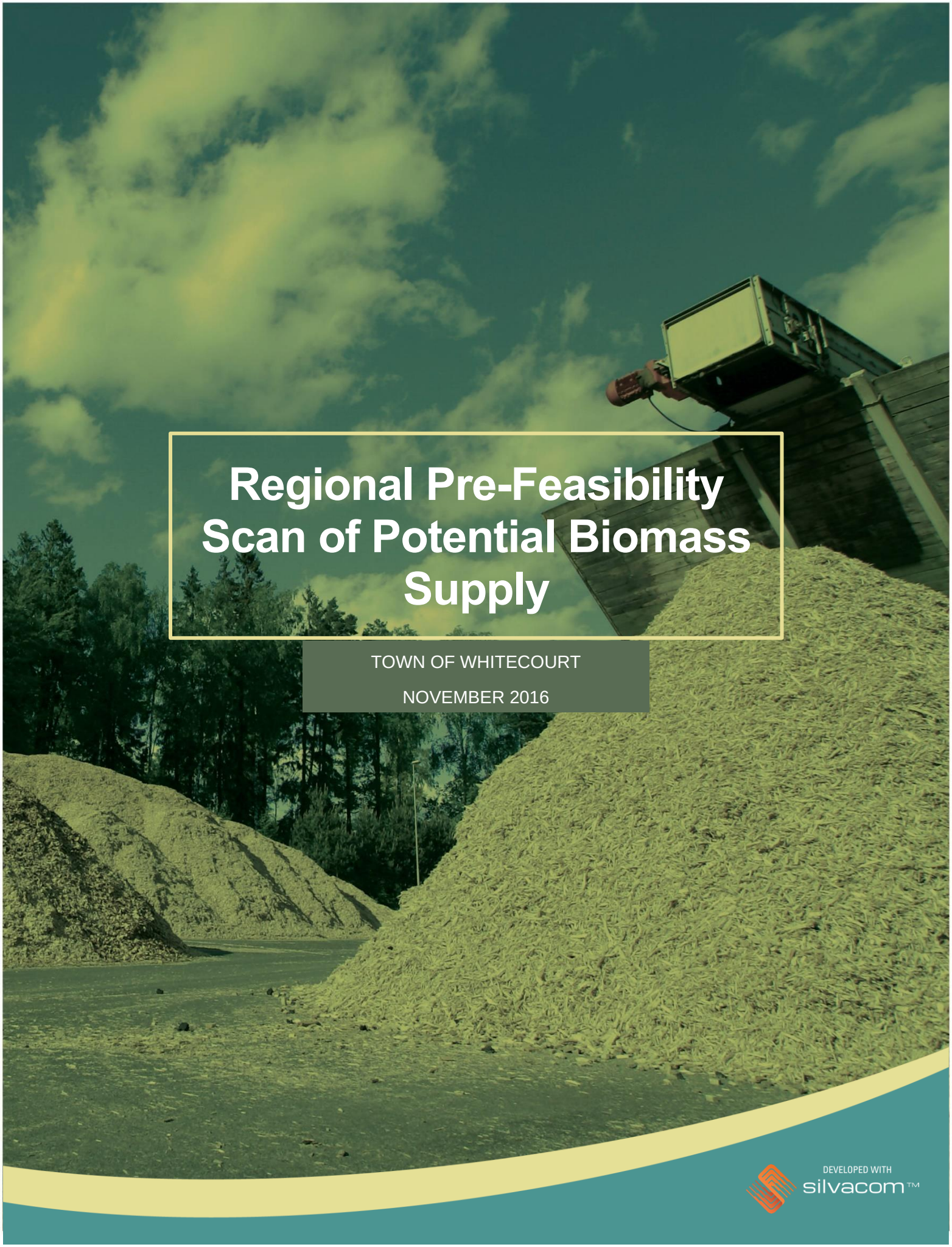

Regional Pre-Feasibility Scan of Potential Biomass Supply

TOWN OF WHITECOURT

NOVEMBER 2016

DEVELOPED WITH silvacom™

EXECUTIVE SUMMARY

There is a new focus in the bio-economy in Alberta aimed at leveraging one of Alberta's most abundant resources, biomass. Biomass is a renewable resource comprised of biological material taken from living or recently living organisms and as a feedstock is generally processed into one of three categories; bioenergy, biofuels and bioproducts.

An important first step in advancing a regional bio-economy is an inventory and assessment of potential biomass feedstocks. Understanding the make-up of the biomass supply and its location is a valuable resource for communities wishing to establish a business case to attract investment and spur entrepreneurship. A joint initiative between Alberta Economic Development and Trade, Alberta Innovates Bio Solutions and five Alberta communities was established to evaluate the biomass resource potential of these communities leveraging existing biomass data within Alberta's Bio Resource Information Management System (BRIMS). The five participating communities are:

- County of Grande Prairie No. 1,
- Lethbridge County,
- Town of Drayton Valley,
- Town of Sundre,
- Town of Whitecourt.

The BRIMS framework is a province wide collection of potential biomass resources and ecosystem services, standardized by township. The framework was designed to support a data and information management system for biomass companies to assess the relative supply of theoretical biomass. BRIMS includes biomass resources from agriculture, forests and organic waste. For this initiative, the BRIMS database was a primary input to conduct a regional pre-feasibility scan of potential biomass supply for each community.

This report provides a detailed analysis of theoretical biomass supply within three catchment zones surrounding the Town of Whitecourt. Located in north-central Alberta, the region boasts an active agriculture sector as well as substantial forested areas, presenting theoretical biomass feedstock opportunities as displayed in the following table.

Catchment Area	Agriculture – Theoretical Per Annum Estimates (Crops & Livestock)		Forest - Green Area Theoretical Inventory (Allocated & Unallocated Landbase)		Forest – White Area Theoretical Inventory		Forest – Mill Waste Theoretical Per Annum Estimates		Municipal Solid Waste – Theoretical Per Annum Estimates	
	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%	Tonnes	%
0 to 50 km	634,037	8%	65,841,210	13%	7,906,989	14%	440,961	46%	5,904	5%
51 to 100 km	2,207,930	28%	176,168,298	35%	15,190,174	26%	96,474	10%	923	1%
101 to 150 km	5,070,144	64%	259,042,009	52%	35,245,939	60%	413,499	43%	114,420	94%
Catchment Area Total	**7,912,112**	**100%**	**501,051,517**	**100%**	**58,343,103**	**100%**	**950,935**	**100%**	**121,247**	**100%**

The theoretical biomass potential illustrates the maximum potential supply that is bio-physically available. There are many industries who are already taking advantage of both primary and secondary forms of this resource supply, including forest products manufacturing (lumber, pulp, wood pellets), agricultural bedding & fertilizers, and energy production. The results of this analysis provides a foundation for building targeted business cases to support a local bio-economy. The theoretical estimates can be further examined for targeted businesses factoring operational, economic and ecological considerations in utilizing these potential feedstocks.

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PLEASE NOTE: The resolution of the data and summary results will vary depending on biomass type, consistent with the existing data utilized within Alberta's Bio-Resource Information Management System (BRIMS). Data used in this analysis is representative of a snap shot in time and varies dependent on biomass type and source of original data. As such, this analysis may not reflect the current or future biomass supply on the landscape. We are utilizing available data as-is, with no field verification or warranty provided. Biomass potential supply numbers provided will be a theoretical estimate and may not be tactically available. Silvacom Ltd. hereby disclaims any liability and shall not be held liable for any damages including, without limitation, direct, indirect or consequential damages including loss of revenue, loss of profit, loss of opportunity or other loss. Any reliance placed on this material is done so strictly at your own risk. This disclaimer applies to all portions of this biomass potential analysis.

1. INTRODUCTION

1.1 BACKGROUND

There is a new focus in the bio-economy in Alberta to fully utilize one of Alberta's most abundant resources, biomass [1]. Biomass is a renewable resource comprised of biological material taken from living or recently living organisms. There are three general biomass sources constituting the entire biomass potential of a landscape: forest, agriculture, and organic waste. Historically these resources have been used for traditional means such as forest products manufacturing however primary sources and waste streams offer significant potential for use in bioenergy, biofuels and other bioproducts. Advancing the bio-economy has numerous advantages including increasing economic returns from Alberta's natural resources [1] and cleantech innovation to help meet greenhouse gas (GHG) emissions reduction targets [2].

A cornerstone to advancing the regional bio-economy is an inventory and assessment of potential biomass feedstocks. Understanding the make-up of the biomass supply and its location is a valuable resource for communities wishing to establish a business case to attract investment and spur entrepreneurship. In general, there are four types of biomass potential as described by Biomass Energy Europe (Figure 1) [3]:

- **Theoretical potential** – The maximum amount of biomass available for production within fundamental bio-physical limits. In the case of biomass from crops and forests, the theoretical potential is the amount of biomass available taking into consideration limitations associated with soil, temperature, solar radiations and rainfall. In the case of residues and waste, the theoretical potential equals the total amount that is produced.
- **Technical potential** – The fraction of theoretical potential that is available given current technological capabilities (e.g. harvesting techniques, infrastructures and accessibility, processing techniques). It also takes into account other land uses (e.g. food, feed and fibre production) as well as ecological constraints (e.g. nature reserves).
- **Economic potential** – The share of technical potential that can be economically, or in other words profitably produced.
- **Sustainable implementation potential** – The fraction of economic potential that can be produced within a certain time frame and given socio-political realities, including policy incentives and economic, institutional and social constraints. Environmental, economic and social sustainability criteria are also taken into consideration in determining the sustainable implementation potential.

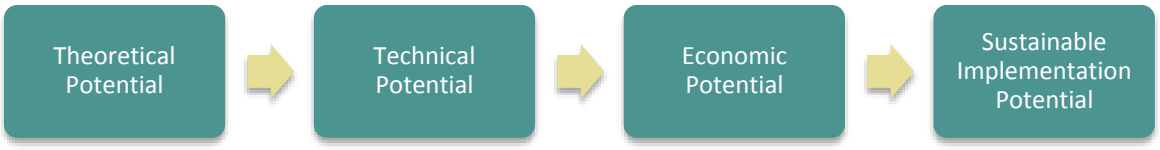


Figure 1 Types of biomass potential [3]

A joint initiative between Alberta Economic Development and Trade (AEDT), Alberta Innovates Bio Solutions (AI Bio) and five Alberta communities was established to evaluate the theoretical biomass resource potential of these communities leveraging existing biomass data within Alberta's Bio Resource Information Management System (BRIMS). The five participating communities are:

- County of Grande Prairie No. 1,
- Lethbridge County,
- Town of Drayton Valley,
- Town of Sundre,
- Town of Whitecourt.

This report provides a detailed analysis of theoretical biomass supply within three catchment zones (0-50 km, 51-100 km, 101-150 km) surrounding the Town of Whitecourt.

The purpose of this report is to conduct a pre-feasibility scan of potential biomass supply in the Town of Whitecourt (Figure 2). In subsequent phases, biomass utilization and existing infrastructure within the community in support of the bio-economy will be evaluated. In turn, opportunities for technology advancement and the expansion of the local bio-market will be assessed.

Figure 2 Phased Approach to Building the Bio-Economy

1.2 ABOUT BRIMS

The BRIMS framework is a province wide collection of potential biomass resources and ecosystem services, standardized by township. This initiative was initiated by AI Bio, with partners Silvacom and Green Analytics. The framework was designed to develop a data and information management system for biomass companies to assess the relative supply of theoretical biomass.

AI Bio's mandate is to "…*further research and innovation in the province and make Alberta more competitive in the global economy. AI Bio will meet the research and innovation priorities of the Government by providing leadership and coordination for research and innovation that supports the growth and diversification of Alberta's agriculture, forest, and life sciences sectors".* Specifically, AI Bio is dedicated to bio-based research [4].

The BRIMS framework is a multi-phase project. The purpose of Phase 1 was to assess the baseline data availability and the associated gaps in an effort to develop a complete biomass inventory for Alberta. Following this assessment, biomass sources were identified province-wide and theoretical biomass was estimated per township. Phase 1 was completed in 2012. Phase 2 of the framework, completed in 2014 built on the Phase 1 proof of concept and expanded the framework incorporating new inventories and methodologies. The third and final phase of BRIMS, currently in progress is focused on the development of a world class geospatial web application for viewing, reporting and interacting with biomass and other ecosystem services data (Figure 3). The end goal is to provide a web-based application to support investment decisions related to the use of biomass and other ecosystem services in Alberta.

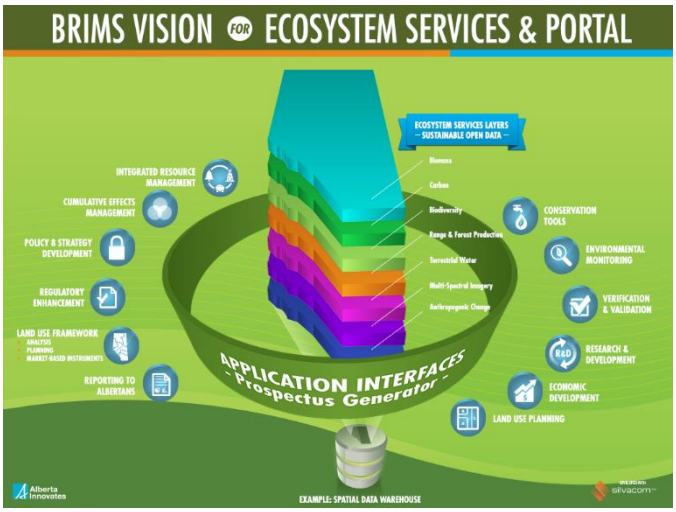


Figure 3 Vision for BRIMS

For more information regarding biomass and its potential, please refer to the Bio Resource Information Management System (BRIMS) webpage.[1]

[1] http://www.brims.ca/

2. METHODOLOGY

2.1 STUDY AREA

The Town of Whitecourt is located approximately 177 km northwest of Edmonton and 279 km southeast of Grande Prairie. The most recent municipal census (2013) counted a population increase of 969 to 10,574 residents [5], representing a 10.1% growth since the 2011 Federal Census [6]. The average age of Whitecourt residents is 32, making it a relatively young town [5].

Forestry is one of the most important economic engines in the region, providing employment opportunities to Whitecourt residents [7]. Three major facilities located in the area are:

- Blue Ridge Lumber Sawmill - produces multi-density fibre (MDF) board and lumber products
- Millar Western Forest Products – produces pulp and dimensional lumber
- Alberta Newsprint Company Pulp & Paper Mill – newsprint producer

The oilfield industry is another major contributor to the economy. The location of Whitecourt in north-central Alberta makes it an ideal hub for the oil and gas industry, which serves the area west of Edmonton to south of Grande Prairie. With some farm land to the south and east of Whitecourt, agriculture plays a role in the town's economy.

Tourists are attracted to Whitecourt for the summer and winter outdoor recreational opportunities. With hundreds of kilometres of designated trails, Whitecourt has branded itself and the Snowmobile Capital of the World [7]. Fishing, mountain biking and hiking are popular summer activities.

Whitecourt is strategically located in the resource heartland of Alberta. Its primary trading area is over 50,000 people. Highway 43 is part of the Canamex Corridor, linking Canada with the United States and Mexico. Highway 43 also offers direct access to the northern regions of Canada and the United States.

This analysis focuses on biomass within concentric catchment areas around the Town of Whitecourt. These catchment areas were created using concentric "as the crow flies" distance measures around the urban/rural interface. Three catchment areas were created (Figure 4):

- 0-50 km
- 51-100 km
- 101-150 km

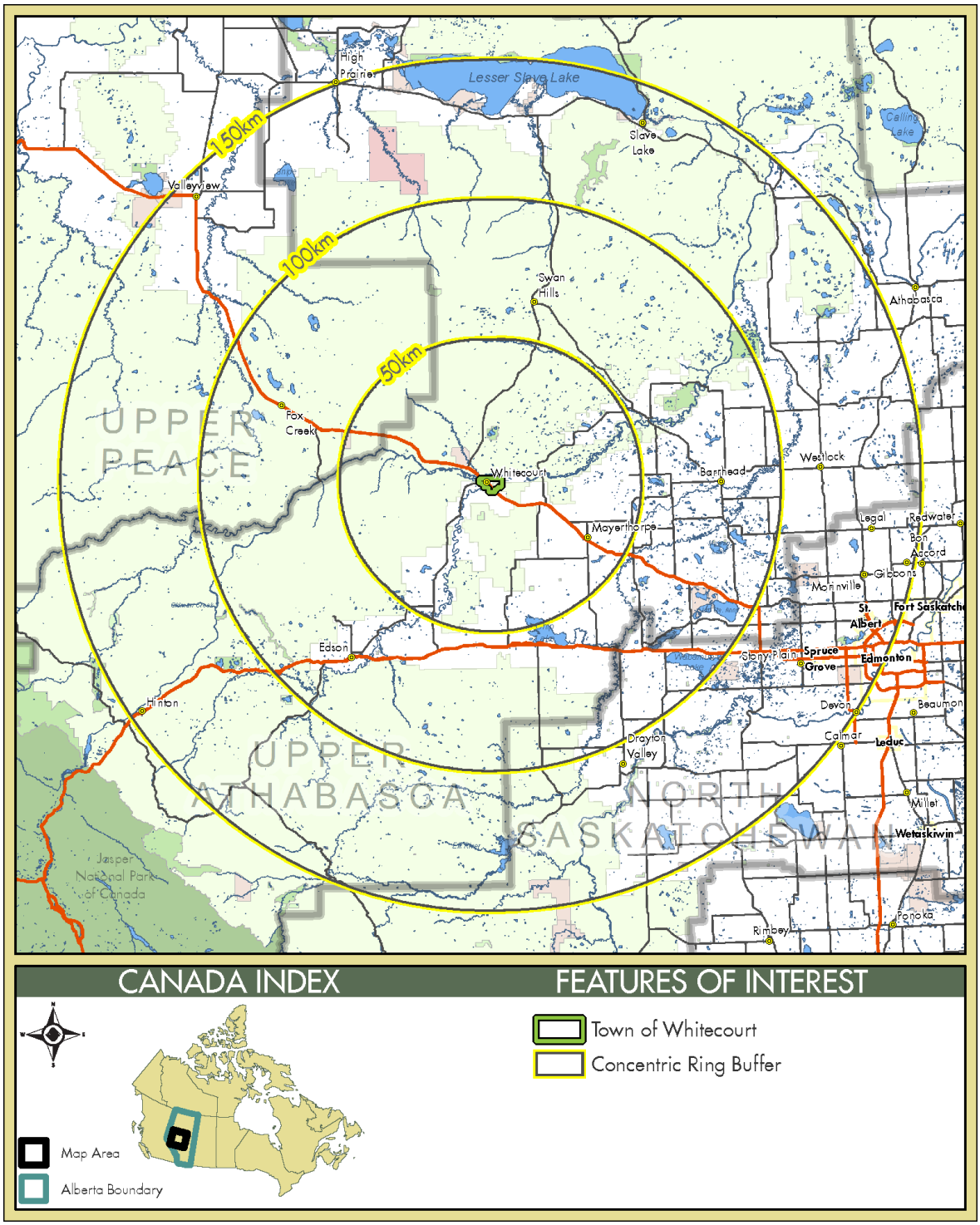


Figure 4 Overview map of the study area

The Town of Whitecourt falls within the Upper Athabasca Planning Region for the province's Land-Use Framework (LUF). The catchment areas surrounding the town intersect with the North Saskatchewan and Upper Peace Planning Regions. LUF is Alberta's approach to managing the province's land and natural resources to achieve long-term economic, environmental and social goals [8]. Under the framework, the province is divided into seven regions that will each have their own regional plan [8]. These plans may influence the sustainable implementation of potential biomass supply in the region.

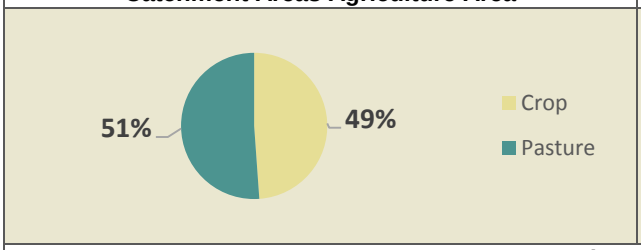
Table 1 summarizes the landscape in the biomass catchment areas. As depicted in Figure 5 and Table 1, forests are the primary landcover type in the catchment areas. In addition to these areas as potential primary sources of biomass, there are potential secondary sources from mill residues, livestock processing facilities and municipal solid waste collected at landfills that are present within the catchment areas (Table 1).

Approximately 1% of the full study area falls within parks and protected areas including portions of wildland parks, provincial parks, natural areas and ecological reserve areas.

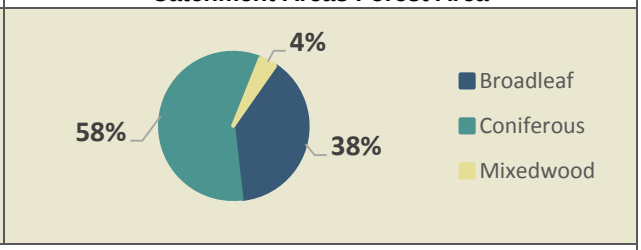
Table 1 Study area landscape characteristics

Catchment Area	Water		Agriculture		Forests		Shrubland / Grassland		Other Footprint[2]		Total	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
0 to 50 km	8,443	4%	124,013	10%	552,146	14%	165,322	12%	53,578	10%	903,502	12%
51 to 100 km	46,035	23%	361,422	28%	1,414,072	35%	494,977	36%	154,565	30%	2,471,071	33%
101 to 150 km	143,336	72%	788,849	62%	2,106,039	52%	696,634	51%	306,648	60%	4,041,506	54%
Catchment Area Total	**197,814**	**100%**	**1,274,284**	**100%**	**4,072,257**	**100%**	**1,356,933**	**100%**	**514,791**	**100%**	**7,416,079**	**100%**

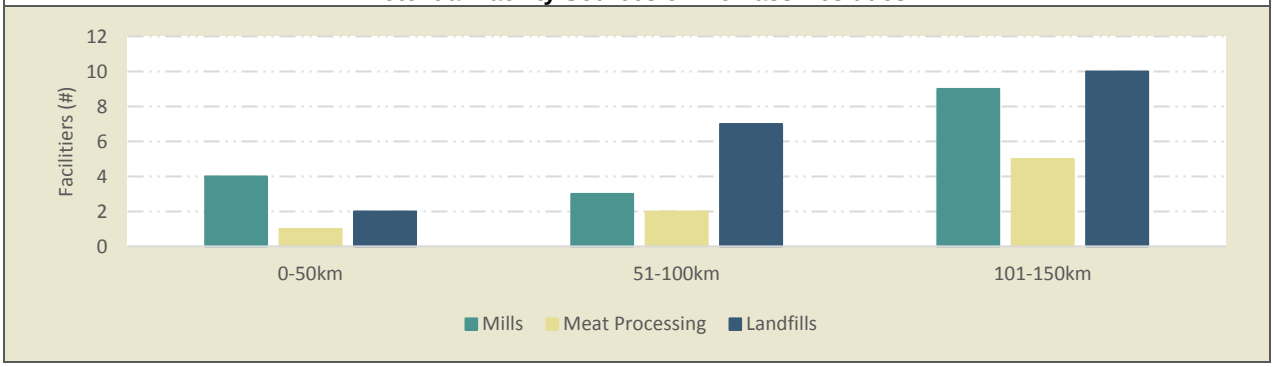
Catchment Areas Agriculture Area



Catchment Areas Forest Area



Catchment Areas
Potential Facility Sources of Biomass Residues



[2] "Other footprint" includes roads, railways, urban and rural industrial/residential sites, seismic lines, transmission lines, pipelines, reservoirs, and well sites.

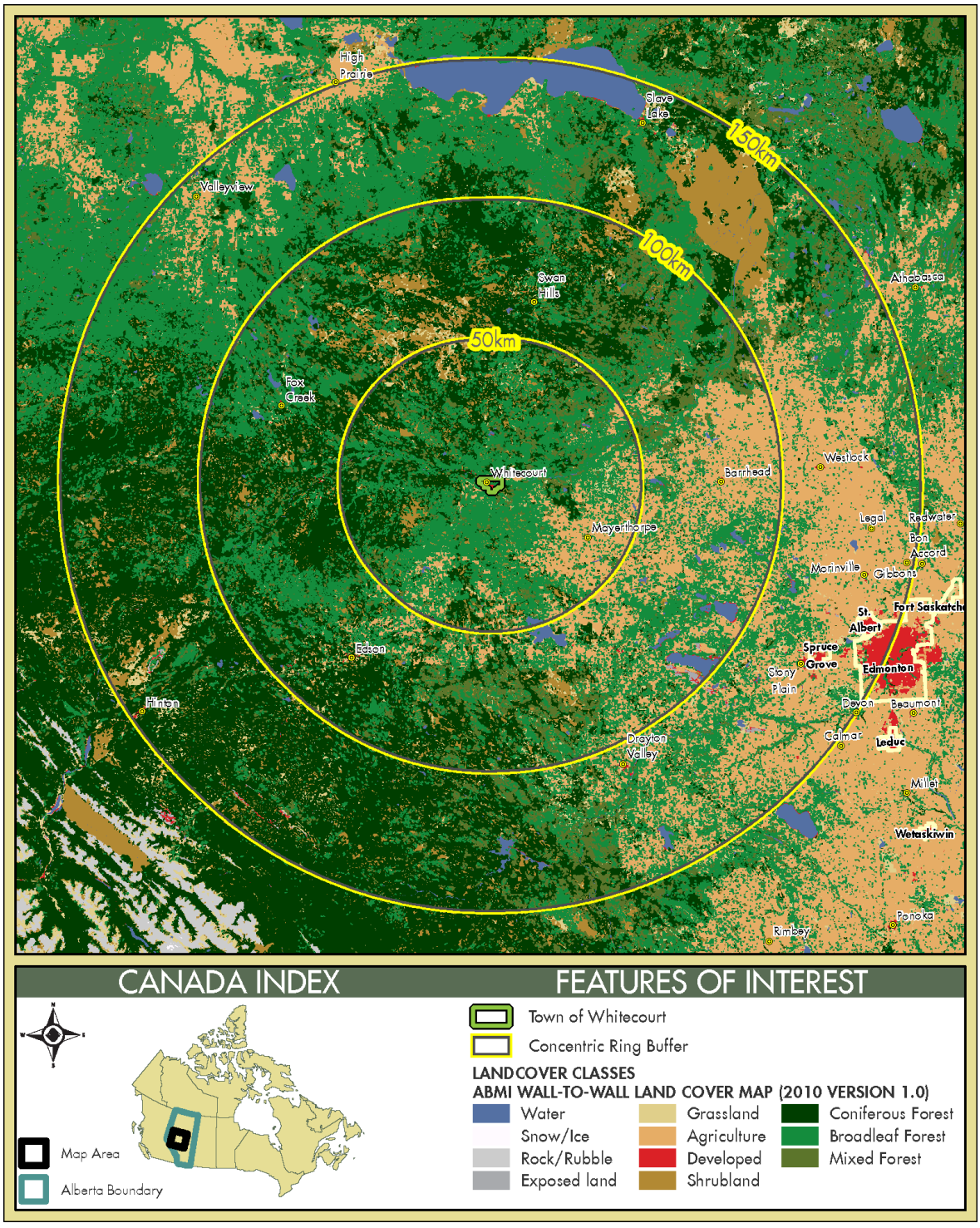


Figure 5 Study area landcover map (Refer to Appendix B for a full size map)

2.2 APPROACH

2.2.1 LANDBASE DETERMINATION

Data was leveraged from the provincial BRIMS database and used to estimate the total theoretical potential biomass (tonnes)[3] within the study area. To localize and enhance the BRIMS outputs for the study area, a number of additional datasets were incorporated to refine potential biomass estimates. Included in this value added process was identifying multiple land cover types (i.e. forested, grassland, pasture, crop fields, human footprint, etc.) using Agriculture & Agri-Food Canada Annual Crop Inventory and ABMI Human Footprint Inventory for 2012 conditions among others. In addition, regional areas where potential biomass resources do exist but are not currently obtainable (i.e. parks and protected areas) were identified and excluded from potential biomass estimates. Table 2 summarizes a list of key data inputs.

Table 2 Data Inputs

Layer	Description	Source	Effective Date
BRIMS	Comprehensive inventory of theoretical biomass potential (tonnes) per township for the province of Alberta.	Alberta Innovates	2015
Municipal Boundaries	Geo-administrative city boundaries	AltaLis	2016
Green/White Area	The green and white areas were used to separate biomass potential calculations	AltaLis	2011
Parks and Protected Areas	Parks and Protected areas were identified as biomass is not currently accessible within these regions	AltaLis	2012
Annual Crop Inventory	Annual crop inventory field classification and mapping	Agriculture & Agri-Food Canada	2015

[3] Tonnes are defined as per the BRIMS framework and can refer to dry tonnes, ODTs, or gross tonnes, dependent on the biomass source.

Layer	Description	Source	Effective Date
ABMI Human Footprint Inventory for 2012 Conditions (Version 3)	The ABMI Human Footprint Map was used to identify developed areas	ABMI	2010
Forest Management Areas	FMAs were used to estimate the amount of forest in the green area that is currently allocated	AltaLis	2013

2.2.2 BRIMS FRAMEWORK

2.2.2.1 BIOMASS POOLS

The BRIMS framework organizes the various forms and sources of theoretical potential biomass in Alberta into a scalable hierarchy of biomass pools (Figure 6) and includes the following components:

1. Forest biomass includes all secondary products derived from wood. Within BRIMS these include:
    a. Stem wood: biomass obtained from pre-commercial and commercial thinning, as well as final felling of forests;
    b. Primary forest residues (i.e. logging residues);
    c. Secondary forest residues obtained from industry by-products such as sawdust, wood chips, bark, etc.; and
    d. Trees outside of Alberta's green area (forested area) such as trees in urban areas along sidewalks, and other infrastructural areas.
2. Agricultural biomass includes biomass derived from energy crops, agricultural residues, and animal waste. Examples of these include:
    a. Oil containing crops (i.e. canola, etc.);
    b. Starch crops (i.e. wheat, barley, etc.);
    c. Harvest residues (i.e. straw);
    d. Manure from livestock; and
    e. Animal processing waste.
3. Lastly, organic waste encompasses other potential biomass sources including:
    a. Biodegradable municipal waste

Agriculture - Crops

- Barley, Canola, Oats, Wheat, Hay
  - Seed
  - Residue

Agriculture - Livestock

- Cattle, Swine, Poultry, Turkey, Sheep
  - Manure
  - Processing Waste

Forests - Green Area - Net Landbase, Deleted Landbase, Unallocated Landbase

- Conifer, Deciduous
  - Wood - Top, Stem, Stump
  - Branches
  - Bark - Top, Stem, Stump
  - Roots - Coarse, Fine
  - Foliage

Forests - White Area

- Conifer
- Mixedwood
- Deciduous

Forests - Mill Residues

- Lumber
- Pulp & Paper
- OSB
- Veneer

Municipal Solid Waste

- Construction & demolition
- Organic Yard Waste & Animal Remains
- Mixed Waste
- Wood
- Sludge

Figure 6 BRIMS framework

2.2.2.2 BIOMASS CONSTITUENTS

Biomass constituents are the properties and sub-components that may be of interest for prospective industries helping to bring the supply and demand chains closer together. Figure 7 illustrates the framework utilized for reporting these in BRIMS[4].

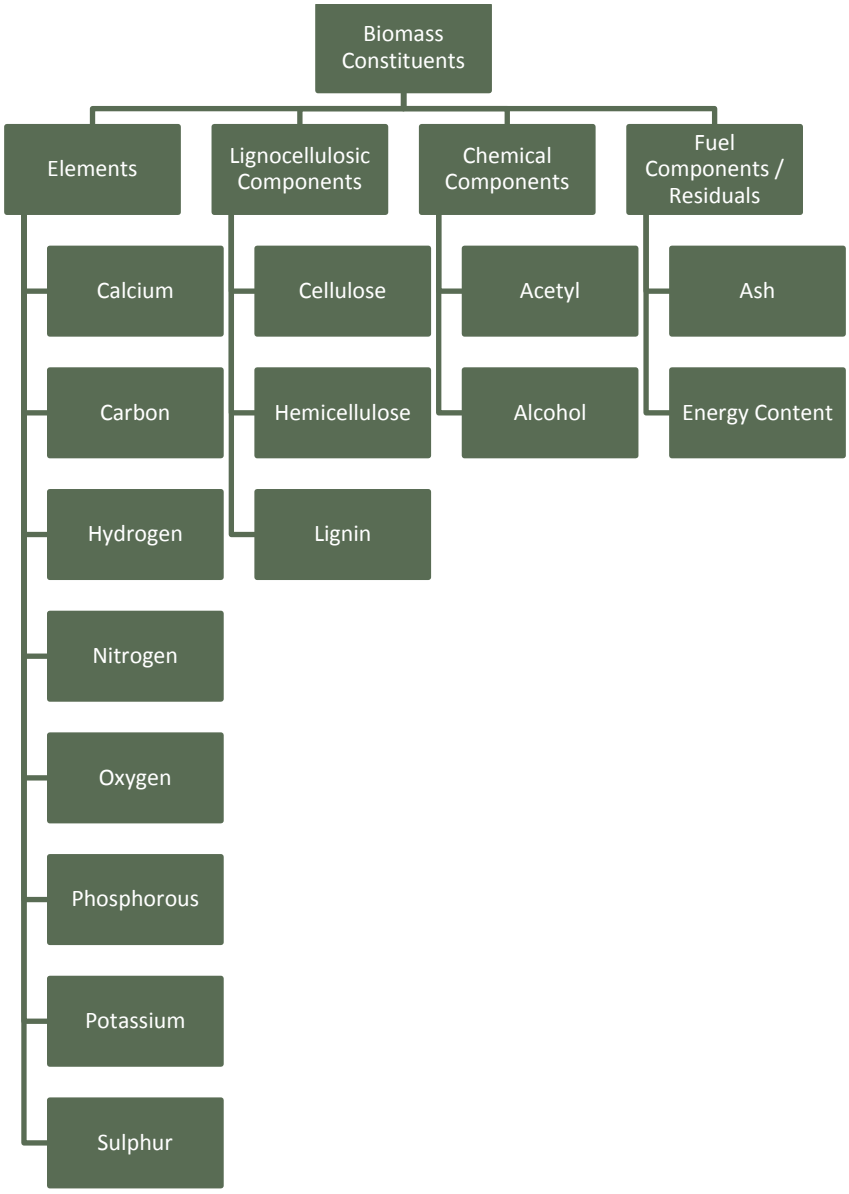


Figure 7 BRIMS biomass constituents framework

[4] Biomass properties and constituents may only be applicable and relevant to specific biomass pools in the BRIMS framework.

3. RESULTS

The majority of the biomass in the area of interest comes from forest biomass and most notably the Green Area forested. After Green Area forest biomass, White Area forested areas offer the most biomass tonnage, followed by agricultural crops, mill residues, livestock and MSW related biomass.

Forest biomass is a stock account of potentially available biomass. Agricultural biomass, MSW, and mill waste are flow accounts of potentially available biomass which refresh yearly as new crops are planted or new livestock harvested, etc. This should be considered when comparisons of forest and other biomass types are included in decision-making processes.

The following graphs summarize the results categorically by biomass source. Section 3.4 summarizes the total biomass potential. Potential biomass supply estimates provided are a theoretical estimate and may not be tactically available. Recoverable factors are not taken into account where some potential biomass is likely to remain in the field or the forest floor. Furthermore, some summarized potential biomass is located in areas that may not be feasible for recovery and other sources may already be committed to alternative uses.

The resolution of the analysis and results will vary depending on biomass type, consistent with the existing data utilized within BRIMS. Tonnes are summarized as *dry tonnes or oven-dried tonnes* consistent with data sources leveraged in the BRIMS framework, unless otherwise stated.

For a detailed results of the biomass pools, please refer to Appendix A.

3.1 AGRICULTURE

3.1.1 CROPS

Biomass sourced from agricultural crops has been separated into crop seed/product and crop residue. Crop seed/product represents the total tonnage of crops in the area of interest (oven dried tonnes) and crop residue is an estimate of remaining portions. Currently only materials remaining in the field following harvest are estimated in the BRIMS framework as potential harvest residue sources. Potential biomass was estimated based on the major crops summarized in the BRIMS framework (Figure 6). The biomass estimates per hectare was leveraged into the productive agricultural land outlined in the study area landbase. Estimates are based on a per annum perspective, using 2014 data. Estimates will vary from year to year as crop yields and the amount of area in crops varies annually.

Table 3 Theoretical potential agriculture crop biomass[5]

Catchment Area	Crop Seed		Crop Residue		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	108,498	5%	504,671	9%	**613,169**	**8%**
51 to 100 km	554,166	27%	1,608,579	28%	**2,162,745**	**28%**
101 to 150 km	1,425,741	68%	3,561,515	63%	**4,987,256**	**64%**
Catchment Area Total	**2,088,405**	**100%**	**5,674,765**	**100%**	**7,763,170**	**100%**

Catchment Areas (Crop Seed + Crop Residue)

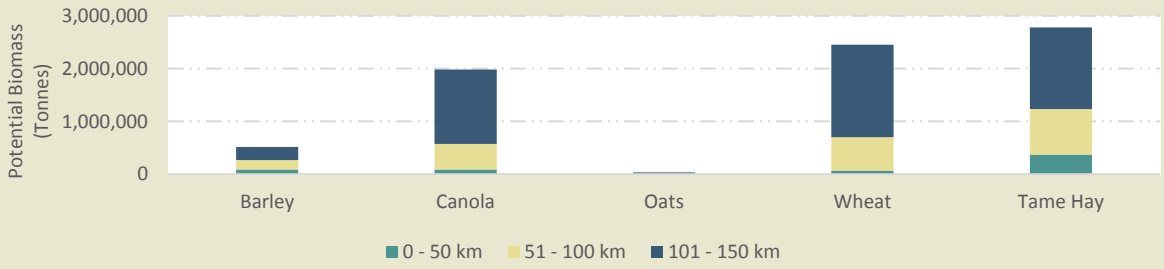
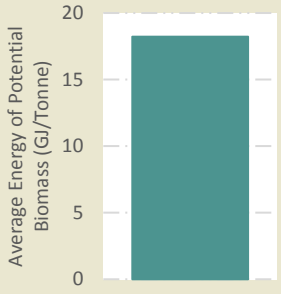
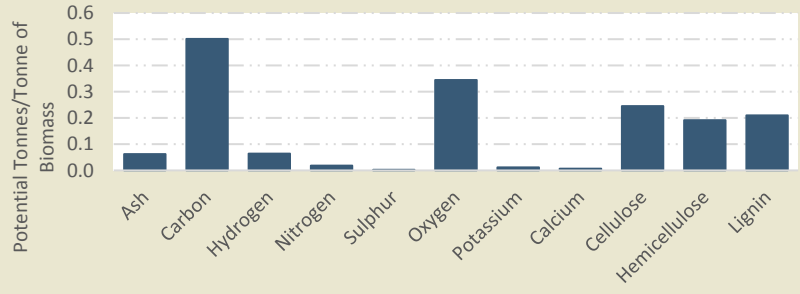


Table 4. Constituent Summary of Potential Crop Biomass

Energy Content	Constituents
	

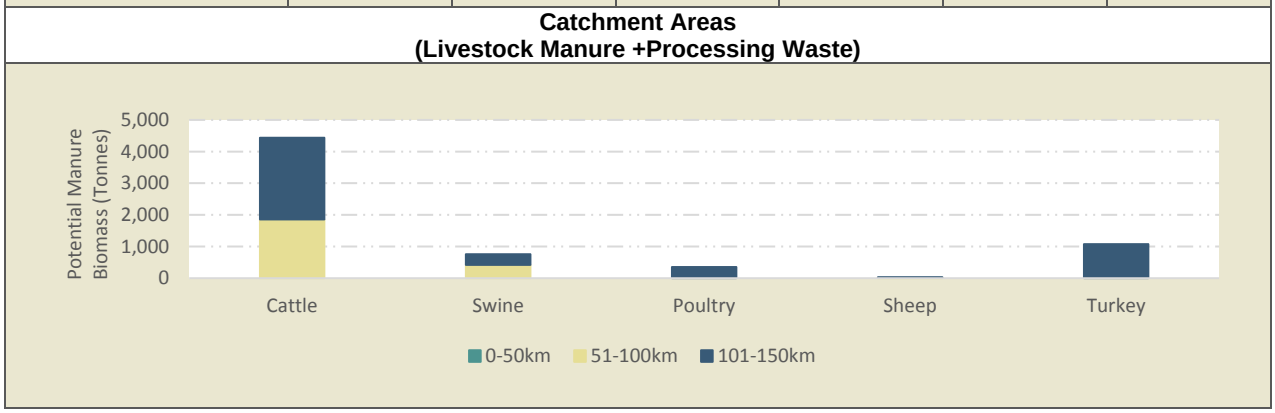
[5] Oven dry tonnes per year as per the BRIMS framework

3.1.2 LIVESTOCK AND POULTRY

Biomass sourced from livestock[6] can be separated into manure and animal processing waste. Biomass estimates for cattle, swine, chickens, turkeys and sheep were collected per township for both manure and animal processing within the BRIMS framework. This estimate was leveraged into productive agricultural areas within the study area landbase. Estimates are based on a per annum perspective. Estimates will vary year to year, depending on the amount of animals raised each year.

Table 5. Theoretical Potential Livestock Biomass

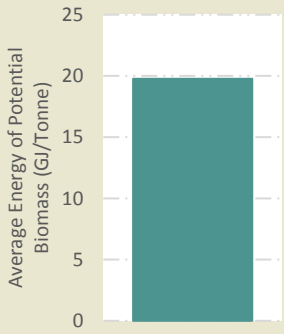
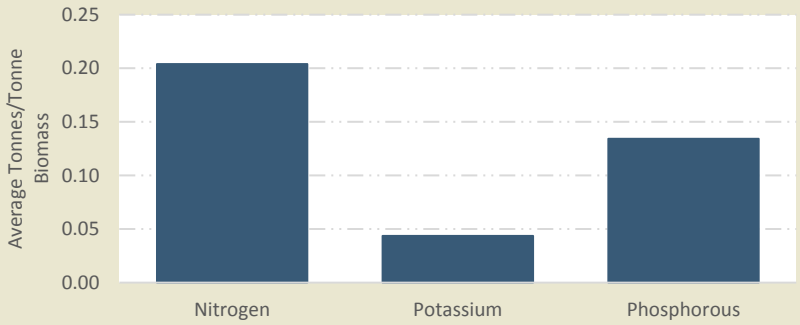
Catchment Area	Livestock Manure		Processing Waste[7]		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	20,868	15%	0	0%	**20,868**	**14%**
51 to 100 km	42,901	30%	2,284	34%	**45,185**	**30%**
101 to 150 km	78,525	55%	4,364	66%	**82,889**	**56%**
Catchment Area Total	**142,295**	**100%**	**6,647**	**100%**	**148,942**	**100%**



[6] For the purposes of this study poultry is defined as livestock

[7] Animals may be shipped to processing plants from other regions. The BRIMS framework does not include an empirical estimate of kilograms of animal processing waste per township. An estimate is computed from the number of animals raised within the region, based on Census Canada data (2010).

Table 6. Constituent Summary of Potential Livestock Biomass

Energy Content	Constituents
	

3.2 WOODY MATERIALS

3.2.1 FORESTED GREEN AREA

The Green Area covers approximately 58% of the province of Alberta [9]. Primary land uses in this area include timber production, oil and gas development, tourism and recreation and conservation of natural spaces. Nearly all of the Green Area is publically owned.

Because the majority of the Green Area is forested, there are many potential sources of biomass. The BRIMS framework identifies potential biomass sources within the Green Area as all parts of the tree including not only the stem but also the top wood, top bark, branches, needles or leaves and belowground biomass (roots).

The BRIMS framework also separates biomass sources into net landbase stands, landbase deletion stands, and unallocated stands. Net landbase stands are comprised of the operable forested area. Deletion stands contain the area of forests that are currently inoperable for forest operations. This includes but is not limited to forest stands that are within defined water buffers, on steep slopes, low timber productivity or other Forest Management Agreement (FMA) specific operability criteria. For the purposes of this analysis, it is assumed that forest area outside of a FMA area is unallocated, although portions of this area may be entirely or partially allocated under a quota or other agreement. Forested Green Area accounts for about 46% of the total study area.

Estimates are based on the amount of theoretical potential biomass within the area of interest, and do not account for forest regrowth or other ecological or sustainability constraints. Estimates do not represent an annual supply. In other words, the theoretical potential biomass includes all the standing biomass in the forested areas.

Table 7. Theoretical Potential Green Area Forest Biomass[8]

Location	Allocated		Unallocated		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	61,236,939	13%	4,604,271	26%	**65,841,210**	**13%**
51 to 100 km	171,184,558	35%	4,983,740	28%	**176,168,298**	**35%**
101 to 150 km	250,587,393	52%	8,454,616	47%	**259,042,009**	**52%**
Catchment Area Total	**483,008,890**	**100%**	**18,042,627**	**100%**	**501,051,517**	**100%**

Catchment Areas Wood Type (Allocated + Unallocated)

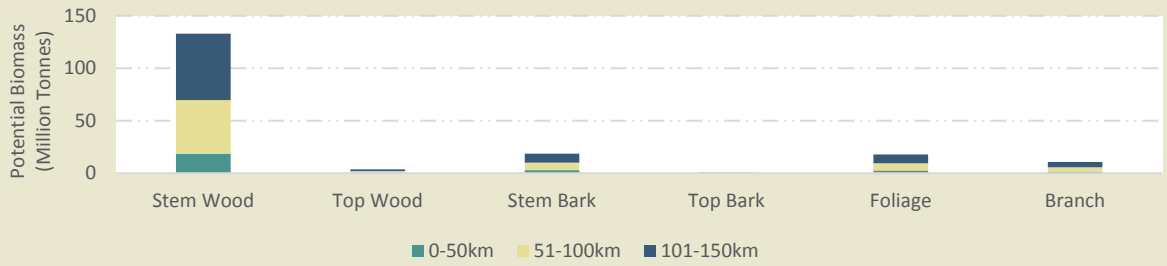
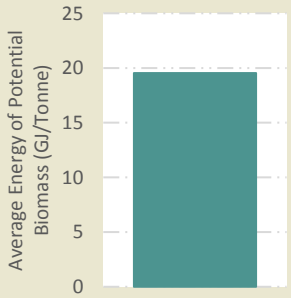
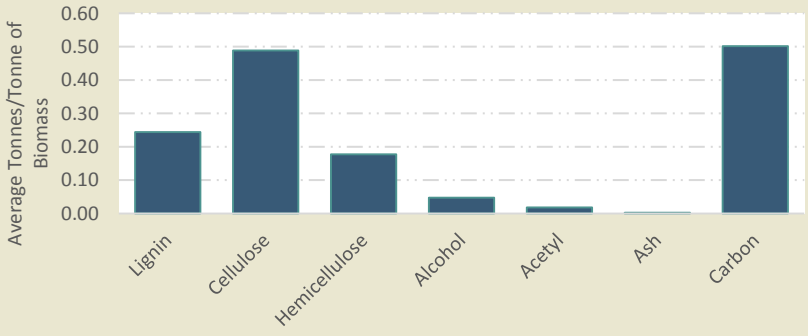


Table 8. Constituent Summary of Potential Green Area Forest Biomass

Energy Content	Constituents
	

[8] Aboveground and belowground biomass in oven dry tonnes as per the BRIMS framework. Estimates do not represent annual supply.

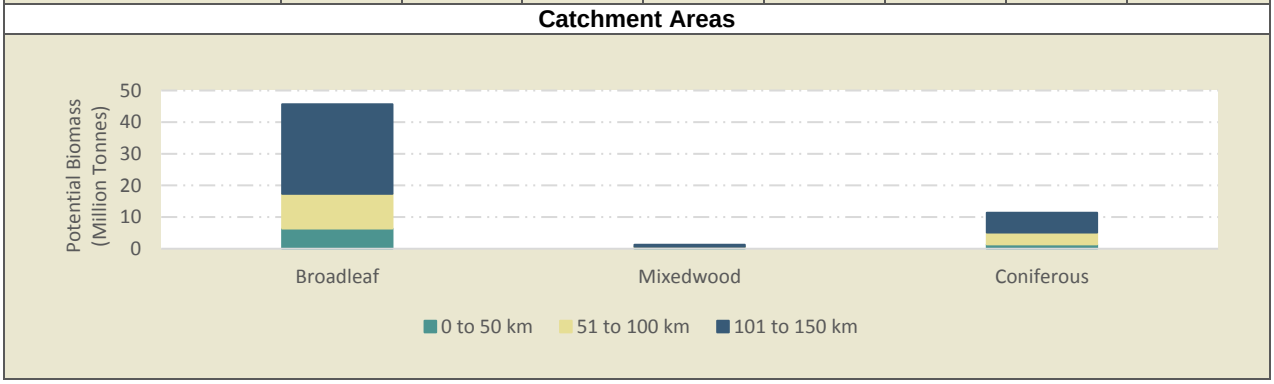
3.2.2 FORESTED WHITE AREA

The White Area in Alberta is comprised of settled lands and covers approximately 42% of the province [9]. Primary land uses include: settlements, agriculture, oil and gas development, tourism and recreation, and conservation of natural spaces. Roughly 75% of the White Area is privately owned [9].

Approximately 9% of the study area is forested White Area which includes private woodlots, plantations and shelterbelts. Potential biomass can be sourced from these woodlots. Biomass summaries include all parts of the tree, including top wood, top bark, stem wood, etc. Excluded from this analysis is stump wood and stump bark as this data is not currently available within the BRIMS framework. Estimates are based on the amount of theoretical potential biomass within the area of interest, and do not account for forest regrowth or other ecological or sustainability constraints. Estimates do not represent an annual supply.

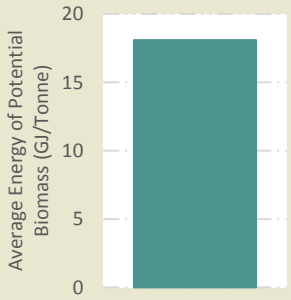
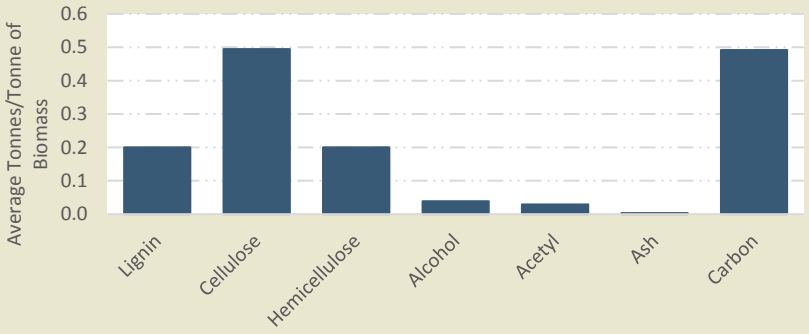
Table 9. Theoretical Potential White Area Forest Biomass[9]

Catchment Area	Broadleaf		Mixedwood		Coniferous		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	6,400,398	14%	153,636	12%	1,352,955	12%	**7,906,989**	**14%**
51 to 100 km	10,953,804	24%	453,705	36%	3,782,666	33%	**15,190,174**	**26%**
101 to 150 km	28,314,202	62%	668,020	52%	6,263,717	55%	**35,245,939**	**60%**
Catchment Area Total	**45,668,404**	**100%**	**1,275,361**	**100%**	**11,399,338**	**100%**	**58,343,103**	**100%**



[9] Aboveground biomass in oven dry tonnes as per the BRIMS framework. Estimates do not represent annual supply.

Table 10. Constituent Summary of White Area Forest Biomass

Energy Content	Constituents
	

3.2.3 MILL RESIDUES

Operating forest product mills were identified within the study area. The BRIMS framework was then leveraged to estimate potential biomass within the region through sourcing waste from saw mills, veneer mills, OSB mills, and pulp and paper mills[10]. Estimates are based on the amount of residue produced by a forest product mill per annum. This residue may already be allocated to other sources and not tactically available. Estimates will also vary year to year as mill production varies. Lumber, pulp and paper, and OSB mills are operating in the area of interest.

[10] Mill waste summarizes the residue surplus from operating mills within the area of interest based on average log volume consumed (m^3). Mills with no production data available and small mills (<100,000 m3/yr) are excluded from the analysis

Table 11. Theoretical Potential Mill Waste Biomass[11]

Catchment Area	Lumber		Pulp & Paper		OSB		Veneer		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	278,722	43%	162,239	65%	0	0%	0	0%	**440,961**	**46%**
51 to 100 km	63,118	10%	0	0%	33,356	95%	0	0%	**96,474**	**10%**
101 to 150 km	300,208	47%	87,626	35%	1,756	5%	23,910	100%	**413,499**	**43%**
Catchment Area Total	**642,048**	**100%**	**249,865**	**100%**	**35,112**	**100%**	**23,910**	**100%**	**950,935**	**100%**

Catchment Areas Mill Residues

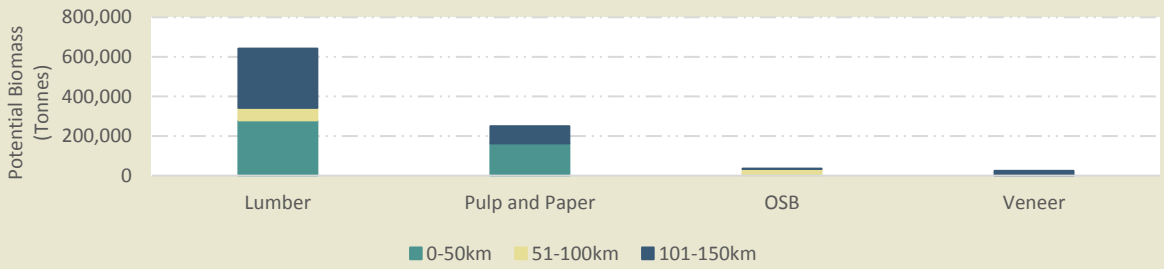
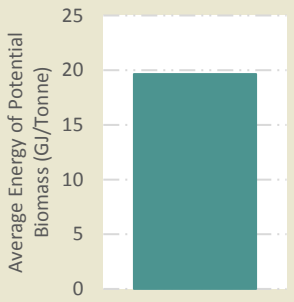
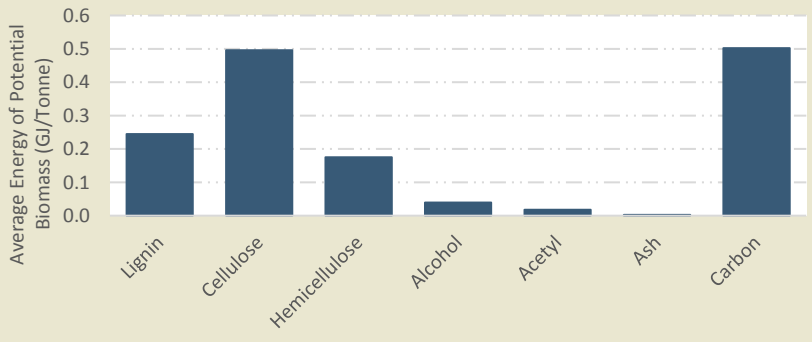


Table 12. Constituent Summary of Potential Mill Residue Biomass

Energy Content



Constituents



[11] Per annum estimate in oven dry tonnes as per the BRIMS framework

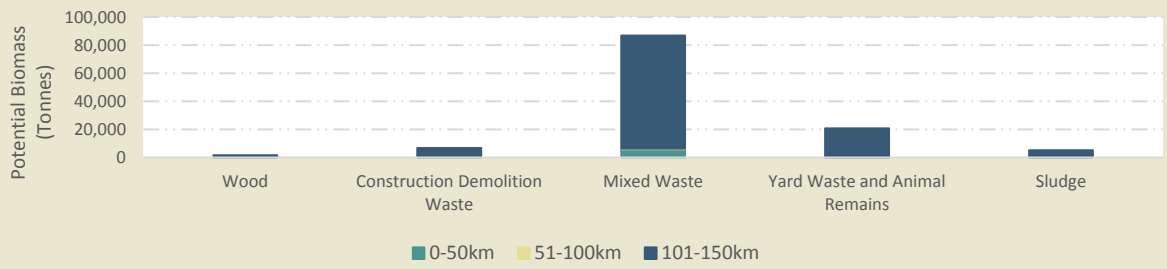
3.3 MUNICIPAL SOLID WASTE

Landfills located within the study area were identified. Estimates of potential biomass are based on five types of municipal solid waste: construction and demolition (wood components only), organic yard waste, wood, sludge and mixed solid waste (organic components only). Estimates are based on the annual reported incoming waste by landfill. Landfill estimates for sludge are assumed to be dry weight, however, landfill reports do not necessarily specify whether or not reported weights are dry or wet. Other sources of municipal solid waste are dry weight and this is reflected in the biomass calculations.

Table 13. Theoretical Potential Municipal Solid Waste Biomass

Catchment Area	Wood		Construction & Demolition		Mixed Waste		Organic Yard Waste		Sludge		Total Potential	
	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent	Tonnes	Percent
0 to 50 km	0	0%	8	0%	5,896	7%	0	0%	0	0%	**5,904**	**5%**
51 to 100 km	0	0%	527	8%	396	0%	0	0%	0	0%	**923**	**1%**
101 to 150 km	1,669	100%	6,200	92%	80,566	93%	20,838	100%	5,147	100%	**114,420**	**94%**
Catchment Area Total	**1,669**	**100%**	**6,735**	**100%**	**86,858**	**100%**	**20,838**	**100%**	**5,147**	**100%**	**121,247**	**100%**

Catchment Areas Municipal Solid Waste



3.4 TOTAL THEORETICAL BIOMASS POTENTIAL

Investment in and innovation associated with biomass in Alberta will likely depend on sound information about the availability of biomass resources in the province. Table 14, Figure 8 and Figure 9 illustrate the amount of potential biomass within the catchment areas.

Table 14. Total Theoretical Biomass

Category	Catchment Areas[12]			
	0 to 50km (Tonnes)	51 to 100km (Tonnes)	101 to 150km (Tonnes)	Catchment Area Total Potential (Tonnes)
Crop Biomass[13]	613,169	2,162,745	4,987,256	**7,763,170**
Livestock Biomass[14]	20,868	45,185	82,889	**148,942**
Green Area Forest Biomass[15]	65,841,210	176,168,298	259,042,009	**501,051,517**
White Area Forest Biomass[16]	7,906,989	15,190,174	35,245,939	**58,343,103**
Mill Waste Biomass[17]	440,961	96,474	413,499	**950,935**
MSW Biomass[18]	5,904	923	114,420	**121,247**

[12] Catchment areas are centred surrounding the Whitecourt Town centre and only include area within the province of Alberta.
[13] Crop seed and residue per annum estimated in oven dry tonnes as per the BRIMS framework
[14] Manure and processing waste per annum estimated in dry tonnes as per the BRIMS framework
[15] Aboveground and belowground biomass in oven dry tonnes in the allocated and unallocated landbase as per the BRIMS framework. Estimates do not represent annual supply.
[16] Aboveground biomass in oven dry tonnes as per the BRIMS framework. Estimates do not represent annual supply.
[17] Per annum estimate in oven dry tonnes as per the BRIMS framework.
[18] Wood, construction & demolition, mixed waste, organic waste and residential sludge per annum estimated in dry tonnes as per the BRIMS framework

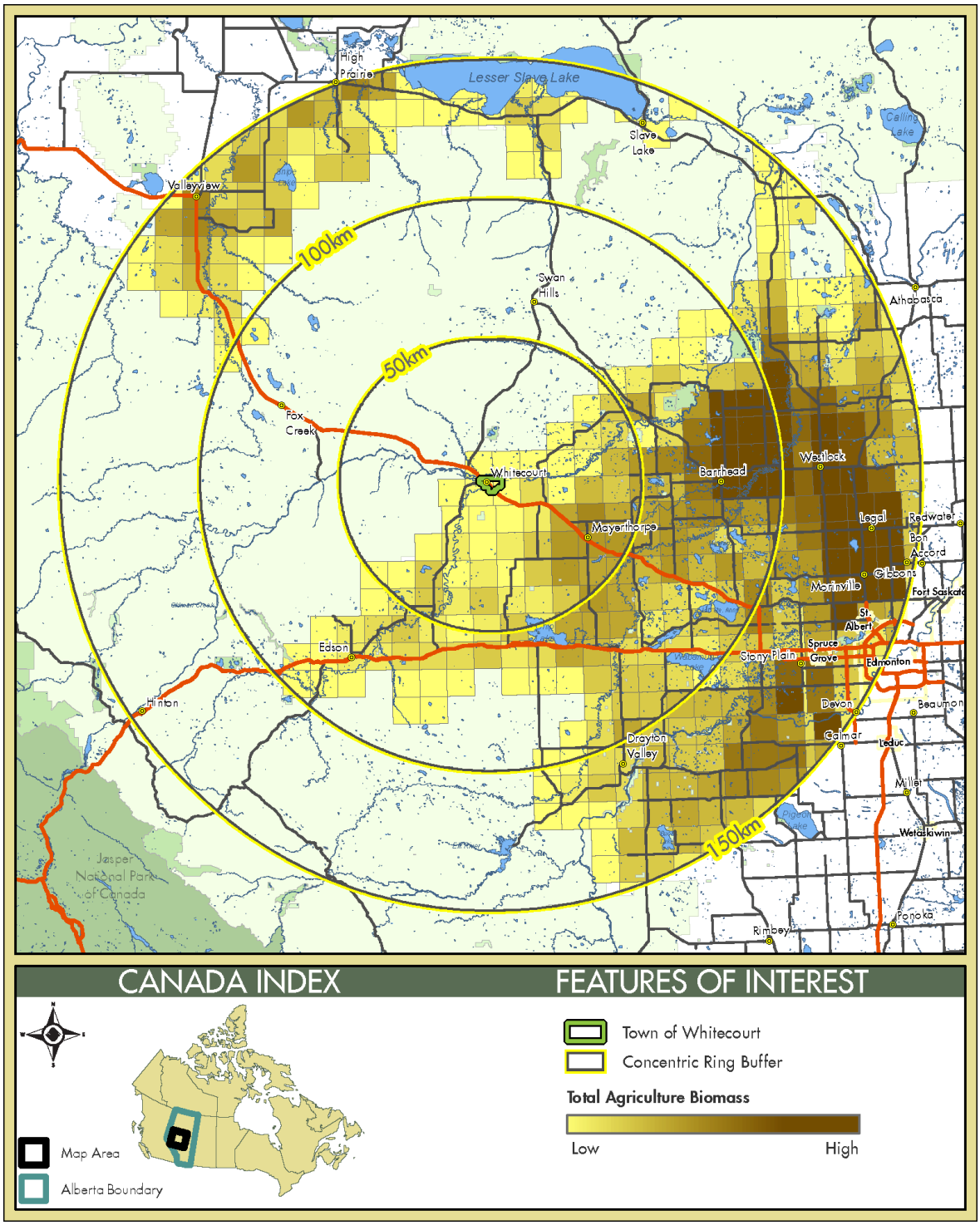


Figure 8 Map of agriculture biomass (See Appendix B for full size map)

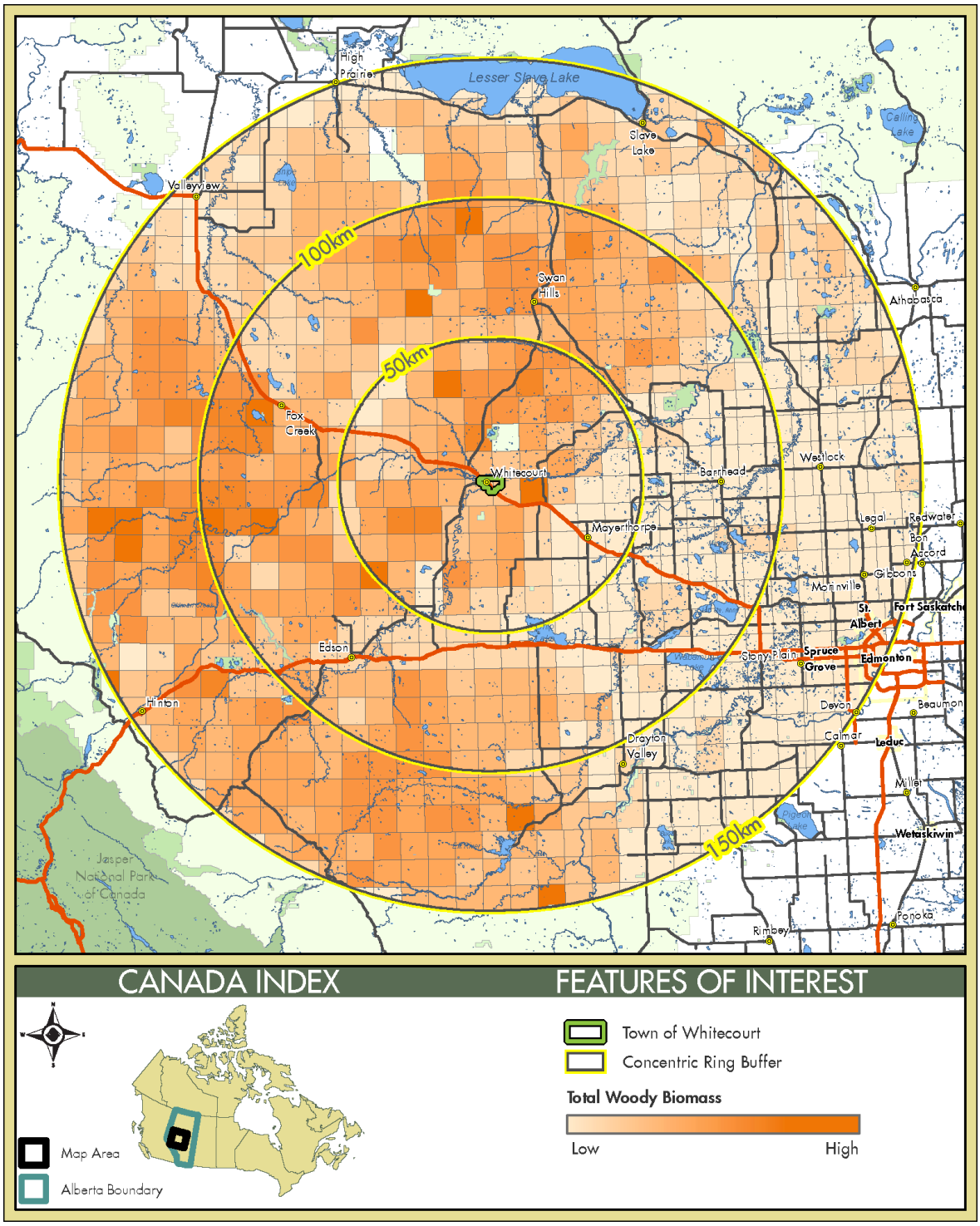


Figure 9 Map of woody biomass (See Appendix B for full size maps)

4. NEXT STEPS

Biomass resource assessments evaluate the resource potential of a given location and provide critical information to support decision-making processes in guiding bio-industry development strategies. This initiative between AEDT, AI Bio and five Alberta communities analyses the make-up and distribution of theoretical potential biomass supply providing a cornerstone to advancing regional bio-economies.

The pre-feasibility scan of potential biomass supply summarized the theoretical resource potential within three catchment zones surrounding the Town of Whitecourt using a spatially explicit, comprehensive biomass inventory, BRIMS. The analysis illustrates the region's full resource potential in forests, agriculture and organic wastes presenting significant opportunity for the community.

The information in this report will help guide the development of targeted business strategies to expand the bio-economy. The analysis can be further refined for targeted industries to examine the technical, economic and sustainable implementation biomass potential. Further regional analysis to assess biomass potential include:

- Analysis of existing industrial allocations and utilization of potential biomass sources
- Technical availability of biomass sources based on environmental constraints, harvesting techniques, processing techniques and infrastructure / accessibility requirements
- Economic potential of biomass resources considering harvesting techniques, processing techniques, transportation costs, etc.
- Sustainable implementation potential of biomass resources considering local policy, social constraints, ecosystem services assessment, etc.
- Risk assessment of biomass feedstocks examining historical variability in supply, climate change and other supply chain factors.

5. Works Cited

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[5] Town of Whitecourt, "2013 municipal Census," Town of Whitecourt, Whitecourt, 2013.

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[8] Government of Alberta, "Land-Use Framework," 2008. [Online]. Available: https://landuse.alberta.ca/LandUse%20Documents/Land-use%20Framework%20-%202008-12.pdf.

[9] Government of Alberta, "Sustainable Forest Management: Current facts and statistics," 2011. [Online]. Available: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/formain15744/$file/GeneralBoundary-CurrentFactsAndStatistics-2011.pdf?OpenElement.

APPENDIX A: THE BRIMS FRAMEWORK

Accompanying this document is a spreadsheet that contains a detailed summary of biomass pools as per the BRIMS framework.

APPENDIX B: ADDITIONAL MAPS

REGIONAL PRE-FEASIBILITY SCAN OF POTENTIAL BIOMASS - TOWN OF WHITECOURT

ABMI WALL-TO-WALL LAND COVER MAP (2010 VERSION 1.0)

LEGEND

FEATURES OF INTEREST

LANDCOVER CLASSES

ABMI WALL-TO-WALL LAND COVER MAP (2010 VERSION 1.0)

- Water
- Snow/Ice
- Rock/Rubble
- Exposed land
- Developed
- Shrubland
- Grassland
- Agriculture
- Coniferous Forest
- Broadleaf Forest
- Mixed Forest

PLANIMETRIC LEGEND

BOUNDARIES

- Town of Whitecourt
- Concentric Ring Buffer
- Provincial Boundary

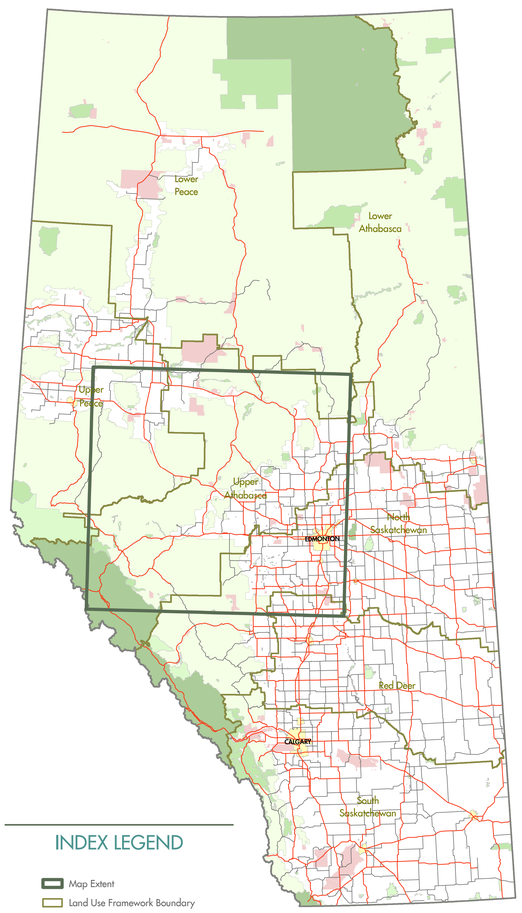
ALBERTA TOWNSHIP SYSTEM

- Township

POPULATED AREAS

- Town / Village / Hamlet
- City

ALBERTA INDEX



INDEX LEGEND

- Map Extent
- Land Use Framework Boundary

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Map Version: 1.00
Map Date: November 15, 2016
Map Production: Silvacom Ltd.
Silvacom Ref: X-035
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REGIONAL PRE-FEASIBILITY SCAN OF POTENTIAL BIOMASS - TOWN OF WHITECOURT

POTENTIAL BIOMASS DERIVED FROM AGRICULTURAL SOURCES

LEGEND

FEATURES OF INTEREST

TOTAL AGRICULTURE (TONNES / TOWNSHIP)

- 1 - 5,000
- 5,001 - 10,000
- 10,001 - 15,000
- 15,001 - 20,000
- 20,001 - 25,000
- 25,001 - 30,000
- 30,001 - 35,000
- 35,001 - 40,000
- 40,001 - 45,000
- 45,001 - 50,000
- 50,001 - 55,000
- 55,001 +

PLANIMETRIC LEGEND

BOUNDARIES
- Town of Whitecourt
- Concentric Ring Buffer
- Provincial Boundary

POPULATED AREAS
- City
- Town / Village / Hamlet

ROAD CLASSES
- Expressway / Highway
- Arterial

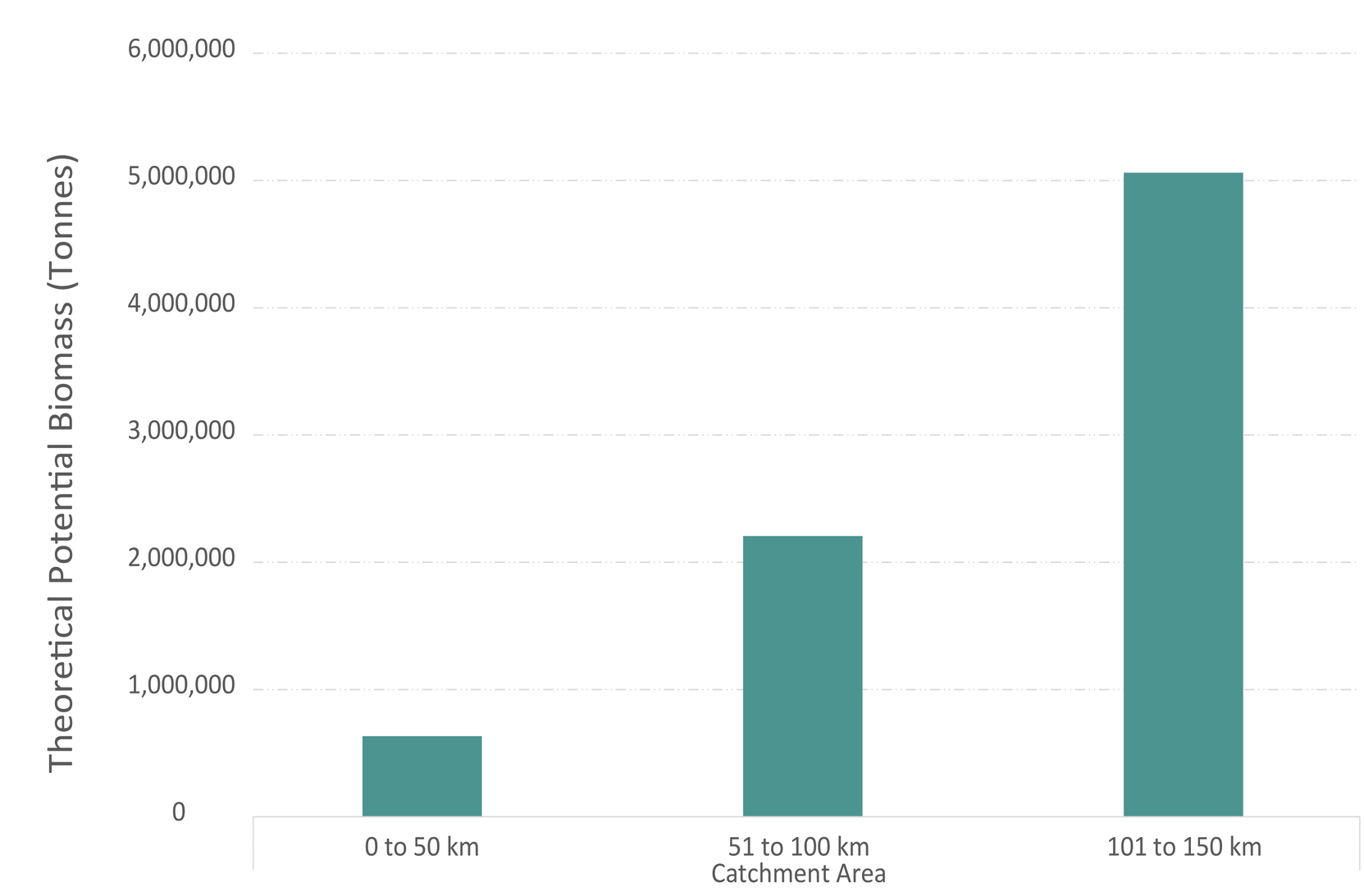
WATER
- Lake / River
- Stream / Canal / Oxbow / Ditch

ALBERTA TOWNSHIP SYSTEM
- Township

PARKS AND PROTECTED AREAS
- National Park
- Provincial Park, Wildland Provincial Park, Wilderness Park
- Natural Area, Ecological Reserve, Wilderness Area, PRA

LAND DESIGNATIONS
- Green Area
- White Area

GRAPH



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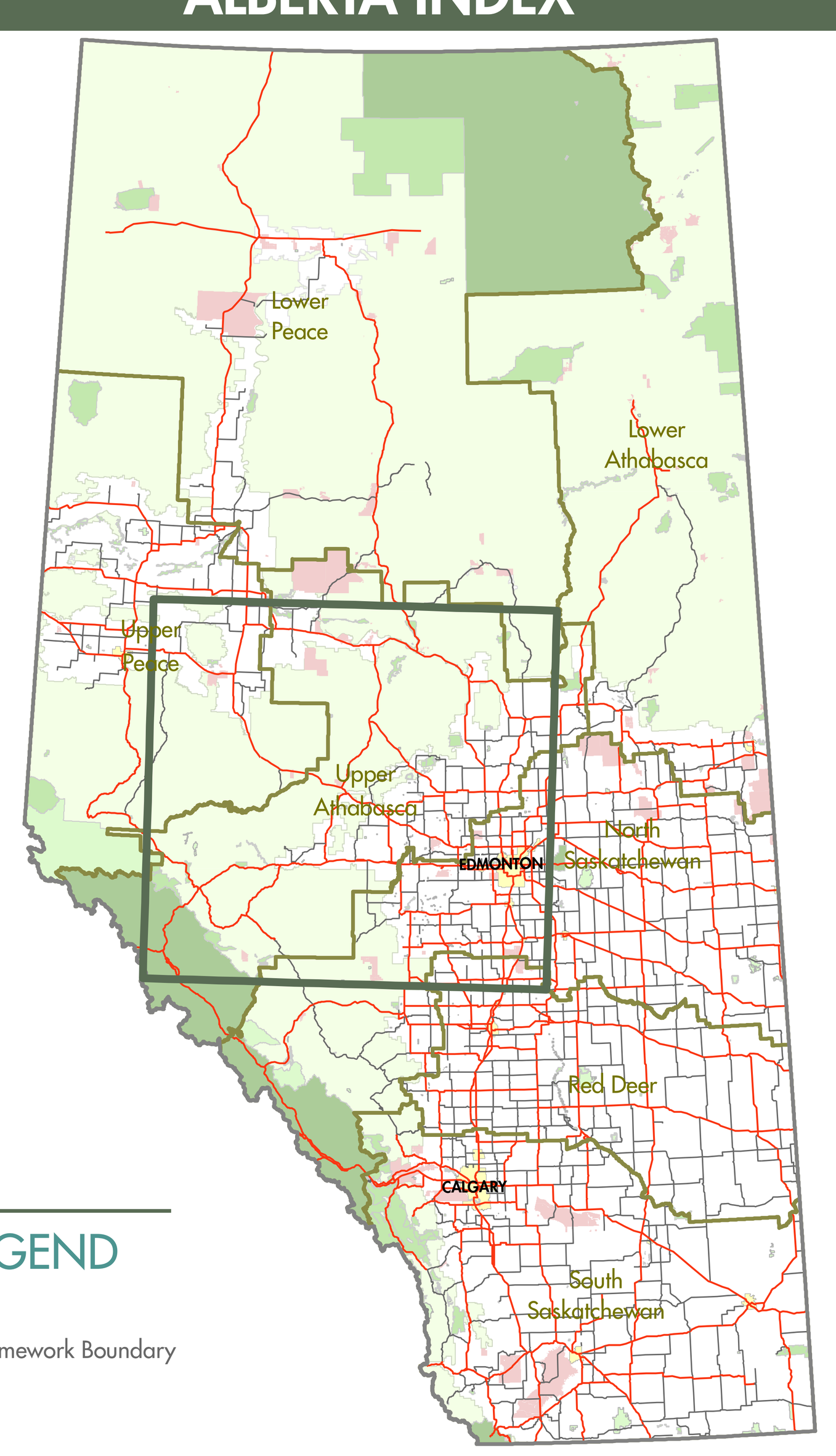

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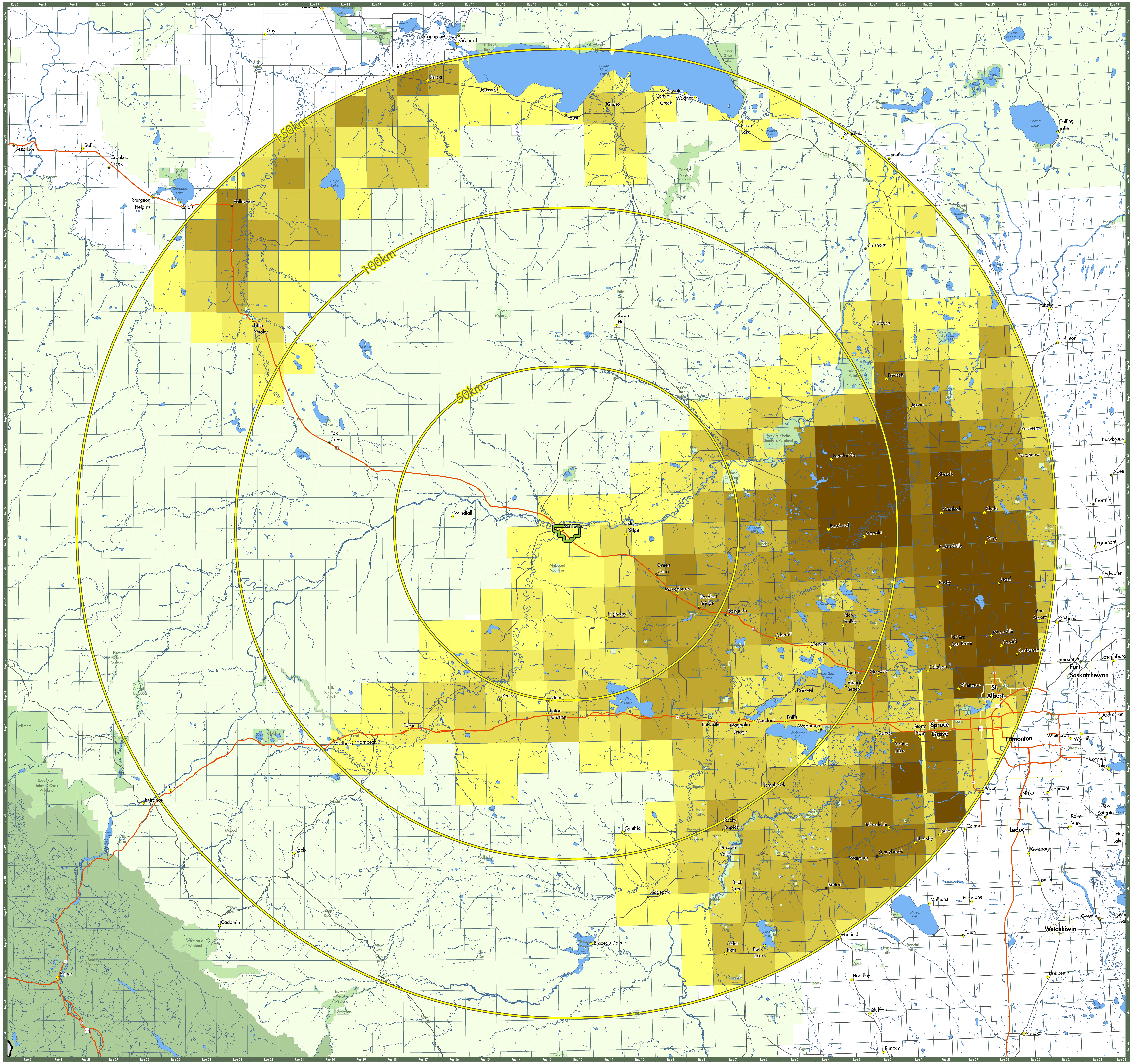

REGIONAL PRE-FEASIBILITY SCAN OF POTENTIAL BIOMASS - TOWN OF WHITECOURT

POTENTIAL BIOMASS DERIVED FROM WOODY MATERIALS

LEGEND

FEATURES OF INTEREST

TOTAL WOODY BIOMASS (TONNES / TOWNSHIP)

- 1 - 250,000
- 250,001 - 500,000
- 500,001 - 750,000
- 750,001 - 1,000,000
- 1,000,001 - 1,250,000
- 1,250,001 - 1,500,000
- 1,500,001 - 1,750,000
- 1,750,001 +

PLANIMETRIC LEGEND

BOUNDARIES
- Town of Whitecourt
- Concentric Ring Buffer
- Provincial Boundary

POPULATED AREAS
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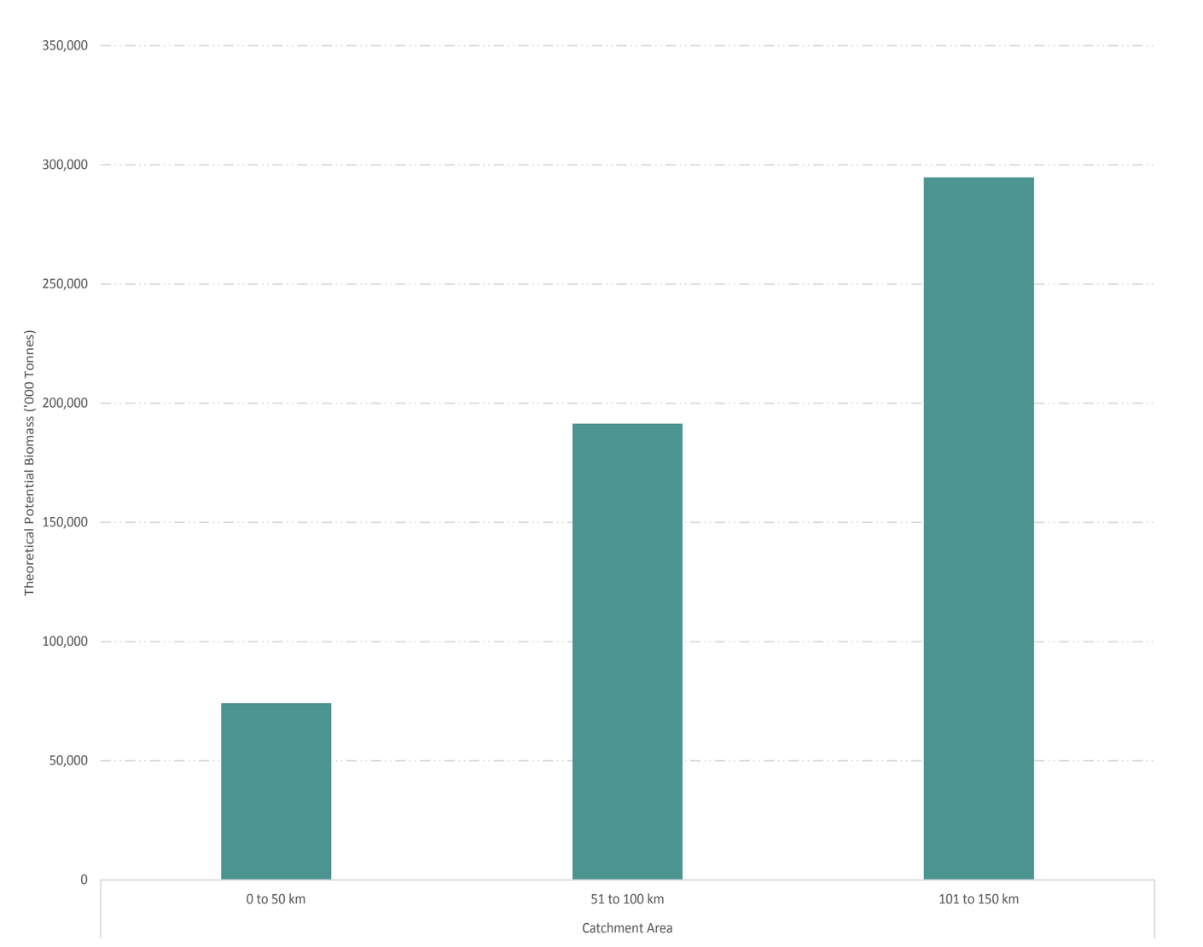
- White Area

GRAPH



ALBERTA INDEX

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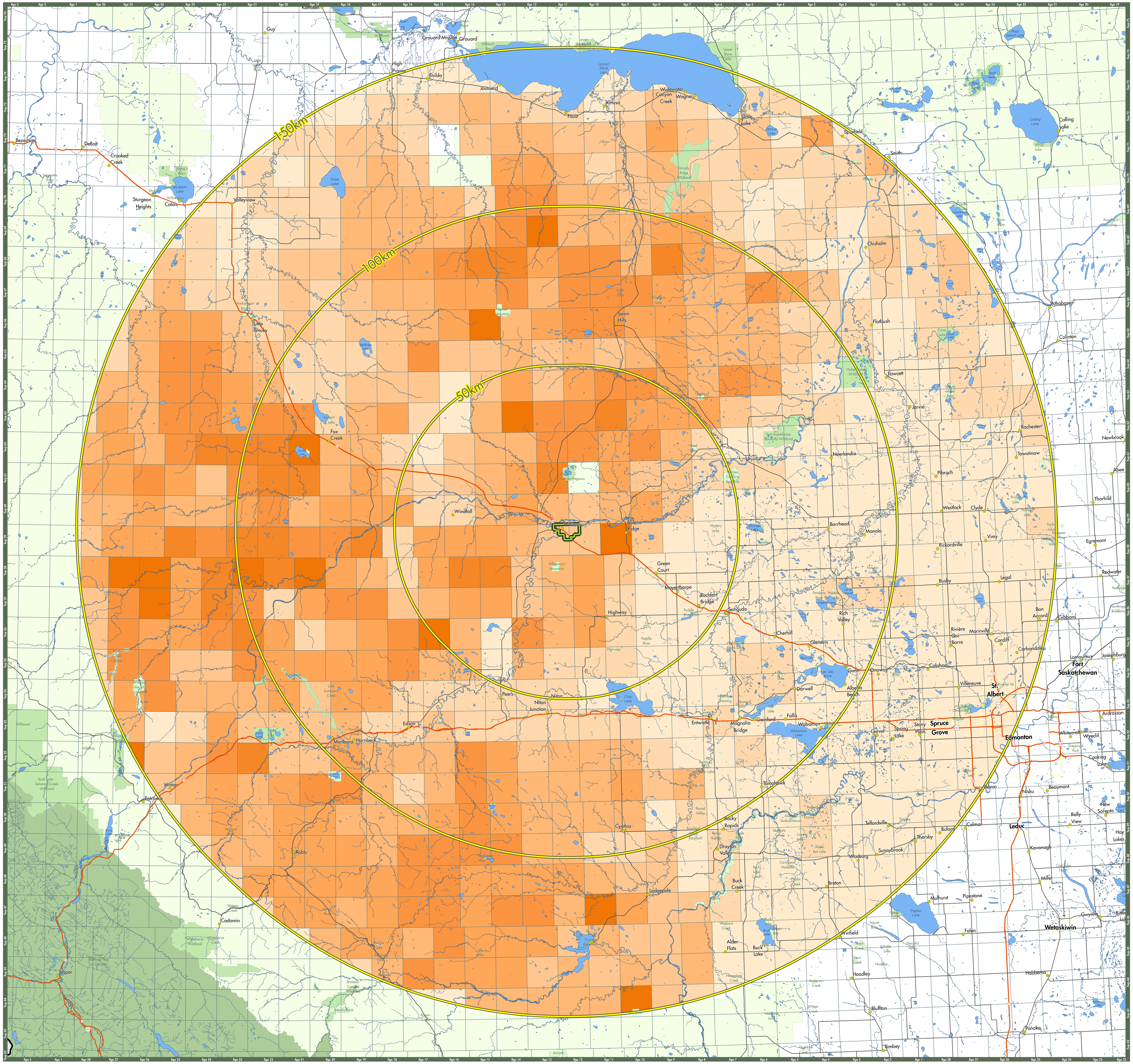

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