Brown AND Caldwell

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Are your Digesters Burping, Frothing, or otherwise not Behaving?

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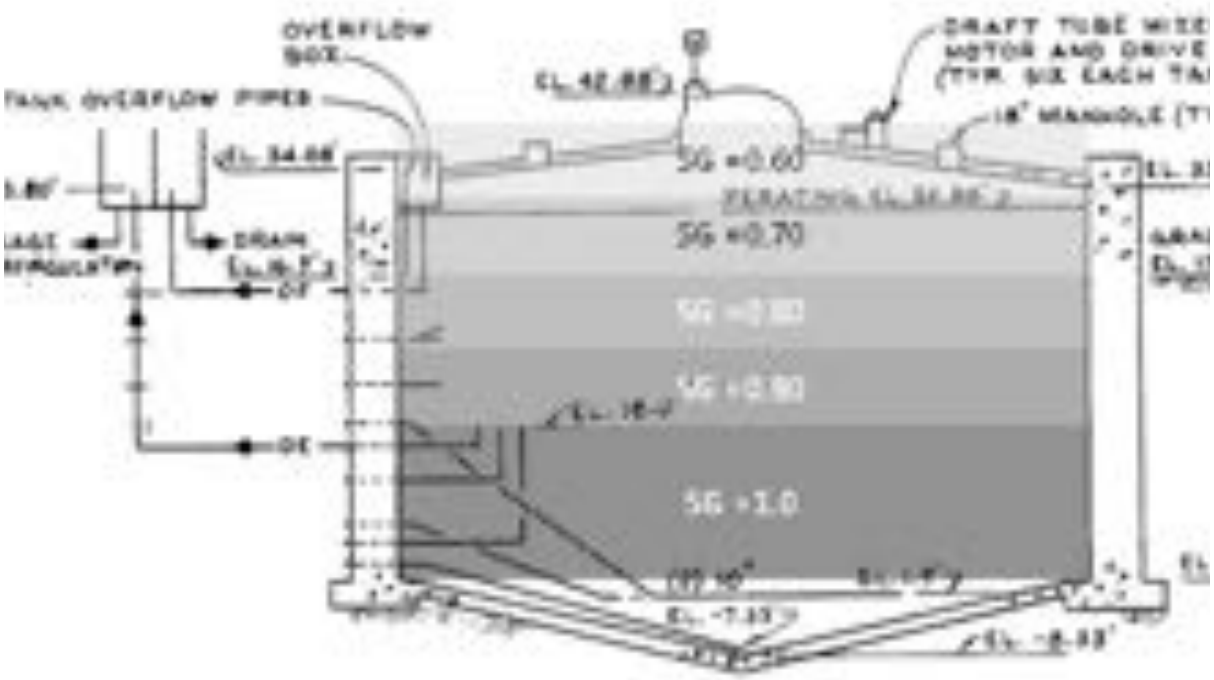
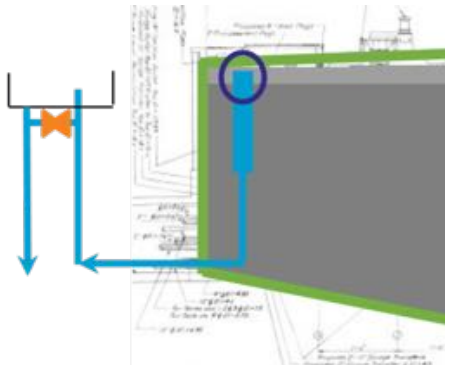
Christopher Muller, PhD, P.E.
Brown and Caldwell

Brown and Caldwell:
John Willis, *Tom Chapman; Jonathan Keaney; Gary Newman;*
Lance Salerno and Perry Schafer
NYCDEP: *Luis Carrio and Peter Pianelli*
Nashville Metro: *Taft McNeal*





Presentation Outline

- Is digesting sludge specific gravity of one?
- What are the process implications?
- Are there design modifications that can help reduce the impact?

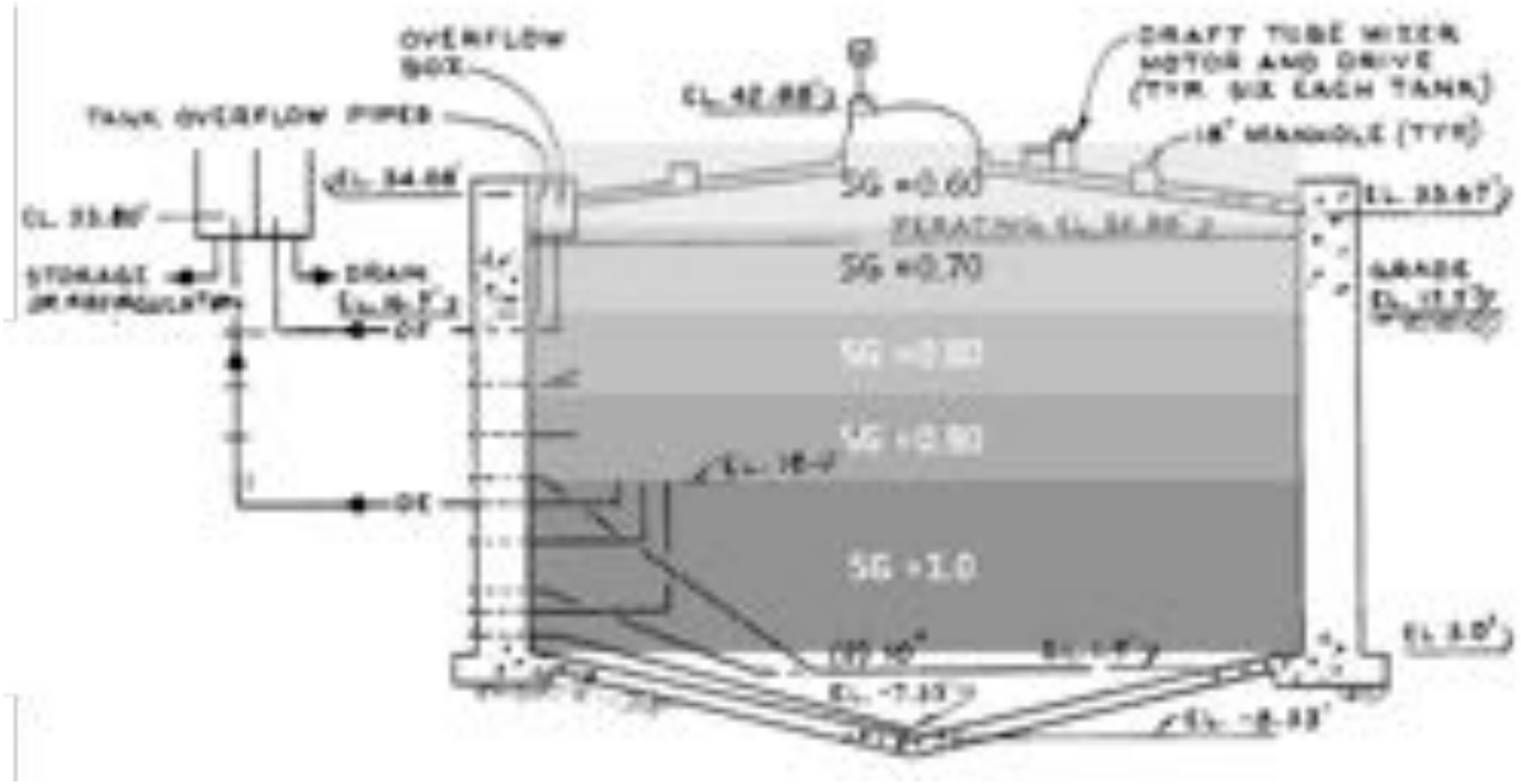
What is going on inside anaerobic digesters?

- Digesters are biologically complex, relying on a series of different microbial communities to reduce sludge mass.
- Not readily observable like open clarifiers or aeration basins
  - View ports
  - Cameras –DCWater has a new camera system inside the digesters
- This means that **we typically make assumptions** about the environment within the digester.
  - Completely mixed
  - Digested sludge specific gravity is close to 1

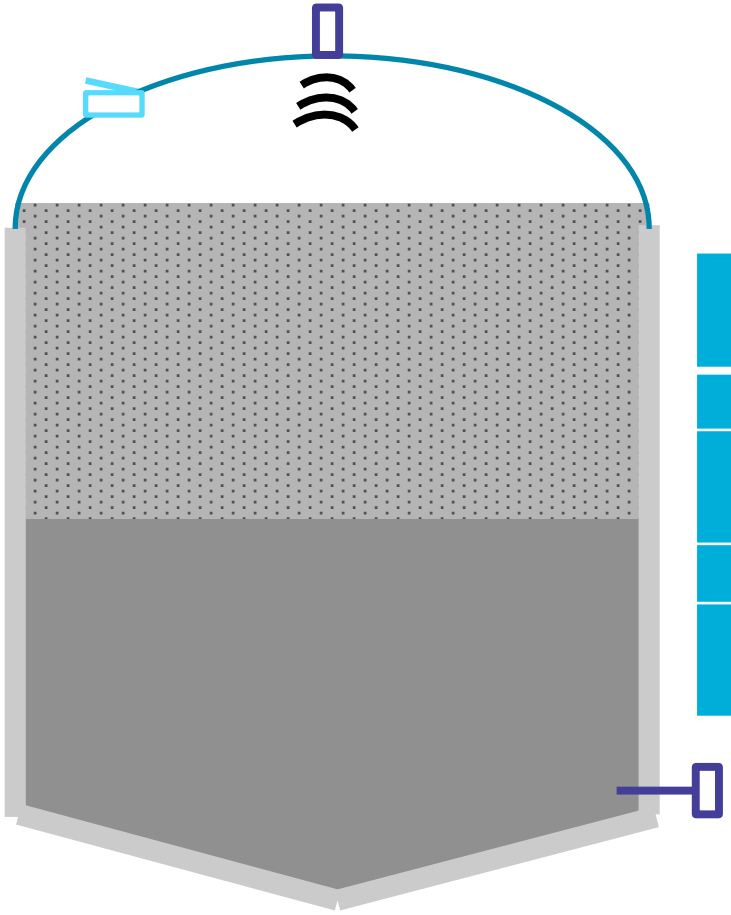
Why might we think that SG = 1 is not correct?

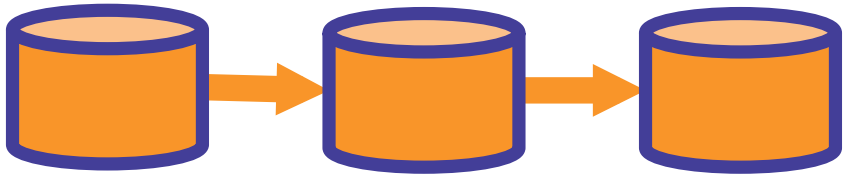
- Digesters produce significant amounts of digester gas as they convert raw sludge to biomass.
- Research on volume expansion has shown that at different viscosities the extent of gas hold up in the sludge changes
  - Higher viscosity more gas hold up, lower the intensity of mixing the lower the overall viscosity of the sludge.
  - Mixing helps convey gas out of the sludge

What may be going on in your digesters



OWASA (Chapel Hill, NC) Measurements

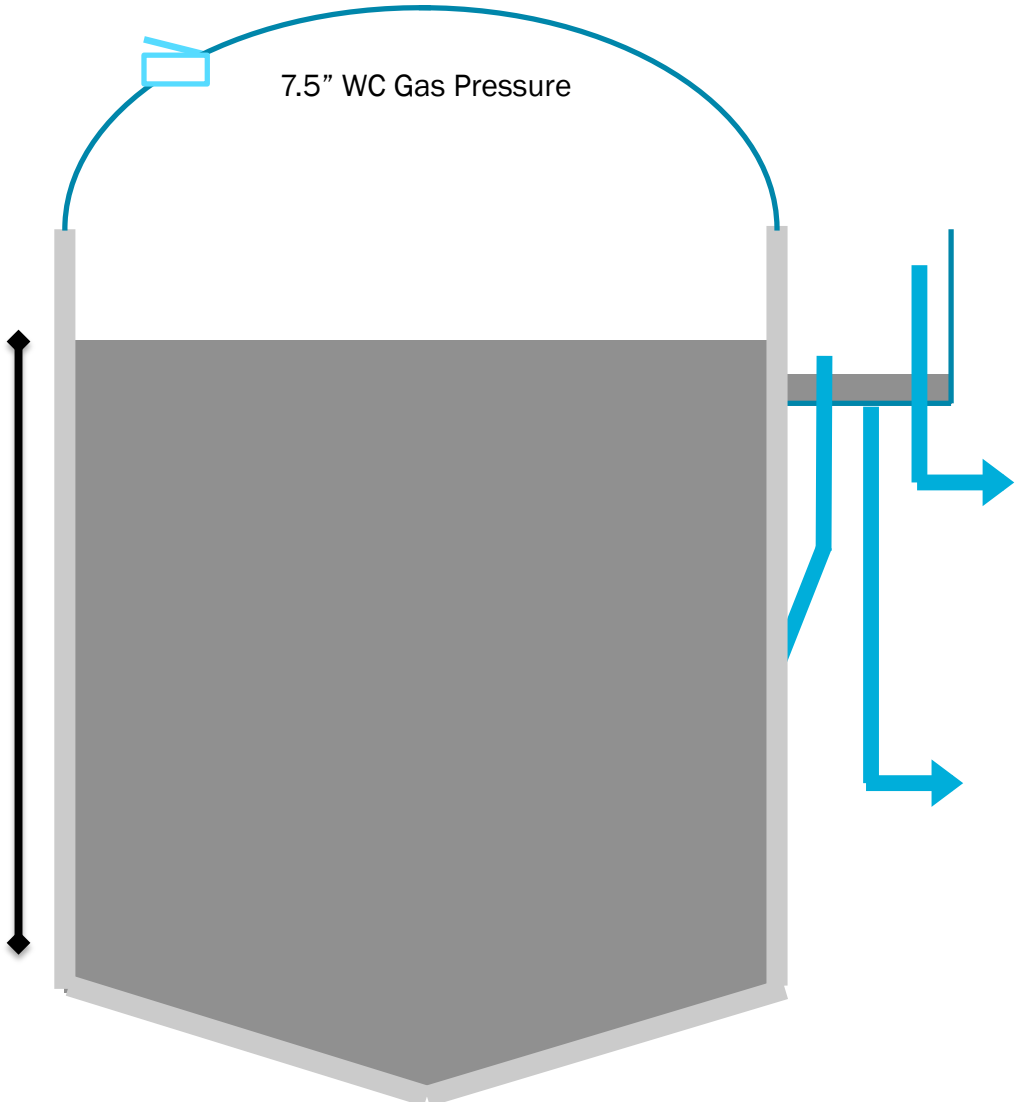




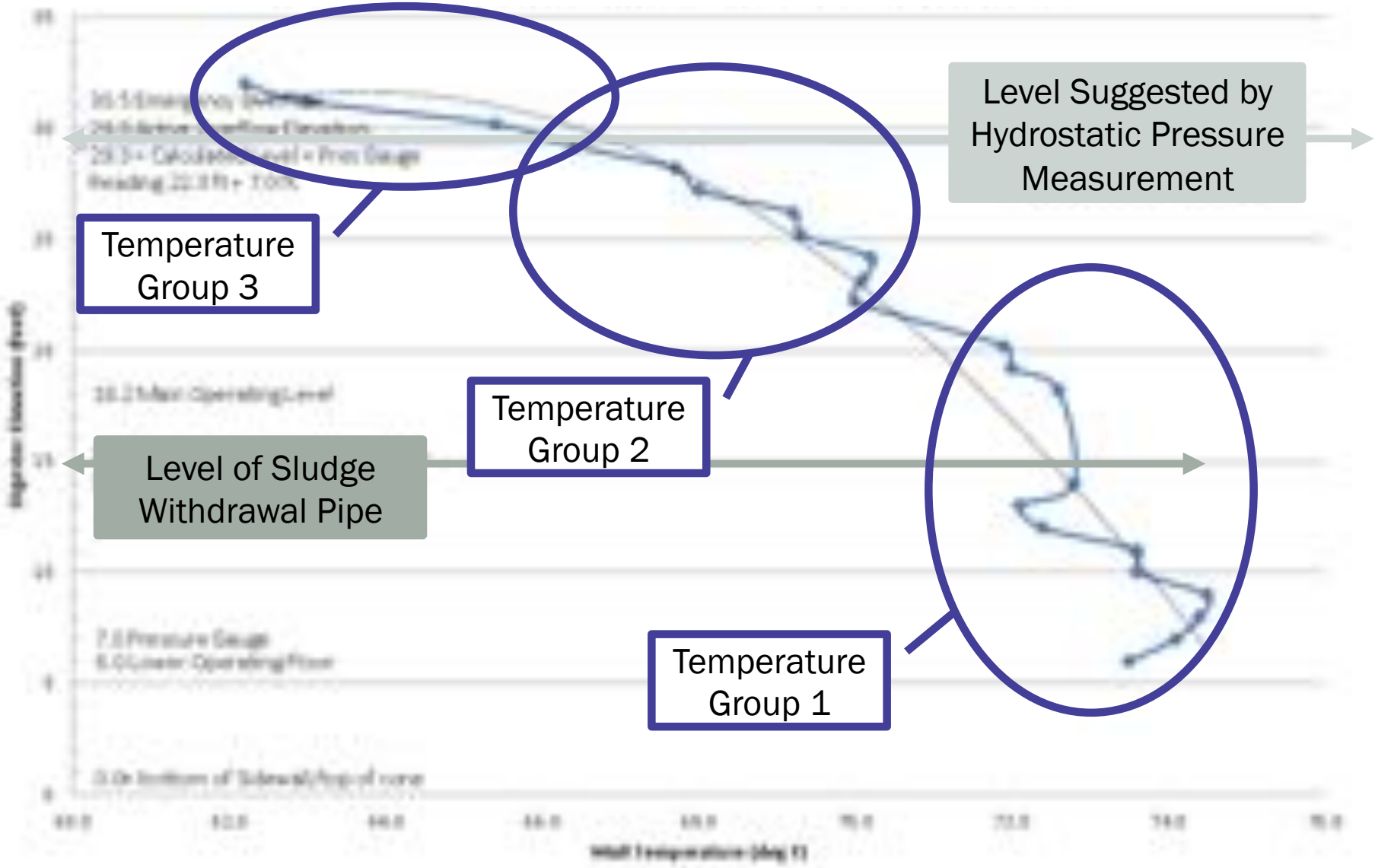
	1st Stage	2nd Stage	3rd Stage
Pressure (ft WC)	22.6	19.3	15.8
Radar Surface (ft WC)	30.4	23.3	19.0
Difference (ft)	7.8	4.0	3.2
Ave. Specific Gravity	74.5%	82.6%	83.2%

Tallman Island digester wall temperature profile

Would expect wall temperature to be fairly uniform if completely mixed and uniform temperature inside



Tallman Island External Wall Temperature



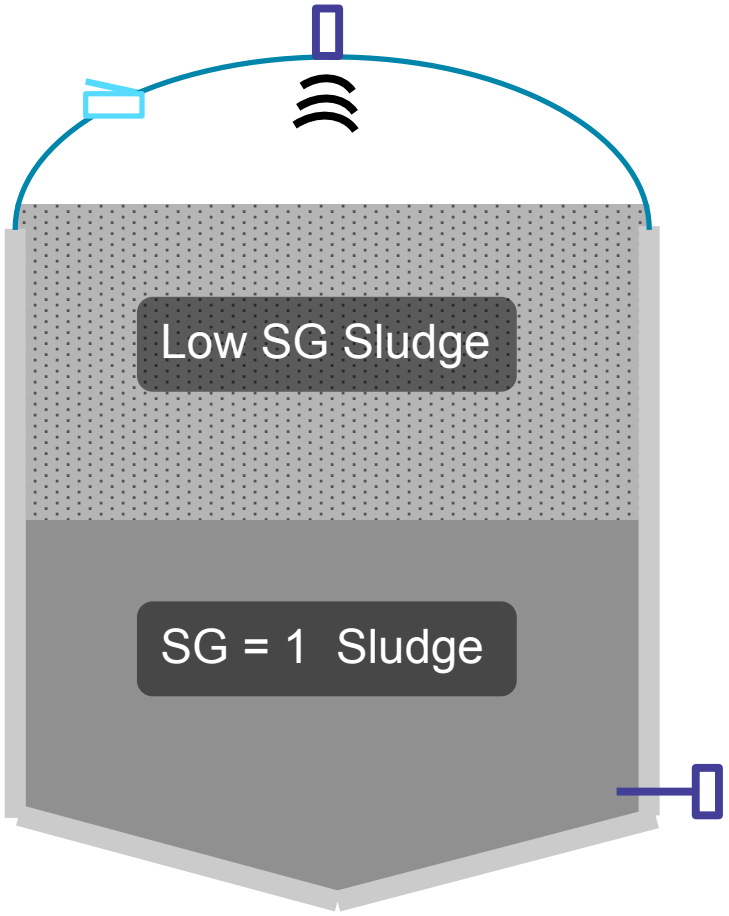
Why do we care?

- Process implications
  - HRT ≠ MCRT
    - Mass in the system divided by mass wasted
    - Biosolids regulations written around MCRT
    - Could you see deteriorated performance
  - Organic loading can be higher than expected
- Operations and facilities impacts
  - Surcharging of digester cover
  - Tank overflows

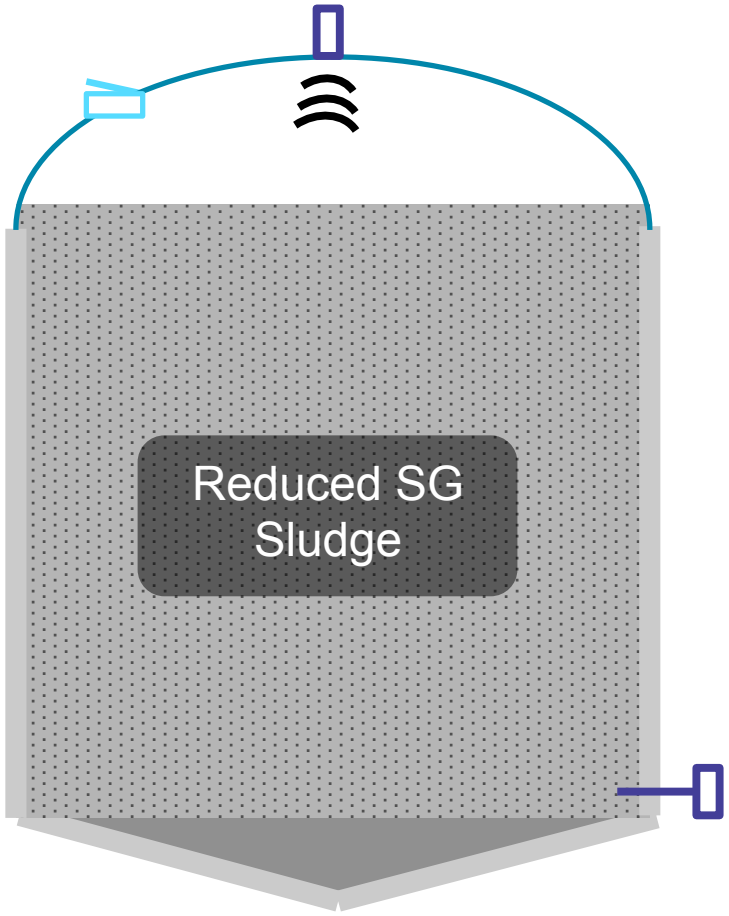
Sludge escaping from the fixed cover digesters in Nashville

Sludge on the covers of Hunts Point digesters

Theoretical analysis of SG impacts on digester process metrics



Reality is likely a stratified system

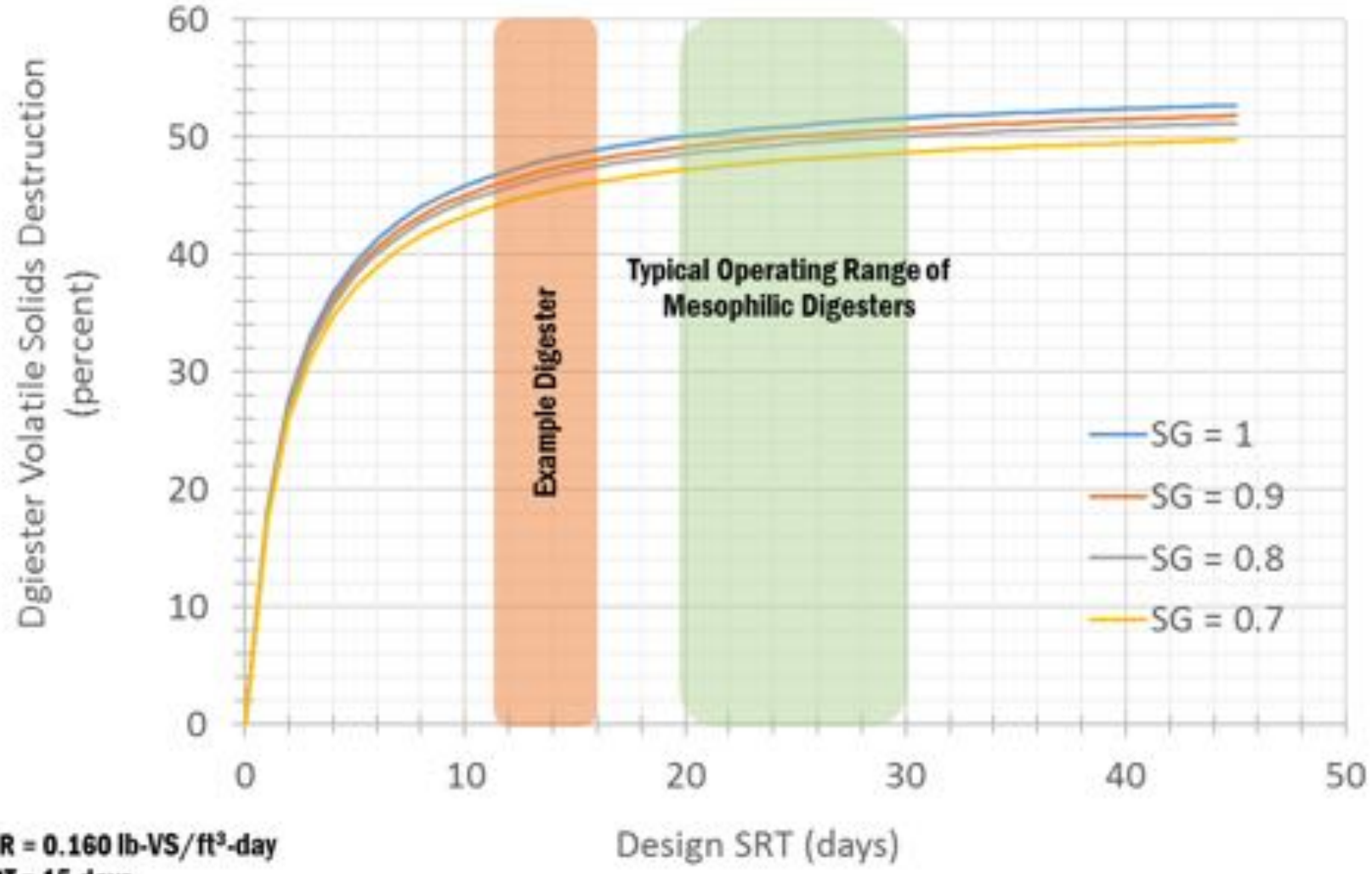


Simplified Model Used

Heavily loaded digester example

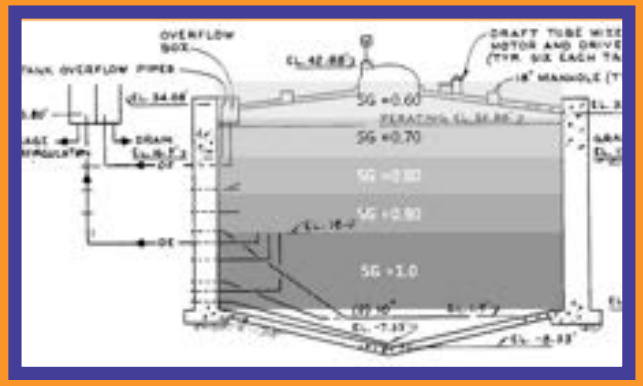
Theoretical MCRT = 15 days
Theoretical OLR = 0.16 lb-VS/ft^3-day

A detectable reduction in VSr may be difficult to see on a daily basis



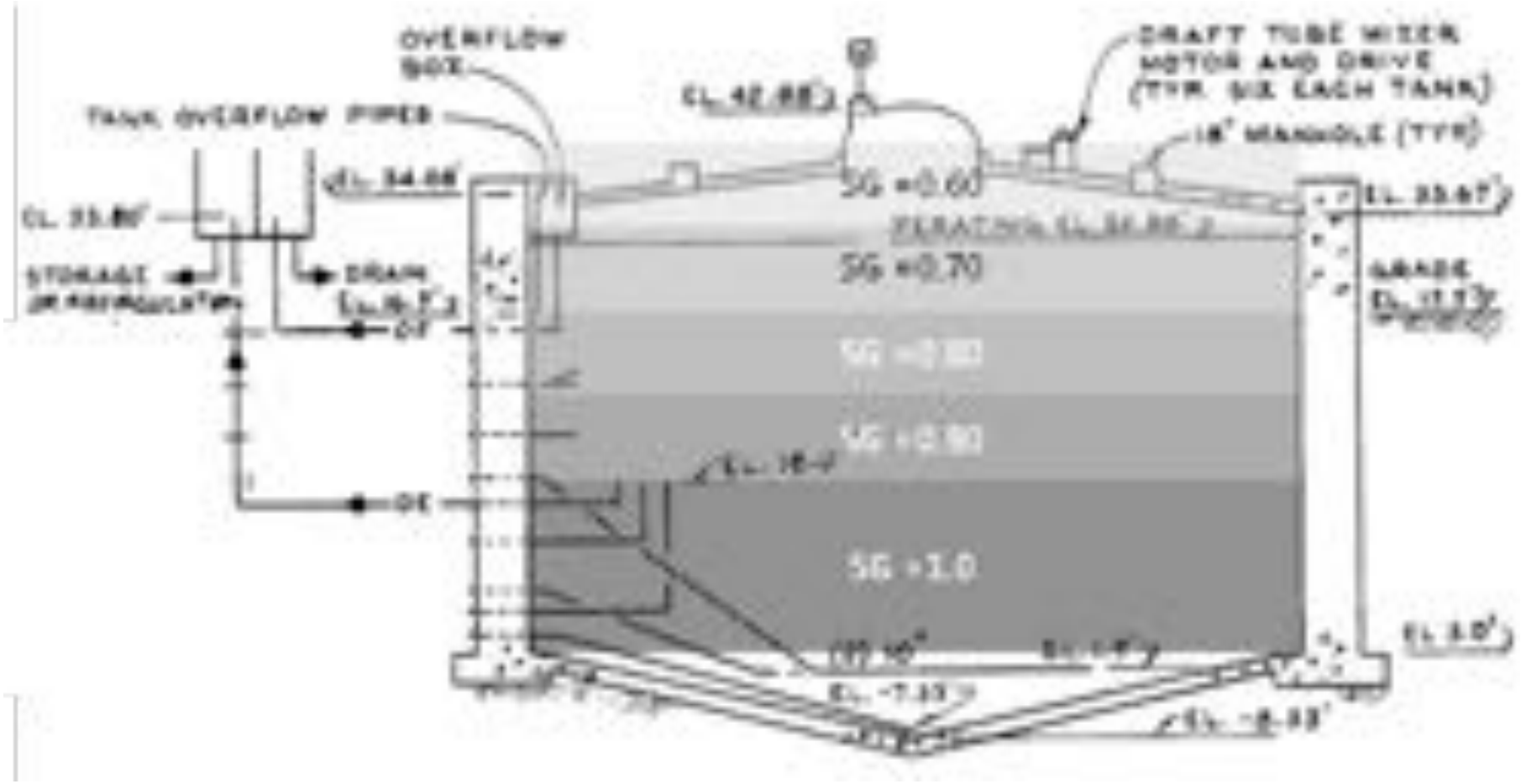
Potential process impacts summarized

- Reduced active volume can result in overloading at apparent loadings below stated design conditions.
  - Especially if stratified and upper portion of the tank is not available.
- Reduced residence time can result in a reduction in VSr resulting in increased biosolids production.
- Reduced residence time could impact biosolids stability (odors)

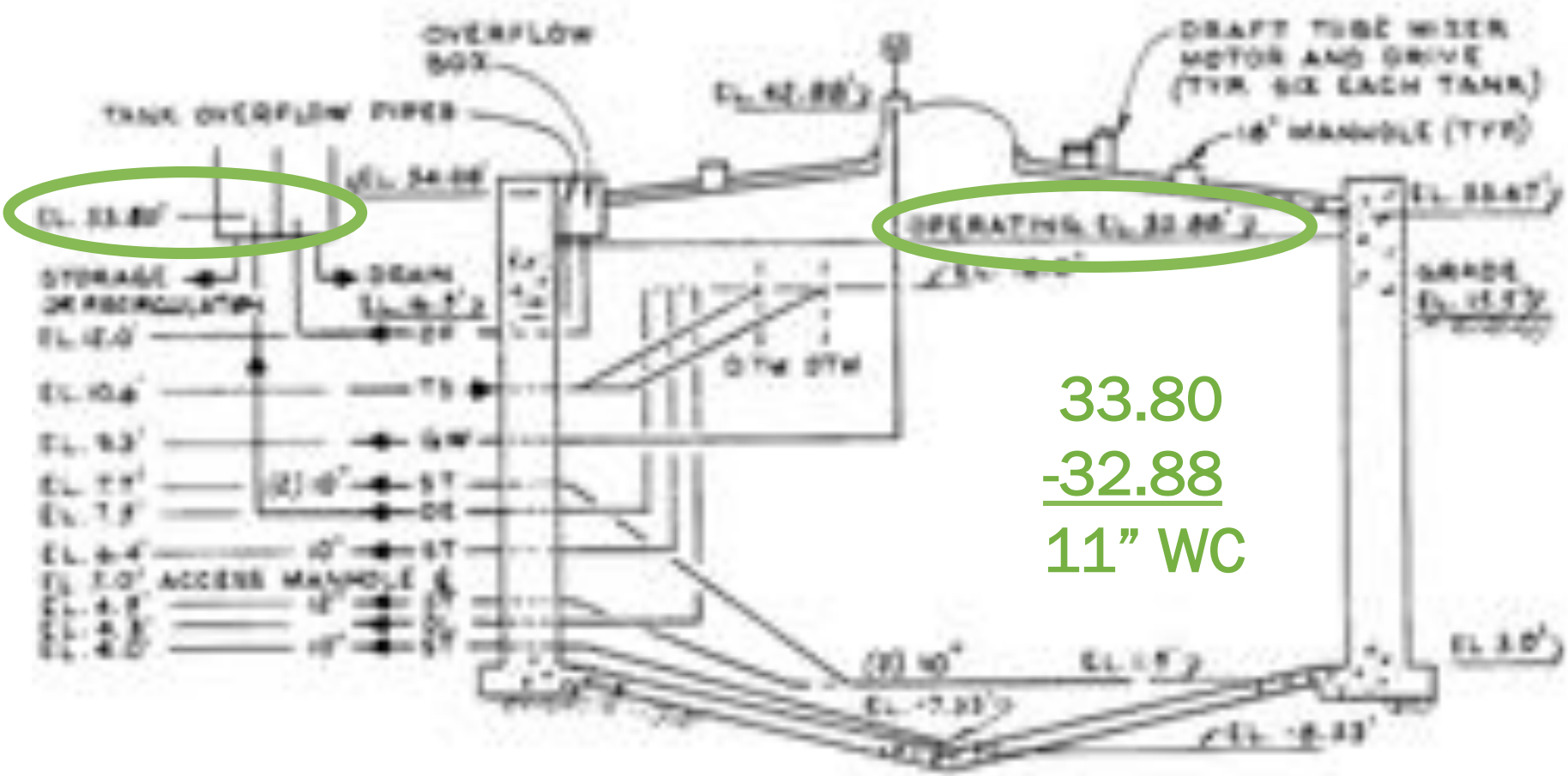


How do we get low-specific-gravity digesting- sludge in our digesters

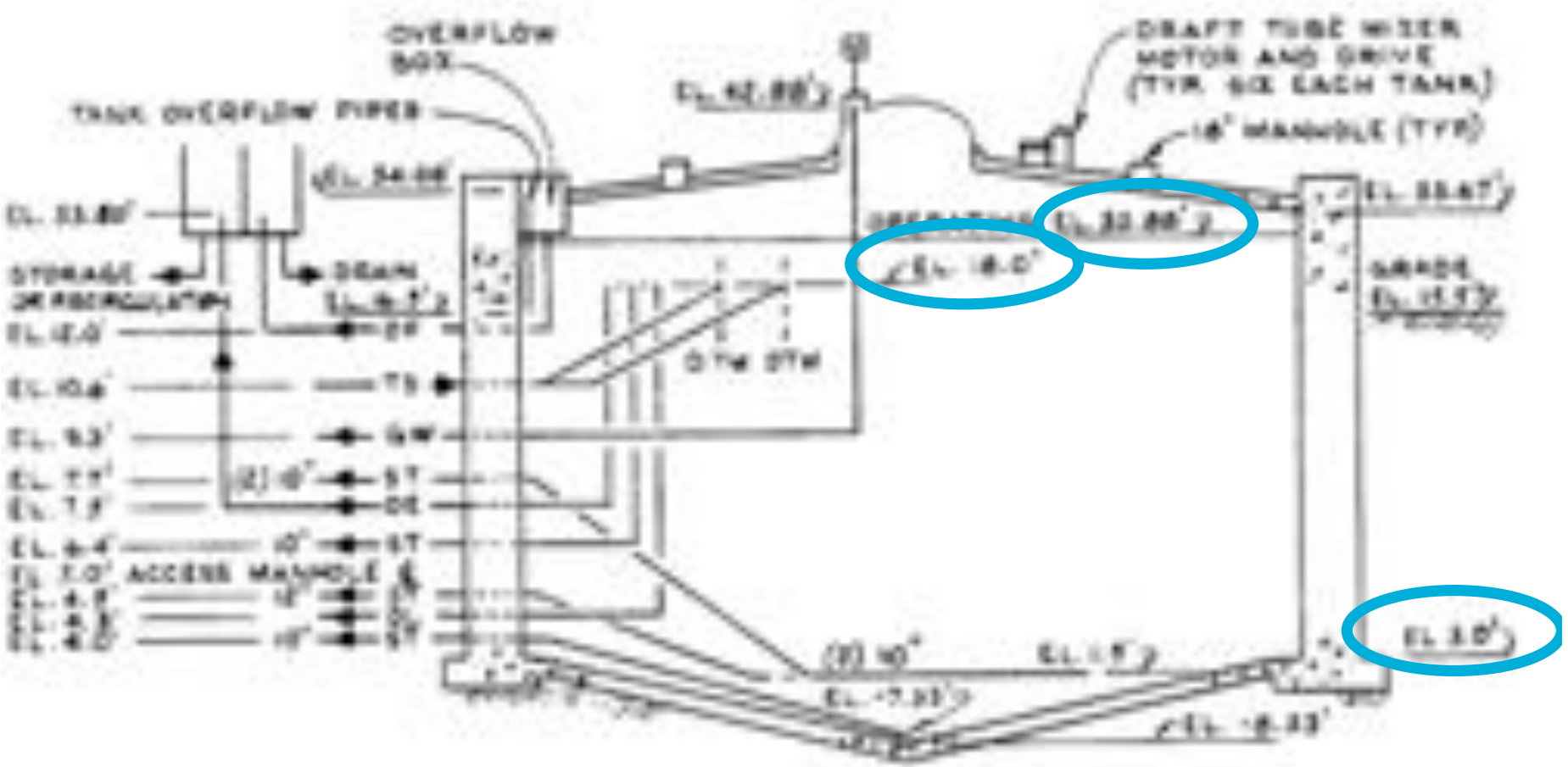
The idea revisited…



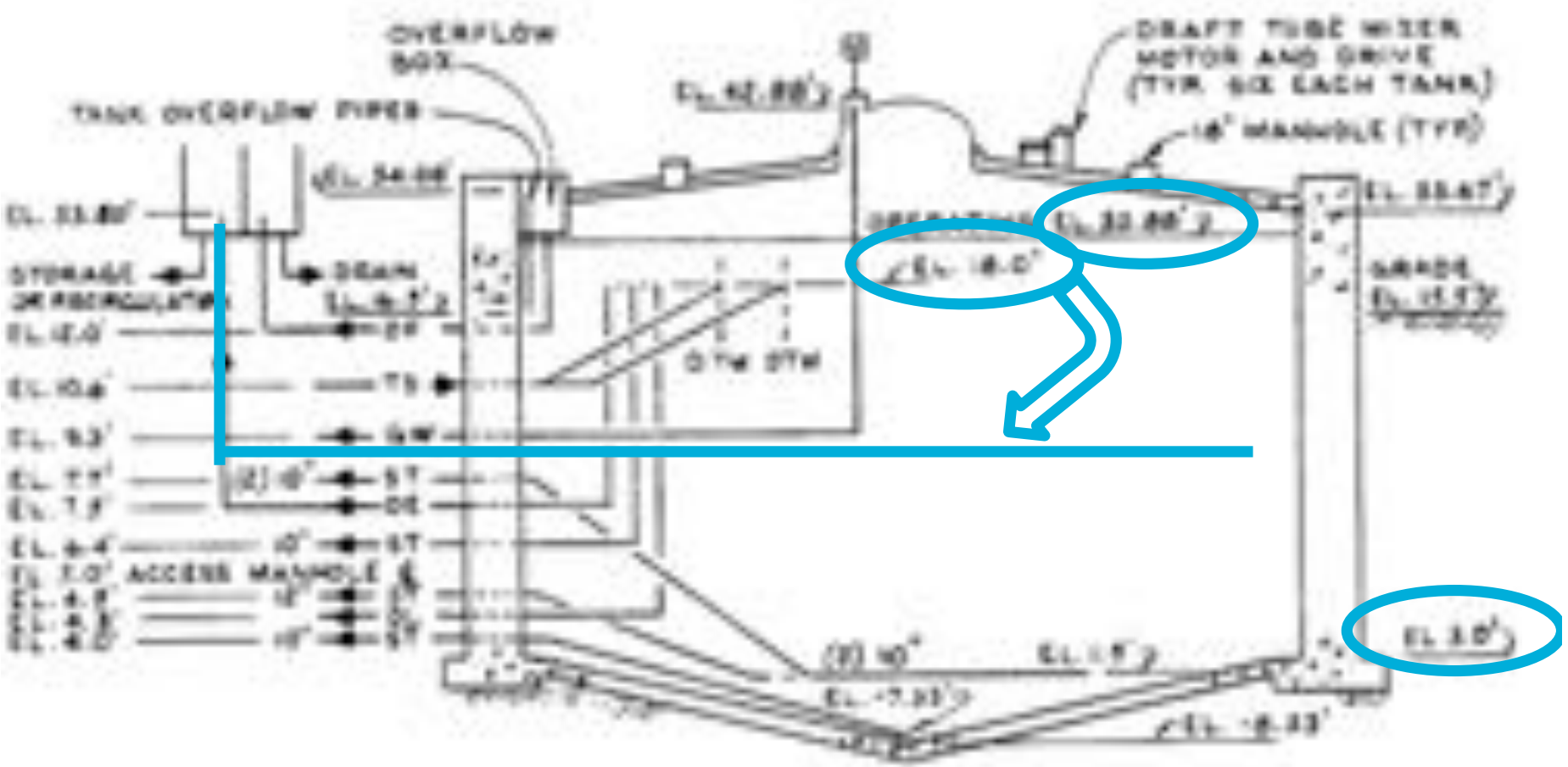
A design common to many digesters suggests we did not consider reduced SG.



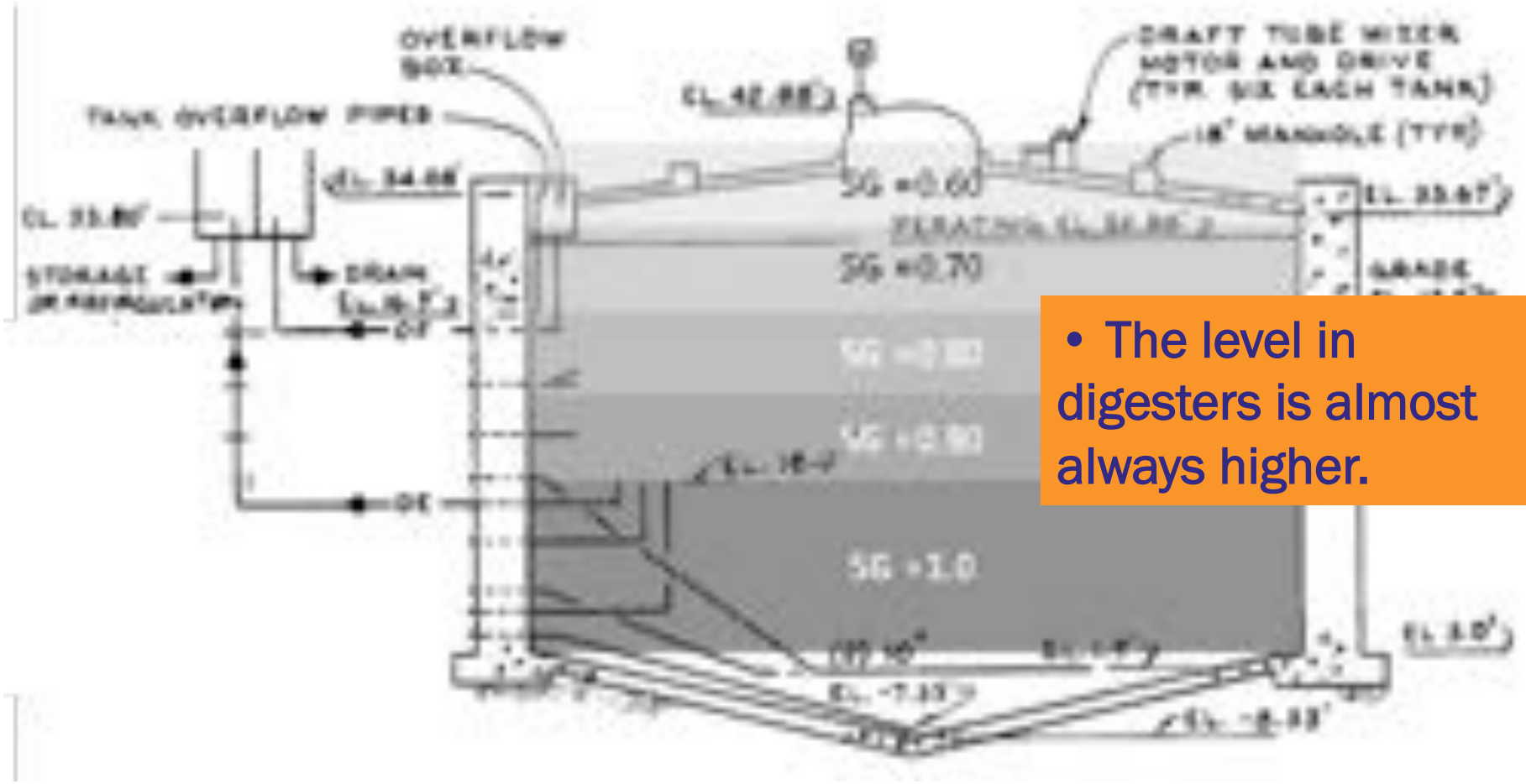
Just to Note: This is Clearly NOT to Scale…



Our draw off should look more like this



What does this cause???



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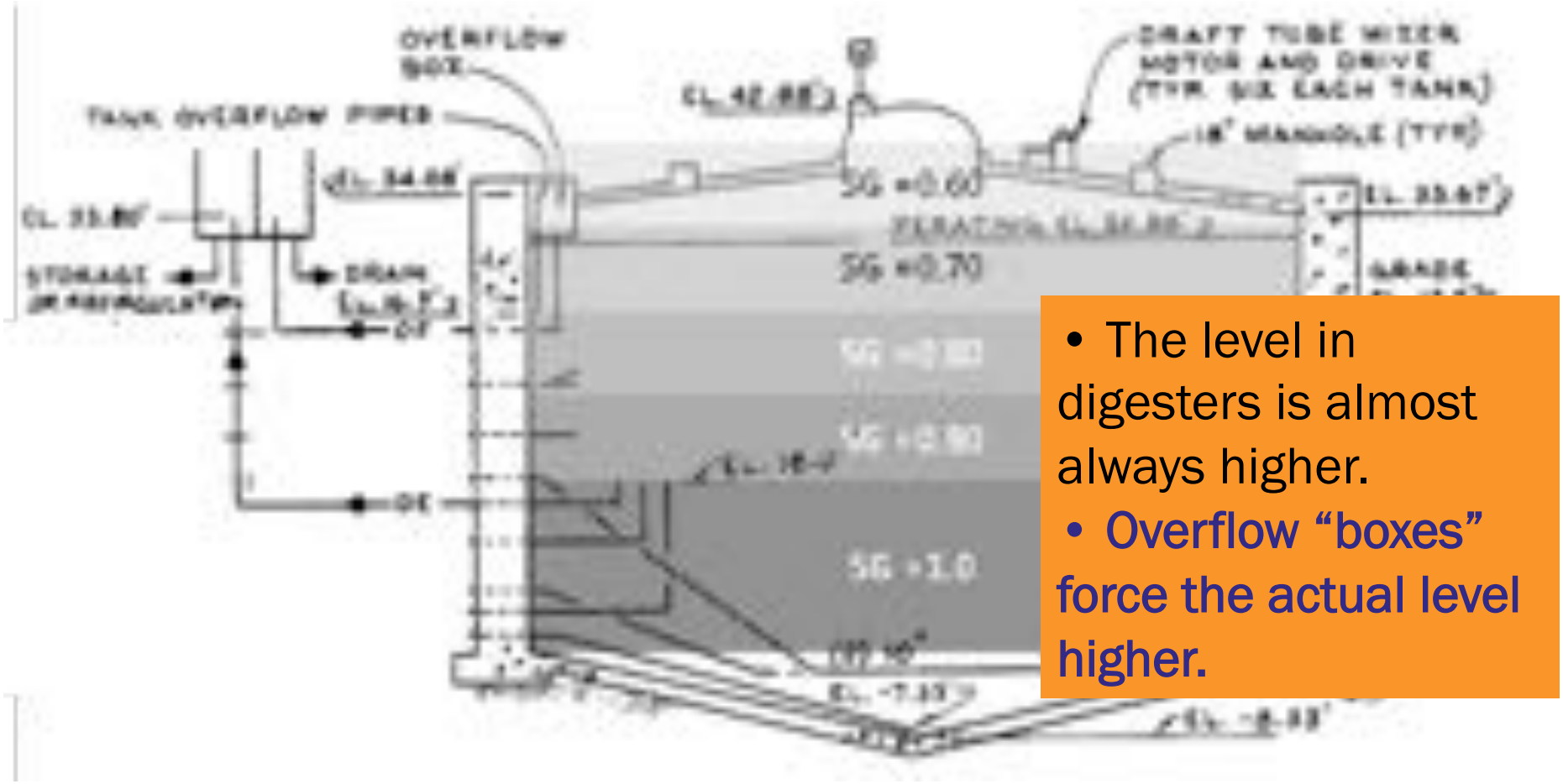
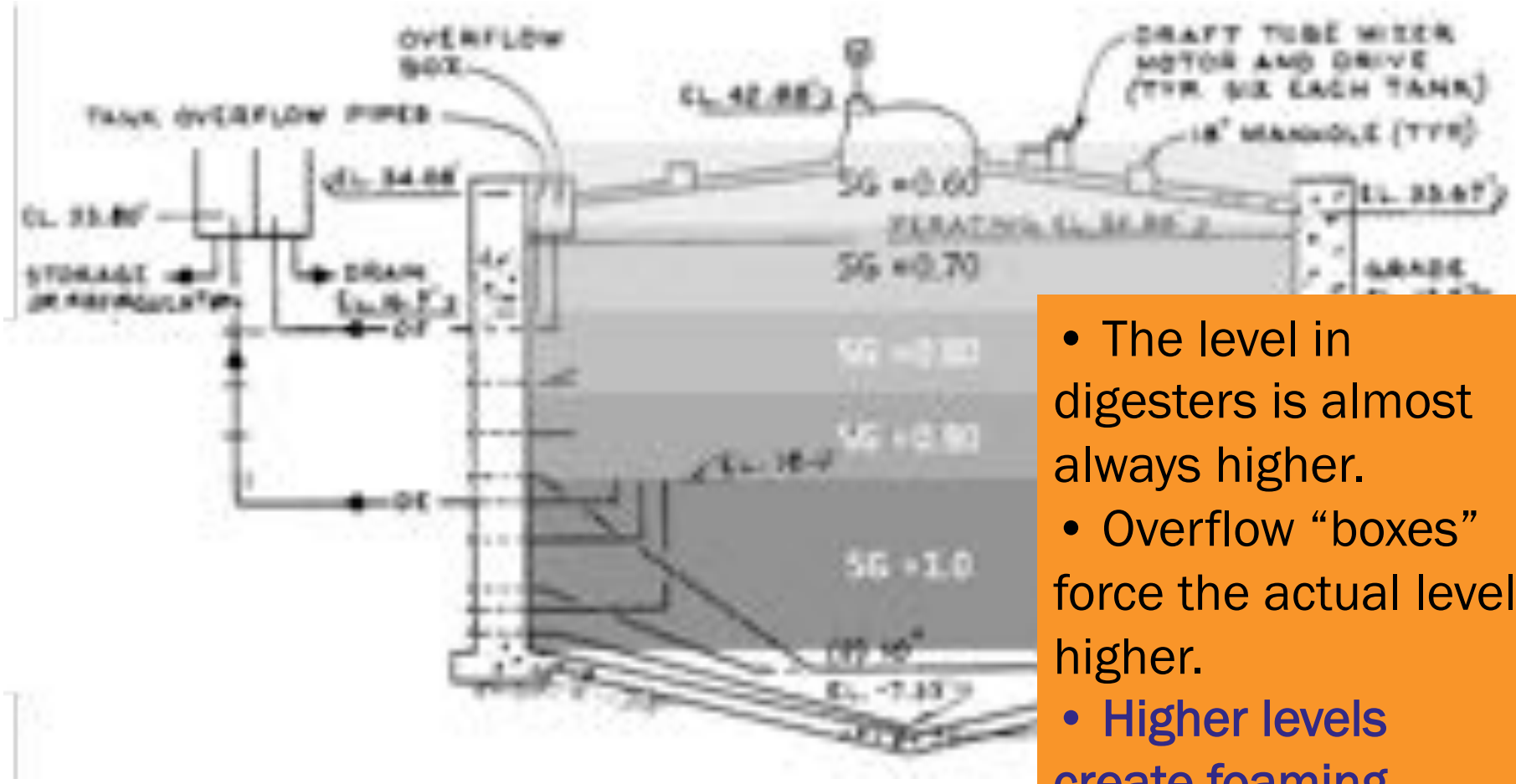


- The level in digesters is almost always higher.
- Overflow "boxes" force the actual level higher.

What does this cause???



- The level in digesters is almost always higher.
- Overflow "boxes" force the actual level higher.
- Higher levels create foaming episodes.

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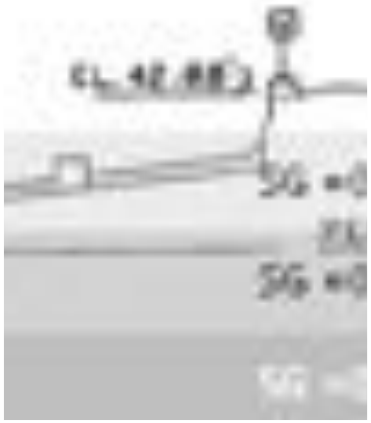
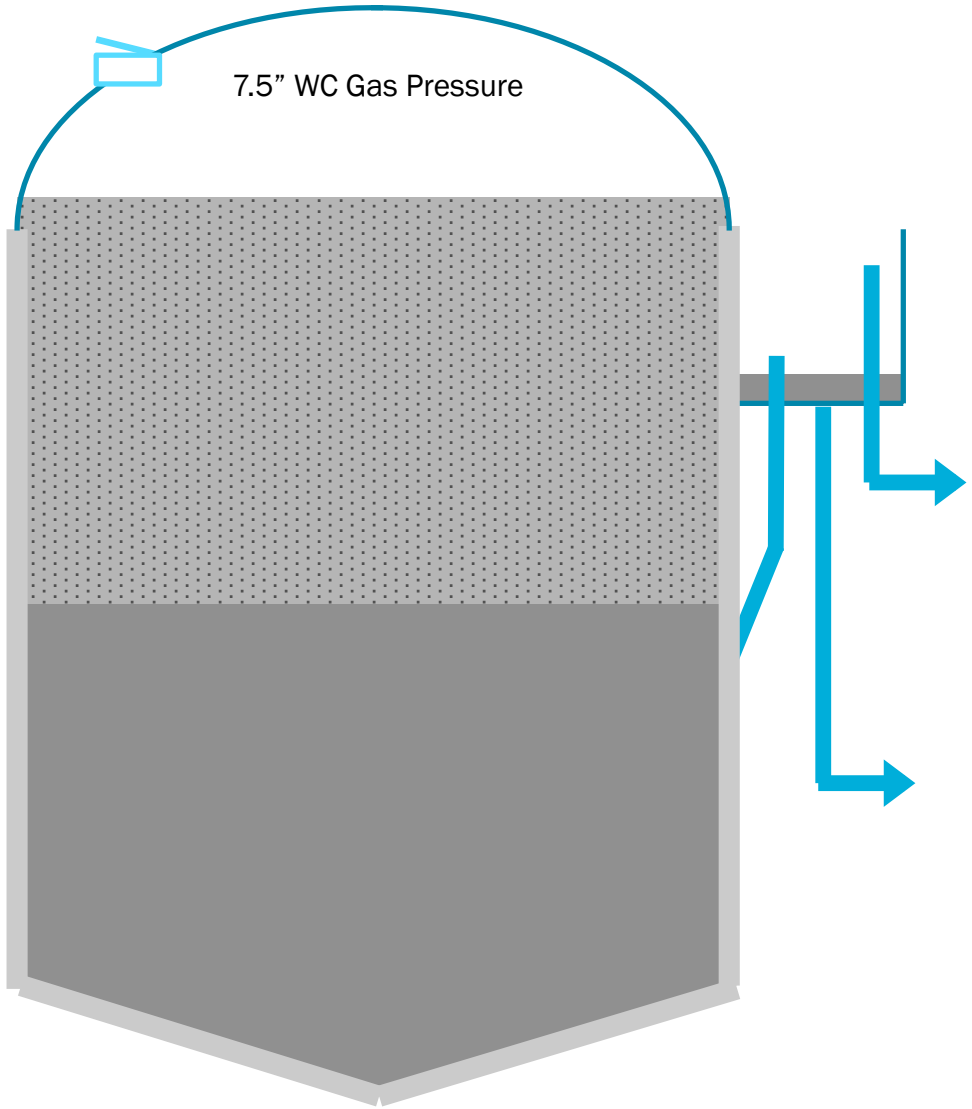


Ultimately:
This can cause
Cover Failures

Tallman Island Trapping Low-SG Sludge in Upper Layers



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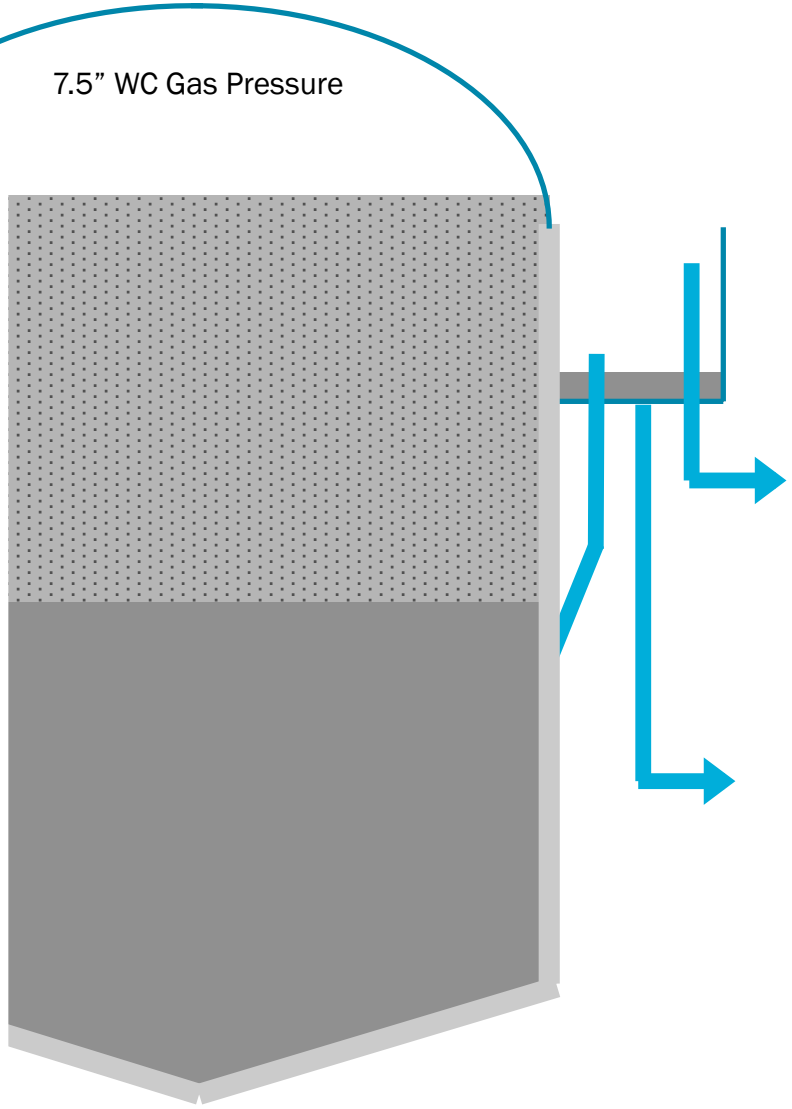
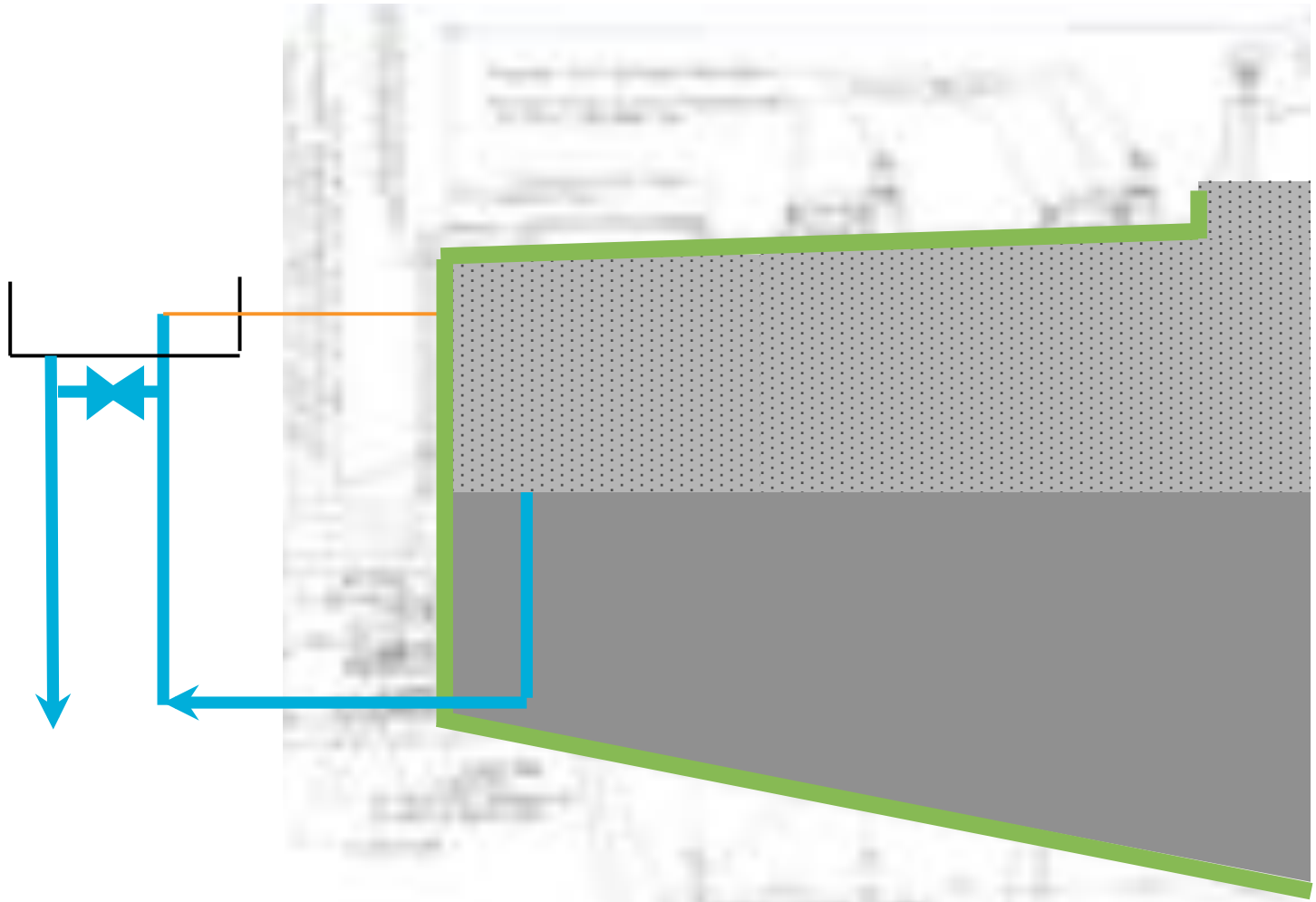


Hunts Point Wasting Configuration Similarly creates Low-SG Sludge Trap



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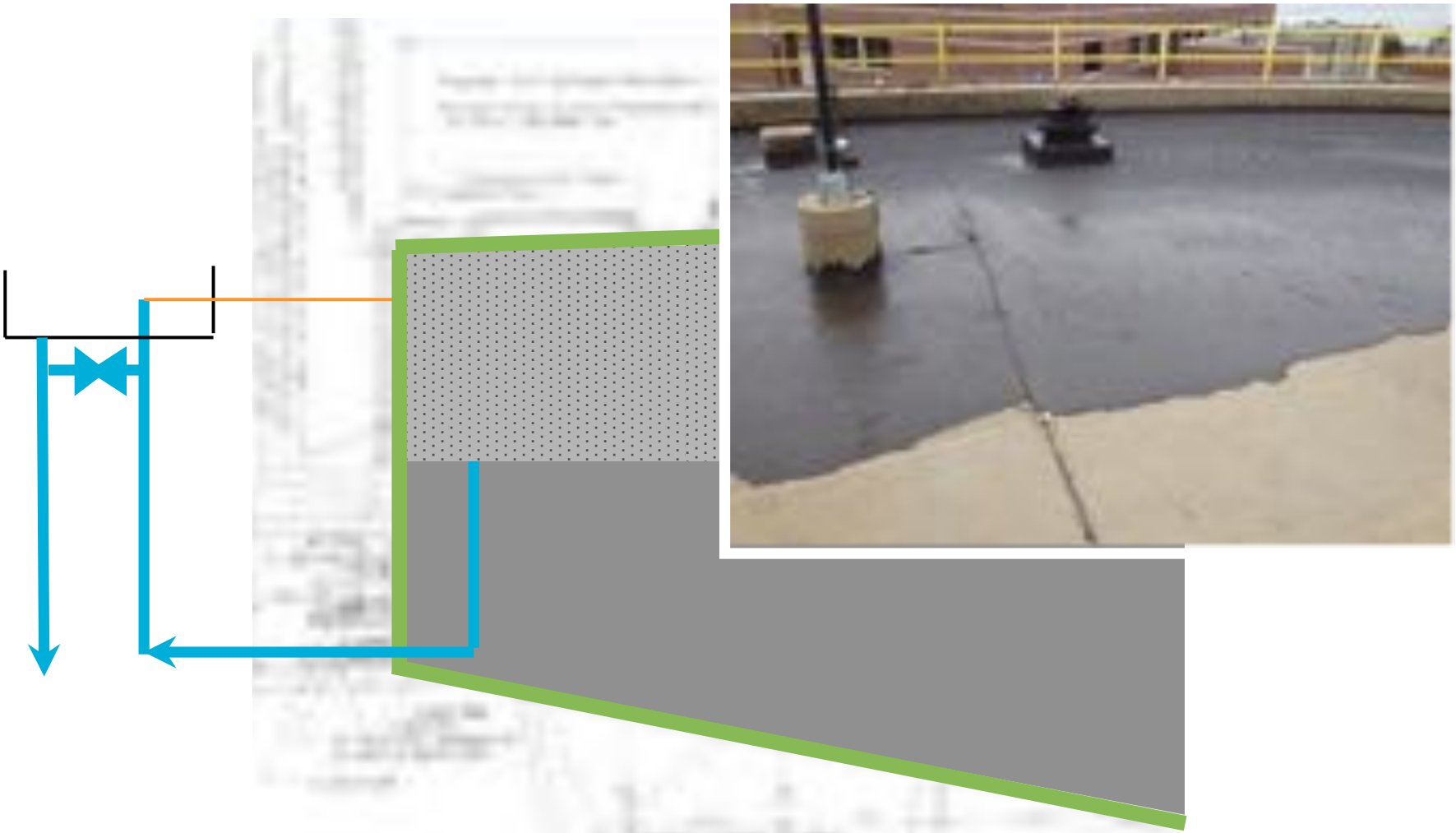
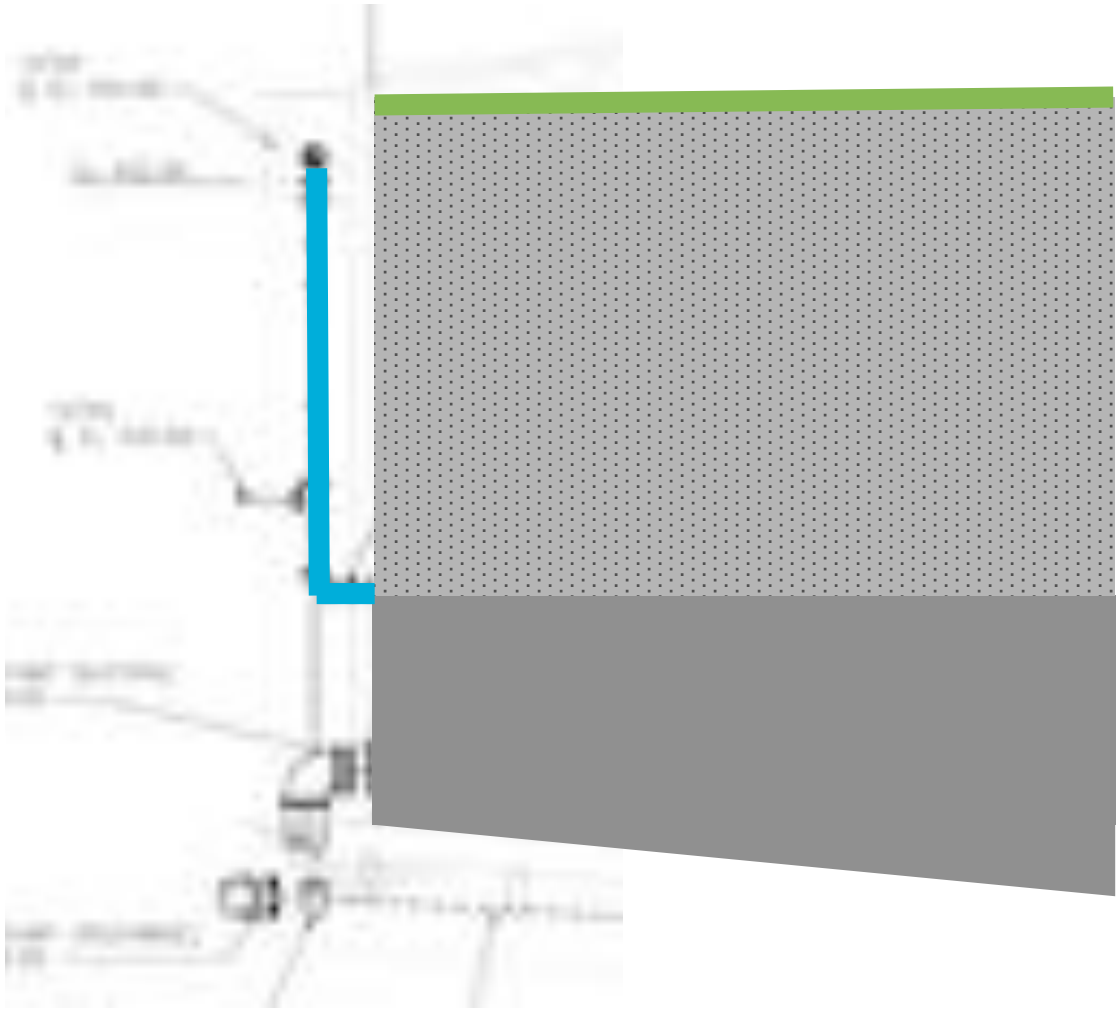


This doesn't just happen in NYC: Nashville, TN



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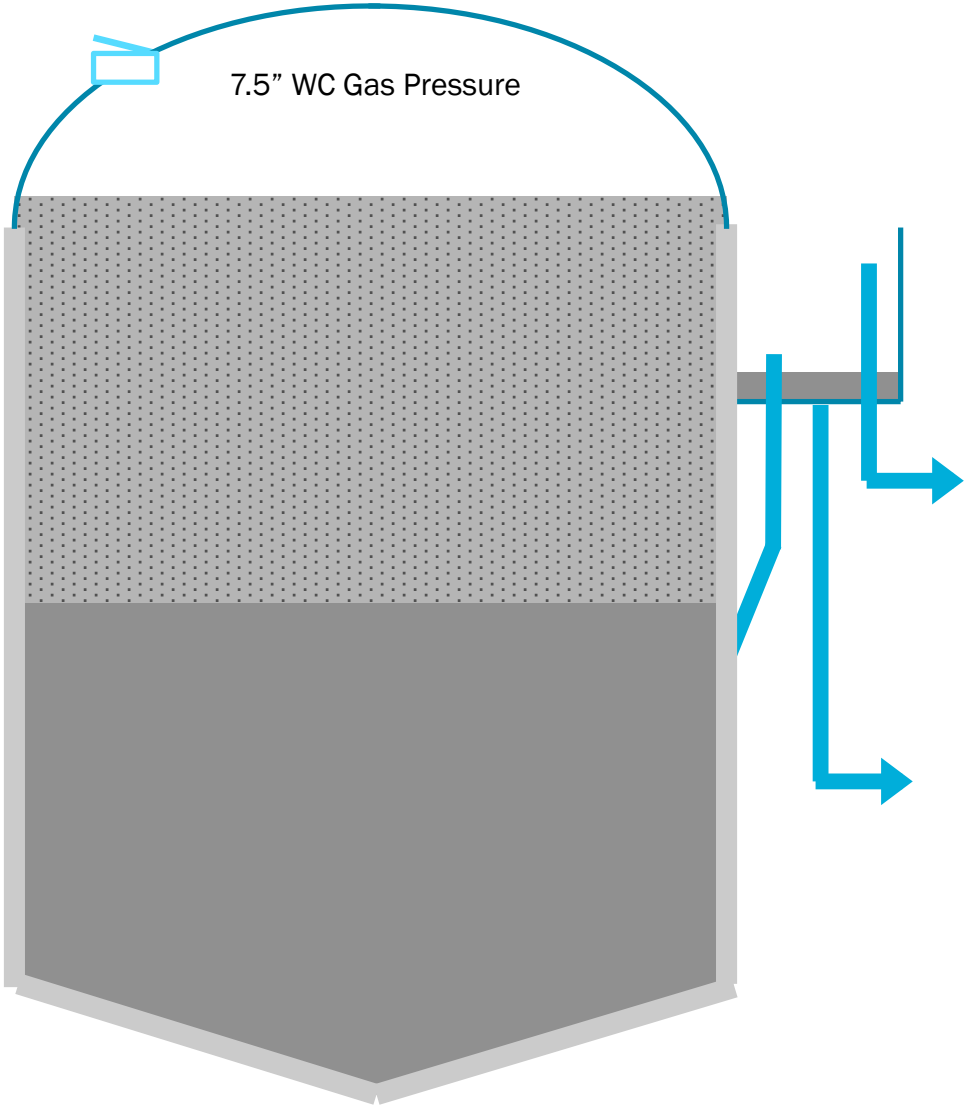
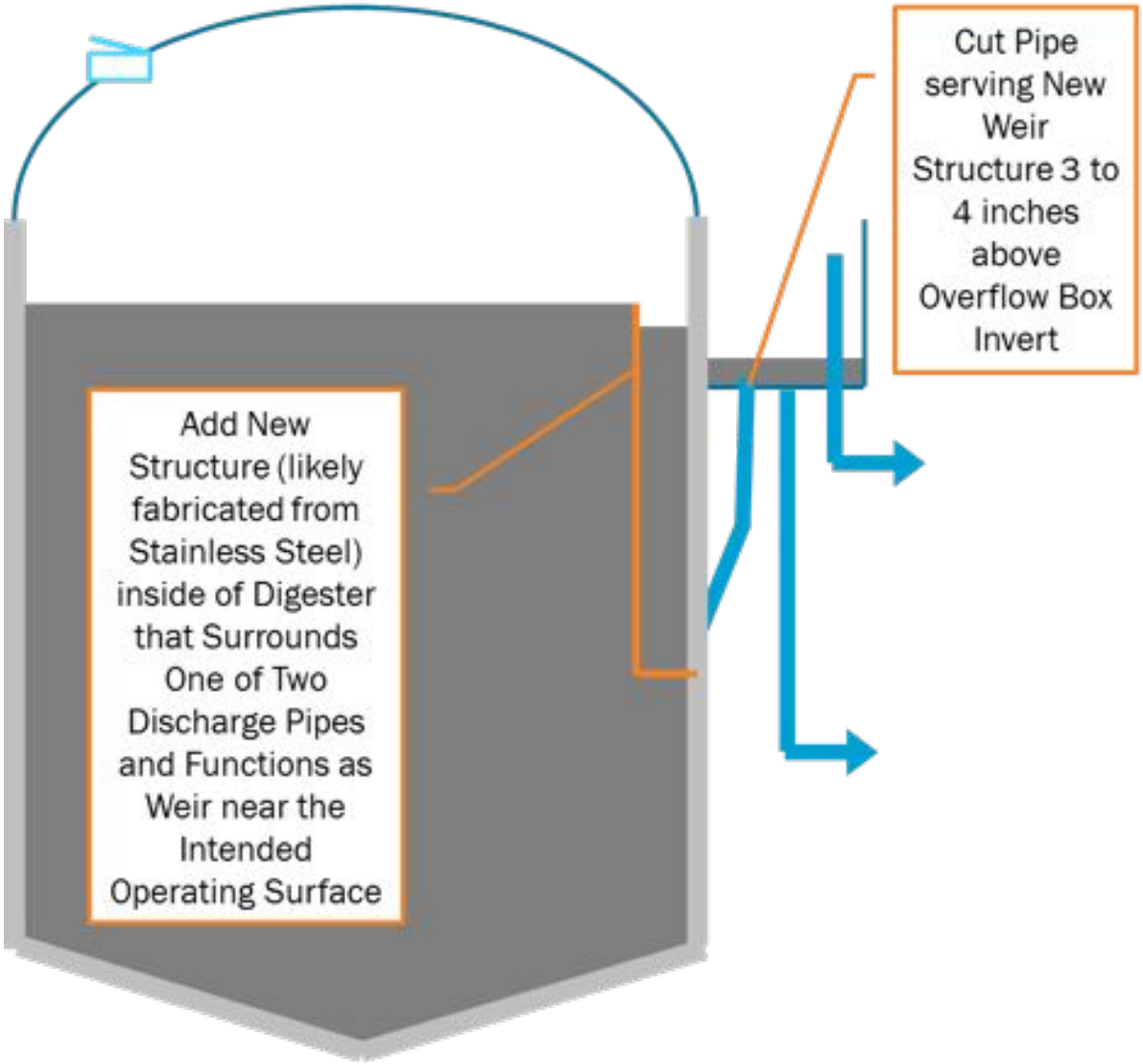
Potential Solutions

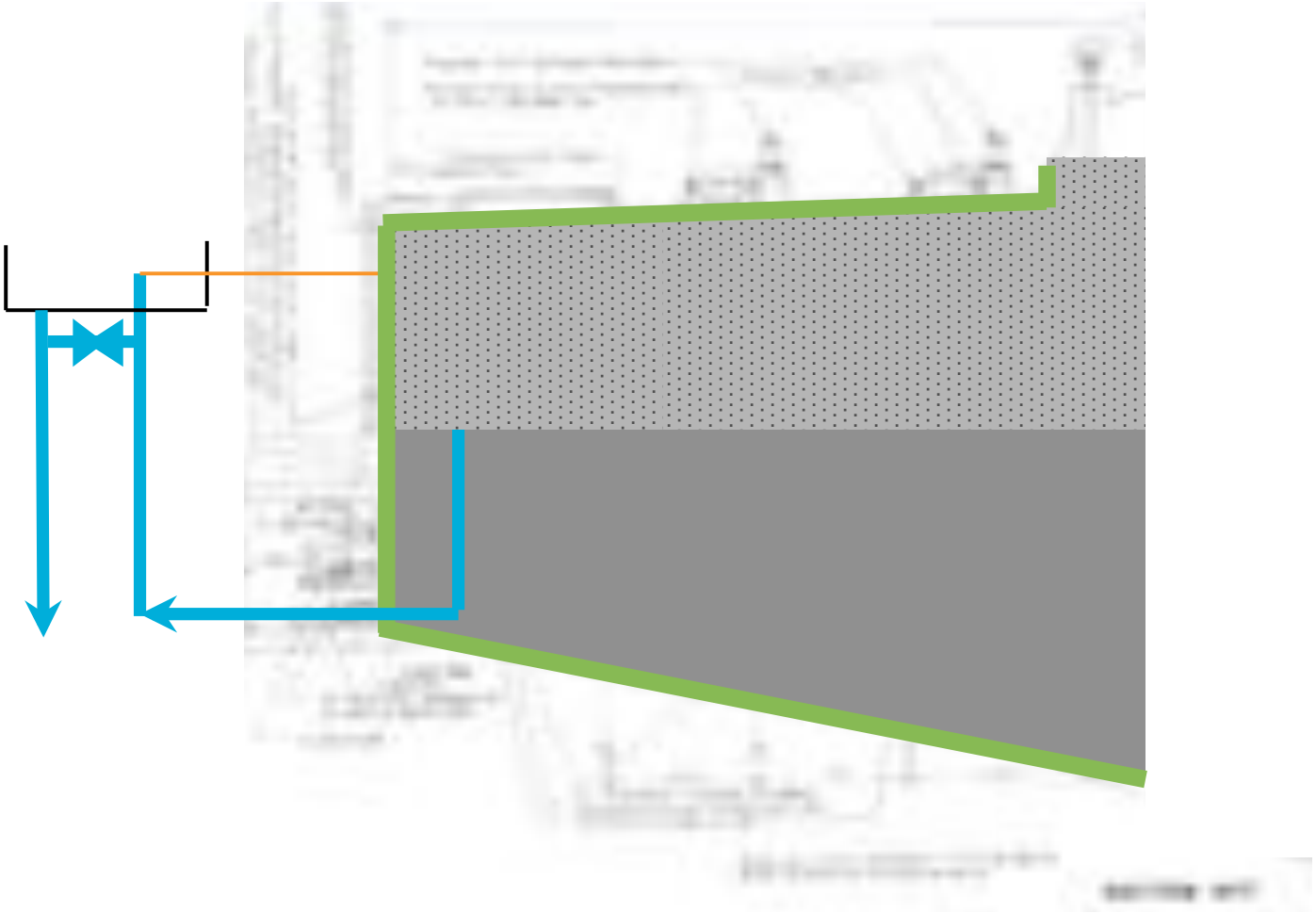
Tallman Island



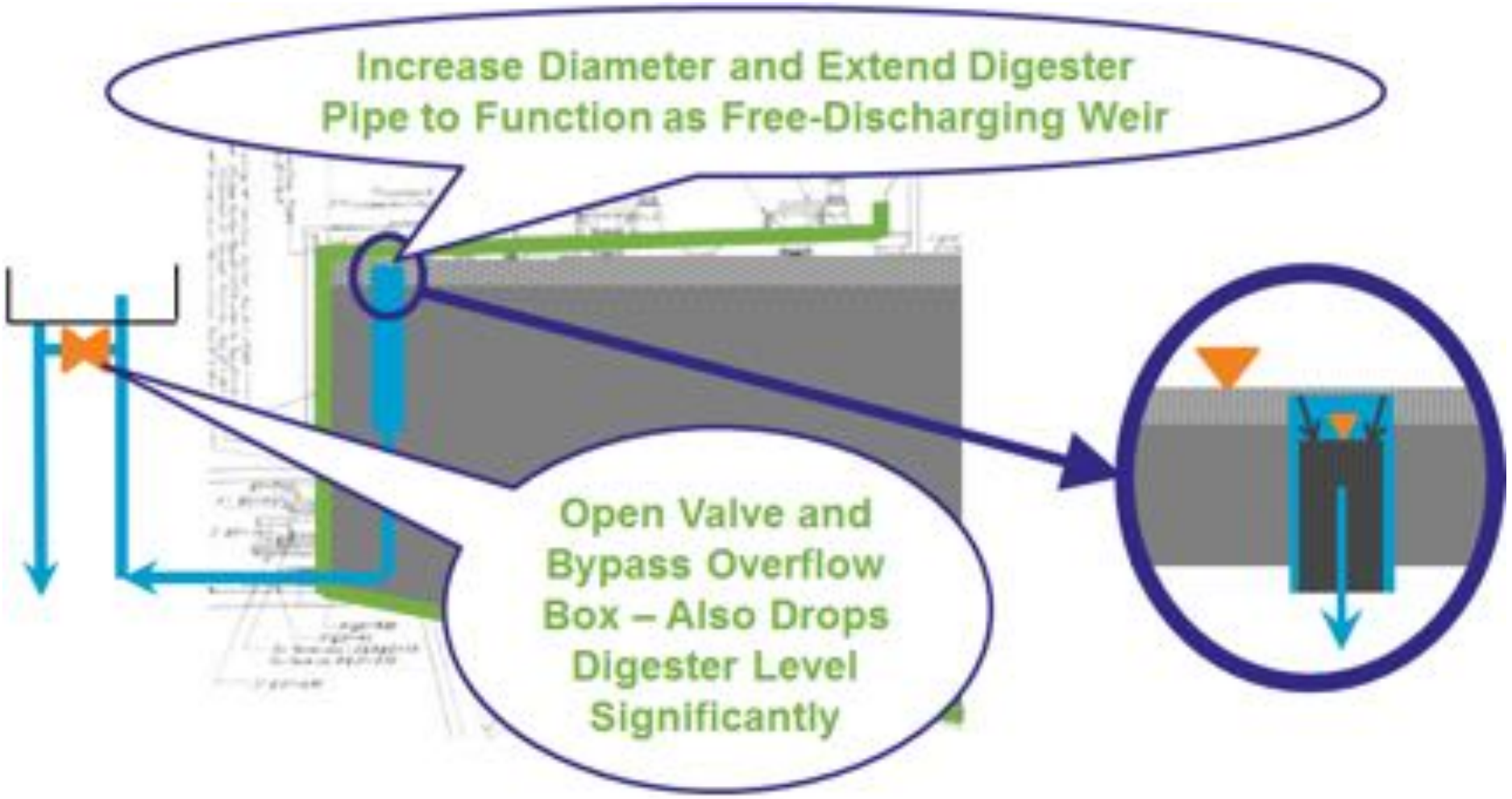
Tallman Island Concept was Steel Plate



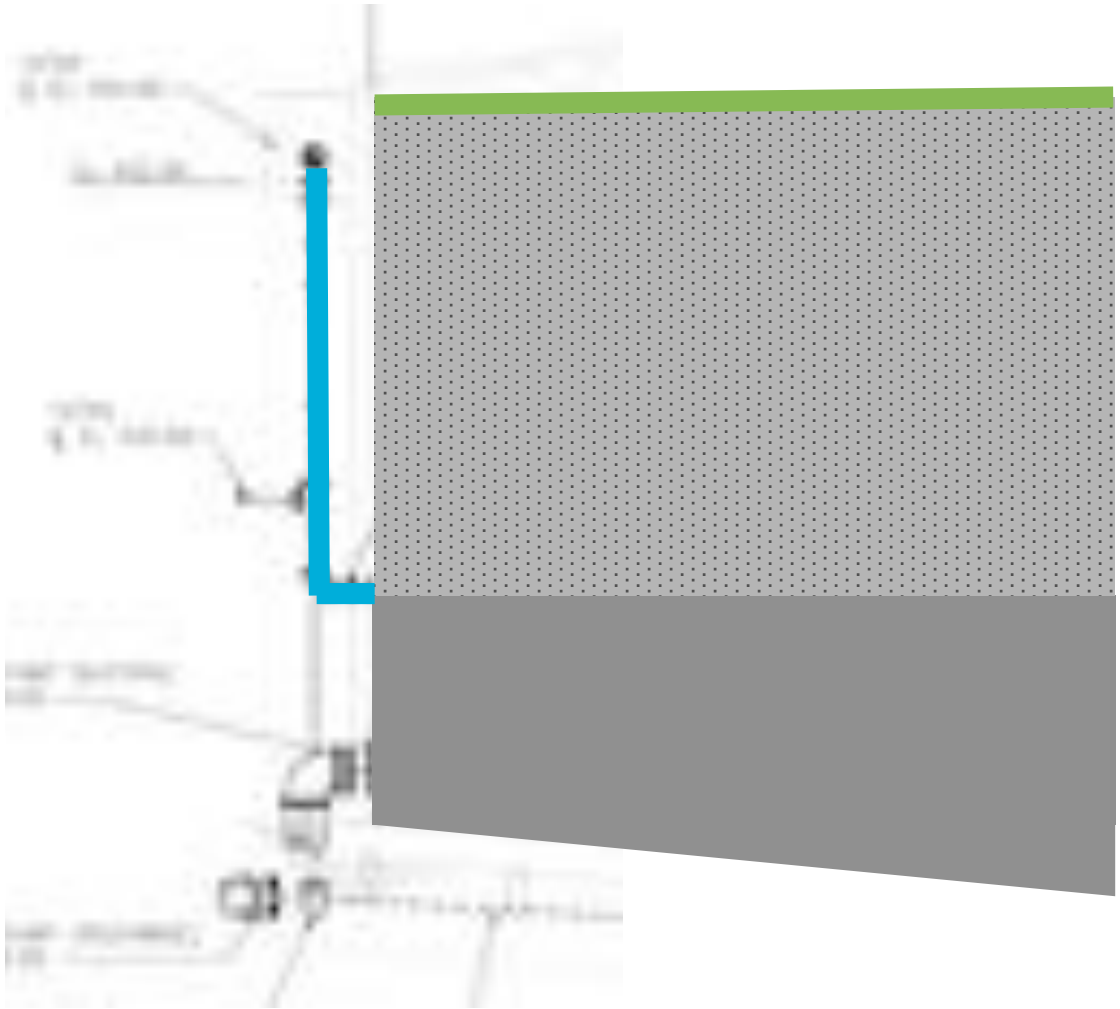
Hunts Point



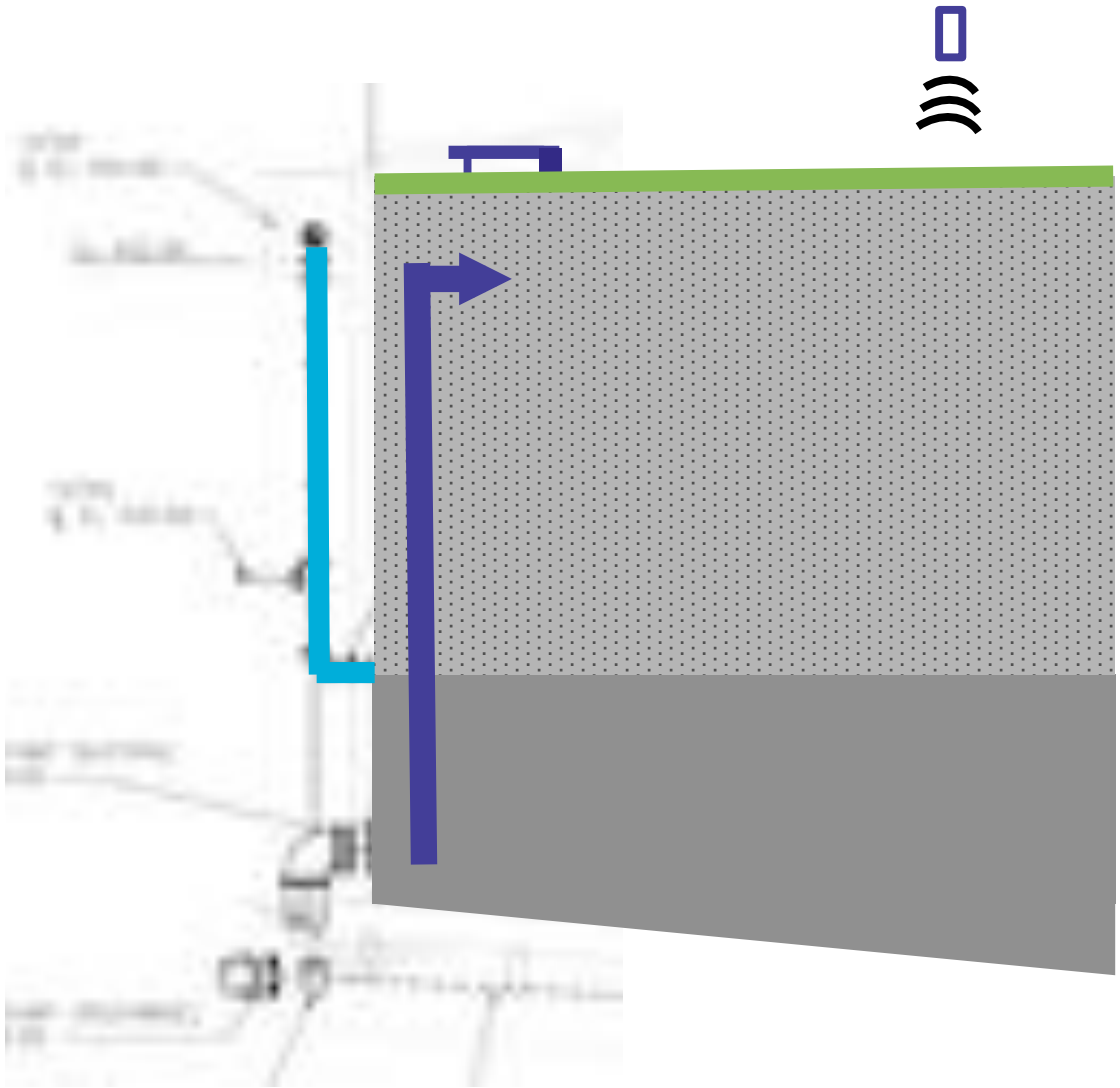
Hunts Point concept is a pipe and valve



Nashville



Nashville's Initial Contractor Fixes

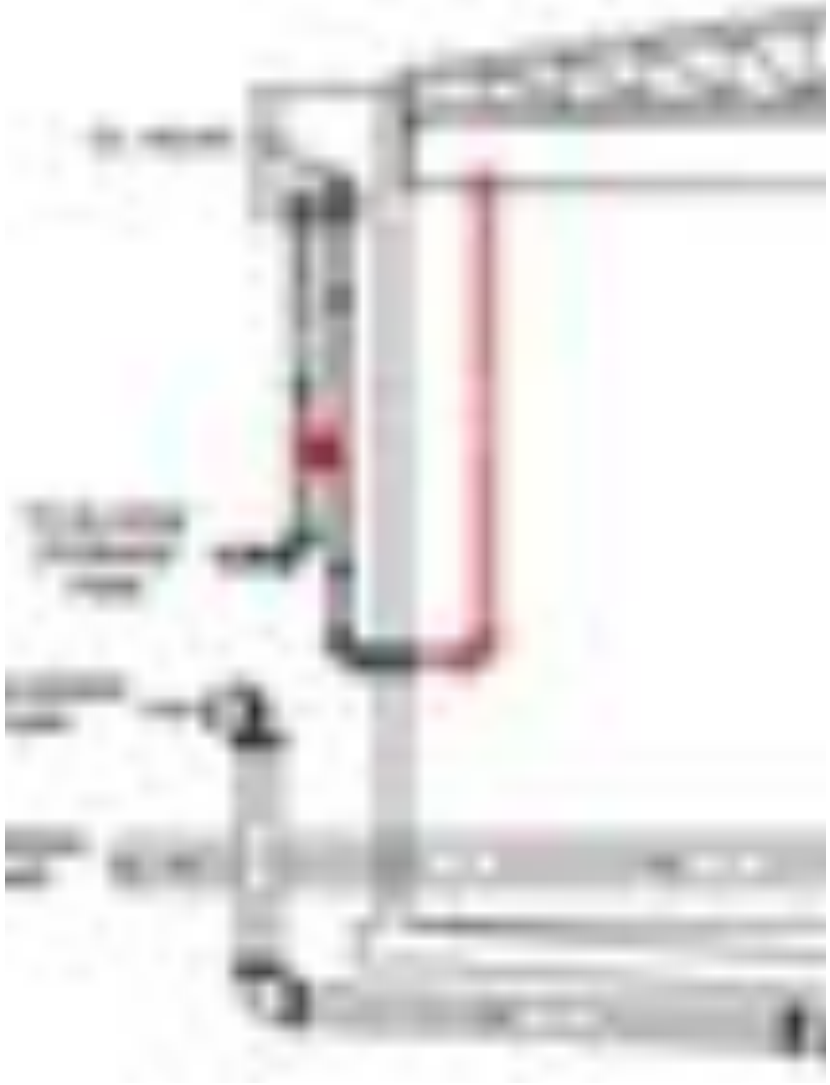


Foam-Busting Surface Nozzle

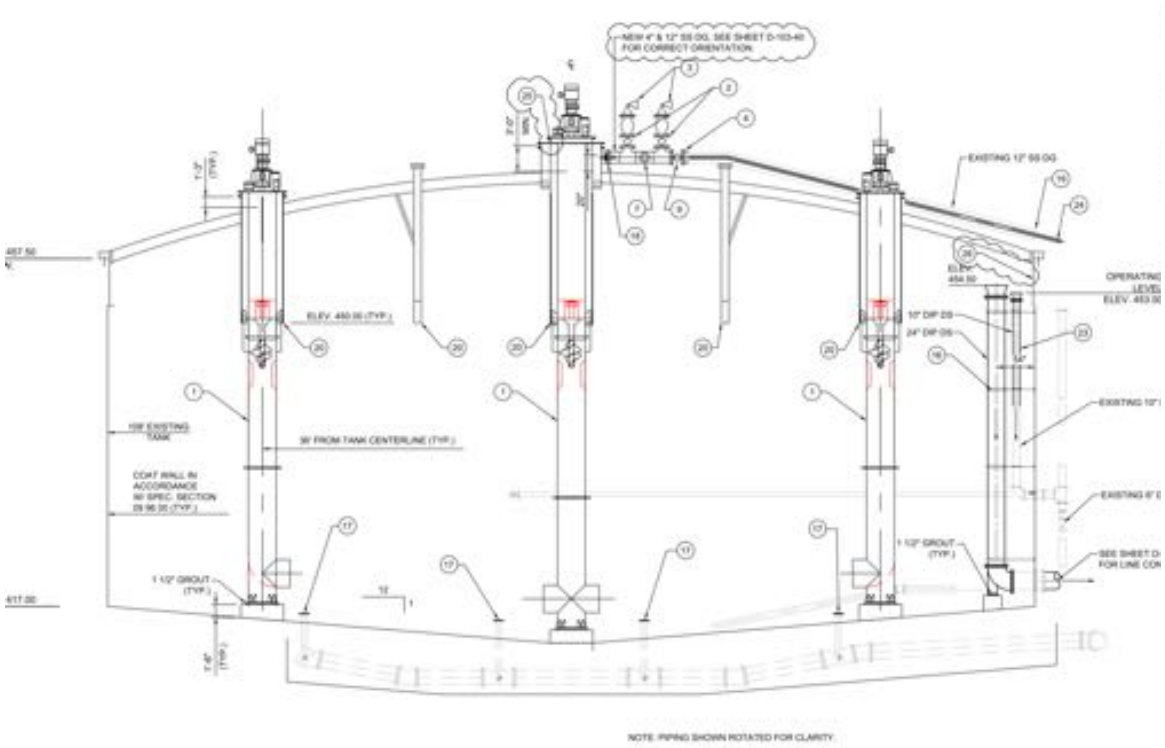
Emergency "Hatch"

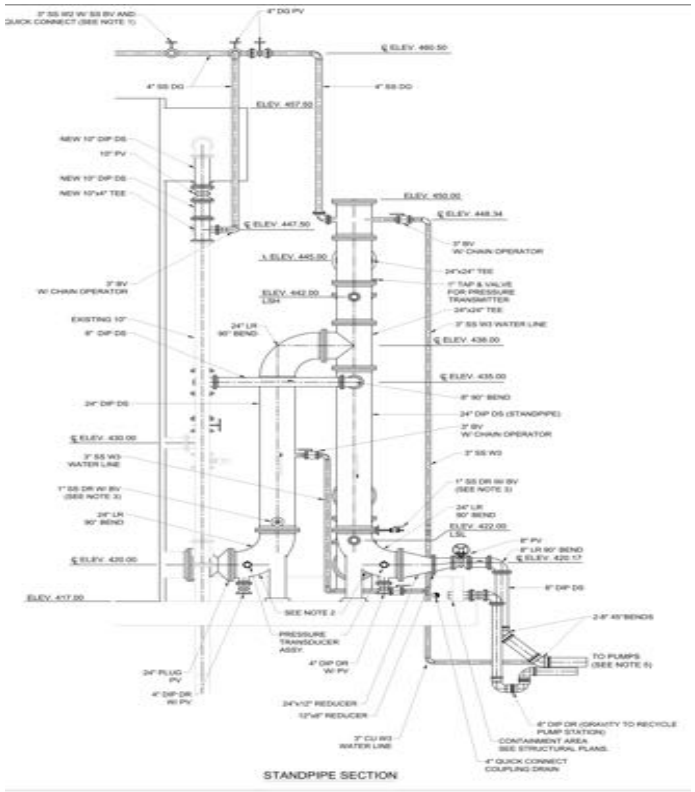
Radar Level Element

Nashville's Current Improvements

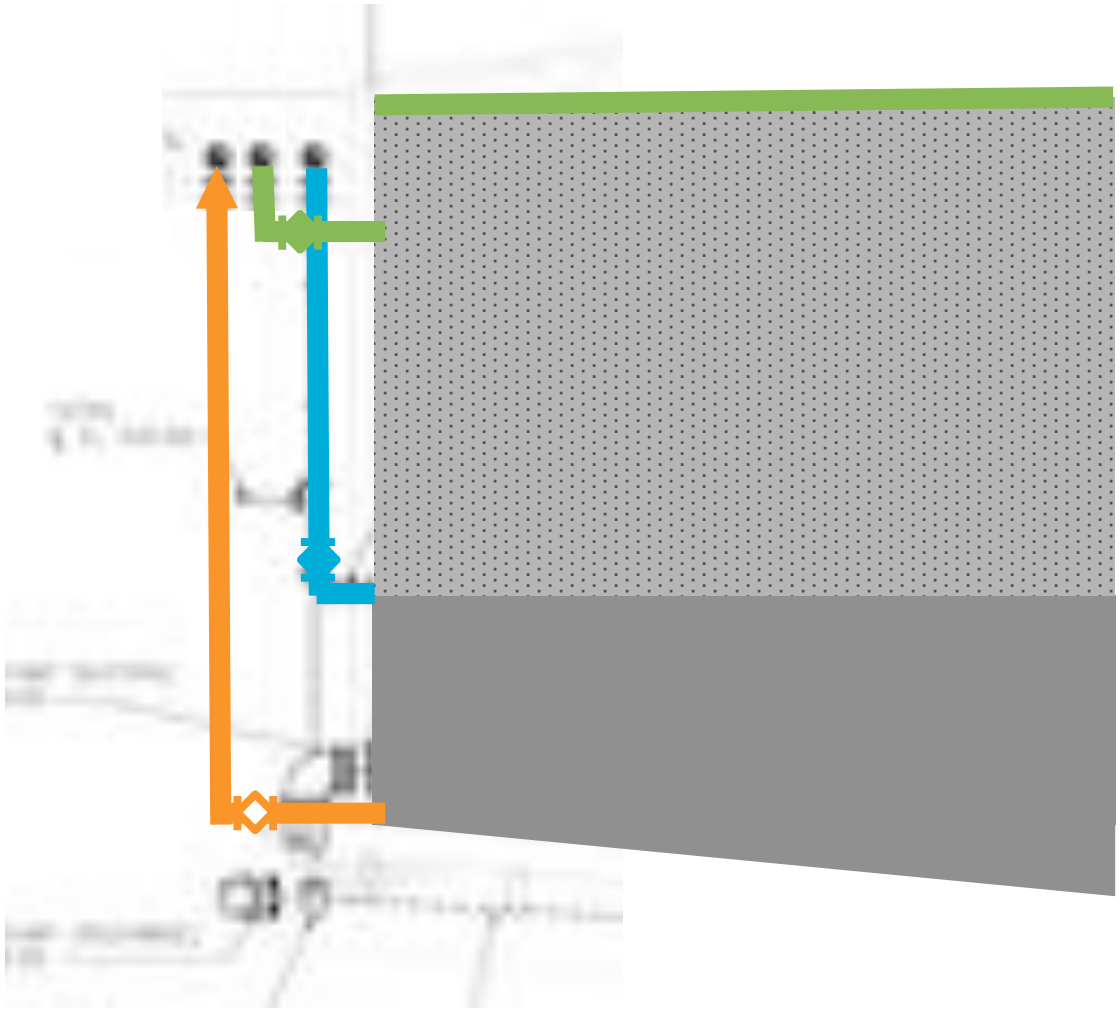


Planned implementation for surface wasting at Nashville





For some Tanks, the “Fix” is FREE



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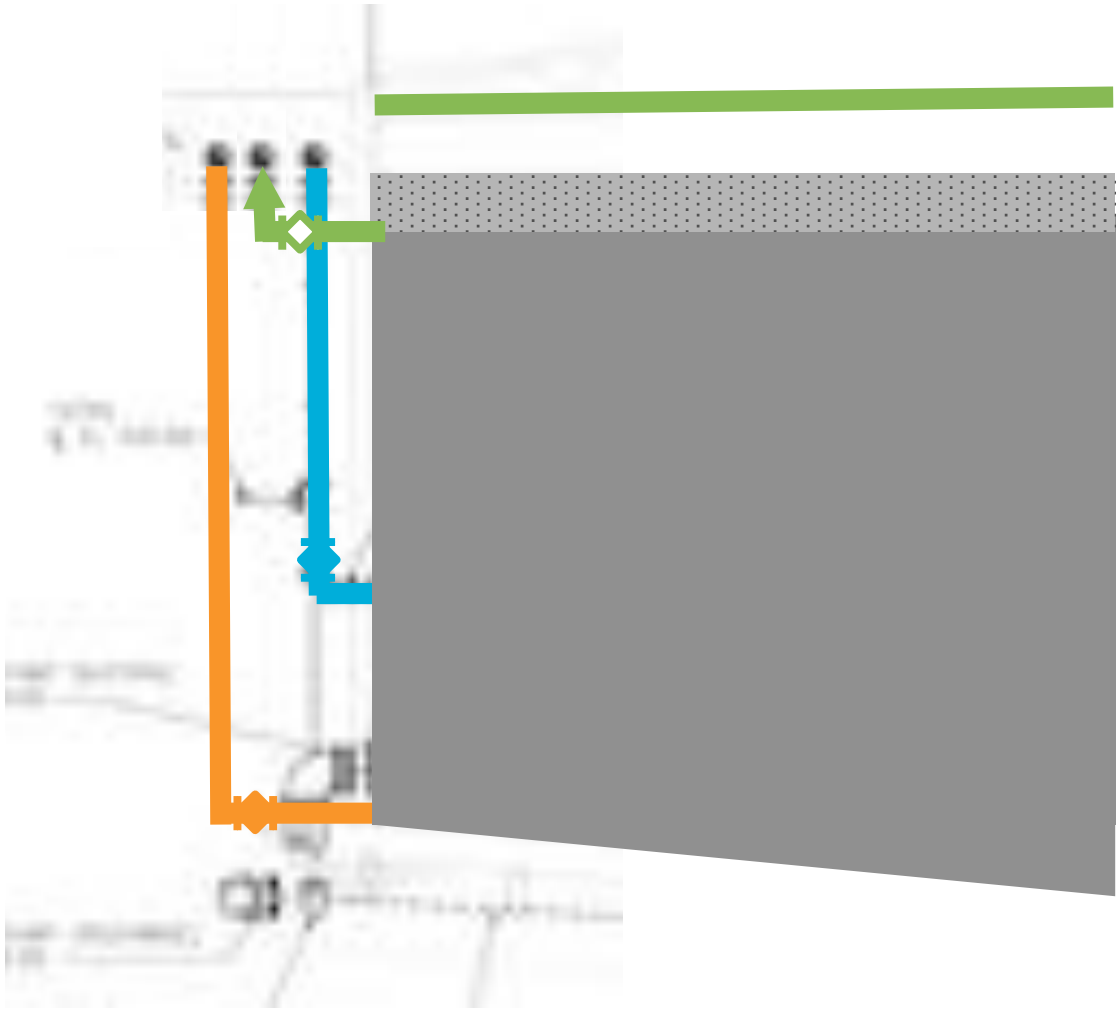
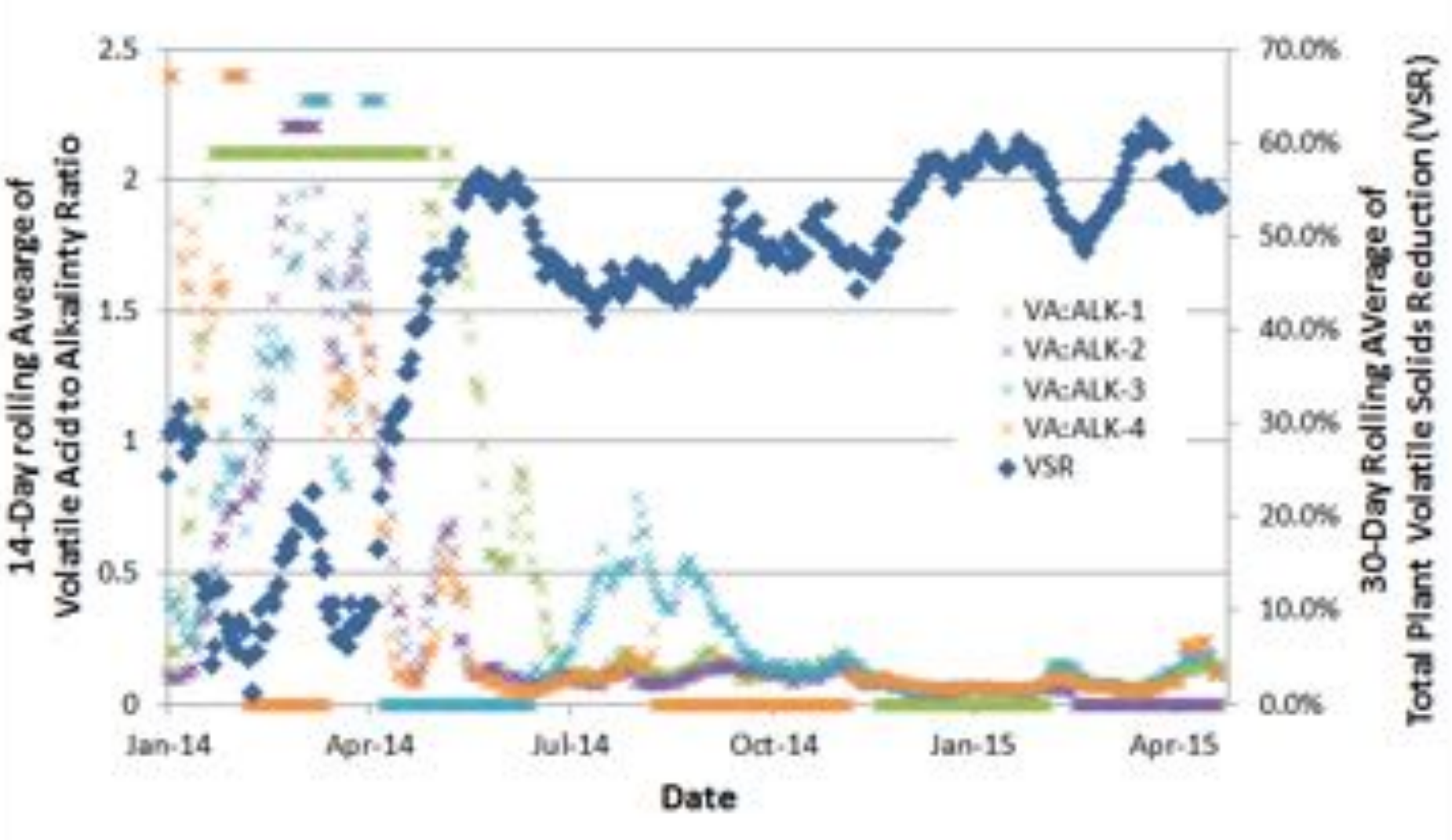


Solution at Owls Head

Owls Head Conversion Performance

Cautioned that surface wasting was NOT the only digester enhancement

Owls Head Conversion Performance



Conclusions

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Our assumptions surround sludge specific gravity in an anaerobic digester may not be correct

- Consider whether this explains some problems/experiences…
- Consider what it means for your next project (upgrade or new digesters)…

QUESTIONS?

it's about connecting

Christopher Muller, PhD, P.E.
(978) 983–2059
cmuller@BrwnCald.com

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