

Flood Investigation Report

Location of Investigation: Vigo Village and Culverstone

Date of incident: 10 June 2019

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
- Tonbridge and Malling Borough Council
- Kent Fire and Rescue Service
- Vigo Village Parish Council
- Meopham Parish Council
- Gravesham Borough Council

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

Summary of event

On the 10th June 2019 heavy rainfall was experienced across the country. 31 flood warnings and 1 flood alert were issued by the Environment Agency across England, with some areas of Kent recording in excess of 100mm of rain in a 24-hour period. The average rainfall for June in Kent is 53 mm¹.

Very heavy rainfall occurred county wide, with areas such as West Kingsdown, Vigo, Snodland and Swanley particularly badly affected. This report will focus on the Vigo and Culverstone area where around 100 properties are known to have been flooded by surface water, many of those were affected internally.

The map in Figure 1 and 2 indicates the areas affected and this is summarised in the table below, together with dates of any previous floods (where known).

Since the time of writing this report we are aware that flooding has occurred on the 20 December 2019 and the 9 February 2020 affecting properties in Culverstone. These incidents occurred following heavy rains across the county on already saturated ground.

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

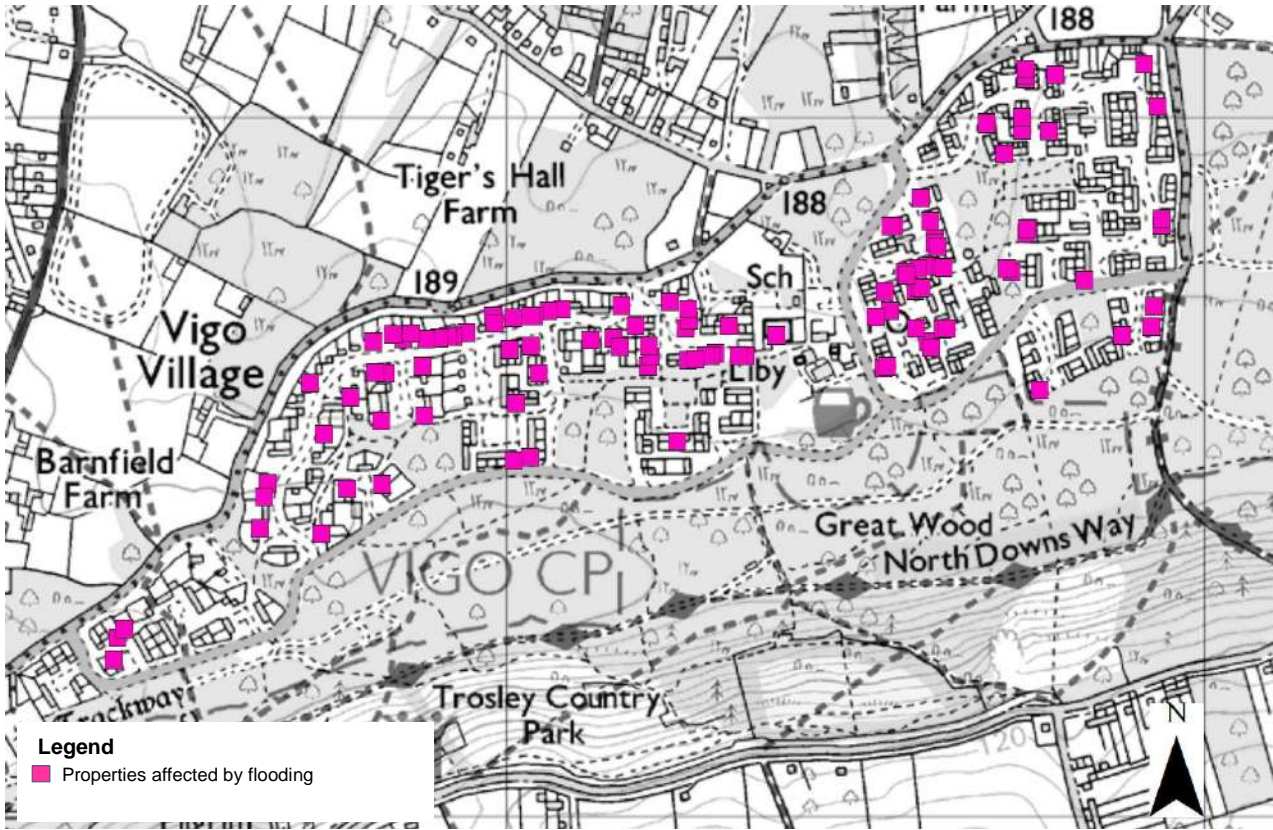


Figure 1 Location of properties in Vigo Village affected by flooding

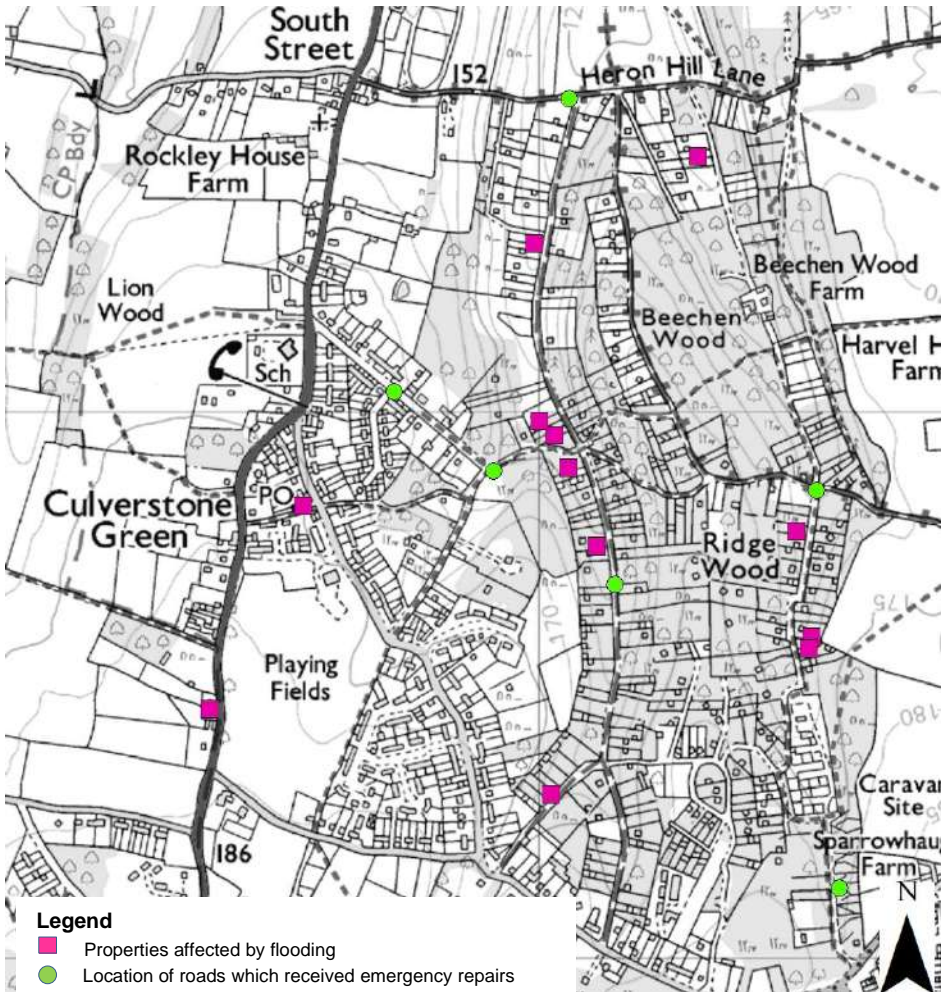


Figure 2 Location of properties and roads in Culverstone affected by flooding

Table 1. Summary of investigated flooding, known flood extent and previous flooding reports

Location of flooding in Vigo	Details of flooding	Source of Report
Admers Wood	4 properties confirmed to have flooded internally and 4 properties experienced external flooding. Overland flows from the surrounding greenspaces affected a number of properties and contributed to flooding on the highway.	KFRS, VVPC
The Coppice	2 properties reported internal flooded from foul sewer 2 properties reported external flooding near lowest point in the road.	KFRS, VVPC
Fern Down	9 properties confirmed internal flooding. Overland flow was reported to have come from Admers Woodland and Admers Wood Road. Properties reported flooding from the foul sewer.	KFRS, VVPC
Ash Keys	3 properties reported flooding external and two of those also reported internal flooding.	KFRS, VVPC
Beech Mast	6 properties reported external flooded at lowest points in the road.	KFRS, VVPC
Timber Bank	36 properties flooded, 19 affected which reported foul water flooding from the rear of the property. 17 experienced external flooding near the lowest point in the road.	KFRS, VVPC, KCC
Chestnut Lane	External flooding experienced at 3 properties	KFRS, VVPC
Churchside	1 property reported internal and external flooding from overland flow to the rear of the property	VVPC
Croftside	2 properties reported flooding – 1 report of internal flooding, water entered property from the land to the rear.	VVPC
Downswood	External flooding affected three properties, with 1 property also reporting internal flooding. Flood water was reported as coming from land to the rear of the property and foul water from the drain.	VVPC
Highview	17 properties experienced external flooding – 7 properties reported internal flooding.	VVPC
Hornbeams	External flooding affected one property	VVPC
Stonecroft	3 properties reported flooding. 1 reported external flooding, 1 property reported internal and external flooding and 1 property reported internal flooding.	VVPC
The Coachdrive	External flooding affected 3 properties	VVPC
The Gallops	External flooding affected 2 properties	VVPC
Vigo School	External and internal flooding	VVPC

Location of flooding in Culverstone	Details of flooding	Source of Report
Heron Hill Lane	1 property reported internal flooding to the cellar of the property	KFRS, MPC
Rhododendron Avenue	5 properties reported flooding 4 properties reported internal flooding and 1 property reported external flooding and flooding in the garage. External flooding affected the road surface	KFRS, MPC
Valley Lane	3 properties reported flooding, 1 property reported internal flooding to the basement and 2 reported external flooding with damage to a retaining wall and sewage tank External flooding affected the road surface	KCC Highways, MPC
Willow Walk	External flooding affected the road surface	KCC Highways, MPC
White Post Lane	1 property reported internal flooding which came through the concrete base of the property	KCC Highways, MPC
Meadow Lane	1 property reported flooding to the garage and external flooding	MPC
Wrotham Road	1 property reported internal flooding	MPC

KCC has previously received reports of localised highway flooding in 2014, 2016, 2017 and 2018. These events were associated with blocked drains and there have been no previous reports of internal property flooding within Vigo or Culverstone.

Site Location, Topography and Flood Risk

The villages of Vigo and Culverstone are located within the district of Gravesham. The villages sit at the top of the North Downs.

Vigo Village lies just below the ridge of the North Downs. Ground levels in the village range from 205 mAOD (above Ordnance Datum) on the western side to 192 mAOD on the east. Woodland surrounds the south and east of the village and the steep scarp slope of the North Downs lies further south, much of this forming the Trosley Country Park. On the eastern side of the village the area between Erskine Road and Harvel Road forms the upper catchment of a dry valley feature.

Culverstone lies to the north of Vigo Village, ground levels in the village range from 183 mAOD in the south and 126.94OD in the north. The area is heavily wooded with two dry valley features running in a northerly direction through the village. The western dry valley upper catchment is a mixture of grazed pasture and woodland forming the Twelve Acre wood, it crosses White Post Lane travels along Meadow Lane and then along Rhododendron Avenue before crossing Heron Hill Lane. The eastern dry valley feature begins at Ferndown Road and Highview within Vigo, crossing Harvel Road it travels along Southfield Shaw and Valley Lane, crossing Heron Hill and converging with the valley to the west.

The national surface water flood map provided by the Environment Agency on the gov.uk long term flood risk information map indicates topographical low points and these valley features to be at a medium to high risk of surface water flooding. Medium and high risk means that these areas have a chance of flooding of between 1% and 3.3% or greater in any one year. An extract from the surface water flood map is shown in Figure 2. It should be noted that all information shown by this mapping, particularly the likelihood of surface water flooding, is a general indicator of an area's flood risk, it is not suitable for identifying whether an individual property will flood.

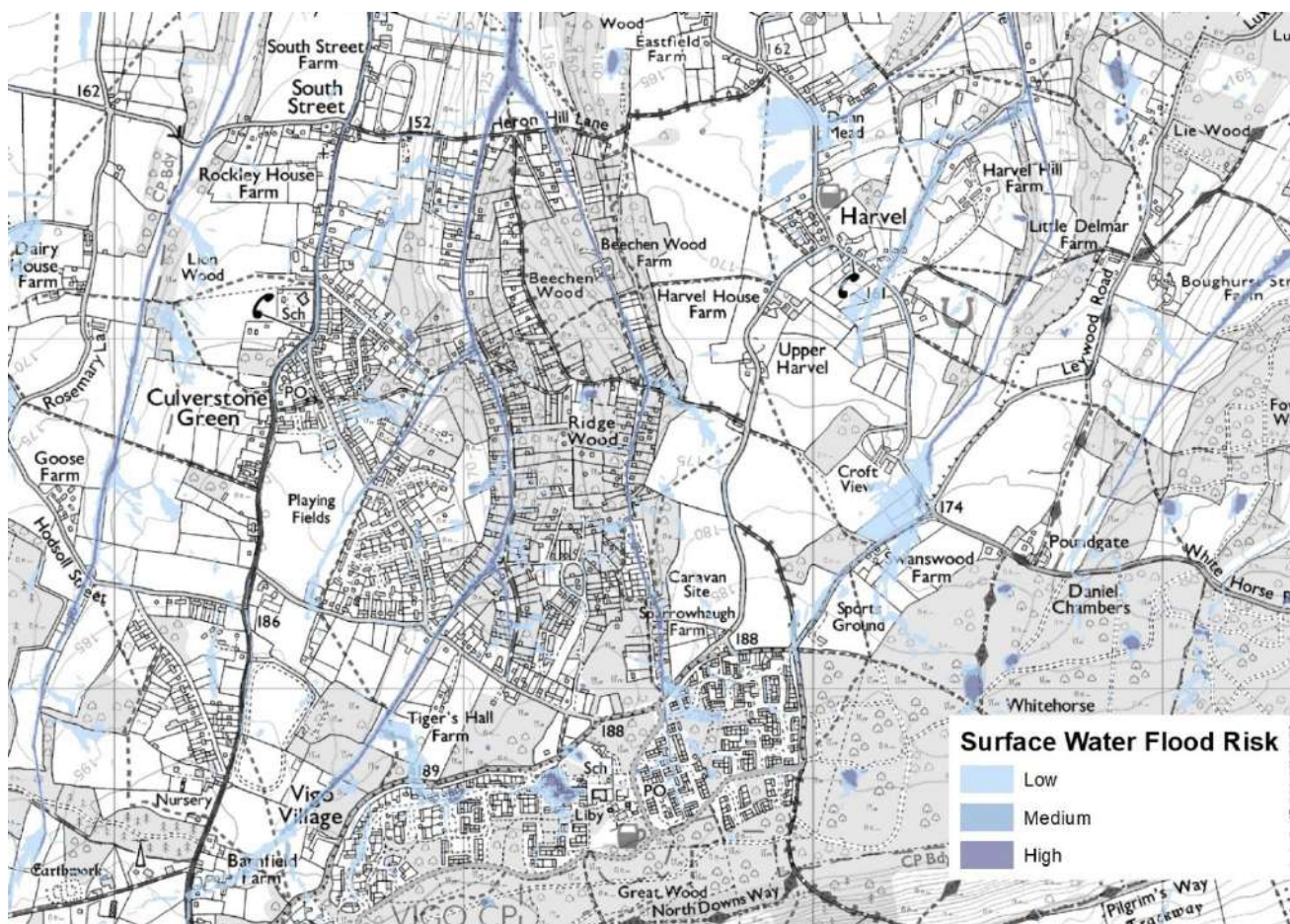


Figure 3 Environment Agency Surface Water Flood Risk Map

Rainfall

Rain Gauge

Commonity Daily Total Rainfall

Rainfall	122.5mm
Time period	24 hours
Annual Exceedance Probability	0.46%
	1 in 217-year return period

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 15-minute intervals or a day. The data can be used with the Flood Estimation Handbook (FEH)² web service Event Rarity Calculator to assess the Annual Exceedance Probability (AEP) of the depth of rainfall that occurred. 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. This is also known as a '1 in 100 year' event.

Figure 3 shows the location of the rain gauges and Table 2 summarises the rainfall recorded at the Environment Agency rainfall gauge stations closest to the path of the storm on 10 June 2019.

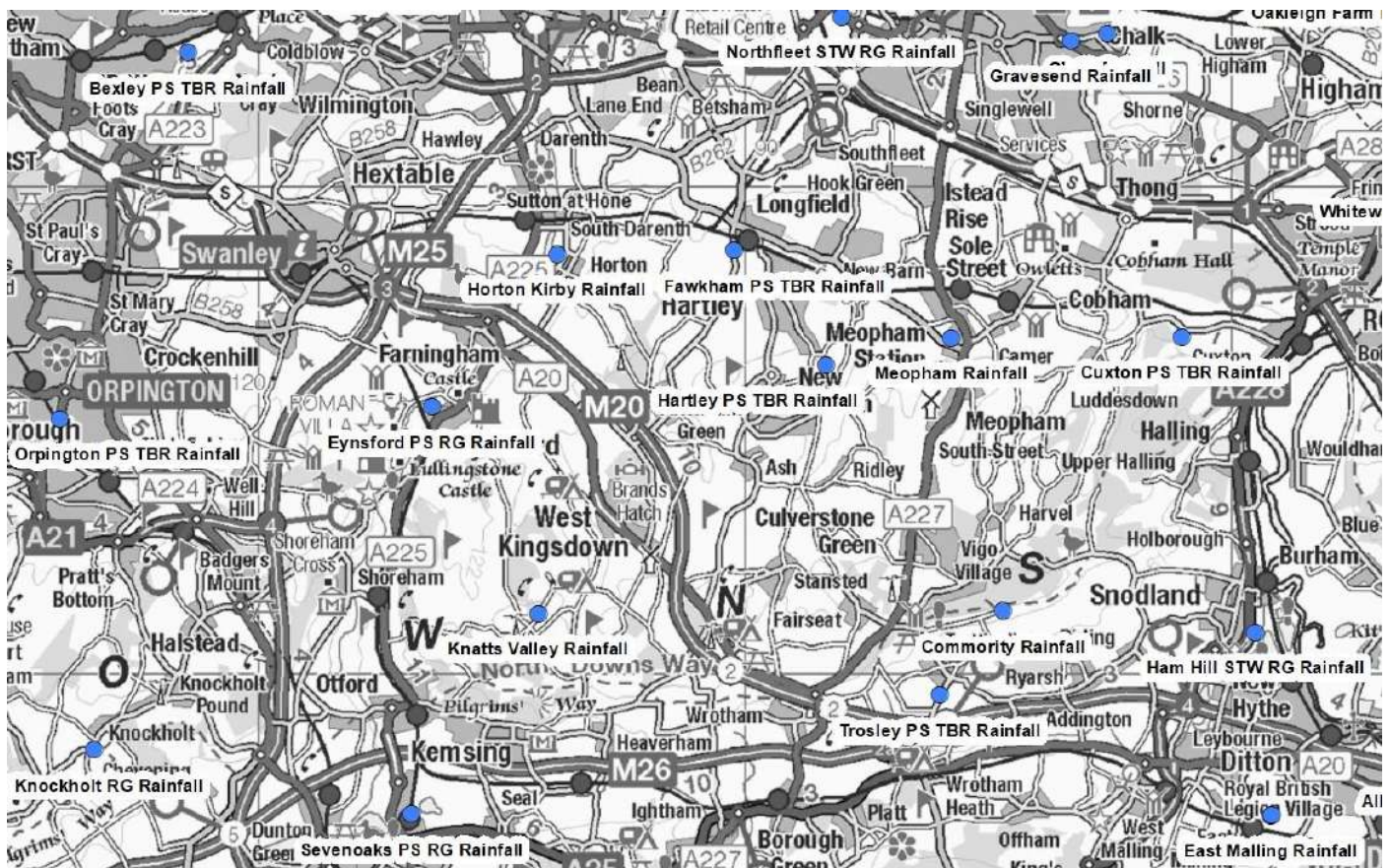


Figure 4 Location of rain gauge stations closest to the path of the storm.

² The Flood Estimation Handbook (FEH), with its subsequent updates and FEH Software, provides the industry-standard methods for assessing flood risk in the UK. It offers guidance on the estimation of rainfall and river flood frequency and development site runoff rates across the UK.

Table 2. Rainfall levels recorded at Environment Agency Rain Gauge station on 10 June 2019.

Rain Gauge	Rainfall	Time Period
Bexley	22.62mm	Daily total
Hartley	70.96mm	01:30 – 22:30
Orpington	94.80mm	01:45 – 23:45
Commority	122.5mm	Daily total
Fawkham	48.60mm	02:00 – 22:45
Sevenoaks	43.86mm	01:45 – 21:15
Eynesford	96.16mm	02:00 – 23:15
Snodland	103.58mm	01:45 – 21:30
Trosley	75.40mm	01:15 – 22:00

The storm tracked broadly from the east to the west across the north downs, this is shown by the high levels of rainfall measured at Ham Hill, Commority, Eynesford and Orpington. Rain gauges to the north and south of this path, Hartley and Trosley respectively, show lower, but still relatively high levels of rainfall. The rain gauges at Fawkham and Sevenoaks which lie further to the north and south respectively show further lower rainfall levels.

The nearest rain gauge to Vigo Village and Culverstone is located at Commority. It recorded a daily total of 122.5mm of rain on 10th June 2019. Given the consistency of this gauge with the others in the path of the storm this rainfall is considered to be representative of the rainfall experienced at Vigo and Culverstone.

Drainage System

Highway run-off is generally discharged via soakaways into the ground throughout Vigo and on the publicly maintained roads in Culverstone. Culverstone also includes privately maintained roads that do not appear to benefit from formal drainage.

It is likely that most private drainage, for residential and commercial premises in Vigo and Culverstone, also dispose of surface water from their roof and hardstanding via private soakaways usually located within their gardens.

Soakaways rely on the natural permeability of the underlying rock for the water to soak into. They are usually made by digging large manholes that are lined with perforated concrete rings or open jointed brickwork. The manhole provides storage for water as it seeps through the perforations in the chamber into the surrounding Chalk bedrock over a period of 24 to 48 hours, ready to accept a subsequent storm. Prolonged very heavy rainfall or multiple heavy rainfall events within a short period can overwhelm the storage available in these soakaways and result in surface water flooding occurring.

The volume of water stored in a soakaway for highway drainage purposes is likely to have been based on the volume of run-off from a storm with a 20% probability of occurring in any one year (a '1 in 5 year' event). This was a standard approach for the time of their construction. Individual soakaways serve relatively small areas of between two and six road gullies. As such they will form a series of smaller discrete drainage systems rather than one for the whole area.

There are public sewers throughout Vigo Village, operated by Southern Water, however these serve as 'foul only' for most connections from residential and commercial premises. There is no public sewer network dedicated to surface water drainage in this area.

Flood description

The first report of flooding was received from Admers Wood Vigo at 19:31, with the Fire Brigade attending Admers Wood and Ferndown to pump flood water at 20:20. Surface water flooding was reported as flowing from the woodland to the south of Admers Wood, crossing Erskine the water travelled along Admers Wood and Beech Mast before flowing along footpaths into Ferndown Road.

The out of hours duty officer attended Timber Bank at 20:18 with a tanker requested at 20:25 to clear flood water from the highway. The officer attended Admers Wood later in the evening to arrange gully cleansing and provide flood sacks to residents.

Residents along Timber Bank reported foul sewers overflowing from manholes within gardens at the rear of properties, at Ferndown residents reported foul water surcharging from toilets and drains.

Flooding was reported on Rhododendron Avenue in Culverstone at 22:18 with internal flooding to the basement of a property.

Vigo School reported that surface water collected within the reception area of the school grounds reaching a depth of three feet and entering the school building.

Surface water flowed along Rhododendron Avenue, Valley Lane and Willow Walk causing the surface of the road to be damaged. KCC Highways carried out emergency repair work to the private unadopted highways adding planings to the road to make it accessible for emergency services. There is no formal drainage along these roads and any drainage that does exist would be privately owned and maintained.

Flooding mechanism

The flooding on 10th June 2019 was the result of the high volume of prolonged rainfall throughout the day. Once the natural capacity of the ground to absorb the rainfall became saturated, surface water flows increased overloading the surface water drainage infrastructure.

When the intensity of the rainfall increased in the evening the runoff from impermeable areas, such as roofs, hardstanding and the highways would have combined with overland flows from the woodland and rural catchment leading to the significant flooding experienced within Vigo Village and Culverstone.

Private drainage and highway drainage network will have become full from the rainfall that fell throughout that day, when the intensity of the rainfall increased in the evening the drainage systems they were overwhelmed and unable to prevent the deep water that lead to flooding of properties at the topographical low points on the flood pathways.

Residents have reported that highways gullies were blocked leading to flooding. Inspections of the soakaways and drainage networks through the areas found defects on Timberbank, Croftside and Beech Mast. At Timberbank defects were found on a section of drainage pipe, one silt trap and the drainage connection into one of the 16 soakaways. At Croftside the pipe connection to the soakaway was found to be displaced and at Beech Mast the drainage pipe leading to the soakaway was found to be damaged. Most of these defects appear to be as a result of tree root ingress. These defects may have had a limited impact on water reaching the soakaways and water may have taken longer to drain away.

At all other locations, inspections found minor defects relating to tree root ingress in some of the assets, but the system was generally functioning.

Given the level of rainfall, and that the storage capacity of the drainage network is relatively small and will have been filled by the rainfall across the day and the infiltration rate from the soakaways will have been exceeded by the intensity of the rainfall, even a fully functioning drainage system would not have prevented a similar flood from being experienced.

Highway drainage is not designed nor intended to provide drainage for areas outside of the highway boundary nor is it intended to provide flood mitigation. The overland flows from land surrounding the villages significantly increased the volume of surface water run-off contributing to both highway drainage systems and any private drainage systems.

Residents reported lifting manhole covers to manage flood water in an effort to protect their properties. The public sewer network operated by Southern Water is designed to take 'foul only' flow. The consequence of this ingress of surface water into this system is it quickly becoming overwhelmed, causing manhole covers to lift and water to surcharge into properties through toilets and downpipes.

Flood response

After the flood, incident recovery activities included the inspection and cleansing of highway drainage by KCC. The table below details the inspections and cleansing completed including the actions undertaken or scheduled to be completed in response to the defects found.

Table 3 Flood response activities undertaken by Kent Highways

Location	Inspection date	Details	Actions
Timber Bank	Surveys completed between March 2020 Cleansing – August 2019	The highway is drained by 50 gullies which have all been CCTV surveyed and all 16 soakaways visually inspected. Minor tree root ingress into pipes has caused cracking and joint displacement.	<ul style="list-style-type: none"> Cleansing of all soakaways has been scheduled. Work completed in May 2020 on footpath leading to Nos 74-78 Timber Bank. The existing small silt-trap has been replaced with a much larger gully pot and the connection re-made into the existing soakaway located on Parish Council land. Works undertaken in June 2020 to repair 27m of damaged drain linking manholes between Nos 98 & 102. Cause of the damage is unknown and will be determined following excavation. It is likely to be due to tree root ingress. KCC intends to raise repairs (other than those mentioned above) as a single set of works. This will help ensure that the drainage pipes do not deteriorate and help prevent future tree root ingress in the longer term. These works are underway as of July 2020.
Croftside	Surveys completed between November 2019 Cleansing – August 2019	Highway drainage includes 6 gullies and a soakaway which have been CCTV surveyed. The connection into soakaway has been found to be damaged.	The connection pipe into the soakaway was found to be damaged due to root ingress, repairs to the connection were completed in June 2020.
Admers Wood	Cleansing – July 2019	The 13 gullies on this road have been cleansed with one gully (adjacent to No. 37) identified as not flowing.	CCTV survey and investigations and root cutting has been scheduled.
Ash Keys	Cleansing – March 2020	The 3 gullies on this road have been cleansed and one gully found to be not flowing.	CCTV survey scheduled to identify fault and assess the condition of the associated soakaway.
Beech Mast	Cleansing - August 2019 Surveys completed February 2020	The highway is drained by 11 gullies, the CCTV survey found the small silt-trap on the footpath outside No. 22 was damaged.	The drain was found to be damaged at point coinciding with a BT trench reinstatement. A larger replacement gully has been installed and new piped connection into the existing soakaway, work was completed in June 2020.
Highview	Cleansing – August 2019	All 68 gullies have been cleansed; some root ingress has been	CCTV survey and root cutting has been scheduled for July 2020.

Location	Inspection date	Details	Actions
		identified.	
Hornbeams	Cleansing – July 2019	All 7 gullies have been cleansed and one gully (adjacent to No. 20) identified as not flowing.	CCTV survey and root cutting has been scheduled.
The Coach Drive	Cleansing – August 2019	All 5 gullies have been cleansed which has identified connection issues with three gullies at the end of the cul-de-sac.	CCTV survey has been scheduled to confirm fault before scheduling any repair work.
Erskines Road	Cleansing – October 2019	The highway is drained by 49 gullies. Cleansing identified two gullies not flowing between Commority Road and Waterlow Road.	CCTV survey has been scheduled to identify fault. Cleansing of two soakaways (near Ash Keys) have been scheduled for cleansing.
Churchside	Cleansing – August 2019	Cleansing of the 7 gullies found no issues.	No further action required.
Ferndown	Cleansing – June 2019	Cleansing completed for the 6 gullies immediately after flood event no issues found.	No further action required.
Stonecroft	Cleansing – September 2019	Cleansing of the 9 gullies found no issues.	No further action required.
The Gallops	Cleansing – December 2019	Cleansing of the 4 gullies found no issues.	No further action required.
Whitepost Lane	Cleansing – December 2019 Surveys completed January 2020	Inspection of the three soakaways identified two in good condition and one which is functioning but requires replacement	The soakaway at junction of White Post Lane and Carters Hill Road, Culverstone is functioning, however detailed inspection found that it is reaching the end of its useful life. KCC is working with the adjacent landowner, Gravesham Borough Council, to construct a replacement soakaway and reshape the junction, kerbing and replacing the gully cover and frames work will commence in August 2020 (following gas works) with further work in GBC land to follow on following ground investigations being completed. The soakaways at junction of Whitepost Lane and Rhododendron Avenue and Meadow Lane are in good condition and require no further work.
Junction of Harvel Road and Southfield Shaw			The gullies at the junction of Harvel Road and Southfield Shaw require further investigations, which has been scheduled, as will the soakaway at this location.

Conclusion and Future Actions

A heavy rainstorm of a 1 in 217-year return period overwhelmed the drainage and led to flooding in Vigo Village and Culverstone. Overland flows from the developed areas of the villages along with surrounding woodland and rural catchment caused water to flow along dry valleys and collect at local topographical low points that caused flooding to properties in the vicinity.

Highway drainage is not generally designed to accommodate storms of this severity. The defects found within the drainage system may have reduced the rate at which the water drained; however the volume of rainfall was the dominant factor in causing the flooding as the drainage system became overwhelmed. It is very unlikely that improvements to the highway drainage could be delivered and be sufficient to prevent a similar flood from happening if this rainfall was experienced again.

Options to mitigate the risk need to focus on preventing the build-up of water at the low points, this includes management of flow pathways from the rural catchment upstream. KCC Flood and Water Management is investigating the feasibility of using Natural Flood Management (NFM) measures to slow overland flows and store surface water reducing the rate at which water collects in areas at risk. However, the location of the villages in the very upper reaches of the catchment may be a limiting factor in finding suitable locations to deliver this approach.

It should be noted that improvements must be cost-beneficial (i.e. the costs of delivering them must be outweighed by the benefits they provide). Any improvements made are unlikely to completely eliminate the risk of surface water flooding - all measures can be overwhelmed by an event of sufficient extremity. Even if the standard of protection is increased in the future, it is unlikely that flooding in a similar event could feasibly be prevented.