

# *Chief Mountain Study - January 2008*

---

## **Background**

The Chief Mountain Study (CMS) is a grassroots driven study directed by a multi-stakeholder, consensus-based working group that includes government, industry, First Nations, landowners, NGO's and Parks Canada. The study arose from local concern about land-use trends and their associated long-term impacts on landscape level indicators such as groundwater stocks, surface water quality, grizzly bear, and native grasslands. The study area is located in the southwestern portion of Alberta including: Cardston County, the Municipal District of Pincher Creek, the Kainai and Piikani First Nations' reserves and Waterton National Park. The area covers roughly 925,000 hectares (2.28 million acres) and is predominantly cultivated agriculture (43% of study area), native origin grasslands (30% of study area) and forests (18% of study area). Human footprint currently covers about 2% of the study area.

## **Key Findings of the Study**

### **Emerging Land use Trends**

- Growth in settlements and transportation networks represent significant threats to grassland integrity in the region.
- Acreages are on track to surpass agricultural residences in area.
- Wind turbines are becoming a significant land use. They have a relatively small footprint but a potentially high visual impact.
- The area needed for recreational activities is increasing rapidly and is expected to surpass the energy sector footprint before 2057.
- Hydrocarbon sector footprint growth is projected to be relatively low compared with other land uses.
- Conventional oil, natural gas, and coal bed methane activity is projected to be substantially less than projected in the adjacent Southern Foothills Study.

### **Emerging Environmental Trends**

- The amount of water held in shallow groundwater aquifers is declining.
- Livestock and humans are primarily responsible for the continuing declines in surface water quality.
- Native grassland integrity (area presence) is projected to decline.
- Forest fragmentation is forecasted to increase.
- Grizzly Bear populations are likely to decline.

# *Chief Mountain Study - January 2008*

---

## **Study Description**

The purpose of the study was to assess the potential cumulative effects of land use and footprint growth within the study area if their current trends continue for the next 50 years. The ALCES® computer simulation model was chosen to assist with projection, analysis and reporting of the changes brought about by natural ecological processes and human land-use. The CMS assessed 4 scenarios: a base case & 3 sensitivity scenarios.

The base case scenario simulated the way things are occurring today to continue over the next 50 years and is intended to be used as a benchmark for comparing outcomes tested in other scenarios or sensitivities.

Model projections into the future are never made with total certainty. Sensitivity analysis is an approach designed to help assess risk and uncertainty associated with model assumptions. This study included 3 sensitivity analyses; 2 were based on changing land use rates of development and 1 was based on assessing the risk associated with the range of estimates from the best available data about current groundwater aquifer volumes.

## **Land Use Sectors Modelled**

The CMS modelled human-based activity including: energy & mining, forestry, agriculture & livestock, transportation, human settlements, general industry, and recreation. The CMS also modelled natural processes including fire and insect disturbance events. Model data was obtained from: the Southern Alberta Sustainability Strategy (Government of Alberta), Southern Foothills Study, Apache Canada Ltd., Shell Canada, Statistics Canada, Canadian Wind Energy Association, Hydrogeological Consultants Ltd., CMS stakeholder group, Forem Technologies and Silvatech Consulting Ltd.

## **Acknowledgements**

Many individuals and organizations contributed to the success of this study particularly Dr. Brad Stelfox (Forem Technologies; an associate of Silvatech Consulting Ltd.), and Mr. Jeff Bectell (CMS project chair). Dr. Stelfox provided the Southern Foothills Study model template and enhancements, technical advice, and assistance with land base information acquisition. As chairman, Jeff Bectell provided countless hours of volunteer time helping acquire data, project administration, and promoting awareness for the final results presentations.

# *Chief Mountain Study - January 2008*

---

## **Summary of the Base Case Results**

### **Land-Use Activities:**

- Invasive plants could increase tame pasture by 15% through the degradation of native prairie.
- Livestock populations are projected to grow: 94,000 more cattle, 31,000 more swine and 21,000 more horses over the next 50 years.
- A constant timber harvest of 89,000 m<sup>3</sup>/year softwood and 36,000 m<sup>3</sup>/year hardwood is projected to create a land base disturbance of 542 ha/year.
- Hydrocarbon energy production is projected to peak in 20 years at 239,000 barrels/year oil, 13 billion ft<sup>3</sup>/year natural gas, and 815 million ft<sup>3</sup>/year coal-bed methane and the associated footprint is assumed to be largely reclaimed.
- The wind turbine industry is projected to grow from a current 251 windmills in the study area to 1,000 by 2057 but only result in an 85 ha increase in footprint area including access roads.
- 86% of new footprint growth is projected to be concentrated in the transportation, residential development, and recreation (e.g.: golf courses, ski hills, soccer fields, hockey rinks, etc.) sectors.
- The most amount of new footprint growth (35% of all new footprint growth) is associated with residential development.

### **Projected Outcomes:**

- Native grassland area is expected to decline by 3% (8,000 ha) over the next 50 years. Eighty percent of this loss is due to invasive plant expansion, while the other 20% is from human footprint (minor roads, trails and towns).
- The total area of invasive plants is forecast to rise by 48% [(22,500 ha to 32,000 ha). (The rate of expansion is greatest over the next 15 years with increasing hydrocarbon sector activity)].
- Surface water nutrient (nitrogen and phosphorus) content is currently 5 times pre-settlement levels and sedimentation is 10 times pre-settlement levels. Over the next 50 years nutrient loading is likely to increase by roughly 25% but sedimentation is expected to remain largely unchanged.
- Groundwater stocks are expected to decline by 18% due to recharge deficits created by cultivation and human footprint, and direct consumption from groundwater wells. Direct consumption is forecast to double by 2057.
- Forest fragmentation is projected to increase primarily due to construction of seismic lines resulting in an average forest patch size that is roughly 16% smaller than now. There is also an expected age class shift from a 'medium-aged' forest (60-120 yrs old) to one with most area in stands 0-60 yrs old, and 120-200 yrs old.
- Grizzly Bear exposure index is forecast to rise 13% resulting in a higher probability of negative impact on habitat utility and a greater risk of encountering humans.

# Chief Mountain Study - January 2008

---

- Linear feature (roads, power lines, pipelines, seismic lines) edge density is expected to rise from about 1.5km/km<sup>2</sup> to about 2.25 km/km<sup>2</sup> by 2045, then stabilize reflecting ongoing hydrocarbon sector footprint reclamation.
- Human population is expected to increase from approximately 23,000 to 55,000 people and the number of people living in acreages is expected to surpass those in agricultural residences by 2040. The area occupied by towns is projected to be twice that of acreages and agricultural residences combined.

## Sensitivity Results

Differences to land use trajectories and indicators, relative to base case are outlined below.

### Land/Resource Use Activity Changes For Each Sensitivity Scenario:

1. Double oil & gas production rates
  - 20% (395 ha) more hydrocarbon footprint by 2040 but only 1.6% of all footprint area.
2. Double human population growth rate
  - Residential replaces transportation as the dominant footprint by 2045.
  - Acreage footprint surpasses agriculture residence footprint by 2042.
  - Urban residence footprint reaches 4 times current level by 2057.
3. Use of lower estimate for current groundwater volume
  - Total groundwater usage remains unchanged but the relative decrease in aquifer volume increases to 62% because of lower initial estimates.
  - Initial estimate used in this scenario is 73% below the average value used in base case highlighting the significant uncertainty in estimates.

### Risk Factors Associated With Uncertainty:

- Residential and transportation developments associated with doubling population growth rate estimates results in 10 times more native prairie losses than would be expected from a doubling of hydrocarbon sector activity.
- Expansion of invasive plants is unresponsive to all sensitivity scenarios. While energy sector edge/area ratio is much greater than residential, total energy sector activity is low so the response is small.
- Double human population growth rate estimates result in a 2% increase in Grizzly Bear exposure index over 50 years when compared with the Base Case. No significant change was observed from doubling hydrocarbon sector activity.