South Tyneside Surface Water Management Plan

South Tyneside

April 2014
Final Report
9Y0387

South Tyneside Council

Royal HaskoningDHV
Enhancing Society Together

HASKONINGDHV UK LIMITED
RIVERS, DELTAS & COASTS

WestOne
114 Wellington Street
Leeds LS1 1BA
United Kingdom
+44 113 3884866 Telephone
Fax
info@leeds.royalhaskoning.com E-mail
www.royalhaskoning.co.uk Internet

Document title	South Tyneside Surface Water Management Plan
Document short title	South Tyneside SWMP
Status	Final Report
Date	April 2014
Project name	South Tyneside SWMP
Project number	9Y0387
Client	South Tyneside
Reference	9Y0387/RR01/303821/Leeds

Drafted by	Emma Beever
Checked by	Granville Davies
Date/initials check	10/04/2014
Approved by	Granville Davies
Date/initials approval	11/04/2014

GLOSSARY

Annual Average Damages (AAD)	The average flood damages that are predicted to occur annually, which could include damages to people, property and the environment.
Annual Exceedence Probability (AEP)	The probability associated with a return period. An event of return period 50 of years has an AEP of 1/50, 0.02 or 2%.
Benefits	Those positive measurable and immeasurable changes that implementation of flood mitigation measures or plans will produce, including damages avoided.
Capping Value	Market value of a property. Inclusion within a cost benefit assessment ensures that property damage cost calculations do not exceed the value of a property.
Catchment	The area contributing flow or runoff to a particular point on a watercourse or within an urban drainage system.
Climate change	Long term variations in weather patterns both natural and as a result of human activity.
Culvert	Covered channel or pipe that forms a watercourse below ground level, or through a raised embankment.
Digital Terrain Model (DTM)	A representation of the ground surface with buildings and vegetation removed. With airborne techniques (e.g. LiDAR – see below) automated filters have been developed which can detect buildings and remove them and fill the gap with interpolated data to create the ground surface representation.
Defra	UK Government department responsible for policy and regulations on the environment, food and rural affairs, including flood risk management.
Depth Damage Assessment	Assessment of the monetary damage value predicted for a property, where increase in damage is correlated to an increase in water depth. Standard national values are used for such assessments, as published in the Multi-Coloured Manual.
Development	The carrying out of building, engineering, mining or other operations in, on, over or under land or the making of any material change in the use of any buildings or other land.
Environment Agency	Government agency charged with the protection of the environment, and with a generally overseeing role relating to flood risk from major watercourses and the coast.

Flood probability	The estimated likelihood of a flood of a given magnitude occurring or being exceeded in any specified time period.
Flood Map for Surface Water	Second edition national surface water flood mapping produced by the Environment Agency.
Flood risk	An expression of the combination of the flood probability and the magnitude of the potential consequences of the flood event.
Flood risk assessment	A study to assess the risk of a site or area flooding, and to assess the impact that any changes or development in the site or area will have on flood risk.
Fluvial Flow	Water contained or flowing within a river or stream.
InfoWorks	Modelling software used to simulate surface water and drainage networks in 2D.
LiDAR	Data set that provides a 3D image of the surface of the earth. LiDAR is the source of data used to create the DTM.
Local Planning Authority	Body responsible for planning and controlling development, through the planning system.
Main River	A watercourse designated on a statutory map of Main rivers, over which the Environment Agency has statutory powers.
National Property Dataset	Part of the National Receptor Database listing the location and details of residential and commercial properties. Produced by the Environment Agency.
National Receptor Database	A collection of risk receptors produced by the Environment Agency including properties (cf. National Property Dataset) and other receptors such as historical sites, sites of environmental interest, critical infrastructure, etc.
Ordinary Watercourse	A watercourse that does not form part of a main river. This includes streams, drains, culverts, and ditches.
Overland Flow	Water flowing over the surface of the land, originating from direct rainfall runoff or other drainage networks (e.g. watercourses or underground drainage) that have exceeded their capacity).
Return Period	The return period of a flood is a measure of its rarity, defined as the average interval in years between occurrences of floods that exceed the flood in question.
Risk	The probability of an event occurring multiplied by the consequence of such an event.
Runoff	Water flow over the ground surface to the drainage system.

Surface Water	Water collected or flowing over the ground not contained within a watercourse. Usually results from heavy rainfall.
Sustainable Drainage Systems (SuDS)	A sequence of management practices and control structures, often referred to as SuDS, designed to drain surface water in a more sustainable manner. Typically, these techniques are used to attenuate rates of runoff from new development sites.
Threshold Level	The lowest level at which water can enter a property (e.g. the height of a doorstep, airbrick or window). These levels are determined from property specific surveys.
Watercourse	Any natural or artificial channel that conveys water.

ABBREVIATIONS

AAD	Average Annual Damages
AEP	Annual Exceedence Probability
AStSWF	Areas Susceptible to Surface Water Flooding
CSO	Combined Sewer Overflow
Defra	Department for Environment Flood and Rural Affairs
FEH	Flood Estimation Handbook
FMfSW	Flood Map for Surface Water
FRR	Flood Risk Regulations
FWMA	Flood and Water Management Act
GIS	Geographical Information System
ICM	Infoworks Combined Model
LiDAR	Light Detecting and Ranging
LLFA	Lead Local Flood Authority
LPA	Local Planning Authority
MCM	Multi Coloured Manual
NRD	National Receptor Database
PFRA	Preliminary Flood Risk Assessment
SAR	Synthetic-Aperture Radar
SFRA	Strategic Flood Risk Assessment
SPRHost	Standard Percentage Runoff (%) HOST
STC	South Tyneside Council
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan

EXECUTIVE SUMMARY

INTRODUCTION

In late 2012 Royal HaskoningDHV was appointed by South Tyneside Council to produce a Surface Water Management Plan (SWMP).

A SWMP 'outlines the preferred surface water management strategy. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall'[1].

This report, which comprises a SWMP for South Tyneside, provides both an overview of the surface water flood risk in the whole of South Tyneside and further information on specific flood hot spots which were investigated in greater detail. The SWMP has been produced with reference to Defra's SWMP guidance,

As Lead Local Flood Authority (LLFA), South Tyneside has led the development of the SWMP. The Environment Agency (EA) and Northumbrian Water Ltd (NWL) have been key partners in the process due to their respective roles in providing a strategic overview of all sources of flooding (EA) and responsibility for sewerage services within the SWMP area (NWL).

RISK ASSESSMENT

Multiple sources and pathways, and the interaction with the sewer network, make the flood mechanisms of surface water flooding complex. To assess the risk from surface water flooding, an integrated catchment model was constructed for the South Tyneside administrative area. This model included both overland flow and the underground sewer network. Flood risk across the area was assessed for a range of rainfall events with different probabilities of occurrence.

Surface water flooding across South Tyneside is found in multiple locations with varying levels of risk and different flood mechanisms. To illustrate the overall level of surface water flood risk in South Tyneside, Table S1 shows the number of properties at risk in two rainfall events modelled for a Do Nothing scenario (a hypothetical scenario to assess the benefits of options) including the risk of climate change and indicates how climate change impacts the number at risk compared to the current scenario. Catchment wide surface water flood maps are included in Appendix B.

The smallest rainfall event modelled for this project had a 3.33% annual exceedance probability (AEP) to reflect the typical design capacity of the sewer network. The sewers were found to surcharge in some locations, which would be expected due to the inconsistent design capacity of an urban sewer system. In several locations flooding was caused. Modelling rainfall events above the design capacity provided information to assist in identifying the risk across the area and consideration for managing the exceedance.

[1] DEFRA Surface Water Management Plan Technical Guidance, March, 2010

Table S1 Number of properties at risk from surface water flooding across South Tyneside

3.33%+CC AEP (1 in 30+CC)		1%+CC AEP (1 in 100+CC)	
No. at risk	Increase	No. at risk	Increase
4904	+924	6394	+887

*Properties have been counted as being at risk when flood depths adjacent to the property are above the assumed property threshold of 150mm.

ASSESSMENT OF OPTIONS

The modelled extents and depths for the study area were assessed. From this, a number of smaller areas were recommended for detailed assessment and consideration of options to reduce surface water flooding. Several recommended areas were already being assessed by project partners (outside the scope of this SWMP), or had been previously assessed and therefore were not progressed. These included Tyne Dock, Hebburn and Boldon. The areas considered for option assessment are included in the Table S2 with a summary of their flood mechanisms and the number of properties at risk within each area.

Table S2 Summary of detailed areas considered within the SWMP

Location	Flood Mechanisms	Total properties at risk in rainfall event			
		3.33% +CC AEP (1 in 30+cc)		1% + CC AEP (1 in 100+cc)	
		No. at risk	Increase from current	No. at risk	Increase from current
Cleadon Lea	• Surface water runoff from agricultural fields to the north. • Storm sewers which take some field run off are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced in Cleadon Lea during a 3.33% AEP event and lower probability events.	34	+16	45	+17
Cleadon Sunderland Road	• Surface water run-off from agricultural fields to the north east. • Combined sewers in the vicinity down Whitburn Road and Sunderland Road are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced during a 3.33% AEP event.	22	+4	37	+9
Fellgate	• Surface water runoff from agricultural fields to the south. • Storm water sewers in the east of the area are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced in Fellgate during a 3.33% AEP event and lower probability events.	24	+14	60	+19
Lindisfarne roundabout	• Flooding at Lindisfarne roundabout occurs from a combination of sources; discharge of several highway drains at this location which are overwhelmed and surface water down the road. • Combined sewers discharging in the south eastern area are overwhelmed in the smallest flood event modelled	18	+4	36	+18

Location	Flood Mechanisms	Total properties at risk in rainfall event			
		3.33% +CC AEP (1 in 30+cc)		1% + CC AEP (1 in 100+cc)	
		No. at risk	Increase from current	No. at risk	Increase from current
	(3.33% AEP) with flooding experienced during this and lower probability events.				
New Market Walk	• Flooding is due to surface water runoff and discharge of the sewers which are overwhelmed in the smallest flood event modelled (3.33% AEP). • Surface water flood risk primarily at two points within the area; along the eastern edge of the railway and south of Chichester Road.	91	+21	113	+24

A long list of surface water management measures was considered for each area and the most suitable measures were used to create options to reduce surface water flood risk. A multi-criteria assessment was carried out to compare each of the options. The criteria used included: environmental impacts, sustainability, costs and technical feasibility. Shortlisted options were tested for effectiveness within the hydraulic model. The outputs from the model were used to provide information on residual risks and to assist with outline estimate costs.

ACTION PLAN

The option assessment outputs have been used to identify an action plan to manage surface water. This plan includes the areas assessed in greater detail in the SWMP and those areas that being investigated outside the scope of the SWMP. However, even beyond these two groups, there are other areas of surface water flood risk across South Tyneside with varying levels of risk and different flood mechanisms. This plan therefore identifies both specific actions to address the areas assessed in detail, as well as catchment wide actions that can improve sustainable surface water flood risk management within the District. The council and other stakeholders should consider these wider actions when undertaking activities. This could:

- Contribute to flood risk being managed through the cumulative benefit of numerous smaller measures.
- Achieve efficiencies and cost savings through incorporating surface water management measures into other works (e.g. development modification, highway maintenance)
- Assist in the adaptation to the potential increase in risk from the effects of climate change through combining flood risk management measures into other works and activities.

CONTENTS

APPENDICES

A Modelling Memo
B Catchment Wide Flood Maps
C Hot Spot Overview
- C1 Fellgate
- C2 Cleadon Lea Overview
- C3 Sunderland Road Overview
- C4 Lindisfarne Roundabout
- C5 New Market Walk
- C6 King George

1 INTRODUCTION

1.1 General Overview and Study Area

Royal HaskoningDHV was appointed by South Tyneside Council in late 2012 to produce a Surface Water Management Plan (SWMP). This report details the work undertaken which has been carried out with reference to Defra's latest SWMP guidance[2].

The borough of South Tyneside is located on the south bank of the River Tyne extending from the mouth of the River Tyne at South Shields, west to Gateshead. To the south the borough is bordered by the City of Sunderland and to the east by the North Sea. The SWMP covers the whole district of South Tyneside Council, a total area of $64km^2$. The study area is outlined in red in Figure 2, with key watercourses within the study area highlighted in blue[3]. The topography of the study area is shown in Figure 3.

1.2 What is a Surface Water Management Plan?

The SWMP technical guidance[2] states that a SWMP is:

'a plan which outlines the preferred surface water management strategy in a given location. In this context surface water flooding describes flooding from sewers, drains, groundwater, and runoff from land, small watercourses and ditches that occurs as a result of heavy rainfall'.

The SWMP provides a framework in which different organisations responsible for surface water management and drainage in a defined area work together to develop a shared understanding of the problems and most suitable solutions. By delivering a co-ordinated action plan, supported by an understanding of the costs and benefits, the SWMP will provide partners with the information to continue to work together to identify measures to mitigate flooding from surface water in the long term.

The SWMP can be used to help the council meet the requirements of the Flood Risk Regulations (2009) and their responsibilities under the Flood and Water Management Act 2010. The SWMP outputs can also be used to inform stakeholders within the council and assist with wider future plans (e.g. planning new development), as well as assisting with public engagement to improve the understanding of the risks of surface water flooding.

There are four phases of a SWMP, as listed below and illustrated in Figure 1:

- Phase 1 – Preparation: preparing and scoping the study requirements, identifying partners and stakeholders to be involved.
- Phase 2 – Risk Assessment: identifying the level of risk from surface water flooding within the study area.
- Phase 3 – Options, considering options to reduce the risk from surface water flooding.

[2] DEFRA Surface Water Management Plan Technical Guidance, March, 2010
[3] The larger sections of culverted watercourses are identified on the figure.

- Phase 4 – Implementation and Review: preparing to implement the strategy, delivering and monitoring actions.

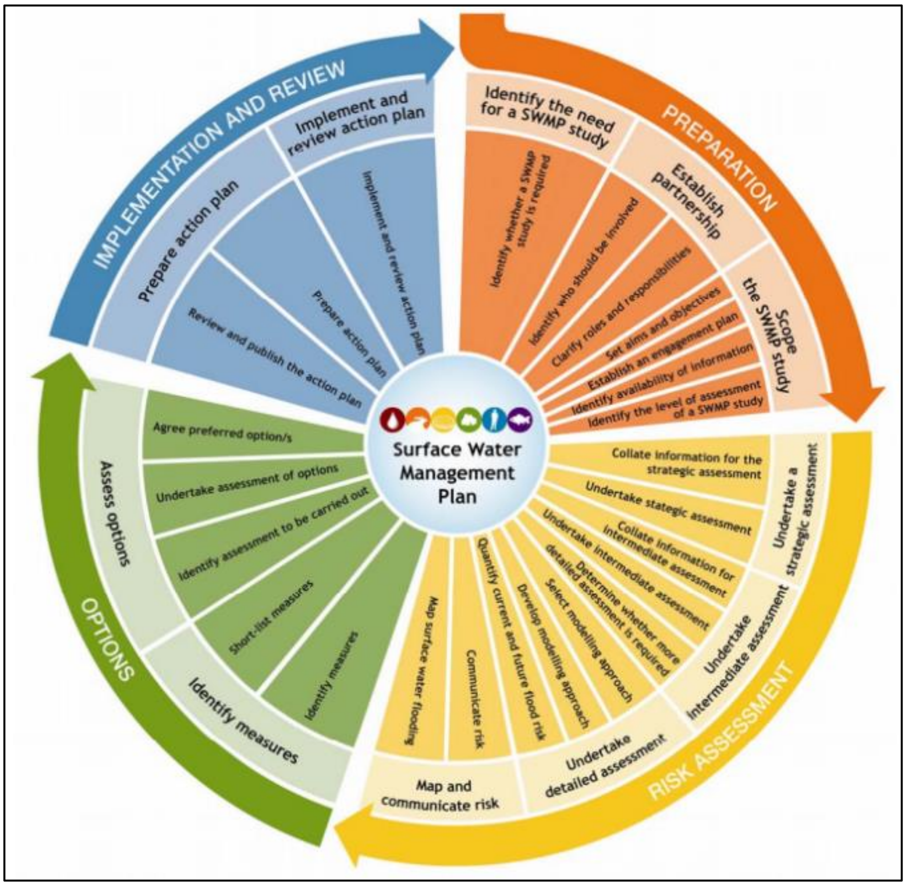
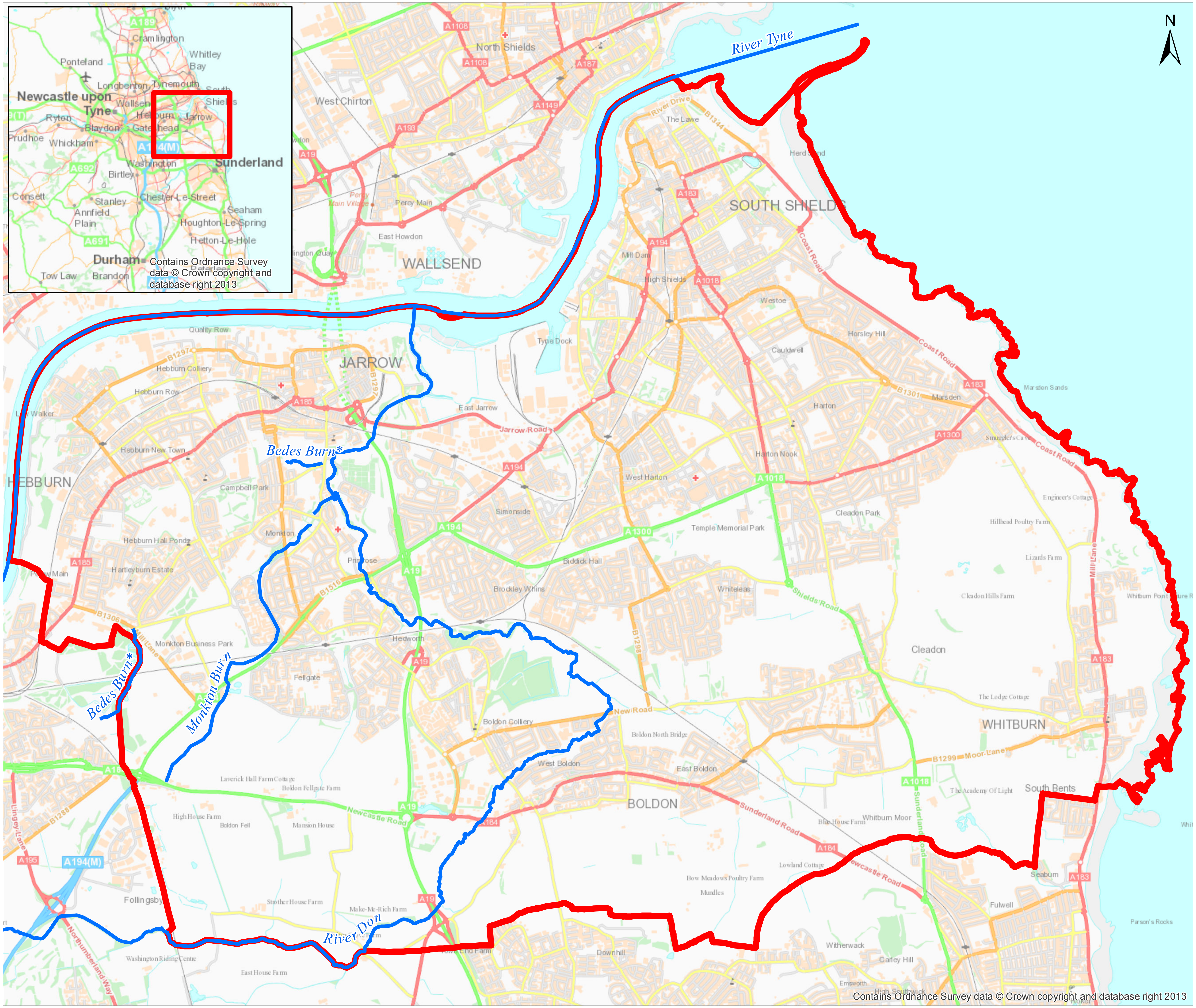


Figure 1 SWMP Framework

1.3 Need for a South Tyneside SWMP

The risk of surface water flooding in South Tyneside was most recently highlighted by significant storm events on both 28th June and 5th August 2012, when heavy rainfall caused flooding to residential and commercial properties across the area. There was also flooding and closure of major strategic transport routes. A flood incident report[4] was prepared by South Tyneside Council as part of their responsibilities under the Flood and Water Management Act 2010. Undertaking a borough-wide SWMP was highlighted as a key immediate action in order to identify the causes and consequences of potential future events.

[4] Flooding Events; Interim Report, South Tyneside Council, 2012.



Legend

- South Tyneside Council
- Study Watercourse

*Bedes Burn is culverted in part

Title

Study Area

Project

South Tyneside SWMP

Client

South Tyneside Council

Date	Scale
08/10/2013	1:35000

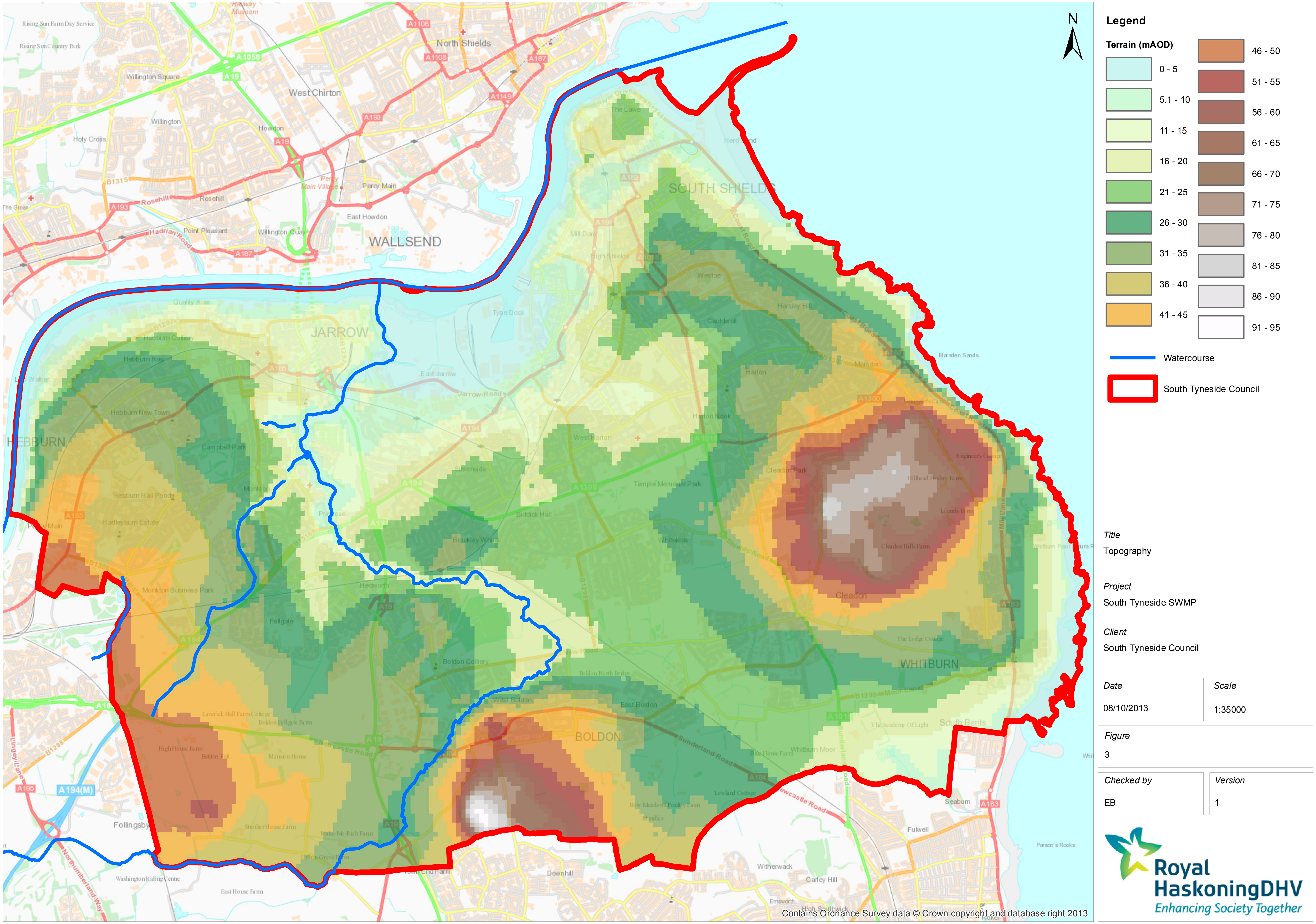
Figure

2

Checked by	Version
EB	1

Royal HaskoningDHV
Enhancing Society Together

Path: C:\1.Projects\9Y0387 - SWMP\Projects\Figures\Report Figures\Figure 2 - Study Area.mxd



Title
Topography

Project
South Tyneside SWMP

Client
South Tyneside Council

Date	*Scale*
08/10/2013	1:35000

Figure
3

Checked by	*Version*
EB	1

Royal HaskoningDHV
Enhancing Society Together

Path: C:\1.Projects\9Y0387 - SWMP\Projects\Report Figures\Figure 3 - Topography.mxd

2 PREPARATION

2.1 Establishing a Partnership

2.1.1 Identification of Partners

Other organisations with responsibility for surface water were identified as key partners to form the steering group for this SWMP. The partnership was established at the outset of work to prepare the SWMP and involves:

- South Tyneside Council (Development Services) – Lead
- Environment Agency
- Northumbrian Water Ltd

2.1.2 Roles and Responsibilities

As part of their local flood risk management responsibilities as the Lead Local Flood Authority (LLFA), South Tyneside Council (STC) has led preparation of the SWMP. The Environment Agency (EA) has a strategic overview role for all sources of flooding and is therefore a key partner in supporting the SWMP process. Northumbrian Water Ltd (NWL) has responsibility for sewerage services within the SWMP area and is therefore a key partner due to the complex nature of surface water flooding, the multiple sources and pathways, and the interaction between surface water flooding issues and the sewer network.

During the initial meeting the partners established clear responsibilities for their involvement in the SWMP.

- Provide and share data where requested in order to carry out the SWMP;
- Actively and openly cooperate in the delivery of the SWMP;
- Continue to work together to achieve the action plan which will form part of the SWMP.

2.2 Objectives of SWMP

Following establishment of the partnership, the overarching aims and objectives of the SWMP were discussed at the outset, and agreed as follows:

- Identify mechanisms and areas of surface water flooding within South Tyneside;
- Identify opportunities to manage surface water within the high risk areas;
- Identify potential flood risk areas and additional opportunities to reduce surface water flood risk as a result of climate change and future development;
- Identify high risk areas within the study area and schemes or mitigation measures to reduce surface water flood risk in these areas;

It was also agreed that site specific objectives would be considered during the relevant phases.

2.3 Previous Studies

STC has carried out several previous studies which included some consideration of surface water flooding. These have been reviewed and are detailed below to assist in developing the scope of the SWMP and work required to carry out the intermediate assessment.

2.3.1 Strategic Flood Risk Assessment (2010)[5]

Local planning authorities (LPAs) carry out Strategic Flood Risk Assessments (SFRAs) to provide sufficient detail on flood risk to inform spatial planning decisions. They are a central source of relevant flood risk information for the LPA. For the South Tyneside SFRA, the national dataset from the Environment Agency, Areas Susceptible to Surface Water Flooding (AStSWF), was used to consider surface water flood risk. This map is based on a 0.5% AEP (1 in 200) rainfall event and includes an allowance for the capacity of the sewers; it categorises the vulnerability of flooding into three bands. The SFRA identified Critical Drainage Areas across the South Tyneside area and recommended these areas were a starting point for further assessment within a SWMP.

2.3.2 Preliminary Flood Risk Assessment (2011)[6]

The PFRA considered past and potential future flood risk across the administrative area from all local sources of flooding: surface water, ground water, and ordinary watercourses. The report collated evidence of 152 historic flooding events, varying in impact and significance. The recorded events had many different reporting mechanisms, and acknowledged that on a local level these were significant to those communities affected. However, the level of local flood risk within South Tyneside was not considered to be nationally significant, and no areas were assessed as meeting the indicative flood risk area thresholds, as defined by the national criteria produced by Defra. Collating the historical data for the PFRA highlighted the limited detail to which surface water flooding has been recorded across South Tyneside, particularly information relating to the extent and depth of floods. The different departments within the council also have varied arrangements for recording incidents.

The Environment Agency national datasets were assessed within the PFRA. This included the Areas Susceptible to Surface Water Flooding (AStSWF) and Flood Map for Surface Water (FMfSW). It was recognised that the Flood Map for Surface Water is more representative of surface water flood risk within South Tyneside. The maps give a general indication of the broad areas at risk, although are not suitable for identifying whether individual properties are at risk. The two datasets were used to estimate the number of properties at risk. For a rainfall event with a 0.5% (1 in 200) chance of occurring, approximately 4000 residential and 100 businesses were estimated to be at risk from flooding to a depth of 0.3m.

[5] South Tyneside Council (2010) Strategic Flood Risk Assessment; Level 1 and 2
[6] South Tyneside Council(2011) Preliminary Flood Risk Assessment

3 RISK ASSESSMENT

3.1 Data Collection and Collation

3.1.1 Initial data collected

The basis of the strategic assessment for this SWMP was information included in the PFRA which was carried out to fulfil South Tyneside Council's responsibilities under Section 10 of the Flood Risk Regulations (2009). Supplementary data was collected from partners initially to verify the scope of the SWMP.

Review of the PFRA and data from the more recent events of 2012 highlighted that flood incidents were spread throughout the borough. Therefore it was identified that there was a need for an enhanced understanding (intermediate assessment) of local surface water flooding issues across the whole area. Table 1 shows the datasets which were utilised as part of this study, along with details of the source of the data.

Table 1 Datasets used

Dataset	Source	Use
EA Surface Water Maps	EA	To flag up key areas at risk based on National mapping.
OS Mapping & Mastermap data	STC	To provide background information and input to the model
Locations & details where available of historic flood incidents	STC	Used to verify the model results.
LIDAR (Light Detection and Ranging)	EA	To provide details of the topography of the area for review and input into the hydraulic model
Locations of Environmental Designations	Website download	Information within the Environment Agency's National Receptor Database to highlight any potential damage to environmental designations.
Schematics and models of sewer networks	NWL	To determine the drainage capacity of the system
Geology data	BGS	This data was downloaded for the UK from the BGS website to give an indication of the underlying geology of the study area and therefore some context to the flood risk areas shown.

3.1.2 Data Gaps and Limitations

In order to progress to an intermediate assessment across the area, the quality of existing data was established, as well as gaps in the available data. The key data collected which could be used within the modelling within the SWMP is included in Table 2**.** A quality rating in line with the system from the Multi Coloured Manual[7] was assigned to each data item. The data quality scores range from 1 (Best Possible) to 4 (Heroic Assumptions). Initial data collected with a score of 3 or 4 was reviewed with additional (better quality) data being sought where possible.

[7] Flood Hazard Research Centre (2010) Multi-Coloured Manual

Table 2 Data and Quality Scores

Data Name	Description	Initial Quality Score	Comment/Limitation	Additional data	New Quality Score
LiDAR	Filtered and unfiltered	3	Where there was 1m or 2m LiDAR (approximately 60% of the area) we would be confident with the model outputs and the uses required, however areas were missing. 5m SAR was available, however this creates limitations in identifying overland flow pathways.	1m Lidar sought and collected for the whole area.	1
InfoWorks Combined Model	Model of: -Hebburn; - Jarrow/ Hedworth - Westoe	1	The models were used as the basis of the ICM model, sewers outside these areas would be added from the coarse model	N/A – Consider if further models necessary in detailed modelling phase.	1
NWL Asset Data	Sewer Network	2	Data used to create a coarse sewer model where ICM model is not available; reduces the quality of the outputs in these areas	Consider if models available at detailed assessment stage.	2
Culverts	Culvert information (photos, invert levels dimensions)	4	No information was available on culvert sizes; assumptions would need tob e made and therefore constrictions would be unknown.	Survey carried out to collect required culvert information	1

3.2 Modelling Overview

3.2.1 Introduction

A hydraulic model was constructed by Richard Allitt Associates (RAA), using Infoworks Integrated Catchment Modelling (ICM) software. The model covered the whole South Tyneside administrative area. The model was constructed to include overland flow and the underground sewer network.

3.2.2 Model Runs

The model was run for the following rainfall events:

- 3.33% AEP (1 in 30 chance of flooding in any given year)
- 1.3% AEP (1 in 75 chance of flooding in any given year)
- 1% AEP (1 in 100 chance of flooding in any given year)
- 0.5% AEP (1 in 200 chance of flooding in any given year)

In addition, sensitivity to climate change was assessed by running each of the above return periods with peak rainfall intensity increased by 20%.

3.2.3 Rainfall

A volume of rainfall was assigned across the watershed using the FEH rainfall runoff volume method and the model was run for a range of storm durations. Surface water flood events tend to result from shorter rainfall events and fluvial events tend to be linked to longer rainfall events. Storm durations of 60, 120, 180, 240 and 300 minutes were run for each of the return periods to identify the critical duration of storm. In the majority of areas the 240 storm duration was identified to be the critical duration by having the greatest flood extent, in the longer storm durations the flood risk began to decrease.

3.3 Intermediate Modelling

3.3.1 Overview

The intermediate model covered the whole South Tyneside area. The model was constructed using the best available information, including:

- Lidar
- Mastermap
- NWL sewer models covering; Hebburn, Jarrow/ Hedworth, Westoe.
- NWL sewer network schematic
- River Don cross sections
- Culvert Information (2013 survey)

3.3.2 Overland Flow

The surface topography was represented in the InfoWorks model as a triangular mesh to reflect the required level of detail of the land surface. In rural areas the mesh was larger, to reduce model run-time, whereas in the urban areas the mesh was smaller, to allow for better representation of the roads and drainage pathways.

LiDAR was collated, ensuring coverage of the whole area. A LiDAR resolution of 1m was selected to ensure detailed representation of topography, including road networks, railway embankments, bridges and underpasses. Mastermap data was then used in the urban area to represent the footprint of the buildings. The footprints of the buildings were raised by 300mm to force the surface water to flow around the buildings. Information for culverts under roads or through embankments was included where available to represent these flow routes.

3.3.3 Fluvial Flows

The larger ordinary watercourses were defined within the model to represent routes of surface water flow. No pre-existing fluvial models were provided for the watercourses within the catchment. However sections of Monkton Burn and Bede's Burn were represented with the Hebburn Infoworks model which was included with the overall model. Survey data for the River Don was also used to represent this watercourse where available; where no information was available LiDAR was used to extract approximate cross sections.

The watercourses receive outfalls from the sewer network, in addition to surface water runoff entering along the length of their banks. If flows exceeded the capacity of the watercourses, the water overtopped the banks and was routed back into the surface mesh.

3.3.4 Underground Drainage

NWL is the sewerage undertaker for the whole of South Tyneside. Where NWL's latest models were available these were incorporated into the integrated surface model. The model enabled surface water flows to flow in and out of the sewerage network; into the network where there is capacity and leaving at the outfall locations and manholes. Where sewer models were not available, the sewer network was represented more simply using the schematic of the network with no detail on invert levels.

Highway gullies were not included within the intermediate modelling stage, due to the scale of the intermediate model which assessed the whole South Tyneside area.

3.3.5 Assumptions and Limitations

Due to the large area that the model covered and time limitations associated with model runs, there are some limitations to the outputs which must be appreciated when interpreting the results.

Intermediate modelling assumptions and limitation

- Houses are represented in blocks within the model and raised; therefore flow routes between individual houses are not represented.
- The flood map shows no properties directly within the flood extents where depths are less than 300mm.as the properties were raised within the model to identify flow paths
- Roads and pavement kerbs have not been included.
- Garden walls, fences and gates have not been included.
- Where channel survey was not available, watercourses have been represented by taking cross sections from the LiDAR.
- Highway gullies were not included in the whole area model.
- Model verification is limited due to the level of historic information available.
- Where culverts could not be accessed during the survey, a number of assumptions have been made regarding culvert sizes.
- Where NWL models were not available, the sewers have been manually added with assumed invert levels and therefore have not been verified by NWL.

3.3.6 Model Verification

Verification of the modelling outputs was undertaken using known historical flooding locations. Many of the historical flooding points correlated well with the modelled flood outlines. Where discrepancies existed they were considered likely to be attributable to the lack of detail included within the model including river cross sections, hydrology, highway drainage, curbs and garden walls. The addition of these assets could provide barriers to flows, altering the flow routes.

3.3.7 Model Outputs

Model outputs for the South Tyneside area were produced to highlight extents of flood risk, depth of flooding and hazard. Appendix B includes the flood extent outputs and hazard mapping. Flood hazard is based on the depths and velocities of flooding and is split into three categories[8]: Danger for some, Danger for most and Danger for all.

The number of properties identified as being at risk of surface water flooding is included in Section 3.6.2. The properties at risk are spread across the area in small localised areas of flooding as shown in the flood maps in Appendix B.

In addition to properties flooding, surface water also causes disruption to the transport routes across the area. The intermediate level flood maps indicate the following sections of major road are at greatest risk:

- The A1 from south of the Lindisfarne junction to the Newcastle road junction
- The A194 roundabout with Temple Road along the edge of the Tyne docks to the A185
- The A184 Sunderland Road into Boldon.
- The A1018 Newcastle Road/Sunderland Road, joining the B1299.

3.4 Identification of Hot Spots

3.4.1 Identification and prioritisation

The modelling extents and depths for the study area were assessed and a number of smaller areas were recommended for further detailed assessment. The areas were discussed between the partners and an agreed prioritised list of areas was drawn up for further assessment within the scope of the SWMP. Table 3 summarises the areas considered. Those areas taken forward to detailed assessment are highlighted in blue. Figure 4 shows the location of these areas within the South Tyneside district.

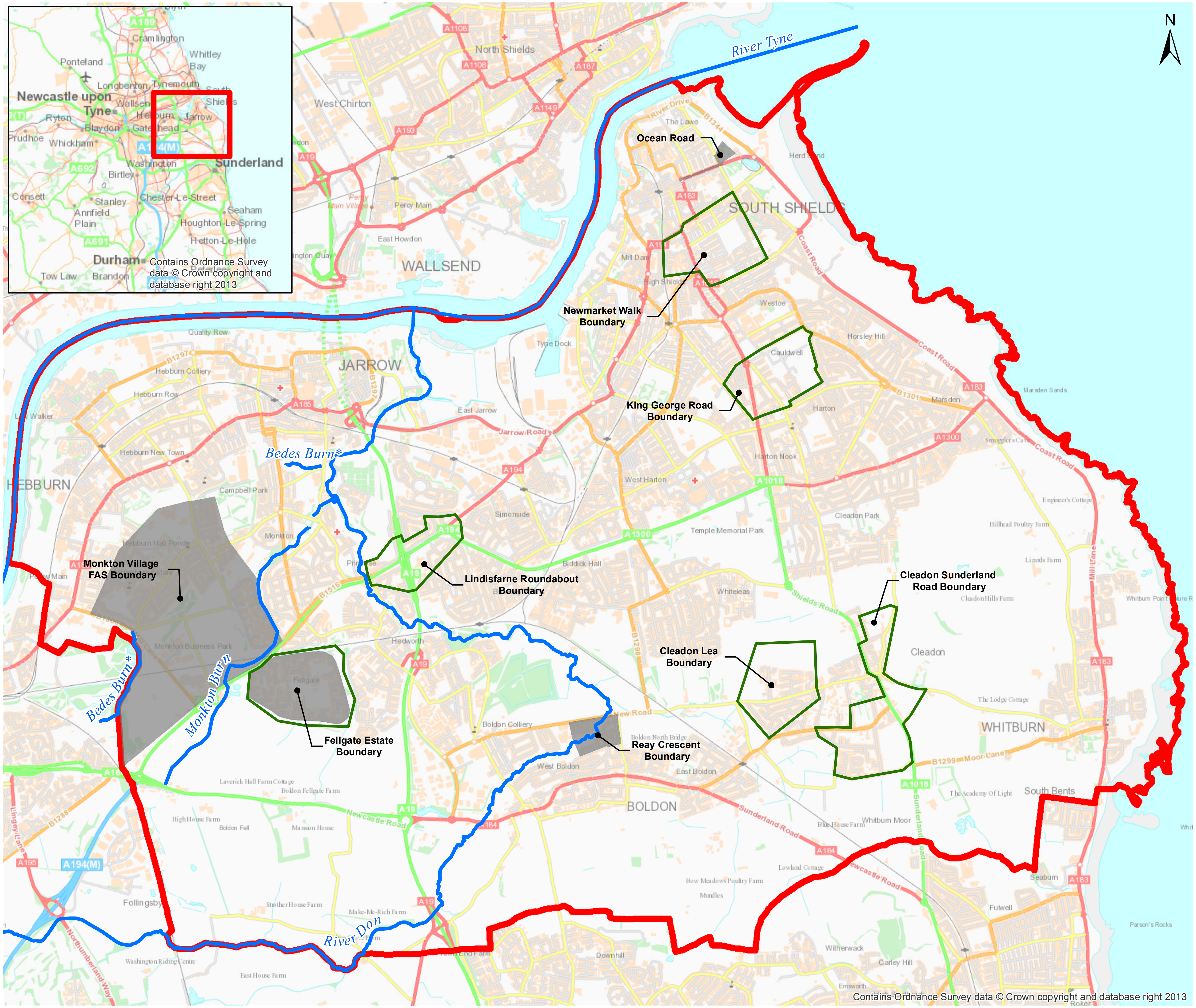
Some areas are already being assessed by the partners in more detail outside the scope of the SWMP, the progress and outputs of these studies will be considered when drafting the action plan.

[8] Defra and Environment Agency Flood and Coastal R&D Programme (2006). Flood Risks to People – Phase 2, FD2321/TR2, Guidance document, available at http://www.rpaltd.co.uk /documents/J429-RiskstoPeoplePh2-Guidance.pdf

Table 3 Areas considered and taken forward for detailed assessment

Area	Summary	Detailed Assessment?
Cleadon Lea	Located in west Cleadon, the intermediate modelling results were supported by evidence of sand bags on sites in addition to the historic flooding records. The partners recommended the area was taken forward for detailed assessment.	Included within SWMP
Cleadon Sunderland Road	The area is located from north east of Sunderland Road at Cleadon, across Whitburn Road to the south west of Cleadon. Although no records of historic flooding had been provided to Royal HaskoningDHV, the partners highlighted there had been historic flooding in the area. The partners recommended the area was taken forward to detailed assessment.	Included within SWMP
Boldon	Located mainly around Reay Cresent in Boldon. The partners; EA, STC and NWL highlighted that they are considering works within the area to reduce flood risk and therefore the area was not taken forward to detailed assessment.	Already being considered outside SWMP
Hedworth	Located between Leam Lane (A194) and the A19 around the River Don. The intermediate modelling results had not matched the suggestions of flood issues from residents during a site visit. However the partners were not aware of historical flooding in the area and it was recommended this area was not taken to detailed assessment within the scope of the SWMP.	Not taken to Detailed Assessment
Tyne Dock	Located between Jarrow Road and Newcastle Road roundabout in the west to Temple Town road in the east. There have been historical records of flooding in the area, however the partners highlighted that a study to reduce flood risk in the area has previously been carried out by NWL. Individual property protection measures have been installed to some properties. It was therefore decided not to prioritise this area for further detailed assessment.	Considered in detail prior to SWMP development
Hebburn	Located from Mill Lane in the south west of Hebburn to Campbell Park in the north east of Hebburn. There are records of historic flooding across the area, however NWL highlighted the area is already being considered within their Hebburn sustainable sewerage study, with STC a key partner. Therefore it was recommended it was not necessary to take forward the area to detailed assessment within the SWMP study.	Already being considered outside SWMP
Fellgate	Located south of Leam Lane and the metro line. The intermediate modelling results were supported by historic flood records; there were also numerous sand bags during the site visit providing evidence of recent flooding issues. The partners recommended the area was taken forward to detailed assessment.	Included within SWMP

Area	Summary	Detailed Assessment?
Lindisfarne Roundabout	Located across the Leam Lane (A194)/ A19 junction, east to the Leam Lane/ John Reid roundabout. The area is considered a strategic transport route and through discussion with wider stakeholders within STC, it was recommended the area was taken forward to detailed assessment.	Included within SWMP
Kings George Road	Located west of the Harton cemetery, south of Caudwell Avenue covering King Georges Road (A1018). The area is a key north to south access route across South Tyneside. The partners recommended the area was taken forward for detailed assessment.	Included within SWMP
Newmarket Walk, South Shields	Located between Westoe Road and the metro line, from Crossgate Road (A194) in to the north to just south of Chichester Road in the south. Although there are no historic records of flooding in the area, the intermediate modelling highlighted an area of significant risk and therefore it was recommended the area was taken forward to detailed assessment.	Included within SWMP



Legend

- Study Watercourse
- Detailed Assessment Within SWMP Study
- Detailed Assessment Outside SWMP Study
- South Tyneside Council

*Bedes Burn is culverted in part

Title
Hot Spots Considered

Project
South Tyneside SWMP

Client
South Tyneside Council

Date	*Scale*
02/12/2013	1:35000

Figure
4

Checked by	*Version*
EB	1

Royal HaskoningDHV
Enhancing Society Together

Path: L:\Sites\UK-Peterborough\Projects\9Y0387\Technical_Data\T5_GIS\Projects\Figures\Figure 4 - Hot Spots Considered.mxd

3.5 Detailed Modelling

3.5.1 Detailed modelling refinements

The six areas highlighted in Table3 were taken forward to detailed modelling. Within each area the model was refined to more accurately represent the surface water flood risk. A summary of the model refinements is given below; further detail is included in Appendix A.

Individual buildings were cut out of the DTM as voids to ensure that flow paths between the buildings and depths against building were observed. The mastermap data was used to lower the roads within the mesh zones of the DTM by 125mm to represent the flow paths. Manholes within the roads were also lowered to match the road level, allowing flows to enter the sewer where appropriate.

Walls and fences along the main flow routes identified in the intermediate modelling were added into the DTM. This ensures a more accurate representation of true flow paths. The detail of walls and fences was taken from site visits, photos and Google maps.

Gullies were represented within the detailed modelling for Cleadon Sunderland Road Lindisfarne and Newmarket Walk where highway flooding was more significant or flows surface water from the highway was contributing to the overall flood risk. Their operation was dependent on the model run; in Do Nothing the gullies were modelled as blocked, whilst for the Do Minimum model the gullies were operating.

Recently constructed sewer models for the Cleadon area were provided at the detailed modelling stage. The model covered the Cleadon Lea and Cleadon Sunderland Road area; this provided a more accurate representation of the sewers in these areas.

The Newmarket model was the only area without an NWL sewer model; therefore the intermediate stage sewer model was used. As a result there were no subcatchments included in the model to contribute flows and as a result the buildings were modelled as in the intermediate phase; raising them by 300mm rather than as voids. This ensured the buildings contributed runoff to the 2D mesh.

3.5.2 Hydrology

The hydrology was updated for the detailed modelling to reflect the specific catchment the individual areas were located within rather than the wider South Tyneside area. The 2D zones for each of the smaller models was drawn ensuring all the catchment contributing to the area was included to ensure flows were not underestimated. The rainfall parameters for each of the areas were chosen to reflect the historical data in the area, using information from FEH. Where there were watercourses present in the detailed areas FEH was used to provide the inflow hydrograph data for the head of the watercourse.

FEH was also used to extract the SPRHost value for each area which was used to generate rainfall and takes into account some aspects such as infiltration.

3.5.3 Model verification

The individual models with a higher level of detail were verified using records from the 2012 events and site visit observations of sandbags highlighting the potential flow paths. There were no photos for the Newmarket Walk to verify the model at this location.

3.6 Quantifying Current Risk

3.6.1 Overview

The current risk due to surface water flooding within each of the areas was quantified following guidance within the Flood and Coastal Erosion Risk Management Guidance[9] (FCERM-AG). Damages to people and property were estimated using water depth data from the model which was used to estimate depth-damage curves through use of the Multi-Coloured Manual[10]. Limitations to the approach are summarised below.

Limitations of the depth-damage calculations

- The approach is considered to provide the best representation of damage to properties, however depth-damage curves are known to be highly sensitive to low depth predictions.
- The calculation of damages is limited to property information available through the use of the National Receptor Database (NRD) provided by the Environment Agency.
- No threshold surveys were available, therefore a generic threshold was applied to all properties to ensure the estimate of damages were not too conservative.
- The depth data to calculate damages were assessed over a generic area within each of the areas of interest to give a rough guide to the damages available. The depth damage calculations carried out in Phase 3 of the SWMP for the cost-benefit assessment of mitigation options will allow the reduction in damages to be assessed.

3.6.2 Damages to property

The National Receptor Database (NRD) was used to identify the commercial and residential property points in each of the modelled areas. Water levels were then extracted for each of the property points for each of the modelled rainfall events. As the buildings had been represented as voids within the model, the flood water was only showing against the buildings, therefore the greatest water levels within 10m of the property points were extracted. The depth data for each property was used to calculate property damages.

No threshold data was available; therefore a generic threshold elevation of 150mm above surrounding ground level was used to limit the number of properties contributing the count of the number of properties at risk. It should be noted, however, that water

[9] Environment Agency (2010) Flood and Coastal Erosion Risk Management Guidance
[10] Flood and Hazard Research Centre (2010) Multi Coloured Manual.

levels below the threshold do contribute damages to the total value. Damages below the threshold reflect damages to space below floorboards, basements, gardens, and foundations which accumulate over time.

Damage to residential property was calculated using the MCM 2010 depth-damage data, accounting for depth of flooding and property type such as detached, semi-detached and terraced. The inclusion of social class and a social weighting was considered too detailed for this settlement wide assessment. Damage to commercial property was included through identification of use and floor area from the NRD (e.g. office, warehouse, retail) and comparison with the appropriate MCM depth-damage data. The numbers of properties for the Do Nothing scenario across the South Tyneside borough (operation of existing assets) are summarised in Table 4. The Do Nothing scenario is a hypothetical scenario which is assessed to allow the benefits of any options to be considered against. The scenario modelled is considered the Do Nothing as no road gullies were included. The number of properties at risk within in each area identified in Section 3.4.1 are included within the appendices reports.

Indirect damages for residential and commercial properties were also calculated in line with the MCM guidance to account for costs incurred during post flood recovery (i.e. temporary accommodation, additional heating and electricity to dry out properties).

The damages were capped at the market value of the properties. Residential market values were based on average property values according to type (i.e. detached, semi, terraced) for the Tyne and Wear region taken from Land Registry for May 2013. The rateable value for commercial properties was derived using their floor areas and the average rateable value per m^2 for their bulk class, from the Commercial and Industrial Floorspace and Rateable Value Statistics for the region. The market value of commercial properties is the multiplication of the rateable value by ten.

Table 4 Number of residential properties at risk in Do Nothing scenario

Total properties at risk in each rainfall event			
3.33% AEP (1 in 30)	1.33% AEP (1 in 75)	1% AEP (1 in 100)	0.5% AEP (1 in 200)
3980	5408	5507	6104

*Properties have been counted as being at risk when flood depths adjacent to the property are above the assumed property threshold of 150mm.

3.6.3 Damages to People

The impacts of flooding on householders include stress, health effects and the loss of possessions. The following two components were considered to calculate damages to health:

- Stress-related impacts – As per the MCM, an allowance of £200 for flooding per year per household has been included in the AAD calculations to account for stress related impacts.
- Loss of life and injury – As water velocities and depths are generally fairly low across the areas, it was not considered necessary to include an allowance of the damage calculation for the loss of life or injury.

3.6.4 Damages to the Environment

Surface water runoff from the urban environment can have a significant impact on receiving water quality, especially where the flood waters interact with the sewer network. However consideration of damages to the environment has not been included within the high level calculations at this stage.

3.6.5 Annual Average Damages and Potential Value Damages

The methodology for calculating Annual Average Damages (AAD) utilises the information obtained from all modelled flood events. The AAD for each of the areas is summarised in Table 5. The AAD includes residential and commercial property damage.

The AAD was used to calculate the Present Value (PV) Damages over the long term; an appraisal period of 100 years was used. The AAD is discounted in line with current guidance from the HM Treasury "Green Book", starting at 3.5% and reducing to 2.5%. The PV Damages include an uplift for the cost of emergency services, local authorities, and the Environment Agency for responding to floods. An uplift of 5.6% was applied in line with the MCM 2010 guidance for urban areas. The damage data has been uplifted using the Consumer Price Index to give a base date of July 2013 for the PV Damages.

The PV Damages for each of the areas where detailed assessment was carried out is also shown in Table 5.

Table 5 AAD Calculations for Do Nothing Flood Risk Scenarios

	AAD	Property PV Damages
Cleadon Lea	£90k	£3,221k
Cleadon Sunderland Road	£153k	£3,374k
Fellgate	£86k	£3,131k
Lindisfarne	£194k	£5,577k
Kings George Road	£12k	£448k
Newmarket Walk	£650k	£21,336k

3.7 Quantifying Future Flood Risk

Table 6 identifies the total number of properties (residential and commercial) at risk in each of the areas at risk in a Do Nothing scenario when an allowance is made for Climate Change. The table also identifies the increase in properties at risk compared to the existing rainfall events. For the individual areas with more detailed assessment made there are substantial increases in properties at significant risk at Fellgate, Cleadon Lea and Newmarket Walk.

Table 6 Number of properties at risk across borough with Climate Change Flows

Total properties at risk in each rainfall event							
3.33%+CC AEP (1 in 30+CC)		1.33%+CC AEP (1 in 75+CC)		1%+CC AEP (1 in 100+CC)		0.5%+CC AEP (1 in 200+CC)	
No. at risk	Increase	No. at risk	Increase	No. at risk	Increase	No. at risk	Increase
4904	+924	5983	+575	6394	+887	7469	+1365

*Properties have been counted as being at risk when flood depths adjacent to the property are above the assumed property threshold of 150mm.

3.8 Map Flood Risk

Mapping has been provided to the steering group in the form of shapefiles and interactive pdfs to show the following across the whole South Tyneside study area, using the intermediate modelling outputs:

- The extent of the modelled flooding for each model scenario, including the climate change scenarios
- The predicted depth of flooding
- The associated hazard.

The detailed modelling carried out for the more localised areas is embedded within the overall study area outputs. Details of each of the detailed assessment areas are included within Appendix C; a summary of the flood mechanisms within each of these areas is in Table7.

Table 7 Summary of flood mechanisms

Detailed Area	Summary of flood mechanisms*
Cleadon Lea	• Surface water runoff from agricultural fields to the north. • Storm sewers which take some of the field run off are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced in Cleadon Lea during a 3.33% AEP event and lower probability events.
Cleadon Sunderland Road	• Surface water run-off from agricultural fields to the north east. • Combined sewers in the vicinity down Whitburn Road and Sunderland Road are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced during a 3.33% AEP event , although flooding is more significant at the 1.33% AEP and lower probability events (particularly when considering the effects of climate change).
Fellgate	• Surface water runoff from agricultural fields to the south. • Storm water sewers in the east of the area are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced in Fellgate during a 3.33% AEP event and lower probability events.
Lindisfarne Roundabout	• Flooding at Lindisfarne roundabout occurs from a combination of sources; discharge of several highway drains at this location which are overwhelmed and surface water down the road. • Combined sewers discharging in the south eastern area are overwhelmed in the smallest flood event modelled (3.33% AEP) with flooding experienced during this and lower probability events. • Flooding around Lindisfarne roundabout becomes deep at the 3.33% AEP event which could inhibit/restrict use of the roundabout; the flood extent becomes larger in lower probability events.

Detailed Area	Summary of flood mechanisms*
Kings George Road	• Flood risk is due to discharge of the combined storm sewer at several locations within the area.
Newmarket Walk	• Surface water flood risk primarily at two points within the area; along the eastern edge of the railway and south of Chichester Road. • Flooding is due to surface water runoff and discharge of the sewers which are overwhelmed in the smallest flood event modelled (3.33% AEP)

*A flood event with a 3.33% AEP event was the highest probability event modelled, flooding may occur in higher probability events although these were not modelled.

Following detailed assessment of King George's Walk it was decided by the partners not to progress this area to option assessment as the risk was solely linked to discharge of sewers and NWL are already considering the issues in the local area.

3.9 Communicate Flood Risk

Due to the nature of the outputs and the potential for property blight, the councils will need to decide upon the most suitable method of dissemination to each group. The key groups identified as part of this study which the findings should be disseminated are illustrated in Table 8 below.

Table 8 Partners and Stakeholder groups

Partners- *Person or Organisation responsible for the decision or actions that need to be taken*	**Stakeholders** - *Anyone affected by the problem or solution or interested in the problem or solution.*
• South Tyneside Council (Development Services) • Environment Agency • Northumbrian Water Ltd	• South Tyneside Council (Highways, Spatial and Emergency Planning) • Members of the public • Riparian Owners • Developers and Regeneration Agencies • Highways Agency • Local Resilience Forums • Regional Flood Defence Committees

4 OPTION ASSESSMENT

4.1 Identification of Options

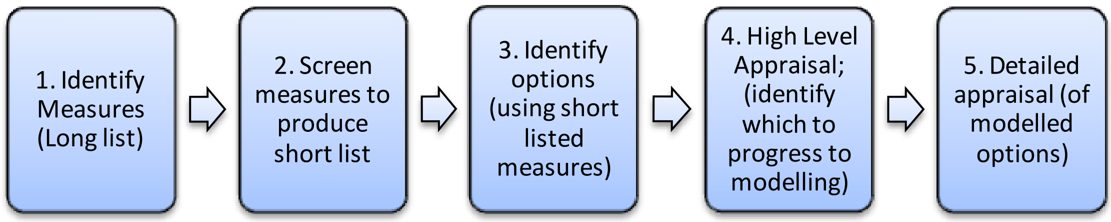
Following detailed modelling of the localised priority areas and assessment of the outputs, potential measures to reduce flood risk were identified. The process to identify measures and options within each of detailed areas is outlined in Figure 5.

Measures to mitigate surface water flood risk were identified from the Defra SWMP guidance[11]; structural, non-structural and adaptation measures were considered. Within the SWMP guidance a measure is defined as:

'A proposed individual action or procedure intended to minimise current and future surface water flood risk, or wholly or partially meet other agreed objectives of the SWMP'.

The measures were screened and discussed with the steering group to assist in identification of the options. Options were proposed for each of the detailed areas using a combination of the short listed measures where considered necessary.

Figure 5 Appraisal of options



4.2 Option Assessment

A high level scoring exercise was carried out against the short listed options to identify which options were considered more feasible and would therefore provide greatest value in taking forward to modelling. The criteria for appraising the short listed options are listed below. Each of the criteria was given a weighting as indicated in brackets, this was discussed and agreed with the partners. The higher weightings were linked to key criteria which assisted in identifying options to achieve the SWMP objectives. Options had to be driven by the technical feasibility, whilst lower weightings were given to criteria that gave potentially wider benefits. The score assigned to each criteria per option ranged between -2 (Severe negative outcome/Impact) to +2 (High positive outcome).

- Economic (30) – The potential cost to implement each option was considered when scoring the economic criteria. Do Something costs scored negatively to reflect the spend required and the higher cost options received a more negative score.

- Technical (20) – These scores were based on an initial assessment on the buildability of each option and the ability of each option to achieve a reduction in flood risk.

[11] DEFRA (2010) SWMP technical guidance

- Site Specific Objectives (20) – The scores for this criteria reflected the likelihood of the option to provide a standard of protection to a 1% AEP event. Options which had greater potential to achieve this standard scored more highly,

- Social Impacts (10) – Considerations for this criteria were based on any potential impacts each option would have to the local community through their operation. Options which required operation from the community such as individual property protection scored more negatively whilst storage of flows at source scored positively reflecting the reduction in disruption to community.

- Environmental (10) – The scores for the environmental criteria were based on considerations for wider environmental improvements which could be provided by the options. Options which involved storage of flows scored more highly to reflect the potential recreational areas which could be created.

- Sustainability (10) – The scores for the sustainability criteria included considerations for the adaptability of the option to enable the standard of protection to be increased in the future, the ease and level of maintenance which would be required by others in the future.

The options with the highest scores were taken forward to more detailed assessment, including modelling and calculation of costs and benefits. In line with FCERM-AG Do Nothing and Do Minimum were also appraised. The Do Nothing scenario represents no active intervention or maintenance, therefore existing gullies would block and any additional existing assets to manage surface water would fail. Do Nothing option is considered in accordance with Defra guidance to compare the other benefit of the other options against. It is usually a theoretical option as it would result in the quicker deterioration of any existing flood defence structures and an increase in blockage in culverts and ditches. Do Minimum assumes continuation of the existing assets and gullies operating, and has been referred to as 'Do Existing' throughout the documents.

The option assessments for each detailed area are included within Appendix C.

4.2.1 Site specific objectives

For each of the areas being considered in more detail the partners discussed whether there were further site specific objectives which needed to be considered when appraising the options. The partners agreed that particularly where the sources of flooding were surface water runoff, an additional objective should be to initially consider options to reduce surface water flooding from a 1% AEP event. Implementing options to this standard would reduce the flood risk to some properties which experienced flooding during the 2012 flood events. Lower standards could be considering following the initial assessment of options within the SWMP.

4.3 Option Modelling

The short listed options were assessed in more detail through modelling using the Info Works ICM model. This provided further information on their technical viability to achieve reductions in flood risk, allow residual risks to be assessed and provided information to assist with the costing of options. Detail on the options modelled is included within Appendix C.

4.4 Economic Assessment

4.4.1 Option Costs and Benefits

The residual damages of the modelled options were calculated by extracting water level data from the modelled flood extents. The same local areas were used as in Phase 3, to extract water levels from the model and calculate the baseline damages.

The modelled flood extents, data extracted from the model and LiDAR were used to estimate the costs of each of the modelled options. Construction costs were calculated using SPONS, and yearly maintenance costs were estimated using previous experience of similar schemes. Due to the scale of the options and the probability of flooding they were trying to reduce flood risk for the partners considered a 100 year appraisal period was relevant. As a result the option costs and AAD damages were discounted over the appraisal period in line with current guidance from the HM Treasury "Green Book" to give Present Value (PV) costs and damages.

The residual damages were used to calculate the Potential Value benefits of each of the modelled options; a cost benefit analysis was then undertaken for each of the options. The results of the economic assessment for the modelled options are shown in Table 9.

The options modelled for Lindisfarne did not achieve significant reductions in flood risk and therefore an economic assessment in such detail has not been carried out. Appendix C4 provides further detail on the options considered and outputs at Lindisfarne.

Table 9 Summary of option costs and benefits

	Option 1 - Do Existing	Option 2 – Do Something	Option 3 – Do Something
Fellgate			
Whole Life Costs	£83k	£1,155k	£1,859k
Optimism Bias (60%)	£50k	£693k	£1,115k
Total PV Costs	**£133k**	**£1,848k**	**£2,975k**
Benefits	£104k	£1,078k	£1,079k
BCR	**0.79**	**0.58**	**0.36**
Cleadon Sunderland Road			
Whole Life Costs	£36k	£1,424k	£814k
Optimism Bias (60%)	£21k	£854k	£488k
Total PV Costs	**£57k**	**£2,278k**	**£1,303k**
Benefits	£168k	£1,308k	£502k
BCR	**2.93**	**0.57**	**0.39**
Cleadon Lea			
Whole Life Costs	£140k	£949k	£834k
Optimism Bias (60%)	£84k	£569k	£501k
Total PV Costs	**£224k**	**£1,518k**	**£1,335k**
Benefits	£50k	£2,709k	£2,688k
BCR	**0.22**	**1.78**	**2.01**
Newmarket Walk			
Whole Life Costs	£30	£573	£568
Optimism Bias (60%)	£18	£344	£341
Total PV Costs	**£48**	**£917**	**£908**

	Option 1 - Do Existing	Option 2 – Do Something	Option 3 – Do Something
Benefits	£686	£3,646	£3,166
BCR	**14.29**	**3.98**	**3.49**

The benefits from the options are due to the reduction in flood risk across the area; either moving the property to a lower probability risk band or lowering of the residual flood water level. Table 10 highlights the number of properties which no longer flood at each modelled flood probability as a result of the options being implemented.

Table 10 Reduction in properties at risk in modelled options

		Option 1 – Do Existing				Option 2 – Do Something				Option 3 – Do Something			
		3.33%	1.33%	1%	3.33%	3.33%	1.33%	1%	3.33%	3.33%	1.33%	1%	3.33%
Fellgate	Res	0	1	1	0	6	21	26	38	2	19	30	35
	Com	0	0	0	0	0	0	0	0	0	0	0	1
	Total	0	1	1	0	6	21	26	38	2	19	30	36
Cleadon Sunderland Road	Res	3	3	2	-1	13	14	19	22	7	10	12	11
	Com	0	0	0	2	2	1	1	2	0	0	0	3
	Total	3	3	2	1	15	15	20	24	7	10	12	14
Cleadon Lea	Res	0	2	0	0	18	28	28	34	18	28	28	34
	Com	0	0	0	0	0	0	0	0	0	0	0	0
	Total	0	2	0	0	18	28	28	34	18	28	28	34
Newmarket Walk	Res	8	16	5	4	9	17	9	4	5	4	-2	-5
	Com	1	0	0	0	2	2	3	2	2	1	1	2
	Total	9	16	5	4	11	19	12	6	7	5	-1	-3

4.4.2 Funding

Under the new Flood and Coastal Risk Management Grant in Aid (FCRM GiA) funding system, launched by Defra/EA in May 2011, surface water flooding problems are eligible for full or partial funding.

The benefits of reducing flood risk are high, both in financial terms (reduced losses, lower insurance premiums) and in social terms due to the avoidance of disruption. Any measures to reduce surface water flood risk will be of direct benefit to property owners and it is therefore appropriate to seek contributions as well as cooperation from individuals prior to implementing works. Obtaining external contributions to projects is a central theme in the revised funding arrangements, and contributions can help secure FCRM GiA. Using the maximum benefits currently identified from the options assessed, an indication of the potential FCRM GiA funding which may be available for each location is shown in Table 11. This is subject to further detailed investigations and would be assessed in relation to other flooding schemes nationally.

Table 11 Potential Funding

	Potential FCRM GiA funding
Cleadon Lea	£218K
Cleadon Sunderland Road	£112K
Fellgate	£113K
Newmarket Walk	£227K

5 IMPLEMENTATION AND REVIEW

The final phase involved preparing an implementation strategy (i.e. an action plan), that will deliver the agreed actions and monitor the implementation of these actions. The SWMP should then be reviewed and updated where required at regular appropriate intervals.

5.1 Action Plan

An action plan has been drafted which includes catchment wide actions in addition to location specific actions for the areas where further detailed assessment was carried out. The studies which have been ongoing alongside the SWMP development have also been recognised. The action plan is included below.

=0=0=0=

	Action				Cost					Timing		Responsibility		Review	
ID	What (Generic)	How (Priority Actions)	Location	Priority Ranking	Investigation/ feasibility	Capital	Other	Benefit	Potential Funding Source	Timeframe	Action Type	Lead Organisations	Primary Support	Frequency	Review Date
								Council Wide							
1	Implement a flood incident log to assist in collecting standardised information	Implement the standardised log. Make all relevant parties within the Council aware of its existence and the information to be recorded. Include: Photos, date, source, extent	Catchment Wide	High			<£5k	Provides improved detail and evidence on historical events to feed into future plans and assist in considering flood risk risk mitigation works	STC/Defra/EA	Short (Implementation) Long Term (Recording)	Flood Risk Regulations	STC	Development Services. Drainage, highways and transport departments within Council. Support required from GIS		
2	Update the uFMfSW map	Use the modelling outputs from the SWMP to provide representative local mapping for the updated Flood Map for Surface Water (uFMfSW)	Catchment Wide	High			<£2k	Flood risk information made more accessible to inform the wider stakeholders	STC/Defra/EA	Short	Flood Risk Regulations	STC	EA		
3	Implement an asset register database	Implement a standardised register of assets which influence and impact flood risk. Guidance and suggested template provided by Defra. Suggested inclusions; culvert sizes, condition, ownership, significance on flood risk	Catchment Wide	High			<£5k	Improved procedures for recording flood risk assets across the area	STC/Defra/EA	Short	Flood and Water Management Act	STC	Development Services. Drainage, highways departments		
		Educate and engage Council departments in asset register to ensure it is populated and used to record flood risk drainage and surface water management assets	Catchment Wide	High			<£5k	Understanding of assets which influence flood risk across the area	STC/Defra/EA	Medium	Flood and Water Management Act	STC	Development Services. Drainage, highways departments		
4	Develop and implement a standardised maintenance schedule	Use asset register to produce annual maintenance regime which is joined up between the different departments/parties who may be responsible for drainage assets	Catchment Wide	High			<£5k	Benefits flood risk mitigation, ensuring all assets are in sufficient condition to operate to their design capacity	STC	Short	Flood Risk Reduction	STC	Development Services. Drainage, highways departments		
		Implement targeted maintenance regime of assets to ensure operational for storm events	Catchment Wide	High			<£15k	Flood risk is not increased through blocked or partially blocked assets; greatest benefit possible provided by assets	STC	Medium	Flood Risk Reduction	STC	Development Services. Drainage, highways departments		
5	Take forward SWMP actions into LFRMS	Take forward existing and any future SWMP actions into the Local Flood Risk Management Strategy for the South Tyneside administrative area	Catchment Wide	High			<£5k	Coordinated flood risk management, with cost-effective prioritisation of assets with limited budgets	STC	Short	Flood and Water Management Act	STC	Development Services. Resilience Team. Drainage, highways departments		
6	Implement and carry out a communication and engagement plan for the areas of significant flood risk	Communicate with a range of stakeholders as identified in the plan to raise awareness of the risks of surface water flooding. Include internal and external stakeholders and the public	Catchment Wide	High			<£5k	Increases awareness of risk from surface water flooding and role of STC as LLFA	STC	Short	Communications	STC	EA		
		Communicate and use findings of SWMP to update local resilience forum community risk registers and update multi-agency flood plans	Catchment Wide	High			<£2k	Increased flood risk adaptation, Emergency response plans include the most up to date information	STC	Medium	Communications	STC	Development Services. Highways		
7	Engage with and provide information to Planning department to inform development decisions and policy	Use maps and outputs of SWMP, identifying more vulnerable areas of surface water flooding to inform development decisions and update the SFRA	Catchment Wide	Medium			<£5k	More informed development decisions with reduced chance of surface water flooding	STC	Medium	Policy	STC	Development Control/Planning		
		Use the SWMP outputs to enhance planning policy to promote the use of appropriate SuDS, and through the work of the SuDS Approval Body (SAB) ensure approval of drainage systems are used to inform planning decisions for new and re-developments	Catchment Wide	Medium			<£5k	No future increase in surface water flooding and long term reduction in flooding	STC	Medium	Policy	STC	Development Control/Planning		
8	Develop and promote the use of SuDS in existing infrastructure	Creation of the new Suds Approval Body (SAB) in 2014 with all new development requiring SUDS approval by the SAB who will also then be responsible for adopting and maintaining SuDS for more than one house	Catchment Wide	High			unknown	A coordinated approach to the implementation of SuDS, ensuring national standards are met and SuDs are maintained to reduce the risk of future flooding	STC	Short	Policy	Subject to Government Guidance (Likely to be STC)	Development Control		
		Promote the implementation of green roofs on existing buildings and permeable paving or shallow storage in car parks, particularly when carrying out improvement or maintenance works	Catchment Wide	Medium			<£5k	Improved awareness of surface water flooding. Attenuation of flows to contribute to long term reduction in flooding	STC	Medium	Flood Risk Reduction	STC	Development Control/Planning		
		Promote the widespread use of water butts for residential properties	Catchment Wide	High		£15K+	<£5k	Improved community understanding of local flood risk resilience and flood attenuation at source	STC	Short	Flood Risk Reduction	STC	NWL, EA		
		Seek opportunities for retro-fitting of SuDS techniques, particularly in large urban buildings and impermeable areas	Catchment Wide	High			<£5k	Attenuation of flows to contribute to long term reduction in flooding	STC	Short	Flood Risk Reduction	STC	NWL, EA		
9	Review open spaces to consider opportunities for local flood risk mitigation measures	Review open spaces across South Tyneside to consider where practical flood risk management measures can be included such as swales, storage, ponds/wetlands	Catchment Wide	Medium		unknown		Overall cost savings and alignment of aspirations by incorporating flood risk measures in other improvement/ maintenance projects	STC	Medium	Flood Risk Reduction	STC	Parks/Recreation within council		
								Site Specific							
Lindisfarne															

	Action				Cost					Timing		Responsibility		Review	
ID	What (Generic)	How (Priority Actions)	Location	Priority Ranking	Investigation/ feasibility	Capital	Other	Benefit	Potential Funding Source	Timeframe	Action Type	Lead Organisations	Primary Support	Frequency	Review Date
10	Consider long term options to reduce surface water flooding at Lindisfarne Roundabout	Carry out detailed appraisal of options to reduce surface water flooding at Lindisfarne Roundabout, engaging with Highways team. Potential option to install offline flood storage or divert flows to the river; funding to be considered	Lindisfarne A19 Area	High	£30k- £80k	Potentially >£2mill		Flood Mitigation to strategic transport route	STC/Defra/EA	Long	Investigation	STC	Development Services, Highways, NWL		
11	Develop long term options to reduce surface water flooding	Work with NWL to look for joined up opportunities in sewer improvement schemes	Lindisfarne A19 Area	High	£25-£50k			Flood Mitigation to strategic transport route	STC	Long	Investigation	STC	Development Services, Highways, NWL		
12	Develop long term options to reduce surface water flooding	Look for joined up opportunities in highway improvement schemes	Lindisfarne A19 Area	High	£25-£50k			Flood Mitigation to strategic transport route	STC	Long	Investigation	STC	Development Services, Highways, NWL		
13	Localised SuDS in available green space	Carry out localised SUDS options, including storage in roundabout to the east and surrounding green areas to reduce surface water on highways where possible	Lindisfarne A19 Area	Medium	£10k	£500k-£1,000k		Flood Mitigation to strategic transport route	STC	Long	Flood Risk Reduction	STC	Development Services, Highways, NWL		
14	Mitigate surface water flooding impacts during rainfall events	Discuss SWMP outputs with Highways team and emergency planners to consider implementing measures such as warning signs and traffic management measures	Lindisfarne A19 Area	High			£5k	Impacts on road users and emergency services are reduced during rainfall events	STC	Short	Flood Mitigation	STC	Development Services, Highways, Emergency Planning		
Fellgate															
15	Confirm and manage misconnections into foul network	NWL to proactively work with STC to manage the misconnections	Fellgate	Medium	£10k			Reduction in foul sewers being overloaded during rainfall events	NWL	Medium	Flood Risk Reduction	NWL	STC		
16	Investigate funding and implement option to reduce surface water run off	Investigate funding opportunities to install channel to divert flows to nearest watercourse	Fellgate	High	£25-£50k	£1.8 million		Provides flood mitigation to some properties within Fellgate area and diverts surface water flows straight to watercourse instead of entering storm sewer	STC/Defra/EA	Medium	Investigation	STC	NWL		
17	Collaborate with NWL to mitigate flooding from storm water sewers	NWL to assess storm water flood risk within Fellgate and collaboratively work with STC to consider inclusion of mitigation works with Action 16	Fellgate	High	£25-£50k	£1.2 million		Flood risk reduction if capital works implemented	STC/Defra/EA	Medium	Investigation	STC	NWL		
Cleadon Lea															
18	Flood Storage	Detailed assessment to construct flood embankment with active control at the inlet to storm sewer; releasing surface water run off when capacity in sewers	Cleadon Lea	High	£50-100k	£1.2-1.4 million		Reduction in flood risk for properties around Cleadon Lea	STC/Defra/EA/ Landowner	Short	Flood Risk Reduction	STC	NWL , Landowner		
Cleadon Sunderland Road															
19	Flood Storage	Detailed assessment to construct flood embankment and new storm sewer with active control at the inlet; releasing surface water run off when capacity in sewers	Cleadon Sunderland Road	Medium	£80-150k	£1.3-2.3 million		Flood risk reduction from surface water run off, benefit dependent on number of storage areas created	STC/Defra/EA/ Landowner	Medium	Investigation	STC	NWL , Landowner		
20	Collaborate with NWL to mitigate flooding from storm water sewers	NWL to assess storm water flood risk within Cleadon Sunderland Road and collaboratively work with STC to consider inclusion of mitigation works with Action 19	Cleadon Sunderland Road	Medium	within No. 19	within No. 17		Greater reduction in flood risk through investigation into combined flood risk sources (surface water run off and sewers)	NWL/STC/ Defra/ Landowner	Medium	Investigation	NWL	STC, Landowner		
Newmarket Walk															
21	Flood Storage	Detailed assessment to improve local open spaces to create series of flood storage areas	New Market Walk	High	£25-50k	£700k		Reduction in flood risk and improvement in amenity area	STC/Defra	High	Flood Risk Reduction	STC	NWL		
22	Upgrade storm sewer	Detailed assessment to upgrade section of culvert and construct local flood defence	New Market Walk	High	£25-50k	£300k		Reduction in flood risk for properties	STC/Defra	High	Flood Risk Reduction	STC (in combination with No.21)	NWL		
Other															
23	Follow up and implement recommendations of other studies	Carry out actions to reduce surface water flood risk as identified from the Monkton Village Flood Alleviation Study	Hebburn	High				Reduction in flood risk for properties	NWL/STC/ Defra/EA	Short	Flood Risk Reduction	NWL/STC	EA		
24	Follow up and implement recommendations of other studies	As part of the ongoing study at Reay Crescent, Boldon, investigate options to reduce surface water flooding	Reay Crescent, Boldon	Medium				Reduction in flood risk for properties	Defra	Medium	Flood Risk Reduction	EA	STC,NWL		
25	Follow up and implement recommendations of other studies	As part of the regeneration scheme at Ocean Road, South Shields include works to mitigate the risk of surface water flooding in the area	Ocean Road, South Shields	Medium				Reduction in flood risk	NWL/STC	Short	Flood Risk Reduction	STC	NWL		