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The WRC operates in terms of the Water Research Act (Act 34 of 1971) and its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa.

TECHNICAL BRIEF

Sewerage systems

Sewerage system planning made simple

A new sewer system planning tool developed with WRC funding will greatly assist local authorities.

Sewer system panning: The need for support tools

In many instances the preferred sewer systems are water-borne systems (also called conventional sewer systems) consisting of a system of sewer pipes, pumps and other infrastructure needed to transport the waterborne sewage from the point of entry to the point of outfall. Waterborne sewer planning is inherently complex and the planning process is not readily amenable to a low-technology approach.

There is, however, a need for simple tools to assist staff at all local and regional authority levels to complete a basic assessment of sewer systems, give structure to the sewer system (SS) planning process and provide a methodology for compilation of a SS plan. The need for simplicity is dictated by the frequent lack of resources (e.g., computing facilities and staff with sufficient computer knowledge to apply more advanced tools), especially at the level of the smaller, poorer local authorities.

To satisfy this need, the WRC funded a project to develop a product that would be simple enough to provide immediate benefits to the local authority, yet be based on the vast and advanced pool of knowledge available to specialists in the field. The product was intended to acquaint sewer managers with fundamental principles relating to sewer planning and provide them with a set of usable tools, in contrast to directing their attention to advanced software suites currently available.

Lower-technology tools and guidelines would be more effective in aiding relatively small local authorities to expeditiously move towards a sewer system plan that would contribute to improved service delivery.

Approaches to developing planning tools

Knowledge review

The first step was to make an assessment of existing knowledge contained not only in academic publications and key international sources, but more especially also in the so-called 'grey' literature, including locally available design guidelines and consultants' reports – even though relatively few consultants were found to operate specifically in the field of SS planning.

Three-tiered design philosophy

In recognition, on the one hand, of the potential complexity of SS planning (with regard to both the system itself and the sewerage flow and load to be transported) and, on the other hand, the need to arrive at simple procedures for routine use in areas with low service levels, provision was made for the following three-tiered approach:

Level 1: The Level 1 approach comprises the application of the most basic design rules and is intended for use in cases where limited technical skill is available, or the scope of work is relatively small with negligible risk. This approach is adequate only in smaller municipalities and small towns with limited sewer infrastructure. Quite often Level 1 is dominated by factors other than hydraulic considerations (e.g. where the minimum pipe diameter is driven by that needed for rodding and prevention of clogging).

Level 2: The second tier entails a more sophisticated approach incorporating design theories that take into account the hydraulics of system elements, requiring a basic analysis of the system or parts thereof. The analysis of

a single main sewer, or pump station and rising main, are examples of the Level 2 approach. This would typically be the level needed by a medium-sized town.

Level 3: Level 3 essentially requires advanced skills and software tools needed to conduct planning of extensive sewer systems for cities and large metros.

Compilation and presentation of planning tools

Draft sewer system planning tools were developed on the basis of existing knowledge and the chosen design philosophy. These were subsequently workshopped in order to gain feedback and improve concepts prior to arriving at tools that could be delivered to local authorities as being immediately suitable for practical application.

A detailed account of the tool compilation process and its outcomes, geared mainly to academic readership, has been provided in a descriptive text. However, the importance of also making the results of the project available in wall-mounted poster form was recognised. A poster-output was consequently produced as the key means of facilitating the application of project outcomes at local authority level. The individual planning tools, components of which have been incorporated in the poster, have also been documented in detail for those requiring more information on any one particular tool.

Workshops

Workshops were held in various centres with stakeholders from a wide range of municipalities, the focus being on local authorities and other stakeholders involved with SS planning where resources limit the application of expensive, high-technology interventions such as the use of specialist consultants or advanced software applications. Through these workshops, needs of stakeholders with regard to low-technology tools and guidelines for SS planning were established.

Basic tools

The eventual set of basic, hard copy, tools comprised relatively simple check-lists, tables, graphs and diagrams to aid in the critical steps of the planning process. The final toolkit comprised the following components:

Hydraulic Tool

For the limited application of a simplified tool it was considered necessary to use the average velocity as a means to illustrate some essential relationships, often not understood at the level for which this tool is intended. The hydraulic tool provides graphs to visually illustrate critical relationships between the most notable parameters in sewer flow hydraulics.

Infrastructure Costing Tool

Four types of cost incurred through the installation and operation of a sewer system have been identified, these being:

- capital cost (e.g. the cost of constructing new infrastructure);
- operational cost (e.g. electricity for operating pumps, human resources);
- maintenance cost (e.g. repair and refurbishment of ageing infrastructure); and
- carbon cost (e.g. the indirect impact on the environment).

The cost functions presented in the infrastructure costing tool are based purely on capital cost. Operation and maintenance costs are not included in order to sustain the low-technology and user-friendly level of the product. This could be viewed as a limitation, in that these functions could not then be applied to optimise total cost during SS planning. However, it could be argued that when the SS planning process is sufficiently advanced to require such optimisation, a specialist consultant would in any case be needed to conduct the more detailed analyses. The functions based on capital cost alone are adequate for providing estimates of sewer infrastructure replacement value and for verification of budgets for the construction of new infrastructure.

Sewer System Planning Checklist Tool

A checklist tool for SS planning is convenient for identifying and describing necessary SS planning inputs as well as the progression of information from raw data to the final comprehensive SS plan. The adopted tool was based on a checklist which had previously undergone several years of development and been applied in many municipalities of the Western Cape.

Master Planning Process Tool

It was considered imperative to include, in the SS planning toolkit, a process description tool that supersedes a mere verbal description of sewer systems and the sewer planning process. Consequently, a simplified, schematic description of the SS planning process was devised and has been included as a master process planning tool.

Sewer Terms Tool

A list of terms and definitions has been compiled to meet the initial need for a so-called sewer terms tool, required both as an aid to understanding even the simpler, low-technology sewer system planning tools and to set the scene for the future compilation of an advanced dictionary and extended glossary in the field.

Water services development plan (WSDP) Tool

In order to assist local authorities in the improvement of planning functions and service delivery, a method was devised to simplify the transfer of information from the SS planning process to the water Water Services Development Planning (WSDP) process.

The Sanitown sewer system model

In addition to the basic tools described above, a conceptual, hypothetical hydraulic model for SS named 'Sanitown' analogous to the 'Anytown' model used in water distribution system analysis, was developed and tested to make provision for increasing levels of complexity in SS planning. Sanitown input parameters and model topology have been carefully selected and refined to include typical yet realistic problems encountered with the hydraulic modelling and planning of sewer systems.

Conclusion

The value of the simple, basic tools that have been provided does not merely lie in their usefulness for sewer system planning, but also in their value as training tools. Personnel at ground level, responsible for service delivery in many smaller local authorities, are often limited in terms of their basic knowledge regarding the sewer system, its planning and its operation. The tools will assist them in gaining the necessary understanding by illustrating critical relationships between key parameters typically used in sewer system planning.

No matter how extensively and how well the simple planning tools provided by this project are applied in practice, a computer model of the sewer system would, with growth in the system, ultimately be required to correctly assess the system's hydraulic capacity. Such increase in analytical complexity to the level at which modelling is required immediately creates the need for a benchmark model to allow different approaches to the sewer system design problem to be investigated. The Sanitown model fulfils the need for such a benchmark model to enable waterborne sewer system analysis and investigations into optimisation techniques and the performance of available software. This is particularly applicable to South Africa with its unique mix of service delivery challenges involving customers at both the upper and lower ends of the delivery ladder.

Use of the basic SS planning tools and the Sanitown model delivered by this project would greatly assist a municipality in better understanding the working, modelling and planning of a sewer system, and its optimisation in terms of hydraulics and cost.

Further reading:
To obtain the report, *Sewer system planning made simple – for small local authorities* (**Report No: 1828/1/11**), contact Publications at Tel: (012) 330-0340; Fax: (012) 331-2565; E-mail: orders@wrc.org.za; or Visit: www.wrc.org.za