

# Athabasca River Basin: from Glacier to Delta

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Science Outreach – Athabasca

Athabasca University

ARBRI Day, 14 March 2012



# Objectives of Presentation

- Why work with a river basin?
- What is the Athabasca River Basin
  - Physical features of the ARB
  - Why the ARB is important
  - Concerns about the ARB
  - Hopes for the ARB

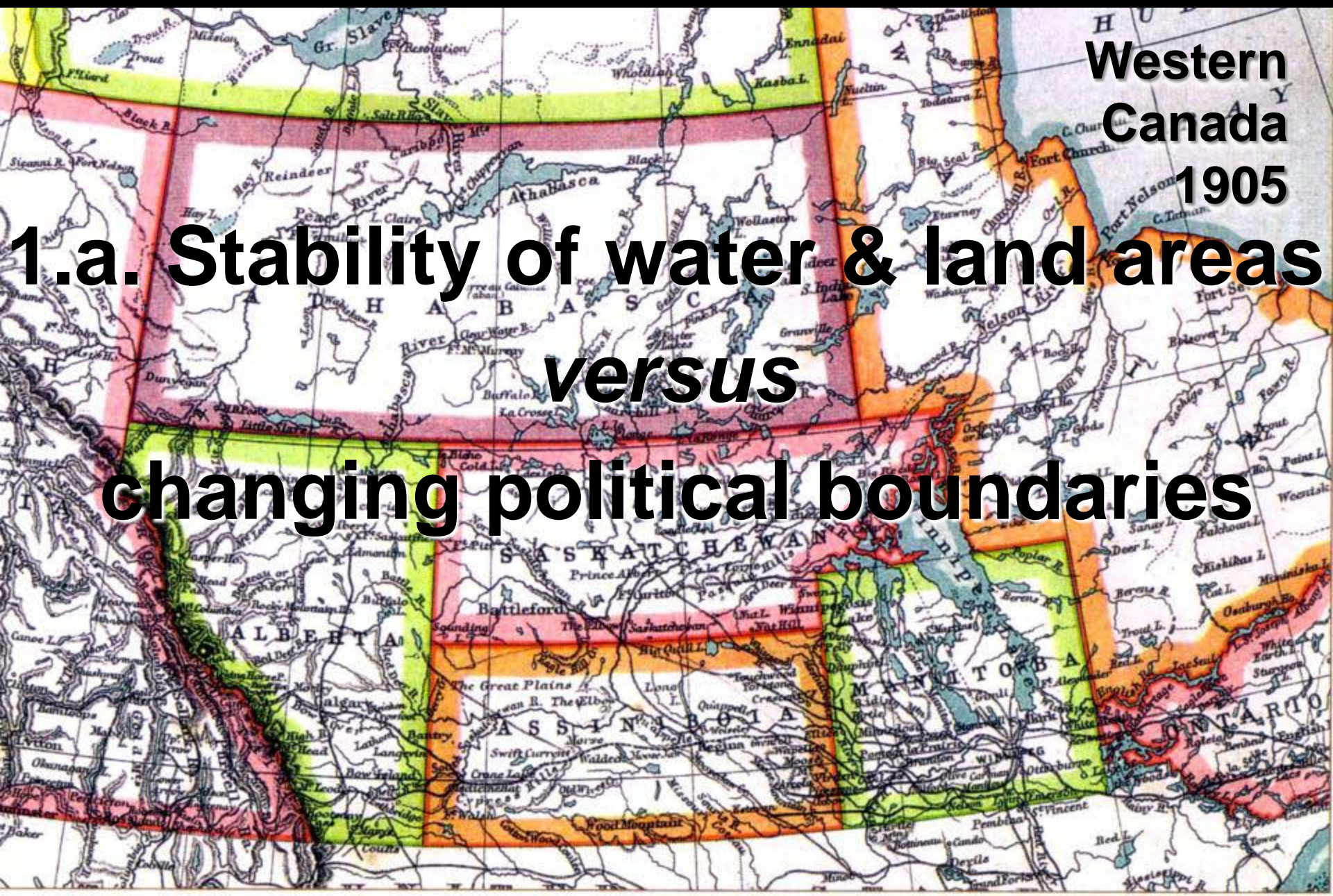
Near the headwaters of the Athabasca River, 2007



# Why work with a river basin?

Western  
Canada  
1905

**1.a. Stability of water & land areas  
versus  
changing political boundaries**





# 1.b. Fort McMurray Boundaries

- Fort McMurray (Hudson Bay Company) 1870
- Village of McMurray (with Waterways) 1947
- Town of McMurray 1948
- Town of Fort McMurray 1962
- City of Fort McMurray 1980
- Regional Municipality of Wood Buffalo (with Improvement District 143) 1995

Photo: 2005

Data: Wikipedia, 30 Dec. 2009



# **Why work with a river basin?**

**2. Integration & accumulation  
of impacts on water, soil &  
organisms  
(but not atmosphere)**

Athabasca River near Athabasca, 2007



# **Why work with a river basin?**

## **3. Implications for humans:**

- ecological sustainability**
- health**
- water, food, fibre, minerals & energy**
- economic sustainability**



# Alberta River Basins

- 7 basins
- 5 sub-basins of the Saskatchewan





# What is the Athabasca River Basin (ARB)?

- ~1,230 km long
- ~133,000 km<sup>2</sup>
- >101 tributary rivers
- >307 named creeks
- >328 named lakes
- no dams or reservoirs



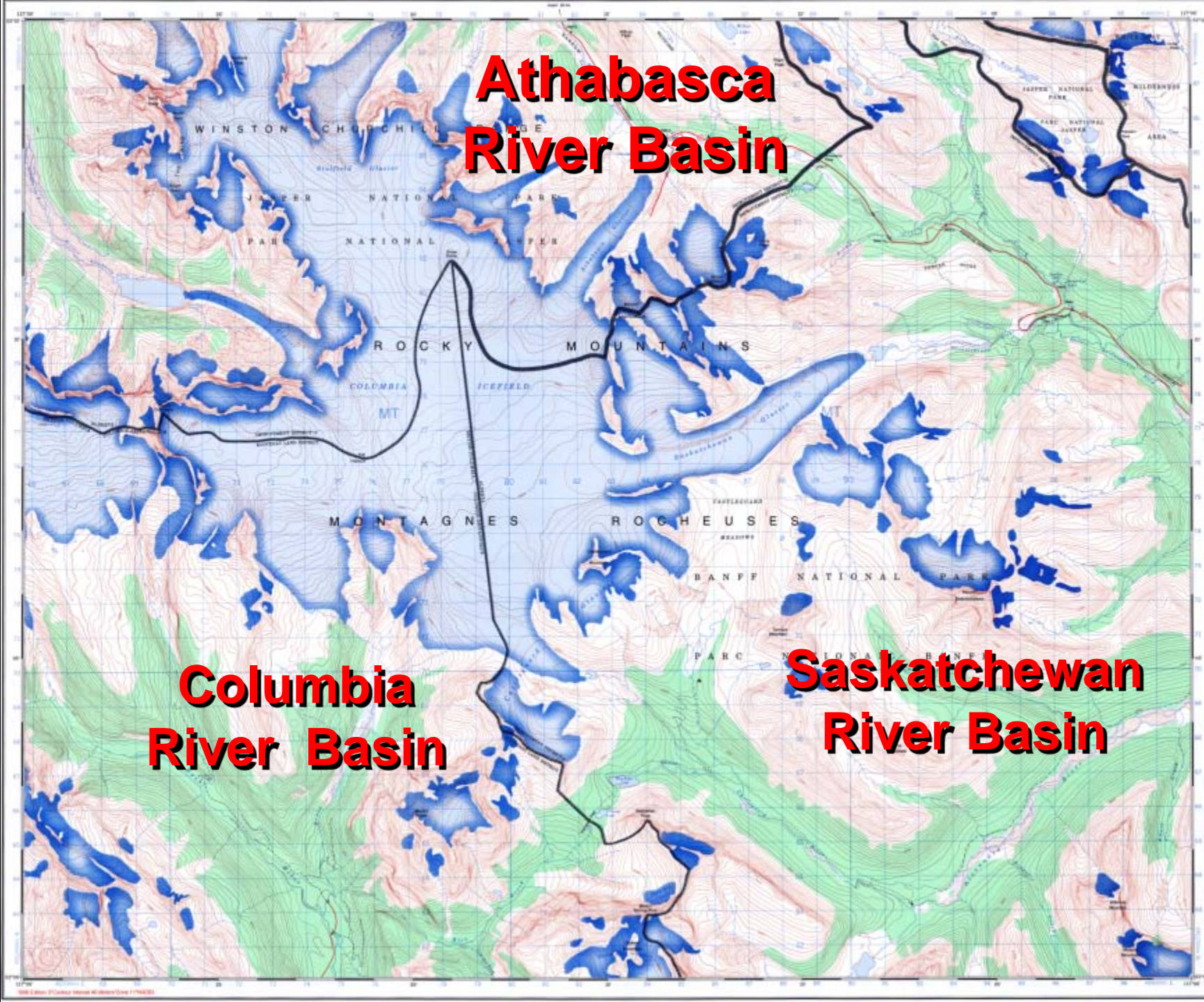


# Columbia Ice Field

**Athabasca  
River Basin**

**Columbia  
River Basin**

**Saskatchewan  
River Basin**





# Upper Portion of the Athabasca River Basin

Snake Indian River

Brûlé Lake

Snarling River

Jasper Lake

Rocky River

• Jasper

Miette River

Maligne River

Whirlpool River

Sunwapta  
River

Athabasca  
River

Columbia Ice Field

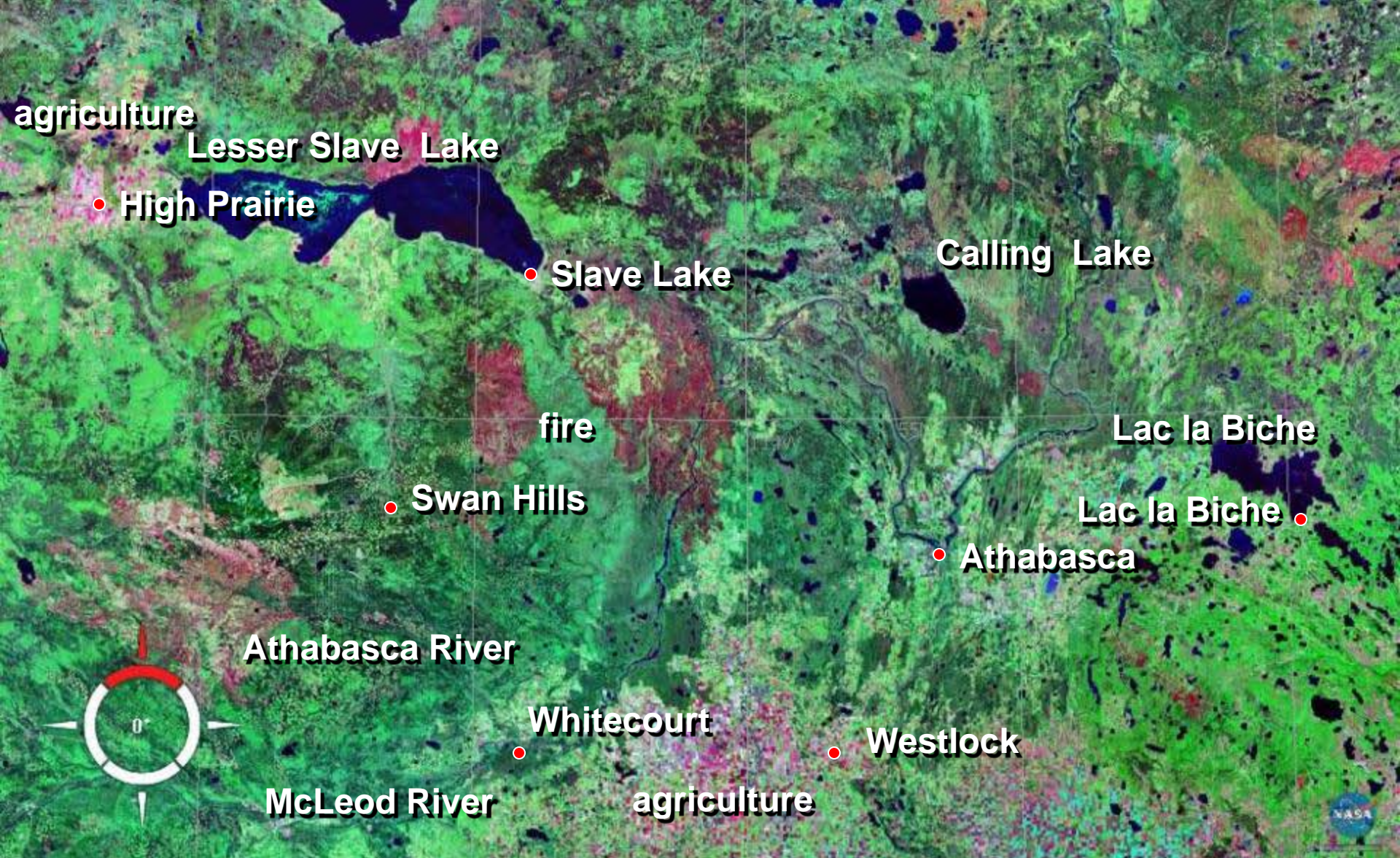






**Athabasca River near Jasper, 2005**

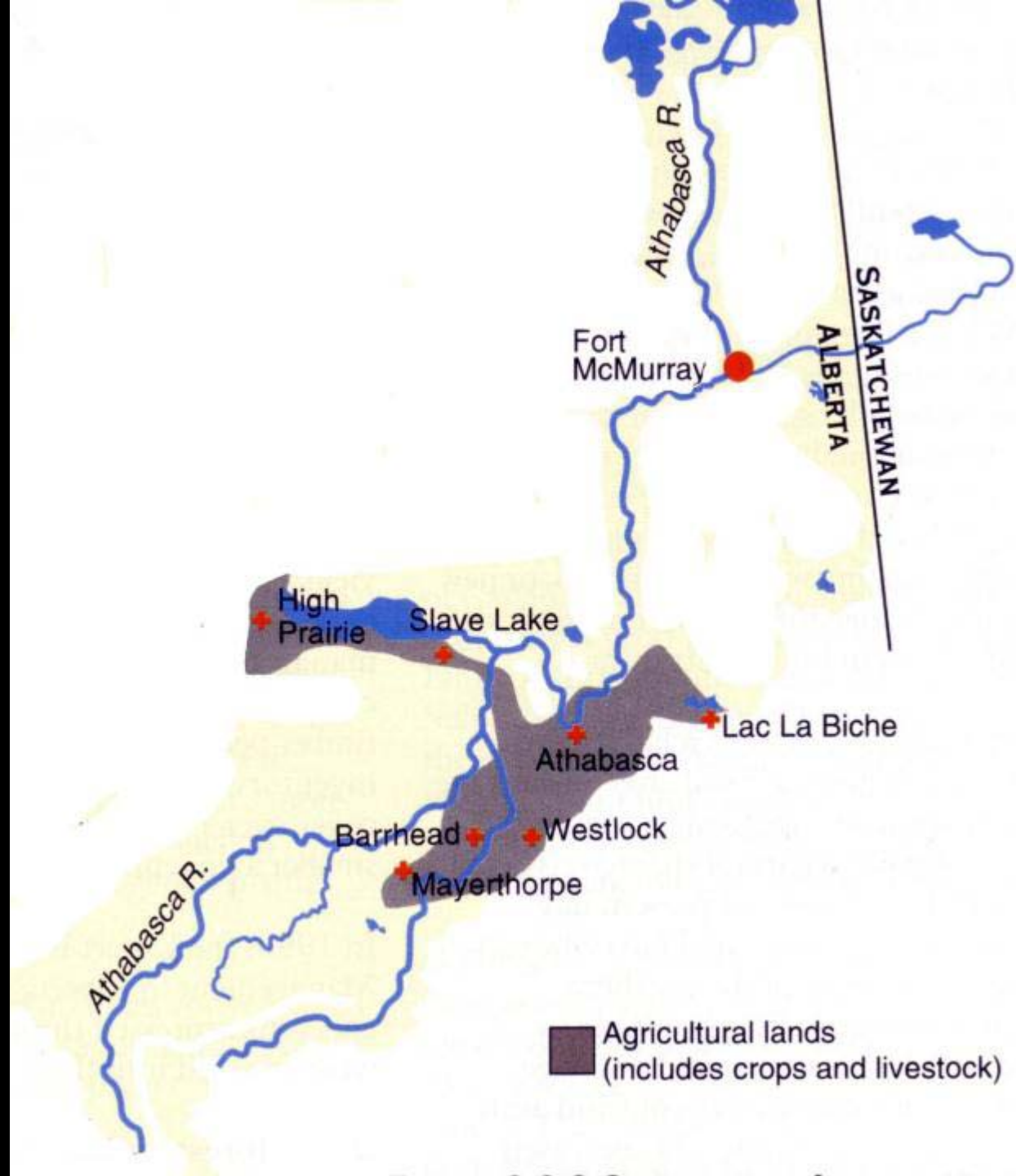




## Central Part of Athabasca River Basin



# Agriculture in the Athabasca River Basin







**Town of Athabasca from Athabasca River, 1991**

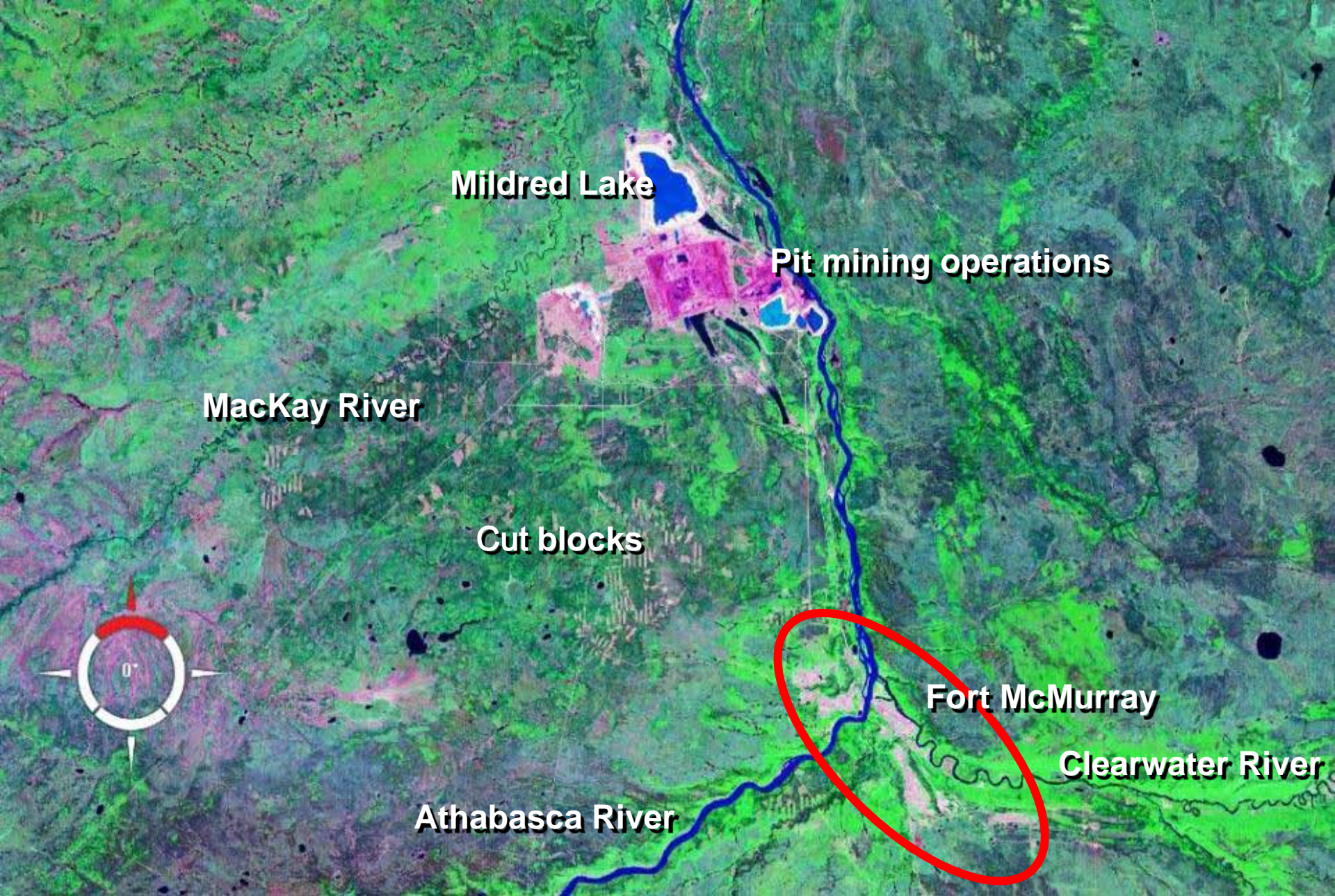




Glenbow Archives NA-2617-32

**Portaging foot of Grand Rapids (1.6 km), Athabasca River, circa 1903-06**





**Mildred Lake**

**Pit mining operations**

**Mackay River**

**Cut blocks**

**Fort McMurray**

**Clearwater River**

**Athabasca River**

# **Fort McMurray Area**





**Athabasca River at Fort MacKay, 1996**





## Peace-Athabasca Delta Area

Source: NASA, World Wind





**Sand Dunes near Athabasca River, 1998**



# Peace- Athabasca Delta







# **Peace- Athabasca Delta**

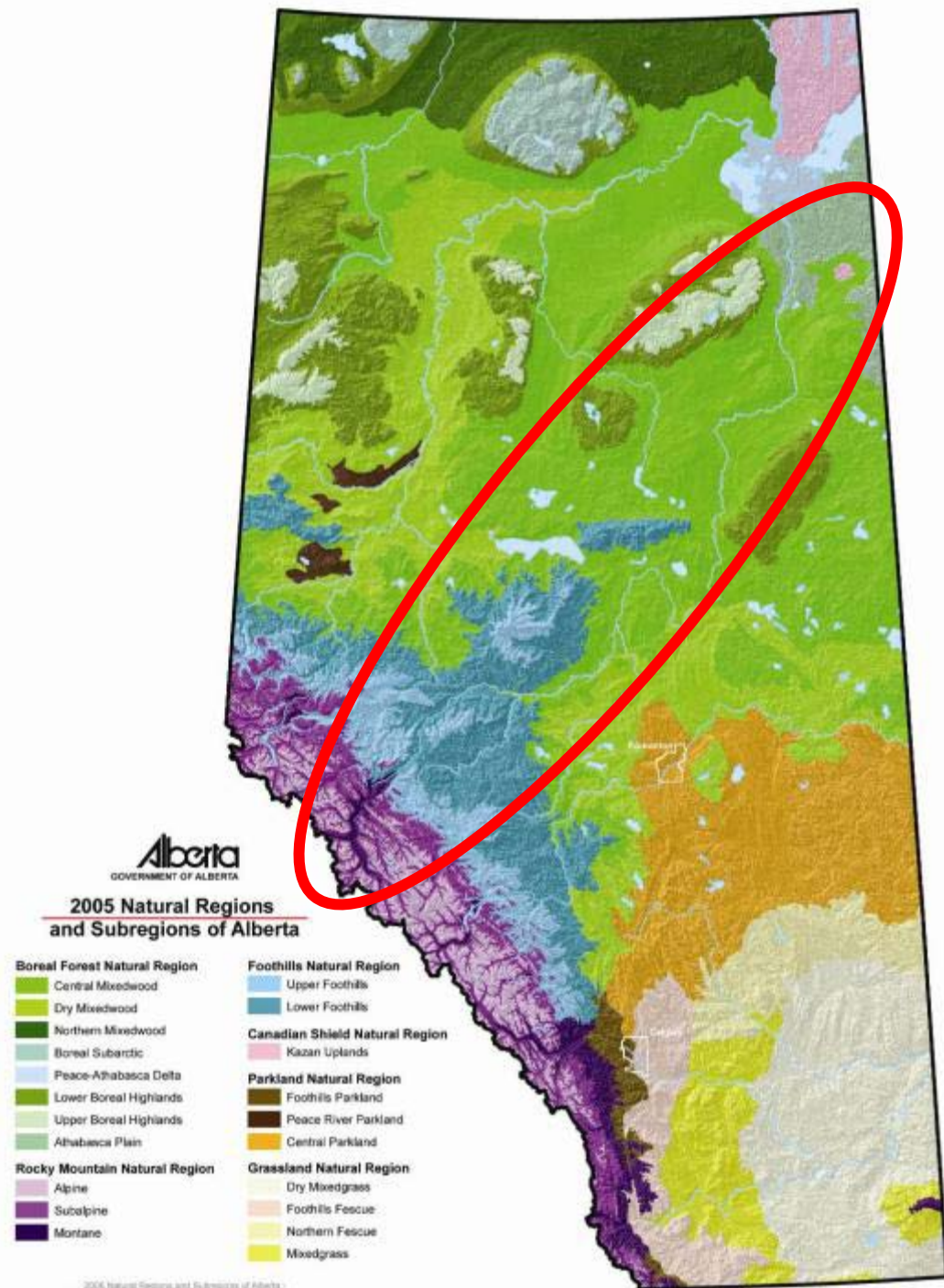
- **4,100 km<sup>2</sup>**
- **>1,000 lakes**
- **sensitive to water levels**
- **all 4 major N.A. bird flyways converge here**

Peace-Athabasca Delta, 1998



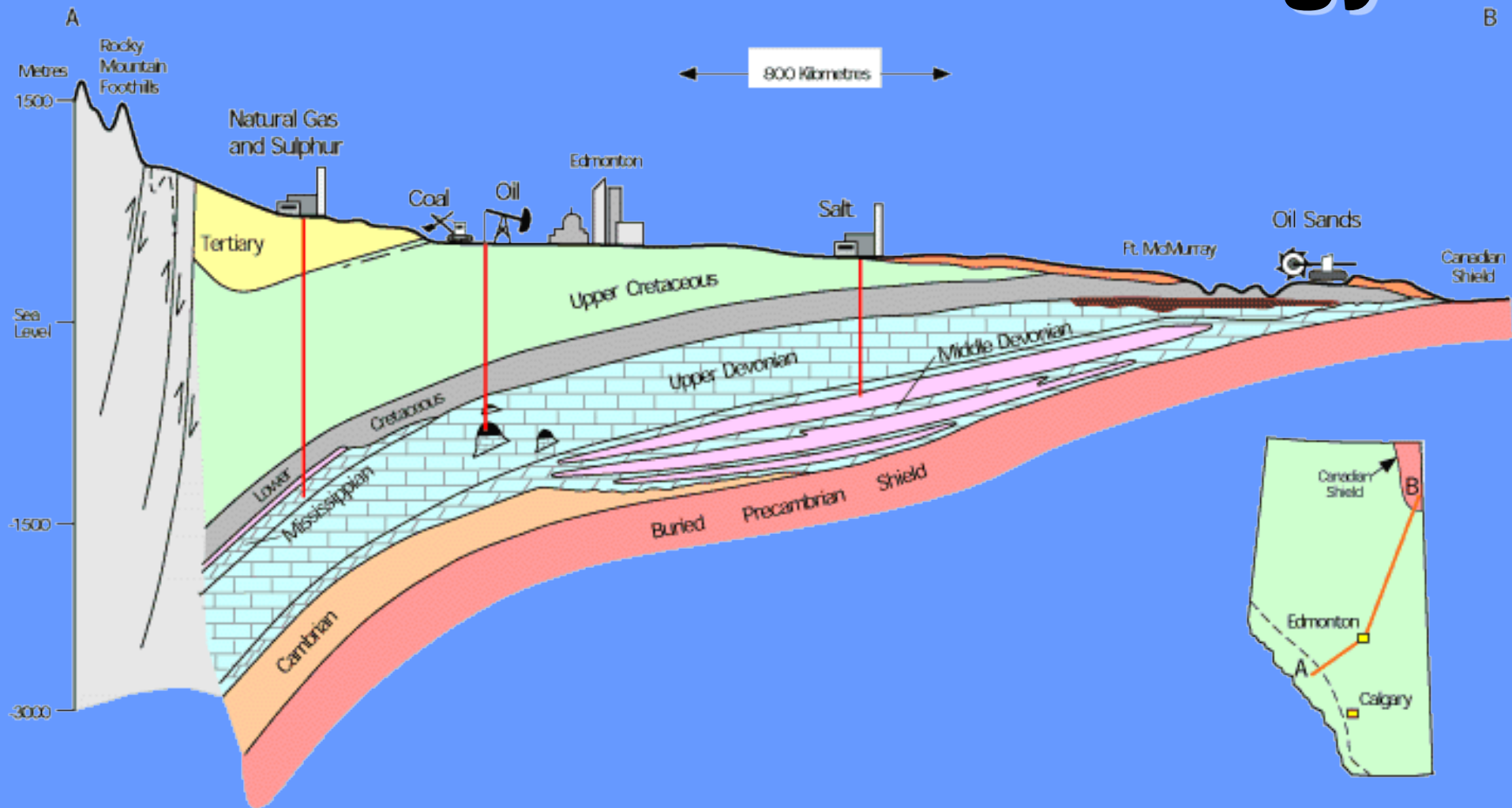
# What is the ARB?

- 3 natural regions and 11 sub-regions





# What is the ARB? Geology



Athabasca River elevation at origin 1,231 m (foot of glacier), at mouth 205 m

Source: [www.abheritage.ca/abnature/geological/photos/...](http://www.abheritage.ca/abnature/geological/photos/...) via Royal Alberta Museum; Mussieux, R. and M. Nelson. A Traveller's Guide to Geological Wonders in Alberta; artist Dan Magee



# What is the ARB?

- ~150,000 people  
(1 city, 12 towns,  
>75 villages, etc.)







# Regional Municipality of Wood Buffalo

51,496 people  
(Fort McMurray 47,705)

Fort McMurray 2004

Source Statistics Canada, 2006





# Towns of the ARB

Hinton	9738
Whitecourt	8971
Edson	8098
Slave Lake	6703
Westlock	5008
Jasper	4265
Barrhead	4209
Lac la Biche	2758
High Prairie	2750
Athabasca	2575
Swan Hills	1645
Mayerthorpe	1474
Total	58194



# What is known about the ARB?





# Major Research Studies - **completed**

- Agriculture Canada: black flies
- AOSERP<sup>1</sup> for Syncrude
- EIAs<sup>2</sup> for AlPac and other pulp mills
- Northern Rivers Basins Study<sup>3</sup>
- Northern Rivers Ecosystems Initiative<sup>4</sup>

<sup>1</sup> Alberta Oil Sands Environmental Research Program, 1970s

<sup>2</sup> Environmental Impact Assessments, 1990s

<sup>3</sup> Athabasca, Peace and Slave River basins, ended 1996

<sup>4</sup> Environment Canada: offshoot of Northern River Basins Study, 1996-2003





# Major Research Studies – on going

- Foothills Research Institute (formerly Foothills Model Forest, 1992)
- EMAN<sup>5</sup> ecological monitoring
- EMEND<sup>6</sup> studies logging and fire
- Alberta Biodiversity Monitoring Institute

<sup>5</sup> Environment Canada: Ecological Monitoring and Assessment Network, 1994-

<sup>6</sup> Ecosystem Management Emulating Natural Disturbance, 1997-





# Major Research Studies – on going

- RAMP<sup>7</sup> monitors water
- CONRAD<sup>8</sup> studies (industries, government & universities)
- WBEA<sup>9</sup> monitors air
- CEMA<sup>10</sup> recommendations

<sup>7</sup> Regional Aquatics Monitoring Program, 1997-

<sup>8</sup> Canadian Oil Sands Network for Research and Development

<sup>9</sup> Wood Buffalo Environmental Association

<sup>10</sup> Cumulative Environmental Management Association



# Why is the ARB important?

1. Human survival
2. Resources
3. Ecological problems
4. Political issues
5. Intellectual interest





# Why is the ARB important?

## 1. Human Survival

- Oxygen,  $\text{CO}_2 \rightarrow \text{O}_2$
- Water for drinking, washing
- Food – wild and agriculture
- Fiber – wild, silviculture & agriculture



# **Why is the ARB important?**

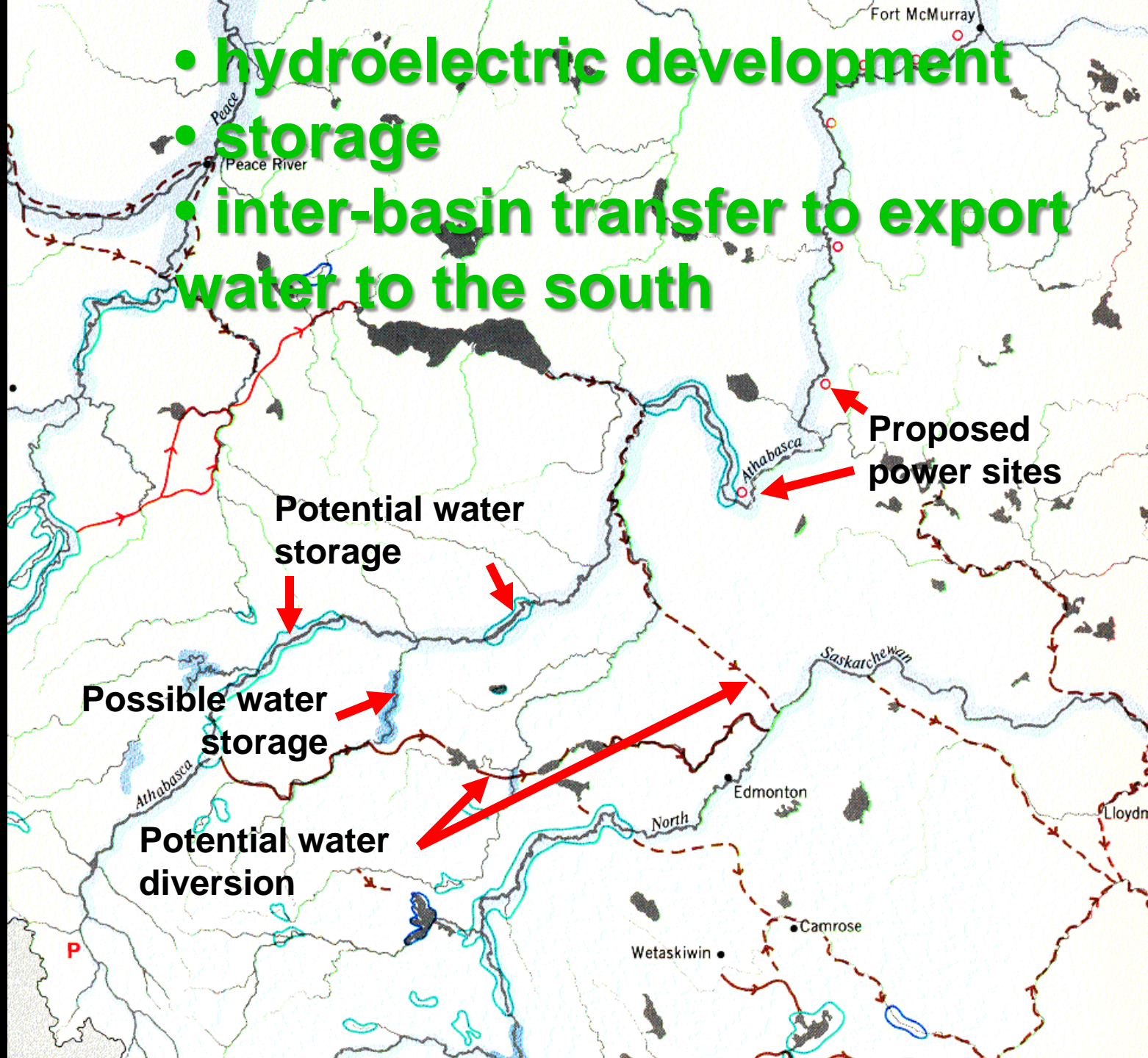
## **2. Resources – renewable**

- Air, water & soil as “free” raw materials for agriculture, forestry & industry**
- Air and water for waste “treatment” (= dilution)**
- Hydroelectricity (potential)**



# Potential Water Use

- hydroelectric development
- storage
- inter-basin transfer to export water to the south





# Why is the ARB important?

## 2. Resources – renewable – wood

- Wood for lumber and plywood
- >12 mills in ARB

Sundance Forest Products, near Edson, May 2007



# Why is the ARB important?

## 2. Resources – renewable - pulp

1. Hinton, Weldwood of Canada, 1957

2. Whitecourt, Millar Western Pulp, 1988

3. Whitecourt, Alberta Newsprint Co., 1990

4. Slave Lake, Slave Lake Pulp, 1991

5. Athabasca, Alberta-Pacific Forest Industries, 1992



# **Why is the ARB important?**

## **2. Resources - renewable**

- Large mammals and fish for food
- Hunting and fishing guides
- Tourism

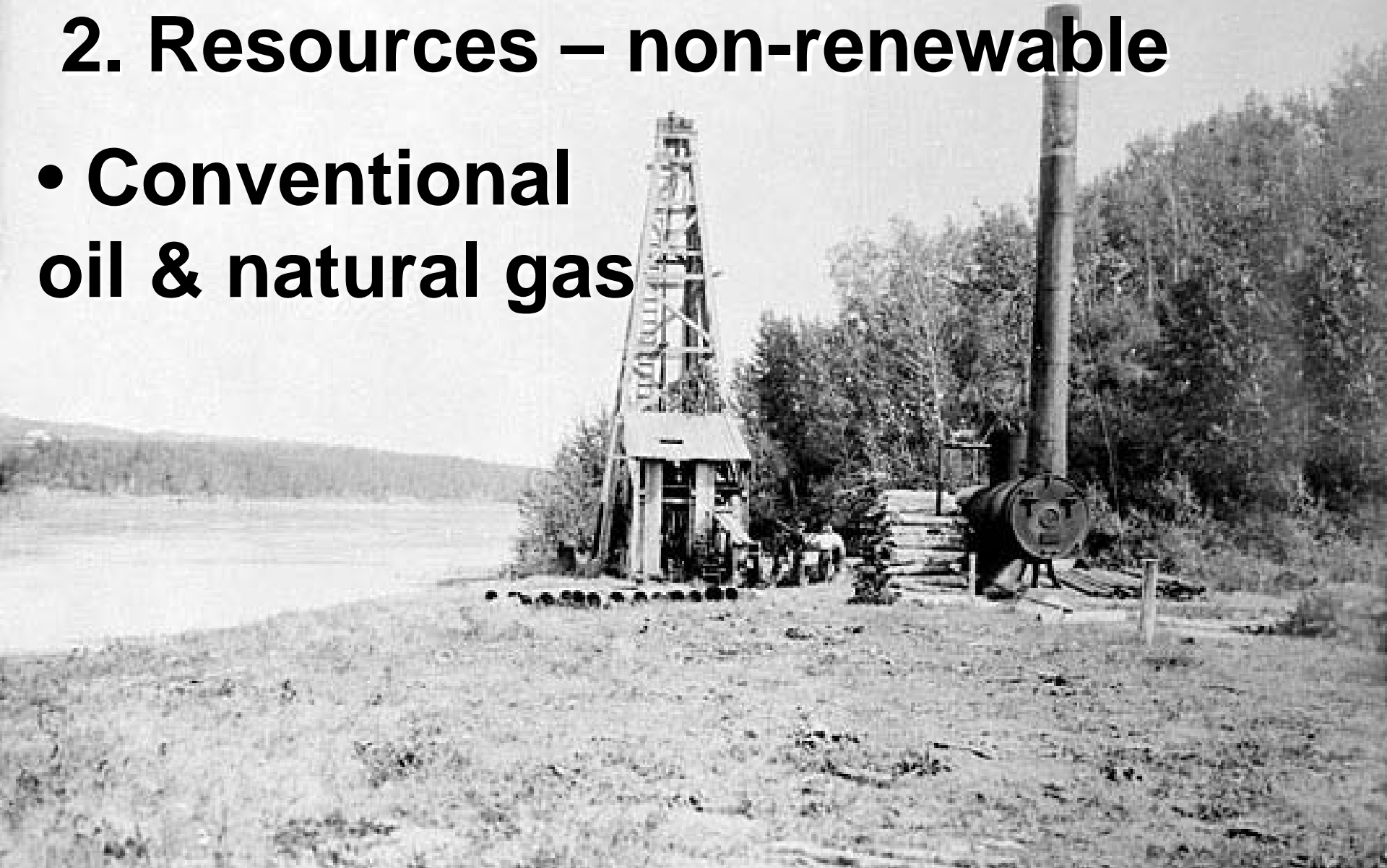




# Why is the ARB important?

## 2. Resources – non-renewable

- Conventional oil & natural gas





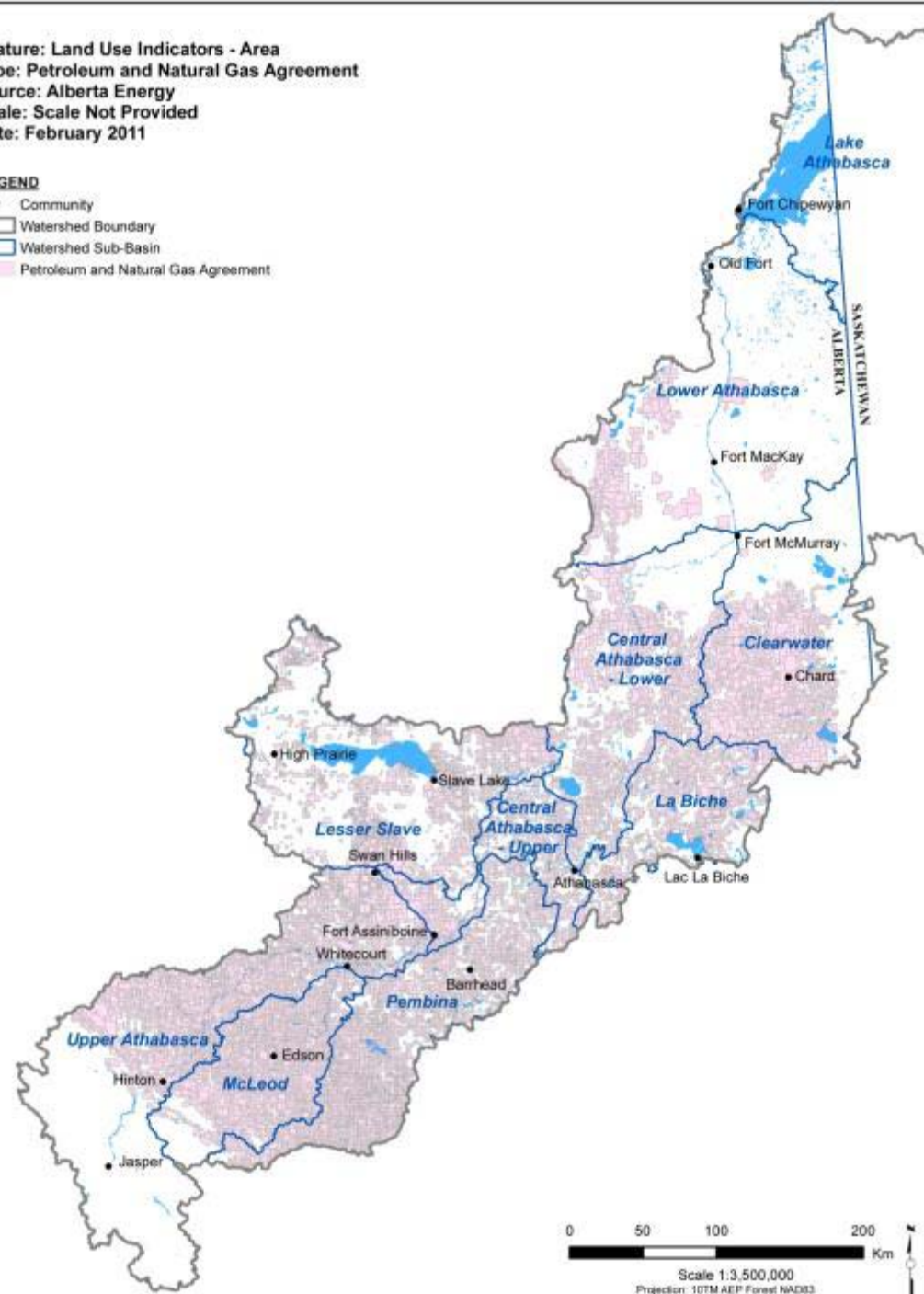
# Conventional Oil & Natural Gas Agreements / Leases in the ARB, 2011

Source: Athabasca Watershed Council, State  
of the Watershed Report, Phase 1, Appendix  
A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indicators - Area  
Type: Petroleum and Natural Gas Agreement  
Source: Alberta Energy  
Scale: Scale Not Provided  
Date: February 2011

## LEGEND

- Community
- Watershed Boundary
- Watershed Sub-Basin
- Petroleum and Natural Gas Agreement





# **Landscape fragmentation by seismic lines, roads, wells, pipelines and processing plants**



Alberta 2003



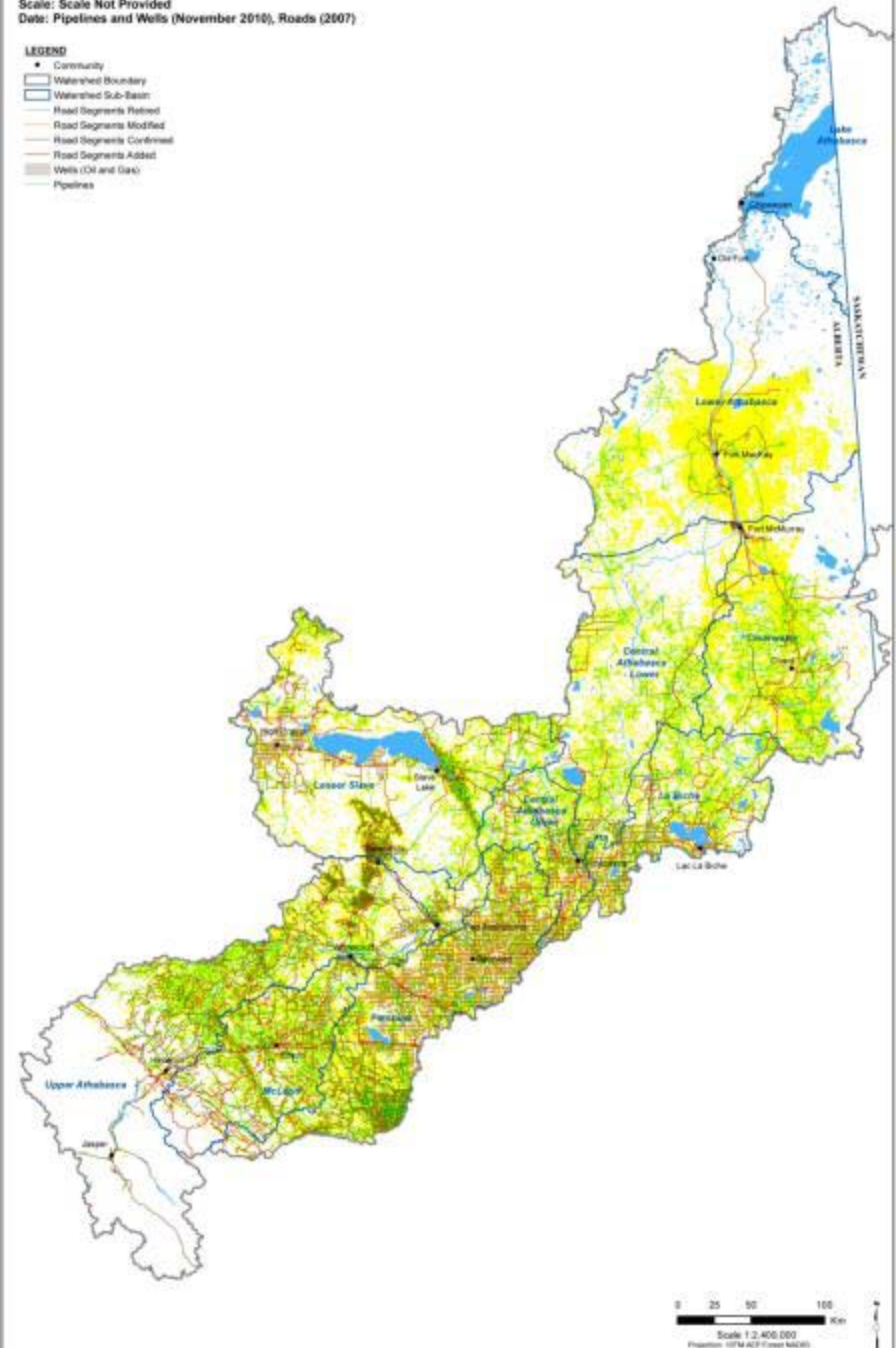
# Pipelines, Oil Wells & Roads in the Athabasca River Basin, 2007/2010

Source: Athabasca Watershed Council, State  
of the Watershed Report, Phase 1, Appendix  
A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indices - Linear  
Type: Pipelines, Wells, and Roads  
Source: Energy Resources Conservation Board and Natural Resources Canada  
Scale: Scale Not Provided  
Date: Pipelines and Wells (November 2010), Roads (2007)

## LEGEND

- Community
- Watershed Boundary
- Watershed Sub-Basin
- Road Segments Refined
- Road Segments Modified
- Road Segments Confirmed
- Road Segments Added
- Wells (Oil and Gas)
- Pipelines



# Why is the ARB important?

## 2. Resources – non-renewable

- Oil/tar sands or bitumen

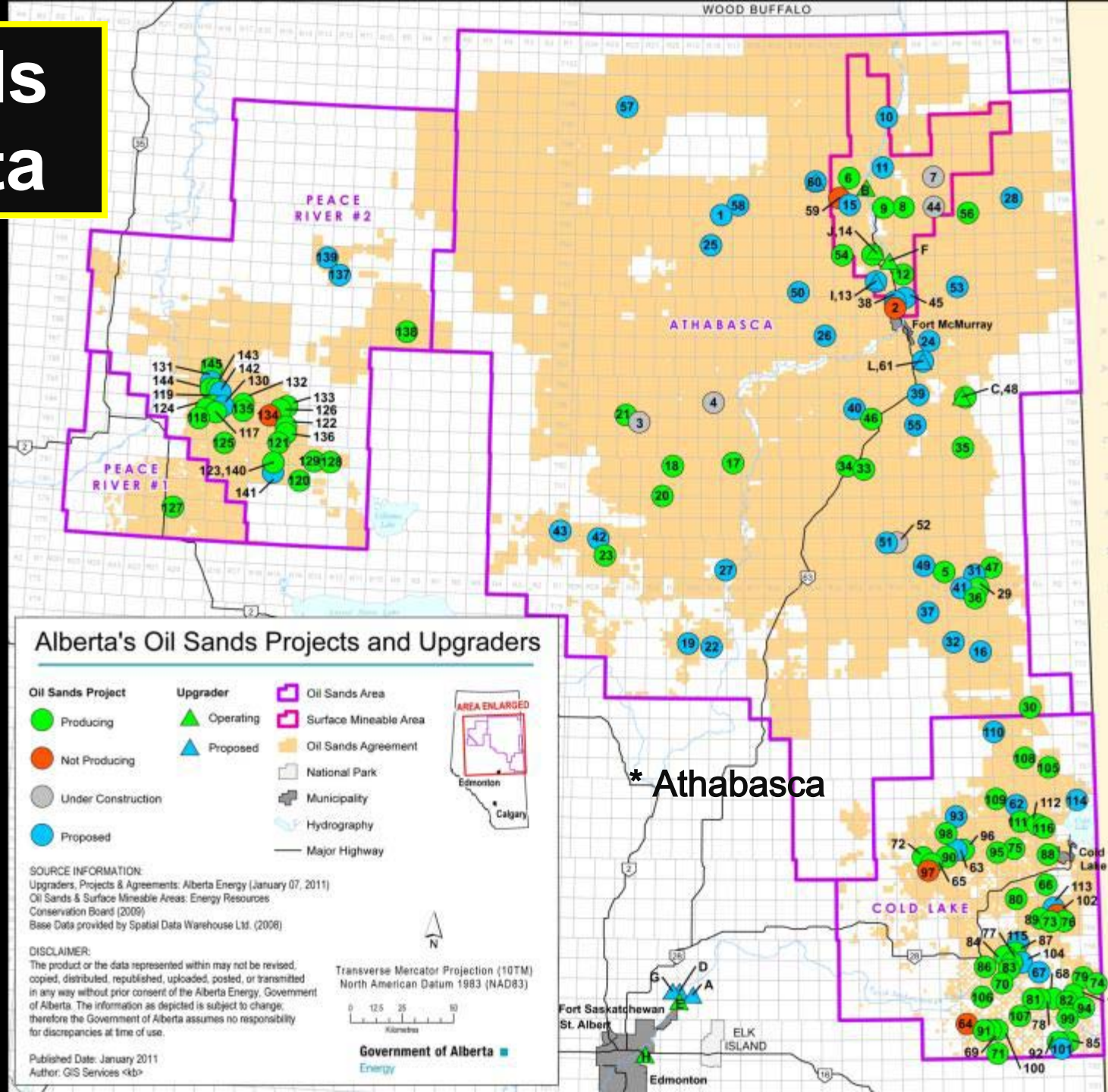




# Oil Sands in Alberta

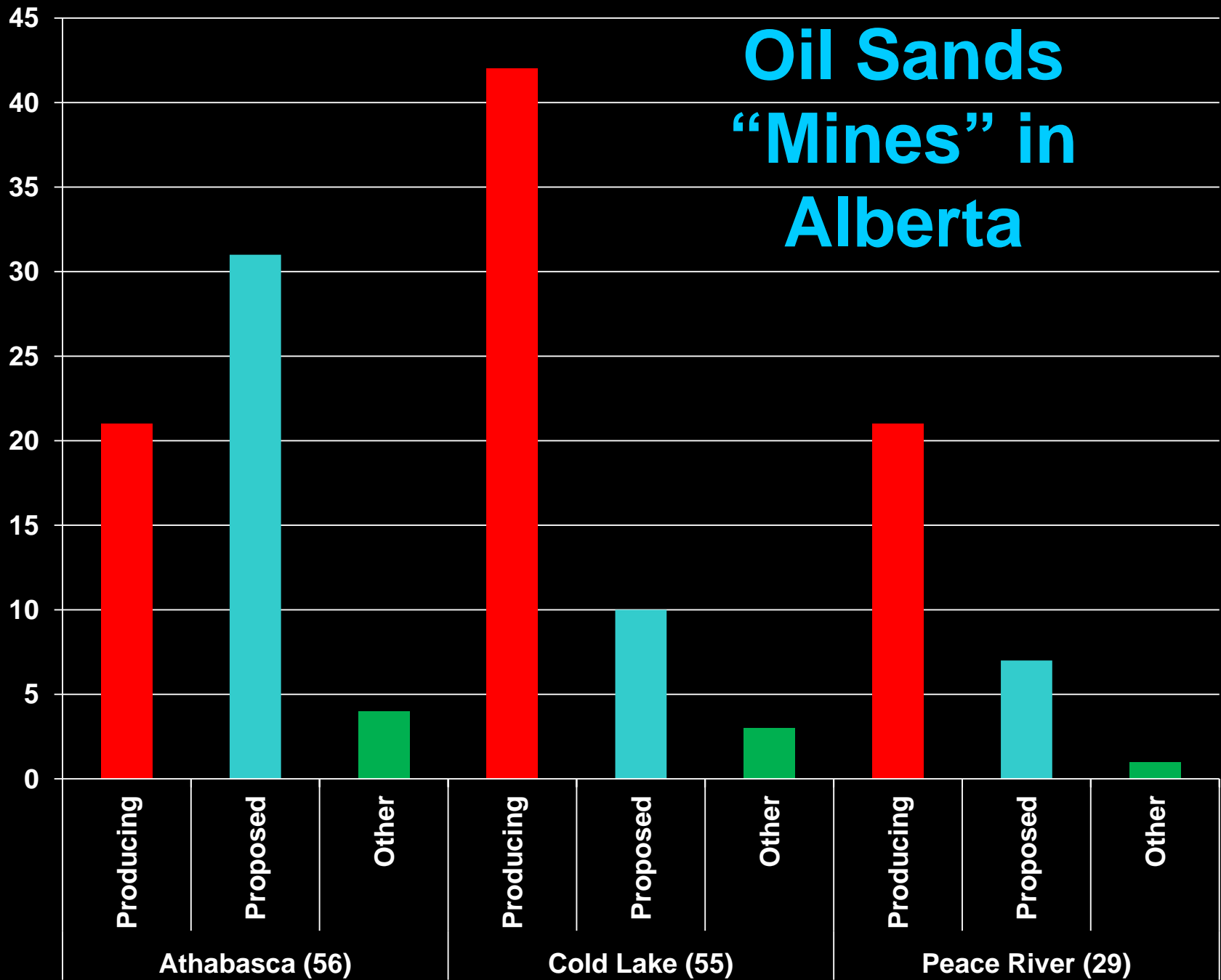


# Oil Sands in Alberta





# Oil Sands “Mines” in Alberta



# Surface / Pit Mining



Fort McMurray area, 2004





**Pit mining  
restricted  
to bitumen  
less than  
70 m deep**

**Fort McMurray area, 2004**



# Tailings Ponds: 720 million m<sup>3</sup> in 130 km<sup>2</sup>





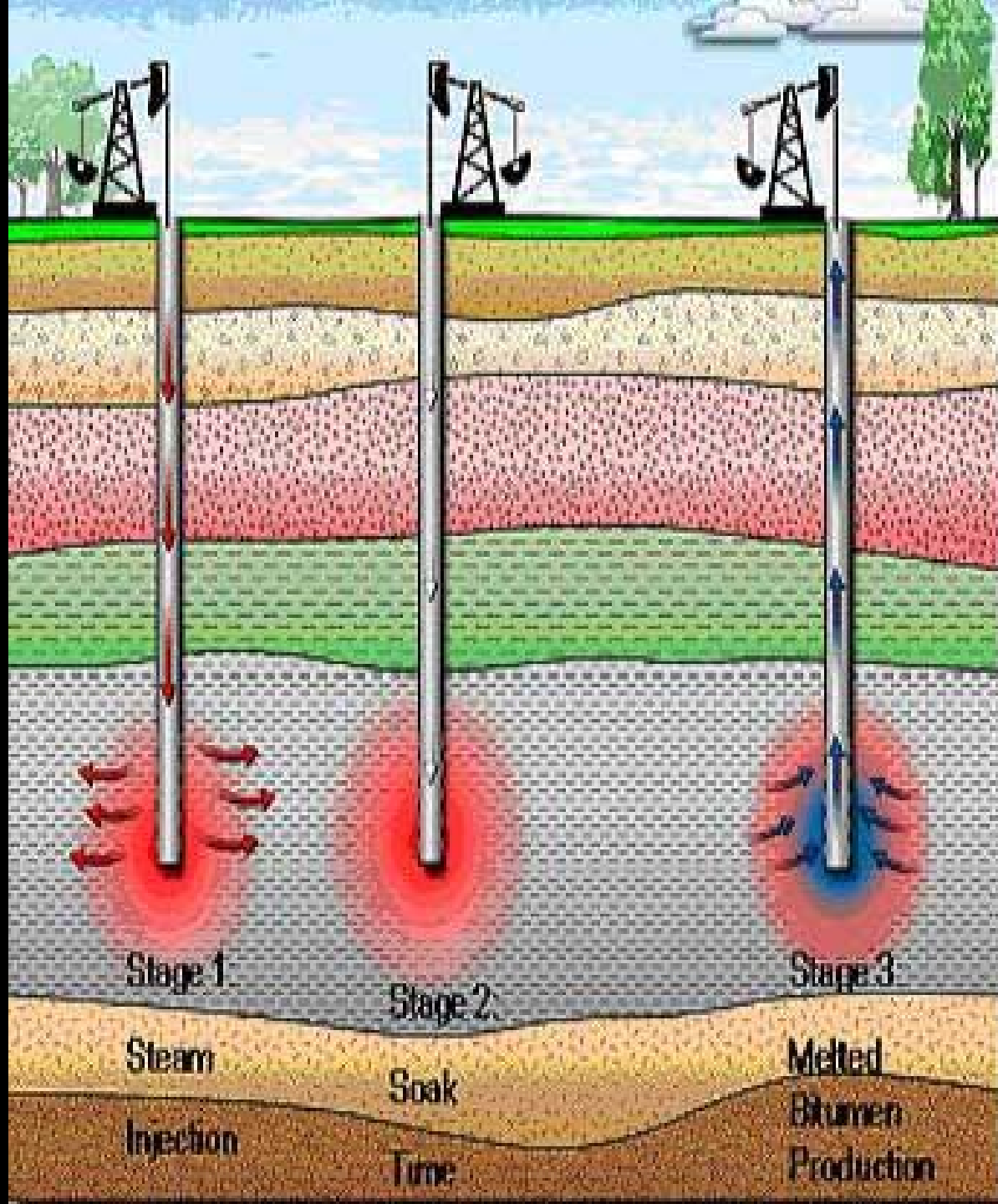
# ***In situ* Oil “Mines”**

- 15% land disturbance but much fragmentation
- Uses lots of natural gas (13% of Canadian total in 2007, 60% by 2030?)
- Uses considerable amounts of water

Near Fort McMurray, 2005

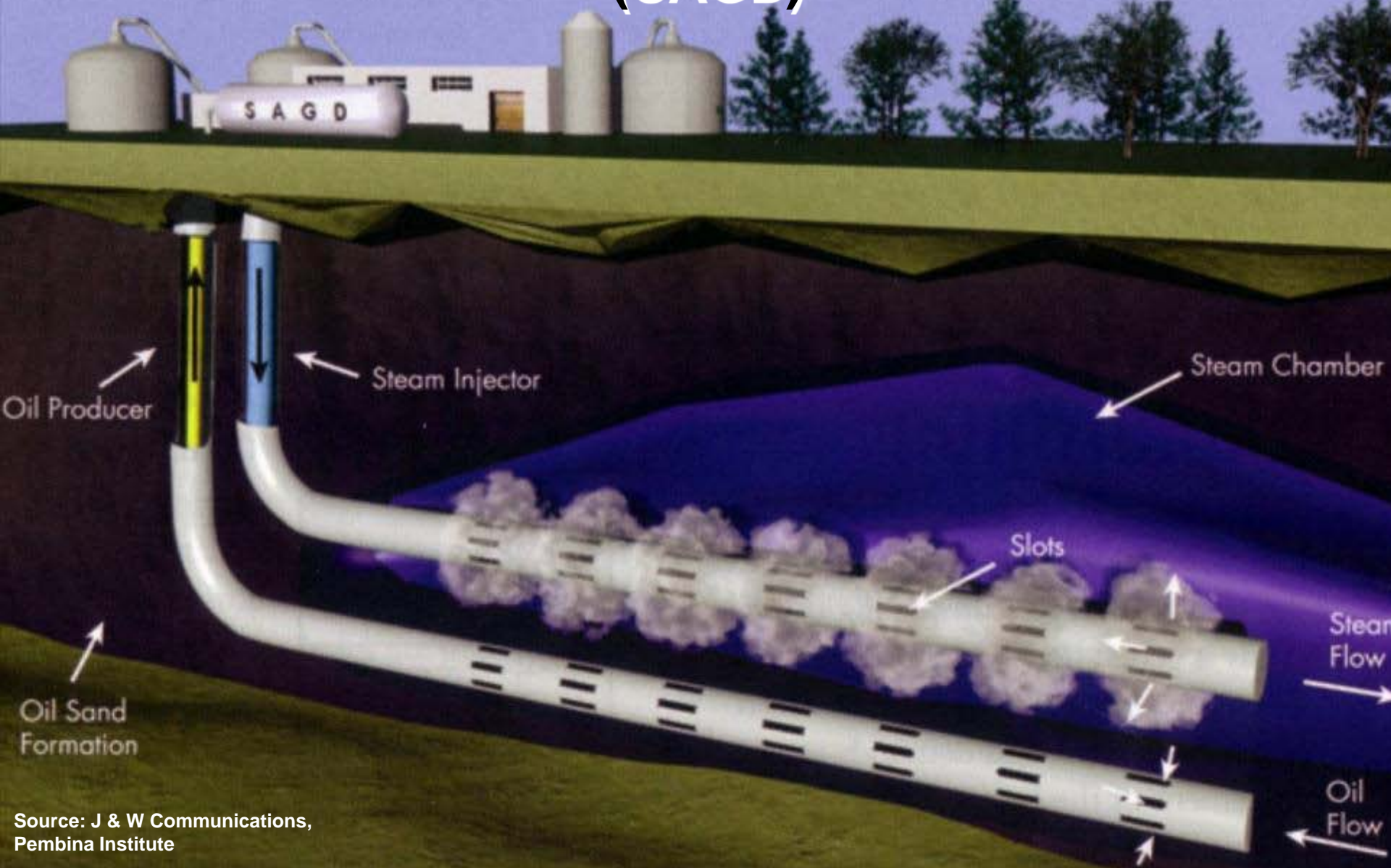
# ***In Situ* Mining: Cyclic Steam Stimulation (CSS) = Primary**

**6-8 month  
cycles**



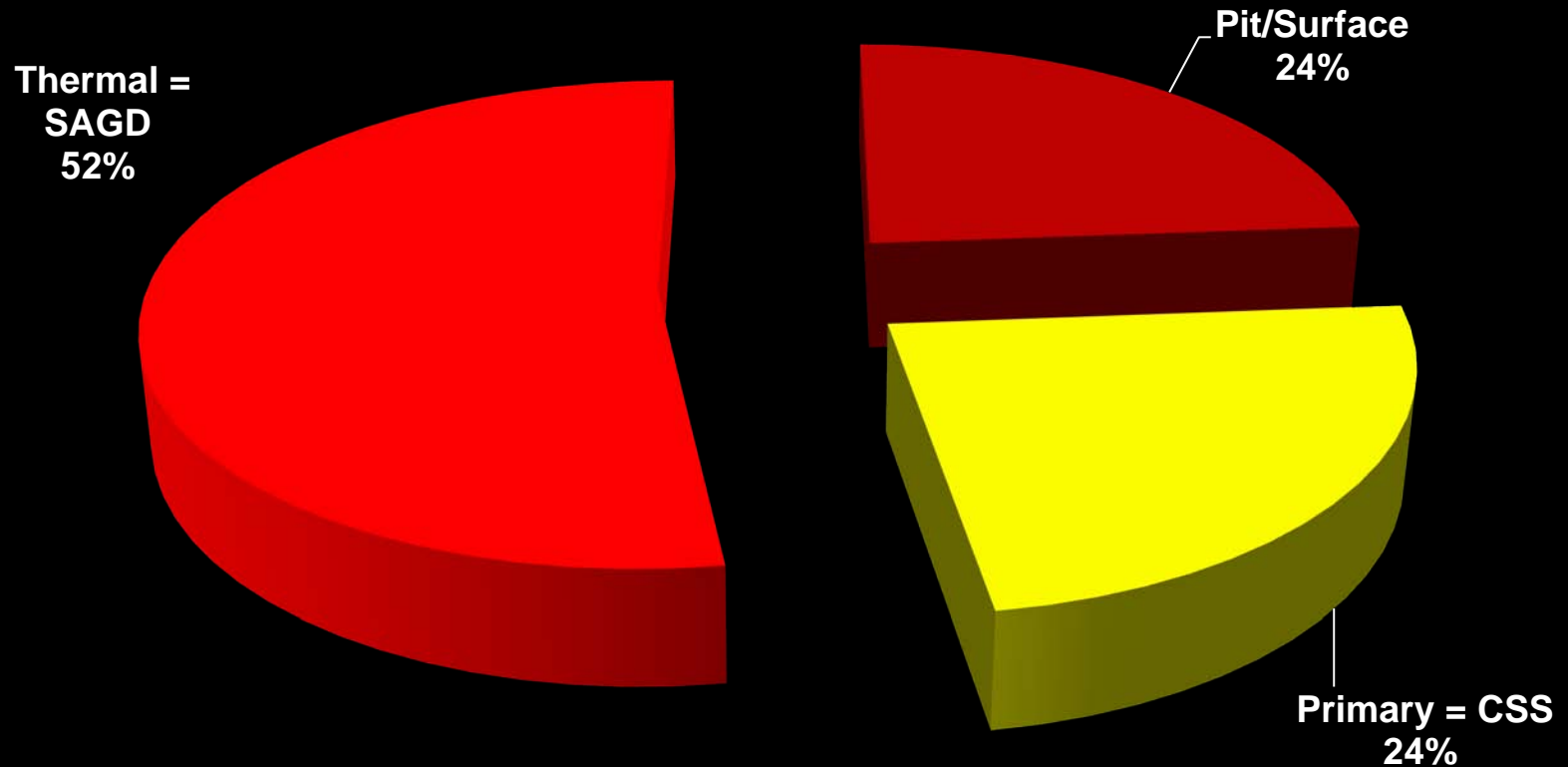


# ***In Situ* Mining: Steam Assisted Gravity Drainage (SAGD)**



Source: J & W Communications,  
Pembina Institute

# Types of Oil Sands “Mines” in ARB



n = 21

+ 31 proposed

+ 4 other

+ 5 experimental

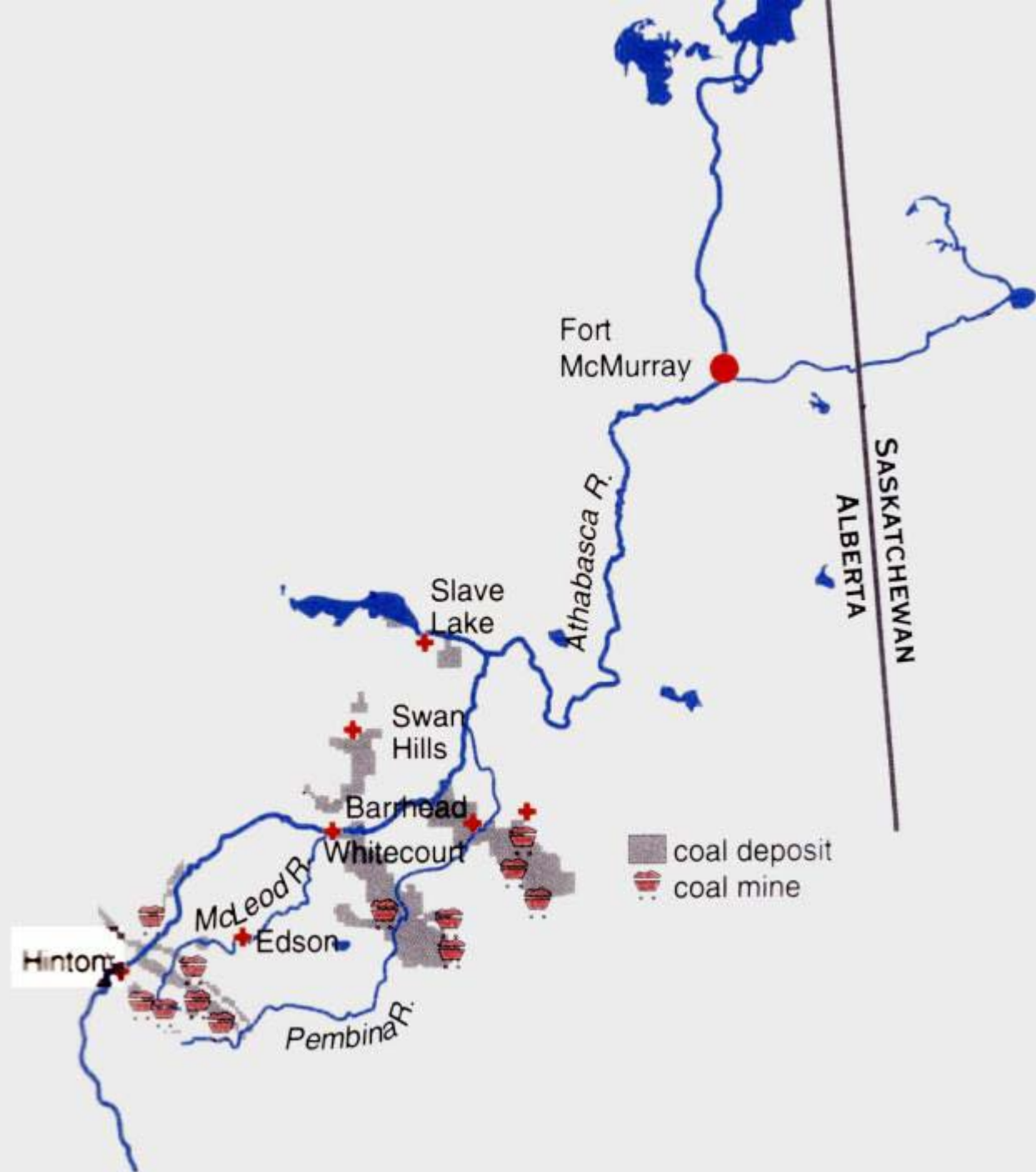
Source: Alberta Energy,  
January 2011



# Why is the ARB important?

## 2. Resources – non-renewable

- **Coal**



Source: Northern River Basins Study,  
Report to the Ministers, 1996

# Why is the ARB important ?

## 2. Resources – non-renewable

- Peat



# Why is the ARB important ?

## 2. Resources – non-renewable

- Gravel, limestone and other minerals



# Why is the ARB important?

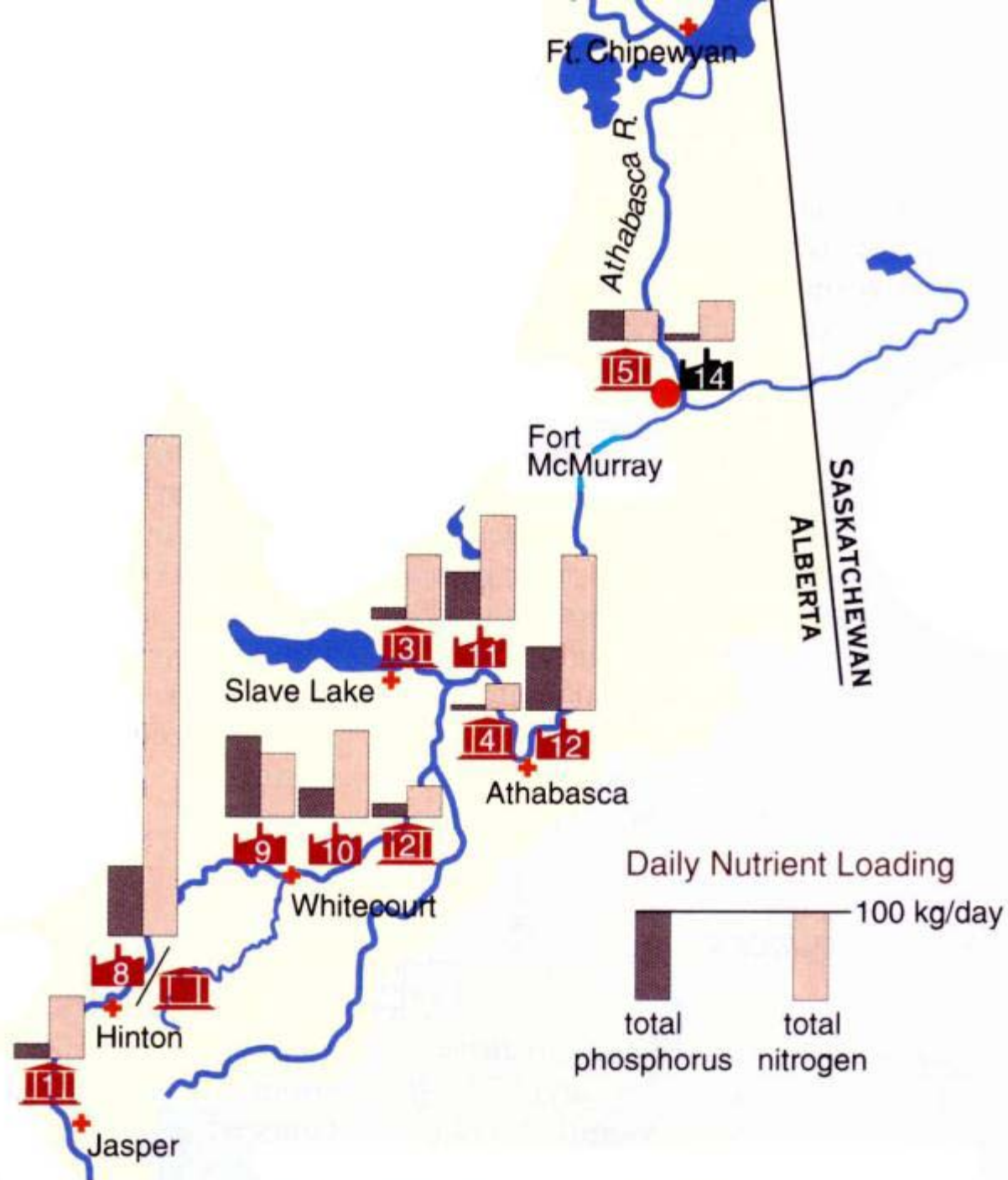
## 3. Environmental Problems

- Water quality, especially toxic chemicals and disease-causing organisms
  - natural e.g. mercury, polycyclic aromatic hydrocarbons (PAHs), cyanobacterial toxins
  - industrial wastes e.g. chlorinated organics
  - erosion from logging
  - agricultural run-off and wastes
  - municipal wastes





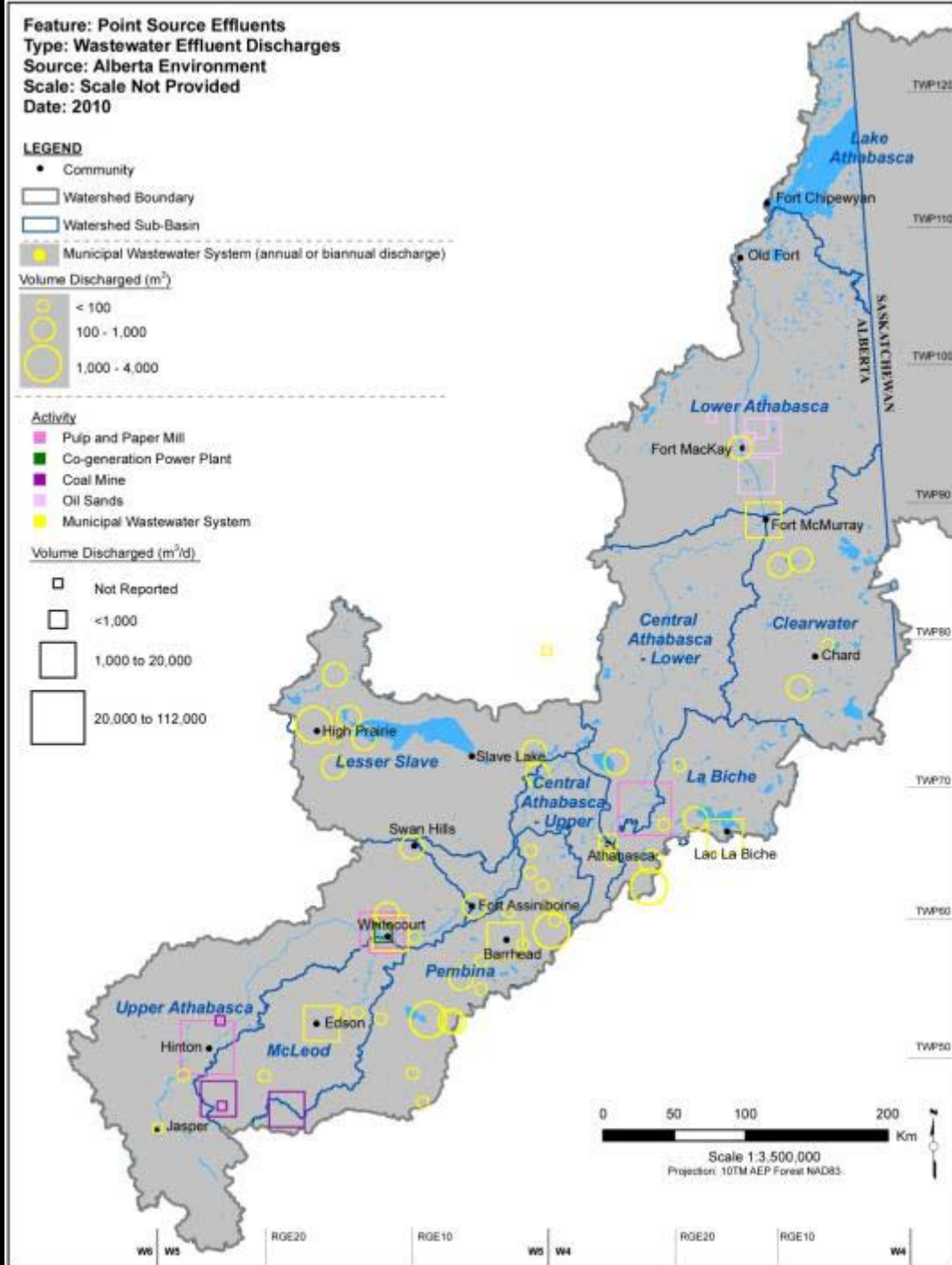
# Point Sources of Nutrient Inputs in the Athabasca River Basin, <1996



Source: Northern River Basins Study,  
Report to the Ministers, 1996

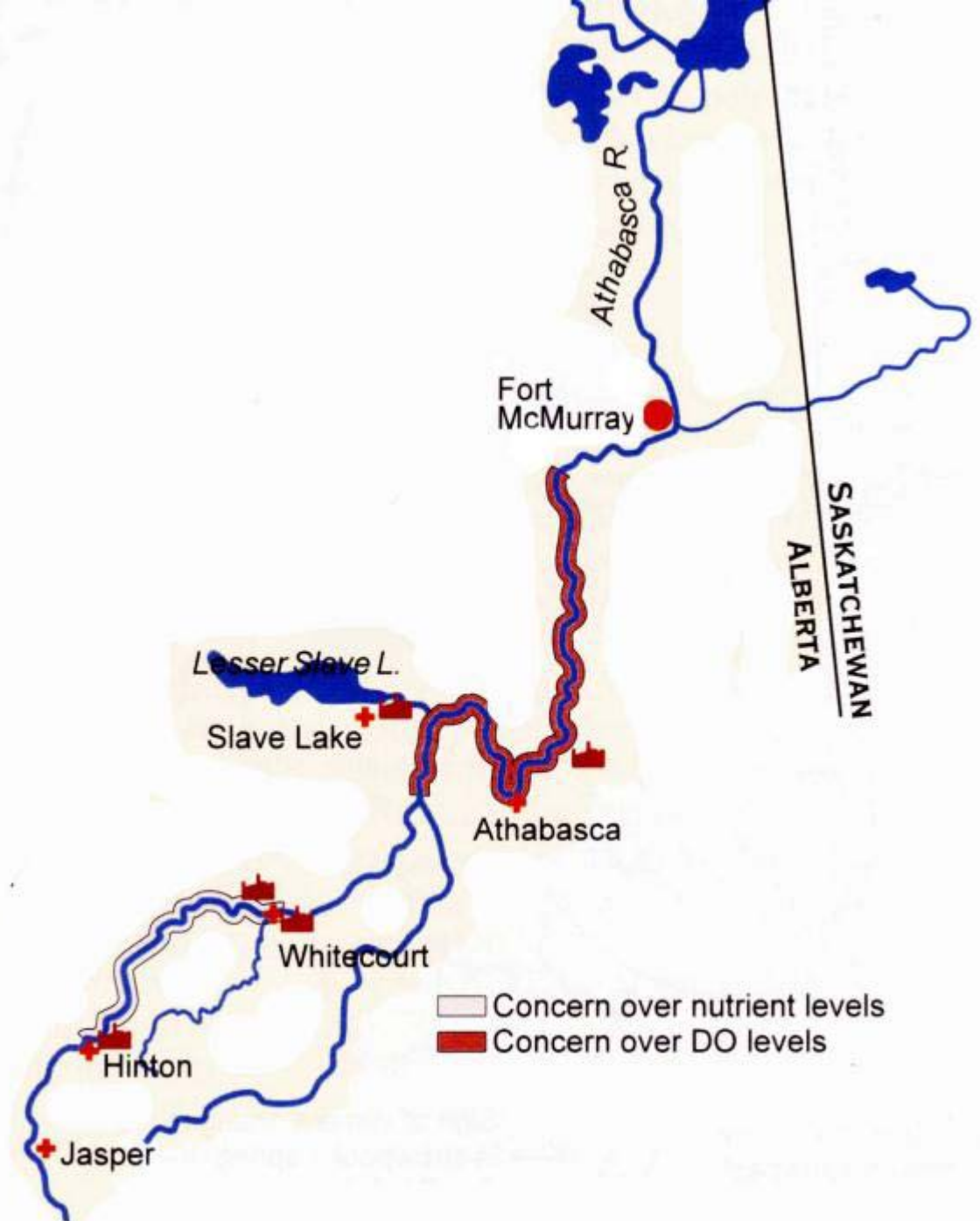
# Point Sources of Wastewater Effluents in the Athabasca River Basin, 2010

Source: Athabasca Watershed Council, State of the Watershed Report, Phase 1, Appendix A2: Maps from the Preliminary Atlas, 2011





# Nutrient and Oxygen Concerns in the Athabasca River Basin



Source: Northern River Basins Study,  
Report to the Ministers, 1996

## 4. Political and Economic Issues

- **Treaty 8 used Athabasca River as a boundary**
- **Export of rural resources to urban areas**
- **Distribution of government taxes and benefits**
- **Employment**





# Why is the ARB important?

## 5. Intellectual Interest

- Archeology and pre-history
- Biology
- Economics
- Geography
- Geology
- History
- Sociology



# Legislative Protection: Federal

- **Fisheries Act**
- **Navigable Waters Act**
- **Environment Assessment Act**
- **Environmental Protection Act**





# **Legislative Protection: Provincial**

- **Water Act**
- **Public Lands Act**
- **Wildlife Act**
- **Forests Act**
- **Wilderness Areas Act**
- **Wilderness Areas, Ecological Reserves and Natural Areas Act**
- **Oil Sands Conservation Act**



# Legislative Protection

- **Regulations & reporting  
( = monitoring)**
- **Enforcement**





# Conservation within ARB

<b>CDN parks (Jasper &amp; Wood Buffalo)</b>	<b>2</b>
<b>AB wildland parks</b>	<b>17</b>
<b>AB + SK (2,240 km<sup>2</sup>) parks</b>	<b>11 + 1</b>
<b>AB wilderness park (part of Willmore)</b>	<b>1</b>
<b>AB ecological reserves</b>	<b>6</b>
<b>AB natural areas</b>	<b>29</b>
<b>AB bird sanctuaries &amp; wildlife area</b>	<b>4</b>

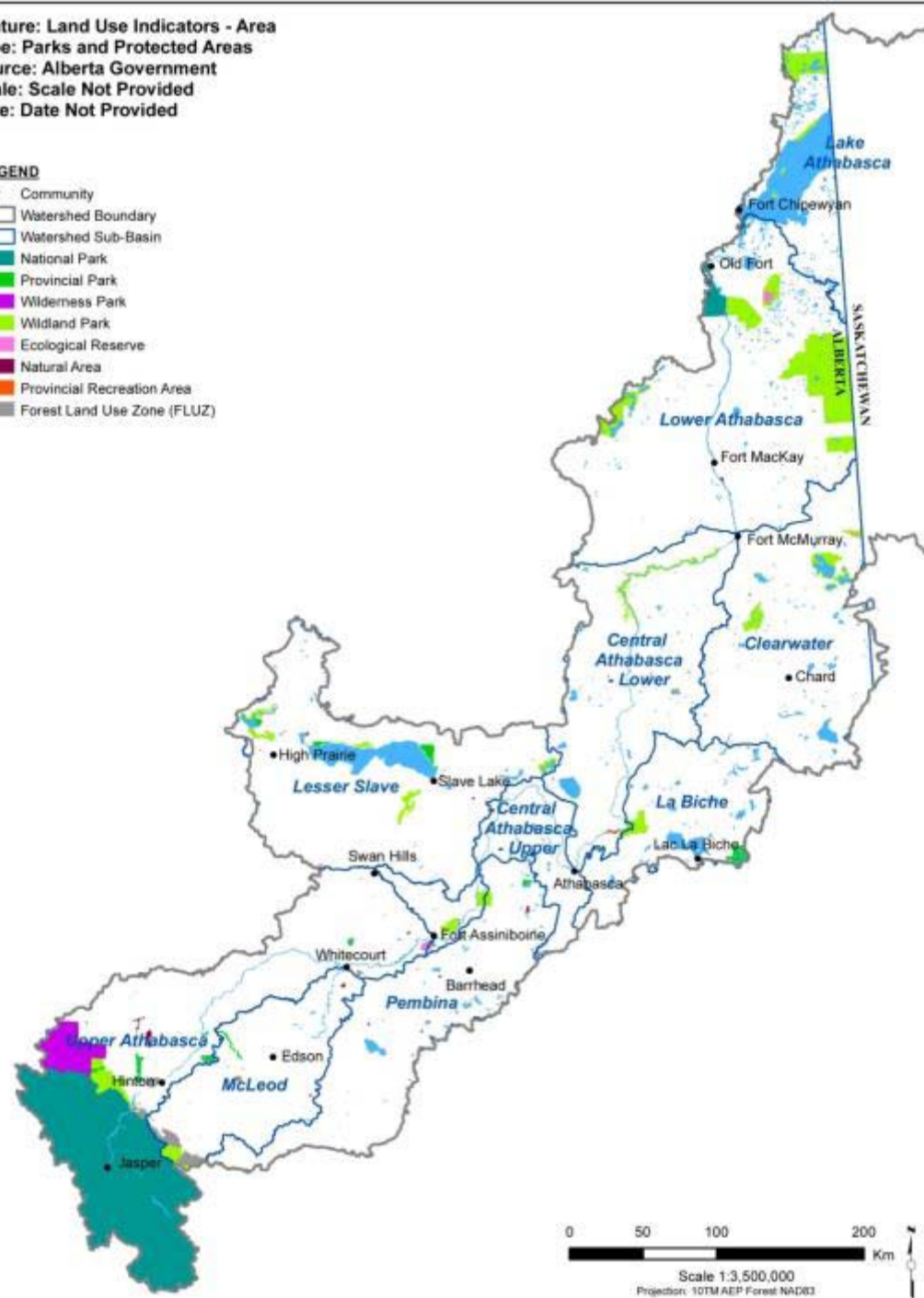
# Parks & Protected Areas in the Athabasca River Basin

Source: Athabasca Watershed Council, State of the Watershed Report, Phase 1, Appendix A2: Maps from the Preliminary Atlas, 2011

Feature: Land Use Indicators - Area  
Type: Parks and Protected Areas  
Source: Alberta Government  
Scale: Scale Not Provided  
Date: Date Not Provided

## LEGEND

- Community
- Watershed Boundary
- Watershed Sub-Basin
- National Park
- Provincial Park
- Wilderness Park
- Wildland Park
- Ecological Reserve
- Natural Area
- Provincial Recreation Area
- Forest Land Use Zone (FLUZ)

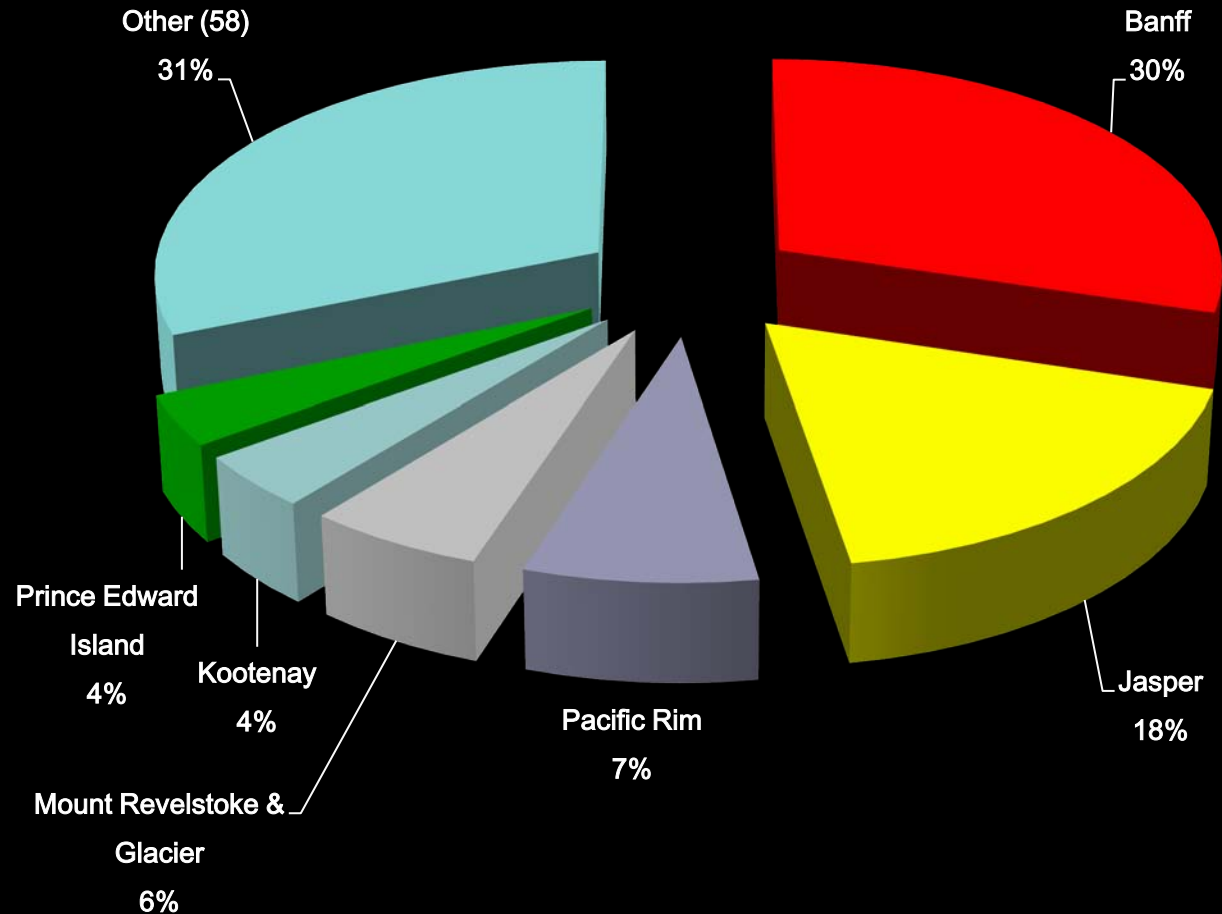




# Visitors to 64 Canadian National Parks

**Jasper:**

- 2<sup>nd</sup> most visited federal park
- 1,868,797 visitors in 2009-2010



# Athabasca River: a Canadian Heritage River

- nominated for natural features, historical significance & river recreation
- Jasper National Park (1989)
- Clearwater in Saskatchewan (1987) and Alberta (2004)





# Basic Concerns of Everyone

Can I drink the water?



Can I eat the fish?



Can I swim in the water?





# Concerns - General

- **Water supply: too much / too little & timing**
- **Seasonal vs. year-to-year**
- **Flooding (e.g. Pembina River sub-basin, Fort McMurray)**
- **Drought**
- **Transport of suspended and dissolved materials**
- **Habitat maintenance**



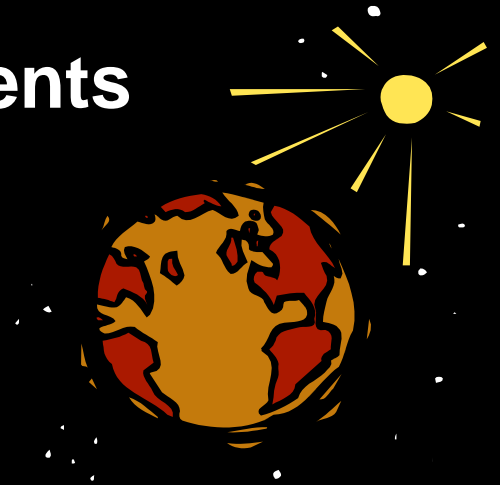
# Concerns - General (continued)

- Over-exploitation of resources
  - renewable → non-renewable
  - non-renewable → exhausted too quickly



# Concerns - General (continued)

- **Global warming → less water for:**
  - native and agricultural plant growth
  - water for municipalities and industries
  - dilution → increased concentrations of toxins
  - flooding of habitats with nutrients





# Concerns – Specific Groups

- **Industry (pulp, oil)**
  - sufficient water for processes via licenses, tradable rights and performance standards
  - storage of water
  - water quality and water treatment (pre- / post-)
  - enough water for effluent dilution
  - spills
  - aquatic organisms

Millar Western Pulp,  
Whitecourt, 2007



# Concerns – Specific Groups

- **Forestry**

- tree growth
- drought
- fire
- tree-feeding insects
- tree diseases
- tree biodiversity



# Concerns – Specific Groups

An aerial photograph of a large-scale agricultural operation. In the foreground and middle ground, there are several large, rectangular pens filled with dark-colored livestock, likely cattle. The pens are separated by wooden fences. To the left, there are large, white, arched structures that appear to be greenhouses or covered walkways. In the background, there are more greenhouses and a line of trees. The overall scene depicts a busy farming or ranching environment.

- Agriculture
  - precipitation for plant growth
  - water for livestock
  - nutrient run-off
  - crop and livestock diseases
  - insect pests / pollinators

Near Baptiste Lake, 2007

# Concerns – Specific Groups

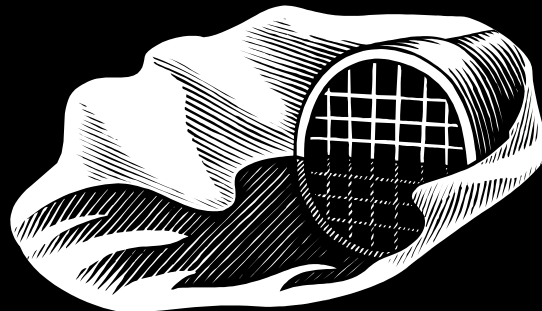
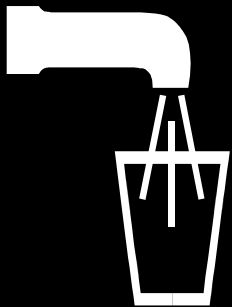
- **Fisheries**
  - water quantity and timing
  - water quality / toxicity
  - habitats
  - catch limits
  - exotics





# Concerns – Specific Groups

- **Municipalities**
  - potable water
  - sewage treatment
  - flooding



# Concerns – Specific Groups

- **Conservationists**
  - **Water (in-stream flow needs) and land for organisms and their habitats**
  - **Toxins**
  - **Biological diversity**
  - **Habitat fragmentation**
  - **River morphology via wide variation of water flow**



# Concerns – Specific Groups

- Tourism
  - water and land recreation
  - range of accessibilities (easy to difficult)



## **What is happening at the provincial level:**

- **WPACs = Water Planning Advisory Councils for each Alberta river → state of the river reports → recommendations to government**
  - **Lesser Slave Watershed Council**
  - **Athabasca Watershed Council**
- **Land planning (upper and lower)**





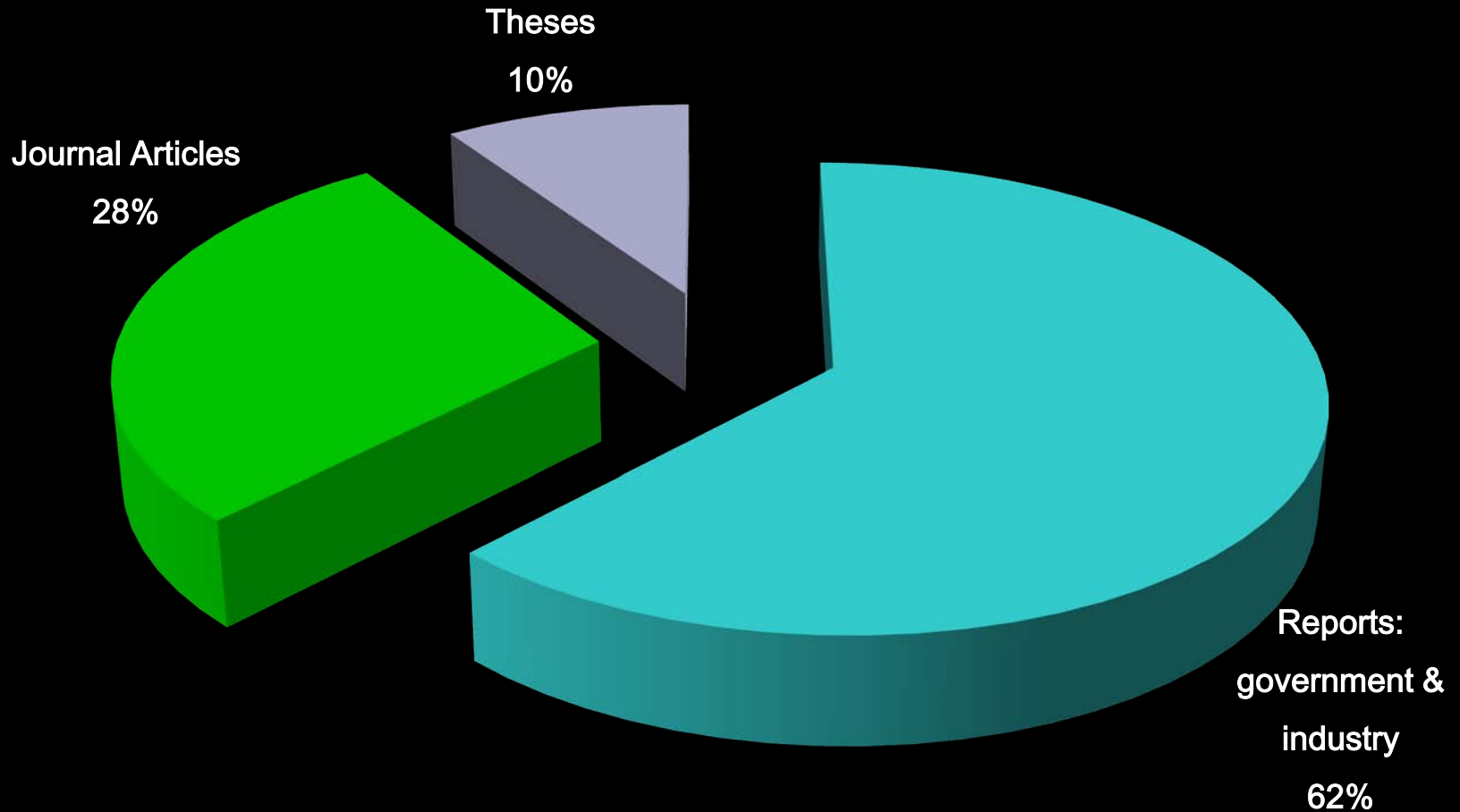
# What is happening at Athabasca University:

- **BARB = Bibliography of the Athabasca River Basin\***
- **BARB → free, on-going, on-line, searchable database**
- **Comprehensive:**
  - **>30,000 science, social science, history and economic references**
- **[www.barbau.ca](http://www.barbau.ca)**



**\* Project of Athabasca River Basin Research Institute (ARBRI), Athabasca University Library, Science Outreach – Athabasca, AU faculty & staff**

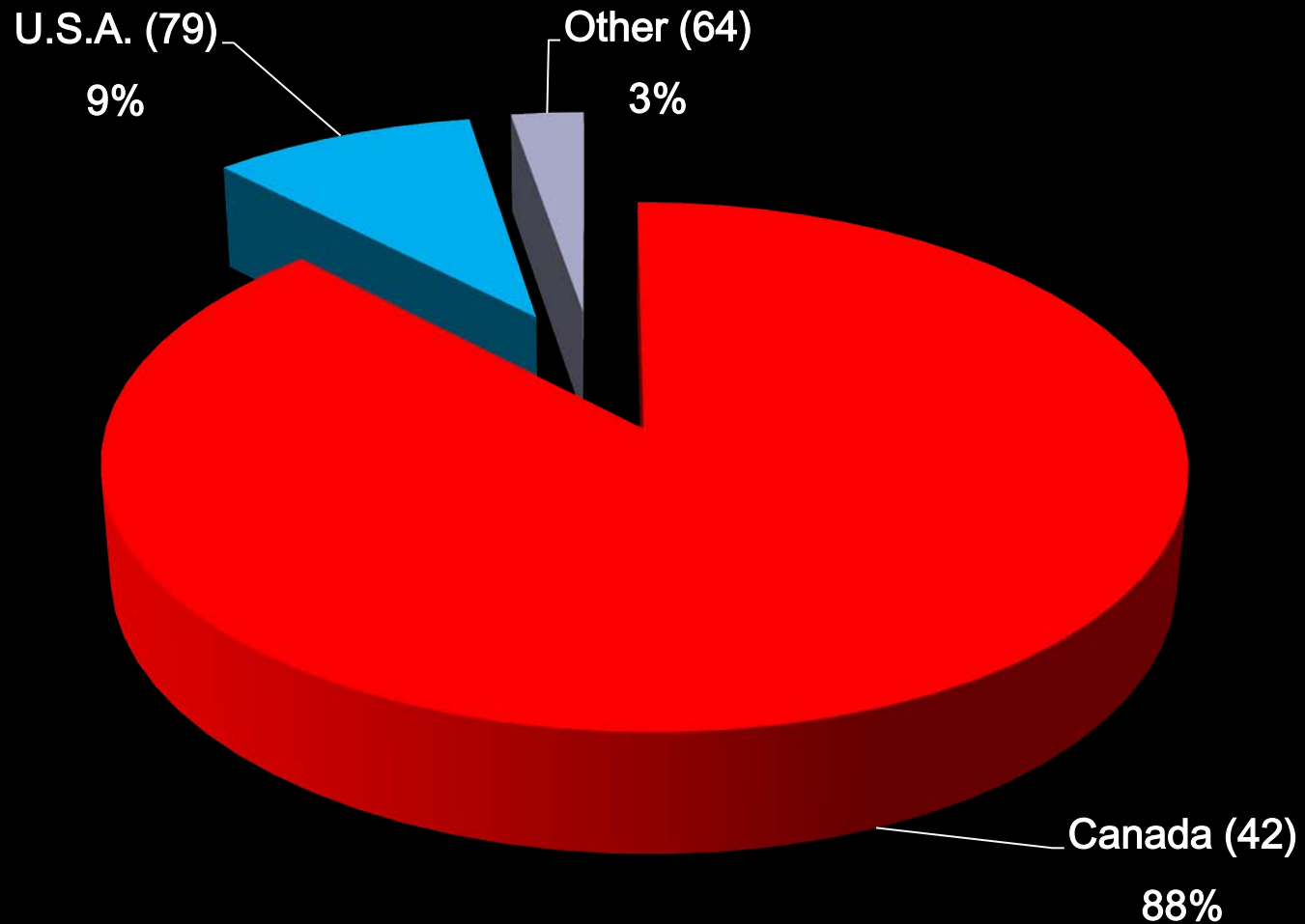
# Science Publications Related to the ARB



Data: Science Outreach – Athabasca, as of 31 August 2010, n = 25,530



# Home Universities (n = 185) of ARB Theses



Of 2,123 Canadian theses, 57% = U of A, 12% = U of C

N = 2,417

# My hopes for BARB over next 5 years:

- **BARB with >50,000 references**
  - ~20% fully-searchable texts (URLs, electronic periodicals, pdf files)
- **AU Library with 3<sup>rd</sup> best collection of ARB materials**





# My Hopes for the ARB

1. Integrated planning for accumulated impacts (e.g. interactions of pulp mill effluents with oil sand PAHs)
2. Monitoring – arms-length, long term and public access
3. Remediation money held in trust (i.e. outside of resource companies and loop holes closed)



# My Hopes for the ARB

4. Research – primarily funded by resource consumers and effluent producers
5. Informed public – interested and active in their river basin
6. AU Library = central depository for all published materials related to the ARB





# Questions?

Contact: Robert  
Holmberg  
[robert@athabascau.ca](mailto:robert@athabascau.ca)

