



Flood Investigation (Section 19  
Report)  
NHS Blood & Transplant Centre  
(24<sup>th</sup> September 2012)

South Gloucestershire Council

# Executive Summary

## Statutory Duty

Section 19 of the Flood and Water Management Act 2010 (FWMA) states that, on becoming aware of a flood which meets certain predetermined criteria, the LLFA (lead local flood authority) must, to the extent that it considers necessary or appropriate, undertake a formal flood investigation in order to determine the relevant flood risk management authorities (RMA's) that should have been involved in the event and how they exercised their functions during and after the event. The LLFA also should investigate which flood risk management actions have been (or should be) taken to mitigate future flood risk and publish a final report. This report should be shared with all relevant risk management authorities.

## Flood Event

On Monday 24<sup>th</sup> September 2012 internal flooding occurred to the NHS Blood and Transplant centre at Filton. This site is a critical establishment for blood supply throughout the Midlands and the South West of England. Whilst heavy rainfall did occur during the morning of the 24<sup>th</sup>, this was not extreme, with an annual probability of around 1 in 15 (7%)<sup>1</sup>.

It was apparent that the flooding event was as a result of a catastrophic failure in nearby culverts which convey the Stoke Brook watercourse. The culverts were located on Network Rail land. It was recognised that these culverts were a flood risk asset and as a consequence condition surveys were carried out on a regular basis. Prior to the flooding event in September 2012, these inspections flagged up deformation of the culverts, which were of corrugated construction. As a result of these findings emergency remedial measures had been undertaken prior to the flooding event, and design work was ongoing on a longer term replacement for the culverts. The emergency remedial measures involved the deployment of pumps on site to mitigate for the reduced capacity of the culverts. Ultimately these pumps were not sufficient to convey the flood water that collected upstream of the culverts, resulting in rapid flooding of the NHS centre.

This resulted in all blood donations being removed from the centre and the site being closed down until it had dried out and had been cleaned ready for reoccupation. Fortunately, due to the quick actions of NHS staff and the speed of their recovery programme they were fully operational two weeks later.

## Outcome of Flood Investigation

Based on analysis completed by the Environment Agency, the flooding that occurred was greater than that expected for the rainfall that occurred even allowing for 70% blockage of the culvert. It is not clear whether the severity of the flooding was a result of increased blockage, inadequate pumping, or the culverts being undersized to begin with.

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<sup>1</sup> This means that within any given year there is a 1 in 15 (or 7%) chance that rainfall of this amount (or greater) will be experienced.

Since the flood event all relevant parties<sup>2</sup> have worked together to deliver a solution to the flooding problem which involves large new box culverts being constructed throughout the Network Rail owned land. If this amount of rain was to fall again over the same time period, then it is very unlikely that there would be any flooding to the NHS centre.

## Acknowledgements

The assistance of the Environment Agency in providing information for this report is greatly appreciated.

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<sup>2</sup> South Gloucestershire Council, Environment Agency and Network Rail

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# 1. Introduction

## 1.1. Context

Section 19 of the Flood and Water Management Act 2010 (FWMA) states that, on becoming aware of a flood which meets certain predetermined criteria, the LLFA (lead local flood authority) must, to the extent that it considers necessary or appropriate undertake a formal flood investigation in order to determine the relevant flood risk management authorities (RMA's) that should have been involved in the event and how they exercised their functions during and after the event. The LLFA also should investigate which flood risk management actions have been (or should be) taken to mitigate future flood risk and publish a final report. This report should be shared with all relevant risk management authorities.

## 1.2. Criteria

It has been agreed that a formal investigation is required following a flood event when any of the following criteria is met:

- Serious injury(ies) or fatality(ies) as a result of flooding
- Internal flooding of 5 residential properties if an urban area (2 if rural area), from an unknown source or multiple sources of flooding
- Internal flooding of multiple industrial or commercial properties
- Flooding of critical infrastructure
- Flooding to an environmental or heritage designated site if that flooding could affect the long term designation of the site
- Repeated flooding to the same receptor(s)

In this instance the NHS Blood and Transplant Centre in Filton is considered to be critical infrastructure due to its national importance.

## 1.3. Consultees

The following bodies were consulted regarding this flood event:

### 1.3.1. Risk Management Authorities

Risk Management Authorities are defined in the FMWA and are given different areas of responsibility depending on their role. They have a duty to co-operate and with each other and to share data where necessary to better deliver flood risk management so as to benefit communities.

- South Gloucestershire Council – Overall responsibility as the Lead Local Flood Authority, and also enforcement responsibility for the ordinary watercourse (the watercourse around the site and Stoke Brook upstream of all railway culverts).
- Environment Agency – Responsibility for the Main River (Stoke Brook downstream of all railway culverts). Also were a consultee on the planning applications in the area and were involved in the post flood event review.

### 1.3.2. Emergency Services

The Avon & Somerset Fire and Rescue Service were involved in the response to the flood incident, operating and providing pumps.

### 1.3.3. Other interested parties

- NHS Blood & Transplant, who operate the site were involved throughout the incident in evacuating the site of people and stock. They also produced post event reviews, mainly focussing on their emergency procedures.
- Network Rail, who are the landowner immediately downstream and are responsible for maintaining the watercourse through their land.

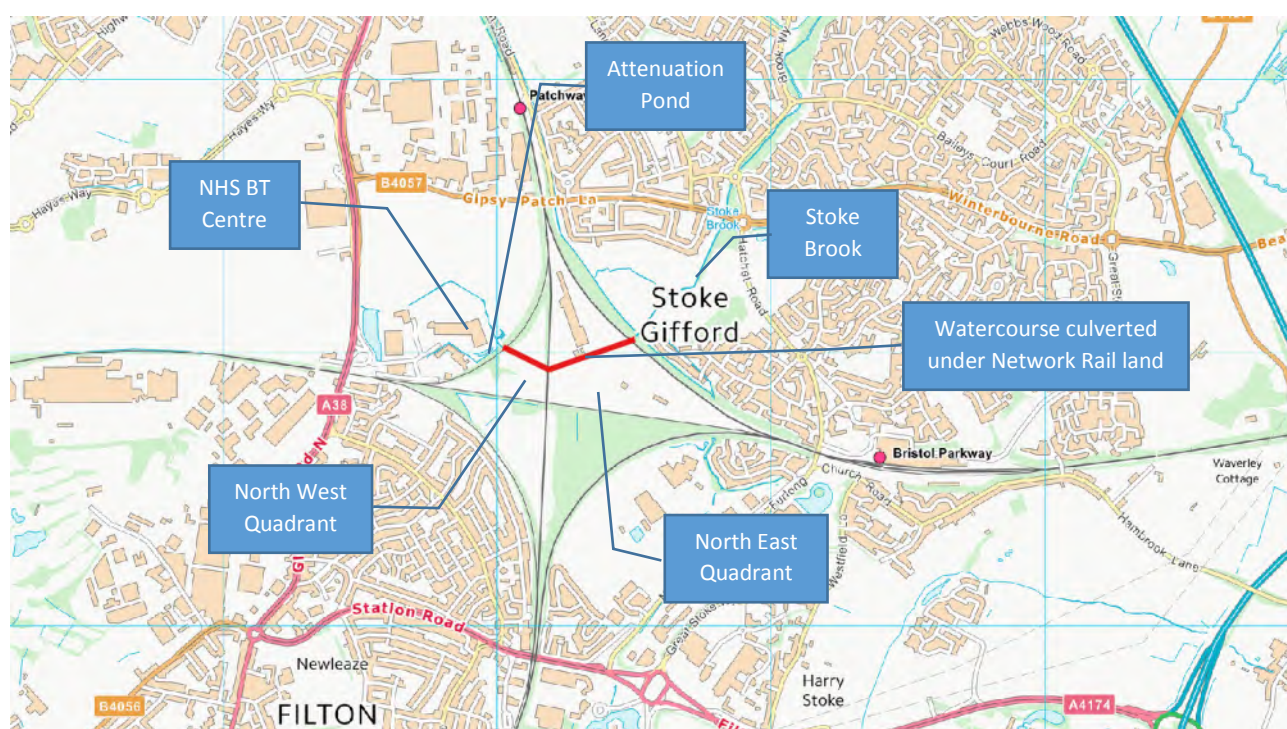


## 2. Site Information

### 2.1. Location

The NHS Blood & Transplant Centre is located at 500 North Bristol Business Park, Filton, BS34 7QH. It is accessed off the A38 Gloucester Road opposite the Filton Airfield. The site consists of a large two storey building with extensive car parking. This site is a critical establishment for blood supply throughout the Midlands and the South West of England. NHS Blood and Transplant manages the national voluntary donation system for blood, tissues, organs and stem cells turning these precious donations into products that can be used safely to the benefit of the patient.

The site location is shown in Figure 1.



**Figure 1 – Location Plan**

A tributary to Stoke Brook runs to the North of the site originating in a lake to the west of the Business Park, but it takes drainage from a wider catchment that includes part of Filton Airfield. Stoke Brook then passes into the land owned by Network Rail within the turning curves of the railway lines (described later as four quadrants). Whilst originally the channel would have been passed through brick arch culverts only under the three railway lines in its path, in more recent times (~1999 – 2005) the area has been used as a landfill site with the channel culverted over the majority of its length until re-emerging downstream of the quadrants.

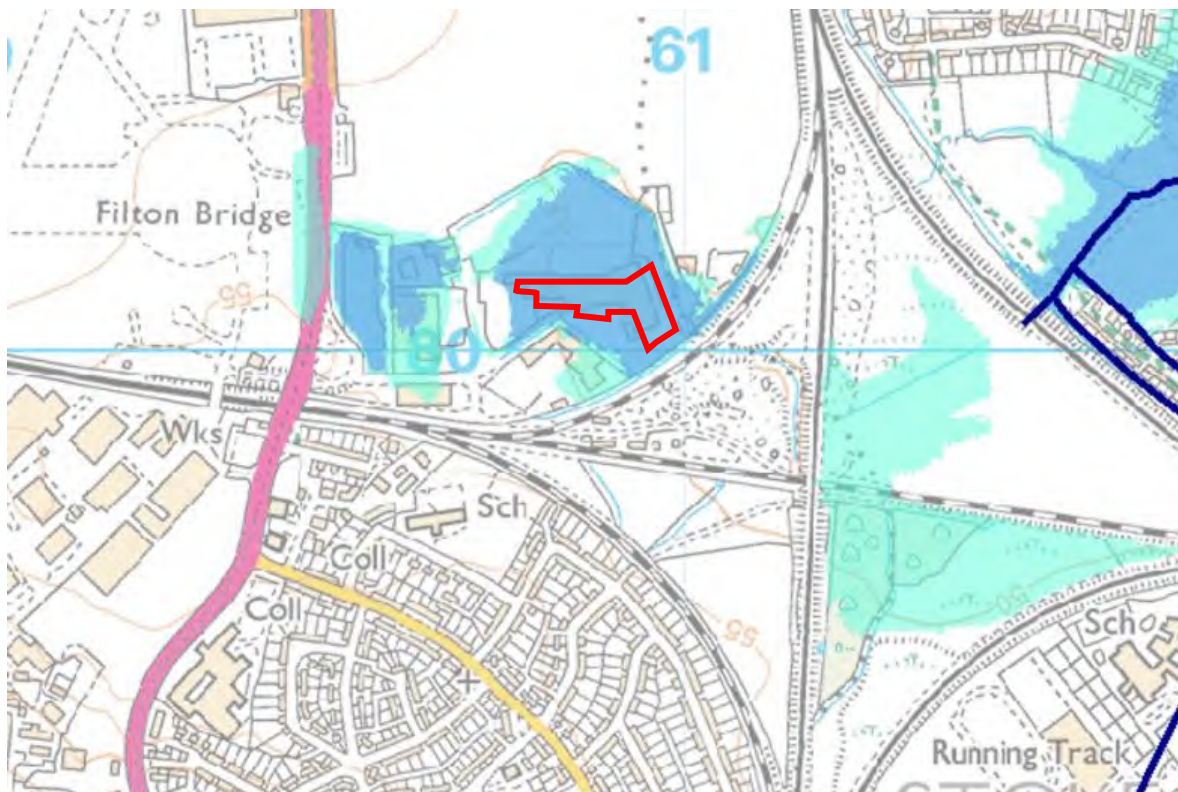
The culvert under the landfill site was constructed from a 1.8m diameter Armco culvert. Following unexpected high water levels upstream of this culvert in January 2011 the condition of this culvert was investigated by Network Rail and found to have deformed and fractured in a number of locations.



**Photos of typical damage to Armco culvert (Note that these photographs were taken after the flood event and may not be reflective of the damage that was there at the time of the flooding)**

Whilst agreement was being reached on a long term solution to a replacement for this culvert, remedial works were undertaken to ensure there would be no further deformation of the culvert and any resulting risk of blockage. This included reinforcement works within the culvert and the provision of over-pumping in the event of high water levels.

In terms of flood zoning, the flood maps produced by the Environment Agency for Planning purposes are referenced below. Figure 2 shows the fluvial flood map prior to improvement works being undertaken at the site, and is therefore reflective of the situation prior to the flood event occurring. This figure shows the site is situated within Flood Zone 3. A further flood map is presented in Figure 5, showing the flood zoning following the improvement works that have now been completed. Figure 3 shows the Surface Water Flood Maps for the area. For surface water the site is considered to be at low to medium risk of flooding.



**Figure 2 – Flood Zone mapping****Figure 3 – Surface Water Flood Mapping**

## 2.2. Drainage System

The site surface water drainage pipeline network, conveying run-off from roofwater and car parks, discharges into an attenuation pond situated to the east of the site. This pond discharges to the watercourse via a controlled outlet device. Whilst the drainage system within the site was overwhelmed during the flood incident this is due to the downstream constraints in the watercourse rather than the drainage network itself.

## 3. Previous Flooding

### 3.1. Summary

Prior to the construction of the NHS building this area was used as playing fields and the flooding history of these is unknown. The building itself commenced construction in October 2006 and was completed in July 2008.

As part of the development proposals for the site a hydraulic assessment was undertaken of the area. The result of this was to recommend the internal floor level to be no lower than 50.5m AOD and the car park and access roads no lower than 50.2m AOD (Planning application reference PT06/0652/RM).

### 3.2. January 2011

In January 2011 flood water backed up from the culverts and threatened to overflow the attenuation pond to the east of the building and flood the centre. The Council investigated this with:

- a) Network Rail to determine whether the culverted watercourse had been inspected over its full length. Network Rail responded providing inspection reports for the original railway embankment brick arch culverts and advising that the new Armco culverts were not an issue.
- b) Terramond Ltd (original developers of the business park) to determine whether the inlet trash screen was being inspected and maintained on a regular basis. Terramond Ltd provided evidence that inspections were being carried out, concurred by NHS BT.

Later in 2011 consultation was held with Hitachi, their drainage consultant (Jacobs Consulting), and Network Rail on to discuss the planning drainage requirements to enable for the construction of a train depot on part of the Network Rail land. At this meeting it was confirmed that Network Rail had commissioned a survey of the culverted watercourse and this showed that sections of the armco culvert had deformations reducing the cross sectional area of the culvert.

A meeting was subsequently arranged by the Environment Agency in February 2012 with Network Rail and other parties including South Gloucestershire Council and NHS BT to ensure that appropriate overpumping provision and an Emergency Action Plan was in place by Network Rail to ensure the upstream NHS BT Centre was protected against an additional risk of flooding due to the deformed unconsented culvert until such time that the culvert was replaced.

The overpumping protection measures were installed in April 2012 and Network Rail's maintenance contractor Birse Rail provided support to operate this system under rainfall conditions to convey flood flow beyond the deformed culvert obstruction.

## 4. Flood Incident

### 4.1. Background

On 24<sup>th</sup> September 2012 flooding occurred at the NHS Blood and Transplant Filton site. Fortunately, through the successful implementation of the NHS's emergency response plan blood was able to be moved to other sites and the site was fully operational again within two weeks following the flooding.

### 4.2. Flood/Weather Warnings

It is not believed that a rainfall warning was issued by the Met Office for this event.

The Environment Agency operate a level gauge on Stoke Brook. As the levels rose on this over Sunday night (23<sup>rd</sup>) and Monday morning (24<sup>th</sup>) the telemetry alarms on this gauge were triggered. As a result, Network Rail operators were deployed to supervise the over pumping.

### 4.3. Rainfall data

Rainfall occurred during the early hours of Monday 24<sup>th</sup> September 2012 as a result of a low pressure system which passed over the UK. This followed an abnormally wet summer.

The Environment Agency has made an assessment of the likely annual probability was of the rainfall in the area during this event. The clear conclusion from this assessment was how localised the rainfall was, with rain gauges only 5km away (Frampton Cotterell and Clifton) recording minimal rainfall. The closest rain gauge to the site is located at Filton Airfield less than 1km North West of the centre however recorded more significant totals. This suggested the following numbers:

- Over the 24 hours prior to 09:00 on the 24<sup>th</sup> September **62.4mm** of rain was recorded which has an annual probability of approximately **1 in 13 (8%)**.
- Over the 7 hour period 01:00 to 08:00 on the 24<sup>th</sup> September **43.4mm** of rain was recorded which has an annual probability of approximately **1 in 15 (7%)**.

### 4.4. Other gauge data

The Environment Agency operate a level gauge upstream of the Filton culverts. On the 24<sup>th</sup> September at 10:00 this recorded a peak level of 2.8m. The datum of the gauge is unknown but is assumed to be bed level. From this the Environment Agency estimated that the peak flood level was around 50.48mAOD, although it was acknowledged that it could be in the range 50.48 – 50.88mAOD. Based on the depth of internal flooding recorded and the planning condition of a minimum flood level of 50.5mAOD a peak flood level of around 50.6-50.7mAOD seems most likely.

The Environment Agency compared this recorded flood level to the results from the modelling completed by Jacobs in 2012 for the Stoke Gifford Flood Risk Assessment. With 70% blockage of the culvert and a 1 in 30 (3.3%) annual probability flood event the modelling predicted an upstream water level of 50.25mAOD. This was compared to 49.42mAOD with no blockage.

There are a number of uncertainties in this assessment, most notably in the assessment made to convert the rainfall into flow, but it does highlight how critical the blockage of the culverts was to the upstream flooding.

## 4.5. Event summary

On Monday the 24<sup>th</sup> September flood water started entering the NHS building at 9:00. NHS staff reported that little warning had been provided prior to this occurring. Within 20 minutes the majority of the ground floor was flooded and within an hour all power was lost to the building. Flooding of 150mm was reported within the building.

This resulted in all blood donations being removed from the centre and the site being closed down until such time it had dried out and had been cleaned ready for reoccupation. Fortunately, due to the quick actions of NHS staff and the speed of their recovery programme they were fully operational two weeks later.

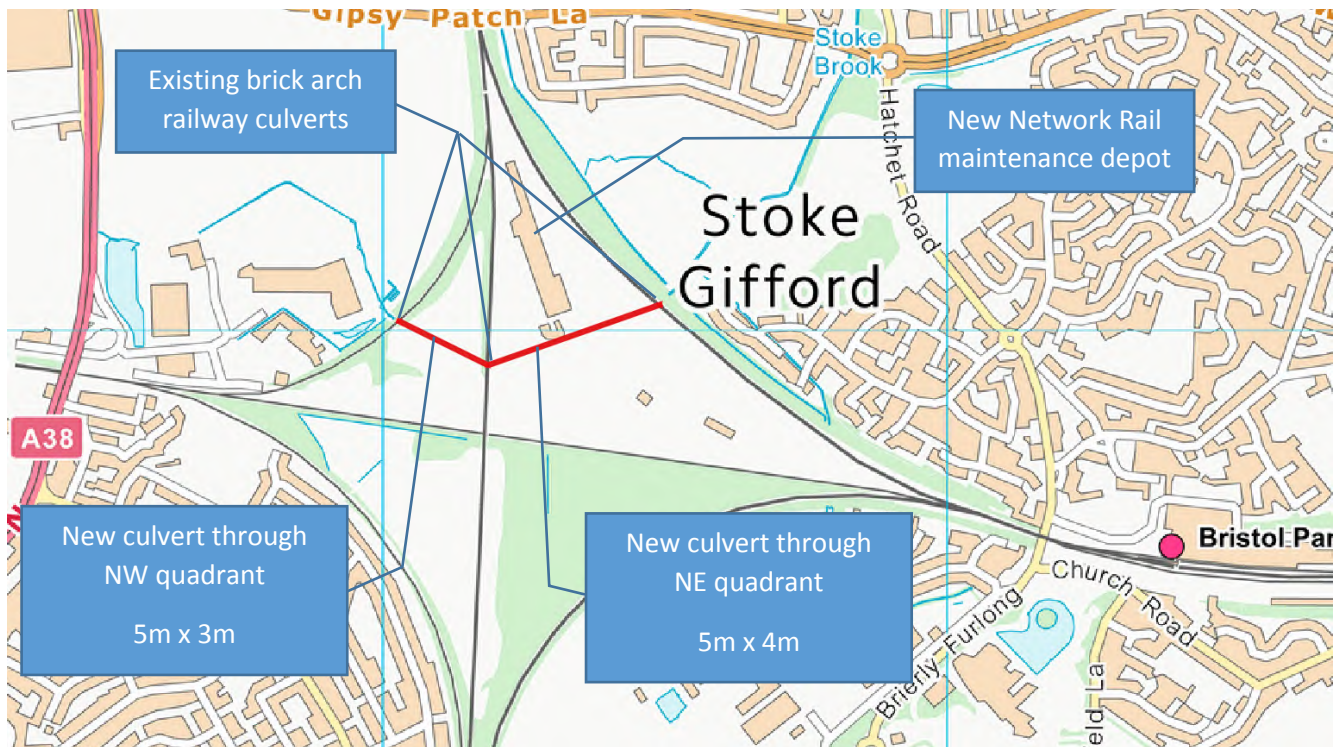
There is some confusion over how many of the planned pumps were being operated by Network Rail contractors at the time of the flooding, with at least one pump having to be turned off due to the generator being surrounded by floodwater. It is clear, however, that the pumps that were available were unable to cope with the amount of floodwater that built up on the upstream side of the culverts with a resultant increase in upstream level sufficient to flood the centre.

Some photos are available online that show the flooding in, and around, the NHS centre. These show that the flood water is effectively stationary as it is ponded behind the partially blocked culverts.

## 4.6. Post event works

Following the flooding South Gloucestershire Council worked in partnership with the Environment Agency, NHSBT and Network Rail and its contractors to resolve the flood risk in this area. This has resulted in a new culvert being constructed in both of the quadrants within the Network Rail owned land. This work has now (May 2016) all been completed and all that now remains of the old channel is the brick arch culverts under the railway lines.

Figure 4 shows the extent of the works with the dimensions of the new box culverts that replace the original 1.8m diameter Armco culverts. The new culvert measures 4m x 3m in the North West quadrant and 5m x 3m in the North East quadrant.



**Figure 4 – Location of improvement works**

The following photos were taken during construction of the new culvert within the North East quadrant.



**Photos during construction within the North East quadrant**

A further hydraulic assessment was undertaken with the improved culvert in 2013. This showed that if a 1 in 100 (1%) annual probability event was now to occur this would only result in a flood level of 50.12m AOD upstream of the culverts. This is 0.38m below the floor level of the centre.

Further assessment was undertaken by the Environment Agency in January 2016 to redefine the flood risk in the area. This has allowed the flood zoning to be refined and shows the centre to now be within Flood Zone 2.

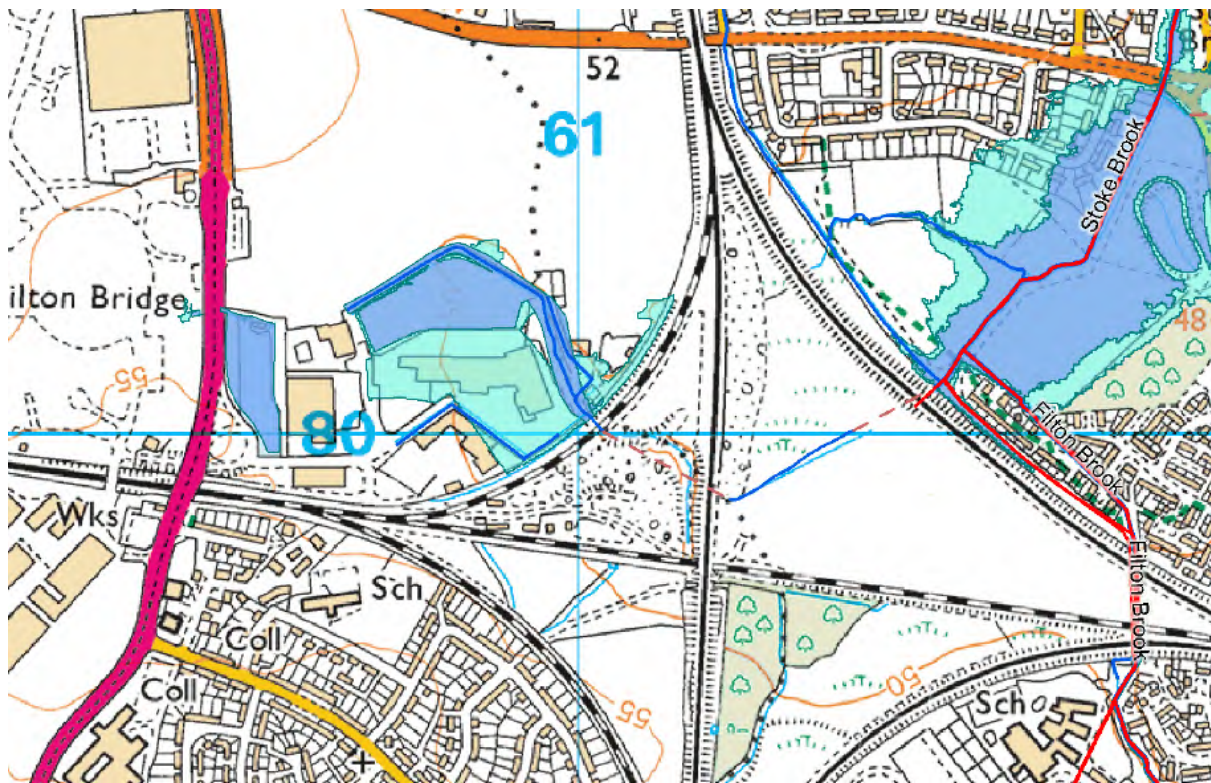


Figure 5 – Revised flood zoning following improvement works



## 5. Responsibilities

The roles and responsibilities of the main bodies involved in flood risk are described in outline below. For a more detailed description please refer to our Local Flood Risk Management Strategy Section 2.

### 5.1. South Gloucestershire Council

We have several different roles before, during and after a flood event. As Lead Local Flood Authority we have a role to develop flood risk strategies and to investigate and record details of flood events, and to maintain a register of structures and features that could have a significant impact on flood risk.

We also have a role to consent works on ordinary watercourses and regulate works done by others. As the Highway Authority we are required to ensure that all local highways are drained of surface water and where necessary maintain highway drainage systems.

We are a Category 1 Responder under the Civil Contingencies Act 2004 and therefore have a responsibility, along with other organisations for developing emergency plans, contingency plans and business continuity plans to help reduce, control or ease the effects of an emergency in South Gloucestershire.

As a Local Planning Authority we have a responsibility to consider flood risk and drainage in our strategic land use planning and the development of our Local Plan, as set out under the National Planning Policy Framework. We are the 'decision maker' on flood risk and drainage for planning applications for development, taking into consideration technical advice from other risk management authorities as consultees (statutory).

Lastly as a landowner we are responsible for the maintenance of Council owned assets which have a role in flood risk management. These include community open spaces, drainage ditches, gullies, trash screens and culverts across South Gloucestershire.

### 5.2. Lower Severn Internal Drainage Board

The Lower Severn IDB is responsible for managing water levels, within rhines, in the Avonmouth and Severnside area, and manages pumping stations to convey rhine flow across catchments. The low lying land in this area is generally flat and is characterised by the Rhines, streams and ditches that discharge into the Severn Estuary. The flood event being considered is not within the Lower Severn IDB area.

### 5.3. Environment Agency

The Environment Agency is designated a Risk Management Authority and is responsible for managing flooding from main rivers (such as the River Avon and the River Frome) and tidal flooding (such as from the Severn Estuary) and have a responsibility to provide a strategic overview for all

flooding sources and coastal erosion. They are also a Category One responder under the Civil Contingencies Act, and therefore had a core role in responding to the flood event.

The Environment Agency are also a statutory consultee in the planning process and were therefore involved in the overall discussions regarding this site, as part of the Hitachi planning application.

## 5.4. Wessex Water Plc

As the sewerage undertaker serving South Gloucestershire, Wessex Water is also designated a Risk Management Authority and is responsible for surface water drainage from development via adopted sewers and for maintaining public sewers into which a significant amount of the highway drainage connects in urban areas.

No Wessex Water Assets are included in this review.

## 5.5. Highways England

Highways England is responsible for managing highway drainage from the motorways and major trunk road network in England, including the slip roads to and from trunk roads. Within South Gloucestershire this includes the M4, M5, M48, M49, M32 and A46 (south of M4).

Highways England are not included in this review.

## 5.6. Riparian Landowners

Anyone who owns land which is adjacent to a watercourse or land which has a watercourse running through it has certain legal responsibilities to maintain the watercourse unobstructed. Where a watercourse marks the boundary between adjoining properties, it is normally presumed the riparian owner owns the land up to the centre line of the watercourse.

## 6. Compliance with responsibilities

Network Rail became aware of issues with the condition of downstream culverts during 2011, following an inspection of the culverts. Network Rail then continued to undertake regular inspections and commenced work with South Gloucestershire Council and the Environment Agency to determine the preferred long term solution to replacing the culverts. Whilst this was being determined Network Rail also instigated temporary remedial works to reduce further damage to the culverts and provide over pumping facilities.

South Gloucestershire Council were aware of the potential issue with this culvert prior to the flood event and worked with the landowner (Network Rail) to address the issue. Although the Council could have taken enforcement action to ensure Network Rail addressed these issues and undertook all repairs, it was agreed that enforcement was not an appropriate engagement method, and the better course of action was to work with Network Rail.

In the flood event of 24<sup>th</sup> September 2012 these temporary works were insufficient to cope with the rainfall that fell on that day. However, it cannot be said for certain that even if the culverts were in their original constructed condition that there would not have been flooding to the NHSBT centre.

Since the flood event all relevant parties have worked together to deliver a solution to the flooding problem here and, if this amount of rain was to fall again over the same time period, then it is very unlikely that there would be any flooding to the NHSBT centre.

## 7. Conclusions

The flooding that occurred to the NHS Blood & Transplant centre on 24<sup>th</sup> September 2012 was a result of high rainfall occurring in the very localised area around Filton. This rainfall had an annual probability of 1 in 15 or 7%. At the time the rainfall occurred the downstream culverts on Network Rail land were known to be in poor condition, and in danger of collapse. Emergency remedial works had been undertaken on the culverts prior to the event and design work was ongoing on a longer term replacement for the culverts.

It was known that the culverts would be unable to convey the same degree of flow as they would have done when constructed and pumps were deployed on site in an attempt to mitigate this. Ultimately these pumps were not sufficient to convey the flood water that collected upstream of the culverts, resulting in rapid flooding of the NHS centre.

This resulted in all blood donations being removed from the centre and the site being closed down until such time it had dried out and had been cleaned ready for reoccupation. Fortunately, due to the quick actions of NHS staff and the speed of their recovery programme they were fully operational two weeks later.

It is not clear whether the pumps were of insufficient capacity to convey the floodwater, or the culvert became more obstructed during the event, or that the culverts were undersized in the first place to take the flow, however the resulting flooding was greater than expected for the rainfall that occurred including allowance for 70% blockage of the culvert.

Since the flood event all relevant parties have worked together to deliver a solution to the flooding problem which involves large new box culverts being constructed throughout the Network Rail owned land. If this amount of rain was to fall again over the same time period, then it is very unlikely that there would be any flooding to the NHSBT centre.

## 8. Recommendations

All the key recommendations that there would have been following this flood event in terms of replacing the culvert have now been implemented. However, the following recommendations will also be considered to provide further reassurance against flooding at this, and other, sites.

1. A flood level gauge could be installed at the entrance to the culverts.
2. Regular inspections should be undertaken by South Gloucestershire Council of both the trash/safety screens at the inlet and outlet to the culvert to ensure no blockage is present prior to flood events. If regular blockages are needing to be removed consideration should be given to either modifying the screens, or locating the source of this debris.
3. Ensure that this, and other similar culverts, are on the Council's High Risk Register of assets.
4. Regular inspections of the culverts should be undertaken by Network Rail.
5. Any future planning applications in the area should be reviewed in detail to ensure they are not increasing peak flows past this site.
6. For the wider authority area, the council should gain greater understanding of any significant culverts on Ordinary Watercourses, especially if there is any residential or commercial properties immediately upstream of the culverts. This may require a more regular inspection programme of culverts and associated structures.
7. Where future planning applications come forward for developments upstream of culverts, irrespective of the status of the watercourse, assessments must be made of the impact on upstream flood levels if there is a major blockage within, or upstream of, the culvert.