Hazen

WSSC WATER
DELIVERING THE ESSENTIAL

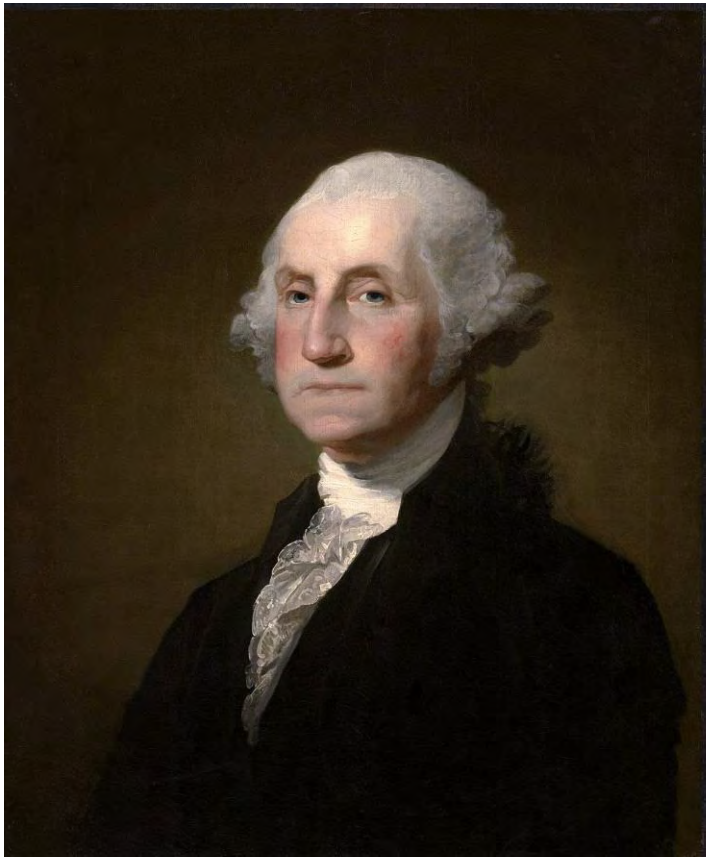
How Much Digestion Do You Really Need for a THP Facility: The WSSC Bio Energy Approach

NEWEA Annual Conference

January 28, 2020

NEW ENGLAND WATER ENVIRONMENT ASSOCIATION
NEWEA
WORKING FOR WATER QUALITY

What Do These Things Have In Common?



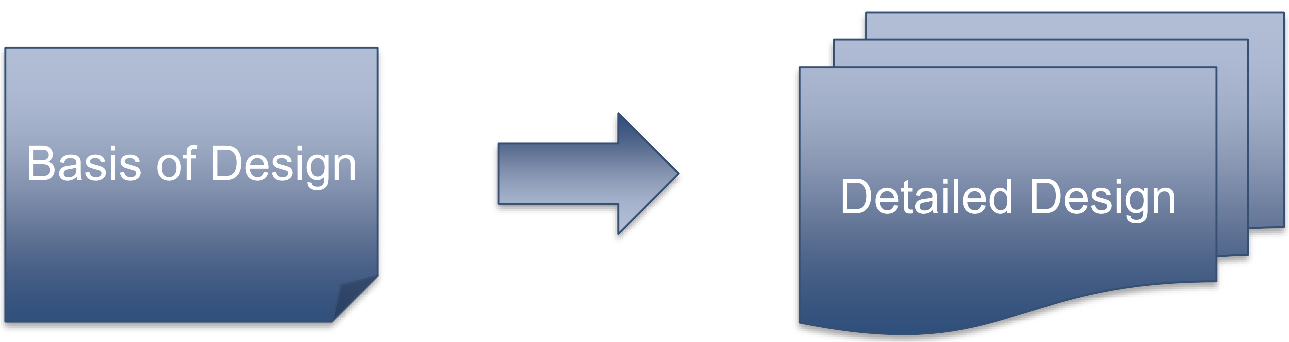
Project Team

Design-Build Team

Program Management Team

Agenda

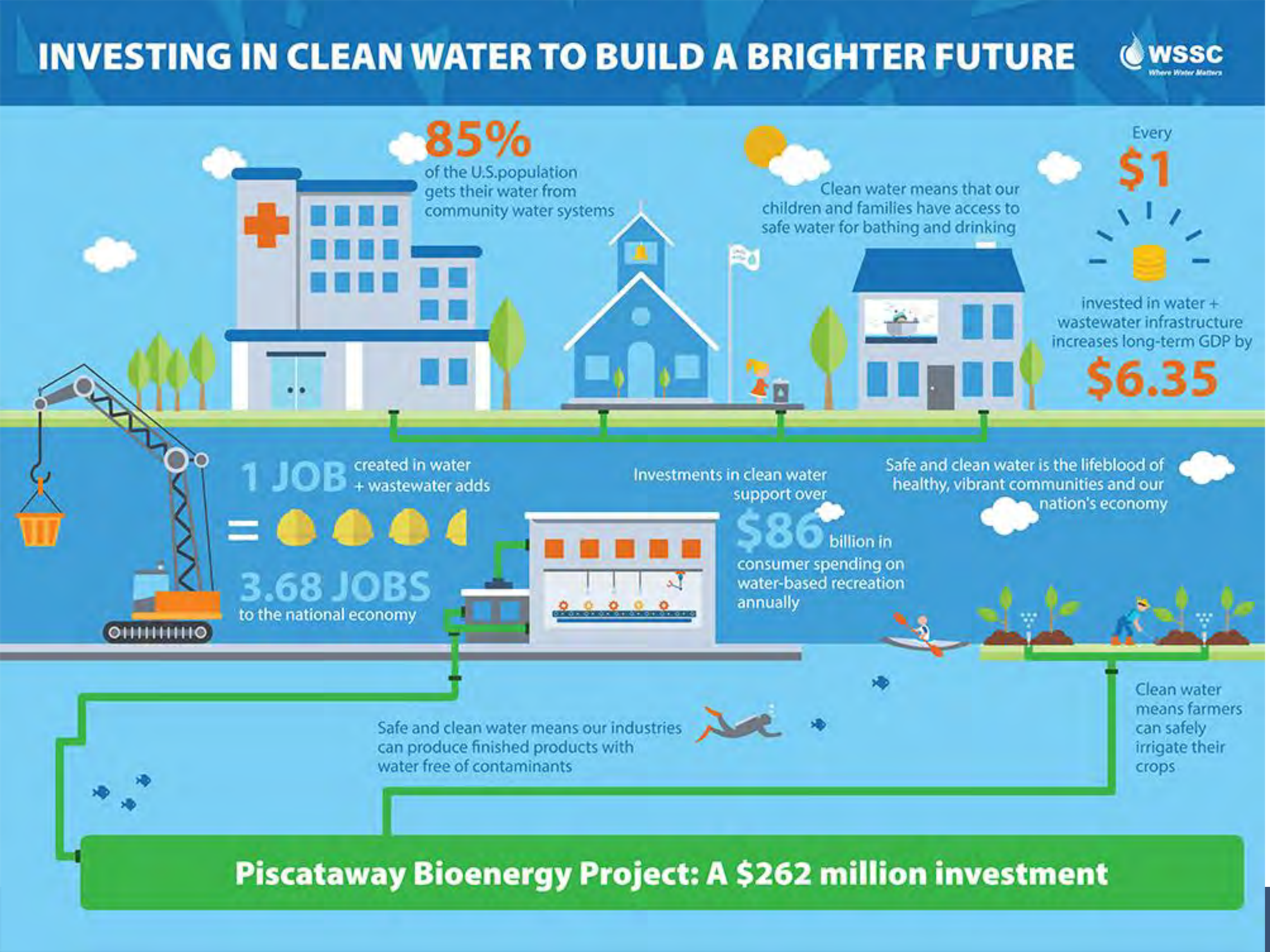
- Overview
- Digestion Decisions
  - Tank Construction
  - Mixing Technology
  - Digestion Volume and Tank Configuration
    - RVE Containment
    - Digested Sludge Storage
- Conclusions and Next Steps



Project Overview

WSSC Bioenergy Project

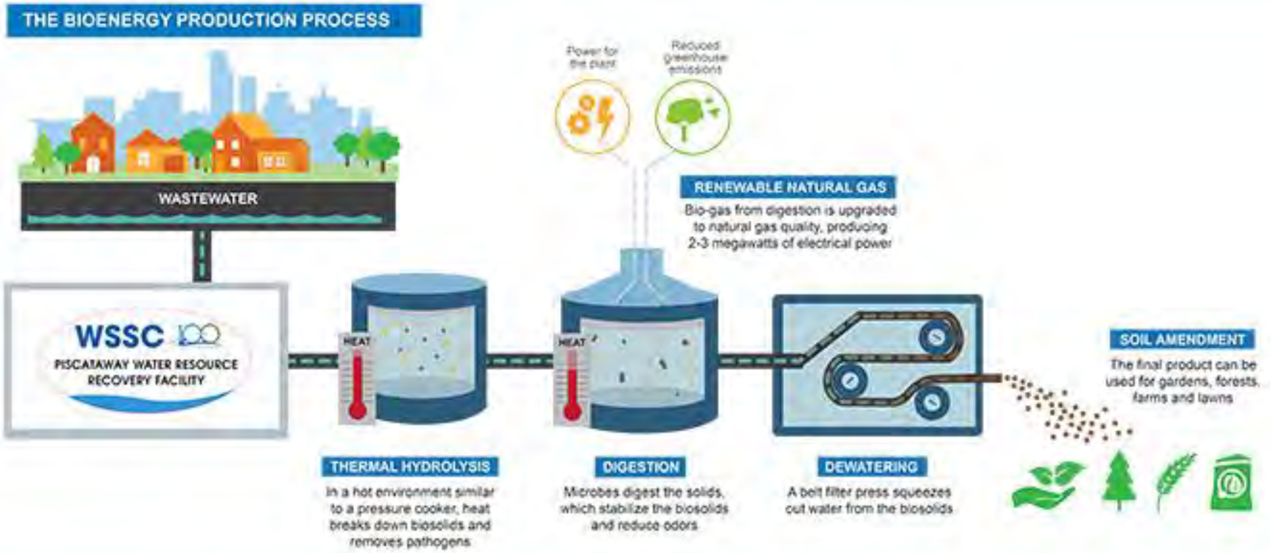
- Sludge will be screened and dewatered at each plant
- Haul pre-dewatered cake from four remote plants to Piscataway WRRF



INVESTING IN CLEAN WATER TO BUILD A BRIGHTER FUTURE
WSSC
Where Water Matters
85% of the U.S.population gets their water from community water systems
Clean water means that our children and families have access to safe water for bathing and drinking
Every $1 invested in water + wastewater infrastructure increases long-term GDP by $6.35
1 JOB created in water + wastewater adds = 3.68 JOBS to the national economy
Investments in clean water support over $86 billion in consumer spending on water-based recreation annually
Safe and clean water is the lifeblood of healthy, vibrant communities and our nation's economy
Safe and clean water means our industries can produce finished products with water free of contaminants
Clean water means farmers can safely irrigate their crops
Piscataway Bioenergy Project: A $262 million investment

INTRODUCING BIOENERGY

WSSC will transform sewage into renewable energy at the Piscataway Water Resource Recovery Facility (formerly known as the Piscataway Wastewater Treatment Plant). Using cutting-edge "green" technology, the Piscataway Bioenergy Project will reduce WSSC's greenhouse gas emissions by 15 percent, while saving customers more than $3 million per year.



WHY BIOENERGY?

SUSTAINABLE

Bioenergy production will enable WSSC to produce Class A biosolids with such high quality they can be used as a soil amendment to help gardens, forests, farms and lawns. This innovative project will reduce WSSC greenhouse gas emissions by 15% and help protect the Chesapeake Bay.

SAFE

Bioenergy production is becoming increasingly popular among water/wastewater utilities nationwide. Class A biosolids are held to the strictest industry standards, regularly monitored, and safe enough to use as a soil amendment to help gardens, forests, farms and lawns.

GREEN ENERGY

Using cutting-edge "green" technology, WSSC will transform sewage into renewable fuel and produce energy to help run the plant. This new process produces methane gas, which is captured and used as a fuel source to run generators that create electricity. This provides Piscataway with a reliable green power source and reduces dependence on fossil fuels.

COST SAVINGS

WSSC is spending now in order to save going forward. Significant cost savings over the long term will come from reducing power consumption from fossil fuels and reducing disposal costs. Piscataway will become WSSC's showcase for achieving optimal value by investing in a green future.

FOR MORE INFORMATION:
wsscwater.com/bioenergy

WHAT ARE CLASS A BIOSOLIDS?

WSSC Where Water Matters

Class A Biosolids are nutrient-rich organic materials resulting from the wastewater treatment process that can be used as a soil amendment to help gardens, forests, farms and lawns.

WHO ELSE IS PRODUCING CLASS A BIOSOLIDS?

WSSC joins a growing list of water/wastewater utilities nationwide using bioenergy to create Class A biosolids. Within our own region, consumers can already buy DC Water's Bloom to use in their gardens.

HOW CAN CLASS A BIOSOLIDS HELP GARDENS AND GREEN SPACES?

Biosolids are soil amendments – a product that's added to soil to improve its physical qualities. Class A biosolids can help plant and turf establishment and topsoil blending, and can even be used as a potting soil blend. Class A biosolids can be useful to everyone from home gardeners to large-scale forest and park managers.

ARE CLASS A BIOSOLIDS SAFE?

Yes! The National Academy of Sciences concludes that "the use of [biosolids] in the production of crops for human consumption, when practiced in accordance with existing federal guidelines and regulations, presents negligible risk to the consumer, to crop production and to the environment." The technical innovations and high heat process used by WSSC to remove pathogens transforms waste into sustainable and useful soil amendments.

ARE THERE DIFFERENT TYPES OF BIOSOLIDS?

There are two types of biosolids: Class A and Class B. WSSC's Piscataway Water Resource Recovery Facility will be producing Class A biosolids. Class A biosolids are held to the strictest industry standards, regularly monitored, and safe enough to use as fertilizer in home gardens. They have virtually no pathogens and contain very low levels of metals.

DO CLASS A BIOSOLIDS HAVE AN ODOR?

Like most soil conditioners (such as compost and fertilizers), biosolids have an earthy smell.

SIGN ME UP!

WHEN CAN I USE WSSC'S CLASS A BIOSOLIDS IN MY OWN GARDEN?

WSSC is still determining how our Class A biosolids will be used. Options we're considering include allowing it to be sold on the open market (as DC Water's Bloom is), private sale to another utility, or private sale/donation to garden and park organizations.

Sign up for updates at wsscwater.com/bioenergy.

FOR MORE INFORMATION:
wsscwater.com/bioenergy

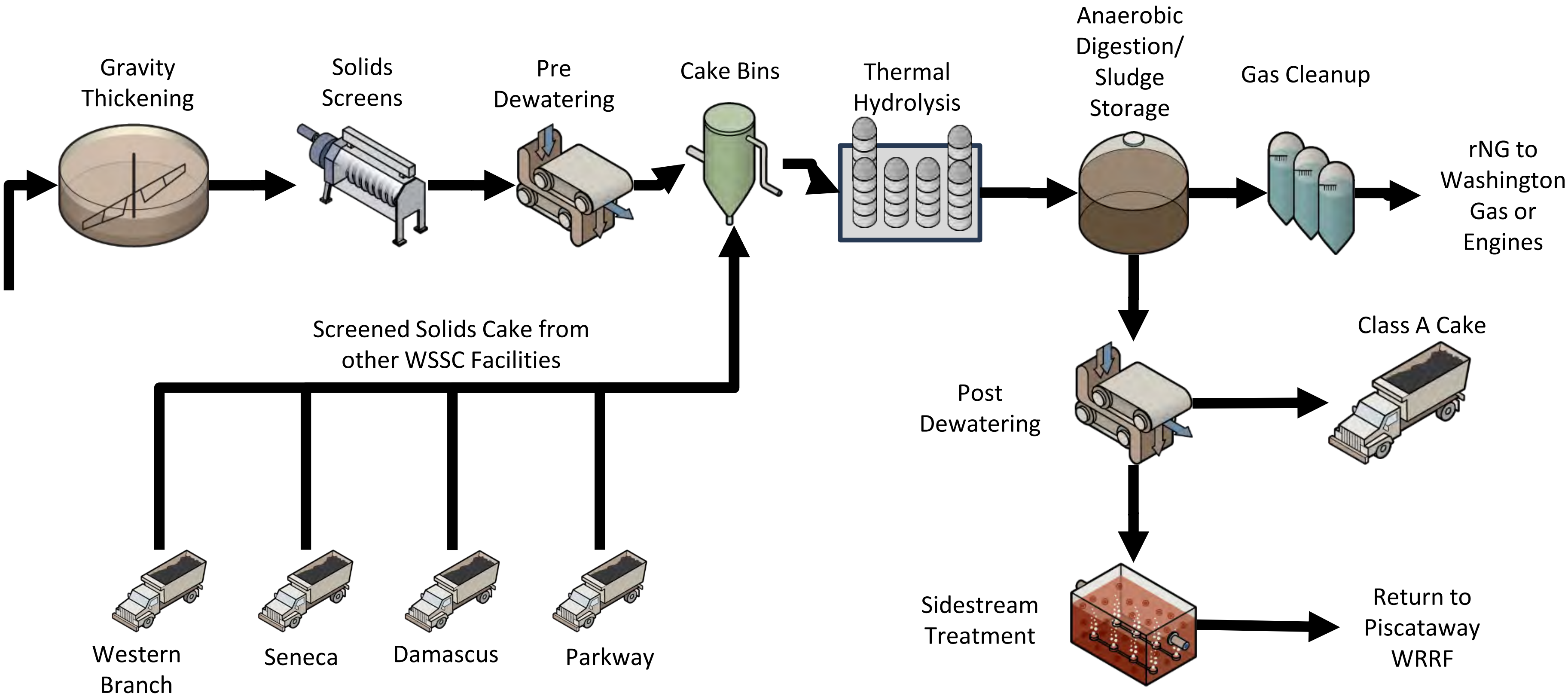
Project Goals

- Create valuable Class A biosolids
- Reduce overall operating costs for WSSC
- Produce renewable natural gas
- Reduce greenhouse gas emissions

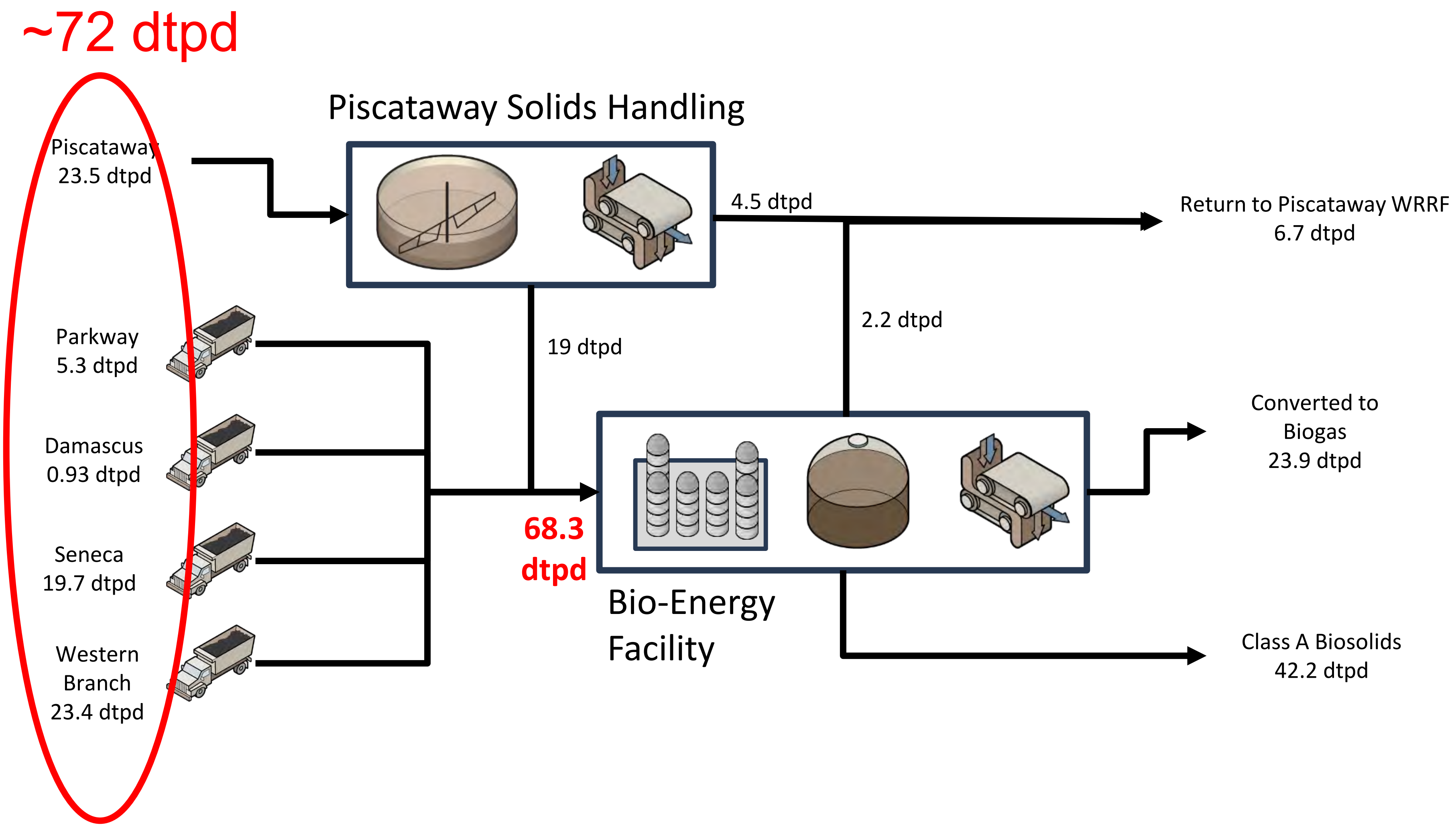
Current Status

- Phase 1 underway
  - Facility demolition
  - Utility relocation
- Phase 2
  - Approaching final design
  - GMP under development

Solids Process Flow Diagram



Solids Mass Balance (2040 Annual Average)



Site Rendering (60% Design)

Let's Focus on the Digesters…

Tank and Cover Construction

Tank/Cover Alternatives

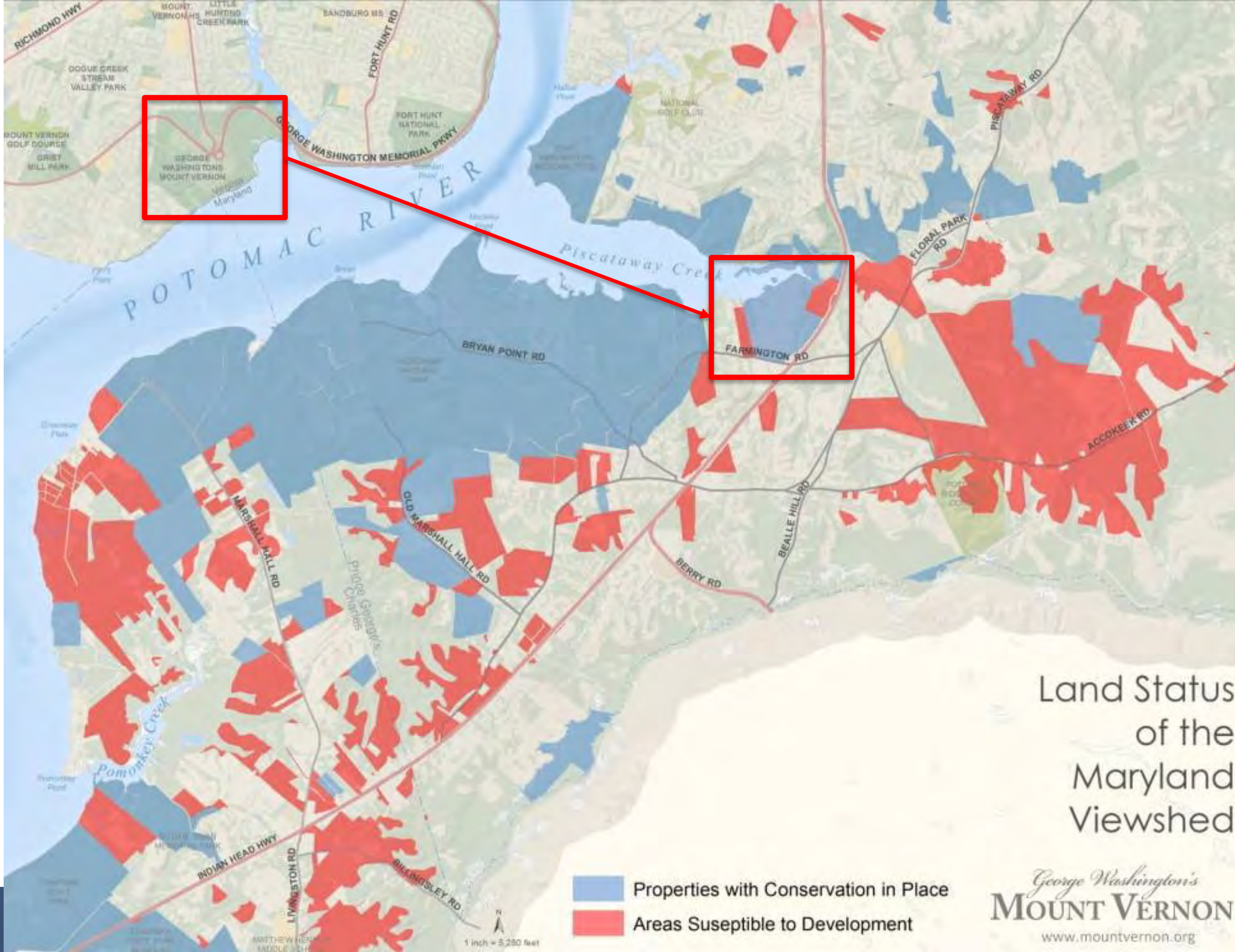
- **Tank**
  - Cast-In-Place
  - Post-Tensioned (like Dutchland)
  - Pre-Stressed (like Crom)
- **Cover**
  - Fixed Steel
  - Fixed Concrete*

* = not viable for post-tensioned

Five Size Under Consideration

- 72-ft ID x 50-ft Sidewall
- 74-ft ID x 50-ft Sidewall
- 76-ft ID x 50-ft Sidewall
- 78-ft ID x 50-ft Sidewall
- 81-ft ID x 50-ft Sidewall

Maximum 50ft sidewall to stay under Mt. Vernon viewshed restrictions with top of dome.



Land Status of the Maryland Viewshed
Properties with Conservation in Place
Areas Suseptible to Development
George Washington's
MOUNT VERNON
www.mountvernon.org
POTOMAC RIVER
Piscataway Creek
GEORGE WASHINGTONS MOUNT VERNON
GEORGE WASHINGTON MEMORIAL PKWY
FORT HUNT RD
FORT HUNT NATIONAL PARK
RICHMOND HWY
BRYAN POINT RD
FARMINGTON RD
FLORAL PARK RD
PISCATAWAY RD
ACCOKEEK RD
BEALLE HILL RD
BERRY RD
OLD MARSHALL HALL RD
MARSHALL HALL RD
INDIAN HEAD HWY
LIVINGSTON RD
BILLINGSLEY RD
Pomonkey Creek
1 inch = 5,280 feet

Notes on Digester Cost Estimates

<u>Common Elements</u>

- x Mixing: not included (assumed equivalent)
- x Foundations: not included (assumed equivalent)
- ✓ Gas Appurtenances: included
- ✓ Wall Coating: included

<u>Differentiating Element</u>

- HDPE liner: only for concrete cover

Estimated Construction Cost ($M/tank)

	72-ft x 50-ft	74-ft x 50-ft	76-ft x 50-ft	78-ft x 50-ft	81-ft x 50-ft
Cast-in-Place Steel Cover	$4.05	$4.15	$4.20	$4.378	$4.53
Cast-in-Place Concrete Cover	$3.15	$3.23	$3.25	$3.45	$3.60
Post-Tensioned (Dutchland) Steel Cover	$3.05	$3.15	$3.23	$3.28	$3.40
Pre-Stressed (CROM-type) Steel Cover	$3.45	$3.55	$3.60	$3.68	$3.83
Pre-Stressed (CROM-type) Concrete Cover	$2.50	$2.55	$2.58	$2.65	$2.75

Mixing Approach

Qualitative Comparison of Mixing

	Draft Tube Mixing	Pumped Mixing
Pros	• Higher energy efficiency 	• Lower capital cost • Easier at-grade maintenance • Standby pump increases mixing redundancy • Chopper pump reduces nozzle clogging potential • Allows variable level
Cons	• Higher capital cost • Large crane for maintenance • Requires constant level • Ragging and clogging on draft tube impeller and entrance/exit of tube	• Lower energy efficiency 

Where Would the Huge Crane Go?

Pumped Mixing Is A Better Value for WSSC

	Draft Tube	Pumped
Cost of Work (CAPEX), $	$750,000	$583,000
Operating Power Consumption, HP	46.5	75.0
20-year Energy Net Present Cost	$534,000	$859,000
20-year Maintenance Net Present Cost	$551,000	$113,000
Total 20-year Net Present Cost (CAPEX + Maintenance + Energy)	$1.84 M	$1.56 M

Digestion Volume

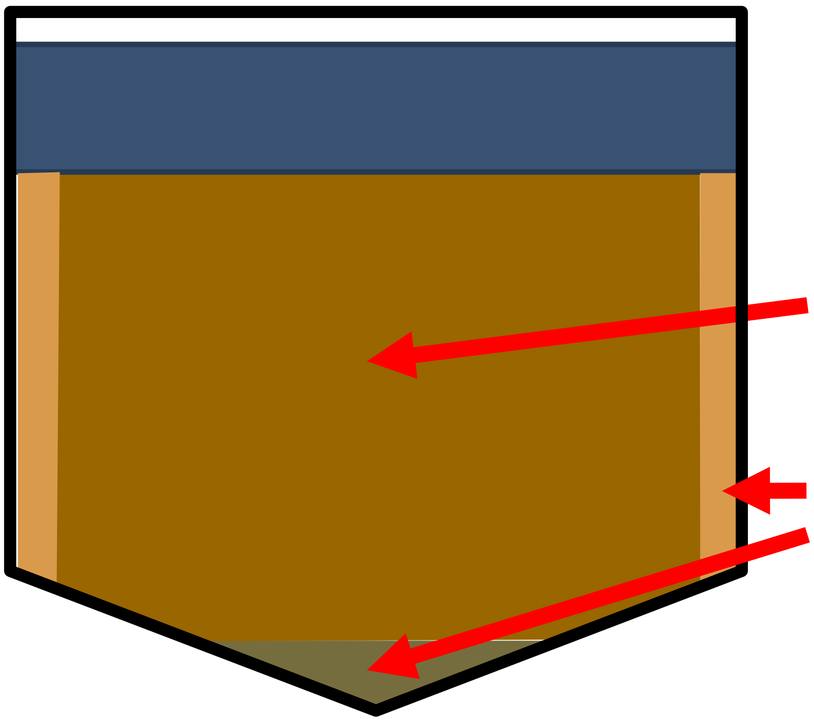
Design Digester Loading Conditions

Table 5.8-2 Basis of Design – Anaerobic Digestion – Loading Design Year 2040

Solids Loading	Annual Average	Peak 14-day
Volumetric Flow Rate, gpd	187,569	234,616
Total Solids Load (lb-TS/day)	140,789	176,103
Volatile Solids Load (lb-VS/day)	105,377	131,965
Volatile Fraction (lb-VS/lb-TS)	0.75	0.75
Total Solids Conc. (lb-TS/lb-solids)	0.09	0.09

→12 day SRT under peak loading conditions (MAX14)

Digester Sizing Considerations



RVE containment = ??% of volume

Active digestion volume = defined based on mass loads and desired SRT

Grit and mixing inefficiencies = 5% of volume

NOT TO SCALE

Continued Study of Volume Expansion

Basis of Design Allowance for Volume Expansion

- Primary Digesters = 5%
- Secondary Digester = 15%

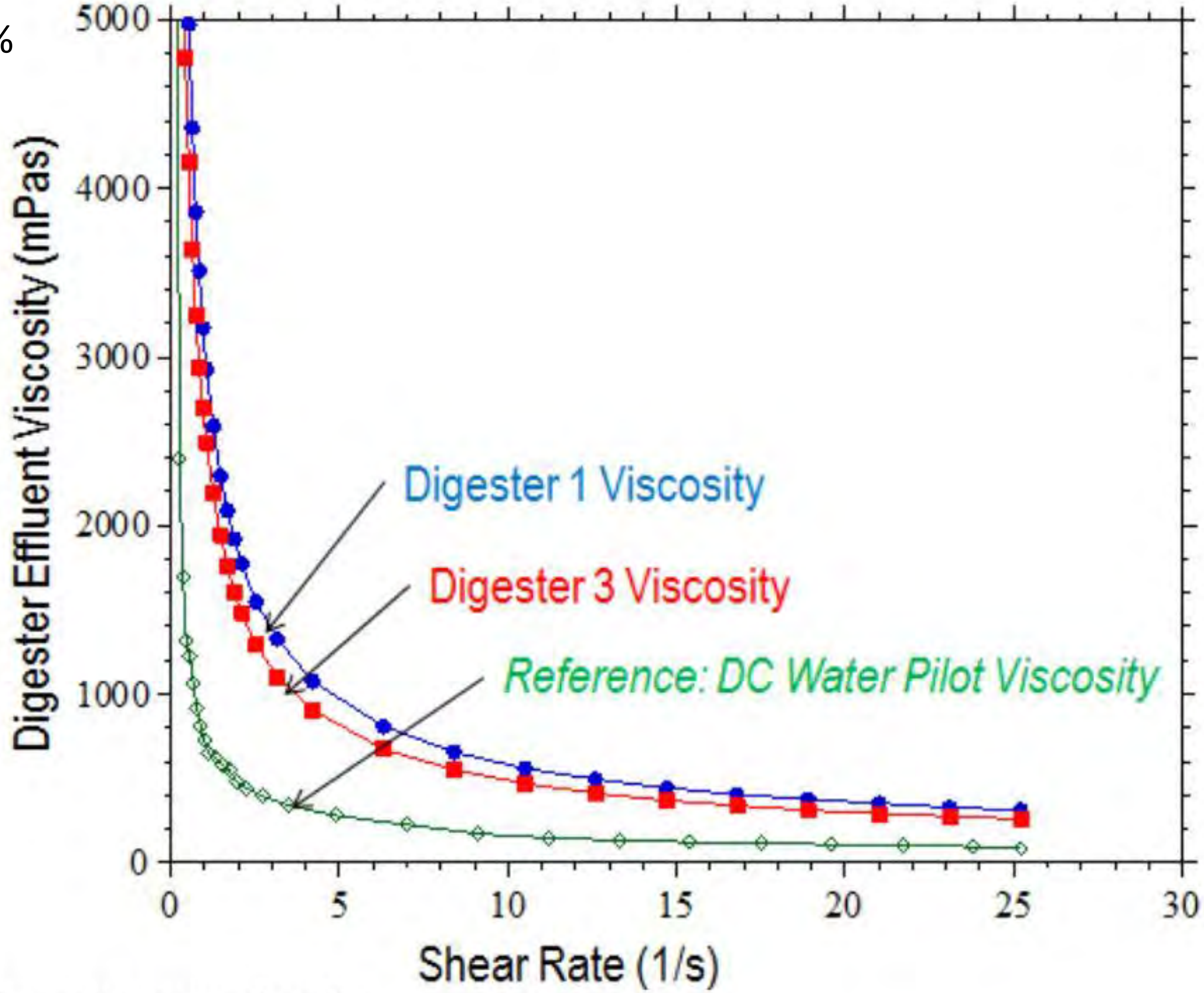


Figure 2: Shear rate versus viscosity

Reference: Moline, C., Higgins, M., Selock, K., Belschner, D., Hentz, L., and Balchunas, B., *Centralized Biosolids Processing with Thermal Hydrolysis and Anaerobic Digestion*, Proceedings 2018 Water Environment Federation Residuals and Biosolids Conference, Phoenix, AZ, May 2018

Continued Study of Volume Expansion

Butyric acid	0.4	0.3	0.2
Isovaleric acid	1.3	1.5	1.2
Al (mg/L)	1,760	1,920	2,130
Fe (mg/L)	950	960	710
Ca (mg/L)	1,890	1,720	1,850
Mg (mg/L)	300	300	310

The viscosity of all the WSSC biosolids mixtures was higher than expected (Figure 2). The viscosity of the DC Water pilot digester operated previously at Bucknell is shown on Figure 2 for comparison. Volume expansion during a no-mix condition resulted in about 30% volume expansion, which is some of the highest values seen in the Bucknell laboratory.

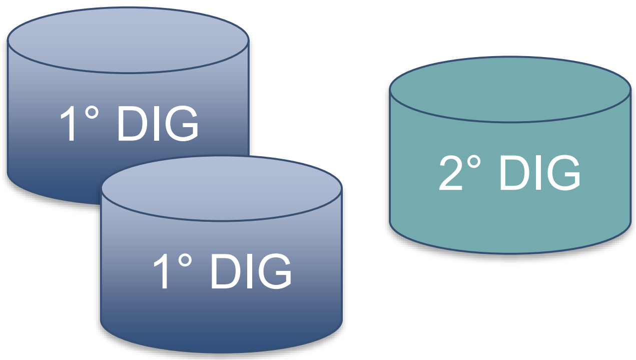
Based on this work, the project team selected to design the digestion system to accommodate up to 30% total volume expansion.

Reference: Moline, C., Higgins, M., Selock, K., Belschner, D., Hentz, L., and Balchunas, B., *Centralized Biosolids Processing with Thermal Hydrolysis and Anaerobic Digestion*, Proceedings 2018 Water Environment Federation Residuals and Biosolids Conference, Phoenix, AZ, May 2018

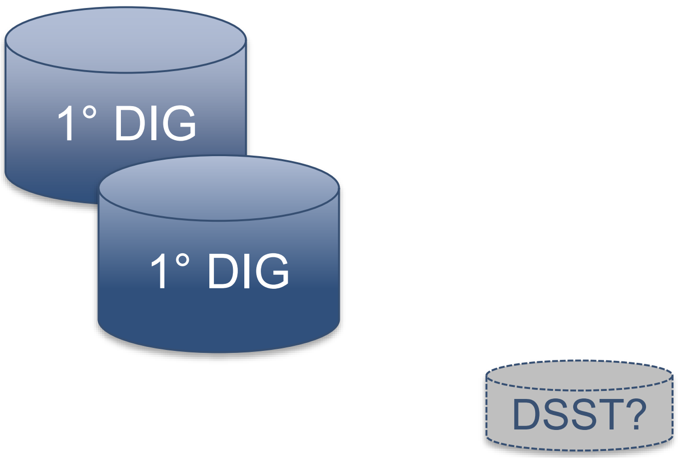
Digester Configuration

Is there value in a 2-tank Solution?

Basis of Design



2-Tank Solution

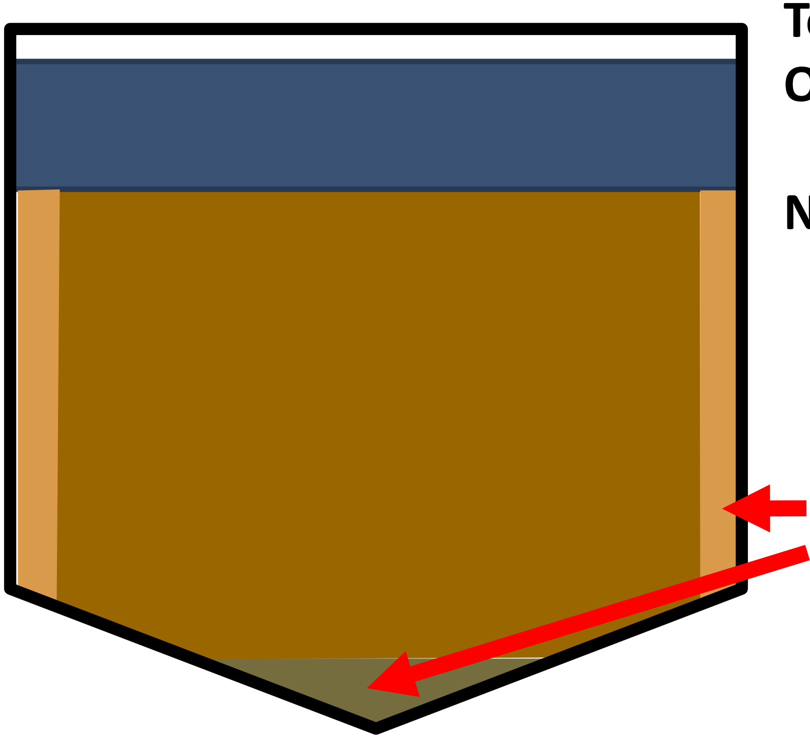


2-Tank solution is the best value for WSSC

	72-ft x 50-ft	74-ft x 50-ft	76-ft x 50-ft	78-ft x 50-ft	81-ft x 50-ft
In-Tank RVE	7%	13%	19%	26%	36%
3rd Tank Required for RVE?	Yes		No		
Total Tank Cost*	$7.5M	$7.65M	$5.16M+	$5.30M+	$5.5M

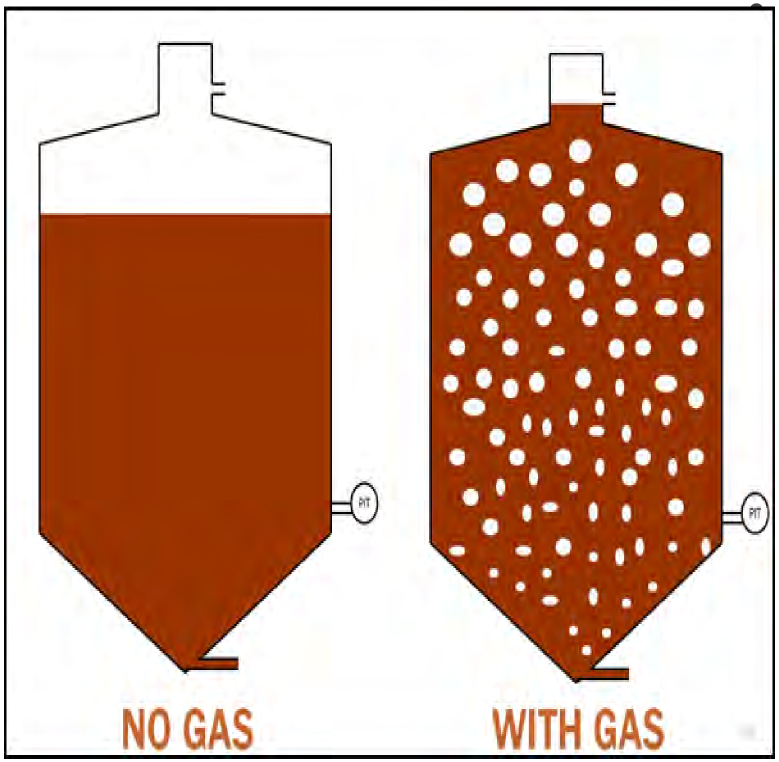
***With the 2-tank solution, additional savings can be realized from less mixing, building, pumps, and piping/valves.**

Digestion Configuration Selected



RVE Containment Approach

Rapid volume expansion (RVE) can be more problematic in THP+MAD systems



Impacts can be exacerbated in tall tanks with limited headspace.

Typical causes:

- Digester startup
- Stopping digester mixing
- Changing mixing intensity
- Poor mixing/inconsistent mixing
- Sudden temperature/pressure changes

Rapid Volume Expansion

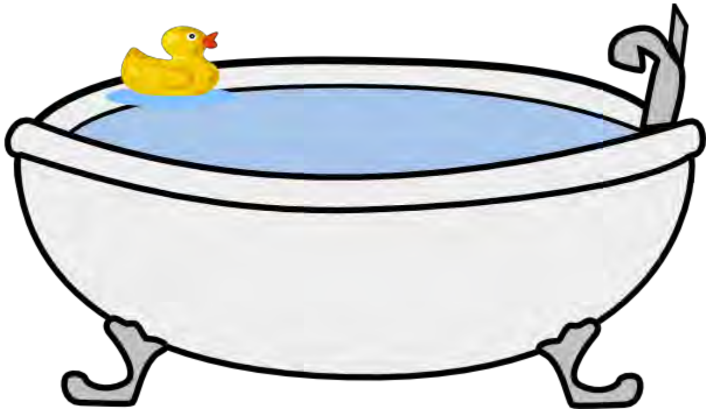
What Does a RVE Event Look Like?

What Does a RVE Event Look Like?

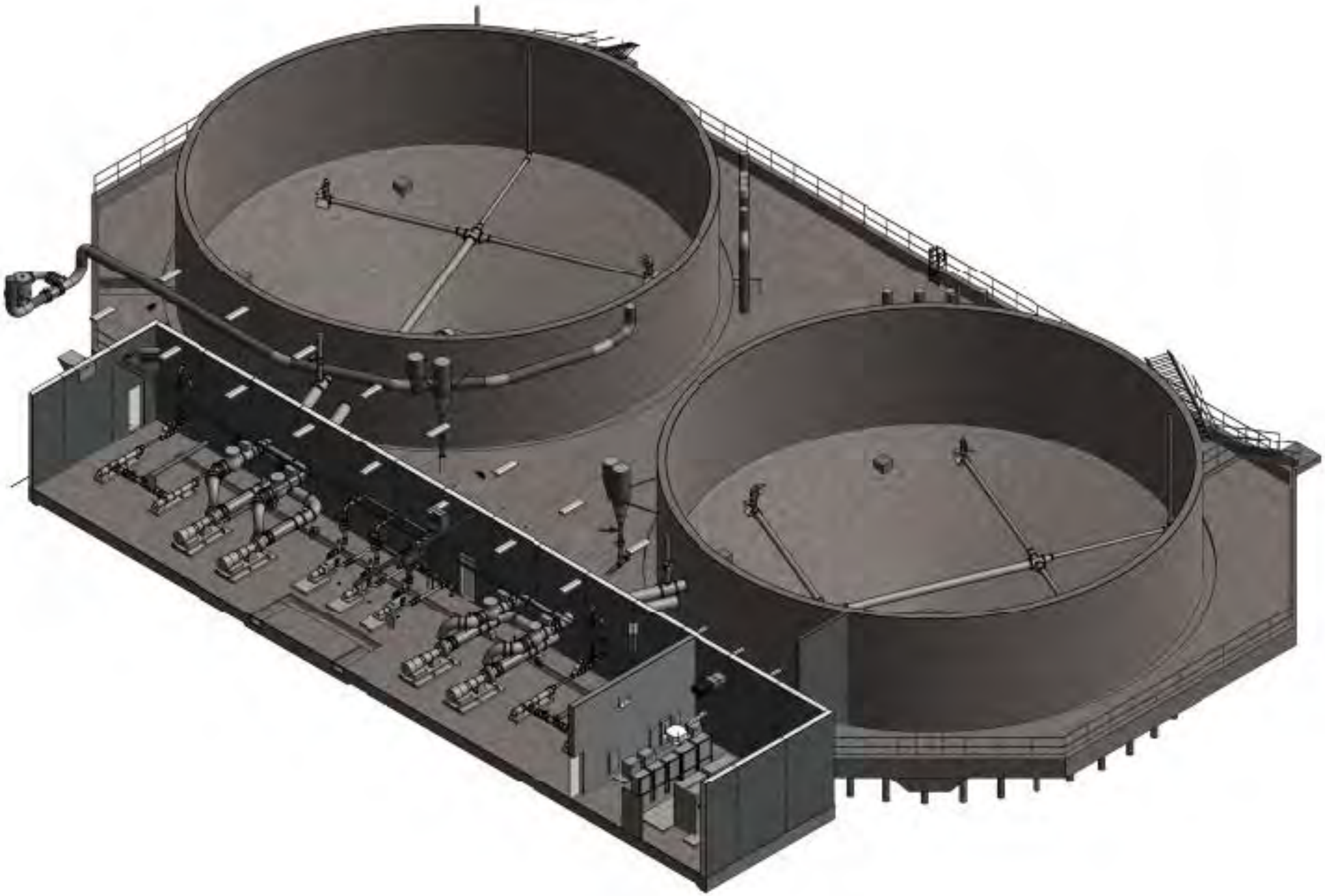
What Does a RVE Event Look Like?

26% In-Tank RVE…where does the rest go?

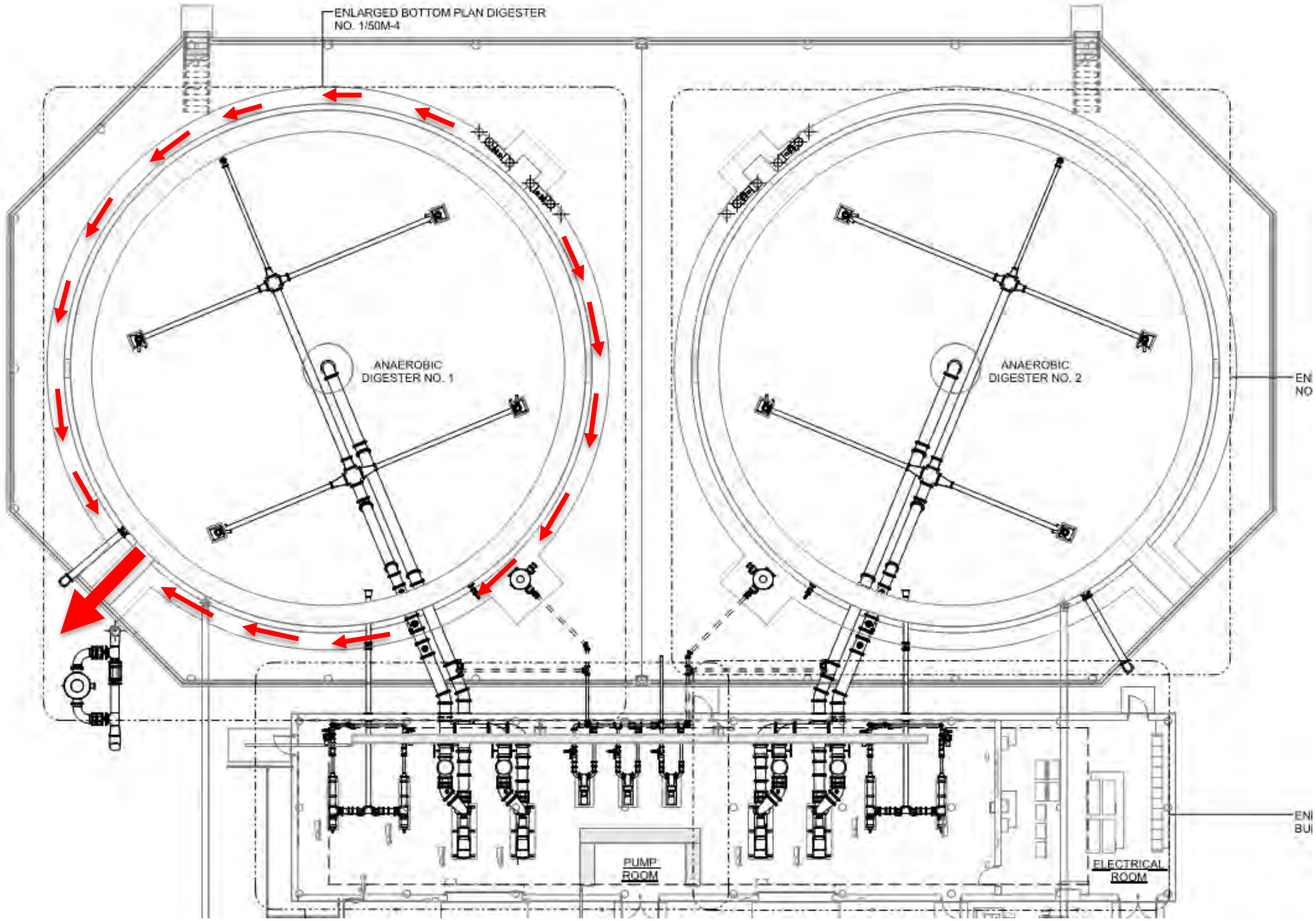
In the bathtub!



60% Design
Digester Containment for 26-30% RVE



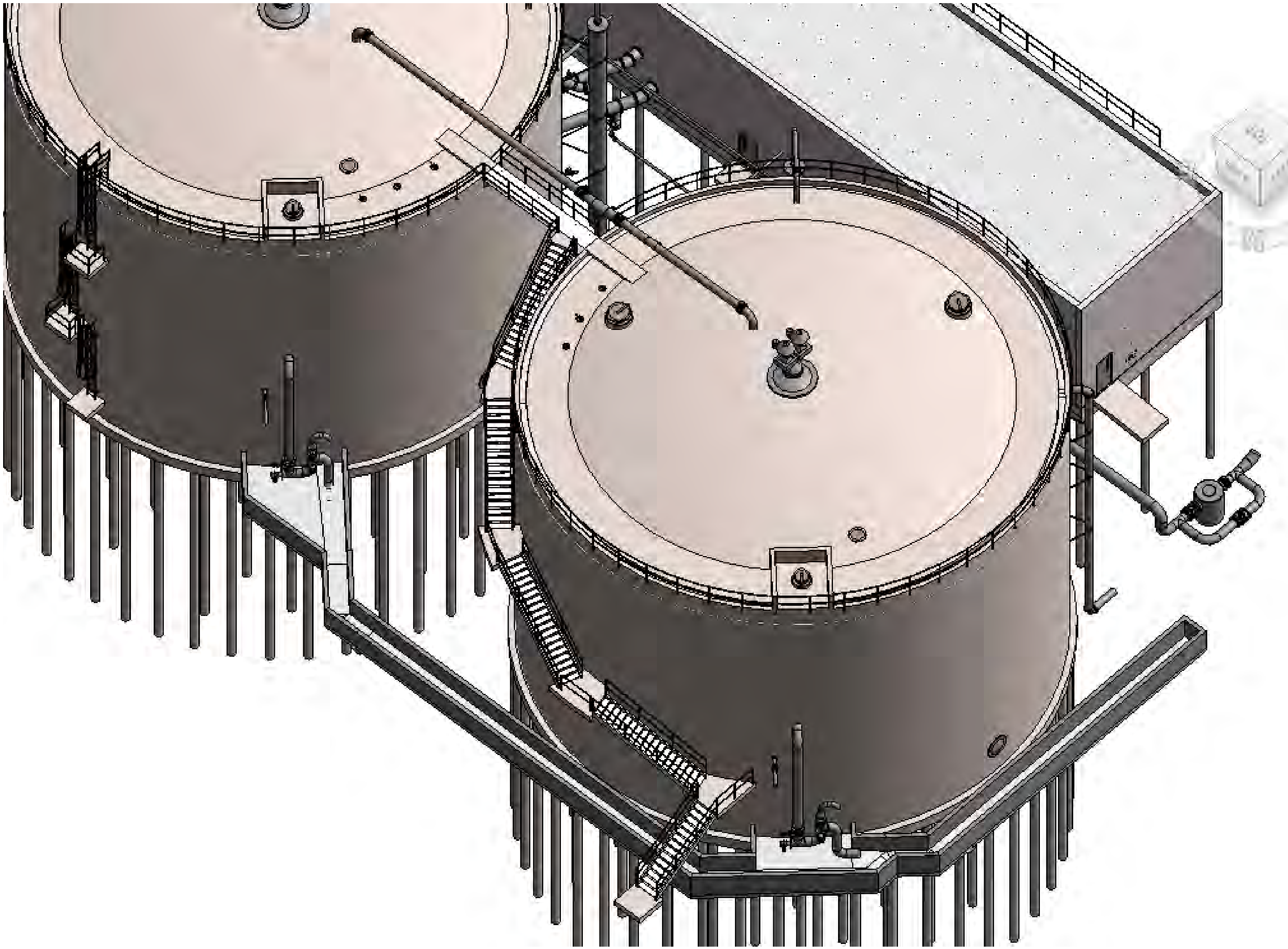
Digester Overflow and Containment



Balancing Risk and Investment…

- Do we need full volume containment?
- What are the maintenance impacts?
- What are the cost impacts?
- Can we contain the excess liquid from leaking but not all of the volume?

→Resulting solution to <u>convey</u> the excess RVE but not <u>contain</u> the full volume



Conclusions and Next Steps

Conclusions and Next Steps

Acknowledgements

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  - Amy Hanna
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  - Chris Muller

Questions?

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