INCREASING CHP PRODUCTIVITY WHILE REDUCING BIOSOLIDS VOLUME AND CLIMATE CHANGING GASSES

EPA Region IX

Innovative Energy Management Workshop

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FOG ENERGY™

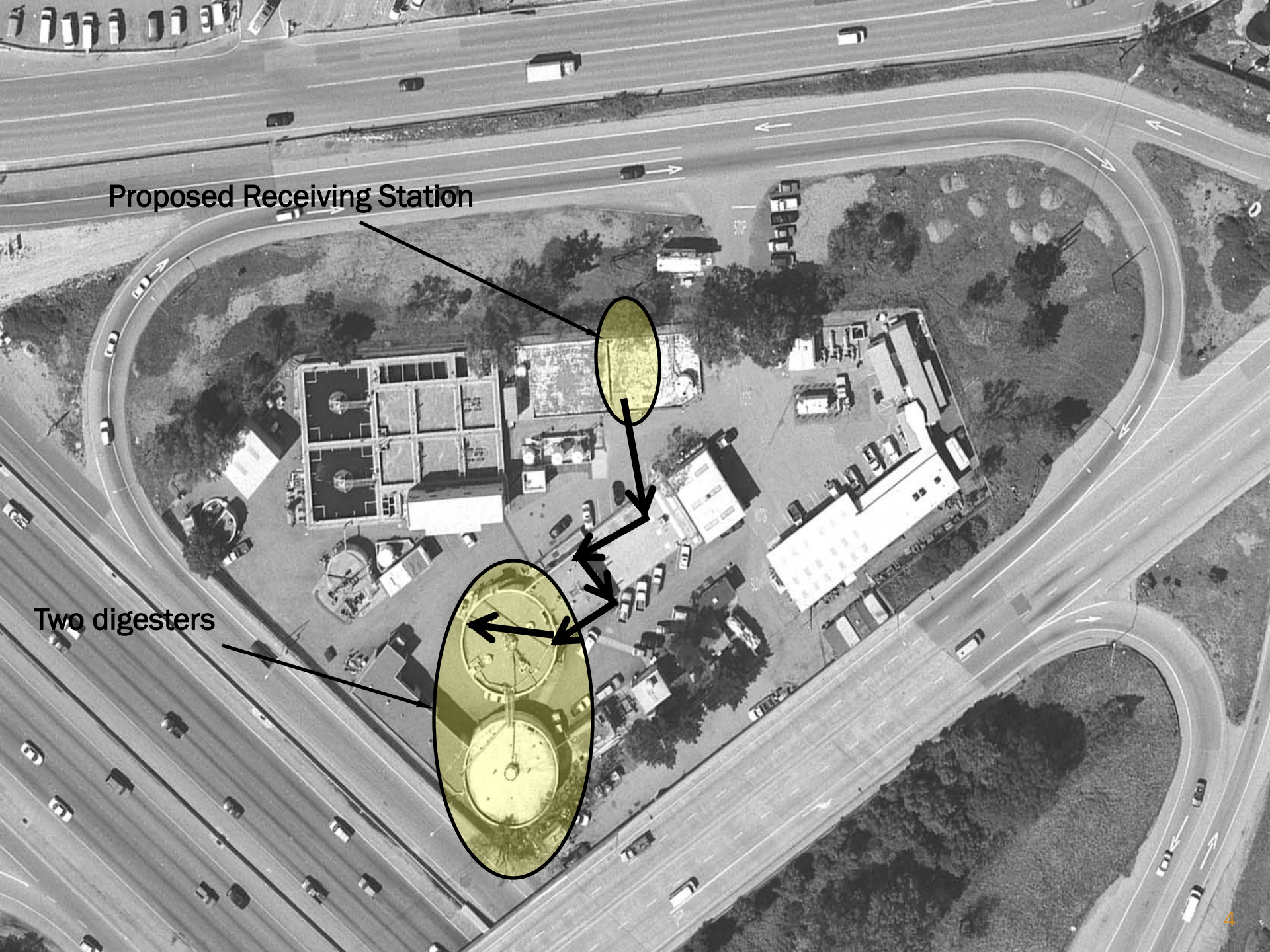
CITY OF MILLBRAE CALIFORNIA

OVERVIEW

- Describe the Millbrae POTW
- Relate the driving and convincing factors
- Describe the system
- Relate reasons to choose grease
- Discuss the results
- Summarize
- Questions

UNDERSTANDING THE TERMINOLOGY

- FOG: Acronym for “Fats, Oils, and Grease,” often interchanged with trap waste
- Yellow Grease: Deep fryer grease or oils
- Brown Grease: Grease found floating in a restaurant grease trap
- Black Grease: Grease congealed inside sewer pipes
- Trap Waste: Sewage (water and organics) and brown grease from a grease trap, often used synonymously with FOG
- IKG: Acronym for Inedible Kitchen Grease


Proposed Receiving Station
Two digesters

THE FACILITY

- Is small and old
  - primary constructed in 1950
  - secondary in 1967
  - serves a population of 20 k
  - less than 5 acre
  - produces tertiary quality effluent
- 3 MGD capacity, 1.8 MGD annual flow
- Peak IWWF = 9 MGD; AWWF 6 MGD
- Facility is road locked
- Facility is shared with other PW crews

UNIQUE ATTRIBUTES

! KNOWING

✖ your system will **enable** you to identify and capture the unique attributes of your plant.

Millbrae identified

- Ample Digester Capacity (2 digesters)
- Easy freeway ON – OFF (road locked)
- Need for major renovation (old)

Millbrae POTW, 7/2007

DRIVING FACTORS

- Antiquated 20 year old ICE co-generator
  - Hard to get parts
  - Polluting
  - Extended down time
- Rising energy costs
  - No new utility generators
  - Price of fossil fuel
- Numerous POTW infrastructure needs…OLD

PROJECT SCOPE: EQUIPMENT REPLACED:

- 55 year old boiler (250 KBTU replaced with 1 MBTU)
- 34 year old stand-by diesel generator (Compressed Natural Gas Storage system and Electrical Switchgear with "basic" island mode functionality)
- 25-55 year old switchgear
- 20 year old co-generator
- 20 year old gas digester mixing system (essential for efficient production of methane from grease)
- 15 year old sludge circulation pump

CONVINCING FACTORS

- 20 years CHP experience
- Innovative – well trained staff
- Ample digester volume
- Neighboring POTW reported long term success receiving grease
- POTWs have historically processed grease

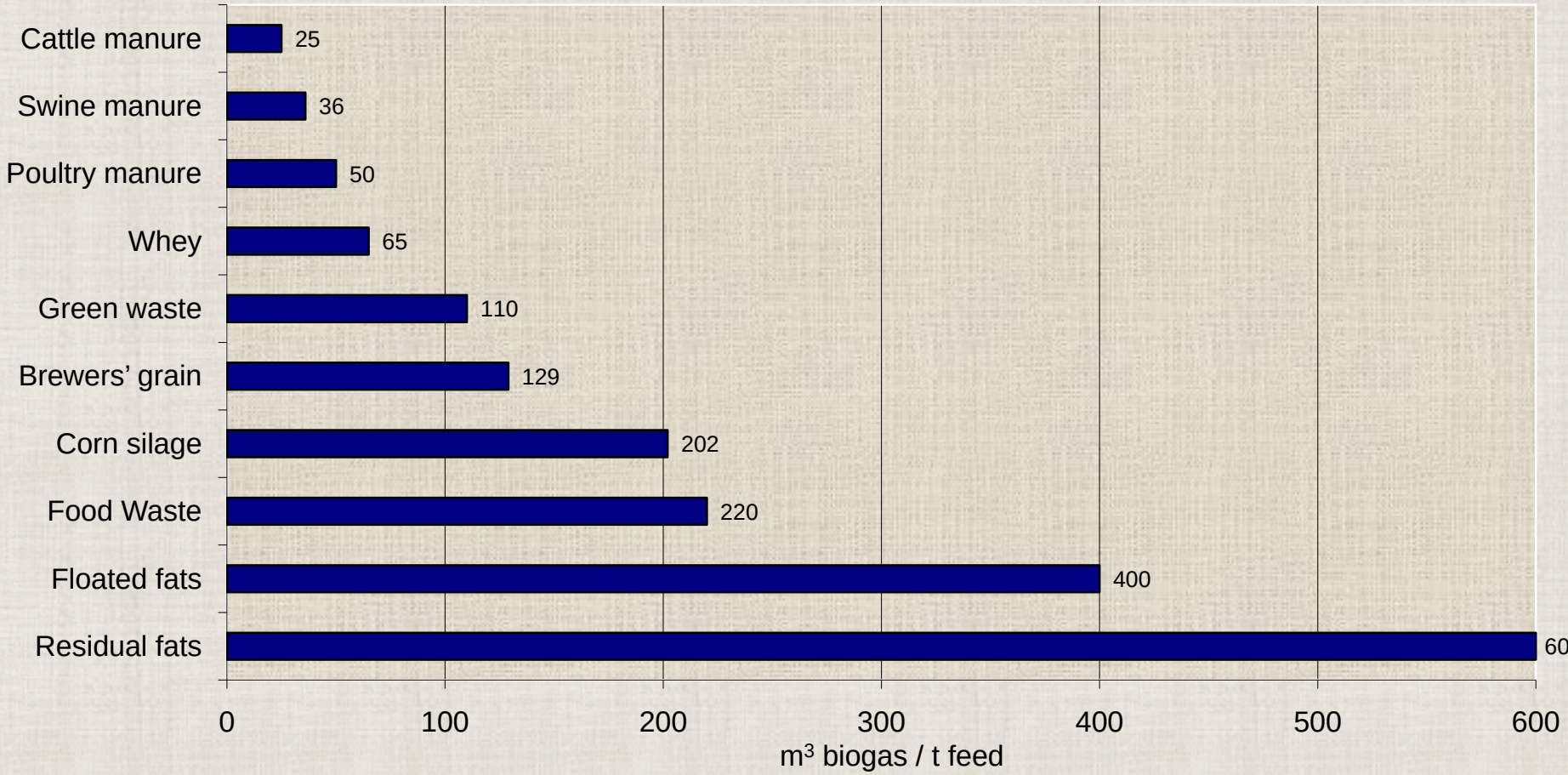
WHY CONSIDER RECEIVING GREASE?

- IKG (brown grease / FOG) found in trap waste
  - Is readily available
  - Disposal problematic
  - Grease is easily digested
  - High energy content
  - Consistent character
- Improved project economics
  - Additional digester gas produced
  - Additional revenue from tipping fees
    - $ 0.06 per gallon

BUT, WHAT IS FOG

- UBIQUITOUS
- INSIDIOUS

BIOGAS PRODUCTION FOR VARIOUS FEEDSTOCK



- Lusk, Philip D (2005). Establishing Credibility. PowerPoint presentation given at Fifth Annual BioCycle Conference on Renewable Energy From Organics Recycling, September 2005, Madison, Wisconsin.

COMMON FATTY ACIDS

FATTY ACID	FORMULA	OCCURENCE
Acetic	CH_3COOH	Vinegar
Butyric	C_3H_7COOH	Butter
Caproic	$C_5H_{11}COOH$	Butter
Caprylic	$C_7H_{15}COOH$	Butter
Capric	$C_9H_{19}COOH$	Coconut oil, butter
Lauric	$C_{11}H_{23}COOH$	Spermaceti, coconut oil
Myristic	$C_{13}H_{27}COOH$	Nutmeg butter, coconut oil
Palmitic	$C_{15}H_{31}COOH$	Animal and vegetable fats
Stearic	$C_{17}H_{35}COOH$	Animal and vegetable fats
Arachidic	$C_{19}H_{39}COOH$	Peanut oil

ANAEROBIC BREAKDOWN OF FATS AND OILS

- Final reaction:

$$CH_3COOH \rightarrow CO_2 + CH_4$$

- Breakdown is complex
- Different microorganisms
- A WW anaerobic environment ideal

BIOAVAILABILITY IS KEY

HOW DID WE BOOST BIOAVAILABILITY?

1. **Automated Preconditioning**
   - Treatment begins immediately as FOG is off loaded.
   - FOG is combined with actively digesting sludge in a precise ratio.
2. **'Bioreactor' Storage**
   - FOG-Sludge Mixture Blended into miscible, stable slurry. **NO separation, NO clogs.**
   - Chemical composition is changed, surface area maximized.
3. **Continuous introduction**

Millbrae FOG Receiving Station

MICROTURBINE

SOME GREASE TRAP PRODUCTION RATES

- National Avg. = 16 lbs / year / person*
- **4.6 billion** lbs / year

  At 1 kW per pound added, that's equivalent to a generating about **4,600 GWh** annually in the US alone (1 GW = 1 billion watts)

That's about 525 MW of new generating capacity

(Millbrae system has achieved 3.22 gross, netting 1.22 kW w/microturbine)

- Sacramento, CA Ave. = 11.2 lbs / year / person*
- Provo, UT Ave. = 26.6 lbs / year / person*

* Source: Wiltsee, G. "*Expanding BioEnergy Partnerships*." *BioEnergy '98, 1*998

MILLBRAE BENEFITS

- Facility improvements worth $6.3 M, w/ $3.2 M of other critical POTW needs
- No new cost to the ratepayer
- New revenue (tipping charges; $0.06 / g)
- Utility savings = $204,600
  - 1.1million kWh per year @ $0.186 / kWh
  - last year, $0.165 / kWh, up @11%
- System configured to serve as standby power
- Increased biosolids destruction more than 25 %
- Reduced biosolids dewatering and disposal costs

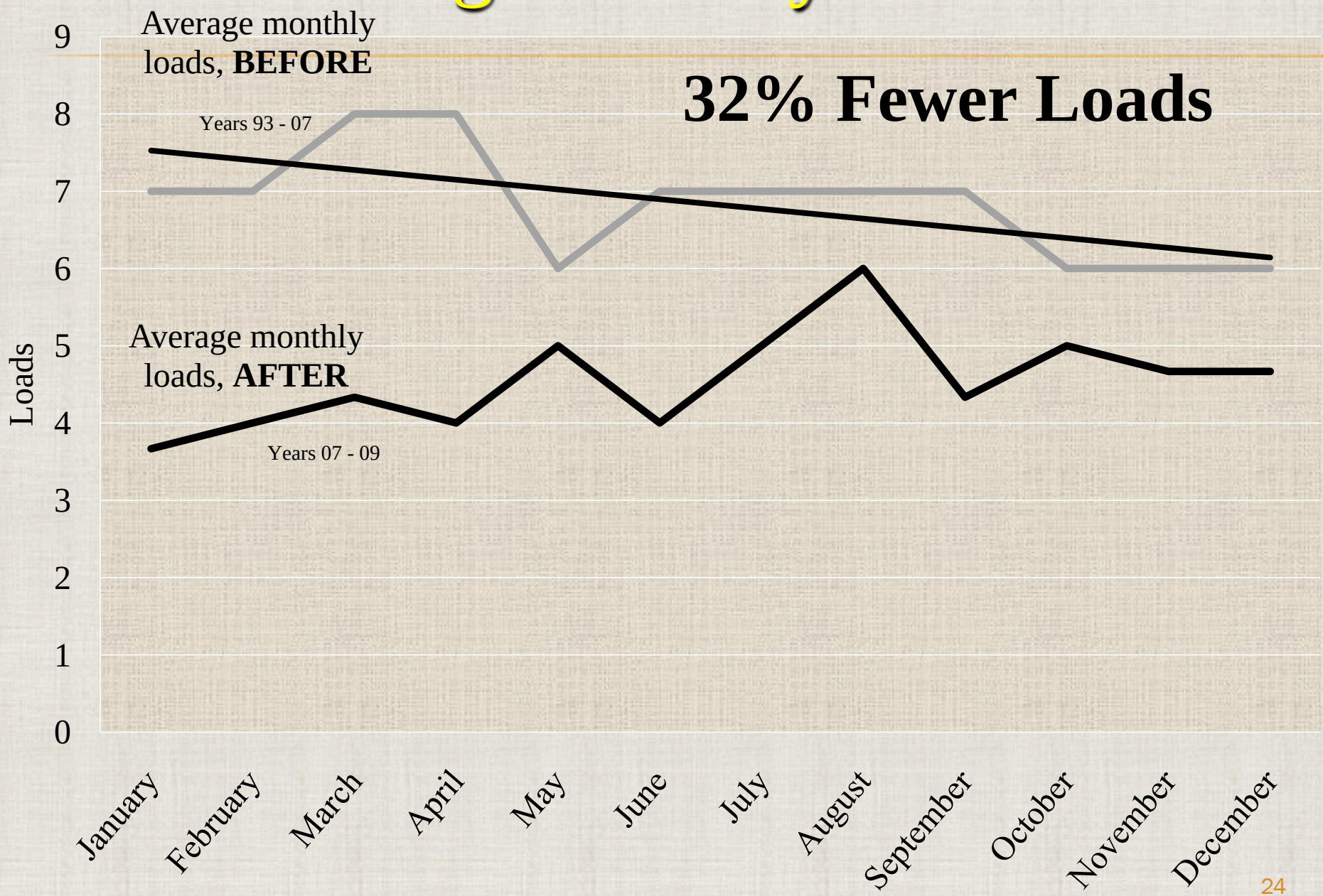
ENVIRONMENTAL BENEFITS

- Clean air
- Less GHG
- Renewable energy
- Reduced landfill disposal
- Less biosolids
- Local grease disposal facility
- No residual waste
- Less trucking
- No chemicals used

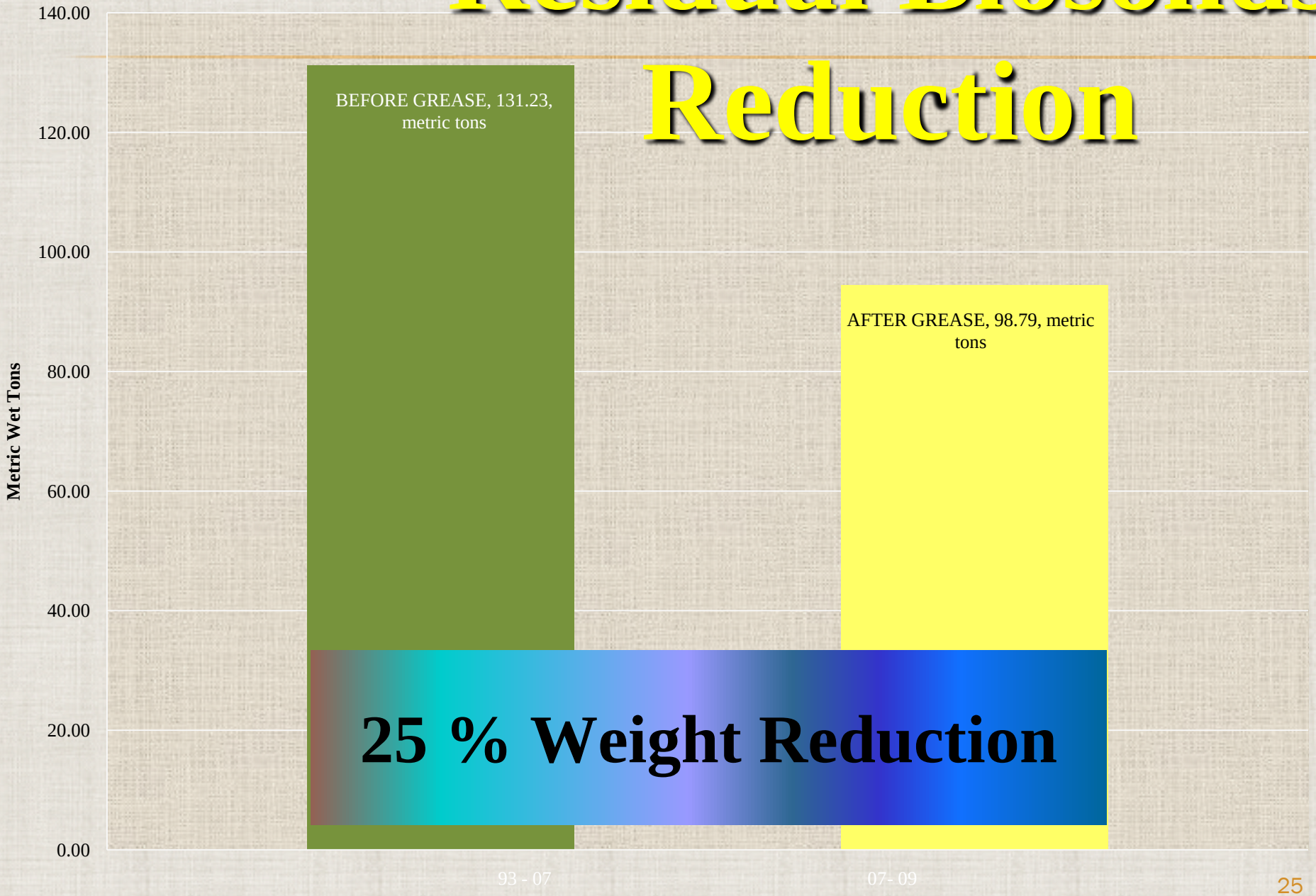
FROM CLOGGED

To Clean

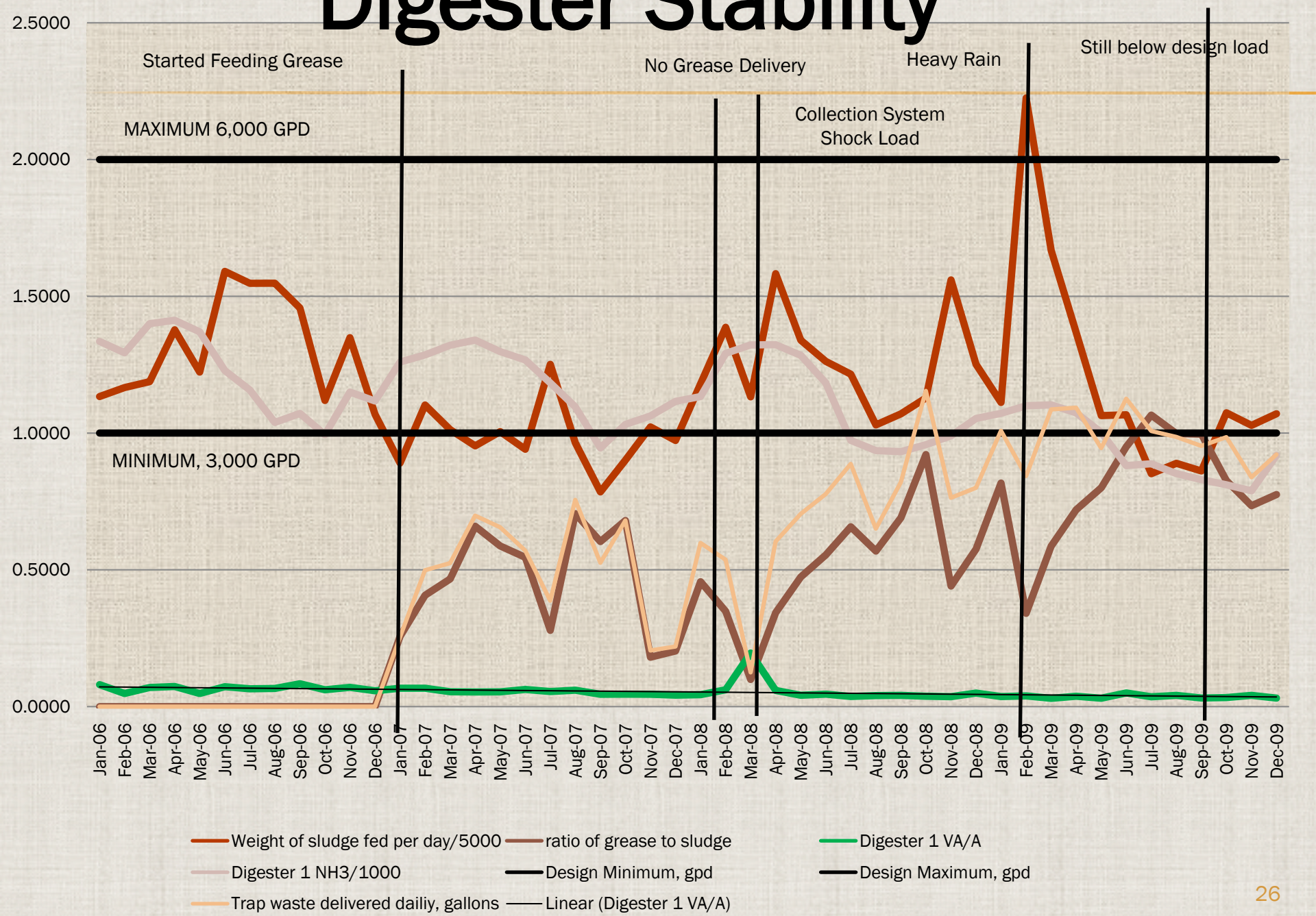
Average monthly loads



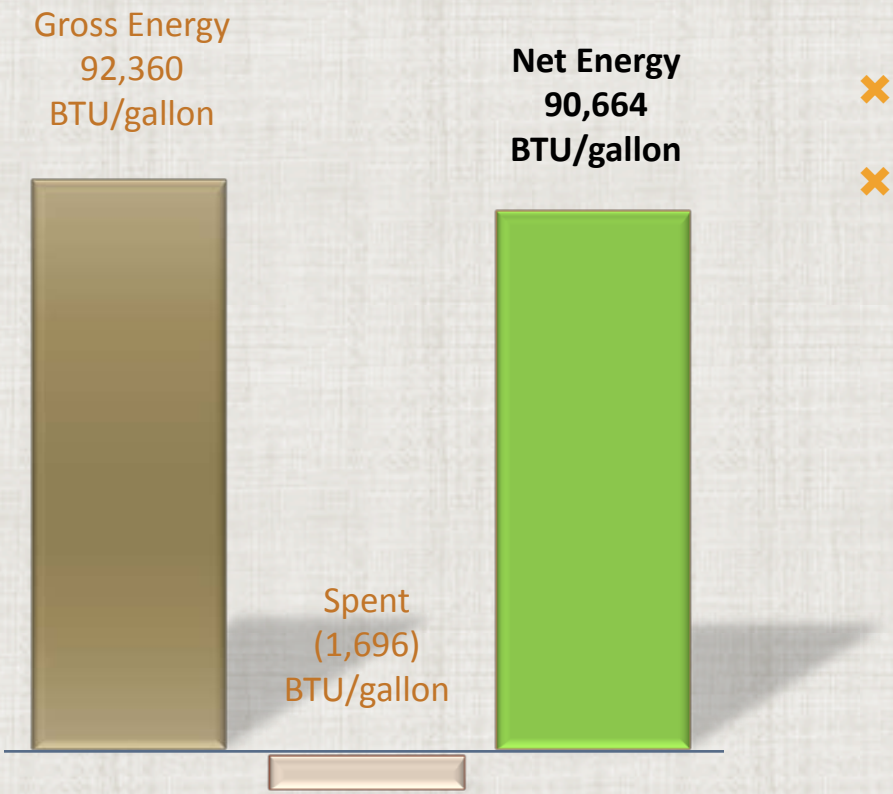
Residual Biosolids Reduction



Digester Stability



SYSTEM PERFORMANCE



Actual FOG Energy Operating Performance

Note: Energy units are expressed as BTU per gallon of brown grease.

- **54X Energy Production Ratio**
- 98% energy conversion efficiency
  - Energy used for powering pumps and system controls only

TAKE HOME MESSAGES!

BIOAVAILABILITY IS KEY

"OPERATOR APPROVED"

"NO DOWN SIDE"

BIOAVAILABILITY

WHY NOT?

Replicate the Millbrae experience around the US to dispose all **F**at**O**il**G**rease to help reduce the GHG impact by <u>20 million metric tons per year.</u>

IMAGINE THE WORLD!

THAT'S LIKE ELIMINATING

- **About 3.7 million cars**

  Taking that many cars off the road will definitely improve the traffic
- **Growing pine trees on an area equal to more than two Yellow Stone Parks (park is 2.2** million acres)
- **The electricity used in 1.8 million homes.***

  That is a pretty dense urban area, like the 9 county San Francisco Bay Area in California

*Equivalency Source: http://www.epa.gov/RDEE/energy-resources/calculator.html

SUMMARY

- Smooth operation
- Benefits of reduced dewatering
- Encourages proper grease disposal
- Helps solve the FOG problem
- Makes electricity from waste
- Cleaner air
- Exceptional results
- Saves money!!!

QUESTIONS ???

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