# Being Shrewd with the Tame
## (Delivering AMP3 in the River Tame Catchment)

***Will Williams and Karen Murrell - WRc plc***
***Paul Brettell – Severn Trent Water***

## *Abstract*

*This paper is a follow up to the paper presented to the WaPUG Autumn Conference last year which described the background to the Tame UPM project and the fast track planning methodology (Fast UPM) which has been adopted. The initial phase of the project was aimed at providing a rapid, strategic level assessment of upgrading solutions, based on models using historic or default data. Subsequent phases have used the results of this strategic level work to highlight areas where it is technically justifiable and cost effective to increase the detail of the assessment, based on the scale of upgrading required and use these data for study prioritisation.*

*This paper provides an update of progress to date and describes how the Fast Track approach has been applied to the Tame catchment to quantify, prioritise and plan for investment in a large complex, urban catchment.*

## Background

Severn Trent Water (STW) investment within the Tame catchment, over the AMP3 and AMP4 periods, will be focussed on improving water quality in the River Tame and its tributaries, within the context of improvements downstream in the River Trent. These improvements will be achieved through a combination of Wastewater Treatment Works upgrading and the remediation of unsatisfactory intermittent discharges.

From the STW viewpoint, the long term upgrading strategy must deliver the necessary improvements to comply with legislation and do so to extremely tight time and budgetary constraints. The size and complexity of the Tame catchment makes it impractical to carry out a conventional UPM study using traditional tools. The Fast track planning approach adopted, using SIMPOLv3, will identify those areas which would benefit from a more detailed study as part of a phased approach, as the level of investment indicates it is cost effective to do so.

The key to Fast UPM is the early identification of the investment priorities within a system which enables a modelling approach to be adopted that concentrates data collection and model refinement where it will have most benefit. Conversely, this enables areas where less upgrading is necessary to be promoted to the engineering design stage more quickly, thereby ensuring a steady stream of projects are delivered over the AMP3 investment period.

## The Tame Catchment

The Tame UPM study is centred in and around Birmingham in the West Midlands. Geographically it encompasses all of Birmingham, Walsall, Sandwell and major parts of Dudley, Wolverhampton & Solihull and has a population of 1.9 million. The catchment, shown in Figure 1, covers an area of 1,067km$^2$, incorporating 6 significant sewage treatment works (Minworth, Coleshill, Ray Hall, Goscote, Willenhall & Walsall Wood).

 

There are 374 operational CSOs in the catchment, of which 92 have been identified as unsatisfactory and require improvement in the AMP3 period. The area has been covered by over 65 Drainage Area Plan (DAP) models which need to be integrated to properly represent the interaction between the sewer and river systems.

This is a very large, complex catchment both in terms of the sewerage and river system. Any UPM work needs to represent these interactions in a way that allows the effects of upgrading to be quantified both in terms of water quality improvements in tributaries as well as on the River Tame as a whole. An integrated approach is therefore essential.

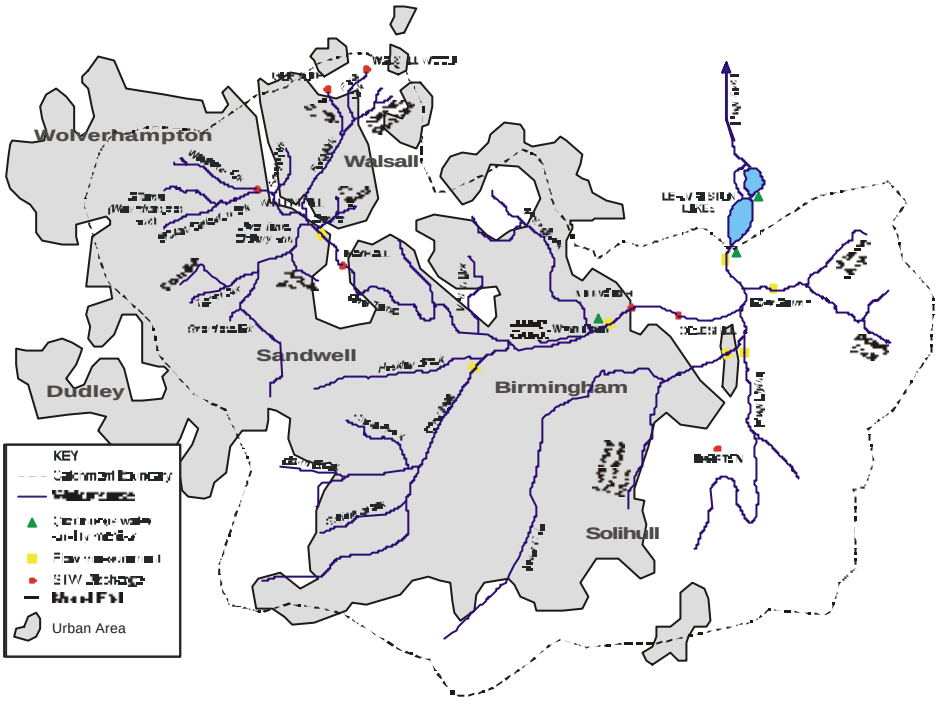


**Figure 1 River Tame catchment**

## Investment Priorities

As with the rest of the industry, AMP3 represents significant challenges for Severn Trent Water both in terms of the time and cost constraints on delivering outputs. On average the company will have to deliver projects for 20% less than AMP2 costs.

The Tame UPM encompasses 25% of all CSO improvements in AMP3, and as such, it is right that a UPM approach is used to derive the most cost effective, best environmental solution to the numerous, complex and interrelated problems. Severn Trent will be investing over £20 Million in CSO improvements in the Tame catchment over the next five years. Figure 2 shows the chronology of UID delivery in the catchment over the AMP3 period.

It is essential that this investment delivers the best improvements at minimum cost and that it is completed by the required deadline. It is important, therefore, that an optimal balance is struck between the planning and construction stages of AMP3 both in terms of costs and timescales.

 

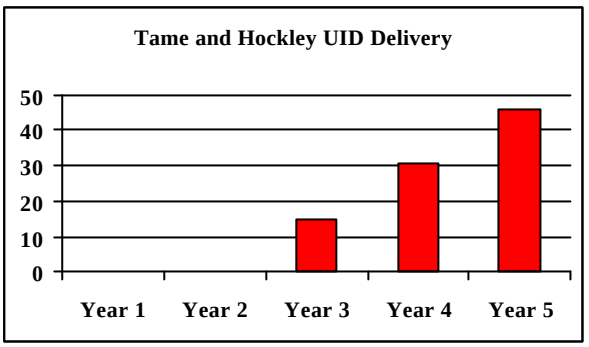


**Figure 2 UID Delivery Timetable**

## Fast Track Planning and SIMPOLv3

WRc have developed a fast track approach for investment planning, which allows rapid, cost effective assessment of the needs of a catchment and the associated modelling, data collection and solution development requirements.

The approach broadly follows the stepwise format of the UPM procedure and is enabled by a combination of WRc's specifically developed software tool (SIMPOLv3) which allows the use of default parameters and rapid sensitivity testing to develop upgrading solutions and assess compliance in terms of cost and risk. This ensures that the level of detail of the data collection and modelling is correct for the scale of scheme, and thus investment required.

SIMPOLv3 is a Visual Basic software package for the simplified modelling of sewerage and receiving water systems. It has been:

- Developed from a range of existing environmental modelling tools including SIMPOL2 (UPM Manual).
- Has enhanced individual river reach modelling capabilities
- Can optimise to a solution
- Can continuously simulate performance over a multi-year period

## Modelling Methodology

For the River Tame catchment a three phased programme has been adopted, as follows:

- Phase A SIMPOLv3 strategic model – conceptualisation and calibration
- Phase B establishment of performance baseline
- Phase C subcatchment model refinement

The following sections describe the work carried out in phases A and B to date and outlines that planned for Phase C.

A desktop study has been completed to collate all known information from; Drainage Area Studies, CSO databases & Thesis records. This information has been compiled on MapInfo.

Phase A of the modelling study involved the conceptualisation, building and calibration of the strategic SIMPOLv3 model, based on existing sewer models, Environment Agency routinely collected data (flow and quality), topographical data and data collected by Birmingham University as part of the URGENT (urban river regeneration) project. Default model

 

parameters where based on past experience and an Environment Agency research project on the use of default values in SIMPOLv2.

This model enabled the examination of water quality in the River Tame and its tributaries and in doing so enabled the performance of individual study areas to be understood and put into context of the catchment as a whole. This allowed the priority for investment in these study areas to be quantified and a check on the prioritisation of studies to be carried out. The model established the linkage between the key polluting drivers and the resulting river impact and in doing so quantified the likely scale and cost of upgrading required.

***Sewer System***

A new model of the Black Country Trunk Sewer (BCTS) was built by STW and WRc, incorporating the missing trunk sewers and sufficient detail to accurately represent the interaction between BCTS and contributing sewered subcatchments during heavy rainfall. Flows in the BCTS can rise to such a level that backing up occurs in the subcatchments draining to the BCTS. The BCTS fills in response to long, low intensity rainfall events. Observed rainfall data, known to cause this effect, were simulated to determine the precise level of this interaction and any associated effect on CSO operation in the subcatchments.

HydroWorks models for the entire Tame catchment were reviewed, and in some cases, converted from existing WASSP and WALLRUS models. These were used as the basis for producing the SIMPOLv3 representations of the sewered catchments.

***River System***

The river system was conceptualised into reaches by identifying those stretches of river considered to be critical in terms of location, number and severity of CSO discharges. The physical characteristics were derived from existing models or historic survey data. Environment Agency historic and routine monitored data were also used to establish headwater and upstream quality conditions. River flow is gauged in a number of locations around the catchment.

***STWs***

Representations of the STW storm tank spills were included as part of the drainage area planning models. Works final effluent was simplistically represented within the strategic model as a final effluent distribution for each of the 6 STWs within the catchment. These are located at Coleshill, Ray hall, Goscote, Willenhall, Walsall Wood and Minworth.

***Strategic Model***

The strategic SIMPOLv3 model links together the spills from the sewer catchments with the river reaches. The pass forward flows are routed via the SIMPOLv3 representation of the BCTS on into Minworth and Coleshill STWs.

Each sewer catchment has been previously calibrated against a verified sewer model. The strategic model was calibrated using historical rainfall, flow and quality data at key locations in the Tame catchment. Influent records at the STWs within the catchment assisted in overall catchment drainage verification.

## Phase A and B - Study Findings

 

The next stage was to assess the baseline performance of the individual study areas to prioritise upgrading, planning and engineering options on a catchment by catchment basis. Figure 3 shows the results of the baseline performance assessment for the strategic model, expressed as receiving water compliance.

The assessment was carried out using a 5-year rainfall timeseries, based on local rainfall data. At this stage a number of sensitivity simulations were carried out to determine which parameters exert the most significant effect over the model results. This developed a priority ranking for areas requiring more detailed SIMPOLv3 modelling and where specific, targeted data collection would be cost effective.

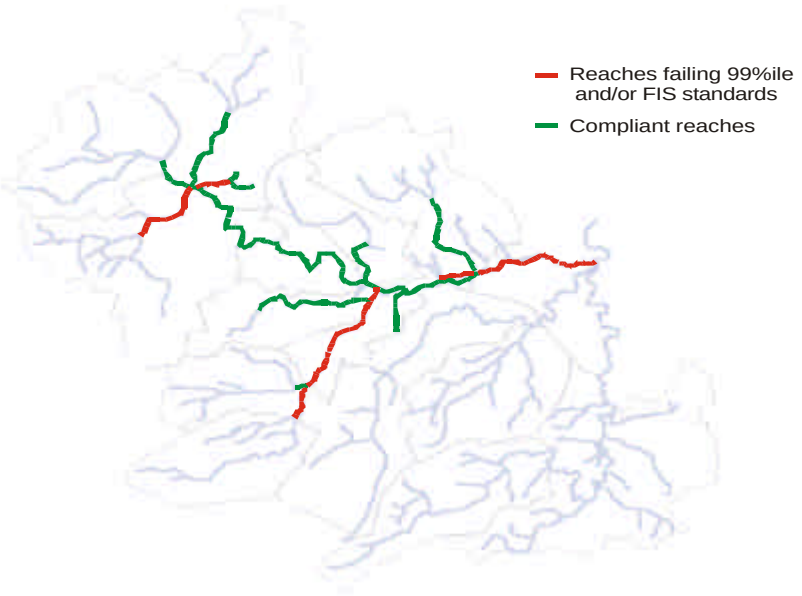


**Figure 3 Strategic Assessment Results – Reaches Failing Quality Standards**

The strategic SIMPOLv3 model was then used to develop preliminary upgrading options and costings, on a subcatchment basis, to enable early negotiations for engineering and planning purposes, as shown in Figure 4. The Tame subcatchments were prioritised into high, medium and lower categories, based on the level of investment required. Those identified as high priority were targeted for detailed modelling as the level of investment required suggested it would be cost effective to do so.

## Phase C

The aim of Phase C is to build on the previous phases and to deliver outline solutions for all the UIDs (not already completed) in the Tame Catchment, in a form which:

- can be agreed by the Environment Agency, and;
- can be passed on to STW Engineering for detailed design, as required to meet the overall programme.

To support this aim requires the achievement of the following key objectives:

- to identify and collect further data where needed to improve, sufficiently, the confidence in the models;
- to enhance the models, in terms of level of detail and reliability, to the extent needed to support outline solution development;

 

- to use the models to identify and confirm outline solutions for all UIDs;
- to maintain appropriate liaison with the Environment Agency and STW Engineering throughout the study such that agreements are reached as required by the overall programme.

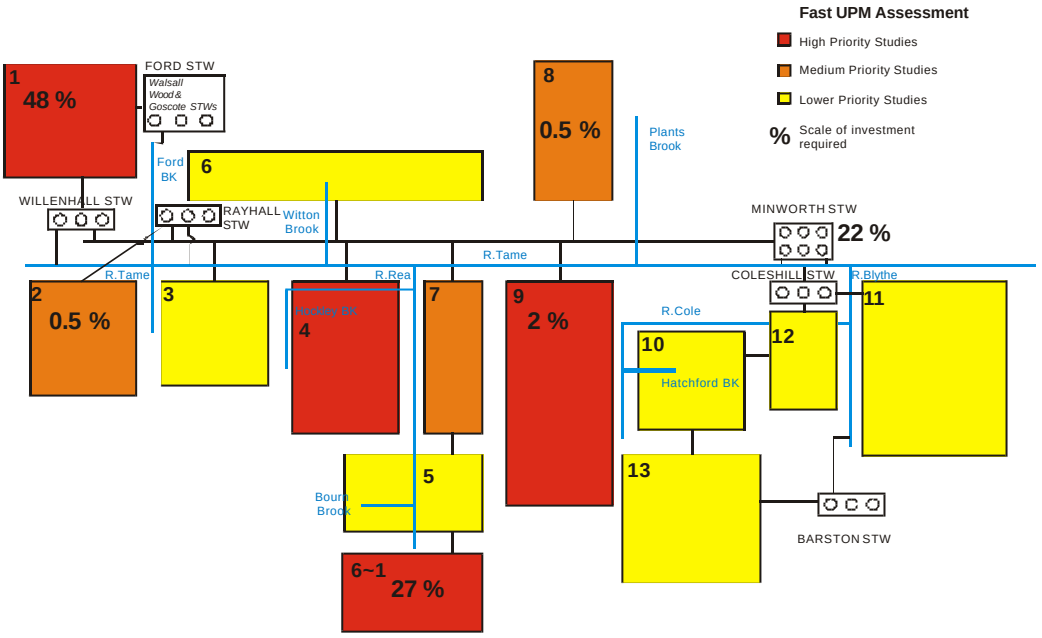


**Figure 4 Prioritisation of the strategic Tame catchment**

### *Planning*

The overall approach proposed for the Tame UPM Study recognises that the successful execution of the project depends upon:

- targeting the areas of greatest uncertainty and highest investment need to ensure that the work is completed cost-effectively and on time ;
- maintaining a close working relationship with the Environment Agency to avoid any undue delay in getting agreement.

Phases A and B have already contributed to the targeting process and there is now a better understanding of where additional effort needs to be focussed. This understanding, linked with the need to work closely with the Environment Agency, has led to a study design comprising a number of General Work Packages, designed to establish agreed procedural guidelines and Area-specific Work Packages, containing detailed protocols pertinent to the specific subcatchments, as shown in Figure 5.

A project of this size and complexity requires careful planning and control. Consequently, this study design incorporates a number of protocol documents that have been developed to facilitate efficient project management and study progress.

 

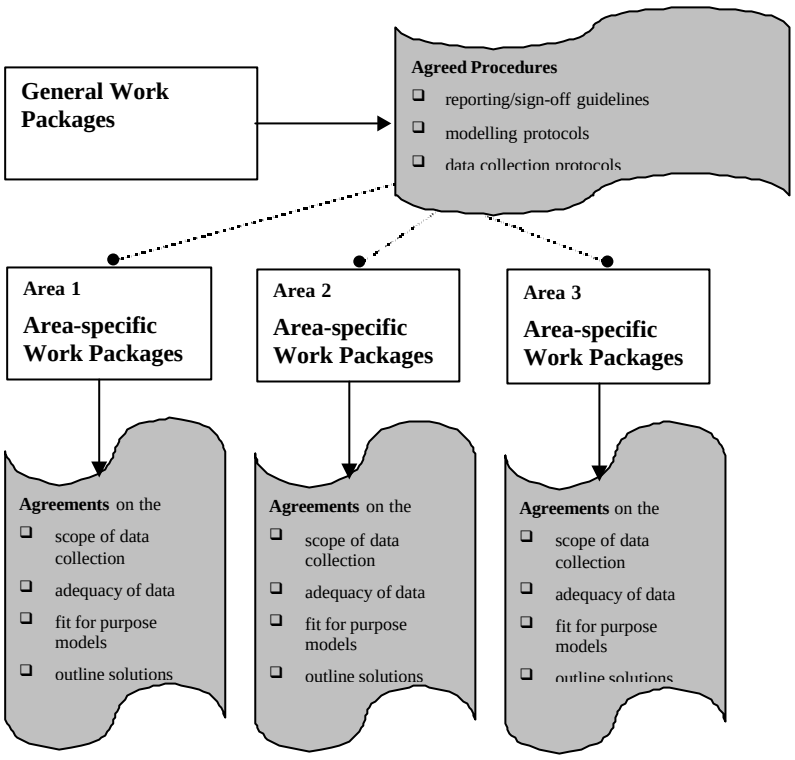


**Figure 5 Tame UPM Study plan work packages**

## *DAS review*

The building, testing and verification of the sewer models are currently being assessed to ensure that they are within the bounds of accuracy specified by the WaPUG Code of Practice for the Hydraulic Modelling of Sewer Systems. Where this is not the case the data collection and modelling requirements to ensure their suitability are being specified. This evaluation will be of particular importance where hydraulic models are located in areas that require significant investment. When this is the case, their accuracy and fitness for purpose is being evaluated and where necessary model upgrading will be undertaken as part of the STW Drainage area Planning (DAP) review process. Figure 6 below shows an assessment of drainage area need based on current DAS model condition and UID delivery date. This assessment has formed the basis of the flow survey planning described below.

 

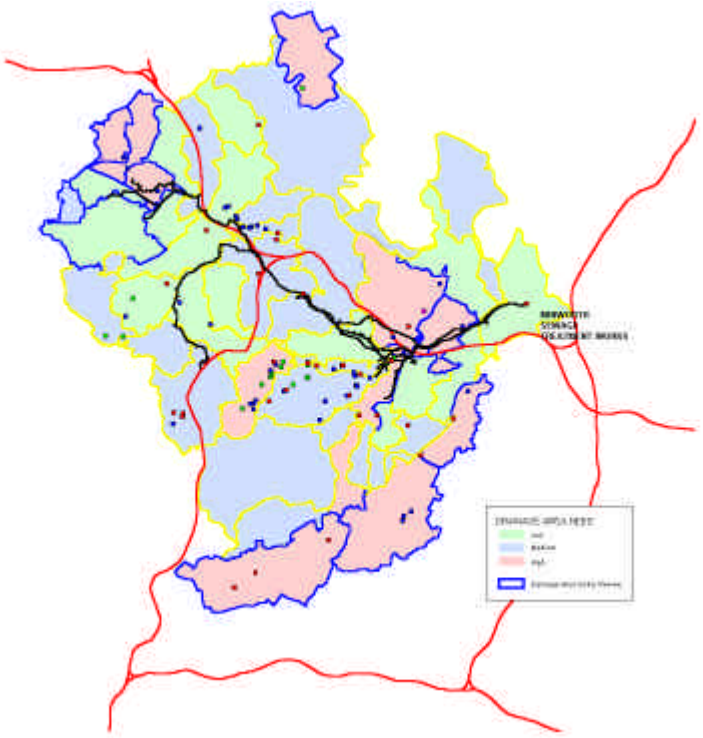

**Figure 6 Drainage area need based on condition and UID delivery**

## Data Collection

With a broad understanding of the investment priority for each subcatchment and the knowledge that initial results suggested that targeted data collection would prove cost effective, data collection surveys were planned to maximise resources in terms of practicability and costs.

Data collection surveys were targeted at improving the confidence of the models used to derive baseline assessment and subsequent solutions. This includes both the drainage area models, which underpin the SIMPOLv3 sewer subcatchments and the quality aspects of the sewer and river modules in the SIMPOLv3 model. The surveys therefore had to cover sewer and river flow and quality.

***Sewer flow surveys***

Sewer flow surveys were planned with a level of detail commensurate with the drainage area need, such that high need drainage areas were targeted first and more comprehensive data collection exercises designed. Survey requirements for medium and low need drainage areas were much less, as these models were either more up to date or not significant in terms of UID upgrading. STW were already undergoing a programme of drainage area review and extended their flow survey programme to include those additional drainage areas not currently part of the review.

WRc are planning and supervising all the UPM data collection, utilising approximately 100 flow loggers, to be rotated around the catchment in a phased approach, which concentrates on the high priority areas first. This has involved discussions with STW's other drainage area contractors, as each drainage area may have a different focus for review, either UPM, flooding, detailed design, rehabilitation, etc. and as such different requirements from the flow survey. The consultants need to satisfied with our data collection numbers and locations as

 

well as specifying a limited amount of others which will enable them to use this data and verify the models satisfactorily, but do so in a timescale which will allow delivery of the Tame UPM. The phased approach allows the high priority catchments to be reviewed first and delivery to WRc of revised DAS models to be used in the UPM study.

***SIMPOLv3 data collection***

The approach to data collection hinged on a number of factors:

- Currently, there is very little useful data on the pollutant concentrations in the drainage discharges – particularly how these concentrations may vary between different subcatchments, between dry weather and storm periods and between combined and surface water only systems;
- Equally, there is little information about the water quality process rates that are appropriate for the river Tame and its tributaries – process rates that will affect oxygen concentrations and the cumulative effect of multiple discharges.
- Default values for pollutant concentrations and process rates are available from other studies and have been documented (WRc 2000). It should be possible to design environmentally sound solutions by using pessimistic values from the ranges of default values available. However, this approach, used in Phases A and B, is unlikely to be cost-effective.
- Equally, it is unlikely to be cost-effective (or indeed practicable in the time available) to do detailed water quality surveys throughout the catchment.
- Instead, the approach involves new data collection on a carefully chosen sample basis. The results from this targeted data collection will then be used to refine the values selected from the default ranges

Protocols were therefore developed covering requirements for:

- Combined sewers: Sites to be selected based on expected BOD loads. Results to be used to assign values to sewer quality parameters.
- Surface water sewers: Selected based on different general land use and having no known CSO inputs. Results to be used to assign values to surface water system quality parameters.
- Treatment works and storm tanks: Results to be used to assign values to storm tank parameters and effluent quality statistics.
- other urban inputs;
- Rivers: Time of travel and dispersion surveys under low and high flow. Results used to assign values to river process parameters.
- Non-urban inputs.

In summary, water quality parameters in the Tame SIMPOLv3 model will be assigned based on existing default data supplemented by data from targeted surveys, based on approximately 70 sampling sites around the catchment. Part of this data will form a strategic data set to be used to confirm the SIMPOLv3 model performance over a number of events, when the detailed model is completed. This data set encompasses sewer and river flow and quality and will provide a gross check on catchment representation.

Data collection is now ongoing, except for the river quality surveys, which have been completed for this year. It may be necessary to undertake further river quality survey next summer to reduce the level of conservatism in the river quality process rates.

## Benefits of FAST-UPM

 

Adopting a Fast UPM approach for the Tame catchment has allowed outline upgrading options to be identified at an early stage of the study. These will be subsequently refined to a level of detail appropriate to the scale of investment required. Having identified these outline solutions, the approach will allow the necessary location and land purchase issues to be identified and addressed early in the planning process thereby avoiding delays as the designs are refined through the course of the study. This will allow the appropriate balance between the planning and engineering phases of the study to be achieved

Overall, adopting this approach has enabled significant study cost and time savings to be achieved and ensured that future investment is targeted in a technically appropriate, cost efficient way by adopting a staged investment strategy over the AMP3 and AMP4 periods.

## The Way Forward

Phases A and B of the study were completed at the end of December 2000. The results of these phases have allowed a performance baseline to be developed for the system. Analysis of this baseline has enabled the investment priorities within the system to be identified and the scale of upgrading required to be quantified. Areas have been identified where the scale of upgrading required justifies further data collection or modelling work due to the scale of potential cost savings in these areas. Conversely those areas where the scale of upgrading required does not justify extra data collection or more detailed impact modelling can now be moved to the engineering phase where the existing DAS models can be used to develop detailed upgrading schemes.

**References**

***Urban Pollution Management Manual Second Edition***, Foundation for Water Research, 1998.

***SIMPOLv2 Default values for use in UPM studies****. Environment Agency Technical Report (Submitted)* WRc 2000.

*For further information please contact:*

*Will Williams*
*Head of Asset Management*
*WRc plc*
*Frankland Road*
*Blagrove*
*Wiltshire*
*SN5 8YR*

*Tel Switch: 01793 865000*
*Tel Direct: 01793 865162*
*Fax: 01793 865001*
*Email: williams_wd@wrcplc.co.uk*

 