Tighe&Bond

Engineers | Environmental Specialists

LESSONS LEARNED INSTALLING AND STARTING-UP THE COMAG PROCESS FOR LOW LEVEL PHOSPHORUS REMOVAL AT THE SOUTHINGTON CT WPCP

NEWEA Annual Conference – January 25, 2022 (Session 20)

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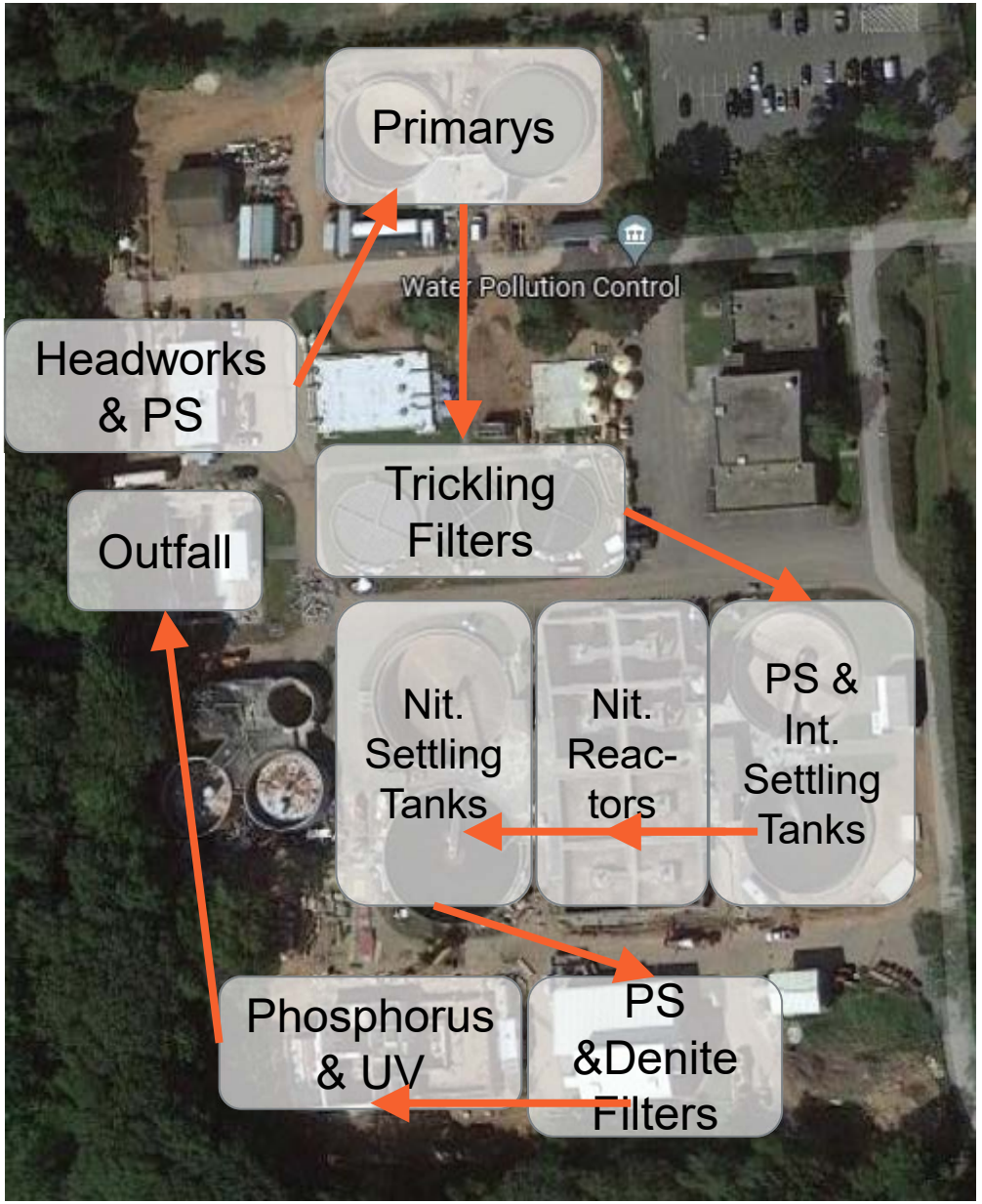
PLANT OVERVIEW - LIQUID TREATMENT



SOUTHINGTON WPCF

- **Design Capacities**
  - Design Average Daily Flow 7.4 mgd
  - Design Peak Hourly Flow 15.9 mgd

- **Drivers for Upgrade**
  - Aging Equipment (most from early 1980s)
  - Odor Control
  - Phosphorus Limits
    - Seasonal – April 1 through October 31
    - Interim Limit - 0.7 mg/L (2013)
    - Final Limit (April 2022)
      - 7.53 lbs./day, Equivalent to
      - <0.2 mg/L at current ADF of 4.5 mgd
      - <0.12 mg/L at design ADF of 7.4 mgd

SOUTHINGTON WPCF UPGRADE

- **Construction**
  - Construction Cost of ~$40 M
  - Notice to Proceed - January 2019
  - Substantial Completion - April 2021

- **Funding**
  - Clean Water Fund
    - 50% grant (low level phosphorus removal)
    - 30% grant (nutrient removal)
    - 20% grant (other costs)
    - Loan
  - Energy Utility Rebate Incentive

EVERSOURCE

PHOSPHORUS TECHNOLOGY SELECTION

Facilities Plan 2014

Technologies were screened through workshops with the town using a ranking process, from several to the top three:

- Ballasted Flocculation
- Disc Filters
- Deep Bed Sand Filters

Technology Scoring

Ballasted Flocculation scored most favorable for:

- Present Worth Cost
- Ease of Operations
- Existing Installations (at the time)
- Low Return Flow Rates
- Seasonal Shutdown Flexibility

Redundancy

For Seasonal System

- Two Full Duty Trains,
- Other installations visited had 1 train of reactors and 2 trains of clarifiers

PRE-PROCUREMENT

- **Public Bidding**
  - Request for Proposals: December 2015
  - Bid Opening: January 2016
  - Notice of Award: March 2016
  - Pilot: June 2016

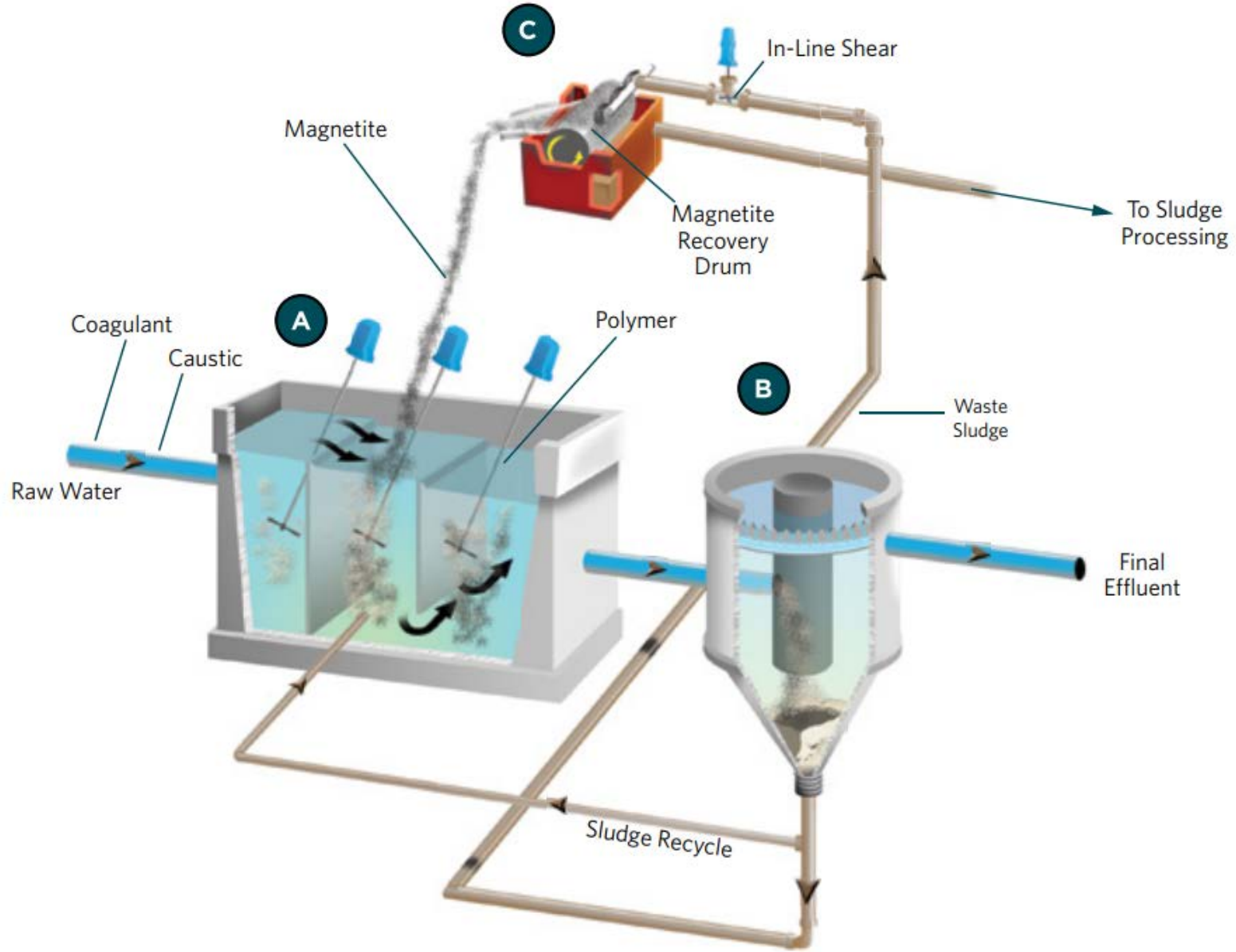
EVALUATION OF BIDS

O&M Guarantees with Bid
- Energy Usage
- Chemical Usage (ferric, PACL, alum)
- Ballast Usage

Evaluation of Life Cycle Costs
- Equipment
- Construction
- O&M and Labor
- Validation Testing
- Warrantee & Service Agreement

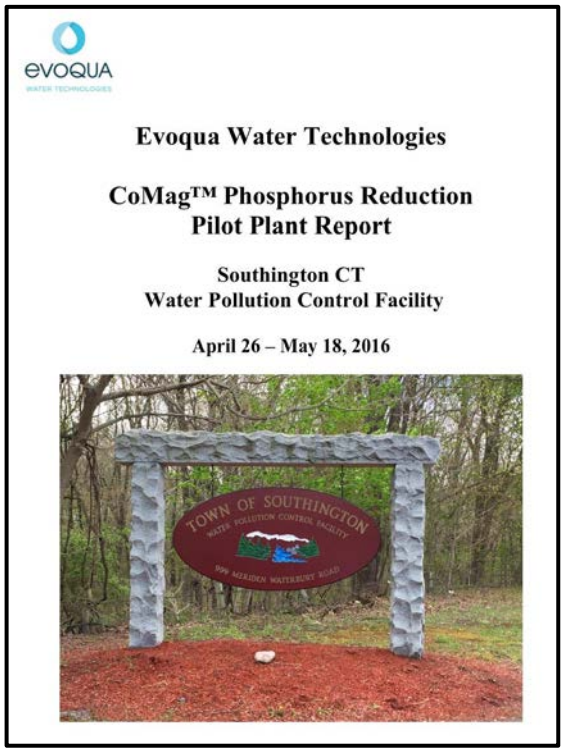
Other Non-Monetary Criteria
- Experience
- Treatment Capability
- Operability & Maintenance
- Hydraulics
- Service & Support

COMAG PROCESS OVERVIEW



BIDDER VALIDATION TEST - GOALS

- **Prove System Performance Guarantee**
  - Effluent P
  - Loading Rates
- **Prove System O&M Guarantees**
  - PACL Usage
  - Alum Usage
  - Ferric Chloride Usage
  - Energy Usage
- **Will Soluble Non-Reactive Phosphorus (SNRP) interfere with performance?**



BIDDER VALIDATION TEST – LESSONS LEARNED

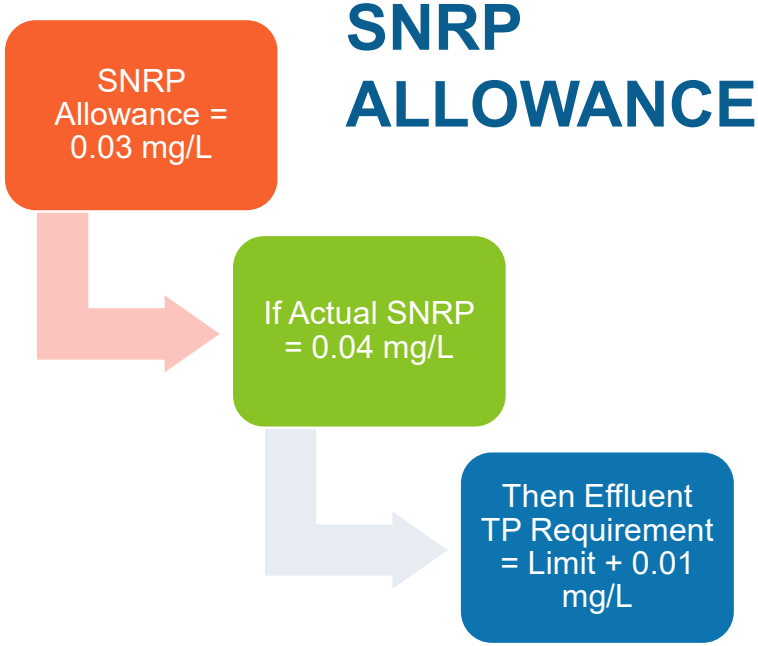
- **Chemical Performance**
  - PACL – Did not perform (High usage) ✗
  - Alum and Ferric – did perform ✓ ✓
  - Re-evaluated Bids – CoMag still first choice

- **Design Plan – Chemical Feed**
  - Design for any Chemical
    - Future Aluminum limits?
    - Corrosivity of Ferric drove material selection
  - Multi-point (PACL – same as temporary system)
  - CoMag (likely Alum – Owner's preference)

SOLUBLE NON-REACTIVE PHOSPHORUS (SNRP)

- SNRP = Soluble Total P – Soluble Ortho-P
- **Concerns**
  - Cannot be removed via treatment
  - Interim systems would for no apparent reason struggle to meet 0.7 mg/L for a week or two each summer (unknown reasons) –Was this due to SNRP?
- **Solutions:**
  - Build “Allowance” in Design Criteria
- **Lessons Learned:**
  - SNRP Not a factor in Jar Tests (winter), Pilot (early summer) or Startup (2021 Season)

SNRP ALLOWANCE

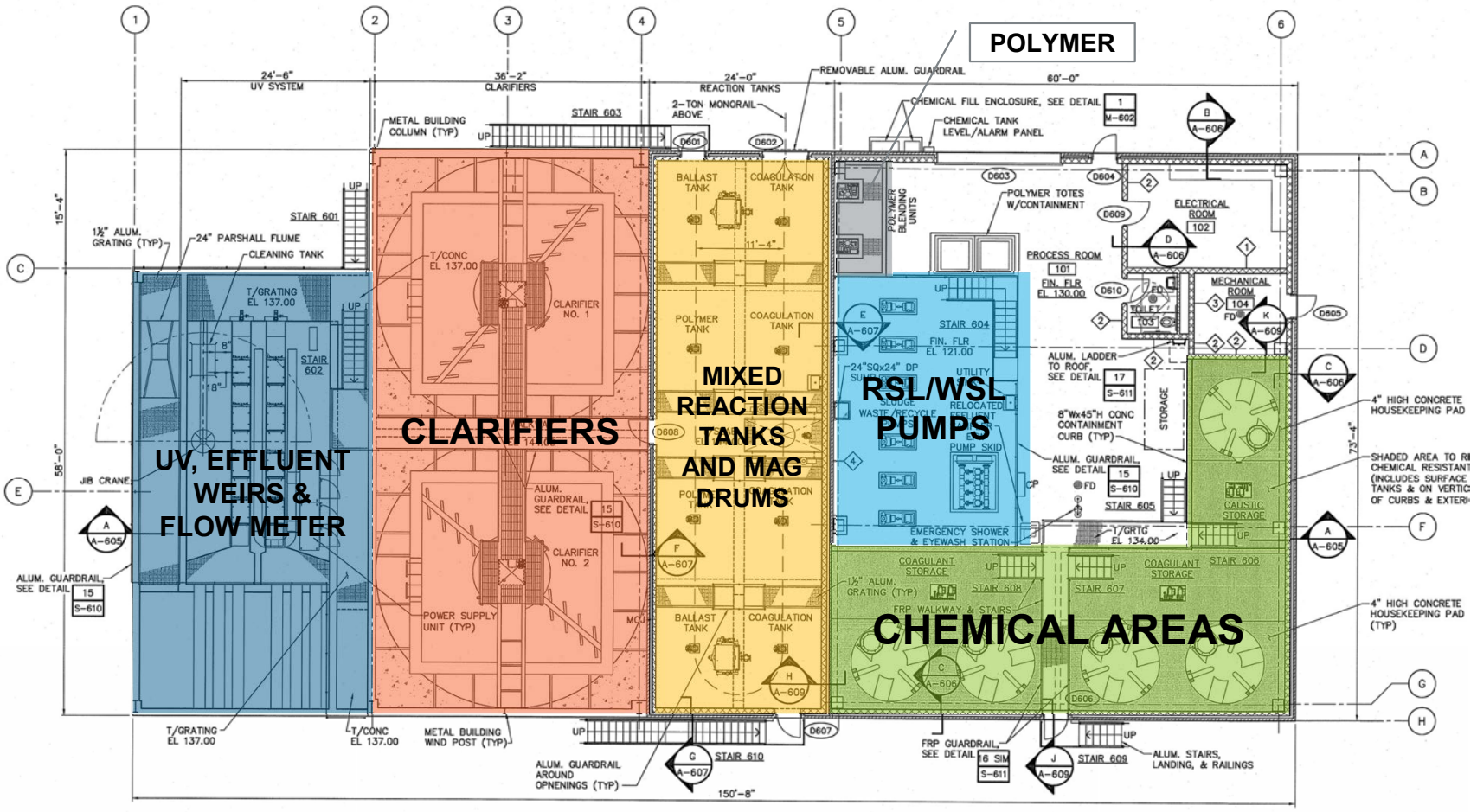


LESSONS LEARNED - DESIGN

- **Plan:**
  - Gravity from Upflow Denite Filters to CoMag (and relocated UV)
  - 15.9 MGD “Denite Pump Station & Filters Work Great”

- **Learned:**
  - Filters were only passing 10-12 MGD
  - At High Flows - Operators shutting down & bypassing (to old UV)
- **Solution:**
  - Get IDI/Suez Mfg Onsite – re-train (new) operators (12-14 MGD)
  - Add a bypass around filters (to get >16 MGD)
  - Denite PLC Code Improvements (over 6+ years)

LESSONS LEARNED: CONSTRUCTION



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LESSON LEARNED: CONSTRUCTION

- **Schedule**
  - CoMag Bid – Jan 2016
  - Construction Start – Jan 2019
  - First CoMag Submittal – July 2019

- **Surprise – Pump Design Change**
  - Changed pumping design from 10% to 5% of plant's ADF
    - Act Fast – Pipe being laid soon!

- **Impacts**
  - Lower Flows means Smaller Pipe Sizes to suspend solids.
  - Revisit Pump Sizing & HP

LESSONS LEARNED: START-UP

- **Plan:**
  - Break-in-period required before performance testing CoMag
    - Troubleshoot equipment
    - Stabilize chemicals (magnetite levels, multipoint dosing)
    - Operator learning curve

- **Issue - Nitrification Reactor Upset**
  - Loss of solids in nitrification reactors
  - Drain valve left open – unintended wasting
  - Delayed Testing for 1 month

LESSONS LEARNED: START-UP

- **Issue - Denite Pump Station & Filters**
  - Effluent Flow oscillations
    - 18 min. cycle
    - +/- 50% variation (e.g., 3-9 MGD)
  - Not trended in Denite SCADA system
  - New information:
    - Visible at CoMag weirs
    - New effluent flow meter

- Ruled out surging air in inverted siphon feed pipe
- Required PLC modifications

LESSONS LEARNED: START-UP

- **Issue – Siphon Effect**
  - Pipe returning solids to reaction tanks had an 18-foot drop
  - Pump design had to assume no siphon effect – free fall in 4” drop pipe.
  - Pump startup demonstrated siphon effect was maintained over wide range of flows – reducing energy costs

PERFORMANCE TESTING GOALS

- **Meet Effluent Requirements**
  - TP < 0.1 mg/L (with O&M guarantees)
  - TP < 0.05 mg/L (potential future limit)

- **Meet O&M guaranteed values**
  - Chemical (Only Alum Tested)
  - Energy
  - Magnetite, plant water consumption, & waste solids flow

Operations and Maintenance Guarantee

Parameter	Unit	Target Value
Average, 48% solution alum dosage	ppmvp	60
Average polymer dosage	ppmvp	2.6
Power Consumption	kWh/d	861
Average magnetite (ballast) usage	lb/d	45

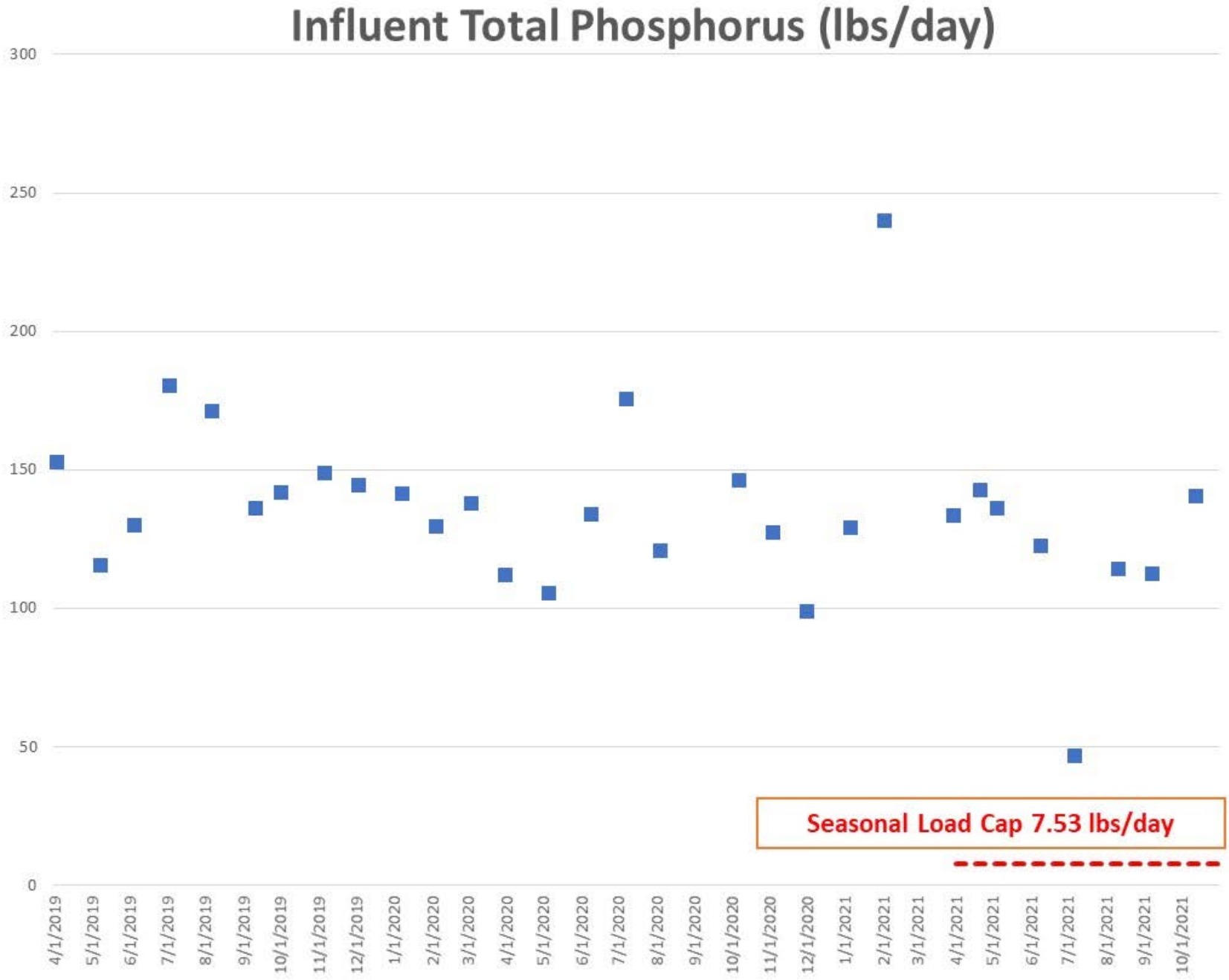
PERFORMANCE TESTING

- **Performance Testing Plan**
  - 28-day test
  - Four full-scale operating conditions
- **Process Adjustments**
  - Coagulant, magnetite, polymer
  - Flow split to parallel trains (1 or 2 online)
- **Effluent Requirements**
  - TSS, Turbidity, Total Phosphorus, pH

PERFORMANCE TESTING

- **Overall Results**
  - Two sets of effluent performance requirements Met ☑
    - All 4 conditions
    - All Criteria (TP, TSS, Turbidity)
  - O&M Guaranteed Values Met ☑
    - Treating to TP<0.1 mg/L
    - Power, chemical, plant water use, magnetite
- **Notes**
  - Some data was not considered (process upsets)
  - Process responded quickly to upsets (polymer shut-downs)
  - Return Sludge Pumping - Typically ran @ 2-3% of Plant ADF (energy usage well below guarantee)

IMPACT ON PLANT OPERATIONS


Influent Total Phosphorus (lbs/day)
300
250
200
150
100
50
0
4/1/2019
5/1/2019
6/1/2019
7/1/2019
8/1/2019
9/1/2019
10/1/2019
11/1/2019
12/1/2019
1/1/2020
2/1/2020
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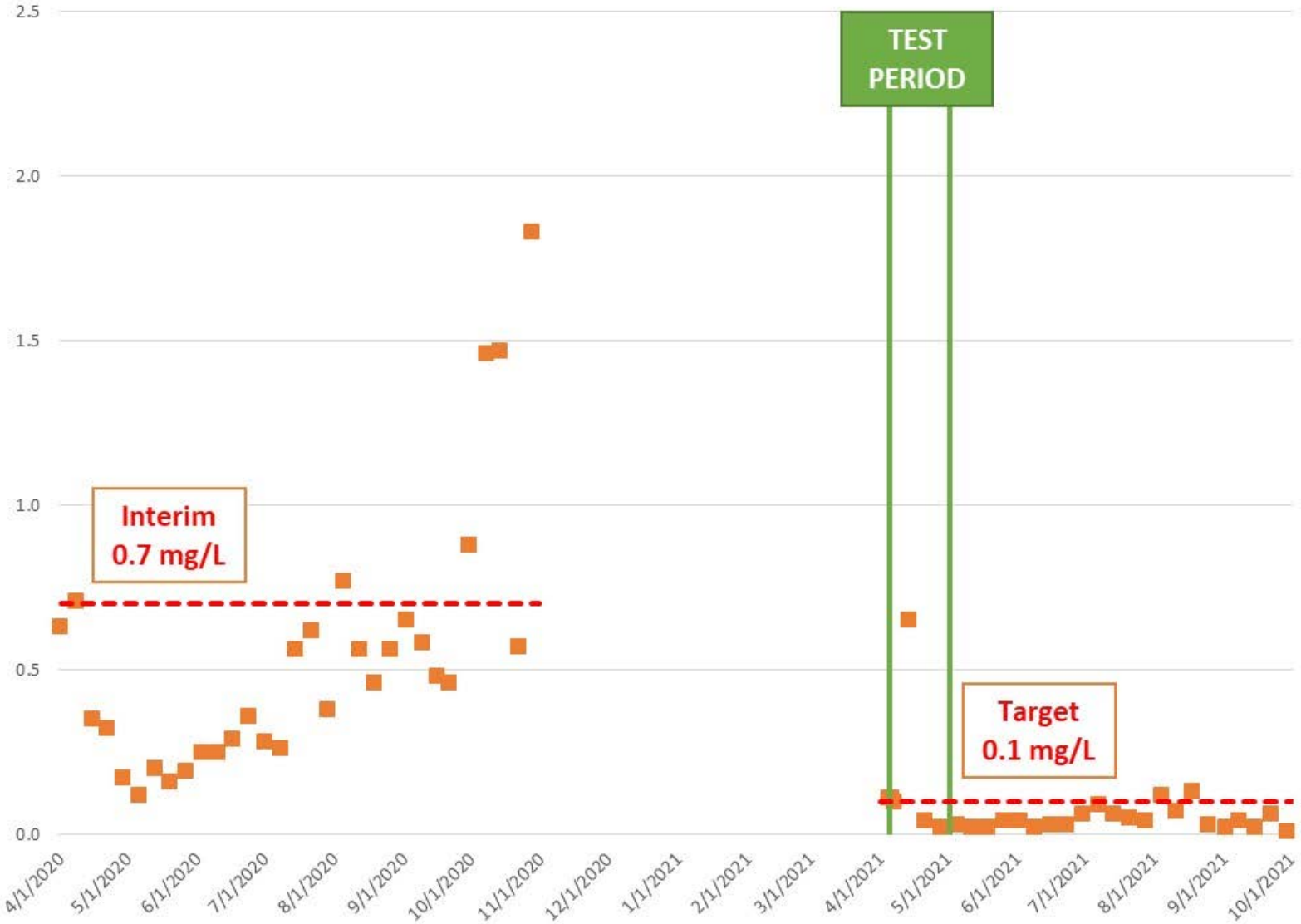
6/1/2021
7/1/2021
8/1/2021
9/1/2021
10/1/2021
Seasonal Load Cap 7.53 lbs/day

Performance Test Results
Effluent Total Phosphorus (mg/L)



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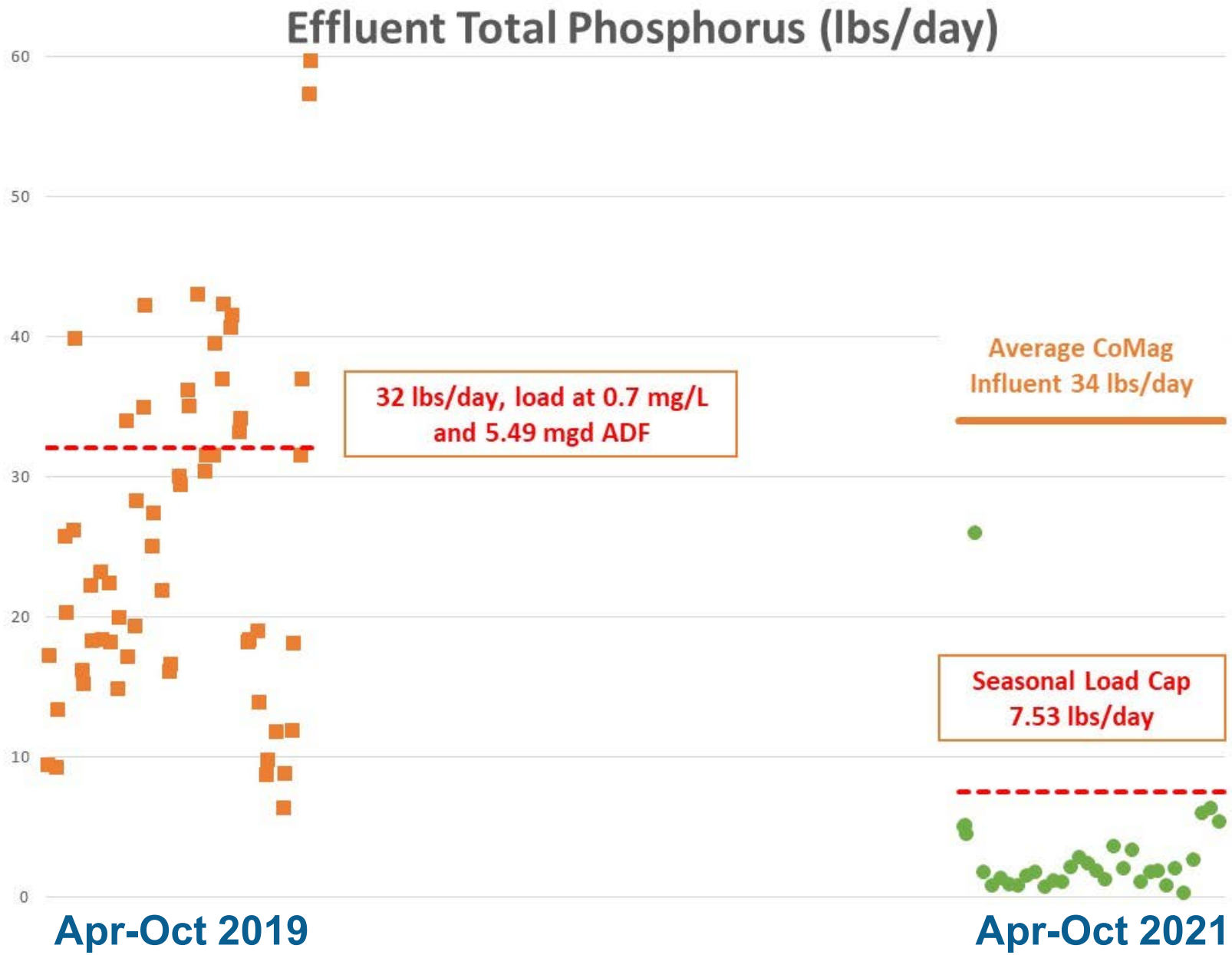
Effluent Total Phosphorus (lbs/day)
60
50
40
30
20
10
0
32 lbs/day, load at 0.7 mg/L
and 5.49 mgd ADF
Average CoMag
Influent 34 lbs/day
Seasonal Load Cap
7.53 lbs/day
Apr-Oct 2019
Apr-Oct 2021

IMPACT ON PLANT OPERATIONS

PARAMETER	CHANGE 2019→ 2021	NOTES
Plant Flow	5.32 mgd → 4.68 mgd	Drier year
Plant Influent TP	147 lbs./day → 116 lbs./day	Lower loads
Effluent TP	25 lbs./day → 3 lbs./day	88% reduction
Effluent TSS	126 lbs./day → 99 lbs./day	22% reduction
PAC Usage (multi-point)	169 gpd → 73 gpd	57% reduction
Alum Usage (tertiary)	0 gpd → 410 gpd	New
Effluent Aluminum	0.11 mg/L → 0.22 mg/L	105% increase

IMPACT ON PLANT OPERATIONS

- **Effluent Quality**
  - Meeting New Permit – 1 year ahead of schedule!
- **Process**
  - Process was robust and reliable
  - Process adjustment reach steady state quickly (~ 1-Hr)
- **Up Ahead for 2022 Season**
  - Continue process optimization with Evoqua
    - Minor Controls improvements
    - Minimize solids carry over from clarifiers to effluent
      - Causing added maintenance
      - Chemistry (Chemical, magnetite)?
      - Other options?

ACKNOWLEDGMENTS

Tighe & Bond

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CT DEEP

Steve Muollo

QUESTIONS?

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QUIZ QUESTIONS (TRUE / FALSE)

- **Jar testing was a good prediction of using PACL for low level phosphorus removal ?**
  - False – Even though the town wanted to use PACL, field testing showed it was not an option

- **The volume of chemicals used decreased after CoMag was started up?**
  - False – PACL usage was reduced by 100 gpd but alum usage increased from 0 to ~400 gpd.