Monktonmead Section 19 Flood Investigation

Final Report

April 2022

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Contract

This report describes work commissioned by James Brewer, on behalf of Isle of Wight Council, by an email dated 07 September 2021. Isle of Wight Council's representative for the contract was James Brewer. Peter Rook and Abigail Legge of JBA Consulting carried out this work.

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Purpose

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Acknowledgements

We would like to thank the Isle of Wight Council, Island Roads, Southern Water and the Environment Agency for their input and support. We would also like to thank the wider community for their contributions to the investigation.

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Executive summary

Background

Following flooding events in the Monktonmead area that occurred between July and August 2021, the Isle of Wight Council (IWC) as the Lead Local Flood Authority (LLFA) is undertaking a formal flood investigation under Section 19 of the Flood and Water Management Act 2021.

It is a statutory requirement for LLFAs to investigate flooding to the extent that it considers it necessary or appropriate.

The Monktonmead study area is located within Ryde, a town in the north of the Isle of Wight. The Monktonmead Brook is a watercourse which runs through Ryde towards The Solent and is classed as a main river.

The flooding that occurred in the Monktonmead area caused internal flooding to at least 32 properties and fulfils the criteria for a Section 19 investigation. IWC has appointment JBA Consulting to undertake this investigation on its behalf.

For more information see Section 1.

Stakeholder engagement

As part of the Section 19 investigation, we engaged with local stakeholders in the Monktonmead area, including residents, community representatives and other Risk Management Authorities.

The objectives of engagement are to:

- Gather facts, opinions and data to aid the understanding of the investigation
- Enable the involvement and buy-in of the community in the investigation
- Disseminate the findings of the investigation to the community

For more information see Section 2.

Catchment characteristics

Section 3 describes the watercourses, urban drainage network, topography and geology of the Monktonmead area

Long-term flood risk information

Section 4 summarises the existing long-term flood risk information on the risk of flooding from rivers, surface water and groundwater. Historically, the Monktonmead area has experienced frequent flooding, particularly from surface water and as a result of drainage issues and tide locking. However fluvial flooding is also a risk due to the presence of the Monktonmead Brook and tidal flooding due to the proximity to the coast.

Flood Risk Management

Responsibility for flood risk can be divided into "flood risk management" and "emergency response". Section 5 describes the roles and responsibilities of the various bodies involved in flood management and emergency response. Section 5.3 describes the existing flood risk management activities undertaken, including: flood warning; flood alleviation schemes; Property Flood Resilience; Community Flood Plan; and planning and development control activities.

For more information see Section 5.

Hydrological analysis of the flooding in July and August 2021

The storm event that affected Monktonmead on 25 July was estimated to have been between a 1 in 42 and a 1 in 107 year event which can be expressed as a storm event with approximately a 1% - 2.5% chance of occurring in any given year. Therefore, the storm was an extreme rainfall event, with a large volume of rainfall occurring in a relatively short amount of time.

The storm events on 27 July 2021 and 2 August 2021 were estimated to be between a 1 in 3 and 1 in 9 year event (33% - 11% chance), and a 1 in 4 and a 1 in 7 year (25% - 14% chance) event, respectively. Therefore, neither of these events were extreme. The timing of the rainfall did however correspond with the high tide in both these cases.

For more information see Section 6 and Appendix B.

Incident response

Several agencies responded to the flooding event in the Monktonmead area, including the Isle of Wight Council, Environment Agency Hampshire Police, Hampshire and Isle of Wight Fire and Rescue service, and Island Roads. A timeline of the incident responses for the event on 25 July, 27 July and 2 August 2021 are given in Table 7-2, Table 7-3 and Table 7-4, respectively.

Source-pathway-receptor analysis

The sources, pathways and receptors of flooding were as follows:

- Sources – extreme rainfall, combined sewer, Monktonmead Brook
- Pathways – overland flow, surface water drainage exceedance
- Receptors – confirmed internal flooding of at least 32 residential properties, resident displacement, loss of possessions, negative mental and physical health impacts. Flooding of at least two commercial properties, road closures, damage to the railway line.

For more information see Section 8.

Capacity review

As outlined in Section 6.1, the rainfall event on 25 July 2021 was estimated to be between a 1 in 42 and a 1 in 107 year event (1% to 2.5% annual probability occurrence) which is an extreme rainfall event. Whilst Southern Water reported capacity issues on the sewer network during the event, this is unsurprising considering the volume of rainfall that fell on the Monktonmead study area. In addition, the sewer system is mostly made up of combined sewers and therefore accepts both foul and surface water flows, including discharges from the highway drainage system. Southern Water reported capacity issues during the subsequent events on 27 July and 2 August 2021, despite the low rarity of the rainfall that occurred on these dates.

Based on the presence of foul sewage in flood water within some of the affected areas, it can be ascertained that hydraulic overload of the combined sewer system occurred during the event, which resulted in foul sewage emerging from the system and mixing with surface water runoff.

Discussion, appraisal and recommendations

In this section, we discuss in more detail some of the aspects of flood risk management in the Isle of Wight, what worked well during the events in July and August 2021, and what could be improved. We also consider potential options to mitigate flood risk and reduce damages caused by flooding.

We undertook a high-level option appraisal focussing on the potential benefits, practicality, and viability of each option. We carried out a multi-criteria analysis to compare each option, which included consideration of a range of different factors, for example the potential contribution towards reducing flood risk to property, people and communities. For more information see Section 10 and Appendix A.

Conclusion

A series of recommended actions for the Risk Management Authorities and stakeholder organisations are presented below.

For more information on options, recommendations and conclusions see Section 11 and Appendix A.

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Timescale
Property Flood Resilience (PFR) Scheme	Isle of Wight Council	7	1 – 5 years
Community flood resilience	Isle of Wight Council / Flood Action Groups	7	< 1 year
Understand the impacts of the Simeon Street recreation ground flood wall on surface water flood risk	Environment Agency / Isle of Wight Council	8	<1 year
Disconnecting roof water drainage	Southern Water / Isle of Wight Council	3	1 – 5 years
Upgrading sewer capacity	Southern Water / Island Roads	6	Long term strategic aim
Improving asset maintenance	Island Roads / Southern Water/ Isle of Wight Council	6	<1 year
Alterations to kerb levels	Isle of Wight Council / Island Roads	6	<1 year
SuDS measures in the East Hill Road and West Hill Road areas	Isle of Wight Council/ Island Roads	4	1 – 5 years

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Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGS	British Geological Society
CCTV	Closed Circuit Television
DTM	Digital Terrain Model
EA	Environment Agency
FEH	Flood Estimation Handbook
GIS	Geographic Information Systems
IWC	Isle of Wight Council
JBA	Jeremy Benn Associates
LiDAR	Light Detection and Ranging
LLFA	Lead Local Flood Authority
PFR	Property Flood Resilience
RMA	Risk Management Authority
RoFSW	Risk of Flooding from Surface Water (Environment Agency mapping)
SWMP	Surface Water Management Plan
WASC	Water and Sewerage Company
WTW	Waste Treatment Works

1 Introduction

1.1 Background to investigation

Following flooding in Ryde in July and August 2021, Isle of Wight Council (IWC) as the Lead Local Flood Authority (LLFA) is undertaking a formal flood investigation under Section 19 of the Flood and Water Management Act 2010[1].

It is a statutory requirement for LLFAs to investigate flooding to the extent that it considers it necessary or appropriate. Isle of Wight Council has outlined its criteria for undertaking a Section 19 investigation in its **Flood Investigation Protocol**[2].

- *Where there is ambiguity surrounding the source or responsibility of a flood incident;*
- *Where internal flooding of one property has been experienced on more than one occasion; OR*
- *Where internal flooding of a group of properties has been experienced during a single flood incident; OR*
- *Where flooding resulted in disruption of one or more items of critical infrastructure; OR*
- *Where a single flood incident resulted in flooding that affects vulnerable individuals; OR*
- *Where there is risk to life as a result of flooding.*

Any flooding event that a risk management authority deems significant but does not meet the agreed thresholds may be assessed for consideration by the strategic flood management group.

The flooding that occurred in Ryde caused internal flooding to at least 32 properties and meets the criteria to trigger a Section 19 investigation. The IWC has appointed JBA Consulting to undertake this investigation on its behalf.

1.2 Site location

The Monktonmead study area covers a large proportion of Ryde, a town in the north of the Isle of Wight. The Monktonmead Brook is a watercourse which runs through Ryde towards The Solent and is classed as a main river.

1.3 Data collection

A wide range of data has been collected and assessed to inform the Section 19 investigation. This has been used to understand the causes of flooding in Monktonmead and to establish the context of the area. This includes the following:

- Open-source data from GOV.UK
- Photographs from the site visit, showing flood sources, pathways and receptors
- Rainfall data
- Residents' questionnaires
- Information from authorities on drainage infrastructure, such as highways and water companies
- Other data such as photographs, newspaper articles and notes from the event

1 Flood and Water Management Act 2010 Section 19 (accessed 17 May 2021): https://www.legislation.gov.uk/ukpga/2010/29/section/19

2 Isle of Wight Council Flood Investigation Protocol: https://www.iow.gov.uk/azservices/documents/2821-Flood-Investigation-Protocol-March-2015.pdf

2 Stakeholder engagement

We engaged with multiple local stakeholders in the Monktonmead area including residents, community representatives, landowners, other Council departments, Council Members and Risk Management Authority (RMA) partners.

The objectives of engagement are to:

- Gather facts, opinions and data to aid the understanding of the investigation
- Enable the involvement and buy-in of the community in the investigation
- Provide more technical debrief with RMA and operational partners
- Disseminate the findings of the investigation to the community

A list of key stakeholders and how we engaged with them is shown in Table 2-1. The engagement terminology is taken from Environment Agency's 'Working with Others' (2013) methodology:

- Inform - provide information
- Consult - receive, listen, understand and feedback
- Involve - decide together
- Collaborate - act together
- Empower - support independent action

Table 2-1: Key stakeholders

Role	Organisation	How to engage	Type of engagement
Residents	N/A	Consult	Site visit, online questionnaire, correspondence
Flood Action Group	Ryde Flood Action Group	Consult	Public engagement meeting, correspondence,
Parish/Town Council	Ryde Town Council	Consult	Invitation to contribute, correspondence, public engagement meeting
Water and Sewerage Company (WASC)	Southern Water	Involve	Invitation to contribute, correspondence, data provision
Highways Authority	Isle of Wight Council / Island Roads	Involve	Invitation to contribute, correspondence, data provision
Environment Agency	Environment Agency	Involve	Correspondence, data provision
LLFA	Isle of Wight Council	Involve	Invitation to contribute, correspondence, online survey distribution, site visit, data provision
Council Members	Isle of Wight Council	Consult	Invitation to contribute
Emergency Planning	Emergency Management IWC	Consult	Invitation to contribute, correspondence

3 Catchment characteristics

3.1 Topography

The Monktonmead study area is relatively low lying, with elevations ranging between 5 and 60mAOD. The topography of the study area has a valley-like structure, with higher elevations in the east and west and the lowest elevations associated with the Monktonmead Brook floodplain. The land generally slopes towards the river and the coast, as seen in Figure 3-1.

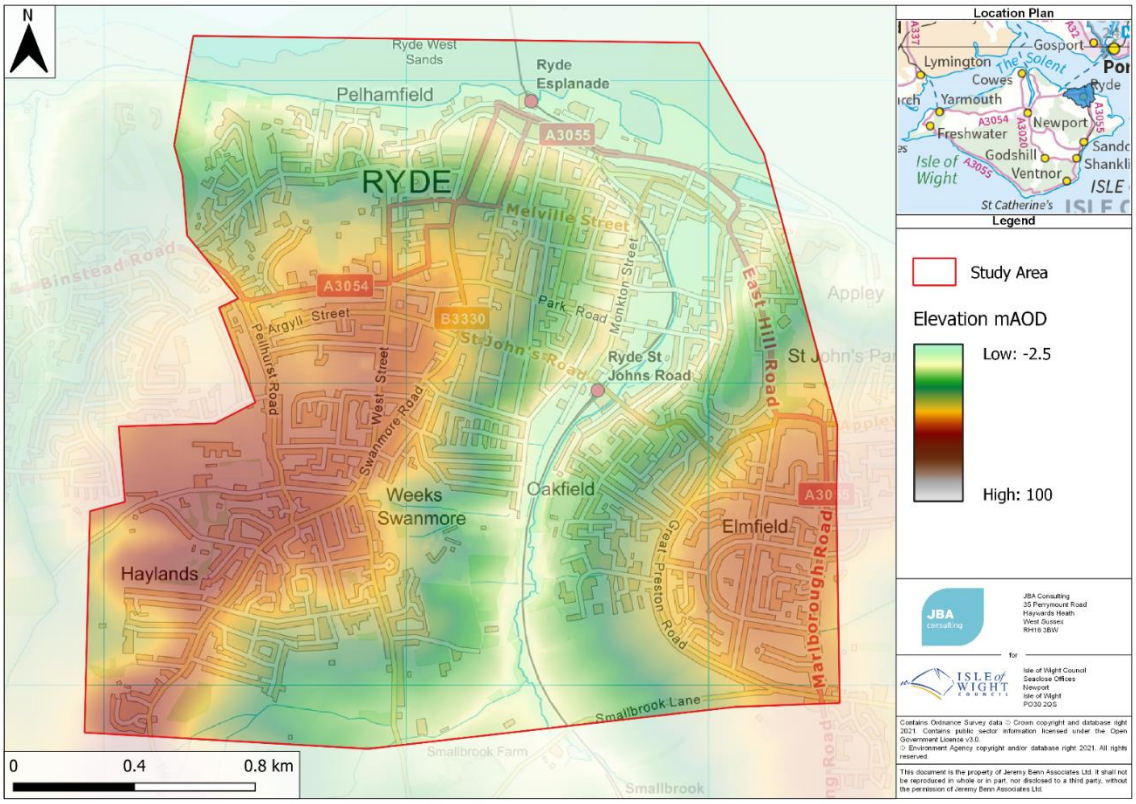


Figure 3-1: The topography of the study area

3.2 Geology and soils

British Geological Survey (BGS) 50K mapping shows that the Monktonmead area is underlain by bedrock of various rock strata, as can be seen in Figure 3-2. The bedrock of the coastal region and along the route of Monktonmead Brook is the Headon Hill formation (mudstone and limestone interbed) followed by Bembridge Limestone Formation (limestone, shelly). This is followed by Bembridge Marls Member (calcareous mudstone and limestone). In the west there is Hamstead Member bedrock (clay, silt and sand). The BGS Aquifer Designation Map[3] defines the bedrock as Secondary A strata, which is classified as permeable layers capable of supporting water supplies at a local scale and can form an important source of base flow to rivers.

The superficial deposits in the area, as seen in Figure 3-3, are mostly head (gravel, silt, sand and clay) and the Wootton Gravel Complex (gravel, sandy, clayey and silty) in the east and west. There is also Alluvium (clay, silt, sand and gravel) associated with Monktonmead Brook, as well as beach and tidal flat deposits associated with the coast.

3 https://magic.defra.gov.uk/MagicMap.aspx

The soils in the area, defined by the Soilscapes Map[4], are mostly slowly permeable, seasonally wet, slightly acid but base-rich loamy and clayey soils with impeded drainage. Freely draining, slightly acid loamy soils can be found in the east in Oakfield and Elmfield, and in the west around Ratcliffe Avenue.

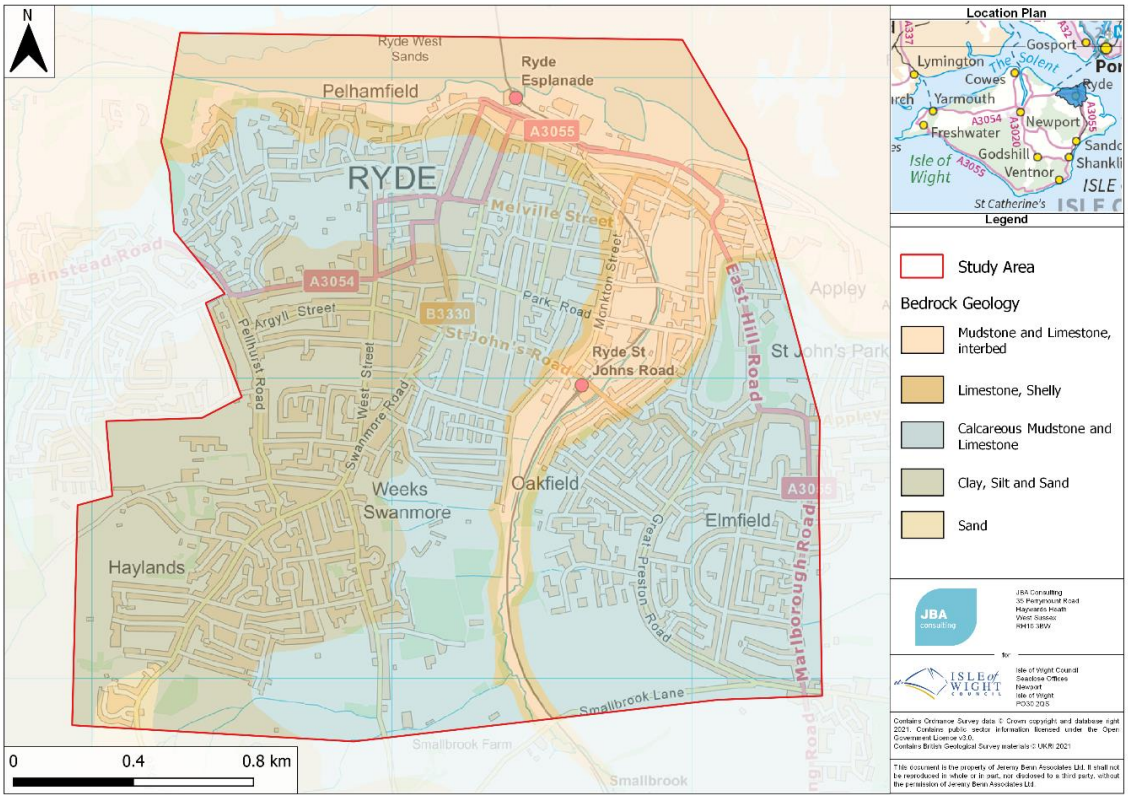


Figure 3-2: The bedrock geology of the study area

4 Cranfield University http://www.landis.org.uk/soilscapes/

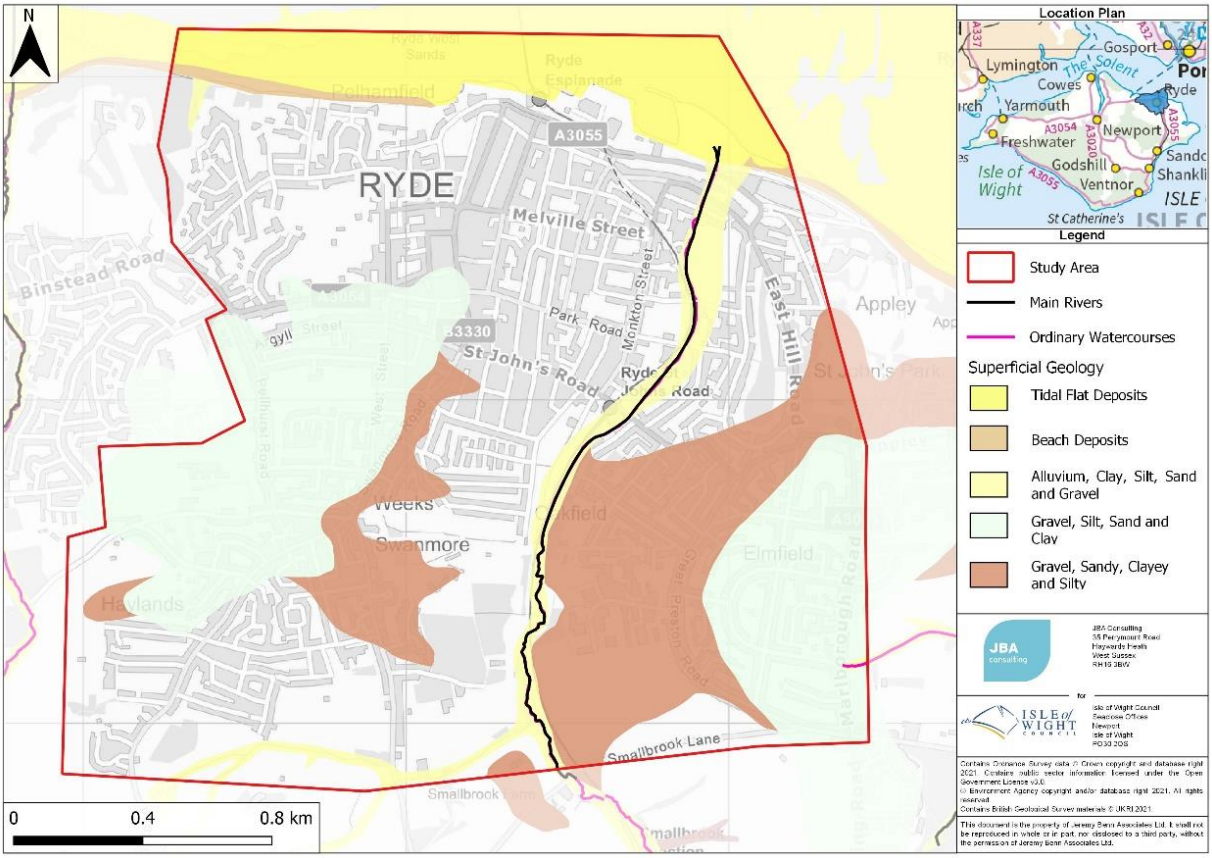


Figure 3-3: The superficial geology of the study area

There is a diverse range of superficial deposits and soils, and therefore it is likely that permeability would be variable across the Monktonmead study area. There will be areas where there is a high permeability and others where it may be very low. The catchment is also steep and heavily urbanised, which could have a greater influence than underlying geology on surface water flow routes. The combined influence of these characteristics may contribute to a greater risk of the formation of surface water runoff.

3.3 Drainage system and river network

Rivers in England are designated as either 'main rivers' or 'ordinary watercourses' by the Environment Agency. The risk of flooding from main rivers is managed by the Environment Agency through maintenance, improvements and construction works. Ordinary watercourses are, in most cases, the responsibility of individual riparian owners, however the LLFA has a responsibility to ensure that landowners are undertaking their riparian responsibilities under the Land Drainage Act (1991). The LLFA also has discretionary powers to undertake flood risk management works on ordinary watercourses.

The hydrology of the area is shown in Figure 3-5,in which one main river, Monktonmead Brook, drains a catchment of approximately 10km^2 in area. Monktonmead Brook begins within the Eaglehead and Bloodstone Copses preservation site in Brading, flowing in a northern direction towards and through Ryde as an ordinary watercourse. The Brook becomes a main river downstream of Smallbrook Lane, as it enters the Monktonmead study area. The lower course of the river is mostly concrete lined as shown in Figure 3-4, and then is culverted downstream of the Simeon Street Recreational Ground. The culvert carries the flow to the harbour via the pumping station located at the sea wall. The outfall on the beach is fitted with a tidal flap to prevent ingress of sea water at high tides.

Figure 3-4: Monktonmead Brook at Ryde St Johns Road Railway Station in normal conditions

The wastewater drainage in Ryde is managed by Southern Water. Ryde falls under the Sandown New WTW (waste treatment works) sewer catchment. The sewage network is made up of gravity sewers and rising mains (pumped systems). Surface water runoff from this catchment is discharged to the English Channel via a long outfall pipe.

The highways drainage network across the Isle of Wight is managed by Island Roads, in agreement with the IWC. This includes maintenance of the drainage network, such as gully and drain cleansing, street cleansing, and maintenance of highway ditches.

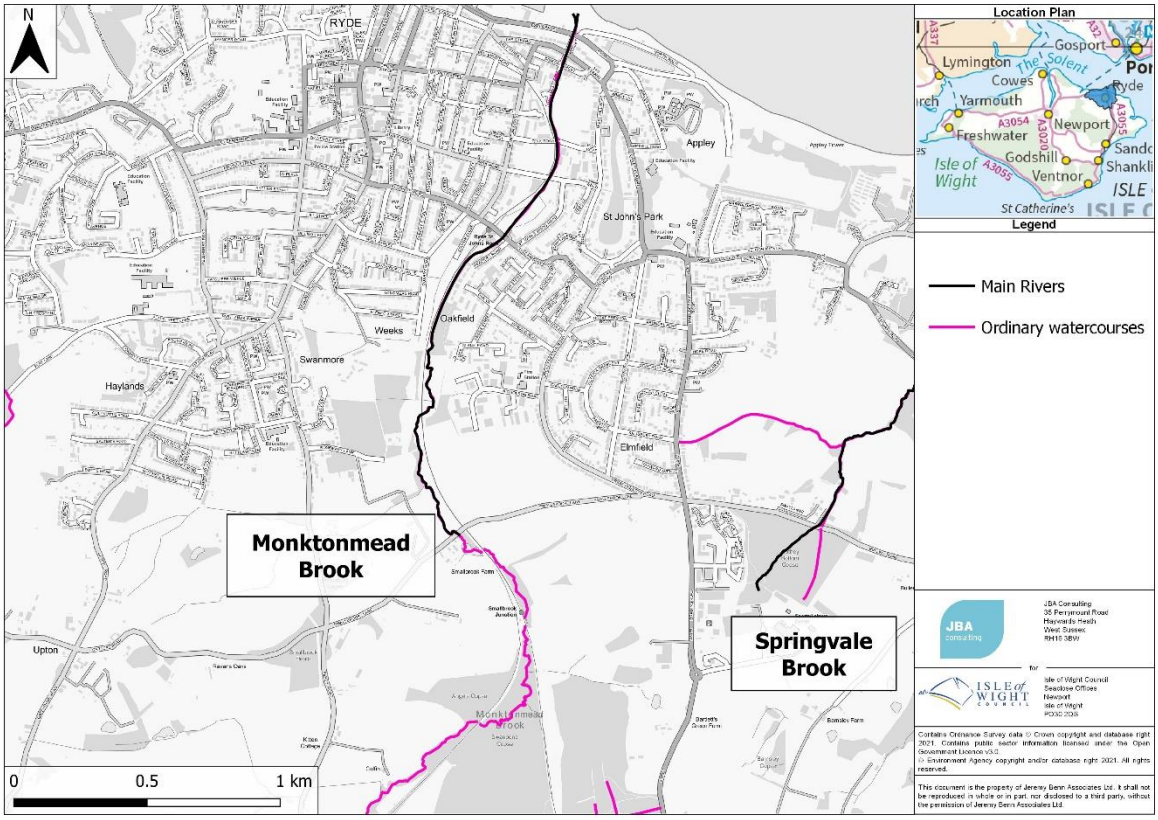


Figure 3-5: The watercourses in the study area

4 Long-term flood risk information

4.1 Risk of Flooding from Rivers and Sea

The Environment Agency's Flood Zone data, shown in Figure 4-1, defines areas at risk of flooding from fluvial and tidal sources. Areas within Flood Zone 2 have between a 0.1% and 1.0% chance of flooding from rivers (or between a 0.1% and 0.5% chance of flooding from the sea) in any given year. Areas within Flood Zone 3 have greater than a 1.0% chance of flooding from rivers (or greater than a 0.5% chance of flooding from the sea) in any given year. In the study area, the risk of flooding from rivers and the sea is mostly confined to the course of Monktonmead Brook and along the coast, the majority of which is within Zone 2. It should be noted that these Flood Zones represent undefended flood risk and therefore do not take into account existing flood defences.

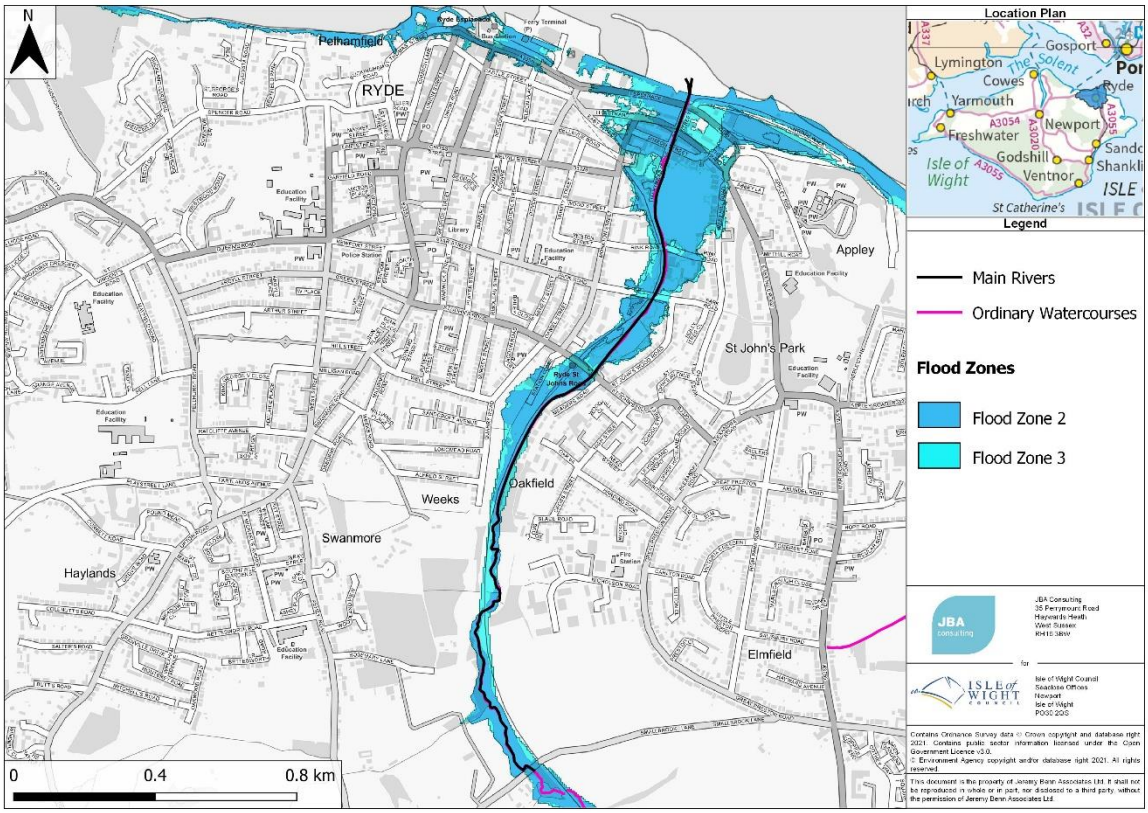


Figure 4-1: Risk of Flooding from Rivers and Sea

4.2 Risk of Flooding from Surface Water

Flooding from surface water runoff (or 'pluvial' flooding) is caused by intense short periods of rainfall. It often occurs where the natural (or artificial) drainage system is unable to cope with the volume of water. Surface water flooding problems are inextricably linked to issues of poor drainage (or drainage blockage by debris) and sewer flooding.

The Risk of Flooding from Surface Water (RoFSW) data is national scale mapping showing the risk of flooding from surface water runoff, published by the Environment Agency. The map in Figure 4-2 shows the areas at risk of flooding in response to rainfall events with the percentage chance of event occurring in any given year (Annual Exceedance Probability):

- High risk - greater than a 3.3% chance (1 in 30 years)
- Medium risk – between a 3.3% and 1.0% chance (1 in 100 years)
- Low risk – between a 1.0% and 0.1% chance (1 in 1,000 years)

There is a heightened surface flood risk along natural depressions, including along Monktonmead Brook, and the Simeon Street recreational ground, both of which are at risk of flooding during rainfall events with greater than a 1 in 30 year or 3.3% annual occurrence. Other areas at risk of flooding include smaller surface water flow paths near the coast, and in the south across Haylands, and in Swanmore, which form during rainfall events with a 1% chance of occurring in any given year.

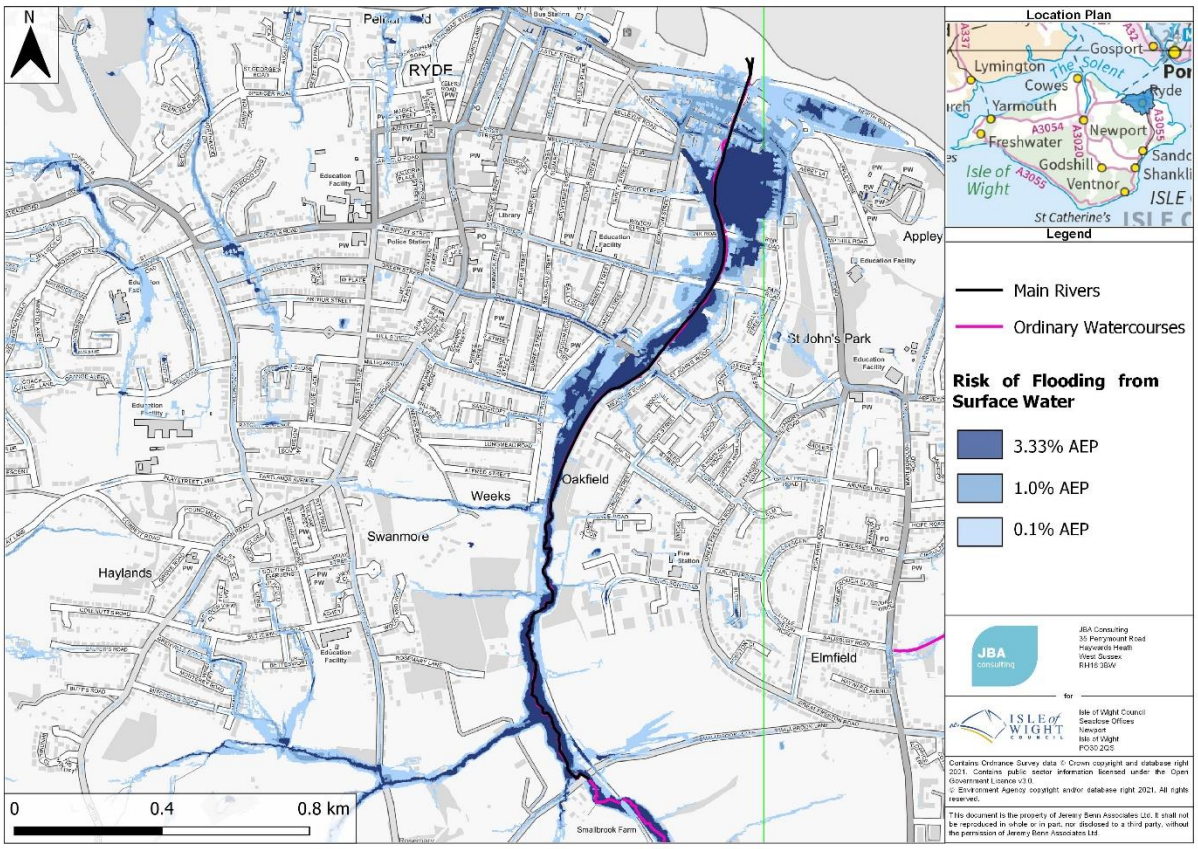


Figure 4-2: Risk of flooding from surface water

4.3 Groundwater flooding

Flooding from groundwater occurs when the water table within the underlying rock or soil rises above ground level or interacts with properties or infrastructure below ground level. Data on groundwater was not available for the Section 19 investigation. However, based on the underlying geology and soil types, which are muddy limestones and soils with indications of impeded drainage, groundwater is not expected to be a significant flood risk in the Monktonmead area. Furthermore, responses from stakeholders have not indicated groundwater flooding to have been a significant issue.

4.4 Flood history

Table 4-1 details the known flood history in Ryde sourced from the previous Strategic Flood Risk Assessment[5]. Ryde has a long history of flooding, but the records prior to 2000 are limited.

5 Isle of Wight Council https://www.iow.gov.uk/azservices/documents/2782-SFRA%20Mk2%20-%20Jun%202010.pdf

Table 4-1: Flood history

Date	Source of flooding	Description of impacts
1999	High water levels in the Brook due to sand blocking the outfall	Unknown
2000	Groundwater, sewer, fluvial	70 houses flooded, basement flooding identified as the key issue. Coincidence of high tide, pump failure and high river flow.
2010	Unknown	60 properties flooded, the rainfall event had a low return period
2013	Surface water drainage and foul sewer	22 properties affected, 16 of which were flooded internally

5 Flood Risk Management

Responsibility for flood risk can be divided into "flood risk management" and "emergency response". The following section describes the roles of the various bodies involved in flood management, with roles and responsibilities for emergency response described in Table 2-1.

It should be noted that the responsibility for reducing the impacts of flooding to any property remains with the owner of that property, not with any risk management authority. Isle of Wight Council, the Environment Agency and other risk management authorities have the statutory powers to carry out works for flood risk management purposes or other works to reduce flooding but are under no statutory duty to do so.

5.1 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different Risk Management Authorities (RMAs)[6]. The Flood and Water Management Act places a duty on all flood risk management authorities to co-operate with each other. The act also provides Lead Local Flood Authorities and the Environment Agency with a power to request information required in connection with their flood risk management functions.

5.1.1 Lead Local Flood Authority (LLFA)

LLFAs are responsible for managing the risk of flooding from surface water, groundwater (water which is below the water table under the ground) and ordinary watercourses (non-main rivers) and lead on community recovery. The LLFA is also responsible for developing, maintaining and applying a strategy for local flood risk management in their area and for maintaining a register of flood risk assets.

Isle of Wight Council is the LLFA for Ryde.

5.1.2 Environment Agency

The Environment Agency is sponsored by the Government's Department for Environment, Food & Rural Affairs (Defra), and is tasked with the protection and conservation of the water environment in England, the natural beauty of rivers and wetlands and the wildlife that lives there.

The Environment Agency's responsibilities include: water quality and resources; fisheries; conservation and ecology; and operational responsibility for managing the risk of flooding from main rivers (usually large streams and rivers), reservoirs, estuaries and the sea. The Environment Agency has permissive powers (but not a duty) to carry out flood and coastal risk management work and to regulate the actions of other flood risk management authorities on main rivers and along the coast.

Flood risk management work can include: constructing and maintaining 'assets' (such as flood banks or pumping stations) and works to main rivers to manage water levels and make sure flood water can flow freely; operating flood risk management assets during a flood; channel maintenance on the river; issuing flood warnings; and responding to incidents.

The Environment Agency can also do work to prevent environmental damage to watercourses, or to restore conditions where damage has already been done. The strategies for flood and coastal erosion risk management show how communities, the public sector and other organisations can work together to manage this risk.

6 https://www.gov.uk/guidance/flood-risk-management-information-for-flood-risk-management-authorities-asset-owners-and-local-authorities

5.1.3 Water and Sewerage Company

Water and sewerage companies are responsible for managing the risks of flooding from surface water and foul or combined public sewer systems providing drainage from buildings and developed areas.

Southern Water is the Water and Sewerage company for Ryde.

5.1.4 Highway Authority

The Highway Authority for Ryde is the Isle of Wight Council, and the highways function is managed by Island Roads. It is responsible for maintaining the highway drainage system to an acceptable standard and ensuring that road projects do not increase flood risk.

5.1.5 Riparian landowners

Riparian landowners who own land or property next to a river, stream or ditch, (including where this runs through a pipe or culvert), have rights and responsibilities over the management of the land. This includes: a responsibility to let water flow through the land without any obstruction, pollution or diversion which affects the rights of others; keeping banks clear of anything that could cause an obstruction and increase flood risk; maintaining the bed and banks of the watercourse; and keeping structures clear of debris. There is more information on these rights and responsibilities in the Environment Agency online guidance for local residents **'Owning a watercourse'**[7]**.**

5.1.6 Local residents

Local residents should find out about any flood risk in the area, sign up for the Environment Agency's free flood warnings and make a written plan of how they will respond to a flood situation. Business owners should also make a flood plan for their business. There are measures that can be taken to reduce the amount of damage caused by flooding and properties at risk should be insured. Local residents can find out if their property is at risk, prepare for flooding, get help during a flood and get help after a flood.

5.2 Emergency responsibilities

The emergency responsibilities of different organisations are outlined in Table 5-1 below. Please note that Parish and Town Councils do not have a legal obligation to respond to emergencies. Whatever service they provide is voluntary and unique to each Parish or Town Council.

7 Environment Agency (2018) Owning a watercourse. Available at: https://www.gov.uk/guidance/owning-a-watercourse

Table 5-1: Roles and responsibilities in an emergency, during and after a flood event

Local (County and District) Authorities
Coordinate emergency support within their own functions
Deal with emergencies on 'non main rivers'
Coordinate emergency support from the voluntary sector
Liaise with central and regional government departments
Liaise with essential service providers
Open rest centres
Manage the local transport and traffic networks
Mobilise trained emergency social workers
Provide emergency assistance
Deal with environmental health issues, such as contamination and pollution
Coordinate the recovery process
Manage public health issues
Provide advice and management of public health
Provide support and advice to individuals
Assist with business continuity

Police Force	Utility Providers
Save life Coordination and communication between emergency services and organisations providing support Coordinate the preparation and dissemination	Attend emergencies relating to their services putting life at risk Assess and manage risk of service failure Assist with recovery process, that is, water utilities manage public health considerations

Fire and Rescue Service
Save life rescuing people and animals
Carry out other specialist work, including flood rescue services
Where appropriate, assist people where the use of fire service personnel and equipment is relevant

Ambulance Service	Town and Parish Councils
Save life Provide treatment, stabilisation and care at the scene	Support emergency responders Increase community resilience through support of community emergency plan development

Voluntary Services
Support rest centres
Provide practical and emotional support to those affected
Support transport and communication
Provide administration
Provide telephone helpline support

Environment Agency
Issue Flood Warnings and ensure systems display current flooding information
Provide information to the public on what they can do before, during and after a flood event
Monitor river levels and flows
Work with professional partners and stakeholders and respond to requests for flooding information and updates
Receive and record details of flooding and related information
Operate water level control structures within its jurisdiction and in line with permissive powers
Flood event data collection
Arrange and take part in flood event exercises
Respond to flooding incidents
Respond to pollution incidents and advise on disposal
Assist with the recovery process, attending flood surgeries
Advise upon and regulate flood risk activities on and within the flood plains of main rivers

5.2.1 Local Resilience Forum (LRF)

Local resilience forums (LRFs) are multi-agency partnerships made up of representatives from local public services, including the emergency services, local authorities, the NHS, the Environment Agency and others. These agencies are known as Category 1 Responders, as defined by the Civil Contingencies Act.

LRFs are supported by organisations, known as Category 2 responders, such as the Highways Agency and public utility companies. They have a responsibility to co-operate with Category 1 organisations and to share relevant information with the LRF. The geographical area the forums cover is based on police areas.

The Local Resilience Forum is not a legal entity, nor does a Forum have powers to direct its members. Nevertheless, the Civil Contingencies and the Regulations provide that emergency responders, through the Forum, have a collective responsibility to plan, prepare and communicate for emergencies in a multi-agency environment.

The Local Resilience Forum for Binstead is the Hampshire and Isle of Wight Local Resilience Forum (HIWLRF). The HIWLRF has identified coastal flooding, fluvial flooding and surface water flooding as very high risk. Therefore, the HIWLRF has a Multi-Agency Flood Response Plan that provides the framework for the multi-agency response to a flooding incident and details the roles and responsibilities of each agency, as well as the estimated time of onset for flooding, the number of properties at risk, vulnerable receptors and safe evacuation points. THE HIWLRF also work with communities at risk to create Community Emergency Action Plans.

The Island Resilience Forum (IRF) was formed as a sub-group of the HIWLRF to provide an Isle of Wight dimension to planning, concentrating on the risks and challenges faced by island communities. The IRF consists of a tactical level coordinating group of emergency planners to facilitate joint working between island partners.

5.3 Existing flood risk management activities

The IWC Local Flood Risk Management Strategy (2016) details the various responsibilities of key stakeholders and organisations, and the existing flood risk management activities at the time of publication.

The Environment Agency, in partnership with the Southern Regional Flood and Coastal Committee, has undertaken a £5.2m scheme to protect more than 300 homes at risk of fluvial (river) flooding in Ryde. This included the installation of a flood wall around Simeon Street Recreation Ground, Marymead Close and the river boundary of the British Telecom depot, as shown in Figure 5-1. This not only protects homes but allows the Rec to be used as a flood storage area. This scheme, including the flood walls and demountable barriers, is operated and maintained by the Environment Agency.

The Environment Agency has noted that duty officers followed existing procedures during these events and deployed the demountable defences (drop boards) at Simeon Street Recreation Ground during these events. It was also noted that river levels in the Monktonmead Brook did not rise above 2.7m AOD above which internal property flooding has been known to occur.

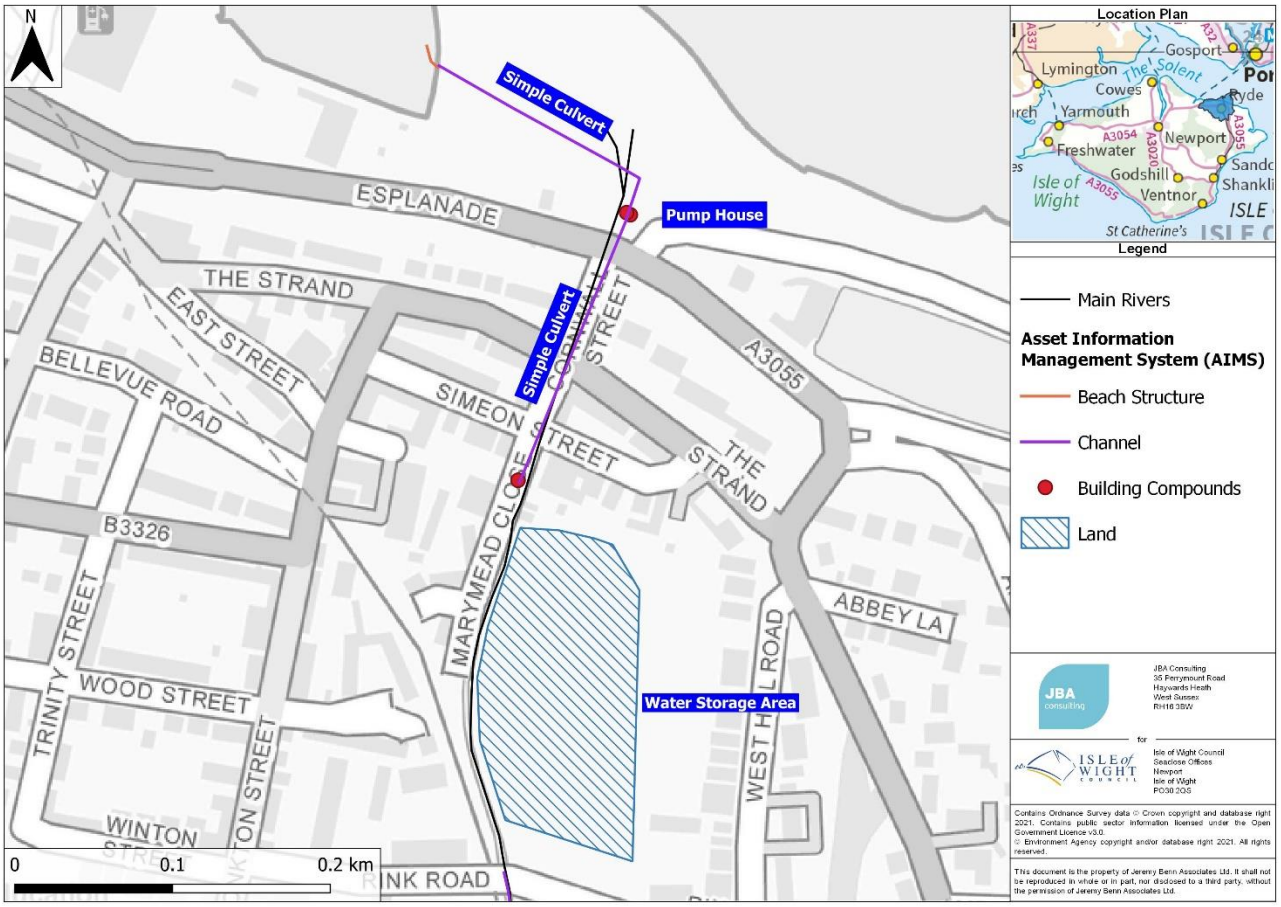


Figure 5-1: The Environment Agency's Asset Information Management System (AIMS) in the Monktonmead area, showing the Simeon Street Recreational Ground and the culverted Monktonmead Brook

Figure 5-2: Flood walls at Simeon Street Recreation Ground

As part of the scheme, a new outfall pipe for Monktonmead Brook has been created from the pumping station at Cornwall Slip to the sea wall at Ryde Harbour. This allows a clear outfall to be maintained, allowing additional flows to be discharged to the sea in heavy rainfall events. The scheme is also designed to significantly reduce the frequency of overtopping of the Monktonmead Brook banks and the resulting flooding of land and properties surrounding Monktonmead. Whilst this will predominantly have an impact on river flows, it should be noted that surface water drainage from much of Ryde also discharges to the Monktonmead Brook.

5.3.1 Flood warning service

The Monktonmead area is covered by the Environment Agency's Flood Warning Service which covers Monktonmead Brook and coastal flooding from The Solent. This service provides communication of flood alerts and warnings by phone, text or email once registered through the government website[8]. Figure 5-3 maps the location of the three flood warning areas that cover the Monktonmead study area. These areas are as follows:

- Ryde coastal area
- Monktonmead Brook at Simeon Street Recreational Ground
- Monktonmead Brook at St Johns.

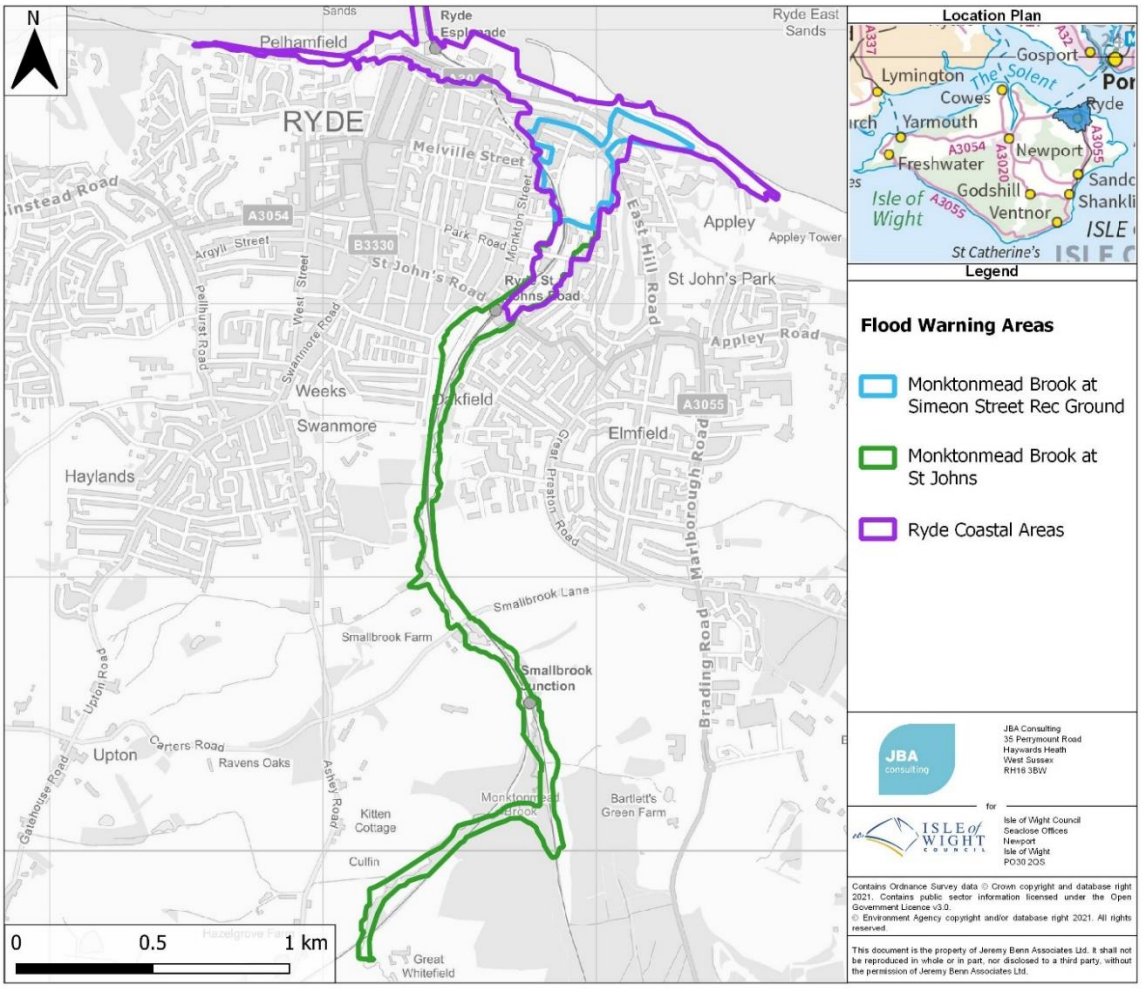


Figure 5-3: The Environment Agency Flood Warning System Areas in Ryde

8 https://www.gov.uk/sign-up-for-flood-warnings

5.3.2 Community flood plans

There is a local Flood Action Group for Ryde, which aids the management of flood risk at a community level.

5.3.3 Maintenance

Maintenance is an essential part of managing flood risk, with landowners, the IWC and EA involved in the maintenance of watercourses, drains and similar infrastructure as shown in Table 2-1.

The legal responsibility for maintenance of the river lies with the riparian landowners (as set out in Section 5.1.5) rather than the Environment Agency or any other authority. The Environment Agency has powers to work on main rivers (including Monktonmead Brook) to manage flood risk. These powers are permissive, which means they are not a duty. The EA's powers allow them to carry out a variety of works to maintain main river channels, assets and structures in order to manage or reduce flood risk to people and property, and to safeguard the health and safety of staff and other river users.

Nationally, the Environment Agency's maintenance works can include weed and grass cutting by hand/machine, channel maintenance, obstruction removal, vermin control, tree/bush work, defence repair, flood reservoir work, structure maintenance and some works to improve habitat and biodiversity. Their maintenance work may include de-silting or dredging where this is proven to be the most cost-effective way of managing flood risk to people and property, without causing a deterioration of the water body as defined through the Water Framework Directive (WFD).

The Environment Agency undertakes an annual visual inspection of any structures and defences through the Monktonmead area that have a Flood Risk Management purpose. Any obstructions to flow, such as fallen trees or blockages are flagged and reported to the riparian landowner, where known. Grass control is carried out on various high flow cuts and flood berms. Further intermittent works may be carried out where there is a justified need and funding available. The Environment Agency may respond the reports of blockages and obstructions and carry out patrols of specific locations during flood events, where resources are available.

Island Roads has an annual programme of drain, streetand gully cleansing for roads and are responsible for managing sandbag stock at strategic locations.

6 Hydrological analysis

A range of hydrometric data has been collected and analysed to understand the hydrological factors behind the flooding that occurred, this includes data from:

- Tipping bucket rain gauges;
- Rainfall radar (HYRAD);
- River level gauges;
- Tide levels.

As there was only a single rain gauge that was local to the Monktonmead area, rainfall radar data (HYRAD) from the Met Office has been obtained and analysed as a point of comparison to the rain gauge data and as a sensitivity check.

The Monktonmead Brook is understood to have flooded during the event on 02 August 2021, and as a result river level gauge data has been requested to understand the magnitude of the fluvial flooding. Tide levels have also been obtained to understand whether tide locking may have been a factor during any of the three events being assessed. It is understood from discussions with the Environment Agency that internal property flooding can occur when river levels in the Monktonmead Brook are >2.7m AOD, the EA noted that this did not occur during these events.

As it has been ascertained that the majority of internal flooding incidents occurred on 25 July, this section focuses on that event in greater detail. However, further details of the analysis undertaken on the 27 July and 02 August events is detailed in Appendix B.

6.1 25 July 2021

6.1.1 Conditions at the time

The rain gauge at Ryde Vineyard shows that rain fell throughout the day of 25 July 2021 in Ryde, starting at approximately 03:45. The rainfall continued until approximately 14:45, gradually becoming more intense. The data shows that from 14:45 to 16:00, highly intense rainfall fell on Ryde, with approximately 45mm of rain falling within this period. This is demonstrated by the graph in Figure 6-2.

The HYRAD data indicates that this highly intense rainfall originated from the north before moving inland, with the most intense rainfall (Figure 6-1) occurring at approximately 15:30, with maximum recorded intensities in the Monktonmead area of 17mm in a 15-minute window. This period of high intensity rainfall ended at approximately 16:00. The highest totals were recorded in the west of the study area, with similarly high levels falling in the centre.

A comparison of the HYRAD and tipping bucket rain gauge data (Table 6-1) showed similarities between the two datasets with regard to the daily totals and similar data for the 15-minute totals.

The tidal gauge at Ryde Pier shows that the rainfall event corresponded with a receding tide, as shown in Appendix B. Therefore, it is unlikely that tide locking of the Monktonmead Brook or drainage systems occurred.

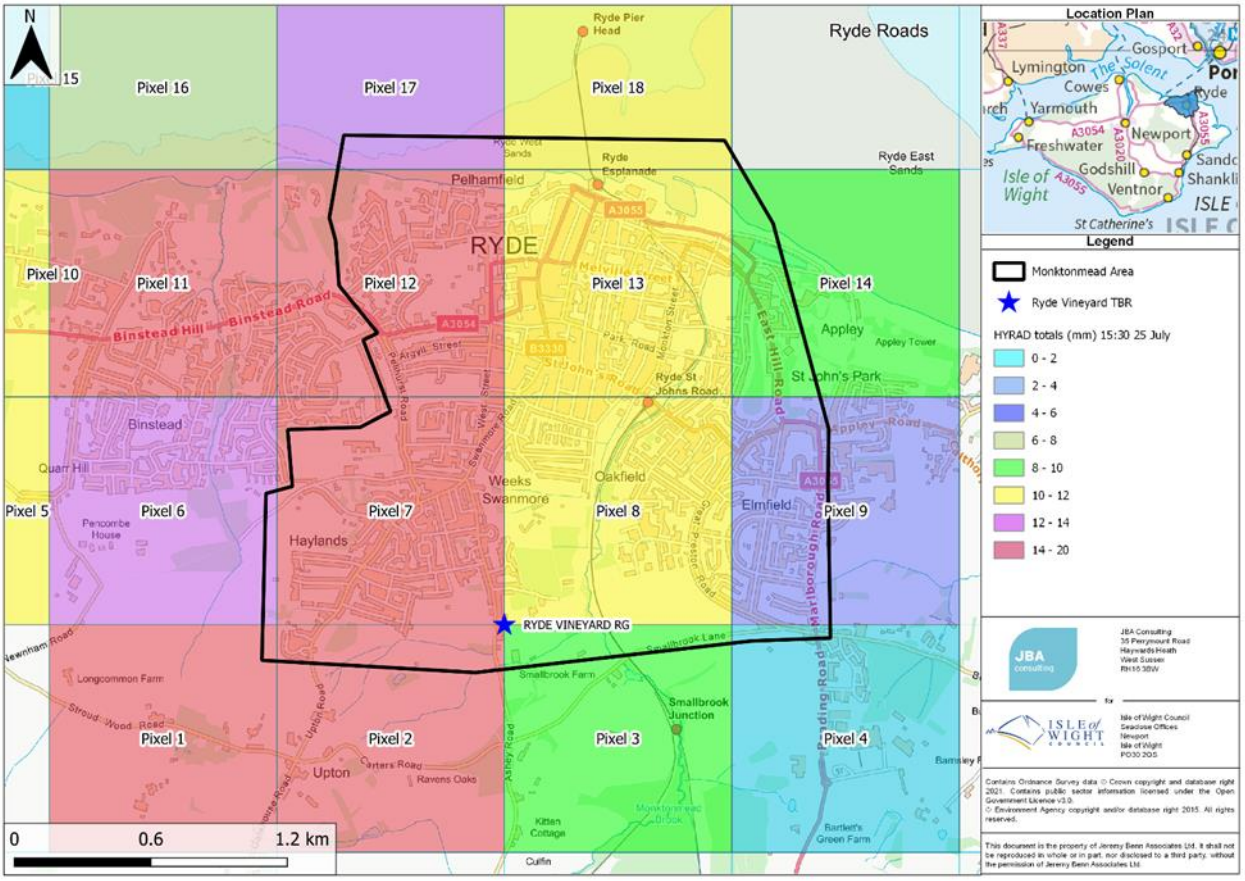


Figure 6-1: Hyrad rainfall for the Monktonmead area on 25 July 2021

Table 6-1: Rainfall totals in the Monktonmead area on 25 July 2021

Rain gauge	Approximate distance from study area * (km)	Daily total on 25 July 2021 (mm)	Grid reference
Ryde Vineyard	0.9	64.40	459000, 91000
HYRAD (Pixel 7)	0.0	73.66	458500, 91500
HYDRAD (Pixel 8)	0.0	53.01	459500, 91500
HYRAD (Pixel 12)	0.0	59.69	458500, 92500
HYRAD (Pixel 13)	0.0	58.10	459500, 91500

*Distance to the centre of the Monktonmead study area

6.1.2 Rainfall return period estimation

Rain gauge data provided by the Environment Agency has been used to estimate the return period of the storm events in the Monktonmead area. The closest tipping bucket rain gauge is the Ryde Vineyard gauge, which is located approximately 1km from the centre of the study area. The decision was made to use this gauge as the data was very consistent with that of the HYRAD data.

The Flood Estimation Handbook (FEH) web service was used to purchase point descriptors for Monktonmead, allowing the rainfall rarity, or storm return period, to be calculated for a range of storm durations (1hour, 2 hour and 4 hour) for each event. Table 6-2 details the calculated rainfall return periods.

The storm event that affected Monktonmead on 25 July 2021 was likely to be between a 1 in 42 and a 1 in 107-year event which can be expressed as a storm event with **approximately a 1% - 2.5% chance of occurring in any given year**. Therefore, the storm event was an extreme rainfall event, with a large volume of rainfall occurring in a relatively short amount of time.

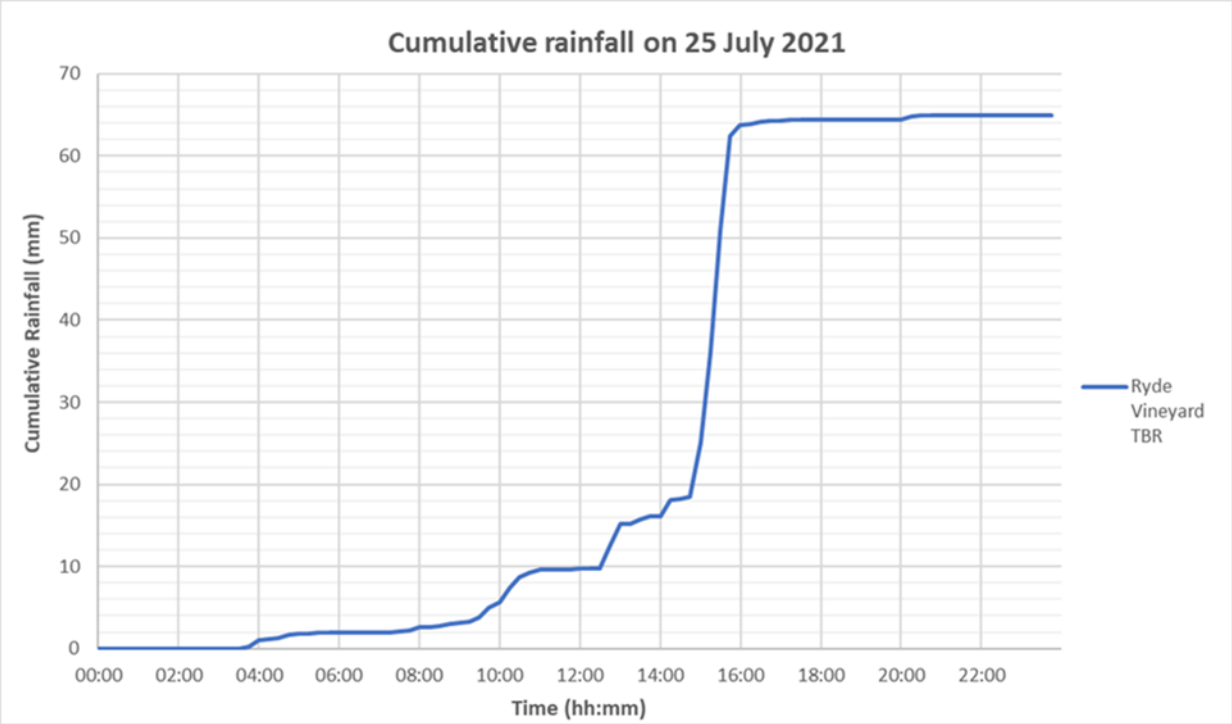


Figure 6-2: The cumulative rainfall on 25 July 2021 recorded by the Ryde Vineyard TBR gauge

Table 6-2: The rarity of the rainfall event in Monktonmead on 25 July 2021

Storm Duration (hours)	Maximum Rainfall (mm)	Return Period (years)	Approximate AEP* (%)
1	43.99	107.95	0.9
2	46.31	52.87	1.9
4	52.75	42.70	2.3

*Annual Exceedance Probability – percentage chance of event occurring in any given year.

6.2 Subsequent events

6.2.1 Conditions at the time

Flooding was reported to have occurred on additional dates to the large storm event on 25 July 2021. The main dates for the further flooding were 27 July 2021 and 02 August 2021. However, it should be noted that responses to the stakeholder survey reported further incidents of flooding on other dates but these incidents affected fewer properties.

Rainfall began at approximately 01:00 on 27 July 2021 with most rainfall occurring between 01:00 and 03:00. In this 2-hour period, 28mm of rain was recorded. On 02 August 2021 the rainfall began at around 04:00, with most of the rainfall occurring between the hours of 06:00 and 07:00. During this period, approximately 30mm of rain was recorded. The data from these events is presented in Appendix B, and highlights the short period of time in which the rain fell.

The rain gauge at Ryde Vineyard and the rainfall radar data (HYRAD) show low levels of rainfall for both 27 July 2021 and 02 August 2021. Table 6-3 and Table 6-4 summarise the rainfall totals recorded by the Ryde Vineyard gauge and the HYRAD data for the 27 July 2021 and 02 August events respectively. There was no HYRAD data available for 27 July 2021.

The tidal gauge at Ryde Pier shows that the 27 July and the 02 August rainfall events corresponded with a receding tide, therefore it is possible but unlikely that tidal locking did occur.

Table 6-3: Rainfall totals in the Monktonmead area on 27 July

Rain gauge	Distance from Monktonmead*	Daily total (mm) on 27 July 2021	Grid reference
Ryde Vineyard	961m	29.02	459000, 91000

Table 6-4: Rainfall totals in the Monktonmead area on 02 August

Rain gauge	Distance from Monktonmead*	Daily total (mm) on 02 August 2021	Grid reference
Ryde Vineyard	961m	32.49	459000, 91000
HYRAD (Pixel 7)	0	13.70	458500, 91500
HYDRAD (Pixel 8)	0	25.57	459500, 91500
HYRAD (Pixel 12)	0	11.76	458500, 92500
HYRAD (Pixel 13)	0	23.97	459500, 91500

*Distance to the centre of the Monktonmead study area

The same hydrology methods used in Section 6.1.2 were repeated for the subsequent dates. The rain gauge data and the HYRAD data both indicate low return periods for the storm events for both dates.

The storm event that affected Monktonmead on 27 July was likely to be between a 1 in 3 and a 1 in 9 year event (33% - 11% chance of occurrence). The storm event that affected Monktonmead on 02 August was likely to be between a 1 in 4 and a 1 in 7 year event (25% - 14% chance of occurrence).

6.3 Summary

Whilst the storm event that occurred on 25 July can be considered an extreme event, the subsequent storm events that occurred on 27 July and 02 August 2021 were not especially extreme. However, it can be assumed that the previous event (25 July 2021) created waterlogged soils in the area, making the catchment sensitive to later rainfall during the 27 July and 02 August events. The extent of flooding from frequent storm events could also indicate limitations in the capacity of the drainage system in Monktonmead.

Event	Total rainfall (mm)	Estimated storm return period	Annual probability
25 July 2021	64.96	1 in 42 and a 1 in 107 year	1% – 2.5% annual probability
27 July 2021	29.02	1 in 3 and a 1 in 9 year	33% - 11% annual probability
02 August 2021	32.49	1 in 4 and a 1 in 7 year	25% - 14% annual probability

7 Incident response

Several agencies responded to the flooding events in the Monktonmead area, including the Isle of Wight Council, Hampshire Police, Hampshire and Isle of Wight Fire and Rescue Service, the Environment Agency and Island Roads.

The Environment Agency has noted that duty officers followed existing procedures during these events and deployed the demountable defences (drop boards) at Simeon Street Recreation Ground.

Table 7-1: Reports of internal flooding from each event

Event	Reports of internal property flooding*
25 July 2021	22
27 July 2021	2
02 August 2021	8
Total	**32**

* Please note that numbers of properties are indicative and based on survey responses and data collected from risk management authorities

25 July 2021

The Met Office issued weather warnings corresponding with the period of flooding. These warnings were as follows:

- 23 July 2021, 15:00 to 23:59, yellow wind warning with a medium likelihood of low impacts
- 24 July 2021, 20:00 to 22:00, yellow thunderstorm warning with a low likelihood of medium impacts
- 25 July 2021, 09:00 to 23:59, yellow thunderstorm warning with a very low likelihood of medium impacts.

These warnings triggered a response within the Council and the Emergency Management team corresponded with Island Roads to check that the strategic sandbag stocks were full and accessible.

The Environment Agency released an official Flood Alert for the Monktonmead Brook at 18:11 on 25 July 2021, which was disseminated by local news companies. The Flood Alert was upgraded to a Flood Warning at 19:40. Residents were advised to protect their houses and to move cars away from St Johns Station and low-lying areas.

The emergency services were overwhelmed with calls concerning the flooding and physical response was therefore limited. Incident calls were recorded by the Hampshire and Isle of Wight Fire and Rescue Service (HIWFR) between 16:15 and 21:45, to which advice was given, with residents told to protect their houses with the available sandbags and flood boards. In the afternoon, Hampshire Police reported several flooding issues in the area, including an exposed manhole in St Johns Road caused by a lifted manhole cover, as well as internal property flooding on Argyll Street and Ryde High Street, to which they responded by contacting the Fire and Rescue Services. Hampshire and Isle of Wight Fire and Rescue Services evacuated a property due to internal flooding at the High Street in Ryde at 16:34. Sandbags are readily available at the Simeon Street recreational ground in case of flooding events such as this, but Island Roads were asked to replenish the stock at 21:45.

A timeline of the incident response for this event is given in Table 7-2.

27 July 2021

On 27 July 2021 an official Flood Alert was released for the Monktonmead Brook by the Environment Agency at 05:18. Residents were advised that the railway track upstream of St Johns Station, near Monktonmead Brook was expected to flood, so to avoid the area.

This alert did not update to a Flood Warning. On this date there were two recorded calls to HIWFR concerning the flooding at 18:01 and 21:45. There were no other responses recorded.

A timeline of the incident response for this event is given in Table 7-3.

02 August 2021

On 02 August 2021 the Environment Agency issued an official Flood Alert for Monktonmead Brook at 09:48 which was then updated to a Flood Warning at 10:25. Residents were advised to take action to protect properties and to consider moving vehicles from areas near the rivers, the railway line and low lying areas. It is understood that it was during this event that the railway line flooded from the Monktonmead Brook.

The emergency services received calls concerning the flooding between the hours of 07:52 and 15:58.

A timeline of the incident response for this event is given in Table 7-4.

Table 7-2: Timeline of incident response on 25 July 2021

Time	Activity/event	Agency
Afternoon	Manhole lifted on St Johns Road opposite the junction with St Johns Wood road, hole in carriageway. Temporary barriers put in place.	Island Roads
Afternoon	Property flooding, fire services called to Argyll Street	Hampshire Police
16:34	Property flooding, resident evacuated from house on High Street, Ryde	Hampshire and Isle of Wight Fire and Rescue Services
16:37	Property internal flooding reported, High Street, Ryde	Hampshire Police
18:11	Flood Alert issued for Monktonmead Brook	Environment Agency
19:40	Flood Alert updated to Flood Warning for Monktonmead Brook	Environment Agency

Table 7-3: Timeline of incident response on 27 July 2021

Time	Activity/event	Agency
05:18	Flood Alert issued for Monktonmead Brook	Environment Agency

Table 7-4: Timeline of incident response on 2 August 2021

Time	Activity/event	Agency
09:48	Flood Alert Issued for Monktonmead Brook	Environment Agency
10:25	Flood Alert updated to Flood Warning for Monktonmead Brook	Environment Agency

8 Source-pathway-receptor analysis

The Source-Pathway-Receptor model is a concept that can provide an understanding of all aspects of flood hazard. It breaks a flood incident down into three elements:

- Source - the origin of flood water
- Pathway - a route or means by which a receptor can be affected by flooding
- Receptor - something that can be adversely affected by flooding (e.g. people, property, infrastructure)

We analysed the information available to determine the main sources of the flood water, the pathways it took and the main receptors. These are summarised in Figure 8-2, Figure 8-3, Figure 8-4 and Figure 8-5and described in the following sections. Figure 8-1 shows the locations where internal flooding was reported to have occurred in July and August 2021. The flooding in Ryde occurred across the town, rather than at a single location, and included many isolated flood incidents. Based on the survey responses and the data received, we have produced source-pathway-receptor mapping and analysis for the areas with the most significant flood impacts, this includes:

- Great Preston Road;
- Argyll Street;
- Bettesworth Road area;
- Buckland Gardens

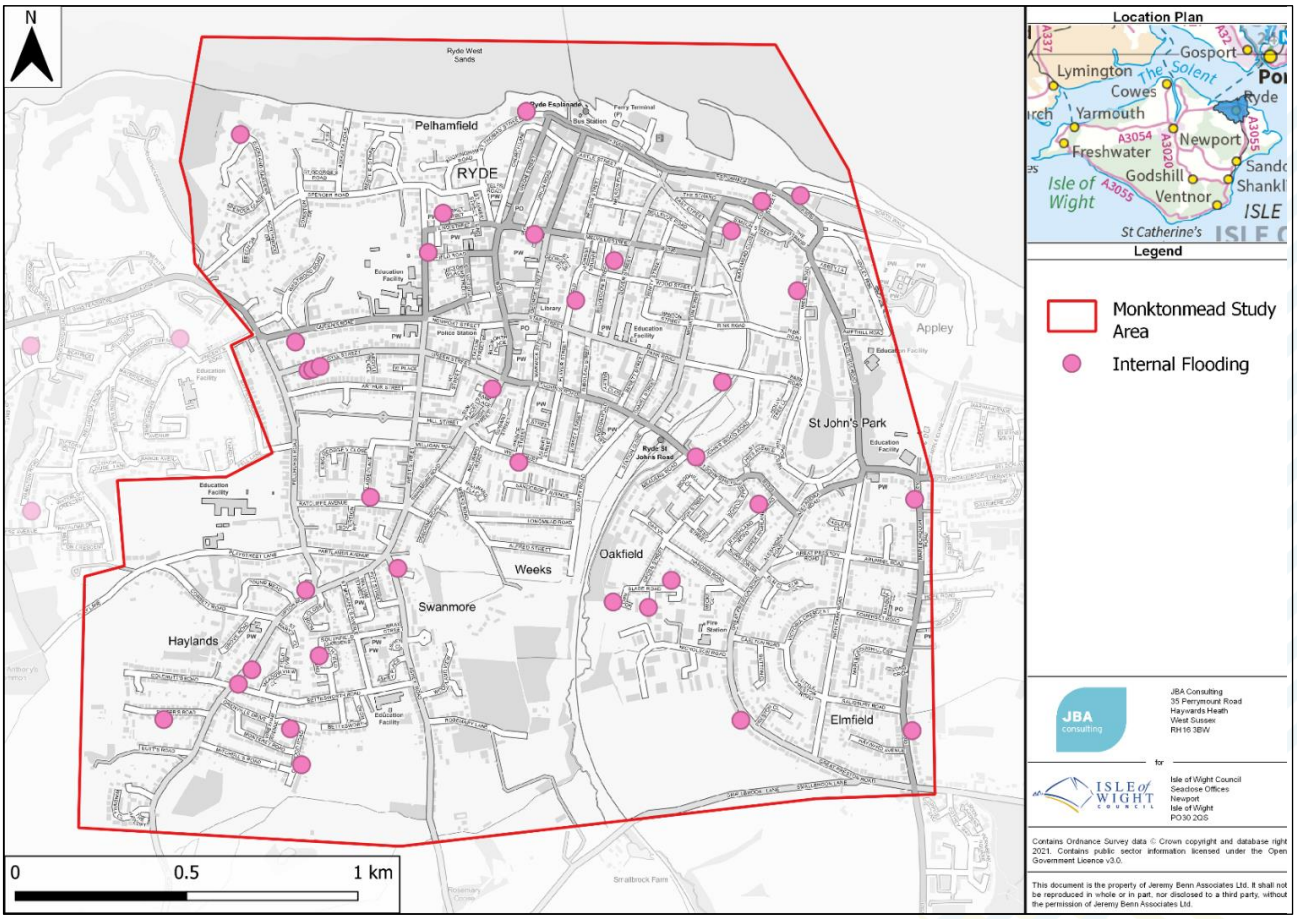


Figure 8-1: Reported incidents of internal flooding in the Monktonmead study area in July and August 2021

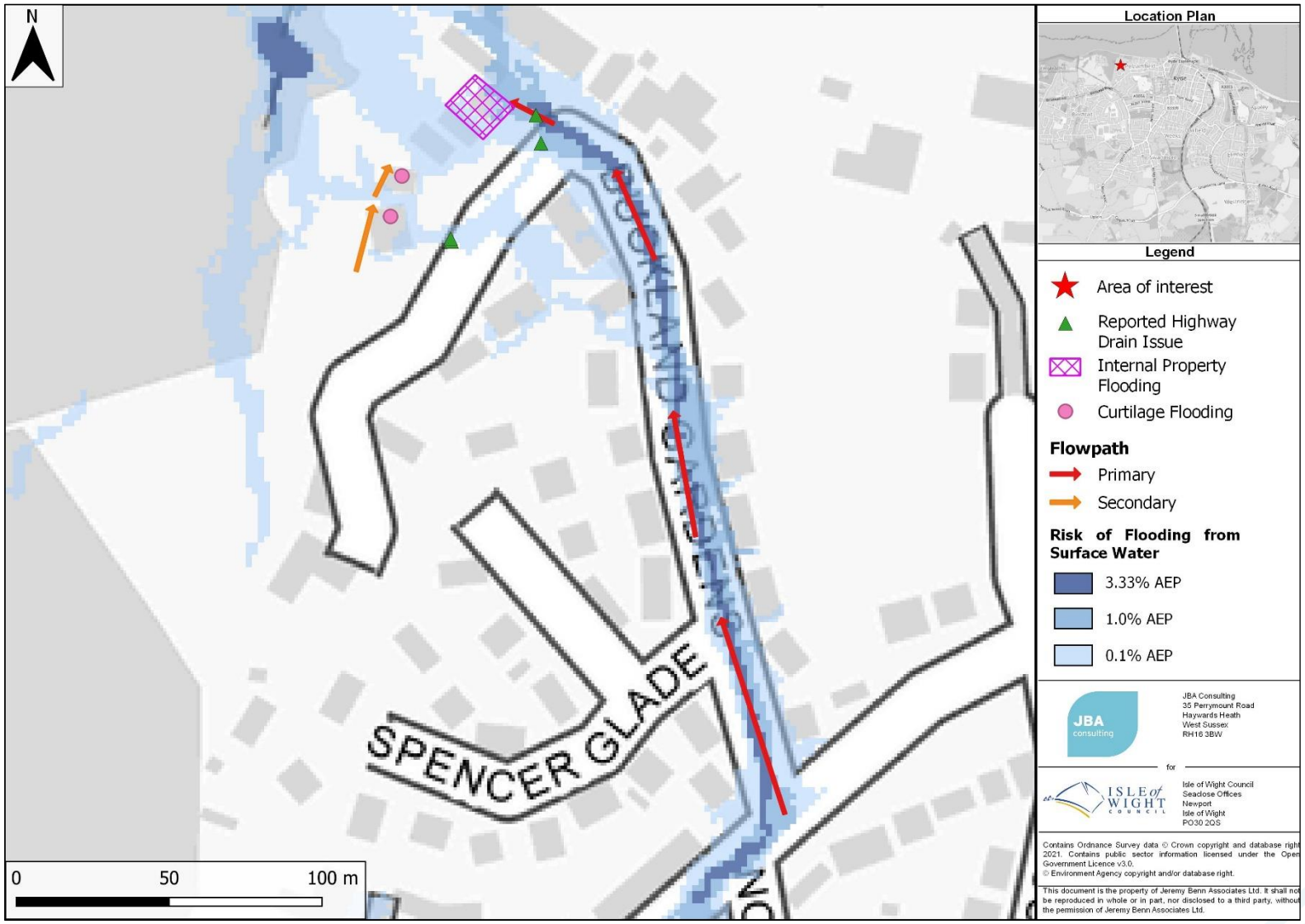


Figure 8-2: The flood water pathway in the Buckland Gardens area

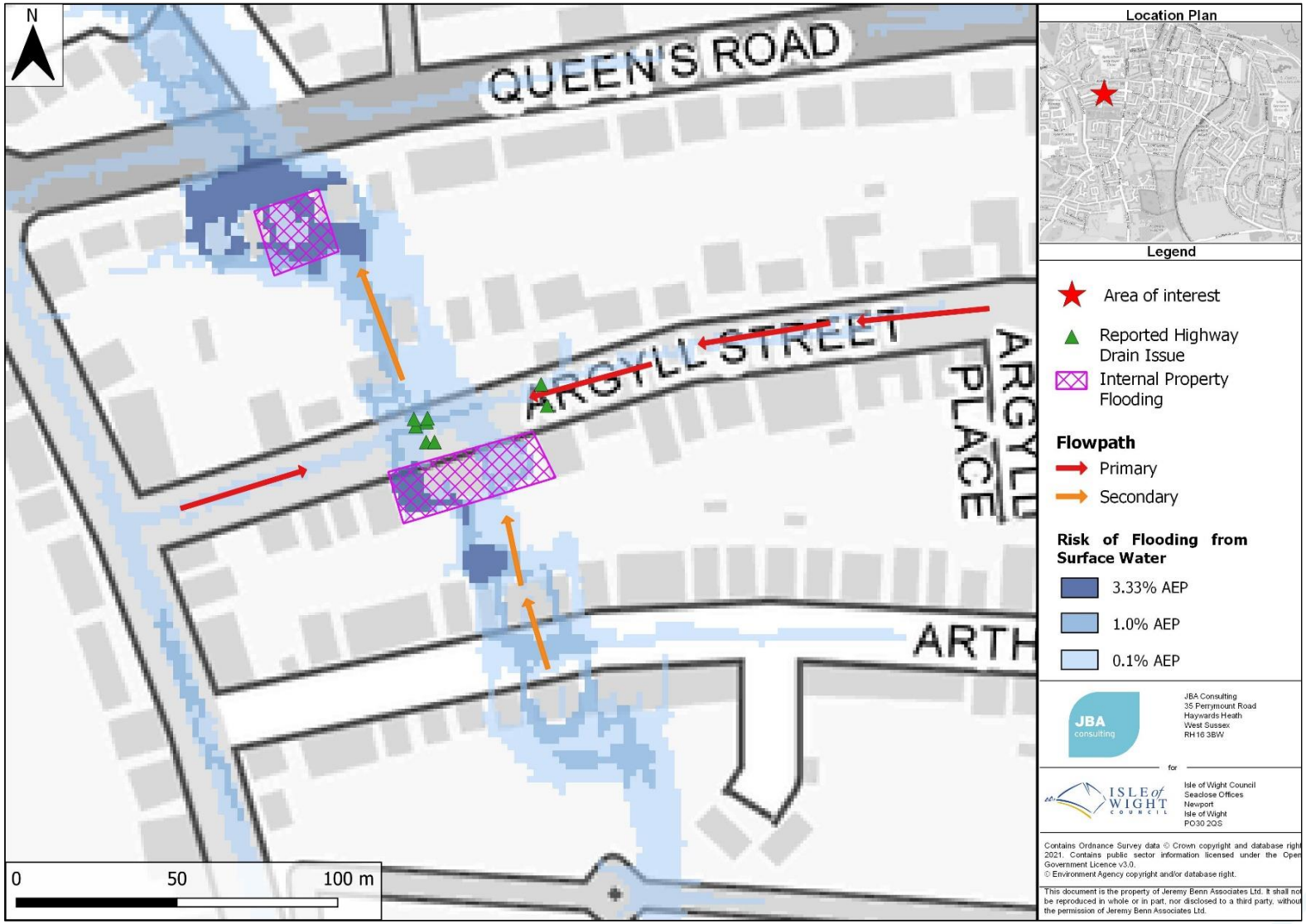


Figure 8-3: The flood water pathway in the Argyll Street area

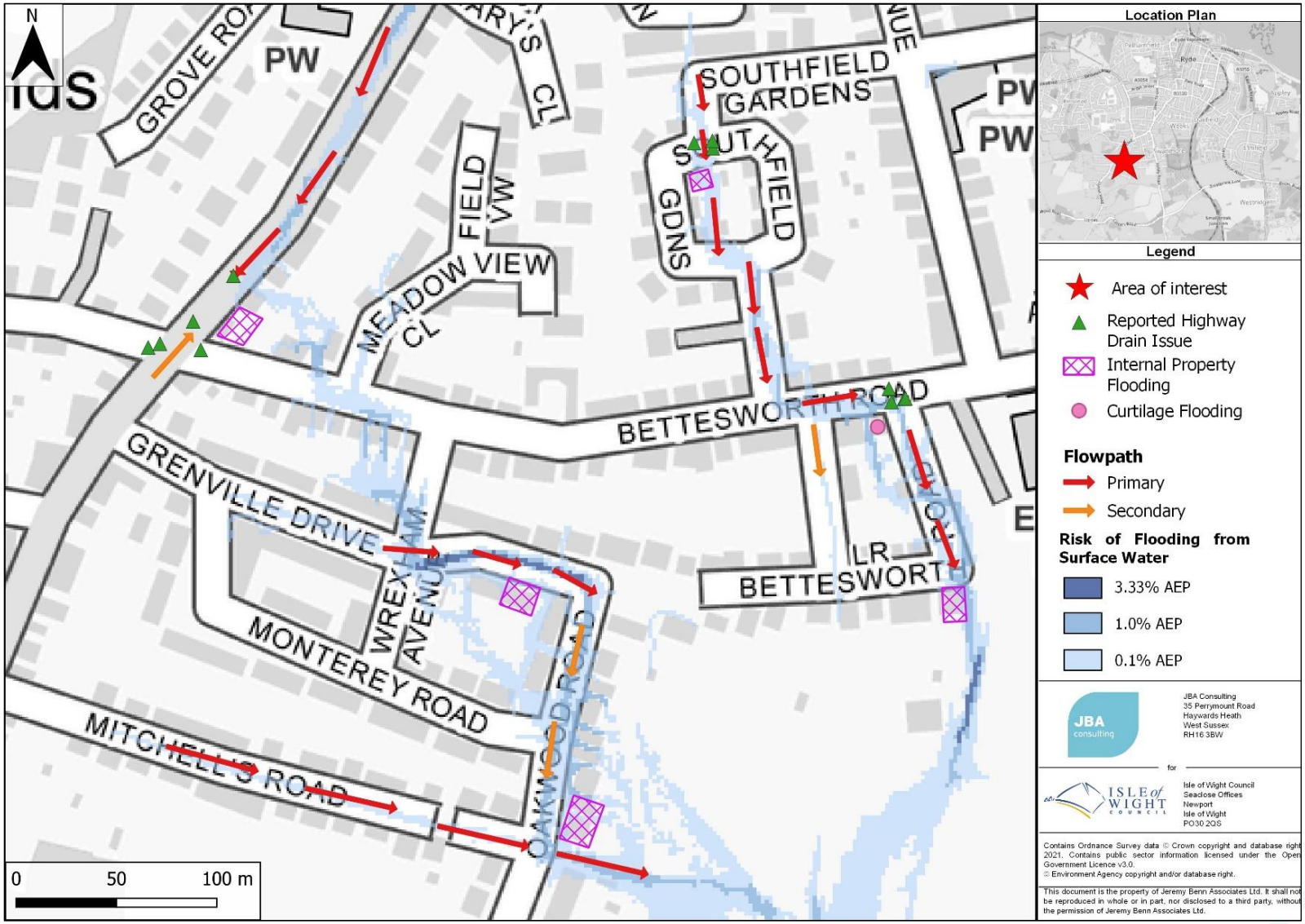


Figure 8-4: The flood water pathway in the southwest of the study area

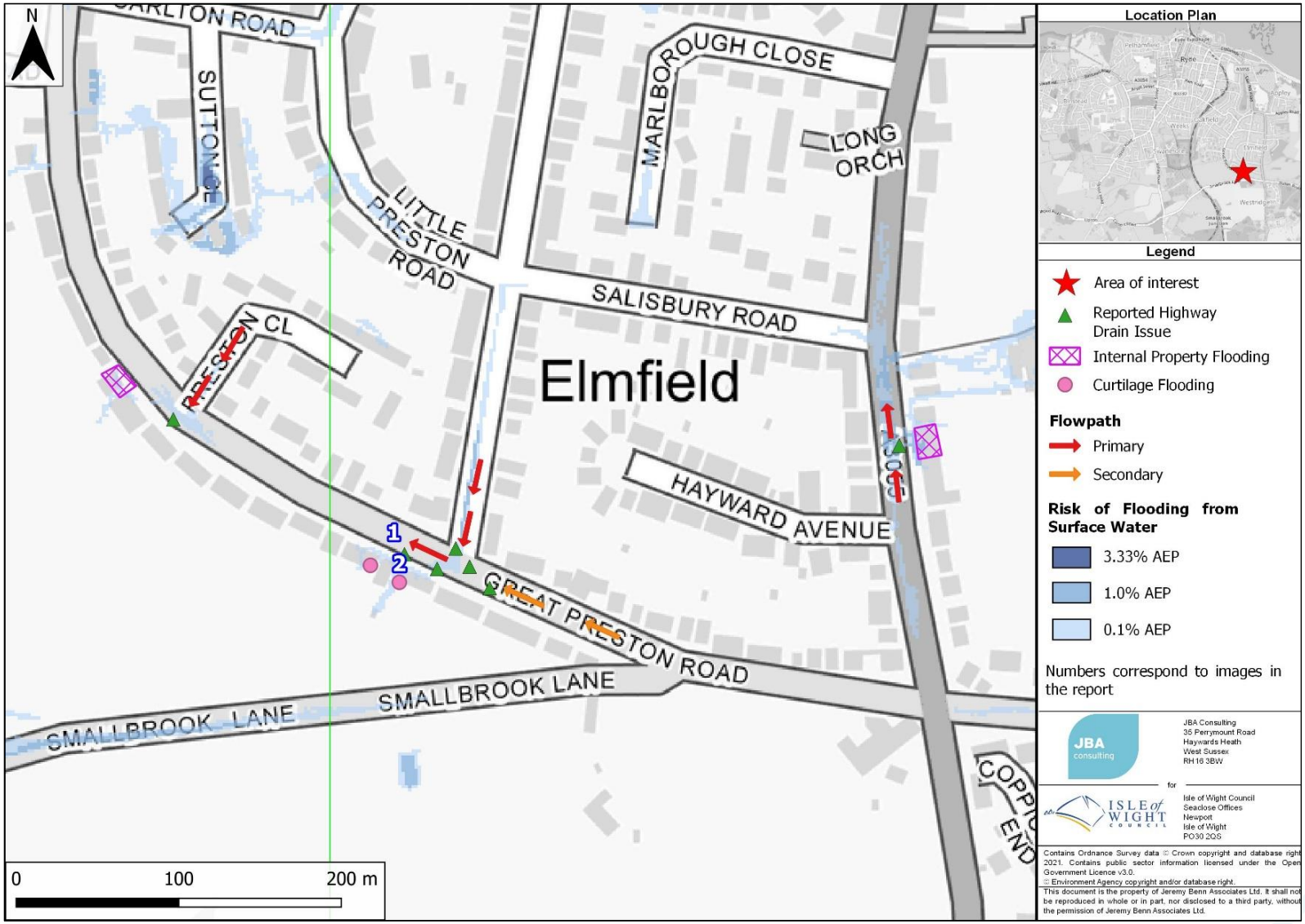


Figure 8-5: The flood water pathway in the Great Preston Road area

8.1 Source

8.1.1 Monktonmead Brook

Monktonmead Brook, which runs through the study area, had active flood warnings on 25 July 2021, 27 July 2021 and 2 August 2021. Responses to the stakeholder engagement survey and photographic evidence identify areas in which the river overtopped its banks, although this understood to have only occurred during the 02 August event. Furthermore, the areas affected by the fluvial flooding were sections of the railway line and railway depot, but no internal property flooding from this source was reported.

8.1.2 Extreme rainfall

The intense rainfall experienced in Ryde during the three rainfall events caused a large volume of water to fall directly onto the ground surface, leading to diffuse sources of flooding. The flooding pathways are detailed in Section 0. Responses to the stakeholder engagement survey reported several problems with highway drainage as a source of flooding for the flooding events on 25 July 2021, 27 July 2021 and 02 August 2021. Issues such as blockages and insufficient drainage were reported to generate water runoff and pooling on the road. The responses have also identified the backing up of foul drains as a source of flooding. Reports note foul water backing up through internal drains as well as external drains, leaving behind toilet paper inside properties and in gardens. The backing up of surface water drains has also been reported causing flooding of gardens as well as limiting the drainage of the surface water from property guttering.

Although all three events are of relevance, the majority of the flooding occurred on the 25 July, with fewer properties reporting flooding on the 27 July and 02 August. As a result, the majority of this analysis relates to events occurring on 25 July 2021.

8.1.3 Combined sewer

Due to the presence of foul sewage identified in the flood water, the sewer system is considered to have been an additional source of flooding. Based on the hydrological analysis from the events, hydraulic overload to this system likely took place as a result of extreme rainfall on 25 July. This would have resulted in foul sewage emerging from the combined sewer manholes and mixing with flood water. However, this should be considered a secondary flood mechanism.

8.2 Pathway

The flooding that occurred in the Monktonmead area was dispersed across the study area, as shown in Figure 8-1. However, to further understand the pathways of flooding, significant flow paths have been focused on and will be discussed in the following section. Figure 8-2, Figure 8-3, Figure 8-4, and Figure 8-5 demonstrate the pathways of the water during the flooding events on 25 July 2021, 27 July 2021 and 02 August 2021. The data suggests that the pathways described in the following section were repeated during subsequent rainfall events in the 2021 summer months.

In the north of the study area, the flooding follows the RoFSW mapped flow path, as shown in Figure 8-2. The surface water flows north along Buckland gardens, down the natural slope towards the coast. This water was reported to have not been intercepted by the available highway drains as they were overwhelmed. Instead, the flood water carried on towards the properties, causing internal flooding. To the west of the main flow pathway, a secondary flow path travels through the gardens of properties in Buckland Gardens.

Along Argyll Street the road acts as a conduit for the flood water, shown in Figure 8-3, with surface water flowing from the east and west towards the main flow path, as shown in the RoFSW map. Responses to the survey suggest the drains on Argyll Street were

overwhelmed by the water, exacerbating the highway flooding. Flood waters on the road then flowed into properties. Water also flows in a northerly direction from Arthur Street to Argyll Street and across to Queens Road, through gardens and properties, along the topographic slope of the area.

Figure 8-4 shows the flood pathways in the southwest of the study area. In the north of this area, the flooding pathway in the Southfield Gardens area reflects the topography of the area and follows the pathway shown in the RoFSW map. The higher elevations found in the north of Southfield Gardens slope in a southern direction towards Bettesworth Road, with the water reported to flow along the roads and through gardens, causing internal flooding. Responses to the survey, customer complaints and recorded issues from Island Roads report of blocked drains at the top of Southfield Gardens, on Bettesworth Road and on Lower Bettesworth Road. In the west of the area, flooding was recorded along Upton Road, along which flood water flows in a southern direction towards Grenville Drive, along the topographic slope of the area. The RoFSW map shows a small pathway for this area, but not as large as the responses to the survey suggest, possibly due to highways drainage and sewer not being accounted for within the mapping which were exceeded and therefore contributed to the flooding. Further, there were reports of a gully being removed following the resurfacing of Upton Road which could have also contributed.

The pathway to the south shows that Grenville Drive and Mitchells Road acted as conduits for the flood water, as water flows down both roads along the topographic slope. This pathway reflects the RoFSW mapping, with Grenville Drive being predicted to flood during rainfall events with greater than a 3.3% annual chance. Gully issues were recorded on Oakwood Road.

There are a series of surface water pathways occurring on Great Preston Road, shown in Figure 8-5. In the west, there is a small pathway along which water flows down Preston Close in a southern direction onto Great Preston Road. The highways flooding is considered to be exacerbated by blocked drains on Great Preston Road, which have been reported as being tarmacked over. Flood water on the road then flows into properties along the topographic slope, as seen in the photographs in Figure 8-6 and Figure 8-7. In the south of the area, surface water flows in a western direction on Great Preston Road. Flood water flows along the secondary pathway down High Park Road, joining the main pathway where the highways drains were overwhelmed, and the flood water travelled over dropped kerbs into properties. To the east, on Marlborough Road, flood waters from the road were reported to flow into driveways and properties. This area has a history of reported drainage issues and during the events of summer 2021, drains were reported to back up inside properties and on driveways.

Figure 8-6: Photograph showing highway flooding on Great Preston Road

Figure 8-7: Photograph of water flowing along the side of a property on Great Preston Road

8.3 Receptor

8.3.1 People

Flooding in this area has had detrimental effects on the residents and their wellbeing. Such impacts have been described by the residents in the stakeholder engagement survey responses. Residents have experienced physical health issues, including back pain and fatigue caused by moving sandbags and belongings, emptying water from their properties and from the intense cleaning that was required after the flood subsided.

The responses also describe the impact on the residents' mental health that has occurred due to the flooding. Residents are stressed about future flooding events, with many explaining the increase in anxiety, with paranoia related to rain, as well as depression and loss of sleep.

A major impact of the flooding has been the disruption to normal lives. Residents have had to move out of their homes into alternative accommodation on either a temporary or permanent basis, with some residents reporting having to leave for six months. People have experienced damage to flooring, furniture and belongings. This has meant some are now living with the damp or having to use dehumidifiers. Reports of foul sewage in flood water were also noted that presented an additional health hazard.

Financial issues have also been raised, with many residents reporting the high cost of repairs and issues with insurance. Residents have identified that they are either no longer able to get insurance for their property or the cost of such has been increased to an unattainable price. Residents have also reported a struggle to sell their properties, with reports of properties being undervalued.

8.3.2 Property

Internal flooding to 31 residential properties and one non-residential property was recorded for the flood events between 25 July 2021 and 02 August 2021. It is suspected that additional properties flooded during this period, although it is not possible to confirm this. Responses to the survey and information provided by the emergency services imply that the flooding durations were as follows:

- 25 July 2021 - between 30 minutes and 2 hours
- 27 July 2021 - unknown
- 02 August 2021 - between 45 minutes and 1 hour

Flood depths of between 25mm and 450mm were recorded inside properties.

Damage to flooring and furniture in ground floor rooms of properties has been recorded, and in some cases the repairs were ongoing at the time this report was written. This was particularly notable in properties which have suspended timber floors, where damp problems were reported after the flooding.

Further properties were affected by external flooding. Impacts to gardens, garages and driveways have been recorded. External flood depths were reported to be between 100 mm and 1m.

8.3.3 Infrastructure

St Johns railway station was significantly impacted by flooding during the events. Newspapers and responses to the survey reported flooding of a stretch of railway by the station during the event on 02 August. Figure 8-8 shows two photographs of the flooding. The damage caused further delays to the upgrade of the Island Line.

The Island Line reported flood waters reaching approximately 450mm in depth at St Johns Station, where it affected the railway station, the track and flooded the depot. The flooding

resulted in newly laid ballast had been washed away from underneath railway sleepers. Electrical, signalling and points equipment had also been damaged by the water.

The flooding event caused damage and disruption to roads, meaning residents could not travel, as the roads became unpassable. Manhole covers were reported to have lifted on St John's Hill and Southfield Gardens, leaving exposed manhole chambers in the road. This posed a significant health and safety risk to passing traffic and pedestrians.

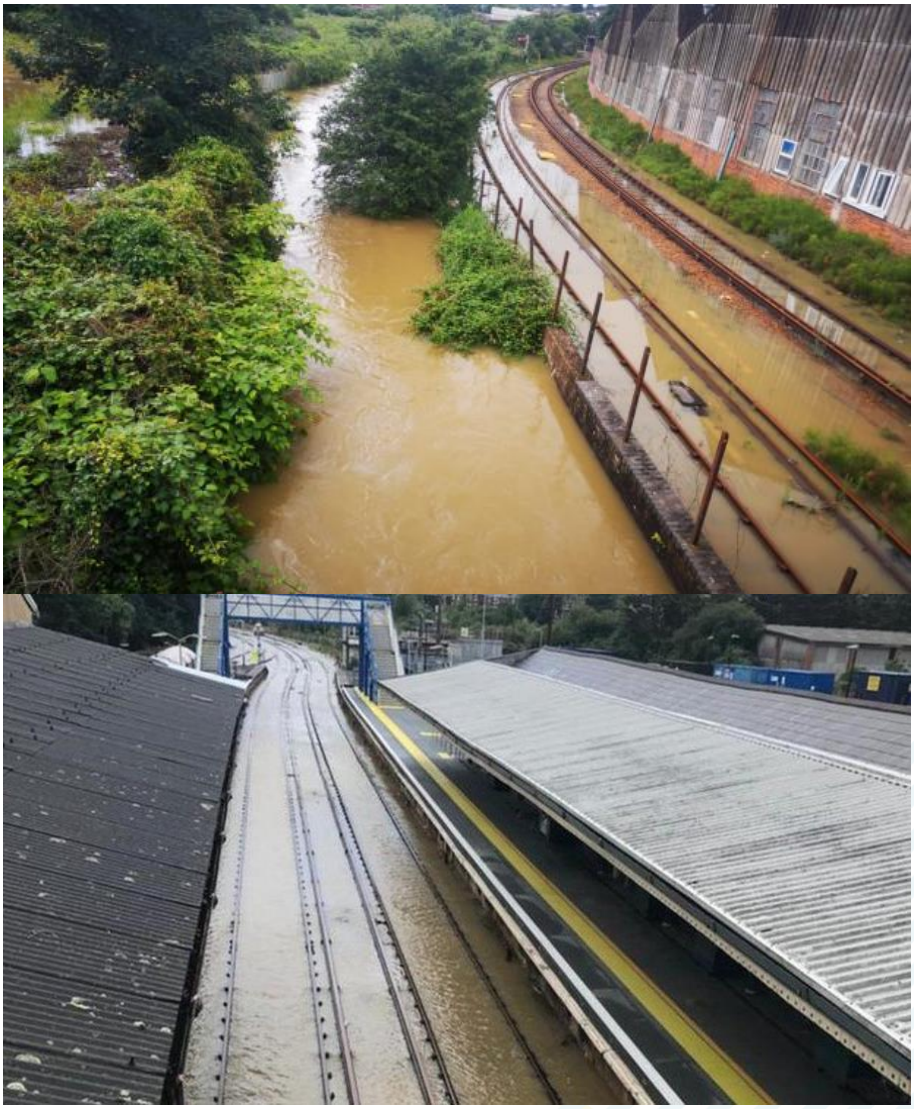


Figure 8-8: Photographs of the flooding at St Johns Station, Ryde[9]

8.3.4 Services

The flooding led to the closure of local businesses, including the Bus Museum and the Captain's Table public house, both of which flooded internally. This led to disruption to public amenities and impacted local businesses at a time when they were vulnerable to the economic impacts resulting from the COVID-19 pandemic.

9 https://www.bbc.co.uk/news/uk-england-hampshire-58097095

https://www.countypress.co.uk/news/19493502.covid-software-now-flooding-blamed-island-line-return-delay/

9 Capacity Review

Southern Water's sewer records were reviewed to understand whether a lack of capacity in the surface water sewer system could have contributed to the flooding.

9.1 Review of sewer network

A review of Southern Water's sewer network indicates that most of the sewer system in the Monktonmead area is combined. In some areas there are separate surface water and foul sewer systems, however this is limited in its extent. Furthermore, some of these separate systems ultimately discharge to the combined sewer system.

9.2 Review of capacity

Information from Southern Water indicates that there have been reports of previous issues with surface water drainage in the Monktonmead area, which includes 39 reported issues between 2015-2020 in the PO33 1, PO33 2, and PO33 3 postcodes, however further details regarding the nature of these issues were not available. A list of roads in the area with historic capacity issues has also been provided. This includes the following roads that were reported to experience flooding during the July and August 2021 flooding events:

- The Strand (Oct 2010, Oct 2013, Dec 2013, Jan 2015, Jan 2016, July 2021, Oct 2021)
- Esplanade (July 2021, Aug 2021)
- West Hill Road (Nov 2011, Feb 2014, Aug 2015, June 2016, Aug 2019, July 2021)
- Lower Bettesworth (Oct 2005)
- Marlborough Road (Aug 2005, Nov 2013, Jan 2015, July 2021)
- Great Preston Road (May 2000, Nov 2009, Nov 2010, Aug 2013, Oct 2013, June 2014, Aug 2014, Nov 2014, Jan 2015, Aug 2021)
- Cross Street (Aug 2019, Aug 2021)

Table 9-1: The recorded capacity issues from Southern Water in the Monktonmead Study area between 25 July 2021 and 7 August 2021

Street	25 July	26 July	27 July	28 July	02 Aug	07 Aug
The Strand	Y		Y			
Northwood Drive		Y				
George Street		Y				
West Hill Road		Y				
Oakwood Road		Y				
Esplanade			Y	Y	Y	
Rosemary Lane			Y			
Bettesworth Road				Y		
Marlborough Road				Y		
Great Preston Road					Y	
Cross Street					Y	
Gwydyr Close						Y

The capacity issues that were noted to occur on dates close to the flooding events of 25 July 2021, 27 July 2021 and 2 August 2021 are shown in Table 9-1.

The **Design and Construction Guidance**[10] for foul and surface water sewers has been reviewed to determine typical sewer design standards. This indicates that modern surface water sewer systems are designed to convey flows from 1 in 30 year events without flooding. It should be noted that these are present day design standards and older surface water sewer systems are unlikely to have been designed to meet these design standards. As a result, the older sewers would be less able to cope with significant flows in comparison to more recently designed sewers. However, the Southern Water capacity improvement scheme (completed in 2015) provided additional capacity in surface water sewer networks on The Strand and Simeon Street to accommodate rainfall up to and including a 1 in 30 year event. The design capacity of public sewers other than in these areas was not made available for the Section 19.

9.3 Conclusion

As outlined in Section 6, the rainfall event on 25 July 2021 had a rarity between a 1 in 42 and a 1 in 107 year event (1% - 2.5% chance of occurrence), which can be considered as an extreme rainfall event. Whilst Southern Water has reported capacity issues around this event, this is unsurprising considering the volume of rainfall that fell in the Monktonmead area, which is estimated to be above the design standard of the sewer system. However, the rainfall event on 27 July 2021 was estimated to be between a 1 in 3 and 1 in 9 year event (33% – 11% chance of occurrence) and the rainfall event on 02 August 2021 was estimated to be between a 1 in 4 and 1 in 7 year event (25% – 14% chance of occurrence). These are not considered to be extreme rainfall events, therefore it is possible that the capacity issues recorded on and around these dates could have contributed or exacerbated to the surface water flooding that occurred. This would need to be confirmed through further investigatory work.

10 Design and Construction Guidance (Appendix C): https://www.water.org.uk/wp-content/uploads/2020/03/SSG-App-C-Des-Con-Guide-v-2-100320-C.pdf

10 Discussion, appraisal and recommendations

10.1 Introduction

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included: consideration of relative costs and timescales; buildability; health safety and environment; stakeholder perceptions and public acceptability; land ownership etc. This included consideration of:

- Contribution towards reducing flood risk to property
- Contribution towards reducing flood impacts on people/communities
- Contribution to improving the availability of data, evidence and modelling to support option development or flood incident response
- Deliverability (including construction complexity, access, designations, services, space, land ownership, available materials and expert equipment or advice required)
- Community / resident acceptability
- Contribution towards biodiversity and water quality betterment
- Contribution towards amenity benefits
- Contribution to carbon reduction
- Maintenance requirements

Relative costs and timescales have been provided for information only and are not included in the scoring. The scoring criteria and full results are described in more detail in Appendix A. Options with a score of 7 or above were taken forward to become recommendations.

It is important to note that this is a high-level, preliminary assessment undertaken by and on behalf of Isle of Wight Council. Therefore, it is for the relevant responsible body or persons to assess these recommendations in terms of their legal obligation, resource implications, priority, as well as the costs and benefits of undertaking such options.

In particular, where taking forward a recommendation is likely to be reliant on securing grants from central government to fund the project[11], significant further work by the responsible organisation will be required to assess the costs/benefit of the proposals, and consideration will need to be given to the timing and availability of funding. This is likely to be the case for the recommendations within this section. For such projects to be taken forward to design and construction, a business case may need to be made into a national programme, with the success of the bids dependent on the following:

- Any works are cost beneficial and financially viable
- The works will provide a sufficient level of benefit for the residents at flood risk
- Any project has considered all sources of flood risk
- The project does not increase flood risk to others (people, property, business)
- The works do not cause environmental harm
- Any proposals are accepted by the community and residents

Based on the identified causes and mechanisms of flooding, we have considered the following options.

11 For further information regarding funding of flood risk management, please see: https://www.local.gov.uk/topics/severe-weather/flooding/paying-flood-and-coastal-erosion-risk/funding-arrangements

10.2 Appraise the feasibility of providing additional combined sewer capacity

It is unlikely that the existing combined sewer has the capacity to manage flows from highways drainage, in addition to surface water runoff and foul flows from development. The existing combined sewer could be upgraded to increase its capacity, as was completed for The Strand and Simeon Street in 2015. The fact that surface water flooding was reported during the 27 July and 02 August events further highlights this, as these were relatively low return period (frequent) rainfall events that the public sewer network would be expected to accommodate.

It is recommended that the capacity of the existing public sewer network is investigated by Southern Water, in partnership with the Isle of Wight Council, to understand the location and nature of these capacity restrictions. An appraisal into the feasibility of upgrading the public sewer system or removing surface water from the combined sewer system should also be undertaken.

10.2.1 Upgrade existing surface water sewer capacity

In some areas where internal flooding has been reported there are separate surface water sewers (Buckland Gardens, Grenville Drive, Monterey Road and Mitchells Road). This system has a direct outfall into a tributary of Monktonmead Brook. In other areas, the surface water sewers connect directly into the combined system, which increases the volume of water discharging to the combined sewer system that has been reported to be over capacity.

The extension of the surface water system and the addition of highway drainage could decrease the probability of highways flooding, whilst also reducing the volume of water reaching the combined sewer system. The extension could be considered for Upton Road, Southfield Gardens and Buckland Gardens.

There would be a number of constraints to this approach, including significant and lengthy disruption to the roads, and the re-routing of the various services which cross the sewer. Much of the system runs through private gardens and gaining access to this third party land would need to be a consideration. A full survey of below ground services would also be required and the presence of services would influence the cost. Upgrading the surface water sewer network would also have water quality benefits as it would reduce the frequency of foul flooding from the combined sewer system.

10.2.2 Disconnecting roof water drainage

Disconnecting existing rainwater downpipes and redirecting surface water runoff into rain gardens, above ground water butts or underground rainwater harvesting tanks, could relieve pressure on the existing sewer system and provide sustainability benefits as a result of water re-use.

Rainwater can be reused for non-potable purposes such as gardening, toilet flushing and car washing with water butts, which can significantly vary in size. They can be provided in a variety of shapes and incorporated into a variety of settings. Rainwater harvesting tanks are typically larger and stored underground with a pumped supply for water re-use. As their capacity is dependent on the re-use of water, both systems should be designed with an overflow to discharge excess water through infiltration or discharge to a downstream drainage component.

It should be noted that Southern Water has a storm overflow task force and 'pathfinder project' that is looking at ways to separate surface water flows from the foul sewer system. Southern Water is engaging with Risk Management Authorities including Isle of Wight Council to do this.

10.3 Improved asset maintenance regimes

One of the contributing factors to the flooding that occurred may have been limited surface water drainage capacity, as flooding was reported during rainfall events of low rarity. Gullies can become blocked from debris washing or falling into them, which thus reduces their drainage capacity. Therefore, blockages can worsen due to weather conditions, time of year, poor usage and damage. Responses to the stakeholder engagement survey and correspondence with stakeholders has highlighted specific areas where gully blockages and impeded drainage issues have been witnessed. In some cases, the removal or coverage of gullies has been reported. A recommendation for inspecting the reported issues, increased gully maintenance and clearance in priority areas could help to reduce surface water flood risk to properties, by increasing the rate and the volume of water conveyed into the highway drainage and sewer systems. Areas of interest for further consideration are:

- Upton Road – resurfacing of road has reportedly removed drains
- Southfield Gardens – where rubbish was reported in the gullies
- St Johns Hill – property drainage reported to be restricted by new pavement

10.4 Property Flood Resilience

Responses to the stakeholder engagement survey indicate that properties in the Monktonmead area flooded internally to depths of between 25 and 450mm and that this was occurring rapidly. It has also been ascertained that many of these properties have previously flooded as a result of surface water runoff. Property Flood Resilience (PFR) can provide effective products and measures, at an individual property level, such as flood doors, flood barriers, automatic airbricks and non-return valves. These measures can help to reduce the impact of future floods, by either aiming to limit water entry (resistance) or by adapting the internal fabric of the property to limit damage (resilience).

Although resistance measures are not able to entirely prevent flood water ingress, they aim to limit damage and ensure that properties are adapted to cope with the impacts of floods and recover quickly from these disruptive events. Resistance measures are generally significantly lower in cost than resilient adaptation works to the property fabric itself, whereby flood water entering a property would lead to minor or no damage. While constraints of both approaches include funding, homeowner willingness and individual property structural risks, the lower cost and less invasive resistance measures will often meet business case cost/benefit approval for Government funding support for community schemes in areas where flood risk is high.

10.5 Community flood preparedness

It is understood that Ryde has a formal Flood Action Group. Formalising and expanding the group could allow the community to undertake solutions such as setting up early warning systems and assisting the community with flooding before, during and after an event. Flood Action Groups can also produce community flood plans and help reduce the impact of any potential flooding on their communities.

It is recommended that a community flood action plan be developed to inform residents how to prepare for, respond to and recover from flooding. It is understood that the sandbags provided for flood protection, normally stored at the Simeon Street recreational ground, were used by residents. However, some were unaware of them or could not collect the sandbags themselves. Emergency flood packs may also be created to use during a flood and once established, the group could apply for community group funding to purchase communal flood protections measures (such as sandbags, inflatable barriers etc). These can be deployed to areas at risk during an event, as well as to vulnerable residents who have difficulty collecting and carrying protection measures such as sandbags and flood boards.

10.6 Appraise the feasibility of providing upstream flood attenuation

Incorporating flood storage upstream of the affected properties could slow down surface water flows and reduce the impacts of flooding in the Monktonmead area. This could include the use of Sustainable Drainage Systems (SuDS) such as rain gardens, basins, permeable surfaces, or underground storage tanks to intercept and temporarily store flows during extreme events, reducing the impact of these events on existing drainage systems.

A scheme utilising flood storage could be taken forward and assessed in terms of feasibility and could be considered with regard to a single location or multiple storage features. This is likely to be a more expensive option due to construction costs and the need to undertake surveys.

This option would potentially be difficult to implement in Ryde due to the lack of available open spaces, highly urbanised catchment and steep topography. Furthermore, as the flooding occurred in numerous locations, it is difficult to identify locations where flood attenuation could provide benefits to a large number of properties.

10.6.1 SuDS measures in the East Hill Road and West Hill Road areas

This option was identified and modelled in the Ryde SWMP (Option 2). The measure identified was the replacement of the impermeable road and pavements with permeable surfaces. However, the SWMP modelling identified limited benefits for this option, and discussions with the SWMP partners confirmed that the local geology would further limit the performance of the SuDS measures and it was therefore discounted. Therefore, other locations would need to be considered.

10.7 Alterations to kerb levels

From the responses to the stakeholder engagement survey and the site visits, a number of dropped kerbs have been noted as exacerbating property flooding. As many property thresholds in the Monktonmead area are at or below ground level, these kerbs provide a preferential flow route for flood water. This has been specifically reported along Ashey Road, Great Preston Road and in Gwydyr Close. Raising these dropped kerbs and raising the remaining kerb heights where possible could allow water to be retained within the highway and encourage flood waters to be directed towards highways drainage instead of property, reducing the risk of flooding during less extreme events.

The Ryde SWMP considered the option of installing kerbs and speedbumps along West Hill Road, to divert the flow down Rink Road and Park Road. The modelling results showed an increase in flood damages to property and was therefore discounted. However, this option was considered within the SWMP with the aim to reduce pooling at the bottom of West Hill Road. Further investigation would be required to consider other locations on a smaller scale, with the aim of protecting properties and diverting flood water towards the drainage network.

10.8 Understand the impacts of the Simeon Street recreation ground flood wall on surface water flood risk

The responses to the stakeholder engagement survey and correspondence with stakeholders has highlighted issues affecting property gardens on West Hill Road. These properties are adjacent to the Simeon Street recreational ground which has a flood wall around its perimeter. It has been reported that this wall has impeded the natural water flow route into the recreational ground, which led to pooling of flood water outside the recreation ground during high rainfall events.

The flood defences in the Simeon Street recreation ground are designed to alleviate fluvial/ tidal flood risk from the Monktonmead Brook and it is unknown whether the impacts of this wall on surface water flood risk would have been fully assessed. It is recommended that Isle of Wight Council works in partnership with the Environment Agency to understand

whether the flood wall could be disrupting existing surface water flow paths. If this has not been sufficiently assessed, it is recommended that surface water modelling of this area is undertaken to further understand this and consider potential solutions to alleviate the diverted surface water flow paths.

11 Conclusion and recommendations

11.1 Conclusions

The flooding that occurred in the Monktonmead area on 25 July 2021, 27 July 2021 and 02 August 2021 caused internal flooding to at least 32 properties and it is suspected that more properties flooded during the event, although it is not possible to confirm this. Isle of Wight Council, as the Lead Local Flood Authority for Ryde, has exercised their power to undertake a Section 19 investigation as this fulfilled its criteria of 'significant flooding'. The council has appointed JBA Consulting to undertake this investigation on its behalf.

Analysis of rain gauge and rainfall radar data from the storm event that affected the Monktonmead area on 25 July, indicates that this was likely to be between a 1 in 42 and a 1 in 107 year event. This can be expressed as a storm event with approximately a 1% - 2.5% probability of occurrence per year. Therefore, the storm event was an extreme rainfall event, with a large volume of rainfall occurring in a relatively short amount of time. The 27 July event was estimated to be between a 1 in 3 and 1 in 9 year event (33% - 11% chance), and the 2 August event was estimated to be between a 1 in 4 and a 1 in 7 year event (25% - 14% chance). These are not extreme events, so it can be assumed that antecedent conditions such as saturated ground from previous events, drainage capacity restrictions and tidal levels may have contributed to the flooding that occurred.

Responses from residents and data from the rain gauge indicate that the storm events occurred as follows:

- 25 July – 15:00 to 17:00
- 27 July – 01:00 to 03:00
- 02 August – 06:00 to 08:00

The reported cases of flooding were dispersed across the Monktonmead area, the pathways of which were inferred to be repeated with each rainfall event. The specific pathways are detailed in Section 8. Responses to the stakeholder engagement survey identified several problems with drainage as a course of flooding, with issues such as blockages and insufficient capacity generating surface water runoff and pooling. The presence of foul sewage in the flood waters indicates the combined sewer system was also a secondary source of flooding. Monktonmead Brook was also recorded to have overtopped its banks. This did not cause any internal property flooding but did cause damage to part of the railway line.

There were various flood pathways recorded in the Monktonmead area. Roads, dropped kerbs, driveways and gardens acted as conduits for the flood water. Main pathways were indicated to have occurred along Buckland Gardens, across Argyll Street, down Upton Road to Grenville Drive and Oakwood Road, and along Great Preston Road and Marlborough Road.

The emergency services were overwhelmed with calls concerning the flooding and therefore their physical response was limited. On 25 July 2021 incident calls were recorded between 16:15 and 21:45 to which advice was given, and residents were told to protect their houses with the available sandbags and flood boards. Hampshire Police reported several flooding issues in the area, including an exposed manhole in St Johns Road caused by the manhole cover lifting, and internal property flooding on Argyll Street and Ryde High Street to which they responded by contacting the Fire and Rescue services. Hampshire and Isle of Wight Fire and Rescue Services evacuated a property due to internal flooding on the High Street in Ryde at 16:34. The incident responses during subsequent events were not provided.

The responses from the stakeholder engagement survey describe the stress and impact on mental health that has occurred due to flooding. Residents are stressed about future flooding events, resulting in anxiety, depression and loss of sleep. Residents have kept

sandbags and flood boards outside their homes in response to the flooding, as seen during the site visit on 21 October 2021.

A major impact of the flooding has been the disruption to normal lives experienced by the residents. Residents have had to move out of their homes into alternative accommodation, either on a temporary or permanent basis. This includes vulnerable residents who cannot stay in their homes whilst repairs are being carried out. People have lost carpets, floorboards, furniture, and belongings from the ground floor of their properties.

A review of Southern Water's sewer network indicates that the majority of sewer systems in the Monktonmead area are combined. The highway drainage system also appears to discharge to the combined system in some areas. Capacity issues have been noted by Southern Water in areas of flooding during and following the flooding events of July and August 2021. However, as the rainfall event on 25 July 2021 was estimated to be an extreme event (between a 1 in 42 to a 1 in 107 year event), the combined sewer system would not have been able to accommodate this event, as modern sewers are typically designed to a 1 in 30 year design standard. It should be noted that these are present day design standards and older surface water sewer systems would not have been designed to meet these design standards. However, the sewer system in The Strand and Simeon Street were part of an upgrade in 2015 and are confirmed to be designed to a 1 in 30 year standard.

11.2 Recommendations

We undertook a high-level option appraisal focussing on benefit, practical and viability considerations. We carried out a multi-criteria analysis to compare each option which included consideration of relative costs and timescales, buildability, health safety and environment, stakeholder perceptions and public acceptability, land ownership etc. This was used to develop recommendations to mitigate flood risk in the Monktonmead area.

The conclusions on which recommendation to consider taking forward are presented below, based on the results of the multi-criteria analysis. Options with a score of less than 7 have been discounted and the full list of assumptions and criteria used in this assessment are provided in Appendix A.

The long list options which scored the highest were developing a Property Flood Resilience scheme and wider community flood resilience. Understanding the impacts of the Simeon Street recreation ground flood walls on surface water flood risk also scored highly.

Table 11-1: Recommendations from the Monktonmead Section 19 investigation

Recommendation	Organisation(s) responsible	Multi-criteria analysis score	Timescale
Property Flood Resilience (PFR) Scheme	Isle of Wight Council	7	1 – 5 years
Community flood resilience	Isle of Wight Council /. Flood Action Groups	7	< 1 year
Understand the impacts of the Simeon Street recreation ground flood wall on surface water flood risk	Environment Agency Isle of Wight Council	8	<1 year
Disconnecting roof water drainage	Isle of Wight Council	3	1 – 5 years
Upgrading sewer capacity	Southern Water / Island Roads	6	Long term strategic aim
Improving asset maintenance	Island Roads / Southern Water/ Isle of Wight Council	6	<1 year
Alterations to kerb levels	Isle of Wight Council / Island Roads	6	<1 year
SuDS measures in the East Hill Road and West Hill Road areas	Isle of Wight Council/ Island Roads	4	1 – 5 years

Appendices

A Multi-criteria analysis methodology

As part of the Monktonmead Section 19 flood investigation, a quantitative assessment was carried out on the long list options, to compare their relative benefits and limitations. The scoring was informed by site conditions, site visit observations and discussions within stakeholders.

The scores were totalled, with:

- A negative score meaning the option has high constraints or meets fewer objectives.
- A score of 0 meaning the option had a neutral impact
- A positive score meaning benefits outweigh constraints and the intervention meets more objectives. The larger the positive score, the more beneficial the scheme.

Table 11-2: Criteria used to assess long list options

Multi-criteria analysis category	Assessment criteria
Contribute towards reducing flood risk to property	Increase in flood risk to any property
	No perceived change
	Reduction in flood risk to property
Contribute toward reducing flood impacts on people/communities	Major / minor negative change in flood impacts on people/communities
	No perceived change
	Minor / medium / major positive change in flood impacts on people/communities
Contribute to improving the availability of data, evidence and modelling to support option development or flood incident response	Does not improve the availability of data, evidence and modelling
	Will provide additional data, evidence or modelling, helpful in development of interventions
	Improvement to data, evidence and modelling which is essential to the development of a capital scheme
Deliverability	Deliverability is at high risk of complexity/constraints
	Not known/not applicable
	Deliverability is at low risk of complexity/constraints
Community / resident acceptability	Community/residents are likely to have objections

Multi-criteria analysis category	Assessment criteria
	No known objections / constraints
	Community/residents are likely to be receptive and have no constraints
Contribute towards biodiversity and water quality betterment	Significant detriment
	No perceived change
	Significant betterment
Contribute towards amenity benefits	Significant detriment
	No perceived change
	Significant betterment
Contribute to carbon reduction	Significant net carbon increase
	Not known/no effect
	Significant net carbon reduction
Maintenance	High cost/frequency maintenance, requires new and specialised maintenance routines
	Not known/no effect
	No active maintenance required (passive maintenance designed)
Timescale	Long term strategic aim (>10yrs to progress, funding route unclear)
	Likely to be able to progress in next 1 – 5yrs
	Quick win (<1yr)
Cost	>£2m
	£500 - £1m
	<£100k

A.1 Long-list options results

An overview of the multi-criteria analysis results is shown in Table 11-3 with the full results shown in Table 11-4.

The long list options which scored the highest were developing a Property Flood Resilience scheme and wider community flood resilience. Understanding the impacts of the Simeon Street recreation ground flood walls on surface water flood risk also scored highly.

Doing nothing was the least beneficial option with a score of -3, followed by business as usual. It should be noted that disconnected roof water drainage and improved asset mapping were also low scoring options, this mostly due to the fact these options would not result in a significant reduction in flood risk to affected properties.

Options to upgrade the existing sewer capacity also did not score highly enough, this is due to the high cost, various disruptions caused by upgrading the sewer system in an urbanised area and the lack of wider benefits.

The flooding experienced in Monktonmead on 25 July 2021 was strongly linked to surface water flows and as this affected many scattered properties across Ryde it is unlikely that flood attenuation options would be viable on cost benefit to address this. As a result, developing a Property Flood Resilience scheme is the most realistic option to address the flooding that occurred across Ryde in conjunction with building community flood resilience. Investigating the impacts of the flood wall at the Simeon Street recreation ground on surface water flood risk should also be explored.

Table 11-3: Multi-criteria analysis scores for long list options

Reference	Option	Lead RMA / organisation	Multi-Criteria Analysis Total Score
1	Do nothing	N/A	-3
2	Business as usual	N/A	1
3	Property Flood Resilience (PFR) Scheme	Isle of Wight Council	7
4	Community flood resilience	Isle of Wight Council /. Flood Action Groups	7
5	Understand the impacts of the Simeon Street recreation ground flood wall on surface water flood risk	Environment Agency Isle of Wight Council	8
6	Upgrade existing sewer capacity	Southern Water / Island Roads	6
7	Disconnecting roof water drainage	Isle of Wight Council	3
8	Improving asset maintenance	Island Roads / Southern Water / Isle of Wight Council	6
9	SuDS measures in the East Hill Road and West Hill Road areas	Isle of Wight Council/ Island Roads	4
10	Alterations to kerb levels	Isle of Wight Council / Island Roads	6

Table 11-4: Full multi-criteria analysis results

Isle of Wight Section 19 Investigations
Multi-Criteria Appraisal Matrix

Originated	Peter Rook	02/02/2022
Checked		
Approver		

Evaluation Scoring: See tab 'Scoring Criteria' for details

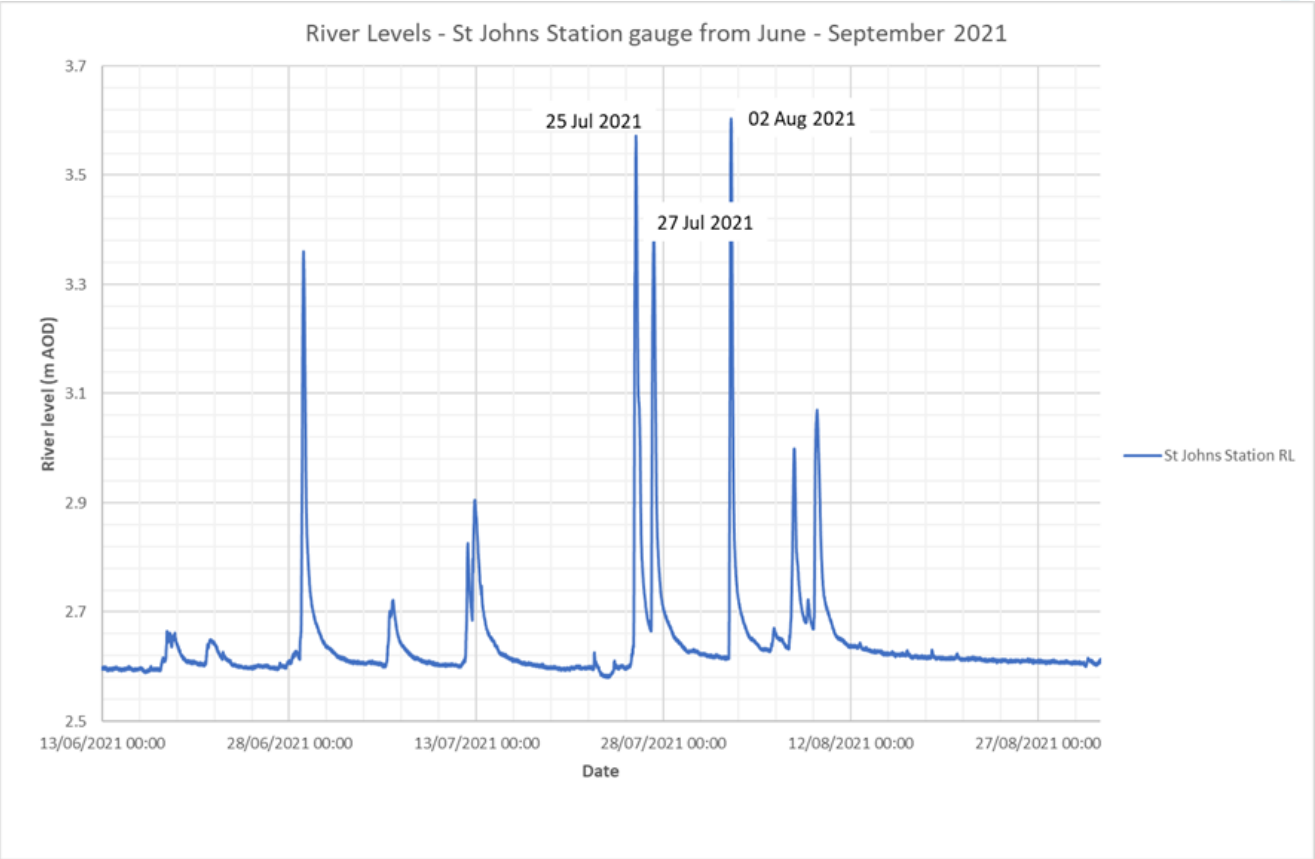
-2	Major negative impact.
-1	
0	Neither positive or negative impacts
1	
2	
3	
4	
5	Major positive impact

Objective	Weighting
1	1
2	1
3	1
4	1
5	1
6	1
7	1
8	1
9	1
10	1
11	0

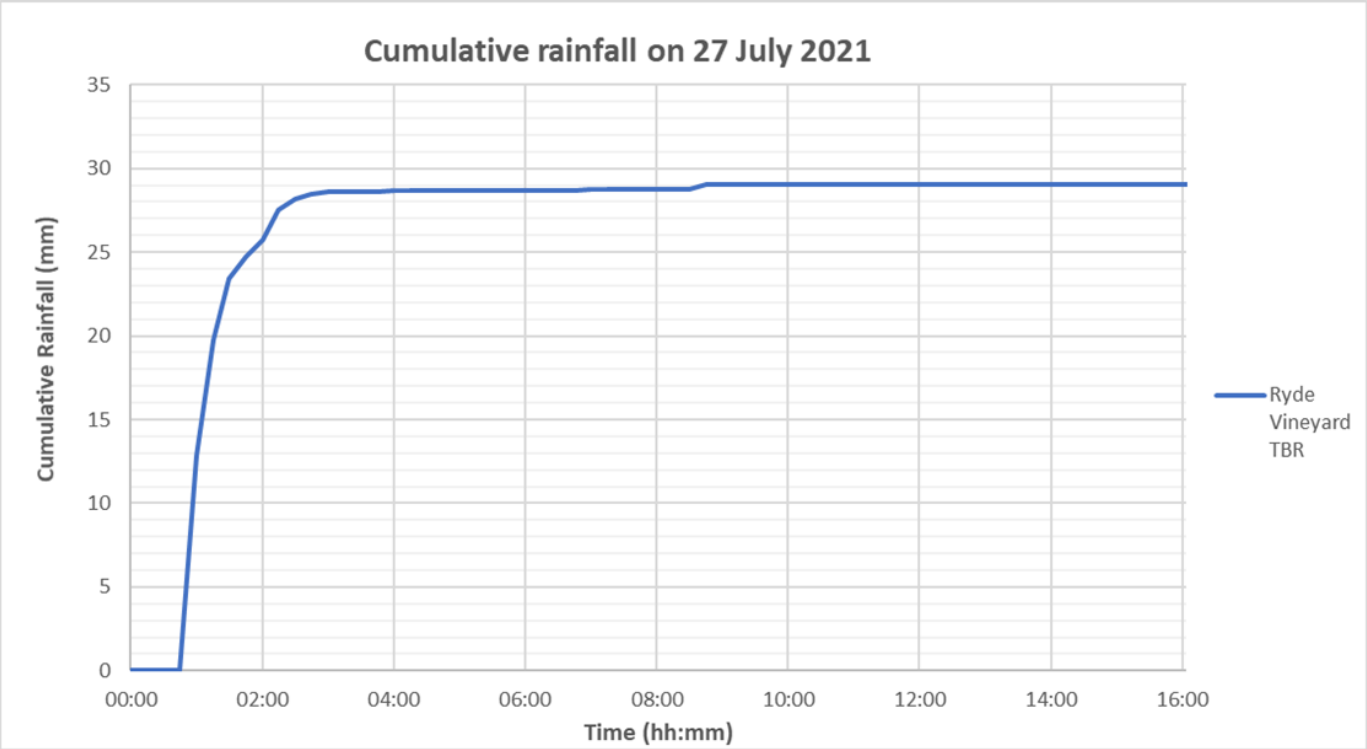
			1	2	3	4	5	6	7	8	9	10	11	
Reference	Opportunities	Lead RMA	Flood risk benefit to property	Flood impact on people	Data and evidence	Deliverability	Community/ resident acceptability	Biodiversity and water quality betterment	Amenity benefits	Carbon reduction	Maintenance costs	Timescale	Cost (for information only)	TOTAL
1	Do nothing	N/A	-2	-2	0	0	0	0	0	0	2	0	5	-2
2	Business as usual	All	0	0	0	0	0	0	0	0	1	0	5	1
	Data and evidence													
3	Property Flood Resilience Scheme	Isle of Wight Council	2	4	0	0	1	0	0	0	0	3	4	7
4	Community flood resilience	Isle of Wight Council/ Ryde Flood Action Group	0	4	0	1	2	0	0	0	0	5	5	7
5	Understand the impacts of the Simeon Street recreation ground flood wall on surface water flood risk	Environment Agency	0	0	5	2	1	0	0	0	0	5	5	8
6	Upgrade existing sewer capacity	Southern Water	3	3	0	-2	1	1	0	0	0	1	1	6
7	Disconnecting roof water drainage	Southern Water	0	1	0	1	1	0	0	0	0	3	4	3
8	Improved asset maintenance regimes	Isle of Wight Council/ Island Roads/ Southern Water	0	1	1	2	2	0	0	0	0	5	5	6
9	SuDS measures in the East Hill Road and West Hill Road areas	Isle of Wight Council/ Island Roads	1	0	0	-1	1	1	0	1	1	3	4	4
10	Alterations to kerb levels	Isle of Wight Council/ Island Roads	1	1	0	2	2	0	0	0	0	5	5	6

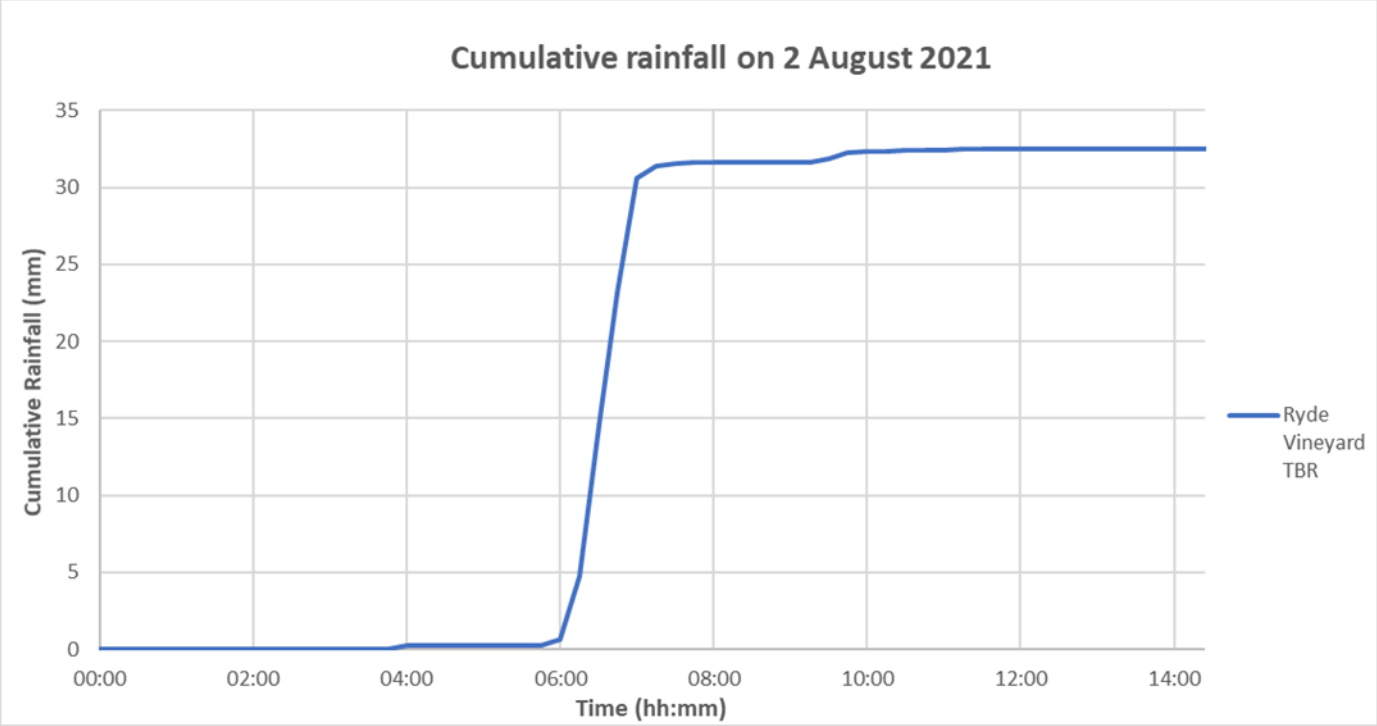
B Hydrological analysis

B.1 River levels from June to August at St Johns station

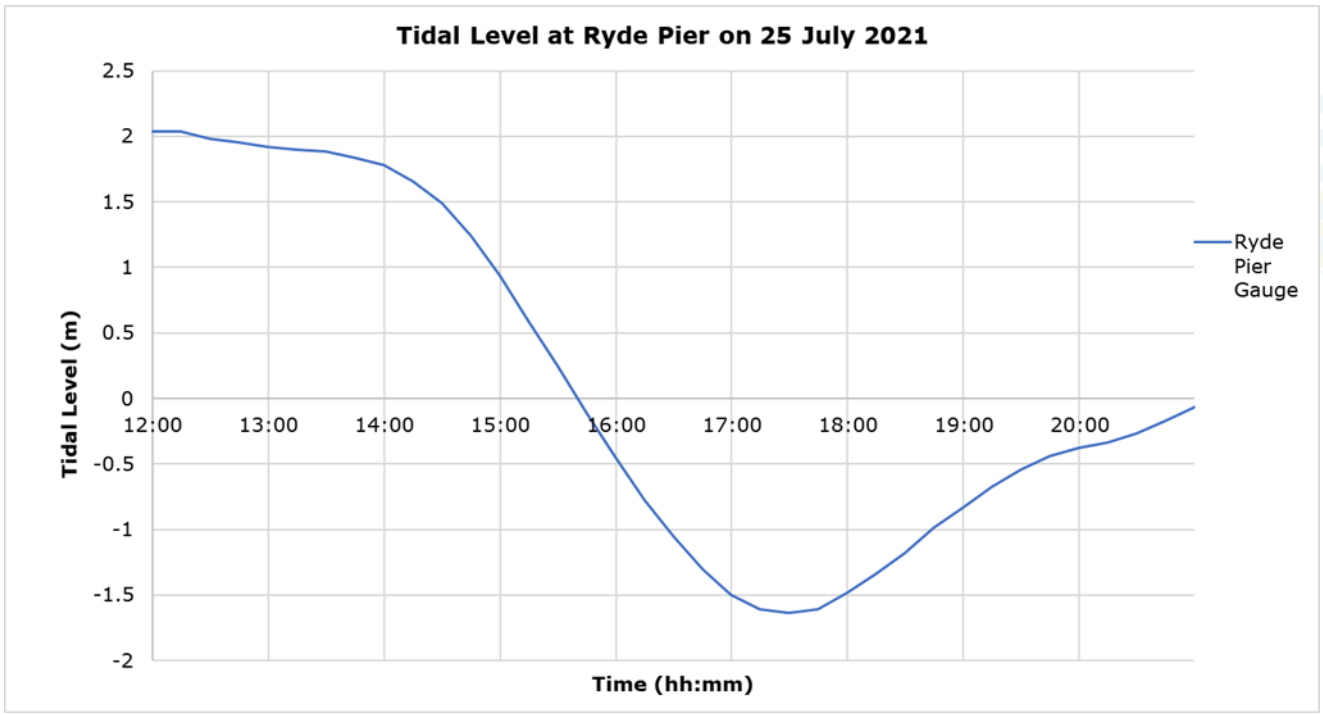


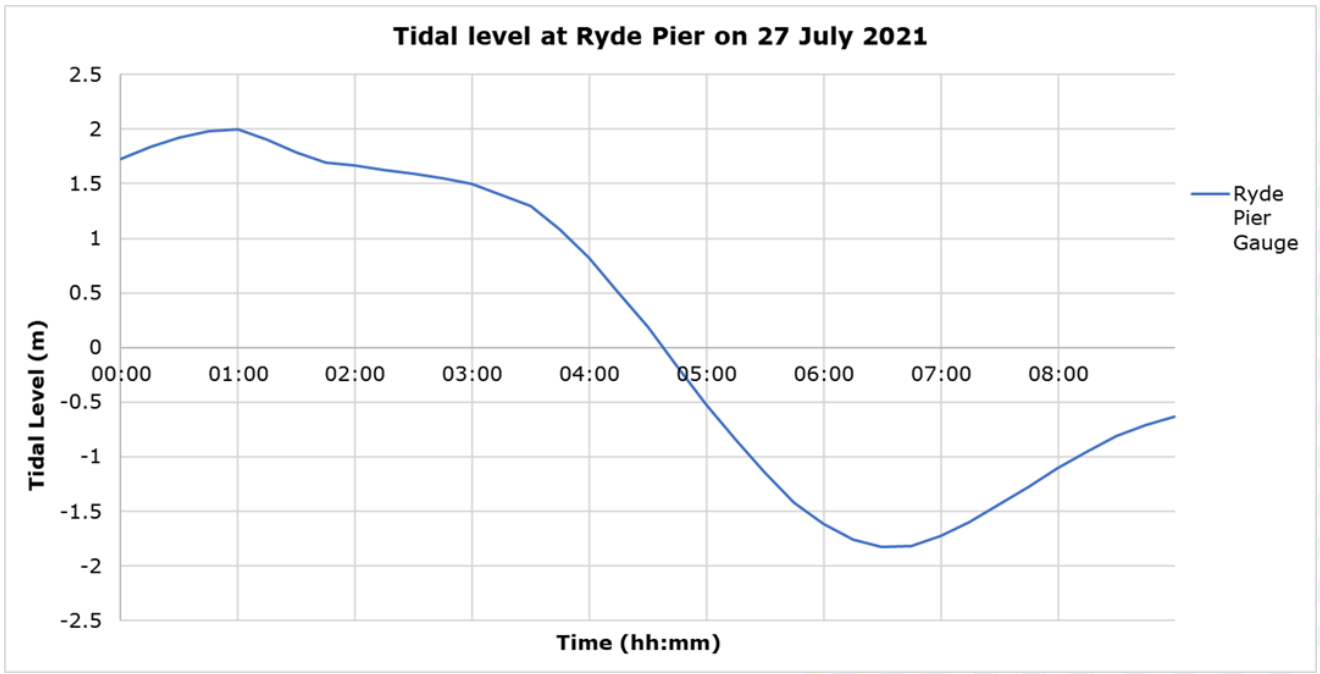
B.2 Cumulative rainfall on 27 July and 02 August events

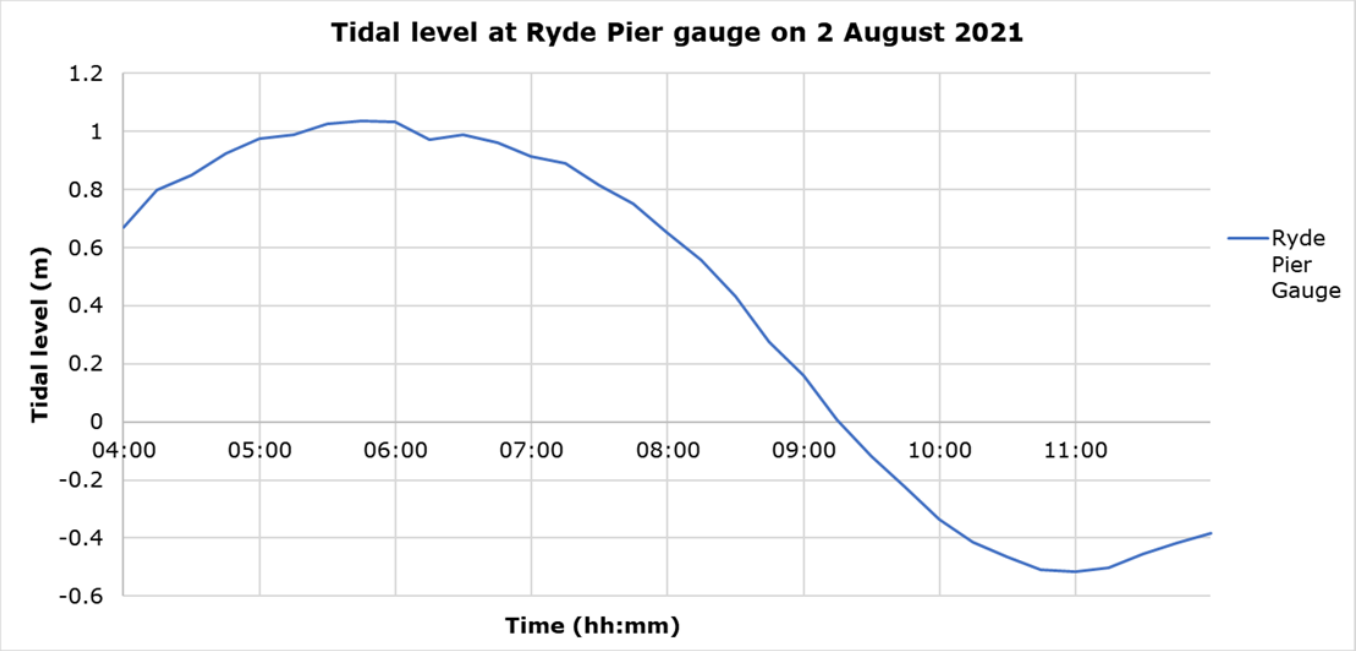




B.3 Tide levels throughout all three events







B.4 Rainfall Return Periods

Table 11-5: rainfall return periods in Monktonmead for 27 July 2021

Storm Duration (hours)	Maximum Rainfall (mm)	Return Period (years)	AEP (%)
1	24.72	9.25	11
2	24.72	4.2	25
4	28.63	3.24	33.3

Table 11-6: the rainfall return periods in Monktonmead for 2 August 2021

Gauge	Storm Duration (Hours)	Rainfall Maximum	Return Period	Approximate AEP
Ryde Vineyard	1	22.89	7.28	14
	2	31.33	8.95	11
	4	31.6	4.35	25
HYRAD (Pixel 7)	1	9.94	1.57	
	2	11.65	0	N/A
	4	11.9	0	N/A
HYRAD (Pixel 8)	1	18.68	4.25	
	2	23.59	3.71	
	4	23.71	2.07	
HYRAD (Pixel 12)	1	8.3	1.36	
	2	9.83	0	N/A
	4	10.3	0	N/A

Gauge	Storm Duration (Hours)	Rainfall Maximum	Return Period	Approximate AEP
HYRAD (Pixel 13)	1	17.69	3.76	
	2	21.91	3.09	
	4	22.13	1.83	

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