

September 2006

Climate Change, Engineering & Operations and Process Control

The UKWIR research programme is currently divided into the following topic areas: drinking water quality and health; toxicology; water resources; climate change; wastewater treatment and sewerage; biosolids; water mains and services as well as regulatory and customer issues. This catalogue lists the reports in the Climate Change, Engineering & Operations and Process Control programme areas.

UKWIR has collaborated closely with the Meteorological Office on the inputs into UKWIR's climate change programme.

This has involved a series of on-going Technology Transfer workshops to brief the water industry on the latest climate developments and to ensure that the climate change scenarios are provided in a format that the

UKWIR reports can only be purchased via the UKWIR website:
www.ukwir.org

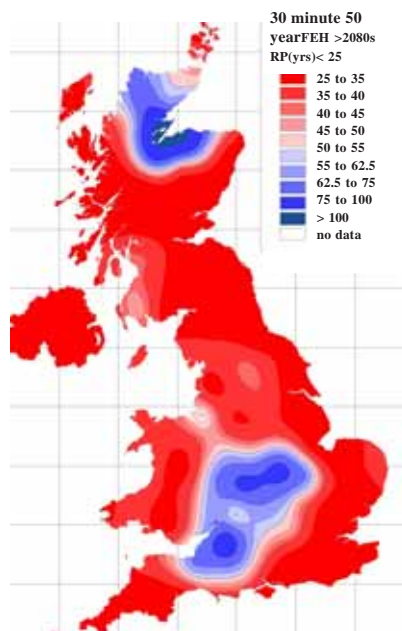
The website also provides information about current and proposed UKWIR research programmes

You can also download the latest version of UKWIR NEWS to get an update on recent projects, publications and technology transfer workshops

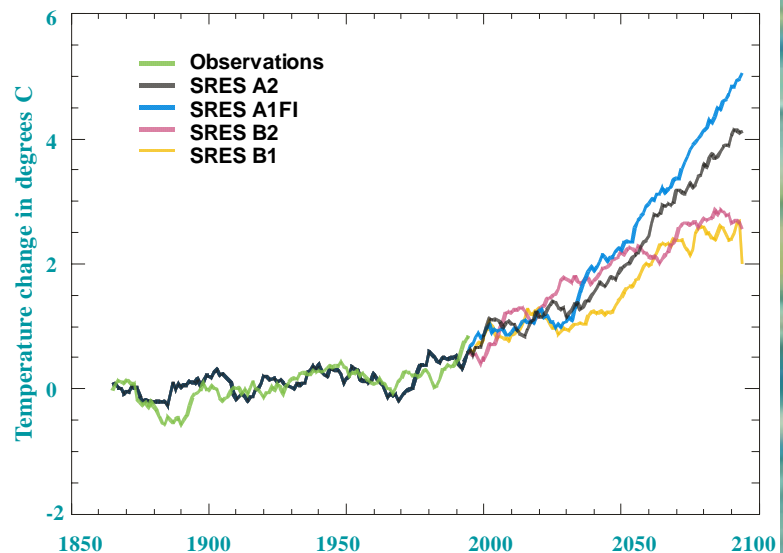
water industry can easily incorporate into the planning process.

A major study *Climate Change and the Hydraulic Design of Sewerage Systems* (see 03/CL/10/0 onwards) has resulted in a dozen reports that have updated the industry's knowledge of sewerage system design.

Graphical example of future rainfall



Central England temperature observed, simulated and predicted



Source: Met Office Hadley Centre

UKWIR was set up by the UK water industry in 1993 to provide a framework for the procurement of a common research programme for UK water operators on 'one voice' issues. UKWIR's subscribers comprise 24 water and sewerage undertakers in England and Wales, Scotland and Northern Ireland to whom these publications are freely available.

Work is often carried out in collaboration with government departments and regulators including the Department for Environment, Food and Rural Affairs; the Drinking Water Inspectorate and the Environment Agency. Work is also done in collaboration with research organisations internationally, including the Global Water Research Coalition.

The work is undertaken by a wide range of companies, academic institutions and other organisations in the UK and overseas. Project management is undertaken by both UKWIR members and individuals employed by UKWIR.

Climate change

Workbook for Quantifying Greenhouse Gas Emissions

Contractor: WRc

Ref: 05/CL/01/3, ISBN 1 84057 372 4, 54pp, £500

A methodology and spreadsheet for estimating greenhouse gas (GHG) emissions from the UK operations of individual water companies has been developed, to assist the production of environmental performance indicators and corporate environmental reports, and facilitate benchmarking. It estimates emissions from drinking water supply, sewage treatment, sludge treatment and disposal, and administration and transport. For each, estimates of total Global Warming Potential (GWP) are made: (i) in broad accordance with the Defra Guidelines and Kyoto Protocol, and (ii) also including short cycle carbon.

Effect of Climate Change on River Flows and Groundwater Recharge, A Practical Methodology:

- A Strategy for Evaluating Uncertainty in Assessing the Impacts of Climate Change on Water Resources

Contractor: University of Southampton

Ref: 05/CL/04/6, ISBN 1 84057 396 1, 70pp, £200

Develops a strategy for evaluating uncertainties related to assessing the impacts of climate change on river flows and groundwater recharge. The strategy considers the use of different climate and hydrological models and methods for translating changes at the global scale to catchment scale changes in river flow and recharge. The approaches form the basis of a practical framework and toolkit to help companies and Environment Agency assess climate change impacts.

- Trends in UK River Flows 1970-2002

Ref: 05/CL/04/5, ISBN 1 84057 387 2, 60pp, £200

Describes an analysis of 47 river flow records and 10 groundwater observational wells that aimed to detect any early signals of climate change due to changes in seasonal water balance. Some short to medium term upward trends in autumn and winter river flow were identified but it is not possible, at this stage, to attribute these changes to climate change rather than natural climate variability. Provides a framework for the water industry to periodically review trends in river flow and compare these with a range of possible climate scenarios.

Climate Change Uncertainty in Water Resource Planning

Contractor: Centre for Ecology and Hydrology

Ref: 05/CL/04/4, ISBN 1 84057 389 9, 81pp, £250

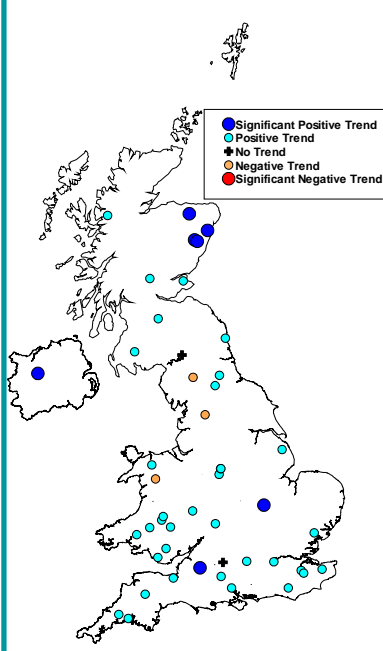
Investigates uncertainty in the impact of climate change on river flows and water resource. Three sources of uncertainty were considered:

- Uncertainty in climate change projections, due to Global Climate Models (GCM), emission scenarios and downscaling techniques
- Uncertainty in climate variability, including natural variability and reproduction of current climate
- Uncertainty in hydrological modelling, including model parameters and model structure uncertainty.

The impact of these uncertainties on the river flow regimes was assessed on thirteen catchments of Britain. Results showed that:

- For the 2020s, uncertainty due to emissions of greenhouse gases is small
- GCM uncertainty is the biggest source of uncertainty. Full impact studies should always consider a range of GCMs
- Downscaling uncertainty is significant but not as great as GCM uncertainty
- Hydrological uncertainty can be significant.

Figure 1. Trends in average autumn river flows from 1970 to 2002. Mann-Kendall test at 95% confidence level



Effects of Climate Change on River Flows and Effect of Climate Change on River Flows and Groundwater Recharge, A Practical Methodology: Use of Climate Change Scenario Data at a Catchment Level

Contractor: HR Wallingford

Ref: 05/CL/04/3, ISBN 1 84057 373 2, 36pp, £200

Provides background information on using the UK Climate Impacts Programme (UKCIP02) climate scenarios and catchment scale climate scenario data developed as the deliverable from task 1 of this research project. An accompanying Excel spreadsheet provides monthly temperature, rainfall and potential evapotranspiration (PET) factors for 190 individual or groups of river catchments in the UK. The catchment boundaries used were Catchment Abstraction Management Strategy (CAMS) areas in England and Wales and Water Framework Directive (WFD) sub-basins in Scotland and Northern Ireland. Removes the need for individual water resources studies to interpolate the UKCIP02 50km2 data to derive catchment rainfall and PET climate change factors. Provides a consistent data set that can be used by all stakeholders.

Effect of Climate Change on River Flows on River Flows and Groundwater Recharge:

- UKCIP02 Scenarios

Contractor: University of Southampton

Ref: 03/CL/04/2, ISBN 1 84057 286 8, 66pp, £150

Presents a procedure for the rapid determination of the effects of climate change by the 2020s on mean monthly runoff and average annual groundwater recharge for strategic scale assessments. The procedure uses three core UKCIP02 scenarios, together with two scenarios characterising the effects of uncertainty and two representing natural climatic variability. Three approaches to translating these scenarios into changes in runoff and recharge are proposed.

- Guidelines for Resource Assessment

Contractor: University of Southampton

Ref: 97/CL/04/1, ISBN 1 84057 010 5, 55pp, £100

Examines the impacts of four climate scenarios on six climatic regions of the UK. Changes in weather parameters such as rainfall, temperature, potential evaporation are given together with the resulting changes in monthly river flows and in groundwater recharge by the 2020s. The results act as an input to the assessment of reliable yields.

Effects of Climate Change on River Water Quality

Contractor: Cascade Consulting

Ref: 05/CL/06/4, ISBN 1 84057 402 X, 100pp, £100

Investigates the potential impact of predicted climate change on water quality in UK rivers, and its implications to the UK water industry, using a newly developed, fully distributed catchment-scale hydrological and water quality model, CAS-Hydro. The model has been developed at the landscape scale, allowing an improved representation of how material is processed and transported across the landscape and into the river channel network. Modelling of the River Derwent and a simulated catchment in southern England demonstrates a risk of climate-induced hydrological and water quality impacts on UK rivers, for UKCIP 1998 medium-high emissions scenario in the 2080s.

Effects of Climate Change on River Water Quality Phase 3 - Scoping Study

Contractor: Cascade Consulting

Ref: 03/CL/06/3, ISBN 1 84057 290 6, 64pp, £150

This is a scoping study for the third phase of investigations into the effects of climate change on river water quality. It firstly investigates what water quality parameters are of concern to the water industry, how they may be affected by climate change, and if this subsequent impact would then be significant. Consideration is then given to modelling approaches, including data issues, that would be needed to develop catchment based water quality models to represent the above, along with identification of catchments on which a completed modelling framework can be used.

Modelling the Effects of Climate Change on Water Quality in Rivers and Reservoirs

Contractor: Centre for Ecology and Hydrology

Ref: 01/CL/06/2, ISBN 1 84057 247 7, 14pp, £350

Models of 5 rivers and 1 reservoir are used to determine whether they are capable of assessing changes in water quality under likely climate change scenarios. All models suggest that no significant effects on water quality would

result. However, it is not valid to conclude that significant effects will not occur. The reasons are found in the nature of the models used, in the way changes were assumed to happen and in the nature of the climate change scenarios themselves.

Review of River and Reservoir Water Quality Models for Predicting Effects of Climate Change

Contractor: HR Wallingford

Ref: 00/CL/06/1, ISBN 1 84057 188 8, 15pp, £60

Reviews existing calibrated water quality models of rivers and reservoirs. A number of river models were identified as suitable candidates to predict the impact of climate change on water quality. Few reservoir quality models have been applied to UK reservoirs. The only models identified as suitable candidates to predict the impact of climate changes were two models of Wrysbury Reservoir: SULIS to predict water quality and PROTECH to predict any changes in dominant algae.

Scoping Study to Identify Research Requirements to Assist the UK Water Industry in Dealing with Changing Patterns of Drought

Contractor: WRc

Ref: 00/CL/07/1, ISBN 1 84057 187 X, 25pp, £100

Determines the requirements for future research into the effects of changes in the occurrence of droughts across the whole range of water industry operations. The project was effected through a literature review and discussions with a range of experts and academics in the water industry. Fourteen action areas were identified where research is required.

Uncertainty & Risk in Supply/Demand Forecasting

- Volume A

Contractor: W S Atkins Consultants

Ref: 03/CL/09/1, ISBN 1 84057 284 1, 77pp, £310

- Volume B

Ref: 03/CL/09/2, ISBN 1 84057 285 X, 41pp

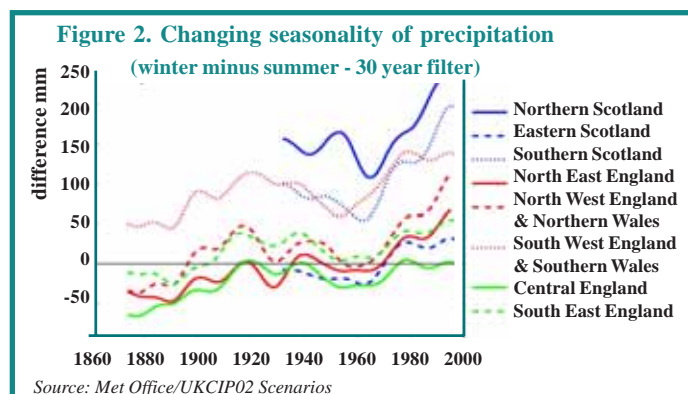
Presents guidelines on how uncertainties in the individual elements of supply and demand can be brought together in an integrated way. The guidelines offer a hierarchical approach that allows the practitioner to select the most appropriate method for a given spatial area. At the simplest level the approach uses data from standard Water Resource Plan Tables, becoming progressively more complex requiring Monte Carlo simulation and then full simulation of the supply-demand balance at a weekly time step. Reviews the economic literature and provides guidance on how to interpret uncertainties and improve the process by which investment decisions are made. Sold with volume 2.

Climate Change and the Hydraulic Design of Sewerage Systems: Summary Report

Contractor: HR Wallingford

Ref: 03/CL/10/0, ISBN 1 84057 361 9, 27pp, £200

Provides an overview of the findings from this major study on the impact of climate change on sewerage hydraulic design. The investigations ranged widely, but with a principle focus on the performance of sewerage systems to future (year 2080) rainfall and what changes might be needed in the hydraulic design of sewerage systems to address any problems that climate change might pose. Other issues include, a summary of international drainage practice and predicted changes in, sea levels and river flows. The findings of the project as a whole were that, while there are significant uncertainties in the prediction of changes in rainfall over the next century the analysis carried out under this project indicates that for many areas of the UK rainfall events are likely to become more extreme. This would result in a significant reduction in sewerage systems performance



particularly in respect of flood protection and CSO discharges and suggests the need for changes in the design of sewerage systems. A set of national rainfall maps in digital or and paper form have been produced to present the results of the rainfall analysis and illustrate the differences between FSR to FEH and the possible changes to extreme rainfall over the coming century.

There are 12 other reports collated in 4 volumes as follows:

Volume I: Climate Change Effects on Rainfall

IA – Climate Change and the Production of FSR, FEH and Year 2080 Rainfall Maps

Ref: 03/CL/10/1, ISBN 1 84057 360 0, 81pp, £225

Covers the work carried out on processing rainfall data from the Hadley RCM models and producing climate change maps for the predicted change in extreme rainfall for various durations and return periods. The work was based on the Medium-High scenario UKCIP98 models available at the start of the study. Also available in association with this report are sets of maps to illustrate the differences between FSR and FEH rainfall and the uplift due to climate change. All maps are available as raster (JPG) images – included with the printed document. Digital images (suitable for ArcView) are available separately at a cost of £1,000.

IB Sensitivity Report: Validation of HadRM3 and Comparison with HadRM2

Ref: 03/CL/10/2, ISBN 1 84057 327 9, 64pp, £50

Extends the work carried out on processing rainfall data covered by report IA in assessing the differences between the predictions from the HADRM2 model (the UKCIP98 output) and the HADRM3 model (the UKCIP02 output). The findings indicated that the changes in the future may be less extreme in terms of rainfall, but that both models should be considered as realistic scenarios for the future climate in the UK.

IC – Seasonality Study

Ref: 03/CL/10/3, ISBN 1 84057 328 7, 30pp, £50

Extends the work carried out comparing the UKCIP98 and UKCIP02 rainfall data breaking the information down into seasons. This was needed due to the major differences in seasonal rainfall patterns that the later model predicts and the importance of seasonal issues in sewer system performance.

Volume II: Rainfall Data Production & Analysis

IIA – Time-Series and Design Event Update

Ref: 03/CL/10/4, ISBN 1 84057 329 5, 148pp, £50

Covers the work carried out on developing a tool (Balerep) for use in generating future rainfall. 100 year time series data output was generated for the present day and 2080 – 2100 Medium-High scenario. Seasonal characteristics of rainfall were considered important to be represented accurately. The use of design storms and the profile to be used for future rainfall is also covered.

IIIB – Time-Series Rainfall – Disaggregation

Ref: 03/CL/10/5, ISBN 1 84057 330 9, 153pp, £50

Covers the work carried out on developing a tool (Cascade) for use in producing high resolution rainfall data from a time series. This tool uses various measures of rainfall characteristics to produce representative rainfall through the seasons. The tool was compared favourably to StormPac which is the only available tool currently available on the market.

Volume III: Sewerage System Modelling

IIIA – Changes in the Performance of Sewerage Networks

Ref: 03/CL/10/6, ISBN 1 84057 362 7, 65pp, £100

Summarises the results from using 5 quality assured drainage models run with both present and future rainfall for 4 representative regions across the UK. The work involved looking at the change in flooding response and the extent of the drainage system modifications needed to return the performance of the systems to their present day performance. In addition to flooding, the performance of overflows and the change in river water quality were also investigated. Makes suggestions where current practice and criteria might need to be changed.

IIIB – Changes in Sewerage Run-off and Water Quality

Ref: 03/CL/10/7, ISBN 1 84057 363 5, 134pp, £50

Documents the use of the time series rainfall data produced for present and future rainfall from 7 sites across the UK to look at the performance of overflow structures (spill frequency and volume) and water quality impact of spills in rivers using simple simulation models. Annual and seasonal runoff was also assessed. The rainfall data was also evaluated and certain modelling parameters quantified.

IIIC – Changes in River Levels and Flows around the UK

Ref: 03/CL/10/8, ISBN 1 84057 364 3, 13pp, £50

Summarises information currently available on probable changes to river flows over the coming century. Recommends that sensitivity analysis should be applied to sewerage design when river characteristics are important due to uncertainty of the flow rate changes. Emphasis is placed on likely water quality impact due to the prediction of drier summers and reduced flows in rivers.

IIID – Increase in Mean and Extreme Sea Levels around the UK

Ref: 03/CL/10/9, ISBN 1 84057 345 7, 12pp, £50

Reviews the available information on mean and extreme sea levels around the UK and the potential impacts of climate change on design conditions for sewerage systems.

Volume IV: Associated Topics; IVA – A Comparison between SOIL and HOST; Implications for Urban Drainage Design

Ref: 03/CL/10/10, ISBN 1 84057 331 7, 55pp, £50

Addresses the issue of urban runoff models being based on FSR and the implications of the trend to using FEH. Recommendations are made as to how to apply current tools using FEH descriptors. In general this is not seen as causing a major difficulty for sewer design and simulation tools.

IVB – International Drainage Practices

Ref: 03/CL/10/11, ISBN 1 84057 365 1, 20pp, £50

Provides a summary of current best drainage practices and the possible future direction that drainage design might take is considered.

IVC - Spatial High Intensity Rainfall

Ref: 03/CL/10/12, ISBN 1 84057 346 5, 15pp, £50

Addresses the difficult issue of the limited spatial extent of extreme rainfall and the likely increase of more extreme rainfall events in the future. The report highlights the limitations of current practice in this area.

Specification of Performance Requirements and Test Methods for Electronic Outputs of Water Meters

Contractor: WRc plc [Medmenham]

Ref: 95/EN/01/4, ISBN 1 84057 070 9, 15pp, £20

A draft specification which identifies the UK Water Industry's operational requirements for remote reading systems as the first step towards developing a UK water industry standard and associated test methods for water meter outputs. To date, much of the electronic equipment used with water meters has failed to operate satisfactorily. Therefore a series of test procedures covering environmental and reliability issues is seen as essential to aid future developments of automatic meter reading equipment.

Specification for Communication Protocol for Water Meters with Electronic Outputs

Contractor: WRc

Ref: 95/EN/01/3, ISBN 1 84057 069 5, 6pp, £20

The absence of an agreed standard defining the communication link for remote reading water meters means that each water meter manufacturer has their own 'in-house' standard. Such a situation hampers the application of remote meter reading systems by water companies due to the incompatibility of the meters and reading systems produced by different manufacturers. Presents the basis for a Water Industry Standard which defines the communication protocol to be used with remote reading water meters. It is a first stage in stimulating discussion on the precise requirements of companies and preferred solutions of manufacturers.

Long Term Monitoring of Detention Tanks

Contractor: WRc

Ref: 95/EN/01/2, ISBN 1 84057 068 7, 17pp, £100

Details progress during the third year of the five year monitoring programme to establish an archive of data on the performance of different detention tank designs for use in the assessment of design guidance. Further data collection is required and ideally information for an event causing a fill volume with a return period of at least once a year at each tank should be obtained. Statistical analysis of the results to date suggest that this will require a further two years, i.e. the full five year monitoring period.

Storm Sewer Data

Contractor: WRc

Ref: 95/EN/01/1, ISBN 1 84057 066 0, 28pp, £100

This project is supplementary to data collection and analysis completed under contract with FWR in 1993. The main objective was to continue the collection of storm sewer data from South Oxhey. These data were entered into the Wallingford Urban Runoff Database (WURD). To supplement data collection two areas of research were investigated showing the catchment area had increased by 4%. Sewer flow surveys in large diameter sewers are performed by Doppler velocity flow measurement instruments the accuracy of which depends on the angle of emission of the acoustic beam. Two contrasting designs were tested and the limited investigation confirmed that one configuration with a 20 degree angle of acoustic beam emission was inappropriate for measuring high flows in large diameter sewers. An alternative design with a 60 degree angle of emission was shown to be more accurate.

Process control

Year 2000 (Y2K) Embedded Systems Project Y2K Contingency Planning Study

Contractor: Carl Bro Group

Ref: 99/PC/01/1, ISBN 1 84057 157 8, 37pp, £400

Reviews the progress to December 1998 made by a representative number of UK water undertakings towards their contingency plans for the millennium event. It considers the critical issues and influences and develops a credible scenario of events for which to plan to maintain normal levels of service.

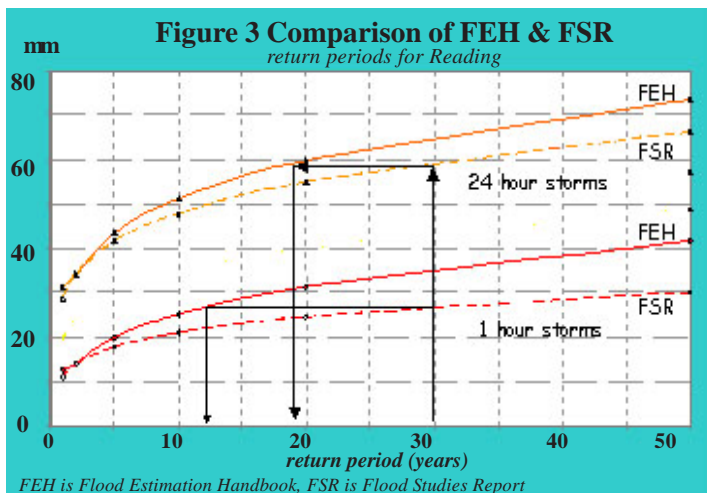
On-line Instrumentation Standards and Practices

Contractor: Process Measurement Technology Limited

Ref: 00/PC/03/1, ISBN 1 84057 180 2, 183pp, £400

Deals with the management and exploitation of on-line measurement in the UK water industry. The results from a survey of the perceptions of managers and practitioners are presented along with other industry data. Recommendations are made for initiatives which might improve confidence in the use of on-line measurements.

Statements contained in this UKWIR catalogue do not necessarily represent the views of UKWIR or the Water Industry



Engineering & operations

Long Term Monitoring of Detention Tanks - Final Report

Contractor: WRc

Ref: 96/EN/01/8, ISBN 1 84057 067 9, 40pp, £100

Detention tanks are used to upgrade sewer systems and offer several benefits. Present design guidance on these tanks is largely based on theoretical work, laboratory modelling and short-term tank monitoring. There is little information regarding the long-term operation of these structures, even though this information is essential to check the accuracy of current design methodology. Improved design can decrease both construction and operational costs. A number of different types of tank were monitored between November 1992 and February 1996 in order to determine how each serves its catchment, and to provide an archive of data for future assessment. For each tank, information was collected on: depth of fill; sediment depth; catchment rainfall; catchment changes; maintenance, and control device verification. Gives a number of conclusions on the performance of the tanks which were monitored, and recommends that this data to be used to review methods for the hydraulic design of sewer tanks.