



Proposal Reference: CP357

**IMPLEMENTING A DO-BASED TOOL FOR
MONITORING NETWORKS**

Proposal for a Collaborative Research Project

JULY 2008

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1. BACKGROUND AND OBJECTIVES

Past studies have shown that changes in the concentration of Dissolved Oxygen (DO) can provide information on: microbial growth; areas of active corrosion; and points of air ingress with subsequent formation of “white water”. Exploitation of DO’s potential as a multi-purpose tool for monitoring networks has in the past been severely hindered because of maintenance requirements/calibration drift of conventional DO instruments. A previous Portfolio project (CP281) has shown that cost-effective, accurate and reliable instrumentation based on a new technology (Optical DO) is now available. This demonstrated that DO trends can be used to identify areas of local activity (e.g. at biofilms) that are a potential risk to water quality. It was also demonstrated that analysis of DO trends at key network points can provide information on time-of-travel, and could therefore be used to validate hydraulic models. The project also developed and applied a mathematical technique for deriving residence time distributions from DO trends before and after a service reservoir or contact tank.

The primary objectives of this work are to develop robust methodologies for using DO data to:

- Assess network condition.
- Estimate time-of-travel and mixing in networks (service reservoirs, contact tanks).

The opportunity will also be taken to examine the feasibility of using DO to assess the condition of domestic systems and to evaluate the contribution of DO to the taste of water.

2. BENEFITS TO PARTICIPANTS

A cost-effective approach to:

- identify where network condition may put water quality at risk;
- assess the effectiveness of interventions to address a quality issue.

A tool for validating existing network hydraulic models and providing qualitative information (e.g. identifying source changes, reverse-flow).

A cost-effective approach to determining residence time distribution in service reservoirs.

3. WORK PROGRAMME

3.1 Work Programme

The key elements of the work programme include:

- Undertaking network monitoring programmes to demonstrate how DO trends can be used to: identify areas at risk; and, provide qualitative information on events in the network.
- Developing a software tool and methodology for analysing DO trend data to provide information on time-of-travel and residence time distribution between network points.
- Undertaking exercises identified previously as supporting wider use and knowledge with regard to DO, including:
 - assessing the feasibility of using the DO trend of the “first-draw” of water to assess condition of domestic pipework;
 - performing taste panel tests to ascertain the contribution of DO to the taste of drinking water.

3.2 Details of Tasks

1. Network monitoring exercises

Three multi-point (at least 4 points) monitoring programmes will be undertaken within suitable networks to demonstrate how:

- DO trends can be used to identify areas at risk, including service reservoirs/contact tanks where ingress is suspected.
- DO trend data “before” and “after” refurbishment can be used to assess the preceding condition of the network, and the effectiveness of the subsequent intervention (swabbing, lining, replacement).
- Time-of-travel and residence time distribution (service reservoirs, contact tanks) can be determined from a comparison of DO patterns between sampling points.

2. Develop a software tool and methodology for RTD

A spreadsheet tool, and associated guidance, will be developed based on work done by WRc previously. The analytical approach will be further tested using data from the field evaluations in Activity 1. This will be used to confirm the robustness of the approach under different hydraulic conditions.

3. Monitoring “first-draw” to assess domestic pipework

A methodology and objective for the tests will be developed. Suitable domestic systems will be selected: it is assumed that for feasibility testing the tests will be undertaken by WRc staff, or possibly contributors’ staff.

4. Ascertain the contribution of DO to the taste of drinking water

A methodology for a test panel test will be developed with specialist support provided by Campden and Chorleywood Food Research Association (CCFRA). This will include submission of samples that have had DO content artificially depleted. Recent literature will be reviewed on the impact of DO on taste.

3.3 Activity Schedule

The schedule of activities is shown below.

Task	Month														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Liaison Group meetings	•			•			•			•			•		
1. Network monitoring															
- equipment spec./purchase		■	■												
- build and test new rigs			■	■											
- programme 1					■	■	■								
- programme 2							■	■	■						
- programme 3								■	■	■					
2. Develop spreadsheet tool											■	■	■		
3. Monitoring “first-draw”												■			
4. Effect of DO on taste		■	■	■											
Guidelines on using DO												■	■		
Implementation workshop															•

3.4 Project Outputs

- A methodology for using DO trends to provide information on network condition. This will be based on the results of the detailed network monitoring undertaken during the project.
- A spreadsheet tool for estimating residence time distributions from trends in DO.
- A workshop will be provided to review the outcome of the work and facilitate implementation of the tools developed during the project.

4. ABOUT WRc AND RELATED WORK

WRc is a leading provider of solutions for the water, waste and the environment industry. For over 75 years, WRc has been providing independent research and consultancy to utilities, regulators, industry, suppliers, the European Union and Governments worldwide.

- CP281 and CP281 extension work to evaluate a range of DO instruments, undertake field monitoring of DO and develop a mathematical approach for using DO trends to provide information on: time-of-travel, mixing within reservoirs.
- Study of “White Water” complaints for a major water utility, including demonstration of the application of DO to identify air ingress during mains cleaning activity (1999).

5. QUALITY ASSURANCE

WRc operates a Quality Management System accredited to BS EN ISO 9001:2000 by National Quality Assurance Ltd, certificate number 17198.

6. LIAISON WITH CONTRIBUTORS

Liaison Group meetings will be held with project representatives as illustrated in the work programme and activity schedule.

7. PAYMENT DETAILS

Your fixed price contribution to this project is detailed on the Authorisation Sheet that will be sent to you for signature.

Invoices will be submitted as follows:

- 20% on receipt of signed order
- 25% on achievement of milestone 1 – completion of rig builds and taste tests
- 30% on achievement of milestone 2 – completion of second monitoring programme
- 25% on completion of guidelines and software

8. SERVICES PROVIDED BY THE CLIENT

Reasonable assistance will be required from those hosting the network evaluations. This may include: setting up of on-line monitoring points; provision of relevant data (regulatory sampling, flows, pressures). WRc may also request additional "grab" sampling for specific water quality parameters) from a network.

9. SERVICES PROVIDED BY OTHERS

CCFRA - Campden and Chorleywood Food Research Association will provide expert support with regard to setting up the methodology and testing of the impact of dissolved oxygen on the taste of water.

10. PROFILE(S) OF KEY WRc STAFF

Mark Watts will manage and provide key technical input to the project.

Mark has been with WRc for 21 years and is a chartered chemist and graduate chemical engineer and works as a Consultant Engineer. Prior to joining WRc, Mark worked for 6 years as a process development technologist in fine chemicals and precious metals manufacture. He has managed a wide range of multi and single client projects covering all aspects of potable water treatment, from comprehensive audits of process and operational practice at individual water treatment works, to performance benchmarking of dissolved air flotation (DAF) and electrochlorination systems. He is sole or joint author of a number of national water industry guides, which include: pH control; chemical dosing; DAF saturator systems and systems for rapid dispersion of chemicals. He has written a number of media articles relating to his areas of technical specialisation.

Jeremy Dudley will be responsible for technical input relating to the spreadsheet to be used modelling of DO trends.

Jeremy is a Senior Process Engineer, with expertise in the modelling of sewage treatment systems; activated sludge systems and modelling of processes and hydraulics at sewage and industrial effluent treatment works, both in the UK and overseas. This has included methanol-aided denitrification systems, modifying activated sludge models to predict the fate of methanol through the aeration system; modifying settling processes to study the partitioning of radionuclides; and routine wastewater modelling for air and oxygen activated sludge systems. He regularly runs training courses for users of the WRc software packages and is responsible for the continued development of WRc's software programs, STOAT, Plan-It STOAT and OTTER, and the software elements for TR61. He developed a programme to compare the power and chemical costs of a large UK utility against the values that would have occurred had they operated following their internal best practice guidelines. Additional mathematical models are currently being added to the treatment processes to better investigate the effect of the best practice guidelines on opex drivers. He has 15 years experience of sewage treatment systems, 10 years experience of

mathematical modelling of sewage treatment systems and pilot work experience with activated sludge and sedimentation

Leo Carswell will provide support with regard to the specification and calibration of DO sensors.

Leo is a Principal Consultant in instrumentation at WRc. He joined the company in July 2002 having completed a PhD in instrumentation for water quality monitoring. He is involved in instrument development, prototype testing as well as performance evaluations of quality analysers, solids monitors, level sensors and flow meters for water, wastewater and sludge applications. He has significant experience in optical instrumentation specifically for freshwater algal and environmental monitoring and is currently managing a number of collaborative research projects. In addition, Leo has experience of supply leakage, specifically in lead pipes, through his involvement in current sampling and analysis programs. He has also been involved in surveying water mains using WRc's Sahara leak location system.

11. CONTRACT CONDITIONS

WRc Contract Conditions for Collaborative Projects will apply to any resulting contract (ref. KMCL/9211068/12.2.08), except as otherwise amended in this proposal.

12. VALIDITY

This proposal is valid for a period of 6 months from the date of the proposal.

APPENDIX A CONTRACT CONDITIONS

WRc plc Contract Conditions for Collaborative Projects

1. DEFINITIONS

CLIENT means an individual, company or other organisation.

CONTRACT means the legal agreement between WRc plc ('WRc') and an individual Client in respect of a project.

PROPOSAL means the detailed offer made by WRc to an individual Client in respect of a project and which forms the basis of the Contract.

2. PROPOSAL ACCEPTANCE

(a) Formal acceptance of a WRc Proposal constitutes an undertaking from the Client to pay his full financial contribution to that Contract, subject to the provisions of clause 11.

(b) Unless stated otherwise, a WRc proposal and any acceptance thereof will automatically be deemed withdrawn if there is insufficient support.

3. TECHNICAL LIAISON

(a) The Client will be invited to nominate a representative to liaise with WRc on technical issues.

(b) Liaison meetings will be held periodically with the Client representatives and others as agreed.

4. PROJECT DETAILS

(a) WRc will carry out the work in a professional manner using suitably qualified and experienced staff.

(b) Details of the scope of work the date for commencement of the work and its duration will be in accordance with the Proposal.

(c) Any changes to these details will be as agreed in writing between WRc and the participating Clients .

5. SUB-CONTRACTS

WRc reserves the right to sub-contract part of the work to a suitably qualified third party(ies) if WRc considers this to be in the best interests of the Contract .

6. SITE WORK

If work is to be carried out using equipment, facilities or premises belonging to or controlled by the Client or any third party the Client will make arrangements for all necessary access to such equipment, facilities or premises. WRc will observe any site or operational instructions imposed by the Client.

7. CONFIDENTIALITY

(a) The parties hereto undertake to keep confidential all information relating to the business operations of or client specific data provided by the disclosing party to the receiving party and which is designated as confidential by the disclosing party. Notwithstanding, this shall not prevent WRc from disclosing to other funders of or in kind contributors to the Contract, information based on the analysis of such client specific data.

(b) The provisions of clause 7 (a) will not apply to information which is in the public domain or becomes in the public domain through no fault of either party to the Contract.

8. OWNERSHIP OF RESULTS

(a) All preexisting intellectual property owned by WRc or the Client or any third party but used in connection with the Contract will remain the exclusive property of the owner.

(b) Unless agreed otherwise in writing all Contract results, including all computer programs reports and other documents, compilations of data, inventions designs methodologies or knowhow and other intellectual property and all related rights will belong to WRc. The Client shall be free to use the results for its own business use. The Client may permit third party consultants or contractors to access the Contract results for the purposes of providing services to the Client. All access to Contract results by third parties must be strictly controlled by the Client. The Client undertakes to use all reasonable efforts to ensure that the third party does not copy the results in electronic, paper or other format nor retain the results in any format after completion of the services for the Client.

(c) In the event that Contract results appear to be capable of commercial exploitation the parties will discuss the same and any collaboration in respect of exploitation and revenue sharing arrangements will be subject to separate written agreement.

9. PRICING

(a) Contracts are generally on a fixed price basis in accordance with WRc's proposal.

10. PAYMENT TERMS

(a) An invoice for an agreed percentage of the Client's contribution for each year of a Contract will be submitted on commencement of the work for that year. Subsequent invoices for that year will be as detailed in the Proposal.

(b) If any delay by the Client or failure of the Client to meet its contractual obligations results in any additional costs for WRc, then WRc shall be entitled to reimbursement of such costs by the Client.

(c) Payment is required within 30 days of receipt of invoice and any sums remaining unpaid after 30 days will incur an interest charge at a rate of 2% above the HSBC's base rate. An interest charge will not be made in respect of invoices not properly raised in accordance with the Contract.

(d) Value Added Tax (VAT) and other statutory taxation will be added to every invoice at the prevailing rate.

11. **TERMINATION**

- (a) Either party may terminate the Contract subject to providing three months written notice to the other party.
- (b) On termination all sums irrevocably incurred or committed by WRc in connection with the Contract will become due for payment. WRc will make available to the Client all Contract results available up to the termination date.
- (c) Notwithstanding the above either party may terminate the Contract with immediate effect in the event of the other party's bankruptcy or liquidation or in the event that the other party commits a remediable breach of Contract which remains unremedied after 28 days from written notification of the breach. Such termination would be without prejudice to the rights accrued by the terminating party up to the date of termination.

12. **LIABILITIES**

- (a) Subject to Clause 12b) each party to the Contract will indemnify and keep indemnified the other party from and against all claims, demands, proceedings, damages, costs, charges and expenses arising out of or in connection with the Contract and due to its acts, omissions or negligence or that of its agents or employees. Neither party shall be liable to the other in respect of any consequential or indirect losses including loss of profit or business opportunity, loss of income or damage to good will or reputation.
- (b) If the medium on which any software is provided to the Client is defective, WRc will replace them at no cost provided they are returned to WRc within 60 days of receipt.
- (c) IN RESPECT OF SOFTWARE PROVIDED TO THE CLIENT UNDER THE CONTRACT WRC MAKES NO REPRESENTATION OR WARRANTIES OF ANY KIND EXCEPT AS PROVIDED IN CLAUSE 12(b) WHICH IS IN LIEU OF ANY AND ALL OTHER WARRANTIES EXPRESS OR IMPLIED INCLUDING WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ALTHOUGH CARE HAS BEEN USED IN PREPARING THE SOFTWARE ALL LIABILITY IS DISCLAIMED FOR ITS ACCURACY OR COMPLETENESS. WRC ASSUMES NO RESPONSIBILITY FOR THE LICENSEES USE OF THE SOFTWARE AND WRC SHALL NOT BE LIABLE FOR LOSS OF PROFITS, LOSS OF USE OR ANY INCIDENTAL CONSEQUENTIAL OR EXEMPLARY DAMAGES AS A RESULT OF SUCH USE, EVEN IF AWARE OF THE POSSIBILITY THEREOF. UNDER NO CIRCUMSTANCES SHALL A CLIENT BRING ANY CLAIM OR CAUSE OF ACTION AGAINST WRC MORE THAN TWELVE MONTHS AFTER SUCH CLAIM OR CAUSE OF ACTION ARISES.
- (d) Neither party shall be liable for any default due to any act of God, war, strike, lockout, industrial action, fire, flood, drought, tempest or other event beyond the reasonable control of either party.

13. **LAW**

The Contract will be construed as a Contract made in England and governed by English Law.

14. **NOTICES**

Any notice required to be given under this Contract may be sent by post from one party to the Company Secretary or other nominated officer at the registered address of the other party. Communications sent by post will be deemed to have been received forty-eight hours after posting.

15. **ARBITRATION**

In the event of any dispute arising between the parties on any matter concerning the Contract, such dispute will be referred to an arbitrator appointed by the parties or in the event of any failure to agree on such appointment, by the President for the time being of the Law Society on the application of any party hereto, such determination to be final and binding on all parties. The language of arbitration will be English. However this clause shall not apply in respect of any claim by WRc against the Client for non-payment of invoices or for any other dispute where WRc's claim is for less than £10,000 and WRc shall be entitled to pursue all such claims through the courts.

16. **VARIATIONS TO CONTRACT CONDITIONS**

Any variation to these conditions will be agreed in writing between WRc and the Client and will be subject to any third party rights.

17. **THIRD PARTY RIGHTS**

Nothing in this Contract confers or purports to confer on any third party any benefit or right to enforce any term of this Contract.

18. **DATA PROTECTION AND FREEDOM OF INFORMATION**

- (a) Both parties undertake that they will duly observe all their obligations under the Data Protection Act 1998, and any associated regulations or legislation.
- (b) WRc will assist the Client in meeting any reasonable requests for information which are made to WRc in connection with the Freedom of Information Act 2000 or any statutory modification or enactment thereof except that the Client shall not disclose to third parties information which is exempt as described within Part II of the said act.