

Sludge Paralysis Meets Regional Pyrolysis

By,
Jarod Stuyvesant, PE



Continue the Conversation

Remove the Stigma

Understand Benefits & Limitations

Protect our Resources

Reduce Costs Responsibly

Why did the treatment plant start investing in stocks?

Because they wanted to turn liquid assets
into solid profits!

01

Normalizing Regionalization

02

Where are we now?

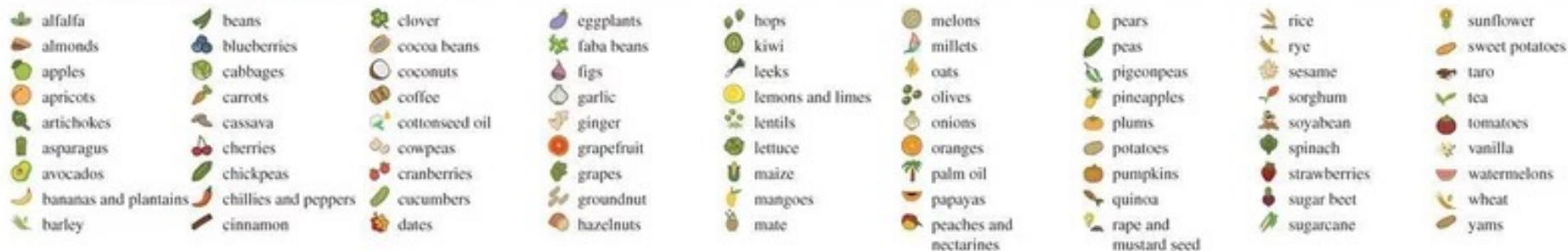
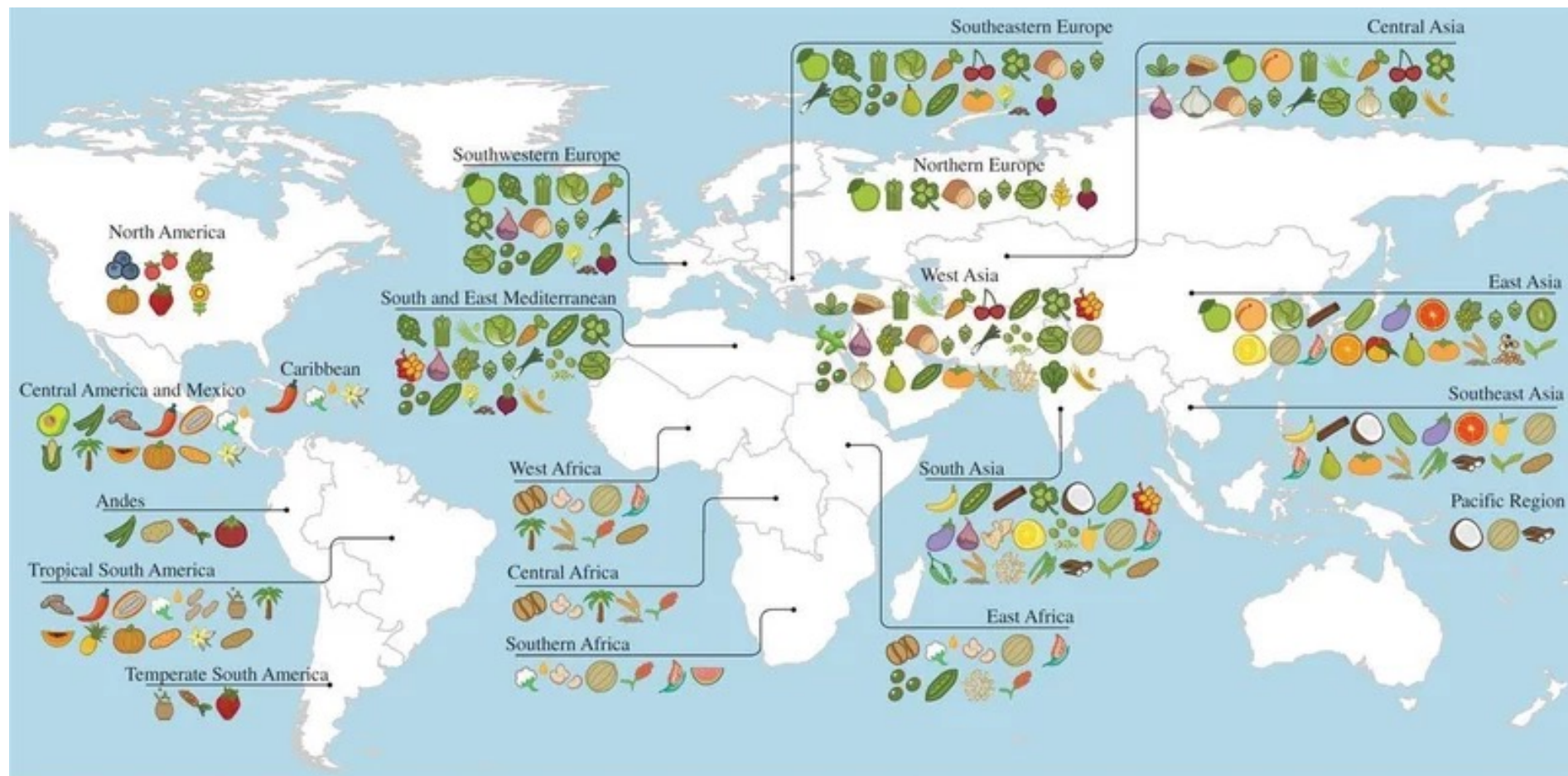
03

Real World

- Analogy Time!! (prizes involved)
- Besides breathing & sleeping, name two things that every human does...



It's not new.
We have
seen this
before...



01

Regionalization

Data Storage Services



Shipping Distribution Centers



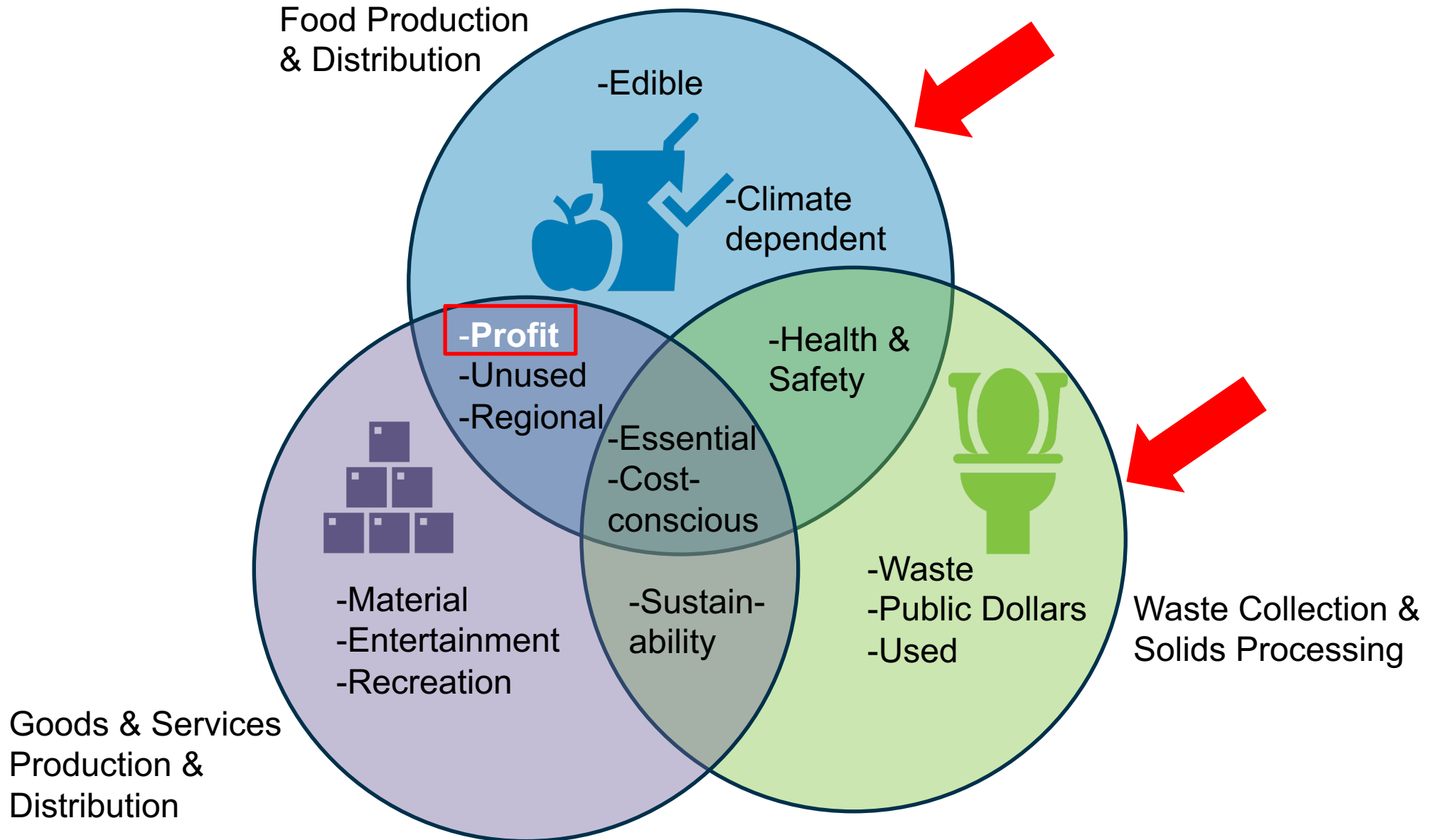
Solid Waste & Recycling Facilities



Farming & Food Production/Supply

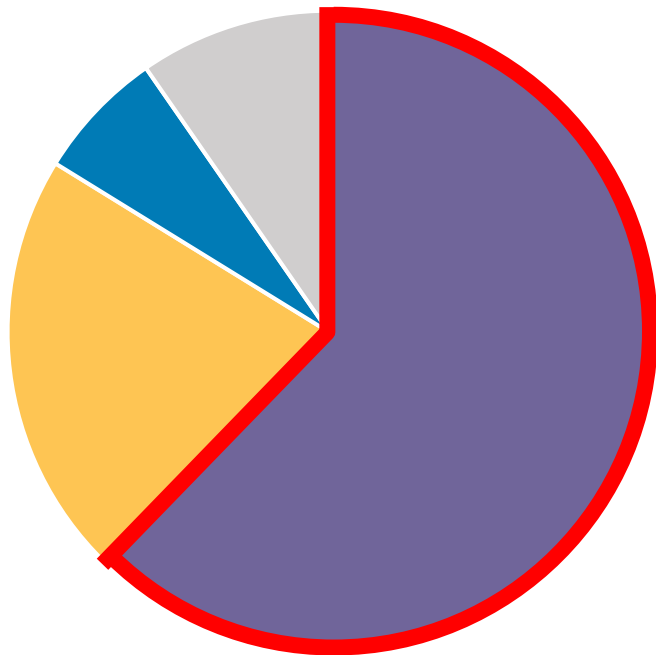


Wastewater/Biosolids Treatment and/or Disposal



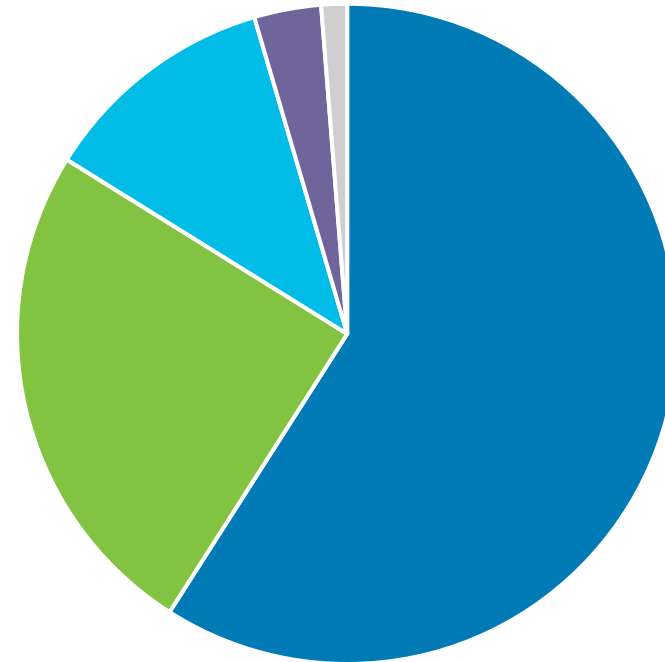
- Example: Cherries

Tart Cherries



■ Michigan ■ Utah ■ Washington ■ Other

Sweet Cherries



■ Washington ■ California ■ Oregon ■ Michigan ■ Other

Tart Cherries from MI



- 96 million pounds
- ~4.5 million lb. to New England
- ~950 miles
- 70,000 lb/trip
- Min. 64 trips/year
- **60,800 miles**
- **9,500 gallons of diesel**

Why? Because people eat them.

- How many supermarkets in Massachusetts alone?

A 405

B 603

C 842



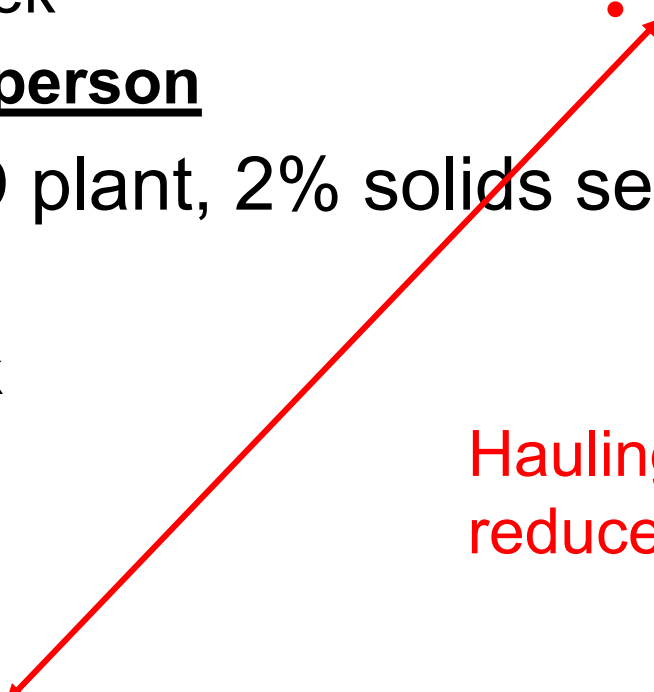
- How many permitted treatment plants in MA?
(MA Individual & Medium General Permits)

A 380

B 473

C 548



- Supermarkets (medium size serving ~11,500 people)
 - 10-20 semi-trucks per week
 - Roughly 50-100 miles per trip
 - 5,000 to 20,000 miles per week
 - **22 to 90 miles per year per person**
 - Wastewater Sludge (1 MGD plant, 2% solids serving ~4,500 people)
 - Roughly 70,000 gallons/week
 - 8 trucks per week
 - Assume 50-100 miles
 - 400-800 miles per week
 - **4.5 to 9 miles per year per person**
- Not included:
- **Miles from food source**
 - **Miles for customers**
- Hauling 5% sludge
reduces numbers by 150%
- 

Why are these two industries SO different?

- Wastewater is gross
- Sink, toilet, shower, repeat.
- Forgotten about
- It's not a commodity
- Wastewater sludge is a ~~by~~product

Let's change the stigma

Biosolids “recovery” instead of “Disposal”

Wastewater treatment and biosolids recovery is a service/product that needs to be adequately paid for.

Wastewater treatment and biosolids recovery is a service/product that needs to be adequately paid for.

Wastewater treatment and biosolids recovery is a service/product that needs to be adequately paid for.

01

Normalizing Regionalization

02

Where are we now?

03

Real World

- 2018 data from source below

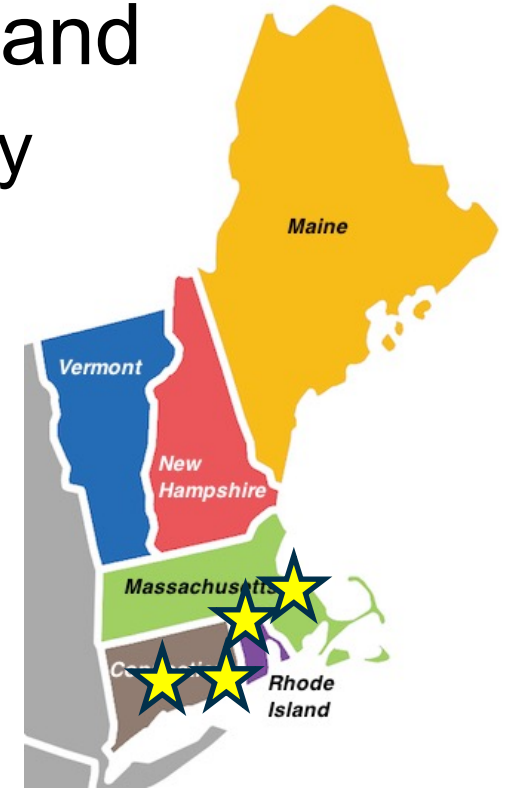
State	Land Application	Landfill	Incineration	Class A Reuse	Unknown/Other
Connecticut	0%	8%	87%	5%	
Maine*	0%	60%	0%	29%	10%
Massachusetts	34%**	17%	43%	4%	2%
New Hampshire	34%	42%	18%	6%	0%
Rhode Island	0%	5%	94%	1%	0%
Vermont	58%	40%	0%	2%	0%

<https://www.biosolidsdata.org>

*in 2018, land application was 9% and it is unclear where this is being re-allocated.

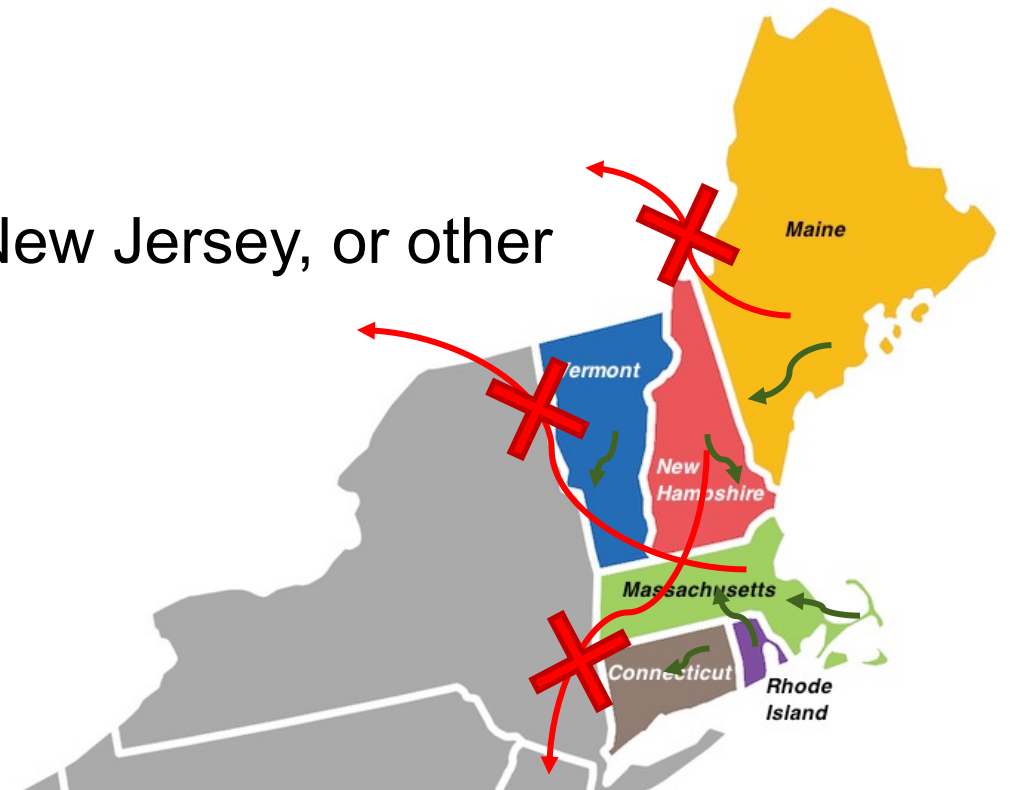
**Deer Island is classified as land applied fertilizer in this data set

- Example Regional Communities in New England
 - Woonsocket, RI (Synagro) – 100 dry tons per day
 - 50% liquid sludge
 - 50% cake
 - Plymouth, MA – Septage receiving from Cape communities
 - 129,000 gallons received per day (~10 dry tons/day)
 - Naugatuck, CT (Veolia)
 - Exploratory Study for Narragansett Bay Commission, Upper Blackstone Clean Water, and Springfield Water and Sewer Commission (2022)
 - 40,000 dry tons per year (110 per day)



- Other Disposal Options across New England
 - Land Application (where acceptable)
 - ME (banned), CT & RI are minimal
 - Dewatering & landfill
 - Sometimes local landfills
 - Sometimes shipped to Canada, New Jersey, or other areas outside New England

Wastewater Sludge (1 MGD plant, 2% solids serving ~4,500 people)
4.5 to 9 miles per year per person





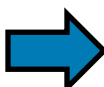


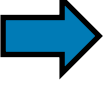




- Population Density

State	Population / mi ²	U.S. Rank
Rhode Island	1,061	3
Massachusetts	901	4
Connecticut	745	5
New Hampshire	154	22
Vermont	70	32
Maine	44	39

- We need to reduce VOLUME responsibly
- Contain and reuse nearby, not Canada or New Jersey

- Existing Regional Facilities are Overwhelmed

- Demand  
- Supply  
- Rates*  
- Maintenance  
- Risk of failure  

Infrastructure + Operation + Maintenance

=

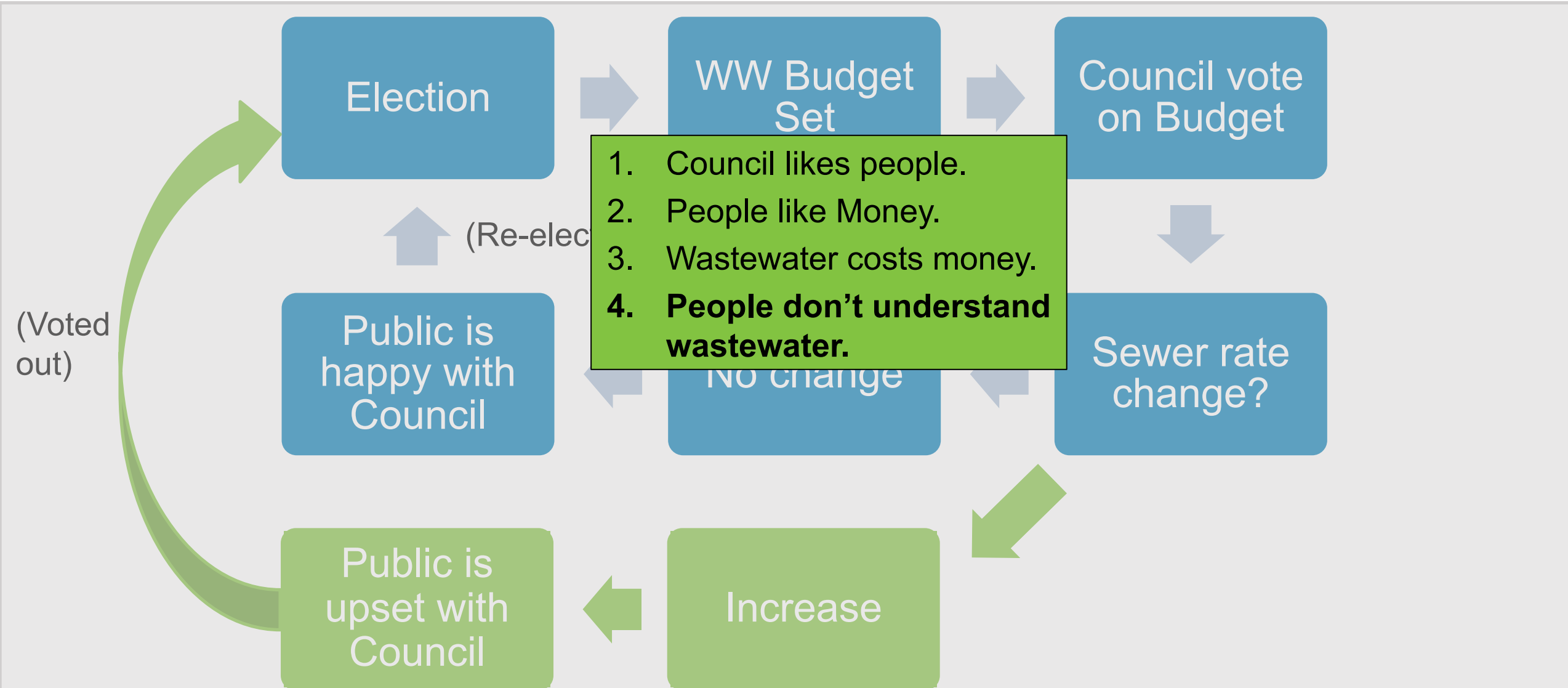
Revenue + Contingency + Profit

Remember this?

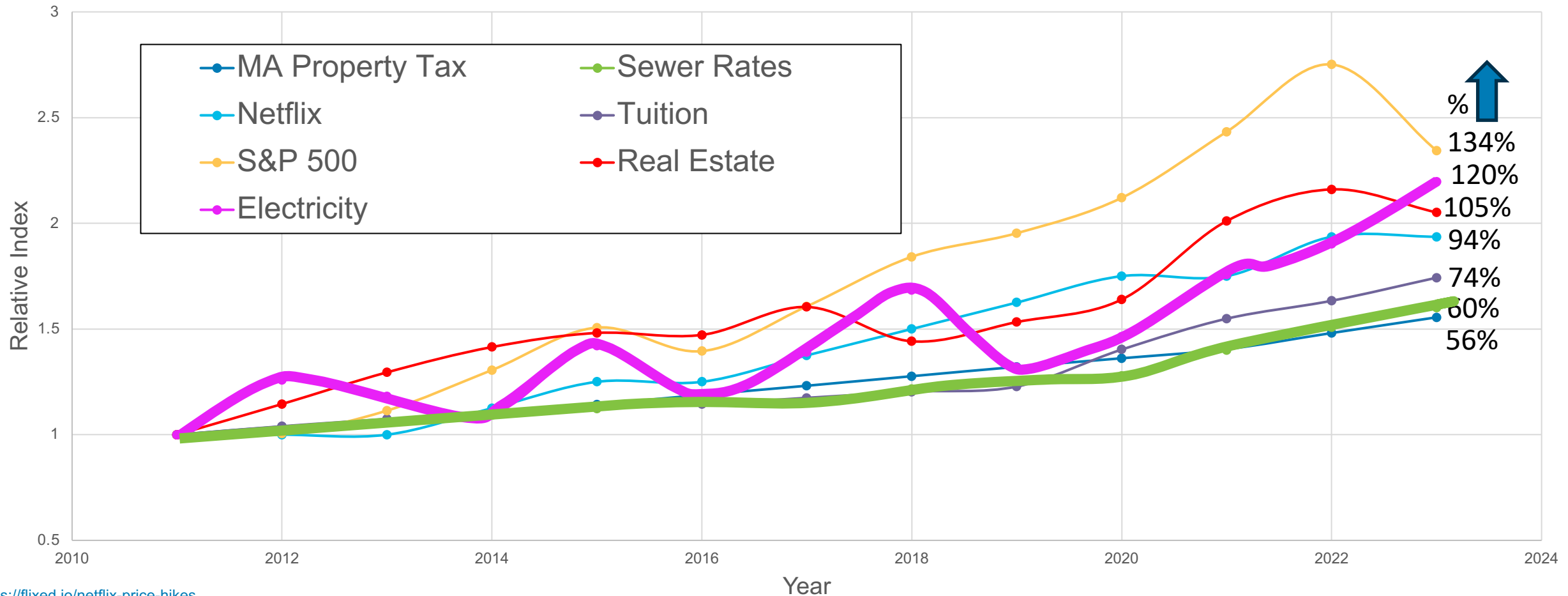
*Some facilities are good about raising rates, but others are in long-term fixed contracts.

Wastewater treatment and biosolids recovery is a service/product that needs to be adequately paid for.

The Sewer Rate Conundrum



Historical Price Changes 2011-2023



<https://fixed.io/netflix-price-hikes>

https://dls.gateway.dor.state.ma.us/reports/rdPage.aspx?rdReport=AverageSingleTaxBill.SingleFamTaxBill_wRange&rdRequestForwarding=Form

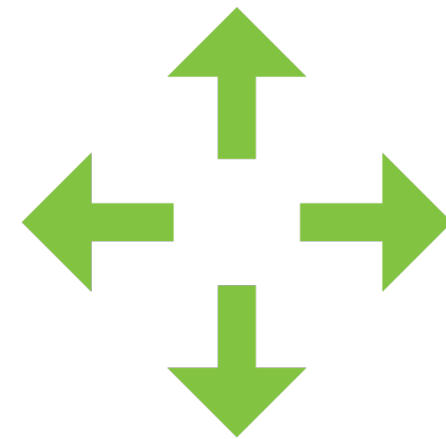
<https://www.ontocollege.com/average-college-tuition/#:~:text=both%20public%20and%20private.&text=In%20brief%2C%20over%20the%20past,over%20a%20decade%20E2%80%94not%20bad.>

https://www.fedprimerate.com/new_home_sales_price_history.htm

<https://www.eversource.com/clp/vpp/vpphistory.aspx>

*Other sources may contain different information

- Educate
 - Educate the public at meetings, offer tours of facilities, send informational flyers, promotional videos
 - Show them photos of sewage in rivers (not from your own Town, of course)
- Transform
 - Consider transforming the way the wastewater department is organized and/or governed
 - Make it a DPW? Privatize it? Assign appointed officials, not elected officials? Electric/gas model?



01

Normalizing Regionalization

02

Where are we now?

03

Real World

- Regional Facility Evaluation

- Option 1 - Digestion, Dewatering, Drying, Pyrolysis



- Option 2 - Drying, Pyrolysis

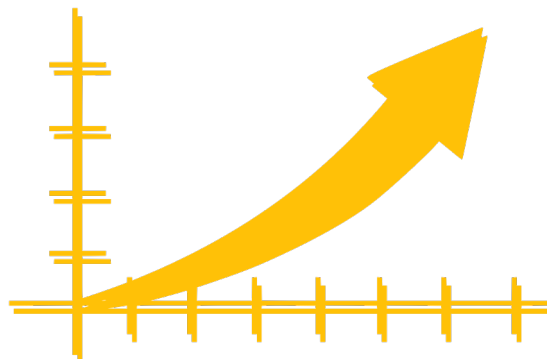


- Option 3 - Drying Only

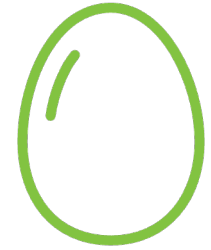


- Scalable facilities that can handle 15 dry tons per day with digestion, or 10 dry tons per day of cake.

- Capital costs, 20 year life cycle cost analysis to determine a “break even” value to charge customers, and determine the value of Pyrolysis.



- Digestion
 - Anaerobic egg-shaped digester(s) 15 day HRT
- Dewatering
 - Centrifuge or Screw Press (>20% solids)
- Drying
 - Plate or Belt dryer (electric or combination electric and natural gas) > 90% solids
- Built-in redundancy
- Storage, continuous operation

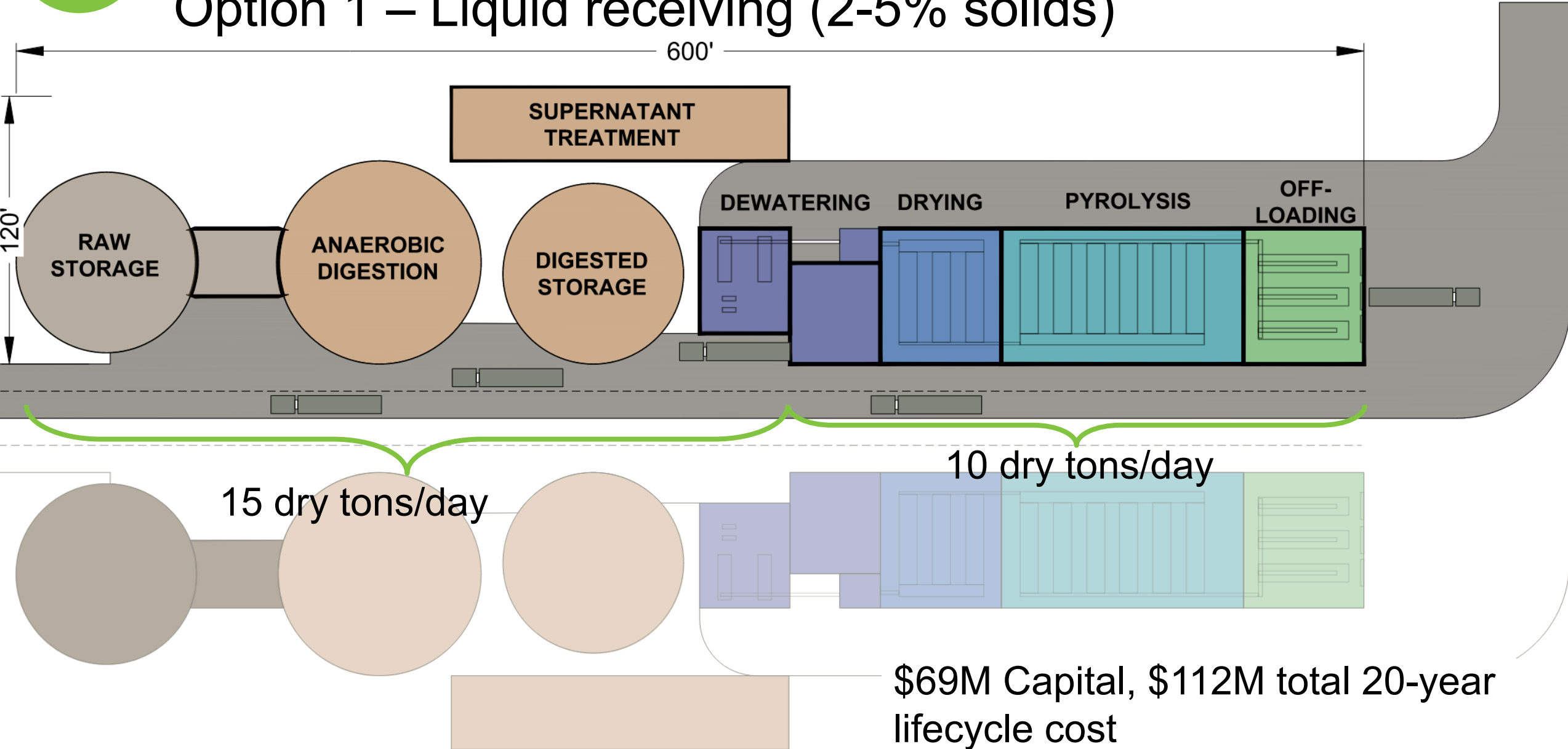


- Pyrolysis (as tested by BioForceTech)
 - Produces biochar which is usable in concrete and black ink markets
 - BioForceTech provides removal services free of charge (included in equipment supply)
 - **Non-detectable PFAS Contaminants in the biochar**
 - **Working on approved testing of air emissions in 2024**
 - Natural gas to start up, can become self-sustaining at temperature
 - 1100 deg. F operating temperature
 - Coupled with their dryer, it can self-sustain the drying process too, if cake is >25% solids

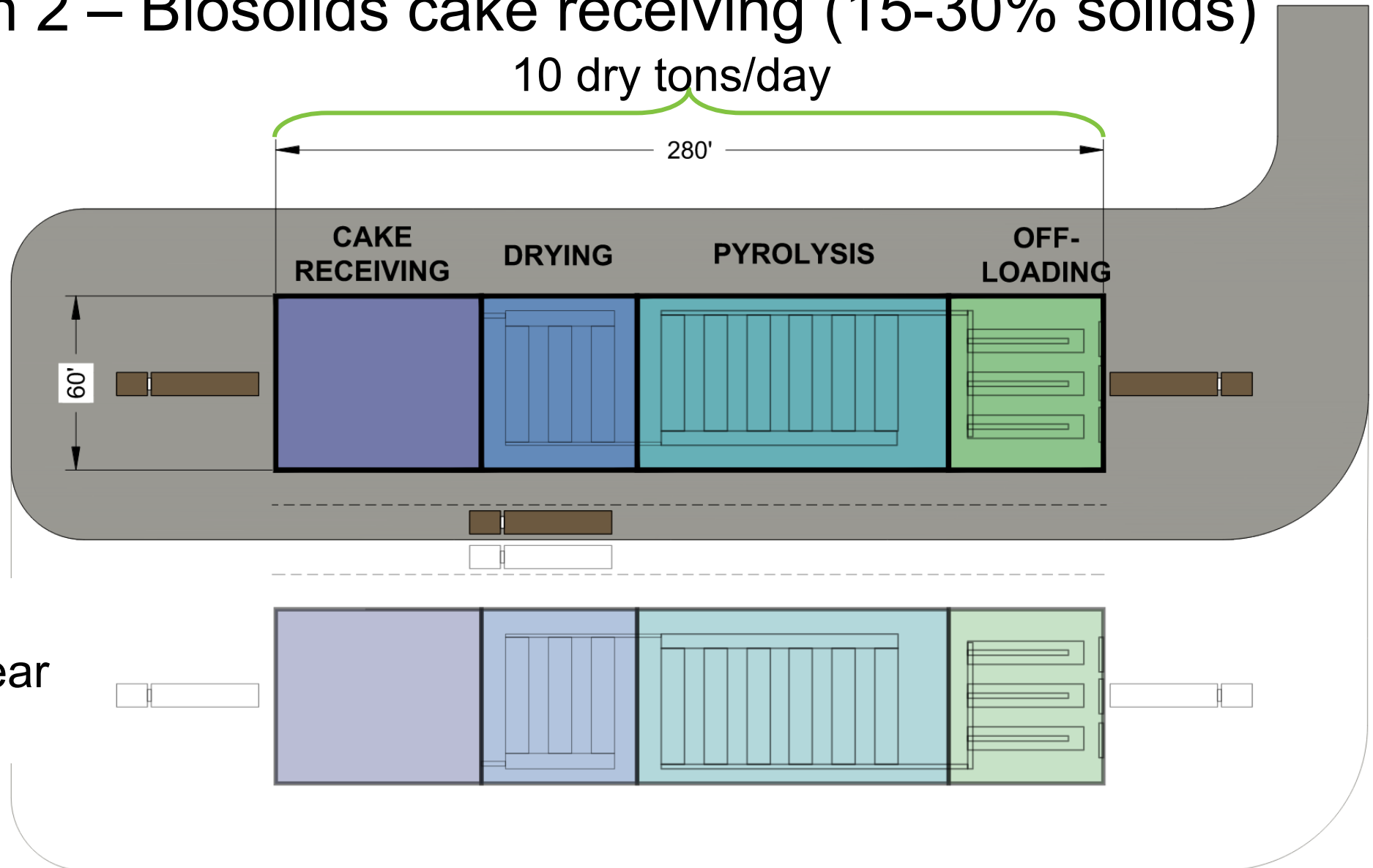


BIOFORCETECH
Corporation

Option 1 – Liquid receiving (2-5% solids)

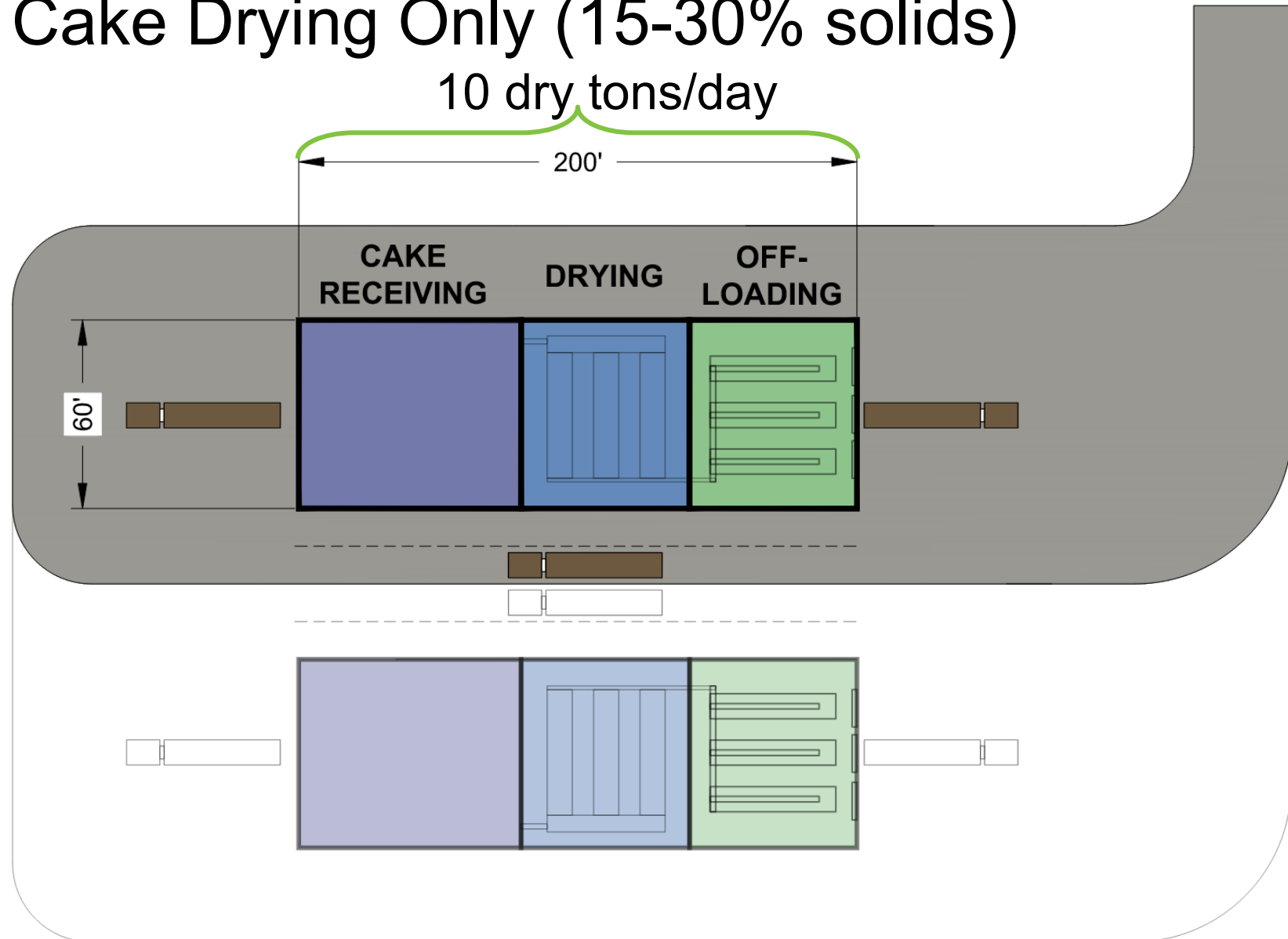


Option 2 – Biosolids cake receiving (15-30% solids) 10 dry tons/day



\$41.3M Capital,
\$69M total 20-year
lifecycle cost

Option 3 – Cake Drying Only (15-30% solids) 10 dry tons/day



\$22M Capital,
\$42M total 20-year
lifecycle cost

Cost Breakdowns

Option	Capital Cost	Annual O&M
1 – Digestion, Dewatering, Drying, Pyrolysis	\$ 68,980,000.00	\$2,156,000.00
2 – Drying, Pyrolysis	\$ 41,310,000.00	\$1,572,000.00
3 – Drying Only	\$ 21,735,000.00	\$1,030,000.00

BUDGETARY. Based on project quotes scaled proportionally and based on available unit prices and estimates in this market.

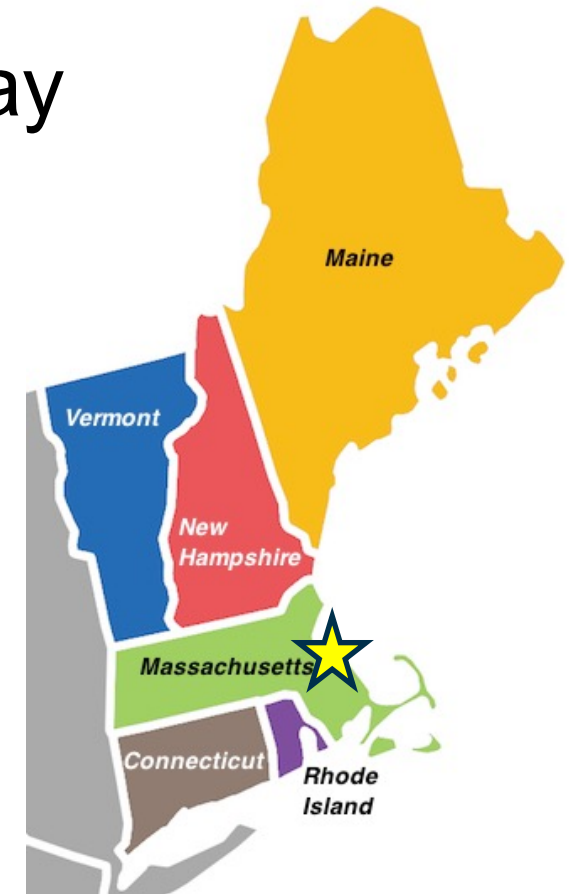
Life Cycle Costs and Acceptance Rates

Option	Description	Life Cycle Cost	Break even at 100% capacity	Break even at 80% capacity	Units
1	Digestion, Dewatering, Drying, Pyrolysis	\$ 112,104,000.00	\$ 0.12	\$ 0.16	per gallon
			\$ 1,123.86	\$ 1,404.82	per 9,000-gallon truck
2	Drying, Pyrolysis	\$ 72,761,000.00	\$ 199.35	\$ 249.18	per wet ton
3	Drying	\$ 42,345,000.00	\$ 116.01	\$ 145.02	per wet ton

- Includes:
 - Capital costs
 - 35% contingency / Contractor OH&P
 - Electric & Natural gas costs
 - Annual O&M, replacements
 - Additional staff (3-6 full time employees)
 - 2023 dollars. Assumed that acceptance rates increase with inflation

Case Study – Plymouth, MA

- Receives 129,000 gallons of septage per day at ~2% solids (10.4 dry tons per day)
- \$1,350 per 9,000-gallon truck
- Pays ~\$630 per 9,000-gallon truck to haul away thickened solids (5%)
- Net revenue of \$1,090 per truck received
- Plenty of space on site to expand regional acceptance

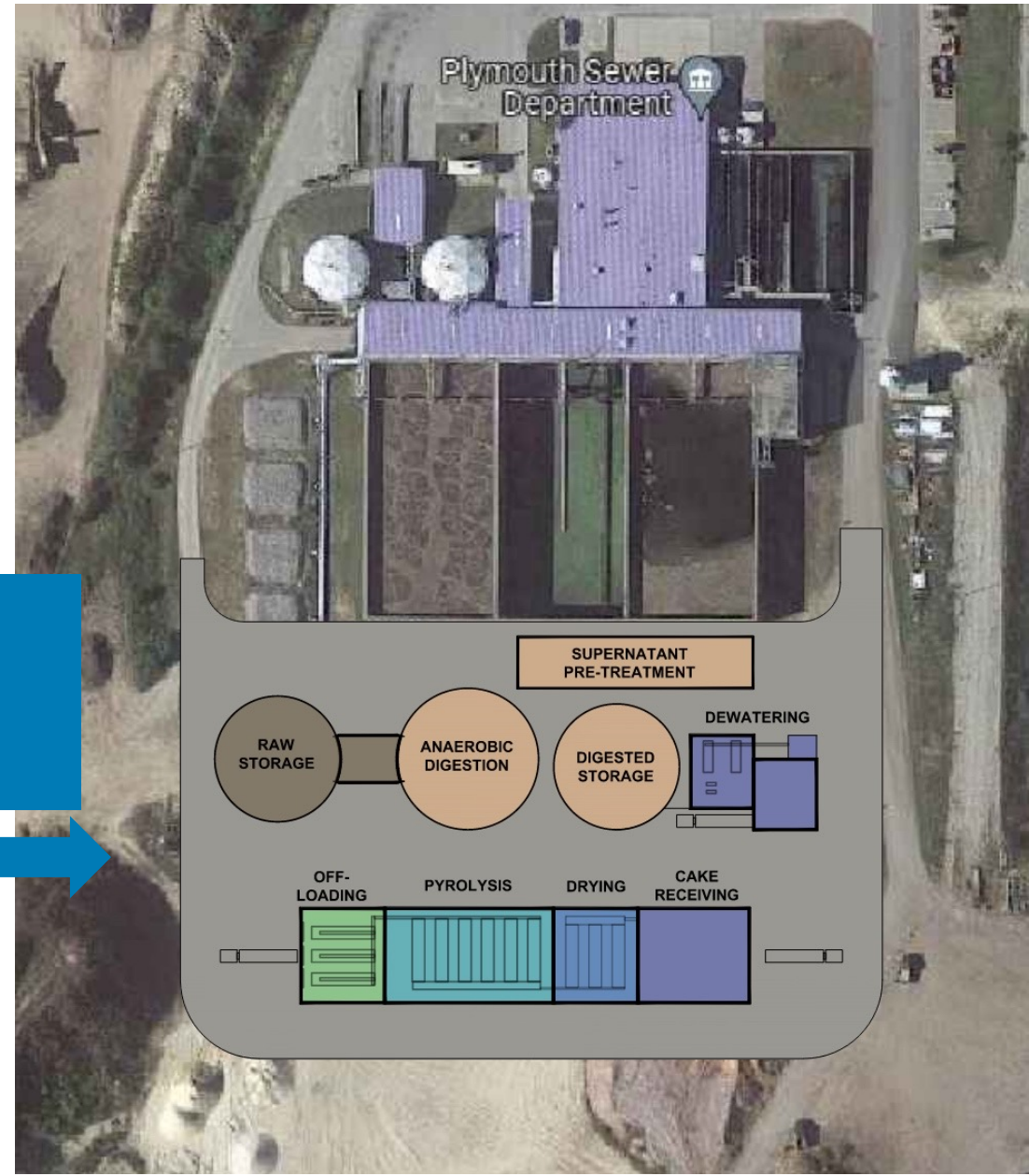


Case Study – Plymouth, MA



OPTIONS

1. Digestion, Dewatering, Drying, Pyrolysis
2. Drying, Pyrolysis
3. Drying

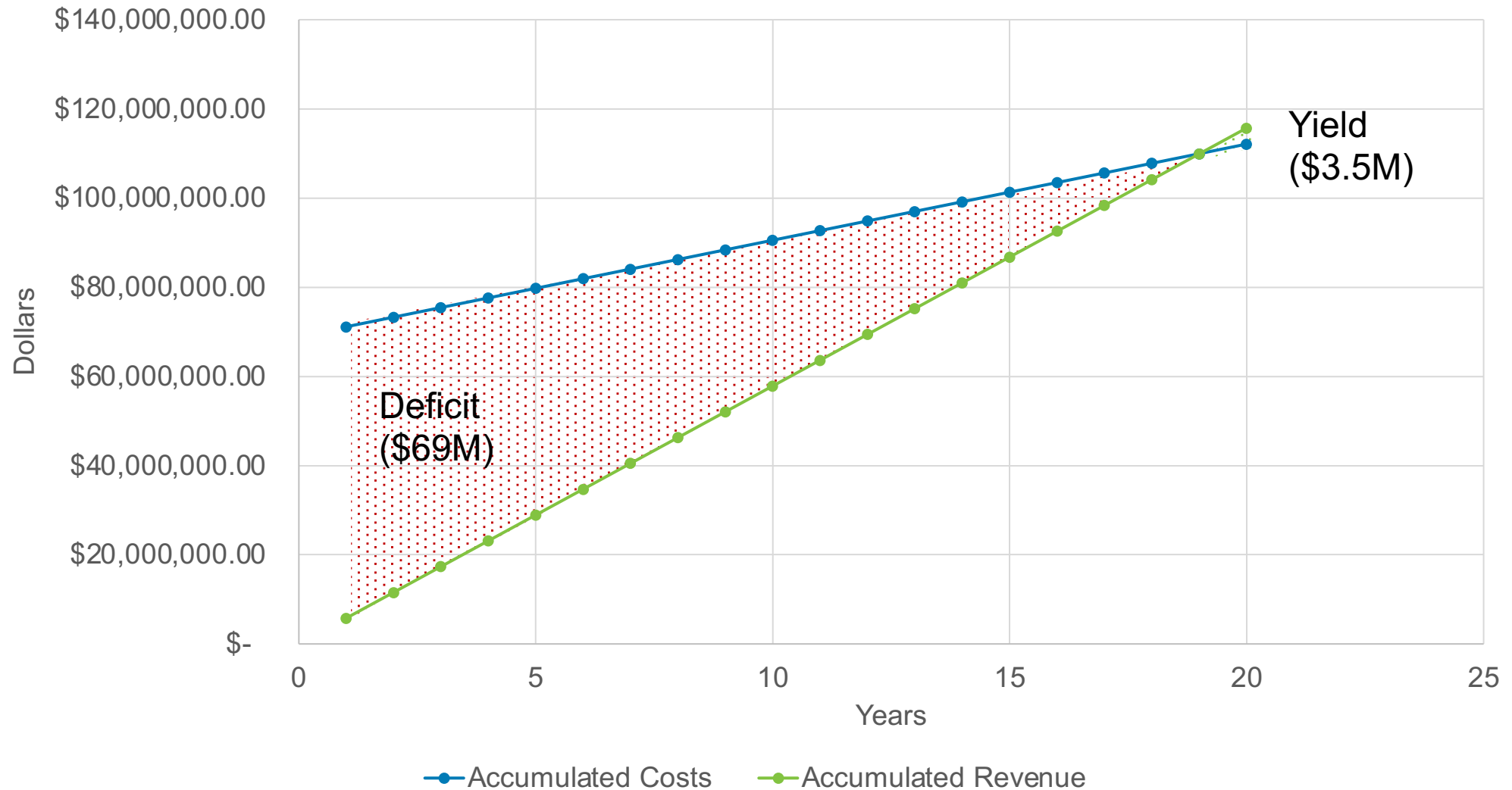


Case Study

Plymouth, MA

- \$1,450 per 9,000-gal truck
- 80% design capacity
- Acceptance rate increases = inflation

Cost vs. Revenue Projection - Digestion, Dewatering, Drying, Pyrolysis

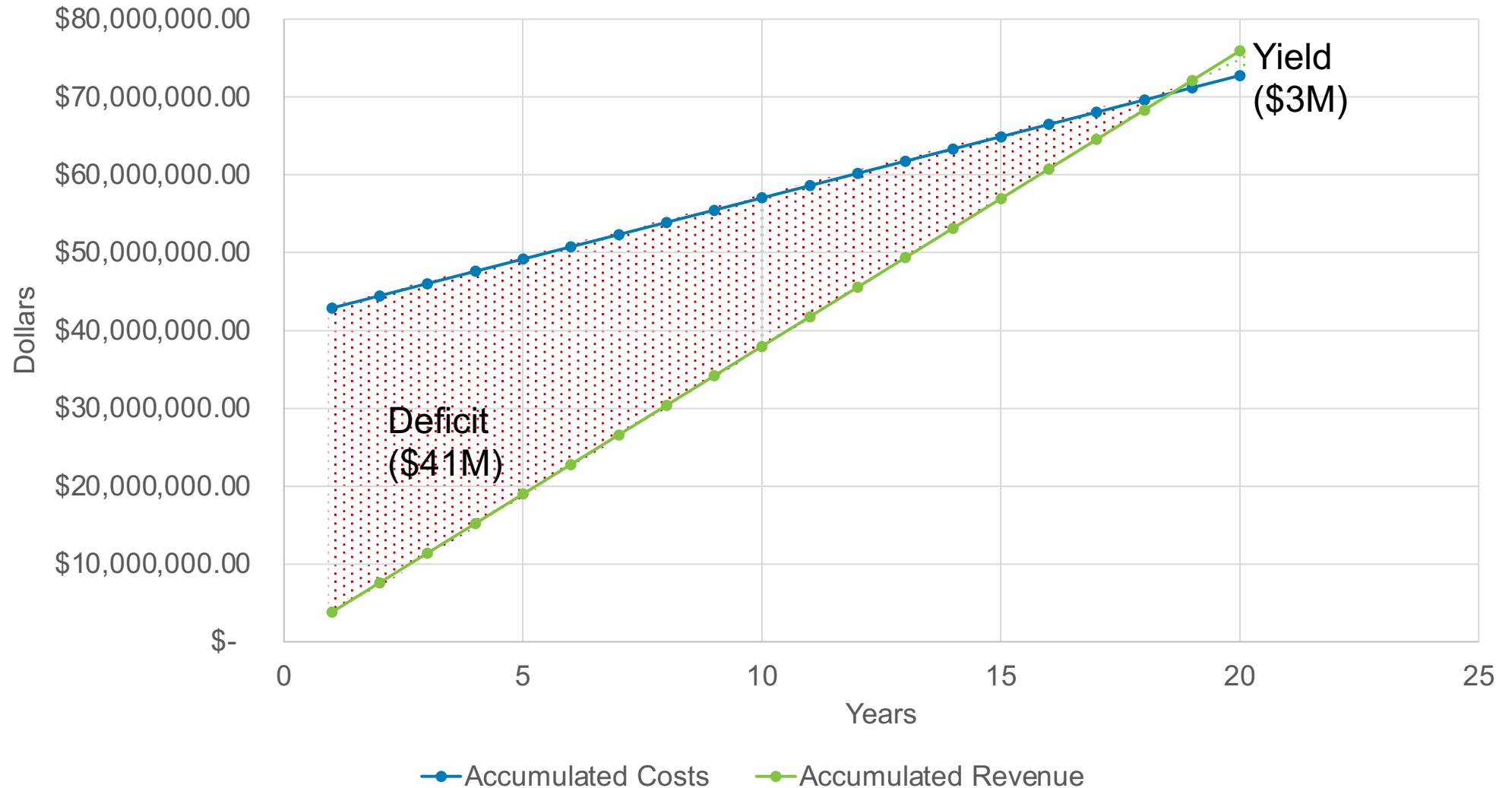


Case Study

Plymouth, MA

- \$260 per wet ton
- 80% design capacity
- Acceptance rate increases = inflation

Cost vs. Revenue Projection - Drying, Pyrolysis

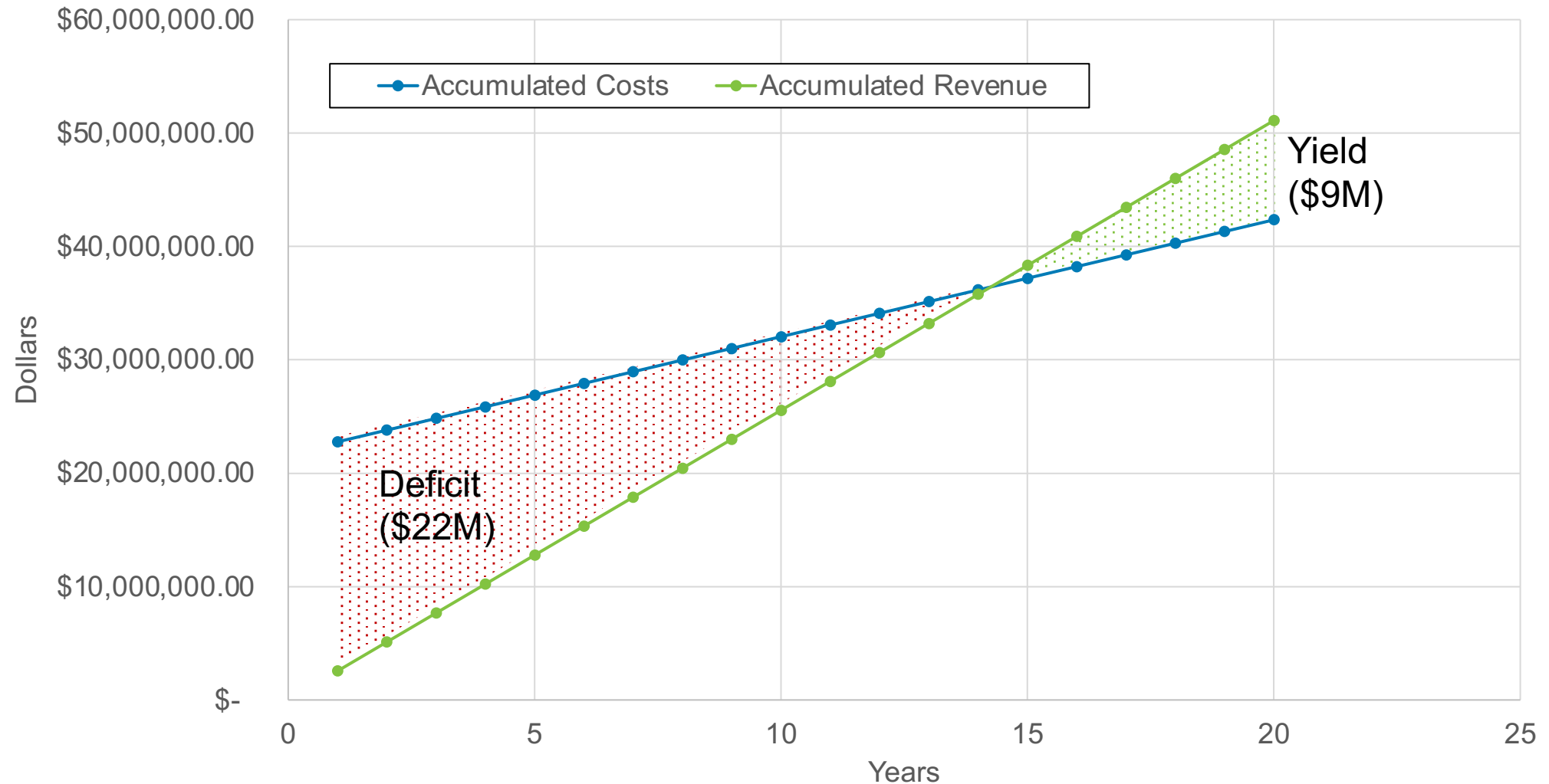


Case Study

Plymouth, MA

- \$175 per wet ton
- 80% design capacity
- Acceptance rate increases = inflation

Cost vs. Revenue Projection - Drying Only



Case Study – Plymouth, MA

Option	Description	Break even at 100% capacity	Break even at 80% capacity	Average Cost in Region	Units
1	Digestion, Drying, Pyrolysis	\$ 0.12	\$ 0.16	\$ 0.11	per gallon
		\$ 1,123.86	\$ 1,404.82*	\$ 995	per 9,000-gallon truck
2	Drying, Pyrolysis	\$ 199.35	\$ 249.18	\$ 208	per wet ton
3	Drying	\$ 116.01	\$ 145.02	\$ 208	per wet ton

*The current rate charged by Plymouth is \$1,350

Regional sludge acceptance rates vary. Plus, pyrolysis offers an additional benefit that should be compensated, compared to existing regional facilities.

Case Study Summary

PYROLYSIS

NEW OPTION GIVEN



YES

NO

YES

\$1,404/truck

\$995

\$985/truck

DIGESTION

NO

\$249/wet ton

\$208

\$145/wet ton

Sludge rates vary. Plus, pyrolysis offers an additional benefit that should be compensated, compared to existing regional facilities.

- Concluding thoughts

- Each state & region is different
- These analyses are subject to variations
- Pyrolysis air testing to be confirmed, still (EPA testing method now approved)
- Economies of scale will benefit the financial evaluations (i.e. 20, 40 + dry tons per day)
- State involvement for initial funding may be essential – PFAS-driven factors, incentives, etc.
- System can be economically self-sustaining at competitive market rates
- Digestion could open the door to regional food waste disposal as well
- Could offer flexible options for liquid/cake to incentivize dewatering on-site to minimize trucking costs. Flexible payment structures based on needs.



Continue the Conversation

ENGAGE WITH YOUR
COMMUNITIES, REGULATORY
STAFF, ENGINEERS, ETC.

Remove the Stigma

COMMUNICATE THE IMPORTANCE
OF OUR INDUSTRY

Understand Benefits & Limitations

PYROLYSIS STILL
BEING TESTED, RISK

Protect our Resources

REDUCE VOLUME, REMOVE
CONTAMINANTS, RE-USE BIOSOLIDS

Reduce Costs Responsibly

DO WHAT MAKES SENSE, BUT DO
WHAT HAS TO BE DONE.

If you're not part of the solution,
you're part of the precipitate

In all seriousness,
We're all in this together.
Even those who aren't in our industry.
Remember, **EVERYBODY POOPS!**

- Jarod Stuyvesant, PE
 - Stuyvesant.jarod@wseinc.com
 - 781-670-5322
- Special Thanks to:
 - Plymouth, MA
 - Montague, MA
 - BioForceTech (Pyrolysis Manufacturer)

Wastewater treatment and biosolids recovery is a service/product that needs to be adequately paid for.