



Assessing the Potential for Adverse Effects to Wastewater Treatment by Loads Received at the Wastewater Receiving Station

Ben Chan, MSc

City of Calgary, Water Quality & Regulatory Assurance



Wastewater Receiving Station - Valleyfield Dump Station

Wastewater loads from industrial haulers that are not entering the WWTP through sewage lines can be brought to two locations.

Loads accepted at the Valleyfield Dump Station are fully monitored by an attendant, with appropriate paperwork needing to be filled out by the hauler



Valleyfield Dump Station

Calgary		HAULED WASTEWATER DISPOSAL MANIFEST (Septage)		E xxxx (R2018-06)	
** A FULLY COMPLETED MANIFEST MUST ACCOMPANY EACH LOAD **					
Receiving Site Used: Valleyfield <input checked="" type="checkbox"/> Bonnybrook <input type="checkbox"/> Other <input type="text"/>					
Name of Hauling Company: JOHN SMITH'S HAULING					
Permit Number	SW-998	License Plate Number	J4-123	Access Card Number	123456
Disposal Date (MM/DD/YY)	01/01/22	Disposal Time	8:30	<input checked="" type="checkbox"/> AM <input type="checkbox"/> PM	
Name and Location of Generator		Details of Load - Date/Time/Volume		pH of Load	
Name	THE WIDGET FACTORY	Volume in Liters	5000	7.5	
Address	74Z EVERGREEN TERRACE	Pick-up Date MM/DD/YY	12/31/21		
		Pick-up Time	7:30	<input type="checkbox"/> AM <input checked="" type="checkbox"/> PM	
Truckvue Sticker	Source of Wastewater	Type of Wastewater	If you checked "Other" provide details		
	<input checked="" type="checkbox"/> Domestic	<input type="checkbox"/> Portable Toilet	SEWER BACK-UP IN BASEMENT		
	<input type="checkbox"/> Industrial	<input type="checkbox"/> Septic Tank			
	<input type="checkbox"/> Commercial	<input type="checkbox"/> Holding Tank			
	<input type="checkbox"/> Other				
Driver Details		Driver Details			
First Name (Print)		Last Name (Print)			
JOHN		SMITH			
Signature		<i>John Smith</i>			
For Internal Use Only					
Valleyfield Attendant Who Took The Sample		Person Responsible for Transporting the Sample to Bonnybrook		Load Received Yes <input type="checkbox"/> No <input type="checkbox"/>	
Bottle #		LJMs ID			

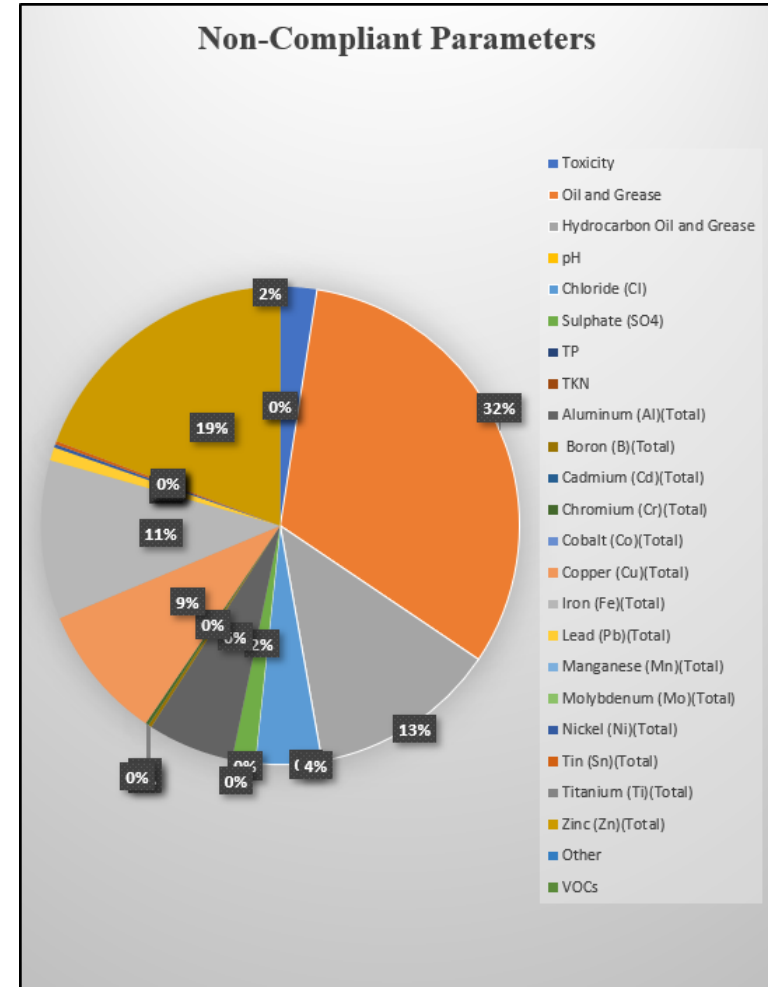
Manifest to be completed with every load



Compliance Concerns

When tested using analytical techniques, monthly samples taken from Valleyfield show that toxic loads are commonplace, with many parameters found to be well above the bylaw limit

Non-compliant parameters that show up the most include oil & grease, Zinc, Iron, and Copper



Breakdown of non-compliant parameters since the start of 2023

The Activated Sludge Process at Bonnybrook Wastewater Treatment Plant



The Activated Sludge Process uses oxygen and microorganisms (bugs) to remove organic pollutants and nutrients in wastewater

Sludge from the secondary clarifier can be sent back to re-seed the bioreactor, and is known as **return activated sludge (RAS)**

When toxic loads are accepted at the Bonnybrook WWTP, this can lead to an increased risk of process upset

This can increase treatment costs as well as decrease capacity



Purpose :

(a) to protect the wastewater system and its processes from damage, obstruction, toxic upset, or loss of efficiency

Schedule “A” - Prohibited Substances

(a) A substance that causes or will cause an adverse effect

(n) Corrosive or toxic wastewater that causes or will cause an adverse effect

Our current compliance framework is insufficient to apply warnings and fines



Laboratory Objectives in Support of the Wastewater Bylaw



Develop a method for assessing adverse effects on activated sludge



Identify samples that may have adverse effects to the activated sludge process



Be able to process a larger number of samples



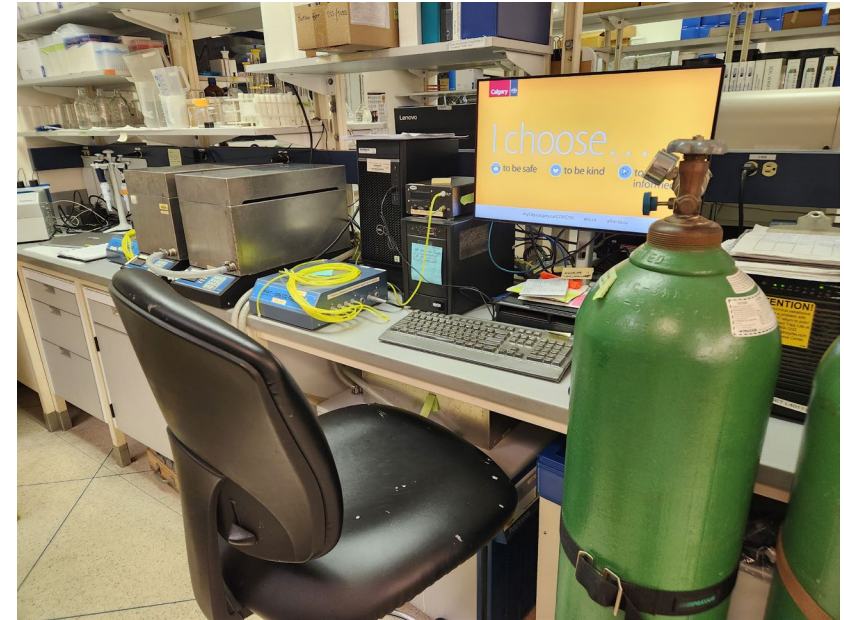
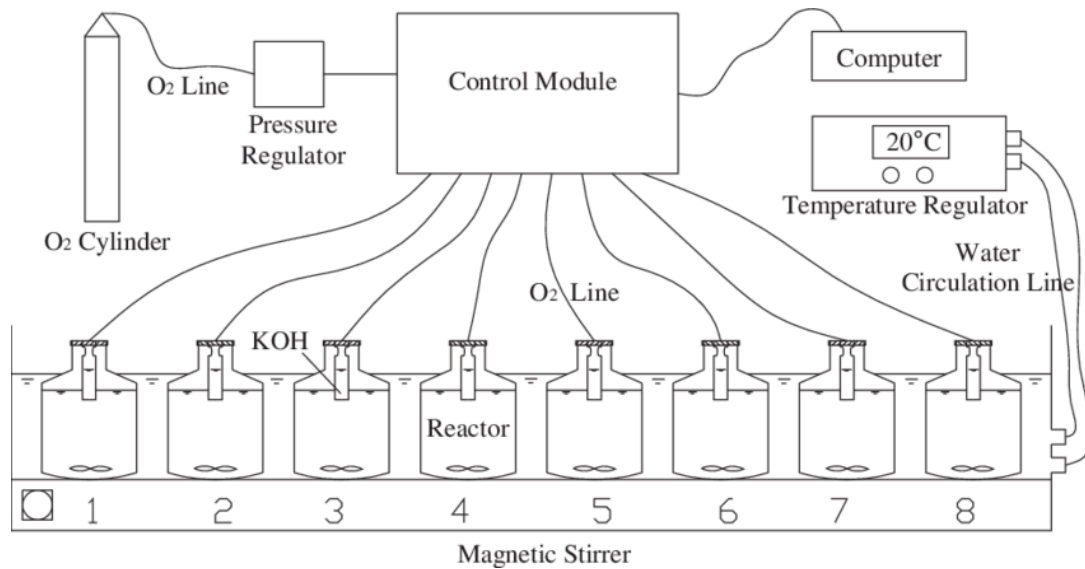
Toxic results would come with associated warnings and fines



Respirometry can be used to Evaluate the Overall Health of Activated Sludge

- A respirometer measures the amount of oxygen consumed by microorganisms in an enclosed oxygen-rich environment
- If microorganism health is poor, we would expect oxygen consumption by microorganisms to decrease
- Traditionally measured in Oxygen Uptake Rate (OUR)
- A lower OUR corresponds to a higher level of toxicity
- A respirometry based toxicity test compares the oxygen respiration rate of activated sludge with and without the presence of a sample or substance
- Since 2005, we have been using a Pulse Flow Respirometer (PF-8000, RSA)

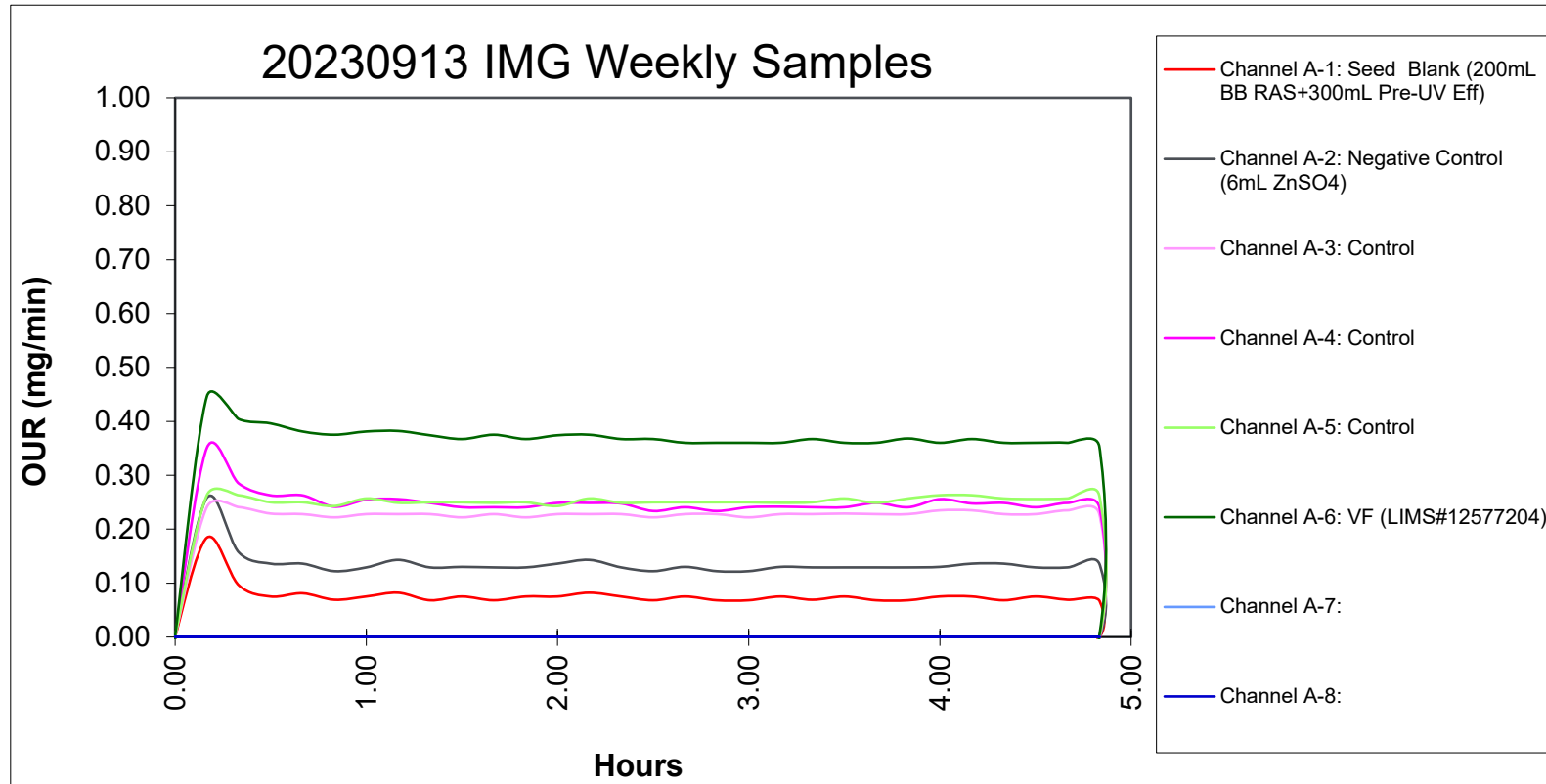
PF-8000 Respirometer (RSA)



- Oxygen is added in small increments into each respirometric vessel in response to microorganism oxygen uptake and carbon dioxide absorption
- A constant oxygen concentration is maintained in the headspace
- Pressure differential is used to measure oxygen uptake indirectly
- A water bath is used to maintain constant temperature. Magnetic stir bars are used to assist in oxygen transfer from the headspace to the liquid phase



PF-8000 Respirometer Results



$$Toxicity\ Index = \frac{OUR_{sample}}{OUR_{control}}$$

Sample	Reported Toxicity Index
A-6: VF	1.53

	Interpretation:
>1	Toxicity not Detected
0.80 - 0.99	Slightly low to very low levels of toxicity
0.60 - 0.79	Moderate levels of toxicity
0.40 - 0.59	Medium to high levels of toxicity
0.20 - 0.39	Very high levels of toxicity
<0.20	Extremely high levels of toxicity

Laboratory Goals to Support the Wastewater Bylaw Revisited



Develop a method for assessing adverse effects on activated sludge



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Be able to process a larger number of samples



Toxic results would come with associated warnings and fines

Limitations of PF-8000 (RSA):

- Instrument is outdated
- Minimum 4-6 hour turn around time. Maximum of 11 samples can be processed in a day
- Due to these limitations, this instrument was mostly used as a screening tool. The instrument was never fully employed as an operational tool with reporting

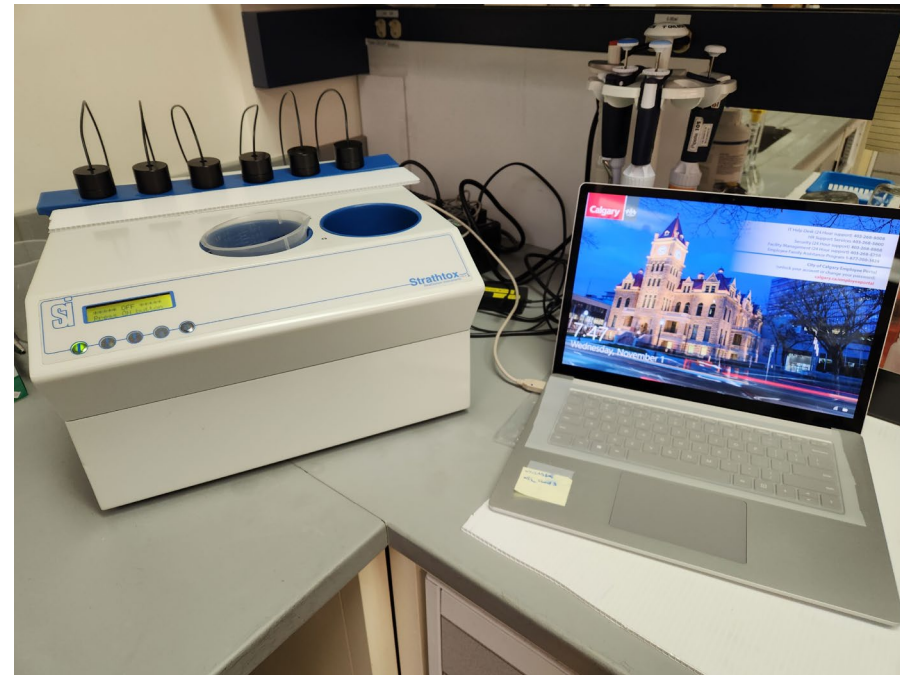


Identifying Alternative Methods for Respirometry – Strathox by Strathkelvin

- Starting in 2020, we began to review the available toxicity assessment technologies
- In 2021, we obtained a SI500 Strathox machine by Strathkelvin to begin testing and method development

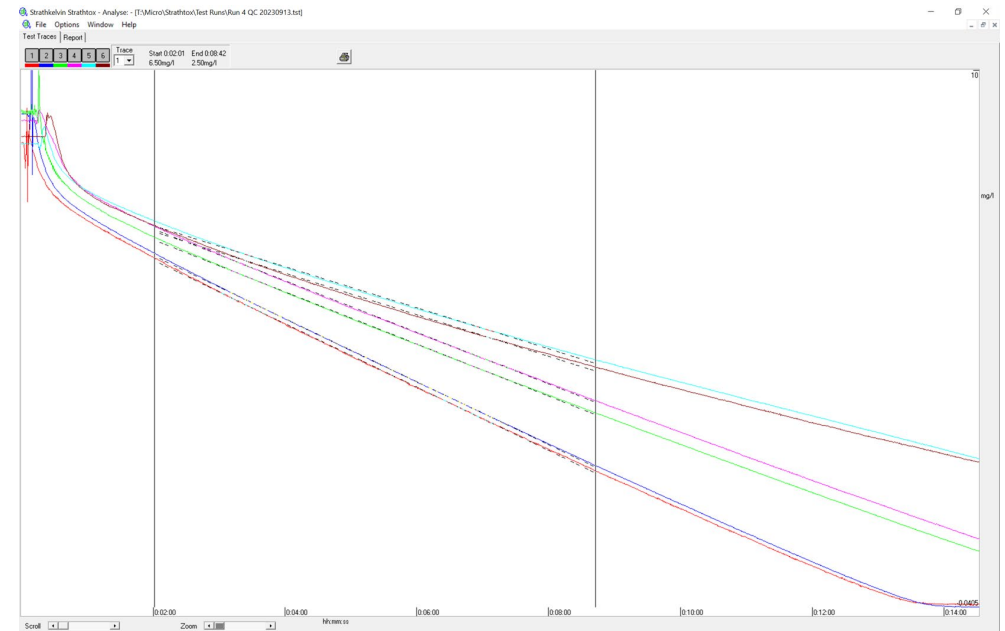
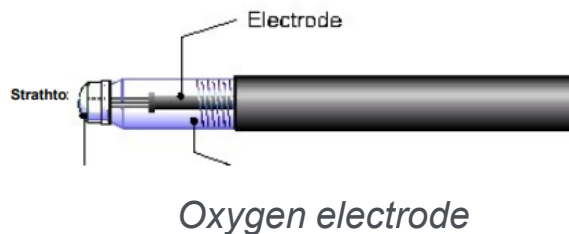
Advantages of SI500 Strathox:

- Shorter runs
- Smaller footprint
- Technical support



Strathox – How Does it Work?

- Uses wastewater biomass
- Measures respiration rate directly using oxygen electrodes
- Environmental conditions are maintained with an internal water bath, aeration probes, and magnetic stir rods
- Test results are reported as Inhibition %



Control run for Strathox



Strathox – Method Development Considerations

- What type of biomass should we use?
- How do we prepare a sample for analysis?
- How do we run the Strathox machine?
- What reference toxicants should be used?
- What type of QA/QC should be done?
- How do we start creating a standardized method and draft an SOP?

What Type of Biomass? – RAS versus MLSS

Return Activated Sludge (RAS)

- RAS is collected directly from a line that runs between the secondary clarifier and the bioreactor
- RAS is settled and concentrated
- A consistent substrate because of how it is collected
- Recommended biomass to use by manufacturer



Secondary Clarifiers

Mixed Liquor Suspended Solid (MLSS)

- MLSS is collected directly from the bioreactor tank
- MLSS is diluted and unconcentrated
- The method of sample collection for MLSS is less consistent than RAS because there is no accessible sample line



Bioreactors

Preparation of Activated Sludge

- The TSS of the activated sludge is adjusted to 3000 mg/L by diluting with DI water and measuring using a portable TSS meter.
- A stock flask is filled with activated sludge up to 500 mL
- The activated sludge stock flask is aerated for at least 30 minutes with a built-in aeration pump
- A constant temperature of 20°C is maintained by the Strathox machine. Magnetic stir bars are added to each sample tube



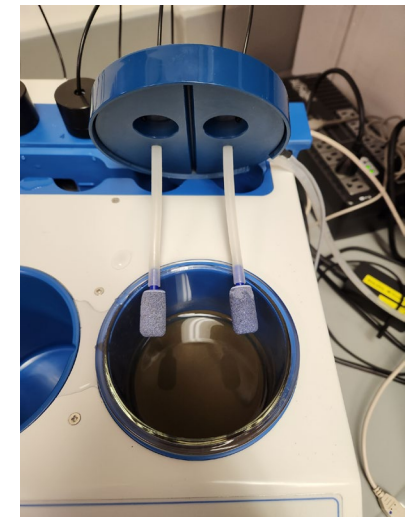
BB RAS



Portable TSS Meter



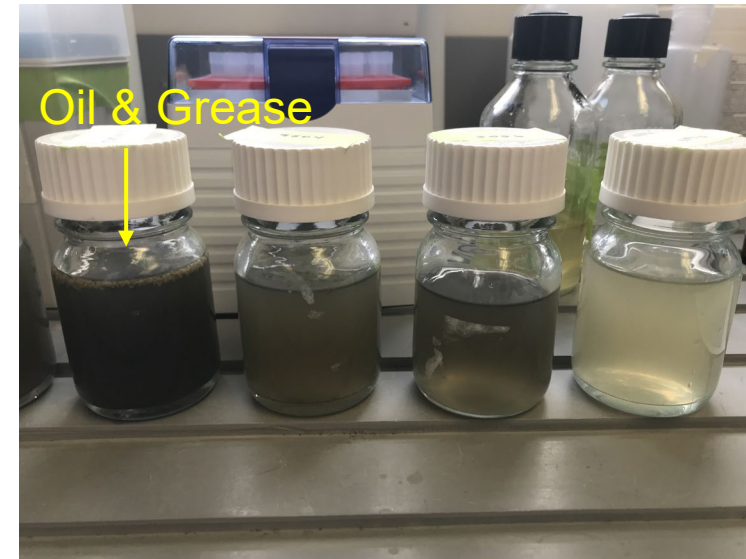
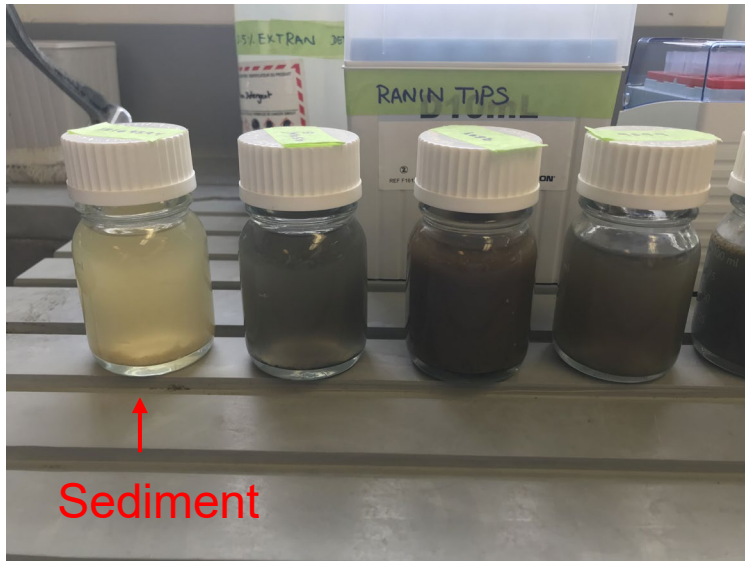
Stock flask



Aeration probes

Preparation of Valleyfield Samples

- Valleyfield samples often contains debris and sediment which can damage oxygen electrodes and produce inconsistent results
- Each sample is aliquoted into a 100 mL Pyrex container, and allowed to settled for at least 30 minutes
- Using a pipette, we take 10 mL of sample at a point above the settled sediment, but below the top layer where oil and grease may form



Strathox Run Set-Up



Each sample tube contains:

- 10 mL of sample
- 2 mL of Synthetic Sewage (food + buffering)
- 8 mL of Activated Sludge (RAS)

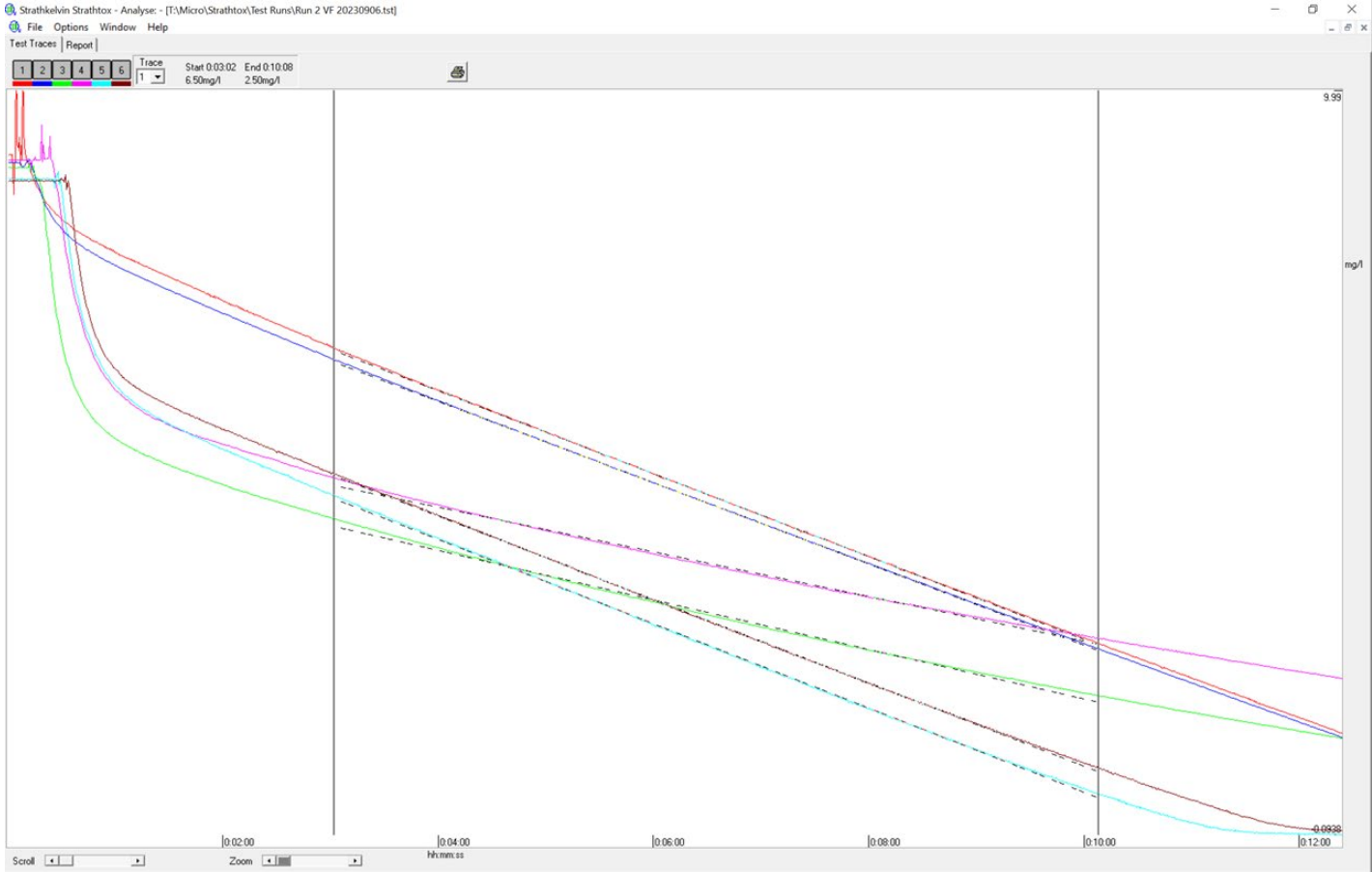
Each rack contains 6 tubes. All samples are run in duplicate.

Each run takes up to 12-15 minutes.

We prepare a control sample with every set, so two samples are can be completed every run

With QC runs, set-up, and clean-up. This can easily accommodate up to 20 samples per day

Strathox Results – Valleyfield Samples



Tube	Sample Information	Concentration (%)	Respiration rate (mg/l/h)	Inhibition (%)
1	Control	0	33.7	
2	Control	100	33.0	2.1
3	VF 48	100	20.1	40.4
4	VF 48	100	18.1	46.2
5	VF 24	100	34.3	-1.7
6	VF 24	100	33.8	-0.2

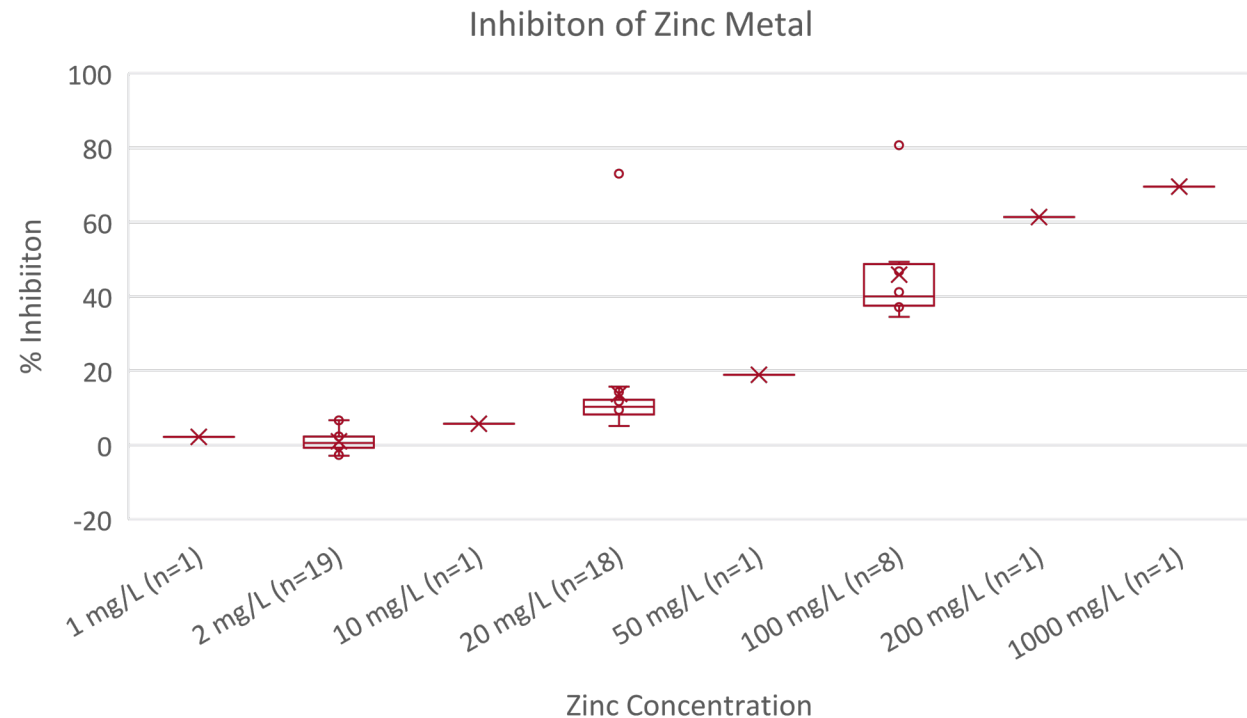


Determining Toxic Reference Controls

Considerations when choosing an ideal toxic reference control:

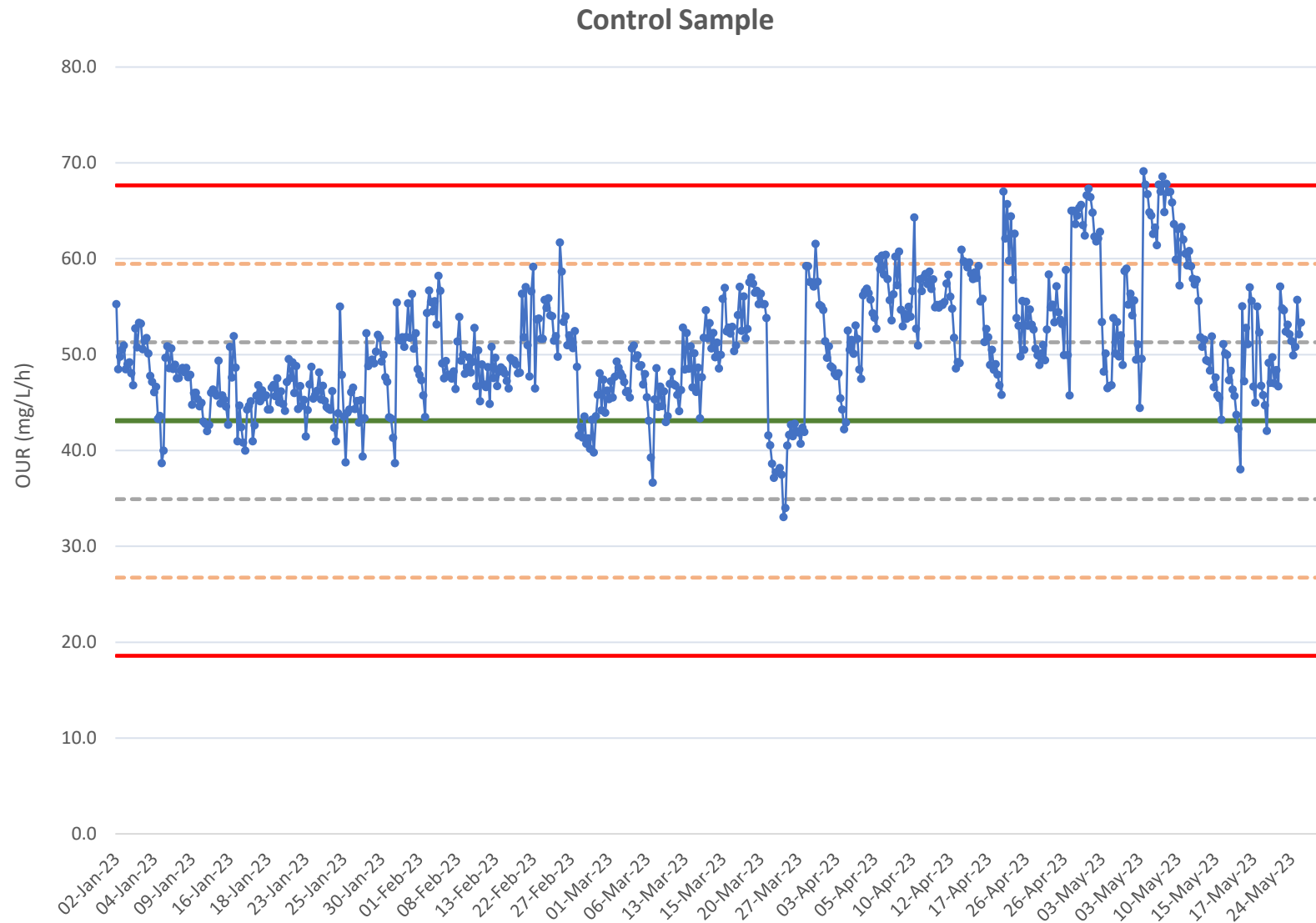
- Readily available in laboratory
- Ideally moderately toxic that produces a desirable toxicity curve
- Safe to use on the lab bench

Toxic Reference Controls:
Zinc (100 mg/L) & 1% Acetone



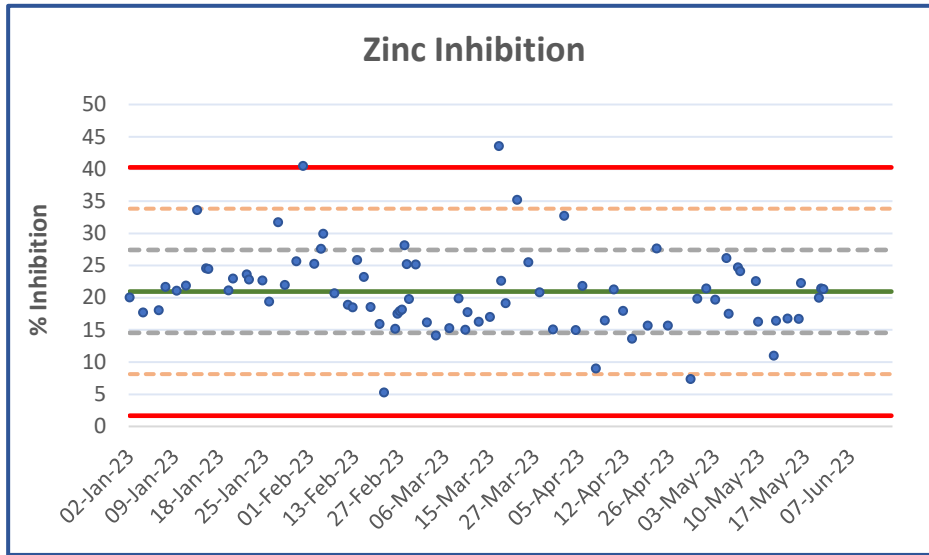
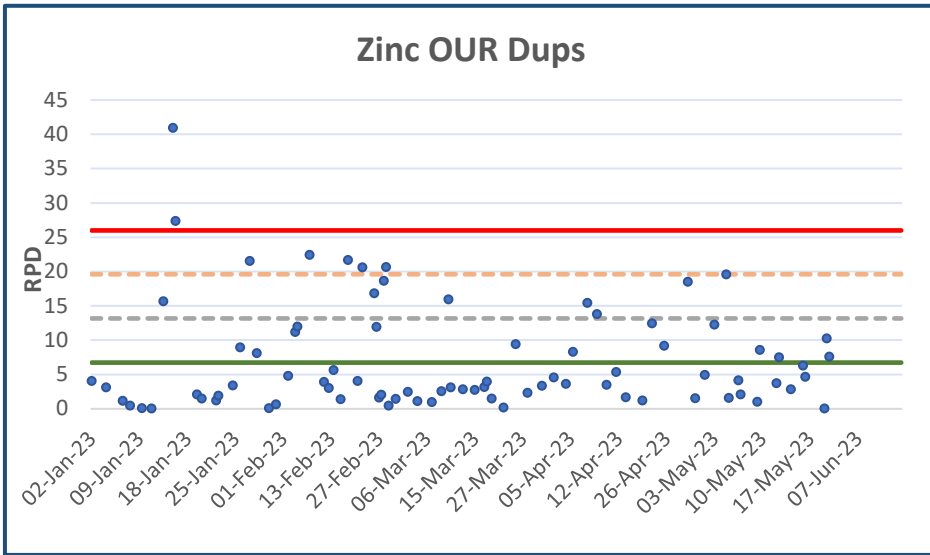
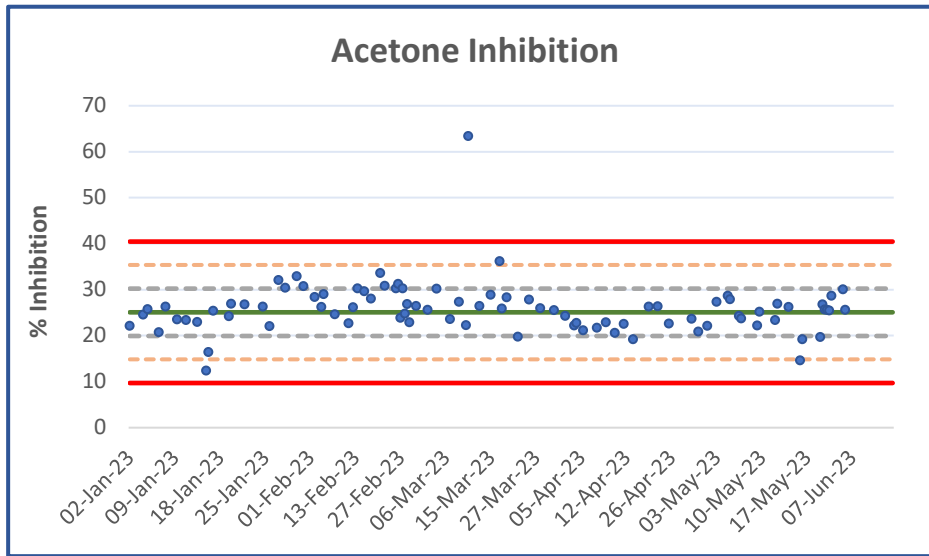
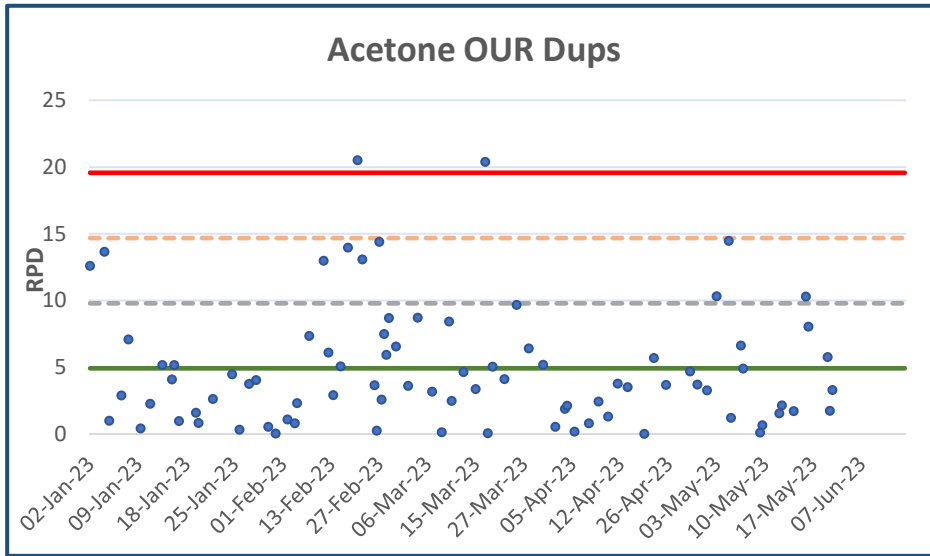


QA/QC and Control Charting – In Progress





QA/QC and Control Charting – In Progress





How to Determine what is an “Adverse Effect”

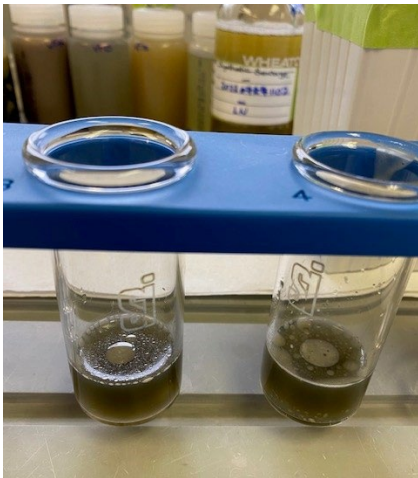
Since the start of 2023:

- Total samples analyzed: 135
- Inhibition >20%: 51 (38%)
- Inhibition >30%: 43 (32%)
- Inhibition >40%: 25 (19%)
- Inhibition >50%: 14 (10%)

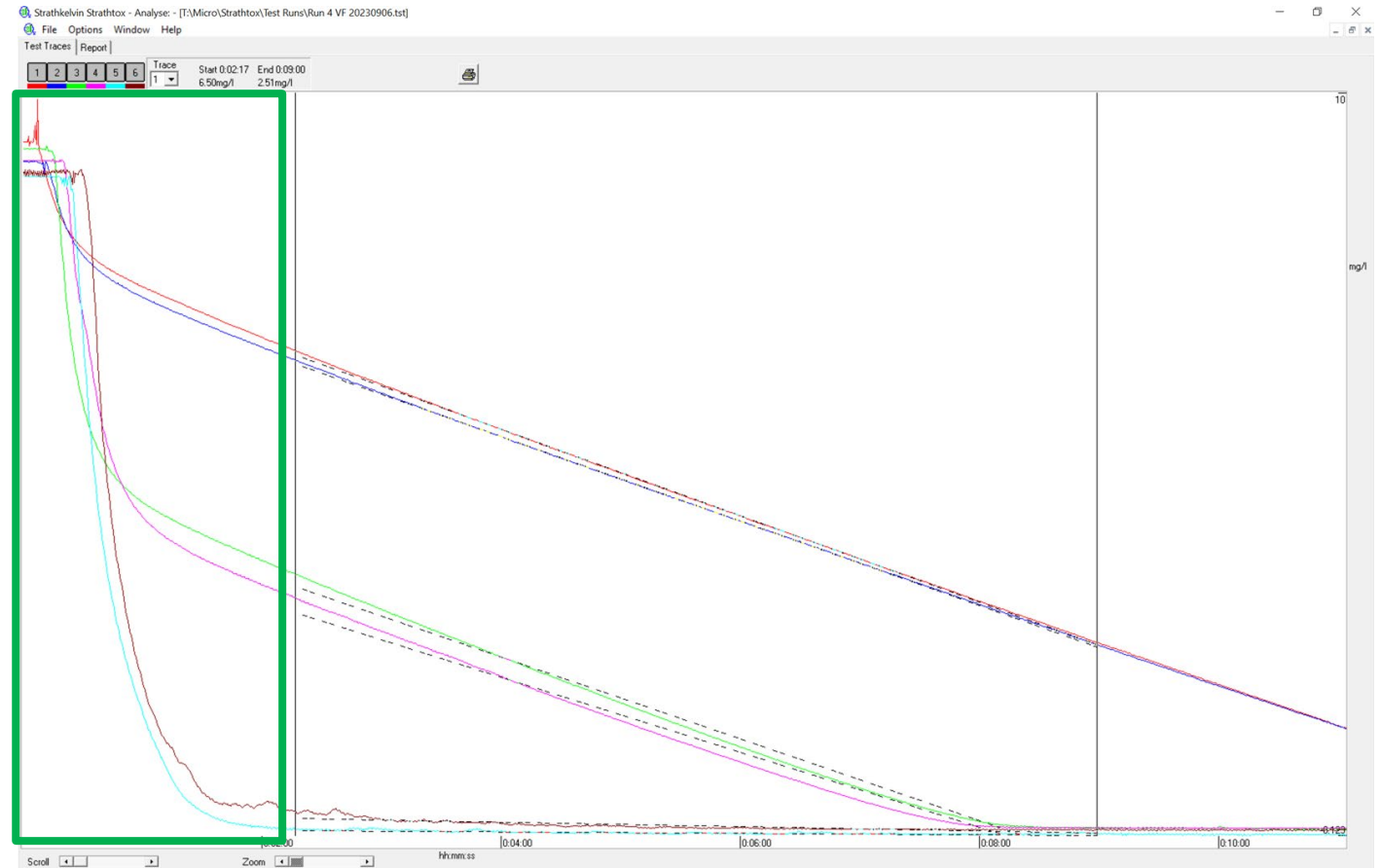
We will determine what inhibition percentage constitutes an adverse effect with statistical analysis once more data is collected

Challenges/Limitations

- Oil & grease
- High solids
- pH
- High oxygen demand
- Data analysis and data interpretation



Oil & grease in sample tubes



High oxygen demand leads to un-interpretable results



Next Steps

- What percent inhibition should be the cut-off when determining whether a sample causes an adverse effect?
- Fine tuning QA/QC charting and appropriate control limits
- Progression on draft SOP
- CALA accreditation

Calgary	ASOP-721 Determination of Adverse Effects on Activated Sludge by Respirometry using <u>Strathtox</u>		
	Creation Date: <u>wwwmdd</u>	Revision Date: <u>wwwmdd</u>	Revision #: 0.0.0
	Owner: Work Group, WQRA		Controlled Document

ASOP-721
Determination of Adverse Effects on Activated Sludge by
Respirometry using Strathtox

Revision #: 0.0.0 Replaces #: 0.0.0

Authorized By:

Team Lead,
Work Group

By signing, I agree this method is deemed fit for the intended use.

Leader,
Business Performance

Revision Table

Section	Additions/Changes/Deletions
Various	Summary of Changes with Reason by Whom on <u>wwwmdd</u>

Status: **Approved (Active)** Page 1 of 22

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Questions/Comments?

