
Terrestrial Ecosystem Management Framework

for the Regional Municipality
of Wood Buffalo



Prepared by

Sustainable Ecosystem Working Group
of the
Cumulative Environmental Management Association

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Executive Summary

The Terrestrial Ecosystem Management Framework (Framework) is the Cumulative Environmental Management Association's (CEMA) recommended approach to managing the cumulative effects of development and resource use on ecosystems and landscapes in the Regional Municipality of Wood Buffalo (RMWB). The Framework aligns with the stated direction of the Government of Alberta (GoA) to enable oil sands development while maintaining ecosystem integrity and social and cultural needs. The Framework is intended to complement the existing policies and regulatory system currently in place.

The Framework has been guided by principles that were designed to ensure:

- Stakeholder and societal values are understood and are reflected in regional environmental, economic, and social goals;
- Trade-offs amongst competing goals are deliberate and transparent, because the maintenance of ecological attributes is not simultaneously possible on all landscapes with the projected rates of development;
- Ecological integrity is managed predominately at the regional scale;
- Management strategies are based on science and Traditional Ecological Knowledge (TEK); and
- Flexibility to adapt to future reality as it unfolds.

The Framework is based on a detailed analysis using models describing development over the next 100 years, and acknowledging energy development as a dominant driver of land use. Three hypothetical management scenarios were developed and contrasted with a base case model to understand indicator performance. Most environmental indicators of terrestrial ecosystems are expected to decline with continued development in the absence of management intervention. Modeling results demonstrate that options are available to mitigate impacts.

The Framework recommends a regional management objective, broad regional strategies, and the application of specific management measures at a sub-regional scale. Establishment of a regional monitoring program is also recommended to measure achievement of desired outcomes.

The concept that healthy ecosystems, and therefore indicators, vary naturally over time has informed the definition of the regional environmental management objective. CEMA recommends that environmental indicators are maintained within 10% below the lower limit of the natural range of variation. This target recognizes that in some areas of the RMWB indicators would be far outside NRV while in other areas they would be within NRV. A system of management response triggers is recommended involving three levels: green being acceptable; yellow being cautionary, indicating that management response planning should be initiated; and red indicating immediate action is required. Trigger conditions are assigned based on a combination of the current monitored levels of an

indicator, and the timeframe within which any reductions are predicted (through modeling) to occur. Four out of the seven identified environmental indicators are currently in a yellow or red condition based on available information, thus requiring immediate action.

In response, the primary recommended regional strategy is the application of a Triad land management approach that is the core of this framework. The Triad approach involves the identification of three land use zones: Intensive, Extensive and Protected.

CEMA recommends

- An Intensive Zone characterized by bitumen extraction comprising 5% to 14% of the RMWB at any time;
- An Extensive Zone characterized by ecosystem forestry and other natural disturbance based activities comprising at least 46% of the RMWB at any time; and
- An expanded permanently Protected Zone where industrial activities are excluded comprising 20% to 40% of the RMWB.

CEMA also recommends further work to refine the sizes of the Intensive and Protected Zones, the application of the Intensive Zone constraint, and specific boundaries for new protected areas.

Aggressive management of off-highway vehicle access is also recommended as a powerful strategy to mitigate impacts on several indicators. Approaches to minimize the extent and duration of footprint, through technological innovation, integrated planning, and improved reclamation are also key. It is vital to engage Aboriginal people in developing strategies for conserving or managing opportunities for traditional land use, particularly in proximity to communities.

Further, CEMA recommends areas of public policy that require adjustment to ensure a coordinated and comprehensive approach to achieving the objectives of the Framework. Application of management strategies is recommended consistent with the management intent for each Triad zone.

Based on the current and forecast condition of indicators, CEMA recommends a variety of immediate and concurrent actions. The Framework includes a schedule of recommended actions and timelines to enable full implementation of the Framework by 2011. This Framework should be reviewed and renewed every five years.

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1.0 Introduction

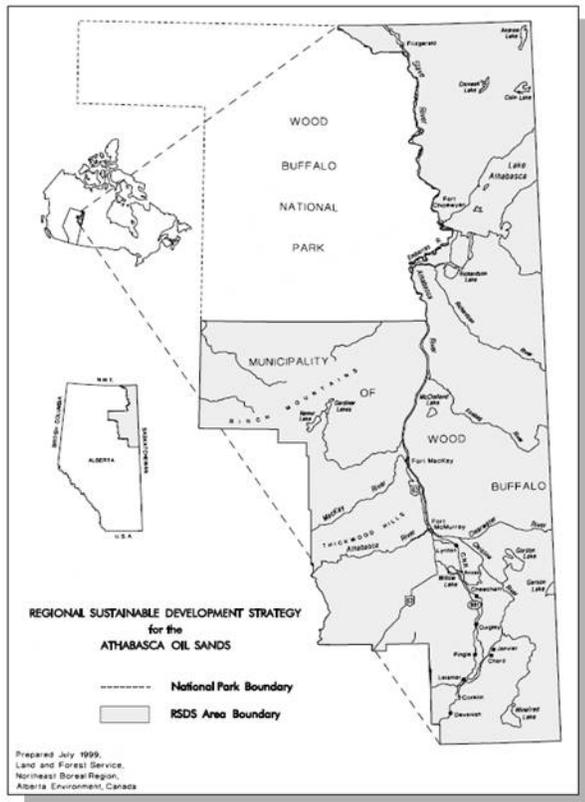
This Framework addresses the urgent need to reconcile competing land uses in the RMWB (see Figure 1) to achieve sustainable environmental, economic and social objectives. It addresses the challenges of highly complex scientific, social and economic regional issues, the rapid pace of regional development, the uncertain nature of emerging cumulative effects management policies and practices, and the need to continue to collect regional environmental baseline data. Development of the region's rich resources must also balance the ecological integrity, economic viability, and the social and cultural needs of residents. Tradeoffs will be needed in order to achieve desired outcomes, and strong leadership will be required as new policies are implemented to support the thoughtful resource allocation and land use decisions that need to be made.

The collaborative efforts used to develop the Framework offer many lessons that can be attributed to the desire of industry, government and public interests to work together to achieve the desired balance. This Framework is workable, defensible, implementable and reflective of the goals and values of Albertans.

Additional supporting documents that informed the development of the Framework are also available (see Appendix 8.5).

CEMA has incorporated Traditional Ecological Knowledge (TEK) that has been provided by Aboriginal Elders. One of the ways in which this knowledge is communicated is through the use of stories. Several of these stories have been incorporated throughout this document.

Figure 1: Location of the Regional Municipality of Wood Buffalo



2.0 Context

2.1 Background about CEMA

CEMA is a multi-stakeholder organization comprised of members representing industry, provincial, federal and municipal governments, Aboriginal communities and environmental non-governmental organizations. CEMA's vision statement is: *"The environment of the region, including the land, forest, air, water, wildlife and biodiversity, will be protected, sustained, and restored over the long term and that the collective activity of industrial activity in the region will not cause any lasting harm to the environment or adverse effects to the health of humans. Should these impacts be evident, the Association and its Members will recommend, promote and implement mitigation action to manage their effects"*.

CEMA's mandate to develop cumulative effects management frameworks for all environmental media within the RMWB (including air, water and land), originates from the Regional Sustainable Development Strategy (RSDS). The [RSDS](#)¹ included 17 specific issues related to the cumulative effects of development on fish, wildlife, and ecosystems (see Appendix 8.4). This Framework was developed through the work of the Sustainable Ecosystems Working Group of CEMA.

Management frameworks developed by CEMA are comprised of management objectives, thresholds for ecosystem sustainability balanced with economic and social values, along with management strategies and tools designed to achieve these objectives. Frameworks approved by CEMA are forwarded as recommendations to the GoA.

2.2 Provincial Context

The Framework is aligned with three major provincial outcomes as described in the draft GoA Land-use Framework ([LUF](#))².

1. Sustainable prosperity supported by our land and natural resources
2. Healthy ecosystems and environment
3. Livable communities and recreational opportunities

¹ http://www3.gov.ab.ca/env/regions/neb/rsds/rsds_final.pdf

² <http://www.landuse.gov.ab.ca/>

In developing the Framework, CEMA also considered the current regulatory system for managing development activities and their impacts on ecosystems. Existing and emerging public policies were considered, including: the GoA commitment to [Sustainable Resource and Environmental Management](#)³, the [draft LUF](#), the [proposed Regulatory Framework for Managing Environmental Cumulative Effects](#)⁴, the Integrated Land Management (ILM)⁵ initiative, and the work of [the Alberta Caribou Committee](#)⁶. Finally, the report of the [Oil Sands Consultations Multi-stakeholder Committee](#)⁷ provided additional guidance and perspective.

2.3 Environmental Context

The RMWB covers 6.8 million hectares of the vast boreal forest that spans Canada and, despite existing industrial development, includes some of Alberta's most intact ecosystems. The RMWB contains a mixture of wetland and upland sites, with more than thirty percent of the landscape characterized as wetlands (such as peatlands). The region's upland areas are a mosaic of pure and mixed stands of white spruce, aspen, black spruce, jack pine and larch. Its ecosystems support a diverse array of wildlife, including moose, woodland caribou, black bear, lynx, fisher, several hundred bird species, and numerous species of fish.

Approximately eight percent of the landscape is currently under some form of protection and, while much of Alberta has been fragmented by industrial development, portions of the region contain some of the province's remaining roadless areas. The annual and sustainable value of ecosystem services in the RMWB is significant, including flood control, carbon storage, water filtration, biodiversity values, and recreation.

2.4 Economic Context

Alberta's oil sands resource is strategically important regionally, provincially, and nationally for the provision of a secure supply of energy to the domestic, North American and global marketplaces. Alberta is second only to Saudi Arabia in recoverable reserves and the GoA is committed to accessing and developing that resource responsibly.

The Athabasca oil sands area represents volume in place of approximately 1.7 trillion barrels, including some 173 billion barrels

"I miss a lot of things such as birds, fewer birds. Now there are so many plants. I used to like calling moose. Nowadays, you can call in all sorts of [industrial] plants but no moose. Years ago you had to be satisfied with what you could find. In 1947, I heard this roaring on the wagon road so my brother and I took off into the bush and we saw people's heads going by. I guess it was a car. It's surprising how the country developed. I do believe that it is very good as it has created all kinds of jobs. But I always remember my father who lived to be 83. He used to say one day there will be nothing to buy in the world, there will be a lot of money but nothing to buy."

Andrew Quintal

³ <http://www.srem.gov.ab.ca/>

⁴ http://www.environment.alberta.ca/documents/CEM_Framework.pdf

⁵ <http://www.srd.gov.ab.ca/lands/usingpublicland/integratedlandmanagement/default.aspx>

⁶ <http://www.albertacariboucommittee.ca/>

⁷ <http://www.oilsandsconsultations.gov.ab.ca/index.html>

of recoverable reserves⁸. Most of the known reserves have been allocated through tenure agreements, and a peak production of four million barrels a day of bitumen is projected. Capital spending on oil sands to-date has been approximately \$47 billion, with \$18.7 billion projected to be spent on construction in 2008, and another \$67 billion worth of projects conservatively forecasted to be completed by 2012⁹.

2.5 Social Context

The region is rich with cultural heritage and diversity; however, its rapidly maturing and expanding economy presents significant challenges for social choices. As the RMWB's thriving, growing hub community, Fort McMurray is challenged with supplying sufficient infrastructure and services required to support its growing population. There are approximately 65,000 residents of Ft. McMurray and an additional 13,000 people that comprise the "shadow population" residing in temporary work camps. The size of Fort McMurray may grow by 50 percent or more in the next ten years to support the planned development and operations of new oil sands projects. That growing population needs places to work and play; the demand for extensive and intensive forms of recreation is expected to increase as regional populations continue to grow.

There are five First Nations communities and many Métis peoples within the RMWB. Aboriginal people have traditionally used this landscape and continue to access it for traditional and subsistence purposes.

3.0 Methodology for Framework Development

The Framework has been developed through a consensus based decision-making process, using an extensive series of workshops. Levels of agreement and areas of divergence were identified to provide a sound foundation for decisions. To develop a shared knowledge base, a proven method of scenario planning was followed. Simulation models were used to identify indicator performance, both spatially and temporally, to evaluate outcomes under different potential management scenarios, and to evaluate the magnitude of risk and uncertainty in achieving goals (see Appendix 8.5, in particular "Summary of Methodology").

The Framework is designed around a hierarchy of high level goals, measurable management objectives, and a set of indicators selected to

⁸ Alberta's Energy Reserves and Supply/Demand Outlook.

http://www.ercb.ca/docs/products/STs/st98_current.pdf

⁹ <http://www.oilsands.cc/pdfs/2007%20RIWG%20Oil%20Sands%20Fact%20Sheet.pdf>

represent elements of system performance. The goal statements, informed by the RSDS, express the collective values of CEMA members. Management objectives translate qualitative goals into quantitative parameters and were informed by science and TEK, but also reflect social value choices. Indicators were selected from a list of potential options using a suite of defined criteria. The treaty and aboriginal rights of regional aboriginal were not explicitly considered, except indirectly through the inclusion of traditional land use as one of the region’s social and cultural values, and through the inclusion of maintenance of opportunities for traditional Aboriginal land use as one of the Framework’s regional goals.

Substantial baseline data was assembled to understand current conditions and support modeling of future indicator performance relative to management objectives over a 100 year horizon. Models were driven by a bitumen production forecast that predicted a peak production of 4 million barrels per day in 2030¹⁰, and CEMA developed models to translate those bitumen production volumes into footprint metrics based on information provided by industry. Ongoing timber harvest was modeled together with bitumen production. CEMA also developed models of indicator response to footprint based on best available science. This included defining a zone of influence around the footprint for each indicator. Modeling was conducted with respect to both direct footprint and at the quarter township level, with the latter representing the larger area influenced by direct footprint from oil sands mining and in situ from the perspective of indicator response.

Three hypothetical management scenarios were developed and contrasted with a base case model (Table 1). Management scenarios were modeled individually and not in combination.

Table 1: Summary of Management Scenarios Modeled

Management Scenario	Key Parameters
Base Case	<ul style="list-style-type: none"> Assumed that parameters such as current practices, footprint intensity, public policies, and market forces remain unchanged.
Expanded Protected Areas	<ul style="list-style-type: none"> An increase in protected areas from the current 8.2% to a specific option of 36% protection (see Figure 2).
Access Management	<ul style="list-style-type: none"> Restriction of off-highway vehicle access from 50% to 75% of various portions of the RMWB. Systematic reclamation of existing 8 m wide seismic lines.
Innovative Approaches	<ul style="list-style-type: none"> Future reduction in footprint intensity from both bitumen extraction and forestry that might be

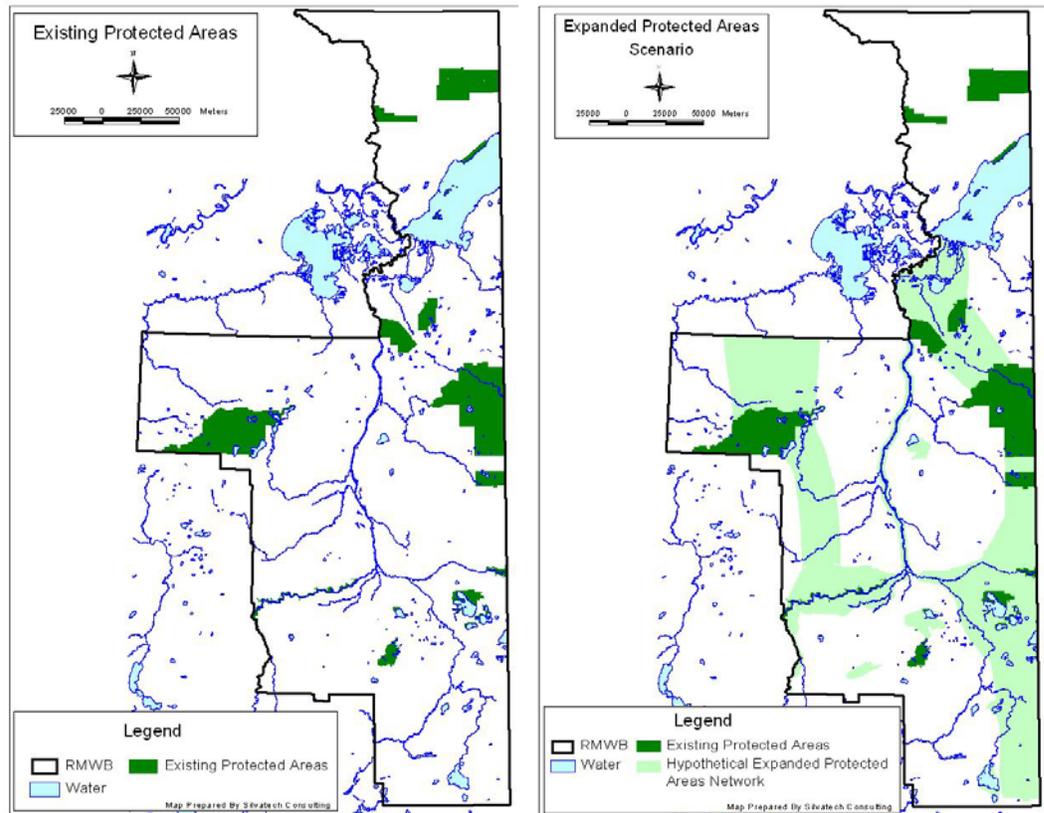
¹⁰ Oil sands mining and in situ production forecasts were provided to CEMA by Alberta Energy and Utilities Board in 2006.

possible with technological innovation and enhanced cross-industry cooperative planning.

- Future reduction in reclamation lag time.

Figure 2: Existing Protected Areas and Expanded Protected Areas Management Scenario

(The figure on the right represents a hypothetical Protected Area scenario used in the modeling expressly for the purpose of learning and is not proposed for protection)



Additional model runs were conducted to address key uncertainties related to forecast bitumen production and reclamation lag times to understand the degree to which indicator performance could be affected if model assumptions are incorrect. The sensitivity of indicators to these two parameters was assessed under three scenarios:

- A doubling of bitumen production to a peak of 8 million barrels per day;
- A doubling of predicted reclamation lag time for each of oil sands mining and in situ developments; and
- Both of the above in combination.

Some social and economic dimensions were modeled, but a detailed analysis of the implications of increased costs arising from future implementation of innovative approaches was not completed. Also, detailed economic and social implications of increasing protected areas were not assessed because candidate boundaries have not been finalized. Furthermore, energy commodities other than bitumen were not modeled.

Some uncertainties exist in the models, and recommendations to address them are provided in Section 5.10.

4.0 Key Learning

Modeling undertaken during the development of the Framework provided key learning in relation to development of trajectory and footprint, indicator status and trends, their sensitivity to key uncertainties, and the expected benefits of key regional management strategies. Learning from the three modeled management scenarios and the sensitivity testing is summarized below.

4.1 Learning from the Base Case Scenario

- Rapidly increasing oil sands development is the key driver of landscape change in the RMWB due to the increasing footprint on the land and the long duration of the footprint.
- Both mining and in situ developments must be considered intensive land uses due to their impacts on environmental indicators.
- The landscape has already been substantially altered in the RMWB and will continue to change due to development in the future.
- Most environmental indicators of terrestrial ecosystems will decline outside their natural range of variation (NRV) with

continued development in the absence of management intervention.

- Indicators of native fish integrity, fisher, moose and black bear are already below their NRV and will continue to decline.
- Linear feature (footprint) density is a key driver of declines in environmental indicator performance, both through their direct impact on landscape structure and through their use by humans and predators.
- Available timber for harvest is expected to be negatively impacted by continued development pressures in the mid- to long-term, in the absence of policy changes or management intervention.
- The population of Fort McMurray is expected to grow to approximately 100,000 by 2030.
- Of the 6.8 Million hectares that comprises the RMWB, current data suggests that some 1.9 million hectares (28%) is underlain by bitumen deposits that are considered commercially viable using current technology (e.g. >50% of deposit is bitumen by composition, and the deposit is at least 15m thick) and ~3.8 million hectares (56%) is underlain by some measurable amount of bitumen.
- Current intensive development covers 1.5% of the RMWB measured by direct footprint, or 1.8% when measured by summing the area of all quarter townships that include intensive footprint.
- The maximum area that would be in an intensively developed condition at any one time is projected to be 2.9% of the RMWB measured by direct footprint, or 4.8% when measured by summing the area of all quarter townships that include intensive footprint.

4.2 Learning from the Expanded Protected Areas Scenario

- Within the expanded network of protected areas modeled, most indicators can be expected to be maintained within their NRV.
- An expanded network of protected areas could be designed without limiting the ability to deliver a 4 million bbl/d peak bitumen production scenario, but could result in long term impacts to timber supply.

- A 20% protected areas scenario could potentially be accomplished with limited conflict with oil sands and forest tenure holdings as of mid-2007, but mineral agreements might still be affected. This potential declines as new tenure is issued.
- The protected areas scenario as modeled overlaps 378,000 ha of commercial grade bitumen, and would also impact the area available for forest harvest.

4.3 Learning from the Access Management Scenario

- Management of motorized human access to landscapes, reduction in linear footprints, and systematic reclamation of historic linear footprint are powerful management tools to mitigate impacts, particularly for moose, black bear, and fish.

4.4 Learning from the Innovative Approaches Scenario

- Innovative management approaches to minimize the extent and duration of footprint, including development and implementation of new technologies, can have benefits to environmental indicators.

4.5 Learning from the Sensitivity Analysis

- All environmental indicators are sensitive to assumptions of bitumen production and reclamation lag. Doubling bitumen production and doubling reclamation lag over base case assumptions results in poorer performance of environmental indicators.
- An 8 million bbl/d peak bitumen production scenario could still be met, along with implementation of an expanded network of protected areas.
- The population of Fort McMurray would be expected to grow to 140,000 by 2030 at a peak bitumen production of 8 million bbl/d.
- The maximum area that would be intensively developed at any one time would be between 5.2% measured as direct footprint to 13.9% when measured by summing the area of all quarter townships that include intensive footprint, based on the double production scenario, using current (base case) reclamation lag assumptions.

5.0 Terrestrial Ecosystem Management Framework

5.1 Purpose

The Framework is a recommended approach to managing the cumulative effects of development and resource use on ecosystems and landscapes at a regional scale. The Framework provides a strategic level approach that is intended to guide the application of tactical and operational level management tools currently in use. It provides a management approach that recognizes the economic potential of the region, maintains regional ecological function, and supports the social and cultural needs of the RMWB and Alberta. The Framework recognizes the importance of responsible development of the energy and forest resources, addresses the region's terrestrial resources in a comprehensive manner, and proposes a considered approach to long-term land and resource development. Value judgments have been considered and trade-offs are recommended, as the maintenance of ecological attributes is not simultaneously possible on all landscapes with the current or projected rates of development.

5.2 Principles

The principles listed below along with [CEMA's principles](#)¹¹ provided the foundation for the planning and decision making process during development of the Framework.

- Management objectives are determined through social choice, informed by science and TEK as well as environmental, social, and economic values within a context of national and provincial goals.
- Flexibility to find the most efficient way to achieve the ends desired.
- Energy development will remain a regional priority and a dominant driver of land use in the region.
- Deliberate and transparent tradeoffs amongst competing goals will be made and will be informed by stakeholder values.
- Ecological integrity will be managed predominately at the regional scale. Management direction will be spatially explicit.

“Have respect for the environment. Mother Earth has a lot of stuff to tell you if you listen. When you listen you can find out what needs to be heard. You'll know when something needs help because you'll feel it. Everything has a spirit; a rock has energy that can be used for something. I was in the field and it hit me a real sad feeling. Oh this is what they were talking about when they said listen to Mother Earth and she'll tell you. That reminded me of having respect for Mother Earth. If you want to listen the animals have something to tell. One time we were having our ceremonies and couldn't leave the tepee and it was a hot day and the fire was going and we started to remember and pray and ask Mother Earth to help us with the heat and then we found some rocks buried in the earth and it was nice and cool and we used them to cool ourselves down. We can use nature to help us with the different things in our life.”

Jessica Talman

¹¹ http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid.697/Itemid.89/

- The adaptive management process will be employed in the design and implementation of the framework.
- A risk management approach will be utilized.
- The consensus process will be used to develop the Framework and will respect the principles of CEMA.

5.3 Regional Goals

Specific goal statements are aligned with the RSDS, CEMA's vision, and the provincial outcomes as described in the draft LUF. The regional goals are value-based statements that are intended to provide meaningful direction for the development of management objectives, strategies and performance assessment. This Framework intends to achieve these goals at the regional scale, yet it is explicitly acknowledged that the achievement of all goals is not simultaneously possible on all landscapes within the region.

1. Sustain viable and healthy populations of native wildlife and fish;
2. Sustain the natural range of vegetation communities, successional patterns and ecological processes;
3. Preserve the diversity of native species, natural ecosystems and landscapes;
4. Sustain natural watersheds and their elements;
5. Sustain a land base for timber harvest;
6. Maintain opportunities for oil sands and hydrocarbon reserves development;
7. Maintain opportunities for aggregate resource development;
8. Maintain opportunities for mineral resource development;
9. Maintain opportunities for tourism development;
10. Maintain opportunities for traditional Aboriginal land use;
11. Sustain recreational capability and availability of wilderness opportunities; and
12. Maintain opportunities for consumptive non-commercial use of fish, wildlife and plants.

Note: This Framework defines a reference point for the environmental goals; however, a benchmark against which achievement of the economic and social goals would be assessed has not yet been established.

5.4 Regional Objective

CEMA recommends a regional objective that allows for some regional scale loss of ecological value resulting from the region's important economic development, while maintaining ecological risk at acceptable levels. The objective was selected as a social choice, informed by modeling results. By setting the objective below NRV, the Framework accepts some degree of long term ecological risk. While the Framework anticipates objectives for social and economic dimensions, quantitative objectives have not yet been established.

CEMA RECOMMENDS—

- 1. An environmental management objective for the RMWB to maintain environmental indicators within 10% below the lower limit of the NRV.*
 - 2. Further work regarding the appropriateness of the environmental objective from the perspectives of feasibility of implementation and better understanding of ecological risk.*
 - 3. Further work to evaluate options and consider the establishment of specific measurable objectives for achievement of social and economic goals.*
-

5.5 Management Response Triggers

The Framework recommends specific thresholds that trigger management responses for environmental indicators (index of native fish integrity, woodland caribou, moose, fisher, old growth birds, black bear, and area of old forest), and is also supported by economic and social indicators to understand performance of the system. Deviation of indicator(s) from the stated regional objective will trigger a management response to identify and address the causes of the indicator's poor performance. Trigger conditions are assigned based on a combination of the current monitored levels of an indicator, and the timeframe within which any reductions are predicted (through modeling) to occur.

Table 2: Management Response Triggers

Condition	Threshold
Green Condition	An indicator is determined to be in a Green Condition when monitoring confirms that it meets the regional objective of being not more than 10% below the lower limit of the NRV, and when modeling predicts that the indicator will remain above the regional objective for at least the next 30 years.
Yellow Condition	An indicator is determined to be in a Yellow Condition when either monitoring measures it at 10-20% below the lower limit of the NRV, or modeling predicts it will drop more than 10% below the lower limit of the NRV within 30 years, both measured across the entire RMWB.
Red Condition	An indicator is determined to be in a Red Condition when monitoring measures it at more than 20% below the lower limit of the NRV, or modeling predicts it will drop to this level within 15 years, both measured across the entire RMWB.

In the event that monitoring data and model predictions identify conflicting results, the higher risk condition should be assumed, consistent with the application of a precautionary approach, providing both monitoring and modeling programs are considered equally reliable for a given indicator. The system of management response triggers has been developed using modeling of habitat effectiveness. Monitoring of habitat effectiveness and monitoring and modeling of populations represent an area of uncertainty as to how the management triggers would be applied. The number of years of monitored levels below the regional objective before a Yellow or Red condition is determined needs to be confirmed. CEMA recommends further work to advance the system from this concept to its implementation in 2011. For example, development of population-level objectives and related management response thresholds and monitoring approaches for woodland caribou, black bear, and moose need to be investigated. Consideration of the need for the same for old growth forest birds should also occur.

Table 3: Current and Forecast Condition of Environmental Indicators

Indicator	Current Condition	Source of Evidence	100 Year Forecast (Base Case)
Woodland caribou (population)	Red	Monitoring	Further declines, local extirpation expected
Index of native fish integrity	Red	Modeling and Monitoring	Further declines
Fisher (habitat)	Yellow	Modeling	Decline to Red Condition
Black bear (habitat)	Yellow	Modeling	Decline to Red Condition
Moose (habitat)	Green	Modeling	Decline to Yellow Condition
Old growth birds (habitat)	Green	Modeling	Remain within Green Condition
Area of old forests	Green	Modeling	Remain within Green Condition

Most environmental indicators are predicted through modeling to decline in the absence of management intervention. Four out of seven environmental indicators are currently in a yellow or red condition based on available information, thus requiring immediate management action to reverse the trend. Consequently, the Framework recommends broad regional strategies, and the application of specific management measures at a sub-regional scale, collectively aimed at reversing these negative trends. This suite of strategies is described in the next sections.

CEMA RECOMMENDS—

4. *Application of the system of management response triggers as described, applied at the regional scale.*
 5. *Further work to the proposed conceptual trigger system prior to implementation to ensure the system is practical and feasible, including:*
 - a. *Temporal aspects such as the length of time before an indicator is assigned a Yellow or Red condition;*
 - b. *The impact of large natural disturbance events such as fire;*
 - c. *The accountability for and frequency of modeling; and*
-

d. Parallel considerations for the related modeling and monitoring system design, particularly related to spatial and temporal resolution and potential implementation at sub-regional scales.

5.6 Regional Management Strategies

The RMWB is a very large and diverse landscape that is capable of delivering a wide range of benefits while sustaining ecological performance. Accomplishing the purpose and goals of this Framework is a complex undertaking that requires the careful selection of effective regional management strategies. The Framework recommends management strategies to achieve management objectives for both the region as a whole and the sub-regional land-use zones defined through a Triad Land Management Strategy.

Six strategies are identified as critical to the success of this framework to manage risk to values in the RMWB:

1. Triad land management;
2. NRV used as a reference for setting management objectives and measuring indicator performance;
3. Inclusion of innovative management approaches/best management practices;
4. Access management;
5. Provisions for meaningful traditional land use; and
6. Public policy adjustments.

5.6.1 Triad Land Management

The Triad is a land-use zoning strategy that seeks to enable achievements of regional environmental, social, and economic objectives by dividing a region into three zones: Intensive, Extensive, and Protected, with permissible land-use activities differing between the zones.

- The priority within the Intensive Zone is economic activities associated with resource production, transportation and urban development.
- The priority within the Extensive Zone is a balance between the maintenance of ecological integrity and sustainable production of natural resources.

- The priority within the Protected Zone is the maintenance of ecological components and processes.

The Triad is an established concept for natural resource management (see Appendix 8.5), and its application is first and foremost a risk management strategy. It explicitly recognizes that intensive resource extraction activities (even those operated under “best practices”) will have numerous and long-lasting adverse effects on ecological values. Equally, the establishment of Protected Zones, where ecological values are maintained within the range of natural variation, will constrain opportunities for economic gain. All values cannot be experienced everywhere all the time; specific values can best be achieved from areas that have the inherent capacity to deliver them. Dividing the RMWB into large zones designated for specific purposes is an effective way to make first order value trade-offs to achieve desired results.

CEMA RECOMMENDS—

- 6. The Triad be implemented as the fundamental regional management strategy to balance social, economic, and ecological values in the RMWB.*
-

The RMWB Triad includes an Intensive Zone characterized by extraction of energy resources (bitumen mining and in situ development, oil and gas) and salvage logging, where aggressive efforts are made to minimize industrial footprints and to encourage rapid reclamation. Human settlement and major infrastructure will represent permanent Intensive Zone. An Extensive Zone will allow for forestry and other activities based on the principles of forest ecosystem management, and will make significant contributions to the maintenance of regional ecological integrity. The Protected Zone will be the anchor for assuring the achievement of ecological integrity outcomes within the RMWB, providing numerous services of natural capital to society including ecological benchmarks and the maintenance of key ecosystem processes and species. Delivery of the regional objective will in part be achieved by defining the extent, location, and acceptable land uses for each of the zones (see Appendix 8.1 for a list of permitted activities by Triad zone).

Intensive Zone

Oil sands extraction is a key regional and provincial priority and this Framework does not contemplate constraining the rate or volume of bitumen produced. Further, areas underlain by bitumen would be available for development, except within the Protected Zone. However, a significant proportion of the RMWB is expected to be intensively developed at some point, and declines in environmental indicators are expected while an area is in an intensively developed condition. Constraining the area of intensive development at any one time is an important strategy towards achieving the regional objective. The intent is to ensure a balance between enabling industrial development, and providing an incentive for the quickest possible reclamation of intensively developed areas to minimize the regional ecological impacts of intensive development. The boundary of the Intensive Zone is not fixed; it will adjust in size and location as new land comes under production and used land is reclaimed and returns to the Extensive land base. The quarter-township metric is currently considered the appropriate measure for evaluating the impact of both mining and in situ footprint on ecological indicators. This is based on assumptions of the amount and configuration of footprint associated with a hypothetical in situ development as modeled, and current scientific understanding of the response of indicators to the footprint.

CEMA RECOMMENDS—

- 7. Outside the Protected Zone, bitumen would be available for development.*
 - 8. Lands undergoing bitumen development would be considered part of the Intensive Zone.*
 - 9. Constraining the Intensive Zone to between 5% and 14% of the RMWB at any time, representing the maximum area in an intensive use condition under base case and double production scenarios respectively. The Intensive Zone is measured by summing the area of all quarter townships that include intensive footprint.*
 - 10. Following reclamation, intensive lands would return to the Extensive Zone.*
-

- 11. Further work to confirm the appropriate size of the Intensive Zone and to recommend the details of how this management strategy would be implemented.*
 - 12. Validating the use of the quarter township metric as an appropriate measure to represent the impact on indicators, and to confirm details of how different types of footprints are accounted for.*
-

Extensive Zone

The Extensive Zone of the RMWB Triad is characterized by non-intensive land uses that are managed to approximate natural disturbance regimes. As such, it is a significant contributor to regional ecological integrity, while still affording economic opportunities. Social/cultural activities including recreation and traditional land uses will also occur in this zone. Land uses with practices that approximate natural disturbances such as ecosystem-based forestry will predominate.

The boundaries of Intensive and Extensive Zones will be dynamic and will change over time. Land subject to oil sands extraction is categorized as Intensive while it is under active development, but will revert to the Extensive Zone upon successful reclamation. Thus the size and location of Extensive Zone will vary through time as new oil sand facilities are developed in the Intensive Zone and then reclaimed.

CEMA RECOMMENDS—

- 13. Designation of an Extensive Zone where ecosystem forestry and other natural disturbance based activities are permitted. This zone should be at least 46% of the RMWB, reflecting the balance of the region that is not Intensive or Protected Zone.*
-

Protected Zone

The Protected Zone plays a critical role in achieving the regional objective. It is also essential to provide

ecological benchmarks to improve understanding of ecosystem function and help design and test performance of management strategies. To succeed in achieving ecological goals and to serve as ecological benchmarks, the Protected Zone must exhibit certain characteristics including:

- Proportional representation of plant communities and landforms in the RMWB;
- The ability to accommodate natural disturbance regimes and still maintain ecological indicators within their natural range of variation;
- Spatial distribution across the region (e.g. not all in the north vs. the south);
- Maintenance of connectivity among individual sites; and
- Individual sites should be as large as possible (approaching 5000 km²).

The reclamation of large tracts of previously intensively developed areas is expected. However, it is unlikely that such areas would exhibit the necessary characteristics of the Protected Zone as previously described. Therefore, CEMA recommends that the boundaries of the Protected Zone of the Triad be permanent.

CEMA supports an increase in the area of the RMWB that is protected. However, analysis to determine the minimum size and location of the Protected Zone necessary to achieve the regional objective and to serve as ecological benchmarks has not been completed. In the absence of that certainty, perspectives vary on the appropriate area for protection.

CEMA RECOMMENDS—

- 14. An expansion of protected lands to 20-40% of the RMWB; this range is reflective of the diversity of perspectives among CEMA members. Building on the analysis of environmental criteria completed to date, specific boundaries should be identified immediately for candidate protected areas to enable their prompt establishment.*
-

15. The GoA initiate and lead a process for identifying new protected areas that involves stakeholders and takes into consideration environmental, social and economic values and concludes not later than December 31, 2010.

16. Compensation be provided In those cases in which establishment of new protected areas affects some resource tenure.

In January 2008, CEMA provided the GoA with a non-consensus [recommendation](#)¹² to temporarily restrict issuance of resource tenure in three specific areas of the RMWB. This was intended to support the recommendation within this Framework to expand the Protected Zone to 20% to 40% of the RMWB.

5.6.2 The Application of Natural Range of Variation

The boreal forest is dependent on natural disturbance, particularly through fires, to maintain ecological form, function and diversity. As a result, all systems and the indicators chosen vary naturally over time and space. Thus, there is an NRV of indicators that can be expected in the absence of human influences and, in response to human influences, indicators may vary to levels outside their unique NRV, providing a reference point for when management intervention may be necessary.

CEMA RECOMMENDS—

17. Indicators be managed in reference to their NRV. Modeling has established a first estimate of NRV for selected indicators. Further work will be required to refine estimates of NRV through improved baseline data, data from monitoring programs, and results of research.

¹² http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid.1305/

5.6.3 Innovative Approaches

Consistent with a continuous improvement model, opportunities should be explored to develop innovative approaches that influence how development occurs on the landscape, particularly ways to minimize the spatial and temporal duration of disturbance footprints. Innovative approaches include the concept of applying the Best Available Technology Economically Achievable, accounting for development of new technologies for resource extraction and reclamation. Inherent in this suite of approaches is the opportunity for multi-user cooperative planning, such as ILM.

CEMA RECOMMENDS—

- 18. Pursuing ILM to coordinate and manage disturbance footprints, with land use planning and decision making being addressed for all development activities including coordinated infrastructure planning.*
 - 19. Minimizing habitat disturbance by continuously improving 'footprint to production ratios' through adoption of emerging technologies.*
 - 20. Adopting evolving methodologies to expedite aggressive, phased reclamation of existing linear corridors and mine sites, and hence reducing reclamation lag time and increase reclamation success.*
 - 21. Utilizing innovative construction and reclamation practices to promote long-term continuity and integrity of watercourses. A cooperative program to identify and rectify existing watercourse discontinuities (e.g. hanging culverts) should be implemented.*
-

5.6.4 Access Management

Access management includes a suite of approaches to reclaim historic linear footprint, reduce the creation of new linear footprint, and minimize its effective utility for movement by both humans and predators. Restricting the use of off-highway vehicles (OHV), is a critical

strategy to reduce impacts to wildlife. It is acknowledged that other forms of access controls as well as existing tools to manage harvest levels are important to address pressure on wildlife and fish resources.

CEMA RECOMMENDS—

22. Aggressive implementation of access management at a level consistent with that modeled (e.g. restriction of OHV access from 50% of the Intensive Zone and 75% of the Extensive Zone, as well as systematic reclamation of existing wide (5 - 8 m) seismic lines).

The expected rise in demand for recreational opportunities requires conscious provision of access to a variety of recreational experiences, but that access must be designed to limit the negative consequences to ecosystems.

CEMA RECOMMENDS—

- 23. Examining the science, utility and application of linear footprint density thresholds.*
- 24. Pursuing targeted reclamation of historic linear footprint that might include giving priority within new protected areas.*
- 25. Reclaiming linear footprint as soon as possible;*
- 26. Taking steps to minimize the utility of new linear footprints for OHV access.*
- 27. Development and delivery of a public education/relations initiative regarding the benefits of managing access on public lands.*
- 28. The GOA should consider available access management tools, and consult stakeholders and aboriginal communities in advance of implementation, such as:*

a. Restricting use of OHVs on linear footprints

through regulatory controls, such as Forest Land Use Zones; and

- b. Establishing designated areas for controlled recreational land uses such as intensive OHV areas as well as trail networks for back-country OHV uses.*
-

5.6.5 Traditional Land Use

The maintenance of opportunities for traditional land use is critical to the ongoing social, cultural, and economic health of Aboriginal citizens and communities and is one of the identified regional goals of this Framework. Opportunities for traditional land use exist where ecosystem integrity is maintained. This is accomplished in part through the management strategies contained in this Framework.

Traditional land use is expected to be impacted by industrial development in the Intensive Zone. Specific areas should be identified in all Triad zones where opportunities for traditional land use would be maintained, recognizing that fewer opportunities for traditional land uses may exist in the Intensive Zone. Proximity to Aboriginal communities is an important consideration to determine the potential for an area to be used for traditional purposes. This work should be guided in part by traditional land use studies that have been completed. Areas identified could be incorporated into the Protected Zone, or established as temporary conservation areas within the Extensive Zone, and/or have particular access management considerations applied. A variety of successional stages necessary to support traditional land uses (e.g. capable of supporting berry producing species, medicinal plants, small mammal or ungulate habitat) is an important consideration for the identification of reclaimed land for potential traditional use.

“My Mother told me, she said to look at the ground, this was in the summer time. Look at that little blade of grass she said it’s trying to find its way, Why do they lay concrete? We need the grass and trees for fresh air to live on this planet, what are we doing? She asked me to ask you, are we going to do something? We need the wind, the water the sun. Everyone of us is to blame. We all have furnaces, we all drive vehicles. She is battling back. Prayer is very strong, ask for Mother Earth to heal herself.”

Bernadette Dumais

CEMA RECOMMENDS—

- 29. Aboriginal people be engaged to identify areas where traditional land use can be maintained. Information on the location and availability of certified reclaimed lands for potential traditional*
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land use should be compiled every few years relative to the loss of similar traditional land use opportunities due to development.

- 30. Government and industry continue to work with Aboriginal communities (e.g. through multi-stakeholder organizations) to coordinate reclamation activities to support traditional land use on undeveloped and reclaimed areas.*
 - 31. Strategies be pursued for the conservation or management of opportunities for traditional land use within all three Triad zones.*
 - 32. Methods of successfully reclaiming land for traditional use be a research priority.*
-

5.6.6 Public Policy Adjustments

Managing the cumulative effects of development is a challenging undertaking, requiring public policy that is current, progressive and enabling. Consequently, one of the core strategies of the Framework is to identify and recommend areas of public policy that require either amendment or enhanced clarity to achieve a coordinated and comprehensive approach to managing ecosystems. These policy obstacles must be resolved; their amendment is required to achieve the objectives of this Framework and reduce the complexity of managing regional ecosystems.

CEMA RECOMMENDS—

- 33. Developing and implementing existing or new Access Management Strategies.*
 - 34. Reconciling the processes for the issuance of surface and subsurface tenure to enable an integrated delivery of management objectives.*
 - 35. Strengthening the requirements for improved rates and success of reclamation.*
 - 36. Expanding the protected zone to between 20 and 40% of the RMWB.*
 - 37. Designating areas for high intensity recreation use.*
-

38. Enabling enhanced forest management to occur on productive sites in the Green Area as an acceptable land use within the Intensive Zone.

5.6.7 Special Considerations

5.6.7.1 Woodland Caribou

Oil sands development is likely to significantly impact parts of caribou ranges within the RMWB, particularly to the Richardson and East Side Athabasca Ranges. Therefore, recovery of caribou on these ranges in the near term is unlikely. This acknowledges a trade-off between bitumen extraction and the maintenance of all caribou herds.

There are opportunities for the establishment of protected areas that would contribute to woodland caribou conservation in the RMWB. Examples include parts of the Richardson, East Side Athabasca and Red Earth ranges. Protection of all caribou habitat is unlikely; however, the strategic combination of new protected areas, access management and the use of innovative management approaches to minimize the number of linear footprints would increase the likelihood of successful stabilization and recovery of caribou in parts of the region.

Woodland caribou is a threatened species currently being managed in the context of a provincial recovery plan. The Alberta Caribou Committee (ACC) is charged with helping to deliver the recovery plan, generally guiding caribou conservation and recovery efforts, and providing recommendations to the GoA. The ACC has signaled their intent to establish an Athabasca Landscape Team (ALT) which would deliver recommendations specific to the caribou ranges in the region. The caribou herds considered by this Framework are encompassed within scope of the ALT, but the ALT also covers areas beyond the boundaries of the RMWB. CEMA's work covers a large portion of the ALT area and, while further work is needed to understand the areas not covered by CEMA, the general conclusions outlined below are likely to hold.

CEMA RECOMMENDS—

39. That conservation and recovery efforts be focused in areas of maximum likelihood of success: first and foremost in the Protected Zone, then in the Extensive Zone. Careful thought should be given prior to investing in recovery efforts in the Intensive Zone. More detailed assessment and planning by the ALT to build on the strategic modeling conducted by CEMA is appropriate. CEMA's analysis ought to be given maximum leverage by the ALT in completing this more detailed recovery planning work.

5.6.7.2 Other Species at Risk

The RMWB supports other wildlife species currently identified by the provincial and federal governments as being at risk or of special management concern, and additional species may be listed as at risk in the future. Ensuring their effective protection to allow for their survival and recovery may be required by legislation. The Framework is strategic and has not been designed to address species at risk. Other management actions within the RMWB may be required and should be based on the applicable recovery strategies or action plans developed by recovery teams for each species.

5.7 Management Intent & Strategies for Triad Zones

The following section identifies the management intent and strategies to be applied within each Triad zone. The identification of management intent reflects social choices based on stakeholder values. Management objectives trigger a management response, most of which are applied at the regional level. Strategies are proposed based on the lessons learned from the modeling, scientific research and social choices during the development of the Framework.

5.7.1 Intensive Zone

5.7.1.1 Management Intent in the Intensive Zone

The primary intent of the Intensive Zone is resource access and utilization, principally oil sands mining and in-situ development as well as other resource extraction

activities such as conventional oil and gas, timber and aggregate. The Intensive Zone is primarily characterized by hydrocarbon, mineral and aggregate extraction, and human settlement within the RMWB. Although reductions in ecological values are tolerated while development is occurring, there is an expectation that the Intensive Zone will contribute to the delivery of some ecological values through reduced footprint size and duration. Such improvements in "footprint intensity" can be measured as the ratio of footprint area to volume of bitumen produced. Progressive reclamation will enable recovery of these areas to the Extensive Zone. More specifically, the management intent within the Intensive Zone is to:

1. Provide for maximum extraction of commercial energy resources;
2. Minimize sterilization of energy resources;
3. Reduce the industrial footprint intensity;
4. Reclaim all industrial land promptly following commercial completion ;
5. Maximize recovery and utilization of merchantable timber (including salvage);
6. Identify, protect and develop aggregate resources as required;
7. Maintain the integrity of known significant cultural resources as per regulatory requirements; and
8. Designate intensive recreation destination areas.

5.7.1.2 Management Strategies

CEMA RECOMMENDS—

40. *The following strategies specific to the Intensive Zone, which are intended to be additive to the regional strategies previously discussed and to the management system currently in operation, including regulatory requirements.*
- a. *The definition of a maximum allowable area in the Intensive Zone is, in concept, intended to operate in combination with defined footprint intensities. This will require industry and government to work closely together so that any constraints are felt across the sector rather than on any particular operation. The maximum area under development at any one time within the Intensive Zone will be refined based on additional analysis, including consideration of the potential for intensive forestry.*
 - b. *Timely and successful reclamation of Intensive Zone footprint following commercial completion is a critical strategy. Regional cooperative reclamation programs should continue to pool human and financial resources. Existing links among the GoA, industry, academia and CEMA should continue.*
 - c. *Reclamation should strive to maintain, to the extent possible, the proportion of vegetation types on the intensive land base as existed in the average pre-development setting.*
 - d. *Coordination between the energy and forest sectors will also be critical, not only in terms of harvest of merchantable timber but between infrastructure development and restoration. Industry should lead the development and implementation of a coordinated infrastructure development plan. Where the forest sector is negatively impacted by energy development or the establishment of new protected areas, compensatory measures to replace lost timber will likely be required. Assuming financial compensation is not a desirable*
-

response, the ability to enhance timber supplies should be enabled through changes to public policy. Options could include establishment of intensive plantations, enhanced forest management on public land, or land exchanges.

- e. Intensive recreational use areas should be developed to accommodate increases in recreation demand from a rapidly growing population and to provide for opportunities lost through access management measures. Options for such areas include non-reclaimed overburden sites, exhausted gravel pits.*
-

5.7.2 Extensive Zone

5.7.2.1 Management Intent in the Extensive Zone

The primary intent in the Extensive Zone is to provide for economic activities while maintaining ecological values over time and space. Land use in this zone is designed to approximate natural disturbance. The Extensive Zone is characterized primarily by a mix of ecosystem-based forestry, non-industrial land uses, and traditional land use, and is critically important for the delivery of ecological benefits on a regional scale. More specifically, the management intent within the Extensive Zone is to:

1. Maintain vegetation composition, distribution and continuity of forest ecosystems;
2. Minimize industrial footprint;
3. Manage industrial and public access;
4. Maintain opportunities for traditional land use;
5. Manage opportunities for recreation;
6. Maintain a sustainable level of timber harvest, and.
7. Maintain the integrity of known significant cultural resources as per regulatory requirements.

5.7.2.1 Management Strategies

CEMA RECOMMENDS—

41. *The following strategies specific to the Extensive Zone, which are intended to be additive to the regional strategies previously discussed and to the management system currently in operation.*
 - a. *Manage the Extensive Zone according to the Natural Disturbance Model (NDM). Implementation of the NDM should focus on maintaining four patterns: 1) stand structure, including residual live trees; 2) historic age-class distribution, including older forest; 3) large aggregations of similar aged forest; and 4) within the aggregations, stand size residual patches. The NDM is based on the assumption that ecological integrity will be maintained if the ecological patterns imposed by human activities approximate the patterns imposed by natural disturbances. In northeastern Alberta, fire is the dominant disturbance and therefore should guide NDM implementation. The NDM is expected to be operationalized through the regulated forest planning process.*
 - b. *Establish ILM as a mandatory requirement for all industrial and infrastructure development, and the primary strategy for managing impacts of valid land uses that are inconsistent with the NDM, such as roads and utility corridors.*
 - c. *Enhance understanding and application of science towards the establishment of a linear feature density threshold.*
 - d. *Establish designated areas for controlled recreational land uses such as a trail network for back-country OHV uses.*
-

5.7.3 Protected Zone

5.7.3.1 Management Intent in the Protected Zone

The management intent in the Protected Zone is to preserve ecological integrity by excluding industrial development and human settlement and to allow for natural disturbances. The Protected Zone is characterized by natural disturbance, low impact recreation and traditional land use. More specifically, the management intent within the Protected Zone is to:

1. Maintain environmental indicators within their NRV;
2. Maintain representative examples of all ecosystem types and seral stages;
3. Maintain designated representative or unique landscapes in natural conditions;
4. Provide ecological benchmark areas to enable comparison with the ecological performance of Extensive and Intensive Zones;
5. Maintain opportunities for traditional land use;
6. Maintain opportunities for recreation; and
7. Protect culturally important sites.

"I was thinking about having a habitat, a place where the animals could go. Little habitats all over where nobody is allowed to go. These are the places where we could keep sacred, where we could go if we needed to be by ourselves. We need a habitat here a habitat there, just a few square miles at a time. We need to keep at least some of the land for the animals and a place for our fishes. This is all I ever wanted to have."

Violet Clarke

5.7.3.2 Management Strategies

CEMA RECOMMENDS—

42. The following strategies specific to the Protected Zone, which are intended to be additive to the regional strategies previously discussed and to the management system currently in operation.

- a. Develop a management strategy to address all forms of natural disturbances that are expected to occur within the Protected Zone, particularly fire and insects.*
 - b. Pursue targeted reclamation of existing industrial footprint.*
 - c. Develop a management strategy to guide the provision recreation opportunities, and management of OHV access.*
-

d. Develop management strategies to maintain opportunities for traditional land use.

5.8 Monitoring

Monitoring is a crucial component of the Framework and is required to assess overall performance. The monitoring system should be designed to:

- Measure achievement of management objectives and enable management responses to be triggered;
- Enable validation of modeling assumptions; and
- Track implementation of Framework recommendations.

The system should be capable of measuring performance at regional and Triad zone scales. Sufficient infrastructure to enable effective data management and reporting is critical.

The Framework has been developed utilizing assumptions and forecasts of expected terrestrial landscape disturbances. Decisions today are not made with full certainty of future activity and the resulting indicator responses. Therefore, what actually happens is not likely to be exactly what has been forecasted. These differences need to be detected and accounted for as the Framework is implemented and this will be accomplished through monitoring.

Monitoring enables the Framework to be refined periodically or corrected by measuring actual activity and indicator performance relative to expectations. In this way, future assumptions and forecasts can be improved over time, resulting in continual improvement of the Framework. This approach is often characterized as "learning by doing", or adaptive management.

Framework monitoring should be integrated with existing and emerging government and industry programs wherever possible to maximize efficiency. CEMA has completed a preliminary review of the Alberta Biodiversity Monitoring Institute's (ABMI) monitoring program and is of the view that ABMI will likely be integral to and provide a foundation for the monitoring system proposed within the Framework. The ABMI plot network, once operational, is expected to provide much of the necessary data at the regional and sub-regional scale. In this respect, CEMA fully endorses the province's support of the ABMI and encourages the GoA to move quickly to secure sustainable funding for the ABMI.

CEMA RECOMMENDS—

43. *A monitoring system be developed and implemented that consists of the following elements:*
 - a. *Wildlife habitat;*
 - b. *Fish and wildlife populations subject to feasibility;*
 - c. *Vegetation composition, age class distribution, and pattern;*
 - d. *Human and natural disturbances; and*
 - e. *Resource extraction and use.*
 44. *Further work to evaluate system design options to assess achievement of objectives and support the management response trigger system.*
 45. *The GoA move quickly to secure sustainable funding for the ABMI.*
 46. *Capitalizing on the ABMI to the maximum extent possible and, where ABMI is found to be insufficient following further evaluation, additional complementary monitoring approaches should be developed and implemented.*
 47. *Rationalizing the monitoring system with existing government and industry programs to maximize its effectiveness and cost efficiency.*
-

5.9 Management Response to Indicator Condition

Implementation of the recommended monitoring system, along with addressing uncertainties in the models (see Section 5.10), provides the basis for the following risk based approach to respond to poor indicator performance when the Framework is fully implemented in 2011 and beyond.

Green Condition

A Green Condition requires no immediate change in management approach, but consideration should be given to any projected or measured long-term trends.

Yellow Condition

Assigning a Yellow Condition is intended to be precautionary to allow time to develop and implement management responses before indicators drop too far from their regional objective. Once a Yellow Condition has been identified, further investigation may be required to understand the causes of the indicator's decline. An understanding of causation is necessary to identify appropriate management responses. Management intervention designed to reverse the declining trend and eventually bring the indicator back into a Green Condition should be initiated as soon as the appropriate actions have been identified.

Red Condition

Within one year of assigning a Red Condition to an indicator, a specific action plan should be developed and implemented to reverse the trend and return the indicator to a Green Condition. The action plan should identify immediate management interventions, and may include directed studies to improve understanding of the causes of the indicator's decline. The action plan should be developed in a multi-stakeholder forum, but the GoA should be accountable for adherence to the timeline.

For both Yellow and Red Conditions, the management interventions may involve expanded or more stringent application of one or more of the strategies identified in the Framework, or in some cases new strategies may be required. It is possible to have multiple indicators simultaneously triggering management responses (yellow or red). In such a circumstance, one action plan should be developed to integrate the needs of all indicators to ensure a coordinated management response. Indicators each respond differently to various aspects of human land uses, and a spectrum of management intervention may be required to address multiple poorly performing indicators. It may not be immediately possible to define the timeframe within which recovery to a Green Condition can be achieved, due to complex and incompletely understood ways in which land uses affect indicators, as well as significant lag times between land use activities and measurable indicator response. The primary objective of management interventions should initially be to reverse declining indicator trends. If management interventions are not having the desired effect, government together with stakeholders would be expected to evaluate options.

The potential impacts on current and future development of management interventions that may become necessary in the RMWB cannot be predicted with certainty. Discussions of costs, options, and trade-offs would need to be part of the development of an action plan.

CEMA RECOMMENDS—

48. The conceptual management response system be accepted.

49. Further work to refine the system, including appropriate actions in both Yellow and Red conditions.

While recovery of indicators to management objective levels would be achieved through application of management strategies appropriate to each zone, the Extensive Zone is critical to achieving the regional objective because of the range of management options available.

Protected Areas

The management objective in the Protected Zone is to maintain environmental indicators within their NRV. Any reduction of indicators below this objective is cause for concern, but the management response may be slightly different within the Protected Zone than elsewhere within the RMWB. Due to the restricted types of activities that are permitted within the Protected Zone, fewer management responses will exist, and the causes of indicator reductions below NRV may require focused study before causation can be determined.

Woodland Caribou

This Framework does not include a specific management response trigger for woodland caribou. Management response planning for this species at risk is already under way under the auspices of the Alberta Caribou Committee.

5.10 Addressing Modeling Uncertainties

CEMA identified the following priorities to improve knowledge and information, and to respond to a number of uncertainties that were identified during the development of the Framework:

- Complete comprehensive and consistent inventories of vegetation and footprint for the entire region;
- Refine models of the NRV for environmental indicators based on empirical evidence;
- Develop population models for key wildlife species including woodland caribou, moose, black bear, fisher and old forest birds;

- Consider altering the bird species comprising the old forest bird index. The index used by CEMA included species that are more “generalists”;
- Validate habitat effectiveness models, including responses of indicators to human disturbances and management actions;
- Validate modeling assumptions related to projected industrial development including footprint size, duration, and reclamation for both surface mining and in situ operations;
- Develop new spatial models to predict indicator response more accurately; and
- Run revised models reflecting planned management actions in combination.
- Periodically revise models and update modeling studies as additional monitoring and scientific data and TEK become available.

6.0 Implementing the Framework

The Framework is an integrated approach, designed to balance economic and social benefits while maintaining acceptable ecological performance. The Framework also carries a cost to the ecological system, and one must not presume that we can “have our cake and eat it too”. Trade-offs have been carefully considered and the Framework has emerged as CEMA’s best effort to present a consensus recommendation on the integrated management of land and ecological resources over time and space. The Framework offers a contemporary approach to social choice informed by science. Should any material changes to the Framework be contemplated, the balance of trade-offs will be affected.

The balancing of social and environmental values in the Framework did not take into account any potential implications for the treaty and aboriginal rights of regional aboriginal communities. The GoA is responsible for consultation regarding the potential implications of the Framework’s finding and recommendations. It is recommended that such consultation be undertaken immediately as it is essential to the successful implementation of the Framework.

The GoA is mandated with developing land use policy and can enable the implementation of this Framework through:

- Approval of the Framework;
- Application of existing policy;
- Amendment of existing policy; and
- Development of new policy instruments.

The Framework requires some changes in public policy to enable the achievement of desired outcomes. The GoA must first acknowledge and accept the need for policy change and then work closely with stakeholders to make those changes.

Other CEMA frameworks for air and water were not explicitly considered in the development of this Framework for potential linkages. The integrated management of cumulative effects to air, water and land is important going forward.

The development of a regional land use plan for northeastern Alberta is expected to be a requirement under the GoA's anticipated LUF. Although the boundaries of the planning region encompassed by this Framework and by the GoA's future plan for northeastern Alberta may not be exactly the same, the findings and recommendations in this Framework will generally apply to the larger region.

Based on the current and forecast condition of indicators, CEMA recommends a variety of immediate and concurrent actions. A schedule of recommended actions and timelines to enable full implementation of the Framework by 2011 is provided in Table 4. The Framework does not prescribe roles and responsibilities for completing all tasks, but this is critical to clarify.

CEMA RECOMMENDS—

- 50. The Framework be accepted by the GoA with roles and responsibilities as well as financial resourcing clearly identified.*
 - 51. The GOA immediately implement the recommendations of this Framework as per the following schedule to enable a variety of actions to be undertaken concurrently, with full implementation of the Framework by 2011 (see Table 4).*
 - 52. The GoA use this Framework to the maximum extent practicable in developing the regional plan under the LUF.*
-

Table 4: Schedule of Actions for Framework Implementation

Triad Zones	2009	2010	2011
Protected Zone	<ul style="list-style-type: none"> Identify candidate locations Assess economic and social implications 	<ul style="list-style-type: none"> Engage stakeholders and consult Aboriginal communities Final decision on specific locations 	<ul style="list-style-type: none"> Formal designations established
Intensive Zone	<ul style="list-style-type: none"> Further develop conceptual model as to how the cap on the Intensive Zone and defined footprint intensities would operate Confirm maximum area of Intensive Zone Validate use of quarter township metric to represent the impact of intensive footprint 	<ul style="list-style-type: none"> Refine operational approach Engage stakeholders and consult Aboriginal communities 	<ul style="list-style-type: none"> Institutionalize within the current regulatory framework
Extensive Zone	<ul style="list-style-type: none"> Engage stakeholders and consult Aboriginal communities Enhance understanding and application of science 	<ul style="list-style-type: none"> Establish linear feature density threshold 	<ul style="list-style-type: none"> Institutionalize within the current regulatory framework
Management Objectives and Response System			
Management Objectives	<ul style="list-style-type: none"> Evaluate feasibility of environmental objective Evaluate options for social and economic objectives 	<ul style="list-style-type: none"> Confirm environmental objective Recommend social and economic objectives 	<ul style="list-style-type: none">
Management Response System	<ul style="list-style-type: none"> Advance the system from concept to implementation Evaluate options for temporal and spatial resolution 	<ul style="list-style-type: none"> Recommend implementation details 	<ul style="list-style-type: none">
Management Tools and Policy			
Access Management	<ul style="list-style-type: none"> Engage stakeholders and consult Aboriginal communities; Develop and execute awareness campaign 	<ul style="list-style-type: none"> Identify priority areas and levels of OHV access control Further evaluate available tools Identify intensive recreation areas 	<ul style="list-style-type: none"> Deploy regulatory measures such as area designations.

Terrestrial Ecosystem Management Framework

Management Tools and Policy cont'd	2009	2010	2011
ILM Planning	<ul style="list-style-type: none"> Identify and establish industry-based infrastructure plan governance Refine/establish regulatory requirement for ILM 	<ul style="list-style-type: none"> Initiate planning 	<ul style="list-style-type: none"> Complete coordinated infrastructure plan Institutionalize ILM requirement within the current regulatory framework
Watercourse Discontinuities	<ul style="list-style-type: none"> Inventory and prioritize 	<ul style="list-style-type: none"> Develop plan, assemble resources and initiate fixes Determine need to amend standards, monitoring, or enforcement 	
Reclamation	<ul style="list-style-type: none"> Identify and prioritize historic linear footprint for targeted reclamation Review current standards, performance and science Initiate priority research on the successful reclamation of land for traditional use Coordinate reclamation related work within CEMA and with other relevant organizations 	<ul style="list-style-type: none"> Develop plan, assemble resources and initiate reclamation Engage stakeholders on standards and performance expectations 	<ul style="list-style-type: none"> Revise reclamation standards and regulatory requirements
Resource Allocation and Management	<ul style="list-style-type: none"> Review and reconcile current tenure system to deliver desired outcomes Rationalize policy on intensive forestry 		
Traditional Land Use			
Maintenance of Opportunities for Traditional Land Use	<ul style="list-style-type: none"> Engage communities to identify specific areas where TLU can be maintained 	<ul style="list-style-type: none"> Determine strategies for management or conservation of TLU areas 	
Monitoring and Research			
Monitoring systems	<ul style="list-style-type: none"> Complete the evaluation of ABMI Recommend additional design elements 	<ul style="list-style-type: none"> Develop data management capacity/ infrastructure 	<ul style="list-style-type: none"> Develop reporting systems Begin monitoring

Monitoring and Research cont'd	2009	2010	2011
Vegetation and Footprint Inventory	<ul style="list-style-type: none"> • Confirm standard and technique for data collection 	<ul style="list-style-type: none"> • Initiate regional inventory of vegetation and footprint 	
Models	<ul style="list-style-type: none"> • Refine models of NRV • Refine models of habitat effectiveness • Refine models of industrial development and footprints • Refine models of old forest bird Index species 	<ul style="list-style-type: none"> • Develop Wildlife Population models 	<ul style="list-style-type: none"> • Run revised models reflecting planned management actions in combination

7.0 Periodic Formal Review of the Framework

CEMA RECOMMENDS—

53. The Framework be reviewed and renewed every five years as part of the adaptive management process.

This allows for management actions to be implemented, performance to be assessed and consideration of new challenges to be undertaken. Consequently, it will be necessary to formally evaluate plan direction and management performance on a predictable schedule that will be transparent and responsibly engages regional stakeholders in keeping the Framework current and relevant. This should include an update of models and assumptions with new data including results of research and monitoring, and adjustment of management strategies as warranted.

8.0 APPENDICES

8.1 Table of Permissible Activities by Triad Zone

This table presents a preliminary listing of those land use activities that might be acceptable within the identified Triad zone, subject to meeting the management intent of the zone and the regional environmental management objective. The list is not intended to be comprehensive or fully prescriptive, rather to represent in general terms the nature of activities CEMA considered as appropriate within each of the zones.

Permissible Activities	Intensive	Extensive	Protected
Fishing	*	*	*
Hunting	*	*	*
Trapping	*	*	*
Snowmobiling	*	*	*
All-Terrain Vehicles	*	*	*
Cities	*		
Towns, Hamlets and Acreages	*		
Campgrounds	*	*	*
Work Camps	*		
Industrial Facilities (sawmills, gas plants)	*		
Other Industrial Developments (gravel, borrow pit, sump)	*	*	
Ecosystem-based Forestry	*	*	
Salvage Forestry	*	*	
Early Mineral or Energy Exploration	*	*	
Mineral Mining	*		
Plantation Forestry	*		
Bitumen Surface Mining	*		
In Situ (Wells, Pipelines, Seismic)	*		
Natural Gas	*		
Conventional oil	*		
Major Transportation and Infrastructure Routes	*		
High Impact Recreation	*	*	
Fire Suppression	*	*	Some
Fire Smarting	*	*	

8.2 Indicators Supporting the Terrestrial Ecosystem Management Framework

Category	Goal	Indicator
Environmental	Sustain viable and healthy populations of wildlife and fish.	Index of Native Fish Integrity
		Woodland Caribou Habitat and Population Response
		Moose Habitat and Population Response
		Fisher Habitat
		Old Growth Forest Birds Habitat
		Black Bear Habitat and Population Response
	Sustain the natural range of vegetation communities, successional patterns and ecological processes.	Area, Pattern and Age of Vegetation Types
	Preserve the diversity of species, ecosystems and landscapes	Area, Pattern and Age of Vegetation Types
		Percent Area Under Protected, Intensive & Extensive Status
Sustain natural watersheds and their elements	Water Flow Dynamics (Discontinuity of Non-mainstem River Systems)	
	Density of Linear Features (Footprints)	
Economic	Sustain a land base for timber harvest	Area of Productive Forest Land and Percentage of Growing Stock
	Maintain opportunities for oil sands and hydrocarbon reserves development	Bitumen Production m ³ (Including Coke and Asphaltenes)
		Conventional Oil Production m ³ (Light and Heavy)
		Natural Gas and Condensates Production m ³
	Maintain opportunities for Aggregate resource development	Aggregate Production Including Limestone (tonnes)
	Maintain opportunities for mineral resource development	Mineral (Non-hydrocarbon) Production Including Uranium (tonnes)
Maintain opportunities for tourism development	# of Visitors	
Resource Use	Maintain opportunities for traditional Aboriginal land use	Index of Native Fish Integrity
		Woodland Caribou Habitat and Population Response
		Moose Habitat and Population Response
		Fisher Habitat
		Black Bear Habitat and Population Response
		Area, Pattern and Age of Vegetation Types
	Sustain recreational capability and availability of wilderness opportunities	# of ha by Recreational Reserve Type (Including *High Capability*)
		# of ha of Reservation or Disposition by Recreation Type
		Density of Linear Features (Footprints)
	Maintain opportunities for consumptive, non-commercial use of fish, wildlife and plants	Recreational Hunting Harvest Level for Moose
		Recreational Hunting Harvest Level for Black Bear

8.3 Description of Process Followed in Developing the Framework

Consensus agreement on indicators developed during four workshops covering:

- *Team Principles* – discussed consensus approach to decision making in the CEMA context
- *Models and Tools* – provided overview of the chosen models and approaches and their effective use
- *Environmental, Resource Use and Economic Indicators* - selected criteria used to identify indicators including: ecological relevance, response variability, management relevance, feasibility of implementation, interpretation, utility and compatibility with selected models

Consensus agreement on regional goals for environment, social and economic needs identified through three workshops covering:

- *Goals* – ratified goals for the region
- *TEK* – developed approaches to incorporate cultural, historical, spiritual and sustainable into the Framework

Consensus agreement on regional management approach supported by one workshop:

- Adopted a Triad land management strategy as the primary basis to balance competing demands for environmental integrity and the development of natural resources

Assessment of management options, opportunities, risks and uncertainty supported by six workshops covering:

- *New Models* – developed for moose, native fish, bitumen surface mining and in situ extraction
- *Simulation Modeling* – developed strategic and spatial forecasting of a 100-year planning horizon in 4 scenarios to assess the management implications of current practices, access management, increase in protected areas and innovative industrial practices
- *Risk Assessment* – conducted sensitivity analyses to quantify risk associated with uncertainty in key forecasting assumptions including bitumen production rates and reclamation success rates

Consensus agreement on Triad Zoning, management objectives and a monitoring system supported by two workshops:

- Reviewed learning gained from quantitative modeling about key drivers and temporal factors, and conducted trade-off analyses to select management objectives for indicators
- Developed a monitoring system framework to measure indicator performance, management practices and system effectiveness, and integrate with existing initiatives such as the ABMI

Facilitation of two Elder's Circle workshops covering:

- Stories and traditional values to inform the management framework
- Feedback on overall methods to develop the Framework

Preparation of the Framework report during two workshops:

- Developed and refined content and structure of Management Framework
- Embedded linkages to on-line reference appendices

8.4 RSDS Issues Assigned to the Sustainable Ecosystems Working Group of [CEMA](#)¹³

Number	Topic	Issue
26	Fisheries - Impacts of Access on Fishing	Over-fishing pressures from increased access. The potential exists for increased access and increased human populations to impact fish populations.
27	Fisheries - Fish Conservation	Activities in the region will result in changes in flow (volume), which in turn will alter fish habitat.
37	Surface Water - Drainage Regime	Restructuring of drainage regimes may contribute to increased erosion and result in impacts to wetlands and change flow rates in tributaries, increase sediment concentration, and have an impact on fish habitat.
39	Surface Water - Surface Water	Changes in open water areas, including lakes and streams. This is an overall issue of watershed management and cumulative changes in flow regimes due to development.
45	Surface Water - Water Quality	Silt and other contaminants increase from logging and development.
48	Terrestrial - Wetland Assessment	The undetermined impact on wetland vegetation communities due to basal aquifer and surface aquifer drawdown, and the uncertainty of lateral distance of impact. This surface drawdown may cause the wetlands to dry up over a significant area, depending on the volume of water removal required to dry a wetland.
52	Terrestrial - End Land-Use	The reclaimed landscape will be used for recreational purposes, with the potential for intensive recreational activities including fishing and hunting, resulting in pressures because of increased access. The capability of the land to support and/or recover after these types of activities has to be incorporated into the closure planning. Public information about the government policy with respect to assurances that the cost of end land use will not be passed along to the public and information about how industry will finance end land use over the long term.
56	Human Health - Traditional Use Values and Mitigation	Impact of development on medicinal plants. Are the plants going to be available within a reasonable distance during development; are the plants going to be available on the reclaimed landscape; and in both cases, are they going to be safe to consume?
58	Terrestrial - Biodiversity Assessment	The Canadian Biodiversity Strategy recommends that environmental impact assessments address impacts to biodiversity. There is uncertainty about the acceptable level of detail and scope of assessments, and the expectations for restoration. Impacts to biodiversity includes changes in landscape and community levels, changes in species and genetic levels, and impacts to rare species like rare plants.
59	Terrestrial - Biodiversity Conservation	Protection of areas in the lease that are not underlain by economic oil sands and are not specifically needed for a mine as biodiversity in situ conservation areas.

¹³ Source: Regional Sustainable Development Strategy: http://www3.gov.ab.ca/env/regions/neb/rsds/rsds_final.pdf

Issue	Issue Capacity	Description
63	Terrestrial - Cumulative Impacts on Wildlife - Habitat Changes	The uncertainty about cumulative impact of individual and multiple oil sands developments on wildlife as a result of the habitat loss, and larger scale (regional) fragmentation of the ecosystem, has major implications to regional wildlife populations. This is particularly important for wildlife species of concern in Alberta such as the Red, Blue, and Yellow listed species.
64	Wildlife - Traditional Use Values and Mitigation	Impact of development on wildlife of high traditional value: moose, rabbits, aquatic furbearers, grouse, waterfowl and squirrels.
65	Terrestrial - End Land-Use	Uncertainty about the type of wildlife that the reclaimed land will sustain, and whether the wildlife (moose, rabbits, aquatic furbearers, grouse, waterfowl and squirrels) that will be sustained is congruent with traditional needs.
66	Wildlife - Traditional Use Values and Mitigation	Concern that increased activity in the region has and will result in increased "unregulated" tourism, which may occur on traditional traplines. What protection do the holders of these traplines have regarding tourism development on their lines?
67	Wildlife - Hunting	Over-hunting pressures from increased access and restrictions on hunting access within the development areas and bag limits within the region. Potential exists for increased access and increased human populations to impact wildlife populations.
69	Terrestrial - End Land-Use	Mitigation of cumulative environmental effects through regional development planning and integrated mine plans for oil sands developments.
72	Terrestrial - Forest Values	Cumulative impact of development on annual allowable cut and other forest values.

8.5 List of Documents Supporting the Framework

The following documents #1, 2, 3 and 5, are found on the members-only area of the CEMA website. Please log in to the members only website before clicking on these document. The remaining documents listed below are found on the CEMA public website at www.cemaonline.ca and the direct link for these are provided immediately following the reference.

DOCUMENTS DIRECTLY SUPPORTING THE FRAMEWORK

1. Silvatech Consulting Ltd. 2008. *Indicator Synthesis: Selection rationale, modeling results and monitoring considerations for key indicators of the Terrestrial Ecosystem Management Framework*. Available online at:
http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid,1405/Itemid,89/
2. Silvatech Consulting Ltd. 2008. *Summary of Methodology for the Development of the Terrestrial Ecosystem Management Framework*. Available online at:
http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid,1333/Itemid,89/
3. Carlson, Matt and Brad Stelfox. 2007. *The Triad Approach: A strategy for Sustainability in the Regional Municipality of Wood Buffalo*. Available online at:
http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid,1334/
4. Canadian Parks and Wilderness Society Northern Alberta and The Pembina Institute. 2006. *The TRIAD Approach: Principles and Recommendations. A Discussion Paper in Support of the SEWG Modeling Initiative*. Available online at:
http://www.cemaonline.ca/component/option.com_docman/task.doc_download/gid,1335/
5. Silvatech Consulting Ltd. 2008. *Data Inputs and Assumptions*. Available online at:
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BACKGROUND DOCUMENTS

Modeling & Management System Design Material

6. Salmo Consulting Inc., URSUS Ecosystem Management Ltd., and GAIA Consultants Inc. 2001. *Review of Predictive Modeling Tools for Wildlife and Fish Key Indicators in the Wood Buffalo Region*. Available online at:

http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1336/

7. URSUS Ecosystem Management Ltd. and Salmo Consulting Inc. 2003. *Review and Assessment of Environmental Effects Information for Wildlife and Fish Indicators in the Regional Sustainable Development Strategy (RSDS) Study Area within the Athabasca Oil Sands Region (AOSR)*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1336/
8. Golder Associates Ltd. 2003. *Information Gathering for the Development Scenario Mapping of the Regional Municipality of Wood Buffalo*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1338/

Baseline Studies

9. Forest/Land Cover/Landforms
 - a. Komex International Ltd. and Inuvialuit Environmental and Geotechnical Inc. 2003. *A Literature Review of Vegetation, Soils, Landforms, Watershed Integrity and Biodiversity*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1331/
 - b. LandMapper Environmental Solutions Inc., Soil-Info Ltd., GISmo Solutions Ltd., Geowest Environmental Consultants Ltd., AMEC Earth and Environmental Ltd. and Pettapiece Pedology. 2006. *Identify, Characterize & Quantify the Types of Landforms and Landscape Patterns Present in the Regional Municipality of Wood Buffalo*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1331/
 - c. AXYS Environmental Consulting Ltd. 2004. *Rare Plants and Special Plant Communities: Mapping and Literature Review in the SEWG Priority 1D Area, Regional Municipality of Wood Buffalo*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1339/
 - d. Bandaloop Landscape-Ecosystem Services. 2005. *Natural Levels of Forest Age-class Variability on the RSDS Landscape of Alberta*. Available online at: http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1340/
10. Wildlife Habitat and Populations

- a. Westworth Associates Environmental Ltd. 2002. *A Review and Assessment of Existing Information for Key Wildlife and Fish Species in the Regional Sustainable Development Strategy Study Area - Volume 1: Wildlife*. Available online at:
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- d. Golder Associates Ltd. 2004. *Wildlife Corridor Literature Review and Synthesis*. Available online at:
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- g. Golder Associates Ltd. 2006. *Canadian Toad Life History and Regional Habitat Model*. Available online at:
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11. Indicators

- a. Olson and Olson Planning & Design Consultants Inc., Watertight Solutions Ltd. and Bandaloop Landscape-Ecosystem Services. 2002. *Landscape, Biodiversity and Watershed Indicator Review and Assessment*. Available online at:
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- a. GISmo Solutions Ltd. 2004. *Watershed and Stream Classification*. GIS database housed by the Cumulative Environmental Management Association Resource Information System (CEMA RIS). See PowerPoint of database project available online at:
http://www.cemaonline.ca/component/option,com_docman/task,doc_download/gid,1350/

Review of Available Management Options

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- a. AMEC Earth and Environmental Ltd., Highwood Environmental Management Ltd., Clark EcoDynamics Inc. and AMEC Earth and Environmental Ltd. 2003. *A Literature Review and Intensity Analysis of Resource Use in the Regional Municipality of Wood Buffalo*. Available online at:
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