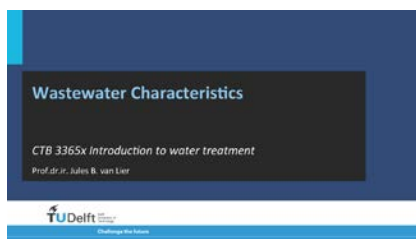


W1b – Wastewater Characteristics

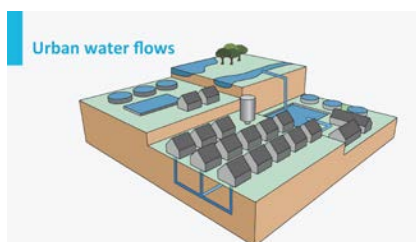


Jules van Lier



After the introductory lecture to urban sewage treatment we now start with the actual content.

Welcome to lecture discussing the flow pattern of the collected urban waters.



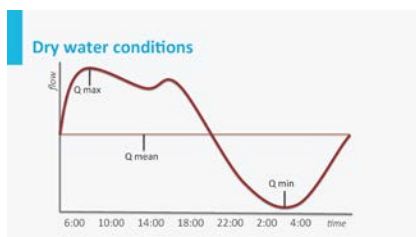
The used urban waters, which we formerly called wastewaters, are collected and conveyed by means of a sewerage network to a central point for treatment.

What are the characteristics of these waters?

There is strong link between the consumption of drinking water and the production of wastewater.

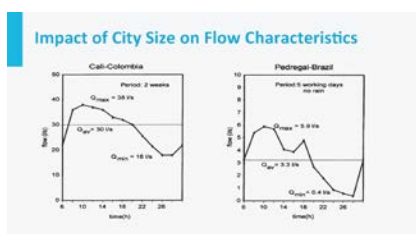
Every m^3 of drinking water, whether used in the household or in industry, will be discharged after usage.

In the Netherlands we collect these used waters with a large sewerage network, that is connected to one of the about 350 sewage treatment plants.



Under dry weather conditions, the drinking water consumption rate, is reflected by the generated sewage flow, with high peaks in the morning and in the evening, and a very low flow in the night.

We therefore distinguish an average or a mean flow, Q_{mean} , a maximum flow Q_{max} , and a minimum flow, Q_{min} .



The total volume of the sewer network creates an hydraulic buffer.

Therefore, when an STP is served by a very small sewer network, we will see a very large flow difference between the minimum flow and maximum flow, with very low flows in the night.

With a large sewer network, these differences are much less. In this slide you see this exemplified by a sewage flow diagram of the provincial capital town of Cali, Colombia, versus the flow diagram of the small town of Pedregal in Brazil.

Both flow diagrams are monitored during dry weather conditions. The flow pattern will drastically change under rainy weather or storm conditions



In the Netherlands, about 50% of the sewer network consists of a combined system and the other 50% of a separate system.

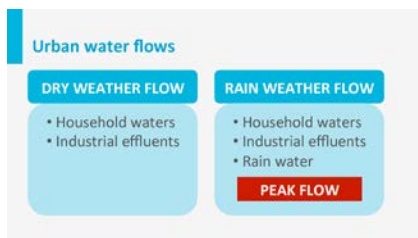
What does this mean? In addition to domestic sewage conveyance, the sewer system generally is also used for urban drainage, the conveyance of rain water from the paved area preventing water nuisance on the streets.

This means that in most areas the maximum flow reaching the STP will be higher during periods of rain.



In addition, the concentration of contaminants will be much lower under rainy weather conditions, changing the sewage characteristics drastically.

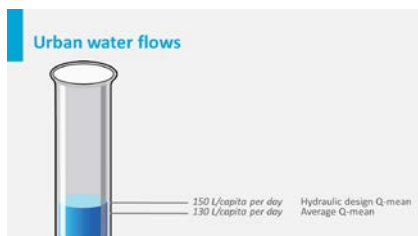
The higher flow in itself, may carry much more inert particles such as street sand and clay particles.



The collected sewage at periods without rain, so the purely collected household waters and industrial effluents, we call the Dry Weather Flow or DWF.

The flow during rainy weather is called the Rain Weather Flow or RWF .

The rain water flow determines the maximum hydraulic load that we can expect to reach the STP, and we therefore, call this flow also the Peak Flow.



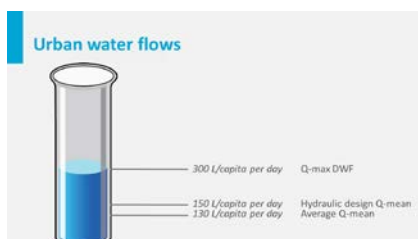
It may be clear that the rain weather intensity fully determines the extent of this Peak Flow.

The hydraulic design for an STP in the Netherlands is based on a mean dry weather flow of 150 L/capita per day or 6.

25 L/capita per hour.

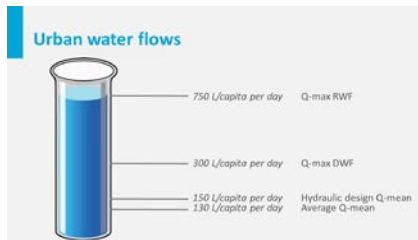
This design base agrees well with the average drinking water consumption of about 130 L/capita per day.

The small difference of 20 L/capita per day can be attributed to the additional drained ground water and/or industrial effluent discharges.



The difference between the diurnal fluctuations between

Q_{mean} and the Q_{max} is about a factor 2, giving design Q_{max} values between 10-15 L/capita per hour.

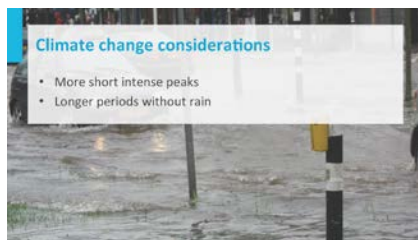


On average, the difference between the dry weather flow Q_{max} and the rain weather flow Q_{max} or Peak flow is again a factor of 2.5, indicating a maximum hydraulic capacity of the STP of 30-50 L/capita per hour, or 750 up to 1000 L per capita per day.

The later agrees with a Peak Flow that is 3-5 times the DWF- Q_{mean} .

Sewage hydraulics and urban drainage capacity will not be discussed in this course but is part of other bachelor and master courses that we offer in our curriculum.

If you are interested you may access the Open Course Ware lecture series of our Department.



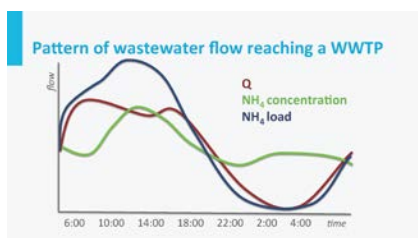
Regarding the Peak Flow occurrence and duration of the Peak Flow, it is of interest to know that many models are currently being develop to predict the rainfall dynamics more accurately.

Owing to climate change considerations, it is expected that the rainfall pattern will differ significantly from the current ones in the years to come: more short and intense peaks and longer periods without rain.

This will have its impact on the required sewer and/or drainage system to be installed.

It must be noted that the hydraulic characteristics of the sewage flow are very important for the physical design calculations, since they will determine the size of the various functional units of the sewage treatment plant, such as grit removal units and clarification tanks.

On the other hand, the hydraulic load has also its impact on the pollutant load to the STP as illustrated in the following is graph:



With only little fluctuations in the diurnal NH_4^+ concentration but strong flow fluctuations between Q_{min} and Q_{max} , the fluctuations in the diurnal NH_4^+ load to the STP are quite considerable.

The term 'load' is used to indicate a specific mass per time unit.

The NH_4 load will impact the biology of the system and thus, strong fluctuations in this load may have an impact on the operational procedures at the STP.



In order to minimize environmental pollution in the Netherlands, an extensive sewer network has been constructed, connecting about 100% of the households to the sewer network, and subsequently, to one of the about 350 STPs in our country.

Costs of Sanitation in the Netherlands

- 110.000 km sewer pipes
- About 350 Sewage Treatment Plants
- CAPEX = 110.000.000 euros
- 2/3 for sewerage
- OPEX = 2-2.500.000 /year
- 40-50% for sewerage, 50-60% for sewage treatment

What are the costs of the sanitation investments in the Netherlands?

With over 100.000 km of sewer pipelines, the sewer network is by far the largest cost factor in the sanitation sector.

The total value of the sewerage and STP infrastructure, expressed as the capital exploitation, or CAPEX costs, is estimated to exceed 110 billion euros with about 2/3 of the costs for the sewer network.

For maintenance, the so-called operational exploitation, or OPEX costs, are estimated at 2-2.5 billion euros per year with about 40-50% for maintaining the sewerage and 50-60% for operating the STPs.

The OPEX alone creates a bill of about 150 euros per citizen per year.

The actual value is lower since part of the costs is also covered by the industry that also makes use of the system.

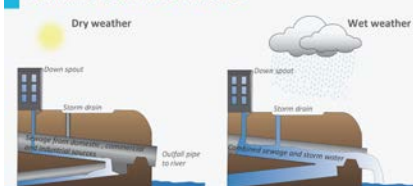
Combined Sewer Overflows



Large recent investments mainly comprised the construction of reception basins, to minimize the environmental impact of the combined sewer overflows, or CSOs.

The constructed sewer network is an 'open' pipeline system.

Combined Sewer Overflows



Meaning that, at heavy rainfall, the internal storage capacity of the sewer network, including that of the sewage treatment plants, is passed.

And non-treated sewage will leave the network via the CSO. Disconnecting rainwater from the main sewer lines will also minimize the CSO nuisance.

We briefly discussed the flow characteristics of the collected sewage.

Since type and extent of the sewerage system determines what is collected, flow characteristics will differ per location.

Next lecture

Focus on sewage pollutants



Now we know how much will come to the sewage treatment plant.

In the next lecture we will focus on the composition, the sewage pollutants.

Wastewater Characteristics

CTB 3365x Introduction to water treatment
Prof. dr. ir. Jules B. van Lier

TU Delft
Challenge the future

Thanks for listening and see you soon.