TRINITY REFINING & SAFETY SYSTEMS

Municipal Waste Landfill Gas to Energy Performance Review

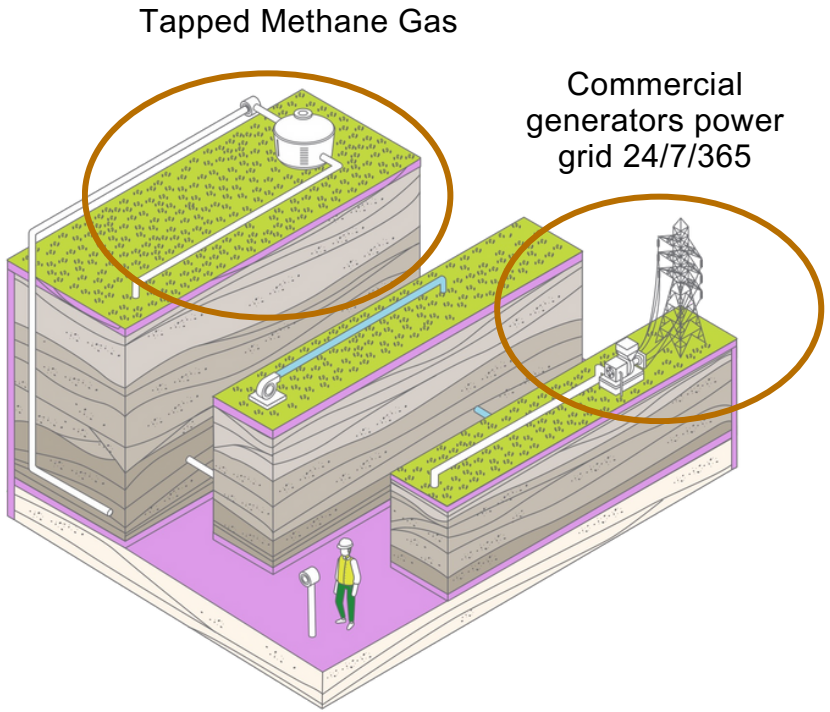
TRINITY
OIL, FUEL, AND WATER SOLUTIONS

MAKING GREEN GREENER TRINITY™

TRINITY RSS

A Solution to Landfill-to-Gas (LFG) Energy Production Costs

LANDFILL-TO-GAS ENERGY



THE PROBLEM

High <u>siloxanes, chlorides, and sulfides</u> aggressively contaminate the oil

Generator engines use <u>full-flow filters</u> that only capture contaminants down to <u>10-20 microns</u> in size.

Wear particles are <u>4-10 microns</u>,

Significant <u>filtering gap</u>

Shortens oil life

Reduces equipment life

Increases operational costs

* Single-site case study
** Noria Corp™ Engine Life Extension Table

THE SOLUTION

Fuel Conditioners

1-Micron By-Pass Oil Filters

Reduced oil contamination by 99%*

Improved oil life 4X

Extended extended engine life 3X

Reduced oil disposal by 67%*

Improved combustion efficiency by 3%*

Reduced operational costs 43%

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LFGTE Case Study

April 2021

- Site #1 LFGTE
- Engine #3
  - Oil changed every 300 hours
  - Trinity installation June 2021
- The base sample was taken on 4/7/2021
  - 308 hours on oil
  - ISO 27/26/23
  - 832,720 >4-micron particles m/L
- The last sample was taken on 04/04/23
  - 2098 hours (600% improvement)
  - ISO 18/15/14 (9 ISO class code improvements)
  - 1537 >4-micron particles m/L (99.82% particle reduction)

June 2022

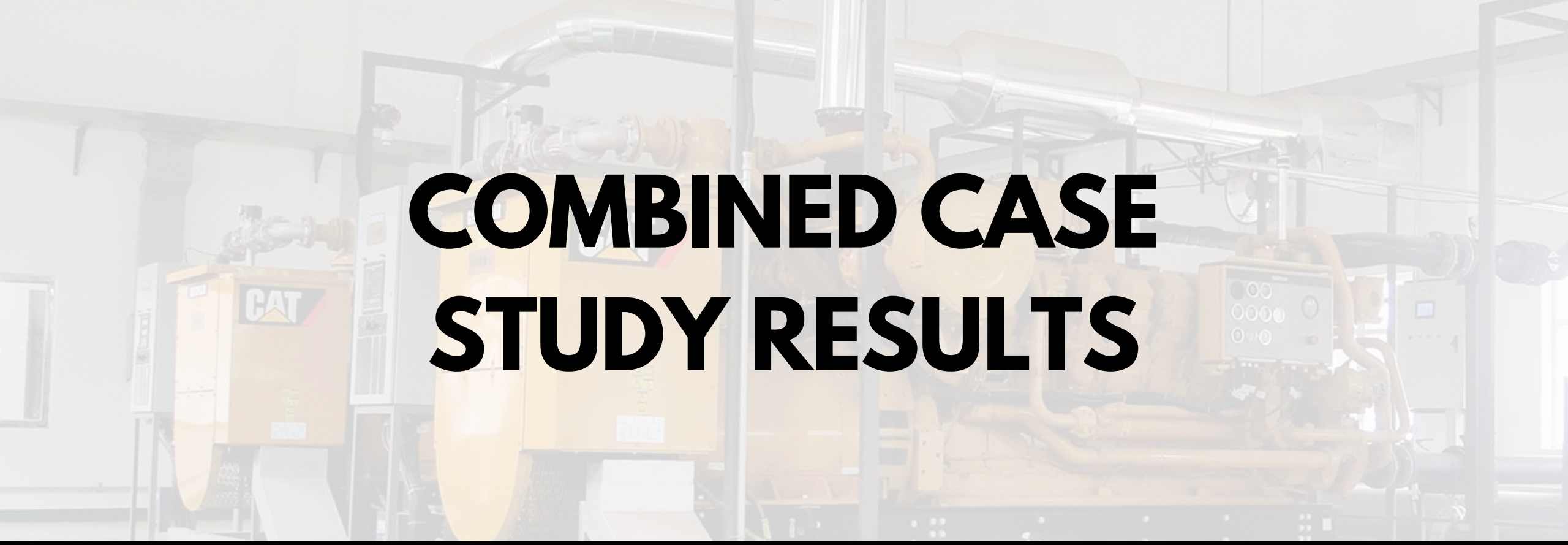
- Added 4 sites and 7 engines
  - Site #2 2x3516 Engines (July 2022)
  - Site #3 – 2 x 3520 Engines (July 2022)
  - Site #4 – 2 x 3516 Engines (Sept 2022)
  - Site #5 – 1 x 3520 Engine (August 2022)
- Two labs
  - Predictive Maintenance Services (Trinity)
  - Petroleum Technologies (Landfill)
  - Close to 15 thousand data points

March 2023

Completed

- Reduced 99% of contaminants
- Improved oil life 1.25X - 7X
- Projected extended engine life 3X*
- Improved operational costs by 48%**

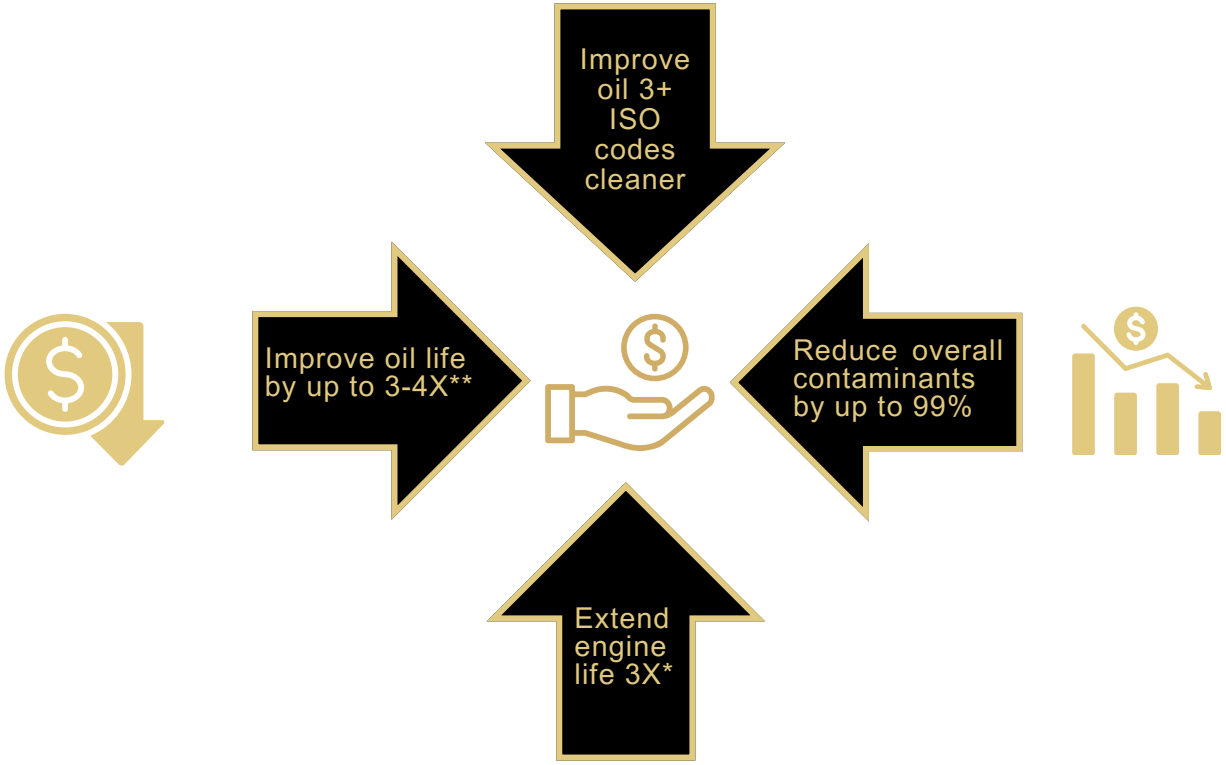
* Noria Corp™ Engine Life Extension Table
** On average and based on Trinity's recommendations

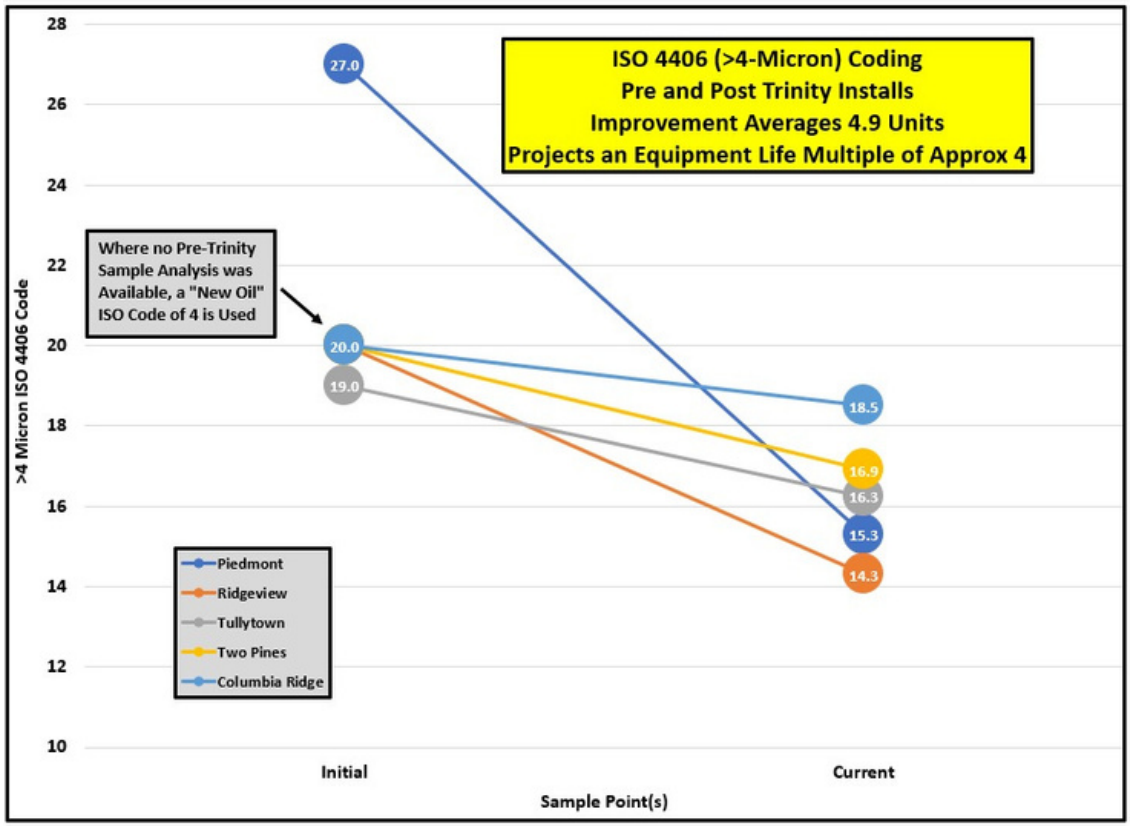


COMBINED CASE STUDY RESULTS

Overall Averages Based on Five Sites and Eight Engines
(Caterpillar 3516 and 3520 Generator Engines)

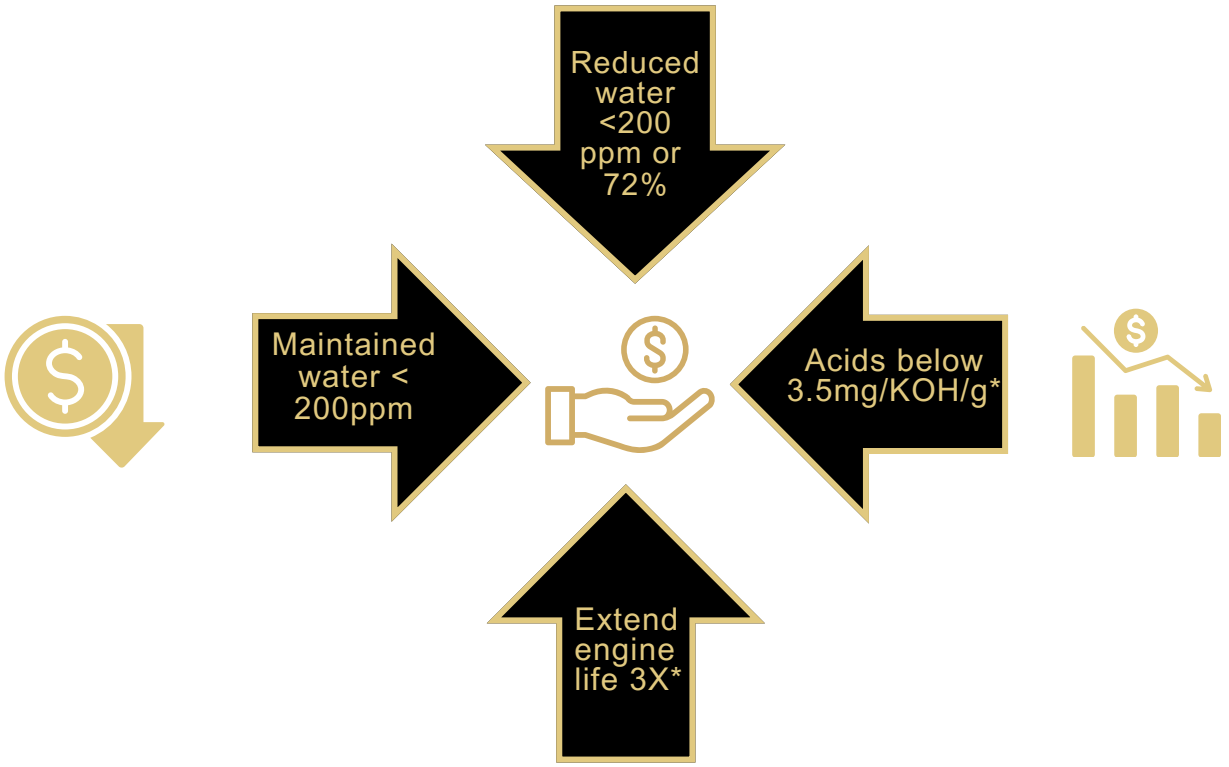
LANDFILL COMBINED RESULTS PERFORMANCE VALUE (PARTICLE COUNT)





* International Standards Organization (ISO) 4406 test (Industry three-digit value used to communicate particulate contamination in oil) ** Noria Corp™ Engine Life Extension Table

LANDFILL COMBINED RESULTS PERFORMANCE VALUE (WATER AND ACIDS)



* Noria Corp™ Engine Life Extension Table

Note: Insufficient data for Columbia Ridge

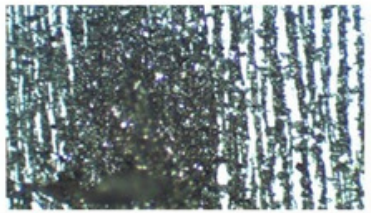
LANDFILL COMBINED RESULTS PERFORMANCE VALUE (FERROGRAPHY)

Reduced Percentage of Large Particles (DL and DS) by 80%

Before Trinity

Piedmont - PreTrinity Install
6/13/2021
834 Hours on Oil

TOP PHOTO (100X)

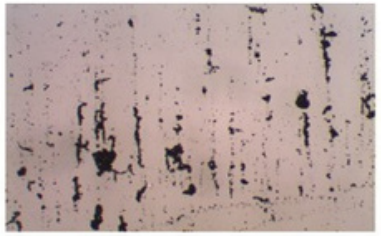


Ridgeview - PreTrinity Install
7/1/2022
192 Hours on Oil

TOP PHOTO SHOWS NORMAL WEAR AND CONT (100X).

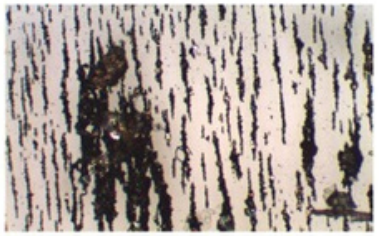
Tullytown - PreTrinity Install
9/19/2022
863 Hours on Oil

TOP PHOTO (100X)



Two Pines - PreTrinity Install
9/29/2022
168 Hours on Oil

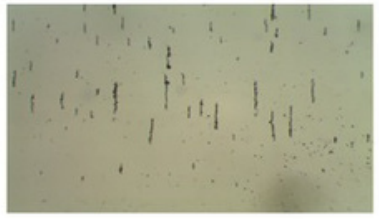
TOP PHOTO (100X)



After Trinity

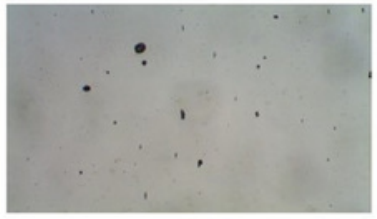
Piedmont - PostTrinity Install
6/18/2021
234 Hours on Oil

TOP PHOTO SHOWS NORMAL WEAR AND CONT



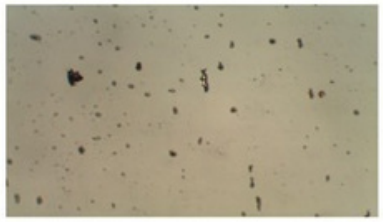
Ridgeview - PostTrinity Install
10/3/2022
501 Hours on Oil

TOP PHOTO SHOWS NORMAL WEAR AND CONT (100X).



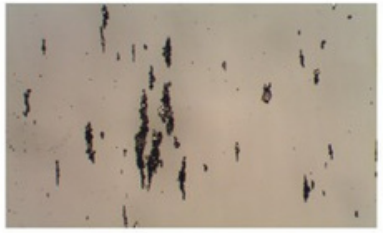
Tullytown - PostTrinity Install
9/26/2022
983 Hours on Oil

TOP PHOTO SHOWS NORMAL WEAR AND CONT (100X).

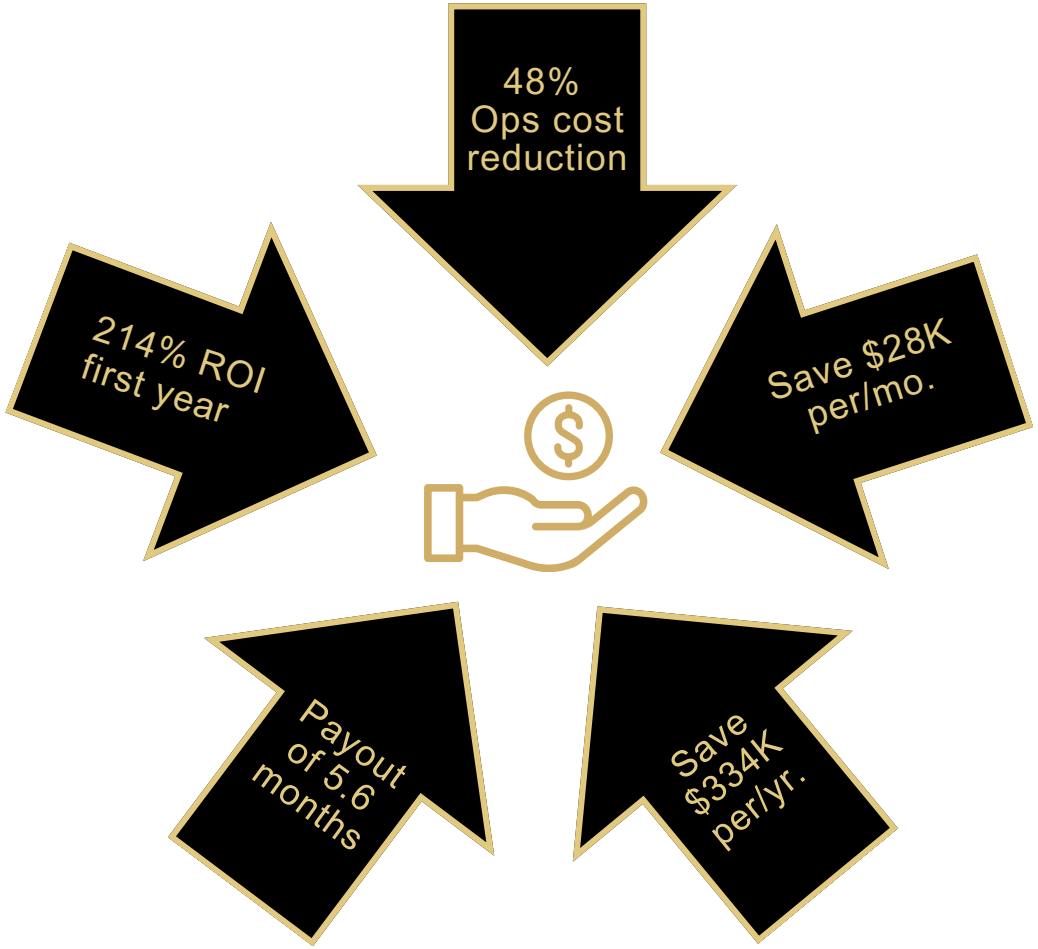


Two Pines - PostTrinity Install
10/3/2022
263 Hours on Oil

TOP PHOTO (100X)



LANDFILL COMBINED RESULTS COST VALUE



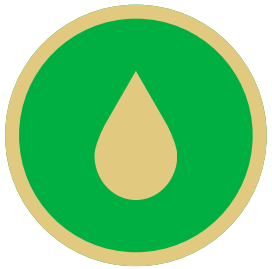
Based on 1.25X to 6X oil life and 1.25X - 3X equipment life

WM COMBINED RESULTS
GREEN VALUE

(BASED ON FIVE SITES AND EIGHT 3516/3520 CATERPILLAR GENERATOR ENGINES)

REDUCE OIL DISPOSAL BY 48%*

SAVE 167K METRIC TONS OF CO2 PER YEAR**



SAVE 8800 GALLONS OF OIL PER YEAR*

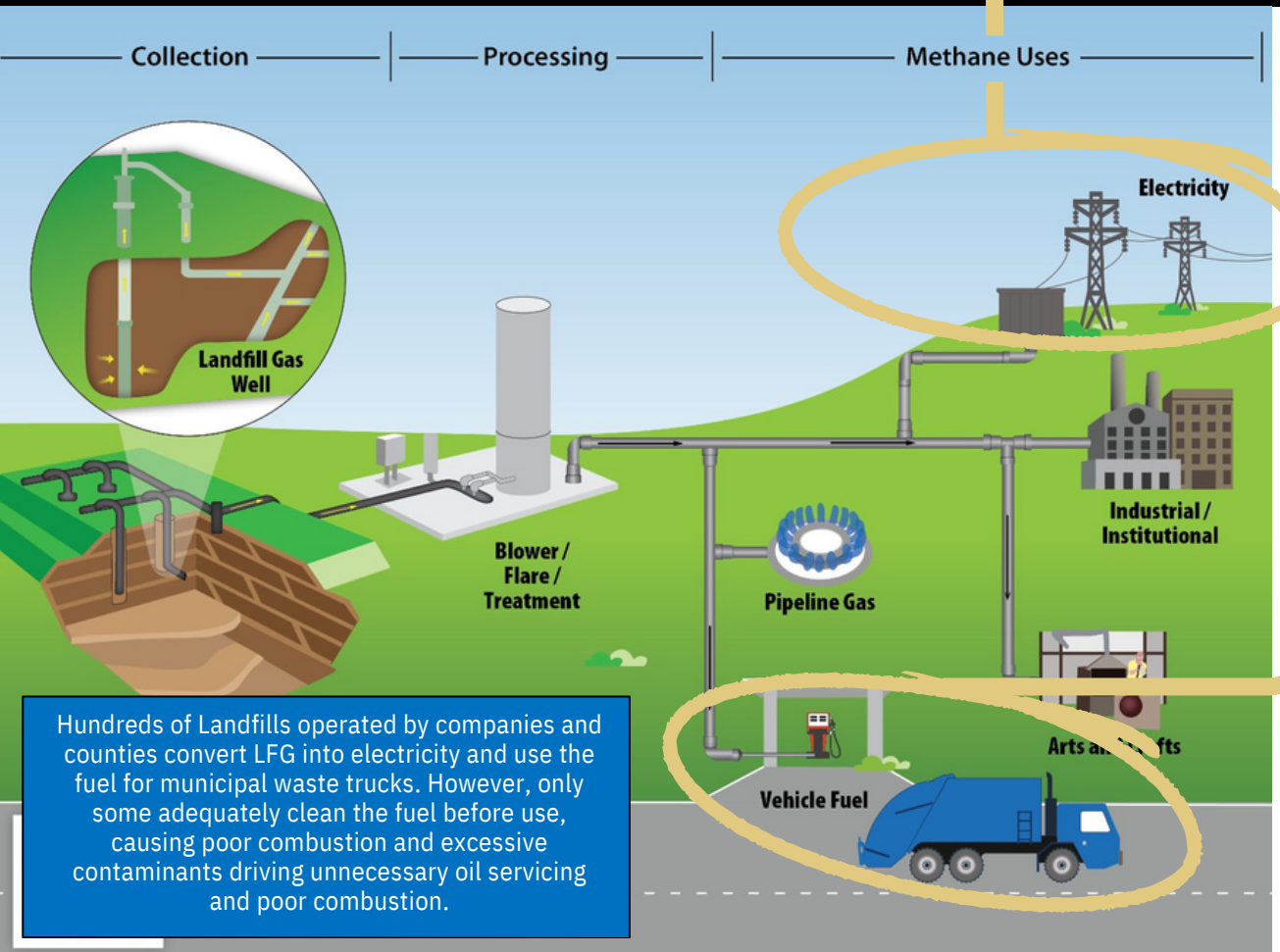
INCREASE COMBUSTION EFFICIENCY BY UP TO 3%

* Based on 2X - 3X oil life multiple
** Based on EPA calculators for CO2 Emissions

THE BIGGER PICTURE

Trinity RSS Impact on Landfill-To-Gas Sites

POTENTIAL LANDFILL LANDFILL GAS TO ENERGY SITE IMPACT



Hundreds of Landfills operated by companies and counties convert LFG into electricity and use the fuel for municipal waste trucks. However, only some adequately clean the fuel before use, causing poor combustion and excessive contaminants driving unnecessary oil servicing and poor combustion.

TRUCKING FLEET

- 6500 trucks
- 15 gallons of engine oil per truck
- 40 gallons of hydraulic oil per truck

TRINITY IMPACT*

- Extend oil change 3X*
  - Save 350 gallons per truck per yr.
  - Save 2.3M gallons or 55K barrels per
- fleet.
  - Save **$5.8M annually per fleet**
- Extend hydraulic oil 2X*
  - Save 40 gallons per truck per yr.
  - Save 260K gallons annually per fleet.Save **$2.3M annually per fleet**
  - Reduce harmful emissions by 5-10%**

**** Discriminants***
•250-hour lube oil change
•1000-hour hydraulic oil change
•$25/g for lube and $9/g for hydraulic oil
•Case studies have shown up to 8X hydraulic oil life extension
***** Based on previous case studies***

GENERATOR ENGINES

- 369 generator engines
- 75 to 150 gallons of oil per engine per oil change (Caterpillar 3516/3520)

TRINITY IMPACT*

- Save 1100 gallons of oil per generator annually*
- Save 405,900 gallons or 9664 barrels of oil annually per fleet
- **Save $6M** annually per fleet**
- Increase combustion efficiency by up to 3%***
- Save 4200 metric tons of CO2

**** Average engine oil change at 400 hours.***
***** $15/gallon***
****** Based on landfill case study***

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DISCUSSION

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