Jacobs Challenging today. Reinventing tomorrow.

Machine Learning to Optimize WTP Operations

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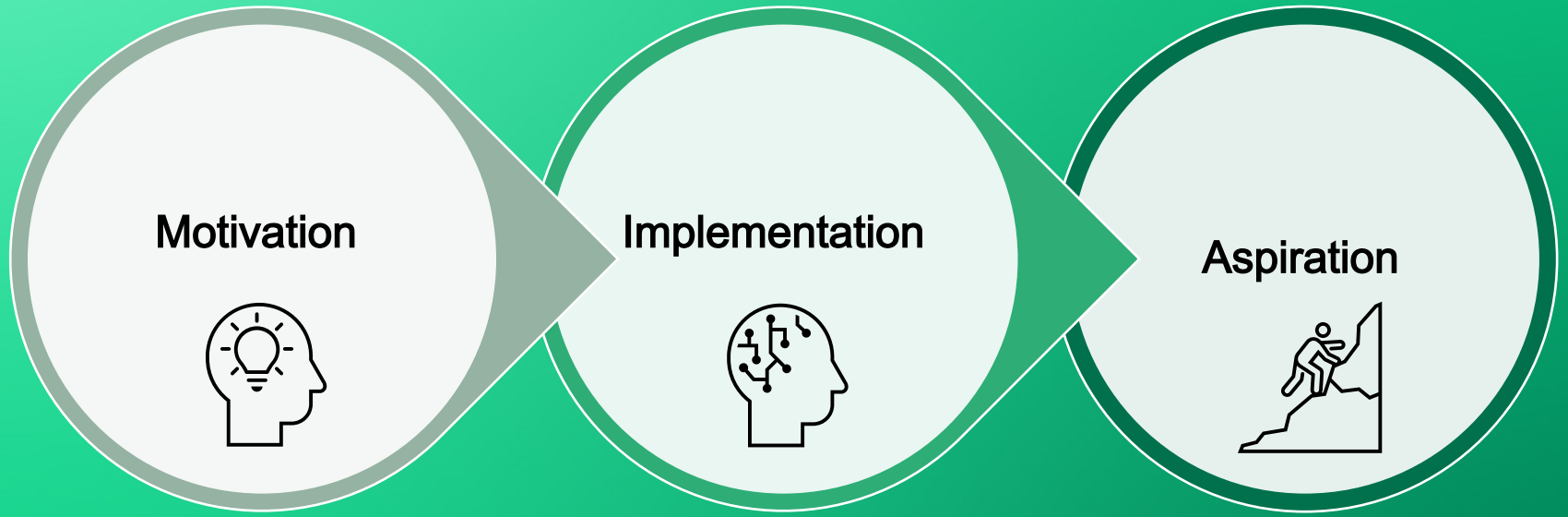
PNWS-AWWA
October 28th, 2021

Agenda



Motivation

Motivation

- There is no simple coagulation “equation”
- Coagulation decisions are made based on experience, intuition, and trial and error
- Efficiency improves water quality, enhances efficiency, and lowers water rates

Why Machine Learning

- Innovative solution that is widely used for many applications

- Machines Can:
  - "Learn" and provides answers based on the historical data, not rules/equations
  - Quickly analyze vast amounts of data
  - Use algorithms to understand complex relations between the various parameters

Machine Learning Applications in Drinking Water Treatment

New Insights

Discover hidden value in online or grab sample data

Forecasting

Predict water quality based on historical information

Anomalies

Contaminant Warning, Instrument Malfunction, or Maintenance Monitoring

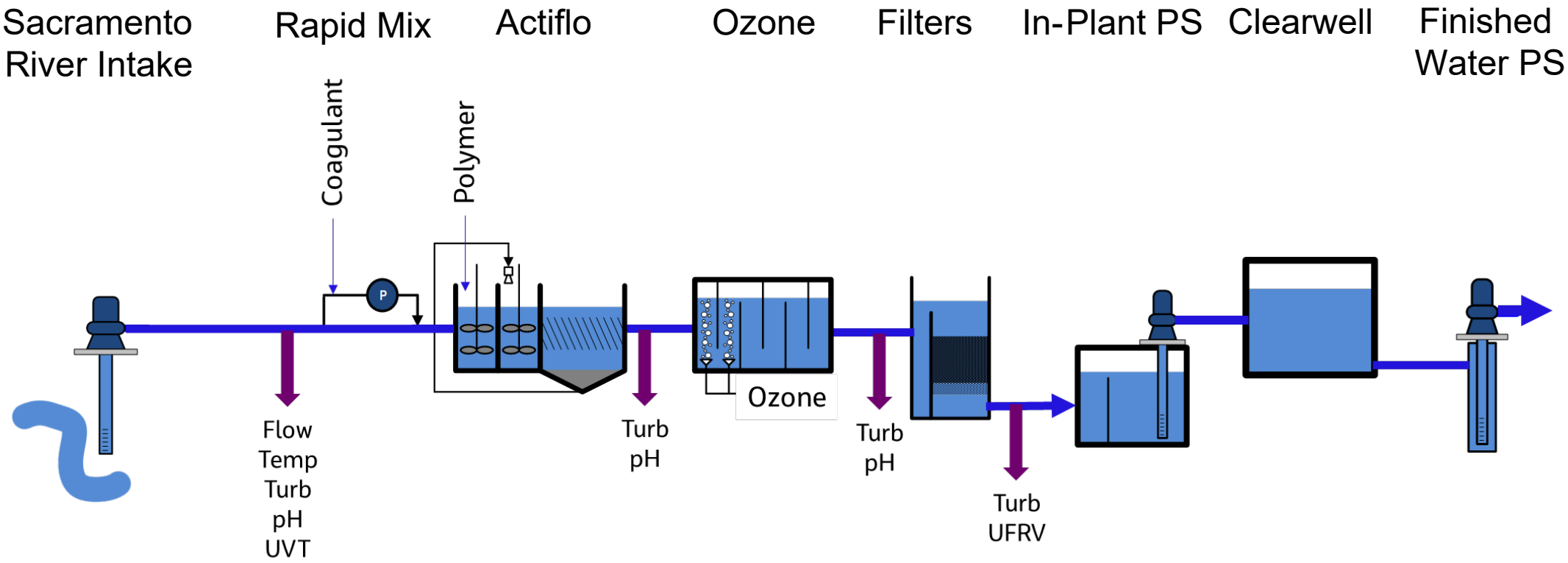
Calibration

Perform sensitivity analysis to any process changes and enhance digital twins

Optimization

Identify chemical and energy savings, improve treatment performance

Woodland-Davis Water Treatment Plant



- 30 MGD WTP
- Commissioned in 2016
- Operated by Jacobs (DBO)
- Located in Davis, California

- Treats Sacramento River water
- Sand Ballasted Clarification
- Ferric Chloride and Polymer used for coagulation

Project Goal

1. Develop a machine learning model to optimize chemical usage

2. Create a dashboard display recommended changes in real time

Poll Question #1

- Where is the Design Build Operate Water Treatment Plant featured in this Machine Learning Project?
  - Bothell, Washington
  - Forest Grove, Oregon
  - Woodland, California

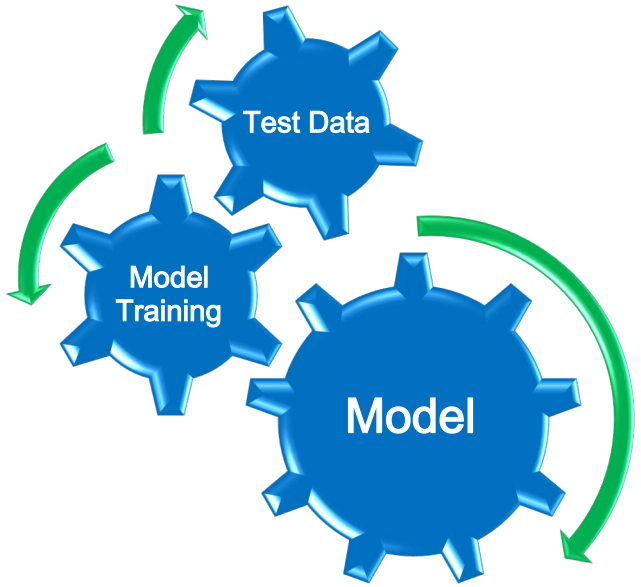
Implementation

Implementation

STEP 1

Collect and Clean Data

STEP 2



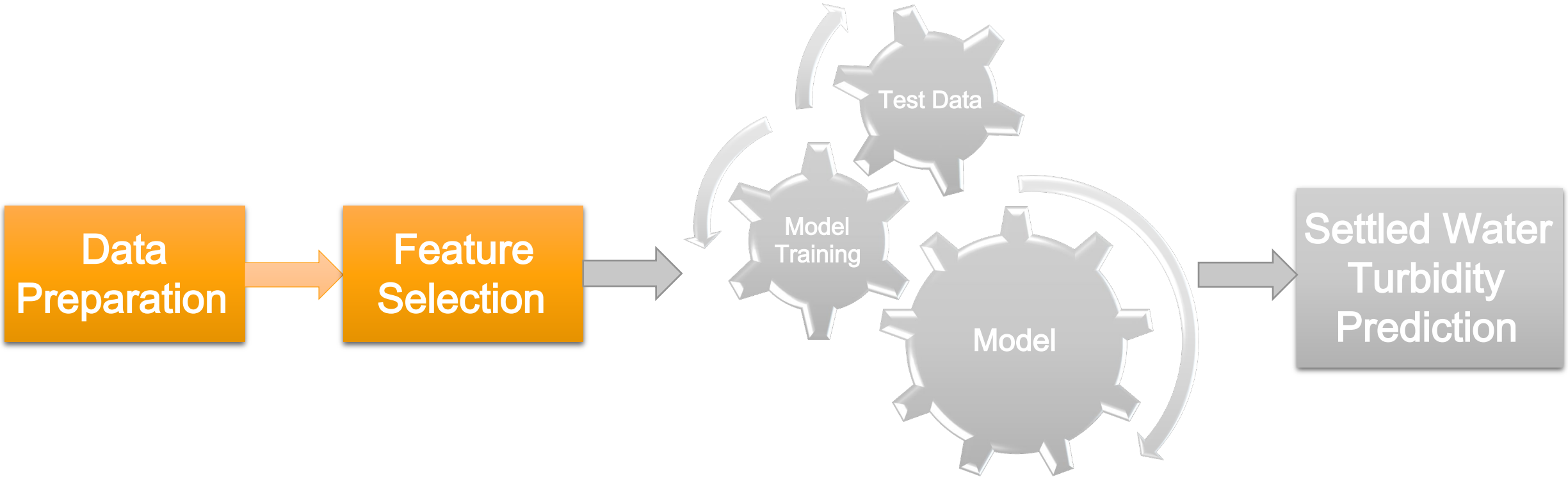
Develop Predictive Optimization Model

STEP 3

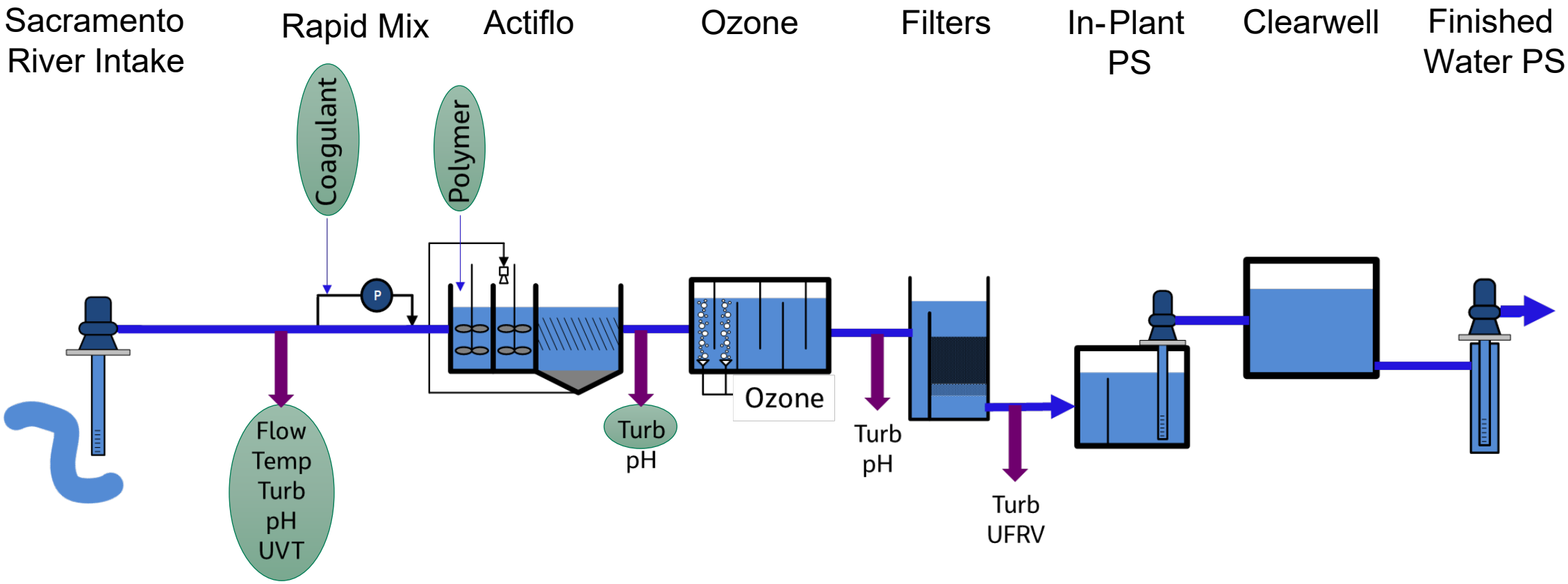
Create Web Dashboard

Collect and Clean Data

Predictive Model Development

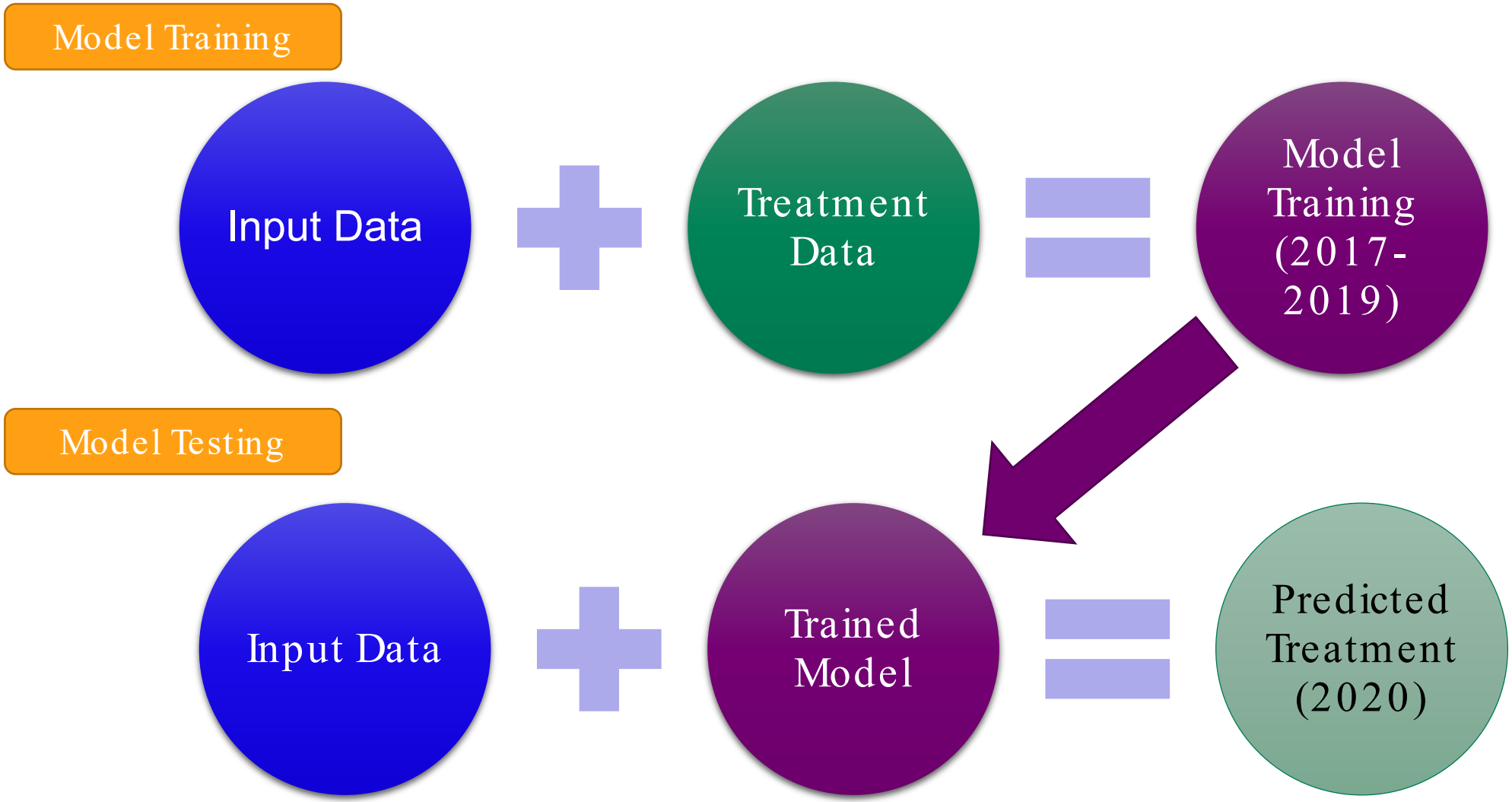


Data Selection

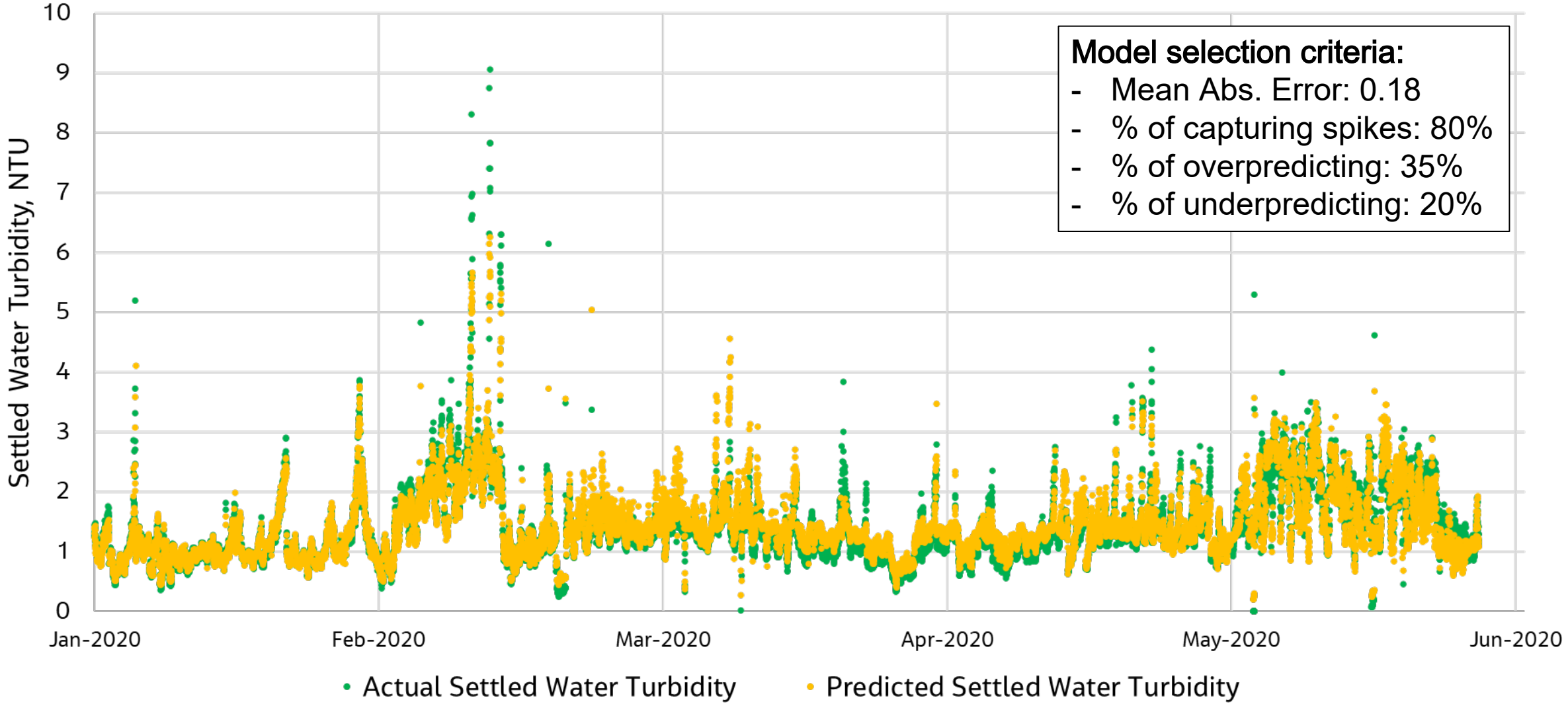


Modeling

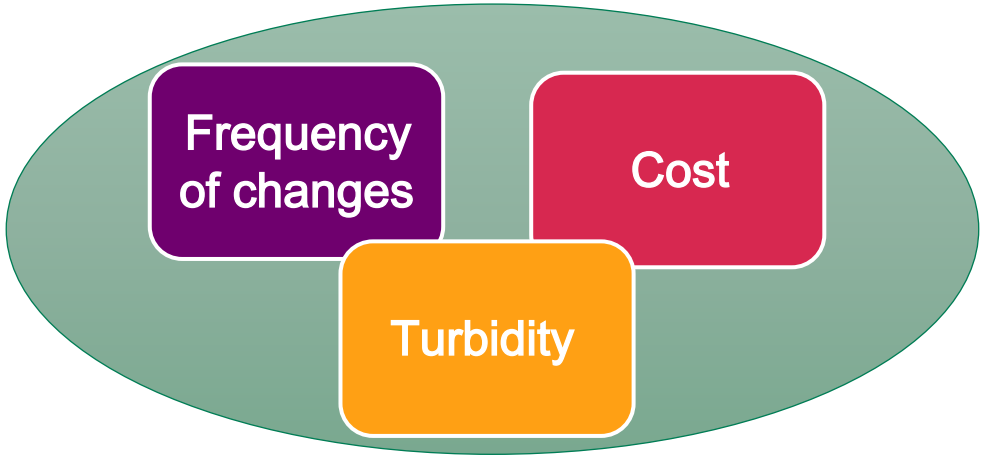
Predictive Model Development



Trained Model Prediction

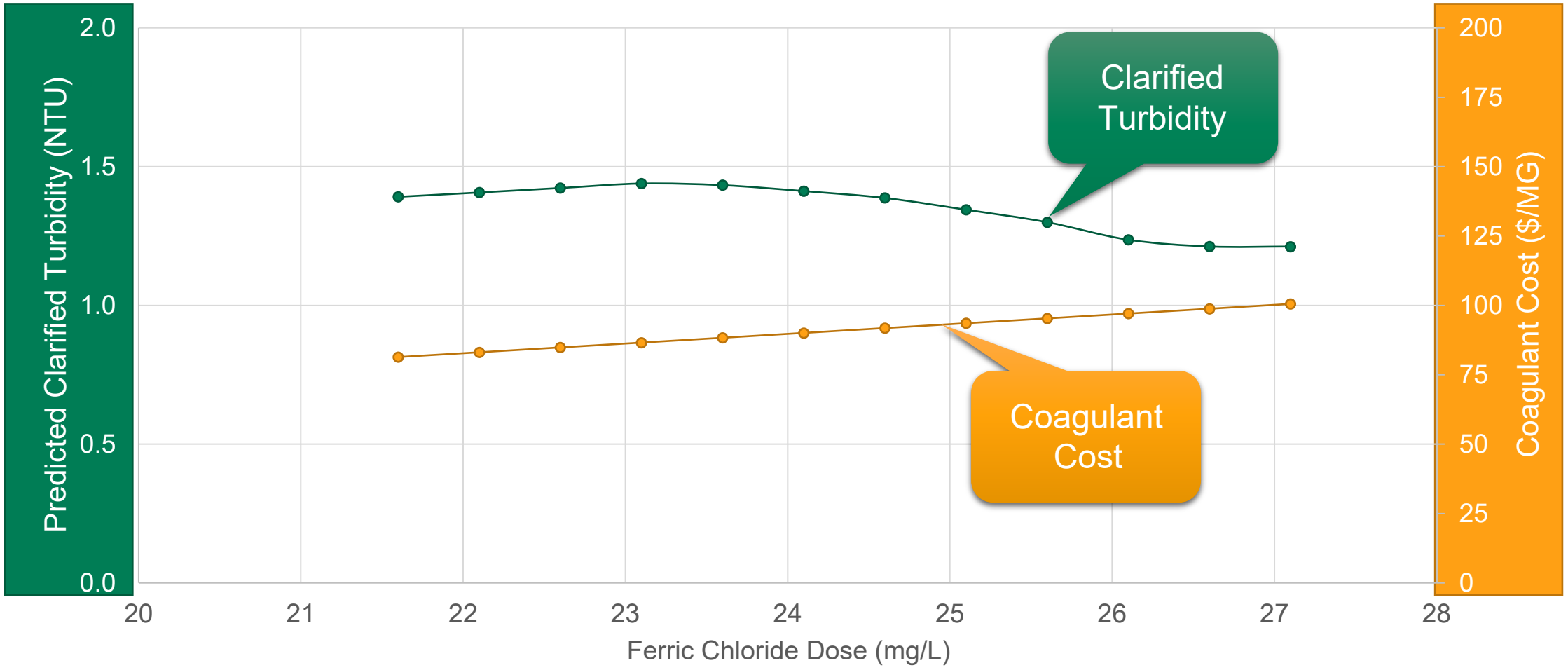


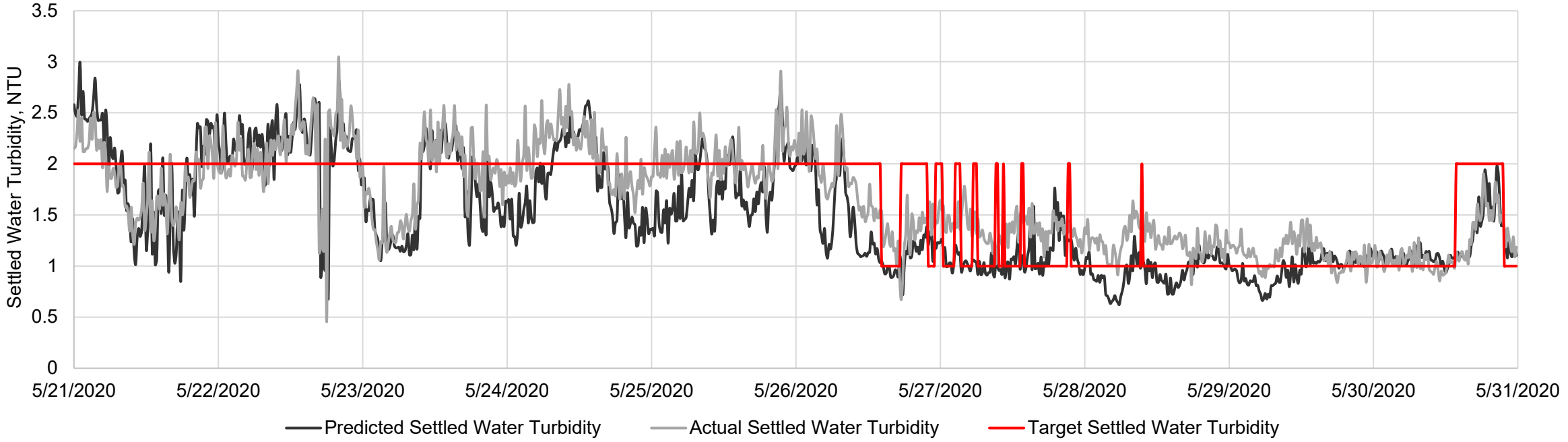
Optimization Equation

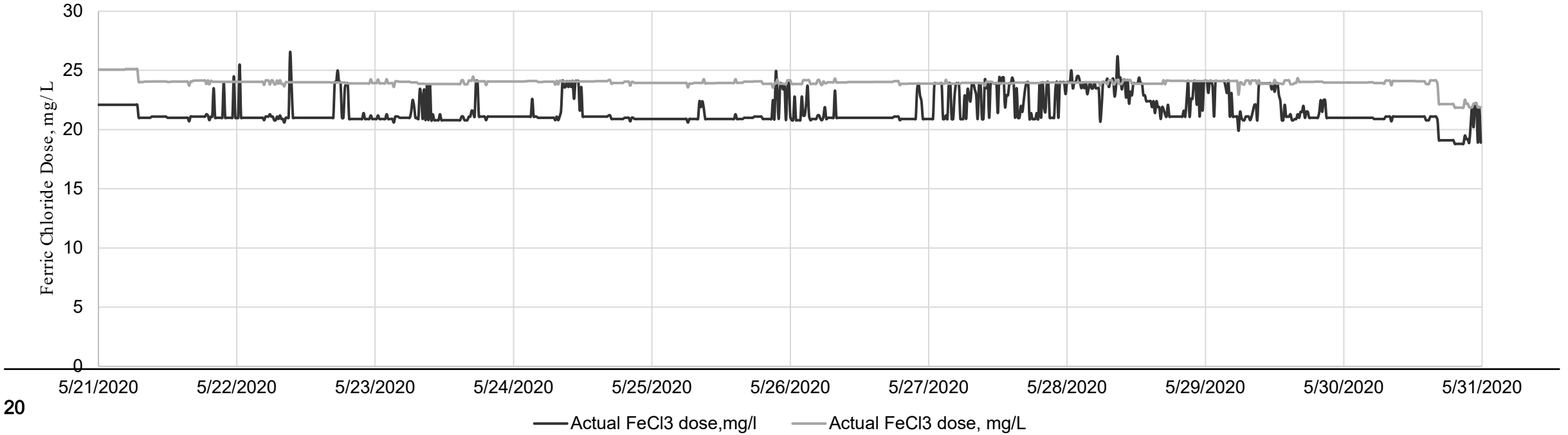


Optimization Function = Minimize the chemical cost + Minimize settled water turbidity + Minimize frequency of changes

Optimization Algorithm




Settled Water Turbidity, NTU
3.5
3
2.5
2
1.5
1
0.5
0
5/21/2020
5/22/2020
5/23/2020
5/24/2020
5/25/2020
5/26/2020
5/27/2020
5/28/2020
5/29/2020
5/30/2020
5/31/2020
Predicted Settled Water Turbidity
Actual Settled Water Turbidity
Target Settled Water Turbidity

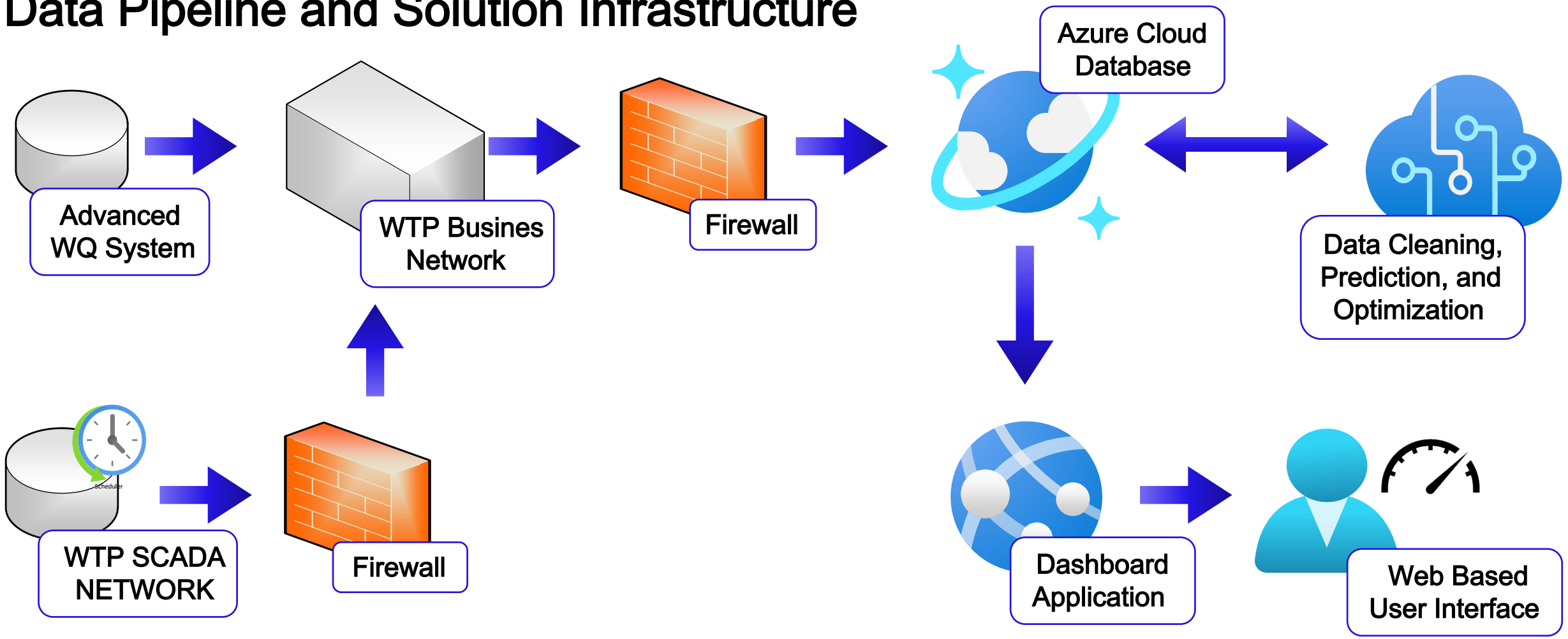

Ferric Chloride Dose, mg/L
30
25
20
15
10
5
0
5/21/2020
5/22/2020
5/23/2020
5/24/2020
5/25/2020
5/26/2020
5/27/2020
5/28/2020
5/29/2020
5/30/2020
5/31/2020
Actual FeCl3 dose,mg/l
Actual FeCl3 dose, mg/L

Poll Question #2

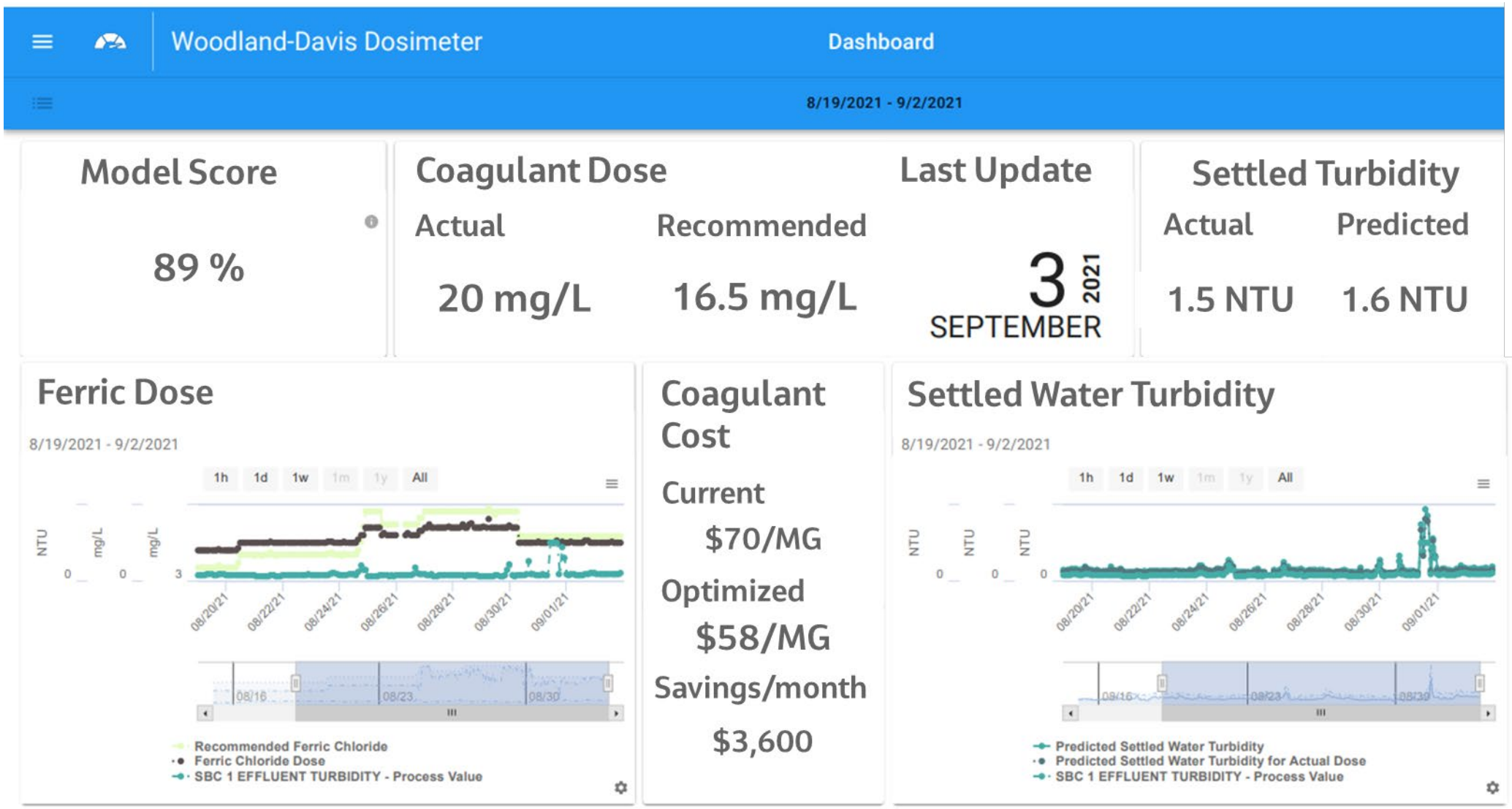
- What parameters were used for coagulant optimization?
  - Chemical cost
  - Settled water turbidity
  - Minimize frequency of changes
  - All of the above

Data Transfer and Dashboard

Data Pipeline and Solution Infrastructure

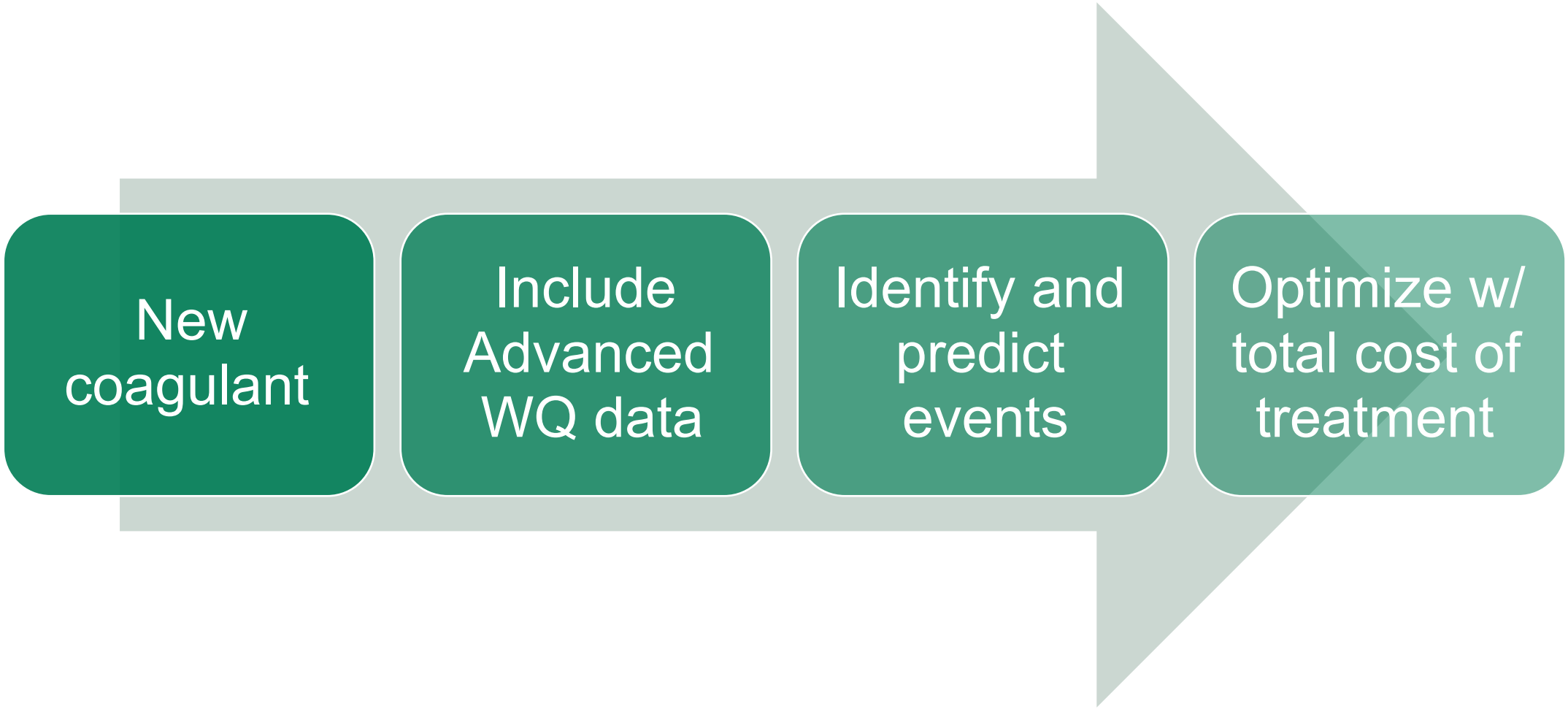


Dashboard


Woodland-Davis Dosimeter
Dashboard
8/19/2021 - 9/2/2021
Model Score
89 %
Coagulant Dose
Actual
20 mg/L
Recommended
16.5 mg/L
Last Update
3
SEPTEMBER
2021
Settled Turbidity
Actual
1.5 NTU
Predicted
1.6 NTU
Ferric Dose
8/19/2021 - 9/2/2021
1h 1d 1w 1m 1y All
NTU
mg/L
mg/L
0
0
3
08/20/21
08/22/21
08/24/21
08/26/21
08/28/21
08/30/21
09/01/21
08/16
08/23
08/30
Recommended Ferric Chloride
Ferric Chloride Dose
SBC 1 EFFLUENT TURBIDITY - Process Value
Coagulant Cost
Current
$70/MG
Optimized
$58/MG
Savings/month
$3,600
Settled Water Turbidity
8/19/2021 - 9/2/2021
1h 1d 1w 1m 1y All
NTU
NTU
NTU
0
0
0
08/20/21
08/22/21
08/24/21
08/26/21
08/28/21
08/30/21
09/01/21
08/16
08/23
08/30
Predicted Settled Water Turbidity
Predicted Settled Water Turbidity for Actual Dose
SBC 1 EFFLUENT TURBIDITY - Process Value

Aspiration

Next Steps


New coagulant
Include Advanced WQ data
Identify and predict events
Optimize w/ total cost of treatment

Acknowledgements

Solutions Manager/S&T: **Kim Ervin**

Intelligent Systems/S&T: **Tim Hill**

Water Treatment Lead: **Enoch Nicholson**

Lead Machine Learning Engineer: **Louisa Tran**

Machine Learning Engineer: **Kat Gomozova**

WTP On-Site Coordinator: **Alyssa “Sunshine” Smith**

Questions?

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