 1 in 100 year event (1% AEP). **1002** properties are flooded during the 1 in 200 year event (0.5% AEP). **1122** properties are flooded during the 1 in 500 year event (0.2% AEP). **1206** properties are flooded during the 1 in 1000 year event (0.1% AEP).	PV damages: £40.1M	It is assumed that continued maintenance will prevent failure of the sewer network. When maintenance is no longer viable it is assumed individual assets within the system will be replace as existing. A direct rainfall model has been used to model the catchment with the existing piped sewer network included.	**594** properties are flooded during the 1 in 10 year event (10% AEP). **704** properties are flooded during the 1 in 25 year event (4% AEP). **799** properties are flooded during the 1 in 50 year event (2% AEP). **873** properties are flooded during the 1 in 75 year event (1.3% AEP). **918** properties are flooded during the 1 in 100 year event (1% AEP). **1002** properties are flooded during the 1 in 200 year event (0.5% AEP). **1125** properties are flooded during the 1 in 500 year event (0.2% AEP). **1206** properties are flooded during the 1 in 1000 year event (0.1% AEP).	PV damages: £40.3M	A direct rainfall model has been used to model the catchment with the existing piped sewer network included. Amendments to the culverts have been made, as listed in the technical issues.	**589** properties are flooded during the 1 in 10 year event (10% AEP). **702** properties are flooded during the 1 in 25 year event (4% AEP). **798** properties are flooded during the 1 in 50 year event (2% AEP). **872** properties are flooded during the 1 in 75 year event (1.3% AEP). **919** properties are flooded during the 1 in 100 year event (1% AEP). **1002** properties are flooded during the 1 in 200 year event (0.5% AEP). **1125** properties are flooded during the 1 in 500 year event (0.2% AEP). **1187** properties are flooded during the 1 in 1000 year event (0.1% AEP).	PV damages: £40.0M	A direct rainfall model has been used to model the catchment with the existing piped sewer network included. Amendments to the culverts have been made, as listed in the technical issues.	**591** properties are flooded during the 1 in 10 year event (10% AEP). **709** properties are flooded during the 1 in 25 year event (4% AEP). **798** properties are flooded during the 1 in 50 year event (2% AEP). **871** properties are flooded during the 1 in 75 year event (1.3% AEP). **920** properties are flooded during the 1 in 100 year event (1% AEP). **1001** properties are flooded during the 1 in 200 year event (0.5% AEP). **1121** properties are flooded during the 1 in 500 year event (0.2% AEP). **1210** properties are flooded during the 1 in 1000 year event (0.1% AEP).	PV damages: £40.4M	A direct rainfall model has been used to model the catchment with the existing piped sewer network included. Amendments to the culverts have been made, as listed in the technical issues.
Infrastructure	The following infrastructure is located in the study area: · Sewage treatment works · 9 educational establishments · 8 health centres/ surgeries · 8 residential care homes · 7 community halls · 4 police/fire stations **1 in 25** year maximum flood depth is 2.6m and average flood depth is 0.096m. **1 in 200** year maximum flood depth is 3.8m and average flood depth is 0.138m.	Impacts not valued. Impacts are predicted due to damage to the infrastructure itself and damage to the service provided.		**1 in 25** year maximum flood depth is 1.6m and average flood depth is 0.092m. **1 in 200** year maximum flood depth is 2.1m and average flood depth is 0.134m. Under Do Minimum the maximum flood depth is reduced when compared to the Do Nothing, however the average flood depth remains around the same depth. Therefore, the option does not completely remove assets from flood risk.	Impacts not valued		**1 in 25** year maximum flood depth is 1.6m and average flood depth is 0.092m. **1 in 200** year maximum flood depth is 2.1m and average flood depth is 0.134m. Under Option 1 the maximum flood depth is reduced, however the average flood depth remains around the same depth. Therefore, the option does not completely remove assets from flood risk. Modelling indicates that the blocking of the culverts causes surface water to back up and subsequently increases the flood risk to the town.	Impacts not valued		**1 in 25** year maximum flood depth is 1.7m and average flood depth is 0.092m. **1 in 200** year maximum flood depth is 2.1m and average flood depth is 0.134m. Under Option 2 the maximum flood depth is reduced, however the average flood depth remains around the same depth. Therefore, the option does not completely remove assets from flood risk. Modelling indicates that this option has the greatest effect on reducing flood risk. Increasing the size of all the culverts allows water to be passed under the railway embankment quicker.	Impacts not valued		**1 in 25** year maximum flood depth is 1.6m and average flood depth is 0.092m. **1 in 200** year maximum flood depth is 2.1m and average flood depth is 0.134m. Under Option 3 the maximum flood depth is reduced, however the average flood depth remains around the same depth. Therefore, the option does not completely remove assets from flood risk. Modelling indicates that the blocking of the culverts causes surface water to back up and subsequently increases the flood risk to the town	Impacts not valued	

Option	Baseline			Do Minimum			Option 1			Option 2			Option 3		
Category	Description and quantification of impacts	Value of Impacts	Assumptions and uncertainties	Description and quantification of impacts	Value of Impacts	Assumptions and uncertainties	Description and quantification of impacts	Value of Impacts	Assumptions and uncertainties	Description and quantification of impacts	Value of Impacts	Assumptions and uncertainties	Description and quantification of impacts	Value of Impacts	Assumptions and uncertainties
Economic Impacts															
Transport	Closure of roads within Minehead and traffic diversion would be required during flood events. Flood depths in excess of 0.40m are predicted during the 1 in 10 year and depths increase to in excess of 1m for 1 in 1000 year event at the following locations- • Park Street • The Parade • Blenheim Road • Espalnade • Quay Street • Vulcan Road • Cats Lane • Brunel Way • Mart Road.	Impacts not valued.		Regular maintenance of the sewer system reduces flooding at lower return periods. The option reduces the flood risk but does not remove the risk to the roads therefore there is a residual risk of flooding. Closure of roads and traffic diversion may still be required during extreme flood events under this option.	Impacts not valued.		The option reduces the flood risk but does not remove the risk to the roads. Therefore, there remains a residual risk of flooding. Closure of roads and traffic diversion may still be required during extreme flood events under this option. Modelling indicates that the blocking of the culverts causes surface water to back up and subsequently increases the flood risk to the town when compared to the Do Minimum.	Impacts not valued.		The option reduces the flood risk but does not remove the risk to the roads. Therefore, there remains a residual risk of flooding. Closure of roads and traffic diversion may still be required during extreme flood events under this option.	Impacts not valued.		The option reduces the flood risk but does not remove the risk to the roads. Therefore, there remains a residual risk of flooding. Closure of roads and traffic diversion may still be required during extreme flood events under this option. Modelling indicates that the blocking of the culverts causes surface water to back up and subsequently increases the flood risk to the town when compared to the Do Minimum.	Impacts not valued.	
Development	Tourism is a major industry in Minehead. Deterioration of the local buildings and landscape may reduce visitor numbers and increase blight. Potential for any recent investment in the area to be lost.	Sunk costs but this option would reduce the likelihood of further regeneration activities with knock-on effects for local economy.	Tourism impacts considered transfer payment, but are likely to be of regional significance and could lead to significant loss of jobs and increased deprivation.	With the surface water drainage system maintained as existing the environment will remain largely as present.	Impacts not valued.		Modelling indicates that the blocking of the culverts increases the flow of surface water into the town. Although the drainage system will be maintained under this options the increased frequency of flooding may constrain development.	Impacts not valued.		With the surface water drainage system maintained as existing the environment will remain largely as present.	Impacts not valued.		Modelling indicates that the blocking of the culverts increases the flow of surface water into the town. Although the drainage system will be maintained under this options the increased frequency of flooding may constrain development.	Impacts not valued.	

Option	Baseline			Do Minimum			Option 1			Option 2			Option 3		
Category	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**
Environmental Impacts															
Water	Potential for release of contaminants associated with business uses in the study area (includes 2 petrol stations and several car repair garages). The substantially increased frequency of flooding may result in increased pollution incidents to the water environment.	Impacts not valued. Release of contaminants could have implications for the town's popular coast beach.	Assumed that once the drainage network has failed the frequency of surface water flooding would result in the businesses affected being abandoned.	The environment would remain largely as present.	Impacts not valued.		Some construction activities may have temporary (and limited) effect on water quality. It is not considered that the increased frequency of flooding associated with this option would impact on the water environment.	Impacts not valued.		Some construction activities may have temporary (and limited) effect on water quality.	Impacts not valued.		Some construction activities may have temporary (and limited) effect on water quality. It is not considered that the increased frequency of flooding associated with this option would impact on the water environment.	Impacts not valued.	
Flora and Fauna	The Dunster Park and Heathlands SSSI and the Exmoor Heath SAC are located on the periphery of the study area. The SSSI site is notified for nationally important lowland dry heath and the SAC is notified for upland wet heath . Due to the rural nature of the areas no significant impacts expected.	Impacts not valued.		No significant impacts expected as the majority of works associated with the maintenance of the drainage system would take place downstream of the SSSI and SAC.	Impacts not valued.		The construction works at the location of the railway culverts would occur some distance downstream of the SSSI and SAC.	Impacts not valued.		The construction works at the location of the railway culverts would occur some distance downstream of the SSSI and SAC.	Impacts not valued.		The construction works at the location of the railway culverts would occur some distance downstream of the SSSI and SAC.	Impacts not valued.	
Landscape	Loss of businesses and properties could result in change to character of area.	Impacts not valued.	Assumed that once the drainage network has failed the high frequency of surface water flooding would result in the buildings affected being abandoned.	The environment would remain largely as present.	Impacts not valued.		The environment would remain largely as present. The increased frequency of flooding when compared to the Do Minimum could have a minor negative impact on the landscape.	Impacts not valued.		The environment would remain largely as present.	Impacts not valued.		The environment would remain largely as present. The increased frequency of flooding when compared to the Do Minimum could have a minor negative impact on the landscape.	Impacts not valued.	

Option	Baseline			Do Minimum			Option 1			Option 2			Option 3		
Category	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**	**Description and quantification of impacts**	**Value of Impacts**	**Assumptions and uncertainties**
Social Impacts															
Health and Well-being	There could be considerable stress impacts due to blight.	Impacts not valued.	Once the drainage network has failed the frequency of flooding would result in the properties affected being abandoned.	The environment would remain largely as present.	Impacts not valued.			Impacts not valued.		The environment would remain largely as present.	Impacts not valued.			Impacts not valued.	
Culture	There are 194 listed buildings in the study area. The majority of which are located in the Alcombe and Higher Town areas. Damage to listed buildings would occur. The study area is also on the edge of a Heritage Coast and National Park Area.	Impacts not valued but could be significant in terms of impact on local heritage.		The environment would remain largely as present. As the option does not completely remove flood risk there is a residual risk of flooding during extreme events.	Impacts not valued.		As the option does not completely remove flood risk there is a residual risk of flooding during extreme events. Increased flooding when compared to the Do Minimum may result in increased damaged to listed and heritage assets.	Impacts not valued.		The environment would remain largely as present. As the option does not completely remove flood risk there is a residual risk of flooding during extreme events.	Impacts not valued.		As the option does not completely remove flood risk there is a residual risk of flooding during extreme events. Increased flooding when compared to the Do Minimum may result in increased damaged to listed and heritage assets.	Impacts not valued.	
Community	Main impact is on tourism, businesses and residential properties. Potential for major impacts due to substantially increased frequency of flooding. This may discourage investment in the area and increase deprivation.	Impacts not valued, but could be significant on some of the most vulnerable members of the community.		The environment would remain largely as present.	Impacts not valued.		Minor negative impacts due to increased frequency of flooding. This may discourage investment in the area and increase deprivation.	Impacts not valued.		The environment would remain largely as present.	Impacts not valued.		Minor negative impacts due to increased frequency of flooding. This may discourage investment in the area and increase deprivation.	Impacts not valued.	

Appendix G

Stakeholder Comments

Comment ID	Comment	Originator	Organisation	Hyder Response	SCC comments to Hyder Response
W1	The draft report is very comprehensive, but isn't the easiest read and is more of a Hyder report rather than a SCC report. Steve may need to tweak the wording accordingly (e.g. section 3.1.1) before it is issued for public consumption. It is also very technical, some of which could go into an appendix?	David Martin	Wessex Water	Noted - however this has been a standard form for many SWMPs and as such would require significant alteration.	Happy to leave the document as is
W2	There are some inconsistencies between your Wessex Water abbreviation; either WxW or WW. We prefer WW.	David Martin	Wessex Water	Changed all abbreviations to WW.	
W3	Section 2.4- WW also provided the old model of Minehead and the model results. More recently (2012) WW provided the newly built and verified model and report detailing predicted flooding needs.	David Martin	Wessex Water	Revised modelling submitted to us on June 7th. Review of the models undertaken and although there is more recent data - there was no significant alteration in the baseline information to warrant a revisit of the Wetspots or planned approach. In addition, the three options had been modelled by this point and as such this newer information was not incorporated.	
W4	Section 2.5.1- Why past tense? (once . .. will be)	David Martin	Wessex Water	There is no section 2.5.1.	
W5	Section 3.1.1- Example of being a Hyder report.	David Martin	Wessex Water	Noted - With SCC for decision on style	Happy to leave the document as is
W6	Section 3.2.1- Page 35. 'of' should be 'or'. WW has only provided flooding incidents caused by hydraulic inadequacies. Blockages and other causes are often random events and are not considered relevant for the SWMP.	David Martin	Wessex Water	Added text- *partial or full blockages*	
W7	For a report dated May 2012, it seems odd that data provided after Sept 2010 has not been included.	David Martin	Wessex Water	Noted - review of data received highlighted additional information collated throughout study period and as such the last evidence received was in Feb 2012. Date amended	
W8	Page 38. 'of' should be 'or'. WW do have a record of whether flood water was foul or surface water. We can provide more details if needed.	David Martin	Wessex Water	Added text- *Coastal or Fluvial Flooding events*	
W9	The comment about Sea defence wall and outfalls not being picked up. This could be a significant risk and one that should be actioned.	David Martin	Wessex Water	Noted - additional comments added to report to highlight that this should be investigated to confirm what happened to the outfalls as perception is that these may have been missed or cut off.	
W10	Section 3.3.2- Insert . . . . . and 'a simplified representation of ' the underground drainage system . . .	David Martin	Wessex Water	Added text- *a simplified representation of*	
W11	Section 3.3.4- WW has far more knowledge than reported here. Why mention cross-connections – do you know of any? Please delete section 3.3.4. If you want to retain the section then I could provide some words when I return from leave.	David Martin	Wessex Water	Deleted section 3.3.4.	
W12	Section 3.4 - Why refer to Anglian Water ?Text is duplicated. Suggest you replace the Wessex Water section with: Maintenance regimes are critical to ensuring the continued and effective functioning of assets. Wessex Water has a proactive and risk-based approach to asset management. All sewers on their GIS has been allocated a risk score, based on the likelihood of failure and the impact, should a failure occur. Due to the public health reasons, Foul/Combined sewers have a higher impact than surface water sewers. WW proactively inspect the highest risk sewers and the findings of this CCTV drives a programme of proactive sewer rehabilitation. Problematic sewers are investigated on a reactive basis and if necessary added onto the WW maintenance programme (e.g. regular inspections or jetting).	David Martin	Wessex Water	Removed Anglian Water typo. Deleted WW test and replaced with text from WW.	
W13	Section 3.5.3- What's a HQ line? Head – discharge? Too much detail?	David Martin	Wessex Water	Added Text- *The HQ line is designated as a Water Level ("H") versus Flow ("Q").*	
W14	Section 3.5.4- Were broken (not where)	David Martin	Wessex Water	Changed to *'were broken'*	
W15	Section 4.5.5- 'or where here are unsatisfactory CSOs ' should be 'or where improvements are required to CSO performance.'	David Martin	Wessex Water	Replaced with- *or where improvements are required to CSO performance*	
W16	Section 4.6.3- What's a SPD?	David Martin	Wessex Water	Supplementary Planning Document.	
W17	Section 4.6.6- WW would also want to become involved in joint campaigns to promote water butts (we offer discounts) and surface water separation.	David Martin	Wessex Water	Added text- *it is recommended that SCC and WW*	
W18	Is an action to also to use the WW newly built and verified model to assess emerging risks?	David Martin	Wessex Water	Noted - Further detail added to Recommendations for ongoing SFRMP to review information available on ongoing basis as this SWMP is a point in time and use the emerging information to help determine and steer the development of the LFRAMS	
P1	Glossary- Suggest you add AStSWF to tie in with the comment at foot of page below.	Paul King	EA	Added abbreviation	
P2	Glossary- No it doesn't. As you say on the next page, the Floods Directive was transposed into UK law by the Flood Risk Regulations 2009. FRA, flood risk maps and plans arise from the Regs.	Paul King	EA	Removed incorrect text and added text- *The Floods Directive was transposed into UK law by the Flood Risk Regulations 2009.*	
P3	Glossary- Good to make ref to National Planning Policy Framework as listed below.	Paul King	EA	Changed NPPF to National Planning Policy Framework	
P4	Glossary- (LLFA)	Paul King	EA	Added abbreviation	
P5	Glossary- (LAA)	Paul King	EA	Added abbreviation	
P6	Glossary- (NPPF)	Paul King	EA	Added abbreviation	
P7	Glossary- Now regulated by the LLFA.	Paul King	EA	Added text- *Ordinary Watercourses are now regulated by LLFA.*	
P8	Glossary- (PFRA)	Paul King	EA	Added abbreviation	
P9	Section 1.8- Why the ref to FRR at section headings?	Paul King	EA	Removed.	

P10	Section 2.4.3- Could be worth making clear that whilst the primary data is covered by the licence the resulting report should be made available without licence. Assuming that none of those licence criteria are exceeded.	Paul King	EA	Added text- *The primary data provided for use in the SWMP is covered by licensing, however, the resulting SWMP report should be made available without a licence.*	
P11	Section 3.5.4- The general assumption used by the EA with the FMfSW was that a 1 in 200 rainfall event results in roughly a 1 in 100 flood event.	Paul King	EA	Added text- *The general assumption used by the EA for the FMfSW was that a 1 in 200 rainfall event resulted in approximately a 1 in 100 flood event.*	
SDB1	This is a new approach to surface water flood risk and it is accepted that the methods have evolved to some extent through the assessment process.	Iain Sturdy	SDB	Noted.	
SDB2	However when considering the outputs it must be remembered that many assumptions and best fit representations are made during the modelling process and that the outputs can only be a best possible representation of these, and confidence must be drawn from comparison with other independent flooding studies, reports and historic records and observations.	Iain Sturdy	SDB	Noted - and additional comments added to report to signal the modelling limitations and uses	
	Hydrological Analysis and Options	Iain Sturdy	SDB		
SDB3	The outputs from the hydrological analysis to identify "Wet Spots" appear to reflect those pathways and receptors that would be anticipated from the topography and the built environment.	Iain Sturdy	SDB	Noted - thanks - NO changes	
SDB4	The prioritisation of wet spots for further investigation appears logical, and largely the outputs from the further modelling and options identification are unsurprising.	Iain Sturdy	SDB	Noted - thanks - NO changes	
SDB5	**However the outputs from the consideration of more effective connection of the floodable area to the Dunster Marsh area are surprising and warrant further consideration.**	Iain Sturdy	SDB	Noted	
SDB6	The Board have suggested that by increasing the number and/ or size of connections under the West Somerset Railway, from the Southern Flood Vulnerable area into the Dunster Marsh, available flood storage volume in the Marsh could be mobilised more effectively thereby reducing the Extent, depth and/or duration of flooding to the Southern area.	Iain Sturdy	SDB	Correct	
SDB7	However the "do something" options show no or limited improvement above the do minimum.	Iain Sturdy	SDB	Correct	
SDB8	**We recommend that further sensitivity testing is undertaken to consider the improved direct connections under the West Somerset Railway to Dunster Marsh.**	Iain Sturdy	SDB	This is a useful conclusion from the study and will be identified further in the conclusions. Unfortunately, to undertake further works would require sanction and funding from SCC and this has been identified as not possible at this stage. Recommendation is to include this into the LFRAMS	
SDB9	Increasing flooding in the Butlins complex will be unacceptable; so there will be limited opportunity to carry flood water through the 3 Western culverts. However the area of the Marsh east of Butlins and to the North of the Railway is substantial and the modelling outputs do not seem to reflect this.	Iain Sturdy	SDB	Agreed re Butlins. The volume to east is being used - but not perhaps to scale warranted and could be further released	
SDB10	For example the do nothing 1 in 200 year drawing (0122) shows a lesser depth of flooding than the Option 2 1 in 200 year drg (0126). This can not empirically be correct.	Iain Sturdy	SDB	I have it that the depths are deeper in 0126 to 0122 as expected. Deeper purple indicating deeper depths.	
SDB11	We have also found it difficult to extend this analysis because in the Appendix D (Modelling Outputs) the modelled events for the do minimum are 1in 25 and 1in 100, but for the options considered are 1 in 25 and 1 in 200.	Iain Sturdy	SDB	Noted - We will aim to amend.	
SDB12	A sensible further option 4 would be to leave the 3 western culverts unaltered whilst increasing the Eastern culvert as in option 3.	Iain Sturdy	SDB	Agreed and noted in the Action Plan as new Action M2a for the reason described in SDB8.	
	Economic Appraisal	Iain Sturdy	SDB		
SDB13	**Exclusions** – Some damages seem to have been excluded without sufficient consideration at an appropriate level of detail. It is questionable whether the damages due to Risk to Life, Transport Disruption and Health and Social benefits would be as minimal as suggested in the report and these may add significant benefits to the appraisal.	Iain Sturdy	SDB	We have excluded the above-mentioned items at this strategic level of appraisal based on previous experience in terms of the respective impact of these on benefit-cost ratios, the amount of additional appraisal work required to calculate them; and whether they represent a realistic addition. This is not to say that they should not be included, were further detailed feasibility investigations undertaken. Taking each in turn. Risks to life, while certainly representing a significant addition to any damage calculation, is unlikely to impact on the benefits, since depths and velocities only change slightly under the options modelled. Transport disruption is particularly complex to calculate, and unless flooding affects a very large volume of traffic and/or requires very long diversions, may not result in sufficient value to reflect the appraisal time spent. In terms of health/social wellbeing benefits, this is directly related to the perceived fear/risk of flooding being taken away – e.g. better quality of life and less stress when adverse weather hits etc. It could be argued that although properties benefit from a reduction in depth of flooding, unless they are completely removed from flooding altogether then this benefit should not be applied. Furthermore, it would normally be associated with a visible form of flooding which had an established historic record, which may not be the case with the flood mechanisms assessed here.	Under the new Partnership Resilience Funding, much more weight is given to residential property damage than all other damages, making the case for extending the assessment even less worthwhile
SDB14	**Assumptions-** Whilst it is understood that some broad assumptions have to be made these should be tested to determine whether or not they are safe. In particular the assumed property threshold of 0.15m and the assumption of no damages for return periods of less than 10years may indicate a broad brush high level approach.	Iain Sturdy	SDB	It is always necessary to apply certain assumptions in economic appraisal, since modelling a complete range of return periods may not be possible and surveyed levels are rarely available for properties over such a large study area. Our report includes sensitivity testing of the threshold level, and would require ground-truthing with actual threshold survey to take this any further.	
SDB15	**Costs-** Is it best practice to include rebuild costs at 50years in the scheme costs? If the scheme design life is 50 years then at 50 years or after this time if the culverts need replacing a further appraisal would be done to determine the benefits at that time. Removing these costs from this appraisal would presumably reduce the capital costs by at least 50%?	Iain Sturdy	SDB	Removing rebuild costs would have less of an impact than 50% because they occur at year 50 and are discounted. We could truncate the appraisal period from 100 to 50 years, but would then also see a reduction in total present-value damages and ultimately benefits. It is normal to include for maintenance and rebuild costs where the option detailed will not provide protection for the entire appraisal period without it.	

SDB16	A 60% additional cost allowance has been included where options include working under the railway. This may be unnecessarily high since this not a main national infrastructure railway route and at the locations being considered is a single track railway with limited associated infrastructure or building constraints.	Iain Sturdy	SDB	We consider the value of 60% to be appropriate, due to the very high risks associated with construction under railways. In addition a sensitivity test, where the risk was reduced to 20% (the standard value used by QS's) produced the below results: Option 1- NPV = £-392k and BCR = 0.3 Option 2- NPV = £-620k and BCR = 0.4 Option 3- NPV = £-950k and BCR = 0.08 The sensitivity test shows that even by reducing the risk to 20% there is still not a economically viable option.	
SDB17	A further 60% optimism bias has been included which again may be unnecessarily high when the reasonably straight forward nature of the engineering works is considered.	Iain Sturdy	SDB	Optimism bias has been applied based on standard practice as set out in the Environment Agency FCERM-AG (2010). The 60% value is recommended for strategic appraisals (i.e. where no specific feasibility level information on options is available) based on HM Treasury analysis of public sector projects. At feasibility stage, this would be reduced to 30%, whilst at PAR/detailed design stage, this would be replaced with a risk contingency value agreed with contractors/stakeholders at a risk workshop, when far more is known about the form of options, construction methods etc.	
SDB18	It would be sensible to test the Economic Appraisal once again having considered the above points, including a the further modelling option 4 suggested.	Iain Sturdy	SDB	We have recommended that these items are reviewed with the SFRMP post SWMP completion, due to the agreed scope of works for the SWMP. Including a note in relation for modelling Option 4	
SDB19	**SUDS Retro Fitting** is supported as one aspect that may contribute to reduced run off rates.	Iain Sturdy	SDB	Noted	
SDB20	**Planning Policy –** This section is largely supported, and this report should be used as a principal too help guide future development strategy.	Iain Sturdy	SDB	Noted.	
SDB21	**SWMP Action Plan and Monitoring –** Considering the current modelling and economic appraisal outcomes this section is supported however if review of the modelling and appraisal sections identifies new outcomes then the action plan may need revising.	Iain Sturdy	SDB	Noted and thanks	