Lakeland Industry and Community Association
Box 8237, 5107W - 50 Street, Bonnyville, AB T9N 2J5
780 812-2182 780 812-2186 www.lica.ca

LICA Watershed Committee
Meeting Minutes
Thursday, December 1, 2022
1:00 p.m. – 4:00 p.m.
LICA Boardroom and Microsoft Teams

Present:	Richard Bourgeois Kellie Nichiporik Clem Parenteau Kelly Dion-McFeeters (via Microsoft Teams) Bill Parker Shawn Elgert (via Microsoft Teams, arrived 1:18 p.m.) Annette Hobart (via Microsoft Teams) Randi Dupras (via Microsoft Teams) Roxane Bretzlaff Kristen Berezanski (via Microsoft Teams)
Observers and Guests:	
Staff:	Kayla Hellum, LICA Environmental Coordinator Vicky Krawchuk, LICA Executive Director Eveline Hartog, LICA Administrative Professional Lori Jodoin, LICA Administrative Professional
Regrets:	John Ilchuk Robert Machatis Amanda Avery Bibo Abdi Siad-Omar

1.0 CALL TO ORDER

Vicky Krawchuk, LICA Executive Director, called the meeting to order at 1:02 p.m.

1.1 Territorial Acknowledgement

1.2 Vision, Mission, and Values

1.3 Introductions

1.4 Roll Call

Initials

1.5 Approval of Agenda

1.5.1 December 1, 2022, LICA Watershed Committee Agenda

#1 Moved by Richard Bourgeois AND CARRIED that the December 1, 2022, Agenda be approved as presented.

1.6 Approval of Minutes

1.6.1 September 9, 2022, IWMPC Minutes

#2 Moved by Roxane Bretzlaff AND CARRIED that the September 9, 2022, Minutes be approved as presented.

2.0 CHAIRPERSON APPOINTMENT

2.1 Appointment of Committee Chairperson

The LICA Watershed Committee appointed Kellie Nichiporik to be chairperson of the committee by acclamation.

3.0 POLICY REVIEW

3.1 Committee Terms of Reference

The LICA Watershed Committee reviewed the original IWMP Terms of Reference document with the intent to amend. The proposed changes were recommended to align it with the newly created LICA Watershed Committee. The following changes to the document were recommended to the Board of Directors.

#3 Moved by Clem Parenteau AND CARRIED that the LICA Watershed Committee Terms of Reference be accepted as amended.

3.2 Policy Review

3.2.1 Policy 1.5 *Decision-Making Process*

The LICA Watershed Committee reviewed Policy 1.5 *Decision Making Process* for information.

3.2.2 Policy 1.12 *Volunteer Hours*

The LICA Watershed Committee reviewed Policy 1.12 *Volunteer Hours.*

3.2.3 Policy 1.13 *Confidentiality*

The Watershed Committee reviewed Policy 1.13 *Confidentiality* and each member was requested to sign a copy for retention by LICA if they had not already done so.

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3.2.4 Policy 2.7 *Board and Committee Expenses and Remuneration*

The Committee reviewed Policy 2.7 *Board and Committee Expenses and Remuneration.*

3.2.4.1 Expense Claim Form

The Committee reviewed the LICA Expense Claim Form.

3.2.4.2 Direct Deposit Option

The Watershed Committee members eligible for stipends were given the option to complete the Direct Deposit form noting that a VOID cheque will be required to accompany the form.

3.2.5 Committee Member Sign-on

The Committee was requested to complete the Board and Committee Sign-on sheet for retention by the Financial Coordinator. Members who have already completed this form were requested to complete the form should their contact information have changed.

4.0 NEW BUSINESS

4.1 Environmental Coordinator Watershed Projects Update

The Environmental Coordinator reviewed projects forthcoming for the Watershed Committee noting:

- If successful in receiving the funding, the WRRP grant will allow LICA to complete a large-scale riparian intactness assessment in the Sand, Martineau, and Lower Beaver River HUC6 watersheds. This project will conclude the assessment of the entire Beaver River watershed.
- The WPAC operational grant was submitted in September 2022. This grant will allow the Environmental Coordinator to develop a riparian health campaign to increase awareness of riparian health within the LICA Region. The Coordinator suggested that in support of the educational campaign, tree seedings would be purchased and given to those committed to healthy riparian areas on their property. It was suggested by the Committee that these seedlings comprise edibles such as Saskatoons and wild roses.

4.2 IWMP Implementation

4.2.1 Top Five Priorities for Beaver River IWMP Implementation

The Environmental Coordinator reviewed the top five priorities identified in the IWMP, with potential implementation strategies. The Committee inquired as to how LICA would move forward on these priorities. Specific to a water quality monitoring program, the Coordinator suggested that one option would be for LICA to seek funding from municipalities in order to conduct water testing and monitoring by trained professionals. A

Initials

Committee member indicated that he would offer the Coordinator the name and contact information of someone who could assist her with further information regarding floodplain maps and watercourses.

The Coordinator thanked the Committee for their ideas, and she suggested that they review the priorities and come back with further suggestions at the next meeting.

4.3 Revisiting the State of the Watershed Report

4.3.1 Current Proposed Budget

The Environmental Coordinator reviewed the budget proposed for the State of the Watershed report which will need to be addressed in 2023. She indicated that the budget of $40,000.00 is being presented as information as the funding has not been secured. Further conversations regarding the State of the Watershed will need to be had to determine the direction needed to revisit the report. The Coordinator is currently researching and making contacts regarding this project.

5.0 ACTION LIST

5.1.1 Follow-up on Action List September 9, 2022

The Committee reviewed the Action List from September 9, 2022. A Committee member inquired if going forward with this action item if the Environmental Coordinator would be presenting the IWMP to municipalities in the LICA region. The Coordinator replied that she would be, and she would also be explaining how the information presented in the report could be implemented in their municipalities.

6.0 UPCOMING MEETING DATES

6.1 Board of Directors Meeting and Christmas Luncheon -December 15, 2022

6.2 Next Meeting - TBD

7.0 ADJOURNMENT

The meeting adjourned at 1:48 p.m.

#4 Moved by Clem Parenteau AND CARRIED that the meeting be adjourned.

Approved on: _____
Date

_____
Signature

_____
Initials

2022-23 Attendance
LICA Watershed Committee Meetings

NAME	December 1, 2022					
John Ilchuk						
Kelly Dion-McFeeters						
Shawn Elgert						
Robert Machatis						
Clem Parenteau						
Amanda Avery Bibo						
Roxane Bretzlaff						
Kristen Berezanski						
Annette Hobart						
Abdi Siad-Omar						
Bill Parker						
Randi Dupras						
Kellie Nichiporik						
Richard Bourgeois						

Notes: ✓ = Present TC = Telephone Conference A = Absent from Meeting

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LICA Watershed Committee Meeting
LICA Boardroom and via Microsoft Teams
Thursday, December 1, 2022
1:00 p.m. - 4:00 p.m.

Item	Agenda	Discussion Leader	Required Outcome
1.0	**CALL TO ORDER**		
1.1	Territorial Acknowledgement	**Vicky**	
1.2	Vision, Mission, and Values	**Vicky**	
1.3	Introductions	**All**	
1.4	Roll Call	**Vicky**	For Review
1.5	Approval of Agenda 1.5.1 December 1, 2022	**Vicky**	For Decision
1.6	Approval of Minutes 1.6.1 September 9, 2022	**Vicky**	For Decision
2.0	**Chairperson Appointment**		
2.1	Appointment of Committee Chairperson	**Vicky**	For Decision
3.0	**POLICY REVIEW**		
3.1	Committee Terms of Reference	**All**	For Decision
3.2	Policy Review		
	3.2.1 Policy 1.5 *Decision-Making Process*	**Vicky**	For Information
	3.2.2 Policy 1.12 *Volunteer Hours*	**Vicky**	For Information
	3.2.3 Policy 1.13 *Confidentiality*	**Vicky**	For Signature
	3.2.4 Policy 2.7 *Board and Committee Expenses and Remuneration*	**Vicky**	For Information
	3.2.4.1 Expense Claim Form	**Vicky**	For Completion
	3.2.4.2 Direct Deposit Option	**Vicky**	For Completion
	3.2.5 Committee Member Sign-on	**Vicky**	For Completion
4.0	**NEW BUSINESS**		
4.1	Environmental Coordinator Watershed Projects Update	**Kayla**	For Information
4.2	IWMP Implementation		
	4.2.1 Top Five Priorities for Beaver River IWMP Implementation	**Kayla**	For Discussion
4.3	Revisiting the State of the Watershed Report		
	4.3.1 Current Proposed Budget	**Kayla**	For Discussion
5.0	**ACTION LIST**		
5.1	Follow-up Action List		
	5.1.1 September 9, 2022	Chairperson	For Review
6.0	**UPCOMING MEETING DATES**		
6.1	Board of Directors Meeting – December 15, 2022	Chairperson	For Information
6.2	Next Meeting – TBD	Chairperson	For Discussion
7.0	**ADJOURNMENT**	Chairperson	For Decision

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Integrated Watershed Management Plan Committee

Meeting Minutes
Friday, September 9, 2022
9:00 a.m. – 12:00 p.m.
LICA Boardroom

Present:	Louise White-Gibbs Robert Machatis Clem Parenteau Amanda Avery Bibo Maureen Delorme-Ouellette (left at 11:12 a.m.) Kristen Berezanski Abdi Siad-Omar Bill Parker Richard Pearce Kellie Nichiporik (arrived at 11:48 a.m.) Roxane Bretzlaff
Observers and Guests:	Sandi Riemersma, Palliser Environmental (via Microsoft Teams)
Staff:	Kayla Hellum, LICA Environmental Coordinator Vicky Krawchuk, LICA Interim Executive Director Tina Johnson, LICA Administrative Professional
Regrets:	Dana Swigart Sharron Blyan-White Annette Hobart Ted Traikovski Richard Bourgeois Madison Arsenault Shana Langley Al Bertschi Randi Dupras Mitch Sylvestre

1.0 CALL TO ORDER

Amanda Avery-Bibo, the Committee Chairperson, called the meeting to order at 9:05 a.m.

Initials

1.1 Territorial Acknowledgement

1.2 Vision, Mission, and Values

1.3 Introductions

1.4 Roll Call

The passing of committee member Delano Tolley was relayed to the Committee.

Three or more consecutive absences were noted for Annette Hobart, Ted Traikovski, and Shana Langley. No action will be taken as this is the final meeting of the year.

1.5 Approval of Agenda

1.5.1 September 9, 2022, IWMP Agenda

#1 Moved by Clem Parenteau AND CARRIED that the September 9, 2022, Agenda be approved as presented.

1.6 Approval of Minutes

1.6.1 August 30, 2022, IWMPC Minutes

#2 Moved by Louise White-Gibbs AND CARRIED that the August 30, 2022, Minutes be approved as presented.

2.0 OLD BUSINESS

2.1 Approval of August 30th Recommendations

Due to the Committee not achieving quorum at the last meeting, several decisions were brought forward as recommendations from that meeting. These will now be approved.

2.1.1 August 30, 2022, Agenda

#3 Moved by Louise White-Gibbs AND CARRIED that the August 30, 2022, Agenda be approved as recommended.

2.1.2 May 17, 2022, IWMPC Minutes

#4 Moved by Robert Machatis AND CARRIED that the May 17, 2022, IWMPC Minutes be approved as recommended.

2.1.3 Adjournment

#5 Moved by Roxane Bretzlaff AND CARRIED that the meeting adjournment at 11:46 a.m. be approved as recommended.

Initials

3.0 ONGOING BUSINESS

3.1 Final Beaver River IWMP (Live Edits)

Live edits from the Committee to the Final Beaver River IWMP document were as follows:

- Requested shared work to highlight in the plan in correction with the recommended actions. This would be under Fisheries Management objectives – Ray Mackowecki
- Carbon credit system needs to be explored and expanded in relation to the plan
- Cover photos of the report were changed to reflect the beauty of the watershed
- Addition of LICA Interim Executive Director Vicky Krawchuk to Ex officio members
- That the passing of Committee member Delano Tolley be recognized and that the plan be dedicated in his honour
- Source water protection plans was added to 9.3.4 implementation tables
- Add 1904 Order in Council moved to create Cold Lake First Nations
- Add 1938 creation of Metis Settlements in Alberta such as Kikino Metis Settlement also noting that the Wolf Lake Metis Settlement established at that time was dissolved in 1941 and that these Metis members moved to Elizabeth Metis Settlement or Fishing Lake Metis Settlement.
- Alberta Environment and Parks is in the process of creating a website that funnels all water data to one area
- Remove reference to Marie Lake in Table 9.2.4 as the Committee no longer felt it was relevant
- Remove the unnamed lakes from Table 13
- Update the page footer from Lakeland Industry & Community Association to LICA – Environmental Stewards (LICA)
- Actions were added to section d) in Table 9.4.4

3.2 Next Steps

The Committee was informed that this was the final meeting for approval of the IWMP document and were thanked for their input and hard work over the past two years. Going forward the LICA Board of Directors will decide on the committee's status and the Environmental Coordinator will follow up with the Committee on the Board's decision.

#6 Moved by Louise White-Gibbs AND CARRIED that the September 9, 2022, final draft of the Beaver River Integrated Watershed Management Plan be accepted as amended.

Initials

4.0 ACTION LIST

4.1 Follow-up on Action List

4.1.1 May 14, 2022

The IWMP Committee reviewed the action list from the May 14, 2022, IWMP Meeting noting that all actions for the IWMP have been completed and that seeking support on the Plan will be ongoing.

5.0 UPCOMING MEETING DATES

5.1 ADMPEC Meeting – September 14, 2022

5.2 Board Meeting – September 22, 2022

5.3 LICA Annual General Meeting – October 6, 2022

6.0 ADJOURNMENT

The meeting adjourned at 11:50 a.m.

#7 Moved by Roxane Bretzlaff AND CARRIED that the meeting be adjourned.

Approved on: _____
Date

_____
Signature

_____
Initials

LICA

Lakeland Industry and Community Association

~~Integrated Watershed Management Plan Committee (IWMPC)~~
LICA Watershed Committee (LWC)
Terms of Reference

The Lakeland Industry and Community Association (LICA) formed the LICA Watershed Committee (LWC) to assist the Environmental Coordinator in watershed management planning and projects including Beaver River Integrated Watershed Management Plan (IWMP) implementation. ~~in the development and oversight of LICA's Integrated Watershed Management Plan (IWMP).~~ The LWC is a working committee of LICA that will ~~which shall~~ report its activities and requests to the Board for approval. The LWC ~~IWMPC~~ is supported by representation from Industry, Government, Indigenous communities, ~~youth, 4 Wing Cold Lake~~, Non-Government Organizations, and the community, ~~and the public,~~ which allows for diverse insight and support when it comes to priorities in the Beaver River Watershed.

1.0 Purpose

1.1 To support the LICA Board's Vision and Mission.
1.2 To operate within LICA Board approved work plans and budget ~~and be~~ while being accountable to the LICA Board of Directors regarding the oversight of watershed management planning and projects and ~~of~~ the implementation and priorities of the IWMP~~. operation, reporting, and management of the IWMP.~~
1.3 To act on behalf of the stakeholders they represent and to bring that perspective when addressing watershed concerns and ~~to~~ the IWMP.
1.4 To make recommendations related to messaging surrounding watershed issues, goals, objectives, targets, implementation, and other items to the IWMP.
1.5 Deliver relevant, accurate, reliable, and credible data and information that addresses stakeholder needs and priorities.
1.6 To act on behalf of the Board to represent stakeholders of the Beaver River watershed. Provide insight into environmental program needs, regional monitoring priorities, and concerns.
1.7 To ensure the dissemination of comprehensive information in and for the IWMP and other watershed reporting.
1.8 To support the implementation of recommendations from environmental management plans such as the Lower Athabasca Regional Plan (LARP), the 2006 Cold Lake Beaver River Water Management Plan and other local land and water management plans.

2.0 Operating Principles

2.1 The LWC ~~IWMPC~~ will follow LICA's Vision and Mission and will operate within LICA's policies in support of the Strategic Plan.
2.2 The LWC ~~IWMPC~~ will meet quarterly at a minimum.
2.3 The LWC ~~IWMPC~~ will report to the Board, and when needed, be responsible for facilitating Board discussion regarding their recommendations.

Reviewed: December 1, 2022

Approved:

2.4 The LWC ~~IWMPC~~ will ensure that the IWMP effectively addresses stakeholder needs through regular evaluation of stakeholders' objectives related to LICA, throughout the implementation process.
2.5 Members will actively participate and contribute to regular meetings and the group's work.
2.6 Members will communicate with employers, organizations, and stakeholders they represent about LWC's ~~IWMPC~~ objectives, priorities, and accomplishments, as well as any issues that may need to be resolved.
2.7 Meetings will be documented with summary notes, decision records and action logs to be issued within a reasonable time for review by the LWC ~~IWMPC~~ prior to the final issue. These will be made available to all LWC ~~IWMPC~~ members as part of the review process.
2.8 The LWC ~~IWMPC~~ will strive for consensus recommendations and decisions. If it becomes clear that the LWC ~~IWMPC~~ cannot make a consensus recommendation, the recommendation of the majority and the non-consensus position(s) will be presented for the Board to decide.
2.9 Ad-hoc focused task groups may be formed to review specific issues such as monitoring plans, special targets, watershed concerns and projects, and contractor selection, and advise the LWC ~~IWMPC~~ on a path forward.
2.10 Outside expertise may be invited to contribute as required as directed by the Technical Staff.

3.0 Membership

The membership of the LWC ~~IWMPC~~ is made up of the Environmental Coordinator, Executive Director, Education & Outreach Coordinator, core members, and resource members. Core members are selected by the sectors that they represent or appointed by the LICA Board. Resource members are subject matter experts and LICA staff that may be included by invitation of the Environmental Coordinator or Executive Director.

3.1 The LWC ~~IWMPC~~ chair will be a Committee Member ~~a Board Director~~ appointed by the Committee at their first meeting after the annual general meeting. ~~Board and must be present at all committee meetings.~~
3.2 The Chair of the Board may attend as ex-officio.
3.3 Community members may be appointed by the Board and shall be eligible for remuneration and expenses according to LICA policy.
3.4 The Board may request additional members from among Industry, Government, and Non-Government organizations to be appointed from their respective sectors and may be eligible for remuneration and expenses according to LICA policy.
3.5 The core membership will be Board approved.
3.6 Core Membership
- 3.6.1 ~~Alberta Environment and Parks~~ Alberta Environment and Protected Areas (~~AEP~~EPA) – Sector nominated
- 3.6.2 Alberta Energy Regulator (AER) – Sector nominated
- 3.6.3 Industry, Oil & Gas – Sector nominated
- 3.6.4 Agriculture and Irrigation- (AGI) Sector nominated
- 3.6.5 LICA Board Directors- Board appointed
- 3.6.6 Indigenous Communities – Sector nominated
- 3.6.7 Environmental Organizations & Special Interest Groups - Sector nominated

Reviewed: December 1, 2022

Approved:

3.6.8 Municipal Governments - Sector nominated
3.6.9 Community Members - Sector nominated
~~3.6.10 Scientific and Academic Organizations & Institutions – Sector nominated~~
~~3.6.11 Youth~~
~~3.6.12 Canadian Forces Base – 4 Wing Cold Lake~~

4.0 Meetings

4.1 Committee meetings will comply with Policy 1.6 Board and Committee Meetings. Please contact the LICA office at lica2@lica.ca for up-to-date policies.

5.0 Roles and Responsibilities of the LWC ~~IWMPC~~ and its Members

5.1 General LWC ~~IWMPC~~ Members
- 5.1.1 Actively participate in meetings and provide technical knowledge and support.
- 5.1.2 Understand and represent the interests and regulatory requirements (if applicable) of the group they represent.
- 5.1.3 Implement ~~Develop~~ key ~~watershed concerns,~~ priorities, goals, recommendations and targets ~~and implementation~~ of the IWMP to address watershed concerns.
- 5.1.4 ~~Assess material and make~~ Make recommendations as required regarding the implementation ~~development~~ of the IWMP.
- 5.1.5 Provide support for planning future phases of the IWMP.
- 5.1.6 Keep the implementation ~~development~~ of the IWMP in alignment with LICA's Strategic Plan and budget.
- 5.1.7 Ensure that the work is being conducted in a transparent manner.
- 5.1.8 Engage other expertise as needed.
- 5.1.9 Form ad hoc groups as needed to work on specific projects related to the LWC. ~~IWMP~~.

5.2 Roles in Addition to General LWC ~~IWMPC~~ Member Roles
- 5.2.1 Environmental Coordinator
  - 5.2.1.1 Act as LWC ~~IWMP~~ Vice-Chair to convene meetings and prepare agendas.
  - 5.2.1.2 Report to the LICA Board as a representative of the LWC. ~~IWMP~~.
  - 5.2.1.3 Lead ad hoc groups as required.
  - 5.2.1.4 Develop annual work plans and budgets for Board approval.
  - 5.2.1.5 Oversee operations and maintenance of environmental programs, including the following:
    - ~~5.2.1.6~~5.2.1.5.1 Establish key performance indicators used to monitor the performance of third-party contractors based on best practices.
    - ~~5.2.1.7~~5.2.1.5.2 Monitor the performance of third-party contractors and report to the Board.
  - ~~5.2.1.8~~5.2.1.6 Report issues of non-compliance to the Board immediately for corrective action or direction based on recommendations from the LWC. ~~IWMP~~.

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Reviewed: December 1, 2022

Approved:

~~5.2.1.9~~5.2.1.7 Review the implementation ~~development~~ of the IWMP to ensure the progress of the IWMP is being met with the standards of the provincial government; update the progress plan as required.

~~5.2.1.10~~5.2.1.8 Stay informed of changes in land and water management as directed by the federal or provincial governments.

~~5.2.1.11~~5.2.1.9 Ensure the environmental programs operate cost-effectively and within budget.

~~5.2.1.12~~5.2.1.10 Develop, coordinate, and deliver community and stakeholder forums throughout the watershed.

5.2.2 Executive Director

5.2.2.1 Advise the LWC ~~IWMPC~~ on LICA policies as required.

5.2.2.2 Act as a liaison between other LICA committees and the LWC. ~~IWMPC~~.

5.2.2.3 Maintain collaborative relationships with stakeholders.

5.2.3 Education & Outreach Coordinator

5.2.3.1 Advise the LWC ~~IWMPC~~ on best practices to engage with the public on watershed-related matters and IWMP implementation. ~~For input on the IWMP.~~

5.2.3.2 Assist in coordinating and delivering outreach activities to engage the public, such as forums.

5.2.3.3 Promote the implementation ~~development and~~ progress of the IWMP to the public and disseminate materials as they become available.

5.2.4 Board Director

5.2.4.1 Act as a liaison between the LICA Board and LWC. ~~IWMPC~~.

5.2.5 Indigenous Representative(s)

5.2.5.1 Ensure Indigenous ~~Traditional~~ Environmental Knowledge is recognized and integrated into watershed projects. ~~The IWMP~~.

5.2.5.2 Provide information about cultural protocols and assistance with appropriate community engagement.

5.2.6 ~~AEP~~ EPA, ~~and~~ AER, and AGI Representative(s)

5.2.6.1 Provide advice and technical input regarding watershed projects, ~~the operations~~ and implementation ~~design~~ of the IWMP.

5.2.6.2 Provide a link to other Government of Alberta and Regulatory staff and resources.

5.2.6.3 Act as a liaison regarding regulatory requirements, policy development, and approvals.

~~5.2.7 Scientific and Academic Organization & Institution(s)~~

~~5.2.7.1 Provide advice and technical input regarding the operations and design~~

Reviewed: December 1, 2022

Approved:

~~of the IWMP.~~

5.2.8 Third-Party Contractor(s)

5.2.8.1 Perform duties according to approved standards and protocols as per their current contracts.

6.0 Evaluation

6.1 The LWC ~~IWMPC~~ shall review its Terms of Reference annually.

Reviewed: December 1, 2022

Approved:

1.5 DECISION-MAKING PROCESS

INTENT:

The Board and committee members make sound decisions which align with LICA's Vision, Mission, and Values.

1.5.1 DIRECTIVES:

1.5.1.1 LICA has adopted a consensus model of decision-making for Board and committee meetings.

1.5.1.2 Annual General and Special General Meetings will follow Robert's Rules of Order.

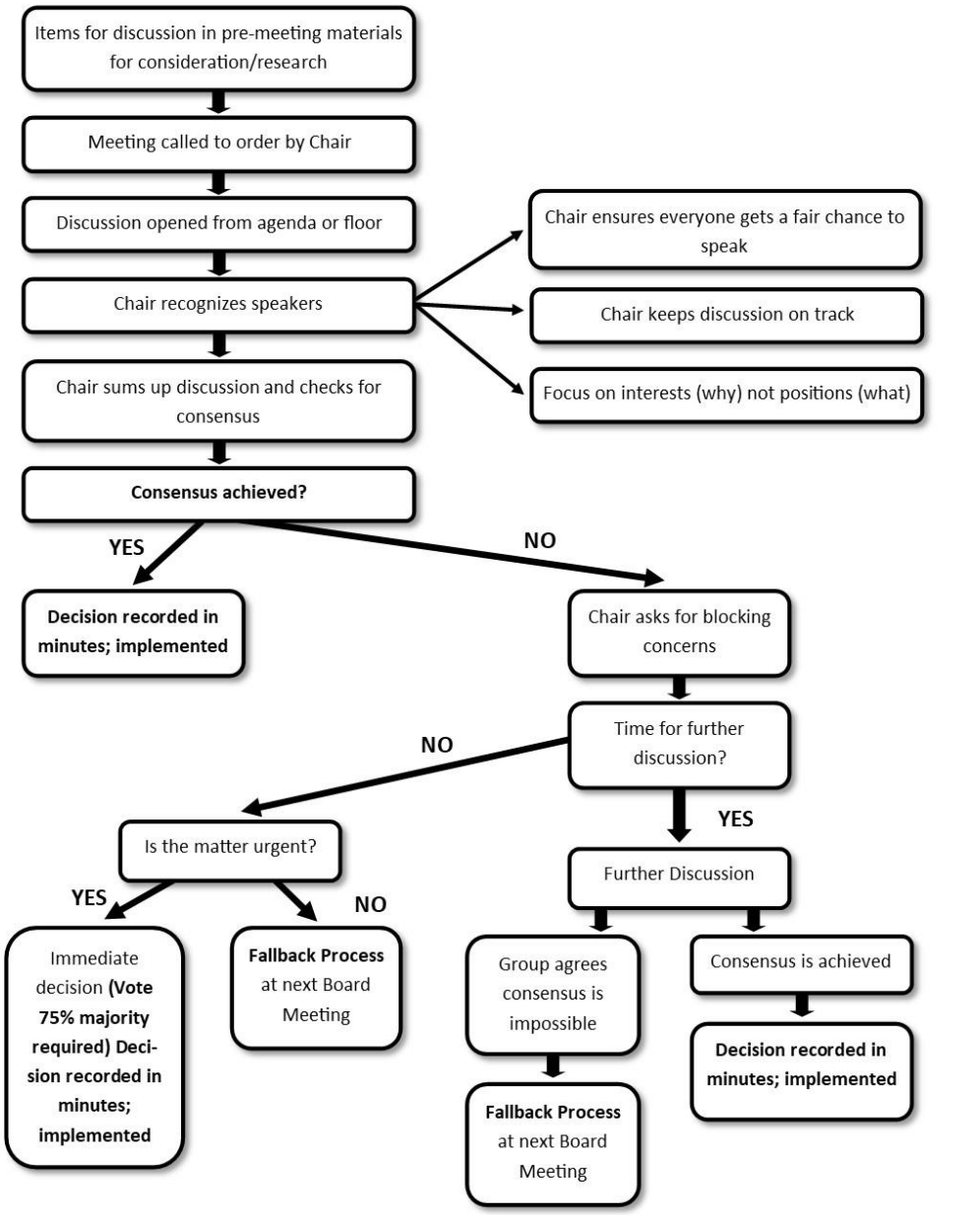
1.5.2 IMPLEMENTATION:

1.5.2.1 At the first meeting of the Board and of each committee, the Chair will indicate that a consensus decision-making process is to be followed as outlined in Appendix A: LICA's Board and Committee Consensus Decision-Making Process.

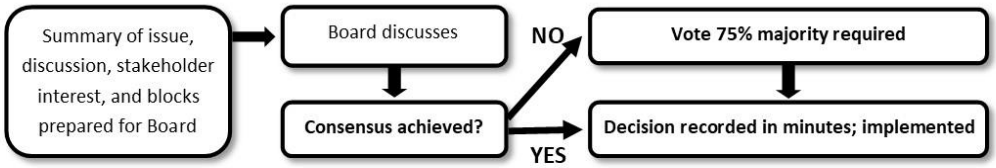
1.5.2.2 Training and guidance in the use of the consensus decision-making process will be made available to all Board and committee members.

Review Dates:– August 25th, 2004; June 12, 2017; September 5, 2018, February 1, 2022
Approval Dates: November 29th, 2001; September 7, 2017; September 13, 2018, February 24, 2022

LICA'S BOARD AND COMMITTEE CONSENSUS DECISION-MAKING PROCESS



FALLBACK PROCESS



Review Dates: August 25th, 2004; June 12, 2017; September 5, 2018; February 1, 2022
Approval Dates: November 29th, 2001; September 7, 2017; September 13, 2018; February 24, 2022

1.12 VOLUNTEER HOURS

INTENT:

The Board recognizes volunteer time by members is critical to the success of LICA. These hours require tracking to use as a "contribution in kind", when applying for grants or direct government funding.

1.12.1 DIRECTIVES:

1.12.1.1 Board and committee members are requested to track hours spent on LICA activities. (Board, committee, and special meetings including preparation, business, outreach, events, workshops, and associated travel)

1.12.2 IMPLEMENTATION:

1.12.2.1 The Executive Director will keep an accounting of total volunteer hours.

1.12.2.2 Individuals are responsible for tracking their volunteer hours on the meeting and/or event sign-in sheet.

1.12.2.3 Any volunteers who require detailed information on hours or duties are expected to keep such logs for themselves. The Executive Director will verify the total number of hours submitted, if requested.

Review Dates: October 27, 2004; Sep 2006; May 2009, February 27, 2017; June 26, 2017, November 26, 2018
Approval Dates: September 29, 2004; Sep 27, 2006; May 28, 2009; April 24, 2017; September 7, 2017; December 13, 2018

1.13 CONFIDENTIALITY

INTENT:

Board and committee members may become aware of confidential information during their involvement with LICA. Under Common Law and the Freedom of Information and Protection of Privacy Act (FOIP) such information must remain confidential and may not be used for personal gain.

1.13.1 DIRECTIVES:

1.31.1.1 Regarding confidentiality of information, Board and committee members will always be governed by the Societies Act, Common Law, FOIP and LICA's Vision, Mission, Values, bylaws, and policies.

1.13.2 IMPLEMENTATION:

1.13.2.1 LICA may need to collect personal information about an individual or organization. Such information will be handled in a secure and confidential manner. LICA's records management practices will be in accordance with FOIP https://www.servicealberta.ca/foip/, and as defined in Policy 2.6-Records Retention.

1.13.2.2 Only the Officers, Executive Director, and Accounting Assistant will have access to confidential files.

1.13.2.3 Board and committee members will annually sign an Oath of Confidentiality (appended) at the first meeting after their election or appointment; any variance from this requirement is subject to Board approval.

1.13.2.4 *In camera* proceedings must remain confidential in accordance with Policy 1.6.

1.13.2.5 Information will remain confidential during and after LICA tenure, unless released by the owner.

Review Dates: **September 27, 2006, May 8, 2008, June 2, 2011; June 26, 2017, November 26, 2018; February 1, 2022**
Approval Dates: **September 27, 2006, May 8, 2008, June 2, 2011; September 7, 2017; December 13, 2018; February 24, 2022**

LAKELAND INDUSTRY AND COMMUNITY ASSOCIATION

LICA – Environmental Stewards

BOARD AND COMMITTEE MEMBER OATH OF CONFIDENTIALITY

I do solemnly declare that I will not disclose any confidential information of any kind that comes to my knowledge respecting any member, employee, contractor or associated organization of the Lakeland Industry and Community Association (LICA) through my involvement with LICA.

I acknowledge that this declaration will remain in force both during and after my tenure as a LICA member.

I understand that if I choose to disclose confidential information, I may be liable for prosecution for breach of confidentiality, and that LICA will not indemnify me for any fines or awards of damages against me.

I have read this declaration in its entirety and understand the contents of this declaration.

_____	_____
Signature of Witness	Signature of Board or committee member
_____	_____
Name of Witness (Print)	Name of Board/committee member (Print)
_____	
Date	

Review Dates: **September 27, 2006, May 8, 2008, June 2, 2011; June 26, 2017, November 26, 2018; February 1, 2022**
Approval Dates: **September 27, 2006, May 8, 2008, June 2, 2011; September 7, 2017; December 13, 2018; February 24, 2022**

2.7 BOARD AND COMMITTEE EXPENSES AND REMUNERATION

INTENT:

Board and appointed committee members who represent the community, Indigenous, and non-government sectors will be reimbursed for pre-approved expenses and time spent on LICA activities.

2.7.1 DIRECTIVES:

2.7.1.1 **Board and committee members shall endeavour to keep expenses and claims to a minimum.** Pre-approved stipends and expenses will be paid where participants are providing service as a LICA Board or committee member.

2.7.1.2 Board and committee members' whose time is covered by their employers are not eligible for remuneration.

2.7.2 IMPLEMENTATION:

2.7.2.1 LICA Board and committee members attending an approved conference may claim stipend for conference days only.

2.7.2.2 Elected and appointed members will be paid stipends and be reimbursed for expenses at the following rates:

- Meetings, events, and training (excluding the AGM) - $ 130.00
- Round-trip mileage in accordance with the Alberta Government rate in effect at the time of LICA's annual organizational meeting.
- Parking as per itemized receipt
- Meal allowances, which include gratuity and GST; no receipts required:

Breakfast - $13.00
Lunch - $16.00
Dinner - $22.00

- Accommodation as per itemized receipt

2.7.2.3 The Board Chairperson will receive a flat rate of $100 per month, over and above any stipends paid.

2.7.2.4 The Officers may receive stipends, upon approval of the Board, for additional duties associated with their roles.

Review Dates: Jan 2006; Sep 2006; Oct 2007; May 2008; Sep 2008; Jan 2010; Jun 2010; May 2011; May 3, 2012; April 3, 2014; October 2, 2014; June 26, 2017; January 8, 2018; April 16, 2018; December 8, 2021
Approval Dates: Jan 24, 2002; Sep 27, 2006; Oct 03, 2007; Feb 04, 2010; Sep 02, 2010; June 2, 2011; May 3, 2012; Oct 02, 2014; September 7, 2017; April 12, 2018; January 27, 2022

2.7.2.5 While there is an expectation of attendance for the complete meeting, event, or training, stipends will be paid only if individuals remain for the major portion of the meeting, event, or training.

2.7.2.6 An individual will receive one stipend per committee event, meeting, or training per day.

2.7.2.7 Mileage will be paid to individuals travelling to and from a meeting, event, or training session related to LICA business. LICA reserves the right to verify mileage charges prior to approval.

2.7.2.8 Where two or more individuals carpool to a meeting, training, or event, only the person whose vehicle makes the trip will be reimbursed for mileage.

2.7.2.9 Industry representatives will be eligible for reimbursement of expenses as pre-approved by the Board of Directors.

2.7.2.10 Other members may be approved to attend meetings, conferences, etc., with reimbursement at the discretion of the Board.

2.7.2.11 Reimbursement will be made after expenses are incurred and receipts and invoices are submitted and approved.

2.7.2.12 Claims other than mileage, meals and stipends require original itemized receipts.

2.7.2.13 All expense and remuneration claims will be reviewed and approved by the Executive Director or Board designate.

2.7.2.14 Where anticipated expenses are known (e.g., conference fees), the Executive Director may pay for them with the LICA credit card.

Review Dates: Jan 2006; Sep 2006; Oct 2007; May 2008; Sep 2008; Jan 2010; Jun 2010; May 2011; May 3, 2012; April 3, 2014; October 2, 2014; June 26, 2017; January 8, 2018; April 16, 2018; December 8, 2021

Approval Dates: Jan 24, 2002; Sep 27, 2006; Oct 03, 2007; Feb 04, 2010; Sep 02, 2010; June 2, 2011; May 3, 2012; Oct 02, 2014; September 7, 2017; April 12, 2018; January 27, 2022

Lakeland Industry & Community Association
P.O. Box 8237, Bonnyville AB T9N 2J5
Phone: (780) 812-2182 Toll Free: 1-877-737-2182 Fax: (780) 812-2186 E-Mail: lica2@lica.ca Website: www.lica.ca

Receipts must be attached to expense form

EXPENSE CLAIM

NAME: _____

ADDRESS: _____ **POSTAL CODE:** _____

Date	Meeting Description	Travel To	KM's	Other	Stipend	Chair Approval
TOTALS						

Authorized By:

Stipend $ _____ **Executive Director** _____

KM _____ **@ 0.61** $ _____

Other Travel Expenses $ _____
(please attach receipts)

TOTAL CLAIM $ _____ **Signature of Member** _____

Includes: travel, meetings, meeting prep/follow-up, tours, conferences, project implementation, services in kind, donations, other

Lakeland Industry & Community Association
P.O. Box 8237, Bonnyville AB T9N 2J5
Phone: (780)812-2182 Toll Free: 1-877-737-2182 Fax: (780)812-2186 E-Mail: lica2@lica.ca Website: www.lica.ca

Receipts must be attached to expense form

6.8 Expenses and Honoraria

Intent:

Board and appointed committee members who represent the community sector are not intended to be out of pocket on LICA's behalf, and so will be reimbursed for pre-approved expenses and time spent on LICA activities. However, it is not intended that LICA stipends become a regular "job" revenue for committee and Board volunteers. Industry and government members' time is covered by their employers, since their LICA activities are employment-related. Board and Committee members shall endeavour to keep expenses and claims to a minimum.

Guidelines:

1. Elected and appointed Community Representatives to the LICA Board and LICA Committee shall be reimbursed for pre-approved meeting and expenses related to:

1.1	Approved Meetings, events, and training	- $130.00 per meeting
1.2	Roadtrip mileage	- 61.0 cents per km up to 5,000 km & 55.0 cents over 5,000 km
1.3	Parking as per receipt	
1.4	Meal Allowances (no receipt required)	- $13.00/Breakfast
		- $16.00/Lunch
		- $22.00/Dinner
1.5	Accomadation as per receipt	

EFFECTIVE DATE: **October 7, 2022**

2. Industry Representatives will be eligible for reimbursement of expenses as approved by the Board of Directors.

3. Representatives will be reimbursed after expenses are incurred and receipts and invoices submitted and approved accordingly.

Procedure:

1. Claims for expense reimbursement must be submitted to the Executive Director prior to the 15th of each month in order to expedite payment. Claims other than automotive mileage and per diem require copies of receipts.

2. All expense claims will be reviewed and approved by the Executive Director.

Approval Date: _____ **Review Date:** _____

LICA
ENVIRONMENTAL STEWARDS
Lakeland Industry and Community Association
Box 8237, 5107W - 50 Street, Bonnyville, AB T9N 2J5
780 812-2182 780 812-2186 www.lica.ca

PRE-AUTHORIZED CREDIT AUTHORIZATION AGREEMENT

Instructions:

Please complete all sections (type or print clearly) to instruct your financial institution to make deposits directly to your account. Return the completed form with a correctly encoded blank cheque marked "VOID" OR a Preauthorized Credit Form from your financial institution to: **Lakeland Industry and Community Association** at the above address

APPLICANT (PAYEE):

Surname: _____ First Name: _____

Surname: _____ First Name: _____

Address/Street: _____

City: _____ Province: _____

Postal Code: _____ Telephone: _____

FINANCIAL INSTITUTION TO BE CREDITED:

Name of Financial Institution: _____

Branch/Location, Street: _____

City: _____ Province: _____ Postal Code: _____

Route/Transit Number: _____ Account Number: _____

(Attach a correctly encoded cheque marked "VOID") **OR** a Preauthorized Credit Form from your Financial Institution

TERMS AND CONDITIONS

1. I (We) as the Applicant(s) and Account Holder(s)/Payee(s) hereby **authorize Lakeland Industry and Community Association** as Payor and the above noted Financial Institution to credit my (our) account at the above indicated branch of the Financial Institution, under Terms and Conditions agreed to by Me (Us) with the **Lakeland Industry and Community Association** as Payor.

2. A credit in paper, electronic or other form may be deposited on My (Our) account which amount may be increased/decreased at a future date as agreed to in writing by Me (Us**). Lakeland Industry and Community Association** as Payor will, to the best of their ability, advise Me (Us) in writing of the revised amount in advance of its effective date.

3. The authorization may be cancelled at any time by Me (Us). I (We) will notify the **Lakeland Industry and Community Association**, as Payor in writing of any changes in the Financial Institution or account information or termination of this agreement at least 10 days prior to the next due date of the pre-authorized credit. Revocation of this agreement does not in any way terminate any other obligation (s) between the Applicant (s) and **Lakeland Industry and Community Association**.

4. Any and all notices required will be sent to the addresses provided herein.

5. **Lakeland Industry and Community Association** may apply in writing to the Financial Institution for reimbursement of the credit if the credit is disputed.

   Items credited will be reimbursed by the Financial Institution, subject to notification by **Lakeland Industry and Community Association** to the Branch of account within 90 days of the transaction date subject to meeting any of the following conditions:

   a) I (We) provided the authorization to the Payor.
   b) The pre-authorized credit was deposited in accordance with this authorization.
   c) The credit was posted to the wrong account due to invalid/incorrect account information supplied by the employee.

   LIABILITY

   The **employee shall be solely responsible for the accuracy and completeness of all information furnished to Lakeland Industry and Community Association and Lakeland Industry and Community Association shall not be responsible in any way for error resulting from the inaccuracy or incompleteness of any information furnished to it by the employee.**

   Lakeland Industry and Community Association shall not be responsible or liable for any claim, demand, cost, expense, damage, penalty, delay or inconvenience to the employee or any other person resulting from failure of Lakeland Industry and Community Association to perform any of the services herein contemplated arising out of any cause beyond the control of Lakeland Industry and Community Association or for any reason whatsoever other than the gross negligence or willful default of (Company Name). Lakeland Industry and Community Association shall not be liable to the employee in any event for any special, indirect or consequential damages.

6. I (We) the Applicant (s) hereby acknowledge that I (We) have read and understand and agree to the Terms and Conditions as contained herein.

7. I (We) warrant that all persons whose signatures are required to sign on the account at my (our) Financial Institution have signed this agreement below.

8. I (We) acknowledge that delivery of this authorization **to Lakeland Industry and Community Association** as Payor constitutes delivery by Me (Us) to the above noted Financial Institution.

_____	_____
Date	Signature of Applicant
_____	_____
Date	Signature of Applicant

FOR JOINT ACCOUNTS: If only one signature is required for the account, then only one Applicant need sign this form. However, if two or more signatures are required for the account, then both or all signatures are required on this form.

Board and Committee Member Sign-On

Contact Information:

Name: _____

Mailing Address _____

_____

Phone # _____

Cell # _____

Email Address _____

Stipend Payment Information (complete if applicable):

SIN # _____

Date of Birth _____

CPP Exempt (circle one) YES NO

Date Signed: _____

Board or Committee Name: _____

Environmental Coordinator Watershed Projects Update

December 01, 2022, LWC Meeting

WRRP Project Grant: Riparian Area Assessments

The WRRP Grant application was submitted on October 14th, 2022. If we are successful in receiving the grant funding, it is anticipated that we will be notified before March 31, 2023

Project Scope: Contract Fiera Biological Consulting Ltd., to complete large-scale riparian intactness assessments in the Sand River, Martineau River-Cold Lake, and Lower Beaver River watershed. The project will be inclusive of three final reports and one presentation of results. The assessment of these basins will conclude large-scale assessments in the whole Beaver River watershed. The Upper Beaver River and Jackfish-Muriel Creeks watersheds were assessed in 2021.

Letters of Support were received from the City of Cold Lake and Cold Lake First Nations.

Figure 1. HUC6 Basin map where areas indicate those included in the current WRRP grant application for riparian assessments.

WPAC Grant: Riparian Health Campaign

The WPAC operational grant was submitted on September 28, 2022. If the anticipated funding is received, the campaign planning will commence after April 2023.

Project Scope: This campaign will be developed by LICA's Environmental Coordinator and will consist of an education portion that increases the awareness of riparian areas by developing brochures, riparian area 'lawn signs' and additional user information that will be available for handout in addition to being housed on the LICA website.

In support of the education portion, tree seedlings will be purchased and given for planting to those committing to healthy riparian areas on their property. A lawn sign will be included with the seedlings for landowners to put up near their riparian areas to aid in further awareness of the campaign.

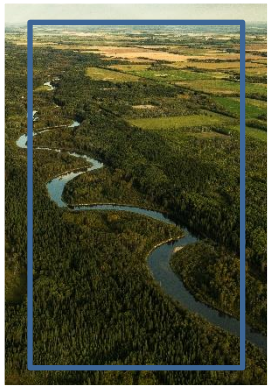
This campaign will promote and enhance riparian area health within the Beaver River watershed.

Table 1. Riparian Area Health Campaign budget breakdown for 2023-2027, as reflected in the WPAC grant application. Please note that the lawn signs will be purchased during 2023/2024 and are anticipated to last the duration of the 4-year term. Trees will be purchased annually beginning in 2024/25.

	2023/24	2024/25	2025/26	2026/27
Riparian Area Health Campaign Budget	$2,500.00	$2,000.00	$2,000.00	$2,000.00
Deliverable	Campaign Development	Campaign Execution		

BEAVER RIVER INTEGRATED WATERSHED MANAGEMENT PLAN




LICA
ENVIRONMENTAL STEWARDS

ACKNOWLEDGEMENTS

LICA would like to thank the IWMP Committee, technical provincial, municipal, First Nation and Métis staff advisors, and all stakeholders for their contribution to the Beaver River IWMP.

LICA IWMP Committee

Abdi Siad-Omar, Alberta Environment and Parks
Al Bertschi, Portage College
Amanda Avery-Bibo, LICA Board
Annette Hobart, Alberta Energy Regulator
Bill Parker, City of Cold Lake
Bob Buckle, City of Cold Lake
Clem Parenteau, Métis Nation Region 2
Dana Swigart, MD of Bonnyville
Delano Tolley, Community
Dylan Landstrom, Beaver Lake Cree Nation
Fin MacDermid, Cold Lake First Nations
Joe Kapala, Town of Bonnyville
Katlyn Degenhardt, MD of Bonnyville
Kellie Nichiporik, Lakeland Agriculture Research Association
Kristen Berezanski, Strathcona Resources
Louise White-Gibbs, Community
Madison Arsenault, Youth
Madison Rehm, MD of Bonnyville
Maureen Delorme-Ouellette, Fishing Lake Métis Settlement
Mitch Sylvester, Moose Lake Watershed Society
Monty Moore, Husky Energy
Randi Dupras, Lac la Biche County
Richard Bourgeois, Muriel Lake Basin Management Society
Richard Pearce, Community
Roxane Bretzlaff, Canadian Natural Resources Ltd.
Robert Machatis, Cold Lake First Nations
Shana Langley, Military
Shelby Kennedy, Kikino Métis Settlement

Ex-officio Members

Kayla Hellum, Environmental Coordinator (current)
Vicky Krawchuk, Executive Director (current)
Rachel Bates, Education & Outreach Coordinator
Kristina Morris, Executive Director
Tricia Fleming, Environmental Coordinator

Dedication

LICA dedicates this plan to Delano Tolley who was a devoted member of the community and advocate for environmental stewardship.

Cover Photos

K. Hellum (centre); L. Vining (R); N. Gillis (top-L); LICA (top-R); R. Bretzlaff (lower-L); Unrau (L; lower-R)

Suggested Citation: Palliser Environmental Services Ltd. 2022. Beaver River Integrated Watershed Management Plan. Prepared for the Lakeland Industry and Community Association, Bonnyville, AB. 88 pp. + Appendices.

Palliser Environmental Services Ltd.

EXECUTIVE SUMMARY

LICA Environmental Stewards (LICA) is a community-based not-for-profit association that is a Synergy Group, an Airshed Zone, and the Watershed Planning and Advisory Council (WPAC) for the Beaver River watershed. LICA completed the Beaver River Integrated Watershed Management Plan (IWMP) as a guidance document and planning tool to achieve the vision of "*A healthy Beaver River watershed for the future*." The IWMP Committee, formed to help oversee Plan development, engaged with watershed Stakeholders, First Nations, and the Métis at key stages to ensure that it is relevant, and reflects local and regional perspectives.

The Beaver River IWMP addresses matters of water quantity, water quality, riparian areas and wetlands, biodiversity, land use, and knowledge and understanding. It establishes common goals for watershed resources, as well as management targets and thresholds that can be used to measure success in achieving the goals. Recommendations were formed that consider available science, and stakeholder, First Nations and Métis input. Implementation tables accompany the recommendations to indicate implementation actions, roles and responsibilities, and timelines.

Watershed management planning and the implementation of the recommendations put forward in this plan are a shared responsibility that require the collaboration of all stakeholders, First Nations, and the Métis. The IWMP will be considered successful when:

- It is fully implemented through the collaboration of all stakeholders.
- Targets and thresholds are achieved and/or measurable improvements are observed for established indicators.

The IWMP Committee identified five implementation priorities for the recommendations. The priorities listed below have multiple benefits for all stakeholders, First Nations and the Métis:

1. Develop and implement a long-term surface water quality monitoring program in collaboration with all stakeholders to leverage resources and achieve mutual goals.

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.

3. Seek opportunities to support riparian restoration where assessments indicated health condition does not achieve targets and/or thresholds.

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 Sub-Regional Plan).

4. 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.

LICA will track the progress of the Beaver River IWMP implementation and reported on actions regularly. A more comprehensive review of the plan will take place every five years.

TABLE OF CONTENTS

ACRONYMS

AAF	Alberta Agriculture and Forestry
ABMI	Alberta Biodiversity Monitoring Institute
AEP	Alberta Environment and Parks
AER	Alberta Energy Regulator
AIS	Aquatic Invasive Species
ALMS	Alberta Lake Management Society
ALSA	Alberta Land Stewardship Act
ALUS	Alternative Land Use Services
ASB	Agricultural Service Board
AOPA	Agricultural Operations Practices Act
ASVA	Association of Summer Villages in Alberta
AUMA	Alberta Urban Municipalities Association
AWC	Alberta Water Council
AWC	Athabasca Watershed Council
BMP	Beneficial (Best) Management Practice
BRWA	Beaver River Watershed Alliance
CEP	Water Conservation, Efficiency and Productivity
CLAWR	Cold Lake Air Weapons Range
CLBR WMP	Cold Lake-Beaver River Water Management Plan
CLFN	Cold Lake First Nation
CLSR	Cold Lake Subregion
CLSRP	Cold Lake Subregional Plan
DUC	Ducks Unlimited Canada
EFP	Environmental Farm Plan
EPEA	Environmental Protection and Enhancement Act
FCM	Federation of Canadian Municipalities
FMO	Fisheries Management Objectives
FIN	Fall Index Netting
FSI	Fish Sustainability Index
GOA	Government of Alberta
IBA	Important Bird Area
IBI	Index of Biological Integrity
IOGC	Indian Oil and Gas Commission
IRP	Industry Respected Practice
GOWN	Groundwater Well Observation Network
IWMP	Integrated Watershed Management Plan
IWMPC	Integrated Watershed Management Plan Committee
LARA	Lakeland Agriculture Research Association
LARP	Lower Athabasca Regional Plan
LICA	Lakeland Industry Community Association
LUB	Land Use Bylaw
MDP	Municipal Development Plan
LICA	Lakeland Industry Community Association
OGCR	Oil and Gas Conservation Rules
PPWB	Prairie Provinces Water Board
QWAES	Qualified Wetland and Aquatic Environmental Specialist
SHL	Special Harvest Licence
SWAD	Surface Water Allocation Directive
TEK	Traditional Ecological Knowledge
USEPA	United States Environmental Protection Agency
WCO	Water Conservation Objective
WPAC	Watershed Planning and Advisory Council
WQO	Water Quality Objective
WSC	Water Survey of Canada
WSG	Watershed Stewardship Group

1.0 INTRODUCTION

LICA Environmental Stewards (LICA) is a community-based not-for-profit association that is a Synergy Group, an Airshed Zone, and the Watershed Planning and Advisory Council (WPAC) for the Beaver River watershed. LICA focuses on environmental monitoring, environmental management, and community education and outreach. As the designated provincial WPAC for the Beaver River watershed in Alberta, LICA reports on watershed health, leads collaborative planning, and facilitates education and stewardship activities. This work supports the goals of Alberta's *Water for Life Strategy*, namely:

- Healthy aquatic ecosystems
- Safe, secure drinking water supplies
- Reliable, quality water supplies for a sustainable economy

LICA initiated the Beaver River Integrated Watershed Management Plan (IWMP) process to help direct future watershed management activities and achieve the vision of "*A healthy Beaver River watershed for the future*". The Beaver River IWMP is a guidance document and planning tool for resource managers, including governments, planners, Indigenous communities, other stakeholders and landowners in the watershed. The plan identifies goals for improving and/or maintaining watershed health, and makes recommendations on how to reach those goals. An implementation strategy accompanies the IWMP to indicate implementation roles and responsibilities, priorities and timelines.

LICA's IWMP Committee (IWMPC) provided technical knowledge and support in the development of the Beaver River IWMP in collaboration with stakeholders, First Nations and the Métis. Appendix A provides a list of key stakeholders, First Nations and Métis in the watershed. The IWMPC worked collaboratively with communities and stakeholders to establish goals and objectives for watershed management that are supported by clear and comprehensive recommendations regarding water quantity, water quality, wetlands and riparian areas, biodiversity, land use and knowledge and understanding. Effort was made to ensure that this Plan is relevant and reflects local and regional concerns to achieve shared environmental, social, and economic outcomes supportive of a healthy watershed. This Plan builds on previous initiatives devoted to resource management in the Beaver River watershed and is aligned with current provincial and municipal initiatives that support watershed planning in the basin.

1.1 Previous Planning Initiatives

Coordinated planning efforts for the management of natural resources in the Beaver River watershed have occurred for more than 35 years. The list below are provincial plans relevant to the Beaver River watershed. More detail regarding these plans is provided in Appendix B.1.

- 1985 Cold Lake-Beaver River Long-Term Water Management Plan [Summary Document] (Alberta Environment 1985); A plan focused on water quantity and quality to meet long-term user requirements
- 1996 Cold Lake Sub-Regional Integrated Resource Plan (AEP 1996a)
- 2006 Cold Lake-Beaver River Basin Water Management Plan (CLBR WMP) (Alberta Environment 2006a); An update of the 1985 plan to align with the *Water Act* (GOA 1999) and Water for Life Strategy (GOA 2003). It included a key shift to an integrated approach that recognized surface water and groundwater interactions. The Director under the *Water Act*, considers this plan in decision-making.
- 2012 Lower Athabasca Regional Plan (LARP) (GOA 2012) established under the *Alberta Land Stewardship Act* (ALSA)

- 2022 Cold Lake Sub-Regional Plan (GOA 2022a); A plan developed to reduce human footprint in caribou range; implemented under ALSA

1.2 Need for a New Plan

Healthy watersheds support interdependent human, animal, and ecosystem health. Integrated Watershed Management Plans are important for guiding land and water resource management in consideration of the environment, sociocultural values and the economy. Implementation strategies that accompany IWMPs are essential for initiating action. While the CLBR WMP (Alberta Environment 2006a) provides a strong foundation for the management of the eastern Lower Beaver River, it pre-dates important legislative changes that affect watershed management, and it excludes parts of the greater Beaver River watershed. A new plan should also better reflect all stakeholder concerns, including First Nations and Métis Rights and Indigenous knowledge.

2.0 PURPOSE, INTENT, PLANNING CONTEXT AND SCOPE

2.1 Purpose, Intent and Authority

The Beaver River IWMP provides broad guidance for watershed management, and sets out clear direction that will result in consistent, specific actions for integrated management of land and water resources to support long-term watershed health. The IWMP will not replace the existing authorized CLBR WMP[1] (Alberta Environment 2006a), but rather augment it with aspects not previously considered.

While the watershed plan is not legally binding, developing the plan collaboratively means it is more likely to be supported and implemented by decision-makers in the Beaver River watershed.

To maximize opportunities for successful implementation, the IWMP should be supported by all stakeholders, First Nations and the Métis. Recommendations should be incorporated in future planning documents and updates of existing plans that have legal/regulatory authority (e.g., the CLBR WMP, the Lower Athabasca Regional Plan and sub-regional management frameworks, and municipal statutory plans and policies).

2.2 Legislative Policy and Planning Context

The development of the Beaver River IWMP is guided in part by the Framework for Water Management Planning (Alberta Environment 1999), the Guide to Watershed Planning in Alberta (GOA 2015) and the *Water for Life Strategy* (GOA 2003; renewed in 2008). The IWMP:

- Was developed within the context of existing federal, provincial and municipal legislation, policies and regional plans
- Acknowledges and adheres to the commitments outlined in the Inter-provincial Master Agreement on Apportionment (1969) as administered by the Prairie Provinces Water Board[2]
- Reflects current policies and practices in place since the CLBR WMP was completed in 2006

[1] Water Management Plans provide a framework for Alberta Environment and Parks to make water management decisions under Alberta's *Water Act* and *Environmental Protection and Enhancement Act* (EPEA).
[2] 68% of the natural flow of the Beaver River and Cold Lake basins must be allowed to flow to the adjacent province (Saskatchewan).

- Encourages the advancement of policies and practices for continued effort to steward the Beaver River watershed

A compilation of legislation, policy, plans and procedures relevant to the Beaver River watershed is provided in Appendix B.3. At the provincial level, the most notable changes to legislation, policies and plans since 2006 are the *Alberta Land Stewardship Act*, the *Alberta Wetland Policy*, the Lower Athabasca Regional Plan (GOA 2012), and the Cold Lake Subregional Plan.

2.3 Scope

In response to recommendations put forward in the 2006 CLBR WMP, the IWMP:

- Includes the entire Beaver River watershed in its planning area
- Better reflects all stakeholder concerns, including First Nations and the Métis
- Improves municipal influence by providing recommendations related to municipal development planning, including area structure plans for lakeshore (subdivision) development
- Creates a more comprehensive plan by broadening the focus from a specific sector (i.e., oil/gas) to address additional resource management objectives that consider and reflect watershed-scale processes and needs
- Integrates and addresses wildlife and fisheries management issues
- Provides specific recommendations with more implementation detail, as opposed to general recommendations that are not easily implemented

The scope of matters addressed in the plan includes those identified in Section 6.0.

Limitations

The IWMP will not:

- Gather new information to fill data gaps
- Formulate legislation, policy, or regulations
- Address air quality unless it relates to other watershed issues
- Consider the Saskatchewan portion of the watershed

3.0 PLANNING AREA

The Beaver River watershed is located in the boreal plain of east-central Alberta and west-central Saskatchewan (Figure 1), in Treaty 6, 8 and 10 territories and in the Métis homeland northeast of Edmonton (Figure 2). The total drainage area of the Beaver River at its confluence with the Churchill River is 50,003 km^2, with about half of the watershed (22,000 km^2) in Alberta (Beaver River Watershed Alliance (BRWA) 2013).

The Beaver River originates near the Hamlet of Lac La Biche as the outflow from Beaver Lake. It flows in an easterly direction for about 250 km, flowing south of Cold Lake (*Kinosoo*) before entering Saskatchewan. The Cold River originates at the east end of Cold Lake in Saskatchewan becoming the Waterhen River, and continues flowing east to join the Beaver River. The river flows north and joins the Churchill River at Île à-la-Crosse before flowing into Hudson Bay (Figure 1). The length of the river from its source to its mouth is about 661 km. Additional detail about the Beaver River watershed and its sub-watersheds in Alberta can be found in Appendix C, and in the Beaver River State of the Watershed Report (BRWA 2013).

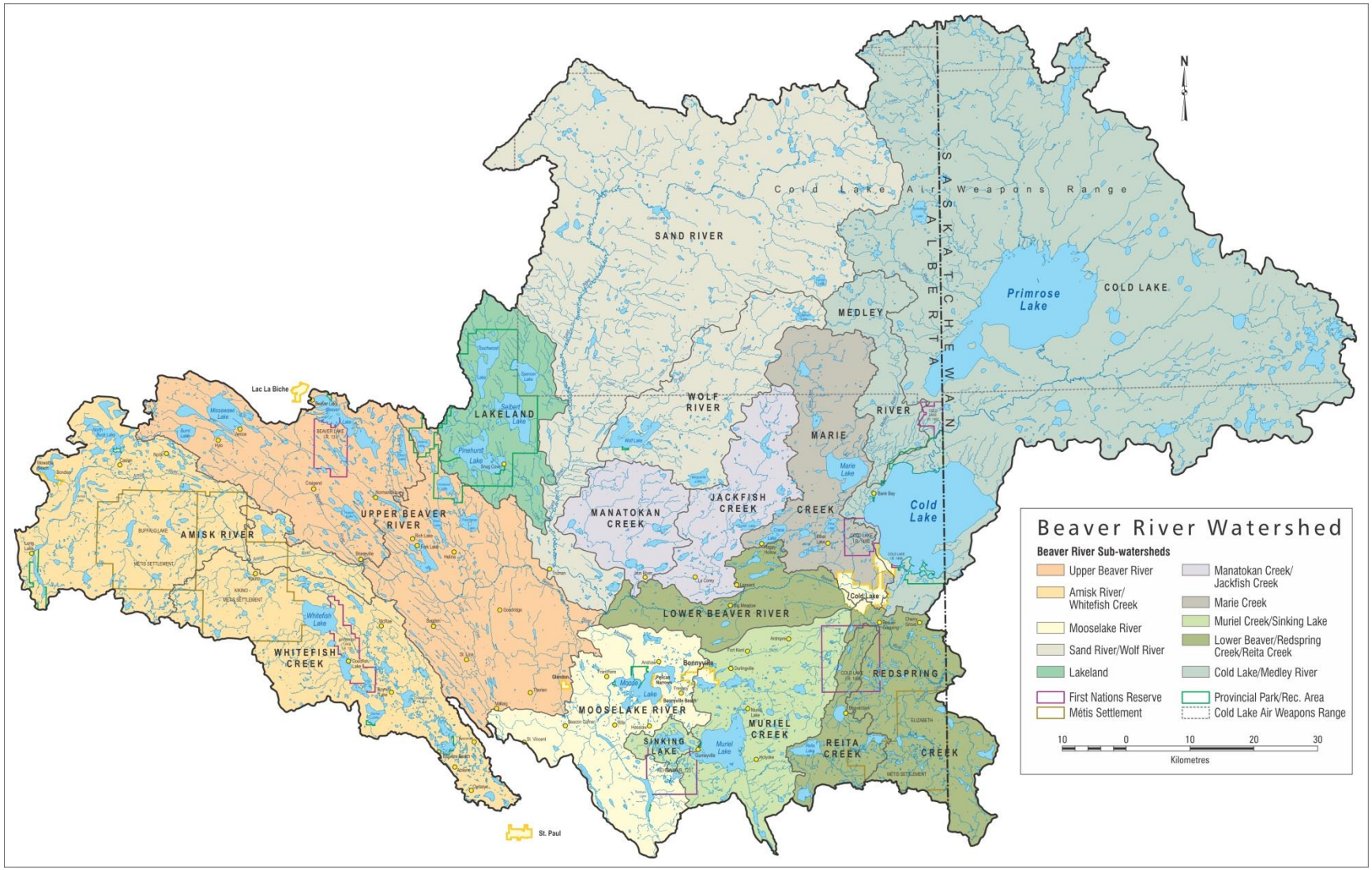
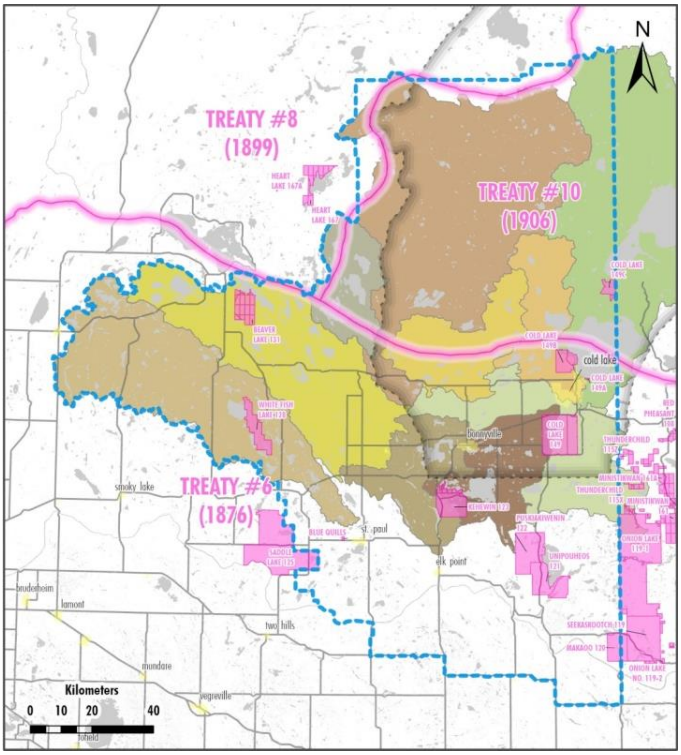
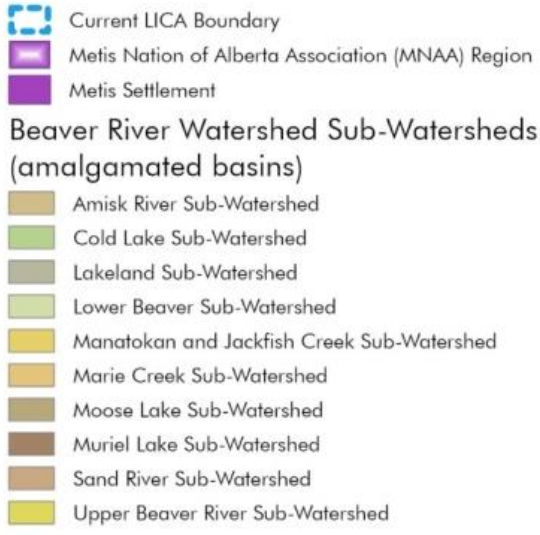


Figure 1. Map of the Beaver River watershed planning area (BRWA 2013).

A. Treaty Areas, Reserve Lands, Traditional Territories



B. Metis Nation of Alberta Association Regions, Settlements



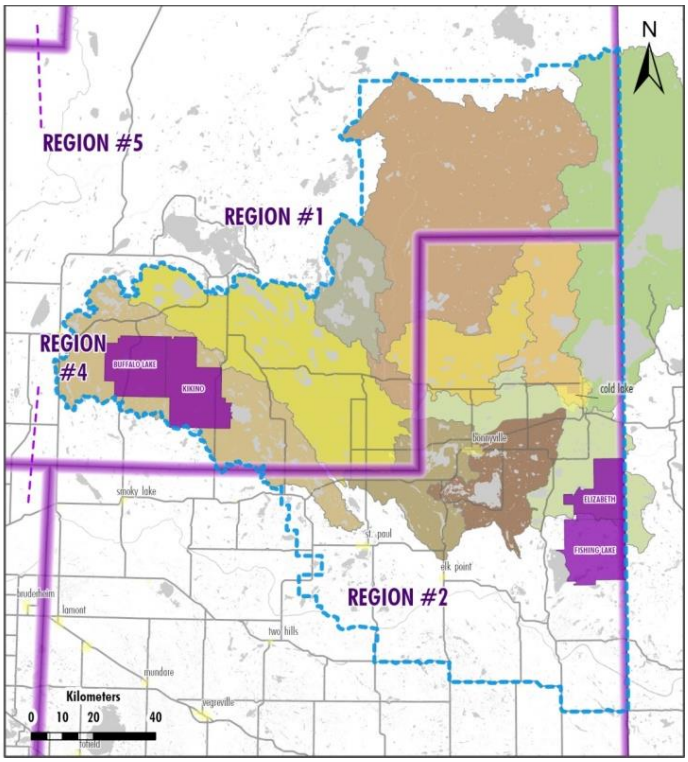


Figure 2. Maps showing A) First Nations treaty areas, reserve lands and traditional territories, and B) Métis Nations of Alberta Association Regions and Métis Settlements.

3.1 Human Footprint

3.1.1 First People

Human presence in the Beaver River watershed dates back to time immemorial. Prior to the arrival of Europeans, the Cree and Dené had established an independent and organized society that included a nomadic lifestyle. The land provided First Nations with everything they required for their mental, physical, spiritual, and emotional well-being (Alberta Regional Professional Development Consortium N.D.). Specifically, the Beaver River watershed and surrounding area provided abundant trapping, hunting, fishing, berry picking, plant harvesting, collection of medicines and camping opportunities. A network of trails was established to reach important places throughout the watershed. Knowledge and traditions were passed down through generations.

The Denesųłiné (Dené, people of Cold Lake First Nations and the only Dené represented in Treaty 6) travelled in small family groups and followed the caribou and other game within their Traditional Territory (Figure 2a). The Dené families spent their winters at Primrose Lake and summers around Cold Lake (thooway-show-tway)[3] and neighbouring lakes.[4] They excelled in trapping and hunting and, on the arrival of the Europeans, the Dené controlled a large portion of the fur trade, being well known for their skills in hide preparation, trade and commerce, and guiding.

The Cree (people of Beaver Lake First Nation, Frog Lake First Nation, Kehewin First Nation, Saddle Lake Cree Nation and Whitefish (Goodfish) Lake First Nation #128) also relied on abundant resources for trapping (e.g., hare, beaver, mink, and others), hunting (e.g., moose and woodland caribou) and fishing. Waterfowl and upland game were seasonally harvested in spring and fall (i.e., ducks and geese), and in winter (i.e., grouse and ptarmigan). Fish was a reliable and staple food during the winter months. Fishing was carried out extensively using complex fishing technology to catch whitefish, lake trout, pickerel [walleye] and pike, among other species (Korea National Oil Corporation 2009).

3.1.2 First Nations Treaties and Métis Harvesting Rights

The traditional practices of trapping, hunting, fishing, and gathering, along with spiritual and cultural practices, continue to be upheld by the Cree and Dené First Nations today. First Nations have traditional values and rights, constitutional rights and key principles embodied in the Treaties (Treaty 6 signed 1876, Treaty 8 signed 1899, and Treaty 10 signed 1906), which guide their way of life and jurisdiction in the Beaver River watershed. Treaty rights are recognized and affirmed in the *Constitution Act* (S. 35), 1982. The 2018 Métis Harvesting in Alberta Policy (GOA 2019) ensures that Métis people who are entitled to harvesting rights as guaranteed by the Constitution Act (s. 35), 1982, have the ability to hunt, fish and trap for subsistence (food). Refer to Section 4.3 and Section 4.6 for additional context regarding First Nations and Métis rights, respectively.

3.1.3 European Settlement

Land use began to change with the migration of European Settlers to the area. These settlers were traditionally farmers who found the rich soils suitable for crop production and raising livestock for subsistence. A chronology of key events that have shaped the current social/cultural, economic and environmental state of the watershed is provided in Table 1.

[3] Cold Lake is called thooway-show-tway in Chipewyan, or “big fish Lake”, and takikawew-sahigan in Cree, meaning "cold lake"; both names were originally given to the nearby lake (Dempsey 1969); Kinosoo or “big fish” is also Cree
[4] Cold Lake First Nations (CLFNS) website

Table 1. Historical timeline of events in the Beaver River watershed from pre-contact to present (compiled by LICA). Note that the establishment date for Whitefish (Goodfish) Lake First Nation #128 is currently not available.

Year	Event	
Pre-Contact	The naming of lakes and rivers	• Long before European settlement, the Cree and Dene People inhabited the shores and woodlands of this area. Named "Kinosoo" or "big fish" after a Cree legend. Cold Lake was renamed by European Settlers upon arrival due to the deep depths and cold water.[1]
1700-1789	Fur Trade	• The Dene Suline was indirectly exposed to the Fur Trade and its activities as early as 1716.[2]
		• Cold Lake House was a trading post built by Montreal traders near the present-day Beaver Crossing (1781)[3], and a second, Shaw House at Moose Lake (1789).[4]
		• Angus Shaw, a fur trader in the North West Company, came to Moose Lake in 1789 and established the North West Company post (Shaw House) on the Northwest shores of the lake.[4] The rivers and streams of this area were the original transportation routes.
1876-1906	Treaties Signed	• The signing of Treaty 6 (1876), Treaty 8 (1899), and Treaty 10 (1906). What is now known as the Beaver River watershed is located within the traditional land of the Dene, Cree, and Métis homeland.
	FN Reserve Established	• Kehewin Reserve was surveyed (1884). 'Reserve Status' was officially granted in 1889 and the Kehewin Indian Reserve #123 was formed.[4]
		• Saddle Lake Indian Reserve was established (1886).[5]
		• Cold Lake First Nations community was established through an Order in Council, prior to formation of Alberta and Saskatchewan (1904)
1900-1910	Industry	• Two sawmills operated on the North and East ends of Muriel Lake (1900).[6]
	Expansion	• The start of new settlers arriving in the Bonnyville area (1907).[4]
	Fisheries	• The first commercial fishing business opened (1908).[4]
	Fur Trade	• Closing of a Hudson Bay trading post near Bonnyville (1908).[4]
	Expansion	• Land surveys were completed in Bonnyville and Cold Lake Areas (1910).[4]
1911-1920	Reserve Established	• Beaver Lake Indian Reserve #131 was established (1911).[5]
	Natural Disaster	• A wildfire burned 60-70 acres near Cold Lake (1919).[4]
		• A wildfire struck the timber around Muriel Lake. Much of the land transitioned from forestry to agricultural use as the local sawmill lost its timber supply (1920).[6]
		• A major drought occurred in the region (1920).[7]
1921-1940	Industry/ Expansion	• The first steam engine arrived in Bonnyville (1928).[4]
	Natural Disaster	• The start of the depression. Very poor growing conditions lead to poor crop yields (1929).[4]
	Tourism	• Tourism bloomed in the Cold Lake area with fishing a large attraction (1920-1930s).[4]
	Natural Disaster	• Jessie Lake dried up and resembled a hay field (1930s).[7]
	Métis Settlement	• Fishing Lake Métis Settlement established (1938). It was not until 1949 that they were given title to the land boundaries they have today.[8]
		• Kikino Métis Settlement established (1938)
		• Elizabeth Métis Settlement established (1939).[9]

Year	Event	
1941-1950	Métis Settlement	• Buffalo Lake Métis Settlement established (1941).[10]
	Industry	• The first powered generator in Cold Lake (1946).[4]
		• A natural gas field was discovered in the Town of Bonnyville limits (1949).[4]
	Natural Disaster	• Flood at Muriel Lake (1950).[6]
1951-1960	Expansion	• Rat control in Alberta is administered and coordinated by Alberta Agriculture and Food. It was established to keep Alberta free of Norway rats (1950).[11]
	Expansion	• Sewer systems opened in Bonnyville (1951).[4]
	Military	• Construction of Canadian Air Force Base Cold Lake began which resulted in the loss of Cold Lake First Nations Traditional Territory (1952).[2]
	Municipal	• MD of Bonnyville officially formed (1955).[4]
1961-1980	Industry	• Imperial Oil starts to look to Cold Lake, proposing projects for the area (1964).[4]
	Métis Nation Zones	• The Métis Association of Alberta's Regions was created. The MAA Bylaws were amended for the first time creating 6 zones (1972).[12]
	Industry	• Exploration of Canada's first steps into tapping the massive oil resource. In 1980, one Plant by Cold Lake was one of only two under construction in Canada's oil sands (1980).[13]
	Industry	• Imperial Oil Ltd. began production of heavy oil in the region (1975).[11]
1981-2000	Infrastructure	• Moose Lake Weir was built to improve fish and wildlife habitat, stabilize the lake level and improve the water supply storage for the Town of Bonnyville (1985).[14]
		• Murphy Road was upgraded to a high-grade road which ran between Muriel Lake to the west with the creeks feeding Muriel Lake to the east (1987).[6]
	Natural Disaster	• Drought in the region (2000).[15]
2001-2020	Natural Disaster	• An agricultural disaster declared in the MD of Bonnyville due to drought and grasshoppers (2015).[16]
		• The highest recorded lake levels since 1966 occurred at Moose Lake and caused flooding (2017).[16]
		• Wildfires occur around Moose Lake (2019).[17]
2021	Infrastructure	• Ongoing discussion and community engagement for the removal and naturalization of the Moose Lake Weir.[14]
		• Walkways constructed in several subdivisions in the MD of Bonnyville that impacted natural drainage and resulted in localized flooding.[16]
	Natural Disaster	• An agriculture disaster declared in the County of St. Paul, MD of Bonnyville, and Lac La Biche County due to severe drought conditions. [16]
2022	Infrastructure	• Removal of the Moose Lake Weir.

[1] Kehewin Cree Nation website; [2] Cold Lake First Nations website; [3] BRWA 2013; [4] Historical Society of Cold Lake and District 1980; [5] Beaver Lake Cree Nation website; [6] Bourgeois, pers. comm. 2022; [7] Ilchuk, pers. comm. 2022; [8] Fishing Lake Métis Settlement website; [9] Elizabeth Métis Settlement Website; [10] Buffalo Lake Métis Settlement website; [11] The Canadian Encyclopedia https://thecanadianencyclopedia.ca/en/article/cold-lake; [12] Métis Nation of Alberta website; [13] City of Cold Lake website; [14] GOA 2021; [15] Elgert, pers. comm. 2022; [16] Lakeland Today 2021; [17] Hellum, pers. comm. 2022

3.1.4 Current Conditions

Today, the Beaver River watershed continues to be rich in natural resources. Watershed resources support First Nations and Métis traditional land use and cultural practices, as well as a variety of industries that contribute to the local, regional, and provincial economy (e.g., oil and gas, agriculture, mining, forestry, development, and tourism and recreation). Maintaining watershed health is an overarching goal for this Beaver River IWMP.

The human footprint is an important indicator of watershed health. The cumulative impact of land use activities in the watershed can affect local hydrology, water quality, riparian areas and wetlands, and biodiversity by altering the natural system that functions to maintain balance in the watershed.

In 2018, the total human footprint covered about 20% of the Beaver River watershed. Agricultural land use accounted for the largest percentage of the human footprint (72%). The majority of the agricultural footprint is categorized as tame pasture. The oil and gas industry footprint accounted for 9%, roads and trails (7%) and forestry activity accounted for 6% of the total human footprint (Figure 3; Figure 4).

This Beaver River IWMP considers the cumulative impact of land use and recommends strategies to minimize and mitigate impacts on watershed health.

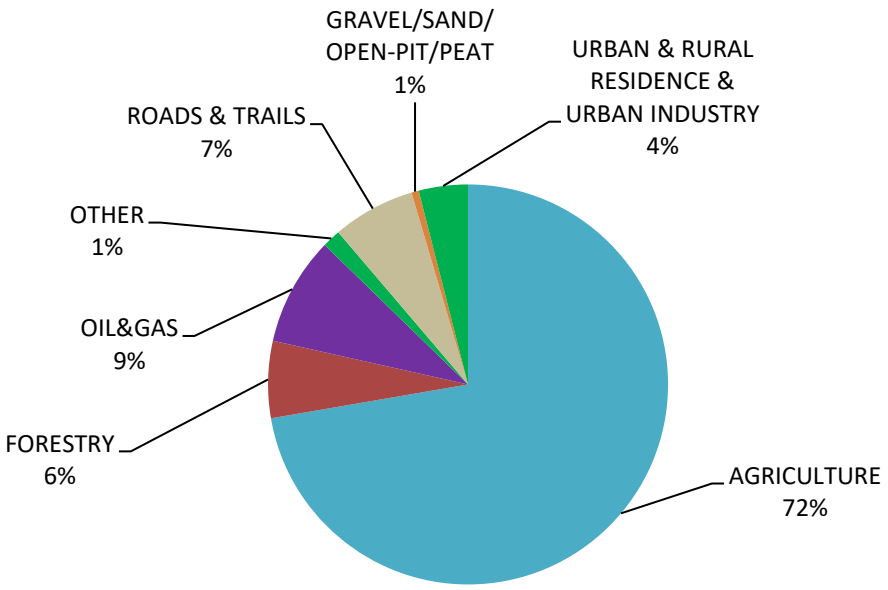


Figure 3. Summary of land use activities that contribute to the total human footprint in the Beaver River watershed (ABMI 2018).

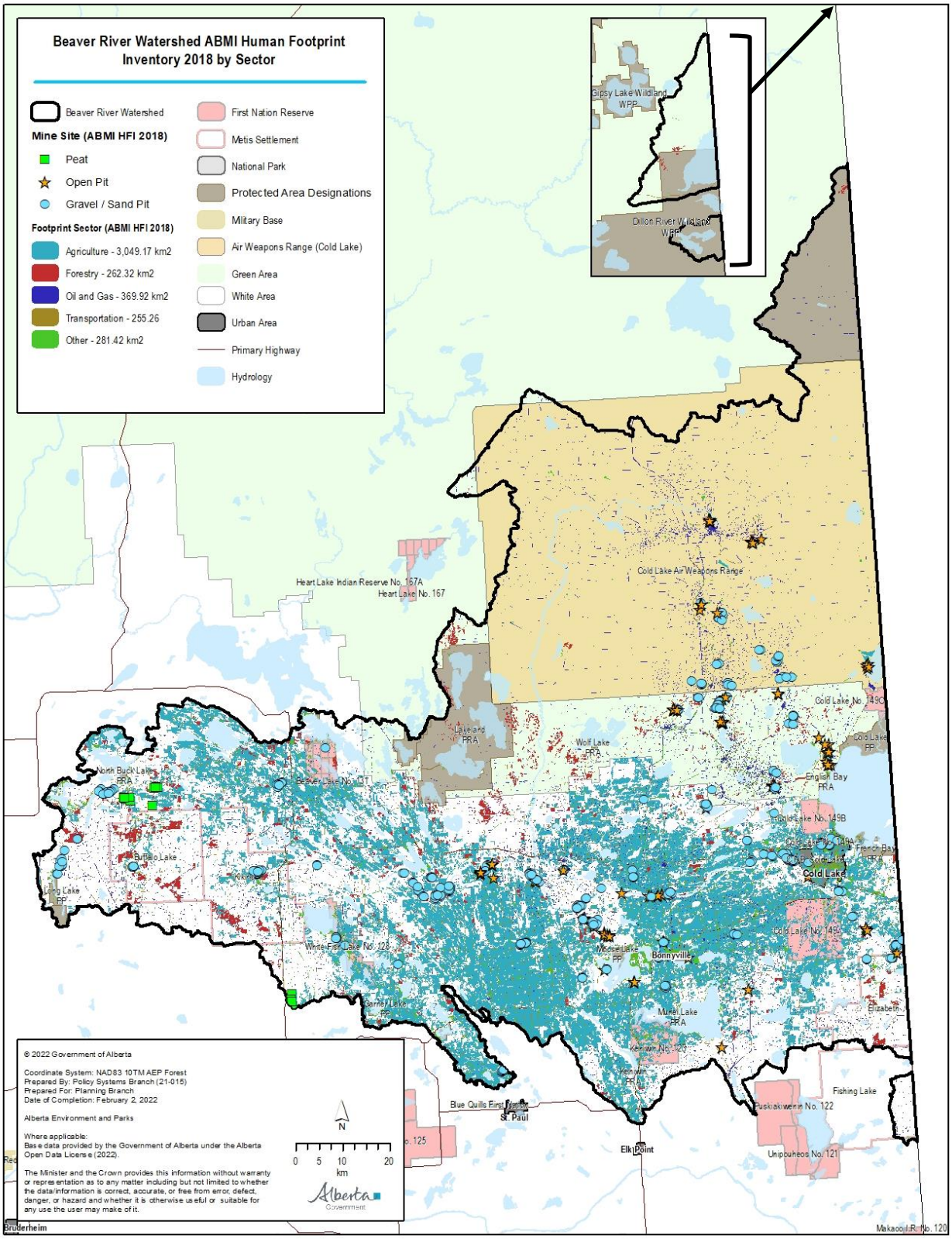


Figure 4. Human footprint in the Beaver River watershed (ABMI 2018). A high-resolution map is available at www.lica.ca. The map inset shows two small parts of the watershed that are disconnected to the north from the larger watershed in Alberta, and are not visible at this scale.

4.0 ROLES AND RESPONSIBILITIES

Watershed management planning and implementation of recommendations is a shared responsibility that requires the collaboration of multiple levels of government, various industries (e.g., agriculture, oil and gas), non-government organizations, landowners, leaseholders, and residents in the watershed. The planning process is considered successful when stakeholders recognize and support their individual or shared responsibility for achieving the collective goals and objectives of the IWMP. General roles and responsibilities for Beaver River watershed management are further described below.

4.1 Lakeland Industry and Community Association

LICA is the designated provincial WPAC for the Beaver River watershed in Alberta; as such LICA reports on watershed health, leads collaborative planning, and facilitates education and stewardship activities. This work supports the goals of Alberta's *Water for Life Strategy*:

- Healthy aquatic ecosystems
- Safe, secure drinking water supplies
- Reliable, quality water supplies for a sustainable economy

LICA will continue to collaborate and engage with stakeholders, First Nations, and the Métis during the implementation phase of the Beaver River IWMP. LICA will also continue to ensure the best combination of scientific information, Indigenous Knowledge and stakeholder, First Nations and Métis feedback is considered in watershed planning. LICA will lead communication, education, and engagement, and help to implement the IWMP by acting on action items specific to LICA and providing support to others implementing the plan.

The role of stewardship groups in the Beaver River watershed is essential to understanding and managing specific lake management concerns. As a WPAC, LICA can support stewardship group activity by

i. Assisting with joint funding applications for projects that will achieve common goals across the watershed (e.g., riparian intactness assessment, water quality investigations, etc.)
ii. Collaborating to host an annual Stewardship Group Forum to facilitate sharing of knowledge and joint planning across the watershed

4.2 Federal Government

The federal government performs a key role in the shared management of watershed resources. The *Canada Water Act* enables cooperative agreements between the federal, provincial, and territorial governments to regulate, apportion, and monitor water resources, and to implement joint programs. The federal government has authority over water quality and publishes water quality guidelines pertaining to the environment, drinking water and recreation. The Department of Fisheries and Oceans oversees fisheries resources and fish habitat under the *Fisheries Act*. Other federal roles include pollution control, and the management of interprovincial waters (e.g., Cold Lake), navigation and water on federal lands.

The Department of National Defence (CFB Cold Lake)

The Department of National Defence has created a Defence Environmental Strategy that identifies the military's approach to integrating environmental management into activities that support its mandate, including the use of best practices and sustainable development.

4.3 First Nations

The Beaver River watershed is located on Treaty 6, 8, and 10 territories. Beaver Lake Cree Nation, Cold Lake First Nations, Frog Lake First Nation, Kehewin Cree Nation, Saddle Lake Cree Nation, and Whitefish (Goodfish) Lake First Nation #128 have reserve lands and associated traditional territories located in this region.

First Nations have traditional values and rights, constitutional rights and key principles embodied in their treaties, which guide their way of life and jurisdiction in the watershed. Treaty rights are recognized and affirmed in the *Constitution Act* (S. 35), 1982. Treaty rights include protection of traditional ways of life, the right to occupy and use lands and resources (e.g., the right to hunt, fish and trap on unoccupied Crown land), cultural and social rights, rights to consultation, and rights to participate in land and resources management decisions (Government of Canada 2020).

In 2007, the United Nations Declaration on the Rights of Indigenous Peoples was signed. The Declaration affirms and sets out minimum standard rights of Indigenous peoples related to self-determination and self-government, culture and identity, lands, territories and resources, and environment to name a few.

First Nations are reliant on healthy watersheds for sustenance, and to support their way of life. They retain Indigenous Knowledge and information regarding Indigenous Practices that can increase common understanding of watershed resources, and inform recommendations that support the protection and/or restoration of water and land resources.

LICA wants to clearly communicate to First Nations that by participating in the Beaver River watershed planning process, First Nations will not abrogate any rights they have, and the obligation of governments to duly consult with First Nations will not be diminished. Neither the LICA Board of Directors, nor the LICA staff considers any discussion entered into with First Nations to fall within any mandated duty to consult.

4.4 Provincial Government

The provincial government includes multiple ministries that are responsible for the management of public lands and natural resources on behalf of Albertans.

Alberta Agriculture and Forestry (AAF)

AAF is a *Water for Life* partner and shares responsibility for achieving its goals. AAF is responsible for the *Agricultural Operations Practices Act* (*AOPA*), legislation that sets manure management standards in Alberta. AAF strives to develop the agriculture and food industry, sustain the industry's natural resource base and encourage the development of rural communities.

Alberta Energy Regulator (AER)

The AER was founded in 2013 as the single regulator of energy development (e.g., oil, oil sands, natural gas, and coal projects) in Alberta. AER regulates application and exploration, construction and development, abandonment, reclamation, and remediation activities. AER is authorized to make decisions on applications for energy development, monitoring for compliance assurance, decommissioning of developments, and all other aspects of energy resource activities. This authority extends to authorizations pursuant to the *Public Lands Act*, the *Environmental Protection and Enhancement Act (EPEA)* and the *Water Act* that relate to energy resource activities. Oil and gas activity is regulated by the Alberta Energy Regulator.

Alberta Environment and Parks (AEP)

AEP has a legislated mandate to manage air quality, water resources, waste management, cumulative effects, provincial Crown (public) lands, the bed and shore of naturally occurring water bodies, and biodiversity (including fish and wildlife resources). AEP is responsible for key legislation and policies influencing watershed management, including Alberta's *Water Act* and Wetland Policy.

4.5 Municipal Governments

The Beaver River watershed is represented by the rural municipalities of Athabasca County, County of St. Paul, Lac La Biche County, Municipal District of Bonnyville, Smoky Lake County, and Thorhild County. Urban centres include the City of Cold Lake, the Town of Bonnyville, and the Village of Glendon. Under Part 17 of the *Municipal Government Act* (MGA), municipalities have responsibilities in planning, regulating, subdividing, and developing land in Alberta. Municipalities have the authority to create statutory plans (i.e., intermunicipal development plans, municipal development plans, area structure plans, and area redevelopment plans) to identify future plans for development within municipal boundaries and the immediate surrounding area. Municipalities are required, by the MGA, to adopt a Land Use Bylaw that divides the municipality into districts, prescribes the types of land uses permitted, establishes development standards, and provides a system for issuing permits. Municipalities promote economic development in the region. Many municipalities also support programs, services and education initiatives that promote stewardship of watershed resources.

Agricultural Services Boards (ASBs) form part of the rural municipal government and are responsible for administering and developing programs to complement Provincial legislation, including the *Agricultural Service Board Act*, the *Weed Control Act*, the *Agricultural Pests Act*, and the *Soil Conservation Act*. It is generally the role of the Agricultural Fieldman to implement the work plan established by the ASB.

Summer Villages

Summer Villages are designated municipalities established by the Government of Alberta. The Summer Villages of Bondiss, Bonnyville Beach, Mewatha Beach and Pelican Narrows are in the Beaver River watershed. All four Summer Villages have Land Use Bylaws in place, some with specific reference to shoreline management. The Association of Summer Villages in Alberta (ASVA) provides a forum for all Summer Villages in the province. The ASVA undertakes special initiatives that seek to address challenges facing Alberta's lake communities (e.g., Lake Stewardship Guide). Summer villages strive to minimize or mitigate human impact on the environment by promoting lake stewardship, including lake planning and implementation of actions that help protect water quality.

4.6 The Métis

Métis Nation of Alberta

The Métis Nation of Alberta (MNA) is the representative voice of the Métis people in Alberta. The MNA governance is divided into six regions across the province, including Region 1 and Region 2 that span areas of the Beaver River watershed. The MNA represents all Métis at the provincial and federal levels. The MNA is striving to establish a modern-day treaty with the Federal Government that recognizes land and resource rights including secure harvesting rights, and rights to self-government.

In 2019, the MNA signed the first self-government agreement between the Government of Canada and a Métis government.

Métis Settlements

In 1938, the MNA lobbied for the *Métis Population Better Act* that provided Métis with a secure land base and services on Métis settlements. In the Beaver River watershed, the Métis Settlements of Elizabeth, Fishing Lake, Buffalo Lake and Kikino coordinate the development of natural resources with the GOA. The Métis Settlements General Council (MSGC), established by the *Métis Settlements Act,* addresses matters that affect the collective interests of the Métis Settlements.

The 2018 Métis Harvesting in Alberta Policy (GOA 2019) ensures that Métis people who are entitled to harvesting rights as guaranteed by the *Constitution Act (s. 35), 1982*, have the ability to hunt, fish and trap for subsistence (food). Both the Métis Nation of Alberta and Métis Settlement members have harvesting rights in designated harvesting areas if they have a demonstrated historical connection to a Métis Harvesting Area in Alberta and a contemporary connection to the same community. Harvesting Areas B and D cover most of the Beaver River watershed.

4.7 Industry

Agriculture

Agricultural lands cover about one-third of the watershed. About half of the agricultural land in the watershed is pasture land and 36% of the area is cropland. As a main industry in the Beaver River watershed, farmers and ranchers have a large role in watershed management, including the maintenance of water quantity and quality, and healthy riparian areas and grassland. Agricultural activity must comply with provincial legislation (*AOPA)*. The Grazing Lease Stewardship Code of Practice was signed by the Alberta Beef Producers, the Alberta Grazing Leaseholders Association, the Western Stock Growers Association, and the provincial government. The Code of Practice identifies the roles and responsibilities that public land grazing leaseholders have in land management.

Forestry

Two Community Timber Permit Programs are currently active in the Lac La Biche Forest Area's Forest Management Unit LO1. The programs' annual volume harvests are 30,000 m^3 of deciduous and 14,000 m^3 of conifer trees. All forestry operations in the watershed are conducted according to the Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2022b) and Timber Harvest Planning and Operating Ground Rules: Northeast Alberta Regional Area- Specific Addendum (GOA 2022c). Approximately 8 timber permits are issued annually to program members and competitive sale winners.

Oil and Gas

The Cold Lake oil sands deposit is one of the largest in Alberta. Since Imperial Oil began production of bitumen in 1975, oil and gas exploration and development have increased in the Beaver River watershed. Several companies now conduct *in situ* recovery operations from the Cold Lake oil sands, including areas within the Cold Lake Air Weapons Range (BRWA 2013). Oil and gas activity is regulated by the Alberta Energy Regulator. Oil and gas companies have a responsibility to develop resources in a way that minimizes impacts on watershed resources. The Canadian Association of Petroleum Producers (CAPP) encourages responsible development in the upstream oil and gas industry. CAPP aims to enable environmentally and socially responsible performance, and encourages the use of best management practices to reduce impacts on air, land, water, and people.

Oil and gas activity is regulated by Federal and Provincial laws, regulations and Codes of Practice, including EPEA, the *Water Act*, the Water Ministerial Regulation and the Enhanced Approval Process as

specified in the *Public Lands Act*. The Oil and Gas Conservation Rules (OGCR) encompass management Directives, including OGCR Section 2.120 which regulates water pollution control.

Sand and Gravel Extraction

The Alberta Sand and Gravel Association (ASGA) represents Alberta's sand and gravel operators on key industry-related issues and proposed regulatory changes, while advocating environmental responsibility. ASGA works with communities and regulatory bodies to encourage responsible development and to ensure land reclamation following gravel extraction. Land must be reclaimed to a capability equal to or better than pre-disturbance. Exploration, extraction, and reclamation activities are regulated by Federal and Provincial environmental laws, regulations, and Codes of Practice (e.g., *Environmental Protection and Enhancement Act (EPEA), the Conservation and Reclamation Regulation* and Code of Practice for Pits), as well as the *Municipal Government Act*.

Peat Mining

Peat has been harvested in Alberta for horticultural purposes (e.g., growing media by commercial growers) since the mid-1960s (GOA 2016). In the Beaver River watershed, peat mining activities encompass an area of about 4.7 km^2 (ABMI 2018). Removal of peat from public land requires a formal disposition under the *Public Lands Act* and the *Public Lands Administrative Regulation* (*PLAR*). The PLAR requires reclamation of public land to an equivalent capability when operations end for any reason (e.g., expiry, abandonment). Peat mining is further regulated by *EPEA*, and wetland drainage is subject to approval under the *Water Act*. Peat land available for allocation is categorized as Low Sensitivity Public Lands (no constraint) or High Sensitivity (constraints imposed by sensitive or critical habitat (GOA 2016).

4.8 Watershed Stewardship Groups, Non-Profit Organizations, Academia

As partners in the *Water for Life Strategy*, Watershed Stewardship Groups (WSGs) are key partners in watershed management planning, beneficial management practice implementation, and education and outreach programs in the Beaver River watershed. WSGs encourage watershed stewardship at a local level. Similarly, many non-profit organizations support watershed management and stewardship efforts through planning, environmental condition monitoring and evaluation, and education initiatives. Universities and research institutes provide essential data and perspectives on emerging watershed issues and environmental conditions by undertaking primary research. Academia may identify research needs, as well as suggest how data and knowledge gaps can be addressed.

4.9 Residents

Residents have valuable knowledge and insight about current watershed conditions and can provide direction on how to achieve community goals. Residents also have a role in local stewardship and helping to maintain a healthy watershed.

5.0 INFORMATION ASSEMBLED

LICA worked closely with the IWMP Committee and technical advisors to compile relevant plans, policies, and technical reports for the Beaver River watershed. The Beaver River State of the Watershed Report (2013), LakeWatch Lake Monitoring Reports (ALMS), and Riparian Intactness Assessments (Fiera Biological 2021a and 2021b) were considered. In some instances, raw data (related to water quantity and quality) and Provincial spatial data relevant to the Plan were available; this data was accessed, summarized, or mapped and used to support stakeholder engagement and recommendations. Refer to Section 12.0 for a complete list of literature cited in the development of this plan.

6.0 MATTERS, GOALS AND OBJECTIVES

6.1 Matters

The scope of matters listed below reflects concerns expressed by the community during the engagement process (Section 8.0), as well as the best available science. Concerns are related to surface water and groundwater quantity and quality, wetlands and riparian areas, biodiversity, land use, climate change and knowledge and understanding. Matters may not apply to all areas in the watershed.

Surface Water

Quantity

- Fluctuating water levels (lakes and wetlands) and streamflows caused by climate change, climate variability (e.g., temperature, evaporation, and precipitation), and/or development that can:
    - Impact water availability for municipal water supplies, agricultural uses, and First Nations and Métis
    - Increase risk of flooding, and impacts associated with drought
    - Impact recreation activity
    - Impact infrastructure
    - Alter aquatic, riparian, and upland habitat
    - Alter land use (e.g., cultivation, development) around wetlands and ephemeral streams (watercourses that flow briefly in direct response to rainfall or snowmelt (USEPA 2015)).
- Surface water withdrawals.
- Altered drainage patterns and/or discharges of treated effluent, and stormwater.

Quality

- Water quality in lakes and streams does not meet the desired end uses (e.g., drinking water, contact recreation, agriculture, Indigenous traditional practices, and/or wildlife and aquatic species needs) in some areas due to soil type and geology, climate change and variability, and/or influx of point and non-point source pollution from adjacent lands (e.g., nutrients, sediment, bacteria).
- The influx of nutrients originating from external sources and the internal natural cycling of nutrients contributes to eutrophication in many lakes in the watershed.

Groundwater

Quantity

- Uncertainty regarding groundwater quantity resulting from climate change and variability, and withdrawals for human and industrial use.

- Limited understanding of the impact that groundwater withdrawals have on aquifer dynamics (e.g., shallow/deep aquifer interactions) and on lake water levels and streamflows (i.e., groundwater-surface water interactions).

Quality

- Human health concerns related to naturally occurring and/or human-caused mobilization (e.g., thermal mobilization) of trace metals (i.e., arsenic and uranium) in concentrations above drinking water guidelines.
- Concerns related to land use, including potential contamination from improperly/maintained abandoned water wells, landfills, agricultural activity, septic fields and, oil and gas activity (casing failures).

Riparian Areas and Wetlands

- Loss of riparian areas and wetlands and their respective functions:
  - Water storage (absorptive capacity, flood control) and water balance in lakes/streams
  - Groundwater recharge
  - Water quality (retention of nutrients, suspended sediment, soil and associated contaminants)
  - Biodiversity
  - Ecological services (recreation, carbon sequestration, stormwater treatment)

Biodiversity

- Fragmented and poor-quality habitat, due to increased road density, access, recreational activity, industrial activity (e.g., pipelines, well-sites, mining [sand and gravel]), forestry and other developments).
- Changing abundance and/or size of certain fish and wildlife species in the watershed.
- Beaver dam removal and the need for due consideration of potential environmental impacts
- Potential threat of terrestrial and aquatic invasive species (e.g., quagga mussel, Himalayan Balsam) in and adjacent to waterbodies in the watershed.
- Berries, plants, and animals are safe to eat.

Land Use

- Cumulative impact of development and industry on water resources, ecosystem and landscape function (including riparian areas and wetlands), biodiversity, and First Nations and Métis traditional land use.

Climate Change

- Impacts of climate change as it relates to:
  - Water availability and quality
  - Increased risk of drought, fire and floods,
  - Pest management (e.g., forest insects and diseases)
  - Altered landscapes and habitat conditions
  - Risks to fish, wildlife, and vegetation

Knowledge and Understanding

- Gaps in knowledge and understanding of natural conditions and anthropogenic (human-caused) impacts on watershed function.
- Limited public understanding or use of First Nations and Métis Rights, Indigenous Knowledge and Practices in the development and implementation of plans and policies.

6.2 IWMP Goals and Objectives

6.2.1 Overarching Goal

Collaborative management of land and water resources that results in a healthy Beaver River watershed.

The LICA IWMP Committee (2020) established that a healthy watershed supports interdependent human, animal, and ecosystem (aquatic and terrestrial) health where:

- Human health is described by individual and community physical, mental and social well-being, including the ability to express one's culture.
- Domestic and production animal health involves physical and psychological well-being that supports productivity, reproduction, and expressions of innate characteristics.
- Wildlife health involves resiliency under changing environmental conditions and the ability to sustain their ecological, social, and cultural roles.
- Ecosystem health involves the ability to maintain and improve organizational structure and function, resilience under stress, and to continuously provide quality ecosystem services.

6.2.2 Specific Goals and Objectives

Specific goals and objectives were formed to provide a clear direction of purpose for the Beaver River IWMP (Table 2). The goals are broad statements that reflect the main concerns for natural resource management in the basin; the goals emphasize what the IWMP will accomplish (the outcomes of the Plan). Objectives were established to guide the planning process and achieve the goals. These objectives are measurable and may be used to indicate milestones throughout the planning process.

Table 2. Values, goals and objectives leading the development of the Beaver River IWMP.

Value	Goal (Outcome)	Objective
Water Quantity	Secure, reliable water supplies are available for desired uses (i.e., environmental, First Nations and Métis, municipal, agricultural, industrial, and recreational).	1. Review and determine the status of existing Water Conservation Objectives in the original Cold Lake Beaver River Water Management Plan (Alberta Environment 2006a). 2. Review the need to establish Water Conservation Objectives for streams and lakes outside of the original CLBR WMP planning area. 3. Recommend strategies to address fluctuating water levels at priority lakes[5] where human impacts contribute to flooding or low water levels in the watershed. 4. Recommend strategies that encourage water conservation. 5. Understand the status of current surface water and groundwater initiatives and recommend strategies to better manage the resource.
Water Quality	Surface water and groundwater quality that is protected from external sources of contamination,	1. Establish Water Quality Objectives that are compatible with the Surface Water Quality Management Framework for watercourses having sufficient data available.

[5] Appendix E summarizes criteria used to identify priority lakes.

Value	Goal (Outcome)	Objective
	and is maintained within the range of natural variability.	2. Establish Water Quality Objectives for major recreational lakes. 3. Identify stormwater management targets and Low Impact Development strategies to minimize development impacts on water quality (and quantity). 4. Identify appropriate land use, management and stewardship strategies to maintain and/or improve water quality.
Riparian Areas and Wetlands	Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.	1. Establish riparian setbacks and management objectives/targets that can be applied consistently throughout the watershed. 2. Recommend actions that contribute to healthy riparian areas and wetlands.
Biodiversity	Fish, wildlife, and plants are healthy and resilient to changing environmental conditions. Their ecological, social, and cultural roles in the watershed are sustained.	1. Identify appropriate land use targets and thresholds to better understand and track cumulative impacts on aquatic and terrestrial habitat. 2. Recommend best management practices and actions that improve wildlife habitat, health, and biodiversity. 3. Recommend appropriate actions to address the risks associated with invasive species.
Land Use	Cumulative effects of diverse land uses are reduced or mitigated to maintain and/or improve ecosystem health.	1. Recommend appropriate water and land management practices that mitigate impacts of industry and development (i.e., urban, recreation, agriculture, oil and gas, forestry, and sand and gravel extraction), and maintain and/or improve ecosystem health.
Climate Change	Climate change considerations are central to all watershed-related planning and decision-making processes.	1. Recommend climate actions and climate change mitigation and adaptation strategies related to watershed management for consideration by decision-makers, resource managers and residents.
Knowledge and Understanding	Indigenous Knowledge and scientific research guide decision-making.	1. Assess and prioritize knowledge gaps in the Beaver River watershed. 2. Recommend outreach materials and other tools to disseminate Indigenous Knowledge and scientific research related to watershed health.

7.0 INDICATORS, TARGETS AND THRESHOLDS

Indicators, targets and thresholds will be used to measure success in achieving watershed goals, objectives, and desired outcomes. Indicators are identified for major watershed values (Table 3). Indicators refer to an easily measurable attribute that reflects one aspect of the underlying condition or state of watershed health (ESRD 2012b). Examples of indicators include nutrient concentrations and riparian health scores. The indicators expand on those identified in the State of the Watershed Report (BRWA 2013). Criteria used to establish indicators included: relevance to the watershed, importance to residents and stakeholders, and measurability.

Targets and thresholds are numerical (quantitative) or written (qualitative statements) that reflect desired or achievable conditions of attributes used to measure watershed health. Targets are used to

determine how valued components in the watershed rate or compare to acceptable or desired ratings and/or conditions. Interim targets, thresholds and objectives may be established when comprehensive or local data is unavailable.

Recommendations in the IWMP will be reviewed using a social and economic filter. Watersheds should be liveable places and support thriving communities.

Table 3. Watershed condition indicators for the Beaver River watershed.

Value	Indicator	Measure	Significance
Water Quantity	Water Supply	Streamflow volume (deviation from the natural (baseline) condition)	Streamflow and water levels should reflect a normal range of conditions and support channel processes (erosion/bank building), aquatic life, the riparian environment, and communities.
		Lake water levels	Maintaining appropriate water levels supports: - Water supplies for communities - Recreation (boat access, beaches, fish habitat) - Aquatic life - Downstream needs for aquatic life and waste assimilation
		Water Conservation Objectives/Instream flows	Established to maintain a minimum flow in streams to support aquatic life or meet transboundary water apportionment.
	Water allocation and use	Water licences and registration; water use reports	Water supplies support aquatic life, communities, and economic activity.
	Groundwater	Water levels	Groundwater is an important water supply.
			Groundwater contributes to the overall water balance in watersheds.
Water Quality	Lake trophic status	Phosphorus, chlorophyll *a* and secchi disk measurements	Deviation from normal conditions (established through long-term trend analysis) suggests a change in water quality (e.g., a degradation or improvement). Surface water quality should support designated or desired end uses.
	Water chemistry	Dissolved oxygen, salinity, nutrients, metals (including arsenic), pathogens, and other toxins (pesticides). Concentration and/or load, spatial and temporal trends	
		Number of parameters and frequency that parameters exceed established guidelines or objectives	Guidelines and objectives are established to determine water suitability for a variety of uses (e.g., drinking water, contact recreation, crop irrigation, livestock water, aquatic life).
	Aquatic Life	Species diversity and abundance	Tolerance of benthic invertebrates and fish to water quality conditions differs among species.
	Water temperature	Optimum (range) and maximum (threshold) water temperature	Optimum and maximum water temperature tolerance should be maintained to support all life stages of aquatic life.

Value	Indicator	Measure	Significance
	Recreation	Number of water quality advisories posted per year	Posted water quality advisories indicate poor water quality and concerns for human health.
Riparian Areas and Wetlands	Riparian function (lotic systems)	Riparian health scores (condition)	Functioning riparian areas contribute to water supply, water quality, river channel and shoreline stability, and biodiversity.
		Intactness (condition, extent)	
	Wetland cover (lentic systems)	Percentage wetland area	
		Wetland loss	
		Impact thresholds (i.e., footprint on each wetland type)	
Biodiversity	Fish, Wildlife and Vegetation	Species composition (variety of seasonal and resident species)	Aquatic and upland systems that support a diverse group of native fish, wildlife, and plant species are more resilient to ecological adversity or changes to environmental conditions.
		Population estimates	
		Index of Biological Integrity	
		Regulated invasive plants, disturbance and rare plants	
		Percentage change in land cover (footprint, linear disturbance, critical habitat)	
		Watercourse crossings and stream connectivity.	Poorly placed or maintained crossings and culverts can increase sediment and erosion, and impede fish passage.
Land Use	Change to human footprint	Percentage change in land use cover (agriculture, forestry, oil and gas)	Monitors land use changes and quantifies cumulative impacts of multiple land uses in watersheds.
	Population	Census data	Important social and economic indicators for municipalities
		Growth rate	
	Recreation and Tourism	User data (day use, registrations)	Trends indicate whether pressure on resources is increasing, stable or decreasing.
	Access	Road density	High road densities can impact fish through increased sedimentation, impassable culverts that prevent upstream migration and increased harvest due to improved accessibility.

8.0 ENGAGEMENT PROCESS

8.1 Goal and Objectives

Watershed stakeholders, First Nations and the Métis were encouraged to participate in the development of the Beaver River IWMP to ensure relevancy, long-term viability, and collaborative implementation of the plan. Appendix A lists key stakeholders in the Beaver River watershed.

The following objectives guided the engagement process:

1. Involve stakeholders, First Nations and the Métis in the IWMP development process; seek input at key stages in the development of the IWMP
2. Share information about the IWMP, Beaver River watershed, and progress related to IWMP development

3. Identify and gather existing technical and scientific material to support the development of the IWMP, and address questions and concerns
4. Facilitate and establish a common public understanding of the hydrological, ecological, socio-cultural, and economic state of the Beaver River watershed and associated issues
5. Promote communication between agencies responsible for watershed management, stakeholders, First Nations and the Métis to maximize collaboration and effective stewardship of the Beaver River watershed.

8.2 Engagement Sessions

The IWMP Committee met with stakeholders during scheduled engagement sessions hosted at key stages in the development of the IWMP (Table 4). Stakeholders had the opportunity to provide input at virtual and in-person workshops, through online response forms, and by written letter or email submitted to LICA or the IWMP Committee during the designated time periods. Stakeholders, First Nations and the Métis were encouraged to contribute insight, ideas, and technical information to reflect community perspectives in the IWMP. "What We Heard" summary reports related to stakeholder engagement are posted on LICA's website (https://lica.ca/watershed/iwmp/).

Input gathered through engagement was considered alongside best scientific information and Indigenous Knowledge to develop credible recommendations for resource management.

Table 4. Engagement sessions hosted at key stages in the development of the Beaver River IWMP.[6]

Draft Terms of Reference (February-April 2021)	•Review intent and scope of the Beaver River IWMP •Review and confirm watershed condition, key issues and opportunities for watershed management •Review roles and responsibilities, work plan and schedule •Seek input into data availability: technical reports, research, knowledge
Draft #1: Indicators, Targets and Thresholds, Early Recommendations (March 2022)	•Review "What we Heard: Session I •Review and confirm draft indicators, targets and thresholds •Review and discuss preliminary recommendations
Draft #2: Recommendations and Implementation Strategy (June 2022)	•Review "What we Heard: Session II •Review, discuss and refine recommendations •Develop implementation strategy
Beaver River IWMP (October 2022)	•Presentation of the Final Beaver River IWMP •Summary of next steps

[6] The Beaver River IWMP Terms of Reference was drafted using previous planning initiatives related to the Beaver River IWMP 2014-2016 (Keess 2013; Keess 2014; Riemersma and Dolan 2016).

9.0 RECOMMENDATIONS AND IMPLEMENTATION TABLES

Recommendations are put forward to address issues and achieve the goals and objectives established in Section 6.2.2. Relevant recommendations from existing plans relevant to the Beaver River watershed were carried forward in this IWMP. New recommendations were developed collaboratively to address new matters, and to align with current initiatives, directions, and values.

9.1 Plan Administration

9.1.1 Adoption

a) The goals, objectives and desired outcomes in the Beaver River IWMP should be adopted by all stakeholders.

9.1.2 Governance

a) Recommendations should be considered in the development and update of municipal and provincial policies, procedures, and planning and development standards and guidelines.

b) An IWMP Implementation Committee should be struck to promote the implementation of the Beaver River IWMP within members respective sphere of influence. Committee members should respect, support and collaborate with other watershed stewards to achieve common goals and objectives for the Beaver River watershed, where possible.

c) IWMP Implementation Committee members should work with their respective colleagues in each jurisdiction to implement the Plan and achieve desired outcomes according to each jurisdiction's priorities.

9.1.3 Implementation and Review

a) All stakeholders having a role in implementation (Section 4.0) should review the recommendations and prioritize actions according to the guidance provided in the implementation tables. Some of the recommended actions may be accomplished by individual partners, while other actions may be undertaken collectively. The IWMP should be used to develop work plans that will support the active implementation of recommendations.

b) LICA should undertake an annual review of the Beaver River IWMP implementation progress to determine if the desired results of the Plan are being achieved.

c) Amendments to the IWMP may be made periodically by consensus of the LICA Board. Minor changes should be made at the discretion of LICA; fundamental changes (e.g., targets) should be brought to Stakeholders. The Plan should remain adaptive and flexible to respond to new information as it becomes available.

d) A more comprehensive review of the IWMP should occur every five years. At that time, the implementation status of the recommendations should be thoroughly reviewed; recommendations that have been achieved should be removed from the plan, new legislation,

policies, or plans should be documented, and new issues should be highlighted and addressed. LICA should lead the review and update of the plan in collaboration with stakeholders, First Nations and the Métis.

9.1.4 Communication with Stakeholders

a) LICA should assist in tracking IWMP implementation progress in collaboration with its partners and develop an annual IWMP implementation progress report to disseminate to stakeholders.

9.2 Water Quantity

9.2.1 Goals and Objectives (from Section 6.2)

Goal: Secure, reliable water supplies are available for desired uses (i.e., environmental, First Nations and Métis, municipal, agricultural, industrial, and recreational).

Objective 1. Review and determine the status of existing Water Conservation Objectives (WCOs) in the original CLBR WMP (Alberta Environment 2006a).

Objective 2. Review the need to establish WCOs for streams and lakes outside of the original CLBR WMP planning area.

Objective 3. Recommend strategies that encourage water conservation and how to achieve them.

Objective 4. Understand the status of current surface water and groundwater initiatives and recommend strategies to better manage the resource.

9.2.2 Targets and Thresholds

9.2.2.1 Existing 1969 Master Agreement on Apportionment

Water management in the Beaver River and the Cold Lake sub-basins must adhere to the Inter-provincial Master Agreement on Apportionment (1969) which states:

> "Sixty-eight percent (68%) of the natural flow of the Beaver River and Cold Lake basins must be allowed to flow to the adjacent province (Saskatchewan)."

9.2.2.2 Existing Cold Lake-Beaver River Water Management Plan

Water conservation objectives (WCOs) were recommended in the CLBR WMP (Alberta Environment 2006a) specifically for the Beaver and Sand rivers, and for May, Manatokan, Muriel, Reita and Tucker lakes (Table 4). In addition, general targets were established for other streams, lakes, and wetlands in the watershed. Targets relate to

i. Diversions and withdrawals for industrial use (namely steam injection) and municipal purposes (provisions for household and traditional agricultural use under the *Water Act* are summarized in Section 9.2.2.3)
ii. Licensed withdrawals (restrictions when water levels reach a particular threshold)

The existing WCOs presented in Table 5 are currently applied by Alberta Environment and Parks to support decision-making. This Beaver River IWMP supports the continued use of the established WCOs and targets.

Table 5. Established WCOs and targets for select rivers and lakes named in the CLBR WMP (Alberta Environment 2006a).

Application	Water Conservation Objectives and Targets	Objective
Rivers		
Beaver River	No diversions for steam injection purposes. Other diversions will be considered on a case-by-case basis, providing they do not harm these values and functions.	Protection of recreational values, fish populations, other freshwater aquatic life, and aquatic ecosystem functions.
Sand River		
Other Streams		
Lakes		
May	No licensed withdrawals.	Conservation of fisheries, wildlife, and recreation.
Manatokan		
Muriel		
Reita		
Tucker		
Other		
Cold River and Long Bay	The cut-off level for industrial diversions from Cold Lake is 534.55 m a.s.l. When this cut-off level is reached, municipal withdrawals shall also be reduced through the implementation of additional conservation measures.	Maintain access to critical fish spawning habitats.
Lakes and Wetlands	No long-term diversions (i.e., more than one year) for steam injection purposes from lakes and wetlands in the CLBR Basin outside Cold Lake. Other diversions from surface waters will be considered on a case-by-case basis, providing they do not harm these values and functions.	Protection of fish, wildlife and recreational values and aquatic ecosystem functions

9.2.2.3 Existing Household Statutory Right and Traditional Agricultural Registration

Under the *Water Act*, the Household Statutory Right provides for the use of up to 1,250 m^3 per year of water for human consumption, sanitation, and the watering of lawns, gardens, trees, and some animals. This water use must be associated with a household or dwelling place and the water must be sourced on or under the land where it is used. There is no document issued for household users who have priority over all other users in the basin.

When the *Water Act* was first proclaimed (1999), traditional agricultural users were encouraged to register their livestock use and establish priority within the prior allocation system. The Traditional Agricultural Registration is for water use within a farm unit of up to 6,250 m^3 per year for the purpose of raising animals or applying pesticides to crops. The water must be sourced on or under the land where it is used. A document provides a record of the registration including the location of the water source and a priority number (first date of use). Registrations differ from licenses in that they cannot be transferred to another location. The registration is similar to a license as it determines who is entitled to receive water first during a water shortage.

9.2.2.4 Recommended Surface Water Allocation Directive Targets

Uncertainty exists for the future condition of river flows and lake water levels in the watershed. This uncertainty stems from unknown developments that may be proposed and the impact that climate change and climate variability may have on watershed hydrology in the future.

Water Conservation Objectives (WCOs) and Instream Objectives (IOs) are administrative tools that are implemented by the Director appointed to manage water under Alberta's *Water Act*. Currently, no WCOs or IOs have been established for watercourses in the watershed to protect low flow conditions, except for the Beaver River in the Master Agreement on Apportionment (1969) (AEP, pers. comm.), and for select lake water levels in the CLBR WMP (Alberta Environment 2006a) (Table 5).

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.*

Consistent application of the SWAD (GOA 2021) in the Beaver River watershed is recommended to address the uncertainty of future water use (e.g., additional withdrawals) and its impact on low flow conditions (Table 6). An additional target related to natural variation is recommended to address high flow conditions that may impact lakeside communities where local infrastructures have been built on the floodplain (Table 6). Refer to Section 9.6.2.2 for the SWAD target related to wildlife.

Table 6. Application of the Surface Water Allocation Directive target to achieve low flow condition objectives, and recommended targets to maintain natural flow variation in the Beaver River watershed.

Condition	Target	Objective
Low Flow	In the absence of a Ministerial Order, consistently apply the Surface Water Allocation Directive (GOA 2021) where: i) A streamflow threshold of Q80 for headwater streams (Order 1-4) would be applied prior to approving temporary diversion license applications. Use mean annual discharge where possible as determined by the Alberta Flow Estimation Tool for Ungauged Watersheds and/or an evaluation of flow conditions at key WSC gauging stations. ii) When streamflow falls below Q80, withdrawal from the upstream smaller creeks (stream orders 1-4) are suspended. If flow at the key station continues to decrease below Q95 then stream orders 5 and 6 will be closed for diversion until sustainable flows are observed. iii) Water can be diverted from stream orders 7 and 8 with limitations to a cumulative diversion of 5%.	Future withdrawals should not impact the aquatic environment. Protection of water quality and aquatic life.
	A net increase in hydrologic connectivity where possible.	
Natural Variation	The number of unregulated streams and lakes in the watershed is maintained or increased.	Natural variability in streamflows and lake water levels support watershed health.
	A net decrease in flood damage from high water due to improved floodplain management.	Land use strategies are in place to minimize flood impacts on infrastructure.

9.2.3 Recommendations

9.2.3.1 General

a) In the absence of a Ministerial Order (specific advice or objectives), the Surface Water Allocation Directive (GOA 2021) should be used to provide consistent, predictable provincial water allocation guidance in the Beaver River watershed (Table 6).

b) No new dams (as described in the CLBR WMP) should be constructed for water storage and multiple uses in the planning area (Alberta Environment 1985; Alberta Environment 2006a).

c) As much as practicable, maintain hydrologic processes and connectivity in the watershed to minimize the potential to isolate lakes and wetlands from their catchment. Where water level drivers are understood, effort should be made to remediate hydrologic processes.

   Naturalizing water levels and restoring connectivity through the removal of weirs, dams and dykes that were built by humans should be carefully considered, particularly at waterbodies that have been modified in other ways to accommodate infrastructure such as railways and highways. Beaver management and the removal of natural dams is discussed in Section 9.6.3.5.

9.2.3.2 Groundwater

a) Continue to refine groundwater models[7] in the CLBR area as information from the CLBR groundwater monitoring network becomes available. Future efforts should consider:
   i. An integrated modelling tool (including groundwater, surface water, land cover and climate) to assess long-term trends and predict cumulative effects on water resources in the future.
   ii. Subwatershed-scale groundwater models to refine the current understanding of hydrological processes near key surface water features. This could include a desktop assessment of groundwater availability and use for specific aquifers to provide insight into the local water balance.

b) Alberta Geological Survey in partnership with AER should complete the mapping for deep groundwater availability and non-saline water use (south of Cold Lake) in the CLBR Basin.[8]

[7] There are two regional groundwater models relevant to the Beaver River watershed: a model for the Cold Lake Beaver River Basin (that covers the footprints of the CLBR Basin), and a model for the South Athabasca Oil Sands Area (a newer model that only provides partial coverage of the CLBR Basin). The current groundwater models were developed at a regional scale and only provide high-level regional information. The existing regional models can provide guidance on the overall long-term capacity of the groundwater system for withdrawals, but localized models are needed to refine the current understanding of water balance, and groundwater-surface water interactions.

[8] The Alberta Geological Survey used available regional models to determine groundwater availability based on the regional water balance. AER used this information to report on total allocations relative to availability at the HUC8 watershed scale. The allocated volumes were provided separately for "shallow" groundwater allocations obtained from within 150 m of the ground surface (vs) deeper groundwater allocations obtained from depths greater than 150 m. Estimates of groundwater availability and the ratio of allocation to availability is reported. The availability of deep groundwater is not currently reported for the area south of Cold Lake in the CLBR Basin.

c) There are 17 Groundwater Observation Well Network (GOWN) wells in the watershed (http://environment.alberta.ca/apps/GOWN/#). Most wells used to monitor water level and water quality are north of the Beaver River and east of the Sand River. Continue to monitor these wells, by collecting continuous water level data and annual water quality data. In addition to data storage in an online, interactive map that is publicly available, report on long-term trends and disseminate findings to the community every five years.

9.2.3.3 Lake Water Levels

a) Improve understanding of hydrological processes and drivers of fluctuating water levels for lakes and associated catchments to aid land use decision-making and stewardship.[9] Based on a preliminary assessment of available data (Appendix D), current trends show:
   - Declining water levels at: Mann, Skeleton, Manatokan, Charlotte, Jessie, and Muriel lakes
   - Increasing water levels at: Kehewin, Pinehurst, and Touchwood lakes
   - High variability in water levels at Mann, Marie, and Muriel lakes

b) Lake water levels on First Nation lands and Métis Settlements are generally not monitored. Explore opportunities to implement collaborative lake level monitoring programs with First Nations and the Métis, as well as at other lakes in the watershed, particularly those proposed for increased recreational use (GOA 2012a; GOA 2022a), and/or where fish habitat restoration is a priority.

9.2.3.4 Flood Mapping

Municipalities have observed that the magnitude of floods identified in maps that are submitted as part of the development application process (i.e., at the Area Structure Plan stage) tend to be underestimated. Flood maps that are developed using consistent methods are an important planning tool for municipalities.

a) Flood maps should be created for watercourses and lakes where development is occurring or planned using methods consistent with Provincial standards and include the full extent of the floodplain. The flood maps should be used as an early planning tool for municipal planners, to inform infrastructure design (ditch/culvert sizing), and to educate landowners and land managers about the risk of development in the floodplain. Priorities may include Crane (Moore) Lake, Moose Lake (due to many subdivisions), and Marie Creek.

[9] Lake water levels can vary depending on lake characteristics, interaction with groundwater, surrounding land cover, tributary characteristics, stream connectivity (impacted by anthropogenic and natural disturbance), climate change and climate variability. Fluctuating lake water levels are a concern for communities. While there is limited ability to manage natural flood and drought events, other factors impacting lake water levels may be managed.

9.2.3.5 Water Conservation

In 2003, the *Water for Life* strategy set a target to improve efficiency and productivity of water use in Alberta by 30% from 2005 levels by 2015. Since 2004, the Alberta Water Council (AWC) collaborated to evaluate and report on the contributions of Alberta's water-using sectors to water conservation, efficiency, and productivity (CEP) goals (AWC 2017). Alberta's seven major water-using sectors improved water use efficiency and productivity by 32% during the reporting period, exceeding the *Water for Life* target of 30% (AWC 2017).

a) Continue to encourage water conservation by all sectors to achieve *Water for Life Strategy* goals for CEP and to report progress. Consider summarizing progress related to CEP sector plan implementation for each major watershed to facilitate planning and reporting by Watershed Planning and Advisory Councils.

b) Encourage actions that can reduce household water use through the Keep Our Lakes Blue campaign (LICA 2019). A few actions include:
    - Water lawn or garden in the morning or evening to minimize evaporation
    - Landscape with native plants that will not need irrigation once established
    - Install a rain barrel to collect runoff from rooftops to use for watering gardens
    - Fix leaking faucets or pipes

c) Consider a study to investigate actual water used through Household Statutory Rights and Traditional Agricultural Use to inform water conservation efforts.

9.2.4 Implementation Table for Water Quantity

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.2.3.1 Low streamflows and lake water levels			
a) Consistently apply the SWAD	AEP	Consistently apply the SWAD when considering applications for new water licenses or the temporary diversion of water.	H
b) Water storage and the creation of new dams	AEP	Consider existing water supplies to meet the needs of water users in the Beaver River basin as demand increases.	H
c) Hydrologic processes and connectivity	AER; Alberta Transportation; CLAWR; Municipalities; Oil and Gas Industry; Agriculture Industry	Assess watercourses to determine where streamflow has been disconnected and the cause (e.g., roads, ditches, culverts, other). Determine the scale of impact on hydrology.	M
		Prioritize projects to restore hydrologic processes where the impact on hydrology and aquatic life is highest. Develop a site remediation plan and seek funding opportunities to restore connectivity.	
9.2.3.2 Groundwater			
a) Refine groundwater models	Alberta Geological Survey; AER; AEP; Industry; LICA; CLFNS; Municipalities	AEP should consider this recommendation as the regional Groundwater Management Framework is developed. Refer to existing groundwater numerical models where available (e.g., models for Muriel and Skeleton lakes (2008-2010), developed to understand declining lake water levels at that time).	H
		Identify priority lakes where groundwater-surface water interactions are of interest (e.g., Crane Lake).	M
		Establish specific objectives for the modelling efforts.	
		Gather additional data from stakeholders to support groundwater modelling efforts (e.g., industry seismic/reports mapping the groundwater, Environmental Impact Assessment work, local studies (e.g., Muriel Lake basin).	
b) Deep groundwater availability mapping	Alberta Geological Survey; AER	Continue with the provincial effort to map deep groundwater availability by completing the work for the Beaver River watershed.	M
c) GOWN wells	AEP	Continue to collect continuous water level data and annual water quality data at GOWN wells. Report on long-term trends and disseminate findings to the community every five years.	M
9.2.3.3 Lake Water Levels			
a) Improve understanding of hydrologic processes	AEP; LICA	Assess available water level data (preliminary assessment in Appendix D), and report on historic and current water level trends.	H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
b) Monitor lake water levels of interest to First Nations and Métis	First Nations; Métis; AEP; LICA	Determine FN and Métis interests in lake and stream monitoring. First, identify culturally significant lakes[10]. Establish appropriate indicators to address interest, including lake water levels and water quality (Section 9.3).	H
9.2.3.4 Flood Mapping			
c) Flood mapping	AEP	Collaborate with partners (e.g., municipalities, LICA) to determine the need for floodplain maps at waterbodies and watercourses in the Beaver River watershed. Prioritize the list and systematically work to delineate floodplains and high-water marks.	H
	Municipalities	Establish flood mapping priorities for the watershed.	
		Submit a letter from all municipal Councils in the watershed to AEP's Technical Staff and River Engineers requesting mapping support. Note that AEP's River Engineers only complete floodplain mapping for watercourses, and do not establish high water marks at lakes. However, AEP hydrologists should be able to assist.	
9.2.3.5 Water Conservation			
a) Encourage water conservation by all sectors.	AWC; Industry; Agriculture	The AWC should continue to publish and disseminate the water conservation and efficiency performance reports to all sectors and LICA every five years.	H
b) Reduce household water use	Municipalities; LICA	LICA and municipalities should collaborate to establish water conservation performance targets for municipal water users as part of the Keep Our Lake Blue campaign (refer to Section 9.3.3.3). A 'friendly competition' could be struck among municipalities to help encourage participation.	M
	Residents and Landowners	Implement actions outlined in the Keep Our Lake Blue Campaign.	H
c) Household and agricultural water use reporting	AWC; Municipalities, LICA	Explore strategies for water use monitoring and reporting for household water users, and for agricultural water users.	L

[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] A lake may be viewed as culturally significant because it has been or is a source of subsistence fishing, where medicinal plants were or are grown and gathered, where a certain language is spoken, and/or has been or is being used as sacred traditional ceremonial grounds for the community.

9.3 Water Quality

Current and historic land cover and land use were examined to identify and explain the human influence on spatial and temporal patterns in water quality during the development of the Cold Lake-Beaver River Water Management Plan (Alberta Environment 2006a). The differences in productivity among lakes were attributed to the amount of disturbance in each lake's watershed. Increasing land disturbance was correlated with increased lake productivity as indicated by high total phosphorus concentrations (Alberta Environment 2006b). Water depth was also significantly correlated with lake productivity (as indicated by total phosphorus concentration); as water depth increased, productivity decreased (Alberta Environment 2006b).

In 2013, CPP Environmental (2013) identified potential suitable watershed-scale indicators that influence lake water chemistry. Relationships were derived between water quality of 25 lakes and lake morphometry, natural watershed metrics and land cover, and land use. Natural landscape features (e.g., lake depth) and indicators of human disturbance (e.g., agricultural intensity and disturbance associated with land use cover) were significantly related to nutrients, ions, and metals in lakes. Key findings:

- Nutrient concentrations and algal biomass tend to be higher in shallower lakes (Alberta Environment 2006b; CPP Environmental 2013)
- Landscape position influences salts and minerals; the higher the landscape position the more evaporation and climate are factors; the lower the landscape position, groundwater influences become the greater factors (CPP Environmental 2013)

Current water quality conditions of concern:

- Low dissolved oxygen in winter months (Beaver River)
- Elevated nutrient concentrations during the summer months (streams and lakes)
- Water quality impacts due to recreation (e.g., shoreline erosion, debris left behind from ice fishing activities)

9.3.1 Goals and Objectives (from Section 6.2)

Goal: Surface water and groundwater quality that is protected from contamination, maintained within the range of natural variability, and meets end-use criteria.

Objective 1. Establish Water Quality Objectives that are compatible with the Surface Water Quality Management Framework for watercourses having sufficient data available.

Objective 2. Establish Water Quality Objectives for major recreational lakes.

Objective 3. Identify stormwater management targets and Low Impact Development strategies to minimize development impacts on water quality (and quantity).

Objective 4. Identify appropriate land use, management, and stewardship strategies to maintain and/or improve water quality. (Also refer to Section 9.7)

9.3.2 Targets and Thresholds

9.3.2.1 Beaver River

General provincial water quality guidelines are established for livestock water, irrigation water, contact recreation and the protection of aquatic life for many physical, chemical, and biological parameters (GOA 2018a) (Table 7). These guidelines can be used to determine if water quality is meeting the quality necessary for irrigation, contact recreation and protection of aquatic life when site-specific water quality objectives are not available. Although the Cold Lake-Beaver River planning area was included in the Lower Athabasca Regional Plan (GOA 2012a), the Surface Water Quality Management Framework did not establish water quality objective triggers and limits for either the Beaver River or its major tributaries (GOA 2012a).

Site-specific water quality objectives for the Beaver River are defined by the Prairie Provinces Water Board (PPWB) in Schedule E of the 1969 Interprovincial Master Agreement on Apportionment. These objectives were last updated in 2021 (PPWB 2021) and apply to the Beaver River reach "Beaver Crossing to the Border" (Table 7; Appendix F.1).

9.3.2.2 Tributaries

Tributaries to the Beaver River: There is limited data available for tributaries of the Beaver River. Much of the data available is historic, and/or limited to a few samples per year. Historic data for the Sand River at the confluence with the Beaver River is available for the period 2003, 2010 and 2013 which represents the open season (April-October). The closed season (November-March) is represented by data collected in 2003, 2004, and 2014. This data was summarized in Table 8 and can be used to compare the historic conditions to current conditions if new monitoring programs are implemented.

Lake Tributaries: There is limited data available for streams that discharge to lakes in the Beaver River watershed with the exception of a few recent monitoring programs. A summary of existing water quality data for tributaries to Moose Lake is provided in Appendix F.3.

Data collected in future water monitoring programs at the Beaver River and main tributaries may be compared to the benchmark data, as well as to other applicable water quality guidelines to identify spatial and temporal trends (e.g., improving, stable or degrading). The results of the future water monitoring program should be used to establish comprehensive site-specific water quality objectives for tributaries not currently monitored by AEP, PPWB or LARA.

Table 7. Existing provincial guidelines (GOA 2018a) and water quality objectives (PPWB 2021) for select water quality indicators.

Indicator	Significance	Provincial Guidelines	Beaver River WQOs	
			Open	Closed
Physical/Routine				
Water Temperature, °C	Influences biochemical processes and metabolism of micro-organisms. Thresholds are important to various life stages of fish (See Section 9.6.2.1).	-	-	-
Dissolved Oxygen, mg/L	Indicator for aquatic life.	Acute: ≥5.0 Chronic: ≥6.5 Mayfly Emergence: ≥8.3; mid-May to the end of June	≥5.0	No Objective
pH, pH Units	Influences biochemical processes and has implications for aquatic life.	≥6.5 and ≤9.0	≥6.5 and ≤9.0	≥6.5 and ≤9.0
Total Dissolved Solids, mg/L	Indicator of ions in water.	Irrigation: 500 to 3500 Livestock: 3000	≤500	≤500
Specific Conductance, µS/cm	Can interfere with plant growth. An indicator of ions in water.	≤ 1,000: safe for irrigation >1,000 to <2,000: Possibly Safe ≥2,000: unsafe for irrigation	-	-
Total Suspended Solids, mg/L	Can transport nutrients and contaminants downstream, can bury fish spawning habitat, impact wear-and-tear of equipment, and reduce water treatment efficiency. May have regulatory requirements.	Maximum increase of 25 mg/L from background levels for short-term exposure (<24 hours). Maximum increase of 5 mg/L from background levels for long-term exposure (24 hours to 30 days).	3.0-48.8	3.0-48.8
Nutrients				
Total Phosphorus, mg/L	Stimulates plant growth in aquatic systems, implications for conveyance, recreation, and aquatic life.	**Where site-specific nutrient objectives do not exist:** Nitrogen (total) and phosphorus concentrations should be maintained to prevent detrimental changes to algal and aquatic plant communities, aquatic biodiversity, oxygen concentration, and recreational quality.	0.171	0.127
Total Dissolved Phosphorus, mg/L			0.060	0.060
Total Nitrogen, mg/L	Can stimulate plant growth. Nitrogen fractions can be a concern for potable water.		1.140	1.862
Nitrate as N, mg/L	Concern for potable water and can stimulate plant growth.	3 (chronic 30-d average) 124 (acute instantaneous maximum)	3	3
Bacteria				
Enterococcus spp. (qPCR), cce/100 mL	Bacterial contamination can impact human health via drinking water, irrigation and contact recreation.	<300 (Geometric Mean (30-d interval) <1,280 (Statistical threshold value, no more than 10% of samples should exceed over a 30-d interval)	-	-
Fecal Coliform Bacteria, cfu/100 mL		≤100	≤100	≤100

Table 8. Summary of historic water quality data for select parameters at the Sand River. Red text indicates that the value did not meet the provincial water quality guideline (Table 7).

Indicator		Sand River	
Parameter	**Statistic**	**Open (N=8)**	**Closed (N=6)**
Water Temperature, °C	**Median**	18.66	0.01
	Min	4.33	-0.33
	Max	21.75	0.09
Dissolved Oxygen, mg/L	**Median**	9.11	3.88
	Min	8.38	2.43
	Max	11.83	5.24
pH, pH Units	**Median**	8.14	7.29
	Min	7.87	7.03
	Max	8.57	7.55
Total Dissolved Solids, mg/L	**Median**	103	215
	Min	88	183
	Max	160	227
Specific Conductance, µS/cm	**Median**	188	329
	Min	162	202
	Max	291	406
Total Phosphorus, mg/L	**Median**	0.083	0.035
	Min	0.022	0.022
	Max	0.098	0.045
Total Dissolved Phosphorus, mg/L	**Median**	0.019	0.013
	Min	0.012	0.008
	Max	0.025	0.024
Total Nitrogen, mg/L	**Median**	1.000	1.000
	Min	ND	ND
	Max	ND	ND
Nitrate as N, mg/L	**Median**	0.002	0.019
	Min	0.002	0.002
	Max	0.019	0.200
Total Suspended Solids, mg/L	**Median**	31	2.5
	Min	1	0.5
	Max	58	3
Fecal Coliform Bacteria, cfu/100 mL	**Median**	-	-
	Min	20	-
	Max	70	-

9.2.3.3 Lakes

The provincial water quality guidelines provide a general target for nitrogen and phosphorus concentrations for lakes in Alberta (Table 7). Site-specific objectives can be established by assessing the trophic status of lakes to indicate productivity. Values associated with lake productivity indicators are reported by Nurnberg (1996) (Table 9). Chlorophyll *a* is an indicator used to measure phytoplankton (algae) suspended in water. The visibility of a Secchi disk at depth measures water transparency in a lake that is partly influenced by the presence of algae (Noton 1998).

Table 9 summarizes water quality targets for lakes. Site-specific targets should be developed for lakes that have a need for increased management and where sufficient water quality data is available. Table 10 lists the trophic status of lakes that have historically been monitored.

Table 9. Water quality targets for lakes in the Beaver River watershed (GOA 2018a and Nurnberg 1996).

Source	Target		
GOA 2018a	No increase in total phosphorus (or nitrogen) above historic conditions should occur at all lakes in the Beaver River watershed. Where nitrogen and/or phosphorus have increased due to human activity, develop lake-specific nutrient objectives and management plans where warranted.		
Beaver River IWMP	A reduction in external phosphorus load: Where a current nutrient budget exists and indicates anthropogenic impacts to water quality from external sources (e.g., from point-source discharge, recreational activity, other), efforts should be made to reduce the external phosphorus load.		
Water quality associated with trophic classes (Nurnberg 1996)			
Trophic Class	**Chlorophyll *a* (mg/m^3)**	**Total Phosphorus (mg/L)**	**Secchi Depth (m)**
Mesotrophic	3.5-9.0	0.010-0.030	4 - 2
Eutrophic	9.0-25.0	0.030-0.100	2 - 1
Hyper-Eutrophic	>25	>0.100	<1

Table 10. Baseline trophic status condition of lakes in the Beaver River watershed (ALMS reports; AEP Trophic Graph). An asterisk indicates the lake is of community interest as identified during engagement.

Sub-Watershed	Oligotrophic	Mesotrophic	Eutrophic	Hyper-Eutrophic
		Increasing Productivity →		
Amisk		Amisk Lake North Buck ***Skeleton Lake North**** Whitefish Lake	***Long Lake**** ***Skeleton Lake South**** Floating Stone Lake Garner Lake Goodfish Lake ***Upper Mann Lake****	***Lower Mann****
Cold Lake		Cold Lake Primrose Lake - S Basin	Primrose Lake - N Basin	
Lower Beaver River		Angling Lake		
Manatokan/Jackfish		Bourque Lake	Tucker Lake	
Marie Creek		***Crane (Moore) Lake - ALMS**** Ethel Lake Hilda Lake ***Marie Lake****		
Moose Lake		Chickenhill Lake	Minnie Lake ***Moose Lake****	***Kehewin Lake****
Muriel Creek		Beartrap Lake Garnier (Bluet) Lake	***Muriel Lake****	Jessie Lake
Sand River - Lakeland		Pinehurst Lake Touchwood Lake Wolf Lake		
Upper Beaver		Elinor Lake	Beaver Lake Fork Lake Kinosiu Lake	

9.3.3 Preliminary Recommendations

9.3.3.1 Maintain, Improve and Protect Water Quality

a) Maintain and/or improve the water quality condition in lakes and streams by reducing external nutrient[11] and sediment inputs through BMP implementation and land use strategies appropriate to each sector (refer to Section 9.7).

b) Adopt riparian health targets and apply riparian setbacks to maintain functioning riparian areas and wetlands that contribute to improved water quality, stable streambanks, and reduced erosion in the watershed (refer to Section 9.4.2).

c) Retain wetlands. Mitigate loss or degradation of wetlands, and replace wetlands according to the Alberta Wetland Policy to maintain water quality (refer to Section 9.5.3.2).

d) Assess septic and sewage discharges to the Beaver River, tributaries, and lakes; upgrade systems that contribute to external nutrient loading to surface water using incentives where possible. Consider upgrading systems that connect with municipal infrastructure.

e) For new developments, municipalities should strongly consider municipal sewer and water for properties adjacent to lakes, as opposed to septic tanks or fields (similar to infrastructure upgrades at Lac La Biche).

f) Assess the need and interest for community source water protection plans to protect the quality and quantity of local water supplies as land use and climate changes.

9.3.3.2 Monitoring and Evaluation

Currently, AEP monitors three sites at the Beaver River: At Gravel Pit U/S AB_SK Border, At Hwy 892, and At Hwy 28 Near Beaver River Crossing. These sites satisfy the needs of the PPWB's WQO assessments. In addition to the lower reach of the Beaver River (downstream of Hwy 28), there is interest in water quality at the Beaver River upstream of the confluence with the Sand River to the headwaters. Additional water quality data collected at major tributaries to the Beaver River (e.g., the Sand River) and recreation lakes would help determine sources of nutrients or other parameters of concern.

In 2016, AEP established a Tributary Monitoring Network to sample surface water in smaller tributaries of major rivers to better understand environmental change associated with activities such as forestry, agriculture, urbanization, resource extraction, and climate change (GOA 2022b). However, none of the tributaries of the Beaver River are currently included in the program.

a) Implement a water monitoring program for major rivers that includes the mainstem Beaver River upstream of Hwy 28, and its major tributaries. Monitoring locations should correspond with Water Survey of Canada gauging stations where possible. Recommended sites are:

[11] At Ethel Lake, the external sources of phosphorus contributed about 32% of the load (12% attributed to residential areas, 15% to atmospheric deposition, and 5% to the inflow from other lakes. At Moose Lake (2017-2019), 80% of the P load originated from external sources; internal loads represented a large proportion (60-70%) of phosphorus loads during summer for the bays without large tributary inflows: Vezeau, Bonnyville Bay and Island Bay (Associated Environmental 2021).

- Upper Beaver River, including at Hwy 881
- Sand River
- Amisk River
- Martineau (Primrose) River
- Medley River

Objectives of the major river monitoring program should include to

i. Establish baseline conditions
ii. Evaluate current water quality conditions with respect to established guidelines and objectives
iii. Maintain long-term records to examine trends in the relationship to land cover, land use and climate change and climate variability
iv. Report and disseminate findings to the public to encourage stewardship

Water quality should be reported annually, and the monitoring program reviewed every three-to-five years.

b) Continue to monitor lake water quality in the watershed. Consider expanding the monitoring program to include lakes not currently monitored and where community interest is high (e.g., Fishing Lake). Integrate the Indigenous Lake Monitoring Program[12] and other ways of knowledge generation into the monitoring programs (refer to Recommendation 9.3.3.2 f).

Lake characteristics should be used to help refine monitoring programs. Consider unique features of individual lakes to identify parameters that reflect local geology, and/or historic and current land use that may influence water quality (e.g., sulphate resulting from fertilization of lakes with sulphur in the 1930s to increase fish production; lake mixing and internal nutrient sources – iron, sulphur, and phosphorus cycles).

Where possible, group similar lakes based on

- Lake depth (shallow (mixed) lakes vs. deep (stratified) lakes)
- Water residence times to indicate sensitivity (long residence time higher sensitivity, short residence time less sensitive)
- Landscape position: headwaters tend to be more productive
- Internal vs. external loading processes

c) Implement a lake tributary monitoring program with the objectives to:

- Establish baseline conditions
- Detect changes in water quality
- Inform lake nutrient budgets

Discharge (streamflow) measurements should accompany tributary water quality monitoring programs to better understand the nutrient load and flux.

d) Alberta Health Services should implement consistent monitoring programs and increase monitoring frequency at public beaches. Strive to disseminate the monitoring results to the community in a timely way, particularly when algae blooms are observed and cyanobacteria is a concern.

[12] The Indigenous Lake Monitoring Program was developed in response to Indigenous community concerns about the quality of lakes of local importance (AEP 2019a). Cold Lake First Nations and Whitefish (Goodfish) Lake First Nation #128 were part of this program at Cold Lake and Utikumasis Lake, respectively, in 2017-2018.

e) In addition to water chemistry, monitoring programs should consider other water quality indicators, including fish and benthic invertebrates. Explore the use of the Canadian Aquatic Biomonitoring Network (CABIN) protocol[13] for tributaries in the basin.

f) First Nations and Métis knowledge, gathered through cultural practices, lived experiences and observations (including multigenerational observations), lessons and skills can inform water monitoring programs and water quality condition reporting for lakes and streams in the watershed. Consider sharing this knowledge to better inform programs and stewardship activity in the watershed.

9.3.3.3 Lake Stewardship

a) Explore opportunities to support lake stewardship initiatives that improve and maintain water quality with residents and rural landowners. Keys areas of focus may include:
   i. Adopting programs such as Keep Our Lake Blue to encourage participation from all stakeholders.
   ii. Winter recreation impacts, including management of the input of debris from winter recreation activities.
   iii. Hosting Septic Sense Workshops.
   iv. Tree planting or shoreline restoration using bioengineering techniques.
   v. Promoting the use of BMPs by all sectors (refer to Section 9.7).

9.3.3.4 Groundwater

a) Consider monitoring water quality parameters that pose the highest risk to human health (e.g., arsenic).

b) Explore opportunities to create a community-based groundwater monitoring program for areas in the watershed where water level and/or water quality data is limited.

c) Assess the number of domestic abandoned water wells in the watershed and develop a plan to decommission sites with incentives.

d) Host 'Working Water Well' workshops. As part of the program, teach rural residents how to properly maintain and/or abandon water wells.

e) Industrial remediation and reclamation activities should meet end-use criteria according to current requirements outlined in the Alberta Tier 1 and Tier 2 Soil and Groundwater Remediation Guidelines (AEP 2019b; AEP 2022) (refer to Section 9.7.3.4.2).

   If the contamination levels in soil and groundwater exceed levels in the remediation guidelines, the company must remediate to meet the levels in the guidelines. Soil remediation is not limited to the surface; contaminants at any depth must not exceed the levels in the guidelines.

[13] The Canadian Aquatic Biomonitoring Network is a monitoring program developed by Environment and Climate Change Canada that provides a standardized sampling protocol and recommended approach to assess aquatic ecosystem conditions, which includes benthic macroinvertebrates.

9.3.4 Implementation Table for Water Quality

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.3.3.1 Maintain and Improve Water Quality			
a) Reduce external nutrient and sediment inputs	AEP; AER; AAF	Encourage the use of beneficial management practices and monitor and report compliance with existing regulations on Crown Land.	H
	Municipalities	Minimize the potential for erosion at stormwater discharge locations. See 9.3.3.5.	
		Develop integrated stormwater management policies that support low impact development.	
	Industry	Apply industry best practices as recommended and/or according to regulation. See 9.3.3.2 Agriculture, 9.3.3.3 Forestry, 9.3.3.4 Oil and Gas.	
	Landowners	Manage shoreline property to reduce impacts on lakes.	
b) Adopt riparian targets and setbacks	GOA	See Section 9.4.	H
	Municipalities; Industry	Incorporate riparian health targets and setbacks into land use bylaws.	
c) Retain wetlands, mitigate loss	GOA; Municipalities; All Industry	See Section 9.5.	H
d) Assess septic and sewage discharge	Alberta Health Services	Collaborate to understand and document the occurrence of septic/sewage discharge or leakage to surface water. Establish an incentive program to upgrade old systems that may be leaking. Inform landowners of the impact leaking septic systems have on water quality.	H
	Municipalities		
	LICA		
	Landowners	Prevent septic leakage and/or nutrient rich runoff water from fertilized lawns from reaching surface water.	
e) Municipal services in new developments	Municipalities	Determine the feasibility of supplying municipal water and sewer infrastructure to new developments, particularly those developments that are adjacent to lakes.	H
f) Source water protection plans	AWC	Share information with WPACs regarding the web-based system being created to support small communities develop source water protection plans.	H
	AWC; LICA	Work with LICA to host training workshops and share information with communities in the Beaver River watershed.	
	Municipalities; First Nations; the Métis	Explore opportunities to complete source water protection plans. Participate in training workshops if possible.	
9.3.3.2 Monitoring and Evaluation			
a) Monitoring the Beaver River and its tributaries	PPWB	Continue to monitor three sites on the Beaver River, and to report on discursions and trends. Share results with LICA and other watershed stakeholders.	H
	AEP	Include Beaver River tributaries in the provincial Tributary Monitoring Network.	
	LICA; AEP, WSGs; All Industry; Academia	Coordinate partners to secure funding for the monitoring program. Funds may be sought through grant programs or partner contributions.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
		Identify and prioritize sites to include in the program.	H
		Establish a list of parameters and other indicators that should be monitored.	
		Implement the program.	
		Refer to the water quality objectives and historic water quality summaries in Table 6, Table 7, and Appendix F when evaluating and reporting on water quality conditions.	
b) Lake water quality	ALMS; AEP; LICA; WSGs; Academia	Continue to monitor lake water quality in the watershed. Host a meeting with the community to present results, and discuss additional program opportunities (e.g., other lakes, water quality indicators, etc.).	H
c) Lake tributary water quality	LICA; AEP; WSGs; Industry; Academia	See actions for 9.3.3.2 a.	H
		Prioritize lake tributary monitoring programs using the criteria established in (Appendix E), considering available historic water quality data.	
	AEP; WSC; LICA; WSGs; Academia	Access Water Survey of Canada (WSC) streamflow data to use in the assessment of water quality at major tributaries to the Beaver River. Where WSC does not collect streamflow data, consider measuring streamflow either at the time of sampling or continuously using appropriate instruments.	H
d) Monitoring public beaches	Alberta Health Services	Identify priorities for beach monitoring in the Beaver River watershed with stakeholders. Follow the Alberta Safe Beach Protocol[14] to monitor beaches and disseminate results to the community.	H
	LICA; Municipalities	Collaborate with Alberta Health Services to communicate the results of the beach monitoring to the community. Consider reporting updates on websites and social media.	
e) Water quality indicators	LICA; AEP; WSGs; Industry; Academia	Coordinate partners in a meeting to discuss water quality indicators to use in the long-term monitoring program.	H
f) Knowledge sharing	First Nations; the Métis	Consider sharing knowledge with watershed stakeholders, landowners, and residents to help inform water monitoring programs and watershed conditions reports.	H
9.3.3.3 Lake Stewardship			
a) Support stewardship initiatives	LICA	Host a meeting with Partners to discuss the implementation of the Keep our Lakes Blue campaign. Present an annual report to the public regarding the successes of the program. Identify actions that could increase the success of the program (e.g., contests, awards, etc.).	H
	Municipalities; Summer Villages; WSGs	Participate in planning meetings to discuss lake stewardship programs.	
		Encourage residents and landowners to be lake stewards.	

[14] The Alberta Safe Beach Protocol outlines the provincial program to assess and manage the public health risks associated with recreational waters throughout Alberta. It specifies recreational water quality standards designed to protect bathers primarily from microbiological risks and, where applicable, from physical and chemical risks.

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.3.3.4 Groundwater			
a) Groundwater water quality indicators	Oil and Gas Industry; AHS; Academia; LICA	Collaborate to identify a list of groundwater parameters to monitor in support of community-based programs.	M
b) Community-based monitoring	Academia; LICA; Industry; LICA	Lead the development of a community-based monitoring program.	M
c) Industrial reclamation	Industry	Refer to Section 9.7.3.4.2.	-
d) Abandoned water wells	LICA (Partners: AEP; AAF; AHS; municipalities; watershed stewardship groups)	Host groundwater working well workshop(s).	H
		Coordinate partners and create an inventory of abandoned water wells using community surveys.	M
e) Working water well workshops and well decommissioning		Secure funding from federal and provincial programs to properly decommission abandoned water wells. Prioritize those wells that may be located in vulnerable aquifer areas. Promote a water well abandonment program.	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)

9.4 Riparian Areas

Riparian areas are the transition zones between upland and aquatic environments. As such, they provide critical hydrologic, ecologic, social, and economic functions in watersheds. Riparian areas trap and store sediment; build and maintain banks and shores; store water and energy; recharge aquifers; filter and buffer water and moderate water temperatures; reduce and dissipate energy, and support biodiversity. Riparian areas have significant value to First Nations as they support a variety of plants that are spiritually and culturally important, as well as primary habitat for many wildlife species.

Three common methods to assess riparian health have been used in the Beaver River watershed: riparian health inventory, aerial videography, and riparian intactness assessment[15] (Table 11). All methods rely on riparian health indicators to determine the status of the condition. Indicators, including vegetative cover, tree and shrub establishment, and human disturbance are used to indirectly evaluate the ability of a site to perform ecological functions. Although riparian condition reporting varies between methods, riparian areas rated 'unhealthy, poor, or low intactness', or 'healthy, good or high intactness' tend to have similar characteristics. Refer to Appendix G.1 for a list of indicators and their significance in riparian health assessment, as well as a summary of the current riparian conditions in the watershed.

Table 11. Summary of riparian condition assessment methods used in the Beaver River watershed.

Method	Description	Best Condition	Impacted	Degraded
Riparian Health Assessment	Ground-based field assessment	Healthy	Healthy but with Problems	Unhealthy
Aerial Videography	Photo interpretation	Good	Fair	Poor
Riparian Intactness Assessment	GIS-Based Assessment	High Intactness	Moderate Intactness	Low Intactness

9.4.1 Goals and Objectives (from Section 6.2)

Goal: Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.

Objective 1. Establish riparian management indicators, targets and thresholds that are recognized and applied consistently throughout the watershed.

Objective 2. Recommend actions that contribute to healthy riparian areas and wetlands.

9.4.2 Targets and Thresholds

There is evidence that increasing land use disturbance results in poorer water quality and fewer recreation opportunities in lakes, among other lost benefits. Targets and thresholds are used to minimize degradation and maintain key riparian functions to maintain water quality and recreation opportunities. Targets and thresholds identified in Table 12 were established using literature and available data, including the riparian intactness assessment to develop targets for riparian **extent** (% intactness).

[15] Intactness ratings are intended to support a screening-level assessment of management priorities across broad geographic areas. The GIS-based assessments should be used along with more detailed, site-specific field assessments of riparian conditions (Fiera Biological 2021b).

Table 12. Proposed targets and thresholds to manage riparian areas in the Beaver River watershed. A combination of riparian extent, condition and setback measures should be applied.

Measure	Method	Watershed-Wide Target	Watershed-Wide Threshold
Federal, Municipal, First Nations and Métis Lands			
Extent (% Intactness)	Riparian Intactness Assessment	≥75% of the assessed riparian area at watercourses and waterbodies is rated 'high intactness' [a]	≤10% of the riparian area at watercourses and waterbodies rate 'very low + low intactness'
Condition (Score)[b]	Riparian Health Assessment and Inventory	Riparian areas rate healthy (Score ≥80)[c]	Riparian areas rate healthy but with problems (Score ≥60); ≤10% of riparian areas score unhealthy or poor (<60%)
Setbacks (Buffer Width)[d]	Cold Lake Subregional Plan (GOA 2022)	New permanent footprint is not permitted within 250 m of the bed and shore of named waterbodies and the valley break of named watercourses in the planning area (including the Beaver River).	
	Fixed-Width	≥50 m minimum [e]	30 m [h]
	Setback Guidelines (GOA 2012b)	20 m to 60 m + Slope qualifier [f]	
	Riparian Setback Matrix Model (Aquality 2012)	Variable based on site conditions [g]	
Pressure[i]	Riparian Intactness	No net increase in the pressure score of local catchments adjacent to streams.	
		A net increase in the cover of natural vegetation (e.g., forest) and/or wetlands adjacent to streams within High Pressure catchments.	
Industry			
Extent, Condition, Pressure	See Above	Apply Extent, Condition and Pressure targets and thresholds.	
Setbacks	Industry Requirements/Standards	Adhere to industry provincial requirements and standards (Appendix H). Generally, a minimum 100 m setback from waterbodies and watercourses applies to the oil and gas and forestry industries on Crown Land.	

[a] Environment Canada (2013)

[b] Function Score: Riparian areas that score ≥ 80 are not pristine; the target accounts for minor disturbance.

[c] Riparian Health Inventory Scores: Healthy (Score>80); Healthy but with Problems (Score 60 to 79); Unhealthy (Score <60) (Fitch et al. 2001).

[d] Industry should abide by standards set out in relevant legislation (refer to Appendix H.3 for agriculture, Appendix H.4 for Forestry, and Appendix H.5 for Oil and Gas

[e] City of Cold Lake (Appendix H.2); Note that industry has requirements for fixed widths that differ.

[f] Stepping Back from the Water (GOA 2012b)

[g] Requires a Professional Biologist or QWAES to apply the model, a land surveyor and others as required.

[h] A minimum environmental reserve setback of 30 m from either the top of the bank of a river or stream or the high-water mark of a lake applied as established in the MD of Bonnyville's Municipal Development Plan (2007).

[i] Pressure scores may be assigned that broadly characterizes the existing condition of local catchments as it relates to type of land cover and intensity of land use present. These catchments and their associated scores provide general measures to assess and track land use and land cover changes through time (Fiera 2021a).

9.4.3 Recommendations

9.4.3.1 Riparian Area Condition

a) Adopt the riparian area **extent** and **condition** targets presented in Table 12. Efforts should focus on decreasing the percentage of riparian areas in the 'very low + low intactness' and 'unhealthy' categories and increasing the percentage of sites in the 'high intactness' and 'healthy' categories in priority areas through time.

b) Establish a riparian condition monitoring strategy that includes:
- The completion of a riparian intactness assessment for each of the main subwatersheds in the Beaver River watershed.
- Periodic re-visits to monitor riparian health at previously assessed sites to determine progress in achieving watershed goals.

9.4.3.2 Riparian Protection

a) At the time of subdivision, development setbacks should be applied consistently to waterbodies and watercourses (e.g., lakes, rivers, creeks) to maintain important riparian functions in the watershed (Table 12). Setbacks should be applied to new developments at the time a development permit is issued by the municipality.

A minimum setback of 50 m should apply from the top of the bank of waterbodies and watercourses. This should consist of 30 m Environmental Reserve (ER) dedication (as required by the MDP), with the balance of 20 m taken as Environmental Reserve (ER), Municipal Reserve (MR) and/or conservation easement.
- The 30 m should commence from the 1 in 100-year flood line unless a discernable top of bank exists beyond this.
- The embankment is often geotechnical containment and therefore the 50 m setback shall commence beyond this.
- To enable the determination of top of bank setbacks, a top of bank survey for the subject watercourse is a condition of a development permit.[16]

b) Development in the floodplain should be discouraged.[17] Consider developing flood maps (refer to Section 9.2.3.4), that includes a GIS overlay delineating the ER and MR at the lakeshore to support application review processes and decision-making.

c) Municipalities should develop riparian policies to maintain functioning (healthy) riparian areas in the watershed. Riparian policies should indicate activities that may be permitted or restricted in riparian areas. Consider the following permissible activities in the riparian setback[18]:
- Existing uses, buildings, and structures
- Existing roads and pathways
- Public utility installations and facilities

[16] City of Cold Lake LUB 382-LU-10
[17] Existing municipal bylaws state: No development shall be permitted within the 1 in 100-year flood line of any lake, river or creek as established by AEP (City of Cold Lake LUB 382-LU-10; MD of Bonnyville MDP 2007).
[18] Adapted from the Town of Cochrane's Watershed Protection and Water Management Bylaw 2005.

- Maintenance and repair of existing infrastructure
- Existing recreational facilities and associated surface parking
- Existing parks and playgrounds
- Passive recreational uses (e.g., walking); pathways constructed from hard surfaces should be avoided where possible
- Natural areas
- Interpretive signage
- Existing agricultural operations, provided they comply with existing regulations (e.g., runoff regulations); agricultural BMPs should be applied (see Section xx)
- Approved water supply wells or wells and associated technology used for livestock watering

d) Except permitted activities, no further development (including stormwater ponds) or site alteration should be permitted within the riparian setback, thus maintaining riparian lands in their natural state. In a natural state, riparian functions are preserved.

e) Setbacks related to agricultural activities, including manure storage, manure application, and seasonal feeding and bedding sites, are established and regulated through the *Agricultural Operations Practices Act* (*AOPA*). The application of Inorganic fertilizer is indirectly regulated by the *Environmental Protection and Enhancement Act* and pesticide use, application, and storage or washing of equipment is regulated through The *Environmental Code of Practice for Pesticides* and administered by AEP. The agricultural industry should abide by provincial setbacks and established application regulations and Codes of Practice. Refer to Appendix H.3 for agricultural related setbacks.

f) Timber harvest is regulated by legislation (*Forests Act* and Timber Management Regulation). The forestry industry should abide by the setbacks outlined in the Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2022b). Refer to Appendix H.4 for forestry-related setbacks.

g) The oil and gas industry is regulated by the Alberta Energy Regulator. The oil and gas industry should abide by the setbacks outlined in the Integrated Standards and Guidelines: Enhanced Approval Process (GOA 2012c) and apply industry respected practices (IRPs). Refer to Appendix H.5 for oil and gas related setbacks.

h) Continue to seek clarification regarding the implementation of the CLSRP (GOA 2022a) setbacks.

i) At the lake or stream level, a shoreline protection policy should be implemented that protects ≥75% of the shoreline according to Table 12.

j) At the lot level, a shoreline protection policy and regulation should be implemented to protect trees and other natural vegetation on ≥75% of the land area within a 30-metre shoreline setback (or other recommended width) on new residential lots. Encourage this practice on existing residential lots.

9.4.3.3 Riparian Conservation

a) Riparian conservation opportunities exist for all lakes in the Beaver River watershed. Consider policy, planning and conservation measures to conserve high quality riparian areas (where intactness scores are ≥90%). Consider the following conservation recommendations (from Fiera 2021a):
   i. Incentivize voluntary conservation of riparian habitat on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs,
   ii. Develop education and outreach programs to encourage stewardship and conservation of riparian habitats on private land,
   iii. Secure high conservation priority riparian habitats through purchase or through other land securement mechanisms available to conservation groups, land trusts, or municipalities,
   iv. Develop provincial, municipal and/or First Nation development setback and riparian land management policies,
   v. Create a municipal habitat conservation and restoration fund to allow for the securement of high priority riparian conservation areas.

b) Unnamed Lakes (located on Crown Land) generally have high riparian intactness[19]. These lakes should be mapped in provincial and municipal planning documents and provided special designation through planning, policy, and conservation tools.

c) Explore Ecological Goods and Services Programs to encourage riparian area and wetland conservation (e.g., Alternative Land Use Services (ALUS) program, Land Trusts, conservation easements) in agricultural areas.

9.4.3.4 Riparian Restoration

Natural and anthropogenic pressure within local catchments was evaluated to identify riparian areas that may be functionally impaired due to surrounding land use activities (Fiera Biological 2021a). A low level of intactness was attributed to hardened shorelines and was most often associated with shoreline development within urban municipalities and highly valued recreational lakes. In the Upper Beaver watershed, increased pressure was noted in catchments dominated by human disturbance related to agriculture, forestry, and resource extraction activities (Fiera Biological 2021b).

a) For existing developed areas, explore opportunities to restore shorelines to meet the riparian intactness target and threshold (Table 12).

b) Measures should be taken to improve streambank and shoreline vegetation at priority lakes and watercourses, particularly those that did not meet the riparian intactness target and threshold (Table 13). Consider the following criteria to further refine priorities for restoration:
   i. Riparian areas that are of spiritual or cultural significance to First Nations and support the exercise of Treaty Rights (e.g., gather plants, trap)
   ii. Riparian areas or littoral zones that support key fish habitat (i.e., spawning areas)

[19] For the Jackfish-Muriel sub-basin, 14 of 15 unnamed lakes had "high intactness" (100%) (Fiera Biological 2021a). Similarly, in the Upper Beaver watershed 38 of 54 unnamed lakes had "high intactness" ratings (≥90%) (Fiera Biological 2021b).

iii. Degradation of the riparian area is a known contributor to poor lake water quality
iv. Riparian areas that do not meet the target (≥75% high intactness) AND the threshold value (≤10% low + very low intactness)
v. Resource availability

c) Use field validation methods such as the riparian health inventory (Fitch et al. 2001; Ambrose et al. 2004) to determine site details contributing to low condition ratings at priority sites.

d) Explore the use of the following tools to achieve restoration goals:
   i. Incentives for riparian habitat restoration on private land through payment for ecosystem services, changes to tax regimes, or other BMP programs (Fiera 2021a).
   ii. Education and outreach programs to encourage private land restoration, particularly for landowners located upstream of flood prone areas.
   iii. Partnerships with conservation organizations to promote and encourage restoration on private lands.
   iv. Creating a municipal habitat conservation and restoration fund to pay for riparian habitat restoration on public lands, with a specific focus on restoring areas identified as Very Low or Low Intactness.

e) Industry should consider the list of restoration priorities in Table 13 and support community initiatives to restore sites.

Table 13. Summary of sites assessed in the riparian intactness assessments that did not meet the target and/or threshold (≥75% High Intactness and ≤10% Very Low + Low Intactness; Table 12) (modified from Fiera Biological 2021a, 2021b). Sites shaded grey may be considered priorities for restoration, with those shaded green being the highest priority. Note that priorities may differ by stakeholder and their affiliation to the waterbody or watercourse. Refer to Appendix G.2 for additional site assessments (e.g., unnamed lakes) and site details.

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category			High Restoration (%)
		Very Low + Low	Moderate	High	
		%	%	%	
Allday Lake	3.6	48	4	49	47
Amisk River	207.9	15	10	75	11
Amisk River-01	96.4	18	11	71	15
Amisk River-04	15.7	28	1	71	25
Amisk River-05	7.8	3	30	66	1
Beaver River	285.3	23	20	57	17
Beaver River-01	11.5	29	9	62	29
Bunder Creek	76.5	18	25	58	17
Bunder Creek-01	8.7	31	29	39	27
Bunder Creek-02	9.5	33	28	39	23
Bunder Lake	30.5	14	15	72	10
Chappell Lake	8.2	15	6	80	15
Cole Lake	9.2	58	0	41	16
Columbine Creek	80.5	31	24	45	31
Denning Lake	8.2	30	11	59	22
Floatingstone Lake	17.4	18	7	74	13
Floatingstone Lake-01	10.5	46	33	21	46
Garner Lake	16.6	28	11	61	28

Waterbody or Watercourse	Length Assessed (km)*	Proportion (%) of Shoreline in Each Intactness Category			High Restoration (%)
		Very Low + Low	Moderate	High	
		%	%	%	
Greenstreet Lake	7.9	12	20	68	0
Little Garner Lake	4.1	72	1	27	72
Lone Pine Lake	8.3	22	6	73	14
Long Lake-03	3.9	12	2	85	2
Mooselake River	0.2	0	41	59	0
Owlseye Lake	6.7	38	20	42	38
Reed Lake	20.1	68	9	24	67
Skeleton Lake	24.8	13	18	69	5
Snail Lake	6.7	30	2	68	30
St. Lina Creek	89.4	20	30	50	19
St. Lina Creek-01	7.3	14	13	74	13
St. Lina Creek-02	20.6	55	22	24	55
St. Lina Creek-03	13.3	70	22	8	70
Victor Lake	4.6	25	0	75	25
Victor Lake-01	21.7	26	9	65	13
Whitefish Creek	54.0	12	13	75	10
Whitefish Creek-01	4.8	56	24	19	43
Whitefish Creek-02	74.7	14	2	84	7
Whitefish Creek-03	14.4	17	11	72	14
Whitefish Lake	26.9	11	5	84	7
Jackfish Creek	131.4	16	7	77	14
Ethel Lake	11	11	17	72	
Manatokan Lake	12.8	24	9	66	23
Osborne Creek	32.3	7	20	72	3
Jessie Lake	16.6	33	35	33	36
Kehewin Lake	25.2	18	12	69	12
Moose Lake	67.5	20	13	66	15
S. Trib of Kehewin Lake	13.3	8	27	65	
S. Trib of Kehewin Lake-01	10.6	27	53	20	28
Charlotte Lake	27.3	73	23	4	70
Landry Lake B	1.9	32	37	32	
Muriel Creek	88	52	12	36	51
Muriel Lake	51.5	13	19	68	10
Reita Creek		16	7	77	14

9.4.4 Implementation Table for Riparian Areas

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.4.3.1 Riparian Area Condition			
a) Adopt targets and thresholds	AEP; AAF; AER	Adopt riparian area condition targets for Crown Land and integrate targets in industry codes of practice and/or operating standards and guidelines.	H
	Municipalities	Adopt the riparian area condition targets and include them in applicable policy and planning documents.	
b) Riparian condition monitoring	LICA	Develop a strategy to prioritize riparian health assessment work in the watershed.	H
	LICA; Municipalities; WSGs;	Host a workshop with shoreline owners to present riparian health assessment methods and encourage them to complete a self-assessment using incentives.	
9.4.3.2 Riparian Protection			
a) Development setbacks b) Development in the floodplain	Municipalities	Determine the potential impact of riparian setbacks on landowners adjacent to recreation lakes and watercourses.	H
		Specify and apply development setbacks to lakes, rivers, creeks, and ephemeral and intermittent streams at the time of subdivision .	
		Develop a tool that clearly shows the riparian setback delineation.	
	Municipalities; Realtors; Lawyers	Establish a communication strategy for development setbacks to ensure they are implemented and respected in developments.	
		ER and MR provide community access to the lake and should be disclosed at the time of sale/purchase. Explore opportunities to educate lawyers and real estate agents of ER and MR that exist on private lands (e.g., place ER and MR on land titles so the buyer is aware).	
	Landowners	Identify riparian setbacks on all site plans submitted to the appropriate jurisdiction for permitting. A development permit should only be approved after the delineation of the riparian setback is completed.	
c) Riparian policy	Municipalities	Develop a riparian policy, if one has not been created, to guide planning and manage future development on municipal riparian lands.	H
d) Permitted activities in riparian areas	Municipalities	Consider the list of permitted activities in riparian areas. Update applicable land use bylaws to include permitted activities.	H
e) Agricultural setbacks	AAF	Develop and share resources related to agricultural responsibilities outlined in *AOPA*.	H
	Agricultural Industry	Adhere to established agricultural setbacks regulated by *AOPA* (Appendix H)	
f) Forestry setbacks	AAF	Monitor harvest practices to ensure setback compliance.	H
	Forest Industry	Adhere to forestry setbacks established in Northeast Alberta Timber Harvest Planning and Operating Ground Rules (GOA 2018a) (Appendix H).	
g) Oil and gas setbacks	AER	Monitor oil and gas activities to ensure setback compliance.	H
	Oil and Gas Industry	Adhere to oil and gas activity setbacks established in the Integrated Standards and Guidelines: Enhanced Approval Process.	

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
h) CLSRP setbacks	AEP	Clarify expectations regarding riparian setbacks in the CLSRP and communicate these to municipalities, industry and landowners in the watershed.	H
i) Regional shoreline protection policy	AEP; Municipalities	Develop a policy to maintain ≥75% of shoreline habitat.	H
j) Lot level shoreline protection policy	Municipalities	Explore opportunities to maintain ≥75% of shoreline at the lot level using policy and incentives. Tools available to municipalities include: i. Environmental Reserve ii. Conservation Easements (refer to Greenaway 2017 for more information regarding Conservation Easement as a tool for municipalities) iii. Incentives for voluntary conservation including payment for ecosystem services, changes to tax regimes, or other BMP programs	H
9.4.3.3 Riparian Conservation			
a) Riparian conservation	GOA; Municipalities	Update Figure 10 in the CLSRP (GOA 2022) to include names of the named waterbodies and watercourse where the 250 m setback applies.	H
b) Unnamed lakes	GOA	Explore the use of Protected Notation and/or Consultative Notation to protect and/or conserve critical shoreline habitat on Crown Land.	M
c) Ecological Goods and Services	LICA	Organize a forum with Municipalities, GOA and non-government organizations to explore opportunities to provide incentives for riparian management.	M
9.4.3.4 Riparian Restoration			
a) Restoration to achieve targets and thresholds	AEP	Resource managers should prioritize restoration activities on Crown Land where riparian intactness scores are <75%. Consider popular Crown Land recreation areas.	M-H
	LICA; Municipalities; WSGs;	Use available riparian condition data (e.g., the riparian intactness assessment, riparian health inventories/assessments) to further prioritize sites for restoration.	M-H
		Identify partners interested in restoring riparian function on private lands.	H
	First Nations; Métis	Share information with LICA regarding restoration priorities.	M-H
b) Refine restoration priorities	LICA; Municipalities; WSGs	Use field validation methods (e.g., riparian health assessments) to refine priorities and establish restoration plans for priority sites. On private lands, field technicians may interact with landowners and residents to heighten awareness and increase riparian literacy.	H
c) Riparian health assessment/inventory	Cows & Fish; LICA; WSGs	See 9.4.3.1 b.	H
d) Explore administrative tools	LICA; Municipalities	Evaluate administrative tools that could help to restore riparian areas.	H
e) Industry support for community restoration projects	LICA; LICA's Industry Steering Committee	Develop a list of restoration priorities in collaboration with stakeholders, First Nations and the Métis, and seek support for projects.	M-H
	All Industry	Seek opportunities to collaborate in restoration projects.	

[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)

9.5 Wetlands

About 33% of the Beaver River watershed is considered wetland, with ecologically significant areas of poorly drained fens and swamps found in the northern part. Ducks Unlimited Canada classified the water and wetland features: Fens comprised 46.5% of wetland area; swamps represented 23.5%, marshes represented 4.5%; bogs 3%; and open water 22.5% of wetlands (BRWA 2013).

9.5.1 Goals and Objectives (from Section 6.2)

Goal: Healthy riparian areas and wetlands contribute to watershed resiliency with respect to flood and drought, quality water, and critical habitat.

Objective 2. Recommend actions to conserve intact riparian areas and wetlands, and to restore areas that rate unhealthy or poor condition or have low intactness.

9.5.2 Targets and Thresholds

All wetlands contribute to the health of the Beaver River watershed and should be retained. Efforts should be made to retain wetlands, avoid impacts to all wetlands through design, and to mitigate impacts where avoidance is not possible.

9.5.3 Recommendations

9.5.3.1 Wetland Inventory and Valuation

The Alberta Wetland Policy defines wetland values based on functional groups (Table 14). The Alberta Wetland Evaluation Tool (ABWRET-A) provides guidance regarding wetland values, however, assigning values to wetlands remains a challenge for land managers. In the boreal ecosystem, many wetlands are interconnected below ground and the hydrology of these systems is not well understood. Carbon storage potential should also be valued as an important wetland function.

Table 14. Wetland value functional groups based on the Alberta Wetland Policy (AEP 2013).

Wetland Value Functional Groups		Value Category
Biodiversity and Ecological Health	Wetlands are dynamic, complex habitats that contribute to biodiversity and other ecological functions.	A (High)
Water Quality Improvement	Wetlands improve water quality by facilitating sedimentation and filtering pollutants.	B (Moderate)
Hydrologic Function	Wetlands help reduce flooding and soil erosion by storing runoff and slowing its downstream release. They are also important as areas of groundwater recharge and discharge.	C (Moderately Low)
Human Uses	Wetlands support multiple human activities (e.g., recreation, and education) and have varying degrees of cultural significance.	D (Low)
Relative Abundance	The relative abundance of wetlands in an area strongly affects the sensitivity of an area to the effects of further wetland loss.	

a) Complete a detailed wetland inventory for the watershed using the enhanced wetland classification method.

b) Identify tools to assist with wetland valuation, considering the Alberta Wetland Policy and criteria established in the ABWRET-A. Establish a comprehensive inventory of high-valued wetlands in the watershed based on hydrological, ecological, and cultural values.

c) Consider the Biodiversity Valuation Calculation Matrix (DUC 2017) to examine the biodiversity value of specific wetland types to species-at-risk in the watershed.

9.5.3.2 Wetland Retention

a) To maintain high valued wetlands (Category A and B based on wetland value functional groups in Table 14), adopt a policy to avoid impacts to wetlands (through project redesign or relocation). If avoidance cannot occur, minimize impacts to the greatest extent possible using mitigation strategies (BMP implementation during planning and operation). Replacement should apply when wetlands are permanently lost according to the Alberta Wetland Mitigation Directive (GOA 2018b).

   To the extent possible and as highest priority, encourage that wetland replacement is applied in the same sub-watershed relative to where the loss occurred (GOA 2018b).

b) Similar to riparian areas, apply appropriate development setbacks in the watershed to maintain hydrologic function (flood and drought protection), water quality, and biodiversity functions on the landscape. Refer to Appendix H for industry related setbacks.

c) Explore opportunities to establish a carbon credit system as a tool to retain wetlands on the landscape.[20]

9.5.3.3 Wetland Mitigation

a) Consider resource road construction and maintenance practices that mitigate impacts on wetland environments (Ptartington et al. 2016), including but not limited to:
   i. Size and space culverts to promote hydrologic connectivity
   ii. Apply minimal disturbance practices by crossing wetlands when soils are frozen
   iii. Use wide tires on gravel trucks to reduce compaction and improve load-bearing capacity
   iv. Source fill materials from outside wetlands to maintain wetland hydrology
   v. Monitor and repair roads (e.g., rutting, perched/sunken culverts, excessive erosion)

b) In agricultural areas, minimize impacts to wetlands:
   i. Retain temporary wetlands in pastures and cropland to provide early spring breeding habitat for wildlife
   ii. Maintain or restore permanent cover (e.g., perennial forages for hay) in low-lying (wet) areas to provide habitat

[20] Wetlands remove more carbon dioxide from the atmosphere and incorporate it into vegetation and soil compared to forest or upland prairie ecosystems. A study by The Conservation Fund found that wetlands store 81 to 216 metric tons of carbon per acre, depending on their type and location. Carbon credit generally refers to a certificate or permit that allows the purchaser to offset their greenhouse gas emissions through the capturing or sequestering of carbon in the trees and soil, rather than it being released into the atmosphere. One carbon credit represents the reduction of one metric tonne of carbon dioxide or its equivalent in other greenhouse gases.

iii. Avoid cultivating near the edge of wetlands
iv. Maintain, restore, or enhance riparian vegetation for flood and drought mitigation, water quality, and wildlife habitat
v. Delay mowing and haying of grassed waterways and other wet areas until mid-July to reduce nesting losses and fawn mortality. Use a flushing bar when haying
vi. Provide alternative water to livestock to deter the use of wetlands by livestock and to prevent soil compaction in low-lying areas. Use temporary or permanent fencing around wetlands.

9.5.4 Implementation Table for Wetlands

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
9.5.3.1 Wetland Inventory and Valuation			
a) Detailed wetland inventory	LICA; AEP; DUC	Access the Alberta Merged Wetland Inventory data layer and create the detailed wetland inventory map for the watershed.	H
	Lac La Biche County	Share the local wetland inventory data with LICA, and others as requested, to support the creation of a detailed wetland inventory for the watershed.	
b) Wetland valuation	CLAWR; AEP; AAF; LICA	Collaborate to develop a detailed wetland valuation. Apply the Alberta Wetland Policy methodology to assign values to wetlands. Generate a map that shows wetland values as a decision support tool for use by municipalities and industry.	H
	AEP	Assist LICA and municipalities to assign values to wetlands in the watershed according to the Alberta Wetland Policy and Alberta Wetland Rapid Evaluation Tool	
	Municipalities	Consider the wetland valuation early in the planning process. Note that the value of wetlands may change, and wetlands may need to be re-evaluated closer to the application date.	
c) Biodiversity Valuation Calculation Matrix	DUC	Apply the Biodiversity Valuation Calculation Matrix to the Beaver River watershed.	H
9.5.3.2 Wetland Retention			
a) Maintain high-valued wetlands	AEP	*Any work within a water body requires Approval under the Water Act. Wetland retention and compensation are considered in AEP's decisions.*	H
		Review MDPs at an earlier stage so opportunities to retain wetlands are not lost. Consider if the wetland is provincially "Crown claimable" or if decisions can be deferred to the local authority.	
		Address the timeliness of the application review process for wetland restoration projects under the *Water Act* where clear benefits to the watershed were identified (e.g., ecological health, biodiversity, water quality improvement, hydrologic function, and human uses).	
	Municipalities	Develop policy, procedures, and strategies to ensure that wetland management is integrated into urban planning and development, and water resource management.	H

Recommendation	Responsible Jurisdiction	Actions	Priority[a]
	LICA; Municipalities	Collaborate with Land Trust organizations, Ducks Unlimited Canada, Nature Conservancy Canada, and others who have an interest in the preservation of wetlands.	H
b) Development and industry setbacks	All	See implementation actions 9.4.3.2 Riparian Protection	H
c) Carbon credit system	Industry	Explore opportunities to offset carbon production by investing in carbon credits through federal and/or provincial programs, or programs aimed at preservation of ecological goods and services (e.g., ALUS).	L
9.5.3.3 Mitigation			
a) Road construction	GOA; Industry; Municipalities	Refer to available guidance to mitigate the impacts of road construction on wetlands.	H
b) Agricultural activity	Agricultural Industry	Apply grazing and cropping BMPs to maintain wetlands on agricultural land.	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)

9.6 Biodiversity

The watershed is a significant recreational fishery for the province, accounting for 25% of the annual provincial harvest (BRWA 2013). Fish are vulnerable to lake level fluctuations and the effects on shoreline vegetation, which provide spawning and feeding habitat for adults and rearing habitat for young fish. Low lake levels can result in loss of habitat that increases the risk of fish kills in summer and winter. Lake fisheries can also be impacted by surrounding land use in the watershed, particularly where nutrients and other contaminants drain uncontrolled into lakes (BRWA 2013). In the Beaver River, fish diversity and abundance are impacted by poor habitat conditions that include low streamflow velocities, poor water quality (low dissolved oxygen and high nutrient concentrations), and poor riparian conditions.

Fish communities in the Beaver River watershed are summarized in Table 15. Key lake fishes important to First Nations, the Métis and recreational fishermen include Lake Whitefish, Northern Pike, and Walleye.

Marie Lake: Poor translation of the Cree word for the place *methai*, pronounced merai, which translates as a fish (Harrison 1994).

Moose Lake: Known to early French-Canadian fur traders as lac d'Orignal, meaning Moose Lake. This may have been a direct translation of the local Cree name of the same meaning, Mōswa sākahikan (Atlas of Alberta Lakes).

Table 15. Fish community in the Beaver River watershed.

Waterbody/Watercourse	Fish Community
Lakes (general)	Cold-water Fish: Lake Cisco, Lake Trout and Lake Whitefish, with Lake Trout only found in Cold Lake Cool-water Fish: Burbot, Northern Pike, Walleye and Yellow Perch.
Upper Beaver River	Fish species tolerant of degraded habitat (i.e., White Sucker and a few minnow species). It is thought that more sensitive species (i.e., Walleye, Northern Pike and Spottail Shiner) may have been present in the Upper Beaver River in the 1950s
Lower Beaver River Upstream of the City of Cold Lake	Dominated by White Sucker and Lake Chub. Fish species diversity tends to be greater upstream of the City of Cold Lake and includes Burbot, Northern Pike, Walleye and Yellow Perch. There is likely an influx of better-quality water discharged from the Sand River to the Beaver River that supports these cool-water fishes.
Lower Beaver River – Downstream of the City of Cold Lake	Only species that are more tolerant of degraded habitat conditions were observed downstream (e.g., White Sucker, Brook Stickleback) (BRWA 2013). Fish captured furthest downstream had a higher prevalence of infection and parasites indicating habitat stress (BRWA 2013).

9.6.1 Goals and Objectives (from Section 6.2)

Goal: Fish, wildlife, and plants are healthy and resilient to changing environmental conditions. Their ecological, social, and cultural roles in the watershed are sustained.

Objective 1. Identify appropriate land use targets and thresholds (e.g., stream crossings and linear features) to better understand and track cumulative impacts on aquatic and terrestrial habitats.

Objective 2. Recommend best management practices and actions that improve wildlife habitat, health, and biodiversity.

Objective 3. Recommend appropriate actions to address the risks associated with invasive species.

9.6.2 Targets and Thresholds

9.6.2.1 Fish and Fish Habitat

9.6.2.1.1 Index of Biological Integrity (IBI)

The IBI was used to assess the condition of aquatic ecosystems at 47 locations on the Beaver River, Amisk and Sand rivers (Cantin and Johns 2012). Indicators used in the assessment included: fish composition and size, road density, riparian condition, and water quality. Many sites in the upper Beaver River were rated in poor condition. These results are consistent with riparian condition findings (see Section 9.4) where riparian health scored poorly in the same reaches. At the Sand River, ratings were somewhat better, generally ranging from average to good, with few areas rating fair (Cantin and Johns 2012). Sites at Amisk rated poor to fair. A high IBI would suggest that conditions were suitable for aquatic life. Table 16 identifies targets for IBI scores.

Table 16. Fish and fish habitat targets.

Indicator	Target
IBI Scores	>90% of IBI scores rate high for a given stream.
	Improve IBI scores at the Amisk and Beaver River.
Lake FSI Scores	Fish habitat is restored, and fish harvest is in balance with a sustainable fish population.
	No lakes have fish species listed as Functionally Extirpated (Refer to Table 17)
	A decrease in the number of lakes that have Northern Pike or Walleye populations listed as High or Very High Risk to sustainability (Refer to Table 17)
Species Composition	The Upper and Lower Beaver River support a sustainable, cool-water fishery.
	Maintain a sustainable Lake Trout population in Cold Lake.
	Consider smaller fish and other food sources for sportfish as indicators of the health of the system.
Water Temperature	Water temperature should be maintained within the optimum range described in Table 18 for select fish species. A general water temperature of ≤20°C is recommended. Refer to Section 9.3 for additional water quality targets.
Stream Connectivity	Achieve ≥90% stream connectivity in sportfish streams, with 100% connectivity in the mainstem reaches of third-order streams and higher.

9.6.2.1.2 Fall Index Netting and Fish Sustainability Index

Fall Index Netting methods are used by Alberta Environment and Parks to monitor the status of fish populations (i.e., Northern Pike and Walleye). Fall index netting typically occurs during late summer and fall when water temperatures are between 10 and 15°C when fish are known to be more evenly distributed within the lakes (https://www.alberta.ca/fall-index-netting-overview.aspx#).

Fish Sustainability Index (FSI) is the provincial fish-population assessment measure. It evaluates provincial fish status by assessing numerous metrics that are grouped into three main categories:

- population integrity
- productive potential of the habitat
- threats and their mitigation

Indicators are summarized into scores that are reported as a risk rating, from very low risk to very high risk to the fish population (refer to Appendix I for FSI index risk thresholds for Walleye and Northern

Pike). Scores for the most recent FSI assessments in the Beaver River watershed are summarized in Table 17. Targets for FSI scores are established in Table 16.

Table 17. Most recent risk sustainability rating for lakes monitored in the Beaver River watershed. A rating of 'Low' indicates a low risk to fish population sustainability, a rating of 'Very High' indicates a very high risk to the fish population.

Sub-Watershed	Waterbody	Northern Pike	Walleye
Amisk	Amisk Lake	High (2019)	Low-Moderate (2019)
	Goodfish Lake	Very High (2020)	Very High (2018)
	Long Lake	Low (2020)	Low (2020)
	Skeleton Lake	Moderate-High (2020)	Moderate-High (2020)
Manatokan / Jackfish Creek	Tucker Lake	Very Low (2019)	Not Reported
Marie Creek	Crane Lake	Moderate-High (2018)	Very High (2018)
	Ethel Lake	Low (2017)	Moderate (2017)
	Marie Lake	Very High (2020)	High (2020)
	May Lake	High (2019)	High (2019)
Moose Lake	Chickenhill Lake	Extirpated (2019)	-
	Kehewin Lake	High (2018)	High (2018)
	Moose Lake	Moderate-High (2020)	High (2020)
	Muriel Lake	Extirpated (2012)	Extirpated (2012)
Sand River-Lakeland Region	Pinehurst Lake	Very High (2020)	High (2020)
	Touchwood Lake	High (2019)	High (2019)
	Wolf Lake	High (2018)	-
Upper Beaver River	Beaver Lake	Very High (2016; 2018)	High (2016; 2018)
	Elinor Lake	High (2020)	Low (2020)
	Ironwood Lake	High (2019)	Moderate-High (2019)

9.6.2.1.3 Water Temperature

Continuous water temperature data is not available for the Beaver River or its tributaries. However, monitoring at the lower reach of the Beaver River (2016-2020) recorded an average maximum temperature of 22.87°C, with 10% of observations greater than 20°C (Average 90th percentile value of 20.2°C) (refer to Appendix F.2 for current Beaver River conditions). Water temperature targets are identified in Table 19.

9.6.2.2 Wildlife

The Surface Water Allocation Directive (SWAD) provides protection for wildlife sensitive to human disturbance and changing water levels (GOA 2021). For lakes and standing water bodies, important breeding sites for trumpeter swan, piping plover and colonial nesting birds (American white pelican and great blue heron) should be protected by consistently applying the timing restrictions identified in the SWAD or by using site-specific timing information where available (Table 18).

Table 18. Target restriction for wildlife species sensitive to human disturbance (GOA 2021).

Sensitive Wildlife Species	Breeding Season	Target Restriction
Trumpeter Swan	April 1 – Sep 30	No water diversions during the breeding season.
Colonial nesting birds	April 15 – July 31	
Piping plover	April 15 – July 31	

Table 19. Summary of water temperatures required for key sport fish species in rivers and lakes in the Beaver River watershed. Temperatures in **green** are optimum temperatures for growth. Temperatures in **black** are the tolerance range (sub-optimum growth at the lower and upper extreme temperature). Temperatures higher than the upper tolerance range may result in mortality for all life history components and cessation of spawning. Temperatures lower than the lower tolerance range may result in reduced growth for all components, cessation of spawning and increased mortality for incubating eggs and newly-emerged fry.

Species	Egg Incubation	Egg Incubation Timing	Fry	Juvenile	Adult	Spawning	Spawning Timing	Reference
Burbot (*Lota lota*)	**4 - 7°C** **1 - 7°C**	30 days: February to April	NA	**16 - 18°C** **8 - 23°C**	**16 - 18°C** **1 - 23°C**	**1 - 2°C**	February to March (under ice)	1, 2
Lake Trout (*Salvelinus namaycush*)	**5°C** **0.3-10°C**	100 - 150 days: September to January	**12°C**	**6 - 13°C** **0 - 18°C**	**<10°C** **0 - 18°C**	**10°C** **8 - 11°C**	September to October	1, 2, 3, 5, 10
Lake Whitefish (*Coregonus clupeaformis*)	**3 - 6°C** **0 - 12°C**	42 - 182 days: October to April	**14°C** **12 - 20°C**	**14 - 20°C**	**8 - 14°C** **0 - 22°C**	**3 - 6°C** **0 - 7°C**	late-September to January	1, 2, 3, 5, 10
Northern Pike (*Esox lucius*)	**6 - 15°C** **3 - 17°C**	14 days: mid-April to mid-May	**21 - 26°C** **6 - 26°C**	**26°C** **6 - 33°C**	**19 - 21°C** **0 - 29°C**	**6 - 12°C**	April to early-May	1, 5, 9
Walleye (*Sander vitreus*)	**9 - 15°C** **6 - 19°C**	17 - 21 days: mid-April to mid-June	**22°C** **13 - 28°C**	**22 - 28°C** **15 - 31°C**	**20 - 23°C** **0 - 28°C**	**6 - 12°C**	April to May	1, 2, 5, 6, 7, 8, 11
Yellow Perch (*Perca flavescens*)	**10°C** **7 - 20°C**	8 - 14 days: late-April to late-May	**3 - 28°C**	**19 - 24°C** **6 - 31°C**	**19 - 24°C** **6 - 31°C**	**7 – 12°C**	mid-April to early-May	2, 3, 4
Note: Where temperature data is not available for 'fry' component, use temperature data from 'juvenile'.								

References:

1 - Ford *et al.* 1995
2 - Joynt and Sullivan 2003
3 - Scott and Crossman 1973
4 - Krieger *et al.* 1983
5 - Nelson and Paetz 1992
6 - AEP 1996b
7 - Carlander 1997
8 - McMahon *et al.* 1984
9 - Inskip 1982
10 - McPhail 2007
11 - Clapp *et al.* 1997

9.6.3 Recommendations

9.6.3.1 Fisheries

a) Determine local and regional goals, and update fisheries management objectives for lake fisheries in the watershed through conversation with First Nations, the Métis, anglers, and the public. Design and implement effective regulations and management tools to achieve these goals.[21]

b) Implement effective sport fishing regulations, with goals of recovering fisheries and providing more sport fishing opportunities.[21] Consider the potential to develop a 'catch-and-keep' fishery at lakes to support tourism and recreation opportunities and the local economy.

c) Fall Index Netting program reports should include additional key species in lakes (e.g., Burbot, Yellow Perch, Whitefish) that are captured during the fishing effort.

d) Consider other methods to monitor fish populations. Complete angler effort surveys to understand angling pressure and harvest from key lakes of interest in the watershed (e.g., creel surveys), and consider electrofishing at streams.

e) Increase knowledge and understanding among land managers and lake users about the relationships between development, water quality and healthy ecosystems to support the conservation of clean water and healthy fisheries.[21]

9.6.3.2 Fish Habitat and Restoration

a) Continuous water temperature data should be collected at several locations in the Beaver River to assess current fish habitat conditions. Sites may be located downstream of the Amisk River, Downstream of Sand River, upstream of the City of Cold Lake, and downstream of the City of Cold Lake.

b) Identify key drivers of high-water temperature (e.g., lack of riparian vegetation, water diversion or discharge) and develop a strategy to mitigate the impact.

c) Conduct fish spawning surveys to identify lake areas that should be protected from future development, and/or recreation activity during critical spawning periods.

d) Lakes that have been closed to fishing should be assessed to determine the cause of the fishery decline and if the cause of impact has been resolved. Consider restoring a fishery at these lakes if habitat conditions are suitable (refer to 9.6.3.1 b), or enhancing habitat conditions where feasible.

[21] Adapted from Northern Pike (Lakes) FSI, GOA website Northern Pike (Lakes) FSI | Alberta.ca, last accessed Sep 13, 2022.

9.6.3.3 Watercourse Crossings and Stream Connectivity

Studies have shown that as the number of stream crossings increase, fish habitat tends to degrade. Poorly constructed and/or poorly maintained watercourse crossings can result in habitat fragmentation, habitat degradation, and barriers to fish passage. Streams impacted by stream crossings tend to have poor water quality and increased sedimentation. There are an estimated 1,395 watercourse crossings in the Beaver River watershed (WorleyParsons 2012). To increase the availability of productive fish habitat, consider the following:

a) Limit new stream crossings, particularly culverts, and improve existing crossings to ensure fish passage (i.e., single-span bridges or open-bottom channels) according to the Watercourse Crossings Management Directive (AEP 2020).

b) Engage stakeholders and land users in the monitoring of watercourse crossings using the Alberta Watercourse Inventory (ABWCI) App to improve the inventory in the Beaver River watershed. Priority subwatersheds where additional assessment is warranted may be directed to those classified as having "Elevated Disturbance" in the previous watercourse crossing assessment (WorleyParsons 2012) and may include the Upper Beaver River, Moose Lake, Muriel Lake, Reita Creek and Redspring Creek subwatersheds (Appendix J).

c) Create and implement a watershed-wide stream crossing remediation plan including inspection and assessment output, fish passage ratings, sediment/erosion assessment, restoration/replacement priorities, planned remedial work, and timelines (AEP 2020).

   Prioritize sites for stream crossing restoration so stream crossings that fully impede fish movement with the highest sediment load are given a higher priority for remediation or replacement. Consider the hanging culvert assessment and inventory (Worley Parsons 2012) as a starting place.

9.6.3.4 Shoreline Management (Littoral Zone)

a) Shorelines (the littoral zone) provide critical habitat for fish and waterfowl. These shorelines should be inventoried and managed to maintain critical habitat, particularly spawning areas and identified Important Bird Areas. Consider key lakes of interest, including the Long Bay area of Cold Lake, the islands of Moose Lake, and French Bay.

b) Administrative tools should be identified and implemented to manage lakeside development and limit future loss of shoreline habitat. The location and type of development should be assessed alongside shoreline function. Tools may include:
   I. Master planning, shoreline zoning, and development plan review that considers dynamic shoreline processes and protects ecological functions provided by shores
   II. Development setbacks and vegetated buffers adjacent to streams, wetlands, and lakes (Refer to riparian recommendations in Section 9.4.3)
   III. Limits on continuous hard surfaces (e.g., retaining walls) to minimize erosion of neighbouring properties. Natural shorelines dissipate wave energy and minimize erosion.
   IV. Requirements for restoration of the littoral zone where necessary

V. Lot clearing criteria for new developments (e.g., limit lot clearing to improve views to 30% of the property area, in addition to maintaining ≥75% of lot shoreline at the lot level)
VI. Encourage yard management strategies that maintain shoreline functions
VII. Identify and promote best practices for marinas

c) Manage human-induced shoreline erosion by establishing wake-free zones and/or posting speed limits in areas most vulnerable (e.g., shallow water adjacent to the exposed shoreline). Maintain a near-shore speed limit to reduce the suspension of bottom sediments and shoreline erosion induced by wave action.

9.6.3.5 Beavers

Beavers are generally beneficial to watersheds as the dams they create store water in surface and groundwater reservoirs, increase open-water area, aid riparian vegetation, and slow water velocity to reduce streambank erosion and trap sediment. While beavers contribute to watershed health, they can be a nuisance when their activity impacts infrastructure. Efforts have increased in recent years to identify tools that can be used to mitigate the impacts of beaver activity on infrastructure, to allow humans to better coexist with them on the landscape. Tools include fencing of desired trees to prevent harvest, use of repellents/deterrents, and water level controls (Fitch 2016).

a) Determine the occurrence of beavers where there is community concern (e.g., Moose Lake).

b) Explore tools to manage beaver activity where it has impacted infrastructure and hydrologic connectivity (also refer to Recommendation 9.2.3.1 c). Prior to removal, beaver dams should be assessed by a qualified professional to understand potential impacts and recommend management strategies.

9.6.3.6 Cormorants

The double-crested cormorant (*Phalacrocorax auritus*) is a migratory bird that breeds in the northern hemisphere, nesting in trees or on the ground on islands at waterbodies across Alberta. Cormorants consume up to 20% of their body weight in fish per day (AEP 2021). These birds feed on fish species that are easiest to catch and will fly up to 30 – 60 km from their nesting colony to feed. Cormorants can negatively affect fisheries populations when the number of cormorants feeding exceeds the fish resources available in the area (AEP 2021). In the Beaver River watershed, concerns regarding cormorant populations and their impact on local fisheries vary by waterbody.

The following recommendations are modified from the current Cormorant Management Program Activities (AEP 2021):

a) Determine cormorant numbers in the Beaver River watershed (current program extent is the Bonnyville area) and establish a management program to reduce the population size in problem areas as needed.

b) Complete fish community assessments on waterbodies to determine the number and size of fish and any population trends (the current program is confined to the Moose Lake area) (also refer to Recommendation 9.6.3.1 d).

c) Strive to better understand cormorant population dynamics and life strategies in the Beaver River watershed:
   i. Complete movement surveys to determine where cormorants are coming from and where they are feeding.
   ii. Collect and analyze cormorant diet samples to determine what the birds are feeding on.
   iii. Identify other birds that co-nest with cormorants; inventory and implement mitigation measures to prevent disturbance to these species.

9.6.3.7 Key Wildlife and Biodiversity Zones

a) The Beaver River, Sand River and several other areas are indicated as key wildlife and biodiversity zones in the watershed (Figure 5). These areas should be managed to maintain quality habitat:
   i. Avoid development in key wildlife and biodiversity zones
   ii. Minimize and mitigate impacts from future development when it cannot be avoided
   iii. Plan future tourism and recreation to avoid sensitive areas (refer to 9.7.3.5 a)
   iv. Implement riparian and wetland management recommendations (Sections 9.4.3, 9.5.3)

b) Effort should be made to restore habitat where human footprint has already encroached on sensitive areas within key wildlife and biodiversity zones.

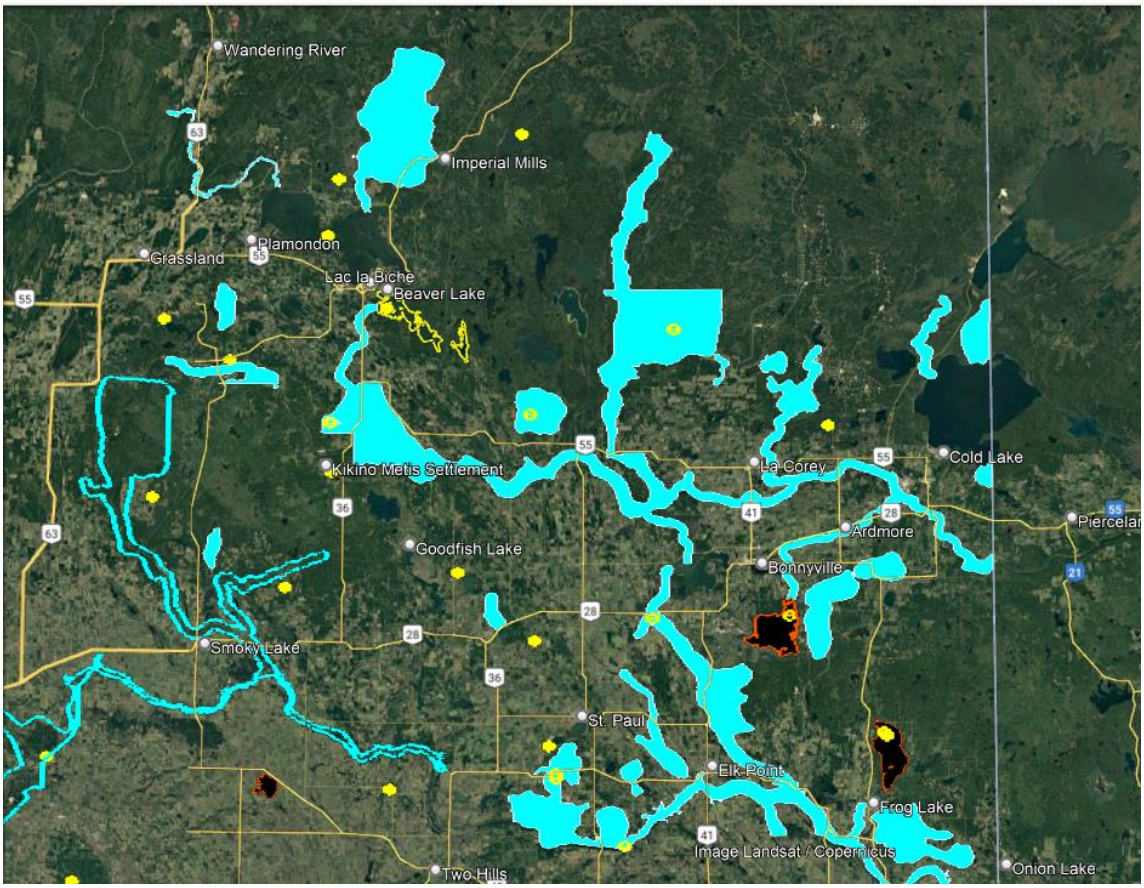


Figure 5. Key wildlife and biodiversity zones (turquoise polygons), including Piping Plover habitat (lakes outlined in orange: Muriel Lake, Frog Lake), important Trumpeter Swan habitat (lakes outlined in yellow: Beaver Lake, Elinor Lake), and colonial nesting bird habitat (yellow dots: e.g., great blue heron).

9.6.3.8 Aquatic Invasive Species and Disease

Himalayan balsam (*Impatiens glandulifera*) is a regulated plant under the *Alberta Weed Control Act* and listed provincially as Prohibited Noxious. It is a summer annual that reproduces by seed only. It is found in riparian areas and requires moist soils and some soil disturbance to establish (e.g., uprooted trees, flooding).

a) Spread of Himalayan balsam occurs mostly from the dispersal of seed from landscape plantings. Consider the following to help control its spread:
    i. Avoid the selling or purchase of Himalayan balsam for ornamental purposes
    ii. Minimize the potential to spread seed by minimizing soil disturbance and erosion in riparian areas
    iii. Himalayan balsam has a shallow root system. Hand-pulling is an effective way to control plants. Plant debris should be incinerated or bagged and sent to a landfill
    iv. Explore biological control options

Aquatic invasive species (AIS) pose an ongoing risk to Alberta's lakes and streams. Species of concern include zebra and quagga mussels, flowering rush, Prussian Carp, and Eurasian milfoil. Whirling disease is also a concern that is present in other watersheds (Oldman, Bow, Red Deer and North Saskatchewan rivers), but has not yet been detected in the Beaver River watershed (as of May 1, 2018).

b) To minimize the potential to spread AIS, consider:
    i. Posting signage at all access points to increase awareness regarding the threat of AIS
    ii. Making boat wash stations available at key access points, particularly during fishing tournaments and the peak summer season
    iii. Reinstating provincial highway inspection stations for watercraft
    iv. Reducing the number of unmanaged boat launches in the watershed where possible.

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.

[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.

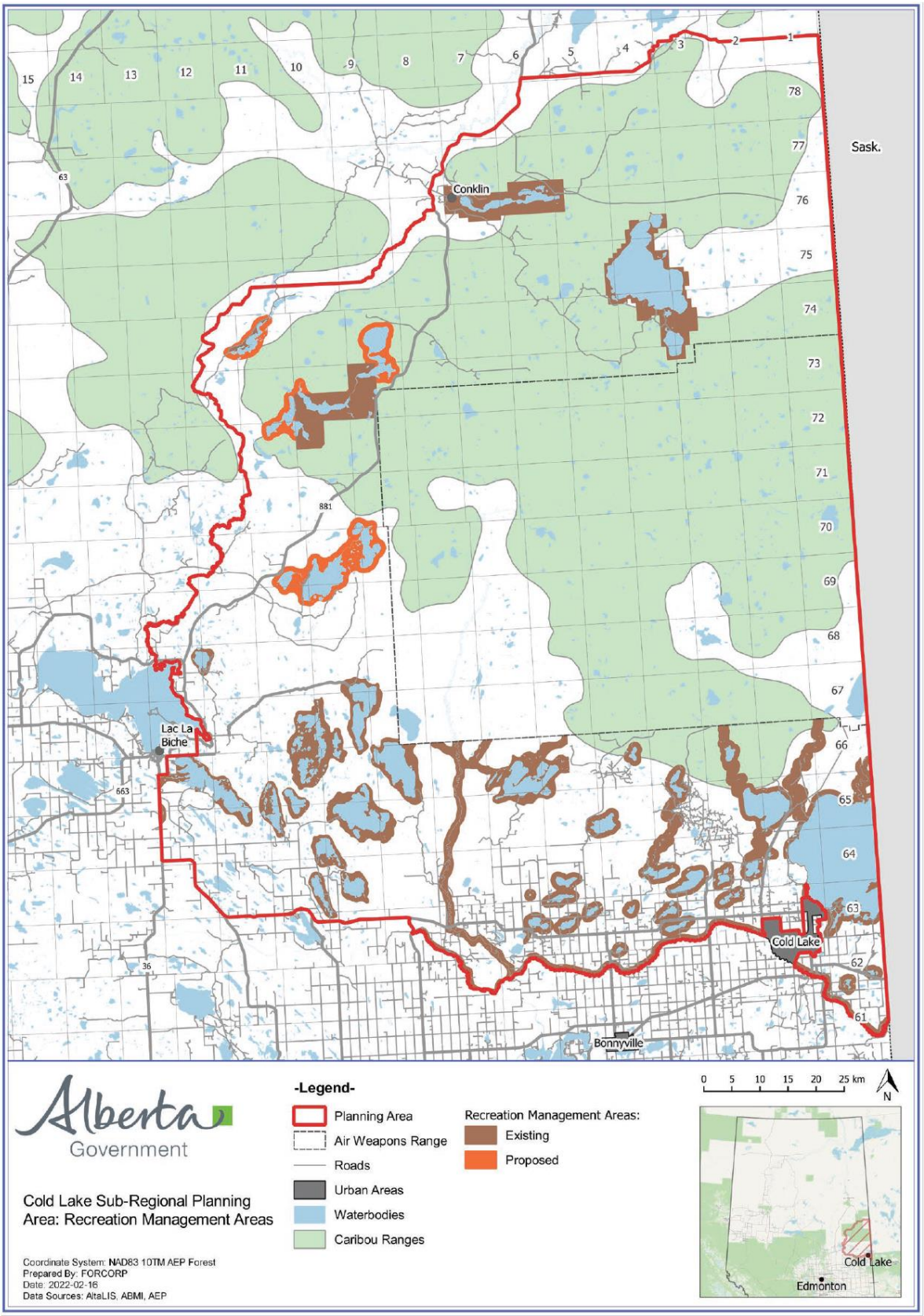


Figure 6. Existing and proposed recreation management areas in the Cold Lake Sub-region (GOA 2022).

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.

I**ndicators** 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.

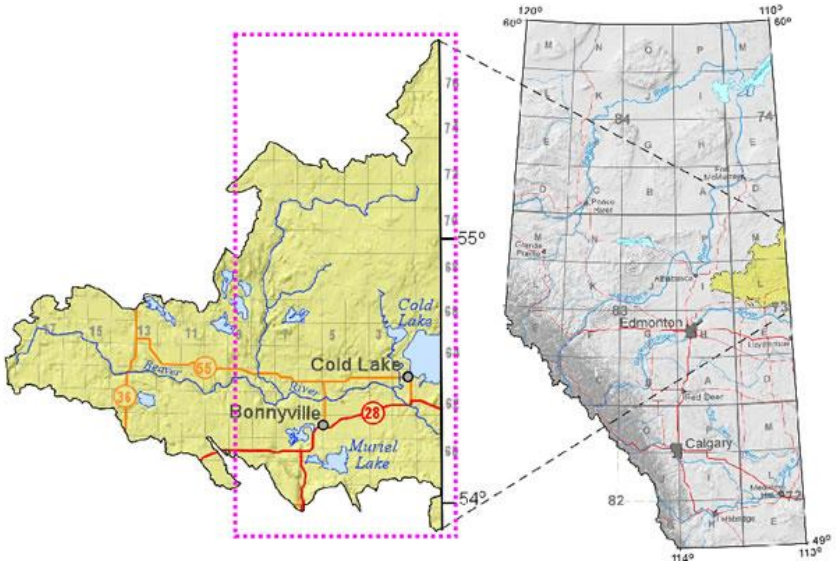


Figure B.1. Cold Lake-Beaver River Water Management Plan planning area (2006) (AEP 2016). Note boundary corrections were made in 2022.

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		
	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

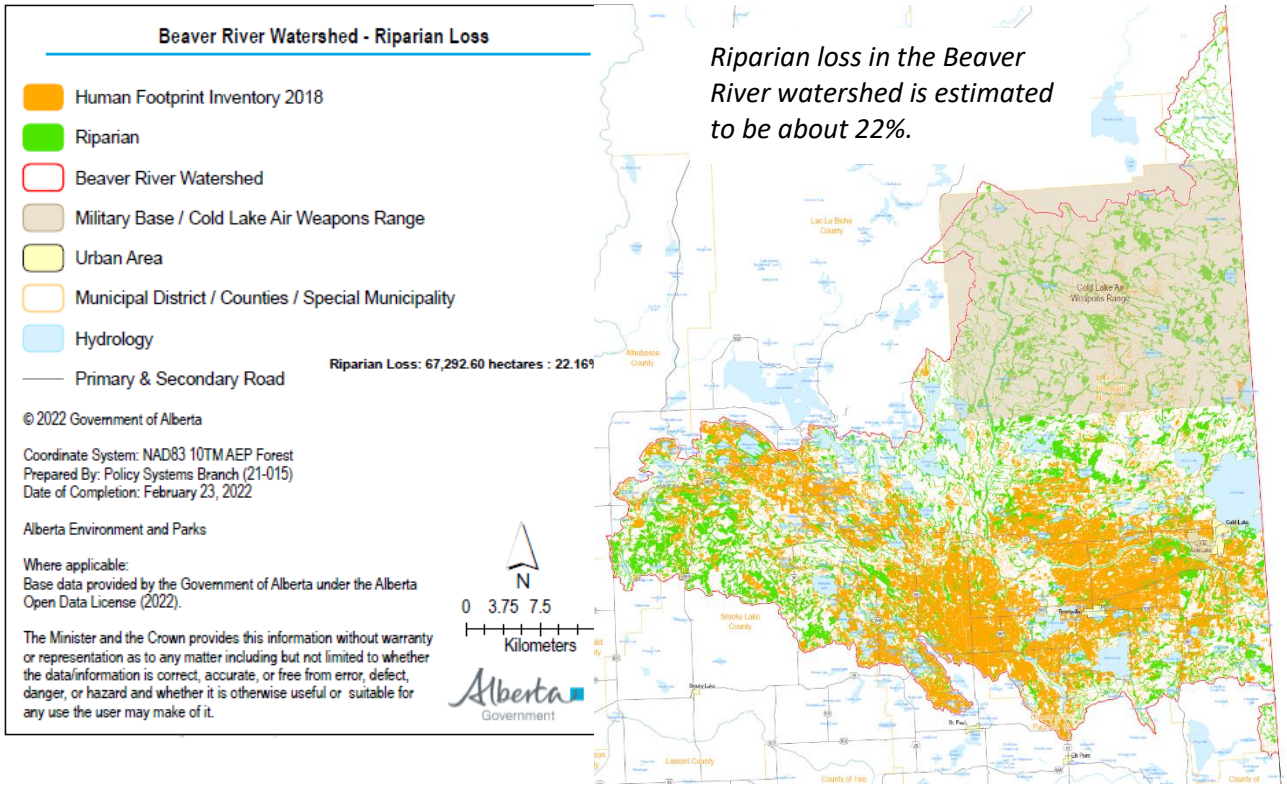
APPENDIX G. Riparian Areas

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 x 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 i**ncludes 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)

Section 10.0 is taken from the Beaver River IWMP. Please refer to the complete document for further context.

10.0 PRIORITIES

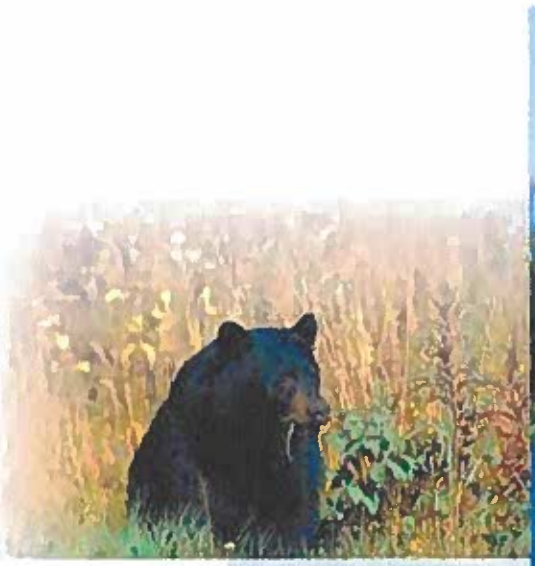
Implementation tables were developed to support the implementation of recommendations presented in the IWMP. The tables summarize implementation actions, identify roles and responsibilities, and suggest a preliminary timeline for each of the main values addressed in the Plan. LICA's IWMPC identified 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.

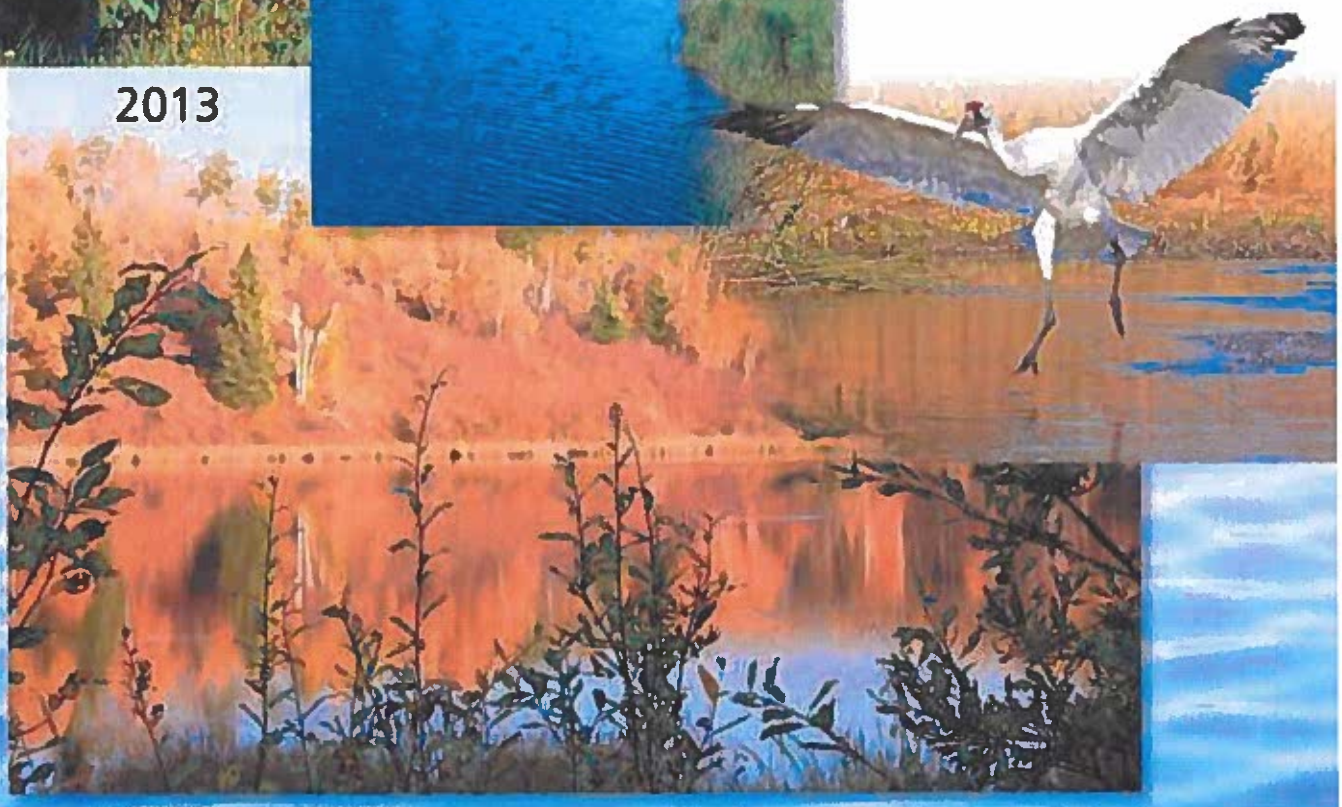
Priority	Recommendation	Lead Role
1.	Develop and implement a long-term surface water quality monitoring program in collaboration with all stakeholders to leverage resources and achieve mutual goals.	LICA, supported by All
2.	Collaborate to implement BMPs and land use strategies to protect water quality 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 habitats. 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

Beaver River Watershed Alliance



Summary Report

2013



The State of the
Beaver River Watershed

CONTENTS

The State of The Beaver River Watershed – A Summary
2013

Beaver River Watershed Alliance

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STATE OF THE BEAVER RIVER WATERSHED

INTRODUCTION

The Beaver River watershed is located in the boreal plain of east-central Alberta and west-central Saskatchewan, about 300 km northeast of Edmonton. The name beaver is likely a translation from the Cree name, *amisk*, and appears as such on maps from as early as 1790. The Beaver River originates near the town of Lac La Biche as the outflow from Beaver Lake and flows generally east for about 250 km passing to the south of Cold Lake – the largest lake in the Alberta portion of the watershed – to enter Saskatchewan. The Cold River originates at the east end of Cold Lake in Saskatchewan and flows east, eventually to join the Beaver River. It turns north joining the Churchill River at Île-à-la-Crosse to flow to Hudson Bay.

For this report, the geographic area of interest is the watershed upstream of the Beaver River at the interprovincial boundary and upstream of the Cold River at the outlet of Cold Lake. To measure and monitor conditions in the watershed environmental indicators are used so that present conditions can be assessed and compared to desirable outcomes. Water management plans can then define management actions required to improve environmental conditions, where required, to achieve these outcomes. However, indicators used in this summary are relative not absolute; that is, the results may not compare to results for other watersheds in the province. Figure 1 depicts the individual sub-watersheds discussed in this summary.

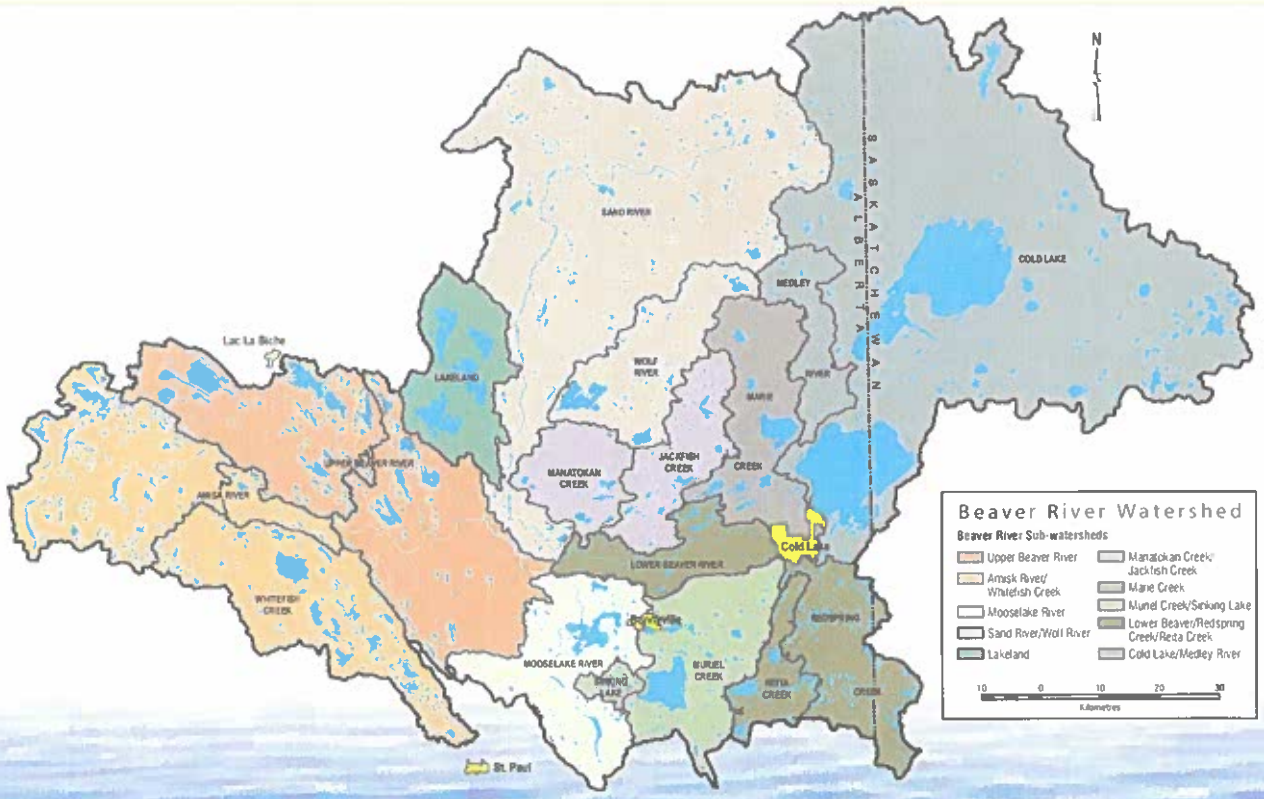


Figure 1 Sub-watersheds of the Beaver River Watershed, Alberta.

LANDFORM AND LAND COVER

The Beaver River watershed in Alberta is triangular-shaped, with the base on the interprovincial boundary and the apex pointing into Alberta. The lowest portion of the watershed is along the Beaver River itself. Higher lands lie along the southern fringe of the watershed and in the north within the Cold Lake Air Weapons Range. Elevations in the watershed range from 750 m to 500 m above sea level. For the most part, the landscape is an undulating to moderately rolling plain, with some hummocky uplands. This landscape is formed by glaciation and, indeed, there are surface features formed as glacial meltwater channels that do not reflect current runoff patterns. For example, a channel containing a chain of small lakes and undersized streams runs into Moose Lake and out of the lake to the Beaver River. Contemporary lakes such as Kehiwin, Bangs and Thin lakes partially occupy the channel.

Although the watershed is dominated by deciduous forest, it lies in Alberta's boreal forest natural region marking the southern limit of closed forest and the northern advance of agriculture. Generally, the southern portion of the watershed is in the dry

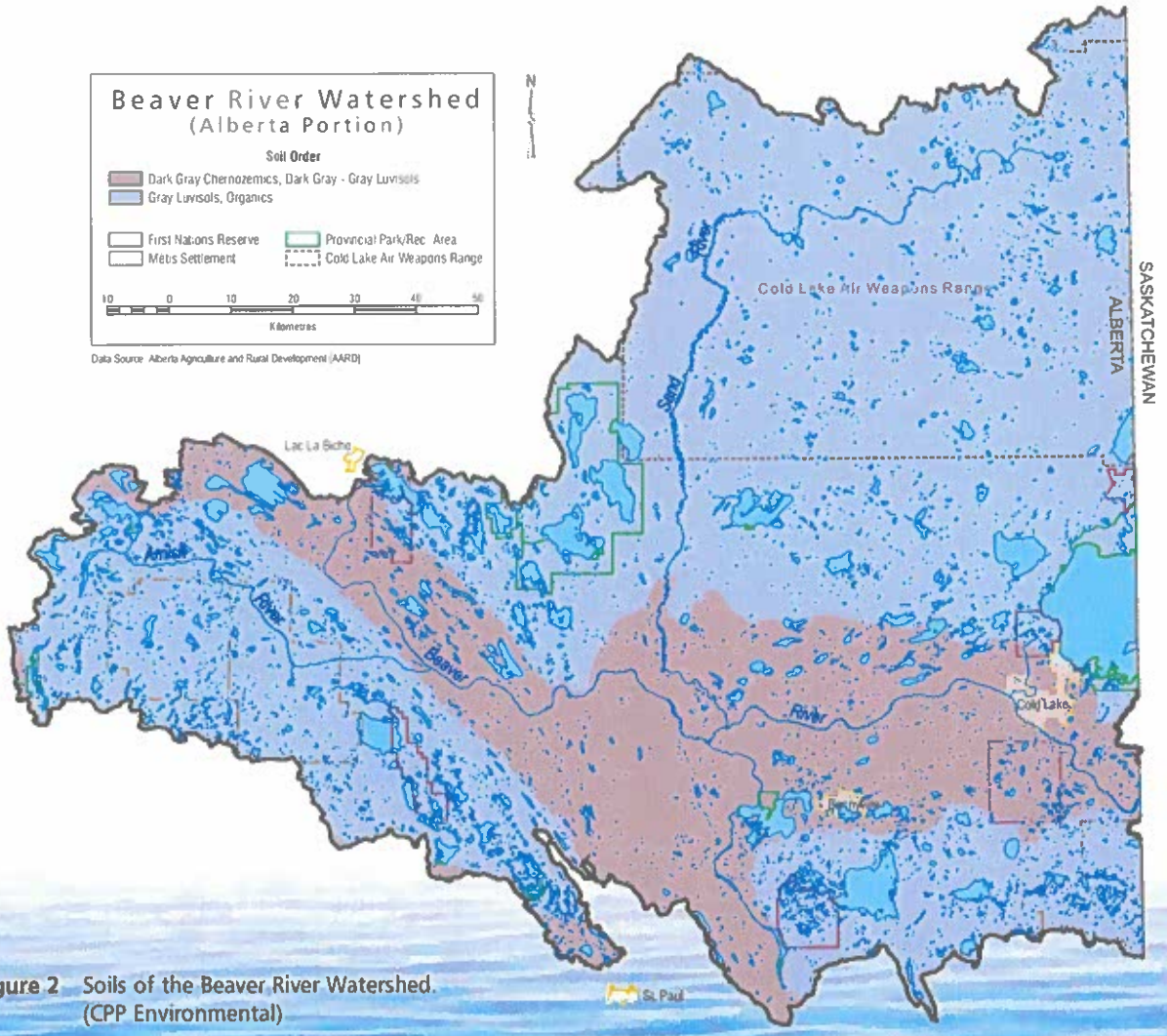


Figure 2 Soils of the Beaver River Watershed. (CPP Environmental)

mixedwood natural subregion while the northern portion of the watershed is in the central mixedwood natural subregion. Although the dry mixedwood subregion tends to have been transformed by agriculture, natural vegetation consists of aspen forest with a shrubby understory. Some white spruce and jackpine occur in dry sites. Natural vegetation in the central mixedwood sub-region consists of a closed cover of tall, trembling aspen, balsam poplar, white birch, and white spruce, with a thick understory of mixed sedges and tall shrubs. The extensive, poorly drained peatlands are usually covered with sedges, willow, black spruce, and tamarack. Jackpine is common in sandy sites.

As shown in Figure 2, the watershed is dominated by grey luvisol soils in well-drained upland areas, both in the north and along the southern boundary. These grey soils are associated with the forests of the central mixedwood sub-region. Wet depressional areas contain significant organic soils. The portion of the watershed extending from Cold Lake towards Beaver Lake and to the north closely aligns with Alberta's designated Green Zone – a less settled area of forested provincial crown land.

Agricultural lands cover one-third of the watershed, much of this associated with the dark grey chernozemic soils and dark grey luvisols of the Beaver River lowlands and the Mooselake River watershed. A good deal of this land is devoted to pasture as cattle operations are the dominant agricultural land use, accounting for 57 percent of all farm operations. Natural and improved pastures cover one half of the agricultural lands while crop lands account for 36 percent. Summer fallowing is rarely used.

The current landcover of the Beaver River watershed is shown in Figure 3. Clearly evident are the large areas where significant human influences predominate,

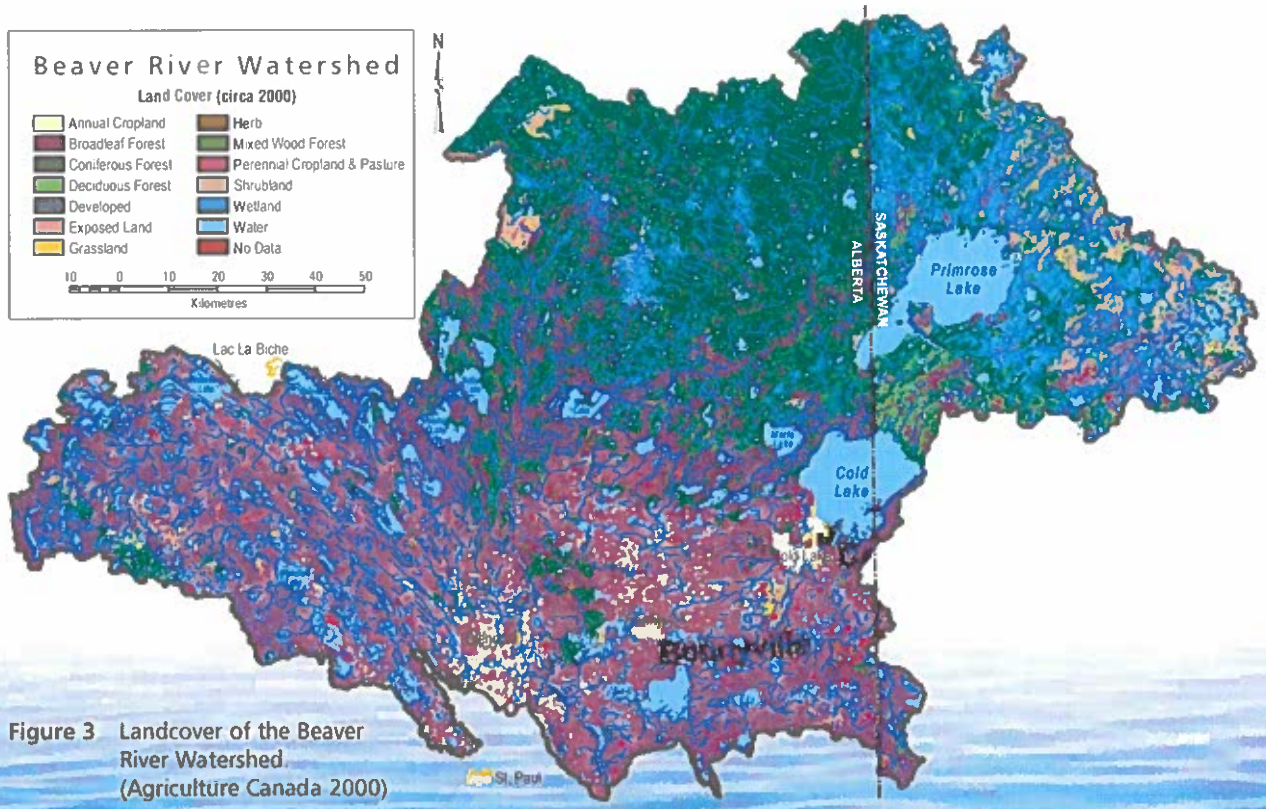


Figure 3 Landcover of the Beaver River Watershed (Agriculture Canada 2000)

particularly in the Beaver River lowlands and the Mooselake River sub-watershed. This modified landscape is the result of agricultural activity. Indicators of agricultural activity such as cultivation and manure production shown in Figure 4 are very closely aligned with the soils classification.

Significant wetlands are found in the watershed. The northern portions are almost completely forested and contain ecologically important areas of poorly drained fens and swamps. Ducks Unlimited Canada has classified the water and wetland features of the Alberta portion of the watershed. Sixty-seven percent is considered upland, the remaining portion being open water or wetland. Of this portion fens comprise 46.5 percent; swamps, 23.5 percent; marshes, 4.5 percent; bogs, 3 percent; and open water 22.5 percent.

Linear features such as roads and seismic lines also alter the landscape. Linear features may lead to increased erosion or may fragment habitat and effects may influence runoff, water quality and ecological integrity. Within the Beaver River watershed, linear features are minimal in the Sand River sub-watershed and relatively sparse in the Cold River sub-watershed. Elsewhere in the watershed linear features are relatively dense, sufficient to give rise to concerns about environmental effects.

An approach to addressing concerns about linear features is to consider stream crossing density. Stream crossings are a potential indicator of road density and may influence fish movement if not well designed. Figure 5 illustrates stream crossing density in the Beaver River watershed. As is the case with linear features, crossing density is low in the Sand River sub-watershed. It also tends to be low in the sub-watersheds north of the lower Beaver River. Crossing density is particularly high in the Muriel and Reita creek sub-watersheds.

Another attribute of a watershed's landscape is riparian health. The condition of riparian zones has significant influence on ecological integrity. The customary surveys of diversity, structure, and health of riparian plant communities have not been carried out in the Beaver River watershed. Riparian conditions on the mainstems of the Beaver and Sand rivers are generally good. While there is some

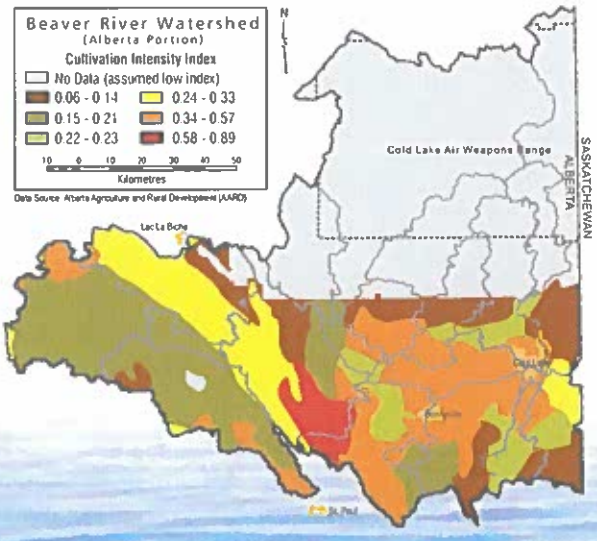


Figure 4a Cultivation Intensity. (CPP Environmental)

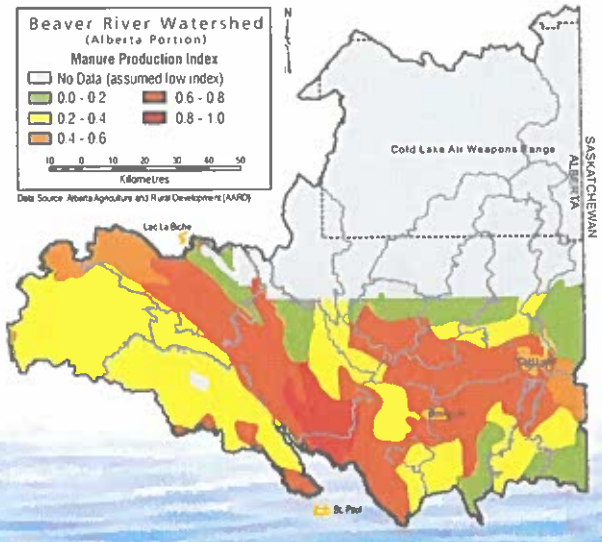


Figure 4b Manure Production. (CPP Environmental)

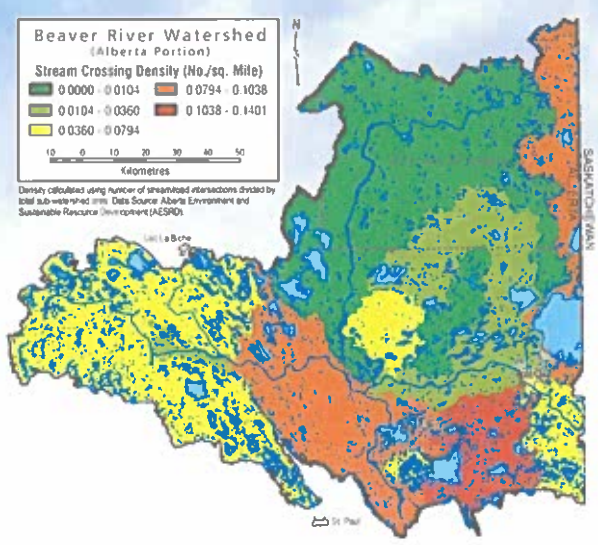


Figure 5 Stream Crossing Density. (CPP Environmental)

exposed soil, an average of seven percent exposed, there is little bank erosion or bank disturbance.

A small number of lakes have been assessed using aerial videography. Results are shown in Table 1.

Emissions of substances such as oxides of sulphur and nitrogen associated with oil and bitumen production may affect both soils and vegetation in parts of the watershed. The deciduous and jack pine forests of the watershed are sensitive to these emissions and to long-term acidification of soils. Some sandy soils south of the Beaver River in the Moose and Muriel lake areas are also sensitive to acidification

CLIMATE

The Beaver River watershed experiences a humid continental to subarctic climate typical of the Canadian interior plains. Winters are long and cold, but sunny, while summers are short and cool. The average annual temperature at the city of Cold Lake is 1.6°C with the summer mean being 15.8°C and the winter mean, -14.5°C. The highest recorded temperature is 36.3°C in June 2002 while the lowest

Table 1 Riparian Health of Marie, Crane, Hilda and Ethel Lakes.

Lake	Healthy (%)	Moderately Impaired (%)	Highly Impaired (%)
Muriel	0	76	24
Marie	82	9	9
Crane	79	7	14
Hilda	78	13	9
Ethel	80	11	9

is -48.3°C in January 1954. Typically, there are 105 to 115 frost-free days and 1251 growing degree-days each year. The average annual temperature has increased by more than one degree in the last 50 years.

Average annual precipitation is 400 to 600 mm. This includes the water equivalent of the annual snowfall, whose average depth is about 120 cm. In general, precipitation increases from east to west and from south to north in the watershed. Annual precipitation at Cold Lake is 440 mm, three-quarters of which falls as rain. Rain in the months of June, July and August accounts for one-half of the annual precipitation. Precipitation trends at Cold Lake indicate that average annual precipitation in the last 50 years has declined. Annual gross evaporation in the watershed ranges from 500 to 750 mm each year. On average, therefore, the entire watershed experiences a moisture deficit.

SURFACE WATER

The principal tributaries of the Beaver River are the Sand River plus Manotokan, Jackfish, and Marie creeks, which enter from the north. The Amisk River drains the western portion of the watershed and, together with the Mooselake River plus Muriel and Reita creeks, enters the Beaver River from the south. The Cold Lake portion of the watershed includes the Medley and Martineau rivers, which enter the lake from the north. Cold Lake itself straddles the Alberta-Saskatchewan boundary.

Unlike many Alberta rivers, the Beaver River originates on the boreal plain rather than on the eastern slopes of the Rocky Mountains. Because of this, runoff is not subject to the stabilizing influence of mountain snowmelt and shows considerable variability from year to year and within the year. The typical runoff pattern is shown in Figure 6, which is a plot of median daily discharge for the period of record. The river rises to a peak in the latter part of April because of spring snowmelt and rain during the snowmelt period, then generally recedes through the remainder of the year. Unlike prairie streams of southern Alberta , however, the Beaver River will respond to summer rainstorms with dramatic increases in flows. Indeed, in some years the summer flow may be greater than the peak flow during spring runoff.

The streamflow record for the Beaver River and its tributaries is relatively short. The Prairie Provinces Water Board, however, has calculated naturalized flows for the Beaver River at Cold Lake Reserve based on statistical correlations with other streams. This record, shown in Figure 7, begins in 1912 and shows an overall slightly decreasing trend, as does the instrumental record beginning in the 1950s.

The streams within the Beaver River watershed flow naturally, unimpeded by dams and other works. As illustrated in Figures 6 and 7, there is considerable variation in flow both within a given year and between years. Annual streamflow in 1992 was the lowest in 100 years while that in 1997 was the third highest. Annual water yield tends to be highest for streams rising in the Cold Lake Air Weapons Range and is lowest for tributaries such as Mooselake River and Muriel Creek.

An indicator of annual streamflow reliability can be calculated by comparing the range in streamflow values to the median. The larger the calculated number, the less reliable the streamflow. There is insufficient data to perform such calculations for the ephemeral southern tributaries of the lower Beaver River; nonetheless, their flows are very unreliable. Streamflow reliability for various sub-watersheds is shown in Table 2. The Cold River has the most reliable flow in the watershed.

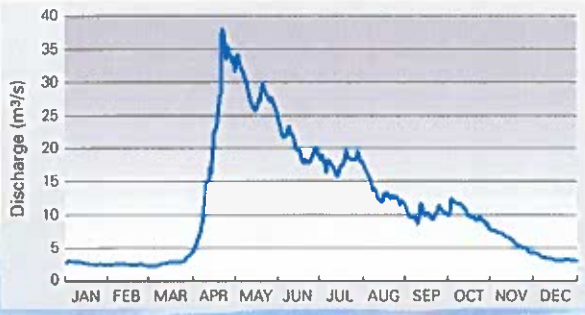


Figure 6 Median Daily Discharge for the Beaver River at Cold Lake Reserve.

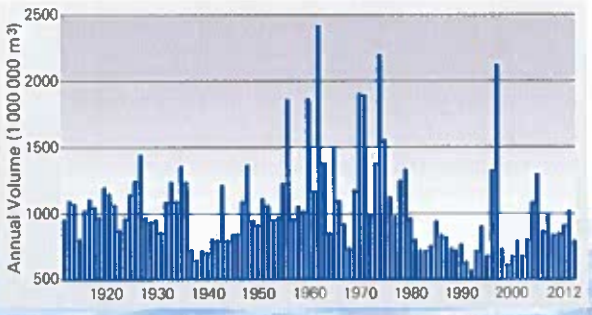


Figure 7 Annual Naturalized Flow of the Beaver River at Cold Lake Reserve.

Table 2 Annual Streamflow Reliability in the Beaver River Watershed.

River	Minimum (1000 m^3)	Median (1000 m^3)	Maximum (1000 m^3)	Range as % of Median
Southern Tributaries such as Mooselake River, Muriel Creek and Reita Creek	--	--	--	very high
Beaver River near Goodridge	146	52 554	478 230	910
Amisk River at Hwy 36	456	29 097	188 320	646
Wolf River at Outlet of Wolf Lake	92	17 560	105 000	441
Sand River at the Mouth	41 072	247 590	1 016 954	394
Jackfish Creek near Le Corey	148	11 117	46 464	417
Beaver River at Cold Lake Reserve	68 226	471 513	1 918 408	392
Cold River at the Outlet of Cold Lake	12 700	421 000	1 410 000	331

Streamflows of the lower Beaver River are also quite reliable due to the significant contribution from the Sand River.

The Beaver River watershed has an abundance of lakes: more than 2000 can be identified with 1:250 000-scale mapping. In general, these lakes can be identified as one of three types. The most common is a typical prairie lake or slough with shallow depths and gently sloping sides. These shallow depressions may be occupied by wetlands or beaver dams in parts of the basin. Such lakes are very sensitive to climate-driven, water level fluctuations.

The second type of lake is one that is deep and has very steep sides. These lakes have been carved by glacier action. (Not all lakes fitting this general description are necessarily ice-carved.) Because they intercept and interact with multiple aquifers, these lakes do not fluctuate widely from year to year. Cold Lake, which is over 100 m deep, is one such lake. The third type is one that lies in glacial meltwater channels. These are often shallow and tend to form chain lakes in the larger meltwater channel. Kehiwin Lake is an example.

The lakes in the watershed provide significant recreational opportunities for residents and visitors. Some are fished to support domestic consumption by aboriginal people. Several, such as Beaver and Wolf lakes, are fished commercially. A few of the lakes supply water for communities and industry. Water levels of a few lakes are regulated by weirs at the lake outlet. Little documentation exists for Primrose Lake, the largest lake in the entire watershed, which lies almost entirely in Saskatchewan.

There are 28 lakes for which sufficient data are available to consider trends in lake levels. In general, lakes in sub-watersheds entering the Beaver River from the north tend to contain lakes whose levels are stable. Some even show very slight increases in water levels. Lakes in the sub-watersheds entering the Beaver River from the south may have either stable or declining water levels. Muriel Lake exhibits the most significant decline of all the monitored lakes.

GROUNDWATER

The bedrock beneath the Beaver River watershed consists of a succession of sedimentary deposits, mainly sandstones, shales and limestone, resting on the Pre-Cambrian shield. The McMurray Formation at a depth of about 600 m is variously water saturated, and a source of brackish water, or bitumen saturated. The heavy oil recovered in the watershed originates mainly in the Clearwater Formation, which overlies the McMurray Formation. The Grand Rapids Formation lies above the Clearwater Formation. These Lower Cretaceous formations range in age from 144 to 97.5 million years.

The uppermost bedrock of the watershed is composed of dark grey marine shales, known as the Lea Park Formation, and underlain by Colorado shales. The Lea Park Formation is a silty marine shale with ironstone concretions. In the southwest part of the watershed, the Lea Park Formation is overlain by the Belly River Group. This consists of a grey to greenish grey non-marine sandstone or mudstone, also with ironstone concretions. These formations date from the Upper Cretaceous period, some 97.5 to 66.4 million years in age.

Prior to glaciation, the bedrock surface was eroded by predominantly eastward flowing rivers. This produced broad paleovalleys with shallow side slopes and low gradients. The dominant valley in the watershed is the Helina Valley, known as the Hatfield Valley in Saskatchewan. Others include the Beverly, Sinclair, Wiau, Kikino, and Vermillion valleys. Original sediments on the valley walls may have originated from as far away as the Rocky Mountains. During the earliest glacial periods these valleys were filled with substantial deposits of sediments as the glaciers advanced and retreated.

Glacier meltwater also scoured new channels in the bedrock surface during the earliest interglacial times. These scoured channels tend to have concave longitudinal profiles and steep side slopes. Their original sediments tend to be derived from the Pre-Cambrian Shield. These channels include the Sand River, Bronson Lake, Big Meadow, Moore Lake and

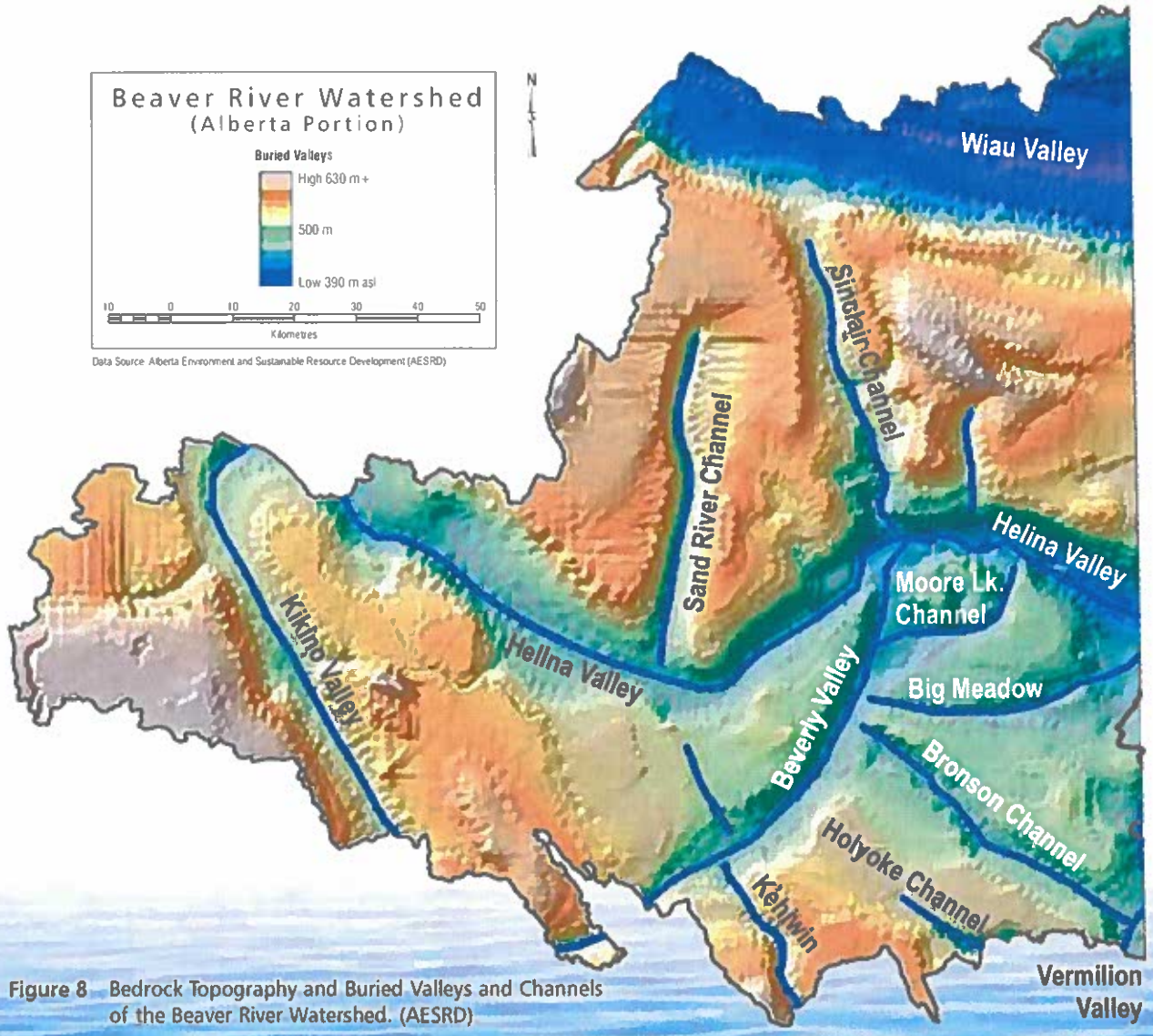


Figure 8 Bedrock Topography and Buried Valleys and Channels of the Beaver River Watershed. (AESRD)

Period	Glacial Event	Stratigraphy		Lithology
Quaternary	Cold Lake	Surficial Stratified Sediment		Sand, gravel, silt
		Grand Centre Formation		Till
		Sand River FM		Sand, till
	Ardmore	Marie Creek FM		Till
		Ethel Lake FM		Silt, clay, sand, gravel
	Fort Kent	Bonnyville Group	Unit 2	Till
			Unit 1	Sand, gravel
			Unit 1	Till
		Muriel Lake FM		Sand, gravel, silt, clay
	Cherry Grove	Bronson Lake FM		Diamict, clay
		Empress Group	Unit 3	Sand, gravel, till
	Preglacial		Unit 2	Clay, silt
Tertiary			Unit 1	Sand, gravel
Upper Cretaceous	n/a	Bedrock (Lea Park or Belly River Formation depending on location within watershed)		

Figure 9 Chart of Drift Formations (adapted from Parks *et al* 2005).

Kehiwin channels. The bedrock topography, as well as the valleys and channels, is shown in Figure 8. It is essential to recognize that the pre-glacial and glacial paleovalleys are independent of present-day surface topography.

The bedrock topography of the watershed is covered by unconsolidated sediments, known as drift, deposited over the last 2.5 million years. The thickness of this drift may vary from zero, where bedrock is visible, to 200 metres in the Sinclair and Wiau valleys. The greatest thickness is in the Moostoos Upland. Layers of drift can be mapped based on the origin and nature of the materials of the various formations. By definition, in Alberta the materials that overlie the bedrock and underlie glacial till comprise the Empress Formation. This formation intersects the bed of Cold Lake. The regional units in the watershed and their basic composition are shown in Figure 9. The Empress, Bronson and Muriel Lake formations lie within the buried valleys and channels of the watershed. The Bonnyville Formation is notable as it is the first formation that extends beyond the buried valleys. Formations above the Bonnyville Formation, from oldest to youngest, include the Ethel Lake, Marie Creek, Sand River and Grand Centre formations.

Groundwater use in the watershed is a significant portion of overall water use and it is the drift formations that govern the presence and characteristics of groundwater. An aquifer can be defined as a water-bearing formation sufficiently porous to yield water to a well. Aquifers can be either bedrock aquifers or drift aquifers. To simplify, drift aquifers may be classified as buried valley aquifers, intertill aquifers and surficial aquifers. Buried valley aquifers are capable of very high water yields. Because of this, petroleum companies have used the Empress and Muriel Lake aquifers as sources of water. In addition, brackish or saline groundwater from much deeper sources is widely used in the petroleum industry.

The water yield from intertill aquifers varies considerably. The sands comprising a surficial aquifer may be at, or just a few metres below, the surface. These aquifers vary in size but, in general, do not yield significant water supplies. Some intertill aquifers have only sufficient sustainable water to supply domestic needs while others may yield sufficient sustainable supply to meet some commercial needs. The surficial aquifers tend to be very responsive to climate conditions. Wells in surficial aquifers are often critically important to on-farm water users.

One other aspect of groundwater in the watershed is the use of deep well disposal of wastewater or excess-produced water (water produced with bitumen) from conventional oilfield and thermal *in situ* operations. The waste water is generally saline and contains oil and soluble organic compounds. Excess-produced water tends to be brackish. Regardless of the source, this water may not be disposed of in a manner that threatens the environment. Deep well disposal into a deep, well-

contained, saline aquifer is considered the safest practice. The general approach is to return the water to deep formations below the bitumen-bearing formations. Deep well disposal is regulated by Alberta's Energy Resources Conservation Board.

Water-well density is one indicator of groundwater usage, particularly from the surficial aquifers of the watershed. This well density, shown in Figure 10, coincides almost exactly with the soils and land cover maps shown earlier in this summary. Well density is not directly linked to water consumption but, in general, water use from the shallow wells that dominate the figure tends to be for agricultural and related purposes and is relatively small. These wells tend to respond to climate factors rather than human use. The roughly 100 deep wells whose water is used for industrial purposes tend to draw down with pumping activity then rebound when pumping ceases.

HUMAN SETTLEMENT

People have lived in the Beaver River watershed since the retreat of the Laurentide ice sheet thousands of years ago. Archeological sites indicate human habitation for at least 7500 years. During the late 1700s, Cree seeking furs as trade goods displaced the nomadic Beaver, Blackfoot and Slavey people. The Woodland Cree, residing in forested areas, fished, hunted and trapped while travelling along waterways in birch bark canoes. They established themselves as intermediaries between the Hudson's Bay Company and the People of the Plains. They also acted as guides for the early European visitors to the northern plains.

The Beaver River trade route from Île-à-la-Crosse at the confluence of the Beaver and Churchill rivers formed one of three important connections between the Churchill River and Athabasca River systems in the

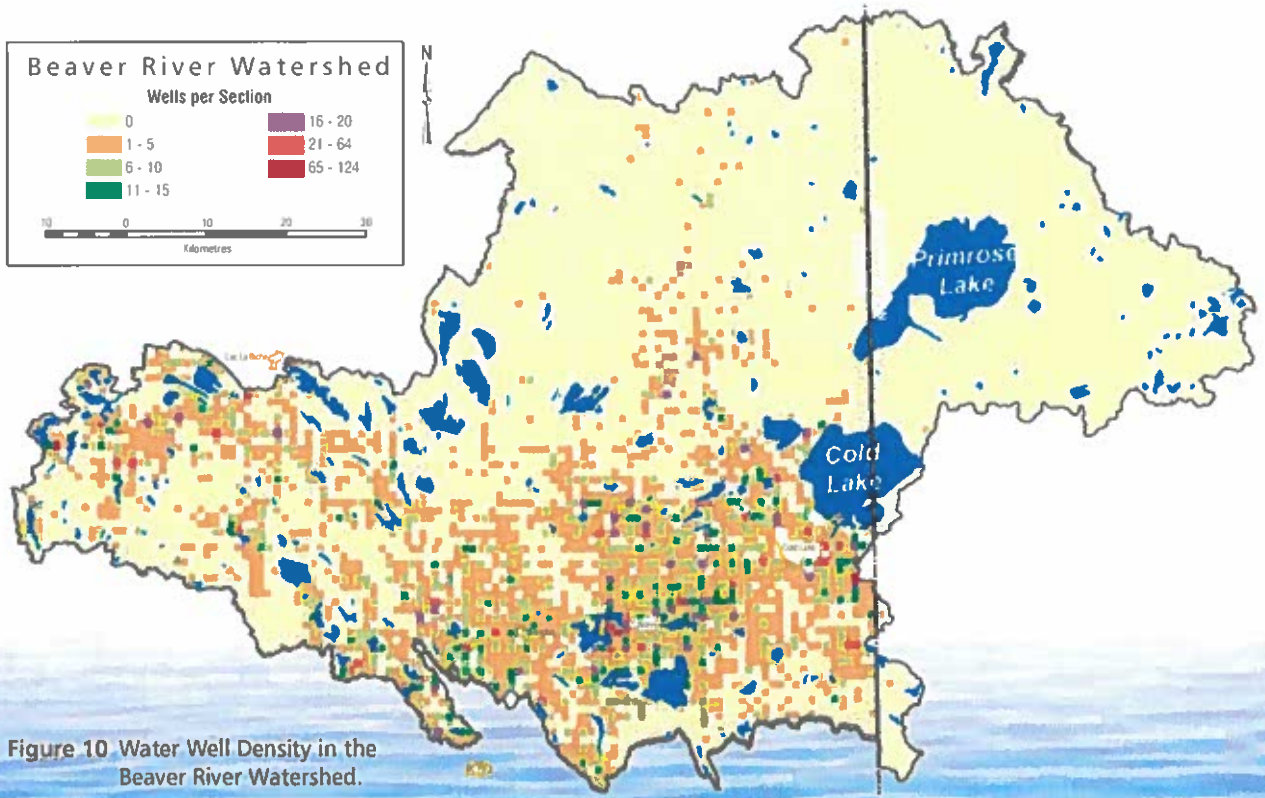


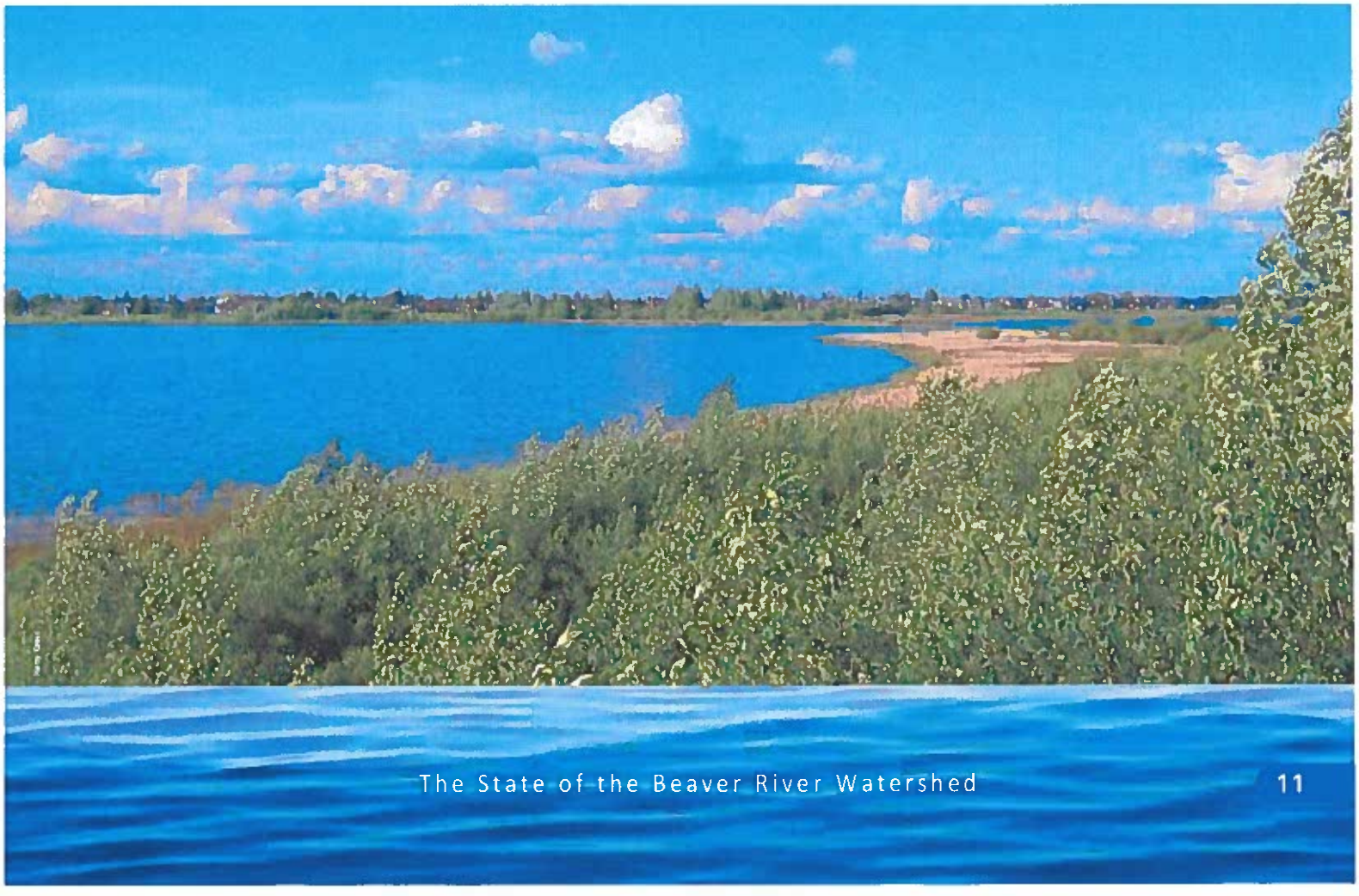
Figure 10 Water Well Density in the Beaver River Watershed.

early days of the fur trade. The route was a means of travelling into the upper Athabasca watershed and the Lesser Slave Lake and Peace River areas, while circumventing the northern plains. The route ran up the Waterhen and Cold rivers to Cold Lake with a portage from the south part of Cold Lake to the Beaver River. Access to the Athabasca watershed was over Portage La Biche near Lac La Biche. The portage was designated a Provincial Historic Resource in 1993 – the only such designation in Alberta.

The North West Company established a trading post, Cold Lake House, near present-day Beaver Crossing in 1781 and a second, Shaw House, at Moose Lake in 1789. By the time David Thompson of the North West Company mapped the route in 1798 it was well established. Another early traveller through the watershed was Gabriel Franchère, a fur-trader, merchant and author who travelled the Beaver River on a trip from Fort Astoria at the mouth of the Columbia to Montreal.

The First Nations communities in Beaver River watershed are in the Treaty 6 area. (The Cold Lake Air Weapons Range lies in Treaty 10 lands, but contains no permanent population centres.) The numbered treaties of western Canada originated with the transfer of Rupertsland from the Hudson's Bay Company to Canada in 1870 and the construction of the first transcontinental railway. There are four First Nations reserves in the watershed.

Oblate colonizing priests played an important role in encouraging agricultural settlers to the watershed in the late 1800s and early 1900s. An early mission was established at Lac La Biche in 1853 but 50 years later St. Paul had become the centre of activity. Father Joseph Thieren established a settlement at Moose



Lake in 1907. The settlement was renamed Bonnyville in 1908 after Father Francis Bonny. Settlement was driven by the arrival of the railway at Lac La Biche in 1914, St. Paul in 1919 and Bonnyville in 1929.

Among the first settlers in the Bonnyville-Cold Lake area were French-Canadian homesteaders. These were followed by immigrants from Ukraine and many other parts of Europe. Logging and road work provided some wage labour, but the economy was largely based on agriculture. A second wave of settlers arrived in the 1930s as agricultural areas of southern Alberta were struck by drought.

Commercial fishing started in the watershed in 1916 and was essentially unregulated until 1939. The dominant catch then was whitefish, as it is today. Fur farming and an associated feed fishery based on tullibee (lake cisco) operated from time to time after the Second World War until the 1990s. First Nations and Métis people continue to operate a domestic subsistence fishery as well as participating in the commercial fishery.

Several sawmills operated in the watershed from the 1920s to 1950s. Handhewn railway ties made from jackpine was the early product. Small portable sawmills operated north of the Beaver River, notably on Touchwood, Pinehurst, Siebert, Jackson, and Blackett lakes. These operations were often conducted from winter ice cover. Poplar and spruce lumber as well as fence posts were the main product.

Métis settlements were created in Alberta in 1938 under the authority of the Métis Population Betterment Act. One-half of the eight existing settlements are in the Beaver River Watershed. Elizabeth and Fishing Lake settlements lie in the municipal district of Bonnyville south of the city of Cold Lake. Buffalo Lake and Kikino share a common boundary and are in Smoky Lake County south of Lac La Biche. In 1990 the province proclaimed additional legislation aimed at securing a land base, gaining local autonomy, and achieving self sufficiency for Métis people.

In 1952, Cold Lake was selected as a site for an air weapons training base. It was chosen because of the flat terrain, good drainage, gravel deposits, low population density, similarities of geography to Europe, accessibility, weather, and the possibility of future economic development in the region. Now known as 4 Wing Cold Lake, it attracts air forces for training from the North Atlantic Treaty Organization (NATO) and around the world. Some 2000 military personnel are stationed at Cold Lake. The associated 11 700 km^2 Cold Lake Air Weapons Range straddles the Alberta-Saskatchewan boundary, including the northern part of the Beaver River watershed. The range is on provincial crown land leased by the federal government.

More recently, Cold Lake has been a centre for oil exploration and development. Imperial Oil began production of bitumen in 1975 and significantly increased production in the mid-1980s. The current cyclic steam stimulation operation has a capacity of 170,000 barrels of bitumen a day. Production is transported to the United States using the Primrose Pipeline. Several companies now conduct *in situ* recovery operations from the Cold Lake oil sands, including areas within the Cold Lake Air Weapons Range.

WATER USE

Water use is a broad term that includes any use of water for any activity, economic or otherwise. Water use can include withdrawal or diversion of water from a source, or water used in place. Water uses may be considered consumptive or non-consumptive. For example, water used in stock-watering is almost entirely consumed, while water used in urban water supplies is almost entirely returned to the environment. Alberta considers the likely consumption of water for a specific use in its

Table 3 Water Allocation from Surface and Groundwater (m^3).

Purpose	Surface Water	Groundwater
Municipal	13 555 000	1 985 000
Agriculture	816 000	1 481 000
Commercial	8 559 000	356 000
Industrial	8 577 000	12 530 000
Other	23 334 000	239 000
Registration	1 123 456	813 586
Totals	58 158 000	17 931 000

licensing process. Summing up of the quantities of water allocated by water licences will overestimate water consumption in a watershed as many licensees do not consume or otherwise use their entire entitlement in a given year.

Water licences are registered by various sectors and sub-sectors. The principal water use sectors in Alberta are municipal, agriculture, commercial, industrial, and other. The latter includes water for flood control, lake stabilization, and wildlife enhancement projects such as Ducks Unlimited Canada projects. There are 346 surface water licences and 4789 registrations allocating 58 158 000 m^3. In addition, there are 458 groundwater licences and 1092 registrations allocating 17 931 000 m^3 in the watershed. Table 3 and Figure 11 show the allocation by use.

The largest single surface water allocation is for 'other,' closely followed by municipal then industrial. Industrial use in the petroleum sector dominates the groundwater allocation. In some cases, these industrial groundwater licences are standby arrangements for use when surface water supplies are low.

Considering the Beaver River watershed in Alberta as a whole, annual water diversions are less than licensed quantities and actual consumption is low compared to the natural flow of the river and its tributaries. In a median year, consumption is less than two percent of the annual runoff. This overall favourable situation must be placed in the context of flow reliability discussed earlier. Because of the unreliable flows of the Beaver River upstream of the confluence with the Sand River and of the flows in the southern tributaries of the Beaver River, water needs may not be met entirely in dry years, despite the allocation being modest.

Concerns about declining lake levels have led to moratoriums on water withdrawals from Manatokan, May, Muriel, Reita, and Tucker lakes. Diversions for steam injection purposes are not permitted from any of the lakes, wetlands or streams of the watershed, except for Cold Lake. This policy is aimed at protecting fish, wildlife, recreational values, and ecosystem function.

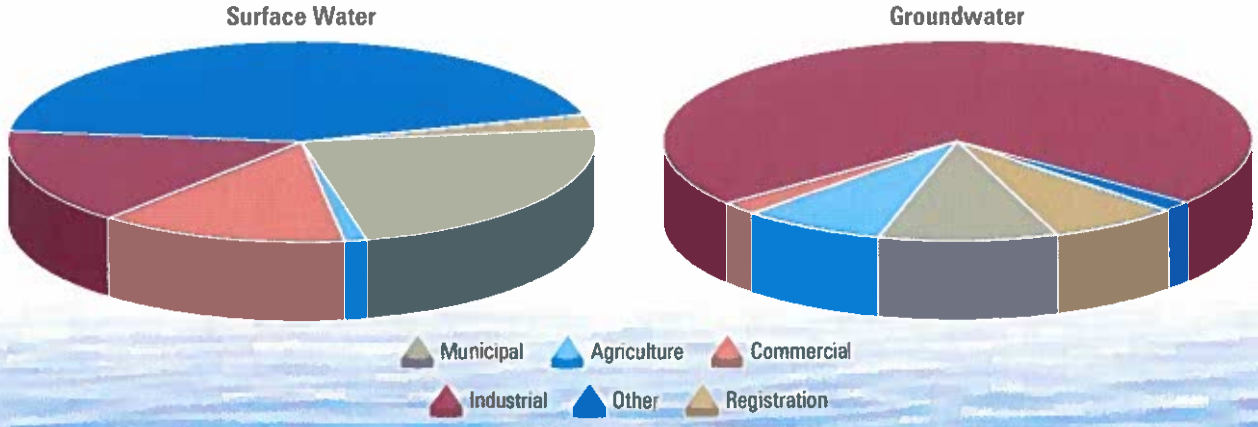
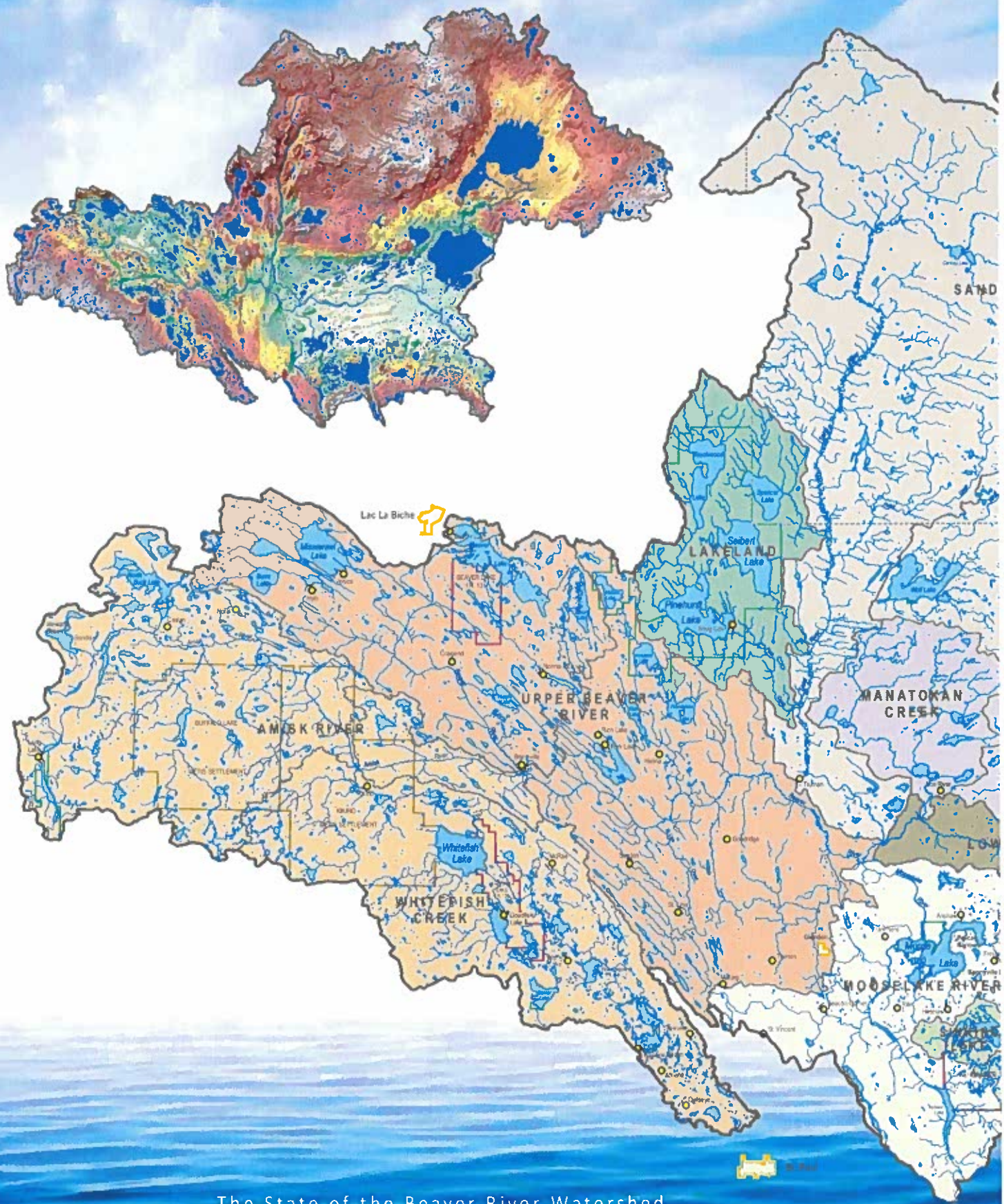
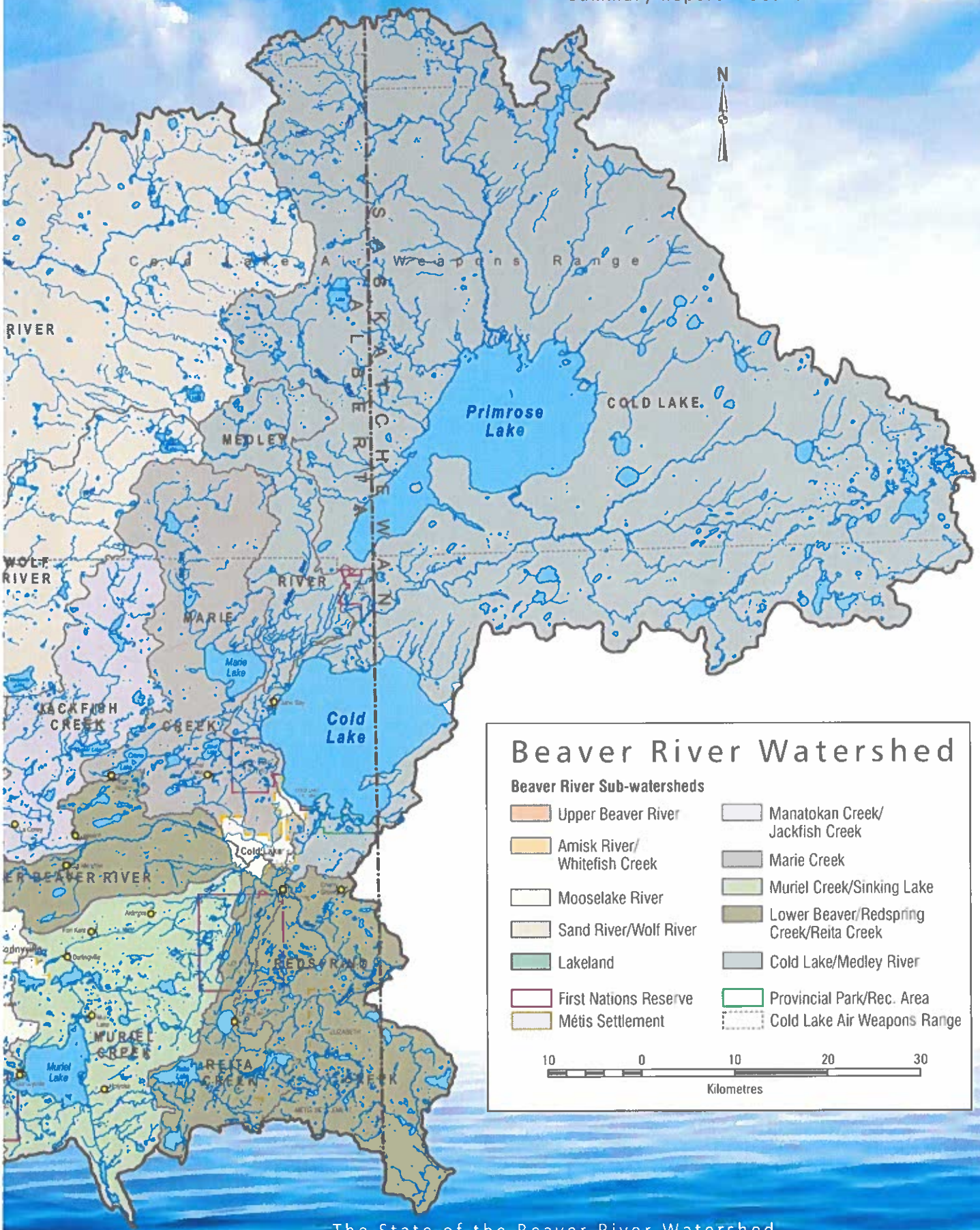


Figure 11 Water Allocation by Water Use Sector.


Lac La Biche
Seibert Lake
LAKELAND
Pinehurst Lake
MANATOKAN CREEK
UPPER BEAVER RIVER
AMISK RIVER
Whitefish Lake
WHITEFISH CREEK
MOOSELAKE RIVER


N
Cold Lake Air Weapons Range
RIVER
Primrose Lake
COLD LAKE
MEDLEY
WOLF RIVER
MARIE
Marie Lake
Cold Lake
CREEK
Cold Lake
BEAVER RIVER
MURIEL CREEK
Muriel Lake
REITA CREEK
Beaver River Watershed
Beaver River Sub-watersheds
Upper Beaver River
Amisk River/ Whitefish Creek
Mooselake River
Sand River/Wolf River
Lakeland
First Nations Reserve
Métis Settlement
Manatokan Creek/ Jackfish Creek
Marie Creek
Muriel Creek/Sinking Lake
Lower Beaver/Redspring Creek/Reita Creek
Cold Lake/Medley River
Provincial Park/Rec. Area
Cold Lake Air Weapons Range
10 0 10 20 30
Kilometres

Actual water consumption varies from sector to sector. Water consumption as a fraction of available supply also varies from sub-watershed to sub-watershed. It can be assumed that almost all of the water diverted for municipal use returns to the ecosystem although in the specific case of the cities of Cold Lake and Bonnyville, water diverted from one water body is returned to another. Almost all of the water diverted for agricultural purposes is consumed: that is, it is not returned to the stream. The industrial and commercial sectors, largely petroleum-related activity, withdraw and consume about one half of their annual allocation.

The water consumption associated with 'other' purposes is no more than 10 percent of the licensed diversion. The reason for this low consumption relates to the way in which lake stabilization projects are licensed in Alberta. In some cases, such as when the current lake level is below the natural sill elevation of the lake, the calculated evaporative loss related to lake stabilization is effectively zero.

Water consumption has been calculated to be about 16 800 000 m^3 from surface water and 14 300 000 m^3 from groundwater in 2005. Figure 12 illustrates water consumption based on 2012 allocations in comparison to the median annual flow. This flow includes the discharge of both the Beaver River and its Alberta tributaries and the discharge of the Cold River at the outlet of Cold Lake.

SURFACE WATER QUALITY

The quality of water flowing in streams or contained in lakes is the consequence of both natural processes and human activity. Water may contain dissolved substances as a result of natural processes. It may also contain plant nutrients, such as nitrogen or phosphorus, as well as trace elements such as selenium, chromium or arsenic. Naturally occurring substances can affect the appearance or taste of water, and may also be harmful to human health and aquatic life, if found in sufficient concentration. Water also contains dissolved gases such as oxygen.

Human activities such as agricultural, urban development, industrial development, and resource development related to petrochemicals, mining, and forestry may degrade the quality of natural waters. Land-use change, of itself, may also affect water quality. The biological quality of water can be changed by the introduction of bacteria normally found in the intestinal tract of humans or animals, or by water-borne pathogens such as *Giardia lamblia* or *Cryptosporidium parvum*. In recent years, concern has increased about pharmaceuticals and personal care products in aquatic systems.

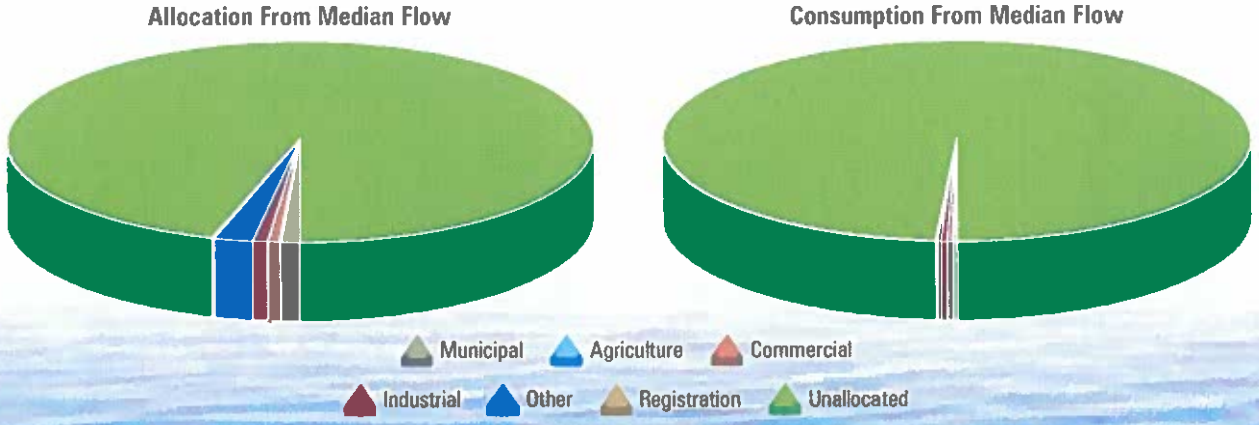


Figure 12 Annual Allocation and Consumption from Surface Water Compared to Median Flow.

The Beaver River and its tributaries, as well as the many lakes in the watershed, tend to be naturally high in nutrients. Like other Alberta streams, concentrations of iron, manganese and copper in the Beaver River watershed are naturally high.

One general descriptor of water quality in a lake is trophic status. This classification, based on biological productivity, has been applied to lakes for many years, and, more recently, has been applied to streams. Trophic classification represents a continuum of biological production ranging from oligotrophic to mesotrophic to eutrophic to hypereutrophic. Oligotrophic systems exhibit very little biological production; the water tends to be clear and well oxygenated. Mesotrophic waters may be moderately clear, but oxygen may be depleted in the deepest parts of lakes. Eutrophic systems may contain high densities of plants and algae. Lakes may produce algae blooms and be low in oxygen. Hypereutrophic lakes are very nutrient rich and will show significant persistent algal blooms. Oxygen depletion can lead to fish kills. Alberta has classified the trophic status of its lakes based on total phosphorus and phytoplankton chlorophyll *a*. Total nitrogen and Secchi depth (a measure of water transparency) criteria have also been added.

About 30 lakes in the watershed, primarily lakes that are accessible and have high recreational value, have been assessed and the trophic status determined. Cold Lake is considered oligtrophic to mesotrophic.

Most of the lakes, however, are mesotrophic or eutrophic. Kehiwin Lake is hypereutrophic. Aside from natural factors influencing their trophic status, lakes in parts of the watershed may also be affected by runoff from agricultural lands. The surface area of the watershed devoted to agriculture is increasing, as is the land area where fertilizer is applied. This in turn increases the nutrient loading to the lakes and hence their vulnerability to eutrophication.

Figure 13 provides an index of lake water quality based on phosphorus and chlorophyll concentrations.

In recent years, incidents leading to serious illnesses and even fatalities arising from poor management of a few municipal water treatment systems in Canada have led to increased public concern over safety of drinking water. A priority outcome of Alberta's *Water for Life Strategy* is safe, secure water supplies. Good quality water, however, has many other uses, including food production, sustaining aquatic life, and water contact recreation, such as swimming or boating. The known uses of a body of water are employed as the basis for determining water quality objectives.

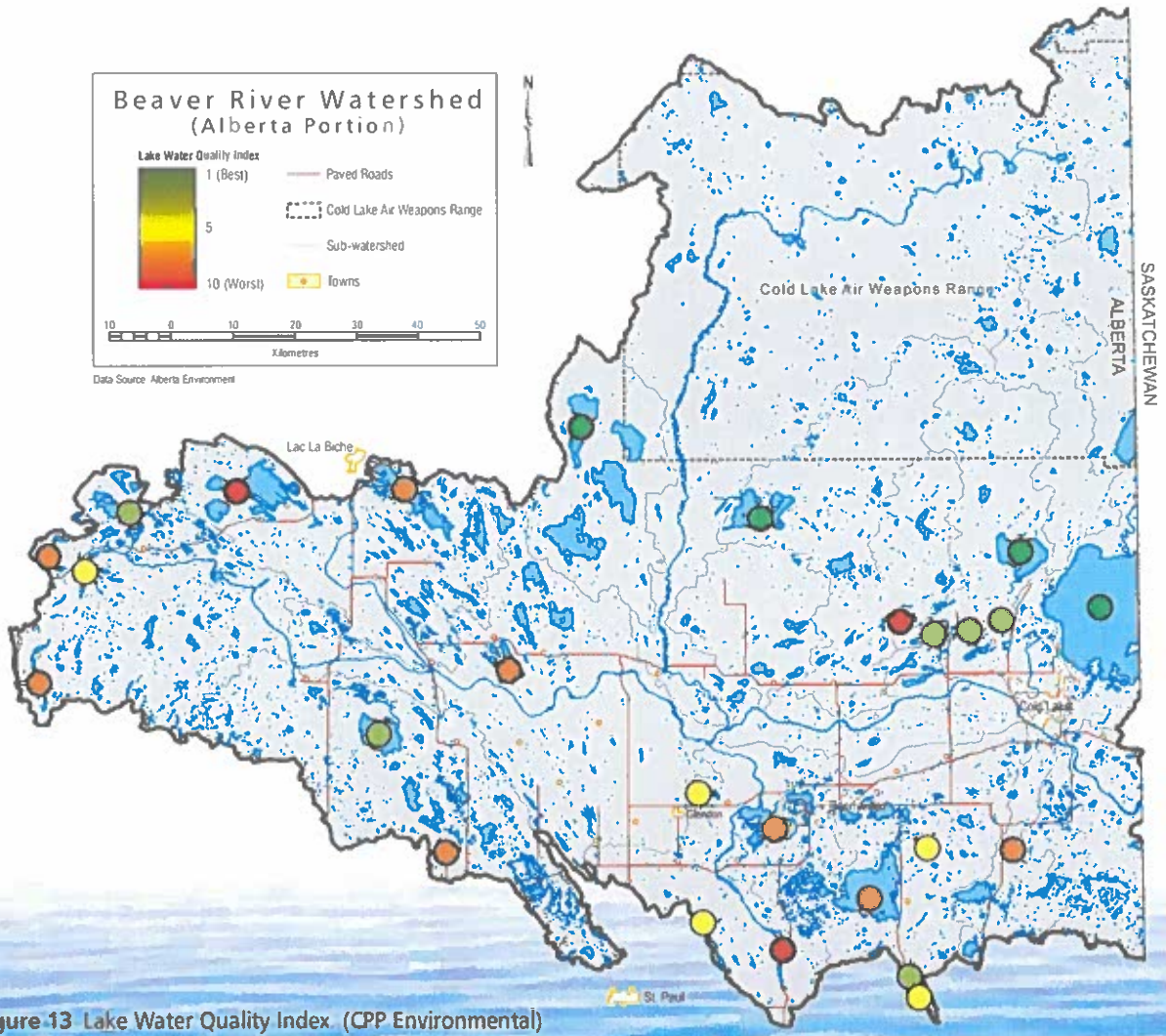


Figure 13 Lake Water Quality Index (CPP Environmental)

These uses may include contact and non-contact recreation, protection of aquatic life, irrigation, and livestock watering.

Determining water quality requires analysis of field samples for a number of chemical and biological constituents. The sampling period varies, depending on the nature of the monitoring program. Water quality monitoring of natural streams may depend on performing a broad range of tests on water samples obtained several times a year over many years. In addition, routine monitoring may be augmented by short-term surveys. Government agencies, at all levels, and private sector groups operate water-quality data collection programs. Monitoring and reporting to government regulators are often requirements for industrial and natural resource developments.

Water quality is monitored at the Beaver River 24 km upstream of the interprovincial boundary and at the Cold River at the outlet of Cold Lake by Environment Canada on behalf of the Prairie Provinces Water Board. Water-quality objectives are established for the Beaver River and the Board routinely reports on whether these objectives are being met. The Board also performs periodic analyses of the data for trends. Water quality objectives have not been determined for the Cold

River. Water quality in the Beaver River is generally good with rare exceedances of objectives being attributable to natural conditions. That said, the overall quality of the river is strongly influenced by the inflow from the Sand River tributary, an almost pristine source. The Sand River and, hence, the Beaver River are subject to naturally low, dissolved oxygen levels in winter.

For the most part, water quality can be considered as improving for the Beaver River near the interprovincial boundary. Nutrient concentrations have declined because of improvements to wastewater treatment facilities at Cold Lake and at 4 Wing Cold Lake. Further improvements to the City of Cold Lake facility are underway. On the other hand there are increases in ions and salinity. Increasing trends have been observed for total dissolved solids, conductivity, pH, sodium, chloride, calcium, and alkalinity. These increases may be attributable to an increasing groundwater component in the river flow.

GROUNDWATER QUALITY

Groundwater quality is dependent on a number of natural factors including:

- quality of the recharging water – whether snowmelt, rainfall, standing water or flowing water
- type of geological material that the groundwater contacts along its flow path
- length of time spent in contact with these materials
- order of the materials in which the groundwater made contact
- degree of mixing with groundwater from other sources
- unique geochemical conditions at the discharge zone, spring or well.

As water infiltrates, it interacts with subsurface materials, including gases, thereby changing its chemical composition. Metals, minerals and organic compounds may be oxidized or altered by other reactions. As water enters the saturated zone, even more complex reactions take place in the absence of oxygen. The effects of these reactions on groundwater quality in the Beaver River watershed are generally known.

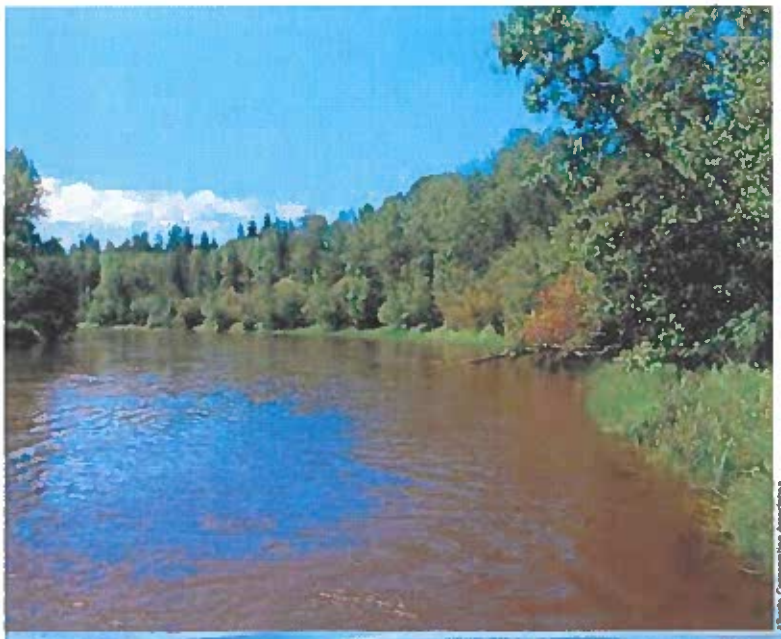
Groundwater quality can also be influenced by human factors such as point or non-point sources of contamination related to urban development, agricultural land use, industrial sources, transportation, and spills or plant upsets.

Groundwater quality is often described in terms of quantity and type of dissolved materials. For example, salinity may be expressed in terms of total dissolved solids (TDS). Fresh water has a TDS of 0 to 100 mg/L, brackish water 1000 to 10 000, and saline water over 10 000 mg/L. For comparison, sea water has a salinity of 35 000 mg/L. Potable water is considered to be any water having a TDS of less than 4000 mg/L although the *Guidelines for Canadian Drinking Water Quality* identify 500 mg/L as a preferred upper limit. Most of the wells in surficial aquifers in the watershed can be considered as having moderate to poor quality water on the basis of elevated TDS levels.

Groundwater quality in the drift aquifers varies in quality from recharge areas to discharge areas. Young groundwaters tend to be naturally hard with high levels of calcium or magnesium. This hardness is reduced as the groundwater comes in contact with clay minerals, losing calcium or magnesium and gaining sodium. Similarly bicarbonate is lost and sulphate is gained as waters age. This situation is typical of prairie groundwaters. In general, groundwaters in drift aquifers in the basin can be considered as potable. On the other hand, groundwaters in the bedrock aquifers are brackish

or saline. These latter groundwaters are now often used in bitumen recovery operations.

In comparing the chemical characteristics of groundwaters to drinking water and other guidelines some other characteristics are evident. Chloride content exceeds the guidelines for six percent of the samples taken. This is typical of farm wells across Alberta. In rare cases, the chloride content exceeds the upper guideline for irrigation water although irrigation is not a significant water use in the watershed. The arsenic content is naturally high and may exceed the drinking water guideline of 10 µg/L in some parts of the watershed. Elevated arsenic levels are most often associated with areas directly underlain by the Lea Park Formation. That is, most of the watershed. Of all the samples taken in the watershed, the drinking water guideline is exceeded in 20 percent of the samples while 63 percent of the samples exceed the freshwater aquatic wildlife guideline. This is high compared to samples from other parts of the province but naturally elevated concentrations of arsenic do occur in other watersheds. The source of the arsenic has been linked to the underlying marine shales. Phenols may be produced either naturally or through contamination from petroleum operations. Phenol concentrations exceed the aquatic life guideline for 16 percent of the samples and the livestock water criteria in 44 percent of the samples.



As one means of reducing impacts of human activity on aquifers, aquifer sensitivity maps have been prepared for much of the basin. These maps designate areas that have high sensitivity to inter-aquifer contamination or surficial aquifer contamination. Surficial aquifers are particularly subject to contamination when surface materials consist of sands and gravels, porous soils, or fractured clays. Areas of high sensitivity having organic surface deposits such as peat have also been identified. The sensitivity information has also been overlain with information on potential contaminant sources to produce vulnerability maps.

AQUATIC RESOURCES

The riparian areas of the Beaver River itself and most of those of the Sand, Medley and Martineau rivers are considered key wildlife areas with respect to biodiversity. Other important riverine riparian environments include smaller tributaries such as the upper Amisk River as well as Mooselake River, Jackfish Creek, and Muriel Creek downstream of Muriel Lake. Particularly important lake areas include Wolf and Frenchman lakes.

Although the watershed has been altered by human activity, much of the watershed north of the Beaver River remains in a near-natural state. The landscape provides habitat for many birds and mammals. Lakes, wetlands and streams and their associated riparian areas support many aquatic species. Natural and improved pastures adjacent to wetlands also provide habitat. The variety of living things and the ecosystems that support them is a reflection of the biodiversity of the watershed.

Biodiversity also includes the genetic diversity within a single species and the interaction among species.

Biodiversity is threatened by loss of habitat and habitat fragmentation. Draining of wetlands and loss of old growth forests through fire, disease or harvesting are examples of habitat loss. Linear features such as roads and seismic lines fragment habitat as do construction of dams and weirs. Road crossings, either bridges or culverts, can also isolate or fragment habitat. The southern part of the watershed is particularly subject to habitat altering influences.

Providing protected areas is one part of taking action to sustain biodiversity. Protected areas are lands identified by governments as having natural and associated cultural values. They are managed legally or by other means to sustain those values. The Alberta portion of the watershed contains Long Lake, Lakeland, Cold Lake and Moose Lake Provincial Parks, the Lakeland Provincial Recreational Area and the White Earth Valley Natural Area. The provincial parks provide habitat for many bird and animal species. Recreational areas also provide some protection.

The myriad lakes of the watershed are a key factor in considering its aquatic resources. Fisheries, wildlife and water-based recreation all depend on the sustainability of those lake systems. Traditionally, the lakes have supported First Nations and Métis traditional use of the watershed, including domestic and commercial fisheries.

Wildlife

Large carnivores in the watershed include the black bear, wolf, and lynx. The most common large herbivores are elk, mule deer, white-tailed deer, moose, caribou, and bison. Smaller carnivores include the coyote, least weasel, river otter, badger, striped skunk, muskrat, marten, and fisher. There are many rodents, such as the northern pocket gopher, beaver, woodchuck, Richardson's ground squirrel, thirteen-lined ground squirrel, Franklin's ground squirrel, least chipmunk, porcupine, eastern cottontail, and snowshoe hare.

Fish and Fish Habitat

The streams connecting lakes in the watershed are generally small, shallow, and slow moving. During the summer, flows may be intermittent and water stagnant with low dissolved oxygen levels that will

Table 4 Fish Species of the Watershed.

Species Type	Common Name
Coldwater Species	Lake Cisco (tullibee) Lake Trout Lake Whitefish
Coolwater Species	Burbot Northern Pike Walleye Yellow Perch
Non-game Species (*rare)	Brook Stickleback Ninespine Stickleback Lake Chub Spottail Shiner Pearl Dace Fathead Minnow Longnose Dace Emerald Shiner River Shiner Finescale Dace Northern Redbelly Dace Slimy Sculpin Spoonhead Sculpin Trout-perch Iowa Darter Logperch* Longnose Sucker White Sucker

not sustain fish populations. The fish species in the watershed are shown in Table 4. Predominant cold-water species are lake whitefish, cisco and lake trout – the latter in Cold Lake. Cool-water species include walleye, northern pike, yellow perch, burbot, and suckers. Walleye, northern pike, lake trout, and yellow perch are most appealing for recreational interests. Lake whitefish are the primary catch for First Nations domestic and commercial interests.

Fish populations are sensitive to lake level fluctuations and their effect on the shallow shoreline area of the lake. These areas provide spawning and feeding habitat for adult fish and rearing habitat for young fish. Low lake levels can lead to loss of habitat and increase the risk of fish kills in both summer and winter. Lake fisheries may also be affected by land use in upland areas that drain into the lake. Nutrients and other contaminants draining from the land will affect water quality.

Alberta's fish and wildlife policy stipulates that the priorities of fisheries management are, first, conservation of fish stocks, then domestic use by First Nations, then resident recreational and commercial fishing of any surplus stock. Under adverse lake level conditions, fish populations are particularly vulnerable to over-harvesting as the sustainable yield tends to decline with lake levels. Fisheries management then becomes a complex lake-by-lake and species-by-species enterprise. Specific provincial policies are aimed at managing walleye and northern pike stocks.

Domestic fishing licences are issued to First Nations and Métis people on request. About 1000 licences were issued annually in the early 1980s and that number has declined to about 190 today. There is no requirement to report annual catch, but it is understood that a small proportion of the licence holders catch a large proportion of the annual catch.

The watershed is a significant recreational fishery for the province, accounting for one-quarter of the annual provincial harvest. Although detailed information is not available, it is believed that recreational fishing effort remains fairly constant, although success has declined. One indicator of recreational fishing activity is the sale of sport fishing licences. Sales to residents have declined from a 1989 peak while non-resident sales are steady. Non-resident sales constitute only three percent of the licences sold.

There has been a pronounced decline in commercial fishing activity from 1989 when consistent record keeping began. The lakes in the southern portion of the watershed generally are not fished annually. At present, only seven commercial licences are issued covering eight lakes in the watershed. Spencer and Primrose lakes account for most of the commercial catch. No new licences are available, but existing licences can be transferred. The target species for commercial fishing is lake whitefish, most of which

are processed and sold to the Freshwater Fish Marketing Corporation. Sport fish caught as commercial by-catch are usually sold locally.

The Alberta Conservation Association has developed a fish-based index of biological integrity (IBI) as a basis for assessing ecological condition of the Beaver River and some major tributaries. Thousands of fish were sampled at 47 locations on the Beaver River itself and on the Amisk and Sand river tributaries. The fish sampled comprised 17 species from 6 families. The species composition and fish size can be related to watershed factors such as agricultural development and road density, riparian factors such as bank disturbance, and water quality factors such as water chemistry. Figure 14 shows the distribution of IBI scores for the sampled streams in the watershed.

Waterbirds

The Beaver River Naturalist Society has identified some 292 bird species in the watershed, including many waterbirds. The boreal lakes and wetlands present many viewing opportunities for waterfowl

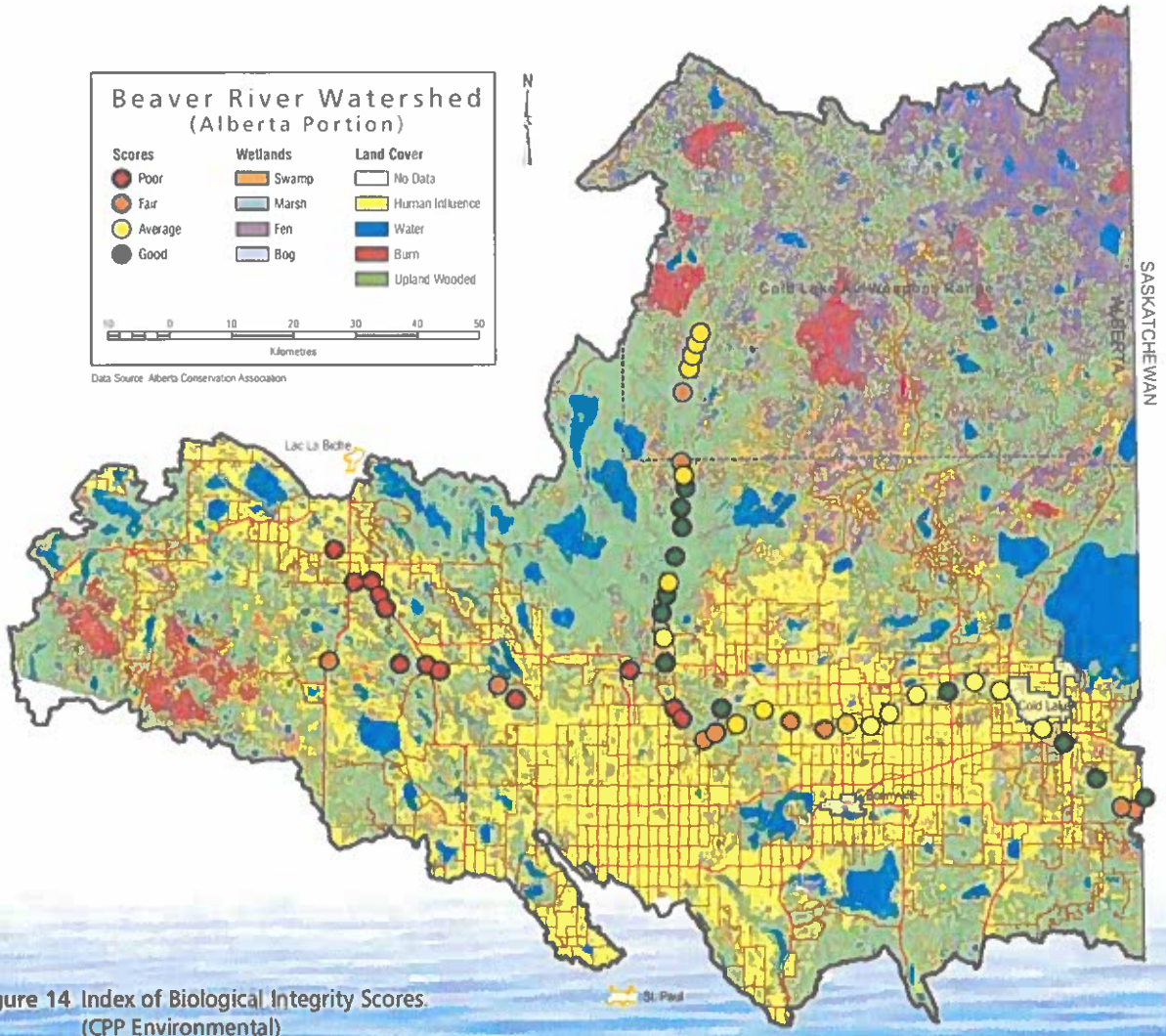


Figure 14 Index of Biological Integrity Scores. (CPP Environmental)

and other waterbirds. These viewing areas are associated with the aquatic values of the watershed. In particular, the Beaver River plain is considered nationally important habitat for ducks and colonial species such as pelicans and cormorants. The Moostoos Upland is considered regionally important. In the 1980s, assessments of water-based wildlife values were made at 57 lakes. These assessments were repeated at 28 of these lakes in 2003. In general, of the 49 bird species surveyed, increased numbers were observed for gladwall, eared grebe, Franklin's gull, white pelican, double-crested cormorant, and Canada goose. Decreased populations were noted for lesser scaup, American coot, and white-winged scoter. These trends are consistent with those observed throughout the prairie pothole region.

For the specific lakes surveyed in the watershed, the presence or abundance of a species was strongly related to changes in lake level or habitat, or both. Lakes maintaining the same level showed very little change in bird populations. Even for lakes showing significant decreases in level two quite different results were evident. Habitat losses led directly to species decline or, in the case where decreased water levels resulted in new shallows and increased emergent vegetation, the results proved beneficial for the birds.

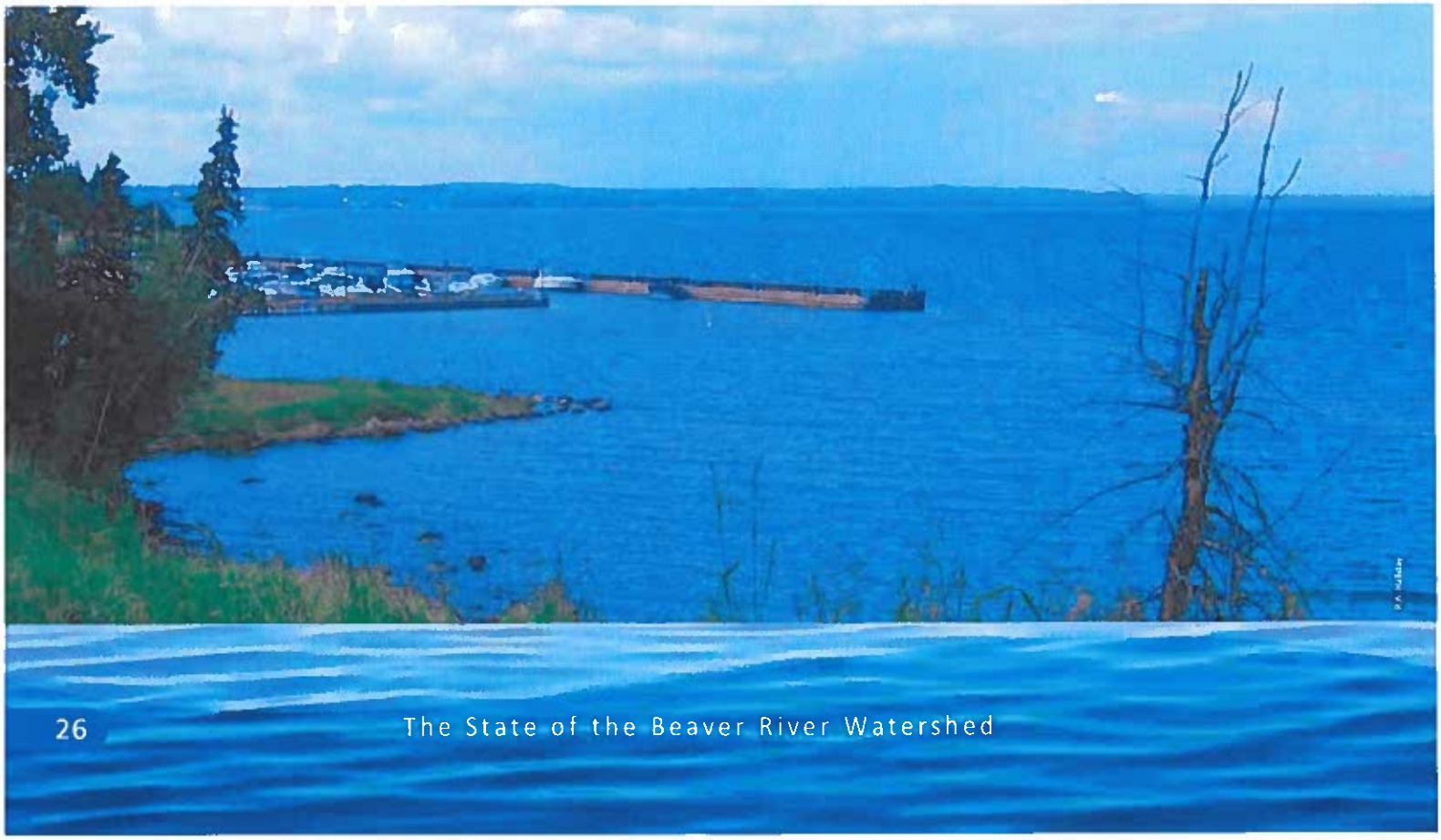
Water-based Recreation

The watershed contains the highest concentration of recreational lakes and high-quality beaches in Alberta. Recreational opportunities include swimming, fishing, picnicking, canoeing, sailing, nature study, and general relaxation. Powerboating and water skiing have been joined by other motorized activities such as personal watercraft and wake boards. There is increasing use of mountain bikes and all-terrain vehicles. Winter recreation, although relatively minor, includes ice-fishing, snowmobiling and cross-country skiing.

In the upper watershed, Lakeland Provincial Park and Lakeland Provincial Recreation Area cover some 590 km^2. Most of the park, except for Helena Lake is outside the Beaver River watershed while most of the recreation area lies within the Sand River sub-watershed. The recreation area is the largest such area in Alberta. Principal lakes include Touchwood, Pinehurst, Seibert, and Ironwood. Of these, only Ironwood Lake is not in the Lakeland watershed. Long Lake Provincial Park and the White Earth Valley Natural Area also provide outdoor recreation opportunities in the upper watershed.

Fourteen lakes in the lower watershed have been studied to identify how water levels may affect recreational facility development and activity. These include major lakes, defined as those generating 30 000 user-days of activity a year. These lakes may feature public facilities, whether provincial (Moose Lake and Cold Lake) or municipal, private facilities such as cottage development, institutional development, or commercial facilities such as campgrounds or boat rentals. The major recreation lakes include Cold, Ethel, Marie, Crane (Moore), Moose, and Muriel lakes.

Secondary lakes have fewer facilities and generate fewer than 30 000 user-days of activity a year. These include Angling, Manatokan and Wolf lakes. Minor lakes have few facilities and user activity is low. These include May, Reita and Tucker lakes. Two inaccessible lakes in the Cold Lake Air Weapons



Range, Burnt and Cariboo, were also studied for comparison purposes. Access to these two lakes for sport fishing has now been closed for both the public and military personnel.

There are campgrounds within the three provincial parks, twelve provincial campgrounds in designated provincial recreation areas, and six municipal campgrounds in the watershed. These sites provide 915 campsites.

Recreational opportunities are very sensitive to water level changes of individual lakes. Low water levels on Manatokan, Moose and Muriel lakes have clearly affected recreational values.

KNOWLEDGE GAPS

Environmental conditions in the watershed are vulnerable to landscape modification, water quality degradation and climate change. Additional information is required if progress on meeting environmental goals under a water management plan is to be tracked and trends determined.

Landscape Modification

The recent wetland classification project carried out by Ducks Unlimited Canada (DUC) is an exceptional resource; however, the information could be improved in two ways. First, the human influence classification should be modified to provide a better understanding of the nature of the influence. Land covers such as annual cropland, and perennial cropland and pasture should be distinguished. This refinement would allow trends in land cover in the southern part of the watershed to be identified. Another refinement of the DUC work would be the inclusion of the portion of the watershed that lies in Saskatchewan but that contributes to flow in Alberta.

Riparian conditions have significant ecological value but, in general, there has been relatively little attention devoted to systematically classifying riparian conditions along principal streams and recreational lakes. The recently obtained aerial photography of the Beaver River itself is an important first step. Studies related to biological integrity could be expanded slightly to ensure stream riparian condition reports are included. Aerial videography surveys of key recreational lakes could also be expanded, especially where there are known development pressures.

Water Quality Degradation

Nutrient concentrations driven by both natural factors and by human activity are an important concern in the watershed. While there have been synoptic water quality surveys of some streams and periodic sampling of some lakes, there is very little systematic monitoring of water quality in the watershed, except for industry monitoring in some sub-watersheds. Monitoring should be sufficient to understand human and natural influences on nutrient levels in principal streams and lakes.

Public concern has been expressed about arsenic concentrations in shallow groundwater wells in the watershed. This is a natural phenomenon but further investigation of mitigation measures for water users is required.

Climate Change

A major concern is the decline in the lake levels of recreational lakes in the watershed. While there has been a consistent increase in temperatures and some apparent decrease in runoff over several decades, it is not entirely certain that the declining lake levels are a response only to climate. Other contributing factors include land-use change. It would be instructive to examine the water balance at say, Muriel Lake, to obtain a better appreciation of the effects of climate and land use on lake levels. This could include an examination of land use trends in the sub-watershed, direct measures of evaporation using eddy covariance instrumentation and hydrological modelling.

CONCLUSION

This summary provides a condensed version of information contained in a larger report on the state of the Beaver River watershed, produced as a tool to assist the Beaver River Watershed Alliance in creating a plan to safeguard healthy aquatic ecosystems in the watershed. The report describes the current state of the watershed, existing and potential factors that may affect its ecosystems, and knowledge gaps that inhibit the decision-making needed to secure a healthy future. This information, along with the indicators of environmental performance provided in the report, can advance implementation of Alberta's *Water for Life Strategy* in the Beaver River watershed.

Water For Life

The information presented in this report can assist implementation of Alberta's Water for Life Strategy in the Beaver River watershed.

Goals

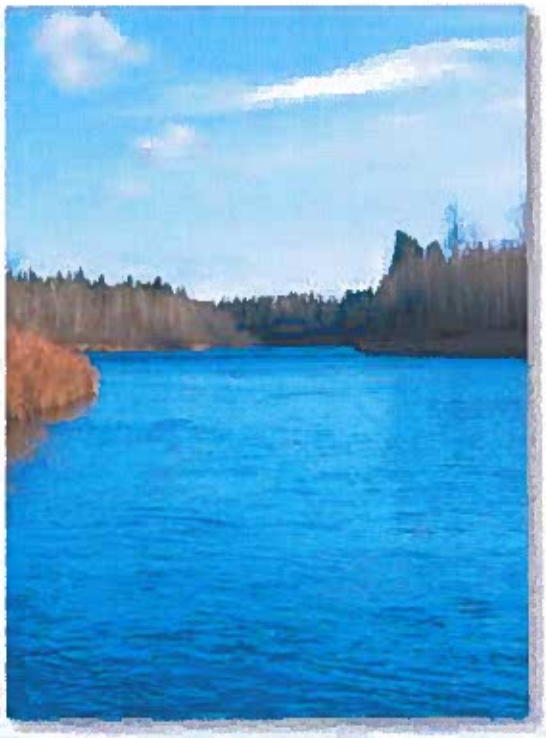
- Safe, secure drinking water
- Healthy aquatic ecosystems
- Reliable, quality water supplies for a sustainable economy

Key Directions

- Knowledge and research
- Partnerships
- Water conservation

Beaver River Watershed Alliance

Beaver River Watershed Alliance



LICA
Lakeland Industry & Community Association

Alberta
Environment and Sustainable Resource Development

December 2022

Current Proposed Budget: Revisiting the State of the Watershed (SOW) Report

WPAC Operational Grant 2023-2027

Within the WPAC operational grant application submitted in September 2022, a total of $40,000 was included over a 3-year term to be allocated to revisiting the SOW report. This is only a proposed budget as confirmation of funding is anticipated to be received in the coming months.

WPAC Operational Grant Proposed Budget: State of the Watershed

Year	2023-2024	2024-2025	2025-2026
Amount	$10,000.00	$10,000.00	$20,000.00
Total			$40,000.00

2013 State of the Watershed Expenses

The first State of the Watershed report was completed in 2013 by the Beaver River Watershed Alliance. The table below includes the expense allocated to the report based on past documentation that could be referenced. Please note that it is possible that not all expenses are reflected below. This is to serve only as additional insight into the resources that were required when the report was first written.

2013 State of the Watershed Reporting

Year	2010-2011	2012	2013
Revenue Stream	Alberta Environment	LICA Budget (WPAC)	LICA Budget (WPAC)
Outcome	SOW ToR and Draft Report	SOW Report	SOW Report
Amount	$65,000	$35,866.99	$22,886.80
Anticipated Total			$123,753.79

Additional Information

The State of the Watershed report should be updated to reflect the current environmental condition of the watershed. There is also an expectation of SOW reporting to be reviewed and updated as required, or after every 8 years, as outlined in the Mandate and Roles Document signed between LICA and the Ministry of AEP in 2022.

The state of the watershed report is one of the 2 key deliverables produced by Watershed Planning and Advisory Councils (WPACs). It describes the history of the watershed, its natural and built features, the condition of the resources, and the impact of human activity on the watershed. State of the Watershed reports are expected to inform the development of Integrated Watershed Management Plans (IWMPs), providing a foundation of information for developing effective management strategies to meet watershed goals (Government of Alberta, 2022).

IWMPC Meeting

Date: September 9, 2022 **Recorder: Tina Johnson**

ACTION LIST

Task	Date to be completed	Person assigned to task	**Y**
Process for Seeking Support			
• Reach out to municipal partners regarding IWMP & getting their support for the Plan	September 2022 - March 2023	Kayla	**IP**

Next Meeting: December 1, 2022