

**Landfill Gas Emissions Destruction, Beneficial Use and Solar Utility
EV Refuse Trucks & Charging System and Recycling Center
Community Center Backup Power Generation facilities
Greenhouse Gas Reduction Measures and Facilities**

Technical Appendix

This Technical Assistance has synergy with the Workplan and Budget Narratives included in this grant application package. The appendix lists or describes the specific models or tools used to develop the GHG emission reduction estimates; the name of the developer/provider of the model/tool and, any other detailed references (e.g., specific versions of the model or tool), as appropriate. Included in this section are (1) Measure Implementation Assumptions, (2) GHG Reduction Estimate Assumptions, (3) Reference Case Scenario (GHG Emissions or Activity Level), (4) Measure-Specific Activity Data, and GHG Emissions Reduced. Reductions are provided in metric tons of CO₂ equivalent [MTCO₂e] and cumulative GHG emission reductions for the periods 2025 - 2030 and 2030 – 2050.

1. Summary

The following table summarizes the reduction in greenhouse gases by implementing the measures and infrastructure facilities requested by this grant ask.

Implementation Measure	MT CH₄	MT CO₂e
Landfill Gas Wellfield to Full Extent 2025 to 2030 Emissions Avoided	65,184	410,260
Landfill Gas Wellfield to Full Extent 2030 to 2050 Emissions Avoided	187,734	8,205,200
Landfill Gas Emissions Destruction Beneficial Use plant 2025 to 2030*	0	0
Landfill Gas Emissions Destruction Beneficial Use plant 2030 to 2050**		31,250
C & D Diversion 2025 to 2030 ¹		419
C & D Diversion 2030 to 2050		1,796
Recycling Diverted 2025 to 2030 ²		34,239
Recycling Diverted 2030 to 2050 ³		171,197
EV Recycling Trucks 2025 to 2030 ⁴		4,750
EV Recycling Trucks 2030 to 2050		19,000
Natural-gas Powered Backup Generators (Diesel generators emit 20.3 MT CO ₂ for four generators) ⁵ 25 Years		17.4
CO ₂ emissions diverted annually EV Charging Stations ⁶ 25 Years (26,180 2025 to 2030; (104,720 2030 TO 2050)		104,650
Solar Utility 2030 to 2050*	n/a	31,250
Total MT CH₄ Methane Reduction 2025 to 2030	65,184	
Total MT CH₄ Methane Reduction 2030 to 2050	187,734	
Total MT CO₂ Carbon Dioxide Reduction 2025 to 2030		470,598
Total MT CO₂ Carbon Dioxide Reduction 2030 to 2050		8,543,430

* The Solar Utility plant which is planned for 10-acre of the 237-acre closed landfill would produce 1 MW, in its' startup year of 2030 would result in resulting in 1,250 tons CO₂e.

**Total avoided CO₂ emissions

¹The total carbon-emission-saving potential can be increased from 0.31 million t CO₂-e (2022) to 0.35 million t CO₂-e (2031). Estimating the Carbon Emission of Construction Waste Recycling Using Grey Model and Life Cycle Assessment: A Case Study of Shanghai July 19, 2022; Huang, editor

² Assessing the environmental impact of waste management: A comparative study of CO₂ emissions with a focus on recycling and incineration, Journal of Cleaner Production; August 2023

³ City_of_Waco_GHG Waste Reduction Calculator warm_v15_nov2020 Excel Model

⁴ Battery electric could be 63% of refuse truck sales come 2030: report; by Maria Rachal, published in WasteDive, January 31, 2023.

⁵ Diesel generators produce particulate matter (PM), volatile organic compounds (VOCs), nitrous oxide (NOx) among other harmful pollutants that create smog and exacerbate respiratory conditions. FEA "The Carbon Footprint of Diesel Generators" <https://www.feace.com/single-post/the-carbon-footprint-of-diesel-generators>

⁶ Reuters: "Lifetime Carbon Emissions of Electric Vehicles vs Gasoline Cars: July 7, 2021: <https://www.reuters.com/business/autos-transportation/lifetime-carbon-emissions-electric-vehicles-vs-gasoline-cars-2021-06-29/>

2. Measure Specific Reductions

a. Expanded Landfill Gas Wellfield – Grant Ask \$4,303,500.00⁷

Project/Measure: Expanded Landfill Gas Wellfield (The City of Waco has already invested \$2.9M in this project)

Estimated Annual Greenhouse Gas Benefits:

252,918 metric tons CH₄ and 8,619,460 metric tons of CO₂e from 2025 through 2050

Expected Community Benefits:

Improved Health and Well-Being; decreased odors, Increased Resiliency and Adaptability; Job Creation and Economic Development and Increased Awareness and Understanding.

Environmental Outcomes:

At least 30 HAP's⁸ have been identified in uncontrolled landfill gases including benzene, toluene, ethyl benzene and vinyl chloride. Exposure to these HAP's can lead to adverse health effects.

Criteria Air Pollutants⁹ for landfill gas include carbon monoxide, carbon dioxide, oxides of nitrogen, sulphur dioxide, particulate matter, hydrocarbons and other NMOC's that cause health impacts.

Expected Outcomes:

Significantly reduced emissions occur from landfill gas withdrawal. It is expected the collection efficiency could range as high as 90-95%

For GHG emissions, CO₂ and CH₄ are the greenhouse constituents that have the most long-lasting climatic impacts and are commonly used to calculate emissions data. Landfill gas has various NMOC's including acrylonitrile, benzene, 1,1-dichloroethane, 1,2- cis dichloroethylene, dichloromethane, carbonyl sulfide, ethyl- benzene, hexane, methyl ethyl ketone, tetrachloroethylene, toluene, trichloroethylene, vinyl chloride, and xylenes¹⁰, however those constituents have not been calculated. Estimated GHG reductions emissions for carbon dioxide and methane were calculated Per 40 CFR §98.323(b)¹¹ The primary GHG gases responsible for climate change are CH₄ and CO₂. Two methods to calculate CH₄ were used for this EPA Grant application. The first method was the 40 CFR §98.323(b). CH₄ was calculated using the following equation but on a daily basis instead of weekly. Method One:

$$CH_{4D} = \sum_{i=1}^n \left(V_i * MCF_i * \frac{C_i}{100\%} * 0.0423 \frac{520^\circ R}{T_i} * \frac{P_i}{1 atm} * 1,440 * \frac{0.454}{1,000} \right) \quad (\text{Eq. FF-3})$$

Where:

CH_{4D} = Weekly CH₄ liberated from the monitoring point (metric tons CH₄).

V_i = Measured volumetric flow rate for the days in the week when the degasification system is in operation at that monitoring point, based on sampling or a flow rate meter (acfm). If a flow rate meter is used and the meter automatically corrects to standard temperature and pressure, then use scfm and replace "520°R/T_i × P_i/1 atm" with "1".

MCF_i = Moisture correction factor for the measurement period, volumetric basis.

= 1 when V_i and C_i are measured on a dry basis or if both are measured on a wet basis.

= 1-(f_{H2O})_i when V_i is measured on a wet basis and C_i is measured on a dry basis.

= 1/[1-(f_{H2O})_i] when V_i is measured on a dry basis and C_i is measured on a wet basis.

(f_{H2O}) = Moisture content of the CH₄ emitted during the measurement period, volumetric basis (cubic feet water per cubic feet emitted gas).

C_i = CH₄ concentration of gas for the days in the week when the degasification system is in operation at that monitoring point (%).

n = The number of days in the week that the system is operational at that measurement point. To obtain the number of days in the week, divide the total number of hours that the system is operational by 24 hours per day.

0.0423 = Density of CH₄ at 520 °R (60 °F) and 1 atm (lb/scf).

520 °R = 520 degrees Rankine.

T_i = Temperature at which flow is measured (°R).

P_i = Absolute pressure at which flow is measured (atm).

1,440 = Conversion factor (minutes/day).

0.454/1,000 = Conversion factor (metric ton/lb).

⁷ SCS Engineers: Phase II, III and Cell III 2022.9.6 Waco 948A – Engineers Estimate - Full Buildout

⁸ Landfill Methane Outreach Program (LMOP); <https://www.epa.gov/lmop/frequent-questions-about-landfill-gas>

⁹ Landfill Methane Outreach Program (LMOP); <https://www.epa.gov/lmop/frequent-questions-about-landfill-gas>

¹⁰ Landfill Gas Basics; Agency for Toxic Substances and Disease Registry; https://www.atsdr.cdc.gov/HAC/landfill/PDFs/Landfill_2001_ch2mod.pdf

¹¹ 40 CFR § 98.323 - Calculating GHG emissions.

The second method was use of the **EPA, LandGEM Landfill Gas Emissions Model, December 2023, version 3.1 Beta**. This model uses inputs of annual tonnages of municipal solid waste derived from annual reporting to the Texas Commission on Environmental Quality. This model is included in the Technical appendix (CityofWaco_landgem-v3.1beta_dec-2023).

Expected short- and long-term outputs and outcomes for methane and carbon dioxide will result in reductions. As landfill gases contain NMOC's, reductions both short- and longer-term are reasonably expected to have direct co-pollutant (e.g., CAPs and/or HAPs) emissions reduced in the general and in low- income and disadvantaged communities as expected outcomes.

b. Project/Measure: Beneficial Use of Landfill Gas Facility (Not included as a funding request, but Emissions Reductions Reported due to the expansion of the landfill gas collection wellfield. This conveys the collected landfill gas to destruction unit, significantly increasing GHG emission capture and destruction, and the CH₄ and CO₂ values are reported and included in the EPA Grant)

Estimated Annual Greenhouse Gas Benefits:

31,250 metric tons of CO₂e from 2030 through 2050

Expected Community Benefits:

Improved Health and Well-Being; Increased Resiliency and Adaptability; Job Creation and Economic Development; and Increased Awareness and Understanding

Environmental Benefits

At least 30 HAP's have been identified in uncontrolled landfill gases including benzene, toluene, ethyl benzene and vinyl chloride. Exposure to these HAP's can lead to adverse health effects. Criteria Air Pollutants for landfill gas include carbon monoxide, carbon dioxide, oxides of nitrogen, sulphur dioxide, particulate matter, hydrocarbons and other NMOC's that cause health impacts.

Expected Outcomes:

GHG reductions are expected to be reduced to near zero emissions. Calculation Source¹²: Emission Reductions and Environmental and Energy Benefits for Landfill Gas Energy Projects, Last Updated May 2023.

Assumptions: Direct Use, AVERT National Average

Calculator Narrative:

The LFG Energy Benefits Calculator can be used to estimate direct, avoided and total greenhouse gas (GHG) reductions, as well as environmental and energy benefits, for a landfill gas (LFG) energy project. For both electricity generation and direct-use projects, reductions of GHG emissions are derived from capturing and destroying landfill methane. GHGs are also reduced by the offset of carbon dioxide (CO₂) emissions. Electricity generation projects displace CO₂ that would have otherwise been generated from fossil fuels burned at conventional power plants. The Output data result follows:

Direct Equivalent Emissions Reduced [Reduction of methane emitted directly from the landfill]		Avoided Equivalent Emissions Reduced [Offset of carbon dioxide from avoiding the use of fossil fuels]		Total Equivalent Emissions Reduced [Total = Direct + Avoided]		
MMTCO ₂ E/yr million metric tons of carbon dioxide equivalents per year	tons CH ₄ /yr tons of methane per year	MMTCO ₂ E/yr million metric tons of carbon dioxide equivalents per year	tons CO ₂ /yr tons of carbon dioxide per year	MMTCO ₂ E/yr million metric tons of carbon dioxide equivalents per year	tons CH ₄ /yr tons of methane per year	tons CO ₂ /yr tons of carbon dioxide per year
7.1574	281,771	0.6310	695,517	7.7884	281,771	695,517
Equivalent to any one of the following annual benefits: <u>Environmental Benefits</u>		Equivalent to any one of the following annual benefits: <u>Environmental Benefits</u> • Carbon sequestered by ___ acres of U.S. forests in one year:		Equivalent to any one of the following annual benefits:		
8,520,751		751,158		9,271,910		

¹² Landfill Gas Energy Benefits Calculator; <https://www.epa.gov/lmop/landfill-gas-energy-benefits-calculator>

• Carbon sequestered by ___ acres of U.S. forests in one year:		• Carbon sequestered by ___ acres of U.S. forests in one year:	
• CO2 emissions from ___ barrels of oil consumed:	16,645,189	• CO2 emissions from ___ barrels of oil consumed:	1,467,379
• CO2 emissions from ___ gallons of gasoline consumed:	805,382,138	• CO2 emissions from ___ gallons of gasoline consumed:	70,999,547
		• CO2 emissions from ___ barrels of oil consumed:	18,112,568
		• CO2 emissions from ___ gallons of gasoline consumed:	876,381,685

c. Project/Measure: EV Recycling Trucks and Battery Storage

Estimated Annual Greenhouse Gas Benefits: \$3,014,000

4,750 metric tons of CO_{2e} from 2025 through 2030

19,000 metric tons from 2030 to 2050

Expected Community Benefits:

Improved Health and Well-Being; Increased Resiliency and Adaptability; Job Creation and Economic Development; decreased reliance on fossil fuels and Increased Awareness and Understanding.

Environmental Benefits

Criteria and Hazardous Air Pollutants from diesel truck exhausts include: Particulate Matter (PM₁₀ and PM_{2.5}), Ozone (O₃), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Monoxide (CO), formaldehyde, and Lead.

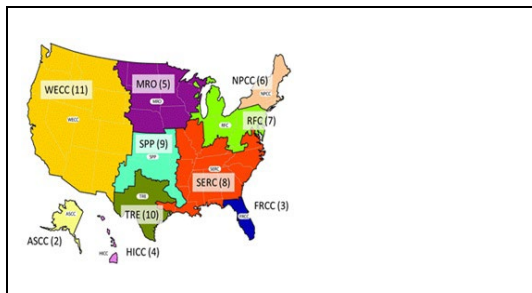
Expected outcomes:

EV Trucks produce zero emissions.

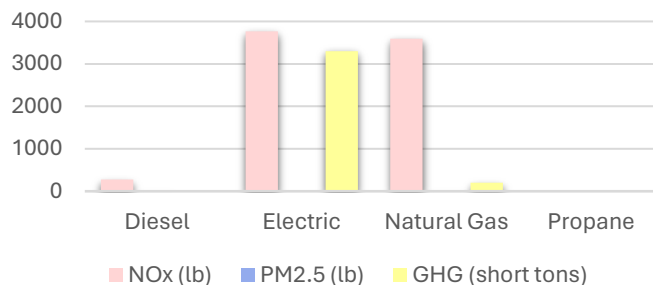
The resultant MTCO₂ was obtained using the following calculations.

HEAVY-DUTY VEHICLE EMISSIONS CALCULATOR ASSUMPTIONS¹³

Project Options	Environmental Mitigation with Scrappage
State	TEXAS
Vehicle Type	Refuse Truck
Number of Vehicles	2
Estimate Lifetime of New Vehicle (Years)	4.56
Funding Options	Diesel Funding Requested \$650,000 Electric Funding Requested \$3,014,000
Annual Miles of New Vehicle	17,033
Fuel Options	Fossil Fuel Electricity - Electric Vehicles (EV)
Source of Emissions Data	Well-to-Wheels GHGs & Vehicle Operation Air Pollutants
Average US Mix	TRE



New Vehicle Lifetime Emission Benefit



New Vehicle Lifetime Emission Benefits				
Pollutant	Diesel	Electric	Natural Gas	Propane
NOx (lb)	278.23	3765.2	3590.85	N/A
PM2.5 (lb)	0.62	8.06	0.62	N/A
GHG (short tons)	0	3300.32	204.29	N/A

New Vehicle Cost Effectiveness				
Pollutant	Diesel	Electric	Natural Gas	Propane
NOx (lb)	\$2,336	N/A	N/A	N/A
PM2.5 (lb)	\$1,444,444	N/A	N/A	N/A
GHG (short tons)	N/A	N/A	N/A	N/A

Information on lifecycle costs, mileage and costs was obtained from actual studies on the City of Waco Solid Waste Fleet¹⁴. This data was included in assumptions that were used for the model inputs.

A second calculation was conducted using the engine manufacturers calculation tool. The Cummins Westport Greenhouse Gas Emissions (GHG) Calculator¹⁵ provides a representative Well to Wheel (WTW) GHG emissions analysis of natural gas engines in different applications. It is based on three published North American Lifecycle GHG Calculators. These emissions calculators assess fuel for its overall GHG impact, including each stage of production and use. Results from this calculator are provided below:

Parameter	Assumption/Output
Region	US Typical
GHG Specification/Model	REET1_2018
New Diesel	2020 Model B6.7
Annual WTW GHG emissions (CO ₂ eq)	(Metric Tons per year) 475
Annual WTW GHG (CO ₂ eq) savings with new vehicles	(Metric Tons per year) 354
TOTAL 2025 to 2030	4,750 metric tons (2 trucks)
TOTAL 2030 to 2050	19,000 metric tons (2 Trucks)

¹⁴ NewGen Strategies and Solutions, LLC; Cost of Hauling to Proposed Landfill Site, dated July 24, 2010

¹⁵ [HTTPS://WWW.CUMMINS.COM/ENGINES/NATURAL-GAS/GHG-CALCULATOR](https://www.cummins.com/engines/natural-gas/ghg-calculator)

Project/Measure: Solar Utility Plant with Membrane Cap: \$24,945,760

Estimated Annual Greenhouse Gas Benefits:

31,250 metric tons metric tons of CO₂e from 2025 through 2050 (1,250*25) *

Expected Community Benefits:

Improved Health and Well-Being; Increased Resiliency and Adaptability; Job Creation and Economic Development; mitigation of high utility bills for disadvantaged communities, significant reduction of landfill gas emissions from the geomembrane liner that is installed below the solar panels deployed, and Increased Awareness and Understanding.

Environmental Benefits

At least 30 HAP's have been identified in uncontrolled landfill gases including benzene, toluene, ethyl benzene and vinyl chloride. Exposure to these HAP's can lead to adverse health effects.

Environmental Benefits

Criteria and Hazardous Air Pollutants from diesel truck exhausts include Particulate Matter (PM10 and PM2.5), Ozone (O₃), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Monoxide (CO), formaldehyde, and Lead.

Expected Outcomes:

Membrane capping is expected to reduce emissions to near zero.

*Additional methane and carbon dioxide emissions are expected to be captured as a result of capping the landfill waste with a geomembrane. Therefore, these captured landfill gases have been included in the quantitative assessment of destruction of the gases as part of the grant request.

To produce the expected 1.4 MW output capacity, It is estimated that the CO₂e offset will be 31,250 MT over the period of 2030 to 2050. According to the Lawrence Berkeley National Laboratory, utility-scale solar power produces between 394 and 447 MWh per acre per year¹⁶. According to the US Department of Energy's Energy Information Administration, the nation averaged 0.85 pounds of carbon dioxide emissions per kilowatt hour generated. Thus, an average 400 W solar panel generating 1.5 kWh per watt per year will offset 510 pounds of carbon dioxide emissions. A single acre of solar panels with a capacity of 1 MW can be expected to offset more carbon emissions than 38,750 trees. Emission reductions for the solar utility plant of up to 10-acres represents a total of the offset of emissions of 65,500 trees. Thus, an acre of solar panels installed to replace natural gas reduces approximately 208 to 236 times more carbon dioxide per year than an acre of forest.

Project/Measure: Additional Recycling Center with Waste Diversion

Estimated Annual Greenhouse Gas Benefits: \$5,573,600

38,435.45 from 2025 to 2030, and 153,742 from 2030 to 2050 metric tons metric tons of CO₂e

Expected Community Benefits:

Improved Health and Well-Being; Increased Resiliency and Adaptability; Job Creation and Economic Development; increased recycling and waste diversion, decreased recyclable waste going to landfill, and Increased Awareness and Understanding.

Increased Access to Recycling Services and Diversion of Wastes

This measure will result in Increased Access to Recycling Center drop off of materials that would otherwise be disposed of in the landfill. This widens the service area and lessens the impact of additional recyclable waste transported by waste collection trucks (this lessens greenhouse gas emissions).

Environmental Benefits

Criteria and Hazardous Air Pollutants from diesel truck exhausts include Particulate Matter (PM10 and PM2.5), Ozone (O₃), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Monoxide (CO), formaldehyde, and Lead.

Expected Outcomes:

People who want to recycle will drive to nearby facilities, thereby reducing emissions from exhausts.

¹⁶ <https://emp.lbl.gov/utility-scale-solar/>

The above estimations were obtained using the U.S. Environmental Protection Agency Waste Reduction Model (WARM). Material inputs used for this model are represented by the table below which is the scaled material inputs taken at the landfill and Cobbs Recycling Center.

Material	Annual Tons Recycled	Total MTCO ₂ E
Yard Trimmings	NA	(1.95)
Mixed Plastics	150.00	(138.83)
Mixed Electronics	50.00	(39.27)
Mixed Metals	146.00	(641.11)
Glass	10.00	(2.76)
Asphalt Concrete	3.00	(0.24)
Tires	40.00	(15.05)
Mixed Recyclables	2,400.00	(6,847.88)

Waste Reduction Model (WARM) was created by the U.S. Environmental Protection Agency (EPA) to help solid waste planners and organizations estimate greenhouse gas (GHG) emission reductions and economic impacts from several different waste management practices.

WARM calculates GHG emissions, energy, and economic impacts for baseline and alternative waste management practices, including source reduction, recycling, combustion, composting, and landfilling. The model calculates emissions in metric tons of carbon dioxide equivalent (MTCO₂E), energy in millions of BTUs (MMBTU), wage impacts, tax impacts, and labor hours supported across a wide range of material types commonly found in municipal solid waste (MSW).

Project/Measure: EV Charging Stations: \$6,855,587

Estimated Annual Greenhouse Gas Benefits:

104,650 metric tons of CO₂e emitted by gasoline powered vehicles from 2025 through 2050.

Expected Community Benefits:

Improved Health and Well-Being; decreased use of fossil fuels for gasoline powered vehicles, Increased Resiliency and Adaptability; Job Creation and Economic Development; and Increased Awareness and Understanding.

Environmental Benefits

Criteria and Hazardous Air Pollutants from gasoline exhausts include: Particulate Matter, Ozone (O₃), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Monoxide (CO), formaldehyde, and Lead.

Expected Outcomes:

Providing additional EV Charging Stations encourages EV use and availability, thereby lessening impacts to air and health.

The method of calculations is provided below from McLennan County data:

Average annual carbon dioxide (CO₂) emissions of a typical passenger vehicle¹⁷

Typical Passenger Vehicle Emissions	4.6 metric tons of CO ₂
Fuel Economy	22.2 miles per gallon/vehicle
Average per year/vehicle	11,500 miles
Number of Registered Vehicles in McLennan County	232,812 ¹⁸
Less Number of EV's	910
Resultant Gasoline Powered Vehicles	231,902
Total Annual (CO₂)/per gasoline powered vehicles in McLennan County	104,650 MT CO₂ (4.6*910) x 25

Project/Measure: Clean Fuel Community Center Power Generators: \$3,763,200**Estimated Annual Greenhouse Gas Benefits:**

17.4 metric tons of CO₂e from 2025 through 2050, depending on the level of usage.

Expected Community Benefits:

Improved Health and Well-Being; Increased Resiliency and Adaptability; Job Creation and Economic Development; resiliency and safety during extreme climatic events, and Increased Awareness and Understanding.

Environmental Benefits

Criteria and Hazardous Air Pollutants from diesel truck exhausts include: Particulate Matter (PM₁₀ and PM_{2.5}), Ozone (O₃), Nitrogen Oxides (NO_x), Sulfur Oxides (SO_x), Carbon Monoxide (CO), formaldehyde, and Lead.

Expected Outcomes:

Propane engines emit 12% less CO₂, 20% less nitrogen oxide and 30% less carbon monoxide (CO) than diesel engines and produce 80% fewer hydrocarbon emissions. Therefore, fewer harmful carbon emissions into the atmosphere.

On October 19, 2021, via Resolution No. 2021-763, City Council approved the funding plan for the City's Coronavirus State and Local Fiscal Recovery ("SLFRF") Program funds under the American Rescue Plan Act ("ARPA"). On February 1, 2022, via Resolution No. 2022-056, City Council approved electing to use the standard allowance of up to \$10 million to replace lost public sector revenue. In addition, the said resolution amended the original funding plan adopted via Resolution No. 2021-763. On August 2, 2022, as part of the presentation of the Fiscal Year 2022-2023 budget, additional amendments to the ARPA Funding Plan were highlighted. These include a reallocation of funds for housing related projects, utility generators, removal of contingency funds, and the addition of the STEAM Center project. Part of the funding plan included an allocation of \$1M for backup generators for three community centers (see attached funding plan). The after-action initiatives from Winter Storm URI included further forward-thinking steps to procure back-up power generation projects for three locations to be used for future warming or cooling centers. These included Dewey, South Waco, and Waco Multi-Purpose Centers. Later additions of generators for Fleet Services and the Animal Shelter were added to this listing.

A Request for Qualifications ("RFQ") No. 2023-006 was released by the City of Waco Purchasing Division of Fiscal Management Services, and interested vendors submitted responses. The qualifications received were evaluated by a multidepartment committee consisting of the Department of Sustainability, Parks, Fleet, and Animal Shelter representatives. After a review, TLC Engineering Solutions, Inc., stood out as the most qualified company who had previously done some work for the City of Waco and had experience with many similar generator projects.

TLC subsequently completed the 100% designs for these generators, but the cost far exceeded the ARPA allocation set aside. The options were to proceed with the installation of diesel generators, as they were the least cost, or add the natural gas generators to the EPA Grant, thereby reducing the CO₂ and other pollutants as a result of diesel operation. This grant

¹⁷ EPA: Greenhouse Gas Emissions from a Typical Passenger Vehicle; [https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=2%20per%20mile.,What%20is%20the%20average%20annual%20carbon%20dioxide%20\(CO2\)%20emissions.of%20CO2%20per%20year](https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle#:~:text=2%20per%20mile.,What%20is%20the%20average%20annual%20carbon%20dioxide%20(CO2)%20emissions.of%20CO2%20per%20year)

¹⁸ Waco District Statistics: Vehicles Registered (FY 2023) 232,172, <https://www.dot.state.tx.us/apps-cg/discos/default.htm?dist=WAC&stat=vr>

request the costs for the installation of natural gas-powered generators over diesel fuel powered generators as part of the City of Waco Greenhouse gas pollution reduction grant. This grant request does not duplicate efforts on behalf of the ARPA funding in which other specific community generator sets have been funded. The following generators as part of the CPRG request:

FACILITY	ADDRESS	GENSET SIZE (kW)
Dewey Center	925 N 9th St Waco, TX 76707	350
Waco Multi-Purpose Center	1020 Elm Ave Waco, TX 76704	200
Doris-Miller Community Center	1020 Elm Ave Waco, TX 76704	900
South Waco Center	2815 Speight Ave Waco, TX 76711	350
Waco Animal Shelter	2032 Circle Rd Waco, TX 76706	350
TOTAL KW		2,150 KW

To calculate the avoided emission factor for a diesel generator in terms of carbon footprint ranges from 1.22 kgCO₂ to 1.94 kgCO₂ depending on the rated power (2 kW to 5 kW) of the diesel generator¹⁹. In the case of the above generators, the total KW is 2,150 KW. Therefore, the calculated CO₂ is 2,150 x 1.94 x 25 years = 104,275 CO₂ x assumed operation time at 30 days per year (two months operation) = 104,275 x 2/12 = 17,379 CO₂ divided by 1,000 to get 17.4 MT CO₂.

Air quality improvements resulting from a worldwide reduction in greenhouse gas emissions would benefit human health and prevent economic losses, according to new research by scientists from NASA, Duke University, and Columbia University²⁰.

Measure: Reporting, Tracking and Coordination with Planning Grant Awardees and, High-Quality Workforce Training: \$1,000,030

Expected Community Benefits:

Increased Awareness and Understanding.

Expected Outcomes:

Semi-Annual, Annual and Final Reporting, attendance at stakeholder meetings, interagency meetings and coordination with Planning Awardees, University and college communication, miscellaneous tasks intrinsic to the grant request. Workforce Training through local technical trade schools and colleges.

In alignment with Executive Order 14082: *Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022*, the City of Waco is in support the creation of high-quality, family-sustaining jobs with the free and fair choice to join a union (such as the Pipefitters Union for the Landfill Gas Emissions Destruction Beneficial Use Plant). This includes an emphasis on the quality of jobs, not just the number of jobs created by these federal investments.

Specific strategies to ensure CPRG implementation grant funds and the implementation of the GHG reduction measures generate high-quality jobs with a diverse, highly skilled workforce and support “high road” labor practices are: (1) Job Fairs that target high school and Technical Trade Schools, such as Texas State Technical College in Waco, Texas that offers programs in Electrical Lineworker and Management Technology; (2) Robotics; (3) Industrial Systems; (4)

¹⁹ Jakhrani et al. Estimation of Carbon Footprints from Diesel Generator Emissions July 2012 DOI:[10.1109/GUT.2012.6344193](https://doi.org/10.1109/GUT.2012.6344193); Conference: International Conference on Green and Ubiquitous Technology (GUT)

²⁰ Temporal and spatial distribution of health, labor, and crop benefits of climate change mitigation in the United States; Research article published in Earth, Atmospheric and Planetary Sciences; November 1, 2021; <https://doi.org/10.1073/pnas.2104061118>

Instrumentation Technology; (5) Plumbing and Pipefitting Technology; (6) Electric Power Control and Electromechanical Technology; and more that specifically include the measures and infrastructure requested in this grant. The Beneficial Use Landfill Gas to Energy Plant, Solar Utility, Recycling Center, EV Recycling Trucks and Community Center Propane Generators create multiple high tech, high paying jobs within the community from either the planning, design, construction, permitting and operation.

Jobs will also include engineering specialties for design, construction jobs, equipment manufacturing jobs, vendors, utility technicians, and increased employment for the end users of the products of this project.

The renewable energy plants will sustainably power many homes with clean, locally generated energy, and provide an estimated 25 direct new jobs and up to 150 jobs from construction to service maintenance indirectly to the area. The *project* will transform the closed landfill site MSW 948A into a multi-megawatt integrated renewable energy utility plant. The addition of multiple EV Charging Stations provides an opportunity for lower income residents to learn about the technology and be employed in the maintenance and care of the stations.

Other outcomes that have not been quantified, but are relevant include, but are not limited to: (1) lower energy demand and residential/commercial energy expenditures, spurring investment in the community; (2) reduced energy bills for residents in low-income and disadvantaged communities, throughout the City of Waco's jurisdiction; (3) reduced exposure to hazardous air pollution or unhealthy ambient air quality, increasing health benefits; (4) increased staff capacity to implement GHG reduction measures; and, (5) enhanced level of community engagement, as measured by an increased number of ongoing actions to engage with organizations and residents of disadvantaged communities, and other interested parties.