HOOKSETT
SEWER DEPARTMENT
DATE RECEIVED 5-13-20

INITIAL	COMMENTS
MRK	
TF	

Hooksett Sewer Commission
March 17, 2020
Workshop Minutes

This workshop was held between 10:00am and 12:00pm. In attendance were Chairman Sidney Baines, Commissioner Frank Kotowski, Commissioner Richard Bairam, Superintendent Bruce Kudrick, Assistant Superintendent John Clark and David Mercier from Underwood Engineering. The purpose of this workshop was for David to update the Sewer Commission on the Phase III capital improvements "pilot phase" testing. This workshop was strictly informational and no decisions were made. The handout that David Mercier gave to all in attendance is attached.

Respectfully Submitted,

Frank R. Kotowski

Frank Kotowski
Clerk

UNDERWOOD
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Technical Memorandum

To: Bruce Kudrick, Superintendent, Hooksett Sewer Commission

Job No: 2160-08

From: David J. Mercier, P.E., Underwood Engineers

Date: March 12, 2020

Subject: **HOOKSETT, NH – WWTF IFAS Train 2 Pilot Hydraulic Tests**

BACKGROUND:

The Town of Hooksett's wastewater treatment facility (WWTF) underwent hydraulic upgrades to IFAS Train 2 under the Phase 3 Capital Improvements Project in 2017-2018. These upgrades consisted of:

- In the first IFAS Train 2 tank (IFAS Tank No. 3), three (3) additional media retention screens were added making for a total of six (6).
- In the second IFAS Train 2 tank (IFAS Tank No. 4), the common discharge header connecting the three media retention screens to a rapid mix chamber was deleted and a total of six (6) media screens were installed in this tank cored directly through the end wall into the floc tank.
- The rapid mix chamber in IFAS Tank No. 4 was demolished.
- The chemical dosing point for IFAS Train 2 was relocated from the old rapid mix chamber 2 to floc tank 2 directly beneath the slow mixer.
- The polymer feed piping and discharge point to IFAS Train 2 was modified to serve as a new magnesium hydroxide dosing line and the dosing point was relocated to be at the nitrate recycle pump 2 suction in floc tank 2.
- At both Floc Tank Nos. 1 and 2, the 14-inch discharge pipe passing through to the secondary clarifier splitter box was removed and replaced with a 20-inch pipe.
- The secondary splitter box was modified to incorporate sharp crested contracted weirs to each clarifier with a large center slide gate to allow isolation of either clarifier.

The goal of the IFAS Train 2 pilot upgrades was to modify the process to be able to sufficiently treat the hydraulic and organic peak loads that could be anticipated at a future average daily design flow of 1.6 MGD. This memo will discuss and present the results of the pilot upgrade hydraulic testing, while pilot upgrade organic testing will be covered under a separate technical memorandum.

UNDERWOOD engineers

The purpose of this Technical Memorandum is to summarize the results of the hydraulic testing and present conclusions on whether the upgraded IFAS Train 2 can pass the desired hydraulic flows without hydraulic backup occurring due to clogging of the media retention screens which was the cause of the loss of media from the IFAS tanks back in March 2011. This will be validated if the field measured water levels through IFAS Train 2 remain stable through an extended operating period (4 hours) at the 20-yr design peak hourly flow rate. A secondary goal is to confirm whether the hydraulic modeling spreadsheet that Underwood has created can accurately predict the water levels that will occur through the upgraded IFAS Train 2 and be used in the future as a reliable predictor of water levels at varying forward flow rates. Note: The work was not intended to create a calibrated hydraulic model but to confirm if the spreadsheet based model can serve as a reasonable predictor.

HYDRAULIC FIELD TESTING:

Hydraulic testing was performed by artificially inducing peak flows through the treatment system and specifically IFAS Train 2 to confirm the adequacy of the upgrade. The future design peak hourly flow rate associated with a 1.6 MGD average daily wastewater flow through both IFAS trains is 9.4 MGD (including RAS & NRCY). During the hydraulic testing of IFAS Train 2, the flow was manipulated to be 4.7 MGD, or half of the design peak hourly flow through both IFAS trains.

Hydraulic testing was performed for a four-hour duration at the WWTF on April 11, 2019 and February 24, 2020. In order to achieve the target flow of 4.7 MGD to IFAS Train 2:

- One effluent pump was utilized to recycle final effluent back through the WWTF to achieve a flow of approximately 2.2 MGD
- One RAS pump was set to maximum speed which increased the flow to approximately 3.3 MGD
- Nitrate recycle pump 2 was manually adjusted to achieve a total combined flow of 4.7 MGD ± 0.3 MGD during the test duration

During the tests, key water elevations were field measured every 15 minutes using survey equipment to check for consistency. These seven locations included:

- Intermediate Splitter Box
- IFAS Influent Splitter Box
- IFAS Tank 3
- IFAS Tank 4
- Floc Tank 2
- Clarifier Splitter Box upstream of the new weir
- Clarifier No. 2 water surface

(Refer to the attachments to this memo for a field measurement location map as well as a copy of the full Hydraulic Pilot Testing Procedure followed.)

For the first test conducted on April 11, 2019, only several months after the upgraded IFAS Train 2 was put into operation, the water levels measured at all seven location were very stable for the entire four hour test, including when the aeration blowers (mixing) was turned down. This can be seen in the attached summary data table for the 4/11/19 test. Further, all field measured water elevations were within 2 inches of the desktop hydraulic model predicted elevations, which is considered to be reasonably accurate for a non-calibrated model (5 of the 7 locations were within 1 inch). It should also be noted that all measured water elevations were lower than predicted by the hydraulic model. Conditions during the 4/11/19 test included a water temp of 10 deg C, MLSS of 2,337 mg/L, and a total media biological mass of 4,859 lbs.

For the second test conducted on February 24, 2020, over one year after the upgraded IFAS Train 2 was put into operation, the water levels measured at all seven location were again very stable for the entire four hour test, including when the aeration blowers (mixing) was turned down. This can be seen in the attached summary data table for the 2/24/20 test. Five of the seven field measured water elevations were above the desktop predicted values, but all seven were within 1.1 inches of the predicted levels. The most likely explanation for the slightly higher water levels seen during the second test is the accumulation of debris over time on the media retention screens. This can be confirmed by plant staff when the tanks are taken down for routine maintenance this summer (2020). Conditions during the 2/24/20 test included a water temp of 11 deg C, MLSS of 4,638 mg/L, and a total media biological mass of 4,142 lbs.

As noted above, during the afternoon of each test, the air was reduced to one blower at 36 Hz or 1,320 scfm to see whether backups would occur under low aeration (mixing) rates. This value compares to 1,300 scfm which was the minimum air flow originally recommended by the IFAS media manufacturer per train. Based on the field measurements taken before and after the blowers were slowed down, the reduction in air did not affect the water level elevations in IFAS Tanks 3 or 4 (or any upstream location) to any noticeable degree, confirming that insufficient aeration induced backup was not occurring.

It should be noted that at 4.7 MGD the BNR outlet weir trough was submerged by approximately 10 inches. This was anticipated and will need to be addressed during additional upgrades scheduled to occur under the Phase 3A project.

CONCLUSIONS:

For both tests, the field measured water levels varied only minimally during the four-hour duration tests, even when aeration (mixing) was decreased. This confirms that the media retention screens were not plugging and hydraulic backup was not occurring, which was the goal of the tests. The tests were both conducted during the coldest period of the year, which is believed to be when the retention screens are most prone to clogging due to the higher mass of growth on the media which makes them harder to mix and more sticky and likely to "raft".

It is Underwood's opinion that the hydraulic testing was a success and proves the upgraded IFAS Train 2 with 30% media fill fraction and twelve media retention screens can pass the desired 4.7 MGD peak flow without backing up, even at temperatures of 10°C when greater biomass exists on the IFAS media. This test should be repeated after the media fill fraction is increased to 35% to confirm there are no hydraulic issues.

We also found that the field measured water levels matched the desktop model predicted water levels reasonably well, confirming that the model can be used in the future to predict water levels at other flow rates.

2160.90

PHASE 3 CAPITAL IMPROVEMENTS – PILOT PHASE
HOOKSETT WWTF, HOOKSETT, NH
Hydraulic Pilot Testing Procedure
April 11, 2019 and February 24, 2020

FULL SCALE HYDRAULIC PILOT TESTING

- NOTES:
  - The hydraulic tests will only be performed on IFAS Train 2 (Tanks 3 and 4) and the peak flows will need to be artificially induced.
  - The duration of each testing event will be between 4-8 hours or that which can be accomplished within a single work day.
  - Perform one day of winter hydraulic testing and one day of summer hydraulic testing at the 30% fill fraction.
  - After the one-year organic full-scale pilot, increase the media fill fraction in IFAS Train 2 to 35% in each tank and repeat the hydraulic testing procedure under winter (or worst case) conditions.

- PROCEDURE:
  1. Take IFAS Train 1 off-line and only run IFAS Train 2 for the duration of the testing. Do this by closing the gate in the IFAS influent dBox to IFAS Train 1, closing the gates in the secondary clarifier splitter box coming in from Floc Tank 1 and out to Clarifier No. 1, and shutting off Nitrate Recycle Pump No. 1.
  2. Adjust the "high level float" alarms in IFAS tanks 3 and 4 to a higher setpoint in order to prevent shutdown of the nitrate pumps.
     a. Disable Floc Tank 2 ultrasonic high-level alarm.
  3. Disable the "combined high flow" alarm and increase the setpoint to 5.0 MGD.
     a. Switch PAC and MgOH chemical feed pump control to manual.
  4. Target a total combined flow (effluent flow, RAS, and nitrate recycle) of 4.7 MGD.
     a. First, stop RAS pump(s). In yard, close valve for effluent pump discharge at outfall, open valve for effluent pump discharge to manhole in yard closest to the new grit system approximately 4 turns, or until effluent flow rises to approximately 2.2 MGD.
  5. Turn RAS pump (1) back on and maximize the RAS flow by changing the control to manual and increasing the pump speed to 100% or 60 Hz.
  6. Switch to manual control for Nitrate Recycle Pump No. 2 and adjust the speed to whatever is necessary to achieve a total combined flow of 4.7 MGD (effluent flow plus RAS plus nitrate recycle).

7. Throughout the test, monitor and adjust the Nitrate Recycle Pump No. 2 speed manually by changing the speed (Hz) to maintain the desired total combined flow of 4.7 MGD.
8. Take water level measurements every 15 minutes at: BNR tank outlet trough, IFAS influent dBox to IFAS Train 2, IFAS Tank 3, IFAS Tank 4, Floc Tank 2, clarifier influent splitter box upstream of the new weir, and Clarifier No. 2 to verify the headloss and to document any backups within those tanks.
9. After two hours, reduce the air to IFAS Tanks 3 and 4 to only that which is needed to achieve 5 mg/L DO in IFAS Tank 3 and 3 mg/L DO in IFAS Tank 4. Record modified speed of blowers and continue test for 2 additional hours.
10. When the testing duration is complete, return all process settings to pre-test conditions and put IFAS Train 1 back on-line and monitor system for a minimum of 30 minutes to ensure flows and water levels return to normal.

Engineer: DCJ,RMB
Date: 4/11/2019
Project #: 2160-08
Project: Phase 3 Capital Improvements Hydraulic Pilot Testing
Town of Hooksett, NH WWTF

	Benchmark	Top of floc tank concrete wall	
a	BM Record Elev	Known	189.85 ft
b	BM Field Elev	Measured #	5.07 ft (BS)
c	Height of Inst.	a + b =	194.92 ft

			Intermediate Splitter Box		IFAS D-Box		IFAS Tank 3		IFAS Tank 4		Floc Tank No. 2		Effluent Splitter Box		Secondary Clarifier 2	
	Time of Day	Flow (MGD)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)
d	10:30:00 AM	4.5	8.03	186.89	8.32	186.6	9.36	185.56	9.49	185.43	9.55	185.37	9.69	185.23	13.07	181.85
e	10:45:00 AM	4.7	7.74	187.18	8.04	186.88	9.27	185.65	9.44	185.48	9.51	185.41	9.64	185.28	13.07	181.85
f	11:00:00 AM	4.7	7.75	187.17	8.08	186.84	9.22	185.7	9.34	185.58	9.5	185.42	9.59	185.33	13.03	181.89
g	11:15:00 AM	4.5	8.07	186.85	8.35	186.57	9.33	185.59	9.34	185.58	9.59	185.33	9.7	185.22	13.03	181.89
h	11:30:00 AM	4.7	7.92	187	8.25	186.67	9.35	185.57	9.48	185.44	9.6	185.32	9.68	185.24	13.05	181.87
i	11:45:00 AM	4.8	7.79	187.13	8.11	186.81	9.27	185.65	9.41	185.51	9.51	185.41	9.63	185.29	13.04	181.88
j	12:00:00 PM	4.8	7.78	187.14	8.11	186.81	9.21	185.71	9.4	185.52	9.5	185.42	9.61	185.31	13.05	181.87
k	12:15:00 PM	4.7	7.85	187.07	8.15	186.77	9.23	185.69	9.38	185.54	9.48	185.44	9.64	185.28	13.06	181.86 →
l	12:30:00 PM	Lunch														
m	12:45:00 PM	4.7	7.81	187.11	8.18	186.74	9.22	185.7	9.38	185.54	9.5	185.42	9.65	185.27	13.06	181.86
n	1:00:00 PM	4.7	7.84	187.08	8.22	186.7	9.24	185.68	9.34	185.58	9.46	185.46	9.64	185.28	13.08	181.84
o	1:15:00 PM	4.7	7.85	187.07	8.15	186.77	9.19	185.73	9.28	185.64	9.47	185.45	9.58	185.34	13.02	181.9
p	1:30:00 PM	4.7	7.87	187.05	8.16	186.76	9.2	185.72	9.35	185.57	9.44	185.48	9.66	185.26	13.03	181.89
q	1:45:00 PM	4.7	7.87	187.05	8.17	186.75	9.19	185.73	9.35	185.57	9.44	185.48	9.61	185.31	13.04	181.88
r	2:00:00 PM	4.7	7.89	187.03	8.18	186.74	9.19	185.73	9.35	185.57	9.48	185.44	9.68	185.24	13.06	181.86
s	2:15:00 PM	4.7	7.95	186.97	8.22	186.7	9.2	185.72	9.38	185.54	9.44	185.48	9.65	185.27	13.06	181.86
t	2:30:00 PM	4.7	7.99	186.93	8.25	186.67	9.23	185.69	9.44	185.48	9.48	185.44	9.63	185.29	13.06	181.86
u	2:45:00 PM	~3.5	8.34	186.58	8.55	186.37	9.23	185.69	9.32	185.6	9.4	185.52	9.7	185.22	13.02	181.9
v	3:00:00 PM	~3.5	8.9	186.02	9	185.92	9.36	185.56	9.59	185.33	9.53	185.39	9.7	185.22	13.07	181.85
w	3:15:00 PM	~3.5	9.66	185.26	9.72	185.2	9.8	185.12	9.86	185.06	9.88	185.04	9.91	185.01	13.06	181.86
	10:30am - 2:30pm Average		7.88	187.05	8.18	186.74	9.24	185.68	9.38	185.54	9.50	185.42	9.64	185.28	13.05	181.87
	10:30am - 2:30pm Variation		-	0.33	-	0.31	-	0.17	-	0.21	-	0.16	-	0.12	-	0.06

Notes:

- One (1) RAS pump at 60 Hz achieved 700 gpm or 1.0 MGD.
- One (1) Nitrate Recycle pump at 60 Hz achieved 1100 gpm or 1.6 MGD.
- The air sparge blower was 37 Hz.
- At 1:09pm, the air was shut off to Train 1 and reduced in Train 2 to one (1) blower at 60 Hz.
- At 1:21pm, the one (1) air blower for Train 2 was reduced to 36 Hz.
- At 2:07pm, the one (1) air blower for Train 2 was put in AUTO. Note: the DO set point in Tank 3 is 4.0.
- IFAS Tank 4 temperature was 10.1 degrees C.
- At 2:35pm, the nitrate recycle pump was turned off.
- At 3:15pm, the effluent pump was turned off.

Key:
Field measured
Hydraulic calculations

	Intermediate Splitter Box	IFAS D-Box	IFAS Tank 3	IFAS Tank 4	Floc Tank No. 2	Effluent Splitter Box*	Secondary Clarifier 2*
10:30am - 2:30pm Average	187.05	186.74	185.68	185.54	185.42	185.28	181.87
Hydraulic Calculations	187.16	186.87	185.70	185.59	185.48	185.34	181.92
Δ Water Elev (in)	-1.38	-1.61	-0.29	-0.65	-0.68	-0.75	-0.61
Δ Field Measured Headloss (in)		3.71	12.72	1.69	1.35	1.75	40.90
Δ Hydraulic Calc Headloss (in)		3.48	14.04	1.32	1.32	1.68	41.04
Δ Headloss (in)		0.23	-1.32	0.37	0.03	0.07	-0.14

*Note: Flow from Floc Tank No. 2 to Effluent Splitter Box and from Effluent Splitter Box to Secondary Clarifier was only 3.3 MGD since the Nitrate Recycle pump No. 2 flow of 1.4 MGD had already come out.

Engineer: DCJ,RMB
Date 2/24/2020
Project # 2160-08
Project Phase 3 Capital Improvements Pilot Testing
Town Hooksett WWTF

Hydraulic Pilot Testing Elevations 2-24-20

	Benchmark	Top of floc tank concrete wall	
a	BM Record Elev	Known	189.85 ft
b	BM Field Elev	Measured #	5.05 ft (BS)
c	Height of Inst.	a + b =	194.9 ft

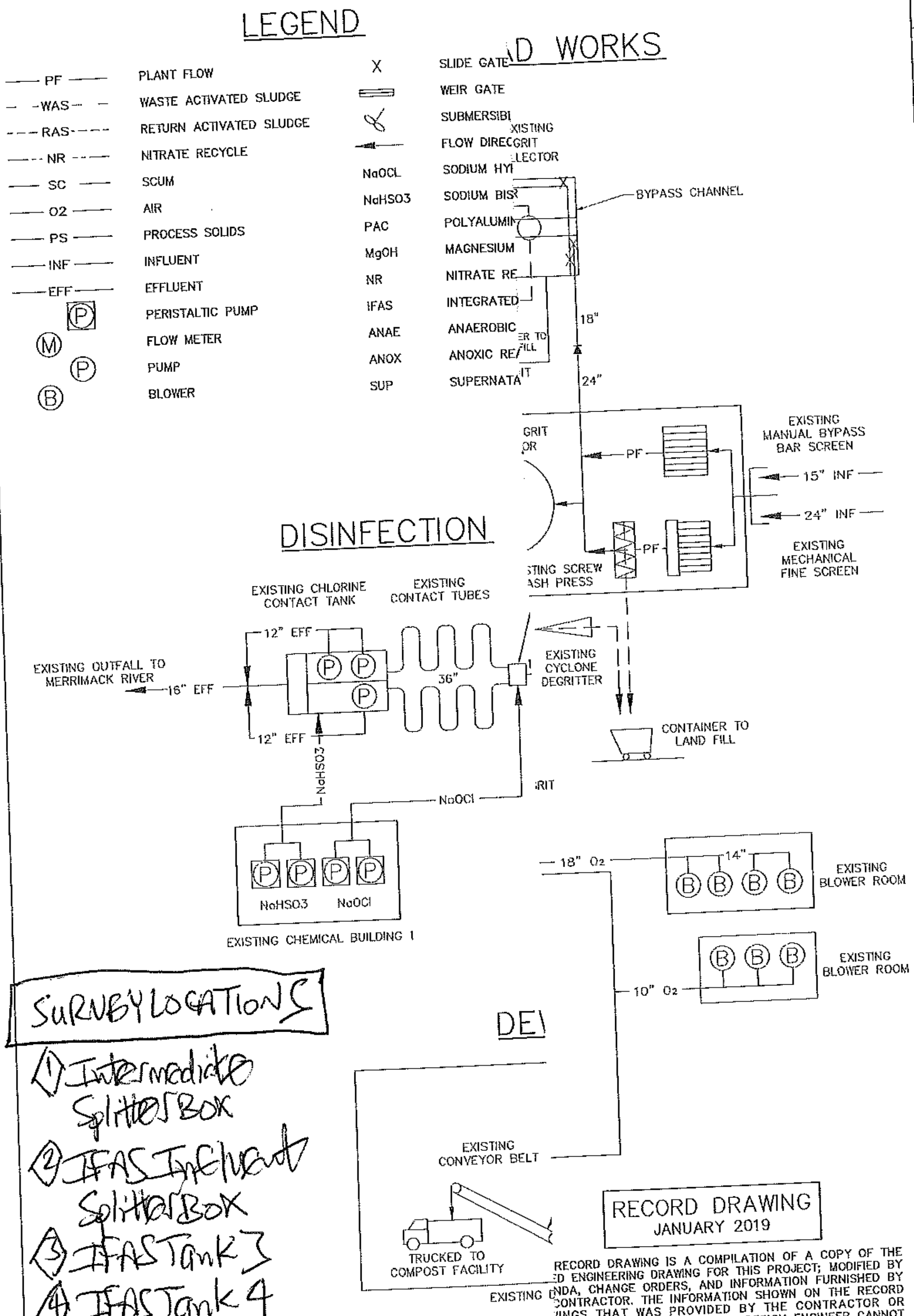
			Intermediate Splitter Box		IFAS D-Box		IFAS Tank 3		IFAS Tank 4		Floc Tank No. 2		Effluent Splitter Box		Secondary Clarifier 2	
	Time of Day	Flow (MGD)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)	FS Measued	Surveyed Elevation (ft)
d	10:30:00 AM	~4.4-4.5	8.07	186.83	8.31	186.59	9.2	185.7	9.35	185.55	9.52	185.38	9.65	185.25	13.2	181.7
e	10:45:00 AM	~4.7	7.87	187.03	8.16	186.74	9.23	185.67	9.33	185.57	9.45	185.45	9.64	185.26	13.06	181.84
f	11:00:00 AM	~4.9	7.62	187.28	7.92	186.98	9.13	185.77	9.29	185.61	9.41	185.49	9.59	185.31	13.08	181.82
g	11:15:00 AM	~5.0	7.55	187.35	7.85	187.05	9.05	185.85	9.21	185.69	9.36	185.54	9.61	185.29	13.04	181.86
h	11:30:00 AM	~5.0	7.53	187.37	7.81	187.09	9.01	185.89	9.2	185.7	9.35	185.55	9.56	185.34	13.1	181.8
i	11:45:00 AM	~5.0	7.68	187.22	7.93	186.97	9.1	185.8	9.22	185.68	9.34	185.56	9.55	185.35	13.06	181.84
j	12:00:00 PM	Lowering													→	→
k	12:15:00 PM	Flow & Lunch													→	→
l	12:30:00 PM	~4.7	7.81	187.09	8.03	186.87	9.2	185.7	9.21	185.69	9.3	185.6	9.53	185.37	13.03	181.87
m	12:45:00 PM	~4.7	7.78	187.12	8.03	186.87	9.09	185.81	9.19	185.71	9.35	185.55	9.55	185.35	13.03	181.87
n	1:00:00 PM	~4.7	7.74	187.16	7.95	186.95	9	185.9	9.16	185.74	9.33	185.57	9.57	185.33	13.11	181.79
o	1:15:00 PM	~4.7	7.72	187.18	7.94	186.96	9.09	185.81	9.28	185.62	9.36	185.54	9.51	185.39	13.11	181.79
p	1:30:00 PM	~4.7	7.72	187.18	8.01	186.89	9.09	185.81	9.22	185.68	9.35	185.55	9.52	185.38	13.1	181.8
q	1:45:00 PM	~4.7	7.73	187.17	8	186.9	9.07	185.83	9.22	185.68	9.35	185.55	9.55	185.35	13.08	181.82
r	2:00:00 PM	~4.7	7.72	187.18	7.91	186.99	9.1	185.8	9.19	185.71	9.39	185.51	9.51	185.39	13.03	181.87
s	2:15:00 PM	~4.75	7.86	187.04	8.01	186.89	9.12	185.78	9.18	185.72	9.37	185.53	9.52	185.38	13.02	181.88
t	2:30:00 PM	~4.7	7.81	187.09	8.06	186.84	9.16	185.74	9.25	185.65	9.36	185.54	9.53	185.37	13.04	181.86
u	2:45:00 PM	~4.3	8.36	186.54	8.67	186.23	9.5	185.4	9.43	185.47	9.51	185.39	9.66	185.24	13.09	181.81
v	3:00:00 PM	~4.1	9.35	185.55	9.47	185.43	9.76	185.14	9.8	185.1	9.78	185.12	9.85	185.05	13.1	181.8
w	3:15:00 PM	~3.75	9.29	185.61	9.5	185.4	9.77	185.13	9.84	185.06	9.83	185.07	9.8	185.1	13.19	181.71
	10:30am - 2:30pm Average		7.75	187.15	7.99	186.91	9.11	185.79	9.23	185.67	9.37	185.53	9.56	185.34	13.07	181.83
	10:30am - 2:30pm Variation		-	0.54	-	0.50	-	0.23	-	0.19	-	0.22	-	0.14	-	0.18

Notes:

1) At 10:06am, the effluent recycle flow was 2.1 MGD, the RAS recylce flow was 730 GPM, the Nitrate recycle flow was 700 GPM resulting in the Combined IFAS flow of 4.1 MGD.
2) At 10:30am, the RAS recycle flow was at 740 GPM and the Nitrate recycle flow was 820 GPM. The Combined IFAS flow was 4.7 MGD.
3) At 10:40am, the Nitrate recycle flow was 950 GPM resulting in a Combined IFAS flow of 4.6 MGD.
4) At 11:00am, the Nitrate recycle flow was 900 GPM, and the Combined IFAS flow was 4.8-4.9 MGD.
5) At 11:15am, the Nitrate recycle flow was 775 GPM, and the Combined IFAS flow was 5 MGD.
6) At 11:25am, the Nitrate recycle flow was 675 GPM, and the Combined IFAS flow was 5 MGD.
7) At 11:45am, the RAS pump tripped out. The effluent valve was closed one (1) turn. The Nitrate recycle flow was 590 GPM and the Combined IFAS flow was 5 MGD.
8) At 12pm, the effluent control valve was opened five (5) turns to prevent high solids going into the river, and the Nitrate recycle flow was lowered to 430 GPM (28 Hz).
9) At 12:10pm, the RAS pump tripped out again. The RAS flow was lowered from 60 Hz to 55 Hz (or 660 GPM).
10) Between 12:15 and 12:30pm, the Combined IFAS flow stabalized at 4.7 MGD.
11) At 1:20pm, the air flow to Train 2 was reduced to 36 Hz.
12) The Air Sparge blower speed was 37 Hz during the test.

	Intermediate Splitter Box	IFAS D-Box	IFAS Tank 3	IFAS Tank 4	Floc Tank No. 2	Effluent Splitter Box*	Secondary Clarifier 2*
10:30am - 2:30pm Average	187.15	186.91	185.79	185.67	185.53	185.34	181.83
Hydraulic Calculations	187.16	186.87	185.70	185.59	185.48	185.34	181.92
Δ Water Elev (in)	-0.09	0.42	1.09	0.92	0.57	0.01	-1.11

	Intermediate Splitter Box – IFAS D-Box	IFAS D-Box – IFAS Tank 3	IFAS Tank 3 – IFAS Tank 4	IFAS Tank 4 – Floc Tank No. 2	Floc Tank No. 2 – Effluent Splitter Box	Effluent Splitter Box – Secondary Clarifier 2
Δ Field Measured Headloss (in)	2.97	13.38	1.49	1.67	2.24	42.16
Δ Hydraulic Calc Headloss (in)	3.48	14.04	1.32	1.32	1.68	41.04
Δ Headloss (in)	-0.51	-0.66	0.17	0.35	0.56	1.12



SuRVEY LOCATIONS

1. Intermediate Splitter Box
2. IFAS Influent Splitter Box
3. IFAS Tank 3
4. IFAS Tank 4
5. Floc Tank 2
6. ~~Clarifier Splitter Box~~
7. Clarifier No. 2

RECORD DRAWING
JANUARY 2019

RECORD DRAWING IS A COMPILATION OF A COPY OF THE ED ENGINEERING DRAWING FOR THIS PROJECT; MODIFIED BY NDA, CHANGE ORDERS, AND INFORMATION FURNISHED BY CONTRACTOR. THE INFORMATION SHOWN ON THE RECORD VINGS THAT WAS PROVIDED BY THE CONTRACTOR OR RS NOT ASSOCIATED WITH THE DESIGN ENGINEER CANNOT ERIFIED FOR ACCURACY OR COMPLETENESS. THE ORIGINAL D DRAWINGS ARE ON FILE AT THE OFFICES OF UNDERWOOD IEERS, INC., 25 VAUGHAN MALL, PORTSMOUTH, NH 03801.

ISSUE FOR	Date	By
APPROVAL	8/11/2017	DJM
CONSTRUCTION	8/30/2017	DJM
RECORD DRAWING	1/2019	DJM

REVISIONS — NO. | APP'D

Drawn/Chk. HAV
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PROCESS FLOW DIAGRAM
PHASE 3 CAPITAL IMPROVEMENTS
HOOKSETT SEWER COMMISSION
HOOKSETT, NEW HAMPSHIRE

DWG NO G2
SHEET 2 OF 26

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Technical Memorandum

File No. 2160.08

To: Hooksett Sewer Commission
From: David J. Mercier, P.E., Senior Project Manager
Cc: Steve Smith, Dan Jacobson – Underwood Engineers
Date: March 16, 2020
Subject: **HOOKSETT, NH – Biological Pilot Technical Memo**

BACKGROUND:

In the fall of 2010, the Hooksett Sewer Commission (HSC) completed a major upgrade to their activated sludge wastewater treatment facility (WWTF) utilizing integrated fixed film activated sludge (IFAS) technology. The goal of the upgrade was to increase the design capacity of the facility from a 1.1 MGD BOD removal only facility to a 2.2 MGD biological nutrient removal facility removing both BOD and ammonia. The facility was also equipped with both anaerobic and anoxic tanks ahead of the IFAS tanks such that the potential would exist to remove both nitrogen and phosphorus. Shortly after startup in the fall of 2010, the plant experienced several hydraulic backups and the exact reasons for these events was not immediately apparent. Then in March of 2011, a major hydraulic backup occurred in the IFAS tanks overnight which resulted in overtopping of the IFAS tanks and spillage of mixed liquor and IFAS media into the treatment plant yard and surrounding drainage swales and ultimately to the Merrimack River. This major operational issue led to forensic engineering and litigation which was finally settled in December 2016.

In early 2017, Underwood Engineers was retained by the HSC to implement a full-scale pilot to construct recommended upgrades to one of the two IFAS treatment trains to test the hydraulic and organic capacity of the upgraded train to confirm that it would perform as expected. This was necessary as the M-chip media utilized in the Hooksett IFAS upgrade is the only municipal facility utilizing this type of media and, therefore, there were no other examples to draw upon. During 2017, Underwood designed an upgrade for IFAS Train 2 which incorporated the following improvements:

- In the first IFAS Train 2 tank (IFAS Tank No. 3), the addition of three (3) additional media retention screens making for a total of six (6).
- In the second IFAS Train 2 tank (IFAS Tank No. 4), demolition of the common discharge header connecting the three existing media retention screens to Rapid Mix Chamber 2 and installation of a total of six (6) media screens cored directly through the end wall into Floc Tank 2.
- Demolition of Rapid Mix Chamber 2 in IFAS Tank No. 4.

- Relocation of the polyaluminum chloride (PAC) chemical dosing point from demolished Rapid Mix Chamber 2 to Floc Tank 2 directly beneath the slow mixer.
- Modification of the polymer feed piping and discharge point to Floc Tank 2 to serve as a new magnesium hydroxide dosing line and relocation of the dosing point to be at the Nitrate Recycle Pump 2 suction.
- Removal of the 14-inch discharge pipes leaving Floc Tanks 1 and 2 and passing through to the clarifier splitter box and replacement with 20-inch pipes.
- Modification of the clarifier splitter box to incorporate sharp crested contracted weirs to each clarifier with a center slide gate to allow isolation of either clarifier.

During the forensic engineering performed during the litigation, Underwood Engineers concluded that the 2009-2010 WWTF upgrade incorporated multiple hydraulic issues which was the reason for the above noted changes, but Underwood also concluded that the M-chip media was not capable of supporting the mass of bacteria that was claimed by the manufacturer. In fact, empirical data analyzed suggested that the media could support a greater mass of bacteria that was non-occluded and functional if less media and greater mixing were provided within the IFAS tanks. As a result, pilot upgrade also included the following:

- Reduction of the media fill fraction in IFAS tanks 1 and 3 from 55% to 30%, and in tanks 2 and 4 from 52% to 30%.

In preparation for operation of the pilot, Underwood Engineers coordinated with the NHDES to prepare a protocol for pilot operations. The protocol developed can be found in ***Appendix A*** and consisted of a two-part testing protocol. The first part is the biological pilot and is the topic of this technical memorandum. The second part of the pilot is to test the hydraulics in IFAS Train 2 only to prove that at peak hour design flows, including return activated sludge flows and nitrate recycle flows, that the upgraded system can perform without plugging of the IFAS media retention screens and backing up of the system. (This hydraulic pilot is the topic of a separate technical memorandum).

The key for the biological pilot was to reduce the amount of media in both IFAS trains so that the current average daily flow will mimic the future design conditions that would occur with more flow and more media in the tanks. Since the key test parameter for the biological treatment system is removal of ammonia at temperatures down to 10 degrees C, it was necessary to run the biological portion of the pilot for a full calendar year to prove that full nitrification can occur consistently during the coldest weather of the year

Based on treatment plant analyses performed by Underwood, it was determined that the maximum flow and load that could be passed through the existing Hooksett WWTF utilizing the M-Chip IFAS media, without performing extreme upgrades at an exorbitant cost is 1.6 MGD as an average daily flow. This is the capacity that the HSC decided to target for a future full-scale upgrade and this is the capacity that the biological pilot mimicked.

The pilot work was bid out and awarded to T. Buck Construction, Inc. in the fall of 2017 but given the late point in the year, the work did not commence until the spring of 2018. Substantial completion was achieved in September of 2018, and final completion in November of 2018.

In preparation for start of the biological pilot, Underwood met with HSC WWTF staff to discuss the implementation of a number of operational changes to provide the pilot with the best conditions to be successful. Those changes included the following:

- Operate both BNR trains, both IFAS trains, both floc tanks, and one secondary clarifier.
- Pace RAS off of effluent flow and set it at a 50% return rate.
- Run both nitrate pumps at a fixed speed of 900 gpm each.
- Maintain a mixed liquor of at least 2,000 during the warm weather up to a mixed liquor of 4,500 mg/L during the coldest weather.
- Perform sludge wasting over a 24-hour period with an equal amount of sludge being wasted each hour.
- Maintain at least two aerated sludge holding tanks on-line at all times so that wasting can occur over 24 hours.
- Maintain steady daily wasting volumes and only increase/decrease the daily waste volume by small increments so as not to disrupt the system.
- Add PAC chemical to the floc tank at a rate of 20 gallons/day split evenly to the two tanks.
- Add magnesium hydroxide to the two floc tanks split evenly at a rate necessary to maintain effluent alkalinity above 60 mg/L.
- Monitor effluent ammonia, nitrite, nitrate, and alkalinity on a daily basis and provide the data to Underwood Engineers for review and comment.

BIOLIGICAL PILOT RESULTS:

The biological pilot originally commenced in November of 2018, but due to plant upsets caused by the transfer of media and mixed liquor back and forth between the trains several times to construct the upgrades and due to the cold weather, the plant was not able to maintain nitrification. Then in December of 2018, a significant nocardia outbreak occurred which resulted in significant foaming in the IFAS tanks and carryover of that foam into the sludge tanks and BNR tanks. Over the next two months, significant efforts went into trying to rid the plant of the nocardia without wasting all of the solids out of the system since the solids were needed in the cold weather to commence nitrification. Ultimately, the plant was forced to perform aggressive wasting and then by re-commencing PAC addition was able to clear up the nocardia outbreak.

The biological pilot was restarted in March 2019. Over the first several months, the plant worked to build up its mixed liquor mass in a gradual fashion, keeping a close eye on the presence of nocardia. Underwood believes that a change recommended at the Martins Ferry Pump Station to allow grease and buildup in the wetwells to continuously pass through the system as opposed to holding it all back and flushing it through all at once as a slug load, helped prevent the reoccurrence of significant nocardia foam in the system. Without a doubt, the continued use of PAC chemical was also a deterrent.

As June 2019 approached and wastewater temperatures began to increase as did the mixed liquor mass, the system began to nitrify again. By late June 2019, the system was fully nitrifying to an ammonia of less than 1 mg/L. As the summer went on and the wastewater temperatures continued to rise, Underwood worked with HSC to waste additional solids and reduce the mixed liquor from 4,500 mg/L down to approximately 2,000-2,500 mg/L. This worked excellent to fully nitrify throughout the summer.

As fall approached and wastewater temperatures began to drop, Underwood coordinated with WWTF staff to start decreasing daily waste sludge volumes to allow the MLSS mass to build back up. Unfortunately, we waited a little too long to make significant changes and it wasn't until late October that larger adjustments were made which did not keep up with the rapidly decreasing wastewater temperature which happened earlier than normal in the fall of 2019. As a result, the plant came close to losing full nitrification and effluent ammonia levels reached 10 mg/L on December 18, 2019. By January 2020 the MLSS had been grown to 4,500 mg/L+ and the effluent ammonia was consistently below 5 mg/L. Wastewater temperature bottomed out at 10 deg C in early February and has stayed there since. At this coldest point we have found that we need to run at an aerobic mixed liquor biomass solids retention time (SRT) of 6.0 days to fully nitrify to less that 1.0 mg/L. For the last two weeks of the pilot (Mar 1-15, 2020), we have been fully nitrifying to less than 1 mg/L effluent ammonia at 10 deg C.

It is also important to note that the IFAS media biomass has continued to increase throughout the pilot. This has certainly contributed to the results that have been achieved over the last few weeks. At the start of the biological pilot, the mass on the media was low given that the media consisted of a mixture of clean media from IFAS Train 1 and media from IFAS Train 2 that had growth on it. As there was more clean media placed in IFAS Train 1, that train is still catching up to IFAS Train 2. As of early March 2020, the media biological mass in IFAS Train 1 and 2 was 3,000 pounds and 4,200 pounds, respectively. Based on historical data with only one IFAS train operating, the winter media biomass topped out between 8,000 and 10,000 pounds so we believe that the current levels are approaching the peak, but may take another annual cycle to reach previous levels.

Figures 1-4 in **Appendix B** present the waste sludge flow rate, IFAS tank MLSS, IFAS tank MLSS SRT, IFAS media mass, and effluent ammonia trends seen during the pilot period as discussed above.

BIOLIGICAL PILOT CONCLUSIONS:

During previous work, an influent wastewater characterization study was performed. Based on the data from that study and a desired annual average design flow of 1.6 MGD for the upgrade, Underwood was able to calculate the required loading rate at current conditions to mimic future conditions with less M-chip media in the tanks (30% fill fraction in four tanks vs. future 35% fill fraction in six tanks). ***Table 1*** below presents the future design criteria for the fully-upgraded facility, the design criteria for the four tank biological pilot study, and the actual loading rates that occurred in the four tanks over the one-year biological pilot period.

TABLE 1 – PLANT LOADINGS

Parameter	2040 20-YR Design	2019 Pilot Design	2019 Pilot Data	Design/Data
Avg Day Eff (Inf) Flow (MGD)	1.60	0.67	0.65	0.97
Avg Day Influent BOD mg/L (lbs/d)	246 (3,283)	246 (1,375)	281(1,294)	0.94
Max Month Influent BOD mg/L (lbs/d)	290 (3,870)	290(1,620)	379(1,710)	1.06
Avg Day Influent TSS mg/L (lbs/d)	247 (3,296)	247 (1,380)	290(1,315)	0.95
Max Month Influent TSS mg/L (lbs/d)	290 (3,870)	290 (1,620)	409(1,738)	1.07
Avg Day Influent TKN mg/L (lbs/d)	46 (614)	46 (257)	46(237)	0.92
Max Month Influent TKN mg/L (lbs/d)	54 (721)	54 (302)	56(294)	0.97
Avg Day Influent TP mg/L (lbs/d)	6 (80)	6 (34)	6(31)	0.91
Max Month Influent TP mg/L (lbs/d)	7 (93)	7 (39)	7(38)	0.97

*Note: Pilot data period was March 15, 2019 – March 15, 2020

As can be seen from ***Table 1***, the actual loads during the pilot were very close to the design load goals, all within 9% of the goal. (Note: In column 5, a value less than 1.0 means the pilot load was less than the design load and a value greater than 1.0 means the pilot load was greater than the design load). Over the one-year pilot period, IFAS tank wastewater temperatures varied from as high as 22 degrees C to as low as 9 degrees C. This is the normal range seen by the treatment facility and exactly what the pilot was meant to encompass, especially in terms of the low temperature at 10 degrees C. The goal of the biological pilot was to prove that four IFAS tanks with 30% media fill fraction could treat influent loads equivalent to design loads for BOD and TSS and fully nitrify ammonia down to 10 deg C without requiring mixed liquors significantly greater than 4,500 mg/L. ***Table 2*** below summarizes operating and performance data for the first two weeks of March 2020 when the process was stabilized with wastewater temperatures at 10 degrees C.

TABLE 2 – BIOLOGICAL PILOT DATA FOR MARCH 1-15, 2020

Parameter	Pilot Data	Pilot/Exist
Effluent (Influent Flow), MGD	0.70	1.04
Influent BOD, LBS/D	1,296	0.94
Influent TSS, LBS/D	1,088	0.79
Influent TKN, LBS/D	215	0.84

Influent TP, LBS/D	44	1.30
IFAS Tank MLSS, mg/L	4,825	1.07
Total IFAS Media Mass, LBS	7,800	NA
IFAS MLSS SRT, days	5.2	0.87
Wastewater Temperature	10	1.00
Effluent BOD, mg/L	11	NA
Effluent TSS, mg/L	12	NA
Effluent Ammonia, mg/L	0.4	NA
Effluent Total Phosphorus, mg/L	0.6	NA

From Table 2, it can be seen that the biological pilot met the intended goal of achieving <1.0 mg/L effluent ammonia at 10 deg C with MLSS within 7% of 4,500 mg/L. For additional data, please refer to ***Appendix C*** which contains multiple charts of plant operations and performance data during the entire pilot period.

RECOMMENDATIONS:

Based on the one-year long biological pilot and the data collected, Underwood's recommendations are as follows:

- HSC should approve Underwood to submit this technical memo to NHDES to request concurrence with the pilot test conclusions and request authorization to proceed with a full-scale upgrade of the plant, implementing changes similar to that piloted.
- Upon receipt of approval from NHDES, authorize Underwood to begin engineering on the full upgrade of the plant to add two new IFAS tanks upstream of the existing tanks and the necessary hydraulic upgrades required to pass peak flows associated with an annual average daily flow of 1.6 MGD through new headworks, existing BNR tanks, the new IFAS tanks, and existing IFAS Train 1.

APPENDIX A

2160.08

HOOKSETT, NH – HOOKSETT SEWER COMMISSION (HSC)

FULL-SCALE PILOT PREPARATION AND PROCEDURES

PHASE 3 CAPITAL IMPROVEMENTS

(11/30/18)

After construction of the Phase 3 Capital Improvements is completed, a full calendar year of full-scale piloting will be performed to confirm the hydraulic and organic capacity of the modified IFAS System. The following paragraphs describe the procedures proposed for accomplishing full-scale confirmation of the upgrade.

IFAS Media Fill Fraction

The IFAS media fill fraction plays a very significant role in the system. The fill fraction affects both the hydraulic capacity and the organic capacity of the plant. Therefore, it is important to establish the correct fill fraction for the full-scale piloting at today's flows and loads so that it will be directly scalable to the future desired flows and loads. Under previous reports, Underwood has projected through modeling that a media fill fraction of 35% in a total of six (6) IFAS basins sized to match the existing IFAS basins will allow an average daily flow of 1.6 MGD to be treated to an ammonia level of 1.3 to 2.3 mg/L at 10°C. This does not quite meet the <1.0 mg/L goal, but that is all the media the HSC has and purchasing additional M-chip media is not an option. Given how close the modeled performance is to the desired goal at 10°C and the fact that if the HSC eventually gets an ammonia or total nitrogen limit it will not be year-round, piloting will be performed at the equivalent of a 35% fill fraction.

Based on the above, at a 35% fill fraction, each tank should be capable of treating the equivalent of 1/6 of 1.6 MGD or 0.27 MGD. This is problematic in that running one (1) train with two (2) IFAS tanks at 35% fill fraction would provide a capacity of 0.54 MGD while running both trains with four (4) IFAS tanks at 35% fill fraction would provide a capacity of 1.08 MGD. The current average daily flow to the Hooksett facility is 0.67 MGD which falls in the middle of those two scenarios.

Because one train at 35% fill fraction is not enough to achieve the desired treatment at today's flow, it will be necessary to conduct the organic pilot testing and the hydraulic pilot testing independently at different fill fractions. Underwood has modeled the plant at 0.67 MGD and projects that a fill fraction of 30% across two trains (4 IFAS tanks) will be able to meet the goal of <1.0 mg/L ammonia at 10°C. However, it is still recommended that hydraulic testing be performed at a 35% fill fraction as described later in the text.

For reference, the following table presents both the true and effective surface area available based on various media fill fractions at Hooksett.

Tank ID	Tank Volume, m3	Fill Fraction	True SA, m2	Assumed Effective SA Fraction	Effective SA, m2
2014 Evaluation/Calibration/Validation					
IFAS 3	227.65	0.55	150,249	0.5	75,125
IFAS 4	221.69	0.52	138,335	0.5	69,167
Total	**449.34**		**288,584**		**144,292**
IFAS 3	227.65	0.55	150,249	0.74	111,184
IFAS 4	221.69	0.52	138,335	0.74	102,368
Total	**449.34**		**288,584**		**213,552**
Oct 2016 Est					
IFAS 3	227.65	0.55	150,249	0.74	111,184
IFAS 4	221.69	0.52	138,335	0.74	102,368
Total	**449.34**		**288,584**		**213,552**
2017 Pilot - Organic					
IFAS 3	227.65	0.3	81,954	0.74	60,646
IFAS 4	221.69	0.3	79,808	0.74	59,058
Total	**449.34**		**161,762**		**119,704**
2017 Pilot - Hydraulic					
IFAS 3	227.65	0.35	95,613	0.74	70,754
IFAS 4	221.69	0.35	93,110	0.74	68,901
Total	**449.34**		**188,723**		**139,655**

** Carrier is Type M (1200 m2/m3)
*** Specific volume = 0.23 m3/m3
SA = Surface Area

<u>Full-Scale Organic Pilot Testing</u>

Under the Phase 3 Capital Improvements Project, the Contractor removed, dried out, bagged, and transported to storage all IFAS media from IFAS Train No. 1 which had been offline and was mostly free of bacterial growth. At the end of the Phase 3 Capital Improvements Project, the active media in IFAS Train No. 2 was distributed through both trains and some of the stored media was added back in to achieve the 30% fill fraction in all four tanks.

In order to perform a full-scale pilot that will be reflective of future desired conditions, Underwood recommends that sludge wasting be performed 24 hours/day utilizing all three (3) available sludge holding tanks. Given that two (2) of the sludge holding tanks could not be used due to leaking underground piping, the Phase 3 Capital Improvements included sealing these lines. Return activated sludge (RAS) rates are recommended to be paced off of effluent flow and should be kept high enough to maintain minimum sludge blankets in the clarifiers so that the mixed liquor organisms are kept within the bioreactors where they are needed to do work. Waste activated sludge (WAS) rates should be lowered to that which is necessary to allow wasting for 15 minutes/hour to maintain the desired aerobic SRT of the system. Because the existing RAS/WAS rate could not be lowered as much as desired due to a high point in the existing combination RAS/WAS line, the Phase 3 Capital Improvements project included installing an automatic air relief valve at the high point in this line.

The anticipated final completion of the Phase 3 Capital Improvements is December 15, 2018. Underwood recommends operating the full-scale organic pilot from December 2018 to December 2019. The rationale for running for a full year is to see the effects of seasonal variations not only in terms of flow and wastewater temperature but in terms of the shift of microbial population from mixed liquor to fixed film as has been observed at the Hooksett facility.

Pre-August 2017, the peak forward flow through the IFAS tanks was limited to 2.4 MGD through one (1) train. This is accomplished by reducing the nitrate recycle rate when influent flows become too high. With the recent addition of air spargers to the screens in IFAS Train No. 1 (August 2017), two (2) trains can now be operated, and the peak hydraulic flow capacity doubles to 4.8 MGD (and has increased even more with the additional screens added to IFAS Train No. 2 under the Phase 3 Capital Improvements). Underwood recommends that the SCADA programming and setpoints be revised so that during the pilot the RAS rate be set at 50% and the nitrate recycle rate be set at 137.5% of effluent flow and that the peak rate for RAS be locked out at 0.83 MGD and nitrate recycle be locked out at 2.3 MGD. This would allow an influent flow of up to 1.67 MGD to be passed with appropriate RAS and nitrate recycle rates before intervention would need to occur to prevent forward flows from exceeding 4.8 MGD combined. At influent flows above 1.67 MGD, the nitrate recycle pumps could be temporarily shut off. NOTE: RAS should not be shut off; this will require a change at SCADA.

Another issue that needs to be addressed in order for the full-scale pilot to be representative of desired future conditions is alkalinity. The wastewater alkalinity needs to be maintained at a sufficient residual to prevent inhibition of the nitrification process. In past reports, Underwood has noted that the Hooksett effluent alkalinity has commonly dropped below 50 mg/L. As a result, the Phase 3 Capital Improvements added a new alkalinity feed system for the plant. During the pilot, this alkalinity feed system should be operated to maintain a minimum effluent residual alkalinity of 60 mg/L.

During the one-year organic pilot testing period, Hooksett should collect composite influent and effluent samples for analysis by an outside laboratory once per week, along with their regular permit data collection. The following data should be collected:

Influent: COD/BOD5/TSS/VSS/TKN/NH3N/TP/Alkalinity

Effluent: BOD5/TSS/TKN/NH3N/TP/Alkalinity

Process: pH, Temp, MLVSS, MLSS, SRT, Biofilm Mass, SVI, plant RAS (concentration and flow, WAS (concentration and flow) and dewatering feed flow, TSS and dewatered cake % solids and hauled wet tons.

Underwood will provide operational advice and assistance to the Town and will review the data being collected on a monthly basis.

Full-Scale Hydraulic Testing

Underwood proposes to perform full-scale hydraulic testing only on Train No. 2 which has been upgraded with additional screens as part of the Phase 3 Capital Improvements. It is proposed that the full-scale hydraulic testing be performed on specific dates by manually inducing the magnitude of the flows desired to match future peak design flows. Hydraulic grade line elevations will be taken during each test at key locations to confirm the accuracy of the calculated hydraulic profile. The duration of each testing event will be between 4-8 hours or that which can be accomplished within a single work day while the plant is manned. The key parameters affecting the hydraulic capacity through the IFAS tanks include water temperature (as it affects the amount of growth on the IFAS media), and the amount of mixing air provided within the basin (which assists in preventing the media from clogging the retention screens). The following hydraulic tests are recommended:

- Summer conditions, warm wastewater, high air flow rate
- Summer conditions, warm wastewater, low air flow rate
- Winter conditions, cold wastewater, high air flow rate
- Winter conditions, cold wastewater, low air flow rate

It is recommended that each hydraulic test be operated for a minim 2-hour period to allow time for stabilization and to confirm whether clogging of the retention screens and backup of wastewater within the IFAS tank occurs at the desired target hydraulic flow. Given that the media fill fraction has been set at 30% for the first year after completion of the Phase 3 Capital Improvements, Underwood recommends that one day of winter hydraulic testing and one day of summer hydraulic testing be done at the 30% fill fraction, and then after the one-year organic full-scale pilot is complete, additional media should be added to IFAS Train No. 2 to increase the fill fraction to 35% in each tank and the hydraulic testing should be repeated under winter conditions.

Regarding the desired hydraulic test flow rate, Underwood via previous reports, has established that the desired peak hourly flow rate recommended for a 1.6 MGD average daily wastewater flow through the IFAS tanks is 9.4 MGD, including RAS and nitrate recycle flows, as can be seen in **Table 1** below.

TABLE 1 - RECOMMENDED PEAK HOUR DESIGN FLOWS

FOR EACH AREA OF THE HOOKSETT WWTF

AREA of PLANT	***GRAVES*** *Peak Hour Design Flow for 2.2 MGD ADF*	***UNDERWOOD*** *Peak Hour Design Flow for 1.60 MGD ADF*
Headworks to SMH C	4.4 MGD Influent **4.4 MGD TOTAL**	5.60 MGD Influent **5.60 MGD TOTAL**
SMH C to Anoxic Reactors 3 & 4	4.4 MGD Influent 2.2 MGD RAS **6.6 MGD TOTAL**	5.60 MGD Influent 1.60 MGD RAS **7.20 MGD TOTAL**
Anoxic Reactors 3 & 4 to Floc Chambers 1 & 2	4.4 MGD Influent 2.2 MGD RAS 2.2 MGD NRCY **8.8 MGD TOTAL**	5.60 MGD Influent 1.60 MGD RAS 2.20 MGD NRCY **9.40 MGD TOTAL**
Floc Chambers 1 & 2 to Clarifiers 1 & 2	4.4 MGD Influent 2.2 MGD RAS **6.6 MGD TOTAL**	5.60 MGD Influent 1.60 MGD RAS **7.20 MGD TOTAL**
Clarifiers 1 & 2 to Merrimack River	4.4 MGD Influent **4.4 MGD TOTAL**	5.60 MGD Influent **5.60 MGD TOTAL**

Full-scale hydraulic testing will be performed on Train No. 2 only as that is the only train that was fitted with the additional screens during the Phase 3 Capital Improvements. During the hydraulic tests, flow to Train No. 1 will be temporarily shut off and all flow will be passed through Train No. 2. Train No. 1 will be isolated by closing the influent gate in the D-box in front of the IFAS tanks and by closing the gate in the secondary clarifier influent D-box coming from Train No. 1.

The recommended forward flow for the tests will be 9.4/2 or 4.7 MGD through Train No. 2. To temporarily achieve this flow, the RAS pump(s) can be turned up to full speed and nitrate recycle pump no. 2 can be turned up to make up the difference so the total of the influent flow, RAS flow and nitrate recycle flow is 4.7 MGD. Total flow will be held as constant as possible at 4.7 MGD for a minimum 2-hour test by adjusting nitrate recycle pump no. 2 flow. During that timeframe, regular measurements of the water elevation in IFAS Tanks 3 and 4 will be taken to verify the headloss occurring and to document any backups which occur within those tanks as a result of retention screen clogging by the media.

APPENDIX B

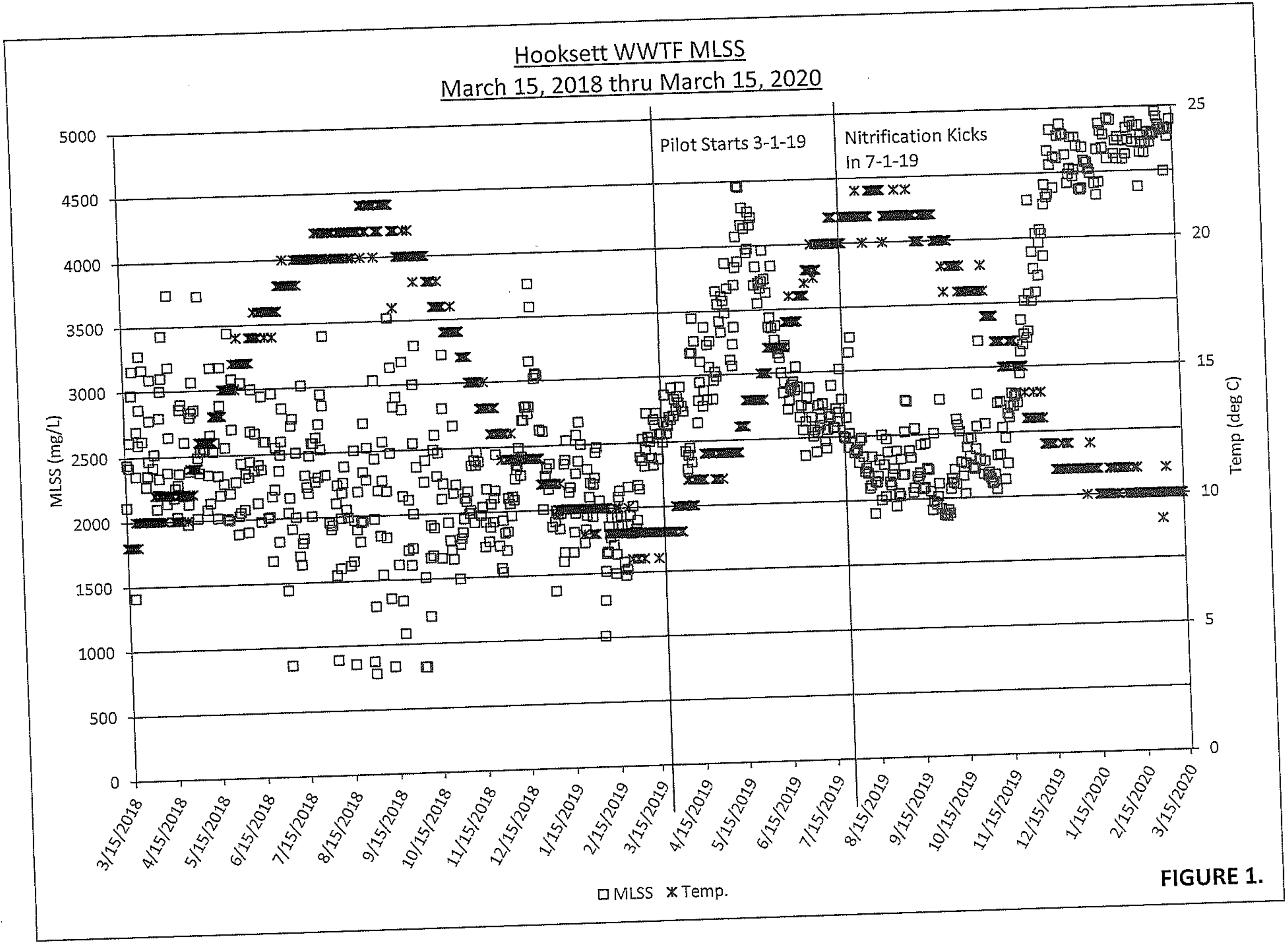


FIGURE 1.

N:\PROJECTS\HOOKSETT, NH\REALNUM\2160 Phase 3 Capital Improvements\08_Comp\Plant Data\2005-2019 Plant Data\

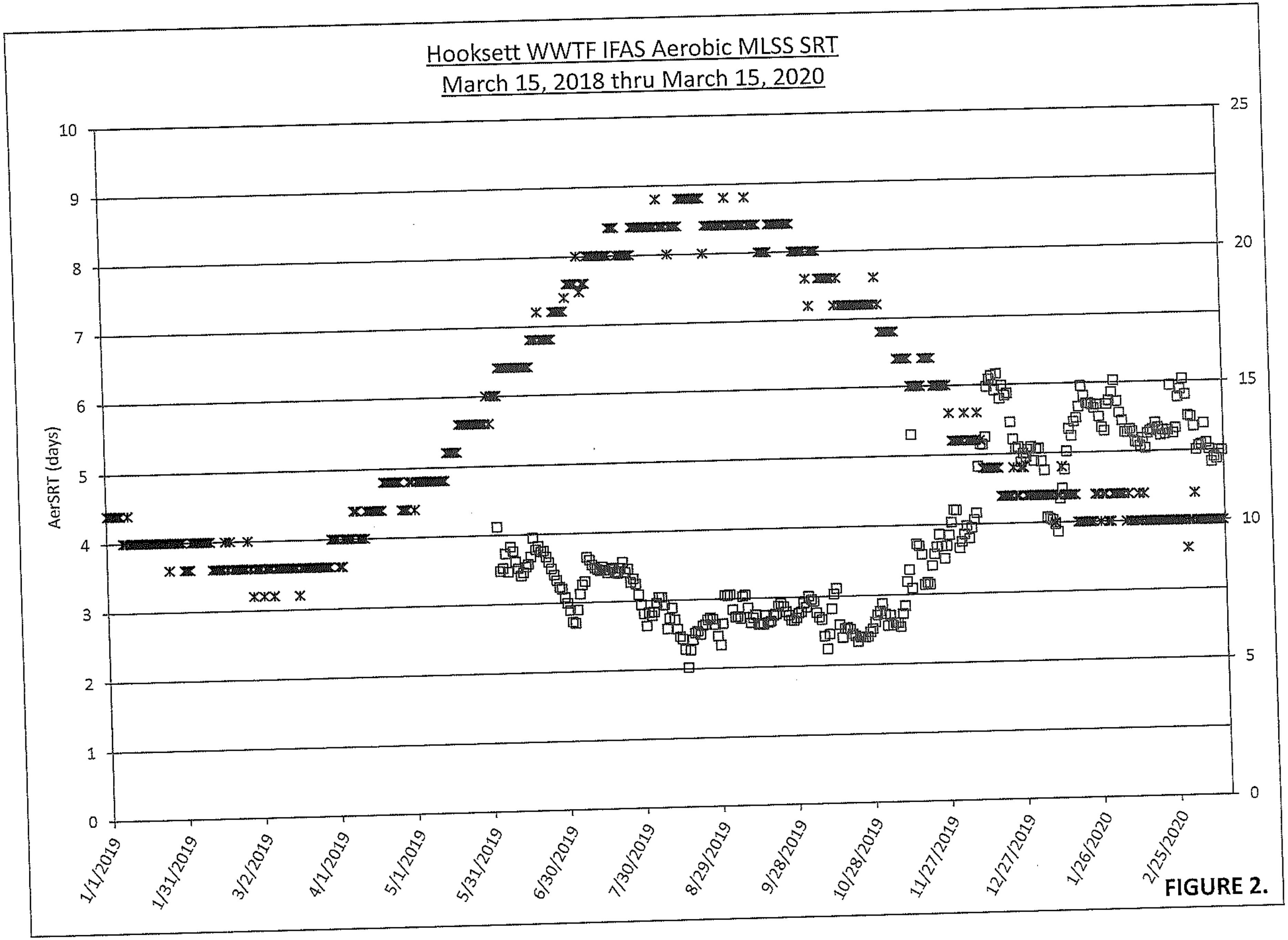


FIGURE 2.

N:\PROJECTS\HOOKSETT, NH\REALNUM\2160 Phase 3 Capital Improvements\08_Comp\Plant Data\2005-2019 Plant Data\June 2005-2020 Plant Data with peaking factors

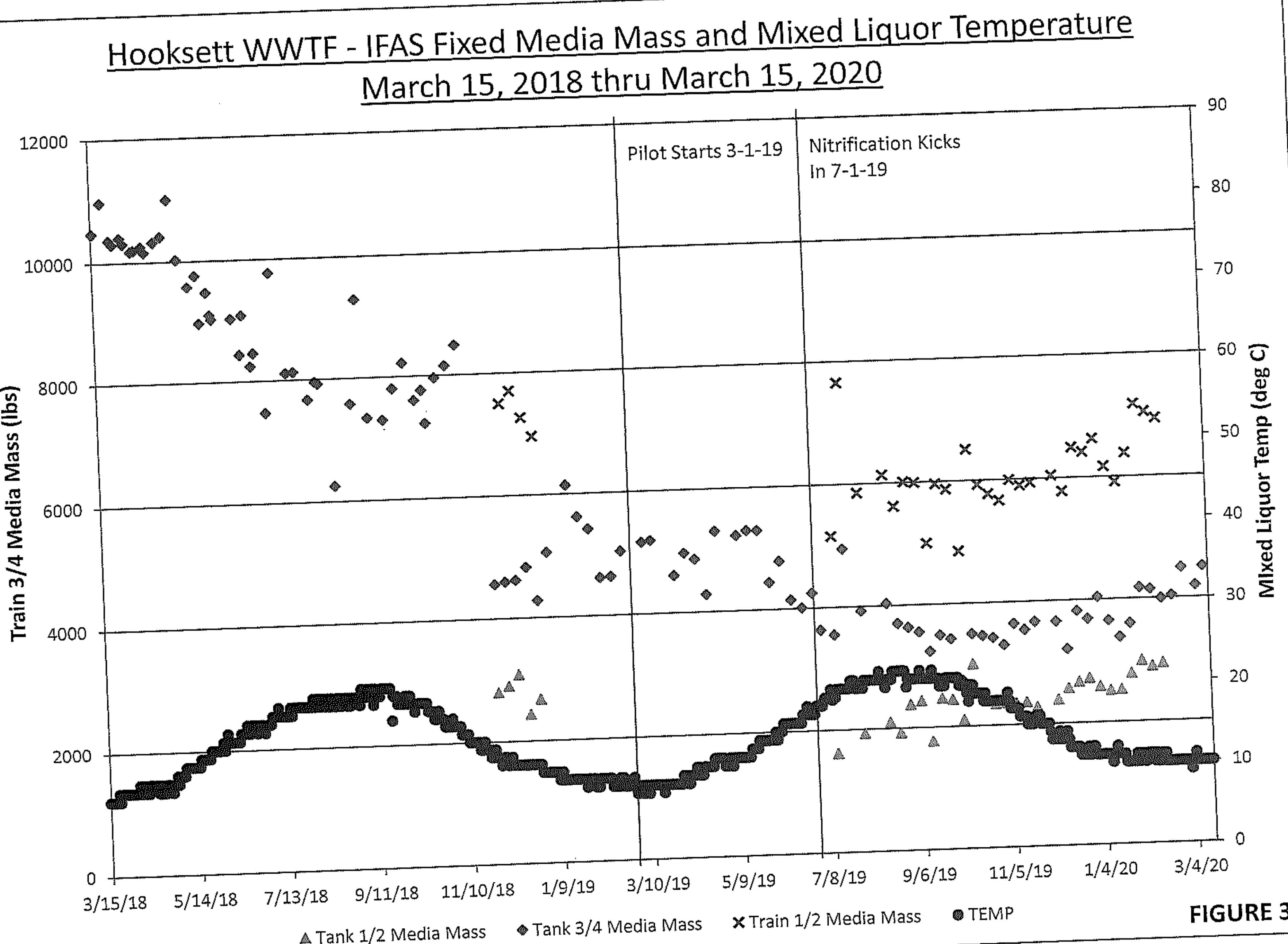


FIGURE 3.

N:\PROJECTS\HOOKSETT, NH\REALNUM\2160 Phase 3 Capital Improvements\08_Comp\Plant Data\2005-2019 Plant Data\June 2005-2020 Plant Data

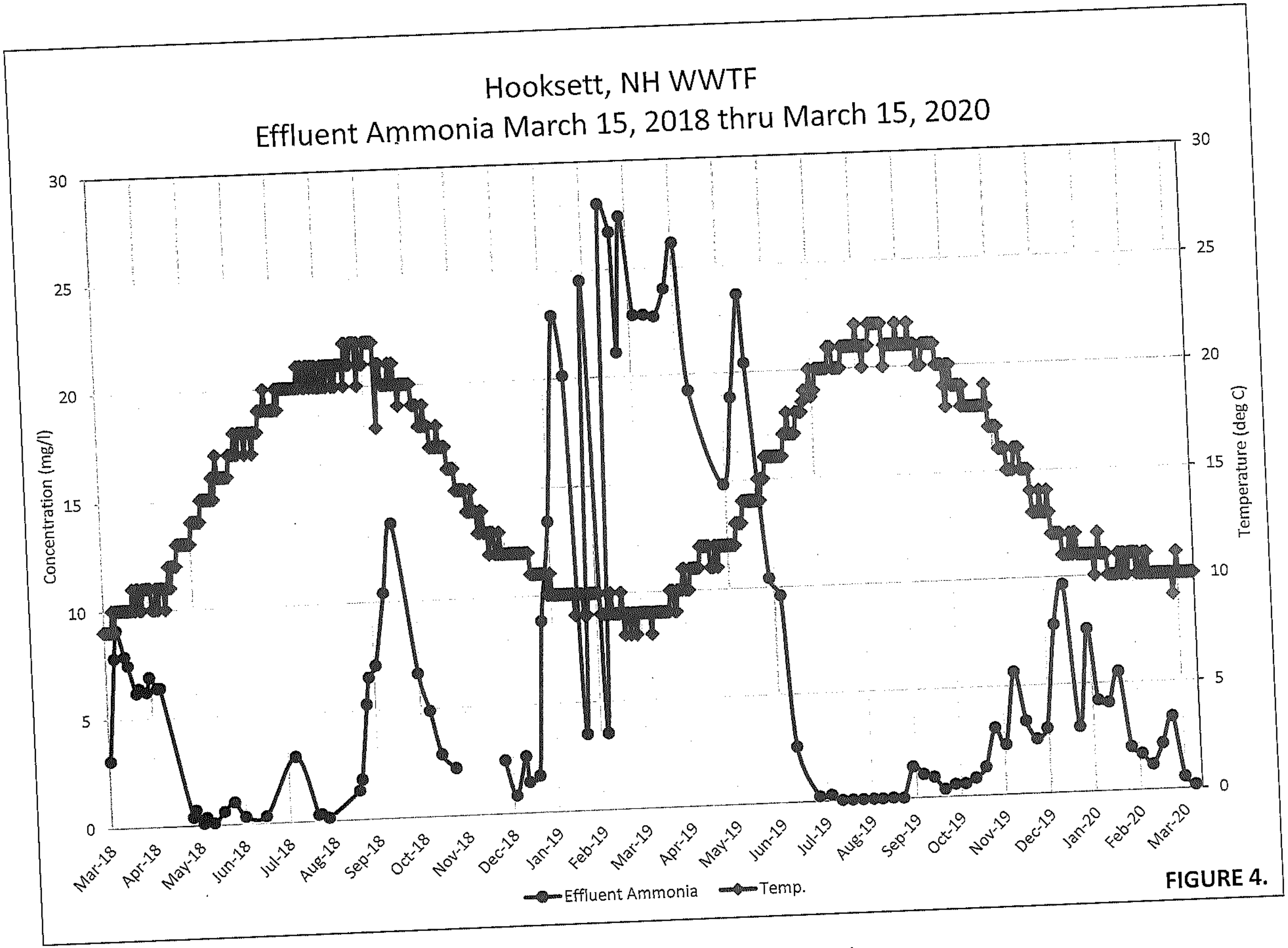
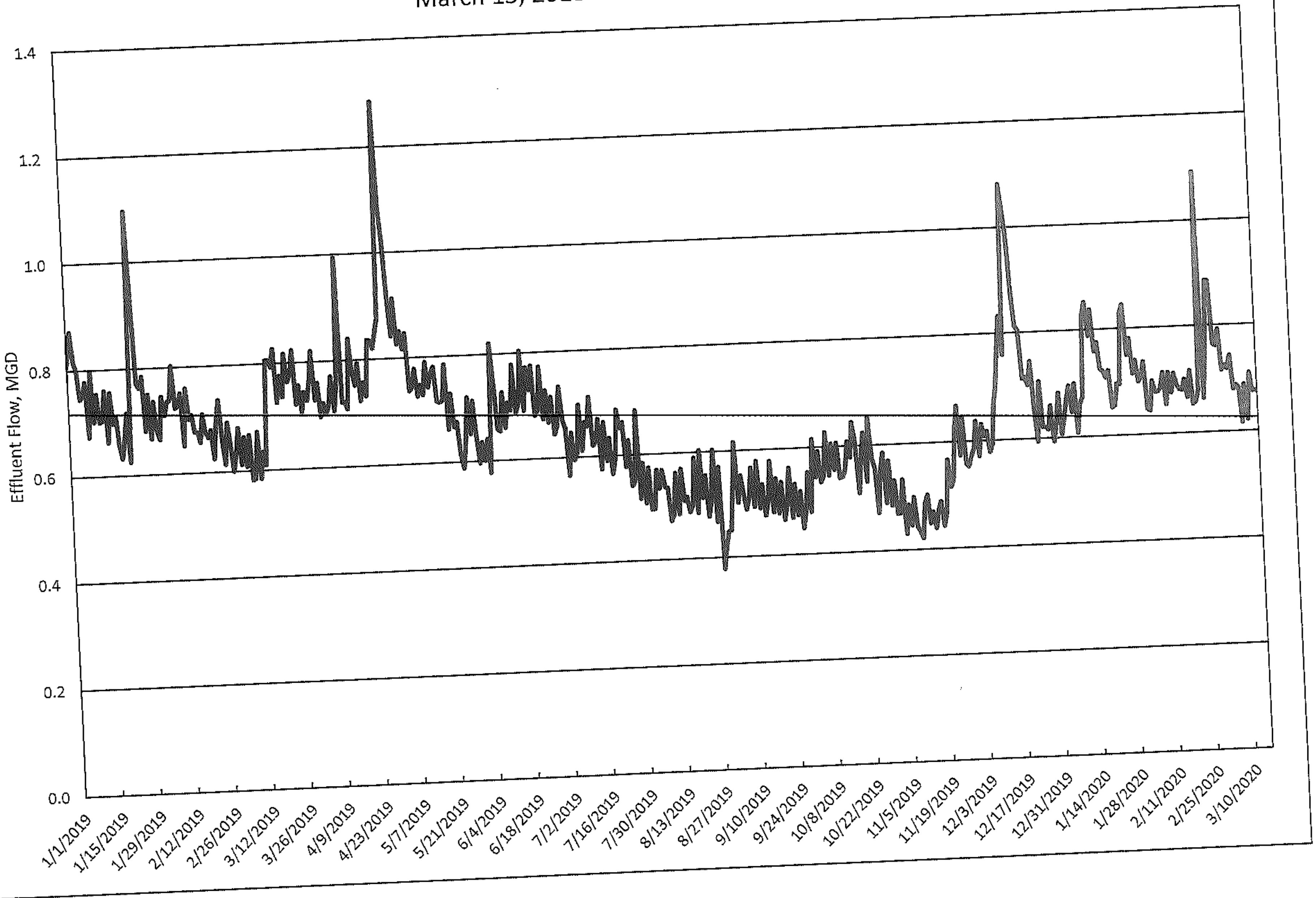


FIGURE 4.

N:\PROJECTS\HOOKSETT, NH\REALNUM\2160 Phase 3 Capital Improvements\08_Comp\Plant Data\2005-2019 Plant Data\

APPENDIX C

Hooksett WWTF Effluent Average Daily Flow
March 15, 2018 thru March 15, 2020



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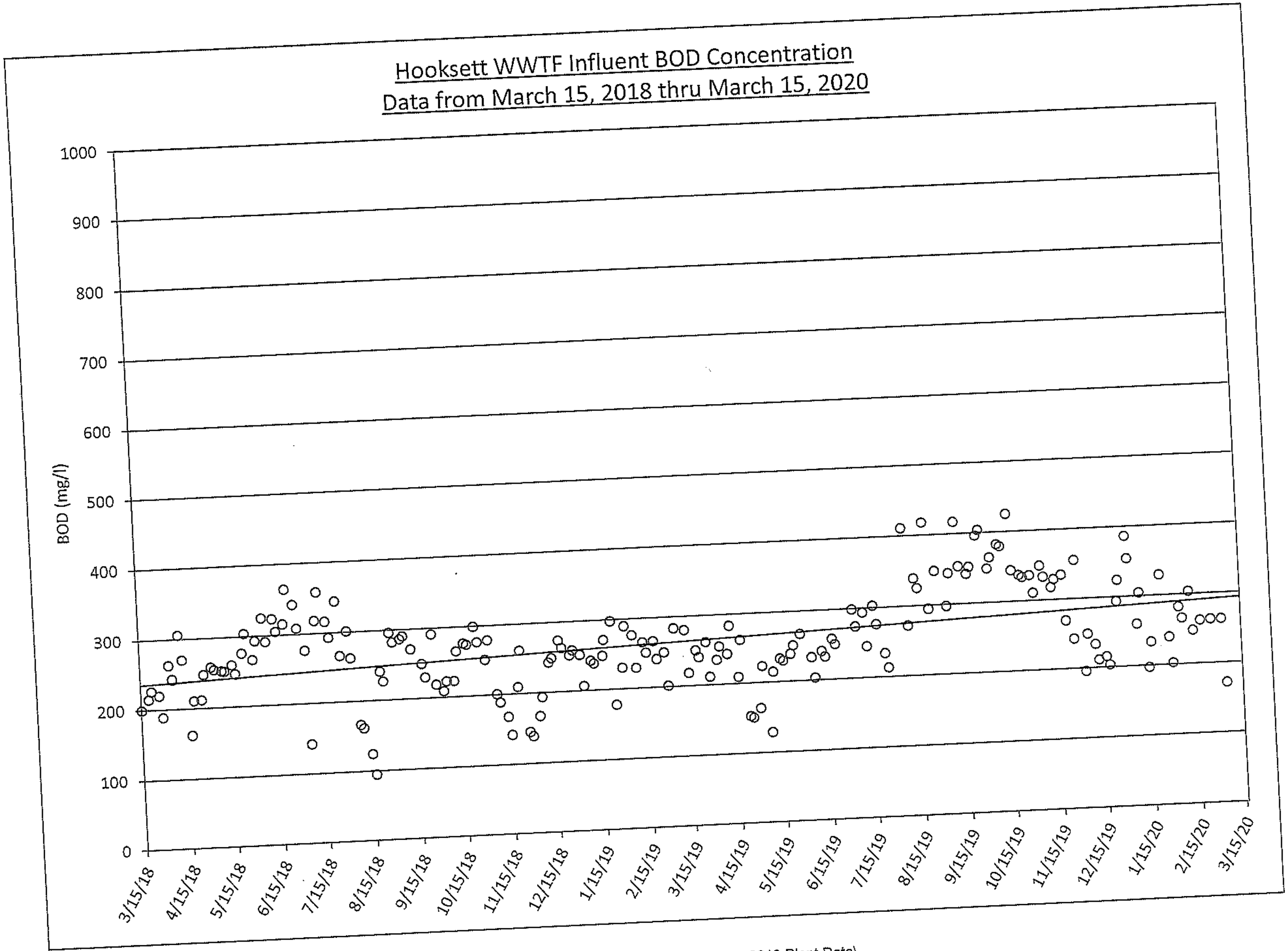

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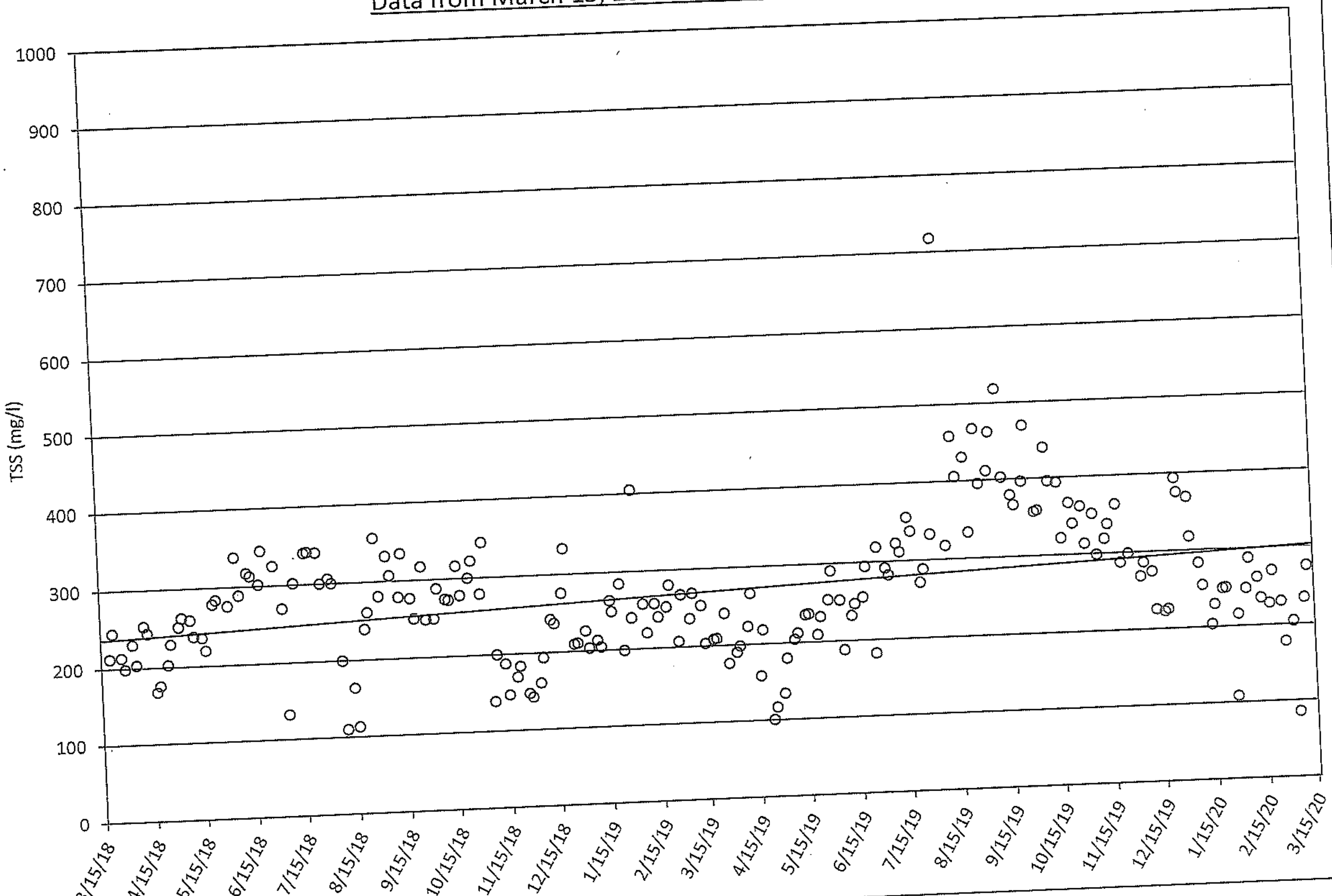
Hooksett WWTF Influent TSS Concentration
Data from March 15, 2018 thru March 15, 2020



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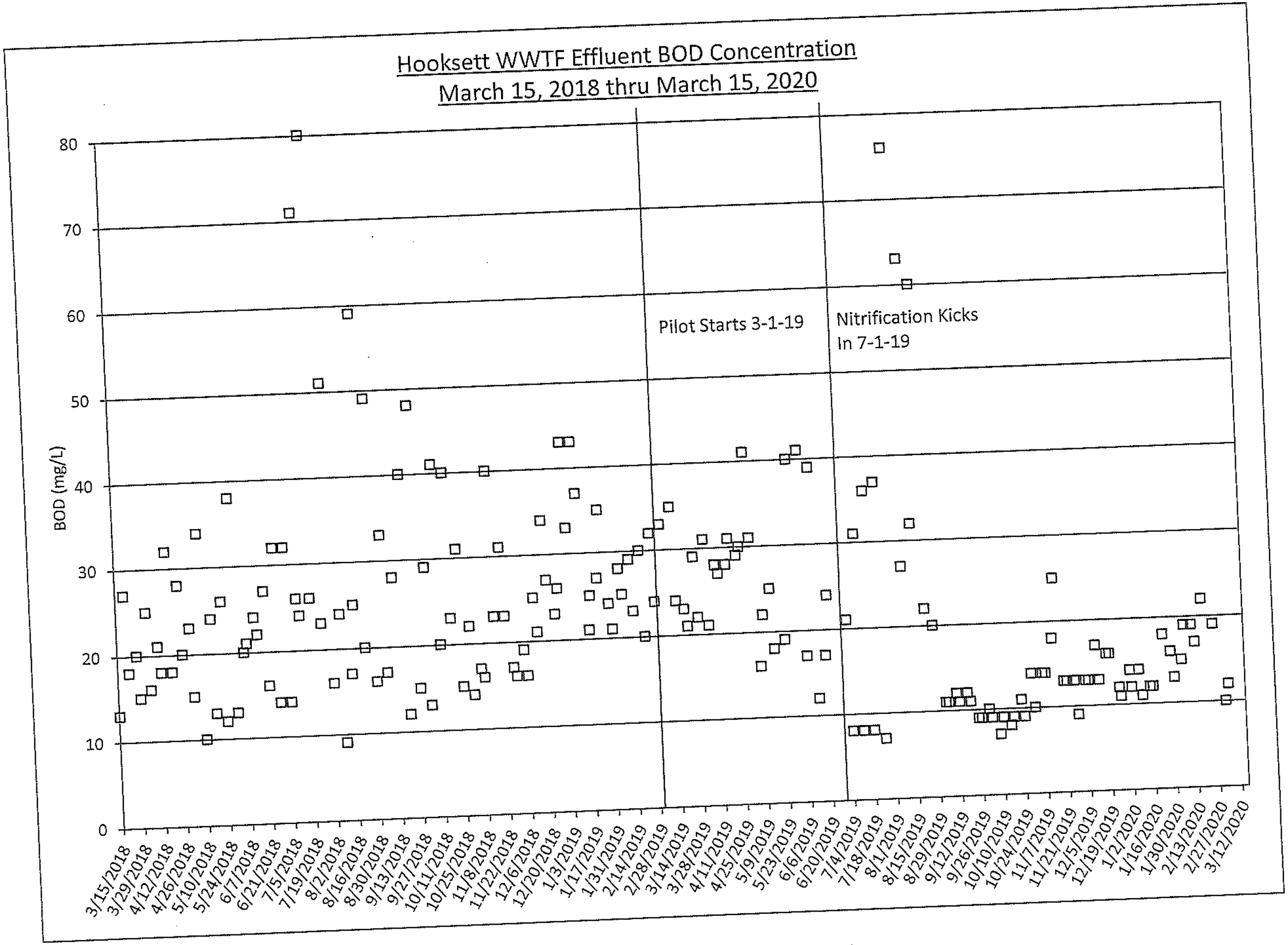

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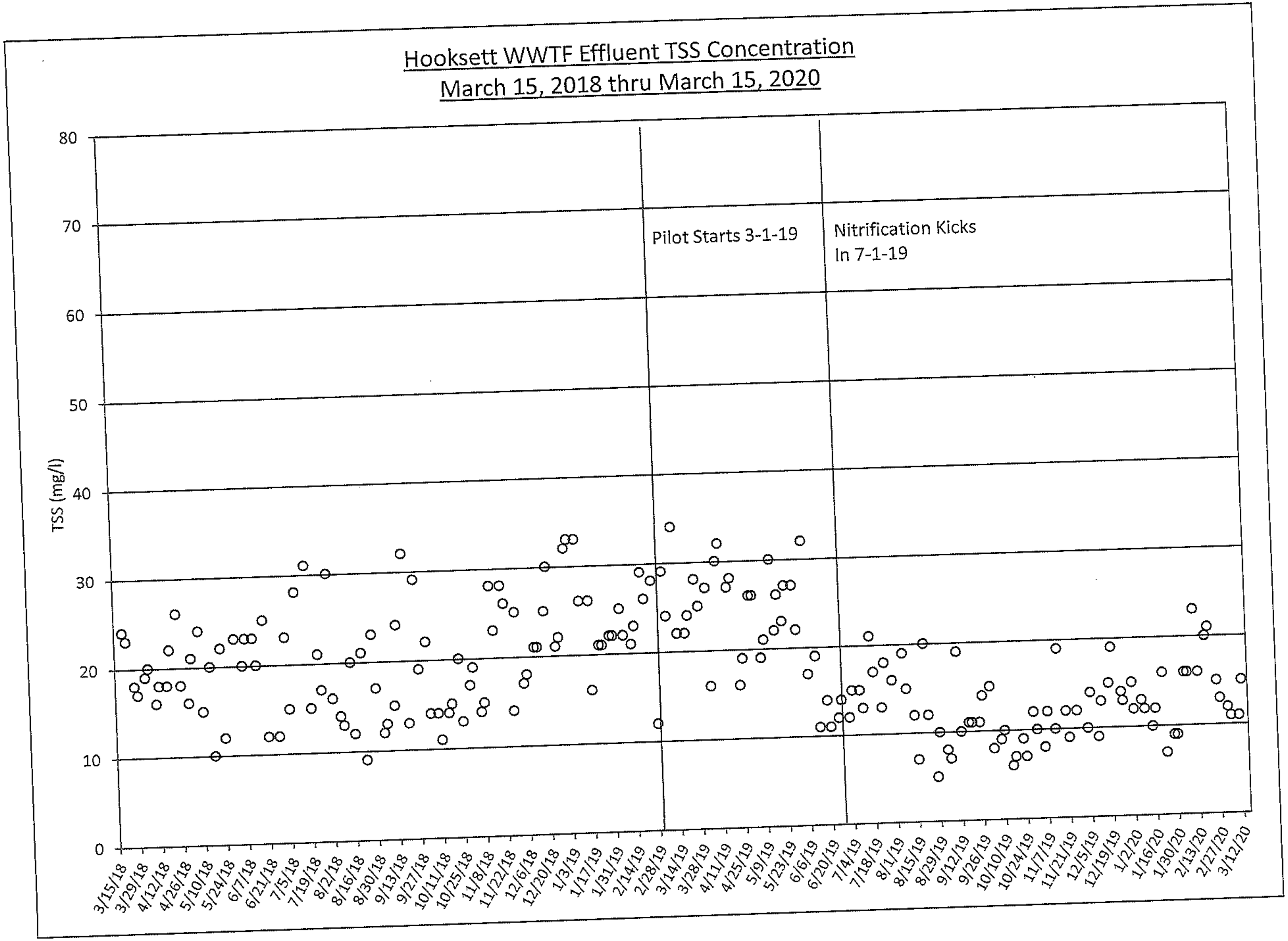

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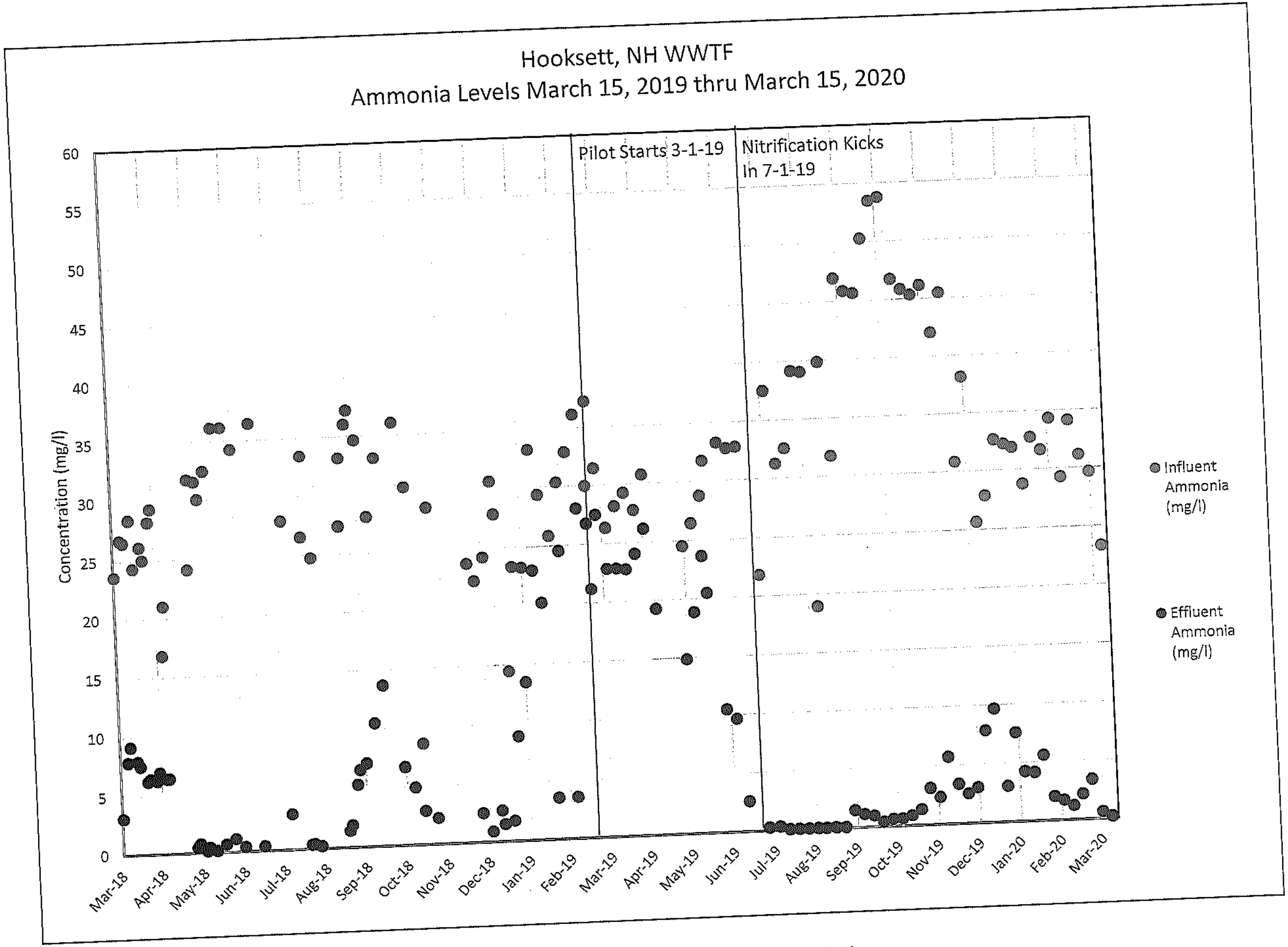
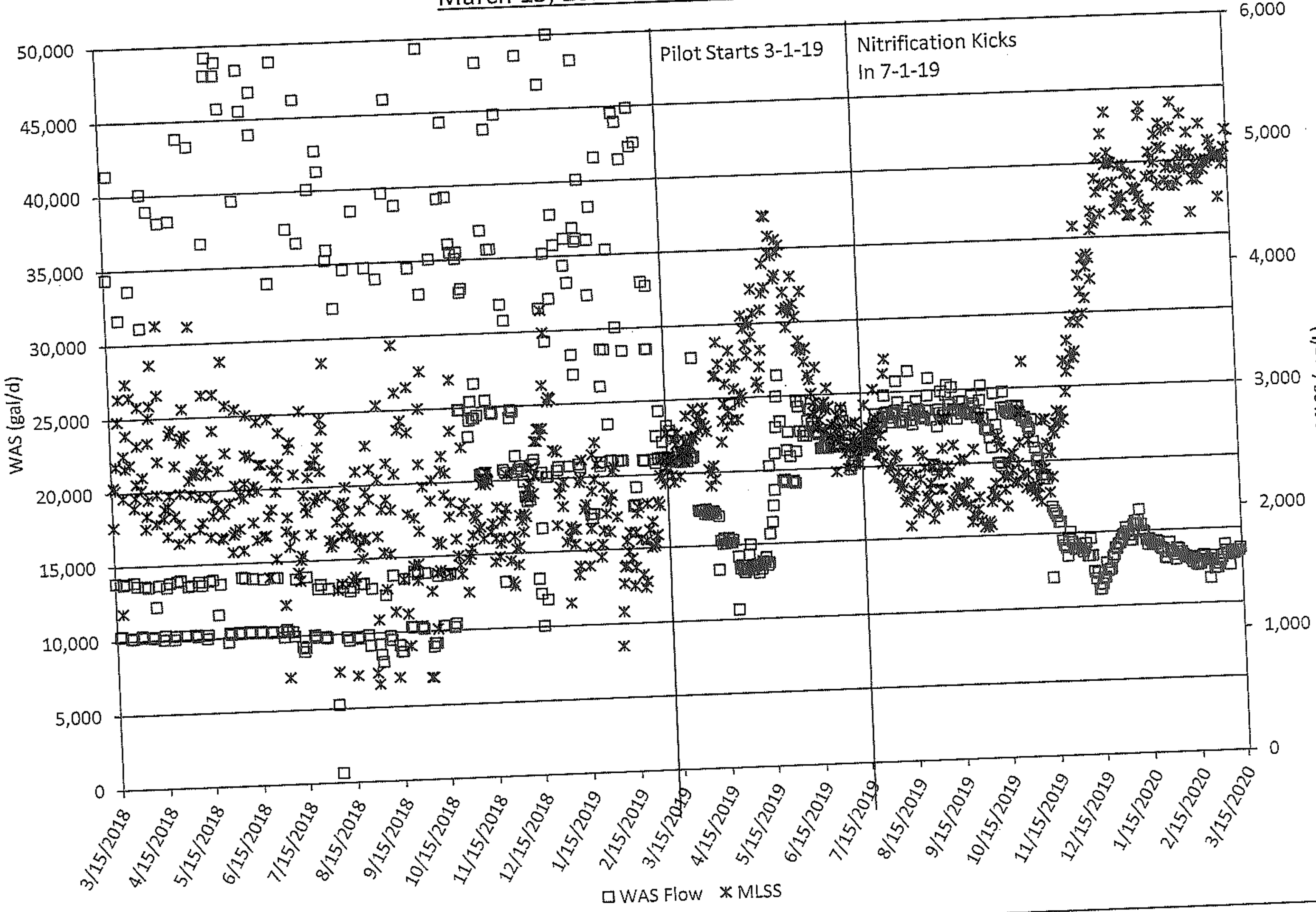

Hooksett, NH WWTF
Ammonia Levels March 15, 2019 thru March 15, 2020
Pilot Starts 3-1-19
Nitrification Kicks In 7-1-19
Concentration (mg/l)
60
55
50
45
40
35
30
25
20
15
10
5
0
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Sep-18
Oct-18
Nov-18
Dec-18
Jan-19
Feb-19
Mar-19
Apr-19
May-19
Jun-19
Jul-19
Aug-19
Sep-19
Oct-19
Nov-19
Dec-19
Jan-20
Feb-20
Mar-20
Influent Ammonia (mg/l)
Effluent Ammonia (mg/l)

Hooksett WWTF WAS Flow vs MLSS Conc
March 15, 2018 thru March 15, 2020



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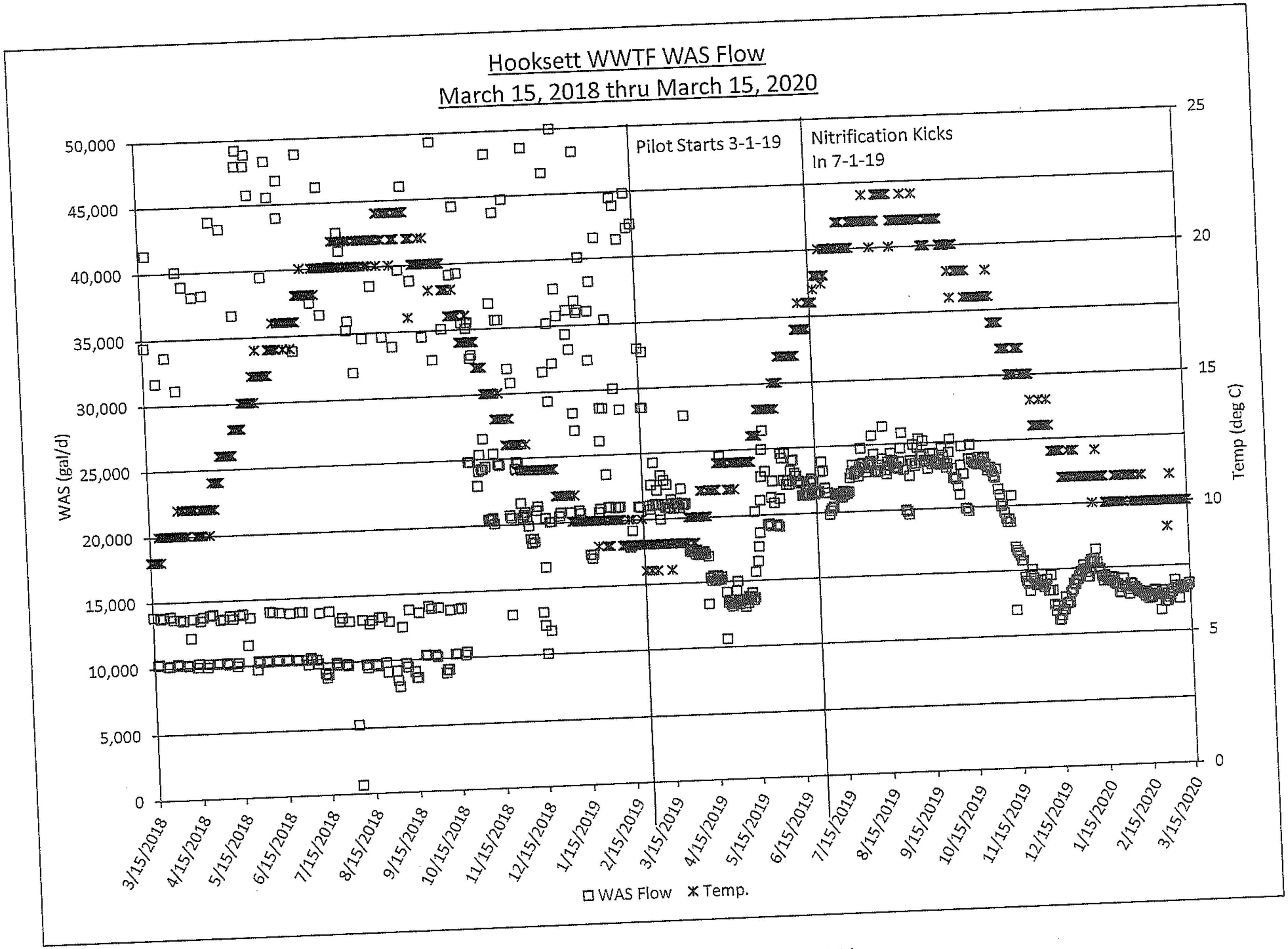

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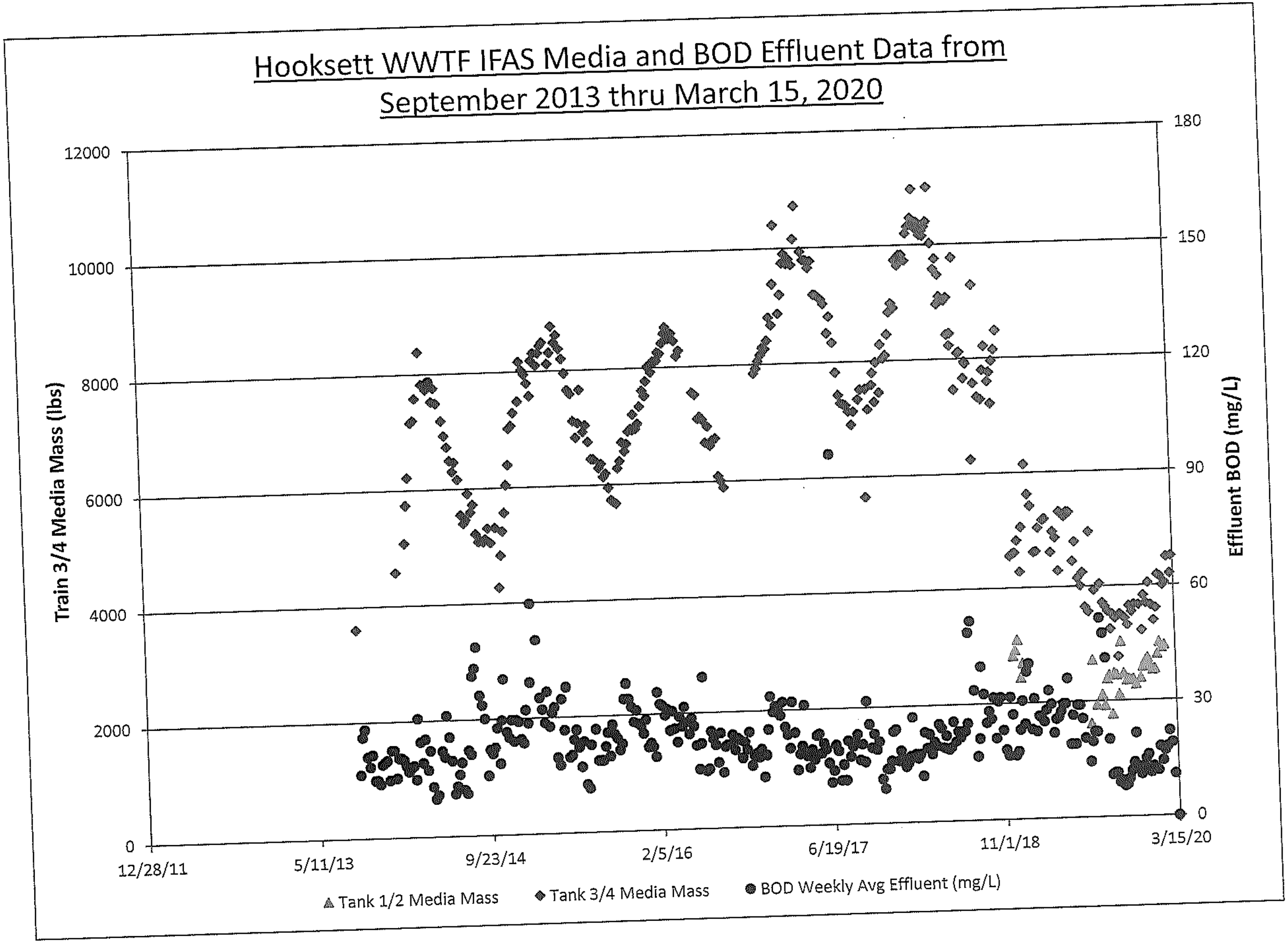

...\HOOKSETT, NH\REALNUM\2160 Phase 3 Capital Improvements\08_Comp\Plant Data\2005-2019 Plant Data\June 2005-2020 Plant Data with peaking factors