Brown AND Caldwell

NEBRA Lunch and Learn Series

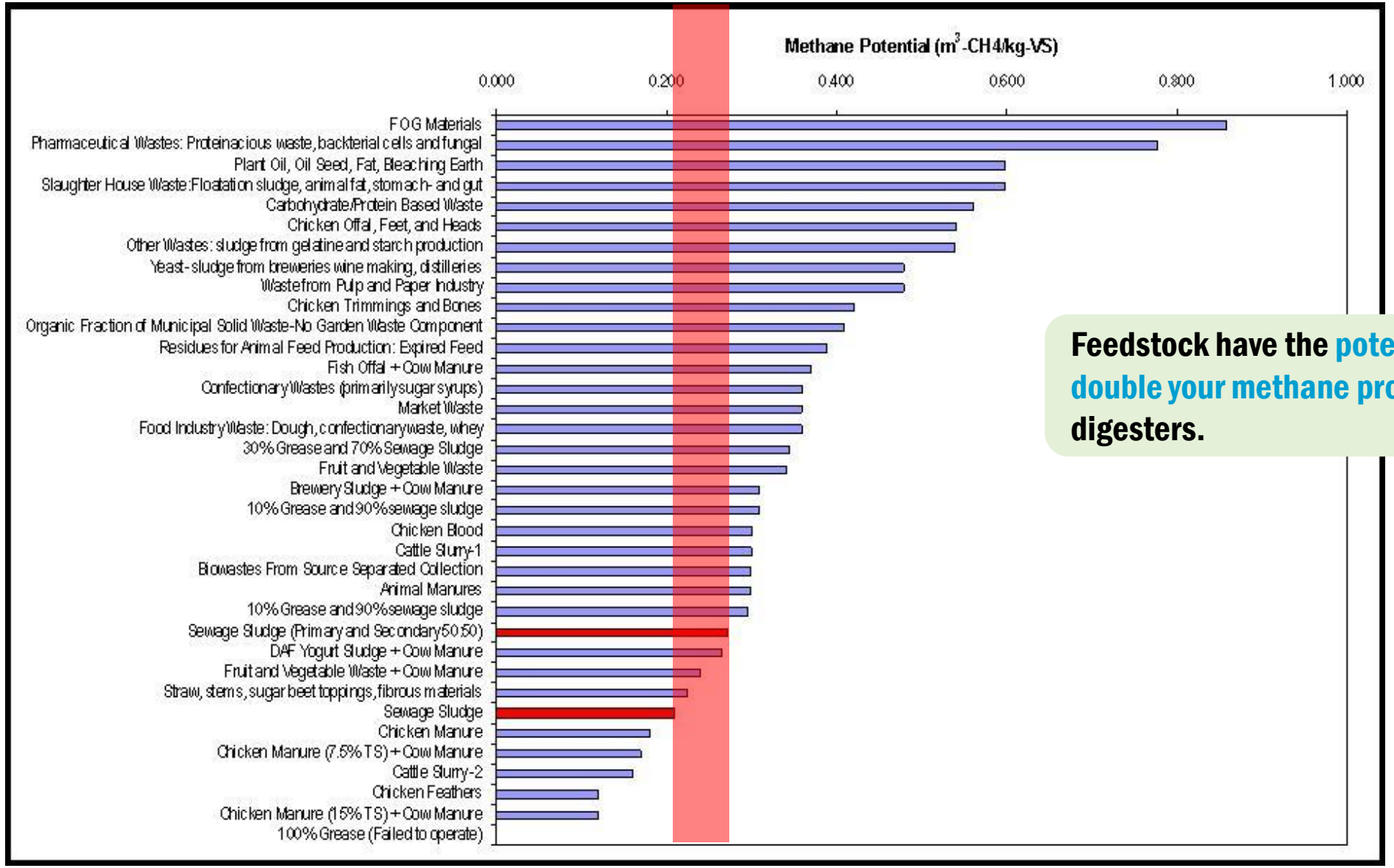
So, I want to put something other than sludge in my digester. How do you decide?

January 08, 2021

AGENDA

- Process Approach to Feedstock Selection
  - Chris Muller, Brown and Caldwell
- Project Approach to Feedstock Selection
  - Wine or Vinegar – The Practical Challenges and Solutions that Result in Co-digestion Success or Failure
    - Bob Wimmer, Energy Systems Group
- Questions

The promise of alternative feedstock acceptance



Feedstock have the potential to more than double your methane production from your digesters.

Growing evidence suggests synergistic digestion reduces overall biosolids production with co-digesiton

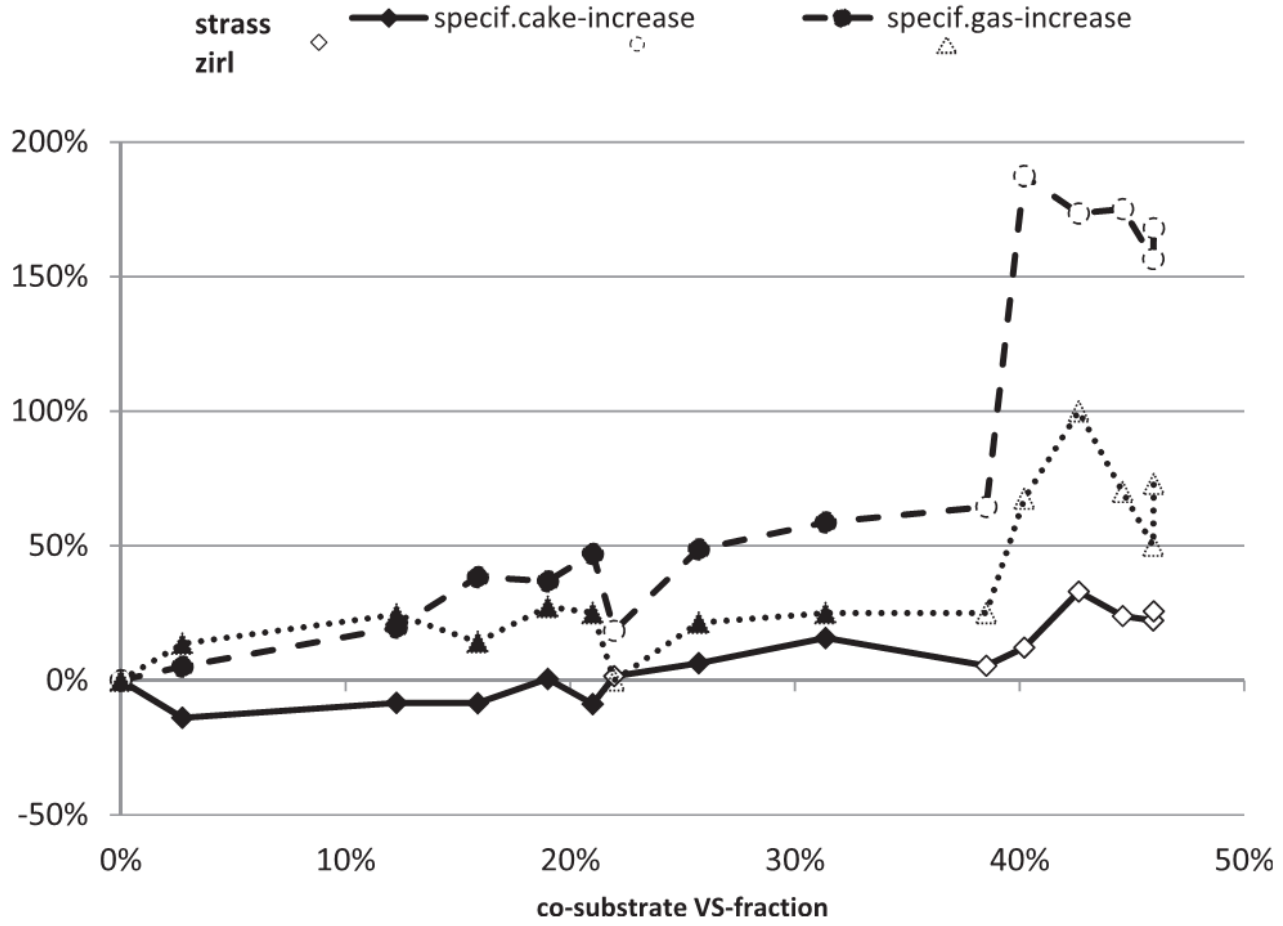


Fig. 4. Specific biogas production, cake production and ammonia return load based on co-substrate addition for Zirl WWTP and Strass WWTP.

- Original observations came from Millbrae, CA with introduction of FOG,
- Aichinger (2015) – noted reduction in sludge production with organic waste addition up to 20 percent of VS load
- Hypothesis is that the carbon to nitrogen ratio is improved making the process more effective.

Citation: Aichinger et al (2015), Synergistic co-digestion of solid-organic-waste and municipal sewage-sludge: 1 plus 1 equals more than 2 in terms of biogas and solids reduction" Water Research, 87, 2015, 416-423.

Is synergy a C:N issue, or is it more complex?

Table 3—BMP results.

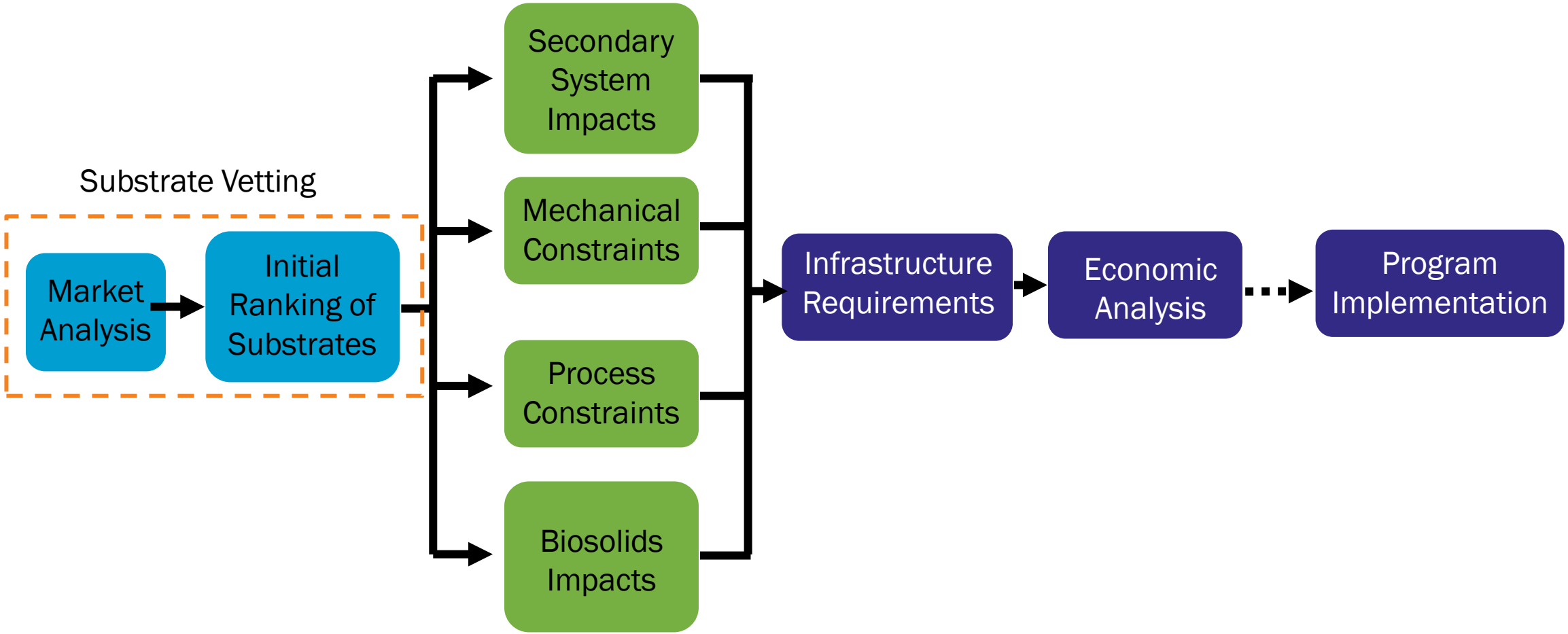
Waste	Concentration range tested (g COD/L)	BMP (mL CH_4/g COD)	Biogas methane (%)
ADF	0.50 to 2.2[a]	350 ± 30	61 ± 15
Yeast production	0.50 to 2.5	2270 ± 340[b]	60 ± 3
Food flavorings production	0.05 to 0.25	940 ± 450[b]	69 ± 1
Restaurant	0.60 to 12	490 ± 260	68 ± 2
Brewery	0.50 to 2.5	410 ± 20	58 ± 6

[a] Higher concentrations caused inhibition and lower BMP values (Zitomer et al., 2001).
[b] Suspect value that is significantly greater than the theoretical maximum of 400 mL CH_4/g COD.

- Zitomer (2008) – noted enhanced methane production with the digestion of yeast waste with sewage sludge, 4-18 percent additional COD destruction needed to balance.
- Attributed the improved digestion to supplemental nutrients and co-factors in yeast from production process
- Produced more gas than is theoretically possible without digestion of the sludge

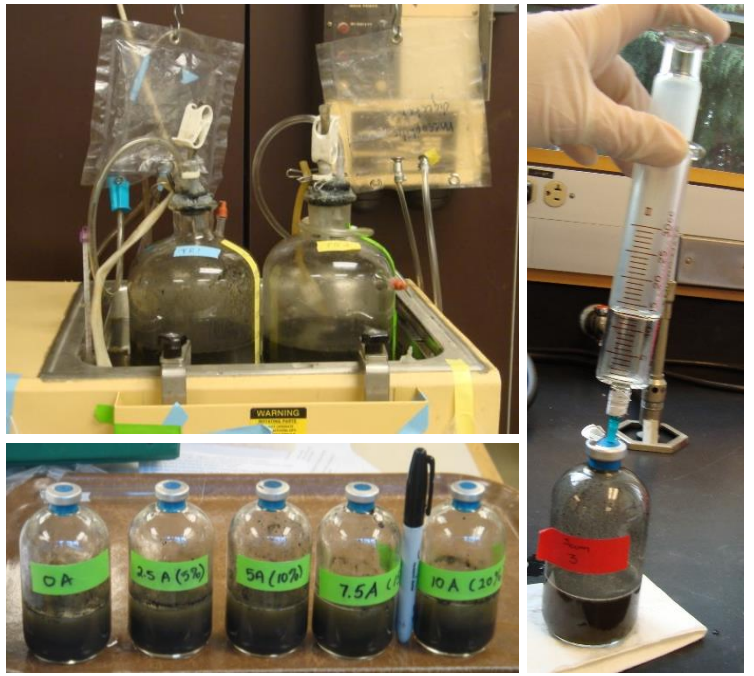
Citation: Zitomer et al (2008), Municipal Anaerobic Digesters for Codigestion, Energy Recovery, and Greenhouse Gas Reductions" Water Environment Research, 80, 3, 229-237.

When we started co-digestion 10+ years ago, we had a basic model for developing co-digestion projects.



A maturing industry practice is now providing additional information surrounding feedstock

Peer Facilities in Operation



Ever growing body of fundamental university research

The value of these pieces of information are relative to where you are in program development and execution.

In the interim period additional considerations have entered the solids management sector

Rapid Volume Expansion (RVE)

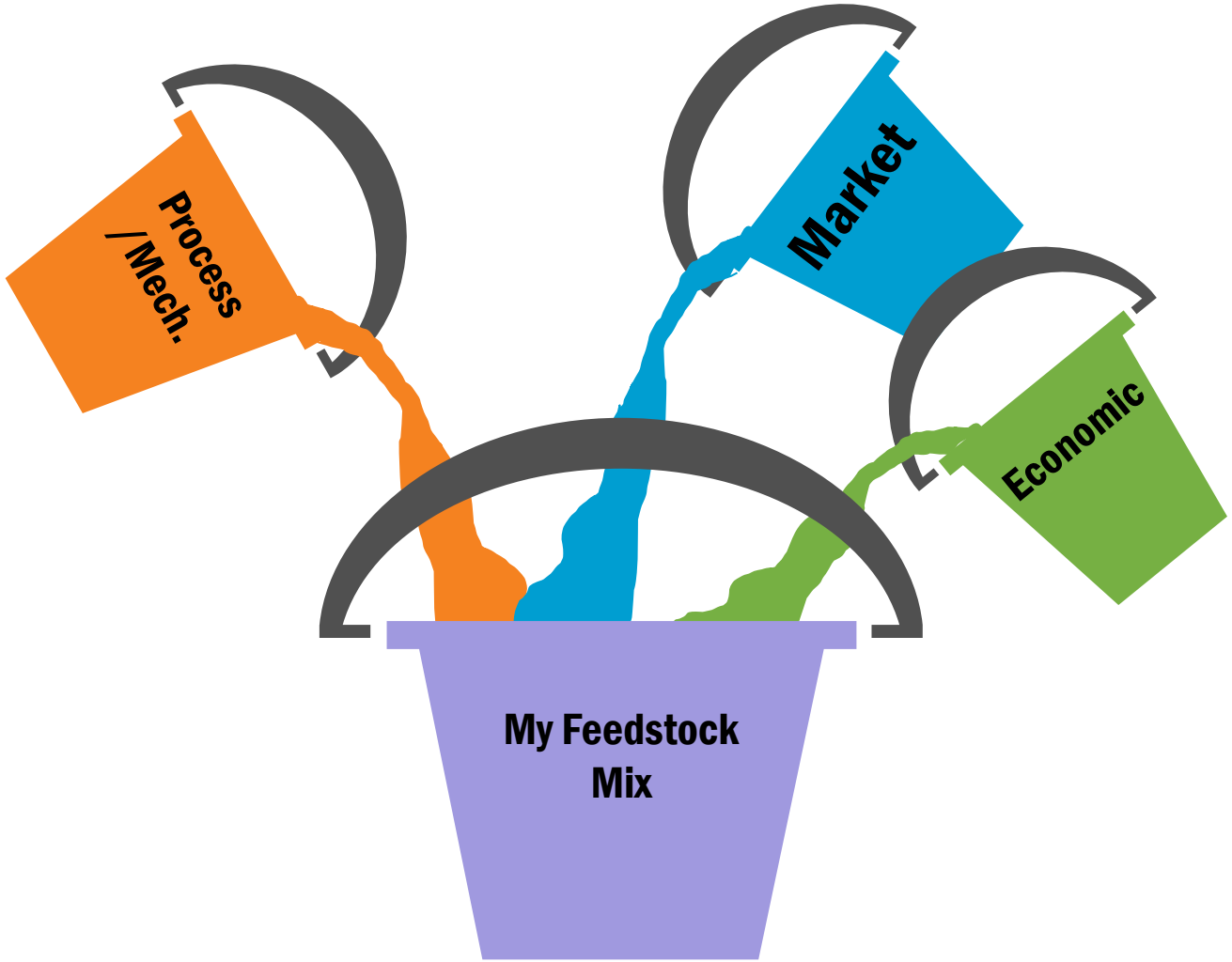
Organics Diversion/Organic Bans

Regional Changes in Biosolids Management Opportunities

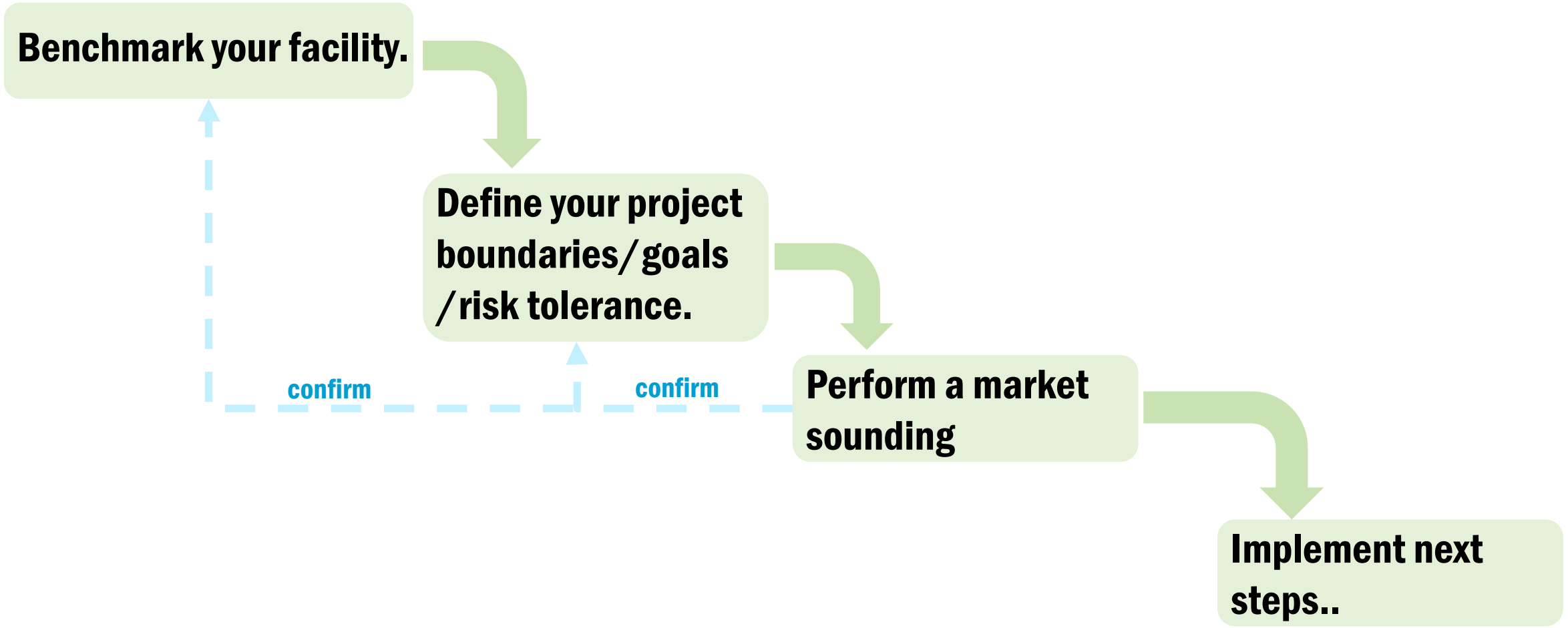
Renewable Identification Numbers (RINs)

PFAS and other CECs

You must balance several factors to get the right mix for your facility.



An approach to selecting your feedstock mix.

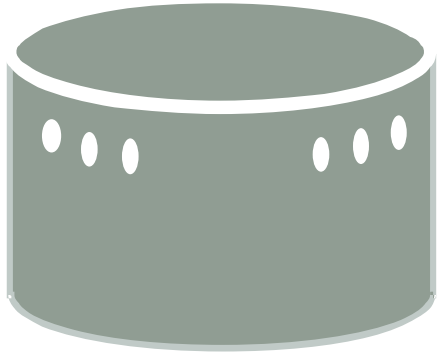


Benchmarking for feedstock vetting: What do I have and what do I need?

Heating Systems

Biogas Systems and Use
AIR PERMITS!!!!

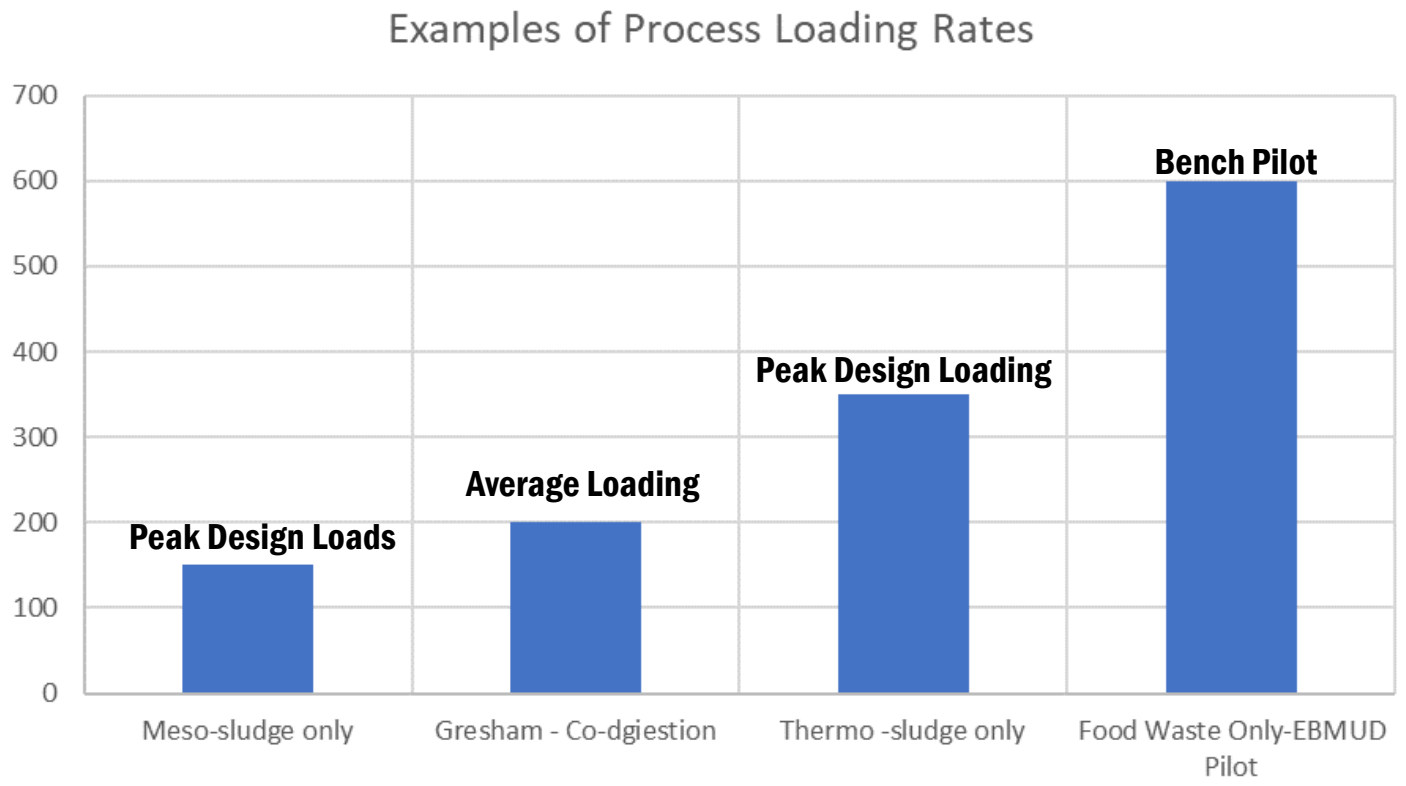
Receiving Facilities
Pre-processing Facilities



Dewatering Capacity
Cake Prosperities
Biosolids Aesthetics

Organic Loading Capacity
Hydraulic Capacity
Ammonia-N
Phosphorus
Sulfur
Mixing

Process Considerations: How much can I take?



Contributing Factors

- HRT (or SRT) – primarily limited by the 503's

Work Around:
Recuperative Thickening

-decouples HRT and SRT, allows for lower strength wastes to be processed

Looking deeper into the characteristics of feedstock show potential issues that can arise

Parameter	ATAD Sludge	Primary Scum	Flower and Vegetable Waste	Blood Product	Rendering DAFT Float	Grease Trap (FOG)	Tallow Tank Residual	Chili, Soup mfg DAF	Confectioner Waste
BOD (mg/L)	12,500	277,000	33,200	51,300	95,700	209,000	63,500	13,900	760,000
COD (mg/L)	45,800	839,000	112,000	100,000	393,000	372,000	239,000	285,000	1,830,000
HEM (mg/Kg)	2,270	568,000	N/A	1,300	10,200	N/A	27,600	97,400	123,000
Ammonia-N (mg/kg)	986	55.2	1,930	10,100	1,440	765	1,830	1,980	2,010
pH	6.8	4	4.8	7	12.4	12.4	5.5	3.9	6.2
TS (percent)	3.1	64.3	11.3	8.7	18.4	21.2	25	19.7	100
Volatile Solids (percent)	74.0	97.9	85.5	57.5	70.1	65.7	98.3	96.8	97
TKN (mg/kg)	1,750	1,240	28,300	142,000	16,000	10,200	12,900	36,300	25,700
Total Phosphorus (mg/Kg)	738	446	3,460	4,700	1,570	841	809	2,710	3,330
Soluble Phosphorus (mg/kg)	72.2	91.1	136	2690	86	60.4	465	320	324

Materials Characterization

- Considerations for sampling
  - How was the material collected?
    - Ex. FOG pump-out, pump-back
  - How did you collect the material?
    - Composite?
    - Dump, mix, sample?
  - Food processing Operations
    - Some processors change seasonally
- Getting a representative sample.

How does my selected feedstock mix?

FOG floats when not adequately mixed

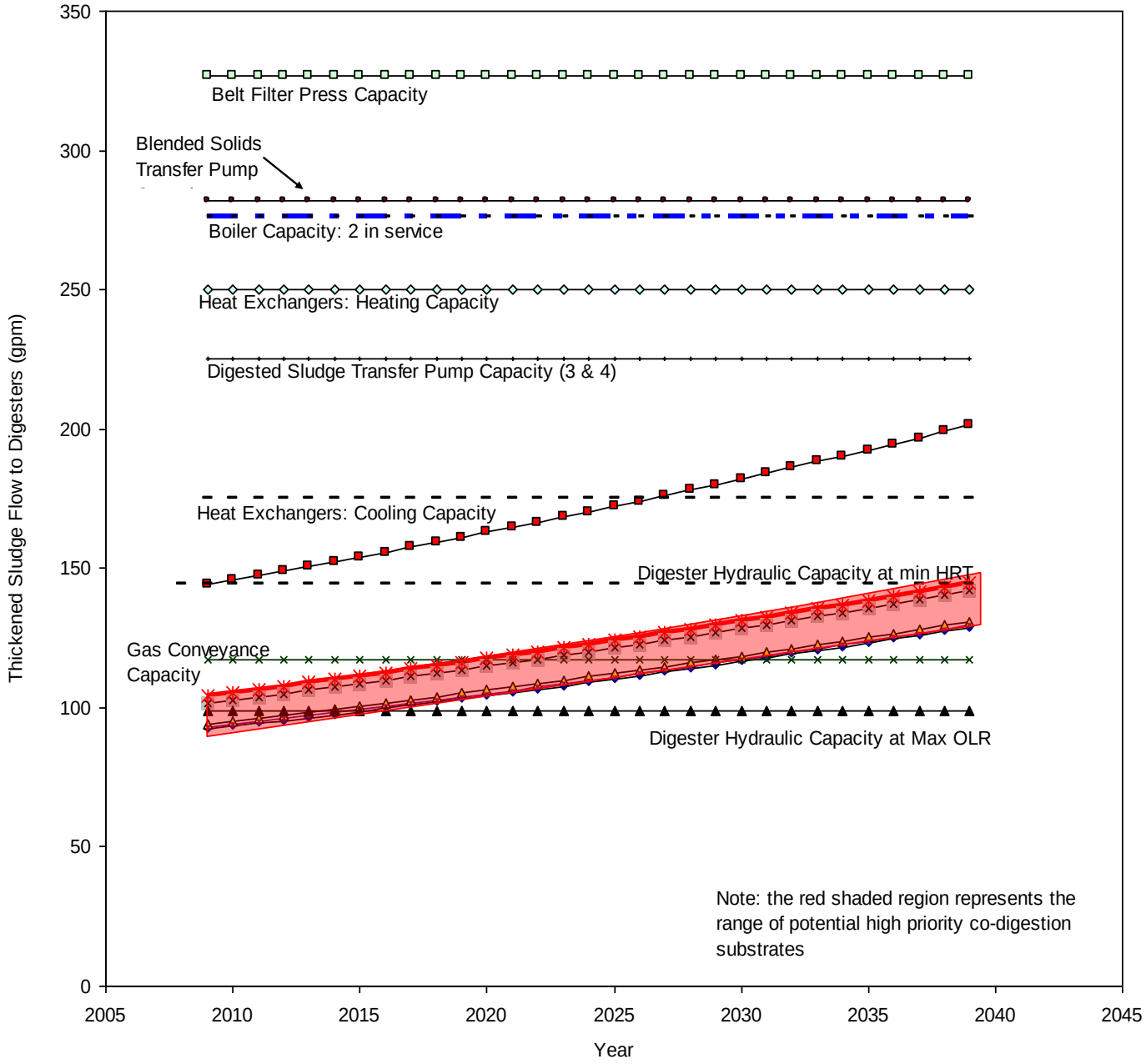
Feedstock Tanks: consider how you want to manage undesirable materials

Ex. FOG: homogenize but don't carry grit into the digester

Mixing impacts extend beyond stratification

- Biogas production
  - Inconsistent feed or episodic incorporation (ex. grease layer fold-in)
- Volume expansion potential
  - Significant inconsistency in biogas production
  - Changes in sludge viscosity
    - Increasing viscosity increases gas hold-up potential

In selecting your feedstock the quantity accepted or targeted may be impacted by other systems limits.



Biosolids implications

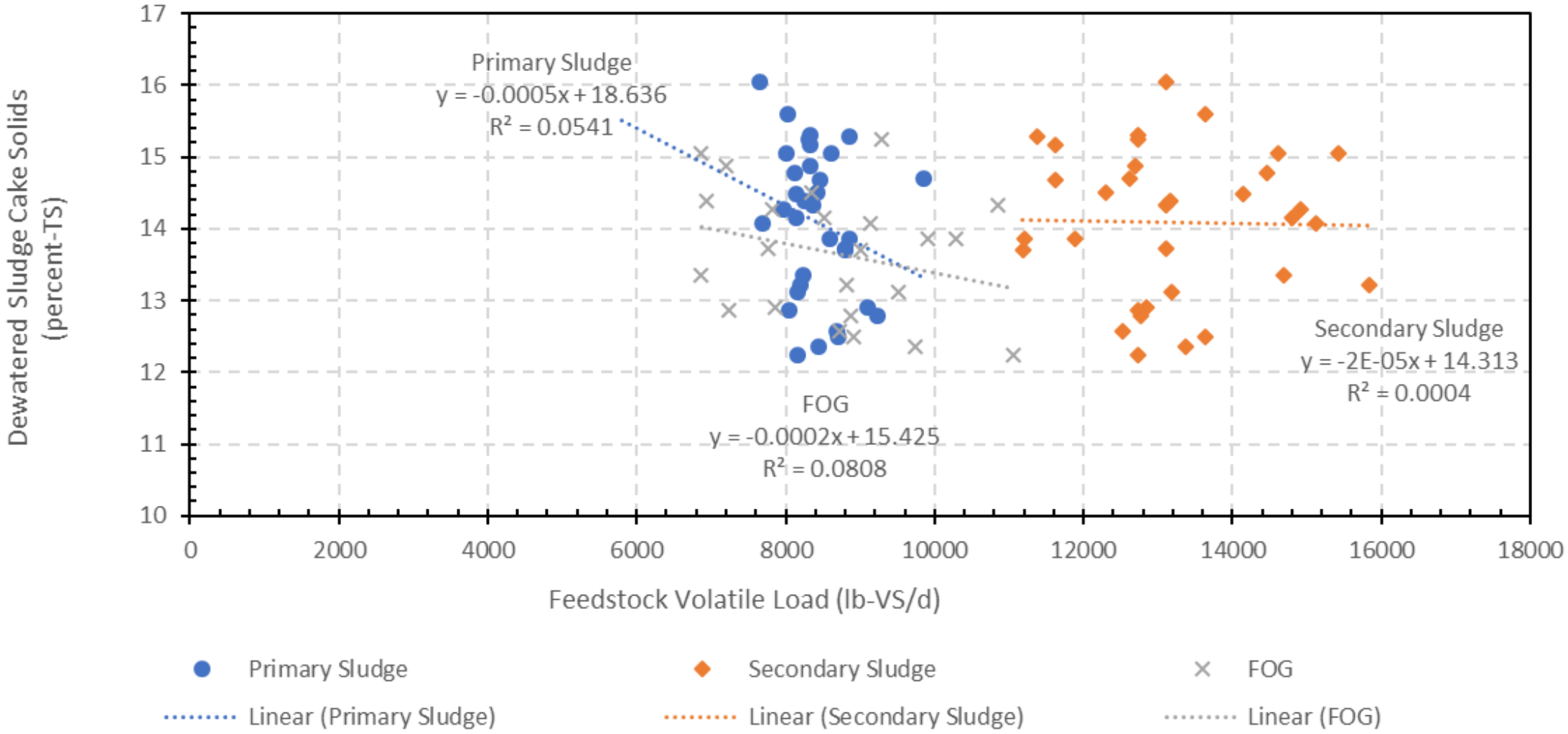
- Grit, glass, plastics, metals
- Dewatering implications
  - Whey materials have been found to reduce cake solids

Food Waste

BIOSOLIDS QUALITY?

Grease Trap Waste

Investigating the decreases in cake solids at a co-digestion plant, FOG did not appear to influence cake solids



Pretreatment needs are materials specific

Food Processing Waste

FOG/Grease Trap Waste

Screening

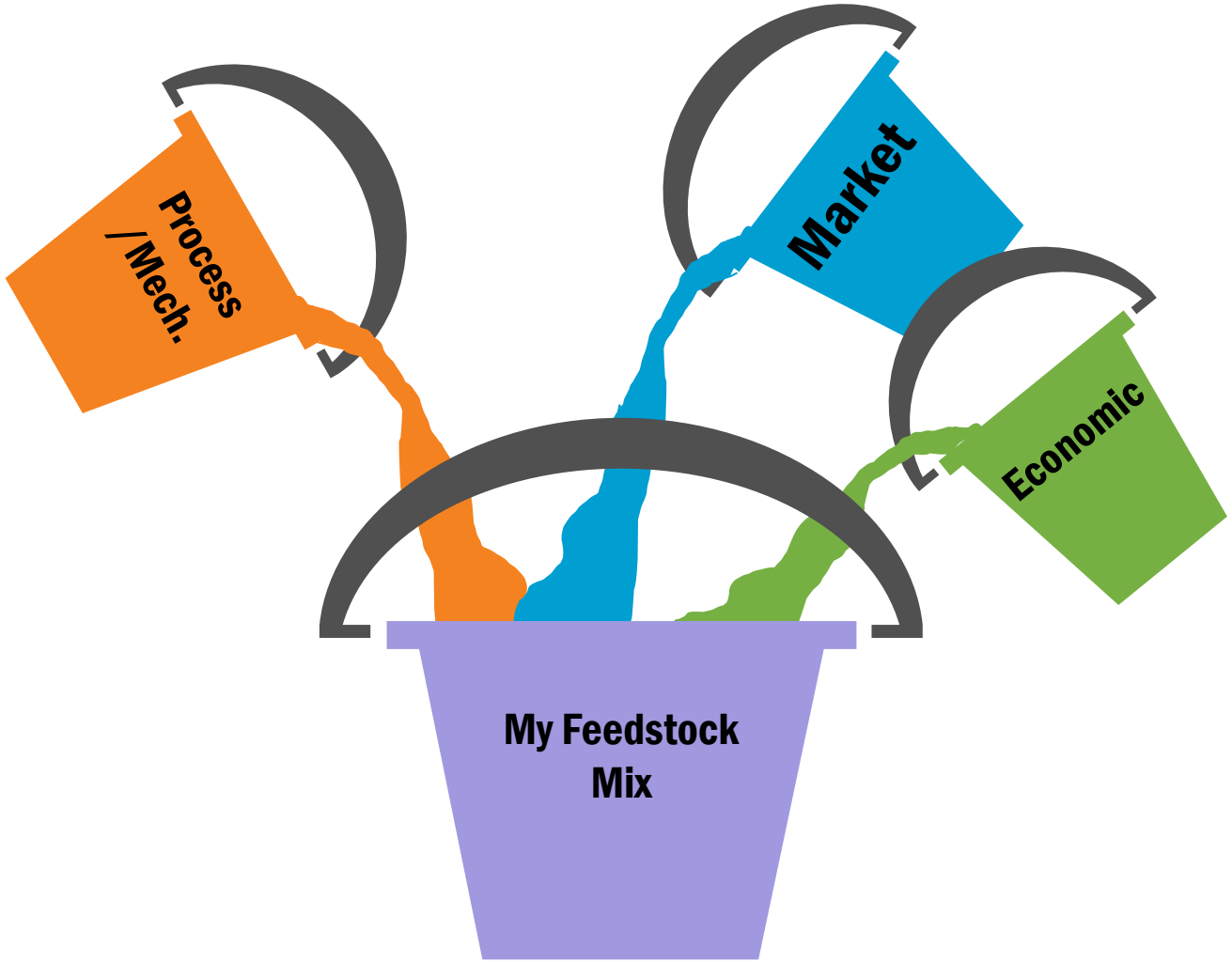
Fine Grit

Heavy Materials

Food Waste

Low Level → **Moderate Level** → **High Level**

You must balance several factors to get the right mix for your facility.



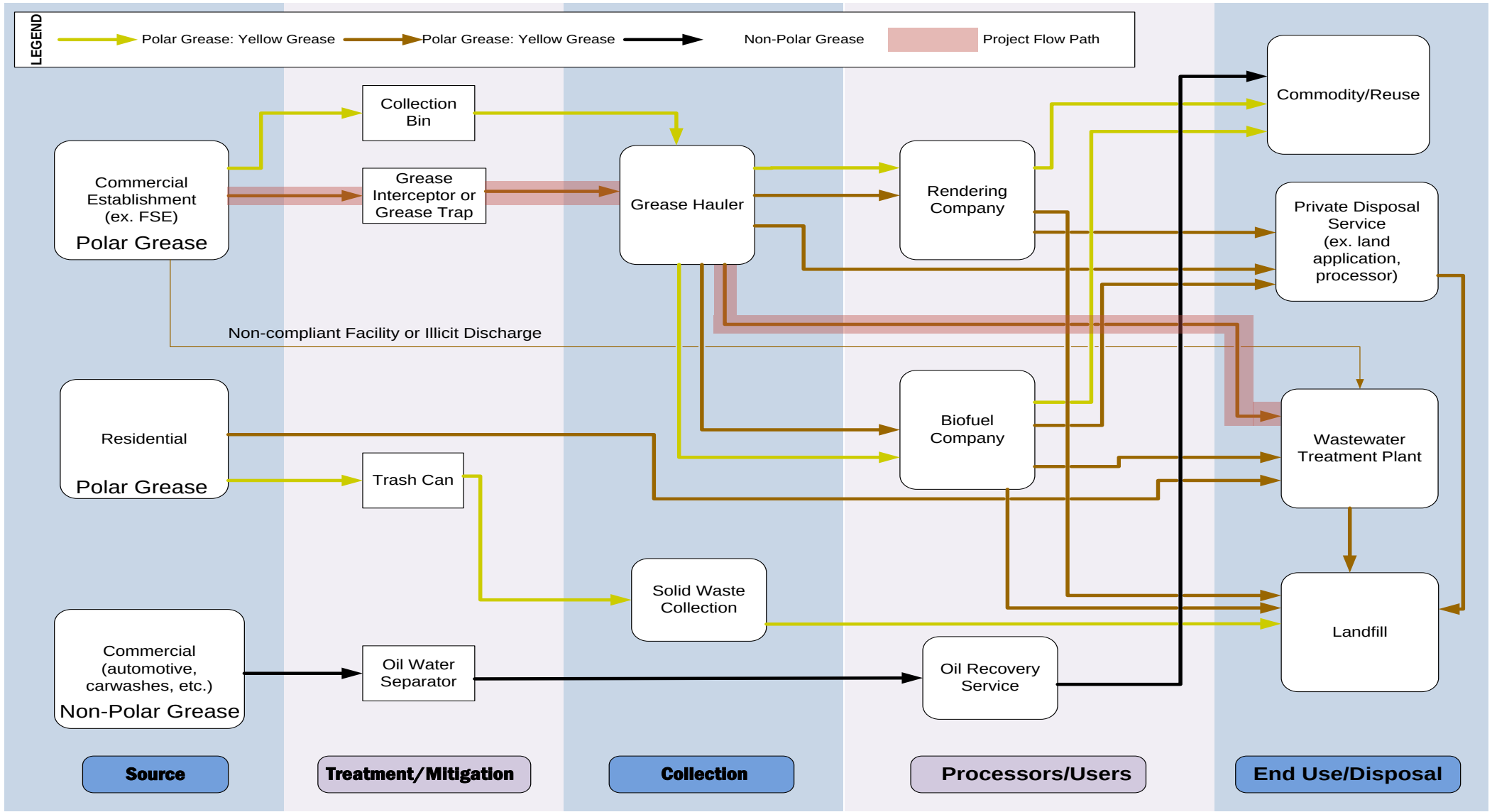
Why would you do a market study?

- Multiple elements to consider
  - Quantity and types of material
  - Current disposal practices
  - Current waste management and disposal rates
  - Other competition
    - municipality or private sector
- Good market study can identify new sources of materials
- Help understand participant drivers
- Identify risks and fatal flaws

Trucked waste offloading at Iona Island WWTP

Trucked waste screen at Iona Island WWTP

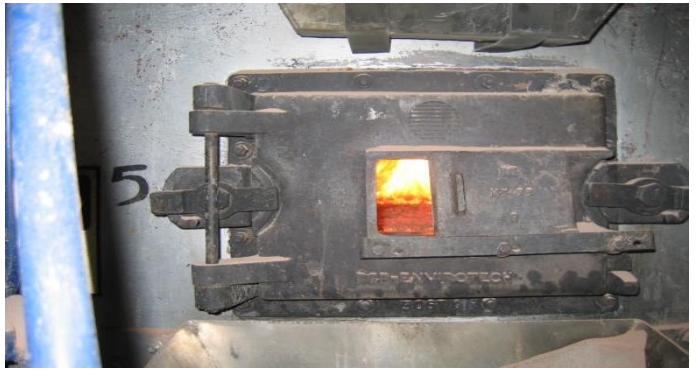
Organics disposal can be complex and have multiple competitive end-uses (ex. FOG)



Market Study- City of Bellingham, WA

- Project to design and construct a FOG receiving facility
  - Use FOG to offset the use of natural gas as a supplemental fuel to their multiple hearth incinerators
- Conducted market study
  - Used study to understand current FOG management practices
  - The study found that FOG was being collected in the market but the availability of the material was limited for the City
  - A Bellingham located facility did not work with the haulers business model
- Avoided installation of an under utilized or unutilized facility

Post Point Wastewater Treatment Plant, Bellingham WA



Multiple hearth incinerator at Post Point WWTP

Market Study- St. Petersburg, FL

- Accept FOG to co-digest with sludge to generate additional biogas for CHP and bio-CNG sale
- Evaluated FOG market
  - Highly competitive market
  - Large regional private sector FOG facility
  - Competitive market can result in financial risk
    - ex. proliferation of FOG facilities in San Francisco Bay area
- Recommended considering other sources of organics

Things to consider when you do a market study

- What data are you expecting to collect?
  - Volume
  - Pricing
  - Practices
  - Services
  - Access
- Be prepared for limited information.
- Approaches
  - In-person
  - Calling
  - Survey – was least effective

FOG being unloaded at Clean Water Services FOG Station

Rock trap at Santa Rosa, CA FOG station

Thank you

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978-983-2059

NEDR – Vetting AD Feedstocks

Wine or Vinegar – The Practical Challenges and Solutions that Result in Co-digestion Success or Failure

Bob Wimmer

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Co-digestion feedstock

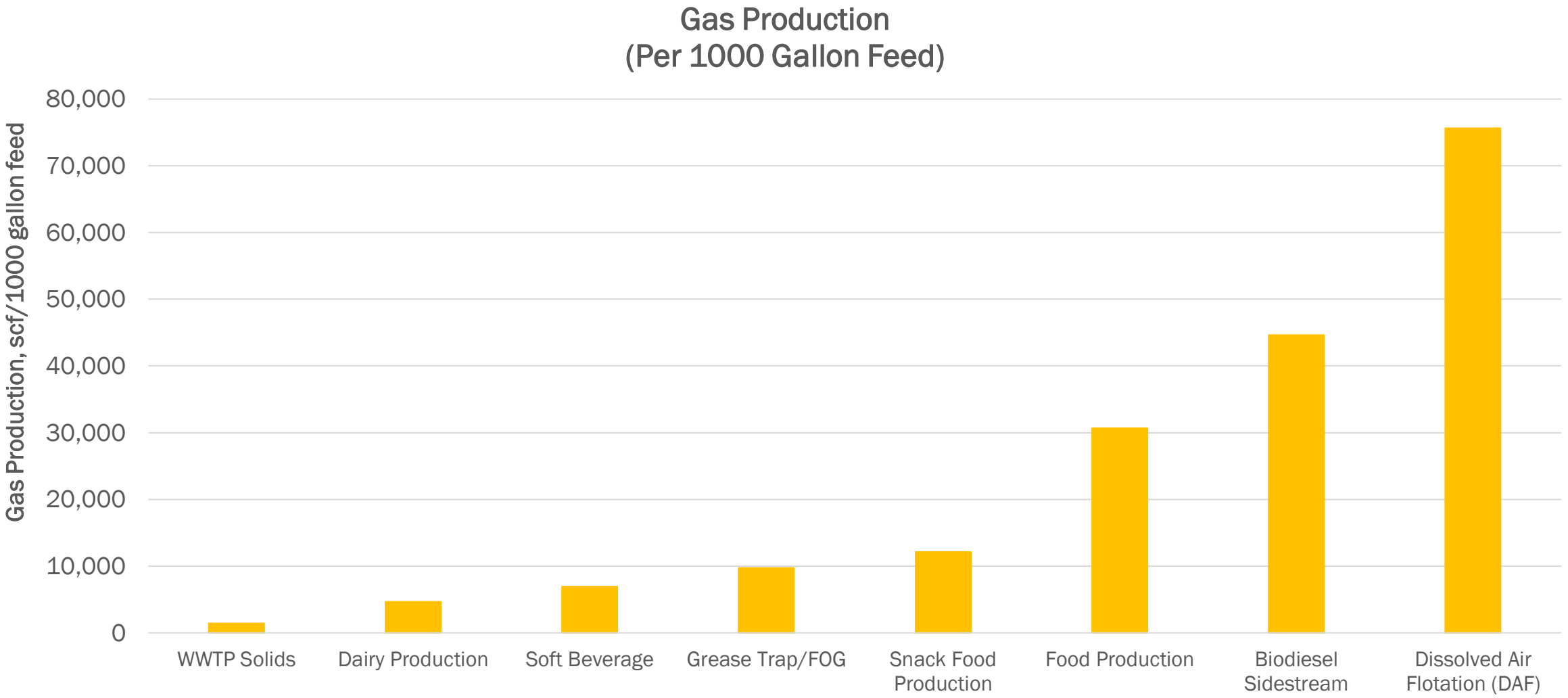
- Municipal sludge
- FOG – Grease interceptor waste
- Biodiesel waste
- Dairy processing waste – milk and eggnog
- Dairy DAF (bottling/milk products)
- Poultry DAF
- Soft drink/beverage (juice/soda)
- Snack food (chip/pretzel)
- Food production

Feedstock Characteristics

	TS (%)	VS (%)	VSR
Thickened primary solids	4 - 5%	80%	65%
Thickened WAS	4 - 6%	80%	35%
Grease trap waste	5%	98%	99%
Biodiesel	23%	99%	98%
Dairy DAF	4%	95%	95%
Poultry DAF/Sludge	18%	96%	97%
Food production waste	23%	99%	98%
Soft drink/beverage*	0%	99%	99%
Snack food production	10%	99%	98%

*75,000 mg/L COD

HSOW Contribution to Gas Production

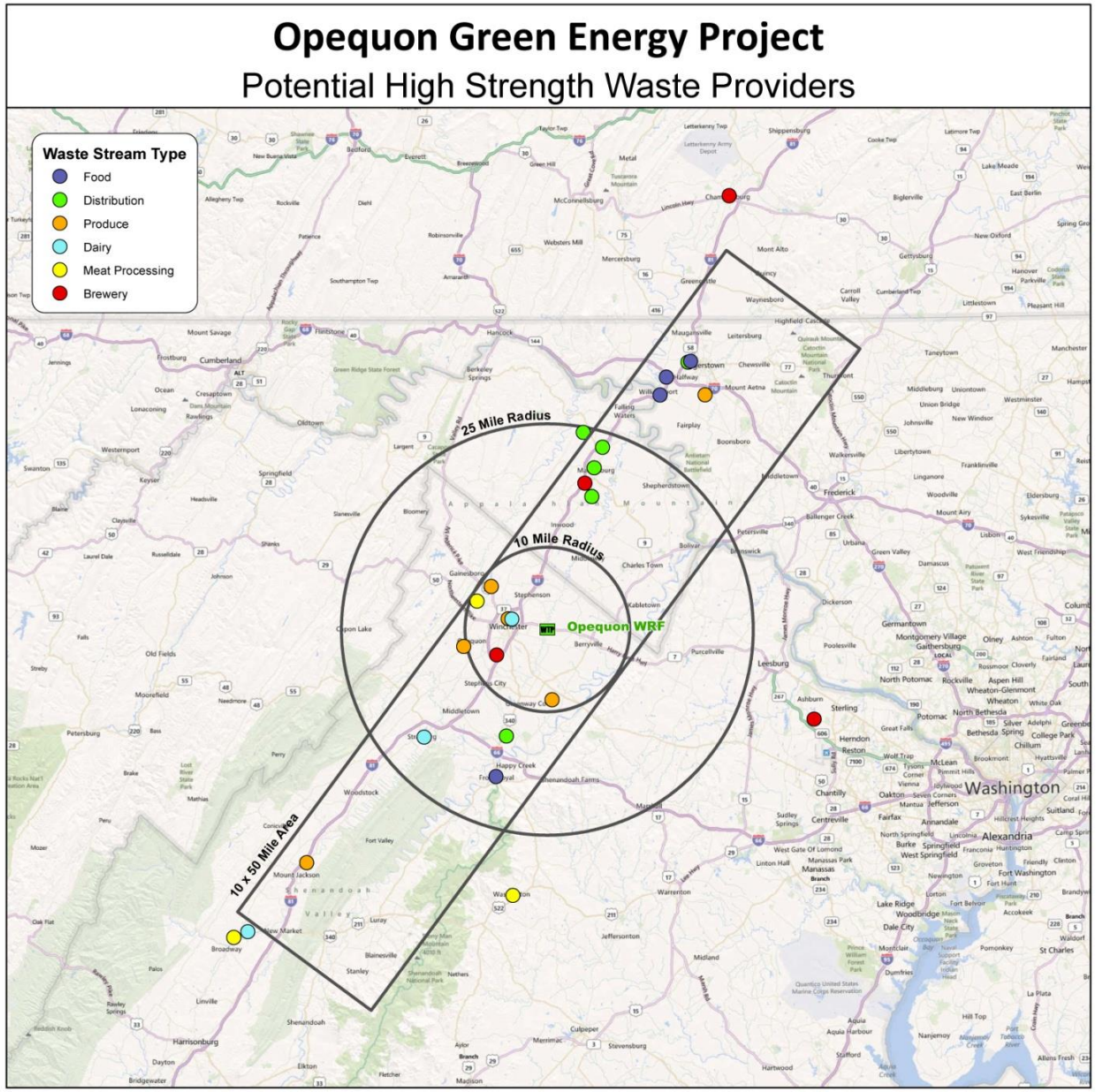


If you build it they will come

- If you talk about it they will ignore you
- If you design it, they may give you data
- If you construct it, they may talk with you
- If it operates, they may consider coming

Courtesy of Virginia Biosolids Council

Co-digestion process – Waste Identification



Find the Anchor Client

Organics and Contracts

- Grease Trap Waste: 5 contracts
- BioFuels: 2 contracts
- Dairy Waste: 3 contracts
- Poultry: 1 contract

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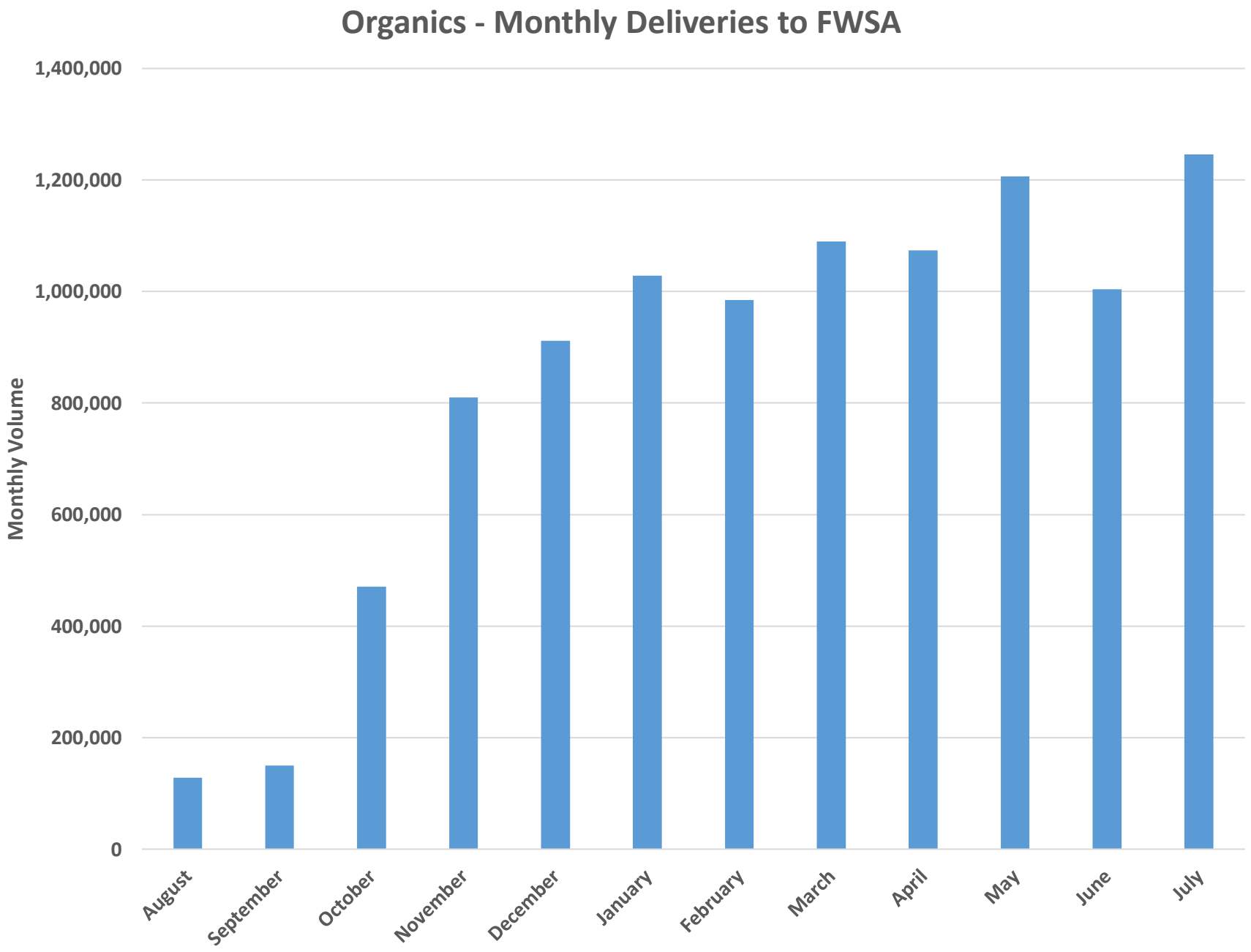
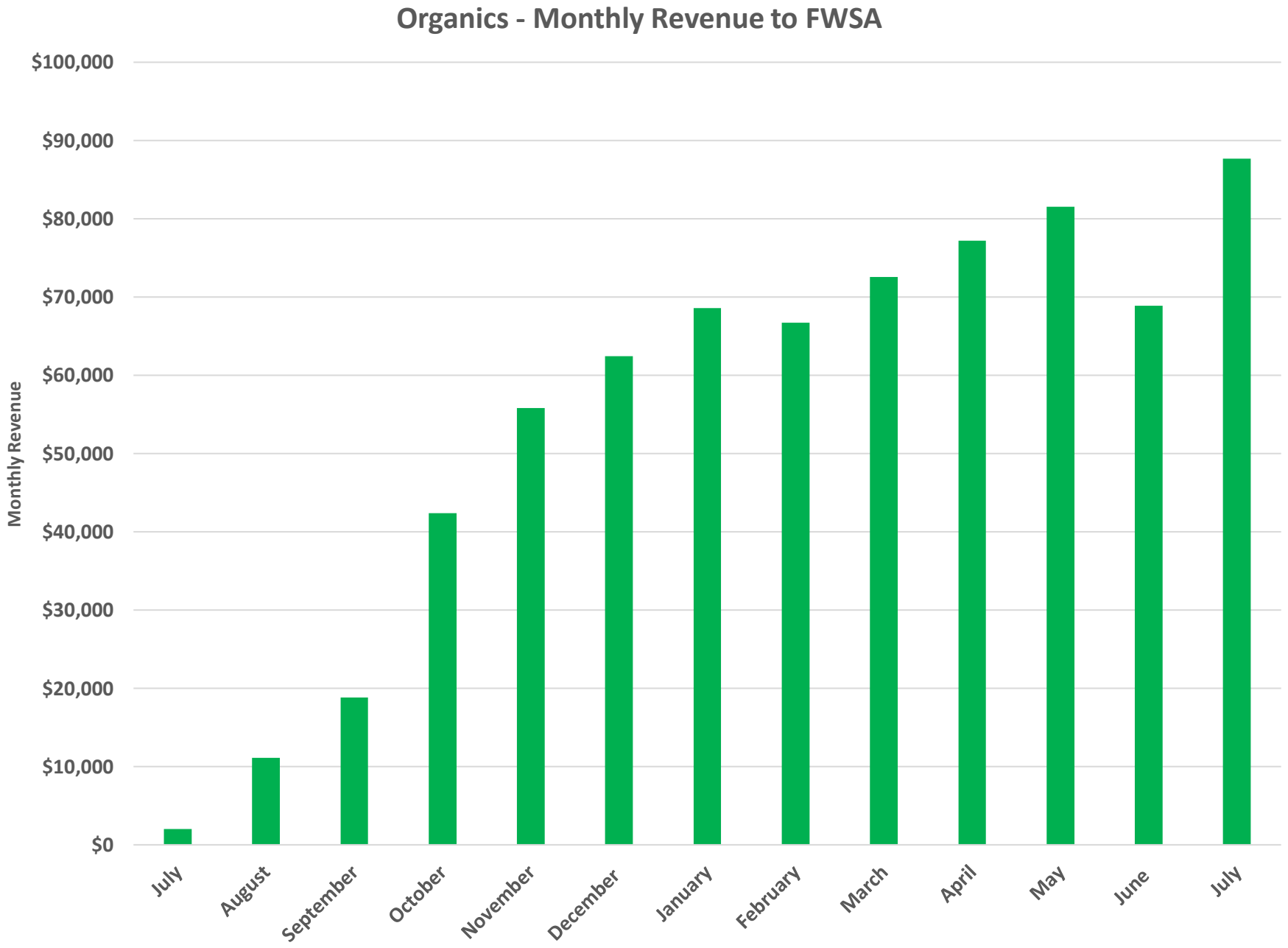

Organics - Monthly Deliveries to FWSA
Monthly Volume
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
August
September
October
November
December
January
February
March
April
May
June
July


Organics - Monthly Revenue to FWSA
Monthly Revenue
$100,000
$90,000
$80,000
$70,000
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
July
August
September
October
November
December
January
February
March
April
May
June
July

If you build it, what do you need to know

- Plan Early for the Variables of the Market.
- Don’t ask for Certainty, You can’t have it.
- The Organics Matters, Not the Provider.
- What Matters More – the Organics or the Truck carrying it?
- The Limiting Factor – Organics In or Biosolids Out?
- This Business is Not for Everybody.

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Get the Right Tools

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Get to the source

If you put more than 30% FOG (or 16% or some other number) if will fail!

Pilot/Bench Scale Testing

20L Digester

1 L/day

42 ml/hour (2.8 Tbs)

0.7 ml/min

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Apply Mixing Energy At the Right Point

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Digesters are robust – if.....

- Energy Intensive pre-mix of TWAS and HSOW
- Manage HSW and store appropriately
- Feed slow and consistent
- Secondary digester as dewatering wide spot
- Feed digesters downstream of Hx

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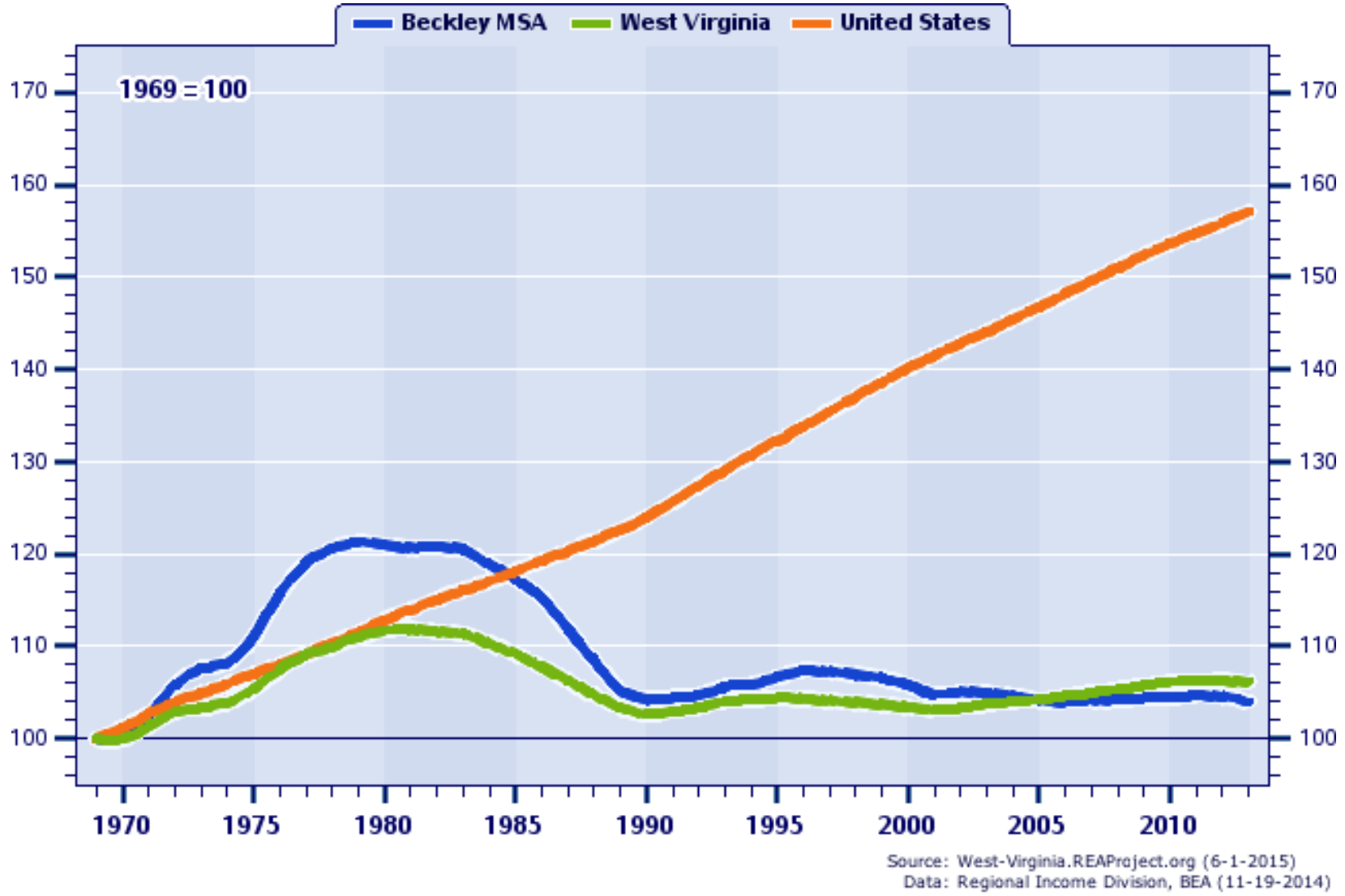
City of Beckley

West Virginia

Population Growth
Beckley, WV vs. the United States



No Revenue Resiliency

BECKLEY SANITARY BOARD
BUDGET ESTIMATE FISCAL YEAR 2013-14

ACCOUNT DESCRIPTION	ACCOUNT NO.	FY 2009	FY 2012	FY 2013	FY2014	CHANGE
REVENUES						
OPERATING REVENUE:						
Sewer Fees	401-000-000-360-01	4,900,000	5,550,000	5,400,000	5,300,000	(100,000)
Bad Debt Recoveries	401-000-000-344-00	5,000	4,000	5,000	5,000	0
Waste Hauler Permit Fees	401-000-000-362-00	0	0	0	0	0
Waste Hauler Disposal Fees	401-000-000-363-00	5,000	10,000	10,000	15,000	5,000
Customers Penalties	401-000-000-364-00	80,500	117,000	110,000	110,000	0
Customers Reconnection Fee	401-000-000-348-00	10,000	18,000	18,000	20,000	2,000
Sewer Tap Permits	401-000-000-348-01	6,000	2,000	2,000	3,000	1,000
TOTAL OPERATING REVENUE		5,006,500	5,701,000	5,545,000	5,453,000	(92,000)
OTHER RECEIPTS:						
Interest - Investments	401-000-000-380-01	10,000	3,000	1,000	1,000	
Miscellaneous Revenues	401-000-000-399-00	10,000	10,000	10,000	25,000	15,000
TOTAL OTHER RECEIPTS		20,000	13,000	11,000	26,000	15,000
TOTAL ESTIMATED REVENUES		5,026,500	5,714,000	5,556,000	5,479,000	(158,000)

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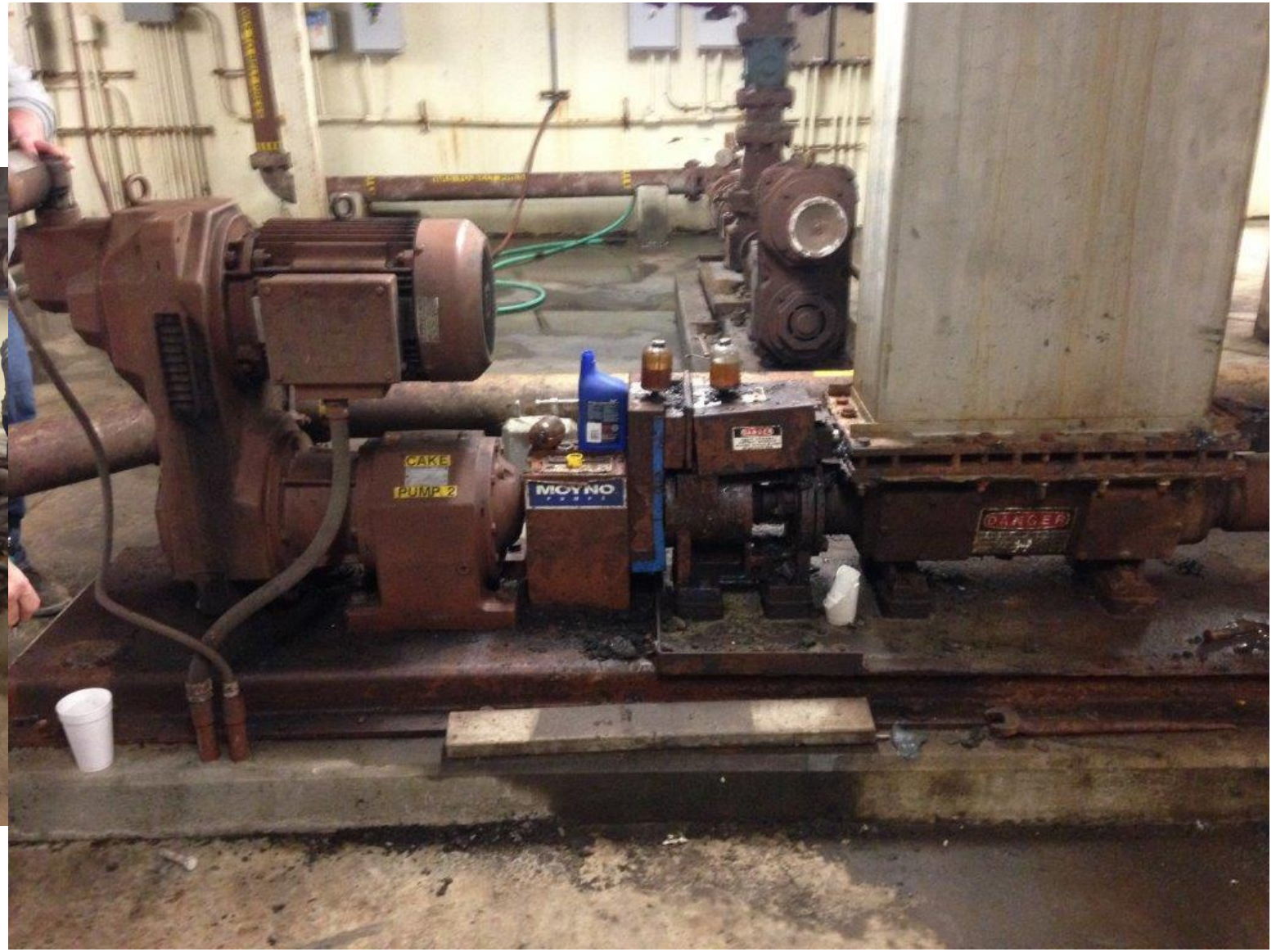
SLUDGE TO DIGESTER


CAKE
PUMP 2
MOYNO
DANGER

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Maximizing the Investment

	Core Infrastructure	Revenue (Co-digestion)	Total
Capital $	($11M)	($2M)	($13M)
Guaranteed Revenue (15 yr)	$0	$6M	$6M
Upside Revenue (15 yr)	$0	$4.5M	$4.5M
Net	($11M)	$8.5M	($2.5M)

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BDP
INDUSTRIES
MADE IN USA
DANGER
ROTATING
MACHINERY
7/10/18, 9:24 AM


8/23/18, 3:48 PM


6/5/18 3:36 PM


The next generation of septage, FOG and sludge screening
Environ-Core
SAVI
11/30/18 11:34:58 AM EST

Summary

- Many will tell you “You Can’t”
- With proper design and attention, “YOU CAN”
  - Good material selection
  - Proper debris removal
  - Wide spots and mixing
  - Slow feeding
  - There ain’t no such thing as a free lunch (TANSTAFL)

Thank You

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Date or speaker or subtitle