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DBP AND DISTRIBUTION SYSTEM CHLORINE RESIDUAL CONTROL IN CARLISLE BOROUGH

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CARLISLE PENNSYLVANIA EST. 1751

Outline

- **Project Background and Objectives**
- **DBP Formation and Control Theory**
- **DBP Control Study Summary**
  - Alternatives Evaluation
  - Recommendations
- **Project Design Collaboration**
- **Construction**
- **Operation and Results**
- **Questions and Comments**

Project Background

SOURCE: MAPQUEST

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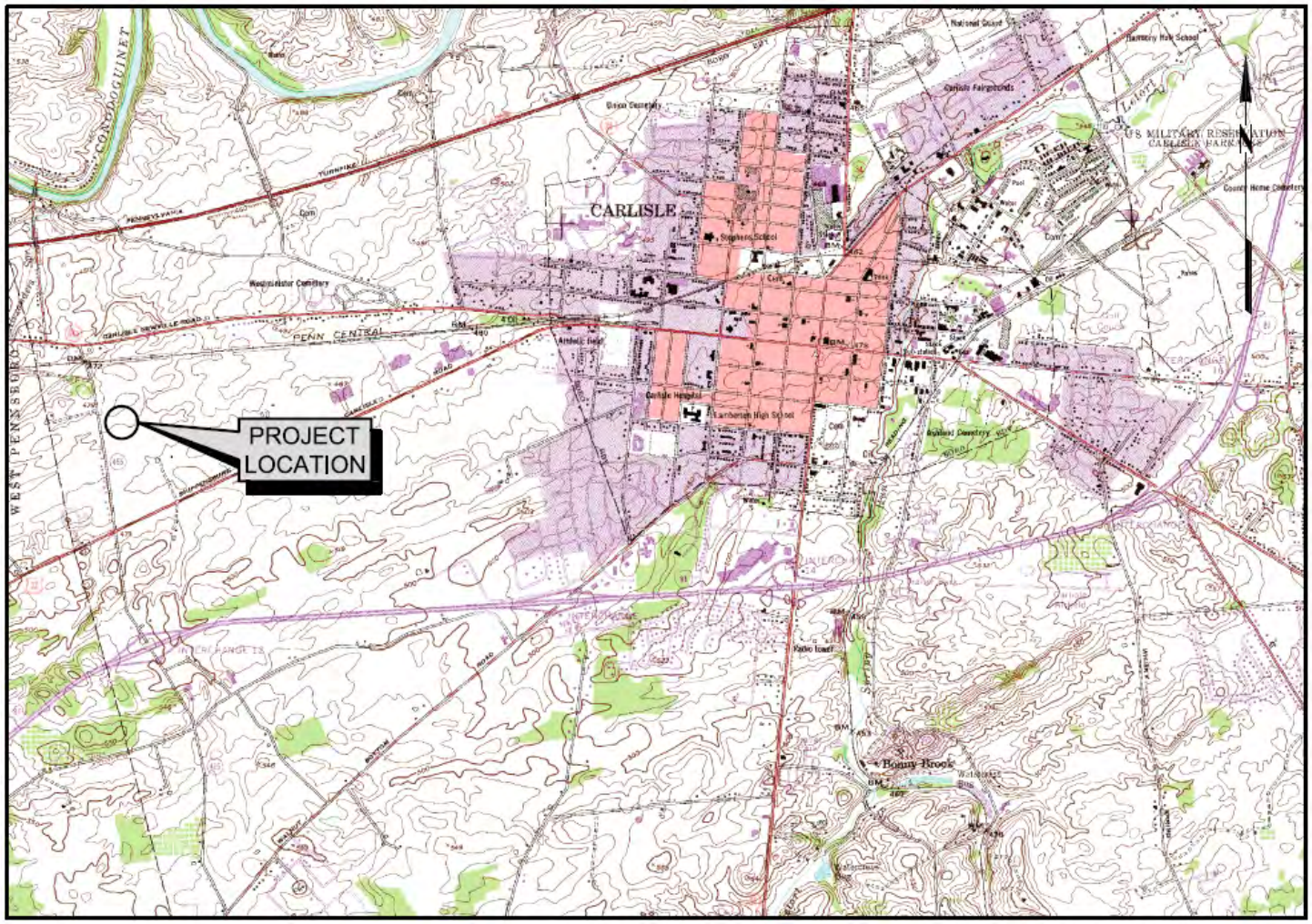
Project Background

- **Borough of Carlisle water system supplies:**
  - Borough and neighboring bulk water customers
  - Serves approximately 20,000 people
- **WTP permitted capacity of 7 mgd**
  - Conventional process with granular media filtration
- **Source of supply - Conodoguinet Creek**
- **Borough and Staff place a high priority on water quality and quality of service**
- **1st in PA to achieve Partnership for Safe Water Phase IV**

Project Location – Demonstrates Root Cause



LOCATION MAP

SCALE: 1" = 2000'

CREDIT: U.S. GEOLOGICAL SURVEY
DEPARTMENT OF THE INTERIOR/USGS
U.S. GEOLOGICAL SURVEY

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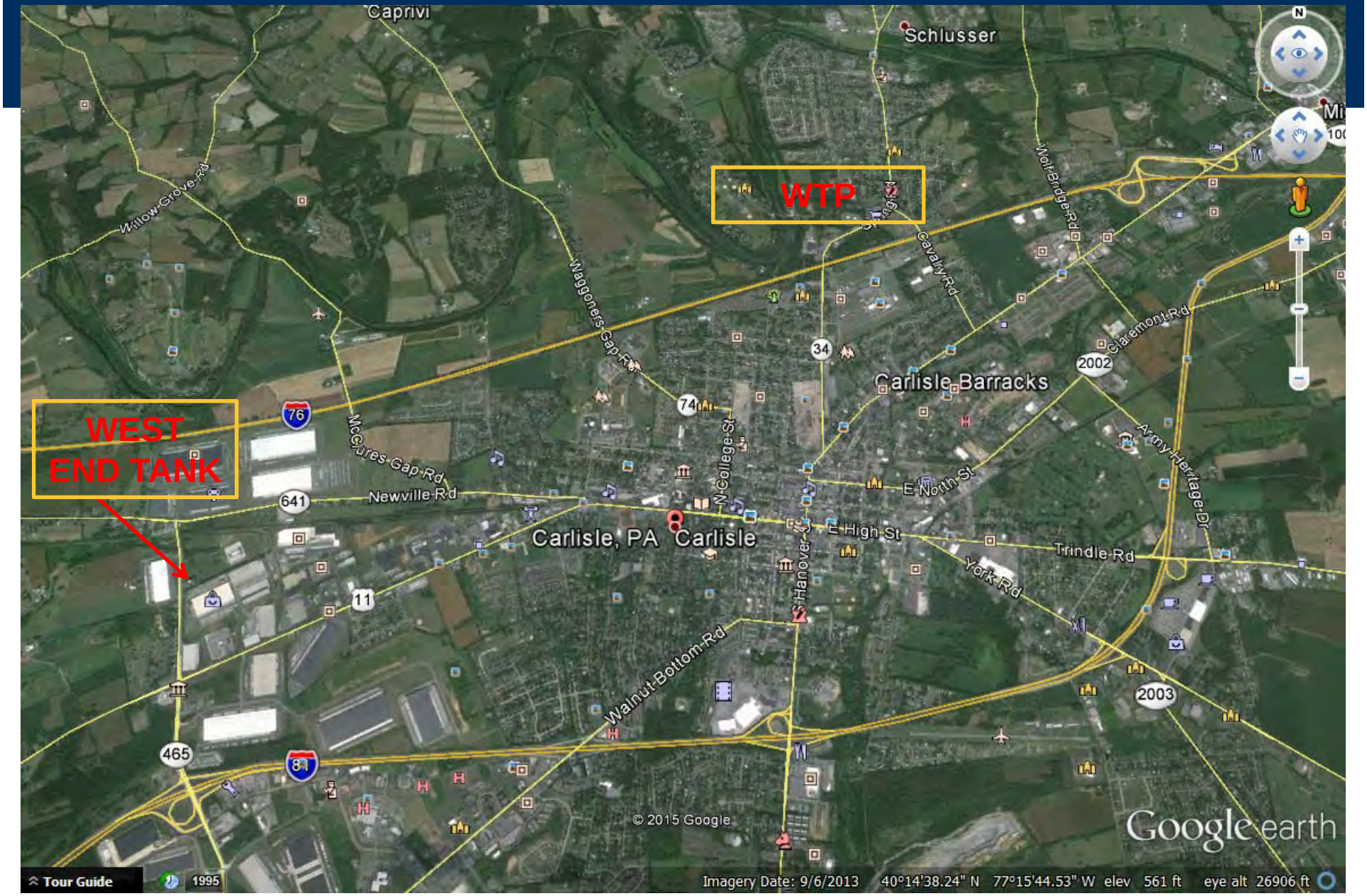

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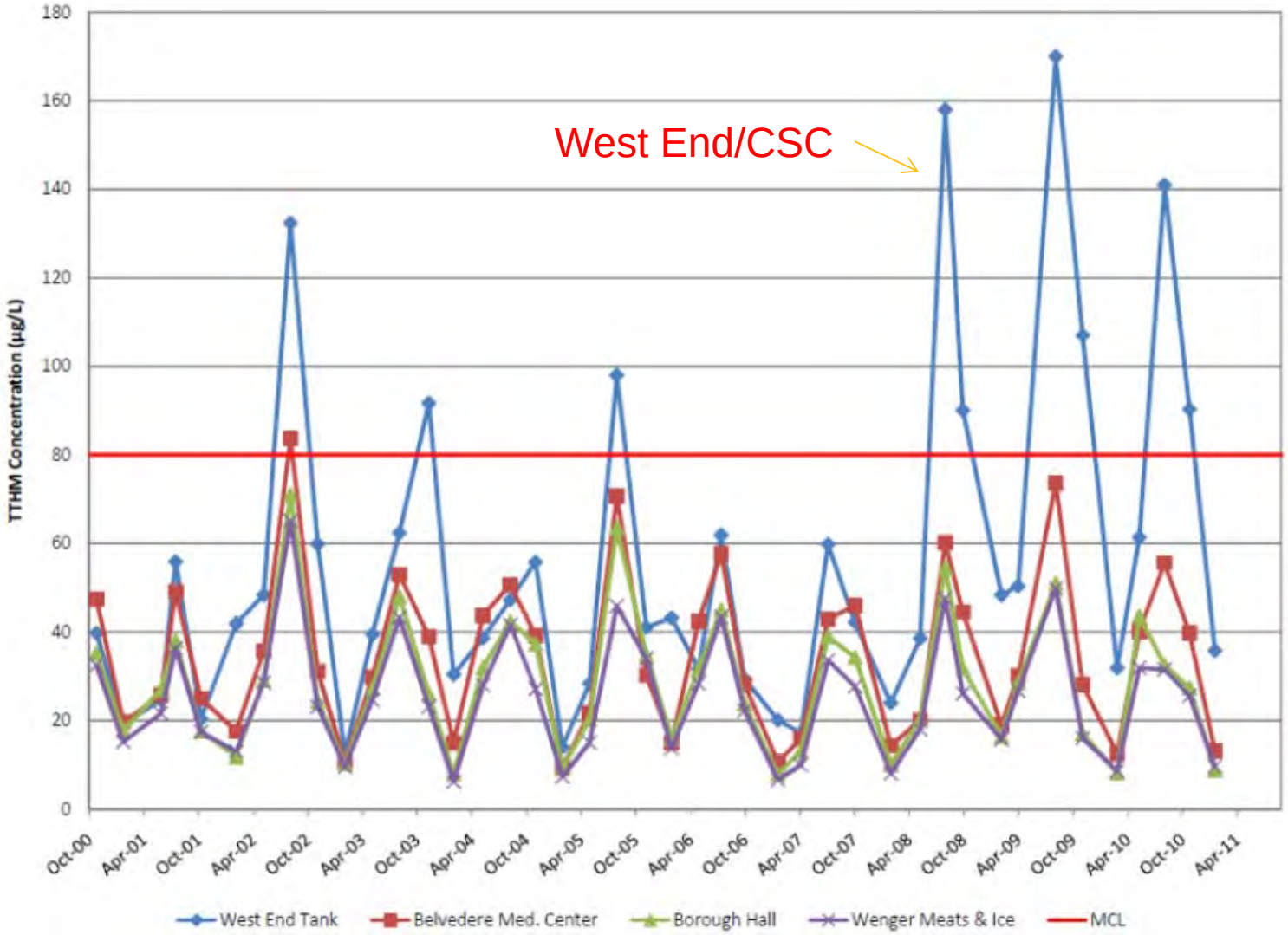
Project Background

- **Staff identified water quality concerns in the system's West End**
- **West End is relatively new – sized for demands**
  - Primarily warehouse development
- **TTHM concentrations very elevated in West End**
- **Booster chlorination required to maintain residuals**
- **Mixing required to eliminate stratification**
- **TTHM concentrations and chlorine residuals are very good in remainder of system**
- **Stage 1 DBPR compliance (RAA) not a problem**
- **Stage 2 DBPR projected to be not in compliance**

Project Background

- **Prior to this project Staff tried to reduce DBP concentrations:**
  - Valve position and distribution modifications
  - Performed a tracer test
  - Considered pumping from tank to reduce water age

Stage 1 TTHM Data



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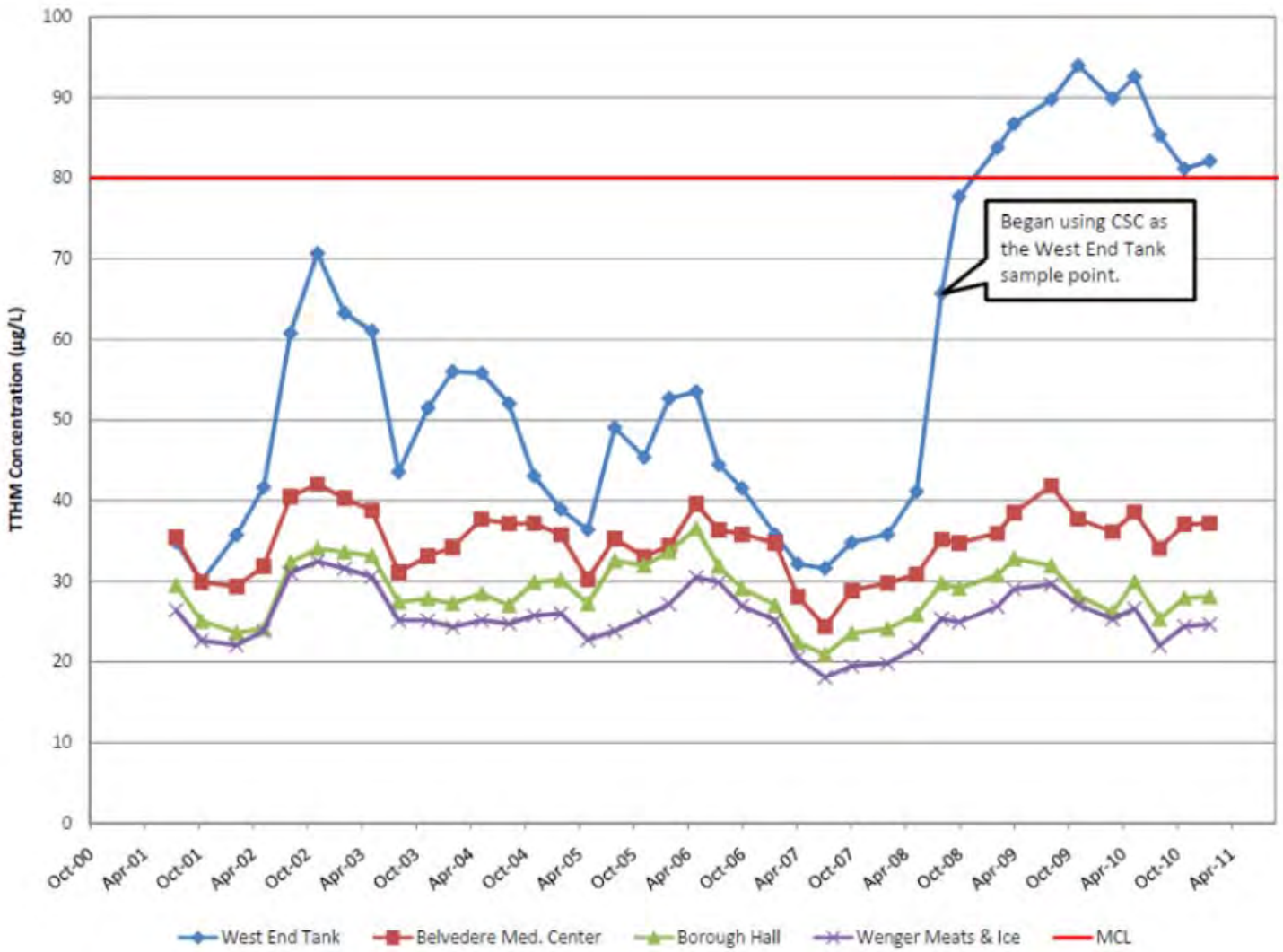
TTHM LRAA (Stage 1 DBPR Data)



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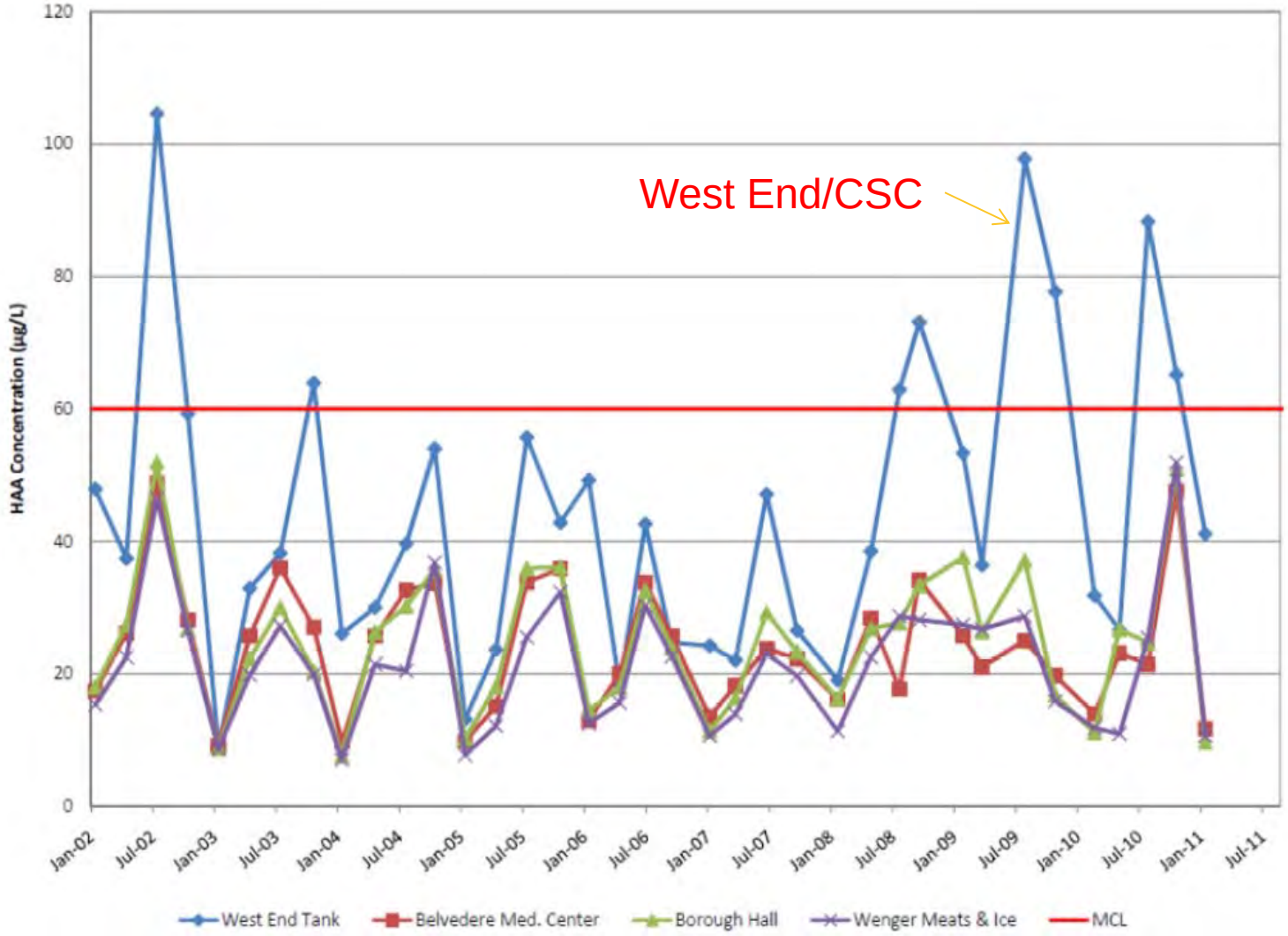
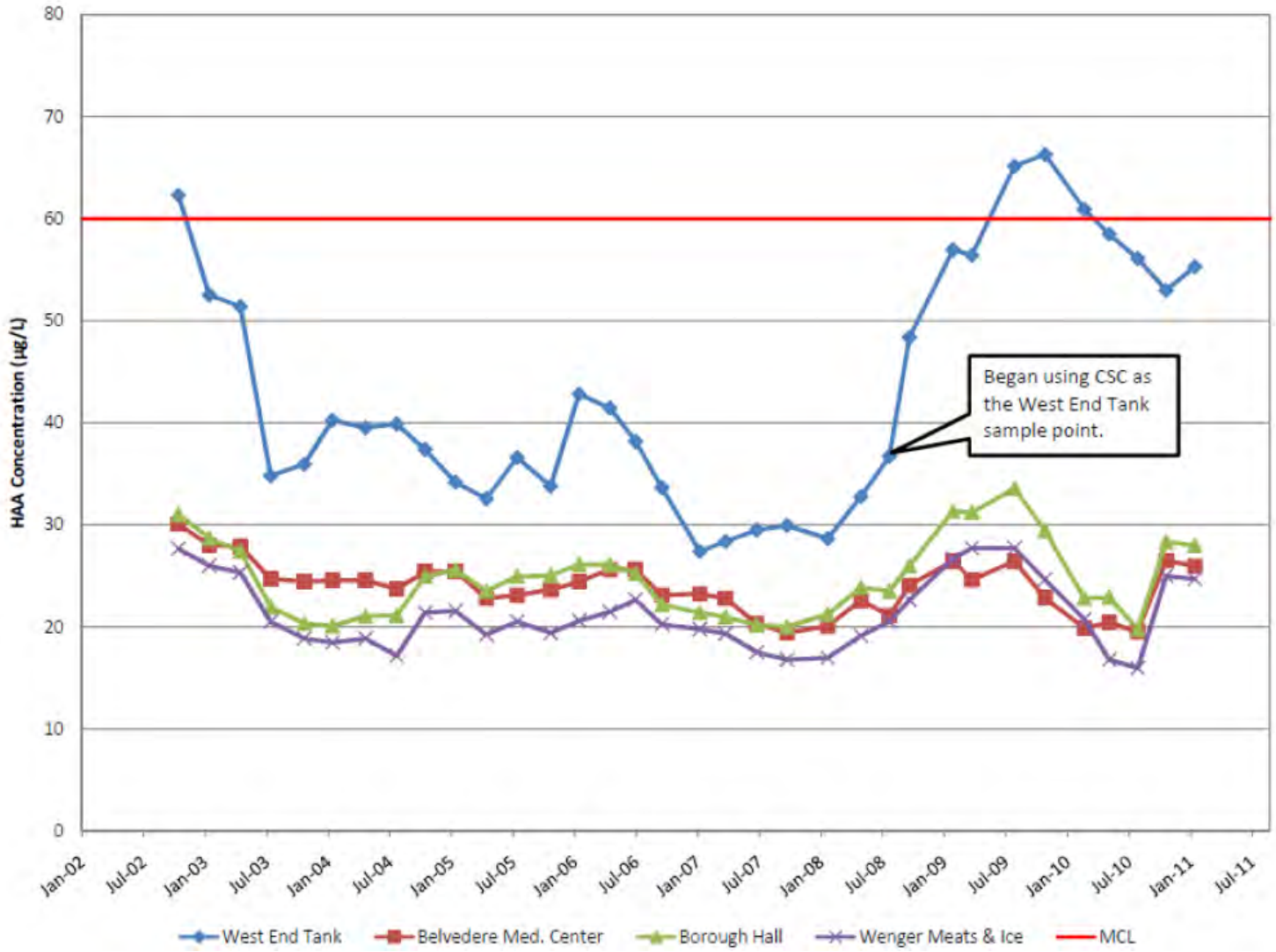
Stage 1 HAA Data



HAA LRAA (Stage 1 DBPR Data)



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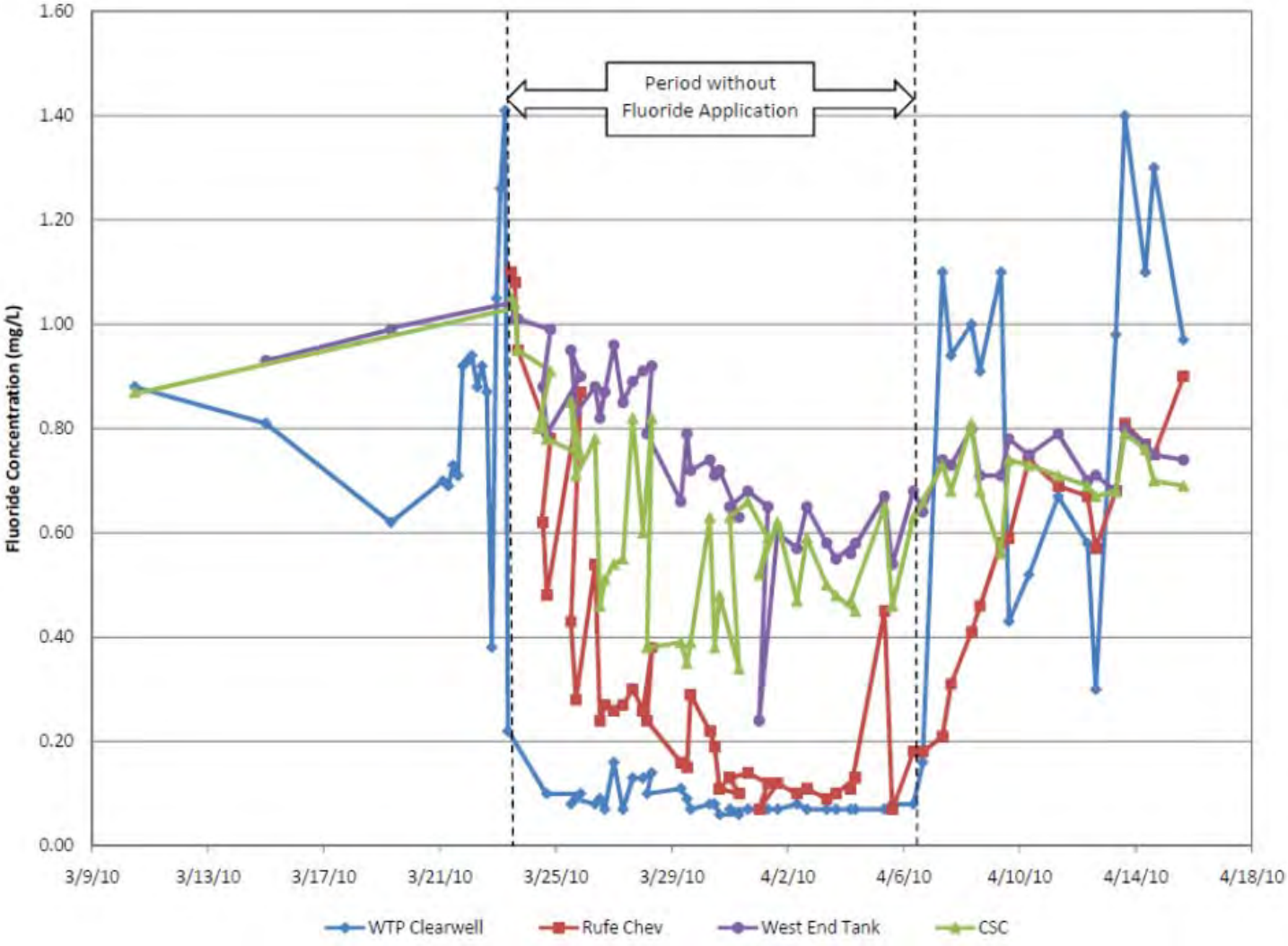
Borough's Fluoride Tracer Test Tells the Story



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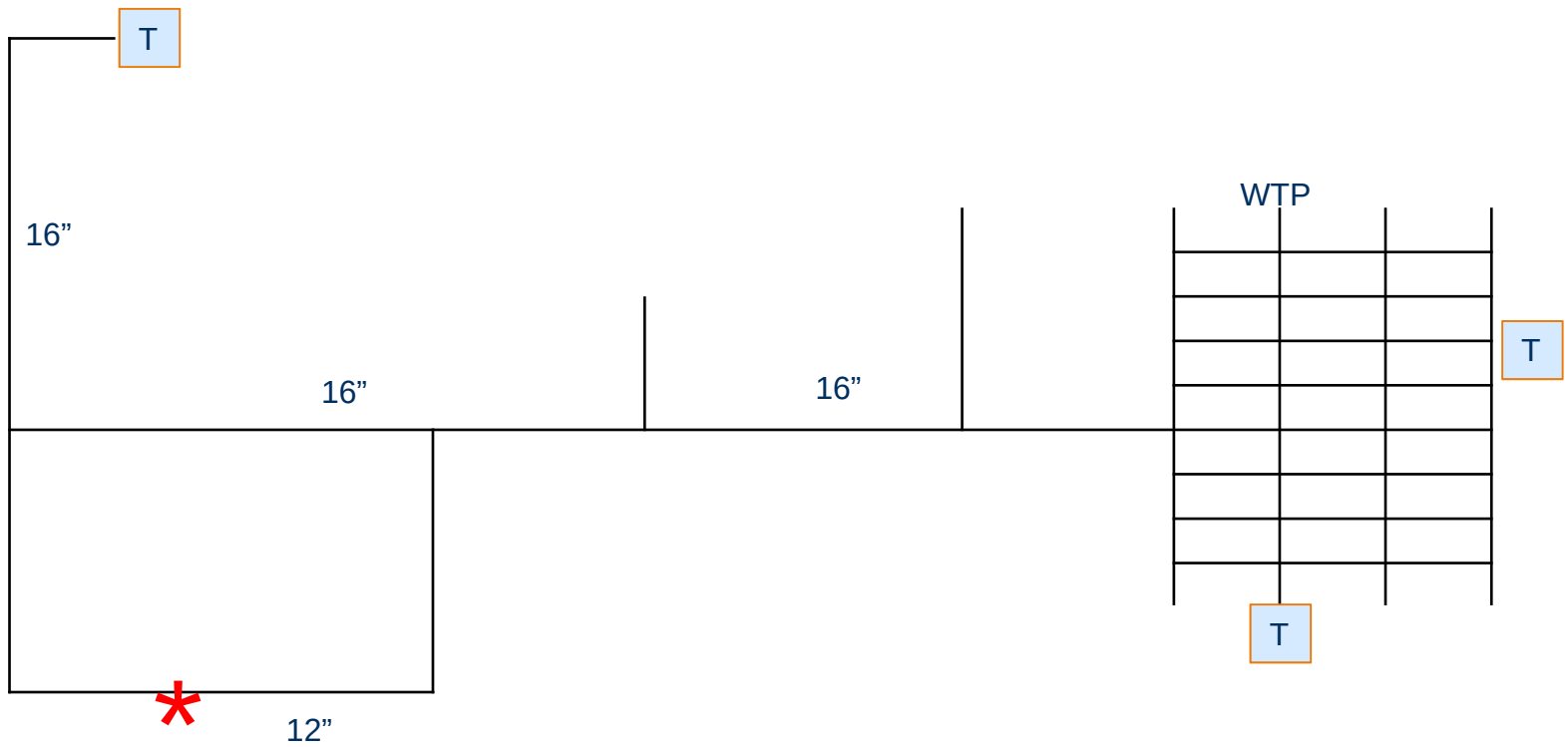
West End Piping Schematic



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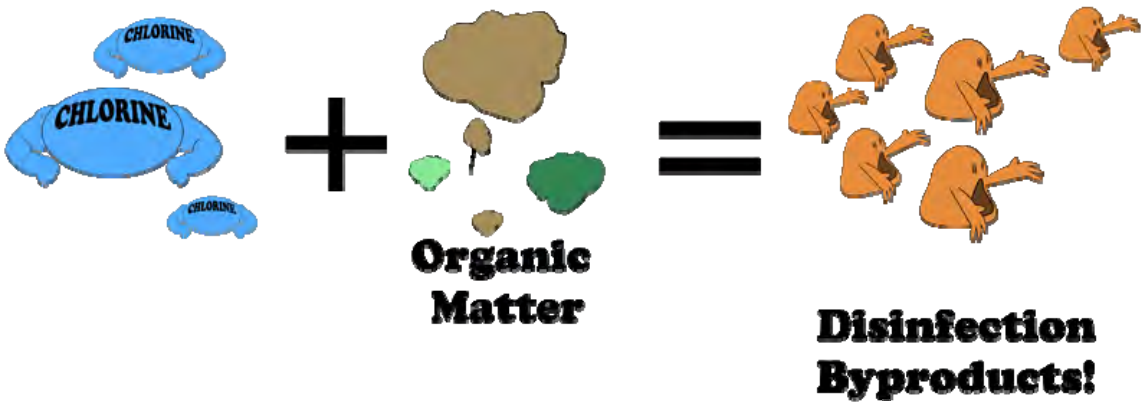
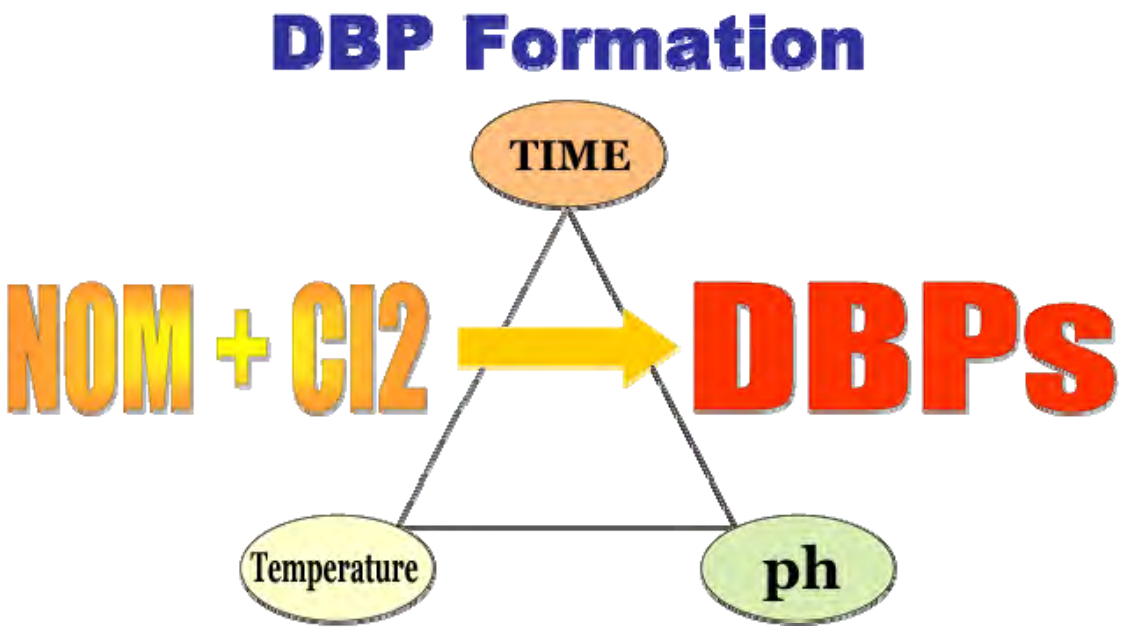
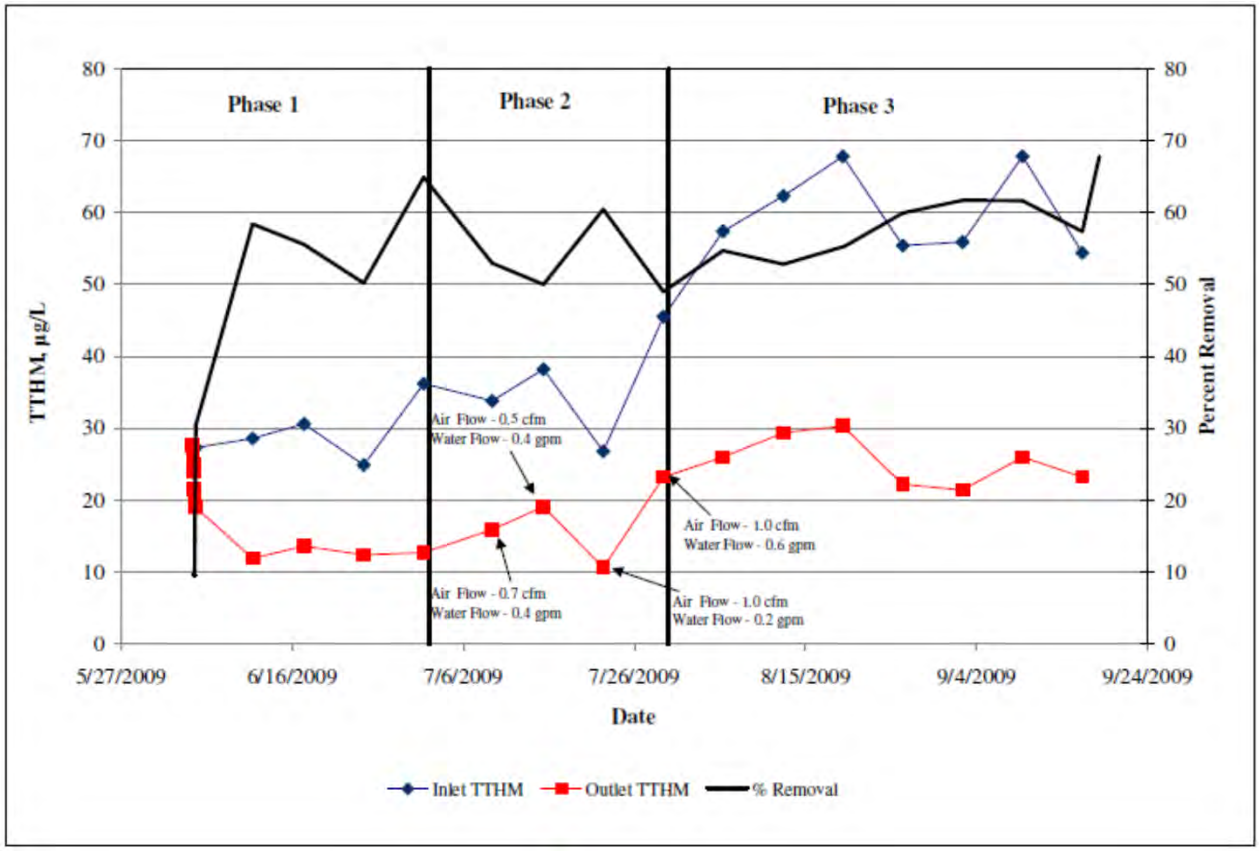
DBP Formation and Control Theory



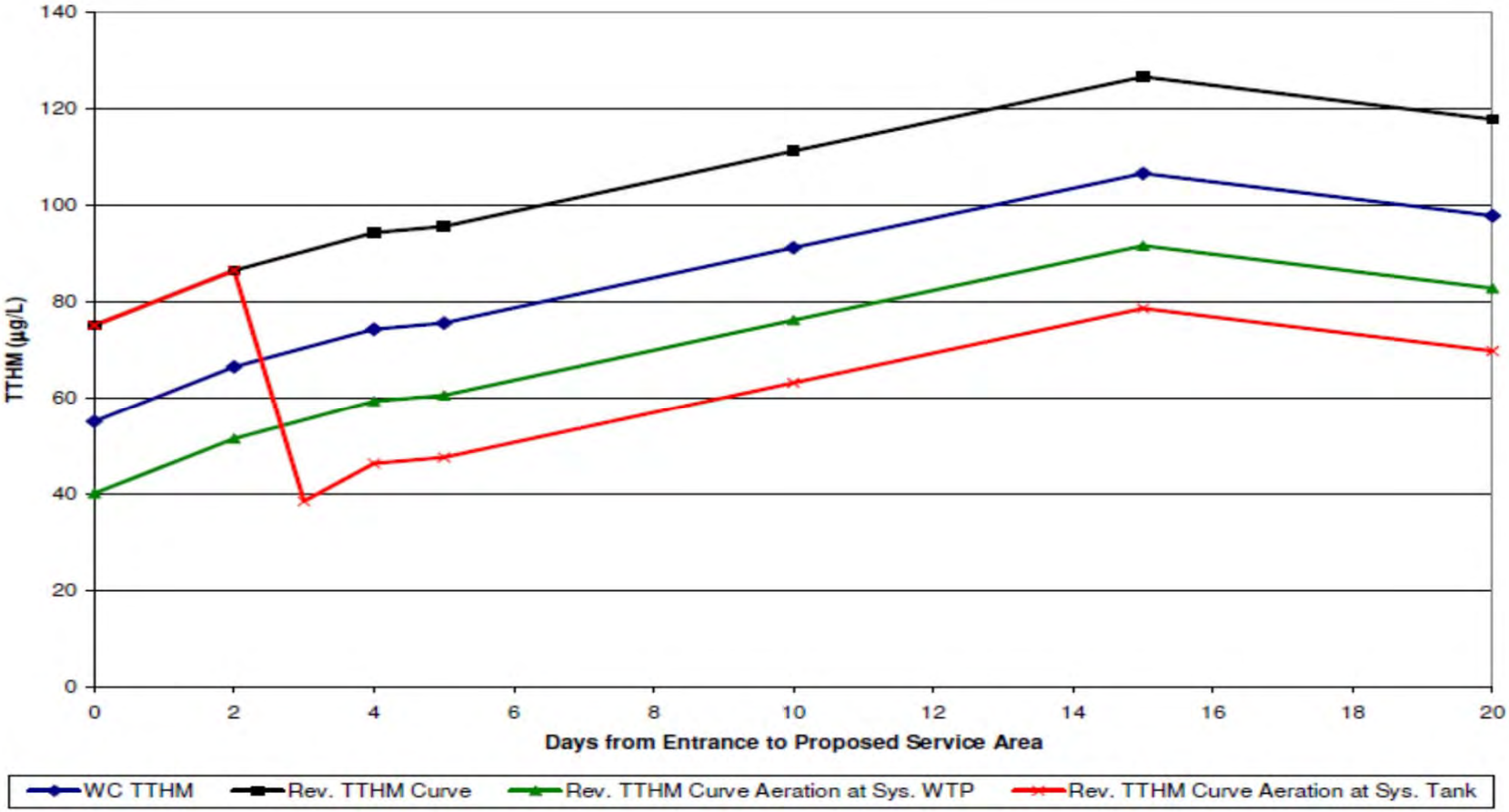
DBP Formation and Control Theory



Proven Approach – Storage Tank Aeration



Well-Designed Storage Tank
Aeration Can Provide TTHM Compliance



Approach – Modification of System Operations

DBP Control via Tank Operating Changes, Aeration

Water Age >> 16 days
(Fluoride Tracer)
Estimated Water Age ~ 32 days

TTHM = 140 - 170 ppb
HAA = 80 – 95 ppb

Projected Water Age Following Operational Changes ~ 7 days
TTHM < 60 ppb
HAA < 50 ppb

DBP Control Study - Summary

- **West End Tank**
  - 2.3 Mgal Standpipe
  - Height to Overflow = 133 feet
- **Floating Storage with Fill/Drain Controlled by WTP**
  - Refill initiated when water level reached 123 feet
  - Cycle occurs approx. two (2) times per day
  - Daily tank turnover approximately 15% (theoretical)
  - Water age much greater – Ref. Fluoride Tracer
- **Existing pumped recirculation system for mixing**
- **Booster chlorination required at tank**
- **Water age and booster chlorine = Elevated DBPs**

DBP Control Study - Summary

- **WTP**
  - Phase IV Partnership
  - Low TOC Effluent
  - Minimal Opportunity to Reduce NOM Cost-Effectively
- **Borough Very Reluctant to Chloraminate**
- **DBP and Chlorine Residual Issues – Localized to West End Area**
- **DBP issues are direct result of excessive water age**
- **Borough Staff Prefer a Localized Approach to Address Distribution System Water Quality**

DBP Control Study - Summary

- **TTHM compliance is primary driver**
- **HAA compliance is also an issue**
- **The Borough needs to reduce both TTHM and HAA concentrations in the West End for long-term compliance with the Stage 2 DBPR**

DBP Control Study – Alternatives Evaluation

- Storage Tank Aeration
- Tank Operation Modifications
- Transmission/Distribution System Modifications
- Alternative Disinfectants
- Biologically Active Carbon/Other Treatment

DBP Control Study – Alternatives Evaluation

- **Storage Tank Aeration**
  - Proven approach for TTHM reduction
  - Can be designed for required % removal
  - Will NOT address HAA concerns
  - Will NOT address water age root cause
  - Will NOT address chlorine residual – booster chlorine required & HAA formation will continue
- **Transmission/Distribution System Modifications**
  - No opportunity for looping
  - Can induce additional flow by CSC site but will not address root cause

DBP Control Study – Alternatives Evaluation

- **Tank Operation Modifications (Pumped Storage)**
  - Longer draw cycles
  - Allow discharged water to be used
  - Limit the volume used, if necessary
  - Can reduce water age to 7 days or less
- **Alternative Disinfectants**
  - Viable alternative
  - Last alternative based on Borough preference
- **Biologically Active Carbon/Other Treatment**
  - Effective for HAA reduction
  - Not effective for TTHM reduction

Recommended Approach: Phases/Multi-Faceted

- **Minor valve position modifications**
- **Convert West End Tank to Pumped Storage – Reduce Water Age**
- **Storage Tank Aeration – If Necessary**

Pumped Storage Concerns

- **Reduction in available fire flow**
  - Flow testing with tank online and offline
  - Fire flow >2,500 gpm with tank offline
  - Lag pump activates at low pressure
- **Reduction in stored volume**
  - Existing effective volume only 175,000 gallons of 2.33 Mgal
  - Increases useable volume to 1.8 Mgal
  - Maintains minimum 175,000 gallons available at all times
- **Loss of Utility Power**

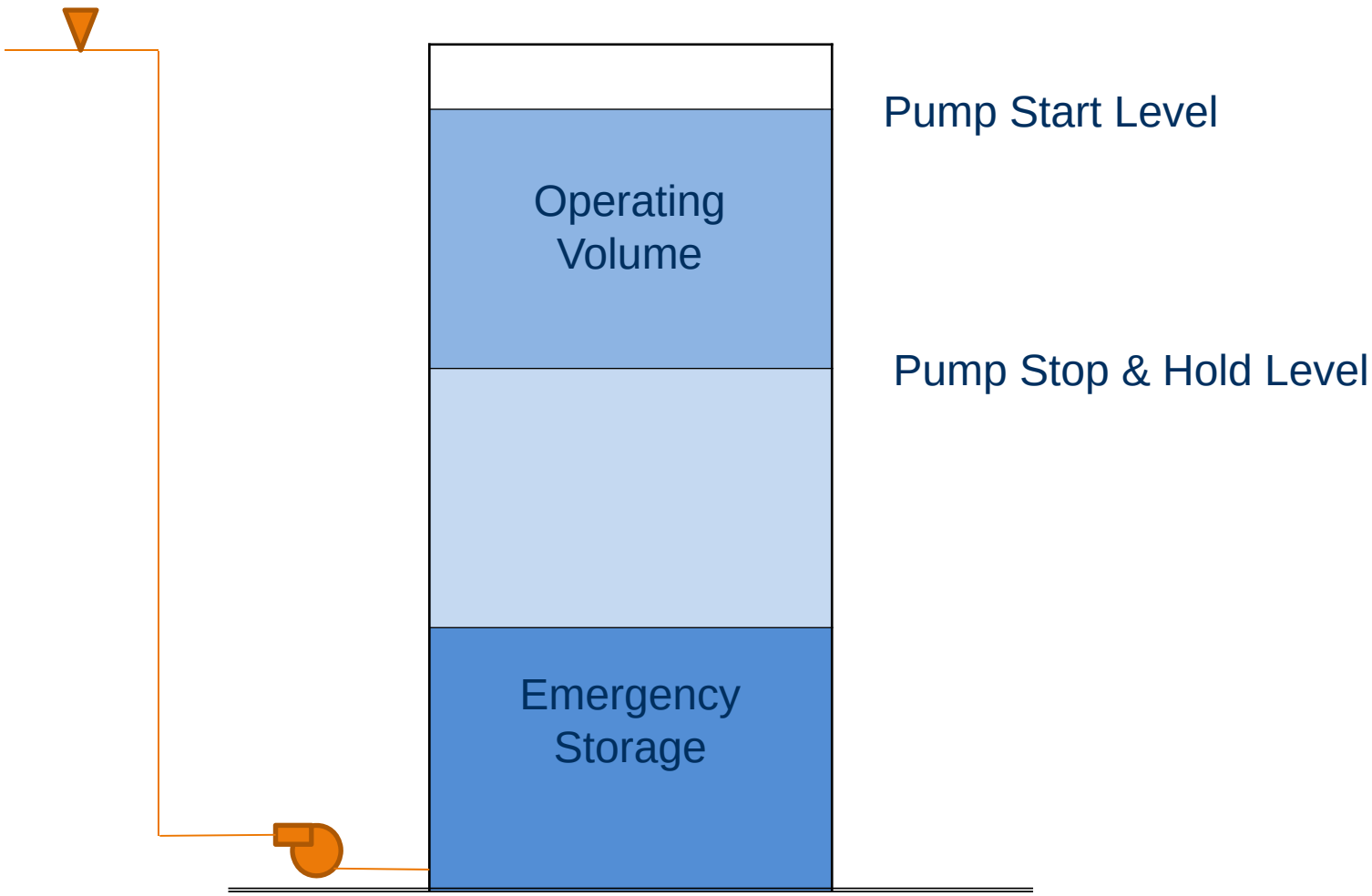
Design Criteria

- **Maintain pumped recirculation/mixing capability**
  - 260 gpm at 30’ TDH, 3 hp
- **Reuse chlorine analyzer, etc. as possible**
- **Provide space for future hypo system, if necessary**
- **Replace fiberglass structure with precast concrete**
- **Two (2) booster pumps**
  - 400 – 500 gpm at 120’ TDH, 20 hp
- **Spray aeration system (bid alternate)**
  - 15 hp spray aerator with 2 hp ventilation blower
- **Motor operated refill and flow control valve**

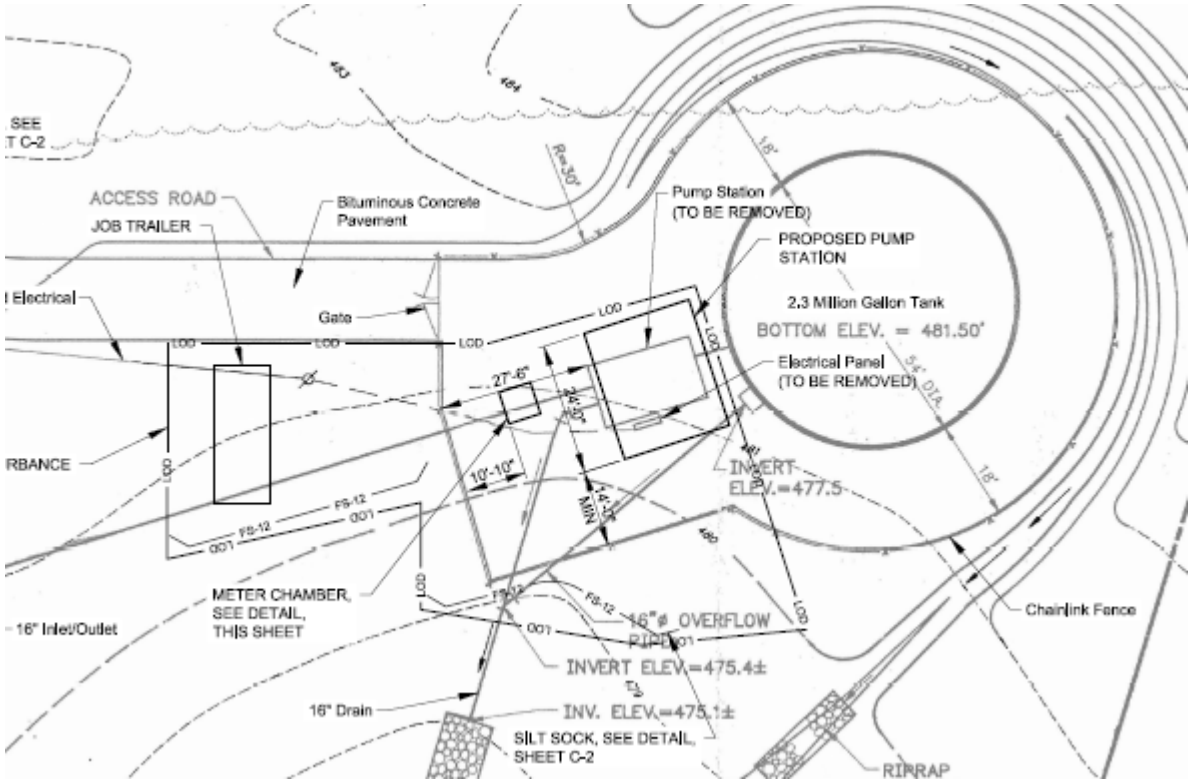
BPS Control and Operation

- **High level start (adjustable)**
- **Pump maintains preset discharge pressure**
- **Lag pump starts if minimum pressure not achieved**
- **Low level pump stop (adjustable)**
- **Delay following pump down (adjustable)**
  - Allow pumped water to be used
- **Refill at a controlled rate (adjustable)**
- **Pumping operations initiated upon completion of fill to high level setpoint**

West End Tank Pumped Storage Operation



West End Tank Project – Site Plan



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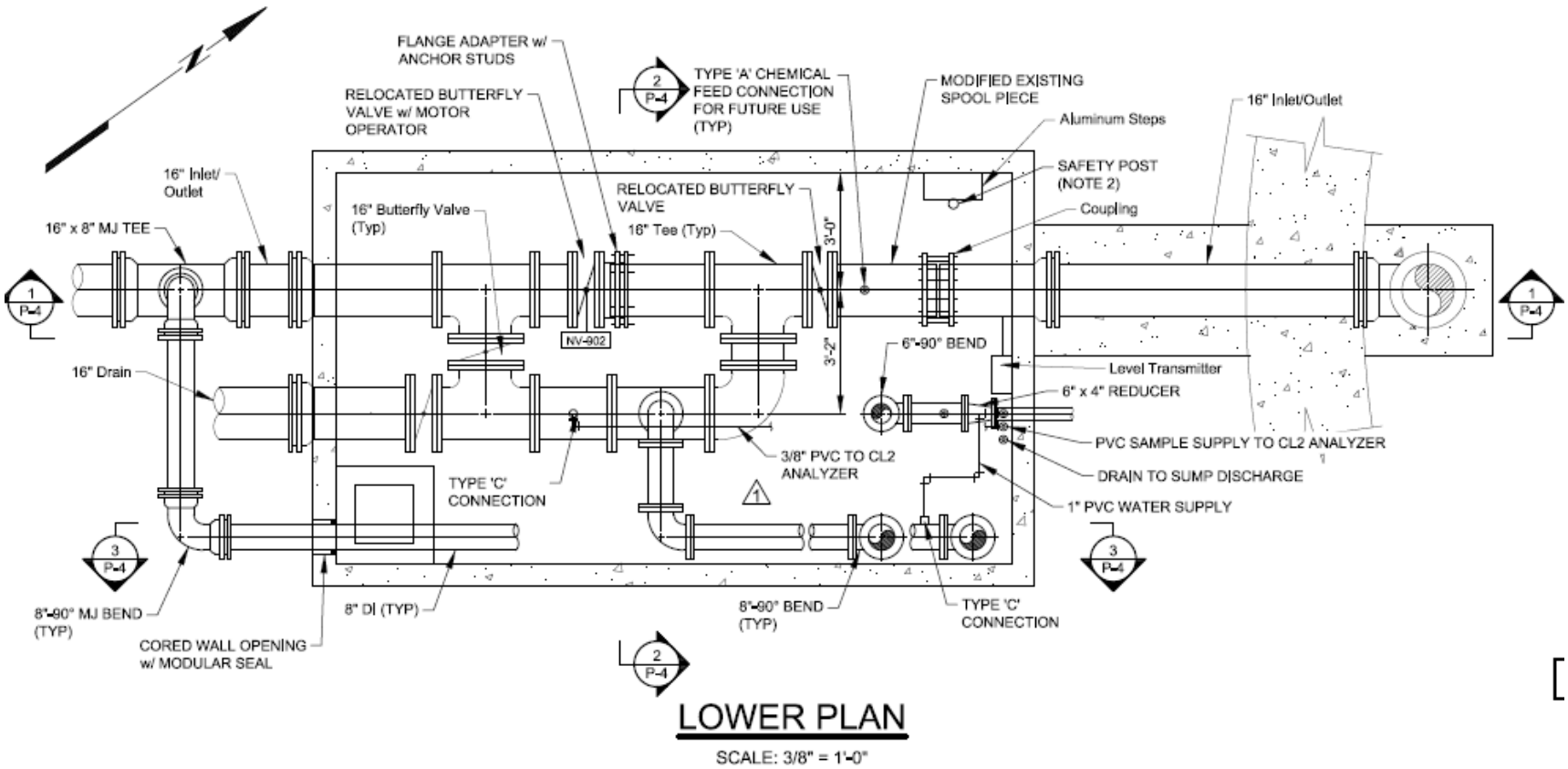
West End Tank and BPS

Lower Plan – Existing Altitude Valve Vault



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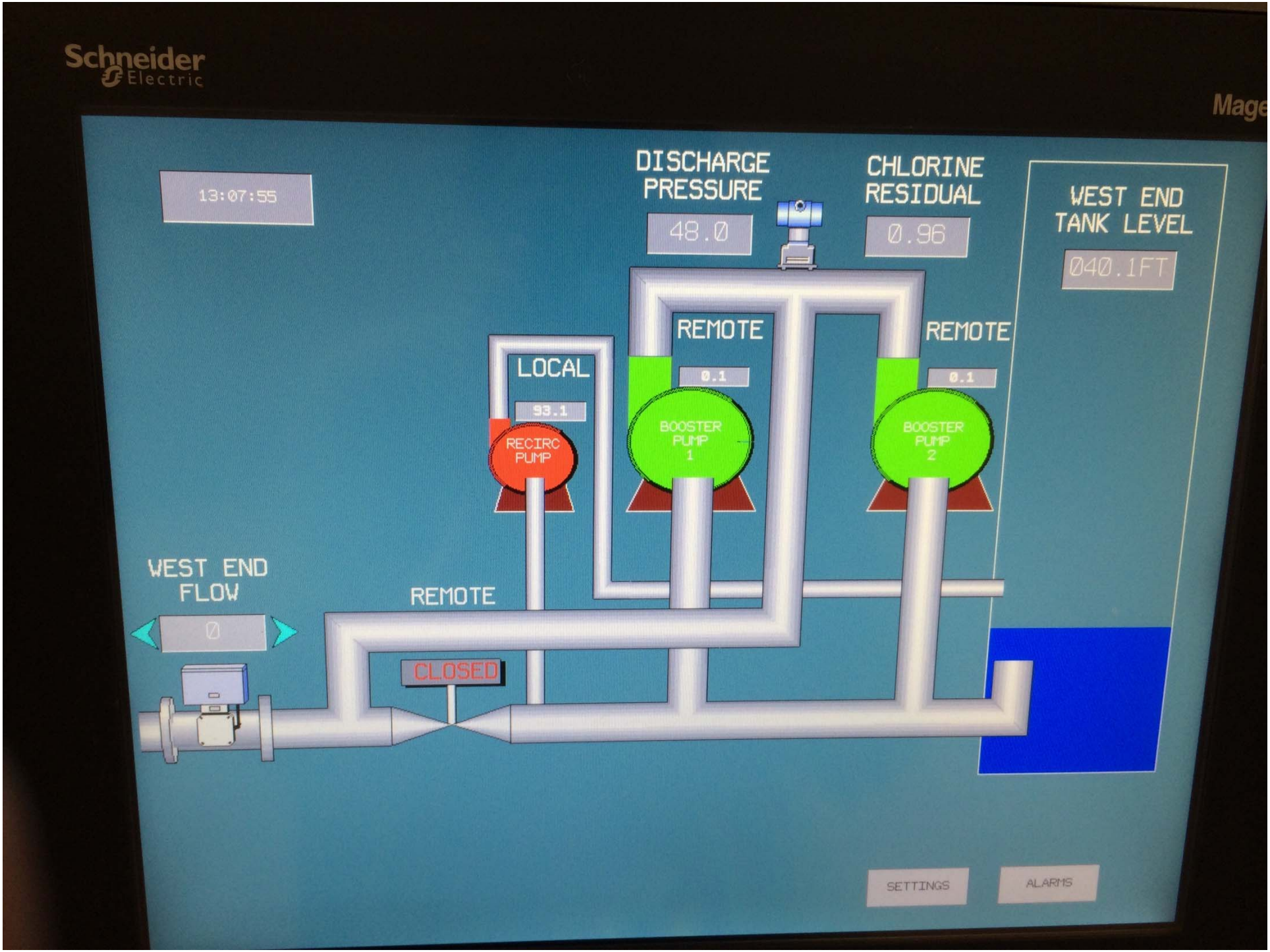
Valve/Piping Vault

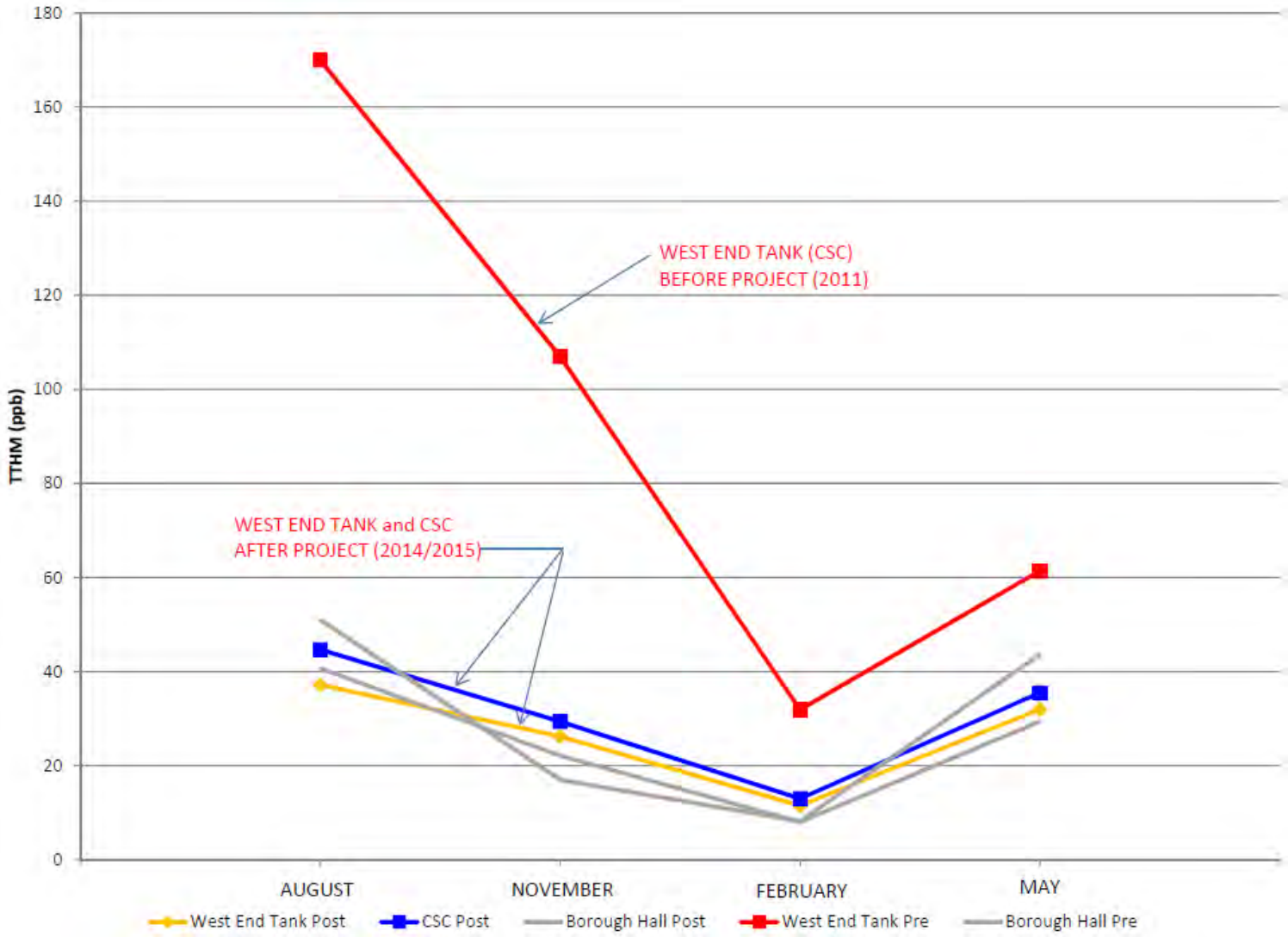
Main Control Panel


Schneider Electric
Mage
13:07:55
DISCHARGE PRESSURE
48.0
CHLORINE RESIDUAL
0.96
WEST END TANK LEVEL
040.1FT
REMOTE
0.1
BOOSTER PUMP 1
REMOTE
0.1
BOOSTER PUMP 2
LOCAL
93.1
RECIRC PUMP
WEST END FLOW
0
REMOTE
CLOSED
SETTINGS
ALARMS

Normal Operating Approach

- **Operation**
- **Emergency/Fireflow**
- **Power Loss**
  - Generator Capable
  - Return to Floating Storage with Emergency Power at WTP

Performance – TTHM Reduction



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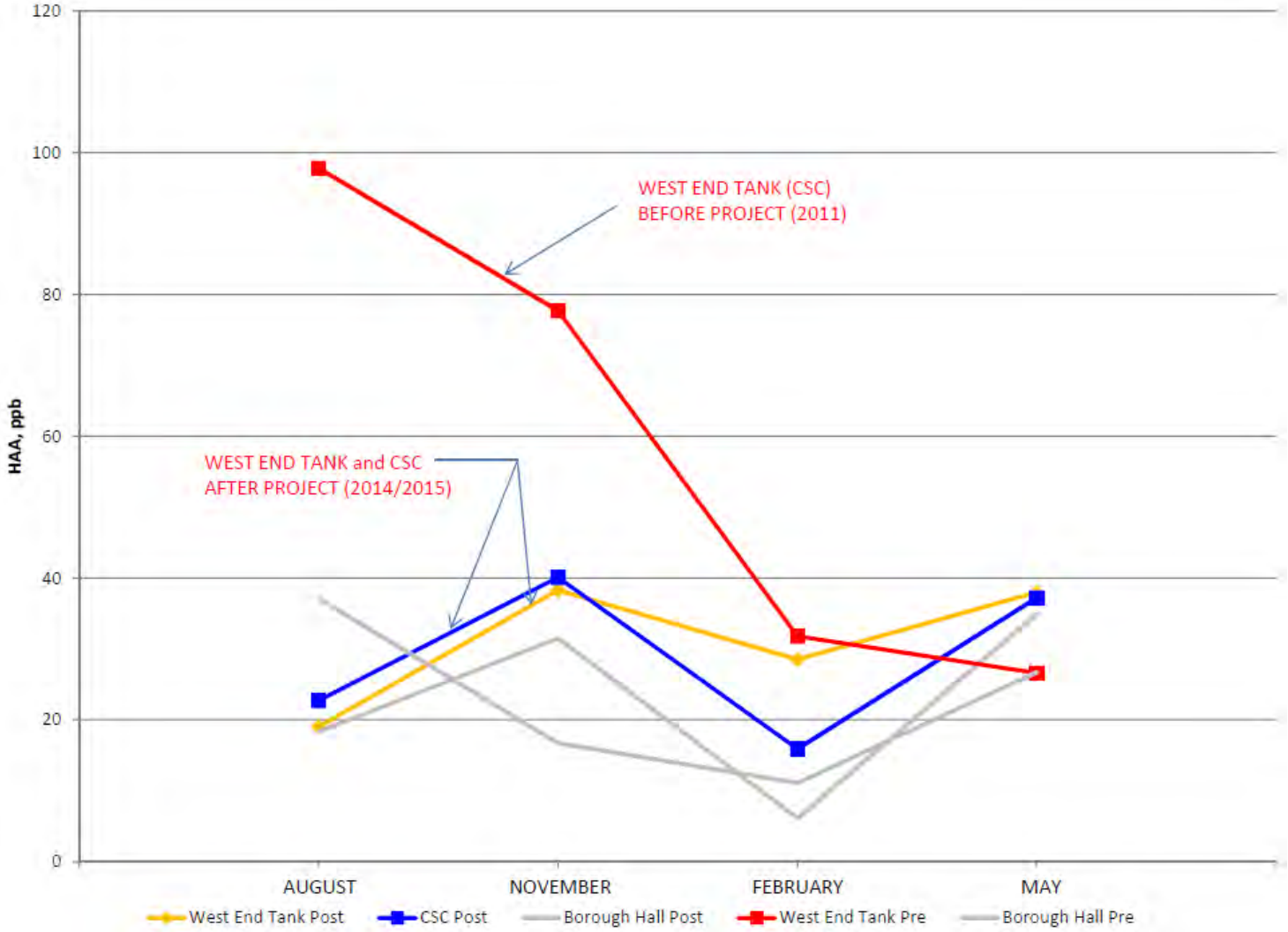
Performance – HAA Reduction



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Conclusions

- **Effective water age control**
  - DBP Compliance
  - Chlorine Residual Maintenance
- **Effective collaboration**
  - Successful Project

Select the Right Approach for DBP & Chlorine Control

- WTP Optimization (TOC, chlorination point)
- Disinfection Modification (i.e. modified pre-conceived ideas related to WTP process recycle)
- Disinfectant Type - chloramines
- Tank Aeration
- System Operation and Tank Operation Modifications

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QUESTIONS & COMMENTS

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