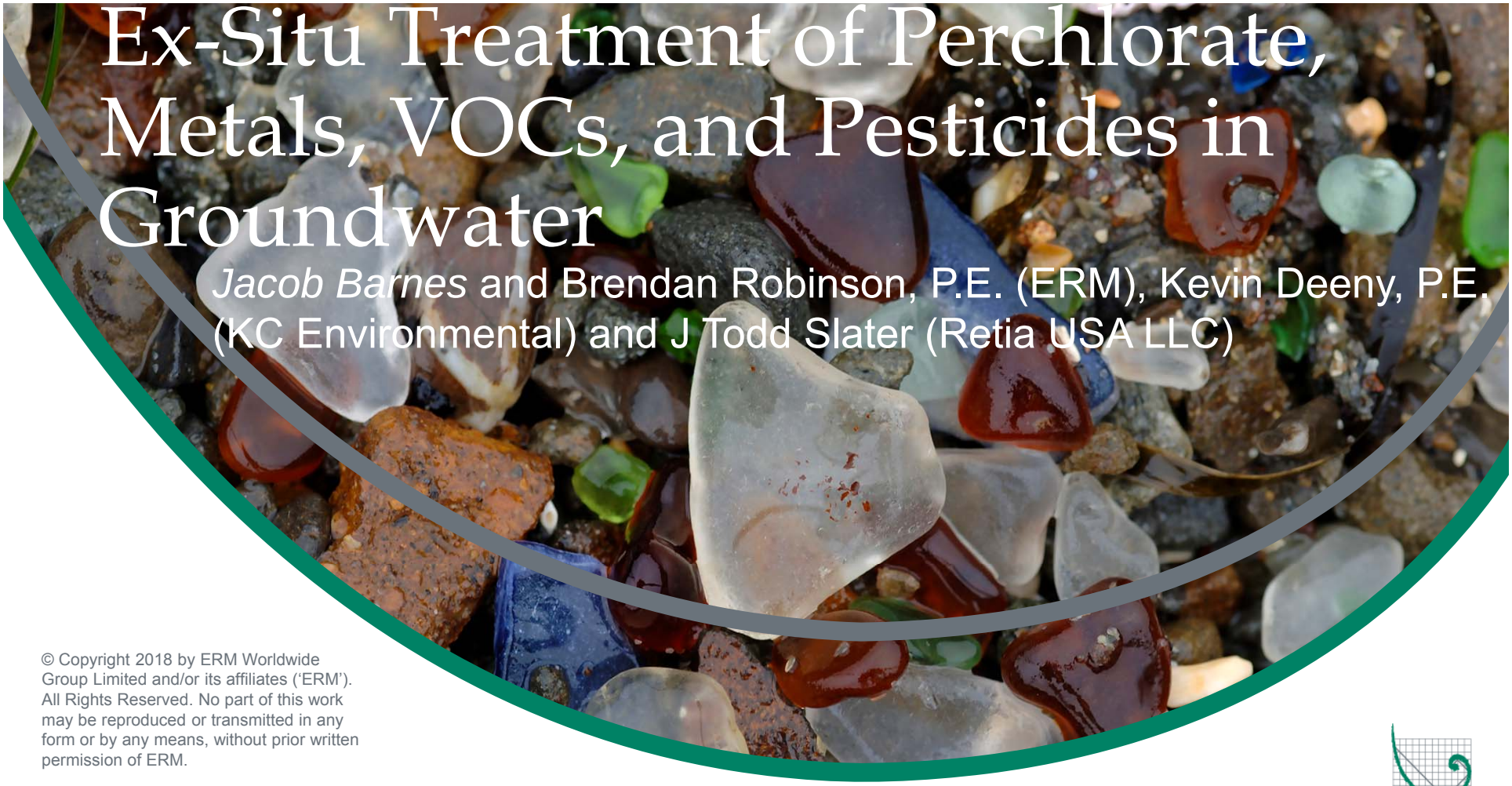
# Ex-Situ Treatment of Perchlorate, Metals, VOCs, and Pesticides in Groundwater

*Jacob Barnes* and Brendan Robinson, P.E. (ERM), Kevin Deeny, P.E. (KC Environmental) and J Todd Slater (Retia USA LLC)





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# Agenda

**01** Introduction

**02** Approach

**03** Results

**04** Lessons Learned

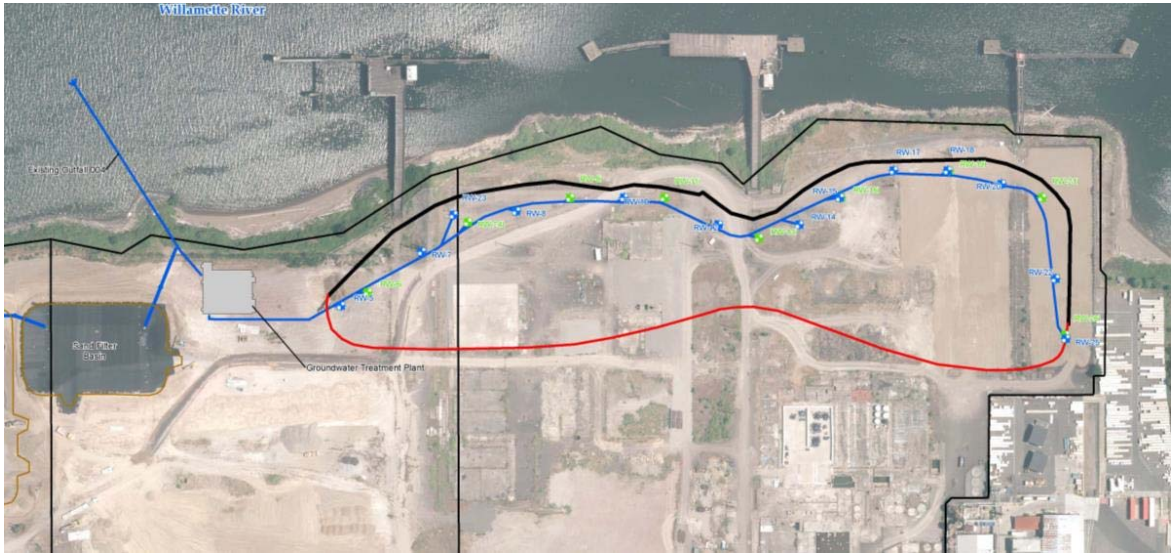
**05** Conclusion

# Introduction

- Former Arkema chlor-alkali facility
- Operations (former) from 1941 to 2001
- Adjacent to Portland Harbor Superfund Site
- Groundwater Source Control Measure (GW SCM)

# Introduction – GW SCM

- Groundwater Barrier Wall (GWBW) – 1,800 LF
- Groundwater Extraction and Treatment (GWET)
- Discharge to Willamette River





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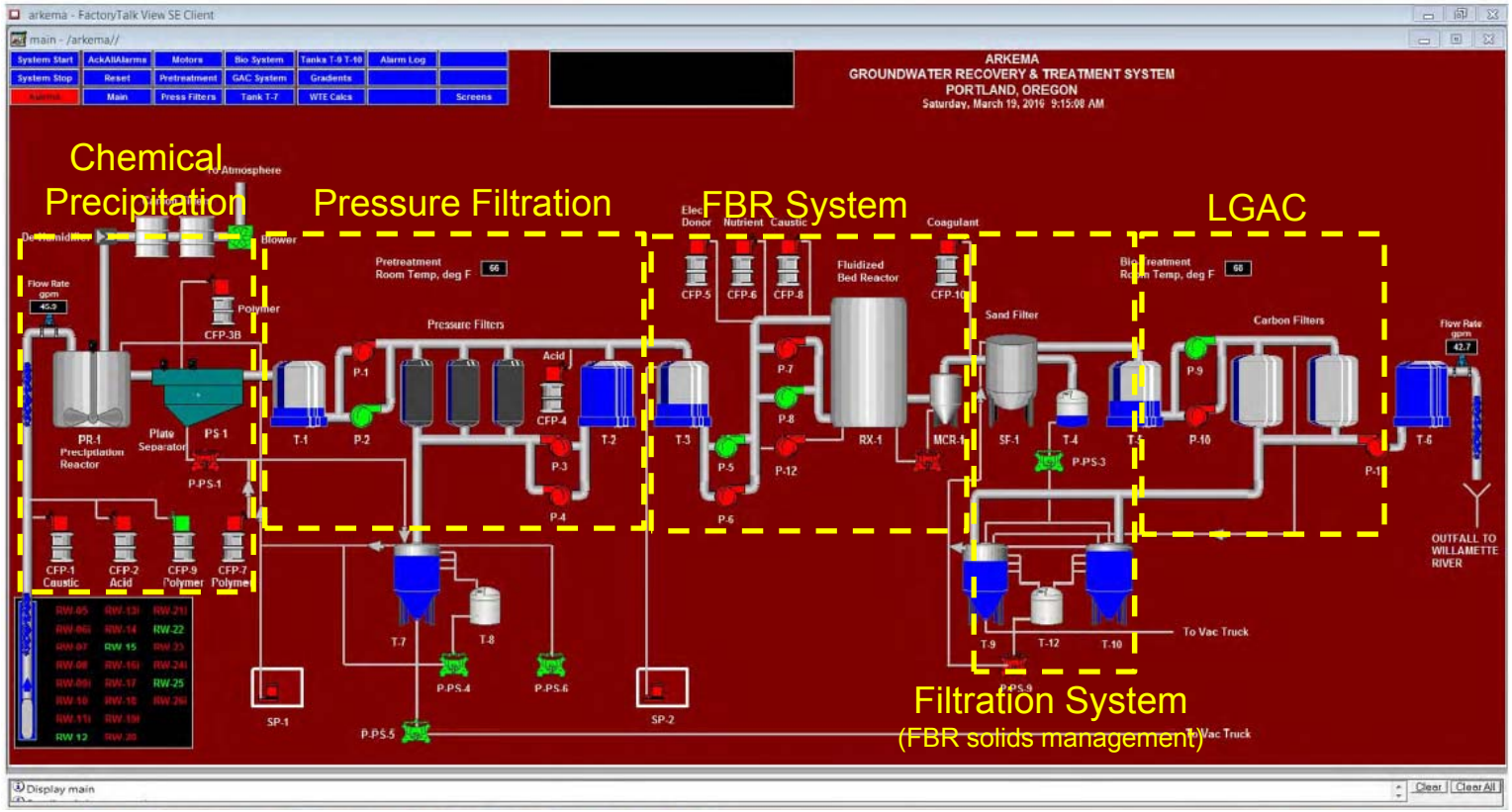
# Approach

- GWET System startup - March 2015
  - 109 GPM design flow rate
- Multiple treatment units
  - Chemical Precipitation
  - Pressure Filtration
  - Fluidized Bed Reactor (FBR) for Perchlorate, Chlorate
  - Gravity Filtration (sand)
  - LGAC for Pesticides (DDx), VOCs

# Approach





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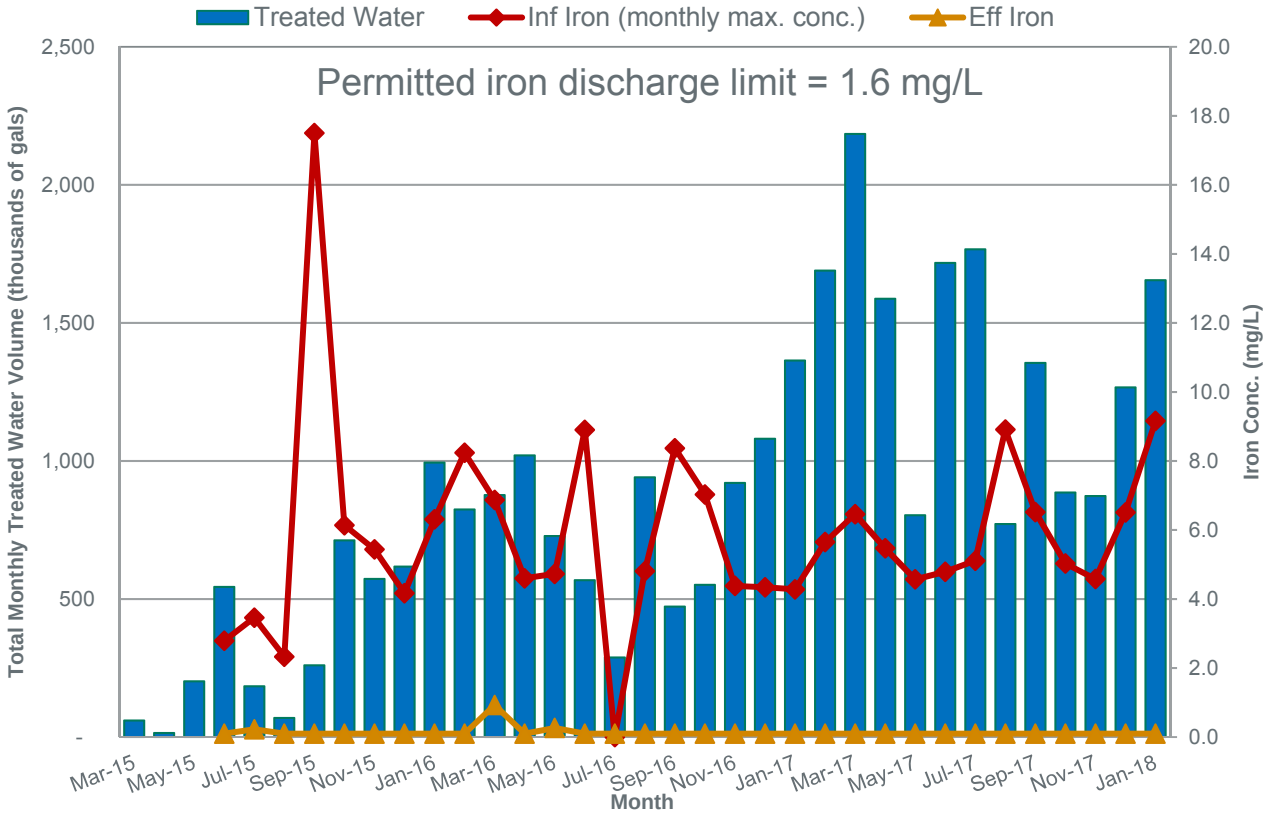
# Approach – FBR

- Organic Carbon Food Source
  - 56% acetic acid solution (electron donor)
    - Adjusted to target residual chemical oxygen demand (COD)
    - 3 gallons per day
  - Nutrients
    - 85% phosphoric  acid solution
    - Urea (46% urea nitrogen)
      - 10 to 11 pounds per day
  - pH Control
    - 25% caustic soda solution
    - Maintain pH of ~7.00

# Results - Metals




- Iron (Fe) at least 71% of total metals
- Coagulant consumption driver
- Total metals also include:
  - Hexavalent Chromium (Cr[VI])
  - As, Cd, Cr, Ni





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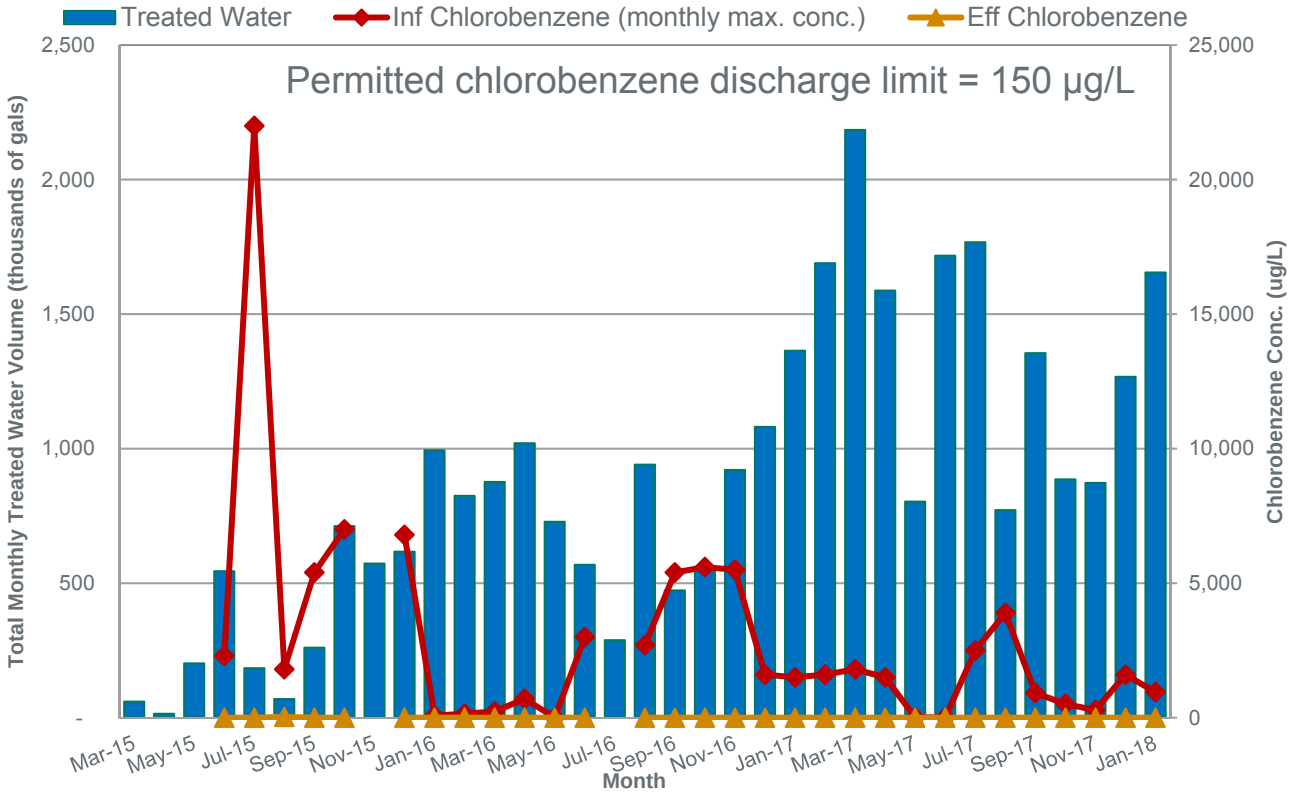
# Results - VOCs




- Chlorobenzene at least 86% of total VOCs
- LGAC
- Total VOCs also include:
  - Chloroform
  - PCE, Benzene





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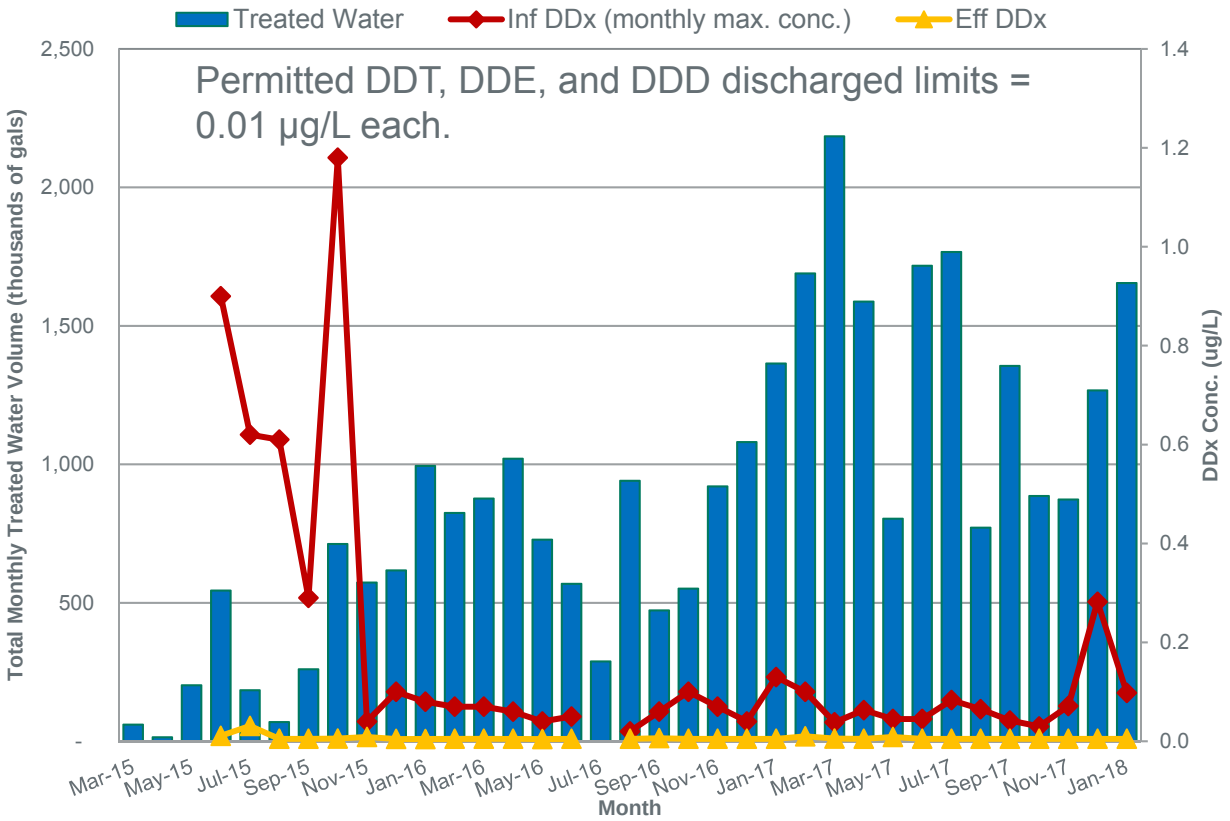
# Results - DDx




- DDx = DDT, DDE, and DDD combined
- DDT at least 40% of DDx
- Solids Management
- Turbidity Monitoring
  - LGAC Inf Avg Turb = 16.6 NTU
  - GWET Eff Avg Turb = 1.5 NTU





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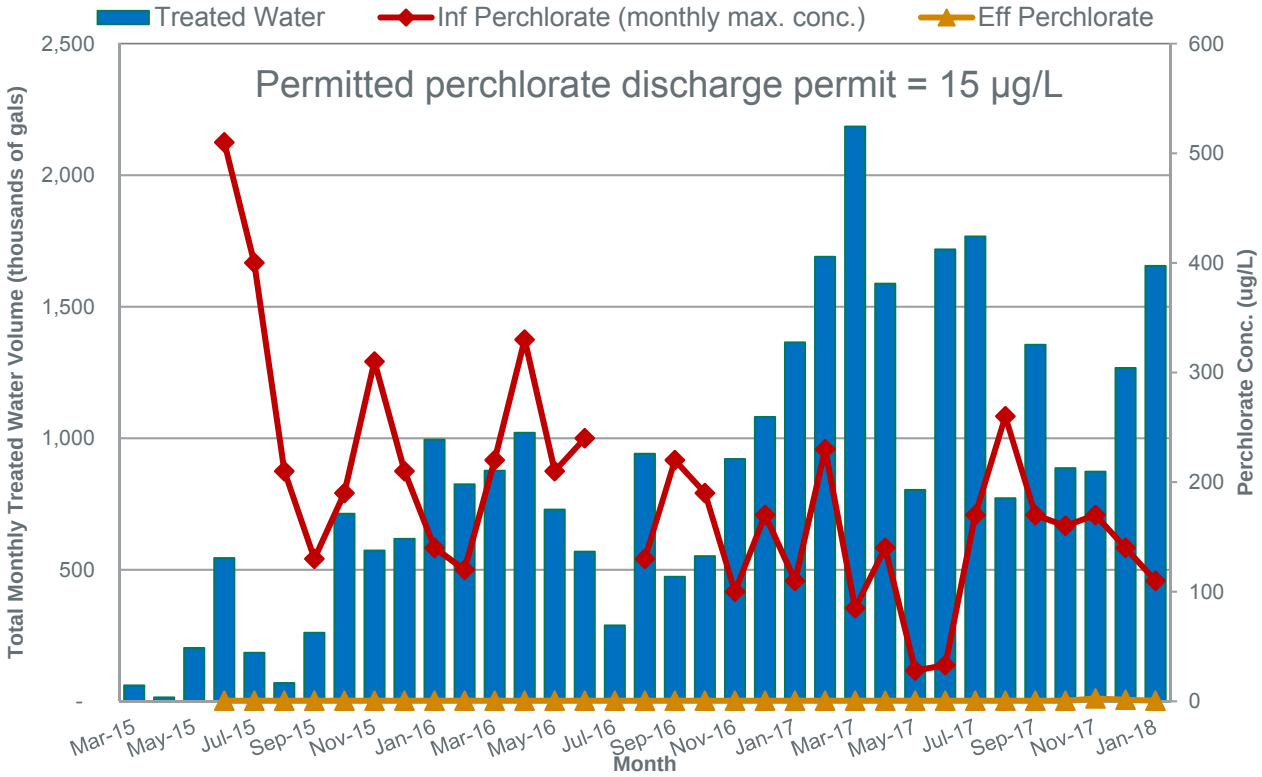
# Results - Perchlorate




- Fluidized Bed Reactor
- Perchlorate Reducing Bacteria





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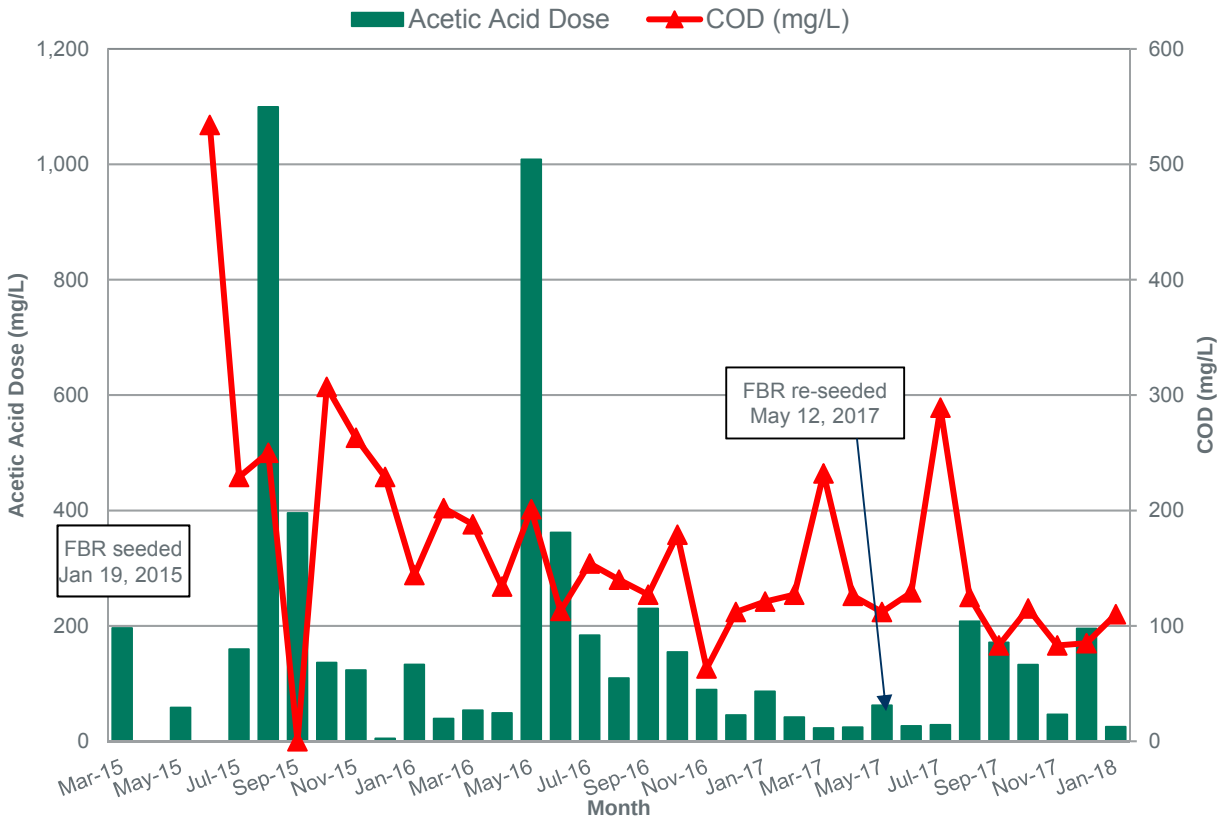
# Results – FBR Operation





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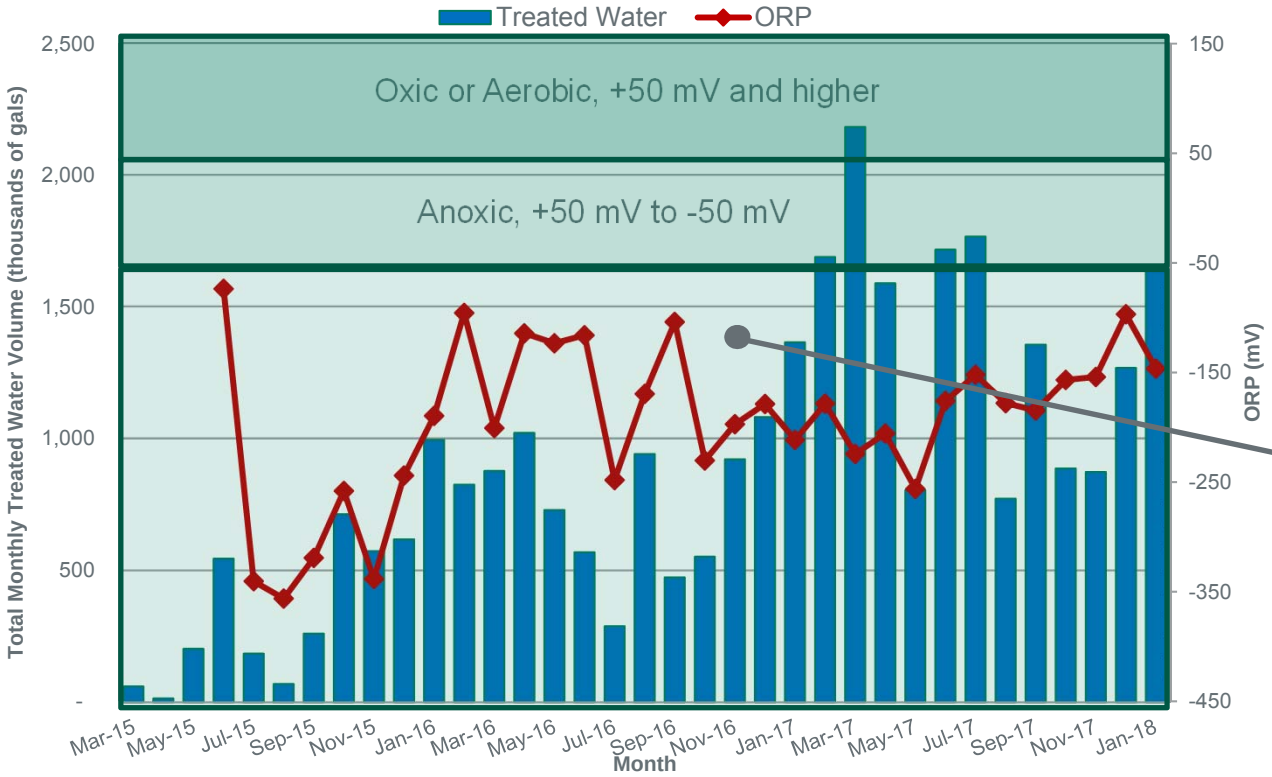
# Results – FBR ORP




- Oxidation – Reduction Potential

Fermentative Anaerobic, -50 mV and lower





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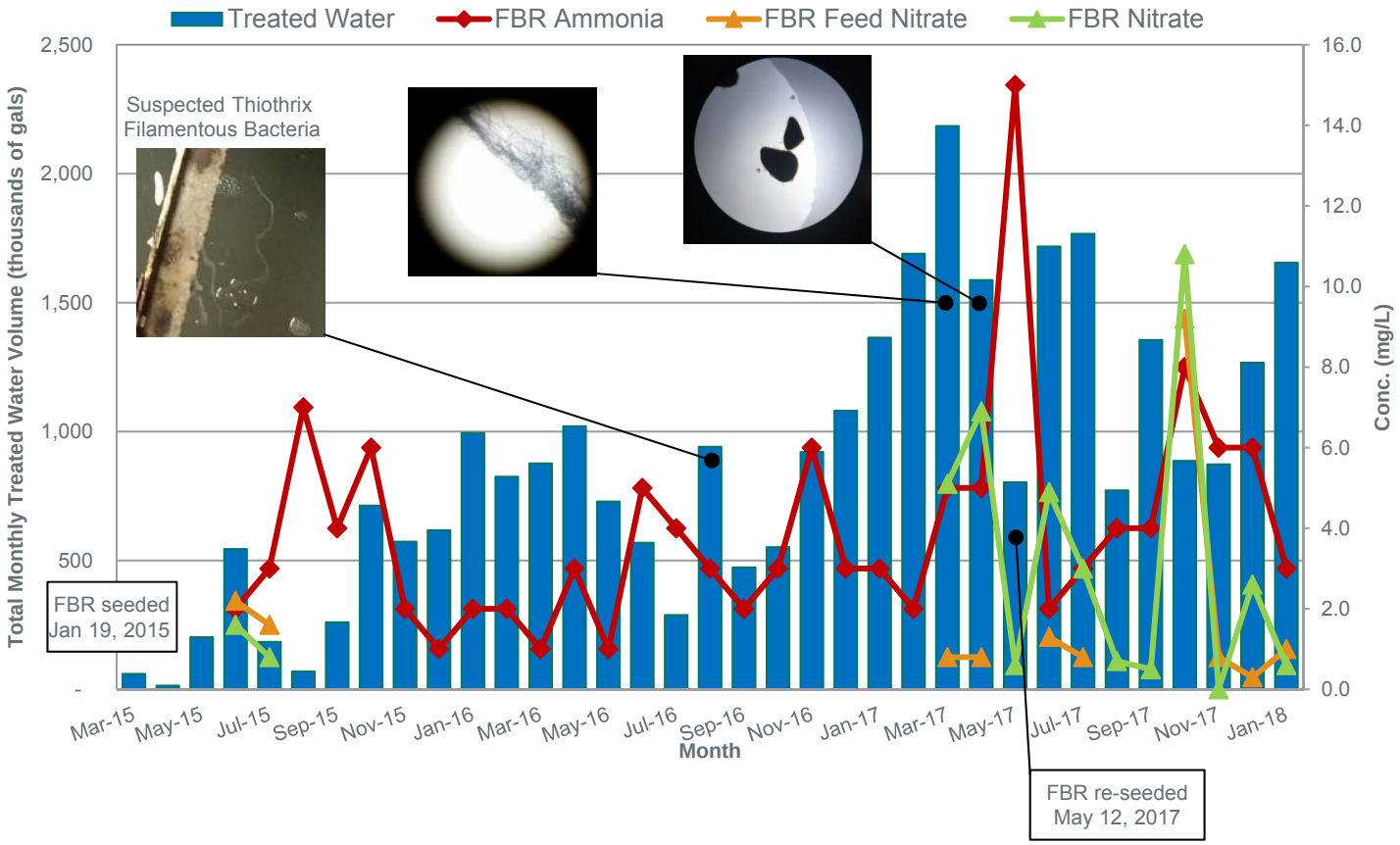
# Results - Nitrification



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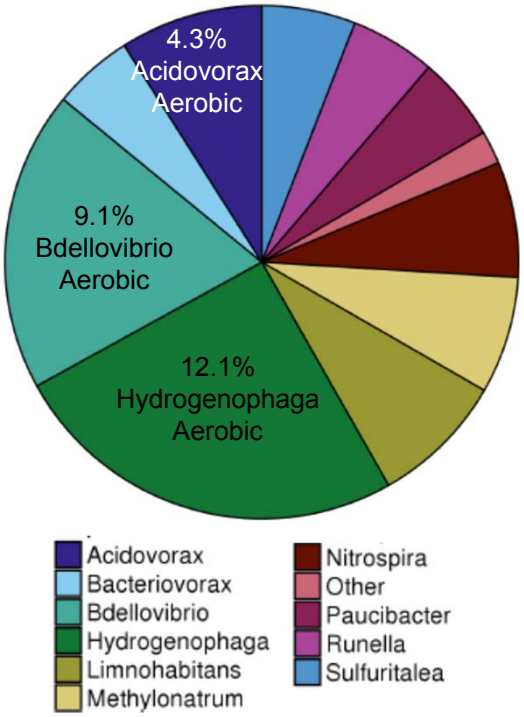
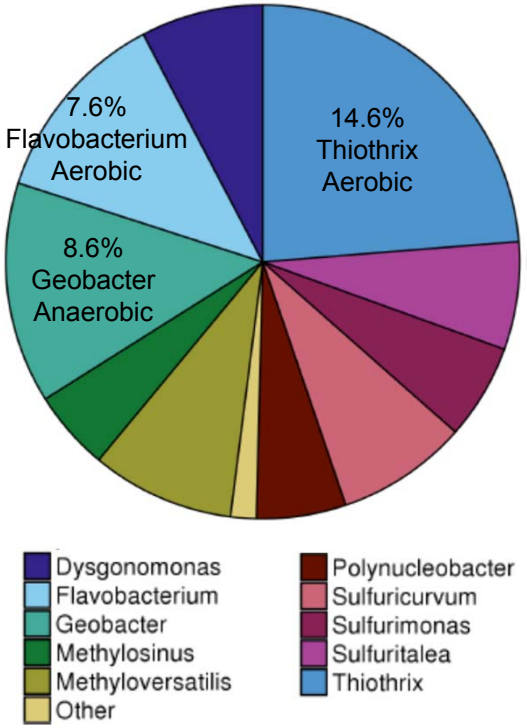
# NGS Results – 9 Mos Post Re-Seed

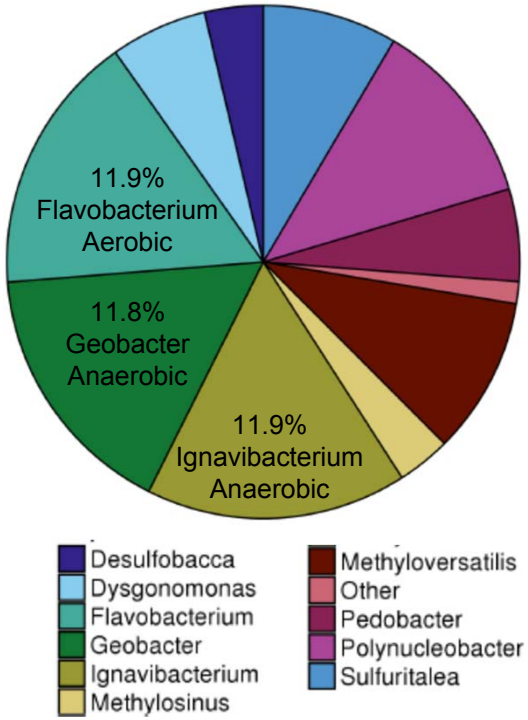
FBR Influent




FBR Recirculation

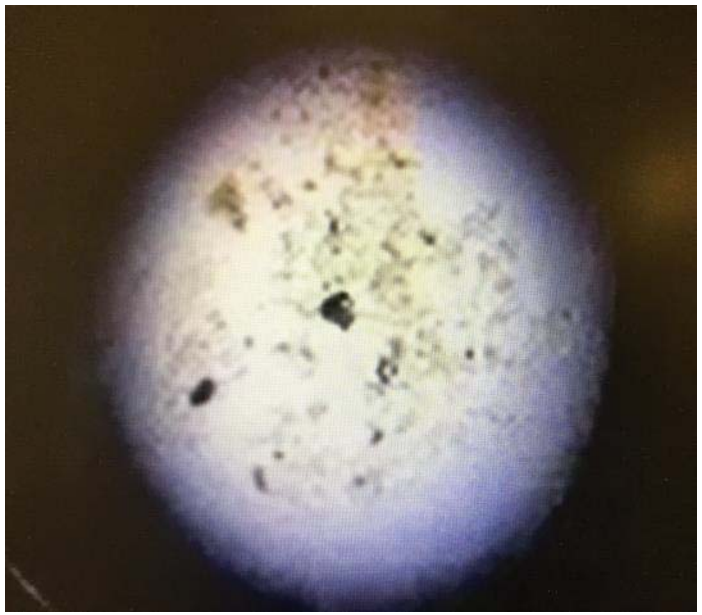



FBR Carbon



# Lessons Learned

- Some ammonia nitrogen from urea converted to nitrite and nitrate
- Presence of nitrite/nitrate suggests limited denitrification and associated decrease in perchlorate reducing reactions
  - Low ORP (below -200 mV)
  - Target ORP of -150 mV
- Biosolids exiting the FBR must be controlled
  - ORP control and coagulant addition
  - Sand filter and LGAC backflushing
  - Turbidity monitoring



# Conclusion

- FBR System is effective over wide range
  - Successful treatment even in non-ideal conditions
  - Varied aerobic and anaerobic bacterial population
- Good solids management is key to DDx removal efficiency
- Increase treatment rate to support overall GW SCM objective
  - Hydraulic control of impacted groundwater
  - Conveyance line cleaning (April 2018)
  - Recovery well redevelopment (April 2018)

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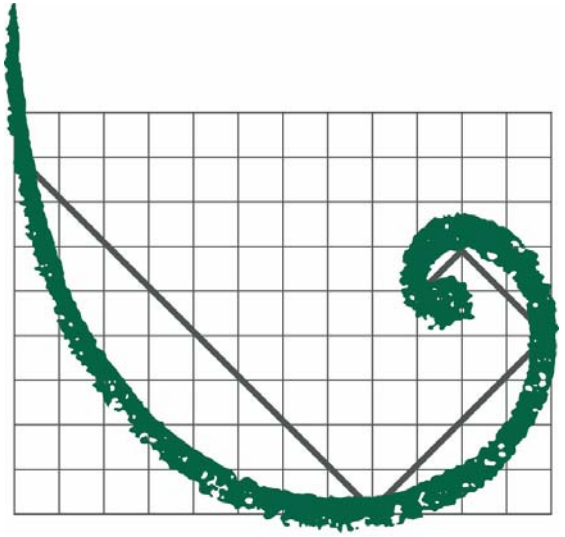
Conference on Remediation of Chlorinated and Recalcitrant Compounds

April 8-12, 2018 | Palm Springs, CA

# Thank You

- Retia USA LLC
- ERM Staff
  - System operation
  - Data collection and processing
- Microbial Insights
  - Next Generation Sequencing analysis and graphics

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