HAVERING DRAINAGE AREA PLANS
A CASE STUDY

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Introduction

The London Borough of Havering is to the east of London and covers an area of approximately 110 km^2 with a population of 230,000 including Romford draining to the Riverside Sewage Treatment Works (STW). The area has a history of sewer flooding and pollution problems which have arisen as the Borough has developed beyond the capacity of the sewer system. Efforts in the past to solve these problems in isolation have been hindered by the complexities of the system. As a result, a set of three Drainage Area Plans (DAP's) were commissioned by the client Thames Water Utilities to be completed by a partnership between the London Borough of Havering's Drainage Group and Montgomery Watson.

In this jointly produced paper, the need for the DAP's, the benefits of the partnership and the modelling complexities will be discussed.

Background and the Need for the DAP

The catchment in the London Borough of Havering has developed greatly over the last 75 years which has led to the population increasing by over 700% to approximately 230,000 people. The sewerage infrastructure constructed with this development has evolved in a piecemeal fashion which together with the progressive interconnection of major sewers and the transfer of flows to Riverside STW has resulted in a complex sewer network.

The area is served by a separate foul and surface water system but due to a combination of illegal connections, poor construction and deteriorating sewers, a high storm response to rainfall occurs in the foul network. This leads to flows in excess of the capacity of the principal sewers which has resulted in a decline in performance across the sewerage network.

The result of these factors is that during minor storm events, predominantly in winter, a significant amount of flooding occurs and in many locations causes internal property flooding. Flooding of unscreened sewage from manhole covers also contributes to pollution problems in watercourses and contaminates some public parks within the area.

Previous models had been built of various parts of the sewer network but verification had been incomplete due to the lack of reliable asset data, the many interconnections between trunk sewers and difficulties in matching the high levels of surface runoff.

In addition to the hydraulic deficiencies within the catchment, many collapses have occurred in the older parts of the sewer network contributing to operational problems. With the lack of catchment wide data on the structural condition of the majority of critical sewers, the need clearly existed for an extensive CCTV survey.

These factors together with the investigation of a proposed regional transfer scheme from a neighbouring STW clearly identified the need to undertake a comprehensive set of DAP's across the whole catchment.

The Partnership

With over 463 km of foul sewers to model and 250 km of sewer to survey, it was clearly going to push the resources and experience of a single organisation to complete the study. Thames Water Utilities soon identified the need to draw together the local knowledge and experience of the Drainage Authority with the Drainage Area Planning experience and modelling ability of the consultant. Initial reactions to this approach were mixed but it was soon agreed that it would, in this case, be the most effective approach.

The work was mostly split according to the strengths of each organisation. Montgomery Watson project managed the DAP's setting up many of the data processing system using in house software as well as modelling two thirds of the catchment and supervising the 82 monitor flow survey. The London Borough of Havering were responsible for modelling the remaining part of the catchment and completed all the on site survey work including the CCTV survey, structural assessment, infil data survey and impermeability survey

Initial difficulties encountered in setting up the project included the logistical problems involved in having a team split between offices in High Wycombe and Havering. Also different computer systems and methods of working required some adjustments. However, by careful planning and by responding to needs as they arose, these difficulties were overcome. Solutions included engineers from both organisations spending time in the other's offices at different stages during the project. Also many of Montgomery Watson's established software and systems used to complete other DAP's were introduced in the London Borough of Havering's offices. Quality Assurance was also established across the two organisations.

From the local authority's point of view the benefits of working in partnership were the acquisition of additional model building and verification experience under the supervision of the consultant especially for large and complex models for catchment wide planning purposes. Previously, the authority had only developed small to medium sized models for the purpose of designing local improvement works.

From the Consultants point of view previous experience of some local authorities had been resistance and a fear of consultants taking work away. In this case, the partnership allowed the consultant access to much of the authorities local historic knowledge of the system so that all aspects of the project were covered and understood. Also the authorities practical experience of capital schemes in the area was valuable in considering solutions.

The partnership between organisations working in both the public and private sector has given all members of staff an insight into the pressures, demands and benefits found within the other's organisation.

Ultimately the client has benefited from the additional local knowledge and modelling experience resulting from the partnership in the final models, reports and solutions produced by the DAP.

The Models

The modelling of the catchment was the primary element of the DAP and was a major task covering an area of 6,000 ha and 230,000 people. The flow survey for all three Drainage Areas included 82 flow monitors. The task was further complicated by numerous inter-connections between trunk sewers and Drainage Areas.

The models were built using the model building utility in STC25 and were run in WALLRUS. Several problems were encountered with data inconsistencies. Many of these were resolved by the contractor undertaking the Thames Water Utilities Regional Sewer Mapping Contract. However, many unknown connections were also identified and surveyed by LB Havering who completed all the ancillary surveys.

The models were verified for DWF conditions using a technique for separating domestic flow from infiltration developed by Thames Water Utilities and Montgomery Watson. This process highlighted some areas of high infiltration but generally showed infiltration to be spread evenly across the catchment. The DWF verification confirmed the existence of several connections which had previously been assumed.

Verification for storm events was less straightforward. To varying degrees, it was observed that a uniform fit was difficult to obtain across the three measured events. A good fit was obtained for the first event but it was not possible to match the volumes for the subsequent events with greater catchment wetness. The only way to match the volumes was to increase the runoff from fast response areas but this resulted in over predictions of peak flows indicated by predictions of surcharging which clearly hadn't been measured.

Thames Water Utilities with Montgomery Watson had been investigating the use of the new UK runoff model under the Beckton project and had proved results in separate systems against long term data. With this in mind, it was decided to test the new UK runoff model on the Havering models, initially on the Montgomery Watson built model of the Romford and Ravensbourne Drainage Areas and subsequently on the LB Havering built Ingrebourne model. The major difference with the new runoff model is the recalculation of catchment wetness during storm events in permeable areas due to increasing saturation of the ground.

The main drawback initially was the calculation of the 30 day rainfall index for the measured storms. This was overcome by using data from the adjoining Gascoigne Road catchment where long term rainfall data had been recorded under the Beckton modelling project. The period of the Havering flow survey had been covered by this long term survey allowing API30 values to be calculated.

Initial runs gave a more satisfactory match without the higher peak flows resulting from force fitting. With adjustment of simulation parameters in the PRM file, an acceptable verification was obtained for the Romford and Ravensbourne model. The subsequent use of the new runoff model in the Ingrebourne Drainage Area highlighted an increase in flooding volumes predicted due to attenuation of surface runoff especially from areas of clay soil. Very close fits were obtained against measured flow and depth data.

Although an acceptable verification was achieved, the lack of available data on design values of API30 proved to be an obstacle. This was an issue raised at the WaPUG 10 meeting in Blackpool and still needs further investigation. In this project, trial values were developed for design storms by comparing values used in verification and values obtained from 5 years of rainfall data used in the Beckton project. Results from these runs showed larger flooded volumes across the catchment although by comparing with simulations using the old runoff model, few additional areas of flooding were predicted by using the new runoff model.

The flooding was validated using Montgomery Watson's flooding prediction software contained within PARASSET. This software processes results from several storm durations for a given return period and translates flood volumes into a graphical representation using standard catchment defaults such as kerb height and level of properties compared to the manhole covers. The initial set of drawings are then confirmed and adjusted by a site visit. A final set of drawings are then produced using site callibrated parameters. For the Havering models, these drawings produced an acceptable correlation between predicted and reported flooding which gave satisfactory confidence in the API30 values used.

The verified models were then ready for use in preparing solutions.

Solutions

With the various catchment problems identified above, the full set of solutions was clearly going to be extensive. It was shown also by the models that different problems were occurring across the catchment. Within the Ingrebourne Drainage Area, flooding was concentrated in the North of the catchment with the more modern trunk sewer having adequate capacity further downstream. In the Romford and Ravensbourne Drainage Areas, flooding was more widespread with many problems due to the lack of capacity in the older trunk sewer. The new runoff model also highlighted the large volumes of storage which would be required to reduce carry on flows to acceptable levels. Despite pre-dating the Urban Pollution Management (UPM) methodology, the modelling work highlighted the potential use of CSO's to discharge screened flows into watercourses rather than retaining large volumes within the sewer system.

As a result of these differences, the main solutions in the Romford and Ravensbourne Drainage Areas were based around major trunk sewer improvements culminating in a storage tank and or CSO's. In the Ingrebourne Drainage Area, the main solutions were based around three storage tanks.

Subsequent to the DAP which was completed in November 1994, the London Borough of Havering have completed the detailed design of the first of the major schemes to be implemented. Known as the Harold Hill Foul Sewer Improvements, the scheme consists of a 6,000m^3 on-line attenuation tank with a Real Time Control variable penstock on the outlet. The Real Time Control technology will reduce the emptying time of the tank by over 10 hours and is related to level sensors in a critical manhole downstream of the tank. The scheme will provide flood protection for a one in ten year event to properties which currently flood during a one in two year event. The anticipated capital cost of the scheme is £1.6 million and construction started on site in April 1996.

An additional study is currently underway by the London Borough of Havering to appraise the feasibility of providing CSO's in the Romford area in accordance with UPM against more traditional upgrading methods. The is likely to reduce the capital cost of schemes in this area.

Conclusion

The Havering DAP's were developed in response to the many deficiencies experienced within the Drainage Areas. It was a complicated project with many new applications of established software and techniques. It was completed by a close partnership between a local authority and a private consultant. As a result of the DAP, significant steps have and are being taken to rectify the deficiencies associated with the catchment.

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Question Richard Kellagher IHS

What values of IF, Soil and Storage Depth did you use ?

Long high return period storms with the new runoff model give dramatically larger storage requirements ?

Answer

The recommended values of IF vary from 0.45 to 1.00 depending on the quality of surface in this case adjustments were made which resulted in IF values towards the upper end of this range.

The soil type was varied across the catchment giving problems with API 30 calculations, this was overcome by applying different values of API 30 to rainfall profiles. Each soil type was given a different rainfall profile index. The default storage depth was used in the PRM file.

The new runoff model did lead to larger volumes being required. In the case of Harold Hill, the storage volume was doubled. However this was due to the soil type and catchment conditions. Storage volumes may not increase to the same extent in other cases.

Question Chris Brown North West Water

The 50 properties on the DG5 that were removed with the scheme , were they all reportable and will they be taken off the register with a scheme designed for a 1 in 10 year storm. We have been agonising over whether running with a 1 in 10 year storm and coming up with a proposal is sufficient.

Answer

Yes they were and they will be removed from the register .

The 1 in 10 year design storm is Thames policy.