

ESSEX RIVERS HYDROLOGY INVESTIGATIONS

MAIN STUDY BRIEF



ENVIRONMENT AGENCY

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ANGLIAN REGION

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Commissioned by:
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THE BRIEF

1 INTRODUCTION

Essex & Suffolk Water (ESW) and the Environment Agency (Anglian Region) are carrying out a joint project to develop a new computer-based numerical model of the Ely Ouse - Essex Transfer Scheme (including the ESW reservoirs at Hanningfield and Abberton). ESW, as part of this project, is commissioning an investigation of the River Stour and the River Blackwater to improve the level of understanding of key aspects of their hydrology affecting operation of the transfer.

2 BACKGROUND INFORMATION

The 1968 Ely Ouse - Essex Act permitted the construction of a scheme to transfer water from the Ely Ouse at its tidal limit at Denver to the headwaters of the Stour, Colne and Blackwater. The scheme - known as the Ely Ouse - Essex Transfer Scheme (EOETS) - is used to support abstractions for public water supply from the Stour and the Blackwater by ESW. To assist with prediction of the behaviour of the system a computer-based numerical model was developed in the late 1970s.

Recent studies have demonstrated significant discrepancies between EOETS model predictions and actual system behaviour. Furthermore, the existing model is recognised as being inflexible and incapable of simulation of the full range of possible future development scenarios. ESW and the Environment Agency, having identified major problems with the existing model, are jointly funding a project to develop a new EOETS model.

An important component of the project is an investigation of key aspects of the hydrology of the Stour and Blackwater affecting operation of the EOETS. An improved level of understanding of critical aspects of the system should facilitate the development of a better model. A scoping study has been carried out for this investigation. This study involved the collection and review of available information and the identification of issues pertinent to modelling of the EOETS.

3 OBJECTIVES

3.1 STATEMENT OF THE PROBLEM

Whilst the EOETS has been used successfully for over twenty years the hydrological impact of transfers is not understood well enough to incorporate in a numerical model. Discrepancies between the existing model and actual system performance are thought to be caused primarily by inadequate representation of physical processes in the Essex rivers during operation of the scheme.

The scoping study for this investigation identified the following issues as requiring further work to improve the level of understanding of the two Essex rivers.

- i) Lack of reliability in the gauging of low flows at several key gauging stations in the Stour catchment.
- ii) Lack of evidence of calibration of the meters recording ESW's abstractions at Stratford St.Mary and Langford.

- iii) A lack of understanding of the impact of transmission losses and groundwater abstractions on river flows in both rivers.
- iv) Lack of reliability in estimated STW discharges used in the production of naturalised river flow sequences used in the EOETS model.
- v) Possible errors in naturalised river flow sequences used in the EOETS model caused by the lack of measurement of abstractions at Wixoe up until 1994.
- vi) A lack of comprehensive understanding of the time of travel of transfers.

Items ii), iii) and vi) are considered to be of greatest importance as their resolution is most likely to facilitate development of a more reliable EOETS model. Further details of the current understanding of the Stour and the Blackwater and the key issues is given in the Scoping Study Report which is included as an Appendix to this Brief.

3.2 PURPOSE OF THE STUDY

The aim of this study is to improve the level of understanding of the hydrology of the Stour and the Blackwater by addressing items iii) and iv) identified above. Item ii) will be addressed separately by ESW.

3.3 SUMMARY OF OBJECTIVES

This investigation has four specific objectives:

- To undertake a comprehensive programme of data collection - including a field data - required to support the investigation of time of travel and river losses in the Stour and the Blackwater.
- To analyse collected data to investigate the relationship between bulk transfers and time of travel in both the Stour and the Blackwater.
- To analyse collected data to investigate the impact of riverbed infiltration, groundwater abstractions and increased evapotranspiration on bulk transfers.
- To produce a report detailing the results of the investigation, including recommendations covering how best to represent river losses and time of travel in a new EOETS model.

4 SCOPE OF THE STUDY

4.1 TIME OF TRAVEL

- l) Obtain the following information from the Environment Agency for the period of operation of the EOETS (1971 to date):
 - Daily bulk transfer data ie. flow records for Kirtling Green Outfall, Great Sampford Outfall and Wixoe.
 - Daily flow data for the 5 No. gauging stations along the Stour and the 4 No. gauging stations along the Blackwater (including the low flow gauge at Langford).
 - Daily rainfall data from monitoring stations in the two catchments.

- Details of operating rules for hydraulic control structures along the Stour and the Blackwater. If appropriate, visit the rivers to make an inspection of key hydraulic control structures.
- ii) Select a representative sample of well-defined steps in EOETS transfer discharged at Kirtling Green outfall to cover the range of transfer pumping rate. If possible identify "slugs" during dry weather conditions. Analyse river flow records to determine the travel time of the pressure wave between gauging stations along the Stour. Determine the relationship between travel time and transfer, taking account of hydraulic control structure operation if possible.
 - iii) Repeat step ii) for EOETS transfer to the Blackwater, using clearly defined "slugs" at Great Sampford Outfall. Analyse river flow records to determine the travel time of the pressure wave between gauging stations along the Blackwater. Determine the relationship between travel time and transfer, taking account of hydraulic control structure operation.
 - iv) Recommend approach to representation of travel time in new EOETS model.

4.2 RIVER LOSSES

A programme of data collection is first to be carried out, including an 8 week fieldwork programme. The collected data are to be analysed to investigate losses along the two rivers.

4.2.1 Data collection

- I) Obtain the following information from the Environment Agency:
 - Monthly and annual rainfall and runoff data for the period of record for the following gauging stations:
 Stour catchment: Kedington, Sturmer, Broad Green, West Mill, Glemsford, Long Melford, Bardfield Bridge, Lamarsh, Langham, Polstead, Hadleigh, and Stratford St.Mary.
 Blackwater catchment: Stisted, Copford Hall, Guithaven and Appleford Bridge and Langford.
 - Daily river flow records for principal gauging stations in the above sub-catchments for the period of fieldwork
 - Daily rainfall data for rainfall gauging stations closest to selected flow measurement sites for the period of fieldwork.
 - MORECS evapotranspiration data for the period of record for Squares 143 and 151.
 - Monthly abstraction data for licences in above sub-catchments with daily maximum licensed abstraction above 2% of Q_{95} at the nearest downstream gauging station, for the period of record.
 - Daily abstraction data for licences in above sub-catchments with daily maximum licensed abstraction above 2% of Q_{95} at the nearest downstream gauging station, for the period of fieldwork.

- Monthly EOETS transfer, Wixoe abstraction and Stour Augmentation Groundwater Scheme (SAGS) data for the period of record.
 - Daily EOETS transfer, Wixoe abstraction, and SAGS data for the period of fieldwork.
 - Estimated Sewage Treatment Works (STW) dry weather flows (DWFs) in above sub-catchments for the period of record.
 - Monthly/annual groundwater levels at observation wells in the vicinity of the main river, especially those in close proximity to public water supply abstraction boreholes for the period of record.
 - Weekly groundwater levels at observation wells closest to flow gauging locations.
- ii) Obtain the following information from the British Geological Survey:
- Logs of boreholes along the Stour and the Blackwater valleys (particularly those for public water supply abstraction wells).
- iii) Undertake a 9 week programme of weekly flow gauging at a total of 25 No. locations on the Stour, Blackwater and their tributaries. Wherever possible survey dates are to be chosen to lie within periods of insignificant rainfall and unchanged operating conditions for EOETS and SAGS in the preceding seven days.

The flow measurement survey will use existing channel/sections suitable for measuring velocity by current-metering. The precise location of sites is to be agreed with ESW's Liaison Officer. For guidance the following locations are envisaged:

Stour catchment

- 4 sites on the Stour between Kedington gauging station and Wixoe
- 6 sites on the Stour between Lamarsh and Langham gauging stations
- 3 sites on the Stour between Langham and Stratford St.Mary gauging stations
- 2 sites on the Box between Polstead gauging station and the confluence with the Stour
- 5 sites on the Brett between Hadleigh and Higham gauging stations

Blackwater catchment

- 4 sites on the blackwater between Appleford Bridge gauging station and ESW's abstraction point at Langford
- 1 site on the Brain between Guithaven Valley and the confluence with the Blackwater

Note: the sites on the Stour between Lamarsh and Langham gauging stations are already identified as they are currently utilised for ongoing monitoring work.

The Environment Agency and Anglian Water Services are understood to be planning a

pumping test at one of AWS's groundwater sources in the Lower Stour sub-catchment for the summer of this year. If this test goes ahead as planned then additional flow measurements may be required at the time of this test.

4.2.2 Data Analysis

- i) The following analyses are to be undertaken to investigate river losses in the Stour and the Blackwater.

Sub-catchment water balance analysis

Calculate the monthly water balance for the period of record for each sub-catchment and determine recorded sub-catchment runoff. Compare with expected figures based on catchment characteristics. Identify sub-catchments displaying significant differences and assess likely explanations.

Review of hydrogeology of Stour and blackwater valleys

Assess the geology along the Stour and Blackwater valleys and the degree of hydraulic continuity between the river and the underlying Chalk in the vicinity of public water supply abstraction wells. Investigate the degree of correlation between changes over period of record in groundwater levels and gauged river flows in sub-catchments.

Flow accretion profiles

Prepare expected and gauged flow accretion profiles along the two rivers for survey dates.

- iii) Using results of the above analyses postulate mechanisms and assess the magnitude of river losses and the impact of groundwater abstractions on river flows. Assess relationship between losses and transfer under range of climatic conditions. Propose method for taking account of losses in new EOETS model.

5 PROJECT INFORMATION

5.1 Programme

The successful tenderer will be appointed in August 1996 and will be expected to commence the project within 2 weeks of appointment. The engagement will for a period of 14 weeks from the date of commencement.

5.2 Reporting

Progress meetings will be held at ESW's offices at Hanningfield, near Chelmsford at approximately monthly intervals throughout the duration of the engagement. The consultant should allow for a total of 4 progress meetings plus a job-start meeting at the beginning of the project. Progress reports should be submitted to ESW's Liaison Officer at least two working days before each Progress Meeting.

A draft of the proposed contents and format of the project report should be agreed with ESW's Liaison Officer within . Four copies of the draft report should be delivered to the Liaison Officer at least 2 weeks before the end of the period of engagement.

Five bound copies and one unbound copy of the final project report are to be delivered to the Liaison officer by the end of the period of engagement. A copy of the final report will also be required on diskette in Wordperfect 6.1 format.

5.3 CONSULTATION & SOURCE DATA

The consultant will be expected to liaise as necessary with Environment Agency staff to obtain data required for the study:

- Mark Huband (Environment Agency, Ipswich - hydrometry)
- Graham Robertson (Environment Agency, Ipswich - water resources)
- Alan Hull (Environment Agency, Ipswich - water resources)
- Tim Barritt (Environment Agency, Kelvedon - operations)
- Glenn Watts (Environment Agency, Peterborough - water resources)

The availability and format of data may vary. All relevant information will be made freely available to the Consultant, although prior notification to the office concerned is essential.

The consultant should include in his price the cost of obtaining information from other third parties.

5.4 ADMINISTRATION OF THE CONTRACT

This project will be undertaken on a fixed fee basis in accordance with the ACE Conditions of Engagement, 1995 Agreement D.

For the purposes of this engagement the ESW liaison officer will be Guillaume Stahl (Water Resources Projects Engineer, Hanningfield).

6 THE PROPOSAL

It is important that the tenderer demonstrates sufficient understanding of the task and his ability to undertake the study. The tender should include the following information:

- Appreciation of the task
- Proposed approach and methodology
- Project organisation and staffing, including curriculum vitae for key staff, and use of regional offices.
- Relevant recent experience
- Detailed work programme
- Proposed use of sub-contractors
- Details of quality assurance policy