PERFORMANCE INDICATORS FOR URBAN DRAINAGE

Wastewater Modelling and the Future for Performance Indicators

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Abstract

The current practice of setting wastewater performance indicators is principally based on records of actual events and historical data sets. However, as performance standards are progressively increased, the ability to predict infrequent and extreme events with confidence becomes more important. This paper examines current and possible future regulatory practice and argues that well-constructed, accurate models used within the correct context, have much to offer the environmental and financial regulators of urban drainage systems in the future.

1. Current Practice

Under the current regulatory system, the performance of the individual English and Welsh water and sewerage companies is reviewed against eight levels of service (or performance) indicators. The results are published by the financial regulator (Ofwat) in a levels of service report. This information is used by Ofwat to determine good, acceptable or poor performance by the companies, and is reflected in price determinations.

For the wastewater function, performance indicators include:

- *Flooding from sewers*
  - The number of properties at risk of internal flooding from sewers due to hydraulic overloading more than twice in ten years and more than once in ten years.
  - Properties which are internally flooded. Sewer flooding can be caused by temporary problems, such as blockages or sewer collapses, or because of hydraulic overloading.

- *Environmental Impact*
  - Sewage treatment works in breach of consent
  - Unsatisfactory sea outfalls
  - Unsatisfactory combined sewer overflows / intermittent discharges
  - Successful prosecutions
  - Pollution incidents
  - Non-compliant bathing waters.

Collapses and the structural condition of sewers are also monitored. Strictly these are not considered to be a 'level of service' unless they result in flooding, but they are used to assess the necessary level of capital maintenance investment to deliver static asset deterioration.

It is clear from the above that most of the current performance indicators evolve from historic performance. Therefore they are backward-looking and depend not only upon the system having failed, but also upon that failure having been detected and reported, and upon the accuracy of the reports.

Inevitably, such a system has a number of shortcomings. Specifically, the system is not ideal for monitoring stringent, frequency-based performance standards with a high return period. Currently, the understanding of the level of service provided to properties which flood less than once in ten years is limited. However, current design standards are typically based upon 1 in 30+ year events. Furthermore, the system depends on complete and accurate reporting. Experience suggests that in practice neither of these requirements is met. Under-reporting and inaccurate reporting of flooding events relating to properties are common. Under-reporting stems from residents' concerns regarding potential diminishing property values, apathy, and possibly disenchantment with the reporting process. Inaccurate reporting commonly occurs through a lack of understanding of the true cause of flooding, be it from foul sewer, surface water sewer, highway drain or land drainage flows.

A further shortcoming of backward-looking performance indicators relates to the impact of social and environmental change. The effects of change (of which climate change is a prime and topical example) are not accounted for in advance. Even if the change is predictable, no investment driver exists until failure has occurred several times.

2. Future Regulatory Trends

Ofwat's stated intentions with regard to regulation in the future were published in its Forward Programme document in April 2000. The salient points are summarised below.

- *Ofwat will monitor companies' outputs and report on their investment using Annual Returns, Regulatory Accounts and specified reports from the quality regulators (i.e. the Environment Agency for wastewater).*
- *Ofwat will exercise firm and fair regulation in order to protect customers.*
- *Ofwat will work with the quality regulator to ensure that the quality and environmental outputs specified in the final determination are delivered. Failure to deliver will result in regulatory action, and failure in legal requirements will result in prosecution or enforcement proceedings.*
- *Ofwat will monitor and report on levels of service, and where standards are poor will seek corrective action, using boardroom pay as a lever. Ofwat will work with companies and Customer Service Committees to establish ways of assessing qualitative aspects of service and, more generally, where practical to ensure that levels of service indicators continue to reflect customers' interests.*
- *Ofwat will reach judgements on appropriate levels of capital maintenance. Ofwat takes the view that stable serviceability is the target and would wish to see lower levels of capital maintenance activity if serviceability was improving.*

The possibility of linking CSO consents to the operational practices used to maintain sewer systems has also been considered as a future improvement; the hypothesis being that it may prove to be possible to improve the quality of watercourses by being more proactive over the conditions in the sewer system upstream of CSOs.

3. Role and Application of Modelling in Regulation

Considering the stated aims of Ofwat listed above, it is believed that modelling provides an ideal means of *'assessing qualitative aspects of service'* where field data and reports may be scarce. Also, models have a crucial role to play in assessing the impact of altering '*levels of service … to reflect customers interests*'.

If the objectives of Ofwat are to be addressed, the role of modelling in the future of regulation must be recognised. A recent report concluded that the best opportunities for making savings in the future lay in changes in operation and management rather than in lower cost new technologies (Babtie, 1998). However, the water industry's traditional approach to sewerage modelling has been to view a model as a means to an end; a necessary step in the development of a capital scheme, eventually leading to network improvements. Unlike the clean water function, waste water network modelling has rarely been viewed as offering an operational tool which, with correct use, might provide the user with the means to manage the network in a far more proactive manner than at present. Advances in modelling technology give this aspiration the opportunity to become reality. The report noted that models will be increasingly important, but at present decisions are based too much on short-term cost benefit analysis and not on long-term strategy. Referring primarily to the design of capital improvements for sewage treatment plants, but drawing conclusions that are equally valid for the improvement and operation of the collection system, it was stated that accuracy of design data was a key area to release potential economies. It was concluded that savings could be made in capital works by more careful collection and collation of design data, and it is believed that the same applies to the continual use and updating of sewerage models.

Some of the reasons why models should play an increasingly important role in the future of regulation are summarised below:

- Models can give complete information about the performance of systems – under-reporting can be eliminated and all at-risk areas identified. This can be achieved by running series of recent actual rainfall through models and monitoring the results.
- Models can be used to look into the future to predict levels of service way beyond those for which good historic data is available. The model can be used to assess the risk of failure in high return period events.
- Models can take account of changes in the catchment, such as development or changes to the system allowing the user to predict problems before they occur, instead of only responding to problems that have already occurred several times.
- Models can be used to predict the effect of changing climate, before the changes happen.

- Models can be used to identify interactions between systems under the control of different undertakers (*e.g.* sewer systems, highway drainage systems, culverted watercourses), so that responsibility is clearly identified and costs can be correctly attributed.
- Models can be used as tool to demonstrate the effects of different levels of investment reflect differing levels of willingness to pay.
- Models can be used to achieve an optimum balance between capital and operational expenditure and to reduce flooding from 'other causes'.

If developed, the above would see a sewer system model forming a central plank of the management system. Continually updated, the model would be run regularly with recent local rainfall so that the performance of the system could be continually monitored and the in-sewer processes such as deposition and erosion of sediment updated. The system's performance could also be projected into the future by using suitable rainfall data, and the results could be used to plan operational strategy. Indeed, from a regulatory standpoint, if the model predicts flooding, or that CSOs fail to meet their required standards, this could count as a failure even if it had not been observed in reality. However, it is accepted that it would be difficult for undertakers to accept a failure which has not actually occurred and to invest substantial sums of money into a predicted, as opposed to actual, phenomenon.

For capital projects already undertaken, an increase in the use of post-project appraisal (PPA) would provide more confidence that the improvements implemented do in fact deliver the intended benefits, and a natural spin-off from PPA is improvements in model updates and maintenance. However, effective implementation of PPA has been lacking in the UK water industry, although a recent UKWIR project has addressed this very issue (Blanksby, 2001).

4. Modelling Technology

Deterministic model platforms have developed enormously over recent years. However, it would be wrong to give the impression that the current model platforms and the current model inventory are entirely suitable to meet all these future challenges. The models themselves will, in many cases, need to be built to a higher standard than is currently typical, and this will carry a cost implication for clients and users. Specific areas for improvement include.

- <u>*Integration*</u>
  Greater integration of models is needed. At present, it is common for different model platforms to be used to represent the various parts of the urban drainage system (one model for sewers, one for treatment processes, one for rivers). One integrated system that represents all the processes would be a significant step forward, providing the user with a more complete understanding of the wastewater cycle. Integrated models would enable the interaction between catchment, collection systems, treatment plants and receiving waters to be understood better. That increased degree of knowledge would then give rise to the implementation of more

sophisticated control systems that will achieve higher performance at less cost.

- *Confidence*
  There is a need for much greater confidence that the model will give reliable predictions over a wide range of conditions than is currently the case. It will be important to have models in which a high degree of confidence can be placed, even when they are operating well beyond the envelope for which they were validated at the time they were built. A combination of careful attention to detail and ongoing improvement based on long-term monitoring will be required.

- *Processes*
  Currently, the hydraulic aspects of sewer performance are much better represented than in-sewer processes such as sediment deposition, erosion and water quality changes. In the future, physical and bio-chemical in-sewer processes will be an increasingly important aspect of model capability. This will be particularly true should CSO spill quality become as significant as quantity in consenting terms. Furthermore, sustainable urban drainage features such as infiltration will have to become an integral part of catchment models.

- *Complexity*
  To adequately represent some parts of some systems it may be necessary to increase model complexity, perhaps using CFD. Models that replicate more of the processes of run-off, entry and flow will be required, again so that greater confidence in the results can be achieved. Models which combine the above ground and below ground phases and the points of connection between them will be required. In the future it is likely that models will have to include systems which are not the responsibility of the sewerage undertaker (such as highways and watercourses) but which do influence the performance of the system as a whole.

5. Where next?

Whilst the above thoughts may be of some interest, they are of no consequence if the water industry and its regulators do not recognise the potential value of models.

As level of service targets become more demanding, so purely historic event records will no longer be adequate. More detailed models covering all aspects of the wastewater system will be an essential tool in reliably projecting performance into the future. However, to achieve this, the ability of our models to predict the performance of the system under extreme conditions must be improved, and current model build specifications must be refined.

In parallel with the improvements in modelling, there will be a need to increase confidence in the rainfall data being used to test the performance of the system. The importance of climate change has been discussed at previous WaPUG meetings and it is generally accepted that reliance on historic data will no longer be sufficient.

A comparison with the role of the Met Office is interesting. Millions of pounds is spent on climate modelling and we are presented with the results many times each day. Yet how important is it really for most of us, compared with the consequences of not operating our sewerage systems optimally? For those of us who live in urban areas, an adequate sewerage system is fundamental to our quality of life. Proper forecasting of wastewater networks would give us the chance to actually influence the future of the system. We could continually run historic data to refine the present position and then use that 'current model' to project into the future. In this way we could produce almost-live predictions of the short-term consequences of current weather, and we could actively modify future performance.

If greater reliance is to be placed upon models, then there will also be a need for an increased degree of model auditing.

6. Conclusions

Modelling of wastewater systems promises much - both for the regulator and the regulated. It will require imagination and investment to deliver this promise; a step-change away from current preconceptions about the place of modelling in the water industry. Modelling platforms must be developed so that the operation of systems can be better represented. This will allow both the industry regulators and practitioners to use models as a predictive tool, and refine the traditional approach of backward looking performance indicators.

In the future, as the Regulator demands higher performance (via tighter performance indicators) and lower prices, models will be the tools that operators will turn to in the search for innovative solutions. The goal must be to develop a unity of model and prototype which is beyond reproach and which will allow intelligent and creative management of wastewater systems to be confidently planned. The standards to which models are built and the ways in which they are used and maintained must be appropriate to their increasing complexity and 'mission critical' role.

The ideas and opinions expressed in this paper are those of the author and do not necessarily represent those of WS Atkins or its clients.

References

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