# Hertfordshire County Council
# Flood Investigation Report
## Admirals Walk, Hoddesdon


**Admirals Walk - Aerial Photography © 2019 Google**

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# Revision Schedule

**Hertfordshire County Council**
**Admirals Walk, Hoddesdon Flood Investigation Report**

| Rev | Date | Details | Author | Checked and Approved by |
|---|---|---|---|---|
| **1** | 06/03/2019 | First Draft | Ana Neves, Senior Flood Risk Officer | Andy Hardstaff Flood Risk Management Team Leader |
| **2** | 13/03/2019 | Second Draft | Ana Neves, Senior Flood Risk Officer | Ryan Thomas, Partnership & Scheme Development Officer |
| **3** | 21/03/2019 | Third Draft | Ana Neves, Senior Flood Risk Officer | Ryan Thomas, Partnership & Scheme Development Officer |
| **4** | 01/05/2019 | Fourth Draft | Ana Neves, Senior Flood Risk Officer | Ryan Thomas, Partnership & Scheme Development Officer |
| **5** | 19/07/2019 | Draft for issue to RMAs | Ana Neves, Senior Flood Risk Officer | Andy Hardstaff Flood Risk Management Team Leader |
| **6** | 09/09/2019 | Final issue with RMAs comments incorporated | Ana Neves, Senior Flood Risk Officer | Andy Hardstaff Flood Risk Management Team Leader |

## Explanation of Acronyms and Terms

| Acronym / Term | Explanation |
|---|---|
| **Adopted Highway** | The term has been used in this report to include all highways maintainable at public expense. This includes historic highways as well as those formally adopted through section 38 of the Highways Act 1980 and preceding powers. |
| **Antecedent conditions** | Antecedent conditions is a term used to describe the relative wetness or dryness of a catchment, which changes continuously and can have a very significant effect on surface water flows during wet weather. Antecedent moisture conditions are high when there has been a lot of recent rainfall and the ground is moist. Antecedent moisture conditions are low when there has been little rainfall and the ground becomes dry. |
| **AEP** | Annual Exceedance Probability (AEP) represented as a percentage (%). For example 1 in 100 year event corresponds to 1% AEP |
| **Attenuation** | The processes of water retention on site slowly being released to a surface water / combined drain or watercourse. |
| **EA** | Environment Agency. |
| **FWMA 2010** | Flood and Water Management Act 2010. |
| **HCC** | Hertfordshire County Council. |
| **LHA** | Local Highways Authority. |
| **LLFA** | Lead Local Flood Authority – This is the role assigned to the unitary or county council for an area with a range of duties and powers to support the management of local flood risk. |
| **LDA 1991** | Land Drainage Act 1991 – Legislation that sets out a range of roles and responsibilities relating to flood risk management. It is also the legislation that gives powers to local authorities to manage flood risk and highlights the role of the landowner to manage watercourses on their land to maintain the flow of water. |
| **LVRPA** | Lee Valley Regional Park Authority. |
| **Riparian Owner** | A riparian owner refers to a person who owns land bounding upon a river, lake, or other watercourse. |
| **RMAs** | Risk Management Authorities – Bodies identified in the FWMA 2010 with roles and powers to manage flood risk. In Hertfordshire this includes the county council as Lead Local Flood Authority and Highway Authority, district councils, Highways England, Environment Agency, Bedfordshire and River Ivel Internal Drainage Board, Thames Water Utilities Limited and Anglian Water Services Limited. |
| **s19** | Section 19 of the FWMA 2010 |
| **Storage** | An area or structure where surface water flows are retained. |
| **SuDS** | Sustainable urban drainage system. |
| **TWUL** | Thames Water Utilities Limited. |

## Executive Summary

Admirals Walk has suffered flooding for a number of years, affecting the highway and surrounding properties. To date there have been no reports of internal property flooding although there are extensive records of properties being affected by external flooding.

Due to the frequent flooding occurrences, Hertfordshire County Council (HCC) as Lead Local Flood Authority (LLFA) has carried out a flood investigation to identify the flooding mechanisms and the relevant management authorities, and published this report.

Rainfall records point out that flooding episodes have occurred in a variety of different rainfall conditions.

The origin of the flooding problems is related to the lack of an effective means of discharge of the surface water collected by the urban drainage. Surface water runoff is captured by the highway drainage network which discharges to a Thames Water Utilities Limited (TWUL) surface water sewer, which in turn discharges to an open ditch located along the back of the properties of Admirals Walk. Survey showed that the ditch appears not to have a positive discharge to Admirals Walk Lake.

The outfalls of the surface water drainage system that discharge into the ditch are in land managed by the Lee Valley Regional Park Authority (LVRPA). During the investigations it was found that the outfall discharge point at the northern end of the ditch is submerged due to the high volumes of silt and a high level of water which is due to the high groundwater level and to the proximity of Admirals Walk Lake. There is a second surface water sewer outfall, located towards the middle of the ditch, that drains the southern area of Admirals Walk however it was not possible to localise this outfall presumably due to the above mentioned reasons.

It was also found that there are several obstructions along the ditch and that the ditch terminates where the embankment of the railway track starts.

The condition of the ditch and the TWUL surface water drainage outfalls have effects on the reduction of the storage capacity of the ditch and on the free discharge of the surface water, contributing for the back-up of the surface water and to the surcharge of the urban drainage network.

It was also found that at points in the surface water network there will a throttling effect caused by a reduction in pipe sizes (typically 375mm connecting into 225mm). As a consequence this will impede surface water draining from the highway because the water will be backing up from the surface water pipe network. This will lead to the surcharge of the highway gullies located at the lowest levels and the properties located near these gullies will be the first to be affected by flooding.

The downstream part of the ditch ends at the embankment of the railway track and river Lynch is located on the other side of the embankment. Throughout the investigations it

was not possible to establish the presence of any link between the ditch and the River Lynch and according to Network Rail there is no culvert connecting to the ditch.

HCC in its role as the LLFA, on becoming aware of the above mentioned flooding issues, has the responsibility to investigate the case using the powers under the Section 19 (s19) of the Flood and Water Management Act (FWMA) 2010 in order to determine the source of flooding and the relevant organisations and stakeholders for resolving this situation.

The main findings of this investigation are:

- Rainfall events with different intensities lead to surcharge of the drainage system network at Admirals Walk.
- The highway gully network relies on TWUL surface water drainage to drain.
- Surface water discharges into a ditch located in the end of rear gardens of properties in Admirals Walk, adjacent to Admirals Walk Lake and the ditch does not have a positive outfall.
- Following the clearance of the ditch and the surrounding area, it was found that the TWUL surface water drainage outfall pipe is submerged and blocked.
- The ditch appears not to discharge anywhere. There is not thought to be functioning infiltration as it is heavily silted and there is a high water level due to the high groundwater level in the area, and this causes water to back up and surcharge the urban drainage network.
- There is a throttling effect within the surface water sewer network, potentially causing water to back up and surcharge the gullies in Admirals Walk, causing pooling water within the road.
- The existence of drop kerbs, reduce the capacity of the highway to hold and store the surface water and facilitates it to flow onto properties.
- The ditch, if historically connected to the river, has been severed by the railway track, and no evidence of a connecting culvert has been found.

The recommendations from this investigation for reducing the risk of flooding are:

- Consider a partnership between the Risk Management Authorities (RMAs) and LVRPA as a key stakeholder to put in place a sustainable urban drainage system (SuDS) scheme such as a swale to positively drain the ditch into the Admirals Walk Lake.
- LLFA to carry out a feasibility study to define the best scheme to drain the ditch into Admirals Walk Lake.
- TWUL to investigate the surface water drainage network and the throttling impact on surface water sewer network.
- TWUL to program and identify any remedial and maintenance works to surface water sewer network.
- TWUL to confirm that the structure near the railway is not one of their assets.
- Local Highway Authority (LHA) to consider raising the footway to keep water in the highway and mitigate the presence of the dropped kerb in Admirals Walk.
- LHA to consider the re-evaluation of the gullies cleaning frequency.
- LHA to continue monitoring the reported faults through the highway reporting system.

- LVRPA to remove the silt from the ditch and any existing structures that are affecting the storage capacity of the ditch.
- LVRPA to contact the Environment Agency (EA) to understand the connection between Admirals Walk Lake and River Lynch and how it is regulated.
- LVRPA to develop and implement a maintenance and inspection plan to assure good condition of the ditch and surrounding land.

# 1. Introduction

## 1.1. Investigation area and background

Admirals Walk is a residential area in Hoddesdon, Broxbourne, Hertfordshire, which in recent years has experienced flooding to the highway and to external property boundaries. In the northern boundary, there is Admirals Walk Lake, a significant body of water that is a 25 acre spring fed gravel pit with natural banks. The New River is located to the west of Admirals Walk and to the east there is a railway track, managed by Network Rail. The surface water for a significantly developed catchment discharges into a ditch via a Thames Water Utilities Limited (TWUL) surface water sewer, which is situated between the rear of properties and Admirals Walk Lake. However, the ditch is not connected to any other waterbodies downstream, causing water to be held within the ditch with no means to drain away (see Figure 1 for a photograph of the ditch and Figure 2 for location plan along with the significant catchment characteristics). Other key catchment notes are:

- The groundwater levels in the catchment, particularly surrounding the lake, are very high. This, in combination with the soil being predominantly composed of clay reduces the ability for the water to infiltrate;
- The highway gully network also drains to the TWUL surface water sewer that discharges to the ditch;
- Properties most at risk of flooding are at a lower level than the highway and there are drop kerbs to facilitate access to the properties;
- The properties are in close proximity and significantly lower in relation to the New River;
- A TWUL foul pumping station is located near the investigation area, however there is no connection between this and the flood events experienced in Admirals Walk.

**Figure 1: Photograph of ditch between property and Admirals Walk Lake**

**Figure 2: Significant catchment characteristics and details**

## 1.2. History of LLFA investigations at Admirals Walk

Admirals Walk suffered flooding to the highway and caused external flooding to two properties on 12 June 2016, which was reported to the Lead Local Flood Authority (LLFA) by Ringway, the highway maintenance term contractor for Hertfordshire.

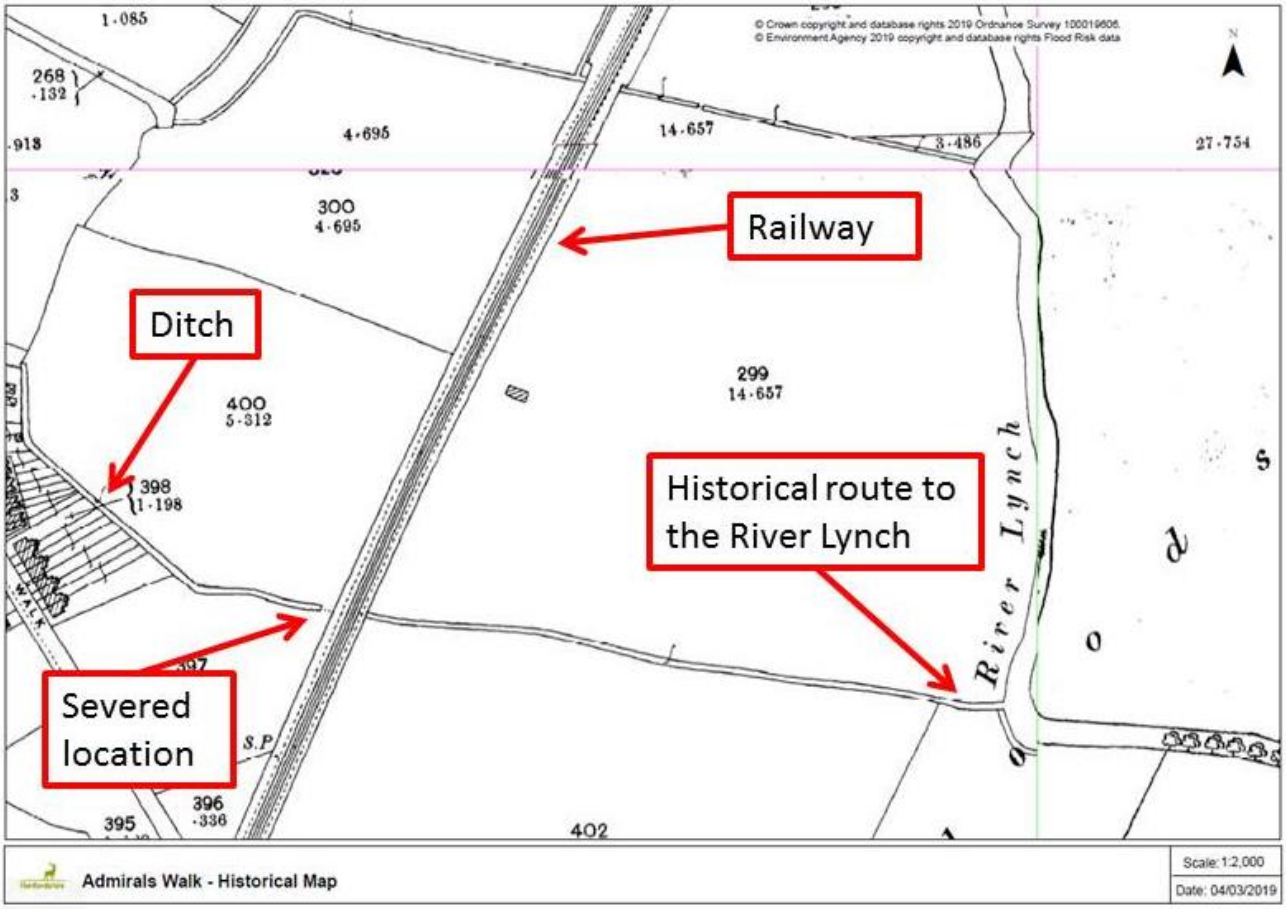
This led to officers from the LLFA visiting the area to determine if the flood event qualified for a Flood Investigation under Section 19 of the Flood and Water Management Act 2010. Officers made the following conclusions:

- As only external flooding to property was reported, the flood event did not qualify for a flood investigation,
- A ditch to the rear of the properties (between Admirals Walk (Highway) and Admirals Walk lake, could not be classified as an Ordinary Watercourse as officers could not establish a discharge location when the ditch reached the railway line (see Figure 3).

This investigation included studying historical maps that indicated that there may have been a connection to the River Lynch (see Figure 4), but this could not be found on site and there was no records on the Network Rail Asset Database.

**Figure 3: Location where the ditch is severed**

**Figure 4: Historical map of Admirals Walk site**




There have been significant changes to the land either side of the railway since the production of the map at Figure 4, with extensive quarrying and subsequent restoration taking place in the catchment, which is likely to explain why the watercourse was severed at some point historically.

A letter was sent to impacted residents and Lee Valley Regional Park Authority (LVRPH) (an identified key stakeholder as the ditch is within land that is their responsibility to maintain) in May 2017 outlining the decision made by LLFA not to reclassify the ditch as an ordinary watercourse.

### 1.3. Justification for further Investigation

Under Section 19 (s19) of the Flood and Water Management Act (FWMA) 2010 HCC as the LLFA, on becoming aware of a flood in its area, must, to the extent that it considers it necessary or appropriate:

- Investigate the incident;
- Identify the Risk Management Authorities (RMAs) with relevant flood risk management functions;
- Establish if the relevant RMAs have responded to the flood event or are proposing to respond;
- Publish its findings; and
- Inform the relevant RMAs of its findings.

An RMA (as defined under Section 6, subsection 13 of the FWMA 2010), has certain powers to manage, regulate, assess and mitigate flood risk. The activities of the following RMAs have been examined as part of this s19 flood investigation for Admirals Walk:

- Hertfordshire County Council as the Lead Local Flood Authority;
- Hertfordshire County Council as the Local Highway Authority;
- Thames Water Utilities Limited;
- Environment Agency.

Along with the RMAs, the following have been identified as key stakeholders due to the proximity of Admirals Walk Lake to the flooding site and the significance of the ditch behind properties:

- Lee Valley Regional Park Authority;
- Network Rail.

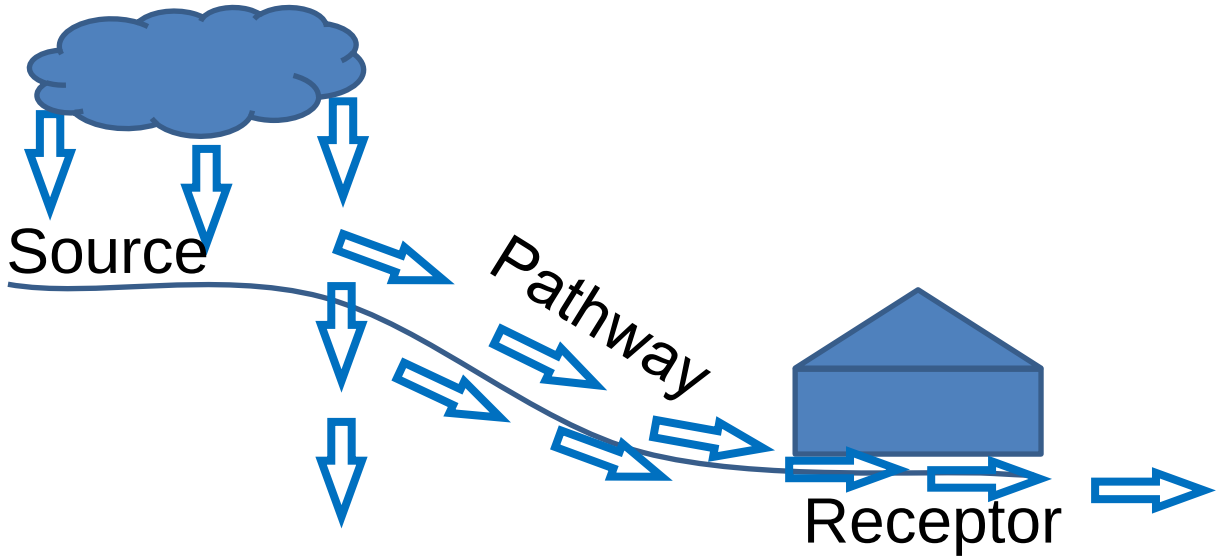
On receiving the report of repeated flooding to the highway and externally to properties, it was determined that this most recent incident met the criteria in Policy 2 of HCC's Local Flood Risk Management Strategy for an investigation to be undertaken due to the uncertainty of the source of flooding and the organisation with primary responsibility for resolving it.

#### 1.3.1. Source pathway receptor model concept

The investigation approach is based on the source pathway receptor conceptual model (represented in Figure 5) in order to better understand the flood risk and the flooding mechanism. The main purpose is to analyse and investigate all parts of the model (source, pathway and receptor), and identify which ones most contribute or are likely to cause flooding in Admirals Walk.

The management of flood risk normally involves the reduction of either the probability of flooding (through management of sources and pathways) or the consequence of flooding (through management of the receptor), or both.

**Figure 5: Overall flooding system showing Sources Pathways and Receptors**




According to the source pathway receptor model, the perfect connection between all the elements allows the surface water to flow and drain away without causing major flooding issues. However, in case of any interference between the three elements of the model, the likelihood of flooding increases significantly.

Identification of the 3 elements of the model in Admiral's Walk:

Source: Rainfall on an urban catchment draining to highway and surface water systems;
Pathway: Highway gulley network, the surface water sewer drainage and the ditch;
Receptor: Road / Flooding pool outside properties.

With the source-pathway-receptor model elements identified, it becomes easy to understand that the problem is in the pathway, which is not functioning leading to road flooding and consequently flooding to the property.

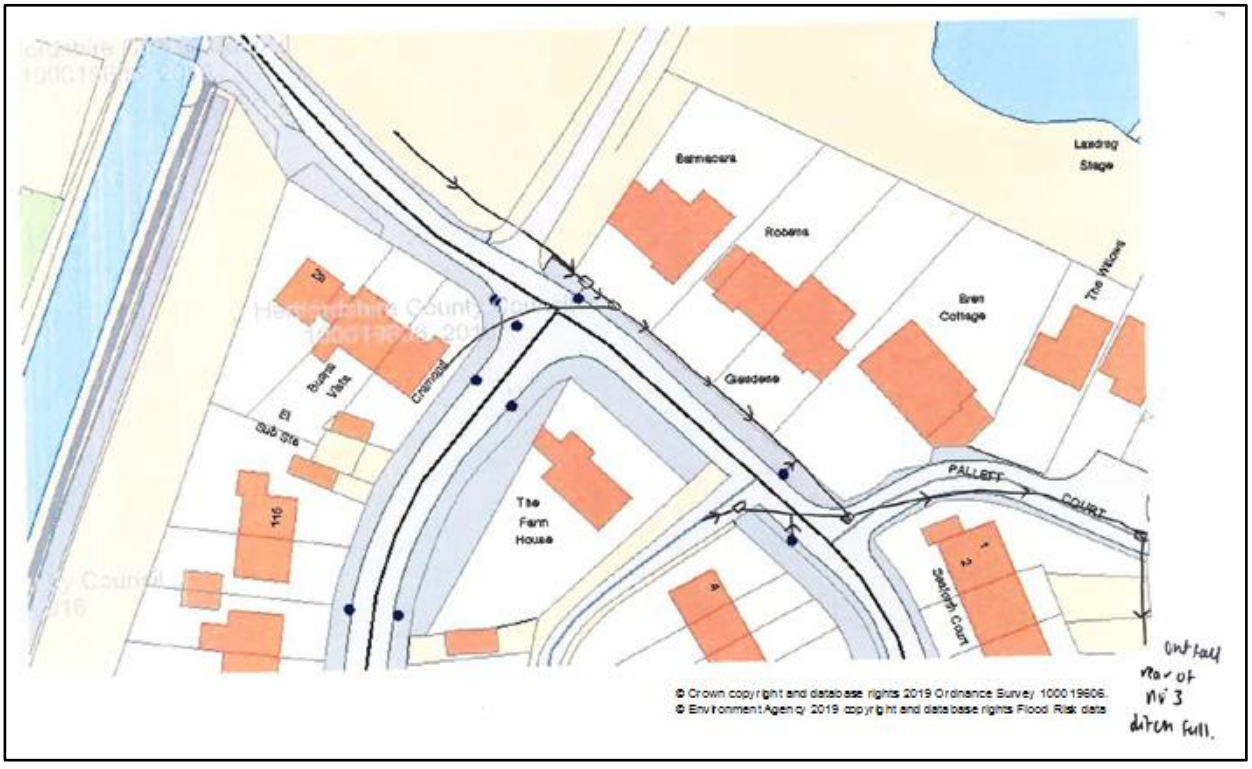
## 2. Urban drainage network

A TWUL surface water sewer is draining residential property rain water to the ditch besides Admirals Walk Lake. There is no independent highway drainage pipework; instead roadside gullies are also connected directly to the TWUL surface water sewer. Foul water is a separate sewer network that has not been included as part of this investigation.

### 2.1. Highway drainage

A CCTV survey of the highway gully network was conducted by Ringway in 2016 to check the condition of the highway drainage network and ascertain if there were any blockages that were contributing to the flood experienced in the highway. The survey confirmed that all gullies in the vicinity had individual connections to the TWUL surface water sewer network and that the highway drainage network was free flowing with no obstructions or defects within the network. Figure 6 shows a connectivity sketch of the highway drainage network in the catchment.

**Figure 6: Ringway highway drainage sketch**



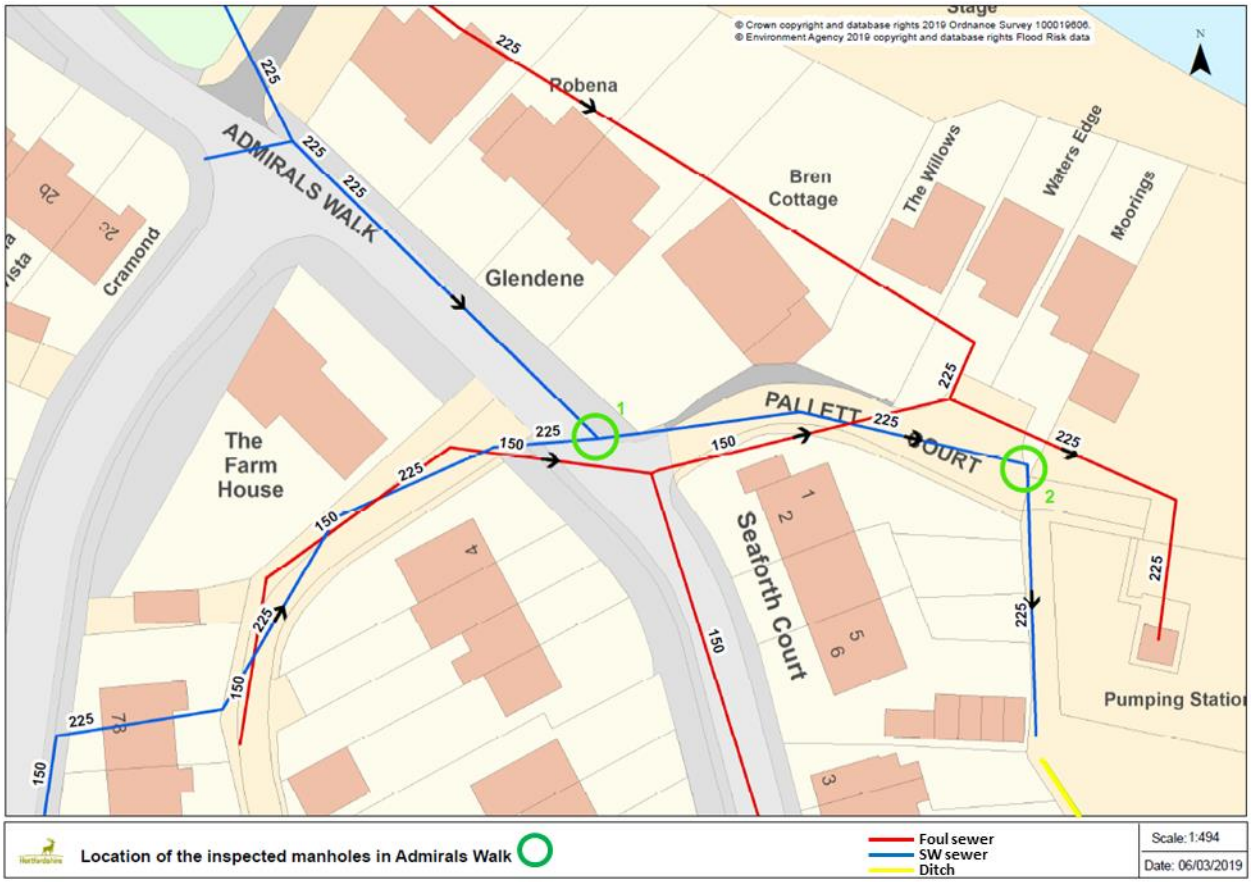

It is noted that the existence of drop driveways to facilitate off street parking in Admirals Walk reduces the storage capacity available in the highway. In the same way it facilitates the surface water to flow towards the front of the properties.

## 2.2. TWUL surface water sewer network

Figure 2 maps the TWUL drainage network system within the investigation area. There are two discharge locations, one off Pallet Close and the other between properties off Admirals Walk (highway).

Manhole covers on the surface water sewer network were lifted within Admirals Walk and Pallet Close to identify sources of water entering the network and to confirm connectivity (marked in Figure 7).

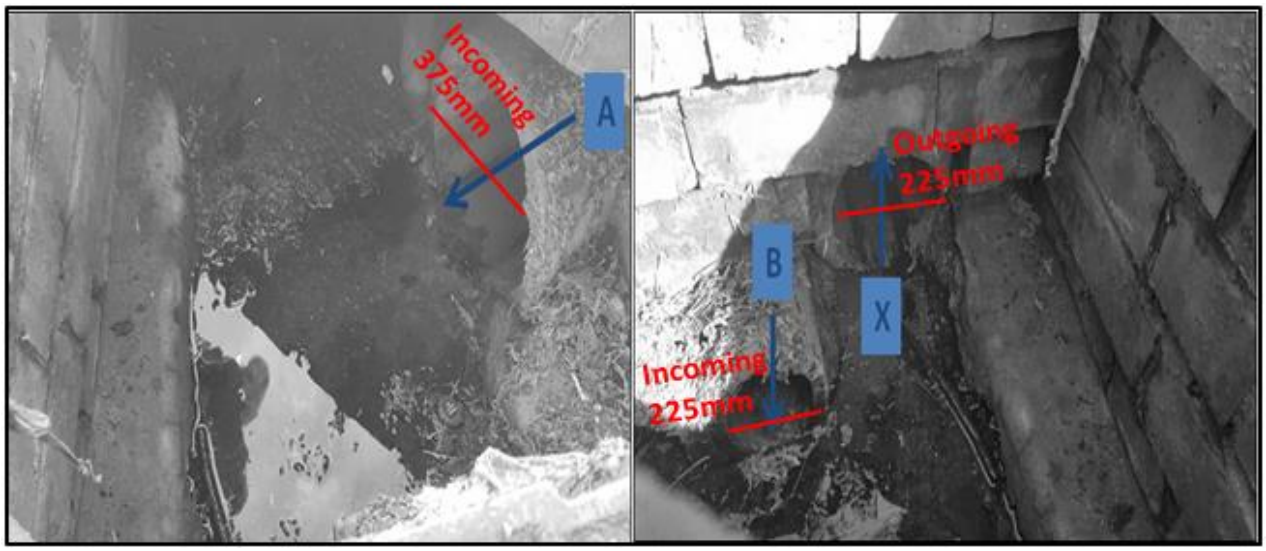
**Figure 7: Location of the inspected manholes in Admirals Walk**




The following assessment was concluded from the investigation with Figure 8 and Figure 9 evidencing the assessment.

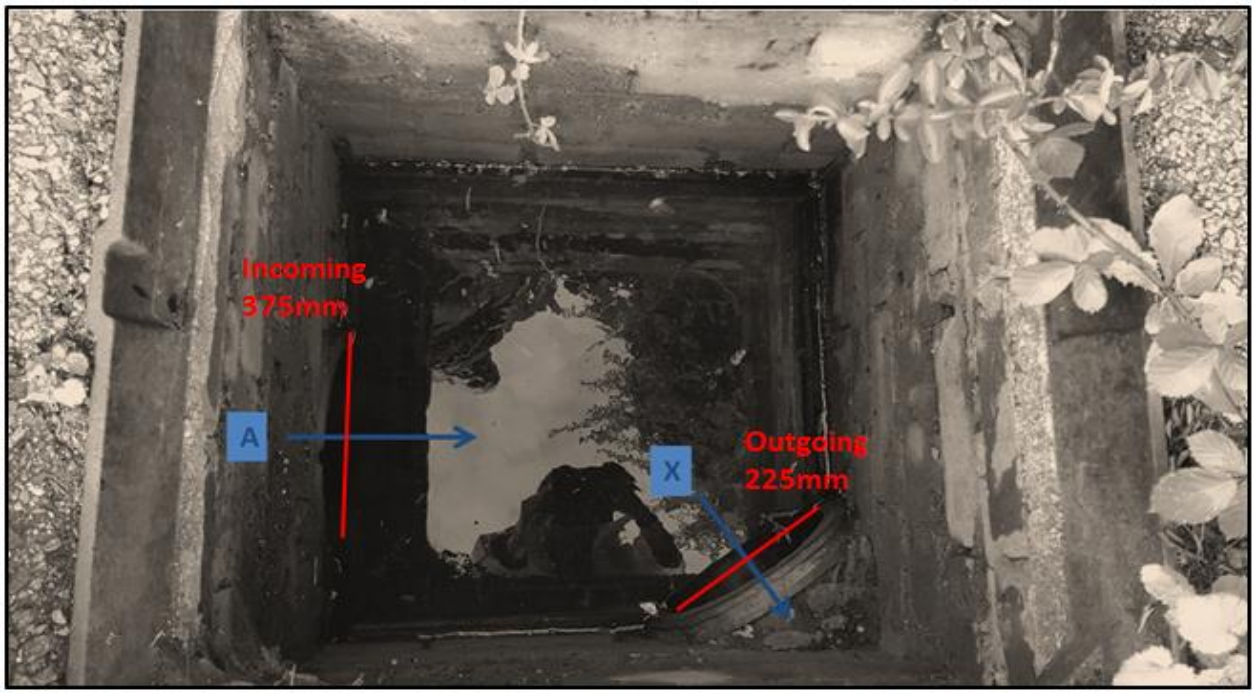
There is a manhole chamber at the junction of Admirals Walk and Pallett Court, which was not plotted on TWUL asset maps (marked as 1 on the map of Figure 7). It was found that there are two incoming pipes (identified as A and B in Figure 8) and one outgoing pipe (signalised as X) and the incoming pipes sizes are larger than the outgoing pipe.

**Figure 8: Incoming and outgoing pipes in manhole chamber 1 at the junction of Admirals Walk and Pallett Court**




In the second manhole chamber (marked as 2 on the map of Figure 7), an incoming pipe was found (identified as A in Figure 9) which is larger than the outgoing pipe (identified as X). The outfall pipe was also found to be much higher than the incoming, suggesting that this was done to allow the chamber to store water and/or sediment.

**Figure 9: Incoming and outgoing pipes in manhole chamber 2 in Pallett Court**



The changing of pipe sizes (smaller outfall pipes than the incoming) is uncommon in urban drainage and usually attributed to holding water back as a storage mechanism, as it can cause a throttling effect. However, in this catchment, the hydraulic constriction of the flow will impede the ability of water to drain from the highway as water will back up within the surface water pipe network, where the highway drainage discharges. This surcharging will occur in the lowest available point, which is the gully next to the junction that is located outside properties in Admirals Walk (see Figure 10). This gully is also located at a lower level compared with the surrounding gullies, which increases the risk of surcharging and flooding occuring.

**Figure 10: Origin of flooding to the highway in Admirals Walk investigation area**

### 2.2.1. TWUL Surface Water Outfall

The majority of the surface water from the northern area of the catchment is draining to a 225 mm diameter pipe that discharges to the ditch that is adjacent to Admirals Walk Lake (see Figure 2 for outfall location).

In the investigation that took place in 2016, this outfall could not be seen due to dense vegetation on the bank restricting access. For this more recent investigation, the LVRPA were identified as the landowners of the ditch and surrounding area. The LLFA contacted them as a stakeholder in the investigation process. Rangers from LVRPA had the ditch and surrounding area cleared to aid our investigation. This helped with the understanding of the condition of the outfall and the condition of the ditch as well.

It can now be confirmed that the northern outfall is totally submerged in standing water (see Figure 11) and is likely to have been like this for a considerable period of time. There are also high volumes of silt in the channel near the outfall and immediately downstream (see Figure 12). This standing water and the high volumes of silt on the ditch bed will impact the ability for water from the outfall to discharge efficiently and contribute to the flooding upstream which will run overland down towards the flooding at the junction of Pallett Court.

**Figure 11: Outfall discharge point at the top of the ditch submerged**

**Figure 12: High levels of silt within the ditch**

The second surface water sewer outfall, located towards the middle of the ditch, drains the southern area of Admirals Walk (see Figure 2). Due to the high silt and water levels in the ditch, this outfall could not be seen and is presumed to be completely submerged (see Figure 13).

**Figure 13: Potential discharge point for southern outfall**

## 2.3. TWUL foul water sewer network

In Pallett Court there is a TWUL foul sewer pumping station. During the flooding occurrences there was no evidence that the pumping station has surcharged and also there was no reported foul water sewer flooding.

## 3. Ditch

The ditch is identified as part of the pathway of the source-pathway-receptor model. The ditch where the surface water drainage outfall discharges was found in very poor condition and over vegetated. As mentioned above, investigation confirmed that the ditch has no positive discharge, it has several obstructions and it is assumed to have been severed at the downstream end where the railway line embankment starts (see Figure 3).

As shown on Figure 11, the top outfall following the clearance of the site was found to be submerged which objectively impacts on the effectiveness of the discharge rate from the surface water sewer. The ditch also was found with large volumes of silt (see Figure 12), high water level, high concentration of nutrients and with several flow blockages due to the over passages built by the residents as it is shown in Figure 14.

**Figure 14: Existing blockages along the ditch**

The overall poor condition of the ditch impacts not only the ability for the surface water drainage to discharge but it also affects the storage capacity of the feature.

The silt volumes in the ditch are a major constraint, however the level of water within the ditch also contributes to the submerging of the outfall. The high water level is unlikely to drop due to two main reasons:

1. The high groundwater level due to the presence of Admirals Walk Lake which will influence infiltration;
2. The ditch is assumed to have been severed as shown in Figure 3 at the railway track at the downstream end of the ditch and for that reason at this moment there is no positive discharge from the ditch.

There is a connection between Admirals Walk Lake and the River Lynch at the north eastern end of the lake, which allows flow between the water body and the main river. The details of this flow and any need to control it could not be confirmed by the LVRPA or EA.

The clearance of the ditch and the surrounding area also revealed the existence of an unknown asset located at the downstream end of the ditch, near the railway line (see Figure 15 and Figure 16).

The LLFA contacted TWUL in order to obtain information regarding the unknown asset that was found, however there is no information in TWUL registers regarding this.

## Figure 15: Unknown asset location


## Figure 16: Unknown assets

## 4. Flooding occurrences analysis

### 4.1. Reports of flooding to the LHA

Since 2014 a more consistent record of incidents has been reported to the LHA. It is assumed that this is not due to an increase in flood events, rather that incidents were now being reported to the LHA on every occurrence of them happening. Table 1 shows records of flood reporting to LHA between years 2014 and 2018.

**Table 1: Flooding reports from Admirals Walk to highways between 2014 and 2018**

| Date of report to highways | Incident |
|---|---|
| 16/10/2014 | Road flooded |
| 11/11/2014 | Road flooded |
| 14/11/2014 | Road flooded |
| 17/11/2014 | Road flooded |
| 17/11/2014 | Road flooded |
| 24/11/2014 | Property damaged by flooding |
| 08/01/2015 | Road flooded |
| 13/01/2015 | Road flooded |
| 15/01/2015 | Road flooded and drains blocked |
| 20/02/2015 | Property damaged by flooding |
| 24/08/2015 | Road flooded |
| 26/08/2015 | Road flooded |
| 26/08/2015 | Property damaged by flooding |
| 02/09/2015 | Property damaged by flooding |
| 16/09/2015 | Road flooded |
| 04/11/2015 | Road flooded |
| 04/11/2015 | Property damaged by flooding |
| 16/09/2016 | Road flooded |
| 01/06/2017 | Property damaged by flooding |
| 06/06/2017 | Property damaged by flooding |
| 29/05/2018 | Footway flooded |
| 29/05/2018 | Road flooded |
| 29/05/2018 | Road flooded. External flooding |
| 16/08/2018 | Road flooded |

The following is a summary from what has been deduced from reports made to the HCC call centre:

- During heavy but not significant rainfall, water is draining towards a highway gully in Admirals Walk which can't drain all the water off the highway;
- Road traffic passing through these flood waters is causing bow waves to overtop kerbs and the pavement, pushing water towards adjacent properties;
- Water has been seen surcharging from a highway gully in Admirals Walk, which has contributed to the volumes of water pooling within the highway and flowing towards property.

A resident has supplied photographs that show pooling water on the road and external extents of their property (see Figure 17 to Figure 18). After the water has drained away from the highway, a considerable amount of silt and debris is left behind (see Figure 19).

**Figure 17: Photographs of flooding on 16 September 2015**

**Figure 18: Photograph of flooding on 12 June 2016**

**Figure 19: Photographs following flooding on Admirals Lake and surrounding area on 13 June 2016 following rainfall event on 12 June 2016**

## 4.2. Rainfall Analysis

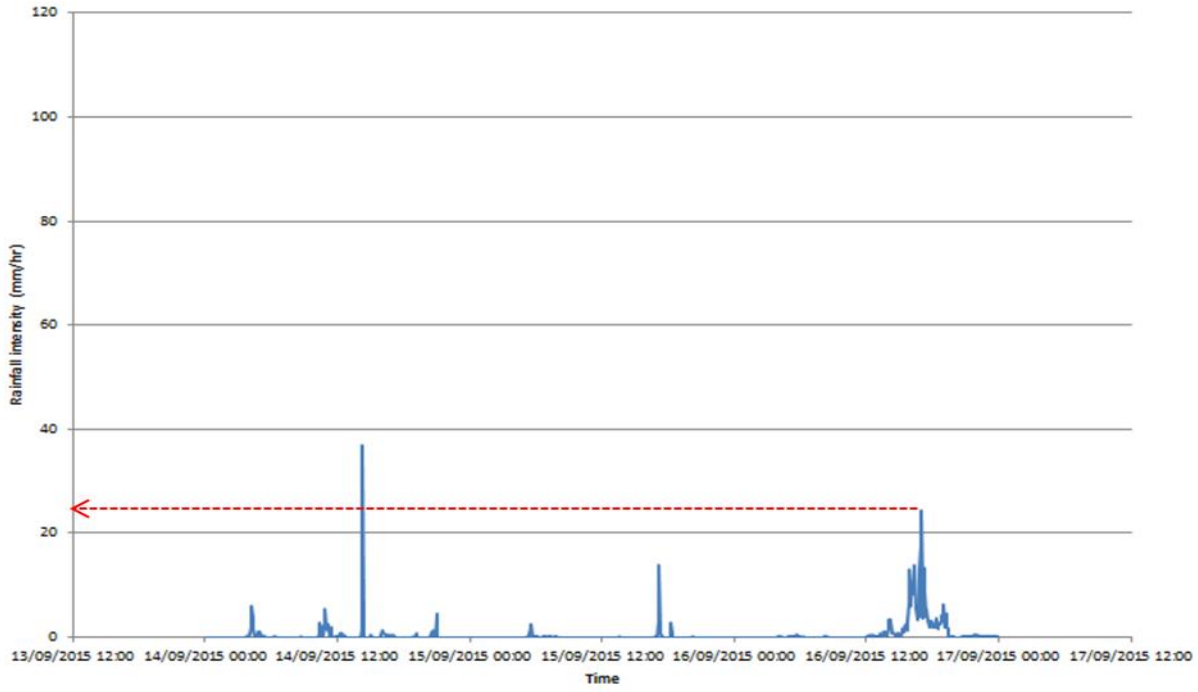
Analysis was undertaken of three separate rainfall events recorded by RADAR data and was correlated against flood events reported by residents. All three events caused the highway and external properties to flood. The software used to compare rainfall events is Map Rain, provided by Meniscus Analytics Platform.

### 4.2.1. Rainfall event 1 – September 2015

The flood event occurred on 16 September 2015 registered a peak intensity of 24.25 mm/hr (see Figure 20). Rainfall can be further defined as a return period or likelihood of occurring in a given year, which is an industry standard of attempting to rank flood events. According to the Flood Estimation Handbook (FEH), this rainfall event corresponded to a return period of approximately 1 in 3 years which is considered a low return period. This can be further expressed as a percentage, known as Annual Exceedance Probability (AEP). For this flood event, it is likely that the probability of this rainfall occurring in a given year was approximately 33.3% (AEP). However, it is important to note that this is a statistical exercise to gauge the size of the flood event and does not mean that Admirals Walk will now not flood for another 3 years.

The rainfall intensity graph in Figure 20 related to the 16 September 2015 flooding shows that other rainfall peaks of a higher intensity were registered in the previous days, before the flood was reported on 16 September 2015. This might have influenced the condition of the surface water sewer which could be already partially surcharged and that the surrounding catchment may have been saturated.

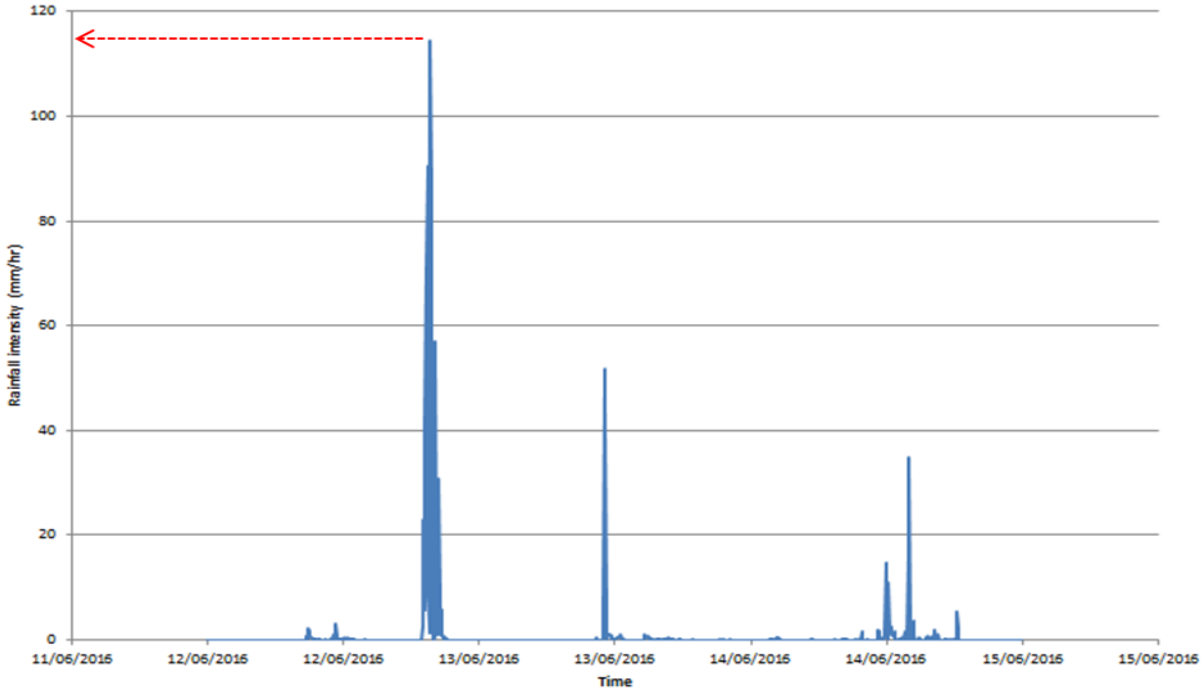
**Figure 20: Rainfall intensity graph for Admirals Walk on 16 September 2015**




### 4.2.2. Rainfall event 2 – June 2016

Substantial rainfall on 12 June 2016 was recorded in Admirals Walk, with a peak intensity of 114 mm/hr (see Figure 21). This high intensity peak corresponded to an event with a return period of 1 in 50 years, which means that it is likely that the probability of this rainfall occurring in a given year is approximately 2% (AEP).

**Figure 21: Rainfall intensity graph for Admirals Walk on 12 June 2016**

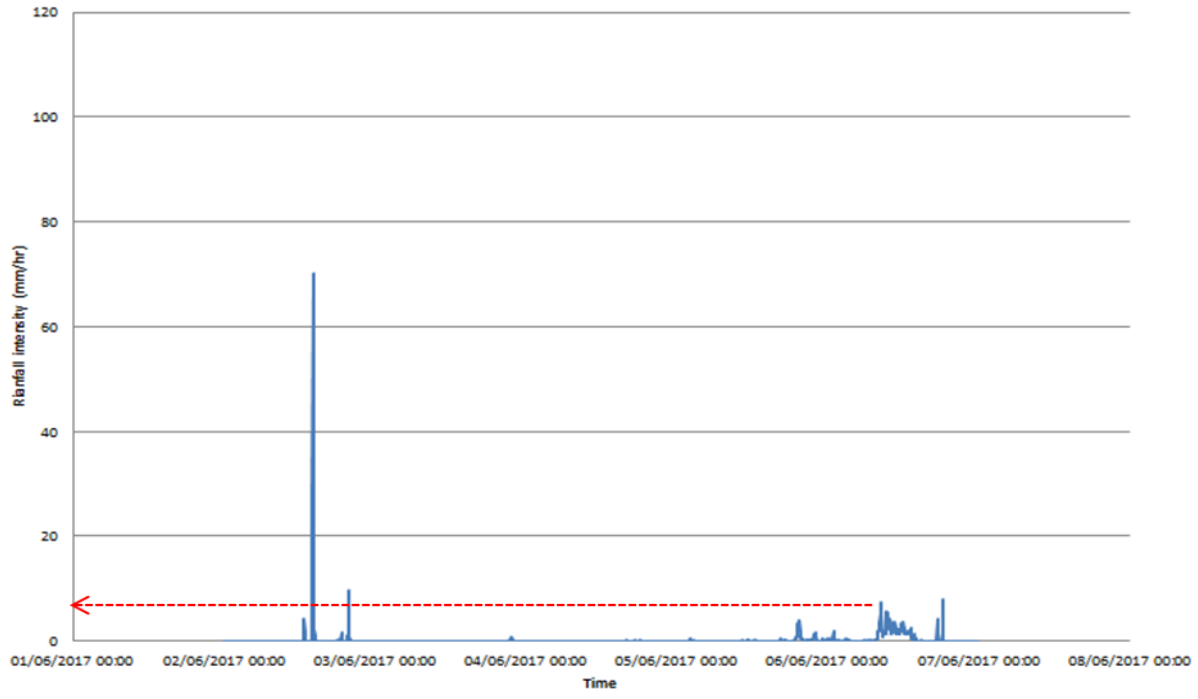


Such a high return period rainfall event was likely to have surcharged both highway drainage and surface water sewer network system. Considering that highway drainage generally will cater for anything between a 1 in 1 and 1 in 10 year rainfall event and the TWUL surface water sewers are generally designed to cater for the 1 in 30 years rainfall events (but historically might not be to this standard), the event that occurred on 12 June 2016 was likely to exceed the capacity of the drainage network leading to a flood.

### 4.2.3. Rainfall event 3 – June 2017

On 6 June 2017 flooding was reported in Admirals Walk. The rainfall intensity graph showed a peak intensity of 8 mm/hr for this day (see Figure 22), which corresponded to a 1 year return period rainfall event meaning that the likelihood of occurring in any given year was 100% (AEP). The graph shows a high rainfall intensity peak some days before the flooding event, which might have contributed by saturating the catchment and filling the storage capacity of the ditch which would have led to surcharging of the surface water sewer. Like in the event of 16 September 2015, the previous rainfall event might have influenced the condition of the surface water sewer which could be already partially surcharged. Also it can be considered that the outfall discharge point was already submerged and therefore unable to accept any additional water flow.

**Figure 22: Rainfall intensity graph for Admirals Walk on 6 June 2017**




The historical rainfall events show that the road flooded in different rainfall events and there was no specific trend identified. There is also evidence that the highest intensity rainfall events did not trigger the flooding events, but they are likely to have contributed to the flooding taking place later by taking up available storage downstream in the receiving ditch.

## 5. LLFA investigation and findings

### 5.1. Flood mechanism

Flooding in Admirals Walk was reported in different rainfall event conditions and has occurred in both higher and lower rainfall intensity events. For the higher events we would expect the catchment to flood, however in the lower return periods, flooding would not be expected.

For instance it has occurred for storms with 2% chance of occurring in a given year corresponding to 1 in 50 years return period. In cases like this, it is more likely to expect flooding to occur as urban drainage networks are not designed to cope with such high volumes of excess water.

The rainfall events associated with the majority of flooding events were not of a severe magnitude and in such conditions flooding would not normally be anticipated. In these circumstances the urban drainage would be expected to have the capacity to easily drain the surface water run off. It can be assumed that in some occasions the antecedent (preceding rainfall) conditions may have contributed to the flooding, by surcharging the highway drainage and the surface water drainage.

From the evidence documented in Section 2 to Section 4, a significant cause of the flooding occurring in Admirals Walk is the inefficiency of the pathway which is failing in the discharge of the surface water. The surface water impeded in discharging to an outfall that is completely submerged by high water levels in the ditch and the lack of a positive discharge from the ditch are the most relevant problems identified. Also the high groundwater level, due to the presence of Admirals Walk Lake, influences infiltration ability.

The fact that the roadside gullies are connected directly to the TWUL surface water sewer contributes to the surcharge of the urban drainage. Furthermore, the throttling effect caused by the changing of the surface water sewer pipe sizes (smaller outfall pipes than the incoming) impedes the capacity of water to drain from the highway. As a consequence the surface water water will back up within the surface water pipe network, where the highway drainage is trying to discharge.

The existence of drop kerbs removes the capacity of the road to store and hold surface water run off in this area and also promotes the run off to easily reach properties.

## 6. Identified RMAs and key stakeholders

### 6.1. Responsible management authorities

Part of the role of HCC as the LLFA in accordance with s19 of the FWMA 2010 is to identify the RMAs that have flood risk management functions relevant to the flooding in Admirals Walk. Those RMAs and their relevant powers and functions are set out below.

#### 6.1.1. LLFA

The LLFA for Hertfordshire has fulfilled its responsibility to carry out a flood investigation under s19 of the FWMA 2010 to:

1. Identify the relevant RMAs;
2. Establish if those authorities intend to utilise their own powers and to what extent.

The actions that the relevant RMAs have agreed to take are set out in the following Section 6.

#### 6.1.2. LHA

HCC as the LHA is the responsible authority to maintain and manage adopted highways including associated drainage infrastructure such as gullies, drainage pipes, and soakaways etc. which have been provided for the sole purpose of draining the public highway. As such, Admirals Walk is highway maintainable at public expense, which is impacted by the flood events.

HCC as the LHA have powers to manage water falling on the public highway under the Highways Act 1980. It is required as far as is reasonably practicable to keep highways open and usable by the public.

In extreme flood events the majority of excess surface water will eventually flow onto the highway as roads act as manmade conduits for such water.

#### 6.1.3. TWUL

TWUL manages the public surface water sewer network in Admirals Walk and it is also responsible for the foul sewer pumping station located at the end of Pallett Court. It therefore has been identified as a relevant RMA. TWUL manages flooding from their network in line with their business plan approved by OfWAT.

TWUL, like all water companies, are required to keep a register of all instances of internal and external flooding of properties, this is referred to as the Flood Risk Registers. This register is used as the evidence to justify improvements to the foul and surface sewerage network.
Only TWUL has the authority to alter the foul and surface water sewer and to manage the flood risk associated with it.

## 6.2. Key stakeholders

### 6.2.1. Network Rail

It is assumed that historically there was a connection between the ditch and River Lynch. However, this is not clear from the historical mapping. When contacted, Network Rail confirmed that they hold no additional information regarding this connection.

### 6.2.2. LVRPA

LVRPA is the land owner of the ditch and the surrounding land. Therefore it has the responsibility to maintain the area including the ditch in order to assure the free outfall from the surface water sewer.

# 7. Conclusion and Recommendations

## 7.1. Conclusion of the flood investigation

Following the investigation it is possible to conclude that:

1. There is no feasible discharge mechanism as the existing ditch where the surface water sewer discharges into, does not have a positive outfall.
2. The outfall discharge point at the top of the ditch is submerged due to the high volume of silt and to the high water level within the ditch, which compromises the ability to discharge.
3. The highway gully network directly connects to the TWUL surface water sewer. The surface water from all sources joins the TWUL surface water sewer and discharges to the ditch.
4. The amount of silt in the ditch as well as the existing blockages along the ditch, reduce the storage capacity of the ditch.
5. The size of the incoming pipes is larger than the outgoing pipes causing a constriction effect to the flow, leading to surface water backing up and surcharging of gullies and chambers located in the lowest point.
6. It is likely that the water in the ditch stays at a constant high level due to the high groundwater level and the proximity of Admirals Walk Lake.
7. The existing low kerbs at the front of some properties facilitate the standing and surcharging surface water to flow towards properties.
8. Although the asset plans show the existence of a second surface water outfall, located in the middle of the ditch, it could not be found presumably because of the high silt and water levels in the ditch.
9. A connection was not able to be found between the ditch and River Lynch, located on the opposite side of the railway line.

## 7.2. Recommendations

The following table (see Table 2) shows the recommendations for the identified RMAs, sets out the actions that are in progress to be completed or were completed until the release of the Final version of this investigation.

**Table 2: LLFA Recommendations to the RMAs and Stakeholders, actions undertaken by the RMAs and following steps**

| RMAs | Recommendations to the RMAs | Actions undertaken by the RMAs | Next actions |
|---|---|---|---|
| LLFA | • Consider a partnership approach with all RMAs and stakeholders for the development of a potential mitigation measure based on a SuDS feature such as a swale, in order to create a positive discharge connection between the ditch and Admirals Walk Lake.<br>• Carry out a feasibility study to determine the best scheme to drain the ditch into Admirals Walk Lake. | • Have carried out an investigation using their powers under the s19 of the FWMA 2010.<br>• Met with all RMA's to discuss the findings of the Technical Report ahead of a public engagement meeting. | • Conduct options and feasibility study and take into account pollution concerns raised by the Lee Valley Rangers.<br>• Include the assessment of Admirals Walk lake levels in the feasibility study.<br>• To share flooding dates and flood reports with TWUL. |
| LHA | • Continue to monitor reported faults through the highway reporting system.<br>• Consider evaluating the frequency of gully cleansing.<br>• Consider raising the dropped kerbs at Admirals Walk.<br>• Consider raising the footway at Admirals Walk. | • Have inspected the condition of the gullies and highways drainage. | • To evaluate the LLFA proposal once it has been finalised.<br>• To identify if they could contribute to the funding of the scheme. |
| TWUL | • Carry out survey to the surface water drainage network in the investigation area.<br>• Program any identified remedial / maintenance works to the surface water sewer network.<br>• Evaluate the hydraulic constriction impact of the flow on the surface water sewer network.<br>• Confirm the asset status near the railway. | • Have confirmed that TWUL do not hold any information regarding the unknown asset found at the end of the ditch. | • To evaluate the LLFA proposal once it has been finalised.<br>• To identify if they could contribute to the funding of the scheme.<br>• To investigate the surface water sewer network and confirm that the foul pumping station does not discharge to the surface water drainage system in flood conditions (this was deemed unlikely). |

| RMAs | Recommendations to the RMAs | Actions undertaken by the RMAs | Next actions |
|---|---|---|---|
| LVRPA | • Remove the silt from the ditch and the existing structures within the ditch that are restricting the overall storage capacity.<br>• Contact the EA to understand how Admirals Walk Lake is regulated and to better understand the connection between Admirals Walk Lake and River Lynch.<br>• Determine a regular maintenance and develop an inspection plan for the ditch and surrounding area to assure the good condition of the site. | • Have carried out the clearance of the ditch and of the surrounding area to confirm the location and the condition of the surface water sewer outfall. | • To evaluate the LLFA proposal once it has been finalised.<br>• To identify if they could contribute to the funding of the scheme.<br>• To contact the EA to understand the discharge into River Lynch and clarify what agreements are already in place.<br>• To discuss if the silt levels could be reduced to allow the pipe to discharge. Long term, this would need to take place in order for any scheme to be implemented.<br>• To investigate long term ownership and maintenance of any implemented assets as an option. |
| Network Rail | • No recommendations. | • Have confirmed that their registers do not show the existence of any culvert underneath the railway track connecting the ditch to the River Lynch. | • No further actions to be taken. |

## 7.3. Actions undertaken by the RMAs and next steps

This section will be updated after the revision from the relevant RMAs and after the public meeting.

**Joint meeting with the RMAs and the key stakeholders**

On 29 January 2019 the LLFA held a meeting with the RMAs and the LVRPA. The main purpose of the meeting was to discuss the findings of the investigation as well as potential actions to help mitigate the flooding issues in Admirals Walk.

The LLFA proposed a SuDS scheme (such as a swale) to connect the ditch to the lake, allowing a positive discharge for the drainage system which is causing the flooding in Admirals Walk. This action was proposed to be carried out in partnership between all the RMAs and LVRPA.

It was proposed that all the RMAs and LVRPA contributed for the scheme's funding.

The LLFA proposed to conduct a feasibility study of the option which the LLFA would completely fund. All attendees agreed to evaluate the LLFA proposal once it has been finalised and evaluation of partnership funding would be considered at a future meeting.

The following table (see Table 3) sets out the outstanding actions from the joint meeting and the actions that are in progress to be completed or were completed prior to the release of the Final version of this investigation.

**Table 3: Outstanding actions from Admirals Walk joint meeting with all RMAs and key stakeholders**

| Subject | Outstanding actions |
|---|---|
| • Creation of a SuDS feature (such as a swale) to connect the ditch to the lake in order to provide a positive discharge point. The creation of a SuDS feature such as a swale could be a simple solution and would not be considerably expensive. | • Conduct options and feasibility study. Take into account pollution concerns raised by the Lee Valley Rangers.<br>• All key stakeholders agreed to evaluate the LLFA proposal once it has been finalised.<br>• All key stakeholders to identify if they could contribute to the funding of the scheme. |
| • There is a sluice gate connecting Admirals Walk Lake to the River Lynch which is 100% open. | • To contact the EA to understand the discharge into River Lynch and clarify what agreements are already in place. |
| • LVRPA identified that a better understanding of the lake levels is required before any option is to be considered. | • Include the assessment of Admirals Walk lake levels in the feasibility study. |

| Subject | Outstanding actions |
|---|---|
| • The submerged TWUL outfall pipe is a key issue in discharging the drainage from the Highway. | • LVRPA to discuss if the silt levels could be reduced to allow the pipe to discharge. Long term, this would need to take place in order for any scheme to be implemented. |
| • TWUL does not have many records of flooding in this area and in terms of obtaining funding the number of flooding reports is important. TWUL requested the LLFA to make the flood reports available. | • LLFA to share flooding dates and flood reports to TWUL.<br>• TWUL to investigate the surface water sewer network and confirm that the foul pumping station does not discharge to the surface water drainage system in flood conditions (this was deemed unlikely). |
| • Long term ownership and maintenance of any implemented assets will need to be agreed. LLFA suggested LVRPA were best placed as they will own the land and have the facility to conduct maintenance. | • LVRPA to investigate this as an option. |