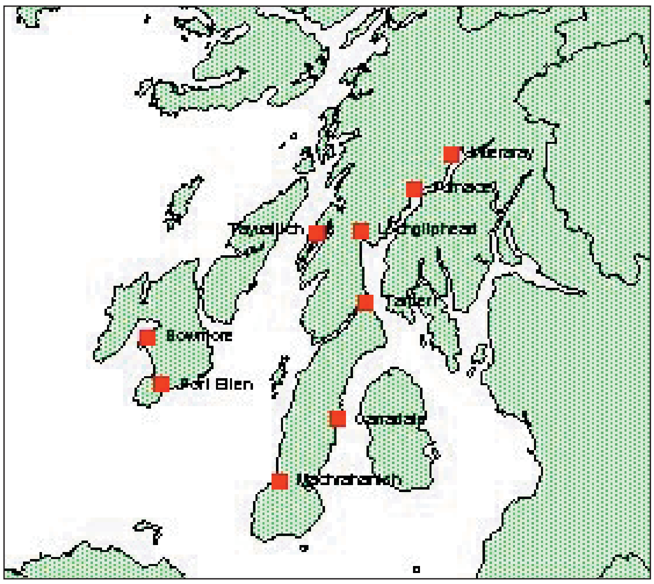
Coastal Communities – a challenge

storm water management in small west coast communities

by Nick Barcock & Gwion Kennard

Scottish Water have identified a number of Coastal Communities that require new or upgraded wastewater collection and treatment facilities in order to comply with the Urban Waste Water Treatment (Scotland) Regulations 1994 (UWWTR). These works are to be completed by December 2005 for UWWTR or by 2003 for the EU Bathing Waters Directive. Scottish Water has set a business target for completion of December 2004. Although the catchments considered within Coastal Communities are generally small (<1000 PE) high rainfall, local conditions and sensitive receiving waters have given rise to significant challenges in the management and disposal of storm water.

Tarbert Harbour, Loch Fyne *(courtesy Hyder Consulting)*



Location map *(courtesy Hyder Consulting)*

Hyder Consulting Ltd (HCL) were awarded one of the three Drainage Area Studies (DAS) commissions to provide preliminary design for sewage collection and disposal at a number of small coastal communities in the west of Scotland.

HCL's commission (Group B) includes nine communities in Mid Argyll, Kintyre and Islay on the West Coast of Scotland. The nine sites are shown in fig.1.

The HCL Commission for Preliminary Design includes:

* **Drainage Area Studies** – initial planning, model build, verification and optioneering;
* **Marine Surveys** & Investigations – bathymetric, geophysical and hydrographic surveys;
* **Marine Dispersion Modelling** – outfall initial dilution and dispersion studies.

Since the award, Scottish Water have commissioned a Joint Venture (JV) consortium of *Biwater Treatment Ltd* and *George Leslie Ltd*, to identify strategic options that include design and construction of new wastewater collection, transfer and treatment facilities. HCL are now working with the JV to provide options that comply with hydraulic, process, environmental, flood and spill requirements.

The receiving water designations for the Coastal Communities cover Shellfish Waters, Bathing Waters, Recreational Waters and Shoreline Waters. All of the study locations are exposed and subject to extreme weather conditions with Standard Average Annual Rainfall (SAAR) of between 1300 and 2100.

Drainage area studies

Phase 1 – Initial Planning Study

This phase involved the following activities: manhole, flow, CSO, impermeable area and pumping station surveys. Other data sources included the Met office, SEPA, council departments, Scottish Water operations, Census data and Ordnance Survey data.

Phase 2 – **Model Build & Verification**

The models built for the DAS's are of Type 11 construction (WaPUG, 1998), and are suitable for use as drainage area planning tools. Through agreement with Scottish Water and by following the Scottish Water (West) Drainage Area Planning Specification it was agreed to construct the coastal community models using the New UK runoff model and to verify the model against the full flow survey data. Verification over the full flow survey period (Fig. 2) is an innovative approach and one that in this particular case is practical to perform, due largely to the small nature of the individual catchments. This phase was concluded with the submission of a Phase 2 report for each catchment.

Phase 3 – Development of Catchment Strategy

Identification and recommendation of the most viable wastewater outfall/storage design solution for compliance with the legislation using integrated catchment and coastal modelling. A number of options for the transfer and treatment of foul/storm flows for each of the catchments were identified and Value Management workshops held on a regular basis. Simpol models (fig.3) of the sewer networks were built and calibrated against the detailed InfoWorks models (in accordance with recommendations given in the UPM2 Manual) and were used to provide preliminary assessments of the flow to be transferred to the WwTW and the size of storm tanks. Phase 3 concluded with the submission of an options report for each catchment.

Marine Surveys Investigations and Modelling

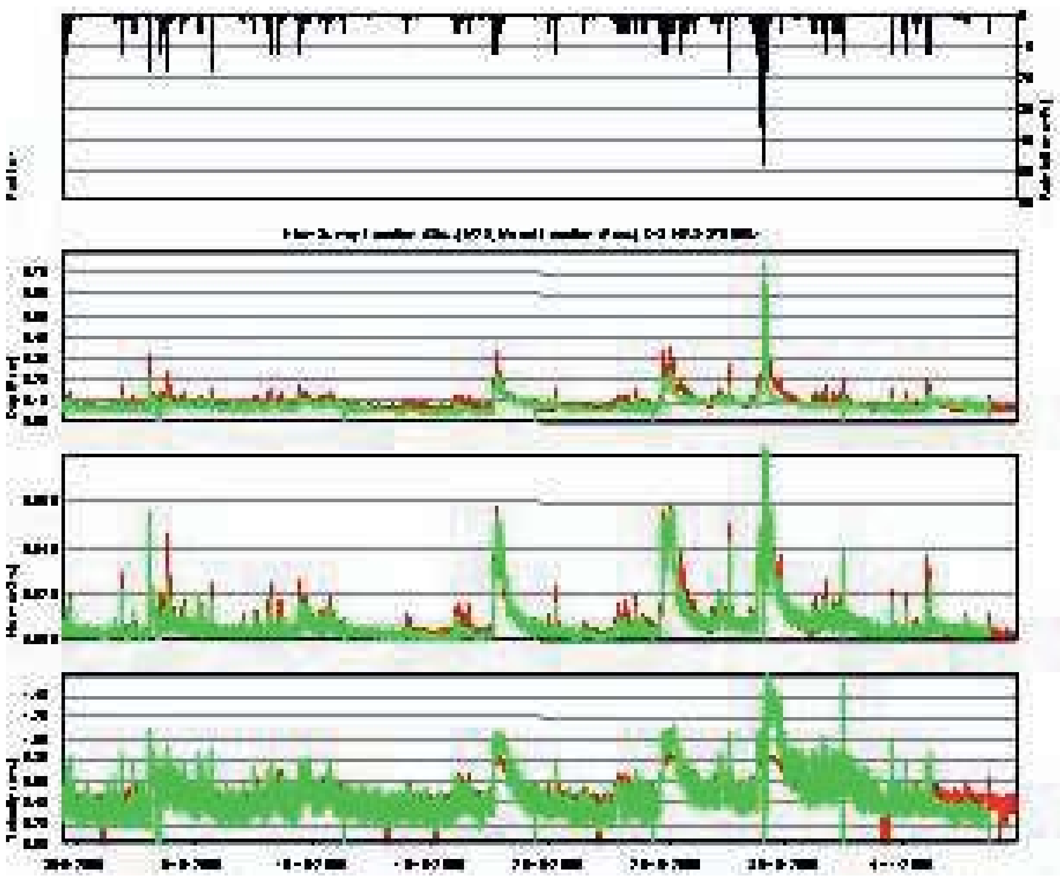
Marine surveys (bathymetric, geophysical and hydrographic) were carried out during the late summer of 2000.

To assess the impacts of treated and storm discharge on the receiving waters numerical hydrodynamic and dispersion models were constructed for each site. Four of the communities lie within Loch Fyne and required detailed modelling to be undertaken. A 2D hydrodynamic and particle tracking model (Delft3D) of Loch Fyne was constructed on a curvilinear grid providing a resolution of 50 to 100m at each of the sites. The remaining sites located in relatively open coastal waters, required simple steady state (CORMIX) models for the assessment of near and mid field dispersion.

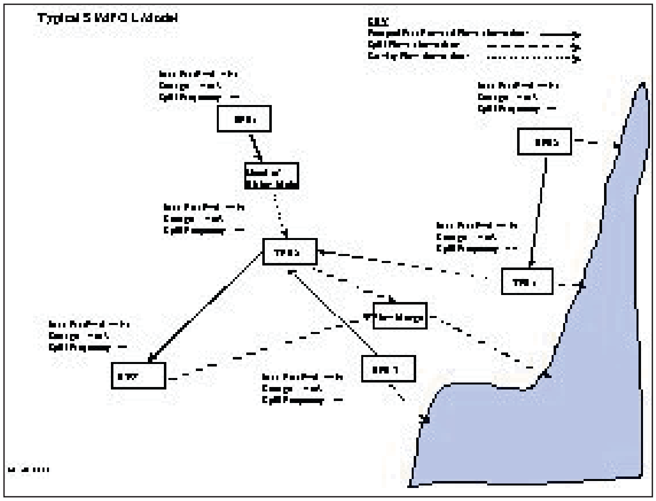
Effluent disposal options

Treated effluent flows are generally low and disperse rapidly in the receiving waters. Long outfalls are not therefore required to reach the required water quality standards. However, the steep bathymetry at most sites required even short outfalls (200m) to be constructed in water depths of between 10 and 30m.

The management and disposal of storm water presented the greatest challenge to the project team. The extremely high rainfall



Typical verification graph *(courtesy Hyder Consulting)*



Schematic of typical SIMPOL model *(courtesy Hyder Consulting)*

requires a high storage volume per capita to meet the relevant emission standard (eg 10 per annum for shellfish waters or 3 per bathing season for designated bathing waters). The relatively small flow to full treatment (FFT) transfer introduces a further risk that large storage volumes cannot be drained down at sufficiently high rates. Available space in many of the catchments is also a limiting factor. These construction and operation constraints produce a relatively high construction cost when compared with larger schemes.

In order to overcome these problems a number of possible alternatives to storage have been assessed. In most cases a combined approach has been adopted as each catchment has its particular limitations.

Increased FFT

Increasing FFT transfer will reduce storage requirements proportionately, but may require large or dual rising mains and associated pumps to accommodate the wide range in flow. An increased FFT needs a larger treatment works that may not operate efficiently over the full range of load from DWF to storm, particularly as effluent is significantly diluted during storms. Higher transfer of flows may be feasible where the level of treatment at the works can be reduced from secondary to primary, although this must be balanced against the need for a longer outfall. An increase in FFT may, therefore, lead to a disproportionate increase in both capital and revenue costs.

Removal of infiltration

Base infiltration reduction strategies may be of limited value in reducing storage volumes as base infiltration is low, particularly when compared with storm runoff.

Surface water separation

Surface water separation provides a potential solution in some areas but can be costly and is in may cases impractical. In a number of catchments with high runoff partial separation is proving to be of potential cost benefit.

Long CSO outfalls

In many instances extending CSO outfalls into deeper coastal waters has provided a viable solution. This approach is based on moving away from an emission based standard (10 spills per annum) to an environmental standard of 95% compliance by, demonstrating through coastal modelling, that 10 or fewer spill events lead to failure of the designated receiving water. However, in some cases, this approach may be limited by a combination of high spill volume, sensitive receiving waters and steep bathymetry. Furthermore, a high spill frequency may be perceived as not providing a significant environmental improvement i.e. the net annual load of untreated effluent entering the receiving water remains high.

Development of options

Storm water management options have been assessed by the use of catchment and coastal models in an integrated approach to determine optimum flow, storage and outfall requirements. Options have been considered on a case by case basis and in negotiation with SEPA. However, established catchment modelling techniques have been used to good effect and combined with detailed modelling of the marine environment has resulted in cost effective solutions that will ensure that Scottish Water will achieve water quality standards.

Partnering

Although not formally part of the overall Scottish Water JV partnership, HCL maintain close liaison and have adopted the overall partnering approach in delivering effective catchment solutions. The key to delivering cost reductions has been optimisation of the transfer system, works, storage and outfalls to provide water quality compliance in the receiving water at least cost. The optimisation process requires collaboration between all members of the project team. Such collaboration has helped to propagate innovative ideas, while the adoption of partnering principles has been an essential element in facilitating a global approach that strives toward delivering sustainable environmental improvements at least cost. This approach has realised significant benefits to Scottish Water. ■

Note on the authors: *Nick Barcock is a Principal Consultant and Team Leader in the Coastal Modelling Section and Gwion Kennard a Senior Consultant in the Sewerage Modelling Group, both at the Water Development Centre, Hyder Consulting Ltd.*