

National Workshop on Small-Scale Sanitation Systems

**A Roadmap for Small-Scale STPs in India:
Fulfilling their Potential for Healthy and Water-Secure Cities**

**Performance of systems :
Evaluation Results**

Presented by:

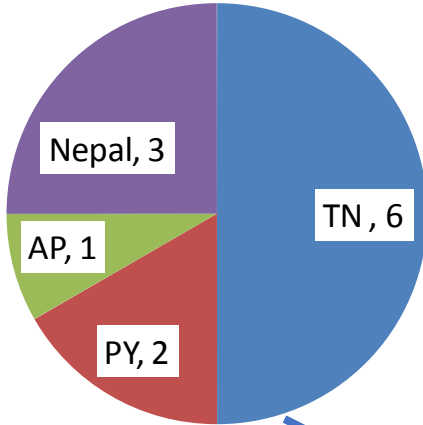
Prof. Ligy Philip
IIT Madras

Table: Classification of Key Small-Scale Sanitation Technology families

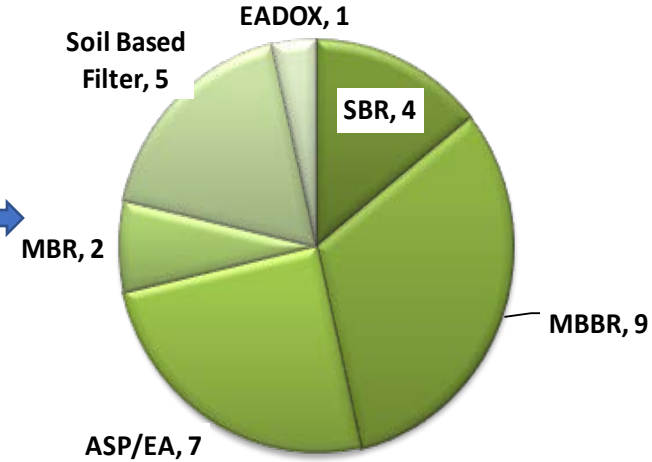
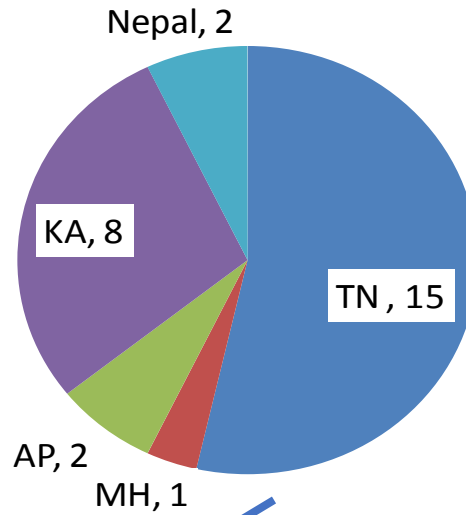
Technology Family	Examples
Suspended Growth Processes	Conventional Activated Sludge Process(ASP), Extended Aeration(EA), Oxidation Ditch, Sequencing Batch Reactor (SBR), Membrane Bioreactor(MBR)
Attached Growth Processes	Moving Bed Biofilm Reactor (MBBR), Submerged Aerated Fixed Film Reactor(SAFF), Rotating Biological Contactor (RBC)
Anaerobic Baffled Reactor (ABR) Bases Systems	DEWATS, DTS
Constructed Wetlands and Soil Filtration Systems	Horizontal-Flow, Vertical-Flow and Hybrid Constructed Wetlands, CAMUS-SBT, SIBF, Phytorid, SPISF
Other Systems	CAACO/FICCO, EADOx, Pond Systems, DRDO Biodigester

In-depth Sampling

ABR Based Systems



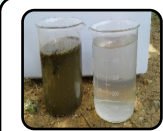
Other treatment systems



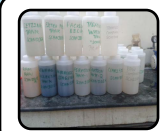
Collecting Inlet sample at every 2 hours



Collection of treated sample at every 2 hours



Comparison of inlet and outlet



Complete treatment units sampling at 8pm

$$V = \frac{Q_n}{\varepsilon Q_n} \times \nabla$$

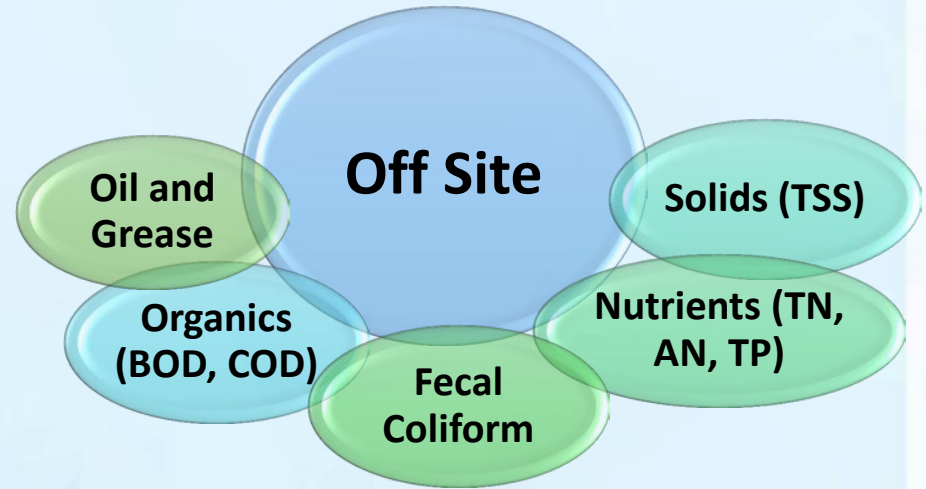
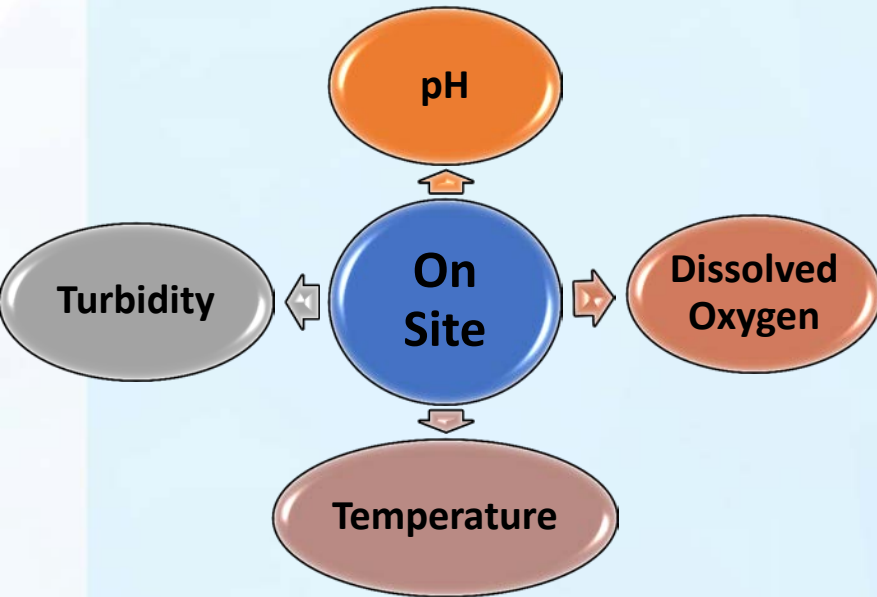
Composite sampling



Grab sampling



Parameter analyzed



HACH on-filed kits

SELVAPUR A
BALAJI M

CENTRAL SOUTH PARK - SHOLTNDAI LUR
(1-8-2017 - 2-8-2017) 2nd Round

Duration Hour (12 hr format)	Onsite observation-Inlet									
	pH	Temp (°C)	DO (mg/L)	Turbidi- ty (NTU)	Flow volume (ml/min)	Flow Volume (liters)	Colour	Smell	Visible solids	Other remarks
10:00 AM	7.51	32.5	0.15	212	-	5.81	Dark colour	odour	yes	-
12:00 AM	7.69	32.2	0.12	216	-	5.81	"	odour	NO	Soap water may be
02:00 PM	7.77	32.2	0.11	207	-	5.70	"	odour	NO	-
04:00 PM	7.63	32.4	0.16	218	-	5.31	"	odour	NO	-
06:00 PM	7.80	31.9	0.11	233	-	5.63	"	odour	NO	-
08:00 PM	7.81	31.8	0.13	246	-	5.58	"	odour	NO	-
10:00 PM	8.02	31.7	0.15	251	-	5.56	"	"	"	-
12:00 AM	3+3							no flow		
02:00 AM	8.09	30.9	0.13	241	-	5.57	"	odour	NO	
04:00 AM	8.11	31.4	0.21	243	-	5.20	"	"	"	
06:00 AM	8.17	31.2	0.18	249	-	4.90	"	"	"	
08:00 AM	8.21	31.2	0.23	251	-	5.50	"	"	"	

Other interesting observations: RWCT: 7.86 DO: 0.11 Temp: 31.8 Turbidity: 208
 AT₁: 8.11 2.18 32.6 223
 AT₂: 8.26 5.56 32.7 210

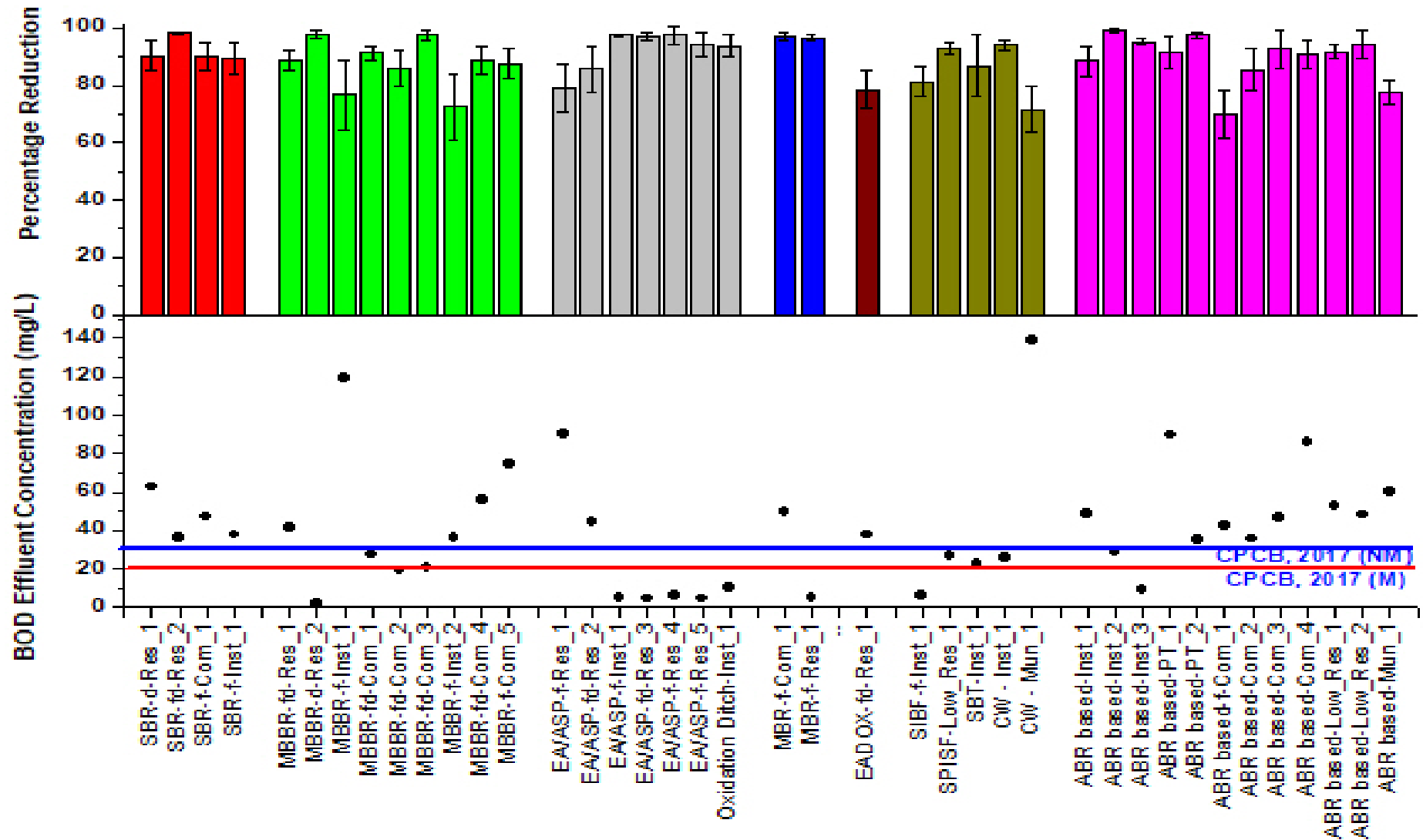
R.C = 7.29 SET: 8.12 1.22 31.9 18.36
 T.C = 8.31 FFT: 8.17 3.68 32.1 47.36
 P.S.F.C.F: Same as 8pm Treated

Hot climate
 Rainy
 NO Rain

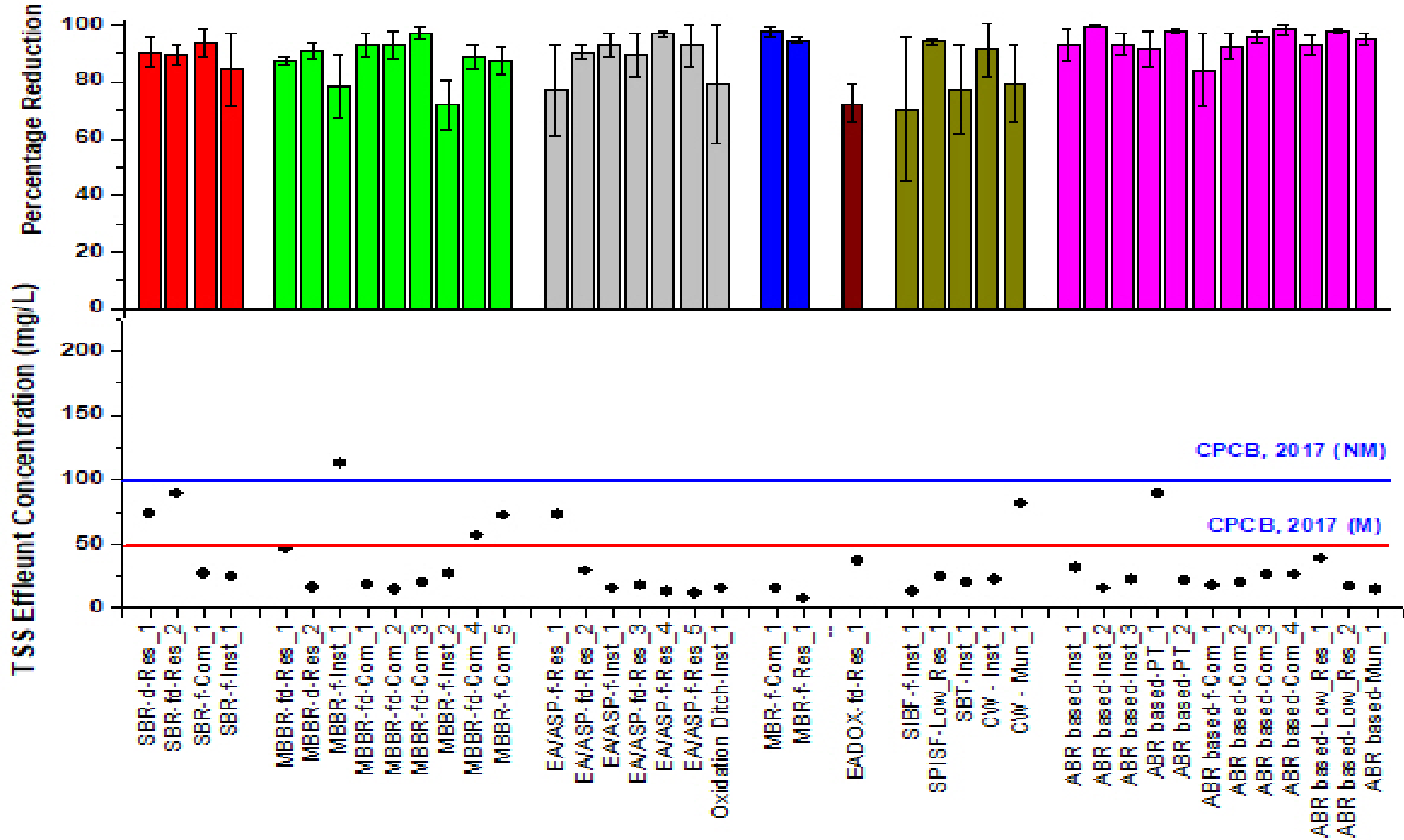
no issues in sight
 Major problem is
 "Odour" more in
 Treated water
 How to rectify it.
 may use treated water for
 flushing and gates

Factsheet

Overall Performance – Biochemical oxygen demand



Overall Performance – Total suspended solids



Removal of Organics and Suspended solids

SBR and MBBR showed removal efficiency of **90-92%** for BOD and **88-90%** for COD

ABR based systems showed a removal efficiency of **60-96%** for COD and **70-98%** for BOD.

Suspended solids concentration in the treated water **are meeting the standard limit** (CPCB, 2017) for the following sites;

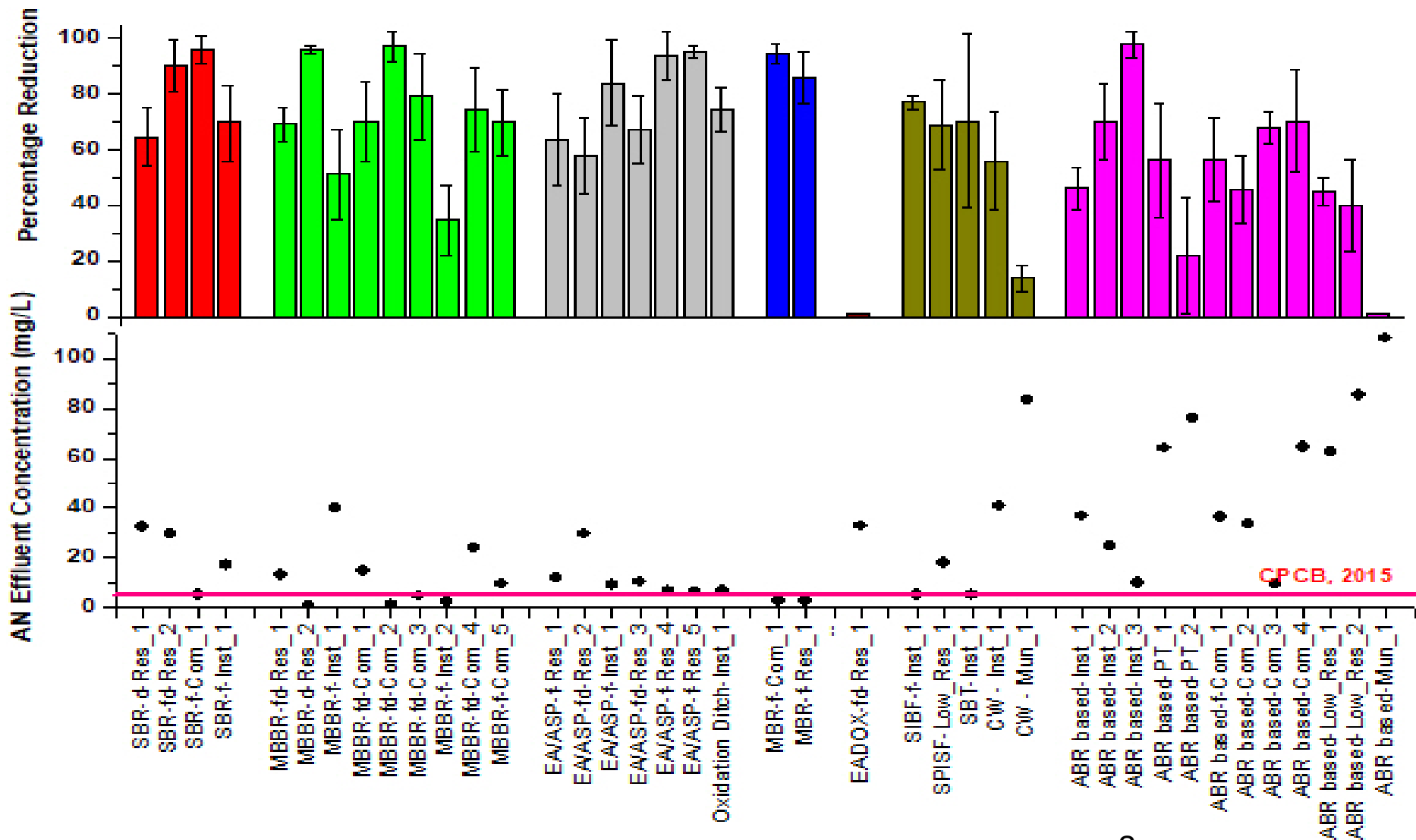
MBBR in commercial complexes,

MBR in commercial complex,

SIBF in institute

ABR based systems in institutes and residential_2

Overall Performance – Ammoniacal Nitrogen



Removal of Ammoniacal Nitrogen

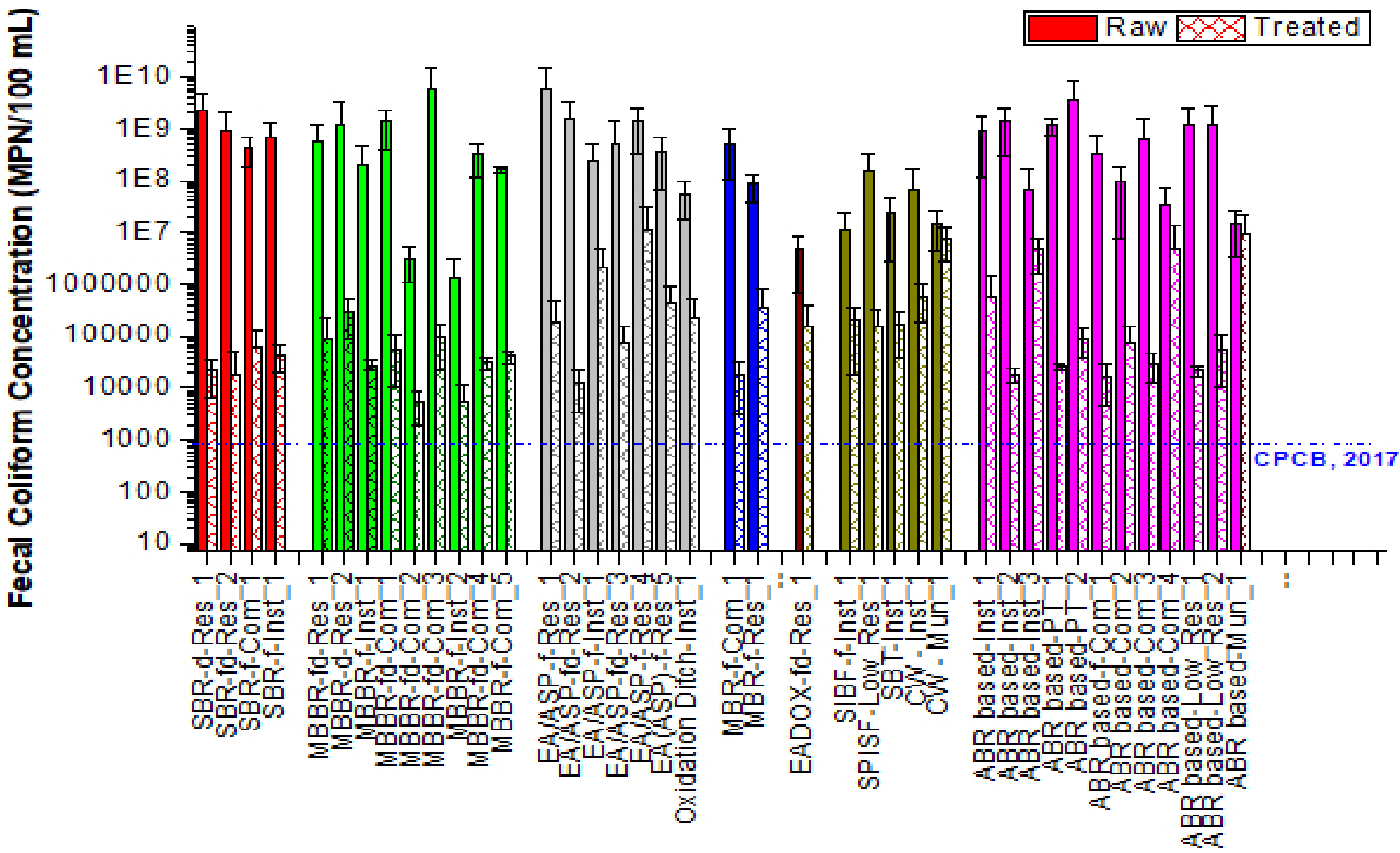
Nutrients removal from wastewater takes place by two processes; namely assimilation and dissimilation i.e., **nitrification and denitrification**

It was seen that amongst the 40 treatment systems evaluated, the maximum nutrients removal and meeting the standard limit ($<5 \text{ mg/L}$ – CPCB 2015) was seen for the

- **MBBR in commercial_2**
- **MBBR-CAACO in commercial and institute building,**
- **MBR in commercial complex and**
- **SIBF in Institute**

The **least removal** of AN was seen for the **ABR based unit operated in public toilet_1.**

Overall Performance – Fecal Coliform



Removal of Fecal coliform

4 to 5 log reduction of the fecal coliform in the **SBR and MBBR system**

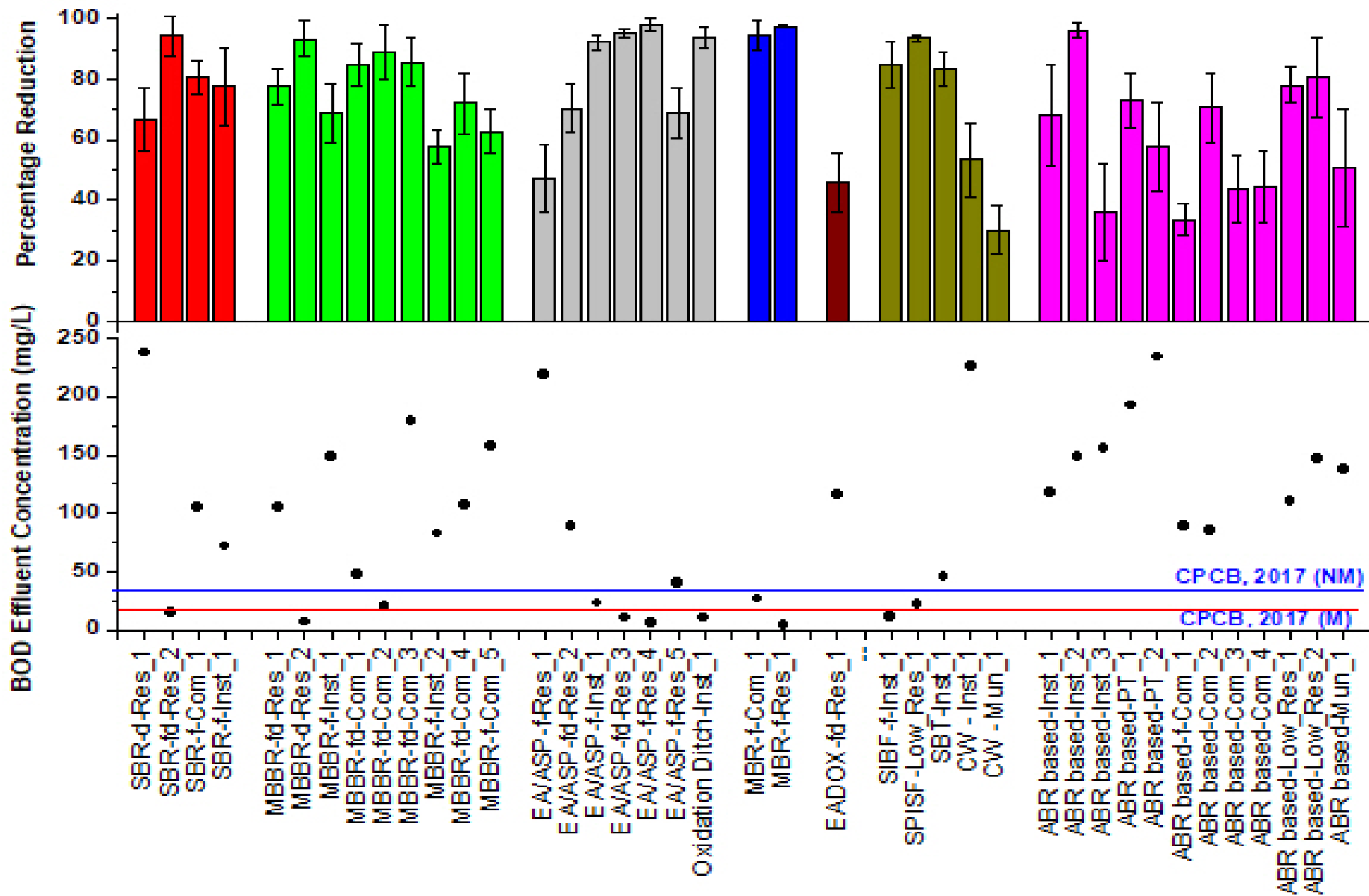
MBBR systems where the **operation and maintenance was not proper**, a **low FC removal** was observed.

Amongst the **ABR based units**, **better performance** was observed for the unit operated in **Institute_2** with **5 log reduction**.

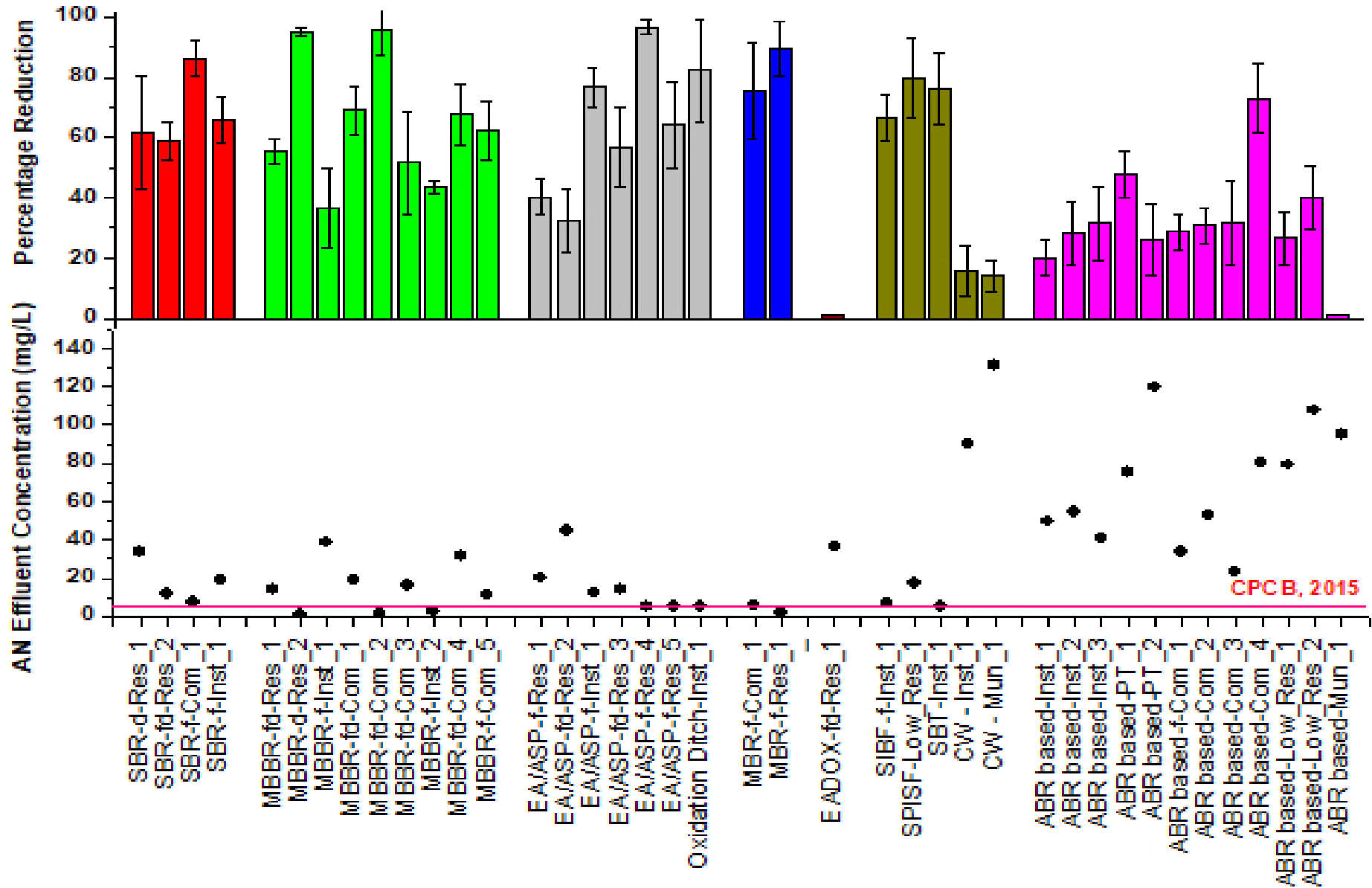
Higher coliform reduction was observed in places where **chlorination** was proper.

None of the treatment systems was able to meet the **CPCB, 2017 standard limit (1000 MPN/ 100 mL)**.

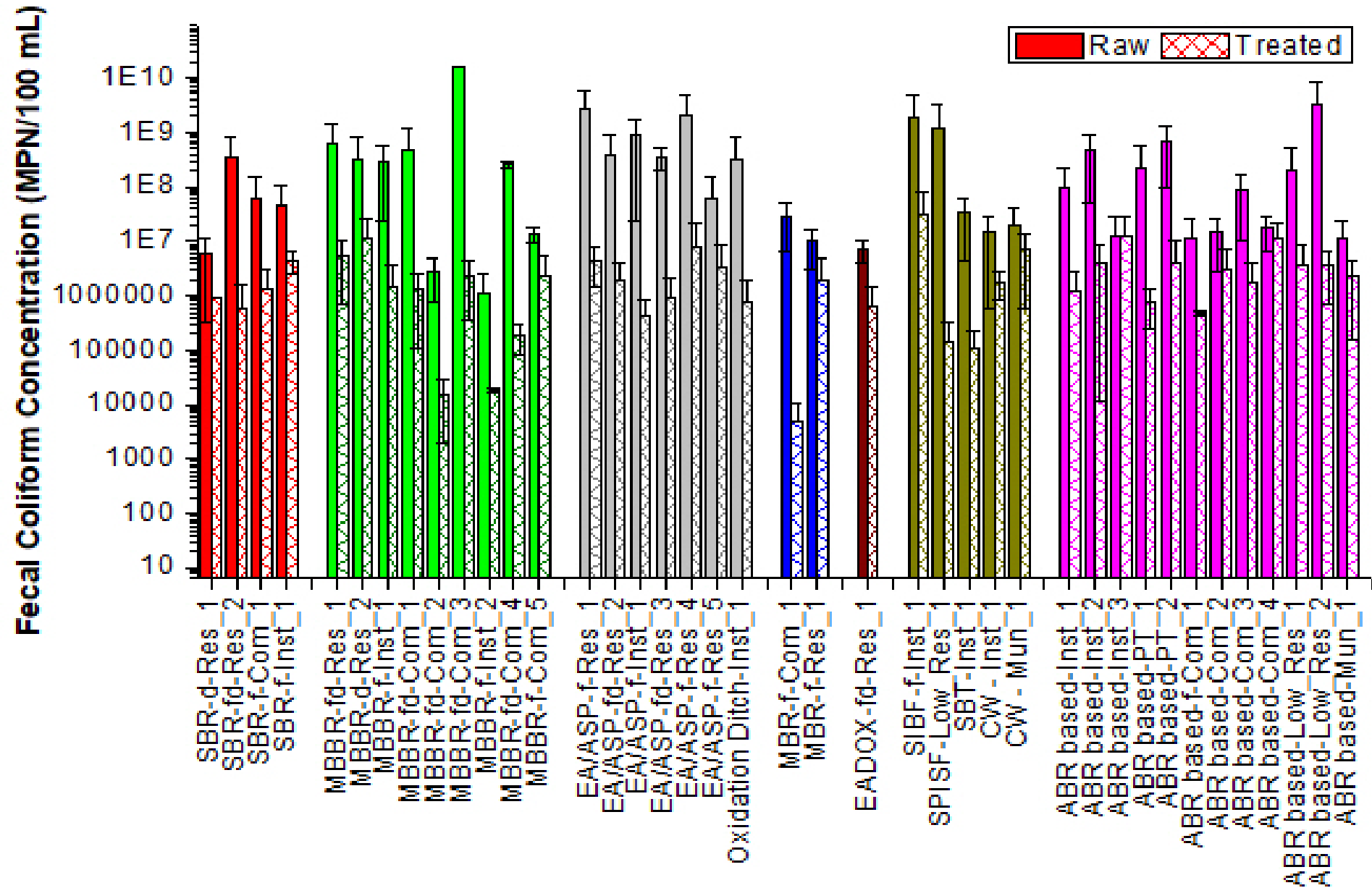
Performance of Biological unit – BOD



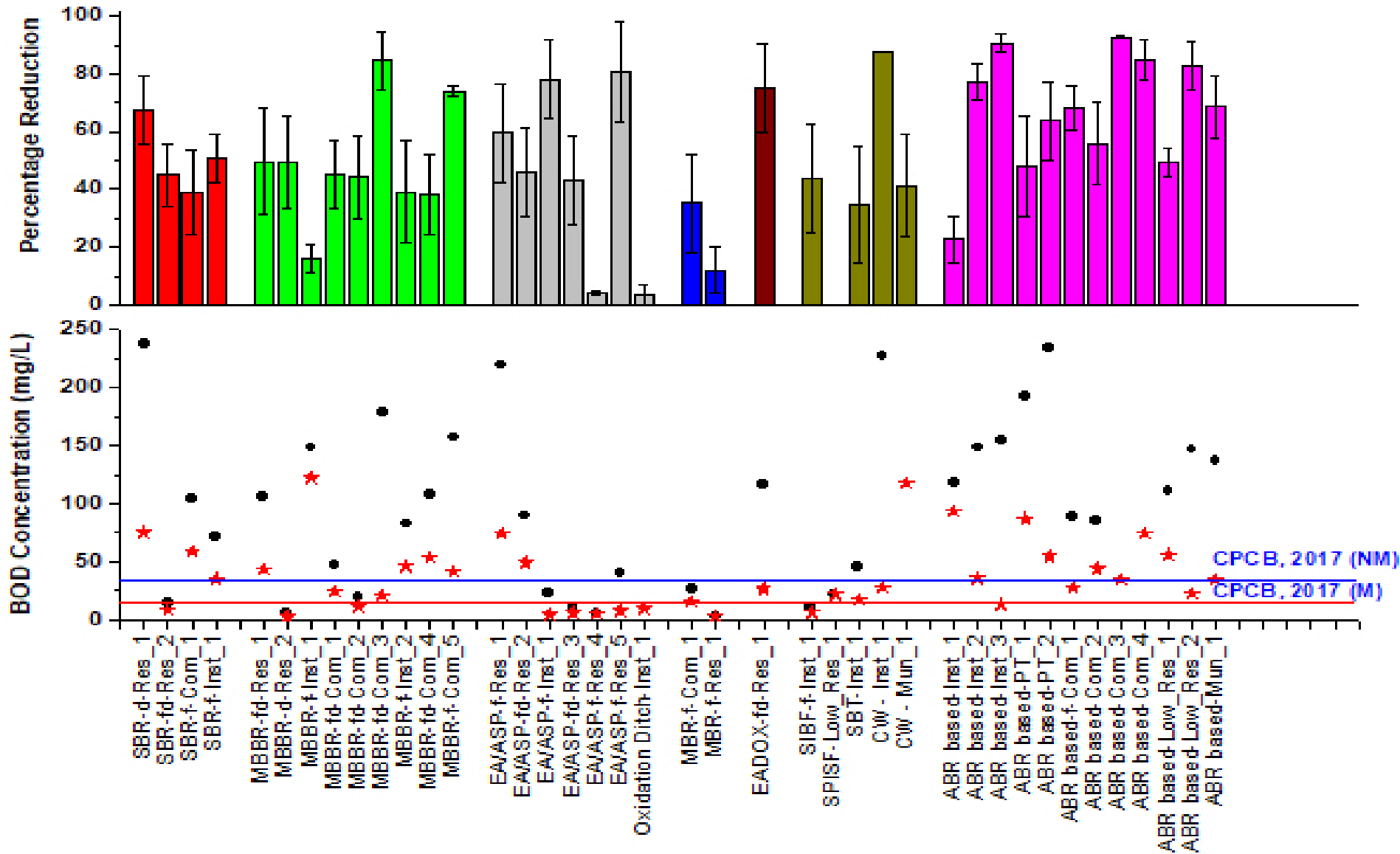
Performance of Biological unit – AN



Performance of Biological unit – FC



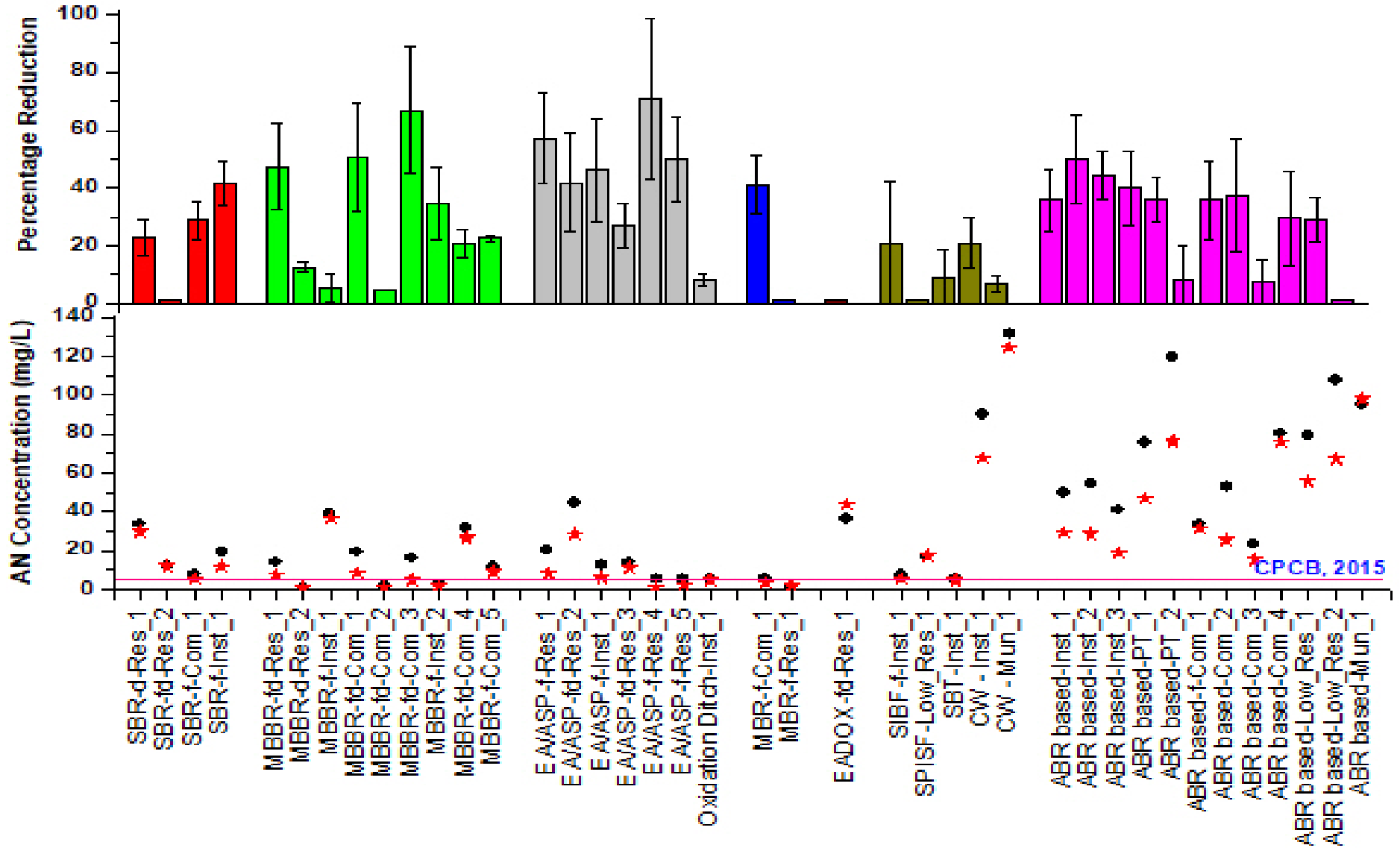
Performance of tertiary unit – BOD



● Effluent concentration after Biological Unit

★ Effluent concentration after tertiary unit

Performance of tertiary unit – AN

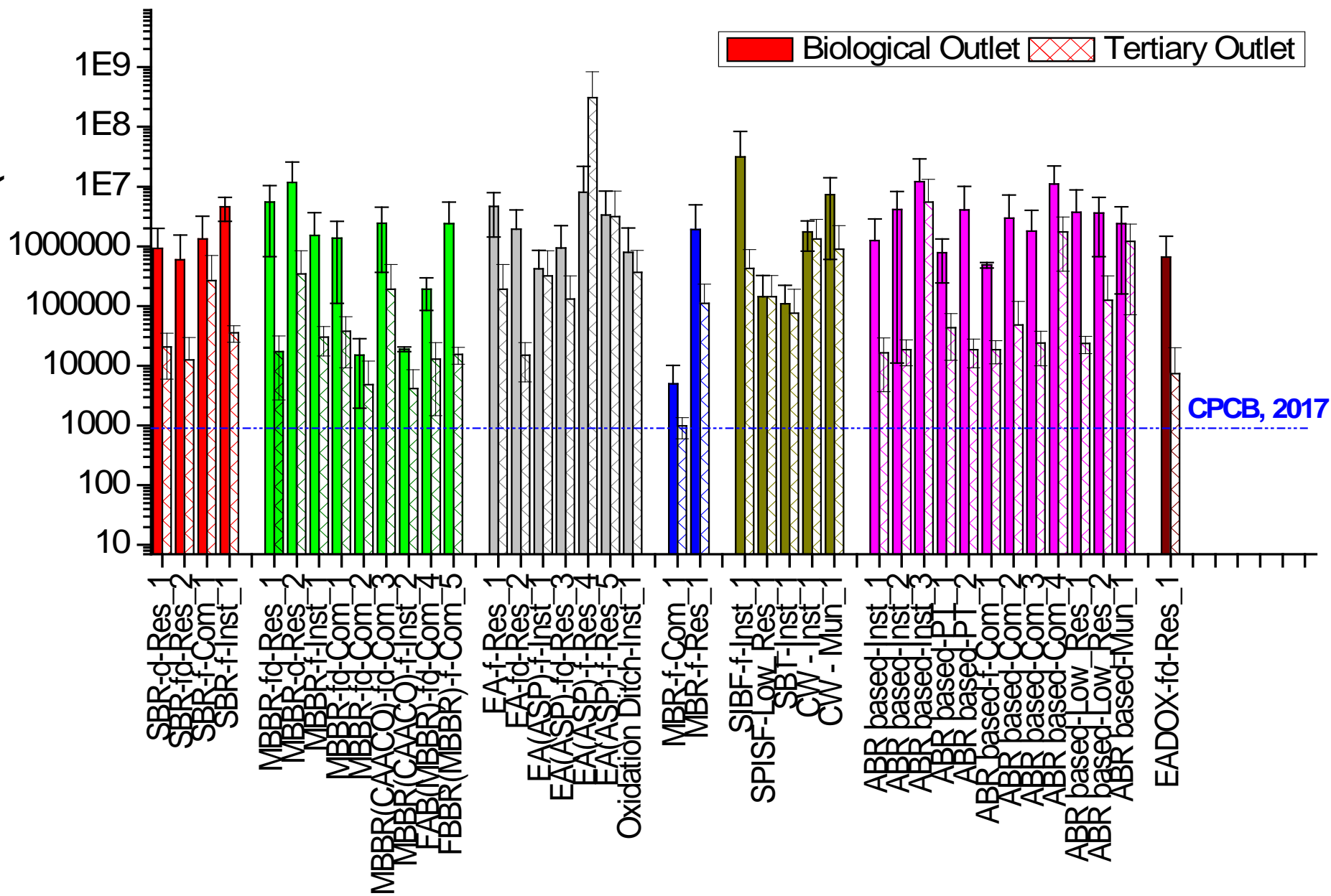


CPCB, 2015

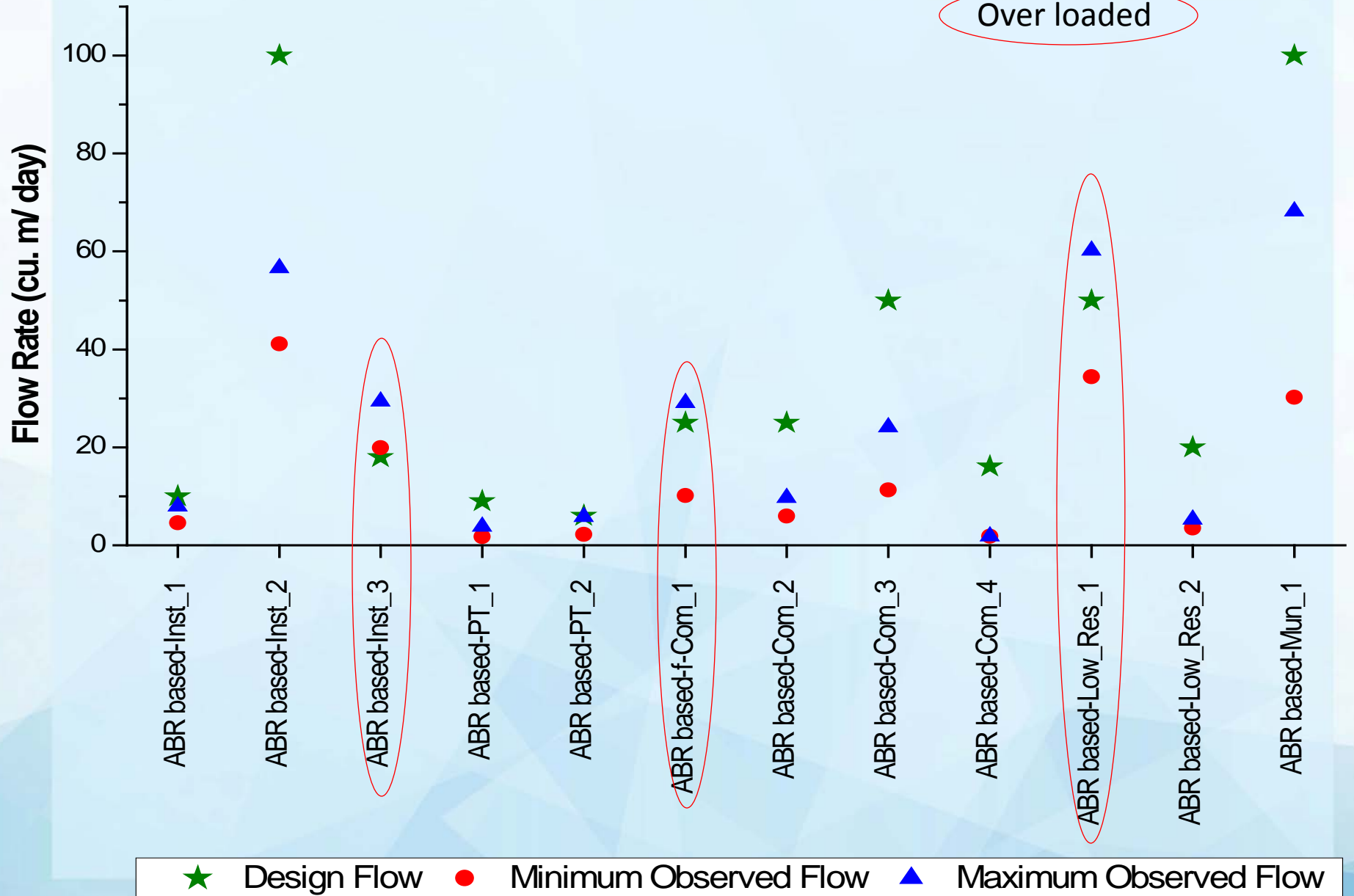
● Effluent concentration after Biological Unit ★ Effluent concentration after tertiary unit

Performance of tertiary unit – FC

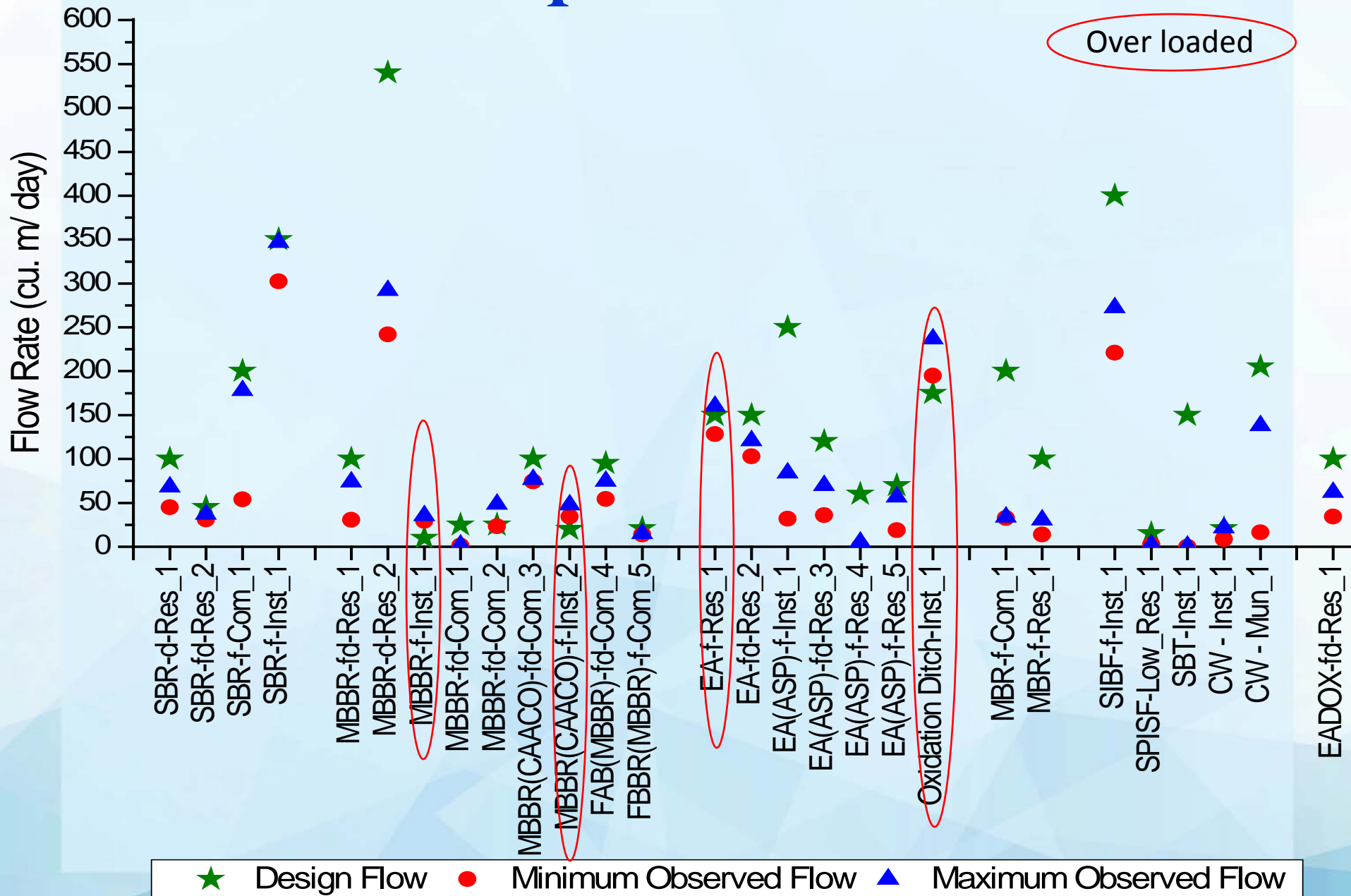
Fecal Coliform Concentration (MPN/100 mL)



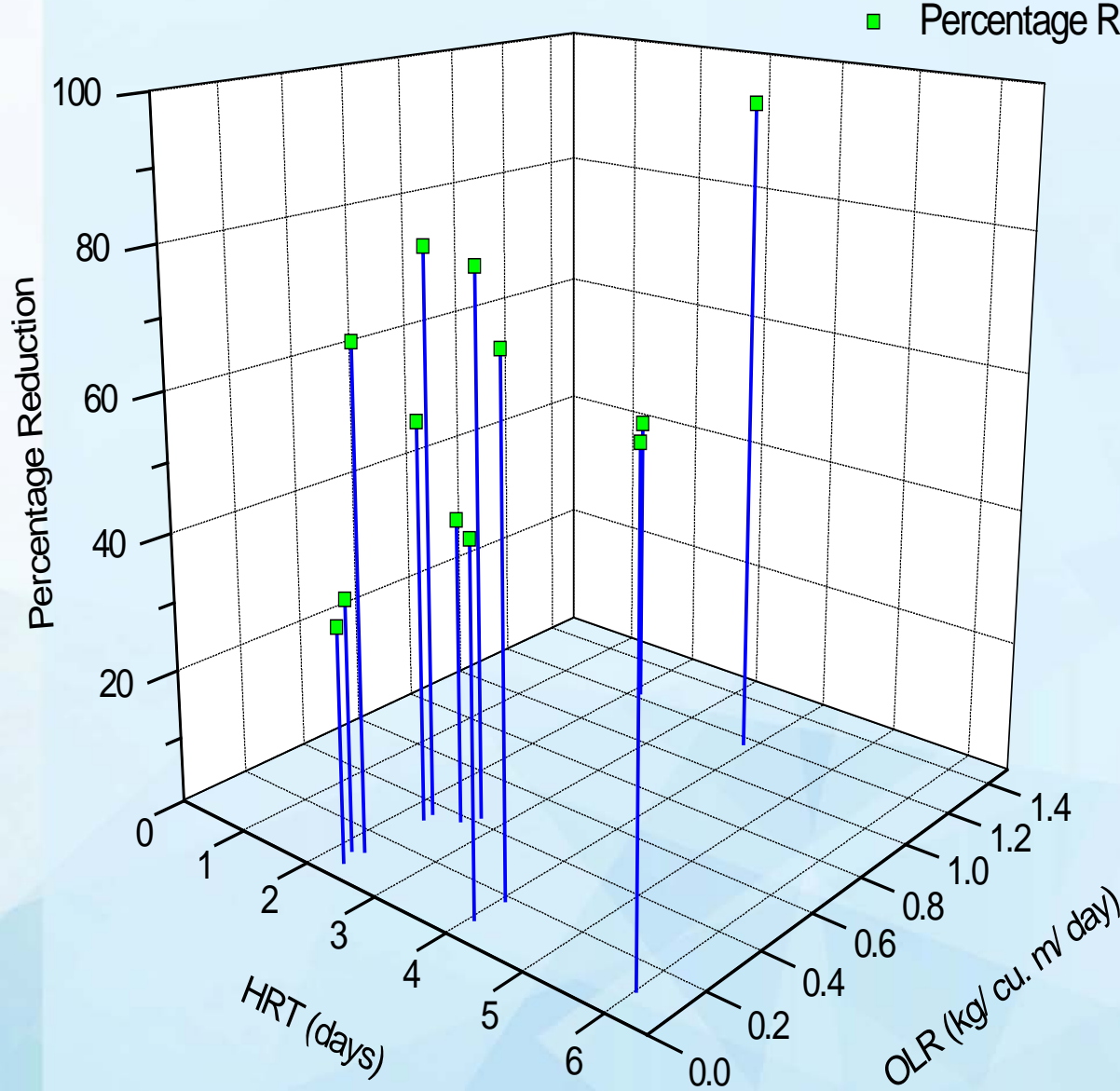
Treatment Capacities – ABR based



Treatment Capacities – Other SSTs



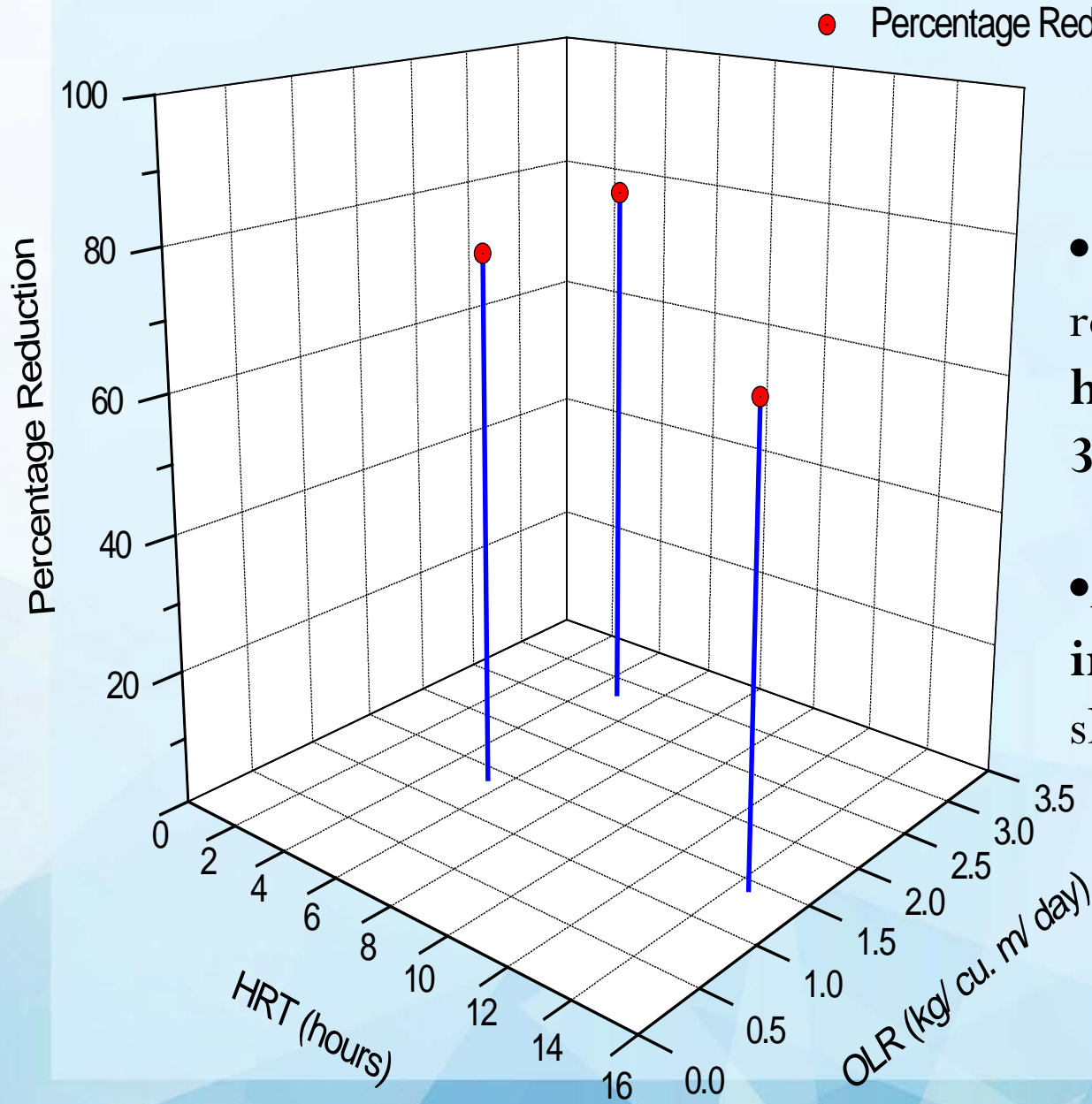
DESIGN CRITERIA – ABR Based system



Major Findings

- ABR showed better removal at HRT of 2 – 4 days and at OLR of 0.4-1.2 kg/cu. m/ day.
- HRT and OLR increases – Showed better removal

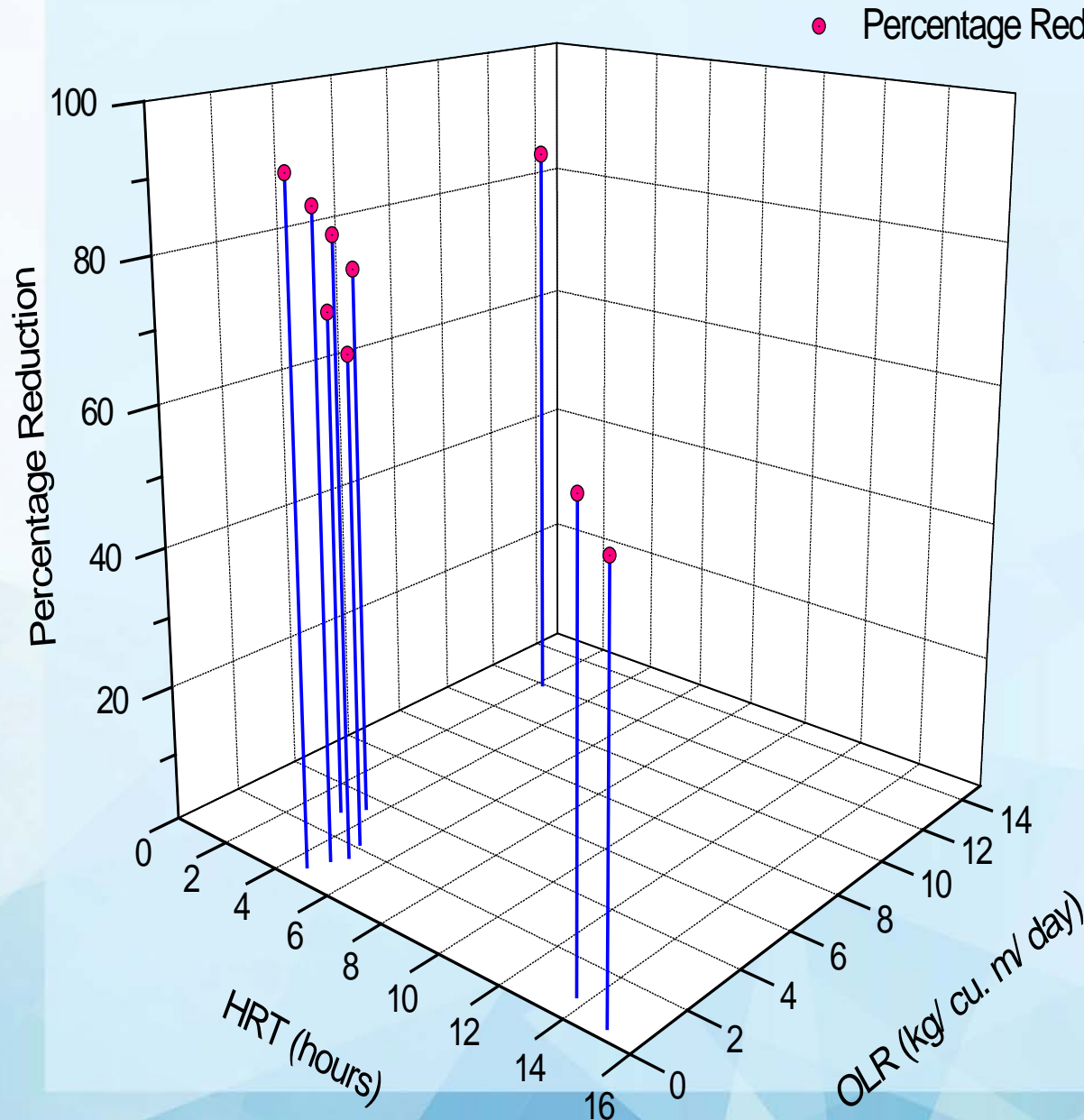
DESIGN CRITERIA – SBR Based system



Major Findings

- SBR showed **better** removal at **HRT** of 4-6 **hours** and at **OLR** of 1.4-3.0 **kg/cu. m/ day**.
- At **same HRT** as **OLR increases** – SBR showed slightly **better** removal

DESIGN CRITERIA – MBBR Based system

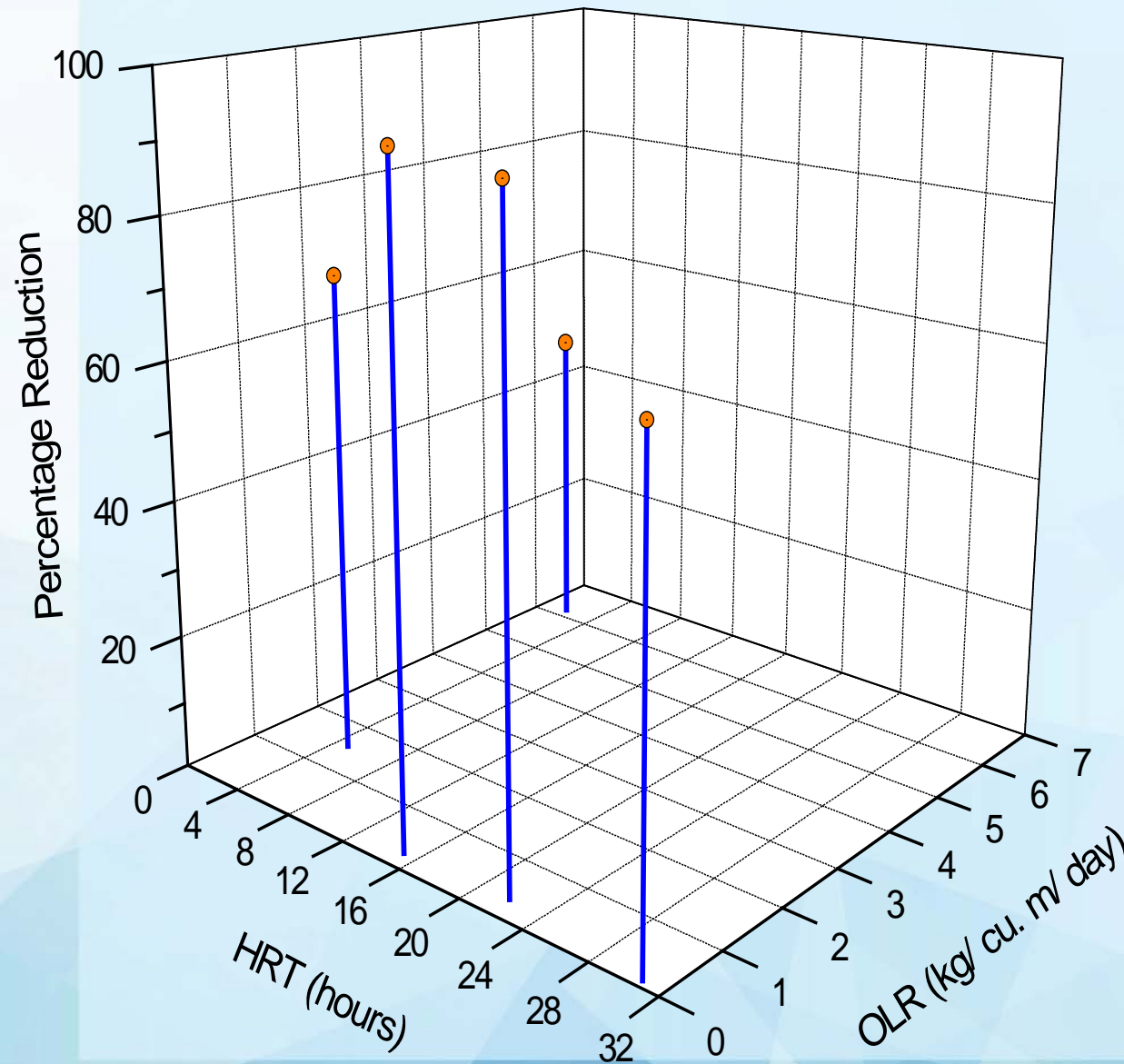


Major Findings

- MBBR showed **better** removal at **HRT** of 4-6 **hours** and at **OLR** of 1.0-3.0 **kg/cu. m/ day**.
- At **same HRT** as **OLR** **increases** – MBBR showed slightly **better** removal

Design criteria – EA/ASP based system

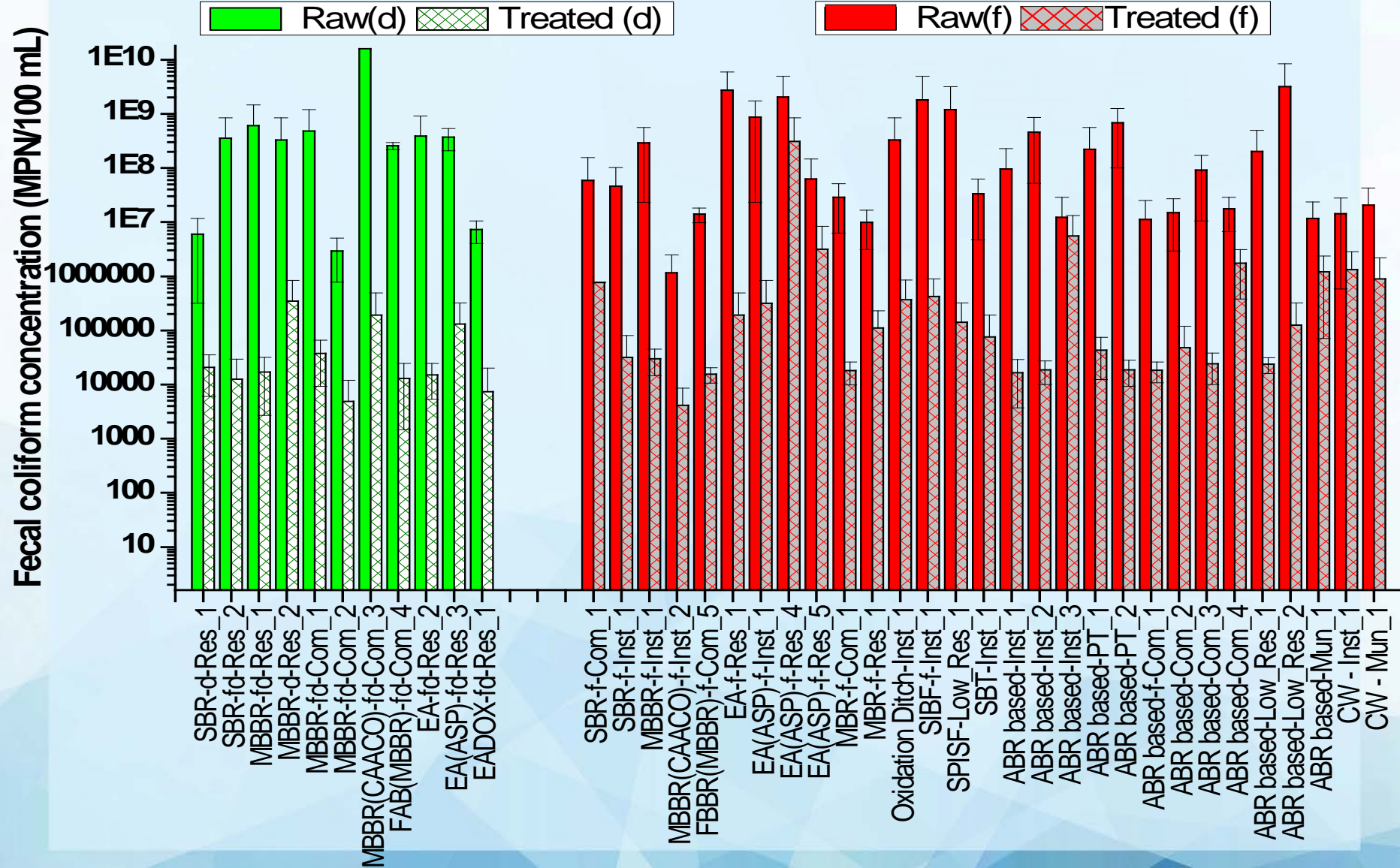
● Percentage Reduction



Major Findings

- EA/ASP showed **better** removal at **HRT of 15-22 hours** and at **OLR of <1.0 kg/cu. m/ day**.
- At **same HRT** as **OLR increases** – EA/ASP showed **lesser** removal

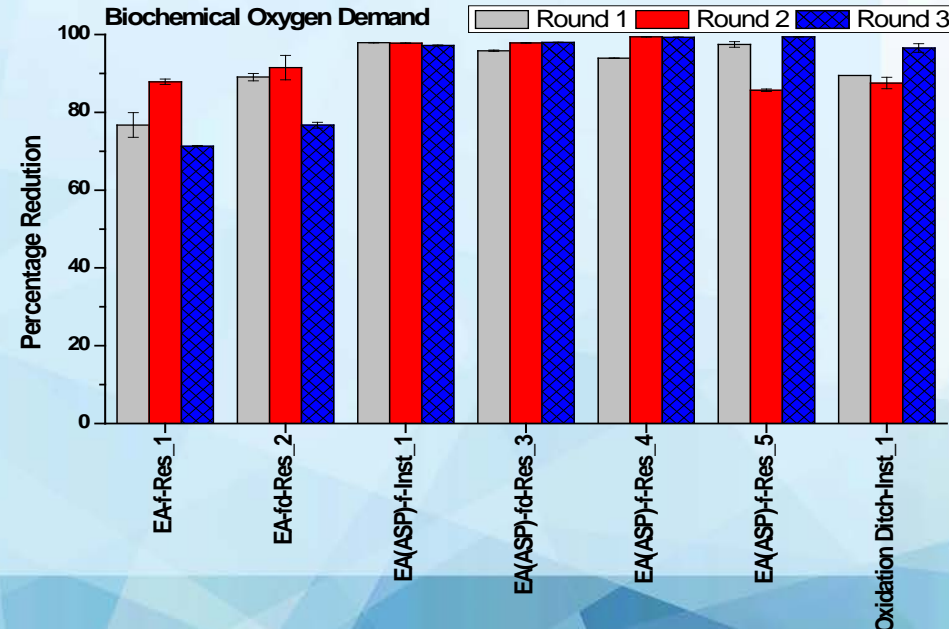
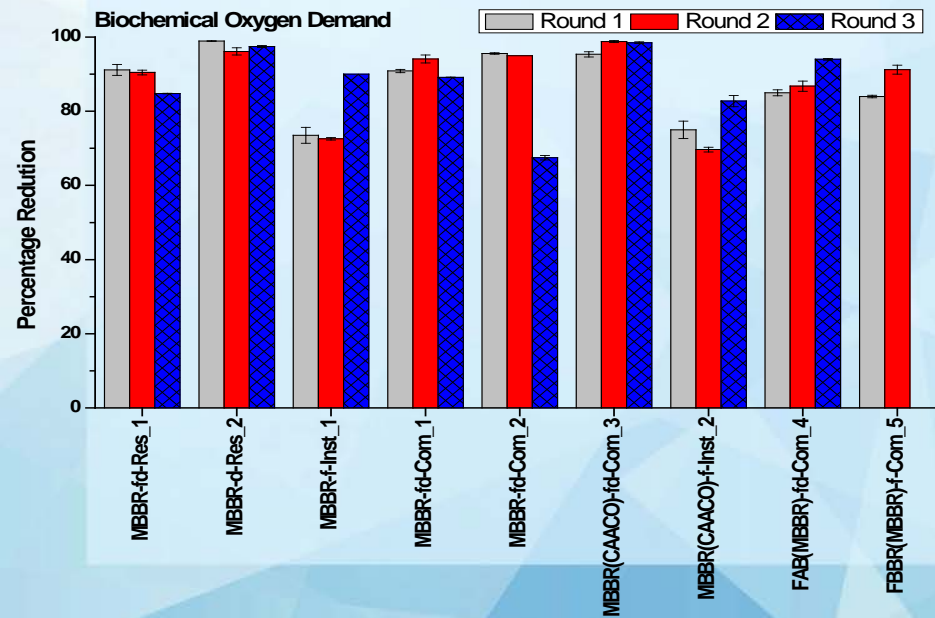
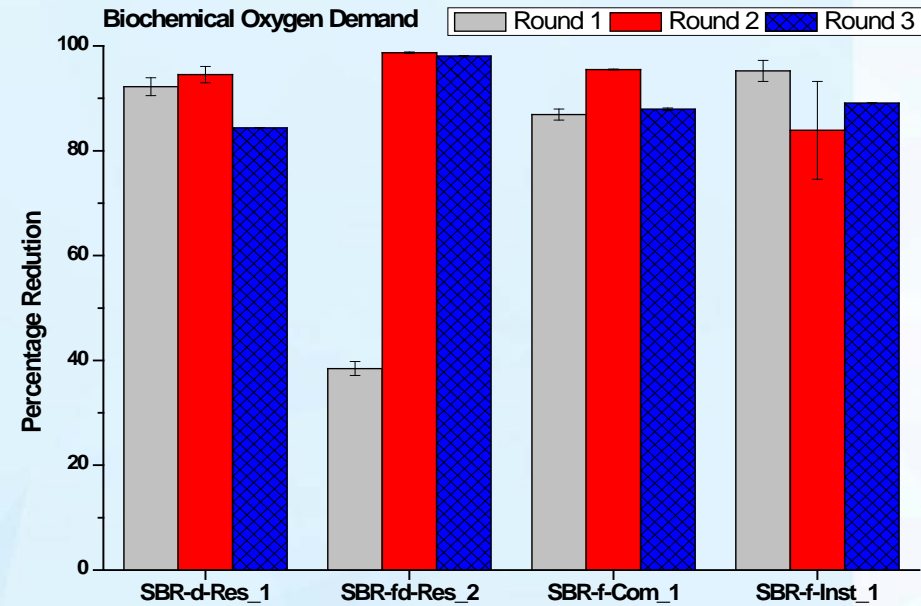
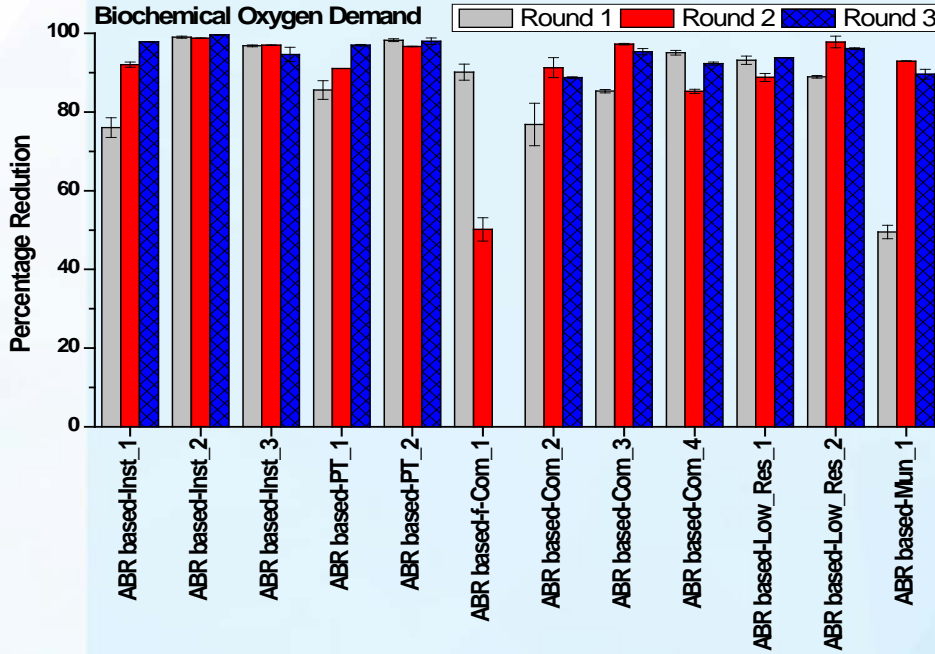
Comparison of FC removal with / without disinfection steps



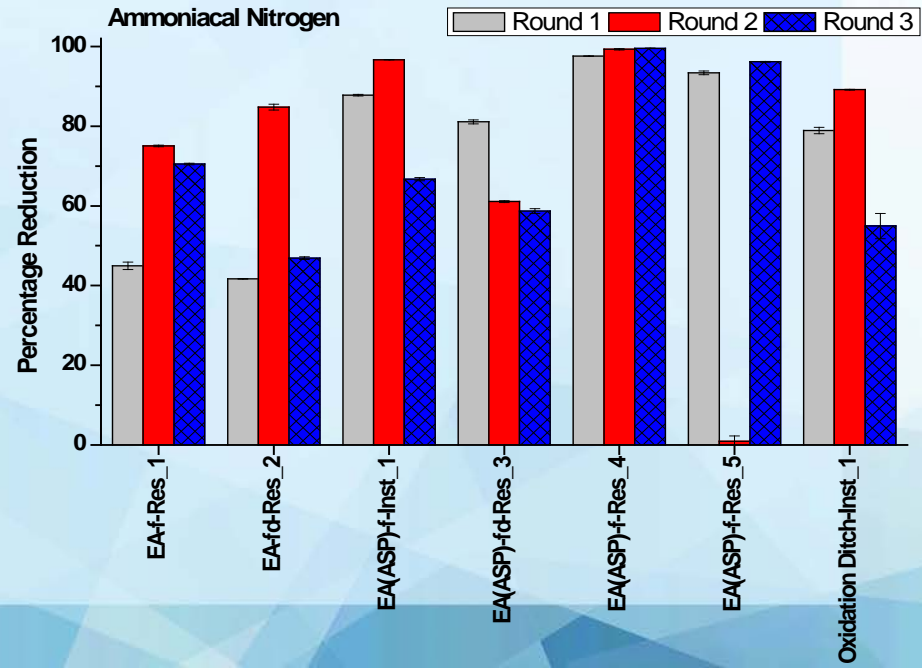
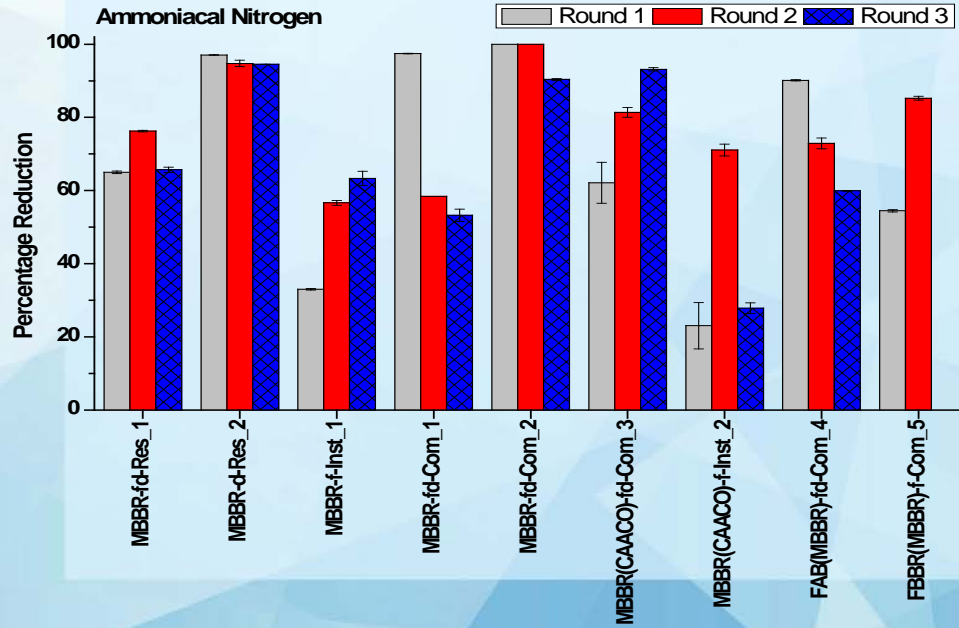
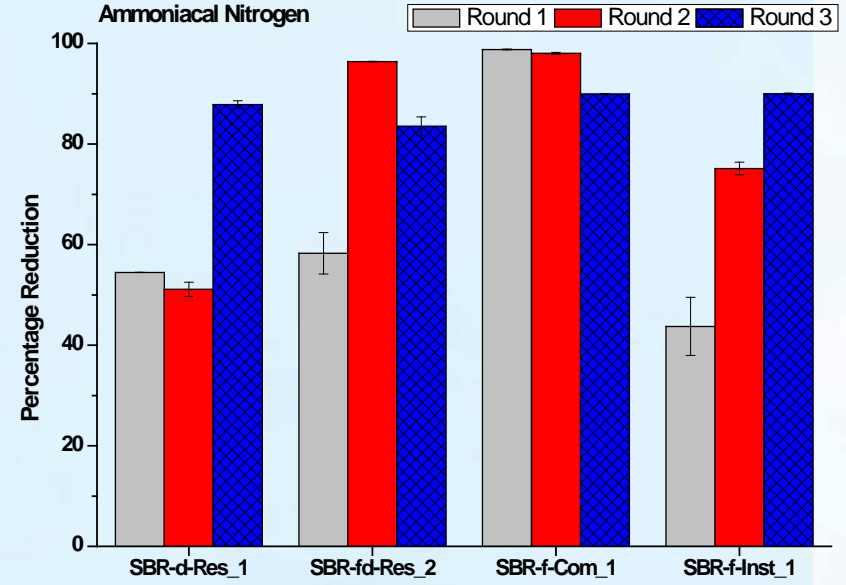
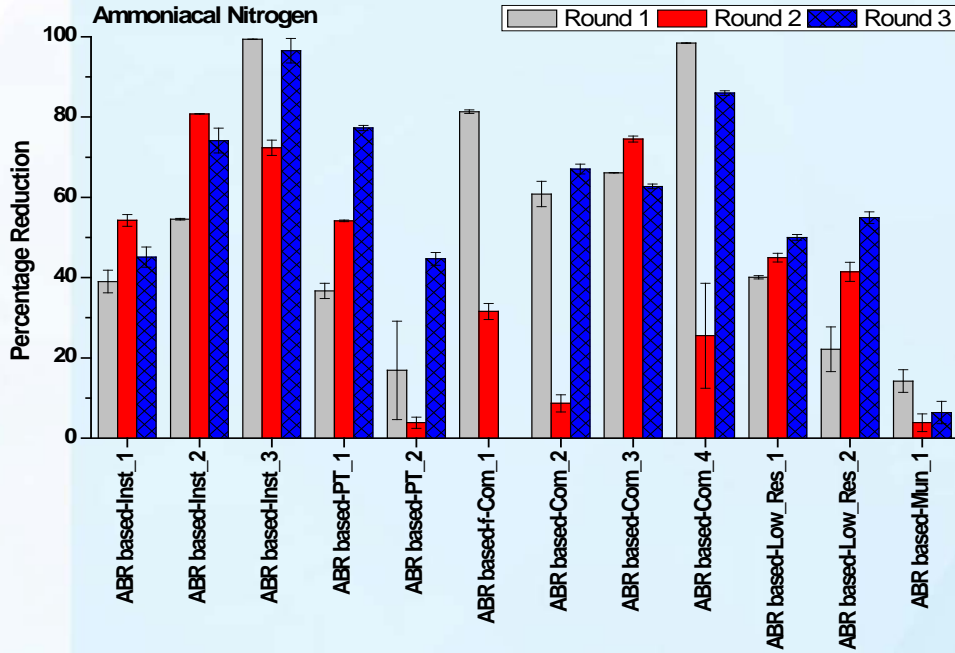
Comparison of FC removal with / without disinfection steps

- For **ASP** – system with **chlorination** showed a higher removal of FC (**4 log reduction**), while system **with no chlorination** showed lesser reduction of FC (**2 log**).
- For **SBR** – system with **chlorination** showed **5 log reduction**, system **with out chlorination** showed 4 log reduction.
- For **MBBR** – system with **chlorination** showed a **5 log reduction** of the fecal contamination, as there is proper chlorination provided, while **with out chlorination** showed 3 log reduction of the fecal material.

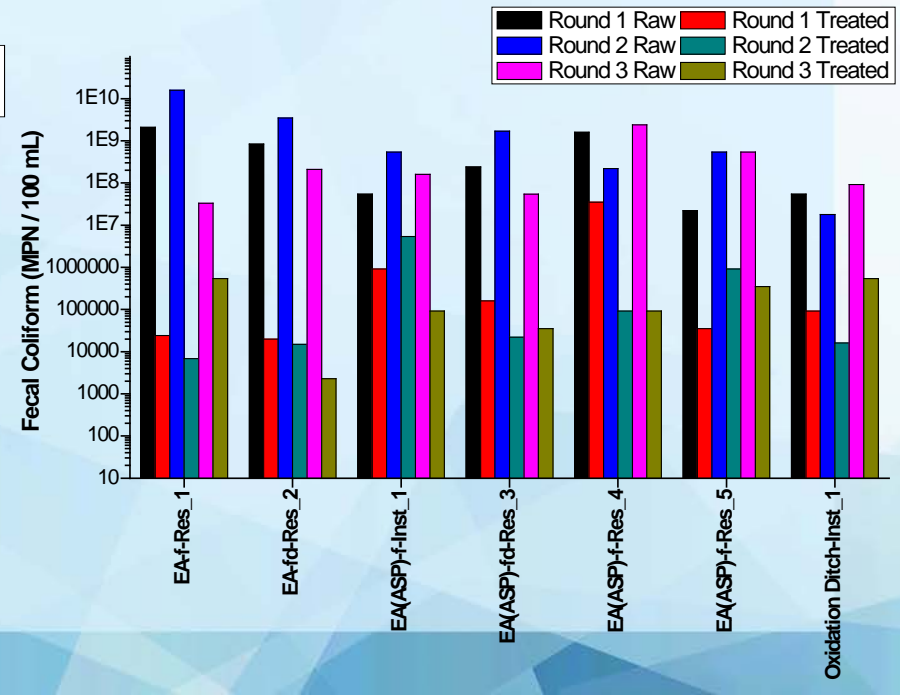
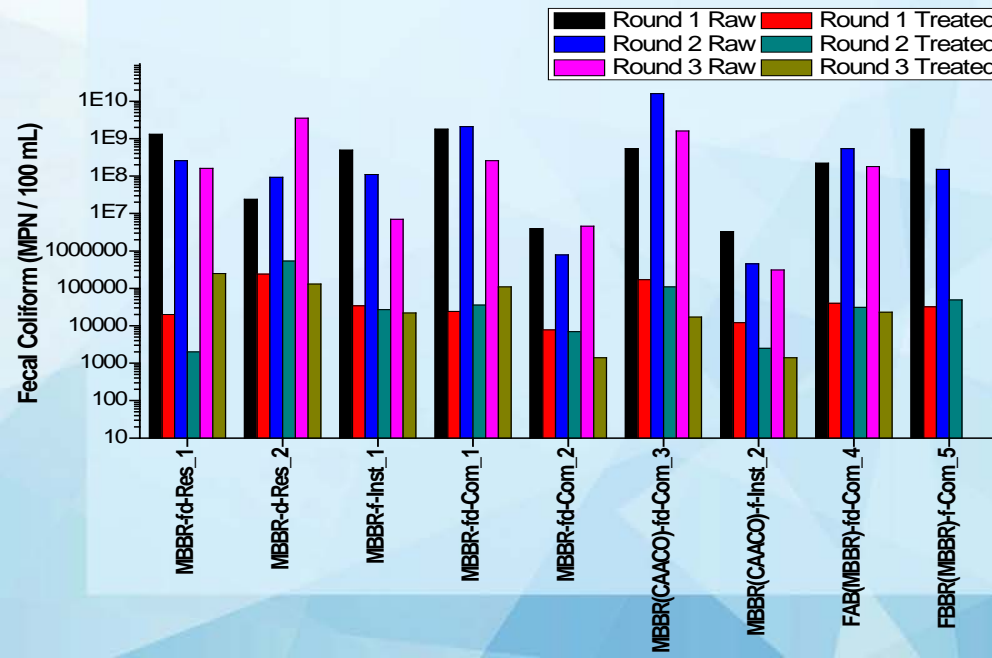
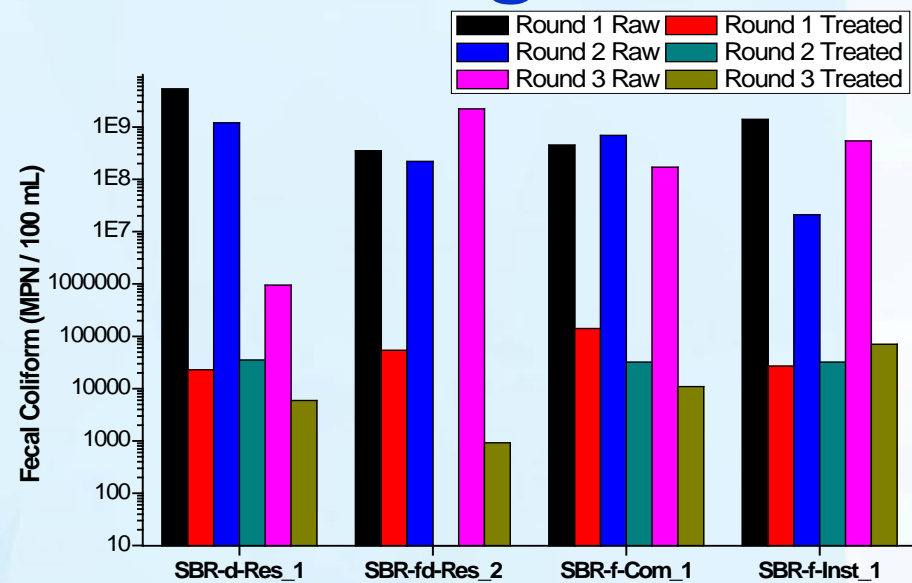
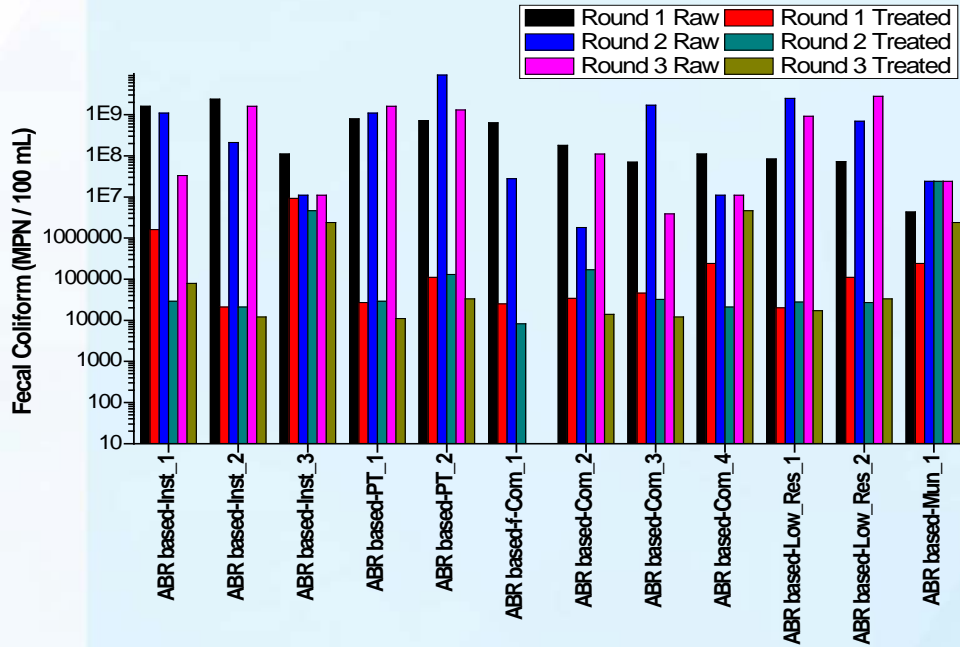
Performance of various technologies - BOD



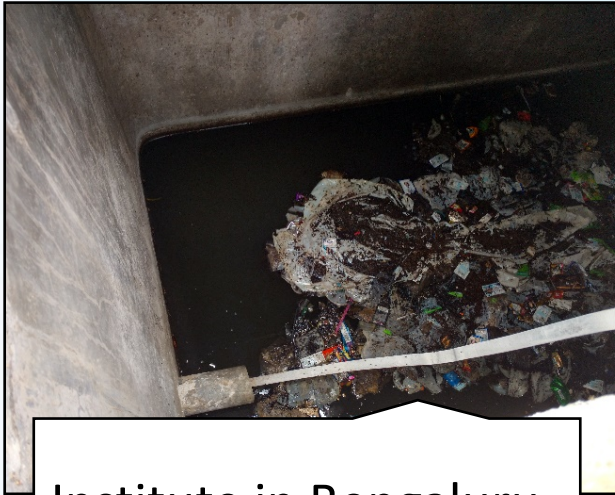
Performance of various technologies - AN



Performance of various technologies - FC



Concerns and Observation



Institute in Bengaluru



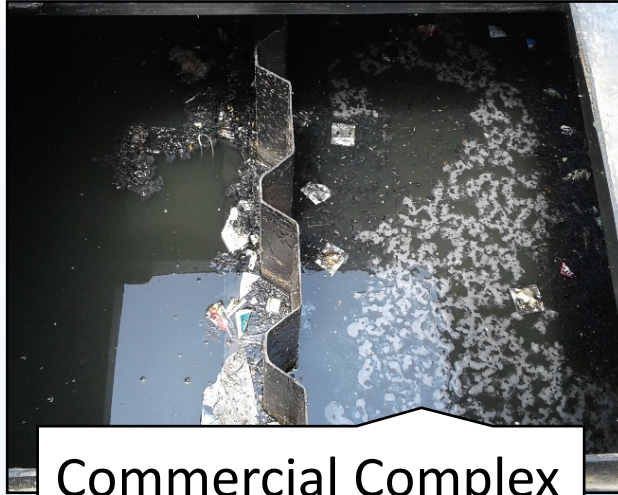
Commercial Complex
in Bengaluru



Commercial Complex
in Hosur, TN

- Plastic materials Floating
- Clogged with plastic and scraps
- Man-hole are fixed and no opening – have to break open
- Few are corroded and brittle

Issues in ABR



Commercial Complex
-Bengaluru-KA



Institute Complex -
Bengaluru-KA



Residential Area,
Kanchipuram

Problems Faced in PGF



Institute in
Bengaluru



Public toilet in Trichy



Residential Area in
Nagpur

Major Findings from 4S project

- The plants which were maintained properly with the designed load performed better.
- Proper operation, maintenance with skilled operator are the most important aspects which decide the performance of a system, irrespective of the technology.
- Wastewater from SSTPs can be reclamation and reused.
- Nutrient removal in ABR based system are meager.
- Sludge management is another challenge faced by SSTPs.
- In urban dwellings, there is no separate space provided for SSTPs.

Conclusion

- Amongst the technologies evaluated
 - SBR , MBR systems performed the best followed by MBBR system, and EA treatment units.
- ABR based systems (Settler-ABR-PGF) were also able to provide good quality treated effluents.
- For the areas with no land constraint whereas availability of uninterrupted power supply is a major problem, ABR based system with PGF seems to be a good option.
- **Proper operation, maintenance** of adequately designed plant and the **availability of skilled operator** is the **mantra for success of any decentralized wastewater management system.**

*Thank
you*

