Final

Southend-on-Sea Borough Council

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Southend-on-Sea 19th September 2014 Flood Investigation Report

November 2015

47071307

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List of Acronyms

AEP	Annual Exceedance Probability (%)
AW	Anglian Water
EA	Environment Agency
ECC	Essex County Council
FWMA	Flood and Water Management Act 2010
LLFA	Lead Local Flood Authority
mAOD	meters Above Ordnance Datum
NGR	National Grid Reference
RMA	Risk Management Authority
SBC	Southend-on-Sea Borough Council

Executive Summary

This report constitutes the findings of the Flood Investigation completed for the flooding event of the 19th September 2014 within Southend-on-Sea. This has been completed under Section 19 of the Flood and Water Management Act 2010.

Southend-on-Sea was subject to widespread flooding, particularly within the central seafront area of Marine Parade and Eastern Esplanade. In total, 63 incidents of flooding were recorded.

The rainfall recorded on the 19th September 2014 was a high intensity, short duration event. 32.8mm total rainfall was recorded from 20:00 – 21:15 at the Southchurch Park rain gauge. At the peak rainfall intensity, 16.2mm was recorded as falling within a 15 minute period. This equates to a return period of approximately 1 in 23 years. Due to the local nature of the storm, the Southchurch Park rain gauge is unlikely to have recorded the greatest rainfall intensity. Radar imagery provided by the Environment Agency shows the peak rainfall intensity to be located to the west of Southchurch Park, at Marine Parade and Eastern Esplanade. The Met Office undertook analysis of rainfall using data from the Thurnham Rainfall Radar. The Met Office estimated that the area of highest rainfall intensity resulted in a 1 in 293 year return period event. The large variation in estimated return period is a result of the difference in peak intensity recorded by the rain gauge and the Thurnham Rainfall Radar. In this instance, the rain gauge is located outside of the main area of the storm; it will therefore return a lower record of rainfall.

This Flood Investigation focuses on incidents of flooding within the central seafront area, as well as areas where flooding has also been recorded to occur previously on the 24th of August 2013, 11th October 2013 or 20th July 2014. The areas being investigated are:

- Central Seafront (Marine Parade, Eastern Esplanade and Victoria Road);
- The High Street;
- Highlands Boulevard;
- Cricketfield Grove;
- Chalkwell;
- Western Esplanade;
- Northumberland Crescent;
- Fairfax Drive;
- Central Southend and Victoria Avenue; and,
- Symons Avenue.

Flooding on the 19th September 2014 was primarily a result of exceptionally intense rainfall, falling across the central seafront area of the borough. The mechanisms for flooding on the 19th September 2014 can be broadly defined into the following categories:

- **Exceedance of drainage network capacity** – In areas including Marine Parade, Vardon Drive and Fairfax Drive, reports suggest that the capacity of the local drainage network was overwhelmed by the intensity of the rainfall. As a result, surface water was not able to enter the drainage network and so accumulated in areas of low-lying topography.

- **Surcharging of the drainage network** –Reports indicate that surface water was surcharging out of gullies in some locations including Victoria Road, Chalkwell Esplanade and The Ridgeway. It has been highlighted that a more detailed investigation is required by Anglian Water in locations that are repeatedly flooding despite new highway drainage being installed or cleared such as Symons Avenue, Northumberland Crescent and The Ridgeway.

- **Maintenance issues** - Flooding at the Warners Bridge Roundabout was considered to be a result of maintenance issues, restricting the function of the highway drainage.

- **Tide-locking** – The tide level was approaching high tide at the time of the rainfall event on the 19th September 2014, meaning it would have been higher than the level of tidal outfalls along the seafront impeding outward drainage. It is possible that not all tidal flap valves were correctly functioning leading to seawater ingress to the overloaded drainage system.

Southend-on-Sea Borough Council and Anglian Water have both taken extensive steps to investigating the causes of flooding across the borough through surveys of the local drainage networks. Where necessary, steps have been taken to rectify issues and provide maintenance as needed. Anglian Water has also assisted at the property level and has provided non-return valves and airbrick covers to properties prone to surface water and sewer flooding.

As part of the investigation, a number of actions have been identified to assist with the ongoing flood management across the Borough. Many of the actions should be implemented by Southend-on-Sea Borough Council along with Anglian Water, the Environment Agency, riparian owners, residents and developers.

1 Introduction

1.1 Background

Section 19 (1) of the Flood and Water Management Act (FWMA, 2010[1]) places a duty on Lead Local Flood Authorities (LLFAs), including Southend-on-Sea Borough Council (SBC), to investigate flood incidents from surface water, groundwater and ordinary watercourses[2] , where it considers it 'necessary and appropriate'.

Section 19 of the FWMA states that:

(1) On becoming aware of a flood in its area, a LLFA must, to the extent that is considers it necessary or appropriate, investigate:

(a) which risk management authorities (RMAs) have relevant flood risk management functions, and

(b) whether each of those RMAs has exercised, or is proposing to exercise, those functions in response to the flood.

(2) Where an authority carries out an investigation under sub-section (1) it must:

(a) publish the results of its investigation, and

(b) notify any relevant RMAs in accordance with Section 19(2) of the FWMA.

The FWMA (Section 6 (13)) states RMAs to be:

- The LLFA (SBC) and neighbouring LLFAs (Essex County Council (ECC)),
- The Environment Agency (EA),
- Internal Drainage Boards (not applicable within SBC),
- Water Company (Anglian Water (AW) as the sewerage undertaker,
- Highways Authority (SBC).

1.2 Criteria for Investigating Flooding Incidents

SBC has developed a set of criteria in order to determine if a flooding event requires investigation. This is based on the assessment of the consequences of flooding that are considered to be sufficiently serious.

Where any of these criteria are met, an investigation will be undertaken. The SBC criteria ask whether there is or whether there have been:

- More than four reports of the interior of a single residential property flooding,
- any reports of the interior of critical infrastructure flooding,

[1] Flood and Water Management Act 2010: http://www.legislation.gov.uk/ukpga/2010/29/contents
[2] An ordinary watercourse includes every river, stream, ditch, drain, cut, dyke, sluice, sewer (other than public sewer) and passage through which water flows which does not form part of a Main River.

- flooding of a transport link such that it has been made impassable for a significant amount of time,
- more than 14 reports of flooding within 50m of a receptor within the past three years,
- potential for accidents or health implications, or
- effects on vulnerable people through service or amenity impacts.

Where the answer to any of the below is 'yes', the need for a Flood Investigation will be considered based on a risk based approach:

- Has there been more than one report of the interior of a commercial property flooding?
- And has this had an economic impact?
- Has the natural environment been affected?
- Is there a threat to a local ecosystem?
- Is the localised flooding known to occur according to historic records?
- Has a request for investigation been received?
- Is a single source of flooding evident?
- Are other flood risk management authorities investigating?

Following the above set of criteria, it was deemed necessary to complete a Flood Investigation due to the significant numbers of flood incidents reported on the seafront, particularly internal flooding of numerous commercial properties. This report will also investigate flooding in areas that have repeatedly flooded in the past (for instance, on the 24th of August 2013[3], 11th October 2013[4] or 20th July 2014[5]). This report constitutes a record of this investigation.

1.3 Risk Management Authority Duties and Responsibilities

The legal framework for managing flooding lies with a number of different agencies; the key responsibilities for each are outlined below. Reference should be made to the relevant legislation and the Local Flood Risk Management Strategy (LFRMS)[6] once complete, for further information.

1.3.1 Southend-on-Sea Borough Council (LLFA)

SBC, as the LLFA, has a strategic overview role and a responsibility to investigate flood incidents from surface water, groundwater and ordinary watercourses where it is considered necessary and appropriate. As part of this role, SBC hold quarterly Flood Group Meetings with the RMAs to discuss and report on flood management.

SBC has a consenting and enforcement responsibility for ordinary watercourse regulation for those ordinary watercourses within the administrative area.

The FWMA outlines that the LLFA has powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management of surface water, groundwater and ordinary watercourses. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it (FWMA Schedule 1, Section 1).

[3] URS (2014) Southend-on-Sea Flooding 24th August 2013 Flood Investigation Report. Available online at: https://www.southend.gov.uk/FLOODING
[4] URS (2015) Southend-on-Sea 11th October Flood Investigation Report. Available online at: https://www.southend.gov.uk/FLOODING
[5] URS (2015) Southend-on-Sea Flooding on the 20th July 2014 Flood Investigation Report. Available online at: https://www.southend.gov.uk/FLOODING
[6] AECOM (2015) Draft Southend-on-Sea Borough Council Local Flood Risk Management Strategy

SBC as the Highway Authority also has the duty to maintain adopted highways within their administrative area under Section 41 of the Highways Act 1980[7]. Highway maintenance includes that of the road drainage networks (drains and gullies).

Under the Civil Contingencies Act (2004)[8], SBC are a Category 1 Responder and therefore have the duty to put in place emergency plans and assess local risks to inform the emergency planning. SBC are also required to make information available to the public about civil protection matters and maintain arrangements to warn and advise the public in the event of an emergency.

1.3.2 Environment Agency

The Environment Agency has a strategic overview role and responsibility to investigate flooding from Main Rivers and the sea. The Agency also has permissive powers to carry out emergency or maintenance work on Main Rivers[9] (see Figure 1-1 Main Rivers and Flood Warnings Map) under Section 165 of the Water Resources Act (1991)[10].

The FWMA outlines that the Environment Agency has powers to designate structures and features that affect flooding in order to safeguard assets that are relied upon for flood risk management for fluvial (Main River) and tidal sources. Once a feature is designated, the owner must seek consent from the authority to alter, remove or replace it (FWMA Schedule 1, Section 1).

1.3.3 Anglian Water

Under the FWMA, Anglian Water is responsible for managing the risks of flooding from surface water, foul and/or combined sewer systems where the sewer flooding is wholly or partly caused by an increase in the volume of rainwater (including snow and other precipitations) entering or otherwise affecting the system. Within Southend-on-Sea, there are sections of culverted watercourse that also fall under Anglian Water responsibility.

Anglian Water has a duty to provide and maintain a system of public sewers so that the areas for which they are responsible are effectually drained (Water Industry Act, 1991)[11]. Sewerage systems are not, however, designed to accommodate flows from severe weather events. AW's level of service is set by Ofwat, the industry regulator. In the context of drainage, severe weather is considered to be 'rainfall events having a storm return period that is less frequent than a rainfall event with an Annual Exceedance Probability (AEP) of 5% (1 in 20 years)'. Therefore, rainfall events with a lower annual rainfall probability than 5% (1 in 20 years) would be expected to result in surcharging of some of the sewer network.

As part of Anglian Water's obligation to Ofwat, they are required to undertake capacity improvements to alleviate sewer flooding problems to properties on their 'at risk register', with priority being given to more frequent property internal flooding problems. Anglian Water prioritises this programme of work on the basis of customers willingness to pay and cost benefit analysis; the benefits to customers must be greater than the whole life cost of the scheme.

1.4 Other Stakeholder Duties and Responsibilities

1.4.1 Essex and Suffolk Water

Essex and Suffolk Water is responsible for maintaining, improving and extending the water mains under Section 37(1)(b) of the Water Industry Act 1991. If a water main bursts, it is Essex and Suffolk Water's responsibility, as the water undertaker, to manage and repair this.

1.4.2 Riparian Owners

Riparian owners are those that own land or property adjacent to a watercourse. Riparian owners have a responsibility to maintain the bed and banks of the watercourse; this includes maintenance of any owned structures, such as trash screens or culverts.

[7] Highways Act 1980: http://www.legislation.gov.uk/ukpga/1980/66/contents
[8] Civil Contingencies Act 2004: http://www.legislation.gov.uk/ukpga/2004/36/pdfs/ukpga_20040036_en.pdf
[9] Main Rivers are watercourses shown on the statutory main river maps held by the Environment Agency, the Department of Environment, Food and Rural Affairs (in England) and the Welsh Assembly Government (in Wales). They can include any structure or appliance for controlling or regulating the flow of water into, in or out of the channel.
[10] Water Resources Act (1991): http://www.legislation.gov.uk/ukpga/1991/57/contents
[11] Water Industry Act (1991): http://www.legislation.gov.uk/ukpga/1991/56

Section 25 of the Land Drainage Act (1991)[12] outlines that where the flow of a watercourse is obstructed; the riparian owner is responsible to resolve the condition. Section 28 of the Land Drainage Act (1991) outlines the responsibility of the riparian owner to undertake maintenance of their watercourse if it is impeding the flow of water.

Riparian owners must let water flow through their land without obstruction and must accept flood flows through their land. Riparian owners have no duty in common law to improve the drainage capacity of a watercourse. Further information can be found in the Environment Agency's document 'Living on the Edge' (2012)[13].

1.4.3 Local Residents

Residents who are aware that they are at risk of flooding should take action to ensure that they and their properties are protected.

Residents should report flooding incidents or potential problems (such as blockages) to the LLFA or appropriate organisation if known.

1.5 Consultation

Investigation of the flooding at Southend-on-Sea on 19th September 2014 has been undertaken in consultation with the key stakeholders and RMAs.

The RMA discussion and consultation process was already in place as a result of the preceding 24th August and 11th October 2013 and 20th July 2014 flooding events. As a result, much of the previous discussion applied to the 19th September 2014 event.

Through the on-going consultation process, the Environment Agency and Anglian Water have provided information on flooding records, clarification of standard response procedures and details of asset locations held by their respective organisations.

1.6 Site Description

Southend-on-Sea Borough is located in the south of Essex and is bordered by the neighbouring boroughs of Castle Point to the west, and Rochford to the north. The Thames Estuary is to the south of the borough.

Southend-on-Sea is heavily urbanised with dense residential and commercial development.

The topography of the borough can be seen in Figure 1-2. Elevations are approximately 45 mAOD in the west of the borough decreasing to approximately 7 mAOD in Shoeburyness to the east of the borough. The borough is bisected by a number of river channels which form valleys across the area. These are most notably associated with Eastwood Brook and Prittle Brook to the west of the borough, which drain in a northerly direction towards Rochford. The southern boundary of the borough has steep slopes where the elevation falls from approximately 40 mAOD to 4 mAOD towards the coast.

There are a number of Main Rivers and ordinary watercourses within Southend-on-Sea; these are plotted in Figure 1-1 along with the associated Environment Agency fluvial flood zones.

The bedrock geology is predominantly London Clay, with the superficial geology of River Terrace Deposits overlying the bedrock in the east of the borough and along the river channels of the Eastwood Brook and Prittle Brook. Around Shoebury and Southchurch there are superficial deposits of Tidal Flat Deposits overlying the bedrock.

[12] Land Drainage Act (1991): http://www.legislation.gov.uk/ukpga/1991/59/contents
[13] Environment Agency (2012) Living on the edge – A guide to your rights and responsibilities of riverside ownership. http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx

Southend-on-Sea Borough Extent

Flood Zone 3

Flood Zone 2

Areas benefiting from flood defences

Flood defences

Watercourses

Main River

Ordinary Watercourse

Notes:

The Risk from Rivers is divided into the following categories:

Flood Zone 1 - Land having a less than 1,000 (0.1%) annual probability of river flooding in any year. Shown as clear on the Flood Map - all land outside Flood Zones 2 and 3.
Flood Zone 2 - Land having between a 1 in 100 and 1 in 1,000 (between 1% and 0.1%) annual probability of river flooding in any year.
Flood Zone 3 - Land having a 1 in 100 (1%) or greater annual probability of river flooding in any year.

This map is intended to provide a strategic overview of fluvial flood risk and should not be used to assess flood risk for individual properties.

Eastwood Brook

Prittle Brook

Prittle Brook Flood Relief Culvert

Muckinghall Brook

Willingale Brook

C - X Ditch

Barge Pier Ditch

SOUTHEND-ON-SEA

RAYLEIGH

0 1 2
kilometres

N

Revision Details	By / Check	Check Date	Suffix
Final	DS/EG		

Purpose of Issue: FINAL

Client: southend on sea BOROUGH COUNCIL

Project Title:
SOUTHEND-ON-SEA
19TH SEPTEMBER 2014
FLOOD INVESTIGATION REPORT

Drawing Title:
RIVERS AND
FLOOD ZONES

Drawn	Checked	Approved	Date
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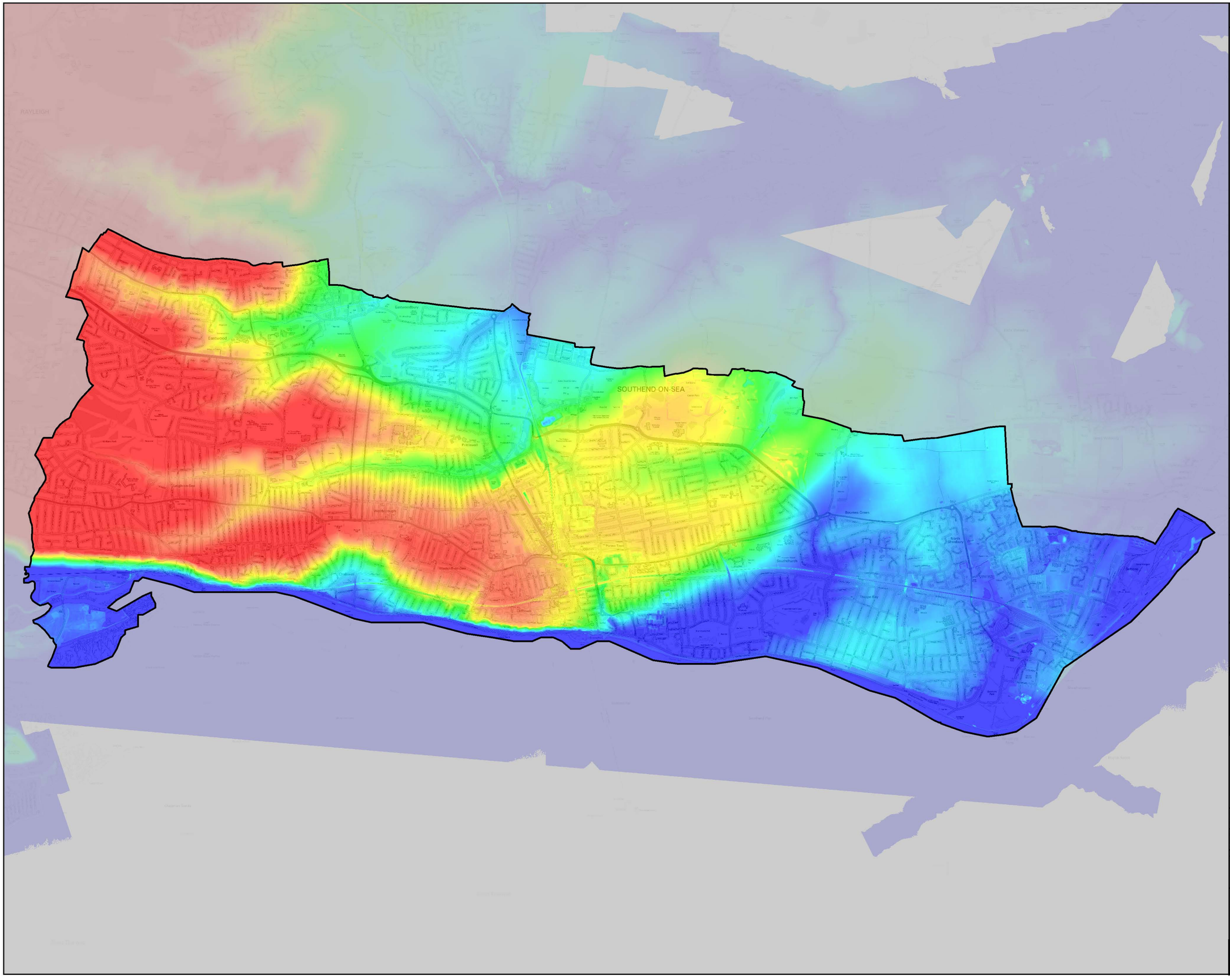
Drawing Number	Rev
Figure 1-1	2



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Legend

Southend-on-Sea Borough Extent

Elevation (mAOD)

- 0 mAOD
- 10 mAOD
- 20 mAOD
- 30 mAOD
- 40 mAOD
- 50 mAOD

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Client: southend on sea BOROUGH COUNCIL

Project Title:

SOUTHEND-ON-SEA 19TH SEPTEMBER 2014 FLOOD INVESTIGATION REPORT

Drawing Title:

SOUTHEND-ON-SEA TOPOGRAPHY

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Drawing Number: **Figure 1-2**

Rev: 2

2 Flood Incident Details

2.1 Overview

Southend-on-Sea was subject to widespread flooding on the 19th September 2014 as a result of heavy rainfall falling over a short period of time across the central southern part of the borough. The following section describes the conditions leading up to the flood event and the resultant impacts.

2.2 Weather Warnings and Flood Alerts

No flood warnings were issued by the Environment Agency on 19th September 2014. It was considered a surface water event for which flood warnings are not issued.

The Met Office National Sever Weather Warning Service issued a yellow warning for rain with a moderate impact but low likelihood. The forecast outlined:

> *"The humid, unstable airmass across southern Britain will remain in place through Friday night and into Saturday. Scattered heavy showers and thunderstorms are therefore likely to continue to affect some areas. Many places will miss these storms, but where they do occur we are likely to see up to 30 mm rainfall in a short space of time, whilst lightning and hail may be additional hazards."*

The forecast continued to say " *heavy showers and thunderstorms are likely to continue through Friday night and into Saturday morning, the main risk receding eastwards…"*

The following warnings and updates were issued on the 18th and 19th September:

- 1st Yellow Warning issued at 11:01 on Thursday the 18th September for heavy showers and thunderstorms on 19th September, with Southend lying at the edge of the warning area.
- Updated Yellow Warning at 05:23 on Friday the 19th September to show a change of the area at warning, extending across Essex.
- 2nd Yellow Warning issued at 11:06 on Friday the 19th September for rain from 00:15 to 10:00 on Saturday the 20th September.

2.3 Recorded Rainfall

The Met Office Rainfall Analysis Report[14] outlined that on the 19th September 2014 convective[15] showers developed, that resulted in heavy thundery showers across south-east England.

2.3.1 Tipping Bucket Rain Gauge Data

Within Southend-on-Sea, the Environment Agency tipping bucket rain gauge located in Southchurch Park (ordnance Survey National Grid Reference 590000, 185000) recorded a 24 hour rainfall total of 34.6mm for the 19th September 2014, 32.8mm of which fell from 20:00 to 21:15. A peak rainfall intensity of 16.2mm occurred over a 15 minute period from 20:45 to 21:00. The 15 minute rainfall totals are shown in Table 2-1 below.

[14] Met Office Rainfall Analysis (November 2014)
[15] Atmospheric convection is often a result of temperature difference, mixing of the air leads to increased winds and cumulus cloud development which can cause thunderstorms and local heavy rainfall

Nearby rain gauge stations at Shoeburyness and Rayleigh recorded very low daily totals of 2.4mm and 0.8mm respectively, highlighting the local nature of the rainfall experienced.

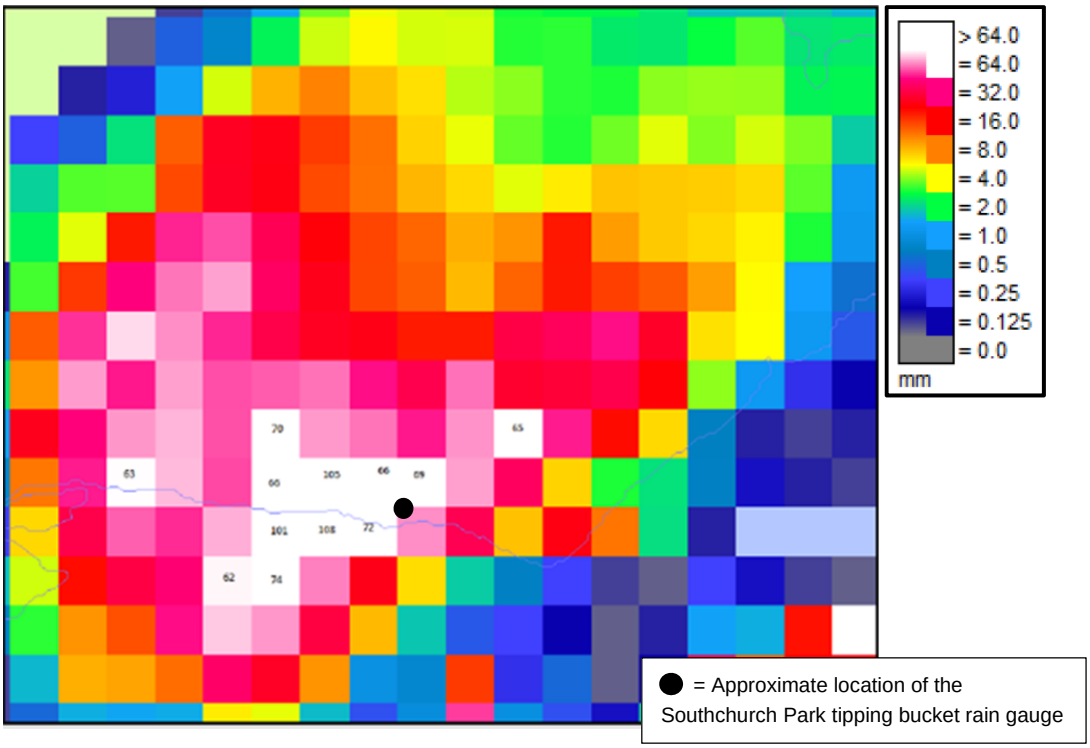
Table 2-1: Environment Agency 15 Minute Rainfall Data at Southchurch Park Rain gauge

Date	Time	15 Minute Depth Total (mm)
19/09/2014	20.00	1.6
19/09/2014	20.15	4.0
19/09/2014	20.30	1.0
19/09/2014	20.45	16.2
19/09/2014	21.00	8.6
19/09/2014	21.15	1.4
Total		**32.8**

2.3.2 Radar Data

Data from the Met Office Thurnham Rainfall Radar Station (1km resolution) estimated a 24 hour rainfall total of 72.2mm and a two hour total of 71.4mm from 19:00 to 21:00 on the 19th September 2014. According to this data set, at the peak rainfall intensity, 41.7mm fell over a 30 minute period between 20:25-20:55. Radar imagery shown in Figure 2-1 below, provided by the Environment Agency, shows the area experiencing the highest rainfall intensity to be located across the central seafront area within Southend-on-Sea.

Figure 2-1: Environment Agency Radar Imagery - Cumulative Rainfall from 20:00 - 21:00



2.3.3 Return Period Calculation

The Met Office used the method outlined in The Flood Estimation Handbook to determine the corresponding likelihood of probability for this type of rainfall event from the rain gauge data and the Met Office Thurnham Rainfall Radar.

The Thurnham Rainfall Radar provided the highest return period for this type of event, with an estimated 1 in 293 year return period for 30 minute peak rainfall. The Environment Agency tipping bucket rain gauge recorded rainfall equivalent to a 1 in 23 year return period event.

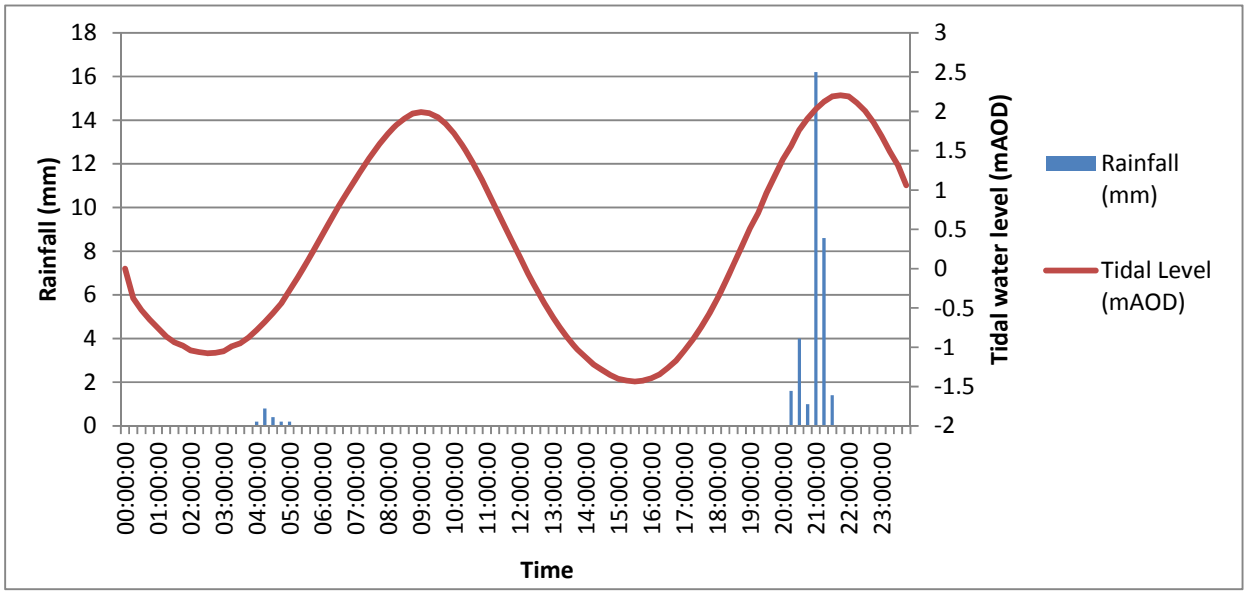
From the datasets discussed above, there is a large discrepancy between the rainfall data recorded by the tipping bucket rain gauge and radar. Rainfall intensity recorded using a tipping bucket rain gauge tends to be more accurate than radar data. However, radar data provides a good spatial coverage of rainfall intensity, whereas rain gauges only provide details of intensity at one given location.

Reference to radar data suggests that the Southchurch Park rain gauge is located to the east of the area of high intensity rainfall. Therefore, the rainfall depths recorded from the rain gauge are unlikely to represent the peak rainfall experienced across Southend-on-Sea.

2.4 Recorded Tide Levels

Some of the flood incidents were recorded along the seafront area and could potentially be affected by tide levels at the time of the high intensity rainfall. Figure 2-2 details the tidal water levels recorded at Southend Pier. It can be seen that the high tide occurred shortly after the peak rainfall, reaching a level of 2.5m at 21:30.

Figure 2-2: Recorded rainfall at Southchurch Park and tidal levels and Southend Pier on the 19th September 2014

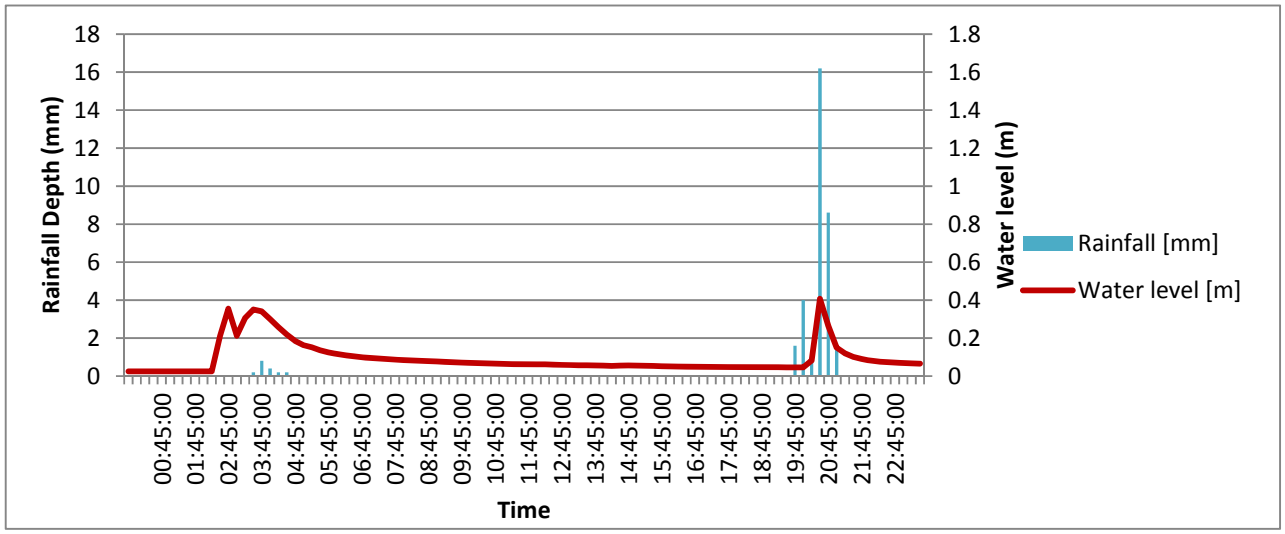


2.5 Recorded River Levels

Water levels of the Prittle Brook are recorded by the Environment Agency at a gauging station within Belfairs Park (NGR: 583292, 187035). Figure 2-3 shows the water levels of the Prittle Brook on the 19th September along with the recorded rainfall.

It should be noted that the Prittle Brook drains from Hadleigh in Castle Point, west through Southend-on-Sea, before flowing north towards the River Roach. As the focus of the storm occurred to the south and west of Southend-on-Sea, the resultant flows within the Prittle Brook through Southend-on-Sea are likely to have been influenced by the rainfall. Figure 2-3 shows a rapid but small response recorded at the Belfairs Park gauging station, following the rainfall event.

Figure 2-3: Recorded Rainfall at Southchurch Park and River Levels at Belfairs Park on 19th September 2014



2.6 Flood Records

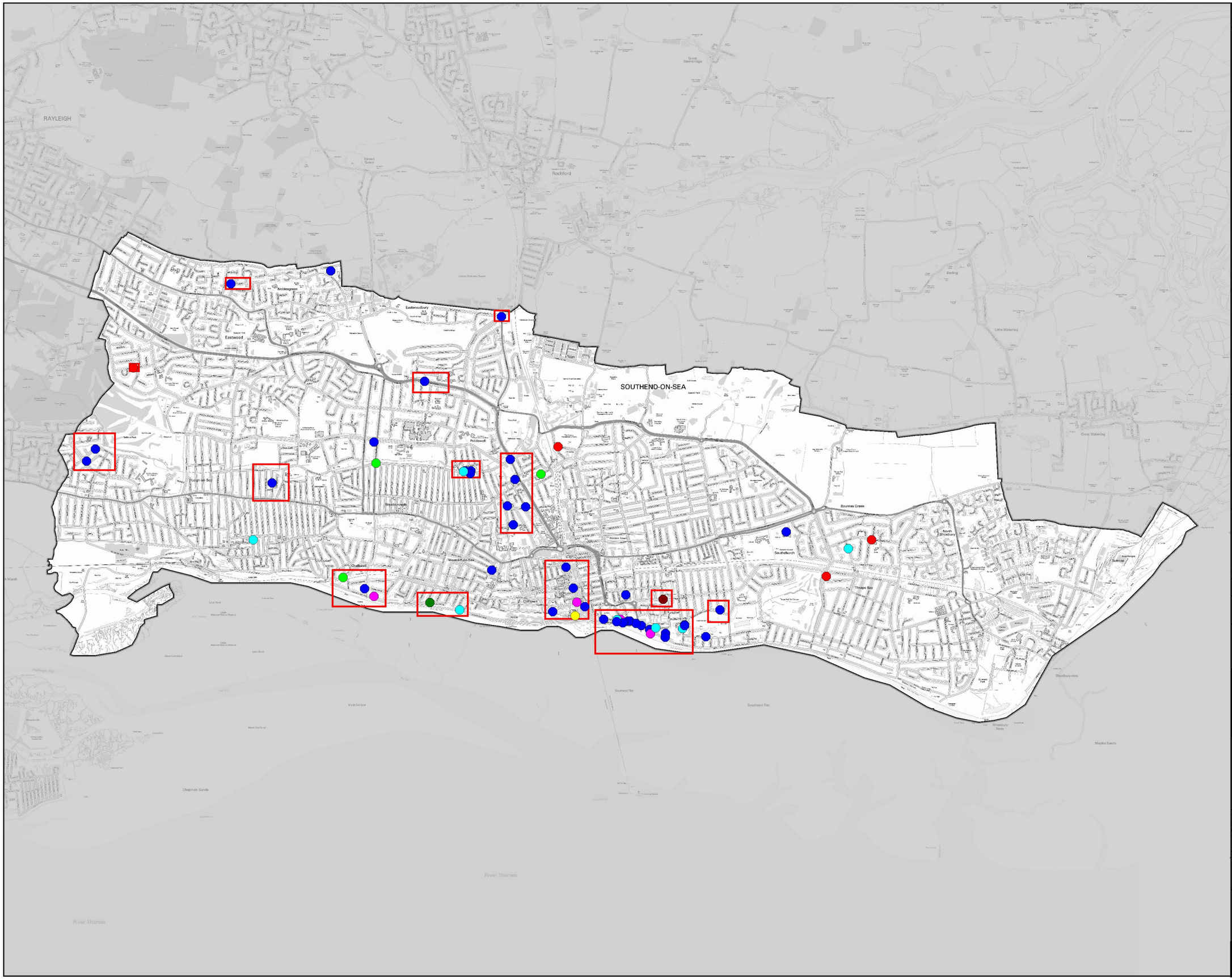
Figure 2-4 shows the locations of recorded flooding across Southend-on-Sea. It can be seen that the distribution of flooding incidents is focused to the west and south of the borough.

SBC have a total of 63 incidents of flooding recorded. Of these, there were:

- 1 record of sewer flooding;
- 1 record of ground movement as a result of flooding;
- 1 record of flooding wherein an emergency rescue was required;
- 4 records of flooding which required pumping;
- 4 records of flooding as a result of blocked gullies;
- 3 records of blown gullies and manhole covers;
- 1 record of sewage backing up;
- 7 records of 'other' flooding incidents including those relating to carriageway damage, debris and sewerage in the road; and,
- 41 instances of flooding from unspecified/combined sources.

The Environment Agency has advised that they had no reports of flooding at the Prittle Brook and Eastwood Brooks on the 19th September 2014.

Anglian Water has 1 record of sewer flooding within Woodgrange Drive in Southend–on-Sea on the 19th September 2014.



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Southend-on-Sea Borough Extent

Areas of Detailed Investigation

Recorded Flooding 19th Septem

- Blocked Gully
- Blown Gully/ Manhole
- Flooding
- Flooding/ Pumping Out
- Ground Movement
- Other
- Rescue From Water
- Sewage Backing Up

'Other' relates to incidents of carriageway damage, debris on roads etc.

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Revision Details	By / Check	Check Date	Suffix	

Purpose of Issue
FINAL

Client
southend on sea BOROUGH COUNCIL

Project Title
SOUTHEND-ON-SEA
19TH SEPTEMBER 2014
FLOOD INVESTIGATION REPORT

Drawing Title
RECORDED FLOODING
19TH SEPTEMBER 2014

Drawn	Checked	Approved	Date
PP	SK	EG	Oct 2015

URS Internal Project No.	Scale at A3
47071307.FIR03	1:40,000

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Drawing Number	Rev
Figure 2-4	2

3 Flooding Mechanisms

The following chapter summarises the flooding investigated for areas identified as being affected on 19th September 2014. For each site, an overview will be provided, flooding mechanisms discussed, RMA responses outlined and actions for flood management suggested.

A site walkover was undertaken on the 23rd January 2015 in order to assess the potential flooding mechanisms at the affected sites.

3.1 Southend Central Seafront (Eastern Esplanade, Marine Parade and Victoria Road)

3.1.1 Overview

The 19th September 2014 rainfall event resulted in the flooding of several residential and commercial properties within the central seafront area. 11 incidents were reported along Marine Parade. Four incidents were reported of commercial properties flooding in the section of Eastern Esplanade between Burdett Road and Southchurch Avenue, a further two between Burdett Road and Victoria Road and four on Victoria Road itself. This area previously suffered severe flooding on 24th August 2013 with many properties suffering repeated flooding on the 19th September 2014.

3.1.2 Mechanisms for Flooding

Eastern Esplanade and Marine Parade are located along the southern boundary of the borough in areas of low lying topography. As can be seen in Figure 3-1to the north of Marine Parade, the ground rises steeply with an approximate gradient of 1:2.5. The rise of the land to the north of the Eastern Esplanade is, however, more gentle. A bank runs diagonally across the borough, north of Eastern Esplanade, from Queensway at Marine Parade to Bournes Green with a slope of approximately 1:25.

Along Eastern Esplanade and Marine Parade, the roadway is very flat with frequent dropped kerbs. Commercial properties typically have low threshold levels. There is significant drainage infrastructure present along the highway of Eastern Esplanade, as can be seen in Photograph 3-1 and Photograph 3-2.

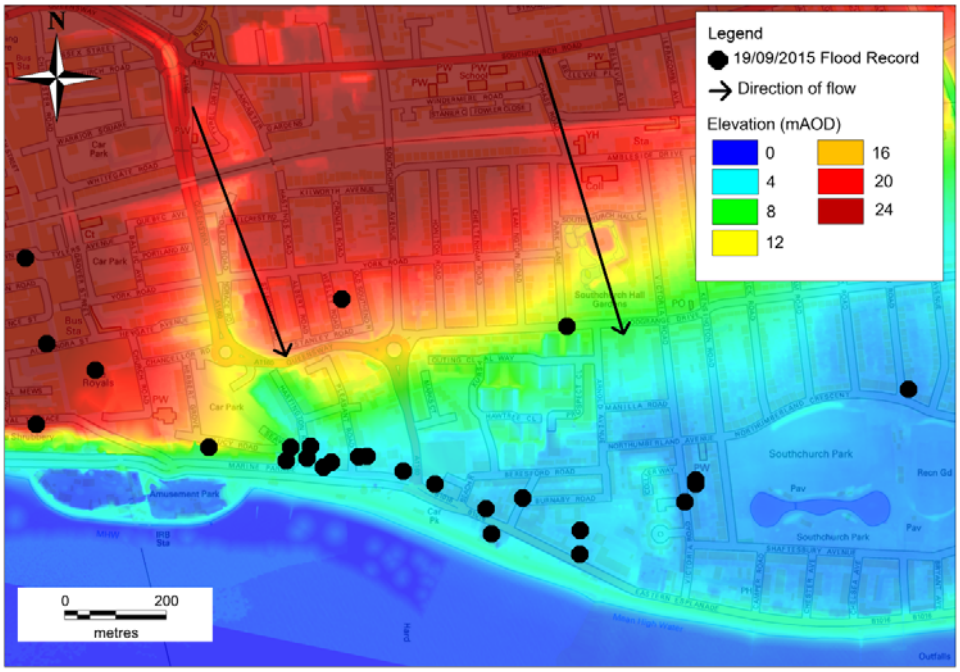
Photograph 3-1: Multiple inlets in the kerb (Eastern Esplanade)

Photograph 3-2: Linear drains in the kerb on Eastern Esplanade looking west

When heavy rainfall occurred on the 19th September 2014, flooding proceeded rapidly, washing into the commercial properties. This has been captured on CCTV footage, where the rapid onset of flooding implies that the volume and rate of rainfall exceeded the capacity of the drainage network, resulting in the rapid accumulation of surface water.

Victoria Road is located at a low elevation of approximately 2-3 mAOD and is susceptible to the accumulation of surface water runoff within the road channel. Frequently, this has resulted in water flooding properties on the eastern side of Victoria Road, 2 of which reported flooding on the 19th September 2014.

Figure 3-1: Topography around Southend-on-Sea Central Seafront
Contains Ordnance Survey data © Crown copyright and database right 2015



Examination of the Anglian Water drainage network shows that Eastern Esplanade and Marine Parade has a complex network of combined and surface water sewers that drain an extensive catchment area across the borough. Within the network, there are a number of Anglian Water assets that are used to manage storm overflows from the combined component of the sewer network. Some areas are also served by a separate surface water sewer network which is predominantly gravity drained to outfalls to the Thames Estuary.

As part of the surface water sewer network, there are two pumping stations in this area that operate to pump surface water to the Thames Estuary. The Eastern Esplanade Pumping Station is located opposite the junction of Eastern Esplanade and Burdett Road. The second is the Lifstan Way Pumping Station, to the east at the junction of Lifstan Way and Eastern Esplanade. The Eastern Esplanade Pumping Station operates one pump which discharges surface water at a rate of approximately 750 l/s. The Lifstan Way Pumping Station has one pump that operates at approximately 800 l/s and discharges water from the pond within Southchurch Park East. During the September 19th event, both pumping stations were operational.

Anglian Water records indicate that the gravity drained surface water outfalls along Marine Parade and Eastern Esplanade are at beach level and tend to be below the mean high water level. This includes a 675mm diameter pipe that discharges below Southend Pier. These outfalls are all fitted with tidal flap vales that ensure sea water cannot flow back up into the sewers. During high tides, these outfalls become tide locked, restricting the discharge of surface water into the sea, however the surface water network has capacity to retain some water within the system until the outfalls become available. In the event that the flap valves fail (e.g. stuck open) sea water will enter the system and reduce the storage capacity within the network. When the capacity of the network is exceeded there is the risk flooding of surface water flooding from the sewer network.

As described previously in Section 2.3, the most intense period of rainfall recorded at the Southchurch rain gauge occurred just before high tide, indicating that the outfalls are likely to have been tide locked at the time of peak discharge, which may have resulted in the reduced capacity of the drainage network.

Victoria Road is served by a complex network of surface water sewers that link into overflows to the boating lake in Southchurch Park. Anecdotal evidence on the 19th September 2014 suggests that a storm overflow sewer at the junction of Victoria Road and Shaftesbury Avenue was at capacity, as water was seen surcharging from manhole covers. Initial investigations suggest that is a result of the storm overflow outfall at Camper Road being stuck open.

3.1.3 Response to Flooding

At the time of the flooding event, Essex Fire and Rescue responded to a number of incidents across the central seafront area, where it was necessary to pump floodwater out of three properties and evacuate one property.

Following the flooding event, both SBC and Anglian Water have undertaken extensive investigations of the drainage network within the central seafront area. The surveys completed to date have found the surface water drainage network to be in good condition.

Due to the complexity of the drainage network within this area and the relationship between surface water and sewer flooding, SBC have appointed AECOM to develop an integrated model of the central seafront area. This is currently being developed and will provide both SBC and Anglian Water details of the interaction between the surface water and sewer flooding.

SBC Emergency Planning has identified two ‘strategic pumping locations’ at the junction of Jetty Mews and Victoria Road and at the junction of Hartington Road and Marine Parade. SBC have developed a procedure for Essex Fire and Rescue to deploy fire engines to this area to pump water from gully chambers, over the sea wall, during times of heavy rainfall.

SBC Emergency Planning has developed a ‘Traffic Management Plan’ that will be implemented by the SBC Highways team during future flooding events. To reduce the effect of flooding from bow-waves (waves created from vehicles driving through flood waters), measures have been put in place to allow for road closures.

SBC are looking at opportunities for incorporating flood risk management through future development within this area.

Anglian Water have outlined that as part of the surveys being completed, where areas have required cleaning, these have been highlighted on the maintenance schedule for annual inspection (and clearing if needed).

SBC and Anglian Water are investigating the potential blockage of the storm overflow outfall at Camper Road and will undertake necessary remedial works.

3.1.4 Suggested Actions

It is recommended that the maintenance regime for gullies (SBC highways) and the surface water drainage network (Anglian Water) is examined and updated as necessary to include more frequent cleansing in areas that are susceptible to flooding within the central seafront area.

Following the completion of modelling by AECOM on behalf of SBC, opportunities should be taken to examine potential flood management schemes. As the flood risk within this area is predominantly surface water and sewer flooding, joint investment from SBC and Anglian Water is suggested.

SBC should work with the local community and businesses to develop community flood groups, with the aim of promoting self-help, developing community knowledge and understanding of flood risk. As part of the flood group, SBC could work with communities to develop community flood resilience.

3.2 High Street

3.2.1 Overview

Surface water floods were reported across this area on 19th September 2014 with an incident of ground movement reported at Royal Terrace. Basement properties on Clifftown Parade suffered internal flooding with others narrowly avoiding flooding through bailing of water by residents.

3.2.2 Mechanisms of Flooding

The northern extent of the High Street and the surroundings areas are located at a relatively high topographic level of 30-35 mAOD. To the south of the study area there are steep slopes falling from approximately 30 mAOD at Clifftown Parade to approximately 10-5 mAOD at Royal Terrace and Lucy Road as shown in Figure 3-2.

Figure 3-2: Topography around the High Street area towards seafront
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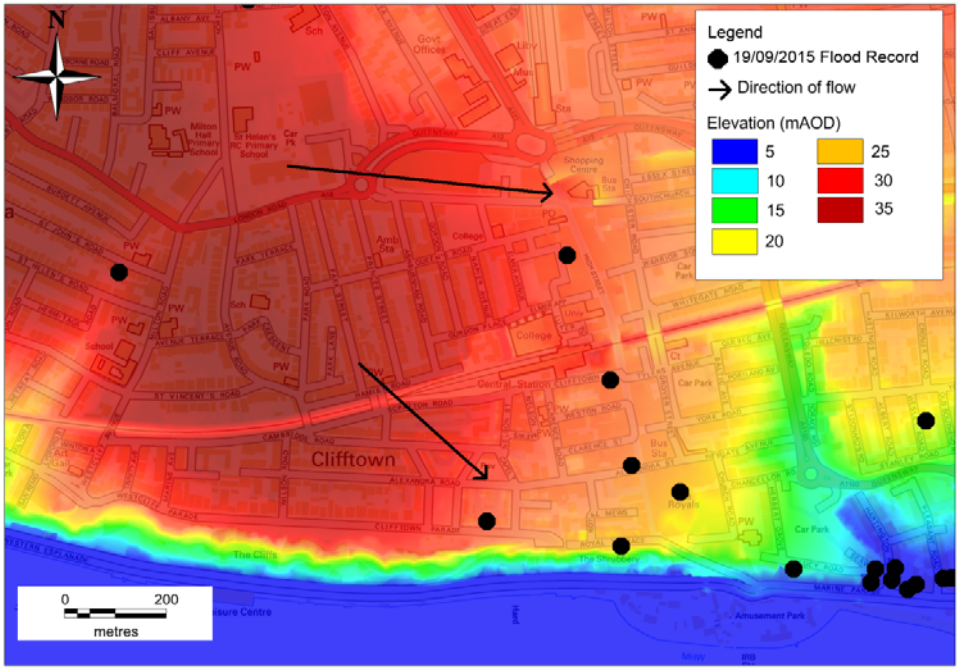

The area of the High Street itself is relatively flat (Photograph 3-3) except for a dip below the railway line. Observations of the gullies and kerb drainage were made during the site walkover. No obvious blockages or constraints were observed other than a small downward dip on Clifftown Parade, which could encourage ponding. Within the pedestrianized area, kerbs were not present, resulting in a flatter surface to assist with access. This results in fewer obstructions to surface water runoff where adjoining roads meet the High Street. With no significant topographical influence, it is likely that flooding around the High Street was due to the high intensity of rainfall, exceeding the drainage capacity of the sewer network.

As with the seafront area, reports from a property owner on Clifftown Parade have attributed the flooding to the sheer volume of water that fell in a short period, which was not able to drain away quickly enough. It is likely that the rainfall was so intense that it simply exceeded the drainage capacity of the local surface water drainage network.

Photograph 3-3: Flat, pedestrianized area of the High Street, looking North from The Royals Centre

Photograph 3-4: Clifftown Road, looking west from High Street with highway drainage evident

Photograph 3-5: The Shrubbery

Photograph 3-6: Looking up Pier Hill from Marine Parade

3.2.3 Response to flooding

Emergency response teams and Essex Fire and Rescue responded to a number of incidents within the area. It was necessary to pump out flood waters at Alexandra Street.

3.2.4 Suggested Actions

It is recommended that inspections of the drainage gullies and the surface water sewers are carried out in the areas which flooded to ensure they are operational and in good condition.

The High Street will be modelled as part of the central seafront model (discussed previously in section 3.1.3), as it forms part of the central seafront catchment area. As part of the modelling process, areas prone to flooding will be highlighted and if required, mitigation measures suggested.

3.3 Highland Boulevard and Vardon Drive

3.3.1 Overview

Highlands Boulevard is located to the west of Southend-on-Sea. Vardon Drive slopes down on a north-east direction from Highlands Boulevard towards the Prittle Brook. Flooding was recorded previously on both streets on the 24th August 2013 and 20th July 2014. Flooding was recorded again on the 19th September 2014.

3.3.2 Mechanisms of Flooding

As shown in Figure 3-3, Highlands Boulevard slopes in a northerly direction towards a tributary of Prittle Brook. There is a dip in local elevation as Highlands Boulevard turns to the north, where flooding was once more observed as it has been in previous incidents. Vardon Drive continues to slope downwards from Highlands Boulevard towards Prittle Brook. Incidents were recorded at the lowest parts of the street on 19th September 2014.

Figure 3-3: Topography of Highland Boulevard and Vardon Drive
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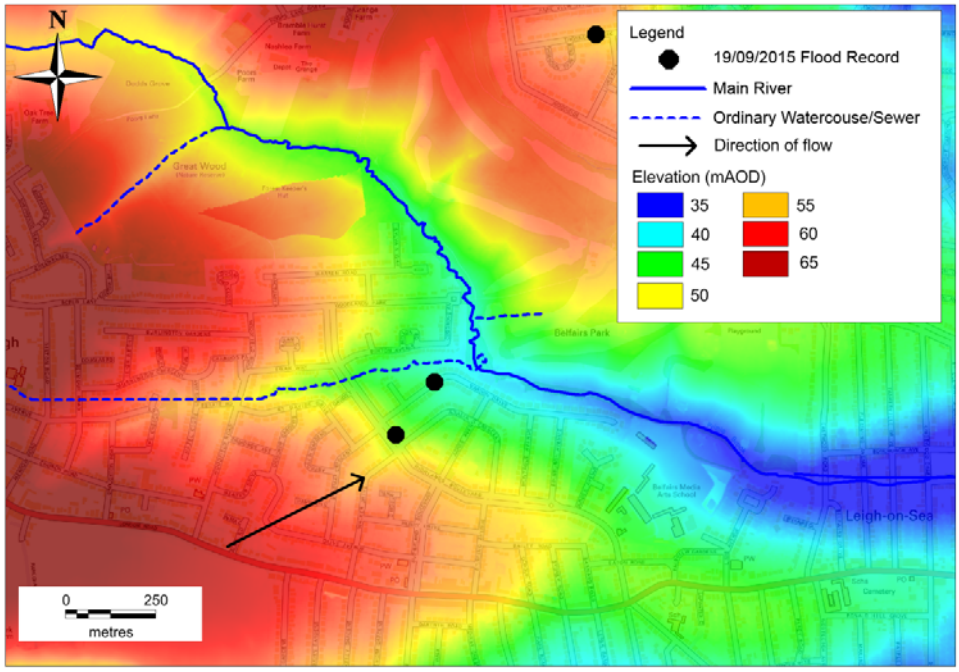


During the site walkover and from previous investigations, it has been observed that there is a considerable slope across the width of Highlands Boulevard, continuing along Vardon Drive. This suggests that the natural flow of surface water is towards Vardon Drive which has very little evident highway drainage along the downhill stretch from Highlands Boulevard.

Surface water runoff, generated from hard standing surfaces, would follow the channel of the road. In the event that the rate or volume of flow is increased, such as during an intense rainfall event, it is likely that water would exceed the capacity of the road channel and flow towards the properties on the northern side of Highlands Boulevard and bottom of the hill on Vardon Drive.

A gully was observed embedded in a dropped kerb above the road level. This appeared largely clear from blockage during the site walkover but would come under significant pressure in a heavy rain storm given the steep slope of the road and surrounds.

The surface water drainage network within the area discharges to a tributary of Prittle Brook. This surface water network also drains the area of Braemar Crescent and its adjoining roads. The southern part of Highlands Boulevard is drained in a north easterly direction towards Prittle Brook.

There is the potential, that if the water level of the tributary of the Prittle Brook rises above that of the surface water outfall, the discharge of surface water would be restricted and may cause backing-up within the local surface water drainage network.

However, flow readings of the Prittle Brook (Figure 2-3) suggest that levels were not particularly high at the time of heavy rainfall on the 19th September 2014. While the river levels may not have impacted surface water drainage at the time of the storm, river levels did rise shortly after the storm which may have impacted the rate at which surface water could drain away. Residents in Vardon Drive report that it took at least an hour after the rain had subsided for surface water to recede.

Photograph 3-7: Vardon Drive – gully embedded in dropped kerb on the bend in the road.

3.3.3 Response to Flooding

Following the previous flood incident on 20th July 2014, all the road gullies were cleaned by the council.

During the flood event of the 19th September 2014, the SBC Environment Care and Highways teams responded to flooding in this area. In the days following the incident, council officers carried out a detailed inspection of the manholes on Vardon Drive to investigate resident concerns that the pipe sizes were inadequate to drain the area. The investigation found that the pipe sizes were in fact larger than previously thought and should be more than adequate for purpose.

During inspection, the outfall at the main head wall which meets the Prittle Brook was found to be severely blocked by detritus and debris, which was removed on 23rd September by a council contractor. It is likely that much of the debris was washed into the system during the rainfall event.

It was noted during the site walkover on 23rd January that highway improvements have been made outside the properties at the lowest point on Highlands Boulevard including a new gully and works to the footway (see Photograph 3-10).

Photograph 3-8: Highlands Boulevard looking north west highlighting the distinct slope in the road towards the affected properties

Photograph 3-9: Vardon Drive looking west from lowest point

Photograph 3-10: Works evident outside affected properties on Highlands Boulevard including new gully in addition to two others in the kerb and new surfacing to the footway.

3.3.4 Suggested Actions

A number of highway assets have undergone or are currently undergoing replacement and improvement within the area:

- Highlands Boulevard - Storm drainage improvements in tandem with residents in-curtilage drainage measures; and,
- Vardon Drive – Gully cleaning and new double road gullies installed in January 2015.

Proposed longer-term management actions recommended for Vardon Drive include cyclic CCTV surveillance to ensure the clear passage of gullies, monitoring of weather forecasts and the arrangement for an Environmental Care Officer to check the condition of road gullies and outfalls on a regular basis.

It is also recommended that use of property level protection is investigated by residents in Vardon Drive as they remain vulnerable in extreme events particularly when they coincide with high river levels in the Prittle Brook.

3.4 Cricket Field Grove

3.4.1 Overview

Prior to the 19th September 2014 flood event, SBC were made aware of one record of flooding at Cricketfield Grove on the 24th August 2013. However following the heavy storm on 19th September 2014, residents advised their local councillor that the street was flooding 2-3 times per year up to knee height. This has resulted in vehicle damage and water washing into properties.

3.4.2 Mechanisms for Flooding

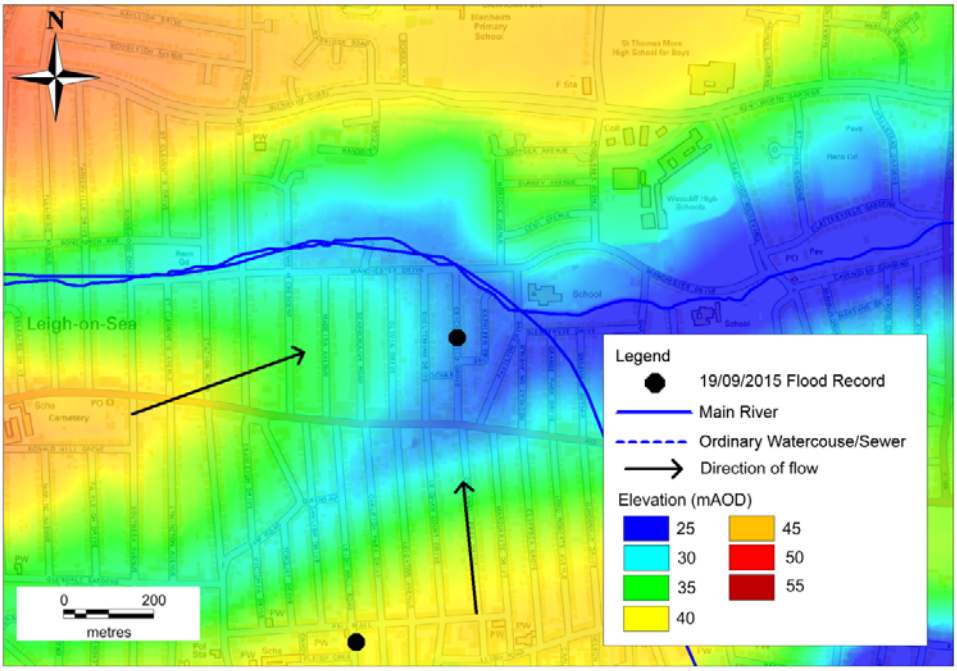
Figure 3-4 shows Cricketfield Grove to be located within a topographical depression associated with the Prittle Brook floodplain. Cricketfield Grove lies at approximately 25 mAOD with relatively steep slopes to the north and west reaching approximately 40 mAOD. The street itself is relatively level, surface water from the surrounding area is likely to pond here during heavy rainfall, particularly if the drainage network is at capacity.

During extreme rainfall events, such as that experienced on the 19th September 2014, the combined and surface water drainage networks were likely to be overwhelmed resulting in reduced drainage capacity.

During the site walkover, it was noted that the surface water outfall pipe to Prittle Brook under Manchester Drive was quite low (Photograph 3-13) and therefore likely to get obstructed when the river levels rise. When high river levels combine with a heavy rainstorm, surface water could quickly back up the drainage system into low lying streets like Cricketfield Grove.

Additionally, it has been noted that parked cars along most of the street present obstructions to gully cleaning vehicles. This can prevent the gullies being jetted as regularly as they are scheduled to be and impede effective road drainage. The council contractor's gully cleansing records show 11 gullies were checked on Cricketfield Grove on 12th May 2014. One gully was not cleaned due to a parked car and all the others were running clear at that time.

Figure 3-4: Topography of Cricketfield Grove and surrounding area
Contains Ordnance Survey data © Crown copyright and database right 2014



Photograph 3-11: Cricketfield Grove looking north to Manchester Drive. Manholes and gullies present

Photograph 3-12: Parked cars along Cricketfield Grove can obstruct gully cleaning

Photograph 3-13: Outfall pipe into the Prittle Brook observed underneath Manchester Drive

3.4.3 Response to Flooding

No emergency response has been recorded at this location as there are no records of a response agency being informed of flooding. The report of regular flooding has been provided by a local councillor following a letter received from residents after the storm on 19th September 2014.

3.4.4 Suggested Actions

More information is required about the flooding in Cricketfield Grove including specific locations in the road that seem most prone to surface water ponding. SBC should engage with local residents about their experiences to inform further investigation into the local drainage system. Further to this, the sewer infrastructure and outfalls to the Prittle Brook should be inspected for blockages and to ensure the capacity is adequate to drain the area.

3.5 Chalkwell

3.5.1 Overview

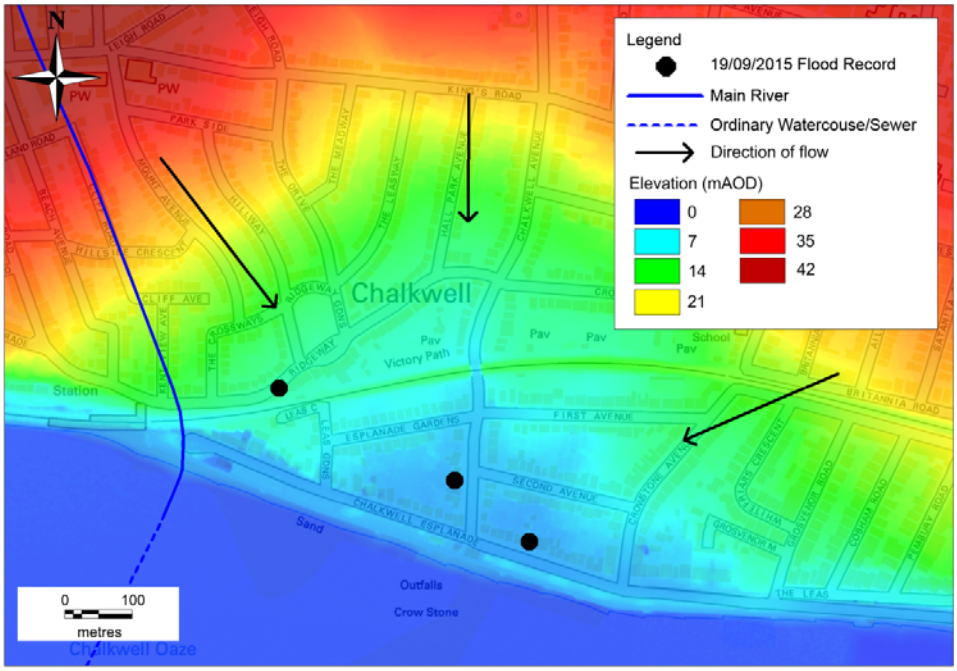
The area of Chalkwell has experienced significant flooding on 24th August 2013 and further flooding on 11th October 2013 and 20th July 2014. On 19th September 2014, flooding was once again reported with three incidents on the Ridgeway affecting commercial properties including a surcharging manhole, a flooded basement Chalkwell Esplanade and a further incident on Chalkwell Avenue.

3.5.2 Mechanisms for Flooding

Figure 3-5 shows that Chalkwell Esplanade is at a low point in the local topography, with an elevation of approximately 4 mAOD. The low lying land, predominantly along the coastline, extends inland in the Chalkwell area. To the north of the affected area, the land rises rapidly at a gradient of approximately 1:20 to a higher elevation of approximately 40 mAOD.

The property flooding along Chalkwell Esplanade was a basement car park which has flooded previously due to its low threshold level. It is reported that a new flood barrier had been installed at this location, but failed to work on 19th September 2014.

Figure 3-5: Topography of Chalkwell and surrounding area
Contains Ordnance Survey data © Crown copyright and database right 2014



Surface water flooding has repeatedly affected commercial properties on the south side of the Ridgeway where a number of dropped kerbs provide a direct pathway for surface water flowing off the higher ground to the north and east. During the site visit on 23rd January 2015, it was observed that work has been carried out to the drainage system in the highway in front of previously affected properties (Photograph 3-14). It was also noted that a number of the existing road gullies had become quite silted up (Photograph 3-15).

Photograph 3-14: New highway improvements on the Ridgeway observed 23/01/2015

Photograph 3-15:The Ridgeway, some road gullies appear heavily silted up on 23/01/2015

The sewer network within this area is largely combined. Chalkwell Pumping Station, located at the eastern end of Chalkwell Esplanade, functions to pump surface water into the Thames Estuary. The pumping station receives overflows from five large pipes draining from Chalkwell Esplanade and Chalkwell Avenue (which receives drainage from the Ridgeway).

In addition, there are another five gravity drained surface water outfalls that discharge surface water at a level of approximately 300mm above beach level, below the mean high water level. As these outfalls are gravity drained, they are fitted with flap valves to prevent backfilling during periods of high tide.

The predominant cause of flooding within this area is associated with the low lying nature of the land in relation to the land to the north, and the presence of a relatively steep slope surrounding the area. As the land to the north is heavily urbanised, the large impermeable surface area is likely to exacerbate surface water runoff, resulting in surface water flooding to the south.

The drainage network also appears to have been overwhelmed within local areas. Water surcharging from the sewer as reported on the Ridgeway would have increased the extent of flooding in the low lying Chalkwell area. The heavy storm on 19th September 2014 occurred just before high tide which may have impeded gravity drained outfalls to the Thames Estuary leading to surface water backing up in the drainage network. The newly installed pumps at Chalkwell Pumping station were operational during the storm event.

3.5.3 Response to Flooding

Essex Fire and Rescue were called to incidents on Chalkwell Avenue and Chalkwell Esplanade, where pumping was required of a basement car park.

Officers from SBC Highways have been investigating blockages within the road gullies in the steep roads north of the Ridgeway which may be contributing to surface water overshooting gullies further up the hill and ponding on The Ridgeway.

Anglian Water have surveyed the surface water drainage network downstream of The Ridgeway and along Chalkwell Avenue and found no issues.

Surveys completed by SBC along Crowstone Avenue found the road gully connections to have been damaged. These have since been replaced.

Following flooding on the 19th September 2014, Anglian Water have installed non-return valves, flood doors and flood gates on properties that had flooded along Chalkwell Avenue and Chalkwell Esplanade.

SBC are investigating the need for additional road gullies to be installed at the junction of Chalkwell Esplanade and Chalkwell Avenue.

3.5.4 Suggested Actions

Natural topography and urban surroundings mean this area will always be vulnerable to surface water flooding. Longer-term management should investigate whether improvements can be made to the drainage capability of the area, which could include a number of measures:

- Reviewing gully cleaning cycles and considering increased cleaning regimes at known 'hotspots' at low topographical points prone to silting up.
- Investigate feasibility and benefits of installing additional road gullies or other drainage infrastructure to capture more surface water during heavy rain.
- Investigate property level protection options for those at most risk.
- Investigate potential installation of emergency temporary over-pumping equipment at Chalkwell Esplanade to prevent the storm network surcharging along The Ridgeway and the surrounding affected areas to the north when the surface water drainage capacity is exceeded in exceptional rainfall events.

3.6 Western Esplanade

3.6.1 Overview

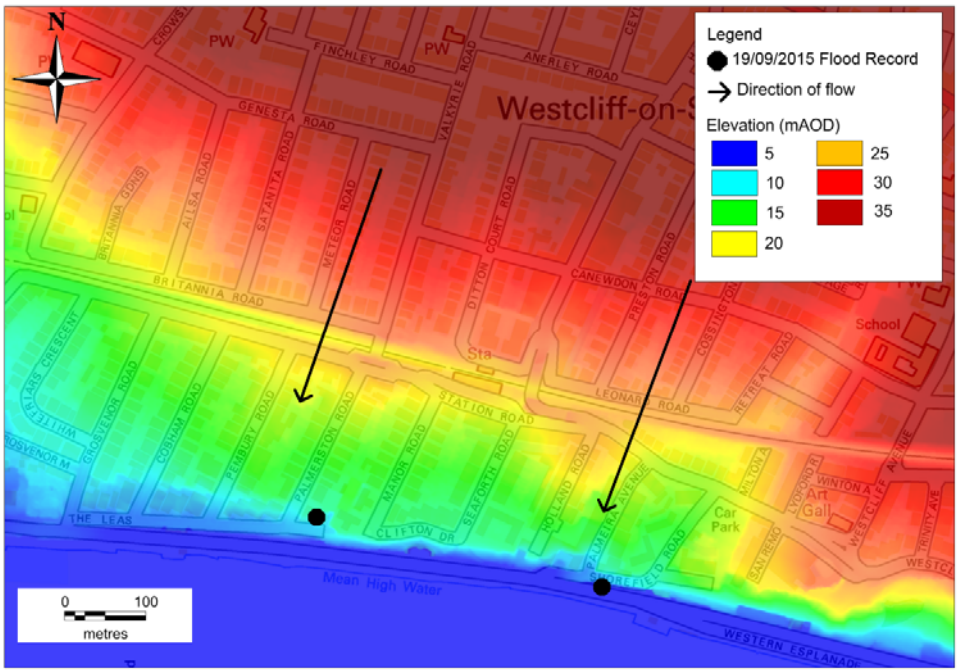
Two incidents were reported in this area on 19th September 2014; one incident of sewer surcharging in a residential property and one of damage to the carriageway (Photograph 3-16).

3.6.2 Mechanisms for Flooding

Figure 3-6 shows that there is a considerable drop in elevation from areas such as Clifton Drive and the northern extent of Palmerston Road to the Western Esplanade and the sea front (from 12.5 mAOD to 4.5 mAOD).

Surface water from Western Esplanade and The Leas (where incidents were recorded on 19th September 2014) drains via a separate surface water network that discharges via a gravity outfall to the Thames Estuary. Due to the high tides at the time of the storm, it is likely that the capacity of the network was reduced by tide locking of the outfall. Water would therefore not have been able to discharge freely from the network. As the drainage area is heavily urbanised, runoff would be rapid. The capacity of the network would therefore reach capacity shortly after the rainfall. Both incidents occurred close to junctions in the network which would support this as a cause of flooding.

Figure 3-6: Topography of Western Esplanade and surrounding area
Contains Ordnance Survey data © Crown copyright and database right 2014



Photograph 3-16 a, b & c: Damage to the carriageway on Western Esplanade caused by flooding on 19th September 2014

3.6.3 Response to Flooding

Following previous flooding events, as part of cliff stabilizations works, SBC are installing a flood relief system that will manage overland flow generated from the area to the north. This will discharge to the Western Esplanade before draining to the Thames Estuary.

Anglian Water has installed non-return valves on basement properties located along The Leas that had been subject to flooding.

3.6.4 Suggested Action

The nature of flooding on 19th September 2014 suggests that the drainage network was unable to cope with the volume of surface water. It is therefore suggested that Anglian Water should undertake a survey of the network to determine if the current infrastructure is adequate for managing rainfall in this area.

Due to the topography of the area, roads closer to the seafront will be more susceptible to surface water flooding. SBC should ensure highways gullies remain clear within this area to prevent water accumulating within the road and investigate whether improvements are possible to increase the ability of the drains to cope in more extreme weather events, particular during occasions of tide lock.

3.7 Northumberland Crescent

3.7.1 Overview

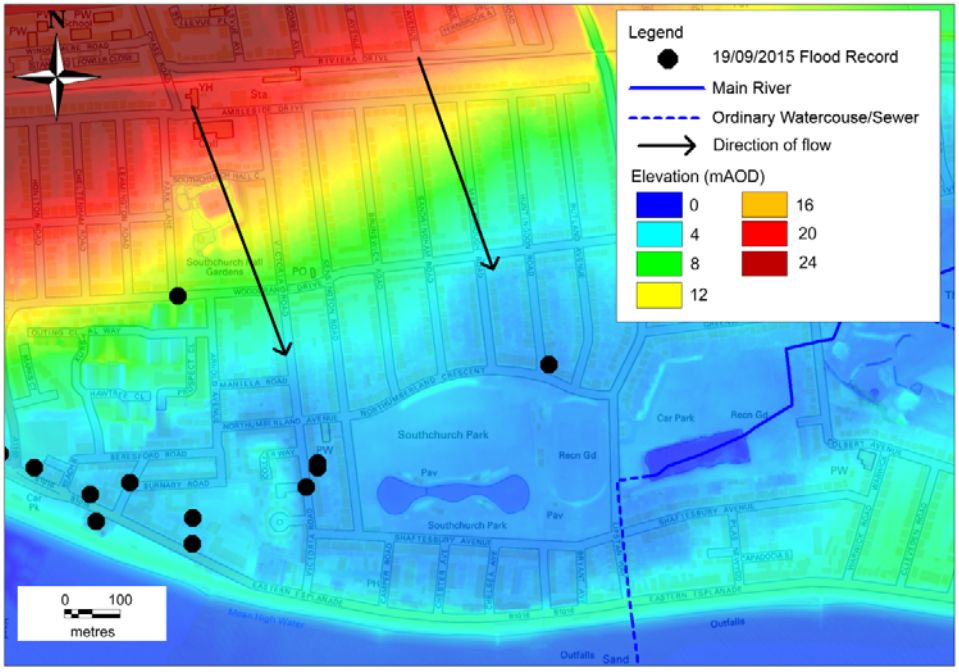
A residential property on the corner of Northumberland Crescent and Huntingdon Road has previously suffered serious internal flooding on 24th August 2013 which was attended by emergency services and has once again been affected by flooding on 19th September 2014.

3.7.2 Mechanisms for Flooding

The area of Northumberland Crescent is relatively flat, and low-lying at approximately 0-3 mAOD as shown in Figure 3-7. The elevation rises to the north of the study area reaching 9-10 mAOD towards the northern end of Brunswick Road. Therefore there is a reasonably steep slope leading down to Northumberland Crescent. The affected property sits at a particular low point where surface water would naturally collect when the capacity of the local drainage system is exceeded.

The local surface water drainage network flows from Northumberland Crescent and the surrounding residential areas in an easterly direction, before turning south at Lifstan Way. The site of flooding sits at a junction in the sewage network where two surface water sewers meet, which may be creating a pinch point during heavy storm events. Surface water is drained by gravity, or is pumped by the Lifstan Way Pumping Station at times of high tide. A pressured surface water sewer also passes beneath Northumberland Crescent, before crossing Southchurch Park and discharging via the Lifstan Way Pumping Station. Anglian Water has completed surveys of the surface and foul network within the area. Tree roots were found to be blocking the surface water gullies at the junction of Huntingdon Road and Northumberland Crescent.

Figure 3-7 Topography around Northumberland Crescent
Contains Ordnance Survey data © Crown copyright and database right 2014



Photograph 3-17 Northumberland Crescent looking east

Photograph 3-18: Residents affected by flooding have installed a new boundary wall as property level protection

Photograph 3-19: New Highway drainage work observed on 23/01/15 outside affected property on Huntingdon Road

Photograph 3-20: A double gully is present in Northumberland Crescent opposite junction with Huntingdon Road

3.7.3 Response to Flooding

Emergency services responded to a flooding incident in Northumberland Crescent however no action such as pumping was reported to have been undertaken.

Anglian Water completed surveys of the surface water and foul drainage networks within the area. Tree roots found to be obstructing the surface water gullies were removed. Anglian Water will conduct quarterly reviews of the drainage network to check for intrusion of tree roots.

In response to the flooding, Anglian Water fitted non-return valves and airbrick covers to the property affected. SBC have made gel bags available to affected residents.

SBC have installed additional gullies on Northumberland Road as well as the development of a rainwater channel within the footway, to manage roof drainage.

3.7.4 Suggested Actions

SBC should consider the potential to alleviate flooding from Northumberland Crescent and the surrounding area through a management scheme utilising the capacity of the lakes within Southchurch Park east and west.

3.8 Fairfax Drive

3.8.1 Overview

Although flooding has not been well documented previously at this location, following heavy rain on 19th September 2014, shopkeepers reported having been flooded three times over the last year and numerous times in the past. Four incidents of property flooding were reported on this occasion.

3.8.2 Mechanisms for Flooding

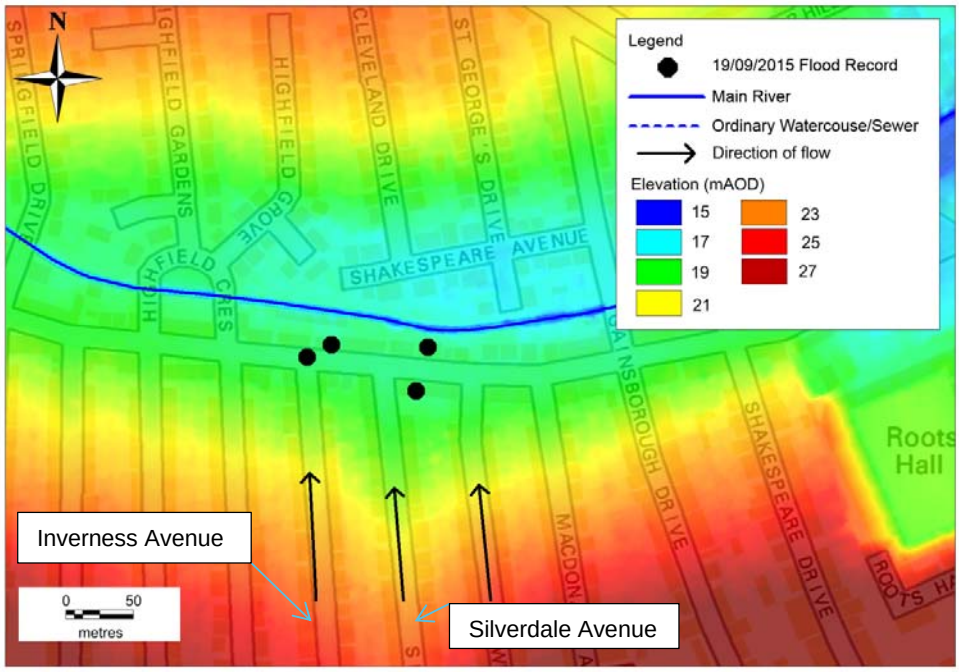
Fairfax Drive lies at approximately 17-19 mAOD and is relatively flat, following the floodplain of the Prittle Brook as shown in Figure 3-8. To the north and south of Fairfax Drive the land slopes upwards extending up to 25 mAOD. As a result, surface water will be channelled towards this location in heavy rainfall events.

It is reported that on 19th September 2014, floodwater was coming down Inverness Avenue and Silverdale Drive (South of Fairfax Drive) and pooling in the area around the shops. Reports to SBC indicate that gullies on Inverness Avenue and Silverdale Avenue were not draining surface water properly, potentially as a result of blockages.

During the site visit on 23rd January 2015, it was noted that vehicle parking was very dense along these streets which is likely to be an obstruction to effective gully jetting in this area. A number of gullies observed appeared to be silted up.

Video footage of the 19th September 2014 provided by a business owner shows significant flooding in the road as people are seen bailing water from his property. A parking layby located in front of some of the worst affected properties does not currently have any drainage and properties have very low thresholds so as surface water accumulates, it will tend to flow towards properties once it overtops the kerb level.

Figure 3-8: Topography of Fairfax Drive and surrounding area
Contains Ordnance Survey data © Crown copyright and database right 2014



There are a number of surface water sewers in the area which drain towards Fairfax Drive from the south. These surface waters discharge via sewer outfalls into Prittle Brook. High water levels in Prittle Brook would potentially restrict the surface

water outfalls, impeding the highway drainage. Likewise, debris accumulating within the surface water drainage network could result in blockages.

The reported incidents on 19th September 2014 occurred close to one of the outfalls to the Prittle Brook so this could have influenced the local highway drainage. It is also possible that the small number of gullies in this area, and their condition, are not adequate in transporting the surface water to the outfall at a sufficient rate and the system simply becomes overwhelmed in storm conditions.

3.8.3 Response to Flooding

Emergency services responded to incidents along Fairfax Drive.

SBC have investigated the potential to increase the surface water drainage within the area of flooding. Two road gullies have been installed in Fairfax Drive outside of the affected properties (completed 20th November 2014).

SBC have arranged for the road gullies along Fairfax Drive, Inverness Avenue and Silverdale Avenue (adjacent roads) to be checked and cleared if needed.

3.8.4 Suggested Actions

The proximity of this area to Prittle Brook makes it particularly vulnerable to surface water flooding where water is not able to freely drain to the river for any reason. An inspection should be carried out to the outfall pipes to ensure they are running clear. It is recommended this is done on a cyclic basis given the vulnerability of the properties in this location. A review of gully jetting should be carried out to identify whether gullies are being regularly missed due to parked cars.

The SBC Highways team should investigate the feasibility of adding additional drainage gullies to enable surface water to drain away more quickly, whilst confirming that the size of the surface water sewer in this area is adequate to cope with the volumes of water that collect on Fairfax Drive.

3.9 Central Southend and Victoria Avenue

3.9.1 Overview

A number of dispersed flooding incidents were recorded to property and the highways in the central Southend area and Victoria Avenue on the 19th September 2014. There are records of significant highway flooding in Victoria Avenue previously on 24th August 2013 and 11th October 2013.

3.9.2 Mechanism for Flooding

Across the central Southend area, the land tends to slope from the south towards Prittle Brook. Elevations decrease from approximately 35 mAOD to 11 mAOD at Pritlle Brook (Figure 3-9).

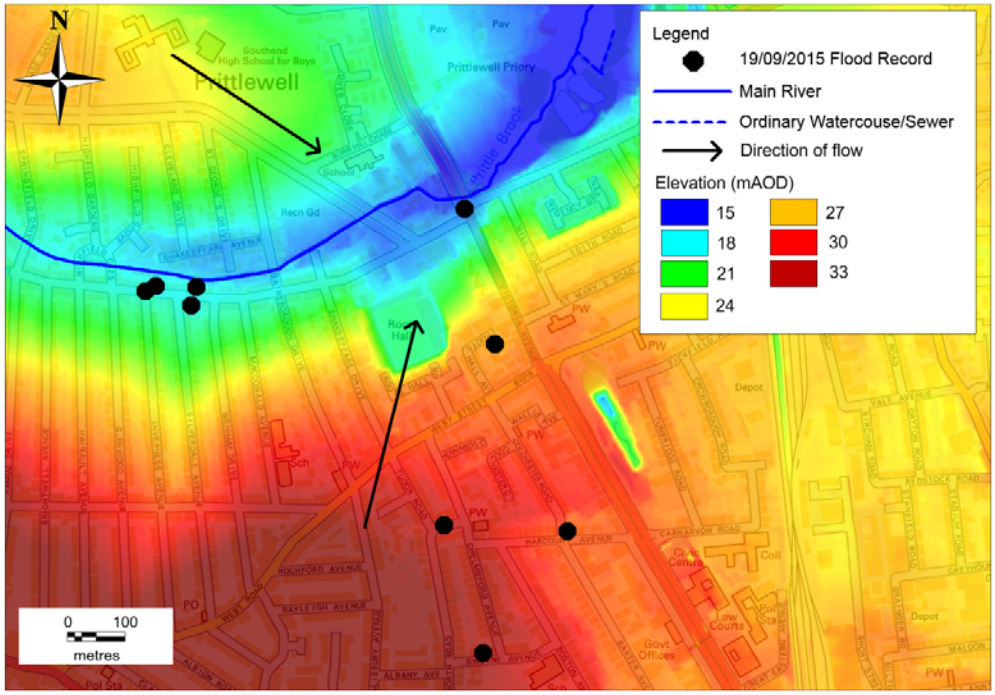
Flooding of Victoria Avenue near the junction with Fairfax Drive and Priory Crescent has occurred a number of times during heavy storms in the last couple of years. It is a low point on the landscape where the road slopes down from both sides. Additionally, water drains to the Prittle Brook just below, leaving the road vulnerable to backed up drainage where outfalls are impeded by high river flows or blockages.

The locations of other reported incidents in the area on 19th September 2014 were investigated during the site visit. They are not located at particular topographical low points, suggesting they may have been influenced by issues with the local drainage. Surface water sewers run along Victoria Avenue and receive surface waters from the surrounding areas of West Street and Harcourt Avenue. Generally surface water sewers flow northwards towards Prittle Brook.

During the site visit it was observed that there was very little drainage present in the road around a reported incident site at North Road, and the camber of the road slopes slightly north where there are a number of dropped kerbs providing a flow path for any accumulating surface water. The public house on the corner has a basement cellar which would be vulnerable.

A reported incident on the corner of Harcourt Avenue and Colchester Road is located close to a change in direction of the surface water sewer, which may be creating a pinch point at this location.

Figure 3-9: Topography of central Southend area
Contains Ordnance Survey data © Crown copyright and database right 2014



Photograph 3-21: Victoria Avenue looking north towards junction with Fairfax Drive

Photograph 3-22: North Road looking east. Low kerbs and minimal drainage observed. Insert of entry to basement cellar.

Photograph 3-23: Corner of Harcourt Avenue and Colchester Road looking north

3.9.3 Response to Flooding

Emergency services were called in relation to a number of flood incidents in central Southend-on-Sea. An incident at Sweyne Avenue required assistance in making the area safe.

3.9.4 Suggested Actions

The most likely cause of flooding in this area is related to the drainage either through insufficient capacity or blockages. It is recommended that Anglian Water conduct CCTV survey of the sewers in the vicinity of reported incidents to establish where there may be capacity problems or potential blockages. SBC Highways should review the road drainage infrastructure in this area to ensure it is adequate to cope with expected volumes of runoff.

3.10 Symons Avenue

3.10.1 Overview

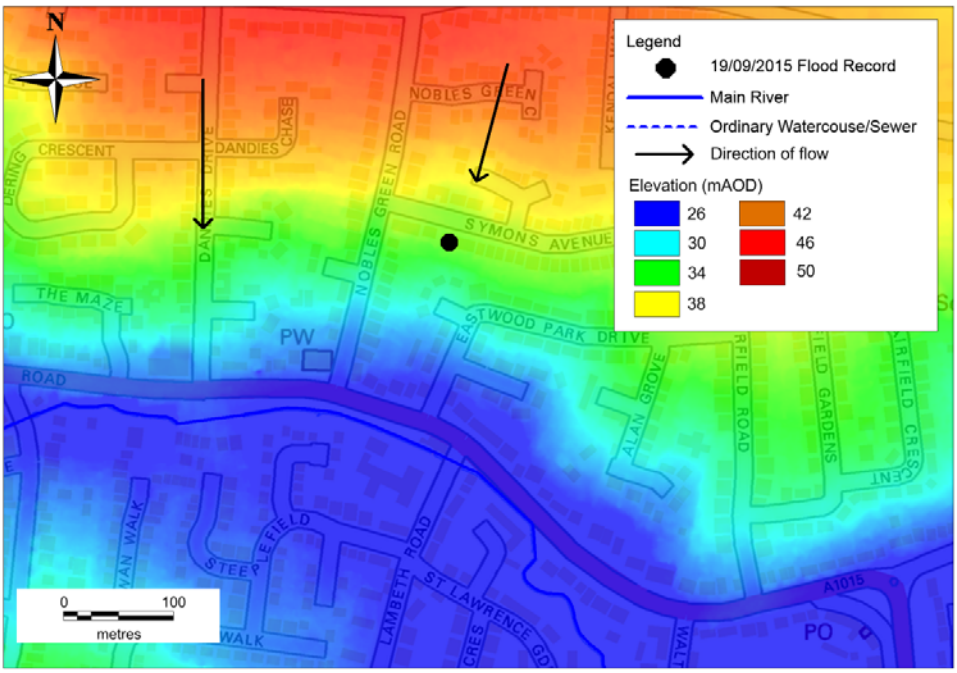
Properties in Symons Avenue are reported to have been affected by surface water flooding on 19th September 2014. Despite no previous records held by the council of flooding for this location, a resident has since reported frequent flooding since around 2008. Additionally, remedial works have already been carried out here to address a known problem by an Anglian Water contractor.

3.10.2 Mechanisms for Flooding

Land to the north of Symons Avenue rises upwards to approximately 50 mAOD at Green lane. From here the land slopes continually down towards Eastwood Brook passing Symons Avenue at 35-40 mAOD (Figure 3-10). The camber of the road slopes to the south. On the southern side of the road, driveways slope downwards towards the properties leaving them vulnerable to surface water runoff during rainfall events.

Following previous flood events, it is reported that a number of new gullies were fitted in Symons Avenue in an attempt to alleviate the problem. There is conflicting anecdotal evidence as to whether flooding has been alleviated with community members suggesting there was a marked improvement with some of the gullies working efficiently. However a gully outside house number 20 was observed to start back flowing whilst one opposite house number 20 did not appear to take water at all leaving the road full of water and several inches flowing into residents' garages.

Figure 3-10: Topography of Symons Avenue area
Contains Ordnance Survey data © Crown copyright and database right 2014



3.10.3 Response to Flooding

SBC have cleared and replaced a gully within Symonds Avenue that was blocked at the time of flooding.

3.10.4 Suggested Actions

It is evident that recent improvements to the highway drainage on Symons Avenue, although partially successful, have not solved the problem of flooding here. Observations from the 19th September 2014 flood suggest there could be some form of

blockage within the local surface water drainage network which requires further investigation from Anglian Water to ensure surface water does not continue to back up in certain points in the road.

SBC's Highway team are in discussions with Anglian Water to investigate improvements to the storm flow at this junction. Improvements to storm flow at this junction would prevent back flow through storm drains into the low lying areas of Symons Avenue.

3.11 Other Areas Affected

3.11.1 Prince Avenue

Prince Avenue (A127) forms a key access route to and from central Southend-on-Sea. Previous incidents have been recorded within this area on 20th July 2014 and 24th August 2013. On 19th September 2014, carriageway flooding was once again reported between the Roundabout near Tesco along towards the junction with Hobblythick Lane.

Surface water is channelled towards Prince Avenue from higher ground to the south. Repeated incidents of carriageway flooding here suggest that drainage is being impeded. Recommendations from the 20th July 2014 Flood Investigation should be pursued including a CCTV survey to determine if there are any blockages or features of the sewer which are likely to reduce its hydraulic capacity. SBC should assist in this through assessment of the highway drainage system which connects to the Anglian Water surface water sewer.

3.11.2 Warners Bridge Roundabout

This area has recorded incidents of flooding from 20th July 2014, 24th August 2013 and 11th October 2013. The roundabout and footway flooded once again on 19th September 2014. The roundabout is at a topographical low point which drains to a tributary of the Prittle Brook making it particularly vulnerable both to surface water flowing off higher ground and backing up of the drainage system when river flows are high.

SBC undertook works to create a chamfered edge to allow for the enhanced flow of surface water into the gullies. This work was completed on the 6th of August 2014. SBC have noted that the kerb inlets are fitted with vertical bars to trap debris, however as a result, these are prone to blockage.

SBC should consider reviewing the road gully provision at the roundabout as well as along the adjoining roads.

3.11.3 Woodgrange Drive

Highway flooding was reported in Woodgrange Drive on 19th September 2014. Emergency services were called to assist an individual at 22:04 from a stranded vehicle which was trying to cross a flooded public highway. The Southend Echo published photos of the carriageway flooded on the junction with Victoria Road in their online article on 20th September 2014.

The local surface water drainage network at this location flows south to outfalls at the Thames Estuary. It is possible that the high tide impeded drainage to the Thames Estuary causing the local surface water drainage system to back up to this location.

Flooding is also known to have occurred to the east of Woodgrange Drive, where properties back onto the embankment of the railway line. Anglian Water, SBC and the Environment Agency are investigating local drainage at this location as it is thought that a land drain runs adjacent to the properties and the railway embankment, towards the Willingale Brook, east of Woodgrange Drive. This land drain may have contributed to surface water flooding at this location.

3.12 Summary of Flooding

Flooding on the 19th September 2014 resulted from a short duration of exceptionally heavy rainfall. The centre of the storm was focused to the south and west of Southend-on-Sea. Rainfall data has been collected from both radar data and local rain gauges and have provided an estimation of a return period of between 1 in 23 and 1 in 293 years.

Flooding on the 19th September 2014 was primarily a result of exceptionally intense rainfall, falling across the central seafront area of the borough. The mechanisms for flooding on the 19th September 2014 can be broadly defined into the following categories:

- **Exceedance of drainage network capacity** – In areas including Marine Parade, Vardon Drive and Fairfax Drive, reports suggest that the capacity of the local drainage network was overwhelmed by the intensity of the rainfall. As a result, surface water was not able to enter the drainage network and so accumulated in areas of low-lying topography.

- **Surcharging of the drainage network** –Reports indicate that surface water was surcharging out of gullies in some locations including Victoria Road, Chalkwell Esplanade and The Ridgeway. It has been highlighted that a more detailed investigation is required by Anglian Water in locations that are repeatedly flooding despite new highway drainage being installed or cleared such as Symons Avenue, Northumberland Crescent and The Ridgeway.

- **Maintenance issues** - Flooding at the Warners Bridge Roundabout was considered to be a result of maintenance issues, restricting the function of the highway drainage.

- **Tide-locking** – The tide level was approaching high tide at the time of the rainfall event on the 19th September 2014, meaning it would have been higher than the level of tidal outfalls along the seafront impeding outward drainage. It is possible that not all tidal flap valves were correctly functioning leading to seawater ingress to the overloaded drainage system.

4 Flood Investigation Outcomes

4.1 Overview

This section of the flood investigation report aims to outline a summary of the responses from each of the RMAs which operate within the SBC area and the suggested actions for further management of flood risk in the future.

4.2 Southend-on-Sea Borough Council

4.2.1 SBC as Lead Local Flood Authority

As the LLFA, SBC has conducted this flood investigation report in response to the flood incidents arising on the 19th September 2014. This report has been compiled through collaborative working with relevant RMAs and stakeholders. This flood investigation report will be published, at which time relevant RMAs and stakeholders will be notified.

In addition, SBC will coordinate with RMAs for further work and investigations in the future and will work collaboratively with local communities to address flooding issues.

4.2.2 SBC as the Highways Authority

The SBC Highways and Environmental Care teams provided the first response to flooding in most incidents which were reported to SBC. SBC operatives attended calls, assessed risk and determined appropriate responses. For many of the incidents, pumping of flood water was not viable and therefore cones, barriers and warning signs were set up as needed and sandbags were distributed.

SBC as the Highways Authority is responsible for the maintenance of the highways across the borough. A large proportion of reported flood incidents on the 19th September and subsequent remediation actions were related to highways, particularly blocked gullies. Consequently the SBC Highways team undertook a number of investigations in the following areas;

- Shaftesbury Avenue;
- Thorpe Hall Avenue;
- Hartington Road;
- The Ridgeway;
- Thorndon Park Drive;
- Samuels Drive and Chadacre junctions with Burlescombe Road; and,
- Ennismore Gardens.

Additionally, a number of highway assets underwent/are currently undergoing replacement and improvement as follows:

- Chalkwell Esplanade and the Leas – Gullies and drainage channels installed;
- Northumberland Crescent – Gullies and rainwater channel installed;
- Clifton Drive – Cliff flood relief scheme to manage overland flow along with cliff stabalisation works;

- Highlands Boulevard - Storm drainage improvements in tandem with residents in-curtilage drainage measures; and,
- Vardon Drive – Gully cleaning and new double road gullies installed on the 5th/6th January 2015.

Some recent drainage improvements have not shown to be effective and further action is required:

Symons Avenue – Despite drainage improvements and the installation of new gullies, there is conflicting anecdotal evidence as to whether flooding has been alleviated at Symons Avenue. Community members suggest there was a marked improvement with some of the gullies working efficiently. However a gully outside house number 20 was observed to start back flowing whilst one opposite house number 20 did not appear to take water at all leaving the road full of water and several inches flowing into residents' garages.

Irrespective of whether the installation of new gullies has proven beneficial for flood alleviation, there is a requirement for further improvements to the main storm drain network, specifically at the connection to Nobles Green Road network. Consequently, SBC's Traffic and Highway Network division are in discussions with Anglian Water Services to investigate improvements to the storm flow at this junction. Improvements to storm flow at this junction would prevent back flow through storm drains into the low lying areas of Symons Avenue.

Areas for broader, longer-term review include the **north side of the Marine Parade** between Southchurch Avenue and Hartington Road which comprises a number of commercial premises by Strategic Transport and Planning Policy.

Similarly, for **Vardon Drive**, long-term maintenance includes CCTV surveillance to ensure clear passage of gullies, monitoring of weather forecasts and the arrangement for an Environmental Care Officer to monitor the condition of road gullies and keep the outfall under observation.

SBC operate a bi-annual clearing of highway drains and gullies as part of their rolling street cleansing programme across the borough. However gully leads are not regularly inspected. SBC operate a reactive approach to the maintenance of gully leads, responding when flooding is observed. Although the network is extensive, SBC should consider developing a proactive maintenance strategy, focusing in areas at greatest risk of surface water flooding.

4.2.3 SBC as a Riparian Owner

As riparian owner, SBC should undertake frequent maintenance and visual inspections of watercourses under their responsibility. This will ensure that flows within the ordinary watercourses are maintained as required.

4.2.4 SBC as a Category 1 Responder

As a Category 1 Responder, SBC have utilised knowledge of recent flooding incidents to revise and update the Emergency Response plan for flooding.

As part of this, the Traffic Management Plan has been revised to indicate roads susceptible to flooding. In these areas, the necessary equipment for implementing road closures has been made available.

Strategic pumping locations have been identified within the central seafront area based on the local topography and the potential to pump water over the sea wall. SBC have developed a procedure for Essex Fire and Rescue to deploy fire engines to this area to pump water from marked gully chambers during times of heavy rainfall.

4.3 Environment Agency

SBC representatives including Emergency Planning Officers work closely with the Environment Agency and in particular Flood Resilience Officers, especially in the aftermath of extreme weather events such as the flooding experienced on the 19th September 2014.

The Environment Agency did not receive any reports detailing property flooding from main rivers including Eastwood Brook or Prittle Brook.

The Environment Agency has confirmed that debris runs and trash screen clearances are undertaken every week within Southend-on-Sea and that Environment Agency Flood Incident Officers instruct field teams to check all known 'hotspots' prior to any forecasted heavy rainfall. These hotspots include the Prittle Tunnel Intake, Glenwood Avenue Debris Screen (now under Anglian Water's jurisdiction) and the debris screen at Manchester Drive.

The Environment Agency will also respond to calls received detailing any blockages of main rivers.

4.4 Anglian Water

Following reports of sewer flooding, Anglian Water have undertaken surveys of surface water, foul and combined networks within numerous areas across Southend-on-Sea, namely:

- Marine Parade & Eastern Esplanade;
- The Ridgeway and Chalkwell Avenue;
- Chalkwell Esplanade and The Leas;
- Clifton Drive;
- Northumberland Crescent; and
- Thorndon Park Drive.

Anglian Water have installed non-return valves, airbrick covers and flood barriers on properties prone to surface water and sewer flooding.

Anglian Water will work with SBC to determine the condition and cause of flooding associated with the Camper Road storm overflow outfall.

Additionally Anglian Water is supporting SBC in the development of the detailed Southend Central Seafront integrated model. The modelling is currently being completed by AECOM on behalf of SBC, to detail the relationship between surface water and sewer flooding within the Southend Central Seafront area. The modelling will be used to refine the understanding of flood mechanisms within the area as well as allowing for the initial assessment of mitigation options.

5 Next Steps

SBC's role as LLFA is to coordinate the management of flood risk within their administrative area. A series of actions for SBC and other RMAs, with respect to flood risk across the borough, are outlined below. Each of the RMAs should provide an update on progress at the quarterly flood group meetings.

If, following a review of this Flood Incident Report and liaison with RMAs, flood risk is considered to be unacceptable at a site SBC should investigate potential capital schemes which could provide flood alleviation within these areas. A follow-up meeting should be held with RMAs to discuss potential options to be taken forward.

5.1 Actions

Suggested actions for the RMAs have been highlighted within each of the areas investigated within Chapter 3. In addition, the assessments of flooding mechanisms highlight several actions that could be applied across the borough. These are detailed in Table 5-1 below.

Table 5-1: Action Plan

ID	Action	Lead RMA (Support)[16]	Area to be Implemented
1	Communication: Encourage residents to report issues of flooding. Outline who this should be reported to (SBC, AW, EA), and what mechanisms are available to report (phone, email, mobile app etc.). Additional information could be made available through the council website. This would be used to ensure as many records as possible are noted.	SBC (EA, AW, residents, business owners)	Borough Wide
2	Records: Ensure systems are set up at the council to efficiently record details of flooding. This is needed to gather as much information as possible about each incident at the time of flooding. This will be essential in ensuring the correct flooding mechanisms are understood.	SBC	Borough Wide
3	Investigate capacity: As many of the flooding incidents are associated with flooding of the drainage system, actions should be taken to survey and identify potential capacity issues.	AW (SBC)	Prince Avenue, Vardon Drive, Symons Avenue, The Ridgeway, Marine Parade, Eastern Esplanade, The High Street, Northumberland Crescent and Fairfax Avenue
4	Implement SuDS: As part of the investigation, the implementation of SuDS has been suggested as part of a long term approach to reducing the pressure on the surface water drainage network. Further investigation into the feasibility of such schemes would need to be examined prior to implementation.	SBC (residents & businesses)	Borough Wide

[16] EA = Environment Agency, AW = Anglian Water

ID	Action	Lead RMA (Support)[16]	Area to be Implemented
5	Investigate the potential for the use of the central verge within Highlands Boulevard as a conveyance route for surface water.	SBC (residents & businesses)	Highlands Boulevard
6	Investigate the potential for flood storage within Southchurch Park to alleviate flood risk to Northumberland Crescent and Shaftesbury Avenue.	SBC (residents & businesses)	Northumberland Crescent, Shaftesbury Avenue
7	As several issues were associated with inadequate maintenance, it is recommended that more frequent maintenance is undertaken, especially for highways drainage.	SBC	The Ridgeway, Vardon Drive, Warners Bridge Roundabout.
8	Community flood groups: As a quick win, SBC could work with residents to ensure flood risk is understood and to develop local flood groups. The formation of local flood groups would be beneficial in disseminating information and managing local flood risk.	SBC (EA, AW, residents, businesses)	Fairfax Drive, Seafront area, Chalkwell Esplanade, Victoria Road
9	Property level protection: As a quick win, residents should consider implementing property level protection where necessary.	Residents and businesses (SBC)	Borough wide.
10	In areas with a single incident of flooding, prioritise investigations should flooding occur again in the future.	SBC (EA, AW)	Ennismore Gardens, Beresford Road, Woodgrange Drive

5.2 Useful Contacts and Further Information

5.2.1 Southend-on-Sea Borough Council

General Enquiries: 01702 215 000

Email: council@southend.gov.uk

https://www.southend.gov.uk/FLOODING

5.2.2 Environment Agency

General Enquiries: 08708 506 506 (Mon – Fri 8am – 6pm)

Incident Hotline: 0800 80 70 60 (24 hrs)

http://www.environment-agency.gov.uk/

5.2.3 Anglian Water

Water and sewage service queries & general emergencies: 08457 145 145 (24 hrs)

http://www.anglianwater.co.uk/

5.3 References and Further Information

- Highways Act 1980: http://www.legislation.gov.uk/ukpga/1980/66/contents
- Water Resources Act 1991:http://www.legislation.gov.uk/ukpga/1991/57/contents
- Land Drainage Act 1991: http://www.legislation.gov.uk/ukpga/1991/59/contents
- Flood and Water Management Act 2010: http://www.legislation.gov.uk/ukpga/2010/29/contents
- Civil Contingencies Act 2004: http://www.legislation.gov.uk/ukpga/2004/36/contents
- Environment Agency Flood Warning Direct: https://fwd.environment-agency.gov.uk/app/olr/home
- Environment Agency 'Living on the Edge' a guide to the rights and responsibilities of waterside occupation: http://www.environment-agency.gov.uk/homesandleisure/floods/31626.aspx
- Environment Agency – River and Coastal Maintenance Programmes: http://environment-agency.gov.uk/homesandleisure/floods/109548.aspx
- Environment Agency – Prepare your Property for Flooding – how to reduce flood damage, flood protection products and services: http://www.environment-agency.gov.uk/homesandleisure/floods/31644.aspx
- Environment Agency – Make a Flood Plan: http://www.environment-agency.gov.uk/homeandleisure/floods/38329.aspx

- Anglian Water – Dealing with Flooding from Sewers http://www.anglianwater.co.uk/_assets/media/LED102_Dealing_with_flooding_from_sewer.pdf
- National Flood Forum http://www.nationalfloodforum.org.uk/

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