Onsite Wastewater Mega-Conference

Sunday, October 25 – Wednesday, October 28

The Westin Westminster, Westminster, Colorado

The views and opinions expressed in this presentation are those of the presenters and do not necessarily reflect the views, policies, or positions of NOWRA

Coupling laboratory experiments with in-situ investigations for the recognition of a new on-site sanitation technique

Case of the optimized vertical sand Filter (*new sizing*)

Abdel Lakel (CSTB)
Alexandre Decout (ATANC)

Parties involved in the study

Coordination

Scientific direction

Observers

Funders

Scientific and Technical Partners

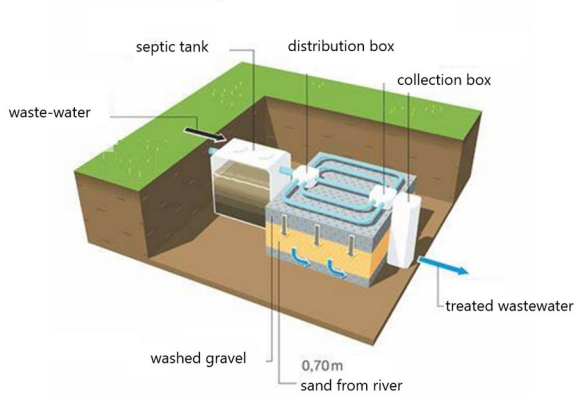
Onsite wastewater treatment plants

In France :

- 15 million people
- 90 000 installations /year

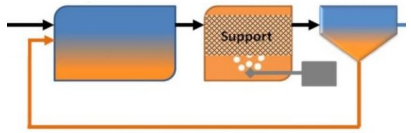


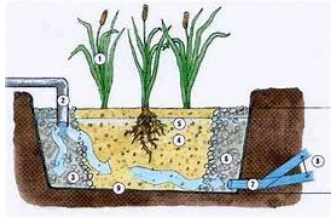
Vertical sand filters : 30 000 installations/year



Packaged wastewater treatment plants

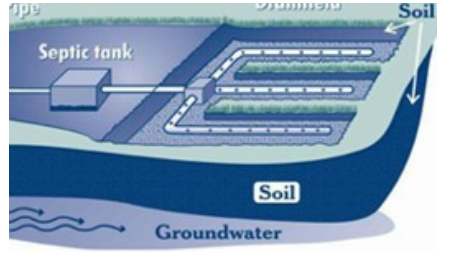






Constructed wetland

Soil infiltration



Study context and timeline

September 2017 : National public study ordered by ministries (2011 2014) : on-site investigations (246 installations)

80% of the systems studied failed to achieve their intended wastewater treatment performance.

ASSAINISSEMENT NON COLLECTIF
Le suivi *in situ* des installations de 2011 à 2016

October 2017 : Kick-off meeting for the study of a new sand filter project

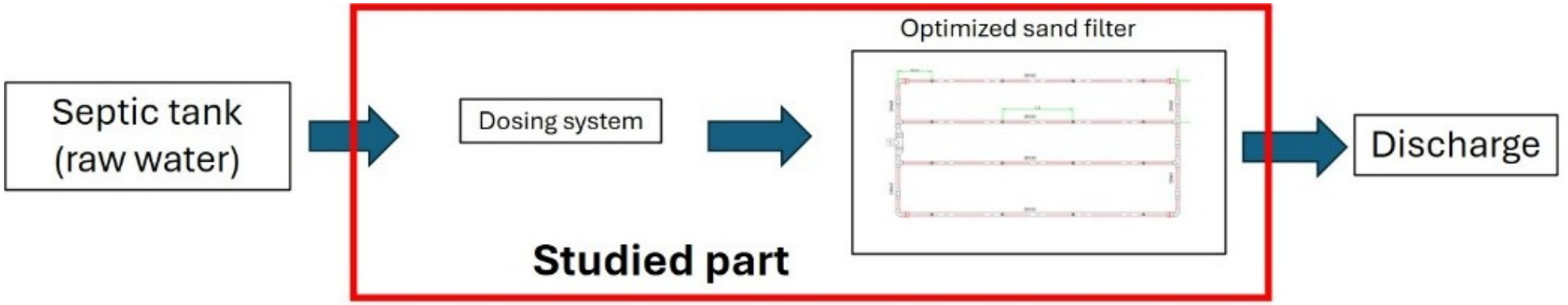
Since 2018 :

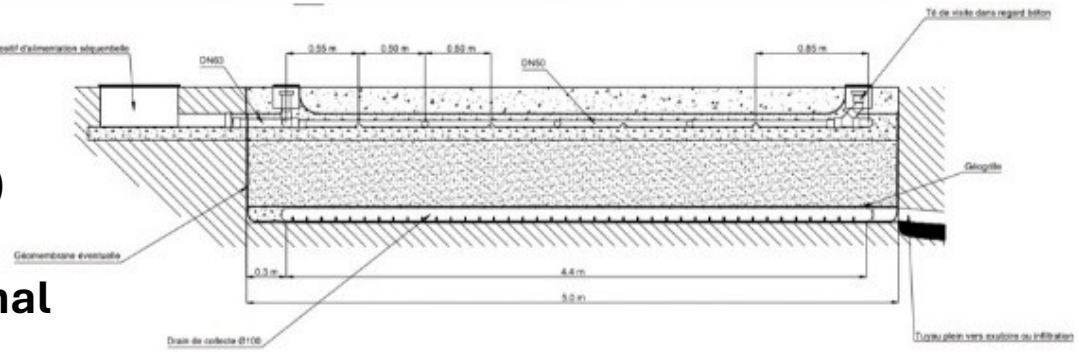
- Collaborative work on methodology, funding, technical specifications, sites selection for *in situ monitoring*
- Verification of the filter's wastewater treatment performance (*full-scale experimental platform under controlled real-world conditions*)
- *In situ* installations : validation of construction methods and assessment of real-world performance

Study context and timeline

- **October 2017** : Kick-off meeting for the study of a new sand filter project
- **2018** : Collaborative work : methodology, funding, conception, sites selection for *in situ m*onitoring
- **May 2019** : **Preliminary ministerial approval** to discuss revision of french réglementation contingent upon favorable study results
- **2020-2021** : **Full-scale pilot testing** (ANSES protocol), **extended to 2024**
- **Late 2021** : **On site installations** of filters and start of in situ monitoring
- **2023-2025** : **Completion of in situ** monitoring and drafting of technical specifications for new-generation sand filters.

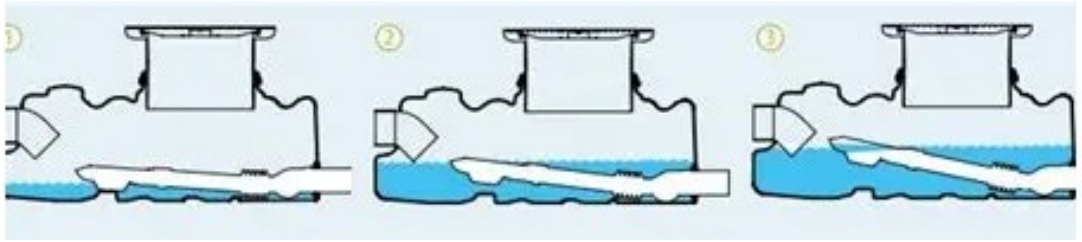
Description of the studied system





- **Surface : 3 m² / EH** (15 m² for single house (5 main rooms)
- **Height : 50 cm**
- **57% reduction in the quantity of sand used in a traditional sand filter**
- **Use of crushed sand for filtration**

Dosing system (manufactured product)



Quality of sands

Sand of first filter :

- D10 = 0.3 mm
- D60 = 1.3 mm
- Percentage of fines particles (size < 63 µm) < 3%
- Origine : from river

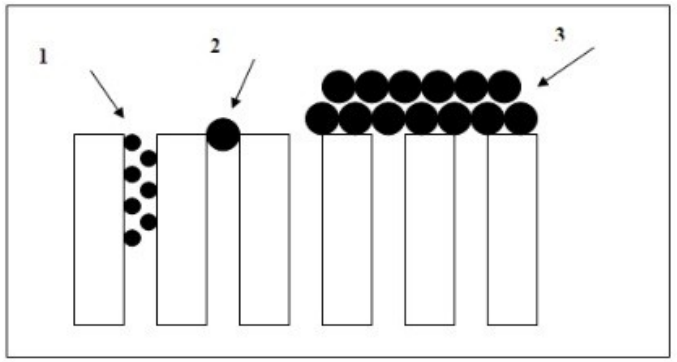
Sand of second filter :

- D10 = 0. 65 mm
- D60 = 2.9 mm
- Percentage of fines particles (size < 63 µm) < 3%
- Origine : crushed sand (sourced from a non-calcareous rock quarry)

Elements of the insaturated filtration phenomenology

Particulate matter (TSS)

Surface deposition & in-depth deposition

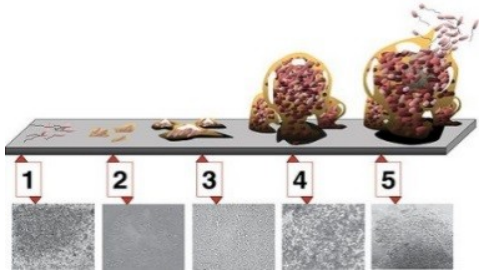


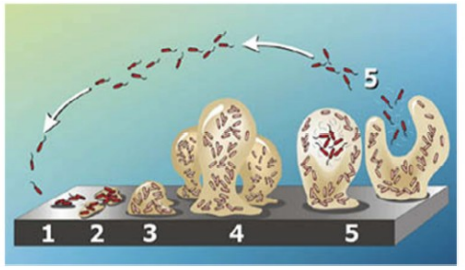
Sand particle size distribution controls :

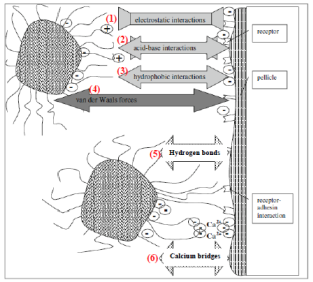
- porosity
- water content
- natural aeration

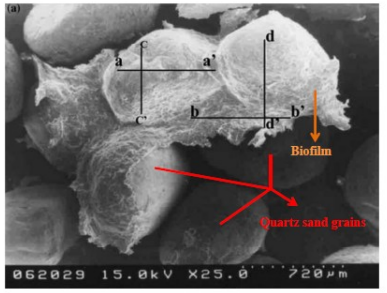
Dissolved pollution

Biofilm dynamics under unsaturated conditions









Full-scale experimental platform at full scale

Duration of experimental studies : 48 weeks (between 2020 and 2021), extended until 2024, representing an additional 1,000 days of operation

Raw wastewater characteristics

		Carbon pollutants		Nitrogen pollutants		Phosphorus
	TSS (mg/L)	COD (mg/O_2/L)	BOD_5 (mg/O_2/L)	KN (N-mg/L)	$NH4^+$ (N-mg/L)	Pt (P-mg/L)
Average	399	814	303	83	58	10
SD	115	203	79	18	15	2
Number of samples 84						

Production of septic effluent :

- From several septic tanks installed (5-day hydraulic retention time) fed with raw wastewater collected from a public sewer network

- Septic effluent conveyed by a pumping system to two filtration systems installed in parallel.

Daily hydraulic pattern and sequences program

Period		Percentage of the total daily volume
1	3 hours	30 %
2	3 hours	15 %
3	6 hours	0
4	2 hours	40 %
5	3 hours	15 %
6	7 hours	0
TOTAL	24 hours	100%

Programme : test duration : 48 semaines

- **Biomass establishment (100 %) :** 4 weeks
- **Nominal load (100 %) :** 30 weeks (2 power failures, on 1 day by failure**)**
- **Under load** : 2 x 2 weeks
- **Over Load :** 150 % : 2 weeks, 200 % : 4 weeks
- **Non – occupation :** 2 weeks
- **Non –occupation stress (load ony in the weekend) :** 2 weeks

Performances of new sand filters

		TSS (mg/L)	COD (mgO_2/L)	BOD_5 (mgO_2/L)	NTK (N-mg/L)	NH4+ (N-mg/L)
Filter 1	Average	6	47	4,5	19	16
	SD	3,2	10,3	1,9	10,3	8,8
Filter 2	Average	5,5	47	3	18,5	16
	SD	2,6	11,5	2,3	10,6	9,1
		Number of samples : 84				

Performance of traditionnal vertical sand filter *for comparison*

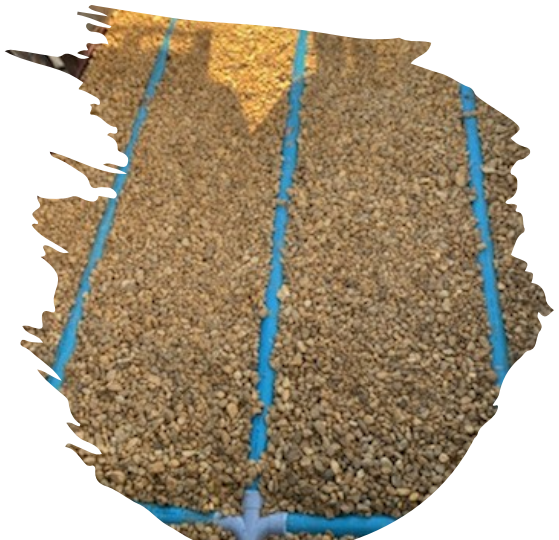
	TSS (mg/)	COD (mg O_2/L)	BOD_5 (mgO_2/L)	NTK (mg N/L)	$N\text{-}NH_4^+$ (mg N/L)	$N\text{-}NO_3^-$ (mg N/L)	$N\text{-}NO_2^-$ (mg N/L)	P-t (mg P/L)
average	6	43	4	10	12	38	1	4
SD	6	22	2	9	10	15	2	2
Value +	53	180	15	47	54	100	9,3	17,4
Value -	1	20	3	2	1	0,2	0,0	1,4

- **38-month** full-scale investigation
- Septic tank volume : 3 m³
- 25 m² filtration area with 70 cm-deep silica sand bed.
- A hydraulic loading rate of 150 $L \cdot PE^{-1} \cdot d^{-1}$

Installation of new sand filters in private residences and in-situ monitoring

Experience from field Implementation

Country	Sites analyzed	Rounded sand (sillicious) from river	Crushed sand	Hydraulic dosing system
Loire Atlantique	4	2	2	4 flush dosing systems
Dordogne	2	2	0	2 pumps
Charentes	2	2	0	1 pump 1 flush dosing system







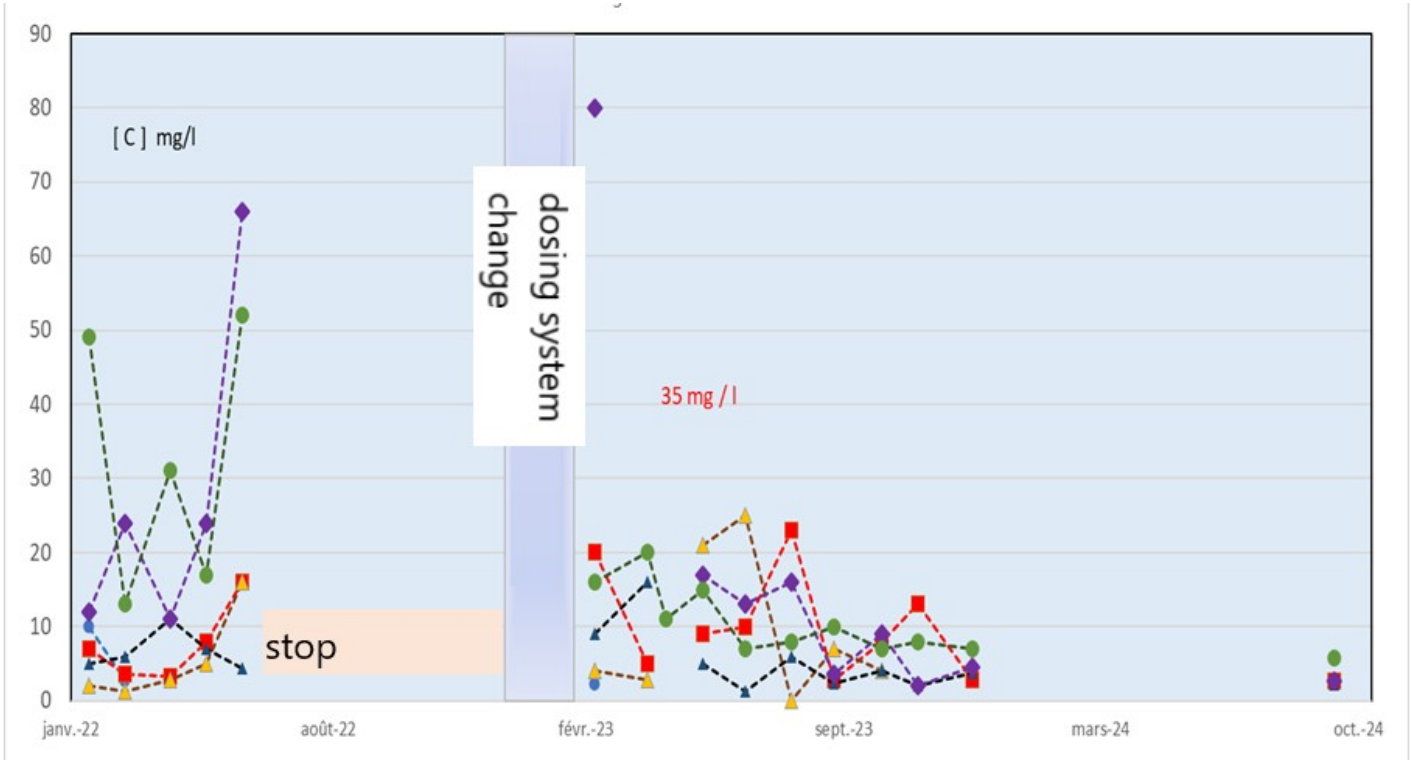
Observations of new sand filter installations

- ✓ Construction similar with conventional vertical sand filter but faster
- ✓ **Poor performance of hydraulic flushes: further characterization is required**.
- ✓ Easy implementation by manufacturers after appropriate training
- ✓ High homeowner satisfaction due to limited maintenance needs.
- ✓ Need to carefully verify the supply of sand delivered to the construction site.

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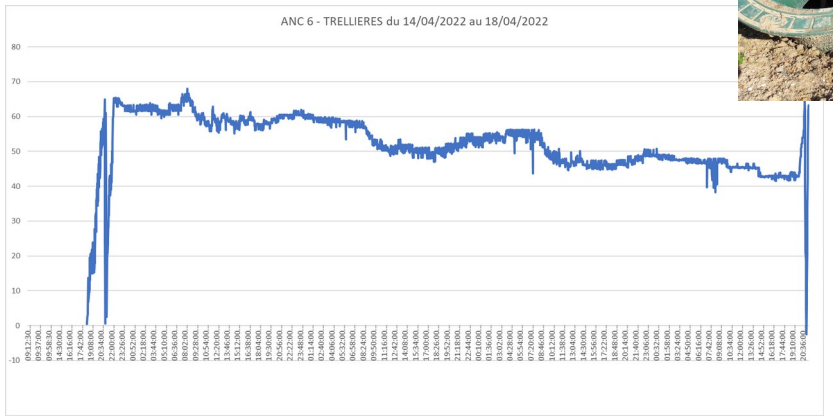
Results of the in-situ monitoring of the new sand filters installations

Example of effet of defective hydraulic dosing device



Example of effet of defective hydraulic dosing device

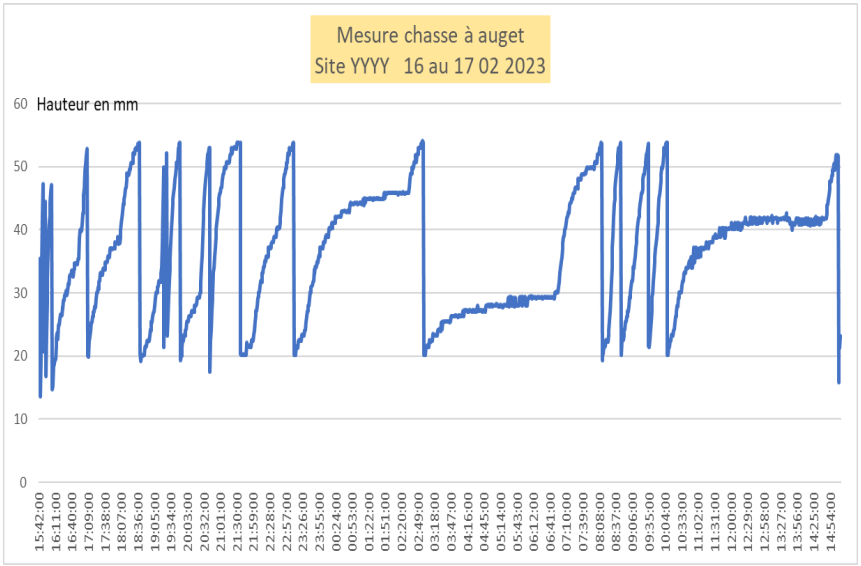




Before

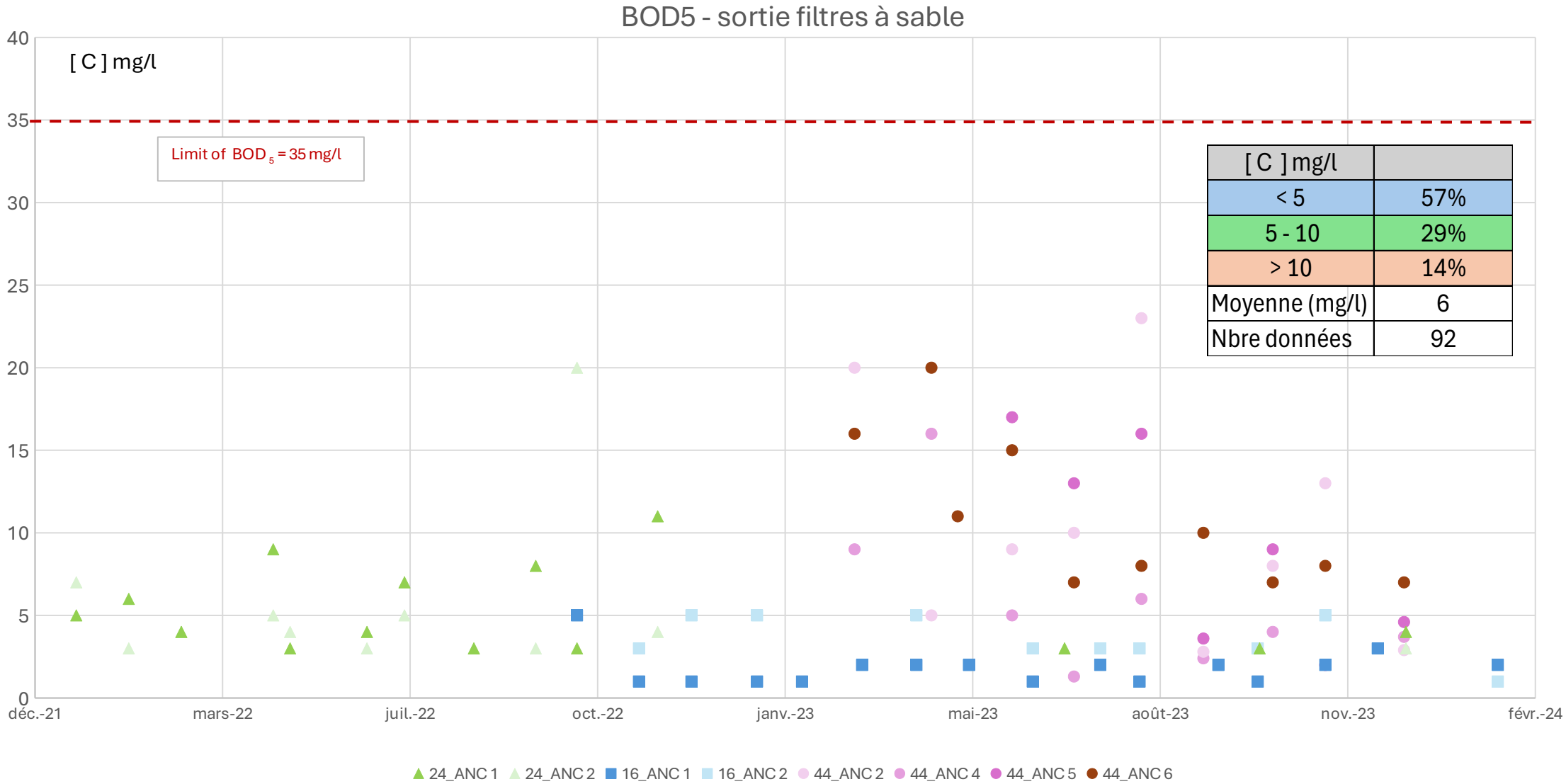
Replacement new flushing device





After

In situ monitoring



[C] mg/l	
< 5	57%
5 - 10	29%
> 10	14%
Moyenne (mg/l)	6
Nbre données	92

Review of Previous Studies

	TSS (mg/)	COD (mg O_2/L)	BOD_5 (mgO_2/L)	NTK (mg N/L)	N-NH_4^+ (mg N/L)	N-NO_3^- (mg N/L)	N-NO_2^- (mg N/L)	N-NO3- + N-NO2- (mg N/L)	P-total (mg P/L)
average	6	43	4	10	12	38	1	39	4
SD	6	22	2	9	10	15	2	15	2
Value +	53	180	15	47	54	100	9,3	100,4	17,4
Value -	1	20	3	2	1	0,2	0,0	0,2	1,4

Performance of a traditional vertical sand filter on a Full-Scale Test Platform over 4.5 years under demanding operating Conditions (CSTB Study).

Field monitoring of traditional vertical sand (INRAE)

- BOD_5 : 6 mgO_2/L
- COD : 48 mg O_2/L
- TSS :13 mg/L
- TKN : 31 N-mg/L
- Ammonium nitrogen : 27 N-mg/L
- Nitrate nitrogen : 51 N-mg/L
- Total phosphorus : 6.5 mgP/L
- Microbiological (indicator microorganisms) : 2 to 3 log units reductions

ANSES test platform versus in situ monitoring

Test platform	TSS	COD	BOD	KN	NH_4^+
Filter 1 (average of 24-hour samples)	6.1	47,3	4,5	19	16,3
Filter 2 (average of grab samples)	5.5	47	3,4	18,5	15,7

Goog installations (on-sites)	TSS	COD	BOD	KN	NH_4^+
Average of 24-hour samples	3.9	45.4	3.1	8.9	8.2
Average of grab samples	3.2	48.3	3.7	8.3	7.6

Installation defects (on-sites)	TSS	COD	BOD	KN	NH_4^+
Average of 24-hour samples	19.3	79.5	10.3	51.3	48.7
Average of grab samples	21.1	80.4	13.3	48.6	45.4

Faulty flushing system (on-sites)	TSS	COD	BOD	KN	NH_4^+
Average of 24-hour samples	50.5	224.1	82.7	81	77.2
Average of grab samples	56	242.3	95	81.5	78

ANSES test platform vs. in situ monitoring

- ✓ Comparable results between the test platform and in situ monitoring.
- ✓ Over-deep installation (50-60 cm instead of 20 cm): BOD_5 and TSS performance maintained below threshold values.
- ✓ Reduced nitrification performance, consistent with observations from conventional sand filters, due to the greater sensitivity of autotrophic bacteria.
- ✓ Hydraulic flushing device malfunction: significant performance loss (above thresholds); *performance recovered following replacement of the commercial device.*

Lessons Learned from the Overall Approach

Lessons Learned from the Overall Approach

- ✓ Test-platform and in situ studies : complementary and inseparable
- ✓ Intermittent loading : essential for proper filter performance.
- ✓ Observed installation defects did not adversely affect effluent quality
- ✓ The system is easy for contractors to install correctly
- ✓ High resilience following prolonged hydraulic flushing malfunction
- ✓ Annual inspection of hydraulic flushing devices is recommended.

The study confirmed satisfactory performance for drained 5- and 6-PE systems.

Current and Upcoming Milestones

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✓ **Regulatory Integration**

Discussions with the Ministries in charge of Health and the Environment regarding the integration of the new sand filter into the French technical regulation

✓ **Dissemination of Results**

✓ **Adoption by the Construction Sector**

Engagement with the French Construction Quality Agency (AQC) to support the inclusion of the technology in professional guidelines, leading to its recognition as a conventional building technique.

This study enabled the definition and refinement of the design, construction and operational requirements of the system throughout the programme. In addition, a draft operational guideline was developed to facilitate its recognition and uptake by insurers and professional construction organisations.

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Thank you