Delft University of Technology

Faculty of Civil Engineering and Geosciences

Section of Sanitary Engineering

CT5520 – Drinking water treatment 2

Design project

Harderbroek (Vitens) – Improving iron removal

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1. Problem description

Raw ground water from location Harderbroek can be characterised as soft, iron containing and anaerobic. To remove iron the minimal requirement is to increase the oxygen concentration. However, with the present treatment set-up iron is not sufficiently removed.

Develop practical alternatives to be realised in the present set-up of the treatment plant. Detailed information about the situation at PS Harderbroek can be found in annex.

2. Actual situation

The treatment plant consists of cascade aeration (4 cascades divided into 2 lanes) to increase the oxygen concentration, rapid sand filtration to remove iron and tower aeration to increase pH.

Raw water quality

The groundwater water quality is given in table 1.

Table 1. Raw water quality PS. Harderbroek

parameter	**unit**	**value**
Temperature	^{0}C	14
Acidity	pH	7.45
Saturation index	-	0.79
Agressive carbon dioxide	mg/l	4.3
Carbon dioxide	mg/l	5.7
Oxygen (dissolved)	mg/l	0.0
Methane	µg/l	< 10
Ammonium	mg/l	0.05
Bicarbonate	mg/l	86
Chloride	mg/l	7
Sulphate	mg/l	11
Sodium	mg/l	5,9
Calcium	mg/l	26
Magnesium	mg/l	1,7
Total hardness	mmol/l	0.72
Iron	mg/l	1.6
Manganese	mg/l	0.11

Design capacity

The design capacity of the treatment can be determined with the following data:

year capacity:	9 mln m^3
maximum day factor (peak factor):	1.8
minimum day factor:	0.7

Abstraction

The well field consists of 10 wells, with a capacity of 200 m^3/h each.

Cascade aeration

The purpose of the cascade aeration is to remove CO_2 and ad O_2.

Number of cascades	4
Steps per cascade	6
Maximum capacity per cascade	450 m^3/h

Rapid sand filtration

The purpose of rapid sand filtration is to remove iron and manganese from the ground water.

Number of filters:	8
Surface per filter:	25 m^2
Sand bed, grain size:	1.0 – 1.6 mm
Height of sand bed:	1.8 m
Supernatant water level:	1.0 m
Flow per filter:	225 m^3/h
Filtration velocity:	9 m/h

Tower aeration

Number of towers	3
Packing material	pall 25 PE
Packing height	2 m
Maximum capacity	320 m^3/h
Surface	6.06 m^2

Clear water storage

The clear water storage is necessary for levelling off the fluctuations in transport and for differences in pumping flows (switches). The necessary water is storage is determined on 5.000 m^3:

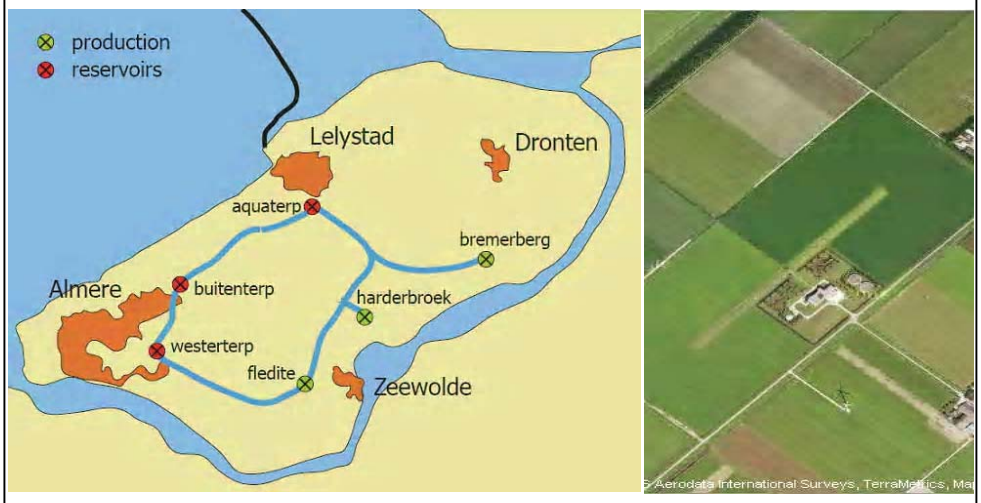
Volume of clear water storage (nett):	5.000 m^3
Number of reservoirs:	2 à 1.500 m^3+ 1 à 2.000 m^3

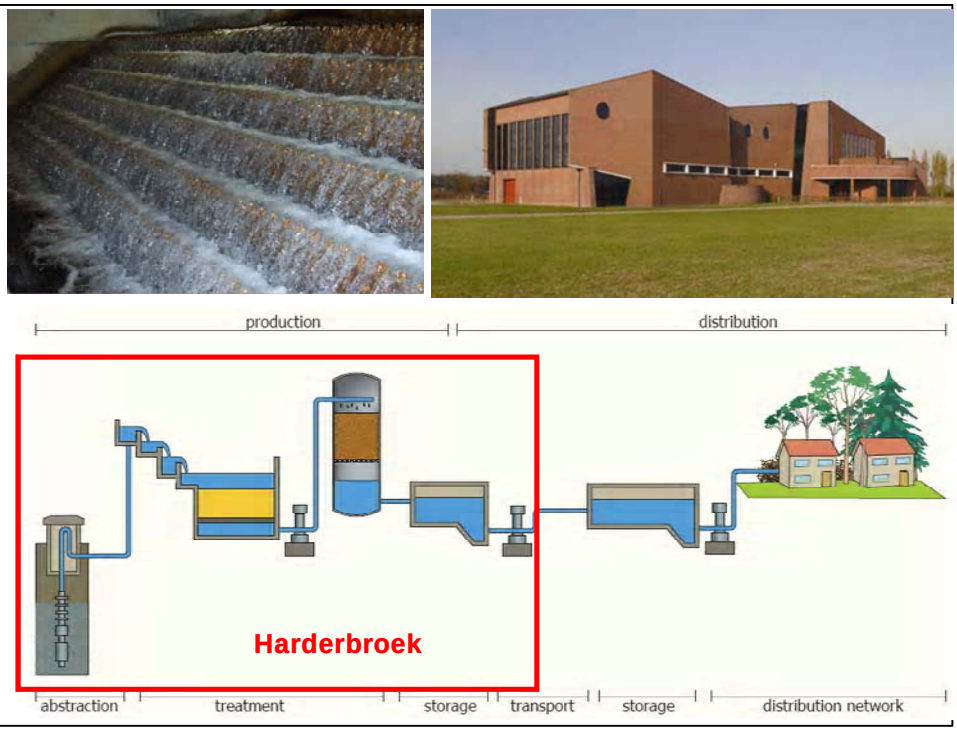
Clear water pumps

Transport capacity:	1.800 m^3/h
Number of pumps:	4 to 500 m^3/h

Annexes:

1. Impression Harderbroek
2. Process scheme
3. Hydraulic line diagram


production
reservoirs
Lelystad
Dronten
aquaterp
bremerberg
Almere
buitenterp
harderbroek
westerterp
fledite
Zeewolde
© Aerodata International Surveys, TerraMetrics, Ma


production
distribution
Harderbroek
abstraction
treatment
storage
transport
storage
distribution network

Process scheme P.S. Harderbroek

Wells:

number: 16
capacity: 200 m3/h per pump

Cascades:

number: 4
capacity: 450 m3/h per cascade 6 steps

FILTERS:

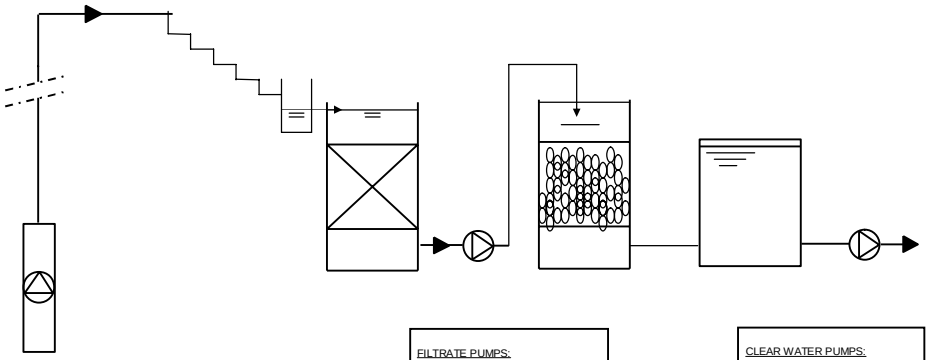
number: 8
max. velocity: 9 m/h
surface area: 25 m2

aeration tower:

number: 3
max. capacity: 320 m3/h
surface area: 6 m2
Beddheight 2 m

RESERVOIRS:

number: 2
volume: 2500 m3 per reservoir

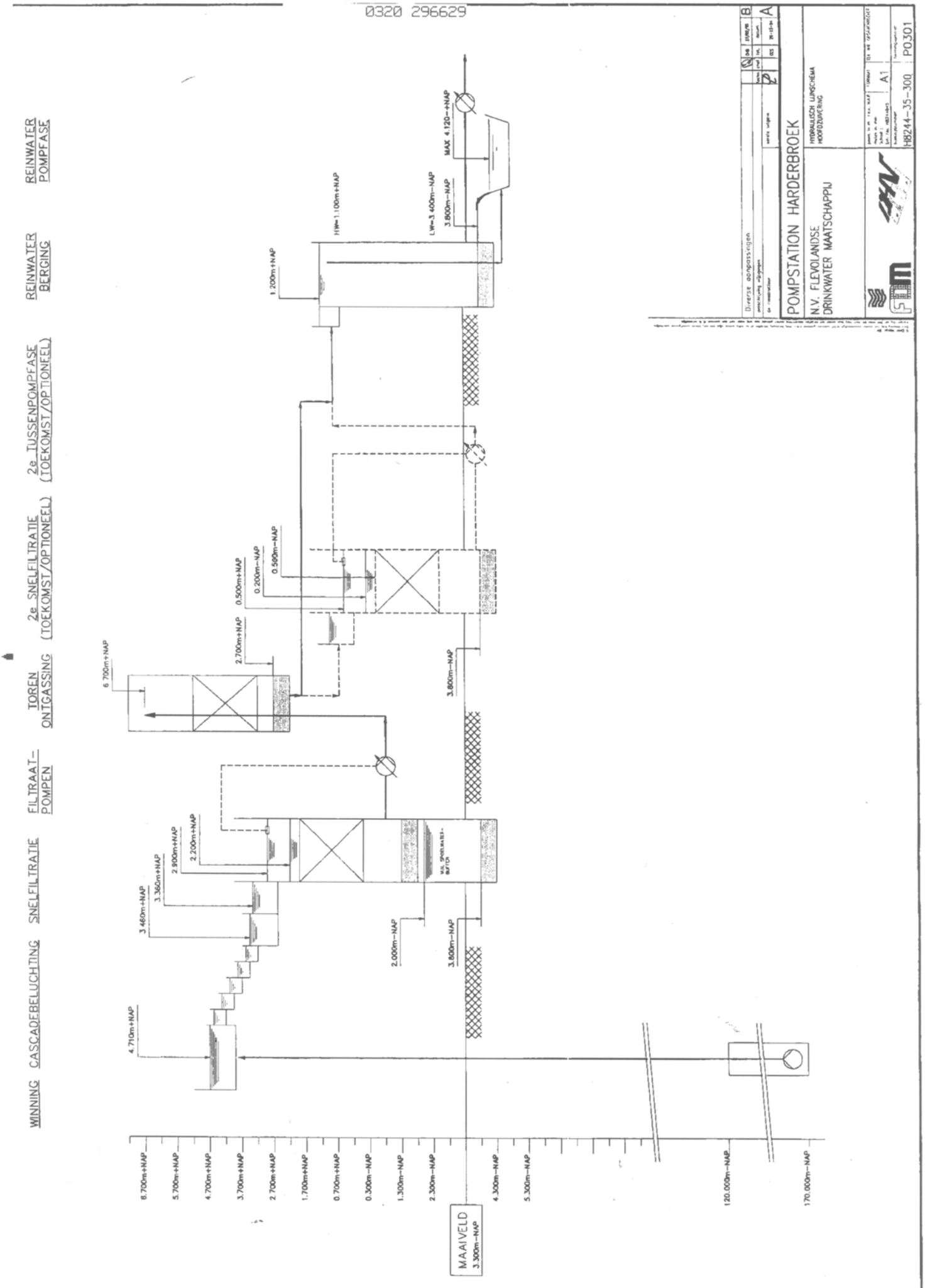


FILTRATE PUMPS:

number: 8
capacity: 225 m3/h per pump

CLEAR WATER PUMPS:

number: 4 a 500 m3/h
number: 3 a 300 m3/h


WINNING
CASCADEBELUCHTING
SNELFILTRATIE
FILTRAAT-POMPEN
TOREN ONTGASSING
2e SNELFILTRATIE (TOEKOMST/OPTIONEEL)
2e TUSSENPOMPFASE (TOEKOMST/OPTIONEEL)
REINWATER BERGING
REINWATER POMPFASE
4.710m+NAP
3.460m+NAP
3.360m+NAP
2.900m+NAP
2.200m+NAP
2.000m-NAP
3.800m-NAP
6.700m+NAP
2.700m+NAP
0.500m+NAP
0.200m-NAP
0.500m-NAP
3.800m-NAP
1.200m+NAP
HW=1.100m+NAP
LW=3.400m-NAP
3.800m-NAP
MAX 4.120-+NAP
MAAIVELD 3.300m-NAP
6.700m+NAP
5.700m+NAP
4.700m+NAP
3.700m+NAP
2.700m+NAP
1.700m+NAP
0.700m+NAP
0.300m-NAP
1.300m-NAP
2.300m-NAP
4.300m-NAP
5.300m-NAP
120.000m-NAP
170.000m-NAP
POMPSTATION HARDERBROEK
N.V. FLEVOLANDSE DRINKWATER MAATSCHAPPIJ
HYDRAULISCH LIJNSCHEMA HOOFDZUIVERING
H8244-35-300
P0301
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