Implementation of Hydraulic Modelling to Support Sustainable Economic and Quality Assurance in the Municipal Water Company in Egedal - Denmark

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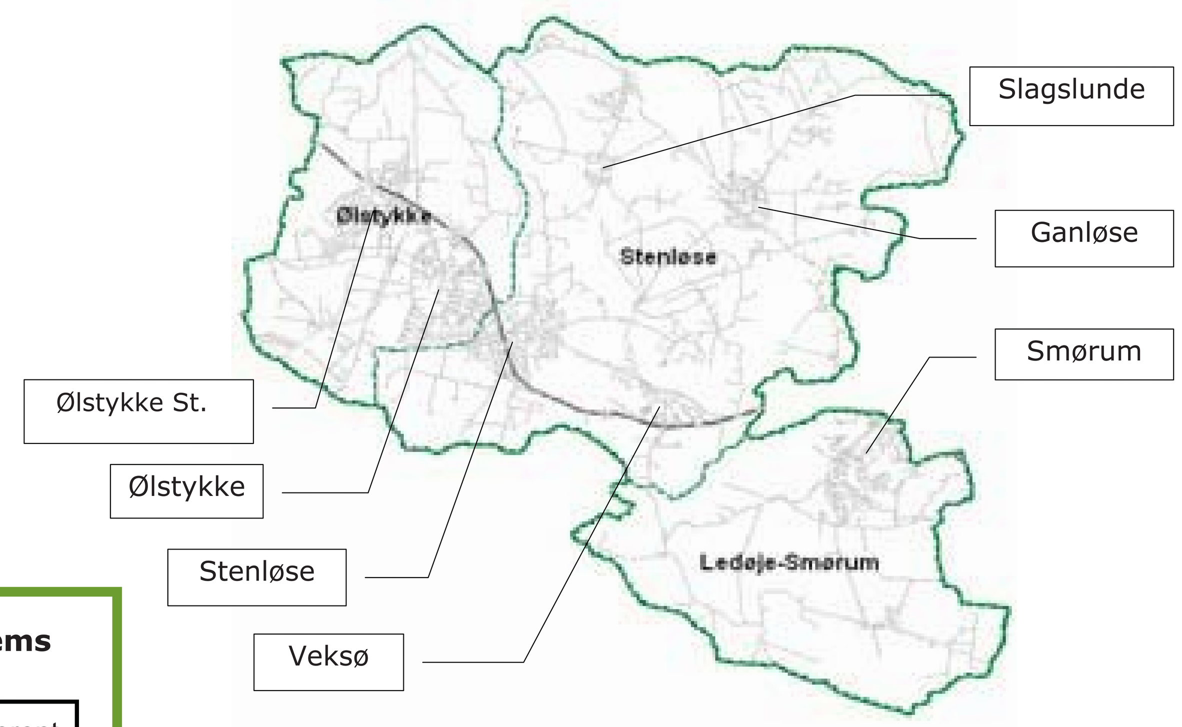


Abstract

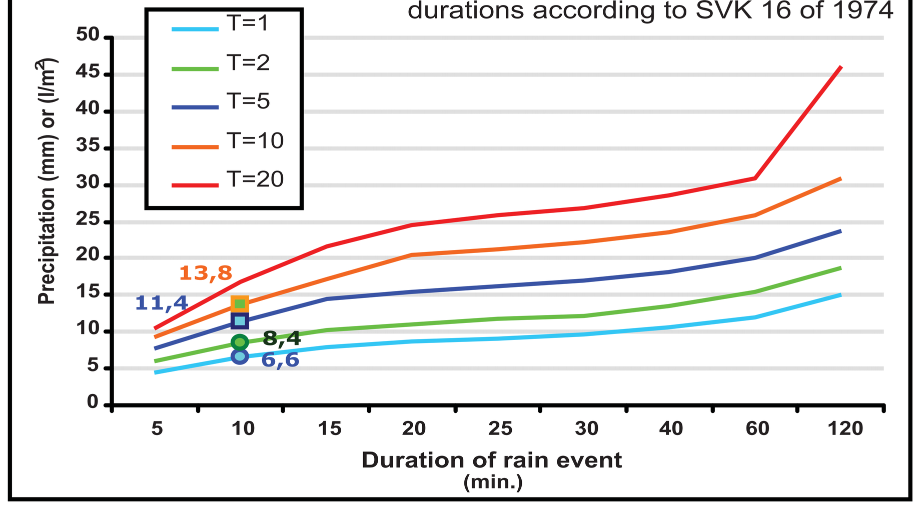
Climate change is an extensive challenge for water companies to optimize drainage systems capacity. Publications of The Wastewater Committee in Denmark no. 27, no. 28 and no. 29 are the recently updated guidelines for hydraulic design of drainage systems in Denmark. Private housing developments are the most typical means of drainage systems expansion. Renovation and reconstruction projects consider higher capacity in drainage systems due to future scenarios of climate change, continuous expansion of impermeable urban quarters and increased restriction on discharge permission according to new water plans in Denmark.

The Municipal Water Company in Egedal (MWCE) implemented Hydraulic modelling successfully for quality assurance of private housing development projects. Hydraulic modelling helped to obtain sustainable economic measures in renovation projects in accordance with the water company perspective. The MWCE has saved 17 million DKK (€ 2.3 million) during the period 2007 to 2009.

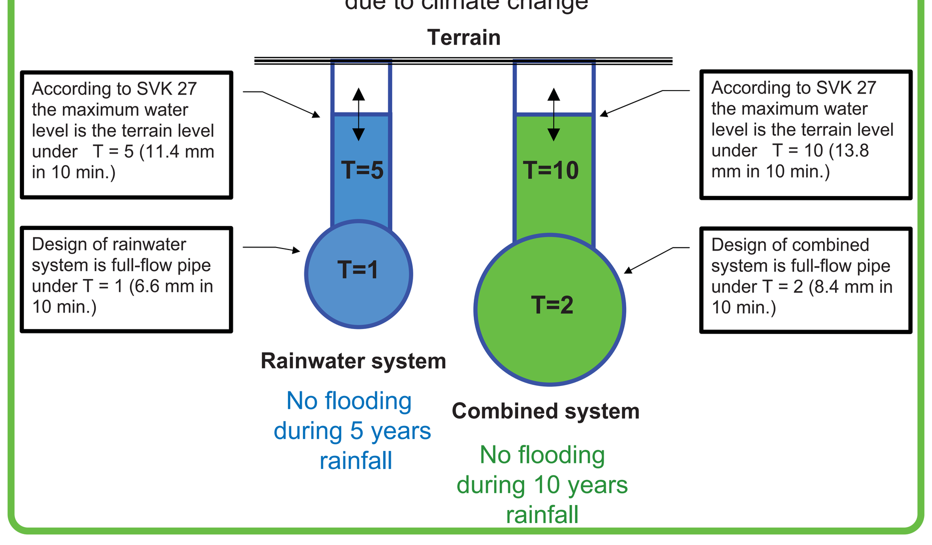
17 million DKK (€ 2.3 million) saved in 3 years

Guidelines of Hydraulic Design of Drainage Systems in Denmark

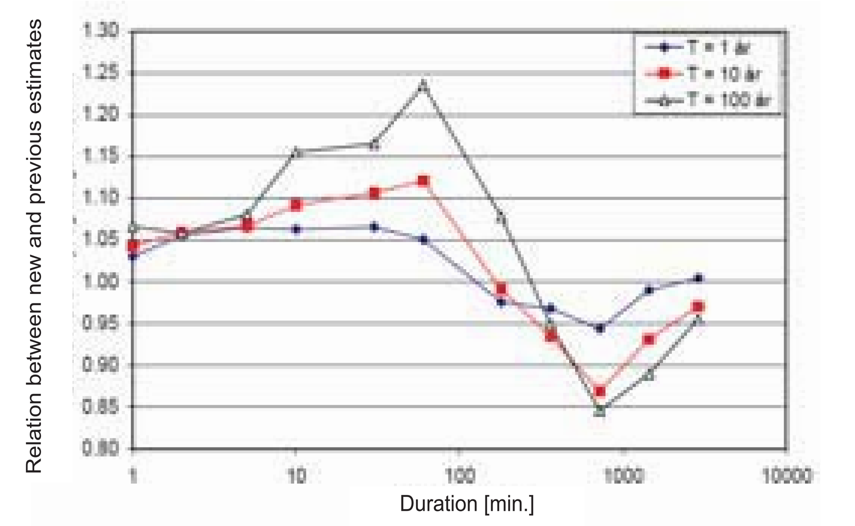
Design curves of 1, 2, 5, 10 and 20-year rain events (T) of different durations according to SVK 16 of 1974



Guidelines according to SVK 27 of 2005 takes flooding into consideration due to climate change

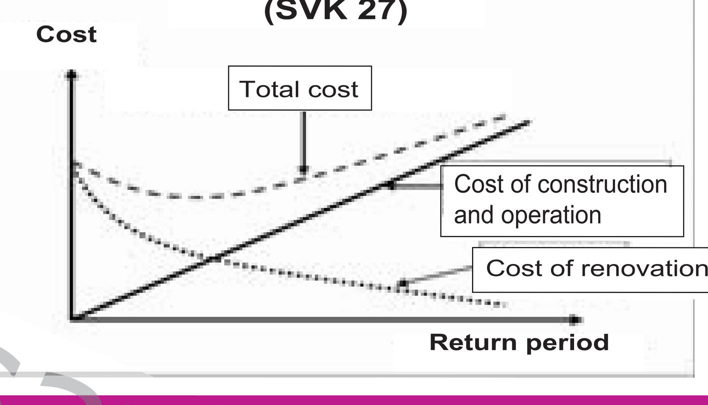


Climate Change SVK 28 of 2006



SVK 29 of 2008 suggests a climate safety factors of
1.2 for 2 years,
1.3 for 10 years and
1.4 for 100 years' lifetime of a drainage system.

Economic Optimization Principle (SVK 27)



The art of planning and management engineering is to provide not less than the minimum level of service that complies with guidelines and at the same time to achieve the lowest point in the curve of the total cost in the figure. This is a strategic goal the MWCE has adopted. The goal is to conceptualize the cost-benefit analysis in project management.

Hydraulic Modelling

Hydraulic modelling has been chosen to realize this policy to support decision-making processes in planning, designing and choice of solution of specific projects and thus to facilitate economic optimization.

Level 1 based on block rain
Level 2 based on CDS-rain and historical rain
Level 3 based on calibrated and verified model

Fields of Implementation

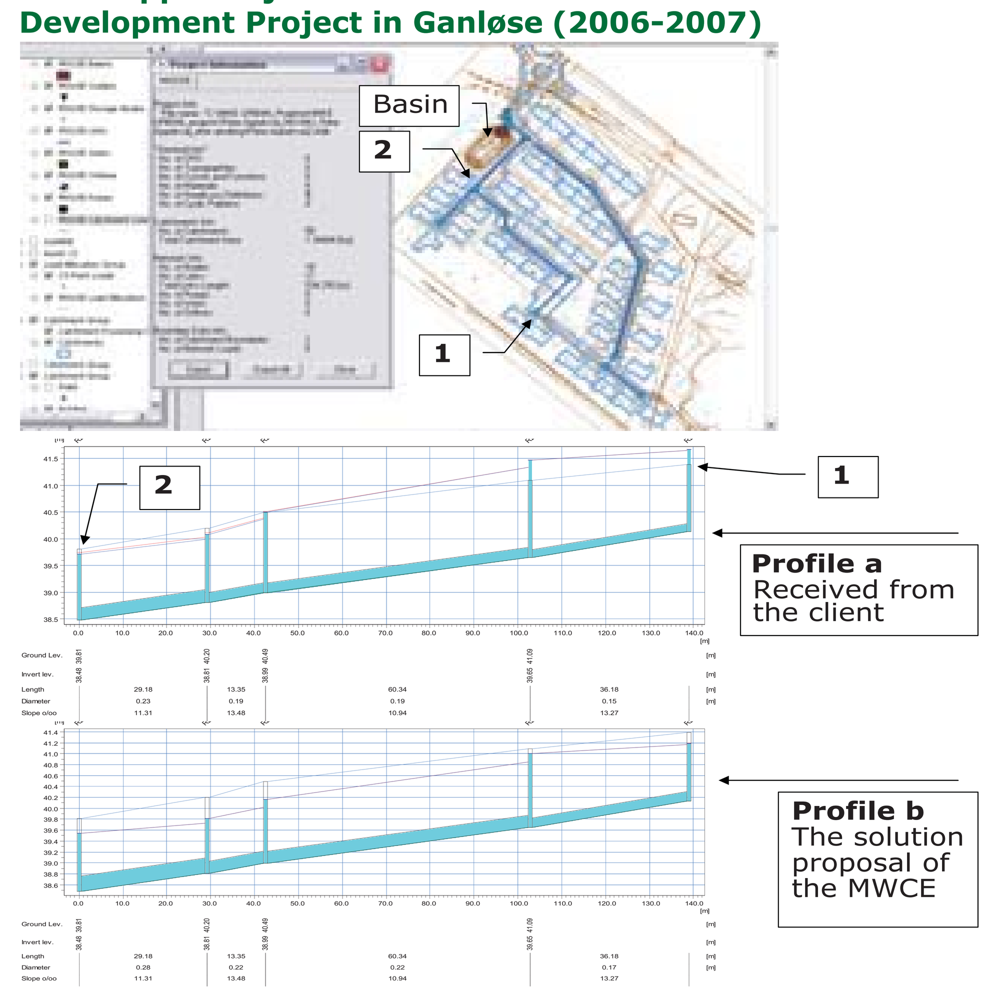
1. Renovation projects
2. Road drainage systems
3. Housing development projects

Case Studies

Conclusions

1. Hydraulic Modelling ensures quality towards guideline requirements.
2. Large savings; as *17 million DKK saved in 2007-2009* due to implementing hydraulic modelling. Project costs reduced and sustainable cost-benefit management acheived.
3. Able to handle the challenge of climate change, which helps a sustainable economic investment.
4. Supporting tasks are essential for modelling such as updating the databases of the pipe system registration, GIS-systems, surveying, flow survey programs, rain gauges and online data.
5. To expand the frontiers of implementing hydraulic modelling in areas of analysis, control and overall planning beyond current implementation of modelling in specific projects in the MWCE, building up expertise within the MWCE is necessary.
6. Modelling should be implemented in decision-making processes due to economic significance.
7. Facilitating the use of modelling requires training of specialist personnel and presenting transparent results to support decision-making. This training and this support must always be available during the process of reaching decisions.

Case study 1
Peter Appelsvej - 42 New Houses Development Project in Ganløse (2006-2007)

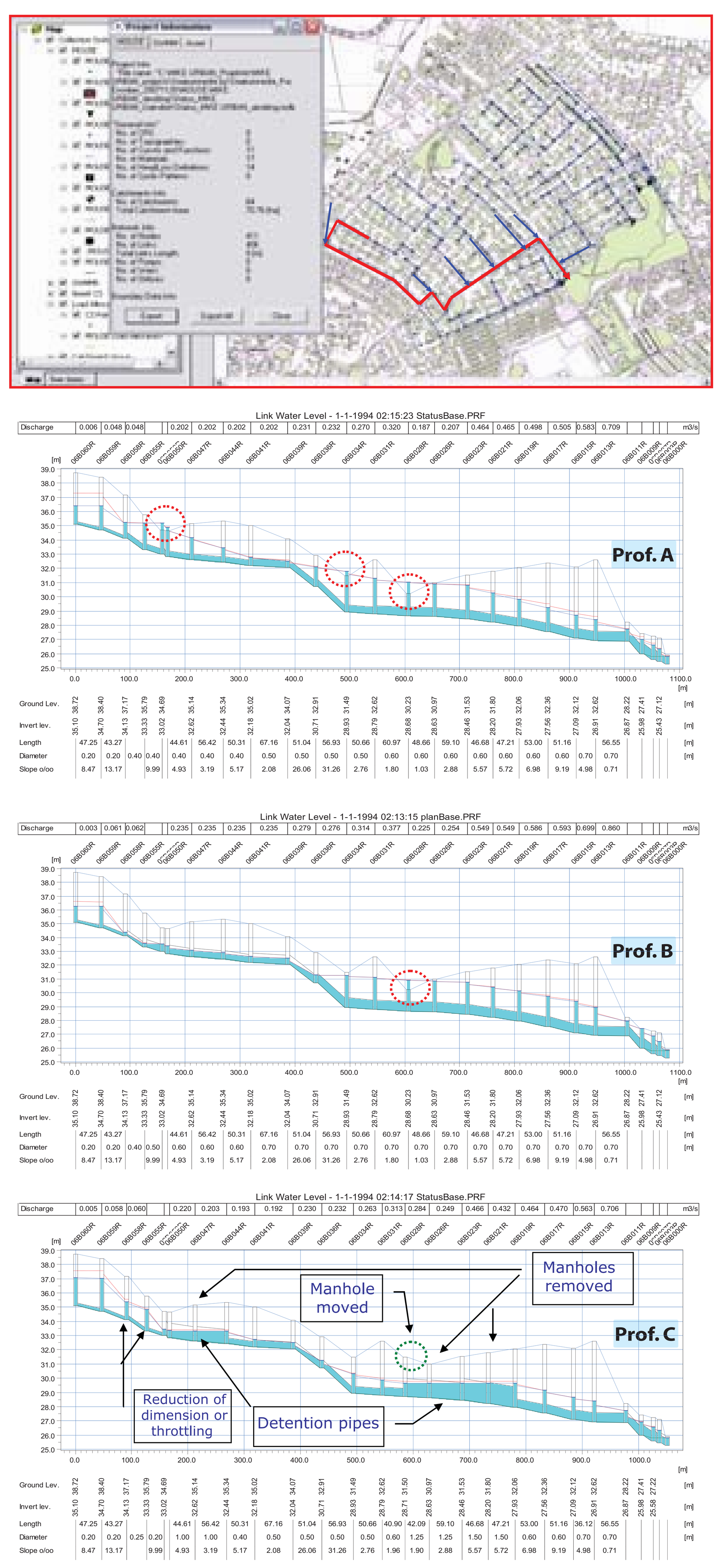


Offered Project
- The client's consultant estimated the cost of the project to about 3 million DKK (€ 0.4 million).
- The project was exposed to flooding during T=5, according to the MWCE's hydraulic model (Level 2, CDS-rain). See an example in the figure.

Optimisation by MWCE
- Necessary adjustments of pipe dimensions.
- Reduction no. of manholes from 32 to 28.
- Optimise the structure design of the inlet/outlet of the basin.
- Removal of tide flex valve.
- Flexibility was given to the contractor to choose the approved environmentally-friendly materials, in order to bid on a lower price.

Achieved results
- The project lived up to the guidelines of SVK 27; no flooding under T=5.
- 55 m3 extra volume capacity gained in the basin with out extra excavations.
- 2.5 l/s adjusted total discharge blow the max. allowed average discharge of 2.7 l/s or 2 l/s/red.ha.
- 1.3 million DKK (€170,000) saved.

Case study 2
Renovation Project in Smørum (2007-to date)



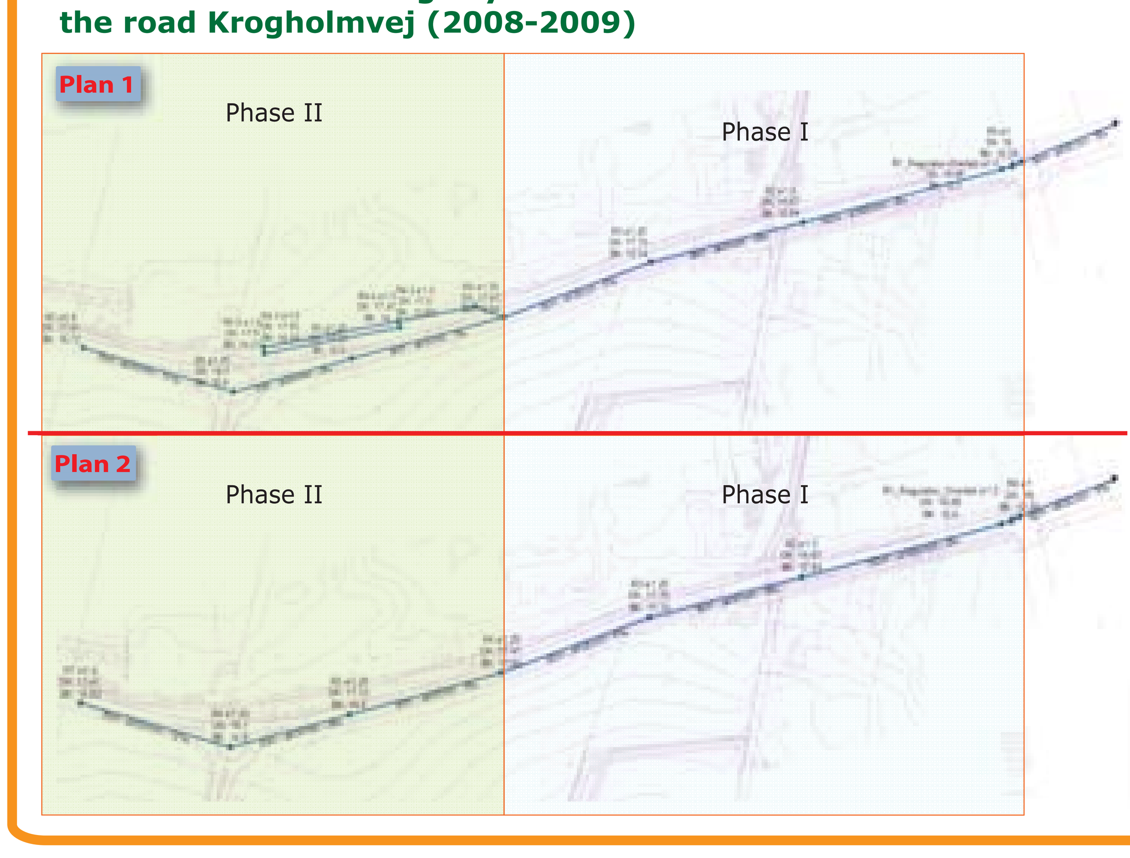
The Project
- Renovation of a separate drainage sytem.
- 71 ha catchments in urban area.
- Uncalibrated MOUSE-model (level 2, CDS-rain) ordered externally.
- Safety factor of 1.44 (1.2 climate + 1.2 uncertainty).
- The focus in this case study is on a 1100 m trunk rainwater sewer pipe in the figur to the left.

- The received status model indicated flooding in three locations (***Prof. A***) under T=5.
- The received solution (***Prof. B***) suggested replacing the trunk sewer with bigger diameter pipes, meaning costs of excavation works and replacement.
- Prof.B appeared still with one flooding location

Optimisations by MWCE
The MWCE evalutedted the solution. Alternative solution (***Prof. C***) produced with no flooding and less excavation works by constructing detention pipes in just two locations and leaving the rest of the pipeline, if necessary, to no-dig methods that are much cheaper.

Acheived results
- No flooding under T=5. Guidelines fulfilled (***Prof. C***).
- 9 millon DKK (€ 1.8 million) saved.
- Level 3 model requested to achieve better results.

Case study 3
New rainwater drainage system for the road Krogholmvej (2008-2009)



The Project
- New rainwater drainage system due to expansion of Krogholmvej.
- Designed project (***Plan 1***) suggested a detention pipe system connected to the northern side of the system.
- Total pipe volume of 434 m3.

Optimisations by MWCE
- A hydraulic model (Level2, CDS-rain) to evaluate received hand calculations (***Plan 2***).
- Safety factor of 1.5 (1.3 climate + 1.15 uncertainty)
- Total pipe volume reduced to 312m3, consists of concrete pipes Ø1m + Ø400.
- 2385 m3 less excavation works.
- 14 pipes reduced to 8.
- 6 detention pipes reduced to 3.
- 13 manholes reduced to 8.
- 122 m3 (244 tons) less surpless soil from excavation work.

Acheived results
- Guidelines fulfilled. No flooding, T=5.
- 2 l/s/red.ha discharge fulfilled.
- 4 million DKK (€ 0.53 million) saved.