SEWER AND STORMWATER FLOODING – DIFFICULT DECISIONS FROM THE UK

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ABSTRACT

Although the cause of the apparent increase in occurrence of severe weather patterns is a topic of significant discussion, the impact of severe rainfall events and the resulting sewer and stormwater flooding is readily apparent.

Whilst we could design infrastructure to accommodate flows resulting from extreme or severe storm events, it is unlikely to be sustainable and could result in significantly larger capital schemes with potentially high operational costs. In reality it is not viable to size infrastructure in this way and inevitably there would be a pinch point, maintenance issue or an even more extreme event that may exceed design parameters.

Local authorities and companies in the UK are becoming increasingly aware that we cannot continue to try to build our way out of the problem. In the UK some engineers and asset managers are trying to move towards managed outcomes rather than resolving all flooding risk.

The managed outcomes concept in its purest form is the design of infrastructure for a set of client approved criteria, with serious consideration given to what happens and how we sustainably manage the location of flooding resulting from severe storms and exceedance events.

The paper describes the approach I have adopted on a number of sewer and stormwater projects as a consultant working with a UK water company, the difficult decisions made and the managed outcomes achieved.

KEYWORDS

Flooding, infrastructure, difficult decisions, managed outcomes.

1 INTRODUCTION

The UK, like many countries worldwide, experiences extreme weather patterns which eventuates in significant pressure on existing river, wastewater and stormwater infrastructure. Fluvial and pluvial flooding are not new problems, however increasing populations or population densities inevitably result in greater loadings placed on existing catchments and infrastructure.

Following severe flooding in the UK in 2007, the government commissioned the Pitt Review which resulted in 92 specific recommendations. A number of businesses, agencies and authorities implemented various strategies to incorporate the recommendations. However, during the winters of 2012 and 2013 extreme weather resulted in further flooding. Each flooding event was followed by significant public outcry with demands to identify the causes of flooding and implementation of changes to reduce the risk of future catastrophe. However it appears that the wider public, who may not have been directly affected by flooding, quickly lose focus on the issue over time as media coverage subsides and political pressure abates. This fluctuation of focus coupled with the financial implication of intervention results in a repeated pattern over many years. Unchecked, this cycle will continue into the future.

Regulation in the UK water industry is a key driver to reducing the risk of flooding. Properties prone to flooding are included on flood risk registers and water companies investigate, design and implement infrastructure improvements to reduce the risk of future flooding at these properties. This reduction in flood risk is specifically identified in UK water company business plans, the performance against which is closely monitored. Similarly the local authorities and environment agency maintain flood risk registers and implement strategies to reduce the risk of stormwater flooding.

Although reports of flooding are received and recorded on flood risk registers by water companies, local authorities and the environment agency, there is an expectation (through regulation and/or government policy) that flooding risk will be reduced over time due to intervention. Whilst working with a UK water company over a five year period, the strategy was evolving to where we were designing to 30-year protection for external flooding and 50-year protection for internally flooding properties. This evolution of infrastructure requirements means that existing infrastructure is being relied upon to perform at a level which it may not have been designed to accommodate.

Flooding alleviation schemes are generally assessed against multiple criteria, however a key consideration is financial viability. Whilst we may possess the technical ability to reduce the risk of flooding, the reality is that a scheme must be affordable and commensurate with area affected.

Whilst elevated flood risk in discrete areas may be reduced through localized infrastructure repairs or improvements, consideration should be given to the effect on the downstream catchment. If there are no adverse effects downstream, it may be completely acceptable to implement conventional improvements. However, flooding of larger or multiple areas within a complex catchment are likely to require a much more holistic approach and a similarly strategic solution.

Once the extent of flooding and the number of properties affected has been identified, it is essential to understand the mechanism of flooding. With the mechanism of flooding documented and understood we can consider the options available to reduce the risk of occurrence.

Many engineers focus on passing flows forward to address capacity constraints, relying on existing downstream infrastructure and infrastructure upgrades. However, there are usually alternatives which either address the root cause of the flooding problem or balance the requirement for storage with passing flows downstream. Whilst we could design infrastructure to accommodate flows resulting from severe or extreme storm events, it is unlikely to be sustainable and could result in significantly larger capital schemes with potentially high operational costs. In reality it is not viable to size infrastructure in this way and inevitably there would be a pinch point, maintenance issue or an even more extreme event that may exceed design parameters.

Constructing infrastructure in rural or remote areas has its own challenges, however, applying a conventional approach to infrastructure upsizing can be extremely challenging and expensive. In some instances, implementation of strategic infrastructure upsizing schemes such as those in busy, narrow urban streets or near culturally sensitive, historic places may not be financial viable. Similarly mitigation options may not sufficiently reduce the risk of flooding.

2 MANAGED OUTCOMES

2.1 THE CONCEPT

'Managed Outcomes' is a theory which a number of Engineers and Asset Managers have successfully applied to develop options which reduce the risk of flooding to areas or properties that would otherwise not be financially viable to implement. Flooding risk is not fully resolved, but instead its location and frequency of occurrence is transferred, or controlled, in order to reduce the extent of infrastructure upgrades. The theory of Managed Outcomes also considers the implications of exceedance events.

2.2 DIFFICULT DECISIONS

In order to better understand the managed outcomes concept we first need to ask a difficult question:

Where is it acceptable to flood?

The answer to this question will vary depending upon the type and location of flooding, and the stakeholder on the receiving end of the question.

The question is best put into a familiar context. If you were able to reduce the risk of flooding in an urban, culturally sensitive or environmentally sensitive area by transferring the risk to other areas, where and under what conditions is it acceptable to flood? Those property owners directly affected by the flooding would almost certainly argue that anywhere other than their land would be suitable. However, others would also argue that they don't want their property to be affected. Similarly, environmentally and culturally sensitive areas and habitats require preservation. Usually areas can be found within the urban environment that could be used for infrequent short term flooding. Potential areas could include, but are not limited to, green open space, playing fields, sport pitches and community land.

Providing areas for controlled flooding within a catchment may enable a reduced scope of infrastructure requirements in constrained or sensitive areas. This approach can utilize the existing network constraints, in conjunction with flow control devices, to attenuate flows. If an area is prone to stormwater flooding, multiple sites across the catchment could be developed to provide storm storage which will reduce the reliance and size of a single attenuation area. These storm storage areas do not necessarily need to be formal basins, but instead can offer flexibility to retain their existing use with a secondary function to provide stormwater attenuation and have reduced consequence of flooding.

Flooding of wastewater networks are likely to generate more difficult discussions, but reaching a decision is not insurmountable. In this instance playing fields or sports fields are unlikely to be an acceptable option. However, flooding a green open space will have a much lower consequence than flooding multiple private properties.

Existing infrastructure constraints, whilst useful to develop a desired outcome, may not always provide sufficient flow control. There are many proprietary flow control products suitable for wastewater and stormwater catchments and which provide greater control than a conventional orifice plate or culvert. It is often necessary to utilize these products to achieve an optimized solution and the desired managed outcome. Some products include self-clearing blockage protection and use innovative designs to provide a consistent and constant pass forward flow regardless of upstream head.

In order to apply the managed outcomes principle it is imperative to engage with all stakeholders to ask the difficult questions and collectively make the difficult decisions regarding flooding, whilst ensuring the environment and culturally sensitive areas are also protected.

2.3 APPLYING THE CONCEPT – CASE STUDIES

The following schemes are examples of where I have successfully applied the managed outcomes approach to deliver financially viable schemes with reduced infrastructure requirements.

2.3.1 STORMWATER CATCHMENT AND PARTIALLY SEPARATE SEWER NETWORK

A large area of residential properties and part of an industrial area in Weymouth, UK were regularly experiencing internal and external flooding due to capacity constraints in both stormwater and sewer networks. The roads in the vicinity were very busy and localized infrastructure upgrades to address capacity concerns were not viable. As part of my investigations an area of roof and hardstanding were identified to discharge to the wastewater sewer. There were no areas suitable for on-site disposal of stormwater and ground conditions were not conducive to soakage, so discharge to the existing stormwater network was the most viable alternative. The stormwater network discharged to a culverted watercourse, laid under industrial buildings and a residential garage block, which already had capacity constraints causing severe flooding. I designed a scheme to separate the impermeable area from the wastewater sewer network and discharge it to the stormwater catchment, applying the managed outcomes principles. Rather than flooding properties, I identified an adjacent area of land, within a College, which was suitable for attenuation of stormwater when network capacity was exceeded. Following discussions with the College, an area along the southern boundary of the cricket pitch was deemed acceptable to utilize. The ground level from the boundary of a cricket pitch was re-graded within the design to provide attenuation but with no loss of usable area. A new outfall and overflow configuration was proposed with flow control devises installed in the stormwater network to ensure controlled flooding occurred within the area identified rather than the adjacent property. In addition to the Managed Outcomes stormwater option, I also designed wastewater gravity return storage (with managed outcomes principles applied) at multiple points in the upstream catchment, to attenuate upstream flows. I also worked with a developer to oversize a proposed pumping station, within a 900 property development site, and created a new wastewater catchment by diverting flows from the existing catchment. The new pumping station was designed to convey flows to the head of a tunnel, discharging directly to the wastewater treatment works, reducing surcharge, overflow operation and flooding in the downstream network. The existing pumping station pass forward flow was reduced by the equivalent flow of the new pumping station, to mitigate potential detriment at the wastewater treatment works. The Managed Outcomes principles, in conjunction with collaboration with a developer, enabled a financially viable scheme to be designed with limited impact on busy roads, residential property, a college, industrial areas and a tourist park with accommodation for 6,000 people.

2.3.2 STORMWATER CATCHMENT

A number of properties and areas in Bournemouth, UK were affected by external stormwater flooding due capacity constraints in a stormwater sewer network. Increasing pass forward flows within the network would have created downstream flooding and was not perceived to be financially viable. Therefore a short length of sewer was upsized to convey flows to a suitable attenuation area adjacent to a playground. Off-line gravity return storage was constructed adjacent to the playground and was sized to provide 20-year protection. A planted bund was installed along property boundaries and along the downstream perimeter of the playground. During exceedance events, when stakeholders agreed the playground would be empty, water would pond within the bunded area rather than flooding private property. Once the storm had abated, stormwater drained via sumps to the stormwater network. Agreeing the option took significant stakeholder engagement but delivered the desired managed outcomes for all parties.

2.3.3 PARTIALLY SEPARATE SEWER NETWORK

Approximately six properties in Poole UK, at a low point in a partially separate sewer network, were experiencing internal and external sewer flooding due to hydraulic inadequacy in the downstream network. Upon investigation it became clear that the network was at the limit of its capacity and required a strategic solution to address flooding. Existing infrastructure could not easily be upsized due to the busy nature of roads, congested nature of existing services and detrimental effects on trees protected by Tree Preservation Orders. Instead I developed a managed outcomes solution to divert part of the catchment and provide a bifurcation, outside the properties affected, into an on-line storage facility with downstream flow control. The large diameter on-line attenuation (with low flow channel and non-slip benching) used a product new to the client and was laid through local authority and community land within an existing easement, before discharging downstream of the hydraulic restrictions. Pass forward flow was managed using a flow control device to ensure no detriment to the performance of the downstream network. The scheme reduced the risk of internal flooding to residential properties to better than 50-year protection (from 2-year). The attenuation was sized to provide storage for the critical duration 20-year storm event, with controlled flooding of a green open space occurring during exceedance events rather than internal flooding to multiple properties. Telemetry was installed to identify when the attenuation was at capacity, so that operational staff could monitor and ensure clean-up following exceedance events.

2.3.4 COMBINED SEWER NETWORK

An area of land adjacent to a river in Gillingham, UK was developed from a factory into 90 residential dwellings. The land was at a low point in the sewer network and within the flood plain. Flooding from four manholes and loss of service at two properties was reported during 5-year storm events. Flood water would pond in both the road and on private land before draining via the stormwater network to the adjacent river, without treatment. The combined sewer catchment, to which the partially separate sewer system within the development discharged via gravity, was at the limit of its capacity and due to the elevation of the development (with cover levels 2m below the downstream pumping station cover level) flooding occurred during network surcharge. I identified that the downstream pumping station was not performing as designed and required refurbishment, however this in itself was not sufficient to address flooding. Conventional flooding alleviation options were not financially viable when considering the properties affected and the scale of works that would have been required. I designed a scheme to isolate the development from the existing catchment when the network surcharged and provided a small waste water pumping station to discharge flows to the adjacent combined sewer network. The pumping station was designed with telemetry control and provision for 12hrs storage within the network to allow flows to be stored during storm events. Isolating the low point in the network enabled greater network surcharge, which enabled flows in excess of the downstream pumping station capacity to be conveyed and discharged to the adjacent river in accordance with the discharge consent. The design resulted in minor flooding detriment predicted at one manhole within an overgrown area outside the boundary of the development and adjacent to the river. Flooding from this manhole was predicted during exceedance events, however flows would be very dilute and would pond before draining via a sump connected to the combined sewer.

3 CONCLUSIONS

The Managed Outcomes concept can be successfully applied to most flooding schemes and, in conjunction with good engineering design, can provide effective options with reduced infrastructure requirements.

In order to apply the Managed Outcomes principle it is imperative to engage with all stakeholders to ask the difficult questions and collectively make the difficult decisions regard flooding, whilst ensuring the environment and culturally sensitive areas are also protected.

REFERENCES

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