9.6.4 Implementation Table for Biodiversity

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.6.3.1 Fish Habitat			
a) Determine local and regional goals for fisheries	AEP	Meet with the community to determine local goals for fisheries in the Beaver River watershed.	H
		Review fisheries management objectives with the community.	
		Explore more opportunities for catch-and-keep fishing in the watershed, using science to help the fishery adapt and grow (GOA n.d).	
	WSGs; Municipalities; LICA	Support AEP in an effort to determine local goals for fishery by circulating information and hosting forums.	
b) Sport fish regulations	AEP	Meet with the community to determine fisheries management objectives for species other than Northern Pike and Walleye.	H
c) Fall Index Netting	AEP	Consider including additional key species in lakes in the FIN monitoring program.	H
d) Fishery monitoring	AEP; Academia; ACA	Collaborate to collect additional fisheries information using a community-based approach. Consider reporting tools, and student-led research to augment FIN data.	H
e) Fish education	LICA	Develop educational resources about the state of the fishery in the watershed, linkages to development, ecosystem processes and water quality to support a healthy fishery.	H
9.6.3.2 Fish Habitat and Restoration			
a) Water temperature monitoring	WSGs; LICA	Deploy water temperature loggers in the Beaver River and other streams based on community interests, to determine if the water temperature is meeting fish habitat needs.	H
b) Strategy to maintain water temperature	LICA	Review IBI scores and riparian intactness assessment to prioritize riparian and streambank restoration activities that could improve fish habitat conditions.	H
c) Fish spawning habitat survey	LICA, Watershed Stewardship Groups	Collaborate to better understand and document critical fish habitat in recreation lakes to inform fisheries goals and management objectives (see implementation 9.6.3.1 a).	H
		Develop resource material to inform the community about fish habitat and actions that can be taken to maintain healthy fisheries (see implementation 9.6.3.1 e).	
	AEP	Collaborate with the community to better understand critical fish habitat.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
d) Determine status of lakes closed to fishing	AEP; LICA; Municipalities; WSGs; First Nations; Metis	Lakes previously closed to fishing should be assessed to determine the current status (see implementation 9.6.3.1 a) A water quality and fish habitat suitability study for several lakes in the watershed was recently undertaken to explore opportunities to restore fish habitat. The results of this work recommended actions such as: - Fish transplants at Upper Mann, Frenchman, Minnie and Vincent Lakes - The consideration of aeration at Lower Mann, Bonnie, Muriel - Water level assessments at Lower Mann, Muriel Refer to EnviroMak Inc. (2022) for more details regarding these assessments. Use this assessment to support next steps to advance fisheries management discussions.	H
9.6.3.3 Watercourse Crossings and Stream Connectivity			
a) Manage watercourse crossings	AEP; Municipalities; AB Transportation; Industry	Consider the need for new stream crossings in project planning.	H
b) and c) Monitor and remediate watercourse crossings	AEP; WSGs; LICA	Collaborate according to the Watercourse Crossings Management Directive (GOA 2020) to inventory and prioritize crossings for remediation.	M
9.6.3.4 Shoreline Management (Littoral Zone)			
a) Shoreline habitat inventory	AEP; Municipalities; WSGs; LICA	Collaborate to map important shoreline habitat, including spawning areas at recreation lakes. Prioritize recreation lakes for shoreline habitat inventory based on community goals and fisheries management objectives (refer to implementation 9.6.3.1 a).	H
b) Administrative tools	Municipalities	Use the resulting shoreline habitat inventory (refer to implementation 9.6.3.4 a) to establish shoreline policies to preserve critical habitat and support healthy fisheries.	M
		Enforce LUBs to maintain shorelines designated as municipal environmental reserve.	H
	AEP	Maintain natural shoreline functions on Public Lands, including in provincial parks and recreation areas.	H
c) Shoreline erosion	AEP	Post speed limits in critical fish and waterfowl habitat areas in recreation lakes.	M-H
	Residents and lake users	Respect speed limits at recreation lakes in the watershed to help maintain the fishery.	H
9.6.3.5 Beavers			
a) Assess occurrence of beaver	LICA; Municipalities; Cows and Fish	Use drone technology to better understand the occurrence (distribution/abundance) of beaver in the watershed.	M-L
b) Identify beaver management tools		Identify areas where beaver activity impacts on local infrastructure or is a nuisance to adjacent landowners.	M
		Explore management options that would allow beaver activity to continue while protecting infrastructure or landowner property.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		Demonstrate the use of management tools in the watershed to increase adoption, where possible.	
9.6.3.6 Cormorants			
a) to c) Cormorant management	AEP, Municipalities; WSGs; LICA	Implement recommendations to better understand the impact of cormorants on the local fishery.	L
		Establish a community-based monitoring program that documents the occurrence of cormorants at recreation lakes and where community interest is high.	M
9.6.3.7 Key Wildlife and Biodiversity Zones			
a) Key wildlife and biodiversity zones	AEP; Industry; Municipalities	Overlay key wildlife and biodiversity zones on maps to assess potential impacts from proposed new developments.	H
b) Habitat restoration	AEP; Municipalities; WSGs; LICA	See recommendations for riparian and wetland restoration (refer to Section 9.4.3 and Section 9.5.3).	H
9.6.3.8 Aquatic Invasive Species and Disease			
a) Himalayan balsam	Municipalities; LICA; LARA; WSGs	Document the occurrence of Himalayan balsam in the watershed.	H
		Create a factsheet about Himalayan balsam and disseminate it to landowners, residents, and greenhouses. Collaborate to organize an event to hand-pull plants.	M-H
b) Implement strategies to mitigate the potential for AIS	AEP	Re-establish highway check-stops for AIS to help prevent the spread.	H
	Municipalities	Establish a boat inspection station, and boat-wash stations at major access points, particularly during fishing tournaments and peak season	H
		Provide training to summer staff working at municipal boat launches to assist with education and proper cleaning techniques for boats.	
		Work with LICA to circulate a notice to ratepayers regarding AIS risks and stewardship.	

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years

9.7 Land Use

The Cold Lake Sub-Regional Plan (CLSRP) is a statutory plan that was recently published (GOA 2022a). The CLSRP outlines a series of land management approaches and requirements for development and human footprint restoration. These aim to maintain or re-establish ecological processes, including landscape and habitat intactness, so that public lands may support the interests of all Albertans, including Indigenous peoples, now and in the future.

The three outcomes of the CLSRP align with the current Beaver River IWMP recommendations. The CLSRP regulations will not be repeated in this document, rather the Beaver River IWMP focuses on minimizing the impacts of urban development, industry (agriculture, oil and gas, forestry, sand and gravel extraction, and peat mining), and tourism and recreation footprints outside of the caribou range (entire Beaver River watershed (Figure 4) and provides recommendations to consider in the proposed Recreation Management Plan recommended in the CLSRP (GOA 2022a).

9.7.1 Goals and Objectives (from Section 6.2)

Goal: Cumulative effects of diverse land uses are reduced or mitigated to maintain and/or improve ecosystem health.

Objective 1. Recommend appropriate water and land management practices that mitigate impacts of industry (i.e., urban, recreation, agriculture, oil and gas, forestry, sand and gravel extraction, and peat mining) and development, and maintain and/or improve ecosystem health.

9.7.2 Targets and Thresholds

Targets and thresholds for ecosystem health were established in the previous sections related to water supply, water quality, riparian areas, wetlands, and biodiversity. These should be considered in all land use decision-making

Requirements for managing industry footprint in caribou range are established in the CLSRP (2022a). No additional targets or thresholds are recommended in the Beaver River IWMP to manage industry footprint. Industry should refer to the CLSRP (2022a) for current requirements related to:

- Access management
- Energy and mineral activity
- Pipeline development and maintenance
- Geophysical exploration
- Forestry
- Surface material extraction (sand, gravel, and borrow)
- Peat
- Transmission lines
- Livestock grazing
- Seismic lines

9.7.3 Recommendations

9.7.3.1 Urban Development

a) Development setbacks should account for natural variability in the hydrologic cycle and be established with consideration for flood and drought conditions, as well as for riparian health (refer to riparian area targets and thresholds Section 9.4.2).

Low impact development (LID) practices can reduce stormwater runoff volume and rate, and thereby maintain receiving water quality (City of Edmonton 2016). Low impact developments have post-development runoff conditions that mimic the pre-development rates and volumes for smaller storm events, and severe, infrequent events. This is generally achieved through the reduction of impervious surface area, integration of "green infrastructure", and stormwater capture and use in developments.

b) Stormwater inputs from urban areas to lakes should be managed to maintain the natural variability of flow rate and volume in each system. By managing stormwater runoff rates and volumes, the quality of stormwater will also invariably improve.

c) Low impact development practices should be incorporated, wherever feasible, in all new developments and/or areas of redevelopment according to the best available science. Low impact development practices may include, but not be limited to:
   - A reduction in hard surface area
   - Retention of natural areas
   - Standards for maximum footprint per lot/land area
   - Absorbent landscaping
     - Increased topsoil depths in new developments (e.g., 300 mm minimum or other appropriate depth as determined through local assessment)
     - Micro-depressions in yards
     - Gentle grades and cross-cut slopes to reduce flow rates
   - Bioretention, including rain gardens and grass swales
   - Stormwater capture and use
   - Stormwater retention ponds where runoff can be stored/treated and released at an appropriate rate
   - Dry riverbed and swales to direct runoff to treatment areas

d) Assess stormwater quality generated from different development types to determine variability in water quality and potential impacts on surface water quality.

e) Implement strategies to improve the quality of urban stormwater discharged to surface water. Consider the following:
   i. Inventory stormwater outfalls and place a sign at each site with the outfall number/name.
   ii. Ensure proper storage, handling, and application of road salt in winter, and dust suppression (e.g., calcium chloride), herbicides and pesticides during the growing season.
   iii. Stockpiled snow, when melting, can be a significant source of contaminants (e.g., salts, nutrients, sediment). Care should be taken to stockpile snow away from surface water.

iv. Consider the use of oil/grit separators to remove solids prior to discharge to surface water.
v. Use stormwater ponds and low impact development practices that manage stormwater volume and release rate to improve stormwater quality.
vi. Educate residents about their role in stormwater management.
vii. Engage partners to implement the Stream of Dreams[22] and Yellow Fish Road Program[23] in local schools.

9.7.3.2 Agriculture

a) Encourage agricultural producer participation in the Environmental Farm Plan (EFP) program.

b) For livestock operations, consider the following beneficial (best) management practices to protect and maintain water quality:
   i. Provide off-stream watering (seasonally or year-round) to prevent livestock from wading in lakes, streams, and wetlands. Off-stream watering has proven to increase weight-gain and reduce scours and hoof problems in livestock.
   ii. Manage stocking rate, timing, and duration of livestock on grazing lands to maintain healthy upland pastures.
   iii. Use temporary or permanent fencing adjacent to lakes, watercourses, and wetlands to maintain healthy riparian areas, when the management of stocking rate, timing and duration on grazing lands cannot be met.
   iv. Develop grazing management plans that promote healthy riparian areas identified by stable streambanks and supported by deep-rooted vegetation.
   v. Use bioengineering techniques to stabilize and restore eroded streambanks, where possible.

c) For farm operations, consider the following BMPs to protect and maintain water quality:
   i. Apply fertilizer at an appropriate rate to avoid excess
   ii. Practice soil conservation on cropped lands to reduce soil erosion, conserve topsoil and protect water quality.
   iii. Minimize or eliminate the use of herbicides and fertilizers adjacent to watercourses. Apply according to *AOPA*.

d) Increase collaboration between municipal Agricultural Service Boards, and other local agricultural organizations to promote the use of BMPs that protect, maintain, and improve water quality, riparian areas, wetlands, and biodiversity in agricultural areas in the watershed.

e) Consider ecological goods and services incentive programs that provide payment for maintaining riparian buffers and wetlands through strategic partnerships.

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[22] The Stream of Dreams Murals Society provides environmental education and is noted for its watershed education through a community art program. This program helps people understand their connections to water and fish habitat and how to make behavioral changes to protect rivers and lakes http://streamofdreams.ca/ .
[23] Trout Unlimited Canada's Yellow Fish Road™ program is an education program targeted to reduce water pollution. The program engages youth, community groups, environmental organizations, and others to protect water by painting yellow fish symbols with the words 'Rain Only' by storm drains and distributing informative fish-shaped brochures to nearby households reminding people that 'Only Rain Goes Down the Drain'.

9.7.3.3 Forestry

a) Apply forest industry standards to harvest practices according to the Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2022b) and the Timber Harvest Planning and Operating Ground Rules: Northeast Alberta Regional Area- Specific Addendum (GOA 2022c):
   i. Avoid excessive soil disturbance through careful planning
   ii. Avoid construction or harvest near ephemeral draws, tributaries, and source water areas. Maintain adequate buffers (minimum setbacks for disturbance from watercourses and wetlands (Appendix H-3)
   iii. Conduct proper road construction, maintenance, and reclamation. Culverts should be properly sized and installed correctly so as not to affect the natural flow of water or increase soil erosion. Consult the Code of Practice for Watercourse Crossings
   iv. Minimize the number of roads crossing streams and wetlands, and reduce the use of culverts using clear-span bridges on fish-bearing streams where practical.
   v. Avoid steep slope road construction or logging activity.

9.7.3.4 Oil and Gas

9.7.3.4.1 General

a) Industry should strive to reduce well density, linear fragmentation and overall 'footprint' in the Beaver River watershed by using innovative approaches to development and minimal disturbance practices. Apply industry standards and practices to oil and gas development in the watershed according to 'Integrated Standards and Guidelines: Enhanced Approval Process (EAP)' (GOA 2012c), *Oil and Gas Conservation Act*, and applicable AER Directives.

b) Assess strategies to reduce water quality impacts from road construction and stream crossings, including:
   - Use of existing roads and horizontal drilling techniques to access resources.
   - Collaborations with other industry sectors on road development planning.

   Refer to Recommendation 9.5.3.3 a for further road construction guidance.

9.7.3.4.2 Remediation and Reclamation

Decommissioning, remediation, and reclamation should occur in a concurrent manner immediately after abandonment of operations. Production equipment, including facilities, tankage, surface pipelines, and wellheads must be removed within one year following well abandonment. Surface improvements such as fences, gates, roads and approaches may remain in place with landowner permission

a) Environmental site assessments (Phase I and Phase II as needed) will be completed at decommissioned sites to determine if remediation measures are required prior to initiating reclamation work. Sites will be remediated to meet end-use criteria established in the Alberta Tier 1 and 2 Soil and Groundwater Remediation Guidelines (AEP 2019b; AEP 2022).

b) Reclamation activity will occur as per the Alberta Reclamation Criteria. Reclamation activity is regulated under EPEA and the Conservation and Reclamation Regulations.

c) Reclamation certificates (issued by the AER) will be received by proponents when they have demonstrated the site has been reclaimed to equivalent land capability as per the Alberta Reclamation Criteria. The AER does not have jurisdiction over Federal lands; thus, the Indian Oil and Gas Commission (IOGC) Reclamation and Remediation and Surrender Process and the Alberta Reclamation Criteria will be adhered to for projects located on First Nation Reserves.

9.7.3.4.3 Emergency Response Plans

a) Industry is responsible for having emergency response plans in place to respond to the possible occurrence of releases into the environment (e.g., from a pipeline breach, surface casing failure, or other event). Companies must develop plans in accordance with Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry (AER 2017). Industry should continue to act in accordance with the Directive.

b) Municipalities should explore the need for a community emergency response plan in the event that they are notified of a release.

9.7.3.4.4 Orphan Wells

a) Assess the extent of orphan wells in the watershed. Complete an inventory and prioritize reclamation work.

b) Recommend wells to the Orphan Well Association for reclamation. A new opt-in mechanism will also be implemented, allowing landowners to nominate sites for clean-up (ref).

9.7.3.5 Tourism and Recreation

Water is a central feature of existing and proposed tourism and recreation areas in the watershed (GOA 2022a; Figure 6). Many of these areas fall within key wildlife and biodiversity zones (Figure 5). Activities will need to be carefully considered to ensure ecological, cultural, and historical values are not compromised. The Cold Lake Subregional Plan (CLSRP) recommends actions to manage tourism and recreation, including the creation of a recreation management plan (excluding the CLAWR), and a recreational trail system network to connect important tourism and recreation features, scenery, and settings (GOA 2022a). Recommendations in the Beaver River IWMP are intended to support recreation management planning and should inform the recreation management plan created for the CLSRP. Note that proposed new Recreation Management Areas are located outside of the Beaver River watershed boundary, but any new areas will have implications for existing areas in the region. Added pressure from increased tourism and recreation may put additional stress on the local fishery.

According to the CLSRP (GOA 2022a), a recreation management plan will be developed that will:

- identify areas to prioritize for outdoor recreation and tourism development opportunities
- maintain high-quality, natural areas on the landscape that will support outdoor recreation activities and tourism development opportunities
- ensure recreation management areas support outdoor recreation activities and tourism development opportunities that are compatible with the ecological values of the area
- consider and manage land uses to ensure they do not compromise the cultural and historical values that also attract users to these areas

a) Prior to developing a recreation management plan for the area, AEP should consider the following:
    i. Inclusion of the entire Beaver River watershed in the planning area to ensure that the proposed activity considers the existing tourism and recreation footprint
    ii. Indigenous land use and traditional rights
    iii. Review available riparian intactness assessment data for Crown Land and develop a policy for its conservation (in addition to the 250 m setback established for the Beaver River and other waterbodies in the Cold Lake SRP (GOA 2022a)
    iv. Develop and/or refine fisheries management objectives with the community (refer to Recommendation 9.6.3.1 a)
    v. Identify and assess critical fisheries habitat and spawning areas (refer to Recommendation 9.6.3.4 a)
    vi. Collect user data as a socio-economic performance indicator, in addition to recreational facilities.
    vii. Consider existing plans for increasing tourism and recreation in the area:
        - The expansion of the Kinosoo Ridge Snow Resort to a four-season destination, including adventure park, camping, mountain biking
        - Development of access points along the Beaver River (e.g., egresses) at appropriate locations

b) Trail networks should:
    i. Avoid sensitive and ecologically important species-at-risk and bird habitat, and culturally significant areas
    ii. Make use of existing, linear disturbances
    iii. Have interpretive signage
    iv. Be equipped with proper washroom facilities at trail heads and tamper-proof garbage cans

c) Maintain infrastructure (e.g., roads) to support a healthy tourism and recreation economy in the watershed.

d) Collaborate with OHV clubs and trappers to construct bridges at watercourses on main trail systems.

e) Develop and provide educational stewardship resources for specific tourism and recreational users, which may include OHV clubs, campgrounds and resorts, and ice fishermen.

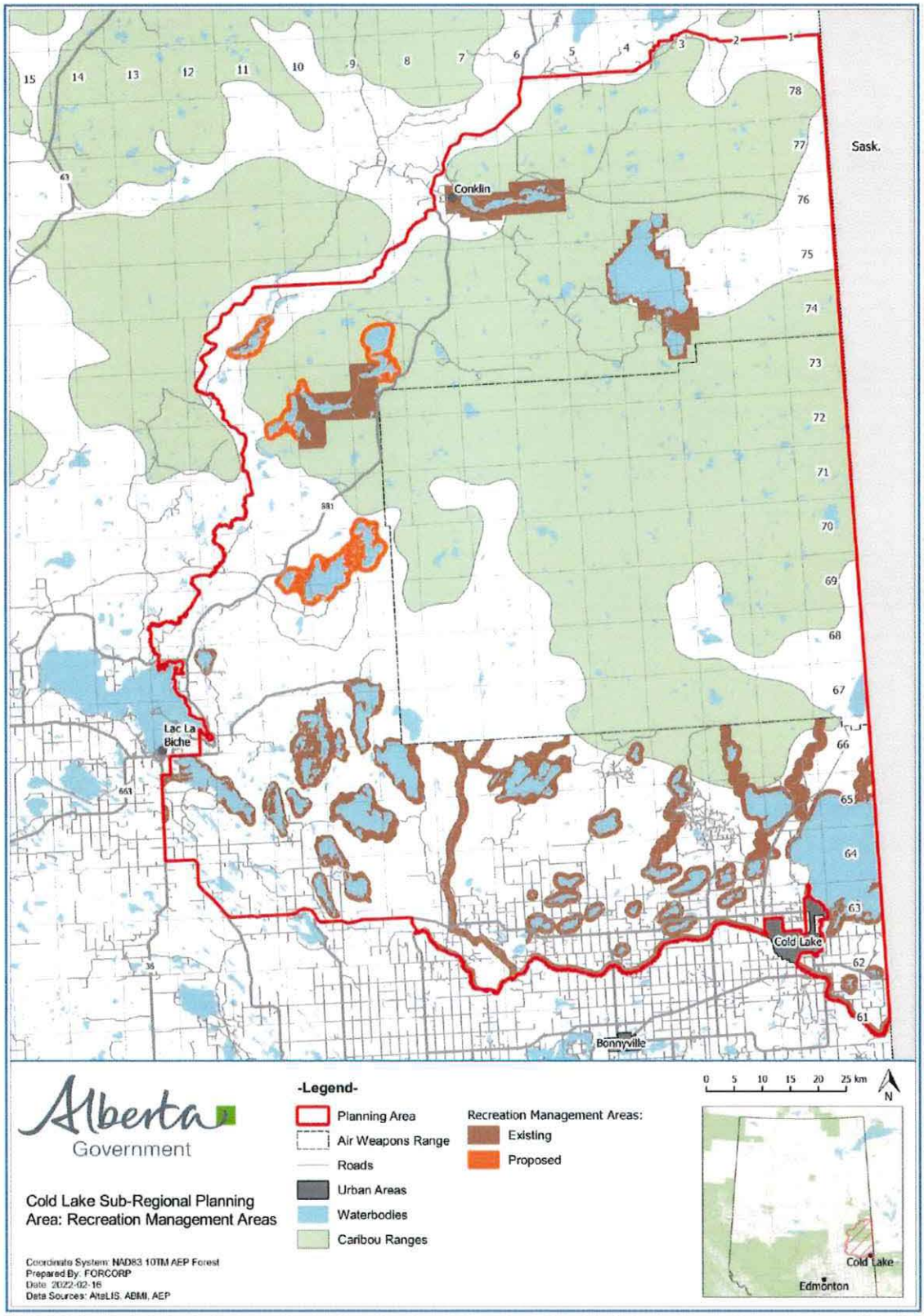

Figure 6. Existing and proposed recreation management areas in the Cold Lake Sub-region (GOA 2022).

9.7.4 Implementation Table for Land Use

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.7.3.1 Urban Development			
a) Development setbacks	Municipalities	Prioritize lakes and watercourses where flooding and impacts to infrastructure is a concern.	H
		Work with AEP to delineate floodplain maps and high-water marks for lakes and watercourses (refer to Recommendation 9.2.3.4 a).	
		Use the flood maps to refine development setbacks where appropriate.	
b) Manage stormwater release rates and volumes	Municipalities	Explore concepts of LID in urban areas to manage rates and volumes of stormwater discharge; consider deep frost and spring conditions (e.g., maximize retention in spring and release at a variable rate).	M-H
c) Incorporate LID practices	Municipalities	Review standards and procedures; consider updates to design standards, construction specification and maintenance procedures that consider LID (e.g., minimum topsoil depths of 300 mm, bioretention).	M-H
d) Assess stormwater quality	Municipalities; LICA	Plan a synoptic survey of municipal stormwater quality where surface water quality is a concern.	M
e) Strategies to improve stormwater quality	Municipalities	Where stormwater quality is poor and impacting surface water quality, explore opportunities to treat stormwater through the use of LID (bioretention), oil/grit separators or other strategies listed in Recommendation 9.7.3.1 e.	M
	Municipalities; Alberta Transportation	Develop a snow management strategy to minimize impacts of snow removal and storage on surface water, and riparian areas and wetlands.	
9.7.3.2 Agriculture			
a) Environmental Farm Plan	LICA; LARA; EFP; Municipalities (ASBs)	Promote the Environmental Farm Plan program. Encourage farmers and ranchers to participate.	H
	Farmers; Ranchers	Complete an EFP and follow-up any actions that are identified to help achieve a healthy Beaver River watershed.	H
b) and c) BMP implementation for livestock and farm operations	Farmers; Ranchers	Complete an EFP to help identify areas on the operation where BMPs may apply.	H
		Consider the BMPs listed in this Plan, and others that may be identified by the agricultural industry. Determine where they may apply to protect water quality and riparian health.	
		Seek cost-sharing opportunities to implement BMPs that result in on-farm benefits and support watershed goals (e.g., Watershed Resiliency and Restoration Program; Canadian Agriculture Program; other).	
	Municipalities (ASBs); AAF	Work with the agricultural community to relate the value of BMP implementation to on-farm and community (watershed-wide) benefits.	
d) Increase collaboration among	LICA; LARA; Municipalities (ASBs)	Establish an agricultural community network that promotes on-farm stewardship programs (e.g., EFP, CAP) and host field days and workshops relevant to agricultural producers.	H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
organizations to promote us of BMPs			
e) Ecological Goods and Services	LICA	Organize a forum to discuss ecological goods and services. Invite the Alternative Land Use Services (ALUS) or other similar organization to present to local governments and landowners.	M
	Municipalities	Participate in a forum to learn more about ecological goods and services programs.	
	Landowners		
9.7.3.3 Forestry			
a) Apply forestry industry standards	Forestry Industry	Apply industry standards to harvest practices, and seek opportunities to implement industry BMPs that result in forest benefits and support watershed goals.	H
	Alberta Agriculture and Forestry	Work with the forestry industry to relate the value of BMP implementation to forest benefits.	
9.7.3.4 Oil and Gas			
9.7.3.4.1 General			
a) Apply oil and gas industry standards	Oil and Gas Industry	Apply industry standards and practices, and seek opportunities to implement industry BMPs that support watershed goals.	H
	AER	Work with industry to promote use of minimal disturbance practices. Promote sharing of information and increased collaboration to achieve watershed goals.	
b) Road construction and stream crossings	Oil and Gas Industry	Implement best road construction practices to maintain water quality.	H
9.7.3.4.2 Remediation and Reclamation			
a) Environmental Assessment	Oil and Gas Industry	Complete environmental assessments and reclamation activity according to applicable guidelines and regulations.	H
b) Reclamation			
d) Reclamation certificates	AER; Indian Oil and Gas Commission	Determine if reclaimed sites meet the Alberta Reclamation Criteria requirements and issue certificates for sites that meet the criteria.	H
9.7.3.4.3 Emergency Response Plans			
a) Emergency response plans	AER	In the event of a release, continue to coordinate AER's response with other municipal, provincial, and federal agencies, and to follow the Energy Resources Industry Emergency Support Plan (ERIESP) during emergencies of large consequence or that require joint response from multiple government agencies.	H
	Oil and Gas Industry	Ensure that an emergency response plan has been created and continue to hold annual emergency exercises.	
b) Community emergency response	Municipalities	Engage with AER and the oil and gas community to determine how they communicate releases, and determine a mechanism to communicate risks to the public through the preparation of a Community Emergency Response Plan. Consider the Voyent Alert! App, a	M-H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		multi-purpose communication service and alerting app that is designed to support communities through rapid dissemination of targeted information (e.g., critical emergencies, or day-to-day notifications.	
9.7.3.4.4 Orphan Wells			
a) Assess the extent of orphan wells in the watershed	AER; Oil and Gas Industry	Complete an assessment of orphan wells and prioritize sites for reclamation.	M-H
b) Recommend wells for reclamation	AER; Landowners; Oil and Gas Industry; Orphan Well Association	Recommend sites for reclamation to the Orphan Well Association.	M-H
9.7.3.5. Tourism and Recreation			
a) Recreation management plan	GOA	The recreation management plan should align with the goals and objectives outlined in the Beaver River IWMP.	H
		In addition to the considerations outlined for the recreation management plan (GOA 2022), planners should consider existing watershed health data and or generate new data related to riparian and biodiversity health.	M-H
b) Trails		Collaborate with the community to plan the proposed trail network. The new trails should not impact water quality, riparian and wetland health, biodiversity or traditional uses.	H
c) Infrastructure supports (e.g., roads)		Ensure that necessary upgrades to highways/access are completed alongside promotion of tourism and recreation to improve visitor experience.	L-M
d) Bridges to span watercourses on trail network.	AEP; Municipalities	Encourage stewardship by OHV and off-road motorized vehicle clubs and users.	M
	LICA	Collaborate with OHV clubs, dealerships, and AEP to develop resources specific to the Beaver River watershed.	M-H
	Trail Users	Use bridge crossings to cross rivers and creeks when possible.	H
e) Stewardship education resources	LICA; Watershed Stewardship Groups	Continue to disseminate existing stewardship resources to the public. Develop new resources to reflect new knowledge and understanding of watershed resources.	H

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

9.8 Knowledge and Understanding

9.8.1 Goals and Objectives (from Section 6.2)

Goal: Indigenous Knowledge and scientific research guide decision-making.

Objective 1. Assess and prioritize knowledge gaps in the Beaver River watershed.

Objective 2. Recommend outreach materials and other tools to disseminate Indigenous Knowledge, and scientific research related to watershed health.

9.8.2 Targets and Thresholds

- Knowledge and understanding of key ecosystem processes increase among land managers and residents.
- Knowledge is used to support sound resource management decisions to maintain watershed health.

9.8.3 Recommendations

9.8.3.1 State of the Watershed Report

a) The Beaver River State of the Watershed Report was completed in 2013. The 2013 report should be updated to reflect the current status of the watershed condition, and consider new information collected to support the assessment.

9.8.3.2 Indigenous Knowledge

While every effort was made to gather and consider First Nations and Métis input into this IWMP through engagement, it is recognized that more conversation is needed.

a) Comprehensive knowledge of watershed resources is desired. Collaborate with First Nations and the Métis to conduct interviews/studies to document experience and knowledge to support future watershed condition reporting and decision-making.

b) Names given to places, waterbodies and watercourses provide insight into the history of an area and what the watershed may have been like pre-contact. Effort should be made to create a watershed map that includes Indigenous place names. A legend should be created that indicates the name given by the Cree, the Dene and the Métis, along with their meanings.

9.8.3.3 Climate Change, Climate Variability and Adaptation

Generally, Alberta is likely to be less cold than currently and have increased total precipitation that will occur mostly in winter and spring as a result of climate change (Zhang et al. 2019). Evaporation and transpiration are expected to increase with warmer temperatures that will contribute to more frequent and intense summer droughts and soil moisture deficits, particularly in the south (Cohen et al., 2019). Noteworthy is the distinction between the impacts of slow-onset climate change (e.g., changes in

average temperature and precipitation patterns) vs. shifts in climate variability and the occurrence of extreme weather events associated with natural hazards (e.g., floods, drought and wildfire).

a) Climate change and climate variability should be considered in all land use planning activities, particularly as it relates to the aquatic environment, such that land use decisions related to urban and industrial development, and tourism and recreation accounts for and mitigates potential future impacts of decisions to the aquatic environment.

b) Assess regional climate (e.g., evapotranspiration, ecology [aquatic, terrestrial aspen]) in the watershed for the historic period of record, and the potential impact on the occurrence of fire, flood and drought. Relate findings to regional infrastructure planning, including development, to promote watershed resiliency.

c) LICA should publish the current understanding of climate change impacts on the watershed with respect to literature and modelling.

9.8.4 Implementation Table for Knowledge and Understanding

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.8.3.1 State of the Watershed Report			
a) Update 2013 State of the Watershed Report	LICA; WSGs	LICA should review the 2013 Beaver River State of the Watershed Report. Develop a Terms of Reference for the update of this report to include new information available since 2013, including but not limited to human footprint mapping, water level trends, water quality monitoring programs, riparian intactness assessments, wetland inventory; estimates of riparian loss, biodiversity (fisheries updates). Condition indicators identified in this IWMP should be considered in the report.	H
		Establish partnerships to increase understanding of watershed resources (research and monitoring), to leverage funding and disseminate findings.	H
9.8.3.2 Indigenous Knowledge			
a) Conduct interviews and studies	LICA; First Nations; Métis; Consultant	Collaborate to document First Nation and Métis knowledge and experience to support watershed condition reporting and decision-making. This may be completed during the next 3 years, and prior to the next update of the Beaver River IWMP.	H
b) Map reflecting indigenous place names	LICA; First Nations; Métis; Consultant	Meet with First Nations and the Métis to determine indigenous place names in the watershed.	H
		Create a watershed map that identifies Indigenous names.	
9.8.3.3 Climate Change and Climate Variability			
a) Consider climate change, climate variability and adaptation in land use planning	Municipalities	Develop and adopt principles to integrate climate change and climate variability assessment in decision-making. Efforts may include research and planning, training and skills development, and infrastructure design and construction from a climate perspective.	H
		Continue to explore climate risks to municipal assets and operations, and to participate ongoing discussions and	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		programs (e.g., Building Green). Develop a climate adaptation plan when feasible.	
	AUMA; FCM	Continue to provide resources as science and understanding about climate change adaptation advances	H
b) Assess regional climate	LICA	Implications of climate change relate to a longer ice-free season, the fishery, more mixing in lakes, storage, wildfire, agriculture, among others. Collaborate to assess regional climate (historic and forecast). Evaluate climate scenarios as it relates to water quantity, water quality, riparian areas, biodiversity and land use.	M-H
		Consider connecting with the University of Saskatchewan (D. Sauchyn) for historical back-casting,	
c) Publish research findings	LICA	Disseminate climate change and climate variability findings to stakeholders to consider in stewardship planning (water conservation, landscaping, development design, other).	M

[a]H=High Priority (implement in 1-3 years); M=Medium Priority (implement in 4-6 years); L=Low Priority (implement in 7-10 years)

10.0 PRIORITIES

Implementation tables were developed to support the implementation of recommendations presented in the IWMP. The tables summarize implementation actions, identify roles and responsibilities, and suggest a preliminary timeline for each of the main values addressed in the Plan. LICA's IWMPC identified five priority recommendations (Table 20) using the following priority criteria:

1. Recommendation provides watershed-wide benefits and/or may benefit all
2. Recommendation addresses current knowledge gaps (urgent need to fill gap vs. interesting information that contributes to general scientific understanding)
3. Aligns with current work and priorities
4. Significant interest in the recommendations expressed

Table 20. List of top five priorities for Beaver River IWMP implementation.

Priority	Recommendation	Lead Role
1.	Develop and implement a long-term surface water quality monitoring program in collaboration with all stakeholders to leverage resources and achieve mutual goals.	LICA, supported by All
2.	Collaborate to implement BMPs and land use strategies to protect water quality and riparian health, particularly where riparian intactness scores are below the target and threshold and water quality is a concern.	LICA, supported by All
3.	Seek opportunities to support riparian restoration where assessments indicated health condition does not achieve targets and/or thresholds.	LICA; supported by All
4.	Collaborate with stakeholders to prioritize and develop a fishery monitoring program, including key habitat. Update fisheries management objectives prior to tourism and recreation planning (proposed in the Cold Lake Subregional Plan).	AEP
5.	Prioritize the completion of floodplain maps for watercourses and high-water marks for lakes to support implementation and enforcement of urban development setbacks through policy and planning.	Municipalities; supported by AEP

11.0 DEFINITIONS

Abandoned A site that is permanently dismantled (plugged, cut and capped) and left in a safe and secure condition. These are also often referred to as decommissioned sites.

Baseline Condition A standard or point of reference against which thing may be compared or assessed.

Bed and Shore Public lands which form the definable channel of a river, stream, or watercourse; or the basin of a lake of other permanent and naturally occurring body of water that is bound by a bank as defined in section 17 of the *Surveys Act* which may or may not be fully covered by water. The shore is the exposed bed when not fully covered by water (GOA 2022a).

Consultative Notations (CNT) are used to "flag" an interest in the land (e.g., administrative, planning or land inventory process) by a particular agency. They don't place restrictions on land use, but alert potential applicants to the agency's concern. Industry also uses consultative notations (identified as a CNC) to show an interest in the land.

Development Includes urban and recreation developments.

Ecological services The direct and indirect benefit that ecosystems provide for humans.

Eutrophication Enrichment of aquatic ecosystems by plant nutrients (e.g., phosphorus and nitrogen); characterized by increased growth of plants and algae. The process of eutrophication can be accelerated by human activity (e.g., effluent disposal, land drainage), and can have negative impacts on aquatic health.

Goals Broad statements that reflect the main concerns for natural resource management in the basin; goals emphasize what the IWMP will accomplish (the outcomes of the Plan).

Inactive A well or associated facility where activities have stopped due to technical or economic reasons. Not all sites in this category are orphaned. Many may be reopened and produce again at a later date.

Indicators Specific physical, chemical, biological, sociological and economic attributes of the watershed and the environment that reflect conditions and dynamics of the broader ecosystem. Indicators can represent human activities on the landscape and the environmental response to those activities.

Indigenous Knowledge held by First Nations, Inuit and Métis peoples that is transmitted from generation to generation. Indigenous Knowledge emerges from complete knowledge systems and is expressed in many formats (e.g., oral, ceremony, artistic creations, and artifacts). Indigenous Knowledge is not all in the past; there is continued growth, innovation and change in practices. Indigenous Knowledge includes history, law, spirituality, agriculture, environment, science, medicine, animal behaviour and migration patterns, art, music, dance, craft, construction, among others. Indigenous (Traditional) Knowledge is held collectively by all members of a community, although some members may have particular responsibility for its transmission. The terms "traditional knowledge" and "Indigenous knowledge" are sometimes used interchangeably (University of Alberta 2020; Government of Canada 2020b).

Industry Generally, refers to oil and gas, forestry, agriculture, sand and gravel extraction, and tourism and recreation, among others.

Intactness In reference to the condition of natural habitat, intactness refers to the extent to which habitat has been altered or impaired by human activity, with areas where there is no human development being classified as high intactness (Fiera Biological 2021b).

Integrated Watershed Management Plan (IWMP) A guidance document and planning tool for resource managers, including governments, planners, Indigenous communities, other stakeholders and landowners. An IWMP identifies goals for improving and/or maintaining watershed health, and makes recommendations on how to reach those goals. An implementation strategy accompanies the IWMP that will indicate implementation roles and responsibilities, priorities and timelines. Through implementation, the plan strives to achieve common goals.

Land Use All uses of land, such as agriculture, forestry, conservation, recreation, tourism, oil and gas, mining, utility corridors, transportation, cities and towns, industrial development, etc. (GOA 2022a).

Littoral Zone The nearshore interface between the terrestrial ecosystem and the deeper zone of a lake.

Low Impact Development A land planning and engineering design approach to managing stormwater runoff. The approach includes land use planning and conservation, as well as engineered hydrologic controls to replicate the pre-development hydrologic regime of watersheds by infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.

Natural Condition Background conditions due only to non-anthropogenic sources.

Objectives Measurable and may be used to indicate milestones throughout the planning process.

Orphan A well or facility confirmed not to have anyone responsible or able to deal with its closure and reclamation.

Protective Notations (PNT) Reservations are placed by public agencies in consultation with the public land manager. They identify land and resources that are managed to achieve particular land use or conservation objectives. Protective notations identify the agency that has placed the reservation, show allowable land uses and may give management guidelines for integrating different uses on the land. Restrictions on land use are based on the characteristics of the land itself. These include soil, vegetation and surface materials and drainage. Local and regional factors such as fish and wildlife requirements or timber regeneration and access, also receive consideration. A protective notation may be triggered by an application for a new or different land use, a municipal or provincial plan (e.g., Integrated Resource Plan) or other government programs. Protective notations specify different levels of allowable land use - limited development, grazing only, or no agricultural use at all. The public may request a review of the notation if they wish to have specific parcels considered for a land use that has been identified as incompatible.

Reclamation The process of replacing soil and re-establishing vegetation on a wellsite so it can support activities similar to those it could have supported before it was disturbed.

Remediation The process of cleaning up a contaminated well site to meet specific soil and groundwater standards.

Riparian lands are transitional areas between upland and aquatic ecosystems that have soil and vegetation characteristics that reflect the influence of water. They have variable width and extent both above and below ground.

Setback A minimum distance that must be maintained between a land use or development activity and a waterbody/watercourse.

Strahler Order: A method of classifying and assigning a numeric order to streams in a network based on the number of tributaries. First order streams are dominated by overland flow and have no upstream concentrated flow; whereas higher order streams have a greater number of upstream tributaries. Stream order increases when streams of the same order intersect (Fiera Biological 2021b).

Surface Water Allocation Directive In the absence of a Ministerial Order, water management plan, water conservation objective, or an environmental management framework, the Surface Water Allocation Directive (SWAD) (GOA 2021) is applied and provides water allocation and use guidance for all new water licences across all sectors, including Temporary Diversion Licenses (TDLs), under the *Water Act.* The SWAD incorporates the fundamental ecological principle of maintaining natural hydrologic variability.

Targets and Thresholds Used to determine how valued components in the watershed rate or compare to acceptable or desired ratings. Numerical or written statements that provide a measurable indication of success in achieving plan objectives.

Thermal mobilization Refers to the mobilization of trace metals when heat or steam is used to assist in the recovery of heavy oil.

Tradition Land Use Traditional land use (TLU) refers to any land use by an Indigenous person that is rooted in their cultural identity and ancestral connection to certain areas. This includes the Treaty right to hunt, fish, and trap for food, but may also include plant harvesting and/or spiritual ceremonies. Analogous terms or phrases may include any combination of 'Indigenous', 'aboriginal', or 'ancestral' and 'users', 'land uses' or 'harvesting'. TLU is often shown as map data or geographic information in both qualitative and quantitative forms.

Fisheries Management Objectives Convey current fishery status, the desired future condition of the fishery (objectives and indicators), the management approach for achieving objectives (fisheries regulations, habitat protection recommendations) and challenges or limitation to achieving objectives. Consultation with stakeholders for setting FMOs typically occurs at the area or local level (ESRD 2014).

Water Conservation Objective (WCO) The amount and quality of water established by the Director under the Water Act, based on information available to the Director, to be necessary for the (i) protection of a natural water body or its aquatic environment, or for the (ii) protection of tourism, recreational, transportation or waste assimilation uses of water, or (iii) management of fish and wildlife, and may include water necessary for the rate of flow of water or water level requirements (adapted from the Water Act).

Watershed: An area that, on the basis of topography, contributes all water to a common outlet or drainage point. Watersheds can be defined and delineated at multiple scales, from very large to very small local watersheds (e.g., square metres, such as a small prairie wetland) (Fiera Biological 2021b).

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13.0 APPENDIX

APPENDIX A. KEY STAKEHOLDERS, FIRST NATIONS, AND MÉTIS

Academic
Lakeland College
Portage College

Business and Industry
ATCO
Green Alberta Energy

CFB Cold Lake

Economic Development
Cold Lake Chamber
Bonnyville Chamber
St. Paul Chamber
Lac La Biche Chamber
Travel Lakeland

Federal government
Agriculture Canada
Fisheries and Oceans Canada

First Nations
Beaver Lake Cree Nation
Cold Lake First Nations
First Nations Technical Services Advisory Committee
Frog Lake First Nation
Kehewin Cree Nation
Saddle Lake Cree Nation
Whitefish (Goodfish) Lake First Nation #128

Industry
Bonnyville Chamber
Cold Lake Chamber
Forestry
Kalinko Enterprises
Lac La Biche Chamber
North East Bulk Transportation
Oil and gas
- Cenovus
- Husky
- Imperial
- Nexen
- OSUM Oils Sands Corp
- CNRL
- Devon Energy

St. Paul Chamber

Local Government (elected officials and staff)
Athabasca County
City of Cold Lake
Lac la Biche County
MD of Bonnyville
Smoky Lake County
St. Paul County
Thorhild County
Town of Bonnyville
Village of Glendon

Local Organizations
Beaver River Naturalists Society
Bonnyville Fish and Game Association
Crane Lake Advisory and Stewardship Society
Lac La Biche Birding Society
Lakeland Agricultural Research Association
Moose Lake Watershed Society
Muriel Lake Basin Management Society
Riverland Recreational Trail Society
Skeleton Lake Stewardship Association

Local Youth

Métis Settlements
Buffalo Lake Métis Settlement
Elizabeth Métis Settlement
Fishing Lake Métis Settlement
Kikino Métis Settlement

Métis Nation of Alberta Regions 1

Métis Nation of Alberta Regions 2

Provincial Government/Regulators
Alberta Energy Regulator (AER)
Alberta Environment and Parks (AEP)
Alberta Agriculture and Forestry (AAF)
Alberta Health (AH)

Provincial/Regional Associations
Agri-Environmental Partnership
Alberta Beef Producers Association
Alberta Biodiversity Monitoring Institute (ABMI)
Alberta Conservation Association
Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA)
Alberta Forest Products Inc (ALPAC)
Alberta Lake Management Society
Alberta Native Plant Council
Alberta Trappers Association
Alberta Wilderness Association
Canadian Association of Petroleum Producers
Cows and Fish (Alberta Riparian Habitat Management Society)
Ducks Unlimited Canada
Land Stewardship Centre

APPENDIX B. SUMMARY OF PREVIOUS PLANNING INITIATIVES, MANAGEMENT FRAMEWORKS, AND RELEVANT LEGISLATION, REGULATIONS AND GUIDELINES

B.1. Previous Provincial Planning Initiatives

The following provides a brief overview of provincial planning initiatives since 1985.

Cold Lake-Beaver River Water Management Plan (1985)

The Cold Lake-Beaver River Water Management Plan (CLBR WMP) was prepared in partnership with Alberta Environment, LICA, and the Cold Lake-Beaver River Basin Advisory Committee. The CLBR WMP was authorized by Alberta Environment under the *Water Act* in 1985 to manage water resources in the Cold Lake and Lower Beaver River Basin (Alberta Environment 1985). The intent of the plan was to provide adequate water quantity and quality to meet the long-term user requirements of the basin. The CLBR WMP made specific recommendations concerning:

- Major oil sands water supply
- Municipal, agricultural, industrial, and minor oil sands water supply
- Surface and groundwater quantity
- Surface and groundwater quality
- Identified lakes to be managed for the purposes of conservation, fisheries, wildlife or recreation.

The CLBR WMP (1985) projected a long-term increase in use of freshwater for industrial activity based on anticipated industrial and population growth in the region. However, this projected demand was not realized. After the plan was complete, significant improvements were made by industry to the efficiency of water use through water recycling and technology that enabled the use of brackish groundwater in operations. Although freshwater use diminished there was a greater need to assess and develop a better understanding of groundwater quality, availability and use.

Cold Lake Sub-Regional Integrated Resource Plan (1996)

The Cold Lake Sub-Regional Integrated Resource Plan (IRP) was initiated in 1986 by an interdepartmental planning Team coordinated by AEP's Strategic and Regional Support Division. The plan was prepared in response to the development of heavy oil and oil sands resources in the area. The Plan was approved by Cabinet in 1996 (AEP 1996a). The planning area covered the eastern part of the Beaver River watershed, excluding the Sand River, First Nation lands, Métis Settlements, and any other federal or private lands. The purpose of the IRP was to promote the coordinated management of public land and resources within the Cold Lake planning area to achieve maximum economic, environmental and social benefits for Albertans. The resource management strategy was based on a 20-year time period. The plan focused on energy, agriculture, forestry and recreation.

Cold Lake-Beaver River Water Management Plan (2006)

In 2006, the Cold Lake-Beaver River Water Management Plan (CLBR WMP) (Alberta Environment 1985) was updated by Alberta Environment, LICA and the Basin Advisory Committee. The 2006 Authorized Water Management Plan intended to provide direction in managing water resources in the combined Cold Lake-Lower Beaver River basin — specifically, to provide adequate water quantity and quality to meet long-term user requirements (Alberta Environment 2006a). The revised plan was prompted by increased industrial and population growth and extended periods of below-normal precipitation that occurred after the original plan was completed. The combined growth and dry weather had resulted in record low water levels in the area's lakes, and low flows in rivers and streams.

Four State of the Basin reports were developed for the Cold Lake-Beaver River area to support planning:

- Surface water quality (Alberta Environment 2006b)
- Surface water quantity and aquatic resources (Alberta Environment 2006c)

- Groundwater quantity and brackish water (Alberta Environment 2006d)
- Groundwater quality (Alberta Environment 2006e).

Key issues and objectives for the WMP were based on the findings presented in the State of the Basin reports. Recommendations addressed:

1) Water Supply and Demand
2) Surface and Groundwater Quality
3) Strategies for Protection of Aquatic Resources

These recommendations reflected additional stewardship needs in the basin, beyond infrastructure and engineered solutions (e.g., dams and diversions). Although regulatory (under the direct mandate of Alberta Environment) and non-regulatory (Best Management Practices) tools were provided to implement the recommendations, no implementation plan was developed to direct activity.

The updated 2006 WMP retains the same planning area as the original 1985 Plan (Figure B.1) and continues to focus on lakes, downstream rivers, and aquifers that are most likely to be affected by existing water withdrawals and future withdrawal applications (AEP 2016). The extent to which the recommendations in the CLBR WMP (2006) were implemented is unclear.

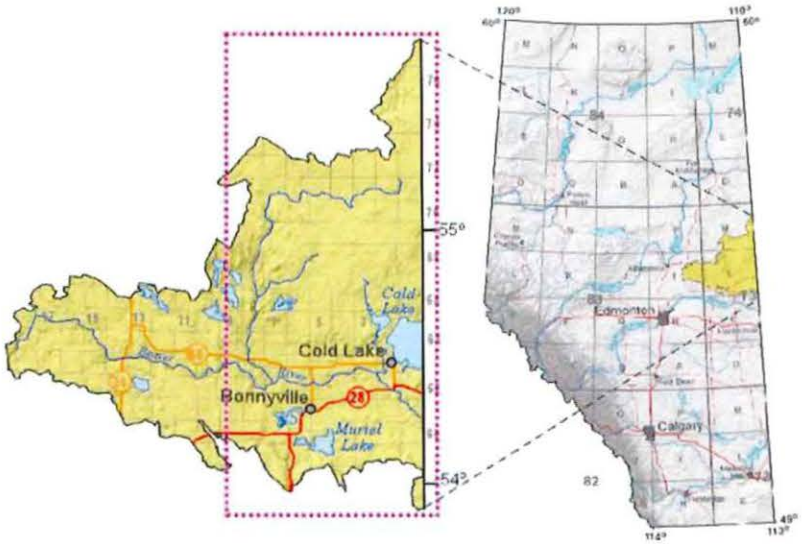


Figure B.1. Cold Lake-Beaver River Water Management Plan planning area (2006) (AEP 2016). Note boundary corrections were made in 2022.

Lower Athabasca Regional Plan (2012)

In August 2012, the Government of Alberta (GOA) approved the Lower Athabasca Regional Plan (LARP) (GOA 2012) which encompasses the Lower Beaver River watershed in its planning area. To support the LARP, the GOA is developing a series of Management Frameworks to identify management targets for air quality, surface water quality, groundwater, biodiversity and landscape management. To date, the Groundwater Management Framework, Surface Water Quality Management Framework, and Surface Water Quantity Management Framework (2015) have been completed. The Biodiversity Management Framework is in draft form (2014), and the Landscape Management Plan is underway. A summary of the frameworks is found in Appendix B.2.

Cold Lake Subregional Plan (2022)

The Cold Lake Subregional Plan (GOA 2022) is intended to support a working landscape, which considers the economy, while also supporting caribou and other species, Indigenous traditional land use, and recreational activities. The Plan focuses on retaining and reclaiming caribou habitat by reducing the human footprint in critical habitat areas.

B.2. Current Provincial Management Frameworks and Plans

Groundwater Management Framework (2013)

The GOA completed the Groundwater Management Framework in 2013 to support the Lower Athabasca Regional Plan (ESRD 2013). The Framework outlined two objectives for groundwater quality and quantity:

- Regional Groundwater Quality Objective: Groundwater quality is protected from contamination by maintaining conditions within the range of natural variability and not exceeding established limits.
- Regional Groundwater Quantity Objective: Groundwater resources continue to support human and ecosystem needs and the integrity of the regional flow system is maintained.

The Groundwater Framework requires the creation of site-specific groundwater management strategies and groundwater management plans (ESRD 2013). These actions are guided by:

- The Groundwater Monitoring Directive (2016)[24], which assists operators of industrial facilities across Alberta in developing and implementing site-specific Groundwater Management Plans.
- The Guidance Document for Groundwater Management Plans for In Situ Operations (pending)[25], which assists operators of in situ oil sands facilities in developing and implementing Groundwater Management Plans specifically, for the management of thermally mobilized elements.

Surface Water Quality Management Framework

The Surface Water Quality Management Framework for the Lower Athabasca applies to the Lower section of the Athabasca River, from just downstream of the Grand Rapids (approximately 135 km upstream of Fort McMurray) to the Athabasca River Delta. Water Quality Limits (WQLs) only apply to AEPs monitoring station on the Athabasca River at Old Fort. Although the framework does not apply to the Beaver River watershed, the goals and principles in the Framework are relevant for future planning.

The goals of the Surface Water Quality Management Framework are to:

1) Identify ambient surface water quality triggers (WQTs) and ambient surface water quality limits (WQLs) to protect surface water quality, clarify Government of Alberta expectations, address cumulative effects, and support pollution prevention and proactive management strategies.
2) Enhance transparency and assurance through regular monitoring, evaluation and reporting on ambient surface water quality conditions within the Lower Athabasca River from the Grand Rapids downstream to the Athabasca River Delta.

While no specific water quality objectives were developed in the provincial *Framework* for the Beaver River watershed, Environment Canada, on behalf of the Prairie Provinces Water Board, monitors water quality in the Lower Beaver River upstream of the interprovincial boundary and in the Cold River at the outlet of Cold Lake. Water quality objectives are established for the Beaver River and the Board regularly reports on whether the objectives have been met (Appendix F.1.). Water quality objectives have not been determined for the Cold River, the Upper Beaver River, or other major tributaries in the basin (BRWA 2013).

Biodiversity Management Framework (2016)

In November 2014, the GOA completed the draft Biodiversity Management Framework for the Lower Athabasca watershed. This draft went for public consultation with comments received to January 16, 2016. The framework applies to public land in the Green Area and provincial parks in the Lower Athabasca Region. While the objectives set in this framework apply to the entire Lower Athabasca Region (including private lands), any actions by

[24] The Groundwater Monitoring Directive and the Guidance Document for Groundwater Management Plans for *In Situ* Operations are not completed as per the Groundwater Management Framework for CLBR. The directive has not been implemented yet; stakeholder consultation for the directive has been scheduled for early Fall 2016.

[25] For *in situ* operations, two directives were developed: 1) The assessment of thermally mobilized constituents and, 2) The assessment and management of non-saline groundwater in direct contact with bitumen. A decision to post these directives to the GOA website is pending (M. Klebek, pers. comm.).

landowners towards meeting objectives is voluntary and subject to availability of tools that support their stewardship efforts.

The Biodiversity Management Framework maintains the following objectives:

- Biodiversity and healthy, functioning ecosystems continue to provide a range of benefits to Albertans and communities in the region, including First Nations' continued ability to exercise constitutionally protected rights to hunt, fish, and trap for food.
- Species at risk are recovered and no new species at risk are designated.
- Long-term regional ecosystem health and resiliency are sustained with consideration of natural disturbance patterns and processes.

Air Quality Management Framework

The Air Quality Management Framework includes setting ambient air quality triggers and limits for nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) with guidance for long-term decision making and management.

Landscape Management Plan

The Landscape Management Plan (LMP) will address issues related to the extent and duration of land disturbances (e.g., access management, recreation, industry access to resources, and Aboriginal interests and priorities) for public land in the Green Area (GOA 2015). The LMP is divided into smaller Resource Management Areas (RMAs) to address local priority issues separately. The following RMAs are relevant to the Beaver River watershed:

- Moose Lake RMA – an important area for traditional land use
- Richardson Backcountry RMA – an important area for traditional land use and motorized recreation
- South Athabasca Oil Sands RMA – a primary area for projected in-situ oil sands development

The Landscape Management Framework proposes to:

- Consider biodiversity indicators and caribou habitat requirements
- Set key areas for progressive and timely reclamation or restoration of legacy footprint
- Implement avoidance and minimization strategies through Integrated Land Management (ILM) practices to ensure areas that are currently intact remain relatively intact
- Set management direction for motorized and non-motorized access in the RMAs, or other areas as required
- Manage the cumulative effects of in-situ development and other footprint in the South Athabasca Oil Sands area
- Establish setbacks and buffers to protect river corridors, lakes and wetlands.
- Incorporate applicable Integrated Resource Plan (IRP) provisions
- Develop a system for monitoring and reporting linear footprint and land disturbance

Northern Pike Recreational Fisheries Management Framework (GOA 2018d)

Walleye Recreation Fisheries Framework (GOA 2018c)

B.3. Other Relevant Legislation, Policies, Plans, Guidelines, and Procedures

This compilation of relevant legislation, policies, strategies and guidelines was modified from descriptions provided in the Lower Athabasca Regional Plan management frameworks (ESRD 2012, ESRD 2013 and ESRD 2014) and other documents and is intended as a general reference. Consult the original documents when applying the legislation, policies and guidelines described below.

B-3.1 Federal

Legislation, Policy, Strategies and Guidelines	Description
Canadian Environmental Protection Act	The primary purpose of CEPA is to contribute to sustainable development through pollution prevention, and the protection of the environment and human health. CEPA sets environmental objectives, guidelines and codes of practice that are used by provincial jurisdiction to develop provincial objectives and standards. Of significance is the *Canadian Water Quality Guidelines* that provide parameters to manage water resources to meet specific uses. CEPA can be used to inform the process of setting outcomes, limits and thresholds in watershed management plans.
Canadian Environmental Assessment Act (2012)	Establishes federal requirements for the environmental assessment and review of projects that have the potential to cause significant adverse environmental effects in areas of federal jurisdiction. Regulations set out a list of physical activities that will or may require an environmental assessment pursuant to CEAA. The Minister of the Environment may designate a physical activity that is not included in the Regulations if he is of the opinion that it warrants an environmental assessment under the Act.
Fisheries Act (Department of Fisheries and Oceans Canada (DFO))	Contains two key provisions on conservation and protection of fish habitat essential to sustaining freshwater fish species. DFO administers section 35, the key habitat protection provision, prohibiting any work or undertaking that would cause the harmful alteration, disruption or destruction of fish habitat. Environment and Climate Change Canada administers section 36, the key pollution prevention provision, prohibiting the deposit of deleterious substances into waters frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation. A deleterious substance can be any substance that, if added to any water, would degrade or alter its quality such that it could be harmful to fish, fish habitat or the use of fish by people. Regulations include the Pulp and Paper Effluent Regulation.
Migratory Birds Convention Act	Implemented to protect and conserve migratory birds, as populations and individual birds, and their nests.
Species at Risk Act (SARA)	The purposes of SARA are to prevent wildlife species in Canada from disappearing, to provide for the recovery of wildlife species that are extirpated (no longer exist in the wild in Canada), endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened. When a species is listed as endangered, threatened or extirpated under *SARA* it becomes illegal to kill, harm, harass, capture or take an individual. A recovery strategy and one or more action plans based on the recovery strategy must be prepared.
Accord for the Protection of Species at Risk	The Accord outlines commitments to designate species at risk, protect their habitats and develop recovery plans.

Legislation, Policy, Strategies and Guidelines	Description
National Framework for Species at Risk Conservation	Supports the implementation of the 1996 Accord for the Protection of Species at Risk by providing a set of common principles, objectives and overarching approaches for species at risk conservation that all participants can share and work toward in a collaborative way.
Canadian Biodiversity Strategy	Alberta is a signatory to the Canadian Biodiversity Strategy (1995), a commitment under the 1992 United Nations Convention on Biological Diversity that Canada signed. Alberta, and other Canadian jurisdictions, agreed to use the Strategy and the Biodiversity Outcomes Framework for Canada (2006) as guides for actions to conserve biodiversity and to use biological resources in a sustainable manner.
Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment (CCME))	CCME is the primary minister-led intergovernmental forum for collective action on environmental issues of national and international concern. CCME is comprised of the environment ministers from the federal, provincial and territorial governments. It provides science-based goals for the quality of aquatic and terrestrial ecosystems, especially water and soil quality guidelines.
Guidelines for Canadian Drinking Water (Health Canada)	The Guidelines for Canadian Drinking Water Quality are established by the Federal-Provincial-Territorial Committee on Drinking Water (CDW) and published by Health Canada.
Guidelines for Canadian Recreational Water Quality (Health Canada)	The main purpose is the protection of public health and safety and is aimed primarily at responsible authorities and decision-makers. It provides guidance on factors that can interfere with the safety of recreational waters from a human health perspective. It recommends the adoption of a preventive risk management strategy that focuses on the identification and control of water quality hazards prior to the point of contact with the recreational water user. It also recommends the use of a multi-barrier approach as the most effective means for protecting users from exposure to water quality hazards in recreational waters.
Programs	
Habitat Stewardship Program for Species at Risk	The goal of the HSP program is to contribute to the recovery of endangered, threatened, and other species-at-risk, and to prevent other species from becoming a conservation concern, by engaging Canadians from all walks of life in conservation actions to benefit wildlife.

B.3.2 Provincial

Legislation, Policy, Strategies and Guidelines	Description
Agricultural Operations Practices Act (AOPA)	Provides the framework for resolving conflicts between agricultural producers and urban/rural non-agricultural producers.
Alberta Land Stewardship Act (ALSA)	The legal basis for regional land-use planning in Alberta; it authorizes the provincial Cabinet to establish planning regions and adopt a statutory plan for each region.

Legislation, Policy, Strategies and Guidelines	Description
Environmental Protection and Enhancement Act (EPEA)	Supports and promotes the protection, enhancement and wise use of the environment and provides a framework for evaluating and controlling the environmental impacts of development. It includes a broad regulatory framework consisting of detailed regulations and codes of practice. EPEA regulates activities that could adversely affect the environment, provides requirements for land conservation and reclamation of industrial activities and contaminated sites, and sets out the criteria and methods when an Environmental Impact Assessment is required. Some aspects of EPEA apply directly to water management and these include the regulation of the drilling of water wells and groundwater protection, the treatment and supply of water for human consumption, and the regulation and management of wastewater and storm water. The Act expressly dictates that "no person shall knowingly release or permit the release of a substance into the environment in an amount, concentration or level or at a rate of release that is in excess of that expressly prescribed by an approval, a code of practice or the regulations"
Water Act	To support and promote the conservation and management of water, including the wise allocation and use of water. This legislation is the primary regulatory mechanism for the management of water resources in the province. The Act sets out rules for the water management planning, environmental assessments, rights to divert and use, priority rights and security of use, transfer of water allocations, approvals for working in and around water, water management works and undertakings, dispute resolution, enforcement. The Act is supported by regulations and codes of practice.
Fisheries (Alberta) Act and General Fisheries (Alberta) Regulation	The *Alberta Fishery Regulations* (1998) was made pursuant to the Federal *Fisheries Act* by the federal government and regulates sport and commercial fisheries in Alberta. The *Fisheries Alberta Act* does not regulate catch limits, restrictions, or fisheries in Alberta, rather this act regulates licensing and regulation of fish buyers and processors, aquaculture operations, and the appointment of fisheries officers for the administration of the Federal *Fisheries Act.*
Forests Act and Timber Management Regulation	Provides the legal framework for the management of forests on public land, including rules for tenure, policies and regulations for acceptable logging methods, standards for wood utilization, and the management of non-timber values. The Timber Management Regulation and Timber Harvest Planning & Operating Ground Rules set forth standards and guidelines for timber harvest planning and specifically stipulate setbacks for timber harvest adjacent to any water body. See Table 2.3 for more detailed information about timber harvest riparian setback operating ground rules. (Fiera – Riparian Lands)
Forest and Prairie Protection Act	Establishes regulations in regard to fire control, prevention and education in the forested and prairie land in Alberta.
Municipal Government Act	Provides municipalities with the authority to regulate water on municipal lands, manage private land to control non-point source pollution, and regulates land use practices for the protection of aquatic environment. Includes the Subdivision & Development Regulation, Land Use Bylaw; Intermunicipal Development Plan, Municipal Development Plan, Area Structure Plan, Area Redevelopment Plan
Provincial Parks Act	Provides the regulatory tools and mechanisms to establish and maintain parks and recreational areas. It specifies the conditions for the establishment of parks, the rules for the acquisition of lands, land dispositions and prohibition of activities for the protection of natural and cultural resources.

Legislation, Policy, Strategies and Guidelines	Description
Public Health Act	Prevention and suppression of disease. Groundwater and surface water are sources of drinking water and provide for recreational water uses. Maintaining these waters in an uncontaminated state, free from chemical or bacterial pollution, helps ensure the prevention or suppression of disease. Private drinking water wells and sanitary systems need to be privately managed to ensure health standards and regulations are being achieved.
Public Lands Act and Public Lands Administration Regulation	This Act provides for the disposition of all provincial public lands in the white zone of Alberta under the administration of the Minister. This Act and its regulations empower the Minister and his/her officers to regulate public lands, to determine their appropriate use, considering all aspects of their physical, economic and environmental constraints. In Alberta, the Province owns most of the beds and shores of all naturally occurring lakes, rivers and streams. Approvals may be required for activities that may impact the bed and shore of a waterbody.
Provincial Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act	Provides the regulatory tools and mechanisms to establish and maintain ecological reserves, natural areas and heritage rangelands. It specifies the conditions for their designation and establishment, and the rules for land dispositions and prohibition of activities for the protection of natural and cultural resources.
Wildlife Act and Wildlife Regulation	When a wildlife species has been designated as endangered or threatened under the *Wildlife Act* it becomes illegal to harvest, traffic, and disturb the nest or den of that species. For endangered and threatened species, a recovery plan will be produced, often involving advice from a recovery team.
Policy	
Alberta Wetland Policy	The Alberta Wetland Policy provides the strategic direction and tools required to: allow for continued growth and economic development in the province; make informed management decisions in the long-term interest of Albertans; and minimize the loss and degradation of wetlands. The goal is to conserve, restore, protect and manage Alberta's wetlands to sustain the benefits they provide to the environment, society and economy.
Industrial Release Limits Policy	Outlines the approach followed by AEP staff to develop industrial release limits for approvals under the *Environmental Protection and Enhancement Act*.
Woodland Caribou Policy for Alberta	A provincial policy that guides implementation plans for caribou ranges to maintain and restore habitat and carefully manage wildlife that may impact Woodland Caribou populations.
Alberta's Biodiversity Policy	Sets the provincial direction for biodiversity management frameworks in Alberta. It states Alberta's commitment to the conservation of biodiversity and the sustainable use of biological resources for the continuing benefit of society. The policy will provide high-level guidance for other activities affecting biodiversity (e.g., species management, forest management and energy sector planning and development)
Water Conservation and Allocation Policy for Oilfield Injection (2006)	The goal of the policy and guideline is to reduce or eliminate allocation of non-saline (fresh) water for oilfield injection, while respecting the rights of current licence holders.

Legislation, Policy, Strategies and Guidelines	Description
Strategies	
Water for Life: Renewal (2008)	Review and reaffirm the GOAs commitment to managing water quality and quantity wisely to benefit current and future generations. It reaffirms the three goals of *Water for Life*: safe, secure drinking water supply; healthy aquatic ecosystems; and reliable quality water supplies for a sustainable economy. The renewal also calls for integration of watershed planning with regional planning under the Land Use Framework and sets clear direction for improved watershed management. This includes: increased focus on regional drinking water and wastewater solutions; accelerated action on achieving aquatic ecosystem goals; development and implementation of a viable governance system to support sustainable water management; and improved monitoring, evaluation and reporting.
Strategy for the Protection of the Aquatic Environment	A requirement of the *Water Act* and major component of the Framework for Water Management Planning. The strategy details the GOA's commitment to maintaining, restoring or enhancing the condition of the aquatic environment, and considers: • The amount of water available or water quantity; • The chemical, microbiological and physical characteristics of the water or water quality; • The physical and biological structure of the water body and the land surrounding it or habitat; and • The plants and animals living in or associated with water bodies, wetlands and riparian areas or aquatic species. The strategy represents an integrated approach to water management in Alberta and applies to all activities and decision-making that could affect the aquatic environment.
Alberta's Strategy for the Management of Species at Risk (2009-2014)	The strategy provides direction for Alberta government staff involved in species at risk management. It is useful to Alberta residents particularly those involved with recovery teams, advisory committees and project partnerships, by helping them understand species at risk program processes, priorities and activities. The goal of the strategy is to ensure that populations of all wild species are protected from severe decline and that viable populations are maintained, and where possible, restored.
Fish Conservation and Management Strategy for Alberta (2014)	Sets out ESRD's vision and mission statements, guiding principles, and goals and objectives for fisheries management. The strategy describes what ESRD will do to manage Alberta's fisheries resources for conservation and sustainable use. It commits ESRD to maintaining biodiversity with respect to fish populations, including species diversity, genetic diversity, and ecosystem diversity.
Alberta's Forest Strategy	Sets direction for the long-term sustainable management of Alberta's forests through an integrated planning approach incorporating wildfire management and forest health considerations along with the performance measures set out in the Alberta Forest Management Planning Standard.
Guidance Documents	
Stepping Back from the Water (2012)	Assists municipalities, watershed groups, developers and landowners in Alberta's settled region determine appropriate water body setbacks for development around our lakes, rivers and wetlands.
Integrated Standards and Guidelines – Enhanced Approval Process (2013)	In collaboration with industry, ESRD consolidated more than 200 guidelines to allow for consistent application of standards across the province, and clarity of regulator expectation on industry. The EAP allows industry to self-attest to achieving stated long-term environmental outcomes and objectives, and the province the ability to provide timely review/approval of

Legislation, Policy, Strategies and Guidelines	Description
	proposed developments. Enhancements to the *Public Lands Act* provide government with tools to take appropriate action if industry does not comply with the process.
Water Quality Based Effluent Limits Procedures Manual	This manual describes procedures for setting water quality-based effluent limits for industrial and municipal discharges in Alberta.
Alberta Soil and Groundwater Remediation Guidelines (2014)	The intent is to maintain soil and groundwater to the highest quality, applying codes of practice, guidelines, policies, and programs to protect them. Assessment and monitoring tools for restoring the quality of soil and groundwater are also developed.
Environmental Quality Guidelines for Surface Waters in Alberta (2018)	Water quality guidelines are science-based numeric concentrations or narrative statements that are recommended to protect various water uses (aquatic life, agriculture (livestock watering and irrigation), recreation and aesthetics.
Frameworks	
Framework for Water Management Planning	This tool outlines the process for water management planning and the components required for water management plans in the province. It is intended to provide general guidance for the planning process. This framework was developed for water management planning under the Water Act rather than the watershed management planning outlined in *Water for Life*.
Alberta Timber Harvest Planning and Operating Ground Rules	Provide direction to forest companies and government for planning, implementing and monitoring timber harvesting operations on timber disposition areas in Alberta.
Alberta's Land-use Framework (LUF) (2008)	Sets out a new approach for managing Alberta's land and natural resources to achieve long-term economic, environmental and social goals. The LUF established land-use regions and called for regional plans.
Plans	
Plan for Parks	Provides a blueprint to guide decisions for managing parks. This long-term plan will help: ensure the sustainability of natural landscapes; enhance recreational opportunities; help to improve the quality of life for Albertans; and ensure the province's parks and recreation areas remain protected yet accessible to Alberta's growing population.
Draft Provincial Woodland Caribou Range Plan	The plan is intended to look at caribou range planning provincewide, with a mind to the environmental and economic realities of individual ranges.
Programs	
Aquatic Invasive Species Program	Campaign to help protect provincial water bodies from aquatic invasive species (e.g., zebra and quagga mussels). The GOA has developed educational materials (e.g., Clean, Drain, Dry, Pull the Plug, and Don't Let It Loose). Print materials (e.g., quick facts, posters, and signage) are available. The program continues to identify the public's role in helping with solutions, working with stakeholder groups to coordinate control efforts, and enhancing legislation, regulations and risk assessment tools.

Legislation, Policy, Strategies and Guidelines	Description
Environmental Flows Program	Provides policy recommendations, conducts environmental flow studies researches aquatic and riparian habitat, reviews water licence applications, works with other agencies and WPACs to set flow and water standards that support healthy fish and wildlife populations.

B.3.3 Municipal

Plans, Policies and Strategies	Description
Statutory Plans (MGA Sections 631-638)	Provide general development policies for all or part of the municipality. Legislation provides for four statutory plans: Municipal Development Plans, Intermunicipal Development Plans, Areas Structure Plans and Area Redevelopment Plans.
Municipal Development Plans (MDPs)	Plan adopted by council that establishes policies for land use. Required by the MGA where population greater than 3500. Recommended for municipalities where population is less than 3500.
Intermunicipal Development Plans (IDPs)	Adopted by two or more municipalities for shared interest in land management (e.g., fringe area within urban/rural municipalities or where municipalities share natural features, such as lakes).
Area Structure Plans (ASPs)	Establish the general land use, transportation and servicing framework for specific areas undergoing substantial new development.
Area Redevelopment Plans	Outline proposals for addressing planning issues when rejuvenating existing developed areas.
Land Use Bylaws (MGA Sections 639-640)	Regulate the use and development of parcels of land. Development is defined as an excavation or stockpile, construction, renovation or repairs to a building, a change in the use of land or intensity in the use of land. All municipalities are required to adopt a land use bylaw. The land use bylaw divides the municipality into districts, prescribing permitted and/or discretionary uses for each district. The bylaw establishes development standards within each district and provides for a system for issuing development permits.
Subdivision Control (MGA Sections 652-670)	To create one or more lots from a parcel of land a subdivision approval from the municipal subdivision authority must be obtained. Conditions may be attached to a subdivision approval, such as: 1. Provide land as environmental reserve (MGA Section 664). 2. Provide up to 30% of the land, less any land taken for environmental reserve or environmental reserve easement, for roads and public utilities. 3. Provide up to 10% of the land for municipal and/or school reserves. 4. Enter agreement to construct or pay for the construction of roads, walkways, public utilities, or off-street parking necessary to serve the development. 5. Pay an off-site levy for the capital cost of water, sanitary sewer, or drainage facilities.

APPENDIX C. Sub-Watersheds

The Beaver River watershed is comprised of ten sub-watersheds that were previously defined in the Beaver River state-of-the-watershed report (BRWA 2013) (Figure 1).

Upper Beaver Sub-Watershed: Refers to the area upstream of the confluence of the Sand River, which contributes substantial flow and affects downstream water quality in the Beaver River (BRWA 2013). The Upper Beaver River has not typically been included in previous planning initiatives.

Amisk River Sub-Watershed: Located south of the Upper Beaver, originates in a former glacier outwash channel at Long Lake in the west. The Amisk River drains several large lakes and is considered a major tributary of the Beaver River (BRWA 2013).

Moose Lake River Sub-Watershed: Rises in the extreme south and joins the Beaver River a few kilometers upstream of the Sand River confluence. The watershed contains a number of long, shallow lakes within glacial outwash channels that generally flow north into Thinlake River before joining Moose Lake (BRWA 2013).

Sand River Sub-Watershed: The Sand River drains much of the watershed north of the Beaver River, including the Cold Lake Air Weapons Range. This river is considered a major tributary to the Beaver River. The upper part of the watershed lies in the central mixed wood natural sub-region, while the lower part is in the dry mixedwood sub-region (BRWA 2013). A major tributary to the Sand River is the Wolf River.

Lakeland Sub-Watershed: This area is comprised of the western tributaries that flow into the Sand River and includes Touchwood Lake, Spencer Lake, Seibert Lake, and Pinehurst Lake.

Manatokan and Jackfish Creek Sub-Watersheds: These sub-watersheds rise in the Moostoos Upland near the southern boundary of the Cold Lake Air Weapons Range. Manatokan Creek and Jackfish Creek flow south to join the Beaver River.

Marie Creek Sub-Watershed: Similar to Manatokan and Jackfish creeks, Marie Creek originates in the Moostoos Upland in the Cold Lake Air Weapons Range and flows south to join the Beaver River at Canadian Forces Base (CFB) – Cold Lake. Marie Lake is a dominant feature in the watershed.

Muriel Creek Sub-Watershed: Muriel Creek flows north to join the Beaver River south of CFB-Cold Lake. This sub-watershed is represented by Muriel Lake, and numerous smaller lakes, including Sinking lake, Jessie Lake and Charlotte Lake.

Lower Beaver River Sub-Watershed: This area includes the Beaver River lowlands from the confluence of the Sand River to the inter-provincial boundary, as well as Reita and Redspring creeks that flow from the south into the Beaver River east of CFB-Cold Lake.

Cold Lake Sub-Watershed: Cold Lake, the deepest lake in the watershed, and Primrose Lake are dominant features shared by Alberta and Saskatchewan. Medley River enters Cold Lake from the north and Martineau River (rising in Saskatchewan) enters Cold Lake from the north-east.

APPENDIX D. Preliminary Assessment of Lake Water Level Fluctuations at the Watershed Scale

The Alberta River Basins online database, as well as other local studies, were consulted to provide a preliminary assessment of lake water level trends and variability to support IWMP discussions. While a complete evaluation of lake water levels is beyond the scope of this plan, the intent was to identify potential lakes where more detailed hydrological investigation may be warranted.

Historic recorded water levels were plotted from the Alberta River Basins database (online), and descriptive water level statistics were computed (i.e., median, minimum, maximum and range). The results were used for a comparison of water level trends and variability of lakes in the watershed (Table D.1). Medoid Partitioning was used to cluster individual lake water level ranges into low, moderate and high degree of relative variability categories (relative to other lakes in the watershed for the period of record), where:

- Low variability: <1.7 m
- Moderate variability: ≥1.7 m and <3.2 m
- High variability: ≥3.2 m

Generally,

- Declining lake level trends were observed at: Mann, Skeleton, Manatokan, Charlotte, Jessie and Muriel lakes
- Increasing lake level trends were observed at: Kehewin, Pinehurst, Touchwood lakes
- Variability in lake water levels was rated high at Mann, Marie and Muriel

Table D.1. Preliminary assessment of lake water levels (descriptive statistics derived from data sourced from AEP).

Subwatershed	Watercourse/ Waterbody	Water Quantity – Lake Water Levels						Variability
		Period of Record	Median	Min	Max	Range	Trend	
Amisk	Amisk Lake	1969-2021	611.69	611.18	612.34	1.16	Stable	Low
	Long Lake	1969-2021	620.82	620.35	621.91	1.56	Stable	Low
	Mann Lake - Upper	1968-2021	614.48	611.30	616.32	5.02	Declining	High
	Mann Lake - Lower	1972-2021	614.28	612.25	616.20	3.94		
	Skeleton Lake (N)	2012-2021	621.92	621.61	622.86	1.25	Declining	Low-Moderate
	Skeleton Lake (S)	1965-2021	622.94	621.61	623.89	2.27		
Cold Lake	Cold Lake	1999-2022	534.94	534.00	535.59	1.59	Stable	Low
	Primrose Lake (N)	1992-2021	598.91	598.25	599.78	1.52	Stable	Low
	Primrose Lake (S)	-	-	-	-	-		
Lower Beaver	Angling Lake	1973-2021	556.89	556.52	557.72	1.20	Stable	Low
	Fishing Lake	No Data	-	-	-	-	-	
Manatokan/ Jackfish Creek	Manatokan Lake	1973-2002	555.23	554.14	556.08	1.94	Declining	Moderate
	Osborne Creek	-	-	-	-	-	-	
Marie Creek	Moore (Crane) Lake	2018-2022	549.25	548.25	550.31	2.06	Stable	Moderate
	Ethel Lake	1999-2022	541.18	540.30	541.77	1.47	Stable	Low
	Marie Lake	2000-2020	573.78	534.93	574.64	39.72	Stable	High
Mooselake River	Kehewin Lake	1967-2021	539.55	538.95	540.36	1.41	Increasing	Low
	Moose Lake	1950-2021	532.66	531.95	534.10	2.15	Stable	Moderate
Muriel Creek	Charlotte Lake	1972-2002	548.28	547.49	549.88	2.39	Declining	Moderate
	Jessie Lake *High water concern*	1968-2019	548.07	547.25	549.32	2.07	Declining	Moderate
	Muriel Lake	1967-2022	555.86	555.16	560.43	5.27	Declining	High
Sand River-Lakeland	Pinehurst Lake	1968-2021	598.83	597.69	599.46	1.78	Stable-Increasing	Moderate
	Touchwood Lake	1969-2021	631.83	630.90	632.27	1.37	Increasing	Low
	Wolf Lake	1968-1992	597.37	597.03	597.72	0.68	Stable	Low
Upper Beaver	Beaver Lake	-	-	-	-	-	-	
	Elinor Lake	-	-	-	-	-	-	

APPENDIX E. Lakes of stakeholder interest in the Beaver River watershed.

Effort was made to understand which lakes in the Beaver River watershed could benefit from additional management attention (e.g., monitoring, restoration). Lakes of public interest were identified during Engagement Session I discussions (PESL 2021). Additional lakes were included in the preliminary assessment if they were identified as:

- Important recreation lakes
- Having unique features that may contribute to poor water quality or be negatively impacted by poor water quality (BRWA 2013)
- Lakes that have increased risk to water quality from external pressures (BRWA 2013) (e.g., shoreline development, recreational activity, point source discharge, poor riparian condition)
- Lakes that have active stewardship groups to support management
- Summer village lakes: Skeleton Lake (Bondiss; Mewatha Beach), Moose Lake (Bonnyville Beach, Pelican Narrows)
- Lakes having cultural significance to First Nations and Métis

Table E.1. Select lakes of interest identified through Engagement sessions (highlighted in green) and a review of other lake values, including water quality and riparian condition, and importance to biodiversity, recreation, and the economy.

Subwatershed	Waterbody or Watercourse	Water Level		Water Quality	% Riparian Area Intact	Importance to Biodiversity	Fishery Risk[c]		Recreation[d]
		Trend	Variability				Northern Pike	Walleye	
Amisk	Amisk Lake	Stable	Low	-	96		H	L-M	
	Long Lake	Stable	Low	Eutrophic	90		L	L	
	Mann Lake - Upper	Declining	High	Eutrophic	85				
	Mann Lake - Lower			H-Eutrophic	87				
	Skeleton Lake (N)	Declining	Low-Moderate	Mesotrophic	69		M-H	M-H	
	Skeleton Lake (S)			Eutrophic					
Cold Lake	Cold Lake	Stable	Low		-				Major
	Primrose Lake (N)	Stable	Low	Eutrophic	-	White Pelican[a]			
	Primrose Lake (S)			Mesotrophic	-				
Lower Beaver	Angling Lake	Stable	Low	Mesotrophic	-				Secondary
	Fishing Lake	-	-	-	-				
Manatokan/ Jackfish Creek	Manatokan Lake	Declining	Moderate	-	66				Secondary
Marie Creek	Moore (Crane) Lake	Stable	Moderate	Mesotrophic	NA		M-H	VH	Major
	Ethel Lake	Stable	Low	Mesotrophic	72		L	M	Major

Subwatershed	Waterbody or Watercourse	Water Level		Water Quality	% Riparian Area Intact	Importance to Biodiversity	Fishery Risk[c]		Recreation[d]
		Trend	Variability				Northern Pike	Walleye	
	Marie Lake	Stable	High	Mesotrophic	94		VH	H	Major
Mooselake River	Kehewin Lake	Increasing	Low	H-Eutrophic	69		H	H	
	Moose Lake	Stable	Moderate	Eutrophic	66		M-H	H	Major
	S. Trib Kehewin Lake	-		-	65				
	S. Trib Kehewin Lake-01	-		-	20				
	UL-120201-02	-		-	74				
Muriel Creek	Charlotte Lake	Declining	Moderate	-	4				
	Jessie Lake *High water concern*	Declining	Moderate	H-Eutrophic	33				
	Landry Lake B	-		-	32				
	Muriel Creek	-		-	36				
	Muriel Lake	Declining	High	Eutrophic	68	Piping Plover	E	E	Major
Sand River-Lakeland	Pinehurst Lake	Stable-Increasing	Moderate	Mesotrophic	-		VH	H	
	Touchwood Lake	Increasing	Low		-		H	H	
	Wolf Lake	Stable	Low	-	-		H	-	Secondary
Upper Beaver	Beaver Lake	-		Eutrophic	95	Trumpeter Swan[a,b]	VH	H	
	Elinor Lake	-		Mesotrophic	99	Trumpeter Swan[a,b]	H-L		
	Vincent Lake								

[a] Important Bird Area

[b] Designated buffer zone around lake to protect habitat

[c] Low (L); Moderate (M); High (H); Very High (VH); Extirpated (E)

[d] Major recreation lakes: those lakes generating 30,000 user-days of activity per year; Secondary recreation lakes: Have fewer facilities and generate less than 30,000 user-days of activity per year; Minor recreation lakes: Have few facilities and user activity is low (May, Reita and Tucker).

APPENDIX F. Beaver River Water Quality Objectives and Tributary Baseline Conditions

F.1. Water Quality Objectives for the Beaver River, Beaver Crossing to Border (PPWB 2021).

Nutrient objectives were developed for the Open water season (April 1 to October 31st) and the Closed ice-covered season (November 1 to March 31). The objective is the 90th percentile of the period of record. A 10% excursion frequency is expected for the period of record objective (PPWB 2013).

Table F.1. PPWB WQOs.

Chemical, Physical or Biological Variable	Unit	Acceptable Limit or Limits		Application
Nutrients		**Open**	**Closed**	
Total Phosphorus	mg/L	0.171	0.127	Background
Total Dissolved Phosphorus	mg/L	0.043	0.042	Background
		0.060	0.060	Background
Total Nitrogen	mg/L	1.140	1.862	Background
Nitrate as N	mg/L	3		Protection of Aquatic Life
Ammonia Un-ionized	mg/L	0.019[a]		Protection of Aquatic Life
Major Ions				
Total Dissolved Solids	mg/L	500		Ag Irrigation + Treatability
Sulphate Dissolved	mg/L	250		Ag Livestock
Sodium Dissolved	mg/L	200		Treatability
Fluoride Dissolved	mg/L	0.19		Background
Chloride Dissolved	mg/L	100		Ag Irrigation
Physical and Other				
pH Lab or Field	pH Units	6.5-9.0		Protection of Aquatic Life
Oxygen Dissolved Temperature > 5°C	mg/L	5	-	Protection of Aquatic Life
Oxygen Dissolved Temperature < 5°C	mg/L	-	-	Protection of Aquatic Life
Sodium Adsorption Ratio	mg/L	3		Ag Irrigation
Total Suspended Solids	mg/L	3.0-48.8		Background
Reactive Chlorine Species	mg/L	0.0005		Protection of Aquatic Life
Cyanide (free)	mg/L	0.005		Protection of Aquatic Life
E. Coli	No/100 mL	200		Recreation
Coliforms Fecal	No/100 mL	100		Ag Irrigation
Metals				
Arsenic Total	µg/L	5		Protection of Aquatic Life
Arsenic Dissolved	µg/L	No Objective		Protection of Aquatic Life
Barium Total	µg/L	1000		Treatability
Berylium Total	µg/L	100		Ag Irrigation & Livestock
Boron Total	µg/L	500		Ag Irrigation
Cadmium Total	µg/L	Calculated[b]		Protection of Aquatic Life
Chromium Total	µg/L	50		Treatability
Cobalt Total	µg/L	50		Ag Irrigation
Copper Total	µg/L	Calculated[b]		Protection of Aquatic Life
Iron Dissolved	µg/L	300		Treatability
Lead Total	µg/L	Calculated[b]		Protection of Aquatic Life
Lithium Total	µg/L	2500		Ag Irrigation
Manganese Dissolved	µg/L	40	2270	Background
Mercury Total	µg/L	0.026		Protection of Aquatic Life

Chemical, Physical or Biological Variable	Unit	Acceptable Limit or Limits	Application
Molybdenum Total	µg/L	10	Ag Irrigation
Nickel Dissolved	µg/L	Calculated[b]	Protection of Aquatic Life
Selenium Total	µg/L	1	Protection of Aquatic Life
Silver Total	µg/L	0.25	Protection of Aquatic Life
Thallium Total	µg/L	0.8	Protection of Aquatic Life
Uranium Total	µg/L	10	Ag Irrigation
Vanadium Total	µg/L	100	Ag Livestock
Zinc Dissolved	µg/L	Calculated[b]	Protection of Aquatic Life
Pesticides			
2,4-D	µg/L	4	Protection of Aquatic Life
Bromoxynil	µg/L	0.33	Ag Irrigation
Dicamba	µg/L	0.006	Ag Irrigation
MCPA	µg/L	0.025	Ag Irrigation
Picloram	µg/L	29	Protection of Aquatic Life
Endosulfan	µg/L	0.003	Protection of Aquatic Life
Hexachlorocyclohexane (gamma-HCH) (Lindane)	µg/L	0.01	Protection of Aquatic Life
Hexachlorobenzene	µg/L	0.52	Ag Livestock
Pentachlorophenol (PCP)	µg/L	0.5	Protection of Aquatic Life
Altrazine	µg/L	1.8	Protection of Aquatic Life
Diclofopmethyl (Hoegrass)	µg/L	0.18	Ag Irrigation
Metolachlor	µg/L	7.8	Protection of Aquatic Life
Metribuzin	µg/L	0.5	Ag Irrigation
Simazine	µg/L	0.5	Ag Irrigation
Triallate	µg/L	0.24	Protection of Aquatic Life
Trifluralin	µg/L	0.2	Protection of Aquatic Life
Glyphosate	µg/L	Report Detections	Protection of Aquatic Life
AMPA	µg/L	Report Detections	Protection of Aquatic Life
Fish Tissue			
Mercury in fish (muscle tissue)	µg/kg	200	Fish Consumption
Arsenic in fish (muscle tissue)	µg/kg	3500	Fish Consumption
Lead in fish (muscle tissue)	µg/kg	500	Fish Consumption
DDT (total) in fish (muscle tissue)	µg/kg	5000	Fish Consumption
Aquatic Biota Consumption			
PCB in fish (muscle tissue) mammalian	µg/TEQ/kg diet wet weight	0.00079	Fish Consumption
PCB in fish (muscle tissue) avian	µg/TEQ/kg diet wet weight	0.0024	Fish Consumption
DDT (total) in fish (muscle tissue)	µg/TEQ/kg diet wet weight	14	Fish Consumption
Toxaphene in fish (muscle tissue)	µg/TEQ/kg diet wet weight	6.3	Fish Consumption
Radioactive			
Cesium-137	Bq/L	10	Treatability
Iodine-131	Bq/L	6	Treatability
Lead-210	Bq/L	0.2	Treatability
Radium-226	Bq/L	0.5	Treatability
Strontium-90	Bq/L	5	Treatability
Tritium	Bq/L	7000	Treatability

a. Ammonia objective: Expressed as mg unionized ammonia/L. This would be equivalent to 0.0156 mg ammonianitrogen/L (0.019*14.0067/17.031). b. The objective value in µg/L is a function of total hardness (CaCO3 mg/L) in the water column: Cadmium Total is calculated using Cadmium = 10{0.83(log[hardness]) – 2.46 }. Copper Total's objective is 2 when total hardness is 180, and calculated using 0.2*e{0.8545[ln(hardness)]-1.465} when total hardness is ≥82 to ≤180. Lead Total's objective is 1 when total hardness is ≤60 or unknown, 7 when >180, and calculated using e {1.273[ln(hardness)]- 4.705} when total hardness is >60 to ≤180. Nickel Dissolved is calculated using 0.998*e {0.8460[ln(hardness)]+2.255}. Zinc dissolved is calculated using Zinc = exp(0.947[ln(hardness mg·L-1)] - 0.815[pH] + 0.398[ln(DOC mg·L-1)] + 4.625).

F.2. Beaver River Current Water Quality Condition Assessment

A water quality data request was made to AEP. Historic data was provided via Excel spreadsheet that included data to 2020. Current water quality conditions for the five-year period 2016 to 2020 for three sites currently monitored by AEP are reported using descriptive statistics (i.e., median, minimum, maximum and 90th percentile values) (Table 9.6). Descriptive statistics were also used to summarize historic data for the period (2003-04 and 2010-2014) at the Sand River, one of the main tributaries to the Beaver River, and at Yelling Creek (period 2004-07; 2017, 2019 and 2020) (Table 9.7).

Table F.2. Select water quality objectives for the reach Beaver River at Beaver Crossing to the Border (PPWB 2021) and current water quality conditions for the Beaver River, open (April-October) and closed periods (November-March), 2016-2020 (AEP 2021). Refer to Appendix F.1 for a complete list of PPWB (2021) water quality objectives, including total metals, pesticides and radioactive parameters. Red text indicates that the value did not meet the water quality guideline or objective.

Indicator	PPWB WQO		Statistic	At Hwy 28 Near BR Crossing		At Hwy 892		At Gravel Pit us AB_SK Border	
Seasonal	**Open**	**Closed**	-	**Open**	**Closed**	**Open**	**Closed**	**Open**	**Closed**
Total Phosphorus, mg/L	0.171	0.127	90th	0.150	0.058	0.151	0.060	0.096	0.053
			Median	0.077	0.042	0.072	0.045	0.037	0.021
			Min	0.034	0.023	0.030	0.026	0.009	0.002
			Max	**0.200**	0.100	**0.190**	0.140	**0.490**	0.180
Total Dissolved Phosphorus, mg/L	0.060	0.060	90th	0.048	0.025	0.035	0.029	0.051	0.026
			Median	0.022	0.016	0.019	0.015	0.033	0.018
			Min	0.006	0.003	0.006	0.004	0.006	0.002
			Max	**0.093**	0.037	**0.100**	0.053	**0.360**	0.180
Total Nitrogen, mg/L	1.140	1.862	90th	1.100	1.300	1.100	1.380	1.300	1.380
			Median	0.930	1.100	0.910	1.100	1.000	1.200
			Min	0.590	0.640	0.570	0.650	0.650	0.810
			Max	**1.400**	1.600	**1.400**	1.700	**3.000**	1.500
Nitrate as N, mg/L	3	3	90th	0.065	0.276	0.057	0.274	0.089	0.296
			Median	0.021	0.170	0.020	0.150	0.044	0.180
			Min	0.002	0.002	0.002	0.002	0.002	0.002
			Max	0.110	0.330	0.110	0.340	0.510	0.340
Dissolved Oxygen, mg/L	≥5	No Objective	90th	12.53	**6.15**	12.66	**4.89**	12.53	**5.89**
			Median	9.29	**2.95**	9.54	**2.39**	9.17	**2.55**
			Min	**5.46**	**0.00**	**5.10**	**0.00**	**5.55**	**0.00**
			Max	13.08	7.86	13.20	7.74	13.22	8.29
Annual									
Temperature, °C	No Objective		90th	20.23		20.04		20.23	
			Median	2.68		3.06		2.68	
			Min	-0.21		-0.25		-0.21	
			Max	23.16		22.30		23.16	
pH, pH Units	≥6.5 and ≤9.0		90th	8.11		8.16		8.10	
			Median	7.68		7.84		7.64	
			Min	**6.35**		6.51		**6.33**	
			Max	8.53		8.61		8.42	
Total Dissolved Solids, mg/L	≤500		90th	280		280		290	
			Median	200		185		200	
			Min	110		98		110	

Indicator	PPWB WQO	Statistic	At Hwy 28 Near BR Crossing	At Hwy 892	At Gravel Pit us AB_SK Border
		Max	340	320	350
Specific Conductance, µS/cm	≤1000 µS/cm**	90th	497	505	515
		Median	346	321	341
		Min	203	198	198
		Max	569	536	594
Total Suspended Solids, mg/L	3.0-48.8	90th	48	49	49
		Median	10	10	11
		Min	1	1	1
		Max	**80**	**77**	**97**
Fecal Coliform Bacteria, cfu/100 mL	≤100	90th	72	64	82
		Median	10	20	20
		Min	5	4	5
		Max	**210**	**240**	**110**

*Note a review of seasonal data showed that November dissolved oxygen concentrations was generally high (~10 mg/L or higher) at each site during the 5-year period. To reflect this trend, November dissolved oxygen concentrations were included in the open water season period (i.e., April-November).
**Environmental Quality Guidelines for Alberta Surface Waters (GOA 2018a)

F.3. Moose Lake Tributary Data (LARA 2021)

Table F.3. Water quality data summary for tributaries to Moose Lake (LARA 2021).

Tributary	Date Range	Statistic	E.Coli	pH	Dissolved Organic Carbon	Ammonia-N total	Total Kjeldahl Nitrogen	Dissolved Phosphorous	Total Phosphorous	Total Dissolved Solids	Total Suspended Solids
Mooselake River	2017-2020	Sample Size	4	4	17	17	17	17	17	17	17
		Median	55	8.495	19	0.170	1.800	0.056	0.095	560	4
		Min	22	8.28	16	0.008	1.500	0.025	0.052	240	1.3
		Max	300	9.17	28	0.830	2.700	0.210	0.320	590	24
Yelling Creek (at Kennedy Flats)	2017, 2019, 2020	Sample Size	4		11	11	11	11	11	11	11
		Median	116		35	0.057	2.800	0.360	0.560	390	5.4
		Min	16		20	0.039	2.000	0.091	0.460	250	2.3
		Max	410		46	0.160	8.000	0.980	3.100	770	30
Thinlake River at Hwy 28	2017-2020	Sample Size	4	4	17	17	17	17	17	17	17
		Median	108	8.23	22	0.130	2.000	0.200	0.480	700	12
		Min	33	7.87	17	0.030	1.700	0.085	0.140	260	2
		Max	180	8.25	34	1.100	3.400	0.430	0.800	1100	87
Thinlake River at Franchere Bay	2017-2020	Sample Size	4	4	17	17	17	17	17	17	17
		Median	25.2	8.195	22	0.079	2.000	0.260	0.290	540	7.2
		Min	7	7.83	18	0.018	1.700	0.014	0.077	260	1.7
		Max	300	9.32	45	0.370	3.200	0.550	0.600	720	87
Valere Creek	2017-2020	Sample Size	4	4	17	17	17	17	17	17	17
		Median	90.5	8.44	24	0.170	2.500	0.390	0.480	560	11
		Min	29	7.89	16	0.026	1.400	0.038	0.150	250	3.2
		Max	370	9.17	37	1.800	500.000	0.690	72.000	720	9300
Wood Creek	2019-2020	Sample Size	1	2	8	8	8	8	8	8	8
		Median	43	8.32	39	0.130	3.950	1.300	1.300	390	11.85
		Min	43	8.21	30	0.042	2.800	0.550	0.990	230	7.3
		Max	43	8.43	51	0.260	4.400	1.600	1.800	510	28

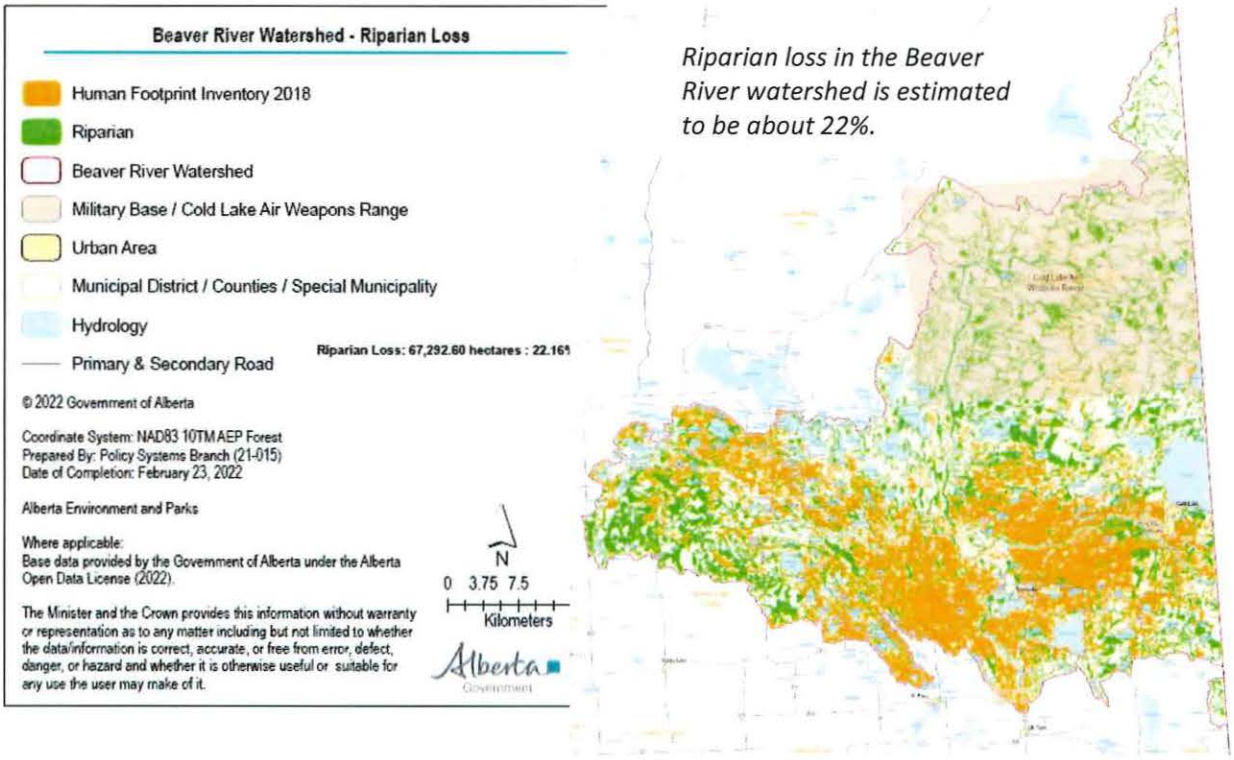
APPENDIX G. Riparian Areas

G.1. Riparian Condition Indicators

Table G.1. Riparian condition indicators and their significance.

Riparian Health Indicators	Significance
Vegetative Cover of Floodplain and Streambanks	Native plants provide deep binding root masses to maintain streambanks, slow the flow of overland runoff to facilitate water quality improvements, and provide summer and winter forage for wildlife and livestock.
Preferred Tree and Shrub Establishment and Regeneration	The root systems of woody species stabilize streambanks, while their spreading canopies provide protection to soil, water, wildlife and livestock.
Standing Decadent and Dead Woody Material	The amount of decadent and dead woody material may indicate a change in water flow due to human or natural causes; dewatering of a reach can change vegetation from riparian to upland species; flooding of a reach or a persistent high-water table can kill or eliminate some species, or lead to chronic overuse of browse, physical damage such as rubbing and trampling and climatic impacts.
Utilisation of Preferred Trees and Shrubs	The root systems of woody species provide streambank stability. Removal of this material reduces stability, causes loss of preferred woody species and leads to invasion of disturbance and weed species.
Occurrence of Invasive Plant Species	Invasive plants do not provide deep-binding root mass for bank protection, and provide minimal structural and habitat diversity when present in high densities. Weeds impact wildlife/livestock by replacing vegetation used for shelter/food.
Disturbance-Increaser Undesirable Herbaceous Species	Disturbance plants generally do not have deep binding root masses to protect streambanks and they provide minimal structural and habitat diversity when present in high densities. These plants are not as palatable to wildlife and livestock.
Streambank Root Mass Protection	Root masses provided by native vegetation act similar to Rebar holding streambanks together, preventing erosion and limiting lateral cutting.
Human-Caused Bare Ground	Bare ground is void of plants, plant litter, woody material or large rocks and is more susceptible to erosion processes. Human-caused bare ground may be caused by livestock, recreationists and vehicle traffic. It provides an opportunity for disturbance or weed species.
Streambanks Structurally Altered by Human Activity	Structural alterations of the streambanks (e.g., mechanically broken down by livestock activity or vehicle traffic) increase the potential for erosion while inhibiting the establishment of riparian vegetation.
Human Physical Alteration to the Rest of the Polygon	Stable streambanks maintain channel configuration and bank shape. Altered streambanks may increase erosion and mobilize channel and bank materials. Water quality can deteriorate and instability can increase downstream.
Stream Channel Incisement (Vertical Stability)	Incisement can increase stream-energy by reducing sinuosity, water retention and storage and increase erosion.

G.2. Current Riparian Condition



Riparian loss in the Beaver River watershed is estimated to be about 22%.

The Alberta Riparian Habitat Management Society (also known as Cows and Fish) conducts Riparian Health Assessments using indicators related to the function of the ecological components within the riparian area (i.e., vegetation, soil, and hydrology) (Table G.2) (Fitch et al. 2001). Based on these indicators, sites can be rated:

- Healthy (score 80 or above): riparian area functioning with minor impairment
- Healthy but with problems (score 60 to 75): riparian area functioning, moderate impairment
- Unhealthy (score less than 60): riparian area impaired, little ecosystem function

In the Beaver River watershed, 59 sites were assessed between 2002 and 2019. The average health rating for these sites was 59.1% (unhealthy)[26] which is below the provincial average of 69% (healthy but with problems)[27].

In 2012, aerial videography was used to assess riparian conditions at the Beaver River and at seven lakes in the watershed (Crane, Ethel, Hilda, Marie, Moose, Muriel, and Tucker) using a scoring system of good, fair, or poor. Results ranged from 99% 'Good' at Tucker Lake to 0% 'Good' at Muriel Lake. In general, unhealthy scores were attributed to recreation and residential development (as well as climate change).

[26] Beaver (Churchill) River Basin Overall Riparian Health 2002-2017 (n=59 sites), based on data up to 2019 and is subject to change once 2020 data is included (O'Shaughnessy, pers. comm.).

[27] Cows and Fish Riparian Health Inventory Data 1996 – 2019. Based on 2,974 sites, on 822 waterbodies in Alberta.

Table G.2. Riparian condition assessment using aerial videography.

Waterbody	% of Shoreline within Condition Category		
	Poor	Fair	Healthy
Crane Lake	14	7	79
Ethel Lake	9	11	80
Hilda Lake	9	13	78
Marie Lake	9	9	82
Moose Lake	26	13	61
Muriel Lake	24	76	0
Tucker Lake	0.4	0.4	99.2

Most recently, Riparian Intactness Assessments were completed for a large number of named and unnamed lakes and watercourses in the Jackfish-Muriel basin (Fiera Biological 2021a) and the Upper Beaver watershed (Fiera Biological 2021b) using a GIS-based approach. When intactness was compared by subwatershed, the Marie Creek subwatershed had the greatest proportion of shoreline rated as High Intactness (97%), followed by the Middle Beaver River (88%) and Jackfish Creek (85%) subwatersheds. In the Upper Beaver watershed ratings were somewhat lower. In the Amisk River subwatershed, shorelines rated 79% High Intactness and the Upper Beaver River subwatershed rated 63% High Intactness.

The proportion of shoreline rating Very Low + Low Intactness was greatest in the Muriel Creek basin (33%) (Fiera Biological 2021a), followed by the Upper Beaver River subwatershed that rated 20% Very Low +Low Intactness. and the Amisk River subwatershed (13%). Results varied by waterbody and watercourse. A summary of resulting shoreline intactness ratings is provided in Tables G3 to G-6.

In all three studies, riparian condition generally scored poorest in areas where shorelines were developed (e.g., vegetation removed, shorelines hardened using rock and retaining walls, etc.).

Table G.3. The proportion (%) of shoreline intactness within intactness categories, and % high restoration potential for lakes and streams included in the Jackfish-Muriel creeks assessment (Fiera Biological 2021a).

HUC 8 Watershed	Waterbody / Watercourse	Length Assessed (km)	Proportion (%) of Shoreline in Each Intactness Category					High Restoration (%)
			Very Low	Low	Very Low + Low	Moderate	High	
Jackfish Creek	Bourque Lake	18.2	0	0	0	0	100	
	Bourque Lake-01	14.3	1	1	1	0	99	
	Bourque Lake-02	9.8	4	3	7	0	93	
	Bourque Lake-03	3.6	0	0	0	0	100	
	Jackfish Creek	131.4	11	5	**16**	7	**77**	**14**
	Tucker Lake	16.2	0	1	1	0	99	
	UL-120201-07	4.6	0	0	0	0	100	
	UL-120201-09	1.1	0	0	0	0	100	
	UL-120201-10	1.5	0	0	0	0	100	
	UL-120201-11	1.5	0	0	0	0	100	
	UL-120201-12	1.5	0	0	0	0	100	
Marie Creek	Burnt Lake	10.7	0	0	0	0	100	
	Ethel Lake	11	5	5	**11**	17	**72**	
	Marie Creek	173.5	1	1	1	0	99	
	Marie Lake	29.9	0	3	3	3	94	
	May Lake	8.8	0	0	0	0	100	
	UL-120201-08	3	0	0	0	0	100	
	UL-120201-13	3.3	0	0	0	0	100	

HUC 8 Watershed	Waterbody / Watercourse	Length Assessed (km)	Proportion (%) of Shoreline in Each Intactness Category					High Restoration (%)
			Very Low	Low	Very Low + Low	Moderate	High	
	UL-120201-14	3.3	0	0	0	0	100	
	UL-120201-15	2.7	0	0	0	0	100	
Middle Beaver River	Beaver River	154.1	6	1	7	0	93	5
	Manatokan Creek	23.4	2	4	6	6	88	
	Manatokan Lake	12.8	12	13	24	9	66	23
	Osborne Creek	32.3	3	5	7	20	72	3
Moose Lake	Bangs Lake	10.9	0	0	0	0	100	
	Bentley Lake	7.1	1	0	1	1	97	
	Chickenhill Lake	11.7	1	2	3	0	97	
	Jessie Lake	16.6	24	8	33	35	33	36
	Kehewin Creek	13.6	1	2	3	10	88	
	Kehewin Lake	25.2	11	8	18	12	69	12
	Kehewin Lake-01	13.5	4	0	4	5	91	
	Moose Lake	67.5	12	8	20	13	66	15
	Mooselake River	32.2	1	1	2	1	98	
	S. Trib of Kehewin Lake	13.3	2	6	8	27	65	
	S. Trib of Kehewin Lake-01	10.6	20	8	27	53	20	28
	Thin Lake	10.6	1	1	2	0	98	
	Thinlake River	21.7	1	1	2	6	92	
	UL-120201-01	4.1	0	0	0	0	100	
	UL-120201-02	4.3	21	0	21	5	74	
	UL-120201-04	2.7	4	0	4	0	96	
	UL-120201-05	2.6	0	0	0	0	100	
Muriel Creek	Charlotte Lake	27.3	58	14	73	23	4	70
	Garnier Lakes A	2.4	0	0	0	0	100	
	Garnier Lakes B	9.2	0	0	0	0	100	
	Garnier Lakes C	6.2	0	3	3	0	97	
	Garnier Lakes D	3.3	3	0	3	0	97	
	Jerome Lake	2.5	0	0	0	0	100	
	Landry Lake A	2.9	0	0	0	0	100	
	Landry Lake B	1.9	26	5	32	37	32	
	Michel Lake	4.5	0	0	0	0	100	
	Muriel Creek	88	42	10	52	12	36	51
	Muriel Lake	51.5	7	7	13	19	68	10
	Muriel Lake-01	19	4	1	4	0	96	
	St. Pierre Lake	2.6	0	0	0	0	100	
	UL-120201-03	5.5	0	0	0	0	100	
	UL-120201-06	1.3	0	0	0	0	100	
Reita Creek	Reita Creek	72	-	-	7	29	64	

Table G.4. Summary of shoreline intactness by subwatersheds and municipal, First Nation and watershed stewardship group boundary (modified from Fiera Biological 2021a).

Spatial Extent	Length Assessed (km)	Proportion (%) of Shoreline within Intactness Category				
		Very Low	Low	Very Low + Low	Moderate	High
Jackfish-Muriel Creeks Watershed	1168.8	9	4	13	7	80
Jackfish Creek Subwatershed	203.7	7	3	11	4	85
Marie Creek Subwatershed	246.2	1	1	2	1	97
Middle Beaver River Subwatershed	222.6	6	2	8	4	88
Moose Lake Subwatershed	268.2	7	4	12	12	77
Muriel Creek Subwatershed	228.1	25	7	33	12	56
Town of Bonnyville	7.3	42	19	62	38	0
CLFN Traditional Territory	888.7	10	4	14	6	80
MD of Bonnyville	989.5	10	4	14	6	80
Muriel Lake Basin	71.8	6	5	11	14	76

Table G.5. The proportion (%) of shoreline intactness within intactness categories, and high restoration potential for lakes and streams included in the Upper Beaver watershed assessment (modified from Fiera Biological 2021b).

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category										High Restoration (%)
		Very Low		Low		Very Low + Low		Moderate		High		
		km	%	km	%	km	%	km	%	km	%	
Allday Lake	3.6	0.7	20	1.0	28	1.7	48	0.2	4	1.8	49	47
Amisk Lake	25.5	0.2	1	0.1	0	0.3	1	0.6	3	24.5	96	
Amisk Lake-01	28.2	0.2	1	0.1	0	0.3	1	0.2	1	27.7	98	
Amisk Lake-02	9.7	0.1	1	0.4	4	0.5	5	0.1	1	9.2	94	
Amisk River	207.9	16.4	8	14.3	7	30.7	15	20.9	10	156.4	75	11
Amisk River-01	96.4	14.5	15	2.6	3	17.1	18	10.5	11	68.8	71	15
Amisk River-02	21.9	0.5	2	0.4	2	0.9	4	0.0	0	20.9	96	
Amisk River-03	35.3	0.5	1	0.9	3	1.4	4	0.4	1	33.5	95	
Amisk River-04	15.7	3.9	25	0.5	3	4.4	28	0.2	1	11.1	71	
Amisk River-05	7.8	0.1	1	0.2	2	0.3	3	2.3	30	5.2	66	
Beaver Lake	74.8	1.5	2	1.2	2	2.7	4	1.0	1	71.1	95	
Beaver River	285.3	36.0	13	27.1	10	63.1	23	58.2	20	164.0	57	17
Beaver River-01	11.5	2.8	24	0.5	5	3.3	29	1.0	9	7.2	62	29
Beaver River-02	38.3	1.4	4	2.3	6	3.7	10	3.7	10	31.0	81	
Big Johnson Lake	11.3	0.0	0	0.2	1	0.2	1	0.2	2	10.9	97	
Buffalo Lake	16.6	0.5	3	1.0	6	1.5	9	0.1	1	15.0	90	
Buffalo Lake-01	13.5	0.1	1	0.0	0	0.1	1	0.7	5	12.6	93	
Buffalo Lake-02	39.2	0.5	1	1.2	3	1.7	4	2.6	7	34.9	89	
Bunder Creek	76.5	8.4	11	5.3	7	13.7	18	18.8	25	44.0	58	17
Bunder Creek-01	8.7	2.3	27	0.4	4	2.7	31	2.5	29	3.4	39	27
Bunder Creek-02	9.5	1.1	12	2.0	21	3.1	33	2.6	28	3.8	39	23
Bunder Lake	30.5	2.0	7	2.1	7	4.1	14	4.6	15	21.8	72	10
Cardinal Lake	5.3	0.2	3	0.4	7	0.6	10	0.1	1	4.7	89	
Chappell Lake	8.2	0.3	4	0.9	11	1.2	15	0.5	6	6.6	80	15
Chota Lake	6.4	0.0	0	0.0	0	0	0	0.0	0	6.4	100	
Cole Lake	9.2	1.5	16	3.9	42	5.4	58	0.0	0	3.8	41	16
Columbine Creek	80.5	18.8	23	6.5	8	25.3	31	19.2	24	36.0	45	31
Denning Lake	8.2	1.8	22	0.6	8	2.4	30	0.9	11	4.9	59	22
Elinor Lake	29.0	0.1	0	0.0	0	0.1	0	0.2	1	28.8	99	
Figure Lake	8.1	0.0	0	0.0	0	0	0	0.0	0	8.1	100	
Floatingstone Lake	17.4	1.4	8	1.8	10	3.2	18	1.3	7	13.0	74	13
Floatingstone Lake-01	10.5	3.3	32	1.5	14	4.8	46	3.5	33	2.2	21	46
Fork Creek	16.0	0.5	3	0.3	2	0.8	5	0.4	2	14.9	93	
Fork Lake	28.2	0.8	3	0.2	1	1	4	4.6	16	22.6	80	
Garner Lake	16.6	2.4	15	2.2	13	4.6	28	1.8	11	10.2	61	28
Goodfish Lake	16.5	0.0	0	0.0	0	0	0	0.0	0	16.5	100	
Goodfish Lake-01	22.6	0.2	1	0.4	2	0.6	3	0.1	1	21.9	97	
Greenstreet Lake	7.9	0.0	0	1.0	12	1	12	1.6	20	5.4	68	0
Little Beaver Lake	9.4	0.0	0	0.0	0	0	0	0.0	0	9.4	100	
Little Garner Lake	4.1	2.2	53	0.8	19	3	72	0.1	1	1.1	27	72
Lone Pine Lake	8.3	1.2	14	0.6	8	1.8	22	0.5	6	6.0	73	14
Lone Pine Lake-01	7.4	0.3	3	0.3	4	0.6	7	1.0	13	5.9	80	
Long Lake	30.5	1.0	3	0.5	2	1.5	5	1.6	5	27.4	90	
Long Lake-01	9.2	0.0	0	0.0	0	0	0	0.0	0	9.2	100	
Long Lake-02	7.5	0.3	4	0.2	2	0.5	6	0.1	1	7.0	93	
Long Lake-03	3.9	0.1	2	0.4	10	0.5	12	0.1	2	3.3	85	2
Lower Mann Lake	19.0	0.2	1	1.6	9	1.8	10	0.6	3	16.6	87	
McCullough Lake	5.4	0.0	0	0.0	0	0	0	0.0	0	5.4	100	
Mooselake River	0.2	0.0	0	0.0	0	0	0	0.1	41	0.1	59	0
Norberg Lake	15.9	1.2	7	0.0	0	1.2	7	0.4	2	14.4	90	
North Buck Lake	49.2	0.9	2	1.0	2	1.9	4	2.2	4	45.1	92	

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category										High Restoration (%)
		Very Low		Low		Very Low + Low		Moderate		High		
		km	%	km	%	km	%	km	%	km	%	
North Buck Lake-01	2.4	0.0	2	0.0	1	0	3	0.0	0	2.3	97	
Outlet Lake	5.6	0.0	0	0.0	0	0	0	0.0	0	5.6	100	
Owlseye Lake	6.7	0.5	7	2.1	31	2.6	38	1.3	20	2.8	42	38
Reed Lake	20.1	12.2	61	1.3	7	13.5	68	1.8	9	4.8	24	67
Saturday Lake	3.7	0.0	0	0.0	0	0	0	0.0	0	3.7	100	
Skeleton Lake	24.8	1.0	4	2.2	9	3.2	13	4.5	18	17.1	69	5
Snail Lake	6.7	1.7	25	0.3	5	2	30	0.1	2	4.6	68	30
St. Lina Creek	89.4	10.3	12	6.8	8	17.1	20	27.2	30	45.0	50	19
St. Lina Creek-01	7.3	0.6	8	0.4	6	1	14	0.9	13	5.4	74	13
St. Lina Creek-02	20.6	9.2	45	2.1	10	11.3	55	4.5	22	4.8	24	55
St. Lina Creek-03	13.3	7.2	54	2.1	16	9.3	70	2.9	22	1.1	8	70
Tompkins Lake	4.5	0.0	0	0.0	0	0	0	0.0	0	4.5	100	
UL-120101-01	4.3	0.0	0	0.0	0	0	0	0.0	0	4.3	100	
UL-120101-02	8.7	0.0	0	0.0	0	0	0	0.0	0	8.7	100	
UL-120101-02-US01	3.9	0.0	0	0.0	1	0	1	0.0	1	3.8	98	
UL-120101-03	10.3	0.0	0	0.0	0	0	0	0.0	0	10.3	100	
UL-120101-03-US01	6.3	0.0	0	0.0	0	0	0	0.0	0	6.3	100	
UL-120101-04	3.4	0.0	0	0.0	0	0	0	0.0	0	3.4	100	
UL-120101-05	7.1	0.1	1	0.0	0	0.1	1	0.0	0	7.0	99	
UL-120101-06	8.8	0.0	0	0.0	0	0	0	0.0	0	8.8	100	
UL-120101-06-US01	2.3	0.1	6	0.0	0	0.1	6	0.0	0	2.2	94	
UL-120101-06-US02	2.2	0.0	0	0.1	3	0.1	3	0.0	0	2.2	97	
UL-120101-07	5.1	0.0	0	0.0	0	0	0	0.0	0	5.1	100	
UL-120101-08	4.2	0.0	0	0.0	0	0	0	0.0	0	4.2	100	
UL-120101-09	9.6	1.0	11	0.0	0	1	11	0.0	0	8.5	89	0
UL-120101-10	9.7	0.0	0	0.1	1	0.1	1	0.4	4	9.2	94	
UL-120101-11	9.7	0.0	0	0.0	0	0	0	0.0	0	9.7	100	
UL-120101-12	5.1	0.0	1	0.0	0	0	1	0.0	0	5.1	99	
UL-120101-13	7.7	0.0	0	0.0	0	0	0	0.0	0	7.7	100	
UL-120101-14	5.1	0.0	0	0.0	0	0	0	0.0	0	5.1	100	
UL-120101-15	6.0	0.4	7	0.3	5	0.7	12	0.3	5	5.0	83	0
UL-120101-16	3.4	0.0	0	0.0	0	0	0	0.0	0	3.4	100	
UL-120101-17	2.9	0.0	0	0.0	0	0	0	0.0	0	2.9	100	
UL-120101-18	6.1	0.2	3	0.0	0	0.2	3	0.0	1	5.9	95	
UL-120101-19	5.1	1.9	36	0.2	4	2.1	40	0.0	1	3.0	59	38
UL-120101-20	5.1	0.0	0	0.0	0	0	0	0.0	0	5.1	100	
UL-120101-21	8.3	0.0	0	0.0	0	0	0	0.0	0	8.3	100	
UL-120101-22	7.3	0.0	0	0.0	0	0	0	0.4	6	6.8	94	
UL-120101-23	3.5	0.0	0	0.0	0	0	0	0.0	1	3.5	99	
UL-120101-24	4.8	0.3	7	0.0	0	0.3	7	0.0	0	4.4	93	
UL-120101-24-US01	29.8	0.7	2	0.7	2	1.4	4	1.3	4	27.0	91	
UL-120101-25	2.5	2.1	83	0.3	13	2.4	96	0.1	4	0.0	0	96
UL-120101-26	3.3	0.0	0	0.0	0	0	0	0.0	0	3.3	100	
UL-120101-26-US01	0.7	0.0	0	0.0	0	0	0	0.0	0	0.7	100	
UL-120101-27	4.3	0.1	1	0.1	1	0.2	2	0.8	20	3.3	78	
UL-120101-27-US01	18.1	4.3	24	2.0	11	6.3	35	6.2	34	5.6	31	24
UL-120101-28	3.0	0.0	0	0.0	0	0	0	0.0	0	3.0	100	
UL-120101-29	3.8	0.0	0	0.0	0	0	0	0.0	0	3.8	100	

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category										High Restoration (%)
		Very Low		Low		Very Low + Low		Moderate		High		
		km	%	km	%	km	%	km	%	km	%	
UL-120101-29-US01	10.3	1.6	16	1.2	11	2.8	27	0.6	6	6.9	67	16
UL-120101-30	4.1	0.0	0	0.0	0	0	0	0.0	0	4.1	100	
UL-120101-31	3.5	0.2	5	0.0	0	0.2	5	0.0	0	3.4	95	
UL-120101-32	3.8	0.0	0	0.0	0	0	0	0.0	1	3.8	99	
UL-120101-33	3.0	2.6	88	0.0	0	2.6	88	0.1	4	0.2	8	88
UL-120101-34	8.7	2.1	24	0.5	6	2.6	30	0.7	7	5.4	62	30
UL-120101-35	3.3	0.1	2	0.4	11	0.5	13	0.0	0	2.9	87	
UL-120101-36	3.3	0.1	2	0.0	0	0.1	2	0.1	2	3.1	96	
UL-120101-37	3.2	0.1	2	0.0	0	0.1	2	0.0	0	3.1	98	
UL-120101-38	4.5	0.1	3	0.1	2	0.2	5	0.0	0	4.3	95	
UL-120101-39	3.6	0.7	18	0.0	0	0.7	18	0.1	1	2.9	80	
UL-120101-40	4.8	1.5	32	0.3	5	1.8	37	0.3	6	2.7	56	38
UL-120101-41	5.6	1.3	24	0.2	3	1.5	27	1.1	19	3.0	54	27
UL-120101-42	4.9	1.9	38	0.4	7	2.3	45	1.2	25	1.4	30	45
UL-120101-43	3.4	3.0	88	0.3	8	3.3	96	0.0	0	0.2	5	95
UL-120101-44	2.9	0.0	0	0.0	0	0	0	0.0	0	2.9	100	
UL-120101-45	3.7	2.9	77	0.0	0	2.9	77	0.0	0	0.9	23	77
UL-120101-46	16.6	0.1	1	0.0	0	0.1	1	0.2	1	16.4	98	
Upper Mann Lake	17.3	0.2	1	0.5	3	0.7	4	1.9	11	14.6	85	
Victor Lake	4.6	0.9	19	0.3	6	1.2	25	0.0	0	3.4	75	
Victor Lake-01	21.7	4.7	22	0.9	4	5.6	26	2.0	9	14.0	65	13
Wayetenaw Lake	4.4	0.0	0	0.0	0	0	0	0.0	0	4.4	100	
Whiskyjack Lake	6.7	0.5	8	0.0	0	0.5	8	0.0	0	6.1	92	
Whitefish Creek	54.0	3.9	7	2.4	5	6.3	12	7.2	13	40.5	75	10
Whitefish Creek-01	4.8	0.7	15	1.9	41	2.6	56	1.2	24	0.9	19	43
Whitefish Creek-02	74.7	5.7	8	4.6	6	10.3	14	1.7	2	62.7	84	7
Whitefish Creek-03	14.4	2.1	14	0.4	3	2.5	17	1.6	11	10.4	72	14
Whitefish Lake	26.9	2.0	7	1.1	4	3.1	11	1.3	5	22.6	84	7

Table G.6. Summary of shoreline intactness by subwatersheds and municipal, First Nation and Métis Settlement boundaries (modified from Fiera Biological 2021b).

Spatial Extent	Length Assessed (km)	Proportion (%) of Shoreline within Intactness Category				
		Very Low	Low	Very Low + Low	Moderate	High
Upper Beaver Watershed	2285.8	10	5	15	11	85
Amisk River Subwatershed	1551.6	8	5	13	8	87
Upper Beaver River Subwatershed	734.2	13	7	20	17	80
Athabasca County	234.5	8	3	11	8	90
Beaver Lake Cree Nation	13.5	2	3	5	2	95
Buffalo Lake Métis Settlement	229.1	2	2	4	6	96
County of St. Paul	550.7	15	9	24	15	77
Kikino Métis Settlement	342.6	10	7	17	7	83
Lac La Biche County	443.0	6	2	8	8	91
MD of Bonnyville	202.8	16	12	28	26	72
Smoky Lake County	101.3	12	3	15	3	85
Thorhild County	103.6	1	1	2	2	98
Whitefish (Goodfish) First Nation #128	65.7	17	5	22	22	78

G.6. Targets used to manage riparian areas, experience from elsewhere.

Targets	Source
Shoreline protection policy and regulation implemented to protect trees and other natural vegetation in 75 percent of the land area within the 30-metre shoreline residential water yard setback currently required by the Townships.	https://www.environmentcouncil.ca/healthy-shorelines
Environment Canada states that 75% of the shore area and 30 m back from the water should be left in a natural state to protect water bodies and essential wildlife habitat.	Environment Canada (2013). How much habitat is enough? Third Edition. Environment Canada, Toronto, Ontario. 127 pp.
Shoreline property owners:75% natural shore, 25% accessible area	Ontario Ministry of Natural Resources Dufferin Simcoe Land Stewardship Network (2014)
A 2013 Environment Canada report* recommends that 75% of a shoreline's riparian habitat should be naturally vegetated, however, collected data through Love Your Lake shows that only 22% of assessed properties across Canada meet this recommendation.	Love Your Lakes
Existing property owners encouraged to begin naturalization process, a minimum width of three to five metres is suggested. In general, it is recommended that the entire shoreline frontage is vegetated leaving 15 metres or 25% (whichever is less) open for access (sitting and swimming areas, docks, etc.)	Rideau Valley Conservation Authority: https://www.rvca.ca/stewardship-grants/shoreline-naturalization/how-to-naturalize-your-shoreline#how-much-is-enough
The shoreline produces the ultimate "Edge" effect upon which 70% of land-based animals and 90% of the aquatic plants and animals rely (Kipp and Callaway, 2003)	Kipp, S. and C. Callaway, 2003. On the Living Edge: Your Handbook for Waterfront Living, Rideau Valley Conservation Authority.

APPENDIX H. Riparian Protection and Management Strategies

Riparian setbacks are applied to land use activities undertaken by government, industry and landowners to minimize environmental impacts, risks to infrastructure, pollution prevention, and to maintain public safety. Setbacks from water are regulated by industry to prevent contamination of water from industrial practices, maintain stable streambanks to minimize erosion, and to support biodiversity. Industries have developed setback practices unique to their industry, and are bound by provincial acts and rules (e.g., AOPA, operating ground rules) to abide by these setbacks. The MGA stipulates a minimum setback of 6 m for development from water, however many municipalities recognize that 6 m is not sufficient to mitigate impacts of flooding to infrastructure, or for pollution prevention. The following highlights riparian setback guidelines for municipal development (H-1), and regulatory requirements for agriculture (AOPA) (H-2), forestry (H-3) and oil and gas activity (H-4).

H.1. Provincial Guidance Pertaining to Development Setbacks

Table H.1. Summary of riparian setback guidelines (GOA 2012).

Waterbody	Substrate	Width	Modifiers	Notes
Permanent Water Bodies Lakes, Rivers, Streams, Seeps, Springs Class III - VII Wetlands	Glacial till	20 m	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Slopes >25% are not credited toward the filter strip.
	Coarse textured sands and gravels, alluvial sediments	50 m	None	Conserve native riparian vegetation and natural flood regimes
Ephemeral and Intermittent Streams, Gullies	Not specified	6 m strip of native vegetation or perennial grasses adjacent to the stream channel crest	If the average slope of the strip is more than 5%, increase the width of the strip by 1.5 m for every 1% of slope over 5%	Maintain continuous native vegetation cover along channels and slopes
Class I & II Wetlands	Not specified	10 m strip of willow and perennial grasses adjacent to water body	None	Maintain and conserve native wetland or marshland plants on legal bed and

H.2. Municipal Setbacks

City of Cold Lake (LUB 382-LU-10) **Refer to the source for the most current plans and policies*

6.9 ENVIRONMENTALLY SENSITIVE LANDS: DEVELOPMENT NEAR LANDS SUBJECT TO FLOODING, ADJACENT TO WATERCOURSES AND STEEPER SLOPES

(1) On lands identified as environmentally sensitive, City Council and/or the Development Authority may require the following information to be submitted as part of a development permit application, an application to

amend this Bylaw, an application for subdivision approval, an application to amend a statutory plan, or an appeal:

(a) A geotechnical study, prepared by a registered professional engineer, addressing the proposed development. The geotechnical study will establish building setbacks from property lines based on the land characteristics of the subject property;

(b) A certificate from a registered professional engineer certifying that the design of the proposed development was undertaken with full knowledge of the soil and/or slope conditions of the subject property; and

(c) A certificate from a registered professional engineer when the proposed development includes cut and/or fill sections on slopes, including the addition of fill on the subject property. (2) The applicant shall be responsible for the expense of the geotechnical study or certificate. The City, at its discretion, may seek an independent review of a geotechnical analysis submitted by an applicant.

(3) No development shall be permitted within the 1 in 100-year flood line as established by Alberta Environment.

(4) A minimum setback of 50.00 metres is required from the top of bank of watercourses. This should consist of 30.00 metres Environmental Reserve (ER) dedication as required by the MDP, with the balance of 20.00 metres taken as Environmental Reserve (ER), Municipal Reserve (MR) and / or conservation easement. (a) The 30.00 metres shall commence from the 1 in 100-year flood line unless a discernable top of bank exists beyond this.

(b) The embankment is often geotechnical containment and therefore the 50.00 metres setback shall commence beyond this.

(c) To enable the determination of top of bank setbacks in Section 6.8(2), the applicant shall undertake a top of bank survey for the subject watercourse as a condition of the development permit.

(5) Notwithstanding the provisions of Section 6.9 (4) above, the City will require a minimum setback of 15-30 metres, from top-of-bank of a watercourse, in accordance with Department of Fisheries and Oceans requirements.

(6) Land dedicated as Environmental Reserve shall be left in its natural state. (7) The minimum setback in Section 6.9(4) may be reduced at the discretion of the Development Authority where a watercourse is considered to be of a minor nature and there is no risk of adverse effect on development or the environment as determined by the Development Authority.

(8) The Development Authority may increase any required setback or yard for any permitted or discretionary use where the regulation in the District would allow development that may be detrimental to the preservation of shoreland or environmentally sensitive areas, may be affected by being in a floodplain or in proximity to steep or unstable slopes, or may increase the degree of hazard.

(9) Trees shall not be cut, felled or removed on lands identified as environmentally sensitive, without the prior approval of the Development Authority.

MD of Bonnyville (MDP 2007, Section 3.5) **Refer to the source for most current plans and policies*

4) Setbacks

a) A minimum environmental reserve setback of 30 metres (100 feet) from either the top of the bank of a river or stream or the high-water mark of a lake shall be applied, subject to the discretion of Council/Development Authority.

b) Environmental setbacks shall be established as part of the Area Structure Plan approval process.

5) Development of Environmental Reserve land Development shall be allowed to exist on Environmental Reserve lands only if it serves the interests of the general public.

6) 1:100 Year Flood Plain

No permanent residential structures will be permitted within the 1:100-year floodplain of any river, stream or lake shore, unless proper flood proofing techniques are applied. A certificate from a qualified, registered

professional engineer or architect will be required by the Municipal District to confirm that the development has been properly flood proofed.

7) Steep Slopes

Alberta Environmental Protection's Interim Guideline for the Subdivision of Land Adjacent to Steep Slopes (to define and protect the valley crest and toe of slope) will apply so that no development will be permitted within 30 metres (100 feet) from the top or bottom of a valley slope which exceeds a 30 percent grade.

Riparian Setback Matrix Model (Aquality 2012)

The Riparian Setback Matrix Model (RSMM) can be used to establish site-specific, defensible Environmental Reserve setbacks, and to determine development setbacks and land uses for private lands located adjacent to environmentally sensitive areas and/or significant lands within a municipality (Aquality 2012). Input measures include slope of land, height of bank, groundwater table level, groundwater risk, soil type and texture, and vegetation/ground cover. Application of the RSMM generally results in a development setback of 10 m to 60 m in width (possibly greater, depending on local site conditions).

Example Setback Calculation 1. A completely forested site, with zero slope, low groundwater risk and peat soils, results in a 10 m setback.

Example Setback Calculation 2. A site with 100% impermeable surface area, 15% slope, high groundwater risk, and silt soils results in a setback of 60 m.
Sites having slope >15% are reviewed separately by a geotechnical engineer. Additional development restrictions may apply in the 1:100-year flood-prone zone (mapped at the provincial level) if the setback width does not encompass this width. The RSMM requires a Professional Biologist or QWAES to apply the model to individual sites, working with a land surveyor and others as required.

H.3. Setbacks Associated with Agricultural Activity (GOA 2008). Refer to the relevant legislation (i.e., *AOPA, EPEA*) for additional and the most recent requirements.

Table H.3.1. Excerpt of setback requirements for the agriculture industry.

Activity	Setback Requirement
Manure Storage Facilities and Manure Collection Areas	**Common Body of Water**[a] Manure storage facilities[b] or manure collection areas[c] must be constructed at least 30 m (98 ft) away from a common body of water. This does not apply if the owner or operator demonstrates to the NRCB, prior to construction, that either: • The natural drainage from the facility or area is away from the common body of water, or • A berm or other secondary protection for the common body of water constructed by the owner or operator protects the common body of water from contamination. **Flooded Areas** A manure storage facility or manure collection area must not be in an area that floods. • The 1:25 year maximum flood level at a manure storage facility or manure collection area must not be less than one metre below any part of the facility where run-on can come into contact with the stored manure. • If the 1:25 year maximum flood level cannot be determined, the manure storage facility or manure collection area must be not less than one metre below any part of the facility where run-on from the highest known flood level can come into contact with the stored manure. **Natural Water and Wells** Manure storage facilities and manure collection areas must be constructed at least 100 m away from a spring or water well. This does not apply if the owner or operator:

Activity	Setback Requirement
	• Demonstrates to the NRCB, prior to construction, that an aquifer from which the spring rises, or into which the water well is drilled, is not likely to be contaminated by the facility • Implements a groundwater monitoring program if required by NRCB.
Groundwater Resource Protection	• All manure storage facilities and manure collection areas must have either a protective layer or liner that lays below the bottom of the facility and above the uppermost groundwater resource of the site and also meets regulatory requirements. • Solid Manure Storage Facility or Collection Area – The liner must be at least 0.5 m in depth with a hydraulic conductivity of not more than 5×10^{-7} cm/s.
Surface Water Control Systems	Surface water control systems are required to minimize run-on flowing through and runoff leaving a manure storage facility or manure collection area. These systems must not significantly alter regular water flow, must not affect or alter a non-flowing water body and must not be located on a fish-bearing water body. The NRCB will determine if the system has to be designed and certified by a professional engineer.
Runoff Control Catch Basin	Runoff control catch basins must have the following: • A storage capacity to accommodate a 1:30 year one-day rainfall, • A visible marker that clearly indicates the minimum volume possible to accommodate the 1:30 year one-day rainfall event, • A freeboard of not less than 0.5 m when the basin is filled to capacity.
Short-Term Solid Manure Storage	Short-term solid manure storage sites can only be used for an accumulated total of 7 months within a 3-year period regardless of the amount of manure stored. Feedlot pens are not considered short-term manure storage sites and must meet the requirements for a manure storage facility. Short-term solid manure storage sites must be located at least: • 150 m from a residence or occupied building that the producer does not own • 100 m from a spring or water well • 1 m above the water table • 1 metre above the 1-in-25-year maximum flood level or 1 m above the highest known flood level if the 1-in-25-year flood level is not known. If the land slopes towards a common body of water, the following setback distances must be observed: **Mean slope** — **Setback** 4% or less - 30 m Greater than 4% to less than 6% - 60 m 6% or greater, but less than 12% - 90 m If the mean slope is 12% or greater, do not apply or store manure on the land.
Seasonal Feeding and Bedding (Wintering) Sites and Livestock Corrals	Seasonal feeding and bedding sites (wintering sites) and livestock corrals do not require a permit but must be sited and managed to protect surface waterbodies. A seasonal feeding and bedding site or livestock corral must be located at least 30 m away from a common body of water. If this cannot be achieved, the operator must either design the site to divert runoff away from the water or move the manure to an appropriate location away from the water prior to a runoff event.
Manure Incorporation	Manure must be incorporated within 48 hrs when applied to cultivated land except when applied to forages or direct-seeded crops, frozen or snow-covered land or unless an operation has a permit that specifies additional requirements.
Setbacks for Manure Application	Setback distances are required to reduce nuisance impacts on neighbours and to minimize the risk of manure leaving the land on which it is applied and entering a common body of water. Manure must be applied at least: • 150 m away from a residence or other occupied building if the manure is not incorporated • 30 m away from a water well • 10 m away from a common body of water if subsurface injection is used

Activity	Setback Requirement
	• 30 m away from a common body of water if manure is surface-applied and incorporated within 48 hrs of application, except when applied on forage, direct-seeded crops, frozen or snow-covered land. *The setbacks outlined in "short-term solid manure storage" for lands that slope to a common body of water also apply.
Inorganic Fertilizer Application	**Prohibited releases** *EPEA* prohibits operators from releasing into the environment a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect on the environment. An "adverse effect" is broadly defined to mean the "impairment of, or damage to, the environment, human health or safety or property." For example, if a farm operator spreads manure on land at a rate that will overload the nutrient levels in the soil, or releases manure on land where the manure will run into a water body, the operator is in violation of EPEA. **Best management practices** • Apply fertilizer rinsate to a cropped area at a distance greater than 10 m from any surface water source and greater than 60 m from any well. (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex9398) • Storage facilities should be located more than 100 m from water wells and more than 20 m from surface water bodies. • Ensure loading takes place at least 30 m away from a well or surface water (AARD 2004).
Pesticide Use, Application, Storage or Washing of Equipment	The use, application, storage or washing of equipment within 30 horizontal meters of an 'open body of water'[d] are regulated activities in Alberta. Pesticides include herbicides, insecticides, fungicides, rodenticides, and algaecides. Pesticide treatments must be in accordance with the *Environmental Code of Practice for Pesticides* as regulated by ESRD. Regulations concerning pesticide use near an open body of water apply only to undisturbed vegetation along rivers, streams and lakes. Persons applying a pesticide on cultivated land (cropland, improved pasture, managed turf and landscaped areas) must follow pesticide label directions including any buffers specified for open bodies of water. A sufficient buffer of natural vegetation should be left (similar to the buffers identified in *the Environmental Code of Practice for Pesticides*) between cultivated land and open bodies of water. Generally, - Application must not result in the deposit of pesticides into or onto any open body of water except in accordance with subsection 16(12). - Applications must not be made within 250 m upstream of any surface water intake of a waterworks system. - Aerial applications of pesticides to land must not be conducted while flying directly over an open body of water. - Herbicides must not be deposited on areas that have slumped, been washed out or are subject to soil erosion into the water body. Setback distances for pesticide application within 30 horizontal metres (98 ft) of an open body of water is generally determined by the type of pesticide being used, the application rate, type of weed listed under the *Weeds Control Act*, method of application and percentage of the infected area that receives application in a given year. Setbacks are variable but generally range from the edge of the bed and shore to 5 m) (*Environmental Code of Practice for Pesticides* 2010). Applicators may apply the herbicides aminopyralid (when used up to a maximum application rate of 0.12 kg/ha), chlorsulfuron, clopyralid, glyphosate, metsulfuron-methyl (when used up to a maximum application rate of 0.09 kg/ha) and triclopyr (when used up to a maximum application rate of 1.92 kg/ha) no closer than 1 horizontal metre from an open

Activity	Setback Requirement
	body of water (unless otherwise specified on the manufacturer's product label) provided that no more than 10% of any 100 m^2 in the zone 1 m to 5 m from an open body of water receives treatment in any calendar year.

[a]**Common body of water** includes the bed and shore of a water body that is shared by (common to) more than one landowner.
[b]**Manure storage facility** is a facility for composting or storing manure, composting material or compost (does not include facilities at an equestrian stable, auction market, racetrack or exhibition ground).
[c]**Manure collection area** refers to the floor or under-floor pits of a barn, the floor of a feedlot pen and a catch basin where manure collects (not including the floor of a livestock corral).
[d]**Open body of water** includes lakes, streams, rivers, irrigation canals and other natural water bodies. An "open body of water" does not include ponds or dugouts that have no outlet, are completely surrounded by private land, and are less than 4 hectares in area on private land or are less than 0.4 hectares on Public Land. Roadside ditches and small (less than 0.5 m wide), dry intermittent streams are also not considered open bodies of water (GOA 2013).

H.4. Forestry Standards and Guidelines for Operating beside waterbodies and watercourses. Refer to the Operating Ground Rules for additional and most recent requirements.

Table H.4.1. Excerpt from the Standards and guidelines for operating beside waterbodies (GOA 2022b)

Classification	Roads, landings, and bared areas	Watercourse protection areas
Lakes	For shorelines not located within reserved areas, no disturbances shall be permitted within the following distances of the high water mark. On lakes less than 4 ha, no disturbance within 100 m of the high water mark.	On lakes exceeding 4 ha in area, no disturbance or removal of timber within 100 m of the high water mark. Alberta may require additional protection in the GDP; On lakes less than 4 ha, removal of timber prohibited within 30 m of the high water mark and any removal within 100 m requires Alberta's approval.
Oxbow lakes	Construction not permitted within 100 m of oxbow lake.	The buffer shall encompass the area from the high water mark of the main watercourse to 20 m beyond the high water mark of the oxbow lake. Oxbow lakes outside the buffer of the main watercourse shall be treated as water source areas.
Semi-permanent marsh	Construction or log decks not permitted within 30 m of the marsh edge.	No disturbance or removal of timber within 10 m of waterbody.
Shallow open water	Construction or log decks not permitted within 30 m of the waterbody.	No disturbance or removal of timber within 20 m of waterbody.

Section 4.2 Operational Ground Rules (GOA 2022c)

4.2.1 Harvest Area Design

4.2.1.1 Converging watersheds of small permanent watercourses shall have buffers of 100m around the converging point to enhance wildlife corridors.

Table H.4.2. Excerpt from the standards and guidelines for operating beside watercourses (GOA 2022b).

Classification	Roads, landings, and bared Areas	Watercourse protection areas	Operating conditions within riparian areas and water source areas where operations are approved	
			Tree felling	Equipment operation
Large permanent	Not permitted within 100 m of the high water mark or water source areas within the riparian management zone.	No disturbance or removal of timber within 60 m of high water mark. No removal of timber shall be approved within 10 m of the high water mark; Watercourses with deeply incised unvegetated banks shall have the buffer start from the top of the incised valley and not the high water mark.	Trees shall be felled so that they do not enter watercourse. Should slash or debris enter the watercourse immediate removal is required without a machine entering the watercourse.	Where removal of timber within 60 m is approved, no machinery is permitted within 20 m of the high water mark.
Small permanent	Not permitted within 30 m of the high water mark or water source areas within the riparian management zone.	No disturbance or removal of timber within 30 m of high water mark. No removal of timber shall be approved within 10 m of the high water mark; Watercourses with deeply incised unvegetated banks shall have the buffer start from the top of the incised valley and not the high water mark.	Trees shall be felled so that they do not enter watercourse. Should slash or debris enter the watercourse immediate removal is required without a machine entering the watercourse.	Where removal of timber within 30 m is approved, no machinery is permitted within 20 m of the high water mark.
Transitional	Not permitted within 30 m of the high water mark or water source areas within the riparian management zone.	No disturbance or removal of timber within 10 m from the high water mark or to the top of the break in slope where the break occurs within 15 m.	Trees shall be felled so that they do not enter watercourse. Should slash or debris enter the watercourse immediate removal is required without a machine entering the watercourse.	Heavy equipment may operate within 20 m when conditions allow; No skidding through watercourse except on approved crossings.
Intermittent	Not permitted within 30 m of the high water mark or water source areas within the riparian management zone.	Buffer of brush and lesser vegetation to be left undisturbed along the channel. Width of buffer shall vary according to soils, topographical breaks, water source areas and fisheries values.	Trees shall be felled so they do not enter watercourses, unless otherwise approved by Alberta. Should slash or debris enter the watercourse, immediate removal is required without the machine entering the watercourse.	Heavy equipment may operate within 20 m when conditions allow; No skidding through watercourse except on approved crossings.

H.5. Setbacks Associated with Oil and Gas Activity (DACC 2015).

Watercourses

Type	Watercourse Width	Channel Characteristics	Setback Requirements[1]
Large Permanent[2]	> 5 m	Defined channel	100 m
Small Permanent[2]	0.7 – 5 m	Defined channel	45 m
Intermittent/Spring[2]	< 0.7 m	Defined channel	45 m
Ephemeral	-	No defined channel	15 m

Waterbodies

Type	Basin Characteristics	Setback Requirements[3]
Lakes	Open water (> 2 m depth)	100 m
Permanent Shallow Open Water Ponds (S&K V[4])	Open water (> 2 m depth) Deep marsh margin	100 m
Semi-permanent Ponds/wetlands (S&K IV[4])	Emergent deep marsh throughout	100 m
Non-permanent Seasonal Wetlands (S&K III[4])	Shallow marsh	45 m
Non-permanent Temporary Wetlands (S&K II[4])	Wet meadow	15 m setback requirement for well sites and pipelines
Fens	No defined channel; Slow flowing	No specific setback; attempt to leave undisturbed
Bogs	Peatland; Acidic wetland	No specific setback

[1]The setback for watercourses is measured from top of break (valley), or where undefined, from the top of the bank.

[2]May or may not contain continuous flow

[3]The setback from the defined bank of the waterbody or the outer margin of the last zone of vegetation that is not defined/bounded by upland vegetation communities.

[4]Steward, R.E., and H.A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Resource Publication 92, Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C. Northern Prairie Wildlife Research Centre Online, found at Norther Prairie Wildlife Research Centre.

Standard 100.9.6.2: Wellsites, pipeline installations, plant sites and camps shall maintain a minimum 100 m buffer to the edge of valley breaks. In the absence of well-defined watercourse valley breaks a 100 m buffer from the permanent watercourse bank applies.

APPENDIX I. Fish Sustainability Index Risk Thresholds for Walleye and Northern Pike

Table I.1. Walleye adult abundance Fish Sustainability Index scores and risks developed from index netting. Adult catch rate thresholds are based on ten lightly exploited actively managed reference lakes used to establish the very low risk category (FSI 5). The other risk categories were then based on IUCN methodology used to establish sustainability category thresholds (MacPherson et al. 2014) (GOA 2018c).

Adult Abundance FSI Score	Adult Index Netting Catch (fish/net-night)	Sustainability Risk Category
5	>29	Very Low Risk
4	20.3-29	Low Risk
3	14.5-20.3	Moderate Risk
2	5.8-14.4	High Risk
1	<5.8	Very High Risk
0	Extirpated	

Table I.2. Northern Pike adult abundance Fish Sustainability Index scores and risks developed from index netting. Adult catch rate thresholds are based on five lightly exploited actively managed reference lakes used to establish the very low risk category (FSI 5). The other risk categories were then based on IUCN methodology used to establish sustainability category thresholds (MacPherson et al. 2014) (GOA 2018d).

Adult Abundance FSI Score	Adult Index Netting Catch (fish/net-night)	Sustainability Risk Category
5	>21.8	Very Low Risk
4	15.3-21.8	Low Risk
3	10.9-15.2	Moderate Risk
2	4.4-10.8	High Risk
1	<4.4	Very High Risk
0	Extirpated	

APPENDIX J. Watercourse Crossings and Stream Connectivity

The importance of properly placed and maintained watercourse crossings to aquatic ecosystems has increased in recent years as biologists highlight the need to improve stream connectivity, reduce sediment and erosion impacts to streams, and restore fish passage. There are few examples of the use of targets and thresholds to management stream crossings, however the BC Government has established risk indicators for streams in interior BC (BC Government 2017), and the Athabasca Watershed Council has established risk and disturbance indicators (Table J.1). In addition, the Athabasca Watershed Council explored stream connectivity as indicated by the number of culverts per 100 km^2 area of tertiary watershed. This indicator has no ecological thresholds as classification was derived through Jenks statistical analysis and is only relative to the other tertiary watersheds in the Athabasca watershed (AWC 2012) (Table 9.18).

Table J.1. Risk ratings and disturbance classification examples determined for interior BC and the Athabasca watershed.

Risk/Pressure Rating	Interior BC (BC Government 2017)	Athabasca Watershed (Athabasca Watershed Council 2012)	
	Density (# stream crossings/km^2)	Density (# stream crossings/km^2)	Disturbance Classification (# stream crossings/100 km^2 watershed area)
Low	< 0.16	<0.4	Minimal: ≤3.5 culverts/100 km^2
Moderate	0.16 - 0.32	≥0.4 to <0.6	Moderate: >3 to≤9.5 culverts/100 km^2
High	> 0.32	≥0.6	Elevated: >9.5 culverts/100 km^2

A GIS inventory of watercourse crossings was completed in the Beaver River watershed, as well as a field survey in the Jackfish Creek and Manatokan Creek sub-basins to assess their functionality and integrity with respect to stream flow, fish passage, and potential for erosion (WorleyParsons 2012). Results of the GIS inventory are summarized in Table 19.

The number of crossings per km of channel length was determined for the Beaver River watershed data and compared to the BC density risk rating, and the connectivity disturbance classification indicator (number of stream crossings/100 km^2 watershed area) established for the Athabasca watershed. These two comparisons resulted in similar risk/disturbance class ratings. Medoid Partitioning was then used to cluster the culvert data into three groups (NCSS 2019; Bhat 2014). The values clustered together fell within the disturbance classifications developed for the Athabasca watershed, with the exception of the Upper Beaver watershed that was clustered with the Moderate Disturbance grouping rather than in the Elevated Disturbance classification. This preliminary assessment may be used to prioritize watersheds for further assessment and restoration of stream connectivity where feasible.

Table J.2. Number of culverts identified by sub-watershed (WorleyParsons 2012).

Sub-Watershed	Number of Culverts	Watershed Area (km^2)	# culverts/ km^2	# culverts/100 km^2 watershed area	Disturbance Classification	Approx. Total Channel length (km)	# Crossings/km of Channel Length	Risk Rating
Beaver River-Lower	33	479	0.069	6.9	Moderate	133	0.248	Moderate
Beaver River-Upper	684	5844	0.117	11.7	Elevated	3151	0.217	Moderate
Cold Lake	37	6083	0.006	0.6	Minimal	2272	0.016	Low
Jackfish Creek	~~46~~ 51	553	0.092	9.2	Moderate	254	0.201	Moderate
Sand River	21	3609	0.006	0.6	Minimal	1852	0.011	Low
Manatokan Creek	35 (40)	430	0.093	9.3	Moderate	221	0.181	Moderate
Marie Creek	49	834	0.059	5.9	Moderate	325	0.151	Low
Medley River	11	385	0.029	2.9	Minimal	224	0.049	Low
Moose Lake	116	932	0.125	12.5	Elevated	361	0.321	High
Muriel Lake	145	870	0.167	16.7	Elevated	426	0.340	High
Reita Creek	70	293	0.239	23.9	Elevated	208	0.337	High
Redspring Creek	87[a]	733	0.119	16.4	Elevated	356	0.337(?)	High
Sinking Lake	7	80	0.0875	8.75	Moderate	11	0.636	High
Wolf River	16	731	0.022	2.19	Minimal	333	0.048	Low
Total Crossings	1,357[b]	21,856	-	-	-	10,127	-	-

[a] This was reported as 120 in BRWA (2013)

[b] This was reported as 1,395 in BRWA (2013)