# *2007 OCRRA Greenhouse Gas (GHG) Emissions Inventory*

Final Report
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**Prepared for:** **Onondaga County Resource Recovery Agency Greenhouse Gas Committee**

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## Executive Summary

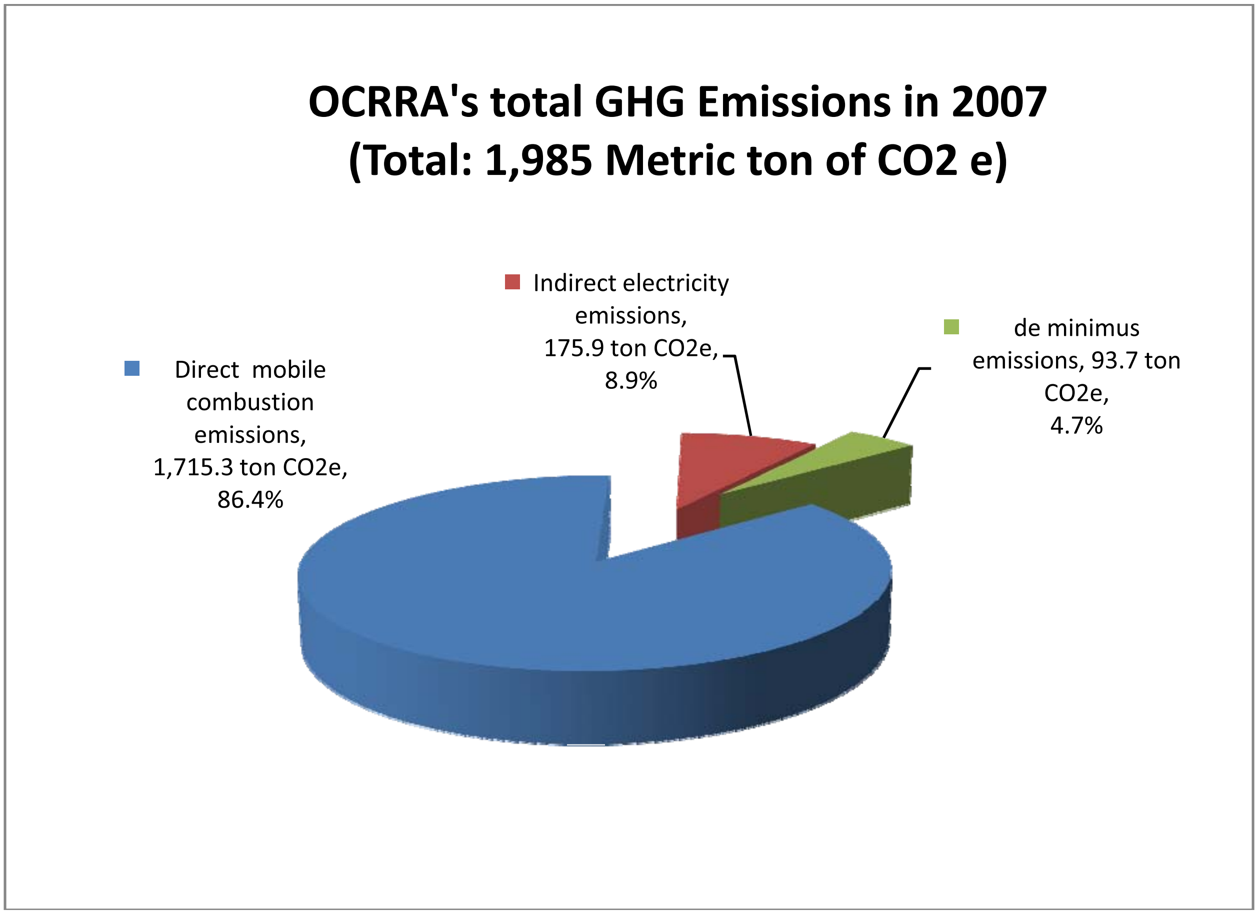
This report summarizes the first annual greenhouse gas (GHG) emissions inventory for the Onondaga County Resource Recovery Agency (OCRRA) and was prepared pursuant to the recommendation of OCCRA's Greenhouse Gas Committee. On September 10, 2008, OCRRA's Board of Directors signed Resolution #1617 to reduce OCRRA's GHG emissions by ten percent (10%) over a five year period commencing in 2009, with 2007 established as the baseline year. The intent of this resolution was to voluntarily reduce OCRRA's GHG emissions and further increase OCRRA's operational efficiency. The first step towards achieving OCRRA's targeted GHG emissions reduction is measuring OCRRA's 2007 baseline emissions. This report describes OCRRA's 2007 GHG emissions inventory.

OCRRA's 2007 baseline GHG emissions are estimated to be 1,985 metric tons of carbon dioxide equivalents ($CO_2e$) and include the following components:

- Direct emissions (Section 3)
  - Mobile combustion (On-road trucks and off-road equipment)
  - Stationary combustion (Use of natural gas and waste oil for heating)
  - Fugitive emissions (Air conditioning and refrigeration units)
- Indirect emissions (Section 4): Electricity purchased from utilities
- Optional emissions (Section 5): Employee business travel

OCRRA's GHG emissions are reported in terms of carbon dioxide equivalents, which take into consideration the global warming potential (GWP) of multiple greenhouse gases including carbon dioxide, nitrous oxide, methane, and hydrofluorocarbons (HFCs).

Mobile combustion constitutes the largest component of OCRRA's GHG emissions inventory (1,715 metric tons CO2e), representing 86.4% of the total GHG emissions. The second largest component is electricity purchased from utilities (175.9 metric tons CO2e), which accounts for about 8.9% of total GHG emissions. Stationary combustion, business travel, and fugitive emissions account for 2.1%, 1.9%, and 0.7% of total GHG emissions, respectively, and are grouped together as part of OCRRA's *de minimis* emissions, since they sum to less than 5% of OCRRA's total GHG emissions. The results of the inventory are summarized in the following chart:




Since 86.4% of OCRRA's GHG emissions are from mobile fuel combustion, initial efforts to reduce GHG emissions should focus on improving fuel economy in OCRRA's trucks and off-road equipment. There are four main focus areas for improving fuel economy: scheduled maintenance, driver education, biofuels, and efficient vehicles and equipment. These are discussed in Section 6.

## Acknowledgement

I wish to thank Tom Rhoads, OCRRA Executive Director, and OCRRA's GHG Committee members for their great support. I want to give special thanks to Amy Lawrence, OCRRA Engineer, for her invaluable knowledge on GHG accounting and tremendous help on data collection and the final report writing. Without them, I could not have completed this report in a relatively short time, while I am writing the final draft of my dissertation.

## 1. Introduction

The baseline GHG emissions inventory was performed for the year 2007, as part of OCRRA's GHG reductions initiative, with the following goals:

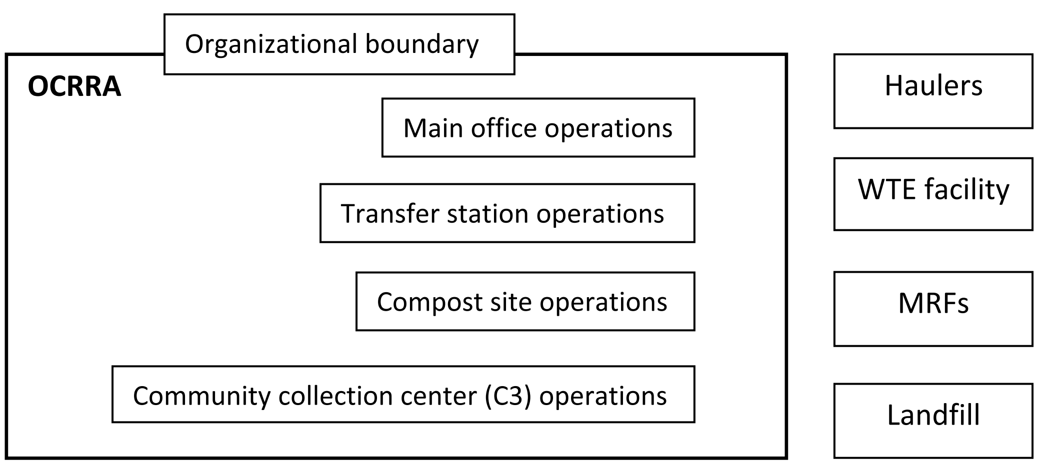
- Management of operations in terms of GHG emissions
- Identification of GHG emissions reduction opportunities
- Achievement of a GHG reduction target
- Reduction of costs by increasing material and energy efficiency

Section 2 provides a brief description of OCRRA's GHG emissions inventory framework. Sections 3, 4, and 5 present direct GHG emissions, indirect GHG emissions, and optional GHG emissions, respectively. Section 6 concludes the report with recommendations for GHG emissions reduction opportunities.

## 2. Inventory Framework

### *2.1 Organizational Boundary*

OCRRA's organizational boundary is based on the operational control approach. Under this approach OCRRA accounts for 100 percent of the GHG emissions from operations over which it has control. These operations include the main office, transfer stations, compost sites, and the community collection center (C3). However, OCRRA's GHG emissions inventory does not include operations at the waste-to-energy (WTE) facility, material recovery facilities (MRFs), or landfill, nor does it include hauler operations. The following figure depicts the organization boundary.




### *2.2 GHG gases covered*

Only gases with direct radiative forcing are included in the inventory. Among GHGs covered by GHG protocols, those relevant to OCRRA operations are carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), and hydrofluorocarbons (HFCs). Other GHGs, such as PFCs (perfluorocarbons) and $SF_6$ (sulfur hexafluoride), are not relevant to OCRRA operations.

These GHGs have differing impacts on climate change. For example, methane ($CH_4$) has a global warming potential of 21, which means that the emissions of 1 metric ton of methane has the same ability to trap heat in the atmosphere as 21 metric tons of $CO_2$. Emissions of GHGs other than $CO_2$ are converted to an equivalent amount of $CO_2$ (referred to as the carbon dioxide equivalent, $CO_2e$), using their corresponding Global Warming Potentials (GWPs). The GWP of nitrous oxide is 310 and the GWP of HFC134a (a refrigerant used in OCRRA operations) is 1300. Although the GWPs for methane, nitrous oxide, and HFCs are significantly greater than carbon dioxide (which has a GWP of 1), the majority of OCRRA's GHG emissions are carbon dioxide emissions.

## *2.3 Operational Boundaries*

The Climate Registry, California Climate Action Registry, United States Environmental Protection Agency (US EPA) Climate Leaders, and World Resource Institute (WRI)/World Business Council for Sustainable Development (WBCSD) GHG Protocol require reporting of GHG emissions associated with direct GHG emissions (Scope 1) and indirect GHG emissions (Scope 2). Other emission sources may be voluntarily reported as Scope 3 emissions.

### *Scope 1: Direct emissions*

Scope 1 emissions are direct GHG emissions that occur from sources that are controlled by the OCRRA. These include emissions from mobile sources (OCRRA's trucking and off-road equipment), emissions from stationary combustion (use of natural gas and waste oil for heating), and fugitive emissions from air conditioning and refrigeration units.

### *Scope 2: Indirect GHG emissions*

Scope 2 emissions are indirect GHG emissions associated with the purchase of electricity.

### *Scope 3: Optional GHG emissions*

Scope 3 emissions currently consist of GHG emissions associated with business travel.

## *2.4 De Minimis Emissions*

According to the CCAR, "*de minimis* emissions are a quantity of GHG emissions from any combination of sources and/or gases, which, when summed equal less than 5% of your organization's total emissions." Emissions that cannot be categorized as *de minimis* are considered significant emissions. This designation was created such that simplified estimation methods could be used for estimating emissions for *de minimis* emissions, to reduce reporting burden, while retaining the requirement for complete emission reporting. The Climate Registry applies a similar concept, referred to as "simplified estimation," which allows simplified estimation for any combination of emission sources up to 5% of the total GHG emissions.

### *2.5 Inventory Protocols*

There are multiple inventory protocols available at this time, including the Climate Registry, CCAR, US EPA Climate Leaders, and WRI/WBCSD Protocol. OCRRA's GHG emission inventory draws upon all of these resources; however it primarily follows the Climate Registry and CCAR protocols.

### *2.6 Inventory Principles*

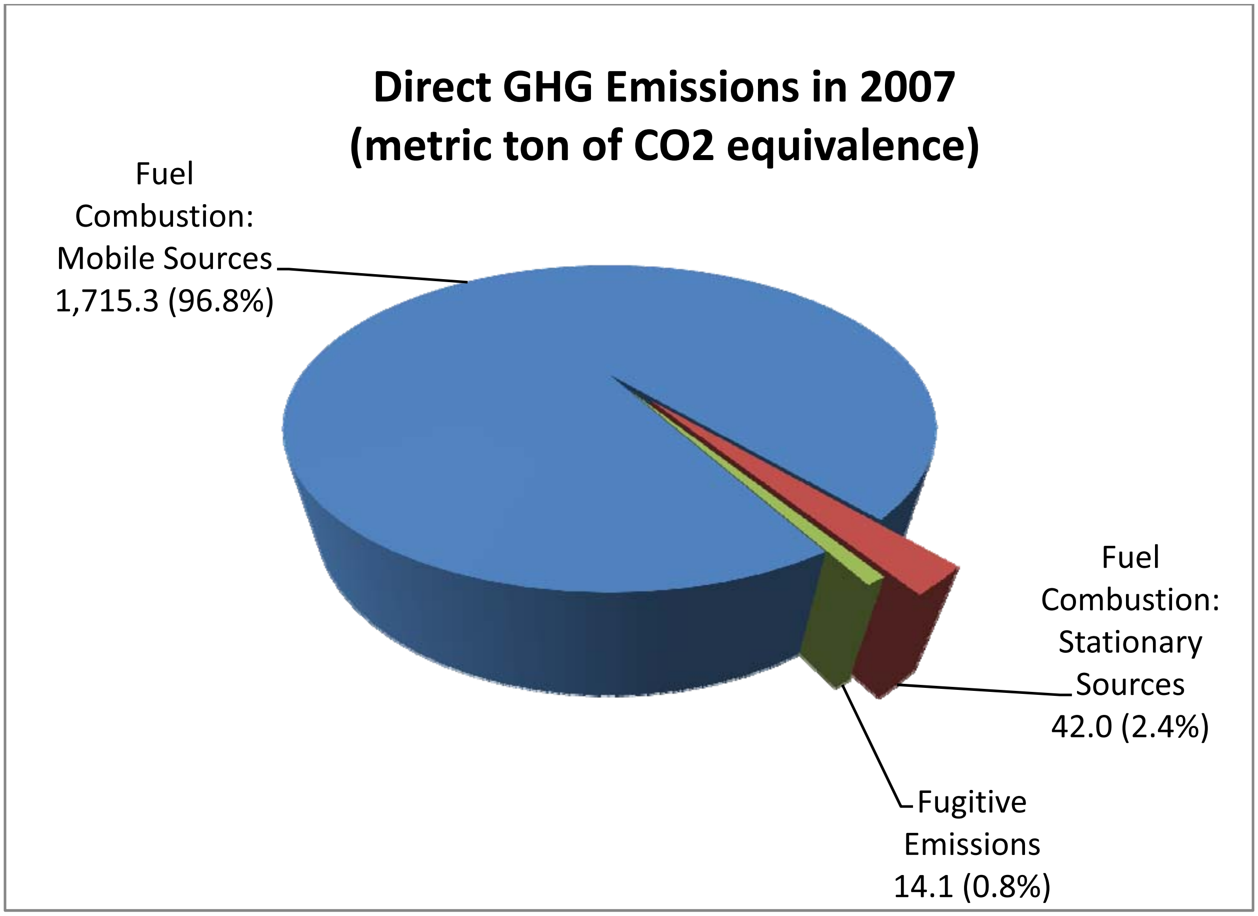
EPA's Climate Leaders Program suggests five principles for a GHG emissions inventory: relevance, completeness, consistency, transparency, and accuracy. OCRRA's GHG accounting and reporting shall abide by those principles, which are more fully described below:

> ***Relevance***: The inventory should contain the information for decision making. The inventory boundary should be chosen according to organizational structure and operational boundaries.
>
> ***Completeness*:** All relevant emissions sources within the inventory boundary should be included. All available data will be utilized to make a good faith effort to provide a complete, accurate, and consistent GHG accounting. Development of an inventory management plan is needed to facilitate monitoring and data collection.
>
> ***Consistency:*** To track and reduce GHG emissions over time, to identify trends, and to assess performance, consistent application of inventory methodology, inventory boundary, and calculation methodology is necessary. Changes in the inventory boundary, methods, data, or parameters should be documented and justified.
>
> ***Transparency:*** Information needs to be recorded, compiled, and analyzed in a way that would enable internal reviewers and external reviewers to verify and attest its credibility.
>
> ***Accuracy:*** Data should be sufficiently precise so that systemic over- or under-estimation should be avoided. The inventory process should be conducted in a manner that minimizes uncertainty as far as practicable.

## 3. Direct GHG Emissions

Direct GHG emissions represent 89.2% of OCRRA's total GHG emissions and consist of two components: GHG emissions from fuel combustion (mobile and stationary) and fugitive GHG emissions. See Figure 3.1 depicting a breakdown of OCRRA's direct GHG emissions.

***Figure 3.1: OCRRA's Direct GHG Emissions in 2007***



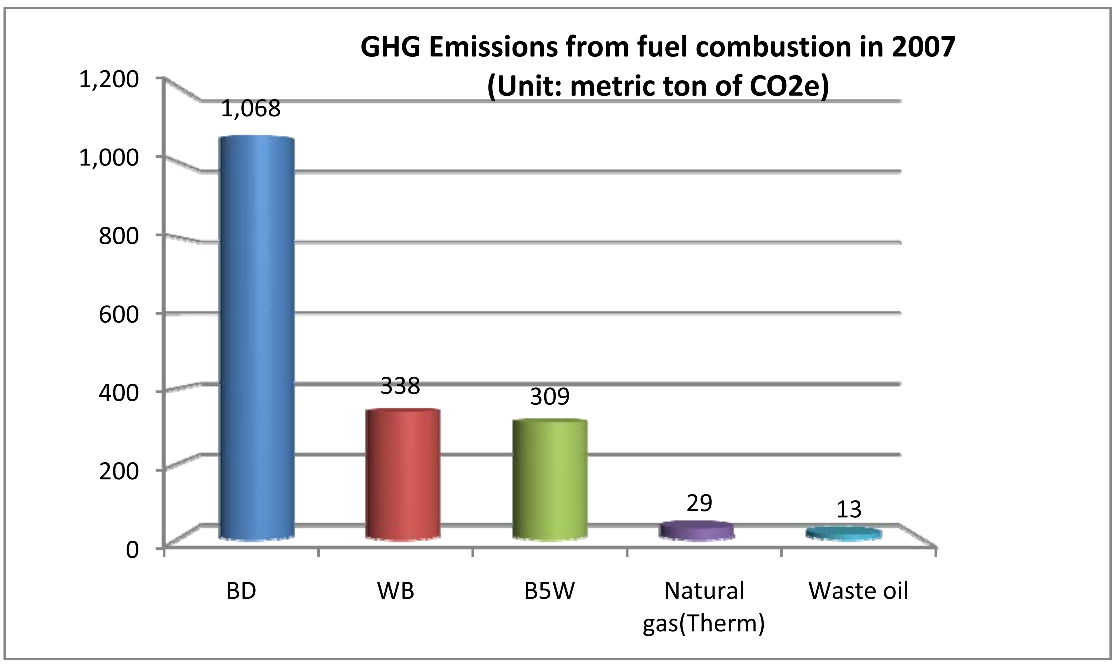

### *3.1 Direct GHG Emissions from Fuel Combustion – Summary*

The GHG emissions associated with fuel combustion are estimated to be 1,757.3 metric tons $CO_2e$, accounting for approximately 88.5% of total OCRRA GHG emissions. As indicated in Table 3.1 and as depicted in Figure 3.2, mobile combustion, which includes combustion of 20% Biodiesel, winter-blend diesel, and 5% Biodiesel (winter-blend), is the primary source of fuel combustion emissions in 2007, with only a small input from stationary combustion sources, which use natural gas and waste oil.

***Table 3.1: Summary of GHG emissions from fuel combustion in 2007***

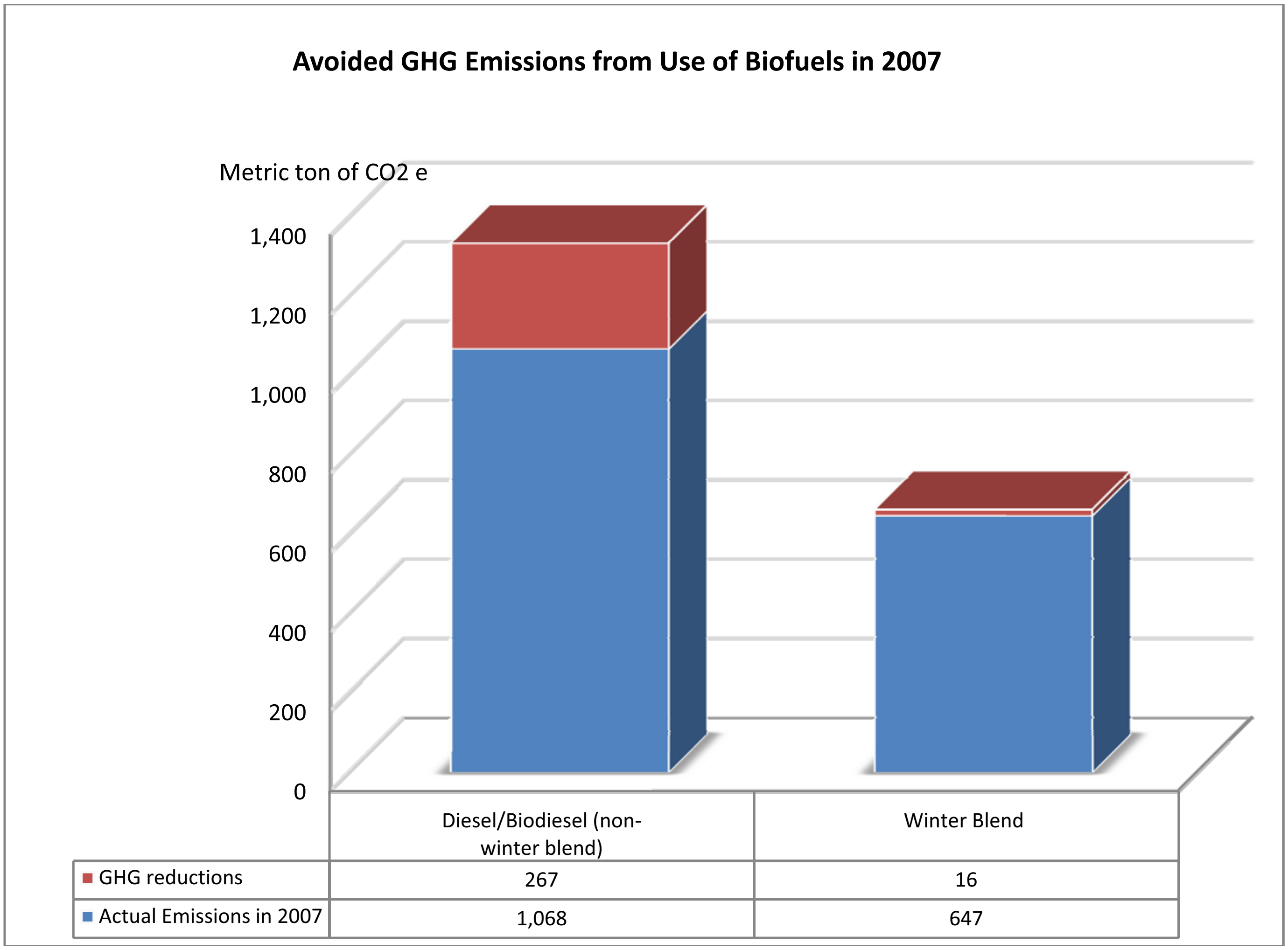
| Fuel Type | Fuel Consumption | Unit | $CO_2$ e emissions (Metric tons) | % of emissions |
|---|---|---|---|---|
| MOBILE SOURCES: | | | | **97.6** |
| 20% Biodiesel | 130,349 | gallon | 1,068.1 | 60.8 |
| Diesel (Winter blend) | 33,602 | gallon | 337.7 | 19.2 |
| 5% Biodiesel (Winter blend) | 32,147 | gallon | 309.5 | 17.6 |
| STATIONARY SOURCES: | | | | **2.4** |
| Natural gas | 19,971 | therm | 29.1 | 1.7 |
| Waste oil | 1,289 | gallon | 12.9 | 0.7 |
| **Total** | | | **1,757.3** | **100.0** |

***Figure 3.2: GHG Emissions from fuel consumption in 2007 (ton of CO2e)***




20% Biodiesel, or B20, is diesel fuel that contains 20% biodiesel fuel. B20 was used to replace 100% diesel during the warm weather season for OCRRA's trucks and off-road equipment at the Ley Creek and Rock Cut Road Transfer Stations and at the compost sites. For the winter season, a winter blend with 5% Biodiesel was used for the second half of the year. By switching to blends containing biodiesel, OCRRA has avoided an estimated 283.3 tons of CO2e (see Figure 3.3). It is expected that OCRRA can further reduce the GHG emissions (2008 estimation: reduction of 15ton of CO2e) by switching to biodiesel winter blend for the entire year. Other fuel-saving tips for fleet vehicles are suggested in the Section 6.

***Figure 3.3: OCRRA's GHG Emissions Avoided Through Biofuels in 2007***




GHG emissions from stationary sources constitute only a small portion of emissions from fuel combustion. These sources are generally used for heating OCRRA facilities and utilize natural gas and waste oil. Natural gas is used at Rock Cut Road and C3 for heating and it constitutes only 1.7% (29.1 tons of $CO_2e$) of the total direct GHG emissions from fuel combustion. Waste oil is also used at Rock Cut Road for heating, which results in an estimated 12.9 metric tons of $CO_2e$, or 0.7% of direct GHG emissions from fuel combustion. Since the GHG emissions from stationary sources are less than 5% of OCRRA's total GHG emissions (accounting for only 2.1%), they are a candidate for being categorized as a *de minimis* source.

### *3.2 Direct GHG Emissions from Fuel Combustion – Methodology*

The methodology for calculating direct emissions from fuel combustion consists of the following steps: obtaining fuel consumption data, finding out fuel mixture ratios for different fuel mixtures, identifying appropriate emission factors, and applying the global warming potential (GWP) to each GHG generated.

Emission factors for fuel mixtures used by OCRRA can be estimated based upon the emission factors for component fuels from *The Climate Registry General Reporting Protocol, Version 1.1, May 2008*. The emission factor for 100% biodiesel is assumed to be zero, since the origin of the fuel is not fossil fuel based. Other GHG inventory protocols also assume biofuels, such as biodiesel and ethanol, are carbon-neutral. Table 3.2 and Table 3.3 provide the emission factors for each fuel, including waste oil and natural gas.

***Table 3.2: Default GHG emission factors for fuel combustion***

| | | Fuel Type (kg/gallon) | | | |
|---|---|---|---|---|---|
| | | Diesel | Kerosene | Biodiesel | Waste oil |
| GHGs (kg) | CO2 | 10.15 | 9.76 | 0 | 9.98 |
| | CH4 | 0.0006 | | | |
| | N2O | 0.0003 | | | |
| | CO2e (kg) | 10.243 | 9.76 | 0 | 9.98 |

Source: EPA Climate Leaders, Mobile Combustion Guidance, 2007

***Table 3.3: Emission factors for natural gas (HHV: high heating value)***

| Emission type | Emission factor | unit |
|---|---|---|
| CO2 | 13.77 | kg/GJ |
| CH4 | 0.9 | kg/TJ |
| N2O | 0.09 | kg/TJ |

Fuel-mix ratio of each blend type for mobile combustion is shown in Table 3.4. GHG emissions for each mixture type are estimated, according to this mixture ratio and emission factors shown above.

***Table 3.4: Fuel-mix ratio by blend type for mobile combustion***

| | Fuel Type | Diesel | Kerosene | Biodiesel |
|---|---|---|---|---|
| Blend type | WB (winter blend) | 0.6 | 0.4 | |
| | BD (20% Biodiesel) | 0.8 | | 0.2 |
| | B5W (5% biodiesel, WB) | 0.57 | 0.38 | 0.05 |

The estimated amount of emissions of different GHGs is not suitable for comparison, since climate forcing effect by each GHG is different from another. Table 3.5 provides Global Warming Potential (GWP) for three types of GHGs emitted by fuel combustion in carbon dioxide equivalent terms.

***Table 3.5: Global warming potential for Greenhouse Gases***

| GHG Type | $CO_2$ | $CH_4$ | $N_2O$ |
|---|---|---|---|
| GWP ($CO_2$ equivalent) | 1 | 21 | 310 |

Source: IPCC 4th Assessment Report: Working Group I Report "The Physical Science Basis", p212 (IPCC 2008)

After estimated emissions for GHGs are multiplied by corresponding GWP values, and added together, we get emission factor for each fuel mixture type (Table 3.6). After multiplying these emission factors in Table 3.6 by the amount of fuel consumption, we get the final estimation of GHG emissions for fuel combustion, as shown in the previous summary table (Table 3.1).

***Table 3.6: Emission Factors for Fuel Combustion***

| Fuel Type | unit | $CO_2$ | $CH_4$ | $N_2O$ | CO2e |
|---|---|---|---|---|---|
| Diesel (Winter blend) | lbs/gallon | 22.03 | 0.0008 | 0.0003 | 22.155 |
| 20% Biodiesel | lbs/gallon | 17.90 | 0.0010 | 0.0005 | 18.065 |
| 5% Biodiesel (Winter blend) | lbs/gallon | 20.93 | 0.0007 | 0.0003 | 21.048 |
| Natural gas | lbs/therm | 3.20 | 0.0002 | 0.00002 | 3.214 |
| Waste oil | lbs/gallon | 22.002 | | | 22.002 |

### *3.3 Fugitive GHG Emissions – Summary*

Fugitive emissions are direct emissions associated with the accidental release or leakage of refrigerant to the atmosphere. Although the total amount of fugitive emissions is very small, most refrigerant materials have tremendous potential for climate forcing.

In 2007, OCRRA's fugitive emissions are estimated at 14.1 metric tons of CO2e from mobile air-conditioning units, refrigerators, window air-conditioners, and building air-conditioning units. This constitutes only 0.7 percent of OCRRA's total GHG emissions and it is not considered significant. The refrigerant type used at OCRRA facilities is HFC134a, the most common refrigerant type with 1300 times greater GWP than that of carbon dioxide.

Like stationary sources, fugitive emissions are a candidate for being categorized as a *de minimis* source, since they accounts for less than 5% of total GHG emissions.

### *3.4 Fugitive GHG Emissions – Methodology*

OCRRA's fugitive emissions stem from two sources: mobile air conditioning (A/C) units and stationary A/C and refrigeration units. Estimation of fugitive emissions from mobile equipment is based on an estimated number of repairs to replace refrigerant in 2007, as well as the refrigerant capacity of the A/C units in the vehicles. Each repair generally requires replacement of the full unit capacity. Therefore, by multiplying the number of repairs by the capacity of the A/C units, the fugitive GHG emissions from mobile sources can be estimated. Then, by applying the GWP of refrigerant used in the vehicle, the emissions will be translated into $CO_2$ equivalent terms.

Rock Cut Road vehicles required approximately 10 repairs. Refrigerant capacity of each Rock Cut Road vehicles is approximately 1.8 lbs. Therefore, the total amount of refrigerant lost from Rock Cut Road vehicles is estimated at 18lbs. Ley Creek vehicles required approximately 5 repairs. Refrigerant capacity of each Ley Creek vehicles is approximately 1 lb. Thus, the total amount of refrigerant lost from Ley Creek vehicles is about 5 lbs. All vehicles use HFC134a as the air conditioning refrigerant. Applying GWP of 1300 for HFC134a to 23lbs of total refrigerant lost from OCRRA's mobile air-conditioning, results in an estimated at 13.56 metric tons of CO2 equivalents fugitive emissions from mobile air-conditioning units.

Stationary fugitive emissions result from refrigerators and stationary A/C units. Most refrigerators and A/C units lose refrigerant over time, but refrigerant replacement is not very common for this type of small equipment. Thus, it is hard to get actual leakage value. The level of information for the refrigeration equipment is also limited. To estimate emissions, the number and types of refrigeration and air conditioning equipment; the types of refrigerant used; and the refrigerant charge capacity of each piece of equipment should be available.

This study uses a simplified estimation method that is suggested by the Climate Registry for emissions that are estimated to be less than 5% of total entity-wide emissions and which lack detailed data (The Climate Registry, May 2008). A simplified estimation method allows for using the upper bound of the capacity range for equipment category, if the capacity of the equipment is not known. This simplified estimation method can also be served as a screening method to determine whether fugitive emission is less than 5 % of total OCRRA GHG emissions.

Most GHG protocols list a range of estimated average annual leakage rate for equipment by category, however emission factors for more specific equipment categories are available from New Zealand Ministry for the Environment's Guidance for Voluntary, Corporate Greenhouse Gas Reporting: Data and Methods for the 2007 Calendar Year. The Climate Registry General Reporting Protocol Version 1.1(the Climate Registry, May 2008) provided approach tools for the estimation and also validated our approach of using simplified estimation method for fugitive emissions.

Table 3.7 shows what assumptions are made for the calculation of fugitive emissions from stationary refrigeration and A/C equipment and how the total GHG emissions are estimated, using these assumptions about refrigerant capacity and annual leakage rate.

*Table 3.7 Stationary Fugitive Emissions*

| | Units | Source Types<br>Medium refrig. | Window A/C | Resid. size C/A | Comm. size C/A | Annual Leakage kg | Annual Emissions $CO_2E$ (kg) |
|---|---|---|---|---|---|---|---|
| Capacity | BTU | | 24000[b] | | | | |
| | kW | | 7.03[c] | 10[e] | 20[f] | | |
| Annual Charge | kg | 0.11[a,1] | 1.406[d] | 2.5[d] | 5[d] | | |
| Leakage Rate[1] | % | **3%** | **1%** | **3%** | **3%** | | |
| Annual Leakage | kg | 0.003 | 0.014 | 0.075 | 0.150 | | |
| Type of Refrigirant | | HFC134a | HFC134a | HFC134a | HFC134a | | |
| GWPs[2] | Unitless | 1300 | 1300 | 1300 | 1300 | | |
| Annual Emissions per equipment | $CO_2E$ (kg) | **4.29** | **18.29** | **97.50** | **195.00** | | |
| **Main Office** | | 1 | | | 1 | 0.15 | 199.29 |
| **RCR** | | 1 | | 2 | | 0.15 | 199.29 |
| **LC** | | 1 | 4 | 1 | | 0.13 | 174.94 |
| Total | | 3 | 4 | 3 | 1 | 0.44 | **573.52** |
| Annual Emissions | Ton of $CO_2E$ | | | | | | 0.57 |

Sources:

1. Ministry for the Environment. Guidance for voluntary, corporate greenhouse gas reporting: Data and Methods for the 2007 Calendar Year. New Zealand.
2. The Climate Registry. General Reporting Protocol. Version 1.1. May 2008

Notes:

a. Internal dimensions of 150cm x 50cm x 40cm is for 300 liters.

b. Capacity of the window unit assumed at 24,000 BTU, which is can cool 1000 to 1400 square feet area.

c. 3412BTU = 1kW

d. 0.2kg per kW cooling capacity for window units and 0.25kg per kW cooling capacity for commercial A/C unit

e. 10kW split commercial air conditioner

f. 20kW commercial air conditioner

# 4. Indirect emissions

## *4.1 GHG Emissions from Electricity – Summary*

The GHG emissions associated with electricity consumption for OCRRA operations are estimated to be 176 metric tons; the second largest component (8.9%) of OCRRA's total GHG emissions. Table 4.1 provides a summary of the $CO_2$e emissions associated with electricity use.

***Table 4.1: GHG Emissions from Electricity Consumption***

| | Electricity used kWh | $CO_2$e emissions ton of $CO_2$e |
|---|---|---|
| Total | 551,094 | 175.9 |
| % of total GHG emissions | | 8.9% |

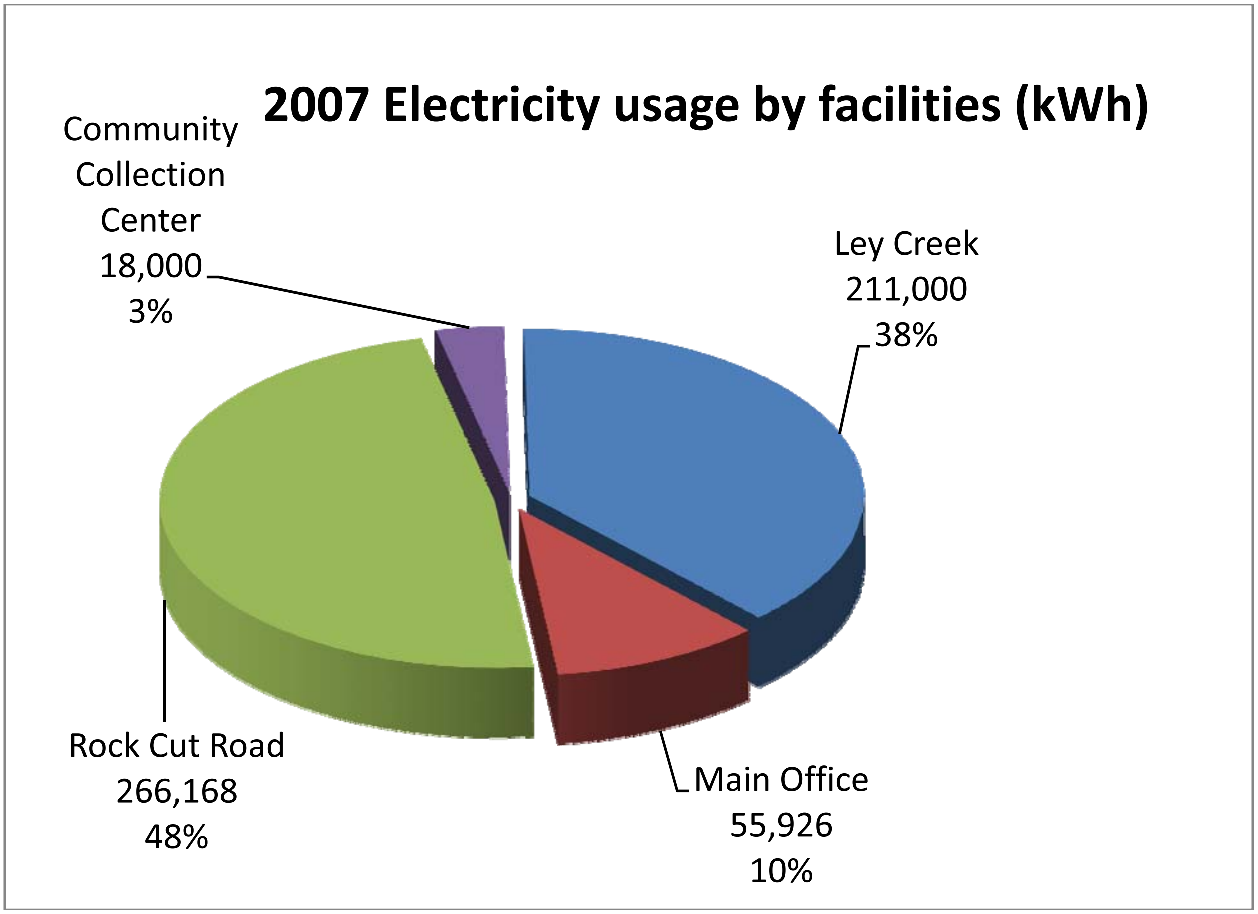
OCRRA has little control over GHG emissions generated from its purchased electricity. Therefore, the best way to reduce GHG emissions from electricity consumption is reducing electricity consumption itself, unless OCRRA installs renewable or alternative energy equipment for electricity generation.

Among the four facilities which use electricity, Rock Cut Road facility used 48.3% of OCRRA's total electricity consumption resulting in 85 ton of $CO_2$ equivalent indirect GHG emissions. Table 4.2 provides GHG emissions from purchased electricity consumption by facility. Figure 4.1 depicts this information visually.

***Table 4.2 GHG emissions from Electricity consumption by facilities***

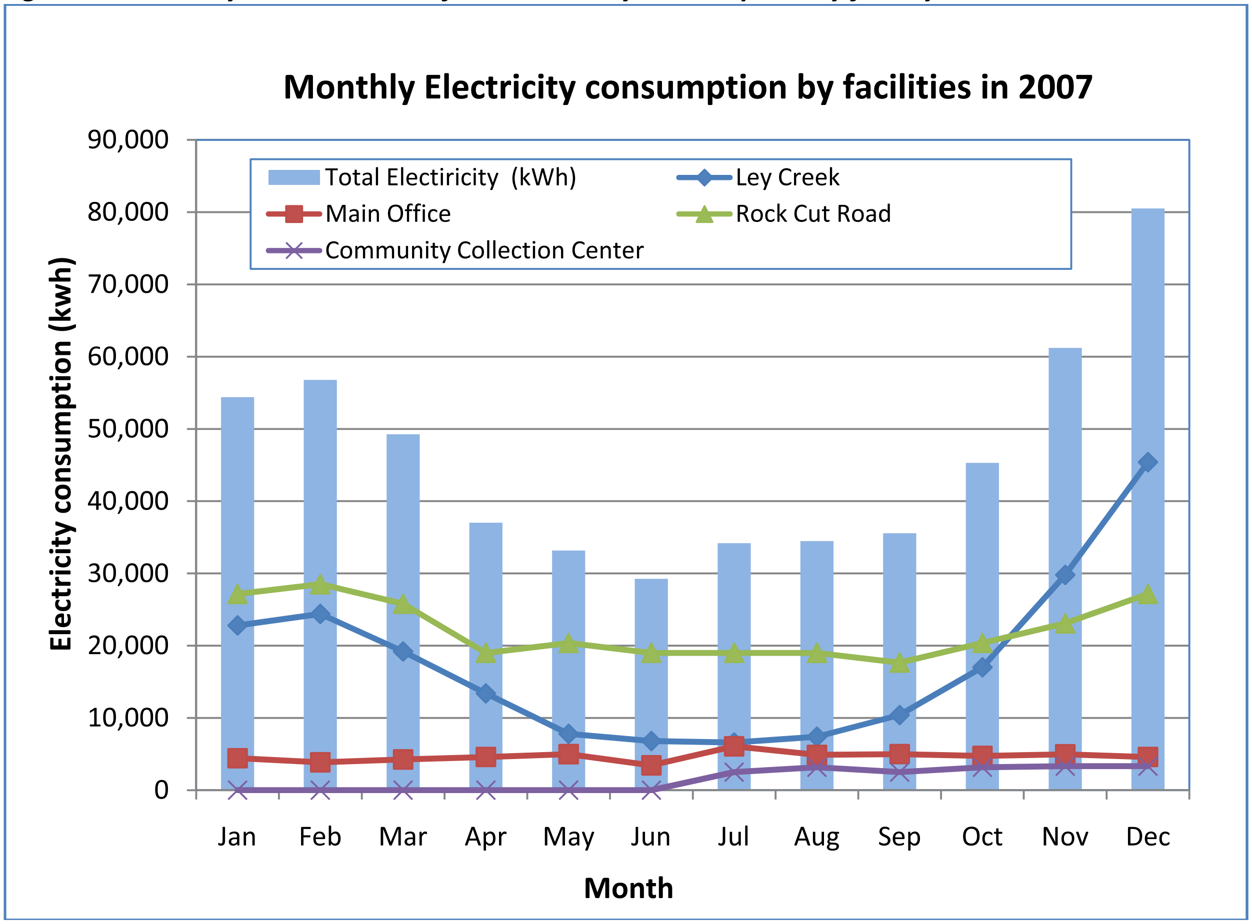
| | Metered Usage (kWh) | | | | Total Electricity |
|---|---|---|---|---|---|
| | **Rock Cut Road** | **Ley Creek** | **Main Office** | **C3** | **(kWh)** |
| Total (kWh) | 266,168 | 211,000 | 55,926 | 18,000 | 551,094 |
| $CO_2$e (lbs) | 187281.2 | 148463.8 | 39350.6 | 12665.1 | 387760.826 |
| Ton $CO_2$e | 85.0 | 67.3 | 17.8 | 5.7 | 175.9 |
| (% total) | (48.3) | (38.3) | (10.1) | (3.3) | (100.0) |

***Figure 4.1 OCRRA's Indirect GHG Emissions by facility in 2007***




As shown in Figure 4.2, electricity consumption peaked in December and the lowest in June. Electricity consumption is fairly constant throughout the year at the main office, C3, and Rock Cut Road. However, Ley Creek shows quite contrasting consumption patterns between summer and winter. December electricity consumption (45,400kWh) at Ley Creek is over 6.8 times of June electricity consumption (6,600kWh). C3 opened in July 2007, and as such, only includes electricity consumption from that point forward.

*Figure 4.2 Monthly GHG emissions from electricity consumption by facility in 2007*




### *4.2 GHG Emissions from Electricity – Methodology*

The methodology for calculating GHG emissions associated with purchased electricity consists of obtaining electricity consumption data (kWh) and applying appropriate emission factors.

OCRRA collects monthly, facility-specific electric consumption data in kWh. Emission factors for purchased electricity were obtained from USEPA eGRID2007 Version 1.0, which was released in September 2008. This report includes the most recently published emission factors specific to the Upstate New York region; however it is based on 2005 data. The emission factors are presented in Table 4.3.

***Table 4.3 Grid Electric Emission Factor***

| | GHG emissions [1](lb/MWh) | | | |
|---|---|---|---|---|
| **year** | $CO_2$ | $CH_4$ | $N_2O$ | $CO_2e$ |
| 2005 | 699.63 | 0.02482 | 0.01119 | 703.62012 |

1. From USEPA eGRID2007 Version 1.0. Released in September 2008. The emission factors are for NPCC Upstate New York.

# 5. Optional GHG Emissions

### *5.1 GHG Emissions from Business Travel – Summary*

GHG emissions associated with OCRRA's business travel are estimated to be 37.6 metric tons $CO_2$e, which is approximately 1.9% of the OCRRA's total GHG emissions. Car travel accounts for 34.5 metric tons of $CO_2$e and air travel accounts for 3.1 metric tons of $CO_2$e.

Business travel is considered a Scope 3 emission, which is optionally reportable.

### *5.2 GHG Emissions from Business Travel – Methodology*

The methodology for estimating GHG emissions associated with business travel consists of the following steps: determining total mileage for car and air travel; apply appropriate emission factors; and applying the GWP factors for climate forcing.

GHG emissions from business travel were estimated based upon the available documentation. For car travel, mileage was estimated by dividing the total dollar amount of employee-reimbursed expenses by the federal mileage rate for 2007. For air travel, trip origin, destination, mileage, number of stops, and number of passengers were used.

Total $CO_2$e emissions associated with OCRRA's employee business travel by car is estimated at 34.5 metric tons. This estimate is based on 88,000 miles of car travel by OCRRA. The $CO_2$e emission factor applied for car travel mileage is 0.392 kg $CO_2$ per vehicle mile. This emission factor is for medium-sized automobile that runs 23 miles per gallon of gasoline on average. The source for the emission factor is the protocol developed by the World Resources Institute for calculating GHG emissions associated with business travel (Mobile Combustion $CO_2$ Emissions Calculation Tool. Version 2.0. WRI-WBCSD GHG Protocol Initiative, June 2006. *Available at http://www.ghgprotocol.org/calculation-tools/service-sector).*

Total $CO_2$e emissions associated with business air travel is estimated at 3.05 metric tons (6,729lbs). The estimate is based on seven domestic flights, totaling 12,870 land miles. The $CO_2$e emission factor applied for air travel mileage is 0.105 kg $CO_2$ per passenger kilometer (0.168 kg CO2 per passenger mile). The estimation is adjusted to account for take-off fuel consumption. The take-off fuel consumption is estimated at 34.06 kg/takeoff/passenger. GHG emissions associated with a single passenger trip are estimated as follows:

GHG emissions (kg $CO_2$e) = 34.5 (kg $CO_2$e) × number of take-offs + 0.105 (kg $CO_2$e) × distance (land miles)

The source for the emission factor and takeoff fuel consumption is the protocol developed by the World Resources Institute for calculating GHG emissions associated with business travel (Mobile Combustion $CO_2$ Emissions Calculation Tool. Version 2.0. WRI-WBC SD GHG Protocol Initiative, June 2006. *Available at http://www.ghgprotocol.org/calculation-tools/service-sector).*

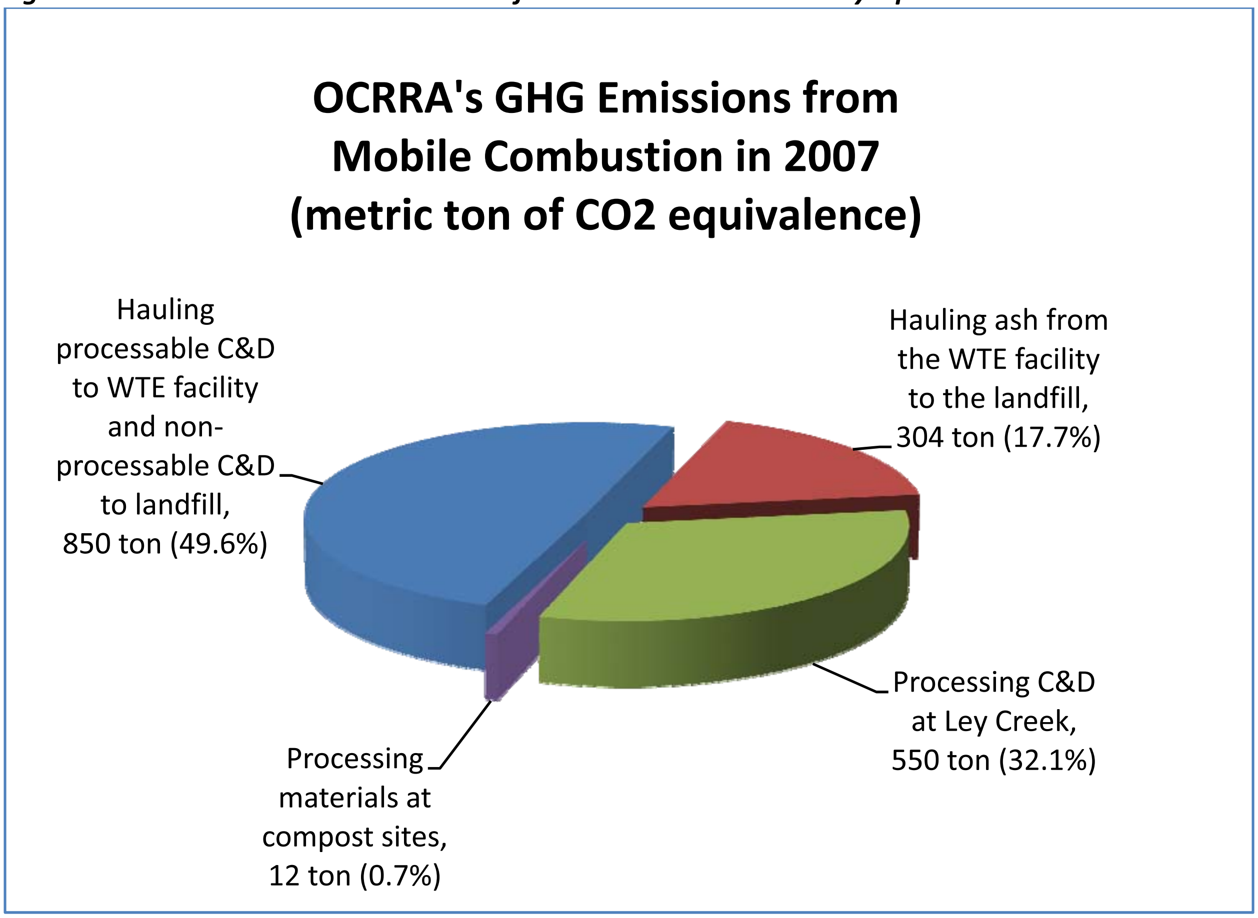
***Table 5.1 GHG emissions from Air Travel***

| # of people | # of stops | Distance (land miles) | Total distance (land miles) | lbs CO2 / person | lbs CO2 / trip |
|---|---|---|---|---|---|
| 1 | 1 | 596 | 596 | 371.4 | 371.4 |
| 1 | 3 | 1784 | 1784 | 962.5 | 962.5 |
| 2 | 3 | 1606 | 3212 | 896.4 | 1792.9 |
| 3 | 3 | 2426 | 7278 | 1200.8 | 3602.4 |
| Total | | | 12870 | | 6729.3 |

## 6. GHG Emissions Reduction Opportunities

Since 86.4% of OCRRA's GHG emissions are from mobile fuel combustion, initial efforts to reduce GHG emissions should focus on improving fuel economy in OCRRA's trucks and off-road equipment. Figure 6.1 illustrates the breakdown of OCRRA's mobile combustion GHG emission by operation.

***Figure 6.1 OCRRA's 2007 GHG Emissions from Mobile Combustion by Operation***




There are four main focus areas for improving fuel economy: scheduled maintenance, driver education, biofuels, and efficient vehicles and equipment.

### *6.1 Scheduled Maintenance*

Performing regular scheduled maintenance is the most effective way of reducing overall cost. Proper vehicle maintenance not only extends vehicle longevity, it also improves fuel economy, thereby reducing GHG emissions.

Key maintenance areas to consider include:

- Axle alignment (front axle and drive axel alignment)
- Tire pressure
- Lubricants
    - Engine, transmission, and differentials - will help save fuel
    - Switch to lower-viscosity oil in frigid weather
- Air flow
    - Aerodynamics figure enormously into fuel economy, as well as performance
    - Check for cracked, dent, or broken aerodynamic devices
    - Air intake: Timely service on the air cleaner, turbo, overheads, and charge air cooler
    - Any restrictions or altercation of air flow will upset balance of the engine, costing fuel economy and high cost repairs

***6.2 Driver Education***

Driver education is not only important for safety; it can also have a dramatic impact on fuel efficiency. According to a Bridgestone study, the best drivers use 35% less fuel than the worst drivers.[1]

Key education areas to consider include:

- Tracking fuel consumption: By recording and analyzing fuel consumption data, better management strategies and realistic goals can be established
- Cut back on idling: Cutting idling time to zero, instead of 50% of driving time can save 7-10% of fuel
- Speed: Increased speed will save travel time, but will reduce fuel economy (see Cummins' Rule of Thumb for MPG[2], shown below) and increase engine and tire wear - proper information should be given to drivers in order to get maximum benefit by driving at the appropriate speed for the given circumstances, such as weather, road type, speed limit, load, and schedule
    - A 1 mph decrease equals 0.1 mpg improvement.
    - A 10 percent decrease in idle percentage equals 0.1mpg
    - Expect as much as a 15% variation in mpg between winter and summer.
- Load: Load is directly related to fuel consumption – removing dead-weight items from the vehicle will save fuel

***6.3 Biofuels***

Unlike fossil fuels, biofuels are considered to be carbon neutral because the feedstock for biofuels actually absorbs the same amount of carbon from the atmosphere during growth that is released during

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[1] Bridgestone. Real Questions real Answers: Tires & Truck Fuel Economy, a New Perspective. Special Edition Four. 2008. The article suggests top 10 controllable fuel economy factors. Drivers, speed, tires, and idling are top 4 factors that can improve fuel economy by 6-35%.

[2] Commercial Carrier Journal. Midyear Report 2008. Additional info is available at *http://everytime.cummins.com*

combustion. By switching to 20% biodiesel from traditional diesel, OCRRA has avoided about 283.3 tons of CO2e in 2007.

### *6.4 Efficient Vehicles and Equipment*

The decision to buy fuel efficient vehicles depends on the cost-benefit equation. Some vehicles with a high potential of fuel saving may have higher capital costs, as compared to conventional vehicles. For example a hybrid truck that can save $5,000 a year at a current diesel price of $ 3.50, may cost an additional $50,000 to purchase. These factors should be considered when evaluating the decision to buy more efficient vehicles.