

# Flood Investigation Report

Location of Investigation: Five Oak Green

Date of incident: 9 February 2020

This document has been prepared by Kent County Council Flood and Water Management Team as the Lead Local Flood Authority under Section 19 of the Flood and Water Management Act 2010, with the assistance of:

- Kent County Council (KCC)
- Environment Agency
- Southern Water
- Kent Fire and Rescue Service (KFRS)
- South East River Trust

The findings in this report are based on the information available to KCC at the time of preparing the report. KCC expressly disclaim responsibility for any error in or omission from this report. KCC does not accept any liability for the use of this report or its contents by any third party.

This report can be found [here](#) where more information can be found about the requirements and trigger for a Section 19 investigation and the roles and responsibilities of Risk Management Authorities.

For further information or to provide comments, please contact us at [flood@kent.gov.uk](mailto:flood@kent.gov.uk)

## Summary of event

On the 9<sup>th</sup> February 2020 Storm Ciara caused heavy rainfall and strong winds across the country. The Environment Agency issued 186 Flood Alerts and 74 Flood Warnings across the country, with 11 Flood Alerts and 2 Flood Warnings located within Kent County Councils (KCC) administrative area.

During the afternoon of the 9<sup>th</sup> February 2020 a particularly intense band of rain fell across Kent, which caused flooding to Five Oak Green and surrounding areas. The nearest rain gauge to Five Oak Green is at Paddock Wood which recorded approximately 28 mm of rainfall in 60 minutes. The average monthly rainfall for February in Kent is approximately 53.4 mm<sup>1</sup>. Consequently, river levels rose quickly within the Alder Stream and as a result over topped the riverbanks. Highway drains, drainage ditches and the local combined sewer network were also unable to cope with the volume of rainfall. There are also several reports of power cuts that occurred during the storm as a result of the strong winds.

Approximately 40 properties are reported to have been flooded by a combination of overland flow, sewage and surface water with many of these properties experiencing internal flooding. The approximate locations of the reported flood incidents are shown in Figure 1 below (please note: only the roads where the properties are located have been mapped, and not the individual properties).

---

<sup>1</sup> Source: <https://www.southernwater.co.uk/water-for-life/regional-rainfall>

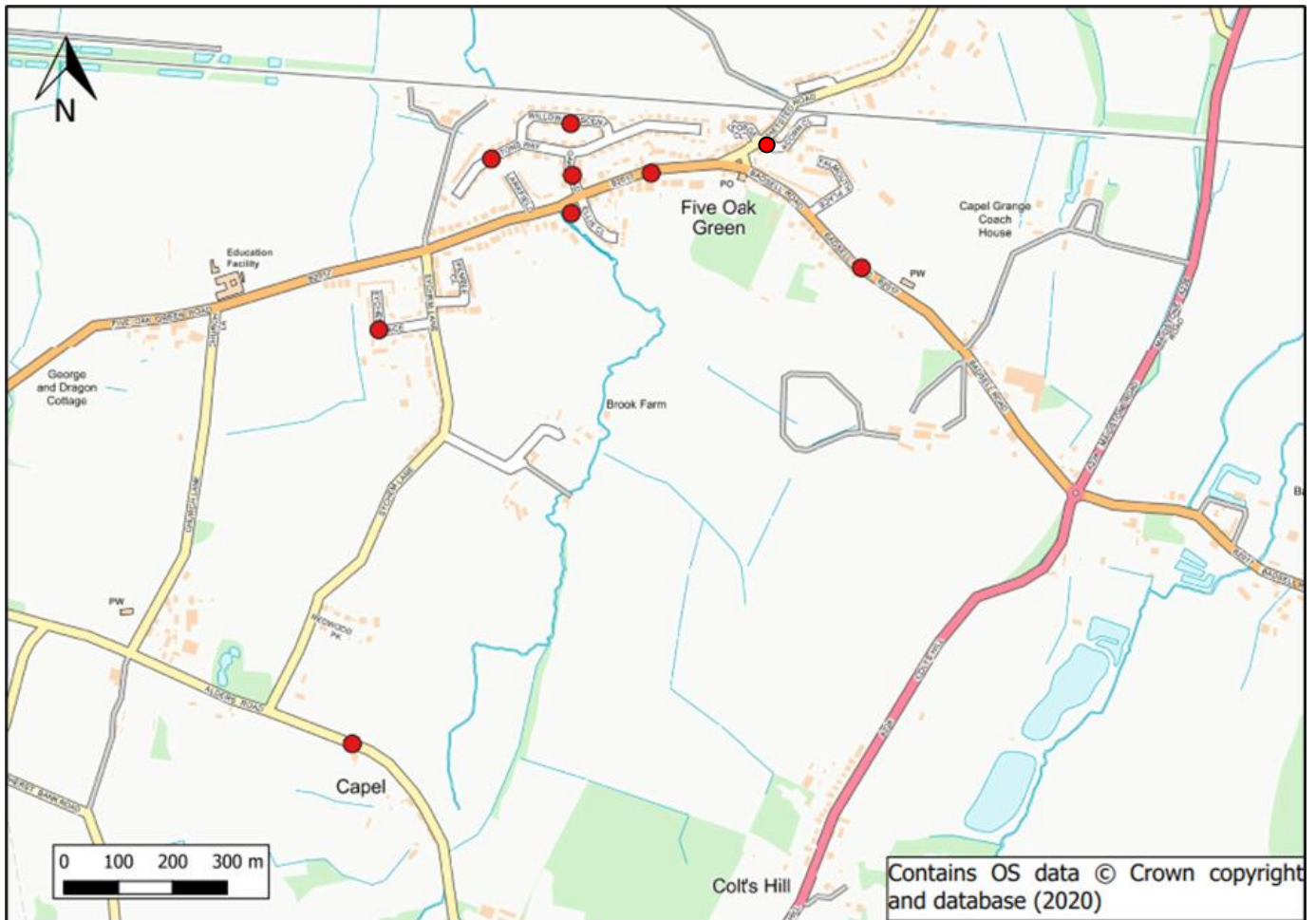


Figure 1 Location of reported flood incidents

KCC undertook a survey of affected residents in September 2020 collating information about the events of the flood to inform this Section 19 investigation. Table 1 provides a summary of the investigated flooding issues and known flood extents, including the information collated from the flood survey.

Flood incident data from Southern Water has also been obtained due to the reports of sewerage flooding. Several reports of hydraulic overload within the system were reported on the 9<sup>th</sup> February 2020 during Storm Ciara. Southern Water failed to provide information regarding the location of where the system experienced hydraulic overload.

Table 1 Summary of the investigated flooding issues

Location	Details of flooding	Source of Report
Alders Road	9 properties flooded internally, including 1 commercial property. Properties reported flooding of up to 30cm internally.	KCC / Flood survey
Nortons Way	5 properties flooded internally, with reports of up to 20cm of floodwater within properties.	KCC / Flood survey
Badsell Road	5 properties flooded internally, with reports of up to 15cm of floodwater within properties.	KCC / Flood survey
Brookdene	Multiple properties affected by flooding, 1 confirmed property experienced internal flooding.	KCC / Flood survey / KFRS
Oak Road	2 properties flooded externally.	KCC / Flood survey
Willow Crescent	3 properties flooded internally, with reports of up to 20cm of floodwater within properties. 2 properties reported external flooding.	KCC / Flood survey
Sychem Place	8 properties flooded internally, with reports of up to 20cm of floodwater within properties.	KCC / Flood survey / KFRS
Five Oak Green Road	5 commercial properties flooded internally.	KCC / Flood survey
Whetsted Road	2 properties flooded internally, 1 domestic and 1 commercial.	Flood Survey/TWBC

## Rainfall and River Levels

### Rainfall

Rain Gauge	Paddock Wood (station number: 295292)
<b>Rainfall</b>	27.94mm (1 hour: 17:15 – 18:15)
<b>Annual Exceedance Probability</b>	3.33%
	1 in 30-year return period

Storm Ciara began in the North of the country on the 8<sup>th</sup> February before moving South towards Kent during the early evening of the 9<sup>th</sup> February. The rainfall gauge at Paddock Wood recorded 27.94mm of rainfall between 17:15 and 18:15 with a total of 38.24mm rainfall recorded at the gauge on the 9<sup>th</sup> February.

Rainfall around the county is recorded by a series of rain gauges operated by the Environment Agency. These report the rainfall depth recorded over either a 15-minute interval or a day. To assess the rarity of the rainfall that fell the Flood Estimation Handbook<sup>2</sup> (FEH) web service Event Rarity Calculator assesses the Annual Exceedance Probability (AEP), which is the likelihood of rainfall of this depth or more falling in a year in that location. For instance, a rainfall event with an AEP of 1% means that rainfall of this depth or greater would only have a 1% chance of occurring in any one year in that location. This is also known as a '1 in 100 year' event.

<sup>2</sup> FEH is the standard tool in the UK to estimate rainfall return periods. It is used by the Environment Agency and all professional hydrologists to estimate rainfall and rainfall return periods.

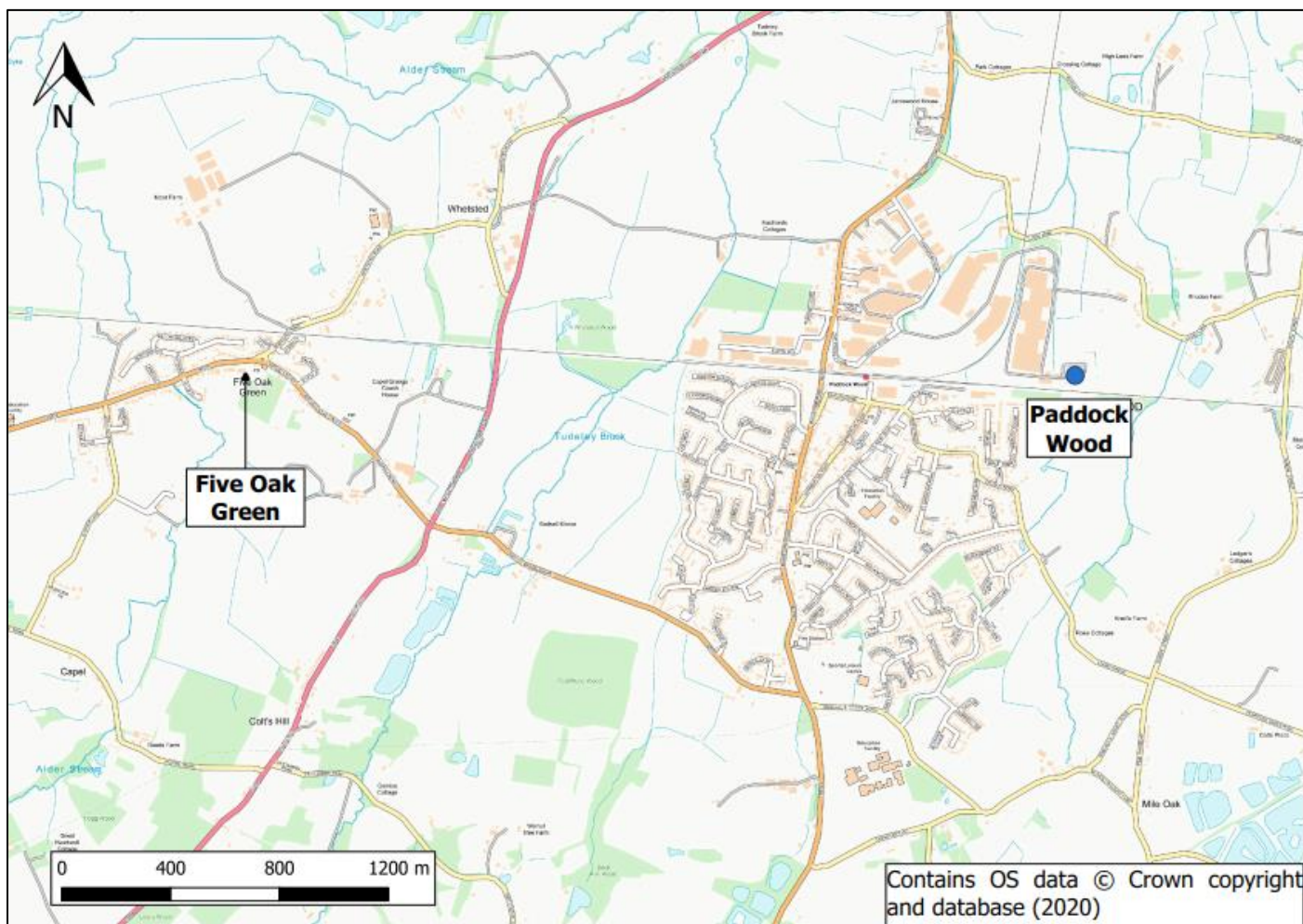


Figure 2 Location of Paddock Wood rain gauge

Figure 2 shows the location of the Paddock Wood rain gauge in relation to Five Oak Green. The rain gauge is located approximately 3 km to the east of the village. The Event Rarity Calculator assessed the Storm Ciara flood event as a 1 in 30-year event at Paddock Wood.

The Met Office<sup>3</sup> have also produced a short report on Storm Ciara providing information regarding rainfall and other weather conditions across the country and provides information regarding the South East. Figure 3 shows the rainfall radar captured during the evening of 9<sup>th</sup> February at 18:00 which is approximately when the heaviest rainfall occurred. The rainfall radar clearly shows bands of intense rainfall (white colours on the radar map) across the approximate area of Five Oak Green. According to the Met Office report rates of rainfall exceeding 32 mm per hour were recorded in some areas within the South East of the country. As a result, this provides some level of certainty regarding the rainfall gauge at Paddock Wood and the rainfall recorded.

Five Oak Green was the only area within KCC's administrative area that was affected by this magnitude of flooding. Although there was county wide rainfall, the flooding experienced was very localised, restricted to Five Oak Green. Although the rain gauge located at Paddock Wood did indicate a large amount of rainfall during Storm Ciara, it is likely that Five Oak Green experienced a greater amount of rainfall in comparison to the rest of the county, and therefore that the rain in Five Oak Green and the Alders catchment was rarer than 1 in 30 years.

<sup>3</sup> Source: [https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2020/2020\\_02\\_storm\\_ciara.pdf](https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2020/2020_02_storm_ciara.pdf)

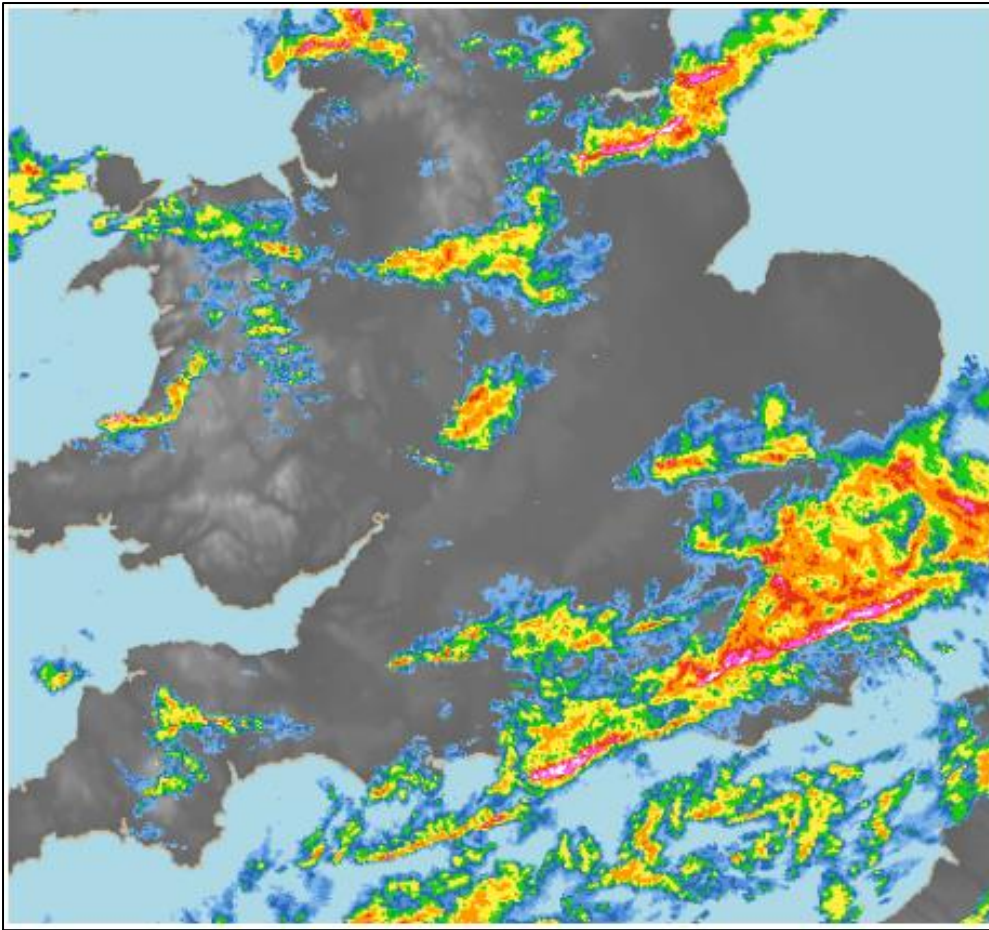


Figure 3 Met Office's rainfall radar during Storm Ciara

### River levels

There are no river gauges on the Alder Stream that record flow or water levels. The Environment Agency has flow gauges on tributaries of the River Medway, which the Alder Stream discharges into nearby. The nearest gauges are located on the River Bourne at Hadlow, the River Eden at Vexour and the River Beult at Stilebridge. Figure 4 shows the location of the three flow gauges in relation to Five Oak Green and the Alder Stream.

The River Bourne gauge at Hadlow is the closest gauge located approximately 4.5 km to the north-west of Five Oak Green. The River Bourne is the smallest of the three Environment Agency gauged rivers and as such is the closest in size to the Alder Stream at Five Oak Green. Data obtained from the Environment Agency for the 9<sup>th</sup> February 2020 at the River Bourne flow gauge is shown in Figure 5, clearly indicating a steep rise in river flows as a result of the heavy rainfall. The increase in flow along the River Bourne is approximately 2 m<sup>2</sup>/s, equating to around 10 times the nominal river flow. The other flow gauges in the surrounding area indicate a much larger increase in flow, this is due to the much larger size of the watercourses. The data from the gauges located along the River Eden and the River Beult are shown in Figures 6 and 7.

The data from the flow gauges indicate the same steep rise in river flows resulting from the heavy rainfall and show a peak of flow on the River Bourne at between 22:00 and 22:30. Consultation with the Environment Agency and reports from local residents indicate that the peak of flow along the Alder Stream was earlier than 22:00 at approximately between 18:30 and 19:30.

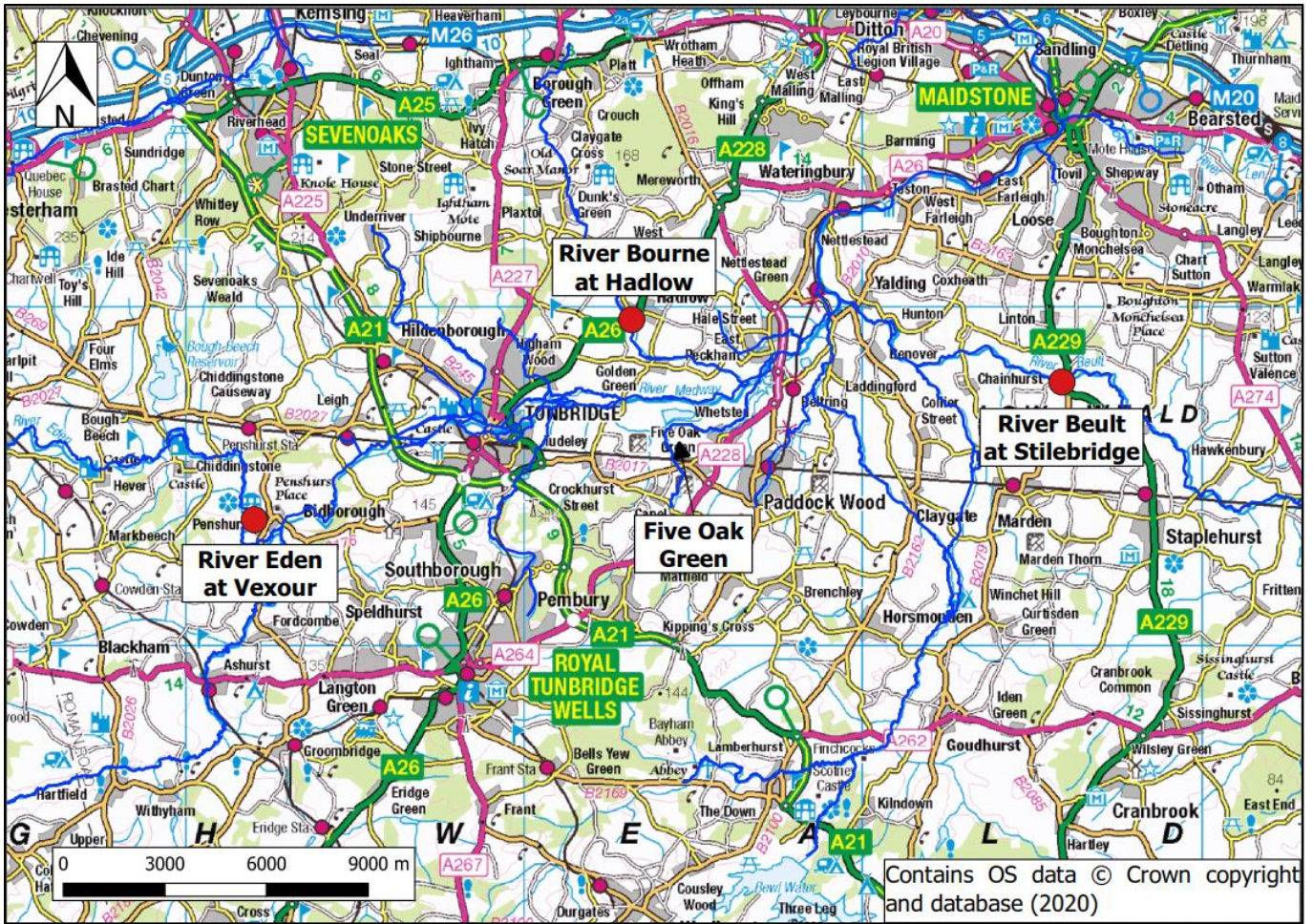


Figure 4 Location of flow gauges

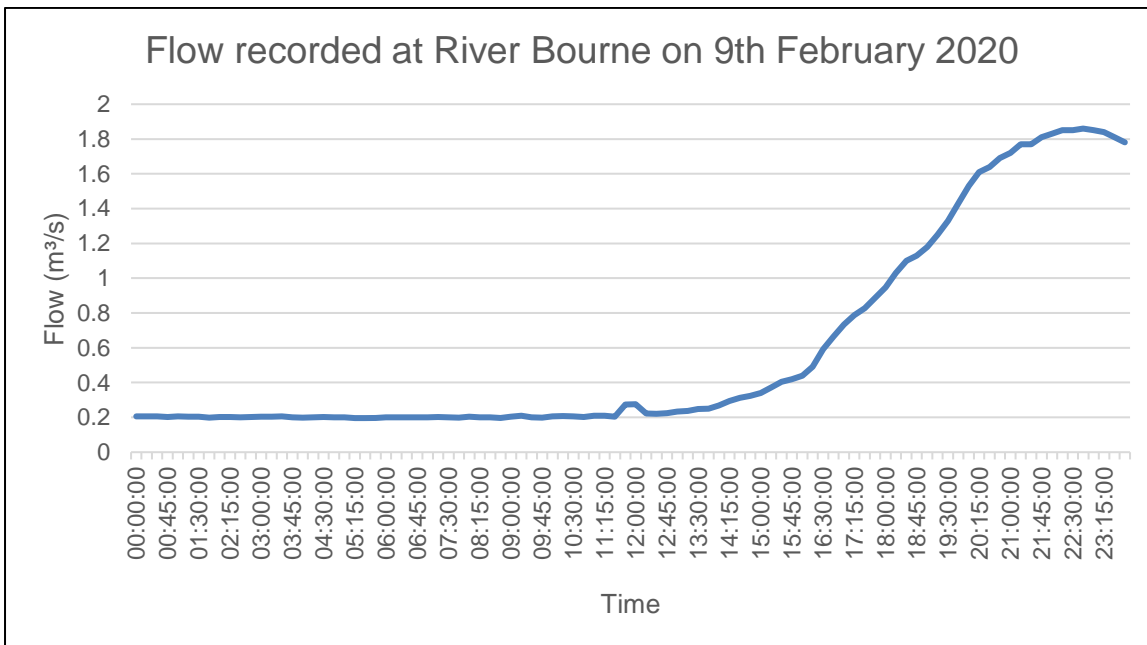


Figure 5 Flow gauge data along the River Bourne recorded during Storm Ciara

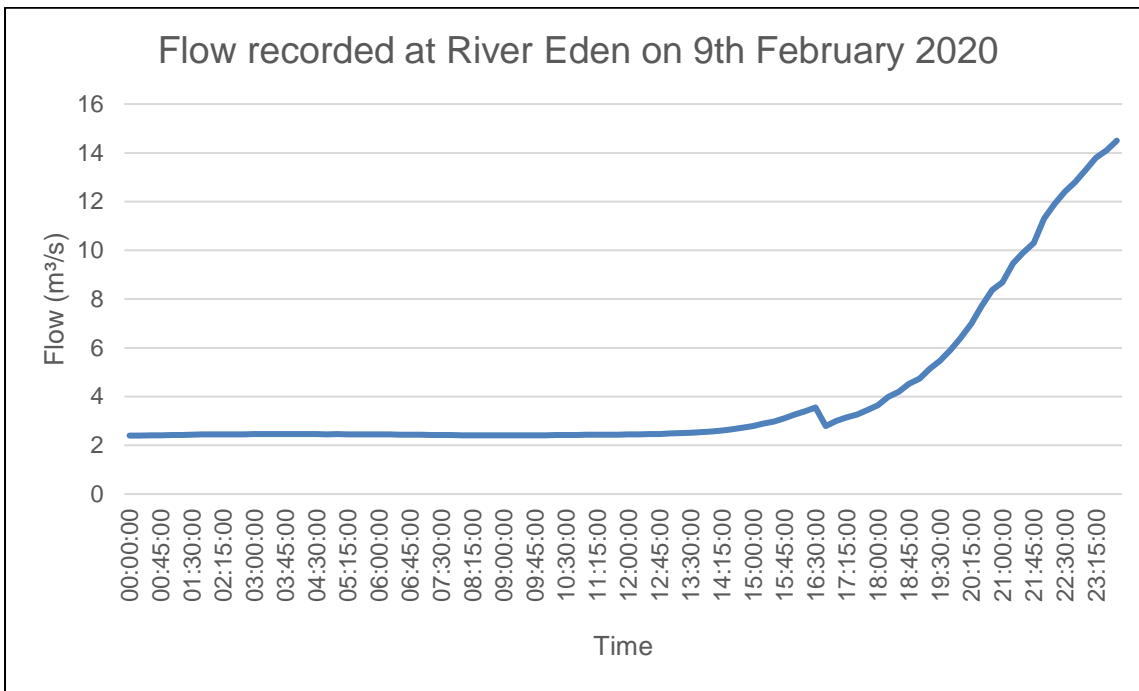


Figure 6 Flow gauge data along the River Eden recorded during Storm Ciara

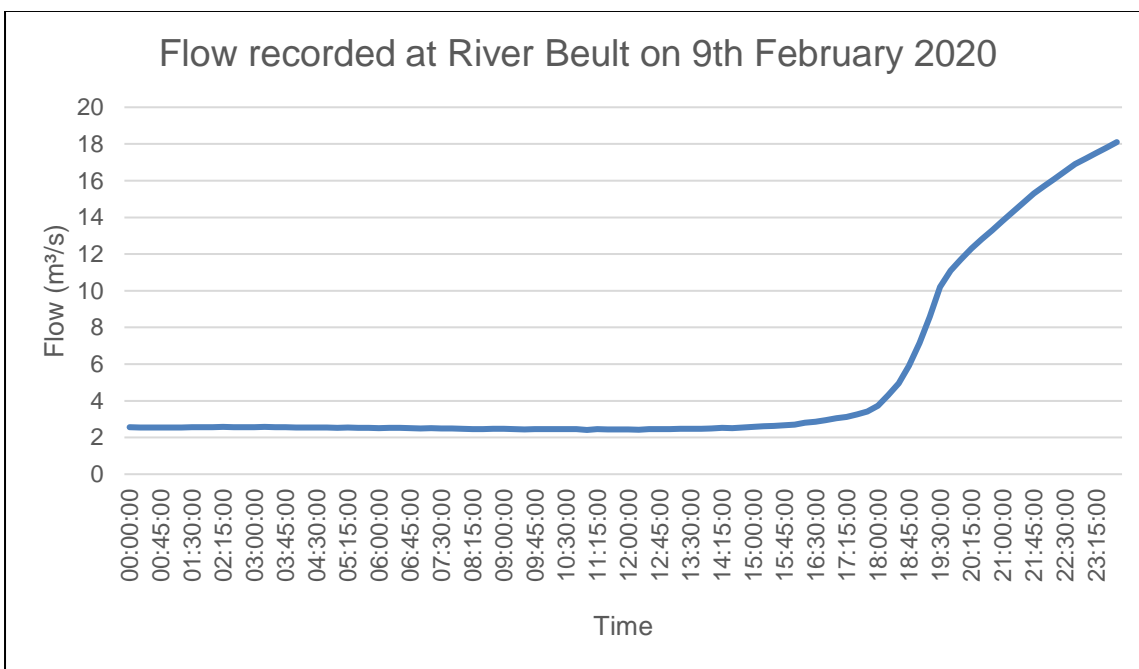


Figure 7 Flow gauge data along the River Beult recorded during Storm Ciara

## Site Location, Topography and Flood Risk

The village of Five Oak Green is located approximately 5.7 km to the east of Tonbridge and sits on the Alder Stream to the south of the railway line from London Victoria to Ashford.

The Alder Stream predominantly flows in a south to north direction, flowing through a 150 m long culvert from Five Oak Road through the centre of the village, the culvert emerges into an open section of watercourse for approximately 20 m before flowing through another culvert under the railway line. North of the railway line the Alder Stream flows through farmland for approximately one kilometre before it turns sharply to the east and flows through the floodplain of the River Medway, which it joins near East Peckham. The catchment of the Alder Stream at Five Oak Green is approximately 8.3 km<sup>2</sup>, the upper reaches of the catchment are as far south as Pembury. The catchment steeply slopes in a south to north direction.

The Alder Stream is classified as a main river from Alders Road to the confluence with the River Medway, where it is regulated by the Environment Agency, and as an ordinary watercourse to the south of Alders Road, where it is regulated by the Lead Local Flood Authority (LLFA).

The surface water drainage system within Five Oak Green consists of public sewers which are owned and maintained by Southern Water and highway drainage owned and maintained by KCC as the Highway Authority. The drainage systems discharge into the Alder Stream.

A review of the Cranfield University Soilscales database indicates that the underlying soils in Five Oak Green are loamy soils with a naturally high groundwater level. The underlying soils within the rest of the catchment of the Alder Stream, to the south of Five Oak Green, are loamy and clayey soils with impeded drainage. This means that rainfall in this area is unlikely to significantly infiltrate into the ground and will runoff over land, especially in heavy rainfall events.

Figure 8 shows an extract from the Environment Agency's Flood Map for Planning (Rivers and Sea). The map indicates that Five Oak Green and the area along Alders Road adjacent to Alder Stream are located within the high-risk Flood Zone 3<sup>4</sup>. The fluvial flood risk is associated with the Alder Stream. Flows within the Alder Stream are well contained within the watercourse upstream of Capel.

Figure 9 shows an extract from the Environment Agency's Flood Risk from Surface Water map. Flooding from surface water is typically associated with natural overland flow paths (including the Alder Stream) and local depressions in topography where surface water runoff can accumulate during or following heavy rainfall events. The Environment Agency's map indicates that the areas at a high risk of flooding from surface water<sup>5</sup> sources include areas that experienced flooding during Storm Ciara. There is also a surface water flow path which is associated with a ditch to the south-west of Alders Road which discharges into the Alder Stream. The areas identified as high risk on the Environment Agency's Long Term Flood Risk map are consistent with the locations of reported properties affected by the Storm Ciara flood event.

---

<sup>4</sup> Flood Zone 2 is defined as having between 1 in 100 year (1%) and 1 in 1000 year (0.1%) chance of flooding from fluvial sources.

Flood Zone 3 is defined as having a greater than 1 in 100 year (1%) chance of flooding from fluvial sources.

<sup>5</sup> High risk of flooding from surface water is defined as having a greater than 1 in 30 (3.3%) chance of flooding.

Medium risk of flooding from surface water is defined as having between 1 in 100 (1%) and 1 in 30 (3.3%) chance of flooding.

Low risk of flooding from surface water is defined as having between 1 in 1000 (0.1%) and 1 in 100 (1%) chance of flooding.



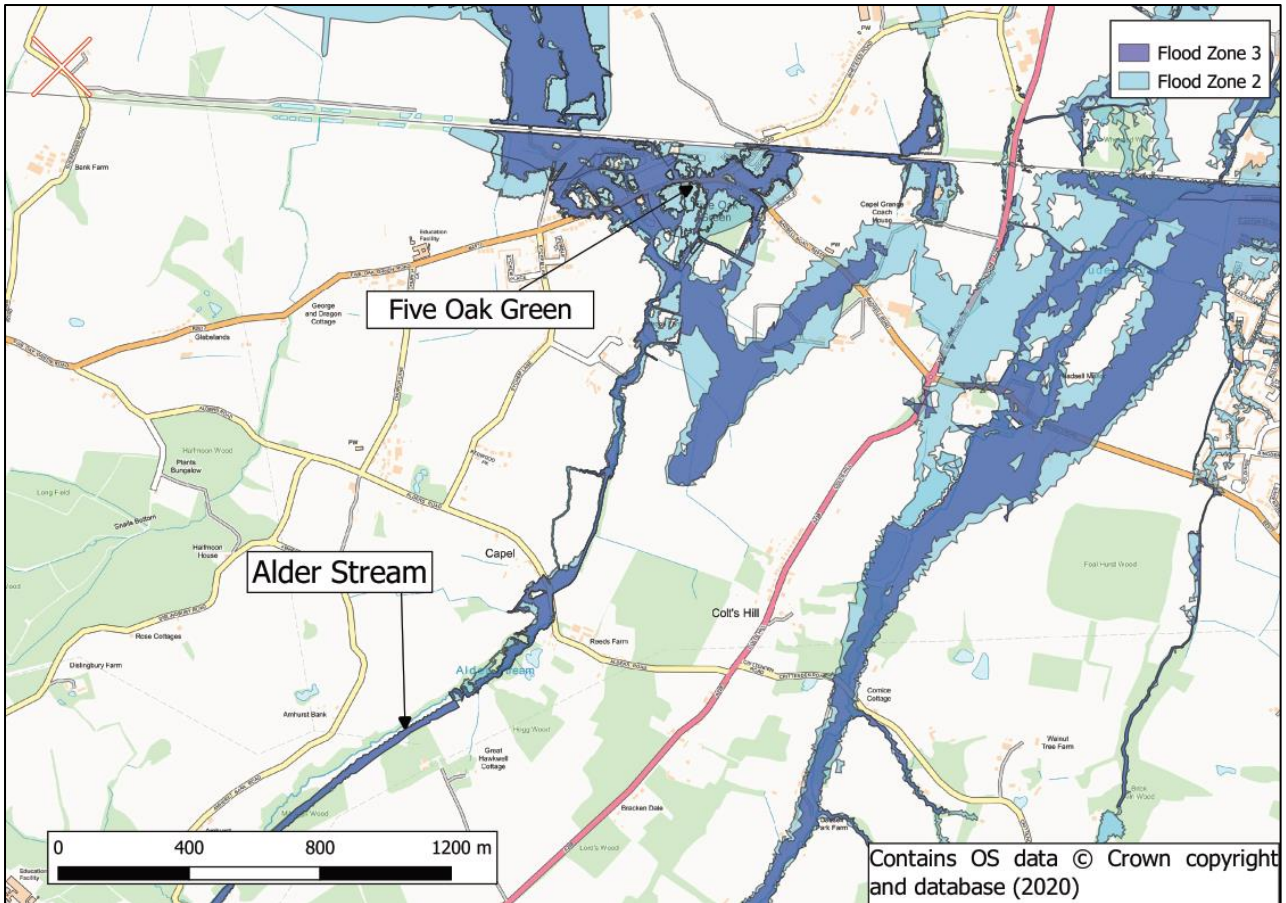


Figure 8 Extract from the Environment Agency's Flood Map for Planning

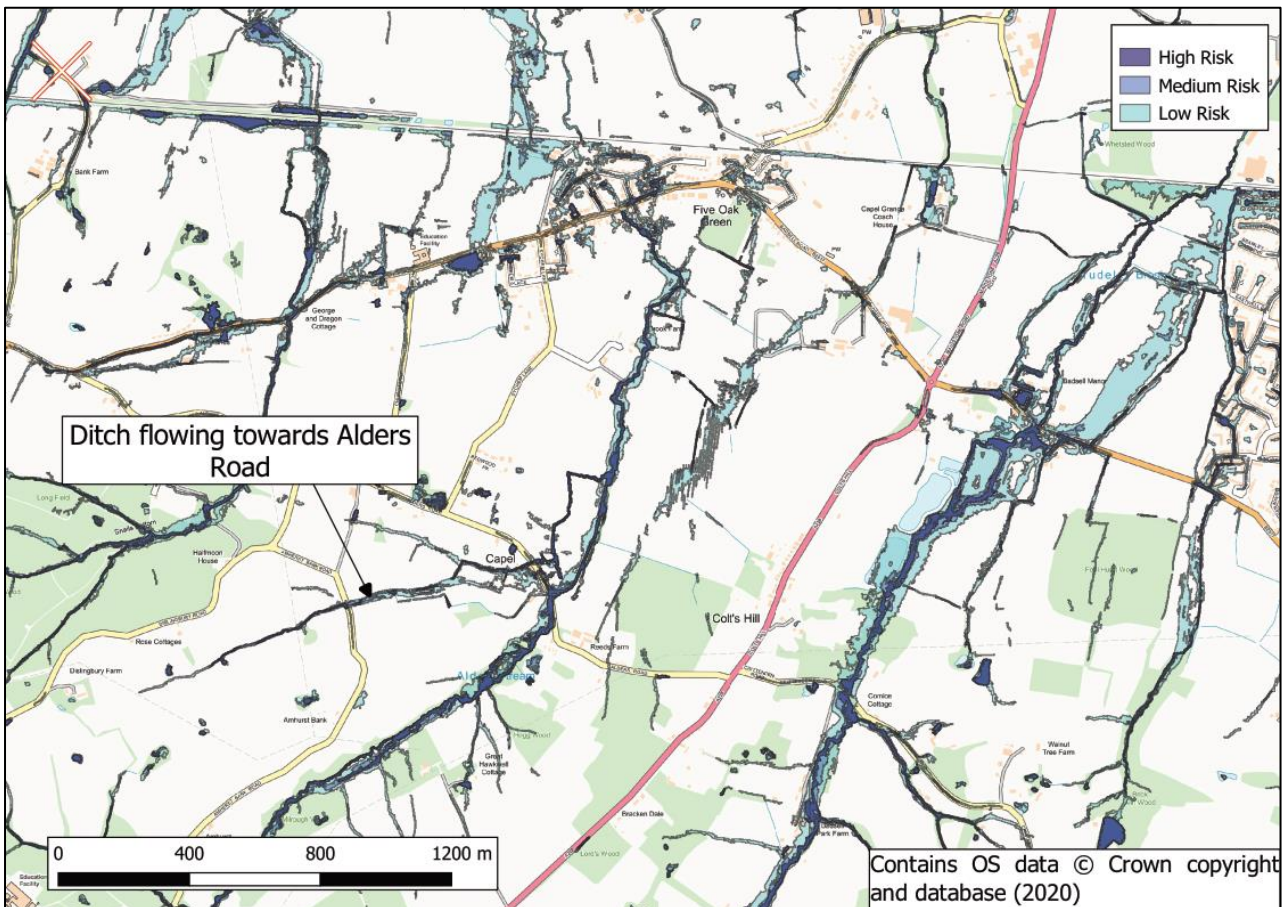


Figure 9 Extract from the Environment Agency's Flood Risk from Surface Water map

## Flood History

There are a number of historic flood events that have occurred in Five Oak Green prior to the event on the 9<sup>th</sup> February 2020. Five Oak Green has flooded on a number of occasions in association with flooding on the River Medway, in November 1960, November 1963, September 1968 and October 2000 are notable events.

Data for more recent events from the KCC's flood incident database, Surface Water Management Plans and the Environment Agency have been collated into Table 2.

*Table 2 Summary of the historic flood records*

Location	Date of flooding	Details of flooding
Badsell Road, Falmouth Place, The Forge	2008 and 2009	Sewer flooding.
Badsell Road	February 2009	Road flooding.
Alders Road	November 2009	Road flooding.
Falmouth Place	November 2009	Blocked drain.
Five Oak Green Road	July 2010	Road flooding.
Five Oak Green Road	September 2011	Road flooding.
Alders Road	January 2012	Road flooding from Alder Stream.
Whetsted Road	September 2012	Highway drainage overwhelmed.
Five Oak Green Road	October 2012	Blocked drainage ditch.
Alders Road	December 2013	Road flooding.
Alders Road	March 2013	Road flooding with several properties affected.
Sychem Lane	July 2013	Blocked ditches causing road flooding.
Badsell Road	December 2013	Surface water caused internal flooding to properties.
Willow Crescent	December 2013	Road flooding up to a depth of 1 foot.
Whetsted Road	October 2014	Blocked drain causing road flooding.
Colts Hill	February 2015	Blocked gullies causing flooding to road and external flooding of properties.
Sychem Lane, Alders Road, Whetsted Road and Badsell Road	August 2015	Blocked gullies along multiple roads causing road flooding.
Whetsted Road	August 2017	Road flooding.
Badsell Road	November 2017	Blocked drain causing road flooding.
Whetsted Road	January 2018	Blocked drainage ditch.
Badsell Road	December 2019	Road flooding.
Willow Crescent	December 2019	Road flooding.
Badsell Road	January 2020	Block drain causing road flooding.

## Flood Alleviation Measures

In order to reduce flood risk to Five Oak Green associated with the Alder Stream, Natural Flood Management (NFM) measures have been implemented through a project led by the South East River Trust. In January 2020, a number of leaky woody structures were placed within a tributary of the Alder Stream approximately 4.3 km to the south-west of Five Oak Green. Figure 10 shows the location of the NFM measures.

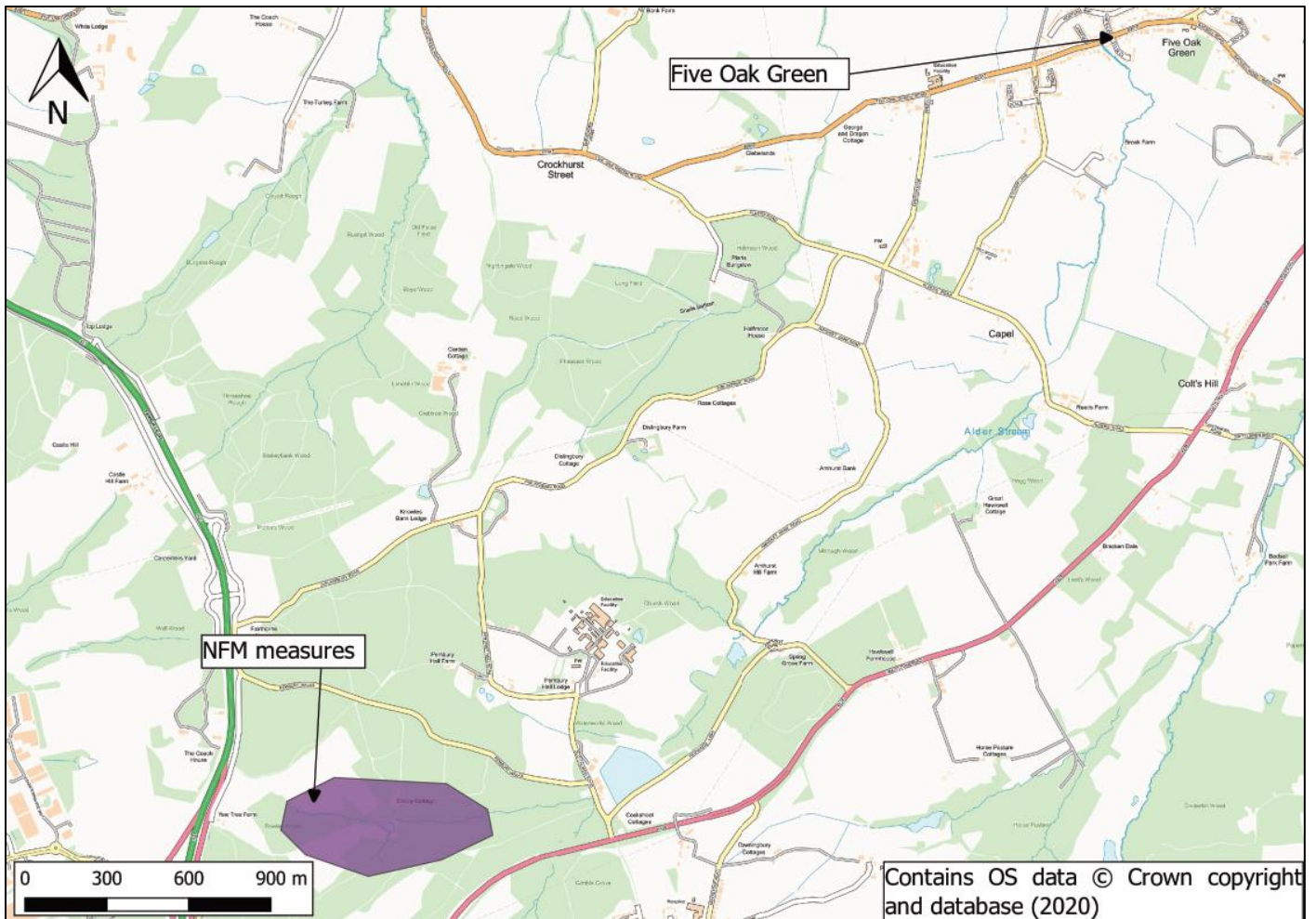


Figure 10 Location of NFM features in the Alder Stream catchment

The aim of the scheme is to reduce and delay the peak river flows within the Alder Stream to reduce the likelihood of flows overtopping the banks and affecting properties. The leaky woody structures were found to be operating well during the flood event as reported by the South East Rivers Trust, although it is too early to understand if the NFM measures had an impact on the amount of flooding experienced at Five Oak Green<sup>6</sup> and they are currently only installed in a small area of the catchment, so are unlikely to provide a significant benefit at Five Oak Green. Figure 11 shows a photograph of one of the leaky woody structures located along the Alder Stream.

<sup>6</sup> Source: <https://www.southeastrivertrust.org/storms-ciara-and-dennis-and-flooding-at-five-oak-green-and-capel/>



Figure 11 Leaky woody structures along the Alder Stream<sup>7</sup>

## Flooding Description and Mechanism

The flood incident that occurred during Storm Ciara on 9<sup>th</sup> February 2020 was the result of intense rainfall during the early evening which led to flows within Alder Stream overtopping its banks along with highway drainage and the local sewer network becoming overwhelmed and unable to discharge into the Alder Stream.

Correspondence with local residents that were affected by the flood incident indicated that the Pembury Reservoir located upstream approximately 3.2 km to the south of Five Oak Green may have contributed to the upstream flows within Alder Stream. The correspondence suggested that there may have been a breach or an overflow from the reservoir into the Alder Stream. Pembury Reservoir is owned and maintained by South East Water. South East Water have been involved in discussions regarding the flood event. The local MP for the area arranged a meeting between the Environment Agency, Southern Water, South East Water, the South East Rivers Trust and the National Flood Forum to discuss the flood incident. During the meeting the potential breach of the reservoir was discussed, and there was no evidence found to support the theory of a breach causing the flood incident. The reservoir was not the source of flooding during Storm Ciara, as confirmed due to the design of the reservoir.

Alder Stream, which flows through the centre of Five Oak Green, is known to have overtopped the banks of the watercourse during the flood event at approximately 20:00, based on evidence provided by the Environment Agency. Alder Stream overtopped the banks upstream of the culvert underneath Five Oak Green Road. Figure 12 shows the approximate location of where the Alder Stream overtopped the banks. Correspondence with the Environment Agency indicates that the trash screen at the inlet of the culvert was free from debris and that peak flows within Alder Stream gradually subsided.

<sup>7</sup> Source: <http://www.environmenttimes.co.uk/news/item/845-naturally-designed-leaky-dams-prevent-flooding>

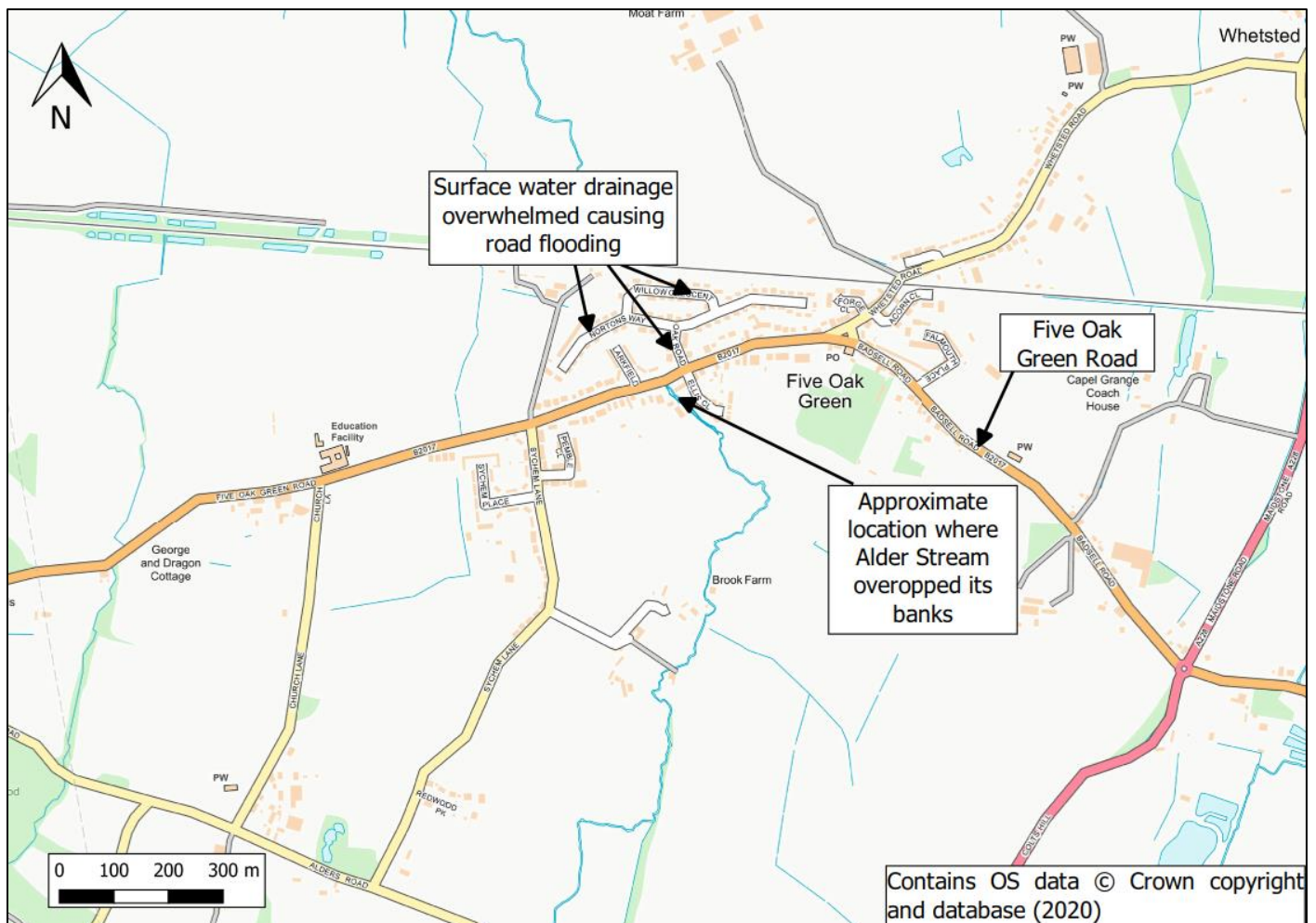


Figure 12 Flooding mechanism for properties located along Alders Road

As a result of the watercourse overtopping its banks the local surface water drainage system would not have been able to discharge into the river causing surcharging of drains and surface water flooding to the local roads.

Properties located in the main area of Five Oak Green reported that the local drainage drains and gullies were surcharging causing surface water to pond and accumulate. Many properties flooded internally up to depths of approximately 30 cm. KFRS attended the flood event along Willow Crescent, Oak Road, Nortons Way and Five Oak Green Road. However, KFRS were unable to pump water out from the flooded properties as there was nowhere for the surplus water to go. The police also attended the event and put a road closure in place for Five Oak Road as a result of the flooding.

The properties located along Alders Road flooded from fluvial sources. Anecdotal evidence suggests that a tributary of the Alder Stream and adjacent ditch located to the south-west of Alders Road were the main causes of flooding to the affected properties located along Alders Road and not the Alder Stream itself. The location and direction of flow in the tributary of Alder Stream and the adjacent ditch is shown in Figure 13, below. This is further supported by site visits undertaken by the Environment Agency after the flood event. Correspondence from residents indicates that floodwaters entered the back of the properties with flood depths of approximately 20 to 30 cm internally.

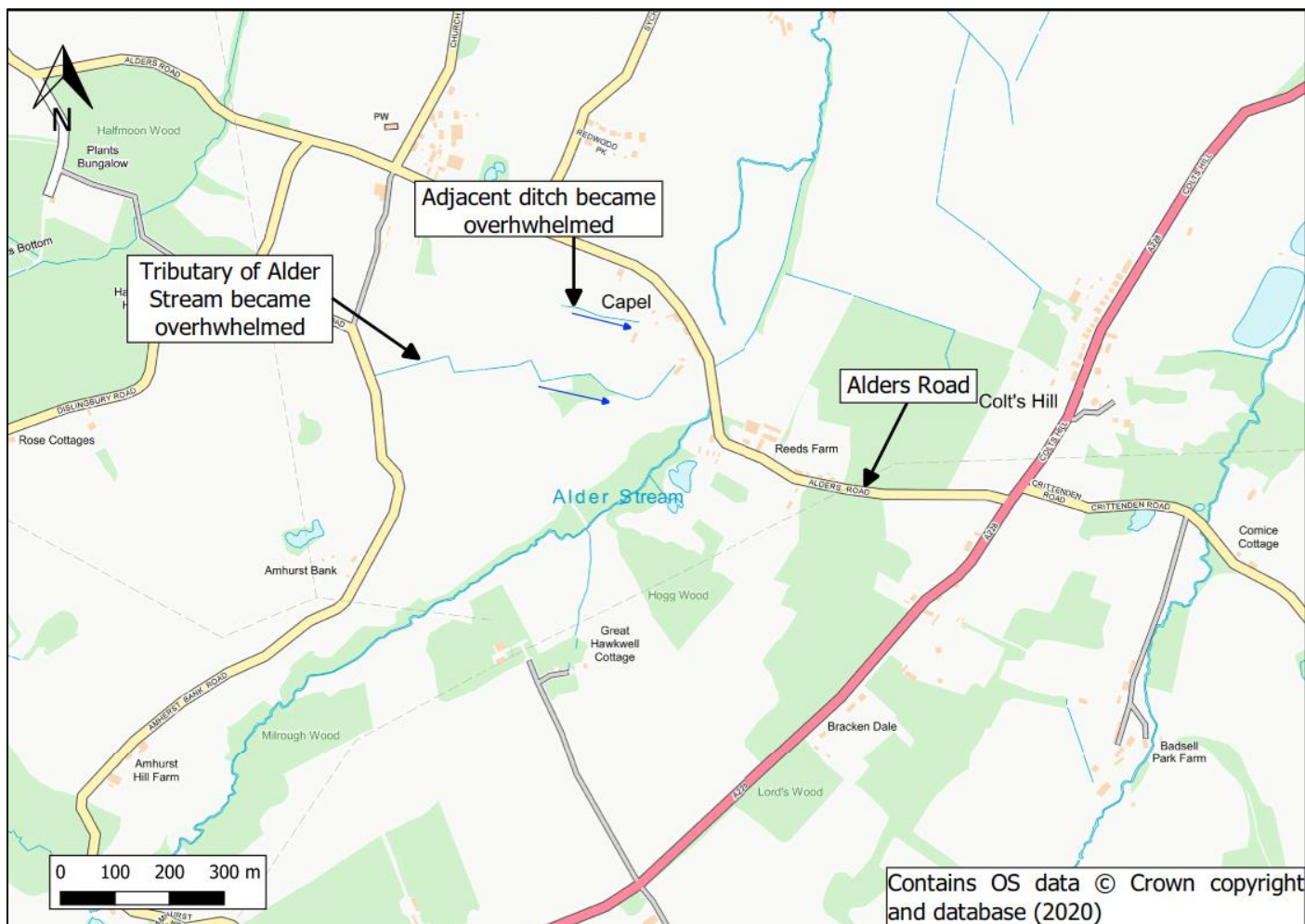


Figure 13 Flooding mechanism for properties located along Alders Road

The properties located along Badsell Road were internally flooded with sewerage during the flood event. Correspondence with the residents indicates that the properties are located in close proximity to Larkfield pumping station which is owned and maintained by Southern Water. As a result of the power cuts that occurred during Storm Ciara, residents reported that the pumping station stopped operating, causing sewerage back up and internally flood the nearby properties as the system was overloaded. Questions remain over the role of the pumping station during the flood event, but reports indicate that the failure led to sewer flooding to properties. Southern Water failed to provide any information or evidence as part of this Section 19 Report to support the reports of what happened at the pumping station.

At the junction of Whetsted Road and Badsell Road surface water overwhelmed the highway drainage and surface water sewer, water accumulated and ponded on the highway at a topographical low point and reached a sufficient depth to enter property. Failure of the pumping is reported to have contributed to the flooding on the highway at this location.

## Flood Response

Since the Storm Ciara flood incident, a number of actions have already been undertaken by risk management authorities and other organisations.

The residents along Badsell Road have been in contact directly with Southern Water and have reported the issue regarding Larkfield pumping station. The local MP for the area has also been in correspondence with Southern Water and has since confirmed that Southern Water have now installed an automatic reset system at the Larkfield pumping station. The automatic reset system should ensure that power is restored without the need for an engineer on site.

KCC Highways have performed a number of routine gully cleansing along the affected roads and have identified a number of blockages and defects. The KCC Highways department did not receive any emergency orders or enquiries during the flooding that occurred during Storm Ciara. Since the flood event a number of issues with the highway drainage have been raised within the Five Oak Green area. Table 3 summaries the different remedial works that the KCC Highways department have undertaken since the 9<sup>th</sup> February 2020 in relation to Storm Ciara. The works include gully cleansing and the removal of blockages identified as well as work to highway ditches. The highways team will continue to undertake remedial works within the highway drainage system to ensure it is able to operate effectively.

*Table 3 Summary of KCC Highways remedial works*

Location	Date	Details
Sychem Place	24/02/2020	Flood clearance work and gully cleansing.
Oak Road	24/03/2020	Gully cleansing.
Willow Crescent	24/03/2020	Gully cleansing.
Badsell Road	14/04/2020	Gully cleansing.
Alders Road	21/04/2020	Gully cleansing, defects in highway drainage found.
Five Oak Green Road	30/04/2020	Gully cleansing.
Alders Road	10/06/2020	Work undertaken to ditch; more investigation required.
Sychem Place	02/07/2020	CCTV survey – blockage identified and removed.
Nortons Way	17/07/2020	Gully cleansing.
Willow Crescent	24/07/2020	Gully cleansing.
Five Oak Green Road	28/07/2020	Gully cleansing, defects in highway drainage found.
Badsell Road	13/08/2020	Gully cleansing.

## Conclusion and Further Work

On the 9<sup>th</sup> February 2020 Storm Ciara caused heavy rainfall and strong winds which led to the Alder Stream overtopping the river banks. The intense rainfall fell over a short duration, as highlighted by the narrow-localised band of rainfall on the rainfall radar image and nearby rainfall gauge. The rainfall gauge is unlikely to have recorded the peak of the event and therefore it is likely that rainfall in excess of 32 mm occurred during Storm Ciara at Five Oak Green. Highway drains and the local combined sewer network were also unable to cope with the volume of rainfall. The failure of the Larkfield pumping station due to a power cut caused internal sewerage flooding of nearby properties. Local residents indicated that the Pembury Reservoir may have contributed to additional flows within Alder Stream although consultation with South East Water found no supporting evidence.

The culvert beneath Five Oak Green may have contributed to the flooding experienced, however further assessment of the capacity of the culvert is required to understand if the culvert is likely to have surcharged during the flooding event. Consultation with the Environment Agency indicated that the culvert has greater capacity in comparison to the channel upstream of the structure. A previous study of the catchment included a hydraulic model completed in 2015. It is likely to be used to further understand the capacity of the culvert. Further consultation with the Environment Agency regarding the performance of the culvert and debris screen will be undertaken by the LLFA.

As one of the main sources of flooding was the local drainage systems surcharging due to the high river levels within the Alder Stream, there may be an opportunity to understand the capacity of the local drainage systems in partnership with Southern Water to determine any potential improvement opportunities and capacity issues.

There are further opportunities that could be explored to see if additional NFM measures would be feasible along other stretches of watercourse within the Alder Stream catchment. Consultation and partnership working with the Environment Agency, the South East River Trust and local landowners will be undertaken to understand the potential opportunities and funding available to install more leaky woody structures or other NFM measures.

Further investigation into potential measures such as bunds could be explored to understand if this would reduce flood risk through storing water upstream within the catchment and diverting flows away from at risk properties to avoid drainage systems becoming overwhelmed and unable to discharge into the Alder Stream.

Without further information from Southern Water, it is not possible to comment on options or opportunities to reduce the risk of flooding from the sewer. We would recommend that Southern Water provide a report of the sewer issues in Five Oak Green to the residents and any plans they have to manage them.