

Brading Section 19 Flood Investigation

Final Report

September 2024

Prepared for:



www.jbaconsulting.com

Document Status

Issue date	September 2024
Issued to	James Brewer (Isle of Wight Council)
BIM reference	MIT-JBAU-XX-05-RP-HM-0005-Brading_Flood_Investigation
Revision	A1-C02
Prepared by	Grace Sheppard BSc
	Technical Assistant
Reviewed by	Peter Rook BSc MSc MCIWEM C.WEM FGS
	Chartered Senior Analyst
Authorized by	Appa Basalov BSa MSa CEpy MCIWEM C WEM
Authonsed by	
	Project Director

Carbon Footprint

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



Contract

Address 35 Perrymount Road, Haywards Heath, West Sussex, RH16 3BW JBA Project Code 2024s0190

This report describes work commissioned by Isle of Wight Council, by an instruction dated 6th February 2024. Isle of Wight Council's representative for the contract was James Brewer. Grace Sheppard and Peter Rook of JBA Consulting carried out this work.

Purpose and Disclaimer

Jeremy Benn Associates Limited ("JBA") has prepared this Report for the sole use of Isle of Wight Council and its appointed agents in accordance with the Agreement under which our services were performed.

JBA has no liability for any use that is made of this Report except to Isle of Wight Council for the purposes for which it was originally commissioned and prepared.

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

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

The methodology adopted and the sources of information used by JBA in providing its services are outlined in this Report. The work described in this Report was undertaken between January and June 2024 and is based on the conditions encountered and the information available during the said period. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where assessments of works or costs identified in this Report are made, such assessments are based upon the information available at the time and where appropriate are subject to further investigations or information which may become available.

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.



Copyright

© Jeremy Benn Associates Limited 2024

Contents

1
1
1
2
3
5
5
5
7
7
8
9
9
10
12
12
16
16
16
17
18
19
20
23
23
27

JBA consulting

	ΒA	
-	P/A	

8	Review of Flood Risk Management Activities		
	8.1	Eastern Yar Strategy	30
	8.2	Brading Marshes Water Level Management Plan (WLMP)	30
	8.3	Role of the RSPB	33
	8.4	Summary	34
9	Subsequen	tactions	35
•	9 1	Community Recovery Grant	35
	9.2	Business Recovery Grant	35
	9.3	Property Flood Resilience grant	35
	9.4	Environment Agency	35
10	Preliminary	appraisal	37
	10.1	Multi-criteria analysis methodology	37
11	Conclusion	and recommendations	40
	11 1	Conclusions	40
	11.1	Recommendations	40
Α	Multi-Criter	ia Analysis	A-42
В	Brading WL	MP FRA Figures	B-1
List of	Figures		
Figure	e 2- 1: The top	oography of Brading parish	5
Figure	e 2- 2 Brading	Marshes during flood conditions	6
Figure 3- 1: Flood Map for Planning at Brading			7
Figure	e 3- 2: Risk of	flooding for surface water mapping	8
Figure 3- 3: JBA 5m groundwater flood map			9
	17		
Figure 5- 1: Comparison of data at two gauges on the Eastern Yar, from 2012 to present 18			ent 18
Figur	Figure 5- 2: Groundwater levels recorded at Alverstone gauge between March and November 2023		
Figure	97-1: Floodir	ng of the watercourse that flows through the gardens of Nicholas C	lose

25

Figure 7-2: Flooding of the watercourse and surrounding garden	25
Figure 7- 3: Source-Pathway-Receptor mapping at Nicholas Close, Brading	28
Figure 7-4: Photograph no. 1- significant pooling outside property on Nicholas Close	29
Figure 7-5: Photograph no. 2- high water levels in the stream located east of Nicholas	S
Close	29

List of Tables

Table 1- 1: Key stakeholders	4
Table 4-1: Roles and responsibilities in an emergency, during and after a flood event	13
Table 5-1 – Rainfall return period estimates using FEH22 from the Knighton gauge	16
Table 5-2: Locations of river gauges assessed for the investigation	17
Figure 8-1: River level data obtained by the RSPB at three locations along the Easter	n Yar
during Autumn/Winter 2023	33



Abbreviations

AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
BGS	British Geological Survey
DEFRA	Department of the Environment, Food and Rural Affairs (formerly MAFF)
DTM	Digital Terrain Model
DWMP	Drainage and Wastewater Management Plan
EA	Environment Agency
FCERM	Flood and Coastal Erosion Risk Management (R&D programme)
FEH	Flood Estimation Handbook
FMfP	Flood Map for Planning
IWC	Isle of Wight Council
LLFA	Lead Local Flood Authority
LRF	Local Resilience Forum
LiDAR	Light Detection And Ranging
PFR	Property Flood Resilience
RoFSW	Risk of Flooding from Surface Water mapping
RSPB	Royal Society for the Protection of Birds
S19	Section 19 post flood investigation
SFRA	Strategic Flood Risk Assessment
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
WLMP	Water Level Management Plan
WPS	Wastewater Pumping Station
WWTW	Waste Water Treatment Works

Executive Summary

Background

The town of Brading covers approximately 14km² on the Isle of Wight and on the Eastern Yar Estuary, between Ryde, Bembridge and Sandown Bay. This report will investigate flooding to at least 6 properties in Nicholas Close, a residential road in the south of Brading, on 25 October 2023. IWC is under a duty to investigate this flood event, in accordance with its <u>Flood Investigation Protocol</u>. IWC has appointed JBA Consulting to undertake this investigation on its behalf.

There have been 5 recorded flood events in Brading since November 2000. Flooding in Nicholas Close was recorded in 2000, 2013 and more recently in 2023 and 2024. Highway flooding is also common in Brading, with the A3055 at Morton Common, which is a key link road to Bembridge and Sandown being frequently affected over the past year with multiple instances of road closures.

Overview of approach

As part of the Section 19 Investigation, JBA Consulting engaged with multiple stakeholders in Brading, including residents, IWC and Risk Management Authority (RMA) partners. Engagement with residents and business owners involved the distribution of an online community survey, which included gathering information on property flooding that occurred on the Isle of Wight during October and November 2023. This included a review of historic flooding information provided by the residents of Nicholas Close.

The Flood Estimation Handbook has been used to estimate return periods for known historic flood events in Brading, including 25 Oct 2023 based on data from the Knighton rain gauge. It is evident that the 2014 events in isolation were relatively insignificant, with return periods of approximately 1 in 1 and 1 in 2.5 years respectively. The event on 24th October 2013 was slightly more significant, with an estimated return period of approximately 1 in 25 years.

Overall, there is a correlation between both rainfall return period and river levels, however a stronger correlation is between known flood events and river levels. This indicates that the flooding in Morton Common and Nicholas Close is strongly influenced by river levels. The catchment is very low lying both upstream and downstream of Morton Common and Nicholas Close, and there is a limited difference in level with a flat gradient. This would likely result in downstream controls, such as the operation of structures and water-levels; and factors such as tide locking being highly influential on river levels upstream.

Key plans and strategies have been reviewed as part of this Section 19 investigation, which includes the Brading Marshes Water Level Management Plan (WLMP), which was prepared and published by the Environment Agency, working in partnership with Natural England. This along with supporting documentation has been reviewed to determine whether proposals to change water levels in the Brading Marshes could have exacerbated flood risk.

Key findings

This review of the Brading Marshes WLMP has highlighted some concerns with regard to the hydraulic modelling approach used as a basis for the WLMP, including:

- The modelling software used
- The modelling approach
- Modelled return periods
- Consideration of climate change.
- Lack of clarity with regard to assumptions used in the modelling.

It is unclear whether more up-to date modelling may exist or whether further studies have been undertaken subsequently. However, based off the information provided for use in this Section 19 investigation it is unclear whether the modelling included in this FRA is sufficient to adequately assess the flood risk impacts of the Brading Marshes WLMP.

Furthermore, it is unclear what subsequent actions have been undertaken by the Environment Agency, Natural England or landowners in implementing the WLMP. The Land Drainage Act 1991 clearly outlines that it would be unacceptable for works by riparian landowners to result in worsening flood risk impacts to existing properties.

Recommendation	Organisation (s) responsible	Multi-criteria analysis score	Timescale
Undertake multi-agency review of Brading Marshes WLMP	Environment Agency, RSPB, Isle of Wight Council	12	<1 year
Improved asset maintenance and management	Environment Agency, Southern Water, Network Rail, Island Roads, Isle of Wight Council	13	<1 year
Review condition and capacity of wastewater pumping station at Nicholas Close	Southern Water	12	<1 year

A multi-criteria analysis identified the following options as the highest rated (score >=12), and the most suitable options to prioritise for delivery:

1 Introduction

1.1 Background to investigation

Following recurrent flooding in Brading, which occurred most recently on 25 October 2023, Isle of Wight Council (IWC) as the Lead Local Flood Authority (LLFA) has commissioned JBA Consulting to undertake a formal flood investigation under Section 19 of the Flood and Water Management Act 2010.

It is a statutory requirement for LLFAs to investigate flooding to the extent that it considers it necessary or appropriate. IWC has identified its criteria for undertaking a flood investigation, outlined in their flood investigation protocol:

- There is doubt surrounding the source or responsibility of a flood incident
- Internal flooding of one property has been experienced on more than one occasion
- Internal flooding of a group of properties has been experienced during a single flood incident
- Flooding resulted in disruption of one or more items of critical infrastructure
- A single flood incident resulted in flooding that affects vulnerable individuals
- There is risk to life as a result of flooding

Although the number of properties experiencing internal flooding is low with 6 properties impacted, however these properties have flooded recurrently. Additionally, the A3055 (Morton Common and Morton Road), which is a major transport link to Sandown has been impacted by repeat flooding which has forced road closures. This flooding therefore meets Isle of Wight Council's criteria to undertake a Section 19 investigation.

1.2 Investigation extent

The town of Brading covers approximately 14km² on the Isle of Wight and on the Eastern Yar Estuary, between Ryde, Bembridge and Sandown Bay. This report will investigate the recurrent flooding to properties in Nicholas Close (at least 6), a residential road in the south of Brading from 2000 – present in addition to flooding along Morton Common.



Figure 1-1: Context map showing Brading, areas that have flooded (areas of interest) and key structures in the Brading Marshes SSSI

1.3 Data collection

Data collection involved the online distribution of a community survey, whereby residents were asked a series of questions relating to the wider flooding events that occurred on the Isle of Wight during the months of October and November 2023. Responses to the questionnaire indicate that flooding of Morton Common and Nicholas Close Occurred on 25 October 2023.

Additionally, in response to the widespread flooding event across the Island, the Isle of Wight Council launched a flood recovery grant, whereby residential properties and businesses directly affected by the floods as a result of Storm Babet (between 19 and 25 October 2023) were able to apply for UK Government funded support. This information, together with the responses from the community survey, were used to understand the areas most affected during this flooding event.

Further data has been collected and assessed to inform the flood investigation. This has been used to understand the causes of flooding in Brading and to establish the context of the area and includes the following:

- Open-source data from GOV.UK
- Hydrometric data
- Information from authorities on drainage infrastructure, such as highways and water companies
- Photographs, newspaper articles and notes from the event

1.4 Stakeholder engagement

We engaged with multiple local stakeholders in Brading, including residents, the Isle of Wight Council and Risk Management Authority (RMA) Partners. Engagement with residents involved the distribution of the online community survey, which included gathering information on flooding that occurred across the Isle of Wight in both 2021 and 2023. Residents also provided a folder of information related to the flooding collected over a long period of time.

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 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 given in Table 1-1. The engagement terminology is taken from the '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 1-1: Key stakeholders

Role	Organisation	How to engage	Type of engagement
Residents	N/A	Consult	Online questionnaire/ flood grant application, data provision
Environment Agency	Environment Agency	Involve	Correspondence, data provision
LLFA	Isle of Wight Council	Involve	Correspondence, invitation to contribute, online survey distribution, site visit, data provision
Hampshire and Isle of Wight Fire and Rescue	Hampshire and Isle of Wight Fire and Rescue	Consult	Correspondence, invitation to contribute, data provision
Natural England	Natural England	Consult	Correspondence, invitation to contribute
Water and Sewerage Undertaker	Southern Water	Consult	Correspondence, invitation to contribute, data provision
Highway Authority	Isle of Wight Council (Island Roads)	Consult	Correspondence, invitation to contribute, data provision

2 Catchment characteristics

2.1 Topography

The topography of Brading is varied, as shown in Figure 2- 1, with the elevation ranging between -2.46mAOD 134.68mAOD. The Brading marshes and floodplain of the Eastern Yar River characterise the eastern part of the parish, an area of low topography. Higher elevations can be found in the south west towards Adgestone and the Brading Downs.



Figure 2-1: The topography of Brading parish

2.2 Drainage system and river network

The River Yar flows south of Brading towards Bembridge Harbour, where it discharges into the English Channel. The Yar is classified as an EA main river and is in its lower reaches as it flows through Brading. The Brading Marshes characterise the eastern part of the parish, stretching from the village of Brading to Bembridge Harbour. The Marshes are managed by the RSPB and are designated Site of Special Scientific Interest (SSSI) due to the extensive wetland area providing a habitat to various species.

Information provided by the Isle of Wight Council, indicates that flooding on 25 October 2023 mainly affected Nicholas Close, a residential road in Brading. A small tributary/drainage channel flows through the gardens of Nicholas Close towards the River

Yar, east of the residential area.. The channel is culverted where it meets the railway line northeast of Nicholas Close. Figure 2-1 shows the River Yar and its tributaries in Brading including the drainage channel east of Nicholas Close.

Figure 2-2 shows the Brading Marshes during a period of significant flooding.



Figure 2-2 Brading Marshes during flood conditions

3 Long-Term Flood Risk Information

3.1 Risk of flooding from rivers and the sea

The Environment Agency's Flood Map for Planning, shown in Figure 3-1, defines areas at risk of flooding from fluvial and tidal sources.

Areas within Flood Zone 2 have between a 0.1% and 1% 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 River Yar and its tributaries are identified as being within Flood Zones 2 and 3, as is Morton Common. Nicholas Close is entirely within Flood Zone 1, this is likely due to the fact the watercourse has not been modelled and does not reflect 'actual' flood risk to these properties.



Figure 3-1: Flood Map for Planning at Brading

3.2 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 3-2 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)

The RoFSW mapping identifies a surface water flow path to the rear of properties in Nicholas Close, it also identifies risk to the rear of properties in Nicholas Close. In this case the mapping is picking up low spots in the LiDAR due to the methodologies used and risk to these properties is predominantly fluvial.



Figure 3-2: Risk of flooding for surface water mapping

3.3 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. The JBA Groundwater Flood Map has been reviewed, this indicates that Nicholas Close is in an area at high risk, with groundwater levels predicted to be close to the surface. The underlying geology is noted to be permeable and predominantly sandstone with interbedded superficial deposits.



Figure 3- 3: JBA 5m groundwater flood map

3.4 Sewer flooding

Sewer flooding can often occur during heavy rainfall when sewer systems can surcharge, resulting in hydraulic overload of the sewer system and flooding at the surface. The Southern Water sewer network indicates that sewer systems in Brading, including Nicholas Close are combined and would accept both surface water and foul sewage. Combined sewer systems are particularly susceptible as they convey both surface water and foul sewage and are often older systems that may not be designed to modern standards.

A Southern Water Wastewater Pumping Station is present at the bottom of Nicholas Close, based on the sewer network, this will pump both surface water and foul sewage from properties in Nicholas Close up to a 225mm trunk sewer in Morton Road.

JBA



Figure 3-4: Sewer network and WPS at Nicholas Close

3.5 Flood history

The Isle of Wight Level 1 Strategic Flood Risk Assessment (SFRA) indicates that previous flooding events have occurred in the Brading area. The following sub-sections highlight the major flood events identified in the Level 1 SFRA, as well as additional events recorded in the area since the SFRA was published. A comprehensive timeline of events is provided in Section 6.

3.5.1 November 2000

Flooding in November 2000 was caused by the coincidence of extremely high flows and neap tides causing a longer than normal period of tide-lock. Most of the flooded area was adjacent to the main river and within the ditches that dissect the Brading marshes. Internal flooding affected one basement flat on Brading High Street. Additionally, Nicholas Close was also affected, although it is unknown if property flooding occurred.

3.5.2 December 2013

Nicholas Close was affected by flooding on 24th December 2013, with Numbers 5 and 6 particularly affected as the occupants of both properties were forced to seek alternative accommodation due to extensive internal damage. The Isle of Wight Fire and Rescue Service attended but were not able to provide flood relief by pumping water away. Sandbags were provided to the affected properties and residents were evacuated to neighbouring properties.

3.5.3 December 2013 – February 2014

Between 24th December 2013 and 7th February 2014, 9 incidents of highway flooding were recorded in the Morton Common, Morton Road and Morton Broom area. Morton Common was closed to traffic on several occasions.

Flooding in 2013/14 occurred as a result of extensive surface water runoff combined with high tide, impacting on water outfall from the Bembridge Marshes.

3.5.4 August 2021

Flooding in August 2021 caused many highway issues, with flooding of West Lane, Coach Lane and Morton Common. Island Roads stated that flooding had caused damage to the carriageway, with closure of the road necessary for repair works to be completed.

3.5.5 April 2024

Heavy rainfall experienced in early April 2024, caused internal and external flooding of No.6 Nicholas Close.

3.5.6 A3055 - Morton Common

It has been noted that the A3055 has flooded increasingly often and on a number of occasions between 2023 and 2024 resulting in road closures, these include:

- 25 October 2023;
- 09 November 2023;
- 05 December 2023;
- 04 January 2024;
- 19 February 2024;
- 23 February 2024;

4 Flood Risk Management

4.1 Flood risk management roles and responsibilities

Flood risk in England is managed by a range of different Risk Management Authorities (RMAs). 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.

4.1.1 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.

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; dredging the river; and issuing flood warnings.

The Environment Agency can also do work to prevent environmental damage to watercourses, or to restore conditions where damage has already been done.

4.1.2 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 Brading.

4.1.3 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 sites. In Brading this responsibility falls under Southern Water.

4.1.1 Highway Authority

The Highway Authority for Brading is 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.

4.1.2 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 including: 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 guide 'Living on the Edge', 'Owning a watercourse'.

4.1.3 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.

BeFloodReady contains information for residents in understanding their flood risk and preparing for flooding:

https://www.befloodready.uk/before-a-flood/understanding-your-flood-risk

Further information, useful contact details and local information (such as sandbag locations) is available on Isle of Wight Council's website:

https://www.iow.gov.uk/keep-the-island-safe/severe-weather/flooding/

4.2 Emergency responsibilities

The emergency responsibilities of different organisations are outlined in Table 4 2 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.

Table 4-1: 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	Attend emergencies relating to their
Coordination and communication between	services putting life at risk
emergency services and organisations	Assess and manage risk of service failure
providing support	Assist with recovery process, that is, water
Coordinate the preparation and	utilities manage public health
dissemination	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



4.2.1 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 Brading 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 Hydrological Analysis

5.1 Conditions at the time

Rain gauge data was obtained from the Environment Agency's <u>Hydrology Data Explorer</u> service to determine the return period of the storm event on 24 and 25 October 2023, as well as the conditions prior to the event. The closest tipping bucket rain gauge to Brading is the Knighton gauge, located approximately 4km west of Brading. Due to the recurrent flooding at Brading, a range of different events have been assessed based on known flood events, these include:

- 5th/6th November 2000
- 24th December 2013
- 16th January 2014
- 14th February 2014
- 25th October 2023

5.2 Rainfall return period estimation

The <u>Flood Estimation Handbook web service</u> (catchment 460650, 86350) was used to estimate a range of return periods for the dates listed above. The event rarity was determined using different durations and depths recorded at the Knighton rain gauge and a best estimate is provided for each event.

Table 5-1 details historical rainfall events with estimates return periods using FEH22. It is evident that the 2014 events in isolation were relatively insignificant, with return periods of approximately 1 in 1 and 1 in 2.5 years respectively. The event on 24th October 2013 was slightly more significant, with a calculated return period of approximately 1 in 25 years. It is evident that these historical rainfall events were much less significant than the one experienced on 25 October 2023, which can be classified as an extreme and infrequent rainfall event.

Event	Storm duration (Hours)	Rainfall total (mm)	Return Period
5 th /6 th November 2000	30.75	57.60	1 in 8
24th December 2013	18	61.20	1 in 25
16 th January 2014	12.25	33.4	1 in 2.5
14 th February 2014	8	22	1 in 1
25 th October 2023	12	83.79	1 in 322

Table 5-1 - Rainfall return period estimates using FEH22 from the Knighton gauge



Figure 5-1: Monthly rainfall totals from the Knighton gauge 2000 - present

Whilst there is a link between extreme rainfall events and flooding in Nicholas Close, there have been instances of flooding such as 14 Feb 2014 and 5/6 Nov 2000 which do not appear to be as extreme. The gauge record has been reviewed as far back as January 2000 to understand the potential impacts of antecedent conditions in the months preceding the events. Figure 5-1 highlights these months in red. This analysis shows that although these events were not as extreme, the preceding months had notably high levels of rainfall and it is likely that antecedent conditions such as soil saturation and tide locking in the Brading Marshes would have played a role in this flooding.

5.3 Impact of river levels

River level gauge data was also obtained from the Environment Agency's Hydrology data explorer service. Table 5- 2 provides information on two river level gauges on the River Yar, located upstream of Brading.

Gauge	River	Grid reference
Alverstone	Eastern Yar	457710, 085593
Sandown	Eastern Yar	459998, 085323

Tabla	- 0.1	l a a a ti a ma	of river			fartha	invention	
Table :)- /*	I OCAHODS	or river	oauges	assessed	lor ine	Invesio	าแดก
1 4010 0		Loodiono	01 111 01	gaagee	4000004		nivoougu	20011

Data shown in Figure 5-1 indicates that levels of the Eastern Yar increased at both locations after the rainfall event on 24 and 25 October 2023. It is evident that river levels increased by approximately 1m at the Alverstone gauge, with 2.3m recorded on 23 October and 3.22m recorded on 25 October. A similar pattern is shown at the Sandown gauge, with 0.59m recorded on 24 October, increasing to 1.12 on 25 October. River levels are relatively consistent at both locations, with high levels recorded in the following weeks after the event.



Figure 5-1: Comparison of data at two gauges on the Eastern Yar, from 2012 to present

Looking further back, there is a clear correlation between elevated river levels prior to and around the time of the most significant flood events in Nicholas Close. These elevated river levels are indicated to last for a significant amount of time before returning to more typical levels. The areas shaded in pink of Figure 5-2 cover the date ranges of:

- Dec 01, 2013 Feb 28, 2014
- Oct 25 Dec 01, 2023

5.4 Impact of groundwater levels

The Hydrology Data explorer service has also been used to analyse groundwater data at locations in proximity to Brading. The Ashey groundwater station is the closest gauge in proximity to the Brading area, but available data is inconsistent. Therefore, the Alverstone gauge (457443, 085007) has been used to assess groundwater levels and is located approximately 3km west of Brading.

Figure 5- 3 shows groundwater levels between March and November 2023. The data indicates that levels decrease steadily from over 20mAOD in the first few months of the year to approximately 19.5mAOD at the end of October. The data also suggests that groundwater levels follow a declining trend throughout the year, until the end of November where levels are shown to increase. The data does not indicate a substantial increase in groundwater levels at the Alverstone gauge after the rainfall event on 25 October. Overall, groundwater levels recorded at the Alverstone gauge are not significant in the months leading up to the event.

Environment Agency LiDAR data indicates that the topography of the groundwater station is 36.4mAOD. When comparing this to groundwater levels of 19.5mAOD on 25 October, it is evident that the ground was not saturated before the rainfall event.



Figure 5- 2: Groundwater levels recorded at Alverstone gauge between March and November 2023

An additional groundwater station located in the southern part of the Isle of Wight is the Sandford Godshill gauge (454151, 081795), approximately 8km from Brading. Although groundwater levels are higher at this location, the data shows a similar pattern to the Alverstone gauge, with a gradual decline in groundwater levels since the early part of 2023. However, it is evident that since the end of October, levels have increased significantly, possibly the result of frequent rainfall events during this period.

5.5 Summary

Overall, there is a correlation between both rainfall return period and river levels, however a stronger correlation is between known flood events and river levels. This indicates that the flooding in Morton Common and Nicholas Close is strongly influenced by river levels. The catchment is very low lying both upstream and downstream of Morton Common and Nicholas Close, and there is a limited difference in level with a flat gradient. This would likely result in downstream controls, such as the operation of structures and water-levels; and factors such as tide locking being highly influential on river levels upstream.

6 Timeline of Events

Several agencies responded to the flooding event on 25 October 2023 including the Isle of Wight Council, Southern Water, Island Roads and the Environment Agency however it has not been possible to put together a timeline of events.

With consideration to the complex and long flood history of Brading, we have put together a timeline of events based on available news stories and information collected by Risk Management Authorities and residents:

Date	Organisations	Description
5 th /6 th Nov 2000	N/A	Reports of flooding in Nicholas Close
25 Mar 2002	EA/ EN/ RSPB	Brading Marshes SSSI Water Level Management Plan (WLMP) published (was not made available for review in this S19)
Feb 2004	EA/ EN/ RSPB	Water level trials in support of the implementation of the original Brading SSSI WLMP
Dec 2006	EA	Publication of Brading Marshes WLMP (in partnership with stakeholders e.g. Natural England, RSPB and relevant landowners)
Jan 2009	EA	Completion of Flood Risk Assessment and modelling work for the Brading Marshes WLMP
Winter 2009 – summer 2010	EA/ NE/ RSPB	Completion of water level trials for raising of water levels in Brading Marshes SSSI, as set out in the WLMP. Conclusions that continued trials would be required over subsequent five years.
2010	EA/ IWC	Publication of Eastern Yar FCERM Strategy
24th Dec 2013	N/A	Reports of flooding in Nicholas Close
16 th Jan 2014	N/A	Reports of flooding in Nicholas Close
29 th Jan 2014	EA/ Southern Water/ IWC/ RSPB/ Brading Town Council/ residents	 Public meeting to discuss flooding issues in Brading Town Hall: Concerns over performance of pumping station which floods Concerns over management of water levels in the Brading Marshes Queries over dredging and why this was not being undertaken
14 th Feb 2014	N/A	Reports of flooding in Nicholas Close
24 Jun 2014	IWC	Publication of Eastern Yar Section 19 investigation
Dec 2014	RSPB/ EA	Statement from RSPB expressing surprise that Southern Water link flooding issues and sewer capacity to management of water levels in Brading Marshes. EA statement
July 2021	N/A	Reports of garden flooding to properties in Nicholas Close

Table 6-1: Timeline of events relating to flooding in Brading

Date	Organisations	Description
Jan 2023	N/A	Reports of flooding in Nicholas Close, residents had to move out of flooded property for majority of the year.
25 th Oct 2023	Southern Water	Reports of flooding in Nicholas Close and A3055 at Morton Common. Southern Water deployed five tankers to remove contaminated flood water from Nicholas Close.
09 Nov 2023	N/A	Reports of flooding and road closures of A3055 at Morton Common
05 Dec 2023	N/A	Reports of flooding and road closures of A3055 at Morton Common
04 Jan 2024	N/A	Reports of flooding and road closures of A3055 at Morton Common
19 Feb 2024	N/A	Reports of flooding and road closures of A3055 at Morton Common
23 Feb 2024	N/A	Reports of flooding and road closures of A3055 at Morton Common

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

- 24 October 2023: Yellow warning of rain issued at 11:00 on 24 October. Valid between 18:00 on 24 October and 10:00 on 25 October.
- 25 October 2023: Amber warning of rain issued at 06:13 on 25 October. Valid between 06:13 and 10:00.

The Met Office issues the following guidance on what its weather warnings mean:

- Yellow: You should check the details of the forecast and consider taking steps to minimise impacts for you and your household. Even in a yellow warning area, people will see disruption to a greater or lesser extent, so it's important to check the details and see which steps you could take to prepare.
- Amber: Disruption from an Amber warning is more likely and more widespread. You should change plans that could be impacted by the weather and take action to protect yourself and your property.
- Red: These warnings are reserved for very dangerous weather with a high level of certainty. You should take direct action to keep yourself and others safe from impacts of the weather. It's likely there will be a risk to life, as well as substantial disruption to travel and infrastructure.

Nicholas Close is covered by the Environment Agency's Flood Warning Service (Sandown, Brading and Bembridge on the Eastern Yar Warning Area). Additionally, the eastern area of Brading, including Nicholas Close, is also covered by the Easter Yar Flood Alert Area.

It is evident that Southern Water deployed 5 tankers to Nicholas Close in order to remove contaminated flood water and transfer this to Sandown Wastewater Treatment Works.



Additionally, Island Roads reported numerous road closures around the Island due to flooding on 25 October, with Morton Common (A3055) in Brading reported to have been closed.

Correspondence with the EA indicates that an incident response contractor, as well as EA officers, visited Nicholas Close on various occasions between 25th October to 16th November 2023, to check for blockages and carry out a welfare check on residents. It was noted that no visible blockages were located.



7 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 all of the information available to determine the main sources of flood water, the main pathways it tool and the main receptors. The Source-Pathway-Receptor map (Figure 5-1) focuses on the area of Nicholas Close and the flow paths present along the residential road.

7.1 Nicholas Close

7.1.1 Source

The intense rainfall experienced in Brading on 24 and 25 October 2023 caused a significant volume of water to fall directly onto the ground surface. Additionally, information obtained from gauge records (see Section 5) indicates that heavy rainfall increased water levels of the marshes and the River Yar over the preceding month. It is likely that high levels of rainfall combined with backwater effects and tide locking from the Brading Marshes may have contributed to the flooding although this cannot be conclusively proven without further work.

Surface water runoff was likely a secondary source of flooding, as Brading is situated at the bottom of Brading Down. There is a steep gradient from the Down to Nicholas Close and it is likely that this results in a 'flashy' catchment response to rainfall.

7.1.2 Pathway

Figure 5- 2 demonstrates the pathways of flood water within Nicholas Close during the flood event on 25 October 2023. It is evident that the main pathway originated from the ordinary watercourse, which is located east of the residential area. Nicholas close is characterised by extremely low elevations, ranging between approximately 1mAOD adjacent to the watercourse, to approximately 3mAOD at the junction of Morton Road. As this is the case, surface water flows from Morton Common and Morton Road towards the watercourse east of Nicholas Close. This resulted in channel exceedance and the inundation of the residential area, with significant flooding.

The Risk of Flooding from Surface Water mapping indicates that surface water would pool at the junction with Morton Road before flowing down Nicholas Close, likely coinciding with flooding from the ordinary watercourse. It has been noted by residents that the Network Rail culvert EW1-28 has been blocked by silt and may not be functioning as intended, having



last being cleared three years prior. Whilst this could potentially exacerbate flood risk, the flood history of Nicholas Close predates this and it is considered unlikely to be the sole cause of the flooding experienced by residents. As blockage of this culvert may have played a role in the flooding that occurred on Nicholas Close, it is recommended that assets are regularly maintained, as outlined in Section 11.2. Even though maintenance of the culvert may not have prevented the flooding, it may have reduced the impacts and therefore should still be carried out.

7.1.3 Receptor

Six properties in Nicholas Close were affected by flooding on 25 October, with at least two affected by internal flooding. Photographic evidence provided as part of the community survey shows the high water levels of the culverted watercourse, which overflows into the surrounding garden (Figure 7- 1). Additionally, Figure 7- 2 show flooding of the garden adjacent to the one shown in the previous image.



Figure 7-1: Flooding of the watercourse that flows through the gardens of Nicholas Close



Figure 7-2: Flooding of the watercourse and surrounding garden

MIT-JBAU-XX-05-RP-HM-0005-A1-C02-Brading_Flood_Investigation

It is evident from the Flood grant application forms that some residents had to vacate their homes due to internal damage caused by the flooding. Evidence provided by residents highlights that flooding submerged the garden, driveway, and house of one property along Nicholas Close. The residents include an elderly couple who were displaced for the second time in 2023 after the October flood event. The couple were forced to vacate their property for at least 6 months in order for their home to undergo extensive repair and renovation. The resident states that furniture and personal possessions have been destroyed, causing distress and sadness due to the loss of sentimental items.

Information gathered from residents also suggests that the Southern Water pumping station, located at Nicholas Close, flooded on 25 October 2023. This caused sewage to leak into surrounding properties.



7.2 A3055 - Morton Common

The A3055 (Morton Common), is a key transportation route for the island between the north and south of the island, between settlements including Ryde, Bembridge, Sandown and Shanklin. It has been noted that this road has been flooding increasingly often with several road closures in late 2023 and 2024, including:

- 25 October 2023;
- 09 November 2023;
- 05 December 2023;
- 04 January 2024;
- 19 February 2024;
- 23 February 2024;

This has resulted in significant disruption and economic impacts as a result. As with Nicholas Close, it is likely that high levels of rainfall combined with backwater effects (when water in a river is obstructed by something such as a bridge, it can back up causing higher water levels and potential flooding) and tide locking from the Brading Marshes may have contributed to the flooding although this cannot be conclusively proven without further work.

JBA consulting



Figure 7-3: Source-Pathway-Receptor mapping at Nicholas Close, Brading

MIT-JBAU-XX-05-RP-HM-0005-A1-C02-Brading_Flood_Investigation





Figure 7-4: Photograph no. 1- significant pooling outside property on Nicholas Close



Figure 7- 5: Photograph no. 2- high water levels in the stream located east of Nicholas Close



8 Review of Flood Risk Management Activities

8.1 Eastern Yar Strategy

The Environment Agency in partnership with the Isle of Wight Council have set out a plan to manage flood and erosion risk along the coastline. This strategy is known as the *Eastern Yar Flood and Erosion Management Strategy* and was finalised in 2010. The catchment area includes the Eastern Yar River, Bembridge Harbour, St Helens and the coast along the front of the Duver Peninsula.

This strategy involved raising the sea defence around Embankment Road in line with sea level prediction. This sea defence structure protects 450 properties at risk of coastal flooding, as well as preventing tidal waters from entering the Eastern Yar River, which also helps to protect the Brading Marches.

8.2 Brading Marshes Water Level Management Plan (WLMP)

The Brading Marshes Water Level Management Plan (WLMP) was prepared and published by the Environment Agency, working in partnership with Natural England. The WLMP provides a means by which the water level requirements for a range of activities within the marshes, including agriculture, flood risk management and conservation, can be balanced and integrated within the SSSI.

In the context of the WLMP, the term 'penning level' refers to specific water levels maintained at structures like the Bembridge Sluice to achieve desired water conditions for habitat conservation and flood risk management. A review of the WLMP (2006) proposed to increase the penning level of the Bembridge tide gate throughout the year, to support the species for which the site is designated. The preferred option was to increase the penning level from -1.0m OD in winter and -0.5m OD in the summer to a level of -0.2m OD throughout the year.

The WLMP acknowledges that the penning level proposal would result in the loss of 255,000m3 of floodplain storage which would lead to direct impacts within the marshes and potentially upstream due to backwater effects. This investigation notes that these proposals could be acceptable in principle provided there are not detrimental off-site flood risk impacts, for example to residential properties.

The EA are responsible for managing the Bembridge sluice gates, located east of Brading on the Eastern Yar, as shown in Figure 1-1. The Bembridge sluices are managed to maintain a level of approximately 0m AOD, although this level fluctuates depending on tides. The penning level is lowered gradually to ensure that during periods of high flows, the level stays close to 0m AOD.

The Middle and Great Sluices are operated biannually. Tilting weir and drop boards are closed during the summer months (usually in May but this is dependent on weather conditions) and then opened for Winter, usually in September or October.

8.2.1 Brading Marshes WLMP – Flood Risk Assessment

The Environment Agency commissioned Atkins to prepare a Flood Risk Assessment (FRA) in 2009 to assess the proposals to manage water levels as part of the Brading Marshes SSSI WLMP.

Hydraulic modelling of the Eastern Yar was carried out based on three scenarios (basecase, WLMP and WLMP plus mitigation). It was concluded that under the base case and WLMP scenarios, flooding at No. 5 and 6 Nicholas Close is predicted. However, during the WLMP plus mitigation scenario, there is a slight reduction in the area under the hydrograph at No. 5 and 6 Nicholas Close, including the duration of flooding at No. 5.



(e) Upstream of Yar Bridge (in-river)

Figure 8-1 Appendix B from Atkins 2009 FRA – Hydrograph detailing flood levels and durations at Nicholas Close in baseline and WLMP scenarios

The WLMP would result in a slight increase in flood duration at Nicholas Close, to mitigate this the mitigation scenario proposed the following measures:

- 1. the lowering of tide-gate penning levels at the Bembridge Tide-gate from -0.2 to -1.0m OD and;
- 2. opening the Little (or Middle) Sluice tilting weir to its minimum level once the flood arrives at the boundary of the 2D model at Alverstone.



It is unclear whether the above measures have been implemented as part of the WLMP. Therefore, a multi-agency review of the WLMP should be undertaken, as outlined in Section 11.2.

8.2.2 Modelling approach

This investigation has noted the following points with regard to the FRA and modelling approach undertaken:

- Modelling software the FRA has used a 2-dimensional 'HYDROF' model (assumed to be HYDROFLO) – this software is considered legacy and is not benchmarked by the Environment Agency for flood modelling. It is unclear whether this provides a reliable indicator of flood risk to specific properties and the report acknowledges the limitations of the model in this regard.
- Modelling approach considering the importance of structures and features in controlling water levels in the marshes and surrounding areas it is unclear how structures, flow controls and operational rules have been considered in the model. 1D or 1D-2D modelling approaches are likely to better represent structures. Furthermore, the impacts of tide-locking which will be highly influential on flood risk have not been considered.
- **Return periods** the modelling has only assessed the 1% AEP event (1 in 100 year) and states that a greater range of return periods would be considered as part of a more detailed FRA it is unclear if this has been undertaken or commissioned.
- **Climate change** the modelled scenarios do not include any consideration of climate change on peak river flows, on the Isle of Wight this could result in an increase in flows of between 15% and 99% dependent on the scenario and epoch considered. Furthermore, impacts of sea-level rise have not been considered in the modelling
- **Assumptions** details on the assumptions used in the model have not been made clear, for example it is unclear what hydrological methods have been used, how inflows have been derived and whether boundary conditions are appropriate.

Consequently, the modelling approach is not sufficient to adequately assess the flood risk impacts of the Brading Marshes WLMP.

8.2.3 Winter 2009 - Summer 2010 water level trial

The Environment Agency subsequently undertook a water level trial on the Brading Marshes between 20 November 2009 and 31 July 2010 to understand the impacts of implementing the Brading Marshes WLMP and in consultation with landowners. The objectives of this trial included:

1. Trial the remote operation of Bembridge Sluice (objective postponed from earlier trial);



- 2. Monitor the rate at which water levels in the E. Yar and on the adjacent floodplain drop in relation to the tidal cycle;
- 3. Assess time taken (November) to reach target water levels (-0.2 mOD) in the Eastern Yar and adjacent floodplain (tie in with previous water level trials);
- 4. Understand how the water levels on the marshes may vary over the duration of a longer-term trial, in particular the transition from winter to spring;
- 5. Trial creation of suitable conditions to permit an increase in distribution and abundance of key over-wintering and breeding waders;
- 6. Assess how the trial and associated water levels help landowners to meet their HLS objectives;
- 7. Improve understanding and appreciation of the objectives of the WLMP amongst landowners over the winter period;
- 8. Review the operation of Bembridge Sluice to ensure it is functioning as intended.

The report made a number of conclusions and recommendations, notably the Environment Agency acknowledged that there were deficiencies in its understanding of the hydrology of the area and responses to management interventions. The EA and Natural England noted that continued trials would be required for the implementation of the WLMP over the next five years to better understand impacts and to provide consistency in optimal water levels.

8.3 Role of the RSPB

The Brading Marshes SSSI are managed by the RSPB, who undertake extensive habitat management to restore and enhance wetland habitats within the marshes to encourage the presence of bird species. The RSPB state that the work it has carried out on the marshes has ensured better control of water levels, thus, minimising the risk of flooding in Brading. It is understood the RSPB is also a significant landowner in the Brading Marshes and has purchased land for the purposes of habitat creation.

River level data, covering Autumn/Winter 2023, was obtained by the RSPB at three locations between the Bembridge sluices and Sandown along the Eastern Yar. This data is shown in Table 8- 1.

Location of river level logger	Date	Time	Maximum river level (m AOD)
Upstream of Yarbridge in the vicinity of Nicholas Close tributary	02/11/2023	04:00	1.42
Between Yarbridge and Great/Middle sluices	02/11/2023	09:00	1.00
Between Great/Middle sluices and Bembridge	05/11/2023	20:00	0.5

Figure 8- 1: River level data obtained by the RSPB at three locations along the Eastern Yar during Autumn/Winter 2023

8.4 Summary

The review of the information provided by the Environment Agency is inconclusive in determining whether the management of the Brading Marshes has exacerbated flood risk to Brading, It is plausible (although not proven), based on the topographical and hydrological characteristics that increased water levels in the Brading Marshes could have resulted in or exacerbated flood risk to properties in Nicholas Close and the A3055 at Morton Common.

Any review of the WLMP should include an outcome or clear understanding of the roles and responsibilities of the RSPB and their relationship with the Environment Agency.

The Land Drainage Act 1991 outlines that it would be unacceptable for works by riparian landowners to result in worsening flood risk impacts to existing properties. The Land Drainage Act provides the LLFA with a clear route to seeking resolution in such circumstances, and negotiating with relevant landowners is key to ensure appropriate actions and/or works are carried out to help mitigate flooding.

9 Subsequent actions

9.1 Community Recovery Grant

Flooded households in affected areas were able to apply for up to £500 to get cash quickly to help with immediate costs. The grant was available to anyone whose primary home suffered internal flood damage, or for people who were not able to live in their property, as a direct result of Storm Babet between 19 and 25 October 2023. Flooded households were also eligible for a 100 per cent council tax discount for a minimum of three months — this means affected residents did not have to pay council tax during this period.

9.2 Business Recovery Grant

Small-to-medium sized businesses were eligible for up to £2,500 from the Business Recovery Grant to help them return quickly to business as usual. The business had to be a Small and Medium Sized Enterprise (SME) at the point of grant award.

The business must have been trading at and/or from the property at the point that the property was impacted by Storm Babet. For the purposes of this grant scheme, a business is trading if it is engaged in business activity. The business must have been either:

- Directly impacted by Storm Babet for instance the business suffered flood damage to the property, or
- Indirectly impacted by Storm Babet for instance access to the business premises is severely restricted as a result of flooding, including restricted access for customers, suppliers or staff.

Businesses that have not been able to operate due to flooding at their premises may be eligible for 100 per cent Business Rates Relief for a minimum of three months.

9.3 Property Flood Resilience grant

Isle of Wight Council is administering a Property Flood Resilience grant on behalf of DEFRA, for properties affected by flooding between 19 – 25 October 2023. Eligible property owners (both domestic and commercial) can apply for up to £5,000 (including VAT) towards the cost of flood resilience and recoverability measures. Up to £800 of the grant must be for survey costs.

9.4 Environment Agency

Following the flooding in 2021 and 2023, EA Asset Performance and PSO Teams have carried out the following activities in Brading:

- Requested that Network Rail carry out essential culvert clearances under the railway line
- Reviewed the maintenance schedule and extended the winter setting period of the tilting weir and drop boards on Great and Middle Sluice allowing more water onto the marsh.



- Continued to follow procedures in managing the water levels as set out in the Brading Marshes WLMP
- Six properties on Nicholas Close have been fitted with Property Flood Resilience measures
- PSO Officers continue to support and reassure residents in times of flood alerts and warnings.
- Flood Risk Activity Permit issued for the floodplain restoration project by Hampshire and Isle of Wight Wildlife Trust. The project will see the floodplains in the upper catchment of the eastern yar being reconnected providing water storage in times of high flows. This project is now underway and has already seen an increase in floodplain storage.



10 Preliminary appraisal

10.1 Multi-criteria analysis methodology

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 to reducing flood risk to property.
- Contribution towards reducing flood impacts to people/communities.
- Contribution to improving the availability of data, evidence and modelling to support options for development or flood incident response.
- Deliverability (including construction complexity, access, designations, space, land ownership, availability of resources, equipment or advice required)
- Community acceptability
- Contribution towards biodiversity and water quality betterment
- Amenity benefits
- Contribution towards carbon reduction
- Maintenance requirements

Relative costs and timescales have been provided for information only and are not included in the scoring. The scoring criteria is provided 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 on behalf of Isle of Wight Council. The LLFA must adopt a strategic approach to flood risk management by integrating recommendations from this Section 19 into the broader Local Flood Risk Management Strategy (LFRMS), to ensure that localised action aligns with longterm objectives, funding and resources. In particular, where taking forward a recommendation is likely to be reliant on securing grants from central government to fund the project, 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 being 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

10.2 Long list of options

Based on the identified causes and mechanisms of flooding, the long list of options below have been identified and brought forward for assessment in the Multi-Criteria Analysis (Appendix A) to produce a short list of suitable recommendations.

10.2.1 Multi-agency review of Water Level Management Plan

Based on an initial review of the data supplied by the Environment Agency, it is recommended that the Water Level Management Plan and existing hydraulic modelling of the Brading Marshes and Eastern Yar is reviewed to understand its suitability for assessing flood risk impacts. Following discussions with the Environment Agency, it is understood that the data supplied is the best available information, however it is unclear whether this is still suitable given the age of the plan and supporting evidence.

The modelling techniques described in the 2009 FRA do not appear to be suitable to fully understand the hydraulic interactions between structures and features, if this is the case a new hydraulic model may be required to understand the impacts of implementing the WLMP. A review of the existing modelling will help determine:

- Whether the current WLMP is appropriate for managing water levels in the Brading Marshes, with consideration to flood risk;
- If new hydraulic modelling is needed to refine the current understanding of risk and considering the impacts of climate change;
- Whether any interventions or changes to the WLMP and how this is currently being implemented are required.

It is recommended that a collaborative, multi-agency review of this plan is undertaken by the Environment Agency, RSPB, Isle of Wight Council and other key stakeholders to understand whether the plan remains suitable and whether any additional evidence may be required to support its implementation, or if necessary, make changes to the plan.

10.2.2 Partnership working group

It is recommended that a partnership working group in Brading, involving the EA, residents, landowners (such as RSPB) and other Risk Management Authorities is established to manage water levels in the Brading Marshes. This would involve a collaborative approach with broader consultation whereby relevant partners and residents agree on a new or revised strategy for water level management of the Brading Marshes.

10.2.3 Improved asset maintenance and management

It is understood that concerns have been raised over the management of a Network Rail culvert (asset EW1-28), where the ordinary watercourse adjacent to Nicholas Close passes under the Island Line. Residents have identified that this culverted has been silted up and could increase flood risk if not functioning, it has been noted to have been three years since this culvert was cleared. It is recommended that this asset is prioritised for maintenance and management. Whilst there is no evidence this has contributed to the flooding experienced, it has the potential to lead to flooding of these properties if not adequately maintained.



Figure 10-1: Culvert/ bridge under the Island Line

10.2.4 Review condition and capacity of wastewater pumping station

This investigation has not identified the pumping station in Nicholas Close as being a cause of the flooding, however foul sewage has been in flood water and residents have identified issues with toilets functioning during flood events. It is recommended that the condition and capacity of this pumping station is investigated. Furthermore, opportunities to prevent ingress of flood water into the sewer network in Nicholas Close should be considered.

Further investigation of the ownership and condition of the pipes under No. 6 and 7 Nicholas Close is also recommended.

Additionally, ongoing conversation between the EA and Island Roads/ IWC is taking place regarding scour protection of the Yar bridge, and whether the potential reduction may increase flow capacity under the main road.

JRA

11 Conclusion and recommendations

11.1 Conclusions

The flooding that occurred in Brading on 25 October 2023 caused internal flooding to at least 6 properties. Isle of Wight Council, as the Lead Local Flood Authority, has exercised its power to undertake a Section 19 investigation, as the event fulfilled its criteria of '*Internal flooding of one property has been experienced on more than one occasion*' and '*a single flood incident resulted in flooding that affects vulnerable individuals*'. The council has appointed JBA Consulting to undertake this investigation on its behalf. Highway flooding is also common in Brading, with the A3055 at Morton Common, which is a key transport link being frequently affected over the past year with multiple instances of road closures.

FEH22 has been used to estimate return periods for known historic flood events in Brading, including 25 Oct 2023 based on data from the Knighton rain gauge. It is evident that the 2014 events in isolation were relatively insignificant, with return periods of approximately 1 in 1 and 1 in 2.5 years respectively. The event on 24th October 2013 was slightly more significant, with an estimated return period of approximately 1 in 25 years. These historic rainfall events were much less significant than the one experienced on 25 October 2023 (1 in 322), which can be classified as an extreme and infrequent rainfall event.

Due to this range of return periods the flooding at Nicholas Close is not likely to be solely linked to extreme rainfall events. Consequently, antecedent conditions or other factors are likely to be the driving cause of this flooding.

Key plans and strategies have been reviewed as part of this Section 19 investigation, which includes the Brading Marshes Water Level Management Plan (WLMP), which was prepared and published by the Environment Agency, working in partnership with Natural England. This along with supporting documentation has been reviewed to determine whether proposals to change water levels in the Brading Marshes could have exacerbated flood risk.

This review has highlighted some concerns with regard to the hydraulic modelling approach used as a basis for the WLMP, including:

- The modelling software used
- The modelling approach
- Modelled return periods
- Consideration of climate change.
- Lack of clarity with regard to assumptions used in the modelling.

Based off the information provided for use in this Section 19 investigation (which is assumed to be the best available information) the modelling included in this FRA may not be sufficient to adequately assess the flood risk impacts of the Brading Marshes WLMP and it is highly recommended that a multi-agency review of the Brading Marshes WLMP is



undertaken to understand whether water level management of the marshes remains appropriate based on current understanding of flood risk.

Furthermore, it is unclear what subsequent actions have been undertaken by the Environment Agency, Natural England or landowners in implementing the WLMP. The Land Drainage Act 1991 clearly outlines that it would be unacceptable for works by riparian landowners to result in worsening flood risk impacts to existing properties.

Several agencies have been involved in responding to the flooding in Brading, including Isle of Wight Council, Island Roads and Southern Water. It is evident that Southern Water deployed 5 tankers to Nicholas Close following the 2023 flooding in order to transfer the sewage filled water to Sandown Wastewater Treatment Works.

11.2 Recommendations

Carefully considering all possible recommendations for Brading to mitigate future flood events, the following recommendations are highlighted.

It is recommended that all options with a score of 12 or greater are prioritised for delivery, which includes all options identified in the multi-criteria analysis.

Recommendation	Organisation (s) responsible	Multi-criteria analysis score	Timescale
Multi-agency review of Water Level Management Plan	Environment Agency, RSPB, IWC	12	<1 year
Improved asset maintenance and management	Environment Agency, Southern Water, Network Rail, Island Roads, IWC	13	<1 year
Review condition and capacity of wastewater pumping station at Nicholas Close	Southern Water	12	<1 year

Table 21-1: Options that are recommended to be prioritised for delivery in Brading



A Multi-Criteria Analysis

As part of the Brading 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.

Multi-criteria analysis category	Assessment criteria					
Contribute towards reducing	Increase in flood risk to any property					
flood risk to property	No perceived change					
	Reduction in flood risk to property					
Contribute toward reducing	Major / minor negative change in flood					
flood impacts on	impacts on people/communities					
people/communities	No perceived change					
	Minor / medium / major positive change in					
	flood impacts on people/communities					
Contribute to improving the	Does not improve the availability of data,					
availability of data, evidence	evidence and modelling					
development or flood incident	Will provide additional data, evidence or					
response	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					

Table 3: Criteria used to assess long list options

Multi-criteria analysis category	Assessment criteria			
	Deliverability is at low risk of complexity/constraints			
Community / resident acceptability	Community/residents are likely to have objections			
	No known objections / constraints			
	Community/residents are likely to be receptive and have no constraints			
Contribute towards biodiversity	Significant detriment			
and water quality betterment	No perceived change			
	Significant betterment			
Contribute towards amenity	Significant detriment			
benefits	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			

JBA consulting

Long-list options results

Recommendation	Organisation (s) responsible	Multi-criteria analysis score	Timescale
Do nothing	N/A	-2	N/A
Business as usual	N/A	0	N/A
Multi-agency review of Water Level Management Plan	Environment Agency, RSPB, Isle of Wight Council	12	<1 year
Establish a partnership working group for the Brading Marshes	Environment Agency/ Isle of Wight Council	8	<1 year
Improved asset maintenance and management	Environment Agency, Southern Water, Network Rail, Island Roads, Isle of Wight Council	13	<1 year
Review condition and capacity of wastewater pumping station at Nicholas Close	Southern Water	12	<1 year

Table 4: Multi-criteria analysis total scores for long list options



Brading Section 19 Investigation Multi-Criteria Appraisal Matrix

Originated	Grace Sheppard	24/06/2024
Checked	Peter Rook	01/07/2024
Approver	Anna Beasley	02/07/2024

Evaluation Scoring: See tab 'Scoring Criteria' for details

			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	NA	-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	Undertake multi-agency review of Brading Marshes WLMP	Environment Agency	0	0	5	2	1	0	0	0	0	4	5	12
4	Establish a partnership working group for the Brading Marshes	Environment Agency/Isle of Wight Council	0	0	0	2	1	0	0	0	0	5	5	8
5	Improved asset maintenance and management	Environmnet Agency, Southern Water, Island Roads, Network Rail	1	3	2	1	1	0	0	0	0	5	5	13
E	Review condition and capacity of wastewater pumping station in Nicholas Close	Southern Water	0	0	5	2	0	0	0	0	0	5	5	12



B Brading WLMP FRA Figures





Figure 2. Graphical representation of flood risk indicators.





Figure 4. The 1% annual probability fluvial flood event used in the assessment.



Figure 5. The tidal boundary condition used in the assessment.







(b) Harbour Farm (floodplain)





1.30 WLMP Base Case Agricultural land threshold level 1.10 Mitigation Bank level 0.90 Level (m OD) 0.70 0.50 Fields C & F Field B 0.30 Field D Fields A & E 0.10 -0.10 01-Nov 02-Nov 03-Nov 04-Nov 05-Nov 06-Nov 07-Nov

(d) Upstream Great Sluice (floodplain ditch)



(f) Yaverland (floodplain)



(e) Upstream of Yar Bridge (in-river)



(g) Wastewater Treatment Works (floodplain)





(a) Flood magnitude

Assessment Point	Location	Flood magnitude (m OD)				
		Base Case	WLMP	Mitigation		
Α	Brading Marshes (Left Bank)	0.65	0.65	0.65		
В	Harbour Farm	0.65	0.65	0.65		
С	Downstream Great and Little Sluice	0.67	0.67	0.67		
D	Upstream Great and Little Sluice	0.93	0.94	0.93		
E	Upstream Yar Bridge	1.54	1.54	1.54		
F	Yaverland	1.54	1.55	1.54		
G	SW WTW	1.55	1.55	1.55		
Н	Sandown Marshes	1.55	1.55	1.55		

(b) Change relative to base-case

Assassment Point	Location	Scenario		
Assessment Point	Eocation	WLMP	Mitigation	
Α	Brading Marshes (Left Bank)	0.00	0.00	
В	Harbour Farm	0.00	0.00	
С	Downstream Great and Little Sluice	0.00	0.00	
D	Upstream Great and Little Sluice	0.01	0.00	
E	Upstream Yar Bridge	0.00	0.00	
F	Yaverland	0.00	0.00	
G	SW WTW	0.00	0.00	
Н	Sandown Marshes	0.00	0.00	

Table 1. (a) Flood magnitude at each model assessment point under the base-case, WLMP and mitigation scenarios and (b) changes relative to the base case.

			Base-case (-1.00m OD)	WLM	P (-0.2m OD)		Mi	tigation	
	LOCATION	THRESHOLD LEVEL (m OD)							
			Duration (hrs)	Duration (hrs)	Change (hrs)	%	Duration (hrs)	Change (hrs)	%
Brading	Harbour Farm Main	0.90	0.00	0.00	0.00	0%	0.00	0.00	0%
Marshes	Harbour Farm Cottage	0.62	1.75	1.75	0.00	0%	1.75	0.00	0%
	5 Nicholas Close	1.36	27.50	28.00	0.50	2%	27.25	-0.25	-1%
	6 Nicholas Close	1.42	21.25	21.75	0.50	2%	21.25	0.00	0%
	9 Nicholas Close	1.91	0.00	0.00	0.00	0%	0.00	0.00	0%
	10 Nicholas Close	1.92	0.00	0.00	0.00	0%	0.00	0.00	0%
u/s of	11 Nicholas Close	2.18	0.00	0.00	0.00	0%	0.00	0.00	0%
Brading	SW works	2.50	0.00	0.00	0.00	0%	0.00	0.00	0%
Brauing	Yaverland 1	1.98	0.00	0.00	0.00	0%	0.00	0.00	0%
marsnes	Yaverland 2	1.93	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 3	2.13	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 4	2.28	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 5	2.13	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 6	2.14	0.00	0.00	0.00	0%	0.00	0.00	0%

(a) Residential properties

(b) Agricultural land

			Base-case (-1.00m OD)	WLM	P (-0.2m OD)		Mit	igation	
	LOCATION	THRESHOLD LEVEL (m OD)							i i i i
			Duration (hrs)	Duration (hrs)	Change (hrs)	%	Duration (hrs)	Change (hrs)	%
	Landowner B (Field 1)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner B (Field 2)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner B (Field 3)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner B (Field 4)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
Brading	Landowner B (Field 5)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
Marshes	Landowner B (Field 6)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner B (Field 7)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner B (Field 8)	0.10	65.25	65.50	0.25	0%	66.50	1.25	2%
	Landowner E (Field 1)	0.50	13.50	13.75	0.25	2%	13.50	0.00	0%
	Landowner C (Field 1)	0.22	53.25	55.00	1.75	3%	55.50	2.25	4%
	Landowner G (Field 1)	0.20	91.50	108.50	17.00	19%	92.50	1.00	1%
	Landowner G (Field 2)	0.35	89.50	104.75	15.25	17%	88.75	-0.75	-1%
	Landowner G (Field 3)	0.40	87.75	103.50	15.75	18%	87.50	-0.25	0%
	Landowner G (Field 4)	0.25	91.50	107.75	16.25	18%	92.00	0.50	1%
u/s Brading	Landowner G (Field 5)	0.20	91.50	108.50	17.00	19%	92.50	1.00	1%
Marshes	Landowner G (Field 6)	0.40	87.75	103.50	15.75	18%	87.50	-0.25	0%
	Landowner H (Field 1)	0.80	72.50	88.50	16.00	22%	70.00	-2.50	-3%
	Landowner I (Field 1)	0.55	90.00	103.00	13.00	14%	89.75	-0.25	0%
	Landowner J (Field 1)	0.75	76.50	91.00	14.50	19%	75.50	-1.00	-1%
	Landowner J (Field 2)	0.90	63.00	66.50	3.50	6%	61.75	-1.25	-2%

Table 2. Table summarising the duration of flooding at each asset under the base-case, WLMP and mitigation scenarios and changes relative to the base case.

		Base-case (-1.00m OD)	WLN	1P (-0.2m OD)			Mitigation	
	LOCATION	Area (m/brs)	Area (m/brs)	Change (m/brs)	0/_	Area (m/brs)	Change (m/brs)	0/_
Brading	Harbour Farm Main	0.00	0.00	0.00	0%	0.00	0.00	0%
Marshes	Harbour Farm Cottage	0.02	0.02	0.00	1%	0.02	0.00	0%
	5 Nicholas Close	0.78	0.79	0.01	1%	0.77	-0.01	-1%
	6 Nicholas Close	0.41	0.42	0.01	3%	0.40	-0.01	-2%
	9 Nicholas Close	0.00	0.00	0.00	0%	0.00	0.00	0%
	10 Nicholas Close	0.00	0.00	0.00	0%	0.00	0.00	0%
u/s of	11 Nicholas Close	0.00	0.00	0.00	0%	0.00	0.00	0%
Brading	SW works	0.00	0.00	0.00	0%	0.00	0.00	0%
Brauing	Yaverland 1	0.00	0.00	0.00	0%	0.00	0.00	0%
marsnes	Yaverland 2	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 3	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 4	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 5	0.00	0.00	0.00	0%	0.00	0.00	0%
	Yaverland 6	0.00	0.00	0.00	0%	0.00	0.00	0%

(a) Residential properties

(b) Agricultural land

		Base-case (-1.00m OD)	WLN	IP (-0.2m OD)		Ν	litigation	
	LOCATION							
		Area (m/hrs)	Area (m/hrs)	Change (m/hrs)	%	Area (m/hrs)	Change (m/hrs)	%
	Landowner B (Field 1)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner B (Field 2)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner B (Field 3)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner B (Field 4)	16.56	16.87	0.31	2%	16.91	0.35	2%
Brading	Landowner B (Field 5)	16.56	16.87	0.31	2%	16.91	0.35	2%
Marshes	Landowner B (Field 6)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner B (Field 7)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner B (Field 8)	16.56	16.87	0.31	2%	16.91	0.35	2%
	Landowner E (Field 1)	0.96	0.99	0.03	3%	0.97	0.01	1%
	Landowner C (Field 1)	10.03	10.28	0.24	2%	10.26	0.23	2%
	Landowner G (Field 1)	12.62	15.29	2.67	21%	12.41	-0.21	-2%
	Landowner G (Field 2)	9.20	11.28	2.08	23%	8.99	-0.21	-2%
	Landowner G (Field 3)	8.10	9.98	1.88	23%	7.89	-0.21	-3%
	Landowner G (Field 4)	11.48	13.94	2.46	21%	11.26	-0.22	-2%
u/s Brading	Landowner G (Field 5)	12.62	15.29	2.67	21%	12.41	-0.21	-2%
Marshes	Landowner G (Field 6)	8.10	9.98	1.88	23%	7.89	-0.21	-3%
	Landowner H (Field 1)	7.60	7.98	0.39	5%	7.50	-0.09	-1%
	Landowner I (Field 1)	12.81	14.02	1.21	9%	12.65	-0.16	-1%
	Landowner J (Field 1)	8.53	9.11	0.58	7%	8.42	-0.12	-1%
	Landowner J (Field 2)	5.92	6.11	0.19	3%	5.86	-0.06	-1%

Table 3. Table summarising the area under the hydrograph for each asset under the base-case, WLMP and mitigation scenarios and changes relative to the base case.

	LOCATION	Base-case (-1.00m OD)	WLMP (-0.2m OD)	Mitigation
Brading	Harbour Farm Main	No flooding	No flooding	No flooding
Marshes	Harbour Farm Cottage	03/11/2010 22:00	03/11/2010 22:00	03/11/2010 22:00
	5 Nicholas Close	03/11/2010 01:30	03/11/2010 01:15	03/11/2010 01:45
	6 Nicholas Close	03/11/2010 03:15	03/11/2010 03:00	03/11/2010 03:15
	9 Nicholas Close	No flooding	No flooding	No flooding
	10 Nicholas Close	No flooding	No flooding	No flooding
u/s of	11 Nicholas Close	No flooding	No flooding	No flooding
Brading	SW works	No flooding	No flooding	No flooding
Brauing	Yaverland 1	No flooding	No flooding	No flooding
marsnes	Yaverland 2	No flooding	No flooding	No flooding
	Yaverland 3	No flooding	No flooding	No flooding
	Yaverland 4	No flooding	No flooding	No flooding
	Yaverland 5	No flooding	No flooding	No flooding
	Yaverland 6	No flooding	No flooding	No flooding

(a) Residential properties

(b) Agricultural land

	LOCATION	Base-case (-1.00m OD)	WLMP (-0.2m OD)	Mitigation
	Landowner B (Field 1)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner B (Field 2)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner B (Field 3)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner B (Field 4)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
Brading	Landowner B (Field 5)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
Marshes	Landowner B (Field 6)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner B (Field 7)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner B (Field 8)	02/11/2010 06:00	02/11/2010 05:15	02/11/2010 05:00
	Landowner E (Field 1)	03/11/2010 07:30	03/11/2010 07:30	03/11/2010 07:30
	Landowner C (Field 1)	02/11/2010 09:45	02/11/2010 08:30	02/11/2010 08:15
	Landowner G (Field 1)	02/11/2010 01:45	01/11/2010 08:45	02/11/2010 00:45
	Landowner G (Field 2)	02/11/2010 02:00	01/11/2010 12:30	02/11/2010 01:45
	Landowner G (Field 3)	02/11/2010 02:15	01/11/2010 13:45	02/11/2010 01:45
	Landowner G (Field 4)	02/11/2010 01:45	01/11/2010 09:30	02/11/2010 01:15
u/s Brading	Landowner G (Field 5)	02/11/2010 01:45	01/11/2010 08:45	02/11/2010 00:45
Marshes	Landowner G (Field 6)	02/11/2010 02:15	01/11/2010 13:45	02/11/2010 01:45
	Landowner H (Field 1)	02/11/2010 04:30	02/11/2010 04:00	02/11/2010 06:30
	Landowner I (Field 1)	02/11/2010 02:00	01/11/2010 14:15	02/11/2010 01:15
	Landowner J (Field 1)	02/11/2010 02:30	02/11/2010 02:15	02/11/2010 02:15
	Landowner J (Field 2)	02/11/2010 11:00	02/11/2010 09:30	02/11/2010 12:00

Table 4. The start of the flood at each residential property under the base-case, WLMP and mitigation scenarios.





JBA consulting

Offices at

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

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

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

Jeremy Benn Associates Limited

Registered in England 3246693

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