Stantec

City of Columbus Southerly WWTP
S87 Sludge Thickening Improvements

Gravity Settling… Harnessing the Law of Nature

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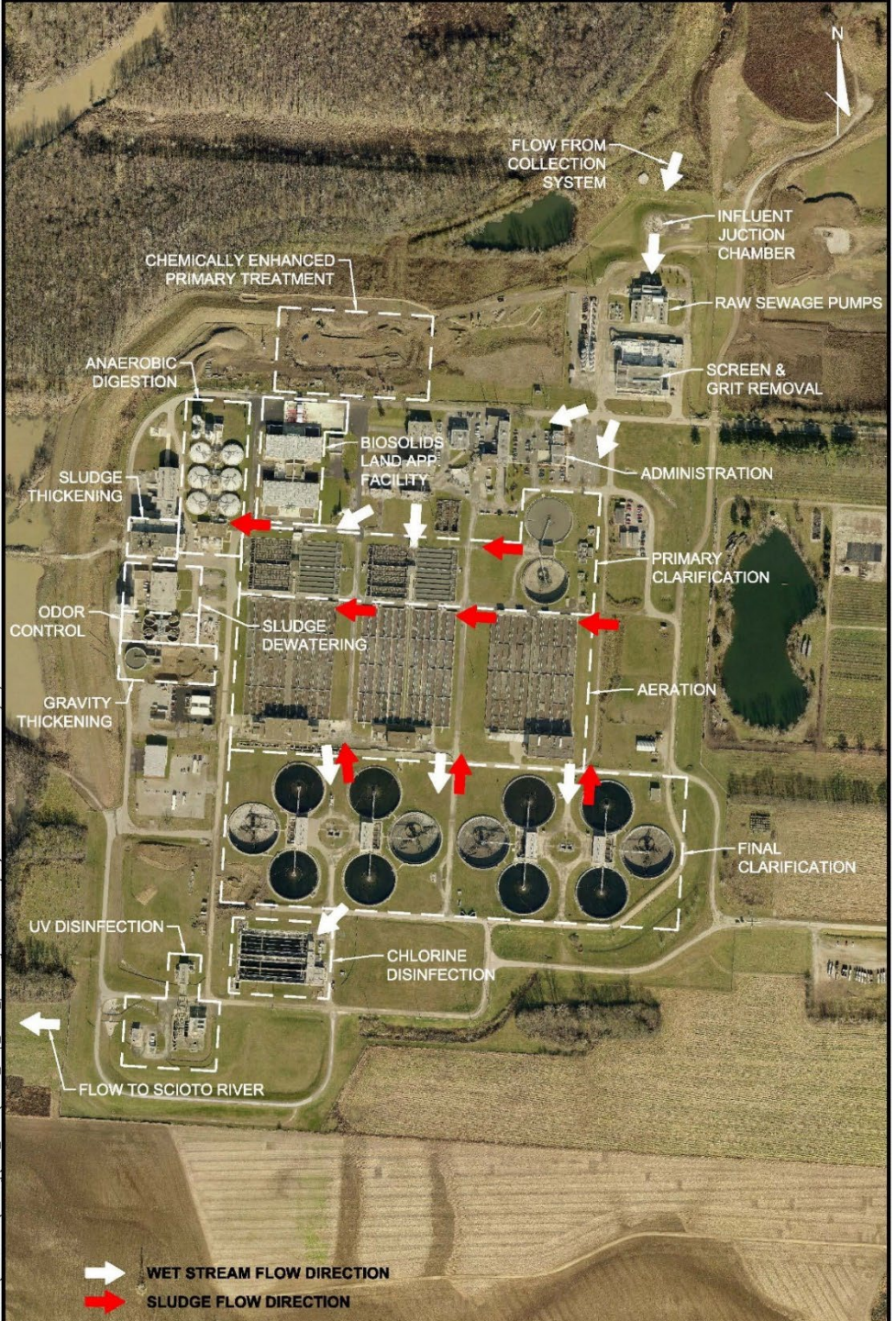

Southerly WWTP

- Original construction in 1967
- 114 MGD Average Daily Flow, 330 MGD Peak Daily Flow
- Employs semi-aerobic selector zone activated sludge secondary treatment
- Currently Constructing CEPT Primary Treatment for wet weather operations. Contract S87 includes:
  - Headworks improvements
  - Sludge thickening improvements

Acknowledgments

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- Brown & Caldwell, Prime A/E and AEC

Brown AND Caldwell

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THE CITY OF COLUMBUS
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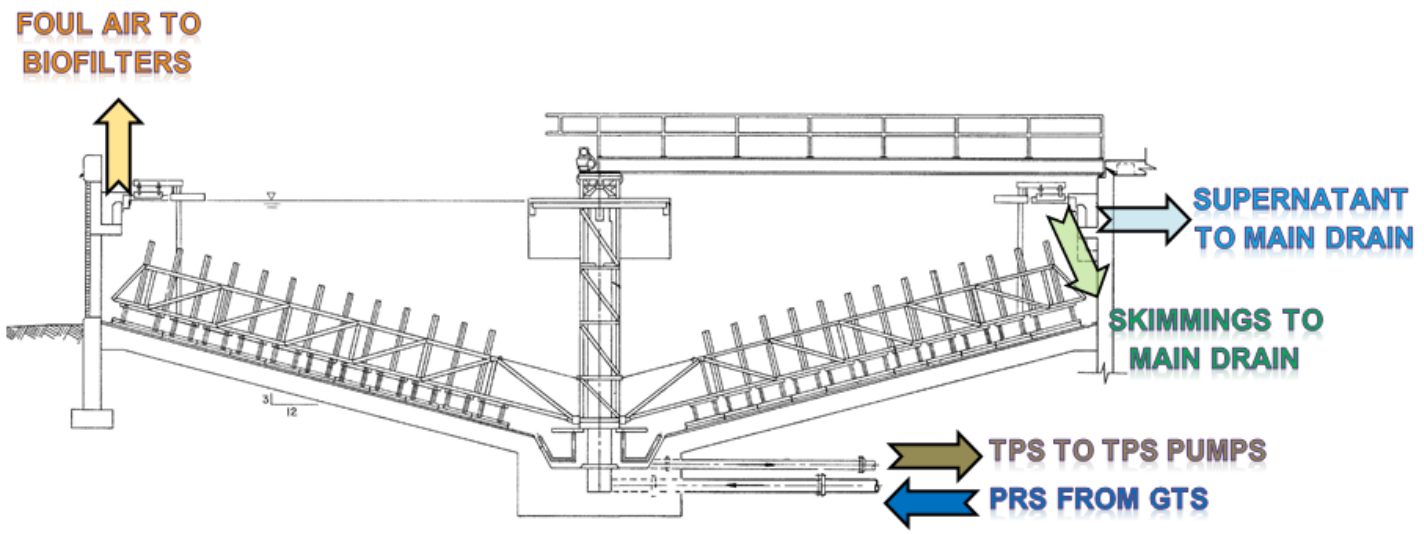
Project Background and Objectives

Gravity Thickening at a Glance

- Gravity thickening was utilized with early WWTP designs including primary clarification, trickling filter, and Imhoff tank designs
- Gravity thickening is a cost effective, low maintenance method of solids thickening that consistently preforms under variable loading scenarios
- Gravity thickening also provides the following benefits:
  - Thickening for digester system sizing and performance
  - Decoupling of wet stream and solids handling
  - Some flow and mass leveling can be accomplished in the bottom cone of the tanks
  - Helps control pump feed to digestion

Gravity Thickener Theory and Operational Parameters

- Sludge Type
- Primary Sludge Production
- Sludge Concentration
- Dilution Water Flow
- Solids Flux
- Tank Overflow Rate
- Thickened Sludge Flow
- Thickened Sludge Concentration



Gravity Thickening Mechanics

- Sludge up-flows through center column and goes through zone settling, transition settling, and compression
- Flushing water (plant effluent) provides odor control and helps provide uniformity in flow and mass feeding as an elutriate
- Typical primary thickening performance is between 5-8% total solids
- Performance is typically lower if co-thickening WAS and primary sludge
- High sludge concentrations (>5%) exhibit non-Newtonian flow characteristics

Sizing Criteria and Regulatory Guidance

- Sizing criteria is established in design manuals including WEF Manual of Practice 8 and 11
- Sizing can be accomplished using on site comparisons and mathematically
- Normal sizing for primary sludge thickening is 20-30 pounds per day/square foot for mass loading and 380-760 gallons per days/square foot for volume loading. Some systems can operate effectively above this range.

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Pros and Cons of Gravity Thickening

Pros

- Few moving parts (only rake/collector assembly)
- Easy to maintain and operate
- Excellent for thickening primary sludge (in particular)
- Provides limited in-system storage

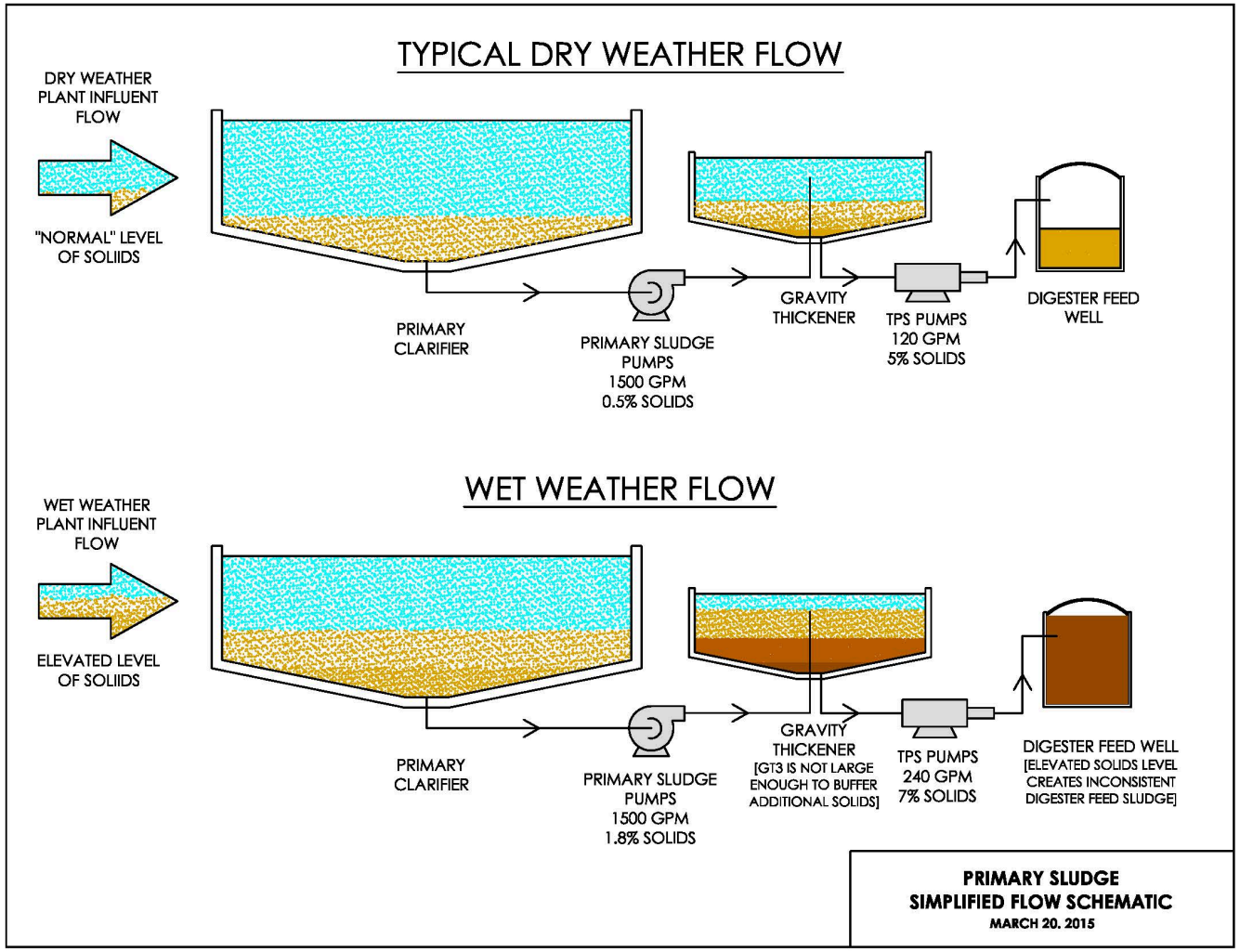
Cons

- Odor generation
- High flushing water demand
- Less certain performance for combined WAS and primary sludge
- Large footprint

History of Primary Sludge Thickening at Southerly WWTP

- Initial Site Construction
- Project 88
- S76
- CEPT Projects

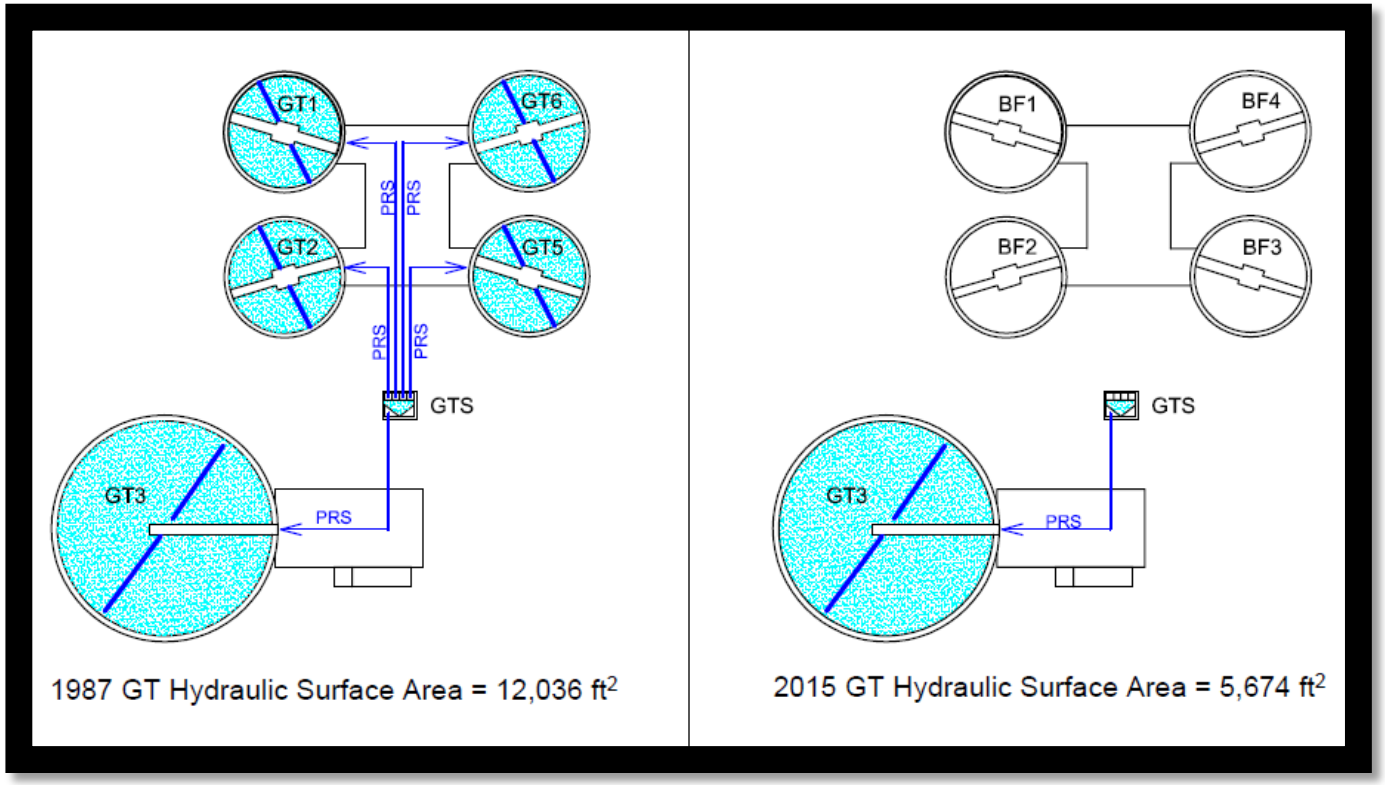
Wet Weather Operation



Primary Sludge Production at SWWTP

- Plant Average Daily Flow of 114 MGD
- Plant Peak Daily Flow of 330 MGD
- CEPT Flow of 110 MGD
- Total Plant Peak Blended Flow of 440 MGD

Flow Stream	Average Flow	Average Solids Production	Peak Flow	Peak Solids Production
Primary Sludge	1,500 GPM	87,820 lbs/day	2,250 GPM	247,700 lbs/day
CEPT Primary Sludge	-	-	1,200 GPM	216,400 lbs/day
Total Flow or Solids to Thickening	**1,500 GPM**	**87,820 lbs/day**	**3,450 GPM**	**464,100 lbs/day**



Existing Gravity Thickener Hydraulic Capacity

- 2015 Max hydraulic capacity based on WEF guidance for existing gravity thickener was between 1,498 and 2,995 GPM. Peak primary production estimated at 3,450 GPM without considering flushing water flow.
- Existing system undersized.

Existing Gravity Thickener Solids Capacity

Total solids production estimated at 464,100 lbs/day

Existing GT surface area is 5,674 SF

Solids flux with just existing GT is 464,100 PPD /5,674 SF= 81.8 PPD/SF… recommended 20-30 PPD/SF

Design additional GT with same dimensions, flux would be 40.9 PPD/SF which still exceeds recommended solids flux rate

Detailed Design

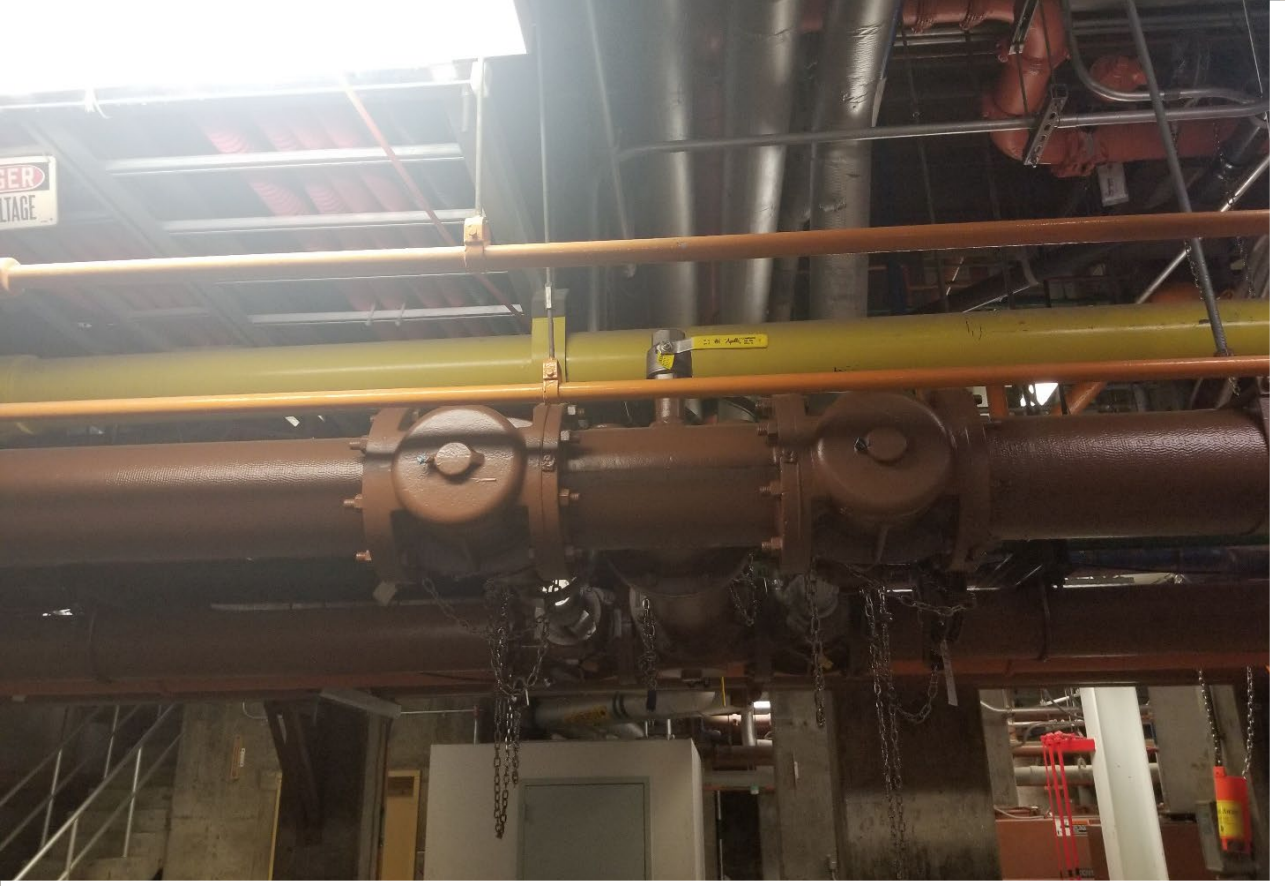
Detailed Design

Thickened Primary Sludge Pumping Design

- Variable sludge thickness and system pressure
- Glass lined ductile iron sludge piping
- Intermediate drain valves for maintenance
- Progressing cavity pump orientation (maintenance)
- Flow meter accuracy vs. head loss
- Flushing water considerations
- Pressure relief on thickened sludge line (rupture pins)

Existing Pump Orientation

Thickened Sludge Flow Meter

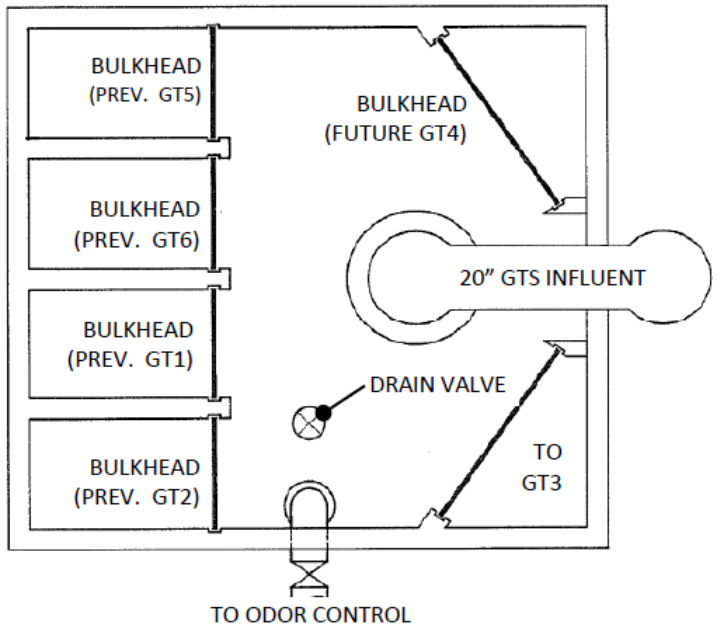


Thickened Sludge Flushing Connections

Rupture Pin Valves

Flushing Water Control Improvements

- Replaced 20” modulating butterfly valve
- Utilized 16” modulating plug valve for fine tuned flow control
- Existing flushing water flow control was limited due to the existing splitter box

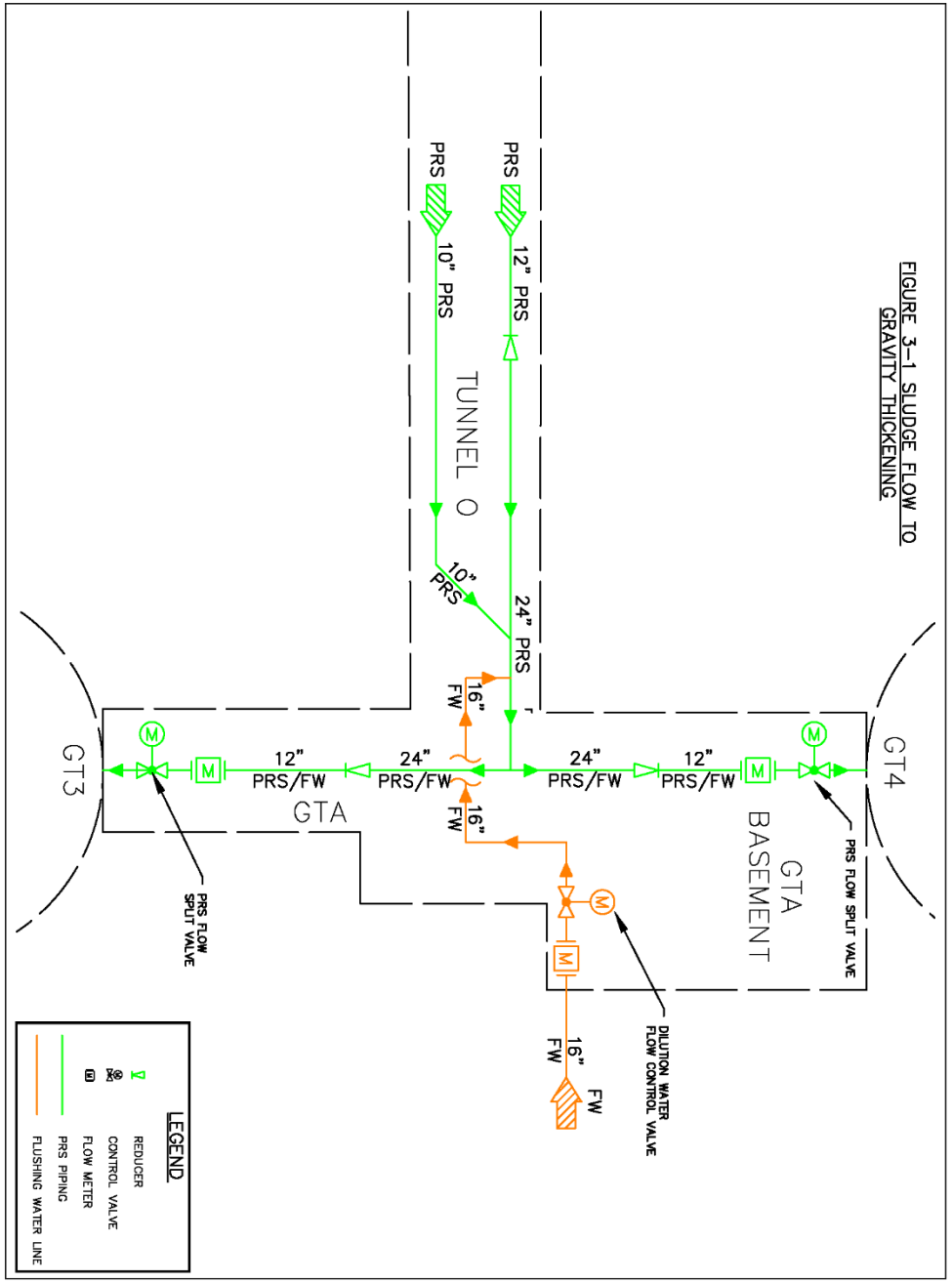


Existing Splitter Box

- Existing splitter box was limited hydraulically to ~2,600 GPM and acted as a bottleneck for flow to the single gravity thickener
- System of flow metering and control was devised with in pipe mixing of dilution water to address splitter box limitations.

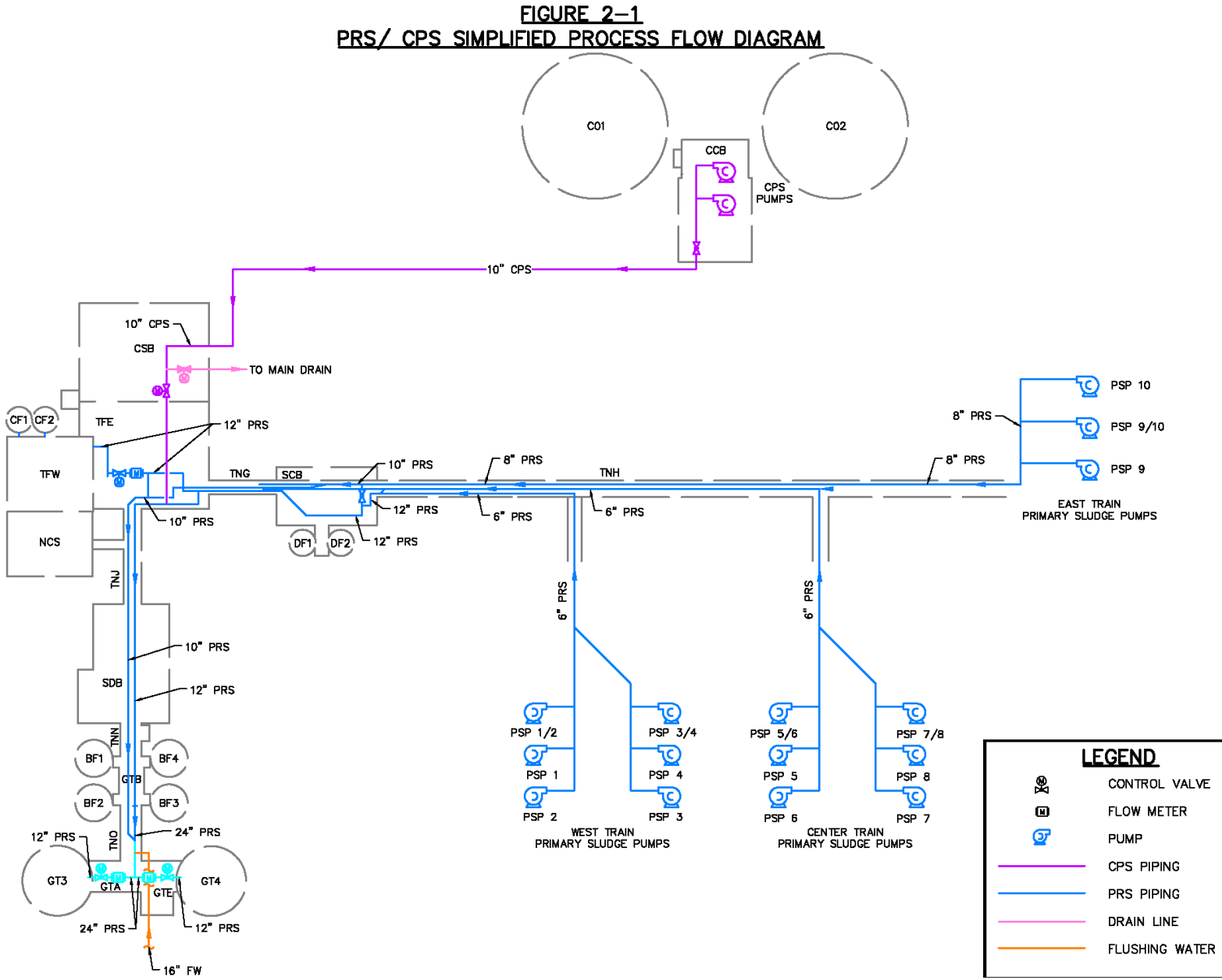
Flow Control Valve & Meter Assemblies

- Flow control can be implemented in multiple ways
- Control valves were selected over a gravity flow splitter box to split the primary sludge flow between the two gravity thickeners



Overall System Primary Sludge Piping

- Modeling
- New 10” Primary Sludge Line
- CEPT Primary Sludge Piping
- GT3/GT4 Flow Split
- Connection to Existing Thickening Centrifuges

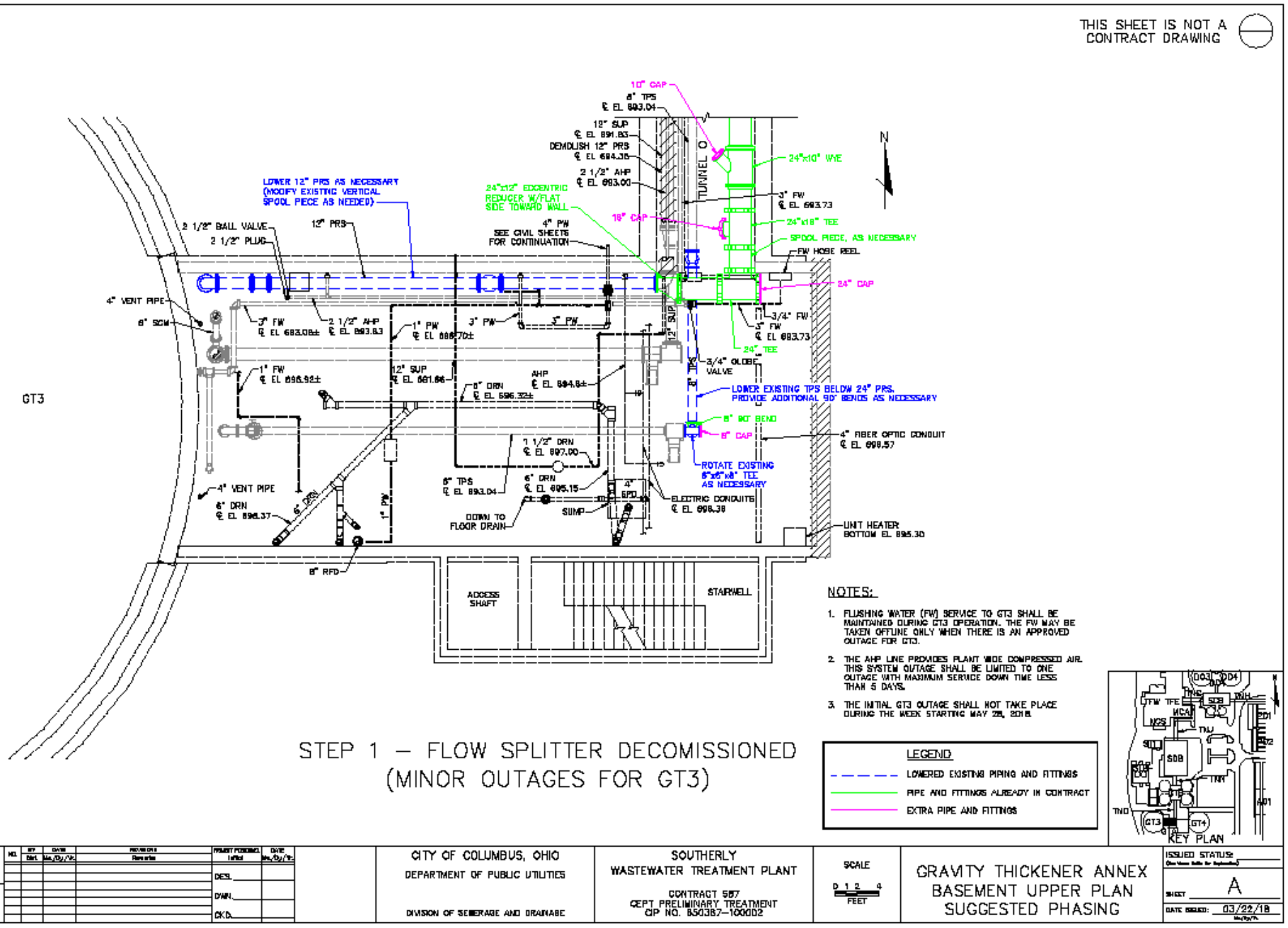


Construction

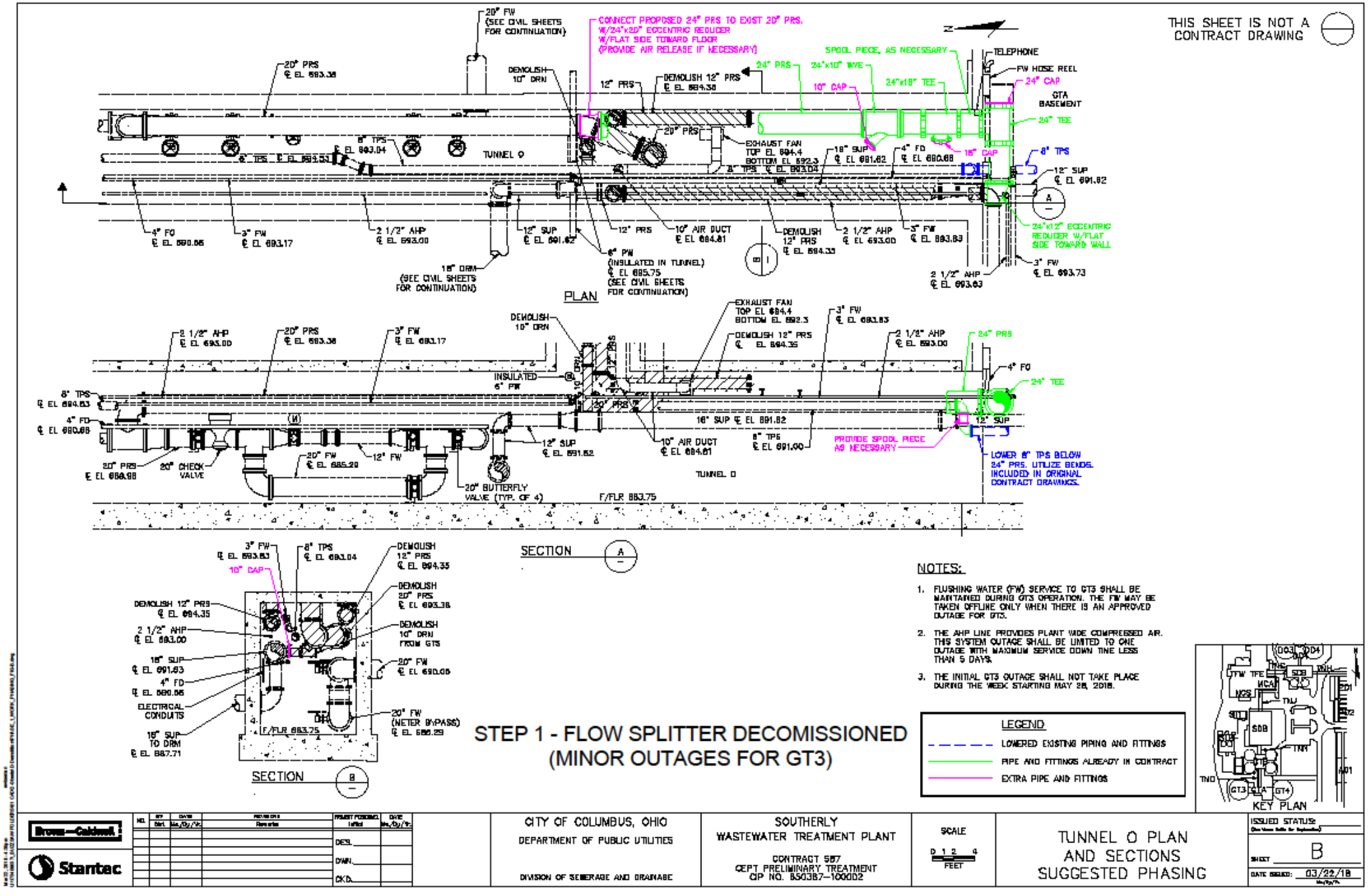
Construction Sequence

- Demolition phasing
  - Splitter box
  - Flushing water
  - Thickened primary sludge piping

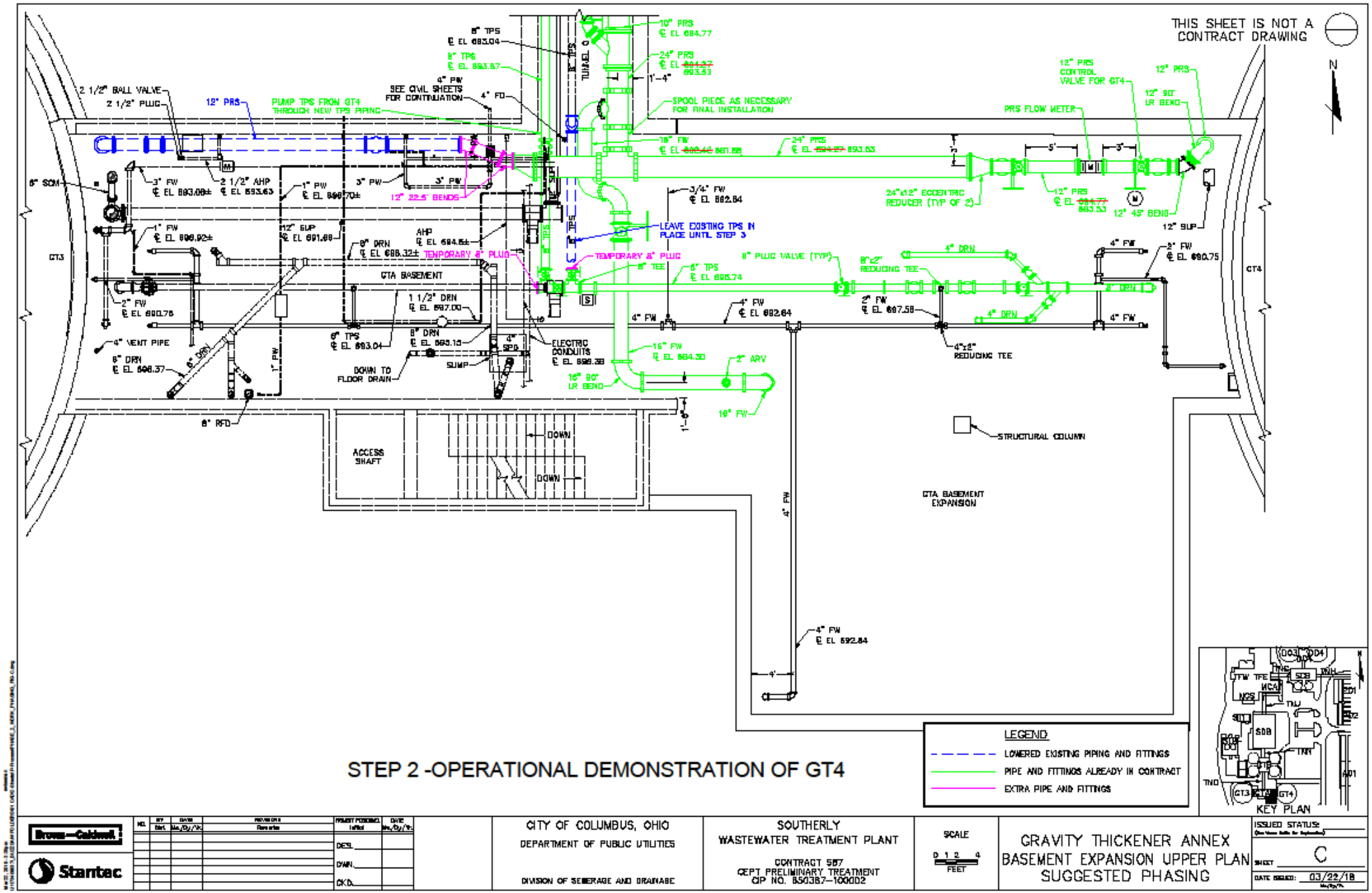
Flow Splitter Decommissioning



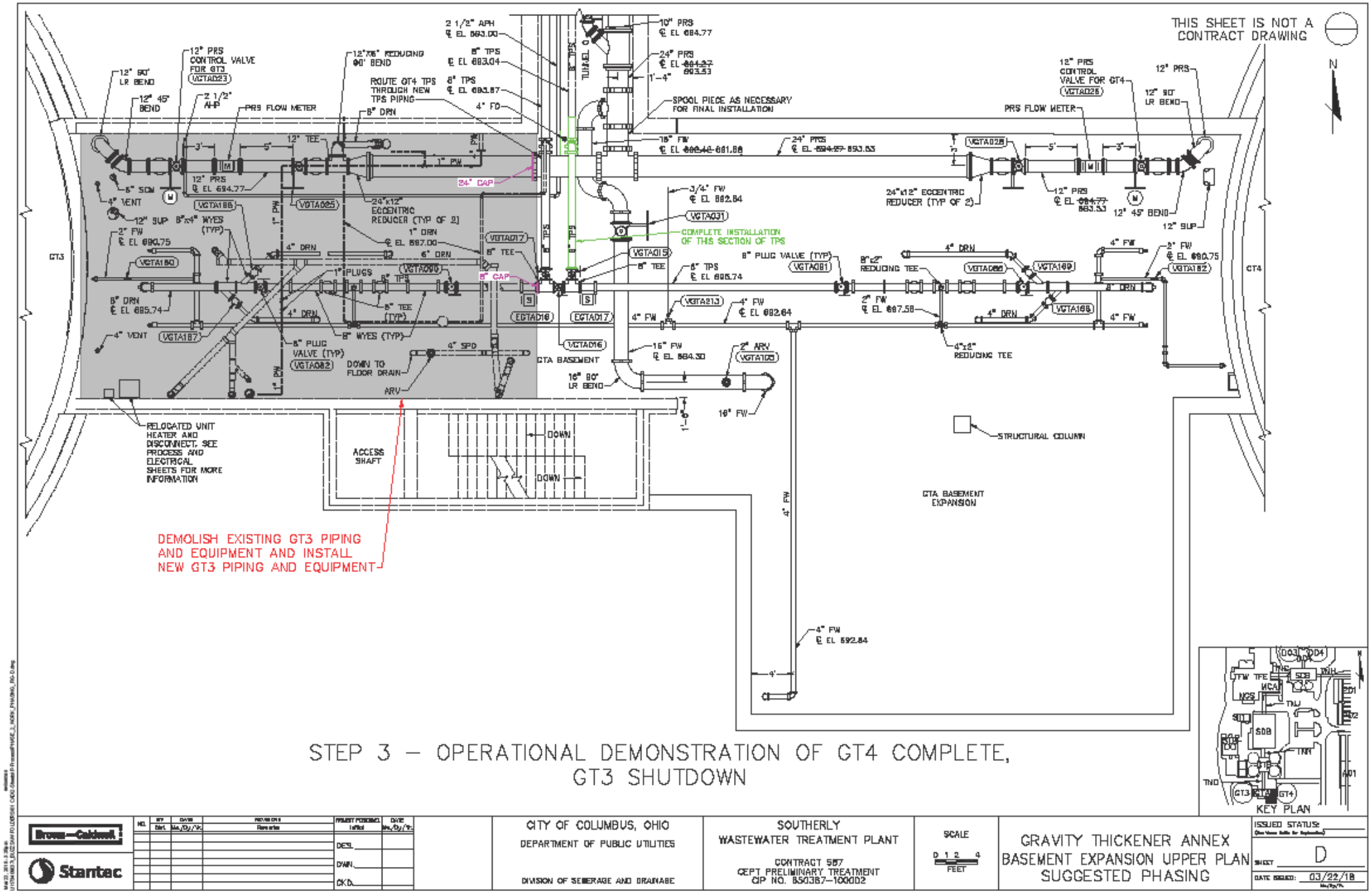
Flow Splitter Decommissioned



New Gravity Thickener Op Demo

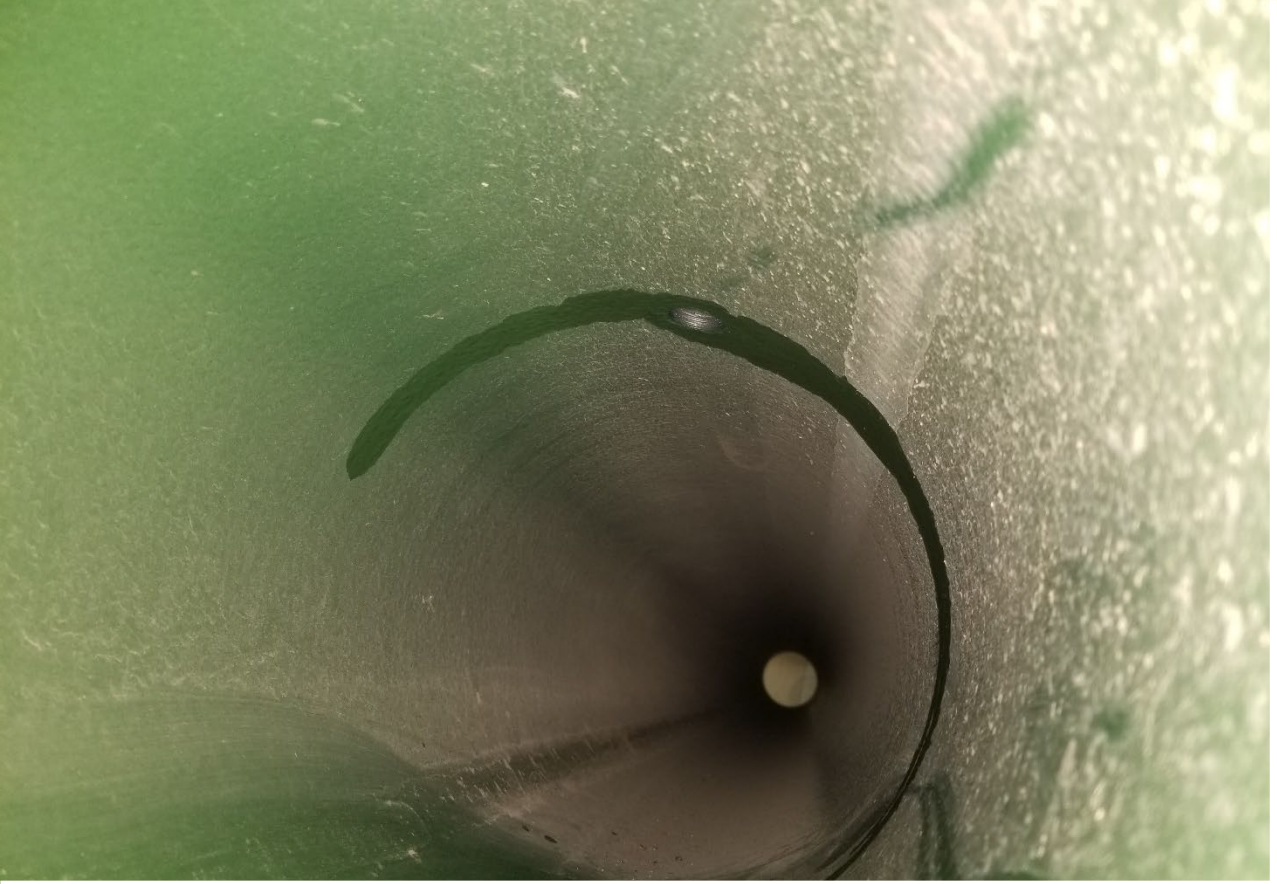


Old Gravity Thickener Offline



Construction Lessons Learned

Complex Piping Layout



Glass Lining

Temporary Sludge Piping

This image is of the interior of temporary PVC thickened sludge piping after 9 months of operation

Mechanism Comparison

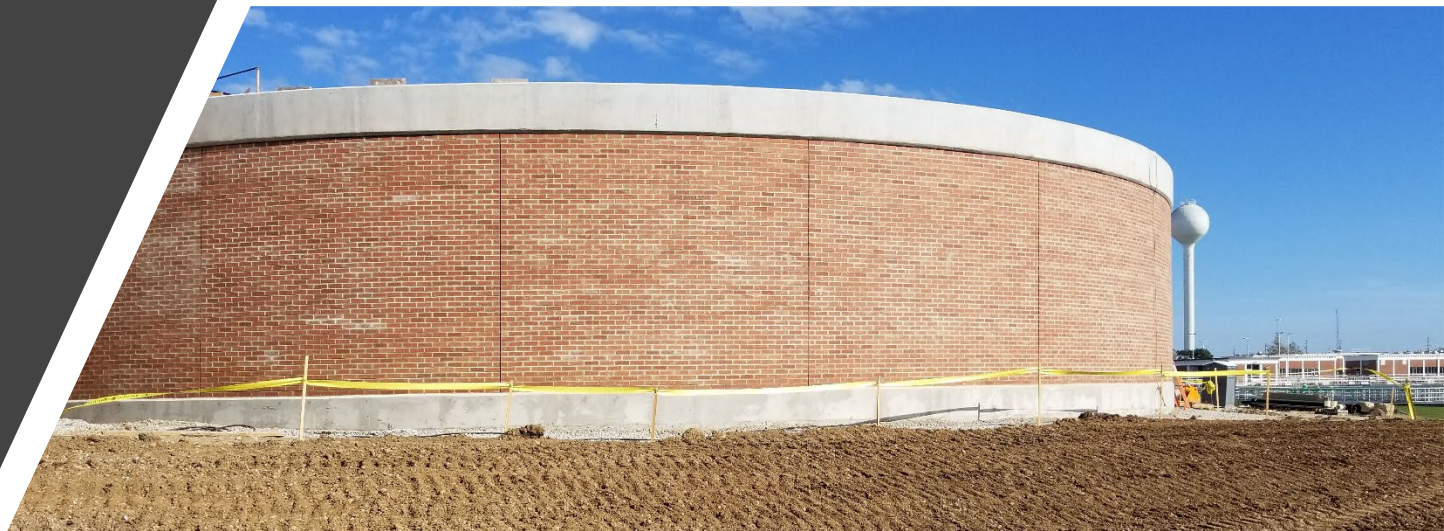
Start-up and Operational Demonstration

Start-up Execution

- Temporary outage required for tunnel piping arrangement changes
- First attempt stopped by drain overflow
- Drain line jetted and brought back in service
- Successfully drained after jetting completed

Current Status

- Operational demonstration of the new gravity thickener complete 6/23/19
- Existing gravity thickener equipment under demolition
- New gravity thickener in regular operation



Final Operational Plan

- Planned operation of tandem gravity thickeners
- Utilization of thickening centrifuges (D-12s)
- Flow balancing control scheme and CPS flow introduction

Lessons Learned

- Gravity thickening is a cost effective, low maintenance method of solids thickening that consistently preforms under variable loading scenarios
- There is a need for detailed construction sequencing plans that consider space limitations
- Plans should be in place to verify adequate pressure ratings for existing process components
- There is more than one way to split/control incoming flow
- Glass lined valves have a substantial lead time

Questions?