Regulation of Real Time Control in Urban Drainage Systems

NRA

National Rivers Authority

WRc plc

Project Record 555/4/NY

NRA Project 553

DRAFT

REGULATION OF REAL TIME CONTROL IN URBAN DRAINAGE SYSTEMS

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Draft Project Record

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EXECUTIVE SUMMARY

This Project Record accompanies R&D Note 555/3/NY which has identified the issues pertinent to the regulation of Real Time Control (RTC) schemes for urban drainage systems and suggested actions and research to allow effective consents to be set for such systems.

The Water Service Companies (WSCs) are increasingly considering the use of active control of urban drainage systems as a means of meeting environmental obligations at least cost. It is assumed that, in principle, the NRA wants to support this trend on the basis of securing the greatest possible environmental benefit from the available financial resources. This being so, certain technical and policy issues need to be addressed by the NRA.

The Note briefly reviews current consenting practice to highlight areas of inadequacy for RTC schemes. Experience of RTC systems to-date is reviewed on a national and international basis and is found to provide very limited guidance on how effective regulation can be exercised within the regulatory framework for England and Wales.

The specific issues which have been identified to require further consideration, together with the proposed actions are as follows:

- **Environmental standards** : The ability of the operator to exercise much more control over discharges means that the environmental standards must be expressed more comprehensively to avoid any "loop-holes" which could be exploited. This requires the underlying science to be examined for gaps in knowledge. As a first stage, a small scale study to review the scientific knowledge and identify development needs (if any) taking approximately 6 months and £25k is suggested.

- **Variability in system operation** : RTC derives its advantage from flexible responses to prevailing conditions. This has two major implications for the NRA; consents must be set on an urban catchment-wide scale to allow "trade-offs" between discharges, and consents must be equally flexible to allow optimal operation. Suggested actions are listed under "Consent conditions" below.

- **Awareness of RTC** : To audit and agree RTC schemes the NRA must have a good awareness of the technology. Several possible ways of developing and disseminating this awareness are suggested based on workshops, collaboration with the WSCs, use of pilot implementation studies and a "task group" to consent RTC schemes nationally.

- **Reliability and risk** : The introduction of more mechanical and electrical equipment into urban drainage systems increases the risk of operational malfunction. Ways have to be found to quantify and manage this risk to ensure adequate protection of the environment. The adoption of established reliability engineering techniques, modified to meet the needs of RTC, is recommended. Development and dissemination of the relevant techniques is estimated to take 1 year and cost £75k.

- **Consent conditions** : Ways have to be found to set consent conditions which allow the flexibility of the RTC system to be used to advantage whilst ensuring protection of the environment. This points towards the use of descriptive, or at least non-numeric, consents. **The NRA has to decide whether it is acceptable to use such consents potentially for multiple, major discharges to important water courses.** A pragmatic way forward, based on the inclusion of control rules in the consent, has been identified for current schemes of limited scope. When the the NRA's policy in respect of the above issue has been resolved, it is likely that general guidelines for consenting RTC schemes, together with some standard consent clauses could be drafted. A work programme of 9 months duration and £50k is estimated for this purpose.

KEY WORDS

Real Time Control, combined sewer overflow (CSO), consent setting.

1. INTRODUCTION

1.1 Overview

R&D note 555/3/NY identifies the issues pertinent to the regulation of Real Time Control (RTC) schemes for urban drainage systems and suggests actions and research to allow effective consents to be set for such systems.

The Water Service Companies (WSC's) are increasingly considering the use of active control of urban drainage systems as a means of meeting environmental obligations at least cost. This being so, certain technical and policy issues need to be addressed by the NRA. The Note identifies these needs and provides an overview of the extent and experience in RTC in the UK and abroad.

Table 1.1 shows the contents of the R&D Note.

Table 1.1 Contents of NRA R&D Note 555/3/NY

1.2 Project Record

The R&D note contains a bibliography of recommended reading on RTC and related topics. The bibliography has been produced as a result of extensive literature searches in the WRc Aqualine database and additional on-line searches. Section 2 of this project record provides the abstracts of these key papers as a guide to their contents and findings.

In addition, details of contacts made in the UK and abroad in the course of this research are summarised in Section 3. All contact were made either by telephone or letter.

2. RTC LITERATURE REVIEW

2.1 On Line Search

An extensive literature search was undertaken to investigate the extent to which the issue of environmental regulation of RTC urban drainage systems had been raised before. Searches were undertaken in the following databases:

(i) INSPEC 1969-1995

(ii) NTIS 1964-1995

(iii) Ei Compendex*Plus 1970-1995

(iv) Enviroline 1970-1994

(v) Pollution Abs 1970-1994

(vi) DIALOG SourceOne (SM) Eng 1991-1994

(vii) Energy SciTec 1974-1995

(viii) Water Resour.Abs. 1968-1994

(ix) WATERNET 1971-1994

(x) WRc Aqualine 1970-1995

No references were found specifically relating to the environmental regulation of RTC systems. The literature covering RTC in general, however, is quite extensive. A number of key references are included in the R&D Note as suggestions for further reading. For information, a summary of these papers is included here if appropriate.

2.2 Summary of Selected Key Papers

BO-NEILSEN J, LINDBERG S, HARREMOES P (1993) Model based on-line control of sewer systems. Proceedings of the 6th IAWPRC Workshop on Instrumentation and Control of Water and Wastewater Treatment and Transport Systems.

A new software package was developed for use in real time control of the flow in combined sewer systems. A central feature of the new software was forecast modelling of the flows and volumes in the sewer system. Based upon forecast model predictions, an expert system or an optimisation module is able to determine the set points for all regulators in the system. The first practical application of the software was in the city of Aalborg.

FOWLER D (1993) Real Test. New Civil Engineer Water Supplement. 28-30.

North West Water and WRc plc were the UK partners in a European research project investigating the improvements to both service and the environment afforded by electronic real time control of sewerage systems. Four pilot schemes were being implemented where key elements would be operated by computers processing data from sensors around the catchment. The project involved one water utility and consultant or research organisation from Denmark, UK, Spain and Italy. The UK pilot scheme was in Bolton, aimed at reducing flooding in the town centre and spill from overflows to rivers. Real time control was being used to complement the works allowing the storage capacity of the attenuation tanks to be used with optimal efficiency. Features of the telemetry system, software packages including a SCADA system are described. Details of the other schemes within the project are also outlined. © WRc

GILL E J (1994) Real Time Control of Urban Drainage Systems. WRc Portfolio Report No. PT1031.

This research project examined the existing capabilities for effectively exercising Real Time Control (RTC) at an operational level for urban drainage systems. RTC is defined as the active operation of movable structures or pumps based on remotely transmitted measurements during the runoff process. A detailed methodology was developed for the design and assessment of RTC strategies using state of the art modelling software. Three contrasting urban drainage systems were studied. RTC strategies were simulated and resulted in improved system performance in terms of reduced CSO spill volume and frequency. Guidelines were developed on when and how to apply RTC technology to typical UK urban drainage systems.

GRIGG N S, SCHILLING W (1986) Automating stormwater and combined sewer systems: The possibilities. Water Engineering and Management. 133, 5, 33-35.

The authors provide some facts about automating stormwater and combined sewer systems and an analysis of the conditions necessary for the success of automation. The observations are based on 15 years of experience in this field in the USA and Canada.

GUSTAFSSON L, LUMLEY D, PERSSON B, LINDEBORG C (1993) Development of a catchment simulator as an on line tool for operating a wastewater treatment plant. Proceedings of the 6th International Conference on Urban Storm Drainage.

The authors describe the approach taken to developing control strategies for the management of wastewater flows towards Goteborg sewage treatment works. Off line simulations indicate that the sewer model can produce accurate inflow forecasts four to six hours forward in time and that 12 hour predictions are useful for indicating trends over a longer time horizon.

KHELIL A, GROTTKER M, SEMKE M (1990) Adaptation of an expert-system for the real time control of a sewerage network: Case of Bremen left side of the Weser. Proceedings of the 5th International Conference on Urban Storm Drainage. 1329-1334.

In 1986, the city of Bremen started the realisation of a computerised system for real time control of part of its network. It was decided to implement an expert-system as part of the

control strategy research. This paper describes the development of control rules to improve system performance.

NOVOTNY V, CAPODAGLIO A, JONES H (1992) Real time control of wastewater treatment operations. Water Science & Technology. 25, 4-5, 89-101.

The concept of real time control as applied to sewage treatment facilities is discussed. In contrast to the usual static, or time variant, mode of control in which sewage in excess of a pre determined capacity was bypassed or diverted into an overflow. RTC used mathematical models to predict the near-future influent loads, parameters and performance of the system and the quality of the effluent. The operation of the system could then be adjusted and optimised either automatically or manually. The components of RTC systems are listed and examples of existing RTC systems for operation of sewage treatment facilities are described. There are 37 references. © WRc

ROBINSON M S (1990) Operating of instrumentation, control and automation at Holdenhurst sewage treatment works, Bournemouth. Journal of the Institution of Water and Environmental Management. 4, 559-569.

Operating experiences of the design, construction, and daily use of automation at a coastal sewage treatment works are described. A full description of each automated item of plant is given, together with an overview of the completed scheme. Cost savings as a result of automation are assessed, and improvements in works' operation and effluent quality are outlined. Development of an expert system for regulating storm discharges is also given.

SCHILLING W (1991) Real time control of urban drainage systems - from suspicious attention to wide spread application. Advances in Water Resources Technology 1991. Proceedings of the European Conference Advances in Water Resources Technology.

An urban drainage system is operated in real time if process data, which are currently monitored in the system, are used to operate flow regulators during the actual process. Real time control offers a potential way to reduce flooding and pollution problems with relatively little investment cost. Side benefits such as less energy costs (pumping), improved wastewater treatment, in sewer sediment control, supervision, understanding, and record keeping of systems performance are also achieved.

TIDSWELL R G, WILLIAMS W D (1994) Bolton RTC - A glimpse at the future. Proceedings of the Wapug Autumn Conference 1994.

This paper discusses the use of a simple hydraulic model of the Bolton town centre sewer system to develop control rules for the operation of that system in real time. The software used was Mouse Pilot, developed by DHI, which enabled the rapid simulation of one years rainfall to assess the performance of control strategies during dynamic loading. Results are presented which describe a 14% reduction in total spill volume using global control. Future savings in the region of 30% are estimated if control of both tank filling and emptying is achieved.

3. RTC CONTACTS

3.1 Overview

A large number of contacts were made in the preparation of the R&D Note. Contacts were made throughout the UK water industry and in Europe and North America. Contacts were either operators of RTC sewerage systems, regulatory authorities or technical experts in the field of RTC.

In order to standardise the responses to requests for information a standard series of questions were posed. These questions were either included in a letter or fax or gone through over the telephone. The questions were of the following form with some aimed specifically at operators and others at regulators both in the UK and abroad:

- Are you aware of any operational RTC systems?
- Are you aware of any planned or pilot RTC applications?
- Have you had any formal or informal discussions on consenting CSOs in RTC systems?
- How are CSO consents set in your country?
- Do you have any other comments on RTC?

The responses to these questions are included in Table 3.1. Only questions appropriate to the organisation being surveyed were posed.

3.2 Questionnaire Responses

Table 3.1 Real Time Control Questionnaire Responses

Name	Organisation	Contact Medium	Response
Pedro Buesa Ruiz	Ayuntamiento de Vitoria-Gasteiz (Spain)	Fax	No reply
Nicola Bazzurro	Azienda Munucipalizzata Gas e Acqua - Genova (Itlay)	Fax	No reply
Pere Malgrat	CLABSA - Barcelona (Spain)	Fax	Barcelona RTC system has 18 raingauges, 12 level sensors, 5 pumping stations and 1 gate. RTC is now happening in practice for the first time in Spain. No special regulation of discharges for CSOs operating under RTC. Spanish water industry study group set up (Advanced Management of Urban Drainage Systems) to look at issues such as consenting discharges.
Stuart Ross	Clyde River Purification Board	Telephone	No formal discussions for consenting RTC schemes with Strathclyde RC. Potential for RTC recognised at Kilmarnock (system at full capacity) - no discussions yet.
Marzio Malagutti	Commune di Mantova-ASM (Italy)	Fax	No reply
Antonio Zerman	Consorzio della Riviera Veronese del Garda (Italy)	Fax	No reply

Name	Organisation	Contact Medium	Response
Hans Hartong	Consultant (Netherlands)	Fax	No reply
Berislav Tomicic	Danish Hydraulic Institute	Fax	SPRINT Project SP226 (RTCUDS) has not tackled the issue of environmental regulation. Possibility for new research in the upcoming 4th Framework Programme.
Jean-Marie Delattre	Director of water and sewerage Seine St Denis (France)	Fax	No reply
Rienk de Vries	EMA (UK)	Telephone	R de V has made presentations to NRA in both Yorkshire and Bristol on the topic of RTC(and also spoken to several of the companies). Felt there had been much interest and useful discussion. Had specifically requested to have opportunity to tender for this project and felt he had been misled over not being on tender list (quote "was livid"). The strong impression was that whilst he was prepared to talk in generalities about RTC concepts he would not be drawn into specifics despite repeated attempts to steer the discussion that way. This might be as a reaction to not being having the opportunity to tender, or because he (the company) did not have much practical experience to back up the theory. In any event, little additional practical information was gained as a result of the conversation.
Phil Deakin	ENTEC (Northumbrian Water)	Telephone	Entec are looking at potential benefits and ways of implementing RTC for Tyneside scheme on behalf of NW. They have shown positive benefits - but timescales for implementation of an operational scheme will be long. Teesside is considered to be another area with potential for RTC, but no detailed work has been carried out there yet. There are some instances of relatively small local scale problems where the use of RTC is being

Name	Organisation	Contact Medium	Response
			considered to alleviate existing problems, e.g. South Park on the Darlington system. Two automatic penstocks are interfering with one another causing operational problems. A common control system is being investigated to make them work as intended.
Colin Bayes	Forth River Purification Board	Telephone	There are no operational RTC schemes which involve consenting in this area at present. The potential needs for and benefits of RTC on the Levan Valley trunk sewer have been identified. This would involve the utilisation of storage at input pumping stations to minimise the on line storage required as part of this scheme. The potential of an application on the Dunfermline trunk sewer was also identified if necessary water quality improvements are not realised by traditional engineering solutions. At Kirkcaldy a simple local control application uses level floats to monitor the levels in headworks and control the operation of pumping stations. This can result in beach pollution. CB identified the existing harmony between passively controlled systems and receiving waters. This relationship may be altered under RTC. CB identified the approach of HMIP - Integrated Pollution Control .
Doug Lumley	GRYAAB Gothenburg (Sweden)	Fax	Consent simply requires operator to "reduce CSO" and increase treatment capacity from $6m^3/s$ to $8m^3/s$.
Andy Eadon	Haswells (Severn Trent Water)	Telephone	No recognised RTC schemes operational at present. Unofficially, there is a device called a "Strabang Gate" which directs dry weather flows into Willenhall STW (contact Chris Sedgewick - Thame House). Also, on larger works inflows are frequently throttled by penstocks under wet weather conditions to avoid overload of the works, resulting in spill from the upstream system (e.g. Derby) - this may result in a breach of consent conditions. There are still long term plans for global RTC of the Black

Name	Organisation	Contact Medium	Response
			Country Trunk Sewer, with a view to improving utilisation of the existing storage within the system to minimise spills and thereby avoid the need to construct the "missing link" which throttles flows. The financial strictures of AMP2 (40% of total CSO funds) mean that this is not a high enough priority to proceed at present. Some R&D is being carried out at the inlet to the Wolverhampton STW to optimise system performance in terms of inflow/flooding/pollution. Passive control is inadequate, sometime allowing the system to go "out of control". Within Severn Trent the key people concerned with consenting issues are Bob Breach, John Martin and Chris (?). Consenting of RTC systems is recognised to be an issue but no practical answers exist at present. RTC is recognised at a high level (John Banyard) within S-TW to be a major area of development for the future. However, anything that increases revenue costs is considered a bad thing. Hence making the business case for RTC can be difficult depending on discounting calculations. Factors in its favour may be restricted capital under AMP2 and the potential to use RTC to defer capital expenditure.
M Moens	HEIDEMIJ Advies (Netherlands)	Fax	No comment.
Chris Booth	HMIP	Telephone	Discussed the HMIP approaches of Integrated Pollution Control (IPC), Best Practicable Environmental Option (BPEO) and Best Available Techniques Not Entailing Excessive Cost (BATNEEC). Self monitoring was recognised as the way forward for cost effective environmental regulation. Self incrimination is still a problem area under UK law.
Richard Kellagher	Integrated Hydro Systems	Telephone	DoE funded collaborative research project into RTC. Regulatory issues not specifically addressed. Estimating "risk" of RTC seen as important. Members of project steering group are:

Name	Organisation	Contact Medium	Response
			Richard Freestone - NRA Jess Mann - Thames Water Brian McNicol - Wessex Water Dennis Dring - Yorkshire Water Brian Sharman - North West Water Barry Luck - McDowells Richard Long - Acer Richard Allitt - DHV David Walton - Wallace Evans Ian Noble - Montgomery Watson Phil Deakin - Entec Mike Sutcliffe - Anglain Water (retired) Pilot studies in Bradford and Bilbao which are in planning and design stages. Target of project is to produce a strategy statement aimed at informing potential RTC users of the factors to be considered when developing a system.
Ian Noble	Montgomery Watson	Telephone	MW have been involved in the study of the Bilbao (Spain) sewerage system over several years. Latterly the potential of enhancing the performance of the riverside and coastal interceptors, which were originally designed to operate conventionally, has been investigated at a series of levels. The study comprises one of the pilots of the HR/IHS RTC project. Very substantial benefits in terms of reduced spill frequencies (halved) and less storage (40% saving) have been demonstrated by extensive modelling based on use of WALLRUS (and more recently MOSQITO) to optimise the operation of the numerous overflows along the interceptors. Recent work has sought to introduce flow quality and receiving water sensitivity elements into the

Name	Organisation	Contact Medium	Response
			analyses to enhance benefits still more. The interceptor sewers are currently being constructed in accordance with the needs of the global RTC scheme. Environmental regulation influence on the system has been pragmatic. Major influences have been the desire to achieve maximum environmental benefit for the available funds, together with perceived political advantage. Other schemes: some involvement with Tyneside system (confidential), which has strong parallels with Bilbao. Some knowledge of London system - megamodel is running and being used. Believes the approach to RC is very different depending on whether system is introduced at the initial design stage, when the modelling demands can be daunting, or as a means of upgrading existing system performance, which is easier to handle.
Stuart Mitchell	North East River Purification Board	Telephone	No formal consent discussions. Some experiments regarding flow balancing of peak inflows to treatment plants to accommodate less than 3 dwf. Aberdeen is only area of potential.
Roy Wood	Northumbrian Water	Telephone	Tyneside Interceptor scheme was discussed. Scheme is at final stage of construction. A global real time control scheme is planned for the system but is NOT operational at the present time. No active control (even at a local level) is exercised at present. Throttles at CSOs are currently fully open, i.e. maximum flows are passed into the interceptor. This can result in excessive flows arriving at Howden STW. Global control system will seek to use storage in the interceptor and branches to "smooth" flows arriving at Howden and enable selectivity of points of spill to less sensitive areas. Planning appears to be in its infancy and there is no fixed timetable for implementation of any system. Coastal schemes at Whitley Bay and Roker/Seaburn (Sunderland) are further advanced. Here direct coastal discharges have been intercepted and there is a control strategy which:

Name	Organisation	Contact Medium	Response
			- first, pumps to Howden if there is available capacity, - if not, flow is stored until there is, - if storage is filled, flows are pumped to sea. Objective is to minimise pumping direct to sea. Impact assessments have been carried out for residual discharges to demonstrate compliance with Bathing Waters Directive.
Sue Stock and others	NRA Anglian	Letter	Haverhill Scheme: Industrial surface water sewer flows are diverted via hydrobrake to STW. A chemical monitoring system was put in place to automate the diversion in the event of high polluting loads. System abandoned due to reliability and maintenance problems. Desire for NRA involvement at design/planning stage of all sewerage development.
Chris Chubb	NRA Head Office	Telephone	Head office has no information on specific RTC applications NRA are keen to encourage use of RTC. Wish to shape thinking to ensure correct implementation. Main benefit seen to be reduction in pollution associated with large events by selectivity in timing and location of spills.
Clive Gaskell	NRA North West	Telephone	No formal consent discussions with North West Water. Awareness of RTC plans at Bolton & Liverpool. No formal approach made to NRA. Potential for RTC recognised in Manchester and Fylde. Recognition of difficulties in consenting RTC schemes. Current methods unsatisfactory even for passive systems. Monitoring of operational procedures seen as way forward for RTC consenting. Self incrimination problem recognised.
Malcolm Helm	NRA Northumbrian & Yorkshire	Telephone	The Tyneside Interceptor scheme is known to have potential to operate a form of RTC at the interception point of many of the branch sewers into the interceptor sewer. None of the consents for these overflows reflect the

Name	Organisation	Contact Medium	Response
			control capability - all are based on standard Formula A conditions. Concept is understood to be maximised utilisation of transport and storage capacity of both branch and interceptor sewers, with Formula A flows being default. Roy Wood of NW (Pity Me) is contact for more information. It is believed that significant operational problems have been experienced with both penstocks and telemetry links. Only localised water quality problems are experienced in the Tyne following commissioning of the Interceptor scheme - mainly aesthetic problems associated with "coastal strip" discharges. Also River Don scheme where NW are planning RTC on carry on flows from a storage tank to alleviate CSO spill problems. Consent is envisaged simply to require storage to be full before spill occurs. Two marine schemes at Sunderland and Whitley Bay are under construction which may have potential for RTC.
Peter Whalley	NRA Severn Trent	Telephone	No formal or informal discussions with Severn Trent Water Knowledge of some controls over flow to treatment in Black Country Sewer. Not reflected in any consents. Perceived that there may be illegal RTC practised at STW's where penstocks divert flows to storm tanks contravening terms of the consent.
Roger Saxon	NRA South Western	Telephone	There are two major RTC schemes in the Wessex area which have been the subject of discussions between the NRA and WxW. one has been consented and is under review, the other is about to be consented. Bournemouth: Basis for operation is that flows through Holdenhurst works are regulated by a penstock just upstream of the works to a level such that ammonia loads associated with the treated effluent and any storm tank spills do not exceed a concentration of 1.5 mg/l in the river. Acceptable loads are computed by a simple RTC mass balance model which uses 95%ile upstream river quality (very good - 0.1mg/l) and on-line riverflow measurement.

Name	Organisation	Contact Medium	Response
			Sewage ammonia concentrations are also monitored on-line. When discharge loads exceed the limit, inflow to the works is throttled causing the Coastal Sewer Interceptor (CSI) to begin to fill (several hundreds of cubic metres of storage available). When the CSI is nearly full, pumped inflows are cut off, causing spill to sea from these sub-catchments. Overall effect of this operating strategy is to reduce overall spill frequency by only about 20%, but to reduce annual spill volumes by about an order of magnitude. This is because relatively frequent spills still occur when inflow pumps to the CSI are beaten, but spill is marginal and short lived. The number of occasions when the pumps have to be stopped because the CSI is full is small. Hence major spills are rare. The philosophy for consenting this arrangement has been for the NRA to set the general principles by which the system is to be operated and for Wessex Water to incorporate these principles into a detailed operating procedure. This operating procedure forms an annex to the consent documentation. Monitoring of the consent is covered by the requirement for Wessex Water to maintain records of the telemetry readout and operating decisions. These must be available for audit by the NRA. In practice no problems have arisen, so no monitoring of records has been undertaken. Taunton: Problem of regular fish kills in the river due to CSO discharges. Situation arises from having the only storage in the system some 5km upstream of the STW. Situation has been addressed by introducing "blind" storage tanks at the works and at an intermediate point in the trunk sewer. This gives opportunity to "play tunes" with the filling and emptying of the storage to minimise spills. This system is about to be consented and will follow the principles of Bournemouth. Some discussions have been held with SWW regarding pumping stations with storage to control CSO discharges. Basic approach is to provide

Name	Organisation	Contact Medium	Response
			schemes which have potential to achieve more than the minimum basic requirements, then look for flexibility in operating procedures to minimise operating costs. SWW are wanting flexible consent conditions to allow this. No great problems are perceived with consenting of RTC schemes. Key is seen to be working up the scheme with collaboration between the NRA and operator. Needs to be a degree of trust between the parties. The issue of self incrimination can then be side-stepped if prosecution is avoided by the framing of flexible consents with frequent reviews.
John Adams	NRA Southern	Telephone	No formal or informal consent discussions with Southern Water. No existing RTC schemes in Southern Region. Provisional plans for Hastings and Isle of Wight. Simple form of RTC based on 2 pumping stations in Portsmouth area. For operational RTC system it would be a good idea for WSC to provide mimic VDU of SCADA to NRA so NRA can monitor system performance independently. Also, WSC to provide NR A with full results of testing /callibration of RTC system.
David Stott	NRA Thames	Telephone	No formal or informal consent discussions with Thames Water, but operation of pumped CSOs to Thames Tideway is subject of operating agreement dating from 1989 (see below). There are several large pumped CSOs on the London sewer system. The operation of some is automatic, i.e. controlled by float switches. Others are controlled manually, i.e. conscious decisions are made to pump storm sewage to the river. The NRA has little knowledge of the parameters by which these decisions are taken, but it is believed that the over-riding concern is to minimise the risk of flooding in London with energy saving a poor second. On the basis of WRc knowledge it is known that the rules by which pumping is controlled are very conservative because the consequence of flooding is great. The

Name	Organisation	Contact Medium	Response
			consequences of discharges are treated by the "Thames Bubbler" which is deployed at the request of the NRA, but is owned and operated (and the costs borne) by TW. Hence there is an in-built "penalty" for TW if unnecessary discharges are made. These CSOs are said to be effectively unconsented at the present time, but discussions with TW are planned for the future. No other examples in Thames region.
Kevin Thomas	NRA Welsh	Telephone	No formal discussions for consenting RTC schemes with Welsh Water. No known plans for RTC schemes. Region has numerous pumped marine discharges operating with a tide clock. Consents need to be as simple and easily enforceable as possible. Current standard conditions for storm tanks may go some way to meeting RTC needs. KT is chairman of a new group called "Standard Conditions Task Group" comprising NRA + WSA reps. Objective is to review present consent terms for common applications before going on to consider more difficult issues (such as RTC).
Ane Kristiansen	Oslo Kommune (Norway)	Fax	No comment
Martin Osborne	Reid Crowther Consulting Ltd (USA experience)	Telephone/ Fax	Framework for CSO control in USA is to maximise the flow to treatment and minimise the volume of spill. The simplest criteria are either: Average 4 flows per event. 85% of annual flow goes to treatment works The same amount of pollutant goes to the treatment works as if 85% of the flow had gone there. Demonstration by environmental impact modelling that water quality objectives are met. Compliance monitoring achieved through before and after studies rather than continuous monitoring. 6 large RTC systems in USA - Seattle has

Name	Organisation	Contact Medium	Response
			optimisation.
Vergard Halden	SAMFUNNSTEK NIKK (Norway)	Fax	No comment
Augusto Pretner	SGI (Italy)	Fax	No reply
Fausto Gil Pulido	SIEMSA	Fax	No reply
Niels Kofod Andersen	Stadsingeniorens Directorat - Copenhagen	Fax	In Denmark there are no national rules or guidelines for CSO spill settings on sewerage systems. Targets for new schemes are more often set in terms of a reduced annual spill volume. Future regulation of Copenhagen system will probably be based on DO concs. in receiving water . Compliance will be self monitored with occasional spot checks from regulatory authority.
Jess Man	Thames Water	Telephone	Thames Water have no recognised RTC schemes operational at present. TW have a pilot study in place on the Mogden STW catchment (2 million PE). Objective is to minimise risk of flooding and reduce CSO spills. This is a pilot for the whole London system. Strategic studies have been completed which demonstrate substantial benefits to be derived by RTC. Now entering a modelling and detailed planning stage to identify how benefits can be realised. JM confirmed understanding of how existing pumped CSO in London area are operated, i.e. main priority to avoid flooding, secondary to minimise pollution and pumping. Rule for operation are very pragmatic, simple and conservative. Further trail application at Bracknell (120,000 PE) for "intelligent instruments". Main thrust reduced risk of flooding - only one CSO on system. JM sees significant distinction between "on-line" and "off-line" RTC operation, i.e. where real time modelling is used to make

Name	Organisation	Contact Medium	Response
			operational decisions, and where modelling is completed previously to develop rules for operational control which are simply implemented as-and-when circumstances dictate. He perceives the former to offer greater benefits than the latter. At Mogden only "off-line" modelling is currently being undertaken. Confirmed that TW will always need to identify cost benefit to the company before embarking on an RTC scheme. Looking at RTC as an alternative solution to conventional methods.
Wolfgang Schilling	Trondheim University (Norway)	Fax	Schilling is tackling similar issues to the NRA as speaker of the German task group on RTC. Proposed methodology is for operator to undertake self monitoring of CSO and use of storage capacity under RTC. Slowly the RTC strategy can be improved. This approach not liked by the regulator because they want the issue "off the table".
Jan Falk	VAV	Fax	No reply
Lars Goran Gustafsson	VBB-VIAK (Sweden)	Fax	Gotebörg and Malmö are the only two Swedish cities with RTC. RTC is being discussed in 5 other cities. Consenting/regulation issues not yet considered. Expressed great interest in the subject.
H Oebius	VFWS - Berlin	Fax	No reply
Rob Henderson	Wessex Water	Telephone	Confirmed general understanding of Bournemouth system operation, but suggested that it might not be quite as far advanced as led to believe by NRA. Provided more detail for Taunton system. Objective is to retain existing level of flood protection but improve pollution control by better operation of the system and more effective use of the storage. System is operational, but consent discussions with NRA are ongoing. Consent basis is spill frequency and volume assessed over a rolling period of years. Need for winter relaxation has been recognised. Another local RTC system at Weston was identified (see paper by Holland). Simple control of storage tank returns

Name	Organisation	Contact Medium	Response
			based on available trunk sewer capacity. More sophisticated control was planned but dropped. Agreement that WxW will consider RTC as an alternative to conventional solutions and will utilise it wherever there is a business case, i.e. reduced capital spend or deferred spend.
Phil Wildbore	WRc Engineers & Scientists (USA)	Telephone/ Fax	Communication on EPA policy regarding CSO's and permits.
Denis Dring	Yorkshire Water	Telephone	Bradford system is a pilot which is being developed under the HR/IHS project. Present is several storage tanks which are currently being evaluated for local RTC - significant potential savings have been demonstrated. Later, scope for global control will be considered to evaluate additional benefit from this stage. There are ongoing research projects in YW to look at potential benefits of active control at pumping stations (both at works and on the network), detention tanks, CSOs and trade effluent discharges. No conclusions from any yet. YW are very interested in RTC as a concept, but implementation of RTC schemes will only take place when the benefits are clear. YW personnel have toured overseas RTC systems. Different philosophy has been identified. Overseas systems have evolved over considerable time with no clear appreciation of the benefits at the start. YW (and other companies) want to see the benefits at the start and have a full picture at the commencement.