Christchurch City Council

CH2M Beca

# A Tale of Two Sludges – Trialling Operational Temperature Control of an Anaerobic Digester

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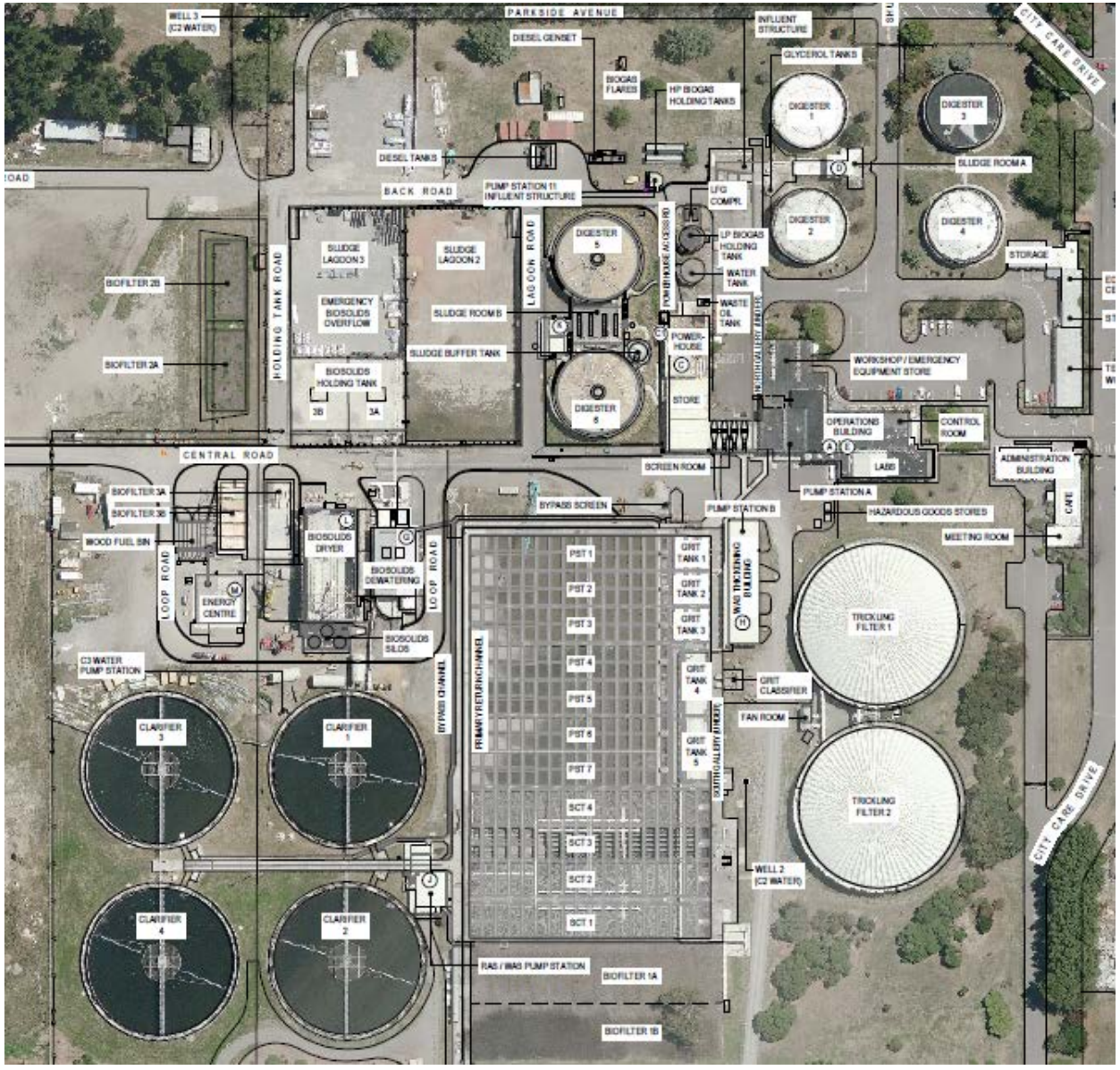
# CWTP- Overview

## Second Largest WWTP in NZ

- Average daily flow of 165,000m³
- Consent only requires carbonaceous treatment
- Final discharge via 3km off-shore ocean outfall
- Biosolids dried and applied to land



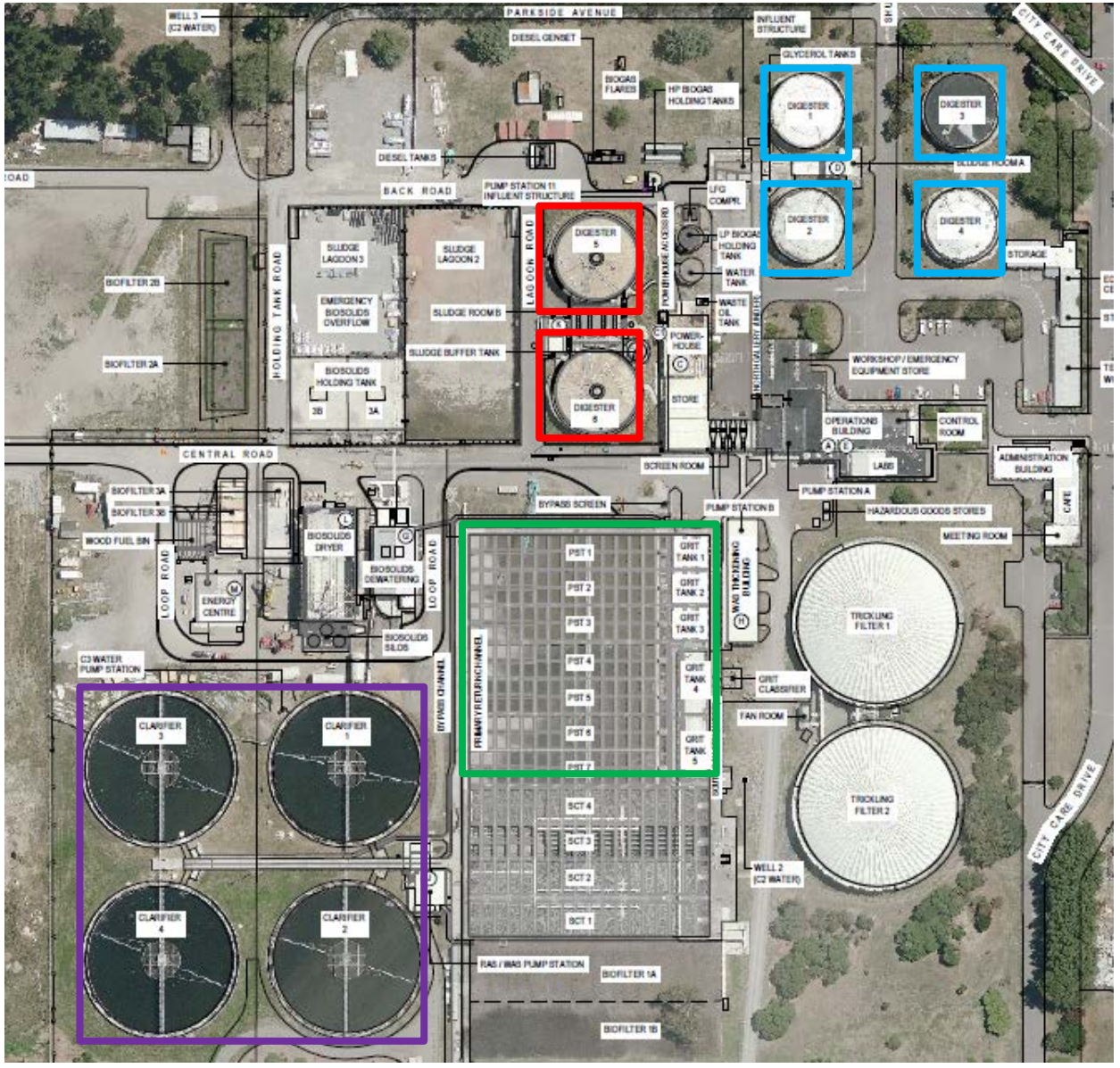
# CWTP - Digestion

**Total Digester Volume: 34,000m³**

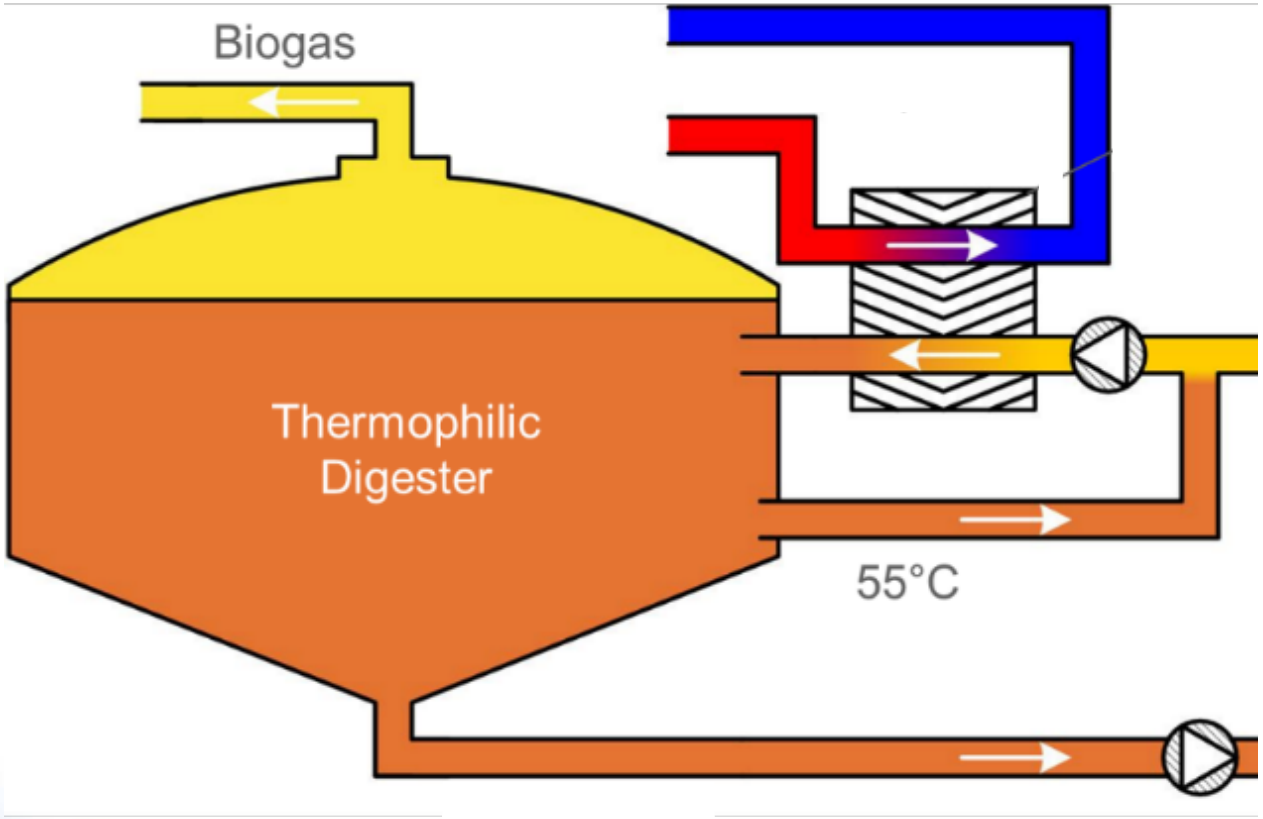
- Two thermophilic digesters (7,000m³ each)
- Four mesophilic digesters (5,000m³ each)

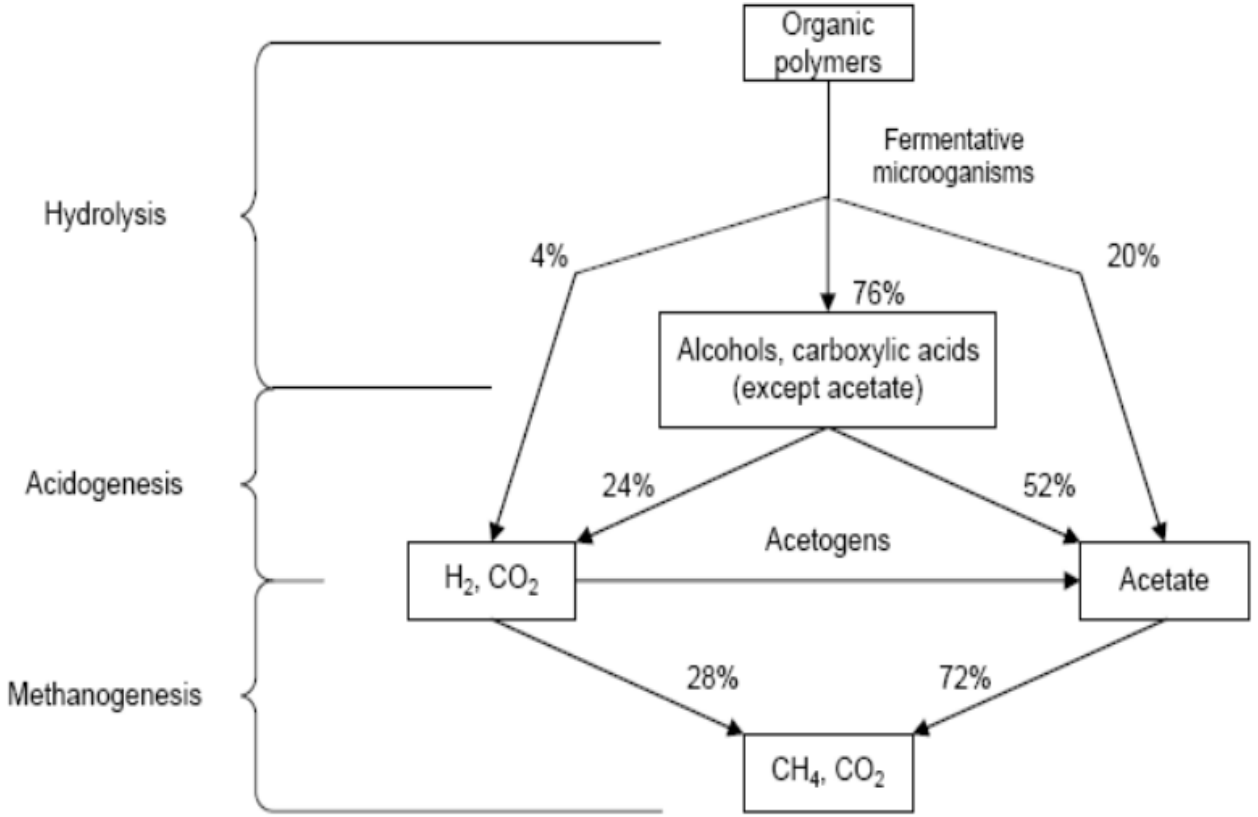
**Receive:**

- Primary sludge
- Secondary sludge

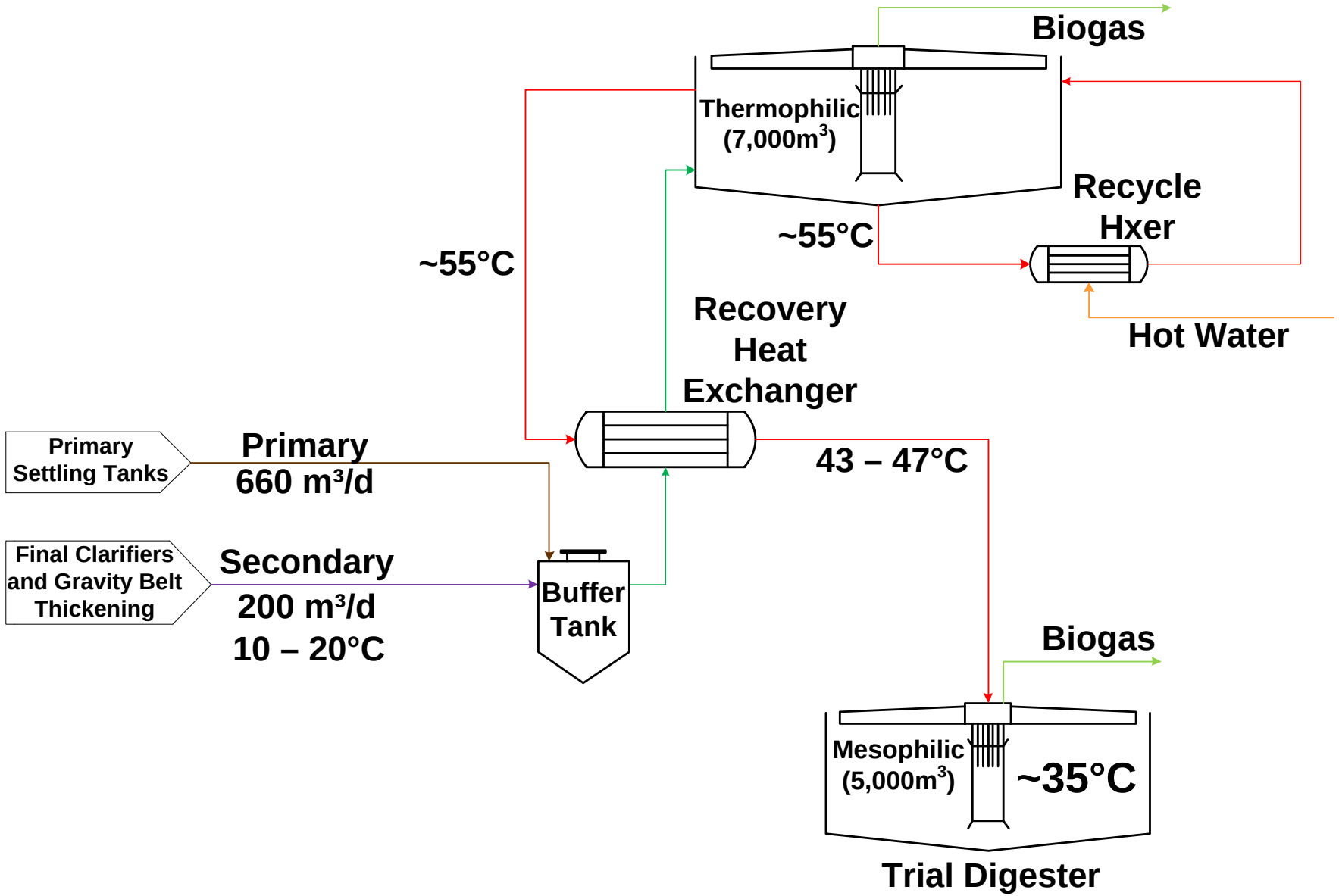


# Anaerobic Digestion



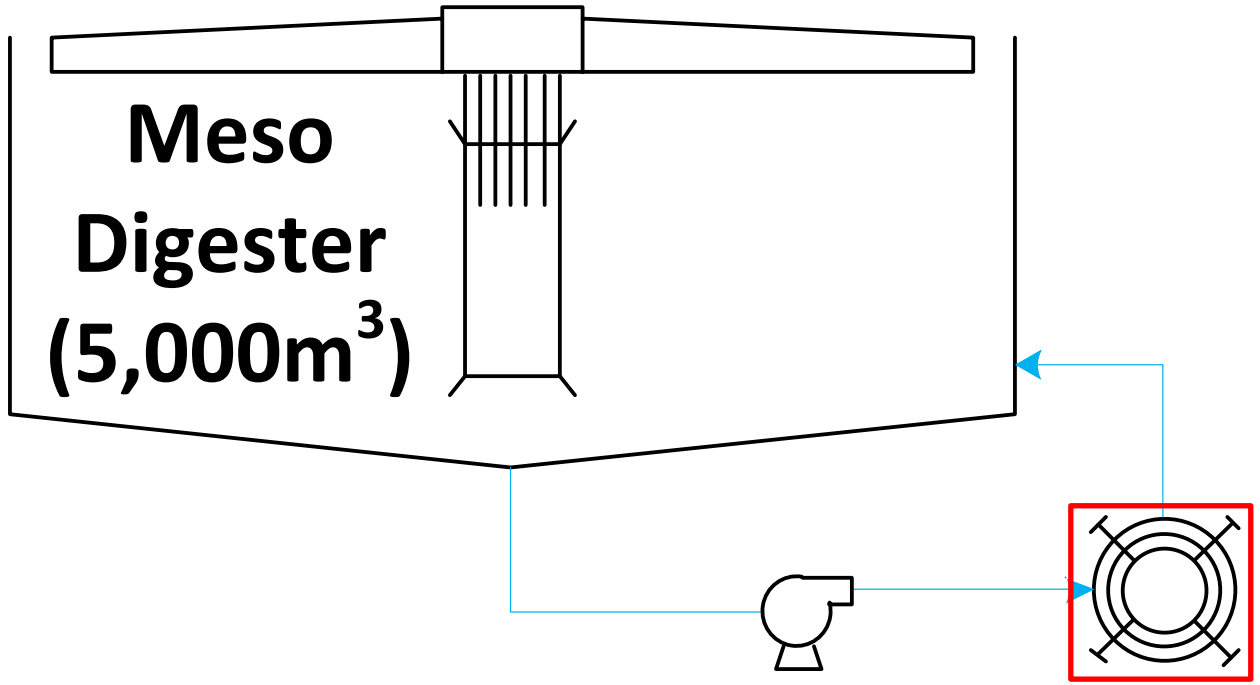
# Current Operation



# Problem Statement

## Spiral Hxers are old

- Hxers well outside of operational life span
- Maintenance issues
- Fouling and scaling
- Consent limitations
- Limited redundancy



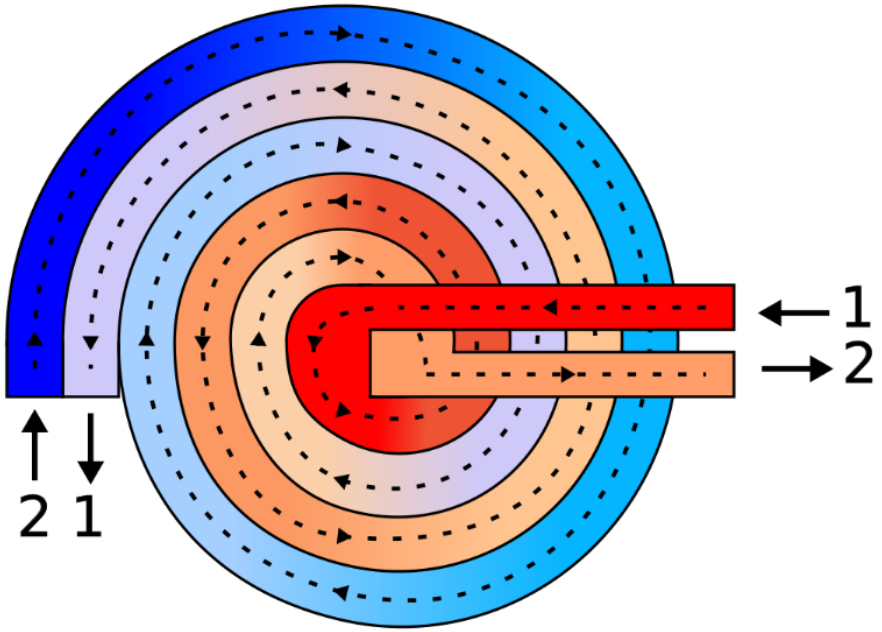
# Options Assessment

A. Replace spiral heat exchangers. Install chiller units.

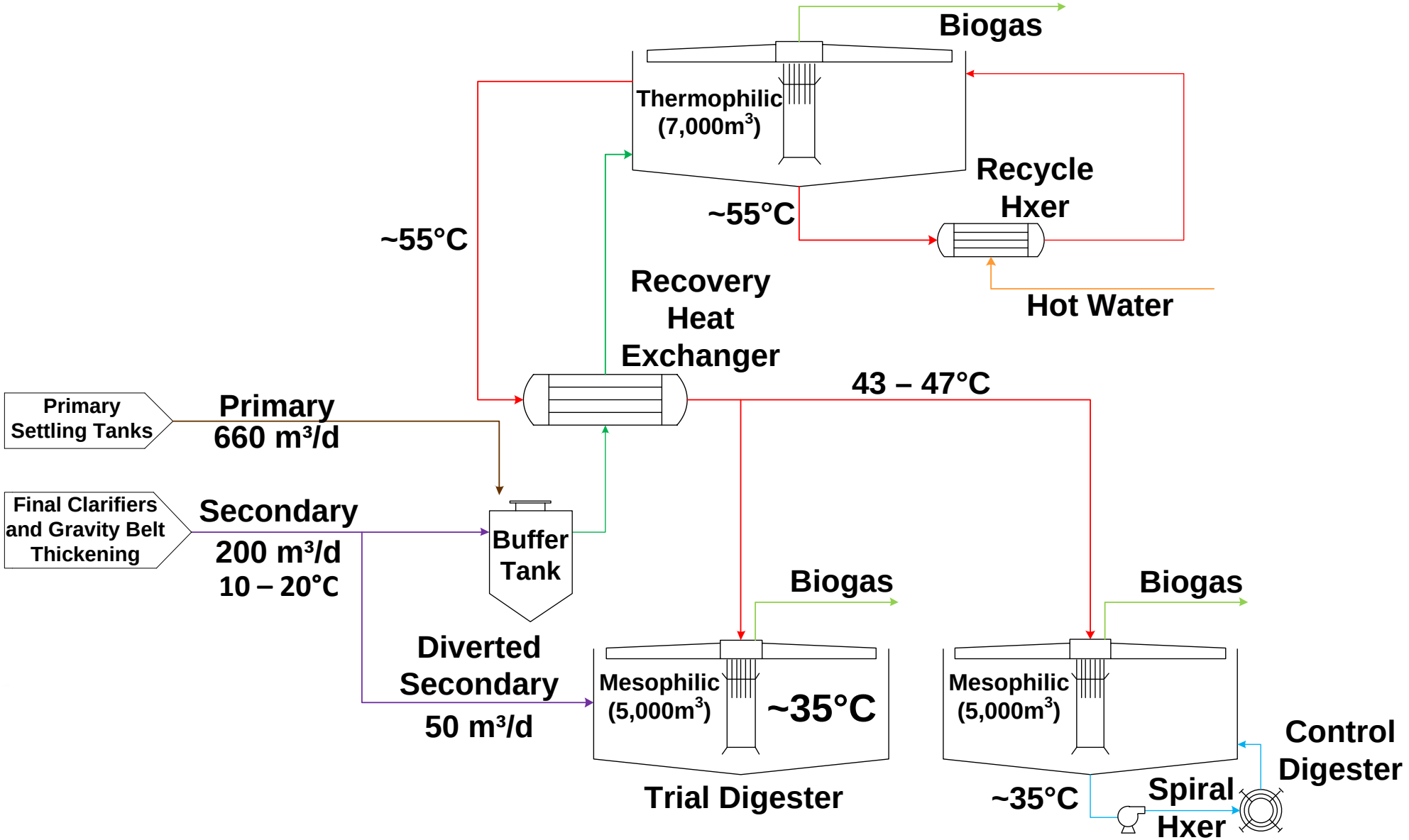
B. Retrofit chiller units to spiral heat exchangers.

C. Divert secondary sludge directly to mesophilic digesters.

D. Water to air heat exchanger (radiator) for heat dump.



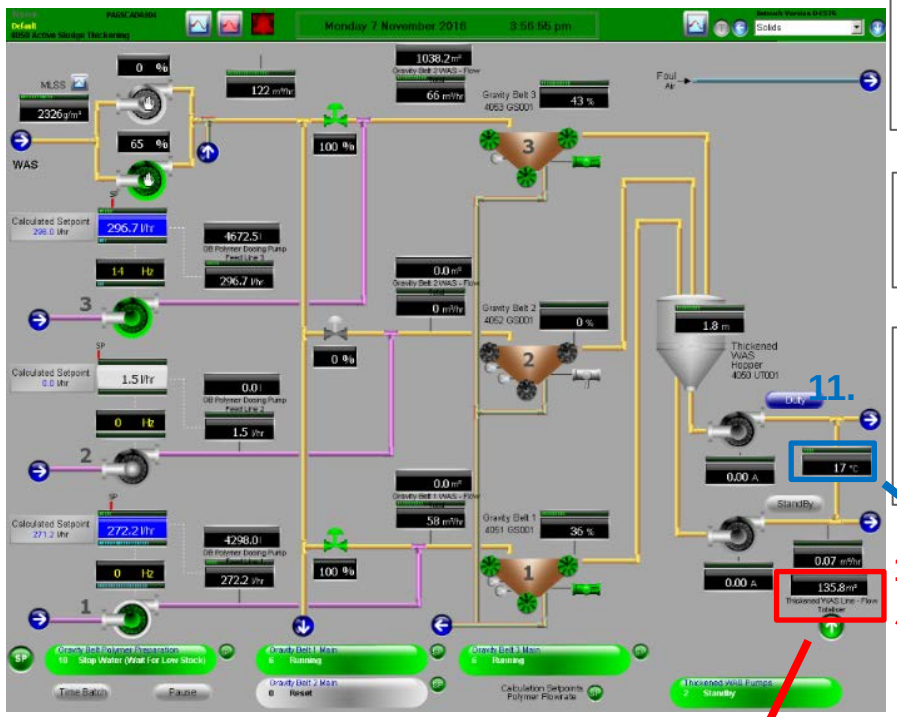
# Trial Operation



# Risk Management

| Risks | Controls (Safety in Design) |
|---|---|
| Foaming | Extensive consultation with client |
| Metabolic imbalance | Procedure developed with operations |
| Loss of temperature control | Ramp-up period |
| No automatic control | Extensive laboratory sampling regime |
| Reduced methane generation | Monitoring |
| Reduced digested biosolids dewaterability | Agreed stop criteria |

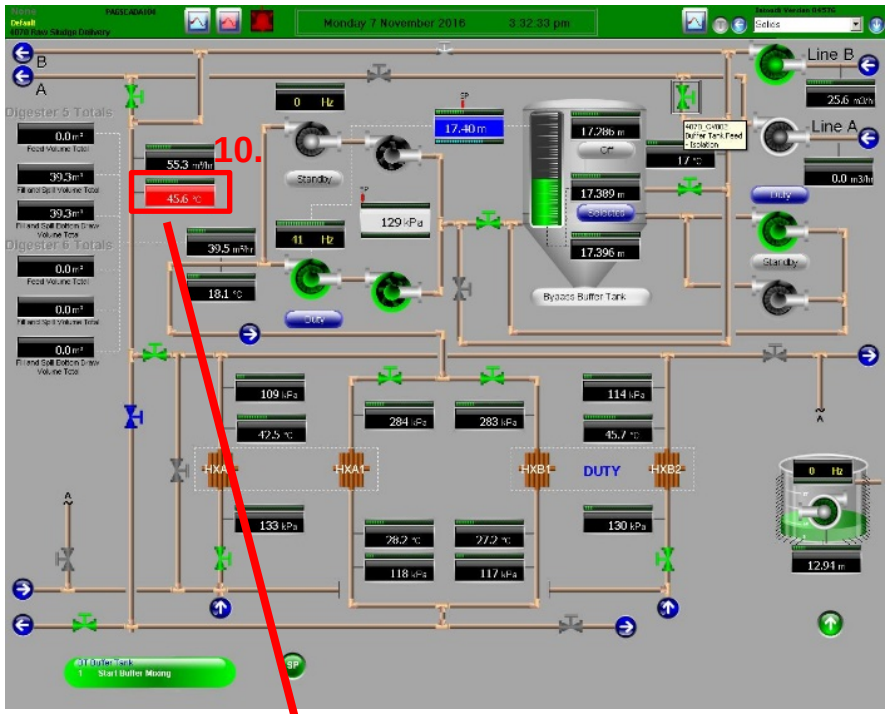
# Operator Procedure




10. Enter thermophilic sludge temperature into spreadsheet

11. Enter WAS temperature reading into spreadsheet

12. Enter WAS totaliser reading into spreadsheet. Record this value in check list




| | | | 7/12/2016 | | |
|---|---|---|---|---|---|
| Task | Action | Parameter | Fill 1 | Fill 2 | Fill 3 |
| Pre-fill Valve Changes | Close | 1. 410.0 OV003 | | | |
| | | 2. 410.1 OV030 | | | |
| | Open | 3. 410.2 OV027 | | | |
| | | 4. 410.0 OV007 | | | |
| | Press | 5. "Cooling Trial" Button | | | |
| | Open | 6. 415.0 OV222 (Fake Valve) | | | |
| | Close | 7. 407.0 OV002 | | | |
| Pre-fill SCADA Changes | Deactive | 8. RSP 6 | | | |
| | Enter into Spreadsheet | 9. Digester 4 Total Sludge Feed | | | |
| | | 10. Thermophilic Sludge Temperature | | | |
| | | 11. WAS Temperature | | | |
| | | 12. Initial WAS Totaliser Reading **(Record)** | | | |
| | | 13. Scaling Factor | 20% | 20% | 20% |
| | | 14. Effective Sludge Mixture Temperature | | | |
| | | 15. New Thermophilic Sludge Spill Volume | | | |

12.

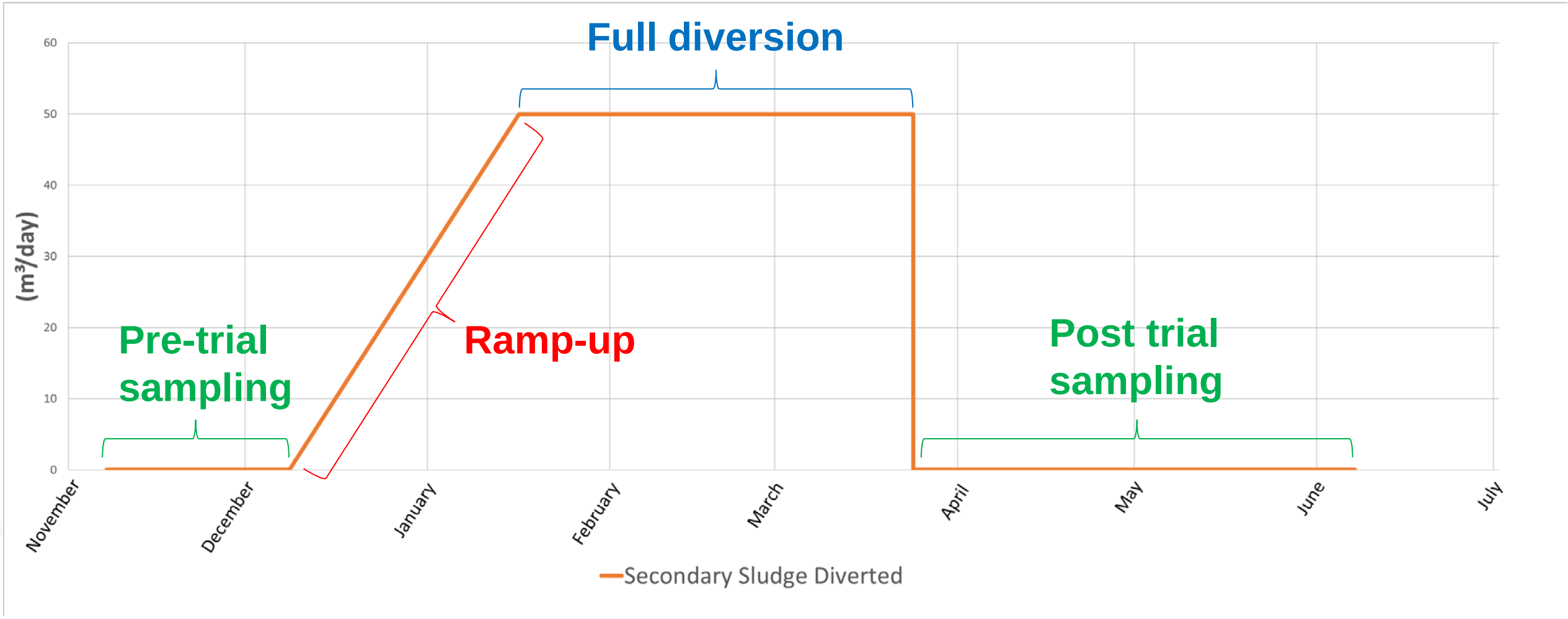
13.

| Inputs | | | |
|---|---|---|---|
| ID | Parameter | Value | Unit |
| 9. | Digester 4 Total Sludge Feed | 60 | $m^3$ |
| 10. | Thermophilic Sludge Temperature | 45.6 | °C |
| 11. | WAS Temperature | 17 | °C |
| 12. | Initial WAS Totaliser Reading | 135.8 | $m^3$ |
| 13. | Scaling Factor | 20% | - |
| 14. | Desired Effective Sludge "Mixture" Temperature | 35 | °C |
| **Outputs** | | | |
| 15. | Thermophilic Sludge Spill Volume | 55.6 | $m^3$ |
| 18. | Final WAS Totaliser Reading | - | $m^3$ |

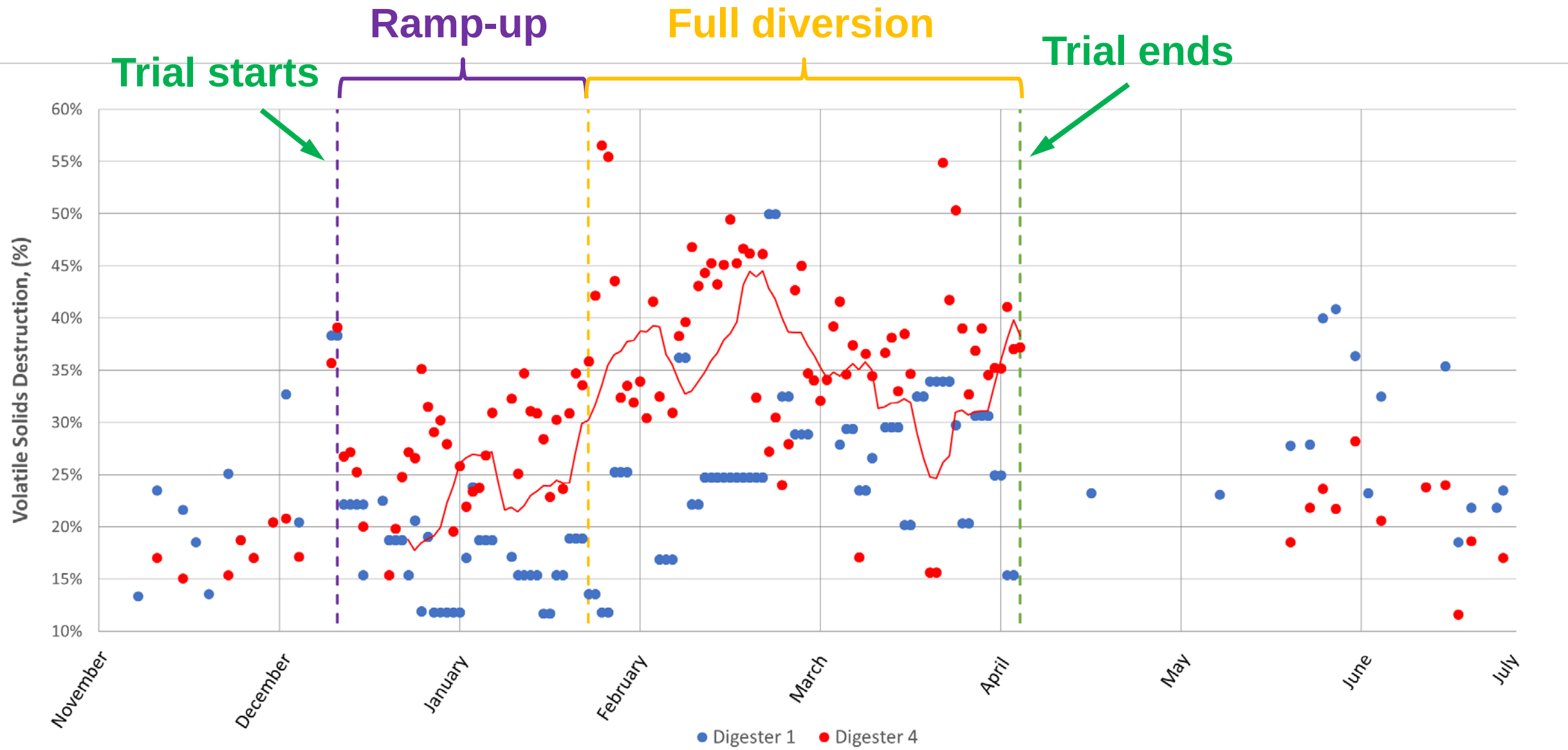
13. Enter scaling factor from checklist into spreadsheet

To access spreadsheet, open "Sludge Cooling Trial Spreadsheet.xlsm" located on the bottom left corner of the graphing screen.

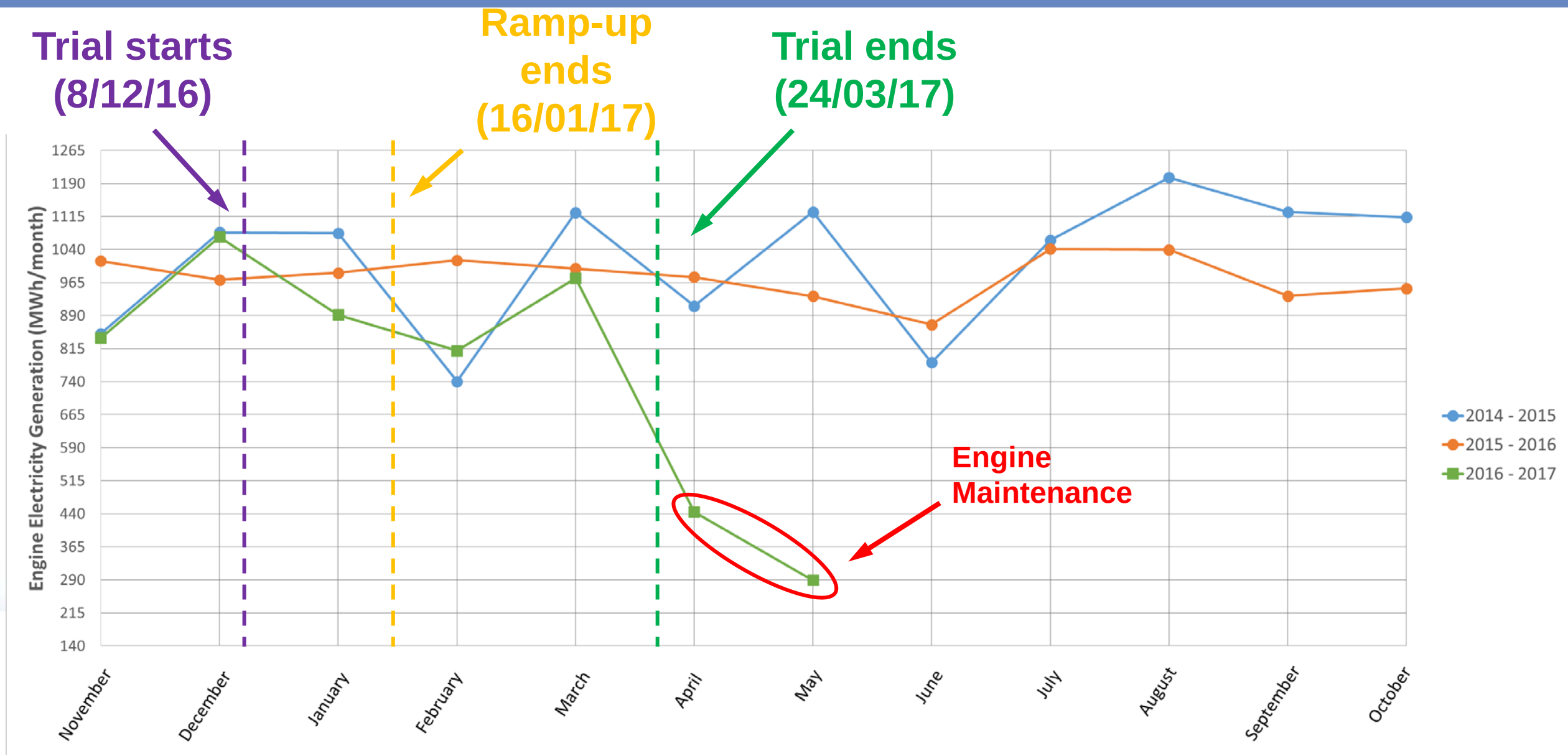
# Trial Time-line



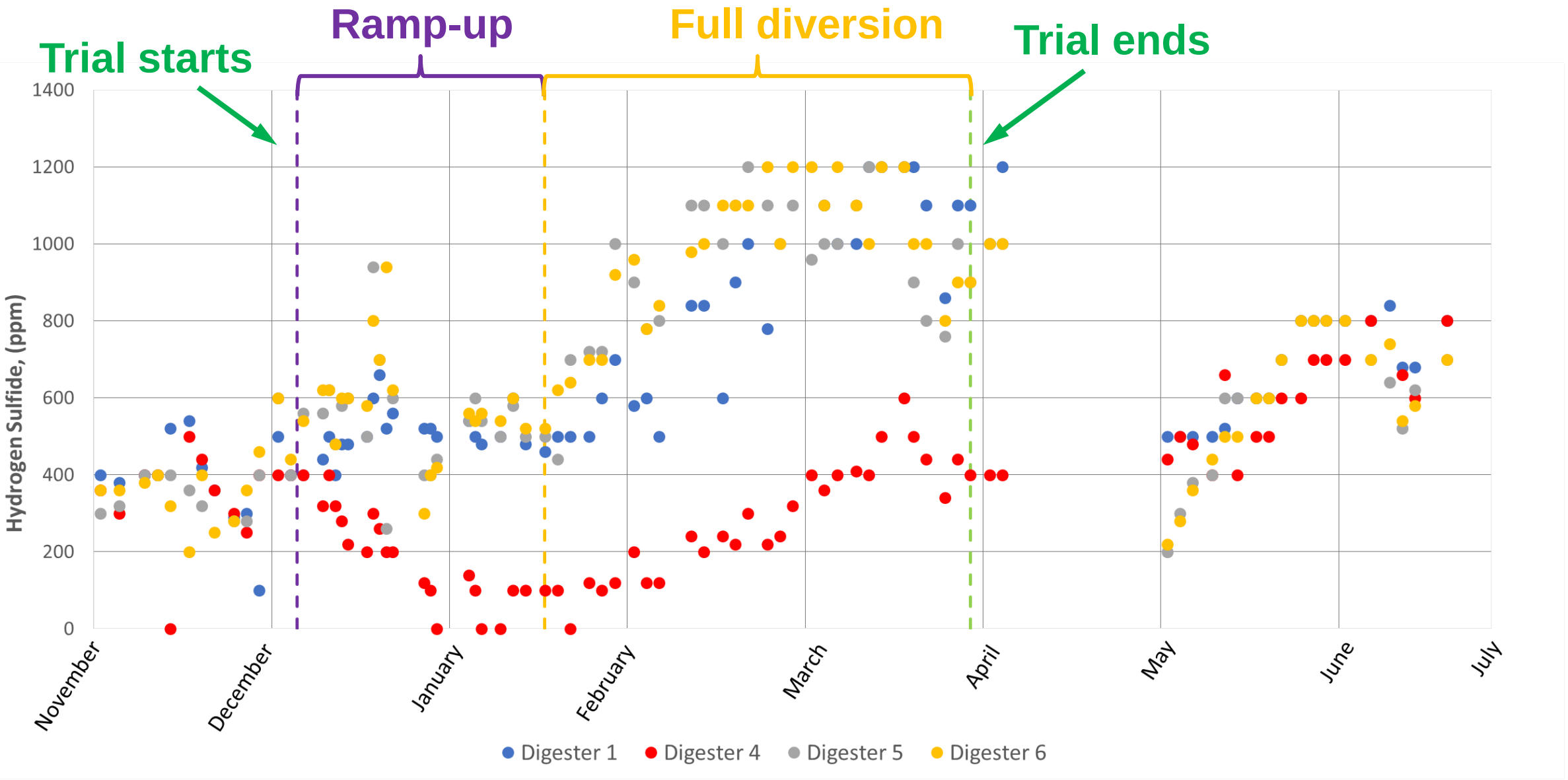
# Trial Outcomes – Volatile Solids Destruction



# Trial Outcomes – Biogas and Electricity



# Trial Outcomes – $H_2S$



# Trial Outcomes – Digester Health and Operation

| Parameter | Criteria for Success | Actual Performance | |
|---|---|---|---|
| **Temperature** | 33 – 35°C | 33 – 35°C |  |
| **Volatile solids destruction** | No reduction | 20% increase for the Test Digester but overall remained similar |  |
| **Volatile acids** | <1,200 – 1,500 mg/L | <96 mg/L for Digester 4 |  |
| **pH** | 6 – 8 | 7.3 – 7.5 |  |
| **Biogas – methane content** | No detrimental change from current | No significant change observed |  |
| **Biogas – Hydrogen sulfide content** | No detrimental change from current | Significant improvement (down to 0 – 100pmm) |  |
| **Final dry cake solids** | No detrimental change from current | Reduction of 4 – 6% DS |  |

# Trial Outcomes - Economics

| | Proposed Solution | Estimated Capex | Estimated Opex |
|---|---|---|---|
| A | Replace spiral exchangers with closed cooling loop | High | High |
| B | Retrofit spiral exchangers with closed cooling loop | Medium | High |
| C | Divert secondary sludge directly to the mesophilic digesters for cooling | Low | Low to medium |

# Questions?

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