

FLOOD EVENT INVESTIGATION WEST KIRBY 09 APRIL 2024

Lead Local Flood Authority investigation into the flood event of 09 April
2024 at West Kirby, Wirral

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EXECUTIVE SUMMARY

This investigation identifies the causes and effects of flooding to South Parade, West Kirby on Tuesday 9th April 2024.

Storm Pierrick, as named by the French meteorological service Météo France, was coincident with high spring tides. This combination of conditions resulted in flooding of the highway and 3 residential properties and a store-room to a business at South Parade.

The predicted high tide at Hilbre Island, of 4.92m Above Ordnance Datum (mAOD), was accompanied by locally recorded conditions of gale force winds from a west north-westerly direction along with a surge of approximately 1.0m. Offshore wave heights of 3.5m were recorded in Liverpool Bay. Nearshore bathymetry transforms offshore waves of this stature to waves approximately 1.0m high inshore. A combination of these conditions resulted in a sea level that submerged the old sea wall at South Parade. The waves hitting the new flood defence at force and the water from those reflected waves being carried by the strong north westerly wind resulted in an accumulation of water on the highway behind the wall, with the lowest points of South Parade impacted the most.

The Highway drainage was initially unable to drain the water away due to a combination of tide-locking due to the height of the tide above the outfalls and operational problems with the highway drainage system as a result of water borne debris.

The accumulation of water from the reflected waves and spray resulted in flooding to 3 residential properties and the storage area of a local business. Parts of Coronation Gardens were flooded. Water was retained on the carriageway and landward footway in the lowest parts of South Parade due to a tide locked highway drainage system. The water that had accumulated drained overland to the south and eventually through the highway drainage system once tide-locking ceased. The highway was clear of most standing water after 4 hours.

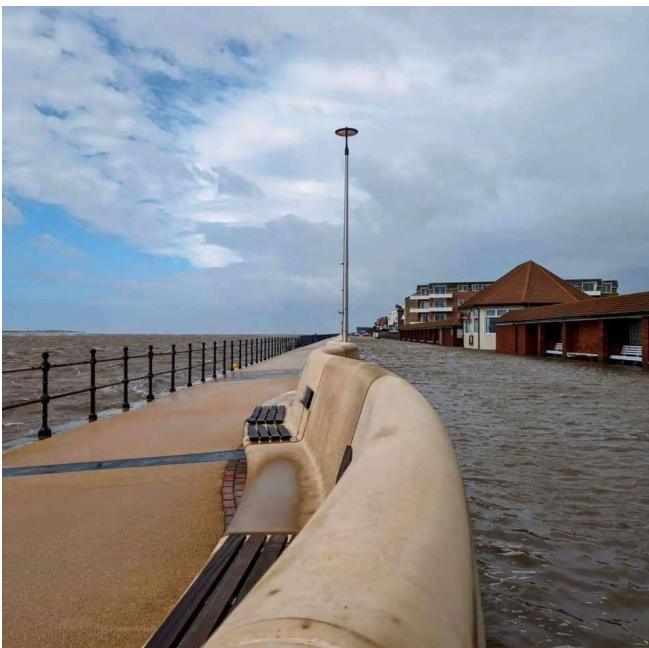


Figure 1 Standing water on highway maximum depth approximately 200mm

1 INTRODUCTION & BACKGROUND

Section 19 of the Flood and Water Management 2010 places a duty on Wirral Council as the Lead Local Flood Authority (LLFA) to record, investigate and report flood incidents where it considers it 'necessary and appropriate'.

Section 19 : Flood and Water Management Act 2010

- 1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate—
 - (a) Which risk management authorities have relevant flood risk management functions, and
 - (b) Whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
- 2) Where an authority carries out an investigation under subsection (1) it must—
 - (a) Publish the results of its investigation, and
 - (b) Notify any relevant risk management authorities

This section of the Act leaves the determination of the extent of flood investigation to the LLFA. It is not practical or realistic for Wirral Council to carry out a detailed investigation into every flood incident that occurs, but the LLFA will, at a minimum, record details of every flood incident of which it is made aware.

Wirral Council adopted its Section 19 Flood Investigation Policy in April 2012. This sets out when the Council, as LLFA, deems a flooding incident as 'significant' and therefore will undertake a formal Section 19 Flood Investigation and publish the results of this investigation.

Wirral Council Flood Investigation Policy (2012)

For the purpose of reporting Flood Investigations, a flooding incident is deemed significant if it:

- Caused internal flooding to 8 or more residential properties/business premises within a kilometre square area;
- Flooded one or more items of critical infrastructure e.g., a pumping station, an emergency services station, electricity sub-station, hospital etc, or;
- Caused a transport link to be totally impassable for a significant period.
 - o **Category 1:** highways (motorways) and rail links – 1 hour or more
 - o **Category 2 and 3a highways:** 2 hours or more
 - o **Category 3b, 4a, 4b highways:** 4 hours or more

Although the locally agreed triggers that would ordinarily launch a Section 19 Flood Investigation have not been met in this instance, the issues that occurred during and immediately following the storm of the 9th April 2024 at South Parade West Kirby have been the focus of much public interest. For this reason, Wirral Council in its role as Lead Local Flood Authority has undertaken an investigation into those events.

2 ROLES AND RESPONSIBILITIES OF RISK MANAGEMENT AUTHORITIES AND OTHERS

The legal framework for managing flood risks lies with a number of different ‘risk management authorities’ as defined under Section 6(13) of the Flood and Water Management Act 2010.

The key responsibilities for each risk management authority are outlined in the sections below.

2.1 Wirral Council

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

Wirral Council hosts three risk management authorities:

(i) Lead Local Flood Authority (LLFA)

As the Lead Local Flood Authority (LLFA), Wirral Council is responsible for managing the risk of flooding from ‘local’ sources which includes surface water, groundwater and watercourses that are classified as ‘ordinary watercourses’.

The LLFA has a responsibility to investigate flood incidents where it is considered ‘necessary and appropriate’. As part of this role, Wirral Council holds Operational Flood Group Meetings with other flood Risk Management Authorities (RMAs) to discuss and report on flood risk management.

The LLFA does not have an operational role in responding to flooding during a flood incident, however it does have a post-event responsibilities.

(ii) Highway Authority

As the Highway Authority, Wirral Council is responsible for managing the risk of flooding on the adopted highway.

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

The Highway Authority does have an active role in responding to flooding from the highway during flood incidents and will respond to call outs during flood incidents.

(iii) Coast Protection Authority

As the Coast Protection Authority, Wirral Council is responsible for managing the risks of flooding and erosion at the coast.

2.2 Environment Agency

The Environment Agency has a strategic overview role and responsibility for flood and coastal erosion risk management in England. The Environment Agency is also a risk management authority with responsibility for managing the risk of flooding from watercourses classified as 'Main Rivers' and the sea.

The Environment Agency has permissive powers to issue flood warnings to communities at risk of flooding. It should be noted that is a permissive power and is not a statutory duty.

The Environment Agency has an active role in responding to flooding from Main Rivers and the sea during flood incidents.

2.3 Local Residents

Where residents are aware that they are at risk of flooding it is their responsibility to ensure that they and their properties are protected. Residents should report flooding incidents or potential problems to the LLFA or appropriate risk management authority if known.

3 FLOOD INCIDENT DETAILS

3.1 Overview

On Tuesday 09 April 2024 Storm Pierrick, as named by the French meteorological service Meteo France, arrived a few days after storm Kathleen (as named by the UK Met Office). The low-pressure system brought strong winds and rain that coincided with high spring tides leading to significant inland and coastal flooding around the country.

- A coastal holiday village at Bracklesham in West Sussex experienced severe flooding that injured as many as 100 people and triggered a major rescue operation.
- Persistent frontal rain affected NE England and E Scotland on the 09 April and resulted in road flooding and the temporary closure of the East Coast Main Line between Newcastle and Morpeth.
- The impact of the storm moved north from the south coast to North Wales, where strong winds brought coastal flooding to several communities. Flooding occurred on Llanfairfechan promenade, and severe damage was caused to Craig y Don promenade in Llandudno. Seawater overtopped defences at Kinmel Bay, spilling into Golden Sands Holiday Park and affecting Sandy Bay. It is estimated that between 10 and 20 properties were isolated by the flood.

Forecast wind, wave, tide and surge conditions triggered the operation of the West Kirby Flood Alleviation Scheme Operational Plan by the Coast Protection Authority. The plan sets out the full closure of the West Kirby Flood Alleviation scheme through installation of demountable boards and closure of mechanical gates.

At West Kirby, conditions were such during the flood event that the crest of the old sea wall was exceeded with waves travelling over the promenade where they were reflected vertically against the new flood wall. Onshore winds had sufficient strength to blow significant volumes of water over the new flood wall onto the carriageway. This process, as evidenced by video footage of the event, lasted for approximately 1.5 hours either side of the 12:02 BST high water at Hilbre and resulted in a significant volume of water on the highway. Whilst the new flood defence was effective at stopping travelling waves from moving across the highway to properties on South Parade there was still sufficient energy in the overtopped water to move vehicles parked along South Parade.

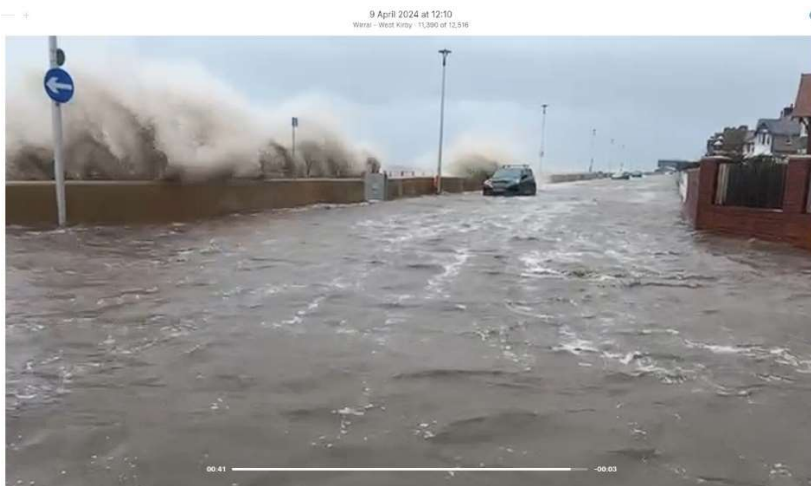


Figure 2 Conditions at High Water on 09 April 2024

Water entered three properties and the storage areas of a local business. The depth of water was also sufficient to reach part of Coronation Gardens.

Elsewhere on Wirral flooding and damage also occurred to areas of New Brighton and Meols. At Kings Parade, New Brighton, overtopping reached the highway with a large volume of water contained by the flood defences on Ian Fraser Walk. The Fort Perch Rock car park was inundated and tidal water reached the landward side of Marine Promenade.

In Meols, tidal water reached the landward side of Meols Parade, flooding some driveways with damage occurring to the sea wall coping and promenade surfacing.

3.2 Meteorological Conditions

Meteorological conditions are recorded at West Kirby. During the high water period on 09 April 2024 winds of speed 45 mph in a west-north-west (WNW) direction were recorded. This equates to Force 9 on the Beaufort wind scale.

3.3 Tide & Wave Data

The predicted height of the tide at Liverpool on 09 April 2024 at 12:30 PM (BST) was 5.30m Above Ordnance Datum (AOD). Tidal predictions for Hilbre Island gave a predicted height of 4.92m AOD at 12:02 PM (BST).

The National Tidal and Sea Level Facility run by the National Oceanographic Centre were predicting a surge (uplift) on the predicted tide levels of approximately 0.3m.

The recorded tide level at Liverpool was 5.52m AOD. Data is not recorded at Hilbre Island.

[Latest forecasts \(residual\)](#) | [Latest forecasts \(total level\)](#) | [Archived 0–6hr forecast](#) | [Archived fore](#)

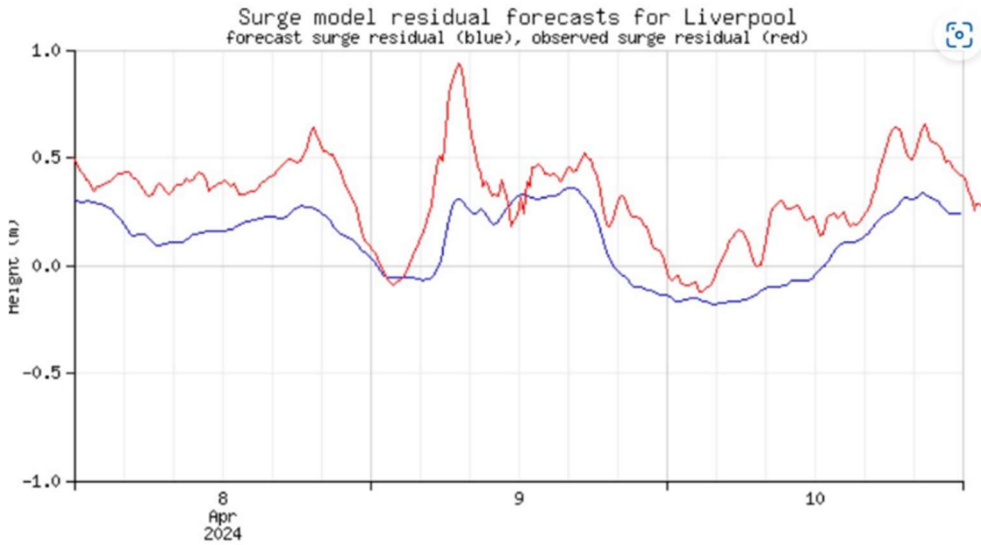


Figure 3 Forecast and observed surge data for Liverpool

It can be seen from Figure 3 above that a more significant surge occurred during the flood period before high water.

Wave heights are recorded at the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) WaveNet buoy in Liverpool Bay. Forecasts of offshore wave heights of approximately 3.1m were made in the days preceding 09 April 2024. Waves of height 3.55m were recorded at the Liverpool Bay WaveNet buoy during high water period. Waves of this stature will be transformed by underlying bathymetry to heights of approximately 1.0m inshore at West Kirby.

Water level is recorded locally by Wirral Council at West Kirby by means of a water depth pressure transducer. A maximum water level of 6.0m AOD was recorded during the high water period on 09 April 2024. It is likely that local conditions at West Kirby, primarily due to the presence of the Marine Lake which provides an environment for waves to increase in height, are susceptible to wave set up whereby sea levels are elevated due to the presence of breaking waves. On site observations of the old sea wall crest (minimum level 5.5m AOD, maximum level 5.8m AOD) being exceeded during the high water event on 09 April 2024 would provide confidence in the locally recorded mean sea level.

Figure 4 below shows the conditions recorded at the Marine Lake during the event. The dark brown line shows the depth of water recorded relative to Ordnance Datum (OD).

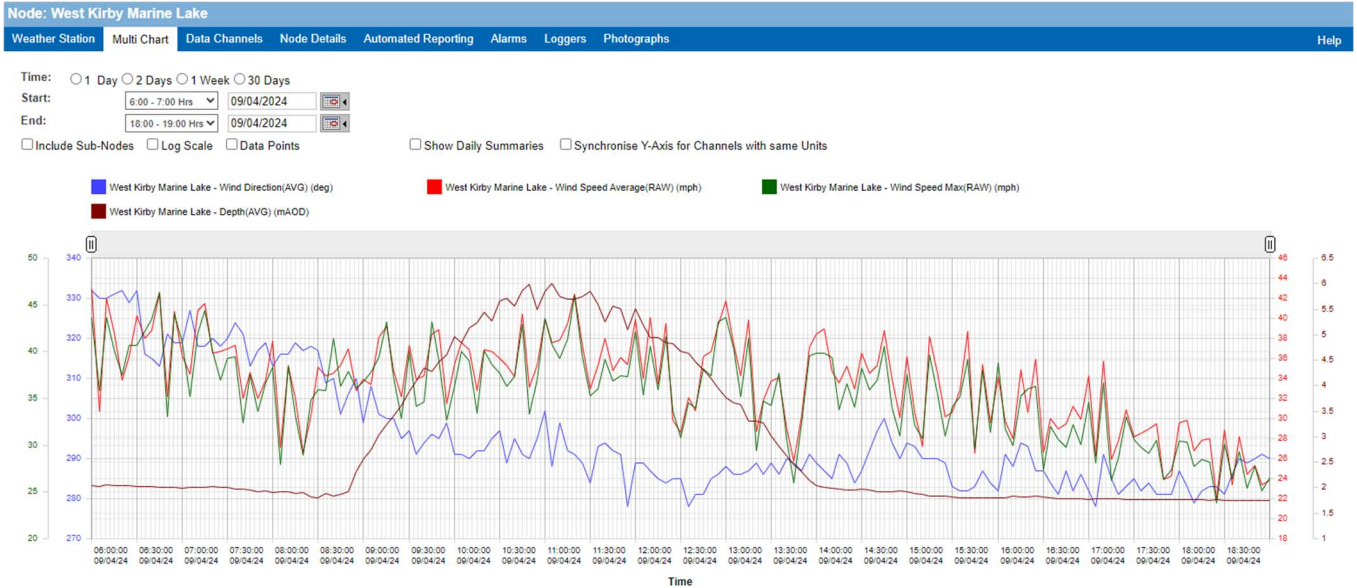


Figure 4 Recorded data, West Kirby 09-04-2024

3.4 Joint Annual Exceedance Probability (AEP)

To determine a joint Annual Exceedance Probability for a tidal flood event the likelihood of two extreme conditions occurring at the same time has to be established. In this instance the two extreme conditions are:

- Mean sea level
- Wave height

HR Wallingford have developed a JOIN-SEA spreadsheet approach which allows data from both variables to be inputted to generate a range of conditions against each joint exceedance probability. Recorded data can then be compared to give an indication of the order of return period.

It needs to be borne in mind however that a range of conditions will provide the same joint annual exceedance probability. For example a relatively normal extreme sea level with very high extreme wave heights may have the same joint annual exceedance probability as a very high extreme sea level with lower magnitude wave heights.

In February 2011, the Environment Agency’s Evidence Directorate published the study Improved Coastal Flood Boundary (CFB) Conditions for the UK mainland and islands. This project, which resulted in the derivation of new extreme sea-level estimates for the whole of the UK, was undertaken as part of the joint Environment Agency/Defra Flood and Coastal Erosion Risk Management Research and Development Programme (SC060064). The CFB data study produced sea-level estimates for a range of return periods at 2km intervals around the coast based on tide gauge data up to the end of 2008 and numerical modelling.

Large coastal storm events in December 2013, January and February 2014 resulted in the highest ever recorded sea-levels at many locations around the UK. In addition to these events, there were also an additional five years of tide gauge data available which was added to the datasets used in the original CFB data study and enabled

the calculation of revised extremes as part of the from West Kirby Extreme Sea-level Review by JBA Consulting in January 2015.

There were four tide gauges in the vicinity of West Kirby that were used in the original CFB data study. These are located at Heysham, Liverpool Gladstone Dock, Hilbre Island and Llandudno.

The West Kirby Extreme Sea-level Review by JBA Consulting in January 2015 considered, and updated the sea levels at Heysham, Liverpool, Hilbre Island and Llandudno. It also updated the CFB data at chainages 1152, 1154 and 1156. Chainage 1154 is the closest to Hilbre island and has been used as the variable to define mean sea level at West Kirby.

An analysis of wave heights, from the CEFAS Wave Buoy, in the 240 degrees to 350 degrees sector has been used as the second variable in the JOIN-SEA analysis.

Table 5 Updated 2014 CFB Data for West Kirby

| Return period (years) | Chainage 1152 Sea-Level (mAOD) | Chainage 1154 (Hilbre Island) Sea-Level (mAOD) | Chainage 1156 Sea-Level (mAOD) | 95% Confidence Intervals (m) |
|------------------------------|---------------------------------------|---|---------------------------------------|-------------------------------------|
| 1 | 5.26 | 5.29 | 5.29 | 0.10 |
| 2 | 5.37 | 5.39 | 5.39 | 0.10 |
| 5 | 5.50 | 5.53 | 5.53 | 0.10 |
| 10 | 5.60 | 5.63 | 5.63 | 0.10 |
| 20 | 5.70 | 5.73 | 5.73 | 0.10 |
| 25 | 5.73 | 5.76 | 5.76 | 0.10 |
| 50 | 5.84 | 5.86 | 5.86 | 0.10 |
| 75 | 5.88 | 5.91 | 5.91 | 0.10 |
| 100 | 5.92 | 5.95 | 5.95 | 0.20 |
| 150 | 5.99 | 6.01 | 6.02 | 0.20 |
| 200 | 6.02 | 6.05 | 6.06 | 0.20 |
| 250 | 6.05 | 6.08 | 6.09 | 0.20 |
| 300 | 6.08 | 6.10 | 6.10 | 0.20 |
| 500 | 6.15 | 6.17 | 6.17 | 0.20 |
| 1000 | 6.24 | 6.26 | 6.26 | 0.30 |
| 10000 | 6.56 | 6.57 | 6.57 | 0.50 |

Water level data is recorded at West Kirby Marine Lake, along with wind speed, direction, barometric pressure, and precipitation. Attained water level at high water was recorded at 6.0m AOD. It should be noted however that data is recorded using a water depth transducer, not a Class A tide gauge, and data recorded is unverified.

Dependence under the JOIN-SEA simplified approach is defined in terms of a dependence factor (ρ) or a correlation factor (CF).

For this, the dependence mapping project provides the following for the Liverpool Bay area

| | |
|---|--------------------|
| Dependence for wave directions from 220°-280° | Modest Correlation |
| Dependence for wave directions from 280°-330° | Independent |
| Dependence for all wave directions | Modest Correlation |

Waves approaching the River Dee and north Wirral coast are sheltered from directions south of west by the Isle of Angelsey and accordingly the independent correlation is appropriate for considerations here.

For the purposes of examination a CF value = 2.4 has been used.

Also, to test the robustness of the values obtained by the methodology, to the degree of correlation between the variables, the calculations were repeated for a CF value = 20 and modest rather than independent correlation.

Table 6 Joint Probability Outputs

| Value of first variable: Interpolated sea level West Kirby 2014 update (mAOD) | Joint exceedance return period (years) | | | | | | |
|---|---|------|---|------|------|------|------|
| | 1 | 5 | 10 | 20 | 50 | 100 | 200 |
| | Value of second variable: | | Inshore wave height at CEFAS (2002 - 2018) | | | | |
| 4.85 | 3.34 | 3.88 | 4.11 | 4.35 | 4.66 | 4.89 | 5.10 |
| 5.20 | 2.57 | 3.11 | 3.35 | 3.58 | 3.89 | 4.13 | 4.36 |
| 5.31 | 2.34 | 2.88 | 3.12 | 3.35 | 3.66 | 3.90 | 4.13 |
| 5.53 | #N/A | 2.35 | 2.58 | 2.82 | 3.13 | 3.36 | 3.60 |
| 5.63 | #N/A | #N/A | 2.35 | 2.59 | 2.90 | 3.13 | 3.37 |
| 5.73 | #N/A | #N/A | #N/A | 2.36 | 2.67 | 2.90 | 3.14 |
| 5.86 | #N/A | #N/A | #N/A | #N/A | 2.36 | 2.60 | 2.83 |
| 5.95 | #N/A | #N/A | #N/A | #N/A | #N/A | 2.37 | 2.60 |
| 6.05 | #N/A | #N/A | #N/A | #N/A | #N/A | #N/A | 2.37 |

Table 7 Joint Probability Analysis

| Date | Recorded Sea Level West Kirby (mAOD) | Recorded Wave Height Liverpool Bay (m) | Analysis of Joint Exceedance Return Period | |
|------------|---|---|---|---------|
| | | | CF = 2.4 | CF = 20 |
| 09-04-2024 | 6.0 | 3.55 | > 1:200 | > 1:200 |

The simplified JOIN-SEA approach allows for an **indication** of the order of the joint annual exceedance probability to be derived. In this instance, given the value of the recorded inshore sea level at West Kirby (6.0m AOD) and offshore waves with a height greater than 2.4m would result in a joint annual exceedance probability of 0.5% or lower.

Similarly offshore waves of 3.55m would result in a joint 0.5% AEP event if the inshore sea level exceeded 5.53m.

3.5 Weather Warnings, Flood Alerts and Timeline

- Fri 5/4/24 – Following email correspondence between WBC & EA from Wed 3rd April onwards, demountables were deployed on the 5th April along with an Overtopping Advisory email issued to cover Sun 7th & Mon 8th tides.
- Sun 7/4/24 - Met Office Yellow Warning for wind issued for 9th April.
- Sun 7/4/24, 08:01 – Flood Alert issued by EA for the possibility of spray overtopping from Hilbre Island to Heswall on the 7th April.
- Sun 7/4/24, 16:07 - Flood Alert issued by EA for the possibility of spray overtopping from Hilbre Island to Heswall on the 8th April.
- Mon 8/4/24, 10:30 - Flood Guidance Issued for 9th April – Medium likelihood of Minor Impact.
- Mon 8/4/24, 11:12 - Overtopping Advisory email issued by WBC. Predicted height for Tues 9th at Liverpool Alfred = 10.21m AOD, 0.3m surge prediction & wind forecast of F7 gusting F9.
- Mon 8/4/24 15:52 - Email from EA advising of probable issuing of Flood Warning for the Tuesday high tide for New Brighton.
- Mon 8/4/24 17:38 - Advisory update issued internally to WBC informing of possibility of EA Flood Warning for New Brighton. No change to predicted conditions.
- Tues 9/4/24 8:03 - EA issue Flood Warning for New Brighton along with Flood Alerts for New Brighton to Hoylake and the Mersey Estuary. Flood Alert for Hilbre Island to Heswall in place.
- Tues 9/4/24 8:26 - Advisory update issued internally to WBC informing of Flood Warning for New Brighton. No change to predicted conditions.
- Tues 9/4/24 10:30 to 11:20 – Mechanical flood gates closed at West Kirby.
- Tues 9/4/24 11:30 – South Parade road barrier closed.
- Tues 9/4/24 Approx. 13:30 to 13:45 – Mechanical flood gates opened.

4 DATA COLLECTION

4.1 Consultation

This Flood Investigation Report has been undertaken in consultation with Risk Management Authorities and others.

Data was requested and received from Risk Management Authorities, Emergency Responders and others involved in the flooding. Table 4 summarises the data provided for use during this Section 19 Flooding Investigation.

Table 8 Data Sources

| Consultee | Information |
|--------------------|--|
| Environment Agency | <ul style="list-style-type: none">• Mean Sea Level data• Wave Height data• Flood Warning & Flood Alert data• Modelling data |
| Local Residents | <ul style="list-style-type: none">• Photographs• Flooding reports• Anecdotal evidence |
| Met Office | <ul style="list-style-type: none">• Flood Guidance Statements |

5 FLOODING MECHANISMS

5.1 Definitions

The following types of flooding are relevant to this Section 19 Investigation Report:

- **Coastal** – Coastal flooding happens when the sea floods onto the land. The most common cause of coastal flooding in the UK is storm surges in conjunction with high tides, where the storm wind creates higher than normal waves.

This investigation has not identified the following sources of flooding:

- **Surface Water**
- **Watercourse**
- **Sewer**
- **Groundwater**
- **Combination**

5.2 Findings of Investigation

The predicted high tide at Hilbre Island, of 4.92m AOD, was accompanied by locally recorded conditions of gale force winds (F9) from a west north-westerly direction. A surge of 0.3m was recorded at Liverpool however inshore monitoring of sea level at West Kirby and observations during the event would indicate that the local effects of the surge and wind caused the tide to attain a level considerably higher.

Offshore wave heights of 3.5m were recorded in Liverpool Bay. Nearshore bathymetry transforms offshore waves of this stature to waves approximately 1.0m high inshore. A combination of these conditions at South Parade resulted in a sea level and wave activity that submerged the old sea wall (minimum crest level of 5.5m AOD, maximum crest level 5.8m AOD). Water from reflected waves as they crashed into the new flood wall was blown onto the highway along the full length of South Parade. This water then flowed to the lowest points of the roadway, typically running from north to south and discharging to sea via the boat yard at West Kirby Sailing Club

The large volume of water generated by the reflected waves and spray blown over the flood wall accumulated on the highway as it was unable to drain away through the highway drainage system due to tide locked outfalls. The result was water holding on the highway for a period of time after the promenade on the seaward side of the wall was able to drain overland to the marine lake by gravity as evidenced in Figure 1.

South Parade was not immediately closed to traffic and the impounded water subsequently formed bow waves when driven through by vehicles contributing to the flooding of 3 residential properties and the storage area of a local business. There was also an ingress of water to Coronation Gardens.

Some of the water drained overland to the south and the standing water that remained on the highway mostly drained down through the highway drainage system once tide-locking ceased, although some areas of ponding required waterborne detritus to be removed from the gullies to facilitate this. See Figure 5 below. Re-opening

of sliding and swing gates also aided the drain down of standing water on the highway. The highway was clear of standing water after 4 hours, although some areas were clear after 2 hours, as evidenced in Figure 6 below.

9 April 2024 at 14:07
Wirral - West Kirby - 11,399 of 12,516



Figure 5 Water retained on the highway 2 hours after high water

9 April 2024 at 14:11
Wirral - West Kirby - 11,405 of 12,516



Figure 6 South Parade clear of water 2 hours after High Water

5.3 Flood Incident Response

Resources for clearing tidal debris at West Kirby were deployed from 07:30 AM on the morning of the 10 April 2024. Data received from Merseyside Fire and Rescue and the local RNLI show no calls were received for South Parade during the period of the event.

5.4 West Kirby Flood Alleviation Scheme Performance

A new secondary defence was constructed at the rear of the promenade during 2022 and 2023. The defence provides a physical barrier to prevent waves, that have exceeded the crest of the South Parade sea wall, from travelling across the highway to residential property. Waves that occur during extreme events increase risk to life and cause flooding and damage to property. The new flood wall also acts to retain still water that exceeds the crest of the old sea wall on the promenade which is closed to pedestrians during extreme events.

The flood wall at West Kirby was designed to reduce the risk of flooding to property for events up to an including the 0.5% joint AEP event. As set out in Table 2 above a range of conditions can result in any one event meeting a joint 0.5% AEP.

A direct comparison, at West Kirby, with an earlier extreme event of December 2013 is not possible because data was not recorded locally at the water depth transducer at West Kirby Marine Lake in 2013, however analysis of the data at Liverpool indicates that that event exceeded a joint 0.5% AEP. At West Kirby the impact of the 2013 event was apparent with extensive damage to property along South Parade and 12 properties flooded.

A JOIN-SEA analysis of the data for the 09 April 2024 event indicates that it is likely to have achieved a joint 0.5% AEP albeit with differing conditions to the 2013 event. Whilst 3 properties and a commercial storeroom suffered internal flooding there was minimal damage to local infrastructure as a result of the 09 April 2024 event. Reports received from residents indicate that they felt safer and more protected from the event as a result of the flood wall intercepting energy from waves that would previously have travelled, unimpeded, across the promenade to their properties.

Water from reflected waves blown over the flood wall was retained on the highway and is likely to have contributed to the flooding of 3 properties and business storage area. The new flood wall arrangement prevents water above kerb height from returning to the sea via overland flow when gates and access points are closed. Installation of a non-return flap valve within the flood wall or demountable defence would allow for this water to drain down at an increased rate. As was the case prior to construction of the wall, standing water on the highway up to kerb height will normally disperse through highway drainage outlets once they are no longer tide-locked and free from debris.

6 RESPONSE FROM RISK MANAGEMENT AUTHORITIES

The following Risk Management Authorities had a role in managing flooding that occurred on 09 April 2024

- Wirral Council
 - Coast Protection Authority
 - Lead Local Flood Authority
 - Highway Authority
- Environment Agency

6.1 Wirral Council

LEAD LOCAL FLOOD AUTHORITY

Wirral Council has undertaken this Section 19 Flood Investigation into the flood event. In doing so the LLFA, in accordance with Section 13 of the FWMA 2010, has worked in partnership with the other Risk Management Authorities involved in the incident.

COAST PROTECTION AUTHORITY

The Coast Protection Authority has addressed the risk of flooding from the sea at West Kirby through the delivery of the West Kirby Flood Alleviation Scheme in 2022 and 2023. The risks associated with the access points through the flood wall are addressed in the operational procedure to close them once certain triggers are met. The operational procedure sets out the triggers for installation of the demountable flood boards and also for operation of the mechanical swing and sliding gates.

The triggers in the operational procedure were followed with an instruction to install demountable defences issued on 05 April 2024 and a Tidal Advisory email issued on 08 April 2024

HIGHWAY AUTHORITY

The Highway Authority provides a response to instructions and advisories issued by the Coast Protection Authority.

Instructions to install the demountable boards in the West Kirby Flood Alleviation scheme are completed by the Highway Operations Service (HOS) of the Highway Authority. All demountable boards at West Kirby Flood Alleviation Scheme were installed by HOS ahead of the event of 08 April 2024.

The Highway Authority also acts upon the Advisory emails issued by the Coast protection Authority in response to predictions of tidal overtopping at promenades. On 09 April 2024 Highway Inspectors attended West Kirby ahead of high water and closed the mechanical swing and sliding gates in accordance with the operational procedure.

The Highway Authority also has responsibility for operation and maintenance of the highway drainage system which serves South Parade. The highway drainage system dates from the construction of South parade around 1900 and its function is to drain surface water from the highway surface and does not form part of the flood defence. The water that was blown over the flood wall also contained sand and debris which likely blocked a number of the highway inlets once the system began to draw down and caused a delay in the draining of the highway once outfalls were no longer tide locked. See Figure 5 above.

The Highway at South Parade remained open during the first part of the event until the traffic control barrier was closed by Wirral Council staff from the Wirral Sailing Centre. A review of the triggers for closing South Parade to traffic is included in the Recommendations to this report.

The Highway Authority attended South Parade to resolve operational problems with blocked highway inlets.

6.2 Environment Agency

The Environment Agency have responsibility issuing Flood Alerts and where applicable, Flood Warnings targeted to properties. Ahead of the 09 April 2024 event the Environment Agency issued Flood Alerts for :

- Irish Sea from Hilbre Island to Heswall
- Irish Sea from New Brighton to Hoylake
- Mersey Estuary from Liverpool and Wirral to Widnes

A Flood Warning was also issued at 08:04 on 09 April 2024 for

- Irish Sea at New Brighton

However a Flood Warning was not issued specifically for West Kirby.

The EA attended site following the event, gathering data and provided an initial list of impacted properties. The EA also assisted during the early stages of investigation with survey work on flood outlines.

7 CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

From the impacts around the country and conditions recorded locally, it is clear that Storm Pierrick was a significant event which resulted in extreme sea levels being recorded at Liverpool and West Kirby and combined with extreme wave heights offshore the event which the data suggests, likely met the limit of or exceeded the design standard for the new flood wall at West Kirby.

Damage and disruption occurred across the country and on the Wirral, notably on Meols Parade, Meols which suffered extensive damage to the sea wall and promenade.

At West Kirby gale force winds blowing from a west north-westerly direction, combined with high tides and a high storm surge, drove waves at speed across the promenade on South Parade. The new flood alleviation wall intercepted the waves, reflecting them upwards where they were influenced by the Force 9 west north west winds with the result that significant quantities of water were blown onto the landward side of the wall, which then became trapped by both the wall and tide-locked highway drainage. Once tide levels had dropped sufficiently, this water could drain away, however debris carried in flood waters appears to have impeded the functionality of the highway drains.

Flood water also drained, overland to the south end of South Parade, discharging to the sea via West Kirby Sailing Club boat yard.

Three residential properties experienced internal flooding. These properties, situated at a location where the overtopped water was at its deepest would likely benefit from property level protection to mitigate the residual risk posed by exceedance events, as utilised at other nearby properties. Although a Flood Alert covering West Kirby was in place, a Flood Warning specific to West Kirby was not issued by the Environment Agency as the criteria for issuing the Flood Warning was not met in their forecasting model. Public expectations that the wall would prevent all flooding may have been a factor in not utilising property level protection.

All available data indicates that the 09 April 2024 event should be classified as an extreme event and appears to have been of a greater return period than the design standard of the wall. The overtopping that occurred as a result of the conditions on the day is therefore not unexpected. The new defences however limited the damage that would have otherwise occurred had they not been built.

The new flood wall worked as intended in breaking the energy of the waves and retaining an extreme mean sea level on the seaward side of the wall. Waves breaking at the flood wall will always occur, with the volume of water blown over the flood wall very much dependent on the conditions at the time of the event. All flood risk management infrastructure carries the residual risk of a flood event that exceeds the design standard, such as a flood that overtops a raised flood defence or an intense rainfall event that a drainage system cannot accommodate. The recommendations below look to improve the management of the residual risk as it cannot be eliminated.

7.2 Recommendations

- 1* Installation of non-return valves within demountable flood barriers.
REASON: To improve management of residual risk by assisting drain down of impounded water
OWNER: Coast Protection Authority

- 2 Consider measures to manage residual flood risk to the highway.
REASON: To ensure a holistic approach to flood risk and that any future works do not introduce tidal backflow during high tide/surge events.
OWNER: Highway Authority

- 3* Review forecasting model and triggers for the issue of the Flood Warning for West Kirby
REASON: To improve management of residual risk by providing advance warning to the public of conditions that may result in overtopping.
OWNER: Environment Agency

- 4 Secondary defences to be installed to the entrances to Coronation Gardens during extreme events.
REASON: to improve management of residual risk by preventing the ingress of water
OWNER: Coast Protection Authority

- 5 Raise awareness of the design standard limitations of any flood defence and remaining residual risks. Signpost residents to resources to manage the residual risk through property level protection.
REASON: to improve management of residual risk to property during exceedance events
OWNER: Wirral Council - Coast Protection Authority & Comms

- 6* Review Operational Procedure for West Kirby to include an appropriate trigger for closure of South Parade highway.
REASON: to improve management of residual risk to highway users and property during exceedance events
OWNER: Coast Protection Authority

*Recommendation completed at time of publication