DRAINAGE AREA PLANNING IN ITALY

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1. BACKGROUND

In 1983 an integrated approach to flooding and structural problems was developed and published as the Sewerage Rehabilitation Manual (SRM)[1]. The SRM was subsequently updated to provide initial guidance on pollution arising from sewer discharges in 1986[2].

The principles and the approach in the SRM have been widely adopted in the UK as a standard methodology. WRc, in collaboration with SGI, a local specialist consultancy, has now completed the first full scale trial of the approach in Italy to develop solutions to the urban drainage problems of Mantova in Northern Italy.

The Italian situation is very different from the UK in history, design, operation and financing. Consequently the approach cannot be applied directly. It was, therefore, modified to the Italian situation with a combination of the local knowledge and expertise of SGI and the detailed knowledge of WRc of the both the theory and practice of the approach.

2. MANTOVA

The town of Mantova in North Eastern Italy, approximately 150 kilometres from Milan, was colonised by the Romans around 220BC. A thousand years later in the 9th Century AD, the foundations were laid for Mantova as we know it today: a walled town surrounded by lakes on three sides and cut through by canals, the banks of which are lined with historic buildings. The canals are 3-4m wide, with covered sections of varying design which act effectively as bridges. The roads are narrow and cobbled and the manhole covers are made from marble.

The historic part of the town covers an area of about 360 ha and serves a population of about 40,000. The sewer system is generally combined with approximately 75% draining to a Sewage Treatment Works in the south. The remainder drains to the Rio, a canal through Mantova centre linking the higher and lower lakes. The topography is generally flat resulting in the need for large sewers, laid at shallow gradients.

3. MODELLING

The modelling of the sewer system was undertaken using MOUSE, developed by DHI, Denmark. This was selected as the most appropriate hydraulic simulation package for systems with shallow gradients, looped systems and open channel flows, which are all common to Mantova.

Rainfall inputs, to assess the hydraulic model, were derived from two sources:

1. Design Rainfall data was derived from Depth/Duration/Frequency curves for the region. For the design and analysis of sewer systems, peaked symmetrical rainfall profiles are recommended. Using the rainfall depth for a selection of return periods and durations, the 50 percentile summer storm profiles were generated for each event using the principles in Volume 1 of the Wallingford Procedure[3].

2. An average annual rainfall time series was developed from a 30 year record of local historic rainfall, using the methods given in WRc Report No. ER195E[4].

4. PROBLEMS

At the start of the project there were five perceived problems within the catchment:

1. Water Quality
2. Structural problems
3. Hydraulic Problems
4. Sewer Odours
5. Exfiltration/Infiltration.

5. SOLUTIONS

Water Quality

The project was driven by the desire to improve the water quality in the Rio and surrounding Lakes. The Rio is a tourist feature of the historic centre of Mantova, but approximately 25% of the town drains to the Rio via septic tanks. It is important, therefore, that foul discharges are eliminated.

The traditional solution is resewerage and the construction of a relief sewer to divert flows to the treatment works. However, this would not only be costly but would prove particularly disruptive through the narrow, cobbled backstreets. As in a typical Venetian scene, buildings lie directly on the canal side. There is therefore no canal bank or canal side road in which to build an interceptor sewer. A novel approach was adopted, making maximum use of the existing structures, to provide storage in severe storms.

The approach proposed was to utilise the Rio by constructing a sewer in the bed to intercept all foul connections. Flows would then be pumped into the sewer system downstream. A covered section of the canal was sealed to attenuate flows into the new sewer and to provide approximately 1000m^3 of storage during storm conditions. Weirs at both ends of the section would allow the detention tank to spill to the Rio during severe events. The river water flow in the Rio would be maintained through a new pipe constructed at bed level in the covered section benching.

The verified model was run with the Rainfall Time Series to assess the performance of overflows in the system. Storage at varying locations within the catchment was proposed

to contain the spills from specific rainfall events. The total volume of storage required was 18000m^3.

Structural Problems

In general, the sewers are in good structural condition and therefore it is possible to use no-dig techniques for the proposed rehabilitation of the few defective sewers and where exfiltration/infiltration is a problem. This will minimise disruption.

Hydraulic Problems

UK upgrading practice was applied, designing to trigger and targets identified during the hydraulic assessment of the system. Design storms were used to assess the hydraulic problems of the system. Flooding did not prove to be significant due to the size of the sewers. Sewers in Italy are generally designed to a Method of Storage Capacity using uniform intensity rainfall and, therefore, tend to be oversized. Localised flooding was solved by utilising as much of the existing system as possible, by diverting flows into sewers with spare capacity.

Sewer Odours

The odours are caused by septicity of sewage due to low velocities in the sewers due to the shallow gradients and wide flat inverts. In order to increase velocities, the construction of dry weather flow channels was proposed in the many man entry, flat bottomed sewers. The model was reassessed in order to ensure no predicted flooding occurred due to any reduction in hydraulic capacity.

Exfiltration/Infiltration

In Italy, groundwater is frequently used for abstraction and exfiltration is regarded as a major problem, perhaps on a par with structural and hydraulic problems in the UK. There are fears of contamination of groundwater by sewage exfiltrating from leaking sewers.

Infiltration is a particular problem in the south of the catchment, where the water table lies above the sewers. The extent of the problem was determined with reference to the flow survey and sewer inspection data. Proposed solutions included the use of UK style renovation techniques: sliplining, inversion lining and GRP man entry linings.

6. CONCLUSIONS

This project has demonstrated a successful application of the SRM approach to Mantova, Northern Italy. Some issues highlighted the need for a changed approach on rainfall, modelling, design, inspection, and survey work.

Modifications to the SRM approach can be made to achieve the Italian requirements.

The no dig solutions meant that the disruption was reduced and that it was possible to preserve the historical parts of the catchment.

The recommended capital works showed more than a 50% saving against the original scheme proposals. This was achieved by making maximum use of the existing structures.

In comparison to the UK these capital works savings are at the top of the range of reported savings of 30-50% in WRc Report ER263E[5]. However, with the increasing interest and requirement for higher water quality standards, the need for the SRM approach and the possibility for designing efficient upgrading schemes at least cost has been significantly increased.

REFERENCES

1. WRc/WAA. **The Sewerage Rehabilitation Manual.** 1st Edition. WRc. 1983

2. WRc/WAA. **The Sewerage Rehabilitation Manual.** 2nd Edition. WRc. 1986

3. DEPARTMENT OF THE ENVIRONMENT/NATIONAL WATER COUNCIL/ STANDING TECHNICAL COMMITTEE. **The Wallingford Procedure.** DoE/NWC/STC, Report No. 28. 1983.

4. WRc. **Rainfall Time Series for sewer system modelling.** WRc Report No. ER195E. 1986.

5. WRc. **Sewerage Rehabilitation Manual Pilot Study Programme Final Report.** WRc Report No. ER263E. 1987.

Question

Graham Brine Mott McDonald

What were the sewer records like ?
Were all the critical sewers CCTV'd ?
Were short term flow surveys carried out.

Answer

The records were very poor and some manhole survey work was required, 59 % of A's were CCTV'd (the unit costs for CCTV work in Italy are 500% of U.K. rates).
Short term flow survey work was carried out by Insight Surveys (there are no flow survey companies in Italy). Insight followed U.K safety procedures but safety procedures applied by the Italians were not up to U.K. standard.

Question

Jim Allen Severn Trent Water

Why was SPIDA not used for the project ?

Answer

It was not available and the Italians preferred to use Mouse.

Question

Richard Kellagher Integrated Hydro Systems

In the hydrograph plots the infiltration seemed to occur so soon after the end of the storm, were they sure it was infiltration and not just a feature of Italian hydrological conditions.

Answer

It is difficult to say as AD was not involved in detail in this aspect. Where it occurred the sewers were generally below the water table. The fast response rate was as expected, on free flowing sandy soils.

Question

Richard Kellagher Integrated Hydro Systems

What hydrology is built into Mouse and what was used ?

Answer

Mouse has two levels of sophistication for it's runoff module.

1 A simple runoff factor method, using time-area curves.

2 A more detailed hydrological description including a linear wave routing of hydrography.

The more simplistic approach was used.

Question

David Balmforth Sheffield Hallam University

Was the costing evaluation, 5% of the capital cost of the proposed works and a 50% saving in capital cost between the revised solutions and the original one, the basis of a performance criteria.

Answer

No. These were just some observations.

Question

Martin Osborne Hydraulics Research

Was the 50% summer profile in the Wallingford Procedure applicable to the area ?

Answer

The area is a Mediterranean climate quite similar to that in North Africa where 50% profiles have been used before.

David Beale DHV Burrow-Crocker

Question

What was the level of service required for flooding ?

Answer

No flooding for a 1 in 2 year storm.