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Southern UK biogas site case study overview

Client name redacted version

Changing the world together

Overview

Challenge

Issues with the viscosity of its digestate leading to incomplete AD processing. Resulting in:

- Higher power consumption
- More stoppages and maintenance
- Larger volumes of dry residual solids to be removed
- Lower grade liquid fertiliser
- Fluctuations in biogas yield

Solution

After taking digestate samples and completing a production lifecycle analysis report, Alps Ecoscience proposed a solution incorporating continuous testing, feed stock pre-treatment and patented reactor additives to

- Increase the overall rate of decomposition
- Reduce FOS/TAC
- Increase the CH_4 concentration
- Increase organic loading rate (OLR)

Results

Alps Ecoscience's managed service solution has delivered a stable, hungry anaerobic digester, producing 5% higher methane concentration and 20%+ higher OLR. Commercially this equates to incremental revenue of over £100,000 pa.

Performance summary

- At this Biogas plant, the average daily feed of volatile solid is around 20t VS/d
- Dosing BOC at 10L/d is beneficial for the anaerobic digesters
- During the trial:
  - Biogas produced contains higher percentage of CH_4 (+2% in DG1, +10% in DG2) and lower percentage of H_2S (-29% in DG1, -47% in DG2)
  - FOS/TAC is low and stable (-15% in DG1, -26% in DG2)
  - FOS/TAC is on average 0.28 in both digesters, indicating quicker reduction from biomass to Short Chain Carboxylic Acids (SCCA), and greater conversion to biogas
  - Well buffered system and capable of increasing OLR (approx. +18-23%)
  - Higher VS yield (+3-5%) is likely related to increase in methane purity

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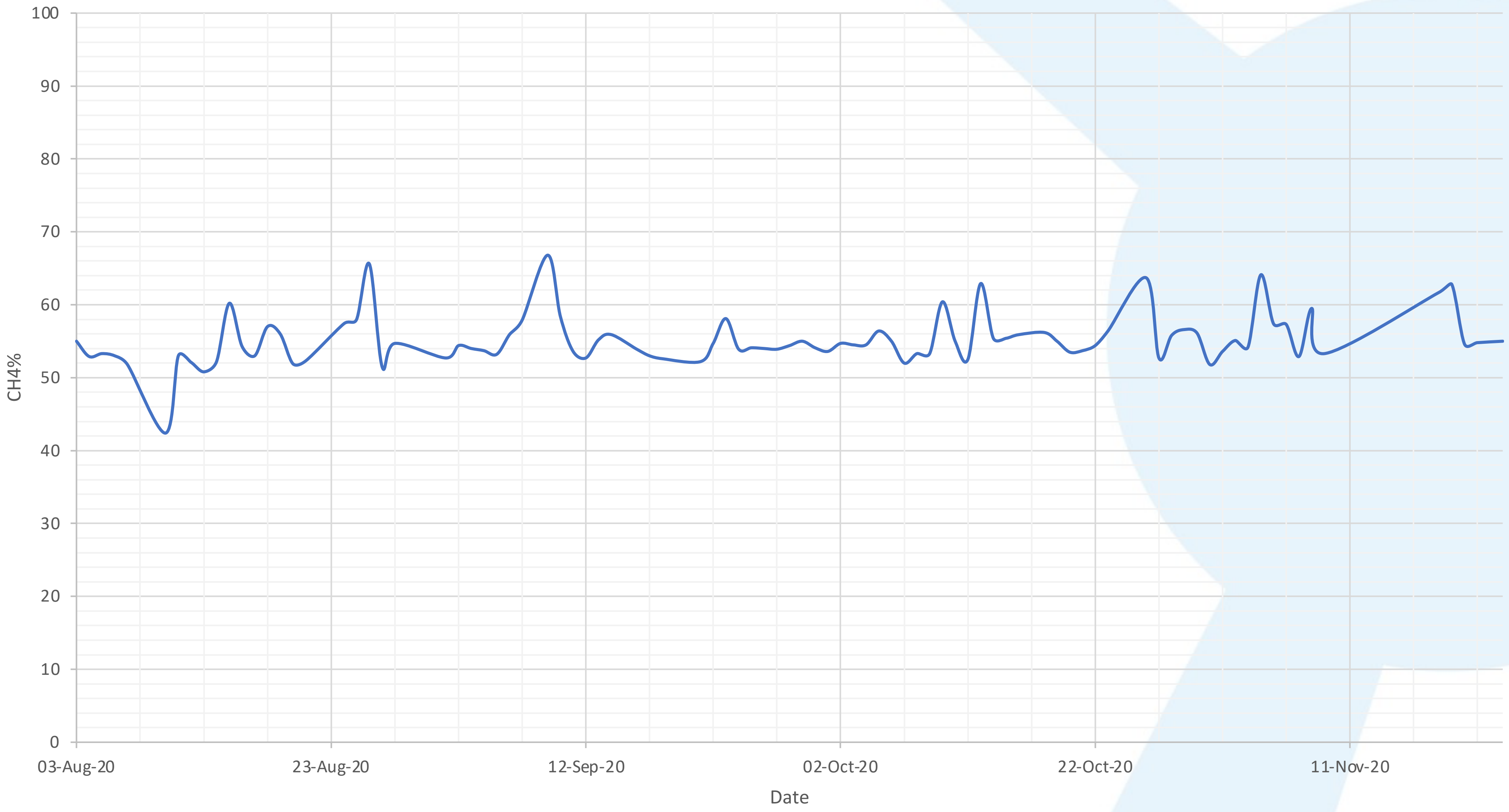
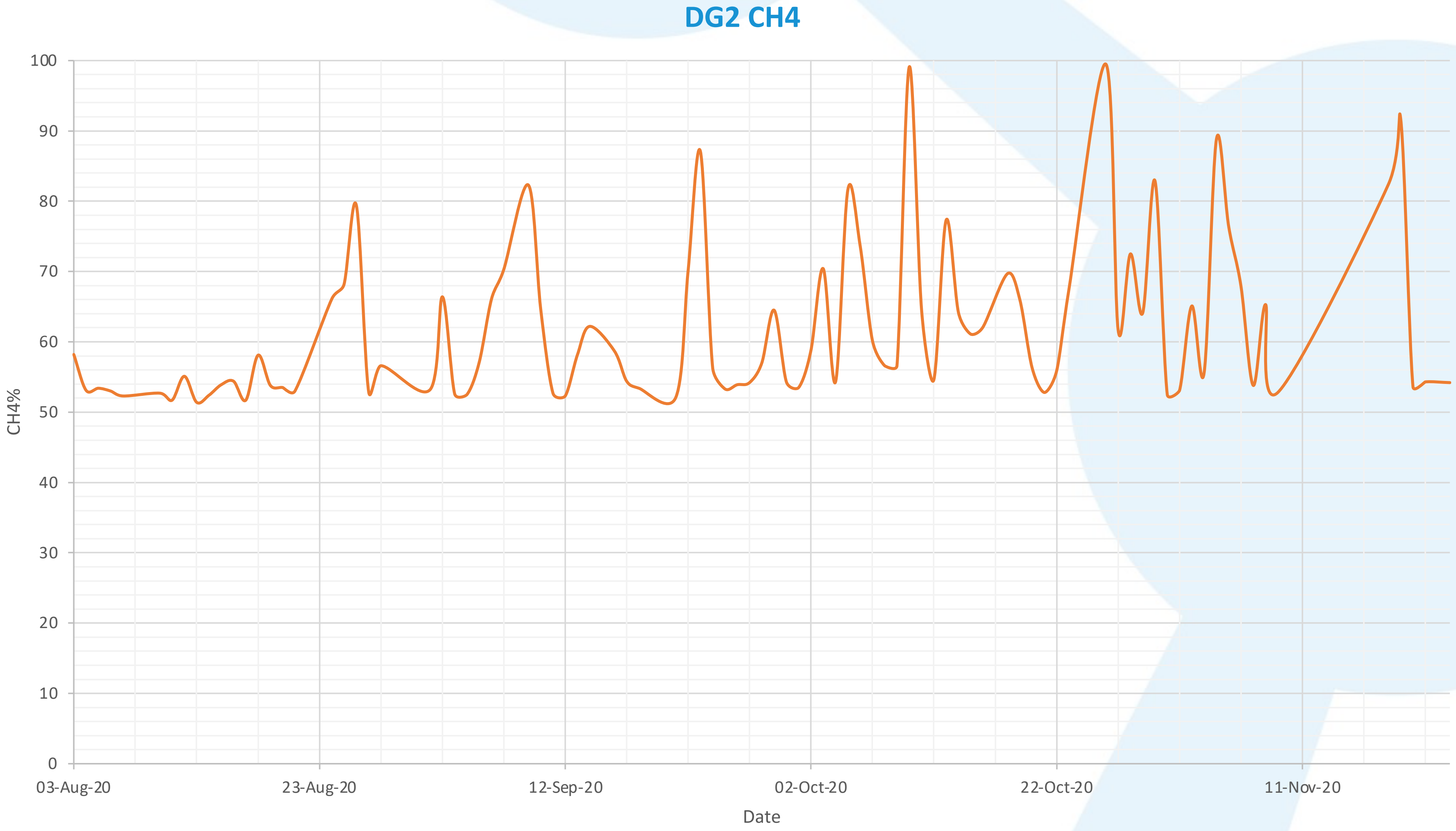
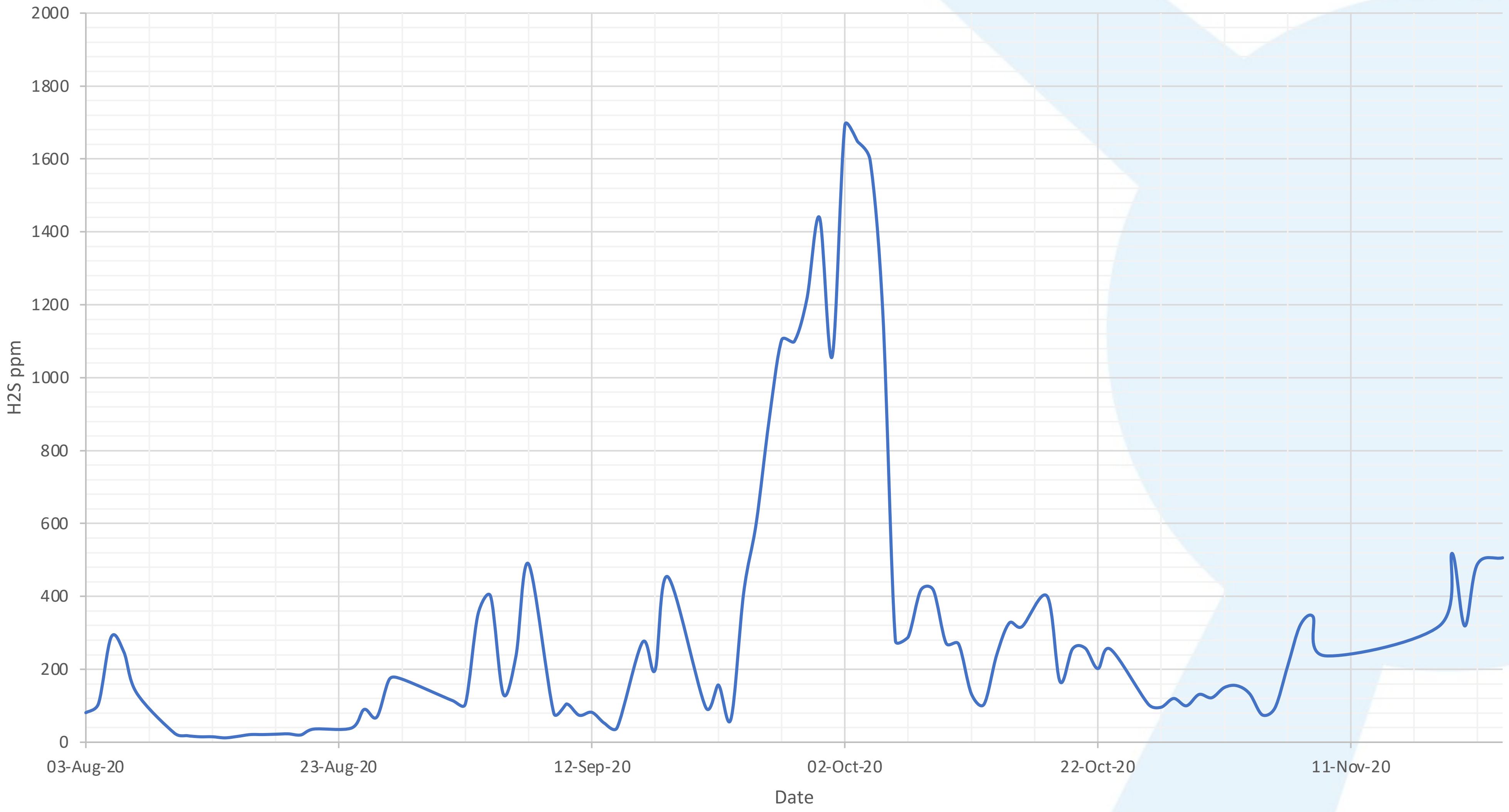
DG1 CH4

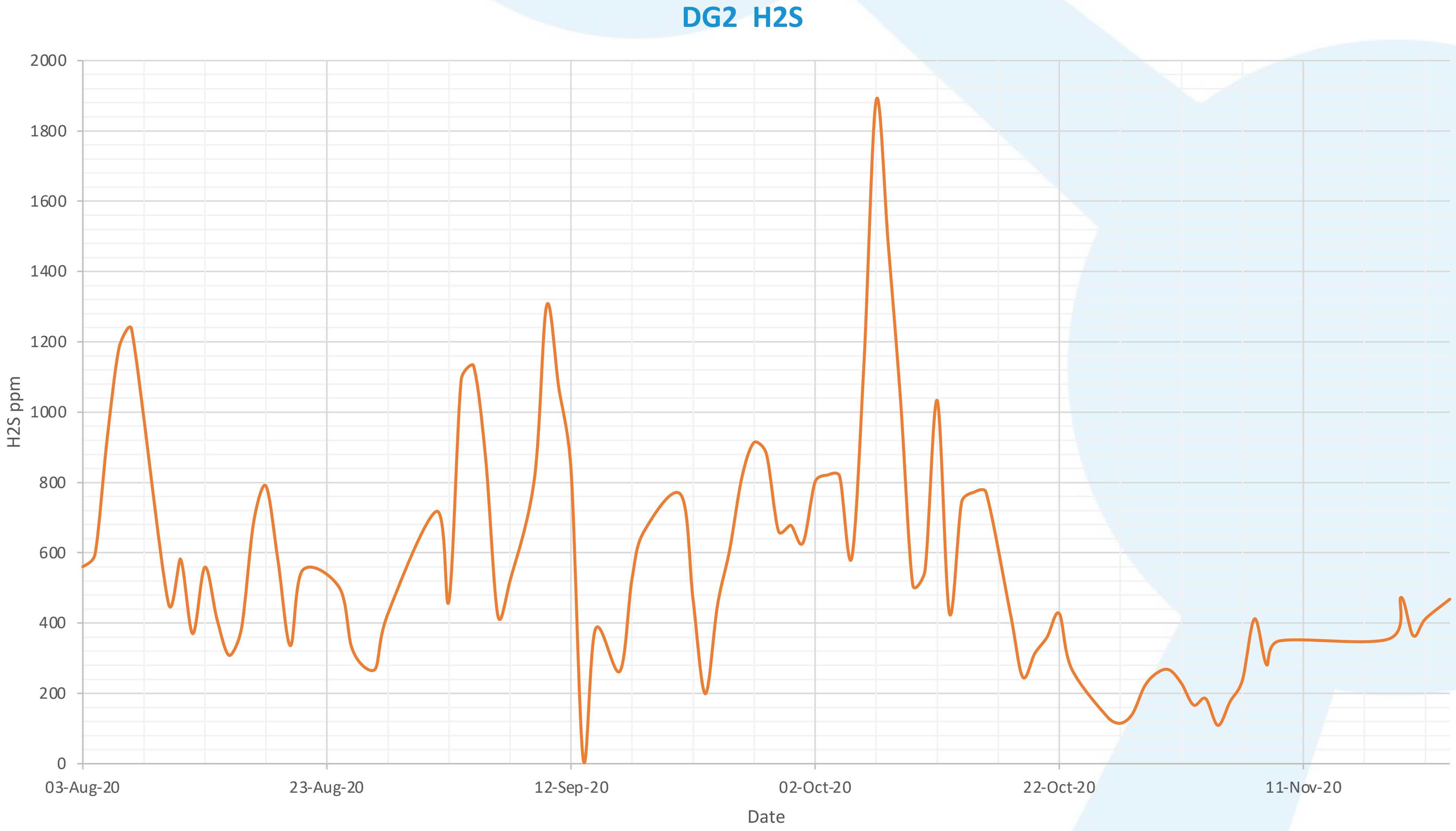

100
90
80
70
60
50
40
30
20
10
0
CH4%
03-Aug-20
23-Aug-20
12-Sep-20
02-Oct-20
22-Oct-20
11-Nov-20
Date


DG2 CH4
100
90
80
70
60
50
40
30
20
10
0
CH4%
03-Aug-20
23-Aug-20
12-Sep-20
02-Oct-20
22-Oct-20
11-Nov-20
Date

DG1 H2S



2000
1800
1600
1400
1200
1000
800
600
400
200
0
H2S ppm
03-Aug-20
23-Aug-20
12-Sep-20
02-Oct-20
22-Oct-20
11-Nov-20
Date


DG2 H2S
H2S ppm
0
200
400
600
800
1000
1200
1400
1600
1800
2000
03-Aug-20
23-Aug-20
12-Sep-20
02-Oct-20
22-Oct-20
11-Nov-20
Date

Gas Quality

	DG1				DG2			
	CH4%	C02%	O2%	H2S ppm	CH4%	C02%	O2%	H2S ppm
Before Trial (03/08/2020 – 11/10/2020)	55.07	46.90	0.20	346.48	59.73	51.95	0.32	672.57
After Trial (12/10/2020 – 23/11/2020)	56.27	46.09	0.28	245.67	65.67	45.30	0.32	355.94
Percentage Increase	2%	-2%	42%	-29%	10%	-13%	-1%	-47%

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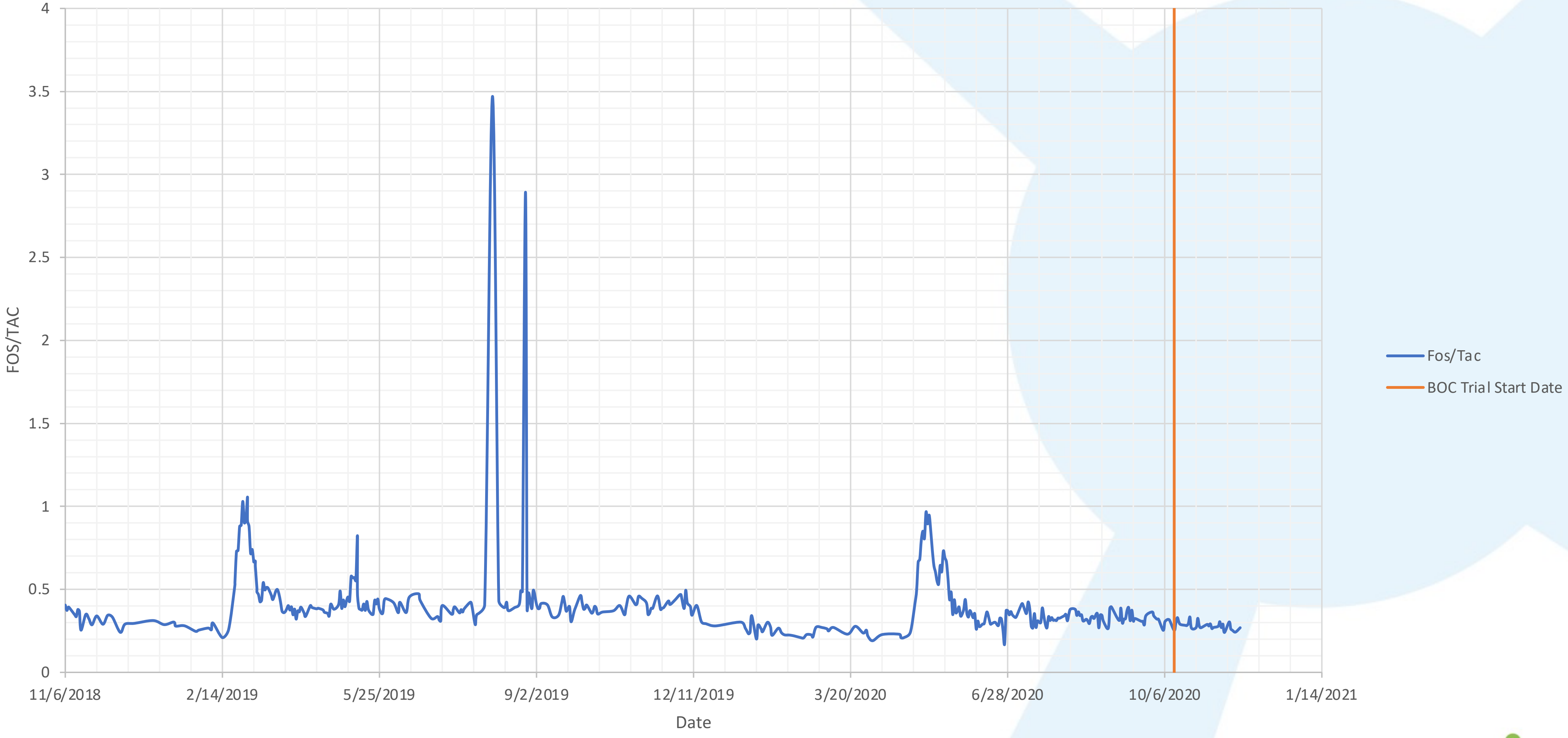
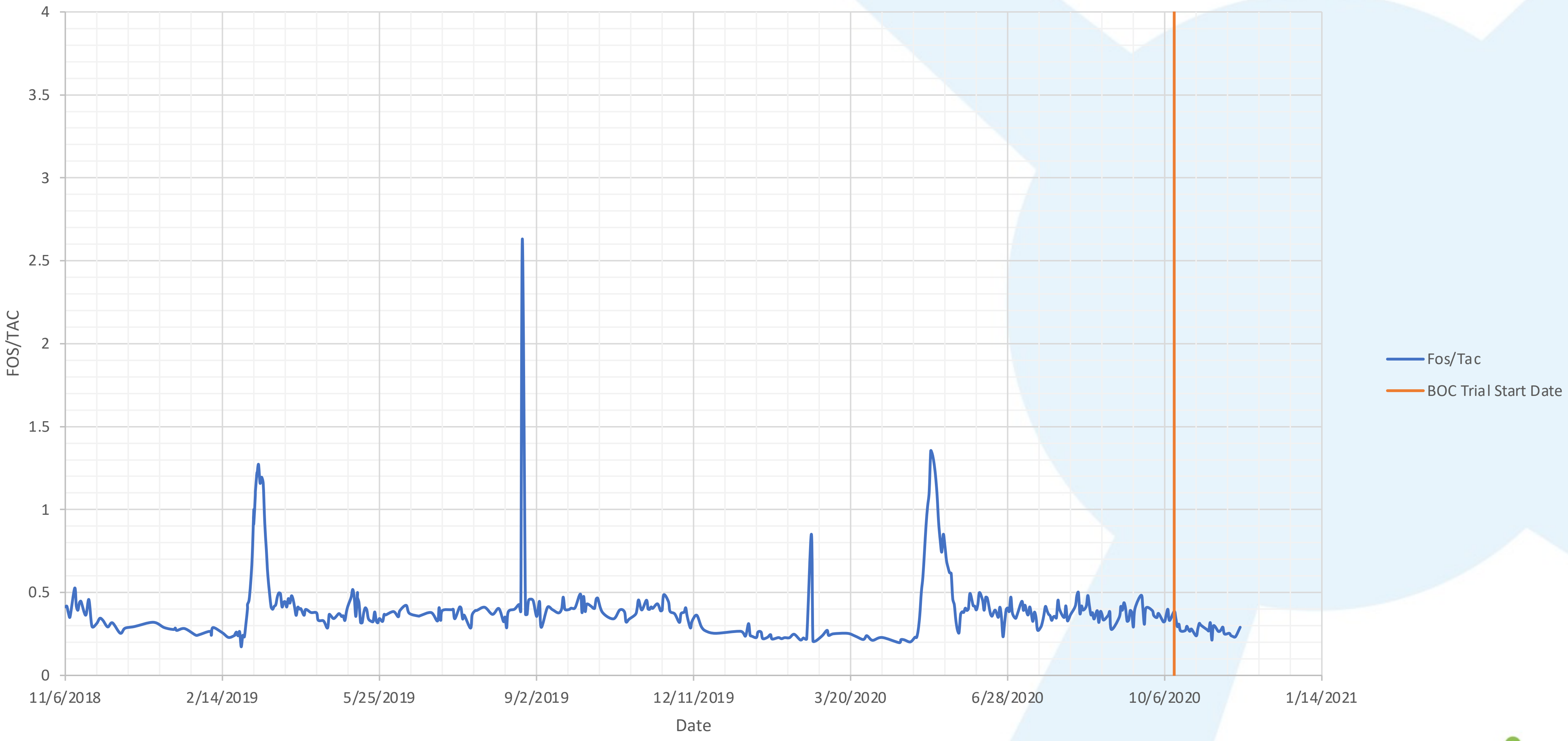
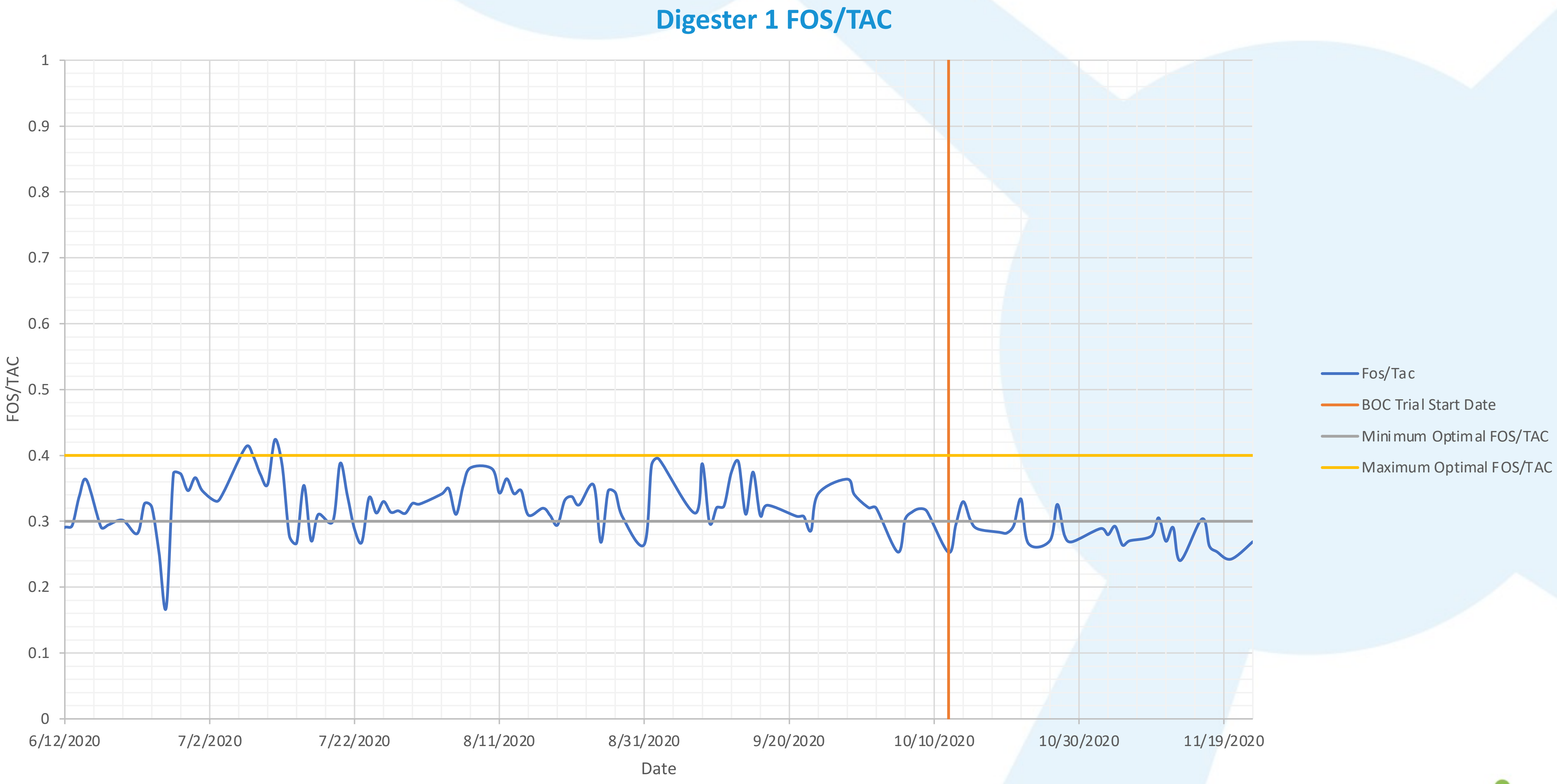
Digester 1 FOS/TAC

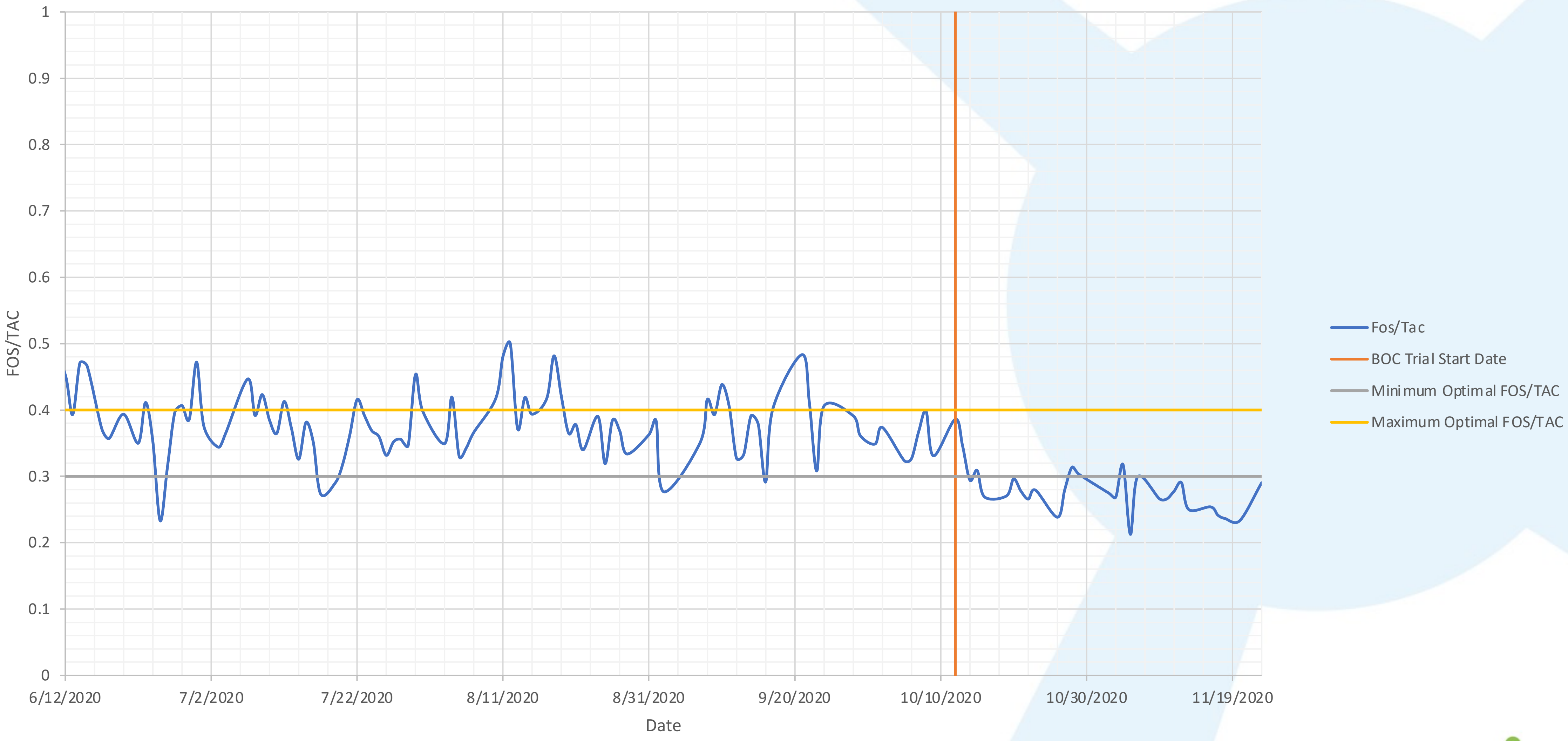


Digester 2 FOS/TAC




Digester 1 FOS/TAC
FOS/TAC
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
6/12/2020
7/2/2020
7/22/2020
8/11/2020
8/31/2020
9/20/2020
10/10/2020
10/30/2020
11/19/2020
Date
Fos/Tac
BOC Trial Start Date
Minimum Optimal FOS/TAC
Maximum Optimal FOS/TAC

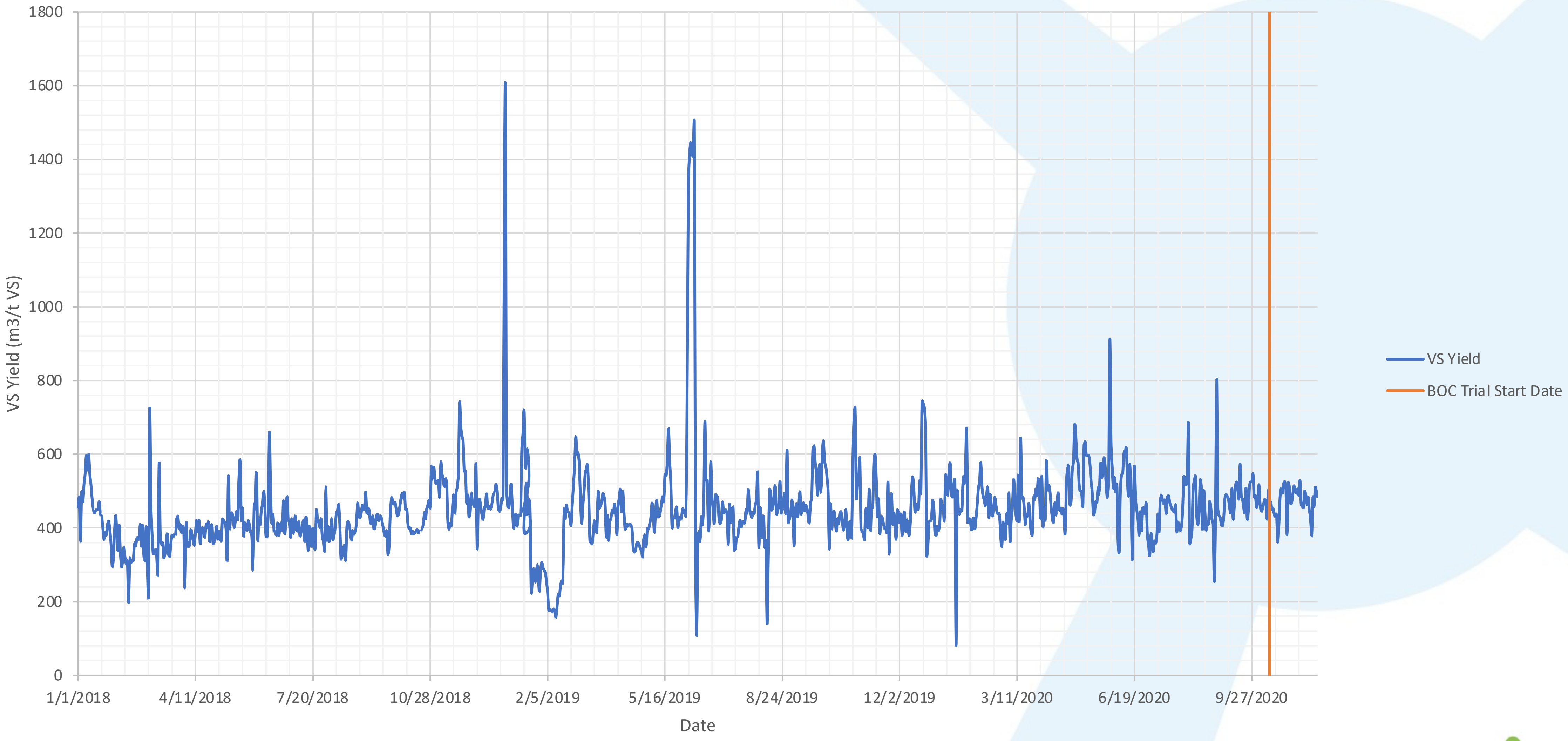
Digester 2 FOS/TAC



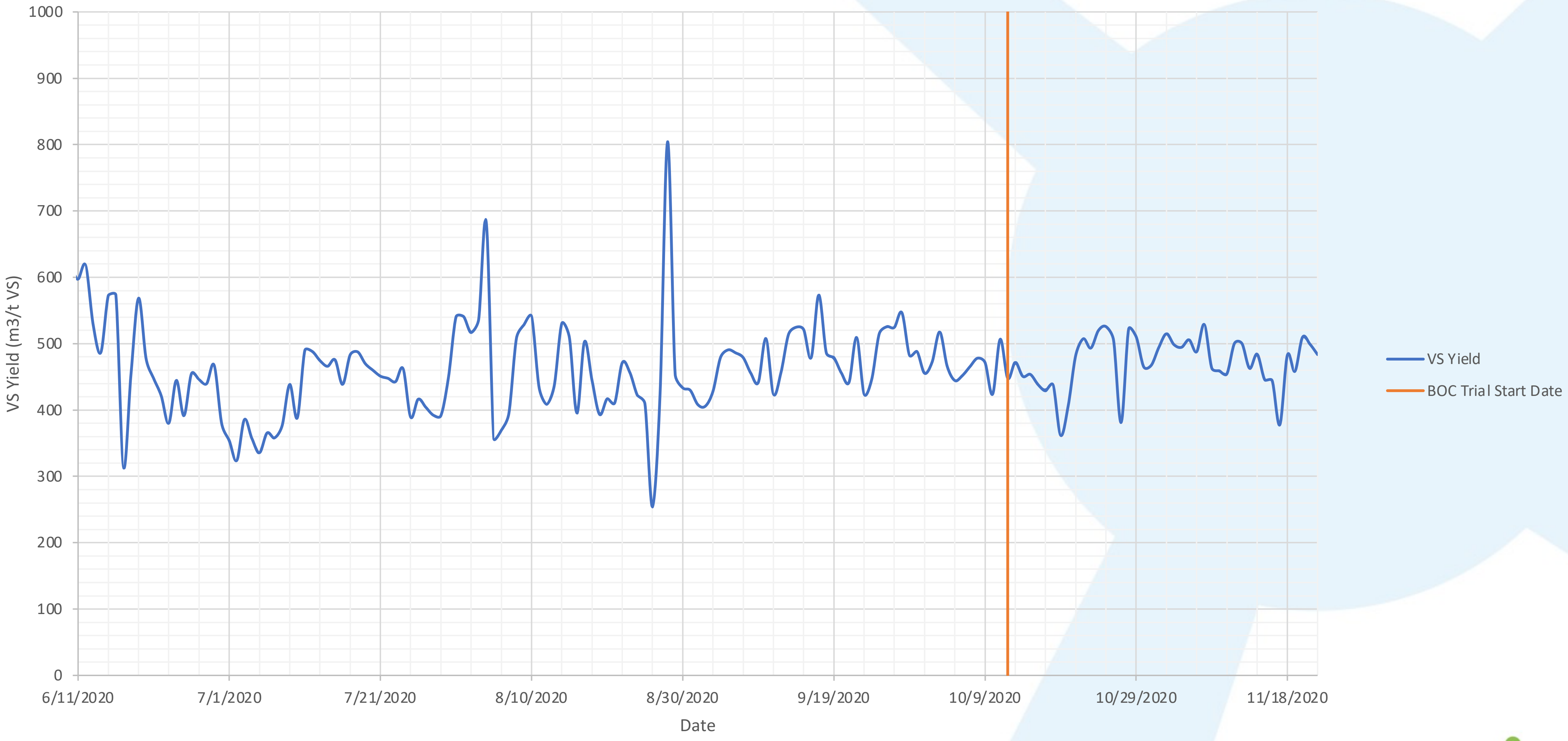
FOS/TAC

	DG1			DG2		
	FOS	TAC	FOS/TAC	FOS	TAC	FOS/TAC
Before Trial (03/08/2020 – 11/10/2020)	2.95	8.92	0.33	3.01	7.98	0.38
After Trial (12/10/2020 – 23/11/2020)	2.39	8.50	0.28	2.25	8.08	0.28
Percentage Increase	-19%	-5%	-15%	-25%	1%	-26%

VS Yield since Jan 2018



VS Yield since Jun 2020



VS Yield

Before Trial (01/01/2018 – 11/10/2020) VS Yield (m^3 CH_4/tVS)	After trial (12/10/2020 – 22/11/2020) VS Yield (m^3 CH_4/tVS)	Increase in VS Yield	Increase in Revenue per tVS[1]	Increase in Revenue per day[2]
449.73	472.07	+ 5%	+ £11.17 per t VS	+ £223.4 per day

1. The calculation is based on the assumption that the revenue for every cubic metre of CH_4 is 50p
2. The calculation is based on the assumption that the daily OLR is 20tVS/d

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VS Yield

Before Trial (11/06/2020 – 11/10/2020) VS Yield (m^3 CH_4/tVS)	After trial (12/10/2020 – 22/11/2020) VS Yield (m^3 CH_4/tVS)	Increase in VS Yield	Increase in Revenue per tVS[1]	Increase in Revenue per day[2]
460.44	472.07	+ 3%	+ £5.82 per t VS	+ £116.4 per day

1. The calculation is based on the assumption that the revenue for every cubic metre of CH_4 is 50p
2. The calculation is based on the assumption that the daily OLR is 20tVS/d

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Future Potential

- Assume that the VS Yield remains around 472 m^3 CH_4/tVS
- Assume that the revenue for every cubic metre of CH_4 is 50p
- Assume that the potential to bring FOS/TAC from 0.28 to 0.35 can lead to 25% increase in OLR

OLR (t Vs/d)	Methane Yield (m^3 CH4/d)	Approx. Revenue per day (£/d)
20	9,441.40	£4,720.70
25	11,801.75	£5,900.88
Difference	2,360.35	£1,180.18
Percentage Increase	25%	25%

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Focus on Organic Loading Rate (OLR).

- The limiting factor in the AD process is the Organic Loading Rate (OLR).
- An existing facility will have had its size (tank size) already determined in the design phase a new facility will need to determine this and given its fixed nature is an important specification.
- Optimisation requires OLR to be addressed by focusing on the beginning of the process, Feedstock and Hydrolysis.
- If Hydrolysis is optimised the transition through the other three stages will be smooth and productivity will therefore be fully maximised.

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Optimisation strategy

- Carefully designed based on strategically timed and placed sampling, lab scale testing and finally a pilot scale test.
- The Hydrolysis stage is the rate-limiting factor, determining OLR and in turn output and productivity. Once at the acid fermentation stage the operations are out of management control.
- Myriad of pre-treatment options requires economic and operational examination to determine viability. Not always obvious/straightforward
  - Crystallinity of the lignocellulose, the degree of polymerization, accessible surface area, and the relative amount of acetyl groups should be considered.
- Some pre-treatment options combine Physical, Chemical and biological methods
  - At lab-scale production increases have been as low as 4% and as high as 500%.
  - 4% increase on some of the larger plants can be the difference between black and red on the income statement.
  - With potentials up to 500% it remains a question of how rather than why.

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Summary

Biological Process Optimisation is exposed to a complex series of transitions that requires careful study through sampling.

The sampling can only be determined by a holistic review including geographical, management, feedstocks and digestate requirements.

Once analysed suitable candidate pre-treatment strategy can be planned and evaluated through lab scale and pilot scale that will produce a robust project level implementation strategy.

The process can take up to 12 weeks and implementation can take a further 12 weeks.

ALPS Ecoscience provide a fully managed service to optimise across the entire AD process lifecycle to maxmise its economic potential.

Biological Process Optimisation delivers commercial value and high ROI.

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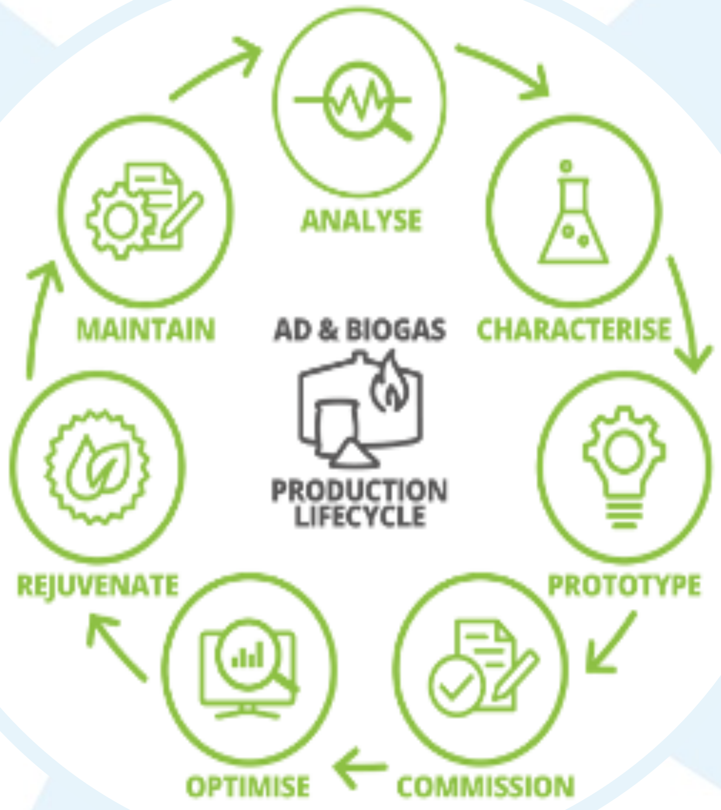
Alps Ecoscience' AD & biogas managed services covers all aspects of the production lifecycle. It is available as either a time and materials or a cost per tonne pricing model.



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