MONITORING AND MODEL CALIBRATION FOR THE SEWER NETWORK IN OSLO

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1 Introduction

The City of Oslo is situated between the woods and hills of Nordmarka and Oslo Fjord. Between Nordmarka and the fjord, seven main watercourses pass through the city. These rivers and the fjord itself are popular recreation areas for the city's population of some 500,000 persons distributed over an area of 140 km^2.

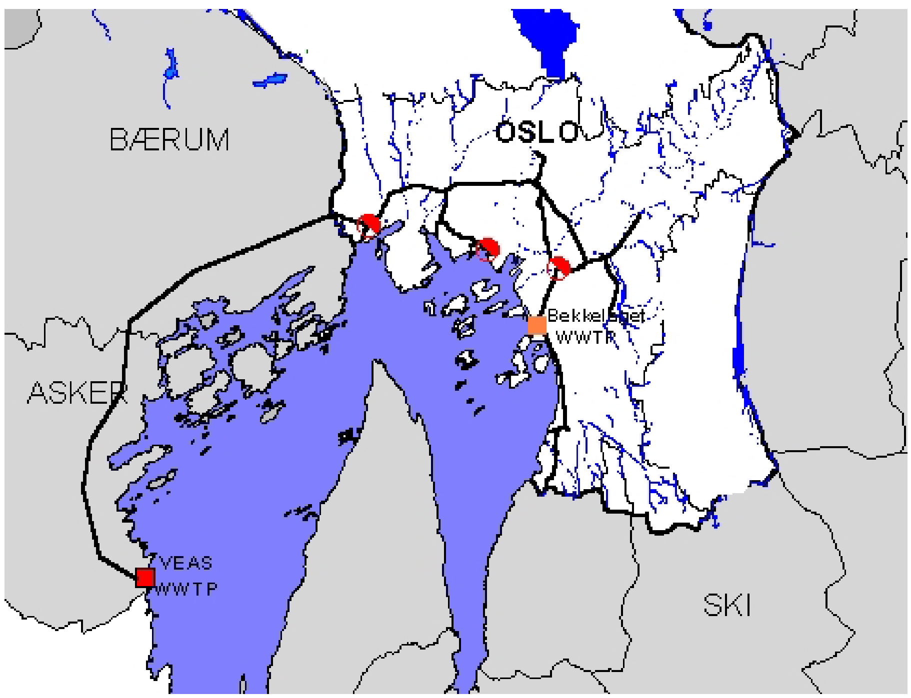

Figure 1: Regional map

Oslo's sewer system has developed over a period of 150 years. Up to the mid-fifties combined systems were mainly used. Subsequently an effort has been made to develop a separate system. The sewer system includes 2,200 km of sewers and 45,000 manholes. 800 km of sewers is combined. The main interceptors in the sewerage network consist of 300 km of pipes with dimensions of 600 mm and over. The sewer system is relieved by a total of 240 overflows, of which three are main overflows from the tunnel system.

The waste water is collected and transported to two treatment plants plant by an extensive system of tunnels. VEAS treatment plant accepts waste water from the western part of the Oslo region and Bekkelaget treatment plant from the eastern part of the region. Within the Oslo City boundary the tunnels amount to 41 km. A 24 km long tunnel extends from the city boundary to VEAS.

In 1997 a systematic work began on monitoring and calibration of a city-wide MOUSE model. This work is a long-term undertaking and is regarded more as on-going work than as a project.

The monitoring and calibration is performed for three types of MOUSE models.

i. Tunnel model
ii. Environmental models
iii. Capacity models

This paper describes the monitoring and calibration of the environmental models.

The **Environmental models** will together cover all the overflow discharges from the Oslo sewer system and will be established sequentially for each watercourse.

Some overflows will prove suitable for elimination, others will be moved, renovated or otherwise improved. VAV sees monitoring and calibration of a MOUSE model as a necessary part of this work.

Photo 1: Fishing in Akerselva

Rivers:	**Progress of monitoring**
Hovinbekken	1998
Alna	1999
Akerselva	2000
Western rivers	
Eastern rivers	

Table 1: Progress of monitoring

2 Monitoring

Network of permanent rain gauge stations

During 1998 the existing network of permanent rain gauge stations in Oslo has been upgraded and increased from five to seven.

The stations are of type Lambrecht and has been linked to VAV's remote control system. All stations have a temperature gauge and a heated bulb for round-the-year measurements.

Photo 2

Photo 3

Mobile rain gauges

Mobile rain gauges are placed on roof of buildings or pumping stations. The rain gauges are of type Newlog Casella.

Flow monitoring

ADS flow monitoring equipment is used to measure flow in main interceptors. The ADS concept with a quadredundant ultrasonic level sensor combined with a pressure sensor and a peak velocity sensor has proven to give very accurate results. Installation and operation of the ADS flow monitors is carried out in co-operation with the supplier, DHI Sweden.

Photo 4

ISCO - Flow monitoring

The Western and Central part of the Oslo tunnel system includes 36 discharge point structures, most fitted with a Parshall or Khafagi venturi measurement channel.

For flow monitoring at this points VAV has available 10 ISCO monitors with ultrasonic level sensors.

The monitoring equipment is linked to VAV's remote control system and is moved to a new discharge point structure every second year.

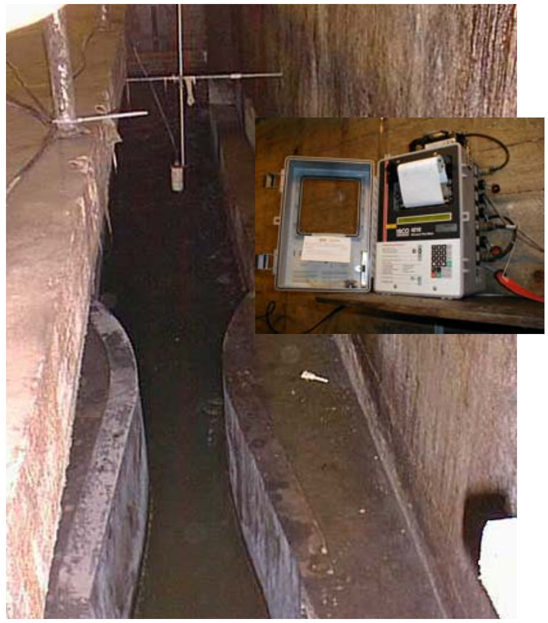

Photo 5

Overflow monitoring

The overflow loggers are sited in locations identified by the Masterplan as primary overflows, i.e. overflows expected to come into use more than once each year.

At overflow weirs with a relatively high crest level we use Overflow loggers of type DT 2000. This measuring equipment is very easy to use and is logging date and time for start and stop of the overflow event.

At overflow weirs with a relatively low crest level we use ISCO monitoring equipment with a ultrasonic level sensor.

Photo 6

Photo 7

Monitoring equipment	**Number of**
LAMBRECHT rain gauge stations	7
CASELLA Mobile rain gauge	9
ADS FLOWMETERS	8
ISCO Ultrasonic level gauges (flow)	10
ISCO Ultrasonic level gauges (Overflow)	5
DT-2000 Overflow loggers	26

Table 2

3 Calibration

Figure 2 illustrates the area of Hovinbekken and the flow monitoring programme 1998.

In the period June to November we used 6 ADS flow monitors for seasonal campaign monitoring, covering Hovinbekken as the figure illustrates.

Additionally we use 1 ADS flow monitor for long-time monitoring, covering the total drainage area for the period September 1997 to September 1999.

For each area we are calibrating a MOUSE NAM model against the results from the ADS flow monitor. For each area the NAM model will be distributed to each subcatchment illustrated in figure 2.

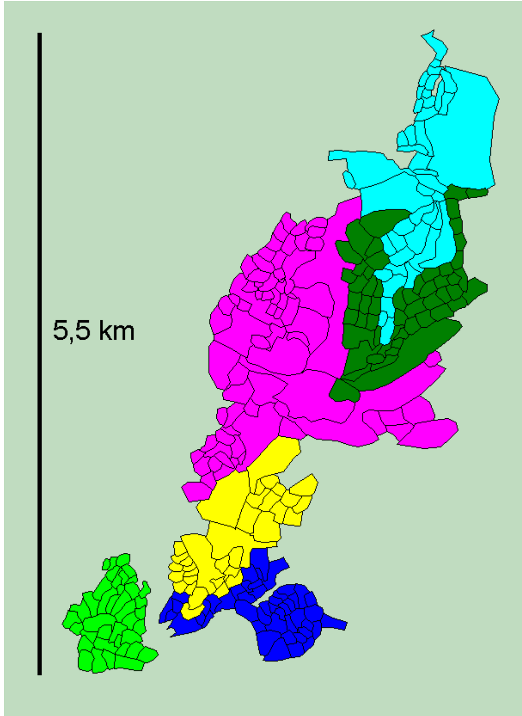

Figure 2

The long time monitoring results and the Overflow monitoring results is used for verification of the calibrated model.

Figure 3 shows measured flow for the long time monitoring ADS versus an ADS campaign monitor installed upstream at the same main interceptor. The period is random chosen.

The figure illustrates the accuracy of the ADS equipment

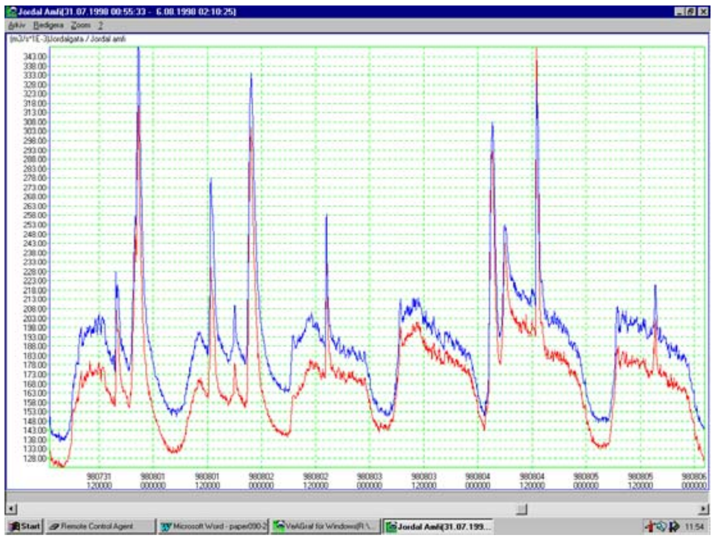

Figure 3

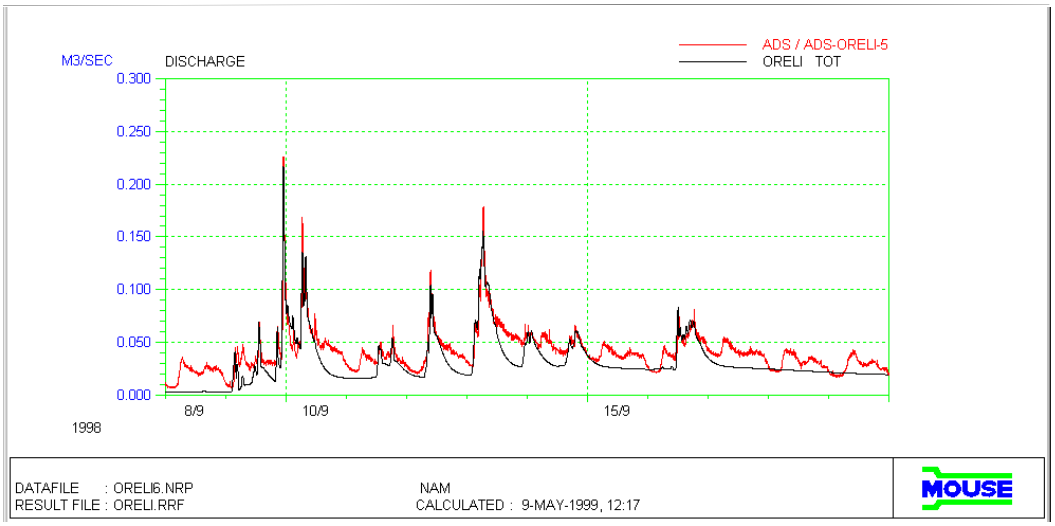

Figure 4

Figure 4 shows measured flow versus calculated flow for a calibration attempt with a single box MOUSE NAM model for an area in Hovinbekken. This is the calibration result before we use the MOUSE-Pipe model and before we have added the diurnal foul flow.

The MOUSE-NAM model is thoroughly verified from calibration against measured flow from larger catchment areas. Our experience is that the MOUSE-NAM model generally gives a good calibration result also for small catchment areas. We would tough like to forward some small user frustrations:

- As figure 4 illustrates the first part of the calibration process would have been easier if it had been possible to add foul flow and a constant flow during calibration with the MOUSE-NAM model.
- It is usually difficult to calibrate MOUSE-NAM for the drainage and infiltration water from non-connected houses and roads 1/2-2 hours after rainfall during the dry summer season.
- It is difficult to get a good result both for periods with rainfall of extreme intensity and "normal" intensity periods for the same set of calibration parameters.
- The degree day snowmelt routine usually melts the snow to early in the winter season.

Most discrepancies we have between calculated and measured flow can however bee related to the distance from the rain gauge to the centre of the drainage area for the flow monitor.

REFERENCES:

Work group, VAV, Note, Computer modelling, Oslo, Outline (1997)