

Combinations of treatment processes for water recycling in the pulp&paper industry

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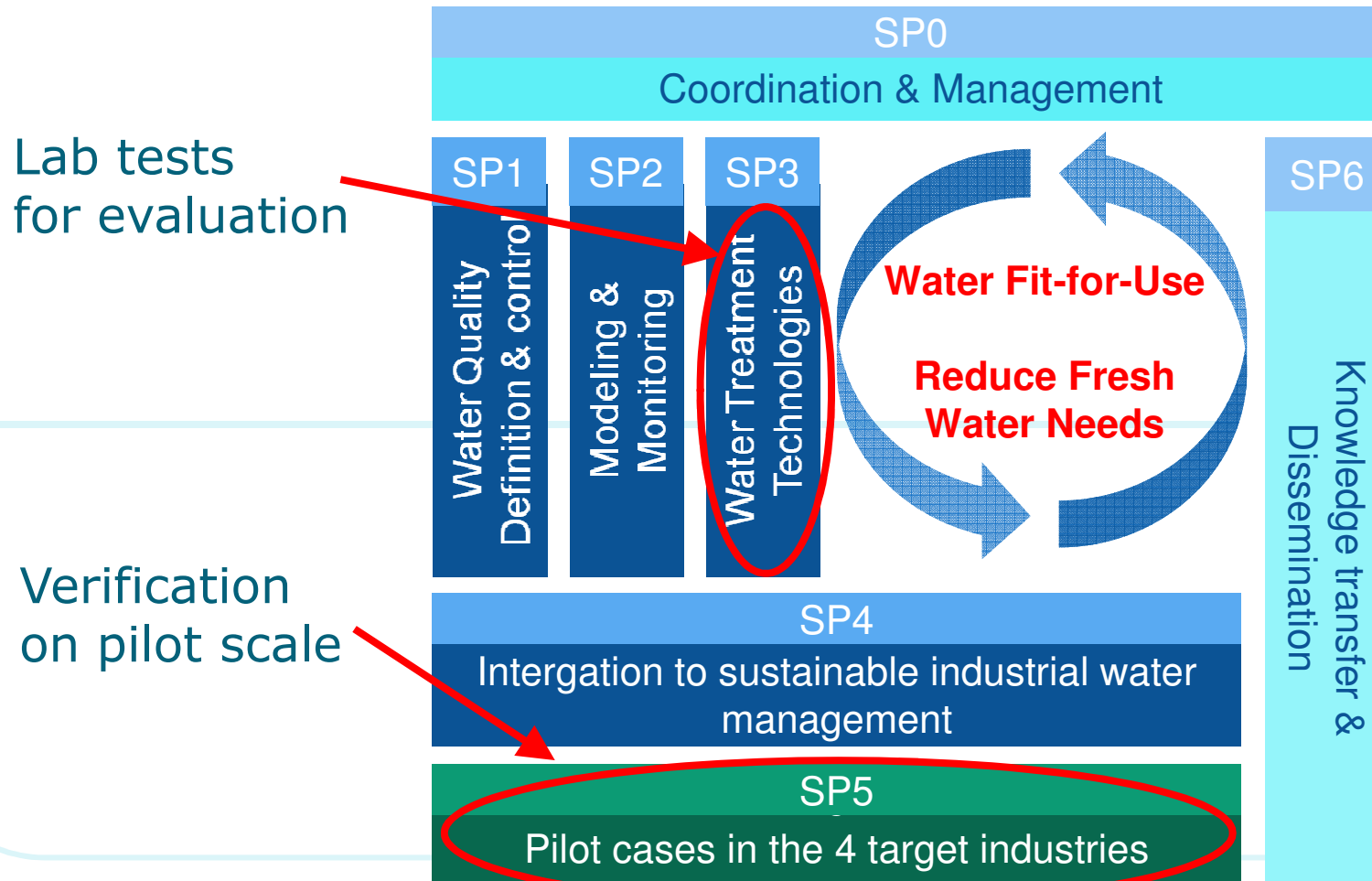




Content

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 - Unit operations
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-
- Treatment lines
 - Outlook

Background





Parties involved

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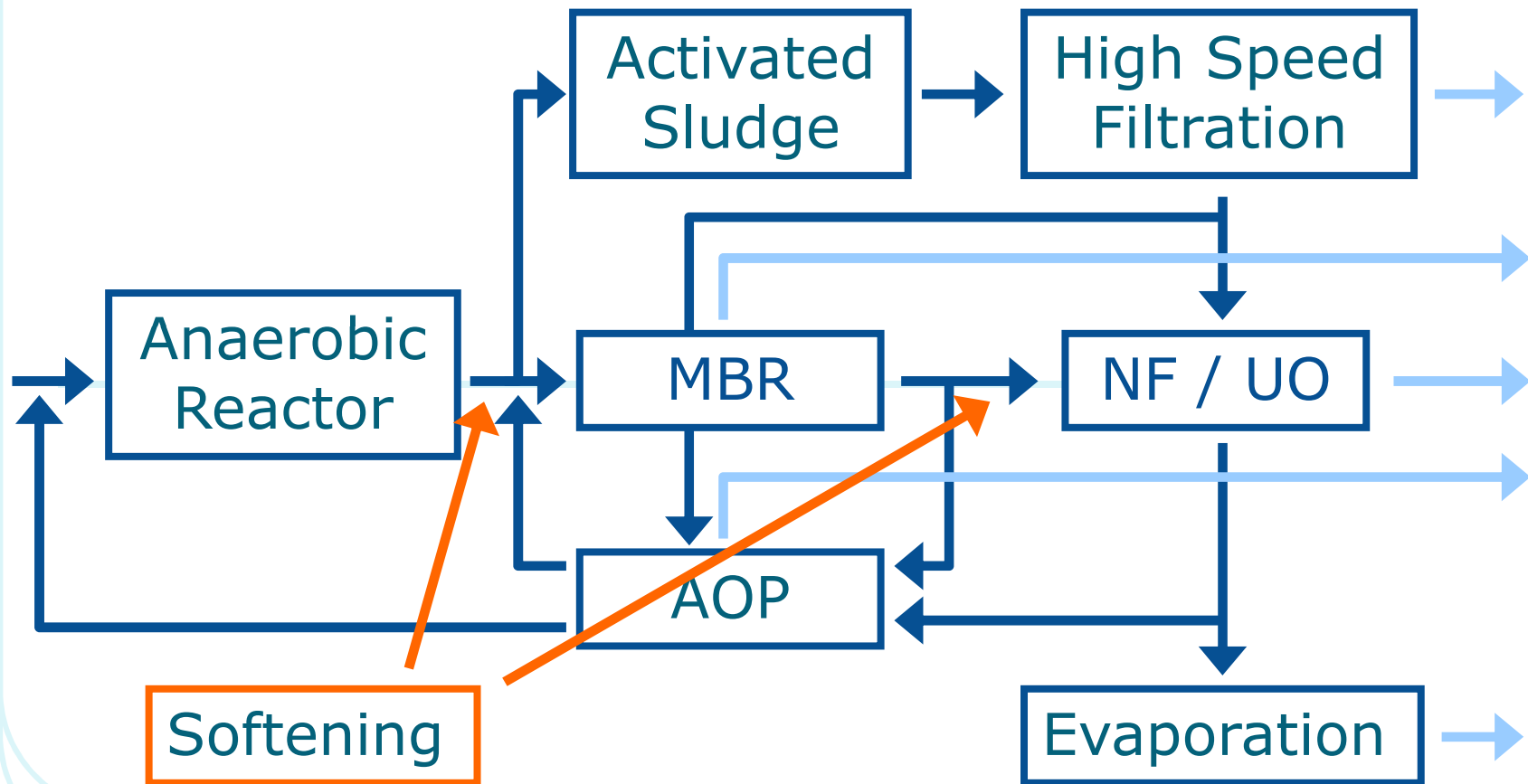


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Unit Operations Scheme



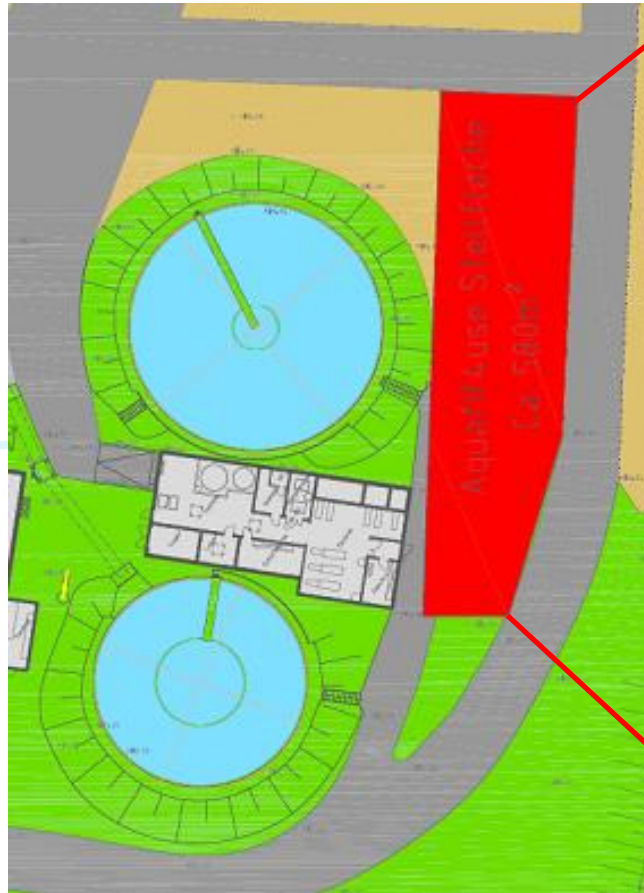
Unit Operations (1)

- Anaerobic Reactor
 - Biological pre-treatment
 - Assessment of concentrate effects
- Activated Sludge / 3FM
 - Biological post-treatment
 - Solids removal, filtration assessment
- MBR
 - Biological post-treatment
 - Filtration assessment (scaling)

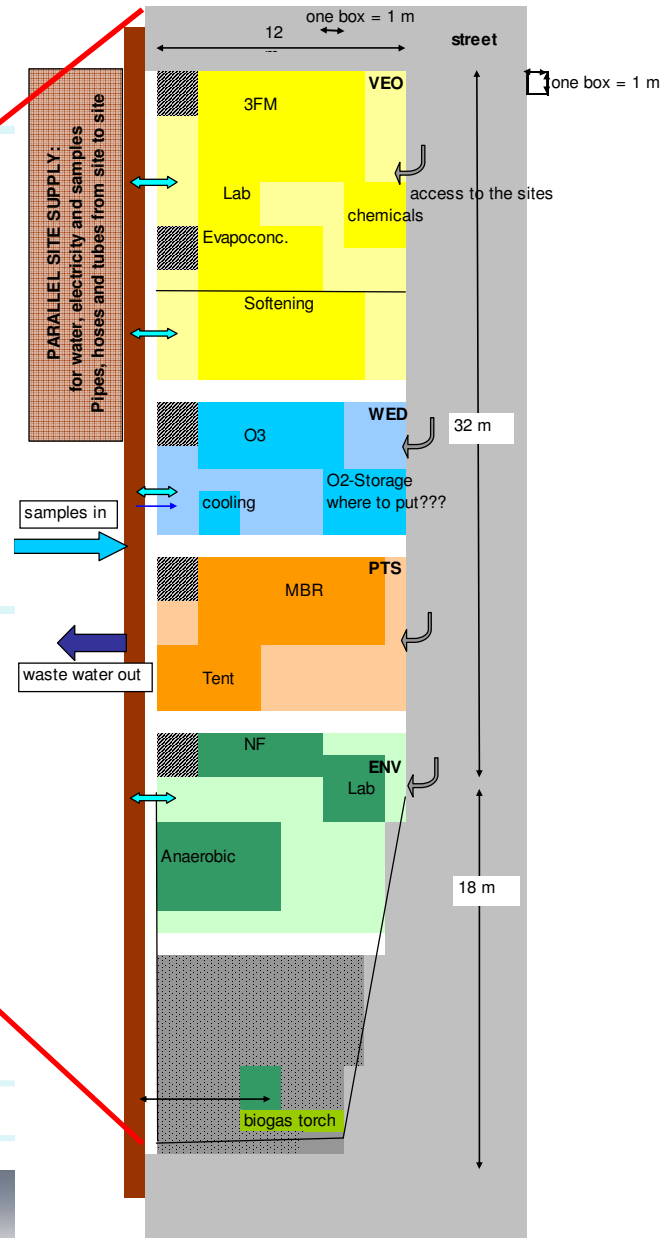
Unit Operations (2)

- NF / UO
 - Production of high grade reclamation water
 - Comparison of pre-treatment: scaling, fouling
- AOP
 - Effluent / concentrate COD + SAC removal
- Evaporation
 - Concentrate handling
- Softening
 - NF pre-treatment vs. conditioning

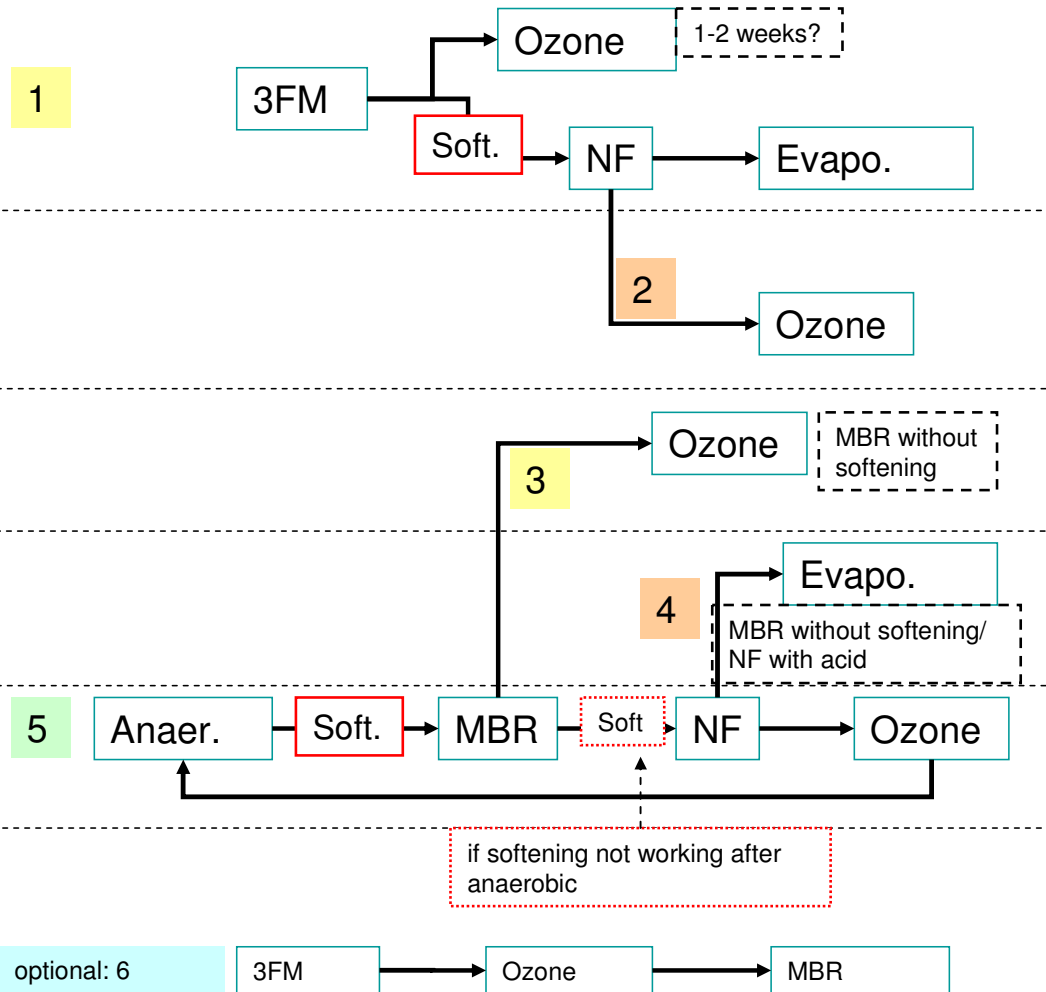
Site planning



- = buffer tank
- = street
- = grassland
- = "supply channel" for samples, fresh water, power, waste water disposal



Treatment lines





Reclamation Water Quality (1)

	Cond. [μ S/cm]	Cl ⁻ [mg/L]	Ca ²⁺ [mg/L]	Colour	SS [mg/L]	COD [mg/L]	BOD [mg/L]
Low (misc. dilution)	500	< 300	< 200	n/a	coarse sieve	n/a	red.
Medium (spraying nozzle)	500	< 200	< 60	n/a	(< 5 μ m) 10 - 15	< 200	low
High (white paper grade)	500	< 200	< 60	none	10	< 50	< 3

Paper type Fiber source Deinking		Graphic				Packaging recovered without	Sanitary fresh	recovered	Other	S
Location	Unit	Process water	1st loop	2nd loop	Mechanical pulp	Process	Process	Process	Process	F
		PM loop	DIP	DIP		PM loop	PM loop	PM loop	PM loop	
pH	-	7,0...8,5 ¹⁾	7,5...8,5 ¹⁾	7,5...8,5 ¹⁾	6,0...7,0 ¹⁾	(5,9) 6,3...7,3 (7,5)	7,1...8,1 (8,1)	7,1...8,3 (8,3)	6,0...8,0 (8,0)	
Temperature	°C	40...60 ¹⁾	40...60 ¹⁾	40...60 ¹⁾	60...80 ¹⁾	35...48 (48)	36...44 (44)	30...46 (46)	26...46 (46)	
Conductivity, 25°C	µS/cm	1 000 ²⁾	3 500 ²⁾	2 000 ²⁾	1 500...2 000 (2 000) ⁴⁾	2 000...6 000 (13 000)	500...1 700 (3 500)	1 000...2 500 (4 000)	500...2 000 (3 200)	
COD	mg/l	1 000 ²⁾	3 500 ²⁾	2 000 ²⁾	2 000...3 000 (10 500) ⁴⁾	1 000...8 000 (25 000)	150...450 (1 000)	500...1 500 (2 500)	100...600 (750)	
Cl ⁻	mg/l	100 ²⁾	n.a.	n.a.	n.a.	100...700 (1 200)	50...350 (700)	60...250 (700)	50...300 (550)	
SO ₄ ²⁻	mg/l	100 ²⁾	300 ²⁾	200 ²⁾	n.a.	200...900 (1 600)	80...200 (900)	150...350 (600)	100...500 (850)	
Ca ²⁺	mg/l					200...1 200 (3 800)	50...400 (1 800)	80...250 (330)	10...80 (250)	
Hardness	mg/l (CaCO ₃)	50 ²⁾	200 ²⁾	150 ²⁾	n.a.					
Cationic demand	µeq/l	25 ²⁾	200 ²⁾	125 ²⁾	n.a.					

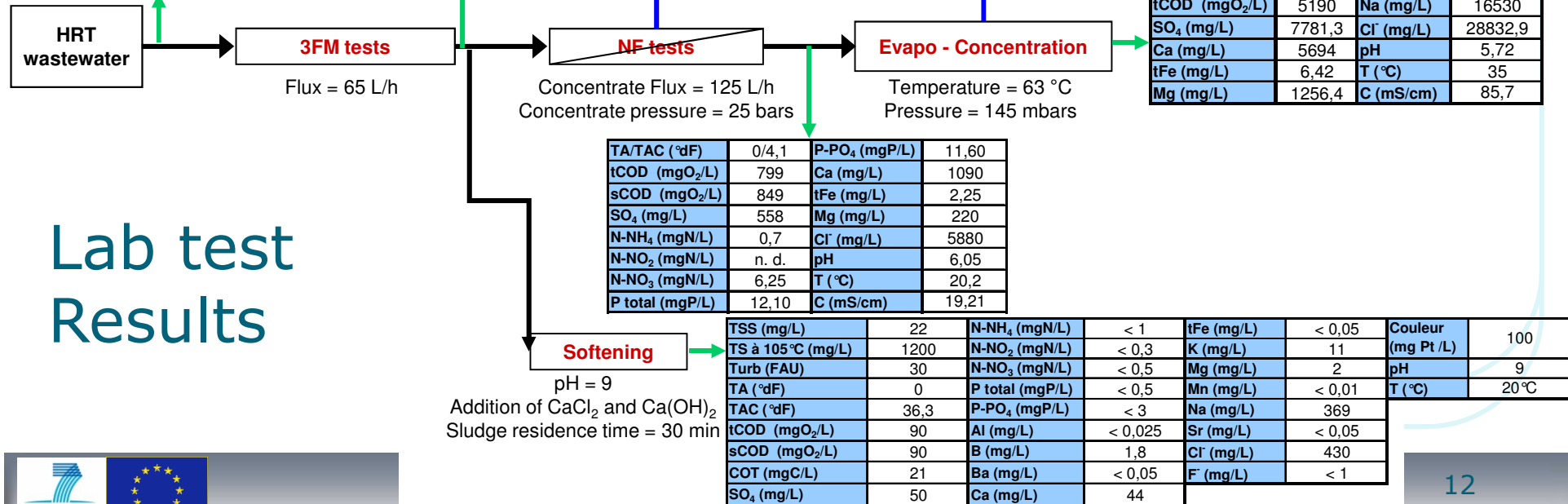


TSS (mg/L)	23
MS à 105°C (mg/L)	1700
Turb (FAU)	21
TA/TAC (°dF)	0/115
BOD ₅ (mgO ₂ /L)	52
tCOD (mgO ₂ /L)	154
sCOD (mgO ₂ /L)	144
DOC (mgC/L)	43
COT (mgC/L)	46
SO ₄ (mg/L)	60
N-NH ₄ (mgN/L)	1
N-NO ₂ (mgN/L)	0,52
N-NO ₃ (mgN/L)	0,22
P total (mgP/L)	0,6
P-PO ₄ (mgP/L)	< 0,6
Al (mg/L)	0,21
B (mg/L)	2,6
Ba (mg/L)	0,1
Ca (mg/L)	140
tFe (mg/L)	0,22
K (mg/L)	9
Mg (mg/L)	20
Mn (mg/L)	0,02
Na (mg/L)	400
Sr (mg/L)	0,58
Cl ⁻ (mg/L)	180
F (mg/L)	< 0,2
Si (mg/L)	5,15
Silice totale (mgSiO ₂ /L)	9,25
pH	8,09
T (°C)	24,3
C (mS/cm)	2,68

TSS (mg/L)	< 10
TS à 105°C (mg/L)	1600
Turb (FAU)	1
TA/TAC (°dF)	0/99,2
BOD ₅ (mgO ₂ /L)	< 1
tCOD (mgO ₂ /L)	98
sCOD (mgO ₂ /L)	97
DOC (mgC/L)	26
COT (mgC/L)	30
SO ₄ (mg/L)	54
N-NH ₄ (mgN/L)	< 1
N-NO ₂ (mgN/L)	< 0,3
N-NO ₃ (mgN/L)	< 0,5
P total (mgP/L)	< 0,5
P-PO ₄ (mgP/L)	< 3
Al (mg/L)	0,16
B (mg/L)	2,6
Ba (mg/L)	0,061
Ca (mg/L)	120
tFe (mg/L)	0,2
K (mg/L)	11
Mg (mg/L)	23
Mn (mg/L)	< 0,01
Na (mg/L)	460
Sr (mg/L)	0,45
Cl ⁻ (mg/L)	170
F (mg/L)	< 1
Si (mg/L)	5
Silice totale (mgSiO ₂ /L)	9,1
Couleur (mg Pt /L)	200

TSS (mg/L)	< 10	F (mg/L)	< 1
TS à 105°C (mg/L)	310	Al (mg/L)	< 0,025
Turb (FAU)	0,3	B (mg/L)	< 0,05
TA/TAC (°dF)	0/0,6	Ba (mg/L)	< 0,05
BOD ₅ (mgO ₂ /L)	2	Ca (mg/L)	< 1
tCOD (mgO ₂ /L)	< 30	tFe (mg/L)	< 0,05
DOC (mgC/L)	< 2	K (mg/L)	4
COT (mgC/L)	< 2	Mg (mg/L)	< 1
SO ₄ (mg/L)	< 20	Mn (mg/L)	< 0,01
N-NH ₄ (mgN/L)	< 1	Na (mg/L)	90
N-NO ₂ (mgN/L)	< 0,3	Sr (mg/L)	< 0,05
N-NO ₃ (mgN/L)	3,30	Couleur (mg Pt /L)	5
P total (mgP/L)	< 0,5	pH	5,68
P-PO ₄ (mgP/L)	< 3	T (°C)	25
Cl ⁻ (mg/L)	160	C (mS/cm)	< 1
Spores de organismes (n/20mL)		< 2	
Coliformes totaux (n/100mL)		100	
Coliformes thermotolérants (n/100mL)		36	
Entérocoques (n/100mL)		1	
μ-org revivifiables à 22°C (n/mL)		214000	
μ-org revivifiables à 36°C (n/mL)		220000	
Legionella sp (UFC/L)		< 500	
legionella pneumophila (UFC/L)		< 500	

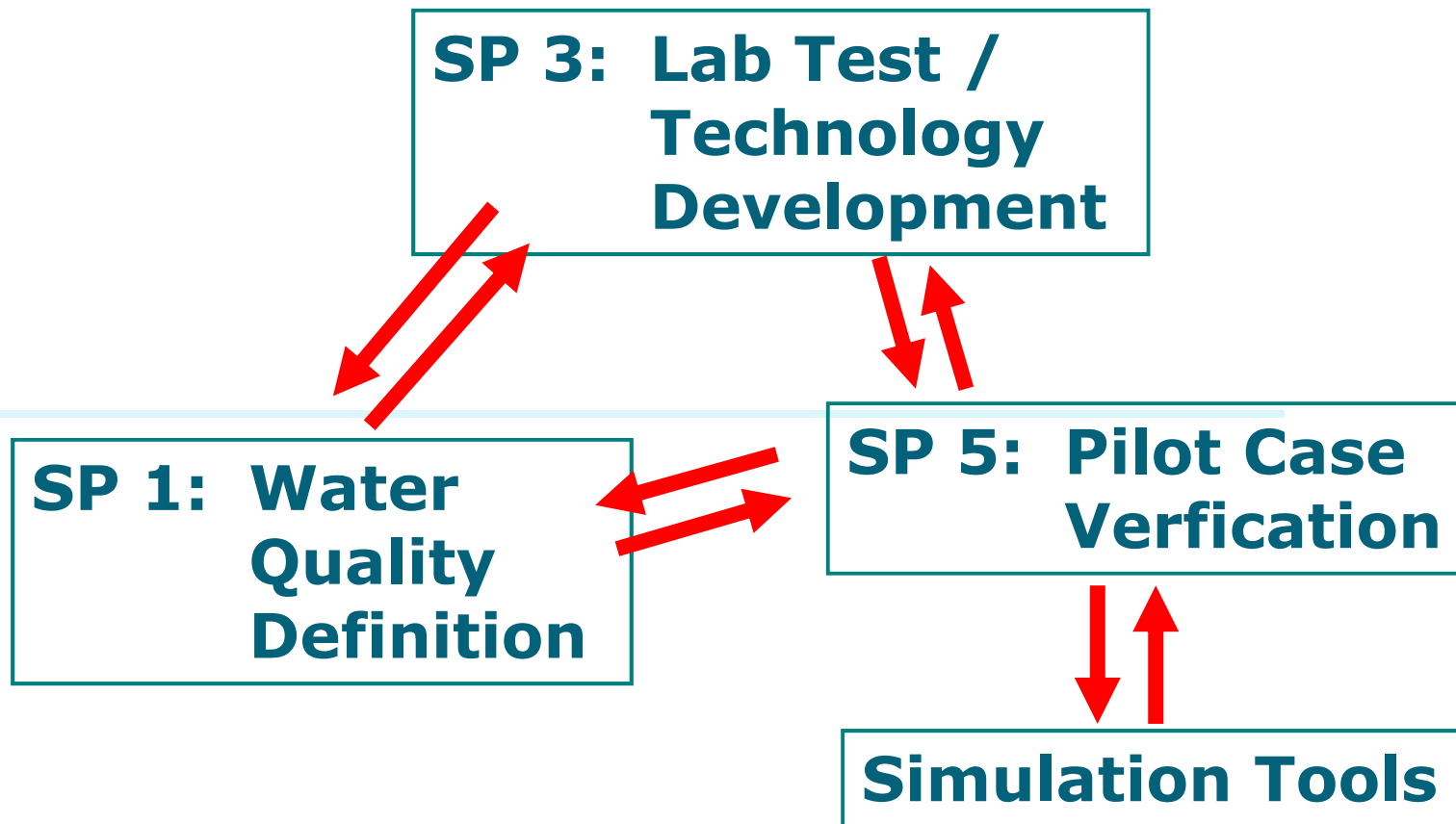
tCOD (mgO ₂ /L)	39
N-NH ₄ (mgN/L)	1,568
Na (mg/L)	6,01
Cl ⁻ (mg/L)	10,41
pH	6,7
T (°C)	25
C (μS/cm)	4,92



Lab test Results



Interactions





Conclusion

- Combination of treatment processes will be chosen according to water quality needs
 - Lab test results will be verified on pilot scale taking changes of influent water quality and process stability into account
 - Comprehensive mapping of water circuits and water qualities on practical level will be done
 - Cost assessment
- ⇒ Comprehensive strategies and guidelines for water reuse in paper industry



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