

- **Option 2 – Online storage:** The solution involves the construction of 160m³ of online attenuation using crate storage cells, beneath the pavement and upsizing 230m of 150mm diameter combined sewer upstream of the proposed storage tank to 225mm diameter. The estimated cost of this option was £689,640.
- **Option 3 – Surface water removal:** Removing an appropriate portion of the roof drainage from the sewers upstream of Trelawney Avenue would ensure that the peak flows from this area were within the capacity of the downstream 150mm diameter pipe for a 1 in 30 year event.

This would be facilitated by directing flows from roof downpipes into green gutters, comprising open channels with planting. The green gutters would act as soakaways since the underlying geology is a base of permeable mudstone and sandstone.

However, this option was too expensive (£1,070,311) and high risk – it required residents to agree to having their roof guttering disconnected and have green gutters in their gardens.

The estimated costs of these options were far greater than the value of the benefits they provide. Therefore, these options were considered not cost-effective and consideration was given to a number of risk-based measures, which alone do not provide the guarantee that the properties are protected in a 1 in 30 year event but reduce the severity and frequency of flooding incidents. The options examined included:

- **Option 4 – Pumping station:** Consideration has been given to a 'cut and pump' solution in the area; however, the hydraulic model indicates that there is no spare capacity in the receiving foul sewers in the adjacent catchments.
- **Option 5 – Water butts:** The impermeable area survey confirmed that the roads upstream of Trelawney Avenue drain predominantly to the surface water system and approximately 95% of the roofs drain to the combined network. Installing water butts at each of the properties upstream would remove surface water from the combined network and lower the risk of flooding along Trelawney Avenue. The water butt set includes a 200 litre water butt, a stand, a connector to the down pipe, porous pipe and non-porous pipe. Once the water butt is fitted to the downpipe using the downpipe connector provided, the section of non-porous pipe is fitted to the tap at one end and the porous pipe at the other end, which is then laid around the outside of the gardens or flower beds.

101 water butt sets would be required for the upstream catchment. With a 100% take up for properties upstream and with water butts 50% full at the start of the storm, this scheme would provide up to 25m³ of storage and would protect both properties up to and including a 1 in 10 year event.

- **Option 6 – Surface water sewer:** The highway drainage from Trelawney Avenue and Trelawney Crescent goes to the combined sewer. A peak flow of 11l/s could be removed during a 50mm/hr intensity storm, which would reduce the frequency of flooding to 1 in 2 year. This option includes the installation of 40m of slotted drain and gullies to intercept highway drainage on Trelawney Avenue and Trelawney Crescent and the construction of 66m of new 150mm diameter storm sewer to connect it into an existing surface water sewer. The estimated cost of this option was £158,209.



Solution

The solution was a combination of measures to separate the highway drainage on Trelawney Avenue and Trelawney Crescent using a new surface water sewer and reducing storm water inflow from roofs using water butts. Raising the kerb alongside properties has provided protection against overland surface water flooding while retaining excess run-off on the highway.

Construction constraints

The main construction constraint was the high density of buried services and tight working area. The new storm sewer was laid in a narrow footpath between houses.

This footpath contained a shallow buried 11kV electric cable and at the end of the path, the new storm sewer had to cross a large number of services including a disused asbestos pipe. As a result the pipe was laid with less than 600mm cover, a concrete surround and 300mm diameter inspection chambers.

Added value

Cardiff County Council was engaged in the scheme at an early stage in the design process and was consulted regarding the gully positions and type of highway drain used. As a result, they have since adopted the highway drainage on Trelawney Avenue and Trelawney Crescent as part of their asset base.

Welsh Water carried out a public engagement exercise with the residents of Trelawney Avenue and the upstream contributing area to explain the purpose of the water butts and how to install them. They distributed letters explaining the history of flooding in Trelawney Avenue and flyers on how to install the water butts.

Although, the combination of interventions only provides a 1 in 20 year solution for properties in Trelawney Avenue, not the designated standard of protection of 1 in 30 years, OFWAT were fully consulted throughout the design and intervention process and have agreed that the DG5 property can be removed from the ARR and the outputs can be claimed.

Conclusion

The risk based approach to flood prevention combining the package of new highway drainage and the installation of water butts to properties in the upstream catchment has provided a cost-effective, sustainable solution to reducing the risk of flooding at the properties on Trelawney Avenue to 1 in 20 year return period, and has been deemed acceptable by OFWAT.

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