Oldbury-on-Severn Flood Report

May 2017

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South Gloucestershire Council

1 INTRODUCTION

This report has been produced to summarise investigations into the local flooding in Oldbury-on-Severn, in particular the flood incident that occurred on 9th March 2016 and to recommend further work that should be undertaken to reduce this risk. This note seeks to improve understanding of the sources of local flooding to the area and the future flooding that might occur.

This report seeks to also provide some further responses to the letters and reports received from the Parish Council concerning flooding in Oldbury-on-Severn.

This report is intended to be used as part of a wider study on flood risk to the area, in which potential options to reduce the flood risk will be discussed further. This work is being completed as part of a 'Local Levy' funded programme[1]. This is not intended to be a comprehensive study and will not have captured all the previous work that has been undertaken in this area. It is intended to help inform the current discussions on flooding and to help identify any 'quick win' options that may be able to be undertaken in a short time frame, whilst feasibility work is continuing into any longer term options.

2 AVAILABLE DATA

2.1 TIDE DATA

Observed tide level data has been provided by the Environment Agency for Avonmouth and Sharpness within the Severn Estuary. The locations of these gauges are shown below in relation to Oldbury-on-Severn.

[1] Wessex Regional Flood and Coastal Committee, Local Levy Programme 2016: South Gloucestershire Flood Risk Mitigation Options Appraisal

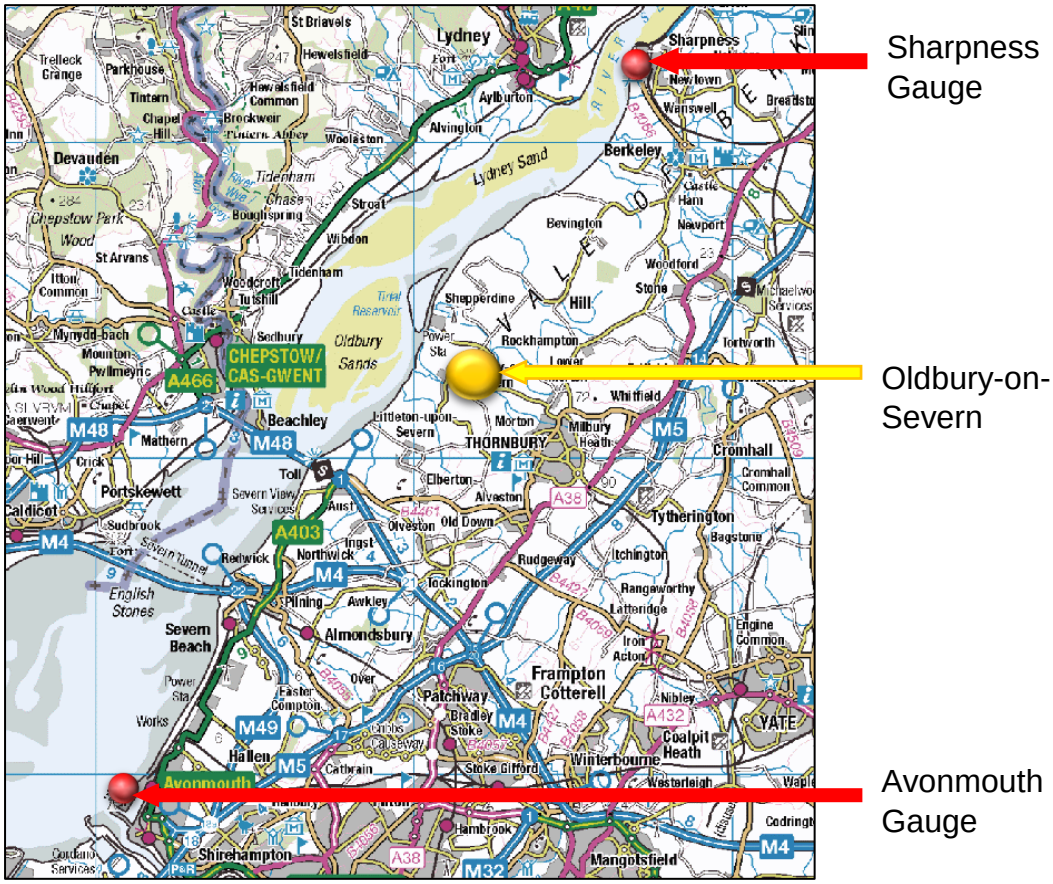


Figure 1 – Location of tidal gauges

From these tide gauges an estimate can be made of the observed tide levels simply using a weighted average of the two values. This does assume a linear change in level between Avonmouth and Sharpness, which is not true in reality, but is a reasonable assumption at this stage in this study, as the results are purely being used to understand the periods of tide locking, rather than the peak tide levels. Figure 2 shows the resulting tide level data.

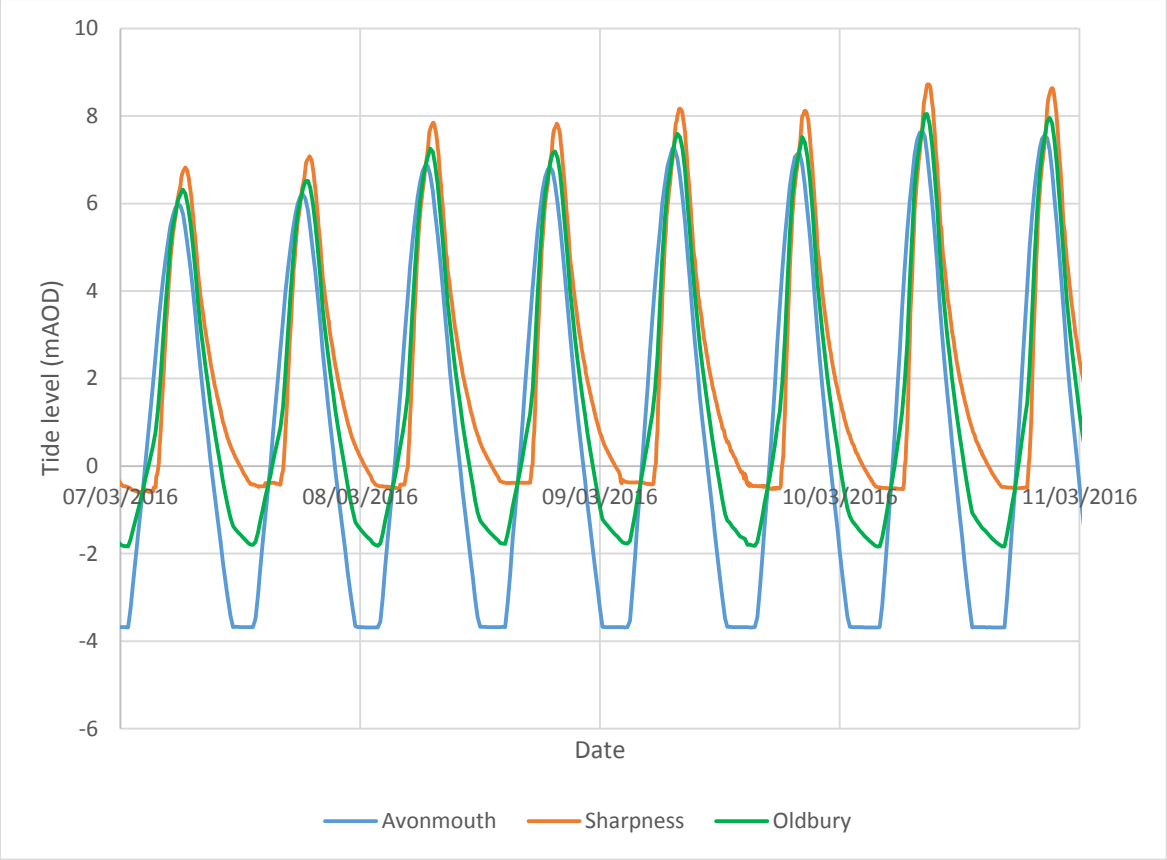


Figure 2 – Observed tide data

2.2 RAINFALL DATA

Observed rainfall data has been supplied by the Environment Agency for the duration of 2016 from a single rain gauge at Cromhall Sewage works. The location of this gauge, in relation to the Pickedmoor Brook/Oldbury Naite rhine catchment, is shown on Figure 3. Whilst it is just outside of the catchment, it should provide a reasonable reflection of the scale of rainfall in the upper catchment. There is likely to have been some significant variations in rainfall over the whole catchment.

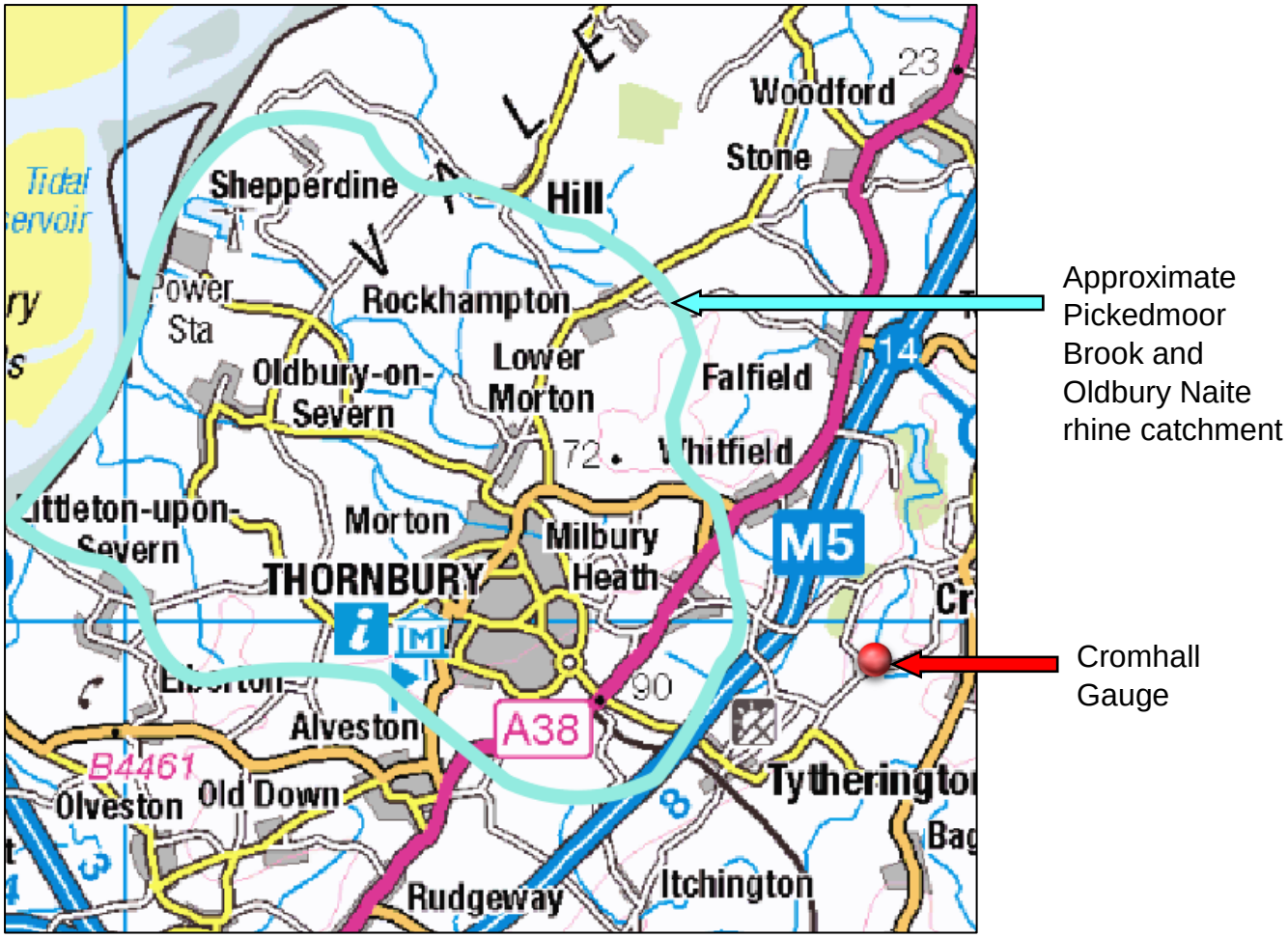


Figure 3 – Location of rain gauge

Figure 4 shows the daily rainfall totals leading up to the flood event on the 9th March 2016. This does show that whilst there was some rain, it was not particularly wet immediately prior to the event. The preceding months however had been wetter than average. Rainfall data from the event is shown in Figure 5. There was fairly sustained rainfall for a nine hour period, but the rainfall was not extreme. The total rainfall in the event is very similar to that calculated by Oldbury Parish Council.[2]

OS mapping and ground level data has been analysed to assess the amount of land that drains to the Oldbury Naite rhine through Oldbury-on-Severn. This suggests a catchment area of approximately 30km^2. It is worth noting that the urban area of Thornbury only accounts for around 8% of this catchment area, with the remainder being almost entirely rural.

An assessment has been made of the likely flow volumes that would have reached Oldbury-on-Severn during the March 2016 event. This is based on the observed rainfall and standard methods to equate this to catchment flows. This would suggest a total volume of approximately 500,000m^3 over a 25 hour period, with a peak flow rate of 10.9m^3/s.

[2] Oldbury-on-Severn Parish Council (August 2016), *Flooding in Oldbury-on-Severn, 9th March 2016*

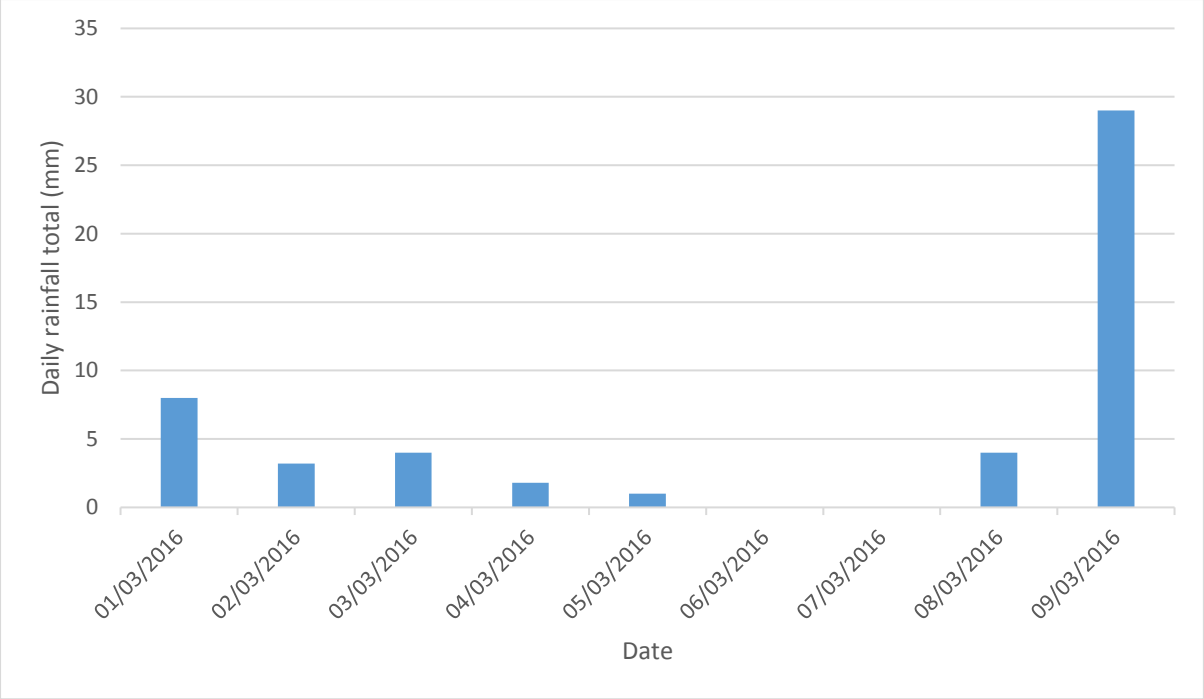


Figure 4 – Daily rainfall totals

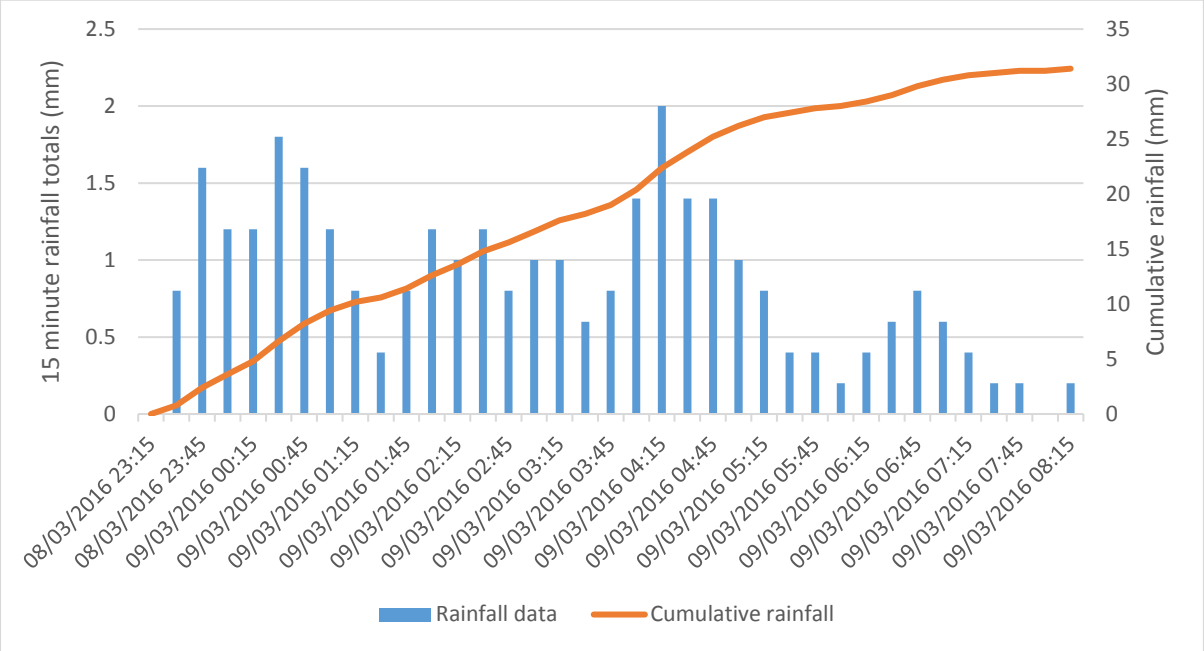


Figure 5 – Rain gauge data for flood event

The rainfall data from Cromhall gauge has also been analysed to determine what other rainfall events there have been recently. This is principally as a result of the high rainfall that was known to have occurred on the 20th and 21st November 2016. The following table compares the peak rainfall intensities during these two events, as well as in the periods prior to the event[3].

[3] For some of the periods prior to the events data from Cromhall was not available, therefore data from a rain gauge in Filton has been used in its place. The results are therefore indicative only.

Table 1 – Comparison of rainfall during March and November 2016 rainfall events

Duration of rainfall	March 2016 event	November 2016 event
Maximum durations of rainfall during events		
1 hour	6.2mm	6.6mm
3 hours	14.0mm	12.0mm
6 hours	27.0mm	15.6mm
1 day	29mm	42mm
Rainfall prior to the events		
5 days	9mm	35mm
10 days	27mm	41mm
1 month	58mm	78mm
3 months	300mm	179mm
6 months	481mm	316mm

As this table shows, whilst the period immediately prior to the November event was substantially wetter, and the total rainfall that fell over a day was over 50% greater than March, it was a much less intense event.

A further analysis has been undertaken to calculate the approximate resulting flows to Oldbury-on-Severn, to then compare against the predicted tide levels[4]. The method for calculating the flows is indicative only, and will not fully take into account the likely attenuation in the moors upstream. It does however allow for a comparison to be made of the two different events in the two following figures.

[4] For this assessment just the predicted tide levels for Inward Rocks have been used. This may differ from the actual observed data previously quoted.

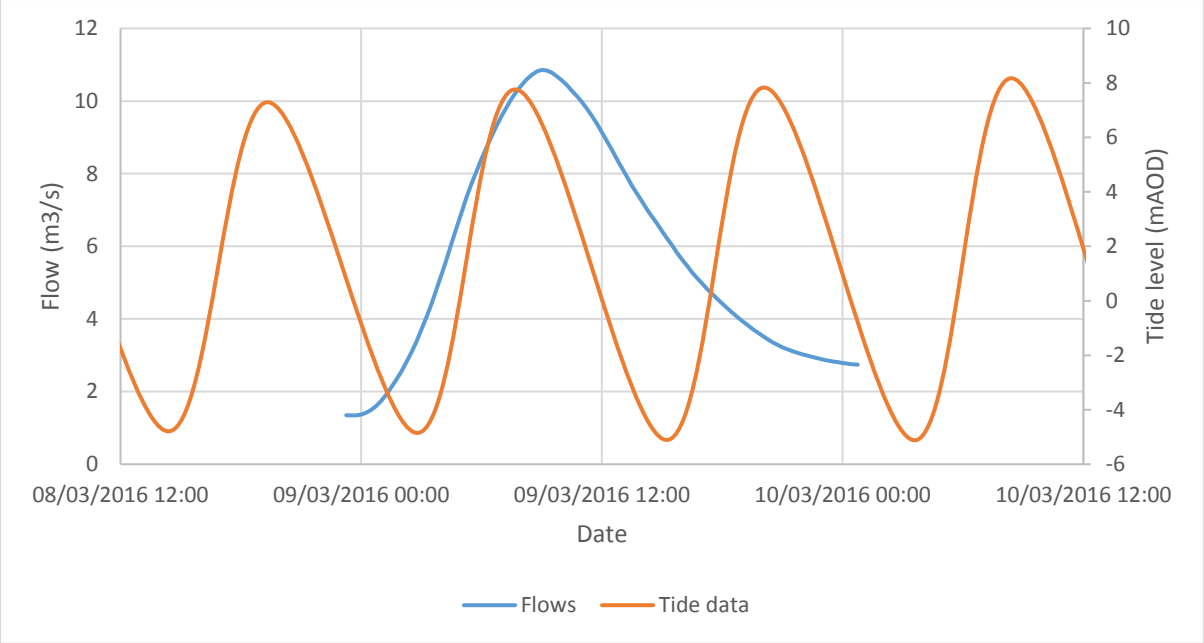


Figure 6 – Comparison of predicted flows and tide levels for March 2016 event

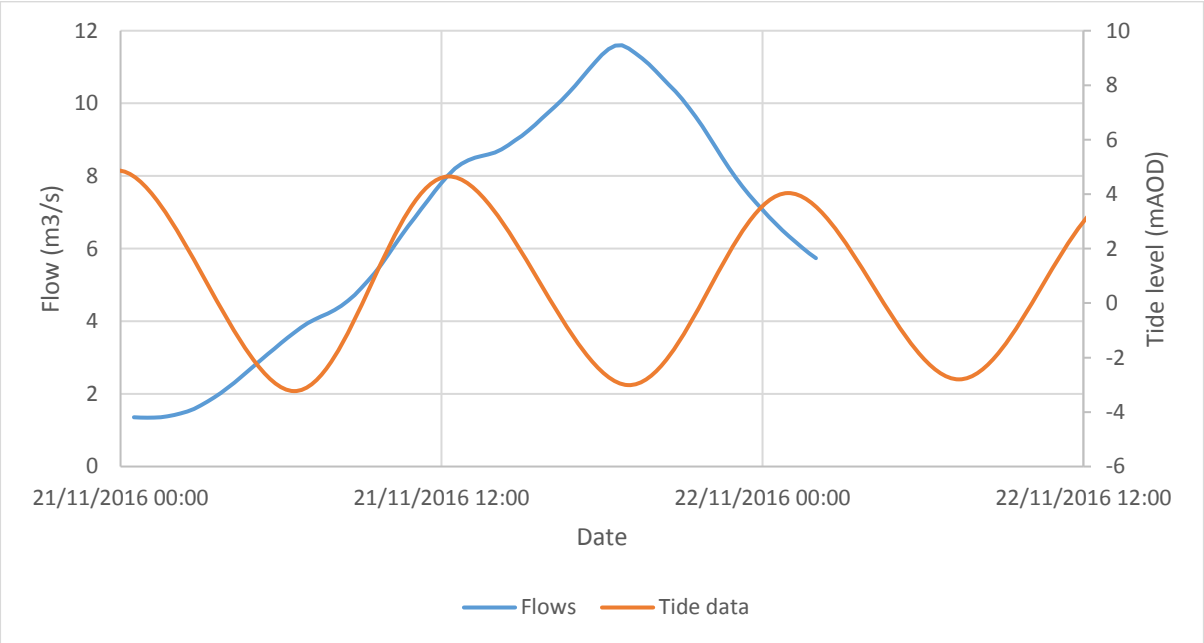


Figure 7 – Comparison of predicted flows and tide levels for November 2016 event

This shows that whilst the November event would have, in theory, resulted in a slightly higher peak flow, it would have risen much more slowly. As a result, it is more likely that the flow peak would have been reduced due to storage in the upstream moors.

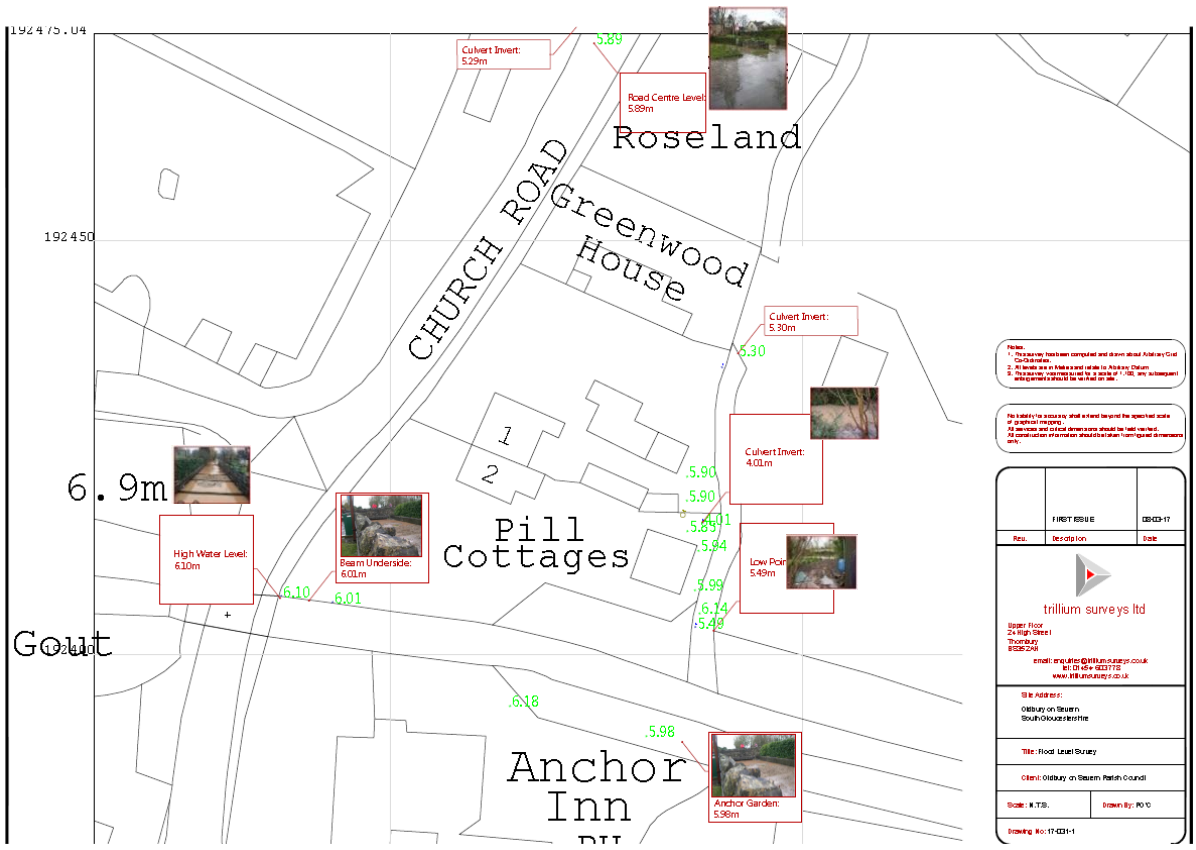
However, the key difference does appear to be in the interaction with the tide. Not only did the peak flow in November coincide with a low tide, whereas in March it coincided with the high tide, but the tidal range in November was substantially less. This is discussed further in Section 3.6.

2.3 LIDAR DATA

LiDAR data is provided freely for use by the UK Government. For this area there is 1m resolution data covering the centre of Oldbury-on-Severn, and 2m resolution data for the remainder of the catchment. This has been used in the analysis that supports this note.

2.4 OBSERVATIONS FROM THE FLOOD EVENT

A substantial amount of data is available on the 9th March 2016 flood event from a number of other reports, along with information collated directly from residents during site visits and public meetings. Of most use is the flooding report produced by the Parish Council[5], which has a thorough review of the flood event, including some surveyed levels from around the peak of the event. This survey was undertaken by Trillium Surveys Ltd and is repeated here in Figures 8 and 9. It is stated that this survey is to an arbitrary datum. However, based on an analysis of known ground levels and defence levels in this area it is thought that this datum will be close to the local Ordnance Survey datum. For example, the defence levels through Oldbury are at approximately 6.5mAOD. A high water level of 6.1m is surveyed, which is consistent with the photographic evidence showing peak levels to be below the crest of any formal defences. However, it would be beneficial to undertake further survey work to verify this datum level.



[5] Oldbury-on-Severn Parish Council (August 2016), *Flooding in Oldbury-on-Severn, 9th March 2016*

Figure 8 – Oldbury Parish Council flood survey at Church Road (some photos have been added in)

Figure 9 – Oldbury Parish Council flood survey at Chapel Road

2.5 PREVIOUS FLOOD STUDIES

There have been a number of previous assessments made of the hydraulic performance of this drainage system. Of most relevance to this report, the Lower Severn IDB commissioned a study in 2002 to review the hydrology of the Oldbury Drainage System. This study was undertaken following flooding in November 2000, in which the flood defences in Oldbury-on-Severn were overtopped.

The study includes a review of the catchment areas and the likely peak design flows, along with comparison against previous estimates. It was estimated that the design capacity of the lower reaches of Lower Oldbury Naite rhine (i.e. below the Pickedmoor Brook confluence) was around 14.4m^3/s, which was deemed to be roughly equivalent to the 1 in 10 to 1 in 20 annual probability flood event. This included an allowance for the likely tide lock period.

The report concluded that there should be a further review of the hydraulic performance of the scheme using a hydraulic model. Particular concern was noted at the capacity of the system in the Upper Oldbury Naite rhine/Rockhampton rhine area. Potential longer term flood alleviation measures were also identified.

3 DATA ANALYSIS

3.1 FURTHER GAUGE DATA

Whilst some very useful gauge data is available for the general area around Oldbury, which combined with the observations made by residents has been essential in producing this report, there would be significant benefit in having some further gauge data.

Ideally it would be beneficial to have further gauges in the following locations:

1. On Pickedmoor Brook downstream of Thornbury to measure flow
2. On Pickedmoor Brook/Oldbury Naite rhine upstream of Oldbury to measure level
3. Upstream and downstream of the tidal gate to measure level

The council are working with the Environment Agency to determine the optimum approach to installing and maintaining gauges.

3.2 NON-RETURN VALVES

There are a number of non-return valves within Oldbury-on-Severn that have been installed by either South Gloucestershire Council (or predecessors), the IDB or private residents. It is clear that not all of these are fully functioning, with some leakage being observed through these structures.

A number of these structures were installed up to 40 years ago and have not been fully maintained over this time. A survey is to be undertaken of all of the flap valves in the area using asset data from the relevant organisation alongside site visits, to determine their current condition and the potential impacts if they were to fail.

From this it can be identified where it would be beneficial to either remove, replace, repair or relocate any non-return valves. If this work is undertaken it should be completed under a memorandum of understanding with property owners. This will need to cover the future maintenance responsibilities.

3.3 CONSISTENT BANK TOP LEVELS

As identified by the Parish Council, there are a number of low spots in the banks within Oldbury-on-Severn that surround the drainage network. Survey work could be undertaken in key locations (if the data does not already exist) to determine the current crest levels. Where there are low spots, which could lead to flooding of properties, consideration should be given to some local bank raising and regrading.

3.4 SURFACE WATER DRAINAGE NETWORK

In several locations within Oldbury-on-Severn there were instances of property or road flooding during the flood event due to the high rainfall resulting in overland flow routes. Based on observations made during the flood event, alongside more detailed level data, some assumptions can be made on the source of this flooding, and the potential for this risk to be reduced.

One instance of flooding is at the Anchor Inn and Christmas Cottage immediately to the south of the main watercourse on Church Road. The threshold levels of these properties are above the peak water levels recorded in the rhine, and therefore whilst the high water levels may have been a factor in the flooding to these properties, the main cause will have been run-off from the surrounding area and the blocked drainage in the Anchor Inn garden. It is understood that work has recently been undertaken to improve this drainage.

Flooding to this, and adjacent areas is exacerbated by runoff down Church Hill and Westmarsh Lane. Whilst work has been undertaken to improve the drainage in this area, there may be opportunities to further improve this drainage. Further investigations could be undertaken into the drainage system around the Church Hill/Westmarsh Lane junction to determine the condition and route of the current highway drainage.

There is also the opportunity to route some drainage into Cowhill Wharf rhine, which runs to the south of Oldbury Naite rhine, and was observed to have spare capacity during the March event. This will require a survey of the former route of Cowhill Wharf rhine, which has become partially blocked, to see if it can be reinstated. This would also then require some works to the highway drainage system and/or the profile of the road, to ensure runoff were to enter this rhine rather than continuing further to the North. If this work was undertaken, there would need to be some consideration into the existing function of Cowhill Great rhine, to ensure this is not affected by the works.

3.5 IMPACT OF TIDE INGRESS

There has been some discussion as to whether the tidal gates contributed to the flood risk in Oldbury. The gates are designed to close when the tide levels in the estuary are higher than the fluvial levels within the rhine. However, there is some concern that they may not close in time, leaving a period where there may be tidal ingress into the system. This concern is partly due to the works undertaken by the Environment Agency to allow upstream eel passage, which included installing a dampener on the tide flap to allow some upstream flow of water on a rising tide. It is impossible to fully answer this question without installing gauges upstream and downstream of the tidal gates and/or making more detailed site observations over a tidal cycle.

To test if there might have been substantially more tidal ingress during the March event, the available volume in the system between the point where the tide gates are likely to be closed (around 4.5mAOD) and the approximate peak flood level in the rhine at Church Road (6.1mAOD), has been calculated from LiDAR data. Figure 10 shows the 6.1mAOD ground contour in the lower part of this area.

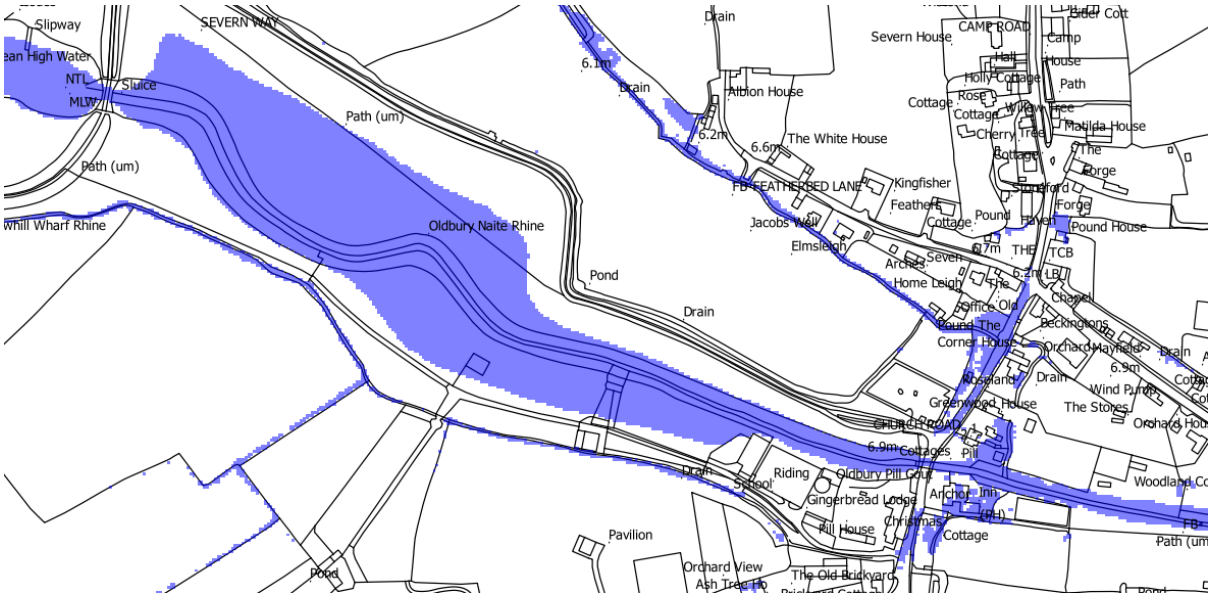


Figure 10 – Extent of 6.1m (AOD) Contour

This equates to a volume of approximately 60,000m^3 which would be easily filled by the amount of rainfall passing from upstream. Combined with observations made during dry periods when the tide flaps were closed, it is considered unlikely that tidal ingress from leakage through the flaps had any significant impact on the peak flood levels in the area.

3.6 IMPACT OF TIDE LOCKING ON FLOODING

During the period that the tidal flaps are closed no fluvial water will be able to escape the system. The tide flaps will close fully once the rising tide exceeds the level within the Rhine. For this assessment, for the March 2016 event, this has been assumed to be at a level of approximately 4.5mAOD. The flaps will reopen as soon as the tide level drops below the level in the Rhine. This has been assumed to be at a level of approximately 6mAOD. This equates to a time period of just under 3 hours across the high tide.

The following figure shows the approximate period of tide locking during the March 2016 event, showing how this interacts closely with the period when the fluvial flows would have been at their highest. During this 3 hour period approximately 110,000m^3 of water will need to be stored, which would easily raise the water levels within the Rhine from 4.5 to 6.1mAOD, as was observed in the event.

If the high tide had occurred 6 hours later than the volume of water needing to be stored would still have been approximately 80,000m^3, which would have still raised water levels substantially within the Rhine system, although maybe to only around 5.8mAOD. Therefore, whilst the timing of the tide in relation to the fluvial peak flows will be important in determining peak levels, due to the duration of high fluvial flows, there is always likely to be a period of fairly high flows during tide locking.

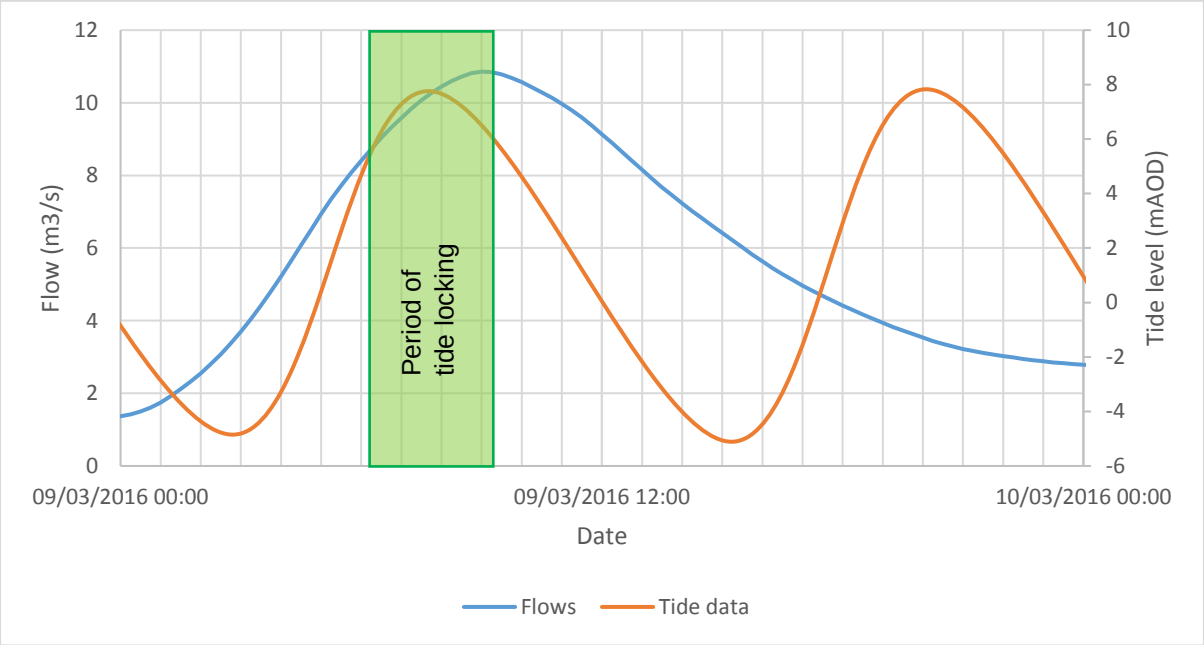


Figure 11 – Tide locking period on 9th March 2016

Figure 12 shows the same analysis for the November 2016 event. Due to the lower tide height and the fact it occurred as the flood levels were rising, it is likely that the tidal flaps may have closed when the tide level was only around 3.5mAOD. However, the volume of fluvial flows being stored would have quickly resulted in Rhine levels exceeding the tide levels, and the flaps would have reopened. Therefore, it is likely that the peak level reached in the Rhine system would not have exceeded much above the peak tide level of 4.5mAOD, which is over 1.5m lower than the levels reached in March 2016.

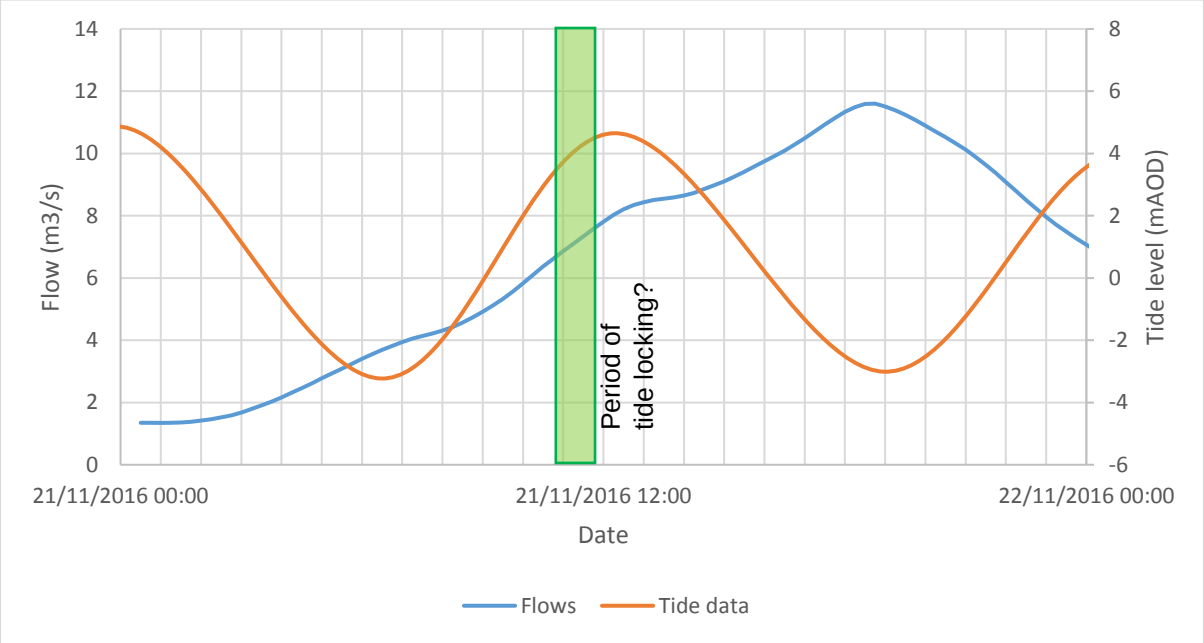


Figure 12 – Tide locking period on 21st November 2016

The conclusion of this assessment is that the flood risk to Oldbury-on-Severn is affected by the tide conditions. Due to the relatively long durations of any fluvial flows, the timing of the tidal peak compared to the fluvial peak is of less relevance than the height of the peak. A significant area of Oldbury-on-Severn is below the level of the local Highest Astronomical Tide (~8.5mAOD), and therefore if any fluvial flow occurs in combination with spring tides it will result in elevated levels within the Rhine network. However, the Rhine level will always be lower than the corresponding tide levels due to the large amount of storage available in the upstream moor areas (see following section).

This analysis might suggest that there is some benefit in increasing the capacity of the tidal flaps, and this should be investigated further. However, it should be noted that there is likely to be limited benefits in this. The existing flaps are large and should be easily capable of conveying the peak flows during low or intermediate tides. The only benefit will therefore come when higher fluvial flows combine with spring tides.

If additional pumping was included, then this would need to be able to convey several cubic metres of water every second to have any meaningful impact on flood levels.

3.7 ATTENUATION IN UPSTREAM MOOR AREAS

Some concern has been raised that the flooding in the Oldbury-on-Severn area would have been much more severe if there had been more rainfall. To answer these questions a better understanding of the impacts of the low lying moor areas upstream of Oldbury is required. Figure 13 shows the ground levels in these areas, which are below 4.5mAOD in places. More importantly is the proportion of this area that is below 6.0mAOD, which was the approximate peak water level in Chapel Road in the March 2016 flood event. In theory, this area should be able to operate as a large storage area to take water from upper Oldbury Naite rhine when water levels are high, but this does require the water to be able to pass from the rhine to the fields.

However, there is less opportunity for water to be transferred from Pickedmoor Brook due to the height of the banks and the lack of connecting drains.

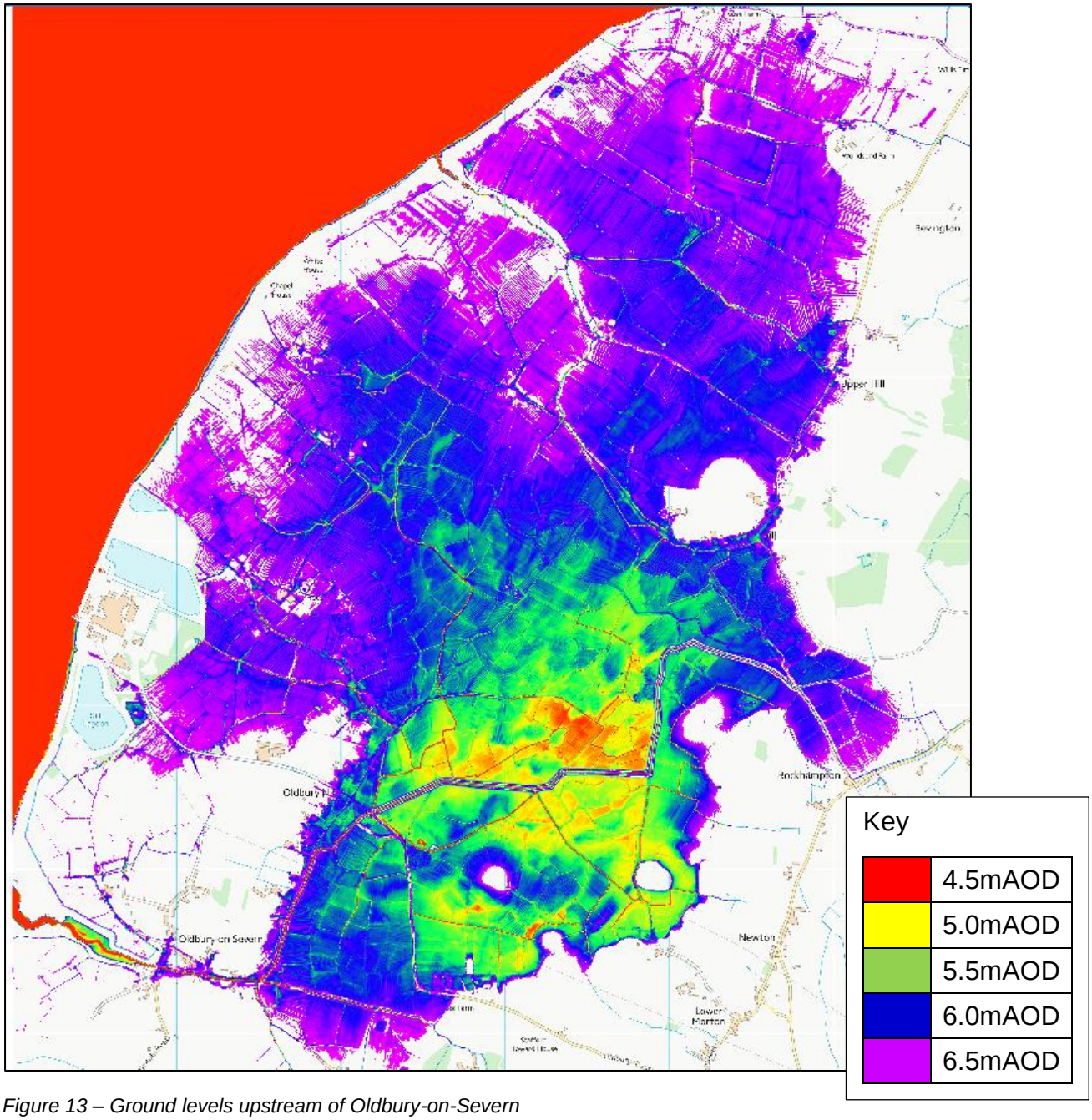


Figure 13 – Ground levels upstream of Oldbury-on-Severn

Table 2 – Storage volumes in moor areas

Level	Area	Cumulative volume
4.5mAOD	Assumed to be zero	Assumed to be zero
5.0mAOD	350,000m^2	90,000m^3
5.5mAOD	2,305,000m^2	750,000m^3
6.0mAOD	6,340,000m^2	2,910,000m^3
6.5mAOD	15,720,000m^2	8,430,000m^3

There are three key points to be considered here. The first is to compare the likely runoff in the March 2016 event (~500,000m^3) with the available storage in this system. It is likely that water levels of around 6mAOD were being achieved with only a small proportion of the available storage being utilised. If this area could be utilised better to attenuate flood water then the peak levels through Oldbury-on-Severn may be able to be reduced.

The second point is that the amount of available storage increases exponentially. Therefore, for flood levels to raise from 6.0mAOD to just a small amount higher should require a large increase in runoff. In order for a more significant number of properties to be at risk of flooding the flood level would have to reach 6.5mAOD, by which point the amount of available storage is several times that of that which is available at 6.0mAOD. This does however assume that flow can be transferred from the rhines into the surrounding fields.

The third point is that once flood levels in the moors are much over 6.0mAOD, all of the adjacent moor areas begin to join up and there are then multiple routes for the flood water to leave the area, other than just Oldbury Naite rhine. It is therefore quite possible that the peak level experienced in March 2016 cannot be exceeded by much, however under more severe events the water could stay at that level for longer durations.

It is recommended that further data is collected on the overall system to allow the hydraulic performance during flood events to be assessed. This will include the need for some bank level survey as well as limited channel cross sections. This will need to be entered into a basic hydraulic model of the area. This can be used to better understand the flow dynamics during the March 2016 event, as well as look at the likely impacts of more severe rainfall. It could also then be used to look at options to reduce the risk.

These options may include increased use of upstream areas for flood storage during more extreme events, or improved connections to other drainage systems where these have spare capacity.

4 RECOMMENDATIONS

It is recommended that the following tasks are undertaken:

- Verify the datum used for the water level survey undertaken by the Parish Council.
- Investigate if flow and water level gauges can be installed on Pickedmoor Brook and Oldbury Naite rhine.
- Inspect repaired drainage system at The Anchor public house (completed in February 2017)
- Identify the locations of flap valves within the area, and detail their current condition and the implications if they do not fully function. Consider replacing existing broken/damaged flap valves under a memorandum of understanding with property owners.
- Collect survey data of the crest level of key embankments to identify low spots.
- Investigate the current highway drainage provision around the Church Hill/Westmarsh Lane junction to see if improvements could be made.
- Undertake a short survey of the former route of Cowhill Wharf rhine to determine if this could be restored to convey some of the runoff from the Church Hill area.
- Investigate the drainage connections from Chapel Road to the rhine to confirm if improvements are required to further prevent flood water passing onto the road prior to the flood wall overtopping.
- Work with the Lower Severn IDB to determine how well the overall drainage system works during high rainfall events to attenuate and convey flood water. This should include a short review of any physical changes that have been undertaken in recent years, and whether there are any opportunities to make further alterations to the system that would reduce flood levels within Oldbury-on-Severn.
- Work with the Lower Severn IDB to identify if other rhine systems can be better utilised to convey flood water, with the aim of reducing the flow of water passing through Oldbury-on-Severn.
- Investigate options to increase the capacity of the tidal gate during conditions when high fluvial flows combine with spring tides.