# CIE4491

## Lecture. How to quantify wastewater flow

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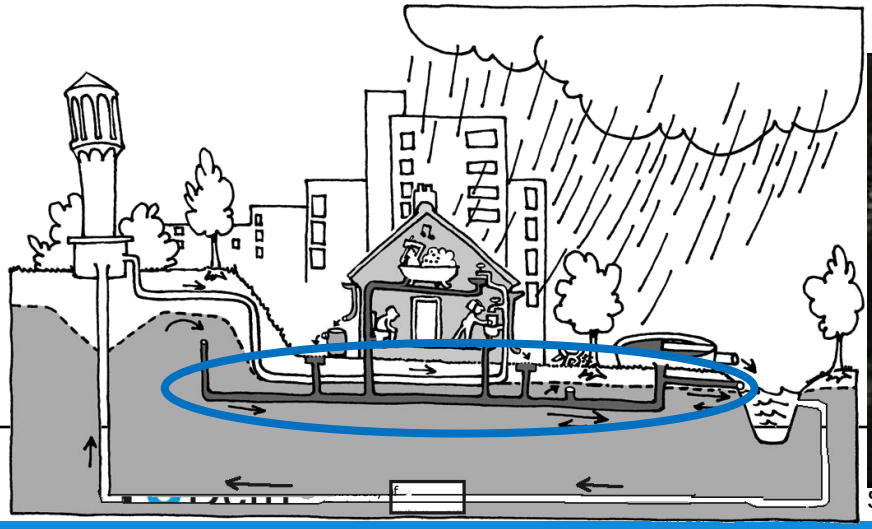
18-9-2013

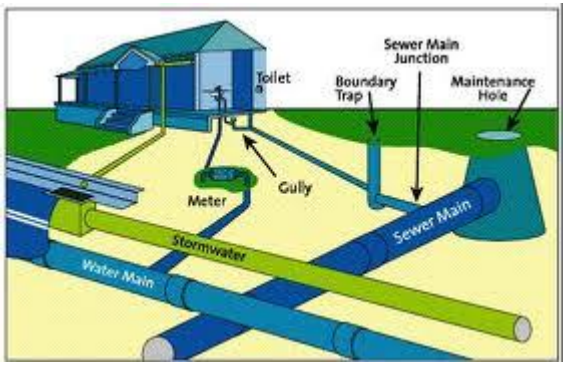


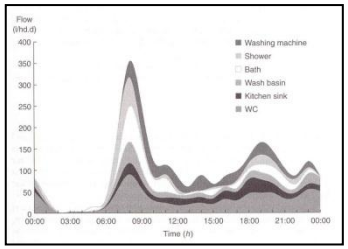
Source: news.bbc.co.uk

Source: www.nu.nl

# Learning objective of this course: design urban drainage system

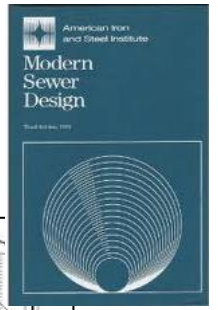
1. Available principles for urban drainage: stormwater and wastewater collection

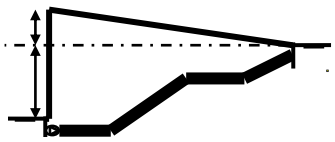



2. How to quantify flows incl. flow variations: stormwater and **wastewater**

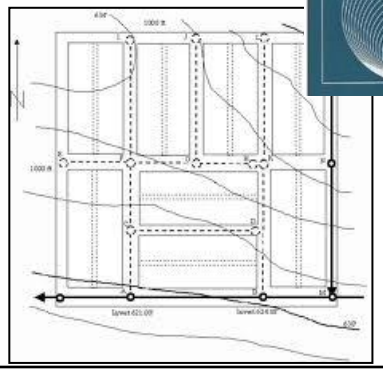
3. Design requirements

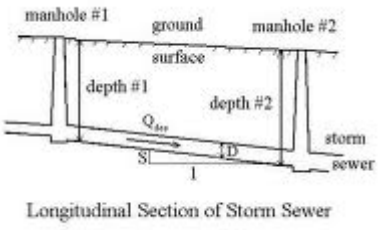


4. Available transport principles: gravity flow, pressurised flow

5. Layout of urban drainage system






6. Principles of hydraulic calculations: design pipe dimensions and vertical profile

# Foul sewer design

- Terminology: wastewater flow; dry weather flow; wastewater sewer/foul sewer

Design steps for wastewater sewers:

- Determine design capacity: dry weather flow
- Determine appropriate design diameter: max filling rate
- Determine bottom gradient: "self-cleansing" capacity

# Dry weather flow

Design steps for wastewater sewers:

- Quantify dry weather flow
  - start from drinking water consumption, assume peak factor to allow for daily variation
  - add industrial ww (if relevant)
  - add groundwater infiltration (+wrong connections), based on assumption/best guess

# Foul/wastewater sewer design

Design steps for separate wastewater sewers:

- Determine design capacity: dry weather flow
- Determine appropriate design diameter: max filling rate
  - max filling rate 50% at design flow: allow for future increase + backup in case of system failure

# Foul/wastewater sewer design

Design steps for wastewater sewers:

- Determine design capacity: dry weather flow
- Determine appropriate design diameter: max filling rate
- Determine bottom gradient: "self-cleansing" capacity
  - NB: wastewater particles with hard-to-predict behaviour

# Foul/wastewater sewer design – bottom gradient

Minimum bottom gradient: "self-cleansing" capacity
(esp. critical in more or less flat areas)

- UK: min self-cleansing velocity 0.6 m/s
- Better: min shear stress: $\tau$ = 0.5-1.5 N/m$^2$

- Rule of thumb: i=1/D (D: pipe diameter in mm)
- Or: min gradient 1:250 (1$^{st}$ section); 1:500 (other sections)

N.B.: 25 years of sewer sedimentation research – unable to predict sedimentation processes!

# Wastewater flow, remember:

- Small compared to stormwater flow
- High organic matter content
  (good for wwtp bacteria, not for CSO)
- Sticky: sedimentation/erosion unpredictable
- Foul sewers sensitive to blockage
- Wastewater systems in flat areas: pumping