# The City of Red Deer
# 2010 Corporate Greenhouse Gas Inventory
December 4, 2012


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## EXECUTIVE SUMMARY

The City of Red Deer (Red Deer) has established its "corporate" greenhouse gas (GHG) inventory in accordance with the CSA/ISO 14064-1 accounting standard[1]. Its 2010 greenhouse gas emissions (GHG emissions) were approximately 137,000 tonnes of carbon dioxide equivalents ($tCO_2e$). This is equivalent to approximately 1.5 $tCO_2e$ per capita. The GHG inventory is a milestone for Red Deer's commitment to its Environmental Master Plan and positions Red Deer among leading Canadian municipalities working to reduce their impacts on climate change.

Red Deer's GHG emissions originate from a variety of activities associated with the provision of municipal services:

- Energy use at facilities (electricity and natural gas use by heating, ventilation, air conditioning, lights and other equipment)
- Energy use for treatment and transport of water, wastewater and landfill waste[2]
- Energy use from community lighting (streetlights, traffic lights, park and parking lot lights)
- Decomposition of wastewater and landfill waste (methane gas)[2]
- Diesel and gasoline use by city owned or operated vehicle fleet
- Refrigerant and sulphur hexafluoride leakage from chillers and electricity transmission and distribution equipment

In 2010, landfill emissions account for the largest part of Red Deer's GHG inventory, representing 48% of The City's total emissions. Other significant emissions sources are facilities (21%), wastewater treatment (9% of total), streetlights (9%) and water treatment (8%). For more information about the GHG inventory breakdown, see Appendix A which summarizes 2010 GHG emissions by source.

The baseline inventory identifies high-level GHG emission reduction strategies. The reduction strategies have been classified into four categories:

- Behavioural change initiatives
- Operation and maintenance practices
- Capital investment opportunities (energy efficiency and renewable energy)
- Innovations in low carbon technologies

Having evaluated the reduction strategies by impact, ease, and cost, we believe that Red Deer can target an absolute 30% GHG emission reduction by 2020 and 50% reduction by 2035, based on 2010 levels and anticipated growth.

Establishing a complete GHG inventory is the first step for Red Deer's GHG management program. By implementing a GHG management program, Red Deer will not only reduce its GHG emissions. It will also gain benefits such as energy cost savings, risk mitigation of future energy price increases and/or carbon costs, and preparation for compliance with future carbon regulation. The GHG management program will also position Red Deer as a progressive municipality with its citizens, employees and businesses.

[1] For definitions and explanations regarding methodology, please see "Definitions and Clarifications" in Appendix B.
[2] These emissions are attributed to the population of Red Deer and the surrounding region.

# 1 INTRODUCTION

## 1.1 Purpose

The City of Red Deer (Red Deer) has developed this 2010 Corporate Greenhouse Gas Inventory (GHG inventory) as part of its ongoing commitment to provide leadership and sustainable municipal services for its community and citizens. Greenhouse gas (GHG) accounting quantifies carbon dioxide, methane and nitrous oxide emissions which are all recognized as key contributors to climate change. GHG emissions (measured in terms of equivalent tonnes of $CO_2$) are one of the most highly accepted and widely used environmental impact measurements.

Red Deer identifies GHG emissions per capita as one of its performance indicators for monitoring environmental progress in its Environmental Master Plan (EMP). The EMP identifies two different emission reduction targets:

- Red Deer as a corporation, which includes GHG emissions from all facilities and services that The City controls
- The Red Deer community, which includes the GHG emissions impacts of all Red Deer citizens

This GHG inventory captures the GHG emissions from Red Deer's corporate activities (they are furthered described in Section 2, Methodology).

The purpose of this corporate GHG inventory report is to:

- Present Red Deer's corporate GHG emissions in 2010
- Define a baseline that can be used to set GHG emission reduction targets, monitor GHG reduction, and evaluate GHG reduction initiatives
- Identify high-level opportunities for GHG emission reduction and reduction target potential
- Establish a data collection protocol to be used for future corporate GHG inventories
- Provide guidance for the development of a GHG management program
- Become the first step to determine Red Deer's community GHG inventory

Red Deer can also use the report to voluntary report on its GHG emissions to show sustainability leadership towards its community: residents, visitors, local businesses and employees.

## 1.2 Background

In 2010, Red Deer had a population of 90,084 within its city limits of approximately 104 sq.km. Red Deer provides a wide range of services to its citizens, and these require energy use and/or result in GHG emissions.

Many services are delivered primarily through *Facilities* including:

- Legislative and government offices
- Neighbourhood community centres
- Recreation and cultural facilities (arenas, museums, pools and parks)
- Public works buildings (garage, maintenance and storage)
- Emergency services buildings
- Residential buildings (community and seniors housing)

Red Deer also provides services through the following *Municipal Operations*:

- Environmental services (water treatment and distribution, wastewater collection and treatment, and landfill provision and management)
- Electricity transmission and distribution
- Streetlights (including traffic lights and site lighting)
- Services from a fleet of approximately 450 vehicles

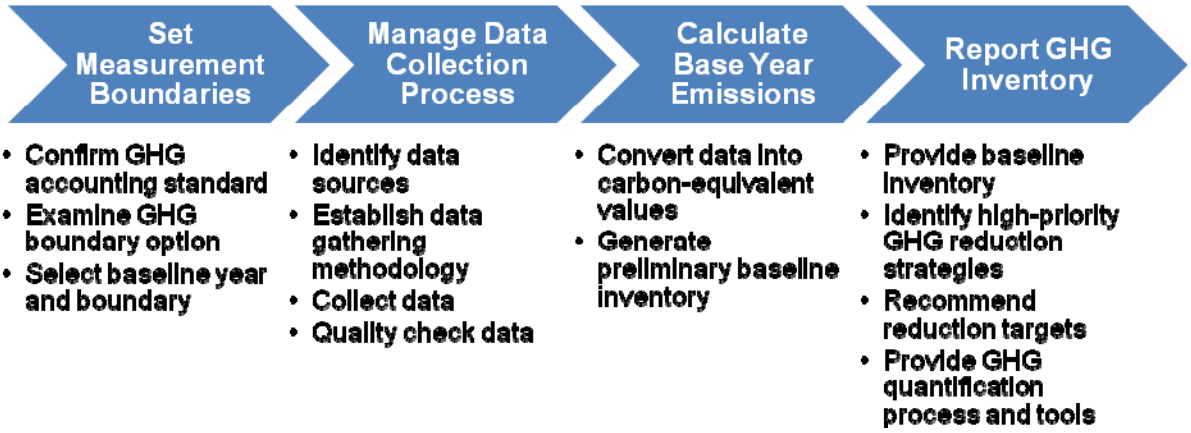
Since municipal operations are not associated with typical buildings, GHG emissions from Facilities and Municipal Operations are analyzed separately in this inventory (see Figure 2 below).

# 2 METHODOLOGY

## 2.1 Inventory Approach

Red Deer's corporate GHG inventory was developed through the following process:

**Figure 1: GHG Inventory Process**




As Red Deer selected the operational control approach for its organizational boundary (refer to Appendix B for Definitions and Clarifications), The City reports emissions from sources it owns or leases and for which it has operational control. Figure 2 illustrates Red Deer's organizational boundaries.

**Figure 2: The City of Red Deer's Organizational Boundary [a,b]**


Notes: a. Figure 2 is not to scale.
b. Community GHG emissions are not included in the Corporate GHG inventory.
c. T&D Transmission and Distribution.

Emissions from different activity sources are typically grouped into the following three scopes[3]:

- **Scope 1:** Direct emissions released from sources controlled by the organization. These include emissions from boiler, furnace or vehicle use, refrigerant leakage from chiller equipment and methane emissions from biogenic processes.
- **Scope 2:** Indirect emissions released by the generation of electricity purchased by the organization.
- **Scope 3** (Optional)**:** Other indirect emissions released from sources that are not controlled by the organization, but result from activity required for the organization to operate like emissions associated with waste. It is not mandatory to include scope 3 emissions in a GHG inventory.

Red Deer's GHG inventory includes scope 1 and 2 emissions[3], specified as mandatory by GHG accounting standards.

## 2.2 Data Collection

Red Deer provided facility-related information, electricity, natural gas, diesel and propane consumption, and refrigerant data using Loop's data collection tool. The City provided vehicle fleet fuel consumption using data from their accounting system records, wastewater data through monthly plant records and landfill data through existing government reported records.

Loop completed a set of quality control tests of the data provided and liaised with Red Deer to obtain missing values and confirm the validity of outlier data. Red Deer's activity data and collection process are described in Appendix D. Proxy methods were used where valid data could not be obtained. Emissions for several facilities that did not have utility data were estimated by extrapolating the average natural gas and electricity consumption from similar facilities by floor area.[4]

[3] For further definition of scopes, please see "Definitions and Clarifications" in Appendix B.
[4] 8% of electricity and 3% of natural gas data was extrapolated.

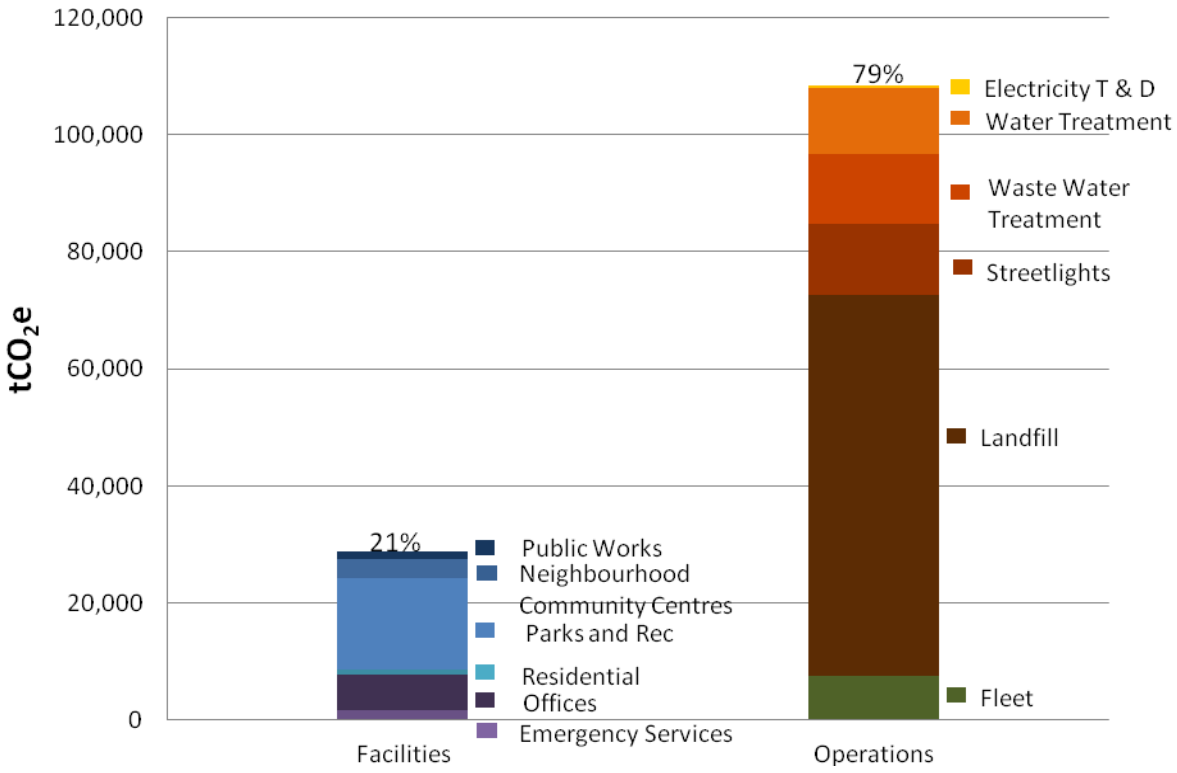
# 3 GREENHOUSE GAS EMISSIONS

## 3.1 Greenhouse Gas Emissions Summary

In 2010, Red Deer emitted approximately 137,000 tonnes of GHG emissions ($tCO_2e$)[5] from city controlled activities. Emissions from Municipal Operations[6] account for approximately 79% of GHG emissions, with the two landfills supplying the largest share of emissions at 48%, followed by wastewater treatment, streetlights and water treatment at 9%, 9%, and 8% respectively. The contribution from The City's vehicle fleet is around 5%.

City facilities account for approximately 21% of GHG emissions, with contributions from parks and recreational facilities at 12%, offices at 4%, public works at 2%, and neighbourhood community centres, emergency services and residential each contributing to 1% of total Red Deer GHG emissions.

**Figure 3: 2010 GHG Emission Breakdown by Facility and Municipal Operations**

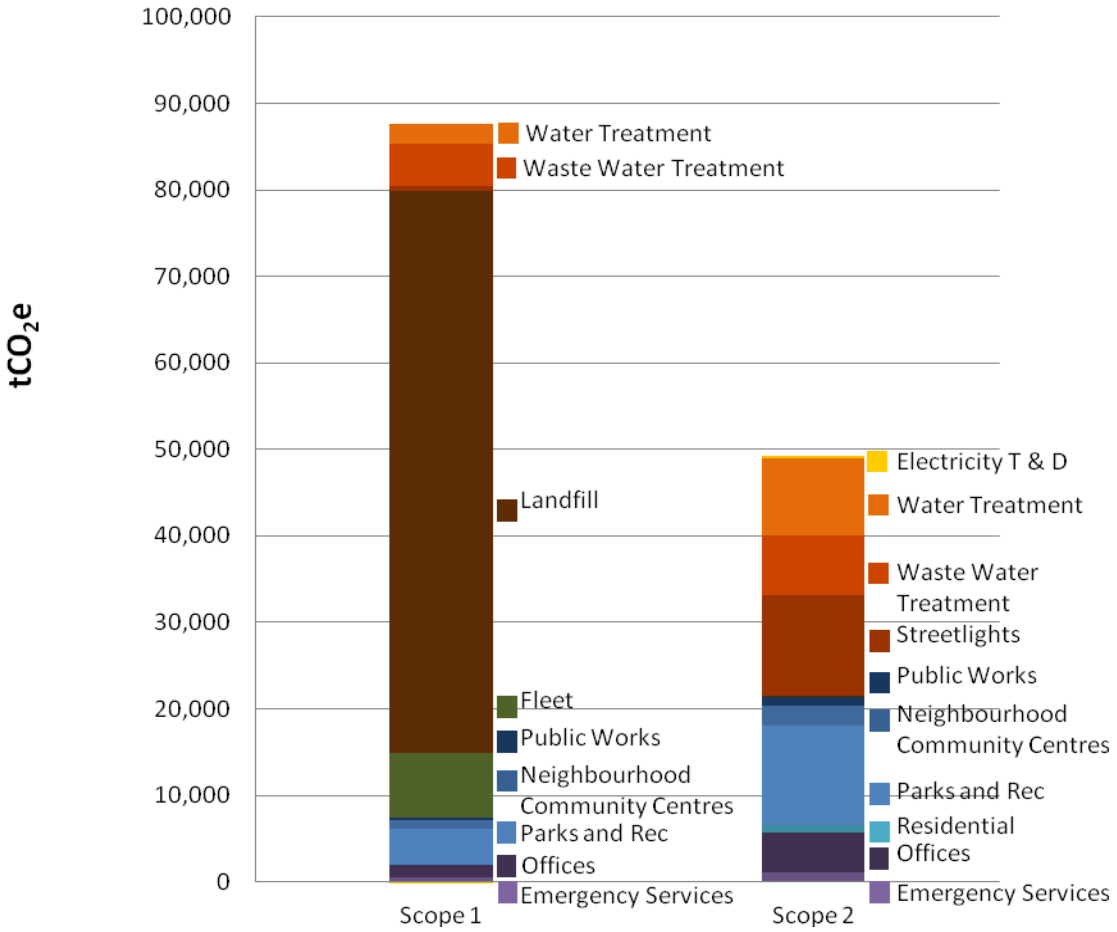



Note: T&D: Transmission and Distribution.

[5] $CO_2e$ refers to "carbon dioxide equivalent". Red Deer emissions include emissions of carbon dioxide, methane, nitrous oxide, and sulphurhexafloride.
[6] For definition of Municipal Operations, please see "Definitions and Clarifications" in Appendix B.

Direct (scope 1) emissions from natural gas, diesel, gasoline, refrigerants, wastewater treatment and landfill account for 88,000 $tCO_2e$ (64%). Energy indirect (scope 2) emissions from purchased electricity account for 49,000 $tCO_2e$, or 36% of Red Deer's GHG emissions, primarily from streetlights, facility HVAC systems, and lighting.

**Figure 4: 2010 GHG Emission Breakdown by Scope [7]**

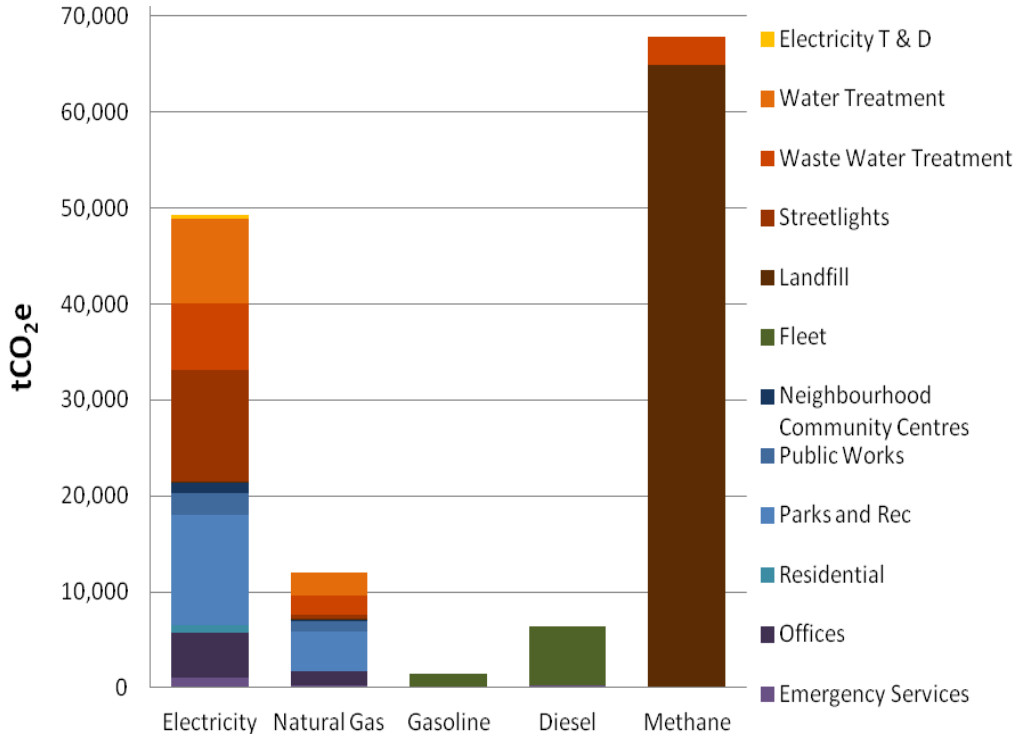



Note: T&D: Transmission and Distribution.

[7] For definitions of Scope 1 and Scope 2, please see "Definitions and Clarifications" in Appendix B.

Figure 5 provides a breakdown of GHG emissions by sources including biogenic sources (landfill, wastewater methane - 49%), electricity (36%), natural gas (9%), diesel (5%) and gasoline (1%).

**Figure 5: 2010 GHG Emission Breakdown by Source**




Please see Appendix A for the complete 2010 GHG inventory breakdown.

## 3.2 Greenhouse Gas Emissions from Facilities

Red Deer's facilities have a wide range of uses, which is reflected in a large variation in facility energy consumption. To determine worst and best performing facilities, they have been analyzed by energy and carbon intensity.

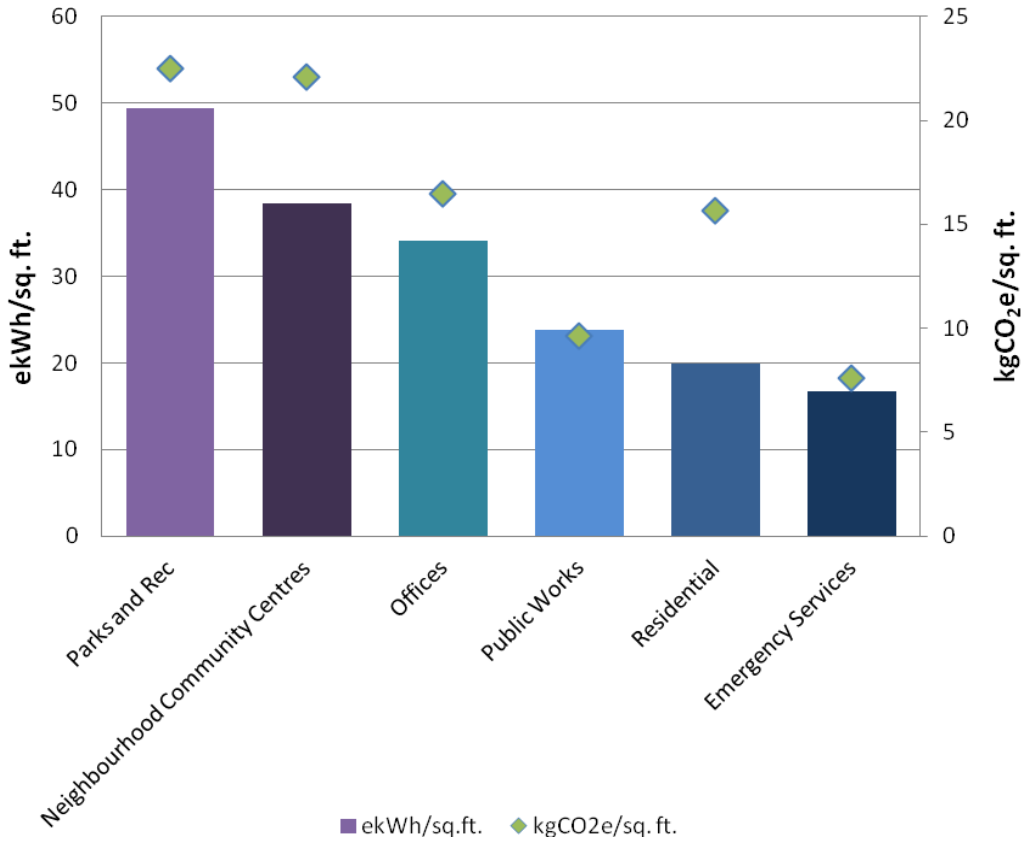
### 3.2.1 Facility Energy Intensity and Carbon Intensity Analysis

A common method for comparing facility energy use is to divide total energy consumption by gross floor area. Energy intensity is represented in equivalent kilowatt hours per square foot (ekWh/sq.ft.). This analysis combines energy use from all sources (natural gas, electricity and diesel) into one comparative unit of measurement (ekWh) per unit floor area. Similarly, carbon intensity ($kgCO_2e$/sq.ft.) looks at carbon emissions per building area.

The analysis identifies facilities with highest energy usage per floor area and can be used to benchmark building performance. Facilities with large GHG emission footprints and high energy and carbon intensity may have significant emissions reduction opportunities. Figure 6 presents the energy consumption and resulting total carbon emissions by facility type.

The difference between energy and carbon intensity is explained by the facility's energy mix (natural gas versus electricity). Residential buildings have a higher carbon intensity due to a higher proportion of electricity consumption compared to natural gas consumption.

**Figure 6: Energy Intensity and Carbon Intensity by Facility Type**




Note: "Residential" refers to City-operated community and senior housing.

Table 1 presents the fifteen facilities with the highest energy intensity and carbon intensity. They collectively make up 54% of facility GHG emissions. The average energy intensity across all Red Deer facilities is 36.4 ekWh/sq.ft. and average carbon intensity is 16.5 $kgCO_2e$/sq.ft. When pursuing energy efficiency initiatives, The City should consider prioritizing facilities that have high energy and carbon intensity and large GHG emission footprints.

**Table 1: Top 15 Highest Energy Intensity Facilities**

| Facility | Energy Intensity (ekWh /sq.ft.) | % of Total *Facility* Energy | Carbon Intensity ($kgCO_2e$ /sq.ft.) | % of Total *Facility* GHG Emissions |
|---|---|---|---|---|
| Old Catholic School Board Office (Culture Office) | 106.8 | 0.3% | 42 | 0.3% |
| Civic Yards 900, 7721-40 Ave - Wash Bay Building | 95.0 | 0.5% | 48 | 0.5% |
| Lions Washroom #2 (Centre) and Lions Ticket Booth and Storage Shed #1 | 78.7 | 0.3% | 72 | 0.6% |
| Transit Terminal/Parkade | 68.7 | 0.7% | 51 | 1.1% |
| Recreation Centre (4501-47A Avenue) | 63.0 | 5.7% | 25 | 4.8% |
| Collicutt Centre | 57.6 | 26.6% | 24 | 24.1% |
| Recreation Centre Service Building (4501–47A Avenue) | 54.3 | 0.2% | 17 | 0.2% |
| Heritage Ranch Equestrian Centre | 53.5 | 0.1% | 51 | 0.3% |
| Great Chief Park Fieldhouse | 51.6 | 0.3% | 24 | 0.3% |
| Bower Ponds Pavilion and Cronquist House | 50.2 | 0.3% | 33 | 0.5% |
| Recreation - Dawe Community Centre | 49.5 | 7.6% | 24 | 7.9% |
| Roland Michener Centre - Pool Facility | 49.4 | 3.7% | 24 | 3.9% |
| City Hall/Library | 43.6 | 8.3% | 20 | 8.2% |
| Parks Maintenance Building (4725-43 St., Building B) | 43.1 | 0.5% | 12 | 0.3% |
| Kinsmen Community Arenas (KinCity) Ice Machine Room | 42.1 | 3.5% | 24 | 4.3% |
| **Top 15 Facility Average/sq. ft. or Total %** | **53.1** | **58.5%** | **24** | **57.2%** |
| **Facility Average/sq. ft. or Total %** | **36.4** | **100.0%** | **17** | **100.0%** |

Note: Percentages are based on the fraction of total *Facility* values. *Municipal Operations* are excluded from this analysis. The complete list is provided in Appendix H. Although City Hall and the Library are two separate buildings, they share one electricity meter, thus they are grouped in this table.

NRCan reports the following average energy intensities which can be used as benchmarks for comparison:

- 38.7 ekWh/sq.ft. for government-owned buildings in the Prairies region[8]
- 48.8 ekWh/sq.ft. for recreational buildings in the Prairies region

Additionally, the Halsall and Loop's Building Database has an average of 33.4 ekWh/sq.ft. for office buildings located in Alberta. While around half of Red Deer properties have higher energy intensity relative to this database average, the average energy intensity of Red Deer's office buildings (32.1 ekWh/sq.ft.) is very close to the database average.

While we cannot draw further conclusions about high energy intensity buildings without more detailed knowledge about each facility, differences in energy intensity are typically driven by difference in activities, operating hours, type and quantity of building equipment, age, building condition, energy efficiency/conservation measures and occupant behaviours. Red Deer facilities contain different types of spaces. For instance, recreation centres can be considered high energy users as can facilities that operate up to 24 hours a day.

## 3.3 GHG Emissions from Municipal Operations

Red Deer's municipal operations provide a wide variety of services that result in the GHG emissions summarized in Table 2.

**Table 2: GHG Emissions by Municipal Operations**

| Municipal Operations | Total GHG emissions ($tCO_2e$) | % Total GHG Emissions | GHG emissions per capita ($tCO_2e$/capita) |
|---|---|---|---|
| Landfill | 65,134 | 47.5% | 0.72 |
| Streetlights | 12,158 | 8.9% | 0.13 |
| Wastewater Treatment | 11,757 | 8.6% | 0.13 |
| Water Treatment | 11,310 | 8.3% | 0.13 |
| Fleet | 7,557 | 5.5% | 0.08 |
| Electricity Transmission and Distribution | 372 | 0.3% | 0.00 |
| **Total Municipal Operations** | **108,288** | **79.0%** | **1.20** |

[8] Source: Table 10.2 from the NRCan Commercial and Institutional Building Energy Use Survey (2000).

Landfill emissions are mainly caused by methane released during decomposition of waste, with a small contribution from electricity used to run the site. Red Deer operates two landfills: the “1972” landfill (closed since 2001) produces 65% of methane emissions while the WMF landfill (presently in use) produces the remaining 35%. Note that transportation of waste to the landfill is contracted out to an external contractor and thus not considered to be under operational control by The City.

The majority of wastewater treatment emissions is due to the energy required to fuel the wastewater treatment plant (WWTP). After central aerobic treatment, anaerobic digesters process the bio solids, which produce methane gas. This gas is then recaptured and a portion (43% in 2010) is used in the plant, while the remaining (57% in 2010) is flared. Using recaptured methane in lieu of traditional natural gas helps to reduce WWTP’s emissions from natural gas consumption.

Streetlights at 9% of the total GHG inventory include a minor contribution (<1%) from parking lots, skating rinks, signs and traffic lights.

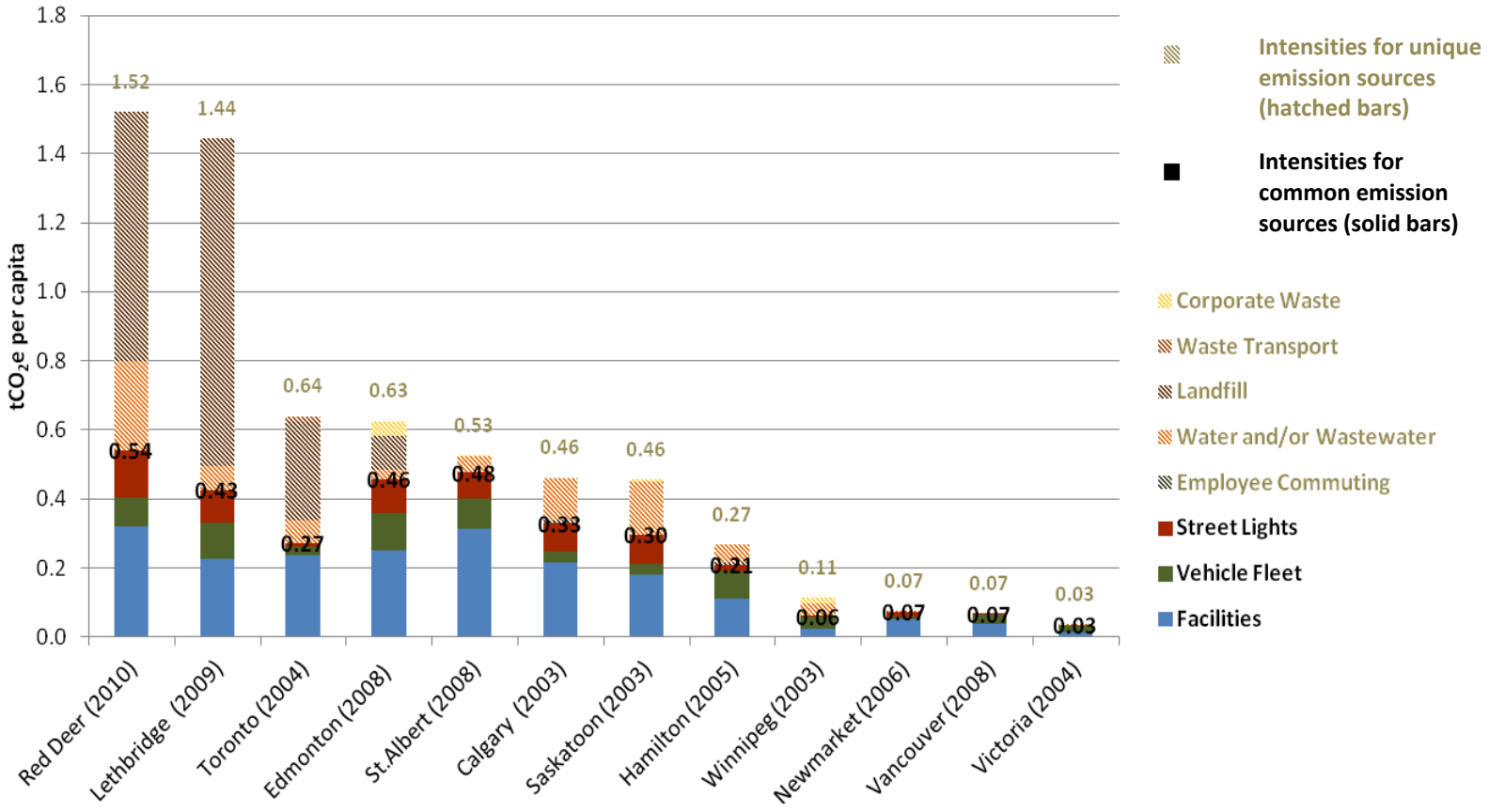
Emissions from vehicles represent less than 6% of Red Deer’s GHG inventory.

Transmission and distribution of electricity, including leakage of $SF_6$ refrigerants, represent less than 1% of Red Deer’s GHG inventory

### 3.3.1 Municipal Operations GHG Emissions per Capita

Municipal Operations are not easily compared on a carbon intensity per area basis. To provide context, we have compared the GHG impact of each municipal operation on a per capita basis with other municipalities. The GHG emissions of Red Deer’s municipal operations are approximately 1.2 $tCO_2e$ per capita, as shown in Table 2 and Figure 7 (the total emissions per capita of 1.5$tCO_2e$ includes facilities). Summary GHG inventories for these benchmarked municipalities are presented in Appendix G.

**Figure 7: Municipal GHG Emissions Per Capita** (Select Municipalities)




Notes:
- Year of inventory baseline in parenthesis.
- Select municipalities include unique emission sources in their corporate GHG inventories (identified by beige text and hatched bars above).
- Red Deer's 2010 corporate GHG inventory does not include waste transport or employee commuting.
- Red Deer's Landfill, Water and/or Wastewater are all regional service providers; the regional populations have not been taken into account and therefore the per capita numbers will be slightly inflated.
- Water and wastewater related GHG emission sources vary for each municipality (see Table 3 and Appendix G).
- Calgary and Hamilton take into account employee commuting; in both cases, this emission source accounts for less than 3% of the city's total footprint.
- 2003 is the most recent year with a publicly available detailed breakdown of GHG emissions for Calgary.

Red Deer's GHG emissions per capita are high, approximately twice the average of these select Canadian municipalities in part because:

- Alberta's electricity is primarily generated from coal
- Red Deer's GHG inventory includes landfill, water and wastewater which are major sources of emissions
- Red Deer's landfill, water and wastewater are all regional services whose populations are not completely included in the per capita numbers

The province of Alberta overall has higher GHG emissions, as the province generates electricity primarily from coal and natural gas sources which have high carbon impact. In contrast, municipalities in British Columbia have hydroelectric power as their primary electricity source, which has a lower carbon impact.

Another factor influencing GHG emissions per capita is a municipality's operational boundaries. Red Deer's corporate inventory includes GHG emissions from landfill, wastewater and water treatment, which account for 65% of emissions. Municipalities that contract out landfill and waste management services do not include these emission sources within their operational boundary. Municipalities that operate their landfill and waste management services frequently pursue advanced waste management technologies (like co-generation; see Section 4.3) to reduce emissions from these sources.

Further compounding this issue is the fact that Red Deer's landfill, water and wastewater all service slightly different regional populations which have not been taken into account in the per capita numbers.

Table 3 compares the impact of different waste management practices on GHG emissions per capita for three peer cities which include waste-related emissions in their corporate GHG inventories: Edmonton, Lethbridge and Toronto. This table illustrates how these different approaches impact GHG emissions per capita and hence make direct comparisons between municipalities difficult.

Moreover, if we compare only the common emissions sources across all municipalities (namely facilities, streetlights, and vehicle fleet; see Figure 7), Red Deer's emissions per capita are more in line with other Albertan municipalities.

**Table 3: Impact of Waste Management Practices on GHG Emissions per Capita**

| City | Source | Description of Waste Management Practices | Impact on GHGs per capita |
|---|---|---|---|
| **Red Deer** | Landfill | ▸ Existing landfills do not have methane capture (The City is currently working to upgrade with methane capture). These service the residents of the City of Red Deer and its surrounding region. | ↑ |
| | Water and/or waste water | ▸ Emissions associated with electricity use for wastewater treatment, water treatment and pumping are included. These service the residents of the City of Red Deer and its surrounding region. | ↑ |
| **Lethbridge** | Landfill | ▸ Waste from the surrounding county is also deposited at the city-owned landfill<br>▸ Existing landfills do not have methane capture (Lethbridge plans to upgrade with methane capture in 2015) | ↑<br>↑ |
| | Water and/or waste water | ▸ Emissions associated with electricity use for water treatment and pumping are included in facilities category rather than "water/wastewater"<br>▸ Lethbridge has an advanced wastewater treatment plant with a co-generation system | ↓<br>↓ |
| **Toronto** | Landfill | ▸ Waste is hauled to landfills in Michigan by private contractors; waste transport emissions are included in its corporate inventory, but methane emissions are not<br>▸ Methane emissions from old city-owned landfills are included, but most have methane capture | ↓<br>↓ |
| | Water and/or waste water | ▸ Emissions associated with electricity use for water pumping and sewage treatment are included | ↑ |
| **Edmonton** | Landfill | ▸ Advanced waste management facilities recover organics via composting and capture landfill methane, reducing emissions | ↓ |
| | Water and/or waste water | ▸ Emissions are excluded from corporate inventory because EPCOR utility company controls these operations | ↓ |

# 4 GHG REDUCTION STRATEGIES

Red Deer has already started to implement GHG reduction initiatives:

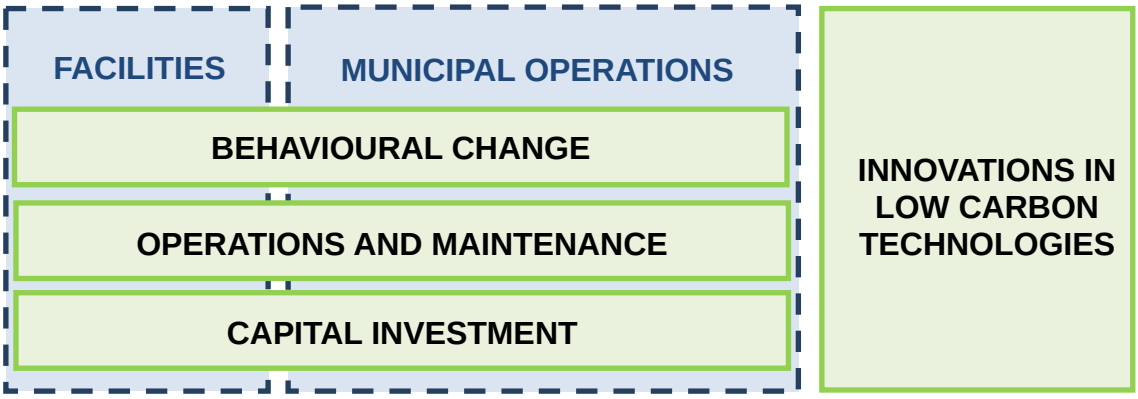
- LED traffic and street light replacement programs
- WWTP methane recapture since 1972 and current expansion
- Bio-solids reuse from wastewater treatment plant
- Collection and composting of yard waste
- LEED certification candidacy of new Civic Yards and RCMP building
- Recreation Centre upgrades
- Establishing an internal City Green Team to help implement change

Through the adaption of the Red Deer Environmental Master Plan (EMP) and the establishment of The City Green Team, The City has started to assess further reduction initiatives:

- Greening the municipal fleet with electric and hybrid vehicles, and bio fuel sources
- Investigating landfill methane recapture opportunities
- Researching curbside organics collection and composting options
- Energy reduction in the offices (computer use, lighting, printing)

In Figure 8 we have outlined a framework which describes four categories of GHG emission reduction strategies. Facilities and Municipal Operations can reduce GHG emissions by facilitating behavioural change, optimizing operations and maintenance, and investing in new energy efficiency technologies, renewable energy generation, and other low carbon technologies. If Red Deer wants to accelerate its GHG emissions reduction or go beyond the total feasible reduction through these strategies, The City can look at carbon sinks through local afforestation and the sourcing and retiring of carbon offsets. However, carbon offsets and sinks have not been included as a part of the proposed GHG reduction strategy.

**Figure 8: GHG Reduction Strategies**




To enable Red Deer to put in place a GHG management program and facilitate GHG reduction target setting, we first describe GHG reduction strategies for each GHG reduction category and indicate reduction potential for each strategy. We then prioritize reduction strategies according to effort, cost and impact to provide guidance to help The City set progressive and realistic GHG emission reduction targets.

## 4.1 Behavioural Change

In its Environmental Management Plan, Red Deer formed an environmental vision that included actively enhancing its rich natural environment and minimizing its ecological footprint through City leadership, community collaboration and active stewardship. The plans include the following core directions:

- *Encourage, Educate, Engage, Enable, and Expect:* delivering an effective engagement, awareness and constituent building process
- *Learn by Doing; Lead by Example*: leading with innovation to develop the knowledge, skills and expertise of local citizens, businesses, and City staff.

These are the first steps to foster the behavioural change that is necessary to create a low-carbon community. Starting with municipal employees will create good examples and stories to take to the Red Deer community and help staff develop citizen-facing initiatives through the delivery of The City's services.

Providing educational programs is an effective way to institutionalize good energy savings habits. Encouragement can be through engaging communication campaigns, internal competitions and recognition, ongoing GHG emissions reporting, and building labels communicating energy and carbon performance. Detailed actions are presented in Table 4.

**Table 4: Behavioural Change Strategies and Savings**

| | GHG Reduction Strategy | Emissions Affected | Typical Savings (% of emissions) |
|---|---|---|---|
| 1 | **Develop awareness and education programs to institutionalize good energy savings habits:**<br>▸ Turn off all equipment (computers, photocopiers, kitchen appliances etc.) and lighting when buildings are unoccupied<br>▸ Use power-save on all equipment<br>▸ Do not change thermal comfort settings<br>▸ Keep doors and windows closed in the summer and winter<br>▸ Create checklists, posters and stickers<br>▸ Encourage employee participation through competitions and recognition | **Facilities** | **10%** |
| 2 | **Nominate GHG reduction champions in each department:**<br>▸ Identify team members across The City's departments and services who will champion the implementation of the GHG reduction program<br>▸ Develop scorecards that report on GHG footprint and reduction KPIs<br>▸ Publish results in league tables (e.g. lowest emitter, biggest reducer)<br>▸ Reward high performers | **All** | **Essential for GHG program management** |
| 3 | **Promote better driving practices to reduce corporate vehicle use and fuel consumption:**<br>▸ Start a fuel-efficiency driver training program<br>▸ Encourage carpooling and alternative modes of transportation to reduce the number of trips<br>▸ When vehicle use is required, encourage drivers to select the smallest most fuel-efficient vehicle available | **Fleet** | **10%** |

## 4.2 Operations and Maintenance

Optimizing operations and maintenance practices through policies, procedures and audit programs across Red Deer's departments can also significantly reduce GHG emissions. Common strategies are presented in Table 5.

**Table 5: Operations and Maintenance Strategies and Savings**

| | GHG Reduction Strategy | Emissions Affected | Typical Savings (% of emissions) |
|---|---|---|---|
| 4 | **Develop green operating procedures for all facilities and municipal operations:**<br>▸ Regularly maintain equipment (boilers, HVAC equipment, lights, doors, and windows at facilities; motors, drives and pumps at plants) | **Facilities** | **5%** |
| | ▸ Maintain building temperature (suggestions: offices 19-21ºC, warehouses/heated storage 16-19ºC)<br>▸ Use the "dead band" temperature method: no cooling/heating between 19-24ºC<br>▸ Heat and cool areas using "zones" (e.g. reduce/eliminate heating in storage areas)<br>▸ Ensure thermostats are placed away from draughts and heat sources | **Water Treatment** | **10%** |
| | ▸ Use controls to manage temperature and lighting (occupancy, daylight, schedule)<br>▸ Upgrade controls with a Building Automation System (BAS) particularly in high energy use facilities like recreation centres<br>▸ Only replace equipment with highest energy efficiency model in accordance with green procurement policy | **Wastewater Treatment** (excluding methane emissions) | **10%** |
| 5 | **Establish a green procurement policy that prioritizes GHG reductions:**<br>▸ Define green criteria that will be used to evaluate purchases of products and services<br>▸ Include energy efficiency and renewable technology requirements for equipment and other purchases<br>▸ Include green facility requirements for all retrofits and new facilities; consider standards such as LEED, ASHRAE 90.1 or Living Building Challenge<br>▸ Define energy efficiency and GHG expectations that can be communicated easily to contractors and suppliers | **Facilities** | **10%** |

| | GHG Reduction Strategy | Emissions Affected | Typical Savings (% of emissions) |
|---|---|---|---|
| | ▸ Consider including third-party rating systems, energy efficiency specifications, or labeling programs (e.g. ENERGY STAR, LEED, ASHRAE, ISO900.1, Environmental Choice) in the policy<br>▸ Consider requirements for life cycle costing and/or incorporating the cost of carbon for large capital investments, particularly to evaluate the economic feasibility of early upgrades for high GHG emission equipment<br>▸ Consider including broader sustainability requirements (e.g. water efficiency and waste minimization to reduce waste and water-related emissions, or compliance with new social and environmental legislation) | | |
| **6** | **Conduct facility energy audits to identify measures or system upgrades that will reduce the energy use and/or cost of operating your buildings**<br>▸ Establish a list of priority facilities with high energy consumption and high GHG emissions intensity | **Facilities** | **10%** |
| **7** | **Consider retro-commissioning of buildings and equipment to optimize existing equipment performance and your operations and maintenance procedures** | **Facilities**<br>**Wastewater Treatment** (excluding methane emissions)<br>**Water Treatment** | **5%**<br>**5%**<br>**5%** |
| **8** | **Maintain fleet vehicles to improve performance:**<br>▸ Start an enhanced vehicle maintenance program to ensure all existing vehicles are operating at maximum fuel efficiency<br>▸ Use low-emitting fuels in vehicles as allowed by manufacturer (e.g. biofuels) | **Fleet** | **10%** |

## 4.3 Capital Investment

The largest GHG emissions reduction will likely be achieved through investments in energy efficiency and renewable energy technologies. Some capital investments may be cost effective by themselves, others can also meet financial hurdle rates through government incentive programs, carbon offset revenue or other revenue-generating market mechanisms.

Leading organizations are integrating energy performance objectives and the (increasing) cost of energy and carbon into capital planning to emphasize the importance of energy efficiency and better prioritize low carbon investments.

As the majority of Red Deer's GHG emissions originate from environmental services (water provision, wastewater treatment, and waste management; 64% of total emissions), capital investment to either mitigate emissions or improve the efficiency and effectiveness of these operations will have the largest GHG emissions reduction potential. Many investments can be assessed on a stand-alone basis, others may be more feasible when considered as current equipment and facilities reach their end of life. Red Deer will need to consult experts to assess each individual opportunity separately.

Energy audits and retro-commissioning will identify facility improvements such as light and HVAC equipment upgrades (see Table 1 for a list of high-priority facilities).

### 4.3.1 Renewable Energy

Red Deer can lower its GHG emissions by generating its own renewable energy. This can be done by capturing methane gas, using waste as a fuel source or installing on-site renewable generation, such as solar hot water, electricity-generating PV technology or wind turbines where feasible.

While renewable energy options are currently associated with a higher energy cost and long payback periods, it provides Red Deer the opportunity to emerge as a low-carbon leader, provide demonstration projects for local enterprise and accelerate market technologies. Red Deer has already installed demonstration solar panels that are building awareness in the community and plans to start tracking the generated renewable energy.

We understand that Red Deer has a goal that all city-owned facilities will be powered by 25% green electricity by 2013 under a five-year contract between The City of Red Deer and ENMAX Energy Corporation. As a note regarding the purchase of renewable energy, we want to clarify that while purchasing renewable energy from a renewable energy provider drives the demand for this type of energy and reduces the province's overall GHG emissions, it does not reduce the GHG emissions for the individual buyer. As grid-sourced renewable energy is included in the provincial energy mix, the implicit GHG reduction benefits are already considered in published electricity emissions factors.

Hence, from a carbon accounting perspective, on-site generation of renewable energy is the only strategy that reduces GHG emissions (as per accepted accounting standards).

Capital investment strategies and typical savings are presented in Table 6.

**Table 6: Capital Investment Strategies and Savings**

| | GHG Reduction Strategy | Emissions Affected | Typical Savings (% of emissions) |
|---|---|---|---|
| 9 | **Continue to implement building lighting upgrades, such as:**<br>▸ Upgrade bulbs (e.g.T8s or T5s from original T12s; use compact fluorescent lamps (CFLs), light emitting diode lamps (LEDs), or solar tubes)<br>▸ Install occupancy and light sensors | **Facilities** | **3%** |
| 10 | **Expand energy efficient street light program** | **Streetlights** | **10%** |
| 11 | **Green the municipal fleet:**<br>▸ Upgrade to fuel-efficient vehicles: consider electric or hybrid models, vehicles that achieve NRCan's "ecoEnergy for Vehicles" awards, or micro-compact vehicles | **Fleet** | **40%** |
| 12 | **Generate renewable energy on-site:**<br>▸ On-site installation of solar hot water, PV solar panels<br>▸ Wind turbines<br>▸ Geothermal | **Total Energy Footprint** | **10%** |
| 13 | **Use flared WWTP methane to replace natural gas consumption** | **Wastewater Treatment** | **50%** |
| 14 | **Investigate landfill methane capture opportunities**<br>▸ Methane capture can reduce landfill emissions 75-90%. 70% is used as a conservative estimate. | **Landfill** | **Assume 70%** |
| 15 | **Commit to ongoing waste management best practices:**<br>▸ Consider curbside organics collection and composting options to divert organic material from the landfill<br>▸ Include methane capture, co-generation, or another renewable energy technology for all new organics processing facilities | **Landfill** | **Assume 50% from waste diversion** |
| | ▸ Research new WWTP and water treatment technologies to minimize methane emissions and improve energy and water efficiency | **Water and Wastewater Treatment** | **Assume 20% efficiency improvements** |

Note that capturing methane from waste decomposition (such as landfills and WWTPs) and using it as a fuel has two carbon reduction benefits:

- The methane is burned, and thus prevents the release of methane (which has a high GWP) into the atmosphere.
- The methane fuel replaces fossil fuel consumption, further reducing the facility's GHG emissions.

## 4.4 Innovations in Low Carbon Technologies

Strategies to address climate change and carbon emissions are evolving globally. As government policy, industry standards, and consumer behaviours change, businesses are likely to respond with innovations in low carbon technologies. Low-carbon technologies produce fewer GHGs than existing technologies that perform that same function (for example, solar power and hybrid-electric vehicles).

### 4.4.1 Carbon Sink and Offset Strategies

If Red Deer wants to take its GHG emissions reduction initiatives beyond the strategies identified above, it can look at opportunities to either create carbon "sinks" by sequestering carbon through tree planting or by purchasing and "retiring" carbon offsets. We have not included carbon sinks and offsets as a part of the proposed reduction strategy.

a) Carbon Sequestration through Afforestation

Though Red Deer already has an extensive parks system, expanding the urban forested areas increases the ability of the community vegetation to absorb carbon dioxide emissions, hence creating a "carbon sink". Afforestation is a method of carbon sequestration that can be deducted from the total GHG emissions.

We understand that the Red Deer Parks Section is completing an inventory of the urban forest coverage and expects to have a baseline established by 2014. Generally the cost of urban forest expansion is high as a GHG reduction strategy, but additional trees provide a wide range of other benefits that can warrant the investment. Afforestation is not included in the strategy to meet the proposed reduction targets.

b) Carbon Offsets

Through the purchase of verified carbon offsets, Red Deer can offset a portion of its GHG emissions annually by retiring the offsets. Like renewable energy purchasing, this offers reputational benefits as well as the opportunity to emerge as an industry leader. "Flagship" properties with a high carbon footprint may consider this option.

There is a variety of carbon offsets that are available to Red Deer. First, there are Alberta-based offsets that are generated under the province's Specified

Gas Emitters Regulation. Secondly there are offsets available from projects in Canada, North America or developing countries. They can be marketed under names such as "Verified Emissions Reductions, the Gold Standard or UN ERU (Clean Development Mechanism). Offsets are currently priced between Cdn$3-20 per $tCO_2e$, depending of origin, quality and verification system. Carbon offsets are not included in the strategy to meet the proposed reduction targets.

## 4.5 Prioritization of GHG Reduction Strategies

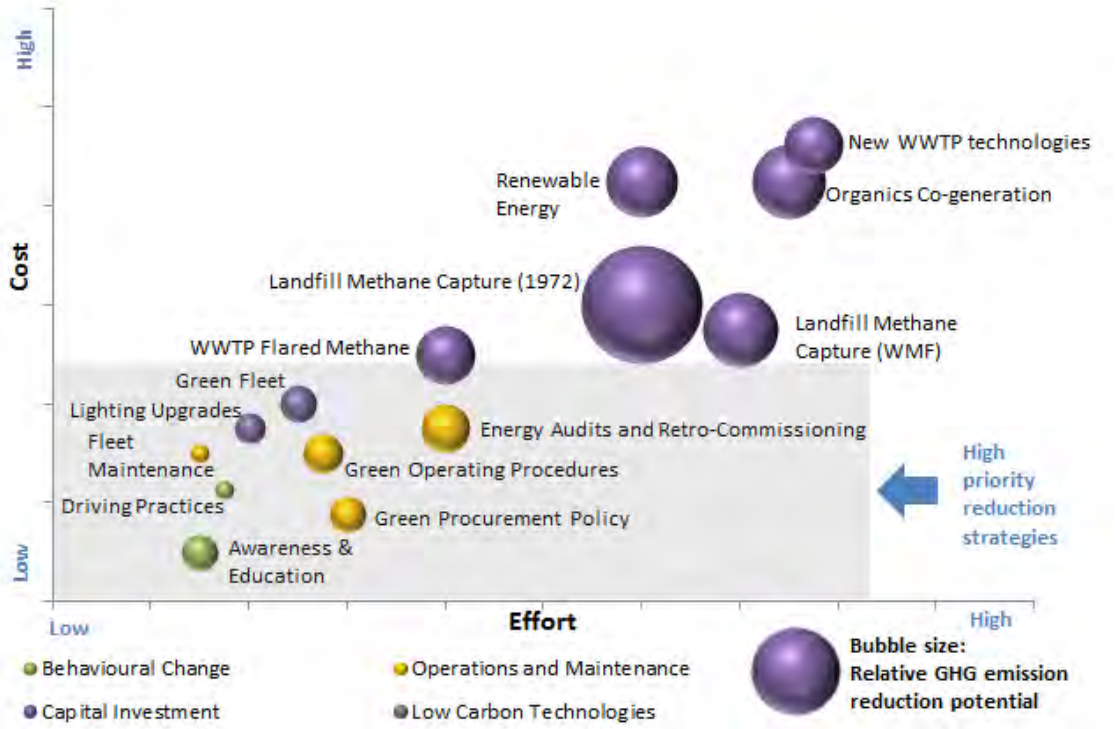
To enable Red Deer starting to prioritize reduction strategies for a GHG management program and facilitate GHG reduction target setting, we have evaluated the effort, cost and impact of each strategy to help The City set progressive and realistic GHG emission reduction targets.

**Table 7: GHG Reduction Prioritization**

| Criteria | Key Considerations |
|---|---|
| **Effort** | ▸ Access to best practices and technologies<br>▸ Time to implement<br>▸ Strategic initiative requiring high-degree of buy-in<br>▸ Number of approvals involved |
| **Cost** | ▸ Scale of capital investment<br>▸ Funding availability<br>▸ Investment return (most energy efficiency initiatives have positive net present value) |
| **Impact** | ▸ Decrease of overall GHG emissions |

The GHG reduction strategies have been plotted according to these prioritization factors in Figure 9. The size of the "bubble" represents the strategy's relative GHG reduction potential.

**Figure 9: Prioritized GHG Reduction Strategies**




## 4.6 Existing Budget for GHG Reduction Strategies

The City of Red Deer already has taken several steps towards reducing its greenhouse gas emissions, and more are being planned. Find below a summary of actions identified in the 2013 budgets:

| Recommended GHG Reduction Strategy | 2013 budget status |
|---|---|
| Awareness & Education | Covered under existing programs: Green Team and Environmental Initiatives. |
| Green Procurement Policy | Covered under Environmental Initiatives existing programs. |
| Green Operating Procedures | $20,000 proposed in 2013 EMP FAR for water audits; water and energy audits are actions identified in EMP; no other budget currently assigned. |

| | |
|---|---|
| Fleet Maintenance | There is a preventative maintenance program already in place to maximize vehicle life cycle; nothing new is currently planned. A smart driver program being developed in 2013 to provide tools to increase fuel efficiency and decrease emissions; there is 5% biodiesel already in our diesel and 10% ethanol in gasoline; budget is planned for an additional fuel tank specifically for biodiesel in 2014 and for an alternative fuel station in 2015. |
| Street Lighting Upgrades | LED lighting being implemented in growth areas to be funded from development. Conversion of existing areas not yet budgeted. |
| Green Fleet | $100,000 budgeted within 2013 EMP FAR for greening the fleet review study; $54,000 capital funding approved for electric car pilot project in 2013. |
| Energy Audits & Retro-Commissioning | $50,000 budgeted within the 2013 EMP FAR to complement Municipal Climate Change Action Centre grants applied for by Recreation. |
| Landfill Methane Capture (1972 landfill and Waste Management Facility) | $2 million approved in 2013 capital budget; construction is subject to outcome of feasibility study. |
| Renewable Energy | No money currently budgeted for renewable energy generation. Currently purchasing 23% renewable electricity from ENMAX (equaled ~$155,000 in 2011) and increasing to 25% but this does not directly reduce The City's GHG emissions as the reduction is actually created by ENMAX and is already included in Alberta's emissions factor for electricity. |
| Organics Co-generation | Identified in Waste Management Master Plan but not yet covered in capital budget. |
| Use Wastewater Treatment Plant Flared Methane | $2 million budgeted in WWTP upgrade capital budget for cogeneration facility, to be constructed in 2014. |
| New Wastewater Treatment Plant Technologies | Not identified in 10 year capital budget. |
| New Water Treatment Plant Technologies | $1.8 million planned & approved in 2013 for HVAC & boiler upgrades that will save energy. |

# 5 GHG EMISSION REDUCTION TARGETS: 2020 AND 2035

Setting GHG reduction targets and continuously measuring and reporting against these targets are a fundamental part of any GHG management program. Targets can be set for The City overall and also be broken down by the operational component of Red Deer's footprint such as waste management, fleet and facilities.

Having a baseline GHG inventory is the first step towards establishing GHG reduction targets. Red Deer aspires to significantly reduce its GHG emissions by 2020 and further by 2035 to show environmental leadership. Our recommendations and analysis below show that this is viable, although challenging with a quickly growing population and demand for city services.

The following approaches are used to inform Red Deer's 2020 and 2035 GHG reduction targets:

- Forecast future GHG emissions using the "Business-as-usual" scenario
- Provide absolute GHG reduction and equivalent emissions per capita
- Identify relevant Red Deer GHG reduction opportunities (see Section 4) and estimate related emission reductions
- Benchmark Red Deer's GHG emissions against other Canadian municipalities with progressive carbon goals and current provincial and federal targets

## 5.1 Absolute vs. Intensity-Based GHG Reduction Targets

The intent of absolute targets is to set a cap for the annual quantity of GHG emissions being released into the atmosphere. Scientists have estimated the absolute maximum concentration of $CO_2$ in the atmosphere and corresponding annual emissions. This is a "fixed" number. To avoid "catastrophic climate related events", it is commonly accepted that we need to reduce emissions to 1990 levels for all future years.

Intensity-based targets reflect GHG emissions relative to a productivity metric such as GHG emissions per capita or per unit of economic activity. Since populations and economies typically grow, over time organizations generally feel more comfortable setting intensity-based reduction targets. Intensity-based statistics are also useful for comparison with other jurisdictions. However, the outcomes of the intensity-based targets need to be aligned with the absolute carrying capacity of the planet.

Best practice for GHG reduction targets is therefore to specify an absolute target (sometimes in conjunction with an intensity-based one). Absolute targets are the only way to control actual emissions and address climate change on a global level. Benchmarks from other Canadian municipalities support setting absolute GHG reduction targets.

## 5.2 Forecasting Red Deer's Future GHG Emissions

Red Deer is a growing municipality in a rapidly developing region. Population projections by The City estimate a 70% increase in population between 2010 to 2031 (from around 90,000 to 150,000 citizens[9]). Services supplied by City facilities and municipal operations will need to be expanded to serve this growing population, resulting in increased corporate GHG emissions.

Future GHG emissions will be influenced by developments that are difficult to predict today. Key drivers are economic development (for instance, population growth linked to jobs in the energy and resource industries), government regulation, technological innovation and changed human behaviours due to societal change.

Red Deer's future GHG emissions are forecast in this report using a "Business-as-usual" scenario with the following assumptions:

- No direct intervention by The City
- No efficiency improvements due to government policy or technology innovation advances
- Emissions from facilities, water treatment, and wastewater treatment are tied to projected population growth
- 35% of landfill emissions are tied to projected population growth (65% of current landfill emissions are due to the historical 1972 landfill that is now closed)
- Emissions related to streetlights, fleet, or electricity transmission and distribution do not substantively increase as these municipal operations tend to grow slowly or not grow at all due to densification

Under these assumptions, Red Deer corporate GHG emissions are expected to increase from 137 $ktCO_2e$ in 2010 to around 160 $ktCO_2e$ in 2020, 192 $ktCO_2e$ in 2035, and 236 $ktCO_2e$ in 2050 (see Figure 10).

Although absolute GHG emissions increase over time under the "Business-as-usual" scenario, GHG emissions intensities per capita decrease (see Table 8 below). The reason for this is that GHG emissions intensities are naturally "decoupled" from population growth due to efficiencies found in densification and shared services. Continued government policy, technological and behavioural change will likely further "decouple" GHG emissions from population growth. This emphasizes why it is important to set absolute GHG reduction targets to control actual emissions.

[9] Source: The City of Red Deer Population Projection Update 2007 – 2031 by Schollie Research and Consulting (2006).

**Figure 10: Red Deer's Forecast "Business-as-usual" GHG Emissions**

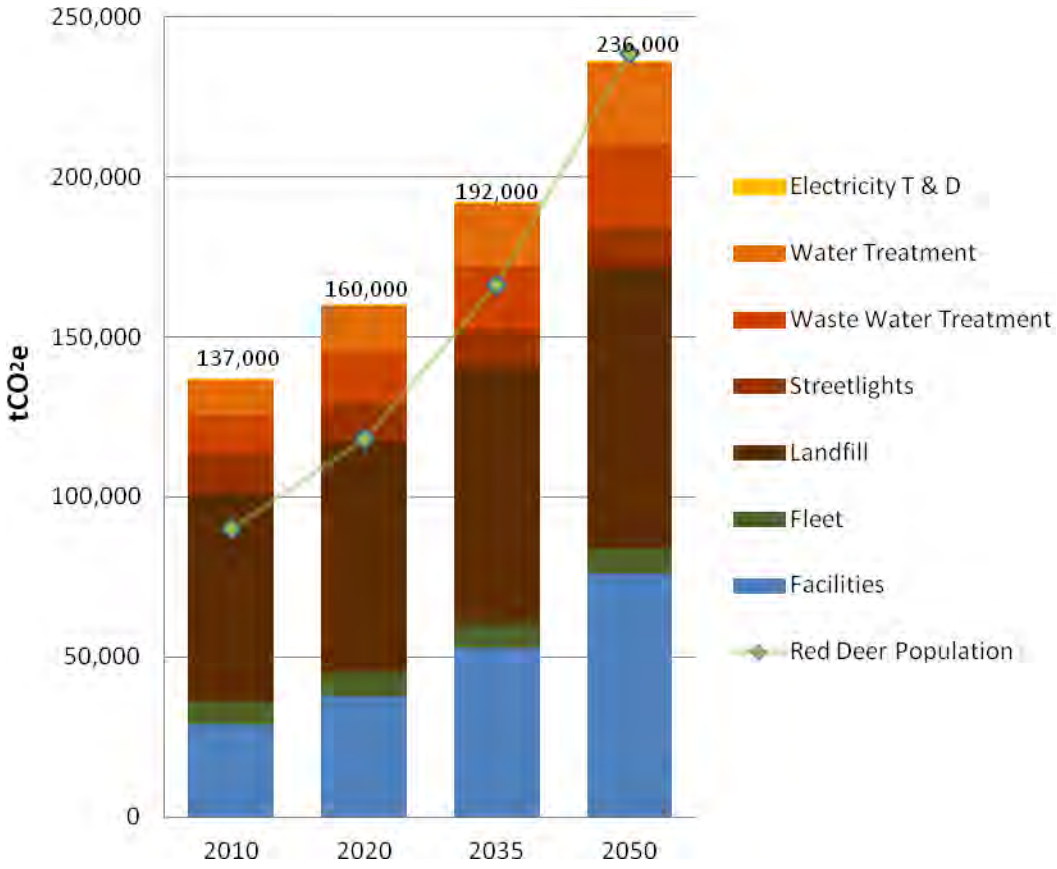



**Table 8: Forecast "Business-as-usual" GHG Emissions (Absolute and Per Capita)**

| Target Year | Projected Population | Forecast GHG Emissions | |
|---|---|---|---|
| | | **Absolute** ($tCO_2e$) | **Per Capita** ($tCO_2e$/capita) |
| **2010** | 90,000 | 137,000 | 1.5 |
| **2020** | 118,000 | 160,000 | 1.4 |
| **2035** | 166,000 | 192,000 | 1.2 |
| **2050** | 239,000 | 236,000 | 1.0 |

## 5.3 GHG Reduction Targets in Other Jurisdictions

Red Deer can use published GHG reduction targets in other jurisdictions to calibrate its proposed reduction targets.

Broad scientific consensus has identified 2°C above pre-industrial levels as the maximum temperature increase we can endure without dangerous climate change. For a chance of not exceeding this 2°C global limit, the United Nations Intergovernmental Panel on Climate Change has shown that developed countries need to reduce GHG emissions to 25 to 40% below 1990 levels by 2020 and 80 to 95% below 1990 levels by 2050.

At the 2009 UN Climate Change Conference in Copenhagen, Canada pledged to reduce GHG emissions to 17% below 2005 levels by 2020.[10] The Canadian Government has also stated a long-term goal of GHG emission reductions of 60 to 70% by 2050.[11]

Alberta set three GHG reduction targets in its 2008 Climate Change Strategy:

- By 2010: reduce GHG emissions 20Mt below "Business-as-usual", as per the intensity-based target established in its 2002 plan (22% improvement in emissions intensity between 1990 and 2010)
- By 2020: reduce GHG emissions 50Mt below "Business-as-usual"
- By 2050: reduce GHG emissions 200 Mt below "Business-as-usual", equivalent to an absolute reduction of 14% below 2005 levels[12]

Canadian municipal targets are generally in the range of 20-80% reduction over a 30-40 year time period (see Table 9 and Figure 11 below).

[10] National Inventory Report 1990-2010, Environment Canada. 2012.
[11] News Release, Government Delivers Details of Greenhouse Gas Regulatory Framework, Environment Canada, March 10, 2008.
[12] Alberta's 2008 Climate Change Strategy: Responsibility / Leadership / Action, Alberta Environment, 2008.

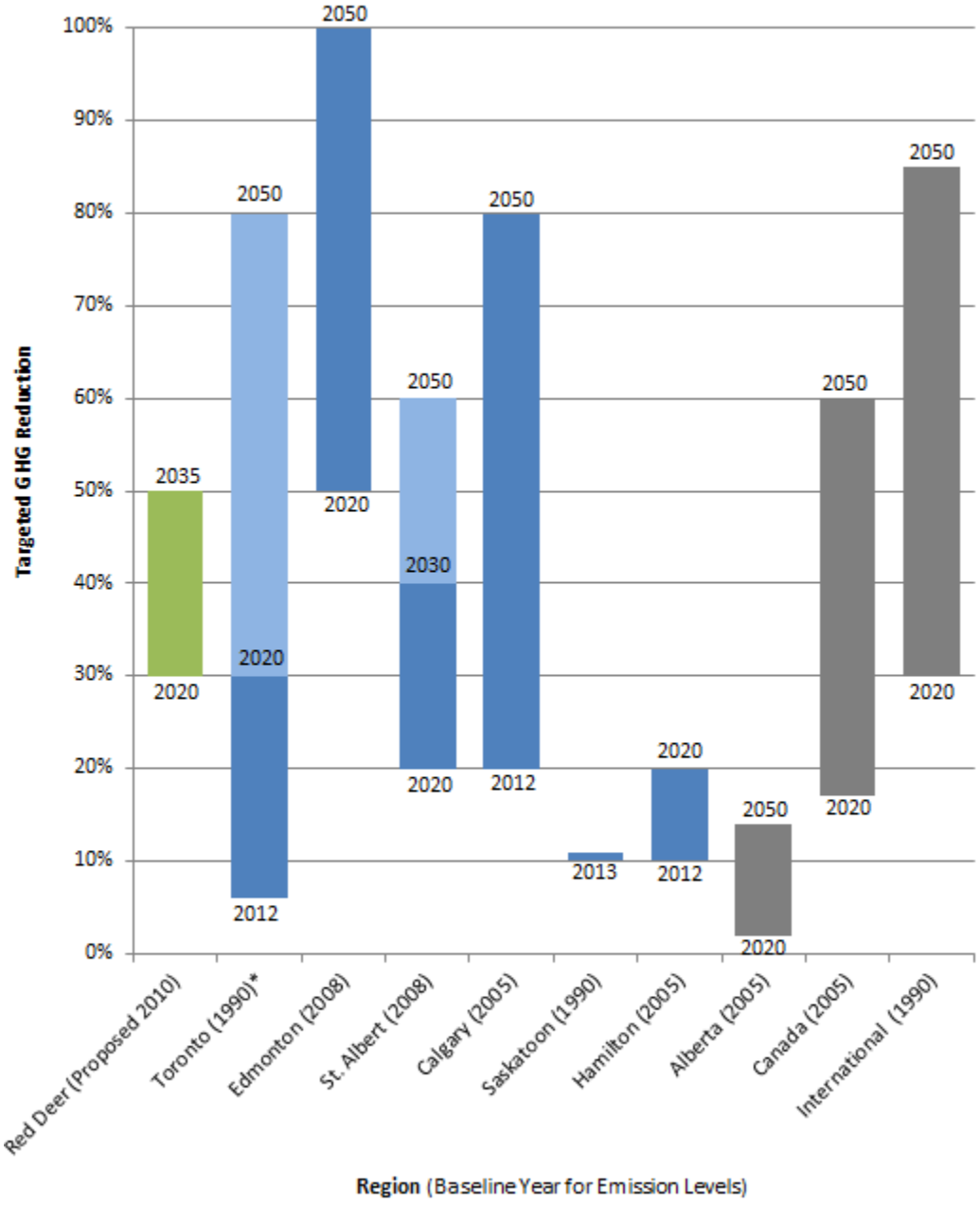
**Table 9: GHG Targets for Select Municipalities**

| City | Target Date | Target (% reduction) | Based on emission levels from year |
|---|---|---|---|
| **Toronto*** | 2012 | 6% | 1990 |
| | 2020 | 30% | 1990 |
| | 2050 | 80% | 1990 |
| **Edmonton** | 2020 | 50% | 2008 |
| | 2050 | Carbon Neutral | 2008 |
| **St. Albert** | 2020 | 20% | 2008 |
| | 2030 | 40% | 2008 |
| **Calgary** | 2020 | 20% | 2005 |
| | 2036 | 50% | 1990 |
| | 2050 | 80% | 2005 |
| **Saskatoon** | 2013 | 10% | 1990 |
| **Hamilton** | 2012 | 10% | 2005 |
| | 2020 | 20% | 2005 |

Sources: Information disclosed by municipalities.

*The City of Toronto has set community reduction targets that include corporate emissions; specific corporate GHG reduction targets have not been set.

**Figure 11: Range of GHG Targets in Other Jurisdictions**




*The City of Toronto's targets include community and corporate emissions.
Note: Summary GHG inventories for benchmarked municipalities are provided in Appendix G, and GHG emissions per capita are provided in Figure 7.

Similar to GHG emissions per capita (see Section 3.3.1), targets for corporate GHG reductions can be influenced by the municipality's operational boundary. If it includes large emissions sources that can be controlled, the municipality can set higher targets. For example, traditional buried landfills can contribute substantial amounts of GHG emissions to corporate inventories, but available methane capture technologies can significantly reduce these emissions. This means that municipalities with traditional buried landfills have significant carbon reduction potential.

Examples of GHG reduction strategies for three peer cities are presented in Table 10 below. While Lethbridge has not yet set GHG reduction targets, Toronto and Edmonton targets are analysed below to provide further insight.

**Table 10: Example Municipal GHG Reduction Strategies**

| City | Target Date | Target (% reduction) | Corporate GHG Reduction Strategies |
|---|---|---|---|
| **Toronto** | 2012 | 6% from 1990 levels* | ▸ Collect methane at remaining landfills<br>▸ Improve facilities' energy efficiency<br>▸ Use district heating and cooling system<br>▸ Transition to a green fleet<br>▸ Develop a green purchasing policy to further reduce emissions[13] |
| | 2020 | 30% from 1990 levels* | |
| | 2050 | 80% from 1990 levels* | |
| **Edmonton** | 2020 | 50% from 2008 levels | ▸ Improve facilities' energy efficiency<br>▸ Improve fleet emissions<br>▸ Upgrade streetlights<br>▸ Expand their urban forest<br>▸ Improve composting energy efficiency.<br>▸ Purchase renewable energy and carbon offsets.[14] |
| | 2050 | 100% from 2008 levels (Carbon Neutral) | |

* Combined corporate and community target. Toronto has not set specific corporate GHG reduction targets.

Moving forward, benchmarking your peers' strategies and discussing best practices with them can be an effective way to collaborate and share knowledge about reducing municipal GHG emissions.

[13] Greenhouse Gases and Air Pollutants in the City of Toronto: Towards a Harmonized Strategy for Reducing Emissions, ICF International, June 2007.
[14] City Operations GHG Management Plan: Supporting The Way We Green, Oct 2011.

## 5.4 Red Deer GHG Reduction Targets

As per the recommended GHG reduction strategies, we foresee a long term GHG management program where Red Deer starts to implement behavioural change and cost-effective energy efficiency initiatives while investigating opportunities for investing in renewable energy generation and low carbon technologies.

Given the reduction strategies presented in Section 4 and the scenario described in Figure 12, it appears viable to achieve a 30% absolute reduction by 2020 from 2010 GHG emission levels, assuming that:

- Emissions from facilities, water treatment, wastewater treatment and landfill grow as per assumptions in Section 5.1, equivalent to a 20% increase from 2010 levels
- Red Deer installs a co-generation unit at the WWTP
- Red Deer installs landfill methane capture technology, starting at the closed 1972 landfill (this landfill currently generates 65% of landfill-related emissions)
- Capital investment initiatives with longer implementation schedules (organics co-generation and other new WWTP technologies) are excluded

Similarly, we believe Red Deer could achieve an additional 20-30% absolute reduction by 2035 from 2010 GHG emission levels in the following scenario.

- Emissions from facilities, water treatment, wastewater treatment and landfill continue to grow as per assumptions in Section 5.1, equivalent to an additional 27% increase compared to 2010 levels
- Red Deer continues landfill methane capture initiatives at the active WMF landfill (this landfill currently generates 35% of landfill-related emissions)
- Capital is available to invest in organics co-generation and new WWTP technologies
- Red Deer invests in further low carbon technologies related to building energy efficiency, fuel switching, renewable energy generation, transportation, and waste and water management, as they become available and economically feasible

We have illustrated the 2020 and 2035 reduction strategy scenario in Figure 12 and Figure 13 below.

Based on this analysis we believe that reasonable GHG emissions reduction targets for Red Deer are:

- Reduce GHG emissions 30% below 2010 levels by 2020
- Reduce GHG emissions 50% below 2010 levels by 2035

**Figure 12: Pathway to 2020 GHG Reduction**

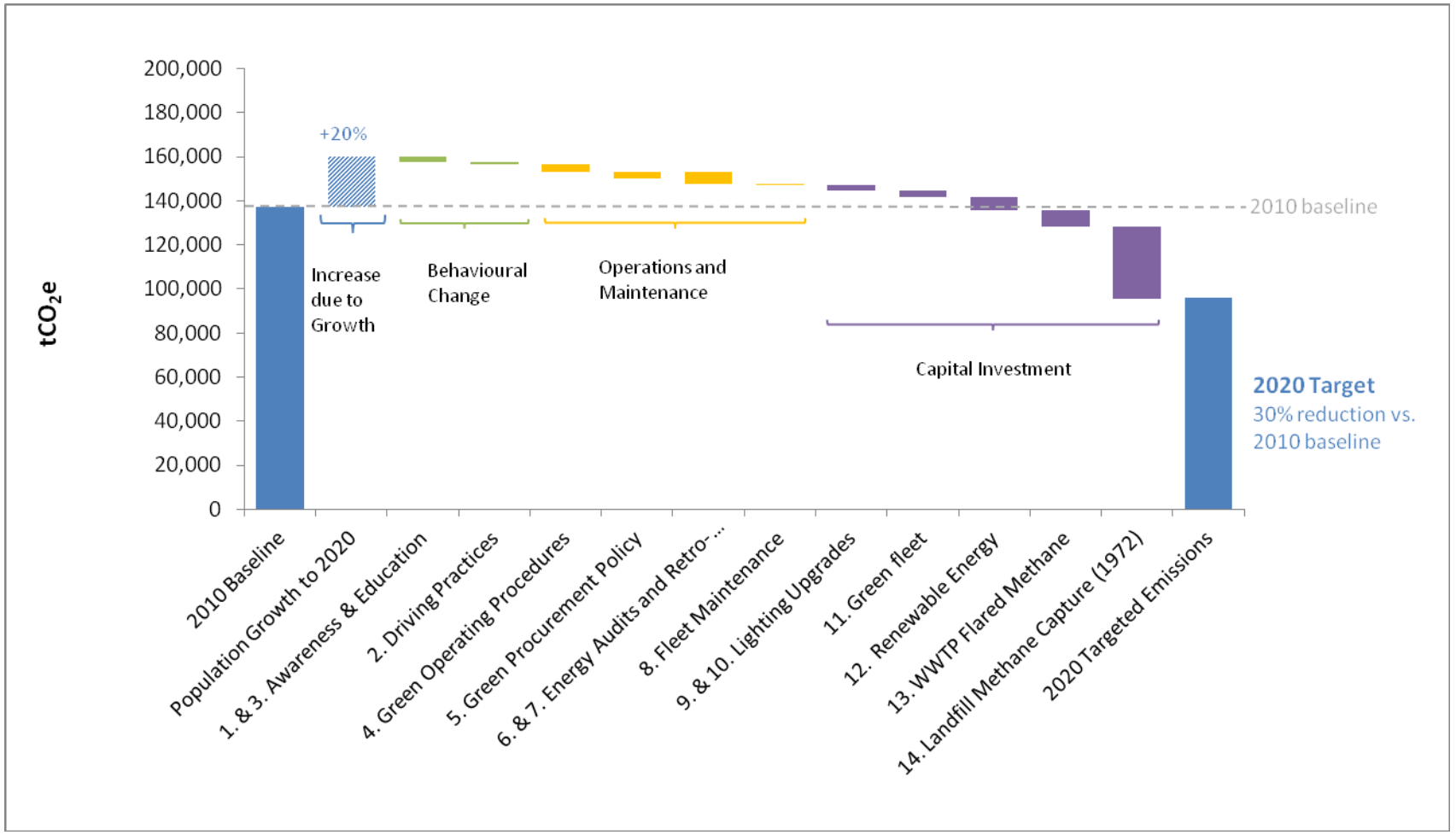
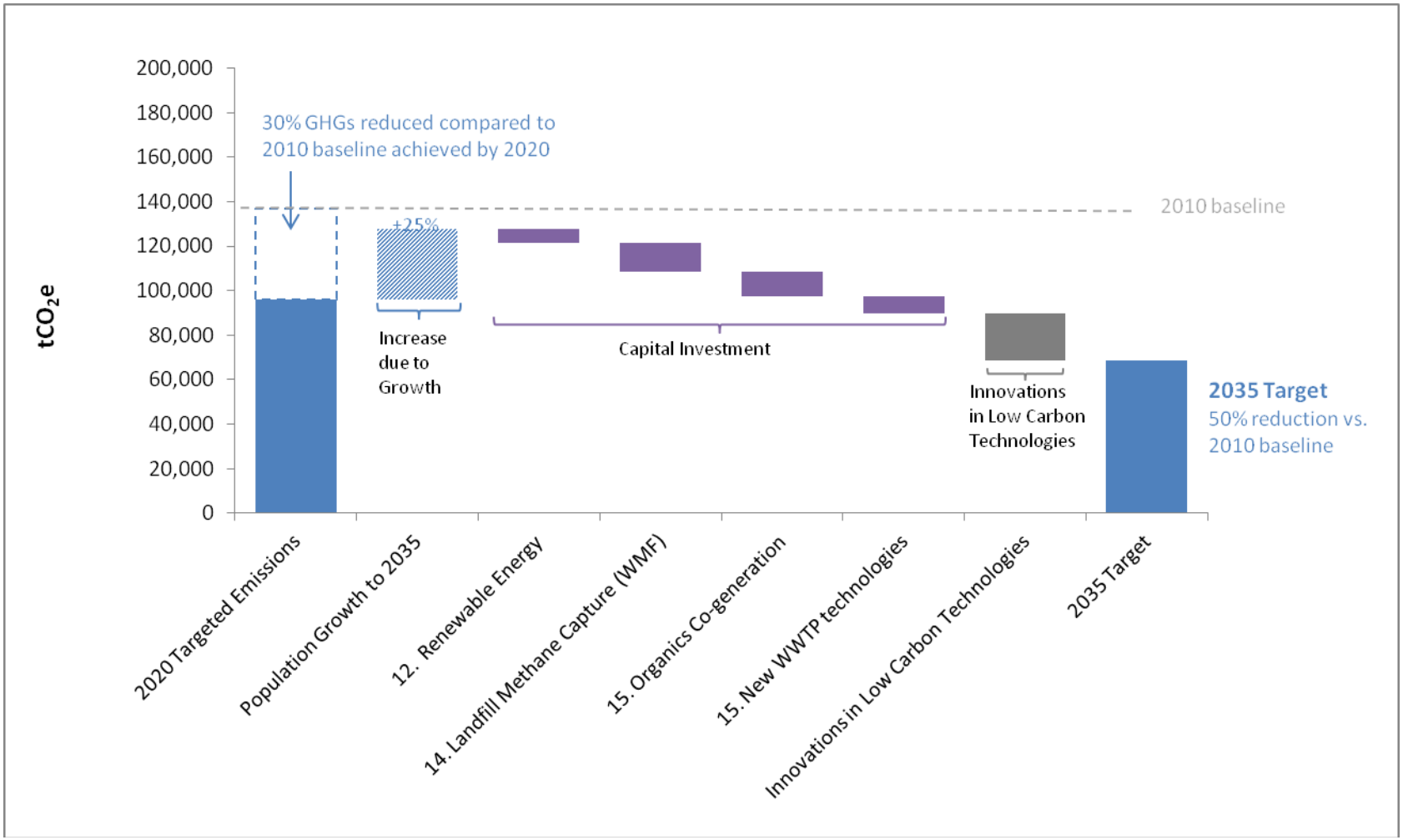


**Figure 13: Pathway to 2035 GHG Reduction**



The projected GHG emissions per capita equivalent to these absolute targets are presented in Table 11 below.

**Table 11: Red Deer Corporate GHG Reduction Targets**

| Target Year | Projected Population | Corporate GHG Reduction Targets | | Equivalent GHG Emissions Intensity | |
|---|---|---|---|---|---|
| | | Absolute ($tCO_2e$) | % Reduction based on 2010 levels | Per Capita* ($tCO_2e$/capita) | % Reduction based on 2010 levels |
| **2010** | 90,000 | 137,000 | - | 1.5 | - |
| **2020** | 118,000 | 96,000 | 30% | 0.8 | 50% |
| **2035** | 166,000 | 68,000 | 50% | 0.4 | 70% |

* GHG emissions per capita are based on population projections. Values associated with absolute GHG reductions will depend on actual population growth.

Although many GHG reduction initiatives may not be cost effective today, a changing regulatory landscape, energy cost increase, potential cost of carbon (permits or taxes), and technology change will change the economics of reduction initiatives along the way. Therefore, aspiring to reduce GHG emissions by 50% from 2010 levels by 2035 is not an unrealistic scenario.

## 5.5 Next Steps

For long-term purposes, modelling the overall Red Deer GHG footprint, reduction program and its high-level economics will be beneficial for achieving support of any proposed reduction program.

In the short-term, to support the implementation of the GHG reduction program, we recommend completing five year costed-carbon reduction plans to ensure sufficient budget, staff, approvals, and time for implementation to meet the desired targets. Results against plan should be reviewed annually.

The reduction plan can be complemented with a funding plan. This can include government incentives, private sector funding and strategies for internal resource allocation. For example, creating an energy efficiency fund which earmarks a set amount of capital towards emissions reduction through energy conservation measures is a common strategy to ensure sufficient annual funding for ongoing GHG reduction initiatives. The energy efficiency fund creates a mechanism where cost savings from early initiatives are earmarked towards further GHG reduction across the Red Deer reduction plan. When cost-effective energy conservation measures have been tapped out, remaining funds or additional funding can be dedicated towards renewable energy initiatives or carbon offsets that will further reduce The City's carbon footprint.

# 6 GHG INVENTORY RECOMMENDATIONS: CORPORATE EMISSIONS

A key component of a GHG management is to constantly improve the quality of GHG activity data. This will improve measurement quality and provide feedback on the GHG reduction program.

In our opinion, the overall quality of the Red Deer GHG activity data is good. There were minimal gaps in the data sets. Omissions were mainly related to a relatively small set of leased facilities.

In order to conform to GHG accounting standards, we investigated all potential activity data sources in the baseline GHG inventory. For example, we included collection of HFCs, PFCs and $SF_6$ in the data collection.

There were no GHG-classified refrigerants reported and only a very small amount of $SF_6$ associated with electricity transmission and distribution. As the associated GHG emissions account for less than 1% of Red Deer's overall GHG inventory, they are not considered material by the CSA/ISO standard. As it takes considerable effort to collect this data, we do not believe it is necessary for Red Deer to collect this data in subsequent years. Emissions from these sources can be estimated based on the 2010 inventory quantities.

Based on our experience, we believe that Red Deer can continue to strengthen GHG activity data measurement through the following actions:

1. **Allocate responsibility for and continue to use Loop's GHG inventory tool:** As a project deliverable, we will provide Red Deer with our GHG inventory data collection and calculation tool. We encourage you to maintain this as it will help you regularly update your GHG inventory and easily be able to compare annual results.

2. **Collect utility data for leased properties**: Around 8% of the GHG inventory emissions are estimated based on portfolio consumption averages. To refine the accuracy of the GHG inventory, we recommend obtaining electricity and natural gas consumption data for all leased properties. This will also benchmark high consuming properties that may benefit from retrofits, resulting in GHG emission reductions. Data can be obtained from lessees or by obtaining tenants' consent to directly request data from energy providers.

3. **Investigate consumption at sites with very high or very low energy intensity:** Prior to establishing the 2011 GHG inventory, properties with anomalous trends in carbon emissions and energy should be investigated to correct any potential errors (see Table 1 for the facilities with the highest energy intensity). Errors can be due to incorrect meter readings or data entry, but also indicate underlying energy and GHG reduction opportunities.

4. **Expand scope 3 emissions measurement and reporting:** Leading Canadian organizations typically include corporate waste output, employee commuting and

business travel in their GHG inventories. We suggest that in anticipation of next year's GHG inventory, Red Deer implement corporate processes to collect appropriate activity data. This can be done through waste audits and as a part of expense reporting and employee surveys.

5. **Obtain third party verification**: GHG emissions measurement and reporting is an indication of progressive management. To position Red Deer as a sustainable organization and environmental leader, we recommend obtaining third party GHG inventory verification by an independent third party every 2-3 years.

6. **Use this Corporate GHG Inventory as a guideline to develop a City of Red Deer Community GHG Inventory**: After completing the "corporate" inventory you will have an improved understanding of GHG emissions drivers and data sources, which you can leverage in your development of a "community" inventory. However, there will be differences in data collection methodologies as a corporate inventory has a high level of actual data, while a community inventory relies more on surveying and sampling of homes and businesses' energy use, vehicle use, travel habits, agricultural practices, etc.

# APPENDIX A 2010 GREENHOUSE GAS INVENTORY

## Table A1: 2010 Greenhouse Gas Inventory

| Fuel Type | Activity | Unit | Emissions Factor | Unit | Emissions | Unit |
|---|---|---|---|---|---|---|
| **Scope 1: Direct Emissions** | | | | | | |
| **Natural Gas** | | | | | | |
| **Alberta** | 6,210,735 | m3 | | | | |
| Carbon Dioxide | | | 1,918 | $gCO_2/m3$ | 11,912 | $tCO_2e$ |
| Methane | | | 0.037 | $gCH_4/m3$ | 5 | $tCO_2e$ |
| Nitrous Oxide | | | 0.035 | $gN_2O/m3$ | 67 | $tCO_2e$ |
| **Total Natural Gas** | | | | | **11,984** | **$tCO_2e$** |
| **Diesel** | | | | | | |
| **Canada** | 100,662 | L | | | | |
| Carbon Dioxide | | | 2,663 | g $CO_2$/L | 268 | $tCO_2e$ |
| Methane | | | 0.133 | g $CH_4$/L | 0 | $tCO_2e$ |
| Nitrous Oxide | | | 0.4 | g $N_2O$/L | 12 | $tCO_2e$ |
| **Total Diesel** | | | | | **281** | **$tCO_2e$** |
| **Propane** | | | | | | |
| **Canada** | 128 | L | | | | |
| Carbon Dioxide | | | 1,510 | g $CO_2$/L | 0.2 | $tCO_2e$ |
| Methane | | | 0.027 | g $CH_4$/L | 0.0 | $tCO_2e$ |
| Nitrous Oxide | | | 0.108 | g $N_2O$/L | 0.0 | $tCO_2e$ |
| **Total Propane** | | | | | **0.2** | **$tCO_2e$** |
| **Refrigerants** | | | | | | |
| **Canada** | | | | | | |
| SF6 | 0.01 | kg | 23,900 | g $CO_2e$/kg | 0.0001 | $tCO_2e$ |
| **Total Refrigerants** | | | | | **0** | **$tCO_2e$** |
| **Fleet Vehicles** | | | | | | |
| **Canada** | | | | | | |
| **Light Duty Gas Vehicles** | 620,200 | L | | | | |
| Carbon Dioxide | | | 2,289 | g $CO_2$/L | 1,420 | $tCO_2e$ |
| Methane | | | 0.12 | g $CH_4$/L | 2 | $tCO_2e$ |
| Nitrous Oxide | | | 0.16 | g $N_2O$/L | 31 | $tCO_2e$ |
| **Canada** | | | | | | |
| **Diesel Vehicles** | 2,234,472 | L | | | | |
| Carbon Dioxide | | | 2,663 | g $CO_2$/L | 5,950 | $tCO_2e$ |
| Methane | | | 0.051 | g $CH_4$/L | 2 | $tCO_2e$ |
| Nitrous Oxide | | | 0.22 | g $N_2O$/L | 152 | $tCO_2e$ |
| **Total Fleet Vehicles** | | | | | **7,557** | **$tCO_2e$** |

| Fuel Type | Activity | Unit | Emissions Factor | Unit | Emissions | Unit |
|---|---|---|---|---|---|---|
| **Wastewater Treatment Plant** (natural gas excluded, accounted for above) | | | | | | |
| **Canada** | | | | | | |
| Methane | 134 | tonnes | 21 | $tCO_2e$/tonne | 2,824 | Methane |
| Nitrous Oxide | 0.3 | tonnes | 310 | $tCO_2e$/tonne | 106 | NitrousOxide |
| **Total Wastewater Treatment Plant** | | | | | **2,930** | **$tCO_2e$** |
| **Landfill** | | | | | | |
| **WMF Landfill** | | | | | | |
| Area ($m^2$) | 68,700 | | | | | |
| Age in 2010 | 11 | | | | | |
| Accumulated tonnes in 2010 | 929,257 | | | | | |
| Volume ($m^3$) | 1,429,625 | | | | | |
| Methane | 1,076 | tonnes | 21 | $tCO_2e$/tonne | 22,602 | $tCO_2e$ |
| **1972 Landfill** | | | | | | |
| Area ($m^2$) | 356,000 | | | | | |
| Age in 2010 | 40 | | | | | |
| Accumulated tonnes in 2010 | 1,629,061 | | | | | |
| Volume ($m^3$) | 2,715,102 | | | | | |
| Methane | 2,016 | tonnes | 21 | $tCO_2e$/tonne | 42,343 | $tCO_2e$ |
| **Total Landfill** | | | | | **64,945** | **$tCO_2e$** |
| **Scope 2: Indirect Emissions** | | | | | | |
| **Electricity** | | | | | | |
| **Alberta** | 51,508,817 | kWh | | | | |
| Carbon Dioxide | | | 950 | g $CO_2$/kWh | 48,933 | $tCO_2e$ |
| Methane | | | 0.04 | g $CH_4$/kWh | 43 | $tCO_2e$ |
| Nitrous Oxide | | | 0.02 | g $N_2O$/kWh | 319 | $tCO_2e$ |
| **Total Electricity** | 51,508,817 | kWh | | | **49,296** | **$tCO_2e$** |
| **Total** | | | | | | |
| **Total Scope 1** | | | | | **87,698** | **$tCO_2e$** |
| **Total Scope 2** | | | | | **49,296** | **$tCO_2e$** |
| **Total Scope 3** | | | | | **-** | **$tCO_2e$** |
| **Total Emissions** | | | | | **136,994** | **$tCO_2e$** |

# APPENDIX B DEFINITIONS AND CLARIFICATIONS

**Accounting Standard:** There are two leading international standards for the quantification of GHG emissions: the CSA/ISO 14064-1-06 Greenhouse Gases - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals, and the WBCSD/WRI standard Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. Loop completed Red Deer's GHG inventory and reporting in accordance with the CSA/ISO 14064-1 standard. Reporting content required by the CSA/ISO standard is presented in Appendix C.

In producing this GHG inventory report, the following five principles set out by the GHG Protocol Corporate Standard on GHG accounting and reporting were followed[15]:

- **Relevance:** This GHG inventory appropriately reflects Red Deer's GHG emissions and serves the needs of its decision-makers to provide a knowledge base from which to set targets and select reduction strategies.
- **Completeness:** Loop has accounted for all GHG emission sources and activity within Red Deer's chosen boundary. It discloses and justifies any exclusions of emissions sources.
- **Consistency:** Loop has produced this report using consistent methodologies to enable meaningful comparisons of GHG emissions over time. Any changes to the methodology will be documented in future inventories.
- **Transparency:** Loop has produced this report in a factual and coherent manner. Any assumptions are stated and calculation methodologies are referenced to ensure transparency.
- **Accuracy:** The quantification of Red Deer's emissions is a true reflection of actual emissions based on the data and estimation methodologies used.

**Carbon Emissions:** see Greenhouse Gas Emissions.

**Emissions Factors:** An emission factor is defined as the average emission rate of a given GHG for a given source, relative to units of activity.

**Greenhouse Gas (GHG) Emissions ("Carbon"):** Greenhouse gases trap energy in the atmosphere and are the primary driver of climate change and global warming. The United Nations Intergovernmental Panel on Climate Change (IPCC) defines six gases under this category: carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs – a family of gases), fluorocarbons (PFCs – another family of gases) and sulfur hexafluoride ($SF_6$). Carbon emissions are measured in the unit "carbon dioxide equivalent" ($CO_2e$) and expressed in metric tonnes ($tCO_2e$) or kilograms ($kgCO_2e$).

**Carbon Intensity ($kgCO_2e$/sq.ft.):** This metric provides an opportunity to compare carbon emissions from facilities in normalized terms of total carbon emissions per facility area (similar to energy intensity).

[15] Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. World Business Council for Sustainable Development and World Resources Institute 2004.

**GHG Inventory ("carbon inventory", "carbon footprint"):** This lists a municipality's sources[16] of GHG emissions and quantity of emissions released from each source during a reporting period. The inventory provides information about the major sources of emissions and identifies how the GHG inventory has changed over a one-year time period. It also reveals opportunities for emission reductions. This information can also be used to communicate Red Deer's carbon reduction efforts and overall "green" strategy to citizens, employees, businesses, community organizations, and government bodies. Loop Initiatives prepared this inventory in accordance with the CSA/ISO 14064-1 standard (also compatible with the WBCSD/WRI "GHG Protocol").

**ICLEI Greenhouse Gas Reporting Protocol**: International Council for Local Environmental Initiatives GHG reporting protocol identifies a number of municipal operations that are typically included in a City Operations' GHG Inventory, including wastewater and water treatment. Loop Initiatives followed these guidelines.

**Inventory Methodology:** Loop followed its GHG inventory process to prepare Red Deer's GHG inventory report:

- Assess Red Deer's needs, understand drivers for GHG management, and operations/organizational structure;
- Select boundaries and emissions sources and scopes;
- Collect carbon emissions data;
- Calculate GHGs in accordance with the CSA/ISO 14064-1-06;
- Recommend GHG reduction strategies; and
- Produce report containing management information (emissions by scope and source, and carbon-intensity metrics).

**Facilities:** Refers to Red Deer's legislative and governance offices, neighbourhood community centres, recreation and cultural facilities (arenas, museums, pools and parks), public works buildings (garage, maintenance, and storage), emergency services buildings (fire halls), and residential buildings (community and senior housing).

**Municipal Operations:** Refers to Red Deer's water treatment and distribution, wastewater treatment, landfill, electricity transmission and distribution, streetlights (including traffic lights and site lighting), and vehicle fleet.

**Operational Control:** See organizational boundary.

**Organizational Boundary:** An organizational boundary refers to the various legal and organizational structures that exist, and determines how GHG emissions are attributed to the company. The organizational boundary is defined as one of three approaches[17]:

- Equity share approach: accounts for GHG emissions based on share of equity in the operation

[16] Examples of GHG sources include: boilers (natural gas combustion), electricity production (mixed fossil fuel combustion), automobiles (gasoline combustion), etc.; see definition of scopes.
[17] Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard. World Business Council for Sustainable Development and World Resources Institute 2004.

- Financial control approach: accounts for GHG emissions based on the financial control over the operation
- Operational control approach: accounts for GHG emissions based on the control of operations

**Reporting period:** The reporting period is defined as the one-year duration for which the quantity of GHG emissions from all sources is calculated.

**Baseline year:** the year the first inventory was calculated.

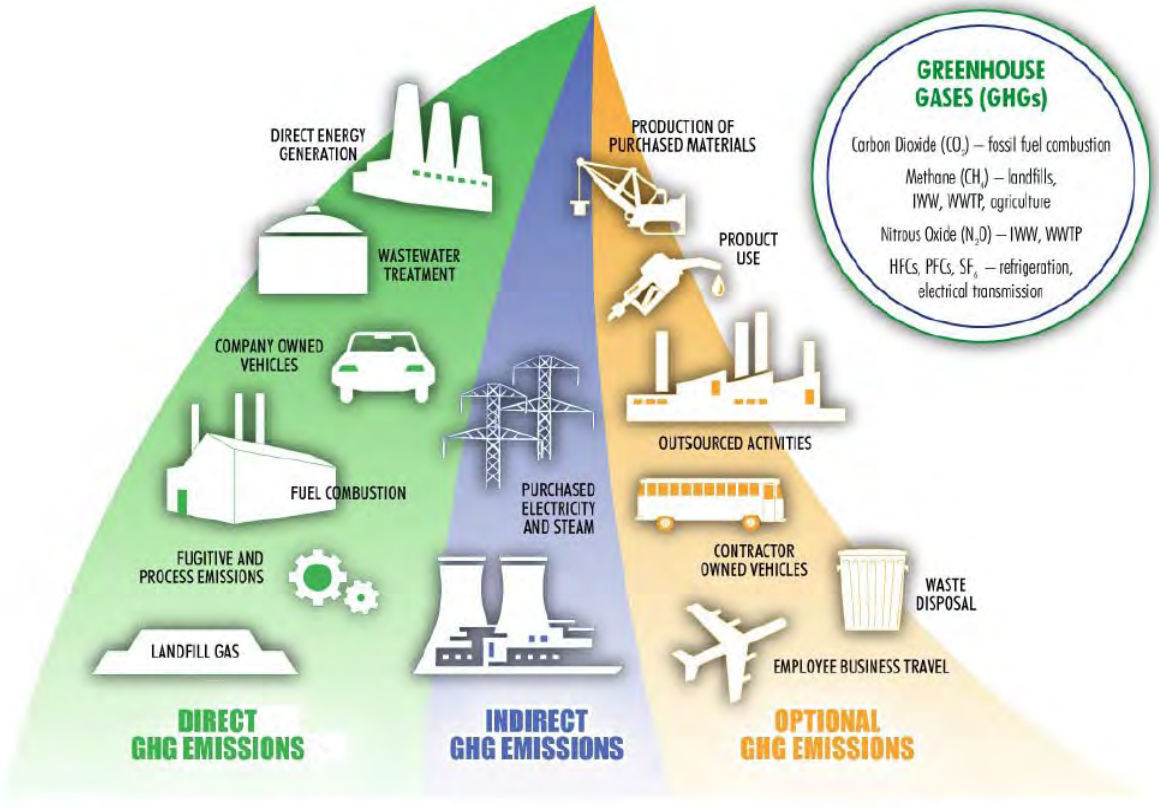
**Scopes (Scope 1, 2 and 3):** A GHG Inventory is comprised of emissions from different activity sources originated from within and outside of the organization. Typically, these sources are grouped into the following three scopes:

- **Scope 1:** Direct emissions that are released from sources controlled by the organization. These include emissions from boiler, furnaces or vehicle combustion, refrigerant leakage from chiller equipment and methane emissions from biogenic processes.
- **Scope 2:** Indirect emissions that are released by the generation of electricity, cooling, heat and steam purchased by the organization (energy indirect emissions).
- **Scope 3:** Other indirect emissions that are released from sources that are not controlled by the organization, but result from activity required for the organization to operate.

Common practice for voluntary GHG reporting is to, at minimum, include scopes 1 and 2, while leaders proactively include select scope 3 emissions in their inventories.

The figure below summarizes GHG emitting activities by scope that can be included in a GHG inventory

**Figure B1: Emission Sources**




Source: Greenhouse Gas Protocol, 2008

# APPENDIX C INVENTORY QUALITY

## Estimation of Uncertainty[18]

A degree of uncertainty exists in any GHG accounting assessment. GHG accounting is not yet an established practice; therefore the methods for collecting data and quantifying emissions continue to evolve as the practice evolves. As Red Deer integrates carbon management into its existing business processes, record keeping procedures will continue to improve, thus positively affecting the quality of GHG information in future inventories.

Table C1 presents our opinion of the level of uncertainty related to this GHG inventory. Our opinion of uncertainty is based on *Table 3: Certainty Ranking for Common Emission Sources*, found in "Measurement and Estimation Uncertainty of GHG Emissions" by the Greenhouse Gas Protocol Initiative.

**Table C1: Certainty Assessment**

| Major Emission Category | Certainty Assessment |
|---|---|
| Natural Gas | High – Red Deer submitted direct metered natural gas data from its utility provider. Natural gas emission factors are less dependent on location and are almost always standard and accurate. |
| Diesel | Fair – Uncertainty may be derived from errors/omissions due to Red Deer's self-reporting. Emission factors for diesel are established and published annually by Natural Resources Canada. |
| Refrigerants | Fair – Uncertainty may be derived from errors/omissions due to Red Deer's self-reporting. Emission factors for refrigerants are established and published by the United Nations' Intergovernmental Panel on Climate Change. |
| Electricity | High – Red Deer submitted direct metered electricity data from its utility provider. Emission factors are based on an annual provincial grid average, containing multiple fuel sources such as coal, natural gas, hydro and nuclear. |
| Wastewater Treatment Plant | Fair –Wastewater treatment plant methane production and capture data are provided by Red Deer's WWTP monthly boiler reports. Guidelines for estimating methane emissions are established in Volume 5: Chapter 6 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. |
| Landfill | Fair – Annual accumulated landfill data are provided by Red Deer. Methane emissions are estimated using guidelines established in Volume 5: Chapter 4 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Calculations follow the Government of Alberta's Technical Guidance for the Quantification of Specified Gas Emissions from Landfills (November 2008). |

[18] *Measurement and Estimation Uncertainty of GHG Emissions.* 2003, The Greenhouse Gas Protocol Initiative.

| Major Emission Category | Certainty Assessment |
|---|---|
| Fleet | High – Gasoline and diesel consumption data was provided by Red Deer's accounting system. Vehicle data was provided exclusively in litres, which is preferable to kilometres. Data was checked to ensure fuel consumption corresponded to reasonable equivalent distance in kilometres. Emission factors for gasoline and diesel are established and published annually by Natural Resources Canada. |

**Roles and Responsibilities**

In an effort to create a credible GHG inventory, the following roles and responsibilities were assigned to ensure consistency, accuracy, completeness, transparency and conformance with CAN/CSA-ISO Standard 14064-1-06.

| Name | Role | Organization |
|---|---|---|
| Lauren Maris | Environmental Program Specialist | City of Red Deer |

Responsibilities:

- To oversee the establishment of Red Deer's GHG inventory by Loop Initiatives.
- To provide Loop Initiatives with activity data; and
- To liaise with Loop Initiatives to clarify data questions, identify and account for anomalies and quality check submitted data.

| Name | Role | Company |
|---|---|---|
| Francisca Quinn | Project Director | Loop Initiatives Inc. |
| Jia Shin | Project Manager | Loop Initiatives Inc. |
| Morghain Gibbons | Project Analyst | Loop Initiatives Inc. |

Responsibilities:

- To advise on accounting standard and overall determination of organizational boundaries, operational boundaries, scopes and sources;
- To request and analyze received data for acceptable accuracy/completeness;
- To collect appropriate emission factors and perform GHG calculations;
- To identify and prioritize carbon emissions reduction initiatives.
- To produce a report consistent with the CAN/CSA-ISO Standard 14064-1-06; and
- To present findings and carbon reduction recommendations to Red Deer.

# APPENDIX D ACTIVITY DATA

Activity data was collected by Loop Initiatives using the methodology summarized in Table D1.

**Table D1: Activity Data**

| Activity Data | Collection Methodology |
|---|---|
| Electricity, natural gas, diesel, propane, refrigerants | Red Deer self-reported and submitted direct metered electricity and natural gas data. Back up fuels (diesel, propane) and refrigerant activity data were provided to Loop using Loop's data collection tool. |
| City-owned and operated vehicles | Red Deer uses one contractor for their vehicle fuel services. Red Deer reported litres of fuel consumed by its fleet of vehicles using data collected in their accounting system. |
| Wastewater Treatment Plant | Red Deer provided wastewater treatment plant methane capture data via monthly WWTP boiler reports. Red Deer also provided 2012 municipal population that was used to calculate residual sludge methane emissions. |
| Landfill | Red Deer provided annual accumulated landfill tonnage and area data in a Specified Gas Emissions Regulation submission previously completed for the Government of Alberta (year 2010). |
| Fleet | Red Deer provided gasoline and diesel consumption data as recorded by their accounting system. |

# APPENDIX E EMISSION FACTORS

Table E1 summarizes the emission factors and sources used in the calculations completed for Red Deer's GHG inventory.[19]

## Table E1: Emission Factors

**CARBON EMISSIONS FACTORS**

| GWP | | |
|---|---|---|
| | $CO_2$ | 1 |
| | $CH_4$ | 21 |
| | $N_2O$ | 310 |

**UTILITIES**

| Type | Province | Emission Factor | Unit | Year | Source | gCO2e/unit | unit |
|---|---|---|---|---|---|---|---|
| Electricity[1] | Alberta | 950 | g $CO_2$/kWh | 2008 | Canada's National Inventory Report 1990-2009, Part 3, Annex 13, Table A13-2, written in 2011 | 957.0 | g $CO_2$e/kWh |
| | | 0.04 | g $CH_4$/kWh | 2008 | Canada's National Inventory Report 1990-2009, Part 3, Annex 13, Table A13-2, written in 2011 | | |
| | | 0.02 | g $N_2O$/kWh | 2008 | Canada's National Inventory Report 1990-2009, Part 3, Annex 13, Table A13-2, written in 2011 | | |
| | | 2.373 | g $SO_2$/kWh | 2006 | NPRI On-line data, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 1.626 | g $NO_X$/kWh | 2006 | CAC Air Pollutant Emissions Spreadsheet, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 0.046 | g PM2.5/kWh | 2006 | CAC Air Pollutant Emissions Spreadsheet, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 0.097 | g PM10/kWh | 2006 | CAC Air Pollutant Emissions Spreadsheet, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 0.013 | g VOC/kWh | 2006 | CAC Air Pollutant Emissions Spreadsheet, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 1.48E-05 | g Hg/kWh | 2006 | NPRI On-line data, Environment Canada and Canada's National Inventory Report 1990-2006, Annex 12, written in 2008 | | |
| | | 0 | kg uranium waste/kWh | 2008 | Canadian Nuclear Association (CAN) Nuclear Fact: "What does nuclear energy mean to Canada?" Canada's National Inventory Report 1990-2006, Annex 9, written in 2008 | | |
| Natural Gas | Alberta | 1.91800 | kg $CO_2/m^3$ | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | 1.9 | kg $CO_2e/m^3$ |
| | | 0.00004 | kg $CH_4/m^3$ | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| | | 0.00004 | kg $N_20/m^3$ | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| Diesel | Canada | 2663.000 | g $CO_2$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | 2789.8 | g $CO_2$e/L |
| | | 0.133 | g $CH_4$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| | | 0.400 | g $N_2O$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| Light Fuel Oil | Canada | 2725 | g $CO_2$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | 2738.4 | g $CO_2$e/L |
| | | 0.18 | g $CH_4$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| | | 0.031 | g $N_2O$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| Propane | Canada | 1510 | g $CO_2$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | 1544.0 | g $CO_2$e/L |
| | | 0.027 | g $CH_4$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |
| | | 0.108 | g $N_2O$/L | 2009 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2011 | | |

**VEHICLES**

| Type | Location | Emission Factor | Unit | Year | Source | $CO_2$e/unit | unit |
|---|---|---|---|---|---|---|---|
| Tier 1 Gasoline | **Canada** | 2289 | g $CO_2$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | 2341.1 | g $CO_2$e/L |
| | | 0.12 | g $CH_4$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | | |
| | | 0.16 | g $N_2O$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | | |
| Light Duty Diesel Automobile | **Canada** | 2663 | g $CO_2$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | 2732.3 | g $CO_2$e/L |
| | | 0.051 | g $CH_4$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | | |
| | | 0.22 | g $N_2O$/L | 2008 | Canada's National Inventory Report 1990-2009, Annex 8, written in 2010 | | |

[19] For definitions of emission factors and sources, please see "Definitions and Clarifications" in Appendix B.

**REFRIGERANTS**

| Gas | Chemical Fo | GWP | Unit | Year | Source |
|---|---|---|---|---|---|
| HFC-125 | $C_2HF_5$ | 2,800 | | 2006 | ISO 14064-1Part 1 Specification with guidance at the organization level for quantification and reporting of GHG emissions and removals, Annex C, 2006 |
| HFC-134 | $C_2H_2F_4$ ($CHF_2$( | 1,000 | | 2006 | ibid. |
| HFC-134a | $C_2H_2F_4$ ($CHF_2$F | 1,300 | | 2006 | ibid. |
| HFC-143 | $C_2H_3F_3$ ($CHF_2$( | 300 | | 2006 | ibid. |
| HFC-143a | $C_2H_3F_3$ ($CF_3$CH | 3,800 | | 2006 | ibid. |
| HFC-152a | $C_2H_4F_2$ ($CH_3$Cl | 140 | | 2006 | ibid. |
| HFC-227ea | $C_3HF_7$ | 2,900 | | 2006 | ibid. |
| HFC-23 | $CHF_3$ | 11,700 | | 2006 | ibid. |
| HFC-236fa | $C_3H_2F_6$ | 6,300 | | 2006 | ibid. |
| HFC-245ca | $C_3H_3F_5$ | 560 | | 2006 | ibid. |
| HFC-32 | $CH_2F_3$ | 650 | | 2006 | ibid. |
| HFC-41 | $CH_3F$ | 150 | | 2006 | ibid. |
| HFC-43- | $C_5H_2F_{10}$ | 1,300 | | 2006 | ibid. |
| HFE-7200 | $C_4F_9OC_2H_5$ | 100 | | 2006 | ibid. |
| Perfluorobut | $C_4F_{10}$ | 7,000 | | 2006 | ibid. |
| Perfluorocyc | c-$C_4F_8$ | 8,700 | | 2006 | ibid. |
| Perfluoroeth | $C_2F_6$ | 9,200 | | 2006 | ibid. |
| Perfluorohex | $C_6F_{14}$ | 7,400 | | 2006 | ibid. |
| Perfluoromet | $CF_4$ | 6,500 | | 2006 | ibid. |
| Perfluoropen | $C_5F_{12}$ | 7,500 | | 2006 | ibid. |
| Perfluoropro | $C_3F_8$ | 7,000 | | 2006 | ibid. |
| Sulfur | $SF_6$ | 23,900 | | 2006 | ibid. |

# APPENDIX F CSA/ISO-REQUIRED INFORMATION

## REPORTING INFORMATION

The following table provides a summary of the reporting information required by CAN/CSA-ISO 14064-1-06 - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. Information provided in the "declaration" column is Red Deer's assertion for this inventory.

**Table F1: Summary of the Reporting Information**

| No. | CSA Reporting Requirement | Declaration |
|---|---|---|
| A | Description of the reporting organization. | Red Deer is a municipality (population of 90,084 in 2010) that operates appr. 200 buildings (186,000 total sq.ft.) and 450 vehicles in Alberta, Canada. This corporate GHG inventory was developed as part of Red Deer's initiative to further understand the climate change impact of its operations, identify GHG reduction opportunities, and develop targets and an action plan to reduce GHG emissions. Red Deer's GHG inventory includes GHGs emitted through its use of natural gas, diesel, electricity, gasoline and propane; refrigerant leakage; and emissions from landfill waste and wastewater treatment. |
| B | Person responsible. | Lauren Maris, Environmental Program Specialist, The City of Red Deer |
| C | Reporting period covered. | January 1, 2010 to December 31, 2010 |
| D | Documentation of organizational boundary | Operational control approach. |
| E | Direct GHG emissions, quantified separately for each GHG, in tonnes of $CO_2e$ | See Appendix A |
| F | A description of how $CO_2$ emissions from the combustion of biomass are treated in the GHG inventory. | Not applicable to this inventory. Flared methane is not included as per Volume 5: Chapter 6 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. |
| G | If quantified, GHG removals quantified in tonnes of $CO_2e$ | Not applicable to this inventory |
| H | Explanation for the exclusion of any GHG sources or sinks from quantifications. | This inventory includes all Scope 1 and Scope 2 GHG emissions.<br>No Scope 3 emissions were included in this inventory.<br>No carbon sinks were included in this inventory. |
| I | Energy indirect GHG emissions associated with the generation of imported electricity, heat or steam, quantified separately in tonnes of $CO_2e$. | See Appendix A |
| J | The historical base year selected and the base-year GHG inventory | Baseline year: 2010 |

| No. | CSA Reporting Requirement | Declaration |
|---|---|---|
| K | Explanation of any change to the base year or other historical GHG data, and any recalculation of the base year or other historical GHG inventory. | Emissions from landfill waste and wastewater treatment plant sludge were calculated using IPCC methodology. |
| L | Reference to, or description of, quantification methodologies including reasons for their selection. | Calculations are based on GHG activity data multiplied by GHG emission factors. Canadian emission factors have been used wherever possible. |
| M | Explanation of any changes to quantification methodologies previously used. | Not applicable to this inventory. |
| N | Reference to, or documentation of, GHG emission or removal factors used. | See Appendix E for details. |
| O | Description of the impact of uncertainties on the accuracy of the GHG emissions and removals data. | Uncertainties in calculations include error margins in emissions factors and self-reported/estimated activity data. Emission factors were determined by the most local and credible sources available at the time of reporting. Scope 1 and Scope 2 activity data is based on metered data and self-reported consumption and corporate automobile use. Waste/wastewater methane emissions were calculated using provided data in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories. |
| P | A statement that the GHG report has been prepared in accordance with ISO 14064-1. | This report has been prepared in accordance with the following standard: CAN/CSA-ISO 14064-1-06 - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals. |
| Q | A statement describing whether the GHG inventory, report or assertion has been verified, including the type of verification and level of assurance achieved | At the date of issue, this GHG inventory has not been verified by a third party. |

## GHG INFORMATION MANAGEMENT

*NOTE: The information provided below is intended to summarize CSA requirements and suggestions for maintaining credible GHG inventory and reporting activities. Red Deer may use this information to guide them in these activities. For additional information Red Deer should consult Loop Initiatives or refer to the following CSA standard: CAN/CSA-ISO 14064-1-06 - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals.*

The CSA standard states that, in an effort to maintain credible GHG inventory reporting in upcoming reporting years, the reporting organization (Red Deer) **shall establish** and maintain GHG information management procedures that:

- ensure conformance with the principles of ISO 14064-1;
- ensure consistency with the intended use of the GHG inventory;
- provide routine and consistent checks to ensure accuracy and completeness of the GHG inventory;
- identify and address errors and omissions; and
- document and archive relevant GHG inventory records, including information management activities.

The CSA suggests that, in an effort to maintain credible GHG inventory reporting in upcoming reporting years, the reporting organization (Red Deer) **should consider** the following:

- identify and review the responsibility and authority of Red Deer staff responsible for GHG inventory development;
- identification, implementation and review of appropriate training for members of the inventory development team;
- identification and review of organizational boundaries (if the inventory is completed by Red Deer staff);
- identification and review of GHG sources and sinks;
- selection and review of quantification methodologies, including GHG activity data and GHG emission and removal factors that are consistent with the intended use of the inventory (if the inventory is completed by Red Deer staff);
- a review of the application of quantification methodologies to ensure consistency across multiple properties (if applicable);
- use, maintenance and calibration of measurement equipment (if applicable);
- development and maintenance of a robust data-collection system;
- regular accuracy checks;
- periodic internal audits and technical reviews;
- a periodic review of opportunities to improve information management processes.

## DOCUMENT RETENTION, RECORD KEEPING AND VERIFICATION

The CSA recommends the following activities for maintaining credible GHG inventory and reporting:

- The organization shall establish and maintain procedures for document retention and record keeping;
- The organization shall retain and maintain documentation supporting the design, development and maintenance of the GHG inventory to enable verification. The documentation, whether in paper, electronic or other format, shall be handled in accordance with the organization's GHG information management procedures for document retention and record keeping.
- The purpose of verification is to provide impartial and objective review of the reported GHG inventory in accordance with the requirements of ISO 14064-3. On a regular basis, the organization should:

    - Prepare and plan for verification in accordance with Sections 8.2 and 8.3 of CAN/CSA-ISO 14064-1-06 - Part 1: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals;
    - Determine an appropriate level of assurance based on the requirements of the intended user of the GHG inventory, taking into account relevant requirements of applicable programmes; and
    - Conduct verification consistent with the needs of the intended user and the principles and requirements of ISO 14064-3.

# APPENDIX G MUNICIPAL GHG INVENTORIES

## Table G1: GHG Inventories for Select Municipalities

| Municipality | Red Deer | Lethbridge | Toronto | Edmonton | St.Albert | Calgary * | Saskatoon | Hamilton | Winnipeg | Newmarket | Vancouver | Victoria | AVERAGE % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study Year** | **2010** | **2009** | **2004** | **2008** | **2008** | **2003** | **2003** | **2005** | **2003** | **2006** | **2008** | **2004** | |
| **Buildings** | 28,706 | 19,387 | 587,598 | 172,200 | 18,404 | 197,100 | 36,270 | 55,090 | 16,179 | 3,717 | 23,500 | 880 | **33%** |
| **Vehicle Fleet** | 7,557 | 8,842 | 63,859 | 74,000 | 5,082 | 24,300 | 6,047 | 42,025 | 21,498 | 583 | 15,500 | 1,620 | **8%** |
| **Employee Commuting** | | Included in vehicle fleet data | | | | 6,800 | | 3,835 | | | | | |
| **Street Lights** | 12,530 | 8,113 | 29,203 | 69,300 | 4,370 | 76,000 | 16,925 | 8,428 | 1,268 | 1,140 | 1,000 | 145 | **6%** |
| **Corporate Waste** | | | | 29,600 | 181 | | 1,619 | | 11,022 | | | | **3%** |
| **Water** | | | | | | | | | | | | | |
| **Water & Wastewater** | 23,067 | 5,893 | 159,315 | 18,500 | 2,679 | 114,000 | 30,437 | 25,680 | 23,331 | 25 | | 11 | **22%** |
| **Contracting Out** | | | | | | | | | | | | | |
| **Landfill** | 65,134 | 81,082 | 721,550 | 67,100 | | | | | | | | | **47%** |
| **Waste Transport** | | | 35,438 | | | | | | | | | | **2%** |
| **Total CO2e** | **136,993** | **123,317** | **1,596,963** | **430,700** | **30,716** | **420,700** | **91,298** | **135,058** | **73,298** | **5,465** | **501,000** | **2,656** | **254,226** |
| **Population** | 90,084 | 85,492 | 2,500,000 | 688,940 | 58,500 | 922,315 | 200,000 | 504,559 | 644,500 | 74,300 | 605,900 | 76,300 | **474,849** |
| **Per Capita CO2e** | 1.52 | 1.44 | 0.64 | 0.63 | 0.53 | 0.45 | 0.46 | 0.27 | 0.11 | 0.07 | 0.07 | 0.03 | 0.47 |

* 2003 is the most recent year with a publicly available detailed breakdown of GHG emissions for Calgary.

Sources: Information disclosed by municipalities.

# APPENDIX H FACILITY ENERGY AND CARBON INTENSITY

## Table H1: Energy and Carbon Intensity for Facilities with Actual Energy Consumption Data Available

| Facility | ekWh /sq.ft. | % of Facility Total ekWh | $kgCO_2e$ /sq.ft. | % of Facility Total $tCO_2e$ |
|---|---|---|---|---|
| Old Catholic School Board Office (Culture Office) | 107 | 0.3% | 42 | 0.3% |
| Civic Yrds 900, 7721-40 Ave - Wash Bay Building | 95 | 0.5% | 48 | 0.5% |
| Lions Washroom #2 (Centre) and Lions Ticket Booth and Storage Shed #1 | 79 | 0.3% | 72 | 0.6% |
| Transit Terminal/Parkade | 69 | 0.7% | 51 | 1.1% |
| Recreation Centre | 63 | 5.7% | 25 | 4.8% |
| Collicutt Centre | 58 | 26.6% | 24 | 24.1% |
| Recreation Centre Service Building | 54 | 0.2% | 17 | 0.2% |
| Heritage Ranch Equestrian Centre | 54 | 0.1% | 51 | 0.3% |
| Great Chief Park Fieldhouse | 52 | 0.3% | 24 | 0.3% |
| Bower Ponds Pavilion and Cronquist House | 50 | 0.3% | 33 | 0.5% |
| Recreation - Dawe Community Centre | 49 | 7.6% | 24 | 7.9% |
| City Hall/Library | 44 | 8.3% | 20 | 8.2% |
| Parks Maintenance Building | 43 | 0.5% | 12 | 0.3% |
| Kinsmen Community Arenas (KinCity) Ice Machine Room | 42 | 3.5% | 24 | 4.3% |
| Red Deer Arena | 38 | 2.7% | 22 | 3.4% |
| Civic Yrds 300-7721 40 Ave - Administration Building | 37 | 4.0% | 18 | 4.2% |
| Parks Maintenance Shop | 35 | 0.1% | 12 | 0.0% |
| Fire Hall #1 | 35 | 2.1% | 14 | 1.7% |
| Civic Yrds 800-7721 40 Ave - Public Works & Environmental Services Heated Storage | 30 | 1.6% | 12 | 1.3% |
| Kinex Arena | 30 | 1.5% | 14 | 1.6% |
| Rotary Park Washroom | 29 | 0.0% | 28 | 0.0% |
| Civic Yrds 200-7721 40 Ave, Red Deer | 28 | 8.0% | 11 | 6.8% |
| Parks Department Construction & Maintenance Shop | 27 | 0.2% | 7 | 0.1% |
| Civic Yrds 500-7721 40 Ave - EL&P & Parks Heated Vehicle Storage Building | 21 | 1.2% | 7 | 0.8% |
| Heritage Ranch Visitor Centre | 21 | 0.2% | 4 | 0.1% |
| Dairyworld Bldg B | 19 | 0.4% | 5 | 0.2% |
| Fire Hall #3 | 19 | 1.6% | 8 | 1.4% |

| Facility | ekWh /sq.ft. | % of Facility Total ekWh | $kgCO_2e$ /sq.ft. | % of Facility Total $tCO_2e$ |
|---|---|---|---|---|
| Fire Hall #2 | 18 | 1.4% | 10 | 1.7% |
| Fire Training Centre (Ed Howell Emergency Services) | 17 | 0.1% | 9 | 0.1% |
| Kin Canyon Rest Room | 14 | 0.0% | 14 | 0.0% |
| Great Chief Park Service Building | 13 | 0.1% | 2 | 0.0% |
| Civic Yards - Building R Fuel Shed | 9 | 0.0% | 2 | 0.0% |
| Lions Washroom #1 (East) and Lions Washroom #3 (West) and Storage Shed #2 | 8 | 0.0% | 4 | 0.1% |
| Alto Rest Cemetery Office/Shop 1417 K.S. | 6 | 0.1% | 3 | 0.1% |
| Fire Hall #4 | 6 | 0.3% | 3 | 0.3% |
| Fire Hall #5 | 6 | 0.5% | 3 | 0.5% |
| Parks Facilities Butler Building | 3 | 0.0% | 3 | 0.0% |
| R.D. Cemetery Office | 2 | 0.0% | 2 | 0.0% |
| PW Salt Storage/Bldg I | 2 | 0.1% | 2 | 0.2% |
| Civic Yards - Parks Cold Storage F | 1 | 0.0% | 1 | 0.1% |
| Great Chief Park Kiwanis Parking Lt/Washroom | 0 | 0.0% | 0 | 0.0% |

Actual energy consumption data was not available for following buildings during this time period because they were leased:

| Facility |
|---|
| Alexander Way - Community Services |
| Allen Bungalow |
| ATCO Building - Records Management Contents |
| Bower Place Activity Centre |
| Clearview Activity Centre |
| Coatam House |
| Deer Park/Lancaster Activity Centre |
| Discovery Canyon bathrooms |
| Discovery Canyon Concession |
| Dojahn House/Quonset |
| Duplex Unit #35, 37, 39, 41, 43, & 45 |
| Duplex Unit #40, 42, 44, 46, & 48 |
| Duplex Unit #50 |
| Duplex Unit #5441, 5443, 5445, & 5447 |
| Duplex Unit #5901, 5903, 5905, & 5907 |
| Duplex Unit #5902, 5904, 5906, & 5908 |

| Facility |
|---|
| Dwelling 5832 53rd Ave |
| Eastview Activity Centre |
| Eastview Estates Activity Centre |
| Fort Normandeau Interpretive Centre |
| Golden Circle Retirement |
| Golf Course Caretaker's Residence |
| Golf Course Clubhouse (Incl. Kitchen & Pro Shop) |
| Golf course Large Maintenance Garage (Grounds Maintenance Building) |
| Golf Course Range Building (Driving Range Building) |
| Golf Course Small Maintenance Garage (Quonset) |
| Grandview Activity Centre |
| Highland Green Activity Centre |
| Kerry Wood Nature Centre |
| Memorial Centre Auditorium/Festival Hall |
| Morrisroe Activity Centre (Anne L. Gaetz School) |
| Morrisroe Extension Activity Centre |
| Mountview Activity Centre |
| Museum |
| Normadeau Activity Centre |
| Old Crossing School House |
| Oriole Park Activity Centre |
| Pines Activity Centre |
| Pioneer Lodge |
| Professional Building Leased Office Space |
| RCMP Building 4602 51 Ave |
| RCMP Station 6592 58 Ave |
| RCMP Storage Facility |
| Riverside Meadows Activity Centre |
| Roland Michener Centre - Pool Facility |
| Rosedale Activity Centre |
| South Hill Activity Centre |
| West Park Activity Centre |