

Design of drinking water treatment plants

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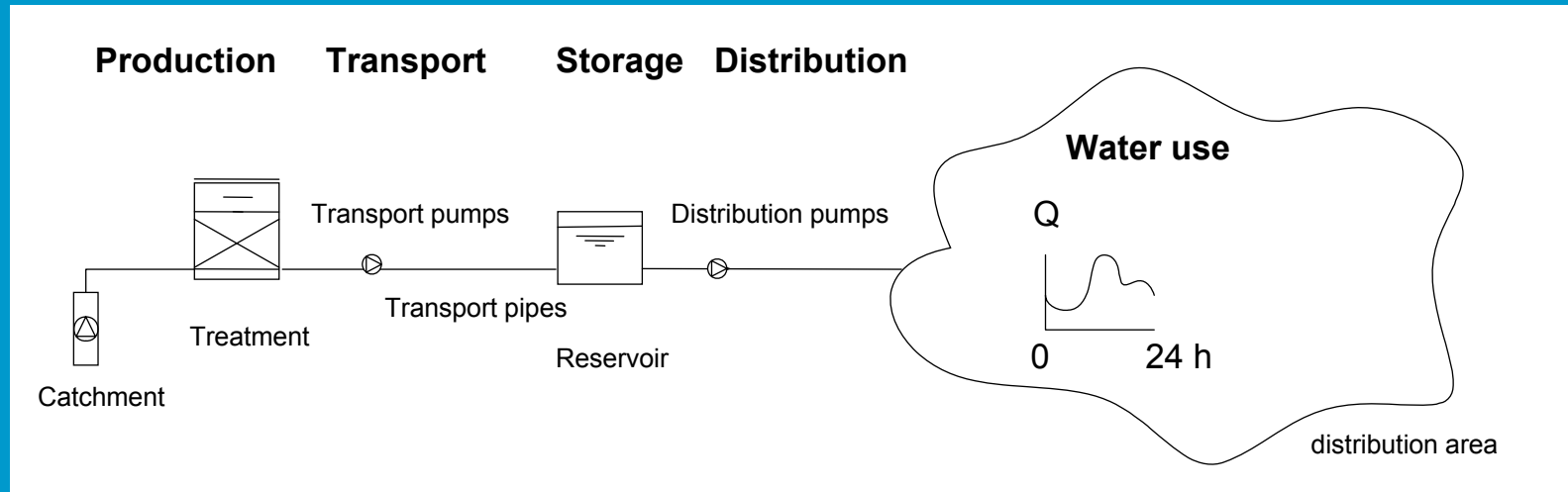
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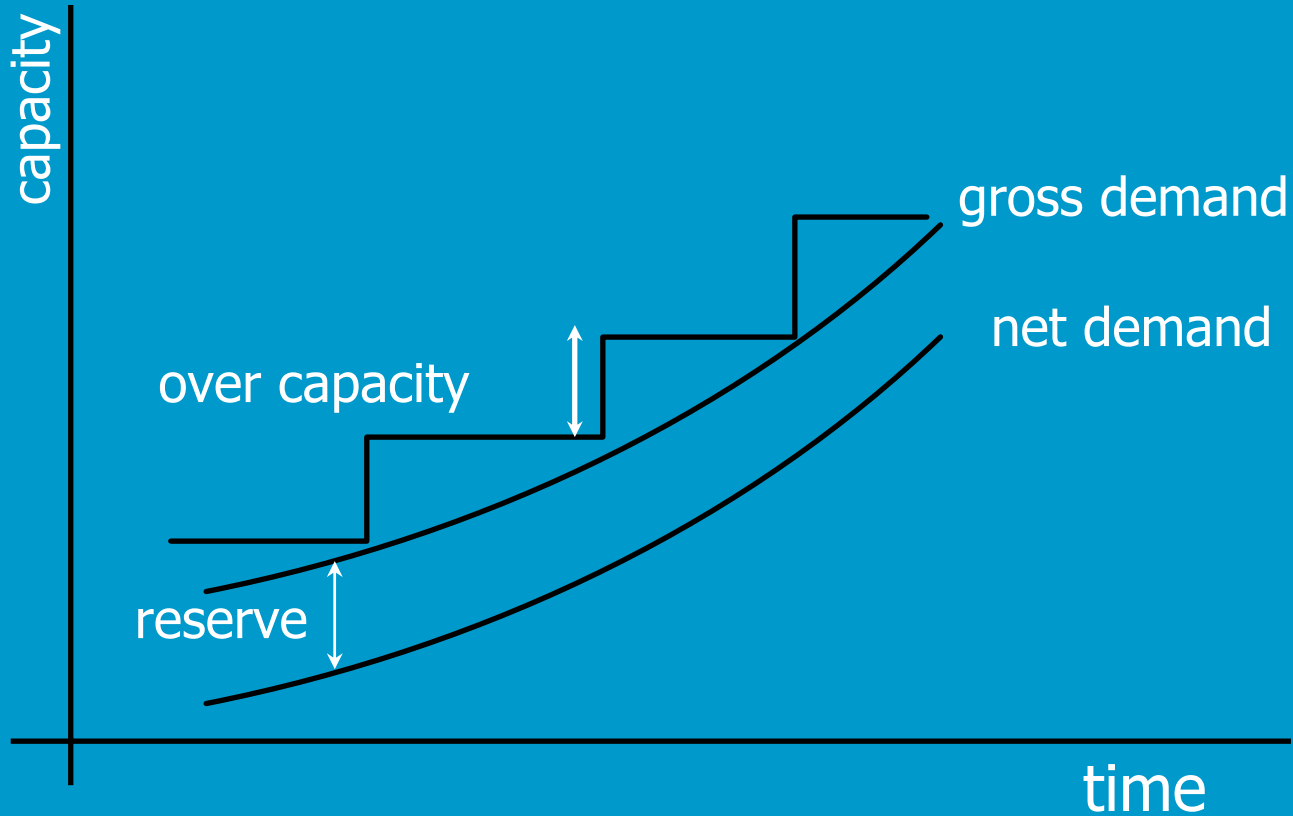
Drinking water from tap to source

Relationship water supply is upstream:



- **Water use** water users, fluctuating demand in distribution area
- **Distribution** supply to different water users, maintain pressure
- **Storage** buffer between production/transport and distribution
- **Transport** smooth transport of water
- **Production** catchment and treatment, steady production

Capacity versus water demand in time



Fluctuations - Events

Events in water use

| period | typical cause |
|------------|-------------------------------------|
| more years | dry summers |
| year | watering of the garden in summer |
| week | Monday=washing day, Sunday= day off |
| day | almost no demand during the night |
| hour | half-time soccer game |

All events may occur at the same time!

Fluctuations - Events

Water use Enschede, saturday July 4th 1998
Argentinië - Nederland 1-2



Variation in water consumption

| | | |
|----------------------------|----------|--------------------------------------|
| Dry/wet year | +8/-6% | of the average consumption |
| Summer/winter | +7/-6% | of the average half year consumption |
| max/min month consumption | +10/-8% | of the year consumption/12 |
| max/min week consumption | +25/-30% | of the year consumption/52 |
| max/min day consumption | +40/-35% | of the year consumption/365 |
| max/min hour consumption | +80/-75% | of the day consumption/24 |
| max/min minute consumption | +85/-75% | of the day consumption/1440 |
| weekday/Sunday | +10/-25% | van de weekconsumptie/7 |

1. Design capacity

average capacity (m³/h): $Q_j = \text{year capacity}/(365 \cdot 24)$

Average capacity on a maximum day in a dry year

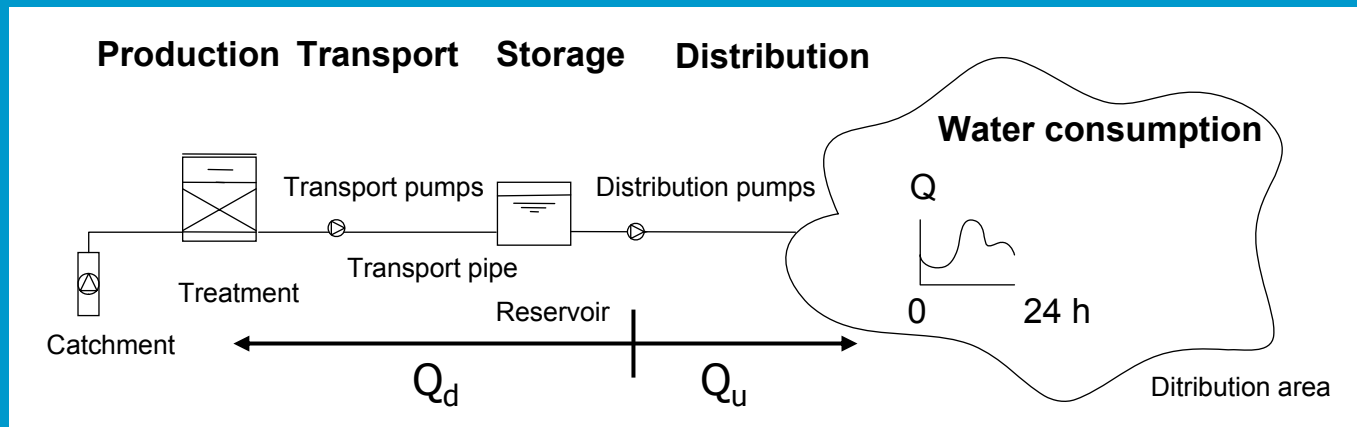
$$Q_d = 1.08 \cdot 1.40 \cdot Q_j = 1.5 \cdot Q_j$$

Capacity on a maximum hour on a maximum day in a dry year

$$Q_u = 1.08 \cdot 1.40 \cdot 1.80 \cdot Q_j = 2.7 \cdot Q_j$$

for catchment, treatment and transport
for distribution pumps and pipes

Q_d
 Q_u



2. Process scheme

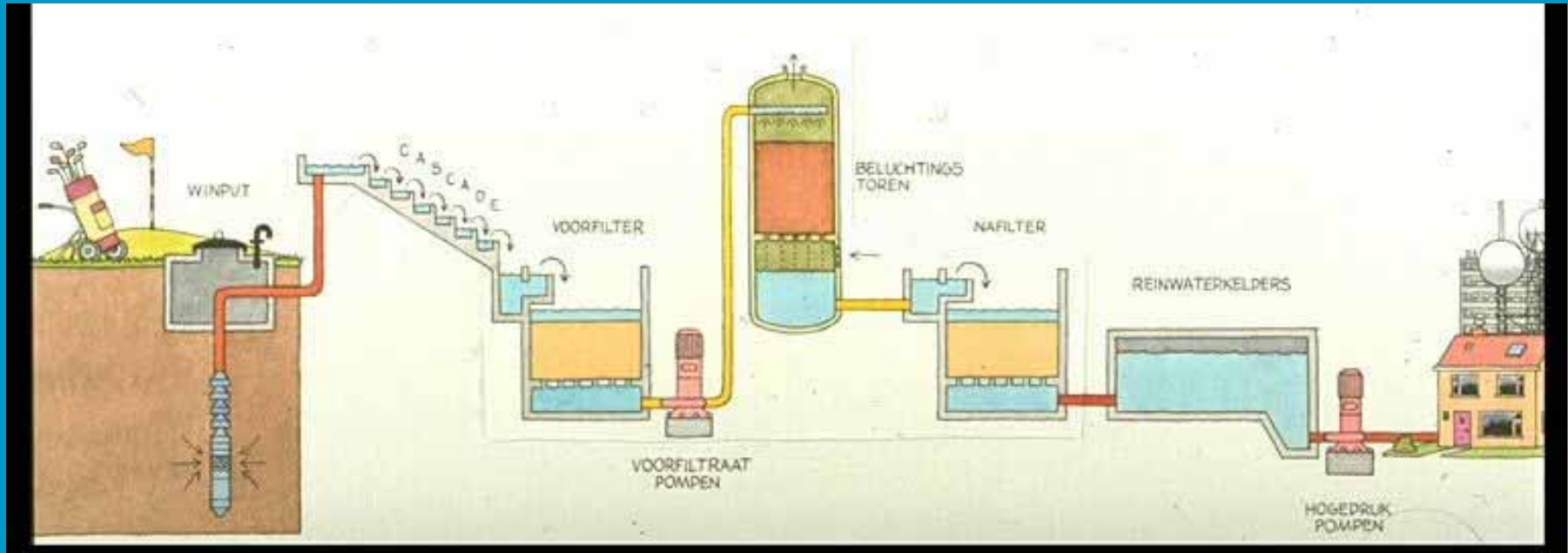
What is the raw water composition?

What are the requirements of drinking water?

- **Drinking water law**
- **Drinking water standard**
- **EG-guidelines**
- **VEWIN-guidelines**
- **WHO-guidelines**
- **USEPA-guidelines**
- **Guide lines Protection Water companies**

Which process scheme is good?

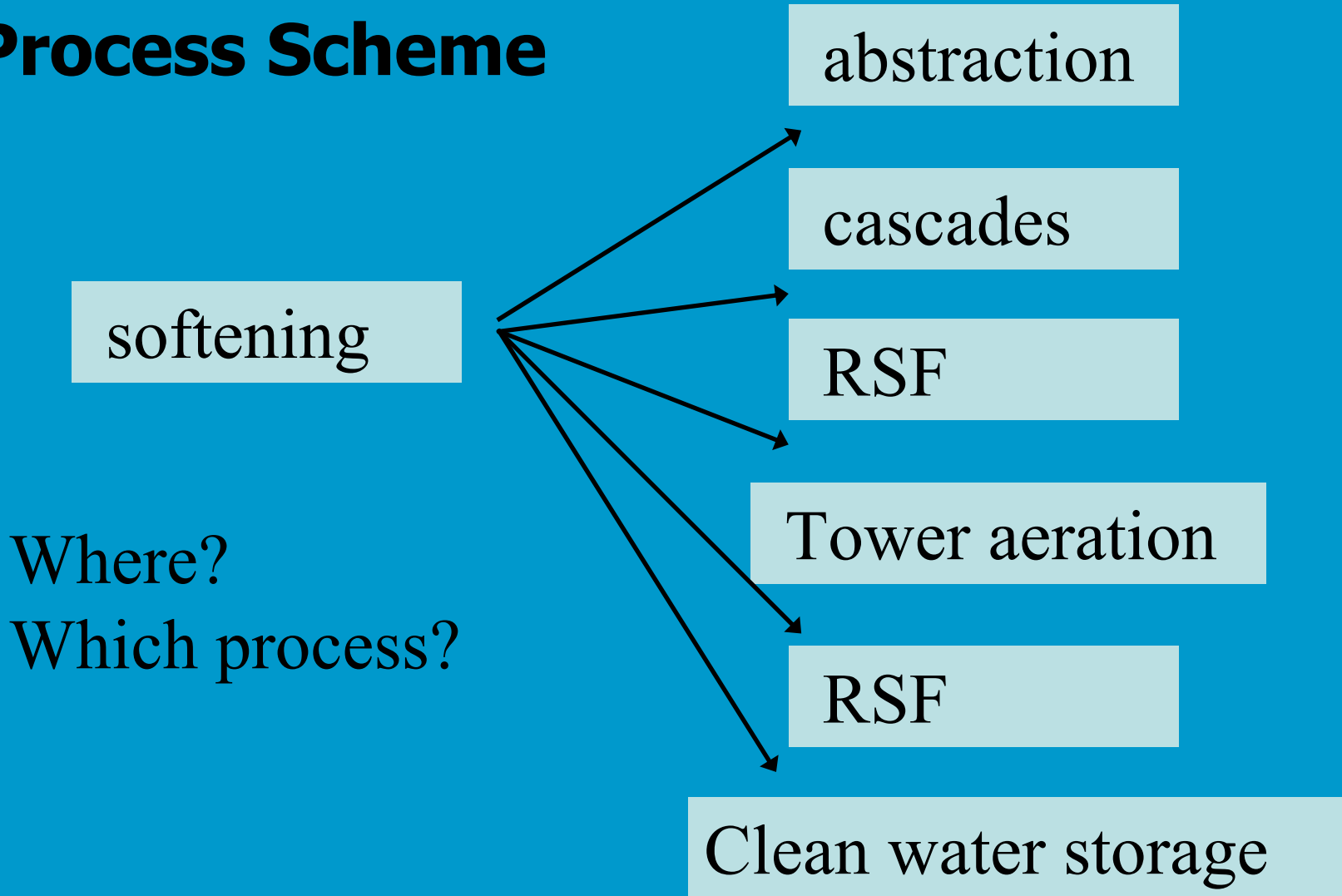
Process scheme



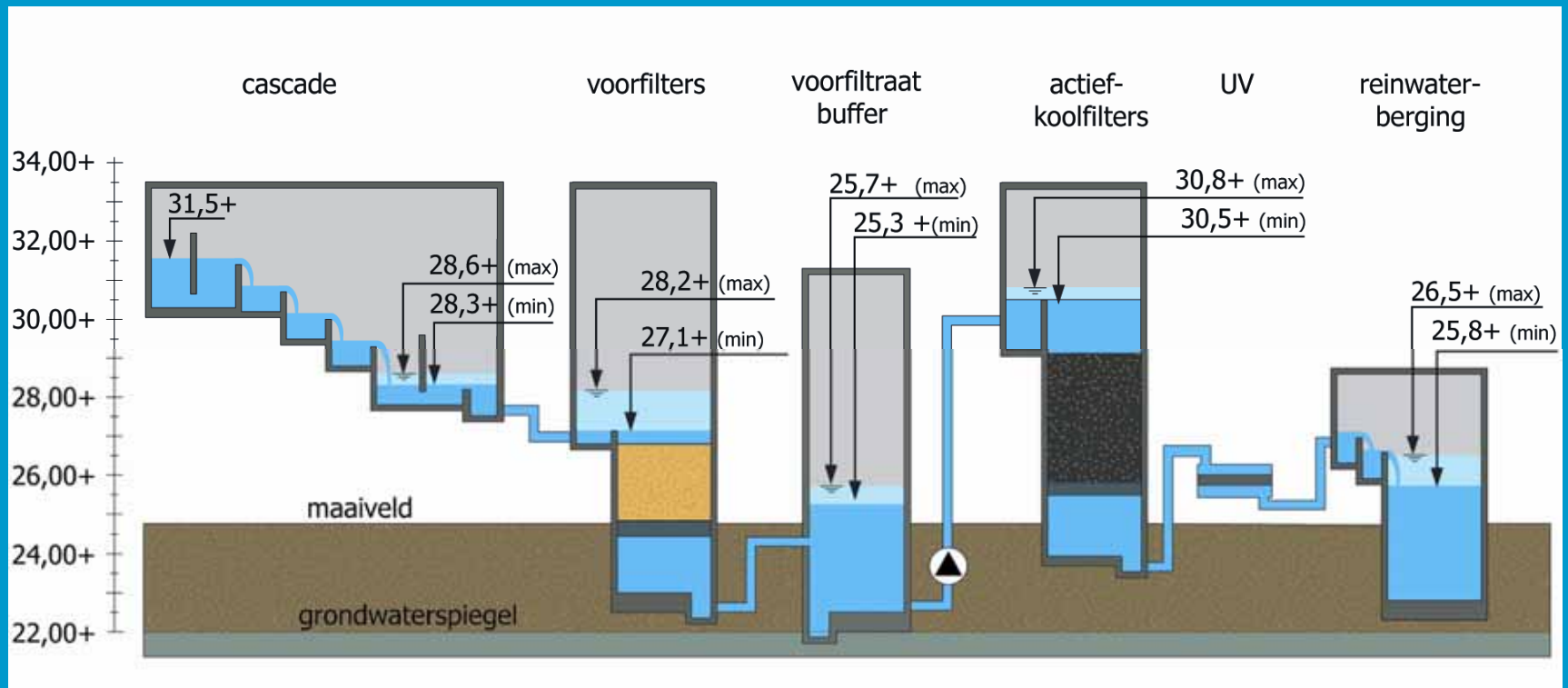
Process scheme

- Experience of comparable treatment plants
- Pilot plant research
- Reliability and robustness
- Quality raw water and clear water

Process Scheme



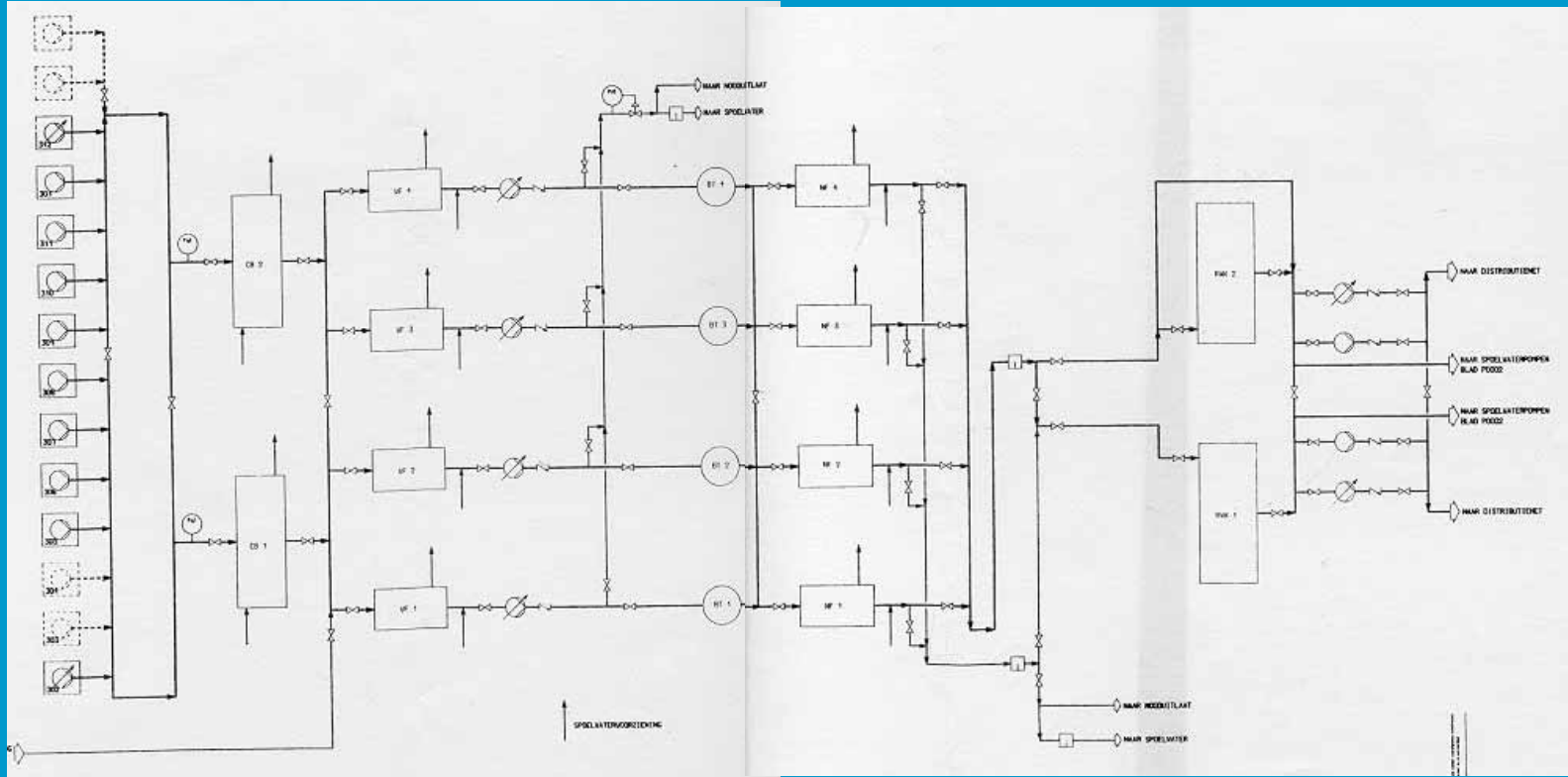
Hydraulisch lijnschema



Hydraulic line scheme

- Foundation depth
- Maximum building height
- Pump phase
- Head loss per treatment step
- Head loss in pipes
- Upstream- from the tap to the sources

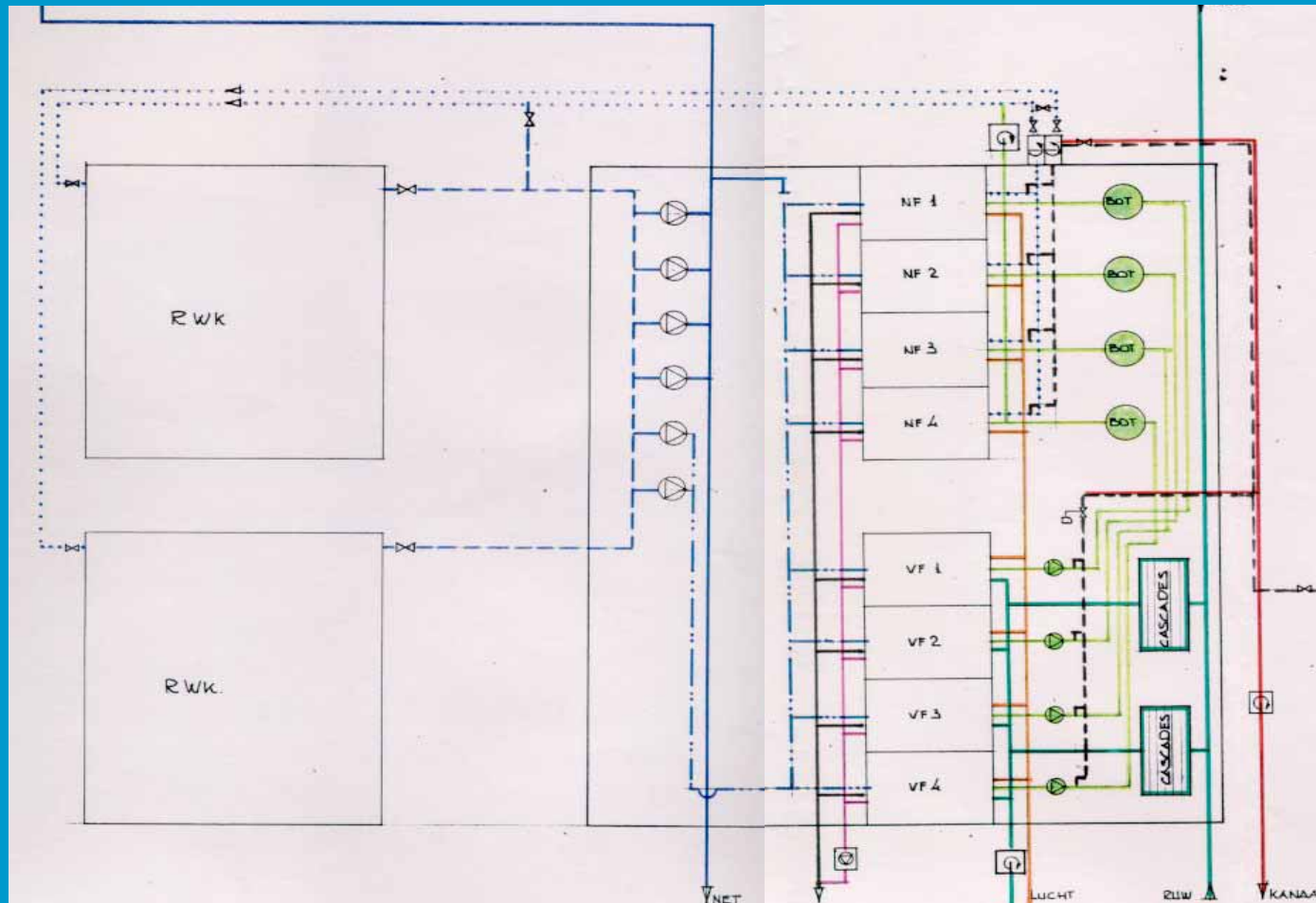
4. Main water flow scheme



Main water flow scheme

- Number of streets
- Reliability water production
- Costs
- Flow splitting – equal flow pattern
- Clear lay out
- Maintenance
- Plant operation/connections

5. Lay out



Lay out

- Clear and logical lay out
- Compact building
- Accessibility
- Architecture
- Structural design

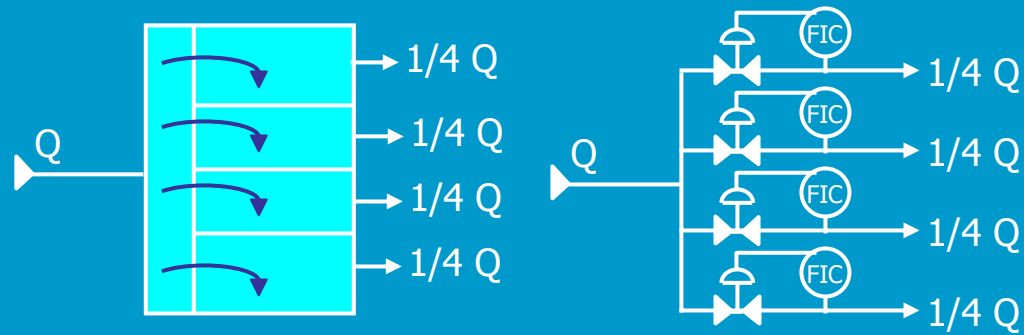
Cross sections

- Ordering of pipes
- Accessibility
- Logical lay out

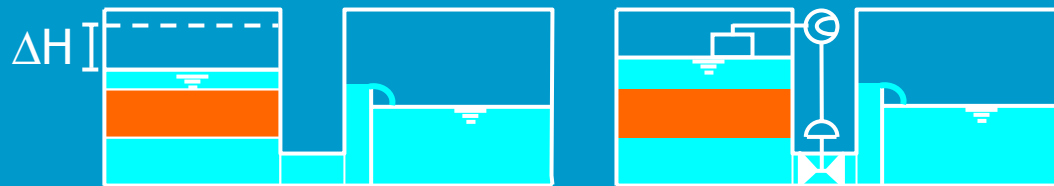
7. Hydraulics

- Calculations of hydraulic losses
- Equal flow division of water over process units
- Economical diameter pipes ($v = 1 \text{ m/s}$)

Hydraulics or Controllers?



Flow splitting over streets



Filter control (compensation for increased resistance)

Architecture

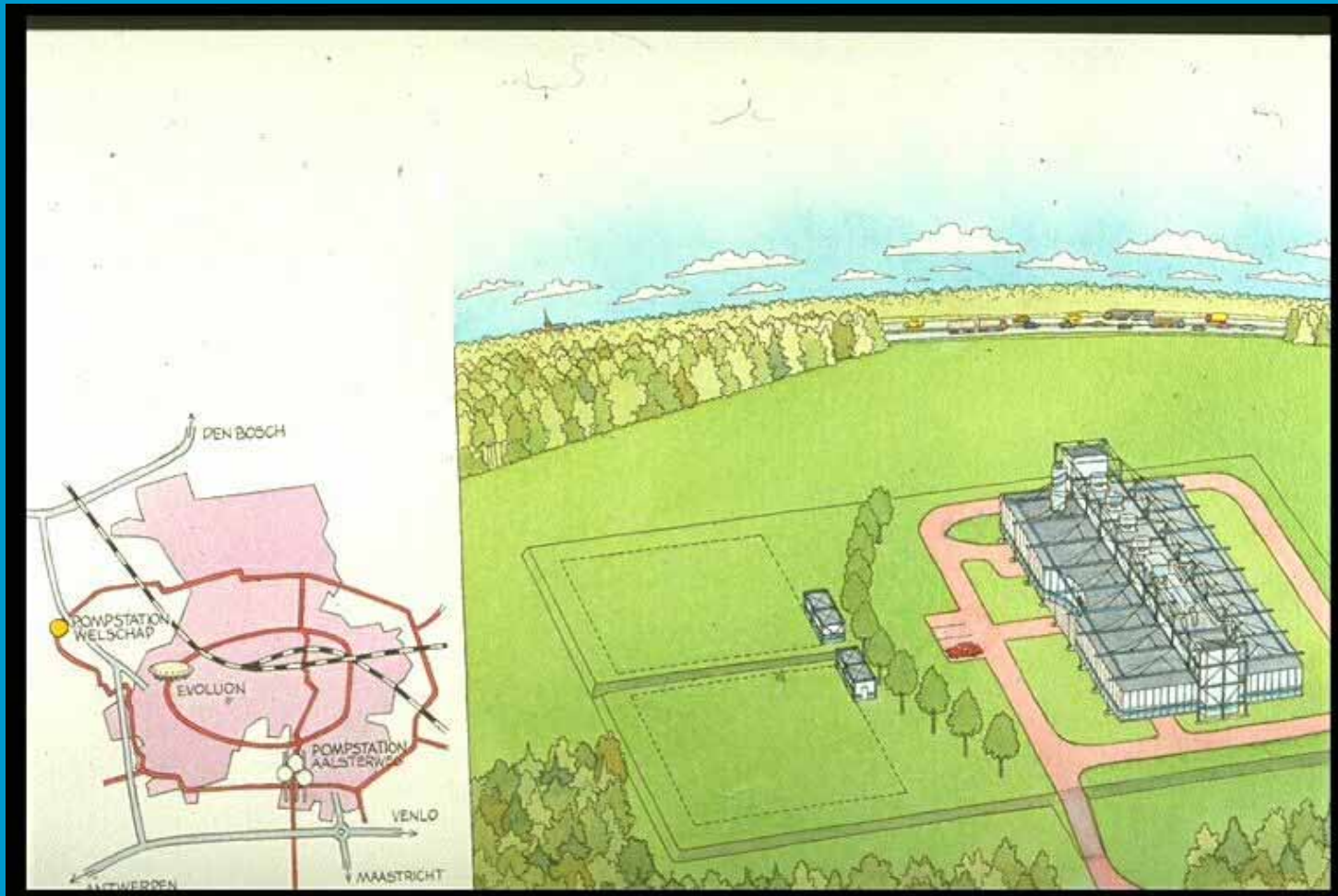


Photo Welschap



Architectuur



Disciplines

1. Process technologie
2. Civil engineering
Hydrology
Structural engineering
Geotechnical engineering
Material science
Landscaping
3. Mechanical engineering
Electrical engineering
Heating and ventilation
Control and instrumentation
4. Architecture

Project phases

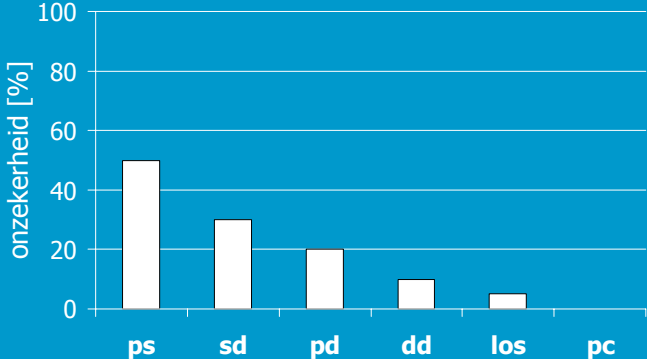
RVOI (Regeling Verhouding Opdrachtgever/Ingenieursbureau)

1. Preliminary investigations →
2. Preliminary design →
3. Final design
4. Tender documents
5. Contracting
6. Detailed engineering
7. Supervision of construction
8. Completion and take-over
9. Operation and guarantee period

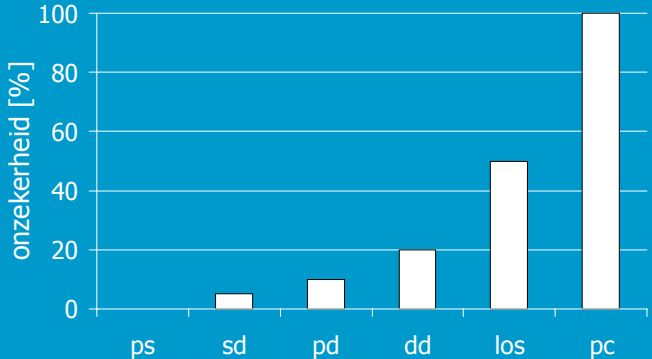


Project phases

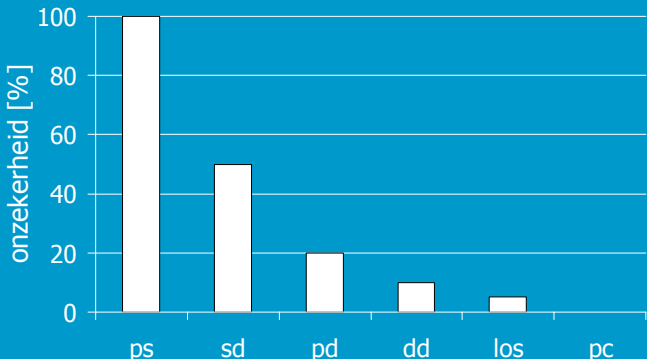
Nauwkeurigheid



Kosten aanpassingen



Veranderbaarheid



Planbaarheid



Voorontwerp

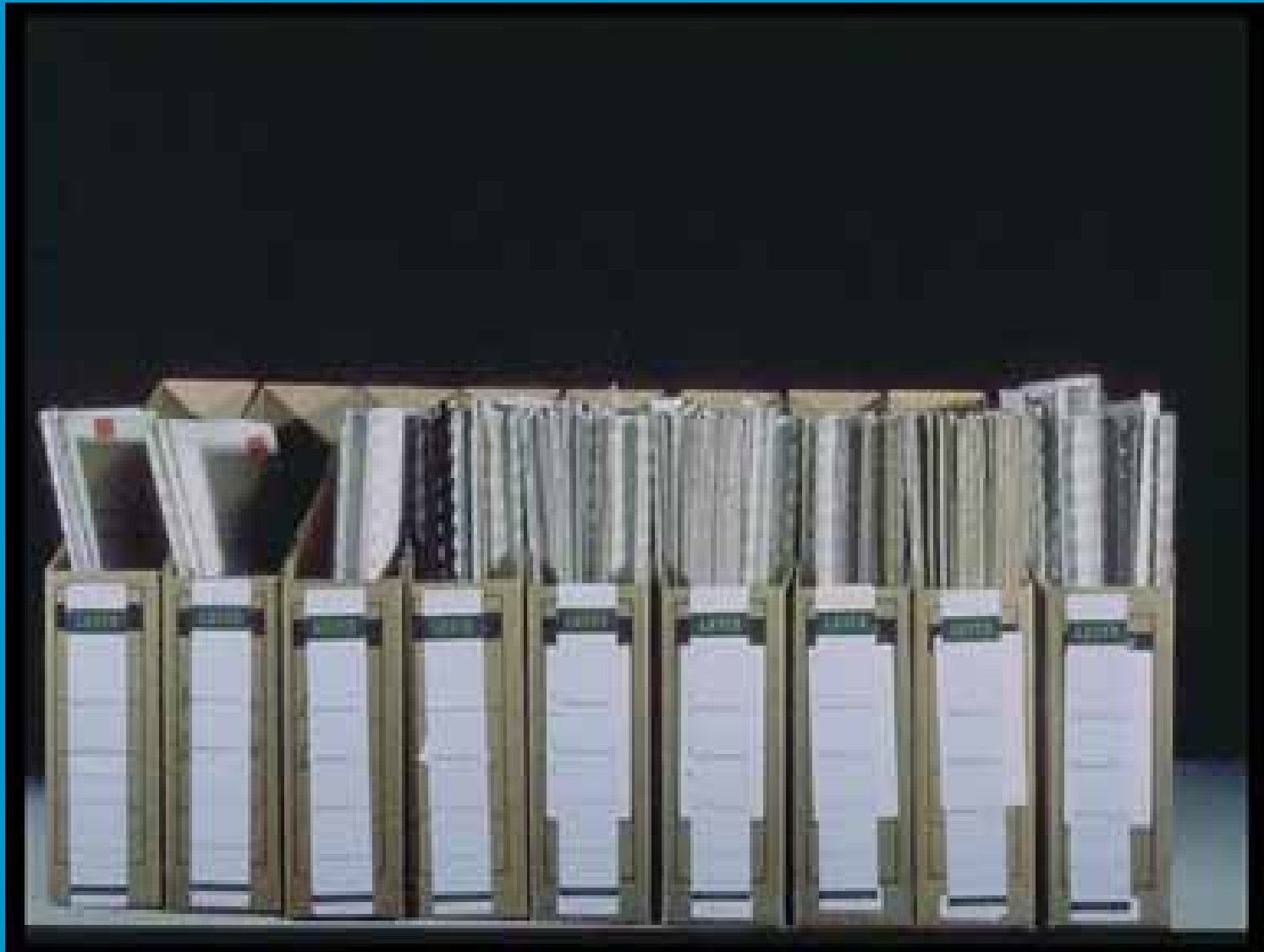
1. **Uitgangspunten en probleembeschrijving**
2. **Schema's**
 - processchema
 - hydraulische lijn schema
 - hoofdwaterloopschema
 - geografisch overzichtschema
3. **Voorontwerp gebouwen**
 - terreintekeningen
 - plattegronden
 - langsdoorsneden
 - dwarsdoorsneden
4. **Begrotingen**

Aanbesteding

1. Normaal werk met volledig bestek, normale kwaliteit, normale levertijd
 - openbare aanbesteding
2. Werk met volledig bestek, bijzondere eisen aan kwaliteit van levertijd
 - openbare aanbesteding met classificatie
 - onderhandse aanbesteding
3. Normaal werk zonder gedetailleerd bestek
 - onderhandse aanbesteding, detaillering in bouwteam
 - turn-Key
4. Werk zonder bestek, bijzondere eisen aan kwaliteit van levertijd
 - selectie volgens examen procedure, detaillering in bouwteam
 - turn-Key

Verrekening

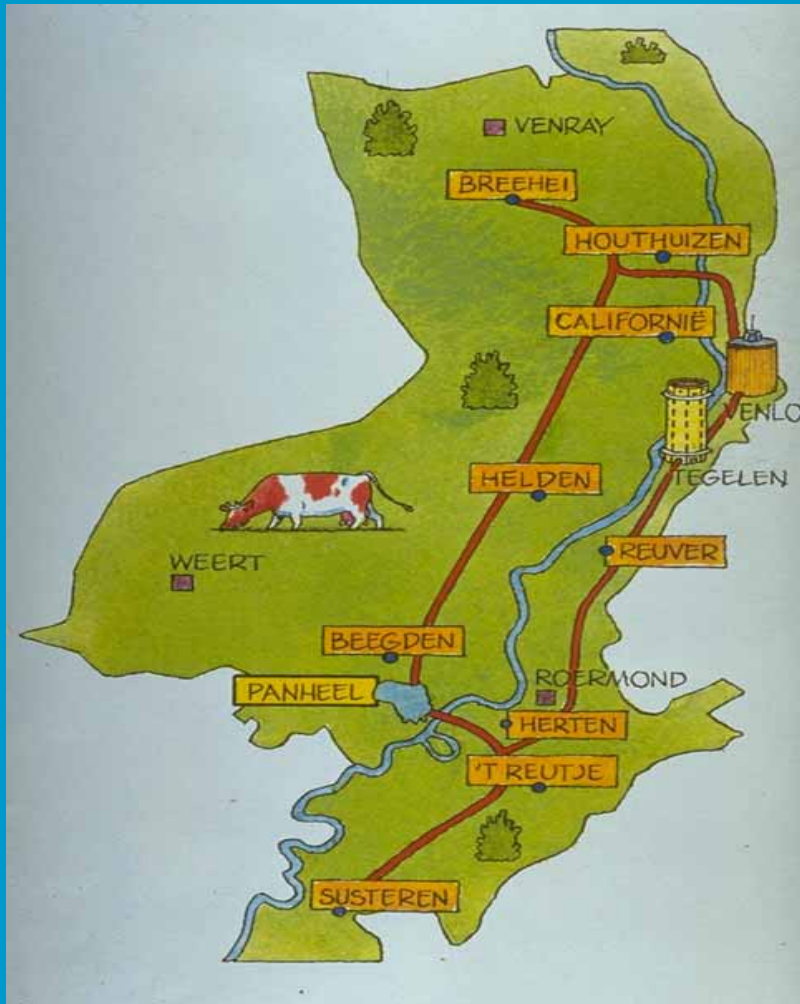
1. lump-sum
2. meer- minderwerk (openbare begroting)
3. regie (verrekenbaar plus winst)



Basis opzet Heel



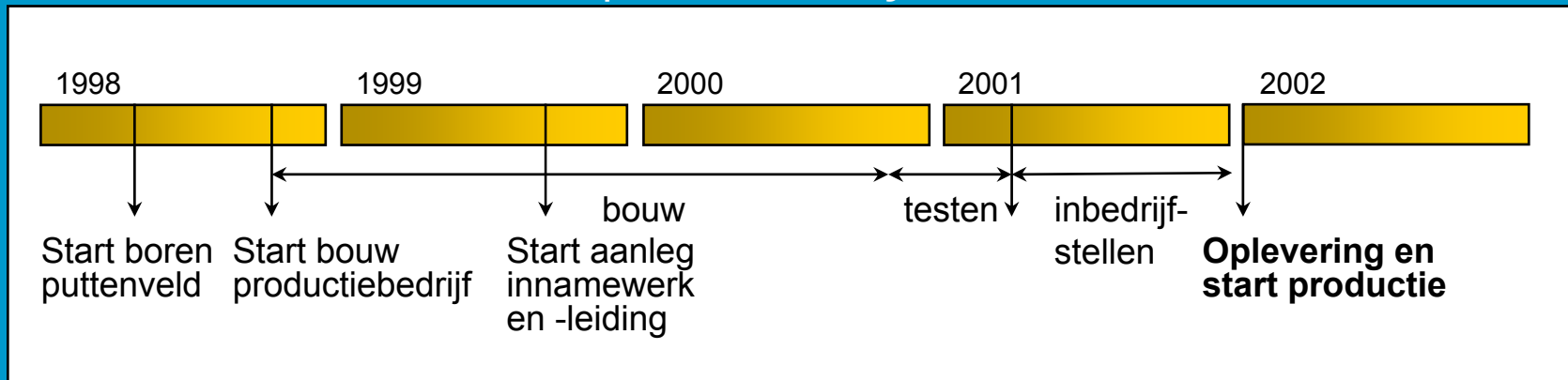
Koppelnet met grondwater



Tijdspad

Geschiedenis WPH:

- 1972: Eerste structuurschema drink- en industriewatervoorziening
- 1980-1985: Spaarbekken Panheel, inrichting en effecten
- 1994: Toetsingskader grondwateronttrekkingen en alternatieven
- 1994: Integraalplan Spaarbekken Panheel
- 1996: MER gereed
- 1998: Start bouw Waterproductiebedrijf Heel



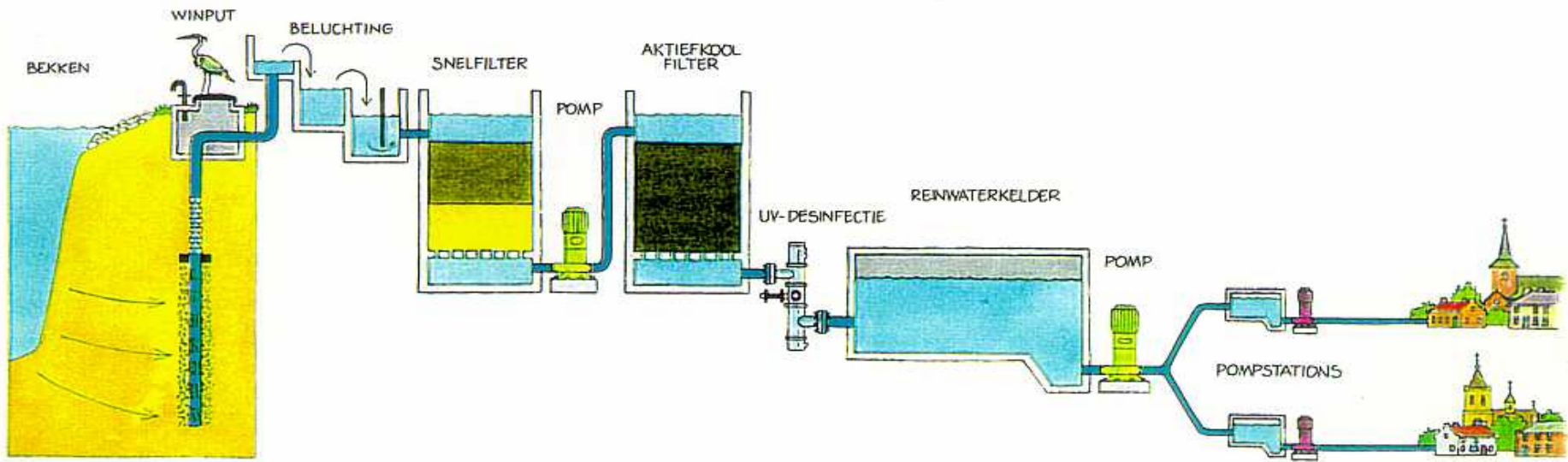


WATERPRODUCTIEBEDRIJF HEEL

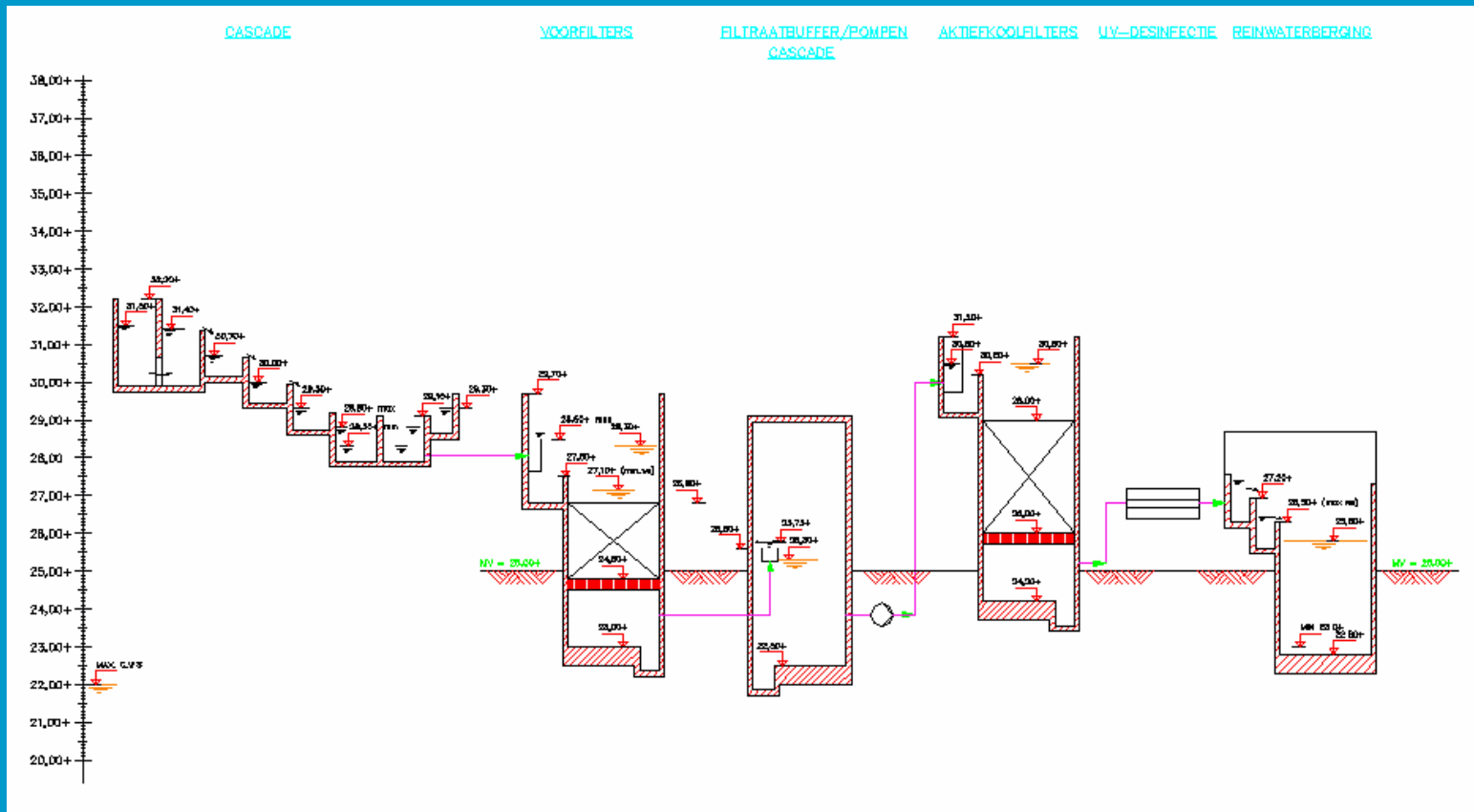
20 miljoen kubieke meter per jaar



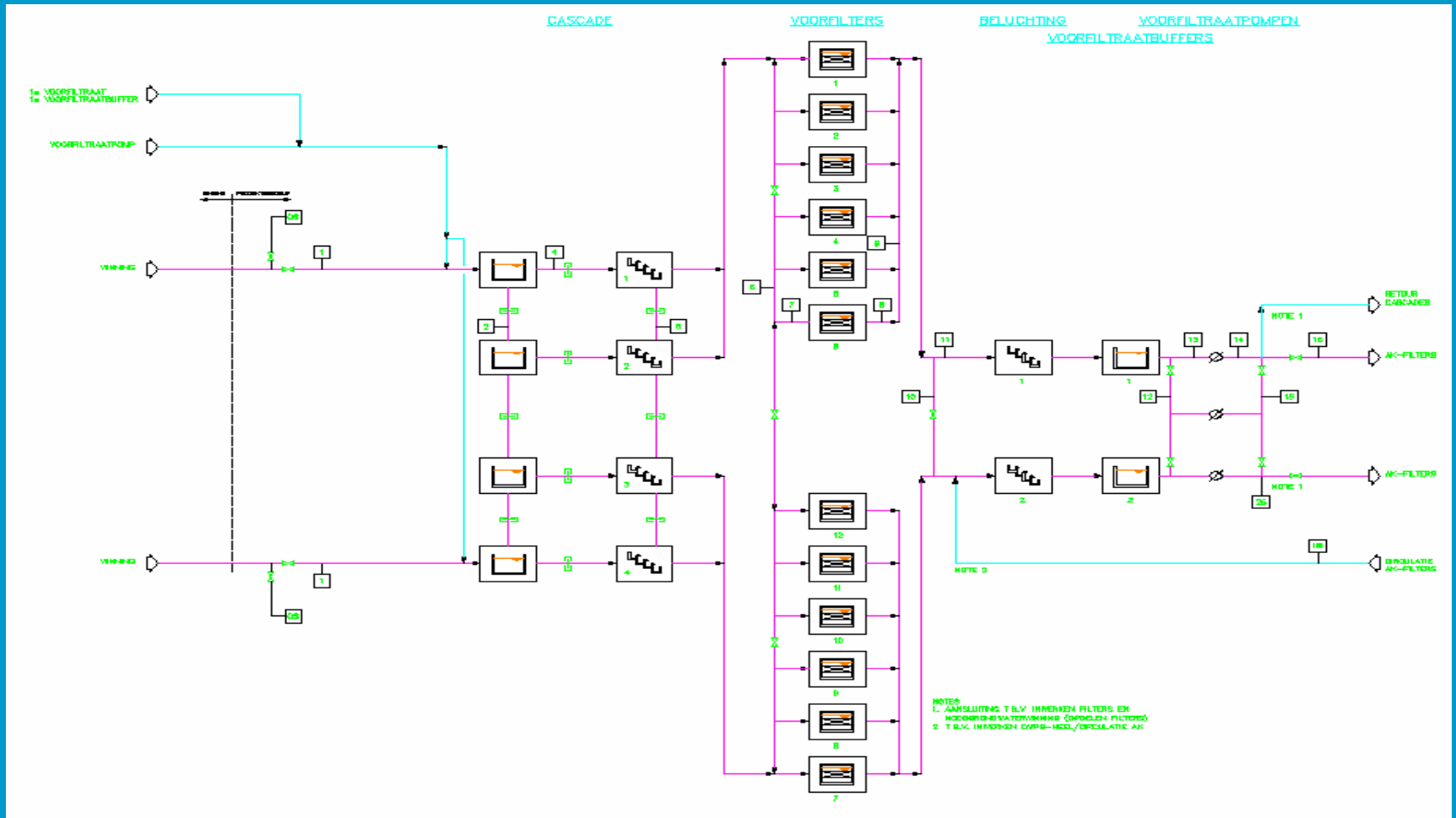
Processchema



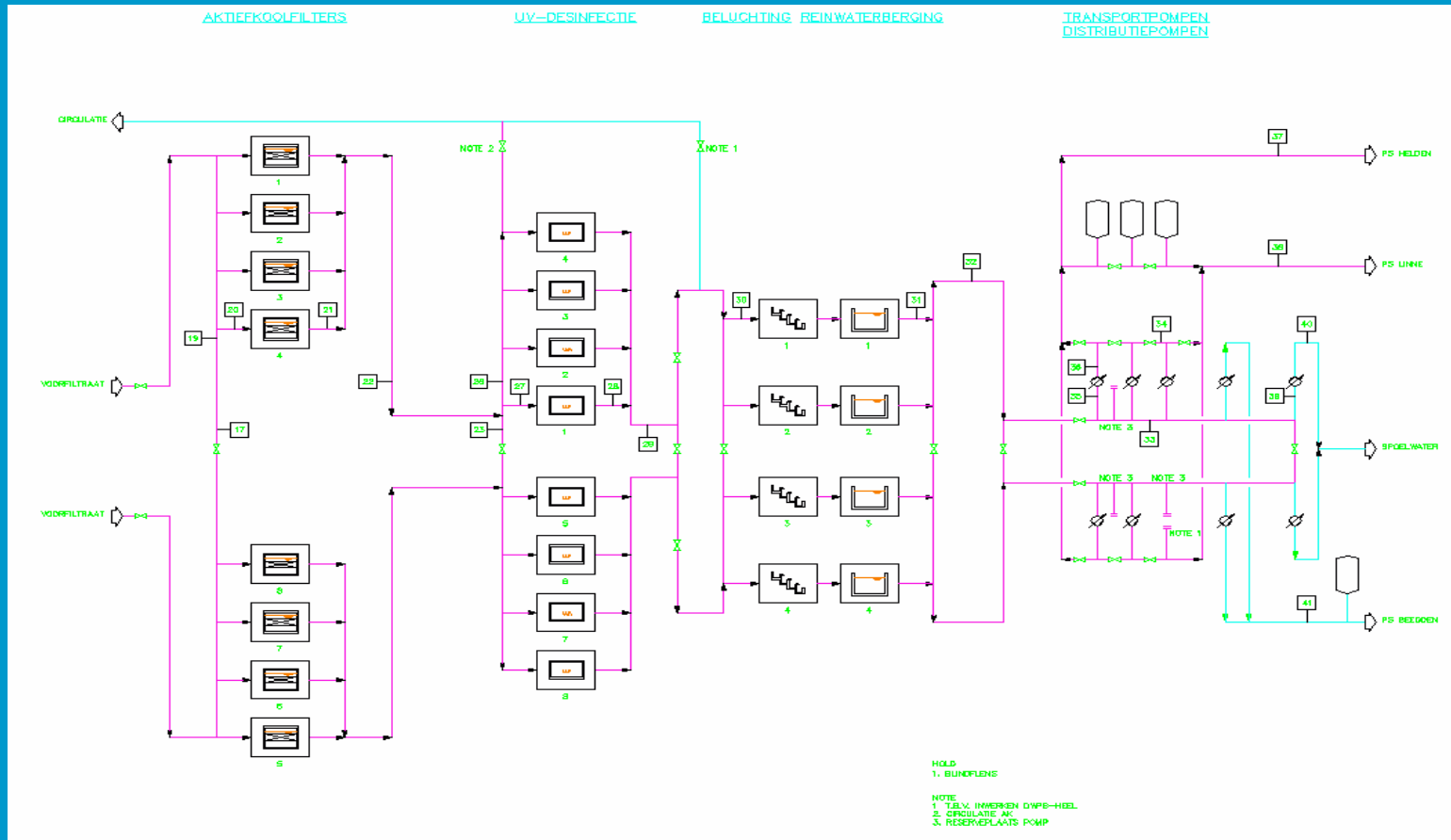
WPH - hydraulische lijn



Hoofdwaterloopschema



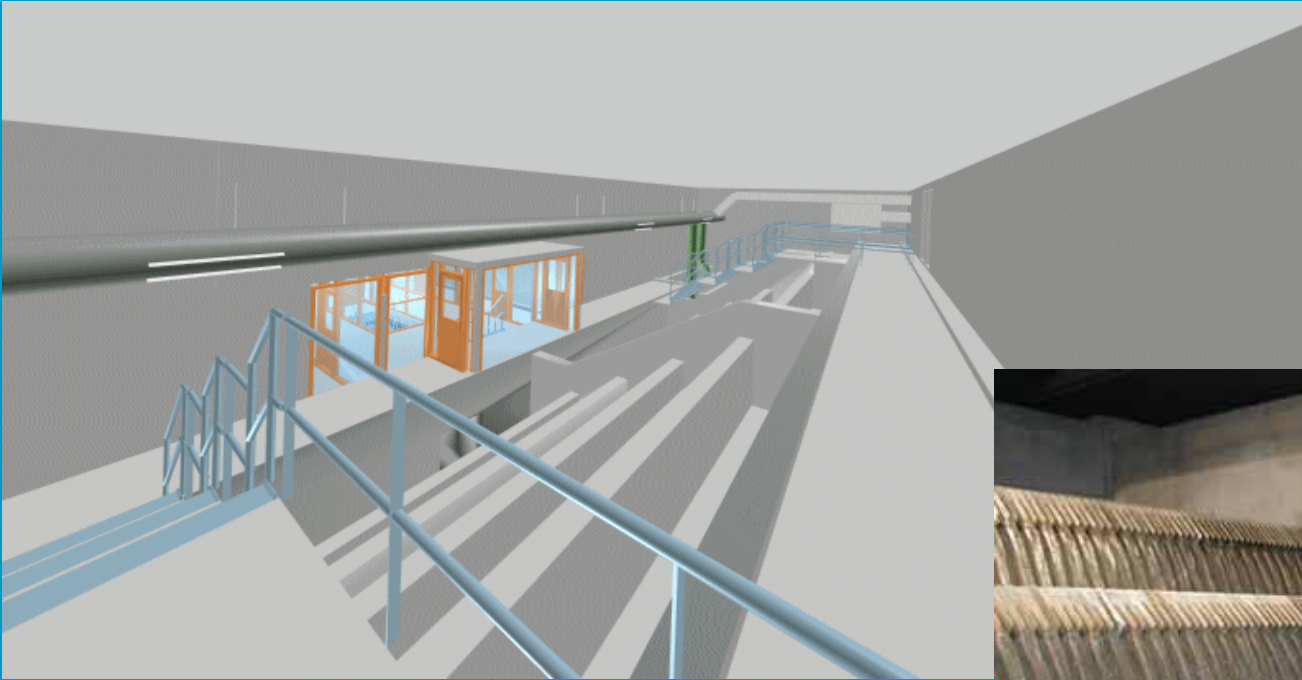
Hoofdwaterloopschema



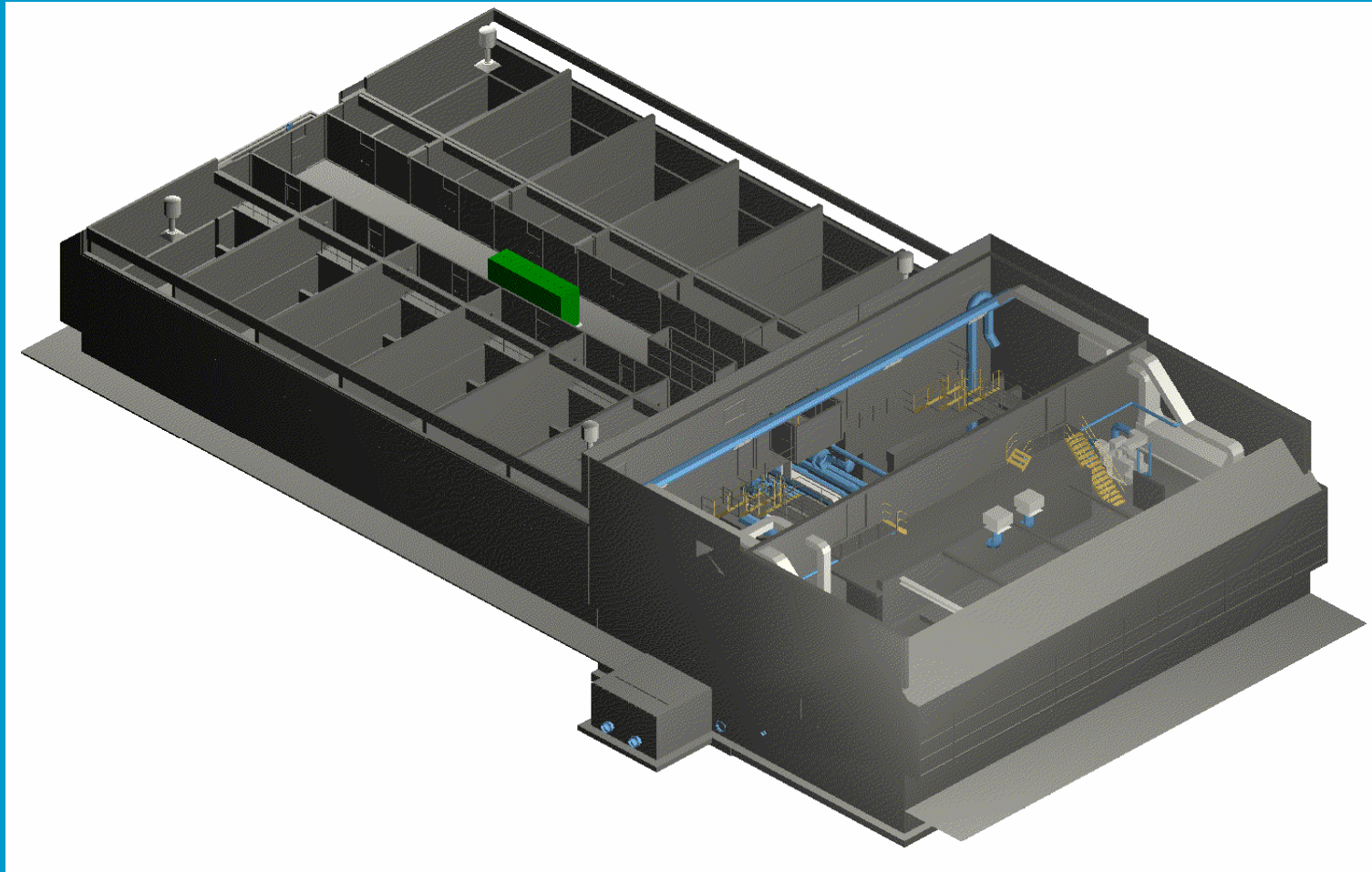
Architectuur



Cascade



Voorfilters



Zuiver drinkwater voor Limburg

WML investeert in unieke combinatie van oppervlaktewater **en** grondwater!



Eindresultaat



Next week

- Overall problem definition
- Design capacity
- Process scheme of the existing process
- Several process schemes
- Discuss the choice of the process
- Discuss the choice of the location in the treatment scheme
- Discuss the use of chemicals if needed