Sewer Asset Management Through Long Term CSO Monitoring
WaPUG Spring conference, Coventry 2005

Jim Grandison (Associate Director)
IETG Ltd, Cross Green Way, Leeds, LS9 0SE

A: Introduction

This paper describes the monitoring of high-risk CSOs by Yorkshire Water Services (YWS), a program that was commissioned between January and December 2004. It looks at the reasons for investing in long-term data monitoring, the system identified to provide the service and also presents, along with some of the initial findings, the benefits of the system for long-term asset performance management.

B: The Need to Monitor CSOs

Much has been written about the desirability of monitoring sewerage networks in general, and CSOs in particular. To date any long term monitoring has been piecemeal, tending to be focussed on specific problem areas. Much of the monitoring that has occurred has been temporary, perhaps as part of a modelling exercise or specific monitoring programs (UPM, Bathing water monitoring etc.) or as part of PPA programs (Ref: Various WaPUG papers). Longer term ongoing monitoring has tended to focus purely on alarms and has tended to be only at sites with power and hard-wired traditional telemetry on-site. This has been due to a combination of the cost of installing these traditional data solutions, particularly at isolated or remote sites where the commissioning costs have been prohibitive and the lack of any genuine business drivers.

This ad-hoc approach has not allowed Water Service Companies (WSC) to identify an overall assessment of the performance of the CSO assets both in terms of their genuine operation, or to assess how their performance through time might be altered.

In AMP3 the wide scale application of screening technology as a solution to the problem of aesthetically unsatisfactory CSOs (UCSOs) has significantly changed the risk profile on CSOs for many WSC's. Solutions are now dynamic in many instances and there is almost certainly a need to monitor the effect of these mechanical assets on the performance of the sewerage network as a whole.

In 2001 Andrew Smith (Dwr Cymru Client Manager) and Dr Robert Andoh (Hydro International Technical Director) identified the benefits of monitoring two particular CSOs at WaPUG's Spring conference (Operation and Maintenance of the Hydro-Jet Screen at 6 sites in South Wales).

Historically many WSC's have resisted the demand to monitor CSOs and whilst this has always remained an aspiration of the EA the realisation has been dogged by technical difficulties.

C: YWS Specific Issues

Like many WSC's YWS have a significant asset base of CSOs. AMP3 resolved around 750 of UCSOs and AMP4 will target the remaining UCSOs. During AMP3 YWS identified the need to monitor CSOs in order to minimise and control the risk of dry weather operation. Assessment of records showing where breach of consent had occurred historically identified a particular issue with remote CSOs where there was a high possibility of blockages occurring. The remote nature of these CSOs and the fact that they would often discharge to small watercourses meant that traditional telemetry solutions were prohibitively expensive largely due to the cost of providing power and telecommunications at each site. YWS wanted alarms to be generated from these high risk CSOs to allow Operations & Maintenance to react in a prompt manner to any dwf spills that might occur. The minimum data requirement was to generate 3 alarms, a high level alarm, a spill alarm, and a return to normal alarm.

Technological developments have now allowed YWS to monitor these remote sites at a reasonable cost and 12 sites were selected for a pilot project early in 2004. Selection was designed to cover the whole region and address a variety of hydraulic conditions, types of CSO and locations with respect to telemetry. The technology operated well and following a modification of the hardware communications protocols allowing direct interface with YWS Logica Telemetry system, YWS decided to roll-out a monitoring network to its top 380 CSOs based on risk of causing a dwf spill due to blockage or other operational problem.

Historically the 380 CSOs would cause around 80 'complaints' per year either from the public or EA due to dry weather operation. Poor CSO performance exposes the WSC to the risk of:

- Fines in 2003 for breach of consent causing pollution over £10,000

Water Company	Incidents	Fines
Southern	10	£73,200
Thames	5	£60,000
Anglian	3	£47,500
United Utilities	8	£46,500
South West	10	£41,000
Northumbrian	6	£25,500
Welsh	5	£12,750
Wessex	3	£15,000

- Reduced Ofwat scores/ranking
  - In 2009 Ofwat will move to a zero based application of the grading assessment to capital maintenance (CM), possibly applying it across the entire investment
  - One of the WSC's has decided that the lack of sewerage asset data in PR04 meant that their capital maintenance submission

for sewerage was considered not to have met the requirements for the Capital Maintenance Common Framework (CMPCF)

- Bad publicity
    - Sewage entering a beck caused many fish deaths. The case concerned the discharge of untreated sewage from a CSO resulting in a Category One incident. Around 2,000 fish were killed which resulted in restocking costs of more than £10,000. In addition to restocking costs the Water Company also had to deploy aerators to increase oxygen levels in the water, plus fines and court fines in excess of £4,000.
    - The EA reports that the water industry is responsible for more than one in six of the 1,468 sewer pollution incidents reported in 2002

- Reduced level of service
    - Blocked CSOs not only spill to the environment but also cause back up in the system with resultant loss of capacity and follow on problems such as silting, flooding etc.

In addition to these problems the poor performance of CSOs in these circumstances can also lead to increase in the WSC cost base:

- Increased OPEX to remove blockages/silting
- Increased OPEX from 'clean up' of water course
- Write-down of CAPITAL values due to screen, plant and equipment damage
    - Prolonged operation of the screens can cause problems with excessive use of powered screens, trip outs, or, if they become hydraulically overloaded or blinded, warping of the screen

C: Solution

The solution selected by YWS was a combination of the traditional with the new.

At sites with power or existing telemetry a traditional solution consisting of an ultrasonic level sensor wired into the RTS outstation via an intrinsically safe barrier was deployed. These sites were then set up on RTS as normal telemetry being 'polled' on a frequent basis to provide a status report.

At other sites the HawkEye CSO Monitoring system was selected. This system provides a fully Hazardous Area approved (ATEX) solution and combines level sensor, data logger, GSM modem and power supply in one unit. HawkEye can be totally installed with the hazardous area, thus reducing the cost of the infrastructure required for more traditional telemetry solutions. HawkEye is capable of operating at 5-minute data logging intervals for 12months depending on frequency of alarm call outs. Rather than operating on a polling basis, these units send in their data during check-in periods and send alarms and current values to YWS RTS.

The decision to rollout to the full 380 sites was made in June 2004 and a target date of 31st December was identified as critical for completion. Delivery of the first units was on 1st September 2004 so the program required almost 100 sites per month to be commissioned over the entire YWS region. The aggressive rollout did not permit time for a pre-site work survey to be undertaken and CSOs were taken from the register. As a result there were some problems in meeting the program identified due to the number and variety of problems encountered on site. Phase 3 implementation has recognised the shortcomings of this approach and a pre-survey has been planned to overcome these problems and limit abortive costs.

Typical problems encountered during the roll-out included:

- CSOs not available due to ongoing AMP3 construction
- CSOs identified on register no longer exist
- CSOs unsuitable for monitoring (Leaping weir!)
- CSO access buried or unsafe
- Property and landowner issues

A number of these problems were insurmountable and, where this was the case, CSOs from lower down the risk register were brought forward. At other sites the problems encountered required either a delay for access or for minor civil works to take place to make the site safe and these were deferred until the end of the rollout. The Phase 2 installations were 98% completed by the deadline date with all residual sites either removed from the register or finally installed by April.

To accomplish such a significant program in such a short time a core team was put together consisting of the following

- Yorkshire Water
  - Pollution Team (Client)
  - Telemetry (support and commission on end system)
  - IT (support on telecoms)
  - Operations (access/plant isolation)
  - Call centre –out of hours alarms

- Drains Aid
  - YWS R&M contractor (small works and response to alarms)

- ETM
  - Safety supervisor CDM and RASWA
  - Planning supervisor (notices/access)

- IETG
  - Provision of equipment
  - Installation of equipment and end-to-end testing
  - Ongoing maintenance
  - Data analysis

D: Results and Benefits

Following the successful trial in Phase 1 the implementation of Phase 2 has been a major success. In the six months since commissioning the majority of sites complaint frequency has reduced to 4 per year. (2 complaints in 6months) This represents an improvement of 95%.

In addition to this headline benefit a great deal of other benefits have been generated. YWS is now starting to accrue knowledge on how its systems really operate and this will undoubtedly inform decisions on future investment and expenditure.

There has been an overall reduction in the number of dwf spills as indicated by the data above. In addition the dwf spills that do occur are identified at an earlier stage making the corresponding remedial action to be actioned at lower cost, be it jetting/blockage removal at one extreme or general river clean up at the other.

Assessment of the data has also allowed some of the causes of dwf spill at frequent offending sites to be identified and rectified on a permanent basis where this was appropriate or affordable, or management strategies applied to ensure that the risk is adequately controlled.

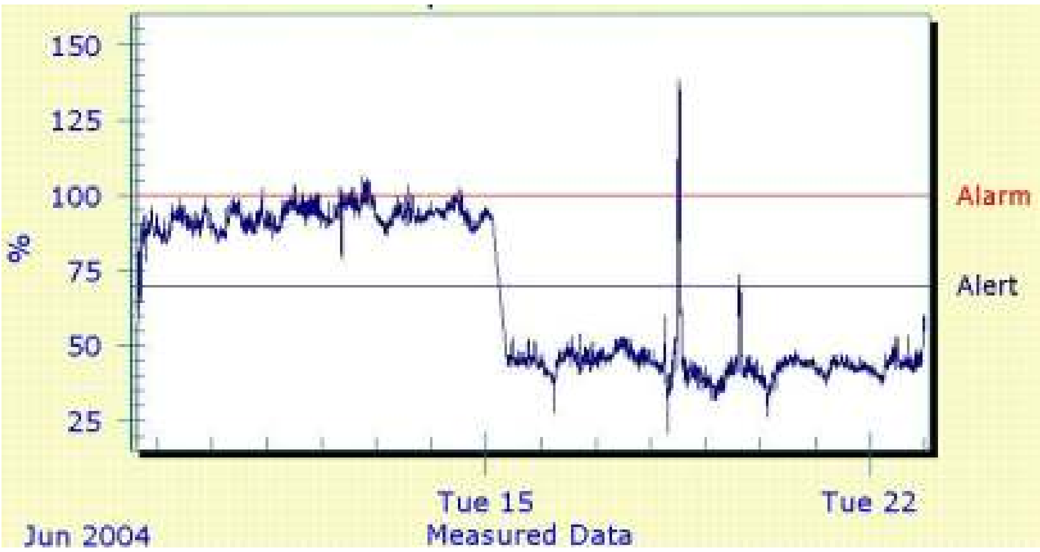
One slight downside is that, in making YWS aware of problems that occur which might not have previously come to attention. For instance temporary blockages that subsequently clear themselves there is now the possibility of more frequent site visits to solve a problem that didn't previously 'register' as existing.

Certainly at the sites monitored YWS are able to act more proactively with the attendant benefits to their customers and the environment.

The following examples illustrate the power of the data being collected and demonstrate some of the early wins for YWS

Case study 1: Frequent blockage with long-term problems

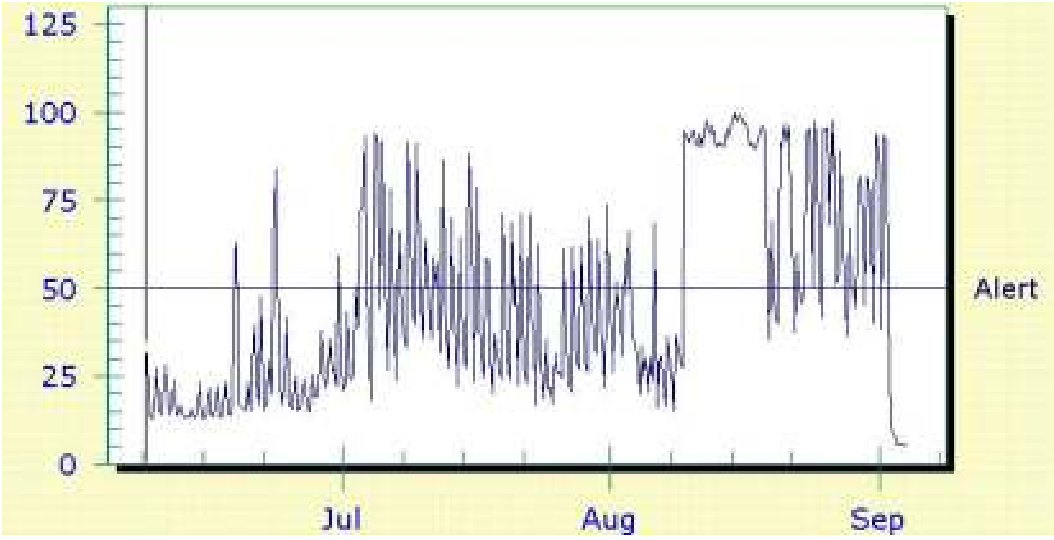
Early on in the program this CSO was identified as a problem. Due to the partial nature of the blockage dwf spills only operated during peak flows. Operations, despite the alarm call out, could not identify a spill despite the back up of the system. Full investigation showed standing water in the chamber plus the fact that the screen was 100% blinded. The system had suffered a total failure.



Case study 2: Gradual blockage due to silt build up

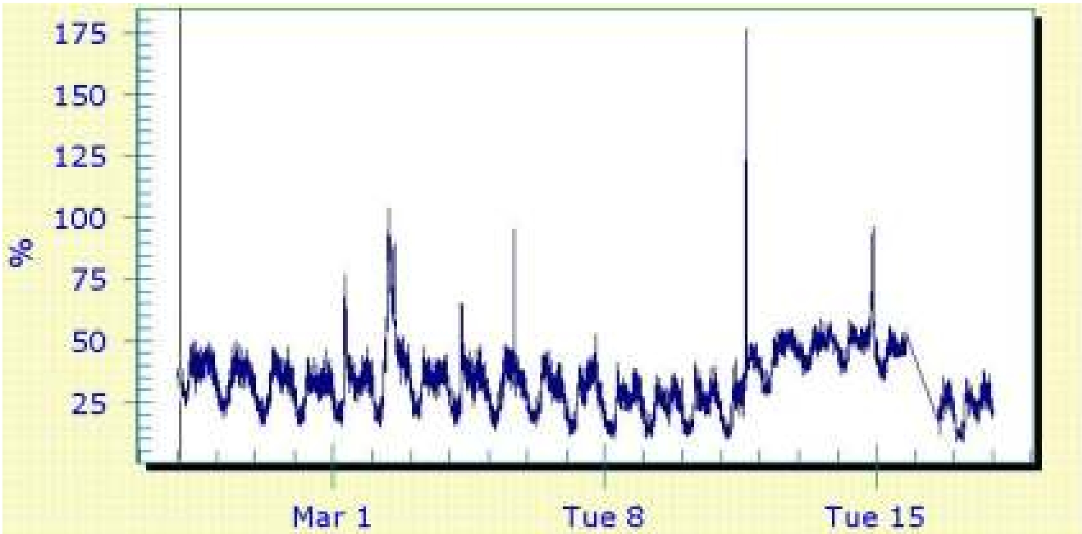
This example shows the benefits moving forward of addressing trend data and example3 shows how this lesson has been learned to the benefit of YWS. Overtime the silt builds up in the system until a critical point is achieved. After this point the build up of silt and debris accelerates until a complete blockage occurs and dwf operation follows.

The solution here was to bring in external specialist cleaning contractors to remove the 18 tons of silt from the chamber. Having identified the problem data trends at this site can now be followed to identify a point at which more cost effective cleaning can control the problem.



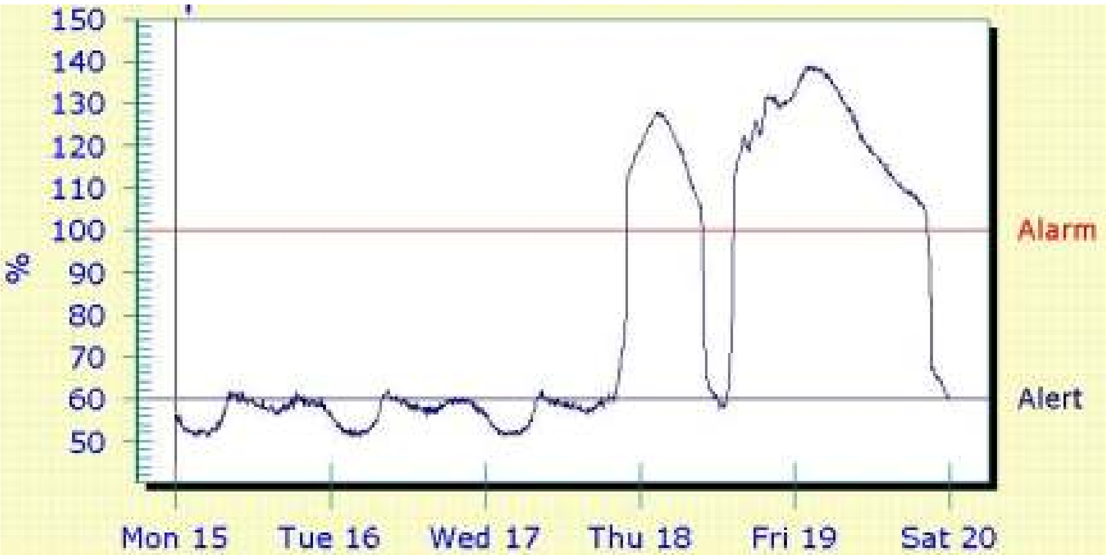
Case study 3: Root blockage

Root intrusion to the sewer caused a gradual build up of debris in the throttle pipe. This was identified at an early stage whilst the throttle retained the ability to pass flow forward and contractors deployed. This site never did spill in dwf and demonstrated the value of looking at all data not just the alarms.



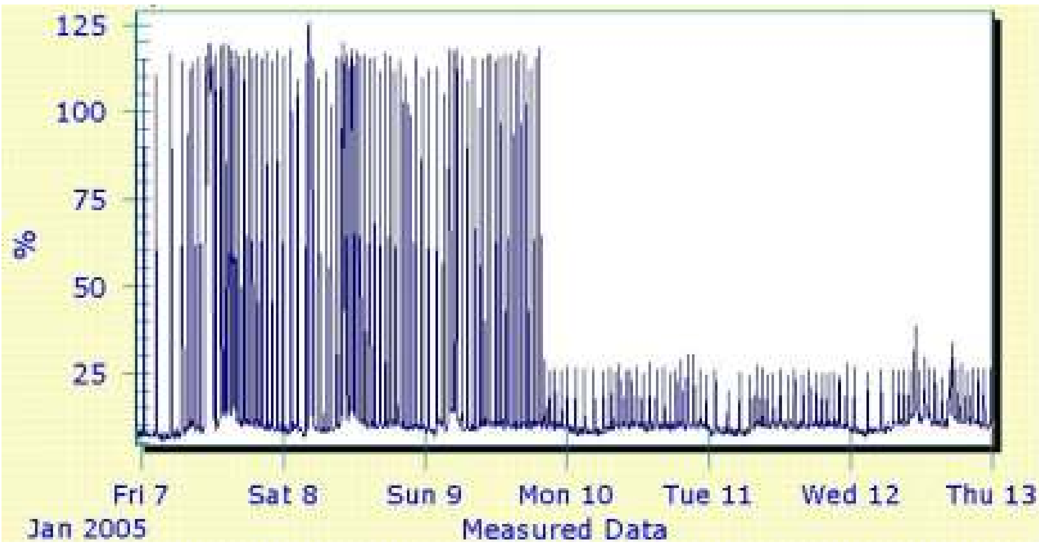
Case study 4: River intrusion

Alarms from the system showing levels above spill were reacted upon by Operations who reported that the CSO was not spilling and there was no blockage. A visit coincident with the spill alarm identified a fault with the none-return valve allowing flow from the river under high stage conditions to flow back into the system, over the weir and into the sewer. YWS were subsequently able to attribute high pump utilisation and power consumption than historically normal at the downstream pumping station to the problem.



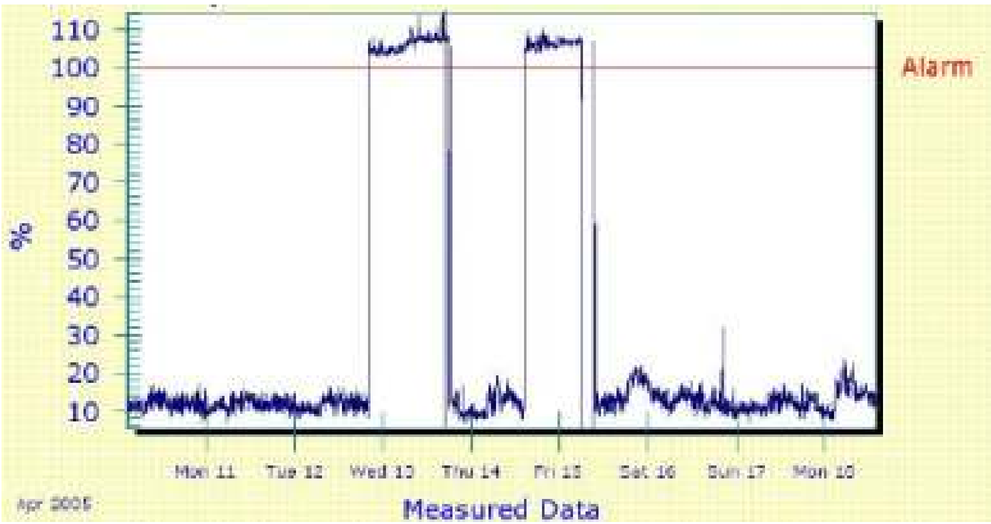
Case study 5: Incorrect pump/weir setting

This site was spilling very frequently for very short periods of time every day (at 20-minute intervals). The data clearly indicates the operation of an upstream pumping station. The change in data pattern occurred after minor civil works took place in the chamber – raising the weir height by a small amount. This modification, combined with a change in the pump settings and frequency of operation upstream provided a simple low cost remedy to the pollution problem.



Case study 6: Transient blockages

This example shows a site where there has been a series of transient dwf incidents due to the nature and frequency of temporary blockages. These blockages self clear after a period without intervention. The ability to track problem sites such as this is a useful facility as without remote monitoring and alarm systems these blockages, which may not be picked up by ad-hoc inspections or complaints, could worsen and cause serious pollution.



E: The Future

Following the success of Phases 1 and 2 YWS have now moved to Phase 3. This will see over 200 additional CSOs monitored using HawkEye, plus other sites using the traditional solution. Phase 3 will take the form of an extended trial, as it will involve the monitoring of all CSOs within Yorkshire Water's west region, regardless of their risk. This will allow YWS to assess the performance of its entire CSO asset base and identify any hidden operational issues. If this is successful a region-wide rollout may follow.

In addition to the extended geographical roll out technical developments are being put on trial. These include improved alarm minimisation to make the whole system smarter and artificially intelligent, allowing the system to 'learn' from the data patterns and allow improved performance via the opportunity to intervene earlier.

As more performance data is gathered it is expected that YWS will be able to use this information to benchmark the performance of different combinations of CSO/tanks and screens allowing them to assess the whole life asset performance for future investment decisions.

Finally, the systems in place are undoubtedly transferable to other collection system problems outside the CSO arena. For example the technology could easily be adapted to provide data and advance warning of issues on problem sewers, DG5 flooding or areas where silting is a known problem. IETG is currently involved in number of pilot studies in these areas.

F: Acknowledgements

The author would like to thank all the engineering and operational staff at Yorkshire Water Services and their supply chain for support in the delivery of this project.

The support of Nigel Smith, Pollution Team Leader and his team in the preparation of this paper and the rollout of the project is particularly noted.