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Introduction

The following section provides a background to this Phase 2 Surface Water Management Plan (SWMP) project. In addition an outline to the work undertaken leading up to the study through the Phase 1 SWMP is provided. The aims and objectives of this report are also discussed.

1.1 Project Background

In May 2011 Devon County Council (DCC) produced a Preliminary Flood Risk Assessment (PFRA). The intended purpose of this assessment was to aid the management of local flood risk and deliver the requirements of the Flood Risk Regulations (2009). It provided a high level overview of flood risk across Devon and helped to identify areas of significant flood risk that need to be investigated further.

The PFRA showed that there are areas which are at risk of flooding within the Devon administrative boundary. In addition, the Environment Agency Flood Map for Surface Water also indicated areas of potentially high risk.

A Phase 1 – Strategic Devon Surface Water Management Plan was subsequently undertaken by Jacobs. The aim of this study was to inform decisions on which areas within DCC’s area warrant further investigation during subsequent phases of the study, including locations requiring an intermediate and/or detailed assessment. Specifically for Exeter, the need to commence a more detailed study was identified, prior to completion of the county-wide assessment.

In October 2012 Devon County Council commissioned Jacobs to undertake the Exeter Phase 2 SWMP with the purpose to identify where local flood risk issues exist (through hydraulic modelling), and develop an action plan to inform options development and appraisal to manage flooding across the study area. Specific options development is not included as part of the current phase.

1.2 Purpose of the Surface Water Management Plan

The following section provides additional information relating to the stages involved in the SWMP process. It also highlights the key sources of flooding investigated as part of this study and the responsibilities and roles associated with managing these sources of flooding.

Under the Flood & Water Management Act 2010, Devon County Council (DCC) is designated as a Lead Local Flood Authority (LLFA). As a LLFA, DCC has a duty to investigate and manage flood risks arising from ‘local sources’ within its administrative area. Local flooding can be caused by the following sources:

- **Pluvial Flooding**: This results from surface runoff caused by intense rainfall which typically ponds in low lying areas before it enters a watercourse or sewer;

- **Groundwater Flooding**: This occurs when water levels in the ground rise above the ground surface. It is most likely to occur in areas underlain by permeable rocks, or alluvial/coastal deposits;

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- **Sewer Flooding**: This is caused when the capacity of the sewer network is exceeded or due to blockages which result in the surcharging of the drainage system; and

- **Fluvial Flooding from Ordinary Watercourses**: Out of bank flow from small watercourses which are not designated by the Environment Agency as a ‘Main River’

Although DCC is responsible for managing flood risk associated with ordinary watercourses, the Environment Agency maintains the responsibility for managing flooding from Main Rivers and the Sea.

As mentioned in Section 1.1, DCC has commissioned Jacobs to undertake a Phase 2 Surface Water Management Plan (SWMP) of Exeter to assist DCC with part of their duties under the Flood & Water Management Act. This is part of a broader process covering different phases of assessment. The aim of this process is determine the risk of flooding from local sources across the county and then investigate in detail areas where risk is determined to be high.

The SWMP process is undertaken in three main phases. These are outlined below:

- **Phase 1 - Scoping**: This a strategic review of information available on flood risks from local sources and the identification of ‘wetspots’, where flood risk is considered to be particularly high. This work has been previously undertaken.

- **Phase 2 - Assessment**: This is a more detailed review of the wetspot areas and their catchment to provide more information on the cause of flooding, the impacts of flooding and the frequency that flooding is expected to occur. Computer based modelling is used to undertake this assessment. This refers to the current project.

- **Phase 3 - Option Testing**: Once the level of flood risk and mechanisms behind it are understood, specific options to manage the flood risk are investigated. If solutions are found to be viable, they are prioritised and an ‘Action Plan’ to address the problems is produced. This would form part of future work.

The initial scoping (Phase 1) of the SWMP was completed in July 2012. Thirteen “wetspots” or areas for further investigation were identified across the county and then prioritised based on their history of flooding and the likely hazard that flooding might pose in the future.

Exeter was identified as being a key “wetspot” within the county, with a total of over 1,200 properties potentially at risk from flooding across six sub-catchments. As a result, Phase 1 of the strategic SWMP recommended that a full SWMP for the Larkbeare Brook, Longbrook, Northbrook, Pin Brook, Taddiforde Brook and St Leonard’s catchments in Exeter should be carried out.

Therefore, a Phase 2 SWMP to assess the risk in these areas in more detail was commissioned which is covered under this report. Phase 2 was sub-divided into two separate stages:

- **Phase 2a**: A data collection and investigation exercise to collate existing data and modelling information, define the approach and extents of the areas to be studied in Phase 2b, and commission additional topographic survey. Note that during this stage it was identified that Taddiforde Brook was already being investigated by Exeter City Council and it was removed from the scope of this study.5

- **Phase 2b**: An assessment of the ‘current risk situation’ within the identified catchments using hydraulic modelling. Note that due to the large degree of

5 A fourth model was produced covering the area of West Exeter. This is not covered in this Summary SWMP report. Additional information is provided in the hydraulic modelling note in Appendix B
connectivity between different areas, the five smaller catchments were re-schematised into three larger catchments covering the same area.

As part of Phase 2a stakeholders were consulted on the approach to be used and the additional data to undertake Phase 2b was obtained. The two key reporting deliverables produced as part of the above are the SWMP summary report and the model build report. The following section outlines the key aims and the content of this SWMP summary report.

1.3 Aims of this Report

An integral part of the Phase 2 SWMP was the production of hydraulic models covering the catchments mentioned above in Section 1.2. The results of these models form the basis for the assessment of risk. The assumptions made and the detail of the process used to construct the models is provided in the model build report in Appendix B.

This Phase 2 SWMP Summary Report is intended to provide an overview of the findings of the modelling and represent the findings in a way that can be used to guide flood risk management decisions by DCC and key stakeholders. It is not intended to be a detailed technical report, although a knowledge of urban drainage and flood risk is required in order to provide appropriate feedback to shape the future direction of the study, particularly with regard to development of options.

The aims of this report are outlined below:

- To summarise how the study and modelling has been undertaken;
- To give an overview of the main areas at risk from local sources of flooding within the study area;
- To recommend the areas of further investigation; and
- To achieve stakeholder ‘buy-in’ for the results of the study and the recommendations made.
The following section provides additional information regarding the catchment areas under consideration as part of this study. A general introduction is provided in addition to catchment specific information relating to the three catchment areas that make up the study area.

2.1 General Overview

Exeter is built across the valley of the River Exe, which flows broadly from north to south through the western part of the urban area (as shown in Figure 2-1). The urban area extends to the east of the River, with the M5 motorway representing the eastern-most boundary.

The topography of the city varies widely between the flat/low lying areas alongside the River Exe (approximately 10 metres above sea level) to the higher/steeper ground that makes up the majority of the urban area on the left bank (east) of the River Exe which rise to over 150 metres above sea level.

Several watercourses flow into the River Exe from both banks, with the main watercourses identified within the county-wide assessment as presenting a potentially high local flood risk being those discharging on the left bank. These run through the urban centre and suburban residential areas of Exeter, and include, Longbrook, Northbrook and Pin Brook. Many sections of these watercourses have been culverted.

*Figure 2-1 - Overview of the Study Area*
2.2 Catchment Areas

2.2.1 Pin Brook

The Pin Brook catchment is the most northerly of the catchments under consideration as part of this SWMP. The area slopes broadly from west/northwest to east, with elevations ranging from 120m above sea level in the west to approximately 30m above sea level close to the M5 motorway in the east where the study area ends. Figure 2-2 below shows the Pin Brook catchment extents.

The main area of urban development within the catchment is Pinhoe, which lies in the lower, eastern part of the catchment. It is made up from a mixture of residential, commercial and transport infrastructure. The majority of the upper catchment to the west is undeveloped land.

Figure 2-2 - Overview of the Pin Brook Catchment

There are a number of sensitive receptors present within the study area. These include three schools; two in the south of the study area and one in the centre. Nationally important infrastructure, including gas distribution, telecommunications and transportation (West of England Main Railway Line) are also present. In addition, there are a number of local electricity substations across the study area.

The Pin Brook watercourse, which is classified as Main River, flows through the study area from north to south, passing under the M5 through a culvert.

Several sections of this watercourse and its immediate tributaries are culverted and urban development has occurred around and above these culverts. There are also a number of other Ordinary Watercourses flowing in culverts within this area.

There have been several recorded instances of historical flooding within the Pin Brook catchment from both fluvial and pluvial sources. During the 1980’s the area was subject to repeated instances of surface water flooding, which was potentially exacerbated due to a lack of capacity within the drainage system. More recently in November 2012, following an
intense rainfall event, significant flooding around Beacon Heath was observed, with the majority of roads acting as significant flow paths for surface water. However, there was a limited amount of reported incidents of internal flooding.

2.2.2 Northbrook

Northbrook is the largest of the catchments under consideration within this SWMP project, covering the original Northbrook sub-catchment as well as the St Leonard’s catchment which was incorporated due to its small size and inter-connections with the Northbrook catchment. The area covers a large part of the urban area of Exeter, including the areas of St Leonard’s, Wonford, Whipton, Heavitree and Stoke Hill, see Figure 2-3 below.

![Figure 2-3 - Overview of the Northbrook Catchment](image)

The topography of the catchment slopes relatively steeply from north to south with a drop in elevation of over 100m across 2km. Much of the catchment is urban in nature and land use is a mixture of residential, retail, commercial and transport infrastructure, although the area also contains a number of open spaces. The upper reaches of the catchment are undeveloped land as shown in Figure 2-3.

The Northbrook watercourse is classed as an Ordinary Watercourse with a relatively large catchment area (>9km²) which runs from Stoke Hill and the Polsoe Bridge/Whipton areas through Heavitree and on down through Ludwell Valley Park. The Northbrook watercourse is predominantly set in a deep channel but is culverted along a number of sections.

Within the St Leonard’s area, an unnamed Ordinary Watercourse runs, almost entirely within a culvert, from The Royal Devon & Exeter Hospital on Dryden Road down to the River Exe adjacent to Rivermead Road. The topography of this watercourse is steeply sloping and it flows through a heavily urbanised area.

There have been several recorded instances of historical flooding within the Northbrook Study area, mainly from pluvial sources. Between 21st and 25th November 2012 the area was subject to widespread flooding resulting from an intense rainfall event which affected several other parts of Devon. Significant ponding occurred along Beacon Avenue in the eastern section of the catchment which affected both residential properties and a local...
Children’s Centre. This was attributed to a recurring land drainage issue within the north of the catchment.

During the 1980’s the area was subject to repeated instances of surface water flooding as a result of inadequate land drainage systems within the north of the catchment. Flooding along the Northbrook Ordinary Watercourse was also observed.

### 2.2.3 Longbrook

The Longbrook catchment encompasses the sub-catchments of Longbrook and Larkbeare, covering the city centre, and parts of Pennsylvania and St Leonards, on the left bank of the River Exe, see Figure 2-4. The catchment slopes gently from northeast to southwest, with a drop in elevation of approximately 50m across 1km.

![Figure 2-4 - Overview of the Longbrook - Larkbeare Catchment](image)

The Longbrook is a completely culverted watercourse. It is understood that the Longbrook culvert has been partially truncated in places and superseded by the later installation of the public surface water system. In addition, Larkbeare Brook is present within this area and is another completely culverted watercourse. It extends from Newtown and the Belmont Road Pleasure Ground down through the Barnfield area discharging to the River Exe at the bottom of Colleton Hill, just downstream of Exeter Quay.

The area is heavily developed with mixed residential, commercial and transportation infrastructure.

There have been several recorded instances historical flooding across the Longbrook study area from both fluvial and pluvial sources. The area suffered a significant flood event during the 1960’s where deep flooding was recorded along the length of the Longbrook watercourse. Approximately 1,000 properties were affected across the whole city with flooding occurring from multiple watercourses. More recently during the 1980’s the whole catchment was subject to repeated instances of surface water flooding, although predominantly affecting properties in the south of the study area. Investigations by Devon
County Council indicated that flooding was potentially exacerbated due to a lack of capacity within the drainage system.

Exeter also suffered a significant flood event during November 2012 with rail infrastructure badly affected approximately 1km to the northwest of the study area boundary, although this was not as a result of flooding in the Longbrook catchment itself. Few details are available with regard to this event and it is not known whether any surface water flooding occurred. The only confirmed report of flooding within the study area occurred from the River Exe at the southern end of the study area where a non-residential property was flooded.
The following section outlines the assessment methodology applied as part of this SWMP. It outlines the general approach undertaken to carry out the hydraulic modelling, as well as the assessment undertaken to identify specific risk areas and prepare a high level baseline economic analysis of potential flood damages.

A detailed discussion of the methodology used for the hydraulic modelling can be found in Appendix B, the hydraulic modelling report.

### 3.1 The Modelling Approach

The objective was to develop three (Pinbrook, Longbrook and Northbrook) detailed Integrated Catchment Models (ICM) covering the catchment areas within the urban area of the City of Exeter (as shown in Figure 3-1). These models were used to better understand the mechanisms, sources and possible consequences of surface water flooding across Exeter. Each of the models was designed to represent (where applicable):

- Direct Rainfall on the urban area;
- Overland flow through the built environment;
- Interaction between the surface water and combined sewer network; and
- Interaction of the above with ordinary watercourses present in the catchment area

It is important to note that although each of the three ICM models was developed to assess surface water flooding (and represent the above points) each model had its own catchment specific considerations. These considerations reflected both the objectives of the SWMP and the client requirements. Additional information relating to the ICM modelling is provided.

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**Integrated Catchment Modelling**

The Integrated Catchment Modelling (ICM) approach aims to bring together an assessment of different mechanisms of flooding into a single model, allowing an understanding of how different flood mechanisms interact under different conditions.

This is different to modelling approaches in the past where separate models were required to simulate the flood risks from watercourses, below ground drainage systems and surface water.

Integrated Catchment Modelling is able to simulate direct surface water flooding using a Digital Terrain Model which allows water to fall on a surface and flow across it under the effects of gravity. It is also able to simulate flows of water along watercourses and through ground pipe networks. Flood waters can be transferred between different networks when their capacity is exceeded, for example simulating sewers surcharging or watercourses overtopping, as well as allowing water to flow back into them, such as surface water flows entering a watercourse or other water body.

How elements of a model are put together is called the model 'schematisation'. Schematising a model requires detailed information on the topography and the size and shape of below ground assets. This information is often derived from detailed remote sensing data such as LiDAR or from detailed topographic survey.

The ICM approach requires the identification of a ‘contributing catchment’ for surface water, drainage systems and watercourses. This can often be counter-intuitive when compared against a purely topographic catchment as sewer systems often do not follow natural topography boundaries, transferring flows from one catchment to another.

ICMs can be used to simulate a wide range of different scenarios representing different weather and antecedent conditions, i.e. the conditions that exist before a major weather event. For example, some systems may be more vulnerable to flooding when there been a long period of wet weather beforehand, leaving the ground saturated and drainage systems already full. In another area the risk of flooding might be influenced more simply by the intensity of the storm over a short duration.
In order to construct an integrated catchment model, information is needed on:

- The topography of the study area;
- The sewer and drainage network;
- Watercourses, culverts and bridges; and
- Land cover type

This information has been collected from the following sources:

- Exeter City Council
- Devon County Council
- South West Water
- Site survey

As discussed in Section 1 and illustrated within Figure 3-1, three catchments have been identified for modelling as part of Phase 2 of the Exeter SWMP; Pin Brook; Northbrook; and Longbrook.

The modelling methodology adopted for this study is provided in more detail in Appendix B.

![Figure 3-1 - Overview of the Modelled Study Areas](image)

The models created as part of the Phase 2 works have been used to simulate a range of different rainfall events with different intensities and different likelihoods of occurring. The model outputs produced include depth, velocity and hazard rating (a function of depth and velocity) across the catchment areas.

### 3.2 The Identification of Risk Areas

The level of risk across Exeter is not uniform; the level of localised flooding is influenced by the watercourses in the area, the piped drainage network characteristics, the topography and the pattern of urban development across Exeter.

The model outputs were used to inform a desk-based analysis that was carried out to identify ‘Risk Areas’ that might require further investigations and/or where options to manage
localised flood risks could be implemented as part of a future study (as outlined in Section 1.2). The ICM outputs were used to identify the extents and likelihood of:

- Flooding from some Main Rivers (this excludes the Exe for example);
- Flooding from Ordinary Watercourses;
- Pluvial flooding along key flow-paths;
- Pluvial flooding of localised depressions; and
- Flooding from surcharging sewers and drainage systems.

Topographic information from LiDAR, Ordnance Survey mapping and information on properties, obtained from the National Property Dataset were used to help in the identification of Risk Areas. These areas were defined through this assessment where:

- The level of risk from flooding is considered to be particularly high compared to the surrounding areas;
- The source and mechanism(s) of flooding are distinct compared to adjacent areas and would require a separate solution to be developed to manage the risk;
- There is little clear direct interaction between flooding in the area identified and adjacent areas (otherwise it may require a unified management approach or solution).

The overall level of flood risk across each study area is discussed in Section 4. A detailed discussion of the identified Risk Areas is contained in Appendix A. For each risk area, key factors have been identified and reported on, covering the following:

- **The key sources of flooding:** Where the flooding originates from and how these sources may interact;
- **The main pathways that flooding travels along:** Key flow-paths and conduits for flood water. These include natural topographic features as well as manmade features like roads and underpasses; and
- **The vulnerable receptors that are affected by flooding:** What and who might be affected by flooding and what the consequences of flooding could be.

This approach effectively describes the Source-Pathway-Receptor model often considered within the context flood risk management.

### 3.3 Economic Assessment

An approach used to quantify flood risk is an analysis of the economic damages to property and possessions that result from different flood events.

Using the outputs from the modelling, a high level preliminary assessment of economic damages was carried out using the Jacobs EcMap tool. The calculation of economic damages is undertaken using standardised guidelines and figures, provided in the Flood and Coastal Defence Project Appraisal Guidance published by Defra in the UK, and also the Middlesex University's Flood Hazard Research Centre's 'Multi-Coloured Manual' (MCM).

Inputs to the tool are flood depth information generated by the modelling for the 20%, 10%, 3.3% and 1% Annual Exceedence Probability (AEP) events (1 in 5, 1 in 10, 1 in 30 and 1 in 100 annual chance events respectively), and property data, obtained from the National Property Dataset. The tool uses the methodology in the MCM to estimate the economic...
damages (on a probabilistic basis) that result at each property within the study over an assessment period of 50 years.

In local flood risk management terms, a 50 year appraisal period is more appropriate than a 100 year period. The 100 year appraisal period is typically adopted for major river and coastal flood defence schemes.

However, the generally smaller nature of interventions to manage local sources of flooding, such as that from small watercourses and rainfall runoff, means that it is not appropriate to assume as a matter of course that they would be effective over a longer period. The effectiveness of interventions to manage local flood risk beyond the 50 year horizon is subject to a broad range of factors, such as planning policy, SuDS implementation, climate change, new development and site re-development; all of which can have a significant effect on the resulting flood hazard in an area.

The primary purpose of this preliminary economic damage assessment is to assist in identifying the high risk receptors and locations within the study area that would warrant most attention in terms of developing options to avoid such damage.

The tool uses different property types (i.e. residential and non-residential) in addition to property valuation to estimate the economic damages resulting from flooding. The tool outputs present value (PV) economic damages as well as Annual Average Damages (AAD). Note that a more detailed explanation of these terms is contained in the box below.

The EcMap tool also summarises the value of damages associated with different property types. Due to the high level nature of the current assessment, several conservative assumptions have been made regarding property values across Exeter which are listed below:

- Factors used to uplift property values (to reflect inflation, costs associated with indirect damages and costs for emergency service responses) have been assumed to be the national average values recommended in the MCM;
- Property damage capping:
  - Residential property values have been assumed to be the national average
  - Non-residential rateable values (per m² of property) have been assumed to be a citywide average from 2005 (the latest available data), uplifted to current values to take into account inflation using a regional average.
- Property thresholds have been assumed to be an average of 0.3m¹⁰ above ground level as determined from the digital terrain model (DTM).
- No damages associated with flooding to infrastructure (for example roads or railways) is included.

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¹⁰ This value is subtracted from the depths recorded at each property which is used to inform the damage assessment.

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³ Property damages are capped to the value of the property. This assumes that the maximum present value (PV) damages that occur at a residential property are limited to its approximate value.
3.3.1 Sensitivity of Preliminary Economic Analysis and Interpretation

The primary assumptions with regard to the economic analysis are listed above, and are fully consistent with standard UK guidelines and approaches.

However, there are further assumptions to set the context for interpreting the economic values derived for flood damages which relate to how the mapping is used in the analysis. These are discussed in more detail below.

(a) Defining a Property as Flooded

Before calculating the flood damages for a property, it is first necessary to define when it has been flooded. There are two basic approaches to this; the property “footprint” method and the property “centre-point” method.

- The footprint method. This assumes that if a building footprint is within the flood outline, flood damage is incurred.
- The centre-point method. This assumes that damage is only incurred if the single point (typically the centre of the building) falls within the flood outline.

In the example below, Figure 3-2, the property would not be defined as being flooded if the centre-point method was used, but would if the footprint method was applied. Both approaches are valid, and their use depends on the specific situation. For this analysis, the “footprint” is used to define the property.

(b) Property Threshold Levels

The threshold level of the property is the level at which flood water surrounding the building would begin to enter into it. In detailed site specific studies the threshold level is normally determined by a physical survey of the property. For areas as large as that covered by the modelling at this stage of the Exeter SWMP this is impractical.
Therefore, in the absence of detailed data of the threshold levels for internal flooding of a property, and the location of the water entry point, it is noted above (Section 3.4) that the threshold level for all properties is assumed to be 0.3m above the ground level given in the DTM. Across the study, actual threshold levels will vary from property to property. A decrease in the threshold level to 0.15m (for example) will result in a significant increase in flood damages.

(c) Removal of Isolated “Flood” Areas

The nature of integrated 2D surface and subsurface water modelling is such that small “polygons” in the model can be shown as flooded areas. Many of these are not “fed” by water along a significant natural surface flow path (or from a sub-surface surcharged system), nor are they necessarily distinct topographic depressions. They are typically a by-product of the process to simplify the highly detailed data used within the model.

These have therefore been filtered out so that properties adjacent to them do not incorrectly attract damages. The size of the areas that are filtered out is a subjective matter, which for this study is selected as 750m².

These three factors, fundamental to the derivation of the economic damages, will give a wide range of overall damages when each factor is taken to its reasonable upper and lower bound. The economic values given below in the analysis for each catchment therefore need to be interpreted carefully, and should not be taken at this preliminary stage as being the “final” damage values.

However, within the context of the approach, it allows the higher risk areas (as indicated by damages) to be identified. Any change in the approach to calculating the specific values would still result in the same high risk areas being identified.

As noted above, the primary purpose of this damage assessment is to assist in identifying the high risk receptors and locations in the study area. Within these high risk areas, when options are being developed, an evaluation of actual threshold levels, water entry points, and localised flow paths may be justified in order to give greater confidence in the economic damages derived. This process may be informed by sensitivity testing of the economic damages by raising or lowering the assumed threshold level of each property to 0.15m (for example). Where significant changes occur, additional investigation may be required to refine the economic case for implementing flood risk management measures.

3.4 Flood Hazard Rating

Although economic damages are a key indicator of flood risk as these are linked to flood depths occurring at property locations, the assessment of damages as described above primarily considers potential damages to property and possessions. Other factors such as the economic impact of loss of life can be included, but in this preliminary assessment, such human factors have not been considered.

Another key element of overall flood risk is therefore the potential hazard that it poses to members of the public, council staff or emergency services workers. Deep and fast flowing water can be very dangerous, able to sweep people off their feet, move vehicles and cause structural damage to buildings and structures.

The Flood Hazard Rating is a methodology recommended by Defra for assessing how hazardous flooding is likely to be. The Flood Hazard Rating is a product of flood depth and flood velocity, as well as taking into account debris that might be carried along by flood water (see below).
The Hazard Rating varies from Low Hazard, where flooding could pose a hazard to vulnerable adults and young children, to Extreme, where flooding can pose a risk to members of the emergency services.

**The Flood Hazard Rating Formula**

Flood Hazard Rating is calculated from the outputs of the hydraulic modelling using the formula:

\[ \text{Hazard} = \text{Depth} \times (\text{Velocity} + 0.5) + \text{Debris Factor} \]

The overall score bands are:

| <0.75 | Low: Flood zone with shallow flowing water or deep standing water |
| 0.75 – 1.25 | Moderate: Danger, flood zone with deep or fast flowing water |
| 1.25 – 2.0 | Significant: Danger, flood zone with deep, fast flowing water |
| >2.0 | Extreme: Extreme danger, flood zone with deep, fast flowing water |

The hydraulic modelling carried out for the Exeter SWMP has calculated the Flood Hazard Rating of potential flooding for all modelled flooding events and this has also been incorporated into the identification and discussion of Risk Areas. In some cases, flood hazard is the principal factor behind identifying a Risk Area.

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Results of the Desk-Based Assessment

The following section discusses the findings following a desk-based review of the model outputs and the likely impact that flooding would have during and after an extreme rainfall event within each catchment. It also discusses the identification of Risk Areas within each modelled area.

4.1 Pin Brook

The Pin Brook study area is in the north of Exeter and covers the mixed rural and urban catchment of the Pin Brook Main River. The main urban developments in this catchment are the areas of Pinhoe and Monkerton, towards the eastern end of the study area.

The model results indicate that there is a widespread risk of flooding across the urbanised eastern parts of the study area. As a result of the steep nature of the topography, the areas of highest flood risk are generally localised along distinct flow-paths. These flow routes represent the various watercourses within the study area but also include several major surface water flow-paths where surface runoff is channelled, resulting in deep and/or fast flowing flooding.

The Pin Brook watercourse represents the principal risk from watercourses, although flooding from a number of the unnamed tributaries of this watercourse is also observed. Flooding from watercourses is generally only extensive in the 1% Annual Exceedance Probability (AEP) flooding event. However, once this mechanism begins to occur it results in significant flooding and may represent a hazard to people.

Key flow-paths can be identified across the study area but are particularly prevalent flowing from the northern area of the catchment such as Pinn Hill and Church Hill. Several of these flow-paths run along the highway. In addition some may well represent the courses of small watercourses that have been culverted or have not been identified by the analysis. Several key flow-paths are seen in the 3.33% AEP event but generally are not predicted to represent a significant hazard. However, in the 1% AEP event, the increased depths and velocities of flooding may represent a significant hazard to people. This is likely to represent a particular issue where flow-paths are channelled along or pass over manmade features such as roads.

Flooding of localised depressions can be found predominantly in the urban area of the catchment and occur where flow-paths flow into areas of low-lying ground with limited outflow capacity from the area. These areas include localised areas in Pinhoe and Monkerton. Although velocities within these depressions are low, deep flooding of 1 or 2 metres is shown from the modelling and may represent a serious hazard. This is particularly true where deep flooding occurs around properties or on the highway.

In the 1% AEP event, the economic damage assessment indicates that Present Value (PV) Damages of approximately £3 million are incurred within the study area, affecting a total of 49 residential properties and 25 non-residential properties. £1.4 million of the PV Damages is associated with residential properties and £1.2 million associated with non-residential properties, whilst the remaining £0.4 million of damages is incurred from indirect or intangible damages.

Considered over the lifetime of the assessment period (50 years) this results in annual average damages of approximately £1.5k and £2k for residential and non-residential properties respectively. The distribution of economic damages across the study area is shown in Figure 4-1.

Table 4-1 summarises the total cumulative number of properties affected by flooding in each event. This shows the majority of the risk is confined to the south of the study area.
Table 4-1 - Summary of Properties Affected within the Pin Brook Study Area

Seven Risk Areas were identified following a desktop review of the modelling results at locations where the level of risk is higher than the average. These Risk Areas result from a range of different flooding mechanisms. The source of flooding in these Risk Areas is predominantly fluvial and is concentrated either along Pin Brook or on the several smaller tributaries which flow into Pin Brook. There are also several significant surface water flow-paths where the risk of flooding is predominantly pluvial. A summary of the Risk Areas is contained in Table 4-2.

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Primary Source of Flooding</th>
<th>Secondary Sources of Flooding</th>
<th>Flood Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN01 Beacon Heath</td>
<td>Fluvial</td>
<td>Pluvial</td>
<td>HIGH</td>
</tr>
<tr>
<td>PIN02 Pinhoe Trading Estate</td>
<td>Fluvial</td>
<td>N/A</td>
<td>HIGH</td>
</tr>
<tr>
<td>PIN03 Thursby Walk</td>
<td>Fluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>PIN04 Pilton Lane</td>
<td>Pluvial</td>
<td>Fluvial</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>PIN05 Main Road</td>
<td>Pluvial</td>
<td>Fluvial</td>
<td>HIGH</td>
</tr>
<tr>
<td>PIN06 Monkerton</td>
<td>Fluvial</td>
<td>Pluvial</td>
<td>LOWER</td>
</tr>
<tr>
<td>PIN07 Langaton Gardens</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>MEDIUM</td>
</tr>
</tbody>
</table>

Table 4-2 - Summary of Pin Brook Risk Areas

The Risk Areas identified in the Pin Brook catchment are presented on Figure 4-2 and are discussed in detail in Appendix A.
4.2 Northbrook

The Northbrook study area is in the east of Exeter and covers the mixed rural and urban catchment of the Northbrook Ordinary Watercourse. The main urban developments in this catchment are the areas of Whipton, Heavitree, Birchy Barton and Wonford, towards the southern end of the study area.

The modelling indicates that there is a widespread risk of flooding across the urbanised central and southern parts of the study area. Due to the steep nature of the topography and heavily urbanised nature of the catchment, the areas of highest flood risk are generally confined to deep localised ponding areas.

Pluvial flooding represents the principal risk from flow being channelled into low lying areas within the catchment as a result of the topography. Flow paths generated are generally extensive in both the 3.33% AEP and the 1% AEP events. However, due to the widespread occurrence of surface water flow paths and ponding areas, flooding may represent a significant hazard to people.

Key flow-paths can be identified across the study area but are particularly prevalent within the central and southern regions of the risk area, where Northbrook is located. Several of these flow-paths run along the highway. In addition some may well represent the courses of small watercourses that have been culverted and ‘hidden’ and have not been identified by the analysis. These may reduce the amount of surface water shown, but could also increase risk in some areas by allowing water to be transferred more quickly, and in greater volumes, than shown in the model.

Flooding of localised depressions can be found predominantly within urban areas throughout the study area and occur where flow-paths flow into areas of low-lying ground. Although velocities within these depressions are low, deep flooding of 1 or 2 metres could potentially be experienced and may represent a serious hazard. This is particularly true where deep flooding occurs around properties or on the highway.

Pluvial flooding within the catchment is exacerbated during high intensity rainfall events as urban drainage systems are overwhelmed by the volume of flow entering the network, which causes manholes in low lying areas to surcharge and also increases the volume of overland flow.

There is a smaller contribution from fluvial flood risk within the study area. Northbrook, an ordinary watercourse runs through the centre of the study area. Out of bank flow is prevalent in areas where flow is constrained, such as culverted sections of watercourse. In this instance flow spills out of bank and accumulates within the floodplain.

In the 1% AEP event, the economic damage assessment indicates that Present Value (PV) Damages of approximately £12 million are incurred within the study area, affecting 244 residential properties and 25 non residential properties. £6.5 million of the PV Damages is associated with residential properties and £3.2 million is associated with non-residential properties, whilst the remaining £2.3 million of damages is incurred from indirect or intangible damages.

Considered over the lifetime of the assessment period (50 years) this results in annual average damages of approximately £1.4k and £5.5k for residential and non-residential properties respectively.

The distribution of economic damages across the study area is shown in Figure 4-3. This shows the widespread nature of the risk as discussed above.
<table>
<thead>
<tr>
<th>Flooding Event</th>
<th>Total Number of Properties at Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% AEP Event</td>
<td>42</td>
</tr>
<tr>
<td>3.33% AEP Event</td>
<td>139</td>
</tr>
<tr>
<td>1% AEP Event</td>
<td>269</td>
</tr>
</tbody>
</table>

**Table 4-3 - Summary of properties affected within the Northbrook area**

Twenty one Risk Areas have been identified from the desk-based review and are listed in Table 4-4 below. The sources of flooding within the Northbrook study area are variable, although predominantly related to pluvial flooding or flooding from urban drainage systems.

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Primary Source of Flooding</th>
<th>Secondary Sources of Flooding</th>
<th>Flood Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTH01 Rollestone Crescent North</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH02 Rollestone Crescent South</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH03 King Arthurs Road</td>
<td>Pluvial</td>
<td>Fluvial</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH04 Summerway</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH05 Woolsery Avenue</td>
<td>Pluvial</td>
<td>N/A</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH06 Pinhoe Road</td>
<td>Pluvial</td>
<td>N/A</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH07 Polsloe Road North</td>
<td>Pluvial</td>
<td>N/A</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH08 Polsloe Road South</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH09 Whipton Barton Road</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH10 Georges Close</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH11 Hanover Road</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>HIGH</td>
</tr>
<tr>
<td>NORTH12 North Lawn Court</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH13 Roseland Drive</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>NORTH14 Wilton Way</td>
<td>Pluvial</td>
<td>N/A</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>Risk Area</td>
<td>Primary Source of Flooding</td>
<td>Secondary Sources of Flooding</td>
<td>Flood Risk Rating</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------</td>
<td>--------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>NORTH15 Honiton Road</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>HIGH</td>
</tr>
<tr>
<td>NORTH16 Northbrook - Rifford Road</td>
<td>Fluvial</td>
<td>Pluvial</td>
<td>HIGH</td>
</tr>
<tr>
<td>NORTH17 Woodwater Lane</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH18 Wonford Street</td>
<td>Urban Drainage</td>
<td>Pluvial</td>
<td>HIGH</td>
</tr>
<tr>
<td>NORTH19 Ludwell Lane</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH20 Topsham Road East</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>LOWER</td>
</tr>
<tr>
<td>NORTH21 Topsham Road West</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
</tbody>
</table>

*Table 4-4 - Summary of Northbrook Risk Areas*

The Risk Areas identified on Figure 4-4 and are discussed in detail in Appendix A.
Figure 4-3 - Summary of Economic Damages within Northbrook

Notes: Flood extents shown have been filtered to remove isolated flood areas.

Legend
- Study Area Extent
- Watercourse
- Modelled Flood Extent
  - 1% AEP Flood Event

Summary of Damages
PV Total Damages (£k)
- >0 - 50
- 50 - 100
- >100
Figure 4-4 - Overview of Northbrook Risk Areas
4.3 Longbrook

The Longbrook study area is situated in the centre of Exeter and covers the urban catchment of the Longbrook Ordinary Watercourse. The City Centre is included within this study area, and is located towards the south of the catchment, close to the River Exe.

The modelling indicates that there is a widespread risk of flooding across the urbanised eastern parts of the study area but, as a result of the steep nature of the topography and due to the heavily urbanised nature of the catchment there are several key localised flood risk areas.

Key flow-paths resulting from both fluvial and pluvial sources can be identified across the study area but are particularly prevalent flowing from the hillier northern area close to Stoke Hill. Several of these flow-paths run along the highway; however, in the 3.33% AEP event, flooding is not predicted to represent a significant hazard due to the shallow depths generally observed.

However, in the 1% AEP event, the increased depths and velocities of flooding may represent a significant hazard to people. This is likely to represent a particular issue where flow-paths are channelled along or pass over manmade features such as roads. In particular, flooding along the railway line is likely to cause widespread disruption to the rail network within the area.

Flooding within the catchment is exacerbated during high intensity rainfall events by the limited capacity of the drainage network which causes manholes to surcharge, resulting in increased volumes of overland flow.

The modelling undertaken for Cricklepit Leat has been prepared to represent a worst case flooding scenario. Consequently the modelling in this area results in a large number of properties being flooded in the 10% AEP flood event, resulting in an unrealistically high value of damages being incurred in this area. Because of this, the Tudor Street Risk Area has been excluded from the economic analysis carried out as part of this study. The modelling of Cricklepit Leat and calculation of likely economic damages in this area should be investigated in more detail during the next phase of the study.

In the 1% AEP event, the economic damage assessment indicates that Present Value (PV) Damages of approximately £9 million are incurred within the study area, affecting 213 residential and 47 non-residential properties. £5.9 million of the PV Damages is associated with residential properties and £1.2 million associated with non-residential properties, whilst the remaining £1.9 million of damages is incurred from indirect or intangible damages.

Considered over the lifetime of the study (50 years) this is likely to result in Annual Average Damages of £1.5k for residential properties and £1.1k for non-residential properties.

Table 4-5 below summarises the total cumulative number of properties affected by flooding in each event.

<table>
<thead>
<tr>
<th>Flooding Event</th>
<th>Number of Properties at Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>10% AEP Event</td>
<td>59</td>
</tr>
<tr>
<td>3.33% AEP Event</td>
<td>129</td>
</tr>
<tr>
<td>1% AEP Event</td>
<td>260</td>
</tr>
</tbody>
</table>

*Table 4-5 - Summary of Properties affected within the Longbrook Study Area*
The distribution of economic damages across the study area is shown in Table 4-5. This shows the widespread nature of the flood risk within this small catchment, as well as identifying clear areas of flood risk associated with the Longbrook, Larkbeare and Cricklepit Ordinary Watercourses.

Eight Risk Areas can be identified from the desk-based review. These predominantly relate to fluvial flooding from one or other of the watercourses. However, issues with urban drainage systems represent a secondary source of flooding in several of the areas. This reflects the integration of the culverted Ordinary Watercourses with the drainage network. A summary of the Risk Areas is contained in Table 4-6

<table>
<thead>
<tr>
<th>Risk Area</th>
<th>Primary Source of Flooding</th>
<th>Secondary Sources of Flooding</th>
<th>Flood Risk Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>LONG01 Tudor Street</td>
<td>Fluvial</td>
<td>N/A</td>
<td>HIGH</td>
</tr>
<tr>
<td>LONG02 Exe Street</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>LONG03 South Street</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>LONG04 Larkbeare Brook Downstream</td>
<td>Fluvial/Pluvial</td>
<td>N/A</td>
<td>MEDIUM</td>
</tr>
<tr>
<td>LONG05 Mount Radford</td>
<td>Pluvial</td>
<td>N/A</td>
<td>LOWER</td>
</tr>
<tr>
<td>LONG06 Belmont Road</td>
<td>Pluvial</td>
<td>N/A</td>
<td>HIGH</td>
</tr>
<tr>
<td>LONG07 Pennsylvania - St James</td>
<td>Pluvial</td>
<td>Urban Drainage</td>
<td>HIGH</td>
</tr>
<tr>
<td>LONG08 Central Station</td>
<td>Pluvial</td>
<td>N/A</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

Table 4-6 - Summary of Longbrook Risk Areas

The Risk Areas are identified on Figure 4-6 and discussed in detail in Appendix A.
Figure 4-5 - Summary of Economic Damages within Longbrook

Notes: Flood extents shown have been filtered to remove isolated flood areas.

The Cricklepit area of the study area has been excluded from the economic analysis.
Figure 4-6 - Overview of Longbrook Risk Areas
The following section outlines the recommendations arising from findings of the Phase 2 Exeter SWMP. General recommendations regarding the continuation of the study as a whole have been made based on the assessment of risk contained in Section 4.

As well as this, specific actions have been recommended for each Risk Area, taking into consideration the desk-based review (in Appendix A). These are contained within the Exeter SWMP Preliminary Action Plan shown in Table 5-1.

The Action Plan contains the recommendations for each Risk Area, ranked according to an assessment of the level of risk within each area.

5.1 Recommendations for the Next Phase of the SWMP

The assessment summarised by this report has found that flood risk across the study areas is highly varied and generally localised where vulnerable receptors are affected by watercourses or significant surface water flow-paths or ponding areas. The desk-based review of flood risk identified 36 Risk Areas across the study areas where further investigation or action is recommended. Eleven of these areas have been classified as ‘high priority’ and 11 have been classified as ‘medium priority’.

Phase 3 of the Exeter SWMP should investigate the Risk Areas with the aims of:

- Confirming our understanding of the local mechanisms of flooding;
- Obtaining more information on properties in Risk Area to understand if they are vulnerable to surface water flooding – for example, threshold levels and water entry points; and
- Identifying viable options for managing the flood risks (that have been identified by this review).

Specifically, Phase 3 of the SWMP should:

- Include feedback from stakeholders on specific locations, as well as undertaking site visits to risk areas to confirm the validity of flow paths, ponding areas, water entry points, critical out of bank flow locations and influencing factors etc.
- Refine the existing ICM models, where critical, to support detailed economic appraisals and option development. This would include:
  - A review of hydrological assumptions for the specific area (rather than the catchment-wide approach), such as infiltration allowances and sensitivity to “lower” i.e. more conservative flow estimates;
  - Obtaining and including highway’s gully data and kerb heights;
  - Refined ground model for key locations and higher resolution 2D mesh;
  - Inclusion of local features that do not show on mapping (such as walls);
- Refine the economic assessment of damages through a more detailed review of property values, types and threshold levels to improve on the generalised assumptions currently being used;
- Develop and test (using the ICM models) the viability of a range of potential options for managing flood risk within key risk areas, including an estimate of costs for any works, in order to identify a preferred option;
- Progress an outline design for a preferred option for managing flood risk at each Risk Area (or selected higher risk areas);
- Identify maintenance priorities in areas where the risk is associated with, for example, blocked gullies;
- Develop submissions for funding to allow flood risk management works to be undertaken, where viable.
The Phase 3 investigations should take a catchment-based approach, focusing on those Risk Areas that have been highlighted as priorities for investigation in the Preliminary Action Plan.

However, it is also likely that some of the Risk Areas not prioritised by the Action Plan will fall within catchments being considered by the Level 3 assessment and may therefore warrant consideration at the same time.

5.2 The Exeter Preliminary Action Plan

The Exeter SWMP Preliminary Action Plan set out in this section is intended to represent a broad roadmap for prioritising and progressing the actions necessary to manage flood risk within the Risk Areas.

5.2.1 Prioritising Risk Areas

As previously discussed in this report, the level of risk across the identified Risk Areas is not uniform. As a result, it is necessary to prioritise the areas with the highest risk where risk management measures are both most necessary and likely to be most viable as a result of the potential economic benefits to be gained, or the reduction in hazard rating that results.

At this high level of the assessment, a simple ranking method has been used to prioritise the risk areas, based upon the information available through the desk-based review:

<table>
<thead>
<tr>
<th>Rank Factor 1 - Indicative Flood Hazard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based upon the modelled Flood Hazard Rating and and assessment of the likely scale of the exposure of people to the flooding event. This is considered to be the most important due to the potential risk to life posed by high hazard flooding events.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank Factor 2 - Total PV Damages</th>
</tr>
</thead>
<tbody>
<tr>
<td>The total PV damage as calculated during the economic assessment. Higher PV damages indicate the higher risk in economic terms, based on the receptors affected and the depth of flooding. By definition, it also represents the potential benefits that may be accrued by implementing measures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank Factor 3 - Number of Properties Flooded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessed from the outputs of the economic assessment. Areas with large numbers of properties affected by flooding are both highest risk and also most likely to be able to attract external funding for potential flood risk management measures.</td>
</tr>
</tbody>
</table>

This simple ranking system has been used to indicate the priority in which Risk Areas should be investigated. Risk Areas where the level of risk is considered to be highest have been highlighted as being prioritised for further investigation. These are the areas incurring the greatest damages, as well as those areas where flooding is considered to represent a high level of hazard to people.
5.3 The Recommended Actions

For the 22 high and medium priority Risk Areas, two generic categories of action have been used in the Action Plan. These are:

- **High Priority Detailed Investigation**: These Risk Areas are considered to suffer the highest level of risk and hazard rating, and should be considered through the Phase 3 Investigations. Detailed investigations of these Risk Areas should look to further refine the modelling to aid in the assessment, informed by site visits and stakeholder input. In these areas, the Phase 3 modelling should also be used to identify a preferred option for managing risk, as well as developing a business case for funding.

- **Medium Priority Detailed Investigation**: These Risk Areas have moderate levels of flood risk, but in particular the hazard rating is not considered to be as high as those classified as high priority. These areas should be considered through the Phase 3 investigations and a range of options to mitigate the risk should be tested to ascertain if there are economically viable options that can be progressed into a full scheme if considered appropriate.

Table 5-1, overleaf, summarises the outcomes from this assessment undertaken as part of this SWMP and outlines the recommended action for each Risk Area investigated across the three catchment areas.

5.3.1 Testing of Quick Win Measures

It is also recommended that the models developed through the Phase 3 assessment, should be used to test ‘Quick Win’ measures. Further information relating to these measures is provided in the following box.

---

**Quick Win Measures**

Quick Wins measures are flood risk mitigation works/actions that can be put in place to help manage known or likely flood risks.

They do not require extensive investigations and funding because:
- They should have clear benefit-cost ratios, though the precise ratio is not known (or required)
- They should not increase flood risk elsewhere

Quick Wins are not usually sufficient to ‘solve’ the flooding issues of particular Risk Areas, but they can have a significant short term and/or local impacts. They should be viewed as an effective flood risk reduction tool that can be implanted without the need to go through a significant design, funding, modelling and consultation stage.

An example of a Quick Win measure could include re-profiling of a road or installation of a ‘speed-bump’ to divert water away from a vulnerable property.

The Phase 2 hydraulic model, or the enhanced model produced through the recommended Phase 3 works, could be used to test the efficacy of minor works such as this.

It is intended that Quick Wins will be tested as early as possible within each Risk Area if they are identified in the options identification process in order to see if they are viable.

---

In addition to the Risk Areas contained in the Action Plan, there are a number of other ‘lower’ risk areas. Investigations to test the viability of options here could be considered as part of...
Phase 3 if, for example, there is a benefit in addressing these areas at the same time as adjacent High Priority areas.

However, there are likely to be other areas within Devon which would have a higher priority. If they cannot be addressed as part of the investigation into other areas, it may be more beneficial to address the risk in other areas before focusing upon these. We have therefore not recommended specific investigations for the ‘lower’ Risk Areas.
### High Priority Detailed Investigation

These Risk Areas are considered to be at the highest level of risk and should be considered through the Phase 3 Investigations.

Detailed investigations of these Risk Areas should look to integrate specific local information into the model.

In these areas, the Phase 3 modelling should be used to identify a preferred option for managing risk, as well as developing a business case for funding.

<table>
<thead>
<tr>
<th>Recommended Action or Investigation</th>
<th>Risk Area</th>
<th>Total No. of Properties at Risk (1 in 100 year)</th>
<th>Hazard Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LONG08 Central Station</td>
<td>91</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>NORTH16 Northbrook - Rifford Road</td>
<td>75</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>NORTH18 Wonford Street</td>
<td>49</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>LONG06 Belmont Road</td>
<td>35</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>LONG07 Pennsylvania - St James</td>
<td>32</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>NORTH11 Hanover Road</td>
<td>26</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>PIN02 Pinhoe Trading Estate</td>
<td>23</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>PIN05 Main Road</td>
<td>13</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>NORTH15 Honiton Road</td>
<td>9</td>
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</tr>
<tr>
<td></td>
<td>PIN01 Beacon Heath</td>
<td>3</td>
<td>HIGH</td>
</tr>
<tr>
<td></td>
<td>LONG01 Tudor Street</td>
<td>No economic analysis has been carried out for Tudor Street</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

### Medium Priority Detailed Investigation

These Risk Areas have moderate levels of flood risk, but in particular the hazard rating is not considered to be as high as those classified as high priority.

These areas should be considered through the Phase 3 investigations and a long-list of possible options should be developed.

Once more information is available, a decision can be made on whether further investigations are required or otherwise (e.g. move to a lower risk category).

<table>
<thead>
<tr>
<th>Recommended Action or Investigation</th>
<th>Risk Area</th>
<th>Total No. of Properties at Risk (1 in 100 year)</th>
<th>Hazard Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LONG04 Larkbeare Brook Downstream</td>
<td>27</td>
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</tr>
<tr>
<td></td>
<td>PIN07 Langaton Gardens</td>
<td>25</td>
<td>MEDIUM</td>
</tr>
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<td></td>
<td>NORTH13 Roseland Drive</td>
<td>17</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>NORTH14 Wilton Way</td>
<td>7</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>NORTH07 Polsloe Road North</td>
<td>6</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>NORTH03 King Arthurs Road</td>
<td>6</td>
<td>MEDIUM</td>
</tr>
<tr>
<td></td>
<td>NORTH10 Georges Close</td>
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</tr>
<tr>
<td></td>
<td>PIN04 Pilton Lane</td>
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</tr>
<tr>
<td></td>
<td>NORTH06 Pinhoe Road</td>
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</tr>
<tr>
<td></td>
<td>NORTH05 Woolsery Avenue</td>
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<td>MEDIUM</td>
</tr>
<tr>
<td>Recommended Action or Investigation</td>
<td>Risk Area</td>
<td>Total No. of Properties at Risk (1 in 100 year)</td>
<td>Hazard Rating</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>--------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------</td>
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<td></td>
<td>LONG03 South Street</td>
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<td>NORTH20 Topsham Road East</td>
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<td>NORTH04 Summerway</td>
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<tr>
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<td>LONG02 Exe Street</td>
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<td>PIN03 Thursby Walk</td>
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<td>NORTH02 Rollestone Crescent South</td>
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<td>NORTH09 Whipton Barton Road</td>
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</tr>
<tr>
<td></td>
<td>NORTH12 North Lawn Court</td>
<td>2</td>
<td>LOWER</td>
</tr>
</tbody>
</table>

These Risk Areas have been assessed as having lower levels of risk compared to other Risk Areas. Investigations to test the viability of options here could be considered as part of Phase 3 if there is a benefit in addressing these areas at the same time as adjacent High Priority areas, for example. However, there are likely to be other areas within Devon which would have a higher priority and it may be more beneficial to address the risk in other study areas before focussing upon these.

*Table 5-1 - Exeter SWMP Phase 2 Preliminary Action Plan*