

**RM REP001 Penshurst Parish Council representation
Environment Agency technical response, September 2020**

Further to Penshurst Parish Council’s representation to Defra, the Environment Agency summarised the letter into four specific issues concerning road flooding in and around Penshurst. Penshurst Parish Council agreed that this summary was an accurate representation of their concerns. These four issues are addressed below.

- 1. Key roads around Penshurst, including Chafford Bridge, Colliers Land Bridge, Rogues Hill and Long Bridge currently experience flooding. Penshurst Parish Council is concerned that future use of the Leigh Flood Storage Area (FSA) will exacerbate the situation and cause flooding of the roads on a more regular basis and for a longer period.**

Penshurst Parish Council (PC) have stated that:

Roads generally flood and become impassable in the following order: 1) Chafford Bridge, 2) Colliers Land Bridge, 3) Rogues Hill, 4) Long Bridge.

The locations are shown on the map below in Figure 1.

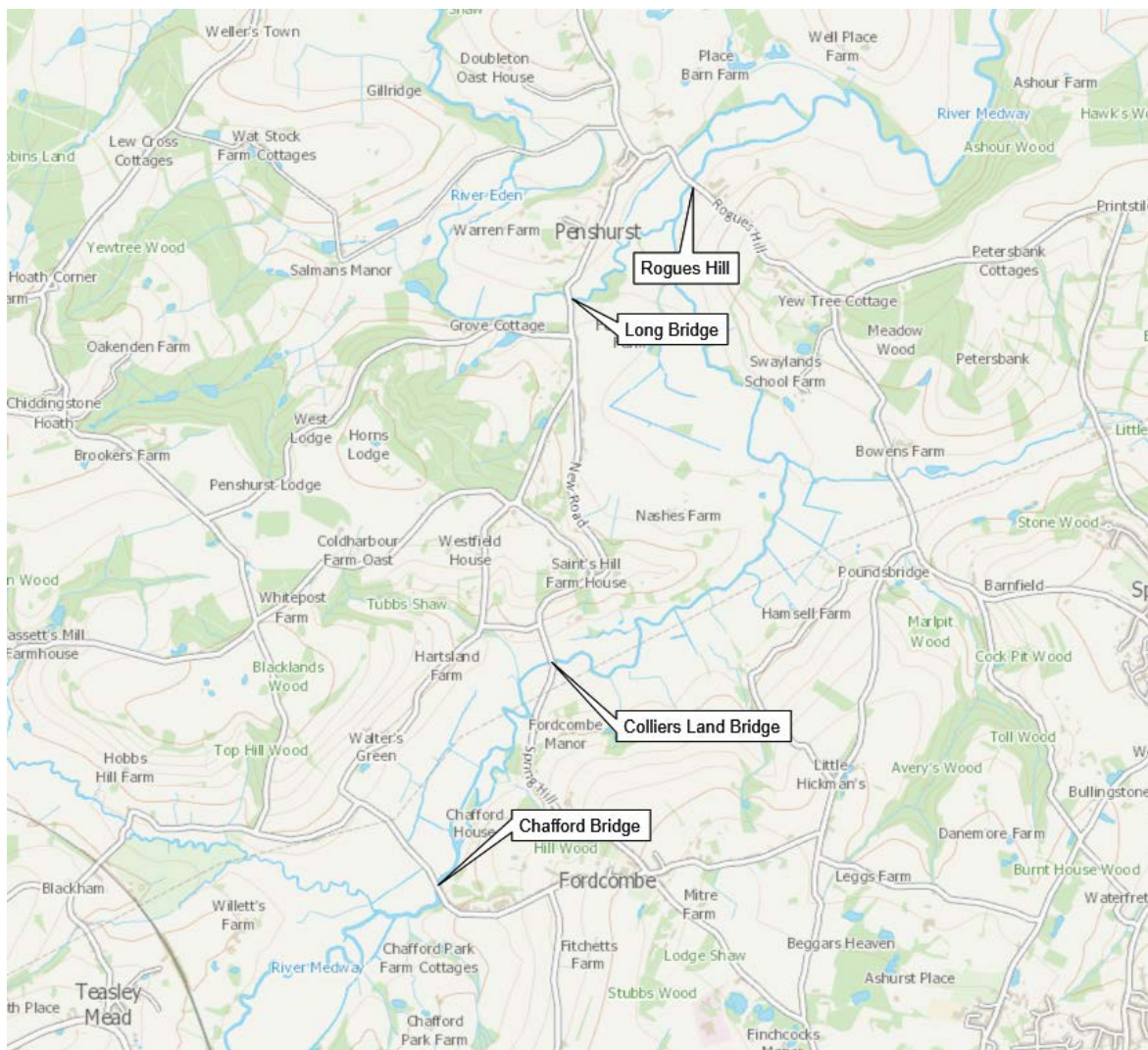


Figure 1: Key locations of road flooding identified by Penshurst PC

Chafford Bridge and Colliers Land Bridge

As stated by Penshurst PC, these locations are the first to flood during a flood event. This is because flooding upstream of Penshurst is driven by high flows from the River Medway and River Eden flowing toward the confluence at Penshurst. As they are upstream of Penshurst, they will experience the peak of the flood first. For example, during the most recent flood event (February 2020) the roads at Colliers Land Bridge and Chafford Bridge were flooded approximately twelve hours before impounding started at the Leigh FSA. There is no influence from the Leigh FSA this far upstream.

The cause and impact of flooding at Colliers Land Bridge and Chafford Bridge can be considered together as they are broadly similar. The Environment Agency operates gauging stations at these locations so the depth and timing of flooding at these sites are known.

Again using the February 2020 flood as an example, the peak level at Colliers Land Bridge was reached at 17:00 on 16 February 2020. The water had been rising for two days and at this time the surrounding land and roads were flooded. The water levels at Colliers Land Bridge gauging station are shown in Figure 2 below. The Leigh FSA did not start impounding water until 17:15 on 16 February 2020 by which time, the peak level at this location had passed. Figure 3 shows the water level at the main embankment of Leigh FSA for the same period of time. This shows that, having peaked at 17:00, the water level at Colliers Land Bridge was falling by the time impounding began at the Leigh FSA. This shows how the water levels at these upstream locations rise before the operation of the Leigh FSA and are therefore not influenced by its operation.

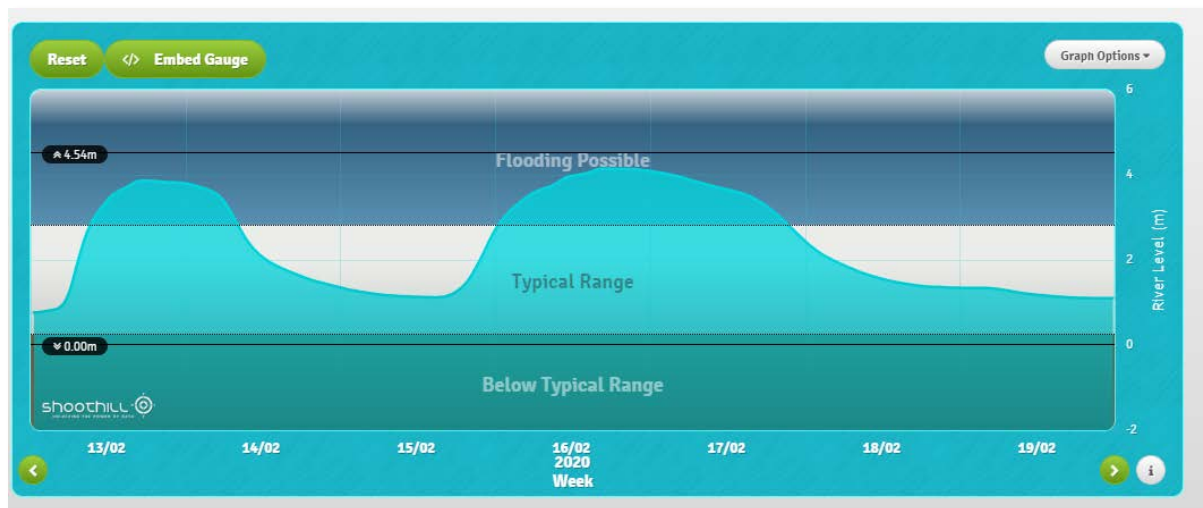


Figure 2: Water levels at Colliers Land Bridge gauging station 13 to 19 February 2020. Image from Shoothill Gauge map using data from an Environment Agency gauging station

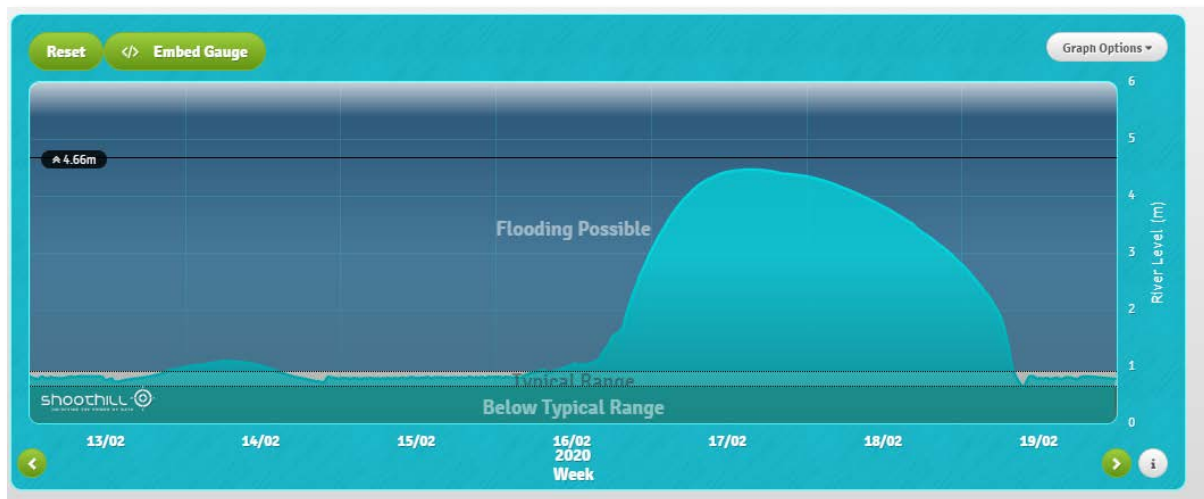


Figure 3: Water levels at Leigh Barrier upstream gauging station 13 to 19 February 2020. Image from Shoothill Gauge map using data from Environment Agency gauging station

The proposed change to increase the maximum impoundment level does not change this situation. This is demonstrated in Figure 4 below. Figure 4 shows the increase in flooding depth from raising the Leigh FSA maximum impoundment level from 28.05m AOD to 28.6m AOD (measured at the main Leigh FSA embankment) during a 1.33% flood event. Every flood event is different, depending on a number of factors including soil saturation and weather patterns. Modelling simulated flood events allow us to vary how much water flows down the catchment and when. The scenario in Figure 4 was chosen to demonstrate the impact of expanding the FSA because it shows the greatest change in flood depths.

There are other examples provide in section 5.1 and Appendix B of the Flood Risk Assessment. During more extreme flood events, the increase in depth as a result of the proposed change, reduces. This is because the natural flood level, which is greater, dominates.

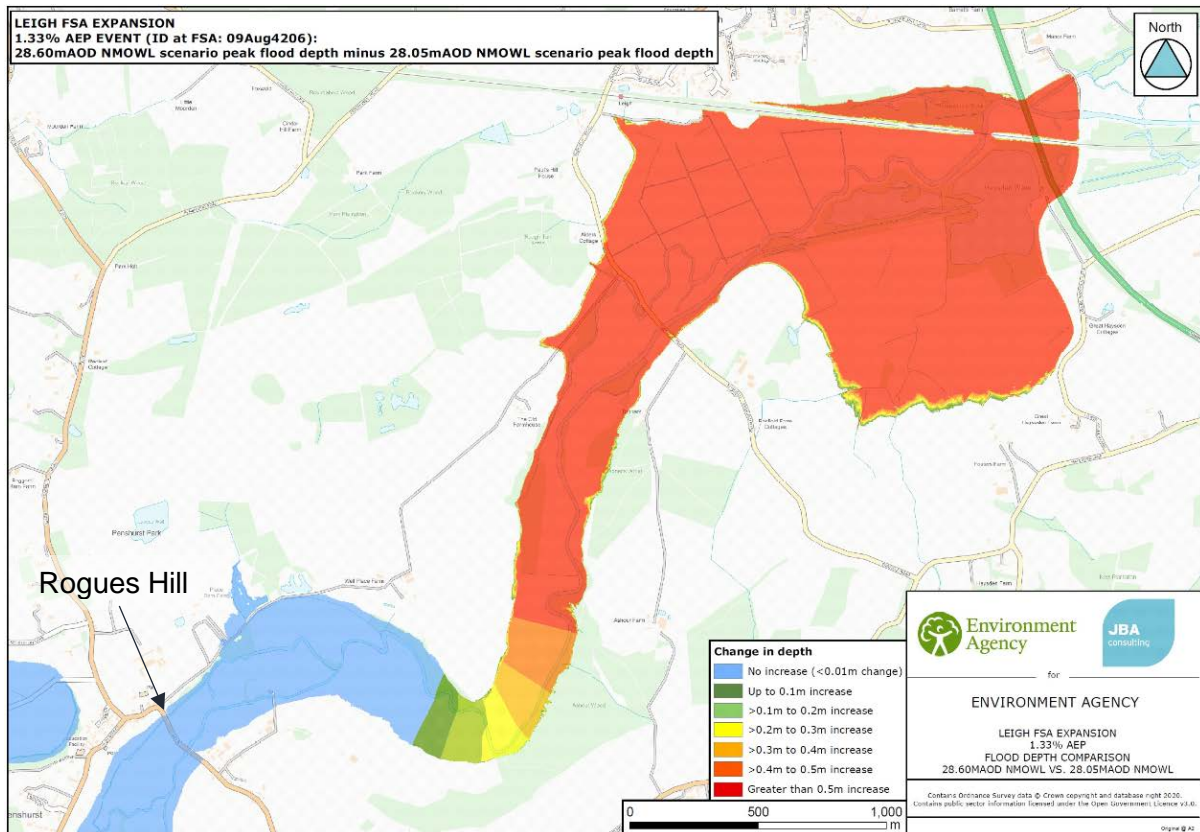


Figure 4: Increase in flood depth in a 1.33% flood event. 28.05m AOD vs 28.6m AOD

Long Bridge

The Environment Agency does not have any gauging at Long Bridge. The nearest gauging station is Penshurst gauging station upstream of Long Bridge on the River Eden. The gauge is approximately 1km upstream of Long Bridge and therefore the level and flow conditions are comparable for the purposes of assessing local flooding because of the proximity and similarity in channel profile and level. Again, using the most recent flood to illustrate, Figure 5 shows the flood levels at Penshurst gauging station in February 2020. The timing of the peak at 01:30 on 17 February corresponds with Penshurst PC's information that Long Bridge floods after Chafford Bridge and Colliers Land Bridge. Comparing Figures 3 and 5 demonstrates that when the water levels in the Leigh FSA were rising as water was stored, the flood level at Long Bridge was decreasing. As with Colliers Land Bridge and Chafford Bridge, this is because the flooding at Long Bridge is caused by the volume of water from upstream on the River Eden, and not by the impounding of water downstream on the River Medway.

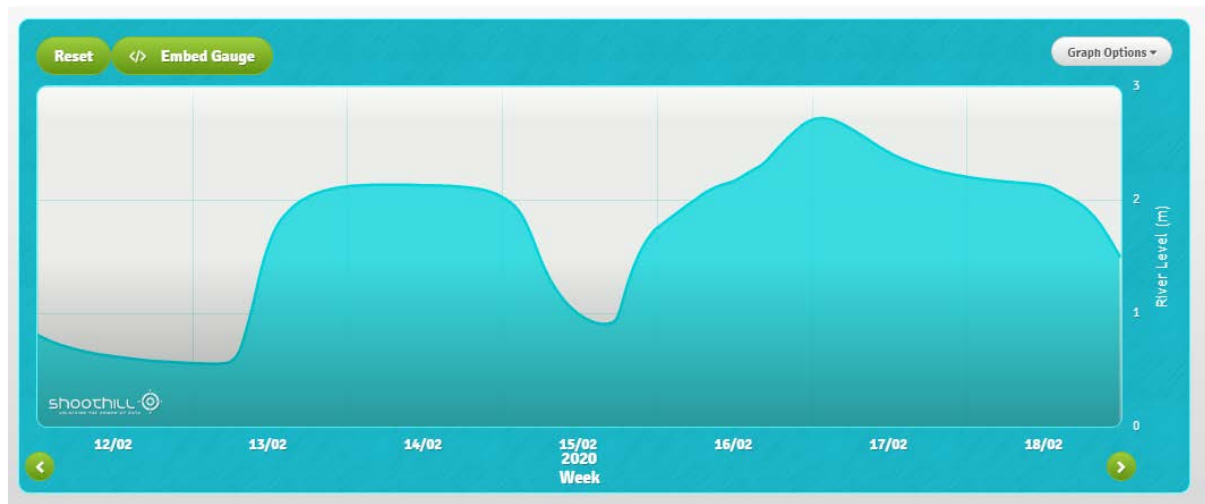


Figure 5: Water levels at Penshurst gauging station 12 to 18 February 2020. Image from Shoot Hill Gauge map using data from Environment Agency gauging station

Rogues Hill

The road, Rogues Hill, is built on a causeway across the flat valley 200m downstream of the confluence of the Rivers Eden and Medway. Rogues Hill passes over the River Medway by Bridge House. The road bridge was repaired after it was damaged in the 1968 flood. Whilst the road is raised above the surrounding fields, the lowest part of Rogues Hill, continues to be particularly vulnerable to flooding. The road acts as a causeway across the floodplain and causes water to back up upstream of Rogues Hill. As the road is slightly raised, it floods later than the surrounding land.

Figure 6 shows how Rogues Hill remains passable whilst the surrounding land is flooded due to the raised road surface. As observed during the flooding in February 2020, even though Rogues Hill remains dry for longer (it remained dry until at least late afternoon on Sunday 16 February), when the depth of water on surrounding land becomes deep enough, the road floods. Flooding at this location is driven by the same upstream flows as the other locations identified by Penshurst PC. As the upstream water level rises, eventually Rogues Hill floods and becomes impassable to most traffic.



Figure 6: Rogues Hill looking North West toward Penshurst. Taken at 13:00 on 16/02/20

Although it is known that Rogues Hill flooded prior to the construction of the Leigh FSA, the Environment Agency sought to understand if the operation of the Leigh FSA causes the road flooding to be deeper than occurred prior to the construction of the FSA. As part of the development of the Leigh Expansion and Hildenborough Embankment Scheme (LEHES), the Environment Agency has carried out flood modelling and surveys to understand the relationship between flooding at Rogues Hill, and the operation of the Leigh FSA. The outcome of this modelling is reported in the Flood Risk Assessment for the scheme dated July 2020, and submitted in support of the planning application.

Ground levels have been identified using Light Imaging, Detection and Ranging (LIDAR) data at the following locations:

- Lowest point on Rogues Hill road: 28.9m AOD.
- Average ground level on floodplain upstream and downstream of Rogues Hill road: 27.6 – 27.8m AOD.

The Environment Agency has carried out flood modelling at Rogues Hill for the following scenarios:

- Natural flooding – flooding that would be experienced if the Leigh FSA were not present and operating.
- Operation of the Leigh FSA to 28.05m AOD - flooding that occurs with the Leigh FSA in operation at the current legal maximum storage level.
- Operation of the Leigh FSA to 28.6m AOD –flooding that would occur with Leigh FSA in operation at the proposed legal maximum storage level.

The flood modelling undertaken has looked at a flood event with a 5% chance of occurring in one year and a much more severe 1% flood event which includes the

increased flow driven by climate change. Modelling of these scenarios ensures that a range of events has been considered.

The result of this modelling is shown below in Table 1. All levels shown are immediately downstream of Rogues Hill road surface.

Flood event annual probability	Natural flood level	Leigh FSA operating at 28.05m AOD	Leigh FSA operating at 28.60m AOD
5%	28.7m AOD	28.8m AOD	28.8m AOD
1% + climate change	29.4m AOD	29.5m AOD	29.5m AOD

Table 1: Flood levels downstream of Rogues Hill for 5% and 1% + CC flood events.

The information presented in Table 1 demonstrates the following:

- Rogues Hill floods due to natural flooding that is driven from high flows upstream.
- The raised causeway that Rogues Hill is built on keeps the road dry during a 5% flood event. (The LIDAR measurement shows the lowest point of Rogues Hill road is 28.9m AOD).
- During an extreme 1% flood event when the impounded water level measured at the control structure reaches its current maximum level (28.05m AOD), operation of the Leigh FSA increases the depth of floodwater over Rogues Hill.
- Increasing the maximum storage level of floodwater in the Leigh FSA from 28.05m AOD to 28.6m AOD will not increase the depth of flooding on Rogues Hill.

During an extreme 1% flood event, (an event more severe than any experienced to date at Rogues Hill) there is potential for the operation of the existing Leigh FSA to increase the depth of flooding over Rogues Hill by up to 0.1m. Due to the timing of the flooding the road would be flooded to at least 0.6m prior to the operation of the Leigh FSA and would therefore be impassable with or without the influence of the Leigh FSA.

Conclusion

Penshurst Parish Council have expressed concern that future use of the Leigh FSA will exacerbate the flooding of the roads and cause this to occur on a more regular basis and for a longer period.

Whilst the existing FSA can increase water levels on Rogues Hill by up to 0.1m, Figure 4 shows that the proposed expansion will not increase the depth of flooding on Rogues Hill. As Long Bridge, Chafford Bridge and Colliers Land Bridge are further upstream, the expansion will not have any impact on the flooding on these roads either.

Furthermore, because the expansion will not increase the depth of flooding on the road, the duration of any flood will not be increased by the proposed change.

2. Penshurst Parish Council is concerned that the Environment Agency is not reducing flood risk to the roads around Penshurst.

The primary objective of the proposed expansion of the Leigh FSA is to provide improved flood protection to properties in Tonbridge and Hildenborough. The proposed expansion will not reduce the flood risk to roads around Penshurst, but it does not increase the flood risk either.

The Environment Agency recognise the risks that arise through flooding of the roads around Penshurst. We always warn the public against driving through flood water. Flooding of these and other roads makes them dangerous, with the potential for drivers to try to pass through the floodwater at Rogues Hill and for cars to become stuck with the obvious risk to life this presents and the ongoing blockage to passage after the floodwaters have receded.

There are a number of organisations involved in managing and responding to flood risk. The Environment Agency has powers to manage flood risk from main rivers and Kent County Council provide and manage highway drainage and roadside ditches. Other organisations and risk management authorities also have roles in managing and responding to flooding.

The risk of flooding in the natural floodplain cannot be eliminated. Warning and informing presents the only viable approach to the management of the risk to road users.

We would like to offer to fund the National Flood Forum to help the local community to set up a flood action group where the concerns of the community can be raised with all of the organisations involved in managing flood risk so that ways to mitigate the impact and improve the resilience of the community to flooding can be explored together.

3. The Environment Agency does not measure the depth of floodwater at Rogues Hill. Penshurst Parish Council is concerned that the Environment Agency may not be aware of the current extent of the flooding on this road and has not taken accurate account of this in the modelling of the proposed impacts to highways of increasing the maximum stored water level in the Leigh FSA.

The Environment Agency has flow gauges upstream of Rogues Hill at Chafford Bridge and Colliers Land Bridge on the River Medway, and Penshurst and Vexour Bridge on the River Eden. This represents a significant investment in flow monitoring. Information from these gauging stations has been used in the 2015 Medway flood model. Whilst it is always possible to further refine the calibration of any flood model by considering more baseline data, the Environment Agency is confident that the modelled flood data represents the best available means of understanding the flood risk at Rogues Hill and flow gauging at Rogues Hill will not materially alter the outputs of the 2015 Medway flood model.

In addition to the 2015 Medway flood model, the Environment Agency has photographs and data showing the extent of land flooded during previous events,

and staff observed the flooding at Rogues Hill in February 2020 to understand the extent of flooding at this location. None of the observations are any worse than predicted by the flood modelling. The timing of the flooding in February 2020 was as predicted by the model. The area around Penshurst was flooded prior to the operation of the Leigh FSA.

4. Penshurst Parish Council would like the Environment Agency to monitor the depth of flood water at Rogues Hill.

The Environment Agency would like to work with Penshurst Parish Council and Kent County Council to install gauge boards at Rogues Hill and appropriate signage to inform road users of the flood depths. The installation of this signage would be funded by the Environment Agency, and we would like to work with Penshurst Parish Council on the design to ensure it meets the needs of local road users.

In addition to providing gauge boards, the Environment Agency's free Flood Warning Service covers Rogues Hill and can provide residents will information about potential flooding at this location.

We understand that there is concern within the community in Penshurst that the effect of operation of the Leigh FSA on flood levels in Penshurst is not fully understood. We are investigating the feasibility of providing additional depth gauging in Penshurst, downstream of Rogues Hill. This will provide definitive data on this issue, and will hopefully provide the reassurance sought by the community.