Pennsylvania AWWA
American Water Works Association

Ironman Challenge –

Challenging Conventional Wisdom in Iron Removal

American Water Works Association Pennsylvania Section
Annual Conference 2016

Lindsey Olson, P.E.
American Water

Sandra Kutzing, P.E. CDM Smith

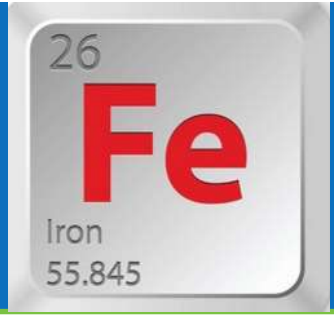
May 12, 2016

CDM Smith

NEW JERSEY
AMERICAN WATER

Agenda

- Review of iron chemistry
- Standard practices for iron removal
- Pre-treatment with flocculation and sedimentation
- Sunset Road WTP Expansion project overview
- Verification of process design
  - Jar testing
  - Pilot testing
- Treatment and status of project



Review of Iron Chemistry

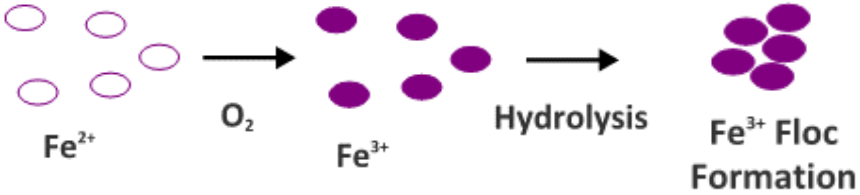
Iron Chemistry

$$Fe^{+2} + O_{2(g)} \Longleftrightarrow Fe^{+3} + HO_2^{\bullet}$$

$$Fe^{+2} + HO_2^{\bullet} \Longleftrightarrow Fe^{+3} + H_2O_2$$

$$Fe^{+2} + H_2O_2 \Longleftrightarrow Fe^{+3} + HO^{\bullet} + H_2O$$

$$Fe^{+} + HO^{\bullet} \Longleftrightarrow Fe^{+3} + H_2O$$



Iron Chemistry

- Why remove?
- Removal principles
  - Increase in oxidation potential of water
  - Increase in pH of water

Standard Practices for Iron Treatment

Iron Removal Practices

Sequestration

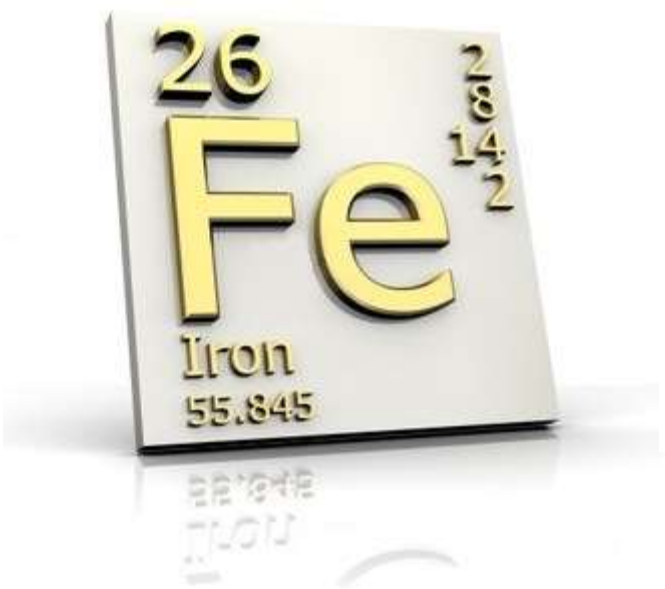
0.3 mg/L < Fe < 0.6 mg/L

Iron Removal Practices

$0.6\ mg/L < Fe < 5\ mg/L$

- Oxidation
  - Air
  - Chlorine
  - Permanganate
  - Chlorine Dioxide
  - Ozone
- Filtration
  - Sand/Anthracite
  - Manganese Dioxide Coated Sand
  - Manganese Dioxide Ore
  - Biofiltration
  - Ion Exchange

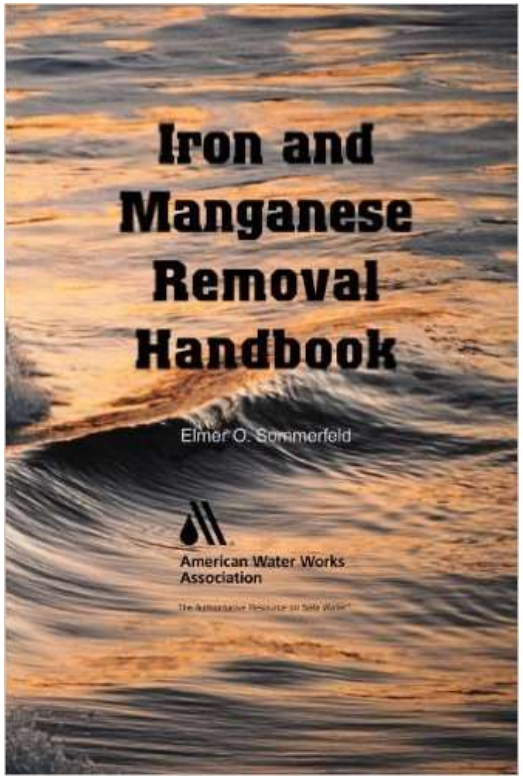
Iron Removal Practices

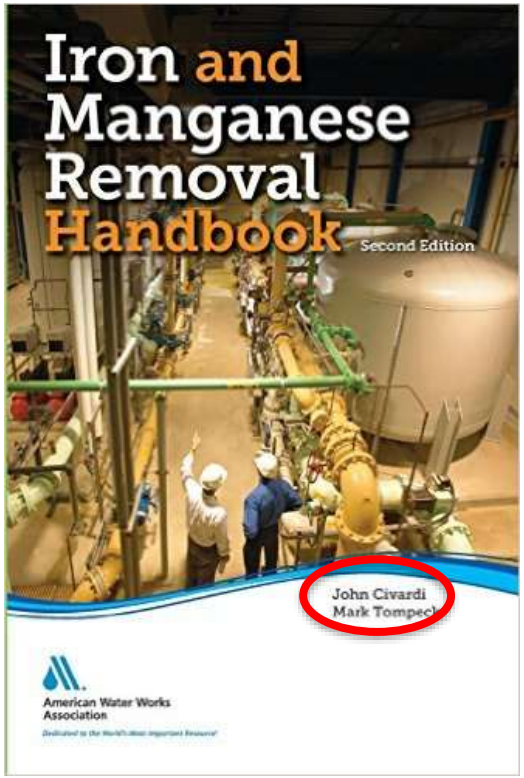


$>$ 5

Iron Removal Practices

Iron Removal Practices



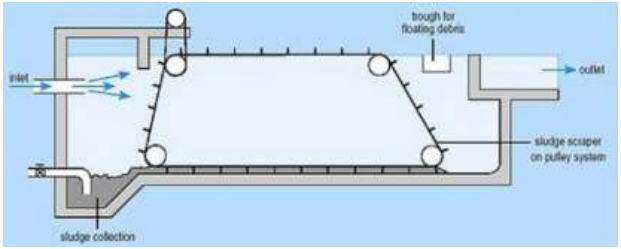


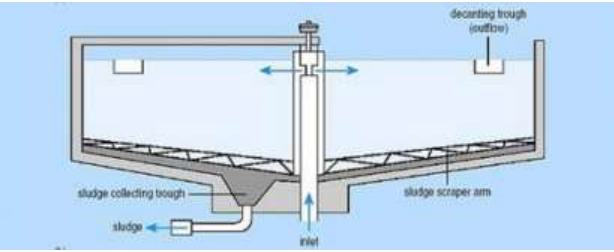
Pre-Treatment with Flocculation and Sedimentation

Flocculation and Sedimentation

Loading Rate = 0.4 gpm/sf

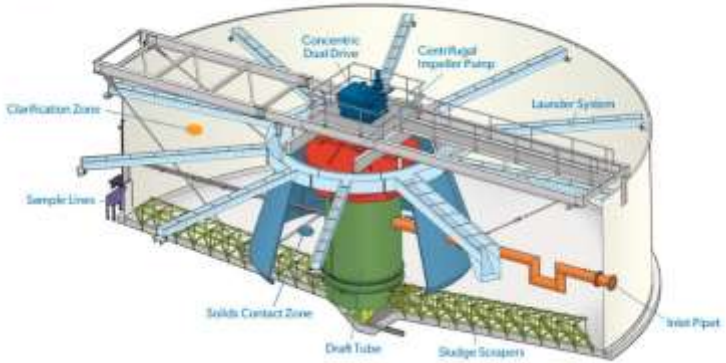
Conventional Sedimentation





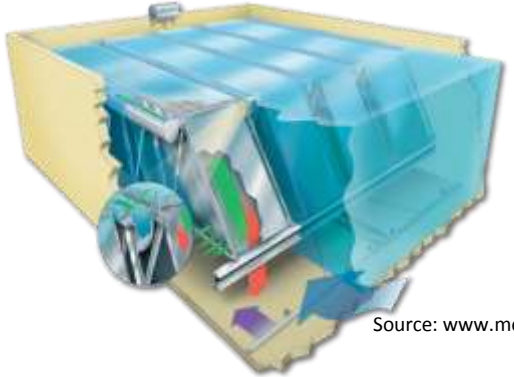
Source: www.open.edu

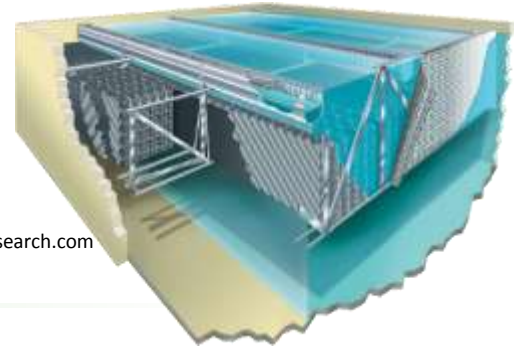
Solids Contact Clarifier



Source: www.westechinc.com

Plates or Tubes

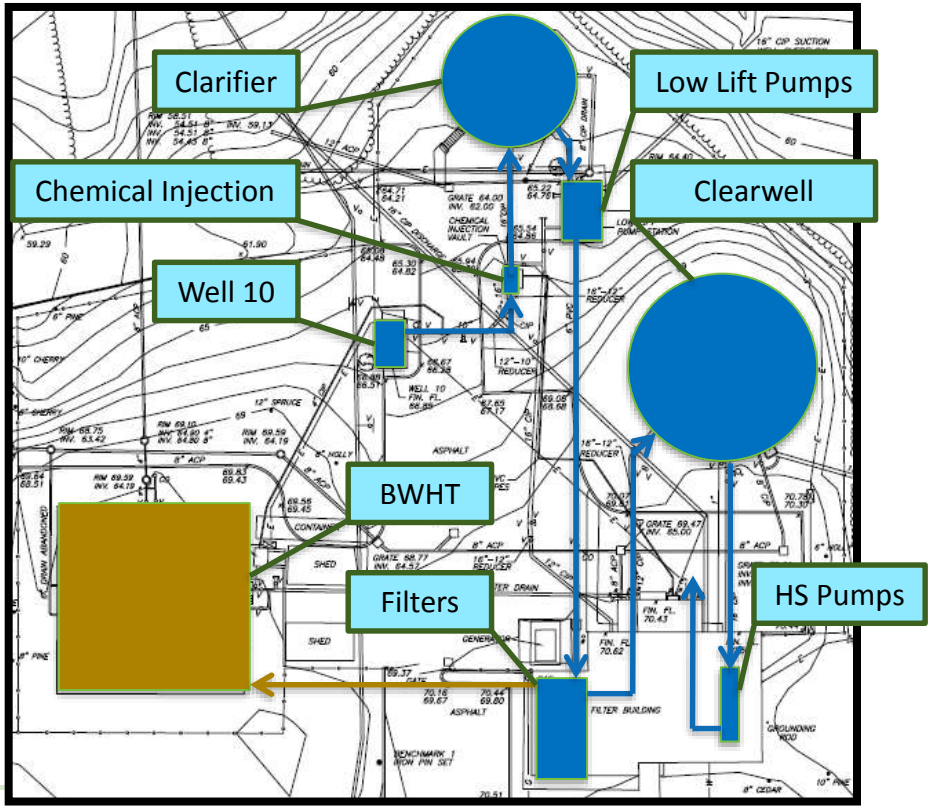




Source: www.meurresearch.com

Sunset Road WTP Expansion Project Overview

Existing Sunset Road WTP



Sunset Road WTP Expansion

Well 10 – 2.2 mgd

Well 17 – 1.7 mgd

Allocation

Monthly = 98.2 MG/month **Yearly = 280 MG/year**

Sunset Road WTP Water Quality

Parameter	Well No. 10	Well No. 17
Alkalinity (mg/L)	20	40
Hardness (mg/L as $CaCO_3$)	60	80
Iron (mg/L)	8.5	9.0
Manganese (mg/L)	0.17	0.15
pH	6.5	6.7

Sunset Road WTP Expansion

Reduce Iron Concentration on Filters

Minimize Capital Costs

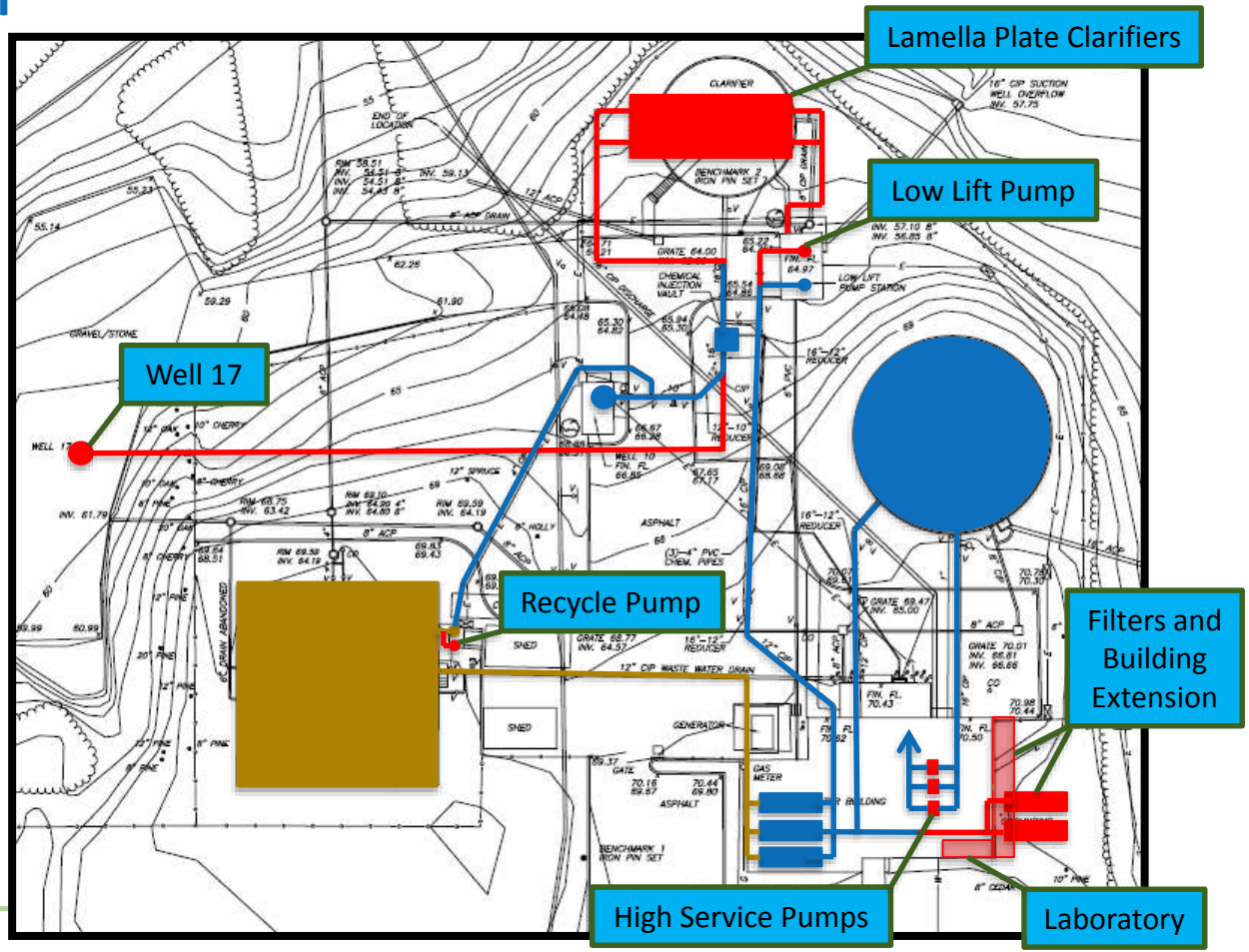
Reduce Chemical Addition

SAFETY

Recycle Backwash Waste

Sunset Road WTP Design Concept

- Roof Modifications
- SCADA
- HVAC
- Chemical Storage



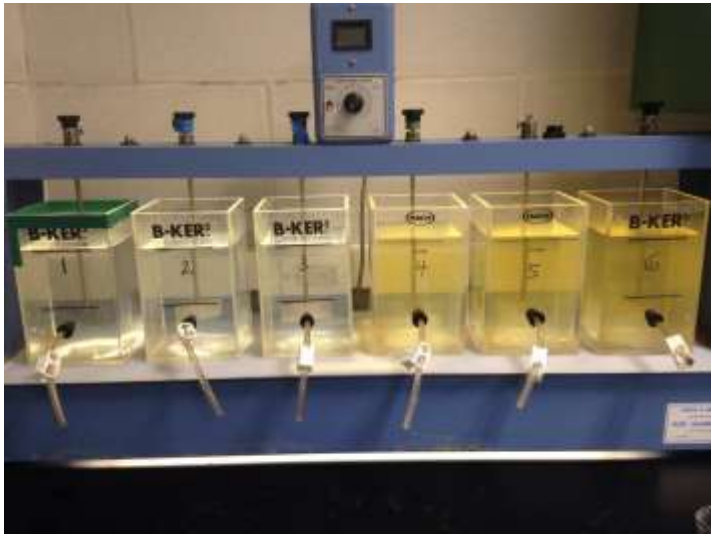
Verification of Process Design – Jar Testing

Process Design Verification

Settling Time

Coagulant

Polymer



Jar Test 1 – American Water

Rapid Mix
15 or 30 sec

Flocculation Time
3, 5, or 8 min

Settling Time
6, 8 or 12 min

Chemicals
Caustic, Hypo and $FeCl_3$

Jar Test 2 – Nalco

Chemicals
Coagulant and
Polymer

Operational Complexity

Building Addition

OPEX - Chemicals

OPEX - Maintenance

Seasonal Facility

PILOT

ALL $FeCl_3$ Runs < 3 mg/L

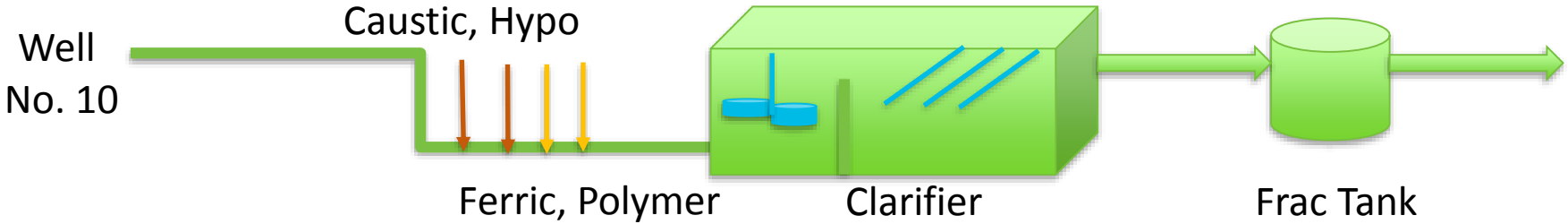
7768 & $FeCl_3$ Run ~ 1 mg/L

7768 & 8158 Run < 1 mg/L

Is it worth it?

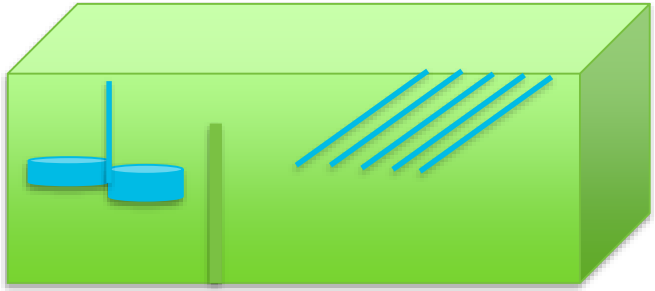
Verification of Process Design – Pilot Testing

Pilot Study – Clarifier



Pilot Study – Clarifier

Flocculation

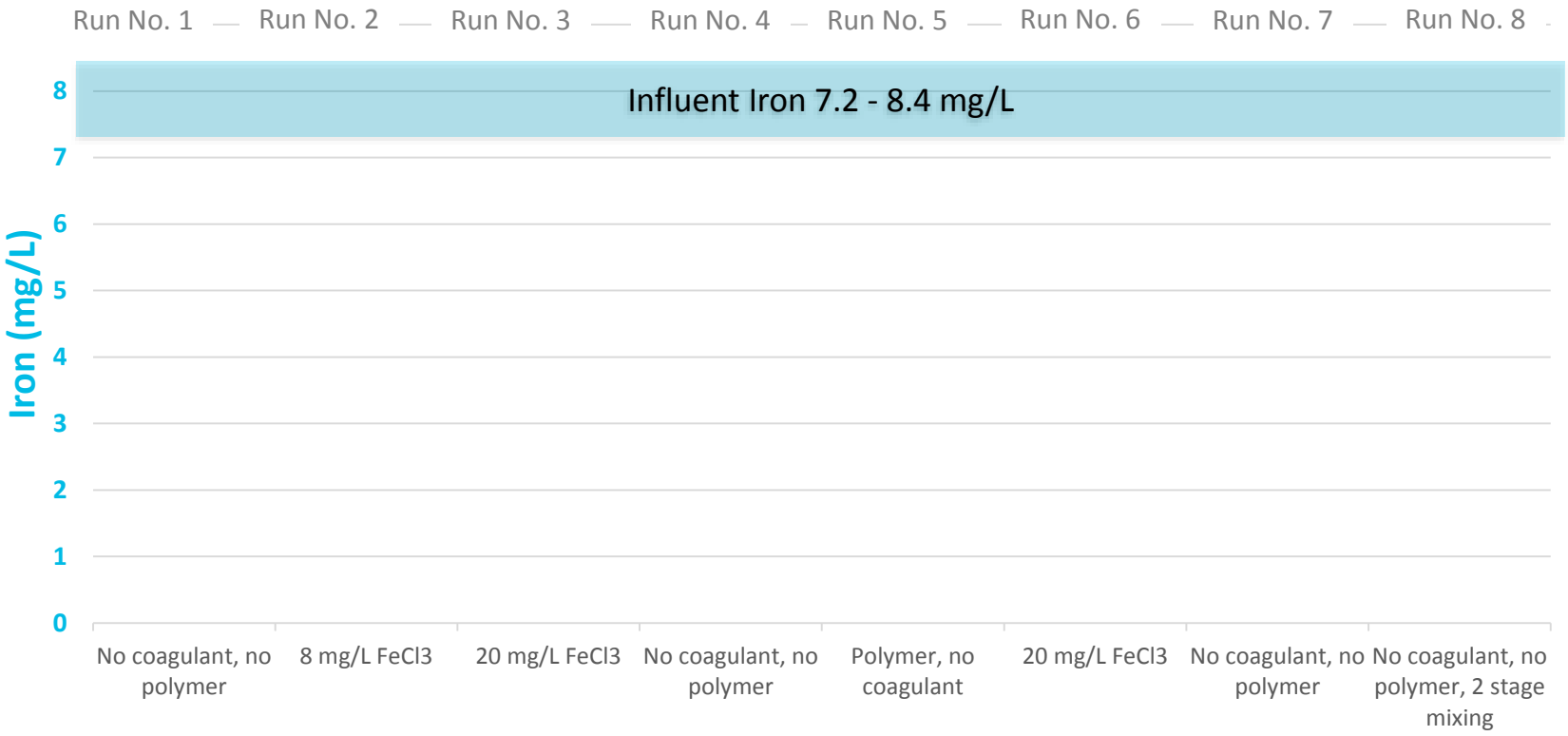


Sedimentation

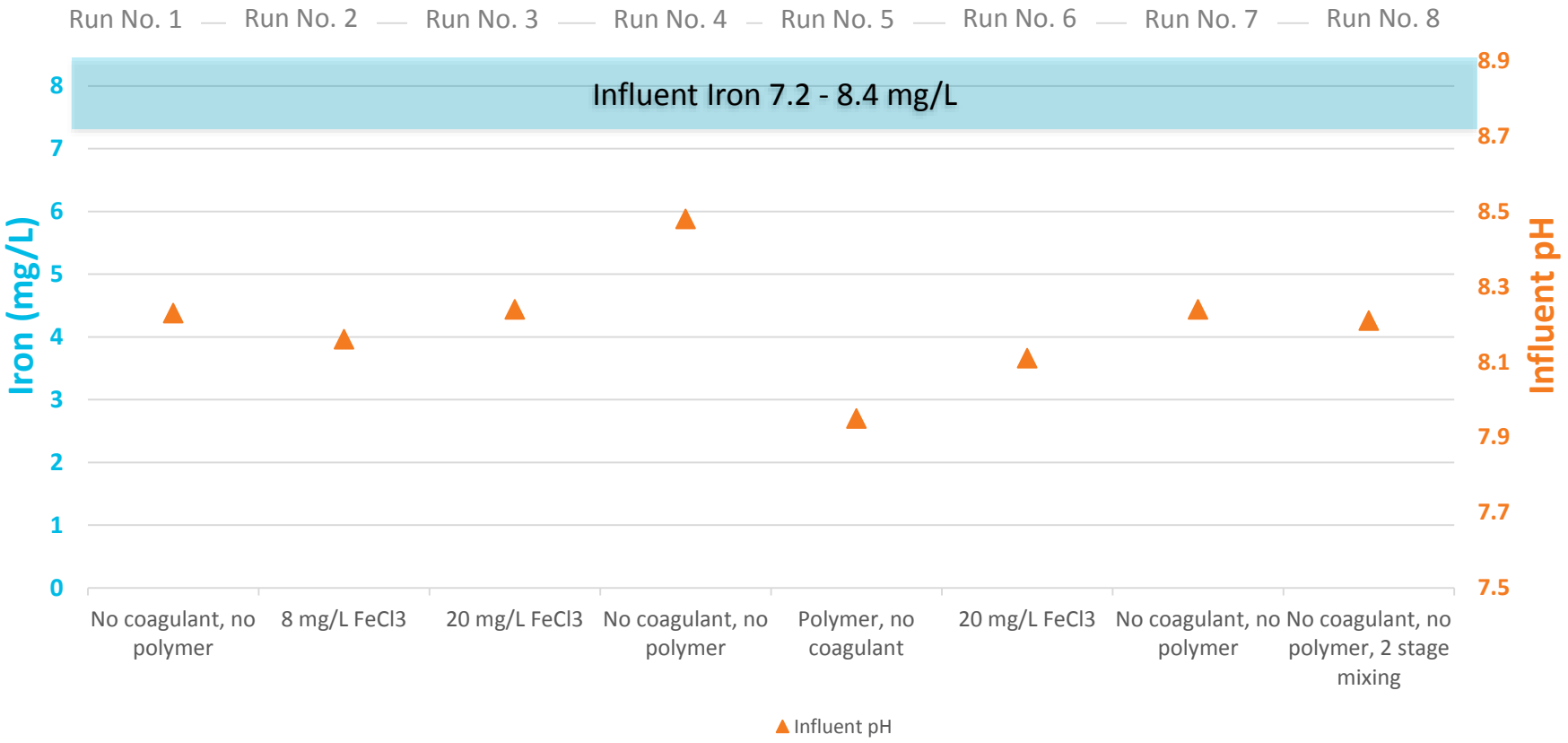
Pilot Study – Clarifier Runs

Run	$FeCl_3$	Polymer	Mixing
No. 1	-	-	1 stage
No. 2	8 mg/L	-	1 stage
No. 3	20 mg/L	-	1 stage
No. 4	-	-	1 stage
No. 5	-	Nalco 7768	1 stage
No. 6	20 mg/L	-	1 stage
No. 7	-	-	1 stage
No. 8	-	-	2 stage

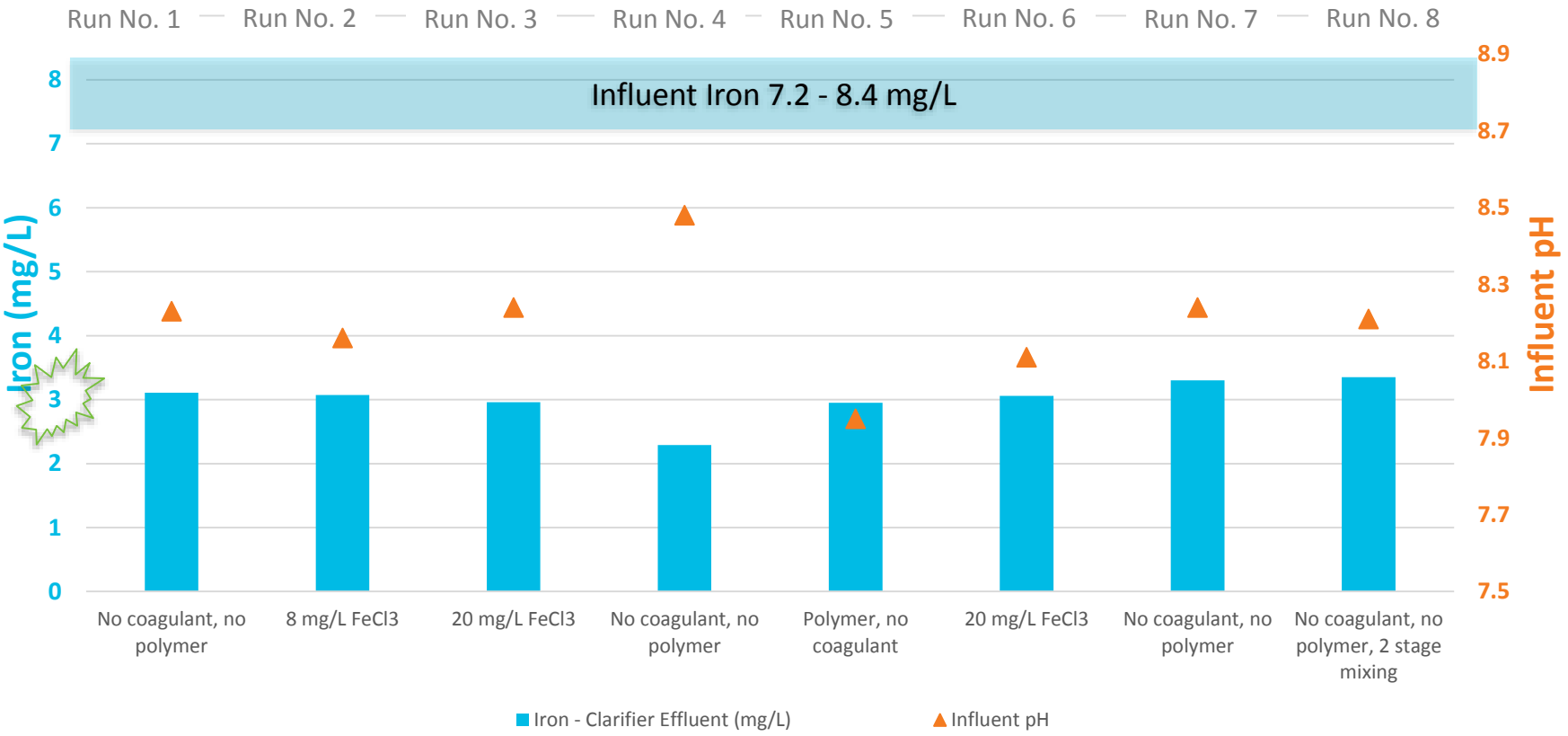
Pilot Study – Clarifier Results



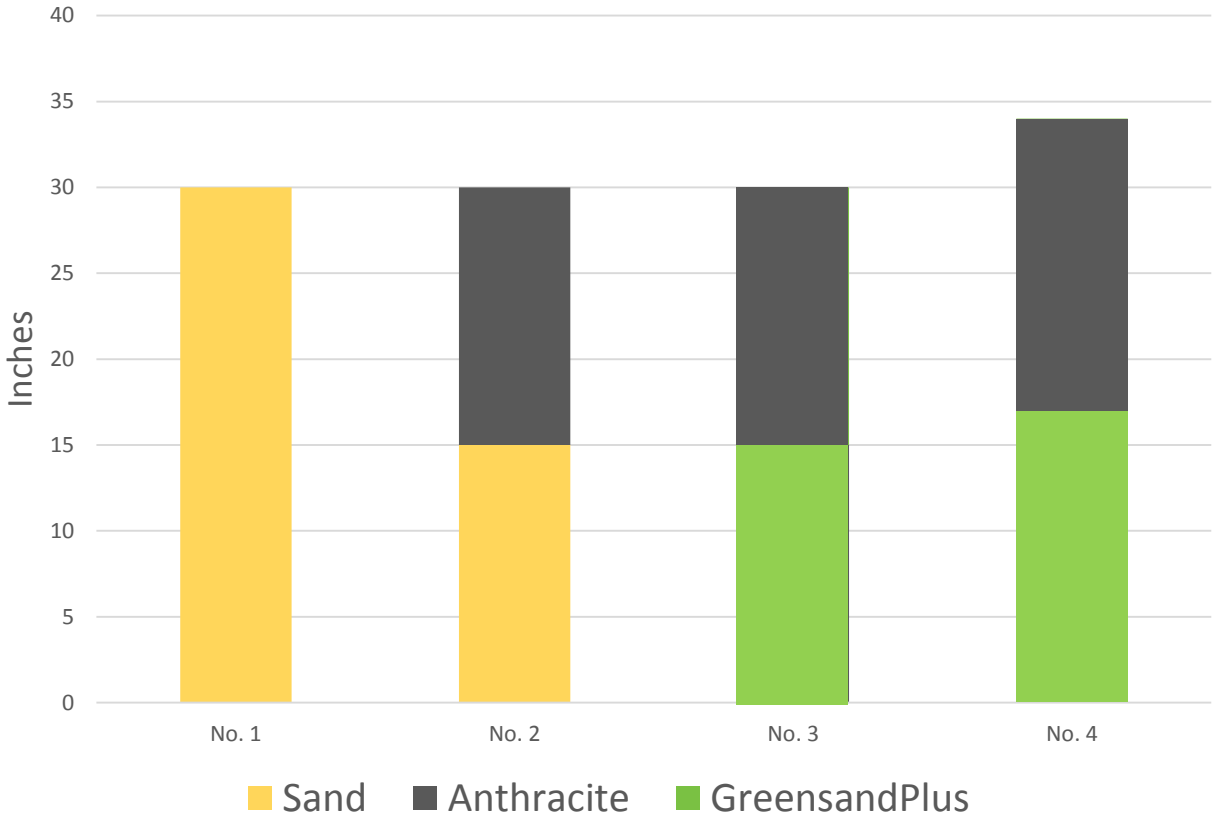
Pilot Study – Clarifier Results

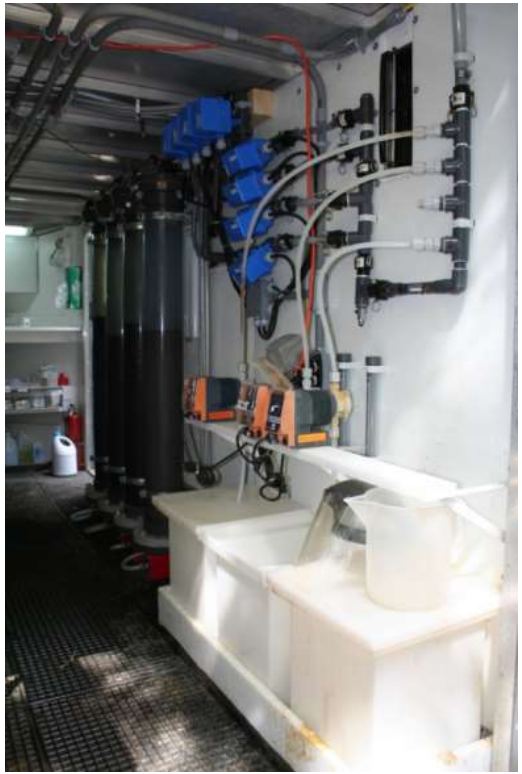


Pilot Study – Clarifier Results

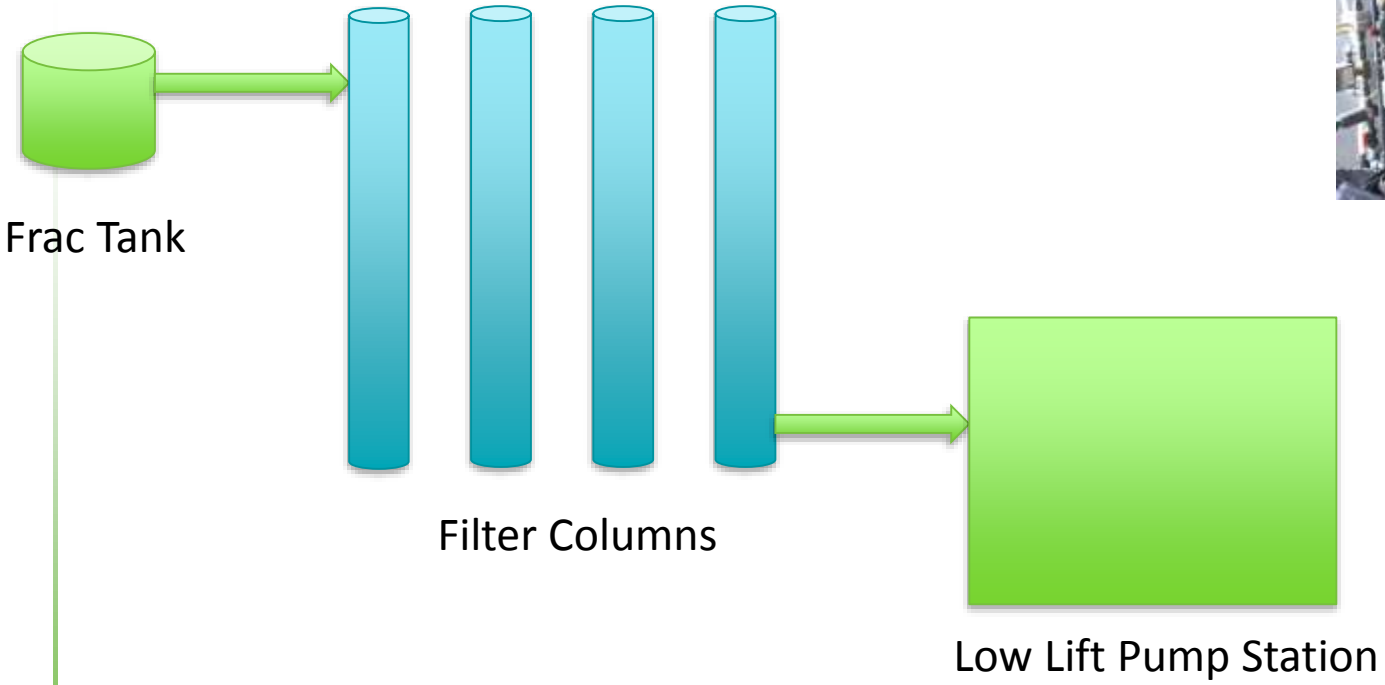


Pilot Study – Filters

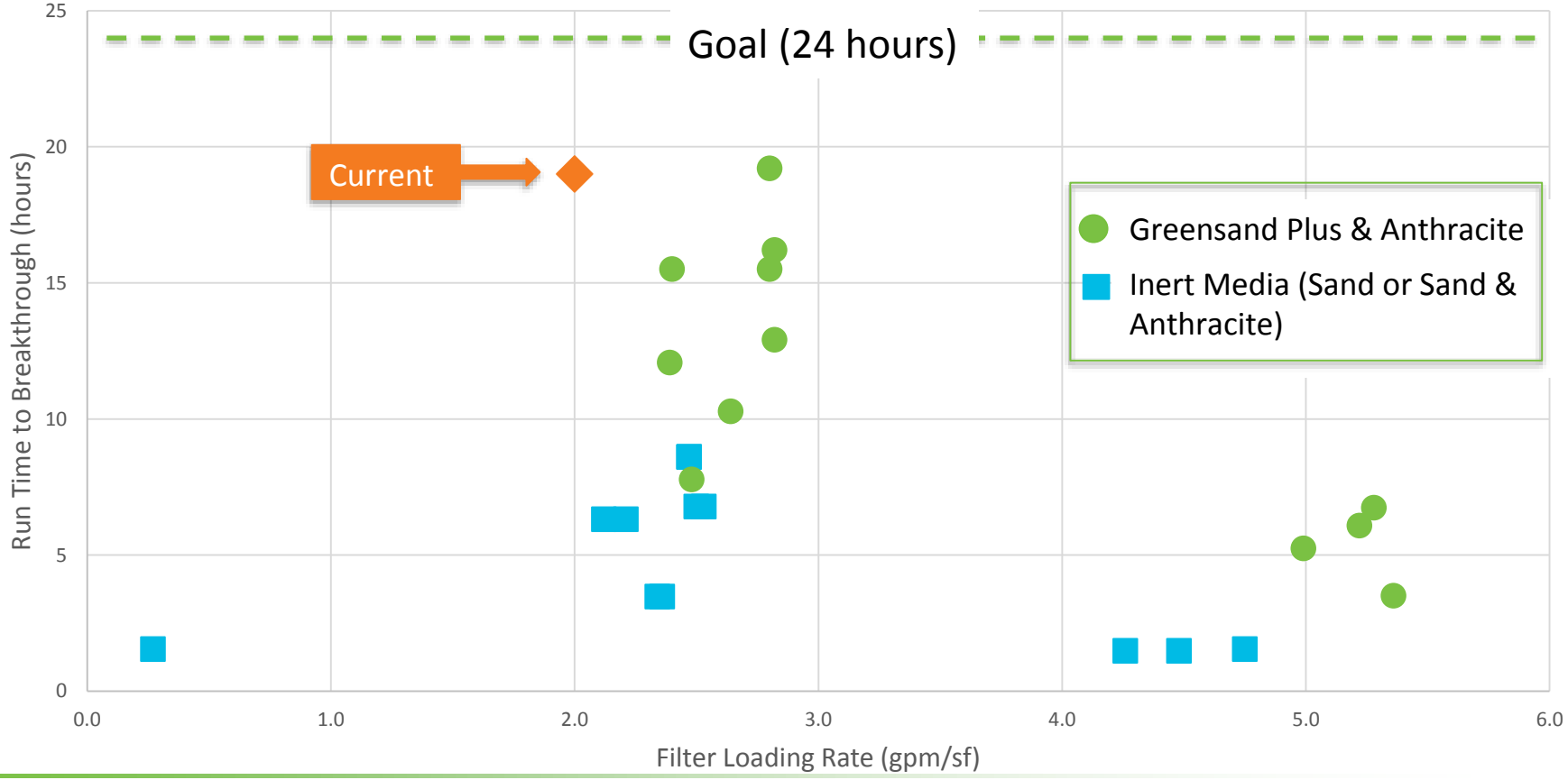




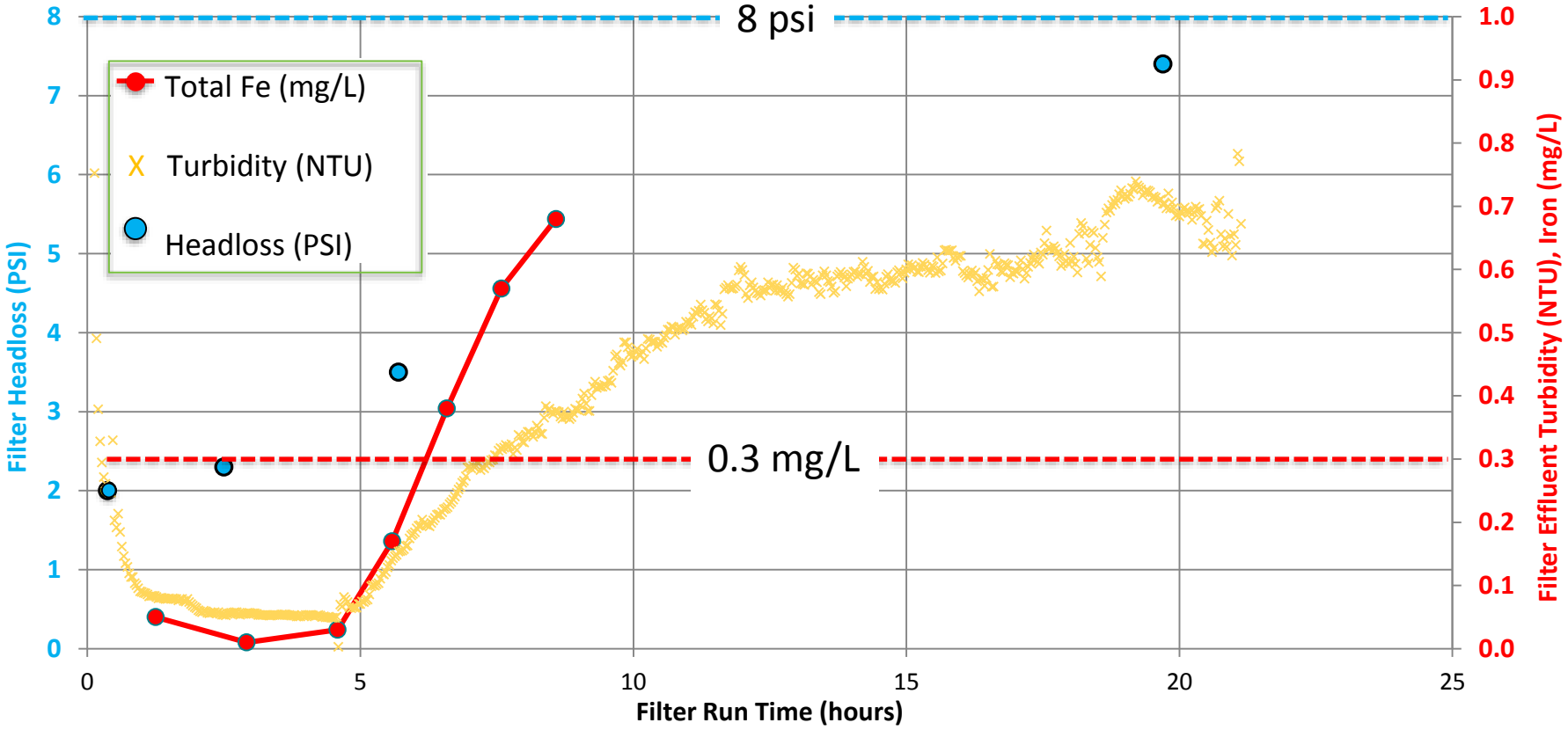
Pilot Study – Filters



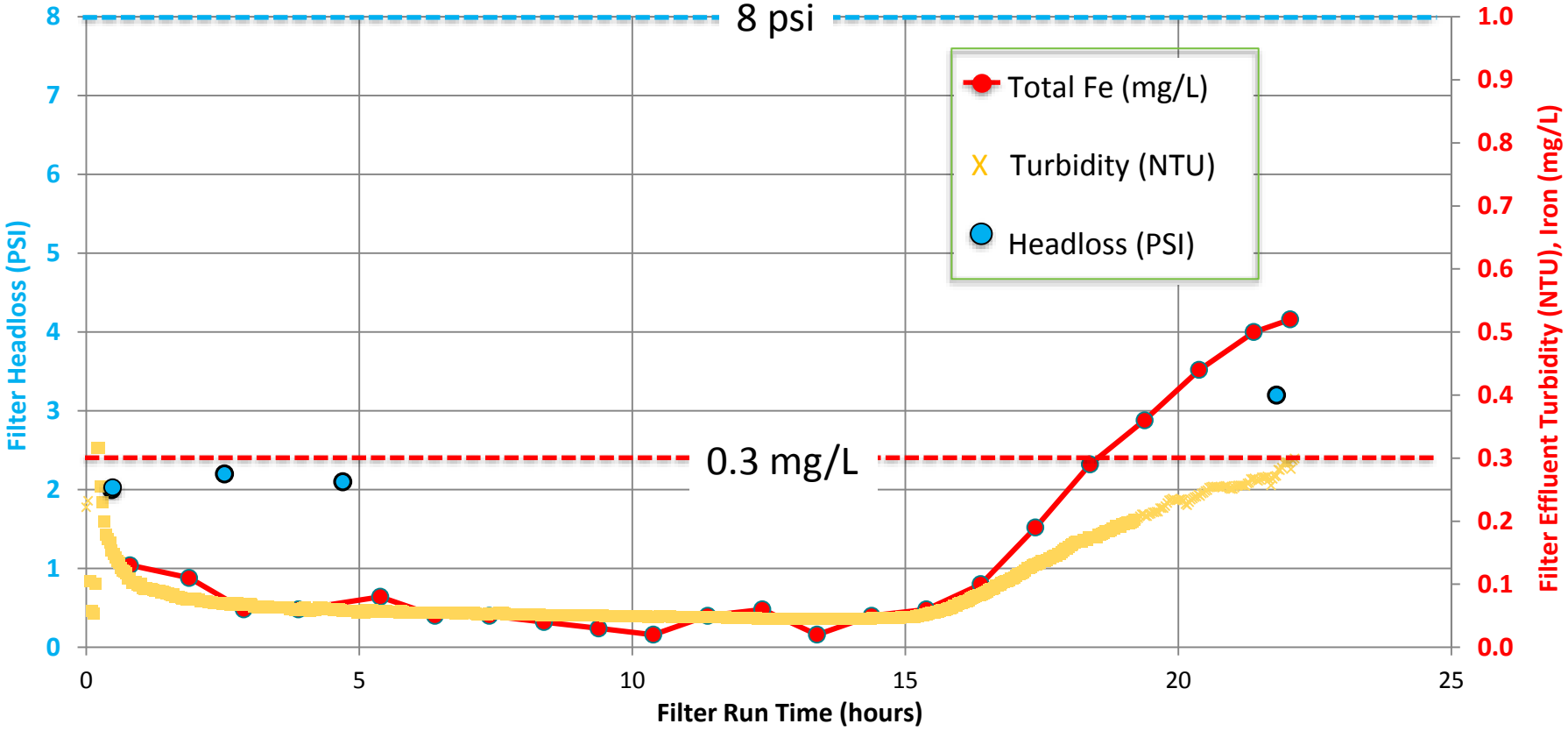
Pilot Study – Filter Results



Filter No. 4 (Run No. 2 – 8 mg/L $FeCl_3$)



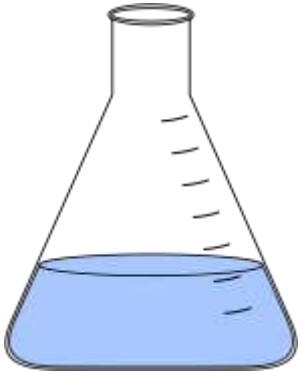
Filter No. 4 (Run No. 8 – No $FeCl_3$, 2 Stage Mixing)



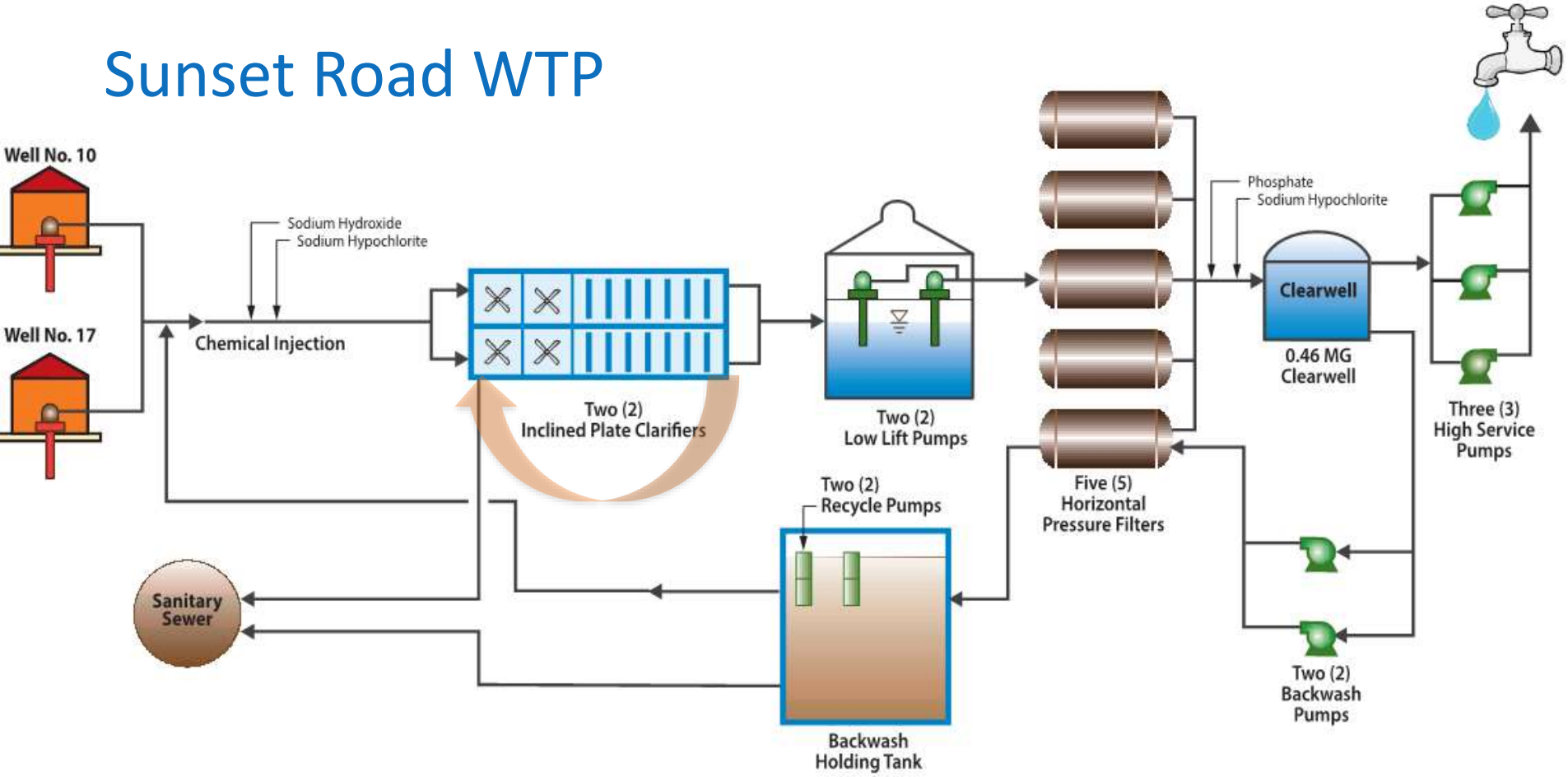
Treatment and Project Status

Treatment and Project Status

- Increased hydraulic retention time
  - Two stage flocculation – 14 minutes/stage at peak flow
  - Inclined plate clarifiers – 96 minutes at peak flow
- Lowered loading rate
  - 0.4 gpm/sf (pilot test) at peak flow
  - <0.3 gpm/sf at average flow
- No coagulant, no polymer
  - Include provisions to recycle iron sludge in the future



Sunset Road WTP



TO BE CONTINUED...

Pennsylvania AWWA
American Water Works Association

Ironman Challenge –

Challenging Conventional Wisdom in Iron Removal

American Water Works Association Pennsylvania Section
Annual Conference 2016

May 12, 2016

QUESTIONS?

CDM Smith

Lindsey Olson, P.E.
Phone: 856-727-6129
e-mail: lindsey.olson@amwater.com

Sandra L. Kutzing, P.E.
Phone: 732-590-4741
e-mail: kutzingsl@cdmsmith.com

NEW JERSEY AMERICAN WATER