CHIEF MOUNTAIN STUDY

A Forecast of Land Use Cumulative Effects

Presentation by: *Barry Wilson*

Mark Hudson

January, 2008

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Presentation Outline

- who we are
- origin of this study and where it fits in
- objectives and deliverables
- context and modelling approach
- key data inputs and assumptions
- Base Case results
- Sensitivity Analyses results
- Conclusions

Who We Are

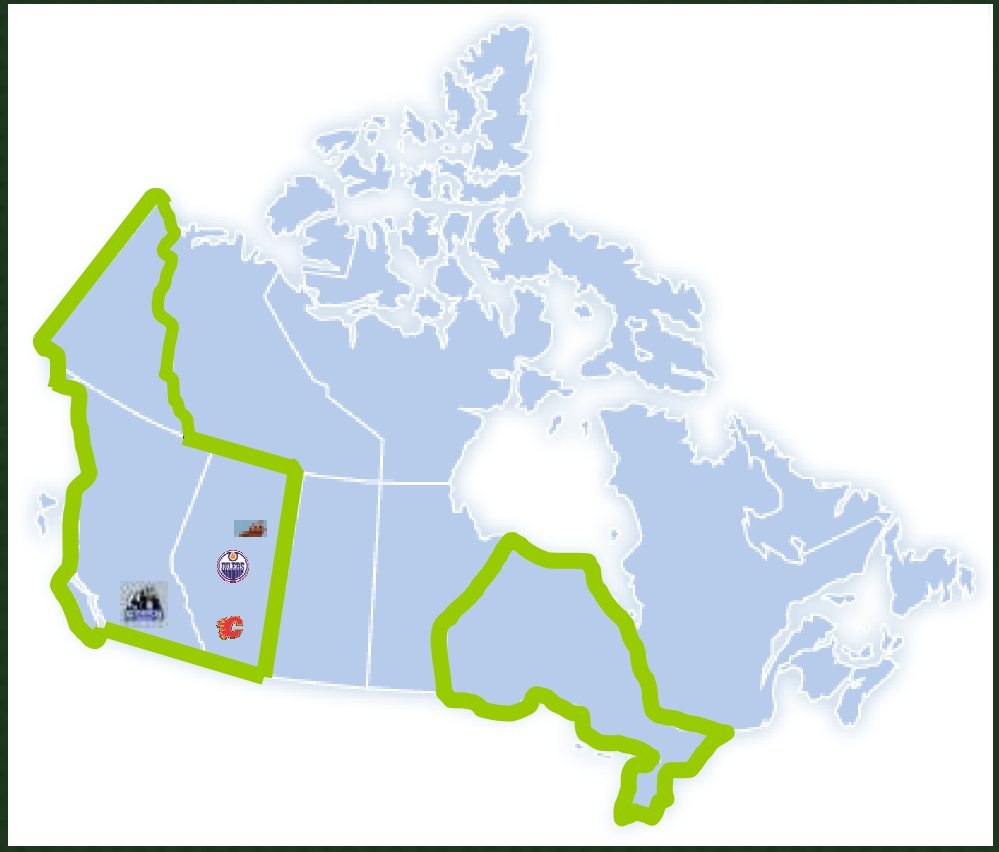
- Silvatech Consulting Ltd. was established in 1983 and is the parent company of the **Silvatech Group**, which includes:
  - Earth Imaging Technologies Inc.
  - Silvatech Resource Solutions Ltd.
  - diverse group of associates

Where We Are

Headquarters:
Salmon Arm, BC

Divisional offices:
Calgary
Edmonton
Lac La Biche, AB

Current Projects:
BC, Alberta,
Ontario, Yukon



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Our Core Business Is Land Base Information

What We Do

- **Core Business**

  Land Base Information

- **Business Units**

  Integrated Land/Resource Inventories

  Environmental Planning and Analysis

  Forest Land Management

  Mapping

Forem Technologies

- Thanks to Brad Stelfox as a **key associate** providing:
  - Southern Foothills Study (SFS) Model template
  - ALCES Model Enhancements
  - Land Base Information
  - Technical Advisor
  - Moral Support ☺
  - http://www.foremtech.com/

Grass Roots Origin of the Study

- March 2007
  SFS Results Presented

- Interest from the Chief Mountain / Chinook Area Land Owner Groups and Cardston County

- Decided that similar study be pursued for this area building from SFS

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- March 2007
  SFS Results Presented
- Interest from the Chief Mountain / Chinook Area Land Owner Groups and Cardston County
- Decided that similar study be pursued for this area building from SFS
- Localized to the Chief Mountain area

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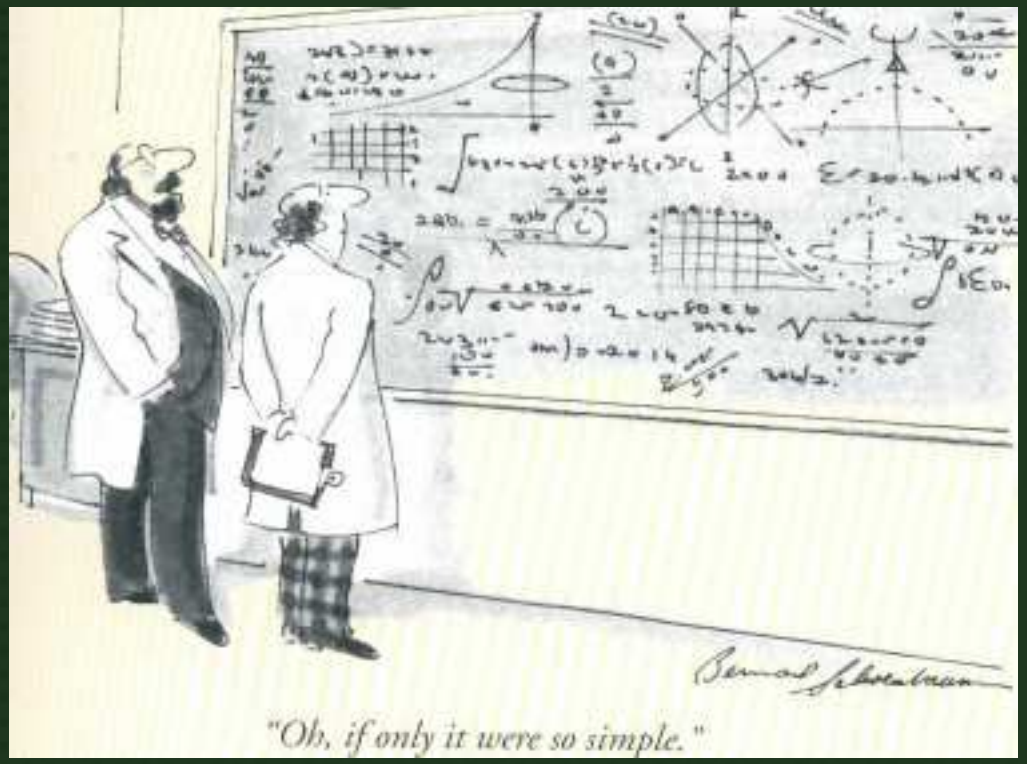
Cumulative Effects Policy Context

- The EIA came about in the 1970's more effective land use planning
- Today, potential environmental impacts of activities are required at both the federal and the provincial level
- moving towards holistic and comprehensive cumulative effects assessments of all potential development trajectories in a landscape

What are Cumulative Effects?

- *the changes to environmental, social and economic values caused by an activity in combination with other past, present, and reasonably foreseeable human activities."*



"Oh, if only it were so simple."

Cumulative Effects Policy Context

The need for strategic level cumulative effects assessments is increasing rapidly:

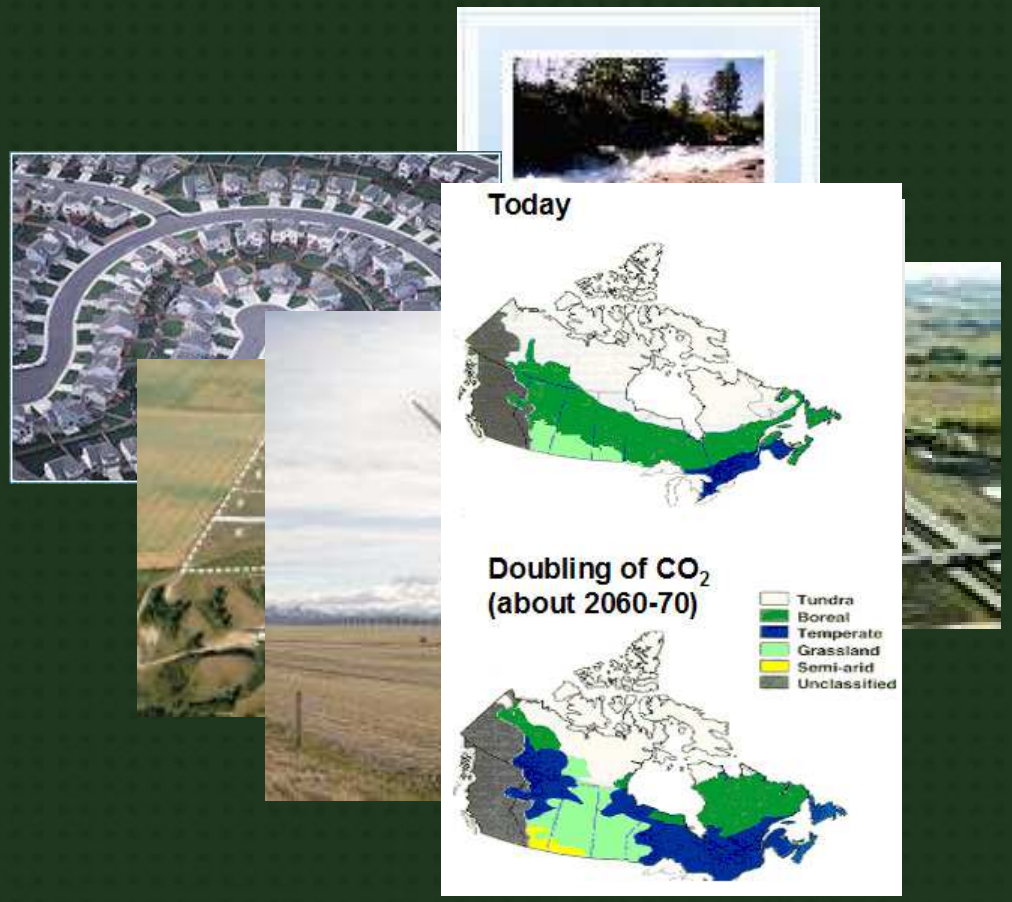
water for life

transportation infrastructure

settlement growth

energy development

climate change



Cumulative Effects Policy Context

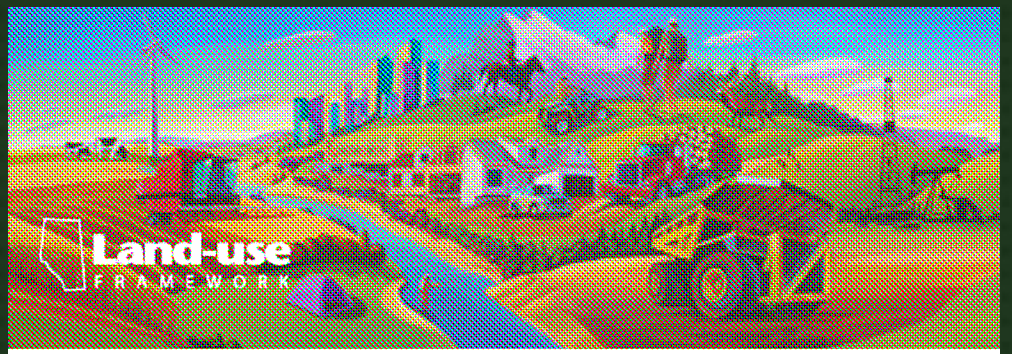
Land Use Framework Directions:

Regional Cumulative Effects Management of Air, Land and Water

Conservation and Stewardship

Continuous Improvement

Inclusion of Aboriginal Peoples



Understanding Land Use in Alberta

Chief Mountain Study (CMS)

Objectives:

1. To use the ALCES® SFS model as a template from which to build the Chief Mountain Study (CMS) model.
2. To modify those aspects of the model pertaining to land-uses that are unique to the CMS; relative to the SFS.
3. To model groundwater dynamics and windmill footprint growth in the study area.

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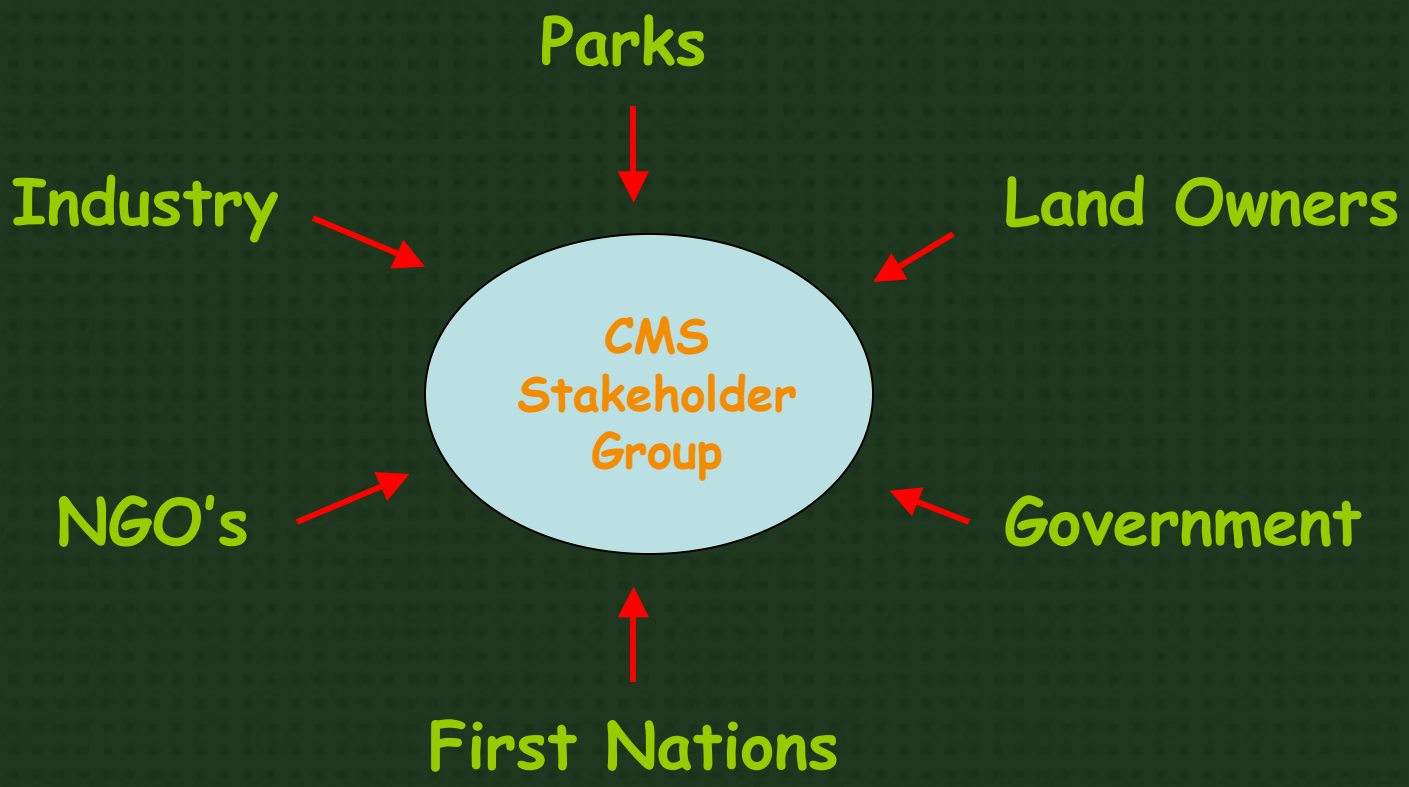
CMS

Deliverables:

1. To perform a **base case** analysis; i.e., project the current ecosystem dynamics and land-use trends over the next 50 years.
2. To perform a **sensitivity analysis** around the land-use(s) that are the major drivers or are subject to the most uncertainty in the study area.
3. To create a **PowerPoint summary** and **executive summary** document for delivery; and presentation of final results to stakeholder group.

CMS Stakeholder Composition



CMS Stakeholders

- Nature Conservancy of Canada
- Southwest Alberta Sustainability Community Initiative (SASCI)
- Chinook Area Land Users' Association.
- Oldman Watershed Council
- Waterton Lakes National Park
- Waterton Biosphere
- Cardston County
- Municipal District (MD) of Pincher Creek
- Chief Mountain Landowners
- Blood Tribe
- Apache Canada Ltd.
- Government of Alberta
- Waterton Townsite
- Canadian Wind Energy Association
- Shell Canada
- Town of Cardston
- Town of Pincher Creek

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CMS Stakeholder Perspectives

- Local Input

- Balancing perspectives across the region recognizing differences between Pincher Creek MD, Cardston County, Waterton Park, and the Kainai and Piikani Nations

1. Local sector experts informing and refining model assumptions

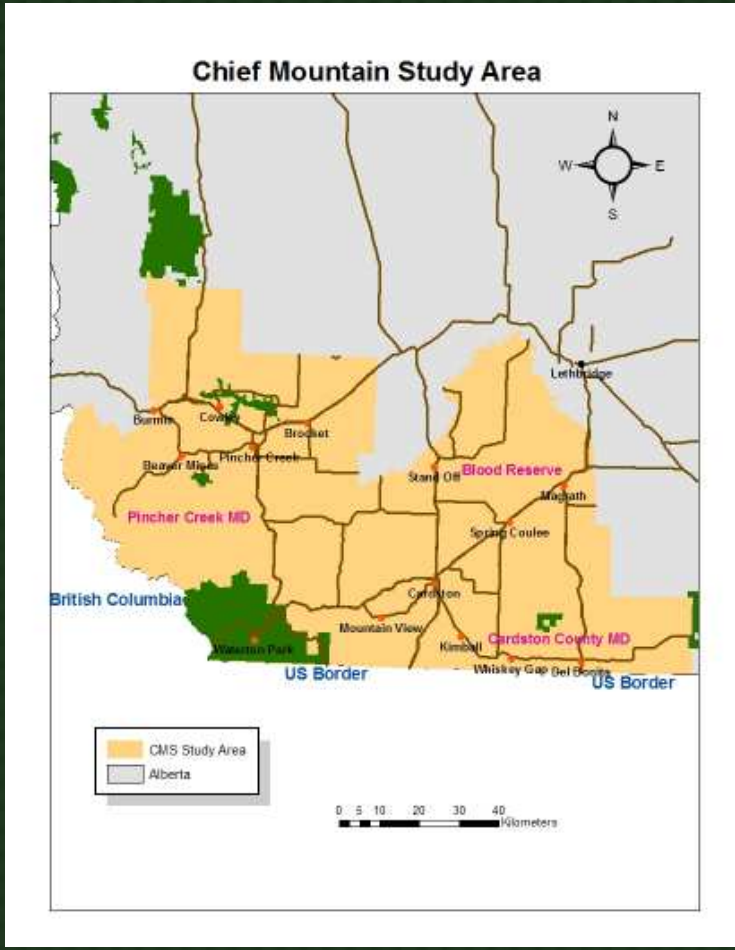
2. Provincial Government supported process built on Southern Alberta Sustainability Strategy (SASS) data and looking forward to Land Use Framework (LUF)

Key Modelling Differences From SFS

- CMS Stakeholder Group Identified 4 Main Adjustments Necessary:

1. Groundwater
2. Wind Turbines
3. Human Settlement Patterns
4. Addition of Sensitivity Analyses

CMS Area



- 925,000 ha or 2.28 million acres
- Pincher Creek MD
- Cardston County
- Kainai
- Piikani
- Waterton Park

- Integrates with Administrative Boundaries
- Contiguous area with relatively similar current and expected land use

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CMS Land Cover Overview

Land base Grouping	Percentage representation (by area) in the study area
Agriculture (Cultivated)	42.7
Grassland (Native Pasture)	29.8
Forests	17.5
Surface Water	3.1
Non-vegetated	2.5
Shrubland	2.2
Transportation	1.4
Residences	0.47
Energy	0.14
Mining	0.02
Other land-uses	0.22

What is ALCES®?

- Landscape simulator that enables resource managers, industry, society and the scientific community to explore and quantify dynamic landscapes affected by single or multiple land use practices and by various natural disturbances such as fire and flooding.
- ALCES® assists resource managers by:
  - Tracking disturbance footprints and economic contributions of land use practices
  - helps identify environmental and industrial conflicts and used to assess mitigation strategies.
- ALCES® is designed to be used for large regional landscapes (200,000's to 20,000,000 ha).

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Using ALCES ®

What ALCES does not do!

- does NOT predict future conditions and flows on defined landscapes.
- It is NOT a crystal ball that informs managers about how "things will be".
- We do not possess predictive insight into precisely how landscapes will unfold.

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Using ALCES ®

What ALCES does do!

- Helps resource managers understand the consequences (both opportunities and risks) of defined land use scenarios
- Helps managers appreciate those variables (environmental, economic, social) that "drive" the landscape, and the consequences of various land use trajectories
- Provides the opportunity to explore strategies that lead to maximizing favorable outcomes and minimizing unfavorable outcomes *(minimize the footprint).*

Strategic, not Operational

The view from 10,000 m

Strategic-level landscape simulation evaluating the strategic consequences and opportunities associated with land use practices within regional landscapes.

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Key Data Inputs and Assumptions

Summary of Acquired Data

Model Section	Data Source
Land base data	SASS
Forestry	SFS/Silvatech
Hydrocarbon	Apache / Shell
Agriculture	Statistics Canada, CMS Group
Livestock	Statistics Canada, CMS Group
Windmills	TransAlta Wind / CanWEA
Groundwater	Hydrogeological Consultants, Brad Stelfox
Human Settlements	Statistics Canada, CMS Group

Key Data Inputs and Assumptions

Agriculture Sector:

Key Data Inputs and Assumptions

Agriculture Sector:

Same as SFS:

- 5 crop types tracked

Cereal, Oilseeds and Pulses,
Forage, Tame Pasture, Specialty

- Constant production rates over 50 yrs
- Constant irrigation area over 50 yrs

Key Data Inputs and Assumptions

Agriculture Sector:

CMS Localized:

- no change in cultivated lands except footprint type (FT) removals
- proportion of landscape type (LT) irrigated (%):

Specialty = 52.7%

Forage = 15.1%

Cereals = 6%

Oilseeds and Pulses = 12%

Tame Grass = 0.39%

- no fallowing

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Key Data Inputs and Assumptions

Livestock Sector:

Key Data Inputs and Assumptions

Livestock Sector:

Same as SFS:

- cattle, swine and horses in feedlots and free range

CMS Localized

- current populations from Statistics Canada Census and Kainai population estimates.
- cattle growth rate (0.45%/yr) half of SFS
- 50% of horse population growth occurs in feedlots (SFS was 0%)
- growth of feedlot area (0.75%/yr) half of SFS

Key Data Inputs and Assumptions

Forestry Sector:

Key Data Inputs and Assumptions

Forestry Sector:

Same as SFS:

- Natural Range of Variation (NRV) age class distribution used to assign ages to the forest inventory

CMS Localized:

- Annual Allowable Cut (AAC) determined by Silvatech using Mean Annual Increment (MAI, m3/ha/year) approach
- In-block road lifespan changed from 100yrs to 20yrs

Key Data Inputs and Assumptions

Hydrocarbon Energy Sector:

Key Data Inputs and Assumptions

Hydrocarbon Energy Sector:

Same as SFS:

- Conventional Oil, Natural Gas and Coal Bed Methane (CBM)

CMS Localized:

- Significantly less activity forecast by sector experts
- Oil – 6% of SFS (5 vs 90 new wells over 50 years)
- Gas – 4% of SFS (17 vs 416 new wells over 50 years)
- CBM – 1.5% of SFS (9 vs 589 new wells over 50 years)
- Refined footprint area and duration assumptions

Key Data Inputs and Assumptions

Wind Energy Sector:

Not Explicitly modelled in SFS

CMS Localized:

- currently 251, (216 Pincher Ck)
- current diameter = 15.1m (179 m^2)
- future diameter = 24m (452 m^2)
- lifespan >50 yrs
- access road is 300 m long by 3.5 m wide

- 85% of windmills on cultivated fields, 15% on native grassland

Key Data Inputs and Assumptions

Human Populations And Settlements

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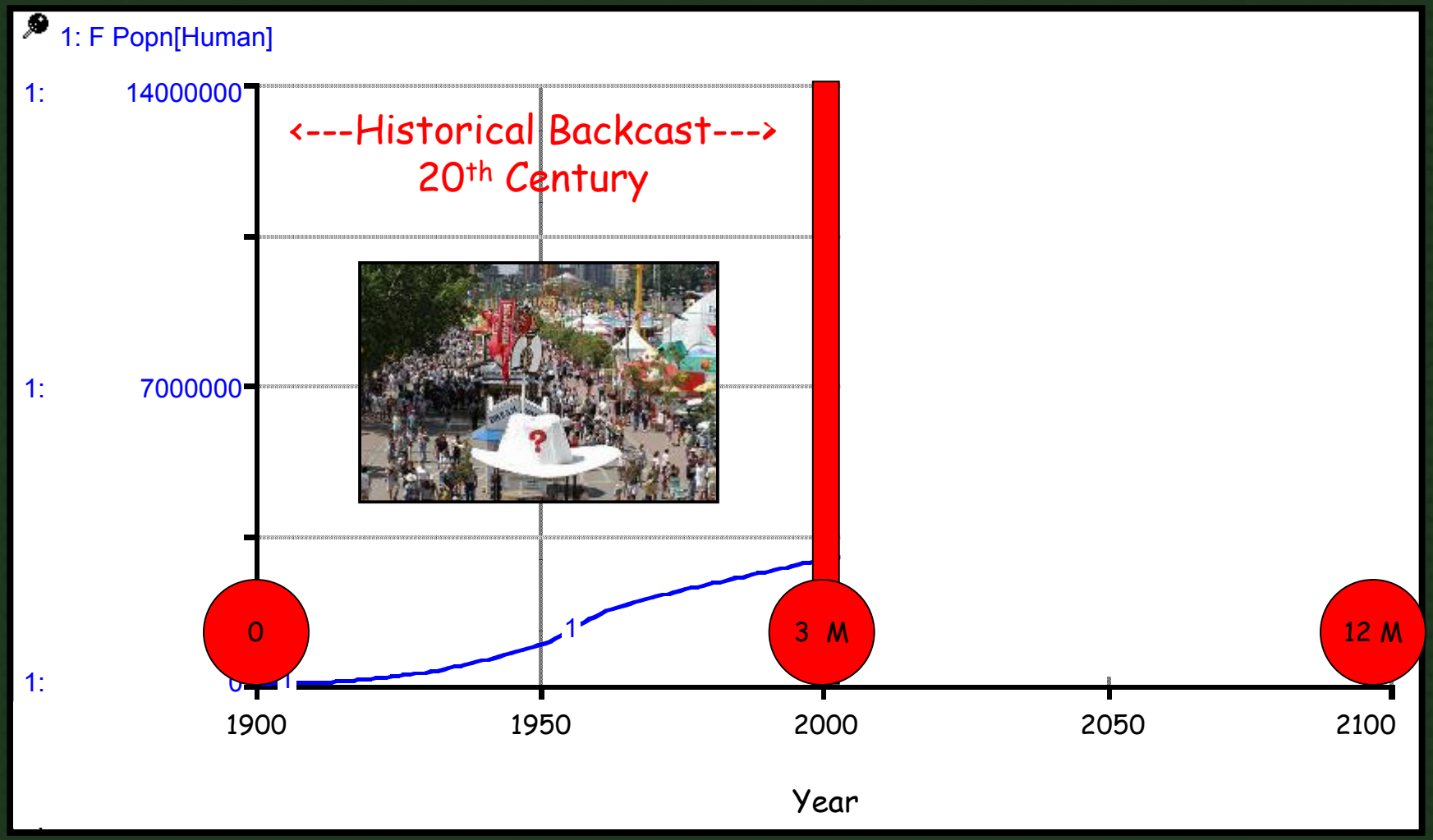
Human Population (#)

Backcast (1900 to 2000) and Forecast (2000 to 2100) for Alberta



source: Southern Foothills Study

Historic and Future Simulated Growth of Calgary
(based on an annual area growth rate of 4.5%)

MD RockyView

Historic
1924
1949
1957
1969
1976
1989
1998

Projected
2010
2020
2030
2040
2050

Airdrie
Cochrane
Kananaskis Border
Redwood Meadows
Langdon
Okotoks

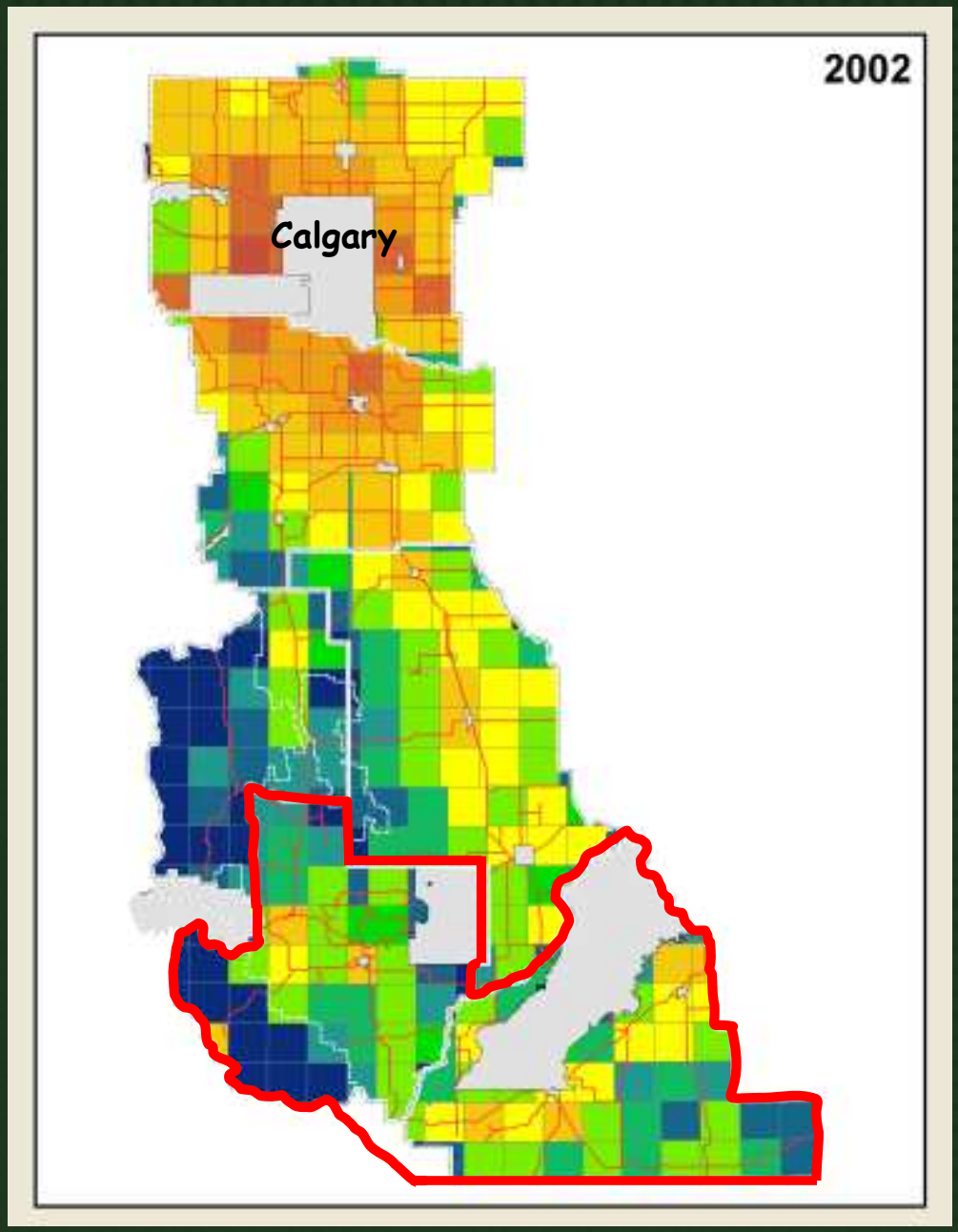
source: Southern Foothills Study

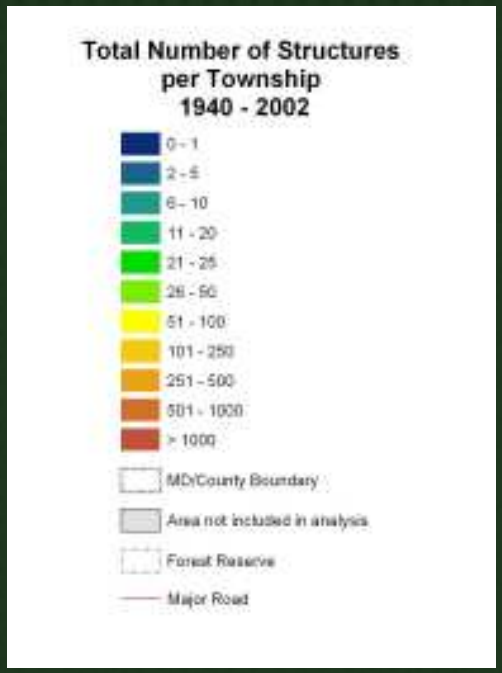
Lethbridge Population Growth

- Current Population: 81,692
- Population Growth Projection similar to Calgary at 3.78%
- 2006-2010 increase of 5,787 people
- 2010 - 2020 increase of 13,000 people
- Urban centers such as Lethbridge are in part driving the "rural residential bow wave"

Development in the CMS study Area

Source: Miistakis Institute





source: Southern Foothills Study

Key Data Inputs and Assumptions

Human Settlement:

Same as SFS:

- population growth rate of 1.8%/yr

CMS Localized:

- growth distributed more in acreages and less in towns
- study area population
- average size of towns
- average number of people/residence

Key Data Inputs and Assumptions

Transportation Infrastructure:

Same as SFS:

- agricultural residence and acreage driveways accounted for in minor roads FT
- CMS Localized:
- transmission lines have no footprint in non-forest areas
- railroad grouped with major roads to enable Wind Turbine modelling

Key Data Inputs and Assumptions

Surface Mining:

Same as SFS:

- gravel pits only
- ratio relative to transportation infrastructure requirements

Key Data Inputs and Assumptions

GROUNDWATER DATA

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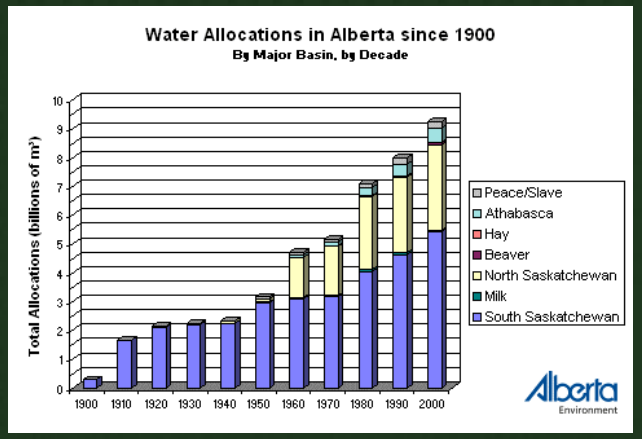
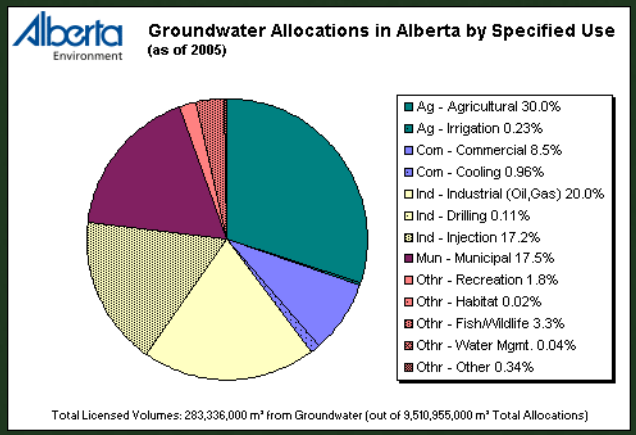
Key Data Inputs and Assumptions

GROUNDWATER DEMAND



water demand (allocations) is 3,600% of 1900 level



Water use in Alberta is predicted to increase to more than 400 million m^3 by 2025 21% ⇧ from today.

Industry – 37%

agriculture-30%

Humans – 19%

Commercial – 10%

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Key Data Inputs and Assumptions

GROUNDWATER SUPPLY

brown areas are areas of water shortage

80% of Alberta's water supply lies in the northern part of the province

80% of our water demand comes from the southern half of the province.

According to Alberta Environment, only 0.01 % of Alberta groundwater is believed to be recoverable.

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Key Data Inputs and Assumptions

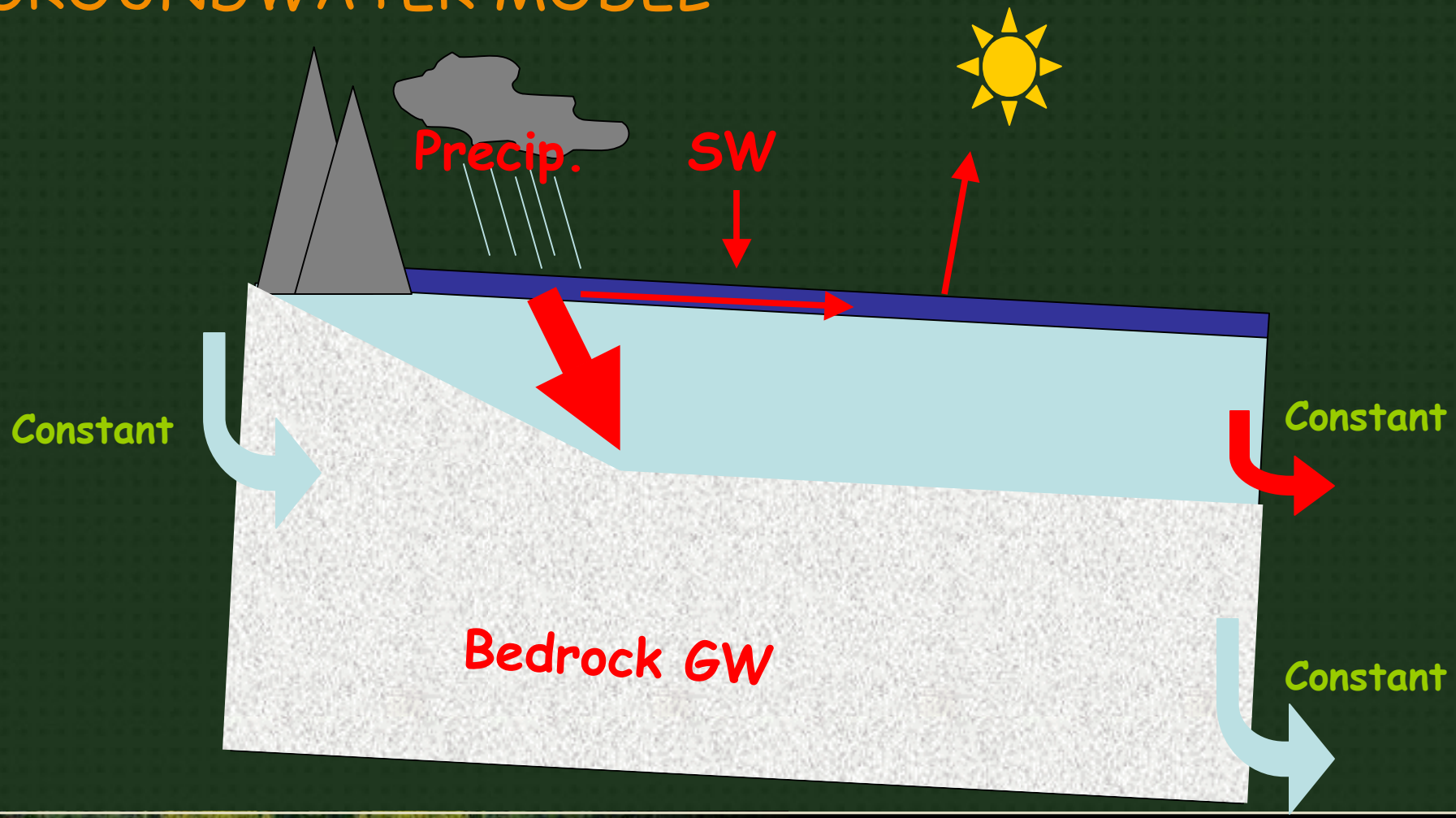
GROUNDWATER DATA

Not tracked in SFS - Module developed for CMS

- area-weighted surficial deposit stocks based on 'Regional Groundwater Assessment for Cardston County' (Base Case uses midpoint of estimated range)
- bedrock aquifers not included because of insufficient data and <3% of total groundwater usage
- Only consumptive use is by humans and livestock
- constant precipitation input converted to surface runoff, evapotranspiration and groundwater (used provincial statistics to determine percentages)

Key Data Inputs and Assumptions

GROUNDWATER MODEL



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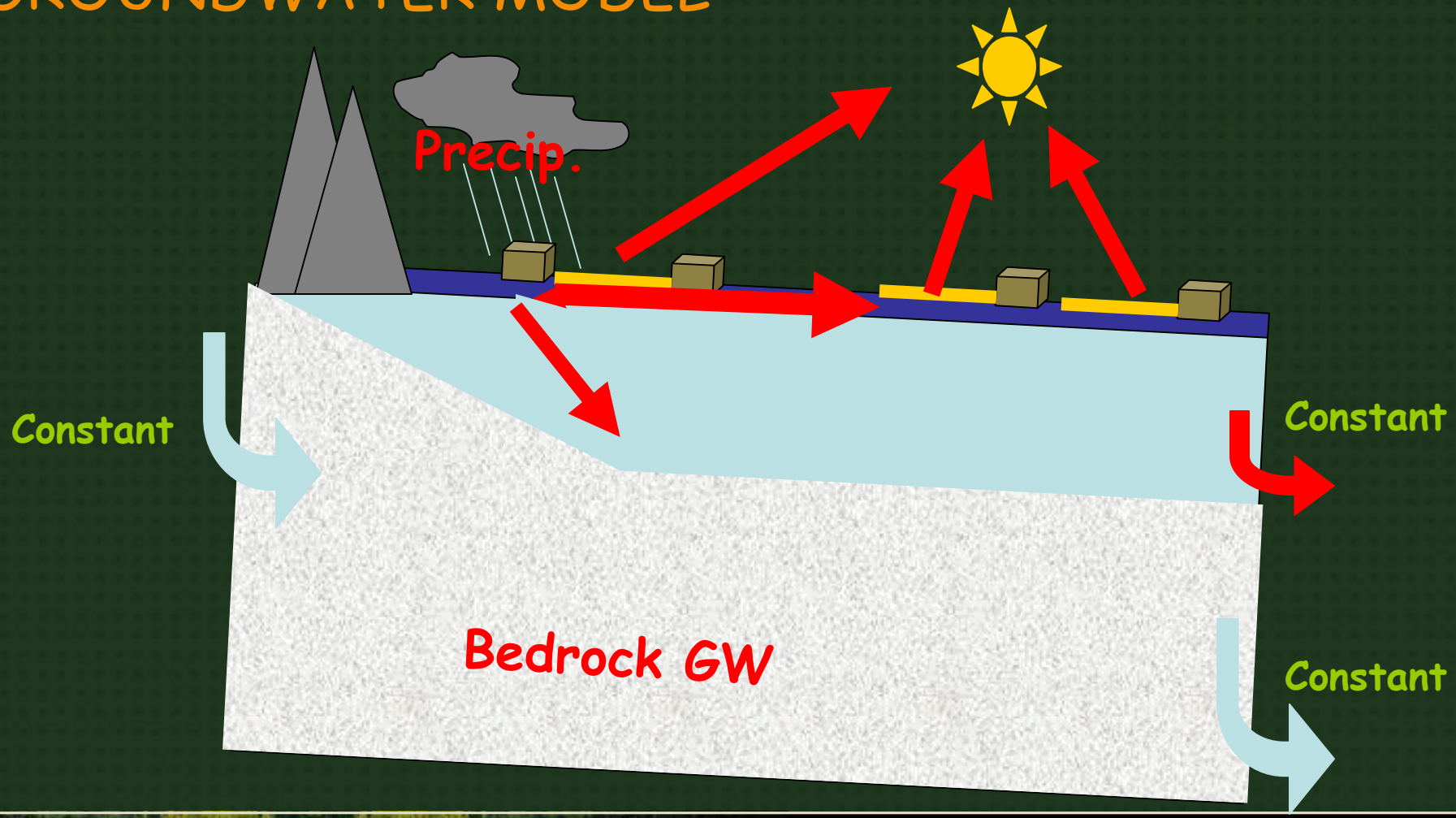
Key Data Inputs and Assumptions

GROUNDWATER MODEL



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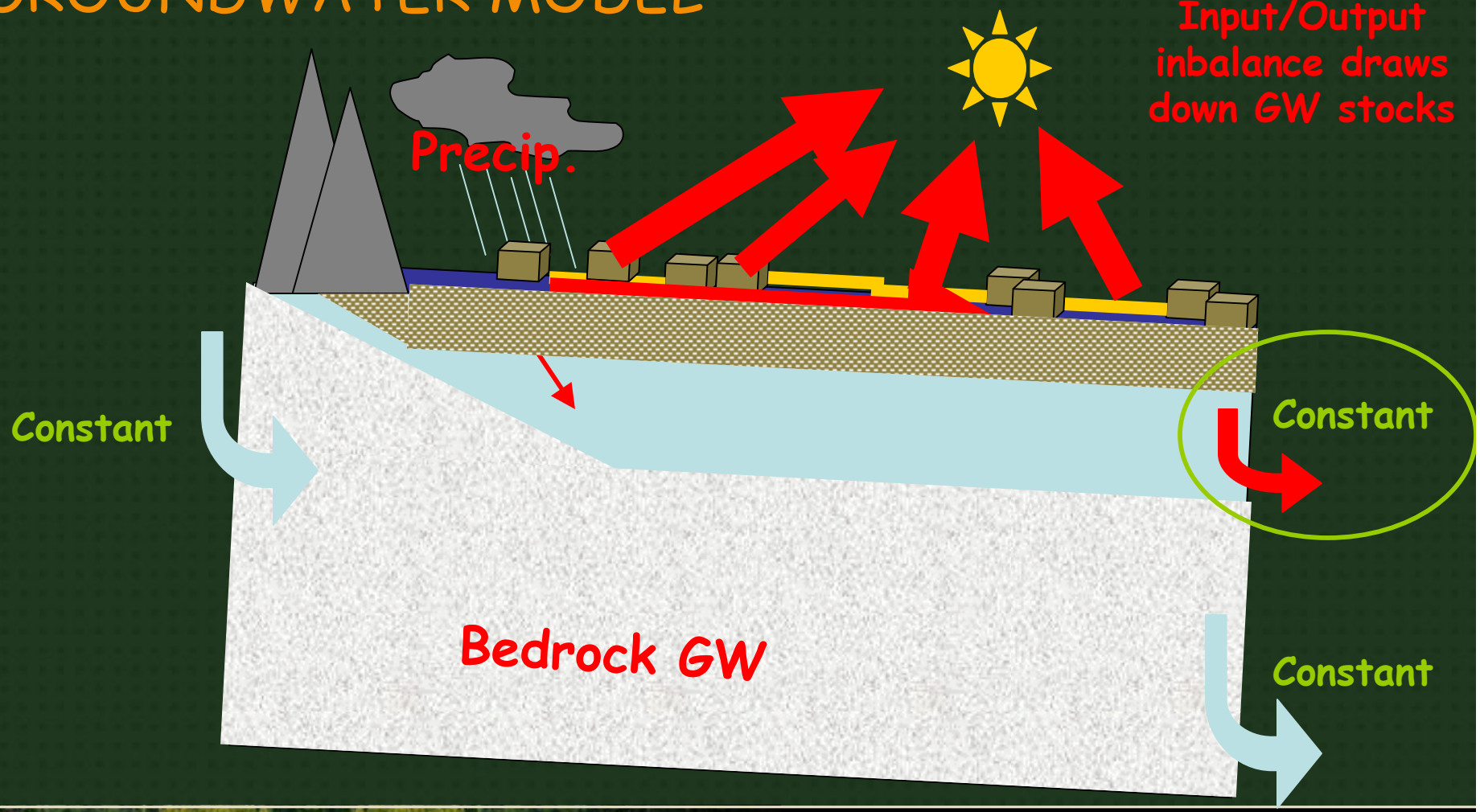

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Key Data Inputs and Assumptions

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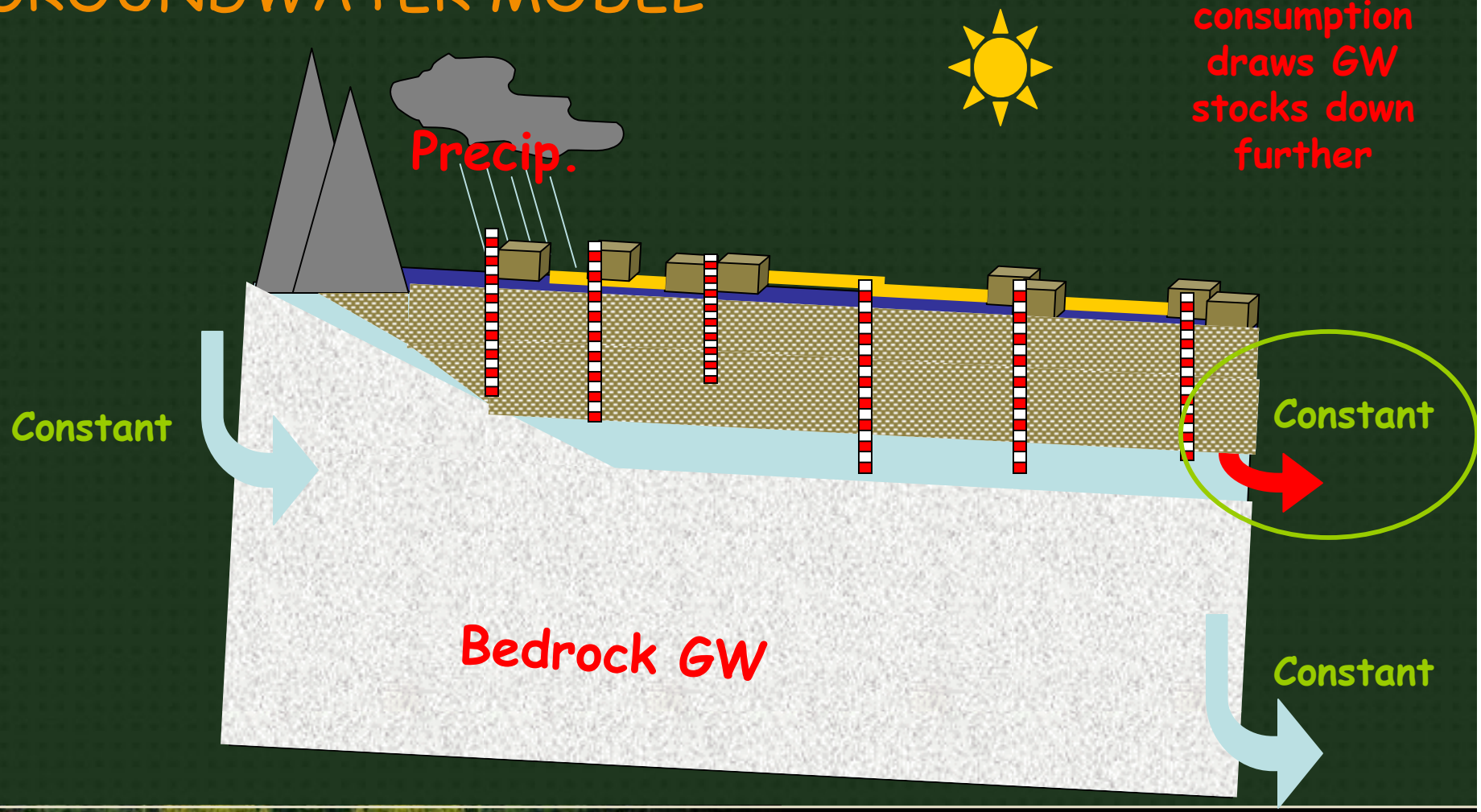

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Base Case Results

Base Case projects current practice forward for 50 yrs

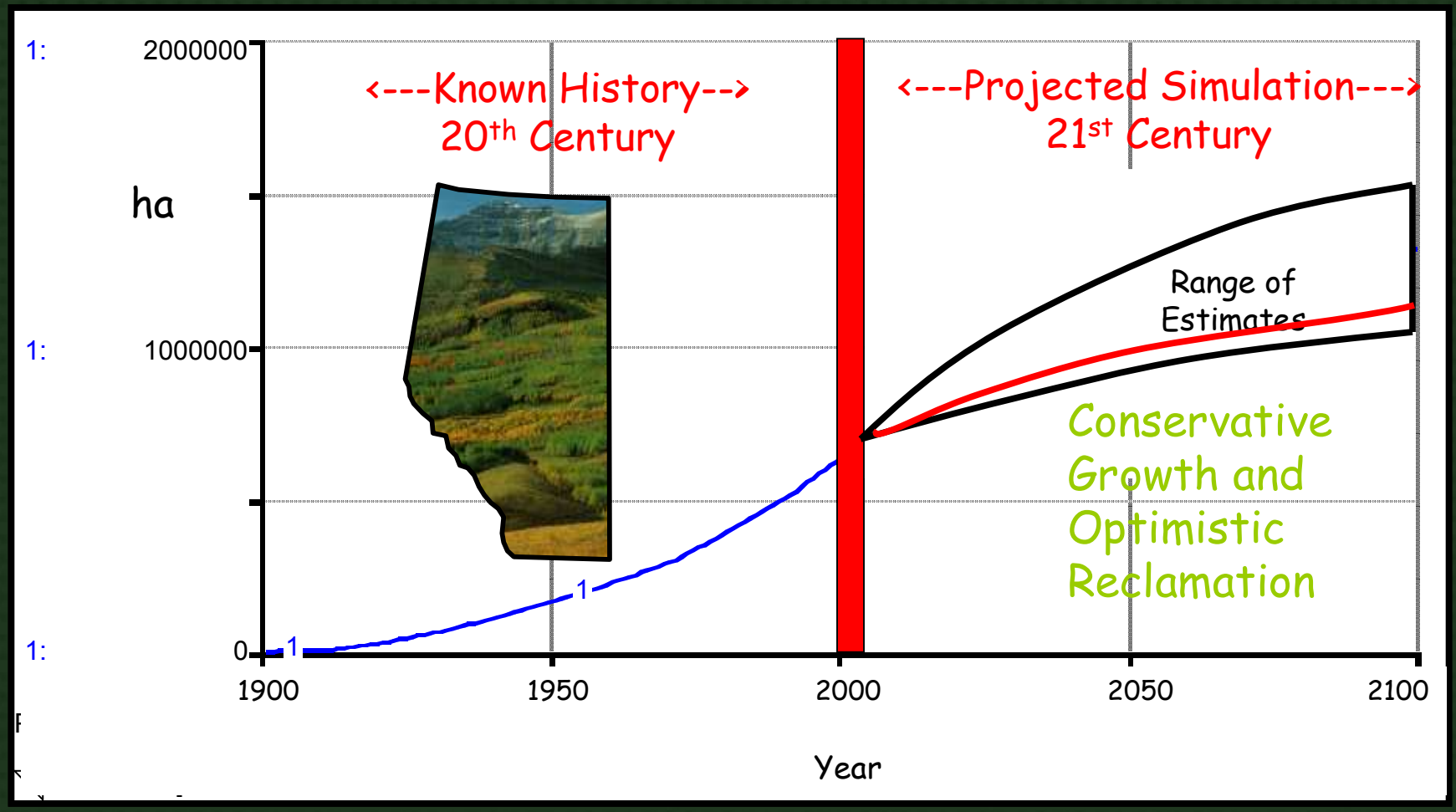
"If activities continue as they are now, this is a likely outcome"

A benchmark to measure other strategies or sensitivities against

We measured:

- Land Use Trajectories / Footprint
- Indicator Performance

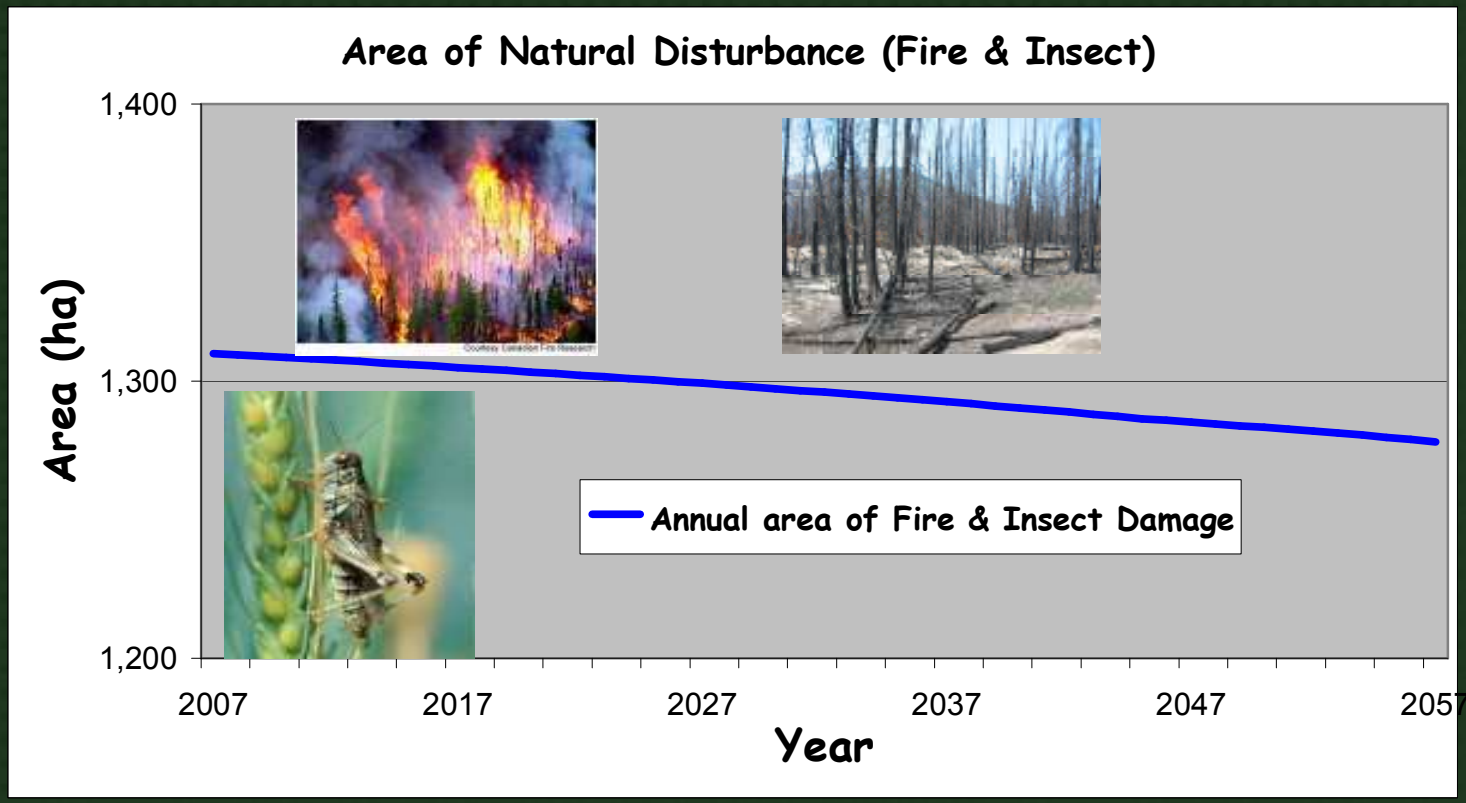
Selecting a Landuse Trajectory



Base Case Natural Disturbance

Natural disturbance agents modeled include fire, and insects

Disturbance simulated at a constant rate, based on an average of past occurrences. Slight decrease due to drop in 'available' vegetated area.



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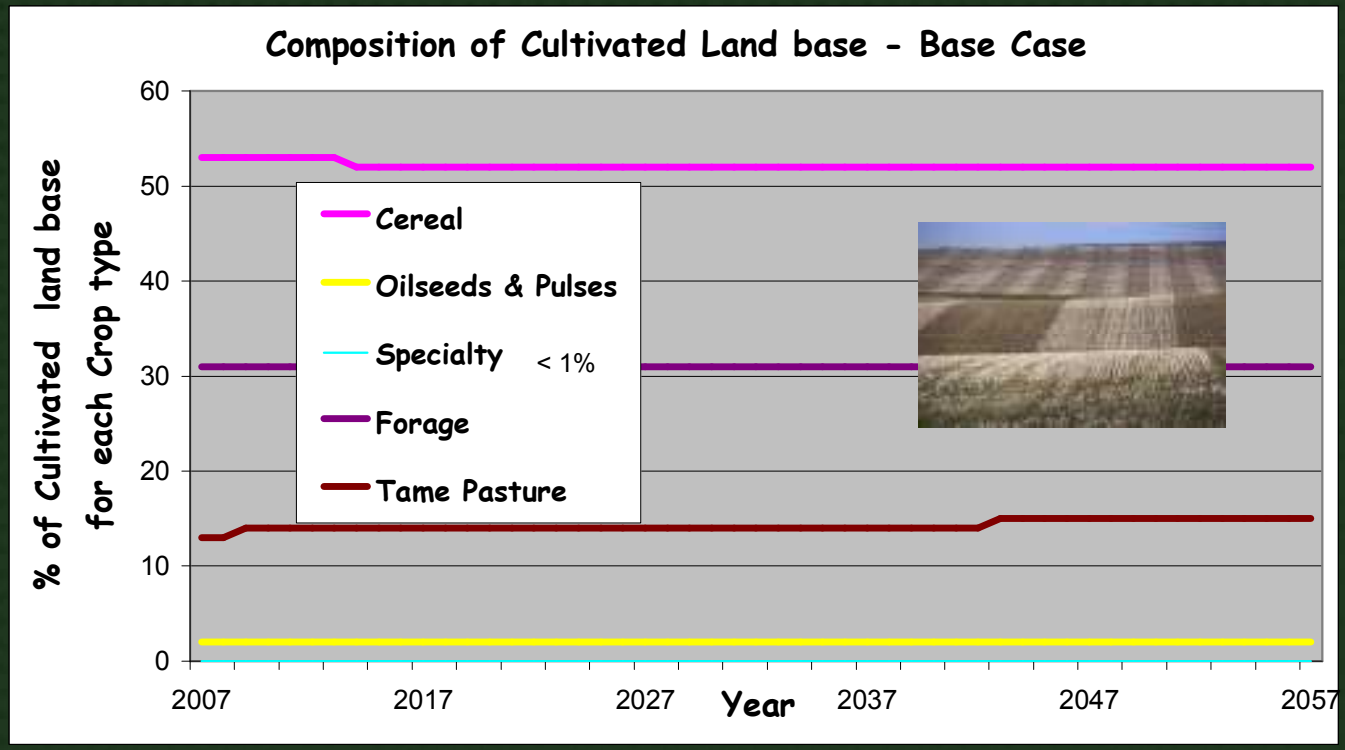
Base Case Land Use Trajectories

Agriculture

Area of cereals is reduced (-2%) primarily from residential growth

Area of tame pasture increases (+15% / 6,400 ha) because invasive plants are assumed to convert native prairie to tame grass



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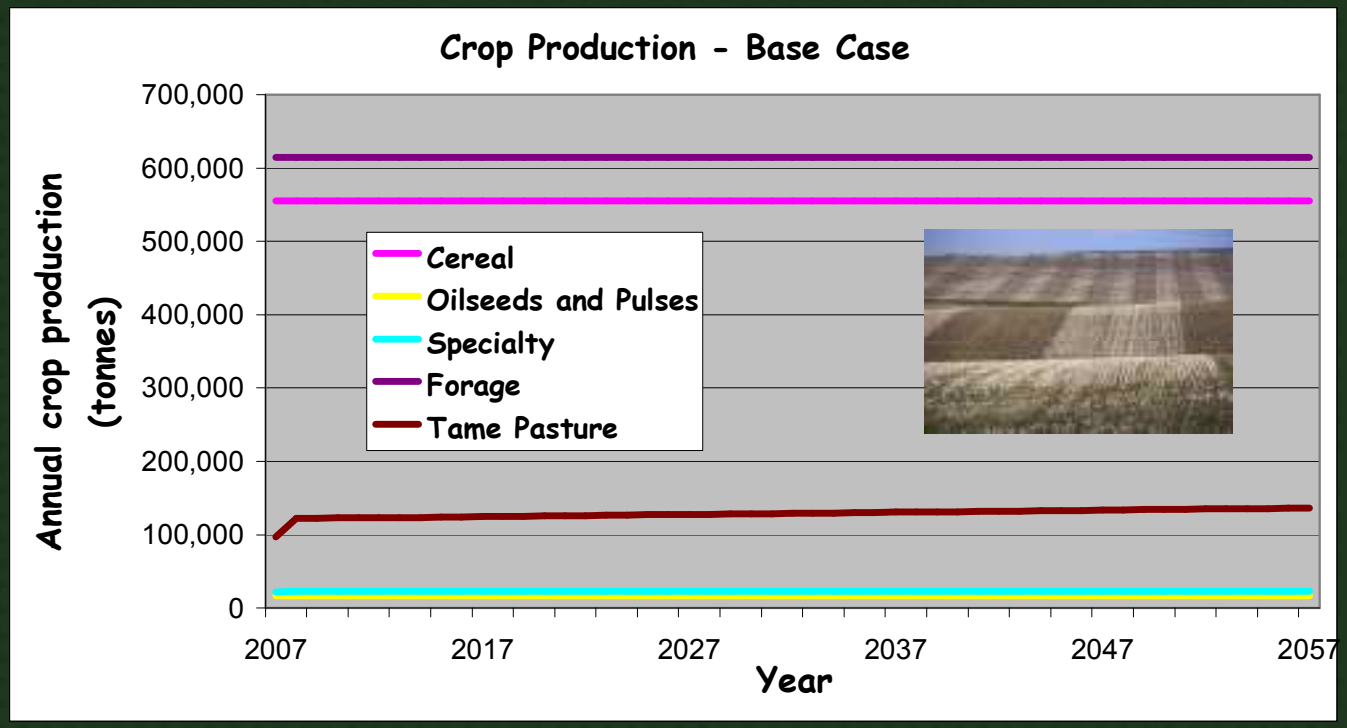
Base Case Land Use Trajectories

Agriculture

Cereal production largely maintained because high productivity irrigation area remains constant (irrigation moves with footprint ingress)

Tame pasture production increases corresponding to its increase in area



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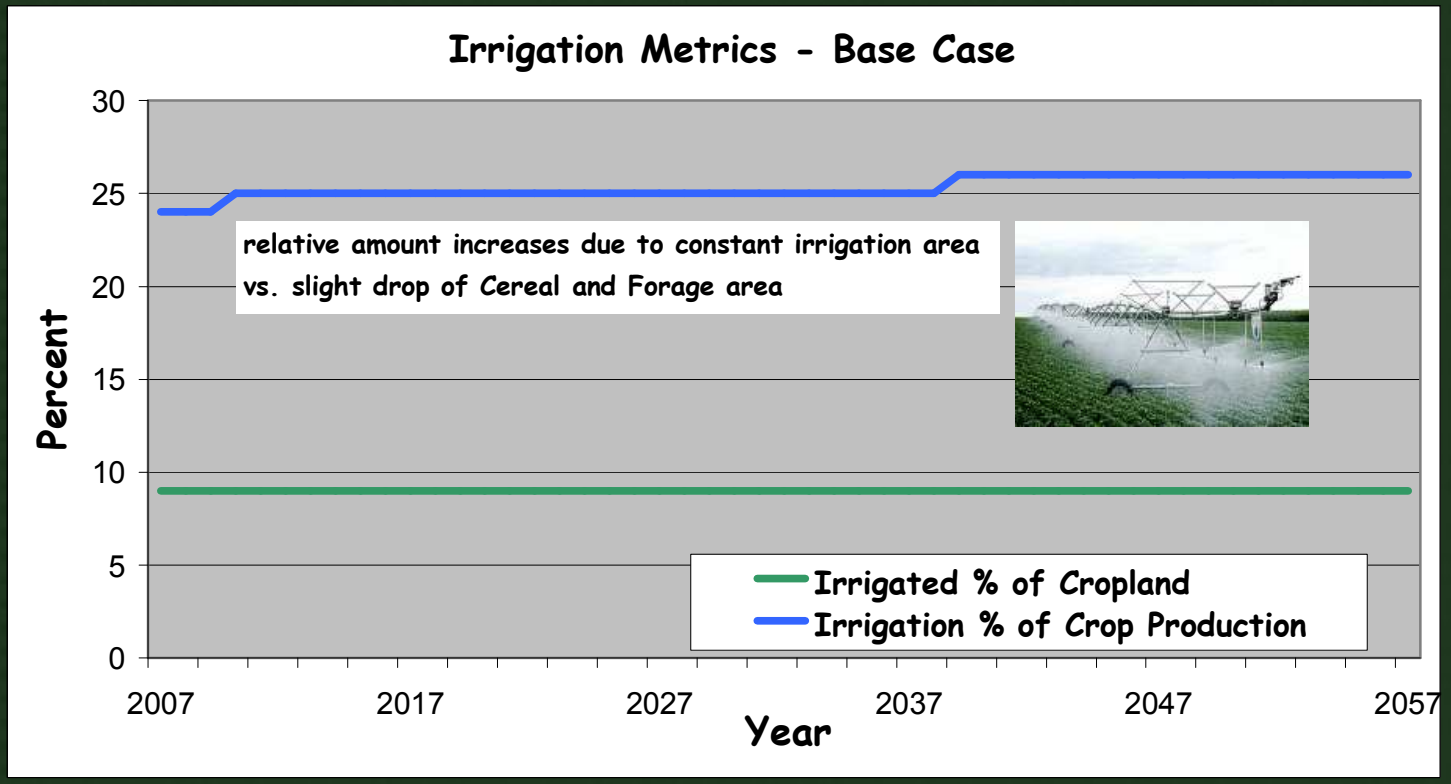
Base Case Land Use Trajectories

Agriculture

Area irrigated (9% of cultivated lands) remains unchanged over 50 years

Irrigated lands generate 25% of the cultivated production total



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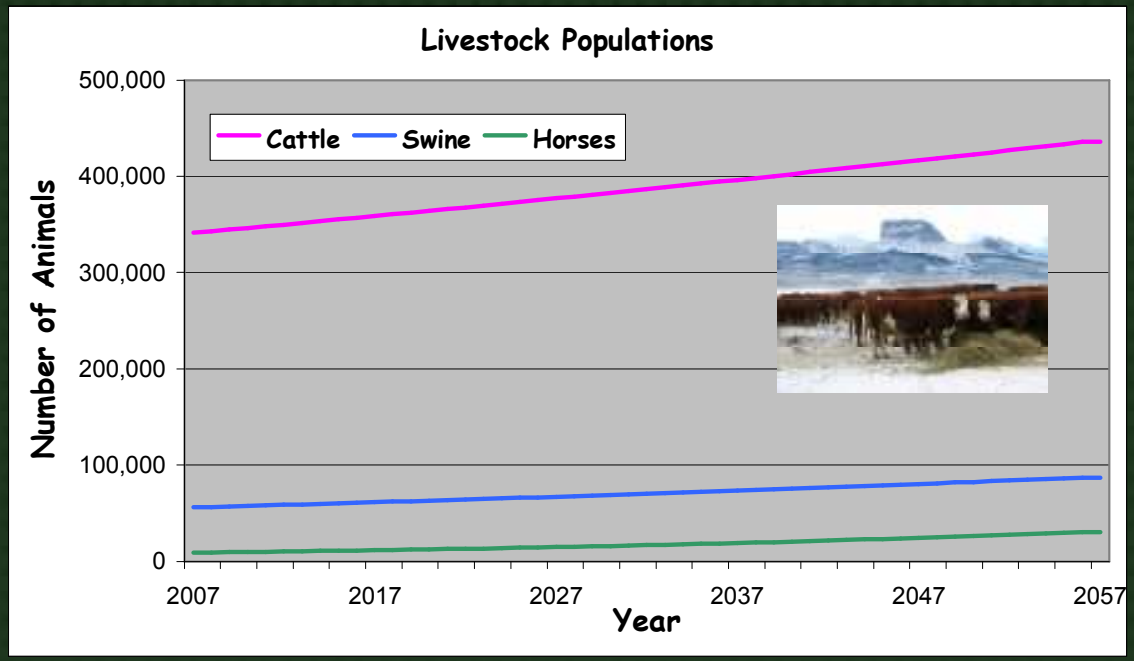
Base Case Land Use Trajectories

Livestock Total

Cattle accounts for 84% of livestock population

147,000 more livestock in the study area in 50 yrs



Livestock	Cattle	Swine	Horses
Present	341,384	56,252	9,101
2057	435,894	87,258	30,518
% Increase	28	55	235
Annual growth rate (%)	0.45	0.9	2.5

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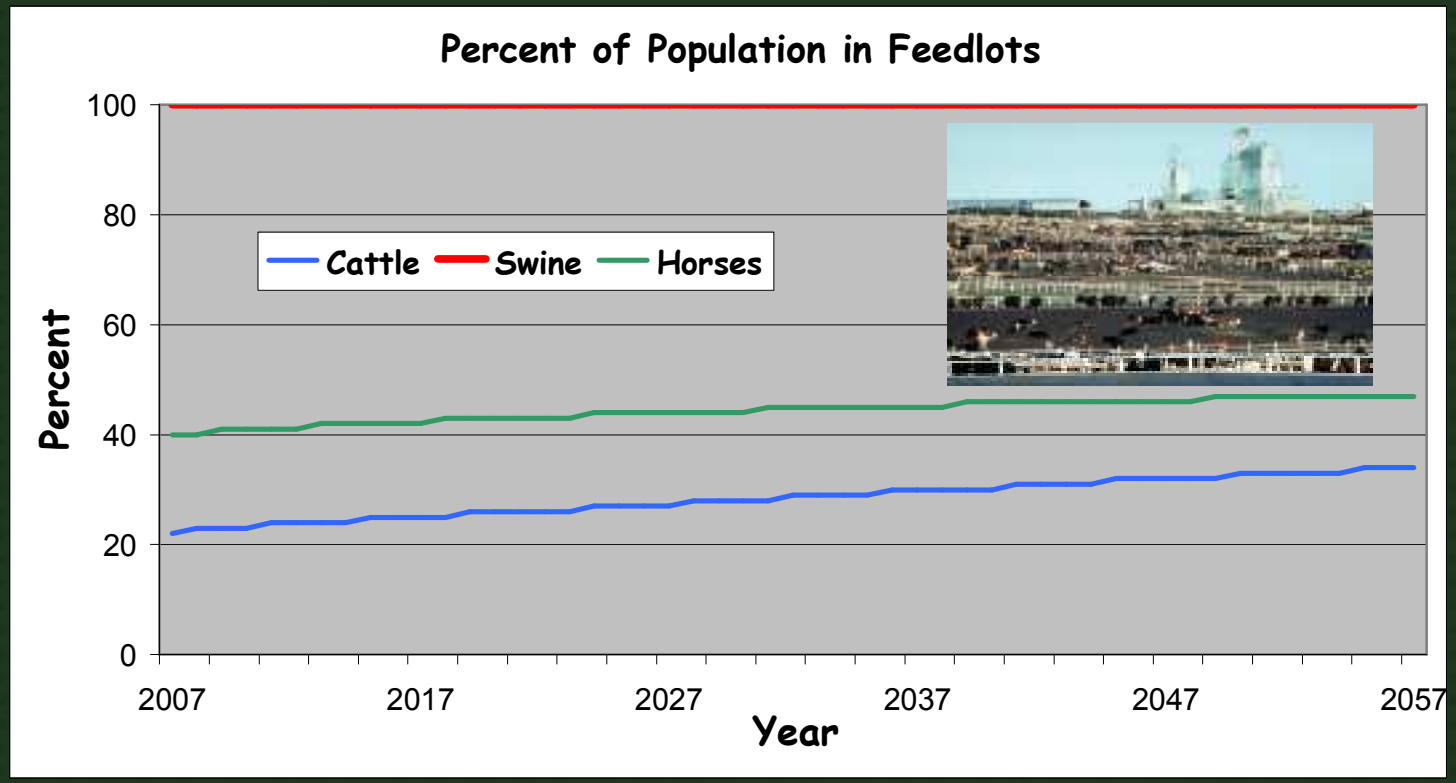
Base Case Land Use Trajectories

Livestock Feedlots

100% of swine are in feedlots

% of horse and cattle populations in feedlots increases slightly



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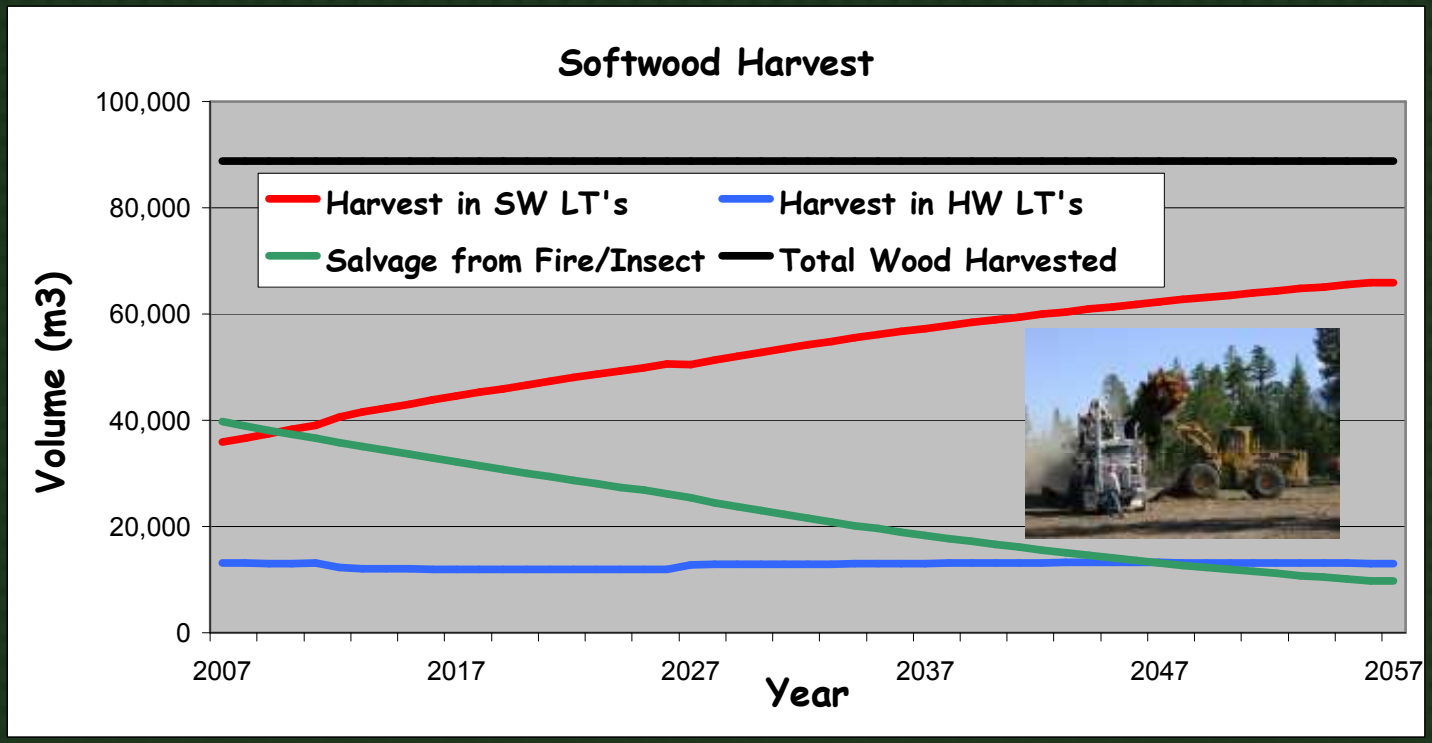
Base Case Land Use Trajectories

Forestry – Softwood Harvest

Average Annual Area Harvested 289 ha

Annual Allowable Softwood Cut is 88, 717 m^3/yr



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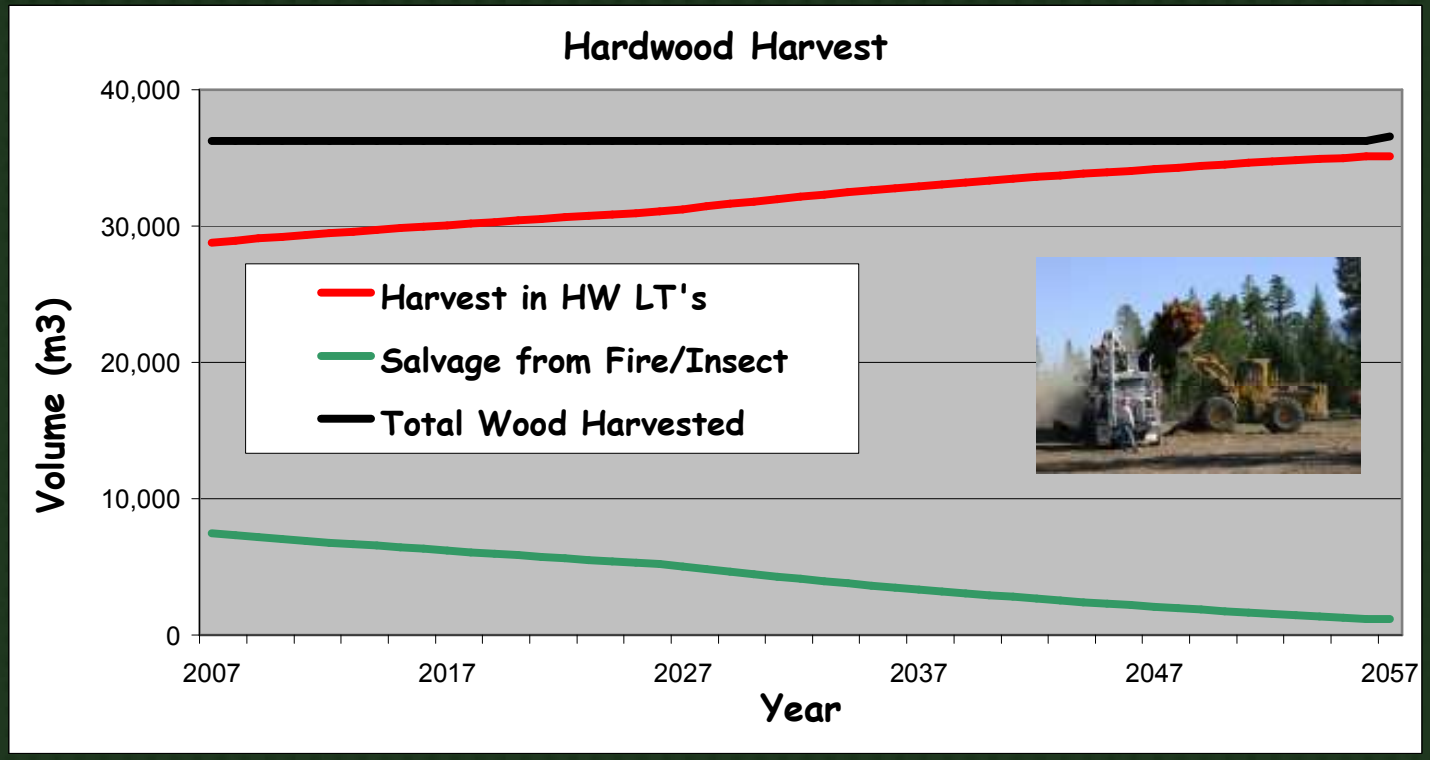
Base Case Land Use Trajectories

Forestry – Hardwood Harvest

Average Annual Area Harvested 253 ha

Annual Allowable Hardwood (Aspen) Cut is 36, 278 m^3/yr



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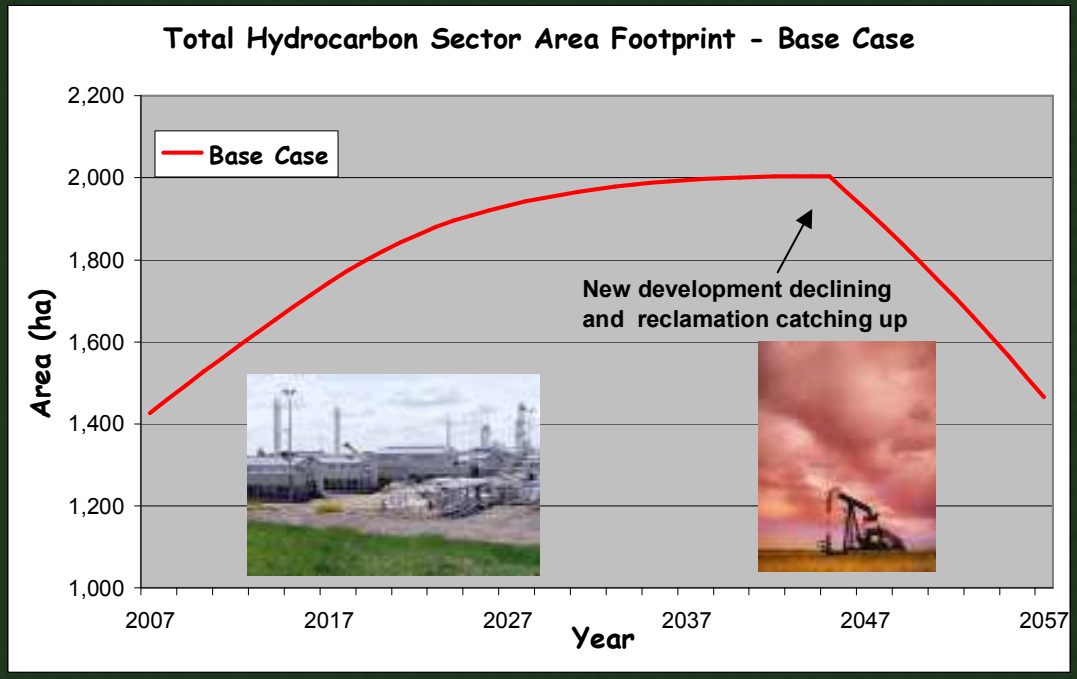
Base Case Land Use Trajectories

Hydrocarbon Sector

Conventional oil production peaks at 38,000 m^3/yr (239,000 barrels/yr) in 20 yrs

Natural gas production peaks at 370 million m^3/yr (13 billion ft^3/yr) in 20 yrs

CBM production peaks for 20 yrs (starting in 2027) at 23 million m^3/yr (815 million ft^3/yr)



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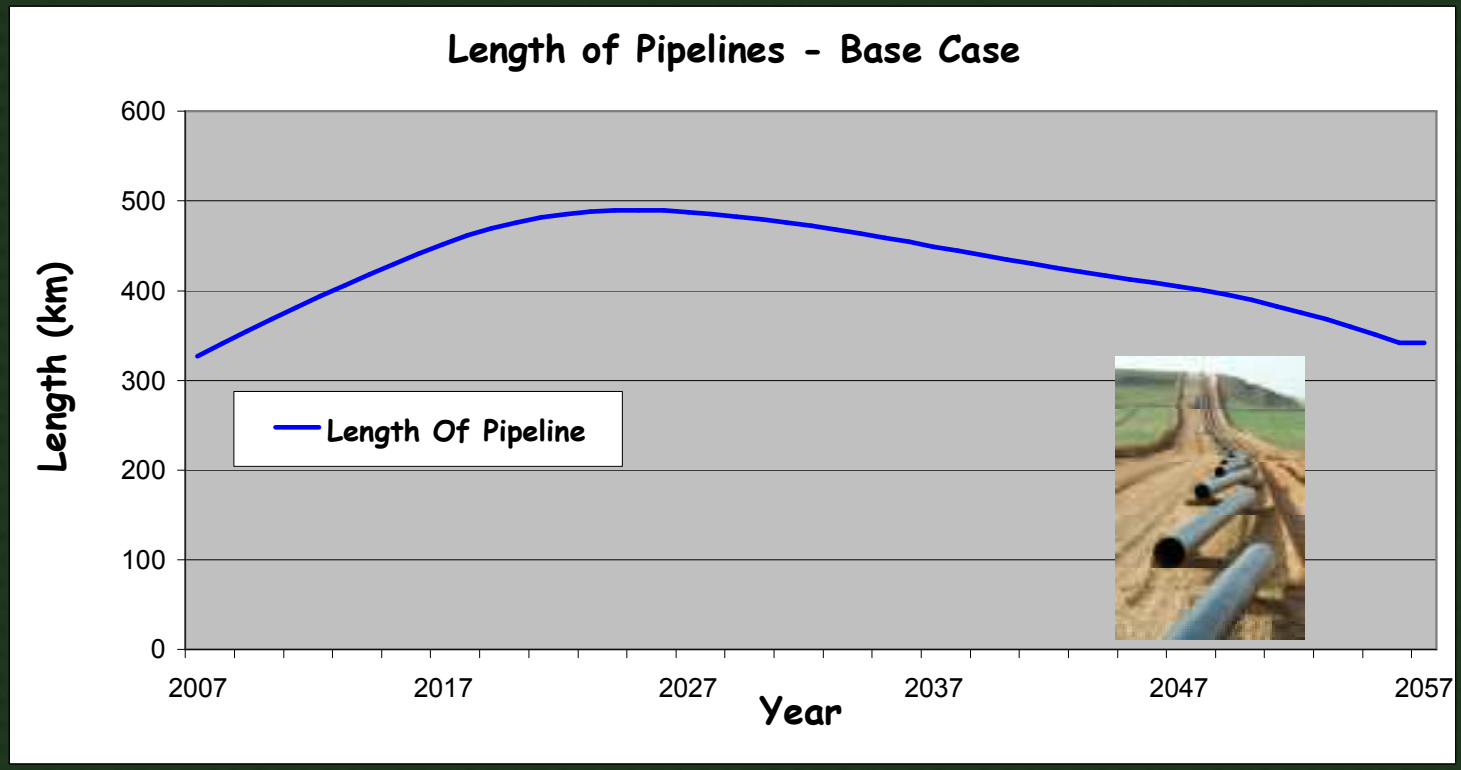
Base Case Land Use Trajectories

Hydrocarbon Sector Infrastructure

Pipelines immediately reclaimed on cultivated lands - 35 yr lifespan elsewhere

Pipelines follow production trajectories



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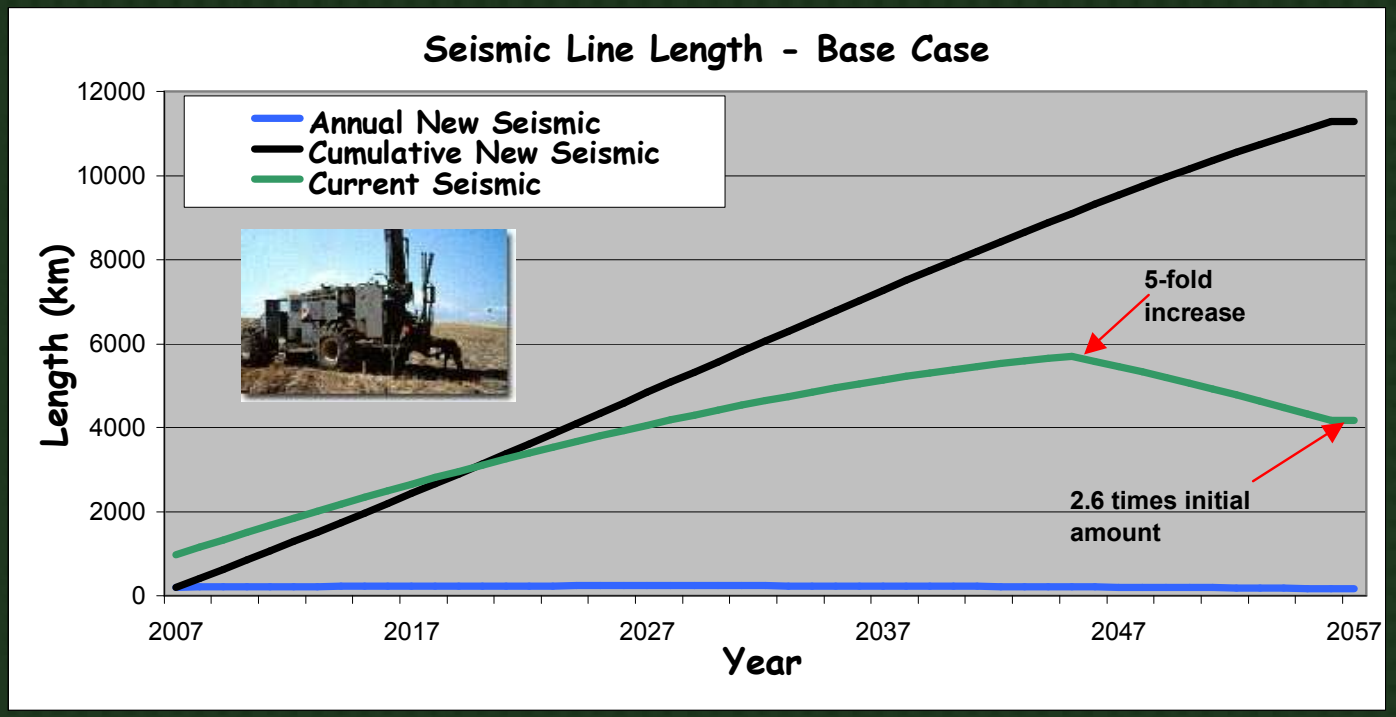
Base Case Land Use Trajectories

Hydrocarbon Sector Infrastructure

Seismic immediately reclaimed on cultivated lands - 37.5 yr lifespan elsewhere

Seismic is independent of production trajectories – includes all exploration



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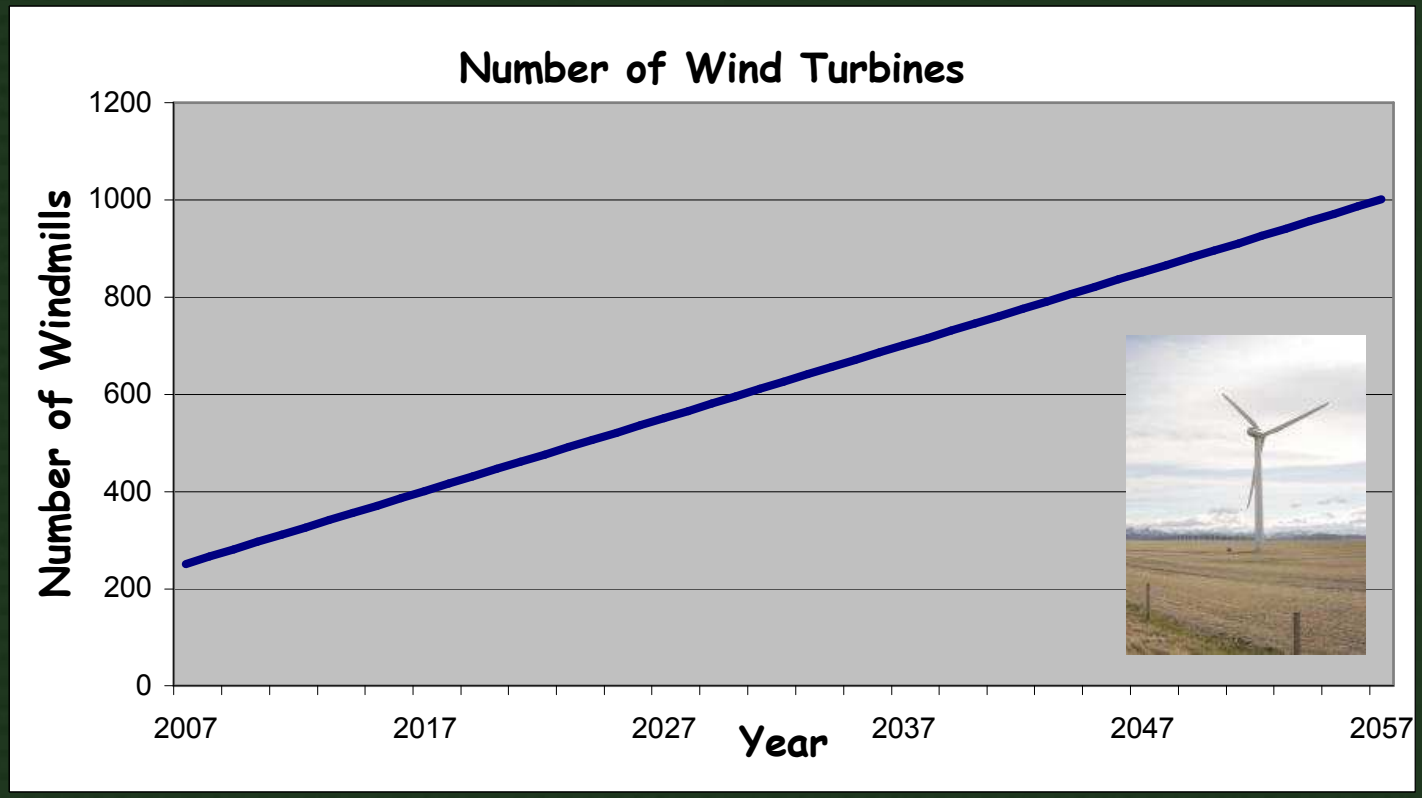
Base Case Land Use Trajectories

Wind Energy Infrastructure

Projected to grow at a rate of 15/year for the next 50 years

Currently 251 windmills; 1,001 in 50 yrs



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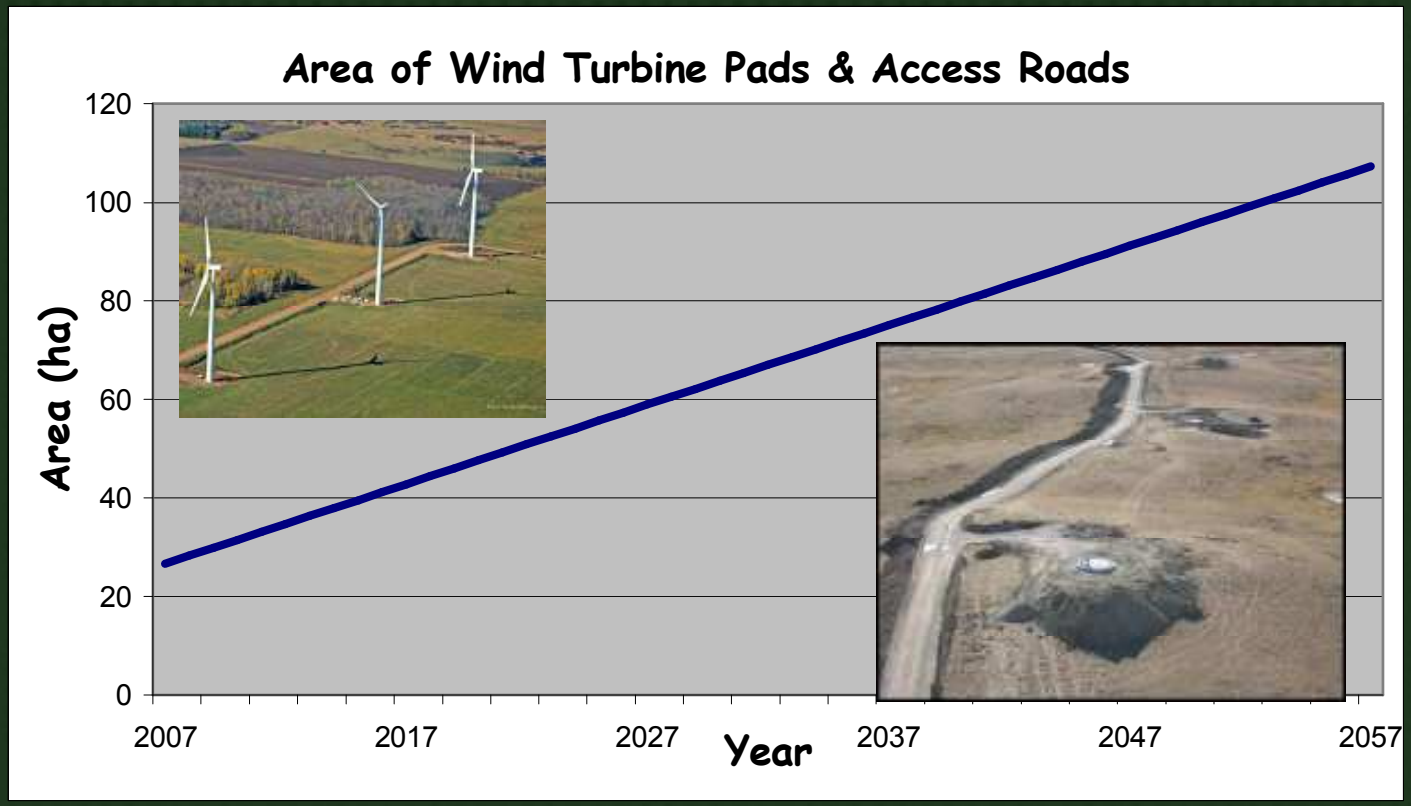
Base Case Land Use Trajectories

Wind Energy Infrastructure

Footprint area projected to increase 300% (85 ha / 210 ac)

Includes all access roads and pads.



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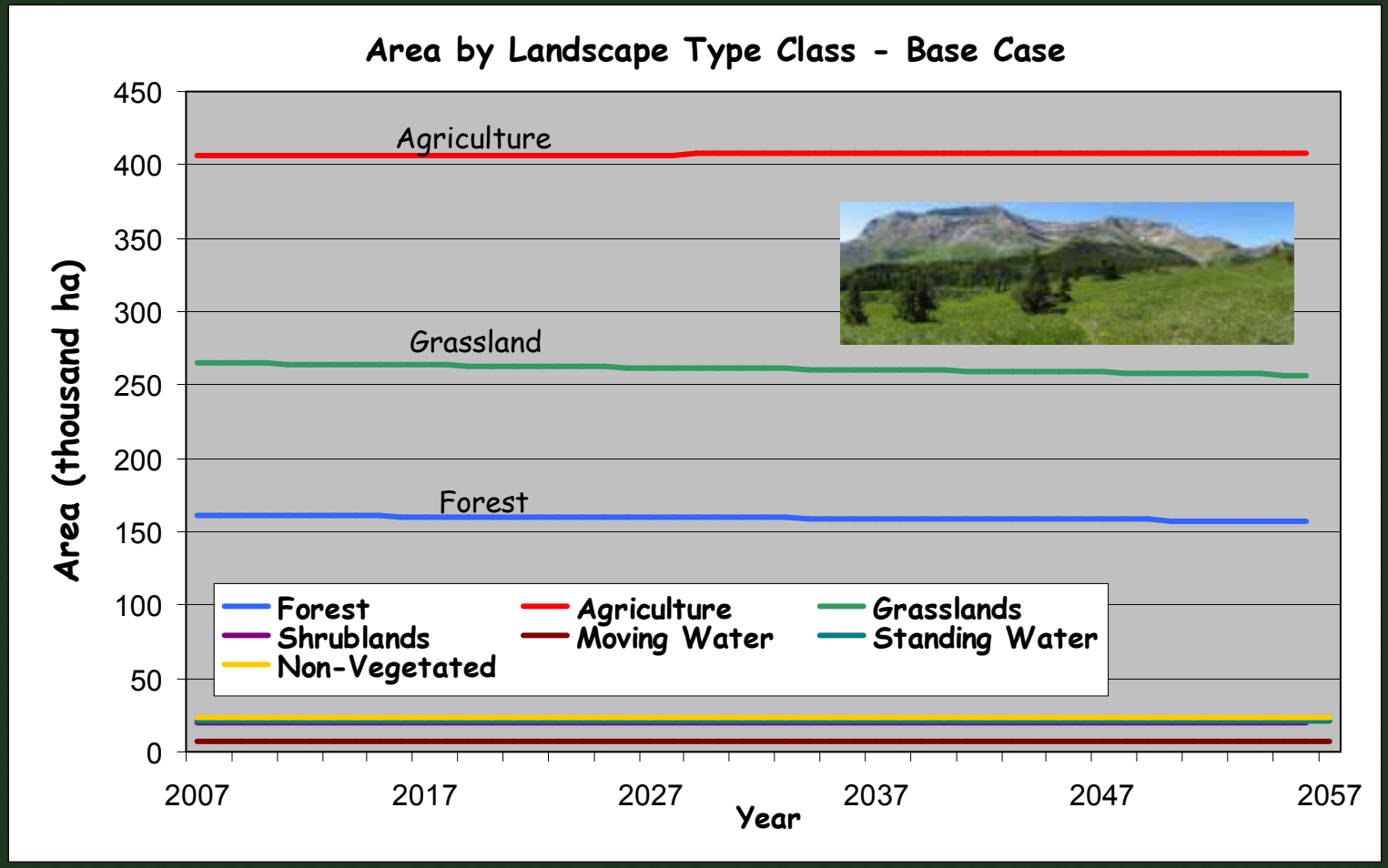
Base Case LT Composition

small change in landscape composition in the next 50 years



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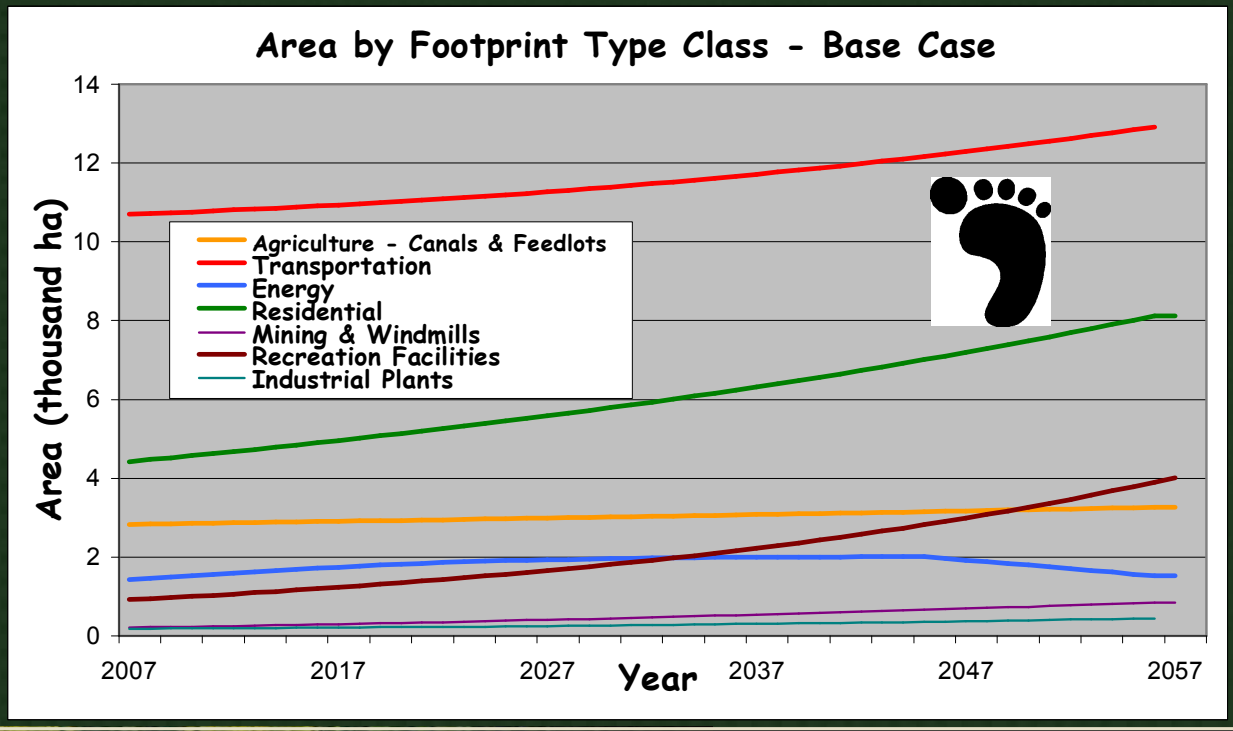
Base Case Footprint Growth

Transportation initially accounts for 47% of all footprint and twice the second highest - residential

All FT's increase over entire projection except energy which peaks 40 years from now

Of all footprints, residential is expected to experience the most growth



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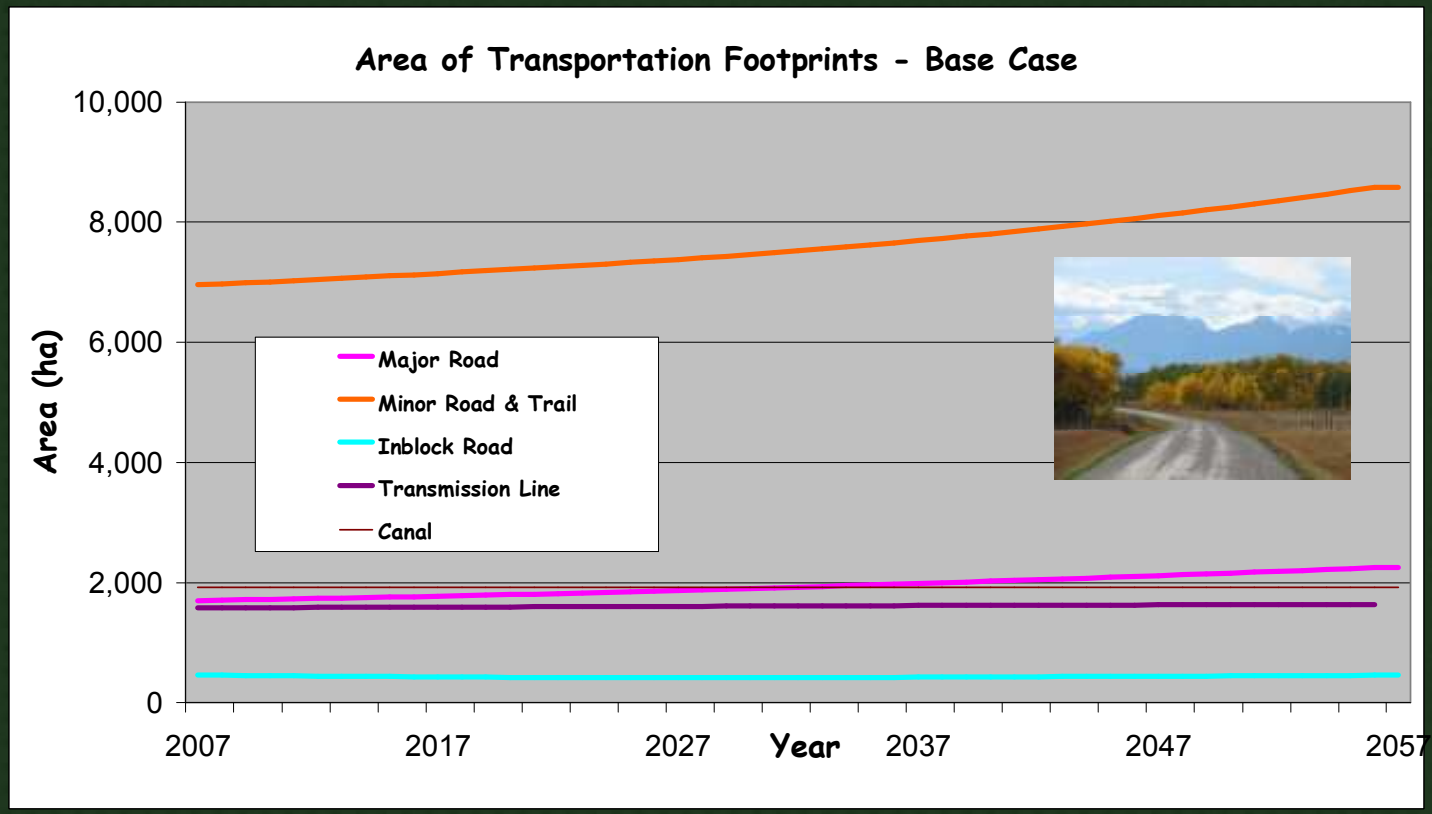
Base Case Transportation FT Growth

Area of minor roads and trails greater than all other transportation combined (65%)

Total transportation footprint area increases by 26%



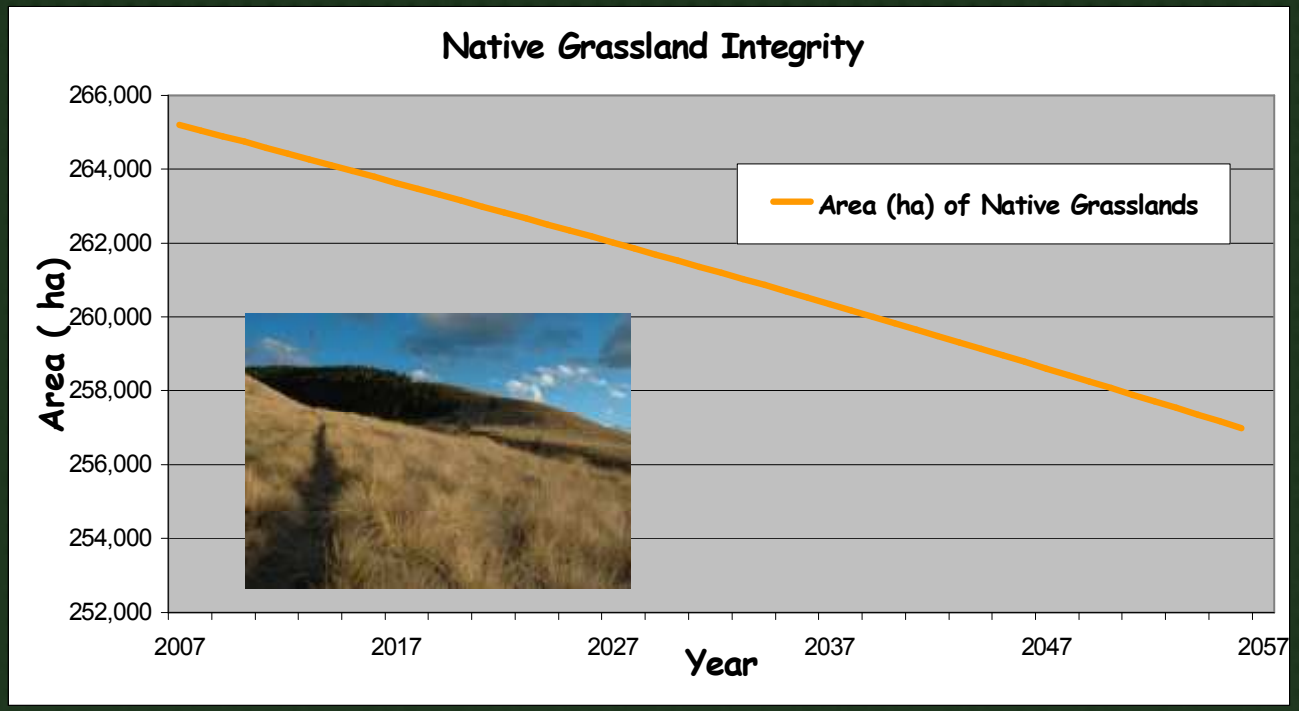
Base Case Indicators

Base Case Indicators

Native Grassland Integrity (Area)

Comprised of mixed grass, fescue and fescue parkland

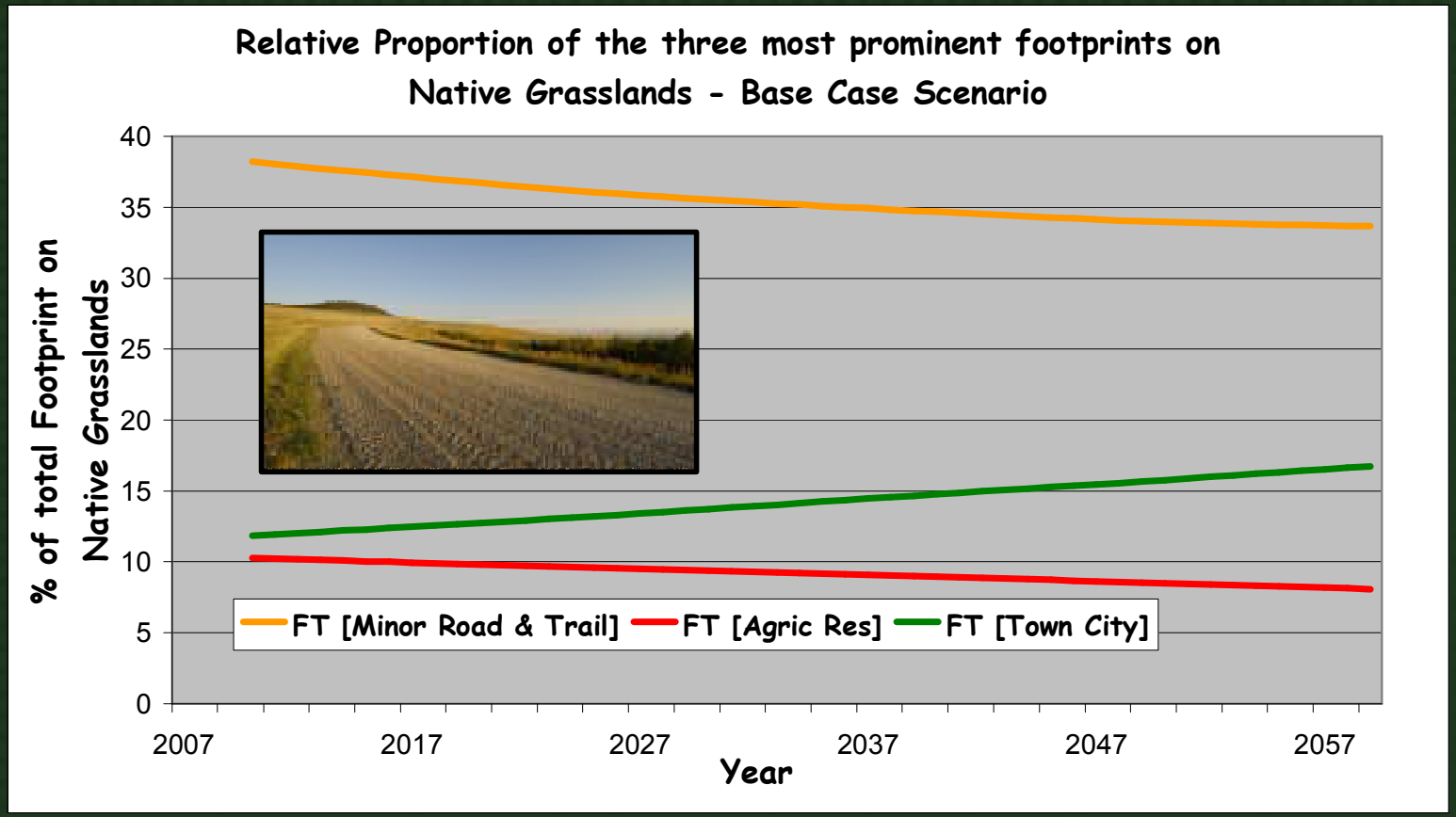
3% (8,000 ha/20,000 ac) decline over the next 50 years (80% due to invasive plants, 20% from footprint)



Base Case Indicators

Native Grassland Integrity

Footprint that contributes most to Grassland loss is minor roads and trails



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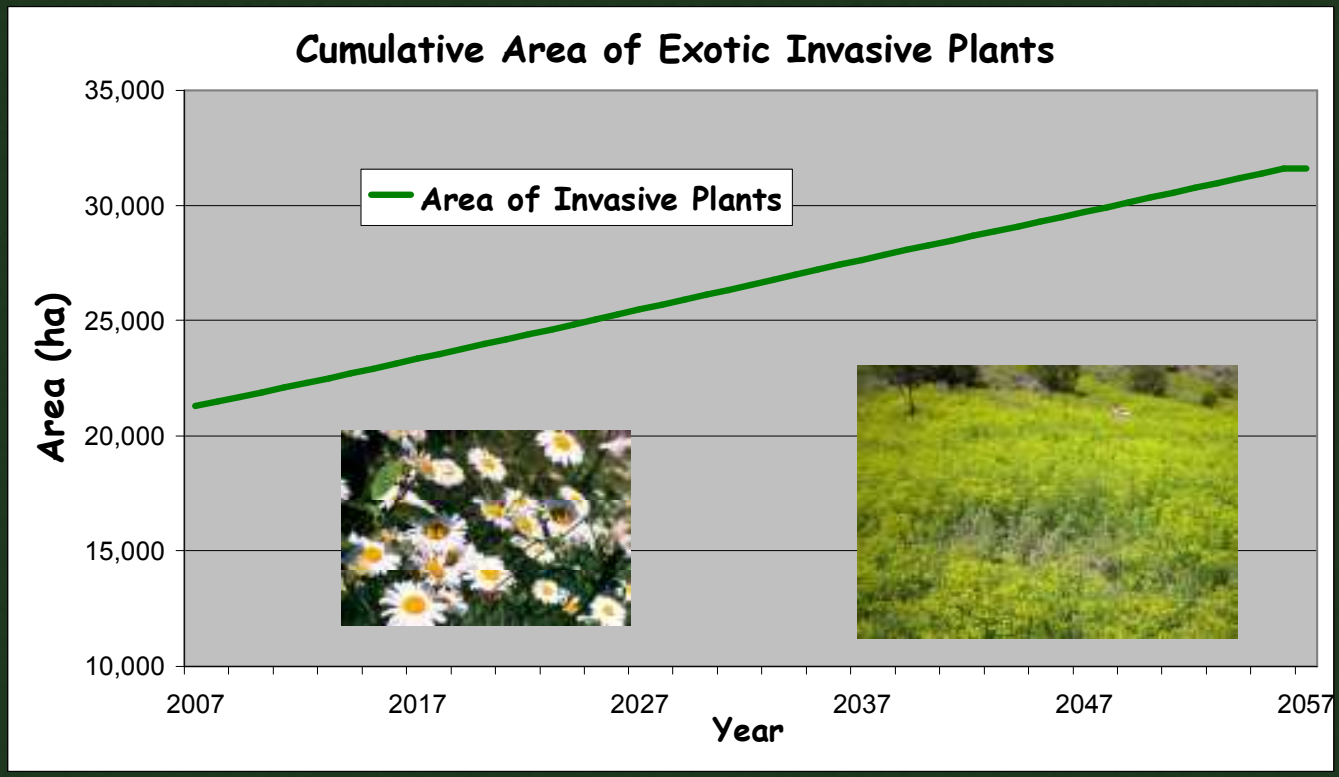
Base Case Indicators

Exotic Invasive Plants

Spread from all footprints, but only establish on Grasslands, Pine, Forest shrubs, and Grassland shrubs (48% increase over 50 years)

Continue to spread after footprints have been reclaimed



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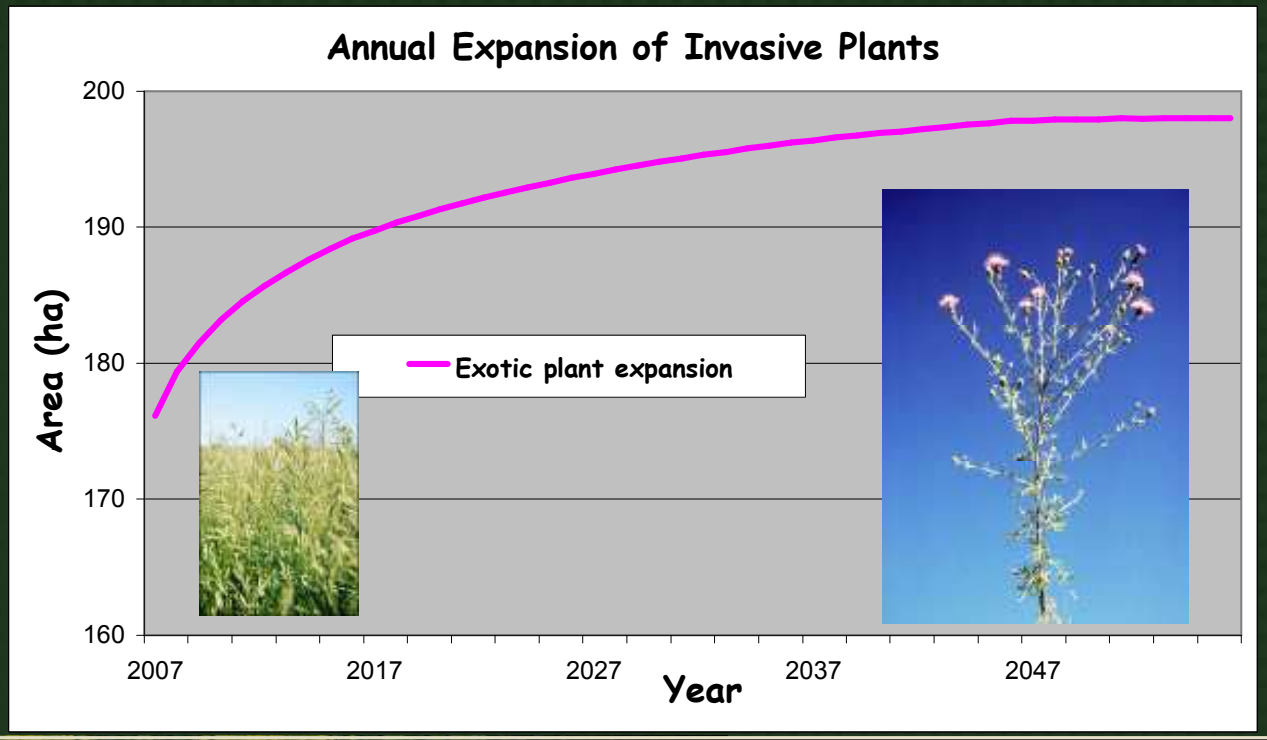
Base Case Indicators

Exotic Invasive Plants

On average, 193 ha (477 ac) of native LT's are converted annually to tame pasture by invasive plants

Annual growth of invasive plants increases more rapidly in the first 15 years due to oil & gas development



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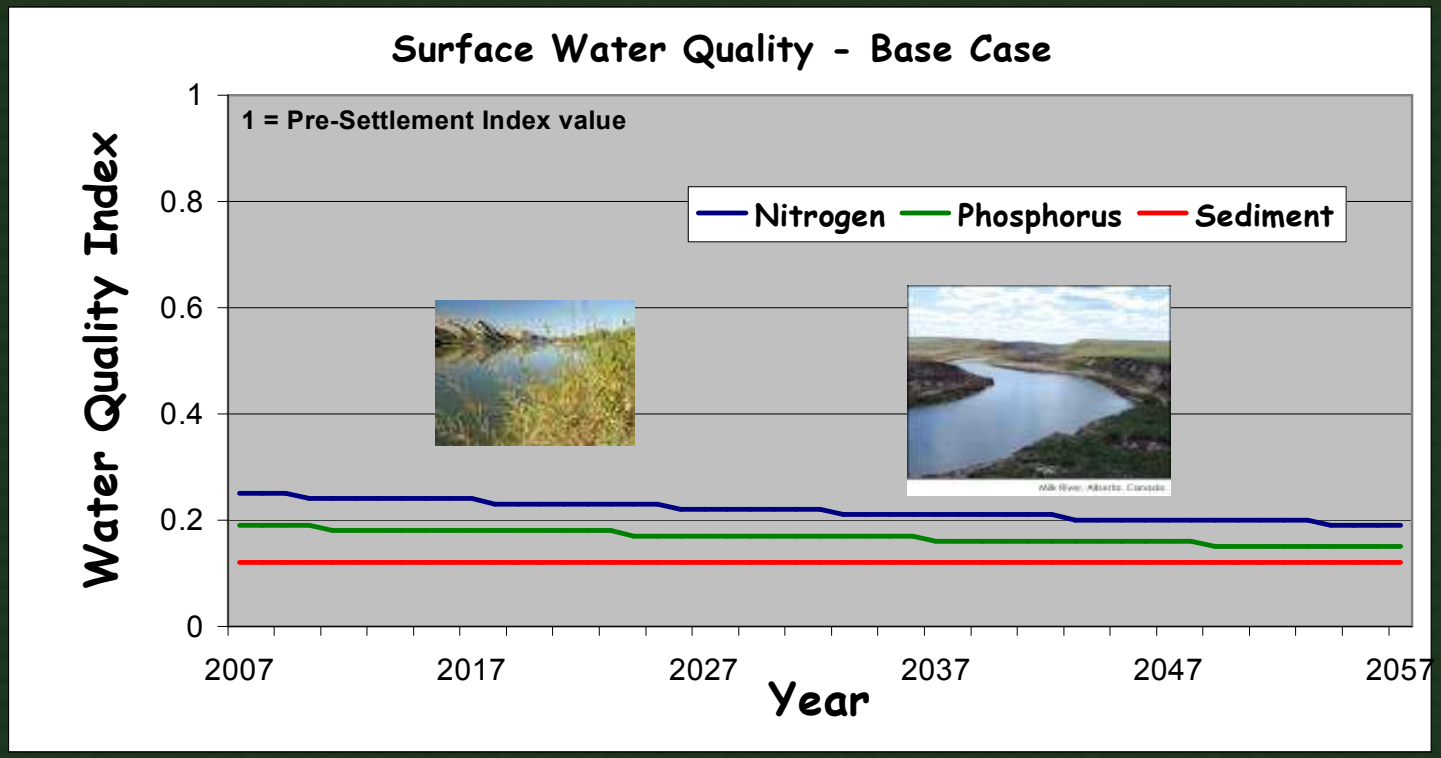
Base Case Indicators

Surface Water Quality

21% ⇧ N 24% ⇧ P over 50 years from increases in # humans and livestock

Nutrient loading is already 5x pre-settlement levels and sediment loading 10x



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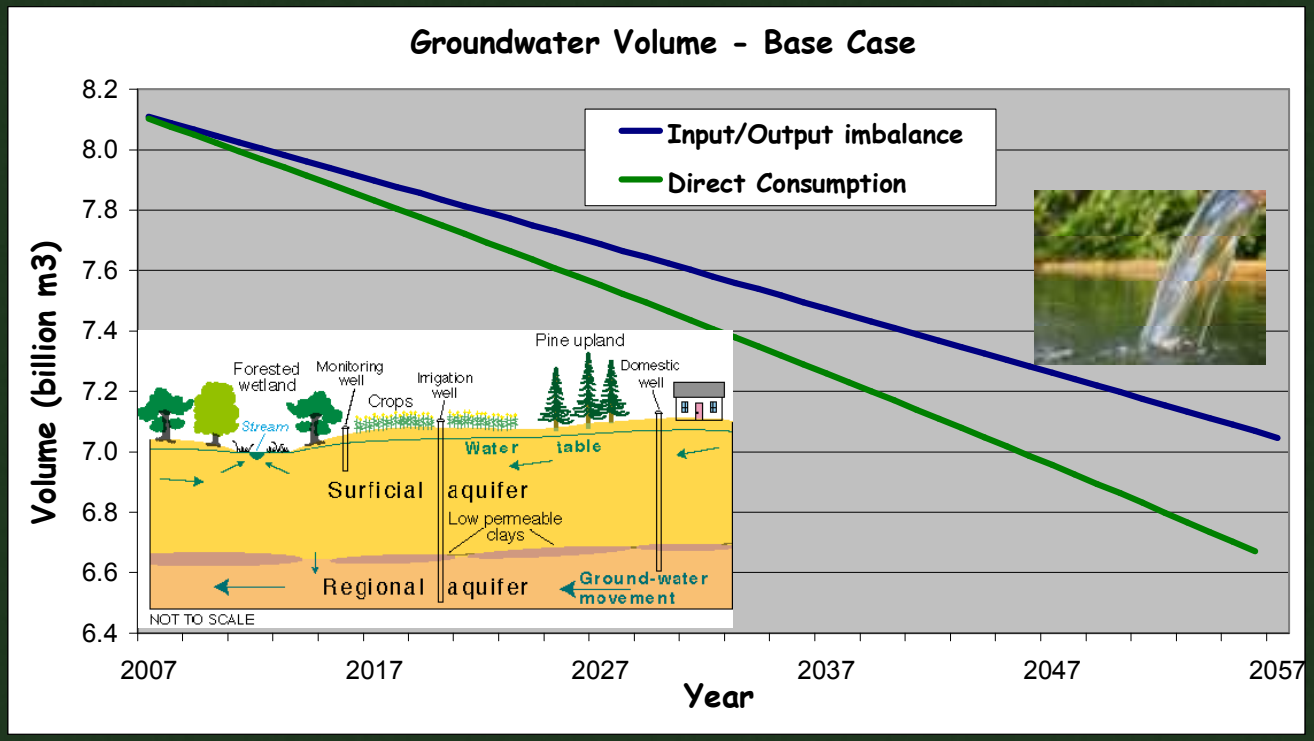
Base Case Indicators

Groundwater Budget

Approximately 13% (1 billion m^3) decline due to aquifer input/output imbalance, a further 5% (0.4 billion m^3) decline with direct consumption



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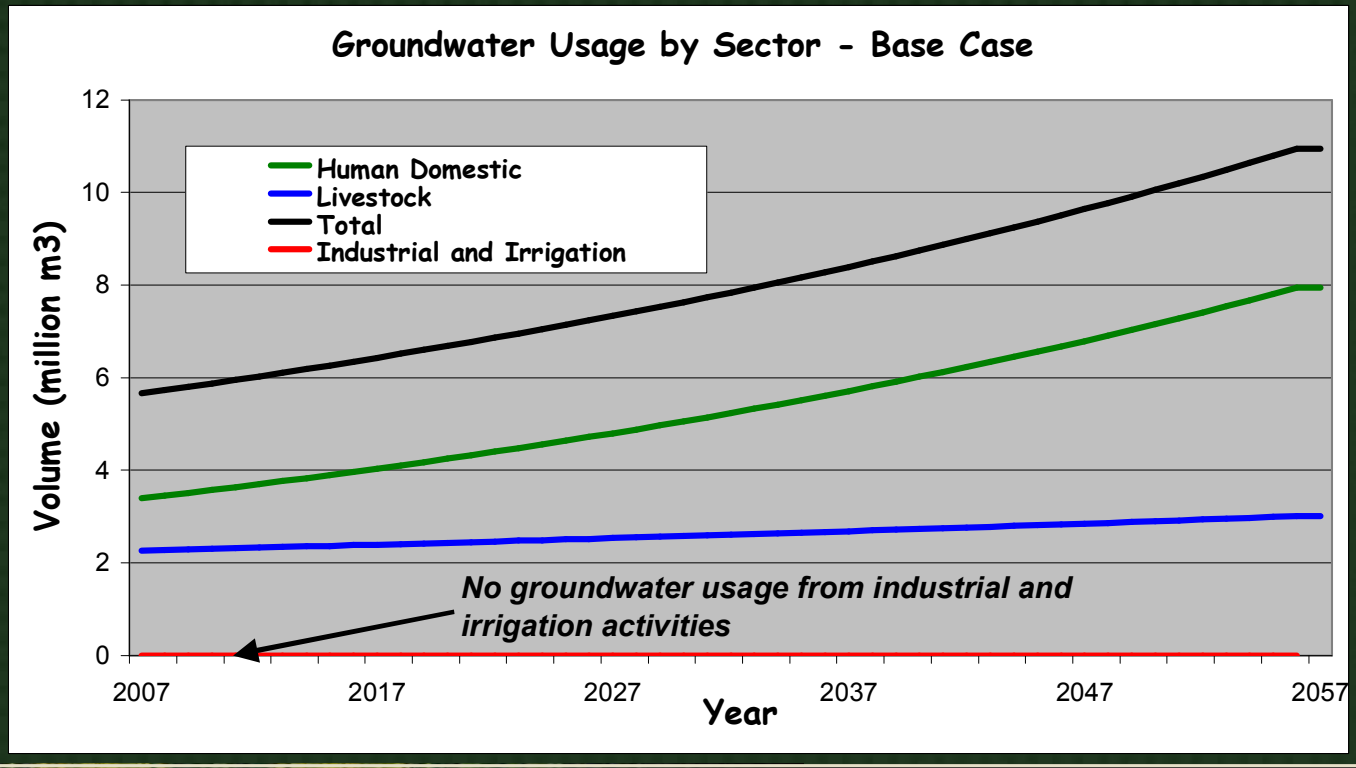
Base Case Indicators

Water Demand (Groundwater)

Total groundwater usage doubles in 50 years.

Humans use roughly 2 times more groundwater than livestock – this difference increases over time.

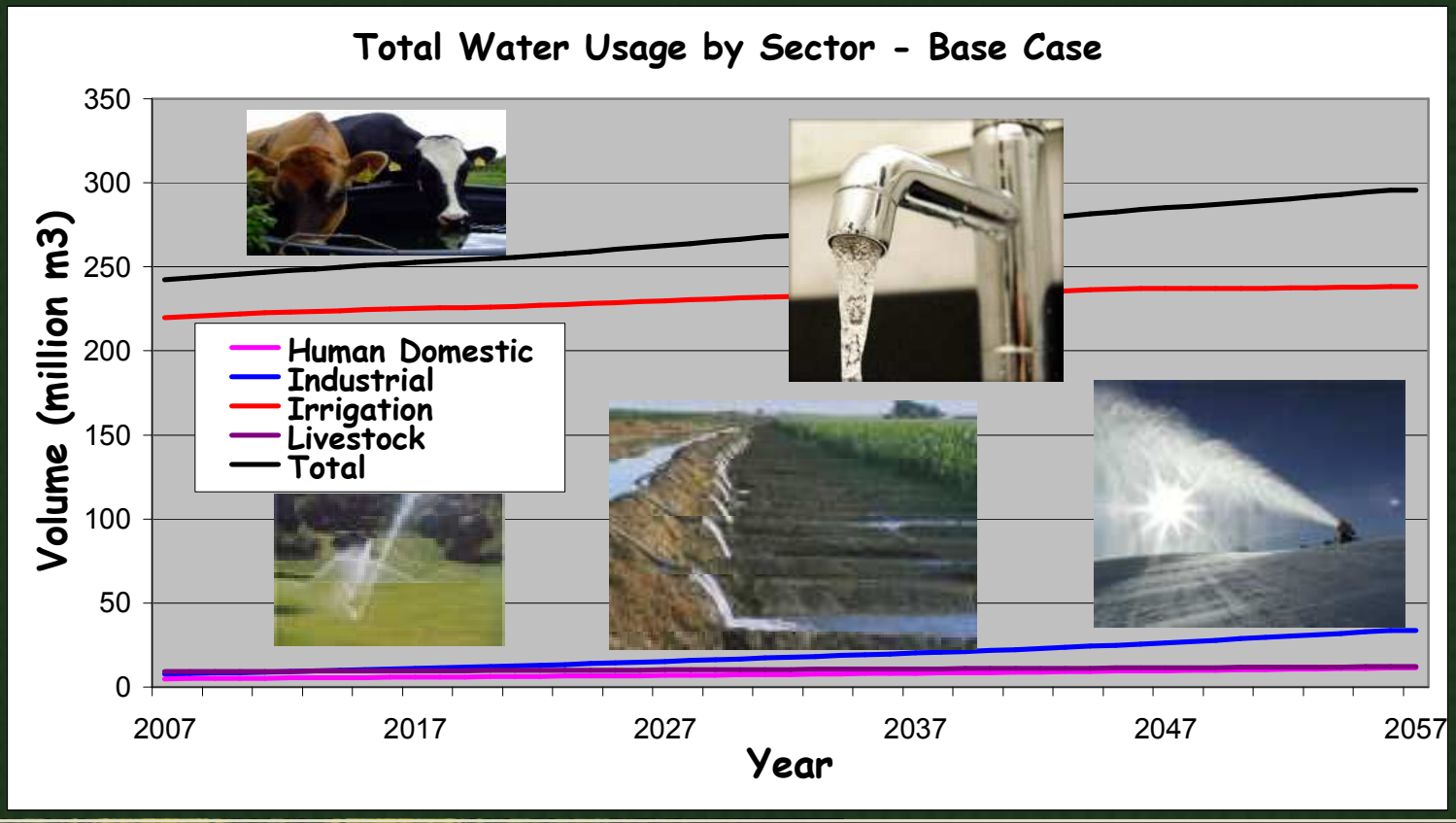


Base Case Indicators

Water Demand (Total)

97% of all water used comes from rivers, lakes, and reservoirs (surface)

Irrigation uses more water than all other land-uses combined.



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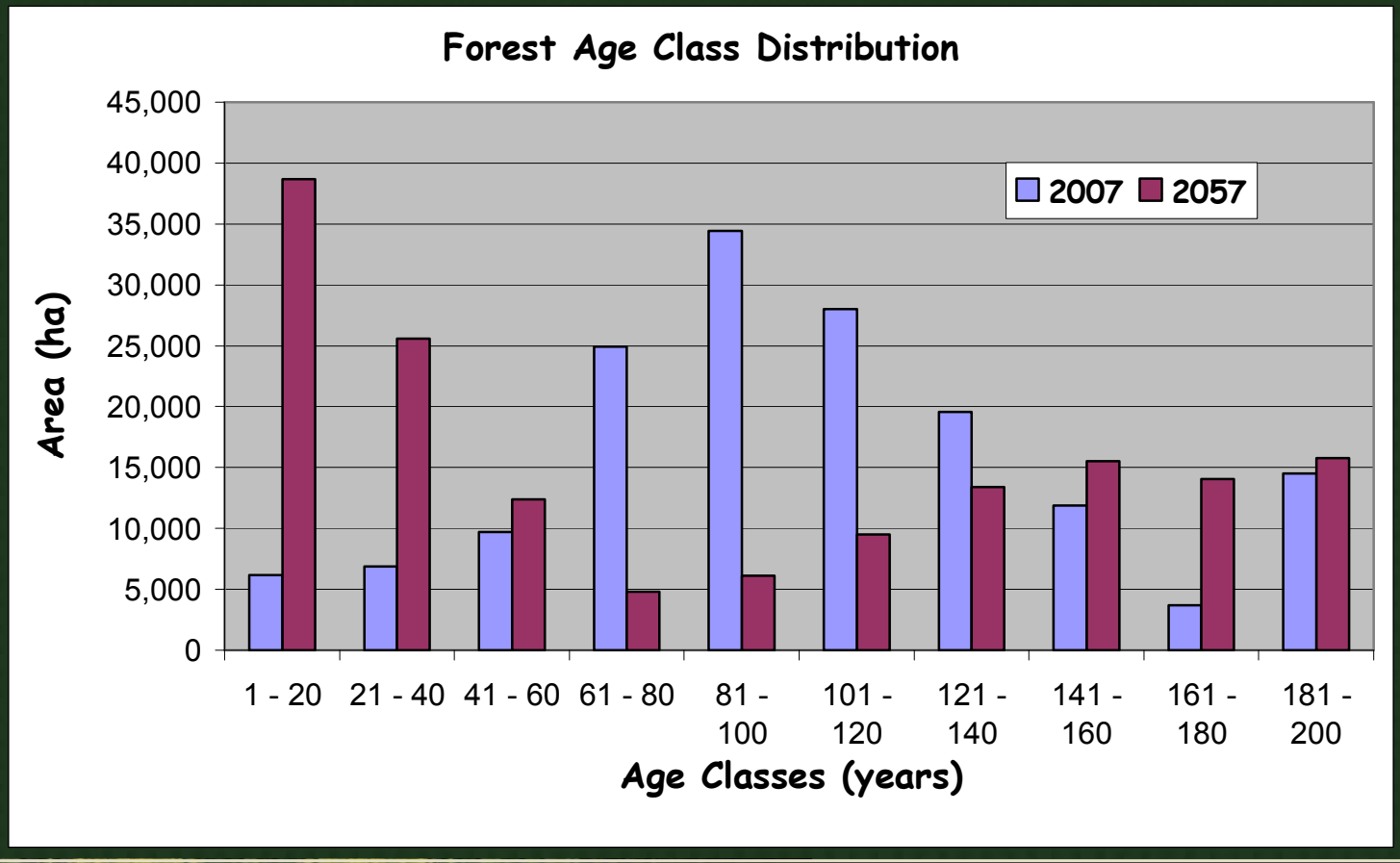
Base Case Indicators

Forest Age

General shift from 'middle-aged' forest to 'young & old' forest

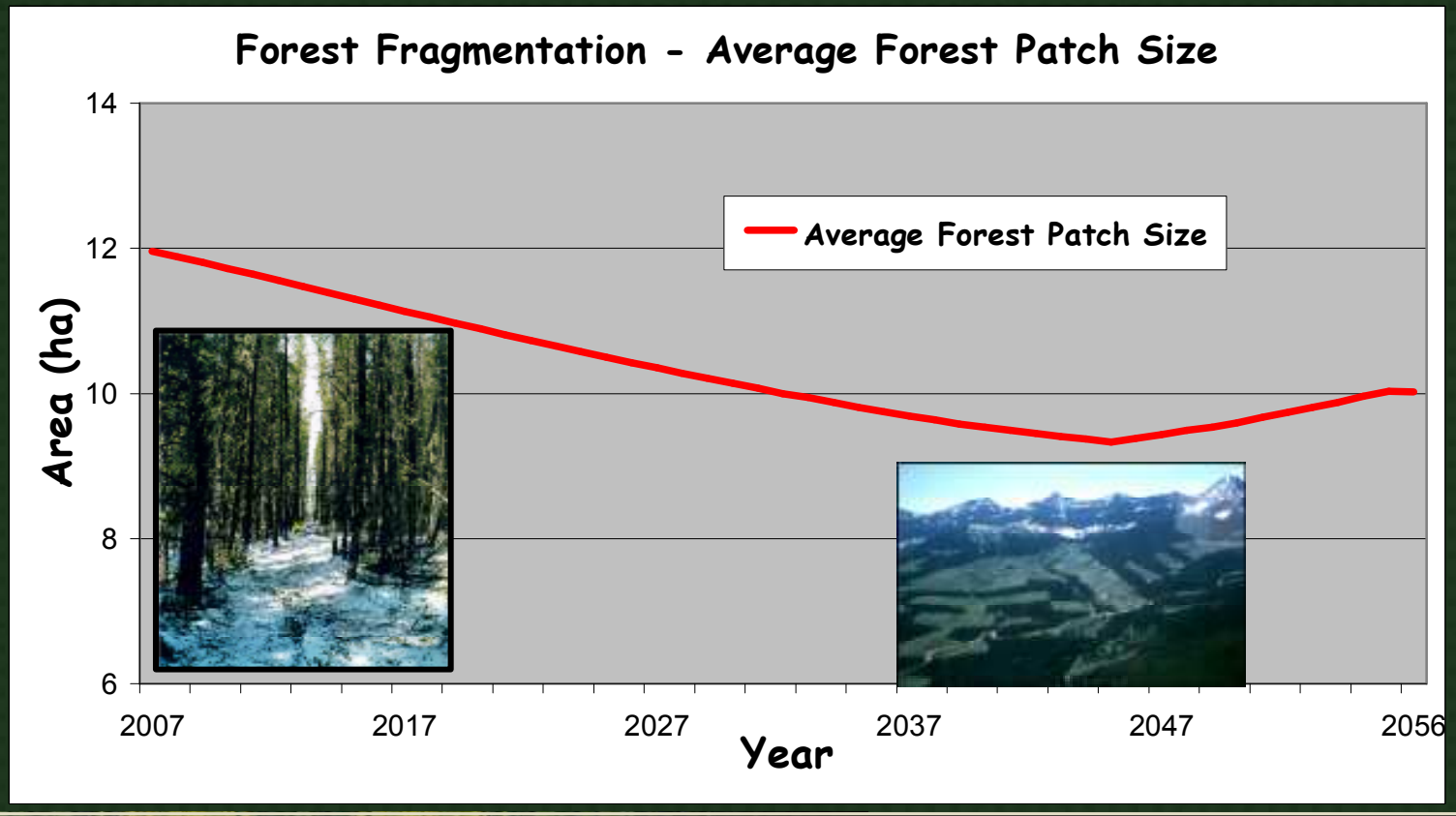


Base Case Indicators

Forest Patch Size

Average forest patch size is forecasted to be 16% less by 2057 than now.

Key driver for this decrease is construction of seismic lines



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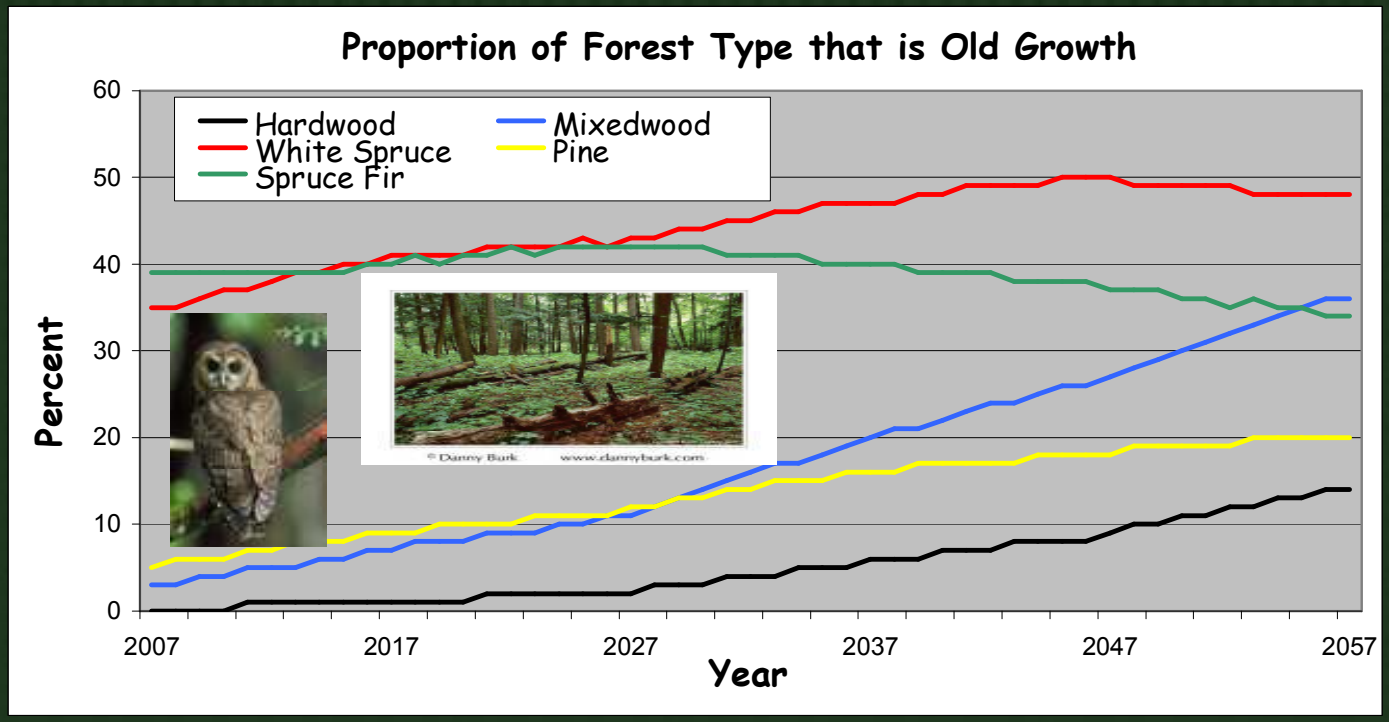
Base Case Indicators

Forest Age Class Distribution

Amount of forest in older age classes increases due to initial age class structure

Key important habitat for many forest birds, mammals, and plants

Largest increase in Mixedwood, Spruce-Fir is the only forest LT that decreases



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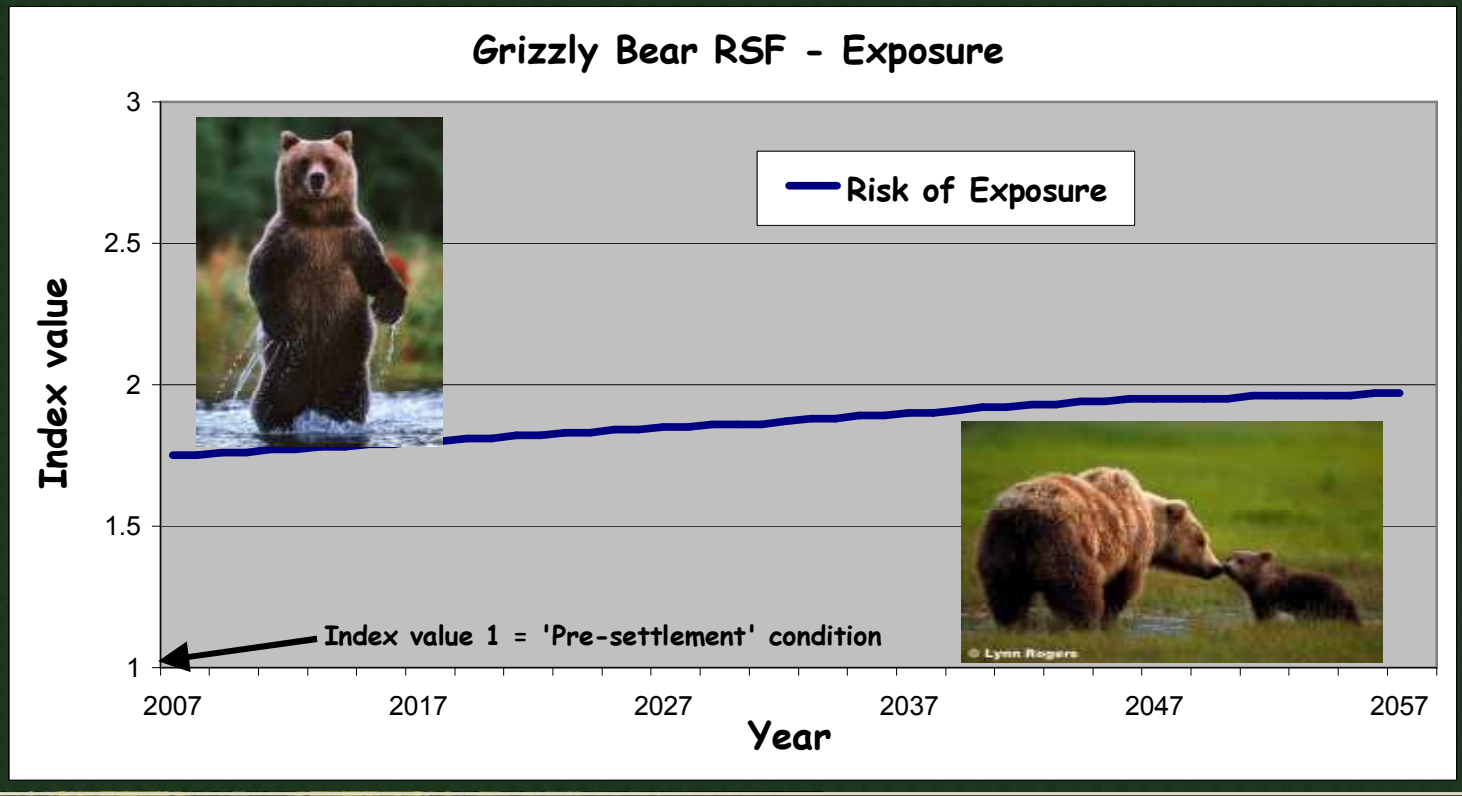
Base Case Indicators

Grizzly Bear Resource Selection Function (RSF)

Keystone species – indicative of other wildlife species performance

13% increase in Exposure Index, i.e., negative impact on habitat utility

Increase in exposure risk due to transportation and residential developments



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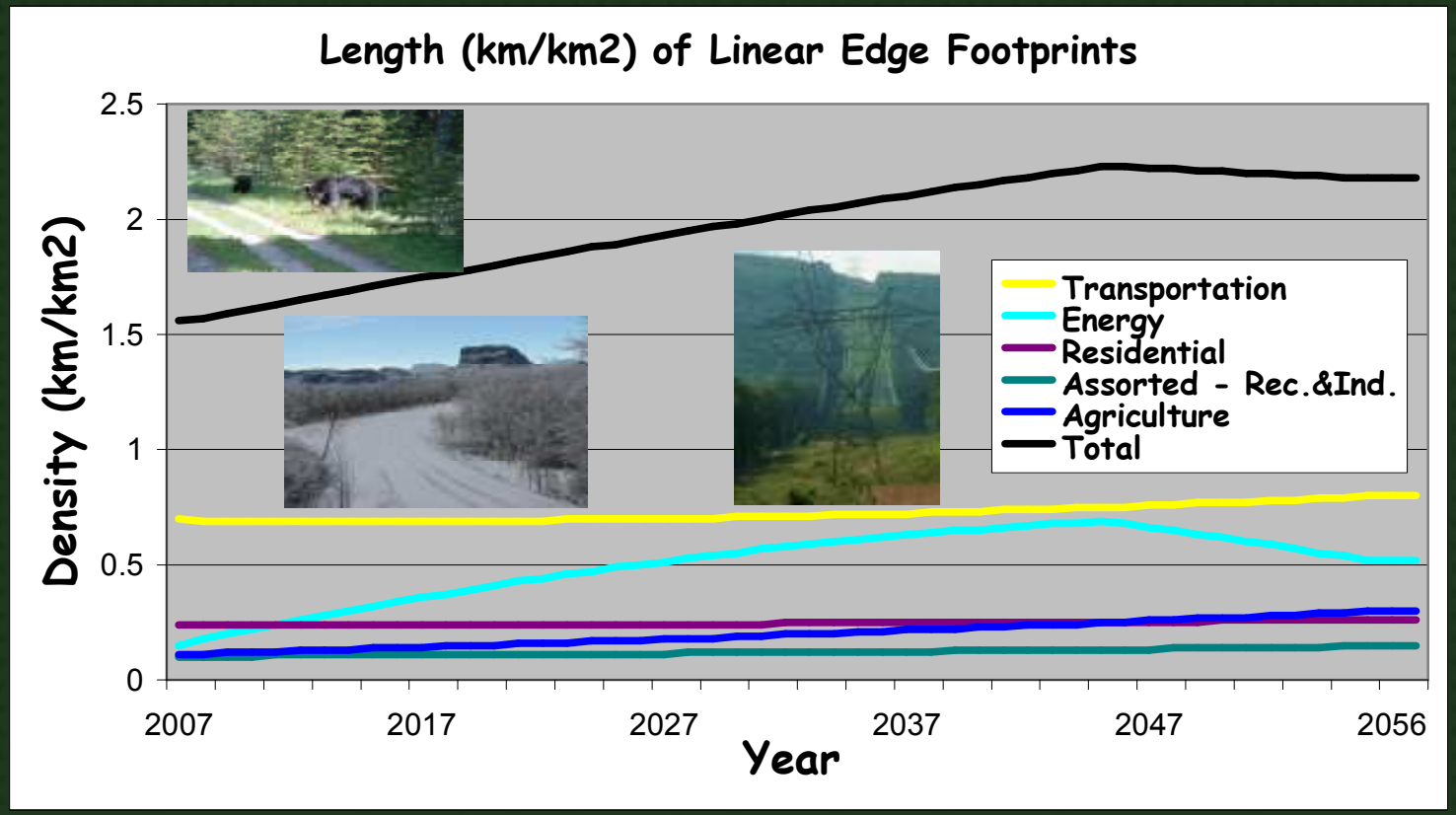
Base Case Indicators

Linear Edge Density

Transportation and Energy Sectors are Major Contributors

Increase (38%) stops around 2047 because of decreased oil & gas activity



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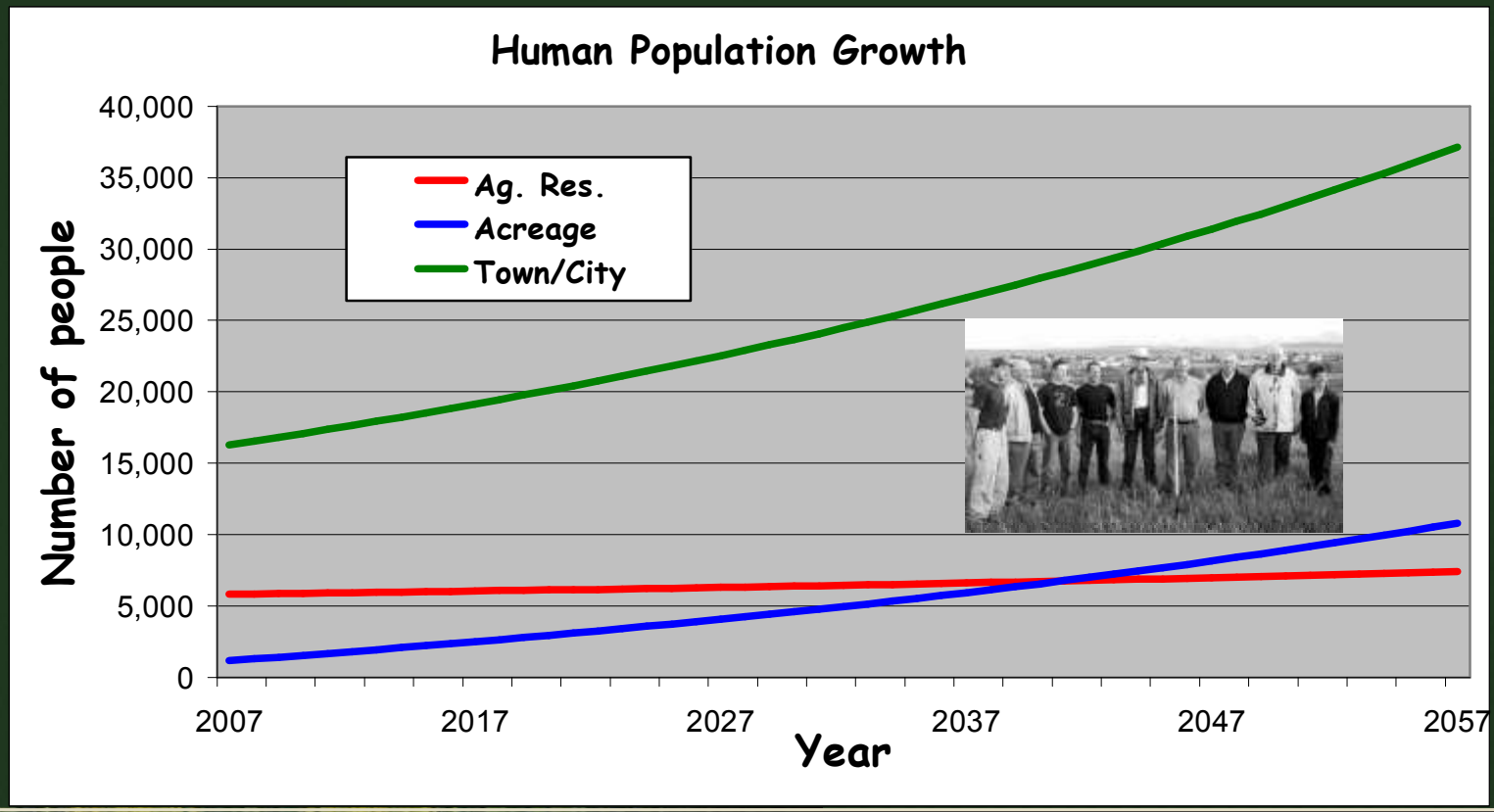
Base Case Indicators

Human Populations

More people in Acreages than Agricultural residences by 2040

Population growth highest in acreages (828%), lowest in Ag. Residences (28%). Population in towns increases 128%



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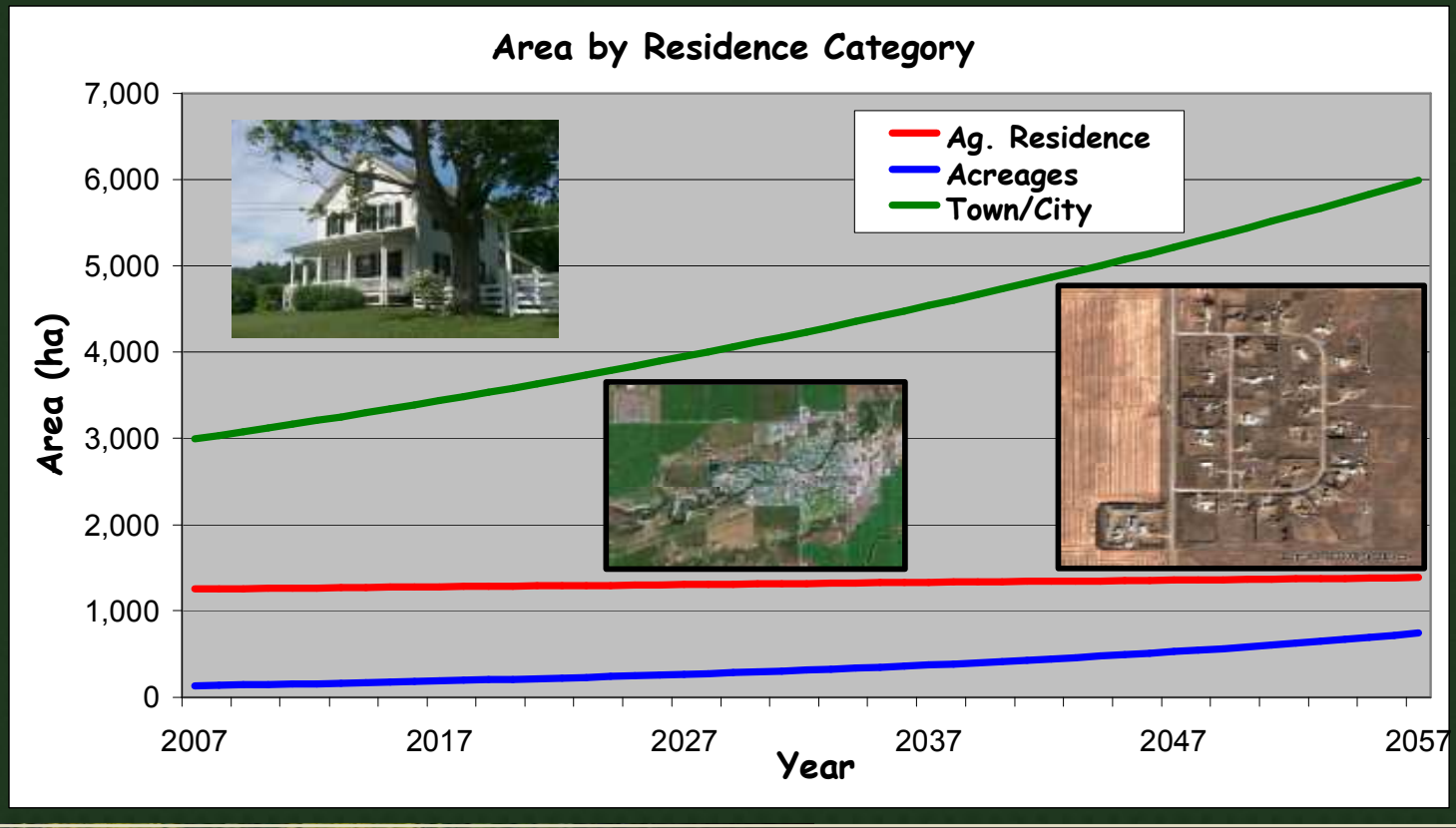
Base Case Indicators

Human Residence Footprint

Area in acreages rapidly catching up to agricultural residences

Area in towns doubles and is more than twice Ag. Residences & Acreages combined.



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BASE CASE ANALYSIS

Overall Summary of Changes to Indicators

Invasive plants are continuing to expand

Forest Patch Size & Linear Edge Density decreases stabilize after 2045 (Oil & Gas reclamation)

	Performance from year 2007-2017	Performance from year 2018-2037	Performance from year 2038-2057
Native Grassland Integrity	-	-	-
Exotic Invasive Plants	+++	++	+
Groundwater Budget	-	-	-
Surface Water Quality	-	-	-
Forest Patch Size	-	-	
Linear Edge Density	+	+	
Grizzly Bear	-	-	-

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SENSITIVITY ANALYSIS

Allows us to assess the elasticity of indicators & footprint metrics in response to changes in a specific model assumption or land-use trajectory.

Helps us to assess the 'cumulative effects' of different forecasted levels of land use.

Helps us to assess risk associated with uncertainty in the model, and explore "what-if" scenarios.

SENSITIVITY ANALYSIS

Three sensitivity analyses were investigated for the Chief Mountain Study:

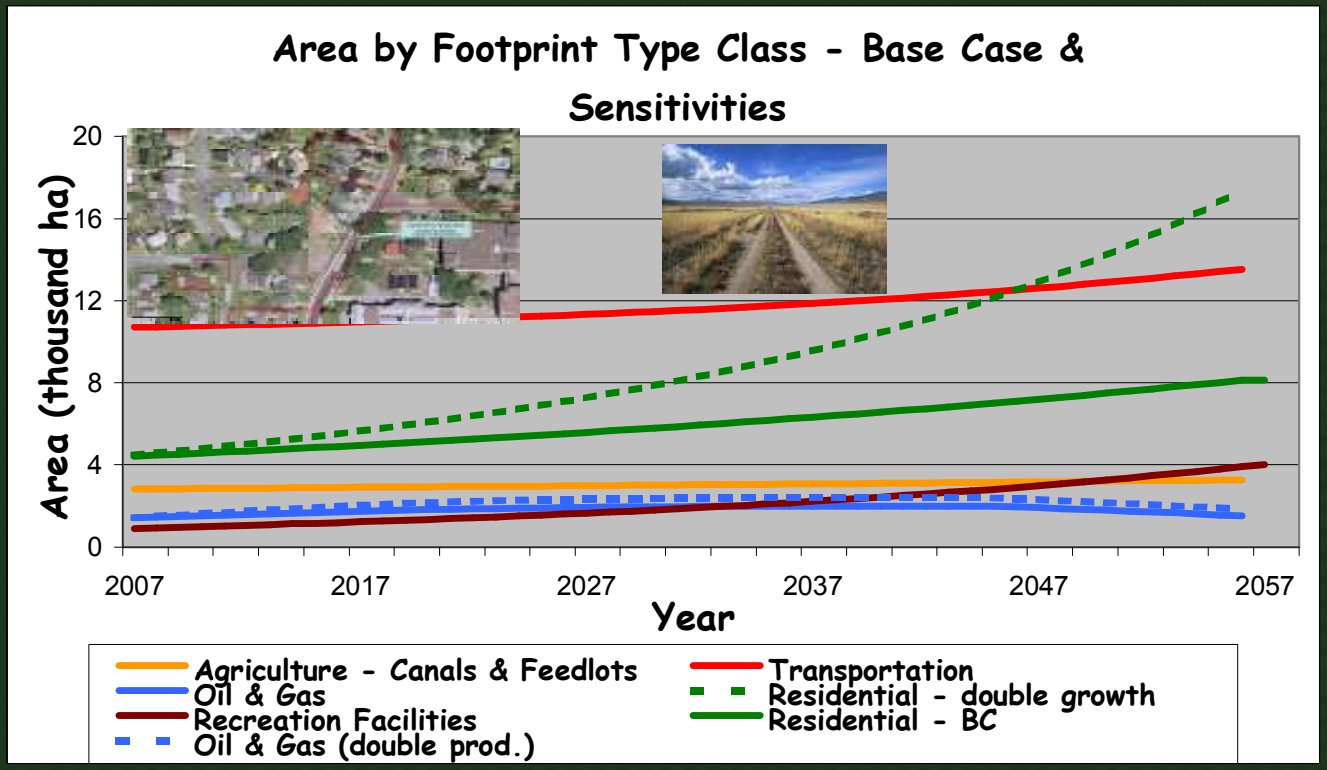
- Double Human Population Growth Rate
- Double Oil & Gas Production
- Lower Limit of Groundwater Aquifer Initial Volume Estimate

SENSITIVITY ANALYSIS

FOOTPRINT CHANGES

Double Population Growth - Residential becomes dominant footprint (replacing transportation) by 2045

Double Hydrocarbon Production – only slight increase in footprint



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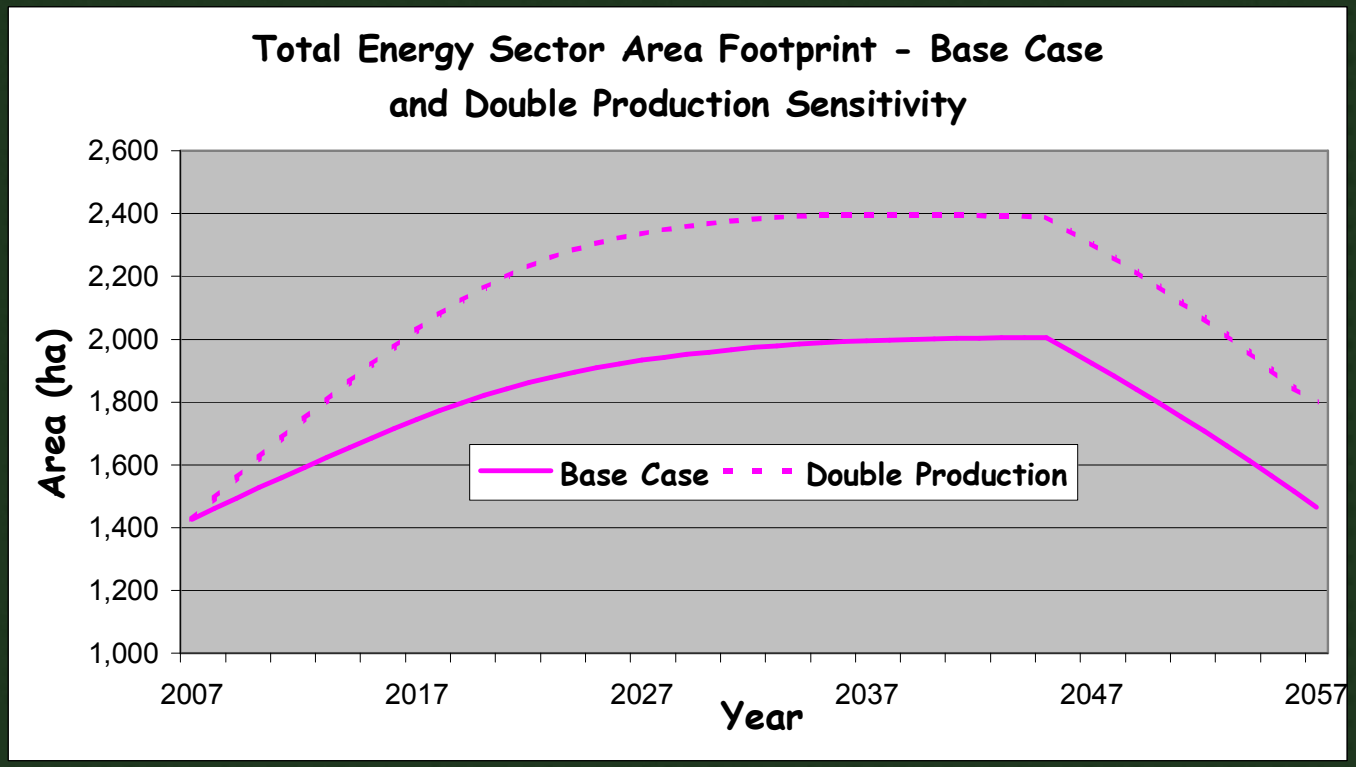
SENSITIVITY ANALYSIS

HYDROCARBON ENERGY FOOTPRINT – Double Production

20% (395 ha) more hydrocarbon footprint by 2040

but only 1.6% percent of total footprint



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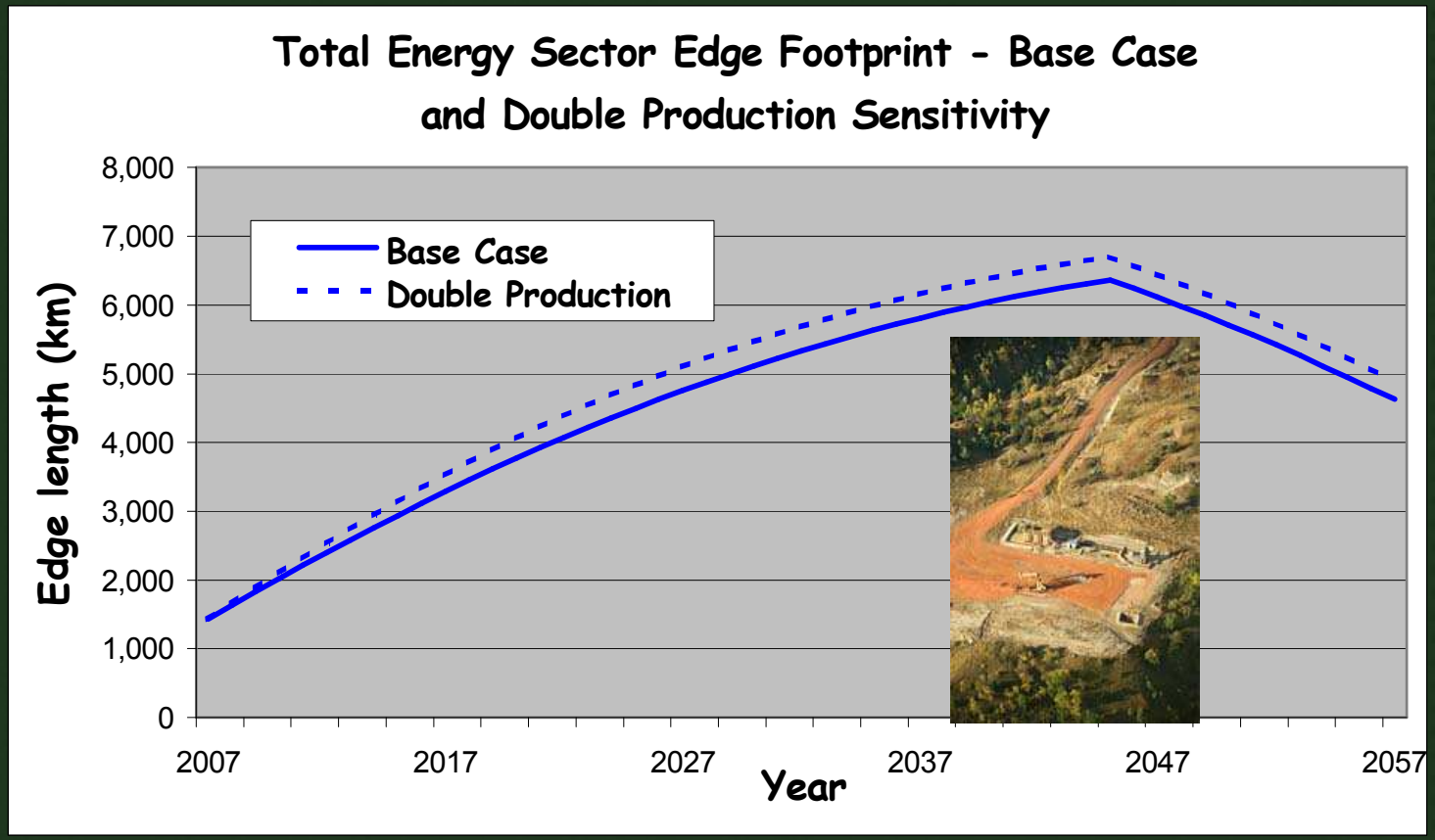
SENSITIVITY ANALYSIS

HYDROCARBON SECTOR EDGE – Double Production

6% (340 km) more edge by 2030 under double production scenario



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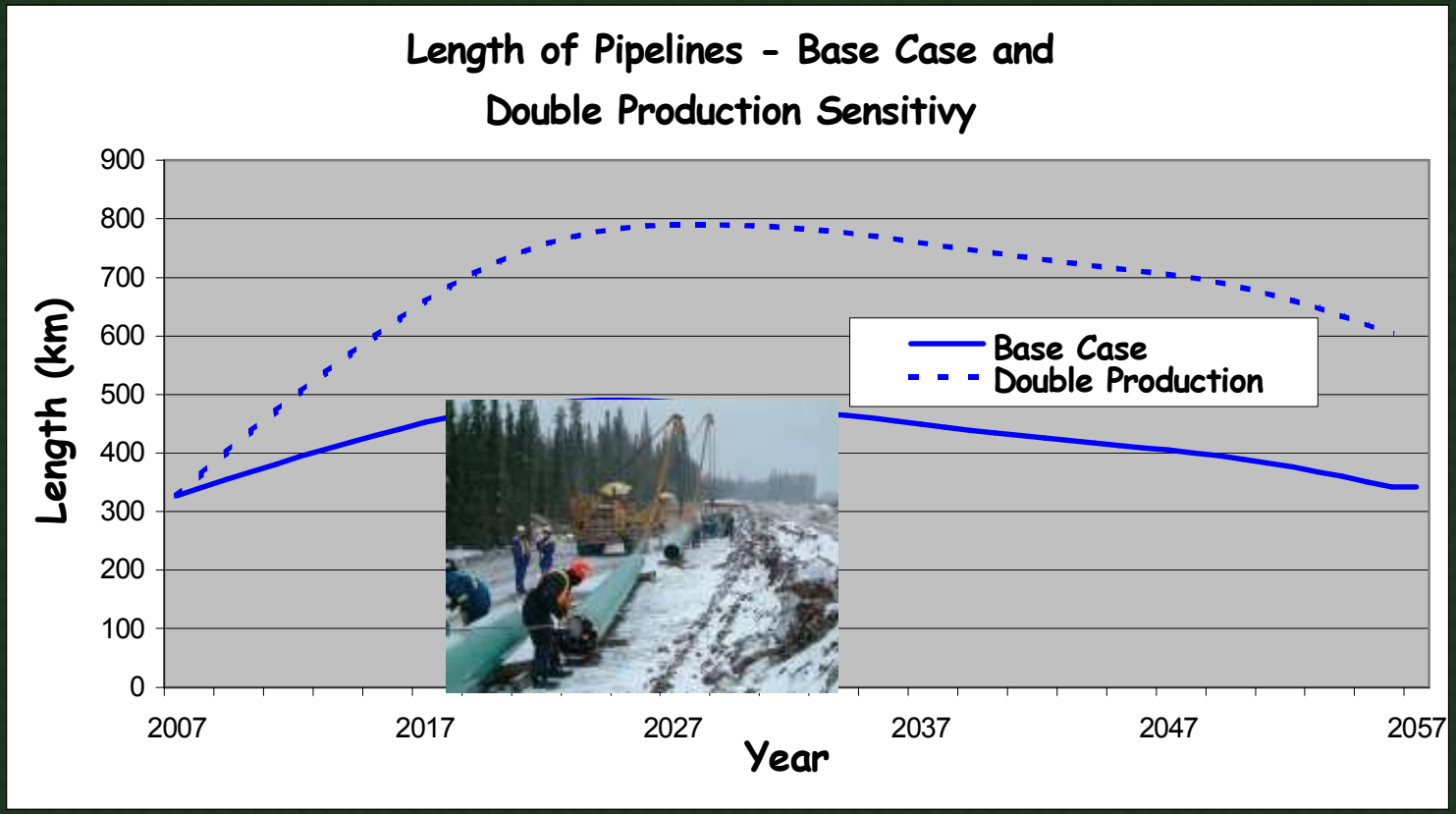
SENSITIVITY ANALYSIS

HYDROCARBON PIPELINE FOOTPRINT - DOUBLE PROD

310 more km (60% increase from base case) of pipeline by 2030



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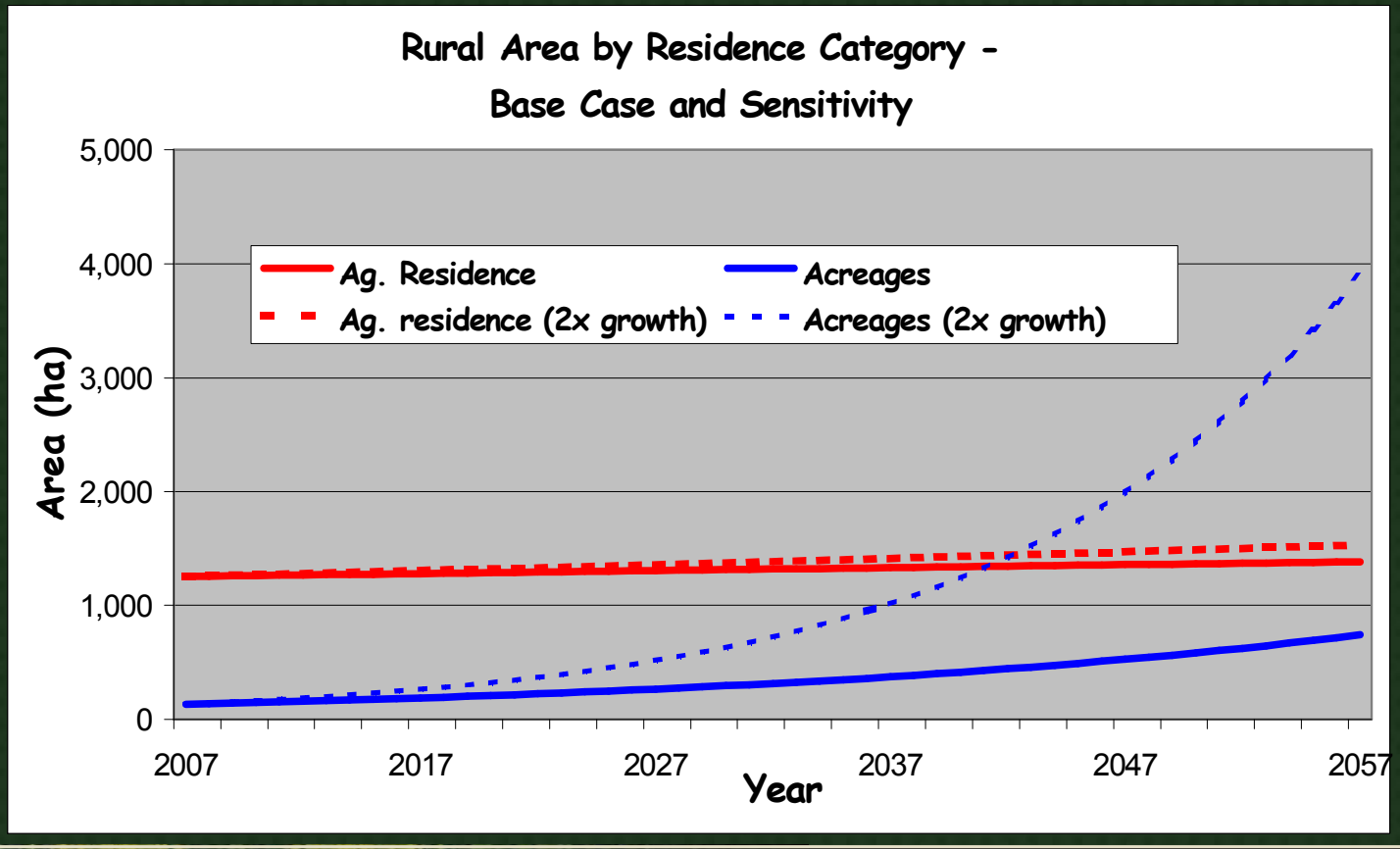
SENSITIVITY ANALYSIS

RURAL SETTLEMENTS FOOTPRINT – DOUBLE POP

Acreage footprint surpasses Ag. residence footprint by 2042



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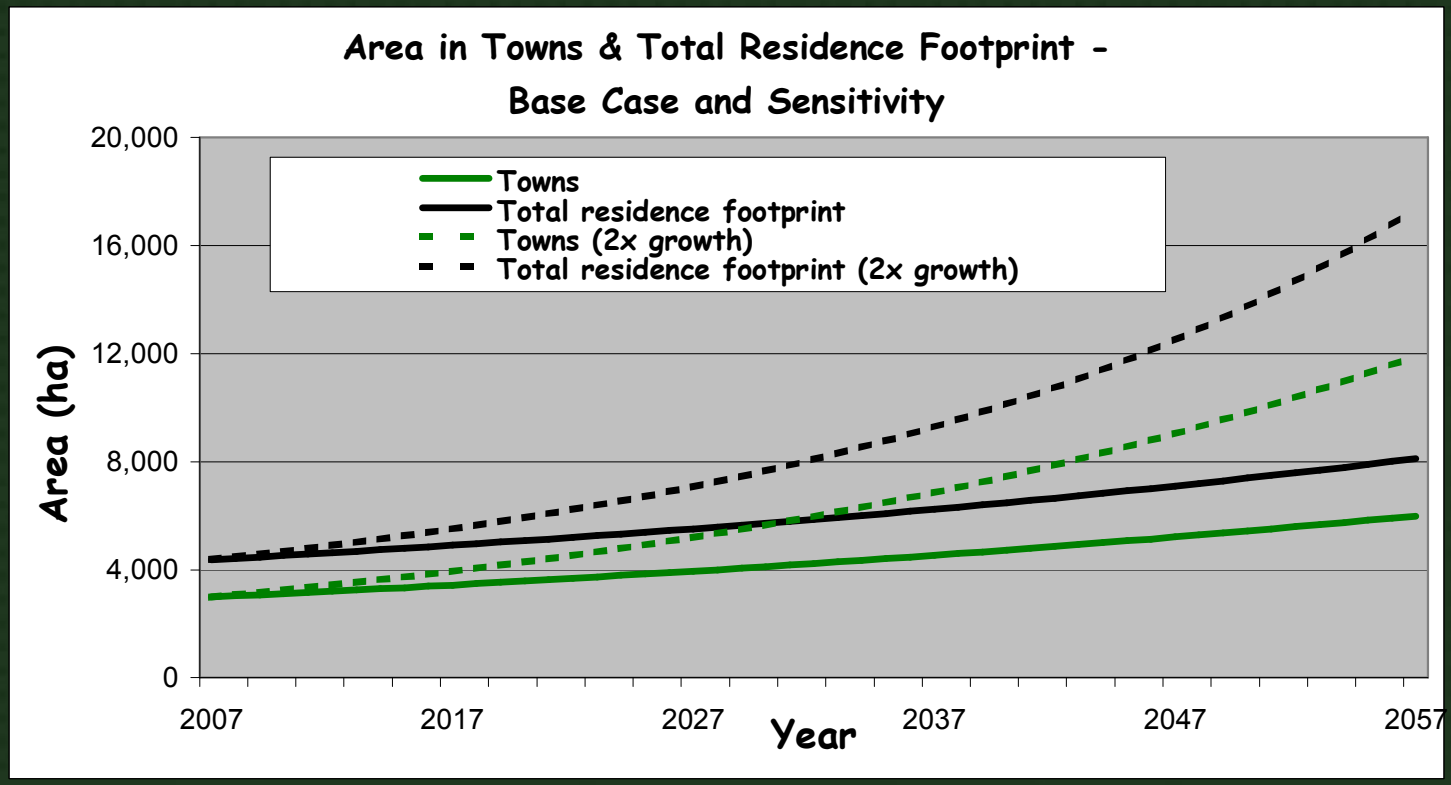
SENSITIVITY ANALYSIS

URBAN SETTLEMENTS FOOTPRINT – DOUBLE POP

Double Base Case urban residence footprint – 4X today



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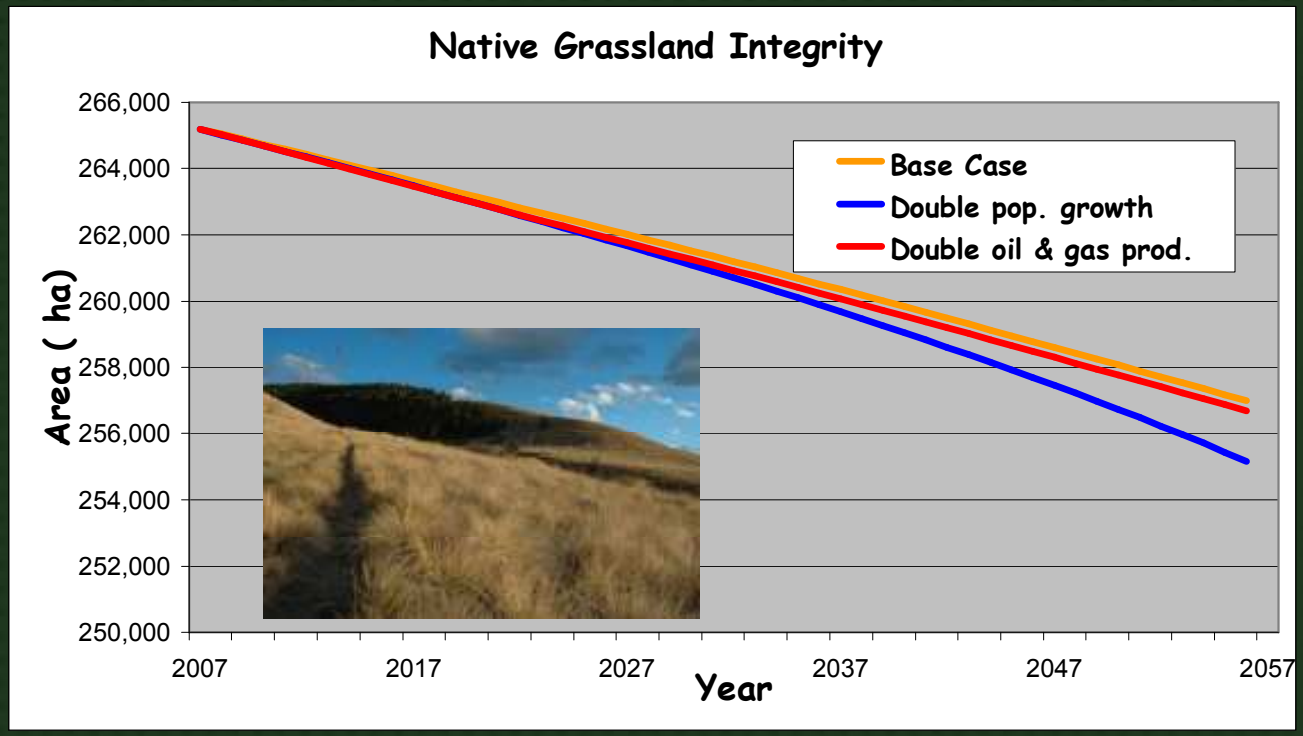
SENSITIVITY ANALYSIS

INDICATORS – Native Grassland Integrity

Residential and transportation developments reduce native prairie 10X more in area than the hydrocarbon sector



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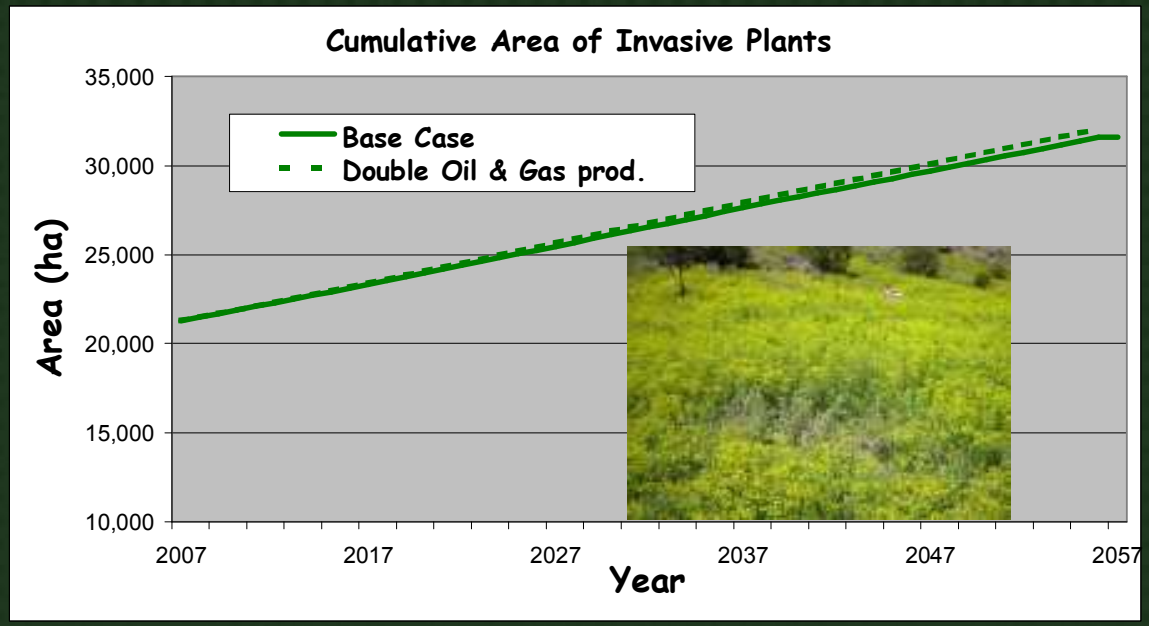
SENSITIVITY ANALYSIS

INDICATORS – Exotic Invasive Plants

Invasive plant spread is insensitive to either sensitivity

only 10% of increased residential footprint is actively bringing invasives and doesn't show up at this scale

while energy sector edge/area ratio is much greater than residential, total energy sector activity is low so the response is small



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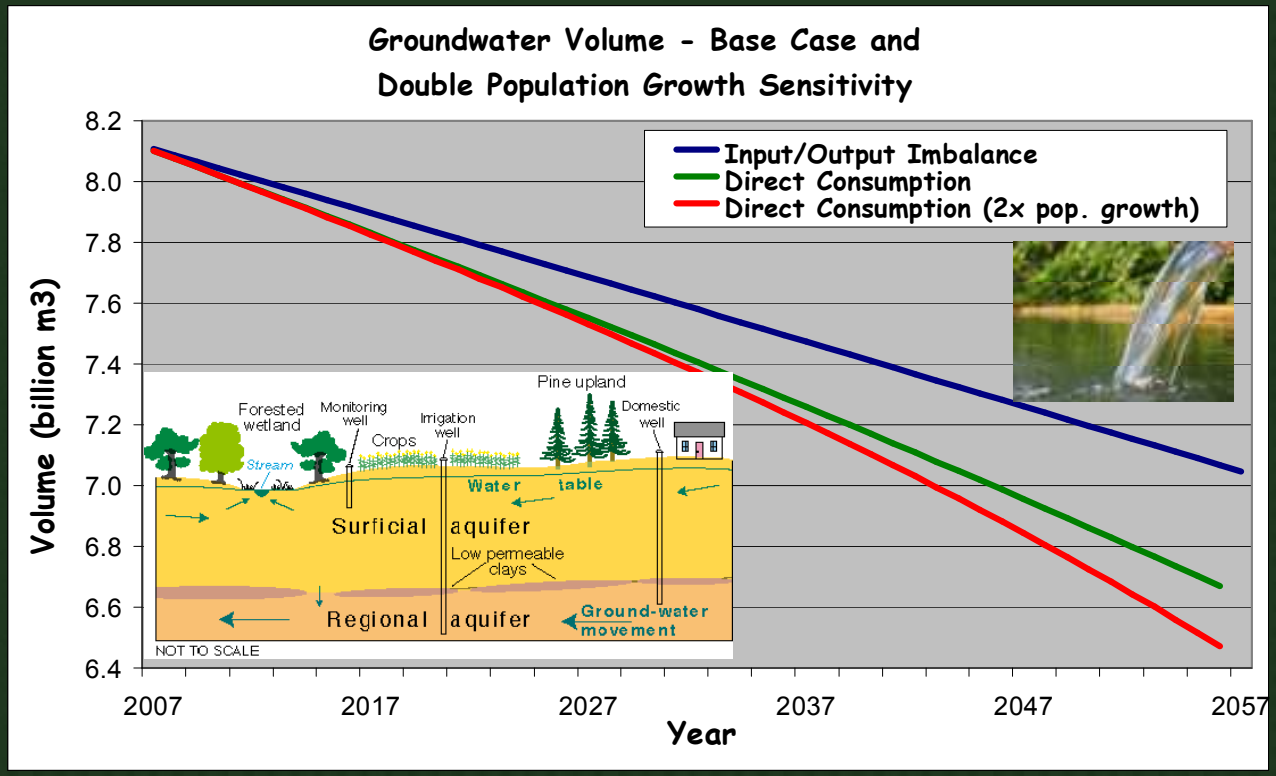
SENSITIVITY ANALYSIS

INDICATORS – Groundwater Budget, Double pop. growth

Double population growth results in 3% drop (200 million m3) in groundwater volume by 2057, relative to Base Case



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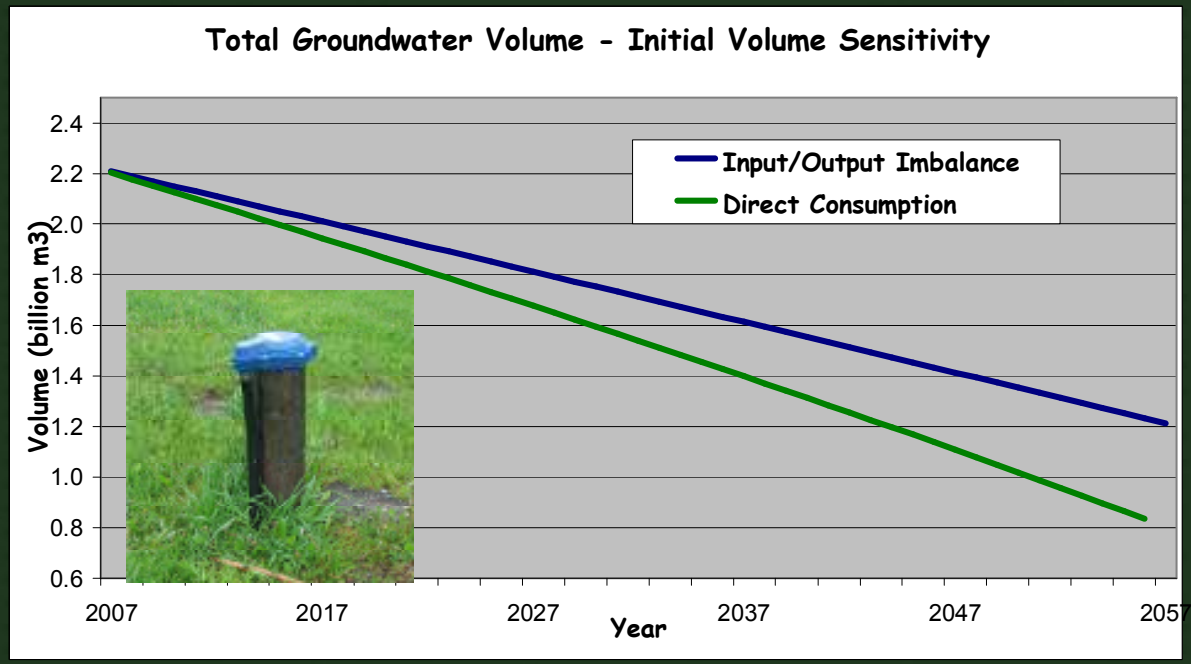
SENSITIVITY ANALYSIS

INDICATORS – Groundwater Budget – Lower Estimate

Amount of ground water lost is same as base case, but relative change is greater because of a significantly lower starting stock

(44% drop from imbalance vs 13% in base case)

(18% drop from direct consumption vs. 5%)



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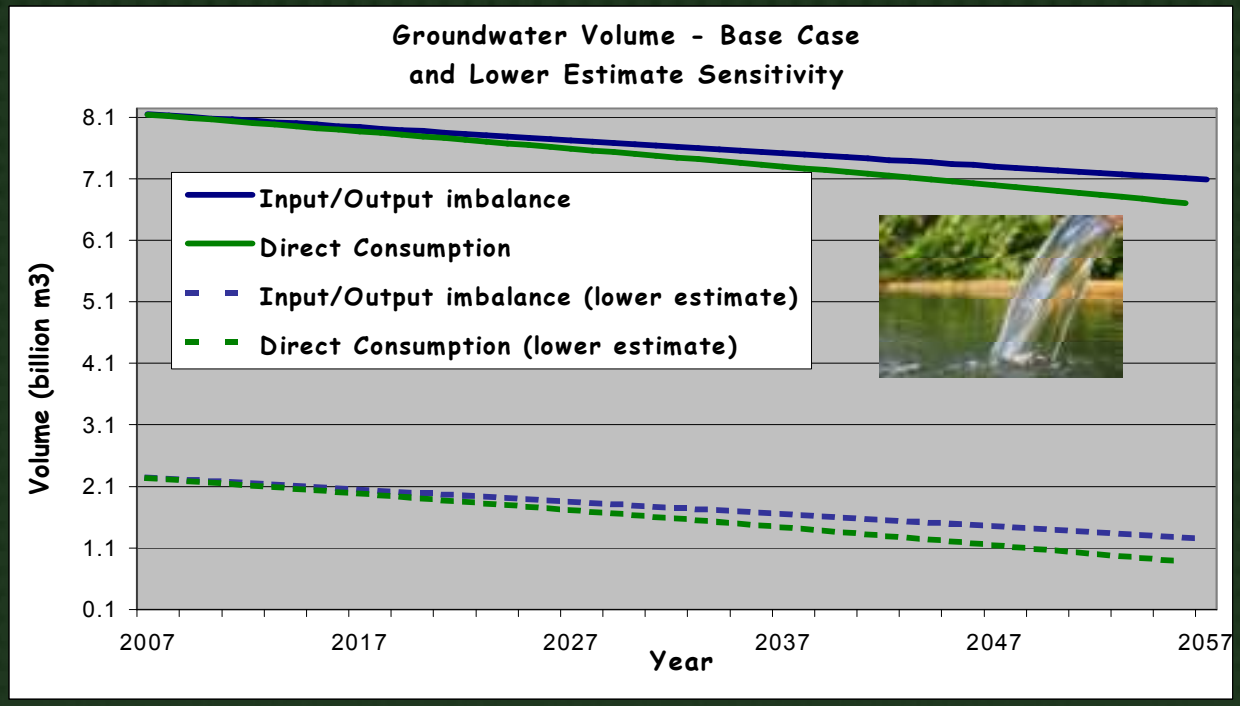
SENSITIVITY ANALYSIS

INDICATORS – Groundwater Budget

Bottom of initial stock range estimate is 73% below midpoint
(High Uncertainty)

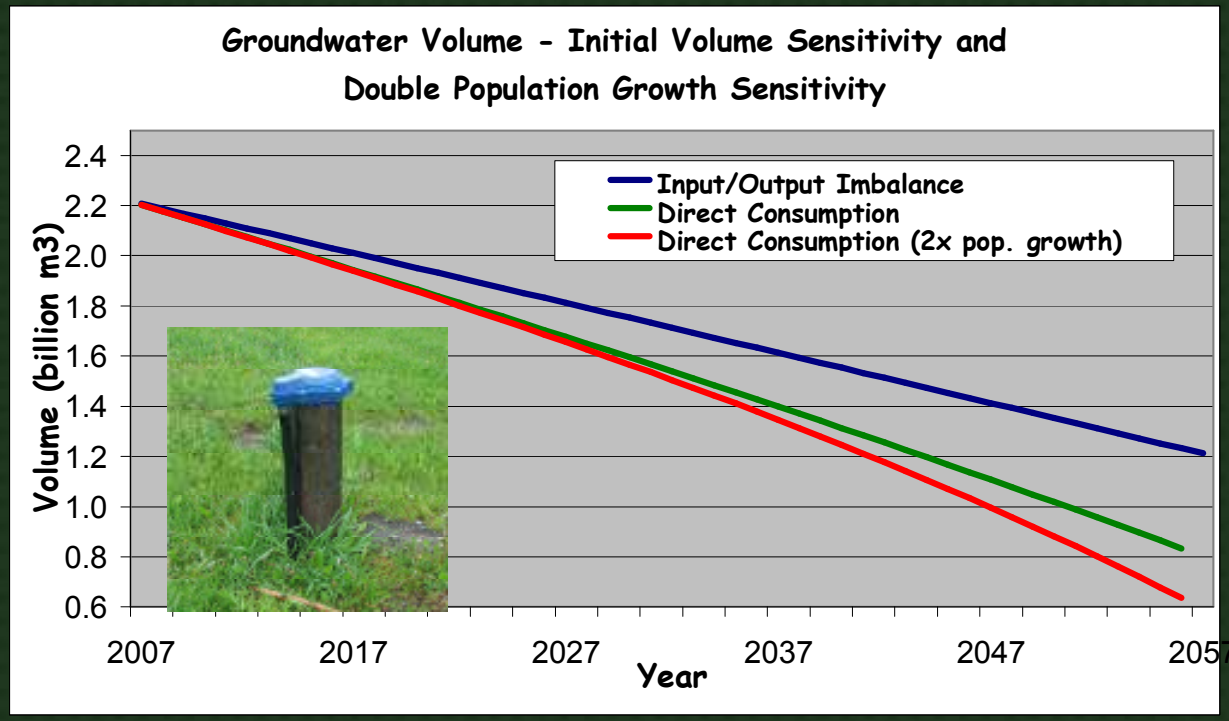
Total aquifer drawdown is the same for both



SENSITIVITY ANALYSIS

INDICATORS – Groundwater Budget (lower limit), Double pop. growth

Change in groundwater volume from base case is same as 'higher initial volume' & double pop. growth scenario: 3% drop (200 million m3) by 2057



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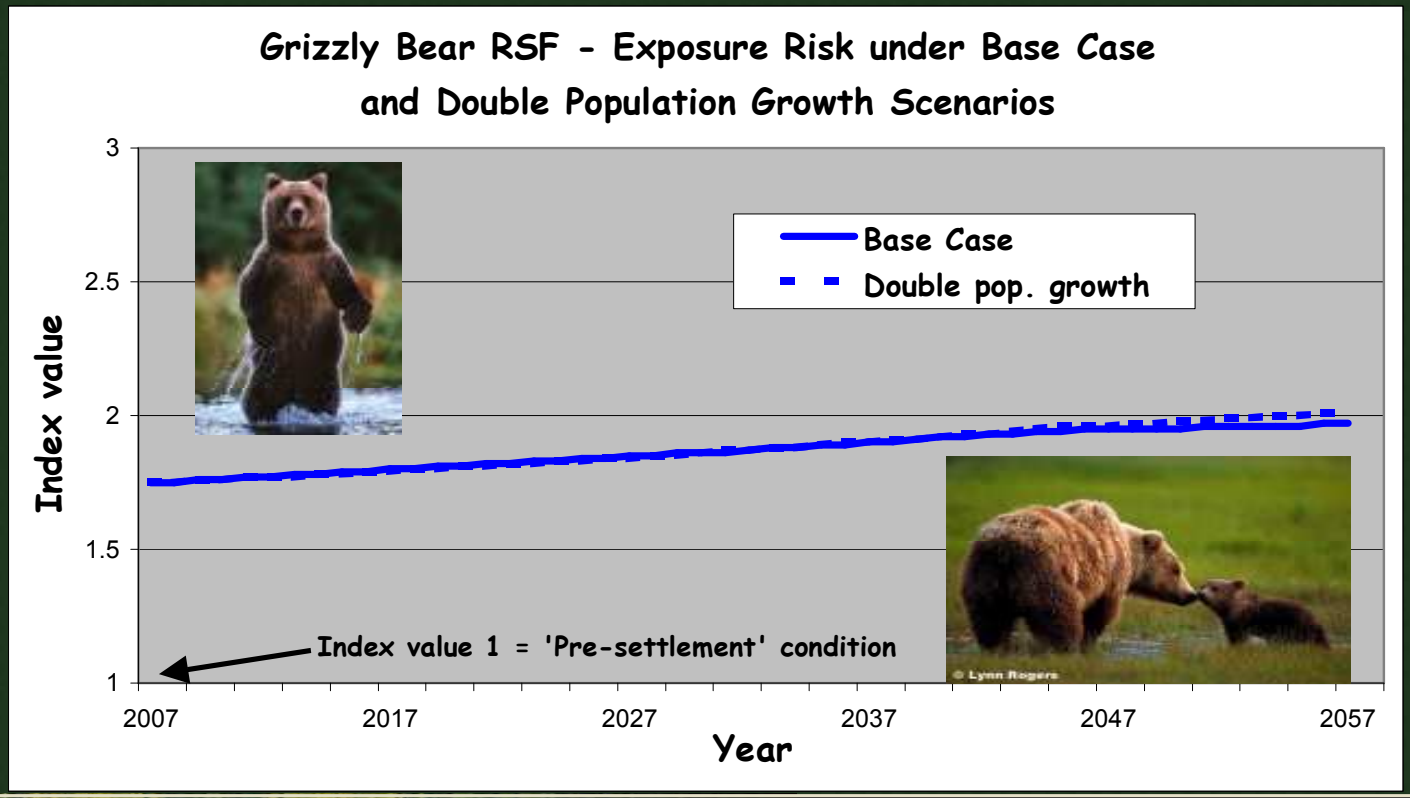
SENSITIVITY ANALYSIS

INDICATORS – Grizzly Bear

15% increase over 50 years (vs. 13% in Base Case) with double population growth rate.

No change for double oil & gas production scenario



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Emerging Land use Trends

- **Expanding Transportation Network**

  Accounts for ½ of all footprint

- **Significant Population Growth Anticipated**

  Settlement growth and transportation network represent significant threats to grasslands

  acreages on track to surpass agricultural residences

- **Energy Sector Footprint Growth is relatively low compared with agriculture, transportation and residential footprints**

  Conventional Oil, Natural Gas, CBM (substantially less than SFS)

- **Demand for Recreational Activities Increasing Rapidly**

  footprint expected to surpass that of energy sector

  highly correlated with population growth

Emerging Land use Trends

- Shallow Groundwater aquifers declining

  existing footprint has created an imbalance

  consumption exceeds recharge

- continuing increases in surface water nutrient loading

  Humans and livestock are the primary contributors to continuing declines in surface water quality

- Wind Turbines becoming significant land use

  small surface footprint

  potentially high visual impact

Emerging Environmental Trends

- Reduced Water Quality and Quantity
- Greater Demand on Groundwater (volumes declining)
- Loss & Degradation of Native Grasslands
- Increased Forest Fragmentation
- Grizzly Bear exposure significantly increasing
- Forests are ageing

Considerations

- Protect Native Grassland Capital from invasives
- Improve estimates of local groundwater stocks and flows
- managing population growth to minimize additional roads, trails and edge
- managing forest fragmentation effects through best practices such as reclamation, bridges, etc.
- Access management to mitigate Grizzly Bear exposure


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