*En*tec Model Solutions

MODELLING A TOTAL CATCHMENT
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INTRODUCTION

Entec is an international environmental consultancy which is able to address most forms of environmental problems, from planning problems to risk analysis and water engineering design. It has about 1100 employees world-wide and offices in the Far East, Middle East, Europe as well as the U.K. It is wholly owned by Northumbrian Water PLC.

BACKGROUND

Saltburn is a popular seaside holiday resort south of Teesside which was developed in Victorian times. It is mainly built on the cliffs and commands a fine view up and down the coast. It has some fine hotels, an operating pier, a sandy beach and some good local walks.

In recent years, however, some samples of the bathing water which are collected by the pier have failed the Bathing Water Directive and this has naturally been of great concern to local people, impinging as it does on the local economy. Northumbrian Water agreed to examine the problem but it was realised from the outset that the problem had complex origins and would need a very comprehensive investigation.

THE SEWER SYSTEM

The sewer system in the Saltburn area is quite complex and comprises two independent systems which serve the towns of Saltburn, Skelton and Brotton and the villages of Lingdale and Boosbeck in the hinterland. Untreated sewage is discharged to sea via two short outfalls at Saltburn and these are felt to be one of the main causes of bathing water failures.

Both systems are combined and have large C.S.O.'s which discharge into relatively small streams. The streams combine into a river which runs across the beach and discharges into the sea less than 200 metres south of the pier. In addition there were some C.S.O.'s discharging directly on to the beach and others discharging into a small stream which flowed into the sea north of the pier. There are three pumping stations within the catchment and sewer pipe sizes from 150mm to 1200mm.

The gradient of these streams and sewers are extremely steep which one would expect from the nature of the terrain. This means that the time of travel for both the sewers and the streams is relatively short.

THE PROPOSAL

The client proposed to intercept flows from the short sea outfall and transport them north to an existing long sea outfall. This proposal posed a number of questions as follows:

- Was the existing sewer system adequate and in good condition?
- Were the existing outfalls the only source of pollution?
- Would transferring the sewer to the long sea outfall increase the risk of pollution from that source?
- What storage would be needed in the system?
- Would surge suppression in the rising main to the long sea outfall be a problem?

It was decided that modelling could provide all of the answers.

THE WALLRUS MODEL

WALLRUS models of both catchments were built and verified during 1991-2 before any other part of the investigation was undertaken. As the catchment fairly naturally split into four it was decided for the purposes of

THE MOSQITO MODEL OF THE SEWER SYSTEM

A flow survey was carried out simultaneously with the pollution sampling to give a cross check on the previously verified model. As the study was particularly directed at examining the effect of the CSO.'s on the watercourse, four samplers were installed in the CSOs themselves. The choice of CSO. was determined from the WALLRUS study.

They were triggered to begin sampling when the level in the overflow reached 50mm. The samples were taken at two minute intervals giving a coverage of 48 minutes which was thought to be long enough to capture the first flush. In the event this was not found to be enough and in the future 12 minute intervals would probably be used.

Because analysing the samples is the most expensive part of the exercise, some rules had to be drawn to decide when samples were to be analysed. The rules were either :-

- If all four samplers collected 12 or more samples then all the samples should be analysed.
- If any one sampler collected all 24 samples then all the samples should be analysed.

This, it was hoped, would reduce the cost of abortive sampling. The determinants which were analysed, were faecal ecoli and suspended solids. This was because the variable needed for the study was ecoli but MOSQITO does not predict this. It does, however, predict suspended solids and this was thought to correlate more closely with faecal ecoli than the other variables which are predicted by MOSQITO.

The correlations between the two were examined using the actual measurements giving somewhat mixed results. Using moving averages gave better results and using log plots made a further improvement but even using these techniques the degree of correlation was mixed some events correlating well and others not at all. This was, on reflection, only to be expected because samples from a sewer are not taken from a homogeneous fluid. This suggests that stochastic methods may have to be built in.

Attempts were made to verify the MOSQITO model using the analyses which had been carried out. The results were again variable, some sites and some events were predicted reasonably well others were not. It seems that the predictions for longer, less intense storms are more successful than those for short intense storms, this is unfortunately the wrong way round.

All in all this was a very valuable exercise and a good deal has been learnt about the limitations of , this has been passed on to HR. The industry is now eagerly awaiting QSIM which will it is hoped incorporate much of the experience gained by those who have used MOSQITO.

THE RIVER MODEL

Because of the high level of discharge from CSOs into the river system and because the river outflows so close to the NRA sampling point, it was felt to be important to study the watercourse system and how it was affected by storm events in the catchment. Flow gauging and sampling stations were set up on both the Saltburn Ghyll and the Skelton Beck.

Analysis of the results showed that a large proportion of the increase in flow during the early part of a storm came from the CSOs as one would expect. Because of the steep nature of the catchment the time of travel was about two hours and again as one would expect the decline in the concentration of faecal ecoli was small. This was an important finding and had a large effect on the final solution to the problem.

The rivers were modelled using HYDRO-1D and because the catchment is steep the kinematic version was also tried. The predicted flows were very similar and agreed well with the measured flows after calibration. Where the duration of storm made rural runoff a factor MICROFSR was used and gave some improvement but it was felt the catchment was too small to give good results.

The ecoli predictions were significantly better using HYDRO-1D rather than the kinematic version for several events. Two different decay constants were used equivalent to T90's of 18.4 and 11 hours, these gave the best fit. Values up to 100,000 faecal ecoli/100ml were measured at the confluence. It was also noticeable that ecoli levels in the watercourse remained high for some days after an event. It was felt that the model could predict the effect of more intense storms with some confidence.