Understanding IFAS - Lessons Learned from the Hooksett (NH) Experience

NEWEA Annual Conference, Boston MA

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WASTEWATER TREATMENT FACILITY
CLEAN WATER MATTERS
HOOKSETT, NH

Agenda

- Hooksett IFAS Background
- Hooksett Investigation Findings
- Key IFAS Design Parameters
- Hooksett IFAS Conclusions
- Recommended Improvements
- Project Take-Aways
- Acknowledgements
- Questions

Hooksett IFAS Background

- WWTF constructed in 1970 and upgraded in 1974 and 1981 to be a 1.1 MGD BOD removal plant
- 2008/2009 Phase 2/2A Capital Improvements
  - Increase capacity to 2.2 MGD
  - Increase treatment to achieve full nitrification (<1.0 mg/L ammonia year-round)

Hooksett IFAS Background Cont.

- Integrated fixed film activated sludge (IFAS) technology chosen for the upgrade – floating media
- Monies approved insufficient so Phase 2 upgrade changed to MBBR with future upgrade to IFAS
- Half way through Phase 2, ARRA monies become available so Phase 2A changes design from MBBR to IFAS

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Hooksett IFAS Background Cont.

- IFAS tanks went on-line Fall 2010
- Documented hydraulic backups occur in November 2010 and again in early March 2011 – construction is still ongoing and investigations are underway
- Major hydraulic backup occurs overnight March 6 into March 7, 2011. Significant mixed liquor and IFAS media overflow tanks and is lost to Merrimack River.

Hooksett IFAS Background Cont.

- Two years pass with no resolution of costs or fixes between Owner-Contractor-Vendor
- Underwood hired by NHDOJ in 2013 as Expert Witness
- Four more years pass in litigation
- Settlement reached in December 2016
- Full Scale Pilot improvements design occurs in 2017
- Construction is scheduled to commence March 2018

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KRÜGER

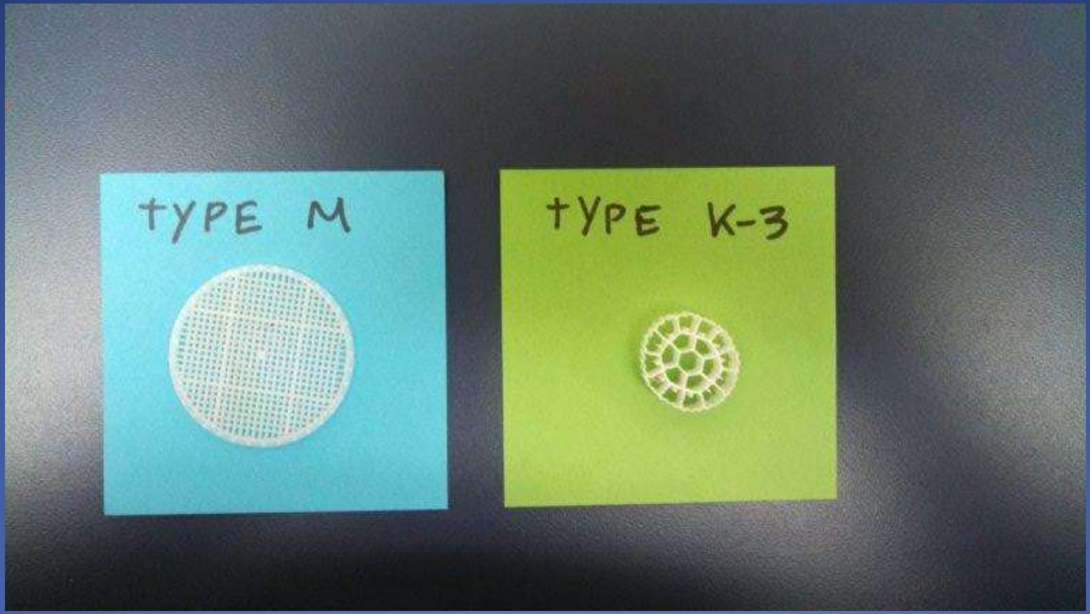

KRUGER

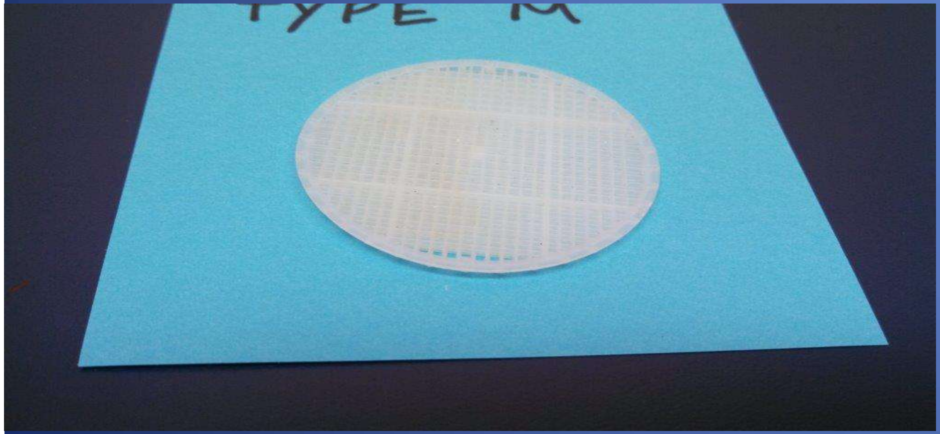
Hooksett Investigation Findings

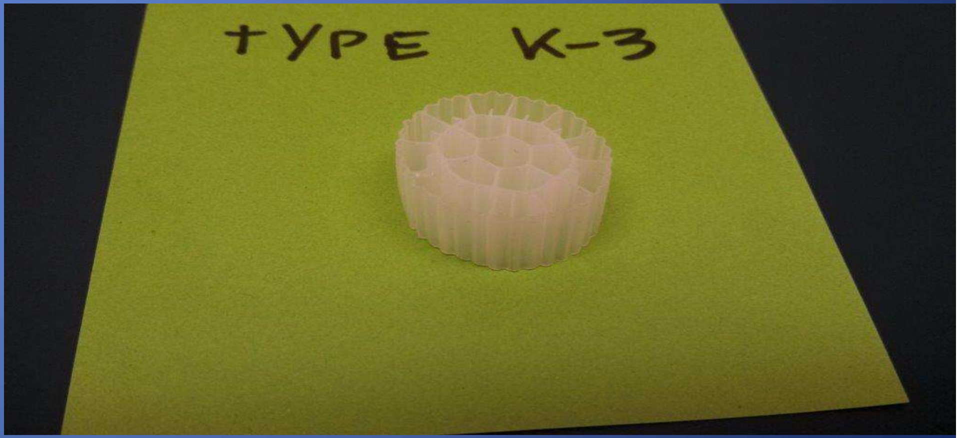
- The peak hour peaking factor used was too low (2.0)
- Yard piping around the BNR and IFAS tanks was sized based on MBBR (no RAS, no NRCY) and was not upsized when ARRA money became available
- The M-chip IFAS media utilized does not perform the same as traditional plastic floating media
  - Hydraulically
  - Biologically

KRUGER PLASTIC BIOFILM CARRIER CHARACTERISTICS

Manufacturer	Name	Bulk Specific Surface Area	Dimensions (Depth; Diameter)
Veolia Inc. (Kruger)	AnoxKaldnes™ K1 or K1 Heavy	500 m^2/m^3	7 mm; 10 mm
	AnoxKaldnes™ K3	500 m^2/m^3	12 mm; 25 mm
	AnoxKaldnes™ Biofilm Chip (M)	1,200 m^2/m^3	2 mm; 48 mm
	AnoxKaldnes™ Biofilm Chip (P)	900 m^2/m^3	3 mm; 45 mm
	AnoxKaldnes™ Matrix™ Sol	800 m^2/m^3	4 mm; 25 mm







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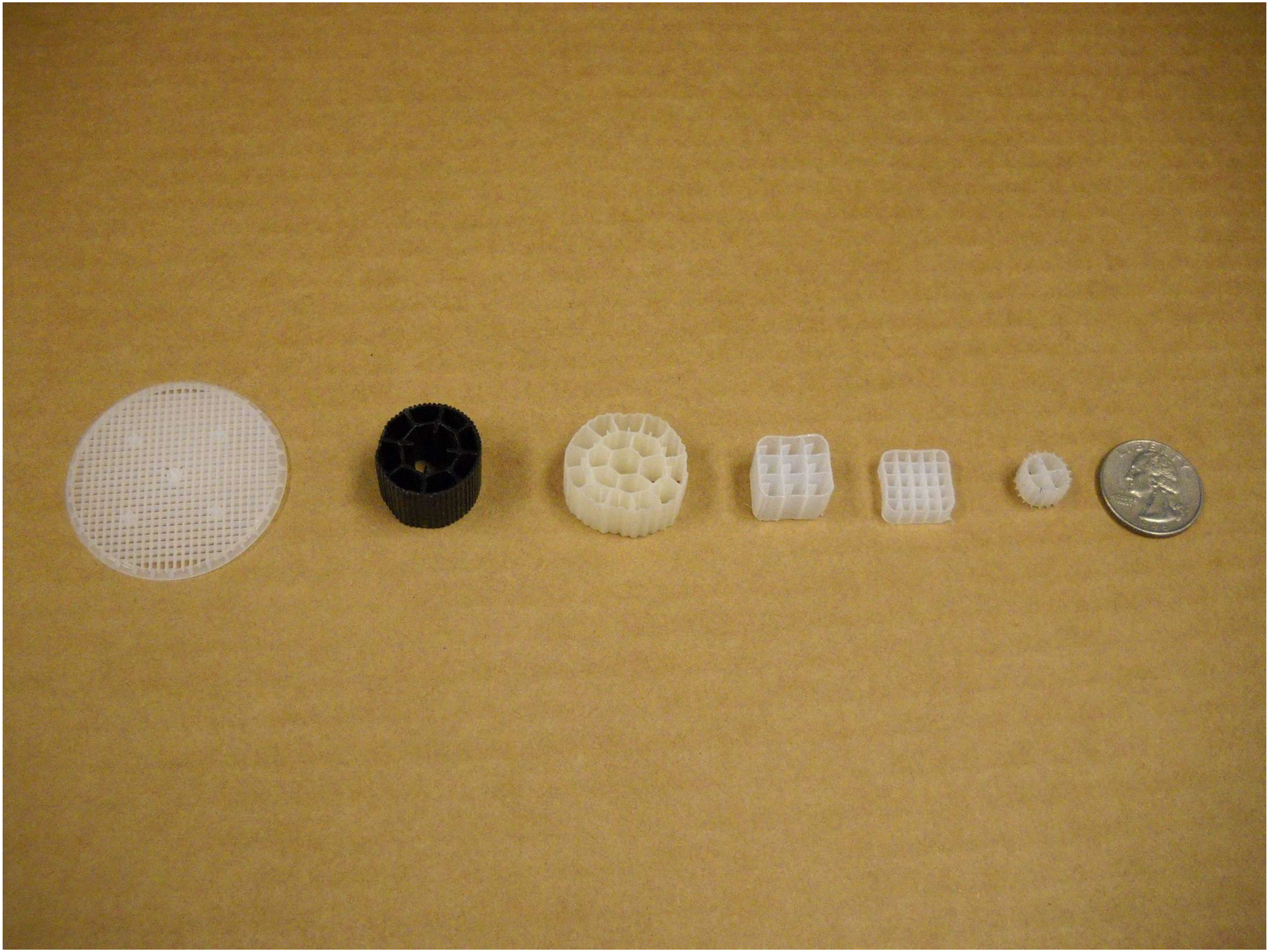

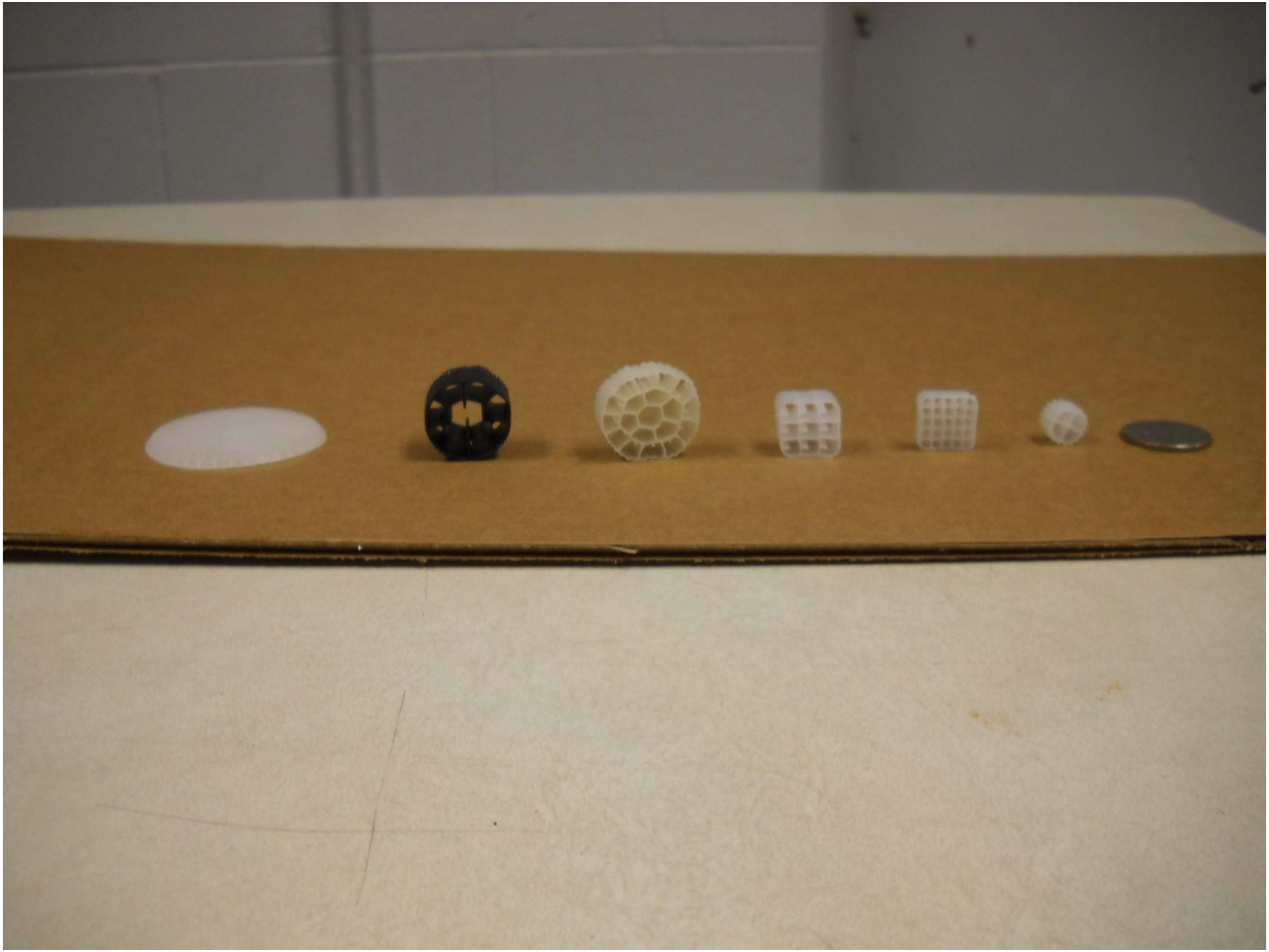

Key IFAS Design Parameters

- Fine Screening
- Media Geometry
- Media Fill Fraction and Surface Area
- Biological Air Requirements
- Mixing Air Requirements
- Reactor L:W Ratio
- Approach Velocity and Screen Loading Rate
- Media Retention Screen Design
  - Diameter - Length
  - Slot size - Arrangement
  - Number - Air sparge!!

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Hooksett IFAS Comparison to Industry Standard

Parameter	Hooksett WWTF	Industry Standard*	Comment
Fine Screening	6 mm then 3 mm	3 – 6 mm	OK
Geometry (diameter and thickness)	Large and flat	Small and thick	Not typical
Applied Specific Surface Area (media SSA x maximum fill fraction)	1,200 m^2/m^3 x 0.55 = 660 m^2/m^3	330 m^2/m^3	High
Biological Air Requirements	3.0 - 5.0 mg/L	2.0 mg/L	High
Mixing Air Requirements	650 scfm (0.9 scfm/ft^2)	0.4 – 0.7 scfm/ft^2	High
Reactor L:W Ratio	1.24:1	0.5:1 – 1.5:1	OK
Tank End Wall Approach Velocity and Screen Hydraulic Loading Rate	28 m/hr 54 m/hr	30 - 35 m/hr 50 – 55 m/hr	OK OK
Media Retention Screen Diameter	12 inches	16 inches	High
Media Retention Screen Submergence	20%	35% to 65 %	Low
Air Spargers	No	Yes	Not typical

*Industry Standard refers to values used for traditional plastic floating media

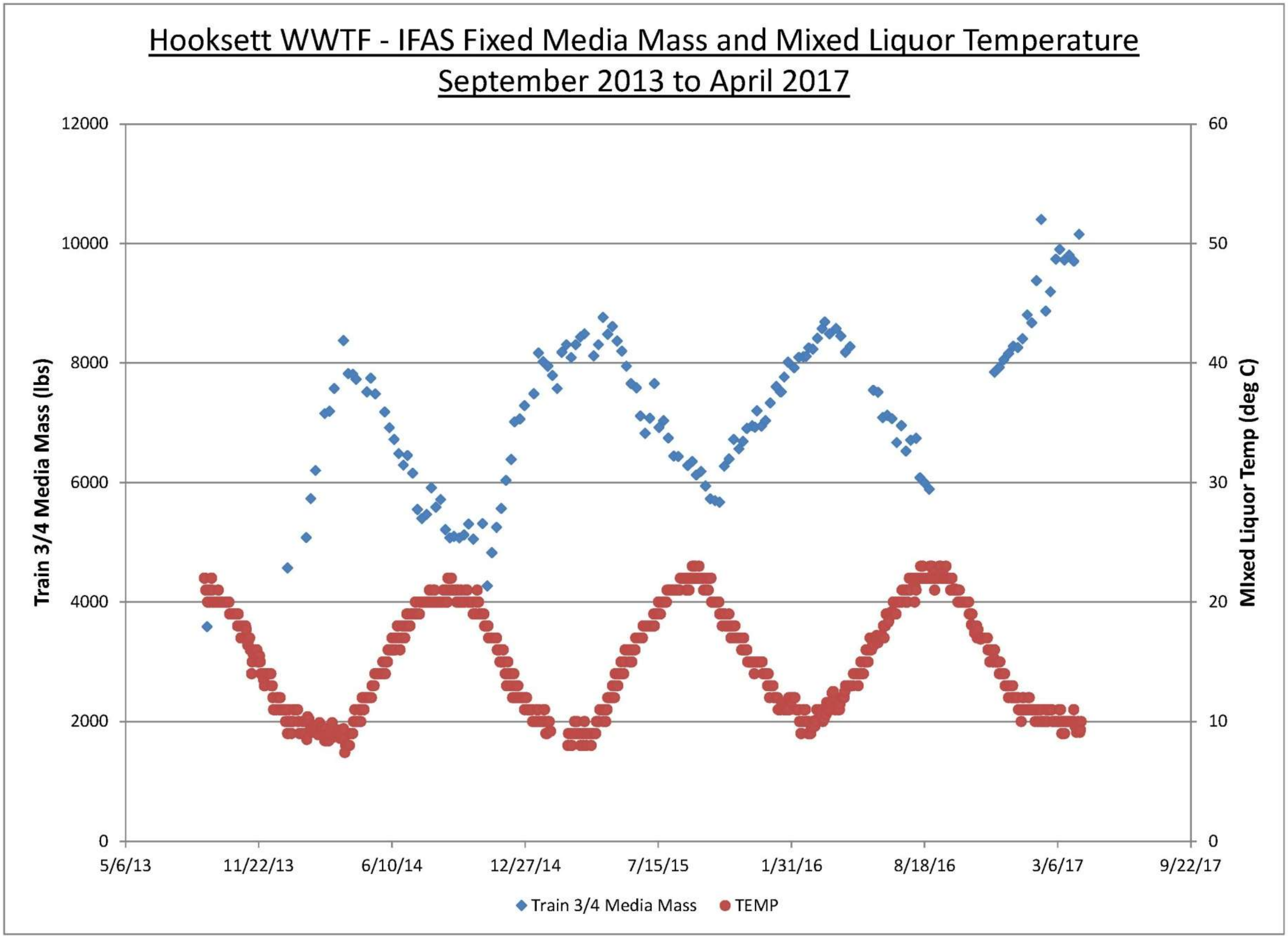

09/05/2013

TABLE 4. HISTORY OF HOOKSETT IFAS RETENTION SCREEN CLOGGING

Information taken from SCADA output graphs														
	Date	Test	Time	Blower Speed (Hz)		Air Flow (SCFM)			Effluent Q	RAS Q	Nitrate Recycle	IFAS Q (MGD)	Screen Hydr	Screen Hydr
Event	(mm/dd/yy)	(Y/N)	(24 hour)	Blower No.1	Blower No.2	Blower No.1	Blower No.2	Total Air Flow	(MGD)	(MGD)	Q (MGD)	(Eff + RAS + Nit)	Loading (m/hr)	Loading (m/hr)
1	11/22/10	N											NOMINAL	ACTUAL
2	03/03/11	N												
3	03/03/11	N												
4	03/06/11	N	20:15	50	35	1888	1283	3171	1.25	0.93	1.04	3.22	40	56
5	09/28/11	Y	13:30	30	34	1131	1253	2383	2.60	0.77	1.00	4.37	54	76
6	10/05/11	Y	8:35	22	30	834	1131	1965	2.87	0.77	0.98	4.62	57	80
7	10/13/11	Y	11:20	30	35	1131	1283	2414	2.45	0.89	1.10	4.44	55	77
8	11/04/11	N	9:25	30	25	1131	948	2079	1.50	0.91	1.11	3.52	43	61
9	11/04/11	Y	14:15	22	30	834	1131	1965	1.80	0.85	1.11	3.76	46	65
10	01/29/12	N	15:00	22	38	834	1405	2239	1.75	0.91	0.85	3.51	43	61
11	02/08/12	Y	11:40	30	22	1131	834	1965	3.60	0.89	1.04	5.53	68	96
12	02/08/12	Y	15:00	30	22	1131	834	1965	2.10	0.89	1.64	4.63	57	81
13	02/08/12	Y	19:10	30	30	1131	1131	2261	3.25	0.89	0.55	4.69	58	82
14	02/09/12	Y	10:55	22	30	834	1131	1965	1.90	0.83	1.00	3.73	46	65
15	02/09/12	Y	12:45	22	30	834	1131	1965	2.20	0.91	1.38	4.49	55	78
16	02/24/12	Y	8:35	22	30	834	1131	1965	1.75	0.86	1.66	4.27	52	74
17	02/24/12	Y	10:15	22	30	834	1131	1965	1.55	0.86	1.27	3.68	45	64
18	06/19/12	Y	14:00	22	30	834	1131	1965	2.15	1.09	1.27	4.51	55	79
19	06/20/12	Y	14:40	30	55	1131	2086	3217	2.45	1.08	1.18	4.71	58	82
20	08/16/12	Y	14:00	22	34	834	1253	2087	1.55	0.45	2.74	4.74	58	83
21	11/06/12	Y	10:00	22	35	834	1283	2117	1.00	0.86	2.74	4.60	56	80
22	01/22/13	N	15:45	35	22	1283	834	2117	0.77	0.77	0.86	2.40	29	42
23	12/24/13	N	15:35	22	38	834	1405	2239	0.95	0.77	1.01	2.73	34	48
24	12/25/13	N	14:50	22	50	834	1888	2722	0.88	0.72	1.01	2.61	32	45
25	12/28/13	N	16:00	44	50	1650	1888	3538	0.88	0.77	1.01	2.66	33	46
26	03/17/14	N	20:45	22	44	834	1650	2484	1.04	0.53	0.95	2.52	31	44
27	03/21/14	N	8:30	22	44	834	1650	2484	1.50	0.69	0.68	2.87	35	50
28	03/30/14	N	8:30	22	34	834	1253	2087	1.55	0.90	0.34	2.79	34	49
29	03/30/14	N	10:30	22	34	834	1253	2087	1.70	0.70	0.34	2.74	34	48
30	03/30/14	N	18:45	22	34	834	1253	2087	1.60	0.50	0.34	2.44	30	42
31	04/05/15	N	12:46	22	44	834	1650	2484	1.55	0.69	0.72	2.95	36	51

Notes:

1. Air flow taken from blower output table from the project O&M Manual.
2. Air knives were installed in IFAS reactors 3 and 4 in July 2012. They were upgraded in April 2014 and a formal cleaning SOP was initialted in May 2014.
3. Event 22 represents conditons at the time of a major clogging after the air knives clogged.



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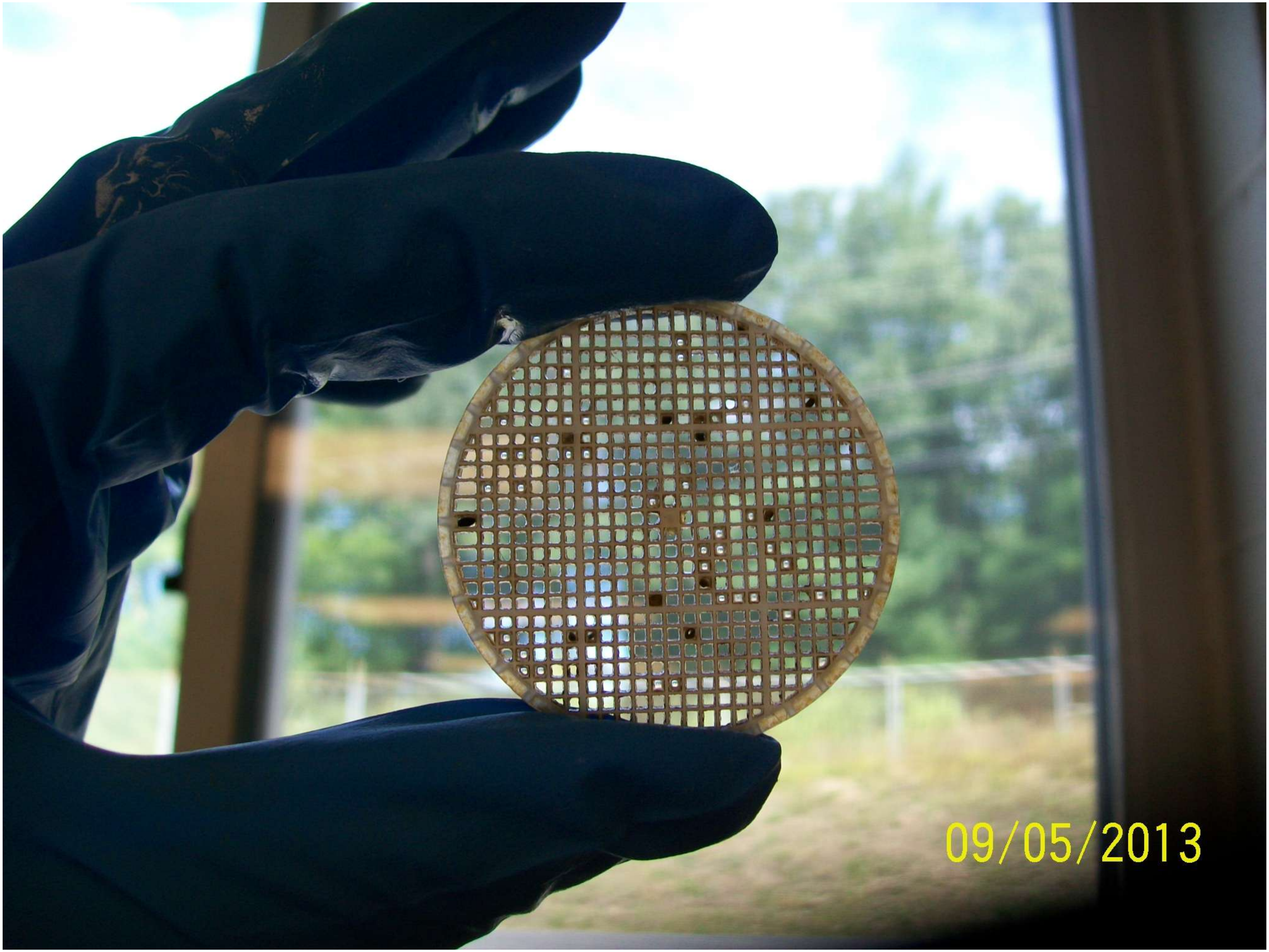
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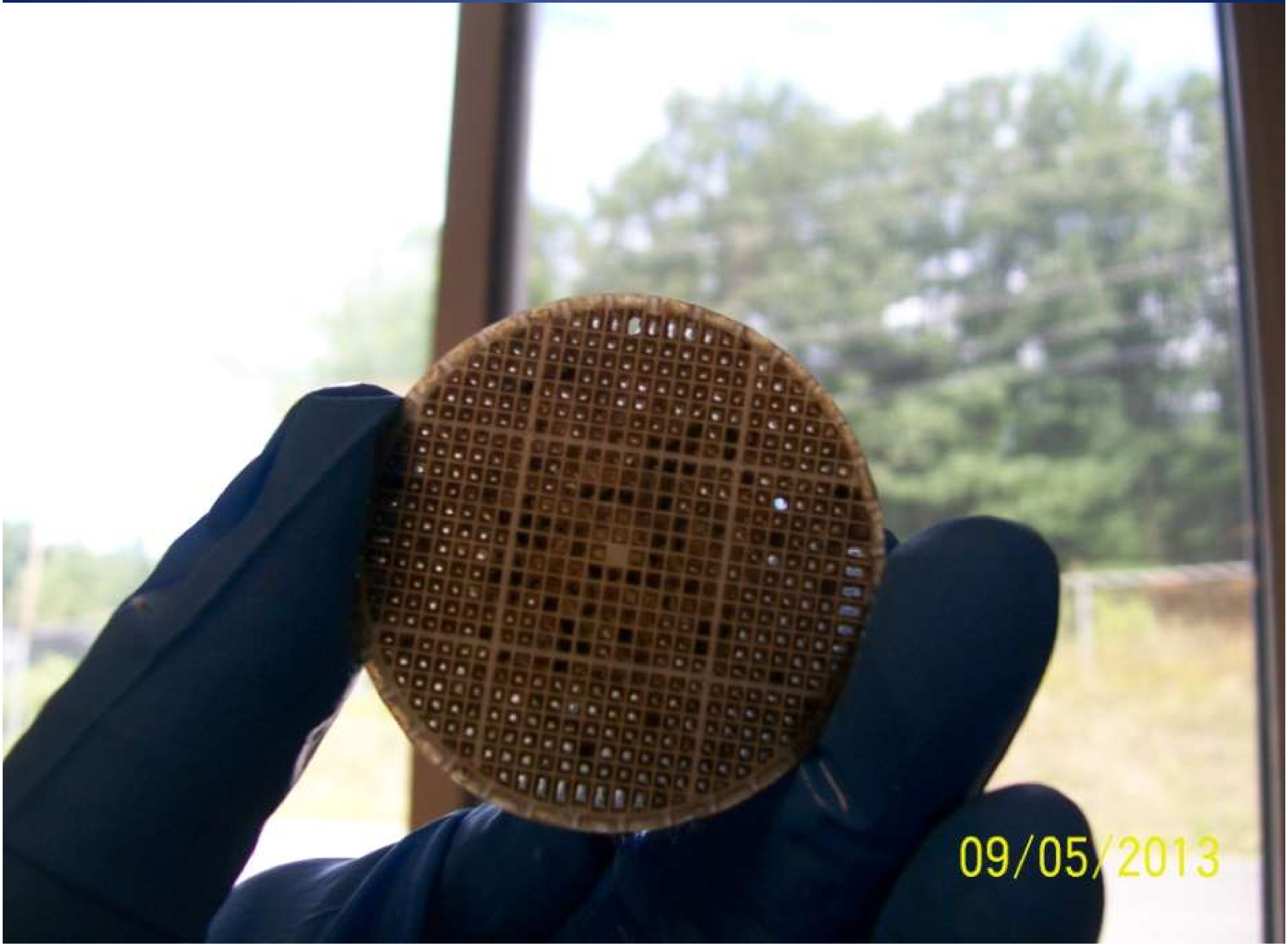
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Hooksett IFAS Conclusions

- Traditional retention screen hydraulic loading rates do not work for M-chip media
- Due to the geometry of the M-chip, higher than normal mixing air is required and air spargers are a must
- Although M-chip has higher available surface area than traditional IFAS media, the surface area is not fully utilized

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Recommended Improvements

Full Scale Pilot – One Train of 2 Tanks

- Replace undersized yard piping out of IFAS tanks
- Reduce media fill fraction to 35% (from 55% and 52%)
- Modify SCADA air control to maintain minimum mixing air of 1,300 SCFM per tank (to be confirmed)
- Increase the number of screens in each IFAS tank from 3 to 6, effectively reducing screen loading rate to 27 m/hr
- Add air spargers under all screens and maintain air flow rate of 60 scfm per screen
- Add an alkalinity addition system

Recommended Improvements Cont.

Full Scale Pilot – Goals

- Confirm that full nitrification to less than 1.0 mg/L ammonia can be met at an average daily flow of 0.67 MGD down to 10 deg C
- Confirm that a peak forward flow of 4.7 MGD can be passed through IFAS Train 2 during the winter without causing backups at a reasonable mixing air flow rate

Next Steps

- Build more IFAS tanks!

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Project Take-Aways

- If it's too good to be true, it probably is
- Verify equipment vendor claims; make them produce full scale evidence of success with proposed product
- IFAS is a viable technology; as with anything it must be applied correctly
- IFAS systems using floating media should always have air spargers, high level alarms, and SCADA automated controls to combat backups
- Do not assume 100% of the media surface area will be utilized

Acknowledgements

- New Hampshire Department of Justice
- New Hampshire Department of Environmental Services
- Hooksett Sewer Commission
  - Sidney Baines, Chair
  - Frank Kotowski, Commissioner
  - Roger Bergeron, Commissioner
  - Bruce Kudrick, Superintendent
- Dr. Clifford Randall, PhD.
- W. Steven Clifton, Underwood Engineers, Inc.

Questions??

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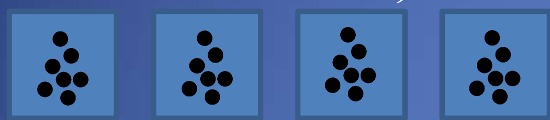
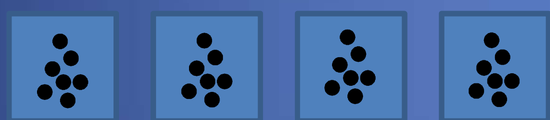
Traditional Activated Sludge Design

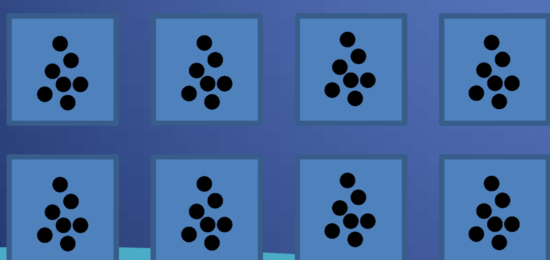
1. Hookset: 1.1 MGD, BOD Removal Only



2. Hooksett: 1.1 MGD, BOD **and Ammonia Removal**

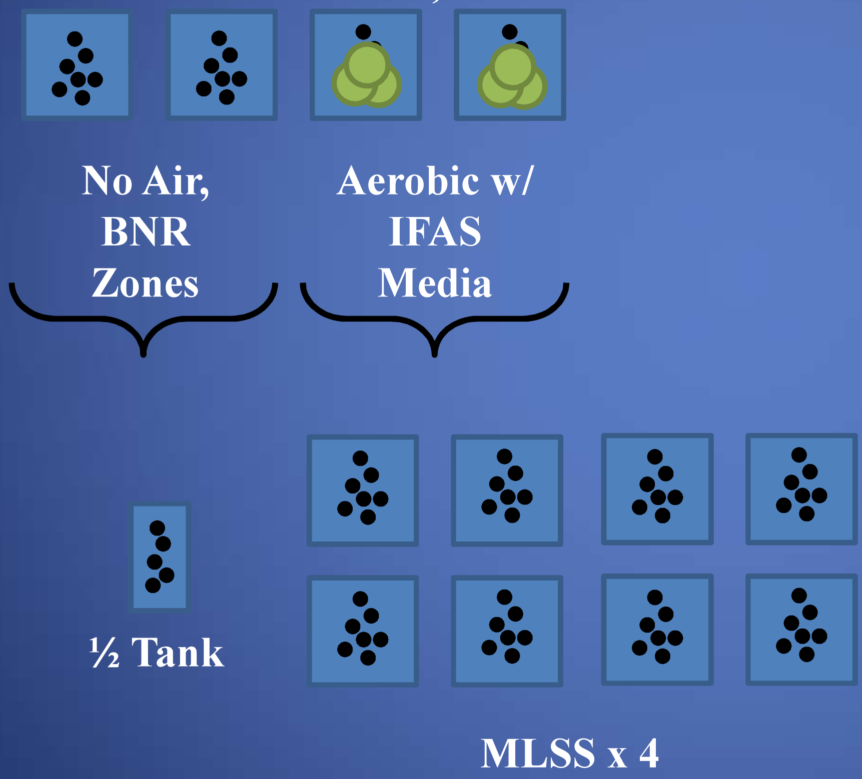


3. Hooksett: **2.2 MGD,** BOD and Ammonia Removal



Kruger IFAS Design

4. Hooksett: 2.2 MGD, BOD and Ammonia Removal



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Comparison of Designs