ECO-FRIENDLY PRACTICES STUDY

Submitted to:

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EXECUTIVE SUMMARY

Human induced climate change is now recognized by the global community as the greatest environmental threat of the 21st century. Flagstaff County is aligned to reduce their carbon footprint through clarity of vision, focused objectives and implementing the recommendations of this study.

This eco-friendly initiative has resulted in the identification of achievable methods to improve Flagstaff County's environmental footprint, including:

- Reducing emissions that are harmful to human health and the environment
- Lowering energy costs
- Maximizing the use of available natural resources
- Promoting smarter energy use – in the field, on the road, and in the office

A functional map of Flagstaff County operations was developed using the 2011-2012 Draft Business Plan to identify operational subcomponents and activities that are the major contributors to greenhouse gas production. County departments were placed in one of three major functional groups: Administration, Environment and Public Works, which were established for the investigation. Supplemental information and clarification of current practices was obtained from Flagstaff County personnel.

The most significant Flagstaff County activities were examined and these activities contributed to the production of 2,438 tonnes of carbon dioxide equivalents (CO_2e) in 2010, or 44.3 tonnes CO_2e per employee.

The Public Works functional group contributed 89.2% (2,175 t) of the CO_2e produced by the County in 2010. This was primarily due to intensive activities involving graders, trucks and heavy equipment, which are responsible for 31.9% (778 t); 22.6% (551 t) and 9.1% (223 t) of the County's output of CO_2e, respectively. The Administration and Environment functional groups had a much smaller CO_2e footprint, contributing 7.4% (180 t) and 3.4% (83 t), respectively, to the County's overall CO_2e.

The activity with the largest CO_2e footprint overall was vehicles, including graders, heavy equipment and trucks. Vehicles accounted for 81%, or 1974 metric tonnes of the County's total CO_2e. Electricity and heating contributed 11% and 8% CO_2e, respectively. Reducing the impact of vehicle emissions can be accomplished by:

- incrementally replacing the vehicular fleet with newer, fuel efficient models
- installing a geographical information system (GIS) in the majority of vehicles

- examining vehicle use including an action plan for driver education and training.

The eco-friendliness of using waste oil as a heating source was difficult to assess due to limited information. Heating with waste oil can be very beneficial relative to recycling, if adequate pre-treatment and emission control measures are used. It is recommended that Flagstaff County continue the practice of utilizing alternative waste fuels, including waste oil; and consider biomass (i.e. clean construction wood waste) combustion for heat energy.

Enhancing waste recycling and diversion practices by Flagstaff Waste Management, along with continued efforts by residents and businesses to reduce municipal solid waste (MSW) sent to the landfill are high priorities. It is proposed that Flagstaff County continue with the *Solid Waste Management Diversion Implementation Project* and focus on the short-term diversion targets recommended in the *2010 Landfill Solid Waste Diversion Feasibility Study.*

The oil and gas industry has a substantial presence in the County and it is suggested that the impacts of their activities on land should be minimized. Designating natural or wetland areas, planting trees or natural vegetation will increase CO_2 absorption. The Shelterbelt Enhancement Program is an ongoing eco-friendly initiative which helps to offset the County's carbon footprint by planting trees.

Significant improvements to the County's carbon footprint have been made by recent eco-friendly practices. The greatest potential for further greenhouse gas reduction lies with vehicular activities (trucks, graders and heavy equipment), currently responsible for approximately 81% of the County's greenhouse gas emissions.

A ranking of eco-friendly initiatives are provided to guide Flagstaff County in their reduction of greenhouse gas emissions. Current eco-friendly practices should be continued and augmented by introducing and implementing new initiatives. A follow-up eco-friendly audit in 3 years is recommended to assess which practices have been most effective and ensure subsequent initiatives are aligned with Flagstaff County policy and strategic direction.

Flagstaff County promotes environmental stewardship as part of their vision and strategic objectives. In addition to maintaining a healthy ecosystem and enhancing the aesthetic appearance within the County, trees and vegetation provide environmental benefits including carbon sequestration. Progressive planning and encouraging the healthy growth of trees and brush is a positive activity in support of Flagstaff County's environmental strategic objective.

1 Introduction

Flagstaff County has been implementing eco-friendly practices over the past several years. As a result of their increased awareness and commitment to the environment, Flagstaff County initiated this study.

The overall purpose of this study is to investigate current Flagstaff County practices and facilities for opportunities to cost-effectively improve their environmental footprint and develop a strategy for phased implementation. The objective of this study is to quantify the environmental impacts associated with Flagstaff County's activities and to rank the identified eco-friendly improvement opportunities in terms of phased implementation priorities. This initiative is aligned with the Flagstaff County Vision and Environmental Responsibility Strategic Objective.

Flagstaff County Vision states:

> *A safe, caring and vibrant rural "Community of communities" committed to working with our neighbours to ensure the quality of life for all citizens. An innovative and progressive "Community" that balances economic prosperity and* ***environmental stewardship****, we deliver a responsible level of service that is both efficient and effective.*

Flagstaff County's Environmental Responsibility Strategic Objective is as follows:

> *To demonstrate Flagstaff County's commitment to environmental responsibility by working to minimize our adverse impact on the natural environment through the adoption of* ***eco-friendly practices****, progressive planning and the use of green technology.*

This eco-friendly initiative is proactive in this time of increasing global environmental awareness and as governments respond with timely action plans. The Government of Canada, under the authority of the Energy Efficiency Act will introduce and/or raise energy efficiency standards for a wide range of energy-consuming products. As a result, 80% of the energy used in homes, businesses and industry will soon be regulated. Stricter regulations will cause inefficient products to disappear from the marketplace over time (Canadian Office of Energy Efficiency, NRC, 2011), which means more energy savings to Canadians.

Although the issue of global warming, caused by the *Greenhouse Effect*, is a natural process, anthropogenic activities such burning fossil fuels may have accelerated the effect. The Greenhouse Effect is often described as the warming of the earth's surface

from radiated heat received from the sun and subsequently trapped by the earth's atmosphere. Trace gases in the atmosphere such as CO_2 and water vapour absorb energy or reflect it back to the surface, creating a similar effect to glass panes in a greenhouse which allow sunlight to pass through but trap some of the radiated heat. Atmospheric levels of CO_2 are increasing by more than 10% every 20 years (Alberta Environment, 2011). We can all help to mitigate and reduce the effects of climate change by protecting, conserving and enhancing our wetlands, forests and other natural spaces, and reducing our greenhouse gas emissions.

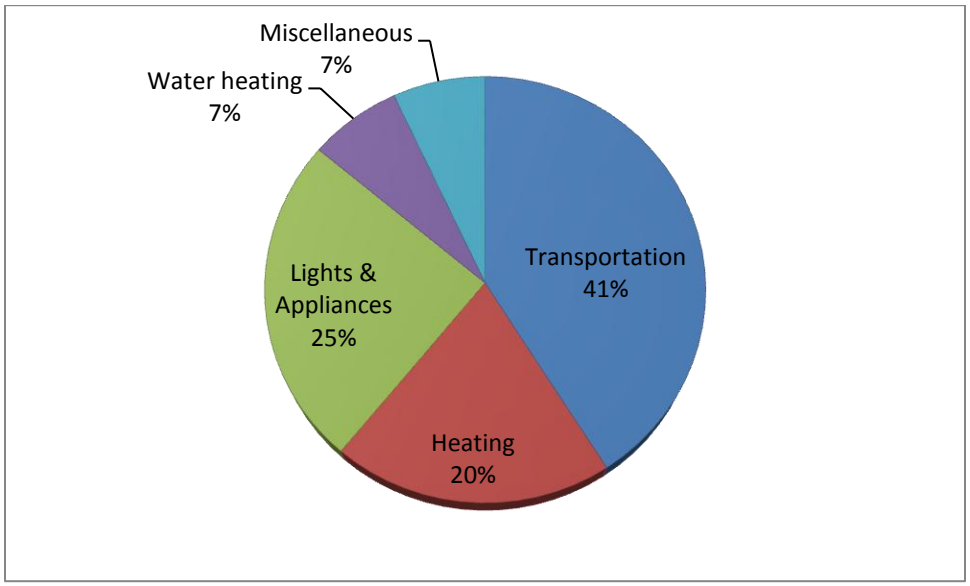
A "*carbon footprint*" is a measure of the greenhouse gas (GHG) emissions associated with an activity, group of activities or a product. Calculating the carbon footprint is a valuable first step towards making quantifiable emissions reductions. This in turn can lead to long term financial savings as well as reducing the climate change impact of Flagstaff County.

The term "*CO_2e*" is an abbreviation for "***carbon dioxide equivalent",*** and is a measure that expresses the amount of greenhouse gases produced in terms of the amount of carbon dioxide (CO_2) that would have the same global warming potential. This allows a single value to encompass the effects of many gases, such as methane, fluorocarbons, and nitrous oxide, in addition to just carbon dioxide. Figure 1-1 shows a breakdown of

the average Canadian personal emissions of greenhouse gases. It is possible for every Canadian to make reductions in each of these categories.

Figure 1-1 Average Canadian Personal Emissions of Greenhouse Gases

(Environment Canada, 2010)



The term "*carbon neutral*" refers to some thing or process with a carbon footprint of zero. Carbon neutrality can be accounted for by first calculating a carbon footprint, then reducing emissions as far as possible, and finally "offsetting" the remainder by purchasing emissions reductions "credits" generated by external projects such as renewable energy schemes or tree planting projects.

The eco-friendly initiative will endeavour to promote smarter energy use by Flagstaff County – in the field, on the road and in the office. These efforts will reduce emissions that are harmful to human health and the environment, save money and maximize the use of available natural resources.

A presentation to Flagstaff Council was made on October 13, 2011 with an additional request for AITF to provide an assessment of contributory carbon sink benefits from the land use in Flagstaff County. This information has been included in the report.

1.1 Organizational Structure of Flagstaff County

The organizational structure of Flagstaff County is shown in Figure 1-2. The chart identifies the formal operational relationships and reflects departmental relationships. There are approximately 55 employees on staff, which varies with the season.

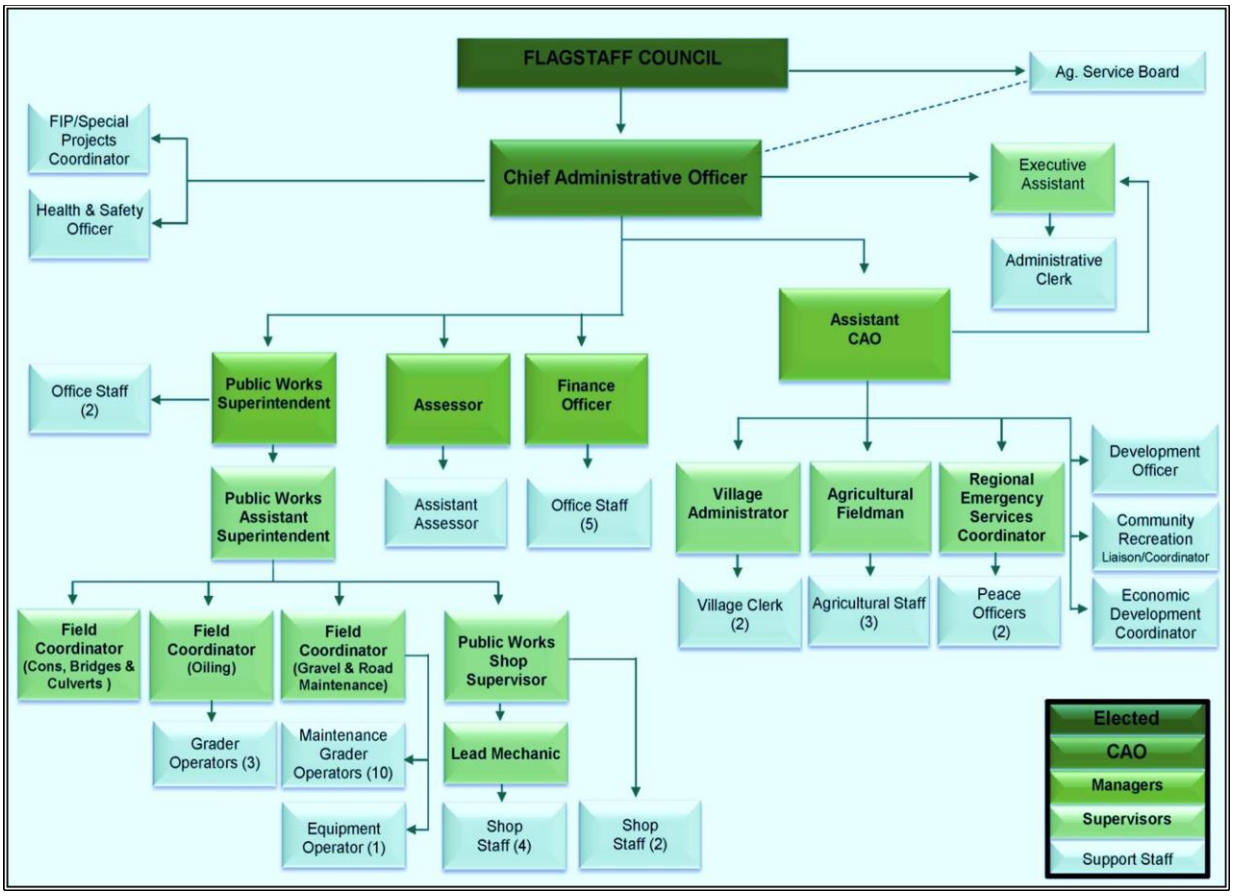


Figure 1-2 Flagstaff County Organization Chart from 2011-2012 Draft Business Plan

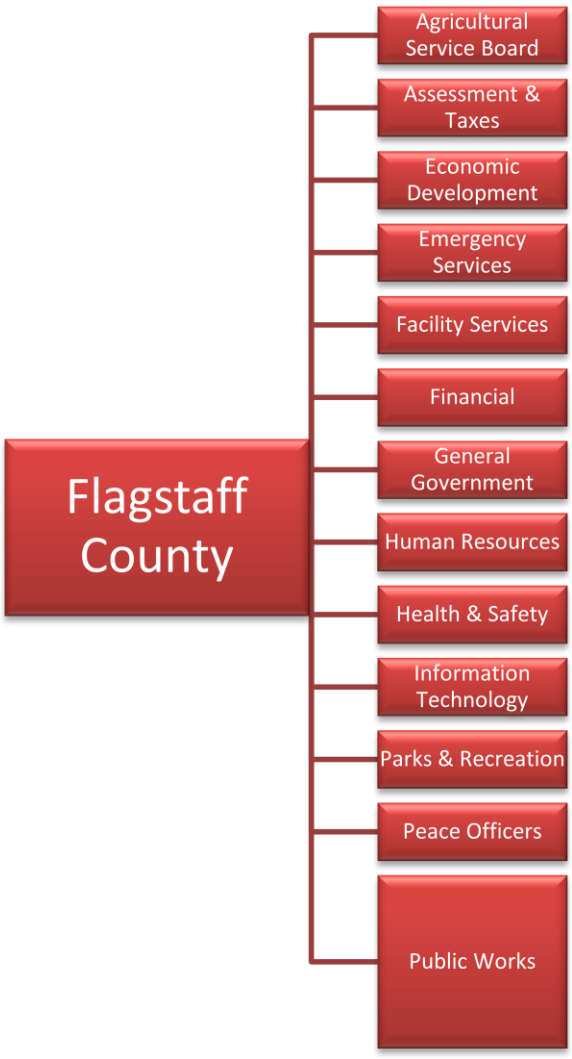


Figure 1-3 Flagstaff County Departments

Flagstaff County departments have different functional roles and responsibilities and are identified in Figure 1-3.

2 Study Methodology

The primary objectives and tasks of this study are:

A. To quantify the environmental impacts associated with Flagstaff County's operations
    - Develop a functional map of Flagstaff County operations to identify operational subcomponents and activities that are the principal contributors to greenhouse gas production
    - Confirm and expand the contributing sub-components using reports and data from Flagstaff County
    - Obtain supplemental information and clarification of current practices from Flagstaff County staff

B. To develop the format and perform an eco-friendly practices assessment focusing on components and sub-components of eco-friendly practices and opportunities
    - Rank the identified eco-friendly improvement areas in terms of potential implementation priorities

C. To identify opportunities to reduce resource use and/or waste generation and subsequent impacts
    - Prepare a listing of current and future eco-friendly activities

D. To develop a strategy for implementation of eco-friendly practices

2.1 Study Scope

The focus of this assessment is on Flagstaff County operations. Unless noted otherwise, all data is restricted to the year 2010. The County's operations consist of a number of activities – some of which the County sub-contracts and some of which it performs internally. Activities are defined to be the sets of tasks, processes or services occurring within Flagstaff County's operations that generate its environmental impacts and/or consume its financial resources. The activities included in this analysis were those that Flagstaff County engages in or uses to perform its business which requires money, materials, or energy and results in environmental impacts. This means that sub-contracted activities also contribute towards Flagstaff County's baseline impacts.

In order to strategically identify and rank eco-friendly improvement opportunities, a functional map of the County's activities was produced based on the County's organizational chart (Figure 1-2) and Departments (Figure 1-3), as well as the Department Programs and Services Table in the Flagstaff County 2011-2012 Business Plan and Budget. A functional map focuses on activities performed and their intended outcomes rather than the organizational relationships.

Flagstaff County Administration, Finance, Assessment and Taxes, Economic Development, Emergency Services, Peace Officers, Health and Safety, Information Technology and other departments were combined into the Administration functional group for eco-analysis – these departments have the least environmental impact.

The Agricultural Service Board (ASB) was combined with Parks and Recreation to form the Environment functional group for eco-analysis. The Agricultural Service Board employs between 5-10% of the County's staff, depending on the season and approximately 8% of the budget. ASB staff also maintains the campground and pond. Due to the unique inputs used in this department such as herbicides and pesticides, the various programs within the ASB were examined in detail. Activities with environmental impacts from each functional group are identified on the right side of the functional maps.

Public Works is allocated approximately half of the Flagstaff County budget, with a 2011 operating budget of approximately $4.2 million and a capital budget of approximately $4.4 million; subsequently, the Public Works departments were examined in detail to identify eco-friendly opportunities.

The functional map in Figure 2-1 outlines and combines the relationship of County operations and their environmental impacts and ensures that the impacts from each activity are not double counted. The functional map also helps to ensure that the available financial information addresses the environmental impacts associated with all the identified activities, thereby enabling identification of any gaps in the baseline assessment. Supplementary information was obtained from the County where necessary.

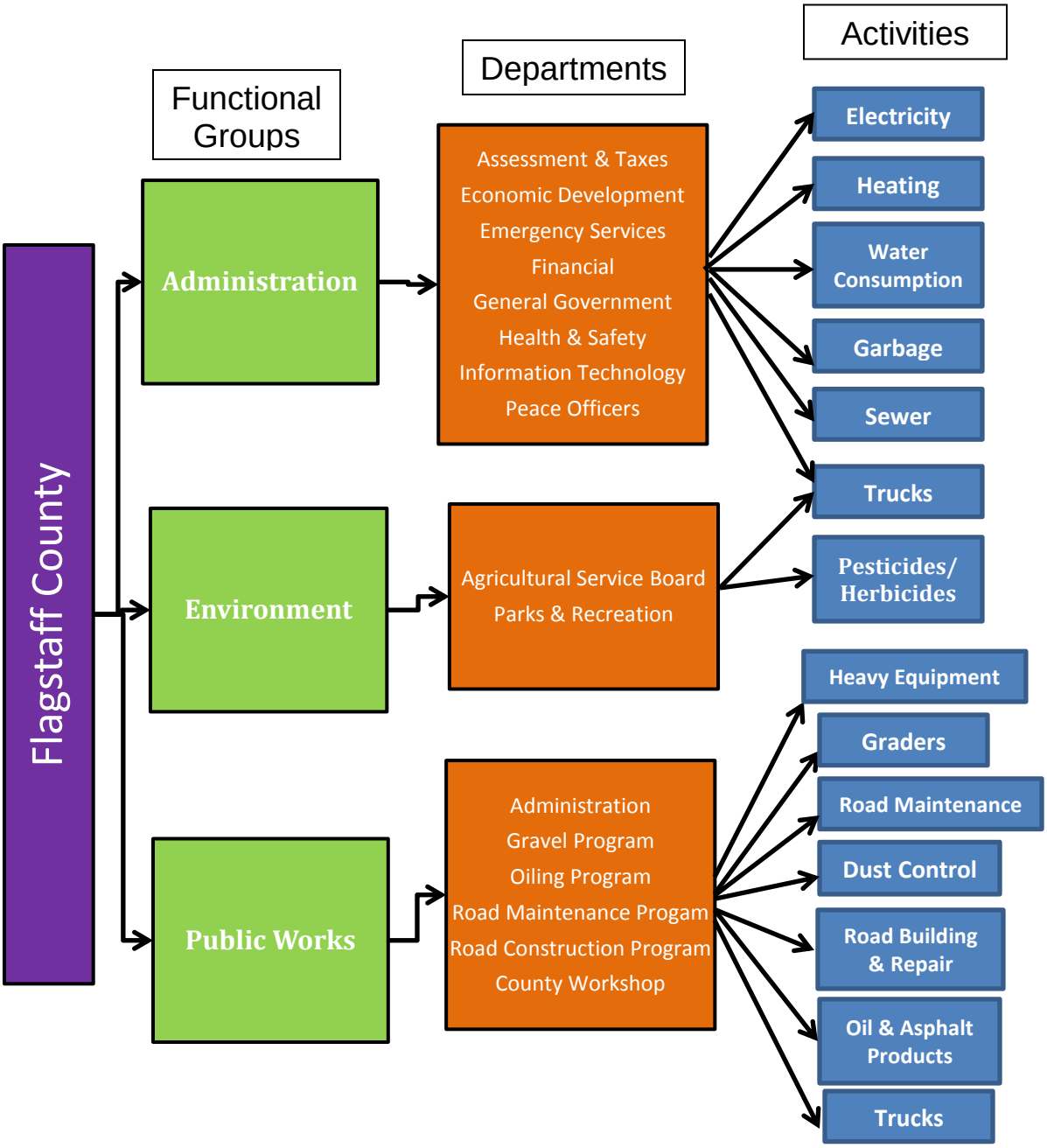


Figure 2-1 Functional Map for Flagstaff County Eco-Analysis

The primary inputs considered in this study include:

- Energy
- Materials
- Water

Inputs are resources required for County operations, such as raw materials or capital goods.

The environmental impact categories resulting from the County's operations included:

- GHG emissions (quantified as kg of CO_2 equivalent emissions or CO_2e)
- Waste water
- Non-hazardous solid wastes
- Hazardous materials (pesticides, poisons, and other toxic substances)

In terms of the amount of detail included in the analysis, the methodology adopted is more strategic rather than exhaustive, meaning that we attempt to capture the major environmental impacts rather than every environmental impact. Such an approach is justified given that the primary aim of this analysis is to identify areas for improvement.

Given the financial costs associated with energy and input materials, the County had significant information associated with all types of energy usage and the major input materials used. Information on hazardous materials like poisons, pesticides and herbicides was also tracked directly by the County, coupled with solid eco-friendly practices for the use of these hazardous materials by the ASB. Limited information exists about water usage and waste materials beyond flat fees levied against the facilities. Thus, the assessment of energy usage and associated GHG emissions in this report are more thorough than the assessment of other categories of wastes.

2.2 Computing GHG Emissions

GHGs are reported based on Scope 1 and Scope 2 emissions. Scope 1 emissions are direct emissions from sources that are owned or controlled by the County, such as building heating and travel in County vehicles. Scope 2 emissions are indirect emissions resulting from the purchase of electricity, steam or heat. Scope 3 emissions include other types of indirect emissions, such as the impacts of employees commuting to work, airline travel, rental cars, etc. Scope 3 emissions are outside the scope of this study and were not quantified.

2.3 Attributing Environmental Impacts

The financial information provided is attributed to specific departments, which was evaluated and combined into functional activities in order to assess the overall environmental impacts of the County. The objective in doing this, however, is NOT to try and rank the environmental performance of one department relative to another. The different roles, sizes, and activities within departments suggest that any such within County comparison would be both unfair and pointless. Knowing the relative impacts of different departments and different activities to the County's overall environmental impacts can help to determine where to focus eco-friendly initiatives to obtain the biggest improvements.

2.4 Identifying Potential Eco-Friendly Practices

Over the past few years, Flagstaff County have introduced several new eco-friendly initiatives, including this Eco-Friendly practices study which will provide recommendations for future initiatives. A listing of the eco-friendly initiatives for the Administration functional group is shown in Table 2.1. Upgrading to energy efficient lighting is ongoing and will realize an approximate energy reduction of 75% for replacement of incandescent lights and 30% for fluorescent tube retrofits.

Table 2-1 Eco-Friendly Initiatives from the Administration Functional Group

Functional Group	Department	Initiative	Year	Estimated Cost	Objective
Administration	General Government	Municipal Development Plan - Environmental Management objectives & policies	2009	$32,910	Mitigate potential problems from development and maintain natural areas for future generations
		East Central Alberta Cumulative Effects Project (ECACE)	2009	$5,000 budget	Determine the long term cumulative effects of planning & development issues on air, land & water
		Heritage/Legacy Lands Policy & Survey	2010	$70,000	Document potential heritage sites and assist in the preservation and protection of historic resources
		Environmental requirements for 3rd party contractors	2010-11		To develop policies and contracts to ensure contractors meet Flagstaff County's environmental requirements
		Lighting improvements	2010-11		To install energy efficient lighting to lower energy consumption
		Fuel efficient vehicles	2010-11		To seek fuel-efficient vehicles when buying new
		Social sustainability project	2011	$50,000 budget	To provide supportive services for seniors, youths and adults in the community by determining the need and developing long term plans
		Small Business Awards - Green Technology Award	ongoing	$250/yr	Promote and recognize businesses that practice and utilize "green technology"
		Hardisty Hub Air Quality Baseline Study	2011	$40,000 budget	To determine a baseline air quality in the Hardisty Hub
		Air shed monitoring best practices research	2011-12		To evaluate co-ordinating the activities affecting air quality in Flagstaff County in a defined area or airshed
		Environmental sustainability	2011-12		To work with other communities to develop a collaborative approach to environmental sustainability
		Water well abandonment project	2011-12	$20,000 budget	To eliminate the risk of groundwater contamination
		Symposium, Trade Fair, Regional Farmer's Market	2011-12		To generate value-added opportunities for agriculture
		Research eco-friendly practices	2011-12	$37,803	To find innovative eco-friendly practices that could be applied to Flagstaff County's operations
		Solid Waste Management Diversion Implementation Project Phase II	2011-12	$42,500	To work with Towns, Villages and Waste Mgmt to divert a percentage of traditional waste from the landfill
	Information Technology	ECACE information integrated into GIS system	2009	$148,969	Baseline data of aerial photography, soil classification, groundwater inventory, topography & vegetation mapped
		Geographic Information System Mapping Project	2011	$25,000	To prepare a visual inventory of right of way, signage, culverts & approaches

Table 2-2 Eco-Friendly Initiatives from the Environment Functional Group

Functional Group	Department	Initiative	Year	Estimated Cost	Objective
Environment	Agricultural Service Board	Alberta Environmental Sustainable Agriculture program	1980's	$38K	To increase the awareness and adoption of beneficial management practices (approx. annual costs from 2009-11)
		Herbicide and Pesticide container collection bins at transfer stations	~1996	n/a	Multiple collection points ensure pesticide containers are recycled
		Handgun spray system for brush spraying	> 10 yrs	n/a	To selectively spray vegetation instead of spraying all with a boom system
		6 Tank-loading facilities	2003-2011	$600K	A reliable supply of untreated water to use for agricultural purposes
		Water well monitoring program	2005	$300	To monitor aquifer levels and track long term trends in the water table
		Motion sensor solar lighting for outhouses at Fish Lake & Diplomat Trout Pond	2010	$120	Provide a light source for outhouses for campers
		Battle River Research Group - Support to Iron Creek Watershed Improvement Society	2011	$12K annually	Research & awareness into local agricultural and environmental issues
		Equipment for rent (e.g. tree planter, sprayer)	ongoing		Promote full use of equipment; enable landowners
		Fish Lake aeration during winter months	ongoing	$1K (power)	Maintain viable fish population, cost included in Fish Lake utilities
		Shelterbelt Enhancement Program	2012-13	$104K	Plant trees & help establish a healthy shelterbelt
		Leafy Spurge Control Program	2012-13	$110K	To help landowners implement their own control programs and enforce non-compliance
	Parks & Recreation	Bottle recycling at parks and campsite	n/a	$0	Eco-friendly initiative
		Enhance County owned parks	2011-12		Beautification
		Develop outdoor recreation areas	2011-12		To provide outdoor recreation, protect natural areas and increase tourism
		Campsite improvements	2011-12	$75K	Functionality & beautification

The Agricultural Service Board has various eco-friendly initiatives focusing on the environment. Support to the Iron Creek Watershed Improvement Society has continued for several years on a number of different projects. The development and implementation of watershed management plans, water conservation and water quality programs are eco-friendly initiatives for the purpose of protecting the environment for future use.

The Flagstaff County Shelterbelt Enhancement Program is a long-term initiative. The Prairie Shelterbelt Program of Agriculture and Agri-Food Canada provide tree and shrub seedlings for establishment of shelterbelts and other agroforestry, conservation and reclamation projects on agricultural lands. The Agricultural Service Board provides a service to landowners to plant the trees and do the initial watering to help establish healthy trees. The cost of the Shelterbelt Program in 2011 was approximately $6,000 and for 2012-13, the MSI (Alberta Municipal Sustainability Initiative) Shelterbelt Position budget is $104,000. The environmental benefits of this program far outweigh the costs.

Table 2-3 Eco-Friendly Initiatives from the Public Works Functional Group

Functional Group	Department	Initiative	Year	Estimated Cost	Objective	Notes
Public Works	Road Maintenance Program	Dust suppressant application on Coal Trail & other locations	2010	$665K	To reduce frequency of gravelling and blading, improve safety and minimize the impact of dust	This includes costs for: calcium chloride product & application, equipment, labour, gravel and water. Locations include: Coal Trail Road, Waste Management Road, Viking Energy Road, Fish Lake, residential dust control, County intersections & dust control
		Remove salt & sand storage from County Shop	2010	$0	To minimize leaching	Public Works has been storing salt at County Yard as Carillon does not have enough storage for the County's requirement - looking at investing in a sand/salt storage shed in the future
		Renovate one grader shed per year	2010	$40K	To improve energy efficiency by re-insulating, energy efficient lighting and new interior walls	Lougheed Grader Shed has been completed. Forestburg Grader Shed is scheduled for 2011 and Daysland Grader Shed in 2012
		Test new dust suppressant products	2010	$75K	To find more eco-friendly and effective products	
	Road Construction Program	Equipment rental service	2010	$60K	To provide small & large specialized equipment to citizens and communities	This includes costs solely for work performed for the Towns and Villages within Flagstaff County
	Oiling Program	Decreasing the number of oiled roads	2010	Unknown	To reduce costs	
	County Workshop	Waste oil furnace	2001	$16,000	To reduce heating bill for the County Shop by supplementing heat with a used oil furnace	2012 budget - $16K for a replacement waste oil furnace; cost savings - reduction in natural gas for heating
		Recycling	n/a	$0	To collect and recycle all recyclable materials	
		Energy efficient lighting	2011	$10,000	To reduce energy consumed by lighting	
		County Yard Beautification Project	2011-12	$5K	To improve the visual appearance of the County Yard	2012 capital budget is $16,500
		County Yard Beautification Project	2011-12	$8K	To hire a consultant to provide a beautification plan for the front of the shop	

Information pertaining to eco-friendly practices was obtained from Flagstaff County annual reports, business plans and personal communication with Flagstaff County staff. Gaps exist in the tables where information was not readily available; however, the tables can be updated in the future to supplement this information.

3 Baseline Results and Improvement Opportunities

The activities outlined in the functional map (Figure 2.1) were evaluated for each functional group. Greenhouse gas emissions and operating costs were calculated based on the data provided by Flagstaff County for vehicles, heavy equipment, graders and buildings. In addition, input materials, water usage, waste production and impacts on land were assessed based on Flagstaff County input and AITF judgement.

3.1 Overview

County-wide summaries of GHG emissions, water usage, and selected materials purchased are given in Table 3-1 to Table 3-4. Greenhouse gases are expressed as kg of CO_2 equivalents (CO_2e) in Table 3-1. Cumulatively, the County's operations are responsible for ~2,422 metric tonnes of CO_2e associated with major activities that cost the County ~$580,000. Across major activities of the County listed in Table 3-2, Graders, Trucks, and Road Building and Repair account for 32.1%, 28.0%, and 12.2% of total CO_2e emissions, respectively. Electricity and Heating for the County's buildings account for 18.5% in total. These activities are further disaggregated in the following sub-sections.

The top three departments contributing to CO_2e emissions (Table 3-2) are, respectively, the Road Maintenance Program (28.5%), the Gravel Program (26.6%), and the County's buildings (18.5%). While buildings are not technically a County department, such a grouping enables an assessment of how the impacts of the County's buildings compare to their program operations.

In terms of water usage (Table 3-3), the County's buildings used ~1540 m^3 of water with ~81% of this usage attributable to the Administration Building. The other materials purchased by the County are summarized in Table 3-4. Note that the assumptions used to compute CO_2e associated with gravel trucking, defined in Appendix 7.3, are not verified and thereby an approximation.

Table 3-1 Summary of Operating Costs and GHG Emissions for County Activities

	Operating Costs		CO2e	
Activity	$	% of Total	kg	% of Total
Graders	$225,075	38.3%	778,035	32.1%
Trucks	$219,849	37.4%	678,032	28.0%
Road building & repair	$0	0.0%	295,288	12.2%
Electricity	$38,857	6.6%	268,824	11.1%
Heavy Equipment	$64,391	11.0%	222,585	9.2%
Heating	$23,308	4.0%	180,054	7.4%
Water Consumption	$3,117	0.5%		0.0%
Sewer	$2,927	0.5%		0.0%
Dust Control	$0	0.0%	0	0.0%
Road Maintenance	$0	0.0%	0	0.0%
Beaver Control	$900	0.2%	0	0.0%
Gopher Control	$0	0.0%	0	0.0%
Oil & Ashphalt Products	$0	0.0%	0	0.0%
Weed Control	$0	0.0%	0	0.0%
Pest Control	$5,561	0.9%	0	0.0%
Garbage	$3,575	0.6%		0.0%
Grand Total	**$587,560**	**100.0%**	**2,422,818**	**100.0%**

Note that greenhouse gases produced by other activities in Flagstaff County were not addressed in the scope of this study due to their lower contribution.

Table 3-2 Summary of County CO_2e Emissions by Activities Occurring within County Departments

Department/Activity	Operating Costs		CO_2e	
	$	% of Total	kg	% of Total
Road Maintenance	$201,242	34.6%	689,962	28.5%
Graders	$163,122	28.1%	563,876	23.3%
Trucks	$21,901	3.8%	70,020	2.9%
Heavy Equipment	$16,219	2.8%	56,066	2.3%
Road Maintenance	$0	0.0%	0	0.0%
Oil & Asphalt Products	$0	0.0%	0	0.0%
Gravel Program	$105,076	18.1%	645,177	26.6%
Trucks	$93,803	16.1%	310,920	12.8%
Road building & repair	$0	0.0%	295,288	12.2%
Heavy Equipment	$11,273	1.9%	38,968	1.6%
Buildings	$71,784	12.4%	448,877	18.5%
Electricity	$38,857	6.7%	268,824	11.1%
Heating	$23,308	4.0%	180,054	7.4%
Garbage	$3,575	0.6%	0	0.0%
Water Consumption	$3,117	0.5%	0	0.0%
Sewer	$2,927	0.5%	0	0.0%
Oiling Program	$83,952	14.4%	286,472	11.8%
Graders	$61,953	10.7%	214,159	8.8%
Trucks	$16,269	2.8%	52,506	2.2%
Heavy Equipment	$5,730	1.0%	19,807	0.8%
Dust Control	$0	0.0%	0	0.0%
Road Construction	$33,027	5.7%	110,716	4.6%
Heavy Equipment	$28,190	4.9%	97,445	4.0%
Trucks	$4,837	0.8%	13,271	0.5%
Public Works Administration	$27,982	4.8%	76,766	3.2%
Trucks	$27,982	4.8%	76,766	3.2%
Agricultural Services Board	$32,433	4.5%	72,484	3.0%
Trucks	$25,972	4.4%	72,484	3.0%
Pesticides/Herbicides	$6,461	1.1%	0	0.0%
County Shop	$11,071	1.9%	34,772	1.4%
Trucks	$8,092	1.4%	24,474	1.0%
Heavy Equipment	$2,979	0.5%	10,299	0.4%
Peace Officers	$10,902	1.9%	29,910	1.2%
Trucks	$10,902	1.9%	29,910	1.2%
Fire	$5,330	0.9%	14,623	0.6%
Trucks	$5,330	0.9%	14,623	0.6%
Office	$2,431	0.4%	6,670	0.3%
Trucks	$2,431	0.4%	6,670	0.3%
Signs	$1,194	0.2%	3,276	0.1%
Trucks	$1,194	0.2%	3,276	0.1%
Health & Safety	$1,135	0.2%	3,113	0.1%
Trucks	$1,135	0.2%	3,113	0.1%
Grand Total	**$587,560**	**100.0%**	**2,422,818**	**100.0%**

Table 3-3 Summary of Water Usage

Department	Description	Water (m3)	% of Total
Buildings	Administration Building	1255	81.4%
	Forestburg Grader Shed	153	9.9%
	Strome Grader Shed	66	4.3%
	Alliance Grader Shed	43	2.8%
	County Main Shop	24	1.6%
	Lougheed Grader Shed	0	0.0%
	Heisler Grader Shed	0	0.0%
	Daysland Grader Shed	0	0.0%
Grand Total		**1541**	**100.0%**

Table 3-4 Summary of Selected Materials Purchased and Used by the County.

Functional Group	Department	Activity	Description	Purchased Materials	Used by County
Environment	Agricultural Service Board	Beaver Control	Dynamite	~ 2.75 kg	~ 2.75 kg
		Gopher Control	Strychnine	611 L	0
		Pest Control	Pesticide	$5,561	0
		Weed Control	Herbicides *	3,324 g	3,324 g
				2,483 L	2,483 L
Public Works	Gravel Program	Road Building & Repair	Gravel	167,000 t	167,000 t
	Oiling Program	Dust Control	CaCl2	2,561,000	2,561,000
			Canola Oil	70,472 L	70,472 L
			Durasoil	12,800 L	12,800 L
	Road Maintenance	Oil & Asphalt	SC250 Oil	234,216 L	234,216 L
		Road Maintenance	Salt	142 t	142 t
			Sand/Calcium	518 t	518 t

* Higher with inventory

The summary of input materials purchased and used by the County was obtained from Flagstaff County Revenue and Expenditure Reports and Draft 2011-2012 Business Plan and Budget; further details were obtained from communications with Flagstaff County employees. Gravel used by the County has been adjusted for the gravel sold based on the financial income from these sales accounting for the County's assumed profit margin of such sales. Pesticides and strychnine are sold to landowners by the Agricultural Service Board; none is used on County property.

3.2 Heavy Equipment and Graders

Use of graders and other heavy equipment totalled 18,700 hours (Table 3-5) with 78% of total fuel costs (and also CO_2e emissions) associated with the use of graders for Road Maintenance, while 22% is associated with other heavy equipment use. The average kg of CO_2e per hour of use is also given by program. Overall, graders working the Oiling Program contribute around 15% more CO_2e (an average of 62.3 kg CO_2e per hour) than graders working on Road Maintenance.

Table 3-5 Total Hours, Fuel Costs, and CO_2e for Graders and Heavy Equipment

	Hours		Fuel		CO2e		
Emissions Source	#	% Total	Cost	% Total	kg	% Total	Avg kg per hour
Graders	**13,616**	**72.9%**	**$225,075**	**77.8%**	**778,035**	**77.8%**	**55.6**
Oiling Program	3,235	17.3%	$61,953	21.4%	214,159	21.4%	62.3
Road Maintenance	10,381	55.5%	$163,122	56.4%	563,876	56.4%	53.0
Heavy Equipment	**5,072**	**27.1%**	**$64,391**	**22.2%**	**222,585**	**22.2%**	**34.7**
Road Maintenance	1,070	5.7%	$16,219	5.6%	56,066	5.6%	47.0
Road Construction	1,130	6.0%	$28,190	9.7%	97,445	9.7%	44.6
Gravel Program	1,340	7.2%	$11,273	3.9%	38,968	3.9%	27.3
Oiling Program	872	4.7%	$5,730	2.0%	19,807	2.0%	23.8
Shop	660	3.5%	$2,979	1.0%	10,299	1.0%	15.6
Grand Total	**18,688**	**100.0%**	**$289,466**	**100.0%**	**1,000,620**	**100.0%**	**45.2**

New off-road diesel engines are subject to emissions control regulations. The U.S. Environmental Protection Agency (EPA) introduced Interim Tier 4 (IT4) regulations, with which Canada is aligned. IT4 regulations require diesel engines with 174 hp or more to reduce particulate matter emissions by 90% and NOx emissions by 50%. Final Tier 4 regulations take effect in 2014 and will require the exhaust emissions (particulate matter and NOx) to be virtually as clean as the air going into the engine. Such emission reductions are achieved through the use of control technologies such as advanced exhaust gas treatment.

Flagstaff County operates a fleet of 14 graders with an average manufacture date of 2008.6. These graders used a total of $225,075 in diesel in 2010. Three graders were purchased in 2010, representing 21% of the grader fleet. Flagstaff County selected eco-friendly models. A new John Deere 770G Grader was purchased in 2010 for road maintenance. The John Deere 770G has an EPA Tier 3 fuel efficient PowerTech™ diesel engine.

A 160M Cat grader was purchased in 2010 for the Oiling Program. The 160M Cat engine includes ACERT™ technology, which allows the engine to supply more power per unit of displacement without causing premature wear; this reduces emissions during the combustion process by using advanced technology in the air and fuel systems. A John Deere 872 was purchased in 2010 for Road Maintenance; this grader has an EPA

Interim Tier 4 technology engine. Manufacturers of these newer graders are able to achieve emission reductions through advanced engine design, with no or only limited use of exhaust gas oxidation catalysts.

Figure 3-1 John Deere 770G Grader

Wherever practical, an overall reduction in emissions can be achieved by upgrading to newer engine technologies and keeping the average age of the fleet to 3 years old or less. The age distribution of the graders is illustrated in Figure 3-2

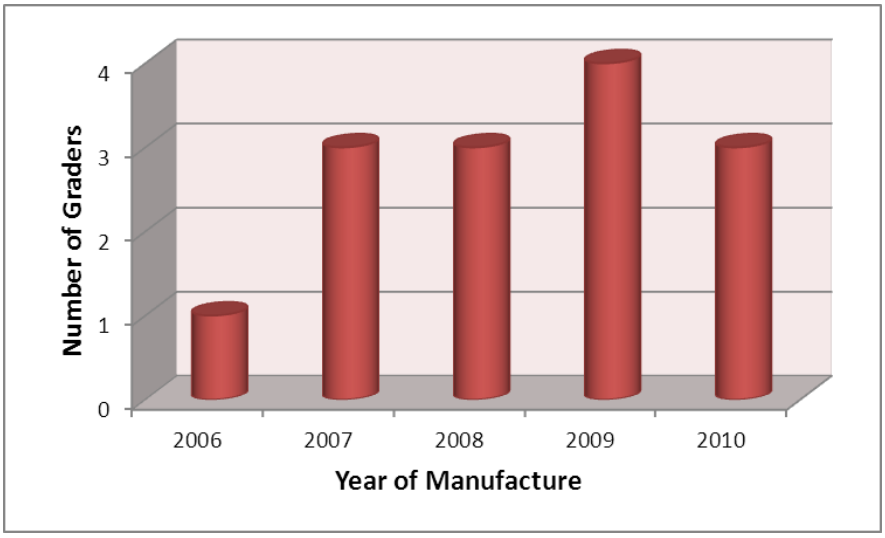


Figure 3-2 Age Distribution of Flagstaff County Graders

A breakdown of CO_2e per unit is presented in Table 3-6. This data can be used by Flagstaff County to evaluate the impact of each grader and assist with identifying graders for replacement.

Table 3-6 Grader Greenhouse Gas Emissions per Unit

Equipment #	Year	Grader Description	Total Hours (2010)	CO_2e per Unit (kg/hr)
G1309	2009	G976 VOLVO	1033	74
G1409	2009	160M CAT	897	73
G1009	2009	140M CAT	1043	69
G610	2010	872G John Deere	1001	67
G707	2007	140H CAT	1240	62
G1407	2007	14M CAT	937	61
G210	2010	770G John Deere	1091	61
G908	2008	140M CAT	934	56
G308	2008	140M CAT	1072	54
G708	2008	140M CAT	1162	54
G107	2007	140H CAT	952	52
G509	2009	G940 Volvo	1202	41
G1210	2010	160M CAT	368	41
G206	2006	140H CAT	684	14

Flagstaff County maintains and operates 16 pieces of heavy equipment, consisting of crawlers, scrapers, loaders, compactors and tractors. Fifty-six percent of this equipment is 5 years old or less. Heavy equipment used $64,391 of fuel and required $33,456 in parts over 2010. The equipment ran a total of 5072 hours, although several of the units were run very little. Calculations were performed to determine the CO_2e from each piece of equipment.

The data presented in Table 3-7 can be used by Flagstaff County to evaluate the impact of specialized equipment and select which vehicles can be considered for replacement based on emissions.

Table 3-7 Greenhouse Gas Emissions from Heavy Equipment

Description	Year	Hours	Total CO_2e (kg)	CO_2e per Unit (kg/hr)
CASE IH 9150 Tractor	1988	252	3,279	13
CASE IH 9170 4WD Tractor	1989	233	9,161	39
6300 John Deere Tractor w/ Loader	1995	18	218	12
544H John Deere Loader	1999	280	5,476	20
420D CAT Backhoe Loader	2001	259	3,026	12
CS563E CAT Compactor	2005	387	7,367	19
D7R XR II CAT Crawler	2006	632	48,429	77
D4G LGP CAT Crawler	2007	135	958	7
815F CAT Compactor	2007	58	3,230	56
627G CAT Scraper	2007	660	90,014	136
297C CAT Skid steer Loader	2008	438	7,637	17
730 CAT Rock Truck	2008	450	13,000	29
EC210C VOLVO Trackhoe	2008	610	20,492	34
544K John Deere Loader	2009	660	10,299	16

Future purchases of heavy equipment should be evaluated for fuel efficiency and reduced emission technology.

3.3 Vehicle Related Impacts

Flagstaff County maintains a large fleet of vehicles, which are primarily light and heavy duty trucks. Table 3-8 summarizes the number of vehicles per department, the average year of vehicles per department and input costs.

Table 3-8 Flagstaff County Vehicle Inputs for 2010

Functional Group	Department	Number of Vehicles	Average Year	Fuel	Lube	Parts	Original Cost of Fleet
Administration	Economic Development	1	2009	$1,139.52	$40.36	$40.86	$28,805
	Emergency Services	1	2007	$5,330	$127	$1,006	$37,868
	Assessment & Taxes	2	2006	$1,292	$41	$583	$57,655
	Health & Safety	1	2009	$1,135	$17	$65	$28,804
	Peace Officers	2	2010	$10,902	$273	$8,809	$71,062
Environment	Parks & Recreation	16	2001	$23,341	$576	$8,007	$526,588
	Agricultural Service Board						
Public Works	Administration	5	2008	$27,982	$651	$10,095	$163,187
	County Shop	7	1998	$11,918	$651	$11,812	$251,795
	Road Construction Program	2	1997	$4,837	$76	$2,314	$54,900
	Oiling Program	8	1998	$16,269	$1,053	$18,816	$330,084
	Gravel Program	11	2007	$93,803	$3,323	$23,290	$1,118,825
	Grader Sheds	3	1995	$2,568	$47	$229	$72,130
	Road Maintenance	7	2003	$19,333	$1,239	$10,675	$467,658
Sub Total Vehicles		**66**		**$219,849**	**$8,115**	**$95,742**	**$3,209,361**
Average			**2004**				

Total County related vehicle travel was ~938,000 km and approximately ¾ of such travel was done with gas vehicles which consumed a total of 115,000 L of gasoline. Diesel related fuel consumption was 103,000 L.

It should be noted that a picker truck assigned to Road Maintenance recorded its usage using hours (instead of km) and therefore is not included in Table 3-8. This truck consumed 1,614 L of diesel and produced 5.5 tonnes of CO_2e.

Of the CO_2e emissions of 672 tonnes for the vehicles in Table 3-8, 53% came from burning diesel and 47% from burning gas. The programs which involved more than 100,000 km of travel included:

- Gravel (227,000 km)
- Public Works Administration (184,000 km)
- Agricultural Services Board (143,000 km)
- Road Maintenance (104,000 km).

Table 3-9 Flagstaff County Vehicle Impacts for 2010

	Distance		Fuel		CO2e		
Emission Source	km	% of Total	Litres	% of Total	kg	% of Total	Avg (kg/km)
Diesel	**225,724**	**24.1%**	**103,372**	**47.4%**	**357,335**	**53.1%**	**1.57**
Gravel Program	127,394	13.6%	75,108	34.4%	259,633	38.6%	1.97
Road Maintenance	40,100	4.3%	12,314	5.6%	42,567	6.3%	1.86
Oiling Program	34,500	3.7%	11,038	5.1%	38,155	5.7%	1.38
Shop	15,230	1.6%	3,187	1.5%	11,017	1.6%	1.24
Agricultural Services Board	8,500	0.9%	1,726	0.8%	5,965	0.9%	0.73
Gas	**712,538**	**75.9%**	**114,862**	**52.6%**	**315,117**	**46.9%**	**0.48**
Office	13,500	1.4%	2,431	1.1%	6,670	1.0%	0.57
Road Construction	23,000	2.5%	4,837	2.2%	13,271	2.0%	0.57
Agricultural Services Board	134,875	14.4%	24,247	11.1%	66,519	9.9%	0.55
Gravel Program	99,500	10.6%	18,695	8.6%	51,288	7.6%	0.52
Signs	6,600	0.7%	1,194	0.5%	3,276	0.5%	0.50
Oiling Program	34,000	3.6%	5,231	2.4%	14,351	2.1%	0.43
Fire	35,000	3.7%	5,330	2.4%	14,623	2.2%	0.42
Public Works Admin.	184,000	19.6%	27,982	12.8%	76,766	11.4%	0.42
Peace Officers	75,500	8.0%	10,902	5.0%	29,910	4.4%	0.41
Shop	34,563	3.7%	4,905	2.2%	13,457	2.0%	0.40
Health & Safety	8,000	0.9%	1,135	0.5%	3,113	0.5%	0.39
Road Maintenance	64,000	6.8%	7,973	3.7%	21,874	3.3%	0.37
Grand Total	**938,262**	**100.0%**	**218,235**	**100.0%**	**672,452**	**100.0%**	**0.80**

The impacts of the gravel program in Table 3-9 include the impacts of gravel trucking after accounting for gravel sales. This calculation and its assumptions are discussed in Appendix 7.3. The greater CO_2e emissions of diesel vehicles in terms of kg CO_2e per km are illustrated in both Table 3-8 and Figure 3-3: engines in diesel trucks are typically larger than those in gas vehicles.

Figure 3-3 also illustrates that there is little correlation between CO_2e per km and vehicle age in the Flagstaff County fleet. Vehicle age is known to influence air pollution emissions due to design changes and improvements in air pollution control devices such as catalytic converters. As vehicles age, the air pollution control equipment deteriorates, causing an increase in emissions such as carbon monoxide and volatile organic compounds.

Flagstaff County has done a commendable job of continuously replacing the fleet, with the average manufacture date of 66 trucks at 2004 and the average manufacture date of 14 graders at 2009; however, it should be noted that there are 10 vehicles exceeding 1.0 kg CO_2e/km (Figure 3-3) which should be inspected for engine emissions. Included in Figure 3-3 are two tractors, which are approaching 30 years old. It should also be noted that the 10 vehicles are predominantly diesel engines, and diesel engines typically produce more torque than gasoline engines for heavy duty applications.

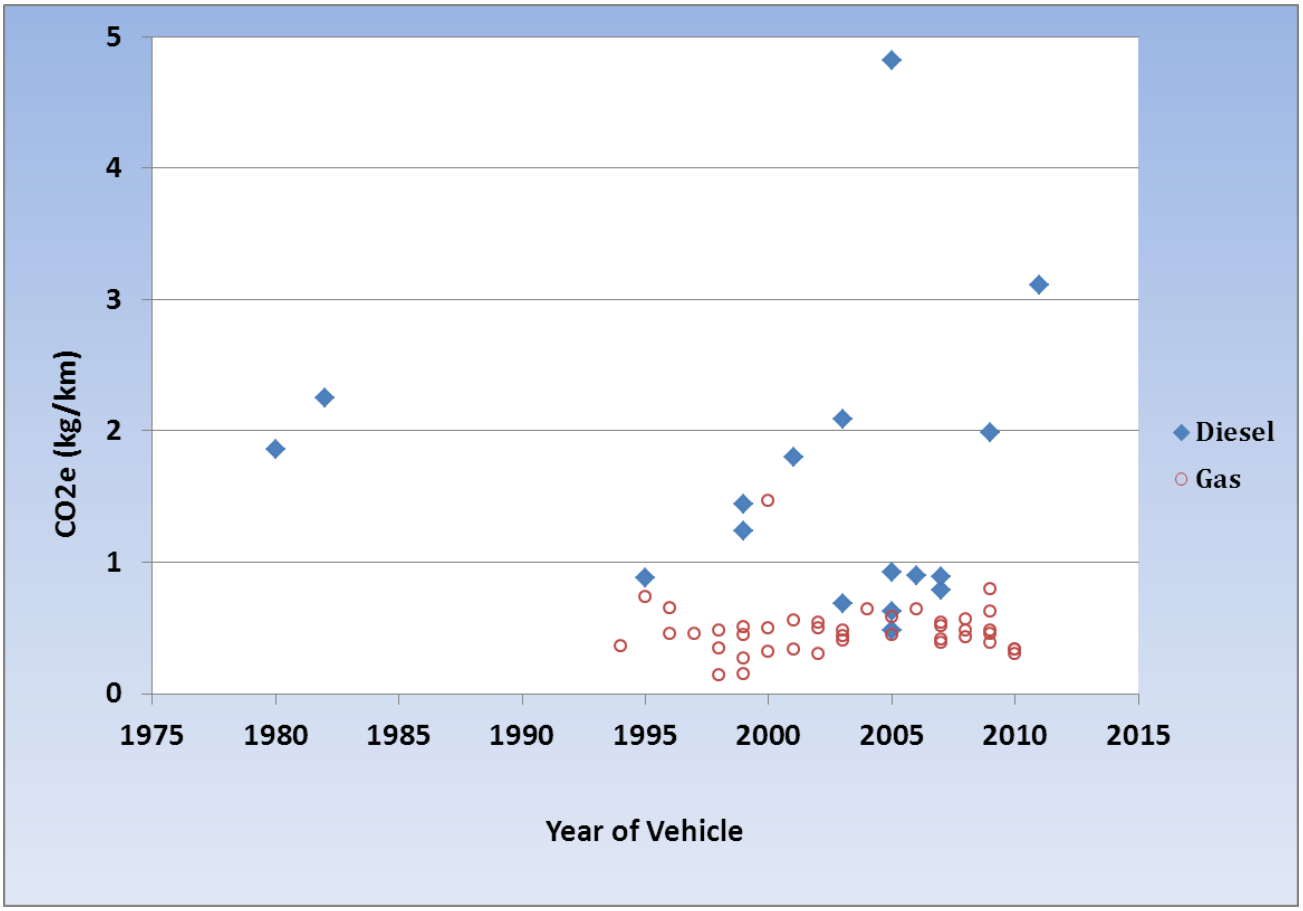


Figure 3-3 Efficiency of Vehicles Based on the Year of Manufacture

3.3.1 Suggested Eco-Friendly Practices

Emission control systems on passenger cars and light duty trucks continue to evolve, achieving more stringent emissions standards with each step. An emission performance standard is a limit that sets thresholds above which further emission control technology is required.

In October, 2010, the Government of Canada committed to reducing its greenhouse gas emissions 17% from 2005 levels by 2020. This target reflects the importance of aligning with U.S. federal regulations and meeting U.S. Environmental Protection Agency (EPA) regulations. Canada is working with the U.S. to reduce emissions from light-duty vehicles.

Cars and light trucks account for about 12% of Canada's total GHG emissions (Environment Canada, 2009). Any significant strategy to address greenhouse gases and pollution must take serious action to address emissions from these vehicles.

The *Passenger Automobile and Light Truck Greenhouse Gas Emission Regulations* are the first regulated national GHG emission standards in Canadian history and will achieve significant and sustained GHG reductions and fuel saving benefits.

The new regulations take effect beginning with the 2011 model year. The regulated standards become more stringent over the 2011 to 2016 model years and will generate progressively larger emission reductions.

Approximately 63% of Flagstaff County's fleet of pick-up and heavy duty trucks is less than 10 years old, with approximately 40% of those vehicles less than 5 years old. This is illustrated in Figure 3-4. Flagstaff County purchases replacement vehicles each year and it is suggested to continue the practice of replacing approximately 7% of the vehicles each year to take advantage of newer technology and reduce maintenance costs. However, vehicles less than 5 years of age can produce more CO2e/km of pollution than older vehicles if they are not properly inspected and maintained.

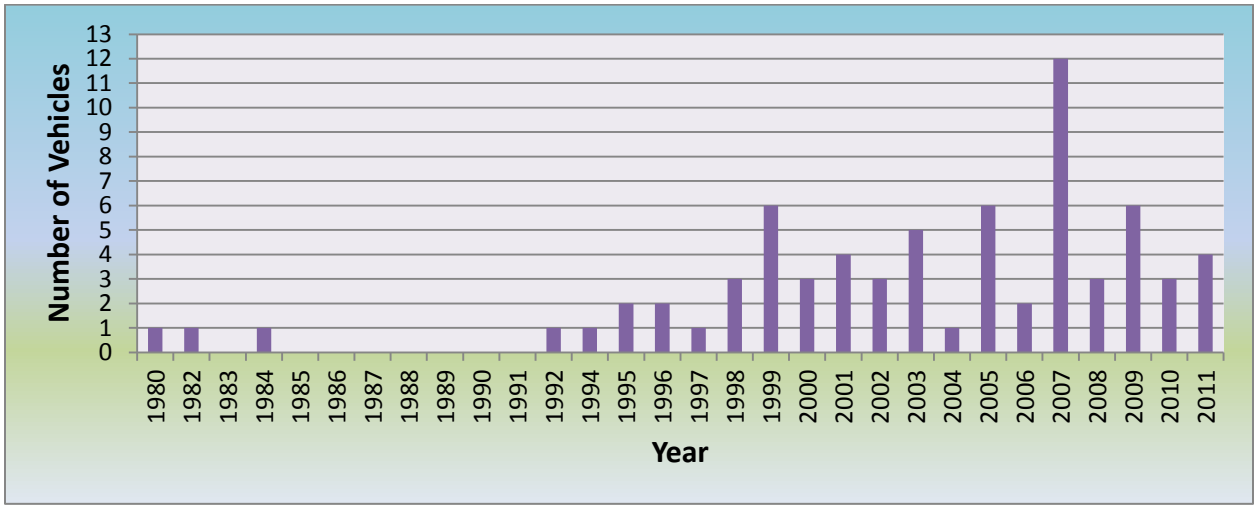


Figure 3-4 Age Distribution of Flagstaff County Trucks

3.3.2 Fuel Efficient Vehicles

Through the authority of the Canadian Environmental Protection Act, 1999 (CEPA), the Government of Canada will be regulating the fuel efficiency of road motor vehicles by establishing stringent standards to progressively tighten limits for greenhouse gas emissions from new cars and light trucks over 2011 to 2016 model years. These standards will align Canada with US national standards for improving fuel economy and reducing greenhouse gas emission (National Resources Canada, 2011). The Government of Canada previously introduced an excise tax on fuel inefficient vehicles and a rebate for highly fuel-efficient vehicles: www.cra-arc.gc.ca/gncy/bdgt/2007/xcs-eng.html

Although hybrid vehicles may not be practical for Flagstaff County due to the low population density, they are worthy of mention. Hybrid vehicles save fuel and emissions by allowing the electric motor with zero emissions to work independently from the gasoline or diesel engine to drive the vehicle. A hybrid vehicle can save money on gasoline, produce 80% less harmful pollutants than comparable gasoline cars, saving approximately 1 tonne of greenhouse gas from entering the atmosphere annually (Hybrid-car.org 2011). Some insurance companies offer discounts on premiums to hybrid vehicle owners.

The County can minimize the impact of day to day vehicle-related business by using the most fuel efficient vehicle to meet the job's needs. When purchasing new vehicles, Flagstaff County can encourage staff to select the most fuel efficient vehicle from the fleet to complete tasks. Decreased fuel consumption translates to better air quality and reduced greenhouse gas emissions; it will also save money by reducing fuel expenses.

- Each litre of gasoline produces 2.4 kg of carbon dioxide (National Resources Canada, 2009).
- Under normal driving conditions, smaller engines deliver better fuel economy than larger engines. (Environment Canada, 2009)
- Options such as power windows and seats increase fuel consumption by drawing extra power from the engine. (Environment Canada, 2009)

Flagstaff County can examine vehicle use as follows:

- Continue tracking fuel consumption in all County vehicles
- Identify the different tasks that vehicles are used for at work and determine the most appropriate vehicle for these tasks

- Identify which vehicles are primarily driven in the city, off road, and on highways - are larger trucks intended for off-road tasks being used in town or on highways?
- Establish a budget for fuel efficient vehicle purchases
- Survey employees for input regarding incorporating fuel efficient vehicles into the workplace; by involving them in the process, they will be invested in the success of the new fuel efficient vehicles

Flagstaff County can implement an action plan by considering the following:

- Maximize fuel efficiency of existing vehicles
- Prioritize the use of specific vehicles for certain tasks
- Have employees share and alternate work vehicles, depending on the job
- Have them sign up to use vehicles on a calendar posted on a shared network drive or bulletin board
- Have all the vehicle keys returned to one location after each use
- Communicate to employees the intentions and purpose of sharing vehicles
- Explain and/or post at key distribution site which vehicles should be used for which tasks
- Dedicate time to researching the various vehicle options

    - See the Green Motor Vehicle Factsheet at: www.onesimpleact.alberta.ca/docs/purchasing.pdf
    - Environment Canada's website: www.ec.gc.ca/education/default.asp?lang=En&n=F6529644-1

- Purchase the most fuel efficient vehicle for the job
- Maintain fuel efficient practices
- Check tire pressure regularly, help drivers to regularly check, adjust and understand the impact tire pressure has on the environment, fuel consumption and on your tires.
- Ensure proper use and regular maintenance
- Continue to track fuel consumption, distances and uses of vehicles
- Calculate and compare the carbon footprint of Flagstaff County before and after major initiatives.

In addition, there are technologies that can be integrated into vehicles to help reduce fuel use, for example:

- Aerodynamic devices installed on the roofs of tractors can result in 2 to 6% fuel savings
- Low rolling resistance tires can help to reduce fuel use by up to 3 to 4% (NRC, 2011)
- Direct tire pressure monitoring systems use pressure sensors located in each wheel to directly measure the pressure in each tire and warn the driver when air pressure in any of the tires drops at least 25% below the recommended cold tire inflation pressure.

The City of Edmonton has a successful driver training program to encourage employees in several departments to improve their driving habits in order to reduce fuel consumption and greenhouse gas emissions. In the first year alone, the driver training program saved an estimated $205,000 (Fleetsmart, NRC, 2011). Fuel-efficient and safe driving techniques are taught to drivers, including how to reduce idling, plan more efficient routes and drive defensively. The average driver records an 11% reduction in fuel consumption applying these instructions (Fleetsmart, NRC, 2011).

In order to encourage driver acceptance of fuel efficient vehicles and driving practices, employees should be reminded that proper driving habits will help save them money with their personal vehicles and the reduction in vehicle emissions contributes to protecting the environment. It is estimated that individual drivers can save at least 300 litres of fuel per year by using fuel-efficient driving practices in their own vehicles – each litre of gasoline saved prevents 2.4 kilograms of carbon dioxide from entering the atmosphere (Fleetsmart, NRC, 2011). Motivation can be provided by giving recognition awards to top drivers in each category of vehicles, e.g. light-duty, heavy-duty, graders).

3.3.3 GPS Tracking System

Driving practices can be monitored by adding a GPS tracking system to the Flagstaff County fleet of vehicles (a GPS project may be already underway), some of the benefits include:

- Improves safety and security
    - Monitor excessive speeding
    - Alerts when vehicles enter restricted areas
    - Recover stolen vehicles/equipment
- Control fuel costs
    - Eliminates unauthorized use of vehicles
    - Eliminate unauthorized route deviations
    - Discourages excessive idling

- Improves supervision and asset management capabilities
    - View current location of all assets and vehicles
    - Improves accuracy of equipment usage for job costing
    - Provides idling, speeding and mileage trends

The cost of a GPS tracking system can vary, depending on the type of system and options selected. From a preliminary discussion with Alex Vielma, of Field Technologies, the initial purchase price per unit is around $200, with a $35 activation fee once installed. Installation could be done by County mechanical staff. The airtime service cost is approximately $30/month per vehicle (GPS Fleet Tracking / GPS Fleet Tracking System).

3.4 Building Environmental Impacts

Building environmental CO_2e impacts are shown in Table 3-10. In terms of CO_2e emissions, 60% are the result of electricity usage and 40% are from building heating. The high value of CO_2e emissions associated with electricity use is a result of fossil fuels being the primary way in which electricity is produced in Alberta. As noted in Table 7-1, each kWh of electricity used is associated with 880 g of CO_2e. For British Columbia – which uses hydro power to generate most of its electricity – each kWh of electricity is associated with only 80 g of CO_2e.

The buildings with the highest CO_2e per m^2 of floor area are, respectively, the complex of buildings at Fish Lake (outhouses, cookhouse, water filtration), the County Main Shop, and the Administration Building. The Fish Lake complex and the Administration Building also have highest electricity costs per m^2. While the buildings at Fish Lake account for only 2.4% of overall CO_2e related building emissions, the County Main Shop and the current Administration Building account for 32.1% and 19.1% of such emissions respectively.

Flagstaff County expect to move into a new administration building late in 2011, which is expected to be more eco-friendly than the current building. Note that a combined electricity bill represented the Parks operations at Fish Lake and Diplomat Trout Pond. The data for the County Main Shop include the impacts of using waste oil as a heating source as calculated in Appendix 7.2.

The buildings with both the highest heating operating costs and highest CO_2e emissions per square meter of area are the Forestburg, Heisler, and Daysland Grader Sheds

which are, respectively, responsible for 5.3%, 2.1% and 3.9% of the overall building related emissions.

Table 3-10 Cost and CO_2e Emissions Associated with Electricity Use and Heating of County Buildings

	Operating Cost			CO_2e		
Emission Source	**$**	**% of Total**	**Avg per m2**	**Total**	**% of Total**	**Avg per m2**
Electricity	**$38,857**	**62.5%**	**$12.3**	**268,824**	**59.9%**	**65**
Fish Lake - 5 Outhouses, Cookhouse, Water filtration	$1,945	3.1%	$47.6	10,986	2.4%	269
County Main Shop	$17,338	27.9%	$10.7	143,905	32.1%	89
Administration Building	$12,150	19.5%	$11.3	85,943	19.1%	80
Alliance Grader Shed	$1,695	2.7%	$8.9	7,559	1.7%	40
Heisler Grader Shed	$1,325	2.1%	$11.4	4,059	0.9%	35
Daysland Grader Shed	$1,240	2.0%	$5.5	5,288	1.2%	23
Strome Grader Shed	$930	1.5%	$5.9	3,406	0.8%	22
Lougheed Grader Shed	$1,130	1.8%	$4.1	5,108	1.1%	19
Forestburg Grader Shed	$1,103	1.8%	$4.9	2,570	0.6%	11
Heating	**$23,308**	**37.5%**	**$7.7**	**180,054**	**40.1%**	**54**
Forestburg Grader Shed	$3,125	5.0%	$13.8	23,640	5.3%	104
Heisler Grader Shed	$1,319	2.1%	$11.4	9,345	2.1%	81
Daysland Grader Shed	$2,990	4.8%	$13.2	17,662	3.9%	78
Lougheed Grader Shed	$2,344	3.8%	$8.6	17,301	3.9%	63
Strome Grader Shed	$1,364	2.2%	$8.6	9,502	2.1%	60
Administration Building	$4,902	7.9%	$4.6	39,739	8.9%	37
County Main Shop	$6,266	10.1%	$3.9	57,644	12.8%	36
Alliance Grader Shed	$999	1.6%	$5.2	5,221	1.2%	27
Fish Lake - 5 Outhouses, Cookhouse, Water filtration	$0	0.0%	$0.0	0	0.0%	0
Grand Total	**$62,165**	**100.0%**	**$10.0**	**448,877**	**100.0%**	**60**

Buildings with the highest cost or CO_2e per m^2 are highlighted in red.

The information available on building water usage is summarized in Table 3-11. The Administration Building uses the most amount of water and also the most water per building area.

Table 3-11 Cost and Associated Water Usage Across Buildings

	Operating Costs			Water		
Building	**$**	**% of Total**	**$/m^2**	**Amount (m^3)**	**% Total**	**Amount per m^2**
Administration Building	$852.3	27.3%	$0.8	1,254.5	81.4%	1.17
Forestburg Grader Shed	$0.0	0.0%	$0.0	152.7	9.9%	0.67
Strome Grader Shed	$231.0	7.4%	$1.5	66.0	4.3%	0.42
Alliance Grader Shed	$328.6	10.5%	$1.7	43.3	2.8%	0.23
County Main Shop	$900.0	28.9%	$0.6	24.0	1.6%	0.01
Lougheed Grader Shed	$420.0	13.5%	$1.5	0.0	0.0%	0.00
Heisler Grader Shed	$385.0	12.4%	$3.3	0.0	0.0%	0.00
Daysland Grader Shed	$0.0	0.0%	$0.0	0.0	0.0%	0.00
Grand Total	**$3,116.9**	**100.0%**	**$1.2**	**1,540.5**	**100.0%**	**0.31**

Buildings with the highest water use per m^2 are highlighted in red.

Note that Daysland Grader Shed is not charged for water and sewer; Heisler Grader Shed pays an annual fee; Lougheed Grader Shed pays a bimonthly fee and the County Shop pays a basic monthly fee. Insufficient information was available to fairly evaluate water usage and waste production.

3.4.1 Suggested Eco-Friendly Practices – Gas and Electricity

A variation in heating costs and electricity usage per square metre among the grader sheds is evident in Table 3-10. The Forestburg Grader shed heating appears to contribute the most CO_2e, at 5.1% of the County total. Flagstaff County has increased energy efficiency by renovating and insulating one grader shed per year. Renovations to the Lougheed Grader Shed are finished; the Forestburg Grader Shed is scheduled for renovations in 2011 and the Daysland Grader Shed will be upgraded in 2012.

The renovations bring about a noticeable reduction in greenhouse gas emissions per square metre: the renovated Lougheed Grader Shed produces 63 CO_2e/m^2, whereas the Forestburg Grader Shed produces 104 CO_2e/m^2.

In addition, energy efficient lights have been installed at the Lougheed Grader Shed and County Shop to lower energy consumption. Golder Associates, in their report of December 2009 recommended the following energy efficiency measures for the Grader Sheds and County Shop:

- Draft exclusion by sealing gaps around doors to reduce heat loss
- Faucet aerators to reduce water use
- Lighting retrofit
- Improve light switch controls to eliminate unnecessary use
- Add controls to existing Grader Shed ventilation to automatically turn on when humidity is high
- Add exhaust fans and controls to Lougheed and Heisler Grader Sheds
- Air curtains or high speed doors to reduce heat loss when roller doors are opened

Adoption of these measures was anticipated to reduce utility bills for the Public Works buildings by around 15%. To date, draft exclusion has been completed on all grader sheds and will continue on an ongoing basis as required. Lighting retrofit has been finished on the Lougheed Grader Shed and County Shop. Faucet aerators, light switch controls, air curtains/high speed doors, ventilation controls and exhaust fans have not

been implemented. The opportunity to lower the energy consumed by Public Works buildings still exists.

The Office of Energy Efficiency, National Resources Canada, has released information relating to energy consumption between residential and commercial buildings. The results summarized in Figure 3-5, show that 55% of energy consumption came from space heating. Lighting was 11% for a comparison.

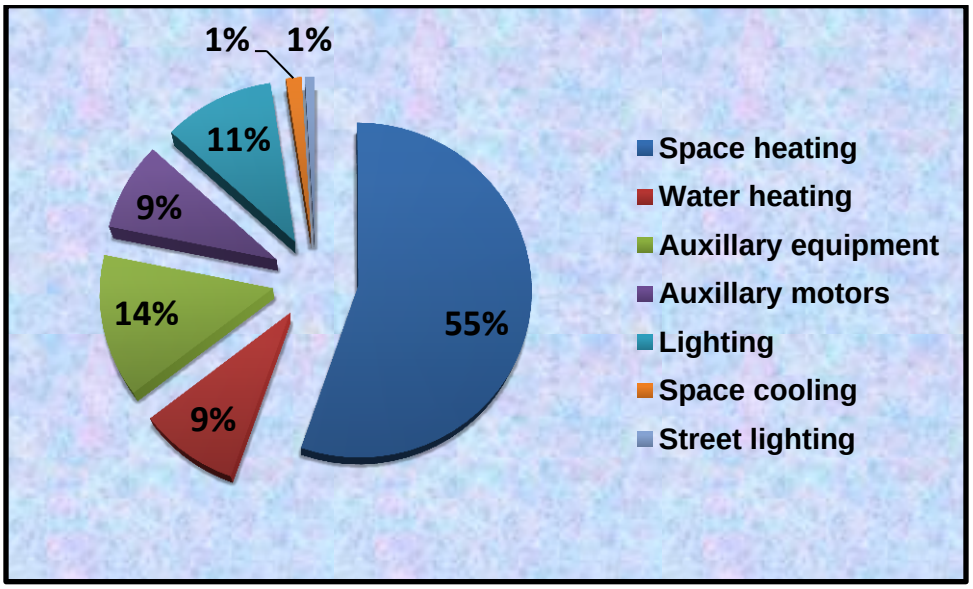


Figure 3-5 Secondary Energy Use by End Use

(2008 Alberta Commercial/Institutional Data – National Resources Canada)

For the most significant impacts on greenhouse gas emissions and heating costs, strategically switching to alternative fuels, such as wood biomass heating for selected buildings, could result in a potential 40% reduction in the cost of energy and CO_2e.

As previously stated, electricity generation in Alberta is primarily from coal, which produces more GHG's than hydro, nuclear or wind power. Therefore, electricity use should be minimized wherever possible. Some suggestions for reducing electricity use are:

- Enable the "sleep mode" feature on computers, allowing less power to be used during periods of inactivity.

- Configure computers to "hibernate" automatically after 30 minutes or so of inactivity. The "hibernate mode" turns the computer off in a way that doesn't reload everything when it is switched back on. Allowing the computer to hibernate saves energy and is more time-efficient than shutting down and restarting from scratch. Shut down computers at the end of the day.

- Unplug seldom-used appliances, such as an extra refrigerator that contains just a few items; this may save around $10 every month on the utility bill.

- Unplug chargers when not charging. Every office has many power supplies to charge cell phones, PDA's, digital cameras, cordless tools and other gadgets. Keep them unplugged until needed.

- Use power strips to switch off computers when not in use for lengthy periods of time to reduce the "standby" power consumption.

- Encourage staff to turn off lights when leaving a room, including unused conference rooms and when stepping out during lunch breaks. Motion sensor lighting may be an alternative option in some areas. Work by daylight when possible – a typical commercial building uses more electrical energy for lighting than anything else.

- Lower the peak demand for electricity to improve the load factor and reduce the amount paid per kWh on a demand rate structure. Examining how and when electricity is used may reveal potential ways to control the load factor. Scheduling or staggering large electric loads so they don't start at the same time will also improve the load factor.

3.4.2 Examination of Burning Waste Oil and Suggested Eco-Friendly Practices

Flagstaff County is a strong proponent of alternative fuels, evidenced by the re-use of lubricant and other waste oils for building heat at the County Main Shop. For the last 10 years the County Shop has used a Reznor waste oil heater to provide approximately half the shop's heating requirements, pictured in Figure 3-6. The Reznor model RA250 is a fan-type unit heater with a propeller fan designed for air delivery to open areas. Oil passes from a supply tank through an oil filter and screen to the heater. An 8" diameter flue provides exhaust for the system.

Waste oil from County vehicles and equipment is collected in a 5000 gallon storage tank throughout the warmer months, and provides heat for the shop in cooler months until the supply runs out – usually around February. Supplemental overhead infrared radiant heating is used when heat from waste oil is unavailable.

Figure 3-6 Reznor Waste Oil Heater at the County Shop

In order to utilize the waste oil in an eco-friendly manner, it is necessary to have a properly designed and operated combustion heating system as can be seen at the County Shop. There are many substances in waste oil which are not combustible and cause substantial environmental and combustion concerns.

Used lubrication oil from internal combustion engines is designated as a hazardous waste for disposal (Waste Type 201) by the Alberta User Guide for Waste Managers. Oil must have a minimum heating value of 5500 Btu/lb to qualify as an alternate fuel.

Burning used oil is typically less polluting than coal combustion; however, used motor oil may contain minute quantities of:

- Gasoline
- Additives (detergents, dispersants, oxidation inhibitors, rust inhibitors, viscosity improvers)
- Nitrogen and sulfur compounds
- A broad range of aromatic and aliphatic hydrocarbons with molecular chain lengths ranging from C15 to C50
- Metals such as lead, (Pb), zinc (Zn), calcium (Ca), barium (Ba) and magnesium (Mg)

These contaminants arise from normal wear of engine components and from heating and oxidation of lubricating oil during engine operation. Used oil may contain higher percentages of polycyclic aromatic hydrocarbons (PAHs) and additives compared to fresh oil and PAH compounds represent a direct hazard to the environment and human health (Hewstone 1994; Vazquez-Duhalt 1989).

Waste oil heaters are designed for combustion of typical crankcase oils, transmission fluids, hydraulic fluids and # 2 heating oil, in any combination up to SAE-50 wt. Emission control measures for the combustion of waste oil include pre-treatment to remove the pollutant precursors. In addition to reducing pollutants, emission controls help improve combustion efficiency and reduce erosion and corrosion of internal surfaces.

Typical pre-treatment measures include:

- Blending waste oil with virgin fuel oil to dilute hazardous components
- Sedimentation and filtration to remove water and large particles (> 10µm)
- Clay contacting – agitation of a mixture of very fine clay and oil at an elevated temperature followed by filtration for removal of contaminants and de-colourization

- De-metallization by acid, solvent or chemical contacting
- Thermal processing to remove residual water and light ends

Burning waste oil creates similar greenhouse gas emissions to burning diesel fuel (~ 2.8 kg CO_2e/L). In 2010, approximately 23.1 tonnes CO_2e was produced from burning waste oil at the County Shop, which represents < 1% of the County's total CO_2e (Appendix 7.2). In comparison, natural gas heating at the County Shop generated 50.7 tonnes of CO_2e.

The combustion of used oil yields a heating value comparable to natural gas. The average heating value of used oil is between 19.5 – 20.3 MJ/kg, which is approximately 10% less than the average natural gas heating value of 20.56 – 23.72 MJ/kg (UN Basel Convention 2005).

The cost of recycling used oil in Alberta is minimal. The Alberta Used Oil Recovery Program uses an Environmental Handling Charge which is charged to the first sellers of oil and oil filters, in order to fund recovery processes. Recovery is funded through financial incentives known as *Return Incentives* for the various collectors of the waste materials.

A CSA-approved wood furnace would be an eco-friendly alternative to supplement natural gas or waste oil heating at the County Shop. Fossil fuel costs are variable, trending higher over the long term, making renewable energy an attractive fuel source. The net CO_2e from burning local wood is near zero; the wood will inevitably release its carbon as CO_2 when it dies and rots. Using surplus wood, or wood obtained from a managed woodland where trees are replanted is a sustainable carbon-neutral source of energy.

The carbon dioxide released when burning wood (~ 1.9 kg CO_2/kg wood) is balanced by the fact that this carbon was taken up by the tree from the air when it grew. Notwithstanding, wood burning cannot be completely carbon neutral because of the fossil fuel used in the harvesting, preparation and transportation of the wood.

3.5 Impacts on Land

3.5.1 Oil and Gas Activity

Considerable oil and gas activity occurs around Flagstaff County. Oil and gas activity can cause permanent disruptions to the environment and its residents including: increased traffic, odours, negative aesthetics, noise, reduced arable area, increased weeds, damaging gravel roads, poor water well quality and land use conflicts.

A. Oil and Gas Facilities

Information pertaining to oil and gas facilities, wells and pipelines was obtained from the Energy Resources Conservation Board (ERCB). There are a total of 380 oil and gas facilities in Flagstaff County, shown in Table 3-12. These include several types of upstream oil and gas facilities, such as oil and gas batteries, compressor stations, as well as disposal, flaring and treating facilities. Batteries are the most numerous.

Table 3-12 Active Batteries and Facilities in Flagstaff County

Type of Facility	# Active
Gas Single-Well Battery	112
Crude Oil Single-Well Battery	70
Compressor Station	39
Gas Multiwell Group Battery	38
Gas Gathering System	29
Crude Oil Multiwell Proration Battery	23
Disposal Well	23
Field Meter Station	9
Enhanced Recovery Scheme	7
Gas Test Battery	7
Crude Oil Multiwell Group Battery	6
Gas Plant Sweet	3
Gas Plant Acid Gas Flaring > 1 T/D Sulphur	3
Acid Gas Disposal	2
Gas Plant Sulphur Recovery	2
Gas Plant Acid Gas Flaring < 1 T/D Sulphur	2
Tank Farm/Oil Loading and Unloading Terminal	2
Gas Multiwell Effluent Measurement Battery	1
Gas Transporter	1
Non-Reporting Meter Station	1

A battery is an upstream facility in an oil or natural gas field that receives untreated oil and/or natural gas from one or more wells. Oil, gas and water are separated at this facility, and the separated liquids and gases are transported by truck, rail or pipeline for further processing or distribution. The water may be injected into a local well where it is disposed into a geologic formation deep beneath the earth's surface.

A single well battery is a production facility for a single well whereas a multiwell battery is a production-reporting entity consisting of two or more wells where production components are separated and measured at each wellhead; production is combined after measurements.

B. Oil and Gas Wells

There are approximately 7250 wells within Flagstaff County, 2343 of which are active wells; 1004 are suspended and 3903 are abandoned. The types of wells are shown in Table 3-13.

Well Status Code Descriptions:

- Active – currently producing oil and/or gas.
- Drilled and cased - has been drilled and cased but not immediately put on production.
- Abandoned and whipstocked - a portion of a well that has been drilled and then abandoned and requires an event sequence to be created. A whipstocked leg is then drilled from the original wellbore.
- Junked and abandoned - equipment has been lost down the well and cannot be retrieved economically; the well is plugged and abandoned.
- Inactive – the well has not reported any production, injection or disposal activities for a period of 12 consecutive months or longer.
- Suspended - a well in which production or injection operations have ceased for an indefinite period of time. A well licensee is required to suspend a well within 12 months after the last production or injection has occurred.
- Abandoned - when a well becomes unprofitable or unproductive, production is ceased by abandoning the well. In abandoning a well, part of the casing is removed and one or more cement plugs are placed in the borehole to prevent migration of fluids between the different formations penetrated by the borehole.

Table 3-13 Wells Located in Flagstaff County

Well Status	# Wells
Abandoned	2001
Abandoned & Re-entered	31
Abandoned & Whipstocked	63
Abandoned Zone	285
Crude Oil Abandoned	388
Crude Oil Abandoned & Re-entered	7
Crude Oil Abandoned & Whipstocked	10
Crude Oil Abandoned Zone	247
Crude Oil Flowing	53
Crude Oil Pumping	1074
Crude Oil Suspended	594
Crude Oil Drilled & Cased	331
GAS	17
GAS Abandoned	373
GAS Abandoned & Re-entered	20
GAS Abandoned Zone	430
GAS Flowing	542
GAS Pumping	39
GAS Suspended	374
ACID-G	4
GAS Testing	16
Junk & Abandoned	5
LPG	4
LPG Suspended	7
WATER	93
WATER Abandoned	21
WATER Abandoned Zone	22
WATER Suspended	29
Other	170
Total wells	7250

The ERCB has recently expanded the “dead zone” setbacks on abandoned wells, meaning no permanent structures can be built within the dead zone. The old regulations required 10 x 15 meters around an abandoned well; this has increased to 20 x 35 meters with an additional 8 meter road access to the abandoned well. Landowners can plant crops over an abandoned well and once an abandoned well receives a reclamation certificate from Alberta Environment, the landowner is no longer compensated for the lease site. For landowners, inactive wells represent a loss of

productive farmland and an increased risk of undetected and continuing soil and groundwater contamination.

ERCB *Directive 020: Well Abandonment Guide* (June 2010), sets out minimum well abandonment requirements that ensure the integrity of the wellbore and protect public safety and the environment. After surface reclamation is complete and a certificate is issued by Alberta Environment, the well site lease notation may be removed from the title. At this point, there is nothing visible on the surface or on the title to indicate the presence of an abandoned well.

Adequate access to an abandoned well site needs to be maintained in case of a leak, which is rare, but requires a service rig and/or a drilling rig and a larger work area and access. Since the abandoned well bore is not visible from the surface, it represents a risk to excavation and construction equipment and safety of the equipment operator if the locations of abandoned wells are not properly identified.

In December 2009, the ERCB estimated the total liability for the reclamation of wells, facilities and pipelines in Alberta, both active and inactive, at over $19 billion (ERCB Liability Management Rating Report, 2009). Abandoned well site records and information about abandoned well locations by township can be obtained from the ERCB Information Services by telephone at 403-297-5311 or by email at Infoservices@ercb.ca.

Reclamation falls under the jurisdiction of Alberta Environment and there are no current timelines in place to reclaim well sites. Information on surface reclamation standards and procedures can be obtained from Alberta Environment.

C. Pipelines

Pipelines are also abundant in Flagstaff County. Table 3-14 and Table 3-15 provide information on the types and number of pipelines.

Table 3-14 Number of Pipelines in Flagstaff County

Pipeline Status	# Pipelines
Operating	2400
Permitted	62
Discontinued	676
Abandoned	881
Total	**4019**

Abandoned pipelines are no longer in operation; all fluids are removed, the pipeline is cleaned, left in a safe condition, plugged or capped at both ends and physically isolated from any operating facility. Abandoned pipelines typically stay in the ground as there are environmental issues to consider when removing a pipeline.

Discontinued pipelines are not currently in operation. The company must ensure the pipeline is physically isolated or disconnected from any operating facility and it is left in a safe condition with corrosion control measures maintained.

Table 3-15 Types of Pipelines in Flagstaff County

Substance	# Pipelines
Natural Gas	1148
Oil Well Effluent	957
Salt Water	99
Crude Oil	74
Sour Natural Gas	70
Fuel Gas	43
Fresh Water	5
LVP Products	4
Total Operating	**2400**

Planning for future oil and gas development could include polling County residents for their opinion. Questions could include impression of current projects in the residents' area and potential or actual impacts of the projects on resident lifestyle.

3.5.2 Seismic Lines

Seismic exploration is used to identify and map oil and gas deposits prior to drilling. The technique involves the production of sound waves at the surface, recording the waves that are reflected back from underlying features, and interpreting these reflections to produce a computer model of subsurface geological structures.

Historically, seismic lines were linear, with widths between five and eight metres, to accommodate very large equipment such as a vibrator truck or drill truck. A significant industrial footprint was left by the lines that were cleared for the placement of dynamite charges. The practice of the day did not include replanting or seeding these lines; they were expected to regenerate naturally. However, once these lines became accessible to other land users, vegetation regrowth was hindered. As a result, many historic seismic exploration lines remain visible on the landscape. Those long straight lines also have an impact on wildlife. Predators can easily travel seismic corridors, prey is more exposed and habitat fragmentation occurs. Seismic lines also act as vectors for the movement of invasive plant species (Maxcy and Litke, 2010).

Low-impact seismic is currently the Government of Alberta and industry standard, which seeks to minimize the disturbance of soil and ground cover with seismic lines that are an average of 5 metres wide and follow a meandering course to preserve larger trees.

Seismic lines, while occupying a small area of the landscape, may have ecological impacts that are disproportionately large relative to their size. A new initiative for Flagstaff County could involve working with landowners to identify and reclaim any land disturbances from seismic activity.

3.5.3 Wetland Areas

Alberta's wetland areas are under considerable pressure from development in the province. Alberta has lost approximately 64% of its slough/marsh wetlands in the settled area of Alberta (Alberta Environment, 2008). Wetlands play an important role in improving the quality and quantity of our water supplies in addition to providing valuable wildlife habitat.

Flagstaff County's support to the Iron Creek Watershed Improvement Society facilitates the preservation of impacts on land in the region. In Alberta, a "Natural Area" designation allows for the preservation and protection for sites of local significance and provides opportunities for low-impact recreation and nature appreciation activities.

Flagstaff County should continue to examine and identify the potential for the designation and protection of “Natural Areas” within the jurisdiction.

In addition, Canada’s “Ecological Gifts Program” provides a way for landowners with ecologically sensitive land to protect nature and leave a legacy for future generations. The program offers significant tax benefits to landowners who donate land or a partial interest in land to a qualified recipient. To date, more than 140,500 hectares (347,183 acres) of habitat have been designated, many of which are home to some of Canada’s species at risk (Environment Canada, 2010).

3.6 Impacts from Waste Materials

Sanitary sewage collection and waste disposal service for buildings within Sedgewick are provided by the Town. The sewer system has been undergoing significant upgrades; and the potable water treatment plant and related processes also require major upgrades. The current Administration building and the County Shop are connected to the Sedgewick sewer system.

The Public Works department is responsible for the majority of the physical operations in Flagstaff County and is the largest generator of a variety of waste. Overall recycling and diversion of waste practices, determined from communication with Flagstaff County staff, are summarized in Table 3-16.

Table 3-16 Flagstaff County Waste Diversion

Waste Stream	Diversion
Sewage	County buildings use town of Sedgewick sewer
Organic Material	Compost bins in Sedgewick & Hardisty, composting at FWM
Paper	Mixed paper recycling bins in municipalities
#2 Plastic	#2 plastic recycling bins in municipalities
Cardboard	Cardboard recycling bins in municipalities
E-Waste	Collected at transfer stations, recycling at FWM
Concrete	Crushed & recycled at FWM
Batteries	Collected & recycled
Chemical Containers	Triple rinsed, collected by FWM, recycled at Swan Hills
Scrap Metal	Stored, picked-up & recycled at FWM
Vehicle & Equipment Batteries	Recycled
Used Oil & Filters	Stored & Recycled at FWM
Tires	Stored & Recycled by FWM
Wood	Re-used, combusted

Municipal solid waste from Flagstaff County is collected, sorted by category, recycled, and thereby diverted from the landfill by Flagstaff Waste Management (FWM). According to the *Landfill Solid Waste Diversion Feasibility Study* (Harfield, Abboud, 2010), recycling accounted for 22.1% and diversion of organic waste and combustibles was 6.7% for a total diversion of 28.8% in 2009, as shown in Table 3-17.

Table 3-17 Flagstaff Waste Management Diversion

2009 Flagstaff Waste Management	
Recycling	22.1%
Diversion of organic waste & combustibles	6.7%
Total Diversion	28.8%

The amount of waste landfilled and diverted from 2002 to 2009 is plotted in Figure 3-7 to illustrate the trend in waste management. Over the 8 year period, the amount of waste landfilled has decreased by approximately 20%, with a 185% increase in diversion. Flagstaff County promotes recycling and waste reduction by providing recycling facilities and educating the public to separate waste. Additional recycling graphs can be found in Appendix 7.4.

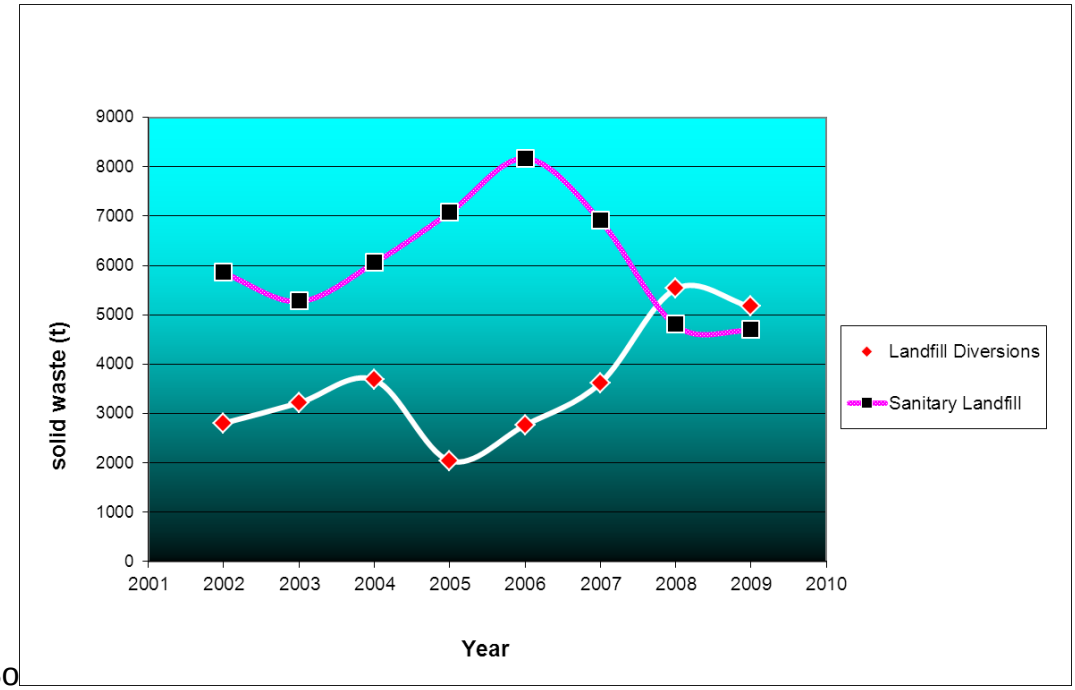


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Figure 3-7 Flagstaff Waste Management Landfill Diversion Trends

The Solid Waste Management Diversion Implementation Project is an ongoing eco-friendly initiative that aims to increase diversion of traditional waste from the landfill. Reducing or preventing landfill waste has many potential environmental and economic benefits. Sustainable diversion of waste from the landfill will increase its life expectancy. Areas to focus on include: organic waste management and composting; construction and demolition (C&D) waste management, pollution prevention, recycling and awareness campaigns.

The current practice of burning construction waste wood at FWM satellite locations should be evaluated for potential biomass combustion heating opportunities. Clean untreated biomass is a valuable alternative fuel.

3.7 Emissions per Employee, Functional Group and Activity

The most significant Flagstaff County activities were examined and identified in their production of 2,438 tonnes of CO_2e in 2010. Comparatively, 37.2 mega tonnes of greenhouse gases are emitted from the oil sands each year – equivalent to over five million cars on the road. Flagstaff County contributes approximately 0.001% to Alberta's total annual GHG emissions (Canada's Oil Sands, 2011).

A useful measure of eco-friendliness can be average annual emissions per employee, calculated in Table 3-18; this is based on approximately 55 employees at Flagstaff County, which varies with the season. Flagstaff County greenhouse gas contributions per employee are approximately 44.3 tonnes CO_2e per year. Comparatively, the average annual CO_2e per capita in Canada for 2008 was 16.4 tonnes (CDIAC, 2008).

Table 3-18 Average Annual Emissions per Employee (2010)

Source of Emissions	# Employees	Total CO_2e (t/yr)	Emissions per Employee (tCO_2e/yr)
graders, trucks, road building & repair, electricity, heavy equipment, heating	55	2,438	44.3

The average annual emissions per employee are broken down by functional group in Table 3-19. The emissions per employee in the Environment functional group may be inflated and needs to be adjusted to include summer staff.

Table 3-19 Emissions per Employee via Functional Group

Functional Group	# Employees	CO_2e		Emissions per Employee (tCO_2e/yr)
		kg	% of Total	
Public Works	29	2,175,524	89.2%	**75.0**
Administration	23	179,997	7.4%	**7.8**
Environment	4	83,470	3.4%	**20.9**

The percent of CO_2e contributions on a functional group basis is displayed in Figure 3-8. The Public Works, Administration and Environment functional groups contribute 89%, 7% and 4% to Flagstaff County's GHG emissions.

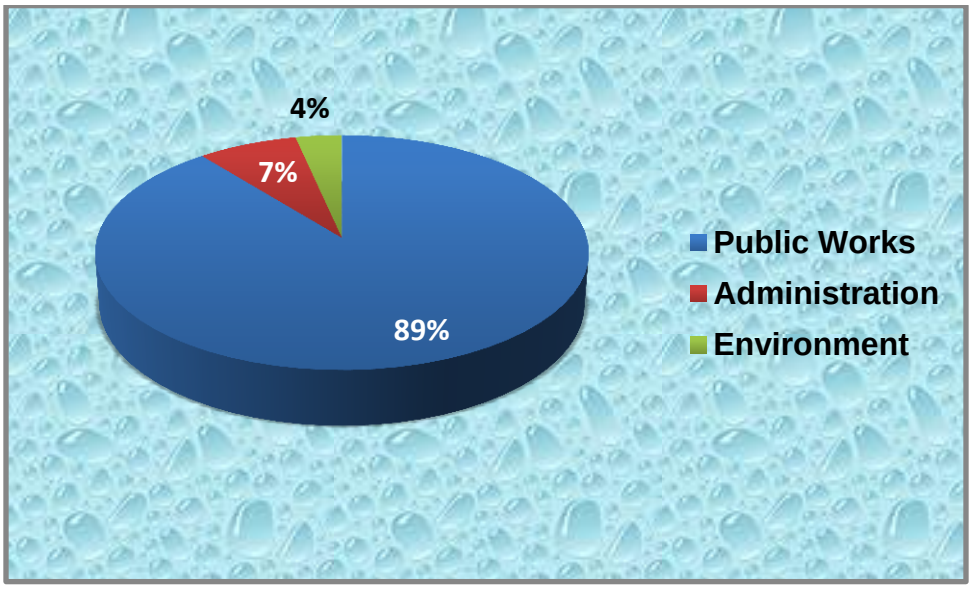

Figure 3-8 Percent of CO_2e Contributed by Functional Group

Vehicles are the major contributor when similar activities are combined, responsible for 81% of Flagstaff County's GHG emissions. Electricity and heating contribute 11% and 8% respectively, as illustrated in Figure 3-9.

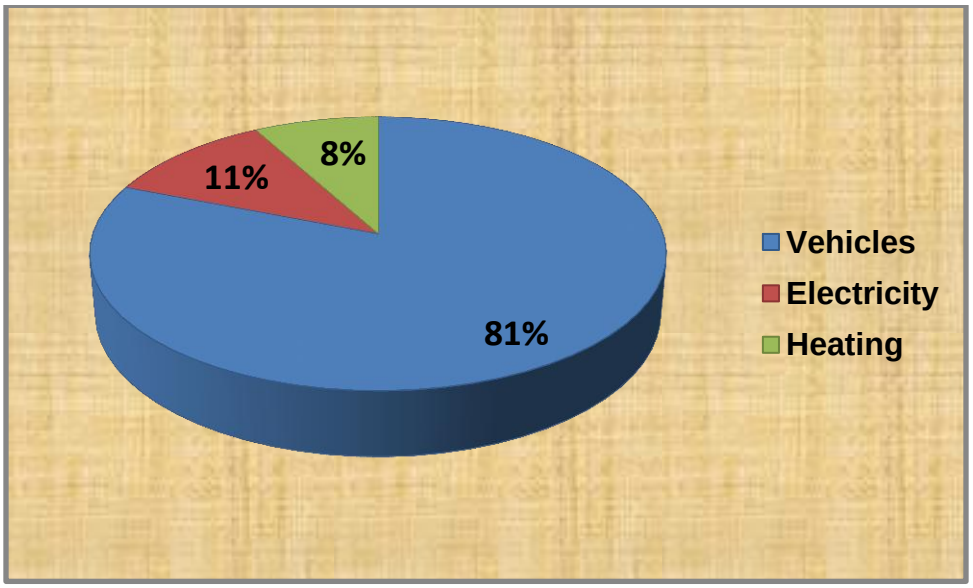

Figure 3-9 Percent of CO_2e Contributed by Activity

3.8 Other Improvement Opportunities

3.8.1 Afforestation

Planting trees is an excellent approach to offset the County's carbon footprint and become carbon neutral. Trees absorb carbon dioxide through photosynthesis to produce oxygen and wood. Planting trees also provides wildlife habitats, reduces soil erosion, rejuvenates the native tree population and enhances the landscape.

Trees are a *Carbon Sink*, which naturally absorb more CO_2 from the air than they give off. Farming and forestry practices which remove forests and wetlands contribute to greenhouse gas emissions. Flagstaff County should continue with the Shelterbelt Enhancement Program and encourage the community and employee volunteers to work together in planting trees and natural vegetation.

3.8.2 Energy Efficient Lighting

Flagstaff County's upgrade to energy efficient lighting is ongoing. Some retrofits have been completed and more are planned for this year. The new generation of energy efficient lighting can use up to 75% less energy and last up to 10 times longer. Most new bulbs provide the same light output but use lower wattages and produce 75% less heat than traditional lighting.

Table 3-20 provides an example of cost savings by replacing one 60 Watt incandescent bulb with a 13 Watt compact fluorescent light (CFL). Replacing one bulb in this manner can save around 118 kg CO_2 per year (GE Lighting 2011).

Table 3-20 Example of Cost Savings (GE Lighting, 2011)

	13W Compact Fluorescent Bulb	60W Incandescent Bulb
Initial Purchase Price (per bulb)	$3.77	$0.27
Replacement Costs (estimated 7 bulbs)	$0.00	$1.89
Energy Costs (based on $0.10/kWh, 8000 hr bulb)	$12.00	$48.00
Total Cost	$15.77	$50.16
Estimated Savings	**$34.39**	

LED light bulbs are also energy efficient. The operational life of current white LED lamps is 100,000 hours, or 11 years of continuous operation. The life of incandescent bulbs is approximately 5000 hours. An LED circuit approaches 80% efficiency, where 80% of the electrical energy is converted to light energy and the remaining 20% is lost as heat energy. Incandescent bulbs operate at around 20% efficiency (LightComp LED Corp, 2011).

Retrofitting old T12 fluorescent tubes with T8 tubes and replacing old magnetic ballasts with electronic ballasts will improve energy efficiency. Table 3-21 provides retrofit replacement tubes for old T12 tubes. The T8 tube is one inch in diameter, compared with one and a half inches for the traditional T12 tube. A 32 watt T8 lamp will use approximately 20% less energy to provide the same light output as a 40 watt T12 lamp. T8 lamps provide optimum system efficiency when used with electronic ballasts. This combination provides significant savings in energy costs (Sylvania, 2011).

Table 3-21 Retrofit Replacement Fluorescent Tubes

Tube Diameter in 1/8"	Nominal Length		Nominal Watts	Notes
	feet	mm		
T8	2	600	18 W	retrofit replacement for 2 ft T12 20 W
T8	3	900	30 W	
T8	4	1200	36 W	retrofit replacement for 4 ft T12 40 W
T8	5	1500	58 W	retrofit replacemement for 5 ft T12 65 W
T8	6	1800	70 W	retrofit replacement for 6 ft T12 75/85 W
T12	8	2400	100 W	retrofit replacement for 8 ft T12 125 W

High intensity discharge metal halide lamps (HID) are being phased out for environmental disposal reasons. Replacing HID lamps by substituting a lower wattage system will result in energy savings; for example, replacing a 400W lamp with a 360W lamp will save 40 watts of power and $80 in energy costs over the life of the lamp. In addition, the colour and uniform quality of the lighting is improved (Sylvania, 2011).

Recycling used fluorescent tubes, CFLs and high intensity discharge lamps is an eco-friendly practice – the primary advantage is diversion of mercury from the landfill. The glass tubing can be turned into new glass articles; the brass and aluminium in the end caps can be reused; the internal coating can be reprocessed for use in paint pigments, and the mercury contained in the tube can be reclaimed and used in new ones. Proper recycling prevents emission of mercury into the environment; however, the actual scrap value of the materials salvaged is typically not enough to offset the cost of recycling. A fluorescent lamp contains approximately 15 mg of mercury on average and a broken fluorescent tube will release its mercury content.

County residents should be encouraged to recycle fluorescent and other mercury-containing lamps and replace with eco-friendly alternative lighting.

3.8.3 Solar Panel-Equipped Vehicles

Specialty vehicles can be equipped with solar panels to allow the driver to power two-way radios, laptops and warning lights without idling the vehicle's engine. This reduces emissions from entering the atmosphere and can save up to 1 tonne CO_2e per vehicle per year (Strathcona County, 2011).

Solar panels cause approximately 3.2 kg CO_2 emissions per watt during their production and will save that amount over about 10 years, not including transport and disposal (Lilo, 2011).

3.8.4 Toilet Replacement Program

The common average toilet uses approximately between 15-22 litres of water per flush. Replacing existing toilet fixtures with ultra-low flush (ULF) or high efficiency toilets (HET) is a proposed eco-friendly initiative. High-efficiency toilets (HET) generally offer significantly better water savings than other toilets, without compromising flushing performance. HETs must flush with no more than 4.8 L. Dual-flush models, that is, toilets that offer the consumer the choice of using a full 6-L flush to remove solid waste or a half flush to remove liquid waste, also qualify as HETs.

To help consumers make a more informed decision, in 2003, Canada Mortgage and Housing Corporation (CMHC) joined the Canadian Water and Wastewater Association (CWWA) and nearly two dozen other housing and municipal partners across Canada and the United States to create the *Maximum Performance (MaP) Testing Program*. The goal of the MaP initiative was to test a wide range of popular toilet models under realistic conditions. The result of their study found that flush volumes were reduced by 68% in single-family dwellings, 56% in office washrooms and 52% in restaurants.

The resulting report contains information to help consumers compare different toilets and decide which model is right for them. The report is updated on a regular basis to reflect the latest models and changes in performance standards. The most up-to-date edition is available free of charge from the CWWA website at www.cwwa.ca.

Dual-flush toilets typically perform much better than single flush models that use 4.8L of water or less and have similar overall water usage. The choice between single- and dual-flush toilets is now related more to personal consumer preference than cost or water savings.

Composting toilets or "waterless" toilets are considered very eco-friendly and of course, since they use little to no water, are extremely conservational. Although these toilets may seem unlikely for your space they are surprisingly easy to maintain and incredibly efficient. These toilets require very little to no water at all, can be either electric or non-electric and come in a variety of sizes and prices. Composting toilets are the most efficient on the market, though usually quite expensive and will cost over $1,000.00 to purchase.

Installing dual or low flush toilets; either by doing a conversion or retrofit will result in less water use, savings to the water bill and an eco-friendly practice. The benefits include:

- Significant reductions in per suite water use (water usage per flush can be reduced by as much as 70%)
- Replacement eliminates losses from undetected water leakage, usually at flapper valve
- Longer, more reliable, savings than tank retrofit devices
- Improved satisfaction with new fixtures

The rate of payback on ULF/HEF toilet fixtures depends on:

- Flush capacity of existing toilet fixtures
- Number of flushes per occupant/day
- Fixture replacement/installation cost
- Water and sewer costs/cubic meter (m^3)

Typical annual toilet water consumption of a toilet with three users = 100 m^3
Typical annual cost for water = approximately $100
Estimated replacement cost of toilets = approximately $180/toilet
Reduction in water costs with ULF toilet = $75/suite

Payback - Less than 3 years (will be less where toilets serve more users)

(CMHC, 2011)

3.8.5 Other Water and Energy Saving Tips

- Add thermostatic controls to car block heaters – control the timing of the availability of power at receptacles to reduce energy usage
- Replace failed electric motors for fans and pumps with high efficiency models
- Clean dirty air ventilation ducts and furnace air filter systems
- Upgrade furnaces to high efficiency models and consider air to air heat exchangers (heat recovery ventilator) for air make-up
- Insulate attic space
- Insulate and air seal walls and install an effective air barrier during exterior wall repair and/or refinishing activities
- Insulate and air seal the underside of floors exposed to unheated spaces
- Minimize air infiltration and reduce condensation by insulating air conditioner sleeves and joints
- Use a foam or sealant to seal air leakage paths around electrical receptacles, window frames and floor junctions on exterior walls
- Seal exterior cracks – caulk all cracks in the building envelope around doors, windows and other exterior joints, or other areas where air infiltrates in cold weather.
- Upgrade weather-stripping on doors and windows
- Regularly maintain water supply taps that have replaceable washers to prevent leaks.
- Reduce the hot water temperature to the lowest safe level that will provide a satisfactory supply of hot water to all users; note that Legionella pneumonia, the bacteria that causes Legionnaires disease can colonize hot water systems below 46°C (115°F). Water heating temperatures above 60°C (140°F) are recommended (CMHC, 2010).
    - ✓ Cost of implementation - $0
    - ✓ Savings – approximately 1% of fuel consumption for each °C in reduction
    - ✓ Payback – immediate
- Reduce hot water supply tank temperatures at night by adding a setback feature to the central temperature controller
- Install a time clock to shut down hot water recirculation during periods when there is little demand for hot water
- When original, lower quality windows are beyond repair or are difficult to maintain, replace with double or triple glazed high performance windows
- Test boiler or furnace combustion efficiency and perform required adjustments on a regular basis to ensure peak operating performance

- Install a time clock control to shut down the operation of the central air supply and/or exhaust fans during periods where ventilation requirements are minimal
- Install time switches on local exhaust fans – use 24-hour or 7-day automatic timers to turn off local exhaust fans at times when they are not required, rather than running them continuously

3.8.6 Flagstaff County Green Team

Create summer employment opportunities for students and unemployed youth by initiating a variety of community development projects that will improve and beautify neighbourhoods, encourage community involvement and help build young leaders. This initiative can be partially funded by taking advantage of available funding for summer students and unemployed youth.

3.8.7 Renewable Energy

Renewable energy is obtained from resources that can be naturally replenished or renewed within a human lifespan, thus the resource is a sustainable source of energy. Renewable energy such as solar, wind, geothermal or hydroelectric currently provides about 16% of Canada's total primary energy supply and can be used to offset the greenhouse gas emissions generated by Flagstaff County. Next to hydroelectricity from moving water, biomass is the second most important renewable energy source in Canada.

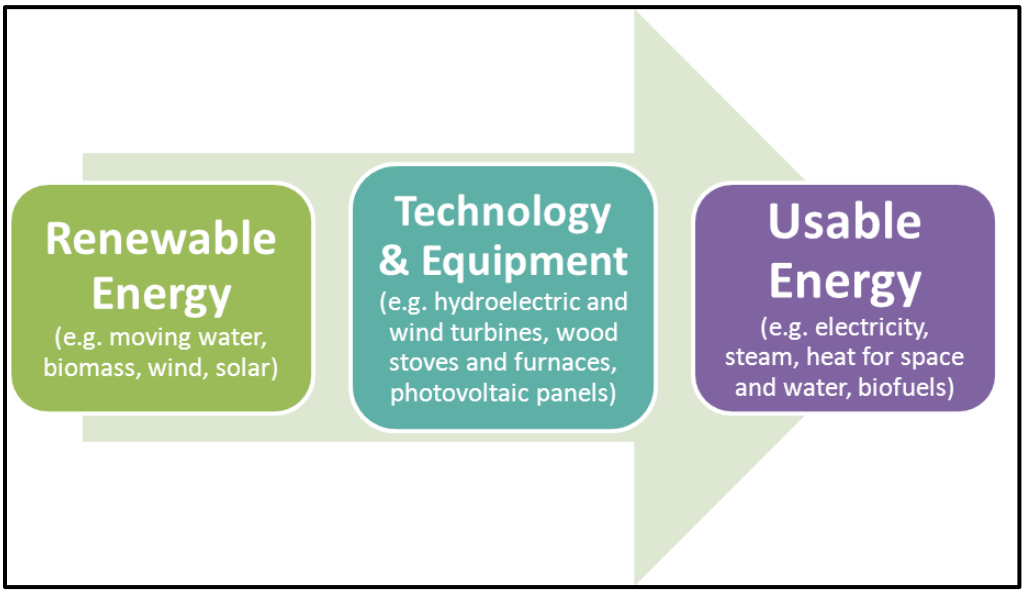

Figure 3-10 The Renewable Energy Universe

The primary types of bioenergy include commercial and industrial heat from combined heat and power (CHP), space heating from firewood and biofuels from agricultural residues, such as methanol and ethanol. Figure 3-10 illustrates various processes to create usable energy from renewable resources.

3.9 Ranking and Implementation Plan for Eco-Friendly Practices and New Initiatives

A plan for implementation was developed using current and proposed eco-friendly initiatives and ongoing Flagstaff County practices is illustrated in Table 3-22. Once the initiatives are implemented they will become eco-friendly practices.

The initiatives are ranked in order of maximum greenhouse gas reduction opportunity. The most significant opportunity for greenhouse gas reduction lies with vehicles which are ranked as the first priority for implementation. Initiatives to reduce building impacts are ranked as second priority. Eco-friendly initiatives for water, land and waste are also significant, though have a lesser impact on greenhouse gas reduction and are ranked as third priority. Section references are included on the table where applicable; references are not provided for new or ongoing Flagstaff County eco-friendly practices. The *Landfill Solid Waste Diversion Feasibility Study* provides details regarding solid waste initiatives.

A follow-up eco-friendly audit is recommended after 3 years, which can be evaluated by comparing to this baseline audit to determine the effectiveness of implemented initiatives, and integrate new eco-friendly initiatives.

Table 3-22 Ranking and Implementation Plan for Eco-Friendly Initiatives

Immediate	Short Term	Long Term
(<18 months)	(18 months - 5 years)	(>5 years)
Priority 1 - Vehicles		
Examine vehicle use and CO_2e (3.3)		
Research fuel efficient vehicles (3.3.2)	Fuel efficient vehicles - replace ~7% vehicles per year (3.3.1)	
Research fuel efficient graders & heavy equipment (3.2)	Replace graders & heavy equipment with fuel efficient models (3.2)	
GPS tracking in vehicles (3.3.3)		Hybrid/flex fuel vehicles (3.3)
Implement vehicle use plan (3.3.2)		Alternative fuel for trucks e.g. biodiesel (3.3)
Driver education & training (3.3.2)		
Priority 2 - Buildings		
Replace waste oil furnace		
Environmental requirements for 3rd party contractors	Waste wood furnace (3.4.2)	
Lighting upgrades (3.8.2)	Complete Golder & Associates 2009 recommendations (3.4.1)	Solar water heating (3.8.7)
Implement water efficiency and conservation strategies (3.8.5)		
Implement energy efficiency and conservation strategies (3.8.5)	Renovate 1 Grader Shed per year (3.4.1)	Integration of renewable energy - solar, wind, biomass (3.8.7)
Priority 3 - Waste		
Community waste initiatives (3.6)	Solid Waste Management Diversion Implementation Project, Phase 2	Tipping fees for recyclable and compostable materials
Increase source separation of waste (3.6)	Crushing & separation of concrete & asphalt for re-use	Gasification - thermal treatment of waste
Composting organics (3.6)	Increase diversion of waste (3.6)	
Strategic recycling		
Priority 3 - Land and Water		
Flagstaff County Green Team (3.8.6)	Intensify reclamation of abandoned wells and pipelines (3.5.1)	
Campsite improvements	Assess effects of oil and gas development (3.5.1)	
Leafy spurge control program	Monitor O &G developmental permit application process (3.5.1)	
Aforestation (3.8.1)		
County yard beautification	Reclaim disturbances from seismic activity (3.5.2)	
Enhance County parks	Designate wetlands and natural areas (3.5.3)	
Develop outdoor recreational areas		
Shelterbelt enhancement program		
Battle River Research Group support to the Iron Creek Watershed Improvement Society		
Developmental planning for the oil & gas industry		
Water well abandonment project		
Fish Lake aeration		
Eco-Friendly Study	**Eco-friendly audit**	**Eco-friendly audit**

3.10 Carbon Offset

A carbon offset is a mechanism aimed at mitigating greenhouse gas emissions. One carbon offset is typically equal to one metric ton of carbon dioxide or equivalent. Offsets can be achieved through a variety of short and long-term projects, including forestry such as planting trees, and renewable energy, including wind farms, small-scale hydro-electricity, and solar power.

Carbon offset markets can be divided into regulatory and voluntary. The European Union Emissions Trading System is currently the largest carbon offset market in the world and acts as a market in emissions reduction. In the international market, companies, organizations and governments buy offsets to comply with caps on the total amount of emissions they are allowed to emit. These caps are set by international bodies on climate change.

Alberta's Greenhouse Gas regulation has established a price for CO_2e at $15/tonne. The Alberta Offset System was developed in 2007 and is in the early stages of implementation. There is currently no approved forestry protocols within the Alberta Offset system; therefore carbon offset using trees is currently categorized as a voluntary market. The voluntary carbon offset market allows individuals, companies and organizations to offset their greenhouse gas emissions from transportation, electricity and other uses. This market operates without caps outlining the limits on carbon emissions.

3.11 Terrestrial Carbon Sequestration

Terrestrial carbon sequestration is the process through which CO_2 from the atmosphere is absorbed by trees, crops and plants through photosynthesis, and stored as organic carbon in biomass and soils. The term "sinks" is also used to refer to forests, croplands and grazing lands, and their ability to sequester carbon. Agriculture and forestry activities can also release CO_2 to the atmosphere. Therefore, a carbon sink occurs when carbon sequestration is greater than carbon releases over some time period.

While all living plant matter absorbs CO_2 as part of photosynthesis, trees process significantly more than smaller plants due to their large size and extensive root

structures. Trees have much more "woody biomass" to store CO_2 than smaller plants, and as a result are considered nature's most efficient "carbon sinks."

As organic materials decay, an even higher body of carbon pool is created in the soils. Some special soils, such as peat, have an even higher level of carbon storage. Soils represent a short to long-term carbon storage medium, and contain more carbon than all terrestrial vegetation and the atmosphere combined (R. Swift, 2001). In Alberta's boreal forests, as much as 80% of the total carbon is stored in the soils as dead organic matter. Table 26 provides soil carbon contents for various range sites and conditions (Prairie Wetlands and Carbon Sequestration, 1999). The carbon value can be converted to CO_{2eq} by multiplying by 3.67.

Table 23. Above-Ground Carbon Contents for Non-Wooded Areas in the Brown Soil Zone

Range Sites	Above-Ground Carbon (tonnes/ha)			
	Range Condition			
	Excellent	Good	Fair	Poor
Clayey	0.25	0.20	0.16	0.13
Loamy	0.25	0.20	0.16	0.13
Sandy	0.20	0.16	0.13	0.10
Dune sand	0.15	0.12	0.10	0.08
Thin	0.15	0.12	0.10	0.08
Badland	0.08	0.06	0.05	0.04
Gravelly	0.15	0.12	0.10	0.08
Saline lowland	0.25	0.20	0.16	0.13
Wetland	0.60	0.48	0.38	0.30

Trees and shrubs thrive in low areas around wetlands and are capable of sequestering large amounts of atmospheric carbon in their biomass. Grasslands contribute to soil organic matter, stored mainly in their extensive fibrous root mats, although overgrazing practices substantially reduce their performance as carbon sinks (C. Hogan, 2009). Grassland above-ground values range from 0.4 to 2.6 tonnes carbon/ha; the below-ground component may increase the amount of carbon by a factor of two to four (Rochette and Jacques, 1995). The woody component of a riparian area in the agricultural black soil zone was determined to have a value of 34.0 tonnes carbon/ha; 22.3 tC/ha in the dark brown soil zone and 20.6 tC/ha in the brown soil zone (Freedman and Keith, 1995).

The above-ground carbon content of eight forage species are shown in Table 27 (adapted from Kirychuk and Tremblay 1995).

Table 24. Above-Ground Carbon Contents for Forage Species in 3 Soil Zones

Species	Soil Zone	Above-Ground Carbon (tonnes/ha)		
		Age		
		1 to 3	4 to 6	7+
Alfalfa - creeping rooted	Brown	1.2	0.9	0.7
	Dark Brown	2.5	1.9	1.3
	Black	1.8	1.4	1
Alfalfa - tap rooted	Brown	1.3	1	0.7
	Dark Brown	2.6	2	1.3
	Black	1.9	1.4	1
Altai wildrye	Brown	0.8	0.6	0.4
	Dark Brown	1.6	1.2	0.8
	Black	1.5	1	0.7
Crested wheatgrass	Brown	1	0.8	0.6
	Dark Brown	1.7	1.3	0.9
	Black	2.1	1.8	1.2
Meadow bromegrass	Brown	0.8	0.6	0.4
	Dark Brown	1.3	1	0.7
	Black	1.9	1.4	1
Russian wildrye	Brown	0.9	0.7	0.5
	Dark Brown	1.1	0.8	0.6
	Black	1.1	0.8	0.6
Smooth bromegrass	Brown	0.8	0.6	0.4
	Dark Brown	1.7	1.3	0.9
	Black	2.3	1.7	1.2

Some current agricultural practices such as fertilizer use, irrigation and soil disturbance lead to carbon loss from soils. Farming practices that incorporate post-harvest crop residues, wastes and by-products back into the soil provide a carbon storage benefit. Changes in cropping practices, such as from conventional to conservation tillage, have been shown to sequester between 0.1 - 0.3 tonnes carbon/year (Lal et al. 1999 and Post 2002). Pastures store an average of 46 tonnes carbon/acre (K.Kirby, 2007).

The total amount of carbon sequestered in an area is affected by the following:

- Cover (i.e. Tree) species
- Soil type
- Regional climate
- Topography
- Management practices

Variances in the carbon sequestering ability of ground cover are evident in Table 28. Note that carbon values for some small native shrubs are not currently available (Prairie Wetlands and Carbon Sequestration, 1999).

Table 25. Predicted Above-Ground Carbon Content Ranges for Four Cover Types

Cover Type	Above-Ground Carbon (tonnes/ha)	
	from	to
Native grassland	0.04	0.9
Tame grassland	0.4	2.6
Native tree/shrub	31.2	41.8
Planted tree/shrub	22.0	213.0

Tree planting has been shown to be a viable way to offset carbon emissions; however, planting trees to offset carbon has been fiercely debated over recent years. Nevertheless, consensus is that tree planting is a valid tool to tackle climate change and one of only a few methods to actually remove existing CO_2 from the atmosphere.

Carbon accumulation in forests and soils eventually reaches a saturation point, beyond which additional sequestration is no longer possible. This happens, for example, when trees reach maturity, or when the organic matter in soils builds back up to original levels before losses occurred. Even after saturation, the trees or agricultural practices need to be sustained to maintain the accumulated carbon and prevent subsequent losses of carbon back to the atmosphere. Older forest stands with increased decomposition produce a lower rate of respiration and therefore net carbon sequestration is much lower – estimated at 0.4 tonnes CO_2e/acre/year.

Planting trees remains one of the cheapest, most effective means of drawing excess CO_2 from the atmosphere. A single mature tree (such as in a boreal forest) can absorb carbon dioxide at a rate of between 7.5 and 22 kg/year, releasing enough oxygen back into the atmosphere to support two human beings http://www.coloradotrees.org. The tree must be at least 15 years old to effectively absorb this CO_2; younger trees absorb very little CO_2. Basically, one tree will absorb approximately 1100 kg CO_2 in its' full, un-interrupted lifetime http://www.carbon-info.org.

Canada's forests cover an estimated area of 303 million hectares and store an estimated 95 Gt (billion tonnes) of carbon; equivalent to 313.5 t/ha or 127 t/acre. Boreal forests store more carbon than any other forest type. Older forests generally store more

carbon than younger forests. The total carbon in a forest ecosystem is stored across several pools: living biomass, coarse woody debris, organic soil horizons, and mineral soil. The majority of boreal forest carbon is stored in soils. (Canadian Forest Service, Canadian Boreal Initiative)

The carbon contents of prairie shelterbelt trees are provided in Table 26. The carbon contents are provincial averages derived from values obtained from trees sampled in the brown, dark brown and black soil zones of Saskatchewan. The total carbon content values assume a root to top ratio of 0.4:1 for deciduous trees, 0.3:1 for conifers and 0.5:1 for shrub species. The calculation of tonnes per hectare assumes a 5 metre wide shelterbelt 2.0 km long.

Table 26. Carbon Contents for 12 Important Prairie Shelterbelt Trees (PFRA)

Species	Above ground carbon		Total carbon	
	kg/tree	t/ha	kg/tree	t/ha
Poplar	267	171	373	298
White spruce	143	66	186	107
Colorado spruce	101	46	132	75
Siberian Elm	100	64	140	112
Manitoba maple	86	55	120	96
Scots pine	81	37	105	60
Green ash	63	51	89	71
Caragana	NA	41	NA	78
Chokecherry	NA	32	NA	60
Villosa lilac	NA	27	NA	50
Buffaloberry	NA	25	NA	47
Sea-buckthorn	NA	18	NA	32

An average 1 km poplar shelterbelt planted with a 2.5 metre spacing between trees would have an above ground biomass of 174.8 tonnes and would contain 84.2 tonnes of carbon.

Carbon sequestration rates for activities intended to improve sequestration are provided in Table 30. The time over which sequestration may occur before saturating is the

longest for forestry activities. Over its' lifetime, a single tree can sequester 1.1 tonnes of carbon.

Table 27. Representative Carbon Sequestration Rates and Saturation Period for Agricultural and Forestry Practices (U.S. EPA)

Activity	Representative carbon sequestration rate in U.S. (tonnes carbon/acre/year)	Time over which sequestration may occur before saturating (assuming no disturbance, harvest or interruption of practice)
Afforestation	0.6 - 2.6	90 - 120+ years
Reforestation	0.3 - 2.1	90 - 120+ years
Conversion from conventional to reduced tillage	0.2 - 0.3	20 - 50 years

NOTE: Afforestation is the establishment of a forest or stand of trees in an area where there was no forest. Reforestation is the re-establishment of forest cover, either naturally (by natural seeding, coppice, or root suckers) or artificially (by direct seeding or planting).

3.12 Flagstaff County Carbon Sequestration

The land area of Flagstaff County is approximately 4,066.9 km^2, or 1,004,953 acres and consists of a variety of land cover types including native and planted vegetation, agricultural crops, water and non-vegetative land. In consultation with Flagstaff County personnel, it was determined that the agricultural crops account for 65.6 % of the land cover, native and tame grasslands account for 26.5 %, native and planted trees account for 4.0 %, municipal vegetative land accounts for 1.8 % and non-vegetative municipal/industrial/commercial land accounts for 1.4 % and water cover accounts for 0.7 %. Please refer to Figure 3-11 for a graphical representation of the various types of land cover in Flagstaff County.

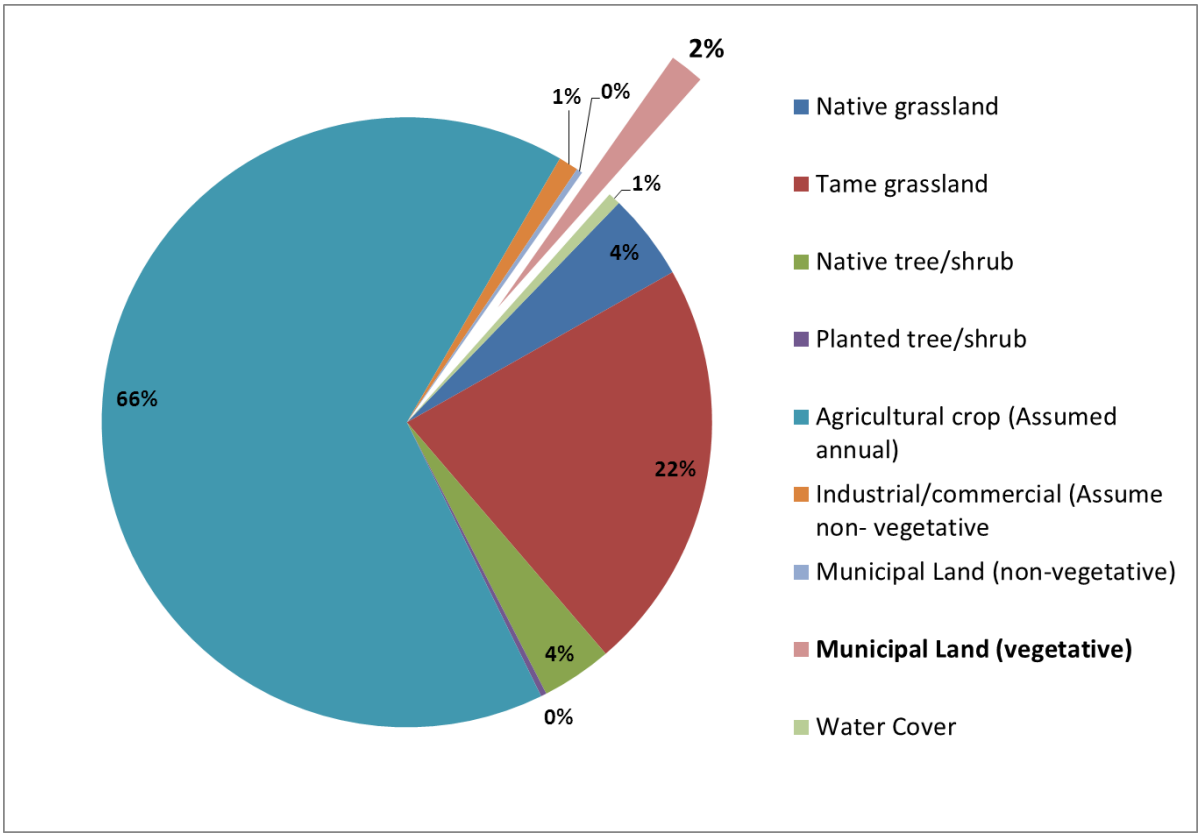

Figure 3-11 Flagstaff County Land Cover Types

The existing land cover areas were determined by Flagstaff County based on the Summary Report: East Central Alberta Cumulative Effects Project, and Flagstaff County GIS (Geographic Information System) data and their file information. It is AITF understanding that the East Central Alberta Cumulative Effects Projects (ECACEP) was not fully completed and the summary report was issued on July 8, 2009 based on the information compiled to that point. The information in the ECACEP report is considered reasonable and representative for the purposes of this study.

For a detailed description of the land cover types and the areas covered, refer to Table 28.

Table 28. Flagstaff County Land Cover Classifications

Land and Water Cover Classifications	% Breakdown	Acres
1. Native grassland (includes wetland land cover)	4.59%	46,105
2. Tame grassland (Includes pasture and hay land)	21.90%	220,116
3. Native tree/shrub	3.74%	37,551
4. Planted tree/shrub (farmyards and shelterbelts)	0.30%	3,000
5. Agricultural crop (Assumed annual)	65.62%	659,431
6. Industrial/commercial (Assume non- vegetative)	1.05%	10,542
7. Municipal Land (non-vegetative)	0.32%	3,256
8. Municipal Land (vegetative, includes 21 properties and road ROWs)	1.83%	18,356
9. Water Cover	0.66%	6,596
Totals	100.00%	1,004,953

Carbon sequestration processes in the environment vary by land cover. As discussed in the previous section, trees sequester carbon to a much greater extent that annual grasses and crops, and mature trees sequester carbon to a greater extent as they mature. Therefore, sequestration of carbon will be much higher in the mature treed areas. Opportunities for future carbon sequestration generally consist of land use classification changes from non-vegetative to vegetative and grassland to trees.

Since Flagstaff County is primarily agriculturally crop based, and native vegetation primarily exists on land (often sloped or inaccessible) less suitable for planting crops or harvesting hay (tame grass), the greatest opportunity for incremental carbon sequestration appears to be through converting grassland to trees, such as road right-of-ways. A more intensive review of the 18,356 acres of municipal land could determine how much land and how dispersed this land is in the county. Of all the cover classifications, only municipal lands are likely able (within the control of) to be favourably converted in terms of cover type.

According to Carbon Offset Solutions, an Alberta-based not-for-profit organization (www.carbonoffsetsolutions.climatechangecentral.com), Alberta is in the process of developing protocols to estimate and verify plant growth and carbon sequestering potential of varietal trees in various regions of the province. The newly drafted

Conservation Afforestation Protocol has attempted to address quantification and policy related methodologies required to prove offset claims, however this draft document was not available during this report investigation. In addition, this protocol does not address carbon sequestration data by Alberta species and this information is not readily available.

As mentioned in the previous section, trees must be at least 15 years old to effectively absorb CO_2 and younger trees absorb very little CO_2. Since one tree can absorb up to 1100 kg CO_2 (US data) in its 40 to 60 year lifetime, this could translate to $13.20 per tree in carbon credits based on $12 per tonne. Carbon sequestration by trees on an area basis is highly variable and is dependent on factors such as tree species, tree density, age, soil type and climate. When the costs of land use dedication (change), planting, protecting, harvesting and managing the land resource, carbon credit brokerage fees, third party verification (and validation) are all included, growing trees for carbon credits is highly unlikely for the dispersed areas within Flagstaff County.

One of the expected requirements in the draft protocol is the conservation easement which will legally prevent the land use to revert back to other purposes during a lengthy life cycle (such as 60 years). When considering the prudent planning of securing a buyer for the carbon credits, the limited (and disconnected) amount of land which could be dedicated to this purpose, the long term perspective required, and the legalities of conservation easements, the carbon credit potential from tree planting does not appear to be pragmatic in Flagstaff County. Other land use considerations for carbon credits appear even less attractive.

When considering Flagstaff County's vision and the Environmental Responsibility Strategic Objective (referenced in the Introduction section of this study), there are many intangible and socio-economic values to be considered in the preserving and increasing treed areas within the County, including parks, private property and road right-of-ways. Trees and brush typically provide for a healthy ecosystem, sequester carbon and are aesthetically appealing. Unless there are compelling reasons related to potential fire hazard or public safety (such as interference with electrical transmission power lines), treed areas are worth preserving within the county. Progressive planning and encouraging the healthy growth of trees and brush is a positive activity in support of Flagstaff County's environmental strategic objective.

4 Conclusions

The following conclusions identify key points arising from this study:

- The most significant Flagstaff County activities were examined and identified in their production of 2,438 tonnes of CO_2e in 2010, or 44.3 tonnes CO_2e per employee. The sources of greenhouse gas emissions examined were graders, trucks, road building and repair, heavy equipment, electricity and heating.

- The Public Works functional group contributed 89.2% (2,175 t) of the CO_2e produced by the County in 2010. This is primarily due to the nature of Public Works' activities involving graders, trucks and heavy equipment, which are responsible for 31.9% (778 t); 22.6% (551 t) and 9.1% (223 t) of the County's output of CO_2e, respectively. Significant improvements to the County's carbon footprint have been made by recent eco-friendly initiatives at Public Works, however, the greatest potential for further greenhouse gas reduction lies with activities concerning vehicles and equipment.

- The Administration and Environment functional groups had a much smaller CO_2e footprint, contributing 7.4% (180 t) and 3.4% (83 t) to the County's overall CO_2e.

- The activity with the largest CO_2e footprint overall was vehicles; which included graders, heavy equipment and trucks. Vehicles accounted for 81%, or 1974 metric tonnes of the County's total CO_2e. Electricity and heating contributed 11% and 8% CO_2e, respectively.

- The eco-friendliness of using waste oil as a heating source was difficult to assess. Heating with waste oil can be very beneficial relative to recycling the oil if adequate emission control measures are used, including pre-treatment of the waste oil to remove the pollutant precursors. The waste oil furnace will be replaced in the next year with a newer model.

- Flagstaff County's initiative to upgrade to energy efficient lighting is ongoing and is expected to realize an approximate energy reduction of 75% for replacement of incandescent lights and 30% for fluorescent tube retrofits.

- Flagstaff County promotes recycling and waste reduction by providing recycling facilities and educating the public to separate waste. Enhancing waste recycling and diversion practices by Flagstaff Waste Management, along with continued

efforts by residents and businesses to reduce municipal solid waste sent to the landfill are high priorities.

- Flagstaff County promotes environmental stewardship as part of their vision and strategic objectives. In addition to maintaining a healthy ecosystem and enhancing the aesthetic appearance within the County, trees and vegetation provide environmental benefits including carbon sequestration. Progressive planning and encouraging the healthy growth of trees and brush is a positive activity in support of Flagstaff County's environmental strategic objective.

5 Recommendations

The following recommendations and supplementary initiatives are offered to assist Flagstaff County in their ongoing efforts to become increasingly eco-friendly and reduce greenhouse gas emissions:

1. Reduce the greenhouse gas impact of vehicles, including trucks, graders and heavy equipment, currently responsible for approximately 81% of the County's greenhouse gas emissions. This can be accomplished by replacing a strategic portion of the Flagstaff County vehicular fleet per year with newer fuel efficient models, installing GPS tracking in the majority of vehicles, examining vehicle use, and implementing an action plan with driver education and training.

2. Complete energy efficient lighting retrofits for all County buildings over the next 3 years; ensuring all T12 fluorescent tubes, incandescent bulbs and high intensity discharge metal halide lamps are replaced.

3. Reduce energy and water consumption by 10% over 3 years using initiatives such as high efficiency toilets, faucet aerators, renewable energy and operational reduction practices including better use and re-use of energy. Where practical, complete the Golder Associates (2009) recommendations at the County Shop and Grader Sheds.

4. Continue with the Shelterbelt Enhancement Program and develop a plan for afforestation. Planting trees and natural vegetation can help to offset the County's carbon footprint and work towards becoming carbon neutral.

5. Increase recycling and waste reduction practices using a strategic combination of awareness campaigns and promotion; composting; construction and demolition waste management and pollution prevention. Continue with the Solid Waste

Management Diversion Implementation Project and focus on the short-term diversion targets recommended in the 2010 Landfill Solid Waste Diversion Feasibility Study.

6. Continue the practice of utilizing alternative fuels, including waste oil, and consider biomass combustion for heat energy, such as clean construction wood waste.

7. Keep records to ensure adequate maintenance on the proposed new waste oil furnace, including frequent filter changes and removing fly ash build-up on the chimney. Closely track the volumes and quality of the waste oil used.

8. Minimize the impacts of oil and gas activity on the land within Flagstaff County; and as part of a strategic plan, monitor the development permit application process. Consider designating natural or wetland areas, planting trees or natural vegetation to increase CO_2 absorption.

9. Continue the practice of environmental stewardship, progressive planning and encouraging the healthy growth of trees and brush within the County.

10. Perform another eco-friendly audit to verify what has been accomplished in 3 years.

6 References

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7 APPENDIX:

7.1 Assumptions

In order to estimate the County's baseline environmental impacts associated with its operations in 2010, a number of computations and associated assumptions are required which are detailed in this Appendix.

Table 7-1 Fuel Costs and Emissions Factors used to Compute CO_2e.

Quantity	Value	Reference
Cost per L		
Average Diesel Price 2010	0.80705 $/L	Flagstaff County Financials
Average Gas Price 2010	0.8636 $/L	Flagstaff County Financials
Average Price of Motor Oil	3.4 $/L	Flagstaff County Financials
Electricity		
Alberta Electricity Emissions Factor (2008)	880 g CO_2e/kWh	Environment Canada http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=EAF0E96A-1
Emissions Factors		Environment Canada http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=CAD07259-1
Diesel	2.79 kg/l	Environment Canada http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1#section2
Gasoline	2.37 kg/l	Environment Canada http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=AC2B7641-1#section2
Combustion of Waste Oil	2.83 kg/l	Based on Exhibit 22 of US EPA Office of Air and Radiation document, 0.45 tonnes/bbl and assuming 1 bbl is 159 l.
Natural Gas	0.18523 kg/kWh	Resources - conversion factors

7.2 County Shop – Estimating Impacts of Burning Waste Oil

To estimate the amount of waste oil likely consumed by the County Shop, the total amount of waste oil coming from heavy equipment, trucks, and graders was estimated from the lubrication costs for each piece of equipment. It was assumed that 30% of the overall lubrication costs came from the costs of oil, and that the average cost of oil was $3.4 per litre. The overall amount of oil from these three sources was then multiplied by an emissions factor to yield kg CO_2e.

The impact of burning waste oil was estimated using the modeling assumptions:

- Waste oil = 2.830189 kg CO_2e/L - based on Exhibit 22 of US EPA Office of Air and Radiation document, 2009.
- 1 bbl = 159.1 L

Using these assumptions, the impacts of burning waste oil was calculated as follows:

- Heavy equipment total effective litres of oil = 1889.66 L
- Graders total effective litres of oil = 3887.7 L
- Trucks total effective litres of oil = 2386.50 L

Note that this calculation does not account for waste oil that may come from sources other than above.

Sum of waste oil = 8163.86 L

8163.86 L * 2.830189 kg CO_2e/L

= 23105.26/1000 kg/tonne

= 23.1 tonnes CO_2e

Used oil containing more than 1000ppm total halogens is presumed to be a hazardous waste (US EPA 40 CFR part 279 – Standards for the Management of Used Oil, June 1, 2011). The used oil maximum allowable levels to be burned for energy recovery are as follows:

- Arsenic 5 ppm
- Cadmium 2 ppm
- Chromium 10 ppm
- Lead 100 ppm
- Flashpoint 100°F minimum
- Total halogens 4000 ppm
- PCBs 2 ppm

7.3 Gravel Program – Estimating Trucking Impacts

A number of critical assumptions were made for the gravel trucking program which need to be reviewed as some of these assumptions are likely not correct. Total gravel sales were $101,421. It was also assumed that gravel was sold at 10% over cost, so the actual cost of the gravel sold is $101,421/1.1, or $91,292. Overall gravel trucking costs are $518,407, so the effective cost of the gravel used by the county is $427,115. We assumed that 20% of these costs related to fuel, so gravel trucking accounted for 105,846 L of fuel or 295,288 kg of CO_2e. These assumptions can be modified as required to more accurately reflect current practices.

Trucking impacts were estimated using the following modeling assumptions:

- Gravel trucking costs directly related to fuel = 0.2
- Gravel sales profit = 1.1

Using these assumptions, CO_2e was calculated as follows:

1. Gravel sales with profit (revenue from gravel sales) = $100,421
2. Net gravel sales (gravel sales with profit/assumption gravel sales profit) = $91,292
3. Effective trucking costs (gravel trucking – net gravel sales) = $427,115
4. Fuel cost (effective trucking costs*assumption gravel trucking costs directly related to fuel) = $85,423.01
5. Average diesel price 2010 = $0.80705/L
6. Litres of fuel (fuel cost/average diesel price 2010) = 105,846 L
7. Total cost (gravel trucking costs/assumption gravel trucking costs directly related to fuel) = $103,681.32
8. Total CO_2e (L fuel/2.78973 kg CO_2e/L diesel) = 295,288 kg

7.4 Flagstaff Waste Management Recycling Trends

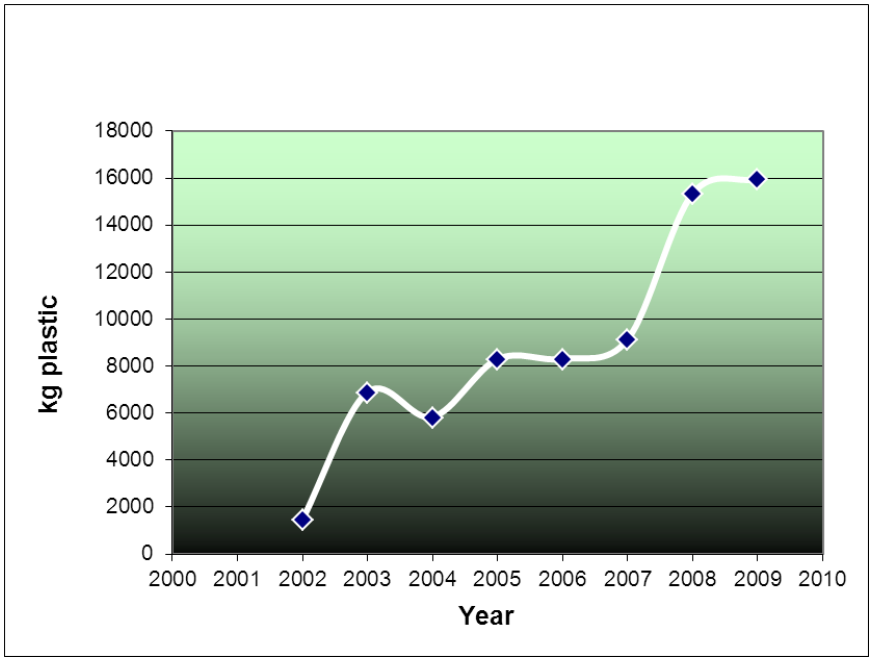

Figure 7-1 Plastics Recycling

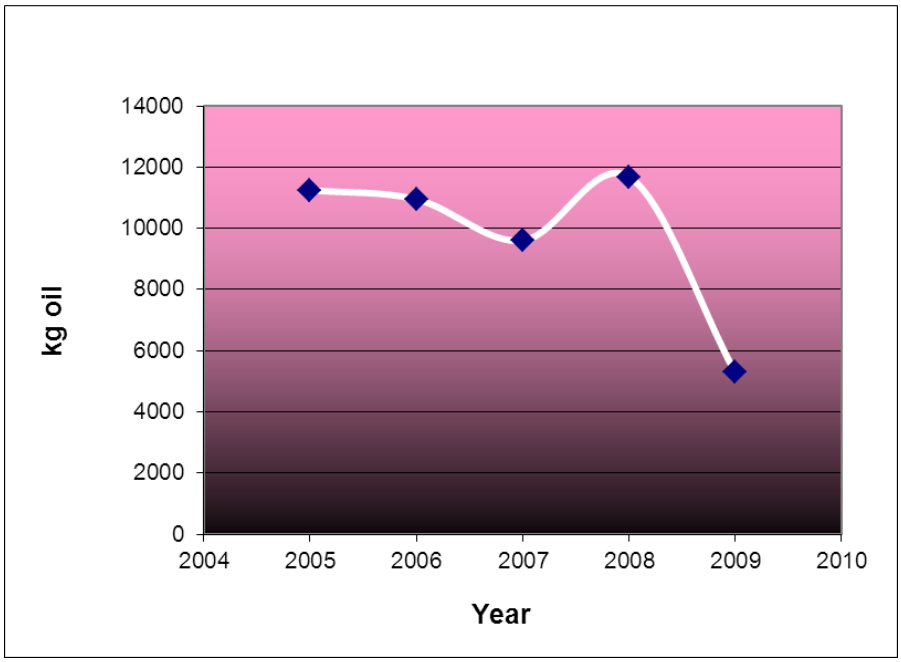

Figure 7-2 Used Oil Recycling

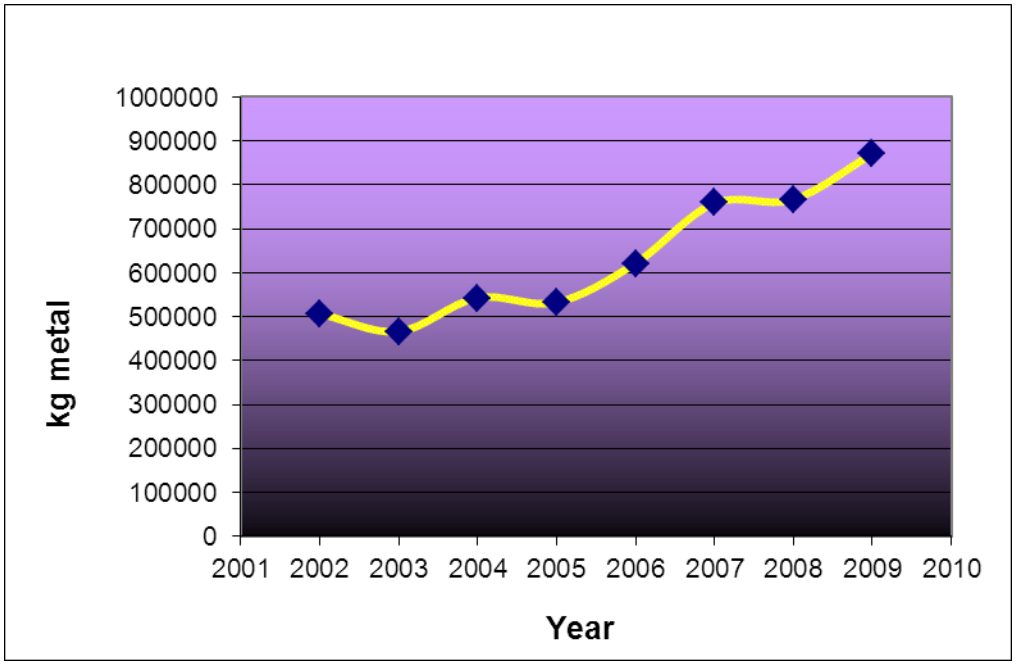

Figure 7-3 Metals Recycling

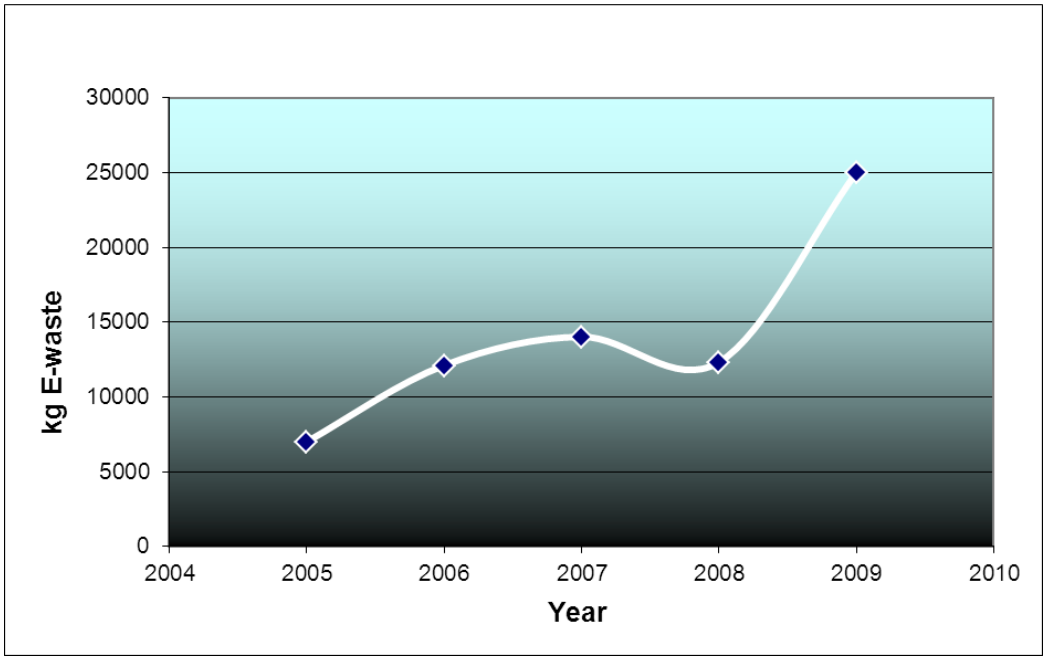

Figure 7-4 E-Waste Recycling

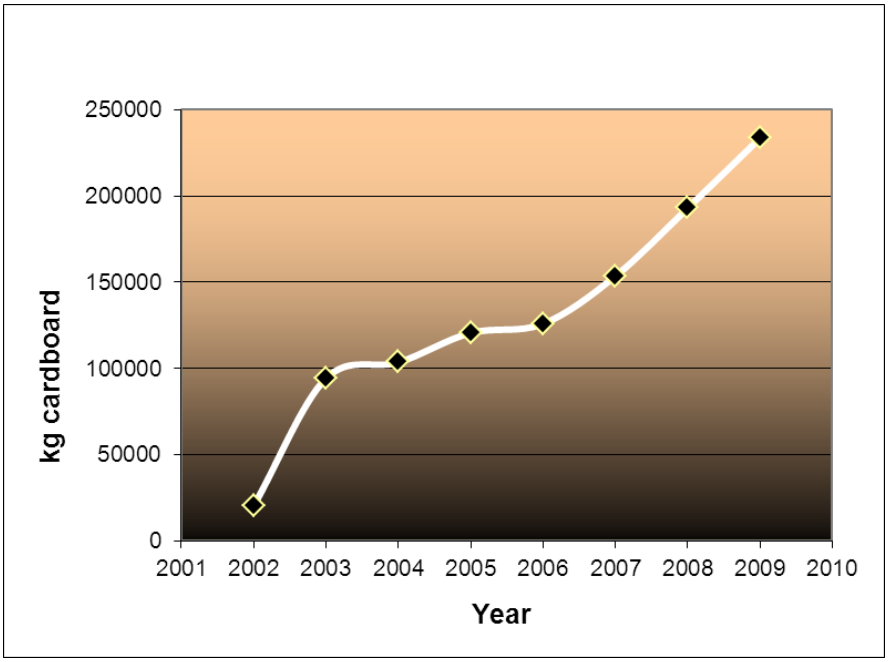

Figure 7-5 Cardboard Recycling

7.5 Greenhouse Gases Specified by the Kyoto Protocol

Greenhouse gases affect the ability of the earth's atmosphere to retain heat. Higher greenhouse gas concentrations in the earth's atmosphere cause global warming through this greenhouse effect. The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCC), aimed at fighting global warming. The Protocol was initially adopted in 1997 and has been signed and ratified by 191 countries; the United States has no intention to ratify.

Six greenhouse gases are identified by the Protocol whose atmospheric concentrations are strongly influenced by human activity. The most important of these is carbon dioxide (CO_2). The global warming potential (GWP) of each greenhouse gas can be expressed in CO_2 equivalents Table 7-2. For gases with a high global warming potential, a relatively small emission can have a considerable impact.

Table 7-2 Kyoto Greenhouse Gases

Kyoto Gas	GWP	Example Sources
Carbon dioxide (CO_2)	1	Burning fossil fuels
Methane (CH_4)	23	Cattle, landfill sites, leaks from disused mines, burning fossil fuels
Nitrous Oxide (N_2O)	296	Emissions from fertilized soils, burning fossil fuels
Sulphur Hexafluoride (SF_6)	22,200	Leaks from electrical and electronics industries
Perfluorocarbons (PFCs)	4,800 - 9,200	Electronics industries, fire extinguishers
Hydrofluorocarbons (HFCs)	12 - 12,000	Leaks from air conditioning and refrigeration systems, LPG storage

Note: the "global warming potential" of a gas is its relative potential contribution to climate change over a 100 year period, where $CO_2 = 1$ (IPCC 2001)

7.6 Examples of Energy Efficiency and Alternative Energy Programs in Alberta (Office of Energy Efficiency, National Resources Canada)

Source: Municipal government

7.6.1 City of Calgary

City of Calgary Rebates for Green Homes

Homebuilders who achieve Built Green certification are eligible for a partial rebate on the cost of the building permit for the home. The value of the rebate depends on the level of certification achieved.

The City of Calgary's Energy Management Strategy

The objective of The City of Calgary's (The City) Energy Management Strategy is to move toward a long-term green energy supply strategy through a strategic alliance with ENMAX Energy Corporation (ENMAX).

7.6.2 City of Edmonton

CO_2RE (Carbon Dioxide Reduction Edmonton)

CO_2RE is the City of Edmonton's community greenhouse gas emissions reduction strategy. It was created by a coalition of more than 20 local companies, non-profit organizations, institutions and government agencies.

SunRidge BuiltGreen Homeowner Rebate Lethbridge, AB

Built Green™ is an industry driven voluntary program that promotes "green" building practices to reduce the impact that building has on the environment. It benefits the homebuyer, the community and the environment.

7.6.3 City of Medicine Hat

HAT Smart - A City of Medicine Hat Environmental Initiative

HAT Smart is a City of Medicine Hat program to educate and assist residents and utility customers in learning about initiatives that can help improve the environment and stretch their energy dollars.

7.6.4 Strathcona County

Strathcona County Rebates for Green Homes AB

Built Green™ is an industry driven voluntary program that promotes "green" building practices to reduce the impact that building has on the environment.

7.6.5 Town of Banff

Town of Banff Residential Rebates and Incentives Home Energy Use Reduction

The Home Energy Use Reduction Program is aimed at helping the residents of Banff reduce the amount of energy used in their homes. The Town of Banff is encouraging everyone to take advantage of these practices so as to contribute to an overall lowering of energy consumption.

Town of Banff Residential Rebates and Incentives Water Use Reduction

Several approaches can help easily reduce the amount of water being used at your home or property. These practices will contribute to an overall lowering of your utility bills each year, a reduction of the amount of water being drawn from local groundwater sources and a reduction in the volume of water treated at Banff's Wastewater Treatment Plant which is eventually discharged into the Bow River.

Appendix 7.7. A Breakdown of CO_2e for Flagstaff County Trucks

Truck #	Department	Description	Year	2010 Odometer (km)	2010 Fuel	Fuel Type	Litres of Fuel	kg CO_2e
T102	Road Maintenance	International 4700 (Picker Truck)	2001	300 hr	$1,614.05	Diesel	1999.9	5579.4
T071	Agricultural Services Board	GMC C7500 Regular Cab	2007	1,500	$341.09	Diesel	422.6	1179.1
T094	Office	Ford F150 S/C XLT 145" 4X4	2009	2,000	$581.82	Gas	673.7	1596.2
T29	Agricultural Services Board	GMC Sierra SL 1/2 Ton 4X4	1997	3,830	$642.57	Gas	744.1	1762.8
TR63	Shop	Kenworth Tractor	1980	1,230	$661.55	Diesel	819.7	2286.8
T022	Office	Ford F150 4X4 Extended Cab	2002	6,500	$709.79	Gas	821.9	1947.3
T994	Agricultural Services Board	Ford F150 SuperCab 4X4	1999	7,500	$724.94	Gas	839.4	1988.8
T025	Agricultural Services Board	Chev Silverado 1 Ton	2002	3,800	$753.87	Gas	872.9	2068.2
T995	Agricultural Services Board	Ford F150 SuperCab 4X4	1999	5,000	$819.47	Gas	948.9	2248.2
T23	Agricultural Services Board	Chev Cheyenne 4X4 3/4 Ton	1995	3,245	$866.71	Gas	1003.6	2377.8
T081	Road Maintenance	International 4300 DT466-210 HP	2005	600	$836.99	Diesel	1037.1	2893.3
T992	Agricultural Services Board	Ford F250	1999	16,000	$897.88	Gas	1039.7	2463.3
T10	Shop	Chev 3/4 Ton	1996	6,000	$1,002.39	Gas	1160.7	2750.0
TR30	Oiling Program	International IHC1900	1982	1,500	$976.24	Diesel	1209.6	3374.6
T002	Agricultural Services Board	Chev Cheynne	2000	9,500	$1,110.35	Gas	1285.7	3046.2
T093	Health & Safety	Ford F150 S/C XLT 145" 4X4	2009	8,000	$1,134.64	Gas	1313.8	3112.8
T984	Shop	Ford F150 Styleside Supercab 4X4	1998	9,063	$1,136.18	Gas	1315.6	3117.0
T092	Office	Ford F150 S/C XLT 145" 4X4	2009	5,000	$1,139.52	Gas	1319.5	3126.2
T031	Oiling Program	GMC Sierra SL 4X2 Standard	2000	6,500	$1,186.66	Gas	1374.1	3255.5
T023	Signs	Ford F150 4X4 Extended Cab	2002	6,600	$1,194.30	Gas	1382.9	3276.5
T07	Road Maintenance	Chev 3/4 Ton	1998	24,000	$1,257.86	Gas	1456.5	3450.9
T17	Road Maintenance	Chev 1/2 Ton	1994	10,000	$1,310.02	Gas	1516.9	3594.0
T053	Road Maintenance	Peterbilt 330 S-437	2005	9,000	$1,264.04	Diesel	1566.2	4369.5
T014	Oiling Program	Chev 2500HD Crew Cab	2001	11,500	$1,401.57	Gas	1622.9	3845.1
T032	Agricultural Services Board	Freightliner M2	2003	7,000	$1,384.46	Diesel	1715.5	4785.8
T983	Road Construction	GMC Sierra SL TK31003	1998	10,500	$1,852.34	Gas	2144.9	5081.8
T091	Road Maintenance	International 5900 (Water Truck)	2006	7,000	$1,819.00	Diesel	2253.9	6287.9
T034	Agricultural Services Board	Dodge Ram 1500 SLT	2003	15,500	$2,279.98	Gas	2640.1	6255.0
T063	Agricultural Services Board	Dodge Ram 3500	2006	10,000	$2,333.42	Gas	2702.0	6401.6
T993	Road Maintenance	Chev CC30943 Crew Cab	1999	13,000	$2,410.22	Gas	2790.9	6612.3
T035	Agricultural Services Board	Chev Silverado 1500 Ext 4X4	2003	15,500	$2,481.87	Gas	2873.9	6808.8
T013	Agricultural Services Board	Chev 2500HD 4X4	2001	13,000	$2,631.69	Gas	3047.3	7219.9
T096	Oiling Program	Dodge Ram 2500 4X4	2009	16,000	$2,642.96	Gas	3060.4	7250.8
T001	Agricultural Services Board	Ford F250 Styleside	2000	5,000	$2,675.19	Gas	3097.7	7339.2
T042	Shop	International 4300 (Service Truck)	2005	14,000	$2,525.44	Diesel	3129.2	8729.9
T075	Shop	Chev Silverado LT 1500 4X4 Ext Ca	2007	19,500	$2,766.52	Gas	3203.5	7589.8
T051	Agricultural Services Board	Dodge Ram 1500	2005	14,000	$2,980.80	Gas	3451.6	8177.6
T15	Road Construction	Chev 1 Ton	1996	12,500	$2,984.97	Gas	3456.4	8189.1
T033	Road Maintenance	Chev Silverado 2500 HD	2003	17,000	$2,994.97	Gas	3468.0	8216.5
T041	Agricultural Services Board	Chev Silverado 4X4 Long Box 1 To	2004	13,000	$3,047.92	Gas	3529.3	8361.8
T076	Oiling Program	GMC C4500 Crew Cab	2007	12,000	$3,094.61	Diesel	3834.5	10697.4
T054	Oiling Program	GMC C5500 Crew Cab 4X4	2005	12,000	$3,201.94	Diesel	3967.5	11068.4
T20	Gravel Program	Western Star Tandem Truck	1995	13,894	$3,541.81	Diesel	4388.6	12243.3
T991	Oiling Program	GMC CSeries 8500	1999	9,000	$3,764.83	Diesel	4664.9	13014.2
T073	Gravel Program	Chev Silverado LT 1500 4X4 Ext Ca	2007	22,500	$4,263.62	Gas	4937.0	11697.0
T310	Public Works Admin.	Ford F150 4X4 Extended Cab	2010	35,000	$4,279.70	Gas	4955.7	11741.1
T210	Public Works Admin.	Ford F150 4X4 Extended Cab	2010	40,000	$4,374.90	Gas	5065.9	12002.3
T083	Public Works Admin.	Dodge Ram 1500 4X4 Quad Cab	2008	33,000	$5,196.45	Gas	6017.2	14256.1
T095	Peace Officers	Dodge Ram 1500 4X4 Quad Cab	2009	30,500	$5,317.01	Gas	6156.8	14586.9
T077	Fire	Dodge Ram 1500 Ext Cab 4X4	2007	35,000	$5,330.16	Gas	6172.0	14622.9
T110	Peace Officers	Dodge Ram 1500 4X4	2010	45,000	$5,585.41	Gas	6467.6	15323.2
T052	Public Works Admin.	Dodge Ram 1500	2005	36,000	$5,927.27	Gas	6863.4	16261.1
T084	Gravel Program	Dodge Ram 1500 4X4 Quad Cab	2008	37,000	$6,551.01	Gas	7585.7	17972.3
T072	Gravel Program	Chev Silverado LT 1500 4X4 Ext Ca	2007	40,000	$7,880.01	Gas	9124.6	21618.3
T082	Public Works Admin.	Dodge Ram 2500 Mega Cab Dodg	2008	40,000	$8,203.28	Gas	9498.9	22505.2
T981	Road Maintenance	Western Star Model 6964F	1999	23500	$8,393.90	Diesel	10400.7	29015.9
T024	Gravel Program	Western Star Tandem Truck	2003	18,500	$11,163.44	Diesel	13832.4	38589.5
T011	Gravel Program	Kenworth T800B	2001	26,000	$13,563.65	Diesel	16806.5	46886.5
T610	Gravel Program	Peterbilt 367 Truck	2011	22,000	$19,804.60	Diesel	24539.5	68460.1
T085	Gravel Program	Western Star Truck 4900SA	2009	47,000	$27,034.74	Diesel	33498.2	93453.1