4. Fresh water supply

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4. Fresh water supply

Goals of this chapter

To know

- elements and concept of fresh water nets
- protection zones around captures
- types of captures with their characteristics
- concept of reservoirs, design volumes
- distribution net types with advantages and disadvantages
- relevant pressures
- design scenarios

Not a goal

Hydraulic design (commercial software)

Fresh water treatment

4. Fresh water supply

Content:

Literature:

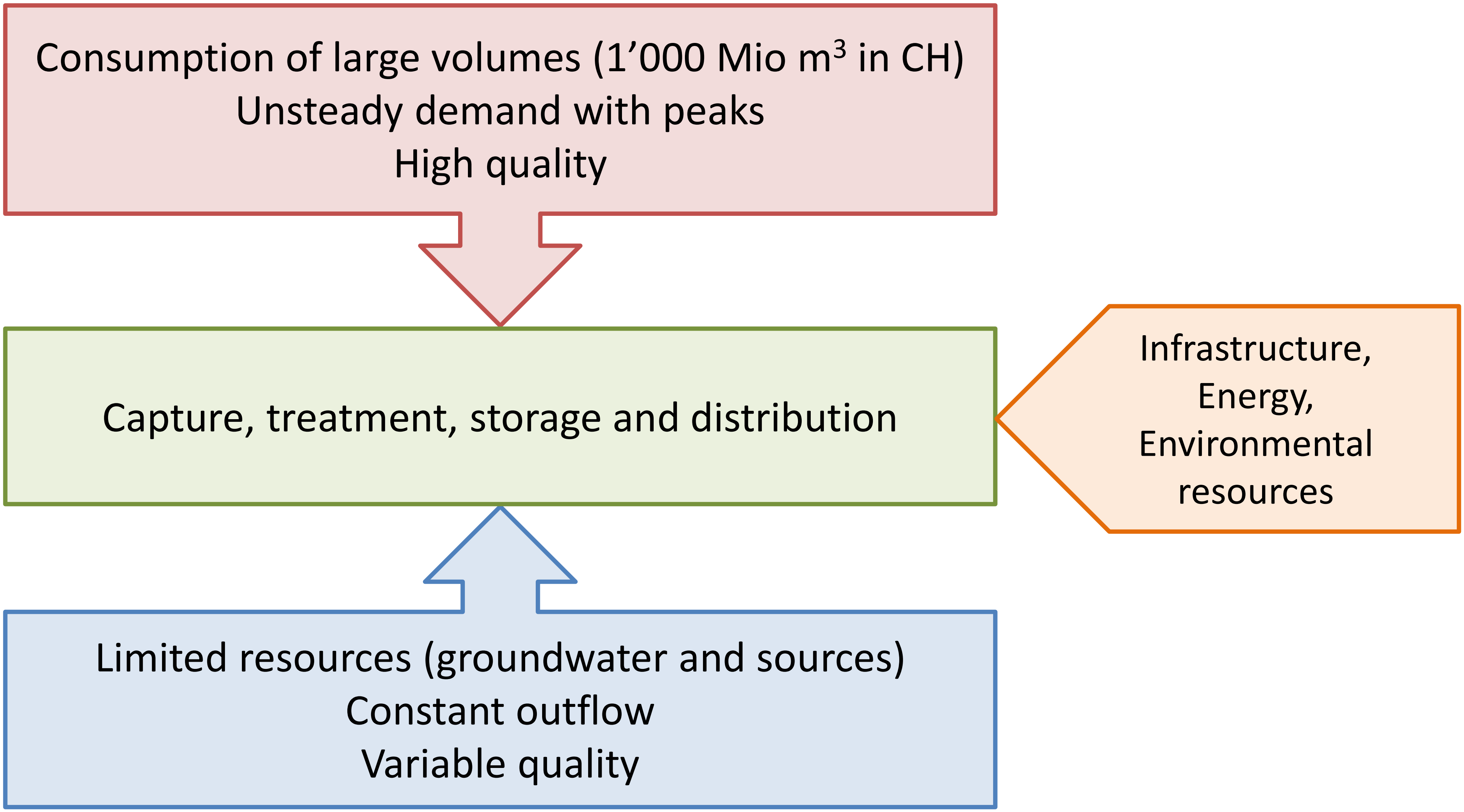
SVGW (2004, 2004, 1989). W3, W4, W6, W10

Grombach, P., Haberer, K., Trüeb, E.U. (1985). *Handbuch der Wasserversorgungs-technik*. Oldenburg Verlag München

Gujer, W. (1999). *Siedlungswasserwirtschaft*. Springer, Berlin

4.1 Introduction

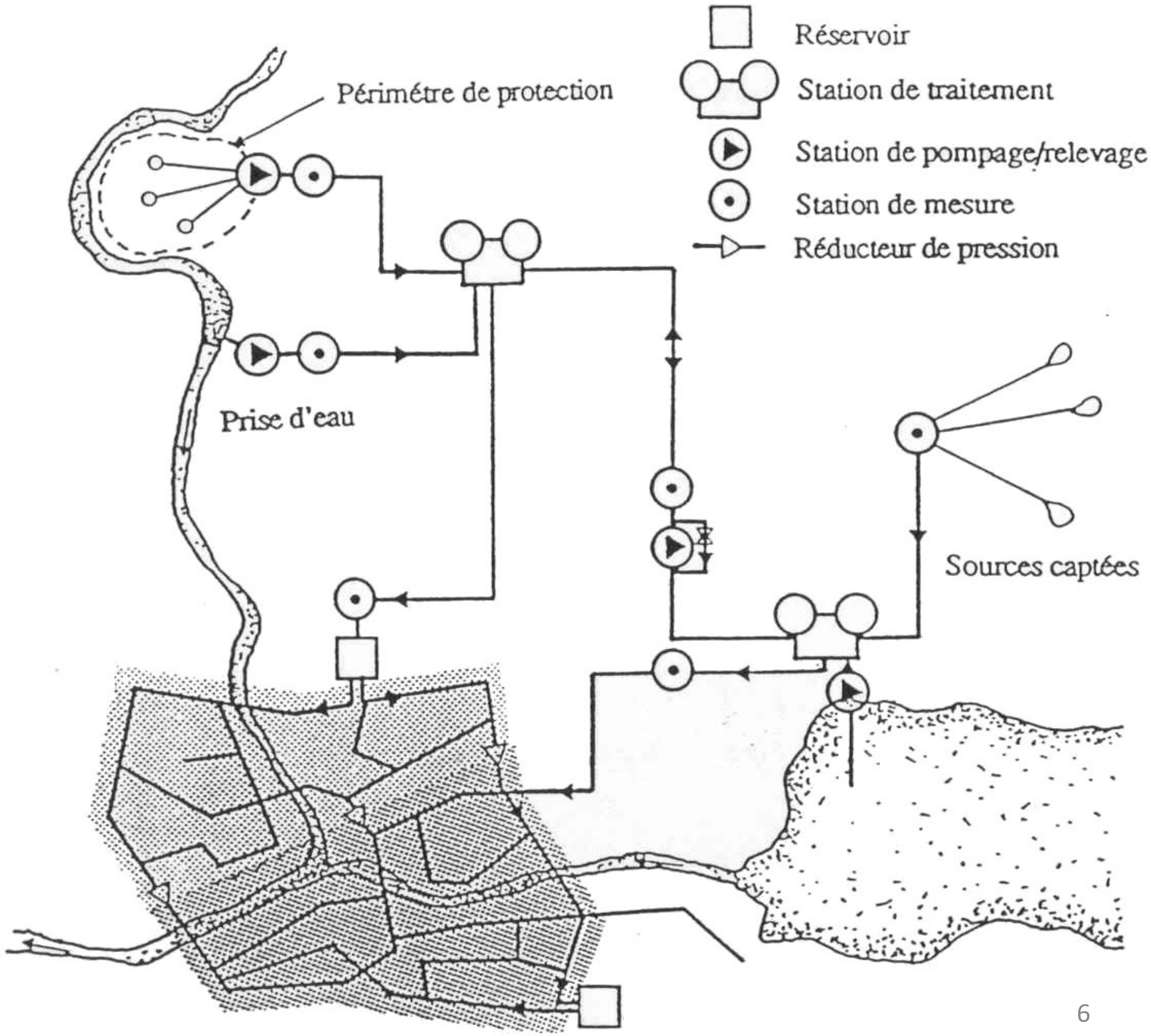
4.1 Introduction



4.1 Introduction

Elements

Protection areas, capture, treatment, storage (reservoir), distribution (net, pumping)



4.2 Capture

4.2 Capture

Where to capture fresh water?

- Discharge measurement over several years at source, maximally 10% of precipitation for groundwater

- Water quality, treatment and energy need

- Ability for protection

- Sustainability

4.2 Capture

Water protection areas (Act on water protection, Annex 4)

Water protection area "A"

- Protects the resources of usable water in the natural environment
- Includes water courses with banks
- Distinction in surface (Ao) and ground water (Au)

Alimentation area "Z"

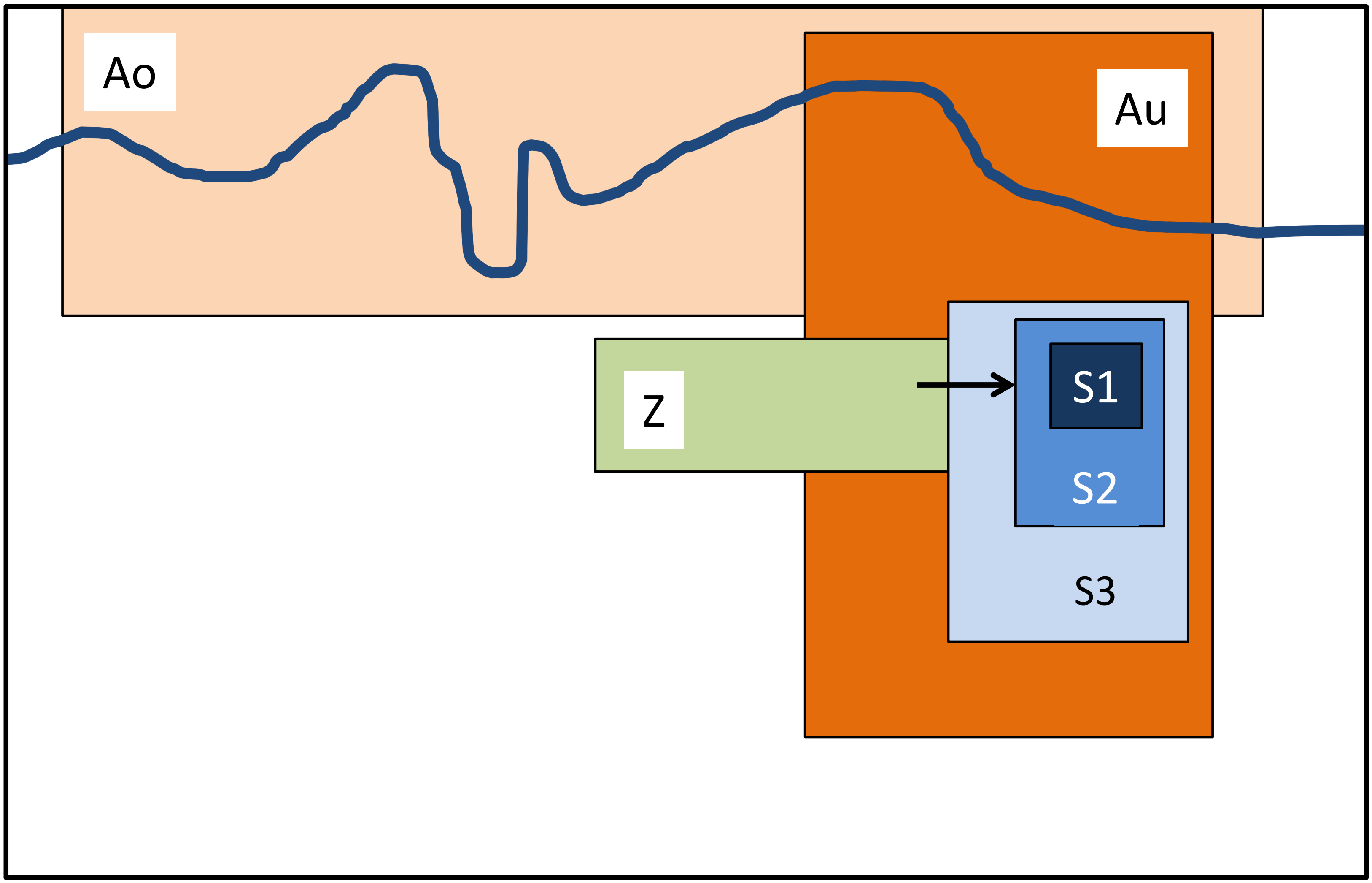
- Protects the area which feeds zones "S"
- Protects the area which feeds water courses
- Distinction in surface (Zo) and ground water (Zu)

Capture area "S"

- Protection of zones near water captures

The cantons provide maps indication the zones "A", "Z" and "S"

4.2 Capture



4.2 Capture

Capture area “S”

S1: caption area

- Avoids damage and contamination of ground water caption.
- All building activities are forbidden
- Includes exclusively installations for water capture

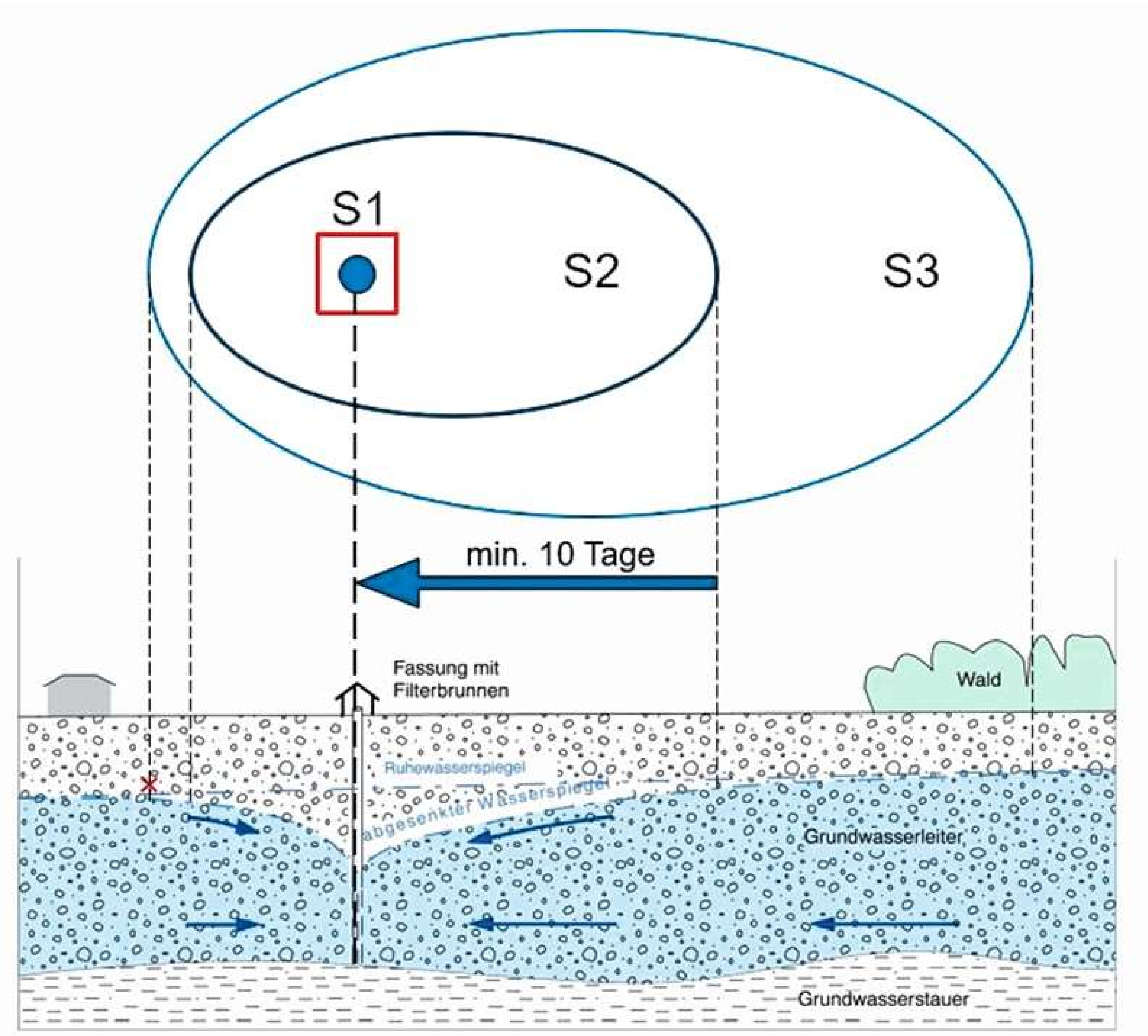
S2: primary protection area

- No pathogens near caption
- No contamination initiated by excavation works, which are forbidden
- No disturbance of ground water flow
- No infiltration of wastewater (e.g. slurry)

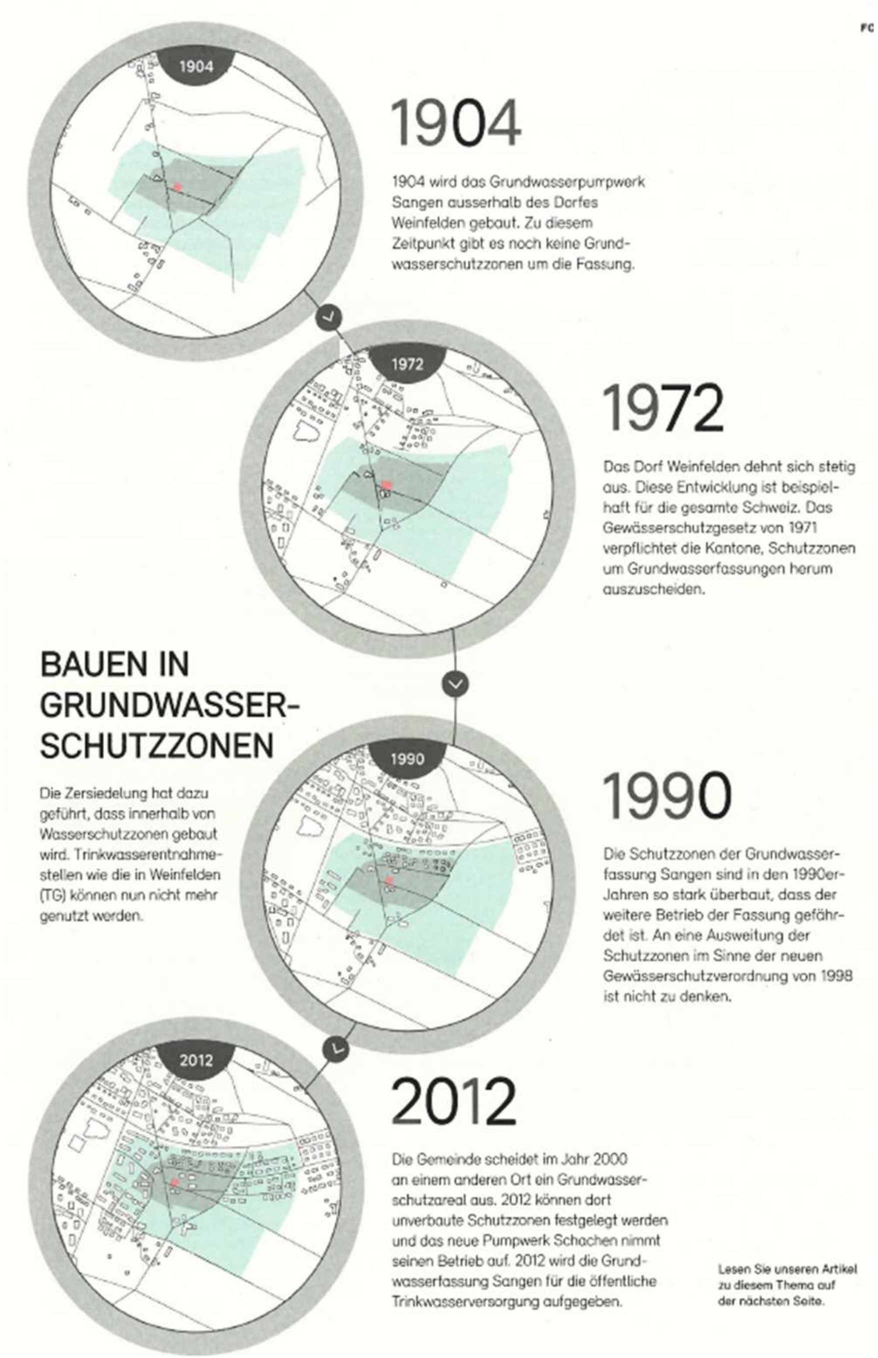
S3: secondary protection area

- Sufficient intervention time in case of accident
- Some industrial & commercial buildings, some underground conduits
- Storage of liquids with potential for water contamination
- No disturbance of ground water flow

4.2 Capture (AQUA & GAS 2019)



4.2 Capture (AQUA & GAS 2019)



BAUEN IN GRUNDWASSER-SCHUTZZONEN

Die Zersiedelung hat dazu geführt, dass innerhalb von Wasserschutzzonen gebaut wird. Trinkwasserentnahmestellen wie die in Weinfelden (TG) können nun nicht mehr genutzt werden.

1904

1904 wird das Grundwasserpumpwerk Sangen ausserhalb des Dorfes Weinfelden gebaut. Zu diesem Zeitpunkt gibt es noch keine Grundwasserschutzzonen um die Fassung.

1972

Das Dorf Weinfelden dehnt sich stetig aus. Diese Entwicklung ist beispielhaft für die gesamte Schweiz. Das Gewässerschutzgesetz von 1971 verpflichtet die Kantone, Schutzzonen um Grundwasserfassungen herum auszuscheiden.

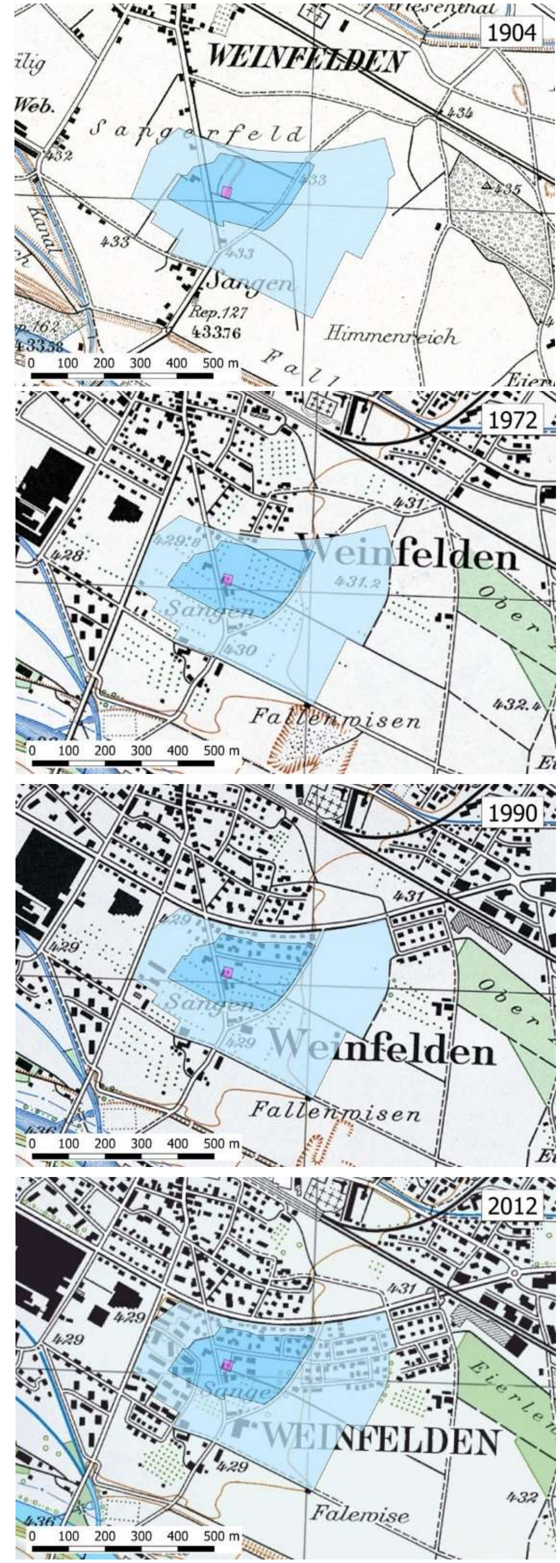
1990

Die Schutzzonen der Grundwasserfassung Sangen sind in den 1990er-Jahren so stark überbaut, dass der weitere Betrieb der Fassung gefährdet ist. An eine Ausweitung der Schutzzonen im Sinne der neuen Gewässerschutzverordnung von 1998 ist nicht zu denken.

2012

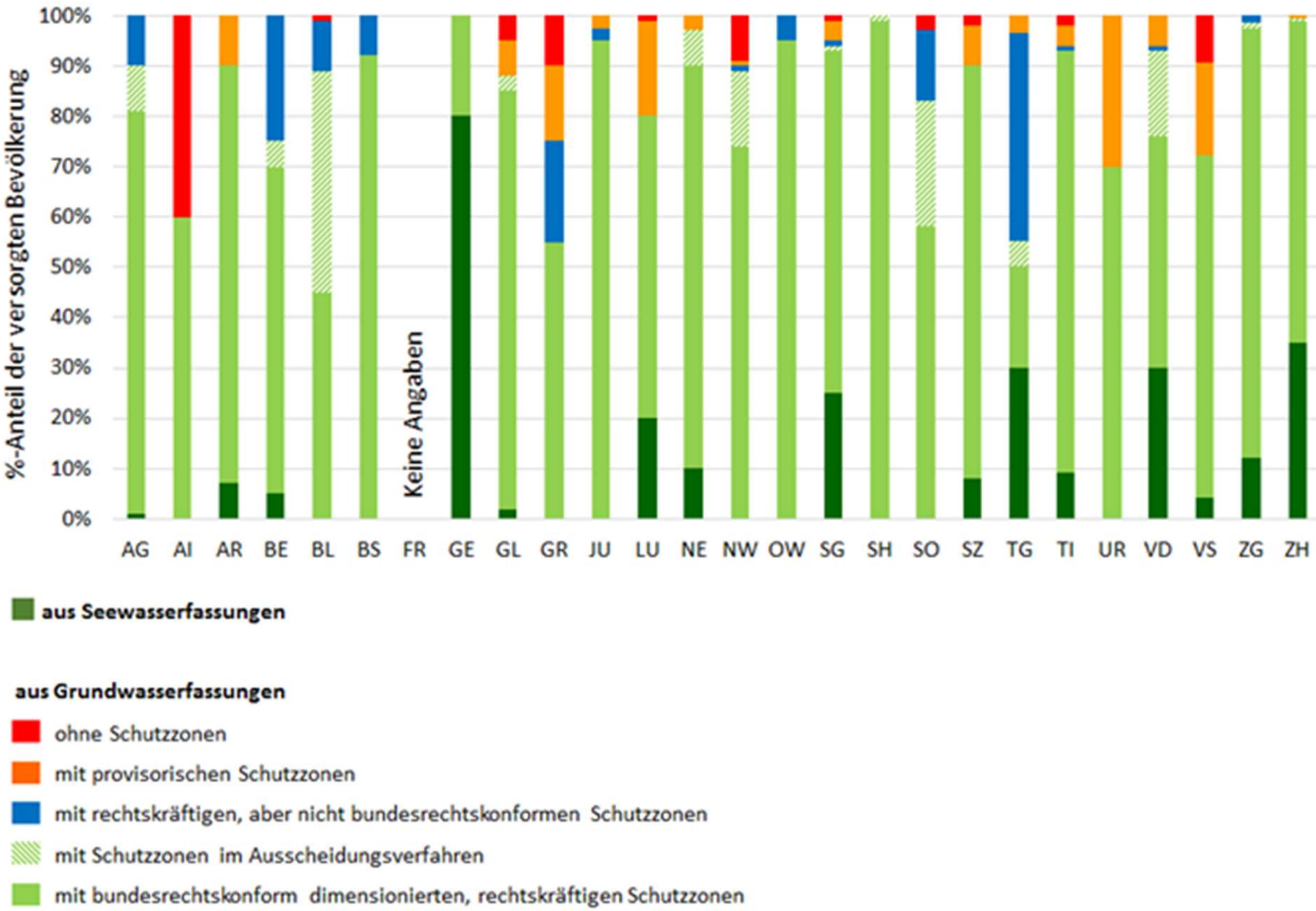
Die Gemeinde scheidet im Jahr 2000 an einem anderen Ort ein Grundwasserschutzareal aus. 2012 können dort unverbaute Schutzzonen festgelegt werden und das neue Pumpwerk Schachen nimmt seinen Betrieb auf. 2012 wird die Grundwasserfassung Sangen für die öffentliche Trinkwasserversorgung aufgegeben.

Lesen Sie unseren Artikel zu diesem Thema auf der nächsten Seite.



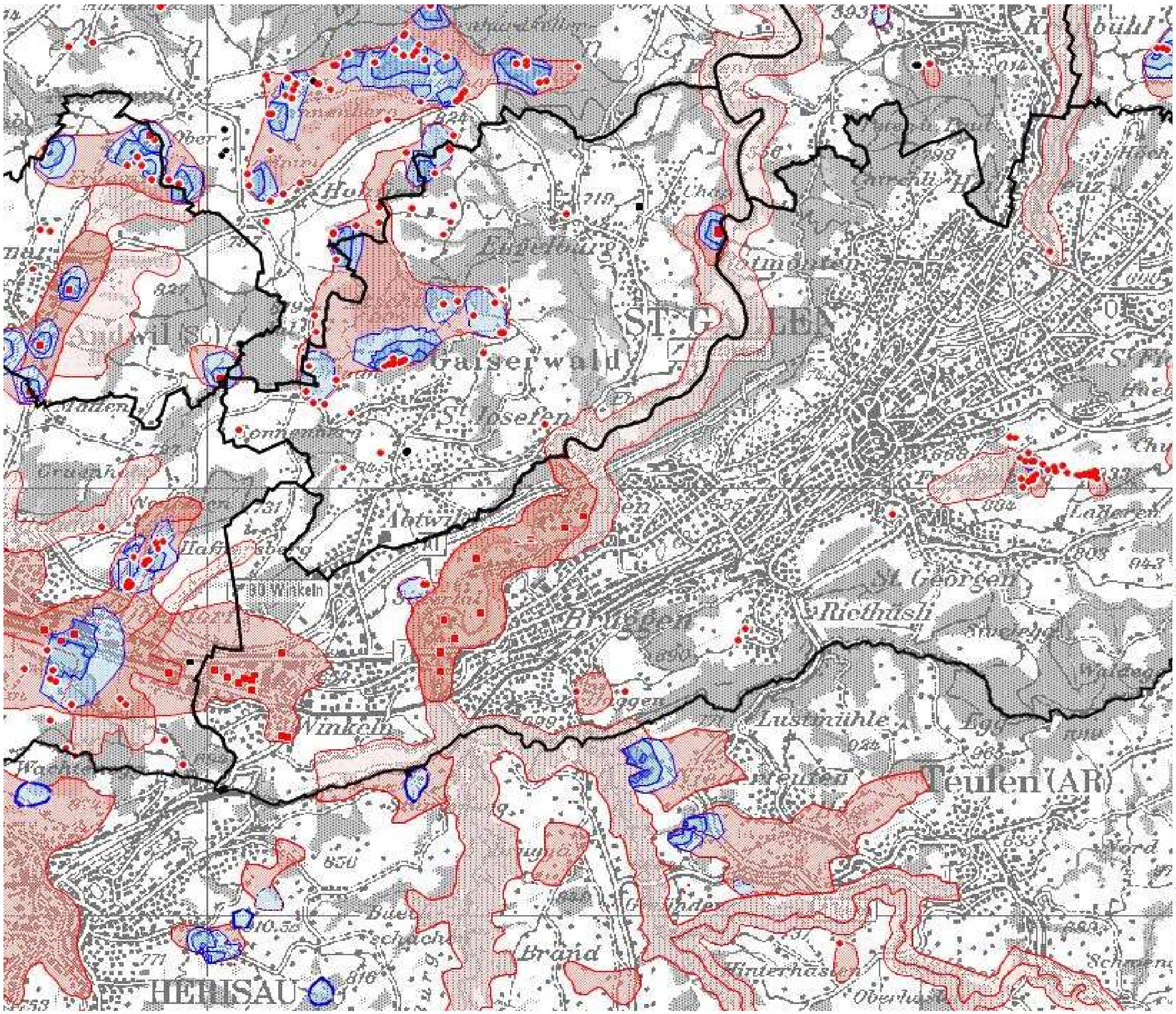
4.2 Capture

Origin of fresh water (AQUA & GAS 2019)



4.2 Capture

St. Gallen



Gewässerschutzbereiche

- Bereiche Au und Ao überlagert
- Gewässerschutzbereich Ao
- Gewässerschutzbereich Au
- übriger Bereich üB

Datum 09.02.2011

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Grundwasserschutzzonen/-areale

- provisorisches Grundwasserschutzareal
- provisorische Grundwasserschutzzone
- rechtskräftiges Grundwasserschutzareal
- rechtskräftige Grundwasserschutzzone S1
- rechtskräftige Grundwasserschutzzone S2
- rechtskräftige Grundwasserschutzzone S3

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Grundwasser

Grundwasserfassungen

- Grundwasserfassung
- Grundwasserfassung aufgehoben, zugeschüttet, versiegt

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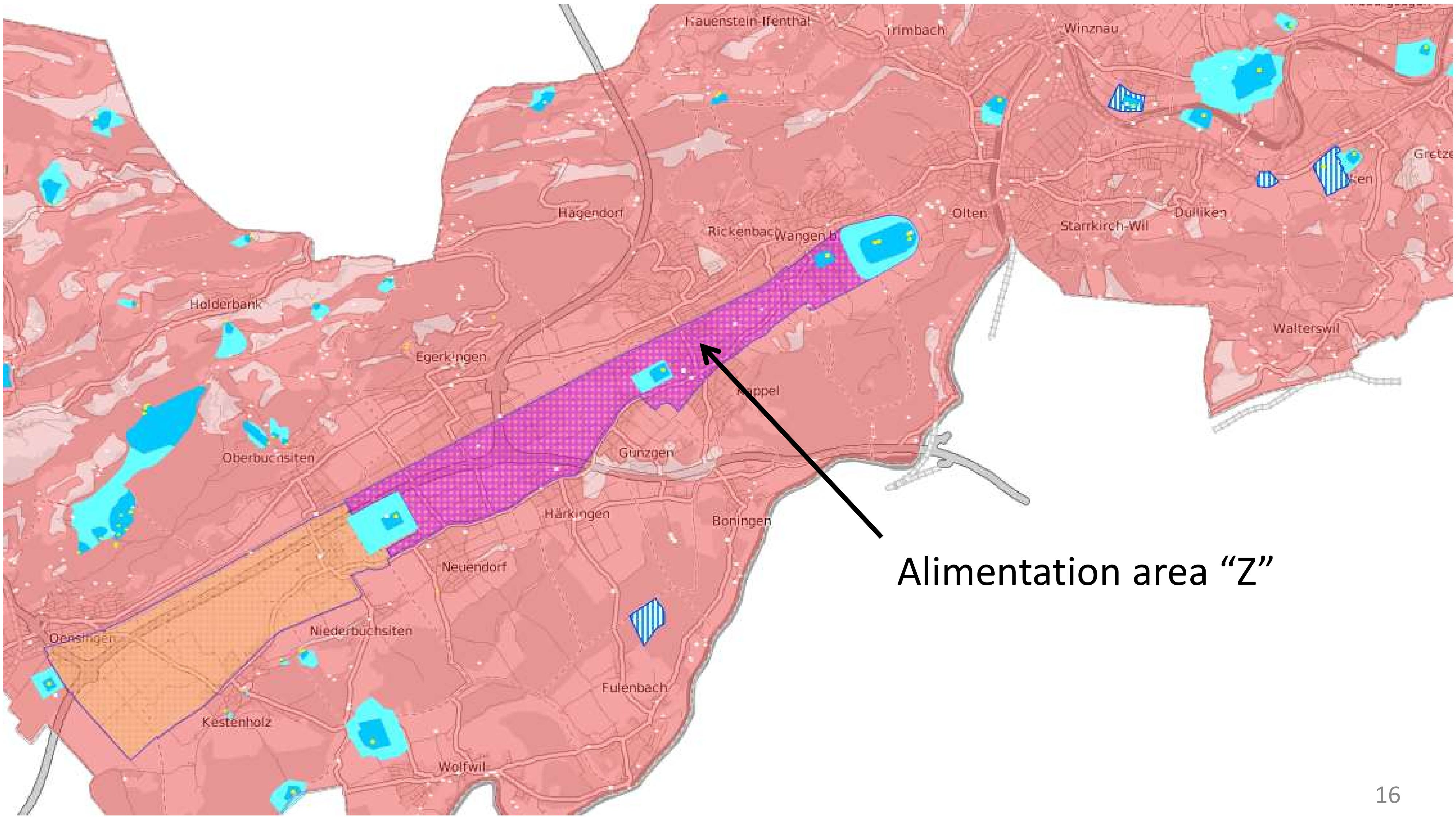
Quellen

- Quelle
- Quelle aufgehoben, zugeschüttet, versiegt

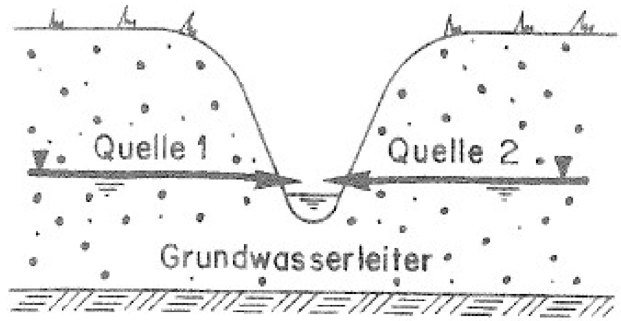
4.2 Capture

Olten

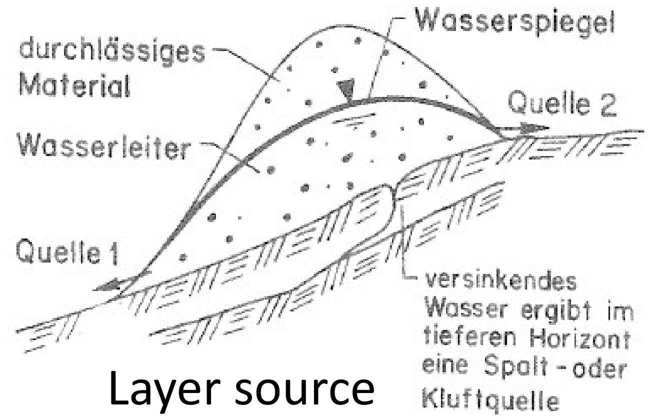


4.2 Capture

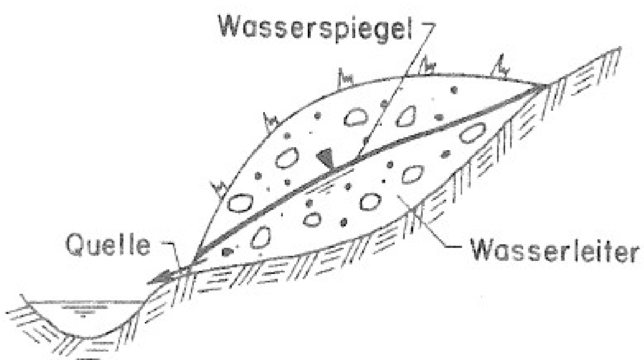
Natural spring types (I) (Grombach 2000) *Precondition: permeable surface layer*



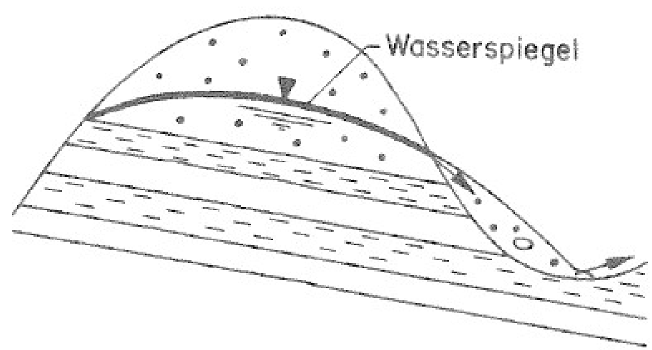
Groundwater source



Layer source



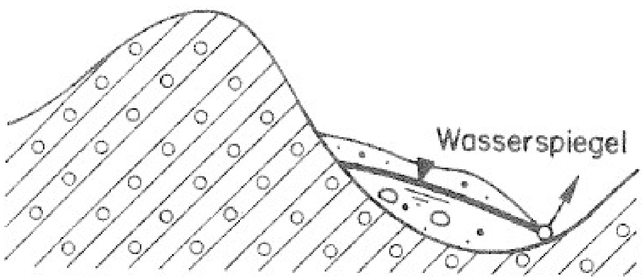
Detritus source



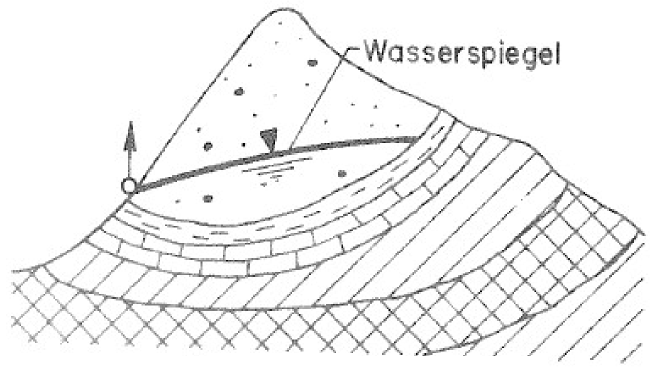
Detritus source

4.2 Capture

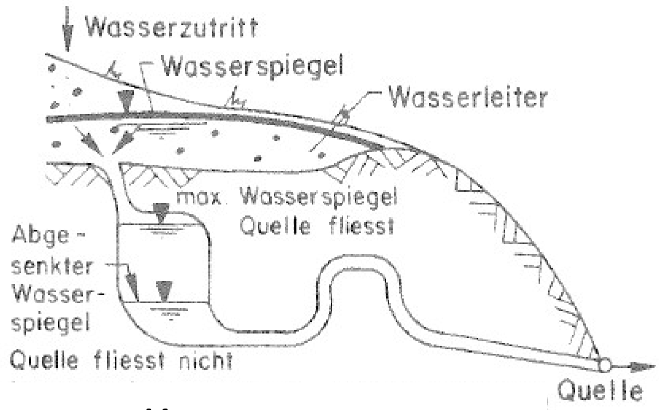
Natural spring types (II) (Grombach 2000)



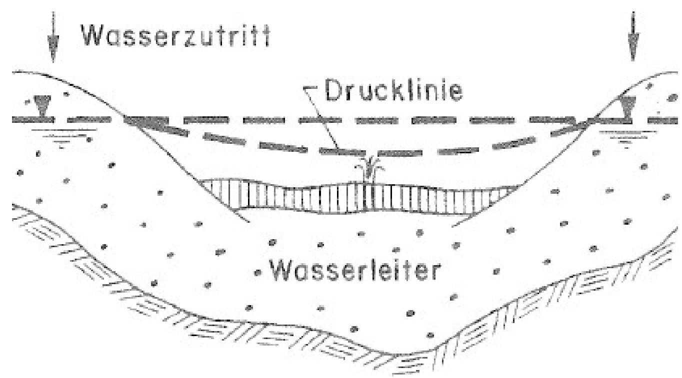
Landslide source



Overflow source



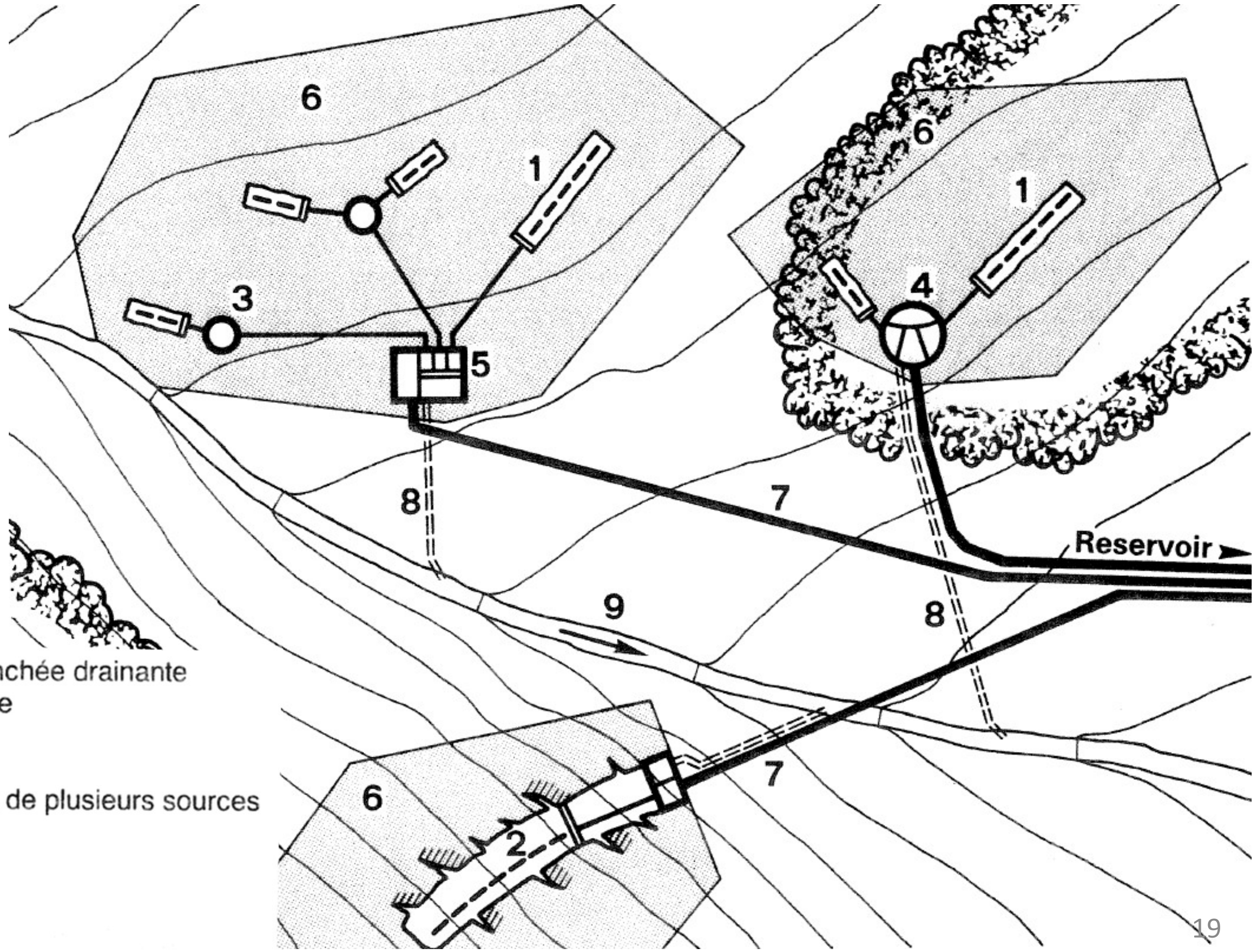
Karst source



Artesian source

4.2 Capture

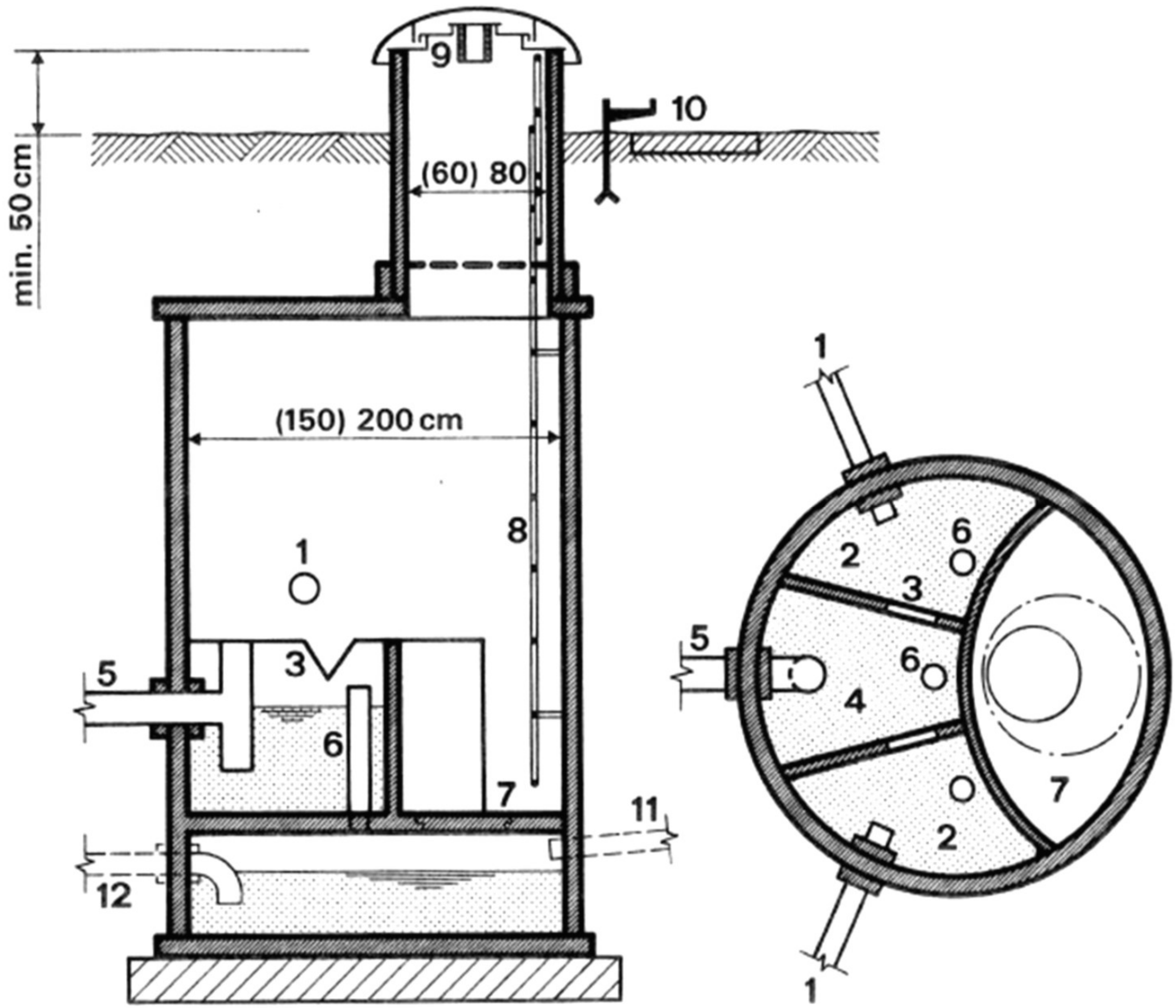
Spring: Capture installation (SVGW W10)



1 Captages de sources en tranchée drainante
2 Captage de source en galerie
3 Chambre (sac) de captage
4 Chambre d'eau simple
5 Chambre de rassemblement de plusieurs sources
6 Zones de protection
7 Dérivation au réservoir
8 Drainage/décharge
9 Emissaire

4.2 Capture

Spring: Capture chamber (SVGW W10)



4.2 Capture

Spring: Capture chamber

4.2 Capture

Springs and pumping station Tuffière/FR

4.2 Capture

Spring: Capture chamber (SVGW W10)

- Discharge and temperature measurement
- Quality control
- Before bringing into service: cleaning and disinfection
- No wood in chamber or around it (fouling, insects)
- Leak-proof and covered by >3 m ground
- Locked entrance; 0.5 m above terrain
- Prefabricated elements
- One sub-chamber per source (to measure and de-connect individually)
- Drainage of overflow with siphon (no air current)
- Pipe to reservoir 0.2 m above ground (no sediment intake), no air entrainment

4.2 Capture

Spring: Capture chamber (SVGW W10)

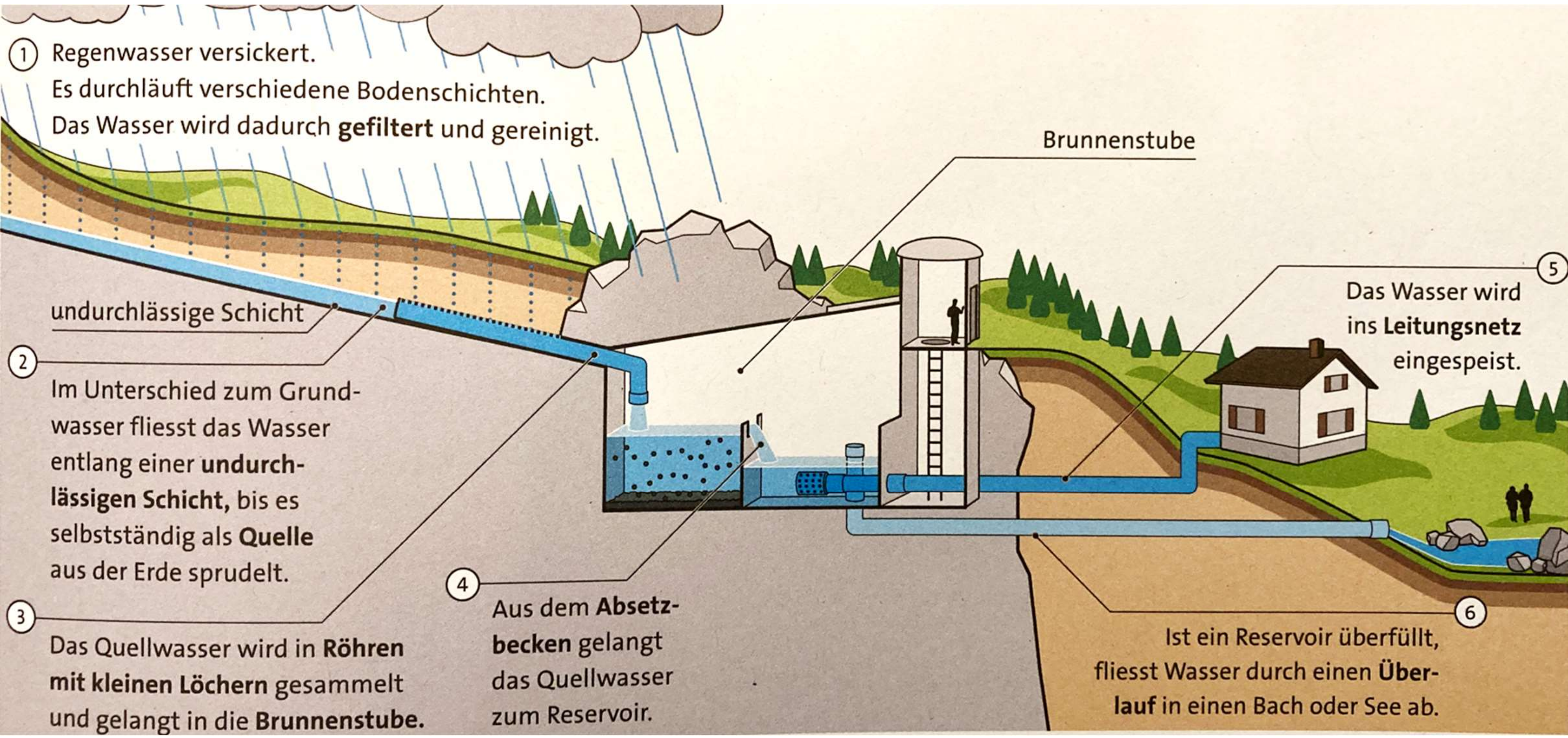
- Next to aquifer
- Sufficient distance to agricultural zones
- Typically at high elevations: no pumps needed
- Excellent water quality, could
- Constant outflow (max/min ca. factor 3)

- Earth cover of >3 m
- No trees in vicinity (roots)

- Adduction pipe with 1 %≤*S*≤5 %
- Washed filter gravel around seepage pipe

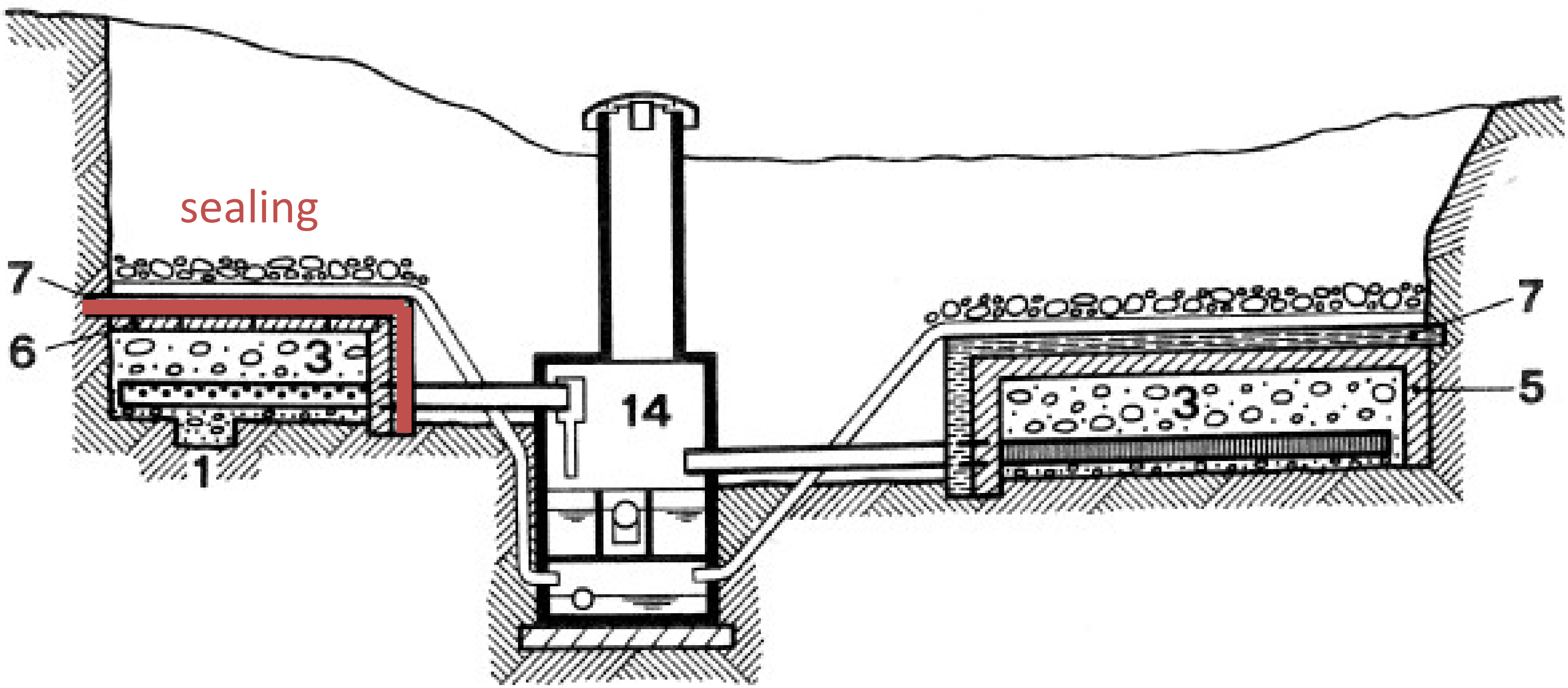
4.2 Capture

Spring: Capture chamber (NATECH LMVZ)



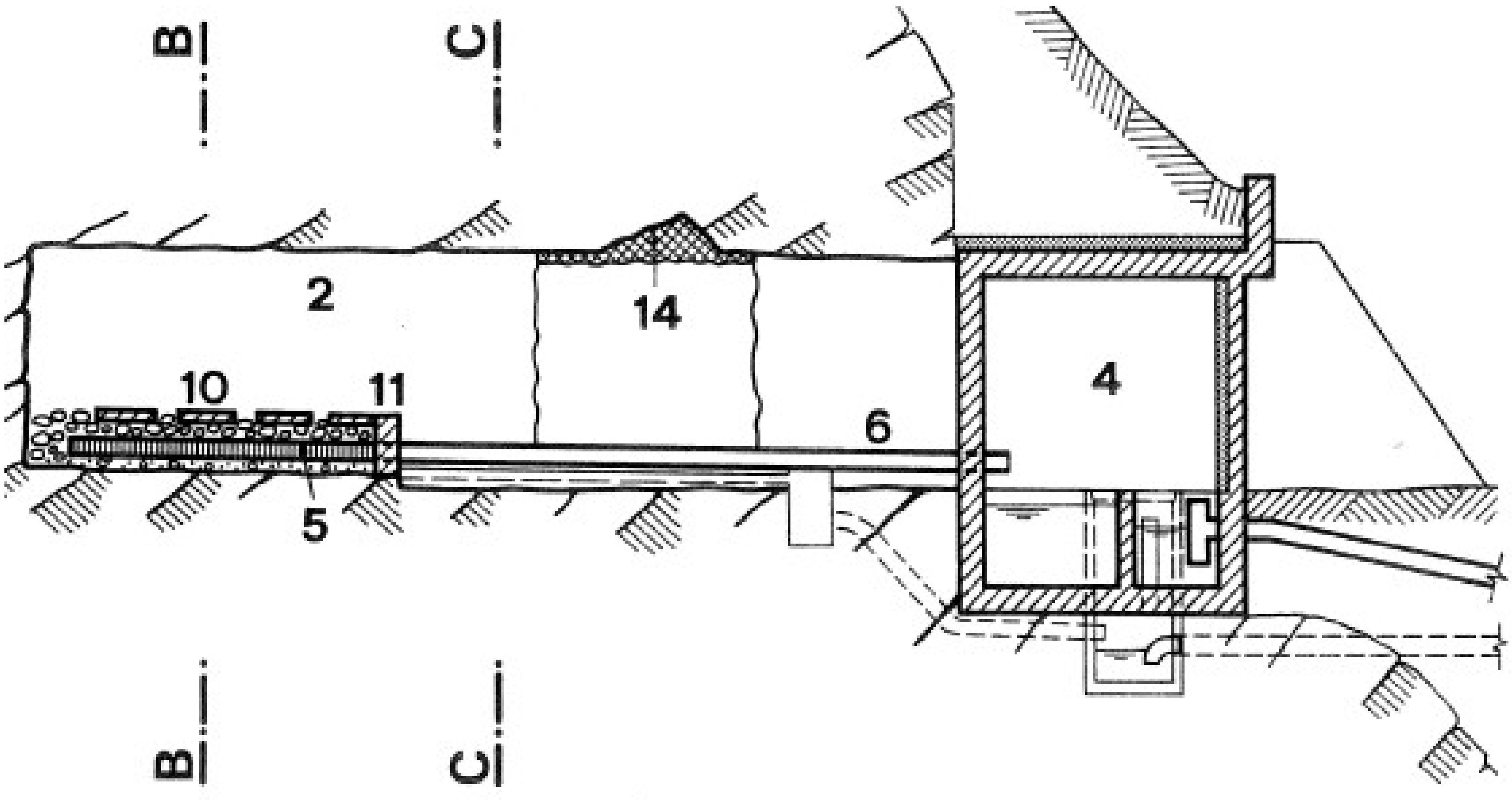
4.2 Capture

Spring: Capture chamber (SVGW W10)



4.2 Capture

Tunnel capture in rock (SVGW W10)



4.2 Capture

Tunnel capture in rock (SVGW W10)

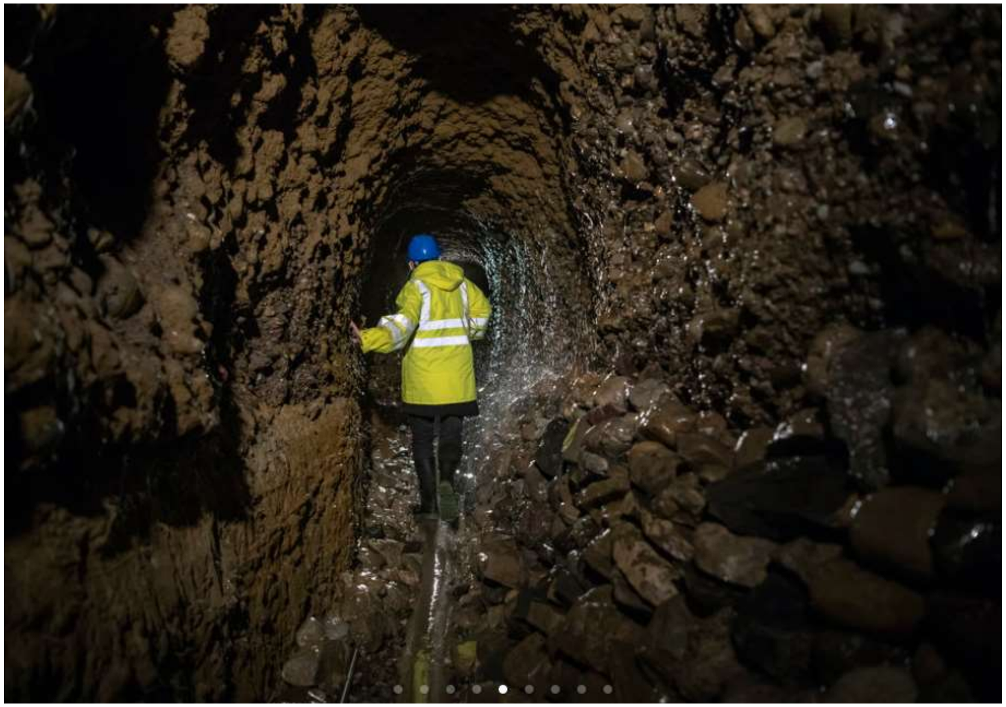
- "Rock sources", only for relevant discharges
- Access tunnel minimum 1.8 m high and 0.8 m wide
- Adduction pipe with 1 %≤S≤ 5%
- Capture chamber at tunnel entrance
- Drainage of tunnel


Ribi SA

4.2 Capture

Tunnel capture in rock
(Tagesanzeiger, 29.11.2018)

Kohlbodenquelle, Wasserversorgung Zürich, 4 m^3/min, zwei 320 m lange Stollen



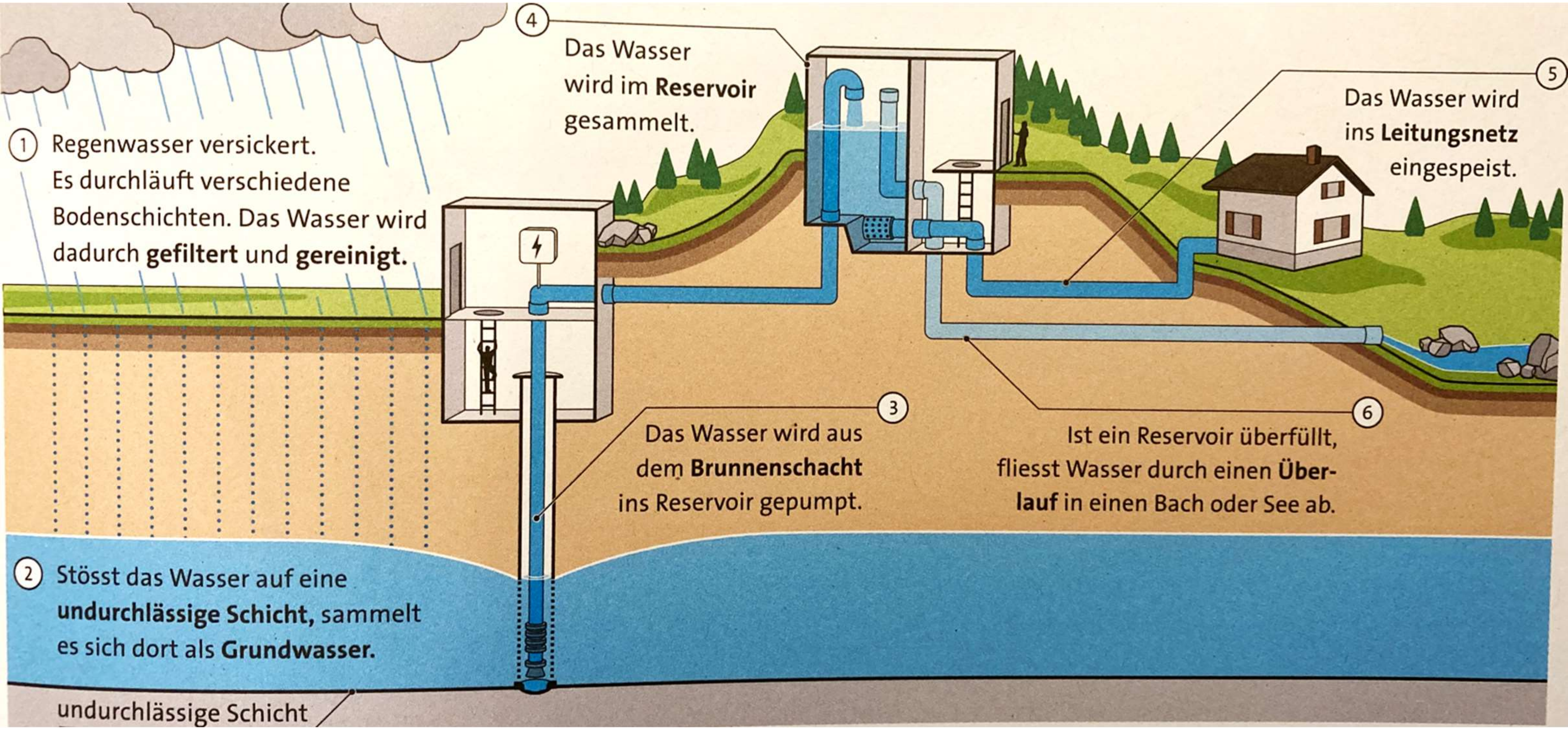
4.2 Capture

Tunnel capture in rock
with reservoir

Les Pilettes, Fribourg
(hors service, ancienne
source Cardinal)

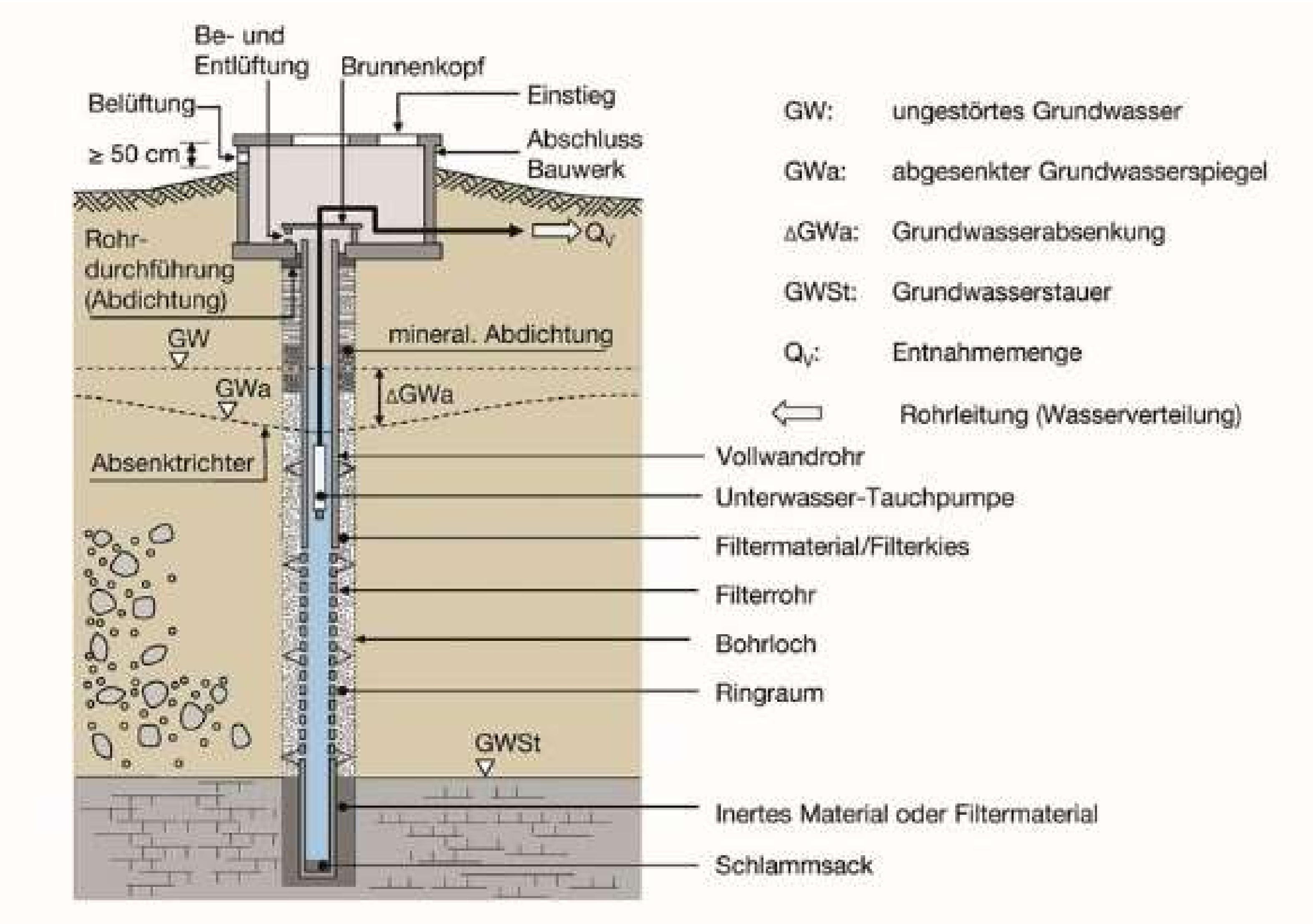
4.2 Capture

Ground water pumping (NATECH LMVZ)
Vertical filter fountain



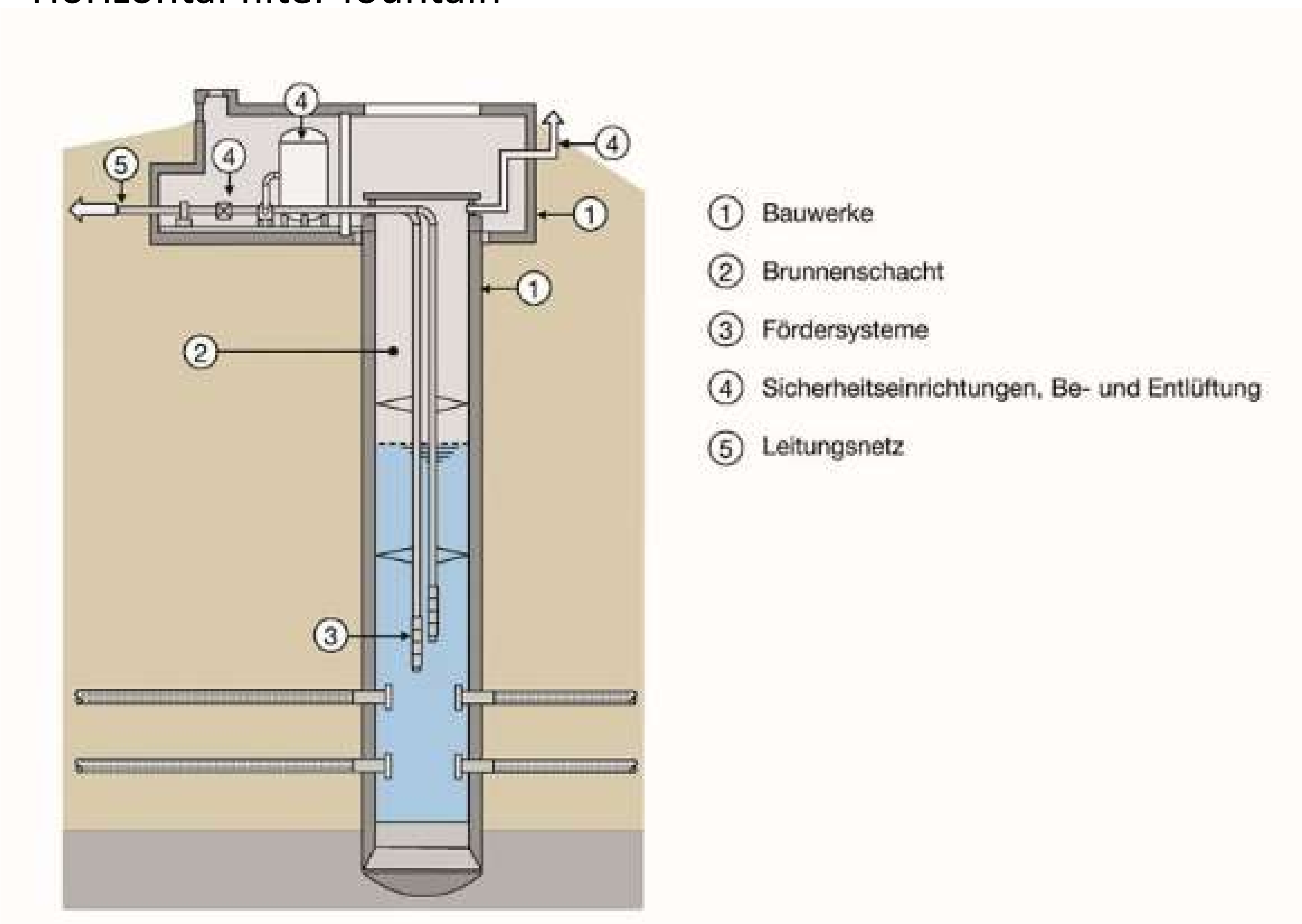
4.2 Capture

Ground water pumping (SVGW W9)
Vertical filter fountain



4.2 Capture

Ground water pumping (SVGW W9)
Horizontal filter fountain



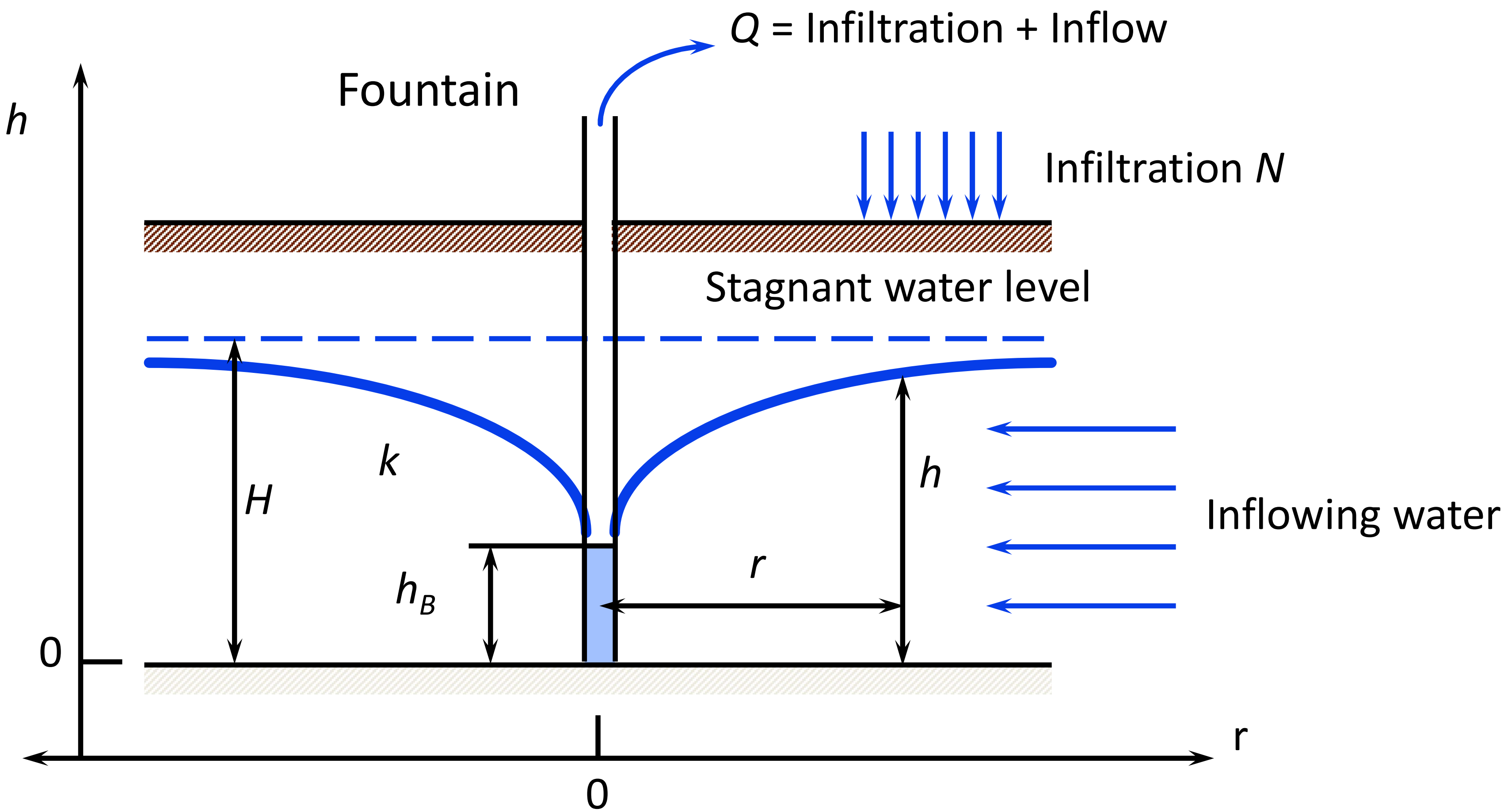
4.2 Capture

Ground water pumping (Gujer 1999)

- Sufficient distance to settlement area and agricultural zones
- Surface water (rivers) increases outflow, but supports infiltration of pollutants
- Common type: vertical “filter fountain” in aquifer
- Increased capacity with additional horizontal adduction pipes
- May cover peaks in water demand
- Delicate to build (to avoid destruction of aquifer)
- Filter layers (gravel) have to be laid out very carefully

4.2 Capture

Ground water pumping (Gujer 1999)
Fountain capacity (Darcy, Dupuit)

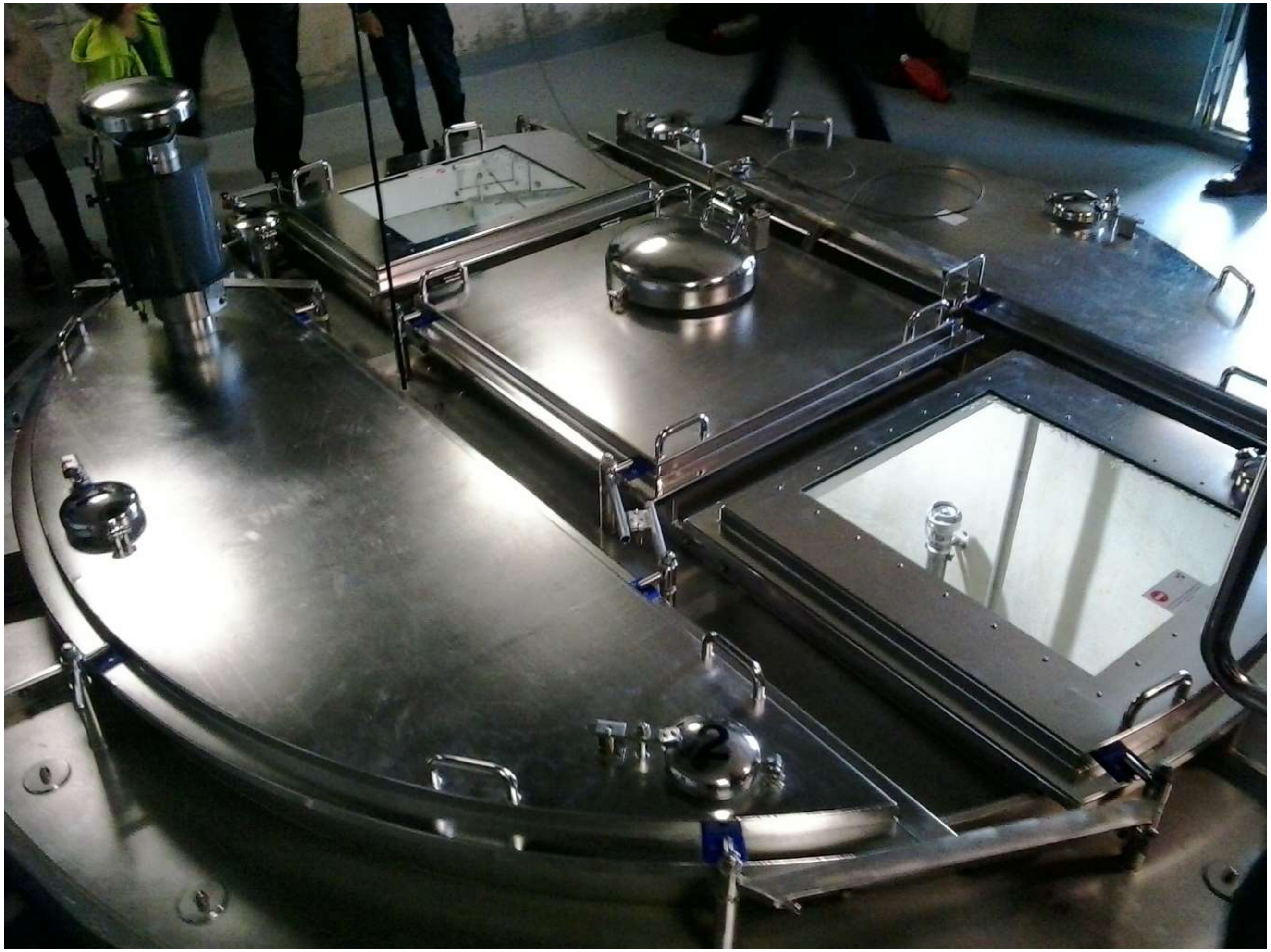


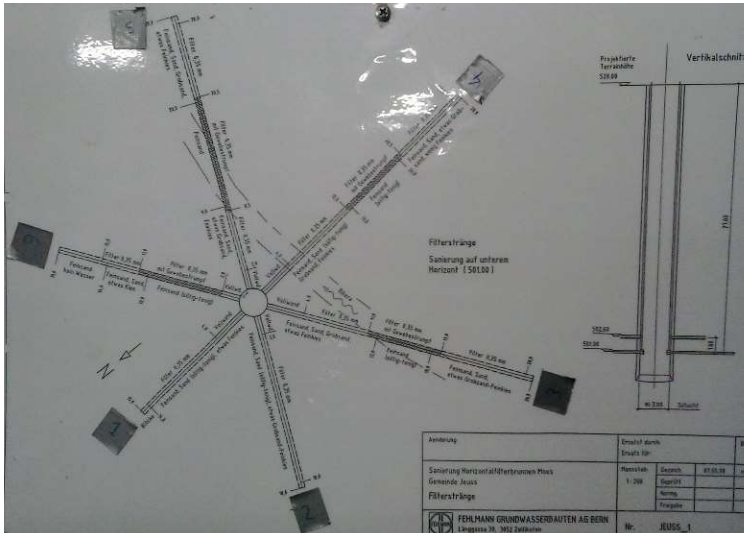
$$Q = \pi r^2 N + 2r\pi hk \frac{dh}{dr}$$

$h_B \geq 0.75H$

4.2 Capture

Ground water pumping station Jeuss/FR





4.2 Capture

(Photo SVGW)

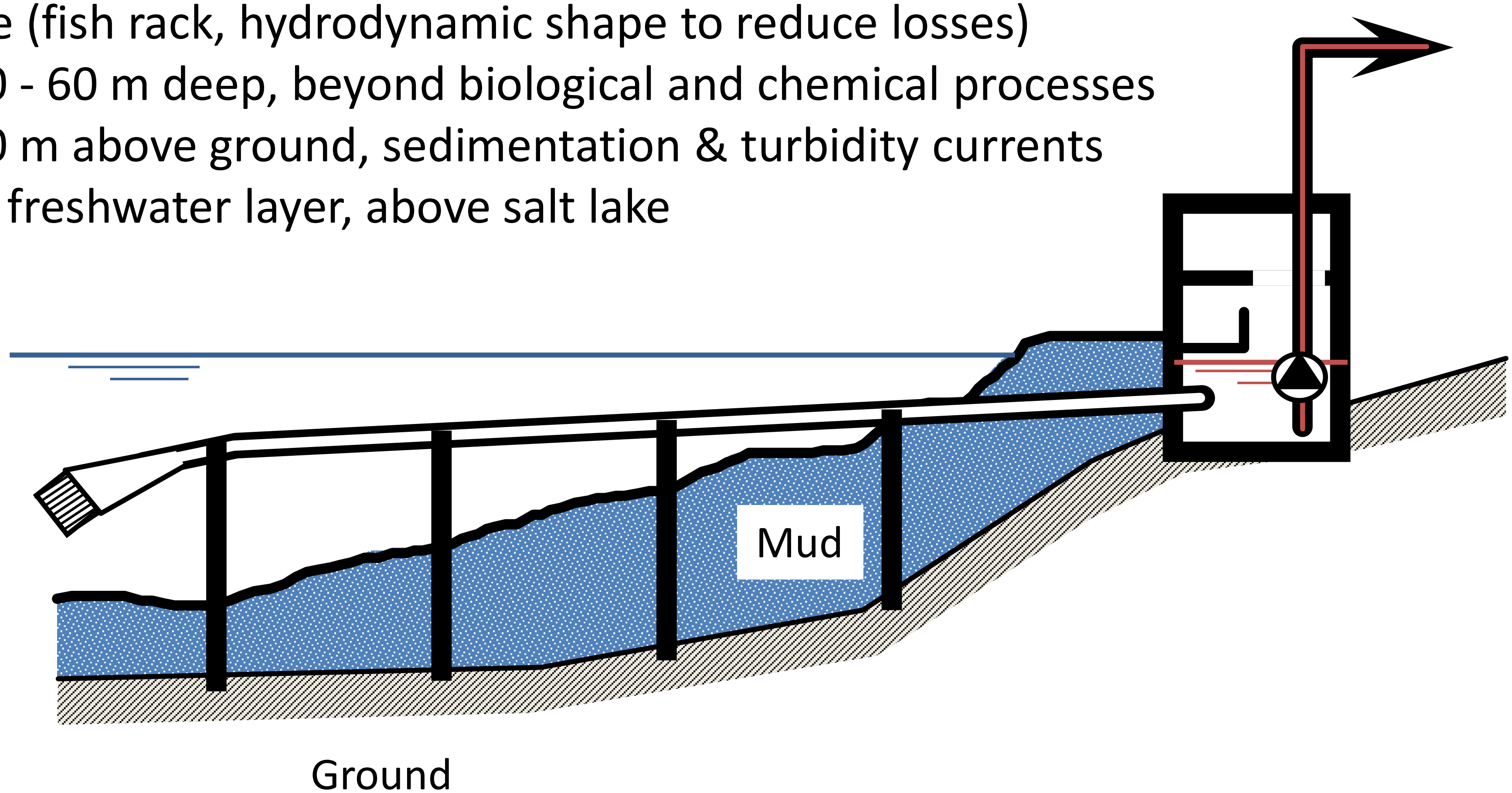
4.2 Capture

Intake (Gujer 1999)

(in deep lakes with constant water level)

Intake (fish rack, hydrodynamic shape to reduce losses)

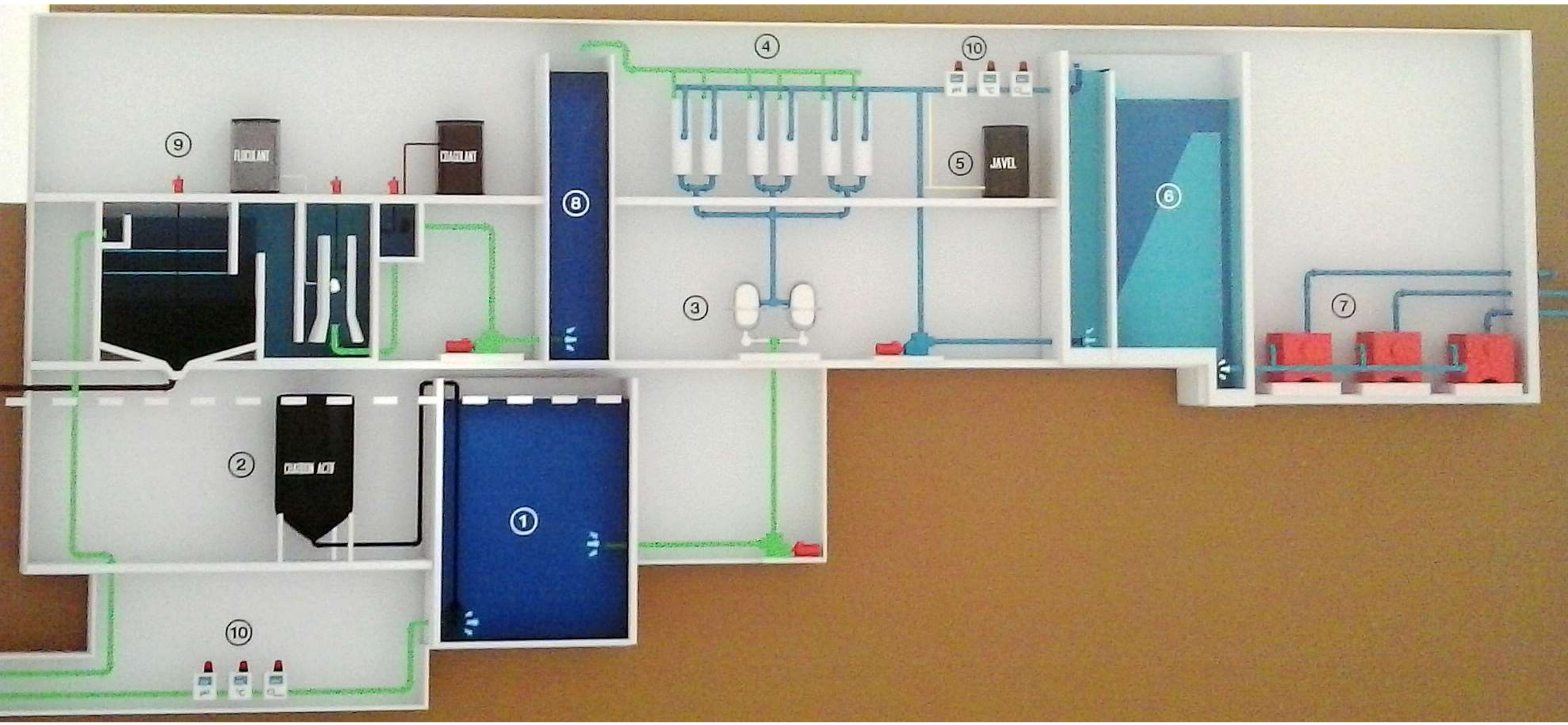
- 20 - 60 m deep, beyond biological and chemical processes
- 10 m above ground, sedimentation & turbidity currents
- In freshwater layer, above salt lake



4.2 Capture

Lake capture: Pump station Lutry

1. lake raw water reservoir, 2. activated carbon supply, 3. pre-filter, 4. micro filter, 5. chlorine disinfection, 6. pot water reservoir, 7. pumping station to upper reservoir, 8. back-flush water, 9. pre-treatment station of back-flush water (cleaned water to lake, contaminated water to STEP), 10. quality control



4.2 Capture

Example Lausanne: Origins of fresh water

Sources	27.5% (120 individual sources)
Groundwater	0%
Lake	70.50% (Lac de Bret 13%, Lac Léman 58%)
Neighbor nets	2%

Treatment

Sources: Disinfection with chlorine

Lake: Léman (Lutry, capacité 1.5 m^3/s) ultrafiltration, Léman (St Sulpice, capacité 3.3 m^3/s) filtration sur sable, Bret chaîne de traitement multi-barrière

- 330'000 consumers in the city of Lausanne and its neighborhoods
- Yearly production of 30 Mio m^3 of fresh water
- 20 reservoirs
- 24 pumping stations with 120 pumps (installed capacity of 152’000 m^3/d)

4.2 Capture

Advantages and disadvantages of lake capture

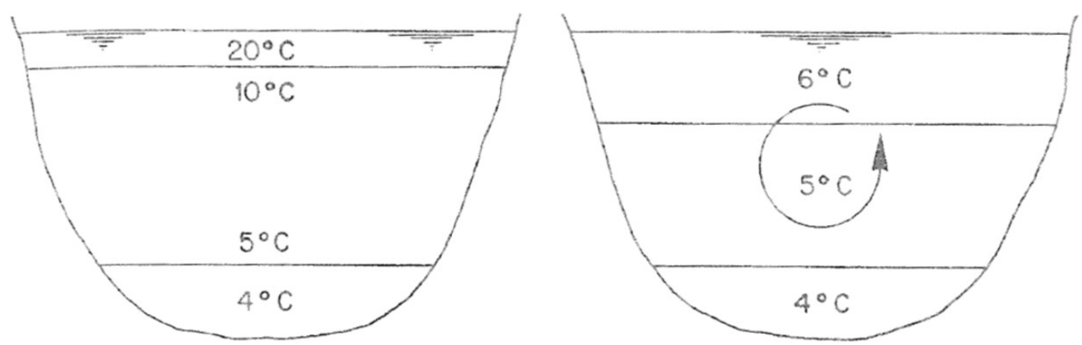
- "Infinite" volume
- Variable production possible
- Water temperature constant and few suspended material
- Consider inflowing rivers, suspended particles enter capture (Lake Constance)
- Treatment and pumping required (electricity consumption, reliability, production losses)
- High degree of pollution, poor water quality
- Production during night (electricity cost)
- Risk for pollution, vandalism (low ability to protect)
- Sustainable for large lake

4.2 Capture

Factors to consider

- Lake type (see next slide)
- Lake volume
- Lake depth, fluctuation of water level
- Water age (inflow volume vs. lake volume)
- Temperature variation over the seasons
- Suspended material (turbidity currents)
- Other use of lake (navigation, recipient water body WWTP)

To temperature variation



Summer = stable
large density differences

Winter = unstable
wind blends water layers

4.2 Capture

Lake capture (Grombach 2000)

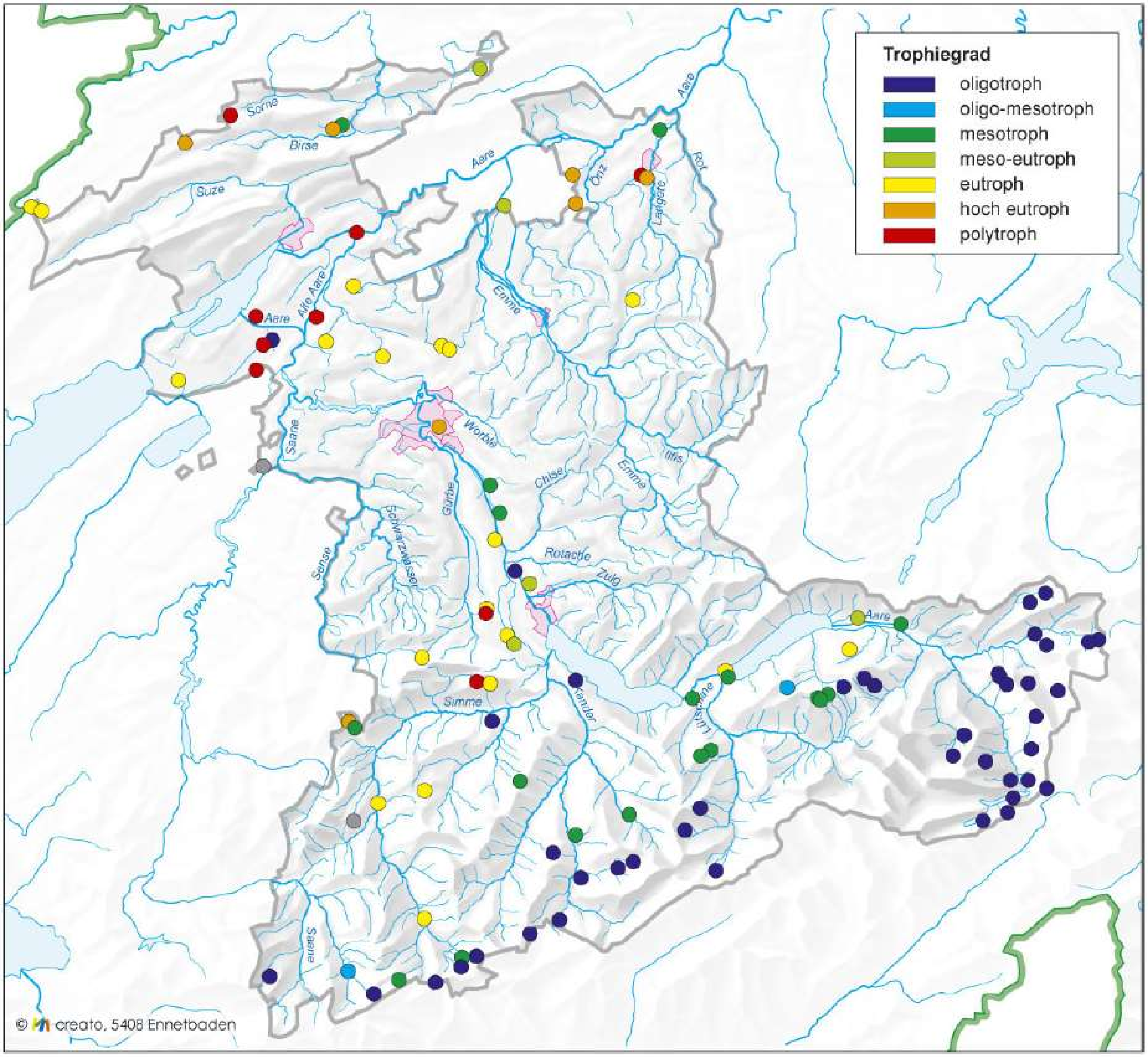
- Oligotrophic lakes. No nutrient, no light (long ice period), low temperature → excellent drinking water reservoir (e.g. Lake Brienz)

- Mesotrophic lakes. Optimal living conditions, enough oxygen and nutrient, complete degradation of organic substances → acceptable drinking water reservoir, but requiring water treatment (Lake Thun)

- Eutrophic lakes. Upper layer with surplus of nutrient and light, high temperatures, high production of organic material. No degradation of the latter in lower layers as oxygen deficit → water caption only in intermediate layer (20 to 60 m) and with intense treatment (Lake Biel)

4.2 Capture

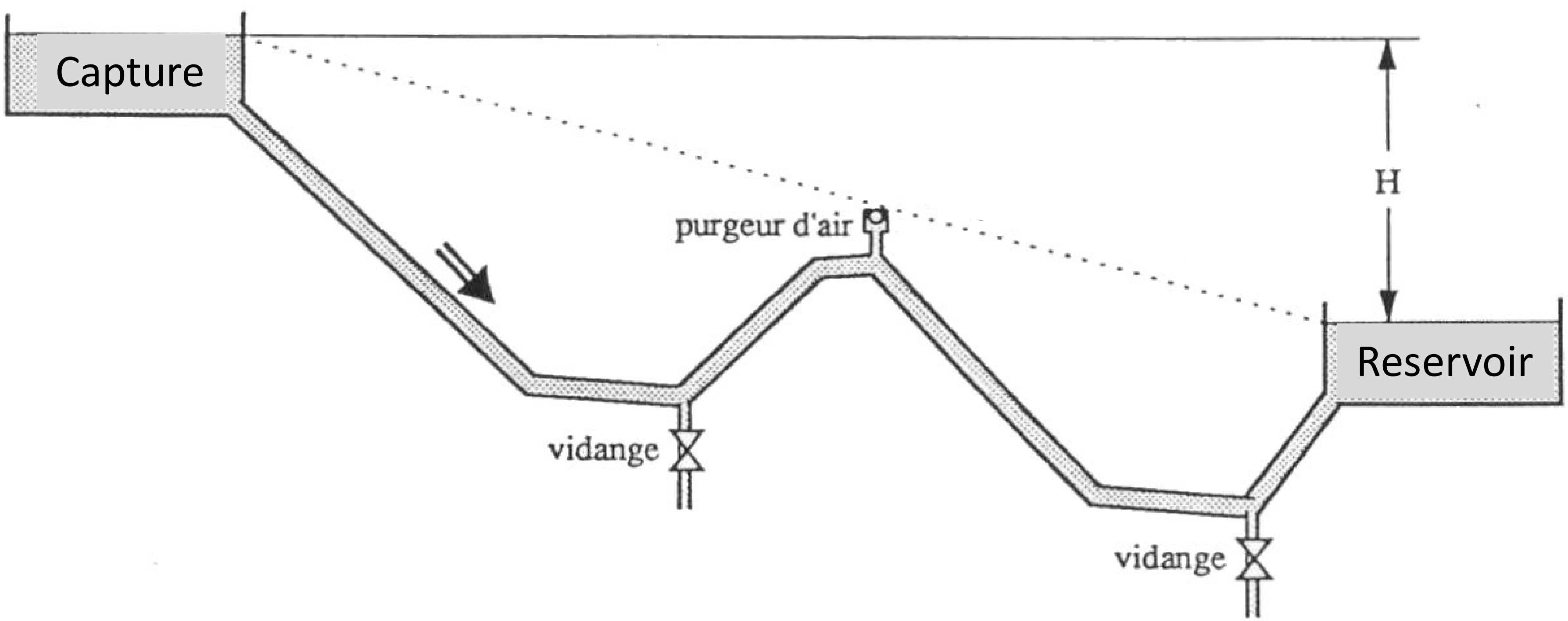
Lake capture: small lakes in canton Berne (AWA Kt. Bern 1999)



4.2 Capture

Transport from capture to reservoir

- Exception: Open channel flow for large volumes over long distances, even topography requested
- Normal case: Pressurized flow in conduit for short distances and small discharges, for erratic topography
- Usually: one conduit per water chamber or capture unit



4.2 Capture

Pressurized flow hydraulics

Two options

Darcy & Weisbach (Σ losses)

$$\Sigma\Delta H = \frac{V^2}{2g}\left[\Sigma\xi_i + \lambda\frac{L}{D}\right]$$

Colebrook & White

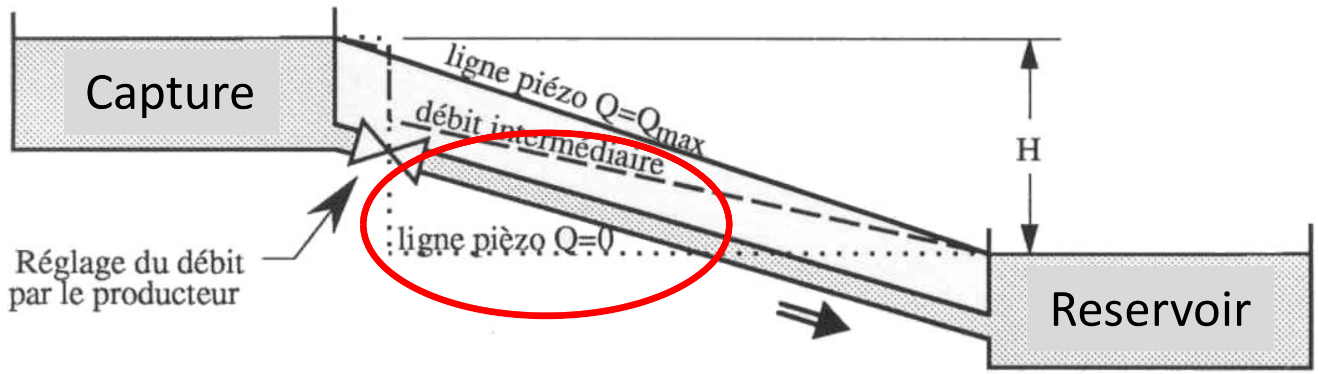
$$\frac{1}{\sqrt{\lambda}} = -2\log\left[\frac{k_s/D}{3.71} + \frac{2.51}{\mathrm{R}\sqrt{\lambda}}\right]$$

Usually $H=\Delta z$, losses for Q_M equal to available head from topography

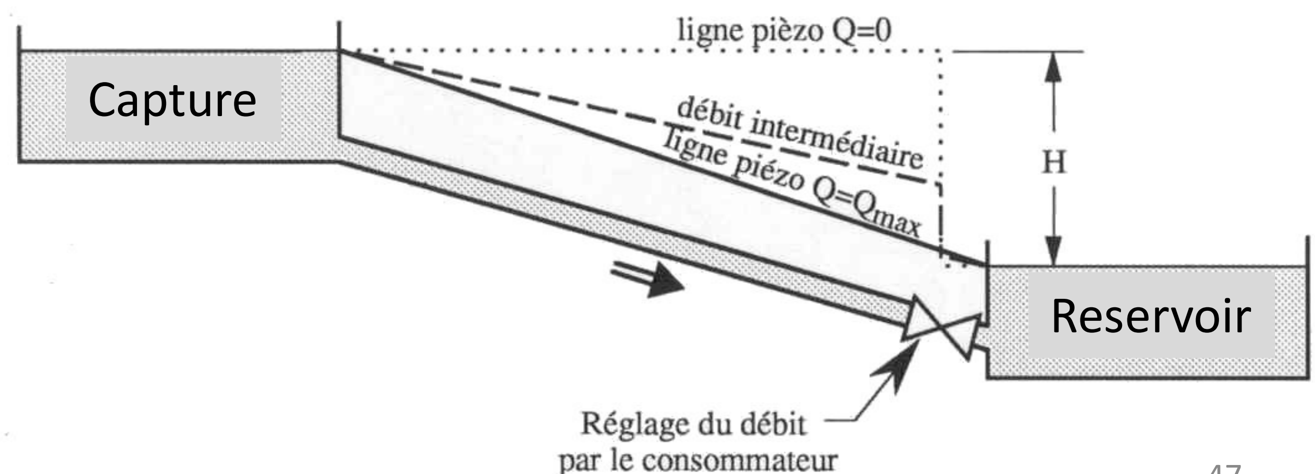
4.2 Capture

Discharge Regulation

Upstream
Q=0 m³/s ⇨ conduit empty (aeration valve)
Closure ⇨ water hammer with negative pressure peaks



Downstream
Q=0 m³/s ⇨ conduit full
Always positive pressures



4.2 Capture

Pumping

(similar to sewer pumping)

Two goals

- To transport the fluid
- To increase the pressure

Alignment

short distances, smooth topography, avoid high points and contra slopes

Economic conduit diameter

- Small conduit ⇨ high losses ⇨ powerful pump
- Choose economic design, optimize cost of pump and conduit system
- Some references recommend for conduit pre-design [l/s and cm]

$$D \cong 1.5^{\sqrt{Q}}$$ V=0.6 m/s

4.3 Reservoir

4.3 Reservoir

Goals

- Storage of volume because instantaneous production ≠ instantaneous consumption
- Storage of potential energy, i.e. pressure (interruption of power supply)
- Storage of consumption reserve (interruption of capture)
- Reserve for fire incident
- Hygienic conditions
- Minimize infrastructure cost

Restrictions

- Elevation due to topography
- Accessibility
- Distance to consumer
- Protection against pollution and vandalism
- No light, no heat or ice formation
- Soil sensitive for settlements
- Earthquake

4.3 Reservoir

Design (SVGW W6)

Location

- Roughly 50 to 100 m vertical above consumer
- Close to consumer

Reserve for fire incident

- 100 to 200 m^3 in village
- 200 to 600 m^3 in city

Volume (economic design of reservoir)

- Equal to average daily consumption
- On average almost 0.2 m^3 per resident and day (experience), including private and trade consumption (but not industry) (SVGW W4)

Maximum storage time of water (Cantonal Laboratories, SVGW W4)

- 2 to 3 days in reservoir (SVGW W6)
- 1 to 2 days in distribution net

4.3 Reservoir

Time	Time	Consumption	"Night pumping"
[h, from]	[h, to]	[% of average daily consumption]	[% of average daily consumption]
0	1	1.2	10
1	2	0.4	10
2	3	0.4	10
3	4	0.4	10
4	5	0.6	10
5	6	1.6	10
6	7	3.7	0
7	8	5.6	0
8	9	6.0	0
9	10	5.8	0
10	11	6.8	0
11	12	8.1	0
12	13	4.2	0
13	14	5.8	0
14	15	5.8	0
15	16	6.0	0
16	17	6.3	0
17	18	8.7	0
18	19	6.7	0
19	20	5.8	0
20	21	4.1	10
21	22	2.5	10
22	23	1.9	10
23	24	1.6	10

Consumption: % of daily average consumption

Pumping: % of daily average consumption

Pumping from lake to reservoir during night, to reduce cost for electricity (pumping and treatment)

4.3 Reservoir

Design (SVGW W6)

Water depth

- To 500 m^3 water ⇨ 2.5 to 3.5 m
- 500 m^3 to 2’000 m^3 ⇨ 3 to 5 m
- 2’000 m^3 to 5’000 m^3 ⇨ 4.5 to 6 m
- Above 5’000 m^3 water ⇨ 6 to 8 m

Aeration of water chamber with filter

Overflow siphon (no air back-flow possible)

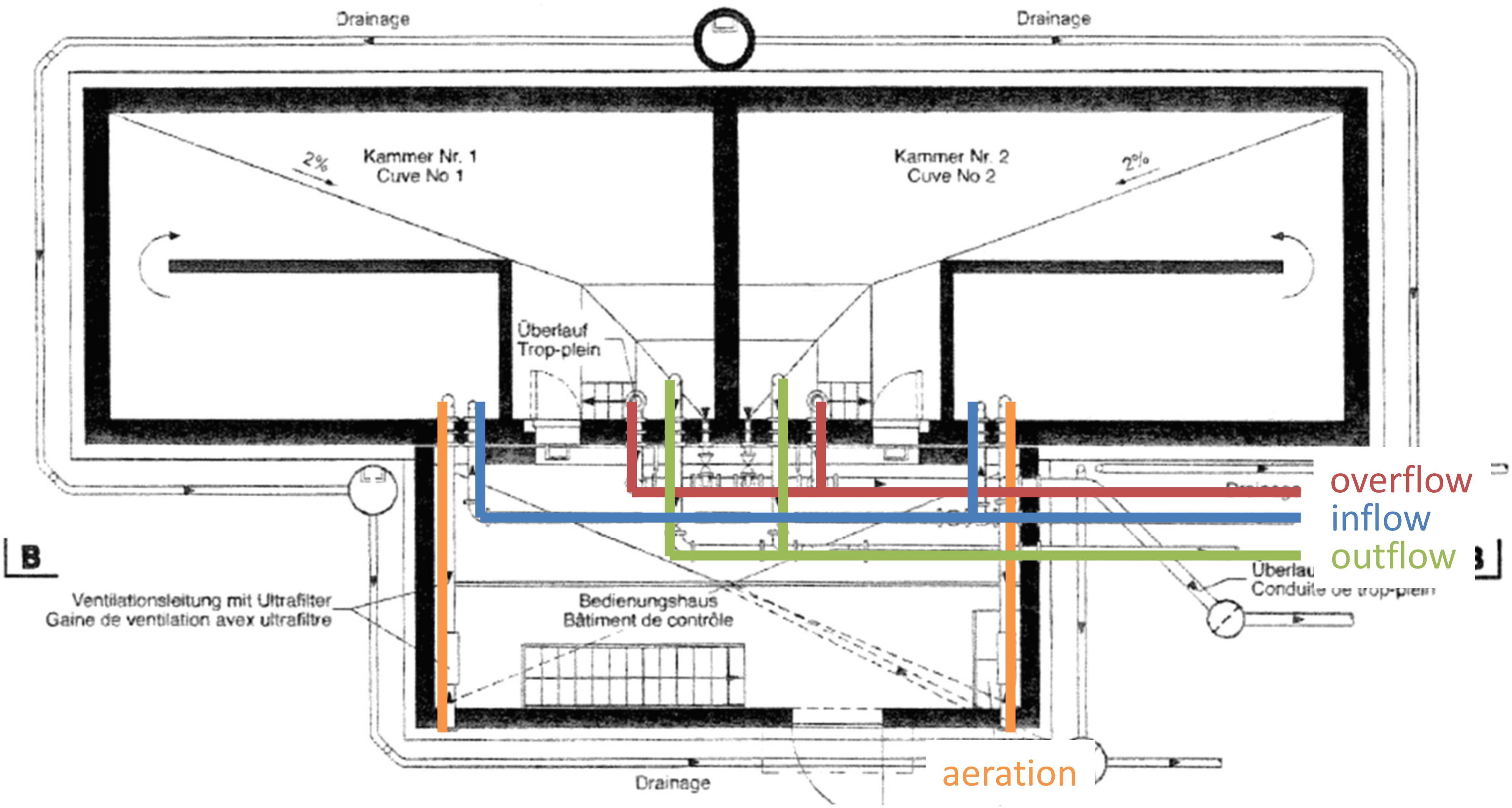
Includes typically two water chambers with flow circulation

Up to 5’000 m^3 rectangular footprint
Higher volumes with circular footprint

4.3 Reservoir

Design (SVGW W6)

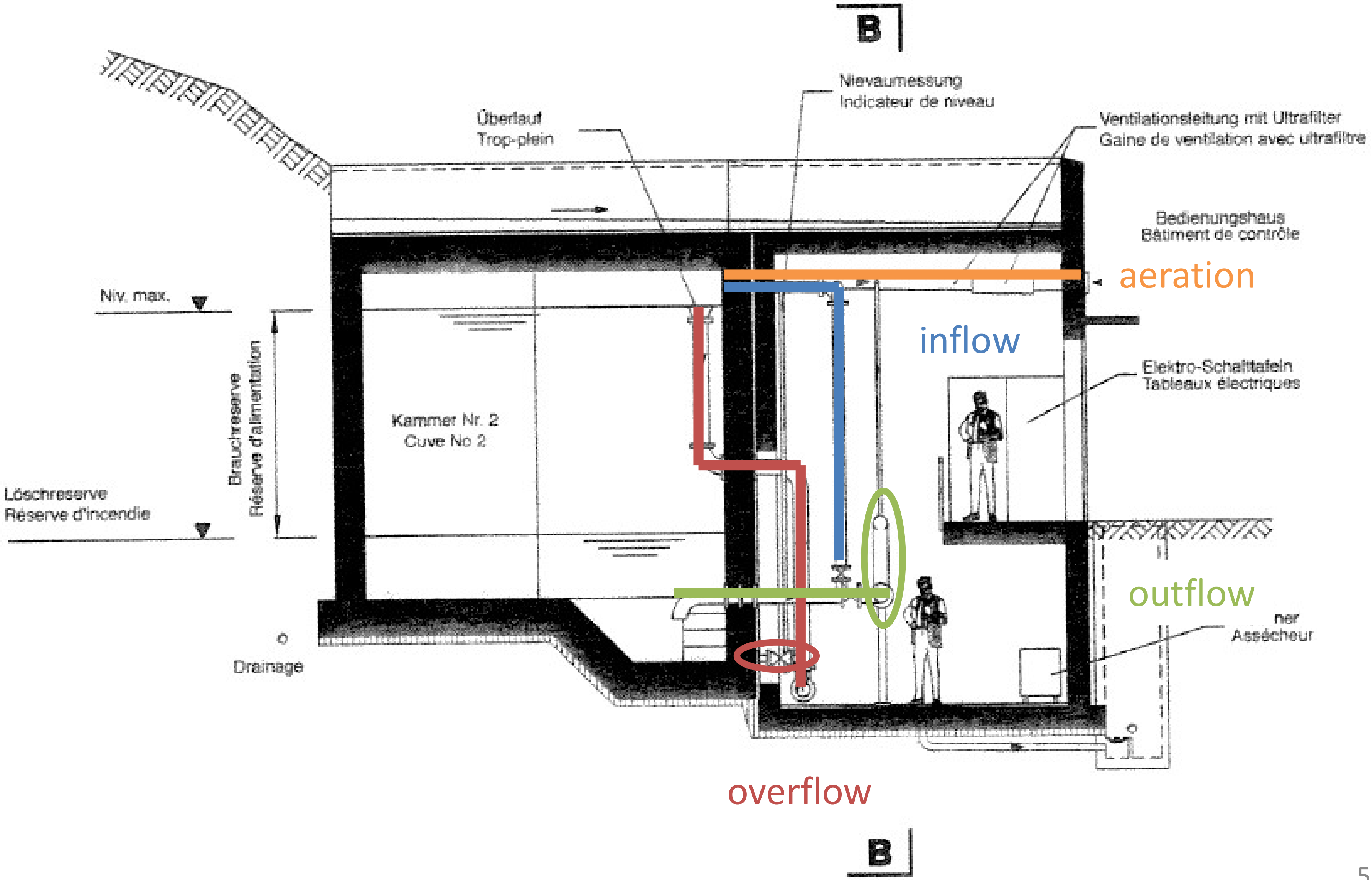
Plan view



4.3 Reservoir

Design (SVGW W6)

Section

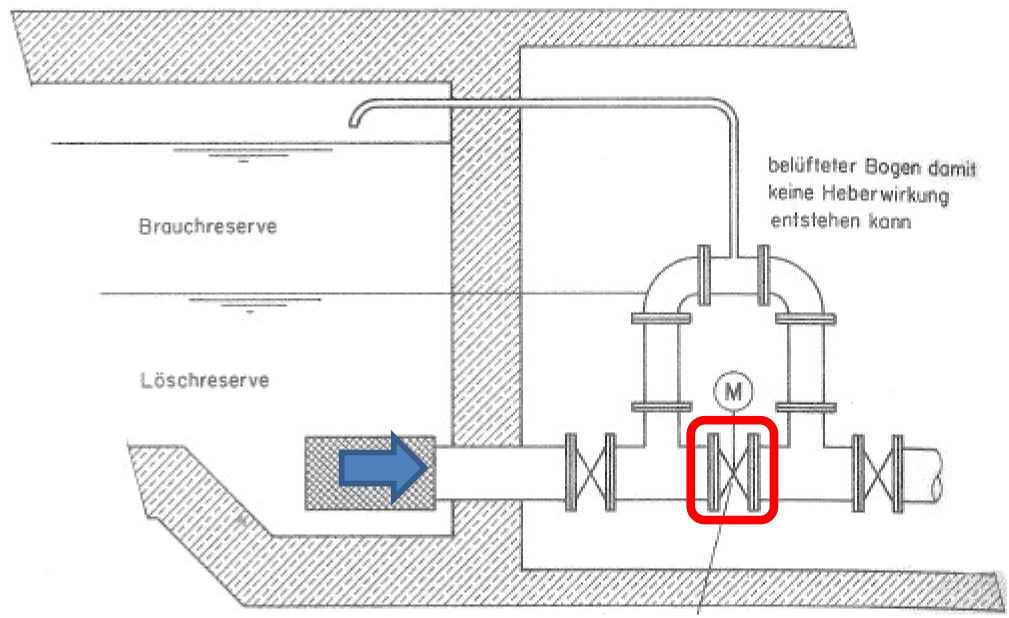


4.3 Reservoir

Design (Grombach, P., Haberer, K., Trüeb, E.U., 1985)

Fire reserve, outlet pipe arrangement

- Fire reserve is activated during every fire drill and incident
- Thereby, low water levels with air entrainment at aerator are prevented (air entrainment into system)
- Fire guards open the valve (with an SMS)
- Industrial services open the valve several times a week for testing and to regenerate water (hygienic reasons, stagnant branch)



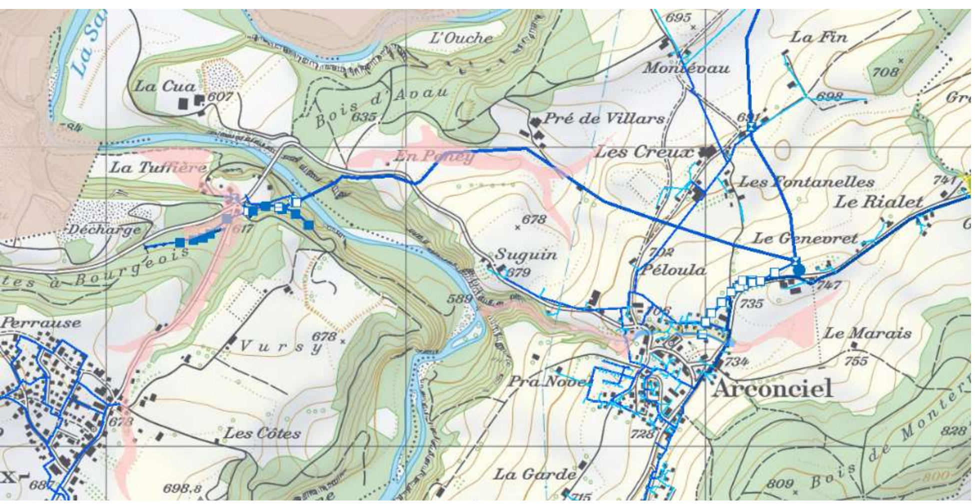
Pumping station: Reserve pump for fire reserve

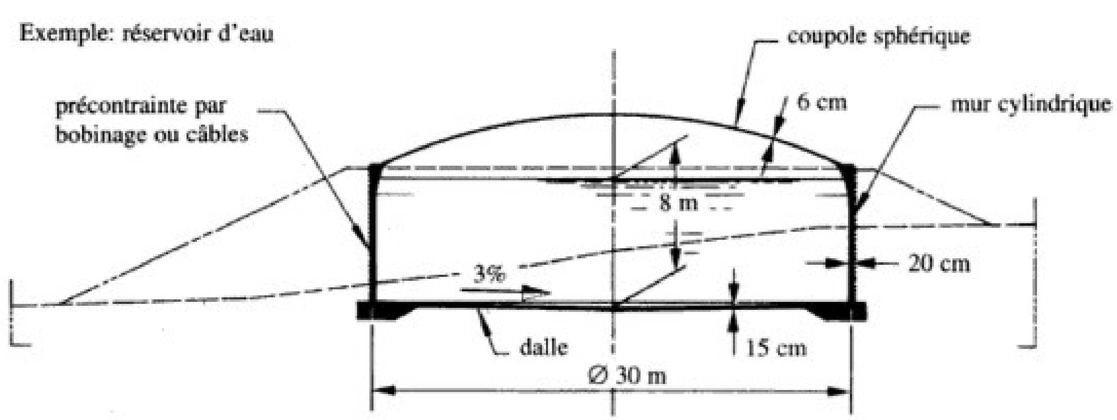
4.3 Reservoir

Design (Ribi SA)

4.3 Reservoir

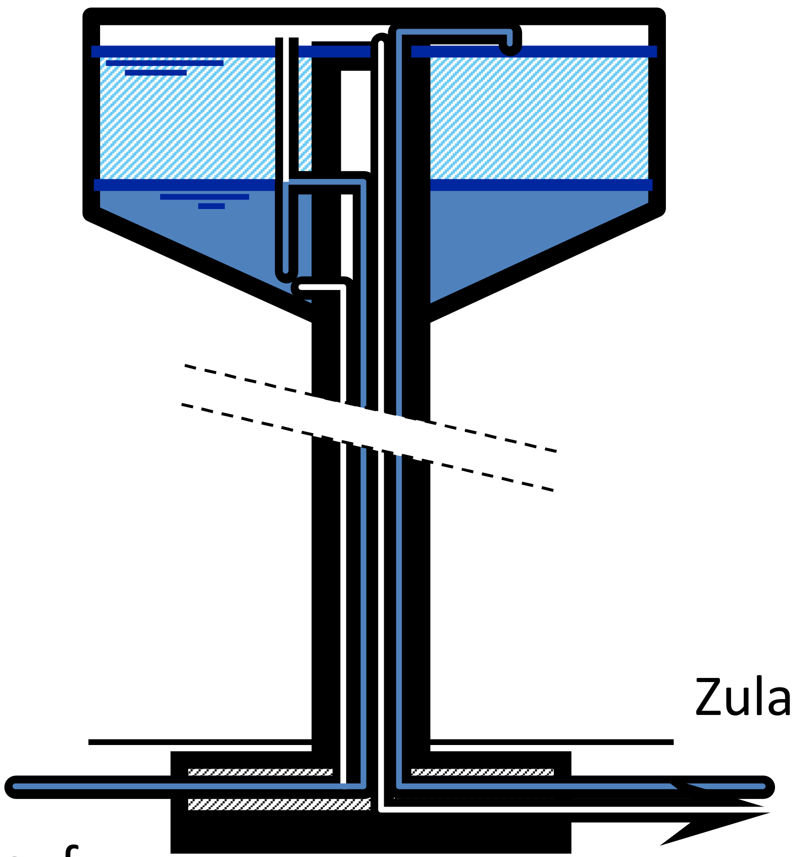
Reservoir Arconciel/FR





4.3 Reservoir

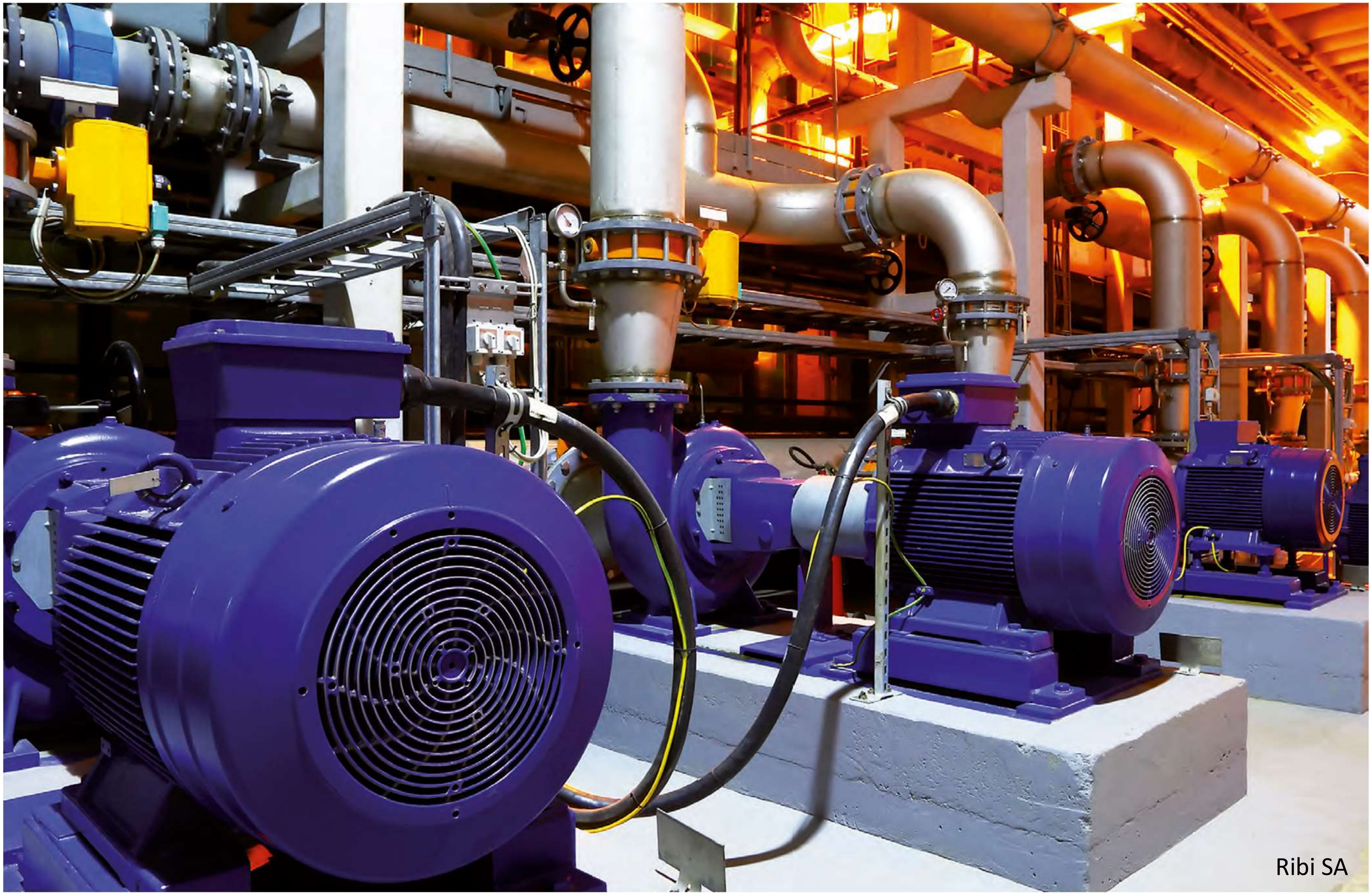
Water tower



Tour d’eau de Benex (rattachée à Prangins), construite en 1928

4.3 Reservoir

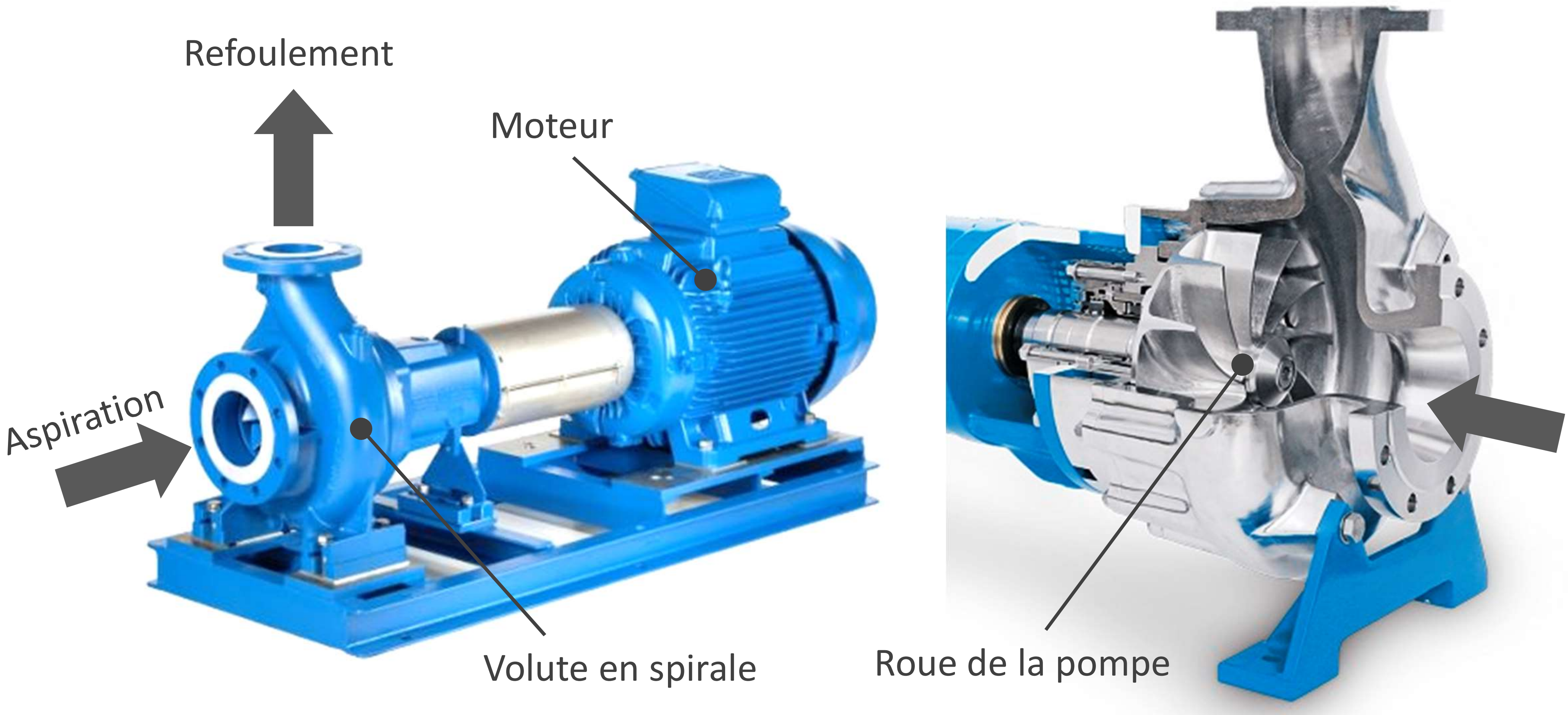
Pumping station



Ribi SA

4.3 Reservoir

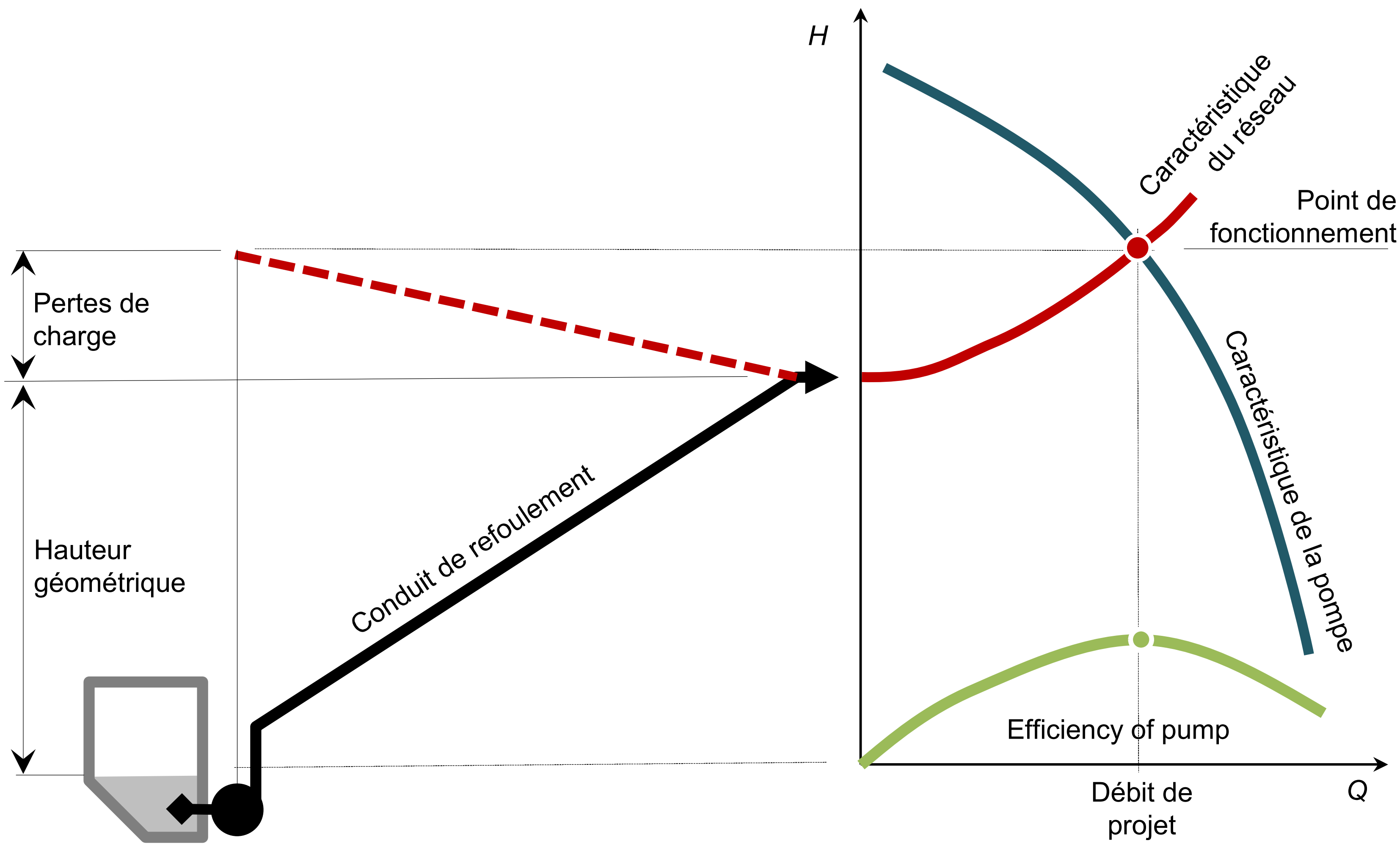
Example centrifugal pump



Carl Heusser AG

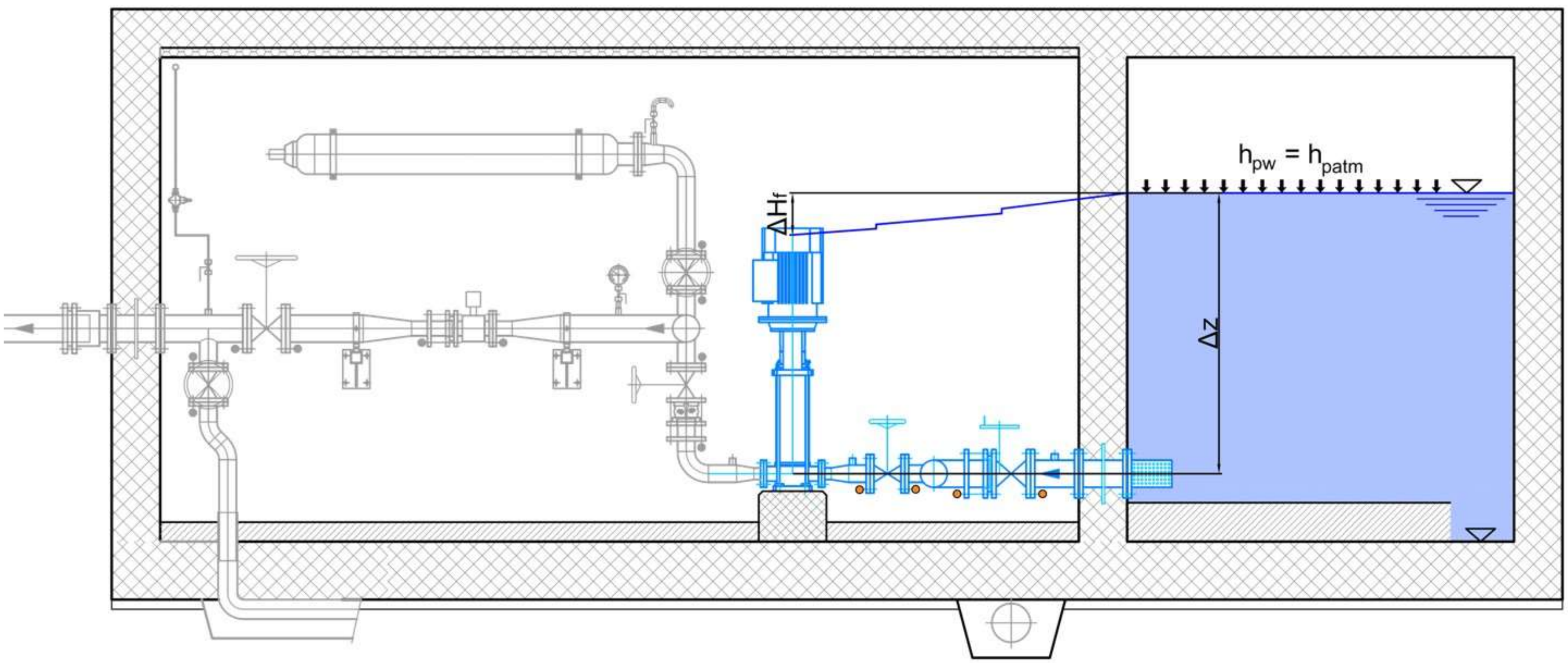
4.3 Reservoir

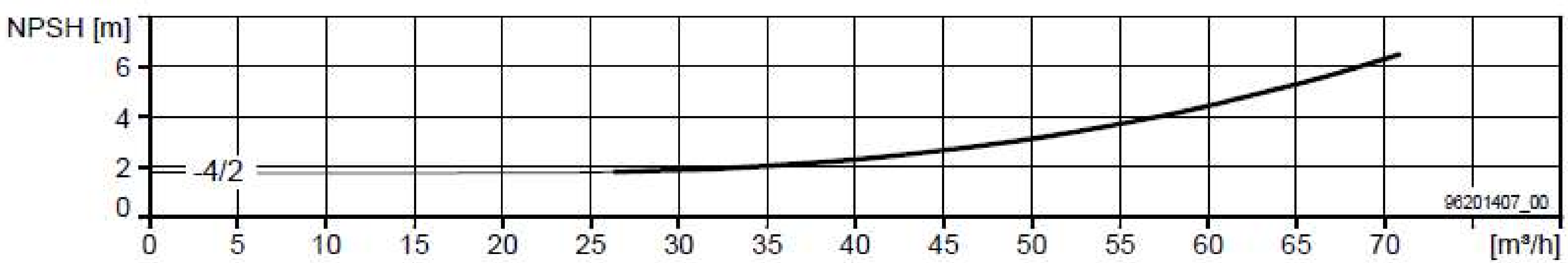
Hydraulic system pump and net



4.3 Reservoir

Minimum aspiration at pump (necessary net positive suction head NPSH)

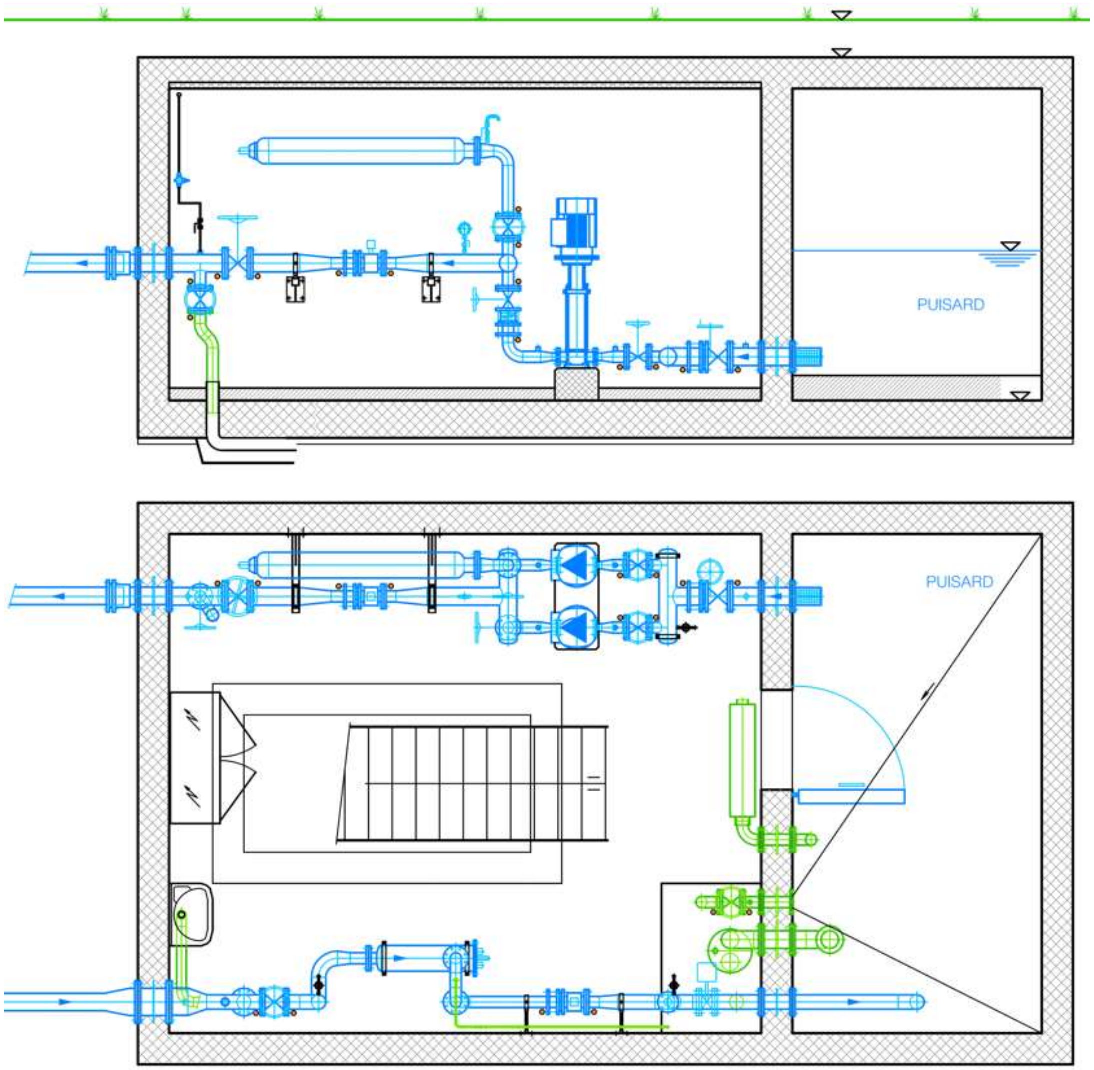




4.3 Reservoir

Example reservoir with pumping station

(Ribi SA)



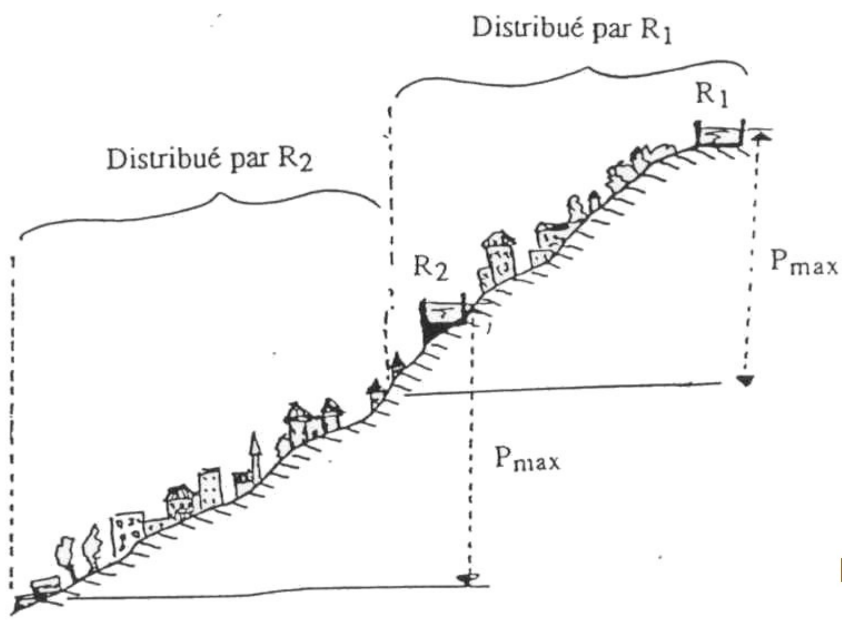
4.4 Net

4.4 Net

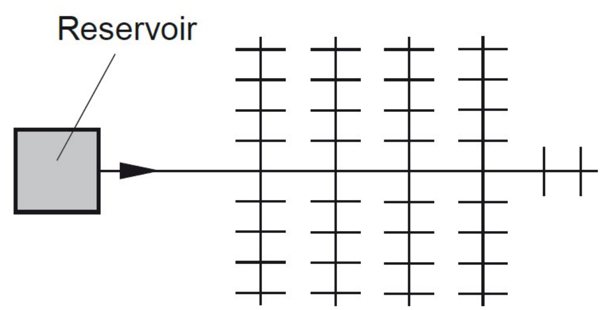
Distribution net

Three types

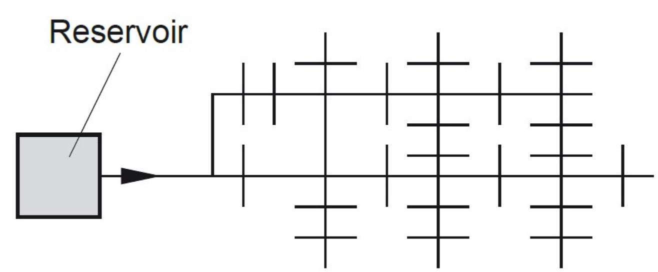
- Ramified
- Meshed
- Stepped



Meshed: no dead end, no interruption, higher capacity, higher cost



Stepped: for steep topographies, to reduce maximum pressures

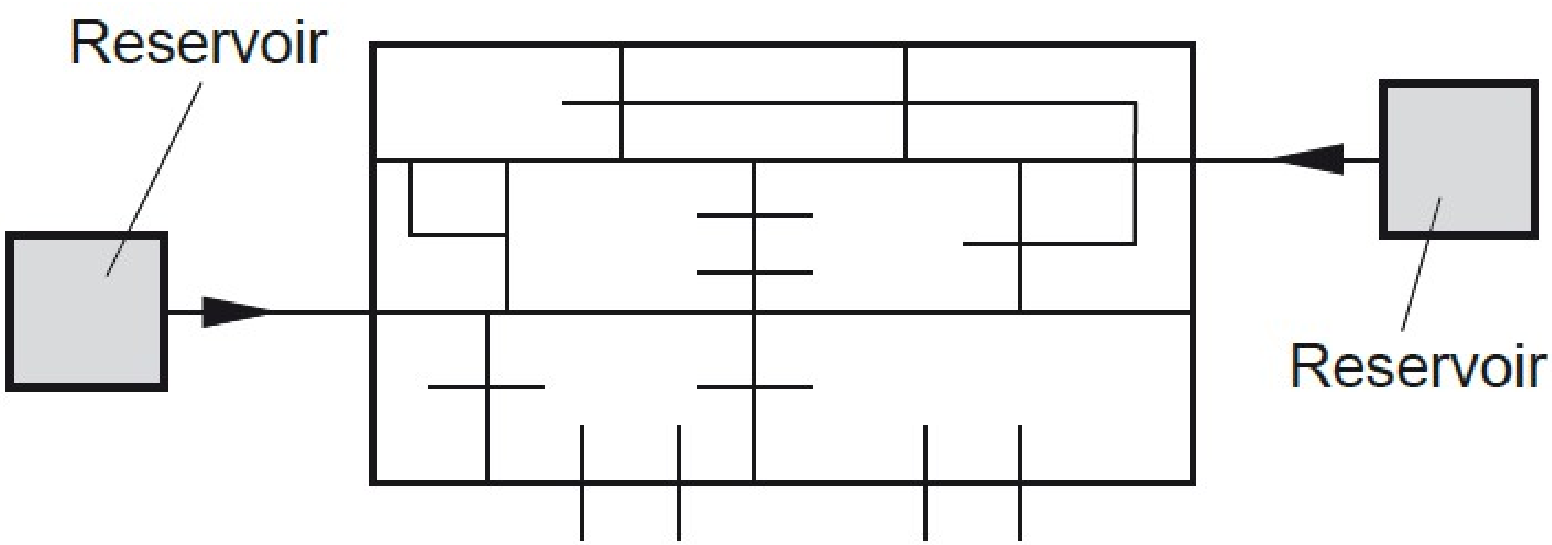


4.4 Net

Distribution net

Meshed nets are recommended, because of

- Uniform pressure level
- Reduced friction losses
- Flow in several directions possible
- Failure of a branch is compensated by an other one
- Flexibility for de-connection (maintenance)
- Better capacities for discharge peaks (with higher pressure)
- Additional reservoir may be better integrated in the system

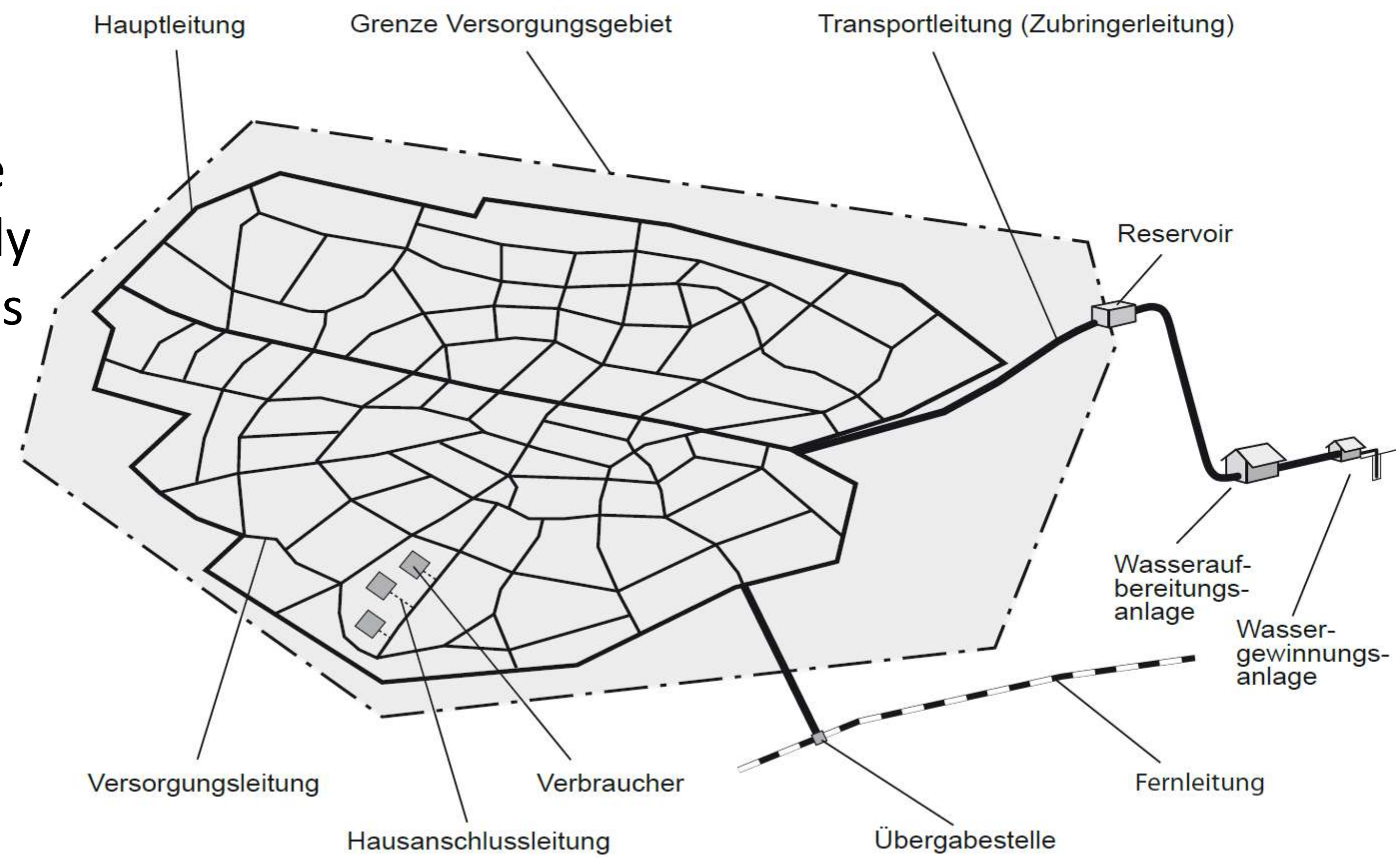


4.4 Net

Distribution net

Conduit hierarchy

- Transport and principal conduit (leave reservoir, large pipes as skeleton of net, ramified, *D*>0.25 m, few connections and installations to keep losses small, placing depth ≥1.4 m)
- Distribution conduit (connected to principal pipe, dense net, meshed, typically conduit on both sides of broad street, fire hydrant)
- House connections (fine distribution to individual houses, with valve)



4.4 Net

Design bases

Discharge

Instantaneous maximum demand (Chapter 3.3) + discharge for fire protection

Pressure

Conduit resistance

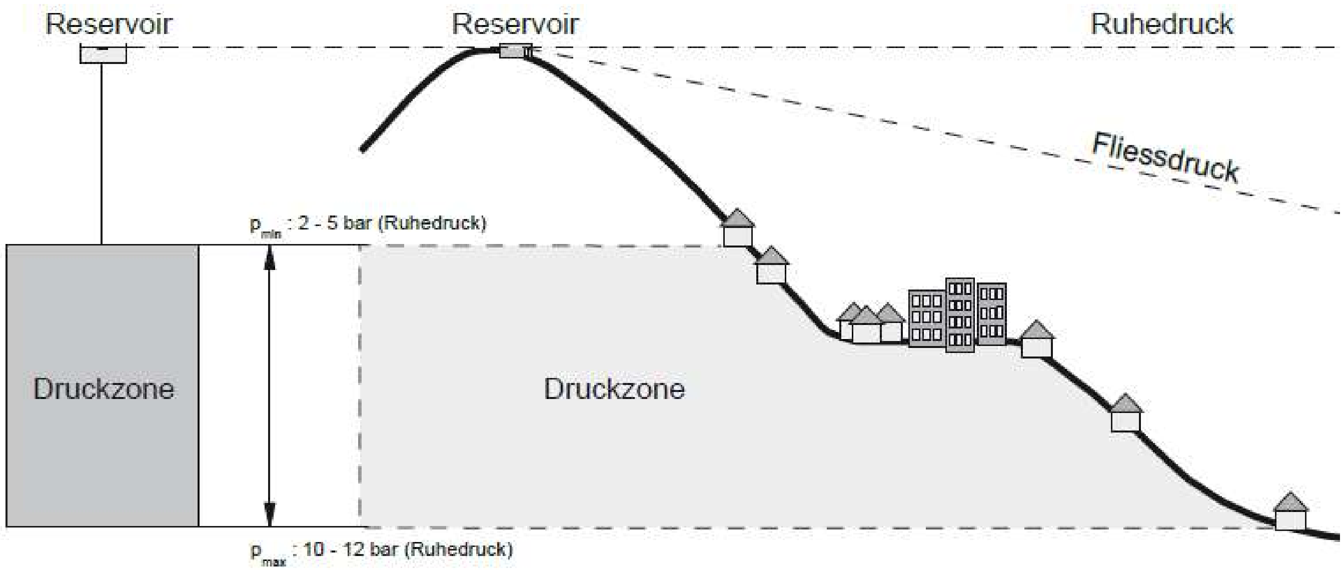
Topography

Height of buildings

Typically 40 to 80 m WC

(flat topo 20 to 50 m)

(steep topo 20 to 100 m)



Maximum static pressure typically ≤ 100 m WC

Flow velocity

Conduit flow velocities between 0.5 and 2 m/s (SVGW W4)

Maximum flow velocity between 2 and 4 m/s (SVGW W4)

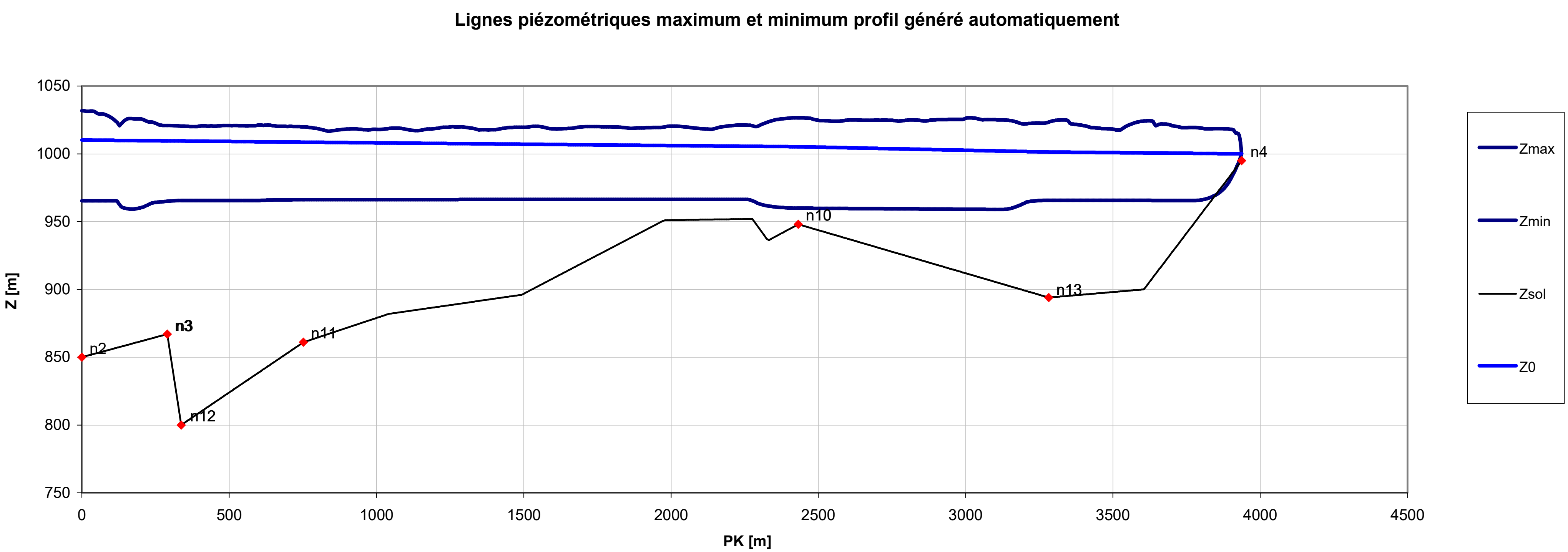
To avoid deposits and stagnant water *V*≥1 m/s (due to fire demand (=large *D*) often not realistic)

4.4 Net

Water hammer

Positive pressure ⇨ resistance of conduit
Negative pressure ⇨ degasing, air and (polluted) water entrainment through joints, implosion of conduit

Pressure lines for pumping (start of pumps, stop due power failure) (Ribi SA)

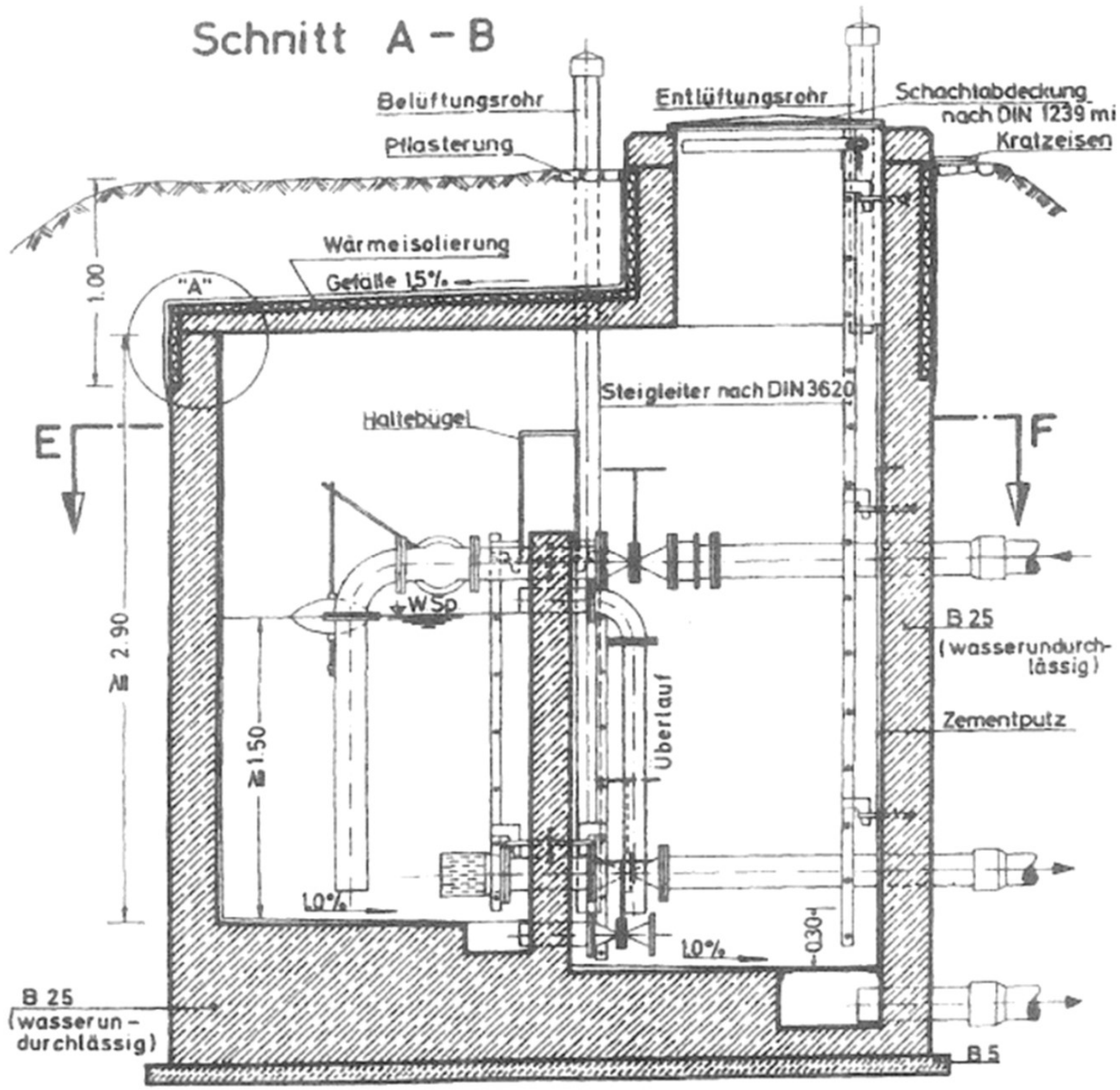


4.4 Net

Pressure reduction (= local energy loss → Freshwater turbine?)

Intermediate reservoir or pressure-reducing chamber
(DVGW W351)

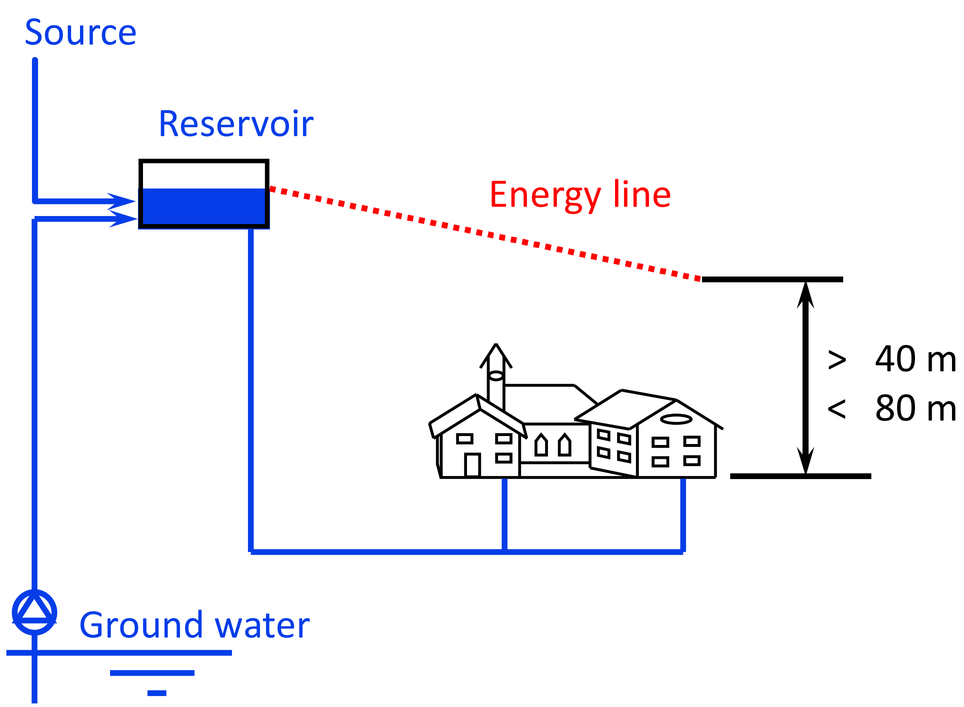
Alternative: reduction valve



4.4 Net

Energy & pressure consideration
(for design discharge)

Reservoir dominated net with 40 to 80 m WC (hilly topography)



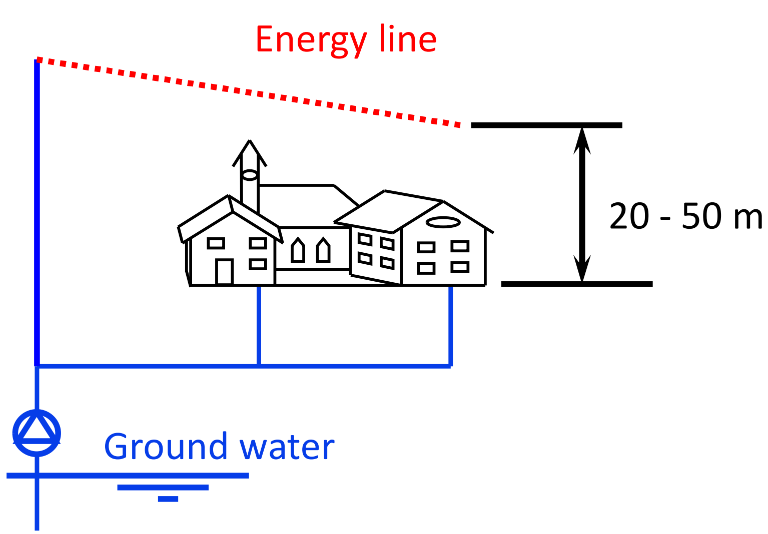
- Optimum type
- Conduit resistance PN=10 bar
- Fire fighting without pump support
- Eight floor houses supply without pump support
- Low pressure fluctuations

4.4 Net

Energy & pressure consideration

(for design discharge)

Pump dominated net with 20 to 40 m WC (plain topography)

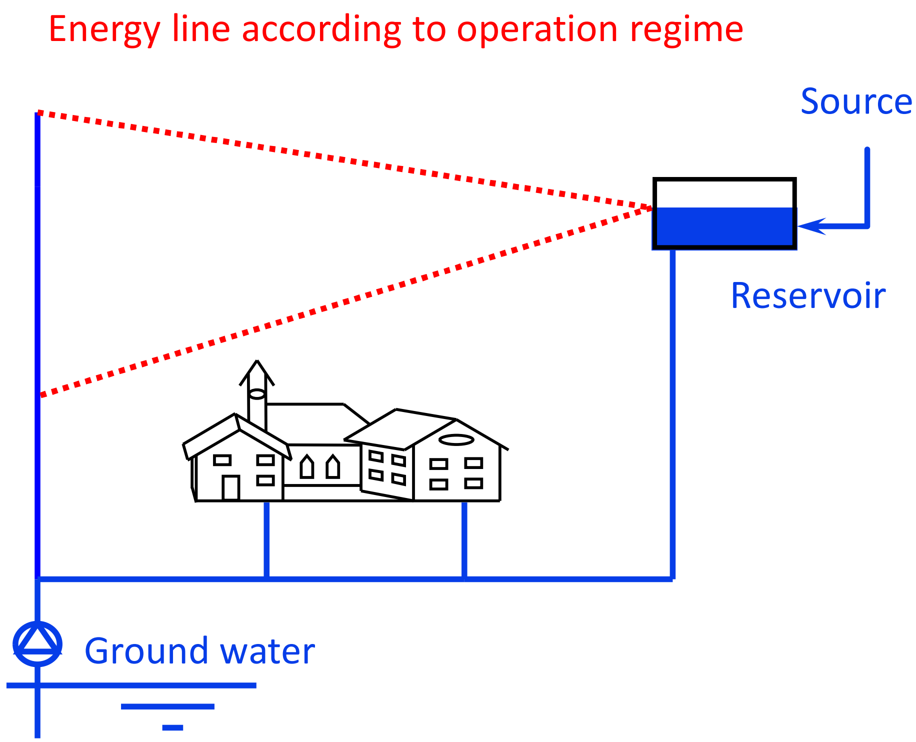


- Pressure provided by pumps
- Operation safety (multiple pump arrangements with emergency generator)
- High buildings: pressure increase necessary
- For low pressure: pollutants enter the conduit (preventive chlorine addition)
- Fire fighting with pump support
- High pressure fluctuations

4.4 Net

Energy & pressure consideration
(for design discharge)

Combined net (typically for Switzerland)

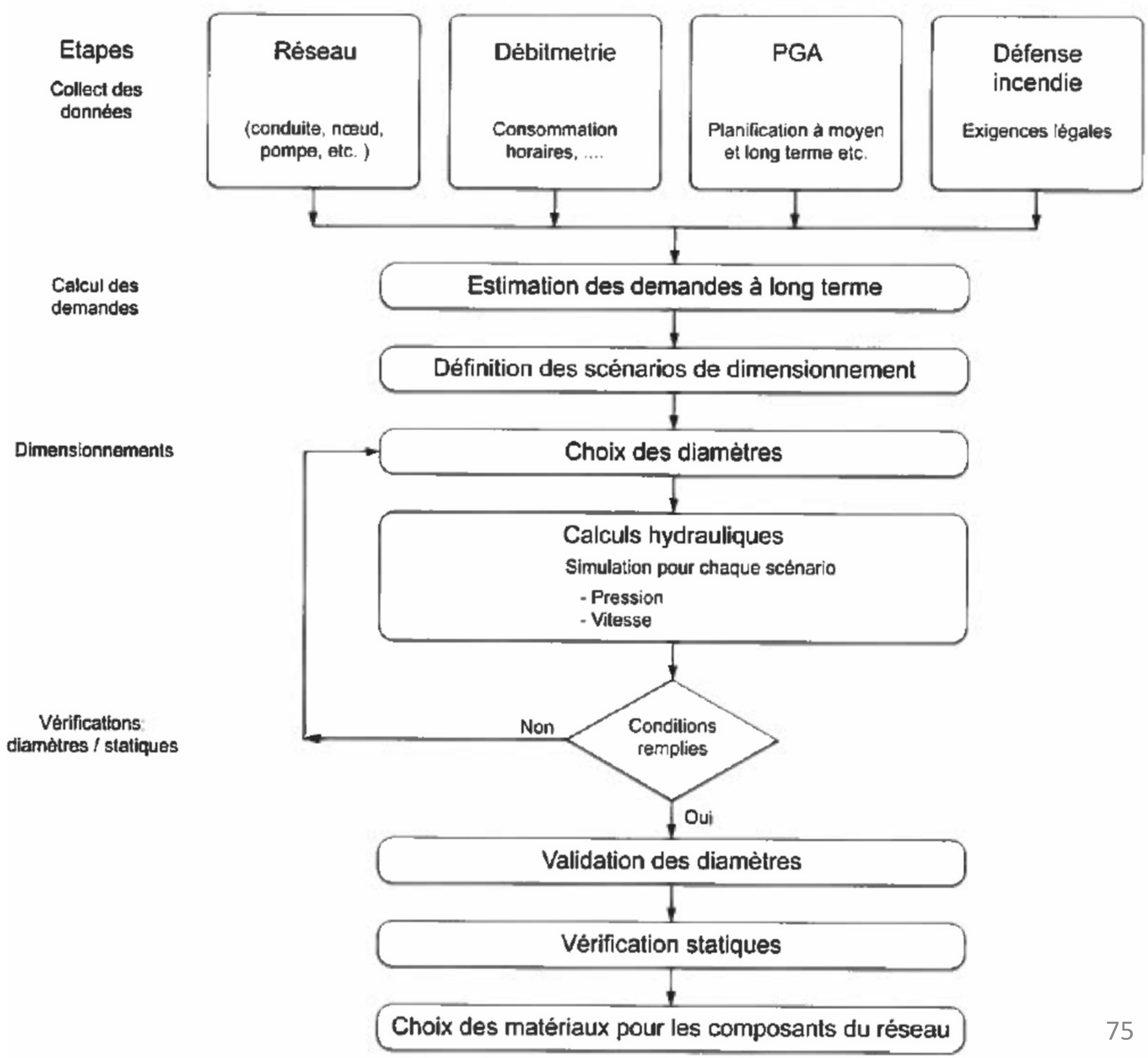


- Main conduits have also transport function
- Water age in reservoir might exceed limit (3d)

4.4 Net

General design procedure

(SVGW W4)



4.4 Net

Design bases

Scenarios

- Instantaneous maximum consumption
- Static pressure without consumption
- Water hammer (pump failure or start, closing and opening of valves)
- Night pumping in reservoir via net
- Fire incident at critical locations
- Blockage of relevant conduits due to failure or maintenance
- Minimum consumption to derive age of water in net
- Damage scenario (outflow pressure on street level)

Net is most sensitive and expensive element in fresh water system
If pumping is required: install ≥2 parallel pumps (2+1) with emergency generator

By the way: Switzerland uses a unique fresh water net for all needs. Countries with poor water quality or small reserves use two nets: a fresh water net of good quality, and an net with reduced quality (grey water net).

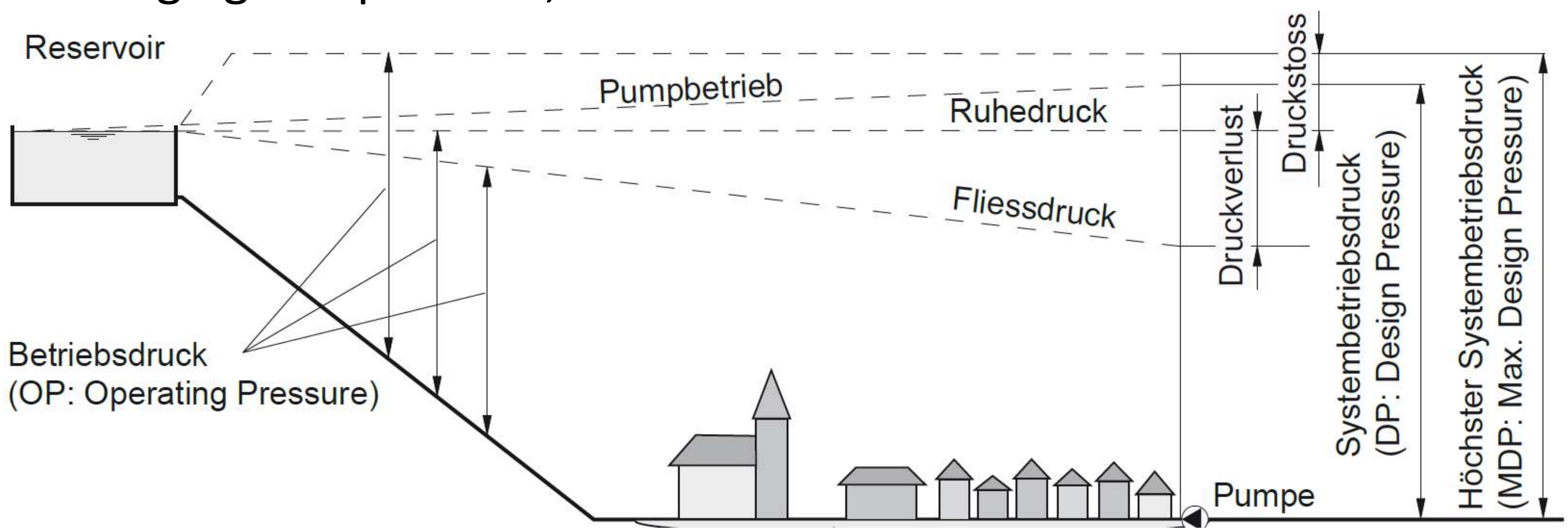
4.4 Net

Hydraulic net performance

Discharges and pressures (SVGW W4)

- Minimum pressure: maximum discharge
- Maximum pressure: Water hammer plus static pressure

Challenging computation, use commercial software



Elements of net

- Nodes (ΣQ=0)
- Conduit (loss characteristics as a function of ΔH)
- Reservoir and pumping station (head-discharge relation)
- Consumer (water loss $Q(H)$)

4.4 Net

Hydraulic net performance

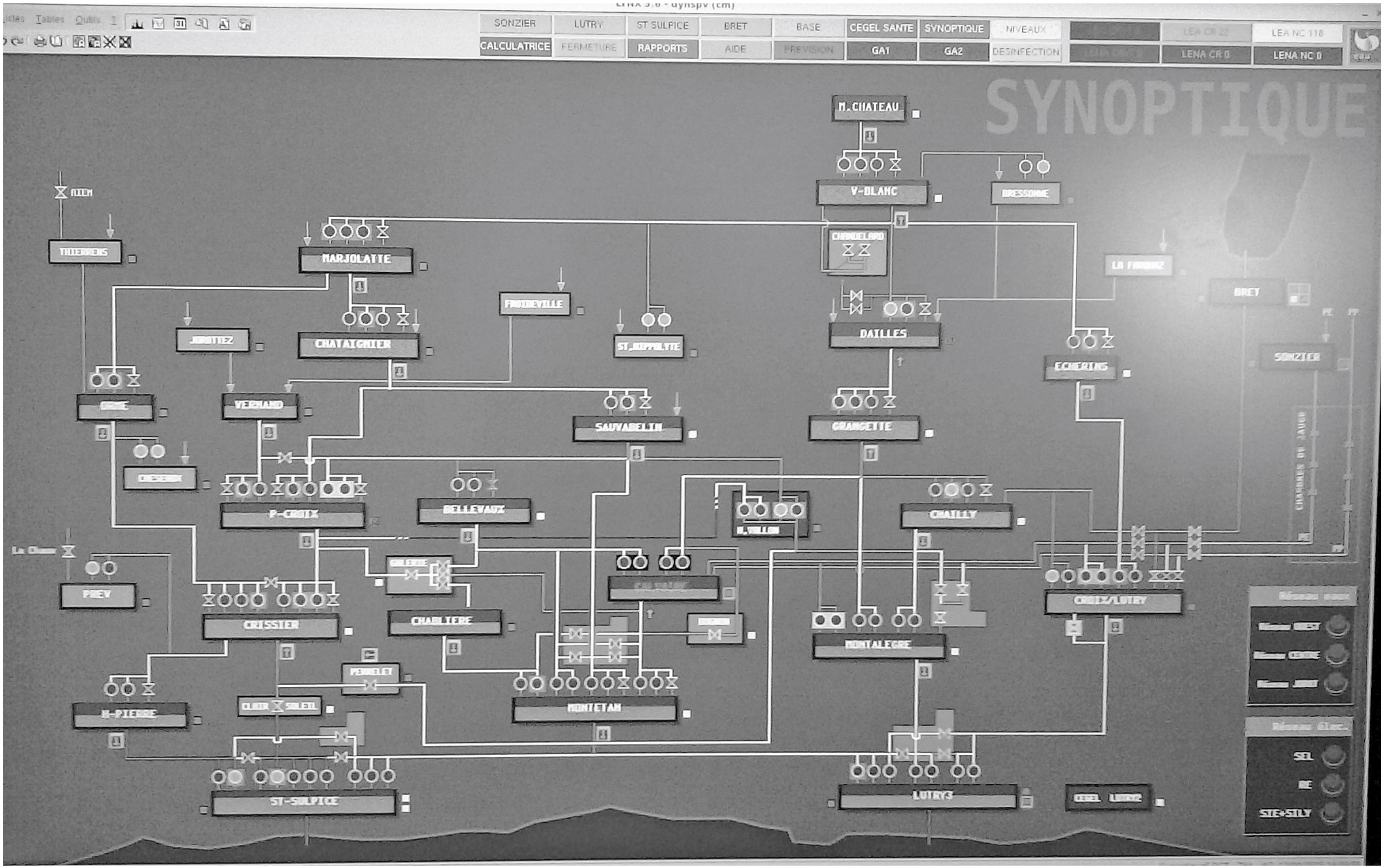
- Pressurized flow
- Hydraulics with Darcy & Weisbach and Colebrook & White
- Provide aeration and de-aeration at high points (filling and empting of net)
- Divide net in sectors which can be taken out of operation (maintenance, rupture)
- Provide installations to reduce the effect of water hammer (abrupt failure of pump)
- Minimum conduit slope 2‰, 1.2 to 1.5 m below surface (maximum 3 m)

Minimum diameters 0.05 m to aliment 30 persons, 0.08 m for 100 persons, and 0.1 for 250 persons

Contact manufacturers for conduit type, length and cost
Frequently: PE conduits up to 160 m WC, for higher pressures cast iron conduits

4.4 Net

Net management Lausanne



4.4 Net

Material

Dissolved materials from pipes must be harmless for health, technically unavoidable, and create no change of the fresh water (SVGW W4.1)

- Ductile cast iron: ductile, high stiffness, internal coating, external protection, isolation against creeping currant (corrosion), expensive
- Polyethylene (PE 100): aging, sensitive to chemical products resulting form chlorine, sensitive to pressure fluctuations (cracking), limited ductile, cheap

Bedding: protection against local force (sand)

Limitation of deformations

4.5 Quality (legal frame)

4.5 Quality (legal frame)

Ordonnance du DFI sur l’eau potable, l’eau de source et l’eau minérale (817.022.102)

Art. 2. Par eau potable, on entend l’eau qui, à l’état naturel ou après traitement, convient à la consommation, à la cuisson d’aliments, à la préparation de mets et au nettoyage d’objets entrant en contact avec les denrées alimentaires.

Art. 3. L’eau potable doit être salubre sur les plans microbiologique, chimique et physique. Elle est réputée telle, à l’endroit où elle est mise à disposition du consommateur:

a) lorsqu’elle répond aux critères hygiéniques et microbiologiques fixés pour l’eau potable dans l’ordonnance du DFI du 23 novembre 2005 sur l’hygiène (817.024.1, voir annexe B);
b) lorsqu’elle ne dépasse pas les valeurs de tolérance ni les valeurs limites fixées pour l’eau potable dans l’ordonnance du 26 juin 1995 sur les substances étrangères et les composants, et
c) lorsque son goût, son odeur et son aspect sont irréprochables.

4.5 Quality (legal frame)

Ordonnance sur la garantie de l'approvisionnement en eau potable en temps de crise (OAEC, SR 531.32)

Art. 4 Quantités minimales
En temps de crise, les quantités minimales d'eau potable suivantes doivent être disponibles: (a) *jusqu'au troisième* jour, autant que possible; (b) *dès le quatrième jour*, 4 l par personne et par jour; (c) *dès le sixième jour*: pour les ménages et sur les lieux de travail, 15 l par personne et par jour

Art. 7 Mise sur pied de dépôts et fourniture de matériel
les *cantons* veillent [sur] la fourniture de matériel lourd tel que tuyaux à raccordement rapide, véhicules de transport, groupes électrogènes de secours et unités pour le traitement de l'eau.

Art. 16 Mesures de la construction
Garantir l'apport en eau même en cas de panne totale du réseau, par le recours aux sources, aux captages de secours, aux réserves de secours ou encore à des livraisons de l'extérieur

4.5 Quality (legal frame)

http://www.wasserqualitaet.ch/
http://www.wasser.ch/

4.6 Pro memoria

4.6 Pro memoria

- Consumption: large volume, unsteady, high quality requested
- Resources: limited volume, steady inflow, variable quality
- Capture, treatment, storage and distribution required

- Water protection areas to guarantee quality
- Source/ground water pumping/lake captures
- Discharge regulation near reservoir

- Reservoir volume ≈ average daily consumption
- Check f_d (chapter 3.3) dependent on in- and outflow characteristics, increase reservoir volume if necessary
- Reserve for fire incident
- Elevation: some 50 to 100 m above consumer
- Guarantee hygienic conditions and flow circulation

- Common are meshed nets
- Static pressures between 20 and 100 m WC
- Design with software, consider relevant scenarios