Pevensey, Cuckmere and Combe Haven Winter 2022/23 Flood Review

Final Report

June 2023

Prepared for:

Pevensey and Cuckmere Water Level Management Board

www.jbaconsulting.com

Pevensey and Cuckmere
Water Level Management Board

Document Status

Issue date	07 June 2023
Issued to	Revai Kinsella
BIM reference	KMY-JBAU-XX-XX-RP-Z-0001-S3-P04
Revision	Version 4.0.
Prepared by	Fiona Barraclough MSci Senior Analyst
	Libby Raines BSc Technical Assistant
	Lisa Chatterjee BSc MSc Chartered Senior Analyst
Reviewed by	Fiona Barraclough MSci Senior Analyst
	Paul Eccleston BA CertWEM CEnv MCIWEM C.WEM Project Director
Authorised by	Paul Eccleston BA CertWEM CEnv MCIWEM C.WEM Project Director

Carbon Footprint

The format of this report is optimised for reading digitally in pdf format. Paper consumption produces substantial carbon emissions and other environmental impacts through the extraction, production and transportation of paper. Printing also generates emissions and impacts from the manufacture of printers and inks and from the energy used to power a printer. Please consider the environment before printing.

Contract

JBA Project Manager	Fiona Barraclough MSci
Address	Pipe House, Lupton Road, Wallingford, Oxfordshire, United Kingdom, OX10 9BS
JBA Project Code	2023s0579

This report describes work commissioned by the Pevensey and Cuckmere Water Level Management Board, by an instruction dated 24th April 2023. The Client's representative for the contract was Revai Kinsella of the Pevensey and Cuckmere Water Level Management Board. Fiona Barraclough, Libby Raines and Lisa Chatterjee of JBA Consulting carried out this work.

Purpose and Disclaimer

Jeremy Benn Associates Limited ("JBA") has prepared this Report for the sole use of the Pevensey and Cuckmere Water Level Management Board and its appointed agents in accordance with the Agreement under which our services were performed.

JBA has no liability for any use that is made of this Report except to the Pevensey and Cuckmere Water Level Management Board for the purposes for which it was originally commissioned and prepared.

No other warranty, expressed or implied, is made as to the professional advice included in this Report or any other services provided by JBA. This Report cannot be relied upon by any other party without the prior and express written agreement of JBA.

The conclusions and recommendations contained in this Report are based upon information provided by others and upon the assumption that all relevant information has been provided by those parties from whom it has been requested and that such information is accurate. Information obtained by JBA has not been independently verified by JBA, unless otherwise stated in the Report.

Acknowledgements

We would like to thank the landowners and occupiers of Pevensey, Cuckmere and Combe Haven, including National Highways and Wealden District Council, who responded to the questionnaire, as well as the Pevensey and Cuckmere Water Level Management Board, for their invaluable input and support for this investigation.

Contents

List of Figures

List of Tables

Abbreviations

AEP	Annual Exceedance Probability
CEH	Centre for Ecology and Hydrology

CFMP	Catchment Flood Management Plan
Defra	Department for Environment, Food and Rural Affairs
EA	Environment Agency
BGS	British Geological Society
IDD	Internal Drainage District
JBA	Jeremy Benn Associates
LIDAR	Light Detection and Ranging
LTA	Long Term Average
mAOD	Metres above Ordnance Datum
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
PCWLMB	Pevensey and Cuckmere Water Level Management Board
RoFSW	Risk of Flooding from Surface Water
RMA	Risk Management Authorities
SAC	Special Area of Conservation
SNCI	Site of Nature Conservation Interest
SSSI	Site of Special Scientific Interest
VWC	Volumetric Water Content
WLMB	Water Level Management Board

Definitions

Light Detection and Ranging (LIDAR): Means by which the height of the land is measured

Main River: Any watercourse marked as a Main River on a Main River map, as designated by Defra. The Environment Agency has powers to conduct flood defence work and regulate any activities within 8m of Main Rivers.

Metres above ordnance datum (mAOD): This gives the actual elevation (e.g., of the height of the land) relative to the mean sea level at the UK Ordnance Datum at Newlyn, Cornwall.

Ordinary Watercourse: Every watercourse that is not designated as a Main River (other than a public sewer), including streams, ditches, drains and passages through which water flows. The Lead Local Flood Authority (LLFA) has powers to regulate works on Ordinary Watercourses. In Internal Drainage Districts, Internal Drainage Boards have powers to regulate activities on ordinary watercourses.

Ramsar site: wetlands of international importance designated under the Ramsar Convention on wetlands: an intergovernmental treaty that aims to conserve wetlands through local and national action and international cooperation.

Executive Summary

Following a wet winter in 2022 - 2023, in which extensive and prolonged flooding was experienced in the Board's Internal Drainage District (IDD), the Pevensey and Cuckmere Water Level Management Board commissioned a review to be better understand the flooding, including the causes and impacts of the flooding.

A review of available rainfall and river level gauge data was undertaken, to assess the characteristics of flooding within the Cuckmere, Pevensey and Combe Haven catchments between November 2022 and March 2023. In addition, a questionnaire was issued to drainage rate payers in the Board's IDD, to understand the impacts of the flooding to people and property.

River and rainfall gauge data across the three catchments showed that flow and water levels in the rivers responded rapidly to rainfall events in November, December, January and March, with up to 12 peak river flow/water level events captured during this period. The EA area situation report reported exceptionally high river levels, with the largest events in terms of river flow were recorded in early, mid and late-November (03/11/2022, 07/11/2022, 17/11/2022, 28/11/2022), as well as mid-December (19/12/2022) and early and mid-January (01/01/2023, 16/01/2023). This reflects the succession of rainfall events which fell on a saturated catchment during this period, with sustained higher than average soil moisture levels recorded from late October until the end of March (with the exception of February).

This corresponds with the frequent and prolonged nature of flooding reported by landowners in the 27 questionnaire responses received for the Cuckmere and Pevensey catchments. Flooding during winter months is a regular occurrence in the Cuckmere, Pevensey and Combe Haven catchments. However, respondents identified that the flooding experienced was particularly deep, extensive and long in duration this winter, particularly in the Pevensey Levels. In two instances, at Rickney Lane, Hailsham and Amberstone, Upper Horsebridge, landowners had not experienced flooding to their land prior to the Winter 2022 – 2023 flooding.

Many in the Pevensey catchment reported that the Levels took longer than average to drain down, with some experiencing a single, continuous flood event over the winter months. The pumped river catchments and surface water drainage systems which drain into the gravity watercourses were reportedly unable to discharge, and water backed up. This in turn impacted the pump assets within these catchments, with questionnaire response mentioning that Newbridge Pumping Station became overwhelmed, and PCWLMB reporting record durations of pumping. This may reflect the amount of rainfall and higher than average soil moisture levels recorded in the Pevensey catchment between November and March. However, it may also be linked to the function of water level management assets. It was reported by PCWLMB officers and the questionnaire respondents that the Pevensey Bridge main gate malfunctioned, with only the two smaller gates remaining open between November 2022 and mid-March 2023, when the majority of the flood incidents were recorded. This will have prevented the Pevensey Haven from draining out to sea,

resulting in sustained high water levels in the gravity-drained Pevensey Levels watercourses. Unfortunately, no open source river flow or level gauge data was available for the Pevensey catchment, so it was not possible to isolate the impacts of these assets within this study. However, the questionnaire responses suggest that closure of the main gate at Pevensey Bridge was a contributing factor to the extent and duration of flooding experienced.

Extensive flooding was also reported throughout the Cuckmere catchment. However, in contrast to Pevensey, questionnaire responses of drain down times in the Cuckmere catchment aligned with those expected by PCWLMB. Only one incident of highway flooding at Glyne Gap was received for the Combe Haven catchment, where flooding typically lasts throughout winter months, and starts to dry in March. However, the rain and river gauge data showed similar timings of peak events across the three catchments.

A wide range of sources and pathways of flooding were reported. Fluvial flooding due to exceedance of the river channels following heavy rainfall was the primary mechanism, with reports of debris in watercourses and blocked structures restricting flow. However, there were also reports of groundwater and foul sewer flooding to land and residential property in Hellingly, as well as surface water flooding to the road network, restricting vehicle access in locations such as Hellingly, Polegate and Alfriston.

The predominant impacts of the flooding were damage to grazing land and grass quality, due to grass remaining submerged for several months. This also resulted in damage to boundary fences. However, in some locations, particularly Hellingly, internal flooding of residential property was reported from groundwater and foul sewers. It should be noted that the flooding was reported to be a regular occurrence, although it was very disruptive.

Several respondents reported a loss of income, with grazing and hay making prevented by the flooded fields, and additional costs required to house livestock and horses indoors (e.g. lighting, heating, feed, muck clearance). Adverse impacts on mental and physical health were also reported, with respondents feeling that winter flooding was worsening.

Due to project timescales, the scope of the assessment did not include the calculation of return periods of the events identified in each catchment. However, event rarity analysis for 03 November 2022, undertaken by JBA Consulting for ESCC, indicated that the scale of storm event was relatively small in the Cuckmere catchment (between 1 in 2-years and 1 in 8-years for Horam and Hellingly) and Pevensey catchment (up to 1 in 2-years for Hailsham). As further work, this analysis could also be undertaken on the rainfall and river gauge data assessed as part of this study, to provide an indication of the rarity of events which occurred over Winter 2022 - 2023.

1 Introduction

1.1 Background to the investigation

Significant flooding occurred within the Pevensey and Cuckmere Water Level Management Board's (PCWLMB) area during winter 2022/23. Following this, the PCWLMB commissioned JBA Consulting to undertake a strategic review of the flooding experienced within the board's area between the 01 November 2022 and 31 March 2023.

This review is intended to provide the PCWLMB with a greater understanding of the flooding experienced (e.g., location, extent, duration and flood depth), its potential causes and its impact on land, properties and infrastructure.

1.2 Scope of the investigation

To obtain information regarding flooding within the PCWLMB's area during winter 2022/23, the following has been undertaken:

- Discussions with the PCWLMB's Area and Operations Managers to establish the key locations which were affected by flooding during Winter 2022 - 2023.
- A hydrological analysis of available rainfall, water level and soil moisture data between August 2022 and March 2023 to establish the catchment characteristics prior to, and during, Winter 2022 - 2023.
- Preparation and issue of a questionnaire completed by landowners and occupants residing within the Cuckmere, Pevensey and Combe Haven catchments. The aim of the questionnaire was to establish details of the observed flooding and its impact on land, properties, infrastructure and people.

This information has been used to:

- Identify a 'timeline' of observed flooding events within the PCWLMB area during Winter 2022 - 2023.
- Assess the mechanisms of flooding by undertaking a 'source-pathway-receptor' analysis for the most significant flood events identified.

1.3 Responsibilities of the Pevensey and Cuckmere Water Level Management Board

Water level management boards (WLMBs), like the PCWLMB, are designated as Risk Management Authorities (RMAs) under the Flood and Water Management Act (2010)[1].

The PCWLMB was established in October 2016 after the abolition of the Pevensey Levels Internal Drainage District (IDD) and River Cuckmere IDD, which were both previously managed by the Environment Agency. The PCWLMB works with partner organisations - including East Sussex County Council as Lead Local Flood Authority, the Environment Agency, Southern Water, Natural England, the Marine Management Organisation and Local Authorities (Eastbourne Borough Council, Rother District Council and Wealden District

1 Flood and Water Management Act (2010). Available at: <https://www.legislation.gov.uk/ukpga/2010/29/contents>

Council) - to manage water levels within the board's area. A key driver of the Board's activities is to provide sufficient water to the national and internationally designated environment sites, including the Pevensey Levels (Ramsar site, Site of Special Scientific Interest (SSSI) and Special Area of Conservation (SAC)), and Unit 6 of the Seaford to Beach Heady SSSI in the Cuckmere Valley. It also regulates and facilitates development within the Board's IDD, under its byelaws and the Land Drainage Act 1991, to ensure flood risk is managed appropriately. The work on new developments is undertaken in partnership with the LLFA by operating a shared service. The Board also provides an emergency response service during periods of high rainfall, drought and tidal surges.

The PCWLMB is not responsible for managing all watercourses and assets within the board's area. The Environment Agency is responsible for managing flood risk from all 'main rivers' inside the board's area (e.g., the River Cuckmere and Pevensey Haven), as well as the day-to-day operation of coastal defences and flood defences on main rivers. The other watercourses (not designated as main rivers) are known as 'ordinary watercourses.' The board only actively maintains the most critical ordinary watercourses (which are not main rivers), equivalent to approximately 25% of the total length of all ordinary watercourses in the Board IDD. However, riparian owners, who own the land crossed by a river, stream or ditch, have responsibilities for letting the water flow without obstruction, maintaining the banks and beds of the watercourse, and keeping structures clear of debris[2]. The remaining watercourses within the board's area are owned by the riparian owner. The PCWLMB policy for watercourse adoption and abandonment is available on their website.[3] To manage flows from ordinary watercourses, the board uses a series of pumps to convey water from the low level carrier drains into the main rivers. Water level control structures, such as weirs, sluices and dam boards then manage the level and flow of water within the channels. Most of the main rivers within the catchment drain via gravity, yet there are a few that are pumped up to the Environment Agency's Honeycrocks and Newbridge Pumping Stations. However, as many of the main rivers are embanked, some sub-catchments within the Board's IDD need to be pumped in order to discharge into the main rivers (see Section 2.3 for further detail).

1.4 Location of Pevensey and Cuckmere Water Level Management Board IDD

The PCWLMB area is located within East Sussex between Seaford and Hastings. The board is composed of three separate drainage catchments (Figure 1-1):

- Cuckmere (804 hectares) - covers the River Cuckmere and some of its adjacent floodplains, extending from Chiddingly and Cowbeech, through Alfriston, and entering the English Channel at the Cuckmere Haven.

2 East Sussex County Council (2023) Riparian ownership. Available at: < https://www.eastsussex.gov.uk/environment/flooding/riparian-ownership>

3 PCWLMB Supplementary Guidance for Adoption and Abandonment of Watercourses. Available at: <https://www.wlma.org.uk/uploads/WMA_Adoption_and_Abandonment_of_Watercourses_Guidance_September_2022.pdf>

- Pevensey Levels (6,413 hectares) - the largest of the three catchments, containing a series of interconnected watercourses and ditches between Eastbourne, Hailsham, Herstmonceux and Bexhill.
- Combe Haven (437 hectares) - the smallest of the three catchments, which follows the Combe Haven River and its tributaries, draining Crowhurst, Bexhill and Hastings.

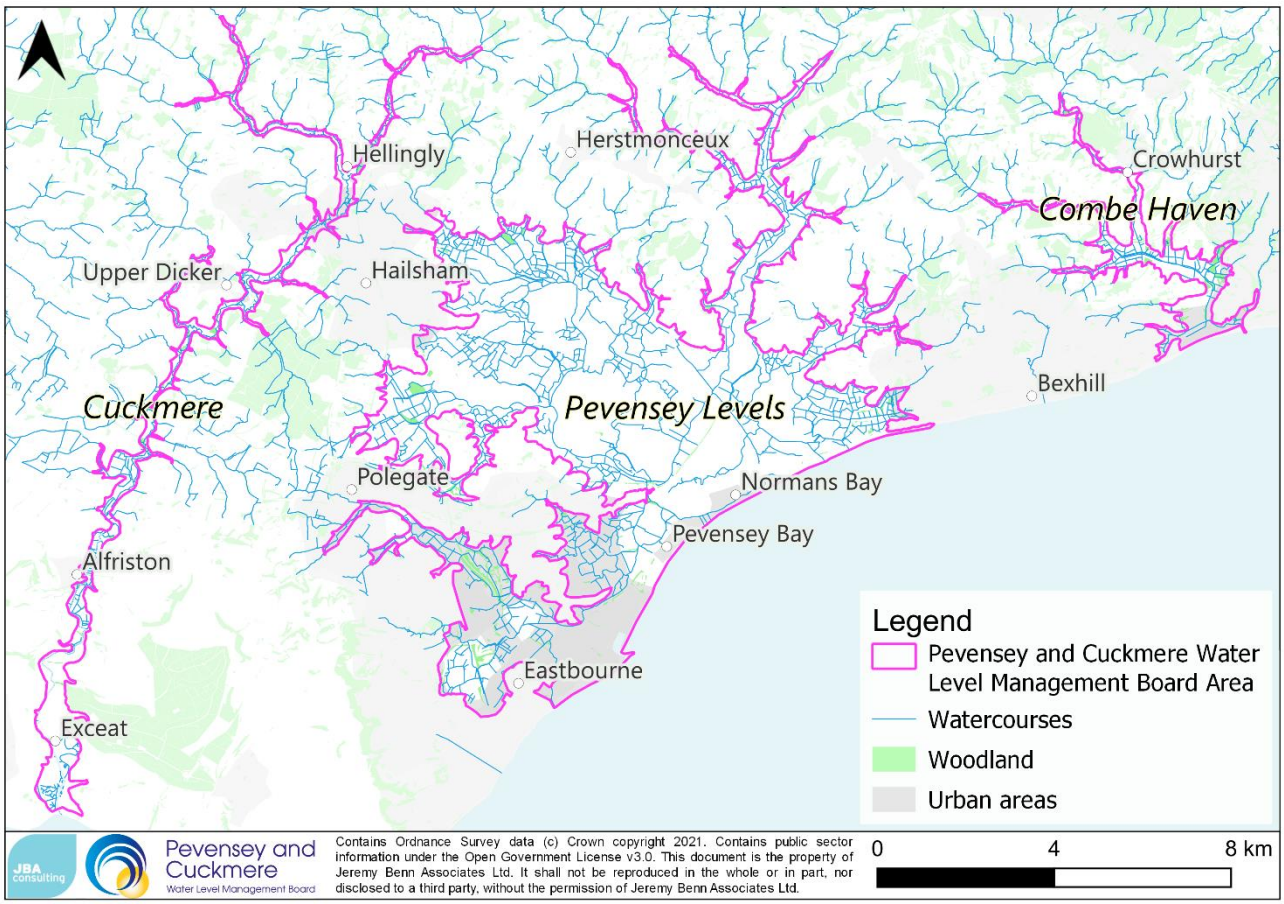

Figure 1-1: Location of the Pevensey and Cuckmere Water Level Management Board Area.

However, the full watershed catchment area of the board is significantly larger, extending into Battle, Hailsham, Hellingly and Heathfield (Figure 1-2). The Board does not have control of the upper reaches of its drainage catchments, so has limited ability to influence incoming flows from this area, except through the shared service with the LLFA on development planning matters.

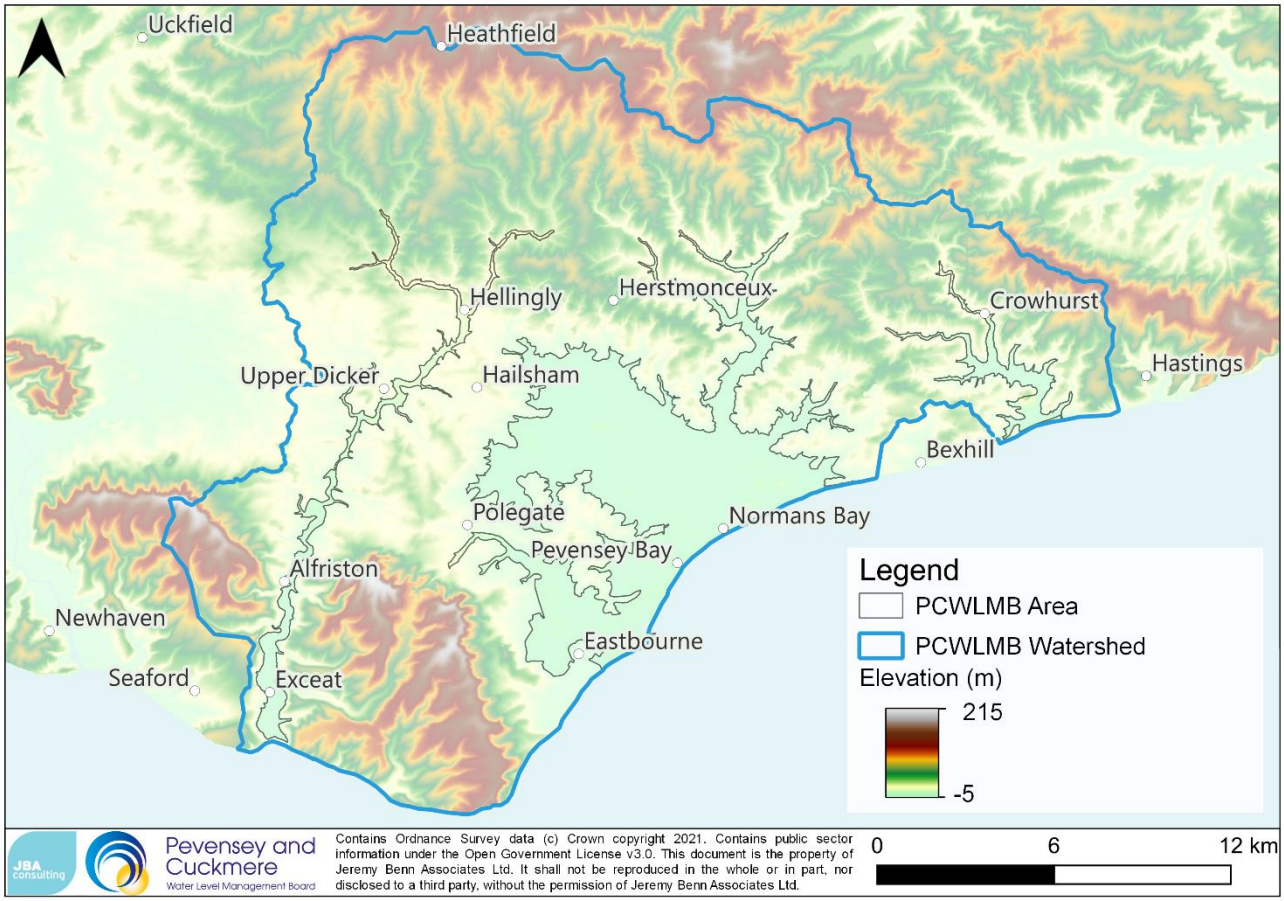

Figure 1-2: Full watershed area compared to the Board's IDD.

1.5 Data collection

A wide range of different data has been collected and assessed to inform this strategic review. This has been used to understand the causes and impacts of flooding within the PCWLMB and to establish the context of the area. This data includes the following:

- Open source data from the Defra data services platform - including the Flood Map for Planning, LiDAR and the Risk of Flooding from Surface Water (RoFSW) mapping;
- British Geological Survey (BGS) bedrock and superficial geology mapping;
- Historic flood records;
- Environment Agency tipping bucket rain gauge and river flow/level gauge data, KISTERS HydroMaster RADAR rainfall data;
- Questionnaire responses;
- Data from the event, such as photographs or observations/ notes.

2 Catchment characteristics

2.1 Topography

The PCWLMB area covers the lower-lying floodplain areas (Figure 2-1) within each of the three drainage catchments, which drain southwards towards the England Channel.

The elevations of the Cuckmere catchment range from 33.68mAOD to -3.26mAOD. The highest elevations are located in the upper reaches of the district at Grove Hill near Cowbeech, and gradually decrease with distance along the River Cuckmere. Downstream of Alfriston, the elevation of the Cuckmere district elevations is mostly below 10mAOD, reaching a minimum of -3.26mAOD at Cuckmere Haven.

In contrast, the Pevensey Levels are extremely flat throughout. While elevations vary between 22.59mAOD and -3.26mAOD, the areas of higher elevation are generally located in the upper reaches of the catchment, near Herstmonceux and Polegate, as well as some areas of raised land in Horse Eye and near Normans Bay.

The Combe Haven catchment has a similar elevation profile to the Cuckmere, with elevation decreasing downstream from 39.36m in the upper catchment to 0.27mAOD at the seafront. However, the area of the highest elevation within the Combe Haven is to the south-west of the catchment at the Pebsham landfill site, parallel to the Combe Valley Country Park.

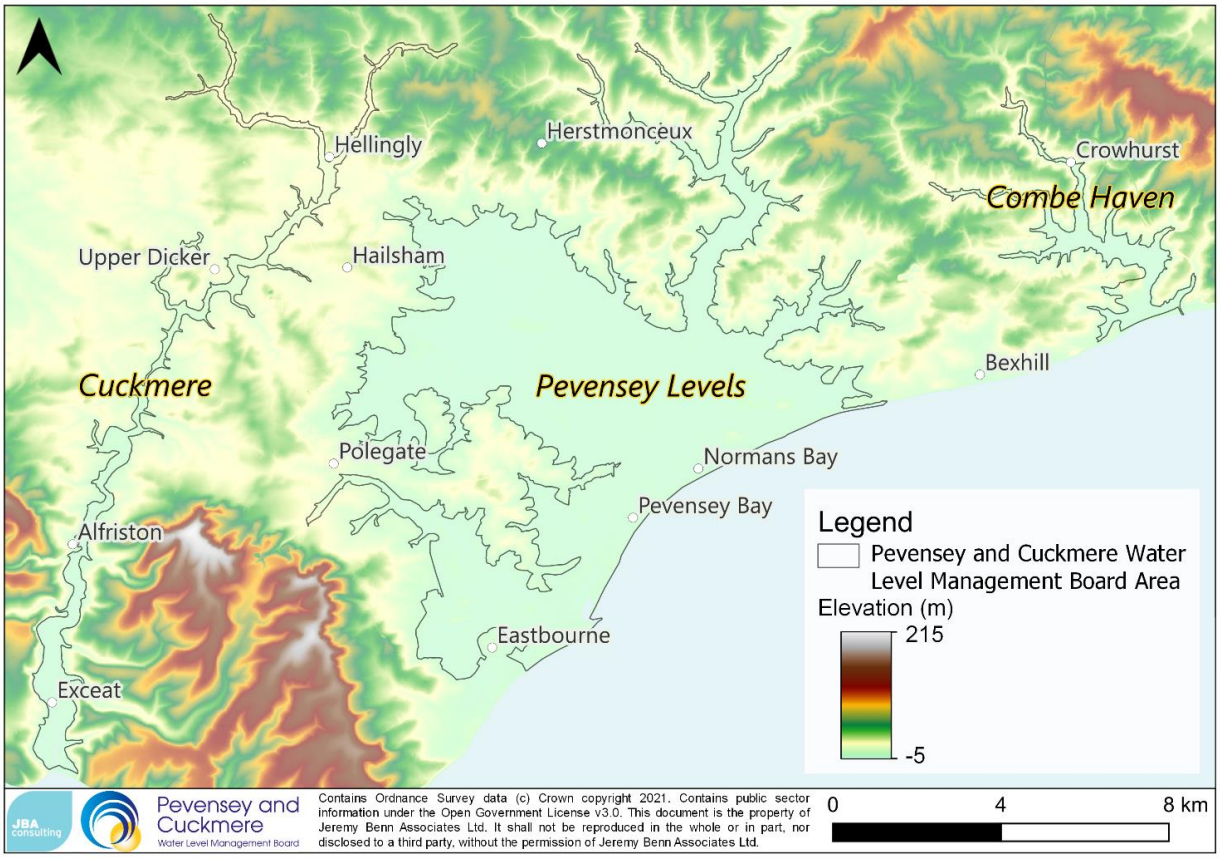

Figure 2-1: Topography of the Cuckmere, Pevensey Levels and Combe Haven catchments.

2.2 Geology

British Geological Survey (BGS) 625km mapping[4] was used to assess the PCWLMB areas geology (Figure 2-2).

The Cuckmere catchment's underlying geology varies from north to south, with the upper reaches mainly underlain by mudstone, siltstone and sandstone (with sandstone and siltstone concentrated around Hellingly). The centre of the catchment near Berwick and Wilmington is underlain by either mudstone, sandstone and limestone, or sandstone and siltstone. Finally, the lower reaches of the Cuckmere, south of Berwick are underlain by chalk.

The bedrock geology of the Combe Haven and Pevensey Levels are predominantly underlain by sandstone and siltstone. However, some small portions of the Combe Haven bedrock geology around Crowhurst and Filsham are mudstone, siltstone and sandstone. The following bedrock geologies underlie the Pevensey catchment:

- Mudstone, siltstone and sandstone within the north (near Hailsham), north-east (Wallers Haven), north-west (near Polegate) and south-west (Normans Bay, Pevensey Bay and Stone Cross) of the catchment.
- Sandstone and mudstone at Langney, Eastbourne.
- Mudstone, sandstone and limestone at Hampden Park and St Anthony's Hill in Eastbourne.
- Chalk in central Eastbourne.

4 British Geological Survey Geology 625K Datasets. Available at: <https://www.bgs.ac.uk/datasets/bgs-geology-625k-digmapgb/>

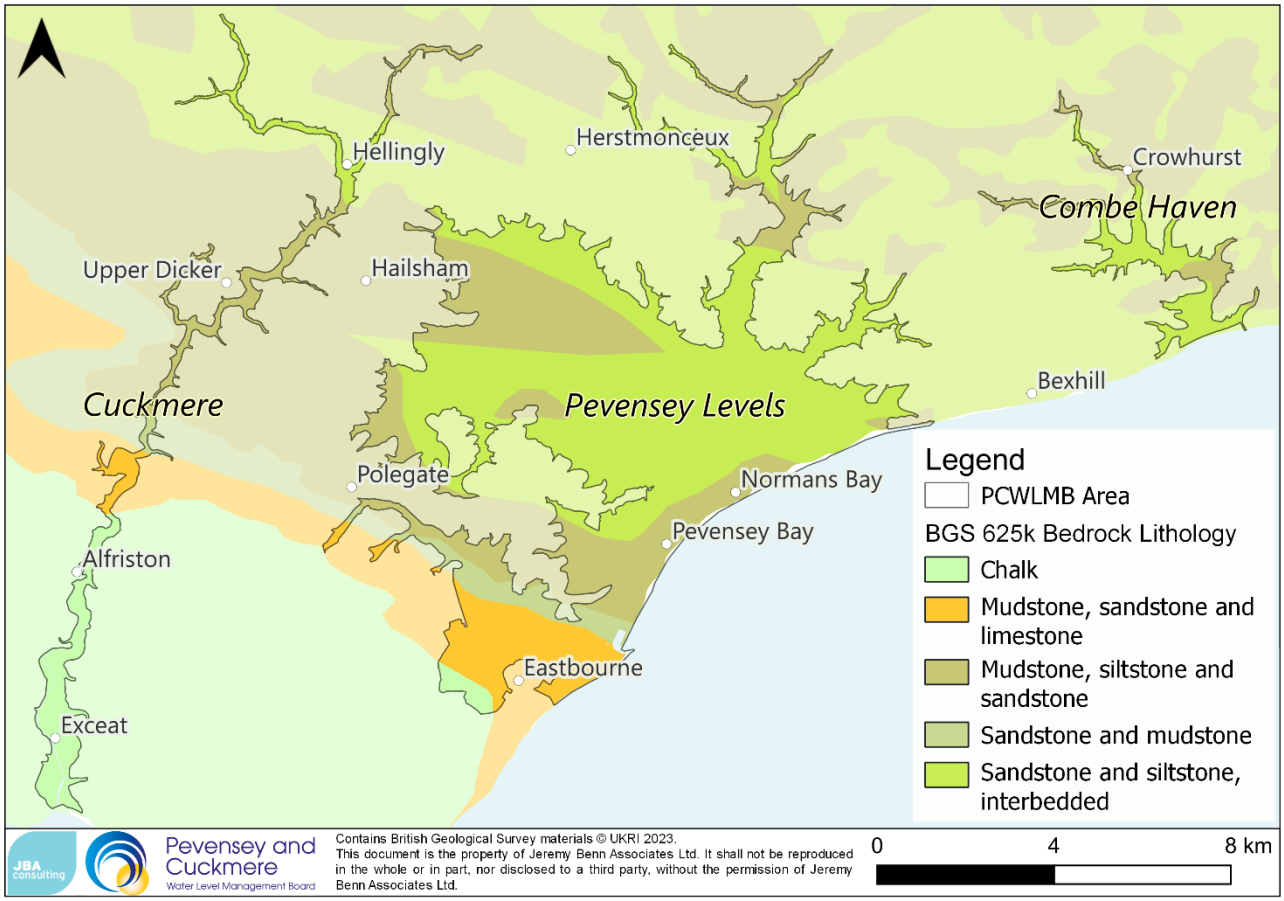

Figure 2-2: The underlying bedrock geology of the Cuckmere, Pevensey Levels and Combe Haven.

This bedrock is overlain by superficial deposits (Figure 2-3). Alluvial deposits of clay, silt and sand are present in the lower regions of the Cuckmere catchment, across the majority of the Pevensey Levels and in a region to the west of the Combe Haven. Additionally, sand and gravel river terrace deposits are present in the upper regions of the Cuckmere catchment, and a small portion of central Eastbourne.

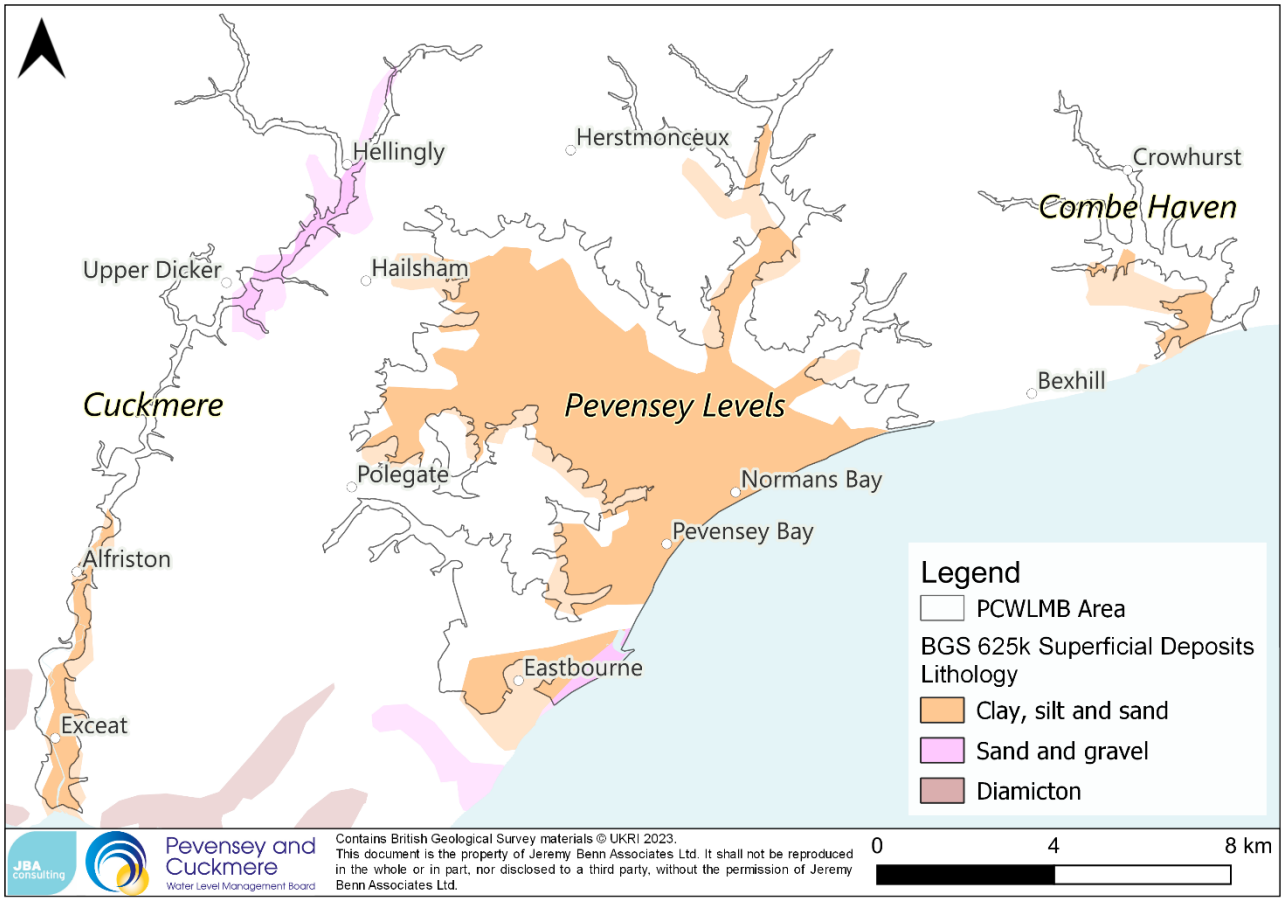

Figure 2-3: The superficial deposits overlying the bedrock geology within the Cuckmere, Pevensey Levels and Combe Haven.

2.3 Land use

2.3.1 River Cuckmere

The Cuckmere catchment is highly valued for landscape, ecology, heritage, livestock grazing and amenity. The iconic meanders of the Cuckmere Haven are a popular tourist attraction, located within the South Downs National Park and the Severn Sisters Country Park, with the western bank at Chyngton Brook owned by the National Trust. The Haven is also an important freshwater and intertidal habitat, which is a designated SSSI. The coastline lies within the Beachy Head MCZ, designated by the MMO, and forms part of the Sussex Heritage Coast (MMO, 2013[5]).

Steep woodland and settlements dominate the upper catchment of the Cuckmere within the High Weald, with land use becoming more rural with distance downstream, turning to grazing land on floodplain, and eventually wetlands within the Estuary. Although it appears to be a natural landscape, the meanders of the Cuckmere Estuary are maintained by

5 Defra and Natural England (2013). Marine conservation zone 2013 designation: Beachy Head West. Available at: Marine conservation zone 2013 designation: Beachy Head West - GOV.UK (www.gov.uk)

human intervention, with the main channel straightened and embanked in the 1800s, to allow more land to be used for grazing.

The key settlements are Heathfield, Hellingly and Upper Dicker in the upper catchment, and the villages of Alfriston, Lullington, Litlington and West Dean in the middle to lower reaches of the catchment.

2.3.2 Pevensey Levels

The Eastbourne and Pevensey Levels cover a 4,300Ha area of grazing marshland, which was reclaimed from salt marsh in the early Middle Ages. The majority of the land is low-lying and flat, intersected by a dense network of engineered straightened channels and manmade ditches, which were introduced to drain the land for grazing. Localised areas forming islands of high ground ('eyes') punctuate the landscape, for example at Horse Eye. Grazing marsh dominates the landscape, although the land is also used for small agricultural holdings, paddocks and allotments (ESCC, 2016)[6].

The Pevensey Levels are one of the most important wetland habitats in southern England, and hold a number of environmental designations, notably international Ramsar designation for migratory wading birds, designation as a SAC for the Ramshorn snail and SSSI designation, with much of the area defined as a National Nature Reserve.

The key settlements are the coastal towns of Eastbourne and Pevensey Bay, and the towns of Hailsham, Polegate and Willingdon in South Wealden. A series of lakes, including Shinewater, Southbourne and West Langney were introduced to Eastbourne Park to provide flood storage to mitigate the impacts of development of new housing and road networks in Eastbourne. The corridor between Hailsham and Eastbourne remains a significant area of future urban growth. In addition, there are smaller villages within the catchment, including Herstmonceux, Stone Cross, Horse Eye, Wartling and Hooe.

2.3.3 Combe Haven

Land use varies within the Combe Haven catchment, from ancient woodland in the steep upper catchment within the High Weald Area of Outstanding Natural Beauty (AONB), to floodplain meadows and open wetland in the lower catchment, including the extensive reed beds at Filsham Reedbed Local Nature Reserve, before the valleys converge in a network of ditches, and reach the sea at Glyne Gap (ESCC, 2016[7]). Due to the diverse habitats, Combe Haven is a SSSI, which attracts wetland birds and many species of butterfly, and the Combe Valley Countryside Park attracts visitors in the south of the catchment.

Key infrastructure in the catchment includes the landfill site and wastewater treatment plant at Pebsham, and the large electricity sub-station at Catsfield. The main settlements include Crowhurst in the upper catchment, and the urban centres of Hastings, Bexhill and

6 East Sussex County Council (2016) The East Sussex Landscape Assessment: Introduction to the Levels. Available at: introduction-to-the-levels.pdf (eastsussex.gov.uk)

7 East Sussex County Council (2016) The East Sussex Landscape Assessment: Combe Haven Valley. Available at: combe-valley-way.pdf (eastsussex.gov.uk)

Bulverhythe on the coast, with north Bexhill identified as an area of growth (ESCC, 2016). Horsiculture (development involving horses and stables) is also widespread in the Combe Haven Valley, especially on the urban fringes of Bexhill (ESCC, 2016). Water quality of the priority bathing water at Hastings is reportedly a concern, with sewer misconnections identified as a contributing factor (Environment Agency, 2023[8]).

2.4 River network

The Cuckmere, Pevensey and Combe Haven catchments are drained by single, or series of primary watercourses, which are in turn each fed by a series of tributary watercourses and drainage ditches (Figure 2-4). Please note that Figure 2-4 does not display all the watercourses within the Cuckmere, Pevensey and Combe Haven catchments.

As some sub-catchments within the Pevensey Levels cannot drain naturally via gravity, a series of pumping stations and other water level control structures (e.g., weirs and sluices) are required to convey flows and maintain water levels within the Board IDD. These assets are shown in Figure 2-4, and identified in the following sections.

8 Environment Agency (2023) Catchment Data Explorer: Combe Haven Operational Catchment. Available at: Combe Haven Operational Catchment | Catchment Data Explorer

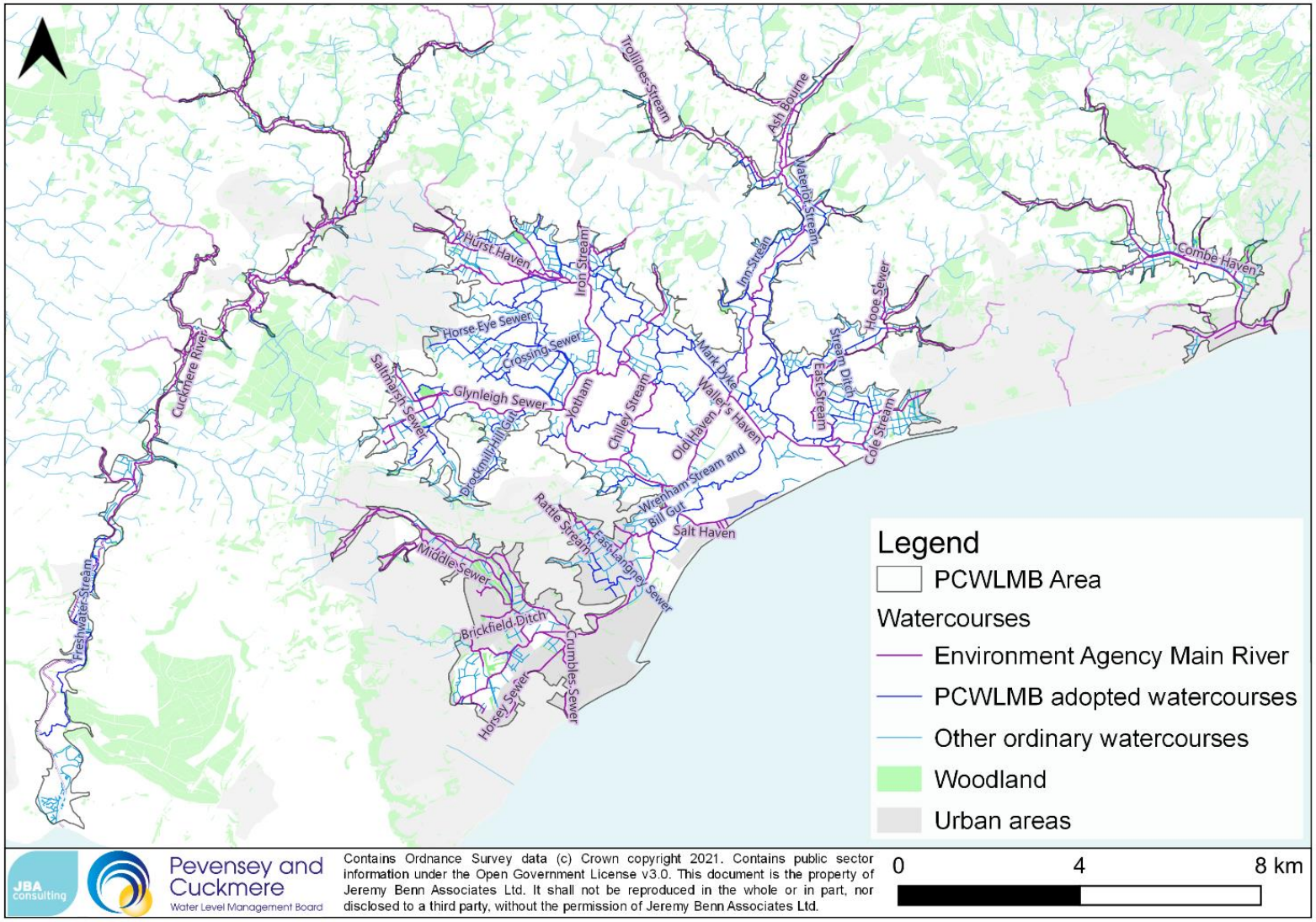

Figure 2-4: Watercourses within the PCWLMB area.

2.4.1 River Cuckmere

The primary watercourse within this catchment is the River Cuckmere, an Environment Agency main river, which drains from Grove Hill into the English Channel at the Cuckmere Estuary. Two channels of the River Cuckmere pass through the estuary: a wide, meandering eastern channel which forms the recognisable landscape of Cuckmere Haven, and 'The Cut' to the west, a channel which was straightened and embanked in 1846, to concentrate flow, diverting it away from the meanders and disconnecting them from the river (Environment Agency, 2009)[9]. The tidal reach of the River Cuckmere extends to Milton Lock, 8,5km upstream of the river mouth. The PCWLMB manages the Freshwater Stream, maintaining water levels within the valley and providing a drinking water source for the cattle responsible for the management of the SSSI (unit 6). Several structures reduce the ingress of saltwater from the River Cuckmere to the freshwater habitat provided by the watercourse.

The Environment Agency deploy mobile pumps to manage surface water flooding, and to manage fluvial floodwaters entering Willows car park in Alfriston during flood events. Some works are proposed by PCWLMB to manage flood risk associated with the River Cuckmere at Alfriston, these include the removal of silt from the left bank over a 500m length from the White Bridge (footbridge) and the repairs to flood embankments over 255m . The first phase of the works, which will involve emergency repairs to the tidal embankments, is intended to start in August/September 2023.

Table 2-1 lists the principal watercourses within the Cuckmere catchment.

Table 2-1: Principal watercourses within the River Cuckmere catchment.

Watercourse name	Watercourse type	Course
Bull River	Environment Agency main river	Rises near Horam and joins the River Cuckmere at Hellingly.
Freshwater Stream	PCWLMB watercourse	Bifurcates from the River Cuckmere at Milton Lock and re-joins the River Cuckmere at Exceat.
River Cuckmere	Environment Agency main river	Rises near Grove Hill and discharges into the English Channel at the Cuckmere Haven.

9 Environment Agency (2009) Cuckmere and Sussex Haven: Catchment Flood Management Plan. Available at: Cuckmere and Sussex Havens: Catchment flood management plan - GOV.UK (www.gov.uk)

2.4.2 Pevensey Levels

The Crumbles Sewer, Salt Haven, Waller's Haven and East Stream Main Rivers drain the Eastbourne Pevensey Levels out into the English Channel. These watercourses are in turn fed by a series of Main River tributaries, including Pevensey Haven, Hurst Haven, Langney Sewer and Glynleigh Sewer, which are fed by a network of smaller watercourses and drainage channels, some of which are managed by PCWLMB. Unlike the Cuckmere and Combe Haven catchments, several of the low-lying sub-catchments within the Pevensey Levels rely on pumping to discharge into the embanked Main Rivers which drain by gravity. A map of the sub-catchments within the PCWLMB area is available on the PCWLMB's website.[10]

The following sub-catchments within the Pevensey Levels catchment need to be pumped to convey flows into main rivers:

- Barnhorn
- Glynleigh and Drockmill Hill Gut
- Horse Eye and Down to Rickney
- Manxey
- Waterlot to Horsebridge
- Star Inn

A list of the Main Rivers and watercourses managed by the PCWLMB within the Pevensey catchment are presented in Appendix A.

Figure 2-5 displays watercourses within the Pevensey catchment. Please note that not all of the watercourses within the catchment are labelled.

10 Key sub-catchments within the PCWLMB's area. Available at: <https://www.wlma.org.uk/uploads/PCWLMB_MapIndex.pdf>

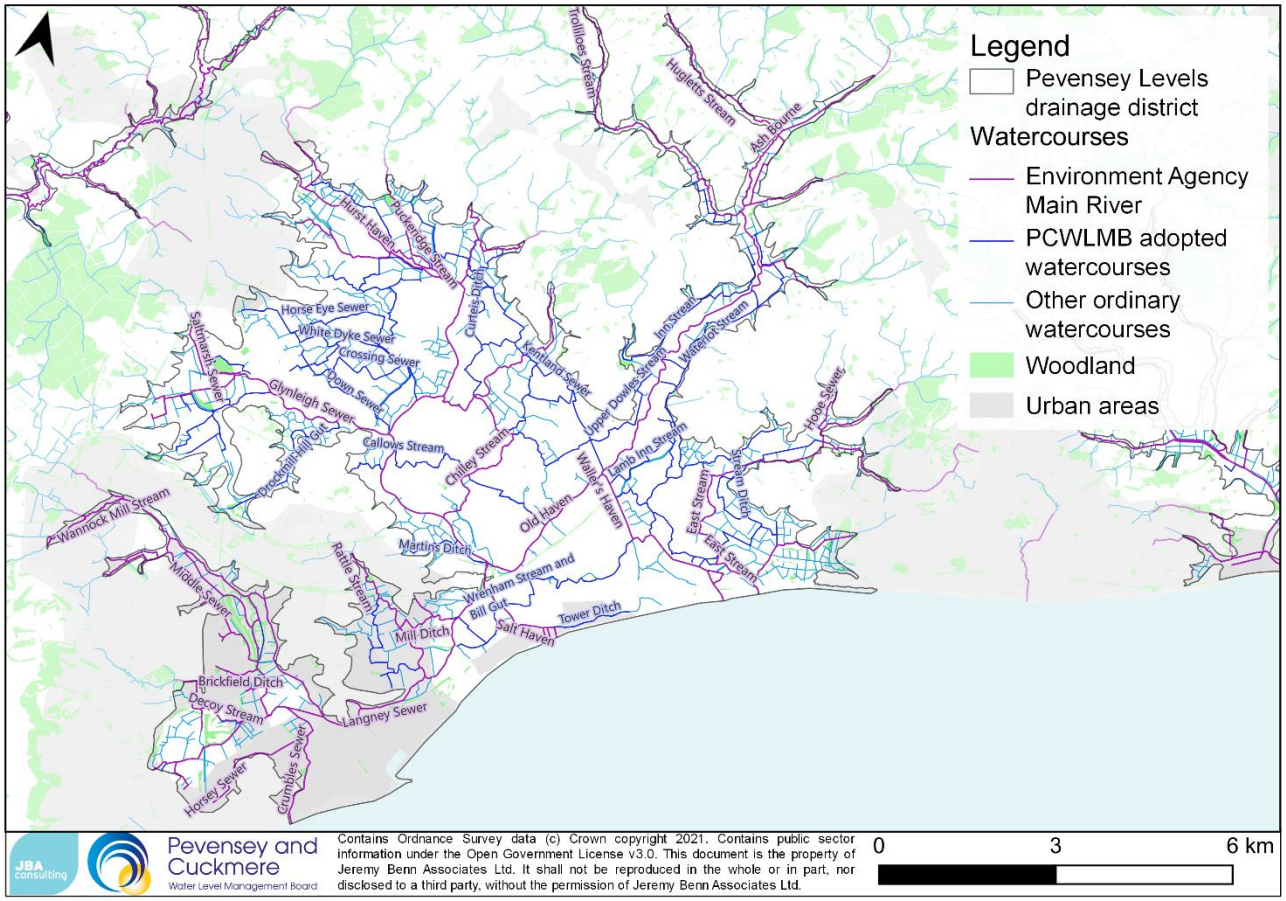

Figure 2-5: Watercourses within the Pevensey catchment.

2.4.3 Combe Haven

The principal watercourse within this region is the Combe Haven, which stretches approximately 9km from near Catsfield and into the English Channel at Bulverhythe. The Combe Haven is fed by the Hollington, Powdermill, Russell and Watermill Streams. The Rackwell Stream and Russell Stream are PCWLMB adopted watercourses within this region.

Table 2-2 lists the principal watercourses within the Cuckmere catchment.

Table 2-2: Principal watercourses within the Combe Haven catchment.

Watercourse name	Watercourse type	Course
Combe Haven	Environment Agency Main River	Rises in north Bexhill, east of Ninfield Road. Approximately 9km is located in the Board IDD, from near Catsfield to the English Channel at Bulverhythe.
Hollington Stream	Environment Agency Main River	Rises in north Hastings at Queensway Gateway and flows through Hastings to meet the Combe Haven at Bulverhythe. The middle and lower reaches are located in the Board IDD.
Powdermill Stream	Environment Agency Main River	Flows approximately 5km from Powdermill Lane, near Kell Wood, and joins the Watermill Stream, before it meets the Combe Haven within the Combe Haven SSSI.
Rackwell Stream	PCWLMB watercourse (165m of the lower reach only)	Rises north of Brakes Coppice, near Telham Lane. Joins the Powdermill Stream as a Main River near Chapel Hill, Crowhurst.
Russell Stream	PCWLMB watercourse	Approximately 300m - rises in the Combe Valley Countryside Park and flows into the Combe Haven.
Watermill Stream	Environment Agency Main River	Rises near Lunsford's Cross and joins the Combe Haven within the Combe Haven SSSI.

3 Flood risk

3.1 Fluvial and tidal

The Environment Agency Flood Map for Planning is shown in Figure 3-1, and presents undefended river (fluvial) and tidal flood risk. The majority of the Cuckmere and Combe Haven catchments are at high risk of fluvial flooding, and are located within Flood Zone 3. This equates to a likelihood, or an annual exceedance probability (AEP) greater than 1% AEP for fluvial flooding, and greater than 0.5% AEP for tidal flooding. The majority of the Pevensey Levels catchment is also at high fluvial flood risk and located within Flood Zone 3. However, a small portion of the north of the catchment near Hailsham is located in Flood Zone 2, and is therefore at low fluvial flood risk. This equates to between a 1% and 0.1% AEP for fluvial flooding and between a 0.5% and 0.1% AEP for tidal flooding. Areas of higher land, known as islands or 'eyes' on the Pevensey Levels are located in Flood Zone 1, which indicates that these areas are not predicted to flood from fluvial or tidal sources in events exceeding the 0.1% AEP event.

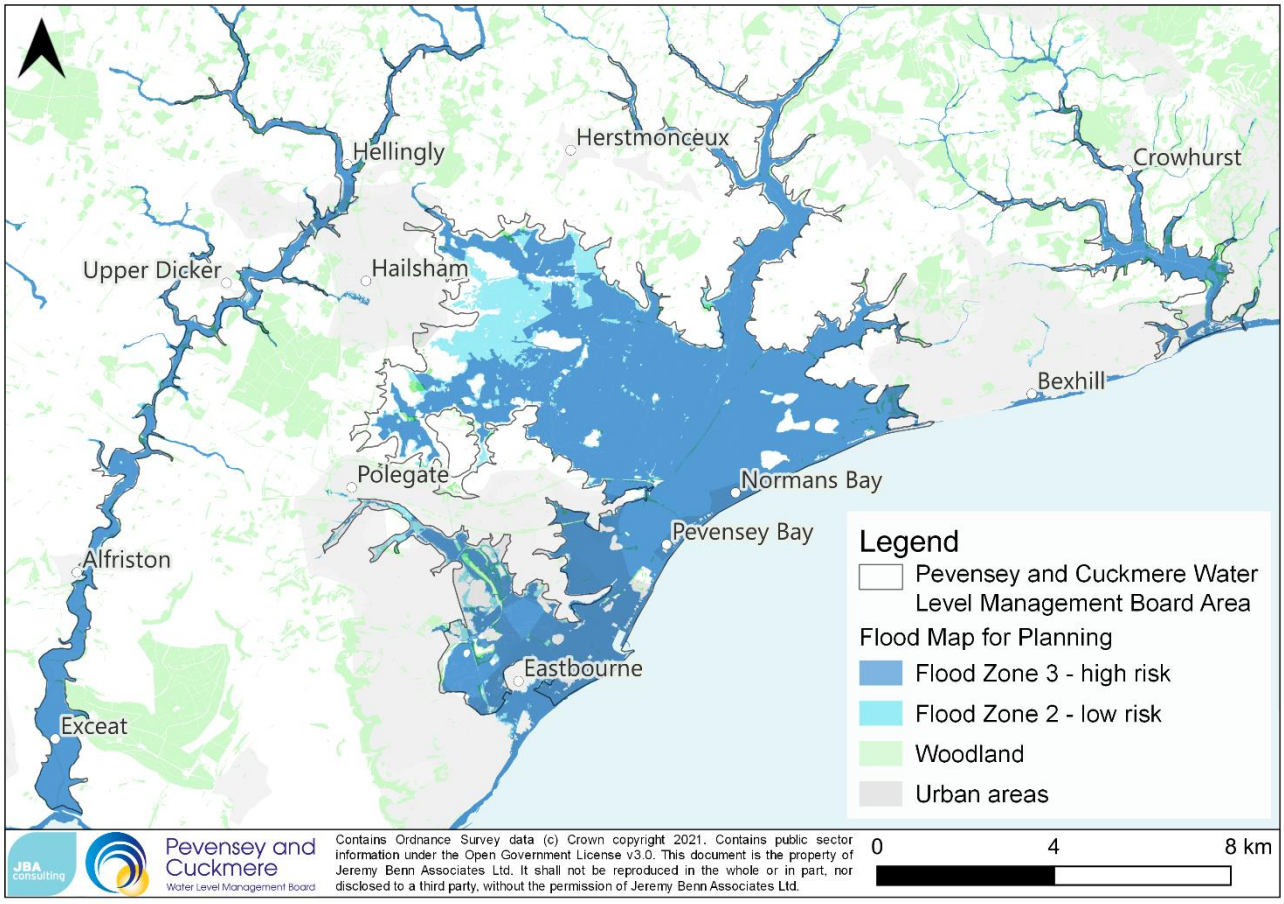

Figure 3-1: The Environment Agency Flood Map for Planning displaying fluvial flood risk.

3.1.1 Flood defences

Figure 3-1 shows the undefended risk of fluvial and tidal flooding within each of the catchments. However, many areas of the Cuckmere, Pevensey and Combe Haven catchments benefit from fluvial and tidal flood defences. These are generally maintained by the Environment Agency.

Key assets within the Board's IDD are displayed in Figure 3-2. Information about Environment Agency maintained assets were obtained from the 'Spatial Flood Defences including AIMS' dataset[11]. The following sub-sections provide an overview of the key flood defence assets within each PCWLMB catchment.

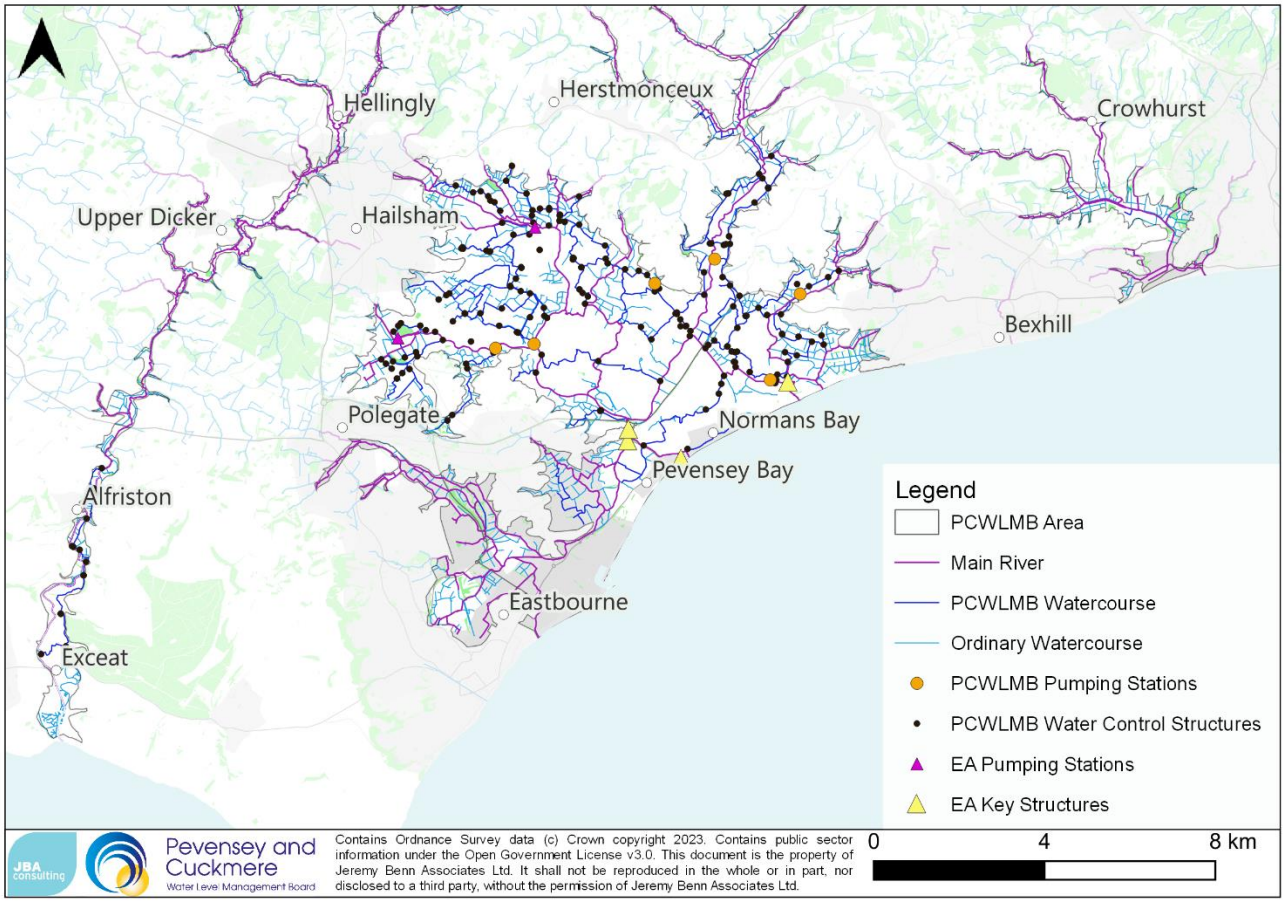

Figure 3-2: Assets and structures used to control water levels, within the PCWLMB area.

3.1.1.1 Cuckmere

In the middle and lower reaches of the Cuckmere catchment, from Berwick to Cuckmere Haven, the Environment Agency maintains flood embankments on both banks of the River Cuckmere. The design standard of protection of these defences ranges from between 1 in 2-years (50% AEP) and 1 in 200-years (0.5% AEP), with their condition varying between 'good' to 'very poor' and 'not recorded.' PCWLMB also operates and manages a number of

11 Environment Agency Spatial Flood Defences including Asset Management Information System (AIMS). Available at: <https://environment.data.gov.uk/dataset/8e5be50f-d465-11e4-ba9a-f0def148f590>

water control structures to regulate flow between the Freshwater Stream, a Board-managed watercourse, and the Main River Cuckmere, managed by the EA. These are largely dam board structures, with doors or flap valves on the main river side, where there is an outfall to the River Cuckmere. As they are located within the banks of the Main River Cuckmere, maintenance responsibilities for the outfalls fall to the EA.

The beach at the Cuckmere Estuary mouth provides a tidal flood defence function, with the beach volume controlled by the balance between sediment supply to the shore and flows from the River Cuckmere clearing the shingle from the beach. Timber training walls were constructed at the river mouth between and 1943 and 1971 to stabilise its location and maintain a channel through the shingle beach (Figure 3-3). As maintenance of the training walls has since been removed, to allow the Cuckmere to be restored into a more naturally functioning estuary, manual intervention has subsequently been required by the EA to remove sediment from the river mouth and deposit it onto the West Beach, where it acts to counteract cliff erosion. The most recent shingle clearance took place in October 2022.

Figure 3-3: Timber training walls through shingle beach at mouth of River Cuckmere (credit: PCWLMB)

3.1.1.2 Pevensey Levels

Figure 3-4 displays a more detailed map of assets within the Pevensey Levels. Alongside other water control structures, the main PCWLMB assets within this catchment are the six pumping stations (Barnhorn, Drockmill, Horsebridge, Manxey, Rickney and Star Inn) used to maintain water levels within Pevensey Level ditches to their design levels.

The Environment Agency maintained fluvial flood defences within the Pevensey Levels include:

- Embankments on the banks of the East Stream, Hurst Haven, Iron Stream, Langney Sewer, Pevensey Haven, Puckerbridge Stream, Railland Ditch, Salt Haven, Wallers Haven and Yotham Embankment. These have a 3.33% AEP design standard of protection, in either a 'good' or 'fair' condition.
- Honeycrocks and New Bridge Pumping Stations pump water from low-lying catchments into the higher level Main Rivers, which drain by gravity.
- The Star Inn Gates are the primary water control structure on the eastern half of the Pevensey Levels, and regulate water levels on the Waller's Haven catchment.
- Pevensey Gates are the second most important water control structure on the Pevensey Levels after the Star Inn Gates, and are the primary flow control structure for the western half of the Pevensey Levels. Comprised of a large main gate, and two smaller side gates, they influence water levels in the Pevensey Haven, Hurst Haven and Glynleigh Sewer.
    - The PCWLMB Operations Manager reported that the motorised valve operator (Rotork) on the main gate broke, and was removed in late Summer 2022, to allow it to be fixed. This required the main gate at Pevensey Bridge to be opened manually, rather than operation being automated based on rising and falling water levels. Mechanical faults on the main gate resulted in it subsequently becoming seized shut and it could no longer be opened manually. The motorised valve was replaced and operation of the main gate was restored again in mid-March 2023. However, during the period of November 2022 to mid-March 2023, the main gate remained closed, and therefore discharge out of the Levels was restricted to the two smaller gates, or weiring over the closed main gate.
- Fence Bridge Gates operate to manage water levels in Langney Haven. Similarly to the Pevensey Gates, Fence Bridge Gates are set to summer and winter levels, and are operated based on telemetry which references water levels upstream and downstream of the gates.
    - There were reports of the motorised valve operator on the Fence Bridge gates experiencing issues during the Winter 2022 - 2023 period.
- Doors at the EA Pevensey depot on the Salt Haven are closed automatically at high tide, to limit the ingress of saline water, and re-open when the tide recedes.

In addition, there are several coastal flood defences at Eastbourne and Pevensey which form part of the 'Pevensey Bay Sea Defence Scheme'[12] and the current 'Pevensey Bay to Eastbourne Coastal Management Scheme'[13].

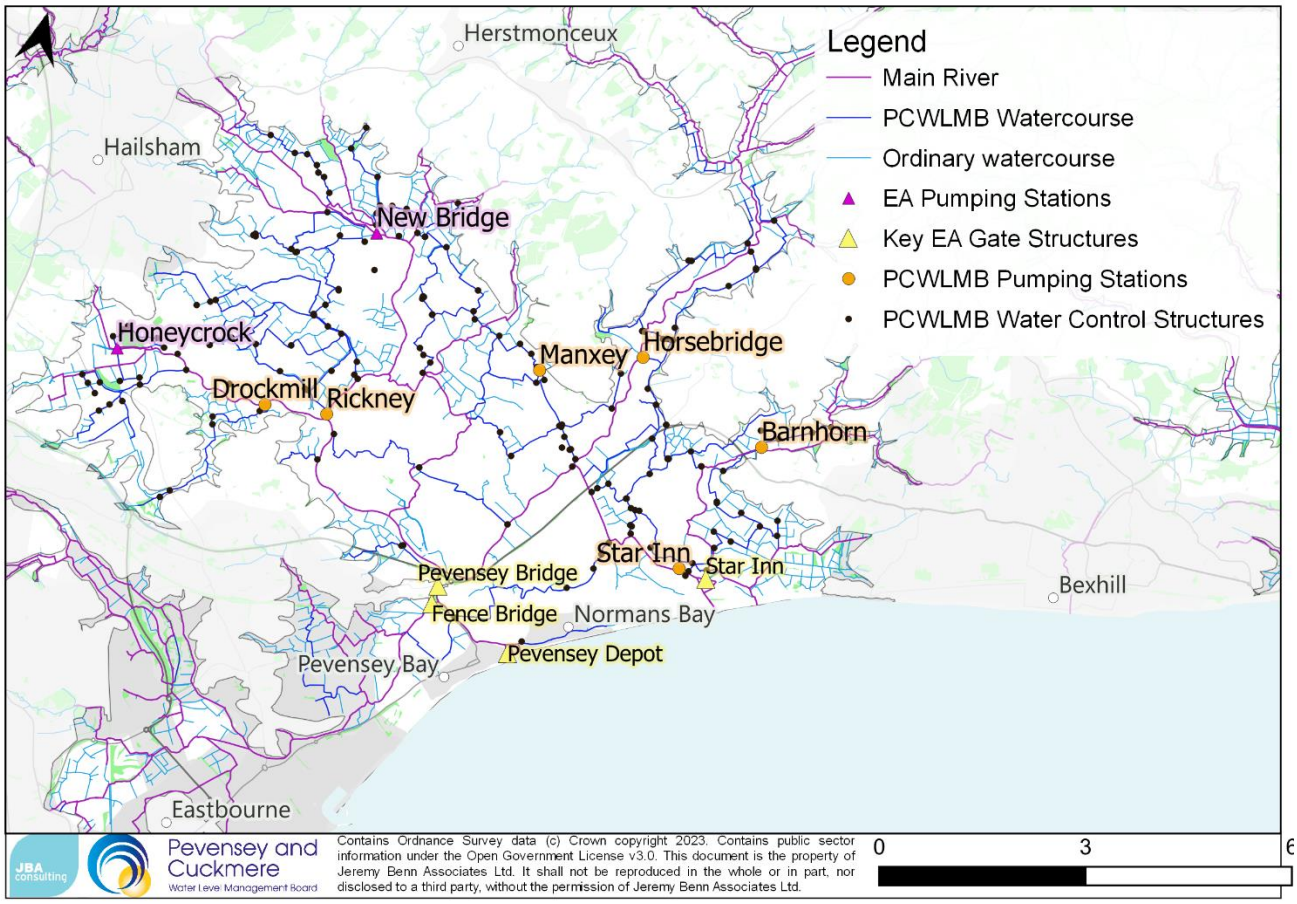

Figure 3-4: Assets used to control water levels within the Pevensey Levels.

3.1.1.3 Combe Haven

The Environment Agency managed flood defences within the Combe Haven include:

- Embankments on both banks of the Combe Haven, Powerdermill Stream and Watermill Stream. The design standard of protection of these is between the 6.66% and 50% AEP event. The condition of these assets are either 'fair' or 'not recorded.'
- A wall on the right (south) bank of the Pebsham Stream, with a 20% AEP standard of protection in a 'fair' condition.

There are no PCWLMB maintained assets within the Combe Haven.

12 Pevensey Bay Sea Defence Scheme. Available at: <https://pevensey-bay.co.uk/>

13 Environment Agency - Pevensey Bay to Eastbourne Coastal Management Scheme. Available at: <https://consult.environment-agency.gov.uk/solent-and-south-downs/pevensey-bay-to-eastbourne/>

3.2 Surface water

The Environment Agency Risk of Flooding from Surface Water (RoFSW) mapping is shown in Figure 3-5.

Areas of high surface water flood risk (at risk of flooding in events up to a 1 in 30-year, or 3.3% AEP) are concentrated in the upland catchments, where the topography is steep. This includes Hellingly and Upper Dicker in the Cuckmere catchment; Herstmonceux, Hailsham, Polegate, Wannock and Willingdon in the Pevensey catchment; and Crowhurst and Catsfield in the Combe Haven catchment.

In contrast, surface water flood risk is low (at risk of flooding in events between a 1 in 100-year and 1 in 1,000-year event, or 1% to 0.1% AEP) on the low-lying floodplains of the lower catchments, where fluvial processes dominate. The exception is within the major coastal settlements of the lower catchments, including Eastbourne, Bexhill and Hastings, where runoff generated on impermeable surfaces results in a high surface water flood risk. The risk of surface water flooding in these low-lying coastal towns is exacerbated by the presence of old, combined sewer systems, and hydraulic locking of sewer and drainage outfalls at high tide.

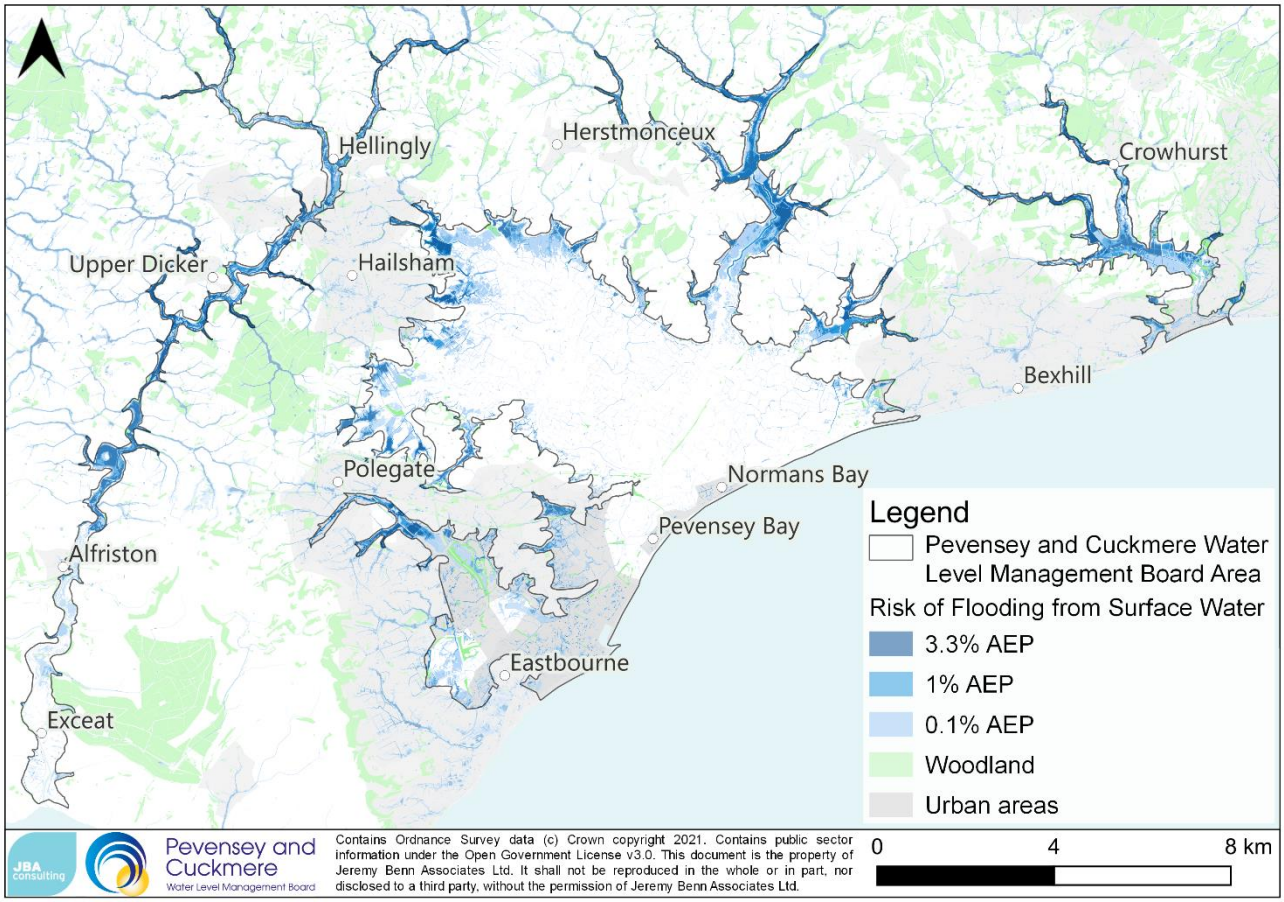

Figure 3-5: Risk of flooding from surface water mapping

3.3 Groundwater

The Cuckmere and Pevensey catchments are underlain by aquifers of the Seaford and Eastbourne Chalk Block in Eastbourne, Lower Greensand in the mid-Cuckmere and sandstones of the Hastings Beds Group in the Cuckmere and Pevensey Levels.

The presence of gravel and shingle deposits adjacent to the rivers and coast, including river terrace gravels in the Cuckmere valley, and storm beach deposits at Cuckmere Haven, Eastbourne, Normans Bay, Bexhill and Hastings, can also result in groundwater levels becoming elevated with rising river and tide levels.

The Environment Agency Catchment Flood Management Plan (CFMP) for Cuckmere and Sussex Havens (Environment Agency, 2009) identifies that in the lower reaches of Combe Haven, groundwater seeping from sandstone formations around Bexhill into the local gravel beds can also result in high groundwater levels, especially at high tide.

Trial pits and groundwater monitoring undertaken by developers to inform appropriate development within the Board's IDD have identified that there is a widespread issue of perched groundwater within the IDD. This is reflected in the depth to groundwater mapping shown in the Guide to Sustainable Drainage Systems in East Sussex (p.20)[14] (ESCC, 2015).

3.4 Flood history

There is a long history of flooding within the Board IDD, particularly within the Cuckmere and Pevensey catchments, with exceedance of the river channel capacity being the main source of flooding. Table 3-1 provides an overview (although not an exhaustive list) of flood incidents identified in British Hydrological Survey records and the Environment Agency Recorded Flood Outlines dataset.

Table 3-1: Record of historic flood events within the Cuckmere, Pevensey and Combe Haven catchments.

14 East Sussex County Council (2015) Guide to Sustainable Drainage Systems in East Sussex. Available at: guide-to-sustainable-drainage-systems-in-east-sussex2.pdf (eastsussex.gov.uk)

Date	Source of flooding	Description of impacts
1703	Tidal and main river - River Cuckmere	'Great storm of [November] 1703' contributed to flooding at the coastline and River Cuckmere (reported as far upstream as Berwick).[15]
1810	Surface water	Reports of flooding in Pevensey in November 1810, reported after a period of heavy rainfall.[15]
1836	Snowmelt	Flooding of low-lying land in the Pevensey Levels.[15]
1839	Unknown	December 1839, flooding of low-lying land in the Pevensey Levels.[15]
1841	Unknown	October - December 1841, flooding of low-lying areas as a result of snow melt.[15]
1875	Unknown	Extensive flooding in the Pevensey Levels, notably Wallers Haven, although the flooding mechanism was not reported.[15]
1974	Main river - River Cuckmere	Flooding at Alfriston and Hellingly after the River Cuckmere exceeded its channel capacity. [15]
1974	Sewer	Flooding at Normans Bay caused by sewer flooding.[16]
1987	Main river - Rattle Stream	Flooding at Westham after capacity of the Wallers Stream exceeded.[16]
2000	Main river - River Cuckmere	October 2000, flooding at Hellingly and Horsebridge after the River Cuckmere exceeded its channel capacity.[16]
2009	Main river - River Cuckmere	January 2009, channel capacity of the River Cuckmere exceeded, contributing to extensive flooding between Chiddingly to Exceat.[16]
2009	Surface water and main river - Hollington Stream	July 2009, reported flooding in St Leonards and South Saxons SNCI after heavy rainfall and the channel capacity of the Hollington Stream was exceeded.[15]
2009	Main river and ordinary watercourses - Combe Haven and Pevensey Levels	December 2009, flooding at the following locations after channel capacity of several watercourses were exceeded.[16] • Combe Haven • Gorridge Stream, Combe Haven • East Stream, Pevensey Levels • Wallers Haven, Pevensey Levels • Old Haven and associated drains, Pevensey Levels • Lottbridge Sewer, Middle Sewer and Shinewater Lake, Pevensey Levels.
2009-2018 No records of flooding available.		
2019	Main river - Cuckmere	October 2019, extensive flooding along the River Cuckmere, especially agricultural land in the Cuckmere Haven.[17]

4 Hydrological analysis of Winter 2022 - 2023

4.1 Hydrological analysis methodology and limitations

As this winter flooding review covers an extended period (01 November 2022 to 31 March 2023) over a large area, the hydrological conditions for the three months prior to the flooding review period (01 August – 31 October 2022) were also assessed.

Several different sources of data were used to undertake the hydrological analysis. The Environment Agency's water situation reports for England[18] were initially reviewed to provide an overview of regional rainfall, river flow and soil moisture data.

A more detailed hydrological analysis of available rainfall, river level and river flow data was also undertaken. To collect rainfall data, ideally tipping bucket raingauges (TBR) should be used. These record rainfall totals every 13 minutes, and this data can be obtained Environment Agency's hydrology data explorer[19]. The benefit of using these *in-situ* TBR gauges is that these record both the intense, localised (convective) rainfall events alongside the broader frontal rainfall events, which generally affect larger areas. There are two TBR gauges within the Board IDD. This first is at Cowbeech, near Herstmonceux, within the Cuckmere catchment, and the second is at Pevensey, within the Pevensey Levels catchment. A further rainfall gauge at Willingdon (Pevensey Levels) was excluded from the analysis because the data was only available as a daily total, rather than 15-minute sub-daily totals available at the other gauges.

To supplement the TBR data, Met Office rainfall radar data for the PCWLMB area was also extracted at a catchment-averaged resolution from the KISTERS HydroMaster[20] database. Radar data uses radio waves to locate and identify the amount of rainfall in the air, so is more likely to detect the broader frontal rainfall than highly localised, convective rainfall. KISTERS HydroMaster provides RADAR rainfall data by sub-catchment, rather than a specific pinpointed location. To identify differences within each PCWLMB catchment, rainfall radar data was obtained to approximately correspond with the upstream, middle and downstream sections of each catchment at the following locations:

- Cuckmere catchment at Hellingly (upstream), Arlington (middle course) and Cuckmere Haven (downstream).

15 Chronology of British Hydrological Events (2023). Available at: <https://www.cbhe.hydrology.org.uk/results.php>

16 DEFRA data services platform - Recorded Flood Outlines, Available at: <https://environment.data.gov.uk/dataset/8c75e700-d465-11e4-8b5b-f0def148f590>

17 Flooding of the Cuckmere Haven (2019). Available at: <https://www.sussexexpress.co.uk/news/people/pictures-taken-with-drone-show-shocking-extent-of-flooding-at-cuckmere-haven-1305545>

18 Environment Agency Water situation reports for England (2023). Available at: <https://www.gov.uk/government/collections/water-situation-reports-for-england>

19 Environment Agency's Hydrology Data Explorer. Available at: <https://environment.data.gov.uk/hydrology/landing>

20 KISTERS Hydromaster. Available at: <https://www.hydromaster.com/en/>

- Pevensey Levels catchment at Horse Eye Level (upstream), Willingdon Levels (middle course, west), Waller's Haven (middle course, east) and Pevensey Bay (downstream).
- Combe Haven catchment at Catsfield (upstream), Tilekiln (middle course) and Bulverhythe (downstream).

Finally, to measure river response to rainfall events, flow gauges and river level measurements were obtained at the following locations to approximately correspond with the upstream, middle and downstream sections of each catchment (also from the Environment Agency's hydrology data explorer):

- Cuckmere catchment – Cowbeech flow (upstream), Leabridge flow (middle course), Sherman bridge (downstream).
- Combe Haven catchment – Crowhurst stage (upstream) and Sheepwash Bridge stage (downstream).

Note that the quality of the gauge readings obtained for the Combe Haven has not yet been checked by an Environment Agency hydrologist.

River level or flow measurement gauges were not available for the Pevensey Levels catchment on the EA Hydrology Explorer. A river flow and level gauge exists on the Waller's Haven in the Pevensey Levels, however data at this station was last recorded on 01 December 2020. The Shoothill Gauge Map contains river level gauge data on the Salt Haven at the EA depot in Pevensey[21]. The gauge record shows a tidal influence, and therefore the gauge appears to be located downstream of the EA tidal doors, which are closed at high tide. The data could not be exported for inclusion in graphs, however levels from the gauge have been included in the description of events within the Pevensey catchment section.

Figure 4-1 displays the locations at which hydrometric was extracted within the PCWLMB area. The locations of the RADAR rainfall are approximate, as data is extracted from KISTERS HydroMaster at a sub-catchment scale.

21 Shoothill (2023) Gauge Map: Pevensey (Salt Haven). Available at: Latest updates on Storm Franklin | GaugeMap

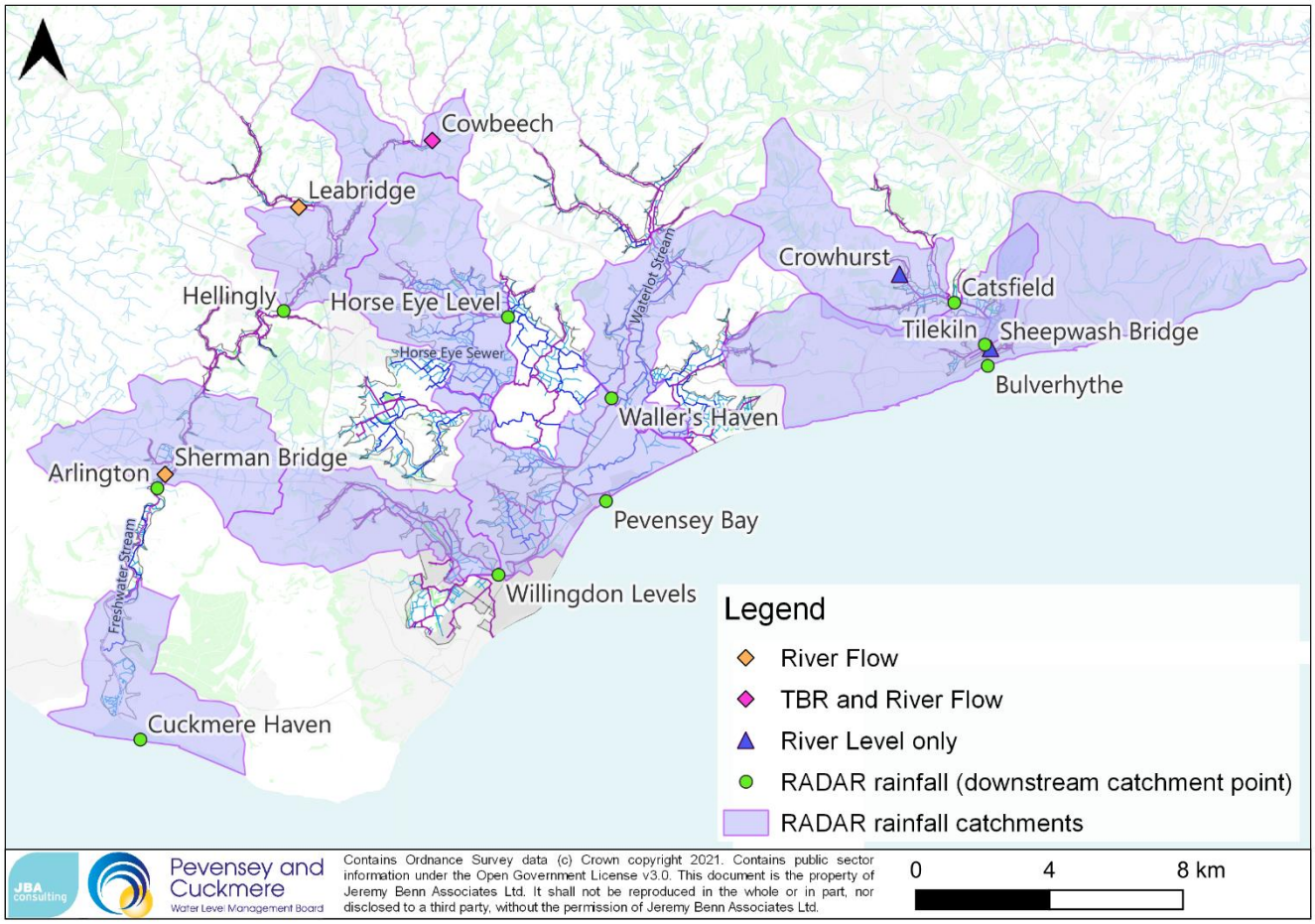

Figure 4-1: Locations of hydrometric data extraction, categorised by data type, used within the hydrological analysis.

4.2 Conditions prior to Winter 2022 - 2023

Prior to the Winter 2022-23 flooding, soil moisture and rainfall conditions - relative to the monthly long-term average (LTA) (1961-1990) datasets - ranged from drier than expected in August to slightly wetter than average in October. These trends were also corroborated in the mean monthly river flow trends.

During August, rainfall was slightly below the LTA, with Cowbeech TBR recording 50.6mm of rainfall during the month and mean monthly river flow levels within the south-east of England generally lower than average. The rainfall events which occurred were generally intense, localised summer rainfall events. However, soil moisture deficit data, which provides an indication of soil dryness, suggests that soils within and around the PCWLMB's area were much drier than expected for August after the prolonged, dry summer.

During September and October, rainfall totals were either normal or above normal compared to the LTA (see Figure 4-2, Figure 4-3 and Figure 4-4), with river flows recovering to normal levels. Soil moisture deficit values indicate that soils were slightly wetter than the LTA. During the latter half of October, rainfall totals significantly increased, with 59.59mm of rainfall recorded at Cowbeech TBR between 15 and 31 October 2022.

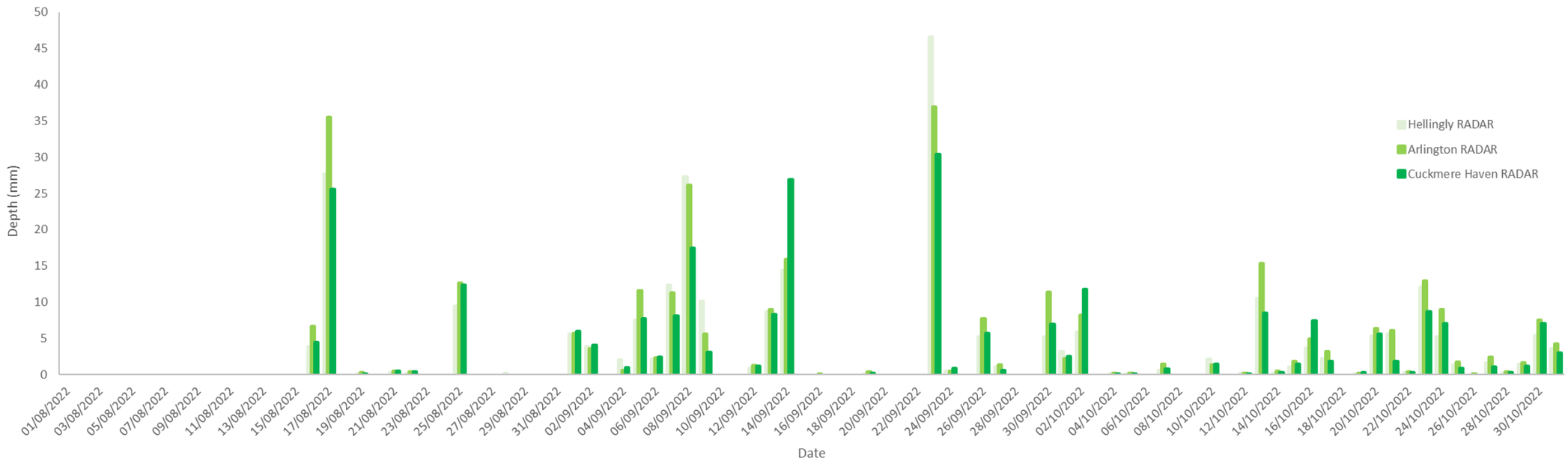

Figure 4-2: Rainfall totals between 01 August 2022 and 31 October 2023 in the Cuckmere catchment

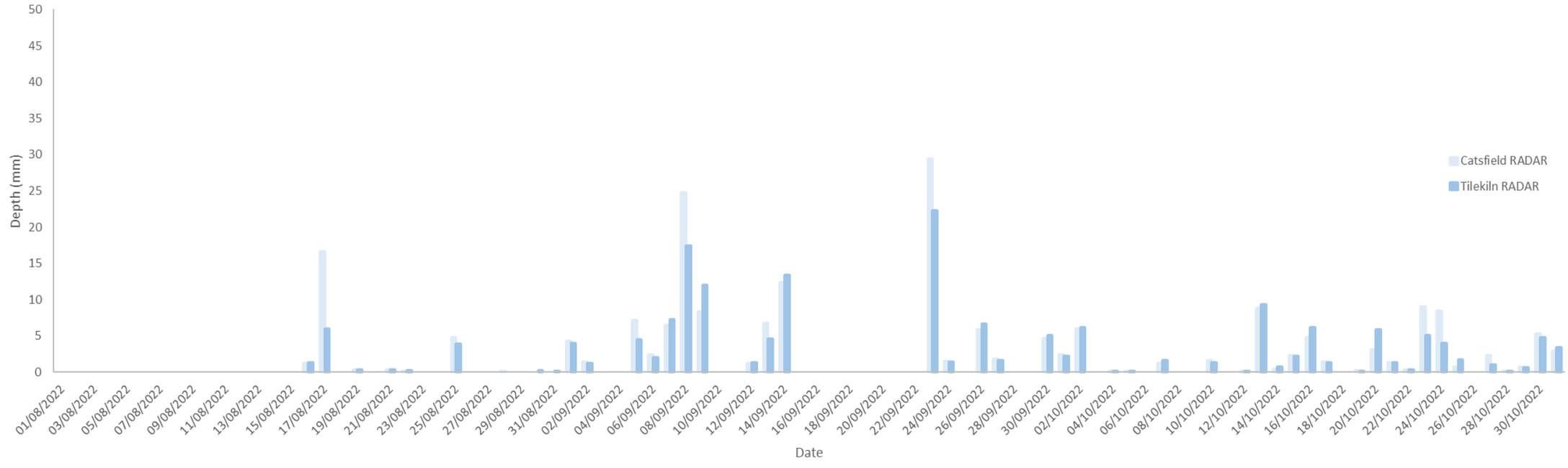

Figure 4-3: Rainfall totals between 01 August 2022 and 31 October 2023 in Combe Haven catchment

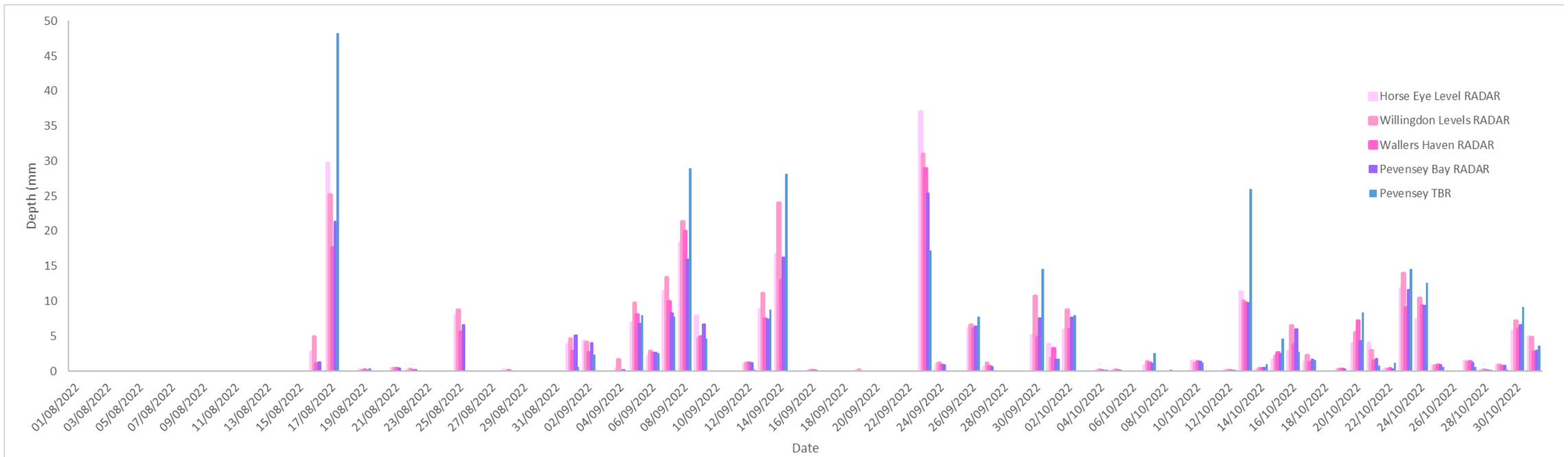

Figure 4-4: Rainfall totals between 01 August 2022 and 31 October 2023 in Pevensey catchment

4.3 Conditions during Winter 2022 - 2023

During the winter (01 November 2022 to 31 March 2023), there were several prolonged periods of above average rainfall impacting corresponding river flow and soil moisture values. Monthly rainfall totals for November, December, January and March were each significantly above their monthly LTA. This section provides a short month-by-month summary of rainfall, soil moisture and river flow conditions, with specific events identified and described in the following section.

During November 2022, rainfall levels were exceptionally high compared to the LTA across south-east England. This trend was also exhibited within the PCWLMB area, with 245.98mm of rainfall recorded at Cowbeech TBR between 01 November and 31 November, with the most intense rainfall events occurring during between 01 and 10 November, 15 and 17 November, and 26 and 28 November (see Figure 4-5). Consequently, soils were wetter than expected compared to the LTA and river levels were also exceptionally high.

Following this, monthly south-east December rainfall totals ranged from above normal to notably high, with 125.20mm recorded at the Cowbeech TBR. Soil moisture levels increased, notably due to prolonged rainfall during the latter half of the month (15 to 31 December), where 108.20mm fell at Cowbeech TBR. Whilst river flow was still above normal, but these had decreased relative to the previous month.

In January, rainfall values were still above normal, with 101.60mm recorded at Cowbeech TBR. This rainfall mainly occurred at the start of the month, with 97.60mm recorded between 01 and 16 January. Soil moisture levels and river flows were still higher than average, although river levels dropped to be nearer to normal values compared to the LTA by the end of the month.

In contrast, February was a much drier month, with rainfall levels notably to exceptionally low. Only 6.8mm of rain was recorded at Cowbeech TBR during the entire month. Due to the lack of rainfall, soils dried, so soil moisture deficit was close to the LTA by the end of the month. River levels also dropped to notably low compared to the LTA.

Finally, similar to November, exceptionally high levels of rainfall occurred in March compared to the LTA. A total of 123.60mm of rainfall was recorded at Cowbeech TBR, with significant amounts of rainfall occurring between the 07 and 10 March, as well as between 22 and 31 March. River flow levels increased to being notably high compared to the LTA, with soil moisture values wetter than average.

4.4 Events identified from hydrological data

Specific events per catchment identified within the hydrological data (both rainfall and river level/ flow) are listed by month within the tables below.

Due to project timescales, the scope of the assessment did not include the calculation of return periods of the events identified in each catchment. However, event rarity analysis for 03 November 2022, undertaken by JBA Consulting for ESCC, indicated that the scale of storm event was relatively small in the Cuckmere catchment (between 1 in 2-years and 1 in

8-years for Horam and Hellingly) and Pevensey catchment (up to 1 in 2-years for Hailsham). Return period estimation is inherently uncertain due to the data and methods used. However, these values can be used to provide an indication of the scale of the events in each catchment. As further work, this analysis could also be undertaken on the rainfall and river gauge data assessed as part of this study, to provide an indication of the rarity of events which occurred over Winter 2022 - 2023.

4.4.1 Cuckmere catchment

4.4.1.1 November 2022

Three events were identified within the Cuckmere Catchment during November 2022, as displayed in Figure 4-5 and Table 4-1: Flooding incidents identified during hydrological analysis within the Cuckmere catchment in November 2022.Table 4-1.

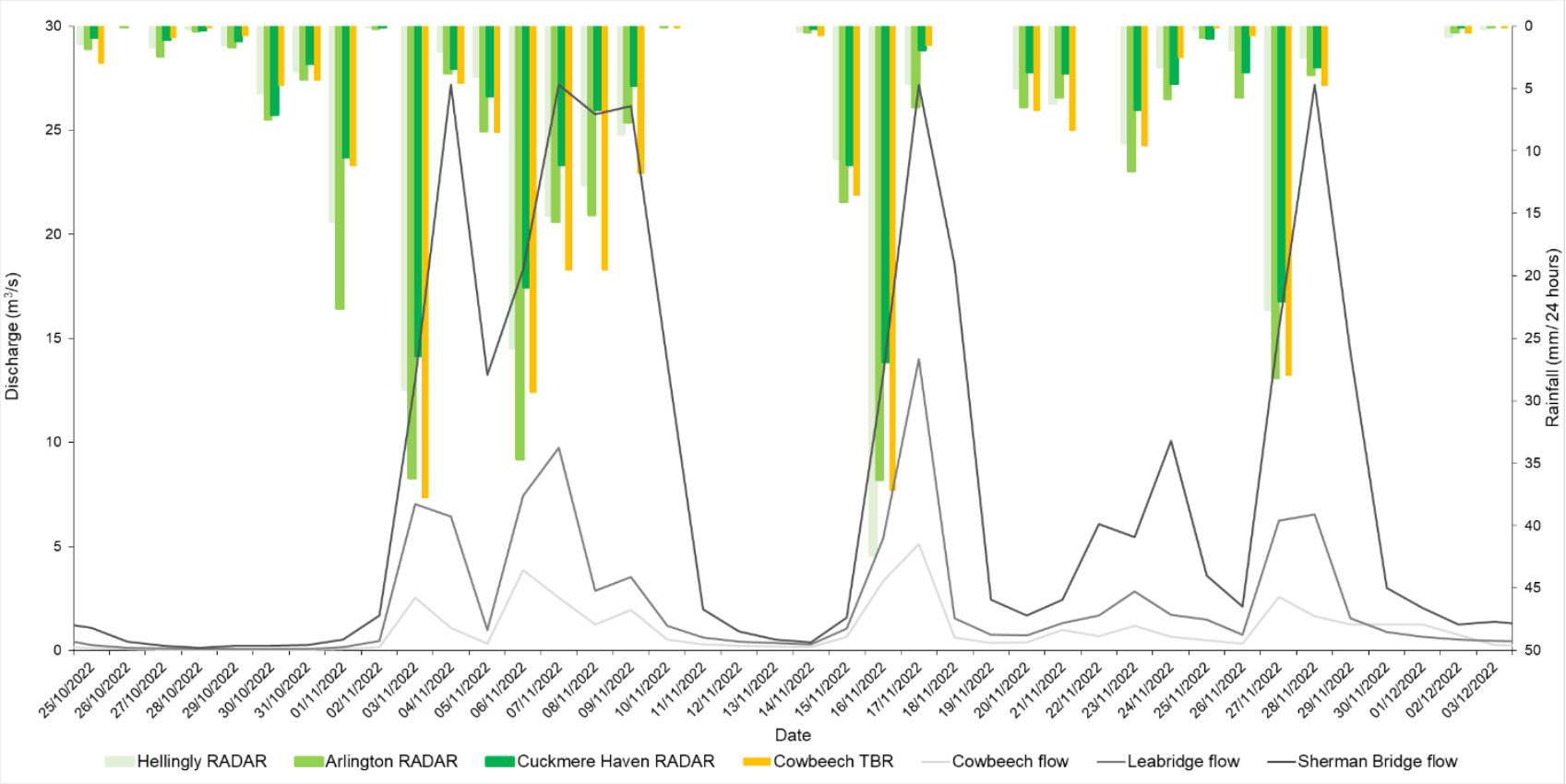

Figure 4-5: Rainfall (mm/ 24 hours) and river flow (discharge, m^3/s) values recorded in the Cuckmere catchment between 25

October and 03 December 2022.

Table 4-1: Flooding incidents identified during hydrological analysis within the Cuckmere catchment in November 2022.

Date and time (24hr clock)	Total rainfall (mm)	River flow response
03/11/2022 (03:00) to 09/11/2022 (07:30)	Cowbeech TBR – 130mm Hellingly – 90.6mm Arlington – 115.3mm Cuckmere Haven – 73.2mm	Almost continual rainfall during this period, with daily rainfall values peaking on 3 and 6 November, with 37.79mm and 29.40mm of rainfall recorded at Cowbeech TBR on these dates respectively. Mean daily river flow (at Sherman Bridge) peaked on 4, 7 and 9 November, reaching above 26m^3/s on each of these days.
15/11/2022 (08:15) to 17/11/2022 (03:00)	Cowbeech TBR – 52.395mm Hellingly – 52.2mm Arlington – 51.1mm Cuckmere Haven – 36.2mm	Key rainfall event occurred on 16 November between 01:00 and 23:00, where 37.20mm was recorded at Cowbeech TBR. Mean daily river flow peaked the next day (17November), with a 27.283m^3/s average flow recorded at Sherman Bridge.
26/11/2022 (23:30) to 28/11/2022 (13:15)	Cowbeech TBR – 33.399mm Hellingly – 24.6mm Arlington – 31.7mm Cuckmere Haven – 24.3mm	Main rainfall event occurred on 27 November between 0:00 and 20:30, with 28.00mm of rainfall recorded at Cowbeech TBR. Mean daily flow peaked to 27.283m^3/s on 28 November at Sherman Bridge.

4.4.1.2 December 2022 to January 2023

Three events were identified within the Cuckmere Catchment between December 2022 and January 2023, as displayed in Figure 4-6 and Table 4-2.

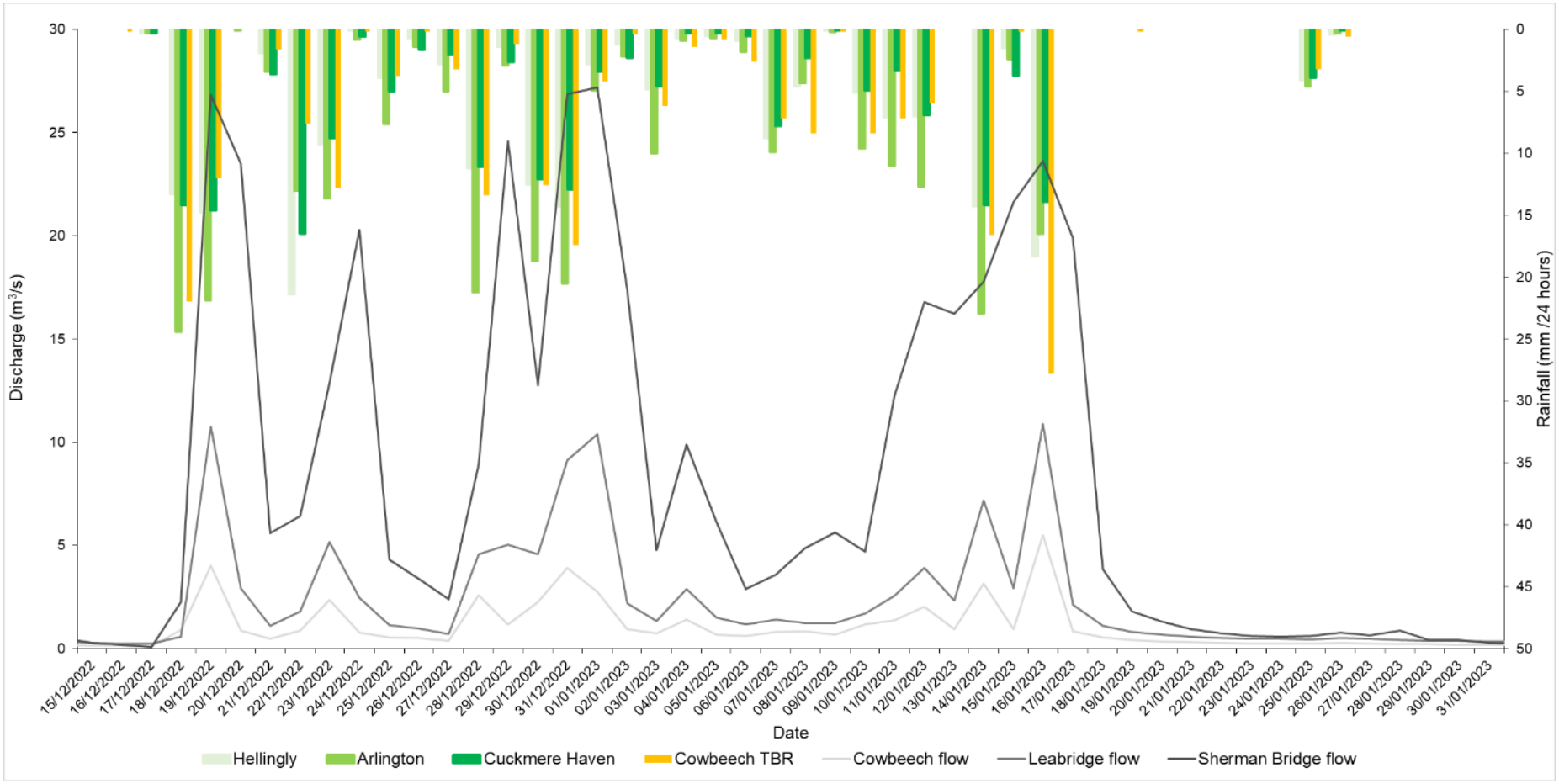

Figure 4-6: Rainfall (mm/ 24 hours) and river flow (discharge, m^3/s) values recorded in the Cuckmere catchment between the 15 December 2022 and 31 January 2023.

Table 4-2: Flooding incidents identified during hydrological analysis within the Cuckmere catchment between the 15 December 2022 and 31 January 2023.

Date and time (24hr clock)	Total rainfall (mm)	River flow response
18/12/2022 (11:45) to 19/12/2022 (22:45)	Cowbeech TBR – 34.0mm Hellingly – 25.7mm Arlington – 42.4mm Cuckmere Haven – 25.9mm	Prolonged, continual rainfall over both days, contributing to mean river flow of 26.83m^3/s
22/12/2022 (8:45) to 23/12/2022 (11:45)	Cowbeech TBR – 14.599mm Hellingly – 7.3mm Arlington – 10.5mm Cuckmere Haven – 8.5mm	Rainfall predominantly occurred on 22 and 23 December, although river levels peaked on 24 December with a 20.78m^3/s mean daily river flow.
28/12/2022 (6:30) to 03/01/2023 (21:25)	Cowbeech TBR – 53.999mm Hellingly – 41.3mm Arlington – 73.4mm Cuckmere Haven – 43.5mm	Most rainfall occurred on 28 December (13.4mm at Cowbeech TBR) and between 30 and 31 December (29.6mm rainfall over both days at Cowbeech TBR). Mean daily river flow corresponded peaked on 29 December, with 24.57 m^3/s flow, then decreased slightly, and then rose again to 27.7 m^3/s on 30 December.
07/01/2023 (16:30) to 16/01/2023 (09:15)	Cowbeech TBR – 80.795mm Hellingly – 60.3mm Arlington – 82.2mm Cuckmere Haven – 50.4mm	River flow steadily increased after prolonged rainfall until 12 January, with a 16.1 m^3/s mean flow at Sherman Bridge. Another mean flow peak occurred on 16 January at Sherman Bridge (24.64 m^3/s).

4.4.1.3 March 2023

Four rainfall events were identified within the Cuckmere Catchment during March 2023, as displayed in Figure 4-7 and Table 4-3.

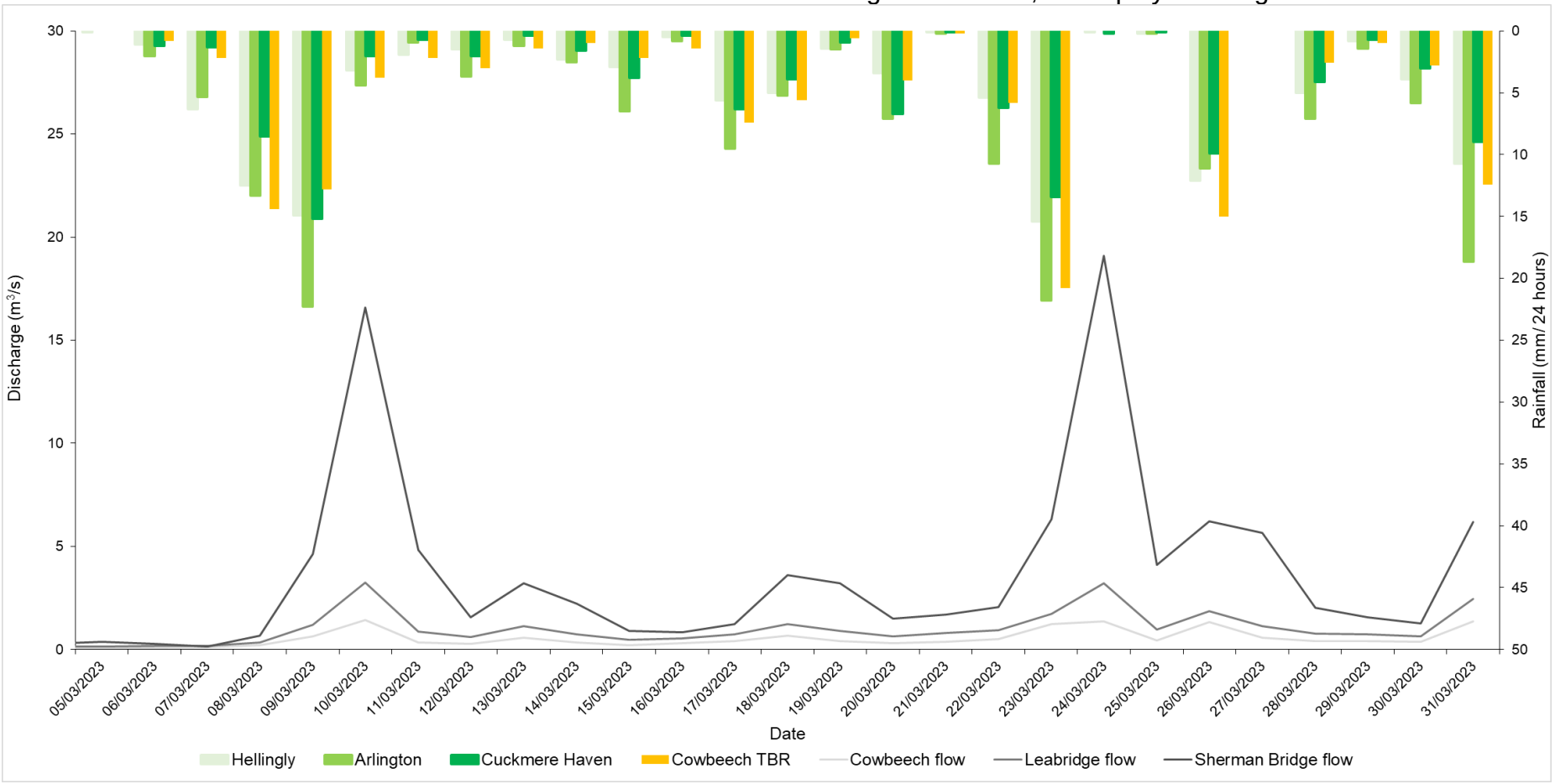

Figure 4-7: Rainfall (mm/ 24 hours) and river flow (discharge, m^3/s) values recorded in the Cuckmere catchment between 05 and 31 March 2023.

Table 4-3: Flooding incidents identified during hydrological analysis within the Cuckmere catchment between 05 and 31 March 2023.

Date and time (24hr clock)	Total rainfall (mm)	River flow response
08/03/2023 (01:15) to 10/03/2023 (02:15)	Cowbeech TBR – 30.6mm Hellingly – 27.4mm Arlington – 36.6mm Cuckmere Haven – 23.6mm	Almost continual rainfall during these dates, with mean daily river levels at Sherman Bridge peaking to 16.57 m^3/s on 10 March.
22/03/2023 (03:15(to 23/03/2023 (22:15)	Cowbeech TBR – 26.598mm Hellingly – 20.3mm Arlington – 30.4mm Cuckmere Haven – 18.5mm	After 20.79mm of rainfall at Cowbeech TBR on 23 March, river flow at Sherman Bridge reached at daily mean of 19.10 m^3/s on 24 March.
26/03/2023 (01:45 to 13:45)	Cowbeech TBR – 15.0mm Hellingly – 12.0mm Arlington – 11.3mm Cuckmere Haven – 9.1mm	Although a concentrated rainfall event, this event had little impact on river flow.
28/03/2023 (06:15) to 31/03/2023 (09:45)	Cowbeech TBR – 16.999mm Hellingly – 15.1mm Arlington – 26.7mm Cuckmere Haven – 11.5mm	Although a concentrated rainfall event, this event had little impact on river flow during the dates analysed.

4.4.2 Pevensey Levels

4.4.2.1 November 2022

Three rainfall events were identified within the Pevensey Levels Catchment during November 2023, as displayed in Figure 4-8 and

Table 4-4. As no open source river flow or level gauge data within the Pevensey Levels was available to extract for use within the assessment, a short hydrological description has instead been provided.

Date and time (24hr clock)	Total rainfall	Hydrological description
01/11/2022 (00:15) to 10/11/2022 (08:00)	Horse Eye Level – 100.5mm Willingdon Level – 107.8mm Wallers Haven – 94.4mm Pevensey Bay – 93.3mm Pevensey TBR - 154.4mm	Prolonged rainfall within the Pevensey Levels between 01 and 10 November 2022, with rainfall peaking on 01, 03 and 06 November, with 20.6mm, 27.7mm and 21.6mm of rainfall recorded respectively at the Horse Eye level gauge.
15/11/2022 (07:45) to 17/11/2022 (05:00)	Horse Eye Level – 49.0mm Willingdon Level – 50.6mm Wallers Haven – 46.3mm Pevensey Bay – 45.9mm Pevensey TBR - 59.79mm	Although the rainfall event lasted approximately three days, the most intense rainfall occurred between 16:15 and 23:00 on 16 November, where 21mm of rainfall was recorded at Pevensey Bay.
16/11/2022 (22:15)	Peak in tidal level of 4.158mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).
27/11/2022 (05:15 to 22:15)	Horse Eye Level – 18.4mm Willingdon Level – 18.6mm Wallers Haven – 20.1mm Pevensey Bay – 17.9mm Pevensey TBR - 26.2mm	Rainfall generally occurred during two peaks between 05:15 and 11:00, as well as between 14:45 and 21:00.

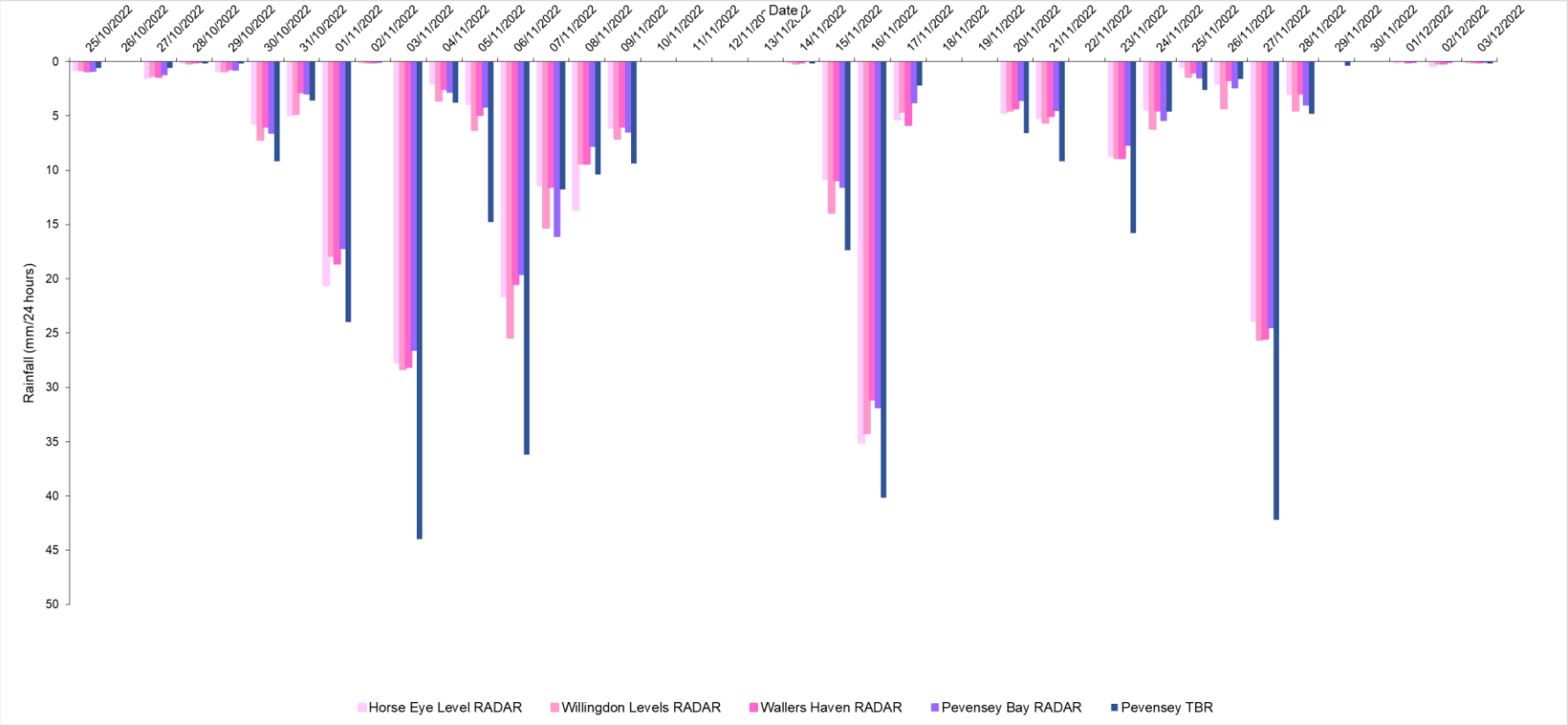

Figure 4-8: Rainfall (mm/ 24 hours) values recorded in the Pevensey Levels catchment between 25 October and 03 December 2022.

Date and time (24hr clock)	Total rainfall	Hydrological description
01/11/2022 (00:15) to 10/11/2022 (08:00)	Horse Eye Level – 100.5mm Willingdon Level – 107.8mm	Prolonged rainfall within the Pevensey Levels between 01 and 10 November 2022, with rainfall peaking on 01, 03 and 06

Date and time (24hr clock)	Total rainfall	Hydrological description
	Wallers Haven – 94.4mm Pevensey Bay – 93.3mm Pevensey TBR - 154.4mm	November, with 20.6mm, 27.7mm and 21.6mm of rainfall recorded respectively at the Horse Eye level gauge.
15/11/2022 (07:45) to 17/11/2022 (05:00)	Horse Eye Level – 49.0mm Willingdon Level – 50.6mm Wallers Haven – 46.3mm Pevensey Bay – 45.9mm Pevensey TBR - 59.79mm	Although the rainfall event lasted approximately three days, the most intense rainfall occurred between 16:15 and 23:00 on 16 November, where 21mm of rainfall was recorded at Pevensey Bay.
16/11/2022 (22:15)	Peak in tidal level of 4.158mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).
27/11/2022 (05:15 to 22:15)	Horse Eye Level – 18.4mm Willingdon Level – 18.6mm Wallers Haven – 20.1mm Pevensey Bay – 17.9mm Pevensey TBR - 26.2mm	Rainfall generally occurred during two peaks between 05:15 and 11:00, as well as between 14:45 and 21:00.

Table 4-4: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 25 October and 03 December 2022.

4.4.2.2 December 2022 to January 2023

Five rainfall events were identified within the Pevensey Levels Catchment during December 2022 to January 2023, as displayed in Figure 4-9 and

Date and time (24hr clock)	Total rainfall	Hydrological analysis
18/12/2022 (11:00) to 19/12/2022 (23:00)	Horse Eye Level – 27.4mm Willingdon Level – 38.6mm Wallers Haven – 23.8mm Pevensey Bay – 28.4mm Pevensey TBR - 40.8mm	Almost continual rainfall within the Pevensey levels between these two dates.
21/12/2022 (22:15) to 23/12/2022 (21:45)	Horse Eye Level – 26.7mm Willingdon Level – 25.5mm Wallers Haven – 24.2mm Pevensey Bay –26.4mm Pevensey TBR - 33.8mm	Overnight rainfall concentrated between 22:15 (21 December) and 03:00 (22 December), with 15.9mm recorded at Pevensey Bay.
28/12/2022 (06:00) to 03/01/2023 (22:15)	Horse Eye Level – 46.9mm Willingdon Level – 65.2mm Wallers Haven – 43.4mm Pevensey Bay – 50.8mm Pevensey TBR - 90.2mm	Continual prolonged rainfall events per day, as displayed in Figure 4-9.
10/01/2023 (06:30) to 12/01/2023 (23:30)	Horse Eye Level – 18.7mm Willingdon Level – 24.2mm Wallers Haven – 16.4mm Pevensey Bay –18.1mm Pevensey TBR - 41.0mm	Concentrated between 16:15 and 19:15 on 11 January.
14/01/2023 (01:30) to 16/01/2023 (07:00)	Horse Eye Level – 34.6mm Willingdon Level – 40.7mm Wallers Haven – 35.1mm Pevensey Bay –34.7mm Pevensey TBR - 79.8mm	Rainfall concentrated between 01:30 and 11:15 on 14 January, with 20.5mm recorded at Wallers Haven.

Date and time (24hr clock)	Total rainfall	Hydrological analysis
14/01/2023 (10:30)	Peak in tidal level of 4.358mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).
16/01/2023 (04:00)	Peak in tidal level of 4.109mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).

. As no open source river flow or level gauge data within the Pevensey Levels was available to extract for use within the assessment, a short hydrological description has instead been provided.

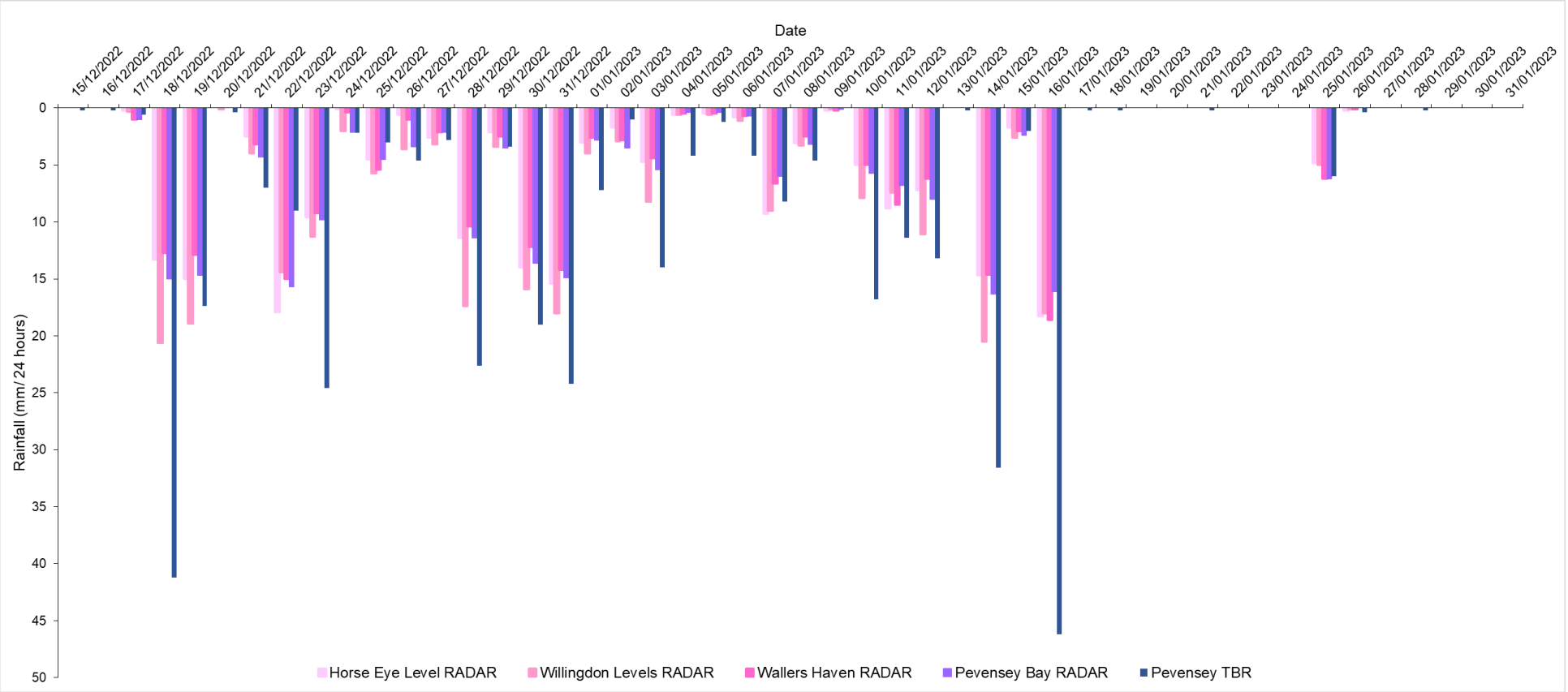

Figure 4-9: Rainfall (mm/ 24 hours) values recorded in the Pevensey Levels catchment between 15 December 2022 and 31 January 2023.

Table 4-5: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 15 December 2022 and 31 January 2023.

Date and time (24hr clock)	Total rainfall	Hydrological analysis
18/12/2022 (11:00) to 19/12/2022 (23:00)	Horse Eye Level – 27.4mm Willingdon Level – 38.6mm Wallers Haven – 23.8mm Pevensey Bay – 28.4mm Pevensey TBR - 40.8mm	Almost continual rainfall within the Pevensey levels between these two dates.
21/12/2022 (22:15) to 23/12/2022 (21:45)	Horse Eye Level – 26.7mm Willingdon Level – 25.5mm Wallers Haven – 24.2mm Pevensey Bay –26.4mm Pevensey TBR - 33.8mm	Overnight rainfall concentrated between 22:15 (21 December) and 03:00 (22 December), with 15.9mm recorded at Pevensey Bay.
28/12/2022 (06:00) to 03/01/2023 (22:15)	Horse Eye Level – 46.9mm Willingdon Level – 65.2mm Wallers Haven – 43.4mm Pevensey Bay – 50.8mm Pevensey TBR - 90.2mm	Continual prolonged rainfall events per day, as displayed in Figure 4-9.
10/01/2023 (06:30) to 12/01/2023 (23:30)	Horse Eye Level – 18.7mm Willingdon Level – 24.2mm Wallers Haven – 16.4mm Pevensey Bay –18.1mm Pevensey TBR - 41.0mm	Concentrated between 16:15 and 19:15 on 11 January.
14/01/2023 (01:30) to 16/01/2023 (07:00)	Horse Eye Level – 34.6mm Willingdon Level – 40.7mm Wallers Haven – 35.1mm Pevensey Bay –34.7mm Pevensey TBR - 79.8mm	Rainfall concentrated between 01:30 and 11:15 on 14 January, with 20.5mm recorded at Wallers Haven.

Date and time (24hr clock)	Total rainfall	Hydrological analysis
14/01/2023 (10:30)	Peak in tidal level of 4.358mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).
16/01/2023 (04:00)	Peak in tidal level of 4.109mAOD recorded at Salt Haven gauge in EA Pevensey depot.	Peak above normal tidal level recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).

4.4.2.3 March 2023

Four rainfall events were identified within the Pevensey Levels Catchment during March 2023, as displayed in Figure 4-10 and

Table 4-6. As no open source river flow or level gauge data within the Pevensey Levels was available to extract for use within the assessment, a short hydrological description has instead been provided.

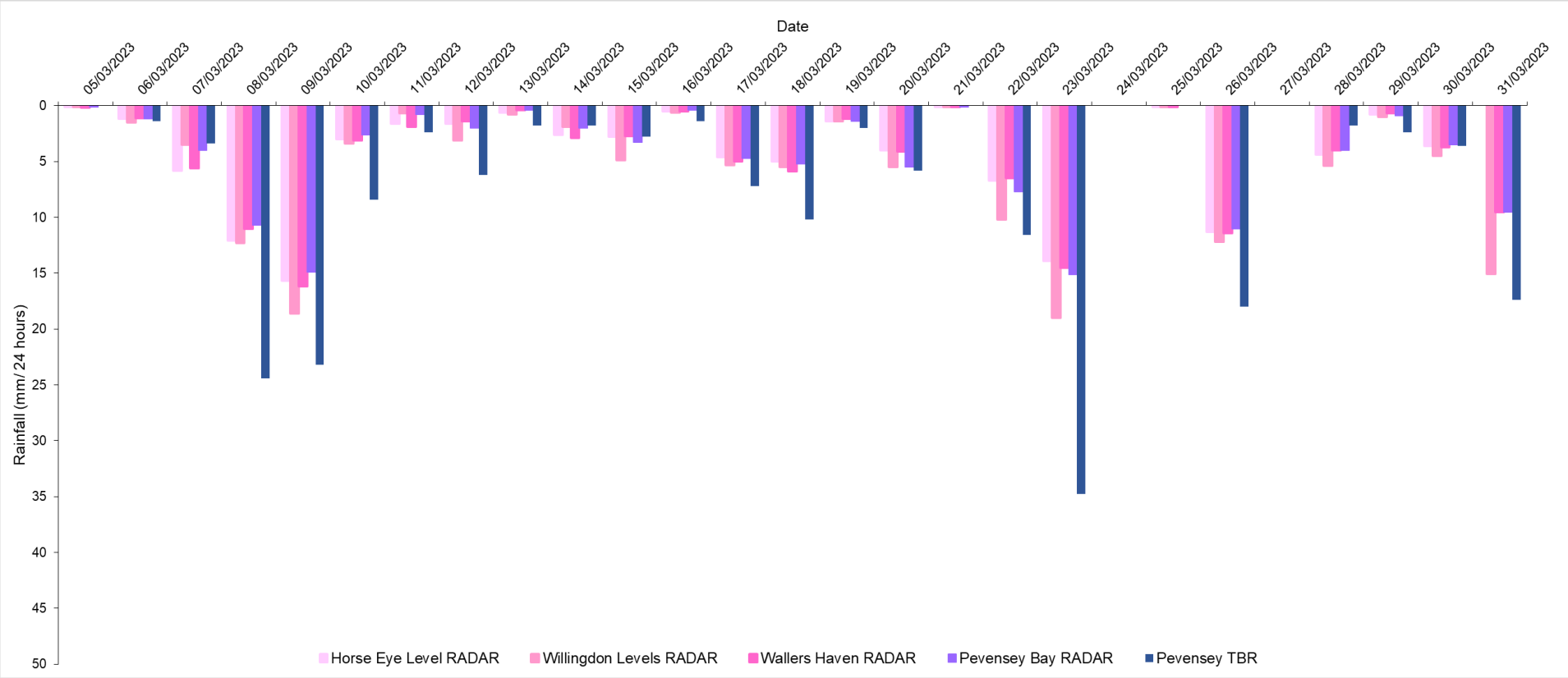

Figure 4-10: Rainfall (mm/ 24 hours) values recorded in the Pevensey Levels catchment between 05 and 31 March 2023.

Table 4-6: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 05 and 31 March 2023.

Date and time (24hr clock)	Total rainfall	River levels
07/03/2023 (07:15) to 10/03/2023 (02:45)	Horse Eye Level – 32.1mm Willingdon Level – 33.5mm Wallers Haven – 32.1mm Pevensey Bay – 28.6mm Pevensey TBR - 58.2mm	Rainfall concentrated on 8 and 9 March, with 25.6mm of rainfall recorded at Pevensey Bay on this date.
22/03/2023 (03:30) to 23/03/2023 (22:00)	Horse Eye Level – 19.6mm Willingdon Level – 27.6mm Wallers Haven – 19.7mm Pevensey Bay – 22.3mm Pevensey TBR - 46.4mm	Rainfall concentrated on 23 March, with 19mm recorded at Willingdon Levels.
26/03/2023 (02:00 to 11:00)	Horse Eye Level – 11.0mm Willingdon Level – 11.5mm Wallers Haven – 10.3mm Pevensey Bay –10.5mm Pevensey TBR - 16.2mm	Intense rainfall event throughout the day.
28/03/2023 (06:30) to 31/03/2023 (14:15)	Horse Eye Level – 15.4mm Willingdon Level – 21.8mm Wallers Haven – 14.2mm Pevensey Bay –13.8mm Pevensey TBR - 23.4mm	Predominantly on 31 March, with 15.08mm of rainfall recorded at Willingdon Levels.

4.4.3 Combe Haven

4.4.3.1 November 2022

Four rainfall and river level events were identified within the Combe Haven catchment during November 2022, as displayed in Figure 4-11 and Table 4-7.

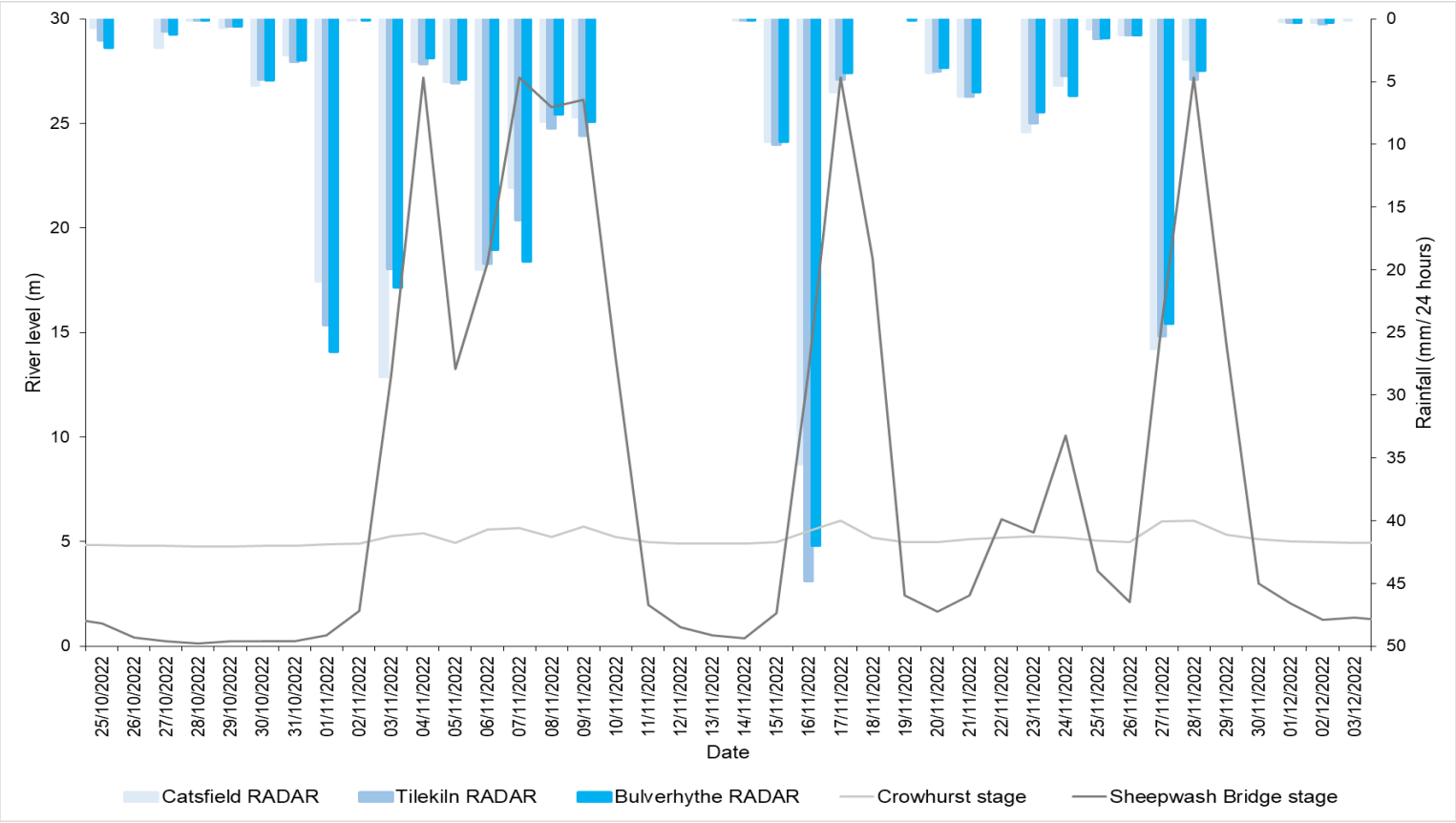

Figure 4-11: Rainfall (mm/ 24 hours) and river level (m) values recorded in the Pevensey Levels catchment between 25 October and 03 December 2022.

Table 4-7: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 25 October and 03 December 2022.

Date and time (24hr clock)	Total rainfall	River level response
01/11/2022 (00:45) to 09/11/2022 (07:15)	Catsfield – 100.1mm Tilekiln – 101.6mm Bulverhythe – 103.9mm	Key rainfall events on 1, 3, and 6-7 November, where rainfall values at Bulverhythe reached 26.5mm, 27.2mm, 18.4mm and 19.3mm per day. Mean daily river levels at Sheepwash Bridge also peaked on 5 November (27.2m) and 8-9 November (27.2m).
15/11/2022 (08:30) to 17/11/2022 (05:15)	Catsfield – 49.4mm Tilekiln – 57.9mm Bulverhythe – 55.2mm	Key rainfall event occurred on 16 November, with 44.8mm of rainfall recorded at Tilekiln. River levels correspondingly increased and peaked the following day.
21/11/2022 (12:15) to 24/11/2022 (18:30)	Catsfield – 18.8mm Tilekiln – 17.5mm Bulverhythe – 17.8mm	Continual rainfall on 21, 23 and 24 November did not have a significant impact on Sheepwash Bridge stage (reached 10.07m).
26/11/2022 (23:30) to 28/11/2022 (11:15)	Catsfield – 28.7mm Tilekiln – 28.4mm Bulverhythe – 26.8mm	Key rainfall event on 27 November (Bulverhythe - 24.3mm), contributed to peak river level of 27.2m on 28 November.

4.4.3.2 December 2022 to January 2023

Four rainfall and river level events were identified within the Combe Haven catchment between December 2022 and January 2023, as displayed in Figure 4-12 and Table 4-8.

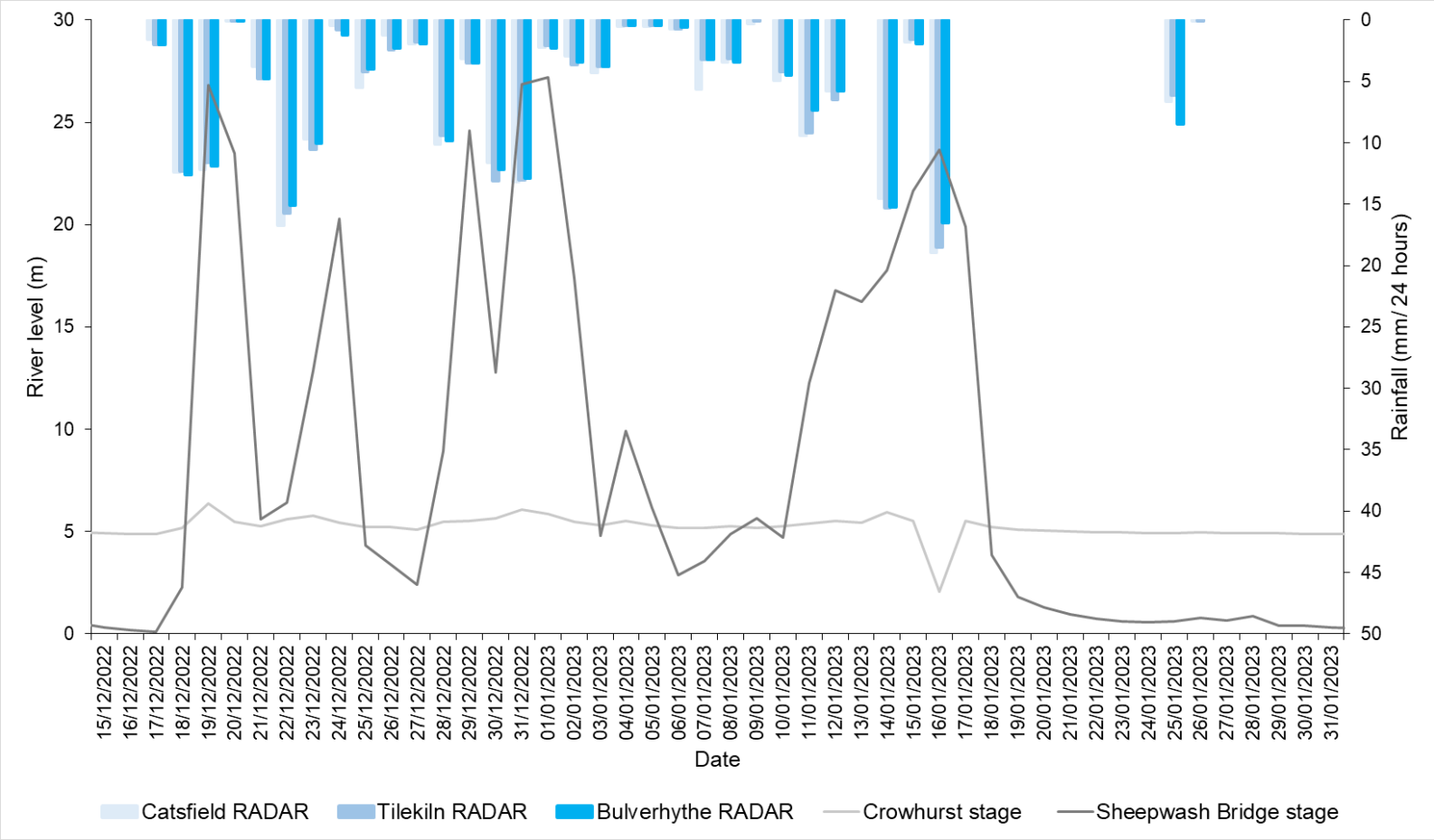

Figure 4-12: Rainfall (mm/ 24 hours) and river level (m) values recorded in the Pevensey Levels catchment between 15 December 2022 and 31 January 2022.

Table 4-8: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 15 December 2022 and 31 January 2022.

Date and time (24hr clock)	Total rainfall	River level response
18/12/2022 (11:30) to 19/12/2022 (11:45)	Catsfield – 22.3mm Tilekiln – 22.0mm Bulverhythe – 22.2mm	River levels peaked on 19 December to 26.8mm at Sheepwash Bridge.
21/12/2022 (22:15) to 23/12/2022 (09:45)	Catsfield – 25.2mm Tilekiln – 24.8mm Bulverhythe – 24.4mm	Small peak in river levels on 24 December to 20.78mm at Sheepwash Bridge.
28/12/2022 (06:15) to 01/01/2023 (00:45)	Catsfield – 35.7mm Tilekiln – 38mm Bulverhythe – 34.9mm	Continual rainfall between these dates lead to peak daily stage of 27.2mm at Sheepwash Bridge on 01 January.
10/01/2023 (07:15) to 16/01/2023 (07:30)	Catsfield – 52.1mm Tilekiln – 52.2mm Bulverhythe – 47.5mm	River levels peaked on 16 January at 19.09m at Sheepwash Bridge.

4.4.3.3 March 2023

Four rainfall and river level events were identified within the Combe Haven catchment during March 2023, as displayed in Figure 4-13Figure 4-12 and Table 4-9.

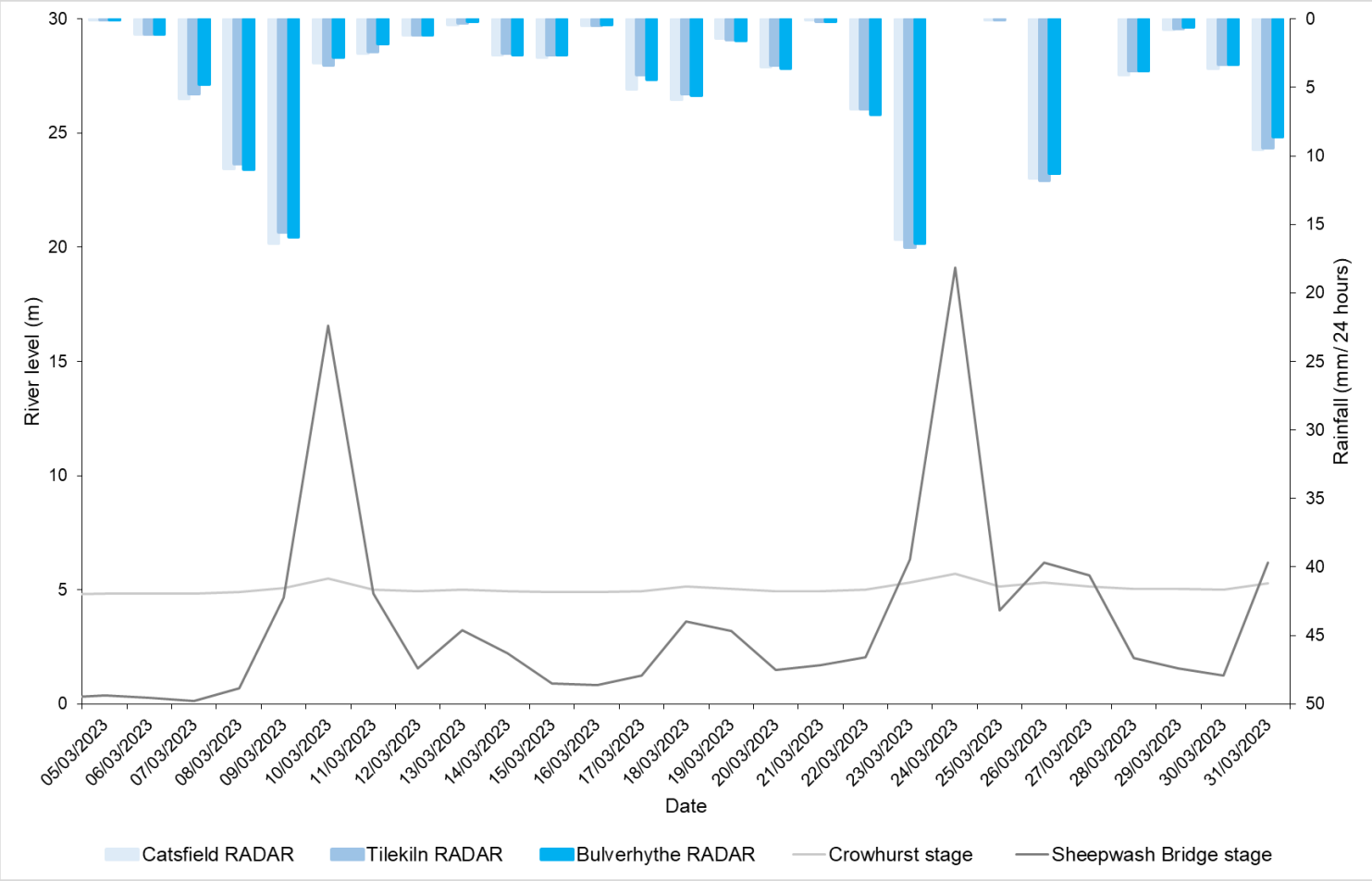

Figure 4-13: Rainfall (mm/ 24 hours) and river level (m) values recorded in the Pevensey Levels catchment between 05 and 31 March 2022.

Table 4-9: Flooding incidents identified during hydrological analysis within the Pevensey Levels catchment between 05 and 31 March 2022.

Date and time (24hr clock)	Total rainfall	River level response
07/03/2023 (07:30) to 10/03/2023 (02:45)	Catsfield – 32.5mm Tilekiln – 31.4mm Bulverhythe – 31.2mm	Mean peak levels peaked to 16.58m on 10 March 2023 at Sheepwash Bridge.
22/03/2023 (03:45) to 23/03/2023 (21:30)	Catsfield – 21.8mm Tilekiln – 22.1mm Bulverhythe – 21.6mm	Mean peak river levels peaked to 19.10m on 24 March 2023 at Sheepwash Bridge.
26/03/2023 (02:15 to 11:00)	Catsfield – 10.3mm Tilekiln – 11.7mm Bulverhythe – 11.1mm	This intense rainfall event had little impact on river levels.
30/03/2023 (22:00) to 31/03/2023 (14:00)	Catsfield – 10.7mm Tilekiln – 10.4mm Bulverhythe – 10.4mm	This intense rainfall event had little impact on river levels.

4.5 Groundwater

The Centre for Ecology and Hydrology (CEH) UK Water Resources Portal[22] provides groundwater monitoring at West Dean No. 3 borehole in the chalk of the South Downs on the eastern margin of the Cuckmere valley, and includes records since 1940 (British Geological Survey, 2023). The recorded data between October 2022 and March 2023 is shown in Figure 4-14. Groundwater levels were shown to be at 'normal' levels in October, rising to 'notably high' in December 2022. Levels in January and early February 2023 rose to 'exceptionally high', reaching a level only exceeded four times since 1940.

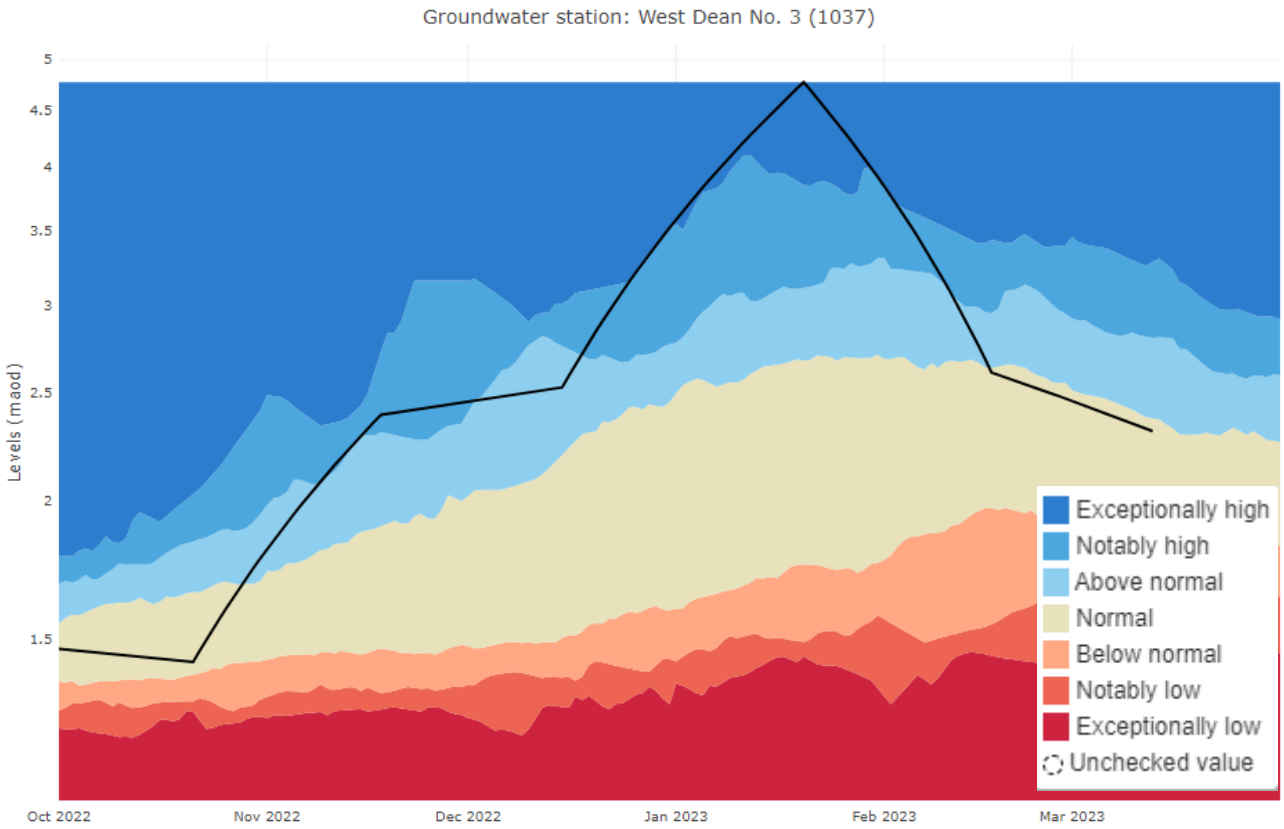

Figure 4-14: Groundwater monitoring levels at West Dean No. 3 borehole between October 2022 and March 2023 (CEH, 2023).

22 Centre for Ecology and Hydrology (2023) UK Water Resources Portal: Lullington Heath COSMOS-UK site. Available at: <https://eip.ceh.ac.uk/hydrology/water-resources/>

5 Timeline of events

A timeline of events recorded during Winter 2022 - 2023 is presented in Appendix B, within the following tables:

- Cuckmere catchment (Appendix B.1)
- Pevensey catchment (Appendix 0)
- Combe Haven catchment (Appendix 0)

6 Source-pathway-receptor analysis

The available hydrometric data and questionnaire responses have been analysed to determine the main sources of flood water, the pathways they took, and the main receptors. These are described in the following sections, by catchment.

A total of 27 questionnaire responses were received between 11/05/2023 and 23/05/2023 (of which 24 landowners had experienced flooding in Winter 2022 - 2023), as well as 31 highway flooding incidents from National Highways.

6.1 Cuckmere catchment

6.2 Source

6.2.1 River

The main primary source of flooding for the majority of receptors in the catchment was reported to be high river levels on the River Cuckmere. River gauge data at Cowbeech, Lea Bridge and Sherman Bridge (see Section 4) show that flow and water levels in the River Cuckmere responded rapidly to rainfall events in November, December, January and March, with a total of 12 peak river flow/water level events captured between November 2022 and March 2023. This reflects the succession of rainfall events which fell during this period, as well as the high soil moisture levels and river levels which were recorded throughout the winter period.. The largest events in terms of river flow were recorded in early, mid and late-November (03/11/2023, 07/11/2023, 17/11/2023, 28/11/2023), as well as mid-December (19/12/2023) and early and mid-January (01/01/2023, 16/01/2023).

Site observations by the PCWLMB Operations Manager and the Board chairman identified that during November 2022, the sluice gates on the Freshwater Stream were operating effectively and (particularly at Dickermans Wall) they were able to drain the Cuckmere Valley quickly at low tide. However, on 11 November 2022, the beach at the mouth of the River Cuckmere was reported to have built up, restricting the capacity of the river channel and impeding water from flowing out to sea. Minutes from the Cuckmere Flood Forum meeting on 17 April 2023 indicate that a channel was cut at the river mouth later in November, which allowed the River Cuckmere to drain out to sea during the winter months, which was reported to help manage floodwaters inland at Litlington.

In the upper catchment, minutes from the Cuckmere Flood Forum meeting on 17 April 2023 identified that Hellingly flooded from the River Cuckmere in early January 2023. Flooding was also reported from tributaries in the upper reaches of the River Cuckmere, including the Wick Stream at Upper Dicker, the Bull River at Hellingly and Milton Hide Stream at Michelham Priory, Upper Dicker.

6.2.2 Rainfall

Intense rainfall was experienced in the Cuckmere catchment on a frequent basis during the months of November, December, January and March. Rainfall data at Cowbeech, Hellingly (RADAR), Arlington and Cuckmere Haven (RADAR) identify that the highest rainfall events throughout the period were recorded on the following dates:

- 03 November (03:00) to 09 November (07:30) 2022 - a maximum total rainfall depth of 130mm recorded at Cowbeech over this period.
- 07 January (16:30) to 16 January (09:15) 2023 - a maximum total rainfall depth of 82mm recorded at Arlington over this period.
- 15 November (08:15) to 17 November (03:00) 2022 - a maximum total rainfall depth of 52mm recorded at Cowbeech and Hellingly over this period.

However, the data also indicates that there was a series of less severe, yet frequent rainfall events throughout late November, mid to late December, early January, as well as early and late March. Although less significant rainfall depths were recorded during these events, they will have contributed to the river flows and overall catchment wetness, resulting in a more rapid response to rainfall.

6.2.3 Groundwater

A number of questionnaire responses note groundwater as a source of flooding. Soil moisture levels rose throughout September and October, and were wetter than average during November, December, January and February. Therefore, soils in the catchment are likely to have been saturated, which will have raised the water table near to the ground surface, and have restricted the infiltration of any rainfall. Due to the presence of gravel river terrace deposits on the floodplain of the upper and middle reaches of the River Cuckmere floodplain (at Hellingly, Lower and Upper Dicker, Berwick and Litlington) elevated groundwater levels would be expected, in response to rising river levels on the Cuckmere.

The groundwater monitoring station at West Dean No.3 borehole the east of the Cuckmere catchment rose from 'normal' levels in October to 'exceptionally high' in January. Unfortunately, dates of flooding incidents were not provided in the majority of questionnaire responses, and therefore it is not possible to correlate the groundwater flooding with either the high soil moisture and river levels, or the high recorded groundwater levels.

6.2.4 Foul sewer network

Minutes from the Cuckmere Flood Forum meeting on 17 April 2023, reported flooding from the foul sewage network in Hellingly during the winter period. The dates of flooding were not specified, but it was reported to be a recurring issue.

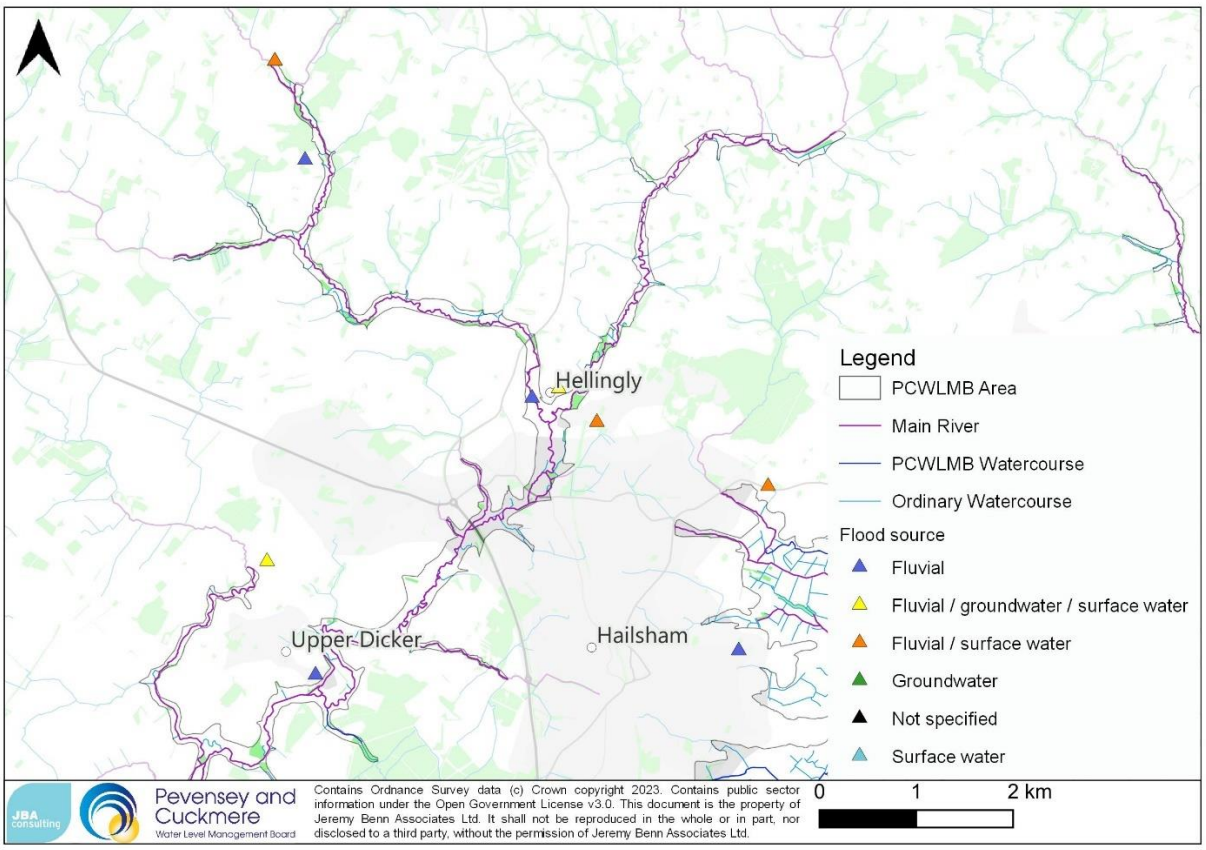

Figure 6-1: Sources of flooding in the upper Cuckmere catchment

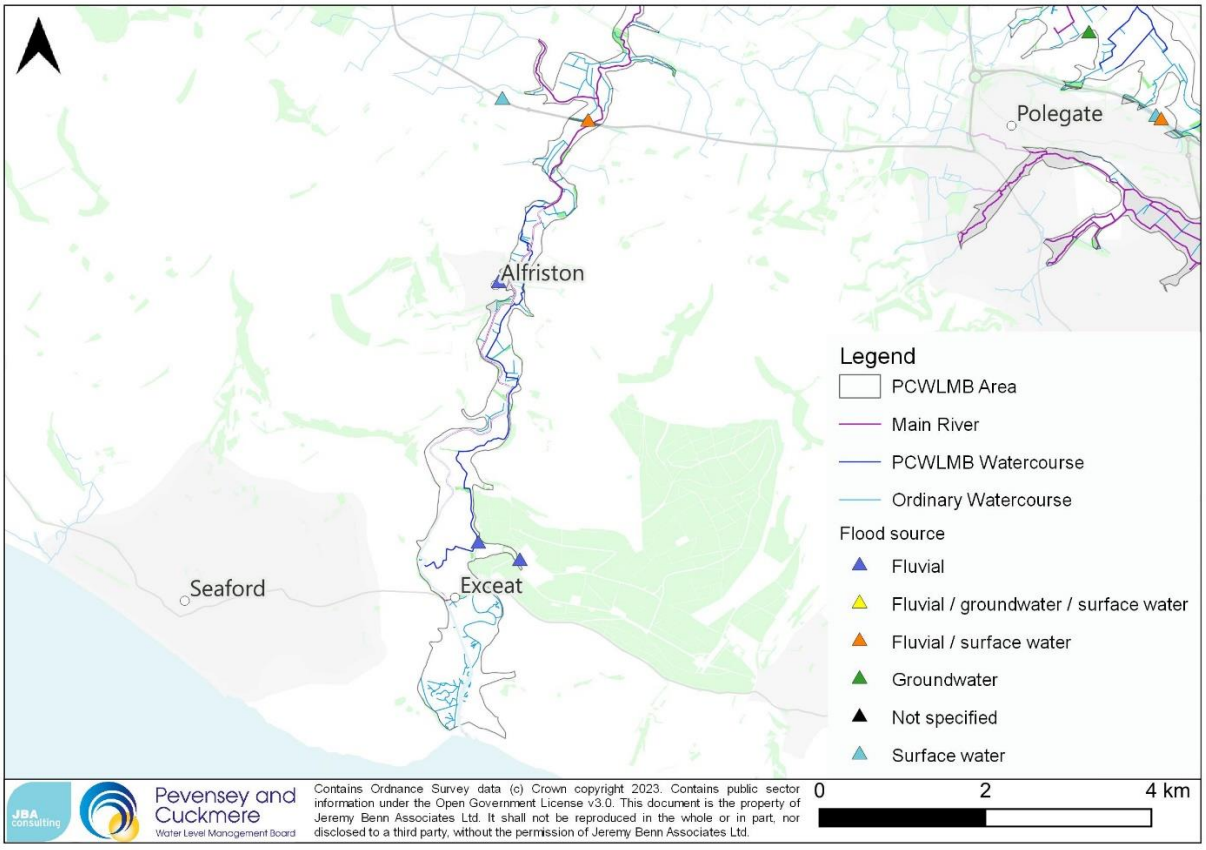

Figure 6-2: Sources of flooding in the lower Cuckmere catchment

6.3 Pathway

6.3.1 Exceedance of river capacity

The reported pathway of flooding was river levels exceeding bank level of the River Cuckmere and its tributaries (including Milton Hide Stream and Wick Stream in Upper Dicker) and spilling out onto the surrounding agricultural land and road network, and flowing towards properties.

Reports of flooding in Alfriston mentioned significant flooding on the left bank of the river on 3 November 2022, with less extensive flooding from the right bank. This is confirmed by photographs provided from November, January and March, which showed the extent of flooding around Litlington (see Section 6.4).

Sections of embankment on the River Cuckmere which had been lowered by erosion influenced the frequency at which the banks were overtopped, and also provided a preferential route for out-of-bank flows (as shown in Figure 6-3).

Reports of flooding from the River Cuckmere and Wick Stream noted the presence of debris in the river, which prevented the river from draining effectively. Debris was also reportedly transported across the floodplain by floodwaters, knocking over fences within its path.

Figure 6-3: Overtopping of the River Cuckmere at eroded sections of embankment (credit: PCWLMB).

6.3.2 Surface water flow paths / drainage system

Impermeable surfaces such as roads were reported to become direct pathways for surface water to run off, and to route floodwaters from the River Cuckmere and its tributaries e.g. Camberlot Road, Upper Dicker. The surface water drainage network includes highway gullies and drains (East Sussex County Council responsibility), and surface water sewers (Southern Water responsibility). These are designed to drain rainwater underground and outfall directly into the nearest watercourse or surface water sewer.

In some locations, the surface water drainage system became overwhelmed and water surcharged from manholes. In other locations, highway gullies became blocked by leaves and debris, leading to rainfall ponding on the road surface, rather than being accommodated by the road drainage system. This resulted in flooding to the road (e.g. Mill Lane, Hellingly; A27 between Berwick and Wilmington), and floodwaters flowing off the road on to surrounding land.

In addition to impermeable surfaces, rain falling on saturated fields can form surface water runoff. This was reported as a pathway of flooding in Chiddingly, where overland flow paths formed on the fields after several hours of heavy rain.

6.3.3 Rising water table

When the water table in the ground rises, following prolonged rainfall, or with rising river levels where gravel river terrace deposits are present, groundwater may reach the ground surface and form overland flow paths or areas of ponding. The rising water table can also ingress into properties through the foundations, floors and walls. This mechanism of flooding was reported at a residential property in Hellingly, although the property had been adapted to improve resilience to flooding (through the inclusion of flood doors and pumps).

6.3.4 Exceedance of foul sewer network

A report from Southern Water in the Cuckmere Flood Forum meeting minutes on 17 April 2023 reported that significant volumes of road runoff (an estimated 80% of the total inflows) entered the foul sewage network in Hellingly via manholes. The additional volume within the sewer network caused the foul system to surcharge, resulting in backing up of the network towards homes, and sewage flooding out of manholes.

6.4 Receptors

Flooding in the River Cuckmere catchment was reported to affect the upper catchment at Upper Dicker (Camberlot Road and Michelham Priory Road) and Hellingly (Mill Lane, Station Road), as well as the middle to lower catchment at Alfriston, Litlington, Lullington and West Dean. Many of these settlements regularly experience flooding. However, during Winter 2022 - 2023 the PCWLMB also received reports of flooding in areas where issues are less frequently reported, such as in Horam.

6.4.1 Property

Residential property

There were two reports of internal property flooding in Hellingly. The first due to groundwater levels rising and entering through the floors and walls of the property, and the second due to flooding from the River Cuckmere and Bull River, exacerbated by backing up through highway drainage system (Figure 6-4). This is reported to be a regular occurrence when the River Cuckmere floods. East Sussex Fire and Rescue Service were called to attend and pump water out of one of the properties. Adaptation measures had been installed at the other property, to improve its resilience to flooding, and to minimise the damage from floodwater.

Both internal and external property flooding was reported on Brightling Road in Polegate, with the source of flooding reported to be the Main River, Wannock Mill Stream.

Figure 6-4: Flooding from the River Cuckmere and Bull River in Hellingly.

Agricultural land

Three reports of fluvial flooding to woodland and agricultural grazing land in the upper Cuckmere catchment at Hellingly and Upper Dicker were received as part of the questionnaire survey.

Land owners reported frequent flooding, with the number of separate flood incidents ranging from five to 15 times between November 2022 and March 2023. Between 90% and 100% of the respondents' land was reported to be affected by flooding, with flood depths

ranging from approximately 0.6m (2 ft) to 1.5m (chest height), and the land taking between two and eight days to drain down after flooding. The duration of flooding experienced was similar to the typical time reported by PCWLMB for water levels to recede in the River Cuckmere (one week).

The flooding resulted in damage to grassland, as well as damage to stock fences by debris transported in floodwater, and rapid deterioration of fences submerged in floodwater.

Figure 6-5: Flooding to grazing land in Chiddingly (date not specified)

Figure 6-6: Flooding to grazing land in Upper Dicker (date not specified)

6.4.2 People

Landowners in Upper Dicker reported how river levels in the Cuckmere could rise between letting livestock out in the morning and bringing them in during the late afternoon, leading to animals becoming stranded on flooded fields. This was also reported on fields used for sheep grazing, which posed a danger to spring lambs. Due to the deep and fast flowing nature of the floodwater, which impacted access roads, those trying to reach horses and livestock were themselves put in danger.

Loss of income was reported as an effect of the flooding, with grassland damaged by floodwater. The flood risk to livestock resulted in them being housed indoors rather than in fields during periods of flooding. This had a financial impact, due to higher costs for feed, bedding and heap removal.

Although questionnaire respondents mentioned that they were used to the flooding, experiencing it on a regular basis, they reported the stress which it causes, particularly flooding to residential property.

6.4.3 Infrastructure

Questionnaire responses identified flooding of roads in Hellingly and Upper Dicker during Winter 2022 – 2023, with the highway drainage systems reportedly unable to accommodate the heavy rainfall and fluvial floodwaters. As mentioned in Section 6.3, deep and fast flowing floodwaters affected access roads in Upper Dicker, and posed a danger to those trying to access the land to rescue livestock. The flooding also resulted in a loss of access to bridleways for the landowner and members of the public.

Flooding to the road network in the middle and lower Cuckmere catchment was also reported in November 2022. In the east of the valley, the C120 road became flooded at Litlington Road on 07 November 2022, spreading to West Dean on 12 November 2022 (Figure 6-9 and Figure 6-10 show flooding at Litlington on 17 November 2022). The C120 is the main access route for the villages of Litlington, Lullington and West Dean, and therefore when the road floods, the villages become cut off. In the west of the valley at Alfriston, flooding to the roads on the week commencing 14 November 2022, resulted in a number of vehicles, including a school bus, becoming stranded in the floodwaters.

Water levels in the River Cuckmere were reported to drop at low tide, allowing the sluice gates (especially Dickermans Wall) to operate effectively and drain the valley quickly.

National Highways provided details of flooding which impacted trunk roads in the Cuckmere catchment. There were two notable incidents:

- 17 November 2022 (09:00 to 21:00) - Flooding of A27 where it crosses the River Cuckmere (between Berwick and Wilmington) (see Figure 6-7 and Figure 6-8)
    - Reports of standing water on agricultural land and eastbound carriageway, extending 200m. Road remained open. Cause reported to be flooding from River Cuckmere, and surcharging of surface water drainage system due to surcharged outfalls.
- 23 December 2022 (14:00) - Berwick, at junction between A27 and the village, extending 20m. Surface water flooding to the carriageway.

Figure 6-7: Flooding to agricultural land by A27 between Berwick and Wilmington on 17

November 2022 (credit: National Highways)

Figure 6-8: Flooding to layby of A27 between Berwick and Wilmington on 17 November 2022 (credit: National Highways)

Both New Road and Station Road in Hellingly were confirmed as flooded on 16 January 2023 (Sussex Express, 2023)[23]. The following roads in Arlington were also reported as having been affected by flooding over the winter months within Cuckmere Flood Forum April meeting minutes (dates not specified):

- Wilbees Road – estimated to have flooded. Blocked road drainage suspected to be a cause.
- Michelham Road – reported to have flooded all winter to nearly 1ft deep. Resolved in March, when a drainage pipe was cleared, allowing surface water to drain away.
- Bridge at Michelham – deep, fast-flowing water on the road for approximately 12 hours each time. Reported blockage of drains under the road.

Figure 6-12 shows that further flooding was experienced in the east of the valley in mid-to-late March, with flooding experienced at Litlington footbridge on 21 March 2023, which coincided with the spring high tide.

23 Sussex Express (2023) PICTURES: Flooding hits Polegate, Stone Cross and Hellingly. 16 January 2023. Available at: PICTURES: Flooding hits Polegate, Stone Cross, and Hellingly | SussexWorld (sussexexpress.co.uk)

Figure 6-9: Flooding around Litlington on 17 November 2022 (credit: Dave Boddington)

Figure 6-10: Flooding at Litlington looking towards Alfriston on 17 November 2022 (credit: Dave Boddington)

Figure 6-11: Less extensive flooding on eastern bank of Cuckmere, north of Alfriston, on 25 January 2023 (credit: Dave Boddington)

Figure 6-12: Flooding from River Cuckmere at Litlington footbridge on 21 March 2023 (credit: Dave Boddington)

6.4.4 Services

Residential properties in Hellingly, particularly in Station Road, were reported to experience restricted toilet usage, and flooding of gardens with sewage from the foul network. A questionnaire response reported that the foul pumping station on Station Road, Hellingly was overwhelmed.

No disruption to electric, gas, telecommunications or water supply networks was reported.

6.5 Pevensey Levels catchment

6.6 Source

6.6.1 River

As in the case of the Cuckmere catchment, the main primary source of flooding for the majority of receptors was reported to be high river levels within the Pevensey catchments.

Flooding was reported to have originated from the following watercourses:

- Common Stream
- Salt Haven
- Hurst Haven
- Glynleigh Sewer
- Martins Ditch
- Ditch between Sayerland Lane and Holmes Sewer (Otham Feed)
- Otham Court Ditch
- Nunningham Stream and tributary ditches.
- Bowley Sewer
- Iron Stream
- Sackville Sewer
- Kentland Fleet
- Whelpley Sewer
- Magham Stream
- Manxney Sewer
- Horse Eye Sewer
- Kentland Sewer
- Waterlot Stream

Questionnaire responses identified several contributing factors to the fluvial flooding, including the inoperable main gate at Pevensey Bridge preventing flows in the catchment from draining out into the sea (see Section 3.1.1.2 for further details), and a reduction in pump capacity at Newbridge Pumping Station preventing water levels from being regulated. The presence of in-channel silt, vegetation and debris were also reported to restrict the capacity of watercourses in the Levels, and prevent surface water and tributary watercourses from draining down.

A further suggested contributing factor was the addition of new housing developments resulting in higher water levels, and a quicker flood response of the catchments to flooding.

6.6.2 Rainfall

Intense rainfall was experienced in the Pevensey catchment on a frequent basis during the months of November, December, January and March. Rainfall data at Horse Eye Level (RADAR), Willingdon Levels, Wallers Haven and Pevensey Bay (RADAR) identify that the highest rainfall events throughout the period were recorded on the following dates:

- 03 November (03:00) to 09 November (07:30) 2022 - a maximum total rainfall depth of 108mm recorded at Willingdon Level over this period.
- 28 December (06:00) to 03 January (22:15) 2023 - a maximum total rainfall depth of 65mm recorded at Willingdon Level over this period.
- 15 November (07:45) to 17 November (05:00) 2022 - a maximum total rainfall depth of 51mm recorded at Willingdon Level over this period.

However, the data also indicates that there was a series of less severe, yet frequent rainfall events throughout late November, mid to late December, early to mid-January, as well as early and late March. Although less significant rainfall depths were recorded during these events, they will have contributed to the river flows and overall catchment wetness, resulting in a more rapid response to rainfall.

6.6.3 Groundwater

A number of questionnaire responses note groundwater as a source of flooding. Soil moisture levels rose throughout September and October, and were wetter than average during November, December, January and February. Therefore soils in the catchment are likely to have been saturated, which will have raised the water table near to the ground surface, and have restricted the infiltration of any rainfall. Due to the low-lying nature of the Pevensey Levels, Due to the presence alluvial gravel deposits close to the river it is likely that groundwater levels there would have been a risen in groundwater in response to rising river levels.

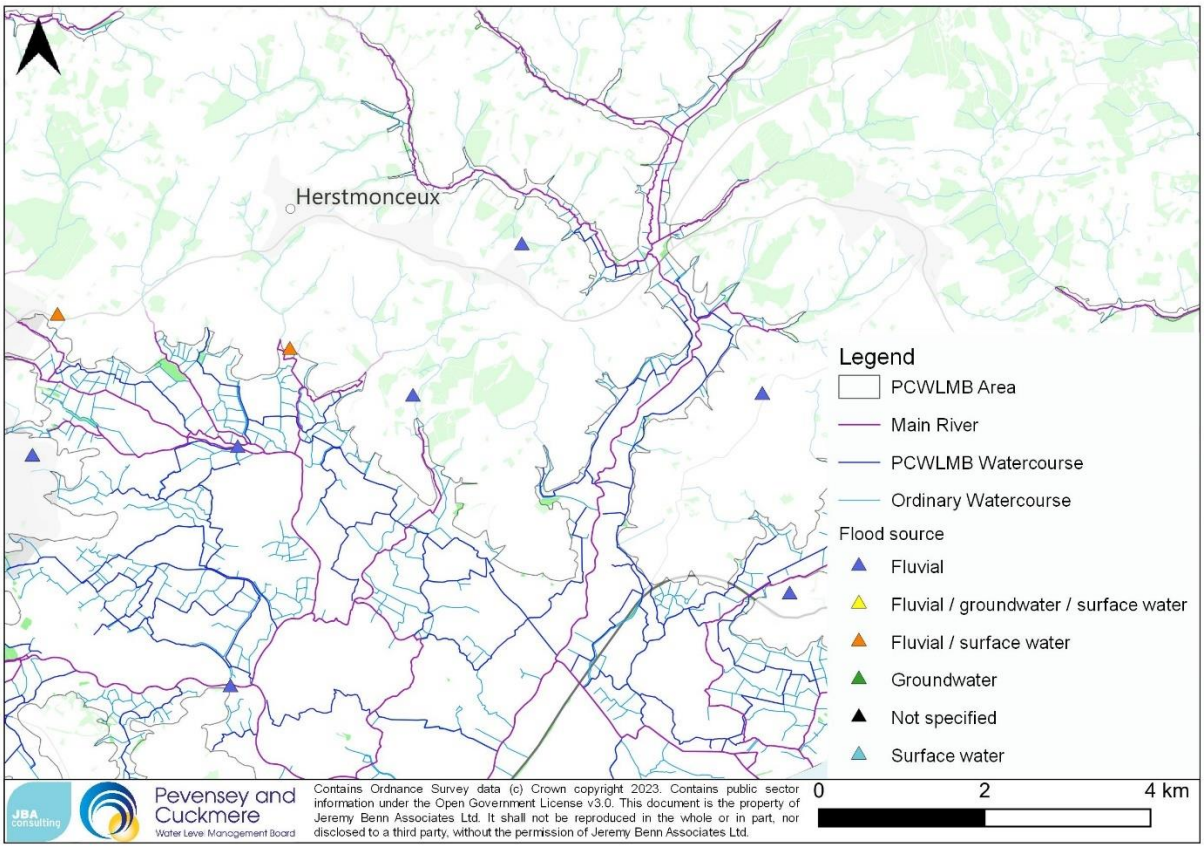

Figure 6-13: Sources of flooding in the upper Pevensey catchment

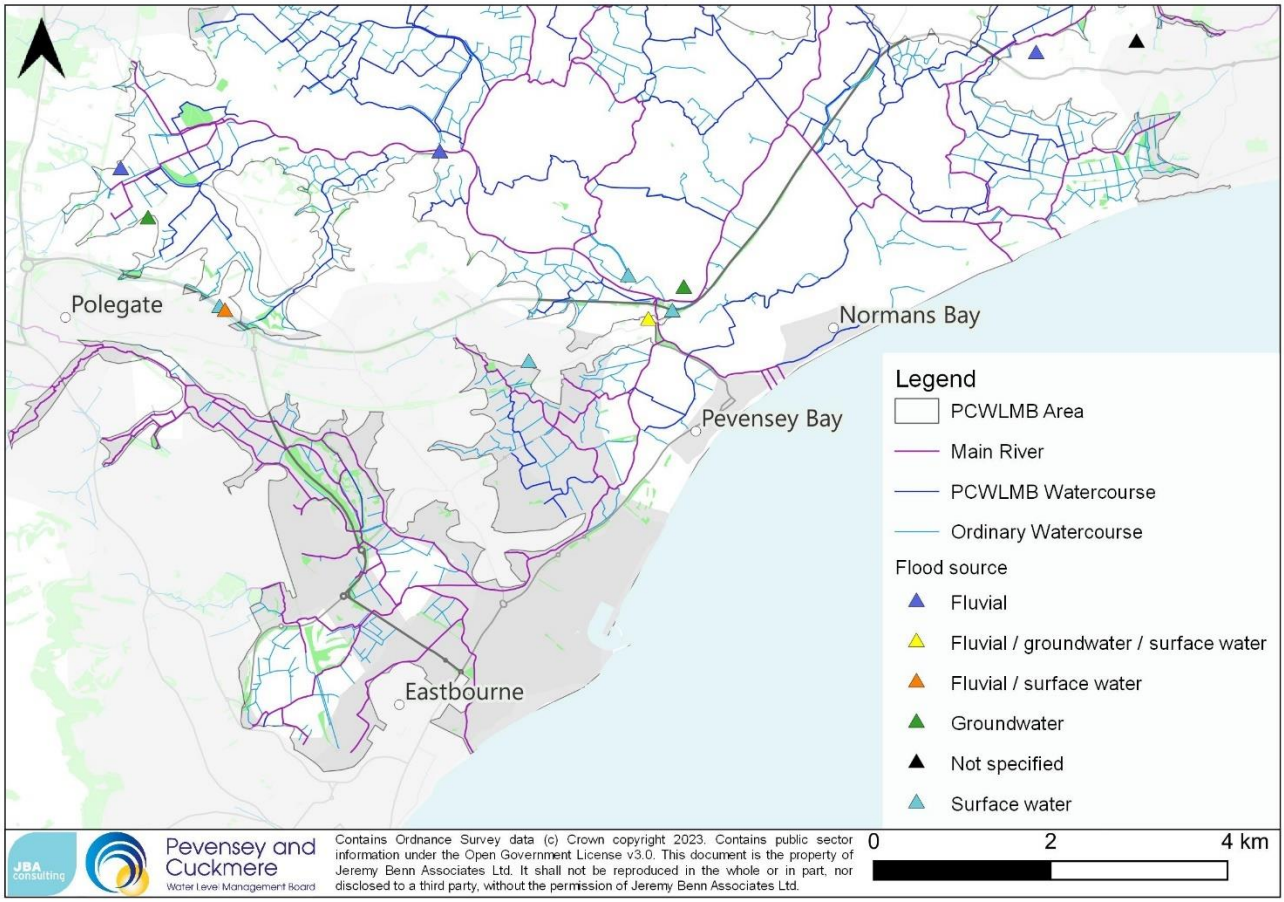

Figure 6-14: Sources of flooding in the lower Pevensey catchment.

6.7 Pathway

6.7.1 Exceedance of river capacity

The primary pathway of flooding recorded in questionnaire responses was rivers in the Pevensey catchment flowing out of bank, after their channel capacity was exceeded, following heavy rainfall.

Several questionnaire responses described a secondary pathway of flow in watercourses backing up and flooding as they were unable to discharge downstream into the receiving watercourse, particularly within the gravity system of the Pevensey Haven. The reason was reported to be the inoperable main gate at Pevensey Bridge (see Section 3.1.1.2 for further details), which prevented flows in the catchment from draining out into the sea, and raised in-channel water levels within the Pevensey Haven. This was reported as an issue in: Martins Ditch at High Street, Pevensey; Rickney Sewer at Rickney Lane, Rickney; Iron Stream at Lower Road, Herstmonceux. The PCWLMB Operations Manager recounted that the main gate was stuck in a fully closed position from late Summer 2022, while awaiting being fixed, and was fully operational in February 2023.

However, on a local scale, there were also reports of tributary watercourses backing up due to in-channel sediment and debris. This was reported as an issue at: Rattle Stream / Mountney Sewer/ Mill Ditch at Rattle Road, Westham; the Hurst Haven in the Newbridge Area; Otham Feed at Sayerlands Lane, North Polegate; and tributaries of the Ninfield Stream / Nunningham Sewer at Tilley Lane, Boreham Street, Hailsham.

Flooding from the Moorhall Stream was reported at Hooe Road, Hooe, near Battle. The Moorhall Stream discharges into the Main River Waller's Haven, but overtopped, and floodwaters flowed to Horsebridge Pumping Station, owned by PCWLMB. A site visit by EA and PCWLMB officers confirmed that the river bank on the Moorhall Stream had been damaged, potentially by a badger sett (Figure 6-15), which encouraged the overtopping of water over the lowered bank. In November 2022, the additional volume of floodwater required to be pumped at Horsebridge Pumping Station resulted in the station using the amount of electricity it typically uses in a year within one month.

Figure 6-15: Damage to banks on Moorhall Stream (credit: PCWLMB).

Within pumped catchments, a reduction in pump capacity was also reported in questionnaire responses to have been a contributing factor, notably at Newbridge Pumping Station. As the pumped catchments rely on the pumping stations to discharge into the gravity system, a reduced rate of pumping would result in higher levels of flooding in the catchment. However, PCWLMB recorded significantly higher than average levels of pumping across all pumps throughout November, December, January and March. Therefore, the duration of pumping required increased, yet it wasn't sufficient to clear the water levels experienced. The increased need for pumping appears to be linked to the inoperable main gate at Pevensey Bridge (see Section 3.1.1.2 for further details), as the Levels would not have been able to drain effectively out to sea through the two smaller

gates, which remained open. This will have raised water levels within the Pevensey Haven (upstream river levels shown in Figure 6-16), and resulted in greater levels of overtopping into the fields, increasing the volume of floodwater which required pumping.

Figure 6-16: Water levels upstream of Pevensey Bridge gates during Winter 2022 - 2023 (credit: PCWLMB).

6.7.2 Surface water flow paths / drainage system

The heavy rainfall was reported within questionnaire responses to have been routed as surface water flow paths along the road network in the Pevensey catchment, with the surface water drainage system on the road network reaching capacity and flooding out. Surface water runoff and exceedance flows were reported to flow off the road and on to surrounding land. This was reported to be an issue at: Lower Road, Herstmonceux; Otham Court Lane, North Polegate; Rattle Road, Stone Cross/Pevensey and High Street, Pevensey.

As in the case of the tributary watercourses, surface water drainage systems were also reportedly unable to discharge, due to high water levels within the receiving ordinary watercourses and Main Rivers. This was reported to be an issue at Rattle Road, Westham.

A further reported pathway of flooding was surface water runoff from fields, which is likely to be a result of rain falling on a saturated catchment. This was reported to occur on fields adjacent to A271 Amberstone, Upper Horsebridge.

6.7.3 Rising water table

Questionnaire responses noted the water table having risen to the ground surface, creating flow paths and ponding on land. This was reported as an issue at Pevensey Bypass, Pevensey; Marshfoot Lane, Hailsham; and at Otham Court Lane, North Polegate.

One response in Marshfoot Lane, Hailsham, noted that the high groundwater levels corresponded with the sustained high water levels in the watercourse. PCWLMB confirmed that groundwater in this area is generally lies close to the ground surface (or is 'perched'), due to the low permeability of the underlying clay geology. Therefore, more permeable alluvium deposits which connect watercourses to the floodplain provide a preferential flow path for sub-surface flows.

6.8 Receptors

Flooding in the Pevensey catchment was reported to affect areas of Hailsham, Battle, Herstmonceux, Polegate, Pevensey, Westham and Upper Horsebridge. In several instances, respondents mentioned that the flooding experienced in Winter 2022 – 2023 was more severe than previous significant flood events, such as October 2000. In two instances, at Rickney Lane, Hailsham and Amberstone, Upper Horsebridge, landowners had not experienced flooding to their land prior to the Winter 2022 – 2023 flooding.

6.8.1 Property

Agricultural land and buildings

An incident of internal property flooding was reported at Herstmonceux Castle, where the Kentland Fleet watercourse was reported to flood and enter the basement of the castle.

However, the main receptor of flooding in the Pevensey Levels was agricultural land, impacting between 0.5 and 150 acres of land belonging to an individual landowner. Flood depths varied across the catchment, from a low of 25mm (1 inch) up to 1.3m (4 ft).

The number of events reported ranged from one continuous flood event over the winter months in Hooe, Amberstone, Hailsham (February until April), Herstmonceux (early November until mid-February) and Pevensey (mid-January until early April), to between seven and 12 individual flood events (Rattle Road, Westham; Hooe Road, Hooe), to flooding every time it rained. Where individual events were identified, drain down times ranged from two to three days (Sayerlands Lane, Polegate), up to three to four weeks (Rickney Lane, Rickney). This is longer than the average time of two weeks reported by PCWLMB for water levels to drain down to normal winter levels after rainfall.

The receptors of flooding included farmyard areas and internal flooding of agricultural buildings, including barns. However, longer term impacts were also reported, including loss of grass species and replacement with marsh plant species, impairment of the soil structure, temporary loss of grass and hay production and permanent loss of grazing land. A deterioration in the quality of grazing land was also reported, with grass species dying after being submerged for a prolonged period of time below floodwater. High groundwater levels were also reported to make ground conditions difficult to access land for feeding and attending to livestock, with soils not reported to dry out until the summer in some locations, such as Pevensey.

Figure 6-17: Flooding to land from Moorhall Stream on 19 January 2023 (credit: PCWLMB).

Flooding of the Salt Haven was reported to impact the adjacent allotments at Waverley Gardens (shown in Figure 6-18). Pevensey Bay over Winter 2022 – 2023. Notably on 14 - 15 January, an allotment owner reported flooding to their allotment for the first time in 15 years, with water levels having risen over the winter months. The depth of floodwater at the entrance to the allotments from Waverley Gardens was reportedly much higher than normal, and water flowed into the neighbouring residential gardens at Waverley Gardens.

Figure 6-18: Flooding of allotments at Waverley Gardens, Pevensey (Credit: Pevensey Parish Council)

6.8.2 People

Some questionnaire respondents described having to change their farming practices in flooded areas, by finding alternative grazing land and housing animals indoors. This, combined with the inability to access the flooded grasslands, resulted in a loss of income.

Although respondents described their land flooding on a regular basis and being used to it, they also described feeling that the situation had become worse in recent years and particularly this year, which resulted in negative impacts to mental and physical health.

6.8.3 Infrastructure

National Highways reported flooding at several incidents of trunk road flooding at Pevensey and Polegate, which included:

- 03 November 2022 (10:00) - Pevensey Roundabout - 10m extent of flooding on the carriageway at the roundabout, following exceptional rainfall. Blockage of highway drainage reported to be a potential contributing factor.
- 23 December 2022 (13:48) (Figure 6-19) - A27 Polegate Bypass near Golden Jubilee Roundabout - 40m extent of flooding on the carriageway at the roundabout, due to surface water flooding. Blockage of highway gully reported to be a potential contributing factor.
- 23 March 2023 (18:45) (Figure 6-20) - A27 Polegate Bypass near Golden Jubilee Roundabout - 100m extent of flooding on the carriageway at the roundabout, due to surface water flooding. Blockage of highway gully reported to be a potential contributing factor.

Flooding, and resulting access issues, was recorded at a number of other roads across the Pevensey catchment, including:

- Otham Court Lane, North Polegate
- Lower Road, Herstmonceux
- High Street and Rickney Lane, Pevensey
- Wannock Road and Wannock Lane, Polegate
- Rattle Road, Stone Cross/Pevensey (closed both ways on 16 January 2023)

Flooding to access roads on private land was also reported to cause issues, with further hazard was introduced when the floodwaters froze, as occurred at Rickney Road, Hailsham (Figure 6-23).

Figure 6-19: Flooding to carriageway on A27 Polegate Bypass (westbound) on 23 December 2022 (credit: National Highways)

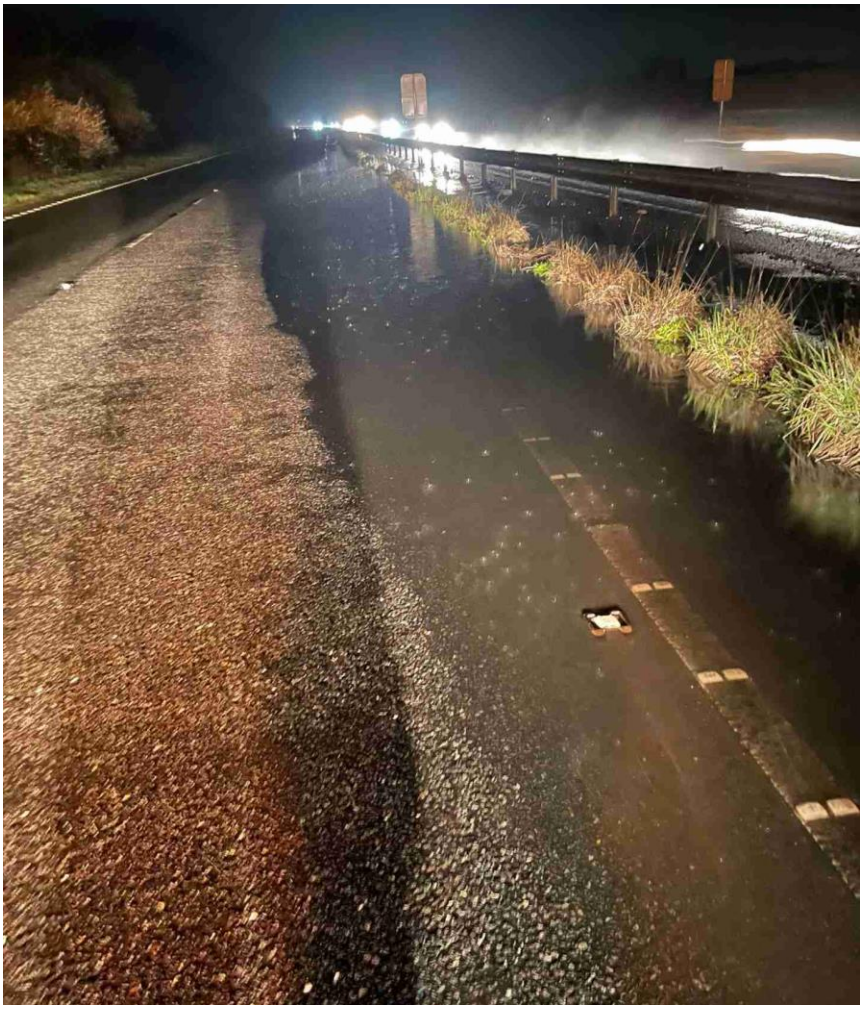

Figure 6-20: Flooding to carriageway on A27 Polegate Bypass (westbound) on 23 March 2023 (credit: National Highways)

Pumping infrastructure was also reported to have been overwhelmed by the volumes of water in the catchment, particularly at Newbridge Pumping Station. PCWLMB reported a significant increase in monthly electricity costs at all pumps across in the Pevensey Levels during December, January and March, due to the sustained levels of pumping required to manage water levels. For example, the average annual electricity budget (in units rather than cost) for Manxey and Horsebridge Pumping Stations was exceeded within a single month in November, and this trend continued in December, January and March.

Figure 6-21: River levels at Horsebridge Pumping Station on 17 January 2023 (credit: PCWLMB).

Figure 6-22: Flooding near Barnhorn Pumping Station on 16 January 2023 (credit: PCWLMB)

Figure 6-23: Frozen flooded farm access track at Rickney Road, Hailsham (date not specified)

6.8.4 Services

No disruption to electric, gas, telecommunications, water supply or sewer networks were reported.

6.9 Combe Haven catchment

One incident of road flooding was reported in the Combe Haven catchment. However no further reports of flooding were received from landowners during the course of the study. Therefore, the sources of flood risk have been assessed by reviewing the hydrological data for the catchment.

6.10 Source

6.10.1 River

River gauge data at Crowhurst and Sheepwash Bridge (see Section 4) show that water levels in the Combe Haven responded rapidly to rainfall events in November, December, January and March, with a total of 12 peak river flow/water level events captured between November 2022 and March 2023. This reflects the succession of rainfall events which fell during this period, as well as the high soil moisture levels and river levels which were recorded throughout the winter period.. The largest events in terms of river level were recorded in early, mid and late-November (01/11/2022, 09/11/2022, 16/11/2022, 28/11/2022), as well as mid and late December (16/12/2022, 31/12/2023) and early and mid-January (01/01/2023, 16/01/2023).

6.10.2 Rainfall

Intense rainfall was experienced in the Combe Haven catchment on a frequent basis during the months of November, December, January and March. Rainfall data at Catsfield (RADAR), Tilekiln (RADAR) and Bulverhythe (RADAR) identify that the highest rainfall events throughout the period were recorded on the following dates:

- 01 November (00:45) to 09 November (07:15) 2022 - a maximum total rainfall depth of 102mm recorded at Tilekiln over this period.
- 15 November (08:30) to 17 November (05:15) 2022 - a maximum total rainfall depth of 58mm recorded at Tilekiln over this period.
- 10 January (07:15) to 16 January (07:30) 2023 - a maximum total rainfall depth of 52mm recorded at Catsfield and Tilekiln over this period.

The one flood incident received identified the source of flooding on 23 March 2023 to be heavy rainfall.

6.10.3 Groundwater

As in the case of the Pevensey and Cuckmere catchments, higher than average soil moisture levels were recorded throughout late October until late March (with the exception of a drier February). This is expected to have resulted in a saturated catchment, with the water table likely to have risen close to the ground surface.

6.11 Pathway

6.11.1 Surface water flow paths / drainage system

The one flood incident received identified the pathway to be heavy rain falling on the A259 at Glyne Gap, with a blockage within the pipework of a highway gully being a potential contributing factor, as surface water was unable to drain away effectively.

6.12 Receptor

6.12.1 Infrastructure

The one flood incident received from National Highways identified deep flooding to the A259 at Glyne Gap, outside the road services, on 23 March 2023 at 22:23 (Figure 6-24). The road and footpath were reported as completely flooded, with a 30m length of the carriageway affected. Crew were required to attend the site to deploy flood boards and investigate the issue.

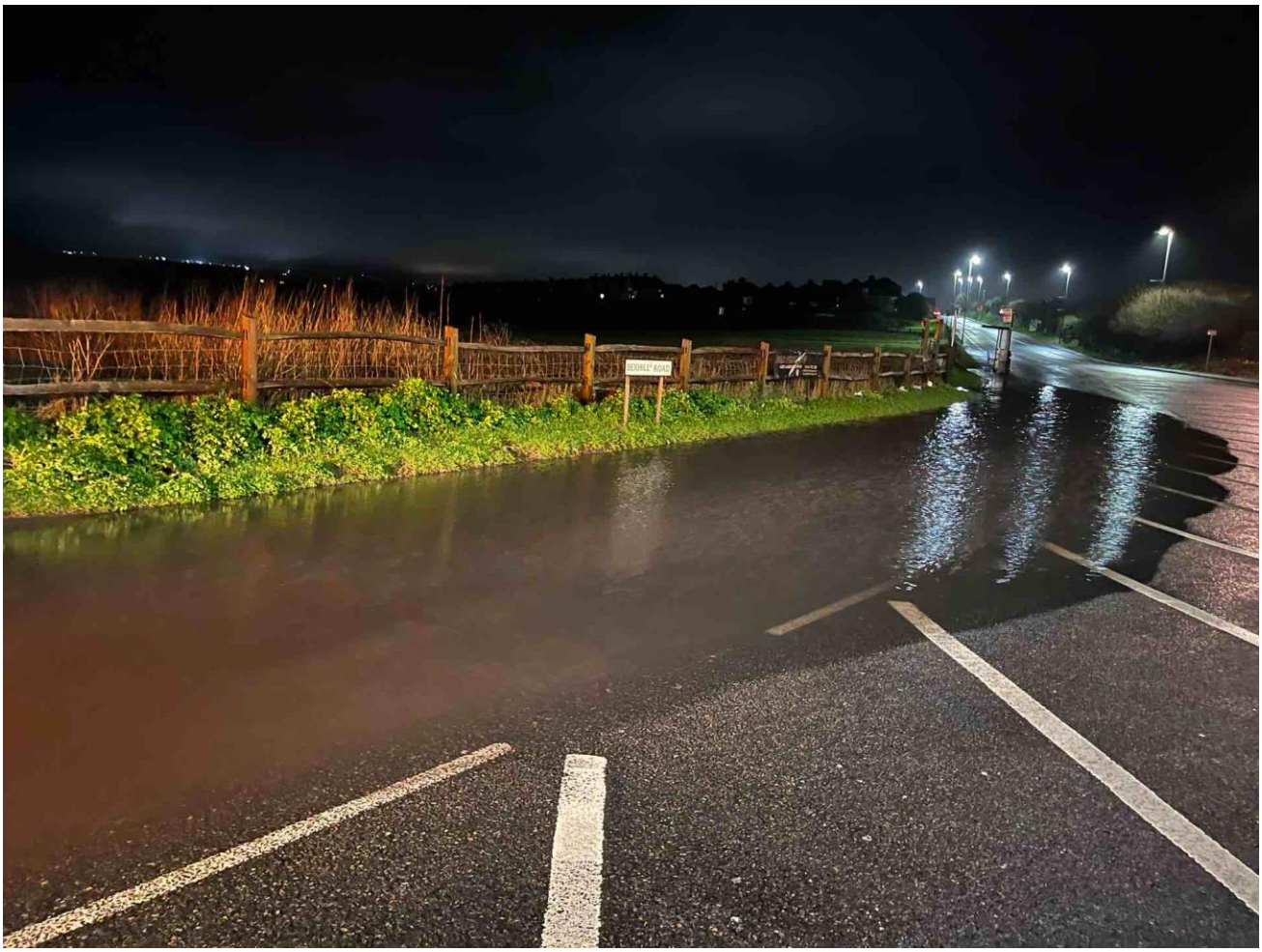

Figure 6-24: Flooding to carriageway on A259 at Glyne Gap on 23 March 2023 (credit: National Highways)

7 Conclusions

A review of available rainfall and river level gauge data, as well as responses to a questionnaire for rate payers, has been undertaken to understand the characteristics and impacts of flooding within the Cuckmere, Pevensey and Combe Haven catchments between November 2022 and March 2023.

A review of river and rainfall gauge data across the three catchments show that flow and water levels in the rivers responded rapidly to rainfall events in November, December, January and March, with up to 12 peak river flow/water level events captured during this period. This reflects the succession of rainfall events which fell on a saturated catchment during this period, with sustained higher than average soil moisture levels recorded from late October until the end of March (with the exception of February). The EA area situation report reported exceptionally high river levels, with the largest events in terms of river flow were recorded in early, mid and late-November (03/11/2023, 07/11/2023, 17/11/2023, 28/11/2023), as well as mid-December (19/12/2023) and early and mid-January (01/01/2023, 16/01/2023).

This corresponds with the frequent and prolonged nature of flooding reported by landowners in the 27 questionnaire responses received for the Cuckmere and Pevensey catchments. Flooding during winter months is a regular occurrence in the Cuckmere, Pevensey and Combe Haven catchments. However, respondents identified that the flooding experienced was particularly deep, extensive and long in duration this Winter, particularly in the Pevensey Levels. In two instances, at Rickney Lane, Hailsham and Amberstone, Upper Horsebridge, landowners had not experienced flooding to their land prior to the Winter 2022 – 2023 flooding.

Many in the Pevensey catchment reported that the Levels took longer than average to drain down, with some experiencing a single, continuous flood event over the winter months. The pumped river catchments and surface water drainage systems which drain into the gravity system were reportedly unable to discharge, and backed up. This in turn impacted the pump assets within these catchments, with questionnaire response mentioning that Newbridge Pumping Station became overwhelmed, and PCWLMB reporting record durations of pumping. This may reflect the amount of rainfall and higher than average soil moisture levels recorded in the Pevensey catchment between November and March. However, it may also be linked to the function of water level management assets. It was reported by PCWLMB officers and the questionnaire respondents that the main gate at Pevensey Bridge was closed shut between November 2022 and mid-March 2023, when the majority of the flood incidents were recorded, as maintenance was required on the gate. This will have restricted the Pevensey Haven from draining out to sea, resulting in sustained high water levels in the gravity-drained Pevensey Levels watercourses, and a greater occurrence of overtopping. Unfortunately, no open source river flow or level gauge data was available for the Pevensey catchment, so it was not possible to isolate the impacts of these assets within this study. However, the questionnaire responses suggest

that asset operation was a contributing factor to the extent and duration of flooding experienced.

Extensive fluvial, surface water and foul sewer flooding was also reported throughout the Cuckmere catchment. However, in contrast to Pevensey, questionnaire responses of drain down times in the Cuckmere catchment aligned with the usual period reported by PCWLMB. Only one incident of highway flooding at Glyne Gap was received for the Combe Haven catchment, where flooding typically lasts throughout winter months, and starts to dry in March. However, the rain and river gauge data showed similar timings of peak events across the three catchments.

A wide range of sources and pathways of flooding were reported. Fluvial flooding due to exceedance of the river channels following heavy rainfall was the primary mechanism, with reports of debris in watercourses and blocked structures restricting flow. However, there were also reports of groundwater and foul sewer flooding to land and residential property in Hellingly, as well as surface water flooding to the road network, restricting vehicle access in locations such as Hellingly, Polegate and Alfriston.

The predominant impact of the flooding was damage to grazing land and grass quality, due to grass remaining submerged for several months. This also resulted in damage to boundary fences. However, in some locations, particularly Hellingly, internal flooding of residential property was reported from groundwater and foul sewers. It should be noted that the flooding was reported to be a regular occurrence, although it was very disruptive.

Several respondents reported a loss of income, with grazing and hay making prevented by the flooded fields, and additional costs required to house livestock and horses indoors (e.g. lighting, heating, feed, muck clearance). Adverse impacts on mental and physical health were also reported, with respondents feeling that winter flooding was worsening.

Due to project timescales, the scope of the assessment did not include the calculation of return periods of the events identified in each catchment. However, event rarity analysis for 03 November 2022, undertaken by JBA Consulting for ESCC, indicated that the scale of storm event was relatively small in the Cuckmere catchment (between 1 in 2-years and 1 in 8-years for Horam and Hellingly) and Pevensey catchment (up to 1 in 2-years for Hailsham). As further work, this analysis could also be undertaken on the rainfall and river gauge data assessed as part of this study, to provide an indication of the rarity of events which occurred over Winter 2022 - 2023.

A Appendix A: Watercourses in Pevensey Levels

Table 7-1: Watercourses in the Pevensey Levels catchment.

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Ashbourne	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
Barnhorn Ponds Stream	PCWLMB	Barnhorn (pumped sub-catchment)
Boreham Pond Stream	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Brickfield Ditch	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Burgh Fleet and Monkham Sewer	PCWLMB	Pevensey (gravity drained sub-catchment)
Callows Stream	PCWLMB	Pevensey (gravity drained sub-catchment)
Cheney Stream	PCWLMB	Star Inn (pumped sub-catchment)
Chilley Stream	Environment Agency	Pevensey (gravity drained sub-catchment)
Christian's River	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
Church Farm Ditch	PCWLMB	Manxey (pumped sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Church Farm Feed	PCWLMB	Manxey (pumped sub-catchment)
Cole Stream	Environment Agency	Star Inn (pumped sub-catchment)
Crossing Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Crumbles Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Curteis Ditch	PCWLMB	Manxey (pumped sub-catchment)
Decoy Stream	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Dodsons Ditch	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Down Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Downwash Ditch	PCWLMB	Glynleigh to Drockmill (pumped sub-catchment)
Dowles Stream	PCWLMB	Pevensey (gravity drained sub-catchment)
Drockmill Hill Gut	PCWLMB	Glynleigh to Drockmill (pumped sub-catchment)
Drove Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
East Langney Sewer	PCWLMB	Willingdon and Langney (gravity drained sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
East Stream	Environment Agency and PCWLMB	Barnhorn (pumped sub-catchment) and Star Inn (pumped sub-catchment)
Foul Ditch	PCWLMB	Star Inn (pumped sub-catchment)
Glynleigh Sewer	Environment Agency	Glynleigh to Drockmill (pumped sub-catchment)
Hankham Sewer	PCWLMB	Pevensey (gravity drained sub-catchment)
Holm Sewer	Environment Agency	Glynleigh to Drockmill (pumped sub-catchment)
Hooe Sewer	Environment Agency	Barnhorn (pumped sub-catchment)
Horse Eye Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Horsey Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Hugletts Sewer	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment) and Horse Eye and Down to Rickney (pumped sub-catchment)
Hurst Haven	Environment Agency	Whelpley (privately pumped sub-catchment)
Inn Stream	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Iron Stream	Environment Agency	Whelpley (privately pumped sub-catchment)
Kentland Fleet	Environment Agency	Manxey (pumped sub-catchment) and Pevensey (gravity drained sub-catchment)
Kentland Sewer	PCWLMB	Manxey (pumped sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Lamb Inn Stream	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Langney Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Lewens Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Lottbridge Sewer	Environment Agency and PCWLMB	Willingdon and Langney (gravity drained sub-catchment)
Manxey Sewer	PCWLMB	Pevensey (gravity drained sub-catchment)
Mark Dyke	PCWLMB	Manxey (pumped sub-catchment)
Martins Ditch	PCWLMB	Pevensey (gravity drained sub-catchment)
Maryland Sewer	PCWLMB	Glynleigh to Drockmill (pumped sub-catchment)
Middle Sewer	Environment Agency and PCWLMB	Willingdon and Langney (gravity drained sub-catchment)
Mill Ditch	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Moorhall Stream	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
Mountney Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
New Ash Bourne	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
New Guy Stream	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
New Stream Ditch	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Ninfield Stream	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
Nuningham Sewer	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Old Haven	Environment Agency	Pevensey (gravity drained sub-catchment)
Old Whelpley Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Percival Road Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Pevensey Haven	Environment Agency	Pevensey (gravity drained sub-catchment)
Picknill Green Stream	Environment Agency	Barnhorn (pumped sub-catchment)
Pinnock Stream	PCWLMB	Star Inn (pumped sub-catchment) Waterlot to Horsebridge (pumped sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Puckeridge Stream	Enviornment Agency	Whelpley (privately pumped sub-catchment)
Railland Ditch	Environment Agency	Pevensey (gravity drained sub-catchment)
Rattle Stream	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Rickney Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Salt Haven	Environment Agency	Pevensey (gravity drained sub-catchment)
Saltmarsh Sewer	Environment Agency	Glynleigh to Drockmill (pumped sub-catchment)
Sew Ditch	PCWLMB	Pevensey (gravity drained sub-catchment)
Snapsons Sewer	PCWLMB	Horse Eye and Down to Rickney (pumped sub-catchment)
Springfield Farm Ditch	PCWLMB	Willingdon and Langney (gravity drained sub-catchment)
Star Inn Feed Ditch	PCWLMB	Star Inn (pumped sub-catchment)
Stream Ditch	PCWLMB	Barnhorn (pumped sub-catchment) Star Inn (pumped sub-catchment)
Tower Ditch	PCWLMB	Pevensey (gravity drained sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Trolliloes Stream	Environment Agency	Waterlot to Horsebridge (pumped sub-catchment)
Upper Dowles Stream	PCWLMB	Manxey (pumped sub-catchment)
Waller's Haven	Environment Agency	Star Inn (pumped sub-catchment) Waterlot to Horsebridge (pumped sub-catchment)
Wannock Mill Stream	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Waterlot Stream	PCWLMB	Star Inn (pumped sub-catchment) Waterlot to Horsebridge (pumped sub-catchment)
Waterhouse Stream	PCWLMB	Waterlot to Horsebridge (pumped sub-catchment)
Whelpley Sewer	Environment Agency	Whelpley (privately pumped sub-catchment)
Willingdon Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Willingdon and West Langney Sewer	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)
Willingdon Upper	Environment Agency	Willingdon and Langney (gravity drained sub-catchment)

Watercourse name	Authority with permissive powers for management	Sub-catchment(s)
Winters Cut	PCWLMB	Glynleigh to Drockmill (pumped sub-catchment)
Wrenham Stream and Bill Gut	PCWLMB	Pevensey (gravity drained sub-catchment)
Yotham	Environment Agency	Pevensey (gravity drained sub-catchment)

B Appendix B: Timeline of events

B.1 Cuckmere catchment

Table 7-2: Timeline of events within the River Cuckmere catchment.

Date	Time	Description of event	Location	Data source
River Cuckmere				
03 to 09 November 2022	03 Nov 03:00 to 09 Nov 07:30	Almost continual rainfall during this period, with daily rainfall values peaking on 3 and 6 November, with 37.79mm and 29.40mm of rainfall recorded at Cowbeech TBR on these dates respectively. Mean daily river flow (at Sherman Bridge) peaked on 4, 7 and 9, reaching above 26m^3/s on each of these days.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
03 November 2022	-	River Cuckmere out of bank at Alfriston. Substantial flooding on fields on the left bank, also flooding (but less significant) on right bank.	Alfriston	PCWLMB on-site observations
07 November 2022	-	Littlington Road flooded, but Alfirston Road not flooded.	Alfriston and Lullington	PCWLMB on-site observations
12 November 2022	AM	Although River Cuckmere levels had dropped, the roads at Westdean were still flooded.	Westdean.	PCWLMB on-site observations
15 to 17 November 2022	15 Nov 08:15 to 17 Nov 03:00	Key rainfall event occurred on 16 November between 01:00 and 23:00, where 37.20mm was recorded at Cowbeech TBR. Mean daily river flow peaked the next day (17 November), with a 27.283m^3/s average flow recorded at Sherman Bridge.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
14 to 20 November 2022	-	Severe flooding at Alfriston, with several vehicles (including a school bus) stranded. Flooding on eastern side of valley, including along Litlington Rd and Lullington Rd (C120 Road), impacting Lullington, Litlington and Westdean.	Alfriston, Lullington, Litlington and Westdean.	Reports from PCWLMB board member and PCWLMB on-site observations

Date	Time	Description of event	Location	Data source
17 November 2022	09:00-21:00	Flooding of A27 where the road crosses the River Cuckmere. Standing water on agricultural land and eastbound carriageway, although road was not closed. Extending approximately 200mm. River Cuckmere flooding out-of-bank and drainage system surcharging due to submerged outfalls.	Berwick – where A27 crosses the River Cuckmere	National Highways
26 to 28 November 2022	26 Nov 23:30 to 28 Nov 13:15	Main rainfall event occurred on 27 November between 0:00 and 20:30, with 28.00mm of rainfall recorded at Cowbeech TBR. Mean daily flow peaked to 27.283m^3/s on 28 November at Sherman Bridge.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
18 to 19 December 2022	18 Dec 11:45 to 19 Dec 22:45	Prolonged, continual rainfall over both days, contributing to mean river flow of 26.83m^3/s	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
22 to 23 December 2022	22 Dec 8:45 to 23 Dec 11:45	Rainfall predominantly occurred on 22 and 23 December, although river levels peaked on 24 December with a 20.78m^3/s mean daily river flow.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
23 December 2022	14:00	Surface water flooding on the carriageway, junction and bus stop, extending approximately 20m. Approximately 300m south-west of the PCWLMB Board IDD.	Berwick – junction between A27 westbound and The Village	National Highways
28 December 2022 to 03 January 2023	28 Dec 6:30 to 03 Jan 21:25	Most rainfall occurred on 28 December (13.4mm at Cowbeech TBR) and between 30-31 December (29.6mm rainfall over both days at Cowbeech TBR). Mean daily river flow corresponded peaked on 29 December, with 24.57 m^3/s flow, then decreased slightly, and then rose again to 27.7 m^3/s on 30 December.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis

Date	Time	Description of event	Location	Data source
07 to 16 January 2023	07 January 16:30 to 16 January 09:15	River flow steadily increased after prolonged rainfall until 12 January, with a 16.1 m^3/s mean flow at Sherman Bridge. Another mean flow peak occurred on 16 January at Sherman Bridge (24.64 m^3/s).	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
08 to 10 March 2023	08 March 01:15 to 10 March 02:15	Almost continual rainfall during these dates, with mean daily river levels at Sherman Bridge peaking to 16.57 m^3/s on 10 March.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
22 to 23 March 2023	22 March 03:15 to 23 March 22:15	After 20.79mm of rainfall at Cowbeech TBR on the 23 March, river flow at Sherman Bridge reached at daily mean of 19.10 m^3/s on 24 March.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
26 March 2023	26 March, 01:45 to 13:45	Although a concentrated rainfall event, this event had little impact on river flow.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis
28 to 31 March 2023	28 March 06:15 to 31 March 09:45	Although a concentrated rainfall event, this event had little impact on river flow during the dates analysed.	Cowbeech, Hellingly, Arlington, Cuckmere Haven	Hydrological analysis

B.2 Pevensey catchment

Table 7-3: Timeline of events within the Pevensey catchment.

Date	Time	Description of event	Location(s)	Data source
Pevensey Levels				
01 to 10 November 2022	01 November 00:15 to 10 November 08:00	Prolonged rainfall within the Pevensey Levels between 01 and 10 November 2022, with rainfall peaking on 01, 03 and 06 November, with 20.6mm, 27.7mm and 21.6mm of rainfall recorded respectively at the Horse Eye level gauge.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
03 November 2022	10:00	Flooding on the Pevensey Roundabout, extending approximately 10m along the highway.	Pevensey	National Highways
15 to 17 November 2022	15 November 07:45 to 17 November 05:00	Although this rainfall event lasted approximately three days, the most intense rainfall occurred between 16:15 and 23:00 on 16 November, where 21mm of rainfall was recorded at Pevensey Bay.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
16 November 2022	16 November 2022 22:15	Peak in tidal level of 4.158mAOD recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).	Pevensey	Hydrological analysis
27 November 2022	27 November 05:15 to 22:15	Rainfall generally occurred during two peaks between 05:15 and 11:00, as well as between 14:45 and 21:00.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
18 to 19 December 2022	18 December 11:00 to 19 December 23:00	Almost continual rainfall within the Pevensey levels between these two dates.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis

Date	Time	Description of event	Location(s)	Data source
21 to 23 December 2022	21 December 22:15 to 23 December 21:45	Overnight rainfall concentrated between 22:15 (21 December) and 03:00 (22 December), with 15.9mm recorded at Pevensey Bay.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
23 December 2022	14:00	Surface water flooding on the highway, extending approximately 40m. Potentially caused by gully blockage. Approximately 150m south of the PCWLMB IDD.	Polegate bypass near the Golden Jubilee Roundabout	National Highways
21 to 23 December 2022	21 December 22:15 to 23 December 21:45	Overnight rainfall concentrated between 22:15 (21 December) and 03:00 (22 December), with 15.9mm recorded at Pevensey Bay.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
28 December 2022 to 3 January 2023	28 December 2022 06:00 to 3 January 2023 22:15	Continual prolonged rainfall events per day, as displayed in Figure 4-5.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
10 January to 12 January 2023	10 January 06:30 to 12 January 2023 23:30	Concentrated between 16:15 and 19:15 on 11 January.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
14 to 16 January 2023	14 January 01:30 to 16 January 07:00	Rainfall concentrated between 01:30 and 11:15 on 14 January, with 20.5mm recorded at Wallers Haven.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
14 January 2023	14 January 2023 10:30	Peak in tidal level of 4.358mAOD recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).	Pevensey	Hydrological analysis

Date	Time	Description of event	Location(s)	Data source
16 January 2023	16 January 2023 (04:00)	Peak in tidal level of 4.109mAOD recorded at Salt Haven gauge in EA Pevensey depot. Highest recorded tidal level at the gauge is 4.79mAOD (06/12/2013).	Pevensey	Hydrological analysis
16 to 18 January 2023	-	Out of bank flooding at the following watercourses: Bowley Sewer, Iron Stream, Kentland Sewer, Magham Stream Sewer, Old Whelpley Sewer, Rickney Sewer, Sackville Sewer, Waterlot Stream. Also, reported flooding at Rickney Lane caused by Rickney Sewer and high water levels on the Glynleigh Sewer. Water held back in the Marsh to take the pressure off the Pevensey Haven, to prevent flooding to a nearby house. Flooding of fields near/at the Barnhorn pumping station. High volumes of water in watercourses near the Horsebridge Pumping station.	Barnhorn, Horse Eye and Down, Manxey, Rickney, Waterlot and Whelpley.	PCWLMB on-site observations
7 to 10 March 2023	7 March 07:15 to 10 March 02:45	Rainfall concentrated on 8 and 9 March, with 25.6mm of rainfall recorded at Pevensey Bay on this date.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
22 to 23 March 2023	22 March 03:30 to 23 March 22:00	Rainfall concentrated on 23 March, with 19mm recorded at Willingdon Levels.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
23 March 2023	18:45 – 20:15	Surface water flooding on the highway, extending approximately 100m. Gully on the highway was blocked and needed to be cleared. Approximately 150m south of the PCWLMB IDD.	Polegate bypass near the Golden Jubilee Roundabout	National Highways

Date	Time	Description of event	Location(s)	Data source
26 March 2023	26 March 02:00 to 11:00	Intense rainfall event throughout the day.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis
28 to 31 March 2023	28 March 06:30 to 31st March 14:15	Predominantly on 31 March, with 15.08mm of rainfall recorded at Willingdon Levels.	Horse Eye Level, Willingdon Level, Wallers Haven, Pevensey Bay	Hydrological analysis

B.3 Combe Haven Catchment

Table 7-4: Timeline of events within the Combe Haven catchments.

Date	Time	Description of event	Location(s)	Data source
Combe Haven				
1 to 9 November 2022	1 November 0:45 to 9 November at 07:15	Key rainfall events on 1, 3, 6-7 November, where rainfall values at Bulverhythe reached 26.5mm, 27.2mm, 18.4mm and 19.3mm per day. Mean daily levels at Sheepwash Bridge corresponded with peaks on 5 November (27.2m) and 8-9 November (27.2m).	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
15 to 17 November 2022	15 November 08:30 to 17 November 05:15	Key rainfall event occurred on 16 November, with 44.8mm of rainfall recorded at Tilekiln. River levels correspondingly increased and peaked the following day.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
21 to 24 November 2022	21 November 12:15 to 24 November 18:30	Continual rainfall on 21, 23 and 24 November did not have a significant impact on Sheepwash Bridge stage (reached 10.07m).	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
26 to 28 November 2022	26 November 23:30 to 28 November 11:15	Key rainfall event on 27 November (Bulverhythe - 24.3mm), contributed to peak river level of 27.2m on 28 November.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
18 to 19 December 2022	18 December 11:30 to 19 December 11:45	River levels peaked on 19 December to 26.8mm at Sheepwash Bridge.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
21 to 23 December 2022	21 December 22:15 to 23 December 09:45	Small peak in river levels on 24 December to 20.78mm at Sheepwash Bridge.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis

Date	Time	Description of event	Location(s)	Data source
28 December 2022 to 1 January 2023	28 December 2022 06:15 to 1 January 2023 00:45	Continual rainfall between these dates lead to peak daily stage of 27.2mm at Sheepwash Bridge on 01 January.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
10 to 16 January 2023	10 January 07:15 to 16 January 07:30	River levels peaked on 16 January at 19.09m at Sheepwash Bridge.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
7 to 10 March 2023	7 March 07:30 to 10 March 02:45	Mean peak levels peaked to 16.58m on 10 March 2023 at Sheepwash Bridge.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
22 to 23 March 2023	22 March 03:45 to 23 March 21:30	Mean peak river levels peaked to 19.10m on 24 March 2023 at Sheepwash Bridge.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
23 to 24 March 2023	22:15 – 02:15	Road and footpath completely flooded, with deep standing water, caused by gully blockage. Extending approximately 30m along the carriageway.	A259 Hastings Road, adjacent to Glyne Gap beach.	National Highways
26 March 2023	26 March 02:15 to 11:00	This intense rainfall event had little impact on river levels.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis
30 to 31 March 2023	30th March 22:00 to 31st March 14:00	This intense rainfall event had little impact on river levels.	Catsfield, Tilekiln, Bulverhythe	Hydrological analysis

C Appendix C: Source-Pathway-Receptor details

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Cuckmere	Mill Lane, Hellingly	River (Cuckmere), groundwater, road drainage	Overtopping of the River Cuckmere (Main River), groundwater rising to the ground surface, exceedance of the road drainage system	Internal residential property flooding. Flooding to non-agricultural land and road.	Extent: all of land under ownership (5.3 acres). Depth: 610 – 915mm (2 – 3 ft). Duration: 6 – 8 hours for each event (five events in Winter 2022-2023).	Regular flooding of land when the River Cuckmere breaks its banks. On some of the occasions, groundwater rises to the surface, impacting buildings. Land unusable for many days afterwards.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Cuckmere	Church Road, Hellingly	River (Cuckmere, Bull River), road drainage	Overtopping of the River Cuckmere and Bull River (Main Rivers). Backing up of road gullies which discharge into the river.	Internal residential property flooding. Flooding to road.	Extent: full width of highway flooded. Depth: Unknown. Duration: Unknown.	Regular flooding of property from the River Cuckmere and Bull River. Floodwater also backed up through highway gullies which discharge into the Bull River. Property required pumping out, and tanker deployed to manage road flooding. Previous foul flooding issues also reported, with works undertaken to manage both foul and highway flooding.
Cuckmere	Camberlot Road, Upper Dicker	Rivers (Wick Stream flowing into River Cuckmere), surface water.	Watercourses overflowing (Main River and Non-Main River), surface water runoff, exceedance of road drainage systems.	Flooding to habitable buildings, farmyard and property garden. Flooding to agricultural land (grazing), posing danger to spring lambs. Road flooding.	Extent: 80 of 85 acres unable to drain down (some currently still out of use). Depth: 610 – 915mm (2 – 3 ft). Duration: 2 to 3 days to drain down after heavy rain (at least 15 occasions in Winter 2022-2023, latest in	Frequent fluvial and surface water flooding to agricultural land, infrastructure and habitable buildings. Reports of debris present in the river, so unable to drain effectively. Also flooding to the road reported, due to drainage system being exceeded by heavy rainfall.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
					early May 2023).	
Cuckmere	Michelham Priory Road, Upper Dicker	River (Main River / Non-Main River), surface water	Watercourse overflowing, surface water runoff	Flooding to agricultural land and access road (becomes impassable).	Extent: 90% of land. Flow paths reach 305mm – 1.2m (12 inches to 4 feet). Depth: Chest height (estimated 1.5m) Duration: 2 – 7 days (occurring at least three times per month in November 2022 – April 2023)	Fluvial flooding to agricultural land from mill feed watercourse. Regular flooding between November until April, as soon as heavy rain begins. Two flow paths form, before gradually subsiding. Fields pond for several days afterwards. Deep and fast flowing water on access road poses danger.
Pevensey	Hooe Road, Hooe (near Battle)	River	Overflowing of watercourse	Flooding and damage to agricultural land (grazing).	Extent: 25 acres of land. Depth: 305 – 915mm (1 – 3 ft). Duration: approximately 2 months in Winter 2022-2023	Fluvial flooding to agricultural land. Pumping stations were reportedly unable to manage flows in the watercourse.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	Tilley Lane, Boreham Street, Hailsham	River (Nunningham Stream and surrounding ditches)	Overflowing of watercourse (Main River)	Flooding and damage to agricultural land (grazing). Have to move livestock.	Extent: most of marsh grazing land. Depth: approximately 610mm (2ft) Duration: Unknown, but seven events in Winter 2022-2023	Repeated flooding from the Nunningham Stream during heavy rainfall. Reports that nearby bank raising and a lack of river maintenance has increased the risk of flooding.
Pevensey	Lower Road, Herstmonceux	River (Main River and Non-Main River), surface water, drainage networks	Overflowing of watercourses, surface water runoff, exceedance of drainage systems	Flooding to agricultural land (grazing), causing gradual deterioration.	Extent: 150 acres Depth: up to 1.2m (4ft) over 100 acres Duration: early November until mid-February with a brief reduction in early January (two events in Winter 2022-2023).	History of flooding, although increase in severity of flooding over last 10 years reported, with a notably high depth and long duration experienced in Winter 2022 - 2023. Reported a reduction in pump capacity at Newbridge Pumping Station and failure of infrastructure at Pevensey.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	Otham Court Lane, North Polegate	Groundwater	Water table rising to the ground surface.	Flooding to agricultural land (grazing), ponding of groundwater in lowest areas of fields. Land remains out of use for 1 week after flooding. Flooding to road.	Extent: approximately 20% of grassland. Depth: 305 – 610mm (1 – 2ft) Duration: November to January (two events in Winter 2022-2023).	Agricultural land remains wet between November and January. Temporary restriction on grazing during this period.
Pevensey	Rickney Lane, Pevensey	Surface water	Surface water runoff (unable to drain away, as river at bankfull conditions)	Flooding to agricultural land (grazing) for 5 weeks. Long term impacts of loss of grass production, species lost, soil structure impaired.	Extent: 50 acres (compared with 40 acres in October 2000) Depth: Unknown. Duration: 3 – 4 weeks in January 2023 (one event in Winter 2022-2023).	Surface water flooding usual in winter periods, but reported prolonged flooding in Winter 2022 – 2023, with the inoperable main gate at Pevensey Bridge reported as the cause. Previous flooding from non-Main Rivers occurred in October 2000.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	Rattle Road, Westham	Surface water, surface water drainage systems	Surface water runoff, exceedance of drainage systems (unable to drain away, as ditches at bankfull conditions)	Flooding to agricultural land (grazing), preventing land from being grazed.	Extent: Half of land affected Depth: 150mm Duration: Unknown (12 events in Winter 2022-2023).	Flooding of agricultural land experienced from 1981 until present. During Winter 2022 – 2023, flooding occurred every time it rained hard. Mechanism of flooding described as surface water drainage systems being able to discharge into ditches, which are blocked.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	High Street, Pevensey	Rivers (Main River and Non-Main River), surface water, groundwater.	Watercourses (Martins Ditch) overflowing, surface water runoff, water table rising to the ground surface.	Flooding and damage to agricultural land (grazing) and agricultural buildings (barns). Flooding to roads.	Extent: Several acres. Depth: 25 – 460mm (1 – 18 inches) Duration: Throughout Winter 2022-2023, until May 2023.	Flooding to agricultural land and buildings, with watercourses and surface water unable to drain into the Pevensey Haven, reportedly due to high in-channel water levels, resulting from the Pevensey Haven not being drained down to winter levels. Surface water and flow in watercourses unable to disperse.
Pevensey	Sayerlands Lane, North Polegate	River	Watercourse overflowing across Sayerlands Lane and onto properties. Also backing up of ditch running from Sayerlands Lane to the Holmes sewer flowing out of bank.	Flooding to agricultural land, preventing grazing and being able to make hay.	Extent: At least 2 acres. Depth: 460 – 610 mm (18 inches - 2 ft). Duration: 2 to 3 days to drain down after heavy rain (flooding every time after heavy rain in Winter 2022-2023, until mid-April 2023).	Frequent fluvial flooding to agricultural land after heavy rain. Ditch running from Sayerlands Lane to the Holmes sewer reported to be blocked for several years. Some debris observed in floodwater. Reported worse flooding in recent winters. Due to frequent and persistent flooding, land adapted to grow marsh weeds.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	Pevensey Bypass, Pevensey	Groundwater	High water table rising up to the ground surface.	Some standing water on agricultural land (grazing). Soft ground due to high groundwater levels.	Extent: Approximately 0.5 acres Depth: Unknown Duration: Single, continuous event for four months (mid-January 2023 – early April 2023)	Prolonged high water table resulting in soft ground and areas of standing water on agricultural land. Land not out of use, but difficulties in accessing land for feeding and attending to livestock.
Pevensey	Rickney Lane, Rickney, Hailsham	Rivers	Overflowing watercourses – water in the Glynleigh unable to drain, due to backing up of water from Pevensey and Hailsham.	Flooding of agricultural land (grazing).	Extent: Approximately 0.5 acres Depth: Unknown Duration: One month (25 December 2022 to mid-January 2023)	Fluvial flooding to land, with cause reported to be issues in water draining down due to the main gate at Pevensey Bridge being closed. No flooding experienced prior to Winter 2022 – 2023.
Pevensey	A271 Amberstone, Upper Horsebridge	Rivers, surface water	Overflowing watercourses, surface water runoff from fields	Flooding of agricultural land (grazing).	Extent: Unknown Depth: 300mm Duration: Three months (February to April 2023)	Flooding from watercourses overflowing and surface water runoff from fields. No flooding experienced prior to Winter 2022 – 2023.

Catchment	Location	Sources	Pathways	Receptors	Observed flood extent/depth/duration	Description
Pevensey	Top Road, Battle	Rivers (Main River, but majority non-Main River)	Watercourse (Common Stream) overflowing	Flooding and damage to agricultural land (grazing).	Extent: 40 – 90% of 30 acres Depth: 152 - 610mm (6 inches to 2 ft) Duration: 2 – 3 weeks before floods again (10 – 12 occasions during Winter 2022 – 2023)	Prolonged annual fluvial flooding to land occurs from Common Stream and the ditch network. Alternative grazing land has to be found.
Pevensey	Waverley Gardens allotments, Pevensey	Rivers (Main River)	Watercourse (Salt Haven) overflowing	Flooding to allotments and adjacent residential gardens	Not specified	Flooding to the allotments from the adjacent Salt Haven throughout winter, with worst flooding reported in January 2023. For some plots was reported to have been the first time that the allotment had flooded in 15 years.

Offices at
Bristol
Coleshill
Doncaster
Dublin
Edinburgh
Exeter
Glasgow
Haywards Heath
Leeds
Limerick
Newcastle upon Tyne
Newport
Peterborough
Portsmouth
Saltaire
Skipton
Tadcaster
Thirsk
Wallingford
Warrington

Registered Office
1 Broughton Park
Old Lane North
Broughton
SKIPTON
North Yorkshire
BD23 3FD
United Kingdom

+44(0)1756 799919
info@jbaconsulting.com
www.jbaconsulting.com
Follow us:

Jeremy Benn
Associates Limited

Registered in England
3246693

JBA Group Ltd is
certified to:
ISO 9001:2015
ISO 14001:2015
ISO 27001:2013
ISO 45001:2018