#1 - REQUEST FOR REVIEW: RA21045 / G&S Cattle Ltd.

Filed By:	**Summer Village of Grandview (c/o Don Davidson)**
Deadline for RFRs:	September 22, 2022
Date RFR received:	September 16, 2022
Status of Party as per Decision Summary:	Not Directly Affected Party

REQUEST FOR BOARD REVIEW

SUBMITTED TO THE NATURAL RESOURCES CONSERVATION BOARD

Application No. RA21045

Request for Review of Directly Affected Party Status

Submitted by Summer Village of Grandview

September 16, 2022

Contents

REQUEST FOR BOARD REVIEW
SUBMITTED TO THE NATURAL RESOURCES CONSERVATION BOARD

Application No:	RA21045
Name of Operator/Operation:	G&S Cattle Ltd.
Type of application *(check one)*:	☒ **Approval** ☐ **Registration** ☐ **Authorization**
Location *(legal land description)*:	NW 3-47-2 W5M
Municipality:	County of Wetaskiwin

I hereby request a Board Review of the Approval Officer's Decision and have the right to request a Board review because *(please review all options and check one)*:

- ☐ **I am the producer seeking the approval/registration/authorization.**
- ☐ **I represent the producer seeking the approval/registration/authorization.**
- ☐ **I represent the municipal government.**
- ☐ **I am listed as a directly affected party in the Approval Officer's Decision.**
- ☒ **I am <u>not</u> listed as a directly affected party in the Approval Officer's Decision and would like the Board to review my status.**

IMPORTANT INSTRUCTIONS

1. **You must meet the specified 10-day timeline; otherwise your request will not be considered.**
2. **Section 1 of this form must be completed only if you are requesting that the Board review your status as "not directly affected". Sections 2 to 5 must be completed by all applicants.**
3. **This form must be signed and dated before it is submitted to the Board for its review.**
4. **Be aware that Requests for Board Review are considered public documents. Your submitted request will be provided to all directly affected parties and will also be made available to members of the public upon request.**
5. **For more assistance, please call Laura Friend, Manager, Board Reviews at 403-297-8269.**

1. PARTY STATUS

(IF YOU ARE NAMED A DIRECTLY AFFECTED PARTY IN THE APPROVAL OFFICER'S DECISION, YOU DO NOT NEED TO COMPLETE THIS SECTION)

Party status (*"directly affected" or "not directly affected"*) is determined pursuant to the provisions of the *Agricultural Operation Practices Act* (AOPA) and its regulations. Upon receipt of an application, the Approval Officer must notify any affected parties. Affected parties include municipalities and owners or occupants of land as determined in accordance with the regulations. To obtain directly affected status, the owner or occupant notified in the above process must provide a written submission to the Approval Officer during the stage at which the Approval Officer considers the application. The Approval Officer will then determine who the directly affected parties are and include this determination in the Decision Summary.

Under its governing legislation, the Board can only consider requests for review submitted by directly affected parties. If you are not listed as directly affected in the Approval Officer's decision, you must request that the Board reconsider your status *(please note that under the provisions of AOPA, the Board cannot reconsider the status of a party who has not previously made a submission to the Approval Officer during the application process).*

In order to request your status be reconsidered, you must explain why your interests are directly affected by the decision of the Board. Please list these reasons below:

My grounds for requesting directly affected status are as follows:

Please refer to Attachment 1, setting out the Summer Village of Grandview's grounds for requesting directly affected status.

2. GROUNDS FOR REQUESTING A REVIEW

(ALL PARTIES MUST COMPLETE THIS SECTION)

In order to approve an application, NRCB Approval Officers must ensure the requirements of AOPA have been met. Your grounds for requesting a Board review should identify any requirements or specific issues that you believe the Approval Officer failed to adequately address in the Decision.

My grounds for requesting a review of the Approval Officer's decision are as follows:

The Summer Village of Grandview ("Grandview") does not request review of the Approval Officer's substantive decision denying Application RA21045. Grandview agrees with the outcome of the Approval Officer's decision. This Request for Review form is submitted for the sole purpose of requesting review of the Approval Officer's decision that Grandview is not a directly affected party ("DAP").

This Request for Review is submitted so that in the event that the confined feeding operation applicant, G&S Cattle Ltd., or any other party requests review of the Approval Officer's decision, and in the event that the request is granted and the Board exercises its jurisdiction to review the decision, Grandview will be given opportunity to participate in the review, including being given the opportunity to put forward evidence and to make submissions at any hearing that may occur.

Further, Grandview asserts that even if there is no Board Review of the Approval Officer's decision denying the CFO, the Board should reverse the DAP decision pertaining to Grandview. The DAP decision was made in error, and if it is allowed to stand it creates a prejudicial precedent against Grandview excluding them from participation in CFO decisions that directly affect them.

For the reasons set out in Attachment 1, Grandview submits that it is a DAP in these proceedings, and requests the Board reverse the Approval Officer's decision on Grandview's DAP status in order to participate in any review (including any hearing) that may occur.

3. REASONS YOU ARE AFFECTED BY THE DECISION

(ALL PARTIES MUST COMPLETE THIS SECTION)

In order to support your reasons for requesting a review, please explain how you believe you would be affected by the Approval Officer's decision.

I believe that, as a result of the Approval Officer's decision, the following prejudice or damage will result:

Please see Attachment 1, outlining the damage and prejudice that will result to Grandview as a result of the Approval Officer denying Grandview Directly Affected Party status.

4. ACTION REQUESTED

(ALL PARTIES MUST COMPLETE THIS SECTION)

I would like the Board to take the following actions with the respect to the Approval Officer's decision:

☑ Amend or vary the decision

☐ Reverse the decision

Please describe why you believe the Board should take this action:

As explained in Attachment 1, the Summer Village of Grandview should be considered a Directly Affected Party in relation to the proposed Confined Feeding Operation. Therefore Grandview requests that the Board should amend or vary the Approval Officer's decision finding that Grandview was not a Directly Affected Party, and should give Grandview the opportunity to participate in any Board Review and hearing that may take place in relation to this matter.

If the Board decides to grant a review (*in the form of either a hearing or a written review*), all directly affected parties are eligible to participate. The Board may consider amending the Approval, Registration, or Authorization on any terms and conditions it deems appropriate. **Please note the Board cannot make any amendments unless it first decides to grant a review.**

If a review is granted by the Board, are there any new conditions, or amendments to existing conditions, that you would like the Board to consider? It is helpful if you identify how you believe your suggested conditions or amendments would address your concerns.

No, there are no new conditions, or amendments to existing conditions, that Grandview wishes the Board to consider. Grandview's position is that the only acceptable outcome of a review is to uphold the Approval Officer's decision denying a permit to the proposed CFO.

5. CONTACT INFORMATION

(ALL PARTIES MUST COMPLETE THIS SECTION)

Contact information of the person requesting the review:

Name: Summer Village of Grandview, c/o Don Davidson (Mayor)

Address in Alberta: [redacted]

Legal Land Description: SE- and SW-27-46-1-W5

Phone Number: [redacted] Fax Number: [redacted]

E-Mail Address: [redacted]

Signature: Don Davidson Digitally signed by Don Davidson Date: 2022.09.16 10:36:36 -06'00' Date: Sept 16, 2022

Please note that all sections of the form must be completed in order for your request to be considered. Also, if you do not meet the timeline identified, your request will not be considered. Form must be signed and dated before being submitted for Board consideration

If you are, or will be, represented by another party, please provide their contact information (Note: If you are represented by legal counsel, correspondence from the Board will be directed to your counsel)

Name:

Address:

Phone Number: Fax Number:

E-Mail Address:

When you have completed your request, please send it, with any supporting documents to:

Laura Friend, Manager, Board Reviews
Natural Resources Conservation Board
John J. Bowlen Building
#901, 620 – 7 Avenue SW
Calgary, AB T2P 0Y8

Phone: 403-297-8269

Email: laura.friend@nrcb.ca

Please note, Requests for Board Review are considered public documents. Your submitted request will be provided to all directly affected parties and will also be made available to members of the public upon request.

For more assistance, please call Laura Friend, Manager, Board Reviews at 403-297-8269.

Attachment 1: Request for Board Review submitted to the Natural Resources Conservation Board regarding Application RA21045

Submitted by the Summer Village of Grandview

c/o: Don Davidson
P.O. Box 100 (605 – 2nd Avenue)
Ma-Me-O Beach, Alberta, T0C 1X0
Phone: (403) 860-1050
Fax: (780) 586-3567
Email: donald_d@telus.net

Dated September 16, 2022

Sent to Laura Friend, Manager, Board Reviews, via email to laura.friend@nrcb.ca

I. Summary:

The Summer Village of Grandview ("Grandview") was denied Directly Affected Party ("DAP") status in the Approval Officer's decision on the application by G&S Cattle Ltd. to construct and operate a new Confined Feeding Operation ("CFO") in the County of Wetaskiwin.[1]

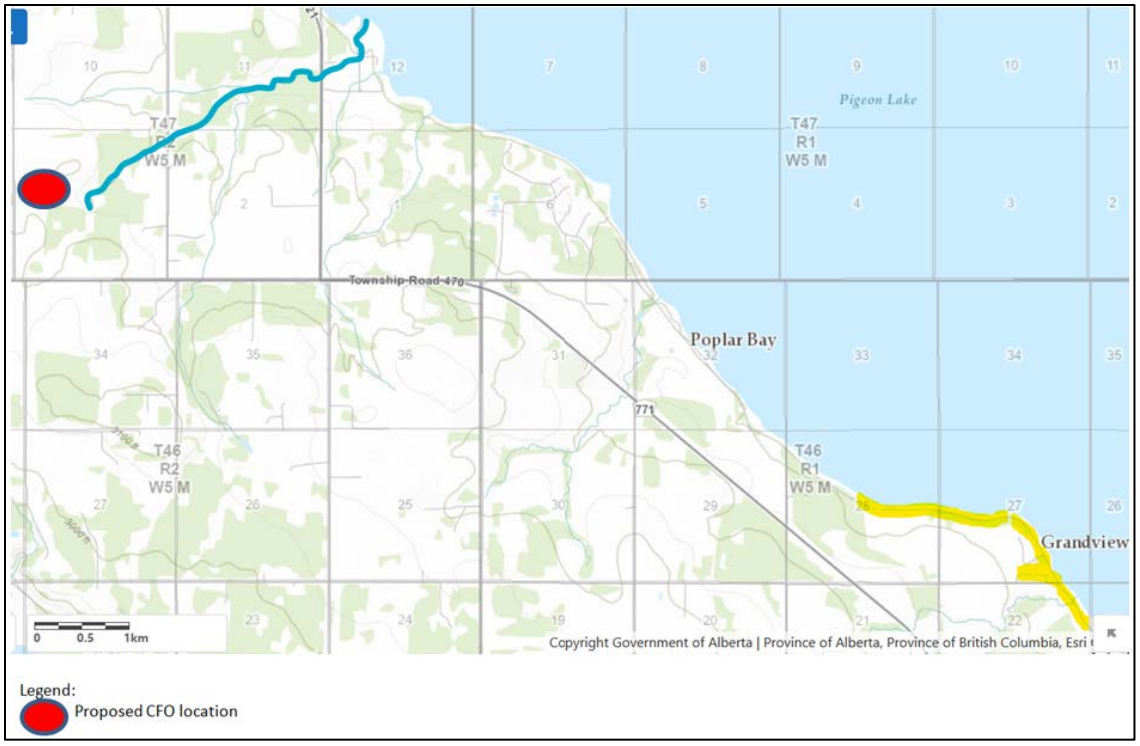
Grandview requests Natural Resources Conservation Board ("Board" or "NRCB") review of the decision to deny Grandview DAP status and requests that the Board reverse the Approval Officer decision in this regard by granting Grandview DAP status. This request summarizes the concerns raised by Grandview regarding negative effects of the proposed CFO and sets out why Grandview meets the five-step test to be granted DAP status, as well as why Grandview is an affected party under the *Agricultural Operations, Part 2 Matters Regulation*. This request demonstrates that the Approval Officer's decision to deny Grandview DAP status was made in error and demonstrates that prejudice or damage will result to Grandview if the Approval Officer's decision is not reversed in this regard, regardless of whether or not the substantive Approval Officer decision is reviewed.

II. Background:

Location of Grandview and Proposed CFO

The map below illustrates the location of Grandview (in yellow) on the shores of Pigeon Lake. The map shows the location of the proposed CFO, as well as the stream (highlighted by blue line) that flows adjacent to the proposed manure storage facility location and into Pigeon Lake.

[1] Natural Resource Conservation Board Decision Summary RA21045 (31 August 2022), ["Decision Summary"], online: <https://www.nrcb.ca/public/download/files/216423>.



Grandview's Statement of Concern

On March 29, 2022, Grandview submitted a Statement of Concern ("SOC") regarding G&S Cattle Ltd.'s CFO Application RA21045.[2]

In that SOC, Grandview requested DAP status. The contents of Grandview's SOC demonstrate that Grandview meets the five-part test for DAP status. Additionally, Grandview can be considered an affected party under Section 5 of the *Agricultural Operations, Part 2 Matters Regulation*. Grandview raised the following concerns with the proposed CFO:[3]

- Grandview has undertaken significant investments to improve and protect water quality at Pigeon Lake, including construction of a regional sewer system, prohibiting lawn fertilizers and herbicides, a yearly tree-planting program, and actively supporting the Pigeon Lake Watershed Association (p 1). The proposed CFO, including manure-spreading lands, will drain directly into Pigeon Lake, contributing to nutrient overload, eutrophication, and harmful algal blooms, therefore undermining Grandview's attempts to lower the nutrients entering Pigeon Lake (p 2).
- Grandview is within 10 miles downstream of the proposed CFO. Many residents and Grandview have riparian ownership, which affords the right to divert water. Thus

[2] Summer Village of Grandview, "Application RA21045 - Statement of Concern" (29 March 2022), ["Grandview SOC"], attached.
[3] Page numbers in this list refer to page of Grandview's SOC.

Grandview is an affected party under the regulations. These residents will be adversely affected by this CFO because of diminished water quality (p 2).

- A stream flows directly from the manure storage area of the proposed CFO into a tributary of Sunset Harbour Creek which enters Pigeon Lake.[4] As well, this creek flows through the manure-spreading area to Pigeon Lake (p 2). The existing Intensive Livestock Operation adjacent to the proposed CFO is located close to the proposed manure lagoon, and phosphorous runoff in this area and in the stream is already high (pp 6, 8). During heavy rainfall and spring freshet, this stream experiences heavy flows into Sunset Harbour Creek and ultimately into Pigeon Lake (p 7). The high phosphorous concentrations found in Sunset Harbour Creek can be expected to increase as the load of manure in the vicinity increases (p 8).
- Cyanobacteria blooms are directly associated with the load of nutrients entering the lake from the adjoining land (p 3). Cyanobacteria blooms are non-trivial: they negatively affect quality of life, property values, and the local economy (p 2); can cause fish kills; and can be dangerous to human life (pp 2-3). Scientific studies recognize the importance of reducing phosphorous migration into the lake to control and prevent cyanobacteria blooms (p 2).
- The management practices and efforts of watershed residents have already shown indications of having a positive effect on water quality at Pigeon Lake, demonstrating the link between nutrient loading into the lake and the intensity of harmful algal blooms (which are the worst case of cyanobacteria blooms) (p 4).
- The 2018 Pigeon Lake Watershed Management Plan ("PLWMP") was developed by the 12 municipalities of Pigeon Lake, including Grandview.[5] Objective 2e of the PLWMP states that there should be no new or expanded intensive livestock operations, including CFOs, within the watershed (p 8). Grandview also participated in the development of the County of Wetaskiwin Pigeon Lake Area Concept Plan ("PLACP").[6] Planning Principle 5.5.2 of the PLACP states that "[l]arge scale confined animal operations are not appropriate in the Pigeon Lake watershed."[7]
- The CFO application does not include locations of watercourses and drainage patterns, as required by the regulations. The watercourse adjacent to the manure lagoon was not considered in the original application, and the locations of adjacent water wells (p 10) were omitted.

[4] Note: in the time since Grandview's SOC was submitted, the proponent updated the application such that the manure storage area is 33 meters, rather than under 30 meters, from the drainage stream. Grandview contends that this does not meaningfully reduce the risk of runoff into Pigeon Lake, given the high probability of multi-day rain events causing the manure storage basin to overflow and the contents to enter the stream. Further, as explained below, as the manure storage area is within 100 meters of the drainage stream, Grandview should be considered a directly affected party in this proceeding.

[5] Pigeon Lake Watershed Management Plan 2018 ["PLWMP"], attached.

[6] County of Wetaskiwin Pigeon Lake Area Concept Plan ["PLACP"], attached.

[7] PLACP at s 5.5.2 on p 11.

Subsequent to filing their SOC, Grandview filed two addenda.[8] Although the Approval Officer gave verbal permission to submit both addenda, it appears that neither were accepted.[9]

The Approval Officer's decision

On August 31, 2022, Approval Officer Nathan Shirley issued his decision denying the application.[10] The reasons the Approval Officer gave for denying the proposed CFO were that the CFO "would pose materially negative and long-lasting effects on the community" and that "it would not be an appropriate use of the land."[11]

In the decision, the Approval Officer dealt with requests by parties to be granted DAP status. The Approval Officer noted that Summer Villages which had filed statements of concern, including Grandview, were deemed to be outside the radius of "affected" parties, but nonetheless could apply for DAP status.[12]

The Approval Officer noted that Grandview's request for DAP status was assessed in the same manner as requests by individuals and found that the statements of concern of the Summer Villages were "similar" to those of parties that were granted DAP status.[13] However, the Approval Officer denied Grandview and seven other Summer Villages DAP status on the basis of "their remoteness from the proposed CFO" and the "low probability of occurrence of the issues they identified."[14] The reasons given by the Approval Officer for denying DAP status to Grandview and the other Summer Villages were exceedingly brief. The Approval Officer wrote only one sentence denying the Summer Villages DAP status, and did not address the concerns of the Summer Villages separately from each other despite the unique circumstances of each municipality.[15] Both of the grounds of denying DAP status to Grandview were made in error. The following sections demonstrate that Grandview meets the five-part test for Directly Affected Party status in connection with this CFO.

III. Test for Directly Affected Party Status:

A party requesting DAP status has the onus to show that:

1) A plausible chain of causality exists between the proposed project and the effect asserted;
2) The effect would probably occur;
3) The effect could reasonably be expected to impact the party;
4) The effect would not be trivial; and

[8] Summer Village of Grandview, "Addendum No. 2 to the Summer Village of Grandview's Statement of Concern" (9 May 2022), attached; Letter dated 8 June 2022 to Nathan Shirley and Fiona Vance, "Request for Status Information", attached.
[9] Decision Summary at p 4.
[10] Decision Summary.
[11] Decision Summary at p 1.
[12] Decision Summary, Appendix C, at pp 12 and 21 (Table C4).
[13] Decision Summary, Appendix C at p 21.
[14] Decision Summary, Appendix C at p 21.
[15] Decision Summary, Appendix C, at p 21.

5) The effect falls within the NRCB regulatory mandate under AOPA.[16]

IV. Argument:

Grandview is an "affected party" under AOPA and the Regulations

Under AOPA, the NRCB notifies (or directs the applicant to notify) all parties that are "affected" by an approval application.[17] An affected party may then apply to an approval officer for a determination on whether that party is a DAP.[18] One way in which a party may be considered an affected party is if that party meets the criteria in Section 5 of the *Agricultural Operations, Part 2 Matters Regulation* ("*Part 2 Regulation*").[19]

Section 5 of the *Part 2 Regulation* directs that, in the case of a CFO located within 100 meters of the bank of a river or stream, a person who is entitled under the *Water Act* to divert water within 10 miles downstream is an affected party. The manure storage facility at the proposed CFO is to be located 33 meters from an intermittent stream. The Approval Officer erred in determining that the intermittent stream was not a stream within the meaning of Section 5 of the *Part 2 Regulation*.[20] This error caused the Approval Officer to improperly exclude certain downstream parties, including Grandview, from the definition of "affected party". Grandview residents within 10 miles downstream of the CFO are entitled to divert water under the *Water Act*, and therefore will be affected by this CFO.

While the AOPA and regulations do not explicitly define the meaning of "stream," subsection 7(1) of the *Standards and Administration Regulation*, AR 267/2002 ("*Standards Regulation*"), dealing with the proximity of a manure storage facility to a common water body, includes intermittent streams within the definition of "common water body" except in a limited situation in which the intermittent stream does not run off of private land.[21]

It is unreasonable and inconsistent that the Approval Officer is required to, and in fact does, consider an intermittent stream as a "stream" when making his determination under subsection 7(1) of the *Standards Regulation*, but then distinguishes intermittent streams from permanent streams in interpreting the meaning of "stream" in Section 5 of the *Part 2 Regulation*. In the absence of any explicit definition of "stream" in either regulation, there must be some consistency in the definition and interpretation of "stream" between the two regulations. Therefore, the Approval Officer erred in determining that an "intermittent stream" was not a stream within the meaning of Section 5 of the *Part 2 Regulation*.

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[16] See Ijtsma, RFR 2011-05/RA11001, 2011-05 at p 4, online: <https://www.nrcb.ca/public/download/documents/80747>; and NRCB Operational Policy 2016-17 at section 6.3, online: <https://www.nrcb.ca/public/download/files/97525>.
[17] *Agricultural Operation Practices Act*, RSA 2000, c A-7, at s 19 ["AOPA"], online: <https://canlii.ca/t/547kg>.
[18] AOPA s 19(4).
[19] *Agricultural Operations, Part 2 Matters Regulation*, Alta Reg 257/2001, at s 5 ["*Part 2 Regulation*"], online: <https://canlii.ca/t/54vrh>.
[20] Decision Summary at p 2.
[21] *Standards and Administration Regulation*, Alta Reg 267/2001, at s 1(1)(d) and s 7 ["*Standards Regulation*"], online: <https://canlii.ca/t/54wbp>.

Further, provisions under other legislation including the *Water Act* and *Environmental Protection and Enhancement Act* include intermittent streams as "streams" for the purpose of environmental regulation and protection.[22] It is inconsistent that Section 5 of the *Part 2 Regulation* under AOPA would exclude intermittent streams without an explicit exception.

Additionally, it is well established within the common law in Alberta and elsewhere that "watercourses" include waters that flow only intermittently.[23]

The NRCB must consider ephemeral and intermittent streams as "streams" since the definition used by the NRCB in the Part 2 Application includes several types of water bodies, making no exception for seasonal ones. In comparison, sloughs often dry up but are still sloughs nevertheless. In the NRCB request for data in the application form for the Part 2 Application, there is no differentiation between seasonal and year-round waterbodies. Specifically, it requests measurements between the manure storage facility and a surface water body (e.g., lake, creek, steam, seasonal).[24] The Approval Officer erred by referring to this stream incorrectly as a drain (which is a man-made system of piping).

Finally, the Approval Officer erred in concluding that the absence of water diversion permits on Pigeon Lake meant that there was no plausible chain of causality between the proposed CFO and personal consumption of water.[25] This ignores the rights of riparian (indicating adjacency to a water body) household users under the *Water Act* to divert water for household purposes without a licence or permit. There are riparian household users within Grandview who can and do divert water for household purposes. Also, Section 5 of the *Part 2 Regulation* acknowledges a party to be an affected party if that party is "entitled" under the *Water Act* to divert water. To be an affected party the *Part 2 Regulation* does not state that water diversion must occur. It is therefore irrelevant if domestic water use comes from wells.

To conclude this section of the argument, Grandview is clearly an "affected party" with respect to the CFO application. This is because many Grandview residents have rights under the *Water Act* to divert water for household purposes, and are located within 10 miles downstream of the CFO. The fact that this provision is in the *Part 2 Regulation* shows it is an important consideration for determination of DAP status. Grandview is therefore an affected party under Section 5 of the *Part 2 Regulations* and should have been given notice of the application under Section 19 of AOPA. While being considered an affected party does not necessarily entitle Grandview to DAP status, the evidence that Grandview is an affected party goes directly to the question of whether there is a causal chain between the proposed CFO and the negative effects anticipated by Grandview. This is discussed more under heading 1), below.

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[22] *Water Act*, RSA 2000, c W-3, at s 1(1)(ggg), online: <https://canlii.ca/t/55391>; *Environmental Protection and Enhancement Act*, RSA 2000, c E-12, at s 1(yyy), online: <https://canlii.ca/t/5575w.

[23] *Makowecki v Yachimyc*, 1917 CanLII 377 (AB CA), at 367-368, 373-376, 385-386, online: <https://canlii.ca/t/gw6s3>; *Kapicki v Andriuk*, 1974 CanLII 282 (Alta. District Court), at paras 28-37, online: <https://canlii.ca/t/2bhmb>; *Harwood Farms Ltd. v Western Irrigation District*, 2021 ABQB 467, at paras 7, 22, 67-68, online: <https://canlii.ca/t/jgh7t>; *Toporowski v Farrell*, 1995 CanLII 387 (BCSC), at paras 1-2, 5, 14-20, online: <https://canlii.ca/t/1dr7g>.

[24] Part 2 Technical Requirements at p 6, "General Environmental Information", online: <https://www.nrcb.ca/public/download/files/111829>.

[25] See Decision Summary, Appendix C, at p 20.

Damage and Prejudice to Grandview as a result of the Approval Officer decision

In the NRCB form for a party to request review of an Approval Officer decision, including review of a DAP decision, Section 3 asks the party to identify the "prejudice or damage" that will result from the Approval Officer's decision. Grandview's SOC outlines the environmental, community, and economic damage that will occur to Grandview if the Board reverses the Approval Officer's decision and the proposed CFO is permitted to be constructed and operated. The Approval Officer's decision denying Grandview DAP status prejudices Grandview because it creates a possibility that the Board could review that decision without Grandview being given fair opportunity to bring evidence and make submissions, despite the fact that Grandview and its residents will be directly impacted by the outcome of such a review.

In the event that the Approval Officer's decision to deny the CFO does not undergo review, Grandview is still prejudiced by the decision that it is not a DAP. If the Approval Officer's decision on DAP status is not reviewed and reversed, it will set an adverse precedent that Grandview cannot be considered a DAP with respect to other CFOs or related decisions in the Pigeon Lake watershed. As outlined in Grandview's SOC, Grandview participates in the Pigeon Lake Watershed Association and in negotiations for land use planning within the watershed. Grandview has also invested considerably in infrastructure and regulations to protect water quality at Pigeon Lake. Grandview's residents have much to lose from the development of CFOs in the Pigeon Lake watershed, and if the decision that Grandview is not a DAP is allowed to stand, then Grandview risks never having the opportunity to be heard in future NRCB proceedings regarding CFOs that directly impact its residents and their livelihoods.

The following paragraphs demonstrate that Grandview meets the five-point test for DAP status, and that consequently the Board should reverse the Approval Officer's determination that Grandview is not a DAP in these proceedings.

1) Plausible chain of causality exists between proposed project and effect asserted

Section II of this submission, above, outlines Grandview's statement of concern ("SOC"). The effects that prompted Grandview to seek to participate in the permitting process of this proposed CFO can be summarized as: a) environmental effects, specifically harmful algal (cyanobacteria) blooms in Pigeon Lake resulting from nutrient runoff from the CFO manure storage facility and manure-spreading lands; b) the effects on the Grandview residents, economy, recreation, tourism, and the larger community; and c) inconsistency between the proposed CFO and land-use planning documents which Grandview participated in creating. The reasons that the Approval Officer gave in denying to permit the CFO were "materially negative and long-lasting effects on the community", and inappropriate use of land. The chain of causality between the effects that led to the Approval Officer denying this application is the *same* chain of causality that exists between the proposed CFO and the effects asserted in Grandview's SOC.

The Approval Officer noted that for this particular CFO, the presumption of acceptability to the economy and community is "rebutted by the significance, variety, and substances of the concerns

expressed by the directly affected parties."[26] As noted by the Approval Officer, the small size of the Pigeon lake watershed relative to the size of the lake and the long residence time of the lake water make this lake particularly vulnerable to inflowing contamination. For this reason, the Pigeon Lake watershed is different from many other watersheds in the province. The effects on the community and the concerns raised by DAPs that led to the Approval Officer's conclusion were the location in a sensitive watershed, the high use of the greater area for recreation, and the efforts by the community to improve the health of Pigeon Lake.[27]

The concerns cited by the Approval Officer as reason to deny the project are the same concerns that Grandview raised in its SOC. As well, Grandview is located in the same sensitive watershed and on the shores of the same lake, relies on recreation and tourism on the lake to sustain its economic viability, and has invested significant resources, including financial resources, into improving and protecting the health of Pigeon Lake. It is clear that the same causal chain exists between the community effects cited by the Approval Officer as reasons to deny the project and the concerns raised by Grandview in its SOC. The effects of an approved project going ahead would include detrimental effects on Grandview.

The Approval Officer also cited several land-use planning documents in his decision that the proposed CFO is not an appropriate use of land. These documents include the Pigeon Lake Watershed Management Plan ("PLWMP") and the Pigeon Lake Area Concept Plan ("PLACP").[28] As outlined in Section II above and as stated in Grandview's SOC, Grandview is a longtime supporter of the Pigeon Lake Watershed Association and was actively involved in developing these two planning documents. Grandview's SOC raised concerns about the inconsistency between the project and these planning documents. Geographically, Grandview lies within the area covered by both the PLWMP and PLACP. Therefore Grandview has a direct interest in ensuring that land use activities in those areas are consistent with both plans. There is a clear causal chain between the proposed CFO and improper land use effects, as evidenced by the Approval Officer's decision, Grandview's SOC, and the expert input by Dr. Vinebrooke.

a) Approval Officer's errors in defining "stream" and considering water diversion rights led to improper constraints on parties granted DAP status

Beginning on page 4, above, this submission demonstrates that the Approval Officer erred in concluding that the stream located adjacent to the manure storage facility of the proposed CFO is not a "stream" for the purposes of identifying affected parties under the *Part 2 Regulations*. As well, the Approval Officer erred in concluding that there were no parties with water diversion rights for the purposes of identifying affected parties under the *Part 2 Regulations*.

When the correct definition of "stream" (which includes an intermittent stream) is used, and combined with the fact that most Grandview residents have *Water Act* rights to divert water from Pigeon Lake, it is clear that Grandview should be considered an affected party under Section 5 of the *Part 2 Regulation*. This means Grandview ought to have been given notice of the CFO

[26] Decision Summary at p 6.
[27] Decision Summary at p 6.
[28] Decision Summary at p 7.

application along with other affected parties. This also reinforces the causal chain between the proposed CFO and the effects on water quality that Grandview raised in their SOC. Due to the flow of water from this stream into Pigeon Lake, Grandview will be directly and materially affected by nutrient runoff from the proposed CFO in the same manner as a party within the affected party radius would be, and perhaps more so.

2) Effect would probably occur

In denying DAP status to Grandview and other Summer Villages that submitted SOCs, the Approval Officer stated that there was only a "low probability of occurrence of the issues they identified."[29]

As outlined above in the section on the causal chain of effect, the reasons that the Approval Officer gave for denying the application included many of the concerns raised by Grandview in its SOC. The Approval Officer cited negative community effects, including effects on the sensitive watershed and on recreation. Effects on the watershed and on recreation, through harmful algal blooms, will directly affect Grandview if they occur, as Grandview is located on the shores of Pigeon Lake and downstream of the proposed CFO.

The Approval Officer concluded that "the evidence indicates a ***strong likelihood*** for the proposed CFO to negatively impact the community in a material way and duration if the CFO were approved" (emphasis added).[30] The anticipated negative impacts cited for this conclusion include impacts on recreational use of the lake, the "concerted and coordinated work put into lake improvement over the past couple of decades", and "various activities" pursued by "many people."[31] Those are many of the same concerns raised by Grandview in its SOC, as outlined in section II above. Therefore the effects that prompted Grandview to submit an SOC are the same effects that the Approval Officer concluded would have a "strong likelihood" of occurring.

From a scientific perspective, the Approval Officer's conclusion that the effects are improbable is simply incorrect. Dr. Rolf Vinebrooke, Professor of Aquatic Ecology at the University of Alberta, explains the connection between increased nutrient runoff (in the form of phosphorous, nitrogen, and dissolved organic matter from cattle manure produced at the proposed CFO) and cyanobacteria blooms as a direct cause-and-effect relationship.[32] As the proposed CFO is located next to a waterway which drains into Pigeon Lake,[33] which is properly characterized as a stream as explained above, it is nearly certain that nutrient runoff from the proposed CFO will enter Pigeon Lake and contribute to the eutrophication effects including harmful algal blooms raised in Grandview's SOC. The manure spreading lands associated with this CFO also have watercourses flowing through them that enter Pigeon Lake, increasing the likelihood of these effects. The Approval Officer himself cited the PLWMP, which states that the Pigeon Lake watershed has a small land base, and water in Pigeon Lake has a high residence time, both of which make Pigeon

[29] Decision Summary, Appendix C, at p 21.
[30] Decision Summary, Appendix F at p 38.
[31] Decision Summary, Appendix F at p 38.
[32] Rolf Vinebrooke, "Expert Limnological Input" (4 June 2022), attached.
[33] Vinebrooke, attached, at p 2.

Lake "susceptible to nutrient accumulation and possible overloading over time."[34] Therefore it was an error for the Approval Officer to find that these same issues identified by Grandview have a low probability of occurring, and Grandview has demonstrated that this part of the test for DAP status is met.

3) Effect could reasonably be expected to impact the party

Grandview exists as a community of residents and tourists because of the health and natural beauty of Pigeon Lake. In its SOC, Grandview stated that it has put a significant investment of municipal resources into improving Pigeon Lake by decreasing nutrients from landscaping and sewage. Grandview has also participated in the Pigeon Lake Watershed Association, including in the preparation of the PLWMP and the PLACP. The local economy and environment could be devastated if the water quality of Pigeon Lake were compromised. The Approval Officer denied the CFO application because, in his opinion, the effects of the proposed CFO on the "greater community" would be unacceptable.[35] A reasonable person would conclude that Grandview, located on the shores of Pigeon Lake, is part of this "greater community" that will be impacted by the proposed CFO. Therefore this third part of the test for DAP status is met.

4) Effect would not be trivial

The effects of the proposed CFO on the environment and economy of Grandview would be far from trivial. As stated in Grandview's SOC, "[a]nyone who has lived through a significant bloom knows the damaging effects a bloom can have on the quality of life at the lake, the property values and the local economy."[36]

In fact, the Approval Officer himself recognized the magnitude of the effects, finding that those effects would be "materially negative and long-lasting."[37]

Dr. Vinebrooke reasons that the effects of eutrophication (which is increased nutrients from run-off) in Pigeon Lake, including effects from the proposed CFO, could "offset many of the remediation efforts" undertaken by Grandview and other parties in the watershed. Grandview and others have invested a non-trivial amount of resources and money into improving and protecting Pigeon Lake, for example by undertaking the construction of a multi-million dollar regional sewer system in collaboration with five other municipalities.[38] If the effects of the proposed CFO undermine this investment, that would present a non-trivial loss of taxpayer dollars and municipal funds for Grandview.

Grandview represents a home and vacation or recreation destination to many people, including residents and families. Losing the ability to use and enjoy Pigeon Lake – possibly forever – would be a non-trivial effect to these people. For those that rely on the lake for their livelihoods through recreation and service industries, long-lasting effects to the lake could be career-ending.

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[34] Decision Summary, Appendix F, at pp 34-35.
[35] Decision Summary, Appendix F, at pp 38-39.
[36] Grandview SOC at p 2.
[37] Decision Summary at pp 1 and 30.
[38] Grandview SOC at p 1.

5) Effect falls within the NRCB regulatory mandate under AOPA

The effects set out in Grandview's SOC fall squarely within the NRCB's regulatory mandate under AOPA. Specifically, Grandview raised concerns about the proposed CFO's likely contribution to degraded water quality and harmful algal blooms in Pigeon Lake, and the effect this would have on the local residents, recreational users, and the economy.

Section 20(1)(b) of AOPA sets out considerations that an Approval Officer is required or permitted to make once the Approval Officer has determined that the proposed CFO is consistent with a municipal development plan and the requirements of the regulations. As the Approval Officer determined that the proposed CFO was consistent with the County of Wetaskiwin Municipal Development Plan, this section of AOPA applies. One of the mandatory considerations under this section is "effects on the environment, the economy and the community and the appropriate use of land."[39] It was this same section that the Approval Officer based his analysis on and which ultimately led to him denying to permit the proposed CFO.[40] This section of AOPA, and the Approval Officer's reliance on it in making his decision, indicate that the effects raised by Grandview are within the regulatory mandate of the NRCB under AOPA.

V. Conclusion and Action Requested:

This RFR of DAP status has set out the reasons why Grandview should be considered directly affected by the proposed CFO and why the Board should reverse the Approval Officer's decision denying Grandview DAP status. It has also set out the damage and prejudice that will result to Grandview if the Approval Officer's decision is not overturned. Grandview has demonstrated that it meets the five-part test for DAP status and has provided sufficient supporting evidence to substantiate its claim.

Grandview requests that the Board reverse the Approval Officer's decision by granting DAP status to Grandview, and thereby giving Grandview the opportunity to participate by bringing evidence and making submissions during any review and hearing process that may result with respect to the proposed or future CFO applications.

[39] AOPA at s 20(1)(b)(ix).
[40] Decision Summary, Appendix F at p 33.

Summer Village of Grandview

P.O. Box 100 (605 - 2nd Avenue)
Ma-Me-O Beach, Alberta T0C 1X0
Phone: (780) 586-2494 Fax: (780) 586-3567
Email: Information@svofficepl.com
Website: www.grandview.ca

March 29, 2022

Natural Resources Conservation Board
Attn: Nathan Shirley, Approval Officer

Via email: Nathan.shirley@nrcb.ca

Re: Application RA21045 - Statement of Concern

Dear Mr. Shirley

The Summer Village of Grandview is hereby submitting a statement of concern over the proposed confined feeding operation as proposed in the subject application and also requesting directly affected party status.

1. **Summer Village of Grandview**

The Summer Village of Grandview is located on the south west shores of Pigeon Lake. One of the five purposes of municipalities as specified under the Municipal Government Act (MGA) is to foster the well-being of the environment (ref: MGA, Section 3). The Summer Village takes this duty seriously and has embraced watershed stewardship in every aspect of our activities and responsibilities.

In collaboration with five other municipalities (the Summer Villages of Ma-Me-O Beach, Crystal Springs, Norris Beach, and Poplar Bay, and the County of Wetaskiwin), we have undertaken a multi-million dollar investment in a regional sewer system to get sewage out of the environment. This project was funded in part by the Alberta Government under the *Water for Life* program, which, as the name implies, has the goal of protecting Alberta's water resources. In our summer village, over 20 septic fields were removed through this project, and our wastewater is now completely contained from collection to disposal.

We have significantly increased the area of environmentally protected areas in order to protect our natural vegetation for absorbing nutrients before they enter the lake. We were the first municipality in Alberta to prohibit both lawn fertilizers and lawn herbicides, again to reduce the nutrient load to Pigeon Lake. We have a yearly tree planting program and have planted hundreds of trees in our summer village. We are a strong supporter of the Pigeon Lake Watershed Association, an organization focused on protecting Pigeon Lake through advocacy, education, and collaboration.

Our residents are passionate about our lake and have raised significant concerns over the 4000 cattle confined feeding operation (CFO) being proposed in an area of the watershed that drains directly into Pigeon Lake through a well-developed drainage pattern. Because the applicant intends to spread manure in this area, the proposed CFO will result in nutrients entering adjacent streams and flowing to the lake. This will have a direct and adverse effect on our Summer Village through the degradation of Pigeon Lake.

2. Application for Affected Party Status

The Summer Village of Grandview is within 10 miles downstream of the proposed CFO. The municipality and many of its residents have riparian ownership as defined by the Water Act. This ownership affords the right to obtain water, which will be adversely affected if this application is approved.

The Summer Village in its entirety will also be adversely affected by the additional nutrient load to Pigeon Lake, which will degrade water quality and cause a significant reduction in property values. We are therefore registering for affected party status and requesting, for reasons submitted herein, that the application be denied.

Specifically we contend the following:

a) *There is an uninterrupted chain of cause and effect between the proposed CFO and the riparian area of our Summer Village*. It will be shown in this submission that there is significant flow from the exact position of the manure storage facility and the manure spreading area through Sunset Harbour Creek to Pigeon Lake. Also, measurements have been presented to show that this flow has already has alarmingly high concentrations of phosphorus from an existing intensive livestock operation. It is well known, particularly to the Natural Resources Conservation Board as the regulator of confined feeding operations, that phosphorus is a nutrient that causes the formation of cyanobacteria blooms. It is also well known by the Government of Alberta, which has provided millions of dollars in funding to reduce the amount of phosphorus entering Pigeon Lake as well as other lakes.

b) *The detrimental effects of phosphorus on water quality are likely to occur*. Pigeon Lake is perhaps one of the most studied lakes in Alberta from a scientific perspective, and without exception, all studies recognize the importance of reducing phosphorus migration into the lake as the primary goal for watershed stewardship. The occurrence of cyanobacteria blooms ("blooms") in 2006 and periodically in subsequent years, spurred on the formation of the Pigeon Lake Watershed Association, the passing of many bylaws and Intermunicipal Development Plans, the implementation of multimillion dollar investments by local communities in wastewater projects, and most importantly, a change in the habits and level of respect of the watershed residents for the watershed. Simply put, if an abundance of phosphorus runs to the lake, the lake will be critically damaged.

c) *The effect will not be trivial*. Anyone who has lived through a significant bloom knows the damaging effects a bloom can have on the quality of life at the lake, the property values and the local economy. Dr. David Schindler, the internationally acclaimed scientist and recipient of the Alberta Order of Excellence in 2008, was largely responsible for identifying the causal relationship between phosphorus and water quality. He gave ample warning of the risks of not controlling phosphorus runoff into streams and lakes. The minimization of nutrients from manure is a foundational conclusion of the *State of the Watershed Report* (Aquality, 2008). The consequential effect of algae blooms is also a major cause of fish kills, the latest

of which occurred during July 2021. Cyanobacteria blooms can be dangerous to human life to the extent that Alberta Health Services monitors beaches and issues an advisory if specified limits are exceeded. A significant bloom occurred during the summer of 2015. This bloom made national headlines as shown below and will happen again unless we take action. Pigeon Lake cannot sustain such an ongoing load of nutrients from this cattle operation.

Pigeon Lake algae warning dashes hopes of scum-free summer

Dave Lazzarino
Aug 05, 2016 • August 5, 2016 • 1 minute read • Join the conversation

Large piles of algae wash up on shore at Pigeon Lake near Mulhurst Bay on September 13, 2015
PHOTO BY GREG SOUTHAM /Edmonton Journal

3. Status of Pigeon Lake

Pigeon Lake has been the victim of many years of improper development practices on both the lakeshore and throughout the watershed. The cumulative effects of a vast number of developments have pushed our lake to the breaking point. This lake has an extremely low flushing rate, estimated to be greater than 100 years, which means the effects of added pollutants are significant. The increase in the number and frequency of harmful algae blooms (HABs) in recent years resulted in the formation of the Pigeon Lake Watershed Association (PLWA) and a flurry of research into what was causing this change.

It soon became apparent that the cause of HABs is directly associated with the external load of nutrients from the adjoining land. Watershed residences became engaged with one common purpose – protecting the lake as a valuable resource for future generations. The PLWA's practices and goals of watershed stewardship are now considered as a gold standard for other watershed groups throughout the province.

The State of the Watershed Report was written in 2008 to establish a starting point and a path forward: where we were then and where we were going (ref: *Pigeon Lake State of the Watershed Report*, Aquality Environmental Consulting Ltd, 2008). This report concluded "External and internal nutrient inputs are a concern to the health of Pigeon Lake. Land use

practices, sewage, and *manure management* around the lake should be managed to *minimize further nutrient loadings to the lake."* (ref: ibid. p.38) (Emphasis added).

The efforts of watershed residents are already having a positive effect on the water quality of Pigeon Lake. Through the implementation of beneficial management practices, nutrient loading into the lake has been decreasing, and the results are starting to show. The intensity of the algae blooms is reducing, and we no longer get the almost yearly health advisories for cyanobacteria. But to sustain the momentum of this improvement, we must not let down our guard. The introduction of a 4000 cattle CFO, with the resulting manure spread over many sections of land in this well-drained area of the watershed, will put a dire strain on the capacity of the lake and set back, perhaps irreversibly, the advances made over the past decades, including the benefit of the regional wastewater system.

4. Topography of Western End of Watershed

The majority of land in the Pigeon Lake watershed lies to the west of the lake. It includes rolling land and many forested areas; however, much of the land has been cleared for agricultural purposes. The area around the proposed CFO is adjacent to an existing intensive livestock operation. This existing operation has approximately 1200 head of cattle that can be readily observed moving around unrestrained in the vicinity of the streams and ponds. This proposed project will more than triple the effects of manure contamination to the environment. The area is drained mainly by Tide Creek and its tributaries but also by other streams and tributaries, including the Sunset Harbour Creek, as it is locally known.

Figure 1 shows the quarter section (NW3-47-2 W5M) in which the proposed CFO is located. This site is drained by the Sunset Harbour Creek and its tributaries, which are ephemeral streams that flow to the northeast approximately 2½ km to Pigeon Lake. There are also other drainage patterns in the area where manure spreading is proposed. During the spring freshet, the rapid runoff of the snow melt has been measured to have a high concentration of dissolved phosphorus. As part of a nutrient loading study, water samples were taken in March 2022 from the two stream crossings on Range Road 22, which are shown in Figure 1. The values for dissolved phosphorus were reported at alarmingly high values of 2.0 and 1.6 mg/L for the north and south tributaries respectively. Dissolved phosphorus is a parameter that gives an indication of the amount of bioavailable phosphorus, which contributes directly to the formation of cyanobacteria blooms.

Sample Description	: RR 22, North, #1	Bureau Veritas Sample Number	: AQL761
Sample Date & Time	: 2022/03/22 16:00	Bureau Veritas Job Number	: EC218604
Sampled By	: ALM	Sample Access	:
Sample Type	:	Sample Matrix	: Water
Sample Received Date	: 2022/03/23	Report Date	: 2022/03/28
Sample Station Code	:		

PARAMETER DESCRIPTION	Results	UNITS	INST.	VMV Code	QA/QC BATCH	RDL	DL
Lab Filtered Nutrients							
Dissolved Phosphorus (P)	2.0	mg/L	KONE	2010	A535183	0.075	0.0030

Sample Description	: RR 22, S, #1	Bureau Veritas Sample Number	: AQL762
Sample Date & Time	: 2022/03/21 15:00	Bureau Veritas Job Number	: EC218604
Sampled By	: ALM	Sample Access	:
Sample Type	:	Sample Matrix	: Water
Sample Received Date	: 2022/03/23	Report Date	: 2022/03/28
Sample Station Code	:		

PARAMETER DESCRIPTION	Results	UNITS	INST.	VMV Code	QA/QC BATCH	RDL	DL
Lab Filtered Nutrients							
Dissolved Phosphorus (P)	1.6	mg/L	KONE	2010	A535183	0.15	0.0030

Note: full sample results are available upon request

Previous work by Alberta Environment and Parks on their study of the phosphorus budget for Pigeon Lake (ref: Pigeon Lake Phosphorus Budget, Chris Teichreb, 2014) measured values of Total Phosphorus and Dissolved Phosphorus in Sunset Harbour Creek at values much smaller. The results show that the values of Dissolved Phosphorus have increased by a factor of almost 20 in less than 10 years! (ref: *2013 Overview of Pigeon Lake Water Quality, Sediment Quality and Non-Fish Biota*, Teichreb, Peter and Dyer, May 2014, page A22). The high values of Dissolved Phosphorus suggest that the land being drained, i.e., Section 3-47-2 W5M, is not being subject to proper stewardship practices. It is recommended that the approval officer visit this land to see what agricultural practices are currently being followed to help determine the starting point of a cumulative effects evaluation.

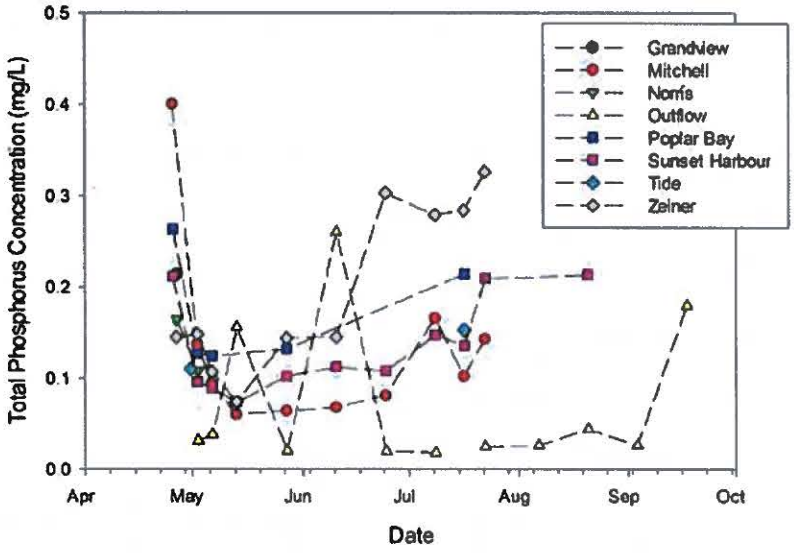


Figure 4-3 Pigeon Lake Streams Total Phosphorus Concentrations, 2013

Ref: *Pigeon Lake Phosphorus Budget*, Teichreb 2014 shows maximum values of Total Phosphorus in Sunset Harbour Creek of 0.2 mg/L compared to 2022 values of greater than 1.6 mg/L of Dissolved Phosphorus in the 2 tributaries

Figure 1. Drainage streams flowing north east to Pigeon Lake. The location of the proposed CFO is highlighted. The white arrows show the locations where the photographs in Figures 3 and 4 were taken.

5. Location of Proposed CFO

The location of the proposed manure lagoon is directly opposite a stream in the drainage pattern for this sub-watershed, which drains to the lake near Sunset Harbour. An enlargement of Section NW3-47-2 W5M is shown in Figure 2. It appears that a current feeding operation is located directly north of the proposed manure lagoon. This structure is also located very close to the stream and should be reviewed, especially in view of the high phosphorus runoff from this area. This stream must have some long-lasting significance as it forms a demarcation between the cleared land and the forested area in the southeast part of this quarter section.

Figure 2. Location of proposed manure lagoon in NW3-47-2-W5M (highlighted) is directly adjacent to a drainage stream.

During periods of heavy rainfall and during the spring freshet, this tributary of Sunset Harbour Creek experiences heavy flows. Photographs taken during the freshet on March 19, 2022, are shown in Figures 3 and 4 of the stream crossing on Range Road 22 and on Hwy 771 respectively. The locations of these steam crossings are indicated on Figure 1 by white arrows.

Figure 3. Steam Crossing on Range Road 22 during spring freshet March 19, 2022.

Figure 4. Stream crossing at Hwy 771 near Sunset Harbour during spring freshet, March 19, 2022.

It is readily apparent from the dark brown colour of the water that the streams are carrying a significant nutrient load from draining the land proposed to be the disposal area for the manure from 4000 cattle. The resulting increase in phosphorus load to Pigeon Lake could well bring Pigeon Lake to the breaking point.

6. Plan for Manure Disposal

If constructed properly, neither the CFO nor the collection area for the produced manure presents any real environmental problems other than perhaps the odour associated with such operations. The true problem arises from the disposal of such a large amount of manure. It appears that this manure will be in liquid form and will be dispersed on a large area of land drained by streams and tributaries that all flow into Pigeon Lake.

The high phosphorus concentrations found in Sunset Harbour Creek, as evidenced by water samples, can only be expected to increase as the load of manure increases. This manure will be applied year after year into the foreseeable future. With the cumulative effects of this proposed operation added to the existing intensive livestock operation on the property and to the effects of development that has already impaired Pigeon Lake, we are basically risking the survival of one of Alberta's premier lakes for a cattle operation that actually contravenes development policies established by the Pigeon Lake Watershed Management Plan, the County of Wetaskiwin, and the Natural Resources Conservation Board. These issues are discussed in the following sections.

7. The Pigeon Lake Watershed Management Plan

The *Pigeon Lake Watershed Management Plan* (the "Plan") was adopted in 2018 by the 12 municipalities of Pigeon Lake and supported by the Chiefs of the Maskwacis Cree Four Nations, the Pigeon Lake Regional Chamber of Commerce, and other key stakeholders. It is a roadmap to guide development in the watershed with the incorporation of beneficial management practices. The Plan recognizes that CFOs have no place within the boundaries of the watershed due to concerns over phosphorus load. Specifically, Objective 2e from the Plan (p. 17), shown below, states that there should be no CFOs within the watershed:

2e	**New or Expanded Intensive Livestock Operations** Statutory land use restrictions on new or expanded intensive livestock operations (including CFO's) are supported in this Watershed Management Plan	Policy	Lead: Mun Support: APLM, GoA, PLWA	Ongoing	No Intensive Livestock Operations

(Note: the Plan can be found at www.PLWA.ca)

8. County of Wetaskiwin Plans

The County of Wetaskiwin (the "County") recognizes the importance of Pigeon Lake and the need for protecting it from harmful impacts. The County has adopted by resolution the *Pigeon Lake Area Concept Plan* ("ACP") in recognition of the need for long-range plans in areas experiencing growth pressures. *"The County of Wetaskiwin recognizes that increased development and growth pressures need to be addressed on a cooperative basis to ensure the long-term protection and sustainability of Pigeon Lake"* (ref: ACP section 1.1). In Section 5.5, policies are presented to guide the County when evaluating a proposal to develop land in the

watershed. The pertinent policy under the heading Agriculture is clear in recognizing that CFOs should not be in the watershed:

> ***5.5.2 Agriculture***
> *Large-scale confined animal operations are not appropriate in the Pigeon Lake watershed.*

The County's *Land Use Bylaw* (LUB) also provides some direction on CFOs within the County. In Section 9.6.1 of the LUB, the County recognizes that CFOs are regulated by the Agricultural Operation Practices Act and Regulations (AOPA) and under the jurisdiction of the Province but clearly states *"it is the County's intent that any negative effect from CFOs should be minimized, and that the Municipal Government Act requires the municipality to identify where new CFOs should locate."*

This is a sensible and responsible approach being taken by the County to achieve their goal of protecting Pigeon Lake. The Area Concept Plan, discussed above, clearly states that CFOs should not be located within the watershed. Although CFOs are not under County jurisdiction, the County addresses a high standard for a similar operation – Intensive Livestock Operations. Section 9.6.7 states that "an existing or proposed Intensive Livestock Operation may be refused if the proposed development is likely to have a negative effect on a watercourse or lake."

Their LUB addresses the spreading of manure in Section 9.6.10 as shown below:

> **9.6.10** Land within identified drainage basins 2.4 kilometres (1.5 miles) around named lakes (as referred to in the Municipal Development Plan) may not be used for manure disposal unless sufficient protection measures are proposed by the operator to prevent manure runoff negatively affecting such lakes. In accordance with the County's jurisdiction regarding Intensive Livestock Operations (ILO). (*amended by Bylaw 2019/44*)

The Application specifies land area that will be used for the spreading of manure. It appears that SE10-47-2 W5M is within the specified distance of 2.4 km, as shown in Figure 5.

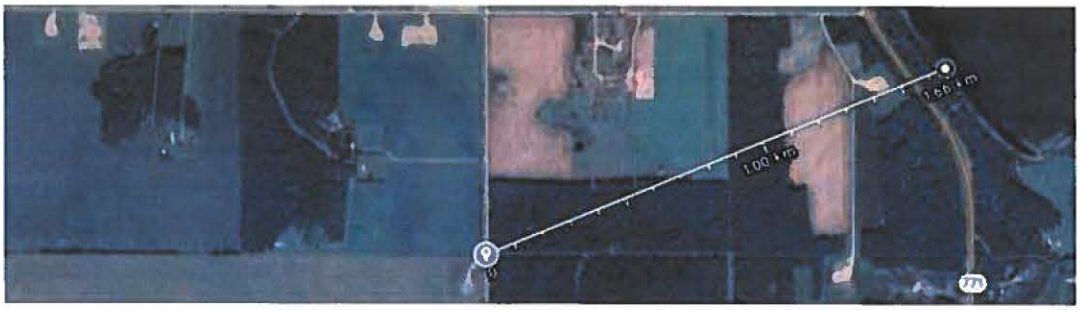


Figure 5. Distance from SE10-47-2W5M to Pigeon Lake is 1.66 km.

The County recognizes that spreading of manure has a negative effect on waterbodies.

The County's *Municipal Development Plan* also provides direction over the concern about the environment. Environmental protection is a focus of this plan as stated in Section 3 shown below:

3 Environmental Protection

Protecting the natural environment from over-development is another focus of this Plan. Concerns regarding lake water contamination, fish population decrease and ground water decline were expressed by the public during the Plan preparation.

9. The Adequacy of the Application

The Regulations are specific as to what is required in the application. Two important items do not appear to be included: water courses and drainage patterns. Drawing C04 appears to show a phantom outline of a water course, but it is not specifically highlighted in the application. Also, the drainage pattern is not shown.

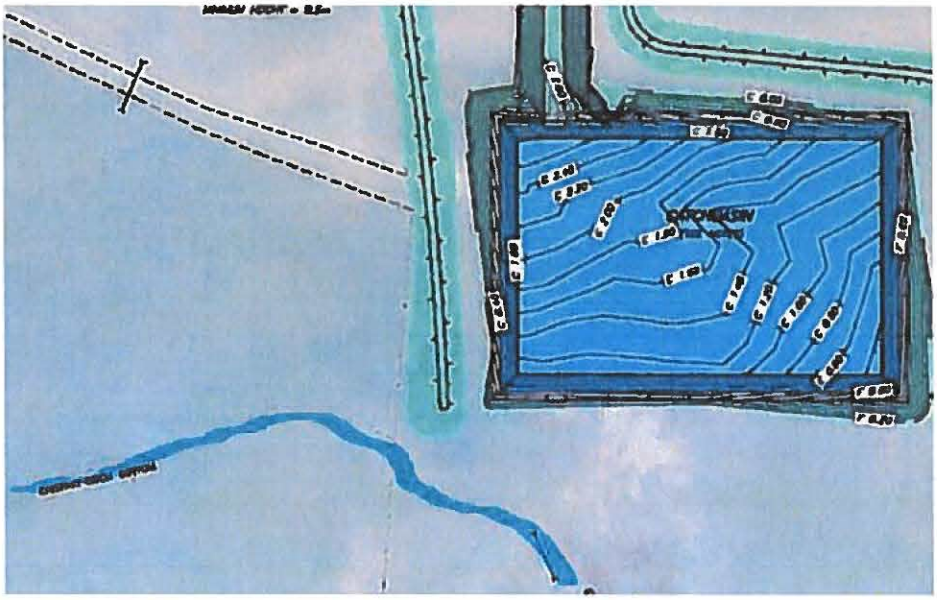


Figure 6. Excerpt from drawing C04 from Application showing adjacent stream highlighted. Notations are illegible on the provided copy.

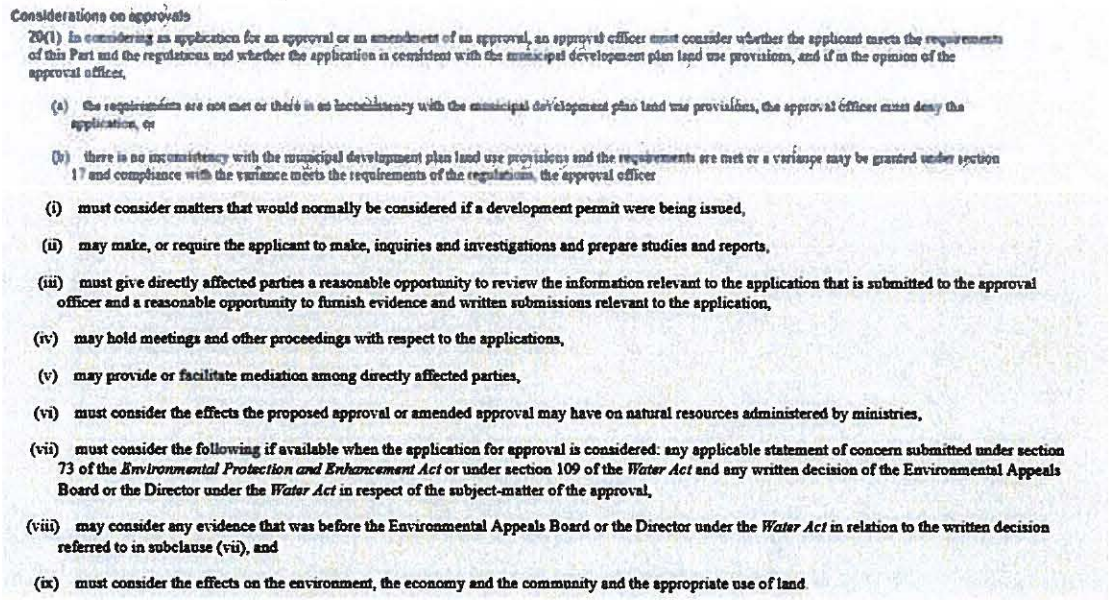
Figure 1 shows this is a water course directly adjacent to a manure lagoon. An excerpt from the referenced drawing is shown as Figure 6 with the water course highlighted for reference purposes. The published application does not show the location of the water wells, nor is the description of the water course legible. However, Figure 6 clearly shows that the manure storage facility fails to meet the minimum setback provisions in AOPA of 30 m.

The drainage pattern is not shown; however, it can be inferred that the area drains towards the stream. This is also implied by the satellite image in Figure 2, which appears to show drainage from a feed lot towards this stream.

10. Regulation by the Natural Resources Conservation Board

CFOs are regulated by the Natural Resources Conservation Board under the requirements of AOPA. While the requirements of AOPA seem to be quite minimal in that the setback distances

seem very small, some important responsibilities are bestowed on the board. Section 20 of AOPA provides these requirements:



Considerations on approvals

20(1) In considering an application for an approval or an amendment of an approval, an approval officer must consider whether the applicant meets the requirements of this Part and the regulations and whether the application is consistent with the municipal development plan land use provisions, and if in the opinion of the approval officer,

(a) the requirements are not met or there is an inconsistency with the municipal development plan land use provisions, the approval officer must deny the application, or

(b) there is no inconsistency with the municipal development plan land use provisions and the requirements are met or a variance may be granted under section 17 and compliance with the variance meets the requirements of the regulations, the approval officer

(i) must consider matters that would normally be considered if a development permit were being issued,

(ii) may make, or require the applicant to make, inquiries and investigations and prepare studies and reports,

(iii) must give directly affected parties a reasonable opportunity to review the information relevant to the application that is submitted to the approval officer and a reasonable opportunity to furnish evidence and written submissions relevant to the application,

(iv) may hold meetings and other proceedings with respect to the applications,

(v) may provide or facilitate mediation among directly affected parties,

(vi) must consider the effects the proposed approval or amended approval may have on natural resources administered by ministries,

(vii) must consider the following if available when the application for approval is considered: any applicable statement of concern submitted under section 73 of the *Environmental Protection and Enhancement Act* or under section 109 of the *Water Act* and any written decision of the Environmental Appeals Board or the Director under the *Water Act* in respect of the subject-matter of the approval,

(viii) may consider any evidence that was before the Environmental Appeals Board or the Director under the *Water Act* in relation to the written decision referred to in subclause (vii), and

(ix) must consider the effects on the environment, the economy and the community and the appropriate use of land.

Basically, this section of AOPA states the Approval Officer must determine if the application meets with the requirements of the AOPA, the Regulations, and the Municipal Development Plan. If there is an inconsistency, then the Approval Officer must deny the application. If not, then the Approval Officer must consider the following:

- matters normally considered if a development permit were being issued (such as the cumulative environmental impact and location of the CFO),
- the effects on natural resources administered by ministries (such as Pigeon Lake, which is controlled by Alberta Environment and Parks), and
- the effects on the environment.

The NRCB has a clear and well defined obligation to consider and evaluate the effects of the proposed CFO on the environment, the economy, the community and the appropriate use of the land. Failure to properly consider factors which cause the degradation of Pigeon Lake will place the responsibility squarely on the NRCB who will be held accountable.

11. Effect and Process

This project is perhaps the most significant perceived threat to Pigeon Lake in recent history. It has the potential of impacting all watershed residents whether or not they are in the Minimum Setback Distance. It will certainly affect the Ministry of Environment and Parks in that there is a Provincial Park campground just over 2 miles downwind of this facility. Anyone that has driven in the vicinity of Gull Lake or other areas of the province where liquid manure is spread knows all too well the enduring smell of liquid cattle manure. This Park will soon gain a reputation of being a "stinky" campground with a consequential loss of tourism. This ministry will also be faced with the challenges of increased fish kills and a possible loss of a major sports fishing lake. The increased flow of truck traffic hauling cattle, grain, manure, and hay unfortunately, as with odours, also expend past the Minimum Setback Distance.

One other aspect that must not be forgotten is highlighted in the following excerpt from the Alberta Water Council, which needs no further elaboration:

> *Cultural and Spiritual Values*
> Since time immemorial, Indigenous peoples have used lakes for all manner of life-supporting and life-affirming purposes, including for travel and as basic sources of food, drinking water and medicinal plants. Lakes are also important areas of cultural, spiritual and aesthetic significance for Indigenous communities. Many Indigenous people believe the Creator gave instructions to respect water, air and the land by keeping it pure, and these original instructions are reflected in many Indigenous beliefs, values and traditions to this day.

Ref: Alberta Water Council *Recommendations to Improve Lake Watershed Management in Alberta,* (2017)

The basic question to be answered is why should such an operation be approved when it will have such detrimental effects on so many watershed residents and visitors. As can be seen from the satellite image in Figure 7, when a bloom appears, it is both transient and ubiquitous, and it affects all lake residents.

Figure 7. Satellite image of Pigeon Lake during an algae bloom Oct. 17, 2018 (ref: ABMI.ca)

The process for considering this application is also a concern. Section 20(1)(iii) and (iv) state that the officer must give affected parties reasonable opportunity to review the application and also that public meetings may be held. With less than one month notice being given and at a time when many of the affected parties are not at the lake, it does not appear that this condition is satisfied. With the resounding outcry of concern from residents near and far, it is a fair question to ask why a public meeting is not being held.

12. Conclusion

The Summer Village of Grandview contends that:

11.1 The Summer Village of Grandview and its residents are directly affected parties. They will be harmfully impacted by the additional phosphorus load this project will introduce to Pigeon Lake, affecting both quality of life and property values at the lake.

11.2 This application does not meet the requirements of the Regulations in that the CFO manure storage facility is located within the minimum setback of 30 m of a stream.

11.3 The requirements of the County of Wetaskiwin's Municipal Development Plan are not met in that the County can stipulate where CFOs can be located and clearly declare, through their Area Concept Plan, that the CFO should not be located within the boundaries of the watershed of Pigeon Lake. Also the MDP specifies manure spreading may not be done within 2.4 km of a named lake (including Pigeon Lake). The measured distance from SE10-47-2 W5M, a quarter designated for manure spreading, is 1.66 km as shown in Figure 5. The Application does not comply with the requirements of the County's development plans and therefore must be denied.

11.4 Legislation requires that the approval process must consider the cumulative environmental impacts this CFO will have on Pigeon Lake. Evidence provided from stream analyses shows that there is already a significantly high nutrient runoff occurring from this area of the watershed.

11.5 Approval of this application would impact natural resources under the purview of the Ministry of Environment, which has jurisdiction over Pigeon Lake, and

11.6 This project is not in the public interest.

13. Recommendation

The Summer Village of Grandview recommends that this application be denied on the basis of its environmental impact to Pigeon Lake and its failure to meet the legislated requirements.

Respectfully submitted by the Summer Village of Grandview

Don Davidson
Mayor, Summer Village of Grandview

cc. County of Wetaskiwin, attn: Rod Hawken
Pigeon Lake Watershed Association, attn: Catherine Peirce
Sylvia Roy, CAO, Summer Village of Grandview

Addendum No. 2 to the Summer Village of Grandview's Statement of Concern

Application No. RA 21045

Date: May 9, 2022

We request that the following addendum be added to the Summer Village of Grandview's Statement of Concern dated March 29, 2022:

Conflict with the County of Wetaskiwin's Municipal Development Plan

Contrary to statements made by the County of Wetaskiwin (County), we contend the proposed CFO does not meet the requirements of the County's MDP. The MDP lists the following requirements for CFOs (p. 10):

a) The County is to identify where the new CFO should locate. Implicitly this means it can state where a CFO should not locate.
b) The minimum distance setback (MDS) of AOPA should be maintained. The MDS relates to residences.
c) Any new CFO must meet the setback distances as illustrated in Figure 3 (1.5 miles for city, town, village, hamlet, school and hospital).
d) Under no circumstance can a CFO be closer than 1 mile from Pigeon Lake. But still, the other specified setbacks must be maintained.
e) All other environmental features must meet the AOPA setback requirements.
f) Figure 3 (p. 11) specifies a setback from a water course as 0.8 km.

Figure 1 of our March 29 Statement of Concern shows that two watercourses traverse Sec 3-47-2 W5M (the section on which the CFO is proposed to be located). No location anywhere in the section meets the minimum setback of 0.8 km from these watercourses. In addition, the arrangement of creeks in this area of the watershed appears to leave no location anywhere that would meet this setback requirement.

It should be noted that the AOPA regulations stipulate setback distances for manure storage facilities, not for CFOs, so the MDP requirement for setbacks from CFOs should govern. The MDP's planning objectives pertaining to the protection of Pigeon Lake and the environment are all consistent with the specified setback of 0.8 km from water courses.

Conclusion

Our previous submission listed several reasons this application should be denied. This addendum shows that the application directly conflicts with the County's MDP. Since AOPA legislation stipulates that the Approval Officer must deny an application that does not meet the requirements of a local MDP, this application must be denied.

The referenced sections of the MDP, including Figure 3, are included below:

Objective 1.4 Minimize the land use conflict with Confined Feeding Operations and surrounding land uses

While the Confined Feeding Operations are under Provincial jurisdiction[4], it is the County's intent that any negative effect from the Confined Feeding Operation should be minimized. The Municipal Government Act requires the municipality to identify where new Confined Feeding Operations should locate.

An Intensive Livestock Operation is a Confined Feeding Operation that is smaller than the threshold size that falls under Provincial jurisdiction, as determined by the Provincial guideline.

1.4.1 The minimum distance setback of Alberta Agriculture Code of Practice, as amended, should be maintained.

1.4.2 For an Intensive Livestock Operation, the Minimum Distance Separation is determined by using the threshold level of the animal or the combined effects of the different kind of animals that are kept on one premise.

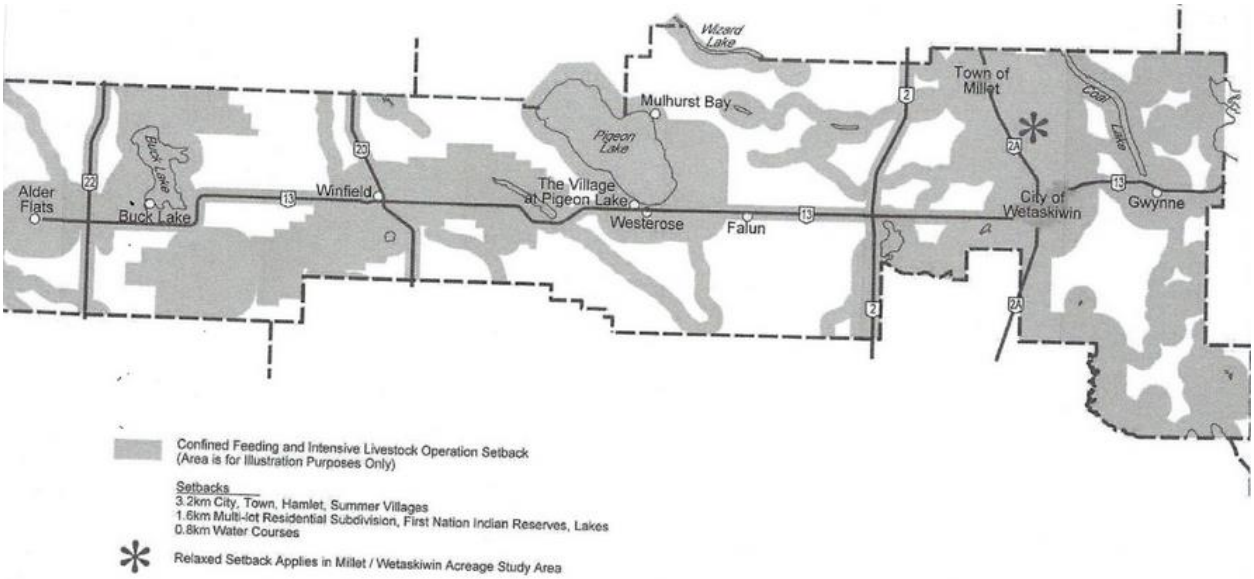
1.4.3 Any size of new Confined Feeding Operation (including Intensive Livestock Operation) must not locate within the following setback distances as illustrated in Figure 3.

a) 2.4km (1.5 miles) from the boundary of any city, town, village, hamlet, and school and hospital.

b) Under no circumstances can a new CFO be located within 1.6km (1 mile) of the following named lakes: Battle Lake, Buck Lake, Coal Lake, Pigeon Lake, Red Deer Lake, Wizard Lake and Twin Lakes.

c) All other unspecified environmental features, including but not limited to lakes not specified in (b), wetlands, and watercourses shall have setbacks in accordance with Alberta Operation Practices Act and Regulations (AOPA) as amended.

Figure 3 which states the setback from a CFO to a water course is 0.8 km.



County of Wetaskiwin No. 10
Municipal Development Plan

Figure 3: Confined Feeding and Intensive Livestock Operation Setback

Scheffer Andrew Ltd.
Planners & Engineers

Scale 1:500 000

Summer Village of Grandview

P.O. Box 100 (605 - 2nd Avenue)
Ma-Me-O Beach, Alberta T0C 1X0
Phone: (780) 586-2494 Fax: (780) 586-3567
Email: Information@svofficepl.com
Website: www.grandview.ca

June 8, 2022

Nathan Shirley. Approval Officer
Fiona Vance, Chief Legal Officer
Natural Resources Conservation Board
Via email

Re: Application RA21045: Requests to the NRCB

The Summer Village of Grandview, along with many other interested parties, is currently preparing for the next step in the approval process of the subject application. It has become apparent that this process, as set out in the NRCB's policies, is not particularly user friendly.

The narrow windows of opportunity for both submitting a statement of concern and a request for review seem to conflict with the NRCB's value statement with respect to fairness. The statement of concern must be submitted within 28 days and the request for review must be submitted within 10 days of the Decision. This means that for requesting a review, a directly affected party must first understand the issues and basis for the decision and then prepare a meaningful review request.

In addition, the Board has, for some reason, decided that the Approval Officer's Decision will also announce who is considered a directly affected party and who is not. This means that anyone who has been determined not to be a directly affected party must also finalize a submission requesting the Board to review that status – all within a 10-day window.

Since most affected parties around CFOs are rural families or small communities with not much experience in preparing legal arguments against the giants of the agri-business world, there should be no reason why the Board or the Approval Officer cannot apply the legislated requirements for notification rather than a Board policy that appears to highly favor the applicant.

In the case of RA21045, literally hundreds of parties who have claimed directly affected party status are currently trying to prepare for a seemingly one-sided battle, uncertain whether to prepare for reconsideration of their status or for a review of the approval of the application or both.

In this regard, the Summer Village of Grandview respectfully requests that the Approval Officer ~~to~~ consider Section 19(7) of AOPA, which states the "approval officer must notify the affected person, organization or member of the public that applies under subsection (f) in writing of the approval officer's determination whether the applicant is a directly affected party." The term "in writing" is usually meant as a direct correspondence with a particular party rather than an inclusion in a decision document. It is our view that this should be done for all parties who have submitted statements of concern and done at the earliest possible opportunity after the decision has been made.

Taking this step would be helpful to all those parties who have an interest in the outcome of the application and would improve the quality of responses.

Another courtesy that would be extremely helpful is to give an update of the timeframe of when the decision is going to be issued.

Also, we request once again that our SOC Addendum #2, submitted and accepted on May 9, be added to your web portal.

Thank you for your consideration of these requests. We look forward to your response.

Yours truly,

Don Davidson
Mayor

UNIVERSITY OF ALBERTA

Department of Biological Sciences
Faculty of Science

CW 312 Biological Sciences Building
780.492.1257/1870
Edmonton, Alberta, Canada T6G 2E9

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June 4, 2022

From:
Dr Rolf Vinebrooke
Professor of Aquatic Ecology
Department of Biological Sciences, University of Alberta
2-271, Centennial Centre for Interdisciplinary Sciences
Cell: 780-919-1421
Tel: 780-492-1870
E-Mail: rolf@ualberta.ca

To:
Whom it may concern

I have been asked by the Mayor of the Summer Village of Grandview Don Davidson to provide expert scientific input on the potential cumulative environmental impacts of the proposed confined livestock feeding operation on Pigeon Lake.

Large livestock operations are increasingly major contributors to the degradation of freshwater ecosystems around the world (e.g., Lake Winnipeg). They generate a variety of chemicals that can directly enter waterways via surface runoff and indirectly via seepage into underlying groundwater, particularly during extreme weather events (e.g., flooding). Elevated concentrations of phosphorus, nitrogen, and dissolved organic matter (DOM) found in water discharge from these agricultural operations pose major threats to lake and stream ecosystems because they stimulate excess growth of various harmful bacteria and algae, termed "eutrophication." Below, I provide greater details concerning the role that each of these groups of chemicals when released into the environment can play in contributing to the future eutrophication of Pigeon Lake.

Phosphorus has long been identified as the key nutrient that fuels algal growth in lakes, such as in Pigeon Lake. For example, very clear and clean water conditions typically exist in Pigeon Lake during the spring and early summer because phosphorus levels are so low (~10 micrograms per litre) as to preclude rapid algal growth. Thereafter, warmer mid-summer water temperatures stimulate release of phosphorus from where it is stored in lake sediments, which then stimulates algal production. If phosphorus concentrations then increase over 30 to 50 micrograms per litre, this results in the proliferation of toxic cyanobacteria. Since phosphorus is a sedimentary element, any even minute external subsidy of this element from the surrounding landscape ends up contributing long-term to that stored in the lake sediments. Thus, the potential for greater release of this limiting nutrient from the sediments increases over years, thereby contributing to earlier and more intense outbreaks of cyanobacteria, termed "blooms." In fact, other lakes in Alberta that have already received large nutrient subsidies now annually experience intense cyanobacterial blooms that begin immediately after spring ice-out (e.g., Lake Isle). Further, climatic warming is known to synergistically increase the impact of phosphorus

on cyanobacterial blooms by accelerating recycling of this nutrient once it has entered a lake. Therefore, a proposed livestock operation that contributes phosphorus in Pigeon Lake will become increasingly worrisome under the rapidly warming climate that we face here in Alberta.

Inputs of nitrogenous compounds can also contribute to algal growth in Pigeon Lake. The importance of nitrogen to blooms becomes evident in mid-summer with the appearance of certain cyanobacteria that can compensate for the lack of this nutrient in the lake by taking it up from the atmosphere. Thus, external input of nitrogen from the landscape would provide relief from nitrogen limitation and thereby stimulate increased algal growth. There also exists a synergistic interaction between external inputs of nitrogen and phosphorus that amplifies their net stimulatory effect on cyanobacterial growth that exceeds the sum of the individual effects of these two nutrients.

External input of DOM from the livestock operation also represents a source of excess nutrients to Pigeon Lake. DOM often consists of organically bound nitrogen and phosphorus, which can be released and made bioavailable to cyanobacteria via photodegradation by exposure to sunlight and enzymatic breakdown by microbes. In addition, DOM is also a very important carbon source for certain potentially toxic strains of bacteria that can pose major health risks to humans and wildlife (e.g., *E. coli*).

In summary, the proposed livestock operation located near a waterway represents a potential downstream threat to Pigeon Lake. The threat mainly involves deterioration of water quality due to excess nutrient runoff fueling toxic cyanobacterial production, and subsequently decomposition of this material that deprives key aquatic organisms of oxygen. The above stated cumulative impacts on water quality and harvestable fish capacity are characterized by several synergistic interactions among excess nutrient inputs and climatic warming. On that note, increasingly extreme climatic events (e.g., flooding events, summer heatwaves) will likely contribute to greater transport of these nutrients into Pigeon Lake where they will also be more rapidly recycled, resulting eutrophication that will offset many of the remediation efforts that have been accomplished over the past decade.

Sincerely yours,

Rolf Vinebrooke

Rolf Vinebrooke

PIGEON LAKE

watershed management plan 2018

Pigeon Lake Watershed Management Plan Steering Committee
May 04, 2018

Working Together for a Healthy Watershed, Healthy Lake, and Healthy Community

TECHNICAL SUPPORT

(RECOMMENDED CITATION)

Pigeon Lake Watershed Management Plan Steering Committee (plwmp.ca). May 2018.
The Pigeon Lake Draft Watershed Management Plan 2018.
Pigeon Lake Watershed Association (plwa.ca) and Alliance of Pigeon Lake Municipalities (aplm.org)

PLAN ADOPTION AND SUPPORT

Pigeon Lake Watershed Management Plan - 2018

Municipal Resolution This Plan has been adopted by municipalities councils having passed the following resolution.

Council, having read and considered the Pigeon Lake Management Plan - 2018, resolves as follows:

1. *To work collaboratively with other Pigeon Lake watershed municipalities, the Pigeon Lake Watershed Association and the Pigeon Lake Watershed Steering Committee to implement the Pigeon Lake Management Plan - 2018.*
2. *To reference and consider the recommendations of the Pigeon Lake Management Plan - 2018 in the development of new or updated Statutory Plans required under the Municipal Government Act and in the ordinary business of the municipality.*

Municipality		Signature	Date
Leduc County,	Mayor		July 3, 2018
County of Wetaskiwin,	Reeve		June 1, 2018
SV of Argentia Beach,	Mayor		June 19, 2018
SV of Crystal Springs,	Mayor		June 13, 2018
SV of Grandview,	Mayor		June 8, 2018
SV of Golden Days,	Mayor		May 29, 2018
SV of Itaska Beach,	Mayor		June 8, 2018
SV of Ma-Me-O Beach,	Mayor		June 8, 2018
SV of Norris Beach,	Mayor		May 30, 2018
SV of Poplar Bay,	Mayor		June 8, 2018
SV of Silver Beach,	Mayor		Aug 20, 2018
SV of Sundance Beach,	Mayor		Aug 20, 2018

Endorsements of the Pigeon Lake Management Plan - 2018 by partner organizations.

Endorsing Organizations	Date
Alliance of Pigeon Lake Municipalities (APLM)	September 20, 2017
Pigeon Lake Watershed Association (PLWA)	December 07, 2017
Alberta Lake Management Society (ALMS)	March 26, 2018
Battle River Watershed Alliance (BRWA)	April 26, 2018
Pigeon Lake Regional Chamber of Commerce	February, 2018

Letter of Support for the Mamawo Mimiw Sakahikan Working Group and the Pigeon Lake Watershed Management PLan

Samson Cree Nation

Ermineskin Cree Nation

Louis Bull Tribe

Montana Band

SAMSON CREE NATION ERMINESKIN CREE NATION LOUIS BULL TRIBE MONTANA BAND

Letter of Support for the Mamawo Mimiw Sakahikan Working Group and the Pigeon Lake Watershed Management Plan

The state of Pigeon Lake and the importance of water for the current residents and future generations is bringing the watershed communities together.

The Maskwacis Cree (Samson Cree Nation, Ermineskin Cree Nation, Louis Bull Tribe and Montana First Nation) support the exploration of partnerships with the Pigeon Lake Watershed Association and the Pigeon Lake Watershed Management Plan (PL Plan) Committee to realize the vision:

Working together for a healthy watershed, healthy lake and healthy community.

The Mamawo Mimiw Sakahikan Working Group is commissioned to investigate opportunities and report recommendations to the Maskwacis Cree.

The Maskwacis Cree recognize that the health of Pigeon Lake and its watershed is complex with multiple governments, municipalities, and stakeholders. We recognize and are concerned that the health of the lake impacts the health of the people who collectively live, work and play at Pigeon Lake. We also recognize that the land, the shore and the lake are important to a healthy natural environment.

The Maskwacis Cree is in support of Mamawo Mimiw Sakahikan Working Group work to:

- Explore how the PL Plan may be important for the Pigeon Lake Reserve.
- Build bridges with the PL Plan Committee and have a voice in the work being done.
- Provide the Maskwacis Cree and the Pigeon Lake Reserve Residents with opportunities to be informed and to participate in the implementation of the PL Plan.
- Identify and share the tools and knowledge from this work, for the benefit of the Maskwacis Cree and Pigeon Lake Reserve.

Given that water is life, and that all living things depend on it, the health of the rivers, lakes, ground water, rain and snow are all of critical importance to the Maskwacis Cree; we, the Maskwacis Cree, as recognized governments for IR 138A Pigeon Lake Reserve endorse and support the formation, work and goals of the Mamawo Mimiw Sakahikan Working Group as stated in this Letter of Support and Terms of Reference.

CONSENTED to by the CHIEFS of the MASKWACIS CREE:

Per: Per: Per: Per:

Chief Vern Saddleback, Samson Cree Nation
Chief Craig Makinaw, Ermineskin Cree Nation
Chief Irvin Bull, Louis Bull Tribe
Chief Leonard SOTR, Montana Band

cc Ermineskin Cree Nation
Louis Bull Tribe
Montana First Nation
Samson Cree Nation
Government of Alberta, Environment and Parks
Battle River Watershed Alliance
Pigeon Lake Watershed Association
Pigeon Lake Watershed Management Plan Steering Committee

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Pigeon Lake Watershed Management Plan Steering Committee

Members *(alphabetical order)*

Tim Belec	President, Lakedell Agricultural Society
Doris Bell**	Former Deputy Mayor, SV of Crystal Springs
Glenn Belozer	Councillor, Leduc County, APLM Rep
Wiebe Buruma	Alberta Agriculture & Rural Development
Don Davidson (Deputy Chair)**	Mayor, SV of Grandview, APLM Rep
Susan Ellis**	Executive Director, PLWA
Robert (Bob) Gibbs, (Chair)**	PLWA Director, WMP Committee Chair
Ruth Harrison	Former PLWA Board, AFGA, NSWA
Tom Karpa	Pigeon Lake Regional Chamber of Commerce
Ron LaJeunesse**	Deputy Mayor, SV of Crystal Springs
Arin MacFarlane Dyer**	Planner, Alberta Environment and Parks
Nicholaus Moffat	Parks Planner, Leduc County
Rex Nielsen	APLM Vice Chair, Itaska Councillor, APLM Rep
Kathy Rooyakkers	Reeve, County of Wetaskiwin
Sarah Skinner**	Watershed Planning Coordinator, BRWA
John Slater	Councillor, SV of MaMeO Beach
Harold Wynn	CAO, SV of Silver Beach and SV of Sundance

** Plan Writing and Engagement Team Member

Plan Advisors

Jane Dauphinee	Senior Planner, Municipal Planning Services Ltd.
Theo Charette	Limnologist, CPP Environmental
Leta van Duin	ED, Alberta Low Impact Development Partnership
Bradley Peter	ED, Alberta Lake Management Society
Kim Barkwell	County Sustainable Ag Program Manager
Hugh Read	Editorial Assistance, Westbridge Communication Inc. & Grandview Beach Councillor
Chris Teichreb	Limnologist Albert Energy Regulator, (Former AEP)
Greg Nelson	Watershed Planner, AEP
Claire Klassen	Limnologist, Alberta Environment and Parks
Richard Casey	Limnologist, Alberta Environment and Parks
Terry Chamulak	Hydrologist, Alberta Environment and Parks
Cristina Buendia-Fores	Hydrologist, Alberta Environment and Parks
Tom Habib	Research Coordinator, Alberta Biomonitoring Institute

INTRODUCTION

Pigeon Lake is a popular beautiful prairie lake which has provided both livelihood and enjoyment for many generations of Albertans. Geologically, the lake is over 10,000 years old, left behind after retreating glaciers. The watershed and lake are part of Treaty 6, for the traditional lands of aboriginal peoples, stretching from Alberta's eastern slopes to the Manitoba border. The Maskwacis Cree (Samson Cree Nation, Ermineskin Cree Nation, Louis Bull Tribe and Montana First Nation) were provided home reserves near Maskwacis, Alberta and a satellite reserve on the shores of Pigeon Lake (Reserve 138A) for traditional access to Pigeon Lake and fishing.

Early settlement activities were based on logging, farming and fishing. Today, in addition to farming, the watershed features several hamlets, acreages and cottage communities, IR 138A, campgrounds and business centers – all creating a significant regional economy.

The lake provides for many types of recreation and the simple pleasures of enjoying nature. All those who live, work and play in the watershed influence the health of the lake. This Pigeon Lake Watershed Management Plan ("Plan") provides guidance as to what we can accomplish together to improve the health of the lake and surrounding watershed.

PURPOSE

The purpose of the Pigeon Lake Watershed Management Plan is to develop a comprehensive, science-based strategy to coordinate action for the protection and improvement of Pigeon Lake, its shore lands, and its watershed.

VISION

Working together for a healthy watershed, healthy lake, and healthy community.

The Plan recognizes that a large-scale complex set of systems and processes influence the overall health of the lake. Many of these processes are nature-based and beyond human control. Similarly, the time frame for positive outcomes is difficult to predict. The Plan advocates for multiples management strategies that are within our collective control. The Plan sets out a road map for collective action in key areas to offset the effects of the past and to restore a better balance for the lake environment. To address the challenges facing the lake, action and commitment is needed by all parties.

GOALS

The Plan's goals are to:

- Reduce the frequency and intensity of algal blooms.
- Improve the health of the watershed and the lake.
- Improve the recreational value of the lake and economic health of the region.

COMMON GROUND

The Plan recognizes that a variety of perspectives and interests exist among the various municipalities and stakeholders of the Pigeon Lake watershed. The Plan focuses on topics and actions that are rooted in science, provide benefit, and represent common ground.

PLAN DEVELOPMENT

Technical development of the Watershed Management Plan progressed in stages over a number of years:

2012-14	Establishment of the Pigeon Lake Watershed Management Plan Steering Committee and Terms of Reference
2013-15	Development of Beneficial Management Practice (BMP) Recommendations and Guides for: 1. Cosmetic Fertilizers and Soil Management 2. Model Land Use Bylaw 3. Surface Water Runoff
2016-18	Preparation of the comprehensive Pigeon Lake Watershed Management Plan was undertaken in several stages.

COMMUNITY AND STAKEHOLDER ENGAGEMENT

The Plan incorporates input from the public and stakeholders starting from the development of the Terms of Reference to the most recent Plan initiative. A summary of engagement initiatives that shaped the current plan are detailed in Appendix B of the Appendix volume. An engagement committee has been directing engagement and communication initiatives. Engagement and communication methods include:

- ✓ Joint Newsletters (APLM/PLWA) – spring and fall
- ✓ PLWA Community Engagement (farmers markets, door to door)
- ✓ PLWA AGM Presentations and Open House
- ✓ PLWMP and PLWA websites
- ✓ Annual Pigeon Lake Leaders Session
- ✓ Facebook since 2014 (Pigeonlakewatershedassociation)
- ✓ Pigeon Lake Twitter
- ✓ Workshops and Open Houses
- ✓ On Line Survey using Survey Monkey
- ✓ Engagement of specific stakeholder groups
- ✓ Presentations to Municipal Councils, AIMS and the APLM

All these strategies have been used throughout the development of the Plan in 2016-18. Public and stakeholder support for the plan has been very positive. The online survey was conducted in the summer of 2017. A total of 176 people filled in the survey on behalf of at least 397 people of which 95.5% own property around Pigeon Lake- see more in Appendix B.

Representations have been made to all 12 Municipal Councils to clarify concerns and seek support. Working with local groups such as the Pigeon Lake Regional Chamber of Commerce has been positive and ongoing.

MASKWACIS CREE

Since the PLWA began, engagement with the Maskwacis Cree has been important. In 2017, the draft Plan gave further impetus for working together. A working group of the Maskwacis Cree has been proposed in support of the Plan Vision and to explore opportunities to work together.

BACKGROUND

Pigeon Lake is a popular recreational lake in central Alberta.

Lake and watershed management planning is a means to address concerns and issues affecting Pigeon Lake and its surrounding watershed. The first two versions of watershed management plans for Pigeon Lake were completed in 1975 and 1985 respectively. In 2000, a Watershed Management Plan for the Pigeon Lake area was adopted by resolution by twelve municipalities (two counties and ten summer villages) with municipal boundaries abutting Pigeon Lake. While currently in effect, this plan needs to be updated.

Following significant algae blooms in 2006, the Pigeon Lake Watershed Association (PLWA) was formed to assist the watershed municipalities and stakeholders in addressing concerns and courses of action. Recognizing the need to plan and work collaboratively with community, municipal, traditional, and provincial partners, the PLWA began commissioning new scientific studies to determine the state of the lake, the shoreline area, and the surrounding lands.

In 2012, the PLWA began a renewed Pigeon Lake Watershed Management Plan that focused on education, beneficial practices and bylaws. This program was directed by a multi-stakeholder Steering Committee. By 2016, the PLWA, in partnership with the Alliance of Pigeon Lake Municipalities (APLM) and Alberta Environment and Parks (AEP), committed to prepare a comprehensive Pigeon Lake Watershed Management Plan (2018) that would combine the knowledge gained from research on the Pigeon Lake area with beneficial management practices for improved outcomes.

FIGURE 1: Aerial Photo of the Pigeon Lake Watershed (Outlined in Black)

The Plan promotes implementation by municipal partners through the statutory planning and bylaw adoption processes. The Plan also identifies actions that can be

implemented by individuals, municipal governments, provincial government, First Nations, non-governmental organizations, and technical specialists.

PROGRESS TO DATE

This Plan is informed by a considerable number of studies and prior initiatives already in place. These efforts have been spearheaded and funded by many organizations including the municipalities, the PLWA, the APLM, several non-governmental organizations, the Government of Alberta, The Government of Canada, the PLWMP Steering Committee, the University of Alberta, and the Alberta Biomonitoring Institute.

The following works are either underway (**u/w**) or completed (✓).

Scientific Studies

STATUS	DATE	TITLE
✓	2001+	Annual LakeWatch Reports (Water Quality) (2001, 2010, 2011, 2013, 2014, 2015, 2016, ongoing)
✓	2008	Pigeon Lake State of the Watershed Report
✓	2006/08	Shoreline Assessments
✓	2010	Hydrological Assessment and Water Balance Update
✓	2010+	Cyanobacteria Monitoring (Since 2010)
✓	2011	Water Quality Conditions & Long-Term Trends in Alberta Lakes
✓	2012	Options for the Control of Blue Green Algae.
✓	2012	Blue Green Algae Management: Review of work to date (PLWA)
u/w	2012+	Investigations of water importation, hydraulic dredging, and phosphorus inactivation
✓	2013	Overview of Pigeon Lake Water Quality, Sediment Quality, and Non-Fish Biota
✓	2013	Aquatic Invasive Species PVC monitoring
✓	2014	Pigeon Lake Phosphorus Budget 2014
✓	2015	PLWA Citizen Cyanobacteria Monitoring
✓	2016	Paleolimnology Sediments Study
✓	2016	Tropic Cascade Mesocosm Research
u/w	2016	Algae Harvesting
✓	2016	Sediment Sampling Study
✓	2016/17	Pigeon Lake Watershed Phosphorus Runoff Model
✓	2017	Pigeon Lake Summary of the Science
u/w	2017/18	Pigeon Lake Bloom Causal Factors
u/w	2017/18	Research on economic costs of blue green algae blooms

Social Research Studies

STATUS	DATE	TITLE
✓	2013	PLWMP Engagement Report "Are We on Track?"
✓	2014	Cosmetic Fertilizer Survey
✓	2015	Clean Runoff Survey

Legislation & Beneficial Practices Guidance

STATUS	DATE	TITLE
✓	2008	Law & Policy Framework Phase I Report
✓	2010	Regulatory and Policy Actions for a Healthy Pigeon Lake Watershed Phase II Report
✓	2012/13	PLWMP Terms of Reference
✓	2012/14	PLWMP Topic I – Cosmetic Fertilizers & Soil Management • Cosmetic Fertilizers Terms of Reference (2012) • Research on North AM Bylaws (2013) • Input from Soil Experts (2013) • Cosmetic Fertilizer & Soil Nutrients Guide (2014-15)

STATUS	DATE	TITLE
✓	2012/14	PLWMP Topic II – Model Land Use Bylaw • Model Land Use Bylaw: Lakeshore Environmental Development Provisions
✓	2012/14	PLWMP Topic III – Surface Water Runoff • Alberta Clean Runoff Action Guide

Stewardship Education and Advocacy

STATUS	DATE	TITLE
✓	2006+	Stewardship and Education Initiatives • Websites, Newsletters & Brochures • Information Booths, Speakers, Education Sessions • Himalayan Balsam Eradication Program • Grandview Creek Restoration • Tree Planting Program • Watershed 101 for new Councillors • Newcomers Packages • Love the Lake (Children's Event)

✓	2006+	Advocacy
		• Meetings and representation at APLM, Annual Information Meetings, Council Meetings, with First Nation Elders and committees when invited, and with all levels of Alberta Environment and Parks.
		• Representing Pigeon Lake & learning from others
		  • At Central Alberta Recreational Lake Forum
		  • At North America Lake Management Society

✓	2006-2016	Living by Water Shoreline Property Consultations
✓	2011+	Review of land development applications & municipal plans • Leduc County (2011 and 2016) • Watermere Resort (2012 & 2014) • County of Wetaskiwin (2013)
✓	2013+	Aquatic Invasive Species Prevention Efforts, Education & Monitoring
✓	2014+	Healthy-Lake Lawns Program • Brochure, 'How to create and maintain better lawns' spring and fall emails and native grass seed
✓	2015/16	Clean Runoff Action • Clean Runoff Introduction brochure • Three municipal demonstration sites installed • Two residential demonstration sites installed and another underway. • One shoreline pilot restoration and demonstration site installed • Watershed Rain Barrel Campaign (57 sold) • 25 Bird Houses & 10 Bat Boxes installed • Landscaper Clean Runoff workshops. • Sold 25 bags of PLWA native grass seed mix (225g)
✓	2017	• Clean Runoff workshop and native plant sale for everyone • Kids took 64 Bird Houses and 12 Bat Boxes home to install • 17 Rain Barrels sold • Two Clean Runoff Residential Demonstration Site Open Houses Shoreline Restoration Open House

SNAPSHOT OF THE LAKE AND WATERSHED

The Pigeon Lake Watershed Management Plan has a study area of 284 km^2; this includes an area of 96.7 km^2 for Pigeon Lake itself, and 187 km^2 for the surrounding drainage area (or 'Watershed'). The boundary of the Pigeon Lake Watershed Management Plan study area is illustrated in Figures 1 and 2. A list of physical properties of the lake and watershed are provided in Table A.

TABLE A: Physical Properties of the Lake and Watershed

PIGEON LAKE PHYSICAL FEATURES	PHYSICAL PROPERTIES
Lake Surface Area	96.7 km^2
Lake Water Volume	603,000,000 m^3
Maximum Depth	9.1 m
Mean Depth	6.2 m
Shoreline Length	46 km
Mean Annual Lake Evaporation	664 mm
Mean Annual Precipitation	534 mm
Mean Annual Inflow	17,000,000 m^3
Mean Residence Time	Greater than 100 Years
Lake Weir Sill Elevation	849.935 m (Above Sea Level)
Watershed Land Drainage Area	187 km^2
Watershed to Lake Area Ratio	2:1

Pigeon Lake is a relatively shallow large prairie lake. Relative to other Alberta lakes, studies of lake bed sediments show that the lake is moderately nutrient rich (eutrophic) and has always produced algae, which in turns supports a robust fishery. The mean residence time to replace the total volume of water in the lake is over 100 years.

Located in central Alberta, the entire Plan area is located within the Battle River Watershed, which is part of the even larger North Saskatchewan River Watershed.

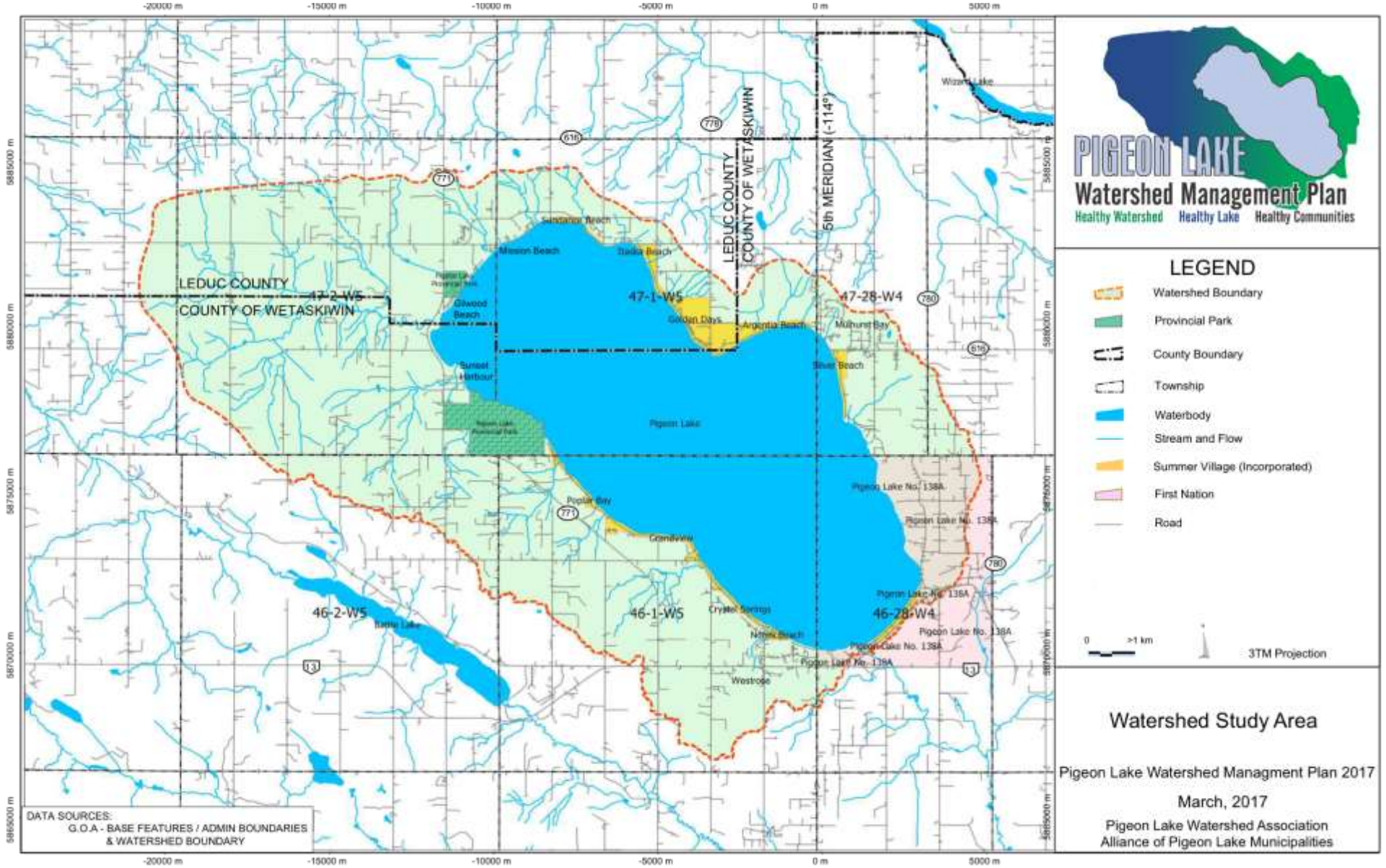
Lands within the Pigeon Lake watershed are administered by ten summer villages, two counties, Maskwacis Cree (IR 138A), and the Government of Alberta (Provincial Parks).

A summary of the science has been prepared by a professional limnologist as a background to the development of the plan. Key factors affecting the overall strategy of the plan are presented below along with key implications.

ALGAE BLOOMS

An important driver of this Plan is that algal blooms have become noticeably more severe and frequent, especially since 2002. Algae are naturally present and are a foundation for the lake's food web and fishery. However, when algae are excessive, they form blooms. Blooms and related health advisories may have caused significant economic and social impacts. The costs of these impacts are being assessed. This Plan promotes a multi-pronged approach to reducing blooms and phosphorus levels.

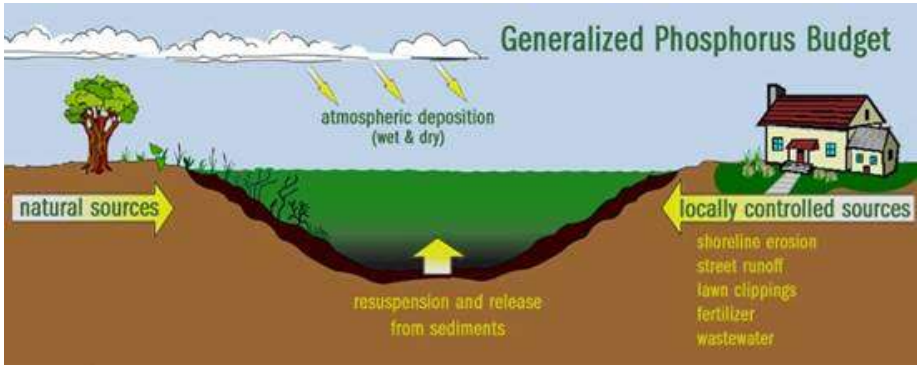
FIGURE 2: Pigeon Lake Watershed Management Plan Study Area



PHOSPHORUS

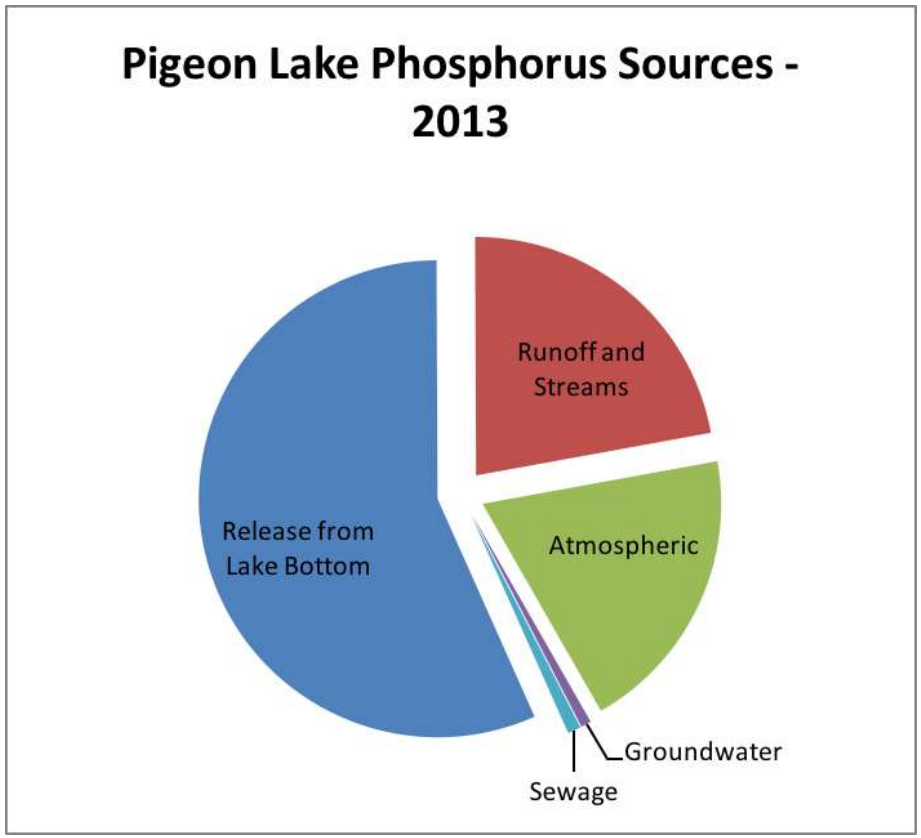
Algae levels are dependent on a variety of factors including climate cycles, sunlight, wind, and nutrient levels in the lake. Specifically, concentrations of phosphorus (a type of nutrient) greatly influence bloom formation. During ice-free conditions, phosphorus enters the lake from the surrounding watershed and the atmosphere (Figure 3) and is taken up by algae. During ice-covered conditions, the suspended sediment and algae (and the associated phosphorus) will settle out into the lakebed sediments, so that phosphorous returns to a low level during ice covered conditions. This cycle is repeated annually.

FIGURE 3: Generalized Phosphorous Budget



The movement of phosphorous into the lake from various sources can be calculated in a "phosphorus budget." During the open-water season of 2013, detailed measurements were taken of phosphorus movement into Pigeon Lake. From these measurements, a summation of annual phosphorus inflows and outflows was prepared in 2014.The phosphorous budget estimates that during the open water season, the lake gains on average 13,250 kg (13.2 metric tonnes) of total phosphorus from sources identified in Figure 4. Each winter, except for small amounts leaving the lake, this amount of phosphorus

FIGURE 4: Phosphorus Sources in 2013



is incorporated into the lakebed sediments, some of which get re-released to the lake in the following years.

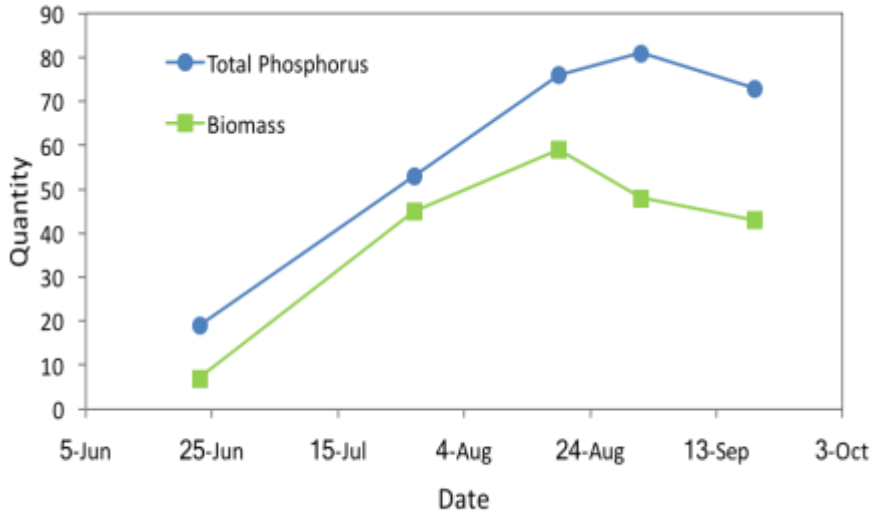
The five colored segments of the pie chart show the relative magnitude of the sources of internal and external loading. The sources of phosphorus that can potentially be managed include runoff, sewage, and release from lake bottom sediments. The Plan will include specific actions to address these sources of phosphorus.

The pie chart (Figure 4) represents only part of a typical year, is generalized and may not be typical of all years. Also, the chart may not fully differentiate

all sources nor all mechanisms and causes of phosphorous entering the lake. More research is needed. Phosphorus from internal sources (the sediments) is phosphorus from external sources deposited in prior years. Managing phosphorus sources from the watershed is a key priority of the Plan.

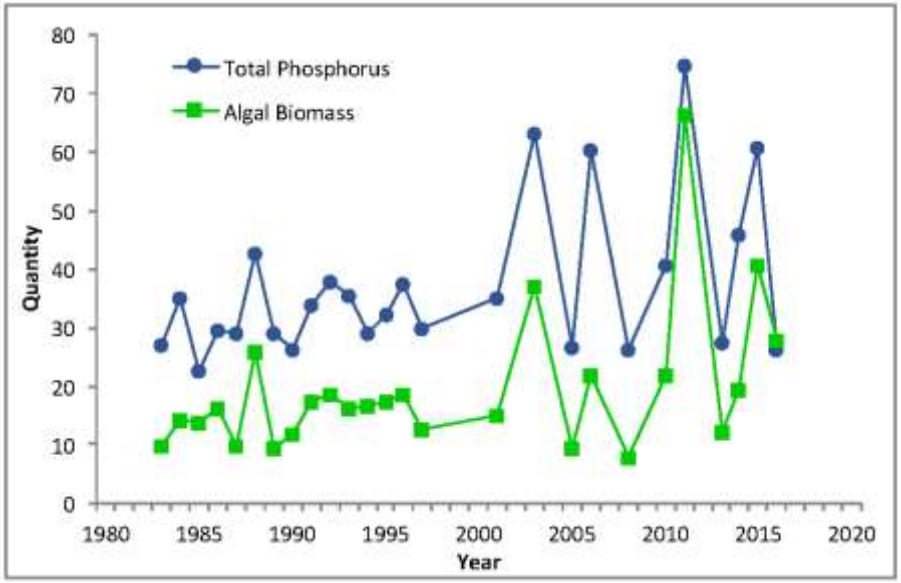
Each year, phosphorus levels in the lake vary from quite low during winter ice cover to higher levels, which in certain years coincide with bloom conditions. Figure 5 shows an example of phosphorus levels in 2015 relative to algal biomass during the open water season.

FIGURE 5: Seasonal Trends in Total Phosphorus and Algal Biomass



Trend lines in phosphorus and algae levels show considerable variations, from one year to the next. Figure 6 shows that since 2002 the pattern of peaks and lows has changed with larger fluctuations and specific years being much higher. There reasons are not fully understood and require more research.

FIGURE 6: Total Phosphorus and Algal Biomass 1983 to 2016



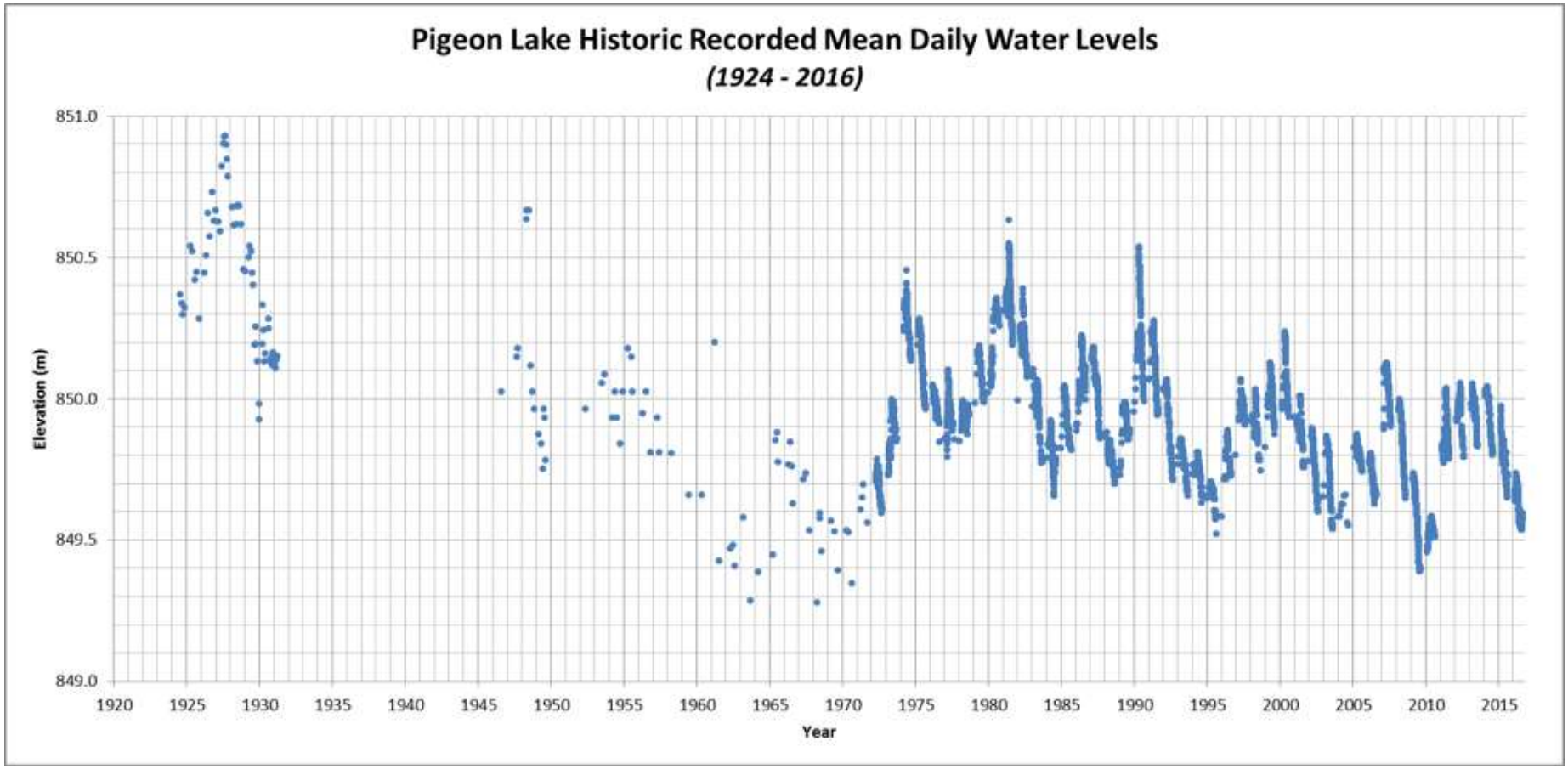
Note: Data points are the annual average value of all samples for each year

LAKE WATER LEVELS

Pigeon Lake is a permanent waterbody. It has a long residence time (the amount of time that water will remain in a basin) of greater than 100 years. The watershed of Pigeon Lake is small relative to the lake itself, with a surface area ratio of approximately 2:1 watershed (187 km^2) to lake (96.7 km^2). Compared to other Alberta lakes, the small drainage area and large evaporative area makes Pigeon Lake particularly sensitive to climatic variability, with changes to precipitation and/or evaporative rates having a considerable impact on lake water levels.

The lake does not have large water withdrawals. The outflow creek that drains Pigeon Lake into the Battle River is fitted with a weir with a crest elevation of 849.935 meters above sea level (masl). When water reaches this elevation, outflow occurs, including a small amount of nutrient release.

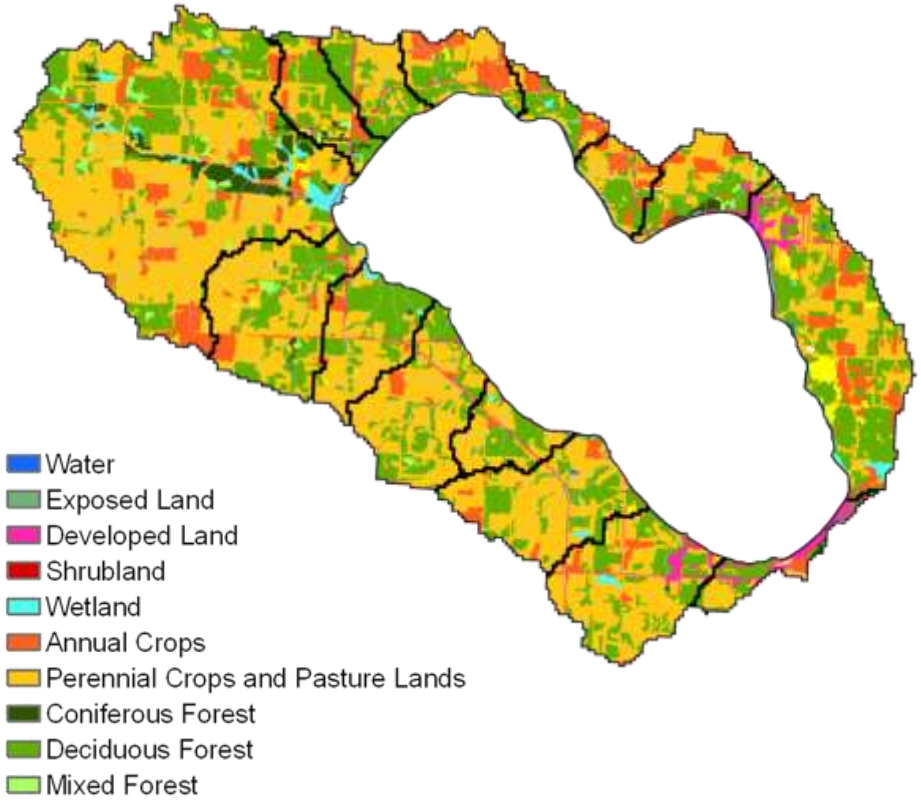
Pigeon Lake has lake level data available since the 1920s. The extensive historical water level data demonstrates that Pigeon Lake experiences ongoing water level cycles of both increasing and decreasing trends when considered over a longer time-period.



LAND COVER AND PHOSPHORUS

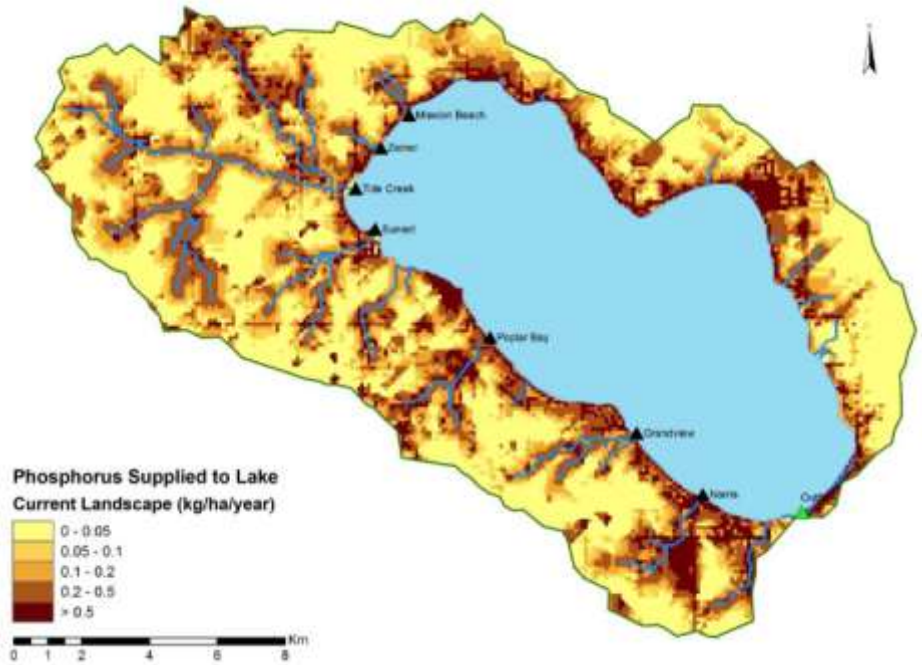
Historically, the watershed was naturally vegetated with forests, grasslands, and wetlands. Currently, the watershed is occupied by a mix of natural vegetation, farming, and developed lands (See Figure 7).

FIGURE 7: Pigeon Lake Watershed Land Cover



The amount of phosphorus runoff from watershed lands is affected to the types of and proportions of land cover. Based on the current land cover types, (for example, forest, pasture, crops, and developed land), a phosphorus loading model was developed. Figure 8 illustrates the pattern of phosphorus intrusion into the lake from the surrounding watershed.

FIGURE 8: Phosphorus Entering Pigeon Lake from the Watershed



Source: Habib. 2017: http://ecosystemservices.abmi.ca/wp-content/uploads/2014/10/ABMI-Pigeon-Lake-Phosphorus-Modelling-final-version-July-2017.pdf

This model shows that areas near streams and the lake shore are the most abundant sources of phosphorus flowing into Pigeon Lake. Based on this information, the Plan will focus on addressing land uses and natural buffers along the streams and lake.

PLAN IMPLICATIONS

From the preceding section and the best available evidence, key considerations affecting the overall strategy and perspective of the plan are:

- Multiple strategies will be required to improve the health of Pigeon Lake. No one strategy (silver bullet) exists that will address the bloom problem.
- The sources of phosphorus that can potentially be managed include runoff, sewage (e.g. septic fields), and release from lakebed sediments.
- The plan identifies three geographic areas where nutrient sources can be managed:
  - The Watershed Lands
  - The Shoreline
  - The Lake
- Managing nutrients, particularly phosphorus, in the watershed is a key priority. Feasible strategies to manage internal loading needs to be further investigated.
- The state of science about Pigeon Lake continues to evolve. Significant knowledge gaps still remain, especially related to nutrient and blue-green algae behavior throughout each season of the year.
- While in-lake treatments have shown promise for smaller water bodies, there are no known examples of successful in-lake treatment interventions for a lake the size of Pigeon Lake. In-lake treatments are short term and require periodic reapplication. Addressing matters such as feasibility, environmental negative effects, regulatory approvals, organizational delivery, and financing means that decisions about in-lake treatment will take further investigation and time.

Photo: Clean Runoff Municipal Demonstration

A ROADMAP

The Plan is organized into four main sections:

- The Watershed Lands: Pigeon Lake watershed up to the height of land surrounding the lake
- The Shoreline: Pigeon Lake's shoreline, including the bank and near shore waters.
- The Lake: Pigeon Lake itself, and
- Working Together: improving our collaboration and organizational capacity

Each of the four key areas of the Plan (Pigeon Lake, Shoreline, Watershed Lands, and Working Together) is structured in the following manner (see diagram):

- ❖ Plan Area (e.g., Watershed, Shoreline, the Lake)
  - Plan Objectives: where we want to go.
    - Recommendations and Actions: How we will get there:
      - Policy: Statutory plans, bylaws, agreements
      - Technical: Science and monitoring
      - Community Action: Advocacy, education, and voluntary action

The recommendations and actions are presented in a tabular form to show how the Plan will be implemented. Alongside of each recommendation are listed:

- responsible parties
- time frame
- measures of success

WATERSHED LANDS

KEY FINDINGS

Reducing the amount of phosphorus pollution entering the water of Pigeon Lake must be a key goal for managing the lake.

The coverage and ecological condition of land cover types with low phosphorous runoff (e.g., forests grasslands and wetlands) should be maintained and/or improved.

Key natural lands such as wetlands and forested lands next to streams and the lake itself should be targeted for restoration. Land use activities should also be restricted in these areas.

OBJECTIVES

Increase land cover types (e.g. forest, wetlands) that have lower nutrient release rates, trap nutrients, and that promote biodiversity.

Improve phosphorous management for all land use activities to achieve a net reduction in nutrient runoff and promote biodiversity.

Promote clean runoff practices to reduce the transport of nutrients to Pigeon Lake.

Protect groundwater that feeds into Pigeon Lake.

LAND COVER & BIODIVERSITY

OBJECTIVE 1 Increase land cover types (e.g., forest, wetlands) that have lower nutrient release rates, trap nutrients, and promote biodiversity.

- Over 60% of the watershed has already been cultivated or converted for human uses, including urban development, pasture/perennial crops, and annual crops.
- Land cover is directly related to the sources and quantity of phosphorus that is entering the lake.
- Promoting land cover types that have low phosphorus runoff is one important watershed management strategy.
- Providing healthy vegetated buffers along water courses,
- Managing wetlands and natural areas as important nutrient traps.
- Promoting natural forest buffers will add to biodiversity (species diversity) important to the ecosystem health of the watershed.

•

LAND COVER & BIODIVERSITY OBJECTIVE 1: Increase land cover types (e.g. forest, wetlands) that have lower nutrient release rates, trap nutrients, and that promote biodiversity				
RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
1a **Land Conservation:** Conserve watershed priority areas with protective designations, including: the Provincial Park, private land conservation purchases, conservation easements, environmental reserves, and land use districts.	Policy	Lead: PLWMP Support: NGO, GoA, Mun, PLWA	Ongoing	Additional 10% over entire watershed
1b **Statutory Plans & Land Use Bylaws:** Retain Natural Vegetation: Develop guidelines and implement policies and regulations within statutory planning documents and municipal land use bylaws to retain natural areas and wildlife corridor (e.g. 80% tree cover for 20-acre lots) within new subdivisions; and for the requirement for development permits for tree and natural vegetation removal on residential lots.	Policy	Lead: Mun[1] Support: APLM, PLWMP	Short Term	100% municipal participation
1c **Statutory Plans & Land Use Bylaws:** Wetlands: Implement policies and regulations in municipal planning documents to retain all wetlands and peatlands as nutrient traps. Implementation tools may include: • Requiring the delineation and classification of wetlands as a component of statutory plan development, subdivision or development permit applications. • Implementing development setbacks from wetlands and peatlands based on their classification	Policy	Lead: Mun. Support: APLM, PLWMP	Short Term	100% municipal participation
1d **Restoration:** Implement programs to encourage the restoration of natural vegetation on lands throughout the watershed including reforestation and restoration of wetlands using incentives such as the Alternative Land Use Services Program (alus.ca)	Community Action	Lead: PLWA Support: Operators, Mun, GoA, PLWMP, NGO	Ongoing	One project per year
1e **Mapping:** map watershed priority areas such as wetlands, wildlife habitat, environmentally significant areas	Technical & Scientific	Lead: PLWMP Support: Mun, GoA, PLWMP	Medium Term	Task Completed

[1] Mun: authority remains with each Municipality to separately act on any given recommendation. APLM (Alliance of Pigeon Lake Municipalities) provides a forum for municipalities to discuss practices and may recommend consideration by member councils, but final authority remains with the member councils

LAND USE & PHOSPHORUS MANAGEMENT

OBJECTIVE 2 Improve phosphorus management for all land uses to achieve a net reduction in nutrient runoff and promote biodiversity.

- Work has begun on introducing beneficial management practices (BMPs) for residential land to achieve nutrient control. The initiatives include:
  - Lawn Fertilizer Ban
  - Model Land Use Bylaw
- Consultation with the agricultural community has been initiated to encourage and implement BMPs to reduce nutrient runoff and improve biodiversity.
- Voluntary adoption of these BMPs needs to be actively supported by the province, municipalities, and stewardship groups.
- Other sectors such as golf courses and the oil and gas industry have beneficial practices that need to be better promoted for local operators.

LAND USE & PHOSPHORUS MANAGEMENT
OBJECTIVE 2: Improve phosphorus management for all land use activities to achieve a net reduction in nutrient runoff and promote biodiversity.

	RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
2a	**Statutory Plans & Land Use Bylaws:** Lakeshore Environmental Area: Adopt an 800 metre "Lakeside Environmental Area" as per the Model Land Use Bylaw, that gives priority to land uses, policies, and environmental provisions designed to protect the lake from nutrient runoff. Policy provisions to include: • Requiring construction management plans with new development permit applications. • Restricting land uses within riparian areas that may increase runoff, increase the potential for contamination of groundwater, and/or impede the effectiveness of important recharge areas • Restricting land uses within 800 metres of the lake where phosphorus and other nutrients, chemicals, or nutrient-rich sediment may pollute the waters of Pigeon Lake. • Requiring a development permit and providing guidelines for the stripping and grading of lands within 800 metres of the bank of Pigeon Lake. Where possible this activity should be discouraged and or sediment controls be implemented during and post construction to eliminate sediment loading of the lake during construction. • Requiring the application of local topsoil and native plants to be included in landscaping plans for new development and redevelopment areas.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Short Term	100% municipal participation

LAND USE & PHOSPHORUS MANAGEMENT OBJECTIVE 2: Improve phosphorus management for all land use activities to achieve a net reduction in nutrient runoff and promote biodiversity.				
• Prescribing a maximum site coverage percentage for non-permeable surfaces on new development and re-development sites within 800 metres of Pigeon Lake. • Prescribing site coverage guidelines for natural vegetation cover that is compatible with FireSmart development principals • Discouraging the compaction of soils during stripping and grading activities that may interfere with natural groundwater recharge and increase surface water runoff. • Prohibiting the excavation or filling in or clearing of all wetlands and stream courses and their associated riparian lands within 800 metres of the legal bank of Pigeon Lake.				
2b **Lawn Fertilizers and Pesticides:** Continue to provide education and support for watershed residents to eliminate lawn fertilizers and pesticides on residential properties and to promote alternative practices.	Community Action	Lead: PLWA Support: Mun	Largely Completed	Annual Programs,
2c **Watershed Stewardship Advocacy & Education:** Encourage landowners (residential, business, recreational and agricultural) to adopt proactive lake-friendly environmental management practices, landscaping and activities. Support land use policies and regulatory measures with public awareness and education.	Community Action	Lead: PLWA Support: Mun, NGO, GoA	Ongoing	Increased Participation
2d **Existing Agricultural Operations:** Encourage agricultural operators to participate in whole farm reductions in phosphorus runoff using the Alberta Agriculture and Forestry Phosphorus Management Tool and the Environmental Farm Plan Program, and to adopt beneficial management practices that reduce nutrient runoff. Promote agricultural erosion and sediment control practices (e.g. low tillage).	Community Action	Lead: Counties Support: PLWA, PLWMP, APLM, GoA	Ongoing	Sector Participation
2e **New or Expanded Intensive Livestock Operations**: Statutory land use restrictions on new or expanded intensive livestock operations (including CFO's) are supported in this Watershed Management Plan	Policy	Lead: Mun. Support: APLM, GoA, PLWA	Ongoing	No Intensive Livestock Operations
2f **Recreational Operations:** Encourage recreational land uses (e.g. golf courses, campgrounds) to adopt beneficial management practices (e.g. Audubon Certification) that reduce nutrient run off and promote biodiversity.	Community Action	Lead: PLWA Support: PLWMP, Mun, NGO, GOA	Ongoing	Sector Participation
2g **Oil and Gas Operations:** Encourage all oil and gas operations to adopt a best management practices on all well sites, batteries, and processing operations to reduce contaminants and phosphorous rich runoff. Encourage future operations to minimize land disturbances.	Community Action	Lead: PLWA, Support: PLWMP, NGO, GOA	Medium to Long Term	Sector Participation

CLEAN RUNOFF

OBJECTIVE 3 Promote clean runoff practices to reduce the transport of nutrients to Pigeon Lake.

The movement of water across the watershed carries nutrients to the lake.

- Suspended sediment with attached phosphorus is also entering waterbodies within the watershed and Pigeon Lake itself.
- Suspended sediment negatively impacts the health of waterbodies by: transporting nutrients to the lake, burying important spawning grounds and impeding the flow of water.
- Low-Impact Development Practices are promoted in the Alberta Clean-Runoff Action Guide for individual lot owners and municipalities.
- Drainage management needs to have phosphorus as the target water quality criteria for the Pigeon Lake basin.

CLEAN RUNOFF OBJECTIVE 3: Promote clean runoff practices to reduce the transport of nutrients to Pigeon Lake				
RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
3a **Roads:** Eliminate salt and pesticide applications for all road allowances within 800 metres of the lake.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Short Term	100% Participation
3b **Statutory Plans & Land Use Bylaws: New Subdivision Stormwater:** Require all new developments to: • provide a storm water quality management plan that is net neutral or better in phosphorus release rates and incorporates low impact development drainage practices. • Regulating post development storm drainage flow to no net increase in amount or rate of water flow offsite. • When applicable, requiring developers to submit and follow Stormwater Site Implementation Plans (SSIPs) that comply with a Master Drainage Guidelines for the Watershed.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Short Term	100% Participation
3c **Statutory Plans & Land Use Bylaws: Sediment and Erosion Control:** all new developments and redevelopment to institute a construction erosion and sediment control plan.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Short Term	100% Participation
3d **Beaver Management:** Manage beaver populations and natural structures in tributaries to promote nutrient trapping while adequately protecting infrastructure and property.	Policy	Lead: PLWA Support: PLWMP, Mun, GOA	Ongoing	100% Participation
3e **Clean Runoff:** Promote clean runoff practices on private and public properties as per the Alberta Clean Runoff Action Guide.	Community Action	Lead: PLWA. Support: Mun, NGO, GoA	Ongoing	Increased Participation
3f **Water Quality Guideline:** Develop a drainage water quality guide with quality and release rates guidelines for new major developments and proposed retrofits for existing drainage systems. Phosphorus is to be recognized as the water quality parameter of greatest concern for Pigeon Lake.	Technical & Scientific	Lead: PLWMP Support: APLM, Mun	Medium Term	Task Completion

GROUNDWATER QUALITY

OBJECTIVE 4 Protect Groundwater that feeds into Pigeon Lake.

- Phosphorus from wastewater is identified in the phosphorus budget as contributing 0.9% of the total phosphorus budget and as a potential source to be managed. Phosphorus from wastewater may be accompanied with fecal coliforms.
- Local municipalities have policies to regulate and minimize potential contamination from private waste water disposal systems. Where private systems still exist near the lake, most are provincially approved pump-out tanks and a small percentage are septic fields.
- Septic fields are a source of nutrient release into groundwater and the nearby lake.
- The Northeast portion of the lake is served with a communal wastewater sewer system (gravity collection system and lagoon). Currently under development is a trunk collection line for the south shore.

GROUNDWATER QUALITY OBJECTIVE 4: Protect groundwater that feeds into Pigeon Lake.				
RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
4a **Statutory Plans & Land Use Bylaws: Groundwater Conservation:** Incorporate water conservation guidance tools into municipal statutory plans and development requirements.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Medium Term	Task Completion
4b **Statutory Plans & Land Use Bylaws:** Groundwater Impact Assessments: Require new major developments in the watershed to demonstrate no negative impacts on existing groundwater users or the lake water supply.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Medium Term	Task Completion
4c **Wastewater Collection:** Support the extension of a regional waste water system to lakeside communities including the two Pigeon Lake Provincial Park campsites.	Policy	Lead: Mun. Support: APLM, PLWA, Local Auth., GOA	Medium Term	Completion of system
4d **Septic Fields:** Eliminate septic fields for residential lots within the Lakeside Environmental Area	Policy	Lead: Mun. Support: APLM, PLWA, Local Auth., GOA	Medium Term	Elimination of remaining fields
4e **Wastewater System Inspections:** Promote regular inspections of both private and communal wastewater systems for integrity and leakage. Systems that fail are to be reported and repaired.	Policy	Lead: Mun, Local Auth. Support: APLM, PLWA,	Ongoing	100% Participation
4f **Water Wells:** Encourage home owners to adopt water conservation and well maintenance practices (e.g. GoA Working Well program). Encourage organizations and municipalities provide information and to host workshops etc.	Community Action	Lead: PLWA Support: Mun, NGO, GOA	Ongoing	Consistent Program
4g **Industrial Groundwater Extraction:** Monitor permit applications and Intervene where warranted on behalf of the watershed to maintain groundwater flows to the lake.	Community Action	Lead: PLWA Support: Mun, NGO,	Ongoing	Effective Monitoring

THE SHORELINE

KEY FINDINGS

Natural lands such as wetlands and forested lands next to streams and the lake itself should be targeted for restoration. Land use activities should also be restricted in these areas.

Ongoing monitoring is necessary to prevent the infestation of aquatic and riparian invasive species.

OBJECTIVES

Improve the health and resilience of the shoreline and near-shore areas

Healthy shorelines (or riparian areas) are critically important for the health and protection of aquatic ecosystems. Thus, these areas should be targeted for protection and restoration efforts.

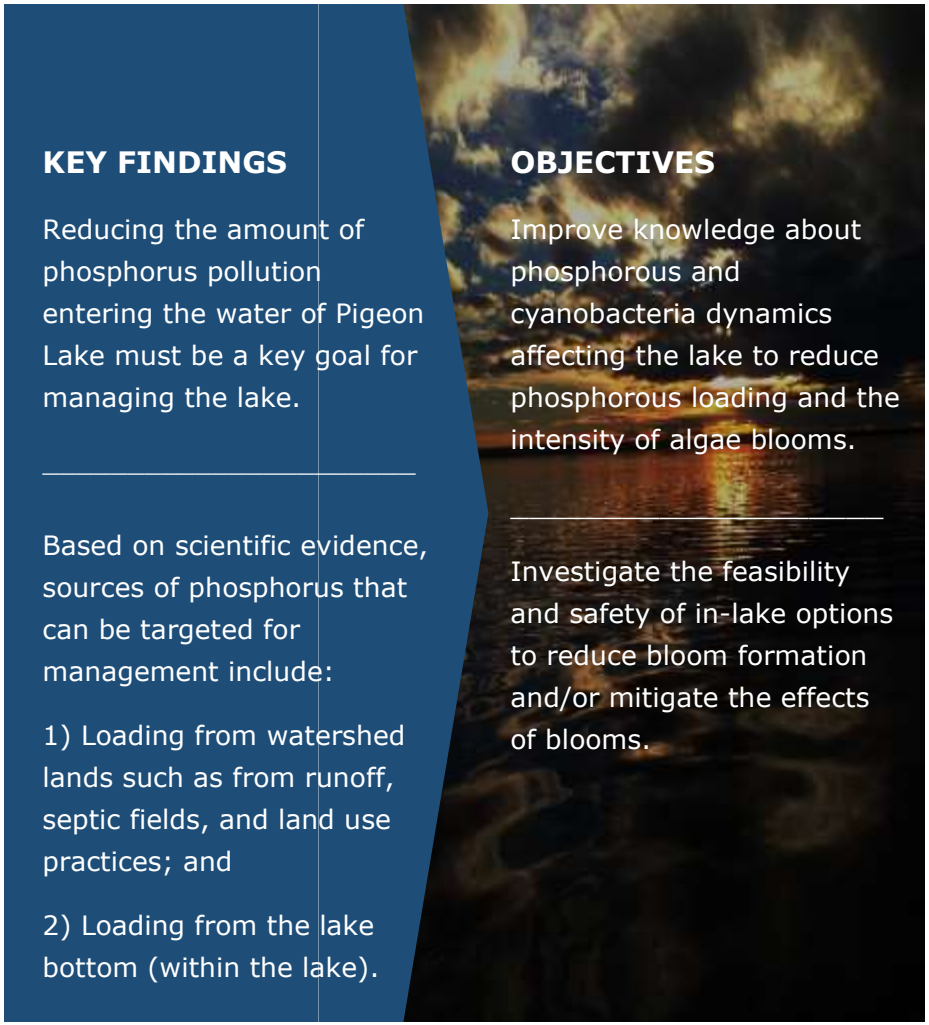
Riparian Beneficial Management Practices (BMPs) involve actions that can be taken by land owners and users within the Pigeon Lake watershed to improve the water quality of the lake and streams. These may include:

- Avoiding the removal of riparian vegetation such as mowing, trimming, or land clearing, if possible. Maintaining natural vegetation cover on shores is preferred to artificial armoring and modification of shorelines.
- Educating watershed property owners and lake visitors about the importance of near-shore vegetation. The current perception of many is that most aquatic plants are all “weeds” and, as such, are a nuisance to lake users. However, educating the public of the ecological value of aquatic vegetation is hugely important to maintenance and improvement of these areas.
- Educating lake users and residents on how to recognize aquatic invasive species is critical for early detection and eradication.
- Developing and encouraging the use of community-based lake access and beaches instead of individual ones. Concentrating the traffic in a few spots around the lake will help to reduce shoreline degradation and destruction.
- Ensuring adequate naturalized setbacks for upland activities such as residential development, cropping, or livestock grazing. This may include leaving a natural vegetation buffer around waterbodies, reducing grazing intensity and access within riparian areas, and planting additional riparian vegetation.
- Eliminating the use of fertilizers and herbicides along the lakeshore.
- Limiting the use of lakeside road salts to reduce lake salinity.

SHORELINES OBJECTIVE 5: Improve the health and resilience of the shoreline and near-shore areas				
RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
5a **Statutory Plans & Land Use Bylaws: Shoreline and Tributary Setbacks:** • For Sensitive shore lands: implement restrictive land use designations that preserve natural buffers. • For new subdivisions: implement development setbacks from the surveyed shoreline of the Lake for new development, based on riparian setback guidelines with a minimum of 30 m, including restrictions for tree and vegetation clearing. At time of subdivision, where existing development would not make the provision of an environmental reserve inappropriate, require the provision of a 30-metre-wide environmental reserve adjacent to the shoreline of the lake. • For existing lot redevelopment: establish minimum building setbacks as per guidelines set out in the Model Land Use Bylaw.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Short Term	Task Completed 100% municipal participation
5b **Statutory Plans & Land Use Bylaws:** Shoreline Modification: Require bylaw provisions consistently across the watershed that any shoreline modification requires a development permit for lands **above and** abutting the legal bank. Municipal policies need to ensure that above legal bank modification approvals are conditional to a Provincial permit being in place for related modifications to the shore below the legal bank. Except for reasonable access shore lines are to be kept in a natural state. Modifications include regrading, natural vegetation clearing, drainage modifications.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA	Ongoing	No shoreline modifications without approvals
5c **Restoration of Aquatic Vegetation:** Retain and re-establish cattail and reed beds to support fish habitat, provide erosion protection and filter nutrients.	Policy	Lead: GoA Support: Mun PLWA	Ongoing	Increased compliance
5d **Lake Shoreline Property Management Guidelines:** Develop a checklist and reference guide to assist development officers and lot owners in addressing the special development requirements for shore line lots. (e.g. On the Living Edge Update).	Community Action	Lead: PLWMP Support: PLWA, APLM, PLWMP, Mun.	Short Term	Task Completion
5e **Shoreline Practices and Restoration:** Provide guidance documents, incentive programs, technical information, and support to shoreline landowners to implement healthy shoreline practices, shoreline restoration, and lake-friendly landscaping.	Community Action	Lead: PLWA Support: Mun, NGO, GOA	Short Term	50% Participation
5f **Algal Biomass:** Provide guidance and support for landowners on addressing algal biomass accumulation along shorelines.	Community Action	Lead: Mun / PLWMP, Support: PLWA, GoA	Ongoing	Consistent information
5g **Noxious Weeds:** Continue invasive species eradication programs, including education, monitoring, and eradiation of prohibited noxious weeds.	Community Action	Lead: MUN, PLWA, Support: NGO	Ongoing	Outbreaks under control
5h **Shoreline Health Assessment:** update the Pigeon Lake shoreline and tributary shoreline health (riparian) assessment.	Technical & Scientific	Lead: PLWMP Support: PLWA GOA	Short Term	Task Completion
5i **Mapping:** Undertake a comprehensive inventory of critical fish and wildlife habitat (such as Sensitive Habitat Inventory Mapping).	Technical & Scientific	Lead: PLWMP Support: PLWA	Medium Term	Task Completion

THE LAKE

High nutrient levels contribute to the growth of blue-green algae. Blue-green algae advisories have been applied to the lake since 2010, which is when the Alberta Health Services (AHS) monitoring program was implemented. Recent algae blooms have impacted the use and enjoyment of the lake by residents and visitors and affected recreational property values within the watershed.



Since blue-green algae can be affected by many climatic and other environmental factors, information gaps about the causal factors for blooms and the behavior of blue-green algae need to be filled.

Pigeon Lake Technical Committees have reviewed several methods that have been implemented in other jurisdictions to address excess lake nutrient levels and harmful algal blooms. Treatment options under consideration include:

PIGEON LAKE & IN-LAKE MANAGEMENT

- Removal of algae:
  - Manipulation of the lake food web to control Blue Green Algae
  - Harvesting algae from the water surface and shorelines and exporting the biomass out of the watershed
- Removal of nutrients:
  - Chemical inactivation of P in the water column via addition of aluminum, calcium, iron and/or lanthanum-enriched bentonite clay (e.g., Phoslock®)

These approaches are currently being reviewed to determine their viability to treat the current water quality problems; however, the circumstances supporting their efficacy at one lake may not be true when applied to another. Review of these strategies requires lake-specific research, environmental and socio-economic risk assessments (including evaluation of potential risks to the lake, financial costs, and overall efficacy), formal stakeholder consultation, and

regulatory approval prior to implementation. Before moving forward with any in-lake treatment, professionally prepared feasibility studies with costs, risks, and benefits are needed and should be made available to the public. Any in-lake engineered treatment will require Provincial Government regulatory approval and should not be undertaken without public consultation and the implementation of a program for on-going scientific monitoring.

The following table provides recommendations and actions for achieving the identified Pigeon Lake and In-Lake Management objectives.

PIGEON LAKE & IN-LAKE MANAGEMENT

OBJECTIVE 6: Improve knowledge about phosphorus and cyanobacteria dynamics affecting the lake to reduce phosphorus loading and the intensity of algae blooms.

OBJECTIVE 7: Investigate the feasibility and safety of in-lake options to reduce bloom formation and/or mitigate the effects of blooms and also to build local defences against harmful invasive species.

	RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
6a	**Advancement of Science:** Identify knowledge gaps relating to the formation of cyanobacteria blooms and techniques for meaningful reductions. Prioritize specific investigations and research projects. Source funds and implement ongoing research for Pigeon Lake.	Technical & Scientific	Lead: PLWMP Support: APLM, Technical Specialists, PLWA, GoA	Ongoing	Coordinated Published program.
7a	**Invasive Species:** Complement the Government of Alberta's province-wide efforts with local initiatives to improve education and build local defenses to keep out aquatic invasive species. Measures include monitoring, public education, signage, and other initiatives	Community Action	Lead: PLWA Support: APLM, Mun, Technical Specialists, PLWMP, GoA	Ongoing	Effective local program
7b	**In-Lake Management:** Evaluate potential management options including project description, costs and financing; effectiveness in reducing phosphorus and algal blooms; reapplication frequency; environmental, social, and economic risks; and regulatory concerns. Implement where feasible.	Technical & Scientific	Lead: Mun, APLM Support. Technical Specialists	Ongoing	Coordinated published program.

WORKING TOGETHER

OBJECTIVE 8 Improve regional collaboration, partnerships and organizational effectiveness to promote collective action for a healthy watershed, healthy lake and healthy community.

- People and different jurisdictions have different and sometimes conflicting perspectives on the nature and scale of Pigeon Lake's problem, the likely effectiveness of proposed solutions,
- The Plan provides an opportunity to coordinate implementation, and assess the organizational assets to implement the plan and its policies

WORKING TOGETHER

OBJECTIVE 8: Improve regional collaboration, partnerships and organizational effectiveness to promote collective action for a healthy watershed, healthy lake and healthy community.

	RECOMMENDATIONS	Type	Roles	Time Frame	Success Measure
8a	**Statutory Regional Plans:** Work toward a watershed-wide Intermunicipal Development Plan (IDP), Regional Collaboration Framework and a sub-regional plan under the North Saskatchewan Regional Plan that all align with the Pigeon Lake Watershed Management Plan. Measures of the Pigeon Lake Watershed Plan 2000 not addressed in the 2018 version will remain in effect until addressed in statutory Plan updates.	Policy	Lead: Mun. Support: APLM, PLWMP, PLWA, GoA	Short Term	Task Completion
8b	**Municipal Development Plans:** Work toward consistent municipal development plans for all Summer Villages, that incorporate the environmental protection policies of the Watershed Management Plan and the Model Land Use Bylaw	Policy	Lead: SV. Support: APLM, PLWMP, PLWA, GoA, TS	Short Term	Task Completion
8c	**First Nations:** Engage the First Nations of IR 138A Pigeon Lake Reserve in the Watershed Management Plan.	Policy	Lead: PLWMP/ First Nations Support: APLM, PLWA, GoA	Short Term, Ongoing	Ongoing
8d	**Watershed Management Plan Updates:** Revisit and update the Watershed Management Plan every five years and rewrite the Plan every ten years to accommodate the changing condition of the lake, success of current recommendations, new scientific knowledge, new legislation, and new stakeholder and organizational assets and interests.	Policy	Lead: PLWMP Support: APLM, PLWA, GoA	Medium to Long Term	Task Completion
8e	**Assess Organizational Assets:** Investigate organizational options to increase effectiveness, staff resources, financing, risk management, and accountability in undertaking watershed and lake management tasks, including coordination of scientific inquiry, action by municipalities, and community action.	Policy	Lead: PLWMP Support: APLM. PLWA, GoA	Short to Medium Term	Task Completion
8f	**Incentives to Promote Voluntary Action:** Develop non-monetary and monetary incentive programs to promote voluntary action for individuals, municipalities and organizations	Community Action	Lead: PLWA Support: PLWMP, APLM, GoA, NGO	Ongoing	Program of Incentives
8g	**Communication and Engagement Plan:** Establish a communications and engagement plans for disseminating and reporting Plan progress to and amongst stakeholders.	Community Action	Lead: PLWA Support: PLWMP, APLM, PLWA, GoA	Short Term, Ongoing	Consistent Program
8h	**Monitoring Plan:** Develop an monitoring plan for environmental trends including lake and tributary water quality and for plan performance including fulfillment of success measures.	Technical & Scientific	Lead: PLWMP Support: PLWA APLM GoA	Medium Term, Ongoing	Effective Monitoring Program
8i	**Phosphorous Budget:** Continue to update and refine the phosphorus budget.	Technical & Scientific	Lead: GoA Support: PLWA APLM	Medium Term	Task Completion

PUTTING THE PLAN INTO MOTION

The following provides a summary of the Plan is to be put into action.

POLICY

Policy and statutory plans are how governments can collaborate to improve the health of the lake and watershed. Recently enacted changes in the Municipal Government Act (MGA) provide a significant opportunity to harmonize regional plans and land use policies. The MGA now requires that all Summer Villages prepare a Municipal Development Plan. Watershed Management Plan objectives and policy recommendations have an opportunity to become common to all Summer Villages. Similarly, all adjacent municipalities will be required to have an Intermunicipal Development Plan (IDP) and an Intermunicipal Collaboration Framework (ICF). Common provisions and policies that reference the Plan in new MDP's, IDP's or ICF's for all municipalities bordering Pigeon Lake should provide common senior land use policy for the watershed including a Lakeshore Environmental Area Planning Zone. Land Use Bylaws are being updated by each municipality and this Plan and Model Land Use Bylaw provide guidance to improve their environmental provisions.

The Province may recognize this Plan under the North Saskatchewan Regional Plan. This status will promote coordination between provincial departments on key objectives and promote municipal policy adoption as statutory plans are being updated

Addressing the resources and effective organizational structures monitoring progress, updating the plan and developing detailed guidelines is an ongoing role of the Plan Steering Committee, which is a joint initiative of the Pigeon Lake Watershed Association and the Alliance of Pigeon Lake Municipalities.

COMMUNITY ACTION

The volunteer actions of individual property owners, business, recreation, farm and oil & gas operators are very important. Organizations such the Pigeon Lake Watershed Association, Municipalities and agriculture extension and industry associations play a key role in promoting beneficial practices and providing information, education and support. The Plan asks all individuals and organizations to:

- Seek out information and beneficial practices relevant to their situation.
- Assess their own properties and operations
- Make beneficial changes incrementally.
- Encourage others and councils to make appropriate changes.
- Support volunteer watershed groups such as the PLWA

TECHNICAL / SCIENCE

Moving forward will require the engagement of experts to provide guidance in a variety of areas including:

- Planning and Land Use Controls including statutory planning, drainage/water quality guidelines.
- Research Ongoing basic and applied lake water quality research and monitoring to address information gaps to help make better management decisions
- In-lake management options feasibility and actions
- Mapping and Plan Monitoring

CONCLUSION

The Pigeon Lake Watershed Management Plan provides a comprehensive, science-based strategy to coordinate action for the protection and improvement of Pigeon Lake, its shore lands, and its watershed.

The roadmap provided by the Plan will enable improved coordinated action of all parties concerned about the health the Pigeon Lake and its watershed. The Plan enables all of us to be "Working together for a healthy watershed, healthy lake, and healthy community".

NOTES

PIGEON LAKE

watershed management plan 2018

appendices

Pigeon Lake Watershed Management Plan Steering Committee
Issued Aug 24, 2018

Working Together for a Healthy Watershed, Healthy Lake, and Healthy Community

TECHNICAL SUPPORT

(RECOMMENDED CITATION)

Pigeon Lake Watershed Management Plan Steering Committee (plwmp.ca). August 2018.
The Pigeon Lake Watershed Management Plan 2018 – Appendices.
Pigeon Lake Watershed Association (plwa.ca) and Alliance of Pigeon Lake Municipalities (aplm.org)

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

Pigeon Lake Watershed Management Plan Steering Committee

Members *(alphabetical order)*

Tim Belec	President, Lakedell Agricultural Society
Doris Bell**	Former Deputy Mayor, SV of Crystal Springs
Glenn Belozer	Councillor, Leduc County, APLM Rep
Wiebe Buruma	Alberta Agriculture & Rural Development
Don Davidson (Deputy Chair)**	Mayor, SV of Grandview, APLM Rep
Susan Ellis**	Executive Director, PLWA
Robert (Bob) Gibbs, (Chair)**	PLWA Director, WMP Committee Chair
Ruth Harrison	Former PLWA Board, AFGA, NSWA
Tom Karpa	Pigeon Lake Regional Chamber of Commerce
Ron LaJeunesse**	Deputy Mayor, SV of Crystal Springs
Arin MacFarlane Dyer**	Planner, Alberta Environment and Parks
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Rex Nielsen	APLM Vice Chair, Itaska Councillor, APLM Rep
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John Slater	Councillor, SV of MaMeO Beach
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** Plan Writing and Engagement Team Member

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Kim Barkwell	County Sustainable Ag Program Manager
Hugh Read	Editorial Assistance, Westbridge Communication Inc. & Grandview Beach Councillor
Chris Teichreb	Limnologist Albert Energy Regulator, (Former AEP)
Greg Nelson	Watershed Planner, AEP
Claire Klassen	Limnologist, Alberta Environment and Parks
Richard Casey	Limnologist, Alberta Environment and Parks
Terry Chamulak	Hydrologist, Alberta Environment and Parks
Cristina Buendia-Fores	Limnologist, Alberta Environment and Parks
Tom Habib	Research Coordinator, Alberta Biomonitoring Institute

APPENDIX A: IMPLEMENTATION PRIORITES

PLWMP 2018 Implementation Priorities

Updated 2018 - 0

Implementation priorities from the Pigeon Lake Watershed Management Plan-2018 found in the attached table. Notes regarding the use and interpretation of the tables are as follows:

1) PRESENTATION ORDER: The forty-six recommendations of the PLWMP 2018 are presented below sorted first by lead agency and second by time frame. This presentation of the recommendations sorted in this order is intended to facilitate the annual review of action priorities by each "Lead Agency" (see Roles column).
2) OBJECTIVE: Coloured Boxes in the first column visually relate to the eight objectives described in the main body of the Plan document and are repeated below.
3) TYPE: Three types of actions or recommendation are identified in the main body of the report and described on page 17. They include Policy, Community Action and Technical/Scientific.
4) ROLES: Roles are allocated into two types: Lead and Support. Being a "Lead" means that this agency or group is best suited to track and organize resources to make progress on the recommendation. Achieving outcomes with Lead organization internal resources is not necessarily expected or required. A Lead agency needs to work with organizations or resources can accomplish the identified outcomes. Descriptors for lead roles are as follows:

Roles:	Roles:	Roles:
Mun= Municipalities	PLWMP= Steering Committee	TS= Technical Specialist/ Researcher
SV= Summer Villages	LA= Local Authorities	FN= First Nation
APLM= Municipal Alliance	GoA= Government of Alberta	O= Operators (farm, golf course, etc.)
PLWA= Watershed Assoc.	NGO= Non-Governmental Organization	LA= Local Authorities

Note: Mun: the authority remains with each Municipality to separately act on a given recommendation. APLM (Alliance of Pigeon Lake Municipalities) provides a forum for municipalities to discuss practices and may recommend consideration by member councils, but final authority remains with the member councils

5) Time Frame: refers to time for substantial completion of recommendation. Lead time is often needed for movement on a given recommendation. Early actions are identified under Annual Priorities
6) Success Measure: Measures have been chosen based on the ability to measure outcomes.
7) Annual Priorities- 2018: An annual review of past progress and annual priorities would be conducted by The PLWMP Steering Committee.
8) LIVING PLAN & ANNUAL REVIEW: Lead agencies are requested to annually review recommendations under their purview, to determine and reassess priorities and report to the PLWMP Steering Committee.
9) PLWMP Steering Committee: this multi-stakeholder committee is the overall steward and coordinator of the PLWMP 2018. The Steering Committee needs to monitor progress and make course corrections as warranted, including reallocation of tasks and redefining time frames and success measures.

PLWMP 2018 OBJECTIVES

LAND COVER & BIODIVERSITY
OBJECTIVE 1: Increase land cover types (e.g. forest, wetlands) that have lower nutrient release rates, trap nutrients, and that promote biodiversity

LAND USE & PHOSPHORUS MANAGEMENT
OBJECTIVE 2: Improve phosphorus management for all land use activities to achieve a net reduction in nutrient runoff and promote biodiversity.

CLEAN RUNOFF
OBJECTIVE 3: Promote clean runoff practices to reduce the transport of nutrients to Pigeon Lake

GROUNDWATER QUALITY
OBJECTIVE 4: Protect groundwater that feeds into Pigeon Lake.

SHORELINES
OBJECTIVE 5: Improve the health and resilience of the shoreline and near-shore areas

PIGEON LAKE & IN-LAKE MANAGEMENT
OBJECTIVE 6: Improve knowledge about phosphorus and cyanobacteria dynamics affecting the lake to reduce phosphorus loading and the intensity of algae blooms.

OBJECTIVE 7: Investigate the feasibility and safety of in-lake options to reduce bloom formation and/or mitigate the effects of blooms and also to build local defences against harmful invasive species.

WORKING TOGETHER
OBJECTIVE 8: Improve regional collaboration, partnerships and organizational effectiveness to promote collective action for a healthy watershed, healthy lake and healthy community.

PLWMP 2018 Implementation Priorities

Arranged by: Recommendation Code

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-1 Land Cover & Biodiversity	1a	Land Conservation: Conserve watershed priority areas with protective designations, including: the Provincial Park, private land conservation purchases, conservation easements, environmental reserves, and land use districts.	Policy	Lead: PLWMP Support: NGO, GoA, Mun, PLWA	00 Ongoing	Additional 10% over entire watershed

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-1 Land Cover & Biodiversity	1b	Statutory Plans & Land Use Bylaws: Retain Natural Vegetation: Develop guidelines and implement policies and regulations within statutory planning documents and municipal land use bylaws to retain natural areas and wildlife corridor (e.g. 80% tree cover for 20-acre lots) within new subdivisions; and for the requirement for development permits for tree and natural vegetation removal on residential lots.	Policy	Lead: Mun Support: APLM, PLWMP	01 Short Term	100% municipal participation
OB-1 Land Cover & Biodiversity	1c	Statutory Plans & Land Use Bylaws: Wetlands: Implement policies and regulations in municipal planning documents to retain all wetlands and peatlands as nutrient traps. Implementation tools may include: · Requiring the delineation and classification of wetlands as a component of statutory plan development, subdivision or development permit applications. · Implementing development setbacks from wetlands and peatlands based on their classification	Policy	Lead: Mun Support: APLM, PLWMP	01 Short Term	100% municipal participation
OB-1 Land Cover & Biodiversity	1d	Restoration: Implement programs to encourage the restoration of natural vegetation on lands throughout the watershed including reforestation and restoration of wetlands using incentives such as the Alternative Land Use Services Program (alus.ca)	Community Action	Lead: PLWMP Support: Operators, Mun, GoA, PLWA, NGO	00 Ongoing	One project per year
OB-1 Land Cover & Biodiversity	1e	Mapping: map watershed priority areas such as wetlands, wildlife habitat, environmentally significant areas	Technical & Scientific	Lead: PLWMP Support: Mun, GoA, PLWMP	02 Medium Term	Task Completed
OB-2 Land Use & Phosphorous	2a-i	Statutory Plans & Land Use Bylaws: Lakeshore Environmental Area: Adopt an 800 metre "Lakeside Environmental Area" as per the Model Land Use Bylaw, that gives priority to land uses, policies, and environmental provisions designed to protect the lake from nutrient runoff. Policy provisions to include: · Requiring construction management plans with new development permit applications. · Restricting land uses within riparian areas that may increase runoff, increase the potential for contamination of groundwater, and/or impede the effectiveness of important recharge areas. · Restricting land uses within 800 metres of the lake where phosphorus and other nutrients, chemicals, or nutrient-rich sediment may pollute the waters of Pigeon Lake.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	01 Short Term	100% municipal participation

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-2 Land Use & Phosphorous	2a-ii	. Requiring a development permit and providing guidelines for the stripping and grading of lands within 800 metres of the bank of Pigeon Lake. Where possible this activity should be discouraged and or sediment controls be implemented during and post construction to eliminate sediment loading of the lake during construction. · Requiring the application of local topsoil and native plants to be included in landscaping plans for new development and redevelopment areas. · Prescribing a maximum site coverage percentage for non-permeable surfaces on new development and re-development sites within 800 metres of Pigeon Lake. · Prescribing site coverage guidelines for natural vegetation cover that is compatible with FireSmart development principals. · Discouraging the compaction of soils during stripping and grading activities that may interfere with natural groundwater recharge and increase surface water runoff. · Prohibiting the excavation or filling in or clearing of all wetlands and stream courses and their associated riparian lands within 800 metres of the legal bank of Pigeon Lake.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	01 Short Term	100% municipal participation
OB-2 Land Use & Phosphorous	2b	Lawn Fertilizers and Pesticides: Continue to provide education and support for watershed residents to eliminate lawn fertilizers and pesticides on residential properties and to promote alternative practices.	Community Action	Lead: PLWA Support: Mun	05 Largely Completed	Annual Programs,
OB-2Land Use &Phosphorous	2d	Existing Agricultural Operations: Encourage agricultural operators to participate in whole farm reductions in phosphorus runoff using the Alberta Agriculture and Forestry Phosphorus Management Tool and the Environmental Farm Plan Program, and to adopt beneficial management practices that reduce nutrient runoff. Promote agricultural erosion and sediment control practices (e.g. low tillage).	Community Action	Lead: CountiesSupport: PLWA, PLWMP, APLM, GoA	00 Ongoing	Sector Participation
OB-2 Land Use & Phosphorous	2e	New or Expanded Intensive Livestock Operations: Statutory land use restrictions on new or expanded intensive livestock operations (including CFO's) are supported in this Watershed Management Plan	Policy	Lead: Mun Support: APLM, GoA, PLWA	00 Ongoing	No Intensive Livestock Operations

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-2 Land Use & Phosphorous	2f	Recreational Operations: Encourage recreational land uses (e.g. golf courses, campgrounds) to adopt beneficial management practices (e.g. Audubon Certification) that reduce nutrient run off and promote biodiversity.	Community Action	Lead: PLWA Support: PLWMP, Mun, NGO, GOA	00 Ongoing	Sector Participation
OB-2 Land Use & Phosphorous	2g	Oil and Gas Operations: Encourage all oil and gas operations to adopt a best management practices on all well sites, batteries, and processing operations to reduce contaminants and phosphorous rich runoff. Encourage future operations to minimize land disturbances.	Community Action	Lead: PLWA Support: PLWMP, NGO, GOA	02 Medium to 03 Long Term	Sector Participation
OB-3 Clean Runoff	3a	Roads: Eliminate salt and pesticide applications for all road allowances within 800 metres of the lake.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	01 Short Term	100% Participation
OB-3 Clean Runoff	3b	Statutory Plans & Land Use Bylaws: New Subdivision Stormwater: Require all new developments to: · provide a storm water quality management plan that is net neutral or better in phosphorus release rates and incorporates low impact development drainage practices. · Regulating post development storm drainage flow to no net increase in amount or rate of water flow offsite. · When applicable, requiring developers to submit and follow Stormwater Site Implementation Plans (SSIPs) that comply with a Master Drainage Guidelines for the Watershed.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	01 Short Term	100% Participation
OB-3 Clean Runoff	3c	Statutory Plans & Land Use Bylaws: Sediment and Erosion Control: all new developments and redevelopment to institute a construction erosion and sediment control plan.	Policy	Lead: APLM Support: Mun, PLWMP, PLWA	01 Short Term	100% Participation
OB-3 Clean Runoff	3d	Beaver Management: Manage beaver populations and natural structures in tributaries to promote nutrient trapping while adequately protecting infrastructure and property.	Policy	Lead: PLWA Support: PLWMP, Mun, GOA	00 Ongoing	100% Participation
OB-3 Clean Runoff	3e	Clean Runoff: Promote clean runoff practices on private and public properties as per the Alberta Clean Runoff Action Guide.	Community Action	Lead: PLWA Support: Mun, NGO, GoA	00 Ongoing	Increased Participation

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-3 Clean Runoff	3f	Water Quality Guideline: Develop a drainage water quality guide with quality and release rates guidelines for new major developments and proposed retrofits for existing drainage systems. Phosphorus is to be recognized as the water quality parameter of greatest concern for Pigeon Lake.	Technical & Scientific	Lead: PLWMP Support: APLM, Mun	02 Medium Term	Task Completion
OB-4 Ground Water	4a	Statutory Plans & Land Use Bylaws: Groundwater Conservation: Incorporate water conservation guidance tools into municipal statutory plans and development requirements.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	02 Medium Term	Task Completion
OB-4 Ground Water	4b	Statutory Plans & Land Use Bylaws: Groundwater Impact Assessments: Require new major developments in the watershed to demonstrate no negative impacts on existing groundwater users or the lake water supply.	Policy	Lead: MunSupport: APLM, PLWMP, PLWA	02 Medium Term	Task Completion
OB-4 Ground Water	4c	Wastewater Collection: Support the extension of a regional waste water system to lakeside communities including the two Pigeon Lake Provincial Park campsites.	Policy	Lead: Mun Support: APLM, PLWA, Local Authorities, GOA	02 Medium Term	Completion of system
OB-4 Ground Water	4d	Septic Fields: Eliminate septic fields for residential lots within the Lakeside Environmental Area	Policy	Lead: Mun Support: APLM, PLWA, Local Authorities, GOA	02 Medium Term	Elimination of remaining fields
OB-4 Ground Water	4e	Wastewater System Inspections: Promote regular inspections of both private and communal wastewater systems for integrity and leakage. Systems that fail are to be reported and repaired.	Policy	Lead: Mun Support: APLM, Local Authorities	00 Ongoing	100% Participation
OB-4 Ground Water	4f	Water Wells: Encourage home owners to adopt water conservation and well maintenance practices (e.g. GoA Working Well program)	Community Action	Lead: PLWA Support: Mun, NGO, GOA	00 Ongoing	Consistent Program
OB-4 Ground Water	4g	Industrial Groundwater Extraction: Monitor permit applications and Intervene where warranted on behalf of the watershed to maintain groundwater flows to the lake.	Community Action	Lead: PLWA Support: Mun, NGO,	00 Ongoing	Effective Monitoring

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-5 Shorelines	5a	Statutory Plans & Land Use Bylaws: Shoreline and Tributary Setbacks: · For Sensitive shore lands: implement restrictive land use designations that preserve natural buffers · For new subdivisions: implement development setbacks from the surveyed shoreline of the Lake for new development, based on riparian setback guidelines with a minimum of 30 m, including restrictions for tree and vegetation clearing. At time of subdivision, where existing development would not make the provision of an environmental reserve inappropriate, require the provision of a 30-metre-wide environmental reserve adjacent to the shoreline of the lake. · For existing lot redevelopment: establish a minimum building setback as per guidelines set out in the Model Land Use Bylaw.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	01 Short Term	Task Completed 100% municipal participation
OB-5 Shorelines	5b	Statutory Plans & Land Use Bylaws: Shoreline Modification: Require bylaw provisions consistently across the watershed that any shoreline modification requires a development permit for lands above and abutting the legal bank. Municipal policies need to ensure that above legal bank modification approvals are conditional to a Provincial permit being in place for related modifications to the shore below the legal bank. Except for reasonable access shore lines are to be kept in a natural state. Modifications include regrading, natural vegetation clearing, drainage modifications.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA	00 Ongoing	No shoreline modifications without approvals
OB-5 Shorelines	5c	Restoration of Aquatic Vegetation: Retain and re-establish cattail and reed beds to support fish habitat, provide erosion protection and filter nutrients.	Policy	Lead: GoA Support: Mun PLWA	00 Ongoing	Increased compliance
OB-5 Shorelines	5d	Lake Shoreline Property Management Guidelines: Develop a checklist and reference guide to assist development officers and lot owners in addressing the special development requirements for shore line lots. (e.g. On the Living Edge Update)	Community Action	Lead: PLWMP Support: PLWA, APLM, Mun	01 Short Term	Task Completion
OB-5 Shorelines	5e	Shoreline Practices and Restoration: Provide guidance documents, incentive programs, technical information, and support to shoreline landowners to implement healthy shoreline practices, shoreline restoration, and lake-friendly landscaping.	Community Action	Lead: PLWA Support: Mun, NGO, GOA	01 Short Term	50% Participation

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-5Shorelines	5f	Algal Biomass: Provide guidance and support for landowners on addressing algal biomass accumulation along shorelines.	Community Action	Lead: MUN / PLWMP, Support: APLM GoA	00 Ongoing	Consistent information
OB-5 Shorelines	5g	Noxious Weeds: Continue invasive species eradication programs, including education, monitoring, and eradication of prohibited noxious weeds.	Community Action	Lead: MUN + PLWA Support: NGO	00 Ongoing	Outbreaks under control
OB-5 Shorelines	5h	Shoreline Health Assessment: update the Pigeon Lake shoreline and tributary shoreline health (riparian) assessment	Technical & Scientific	Lead: PLWMP Support: PLWA GOA	01 Short Term	Task Completion
OB-5 Shorelines	5i	Mapping: Undertake a comprehensive inventory of critical fish and wildlife habitat (such as Sensitive Habitat Inventory Mapping)	Technical & Scientific	Lead: PLWMP Support: PLWA	02 Medium Term	Task Completion
OB-6 Improve Knowledge	6a	Advancement of Science: Identify knowledge gaps relating to the formation of cyanobacteria blooms and techniques for meaningful reductions. Prioritize specific investigations and research projects. Source funds and implement ongoing research for Pigeon Lake.	Technical & Scientific	Lead: PLWMP Support: APLM, Technical Specialists, PLWA, GoA	00 Ongoing	Coordinated Published program.
OB-7 Invasive Species	7a	Invasive Species: Complement the Government of Alberta's province-wide efforts with local initiatives to improve education and build local defenses to keep out aquatic invasive species. Measures include monitoring, public education, signage, and other initiatives	Community Action	Lead: PLWA Support: APLM, Mun, Technical Specialists, PLWMP, GoA	00 Ongoing	Effective local program
OB-7 In-Lake Management	7b	In-Lake Management: Evaluate potential management options including project description, costs and financing; effectiveness in reducing phosphorus and algal blooms; reapplication frequency; environmental, social, and economic risks; and regulatory concerns. Implement where feasible.	Technical & Scientific	Lead: Mun Support: APLM, Technical Specialists	00 Ongoing	Coordinated published program.
OB-8 Working Together	8a	Statutory Regional Plans: Work toward a watershed-wide Intermunicipal Development Plan (IDP), Regional Collaboration Framework and a sub-regional plan under the North Saskatchewan Regional Plan that all align with the Pigeon Lake Watershed Management Plan. Measures of the Pigeon Lake Watershed Plan 2000 not addressed in the 2018 version will remain in effect until addressed in statutory Plan updates.	Policy	Lead: Mun Support: APLM, PLWMP, PLWA, GoA	01 Short Term	Task Completion

OBJECTIVE	Code	RECOMMENDATIONS	TYPE	ROLES	TIME FRAME	SUCCESS MEASURE
OB-8 Working Together	8b	Municipal Development Plans: Work toward consistent municipal development plans for all Summer Villages, that incorporate the environmental protection policies of the Watershed Management Plan and the Model Land Use Bylaw	Policy	Lead: Mun/APLM Support: PLWMP, PLWA, GoA, TS	01 Short Term	Task Completion
OB-8 Working Together	8c	First Nations: Engage the First Nations of IR 138A Pigeon Lake Reserve in the Watershed Management Plan.	Policy	Lead: PLWMP/ First Nations Support: APLM, PLWA, GoA	01 Short Term, to Ongoing	Ongoing
OB-8 Working Together	8d	Watershed Management Plan Updates: Revisit and update the Watershed Management Plan every five years and rewrite the Plan every ten years to accommodate the changing condition of the lake, success of current recommendations, new scientific knowledge, new legislation, and new stakeholder and organizational assets and interests.	Policy	Lead: PLWMP Support: APLM, PLWA, GoA	02 Medium to Long Term	Task Completion
OB-8 Working Together	8e	Assess Organizational Assets: Investigate organizational options to increase effectiveness, staff resources, financing, risk management, and accountability in undertaking watershed and lake management tasks, including coordination of scientific inquiry, action by municipalities, and community action.	Policy	Lead: PLWMP Support: APLM. PLWA, GoA	Short to 02 Medium Term	Task Completion
OB-8 Working Together	8f	Incentives to Promote Voluntary Action: Develop non-monetary and monetary incentive programs to promote voluntary action for individuals, municipalities and organizations	Community Action	Lead: PLWA Support: PLWMP, APLM, GoA, NGO	00 Ongoing	Program of Incentives
OB-8WorkingTogether	8g	Communication and Engagement Plan: Establish a communications and engagement plans for disseminating and reporting Plan progress to and amongst stakeholders.	Community Action	Lead: PLWASupport: PLWMP, APLM, PLWA, GoA	01 Short Term, Ongoing	Consistent Program
OB-8 Working Together	8h	Monitoring Plan: Develop a monitoring plan for environmental trends including lake and tributary water quality and for plan performance including fulfillment of success measures.	Technical & Scientific	Lead: PLWMP Support: PLWA APLM GoA	02 Medium Term, Ongoing	Effective Monitoring Program
OB-8 Working Together	8i	Phosphorous Budget: Continue to update and refine the phosphorus budget.	Technical & Scientific	Lead: GoA Support: PLWA PLMMP, APLM	02 Medium Term	Task Completion

APPENDIX B: COMMUNITY ENGAGEMENT

Background

The Pigeon Lake Watershed Association was formed in 2007 in response to a need for organized and science-based actions to be taken by the watershed residents to address ongoing concerns of diminishing water quality. In 2008, a State of the Watershed report was completed. Included was a recommendation for the preparation of a watershed management plan, which inspired the PLWA to begin work on the plan. This initiative took several years to get started, and to achieve support from the PLWA Board, the Pigeon Lake Municipalities and to build the necessary leadership resources.

In 2012 a Steering Committee was formed to undertake the preparation of the Pigeon Lake Watershed Management Plan. This initiative was funded by the PLWA and supported by the Battle River Watershed Alliance (BRWA), Alberta Environment, and various individuals and municipalities from around the lake.

Further support for the preparation of the Plan was obtained when the Alliance of Pigeon Lake Municipalities (APLM) made a commitment to the preparation of the plan and provided members to sit on the Pigeon Lake Watershed Management Plan (PLWMP) Steering Committee.

It was recognized that a multi-pronged watershed, in-lake and united approach was needed to achieve meaningful action. This was later confirmed by a PLWA membership poll (See *Synopsis of Responses on the PLWA Summary Report on the Methods for the Control of Nuisance Blue-Green Algae (Cyanobacteria),* January 2013). The APLM and the PLWA agreed that a cooperative approach was needed to undertake the important tasks identified for this project. This included increased communication between the two organizations and with the watershed residents. It was recognized that the lake needed more leaders to be involved and to work together in a meaningful way. On April 28th, 2012, the first meeting of Pigeon Lake leaders, the "Gathering for the Health of Pigeon Lake", was held with representation by many municipal councillors and members from two of the First Nations bands, including one Chief and an Elder. This meeting provided focus for the planning process. Based on the success of this meeting, it continued on an annual basis as the Annual Leaders Session.

The work on the plan moved forward by expanding the Steering Committee membership to include local organizations and our Healthy-Lake Partners, (i.e. non-governmental organizations such as the Battle River Watershed Association, and the Alberta Lake Management Society.

Recognizing the importance of engagement, the Steering Committee formed an Engagement Sub-Committee to create a PLWMP Engagement Strategy to ensure that engagement would be an integral part of all the PLWMP work.

During the 2013/14 timeframe, a Terms of Reference for the Plan was developed. The work of the PLWMP was defined in the Terms of Reference as a series of topics leading to the creation of Beneficial Management Practices. Topics were to be addressed over a number of years. Each topic was to have its own terms of reference, committee structure and an engagement component to help build consensus around each new topic. Engagement activities leading to the approval of the Terms of Reference included:

- ✓ Public on line survey entitled "Are we on Track?"
- ✓ Creation of a PLWMP website (www.plwmp.ca)
- ✓ Advertised public workshops
- ✓ 2013 Leaders Session and workshop
- ✓ 2013 PLWA AGM presentations
- ✓ Representations to federal and provincial elected officials and Cabinet ministers.

The 2013 Leaders Session supported topic priorities and also highlighted the need for Government of Alberta support and involvement in the Plan.

A new PLWMP website (www.plwmp.ca) was launched to ensure that the initiative would stand alone and be seen as everyone's plan. Other methods of communication for the PLWMP include PLWA emails and survey invitations, updates on municipal websites, joint APLM/PLWA newsletters, print media advertising for events and PLWA displays at local markets. The PLWA continues to fund and resource much of the engagement and communications. The PLWA contact list includes PLWA members plus key municipal, provincial, federal and Muskwacis Cree contacts. Engagement with the Muskwacis Cree run PL Reserve 138A is a priority, including participation in the Annual Leaders Sessions.

In 2013, three PLWMP open houses and presentations were marketed by various media methods and held on different sides of the lake.

In August of 2013, a survey of 618 community members was conducted and a local paper ad invited other watershed residents to participate. The survey "PLWMP – Are We On Track?" received 184 responses on behalf of at least 386 people. Over 95% of the survey respondents were either fully or somewhat supportive of the goal, guiding principles, PLWMP process and need to create a watershed plan for Pigeon Lake. A sense of urgency and concern for the degradation of the water quality and natural habitat permeated many responses. These responses gave a clear endorsement for the direction and focus of the PLWMP being taken by the Steering Committee.

The Steering Committee moved forward on the highest priority topics. Two topics were chosen as a starting point: Soil Management and Cosmetic Fertilizers, and the Model Land Use Bylaw.

A "Cosmetic Fertilizers: What do you think? Survey was conducted". This time, 344 surveys were completed on behalf of at least 745 people. The responses called for an immediate call for action which led to the municipalities writing bylaws prohibiting lawn fertilizers and, in some cases, lawn herbicides. In addition, the Healthy Lake Lawn campaign was born. Reports on the surveys are created and made available to the public via the PLWA websites.

Starting in 2014, the PLWA has hired summer staff to increase our outreach, disseminate information and receive the views of those in the watershed.

In 2015, a three-year Healthy Lake Clean Runoff Project was initiated given responses to a survey that told us: "We will make changes if you; "Tell us what to do", "Tell us how to do it", and "Make it easy". We focused on actions to clean the runoff from the near shore communities. It involved the creation of the Alberta Clean Runoff Action Guide to tell what and how, demonstration sites, a rain barrel campaign, many communications such as local press articles, and bringing resources to events such as native plants and grass seed; and a video to encourage residents to "Be Part of the Solution and to add some of the clean runoff approaches on their lot.

336 responses on behalf of at least 751 people to an end of project survey informed us that people were reading the CR Action Guide; were talking with neighbours about the need to make changes; that at least 350 changes had been made; and that another 375 were planned.

Each year, updates and progress made on the PLWMP is communicated through various means:

- ✓ Newsletters – spring and fall since 2007, and joint APLM/APLM since 2016
- ✓ Summer Students - since 2014
- ✓ Local Notice Boards
- ✓ PLWA AGM Presentations and Open House
- ✓ PLWMP and PLWA websites
- ✓ Annual Pigeon Lake Leaders Session
- ✓ Facebook (Pigeonlakewatershedassociation) since 2014
- ✓ Pigeon Lake Twitter

Pigeon Lake Watershed Management Plan 2017

In 2016, the Steering Committee initiated the writing of a Pigeon Lake watershed management plan for Pigeon Lake that addressed a complete range of topics related to: the watershed, the shore, the lake and working together. Support for this initiative came from the Government of Alberta, the Board of the PLWA and the Alliance of Pigeon Lake Municipalities plus our Healthy Lake Partners. Engagement strategies and techniques for PLWMP 2017 were adapted from earlier work of the Steering Committee.

The PLWMP engagement continued throughout 2017 in stages including:

- **Preparation of the Science Summary and Initial Drafts:** A day-long meeting was held in January of 2017 at the University of Alberta, organized by the PLWMP Chair. Attendees were a mix of researchers from the University of Alberta, Alberta Health, Consultants including Aquality Consultants Ltd., CPP Environmental, Hutcheson Environmental, Alberta Lake Management Society, Government of Alberta and members of Pigeon Lake organizations including PLWMP Steering Committee, the PLWA, and the APLM including their In-Lake Technical Committee. The objective was to identify the state of knowledge for Pigeon Lake, current initiatives, and critical information gaps. This information provided background to the introductory material in each section of the main report and to the technical summary in this appendix.

Leader's Session Draft – April 2017

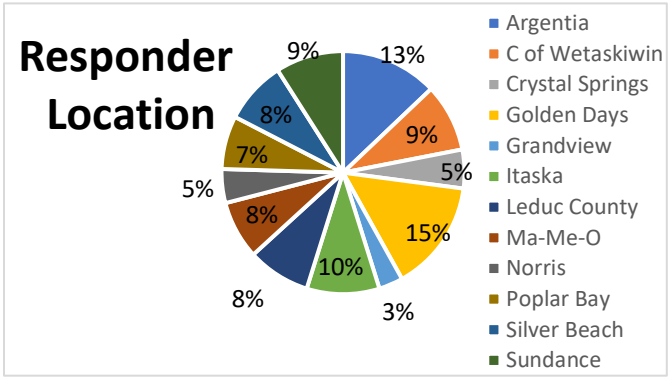
- April 2017, Leader's Session Draft of the Plan: This draft was prepared and issued to the 2017 attendees of the Annual Leader's Session. Forty-eight Pigeon Lake leaders participated including councillors, First Nations, PLWA directors, lake experts and planners. The draft Plan was discussed, and input gathered to improve it. An online survey was completed by 15 participants. This feedback resulted in revisions and updates for the next version.

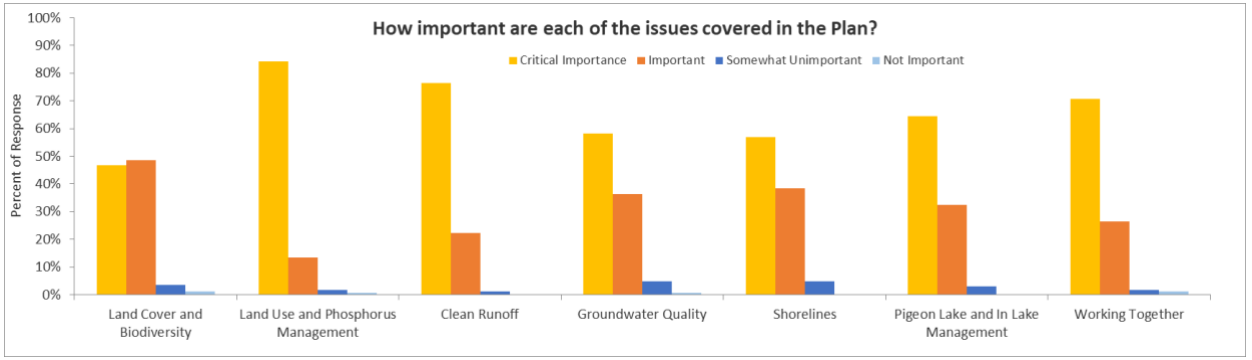
- June 2017, Public Draft of the Plan - Open Houses: the public draft was posted to the PLWMP website and invitations were issued to attend two public workshops and to complete and online survey. Sixty-five people attended the two PLWMP Open Houses. These were advertised in local newspapers, local websites, PLWA emails, Facebook, Twitter and a County of Wetaskiwin 'news flash.'

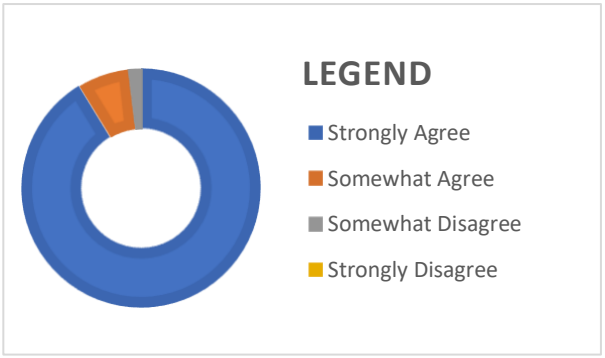
- June- September 2017, Various Events - The PLWA highlighted the Plan at:
    - Summer Village Annual Information Meetings
    - PLWA Annual General Meeting
    - Several Farmer's markets

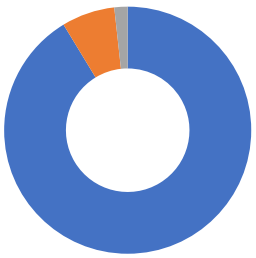
  Panels about the Plan were displayed to encourage discussions and people were asked to read it and complete the on-line survey.

- June 2017, Public Draft of the Plan- On Line Survey: An on-line survey ran over the summer. This was advertised by emails, Facebook posts, and a local paper article (Pipestone Flyer July 12, 2017). A total of 176 people filled in the survey on behalf of at least 397 people of which 95.5% own property around Pigeon Lake. Strong support was indicated for the Plan (see graphs next page)

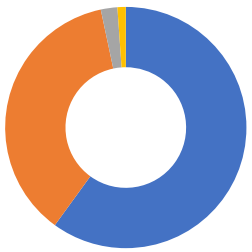




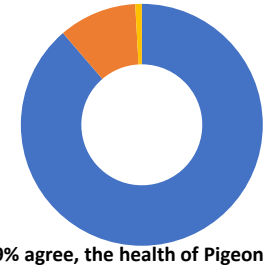




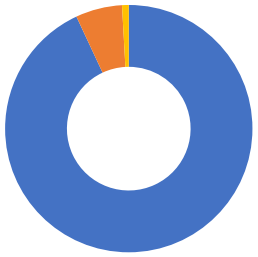
91% Agree with the Plan Vision



95% agree or somwhat agree, The Plan can be implemented.



89% agree, the health of Pigeon Lake requires urgent, decisive, and collective actions across all sectors.



93% agree, Improve the health of the watershed & the lake.

Adoption Draft – September 2017 – June 2018

In September 2017, the Plan was revised based on the public feedback and published to the PLWMP web site as the "adoption draft". A summary of the response to the online public survey was also posted to the site. This version of the Plan was then taken to all municipalities, Healthy Lake Partners and the Maskwacis Cree and the Government of Alberta for statements of adoption, endorsement or support. Organizations were invited to review the document and provide comment and or statements of support. A number of comments and concerns were addressed throughout this process that resulted in changes to the recommendations or text of the final PLWMP document.

- **September 20,** 2017, the Alliance of Pigeon Lake Municipalities voted to endorse the PLWMP.
- **September 09, 2017 –** the PLWA Executive Director gave an update to the Pigeon Lake Regional Chamber of Commerce board. They were asked to consider endorsing the PLWMP. The PLWA is a member of the PLRCC and the PLRCC participates in the annual Leaders Session and sits on the PLWMP Steering Committee.
- **September 29, 2017 –**, PLWMP Chair presented the PLWMP at the Annual Conference of the Alberta Lake Management Society
- **December 4,2017** the Pigeon Lake Watershed Association voted to endorse the PLWMP.
- **September 2017– May 2018 On-going –** The PLWMP Chair and Vice Chair presented the PLWMP to all watershed municipalities and organizations who have sat on the Steering Committee, with the intention of firstly obtaining comments and secondly to obtain resolutions in support of the plan.

Maskwacis Cree and the Pigeon Lake Reserve Engagement. Since the PLWA began, engagement with our First Nation neighbours has been important. In 2017, the PLWMP adoption draft gave further impetus for working together. Examples of past engagement of First Nations include:

- **Annual Leaders Sessions:** All four nations have always been invited, and we usually have a handful attend including Chiefs, Councillors and Elders.
- **PLWA Events:** On occasion First Nations have attended our workshops and Annual General Meetings including a few people from the PL Reserve.
- **POW WOW's:** On occasion the PLWA has attended the local Pow Wow and the 2015 PLWA President was honoured to be invited in the Samson Cree Nation POW WOW and participate in the Grand Entrance


- **PLWA Representations at First Nations Organized Events:** the PLWA has made a handful of presentations to different First Nations groups: A TSAG arranged meeting with Elders and a Technical Committee who were working with Imperial Oil to address the abandoned wells on the reserve.

- **First Nation Representation on the PLWA Board**: Chief Leonard Standing-On-The-Road (Elected Chief of the Montana Nation in 2017) served on the PLWA Board from 2012 through 2015, as the PLWA First Nations Liaison. In 2017, past Erminskin First Nation Councillor, Samuel Minde began to sit on the PLWA Board as the First Nation Liaison. Samuel has worked to form the First Nation working group called: Mamawo Group (Together).

- Muskwacis Cree Mamamo Group (Together).

  In 2017, the PLWA Director and Muskwacis Cree Nations liaison took it upon himself to pull together a group representing all four Nations to see if there was any interest in getting involved with the PLWA and work going on around the lake. At an initial meeting a lot of concern for the lake and how its health impacts people living on the Reserve; the fishery and more was expressed. A series of meetings which also included the GoA, the BRWA, and three PLWA Directors. Four of these people were also members of the PLWMP Committee including the Chair and all were members of the Engagement Sub-committee.

  The outcome of the initial meetings were two documents to be presented to the Maskwacis Cree Council of Chiefs and Councillors for endorsement. One is a Letter of Support for the PLWMP and the second a Terms of Reference for the Mamawo Working Group to:

  - Explore how the PLWMP may be important for the Pigeon Lake Reserve.
  - Build bridges with the PLWMP steering committee and have a voice in the work being done.
  - Provide the Maskwacis Cree Nations and the Pigeon Lake Reserve Residents with opportunities to be informed and to participate in the implementation of the PLWMP.
  - Identify and share the tools and knowledge from this work, for the benefit of the Maskwacis Cree Nations.

APPENDIX C: TECHNICAL SUMMARY

PREFACE

The Technical Summary has been assembled as a foundation to the development of the Pigeon Lake Watershed Management Plan 2017 ("the Plan"). It is intended to update information found in the 2006 State of The Watershed Report and to provide benchmark updates to many of the environmental indicators relevant to Pigeon Lake and its watershed. General watershed planning implications are also identified related to the various topics. These have generally been the background to many of the specific recommendations in the Plan, that were then further refined to address planning policies and tools available.

This summary was prepared by Adam Kraft and Théo Charette from CPP Environmental, with hydrological contributions from Alberta Environment and Parks.

Pigeon Lake is a relatively well-studied lake; several studies have examined the complex interactions between watershed activities and the lake's ecological health. These studies have improved our understanding of Pigeon Lake and have indicated potential natural and human-caused drivers of the nuisance algal blooms (or Harmful Algal Blooms, HABs). The intent of this document is to summarize the current scientific knowledge around the water quality concerns of Pigeon Lake and to highlight where further research or remedial efforts are needed.

The document is organized into three main sections, which outline the state of knowledge at different spatial scales: (i) the Pigeon Lake watershed (Section 1: "Watershed Lands"), (ii) the lake's streams and shorelines (Section 2 "The Shoreline"), and (iii) Pigeon Lake itself (Section 3:"Pigeon Lake").

1 SUMMARY OF THE SCIENCE: WATERSHED LANDS

Nutrient Production and Transport

Surface water flows (overland runoff and streams) make up an estimated 29% of Pigeon Lake's water inputs (Worley Parsons 2010) and transport nearly half of the externally-loaded phosphorus (P, an important nutrient for biological growth) into the waterbody (FIGURE C1). This indicates that both the water quantity and quality of the lake are influenced by the land cover composition of the watershed. The amount of forest and wetland cover is important for aquatic health, yet only 39% of ecological lands remain in the Pigeon Lake watershed. Human activity is extensive, with 61% of the land converted into agricultural or built-up areas (e.g., roads, residential, recreation areas) as of 2013 (FIGURES C2, C3).

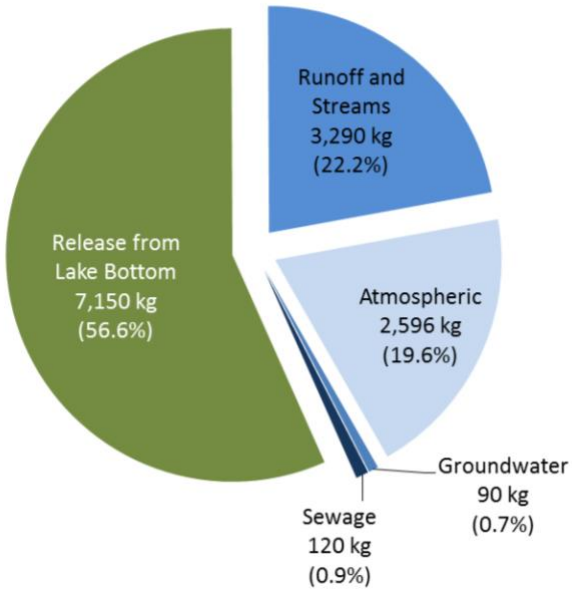


Figure C1: Annual open water season total phosphorus loadings, both bioavailable and particulate forms, into Pigeon Lake in 2013, indicating the relative partitioning between internal and external loadings (Teichreb 2014). Internal loadings refer to the release of P from the lake bottom sediments, whereas external loadings include the runoff from the watershed (i.e., measured flow from streams and creeks that enter the lake and unmeasured diffuse runoff), as well as atmospheric deposition, groundwater inputs and sewage. It is important to note that these results come from one year (2013) of stream sampling data, and thus do not represent average or typical conditions.

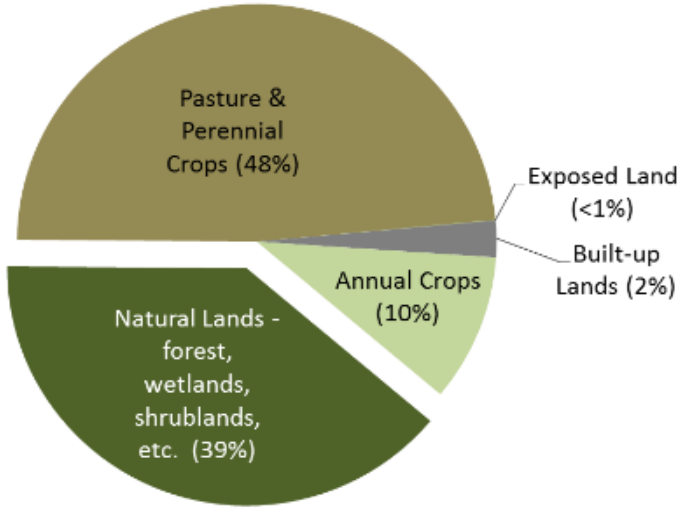


Figure C2: Landscape composition of the Pigeon Lake watershed based on 2013 conditions, showing the relative cover of natural and non-natural land cover types (AAFC 2013).

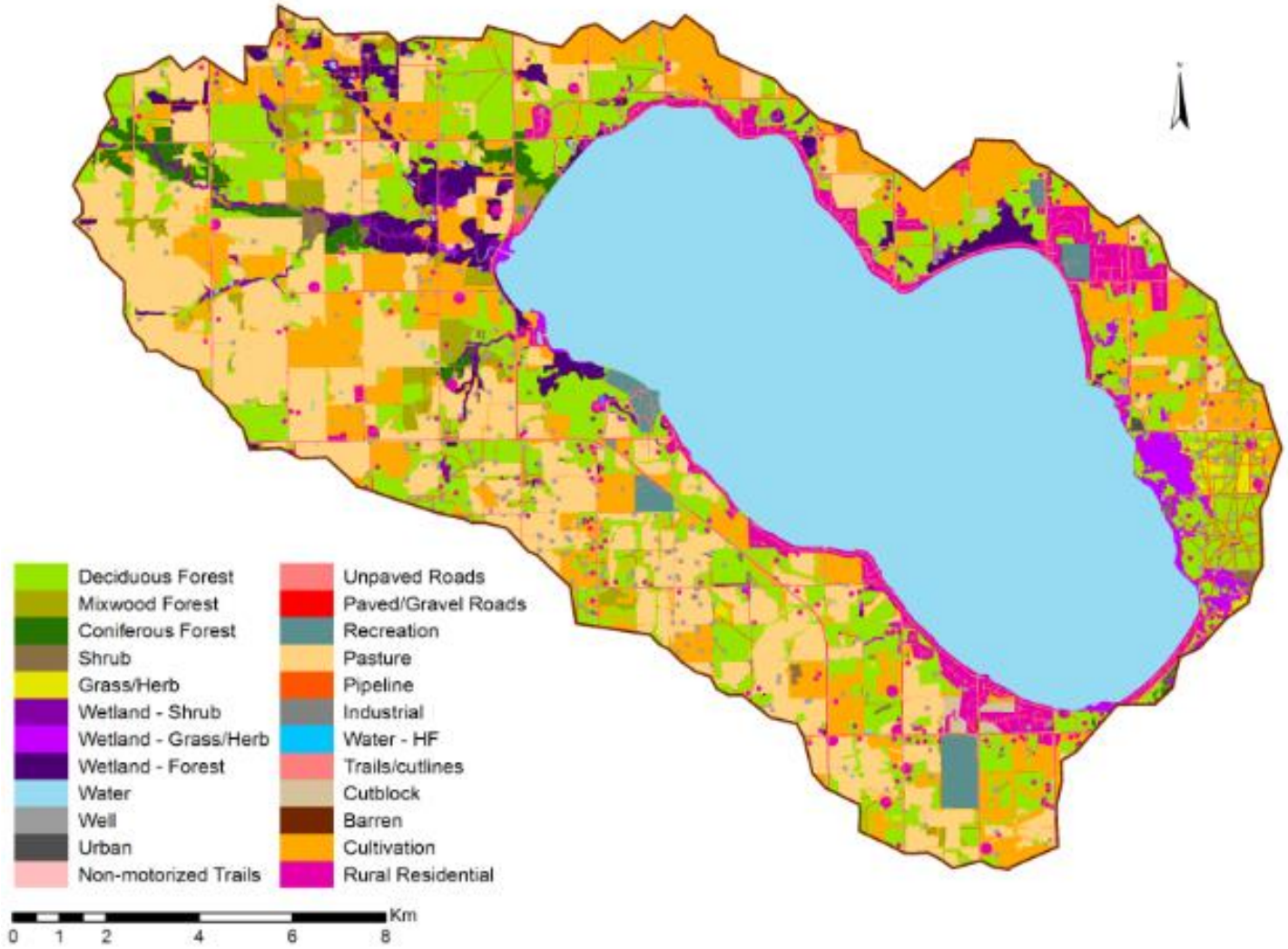


Figure C3: Landscape composition of the Pigeon Lake watershed based on 2012 conditions (Habib 2017).

Runoff from developed areas occurs mainly during spring snowmelt and following rainfall events, and can contain large quantities of nutrients from fertilizers, manure, decayed plant material, and loosened soil particles which will ultimately enter Pigeon Lake. Unlike point source pollution from industrial sites or sewage treatment plants (where the source of pollution is easily identified), sources of pollution resulting from runoff, precipitation or atmospheric deposition are difficult to identify and control due to the multiple sources of pollution and the large transport capacity. These sources of pollution are called non-point (or diffuse) and are mainly influenced by the type of land cover (e.g., agricultural activities, urban areas or natural vegetation cover) and the human activities in the watershed (e.g., pesticides and nutrients from lawns and gardens, land clearing and disruption of the riparian area).

The Pigeon Lake watershed contains considerable rural development and seasonal activity, with extensive cottage and municipal development along the lakeshore and over 100,000 seasonal visitors. While the direct impact of this population on lake water quality is challenging to quantify, a considerable proportion of the external nutrient loading into Pigeon Lake can be attributed to human presence. Human-generated land cover changes and use increase nutrient loading in two main ways:

1. Increasing the nutrient availability in the watershed:
    - Nutrient additions related to lawn fertilizers and agricultural operations.
    - Release of some proportion of sewage and pollutants produced from cottages, campgrounds and day-use areas
2. Facilitating the introduction of nutrients into the lake:
    - Removing natural vegetation and riparian buffers, which act as filters for nutrients and other pollutants
    - Increasing the percentage of hard surfaces, which decreases infiltration, increases the overland flow, and entrains pollutants
    - Land disturbances that release sediment containing phosphorus

Nutrients – notably phosphorus (P) and nitrogen (N) – enter Pigeon Lake directly through seven inflowing streams and many drainage ditches. Nutrient loading rates (annual export quantity; FIGURE C4) varied among streams and with the stream's discharge rate (FIGURE C5). Peaks for P- and N-loading in streams typically occurred in April, decreased through May-June, increased again in July-August (due to storm events) and continued to decline into September-October. 2013 data showed that the streams contributed a relatively small proportion of total external nutrient inputs into Pigeon Lake (collectively, approximately 377 kg/year, or about 11% of total external loadings). However, this information should be used with caution since the 2013 sampling missed a portion of spring runoff as sampling began on April 25th of that year. Generally, comprehensive annual water quality data for the inflowing streams are largely lacking relative to data records for the lake itself.

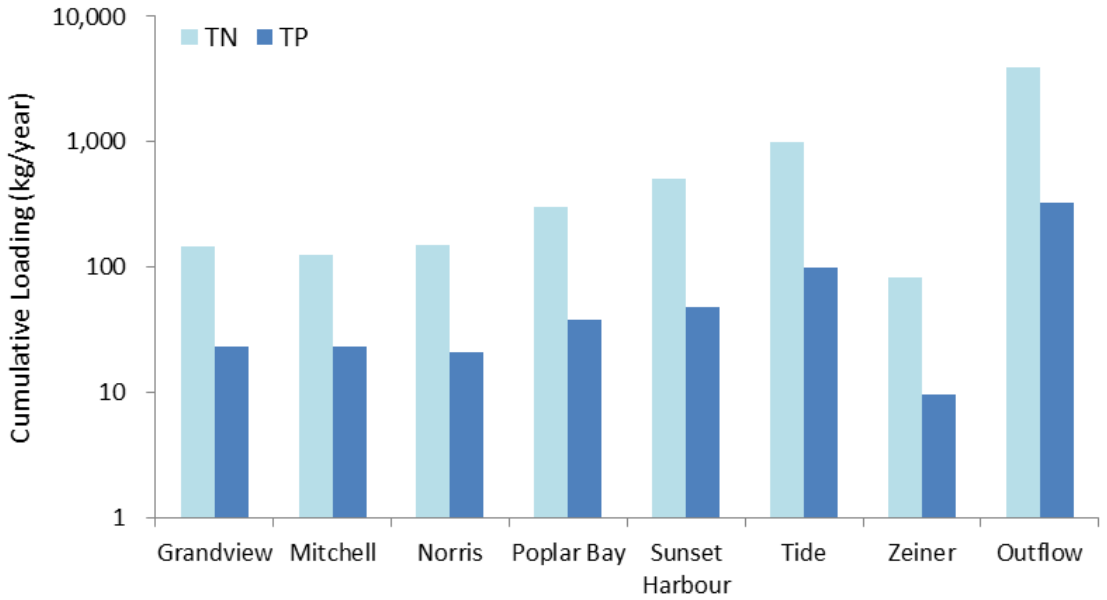


Figure C4: Summary of cumulative annual total nitrogen (TN) and phosphorus (TP) loading from inflowing streams into Pigeon Lake and exports from the outflowing stream in 2013. Data are from Teichreb et al. 2014.

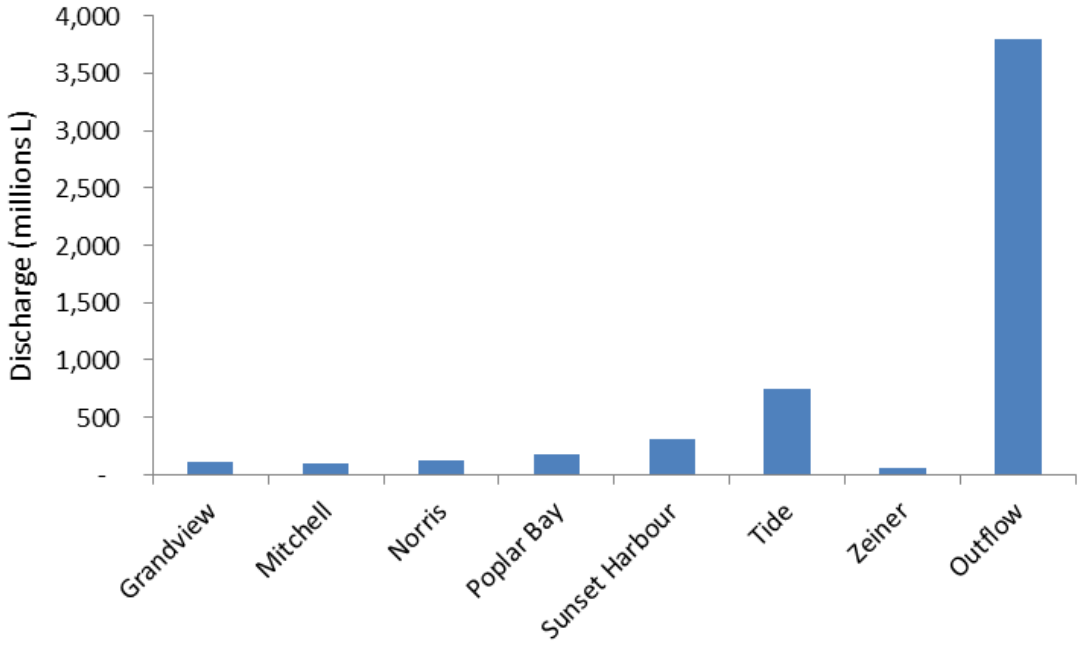


Figure C5: Summary of cumulative annual discharge from inflowing streams into Pigeon Lake and export from the outflowing stream in 2013. Data are from Teichreb et al. 2014.

Land disturbance and development within the watershed contribute to soil erosion and accelerate the rate of nutrient transport to the lake. In particular, the clearing of forests greatly increases the rate of snow melt and thus runoff from the land. Historically, riparian vegetation immediately adjacent to the banks of Pigeon Lake and its inflowing streams are thought to naturally mitigate the rates at which runoff-borne nutrients directly enter the water. Ongoing development has led to the degradation and destruction of these natural buffers, resulting in minimal filtration (i.e. removal of excess nutrients) before they reach the water. Increased land disturbance and the loss of riparian areas increase the rates at which both diffuse and point-source nutrient inputs enter Pigeon Lake. This has other consequences for water quality such as an increase in suspended materials due to increased shoreline erosion.

Phosphorus Forms, Cycle and Sources

In most temperate lakes the nutrient that is in shortest supply, and is therefore limiting to biological productivity, is P. Once P exists in sufficient quantities, growth of phytoplankton can proceed until limited by another factor (e.g., light, nitrogen (N) or wind). Excessive quantities of P can promote problematic overgrowth of cyanobacteria, also known as blue-green algae blooms. Cyanobacteria blooms can sometimes produce dangerous toxins, negatively impacting water quality and causing problems for human and ecological health. While many central Alberta lakes, including Pigeon Lake, are naturally productive, increased human development and land cover changes within watersheds over the past century appear to have increased the rates of P input into waterbodies and accelerated eutrophication rates. Thus, quantifying P inputs into waterbodies is an important first step towards controlling eutrophication to help prevent future water quality issues.

Phosphorus compounds enter the lake in different forms and compositions, depending on their origin. Once in a water body, P undergoes complex chemical and biological reactions which result in it entering the water column. There are two main forms of P: dissolved (soluble) and particulate (as a component of organic and particulate matter). The primary dissolved form of P (orthophosphate, or PO_4^{3-}) is readily available for phytoplankton and plant uptake. In response to varying environmental conditions, particulate P can change from one chemical form to another (a process known as P cycling). For example, microbial decomposition of organic matter can turn organic particulate P into its dissolved form, while in the mineral form, such as clay particles, the process is of a much longer term. Other chemical and physical changes in the water column and the lake sediments can also convert P in soil mineral particles to dissolved P.

FIGURE C6 shows a simplified P cycle in lakes. Phytoplankton and bacteria assimilate dissolved inorganic P and transform P into particulate organic P as it becomes part of their tissues. As plants and animals excrete waste or die, the organic P sinks to the bottom, where bacterial decomposition turns it back to inorganic P. This inorganic P ultimately returns to the water column and becomes again available for uptake. In the sediment, inorganic P will not pass freely into the water column if the sediment-water interface is well oxygenated. In this situation, P is bound to clays and different compounds, such as iron (Fe), calcium (Ca) or aluminium (Al). In some circumstances, increased P release in well oxygenated sediment has been observed at high pH values following resuspension events in the summer when pH increases due to the high photosynthetic activity. However, anoxic (non-oxygenated) sediments release phosphate to the overlying waters at a much faster rate.

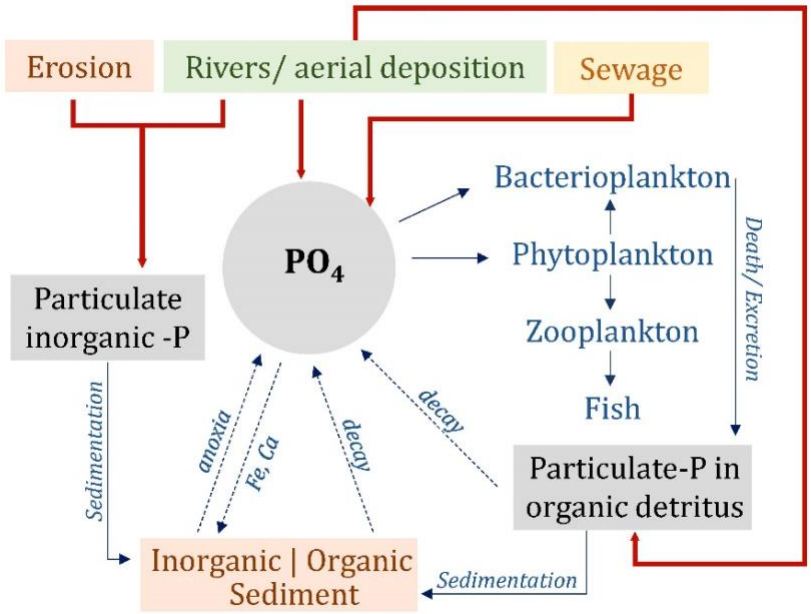


Figure C6: A simplified P cycles in lakes. Red lines = external loading. Dotted blue lines = internal loading. Solid blue lines = internal recycling.

Due to the changes in P forms, the term Total Phosphorus (TP) is used to determine the total amount of P present in the water body, regardless of its chemical identity (dissolved and particulate). However, this term does not inform about the availability of P for plant or phytoplankton uptake – a concept named "bioavailability". The relative proportion of dissolved vs particulate P that enters to a water body will therefore influence algal growth. Particulate forms of P typically enter the lake via wind transport, atmospheric deposition or through erosive processes and subsequent sediment transport. Orthophosphate (i.e., dissolved) forms are generally produced by natural processes. Point sources (e.g. effluents from treatment plants or untreated water), and nonpoint or diffuse sources (e.g. runoff from agricultural sites and application of some lawn fertilizers) largely contribute to the input of dissolved P forms.

In 2014, the Government of Alberta developed a P budget for Pigeon Lake to quantify the total P inputs into and outputs from the lake (Teichreb 2014). The report included external and internal sources (i.e., P from the watershed or atmosphere, and P released from the lake sediments, respectively) and concluded that both contribute to elevated nutrient levels. Relative annual contributions of the total P inputs were estimated to be approximately 43% (5,755 kg/year) from external and 57% (7,510 kg/year) from internal sources (FIGURE C1). Most importantly, this report determined that there is no single problematic external source of P for Pigeon Lake. Of the P that comes from external sources, it was estimated that approximately 48% (2,913 kg/year) comes from diffuse runoff, 43% (2,596 kg/year) comes from dustfall and precipitation, and 9% (587 kg/year) comes from groundwater, point-source inflows and sewage combined (FIGURE C1). Point-source and sewage contribution might seem proportionally small when compared to the contribution of other sources to the total amount of P entering the lake, yet most of the P supplied by these sources correspond to the more readily bioavailable fraction and as such are critically important. Additionally, the specific P contributions from each of these sources may vary among seasons and years according to factors such as wind and precipitation patterns or land use activities (e.g., whether a field is in fallow or being actively tilled and fertilized).

A recent report from the Alberta Biodiversity Monitoring Institute (ABMI; Habib, 2014) expanded upon the initial Pigeon Lake P budget work by using an updated and more-detailed land cover data set (FIGURE C3 and C7), as well as a range of future development scenarios based on the Leduc County's North Pigeon Lake Area Structure Plan (Leduc County 2011) and the County of Wetaskiwin Pigeon Lake Watershed Area Concept Plan (County of Wetaskiwin 2014). This study aimed at evaluating changes in P load into the lake under a variety of development scenarios (new rural and lakeshore development) and land management practices (reforestation and restoration of riparian buffers). However, this model only estimated stream and overland inflows into the lake, and did not consider other external sources (e.g., atmospheric or groundwater inputs) or internal sources (from the lake

sediments). The simulation for the current land scenario indicated that the annual point source and diffuse P loading was 3,707 Kg/year, about 12.6% larger than the input from surface runoff estimated in the original P budget (i.e., 3,290 Kg/y). Despite the differences, both estimates were in the same order of magnitude and discrepancies were likely the result of the inherent model structure and methods for the estimation of complex processes such as nutrient export or retention in a highly developed watershed. Thus, the *relative proportions of P contributions*, rather than the precise loading values, should be considered when determining how to control excess nutrient loading into Pigeon Lake.

Figure C7: Map of watershed-level phosphorus exports into Pigeon Lake, modelled according to current land use intensities. Inflowing and outflowing creeks are indicated (Habib 2017).

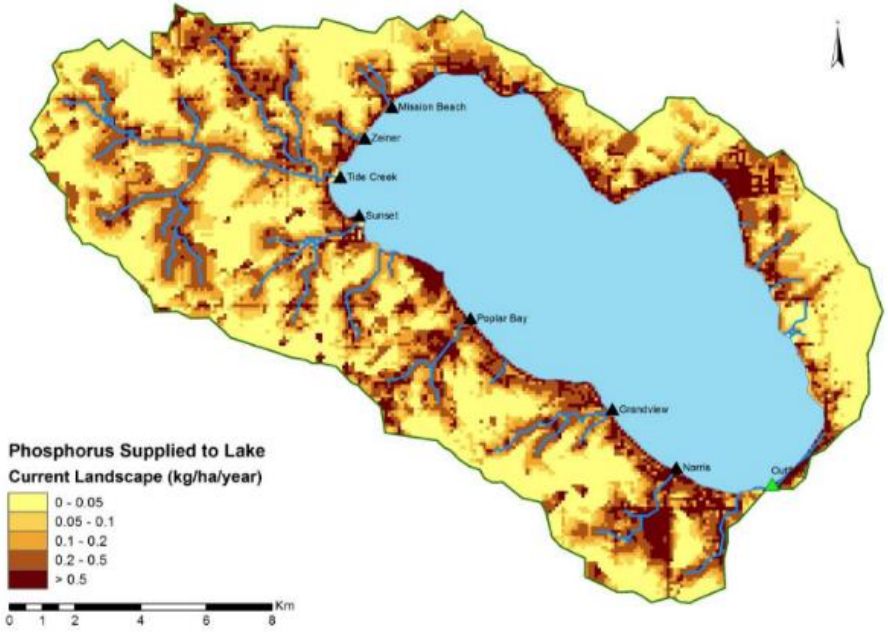
The ABMI simulation also found that relative to the current development conditions (FIGURE C7), the amounts of P that will be exported into Pigeon Lake from the watershed depend on the intensity of future development, though significant reductions were possible in all scenarios if riparian area protection and restoration occurred. Overall, although the ABMI model only accounts for the P input from surface runoff, it provides an effective management tool for evaluating the relative contribution of P from different sources in the watershed as well as for quantifying the efficiency of land management practices.

At the watershed level, P reduction initiatives should focus on reducing diffuse, point-source and sewage inputs of P (FIGURE C1). While diffuse P sources may be the most challenging to effectively reduce and measure success, they represent nearly half of the external P loading into Pigeon Lake and are the largest controllable portion; thus, it is important to explore management options. Sources of atmospheric deposition and groundwater influx of P require further determination; however, implementing beneficial management practices such as conservation tillage practices may help reduce the volatility of cultivated soils to wind erosion, reduce overland transfer of nutrients, and reduction of excess P application to the land may reduce downward migration to groundwater.

Plan Implications

- About 25% of the P inputs into Pigeon Lake come from watershed-level sources making the land cover types and land use activities within the watershed highly influential to the water quality and quantity of the lake. Watershed stewardship and incorporation of Beneficial Management Practices (BMPs; AAFRD 2004) are recommended to decrease both the nutrient concentrations in the inflowing streams and the rates at which overland flow enters the streams.
- The removal of riparian vegetation and watershed tree cover has exacerbated the rates of nutrient export from watershed sources into Pigeon Lake. Modelling has shown that riparian restoration along the lake and stream shores can result in a reduction in external nutrient loading into the water, even when the watershed itself is highly developed. Hence, a riparian and watershed conservation and restoration program should be initiated in the Pigeon Lake watershed, with efforts prioritized in areas of high P loading potential (FIGURE C8).

- Municipalities should adopt riparian setback policies to establish appropriate setbacks from all waterbodies in the watershed to maintain water quality, flood water conveyance and storage, bank stability, and habitat. Tools such as the Riparian Matrix Setback Model (Aquality Environmental Consulting 2010) can be used to manage riparian areas in a local municipality (broad brush approach).
- A significant function of wetlands is their ability to trap and retain nutrients. To increase this function in Pigeon Lake's watershed, wetlands should be conserved and restored. Thus, a list of candidate wetlands for restoration within the watershed should be developed and will streamline watershed improvement efforts under the Alberta Wetland Policy. Also, riparian buffers around wetlands are required to protect function.
- The coverage and ecological condition of natural land cover (e.g., forests and wetlands) should be maintained or improved. Conversion of remaining ecological lands to agricultural, residential, or recreational areas should be limited.
- Diffuse runoff over altered (agricultural, developed, etc.) lands comprises a significant portion of external P loadings into Pigeon Lake. Current practice does not allow for enforcement or rejection of activity based on cumulative impacts decision making. In the context of Pigeon Lake, development decisions should be thoroughly assessed to ensure that there is either a decrease or, at a minimum, no increase in nutrient export relative to current conditions. Municipal governments must ensure their review of impacts is neither too narrow nor too broad. Approvals for any work should also consider the increases to nutrient and sediment loading as a result of alterations in pre-development hydrology and watershed-level land use changes.
- Adoption of clean runoff BMPs by individual land owners and municipalities into their developments and operations will contribute to water quality improvement and increase water use efficiency.
- In agricultural lands, existing BMPs that promote soil health and responsible resource use should be continued and encouraged (e.g., AAFRD 2004). Conservation tillage programs can reduce the erodibility of soils and the subsequent potential for export via runoff. Similarly, precision agriculture approaches can be taken to avoid the export of excess nutrients off the land and into waterways by care



fully controlling the application rate, timing, and placement of inorganic fertilizers or manure. BMPs specific to ranching include reducing the intensity of grazing and trampling near riparian areas and providing water alternatives away from streams.

- In residential areas (i.e. Lakeshore developments, county residential) BMPs and implementation of Low Impact Development (LID) practices in existing and new developments will be very important to reduce P export. Principles and practices for implementing LID practices at Pigeon Lake are detailed in in the Alberta Clean Runoff Action Guide (PLWA and ALIDP 2016). Incorporating low-phosphorus development standards in Land Use Bylaws and statutory plans will be very important to achieve compliance on the part of individual land owners and developers.
- Removal of septic fields, in addition to upgrades to wastewater infrastructure of cottages and public use areas (where antiquated or

ineffective) should be encouraged to improve the water quality of Pigeon Lake. Although sewage inputs to the lake are a relatively small source of P, reducing seepage into the lake will have benefits to water quality since the P forms present in sewage are largely bioavailable for algal and plant uptake (i.e., dissolved forms of P).

- BMPs should include prohibitions on cosmetic fertilizers. A previous initiative to restrict the application of fertilizers and pesticides for cosmetic purposes in the watershed was well-supported by shoreline residents and has been implemented by municipalities throughout the watershed.
- While the dust deposition into Pigeon Lake is very technically difficult to control, atmospheric sources of P represent a significant component of the nutrient inputs to the lake. As such, the source of these inputs, as well as its form and bioavailability, should be better studied to understand where reductions are possible.

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2 SUMMARY OF THE SCIENCE: THE SHORELINE

Riparian Health

Riparian areas are biologically rich and productive areas at the edges of lakes, wetlands and streams. Riparian areas are important habitat and provide essential ecosystem functions to protect the lake's health.

In 2002 and 2008, low-altitude videography was used to conduct a riparian health assessment of Pigeon Lake (SRD 2008). The riparian area surveyed included the collective near-shore area consisting of the lake's shallow water zone (littoral) and the strip of public lakeshore, and the immediately adjacent private land that surrounds the lake. Criteria evaluated to assess riparian "health" included proportion of area covered by natural vegetation, presence of cattails (*Typha latifolia*) and bulrushes (*Scirpus* spp. and *Schoenoplectus* spp.), abundance of trees and shrubs, and the amount of human-caused vegetation removal or physical alteration. The shoreline was divided into consecutive sections and these criteria were used to classify each section into one of three impairment categories: healthy, moderately impaired, or highly impaired. The total length of shoreline in each impairment category was calculated and expressed as a percentage of the total shoreline length.

In both sampling years, the majority of Pigeon Lake's shoreline (65%) was classified as being highly impaired. In 2002, 24% of the shoreline was considered to be healthy and the remaining 11% was moderately impaired, while in 2008 (FIGURE C8) there was a slight improvement in shoreline health, with 29% of the shoreline classified as healthy and 6% classified as moderately impaired. This improvement is attributed to land purchases by the Government of Alberta along the northwest shore, though some improvement in riparian health was offset by poorer health scores elsewhere along the lake. The extensive impairment around Pigeon Lake is associated with the extensive removal of riparian vegetation and shoreline modification (e.g., maintenance of beaches, erosion control structures, installations of docks, boat lifts and marinas, and the construction of cottages adjacent to the shoreline). Notably, sections of highly impaired shoreline were very long and continuous, with healthier sections being largely restricted to areas of minimal cottage development on the northwest and east shores at the Provincial Park and First Nations Reserve (FIGURE C8)

The Government of Alberta has recommended that a similar shoreline assessment should be performed every five years on Pigeon Lake to monitor the extent and integrity of remaining riparian areas (SRD 2008). In addition, assessments of both the health of the lake and tributary riparian areas would highlight priority areas for protection and restoration.

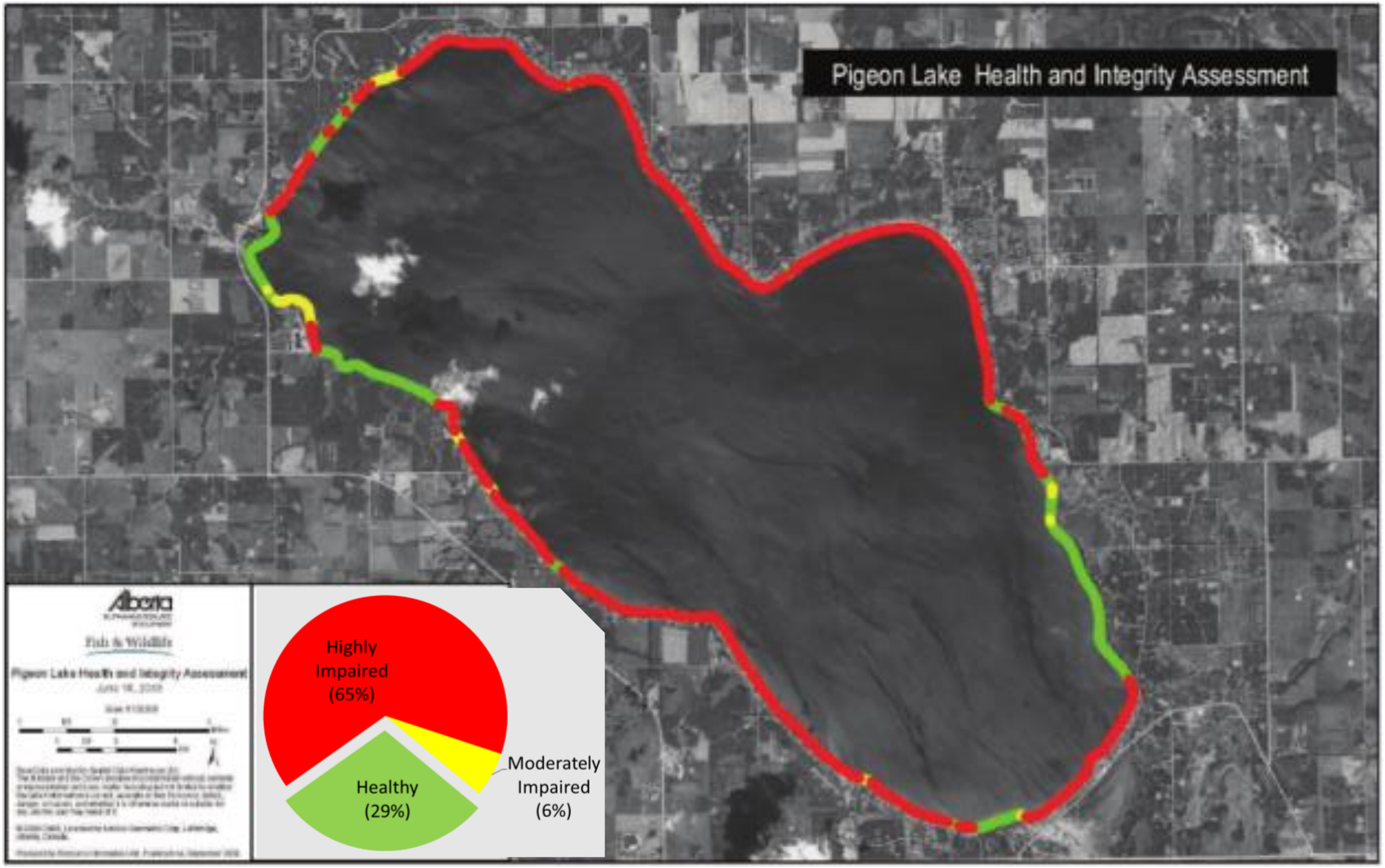

Figure C8: Pigeon Lake shoreline integrity assessment results from a June 2008 survey, indicating the extent of lakeshore degradation around the lake (SRD 2008).

Near-shore Vegetation

Aquatic vegetation (i.e., near-shore within the littoral zone) perform a wide range of ecologically-important functions, including nutrient and contaminant sequestration, shoreline stabilization, buffering water flows, and supporting rich biodiversity. Destruction of littoral habitats entails some loss of these ecological services and will have negative consequences for the biological communities of Pigeon Lake. For example, Northern Pike (*Esox lucius*), hide among vegetation such as cattails and bulrushes to ambush their prey, and rely heavily on the vegetation for spawning and rearing. Removal of the littoral vegetation compromises not only Northern Pike success but may also adversely affect other trophic levels in Pigeon Lake.

The distribution of littoral vegetation around Pigeon Lake is dependent on the extent of shoreline development and substrate type, with finer sediments and sheltered areas being most suitable for growth of aquatic vegetation. Submersed aquatic vegetation communities occur along much of Pigeon Lake's shore, with community composition and density influenced by factors such as water depth, turbulence, and sediment accumulation patterns.

In general, vegetation cover is related to the extent of shoreline development, with the lowest cover occurring in areas of high cottage density. However, no formal vegetation mapping of Pigeon Lake has occurred since the early 1980s. Continued disturbance and vegetation control activities further alter and limit the distribution of both riparian and aquatic vegetation communities, to the detriment of a healthy ecosystem.

Plants commonly found in Pigeon Lake's littoral and riparian vegetation communities are listed in TABLE C1.

Table C1: List of plants typical of Pigeon Lake's littoral and riparian vegetation communities.

Habitat	Growth Form	Common Name	Scientific Name
Littoral	Floating-leaved	Bur-reeds	*Sparaganium* spp.
Littoral	Floating-leaved	Common Duckweed	*Lemna minor*
Littoral	Floating-leaved	Star Duckweed	*Lemna trisulca*
Littoral	Floating-leaved	Variegated Pond-lily	*Nuphar variegatum*
Littoral	Floating-leaved	Water Smartweed	*Persicaria amphibia*
Littoral	Submerged	Autumn Water-starwort	*Callitriche hermaphroditica*
Littoral	Submerged	Common Bladderwort	*Utricularia vulgaris*
Littoral	Submerged	Common Water Moss	*Fontinalis* spp.
Littoral	Submerged	Coontail	*Ceratophyllum demersum*
Littoral	Submerged	Flat-stem Pondweed	*Potamogeton zosteriformis*
Littoral	Submerged	Fries' Pondweed	*Potamogeton friesii*
Littoral	Submerged	Lesser Pondweed	*Potamogeton pusillus*
Littoral	Submerged	Northern Watermilfoil	*Myriophyllum sibiricum*
Littoral	Submerged	Pondweeds	*Potamogeton* spp.
Littoral	Submerged	Richardson's Pondweed	*Potamogeton richardsonii*
Littoral	Submerged	Sago Pondweed	*Stuckenia pectinata*
Littoral	Submerged	Sheathed Pondweed	*Stuckenia vaginata*
Littoral	Submerged	Slender Water-nymph	*Najas flexilis*
Littoral	Submerged	Stonewort	*Chara* spp.

Habitat	Growth Form	Common Name	Scientific Name
Littoral	Submerged	Various-leaved Pondweed	*Potamogeton gramineus*
Littoral	Submerged	Water Buttercup	*Ranunculus aquatilis*
Littoral	Submerged	White-stem Pondweed	*Potamogeton praelongus*
Littoral	Submerged	Widgeon Grass	*Ruppia cirrhosa*
Riparian	Emergent Macrophyte	Bluejoint	*Calamagrostis canadensis*
Riparian	Emergent Macrophyte	Common Cattail	*Typha latifolia*
Riparian	Emergent Macrophyte	Creeping Spike-rush	*Eleocharis palustris*
Riparian	Emergent Macrophyte	Horsetails	*Equisetum* spp.
Riparian	Emergent Macrophyte	Knotted Rush	*Juncus nodosus*
Riparian	Emergent Macrophyte	Sedges	*Carex* spp.
Riparian	Emergent Macrophyte	Sloughgrass	*Beckmannia syzigachne*
Riparian	Emergent Macrophyte	Small-fruited Bulrush	*Scirpus microcarpus*
Riparian	Emergent Macrophyte	Soft-stem Bulrush	*Schoenoplectus tabernaemontani*
Riparian	Emergent Macrophyte	Wire Rush	*Juncus balticus*
Riparian	Forb	American Brooklime	*Veronica americana*
Riparian	Forb	Arum-leaved Arrowhead	*Sagittaria cuneata*
Riparian	Forb	Celery-leaved Buttercup	*Ranunculus sceleratus*
Riparian	Forb	Docks	*Rumex* spp.
Riparian	Forb	Fireweed	*Chamerion angustifolium*
Riparian	Forb	Marsh Ragwort	*Senecio congestus*
Riparian	Forb	Marsh Yellow Cress	*Rorippa palustris*
Riparian	Forb	Nodding Beggar-ticks	*Bidens cernua*
Riparian	Forb	Northern Stitchwort	*Stellaria borealis*
Riparian	Forb	Northern Willow-herb	*Epilobium ciliatum*
Riparian	Forb	Pale Persicaria	*Persicaria lapathifolium*
Riparian	Forb	Philadelphia Fleabane	*Erigeron philadelphicus*
Riparian	Forb	Purple-stemmed Aster	*Symphyotrichum puniceum*
Riparian	Forb	Silverweed	*Potentilla anserina*
Riparian	Forb	Stinging Nettle	*Urtica dioica*
Riparian	Forb	Water Hemlock	*Cicuta maculata*
Riparian	Forb	Water Parsnip	*Sium suave*
Riparian	Forb	Western Willow Aster	*Symphyotrichum lanceolatum*
Riparian	Forb	Wild Mint	*Mentha arvensis*
Riparian	Forb	Yellow Avens	*Geum aleppicum*
Riparian	Forb	Yellow Water Crowfoot	*Ranunculus gmelinii*
Riparian	Non-native Forb (Weed)	Bladder Campion	*Silene vulgaris*
Riparian	Non-native Forb (Weed)	Canada Thistle	*Cirsium arvense*
Riparian	Non-native Forb (Weed)	Caraway	*Carum carvi*
Riparian	Non-native Forb (Weed)	Common Groundsel	*Senecio vulgaris*
Riparian	Non-native Forb (Weed)	Common Mullein	*Verbascum thapsus*
Riparian	Non-native Forb (Weed)	Common Tansy	*Tanacetum vulgaris*

Habitat	Growth Form	Common Name	Scientific Name
Riparian	Non-native Forb (Weed)	Common Toadflax	*Linaria vulgaris*
Riparian	Non-native Forb (Weed)	Creeping Bellflower	*Campanula rapunculoides*
Riparian	Non-native Forb (Weed)	Himalayan Balsam	*Impatiens glandulifera*
Riparian	Non-native Forb (Weed)	Leafy Spurge	*Euphorbia esula*
Riparian	Non-native Forb (Weed)	Meadow Hawkweed	*Hieracium caespitosum*
Riparian	Non-native Forb (Weed)	Orange Hawkweed	*Hieracium auranticum*
Riparian	Non-native Forb (Weed)	Ox-eye Daisy	*Leucanthemum vulgare*
Riparian	Non-native Forb (Weed)	Perennial Sow-thistle	*Sonchus arvensis*
Riparian	Non-native Forb (Weed)	Purple Loosestrife (rare)	*Lythrum salicaria*
Riparian	Non-native Forb (Weed)	Scentless Chamomile	*Anthemis arvensis*
Riparian	Non-native Forb (Weed)	Stinkweed	*Thlaspi arvense*
Riparian	Non-native Forb (Weed)	Tansy Ragwort	*Senecio jacobaea*
Riparian	Non-native Forb (Weed)	White Cockle	*Silene latifolia*
Riparian	Shrub	Alders	*Alnus* spp.
Riparian	Shrub	Bush Cranberries	*Viburnum* spp.
Riparian	Shrub	Chokecherry	*Prunus virginiana*
Riparian	Shrub	Currants and Gooseberries	*Ribes* spp.
Riparian	Shrub	Prickly Rose	*Rosa acicularis*
Riparian	Shrub	Raspberry	*Rubus idaeus*
Riparian	Shrub	Red Osier Dogwood	*Cornus sericea*
Riparian	Shrub	Saskatoon	*Amelanchier alnifolia*
Riparian	Shrub	Willows	*Salix* spp.
Riparian	Tree	Balsam Poplar	*Populus balsamifera*
Riparian	Tree	Paper Birch	*Betula papyrifera*
Riparian	Tree	Trembling Aspen	*Populus tremuloides*
Riparian	Tree	White Spruce	*Picea glauca*

Invasive Species

Existing and ongoing threat: Himalayan Balsam (*Impatiens glandulifera*), a plant listed as a Prohibited Noxious Weed under Alberta's Weed Control Act, was discovered on Pigeon Lake shorelines in the early 2000's. The plant's fast growth rates and aggressive seed dispersal mechanism (including transport in lake water) allowed it to rapidly invade lakeshores and replace native riparian vegetation. Himalayan Balsam infestations can increase shoreline erosion because the plants die off every year (leaving the shoreline bare and exposed for part of the year) and their shallow root systems are ineffective at retaining soil. An action plan for the eradication of this plant from the watershed was developed in 2009, and the Pigeon Lake shoreline was tentatively declared free of Himalayan Balsam in 2015. An ongoing monitoring and control effort is continuing to prevent a repeat infestation and support the re-establishment of native riparian vegetation. Other invasive plants such as Common Tansy and Creeping Bell Flower are rapidly becoming established in the riparian area. Non-chemical actions should be taken by all lakeside communities to combat this invasion.

Emerging Threats: Waterbodies are under constant threat from the unintentional introduction of invasive species. These organisms, whether they are plants, fish or invertebrates, can cause significant damage to the lake's ecosystem. Other areas in Alberta have already seen the effects of waterbody-choking plants such as Eurasian Watermilfoil or Flowering Rush and fish such as Prussian Carp, while species such as zebra and quagga mussels have caused immense devastation elsewhere in Canada. The introduction of these species

was the result of improper care of boats and other recreational items and by the inter-lake transfer of live fish. Extreme care must be taken with water vessels (boats, canoes, fishing gear, etc.) to ensure removal of any plants or animals. The *Clean, Drain, Dry* program has been introduced as a means of protecting lakes from these invasive species.

Some of the species of concern are:

- Zebra mussels (*Dreissnea polymorpha*) and quagga mussels (*D. bugensis*) were introduced to North America via ballast water from Eurasia and have severely disrupted aquatic ecosystems in the Great Lakes Region and elsewhere. These organisms attach to hard surfaces (e.g., boat hulls or propellers) in very high densities and their veligers (larvae) are readily transported in bait containers, live wells and internal ballast tanks. Thus, boats are the primary form of zebra and quagga mussel introduction to new waterbodies. In addition to disrupting aquatic food webs, zebra and quagga mussels pose a considerable nuisance to recreation and impediment to infrastructure; once colonies have established, they are extremely difficult to eradicate. Zebra and quagga mussels have not been detected in Pigeon Lake as of 2017, but similar to Eurasian Watermilfoil, early detection and action is necessary to prevent infestation and potentially irreversible consequences.
- Eurasian Watermilfoil (*Myriophyllum spicatum*), listed as a Prohibited Noxious Weed in Alberta, is a rooted aquatic plant that can be highly disruptive to lake ecosystems. It is an unpalatable food source for native waterfowl and fish, and its rapid growth and ability to grow from stem fragments allow it to out-compete native aquatic vegetation. The plant grows close to the water surface and can restrict swimming and boating access, as well as block water outlets. Eurasian Watermilfoil fragments are easily spread between waterbodies via boats, trailers, anchors and propellers. Lakes in British Columbia, Ontario and Quebec have already become infested. Although the plant has not been found in Pigeon Lake as of yet, some localized infestations exist elsewhere in Alberta. Early detection and a proactive boat maintenance program (clean, drain and dry) will be critical to prevent a serious lake-wide threat in Pigeon Lake.
- Flowering Rush (*Butomus umbellatus*), also listed as a Prohibited Noxious Weed in Alberta, is an aquatic plant that can severely disrupt wetland, river and lake ecosystems. It resembles a large sedge or bulrush but has showy pink flowers and can grow in both emergent and submerged forms. The plant has an extensive root system and – in addition to producing seeds – can reproduce vegetatively from root fragments if they are broken. These root fragments can travel long distances in water and create dense colonies where they establish, crowding out and displacing native aquatic vegetation. Flowering Rush can interfere with boat propellers and its large, dense stands can restrict waterbody access for a variety of lake users. Flowering Rush was sold commercially as an ornamental garden plant but has established in some lakes, rivers, creeks, irrigation canals, and stormwater ponds elsewhere in Alberta. This pant has not yet been observed in Pigeon Lake, though prevention of a Flowering Rush infestation will require early detection and proper control techniques if any plants establish in the waterbody.
- Prussian Carp (*Carassius gibelio*) are relatives of common goldfish and pose a serious threat to Alberta freshwater ecosystems. These fish are extremely hardy, able to survive in conditions of very poor water quality which would be intolerable for other fish species. Additionally, Prussian carp can reproduce asexually and effectively create clones of themselves, contributing to rapid population increases. The source of Prussian carp introduction into Alberta's aquatic ecosystems is unclear, though the impacts on aquatic ecosystems of these fish are well-documented. Prussian carp out-compete native fish species for food and habitat resources and can cause fundamental changes in the aquatic invertebrate communities, possibly leading to trophic collapses. There are established breeding populations in some ponds, lakes and rivers in Alberta, but no fish have been reported in Pigeon Lake as of 2017. Eradication of Prussian carp is very difficult once they are established in a

waterbody; hence, education efforts and prevention of introduction into Pigeon Lake are paramount.

Riparian BMPs

Riparian BMPs involve actions that can be taken by land owners and users within the Pigeon Lake watershed to improve the water quality of the lake and streams. These may include:

- Avoiding where possible activities that involve the removal of riparian vegetation such as mowing, trimming, herbicide applications, cultivating, and land clearing. Maintaining natural vegetation cover on shores is preferred to artificial armoring and modification of shorelines.
- Educating watershed property owners and lake visitors about the importance of littoral vegetation. The current perception of many is that most aquatic plants are all "weeds" and are a nuisance to lake users. However, educating the public on the ecological value of aquatic vegetation is important for the maintenance and improvement of these areas.
- Educating lake users and residents on how to recognize aquatic invasive species is critical for early detection and eradication.
- Encouraging the use of shared docks and day use areas, instead of individual ones.
- Ensuring adequate naturalized setbacks for upland activities such as residential development, cropping, or livestock grazing. This will include leaving a natural vegetation buffer around waterbodies and streams, reducing grazing intensity and access within riparian areas, and planting additional riparian vegetation.
- Eliminating the use of fertilizers and herbicides along the lakeshore.
- Limiting the use of salts on shoreline roads to limit the increase in lake salinity via runoff.

Plan Implications

- BMPs, such as those highlighted above, should be implemented for riparian areas all around Pigeon Lake. Given the extensive development around the lake, educating property owners and municipalities on riparian stewardship will be essential to ensure continued riparian health and function.
- The lake-wide riparian health assessment program should be continued and updated every five years. The last assessment was in 2008, indicating that Pigeon Lake is overdue for an updated shoreline assessment. This monitoring provides important information on how impaired the lakeshore as a whole is, and will inform where to prioritize riparian restoration efforts.
- A similar riparian assessment and monitoring program should be initiated for the inflowing streams into Pigeon Lake, as the ecological integrity of streams will directly affect that of the lake. This may include sensitive habitat mapping and assessment of littoral vegetation at stream tributaries and other key fish habitat areas.
- Consider a comprehensive inventory of critical fish and wildlife habitats such as Sensitive Habitat Inventory Mapping (e.g., Mason and Knight 2001) to identify sensitive shoreline features and habitats surrounding the lake. The resulting Aquatic Habitat Index can be used to inform local mapping and planning initiatives specific to Pigeon Lake.
- To increase the provision of important ecological functions and services, such as fish production and nutrient sequestration, restoration of riparian vegetation all around Pigeon Lake and along the inflowing streams and tributaries should be made a priority.
- Shoreline restoration and strict environmental controls on future development is necessary. Examples of such tools to implement include a regional plan, inter-municipal development plans and/or municipal bylaws.
    - Lake Shoreline Management Guidelines (e.g., EKILMP 2010) can inform municipal development planning specifically to manage the sensitive shoreline features of Pigeon Lake.
    - Implementation of Low Impact Development practices can greatly reduce the runoff of pollutants from the shoreline into the lake (see Alberta Low Impact Development Partnership).

    - Adoption of Sediment and Erosion Control BMP's and Environmental Construction Operations plans for construction activities near sensitive areas to ensure that contractors identify and mitigate their environmental impacts that may result from their activities.
- Ongoing monitoring and proactive efforts are necessary to prevent the infestation of aquatic and riparian invasive species, at both the citizen and government levels.

Sources

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3 SUMMARY OF THE SCIENCE: PIGEON LAKE

Historical Climate and Lake Level Fluctuations

Pigeon Lake is a permanent waterbody and has likely existed for thousands of years; due to its large size and low outflow rates, it has a very long residence time (the amount of time that water will remain in the lake) of >100 years. The watershed of Pigeon Lake is small relative to the lake itself, with a ~2:1 watershed (187 km^2) to lake (96.7 km^2) surface area ratio (FIGURE C3; Table C2). This small drainage basin and large evaporative area makes Pigeon Lake particularly sensitive to climatic variability, with changes to precipitation or evaporative rates having a considerable impact on lake water levels.

Pigeon Lake has a very long residence time (the amount of time that water will remain in the lake) of >100 years.

Table C2: Physical properties of Pigeon Lake and its watershed.

Physical Property	Value
Lake Surface Area	96.7 km^2
Lake Water Volume	603,000,000 m^3
Maximum Depth	9.1 m
Mean Depth	6.2 m
Shoreline Length	46 km
Mean Annual Lake Evaporation	664 mm
Mean Annual Precipitation	534 mm
Mean Annual Inflow	17,000,000 m^3
Mean Residence Time	Greater than 100 Years
Lake Weir Sill Elevation	849.935 m (Above Sea Level)
Watershed Land Drainage Area	187 km^2
Watershed to Lake Area Ratio	2:1

(From Mitchell and Prepas 1990)

Climate varies naturally over seasons and years following general atmospheric patterns (e.g., El Nino Southern Oscillation and the Pacific Decadal Oscillation). For example, FIGURE C9 shows mean annual temperature and precipitation for the Pigeon Lake watershed from 1961 to 2016. (Source: Alberta Agriculture and Forestry (interpolated weather data since 1961 for Alberta townships: https://agriculture.alberta.ca/acis/township-data-viewer.jsp). Mean annual precipitation for this period is 519 mm and mean annual temperature is 2.8°C. For precipitation patterns, there are several episodes of multiyear above average and below average periods: a relatively wet period occurred from 1988 to 1991 and from 1996 to 2001. Drier than normal precipitation consecutive periods (below the long-term mean) were observed from 1966 to 1971 and from 2001 to 2003. Mean annual temperature for the same period is 2.8°C, with values showing an increase over time. Climate change scenarios for the region indicate that an increase in precipitation, warmer temperatures, and particularly less cold winters are expected in the future (Davidson 2010).

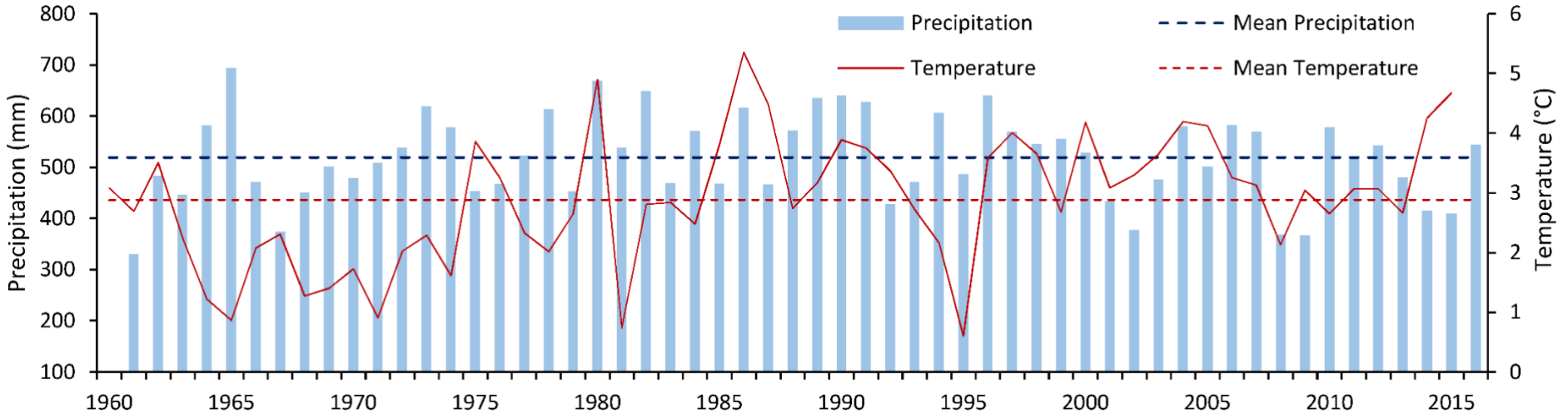

Figure C9. Mean annual temperature and total annual precipitation for the Pigeon Lake watershed.

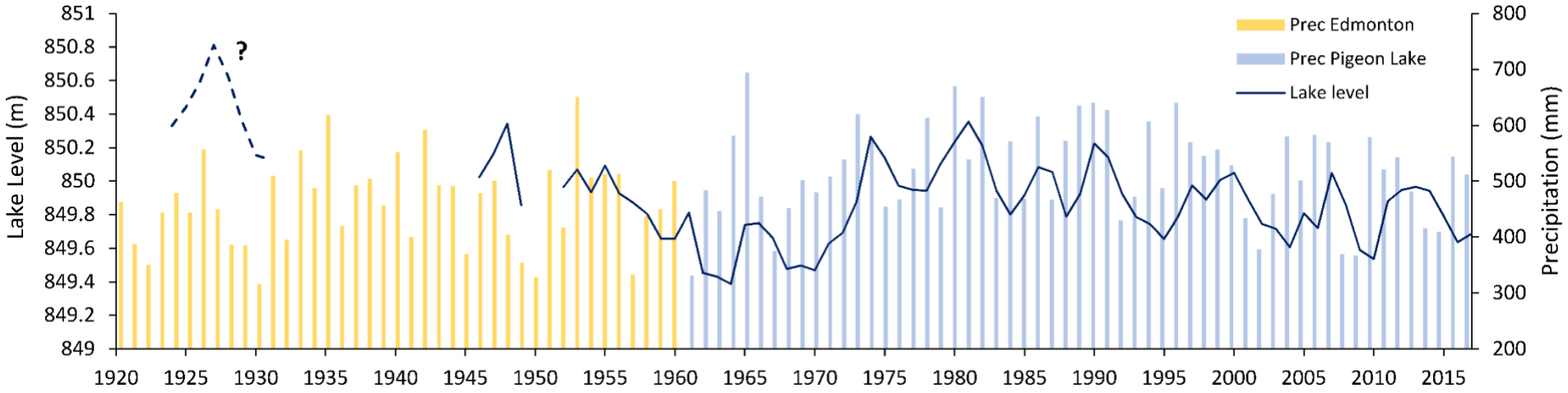

Figure C10. Pigeon Lake mean annual water levels and annual precipitation from 1920 to 2016.

Pigeon Lake historic annual precipitation and mean annual lake levels are shown in FIGURE C10. The annual precipitation from 1920 to 1960 is for the City of Edmonton (yellow bars) and from 1961-2016, shows when climate data became available for Pigeon Lake (blue bars). Data sources include Alberta Environment and Parks, Unpublished data (lake levels for Pigeon Lake); Environment and Climate Change Canada City of Edmonton precipitation data (http://climate.weather.gc.ca/); and Alberta Agriculture and Forestry (https://agriculture.alberta.ca/acis/township-data-viewer.jsp) Pigeon Lake watershed precipitation data.

Pigeon Lake water levels tend to rise and fall in response to cumulative wet and dry precipitation cycles. For example, a 7-year (1967 to 1973) steady increase in annual precipitation resulted in a 5-year (1970 to 1974) rise in Pigeon Lake mean annual water levels. Conversely a 4-year (1999 to 2002) annual precipitation decline caused Pigeon Lake mean annual water levels to decline from 2000 to 2004.

Intermittent water levels have been recorded for Pigeon Lake since 1924 with continuous daily water level monitoring from 1972 to present by Water Survey Canada. Lake levels prior to 1946 were omitted from the analysis because they were based on an assumed datum and could not be reliably converted to geodetic elevations.

Lake levels have not significantly decreased over time at the 95% confidence level during the period 1946-2017, as shown in Figure C11 (p-test = 0.414 and trend slope = -0.001). The shaded box represents the range of most (90 percent) of the historical data (5th and 95th percentiles). The historical data was outside of this range 10 percent of the time. The horizontal dashed line represents the long term median elevation (849.874 m) of the weir sill at the outlet of Pigeon Lake.

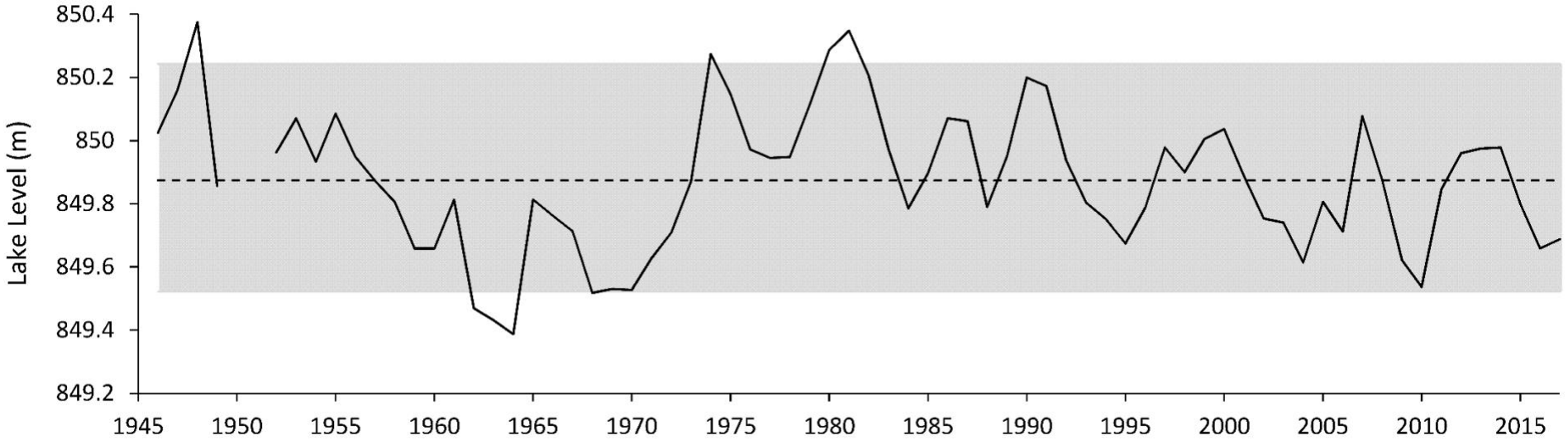

Figure C11: Pigeon Lake mean water level trends (1945-2016). The shaded box represents 5th and 95th percentiles. The horizontal dashed line represents the long-term median elevation (849.874 m) of the weir sill at the outlet of Pigeon Lake.

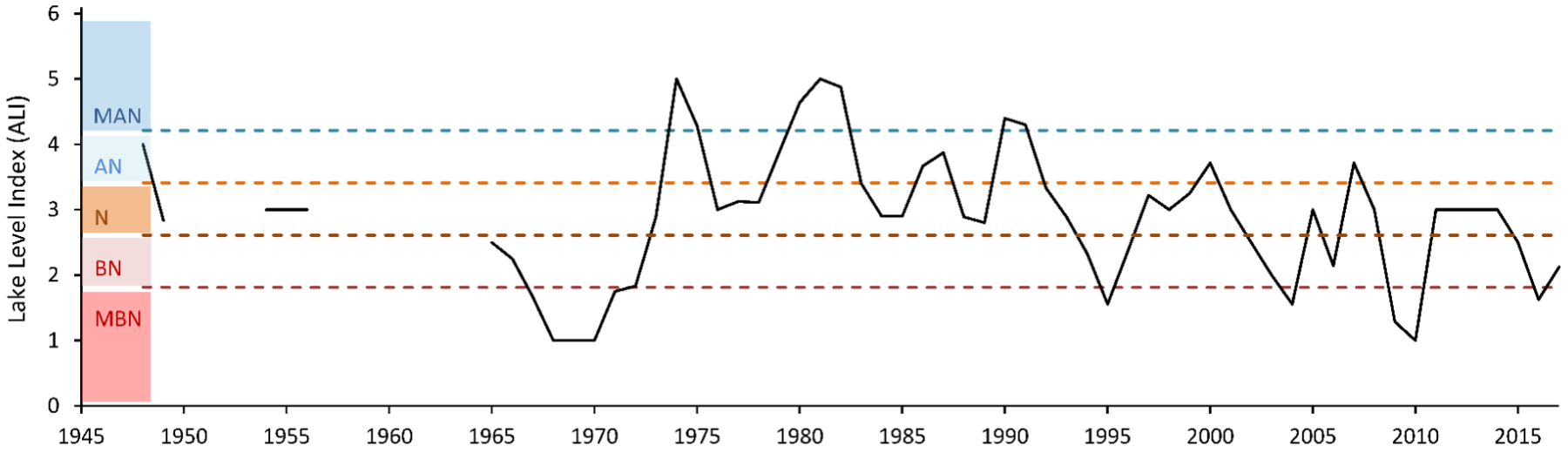

Figure C12. Lake Level Index for Pigeon Lake (1946-2017). Colored areas indicated the range of values for each of the five categories: MAN (Much Above Normal), AN (Above Normal), N (Normal), BN (Below Normal), MBN (Much Below Normal). Note that the index does not include those years with less than 3 lake level measurements.

Alberta Environment and Parks developed the "Alberta Lake Level Index" (ALI; Islam and Seneka 2015) to evaluate the status of lake levels across the province. This method takes into account intra-annual long-term changes in lake levels and has been proved to work well in lakes with limited measurements per year. Annual ALI values for Pigeon Lake, as well as the corresponding category, are provided in FIGURE C12. Lake level oscillations above and below normal are observed and seem to have followed a 20-year cycle: levels were normal or below normal in the 1950s and 1960s; they were normal to above normal from the early 1970s to the early 1990s; they have been normal to below normal from the early 1990s to 2017. Colored areas indicated the range of values for each of the five categories: MAN (Much Above Normal), AN (Above Normal), N (Normal), BN (Below Normal), MBN (Much Below Normal). Note that the index does not include those years with less than three lake level measurements.

FIGURE C13 shows the percent of time Pigeon Lake historic mean daily water levels from 1945 to 2016 equalled or exceeded a certain water level. For example the 70% exceedance is 849.80 m which means historically Pigeon Lake's mean daily water levels equalled or exceed 849.80 m 70% of the time. The 50% exceedance or median historic water level, is 849.922 m, which is 13 mm below the Pigeon Lake Full Supply Level of 849.935m. The 50% exceedance means historically Pigeon Lake's water levels have been above or equal to 849.922 m 50% of the time and below 849.922 m 50% of the time.

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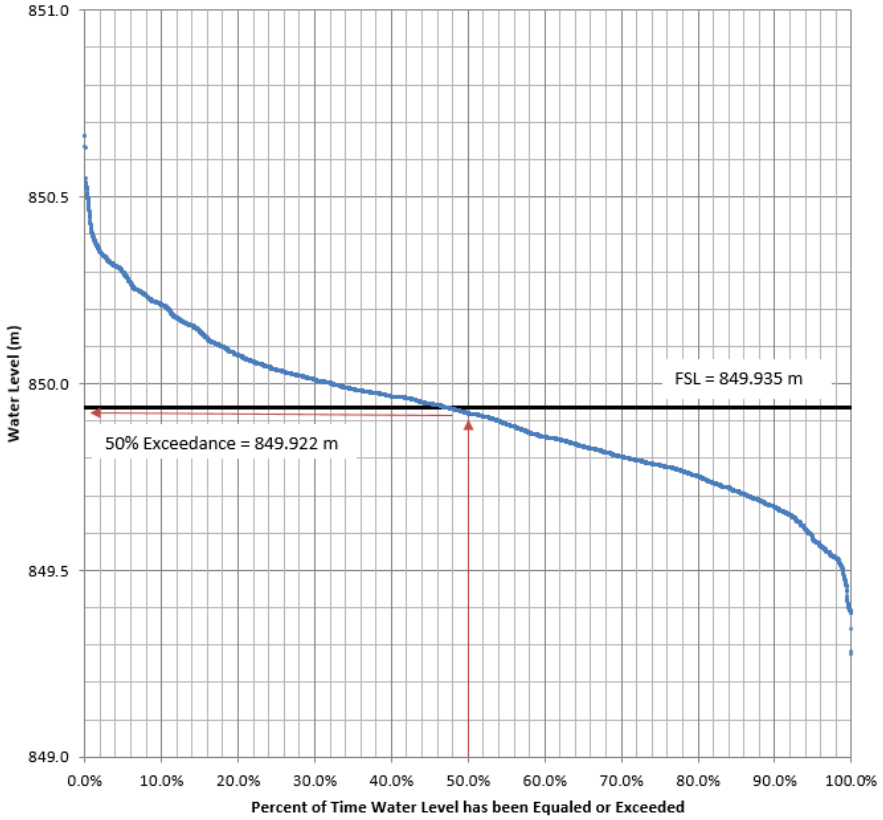

Figure C13: Pigeon Lake Historic Daily Water Levels Percent of Time Equaled or Exceeded (1945-2016).

Worley Parsons modelled the Pigeon Lake water balance from 1993-2009 (17-years) and concluded the mean annual lake input was 684.1 mm, including precipitation (64%), surface runoff (29%) and groundwater contributions (7%). Mean annual lake output was estimated at 701.8 mm and included lake evaporation (93%) and lake outflow (7%, including withdrawals). These results indicated that water losses (mainly through evaporation) exceeded water inputs to the lake, resulting in a mean annual water deficit of 17.7 mm (or 1,730 dam^3/year), matching the observed deficit of 18.7 mm/year for the 1993 to 2009 water balance evaluation period. Alberta Environment and Parks developed a 21-year (1986-2006) Pigeon Lake water balance model (unpublished) and found a mean annual 860 dam^3/year lake volume deficit. The Worley Parsons and Alberta Environment and Parks Pigeon Lake water balance results are summarized in TABLE C3. Although the two Pigeon Lake water balance models were developed independently, simulated different time periods and time intervals, the results were similar. Both concluding Pigeon Lake has similar mean annual surface inflow (19,233 dam^3/year vs 21,539 dam^3/year), groundwater represented a significant inflow component (20% vs. 23%), and there was a net water balance deficit during the simulation period (17.7 mm/year vs 8.5 mm/year) as shown in Table C3. The net deficit suggested by both Pigeon Lake water balance models reflect a relatively short simulation period (17 years vs 21 years) when Pigeon Lake levels were in a downward trend as shown by *Trend 3* in FIGURE C14.

Table C3: Pigeon Lake Water Balance Modelling Results.

Study Author	Worley Parsons		AEP	
Modelled Period	1993-2009		1986-2006	
Total Years	17		21	
	(mm/year)	*(cu.dam/year)*	*(mm/year)*	*(cu.dam/year)*
Inputs:				
Precipitation	438.0	42,653	523.0	50,930
Groundwater Inflow	48.6	4,733	67.1	6,539
Surface Inflow	197.5	19,233	221.2	21,539
Total Inputs	*684.1*	66,619	*811.3*	79,008
Ratio GW to GW&SW	20%		23%	
Outputs:				
Lake Evaporation	657.0	63,979	762.9	74,289
Withdrawals	3.6	347	3.6	355
Lake Discharge	41.3	4,020	53.6	5,224
Total Outputs	*701.8*	68,346	*820.2*	79,868
Net Deficit:	17.7	1,727	8.8	860

FIGURE C14 C14 shows three historic water level trends for Pigeon Lake between 1945 and 2010. Pigeon Lake water levels dropped significantly for 20-years (1950-1970) shown as Trend 1. Pigeon Lake water levels rebounded during the wet years in the 1970s indicated by Trend 2. Trend 3 shows Pigeon Lake in another decreasing cyclic and it was during this time period the two water balance models were developed and why both models correctly demonstrated a net deficit for Pigeon Lake. Both water balance models simulated a relatively short hydrologic time period when Pigeon Lake was in a decreasing trend (Trend 3) therefore the modelling results do not reflect the long-term historic variability of Pigeon Lake climate nor cyclic water level trends (Trends 1 and 2). There is no evidence that the long term average water volume in Pigeon Lake is decreasing beyond historical natural variability

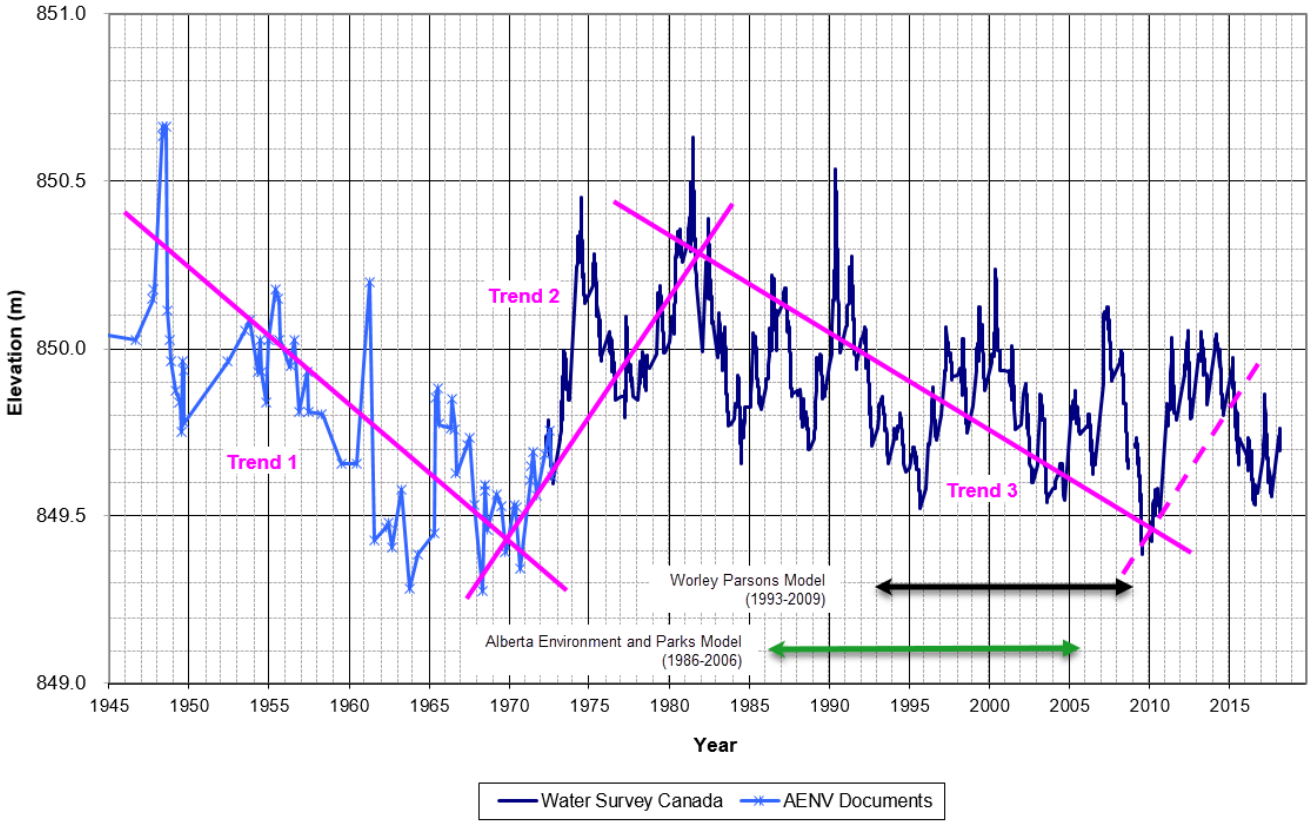

Figure C14: Pigeon Lake Mean Daily Water Level Trends and Water Balance Model Simulation Period.

Overall, extensive historical water level data has demonstrated that Pigeon Lake experiences ongoing water level cycles of both increasing and decreasing trends when considered over a longer time-period as a result of variability in weather patterns (FIGURES C9, C10, C11, C12, C14). In a manner similar to other prairie lakes, the water level varies by approximately 1.3 m. There is no evidence that the long-term average water volume in Pigeon Lake is decreasing beyond historical variability.

The outflow creek that drains Pigeon Lake into the Battle River is fitted with a weir with a sill elevation of 849.935 masl. When the water level reaches this elevation, outflow occurs, including nominal export of nutrients (FIGURES C4, C5). Attempts to maintain water levels above the weir sill elevation may benefit recreational users and may result in the removal of some nutrients from the water column, but issues of nutrient input (both internal and external loadings) would still need to be addressed. Proposals to manage lake levels at

an artificial level above the weir crest elevation entails that supplemental water would have to be introduced into Pigeon Lake from beyond its watershed to increase the lake volume flushing rate (i.e., decrease the lake residence time). Due to the significant regulatory implications and resources required for such a project, further study of the efficacy of such an option should be completed and must address issues such as:

- Implications for downstream flooding and nutrient flushing on water quality of waterbodies downstream of Pigeon Lake.
- Enhanced flood risk for shoreline properties, as well as the potential for ice damage and associated erosion potential.
- Nutrient additions and risk of invasive species from water importation.
- Long-term financial and liability issues for such a project.
- Environmental effects in the water body where the water would be withdrawn from.
- Estimates of nutrient removal recognizing that nutrients concentrations are very low for most of the year and peak only in the months of July, August and September.

Lake Water Quality Studies

Phosphorus is known to be the major nutrient limiting biological growth in lake ecosystems as it is often present in low concentrations relative to other nutrients (e.g., Nitrogen). Consequently, increases in its availability (particularly in the dissolved form) can result in undesirable production of phytoplankton such as cyanobacteria.

Detailed monitoring of P has occurred in Pigeon Lake to determine whether recent cyanobacteria blooms are a response to excess nutrient concentrations in the water. While Pigeon Lake was confirmed to be P-limited relative to N, the blooms are not solely a consequence of external nutrient loading into the lake. Based on the 2014 Pigeon Lake P budget, internal sources of P (internal loading) are estimated to contribute about 57% of the total available P into the lake's water column (FIGURE C1). Mechanisms behind Pigeon Lake P release involve complex chemical and biological reactions and require further study.

Sediment analysis in 2013 detected higher concentrations of dissolved forms of P (such as orthophosphate) in waters near the sediment layer than at the surface, confirming internal release of P from the sediments (Teichreb et al. 2014). Dissolved forms of P are preferentially taken up by phytoplankton and are thought to be released from lake sediments under periodic anoxic conditions associated with minimal wind mixing and de-oxygenation of deeper waters and also from direct uptake from the phytoplankton. Internal P loading can occur even when lake-bottom waters are well-oxygenated, due to warm temperatures facilitating high rates of organic matter decomposition rates and P release.

Chlorophyll-*a* is a photosynthetic pigment produced by phytoplankton and is commonly used to represent phytoplankton biomass. Elevated levels of chlorophyll-*a* indicate high phytoplankton biomass, which are typically caused by an excess of dissolved (bioavailable) nutrients (i.e., PO_4^{3-}) in the water body. This dissolved phosphorus is taken up by phytoplankton, where it becomes part of its biomass. Because of this, a significant amount of phosphorus is stored in phytoplankton. Analysis of chlorophyll-*a* and TP in Pigeon Lake from 1983-2016 show that both parameters fluctuated considerably and, on average, neither had a statistically significant increase over this 33-year period (FIGURES C15, C16). These data indicate that the variability and peaks in P and chlorophyll-*a* may have been higher in recent years, although this requires further examination (e.g., this could be caused by a change in laboratories).

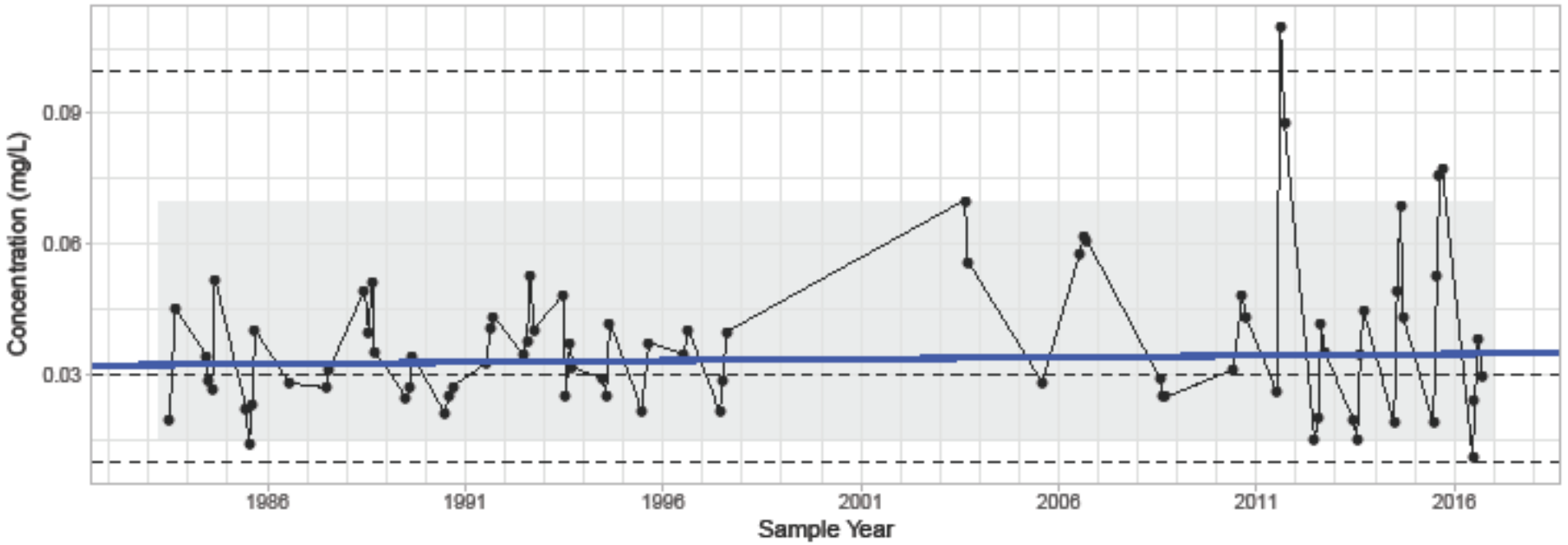

Figure C15: Trend analysis of total phosphorus concentrations in Pigeon Lake over time (1983-2016, June-September data). There is no significant change in total phosphorus concentrations over time (trend test *p*-value = 0.508). The blue line represents the trend line (slope <0.001). The shaded box represents the range of most (90 percent) of the historical data (5th and 95th percentiles). The historical data was outside of this range 10 percent of the time. Horizontal dashed lines represent trophic state cut-offs: oligotrophic <0.01 mg/L; mesotrophic = 0.01 – 0.03 mg/L; eutrophic = 0.03 – 0.1 mg/L; hypereutrophic >0.1 mg/L.

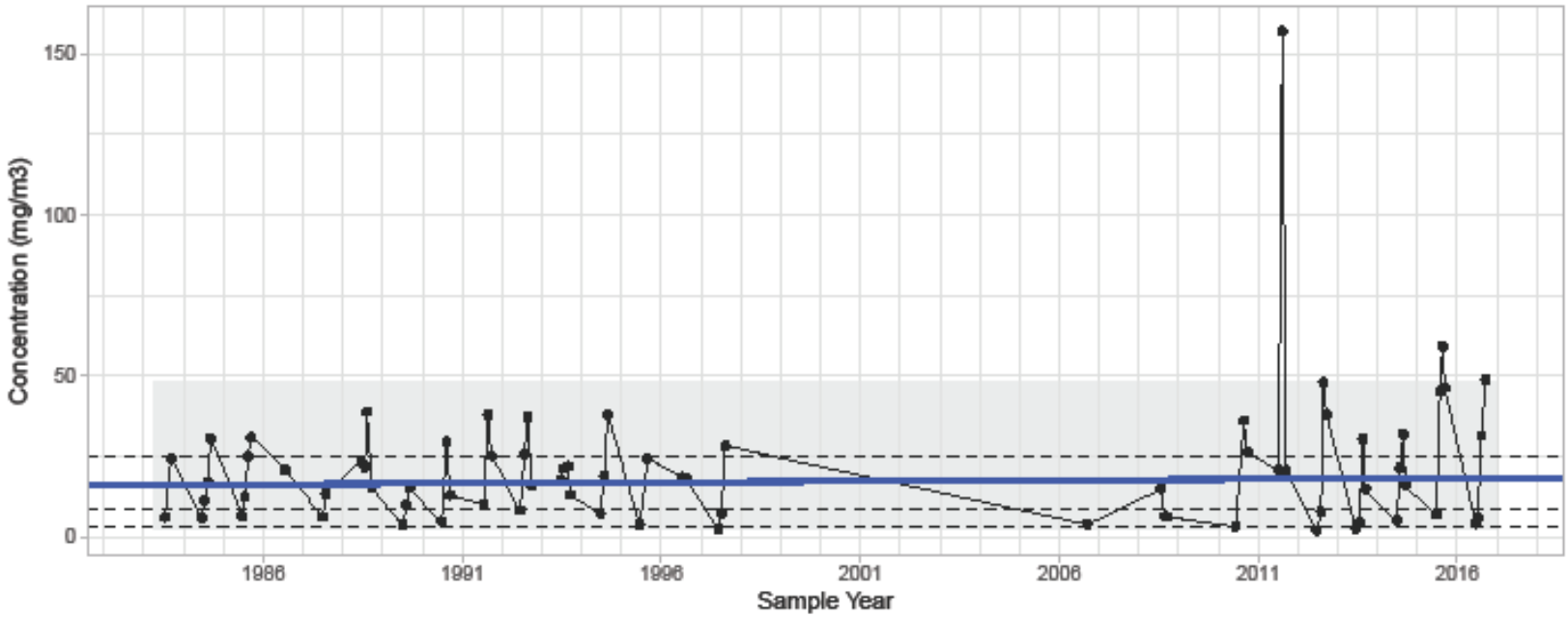

Figure C16: Trend analysis of chlorophyll-*a* concentrations in Pigeon Lake over time (1983-2016, June-September data). There is no significant change in total chlorophyll-*a* concentration over time (trend test *p*-value = 0.529). The blue line represents the trend line (slope = 0.064). The shaded box represents the range of most (90 percent) of the historical data (5^{th} and 95^{th} percentiles). The historical data was outside of this range 10 percent of the time. Horizontal dashed lines represent trophic state cut-offs: oligotrophic <3.5 mg/m^3; mesotrophic = 3.5 – 9 mg/m^3; eutrophic = 9 – 25 mg/m^3; hypereutrophic >25 mg/m^3.

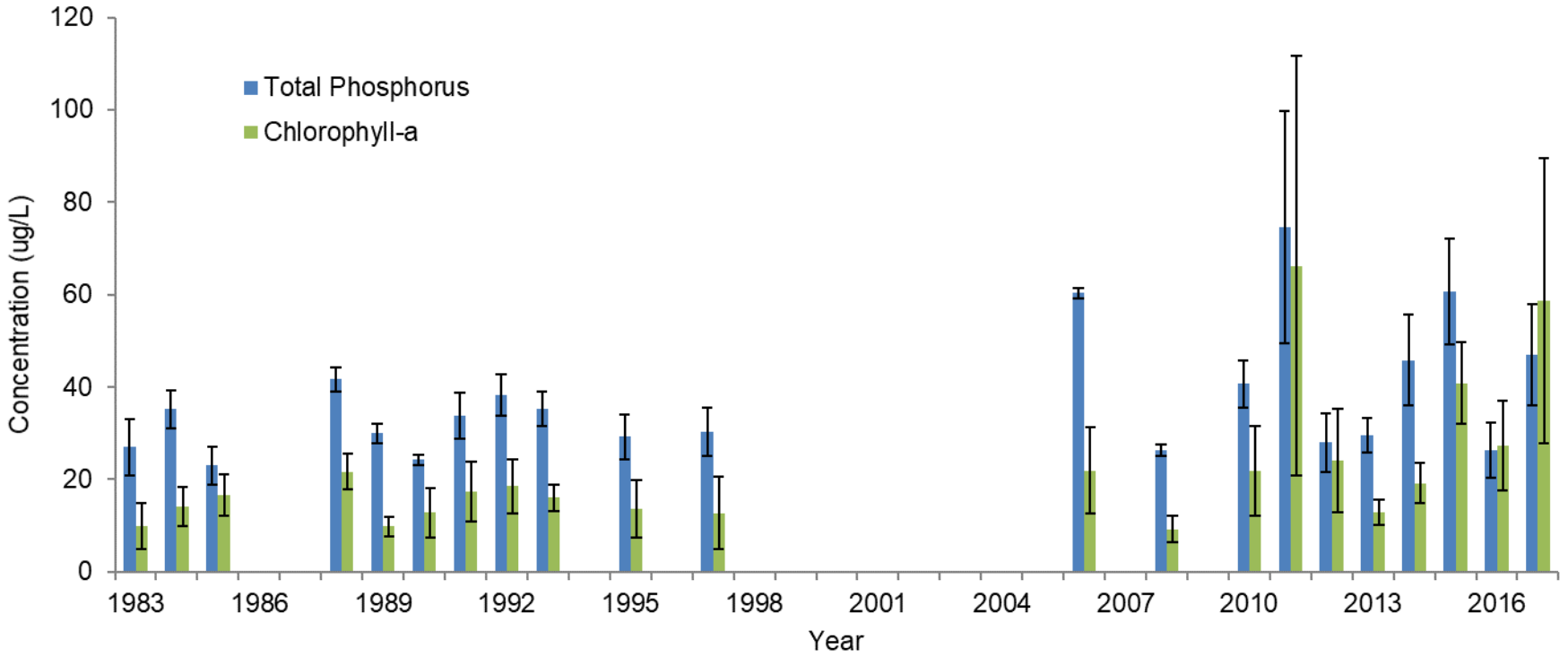

Figure C17: Average annual total phosphorus and chlorophyll-*a* concentrations in Pigeon Lake over time (1983-2017). Note that these variables were analyzed from monthly (May to September) samples taken at 10 sites around the lake, which together represent the conditions of the entire lake. Bars represent standard errors.

FIGURE C17 depicts the variation in average P and chlorophyll-*a* over time. However, there is an incomplete understanding of factors that result in the inter-annual variation in both P and chlorophyll-*a* concentrations. In most years, concentration of TP and chlorophyll-*a* followed an annual pattern, with a steady increase from June and July, peak concentration in August, and a plateau or decrease in September (FIGURE C18). This increase in mid-summer is typical of many shallow lakes, where dissolved nutrients from the decomposition at the lake bottom can be repeatedly distributed to the surface water due to weak thermal stratification.

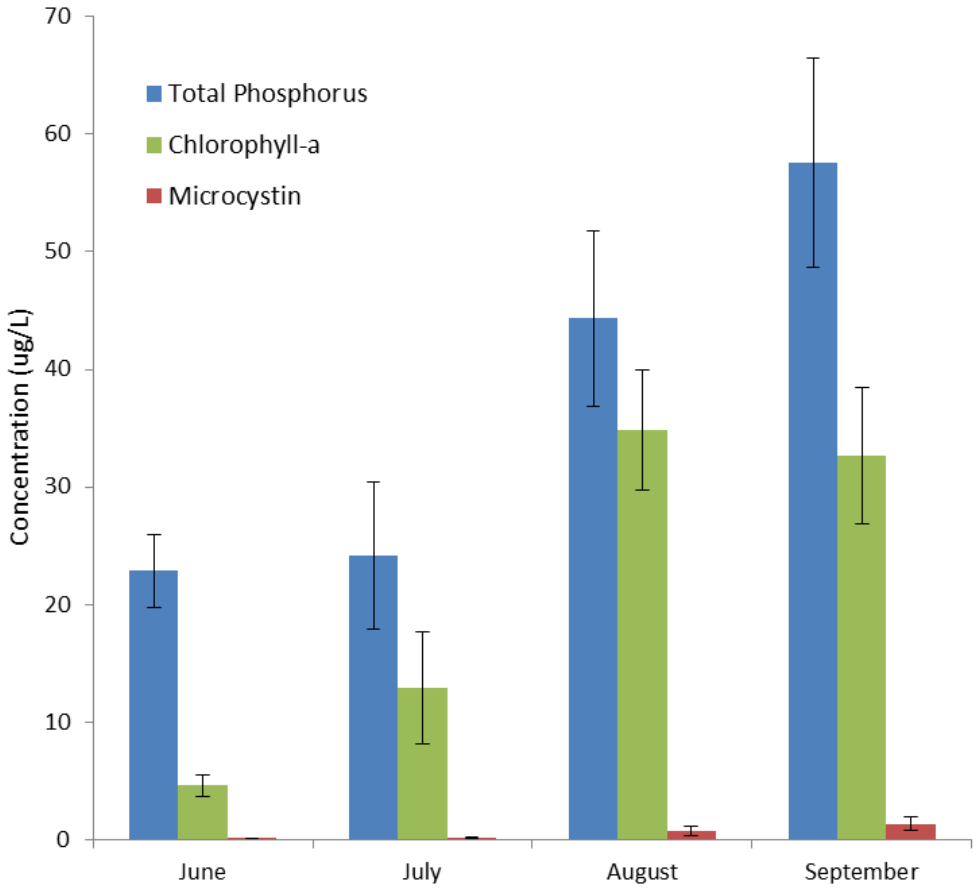

Figure C18: Monthly total phosphorus, chlorophyll-*a*, and microcystin concentrations during the open water season, averaged between 2010-2017. Bars represent standard errors.

Microcystins are toxins produced by certain species of cyanobacteria and sometimes accompany algal blooms. In sufficient concentrations, microcystins can pose a serious threat to human and animal health. In light of the recent cyanobacteria blooms in Pigeon Lake, the Alberta Lake Management Society has conducted annual monitoring of microcystins as part of their whole-lake monitoring program since 2010. Microcystin concentrations were generally low, never exceeding Alberta Surface Water Quality Guidelines for Recreation and Aesthetics (20 µg/L) in open water. Since 2012, Alberta Health Services has been monitoring microcystin concentrations and amount of cyanobacteria consistently at six beaches on Pigeon Lake: Grandview, Ma-Me-O, Mission, Provincial Park, Silver, and Zeiner. As seen in Table C4, these data are very variable, given the dynamic nature of beach ecosystems. Beach microcystin is generally low, except in 2015 when it surpassed the Alberta Guidelines for Recreation and Aesthetics at beach locations at Grandview Beach, Pigeon Lake Provincial Park, and Silver Beach. The amount of total cyanobacteria frequently surpasses the Recreation and Aesthetics Guidelines (100,000 cells/ml) at all beaches, which is not uncommon in Alberta.

Table C4: Microcystin-LR concentration and cyanobacteria cell counts measured at six Pigeon Lake beaches by Alberta Health.

Beach	Minimum value		Average value		Maximum value	
	Microcyst (µg/L)	Cell Count (#/ml)	Microcyst (µg/L)	Cell Count (#/ml)	Microcyst (µg/L)	Cell Count (#/ml)
Grandview	0.03	0	2.32	696,926	59.84	6,787,472
Ma-Me-O	0.03	0	0.88	505,177	13.26	5,610,115
Mission	0.03	0	0.84	583,629	8.25	15,788,134
Prov. Park	0.03	0	2.09	379,846	60.47	3,556,608
Silver	0.03	0	8.92	138,784	483.50	953,094
Zeiner Park	0.05	0	0.73	532,364	15.86	8,040,846

Besides favorable environmental conditions, the success and proliferation of cyanobacteria in Pigeon Lake may be partly attributable to certain aspects of their biology. These include fast reproductive rates, lower light requirements relative to other phytoplankton, decreased palatability to some grazing zooplankton, buoyancy-promoting gas vesicles in certain species, N-fixing capability of certain species, and the ability of certain species to extract P from the sediments directly.

While cyanobacteria-ecosystem dynamics are not yet fully understood in Pigeon Lake, ecological perturbations observed in other eutrophic lakes may indicate some of the potential impacts that cyanobacteria blooms have on Pigeon Lake's biota. For example, the increased turbidity of lake water during and following cyanobacteria blooms decreases light penetration into the water, which suppresses the growth of rooted aquatic vegetation. The capacity of the vegetation to uptake P from the sediments and retain it in biomass is reduced, resulting in more nutrients available for internal loading and feeding cyanobacteria blooms, thereby promoting a positive feedback cycle.

The water temperature of Pigeon Lake is another important factor affecting water quality, as cyanobacteria are known to have a competitive advantage over other phytoplankton in warmer waters. Water temperature varies both seasonally and diurnally, though the shallow basin in Pigeon Lake limits thermal stratification and results in largely consistent temperatures and dissolved oxygen levels throughout the water column.

Metals are naturally present in aquatic environments as an artifact of rock weathering, though elevated levels of certain metals may be indicative of industrial pollution. While 27 metals were detected in Pigeon Lake water column samples in 2003, 2012, and 2014-2017, all of these occurrences were well below their respective water quality guidelines.

Paleolimnological Sediments Studies

The water quality of Pigeon Lake has been well monitored within recent decades in response to the eutrophication and frequent cyanobacteria bloom events that currently affect the lake. However, the existing water quality data record do not cover large periods of Pigeon Lake's watershed development during the mid-20th century, resulting in limited data available to determine whether the lake water quality and algal dynamics baselines have changed over time.

In 2013, a paleolimnological study of Pigeon Lake was undertaken to examine changes in lake water quality over the past century (~1900-2013) using multiple indicators in lake sediments (Köster et al. 2014). Analysis of sediment cores revealed that Pigeon Lake is naturally rich in nutrients and cyanobacteria, with an enrichment of organic materials, P and cyanobacteria counts in the 1950s corresponding to watershed development. Over the entire study period, a slight increase in cyanobacteria abundance relative to other phytoplankton taxa was observed. Additionally, calmer waters and increased lake ion content within the past 20 years were inferred based on phytoplankton community data.

As Pigeon Lake is a naturally productive lake, a realistic water quality management target would be to maintain a water quality standard sufficient for normal recreational use with limited algae blooms. In other words, an acceptable water management target would be to lower nutrient concentrations to a point where the lake maintains excellent fish and wildlife productivity, but enough to reduce the frequency and intensity of algal blooms. As such, realistic expectations of watershed and water quality improvements are necessary. Cyanobacterial blooms are driven not only by watershed activities but also by water temperatures, wind and solar radiation, and internal nutrient loadings.

Food Web Studies

Manipulation of the relative abundances of organisms higher up in the food chain can be an effective approach to regulate cyanobacteria populations under certain conditions. One such approach is to increase the abundance of herbivorous zooplankton and thereby increase the amount of grazing pressure on the cyanobacteria. Researchers from the University of Alberta have begun to conduct such experiments in enclosed systems in Pigeon Lake. More research needs to be conducted to determine if a reduction in cyanobacteria levels in Pigeon Lake may be achieved through a top-down grazing approach before biomanipulation efforts can proceed.

Paleolimnological analysis of sediment cores indicates that cyanobacteria have been part of the phytoplankton community at Pigeon Lake for at least a century. However, favorable water conditions in recent years may have facilitated the excess proliferation of cyanobacteria into blooms. These conditions include not only excess nutrient (i.e., P) availability but also may include climate-related factors such as increased water column stability (due to altered wind patterns) and warmer surface water temperatures. While the exact mechanisms leading to bloom formation in Pigeon Lake are currently unknown, warmer and calmer waters likely give cyanobacteria a competitive advantage over true algae. Because these environmental conditions change seasonally and annually, however, prediction of cyanobacterial bloom occurrence, intensity, duration and location is difficult.

Due to its large size and shallow depth, the waters of Pigeon Lake are relatively well-mixed and thus well-oxygenated. Both dissolved oxygen levels and temperature are relatively consistent throughout the water column (albeit with seasonal variation), with anoxic conditions (dissolved oxygen concentrations < 2 mg/L) developing at depths of 7 m or deeper. As a by-product of photosynthesis, phytoplankton release oxygen into the water column, meaning that during a bloom there is typically an initial increase in the

dissolved oxygen content of the water column. However, when the colony of phytoplankton eventually dies, the decomposition of such a large quantity of biomass consumes much of the dissolved oxygen in the water column and may deplete the oxygen content of the water to critically low levels. Extensive asphyxiation and mortality of other aquatic life can occur, resulting in fish kills.

The fish populations of Pigeon Lake have been monitored for decades, though the precise interactions between cyanobacteria and the fish community are unknown. Dominance of the phytoplankton community by cyanobacteria may disrupt the balance in the natural food web structure of the lake, and thus affect the amount and quality of food for fish. Similarly, blooms may also cause environmental conditions unfavorable to fish health such water high in turbidity and low in oxygen.

In addition to these environmental stressors, fishes such as Walleye (*Sander vitreus*), Northern Pike (*Esox lucius*), Lake Whitefish (*Coregonus clupeaformis*), and Yellow Perch (*Perca flavescens*) have been subject to direct anthropogenic pressures such as habitat modification, angling, and commercial fishing. Despite being a large lake, Pigeon Lake is subject to greater fishing pressure than smaller lakes due to deeper areas of the lake being unusable as fish habitat. Consequently, both fish and anglers are concentrated into the small areas of suitable habitat. Any changes to the amount of available habitat or the existing angling rates will place more pressure on the fish populations and may contribute to a fishery collapse.

Overharvesting appears to have led to the extirpation of Walleye from Pigeon Lake in the 1950s, and the current sustainable population in the lake is the result of intensive stocking efforts in the 1990s. Lake Whitefish populations have fluctuated considerably over the past century but are currently considered to be stable. A large Lake Whitefish mortality event in 2012 was thought to be due to lake temperature but does not seem to have negatively affected overall populations. In Alberta the commercial fishery was ended in 2014. The Northern Pike populations in Pigeon Lake are considered collapsed, and a zero-catch limit was imposed as of April 1, 2016. Factors which may have contributed to this decline include the extirpation of this species in the 1950's, loss of littoral spawning and feeding habitat, direct competition with the reintroduction of Walleye as an apex predator, and overfishing. Similarly, Yellow Perch populations are considered to be in a vulnerable to collapsed state. All species are under threat from ongoing habitat loss and overfishing.

BMPs from Other Jurisdictions

The APLM technical committees have reviewed several methods that have been implemented in other jurisdictions to address excess lake nutrient levels and harmful algal blooms. Treatment options which may be feasible include:

- Short-term treatment options (removal of phytoplankton)
    - Biomanipulation to support top-down biological control of cyanobacteria
    - Harvesting phytoplankton from the water surface and shorelines and
- Longer term treatment options (inactivation of nutrients)
    - Chemical inactivation of P in the water column via addition of alum, calcium, iron or lanthanum-enriched bentonite clay (e.g., Phoslock®)

These approaches are currently being reviewed to determine their viability to treat the current water quality problems in Pigeon Lake; however, the circumstances supporting their efficacy at one lake may not be true when applied to another. Review of these strategies requires lake-specific research, environmental and socio-economic risk assessments (including evaluation of potential risks to the lake, financial costs, and overall efficacy), and formal stakeholder consultation and regulatory approval prior to implementation.

Plan Implications

- To maintain the natural functioning of an aquatic ecosystem adapted to nutrient-rich conditions, an appropriate management target would be to maintain a water quality level amenable for recreational use with a minimal occurrence of algae blooms.
- Pigeon Lake is naturally nutrient-rich, with the P loading into the water column from both the watershed and lake sediments. Thus, actions should be taken to reduce both external and internal nutrient loading into Pigeon Lake, though the allocation of efforts between these sources may vary due to technical, financial, and feasibility considerations. Development of a nutrient reduction model may be an effective approach to determine what combination of activities will result in the most effective remediation with a relatively low level of risk.
- The existing P budget for Pigeon Lake should be recalculated with the additional P data collected from the lake and inflowing streams, including the importance of the spring runoff (freshet), with updates to better reflect the true imports and export rates. For example, the current P budget does not account for biological sources of P, such as that in water-bird excrement or in the biomass of stocked fishes. In addition, the nutrient budget should consider the impact of bioavailable vs particulate P for source identification.
- In addition to increased nutrient availability, cyanobacteria blooms are likely driven by several additional factors such as increased water stability (both turbulence and thermodynamically), changing climate conditions, increased light availability, and shoreline modification. Further research is necessary to identify the interactions of these and other factors and to determine the mechanisms responsible for cyanobacteria bloom dynamics. For example, analysis of long-term water quality and phytoplankton community data may reveal the physical or chemical drivers behind seasonal phytoplankton community shifts favoring cyanobacteria dominance.
- A comprehensive water quality model should be developed for Pigeon Lake to assist with lake management. This could allow various management scenarios to be run and their effects on the lake ecosystem to be predicted, such anticipating potential trophic cascades or simulating the effects of supplemental water inputs on nutrient dynamics. Such a model would ideally incorporate all available hydrological, ecological, and water quality data for Pigeon Lake and its watershed to support informed decision-making.
- Accurate and up-to-date water quality data for Pigeon Lake are essential for updating the P budget and the development of an effective lake- and watershed-scale water quality model.
- Robust fish populations are important to both the ecology of Pigeon Lake and the sustainability of recreational and First Nations fisheries. Additional study of how fish populations interact with cyanobacterial blooms is warranted. Managing fish populations may provide a tool to assist in managing cyanobacterial blooms. In the meantime, a conservative fisheries management approach is recommended.

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APPENDIX D: GLOSSARY

Preface

This Glossary defines technical terms used in the Pigeon Lake Watershed Management Plan 2017 and Appendix C Technical Summary. These are technical terms which are in use by professionals for the management of Lakes and Watersheds in Alberta. Technical terms have been derived from two primary Alberta authorities. Environmental planning terms are derived largely from the latter GoA collection plus broadly sourced.

- Alberta Lake Management Society (ALMS): https://alms.ca/educational-resources/
- Government of Alberta: http://aep.alberta.ca/water/programs-and-services/water-for-life/partnerships/documents/8043.pdf

The reader is referred to the source authorities (above) for technical definitions not found below and for the definition source authorities.

Selected terms have been retained in this collection which are relevant to the Pigeon Lake Watershed Management Plan.

TECHNICAL TERMS – WATERSHED, LAKE MANAGEMENT & ENVIRONMENTAL PLANNING

Adaptive Management

A dynamic system or process of task organization and execution that recognizes the future cannot be predicted perfectly. Planning and organizational strategies are reviewed and modified frequently as better information becomes available. Adaptive management applies scientific principles and methods to improve management activities incrementally as decision-makers learn from experience, collect new scientific findings, and adapt to changing social expectations and demands. (SEM)

Algae

Aquatic, nonvascular organisms which typically contain chlorophyll and usually include the green, yellow-green, brown, and red algae and the blue-green algae (also known as cyanobacteria). (ALMS)

Algal Bloom

Population explosion of algae in surface waters due to an increase in plant nutrients such as nitrates and phosphates.[8] Usually due to excessive blue green algae growth. (ALMS)

Bacteria

Tiny, unicellular organisms that reproduce by cell division and usually have cell walls; can be shaped like spheres, rods or spirals and can be found in virtually any environment. (ALMS)

Beneficial Management Practices (BMPs)

Techniques and procedures that have been proven through research, testing, and use to be the most effective and appropriate for use in Alberta.

Effectiveness and appropriateness are determined by a combination of: (1) the efficiency of resource use, (2) the availability and evaluation of practical alternatives, (3) the creation of social, economic, and environmental benefits, and (5) the reduction of social, economic, and environmental negative impacts. (BRBC)

Benthic

Referring to bottom zones or bottom-dwelling forms. (ALMS)

Benthos

Animals and plants living on or within the substrate of a water body (freshwater, estuarine or marine). (ALMS)

Bioavailability

The amount of a nutrient that is in a form that is available for uptake and use by biological organisms. (ALMS)

Biodiversity

The existence of a wide range of different types of organisms in a given place at a given time. (ALMS)

Chlorophyll

A green, light-absorbing pigment found in plants and other photosynthetic organisms. A magnesium-porphyrin complex, it is an essential electron donor in photosynthesis. The amount of chlorophyll present in lake water depends on the amount of algae and is therefore used as a common indicator of water quality. (ALMS)

Clarity

A measure of the light penetration of water, generally measured using a Secchi disk. (ALMS)

Conservation

1. The planning, management, and implementation of an activity with the objective of protecting the essential physical, chemical, and biological characteristics of the environment against degradation. (EPEA)

2. The process of managing biological resources (e.g., timber, fish) to ensure replacement by re-growth or reproduction of the part harvested before another harvest occurs. A balance between economic growth and environmental and natural resource protection. (G&G glossary)

Cumulative Effects

The combined effects on the aquatic environment or human developments arising from the combined environmental impacts of several individual projects. (WCAG)

Cyanobacteria

A group of aquatic bacteria (also known as blue-green algae) that are capable of photosynthesis. Excessive amounts of cyanobacteria (harmful algal blooms) can negatively impact water quality through production of natural toxins (e.g., microcystin) and through depleting water oxygen levels. (ALMS)

Decomposition

The breakdown of dead organic material through physical, chemical and biological processes. (ALMS)

Detritus

Undissolved organic or inorganic matter resulting from the decomposition of biological parent material. (ALMS)

Dissolved Oxygen

The amount of free oxygen absorbed by the water and available to aquatic organisms for respiration; amount of oxygen dissolved in a certain amount of

water at a particular temperature and pressure, often expressed as a concentration in parts of oxygen per million parts of water (ppm). (ALMS)

Drainage Basin

The total area of land that contributes water and materials to a lake, river, or other water body, either through streams or by localized overland runoff along shorelines. (SWQG)

Diffuse Phosphorus Load

Diffuse is associated with particular land uses as opposed to individual points of origin or discharge. Diffuse phosphorus loading can arise from activities related to agriculture, forestry, urban development, mining, oil and gas, construction, and recreation. Such diverse sources along with the fact that diffuse sources can be transported by rainwater, snowmelt, runoff, air deposition and groundwater, make it difficult to prevent, measure, control, quantify and manage this type of pollution. Land surface (e.g., slope), soil texture, geology, vegetation, hydrology and climate also affect the timing and extent of Diffuse loads. (also known as non-point source pollution; also see pollution)

Ecosystem

A community of interdependent organisms together with the environment they inhabit and with which they interact. (BRBC)

Ecosystem Functions

Processes that are necessary for the self-maintenance of an Ecosystem such as primary production, nutrient cycling and decomposition. The term is used primarily as a distinction from values. (NALMS)

Environment

The components of the earth, including air, land, and water, all layers of the atmosphere, organic and inorganic matter, living organisms, and their interacting natural systems. (EPEA)

Environmental Indicator

A measurement, statistic or value that provides a proximate gauge or evidence of the effects of environmental management programs or of the state or condition of the environment. (NALMS)

Environmental Outcome

The desired environmental end state defining the specific conditions or functions that one expects for the environment. An outcome is an event, occurrence, or condition that results from an activity or program that has an actual effect on resources, the environment, or Albertans. (IHCR

Environmentally Significant Area (ESA)

ESA's are identified areas containing rare or unique elements in the province, or areas that include elements that may require special management consideration due to their conservation needs. ESAs do not represent government policy and are not necessarily areas that require legal protection, but instead are intended to be an information tool to help inform land use planning and policy at local, regional and provincial scales.

Erosion

Movement of soil by water or wind. (ALMS)

Eutrophic

Rich in dissolved nutrients, photosynthetically productive and often deficient in oxygen during warm weather. (ALMS)

Eutrophication

The process by which lakes and streams are enriched by nutrients, and the

resulting increase in plant and algae growth. This process includes physical, chemical, and biological changes that take place after a lake receives inputs for plant nutrients–mostly nitrates and phosphates–from natural erosion and runoff from the surrounding land basin. The extent to which this process has occurred is reflected in a lake's trophic classification: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile). (ALMS)

Evapotranspiration

Loss of water by evaporation from the soil and transpiration from plants. (ALMS)

Exotic Species

Plant or animal species introduced into an area where they do not occur naturally; non-native species.1 Examples area Eurasian Milfoil and Purple Loosestrife. (ALMS)

Flushing Rate/Retention Time

Flushing rate is the rate of water replacement in a lake. Its unit of measure is times/year. Conversely, retention time is the average length of time water resides in a lake, ranging from several days in small impoundments to many years in large seepage lakes. Retention time is important in determining the impact of nutrient inputs. Long retention times result in recycling and greater nutrient retention in most lakes. Calculate retention time by dividing the lake volume by the volume of water passing through the lake in one year. (ALMS)

Food Chain

The transfer of food energy from plants through herbivores to carnivores. An example: insect-fish-bear or the sequence of algae being eaten by small aquatic animals (zooplankton) which in turn are eaten by small fish which are eaten by larger fish and eventually by people or predators. (ALMS)

Geographic Information Services (GIS)

A set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes.

Geospatial

Fusion of geography and information technology collection, management, analysis and integration of geo/location-based data to enable improved decision and policy making.

Geospatial Data

Data pertaining to the geographic location and characteristics of natural/constructed features and boundaries on, above, or below the Earth's surface.

Healthy Aquatic Ecosystem (Healthy Lake)

An aquatic environment that sustains its ecological structure, processes, functions, and resilience within its range of natural variability. Alberta Water Council. 2008

Hydrological Cycle

Refers to the processes by which water moves in the global environment. Includes condensation, precipitation, runoff, storage and evapotranspiration, and quantitatively measured using distribution and concentration. (ALMS)

Kjeldhal Nitrogen

The most common analysis run to determine the amount of organic nitrogen in water. The test includes ammonium and organic nitrogen. (ALMS)

Littoral

Pertaining to or along the shore, particularly to describe currents, deposits, and drift. (ALMS)

Macrophytes

A member of the rooted aquatic plant life of an area, especially of a body of water. Typically refers to emergent plants such as cattails and reeds. (ALMS)

Microcystin

A group of toxins naturally produced by certain species of cyanobacteria. Harmful to human, animal and ecological health in sufficient concentrations. (ALMS)

Morphometry

Measurement of external form.[7] Lake morphometry includes maximum and average depth, surface area, volume, shoreline length, basin shape, etc. (ALMS)

Nitrogen Fixation

The conversion of atmospheric nitrogen (N_2) into an organic form usable by plants and other organisms; nitrogen is typically fixed by bacteria that live in nodules on the roots of legumes and similar plants. (ALMS)

Nutrients

Elements or substances such as nitrogen and phosphorus that are necessary for plant growth. Large amounts of these substances can become a nuisance by promoting excessive aquatic plant growth. (ALMS)

Oligotrophic

Describes a body of water in which nutrients are in low supply. (ALMS)

Orthophosphorus

Dissolved inorganic phosphorus. The dissolved inorganic form of phosphorus that is immediately bio-available for absorption by algae. Also, can be referred to as soluble reactive phosphorus (SRP). Chemical formula is PO_4^{3-}.(ALMS)

Pathogen

A disease-producing agent; usually applied to a living organism. Generally, any viruses, bacteria, protozoans or fungi that cause disease. (ALMS)

Phosphorus

Key nutrient influencing plant growth. Soluble reactive phosphorus (orthophosphorus) is the amount of phosphorus in solution that is readily available or Bioavailable to plants. Total phosphorus includes the amount of phosphorus in solution (reactive) and in particulate form. (ALMS)

Photosynthesis

Process through which light energy, water, and carbon dioxide are converted to carbohydrate and oxygen in the presence of chlorophyll. Occurs in plants, algae, cyanobacteria and lichens. (ALMS)

Phytoplankton

Microscopic plants found in the water. Algae or one-celled (phytoplankton) or multicellular plants either suspended in water (plankton) or attached to rocks and other substrates (periphyton). Their abundance, as measured by the amount of chlorophyll a (green pigment) in an open water sample, is commonly used to classify the trophic status of a lake. Numerous species occur. Algae are an essential part of the lake ecosystem and provides the food base for most lake organisms, including fish. Phytoplankton populations vary widely from day to day, as life cycles are short. (ALMS)

Plankton

Small plant organisms (phytoplankton and nanoplankton) and animal organisms (zooplankton) that float or swim weakly though the water. (ALMS)

Point-Source Pollution or Non-Point Source Pollution

Pollution that originates from one, easily identifiable cause or location, such as a sewage treatment plant or feedlot. (WFL)

Pollutant

A contaminant in a concentration or amount that adversely alters the physical, chemical, or biological properties of the natural environment.

Pollution

Cumulative effect of a pollutant or combination of pollutants on the natural environment of a location or locations. Two types are:

- Point-Source Pollution: that originates from one, easily identifiable cause or location, such as a sewage treatment plant, outfall or feedlot.
- Non-Point Source Pollution: that enter a water body from diffuse or undefined sources and are usually carried by runoff. Examples of non-point sources include agricultural land, coal mines, construction sites, roads, and urban areas. Because non-point sources are diffuse, they are often difficult to identify or locate precisely, and are therefore difficult to control.

Restoration

Measures undertaken to return a degraded ecosystem's functions and values, including its hydrology, plant and animal communities, and/or portions thereof, to a less degraded ecological condition. (ALMS)

Riparian

Pertaining to the banks of a river, stream, waterway, or other, typically, flowing body of water as well as to plant and animal communities along such bodies of water. (NALMS)

Riparian lands are transitional areas between upland7 and aquatic ecosystems. They have variable width and extent above and below ground and perform various functions. These lands are influenced by and exert an influence on associated water bodies8, including alluvial aquifers9 and floodplains. Riparian lands usually have soil, biological, and other physical characteristics that reflect the influence of water and hydrological processes. Alberta Water Council

Residence Time

Length of time that water will remain in a lake or other water body.

Secchi Disk

A 20 cm (8 inch) diameter plate with alternating quadrants painted black and white that is used to measure water clarity (light penetration). The disc is lowered into water until it disappears from view. It is then raised until just visible. An average of the two depths, taken from the shaded side of the boat, is recorded as the Secchi disc reading. For best results, the readings should be taken on sunny, calm days. (ALMS)

Sedimentation

The process of or accumulation of sand and dirt settling on the bottom of a lake. (ALMS)

Shore

The edge of a body of water and includes the land adjacent to a body of water that has been covered so long by water as to wrest it from vegetation or as to mark a distinct character on the vegetation where it extends into the water or on the soil itself. (PSSSPH)

Stakeholder

An individual, organization, or government with a direct interest in a particular process or outcome. (SEM)

State of the Watershed Report

A document that identifies the current condition of a watershed including the physical, chemical, and biological characteristics of its surface and groundwater and the pressures acting on it. (Partnerships)

Stewardship

Stewardship

A principle or approach whereby citizens, industry, communities, and government work together as stewards of the province's natural resources and environment. In general terms, stewardship means managing one's life, property, resources, and environment with regard for the rights or interests of others. This can apply to a person, company, community, government or group. Stewardship is an ethic and a value that results from public education and partnerships. It is people-focused in the sense that it relies on the desire

and ability of people to make good decisions on their own accord that help resource and environmental outcomes. (SEM)

Stratification

The layering of water due to differences in density. Water's greatest density occurs at 4 °C (39 °F). As water warms during the summer, it remains near the surface while colder water remains near the bottom. Wind mixing determines the thickness of the warm surface water layer (epilimnion), which usually extends to a depth of about 6.5 m (20 feet). The narrow transition zone between the epilimnion and cold bottom water (hypolimnion) is called the metalimnion or thermocline. (ALMS)

Surface Water

Water bodies such as lakes, ponds, wetlands, rivers, and streams, as well as groundwater with a direct and immediate hydrological connection to surface water (for example, water in a well beside a river). (SSRB)

Suspended Solids

A measure of the particulate matter in a water sample, expressed in milligrams per liter. When measured on inflowing streams, it can be used to estimate the sedimentation rate of lakes or impoundments. (ALMS)

Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. (UN)

The balancing of opportunities for growth with the need to protect the environment. It reflects a vision of a vibrant economy and a healthy environment. Regarding renewable resources (e.g.: water, timber, fish, and wildlife), sustainability involves managing renewable natural resources so that their status, condition, or use is maintained over time. In this context, the use of a renewable resource, or impacts on it from other human activities, should not exceed its capacity to maintain itself through re-growth, reproduction, and management practices. Regarding non-renewable resources (e.g.: coal, oil, gas, and minerals), sustainability involves the development of resources in a responsible manner. This means protecting the environment during the construction and operation phases and ultimately reclaiming the land disturbed by development. In this context, non-renewable resource development is a temporary land use. (SEM)

Transpiration

The passage of water in plants from the roots through the vascular system to the stoma of the leaves and into the atmosphere. (ALMS)

Trophic Levels

A classification of organisms according to what they eat and their relative position in the food chain (e.g., primary producers, herbivores, predators, decomposers). (ALMS)

Trophic State

Eutrophication is the process by which lakes are enriched with nutrients, increasing the production of rooted aquatic plants and algae. The extent to which this process has occurred is reflected in a lake's trophic classification or state: oligotrophic (nutrient poor), mesotrophic (moderately productive), and eutrophic (very productive and fertile). (ALMS)

Turbidity

Degree to which light is blocked in water because water is muddy or cloudy. (ALMS)

Upland

An area of dry land surrounding or upstream of a water body. (WCW)

Water Act

A piece of provincial legislation in Alberta used to protect the quality of water and manage its distribution. The Water Act regulates all developments and activities that might affect rivers, lakes, or groundwater. (WFL)

Water Body

Any location where water flows or is present, whether or not the flow or the presence of water is continuous, intermittent, or occurs only during a flood. This includes, but is not limited to, wetlands and aquifers. (WFL)

Water for Life: Alberta's Strategy for Sustainability

The Government of Alberta's water management approach, outlining a comprehensive set of strategies and actions that will ensure Albertans have safe, secure drinking water, healthy aquatic ecosystems, and a reliable quality water supply for a sustainable economy. (GWMT)

Water Management

The protection and conservation of water and aquatic ecosystems, including their associated riparian area. In Alberta, several agencies have a mandate in this area. Alberta Environment is responsible for water quality, quantity monitoring, and water allocations. Under the Water Act a Director can set Water Conservation Objectives to protect minimum flow and aquatic ecosystem health. Stakeholders can recommend Water Conservation Objectives to a Director via a Water Management Plan or an Approved Water Management Plan. Alberta Sustainable Resource Development (SRD) manages crown lands including the bed and shores of all water bodies. SRD, through its Fish and Wildlife Division, is also responsible for fisheries and wildlife management. In addition, the Federal Department of Fisheries and Oceans upholds a no-net-loss policy in its mandate to protect fisheries habitat under the Federal Fisheries Act. (Partnerships)

Water Quality

A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose. (ALMS)

Water Quantity

The volume or amount of water. (FWMP)

Watercourse

The bed and shore of a river, stream, lake, creek, lagoon, swamp, marsh or other natural body of water, or a canal, ditch, reservoir or other artificial surface feature made by humans, whether it contains or conveys water continuously or intermittently. (EPEA)

Watershed

Watershed - An area of land, bounded by topographic features, that drains into a shared destination such as a river, stream, lake, pond or ocean. The size of a watershed can be tiny or immense and its boundaries and velocity of flow are determined by land forms such as hills, slopes and mountain ranges that direct water. Within each large watershed, there are many smaller watersheds.

Watershed Approach - Place-Based Approach

A way of thinking and acting that focuses efforts within a watershed, taking into consideration both ground and surface water flow. This approach recognizes and plans for the interaction of land, water, plants, animals, and people. Focusing efforts at the watershed level gives the local watershed community a comprehensive understanding of local management needs and encourages locally led management decisions. (WFL)

Watershed Management / Water Management

The protection and conservation of water and aquatic ecosystems, including their associated riparian area. Because land use activities on the uplands of a watershed can affect ground and surface water quality and quantity, a

broader, more comprehensive approach to planning is often required. A Watershed Management Plan may look at water quantity, water quality, aquatic ecosystems, riparian area, as well as a variety of land use issues as they impact water. Watershed management plans require water and land use managers to work together to ensure healthy watersheds. (Partnerships)

Watershed Management Plan Water Management Plan

A comprehensive document that addresses many issues in a watershed including water quantity, water quality, point and non-point-source pollution, and source water protection. It may or may not include a Water Management Plan. It may also examine ways to better integrate land and resource management within a watershed. (Partnerships)

Watershed Management Planning /Watershed Management Plan

A comprehensive, multi-resource management planning process involving all stakeholders within the watershed, who, together as a group, cooperatively work toward identifying the watershed's resource issues and concerns as well as develop and implement a watershed plan with solutions that are environmentally, socially and economically sustainable. (NSWA)

Watershed Planning and Advisory Council (WPAC)

Collaborative, independent, volunteer organizations with representation from all key partners within the watershed. Their mandate is to engage governments, stakeholders, other partnerships, and the public in watershed assessment and watershed management planning, while considering the existing land and resource management planning processes and decision-making authorities. (Partnerships)

Watershed Stewardship Group (WSG)

Community-based groups made up of volunteer citizens, often supported by local businesses and industries, who have taken the initiative to protect their local creek, stream, stretch of river, or lake. These proactive groups develop on-the-ground solutions to ensure the protection of their specific watersheds. (WFL)

Wetland

Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, water-loving vegetation, and various kinds of biological activity which are adapted to a wet environment.

Zooplankton

A community of floating, aquatic, minute animals and non-photosynthetic protists. (ALMS)

GENERAL PLANNING TERMS

Collaboration

A process through which parties that see different aspects of a problem can explore constructively their differences and search for (and implement) solutions that go beyond their own limited vision of what is possible. Collaboration is a mechanism for leveraging resources; dealing with scarcities; eliminating duplication; capitalizing on individual strengths; building internal capacities; and increasing participation and ownership strengthened by the potential for synergy and greater impact.

Intermunicipal Dispute

A municipality holding the opinion that a statutory plan, land use bylaw or amendment adopted by an adjacent municipality will have a detrimental effect on it.

Dispute Resolution

The process to inform and negotiate a mutually beneficial resolution of a defined intermunicipal dispute. If a mutually beneficial negotiation cannot be achieved the municipalities can seek a resolution through mediation and, ultimately through an appeal to the Municipal Government Board.

Framework

An organized structure of policies, legislation, programs and tasks created to achieve a specific outcome. There can be frameworks for broad policies and strategic initiatives at various scales (e.g. provincial, regional, sector, media); programs and program delivery; and short-term tasks and projects. (SEM)

Growth

Growth of a region or municipality is defined as increase in its size, population or employment.

Governance

The process of decision-making and the process by which these decisions are implemented.

Guideline

A specific performance measure that is not legally binding unless designated in legislation. It is a guide or indication of a future course of action. It describes how something will be accomplished. It may contain numerical performance measures and may deal with multiple uses of water.

Objective

The result of either planned or unplanned actions. For planning purposes, "objectives" are the desired endpoint and should guide the development and implementation of related programs. Outcomes can be broad and long-term in nature or focused. They are used in both direction setting and performance measurement.

Partnership

A relationship in which individuals or organizations share resources and responsibility to achieve a common objective, as well as any resulting rewards or recognition. It often includes a formal contract, new resources and shared risks and rewards. The structure includes a central body of decision-makers whose roles are defined. The links are formalized. Communication is frequent, the leadership is autonomous, and the focus is on specific issues. Partnerships are a form of collaboration.

Methods

The methods are formal agreements between organizations that are sharing people, technology, process or data and explain how the item is being shared and sets out the means and systems CRGIS will adopt when they collect, store, access, compile and analyze information about the region

Policy

1. A governing principle, plan, or consistent course of action developed in order to meet recognized needs and to achieve specific measurable outcomes. Policies are normally broad, conceptual documents that outline approaches and/or considerations to be taken into account by decision makers. Policies do not act as constraints, but provide information. (SEM)

2. A statement of intent that is not legally binding. It sets direction and expectations for activities.

Provincial Land Use Framework

A policy of the Government of Alberta to introduce and implement regional land use plans to ensure the long-term health of Alberta's communities, economy and the environment.

Public and Stakeholder Involvement

The process used to obtain advice or recommendations from a community and engage them in decision-making. Public and stakeholder involvement is an umbrella term that includes a range of interactive approaches including information and education, consultation, collaboration, partnerships, and delegated authority.

Referral

Involves informing adjacent jurisdictions of new or amended plans, land use bylaws or new development proposals providing opportunity to comment on how the proposal may impact them.

Recreation Corridor

Inter-connected crown, public or private lands that are generally linear in form and are of regional significance for the purpose of providing recreational opportunities, such as the Trans Canada Trail, walking trails and parks and open space in the North Saskatchewan River Valley. Regional Recreation Corridors may also provide access to municipal recreation opportunities.

Region

Region, specifically the geographic area contained within the participating jurisdictions.

Regional

Relating to the Region, whether by geographic proximity or by the impact that actions or decision may have on others.

Stakeholder

An individual, organization, or government with a direct interest in a particular process or outcome.

Strategy / Strategic

A perspective, position, or plan developed and undertaken to achieve goals. It is the bridge between policy and concrete actions that outlines how a policy will be implemented to achieve its goals. (SEM)

MUNICIPAL AND REGIONAL PLANNING TERMS

Area Structure Plan (ASP)

A statutory plan identifying many neighbourhoods where residential, commercial, institutional and recreational areas will be located in a previously undeveloped area. These plans also describe the number of people expected to live in the new area and how development will be staged over time.

Development

A change in the use or intensity of use of land or a building or an act done in relation to land or a building that results in or is likely to result in a change in the intensity of use of land or building.

Intermunicipal Development Plan (IDP)

A statutory plan containing broad-based policies that are prepared by two or more neighbouring municipalities. Their main purpose is to ensure that future growth reflects the mutual and individual interests of the municipalities involved. Typically, the focus is on the boundary area between rural and urban municipalities.

Land Use Bylaw (LUB)

A Bylaw that divides a municipality into land use districts and establishes procedures for processing and deciding upon development applications. It sets out rules that affect how each parcel of land in a municipality may be used and developed.

Liveability / Quality of Life

The environmental and social quality of an area as perceived by residents, employees, customers and visitors. This includes safety and health (traffic safety, personal security, and public health), local environmental conditions (cleanliness, noise, dust, air quality, and water quality), the quality of social interactions (neighbourliness, fairness, respect, community identity and pride), opportunities for recreation and entertainment, aesthetics, and existence of unique cultural and environmental resources (e.g. historic structures, mature trees, traditional architectural styles).

Low Impact Development (LID)

A land planning and engineering design approach for managing stormwater runoff. LID emphasizes conservation and use of on-site natural features to protect water quality. This approach implements engineered small scale hydrologic controls to replicate the predevelopment hydrologic regime of watersheds through infiltrating, storing, evaporating, and detaining runoff close to its source.

Municipal Development Plan (MDP)

A statutory plan that functions as a municipality's overall policy guide for future growth and development. The Plan outlines the direction of future development, the provision of transportation systems and municipal services, the coordination of municipal services and programs, environmental matters and economic development.

Municipal Government Act (MGA)

The primary provincial legislation that governs municipalities is known as the Municipal Government Act or MGA. The MGA sets out legislated roles and responsibilities of municipalities and municipal officials.

Municipal Reserve (MR)

Lands designated as "Municipal Reserve" are lands for schools, parks and public recreation purposes provided by the developer as part of the subdivision process.

Non-statutory Plan

A plan adopted by a municipality by resolution to address land use planning or master planning needs.

Redevelopment

The creation of new units, uses or lots on previously developed land in existing urban communities, including brownfield sites.

Statutory Plan

A plan approved by a municipality under the authority of the Municipal Government Act (MGA) with the passage of a municipal bylaw. Examples of a statutory plan are: an inter-municipal development plan, a municipal development plan (MDP), area structure plans (ASP), neighbourhood structure plan (NSP) and area redevelopment plans (ARP).

Social Infrastructure

Social infrastructure, or soft infrastructure, can refer to services provided by or in municipalities such as hospitals, community and recreational facilities, public spaces, social housing, volunteer networks and community-based agencies.

INFRASTRUCTURE TERMS

Infrastructure

Physical assets to provide services to citizens and to support the functioning of a local or regional economy, including roads, sewer lines, transit, emergency response vehicles, recreational facilities, parks, information technology and more.

Infrastructure, Local

Infrastructure that has capital investment and maintenance requirements, including roadways, sidewalks, street lights and traffic signals, transit facilities, solid waste and water delivery systems, potable water distribution systems, storm sewers, sanitary sewers, sports fields, playgrounds, arenas, pools, police and emergency stations, civic buildings and parks to support the concept of complete communities.

Infrastructure, Regional

Infrastructure developed by the federal government, Province, municipality, and/or regional service and provincial commissions to provide services to citizens and businesses, and to support the function of a regional economy (e.g. major interchanges, post-secondary institutions, hospitals, bridges, highways, extension of light rail transit, regional water and/or sewer systems, power systems).

Utilities - Franchised

Facilities for gas, electricity, telephone, cable television, water, storm and sanitary sewer.

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County of Wetaskiwin
Pigeon Lake Watershed Area Concept Plan
February 6, 2014

1 Introduction

1.1 Background

The Pigeon Lake area continues to attract significant attention from landowners wanting to pursue a mixture of residential, recreational and commercial development. With this demand expected to increase over time, concerns have been raised about the lake's ability to support an increase in development and ultimately the added growth pressures. There are also concerns regarding whether there is sufficient infrastructure to support existing and future developments, and the potential for adverse environmental impacts on the lake and surrounding lands. The County of Wetaskiwin recognizes that increased development and growth pressures need to be addressed on a cooperative basis to ensure the long-term protection and sustainability of Pigeon Lake.

Through the County's strategic planning process, Council recognized the need for long range plans in areas experiencing growth pressures. The 2010 Municipal Development Plan draws specific attention to areas in the County meriting special attention for administration to develop plans to better guide future development, and Pigeon Lake is named as one of these areas.

The *Municipal Government Act* is the provincial legislation which empowers municipalities to govern the development of lands within their boundaries in a manner that is logical, timely, economic and environmentally responsible. The planning and development process is based on the cooperation of public and private goals and objectives to achieve harmony.

1.2 Plan Area

Figure 1 shows Pigeon Lake's location in Central Alberta. The study area, as depicted in Figure 2, inexactly follows the Pigeon Lake Watershed. Some allowances were made to include selected growth nodes. Within the plan boundaries are multiple jurisdictional holders. Located on the south side of the lake are the summer villages of Grandview, Crystal Springs, Norris Beach, Ma-Me-O Beach and Poplar Bay. While on the north side of the Lake the summer villages of Silver Beach and Argentia Beach are also within the boundary of the plan. Pigeon Lake Provincial Park, administered by Alberta Tourism, Parks and

Recreation, is located on the west shores of the lake. The Pigeon Lake Indian Reserve is located on the east side of the lake. Although not within the study area, Leduc County and the summer villages of Sundance Beach, Itaska Beach and Golden Days are located on the north side of Pigeon Lake.

1.3 Purpose

The purpose of the Pigeon Lake Area Concept Plan (PLACP) is to set out principles and policies to act as a guideline for new development and redeveloped areas. This will help minimize land use conflicts, mitigate environmental pressure and reduce overall impacts in areas currently experiencing, or those areas forecasted to experience development pressure. This plan helps direct subdivision and development authorities when making decisions on subdivision and development within the PLACP boundary. The PLACP is a long-range planning document that will remain in effect until repealed or amended.

Areas where new development may be considered will be identified. However, no defined limits for new development are set as the County intends to rely on further site-specific analysis; Area Structure Plans and pertinent studies, to determine the level or density of development that can be supported at any particular location.

1.4 What is an Area Concept Plan?

An Area Concept Plan is a non-statutory planning document, adopted by Council through resolution. Although Council intends to follow the policies and strategies outlined in the plan, they are not bound by the content and may exercise discretion.

2 POLICY CONTEXT

2.1 Provincial legislation regulating development

2.1.1 The Water Act

For the subdivision of six or more residential lots per quarter section, the Water Act requires that a detailed Groundwater Assessment be conducted by a professional engineer, geologist or geophysicist, verifying that the current Alberta Environment standard of 1,250 cubic metres of water per year are available for each individual lot. This ensures that there is sufficient water for the proposed development without compromising or depleting the existing water supply. The

County, as part of the Area Structure Plan process, requires a certified engineer's report commenting on the water supply.

2.1.2 Subdivision and Development Regulation

The Subdivision and Development Regulation is a regulatory document outlining the specific rules and regulations relating to the subdivision and development of land in Alberta. This includes the subdivision and development process, the appeal process and mandatory setbacks from certain land uses.

There are a wide variety of land uses within the PLACP boundary (see Section 4.1); as a result it is important to consult the Subdivision and Development Regulation in order to determine what development limitations exist due to mandatory setbacks. Some of the most pertinent legislation includes:

- Setbacks from sewer lagoons: The PLACP area includes the Mulhurst Sewage Lagoon. A development permit cannot be issued and construction cannot occur for a school, hospital, food establishment or residence within 300 metres of the working area of an operating wastewater treatment plant. A subdivision of land for these uses will also not be allowed unless there is a building site more than 300 metres away from the wastewater treatment plant. Setbacks will also be applied to other wastewater containment, storage or treatment facilities including, communal waste water treatment systems.

- Setbacks from waste management sites: Waste management sites with the PLACP boundaries include inactive landfills and waste transfer stations. For an inactive landfill development is restricted within 300 metres from the site. For a waste transfer station, a facility that receives waste materials from a community where it is consolidated by transferring it to a larger vehicle for more efficient and economical transport to a distant waste disposal facility, development is restricted within 300 metres of the site. For an active landfill development is restricted within 450 metres of the site.

- Setbacks from oil and gas operations: There are numerous oil and gas wells within the area. Subdivision or development applications will not be approved if it would result in overnight accommodation or a public facility being within 100 metres of a gas or oil well, although lesser distances may be approved in writing by the Energy Resource Conservation Board (ERCB). Sour gas facilities may require larger setbacks.

- Setbacks from highways: Highways 13, 13A, 771 and 616 pass through the PLACP area. These are within the jurisdiction of Alberta Transportation. Subdivision of land is restricted within 0.8 kilometres of the centre line of a highway where the posted speed limit is 80 kilometres per

hour or greater, unless you meet the conditions laid out. This is within the jurisdiction of Alberta Transportation.

- Other requirements: The provincial regulations also require the municipality to consider soils, topography, water supply, and waste water disposal.

2.2 County policies regulating development

County documents may be divided into two types: statutory and non-statutory.

Statutory Plans	A Statutory Plan is a legal document that must have a public hearing and three readings before being adopted by bylaw. Once adopted, there is a legal obligation on part of both the municipality and the landowners to adhere to the plan. Examples of these plans are the County's Municipal Development Plan and Area Structure Plans adopted by Council.
Non-Statutory Plans	Non-statutory plans are passed by Council through resolution and do not require a public hearing before being adopted, although, it is at Council's discretion to hold a non-statutory public hearing. They are often developed to help encourage a certain direction for development or growth in a particular area. Because these plans are non-statutory they can be less prescriptive, and Council can adapt to changing circumstances. The PLACP falls under this category as a non-statutory plan.

2.2.1 Municipal Development Plan (MDP)

The MDP is a long-range statutory plan that guides land use in the County. In the MDP Council identified the Pigeon Lake area as one that needs careful study and guidance so that development can continue in a sustainable manner; the PLACP addresses this need.

Along with outlining key areas where analysis and specific plans are needed, the MDP influences day to day development through its policies and objectives. These objectives focus on the protection of agricultural land where agriculture is seen as the predominant land use, the development of land in an efficient and sustainable manner, the protection of environmentally sensitive areas, and ensure that development respects existing community character. The Area Concept Plan must comply with the MDP and so these objectives play an important role in guiding development within the plans area and directing the

content of the PLACP. Additionally, when an application for subdivision, development or rezoning is submitted within the area concept plan boundaries, the PLACP in addition to the Municipal Development Plan will be examined to ensure the development, subdivision or rezoning is in compliance and ultimately within the County's long range planning vision.

The MDP provides guidance for land use in the County and is a long-range statutory plan adopted as a bylaw, which directs decision making for everyday development matters.

2.2.2 Land Use-Bylaw (LUB)

The purpose of the LUB is to regulate and control the use and development within the municipality to achieve the orderly, economic and beneficial development of land. To achieve this goal, this Bylaw, among other things:

(a) divides the municipality into districts;

(b) prescribes and regulates for each district, other than Direct Control districts, purposes for which land and buildings may be used;

(c) prescribes and regulates for each district, other than Direct Control districts, subdivision and development standards;

(d) establishes a process for making decisions on development permit applications and the issuance of development permits; and

(e) establishes a process for notification of landowners affected by development permits issued.

2.2.3 Requirements for Area Structure Plans: Policy #6606

In addition to statutory and non-statutory plans, the County ensures sustainable development through a number of policies, specifically Policy #6606, Requirements for Area Structure Plans (ASPs). An ASP maybe required for any development that creates three or more lots in a quarter section, with the exception of those lots created under the Second Yard Subdivision Policy #6607. The purpose of these requirements is to provide the County with comprehensive information about the proposed subdivision and allow stakeholders to comment and provide input. Through the ASP process administration and Council can make informed decisions and identify the impact, whether positive or negative, it may have on the surrounding community.

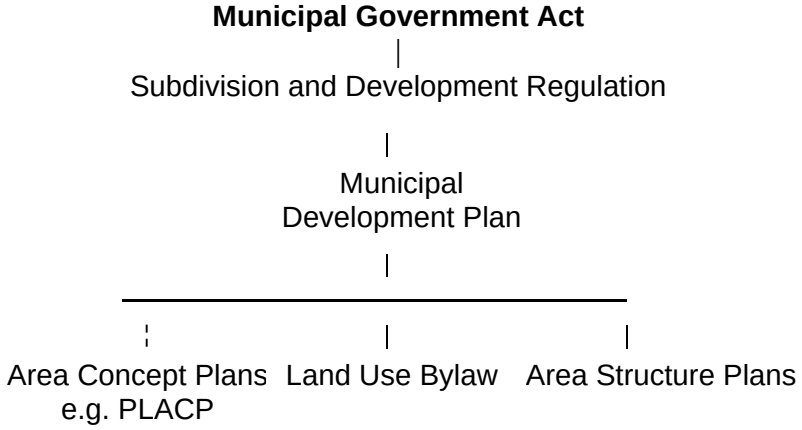
Some pertinent studies and plans that maybe required as part of Policy #6606, Requirements for Area Structure Plans include, but are not limited to:

- Geotechnical report;
- Groundwater Percolation report;
- Storm water management plan;
- Detailed information relating to waste water treatment;
- Water supply (must be in compliance with the *Water Act*);
- Environmental Assessment;
- A traffic impact assessment;
- Public consultation.

The required studies and plans allow for careful consideration of applications to help protect the environment and ensure that development is compatible with the surrounding community.

The Municipal Development Plan, Land Use Bylaw and County Policies, including Policy #6606, Requirements for Area Structure Plans, all work together and play an integral role to support Area Concept Plans.

Figure 3: How the PLACP aligns with other documents



Note: the dashed line represents non-statutory plans

3 Public Engagement in the Planning Process

Public engagement was a recognized, pertinent aspect of the concept plan. Nine varying stakeholder groups were consulted throughout the entirety of developing the PLACP through the use of a focus group. In addition to multiple focus group meetings, an open house was held and the general public was invited to share their opinions and/or concerns. It was important that the plan reflected the broad interests of all the residents, interest groups and adjacent Municipalities alike.

Two different methods of public consultation were used to gather the public's views regarding the PLACP. A focus group with representation of nine varying stakeholder groups was created. The focus group was made up of volunteers representing Summer Villages, Pigeon Lake Watershed Association, agriculture sector, including intensive livestock operations, County of Wetaskiwin, County of Leduc, commercial representation, residential developers, First Nations, Alberta Environment and Alberta Sustainable Resource Development. The focus group played a vital role in the development of the concept plan.

Focus group participants volunteered to partake in the planning process. Advertising for focus group members was publicized concurrently in the Pipestone paper and on the County's website for two consecutive weeks and open to the general public.

4 The Study Area

4.1 Present Land Uses

Present land uses within the plan area are extremely diverse, ranging from agricultural to industrial (oil and gas) to residential to recreational. Agriculture has always been the backbone of the economy with grazing also being a prominent use. The Canada Land Inventory System ranks soil quality, with the highest quality soil as Class 1 and the poorest as Class 7. The soil within the PLACP is mostly ranked Class 3 with poorer soil existing in certain areas (see Figure 4.0).

The oil and gas industry is significant in the area, with numerous oil and gas wells and pipelines located within the PLACP's boundary (see Figures 5.0 & 6.0). Recreation is also important, with facilities like campsites, boat launches, golf courses and hotels located around Pigeon Lake. Recreation draws people into the area during the summer months to enjoy the numerous amenities offered. The range of zoning classification within the area allows for a wide variety of uses and parcel sizes. The Land Use Bylaw 95/54 should be consulted for an explanation of the different land classifications within the PLACP boundaries and the permitted and discretionary uses.

4.2 Present and Future land Use Conflicts

Due to the wide variety of land uses within the PLACP land use conflict is inevitable. As development pressure within the area increases there is the potential for even more conflict. The creation of thorough planning policy and long term plans helps to mitigate some of these conflicts.

Of particular importance is the conflict between residential, agriculture and in some instances, recreational uses in the area, three of the most important land uses. Within the plan boundary are many agricultural operations, ranging in size and type. The policies of the MDP set out as a priority conserving farmland and protecting it from uncontrolled development. However, accepted farming practices can result in dust, odours, and noise which may hamper the enjoyment for those who use the area for recreational purposes. These recreational opportunities are also important to the community and the Province as a whole. It is important that these uses are also protected. Through careful planning and development the needs of these groups and others can be nurtured to create a thriving area based around recreation while still supporting agriculture and reducing land use conflicts.

4.3 Constraints

Pigeon Lake and its surrounding area do not fall under just one jurisdiction, making inter-jurisdictional communication and planning essential. The ten summer villages control land use within their boundaries. Outside the summer villages, the north part of Pigeon Lake falls under Leduc County and their North Pigeon Lake Area Structure Plan, 2010. The Pigeon Lake Indian Reserve is also located within the study area. Additionally, Pigeon Lake itself falls under provincial and federal jurisdiction. These different jurisdictions limit what the County of Wetaskiwin is able to carry out and demands cooperation amongst different stakeholders.

5 Policies

5.1 A Vision for the Watershed and Lake

Our vision for the Pigeon Lake watershed is a healthy natural environment supporting sustainable development coexisting with the recreational value of the lake.

5.2 Goals

In support of this vision, the concept plan adopts the following goals:

- Maintain the quality of the watershed around the lake.
- Protect fish and wildlife habitat and, where possible, restore damaged habitat to a productive natural condition.

- Ensure groundwater will be protected and its use will not exceed sustainable levels.
- Maintain/enhance a visually appealing landscape with ample tree cover.
- Support the types of agriculture that are compatible with the watershed.
- Carefully plan residential and recreational development and redevelopment to be consistent with these goals, using cluster development wherever possible.
- Provide necessary municipal services.
- Involve residents and landowners in all decisions.

The County, acting alone, does not have the power to achieve all these goals, but in areas where municipalities have jurisdiction, these goals will guide the County's decisions.

5.3 Economic drivers

The County benefits from the oil and gas industry for a large part of its tax base. In 2010, linear assessment (mostly pipelines) paid $9.68m to the County in taxes, and machinery and equipment (which includes above-ground oil and gas facilities) paid $2.59m, for a total of $12.27m. This was 53% of the County's total tax revenue.

The oil and gas industry in this part of Alberta has matured, and older facilities and lines are being taken out of service. It is likely that the oil and gas industry will pay less in taxes in future. The County needs to replace this revenue. Residential and recreational development is one of the most promising sources, and Pigeon Lake is the most promising location. This concept plan therefore supports sustainable residential and recreational development in the Pigeon Lake watershed, provided that this development is consistent with a healthy environment that will help support a good economic outlook for the region.

5.4 Reconciling economic and environmental goals

In a recreational lake, good water quality means safe levels of pathogens, and low levels of nutrients. This will result in clear water with minimal algae and plant growth (although too low a level will reduce fish populations).

Pathogens can be minimized by public health education and enforcement, by the installation of municipal sewer systems, and by keeping livestock away from surface water and groundwater recharge areas. These issues are addressed later in the document.

Plant growth is limited by the supply of nutrients, light and temperature in lake water. Although many nutrients are required for plant growth, phosphorus is the limiting factor in most Alberta lakes. Phosphorus may enter the water from various sources: atmospheric deposition, release from bottom sediments, or runoff from the land through streams or groundwater. The first two are outside our control, but surface runoff is, in part, controllable.

The amount of phosphorus entering a lake from the land depends mainly on the use of that land. Forested land contributes about 10 kg/km2/year. Farm land contributes 20 to 50 kg/km2/yr (less from hay land, and more from crops). Urban areas contribute about 100 kg/km2/yr from surface runoff, plus 0.1 to 0.9 kg per person depending on how sewage is treated. (Figures are taken from the 1998 *Pigeon Lake Water Quality Study* by Lilley Environmental Consulting and Dr. Chris Earle of Concordia University College.)

The County's municipal development plan (MDP) gives a very high priority to agriculture. "As a rural municipality with an agricultural base, the County will take responsibility to maintain the farmland for viable agricultural production" (MDP, page 7), however, the Statement of Purpose at the beginning of the MDP says that its first goal is to "maintain a clean environment (with) no negative impact on air, natural resources, water, or soil quality" (page 3). In this regard, the County supports farmers using “best agriculture practices.”

The figures quoted above show that properly designed recreational and residential development can have less of an impact on the environment, and especially water quality, than traditional types of agriculture. For this reason, plus the gains in taxation noted above, the concept plan welcomes properly designed recreational and residential development, ***even on soils which, elsewhere in the municipality, would be protected for agriculture.***

To assist with the restoration of lands back to natural conditions, thereby assisting water quality, the County at its discretion will use its right during the subdivision process to secure Environmental and Municipal Reserves within those lands that most benefit the watershed.

Having said that, we must be clear that no farmer will be forced to sell his land, or to convert it to non-agricultural uses, and he will not be forced to curtail legitimate farm operations because of objections by his neighbours. He must be able to carry on farming responsibly for as long as he wants, and, when the time comes, to pass it on to the next generation or to sell it to another farmer. Any conversion from agricultural to other uses must be voluntary.

5.5 Planning principles

In order to achieve the goals set out above, the County will be guided by the following policies when evaluating a proposal to develop land in the watershed.

5.5.1 Presumption of development approval

Pigeon Lake is seen as primarily a recreational lake, however, standard residential and agriculture remain as predominant land uses in the surrounding watershed. Development is expected, and will be welcome as long as it does not conflict with the planning policies set out here.

5.5.2 Agriculture

Large-scale confined animal operations are not appropriate in the Pigeon Lake watershed.

Recreational and residential development must not diminish the right of neighbouring farmers to manage their land using generally acceptable agricultural practices. This is guaranteed by provincial law (Agricultural Operations Practices Act, section 2).

Farm land will be reserved for agriculture, or released for other uses, depending in part on its assessment rating.

The County's normal policy is to reserve better farm land for agriculture. Section 1.2.1 of the MDP defines this as land with a farmland assessment rating of 30% or more, but because of the recreational value of land near Pigeon Lake, the County may allow residential subdivision on land with a farmland assessment rating up to 50%. Figure 7 shows the location of such land.

Note that this applies only in the Pigeon Lake watershed. The cut-off remains 30% in other parts of the County.

Soil quality does not change at property boundaries. Most quarters have a mixture of good and poor soil. On these mixed quarters, development must normally be clustered on the poorer soil, leaving better soil for agriculture, although small or odd-shaped areas of good soil may be included in the developed area.

5.5.3 Protection of environmentally sensitive areas

Area structure plans for land within the Pigeon Lake watershed must include an environmental impact assessment (EIA) prepared by a professional biologist.

This assessment must identify areas of environmental significance or value such as a Wetland Assessment. It must also address the changes that will be caused by the proposed development, especially loss of habitat and the effect on ground and surface water, and must propose ways of offsetting any losses. The requirement for an EIA may be waived by the County if the land to be developed contains no native habitat or wetlands.

Wetlands, including sloughs, must be left in a natural state, and must not be drained or filled unless there is no alternative. In that case, the developer will be required to construct substitute wetlands as close as possible to the one that has been destroyed. The County may protect the substitute wetland through a conservation easement or other registration on title.

Through referral input by Alberta Sustainable Resource Development and the reserve dedication options under the County's subdivision authority, lake shoreline tributaries and wetlands may be protected by a buffer strip wide enough to prevent damage to these water features.

Land adjacent to creeks, including seasonal flows, must be dedicated as environmental reserve when land is subdivided into small lots. On large lots, the County may take environmental reserve easements instead of land where the circumstances justify it. This decision will be made by council at the time of subdivision. The area to be protected -- the setback --will be determined with input from professional biologists.

If a development area contains a damaged or dried-up creek, it must, as far as practical, be brought back to its natural state, and included in environmental reserve.

On quarters that are only partly tree covered, recreational and residential development must not result in a net loss of tree cover. Where trees must be removed, they must be replaced in such a way as to fill a similar role in the local ecosystem. Normally the lost trees must be replaced within the parcel being developed. However, in special cases, and acting on the advice of professional biologists, the County may allow the replacements at other locations within the Pigeon Lake watershed.

Where a quarter section is partly tree covered and partly cleared, new development must normally be restricted to the cleared areas. Note: That restrictions on the removal of tree cover apply on parcels of land under the Watershed and Rural Conservation districts. Lands under an Agriculture district are allowed clearing for agricultural purposes, however, it would be a disadvantage for the owner of an Agriculturally districted property to clear tree cover if another use for the land were contemplated that would benefit from the attractiveness that tree cover provides to a property. The tree covered areas must be left in their natural state. They may be:

- dedicated as reserve, or
- transferred to a conservation organization (which attracts an income tax credit), or
- registered as the common property of the private lots, or
- retained by a single individual.

In the last two cases, the County will register a conservation easement or similar encumbrance on title to restrict land clearance in perpetuity.

When development is proposed on a quarter which is mostly tree covered, the loss of trees must be minimized, and the County may require the loss to be offset by planting elsewhere in the watershed.

5.5.4 Cleaning up inflows

New development must be laid out in such a way that the surface runoff does not contaminate watercourses or the lake. This will be accomplished through setbacks (see policy 2.5.3 above) and controls, where appropriate, by directing runoff through a treatment wetland (artificial marsh) or storm water ponds where solids will settle out and nutrients will be absorbed by water plants. (Those interested can look at the Olds College website to see the work being done by the College's School of Innovation.)

5.5.5 Sewer service

Subject to the sewage treatment provisions under Sections 5.6 “Land Near the Lake”, all new lots in multi-lot subdivisions under 5 acres in size must be served by a sewage gathering system. (Anything over about two acres is too large to service economically, so developers will be driven to create lots that are small enough to service economically.) On the north side of the lake this will require hooking up to the existing NEPL line. Around the rest of the lake, because there is no line in place at present, on-site holding tanks may be allowed as an interim measure, provided they are designed and constructed to connect to the municipal line in future. This imposes a higher standard but is otherwise consistent with County Policy 6611.

There may be cases where a proposed multi-lot development is so far from a sewer line that building a connecting line is prohibitively expensive. In that case,

the County may allow the developer to install a mechanical treatment system serving that development. The County will investigate amendments to Policy 6611 to require systems to remove phosphorous if the development is within one mile of the lake. These systems will require the approval and regulatory consistency with both the County and Provincial regulators.

In multi-lot subdivisions more than half a mile from the lake, lots over 5 acres in size may continue to use individual sewer systems provided that site conditions are suitable. The area structure plan must include evidence that the land is suitable for such systems which shall include compliance with Provincial regulations that do not allow open discharge systems unless the discharge point is a minimum of 90 metres (295 ft) from all property lines. Along with several site and design pre-requisites, this generally requires a parcel to be a minimum of 3.4 hectares (8.5 acres) in order for the system to comply with property line setbacks (parcels this size are rarely approved in Lakeshore or other districts adjacent to a lake).

Subject to Section 5.6.6, yard site subdivisions (existing first parcel from a quarter section), may continue to use individual sewer systems that conform to the Alberta Private Sewage Treatment Systems Standard of Practice in effect at the time.

In addition to the provisions above, where private sewage treatment systems are proposed in a multi-lot development, the Alberta Association of Municipal Districts and Counties “The Model Process for Subdivision Approval and Private Sewage” should be consulted as a guideline.

5.5.6 Efficient servicing

Multi-lot residential development will be encouraged to locate close to existing services such as present and future water and sewer lines, recreation, and paved roads.

Where the existing road in to a subdivision does not meet current municipal standards, the developer will be required to upgrade it at his own expense.

Multiple lot residential subdivisions will also be subject to the County's Policy 6615, which sets standards for road paving.

5.5.7 Access to recreational opportunities

In order to reduce pressure on lake access points, developers will be required to provide on-site recreation. This may be passive (such as walking and equestrian

trails), conserved natural areas with trails and opportunities for wildlife viewing or social (club houses).

5.5.8 A trail system

Municipal and environmental reserves must be laid out to facilitate the creation of a regional trail system. Developers will normally be required to build the trail within their developments.

5.6 Land near the lake

The planning policies set out above will apply to all new development in the Pigeon Lake watershed. On land within half a mile of the lake, additional policies will apply:

5.6.1 Environmental and Municipal Reserve required

(NOTE: County Council may designate either one under subdivision approval.)

The County will require a strip of environmental and/or municipal reserve between subdivided lots and the lake shore. The width of this strip will be determined by council, bearing in mind section 664 of the Municipal Government Act and the recommendations of professional biologists. Council may also consult the following:

a) *Riparian Setback Matrix Model* endorsed by the Alberta Lake Management Society; and
b) *Stepping Back from the Water* completed by Alberta Environment and Water which can assist with determining standards for setbacks and buffers;
c) Provincial Departments including Alberta Sustainable Resource Development.

5.6.2 High densities preferred

Land close to the lake shore is in high demand. In order to meet this demand, the County will encourage high density development provided it meets the other policies in this document.

5.6.3 Demonstrate access

Within half a mile of the lake shore (Figure 8), developments will not be approved unless people living there will have adequate, legal access to the lake. The rule of ten linear feet of lake front per back lot, which has been in effect since the 1970s, will continue to guide but not bind the County.

5.6.4 Limited development in the riparian area

The lake shoreline must be protected by a buffer strip wide enough to prevent damage to the shoreline. The width of the buffer in each case will be determined by the County after consulting independent professionals. Within this buffer area, the land must normally be left in its natural state, and remediated if necessary, although small areas may be developed for public access. Any lost habitat must be replaced to the satisfaction of provincial regulators.

5.6.5 Walking trails

The County will require developers to build a walking trail on reserve land adjacent to private lots. These trails not only have a value in themselves; they will also help define the edge of public land and prevent encroachment by private landowners.

5.6.6 Sewage treatment

Once a municipal sewer line has been built outside the NEPL area, all new developments within half a mile of the lake, regardless of lot size, will be required to connect at the developer's cost.

The only exception to this rule is where an isolated house is being constructed so far from the sewer line that it is impractical to connect to sewer. In this case, a holding tank will be acceptable but not a septic field. This will be determined by council on a case-by-case basis. Section 5.5.5 should be referred to for more detail.

5.6.7 Stormwater Management

Storm water management facilities are to be designed in accordance with the principles and strategies of low impact development.

5.7 Upland areas

Upland areas are defined as land more than half a mile from the lake. Both large and small lots will be acceptable in these areas.

5.7.1 Small lots

The County will encourage the development of lots which are smaller than the traditional three to five acres. Lots under two acres are preferred. This will make it economic to serve them with piped sewer. However, no more than 48 lots will be approved per quarter section *[this is the limit under CR zoning in the present land use bylaw].* This means that large areas will be left undeveloped to create a rural feel to the development, and to preserve tree cover and better farm land. These large areas may be dedicated as reserve, transferred to a conservation organization, registered as the common property of the private lots, or retained by a single individual. In the last two cases, the County will register a conservation easement or similar encumbrance on title to guarantee future use.

5.7.2 Large lots

The County will be open to requests to zone land in the Pigeon Lake watershed to Rural Conservation. This allows lots of ten acres or more to be created on tree covered land. Sixty per cent of the lot must remain tree covered, and the County may register a conservation easement to guarantee this. (In practice, most owners keep much more of their land in trees.) Detailed requirements are set out in Bylaw 95/54, Schedule B, section 8.

5.7.3 Hobby farms

The County will encourage small-scale agriculture such as horse breeding and training, exotic animal breeding, greenhouses, market gardens, tree farms, and horticulture. Lots of an appropriate size are allowed under Agricultural zoning, but subdivision approval is granted only if the applicant proves his bona fides and his ability to run the proposed operation. Detailed requirements are set out in Bylaw 95/54, Schedule B, section 1.4(b). Alternatively, the County may establish a new district in the land use bylaw to regulate hobby farms.

Applicants will be reminded that it may be difficult to get a water licence to irrigate their land, so they should consider other options, such as trapping and managing on-site surface water.

5.7.4 Severed parcels

The County's land use bylaw allows agricultural land to be subdivided where it is severed by natural features such as creeks and ravines (Bylaw 95/64. Schedule B, section 21). Normally, zoning and subdivision are only granted if the creek flows year round, or the ravine is deep or steep enough to be a real barrier to farming. In the Pigeon Lake area, the County will accept seasonal streams and shallower ravines, but these streams and ravines must be dedicated as environmental reserve and fenced so that the natural vegetation will grow back.

Some of these policies for reconciling conservation and development in upland areas are illustrated in Figure 9.

5.8 Policies for existing developments

5.8.1 Sewage treatment

The County will continue to work with the summer villages and senior governments to establish a municipal sewage gathering and treatment system outside the NEPL area.

Once a municipal sewer system has been built on the south and west side of the lake, the County will encourage the owners of existing lots to connect to it and abandon their existing systems. Connection to the Municipal sewer system will be required if a private existing system requires maintenance and repair, the land is subdivided or a Development Permit is issued to rebuild or replace an existing house. Upon completion of the regional sewer collection system any existing system which has not already connected to the regional system shall upon the passing of supporting bylaws, be required to connect no later than 5 years from the date of completion of the regional system. One way of covering the cost is to consider, where appropriate, re-subdivision of existing lots on condition that they abandon their existing individual systems and connect to the municipal system.

5.8.2 Protecting creeks

The County will encourage farmers and ranchers to keep cattle out of the creeks that flow into Pigeon Lake. This may be achieved by installing off-creek waterers. Construction funds will be sought from senior governments and from conservation organizations. The County's Agricultural Services Board may provide technical help.

5.8.3 Rehabilitating damaged lands

The County will support effects by landowners and third parties to remediate damaged creeks and other areas of environmental value. This support may include direct assistance from the County's parks department.

If a parcel of municipal reserve has been cleared, but is not being used for active recreation, the County may re-establish native tree cover with the advice of conservation organizations.

5.8.4 Redevelopment

Where an existing parcel is being developed, the County will use its development control powers to bring the lot into conformity with the policies set out elsewhere in this Area Concept plan. This will apply particularly to

- setting buildings and other improvements back from water bodies,
- treating waste water in a manner that does not damage the environment,
- protecting and/or restoring tree cover, and
- remediating damaged wetlands.

5.8.5 Testing the water entering the lake

The County will encourage qualified third parties to test the nutrient content of water in the creeks and streams that enter Pigeon Lake. Where a problem is identified, and it is under municipal jurisdiction, the County will take appropriate action.

5.8.6 Fertilizer near Lake

Many newer subdivisions often have restrictive covenants imposed by the developer to limit the application of phosphorus-rich fertilizer on residential lots near the lake. The County will support this and is keen to work with Leduc County and the 10 Summer Villages adjacent to Pigeon Lake to implement a total ban on cosmetic lawn fertilizers.

5.8.7 Groundwater supply

Where a subdivision will result in there being six or more lots on a quarter section, and those lots will use groundwater, the Water Act requires the developer to prove that there is enough groundwater to serve the new lots without depleting the supply to farms and other residences in the area. However, these tests look at each development separately; they do not consider cumulative effects: how much development, in total, can safely be accommodated in the Pigeon Lake watershed.

Much of the necessary background material has already been assembled in the Regional Groundwater Assessment Study undertaken for the County in 2008 by Hydrogeological Consultants Ltd.

When Ponoka County commissioned two cumulative impact studies in the Gull Lake area, it found ample water for all proposed development. There were four separate aquifers at different depths. One of these fed the lake through springs.

Ponoka now requires that new high-capacity wells use a deeper aquifer that is not hydraulically connected to the lake. Wetaskiwin may do the same.

Depending on the results of the cumulative impact analysis, the County may set a cap on the amount of development allowed in the watershed. If any such cap is contemplated, it will be subject to public hearings.

The costs of the regional groundwater study may be recaptured by placing a per-lot levy on new development in the watershed.

6 Implementation

6.1 Changes proposed to the Municipal Development Plan

There is a potential conflict between this Area Concept Plan (ACP) and the policies set out in the Municipal Development Plan. The MDP, in section 1.2.1, defines productive agricultural land as:

(a) land in production with a farmland assessment value of 30% or more;

(b) grey wooded soil producing hay, forage, or other crops; and

(c) land currently used for grazing.

The next section of the MDP says that

1.2.2 Area structure plan[s] or rezoning will not be considered if the land is classified as productive agricultural land as defined above except as allowed elsewhere in the Municipal Development Plan.

In order to bring the ACP into conformity with the MDP, section 1.2.2 of the MDP should be amended by adding the underlined words:

1.2.2 Area structure plans or rezoning will not be considered if the land is classified as productive agricultural land as defined above except as allowed elsewhere in the Municipal Development Plan <u>or an Area Concept Plan</u>.

6.2 Changes proposed to the Land Use Bylaw

The County's land use bylaw is being reviewed, and this is a good time to draft new requirements that will support the policies set out in this Area Concept Plan.

6.2.1 Change the definition of good agricultural land

The present land use bylaw says, in section 1.2:

> *Good agricultural land means:*
>
> *(a) land with a farmland assessment value of 30% or more;*
>
> *(b) grey wooded soil producing hay, forage, or other crops; and*
>
> *(c) bush-covered land with agricultural potential (where potential is determined on the basis of the farmland assessment value the land would have if cleared).*

In order to allow the sort of subdivision proposed in this Area Concept Plan, the definition should be re-written as follows:

> *Good agricultural land is defined as follows.*
>
> *(a) Where an Area Concept Plan has been adopted by council, good agricultural land has the meaning set out in that plan.*
>
> *(b) Where there is no Area Concept Plan in place, good agricultural land means*
>
> *(i) land with a farmland assessment value of 30% or more;*
>
> *(ii) grey wooded soil producing hay, forage, or other crops; and*
>
> *(iii) bush-covered land with agricultural potential (where potential is determined on the basis of the farmland assessment value the land would have if cleared).*

6.2.2 Establish an Agricultural Smallholding district

The following wording from Ponoka County's land use bylaw may act as a model, although some wording may have to be changed to fit the Wetaskiwin situation:

> ***704 Agricultural Smallholding (AS) District***
>
> *704.1 Purpose*
>
> *The purpose of the Agricultural Smallholding District is to provide land for commercial agriculture on parcels smaller than would otherwise be allowed. At the request of the owner, Council may classify land to this*

district if it is convinced that the proposed parcel will support a viable agricultural operation.

704.2 Permitted Uses

Permitted uses are the same as those in the Agricultural District.

704.3 Discretionary Uses

Discretionary uses are the same as those in the Agricultural District.

704.4 Lot Size

The minimum lot size shall be at the discretion of the Municipal Planning and shall be based on the land requirements of the agricultural operation proposed for the site.

703.4 Other regulations

The other regulations for the Restricted Agricultural district are identical to those in the Agricultural District.

6.2.3 Establish a Watershed Remediation district

Part 5 of this Area Concept Plan establishes a goal of remediating creeks that have been damaged by the removal of natural vegetation. As always, incentives work better than regulation, so it is proposed that the County create a new district in the land use bylaw under which these damaged creeks are taken into municipal ownership as environmental reserves, with the upland areas subdivided into private lots. The incentive to the landowner is that, by giving up the damaged creek valley, he obtains saleable lots. A possible wording for the new district is as follows:

Watershed Remediation District

1 Purpose

The purpose of the watershed remediation district is to reduce flooding, improve water quality, and maintain or rebuild wildlife habitat by allowing a pattern of subdivision in which damaged watercourses are taken into municipal ownership as environmental reserves, fenced to exclude livestock and negative human impacts, and managed so that the natural vegetation will regenerate, and the upland areas between those watercourses are subdivided into private lots.

2 Approval Process

2.1 No land shall be classified to Watershed Remediation until an area structure plan or conceptual scheme for that land has been adopted, and in this regard "conceptual scheme" has the meaning given in section 653(4.4)(b) of the Municipal Government Act [and includes an Area Concept Plan].

2.2 An area structure plan or conceptual scheme shall show, among other things, all watercourses and the valleys in which they run, and all wetlands, and shall indicate that the watercourses and valleys and wetlands are to be dedicated as environmental reserve.

2.3 The Subdivision Authority may require the developer to fence all reserve land as a condition of subdivision approval.

3 Permitted Uses

The following uses are permitted:

3.1 Extensive agriculture, subject to the restrictions on land clearance set out in section 8
3.2 Single detached houses, including new manufactured and modular houses
3.3 Parks, recreation areas, and conservation projects
3.4 Public utilities
3.5 Buildings and uses accessory to the above

4 Discretionary Uses

The following uses may be allowed at the discretion of the Development Authority:

4.1 Home occupations
4.2 Bed and breakfast operations
4.3 Extensive recreational uses
4.4 Non-new manufactured and modular houses
4.5 Buildings and uses accessory to the above

5 Number of dwellings on a lot

No more than one dwelling shall be placed on a lot, except where a development permit has been issued under section 8 of Schedule A, Number of Dwellings on a Lot.

6 Lot Sizes

6.1 Lots shall have an area of no less than 8 hectares (20 acres).

6.2 Despite the preceding section,

(a) the area of a lot may be reduced if that is necessary to follow natural boundaries, and

(b) a smaller size may be allowed for a lot containing an existing farm yard site, using the standards of the Rural Residential district, and

(c) the size of lots for utilities, reserves and other public uses shall be as required by the Subdivision Authority.

7 <u>Building locations</u>

Buildings must be set back the following distances from property lines and other features:

7.1	*From a road*	*by the distances set out in section 9 of Schedule A, and illustrated by Figure 1*
7.2	*From a side property line*	*by 5 metres*
7.3	*From a rear property line*	*by 10 metres*

7.4 From a creek, stream, or ravine by 30 metres

8 <u>Maintenance of Natural Vegetation</u>

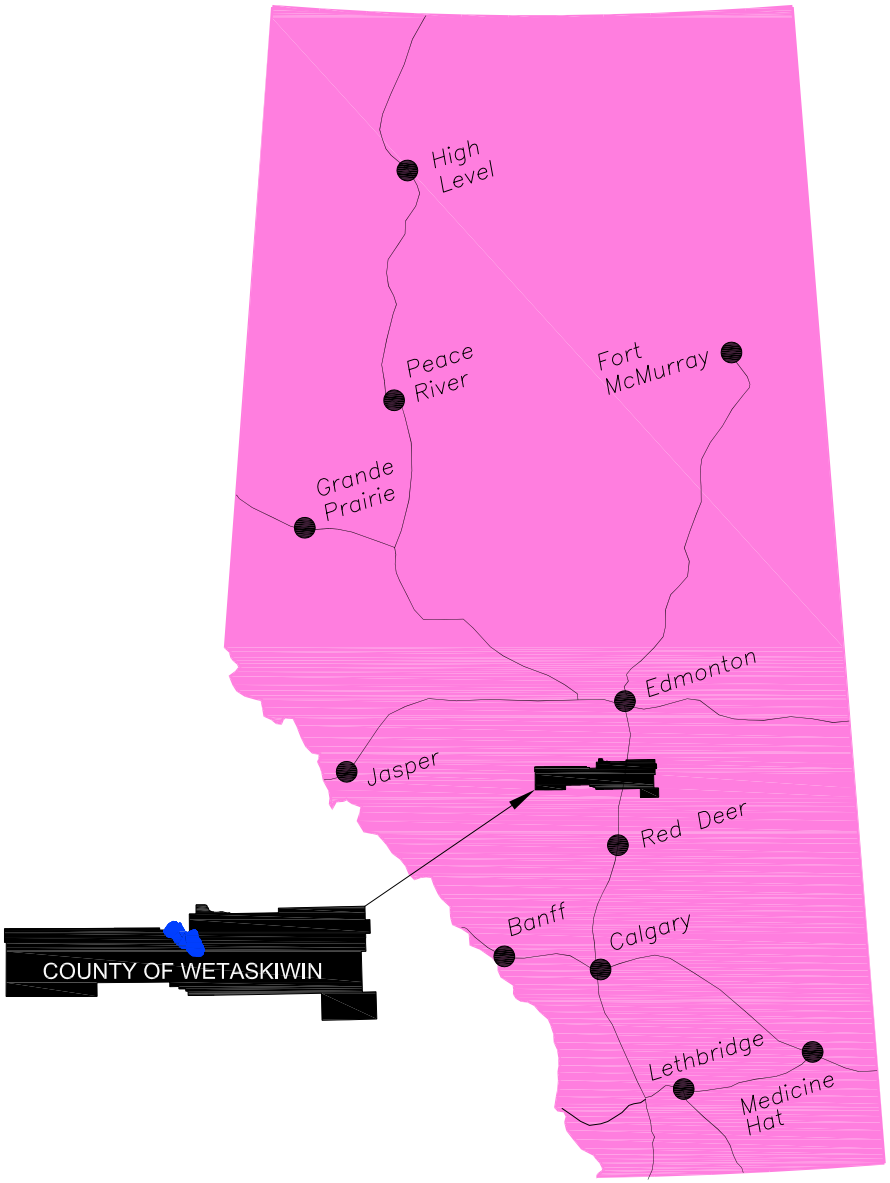
When a lot is created by subdivision after being rezoned to Watershed Remediation ,

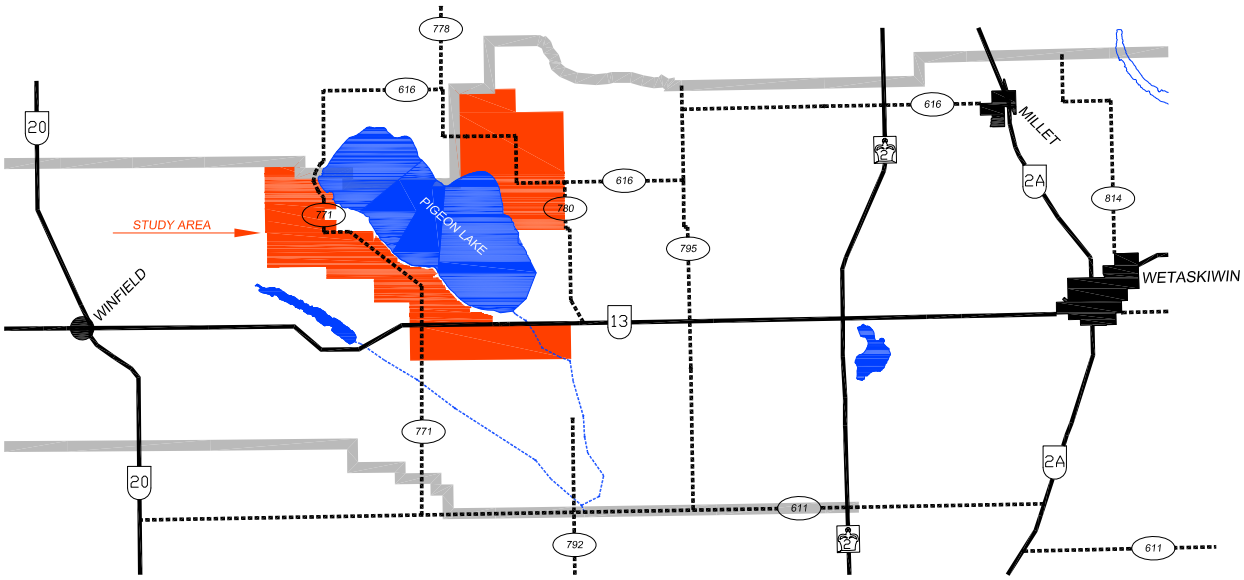
8.1 no more than 20% of its natural vegetation shall be cleared or removed, and

8.2 the Subdivision Authority may require, as a condition of subdivision approval, that a restrictive covenant, conservation easement, or other agreement be registered on the title to enforce restrictions on the clearance of natural vegetation.

Figure 1.0

PIGEON LAKE CONCEPT PLAN LOCATION





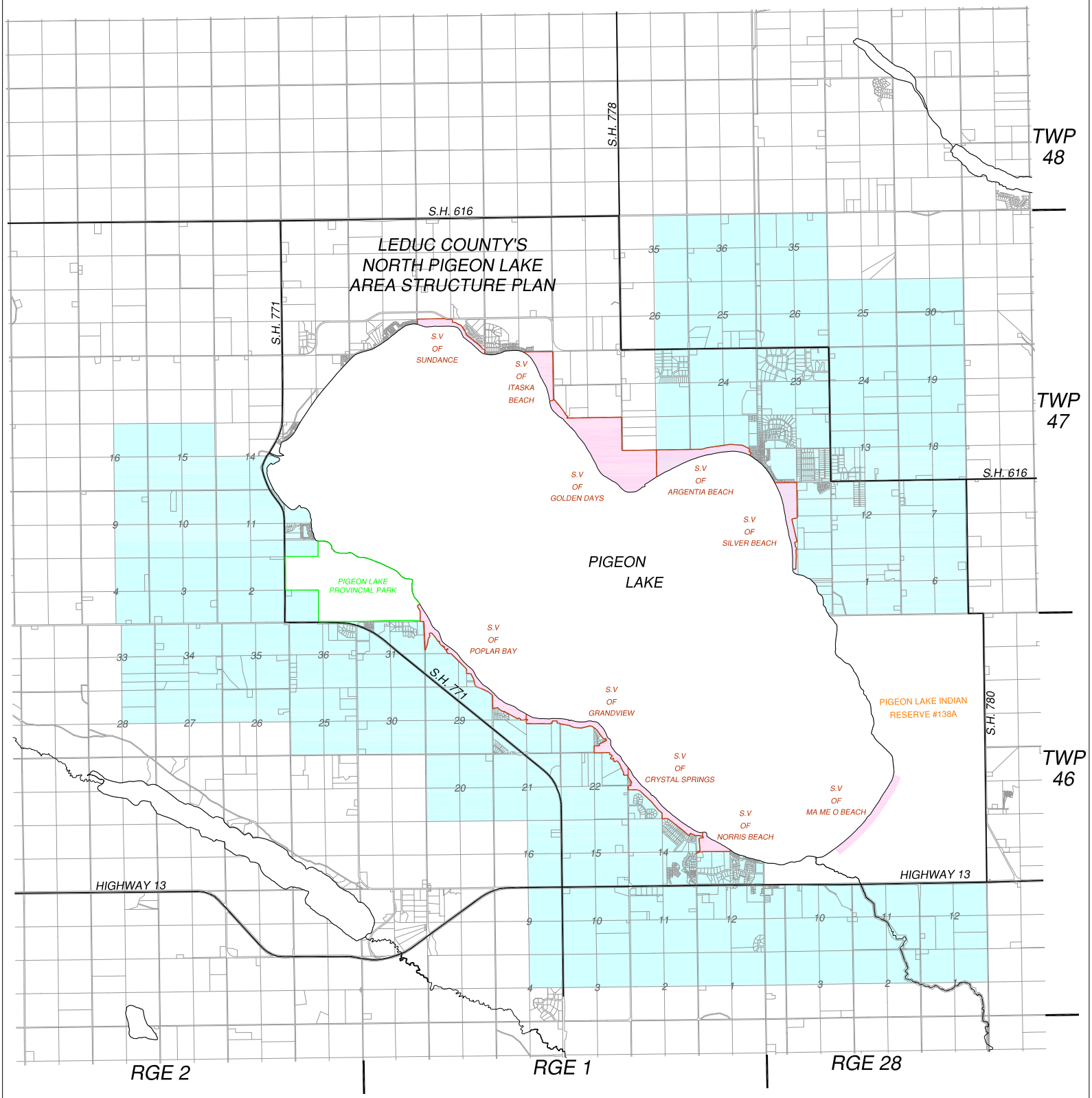


FIGURE 2.0
PIGEON LAKE AREA CONCEPT PLAN
STUDY AREA

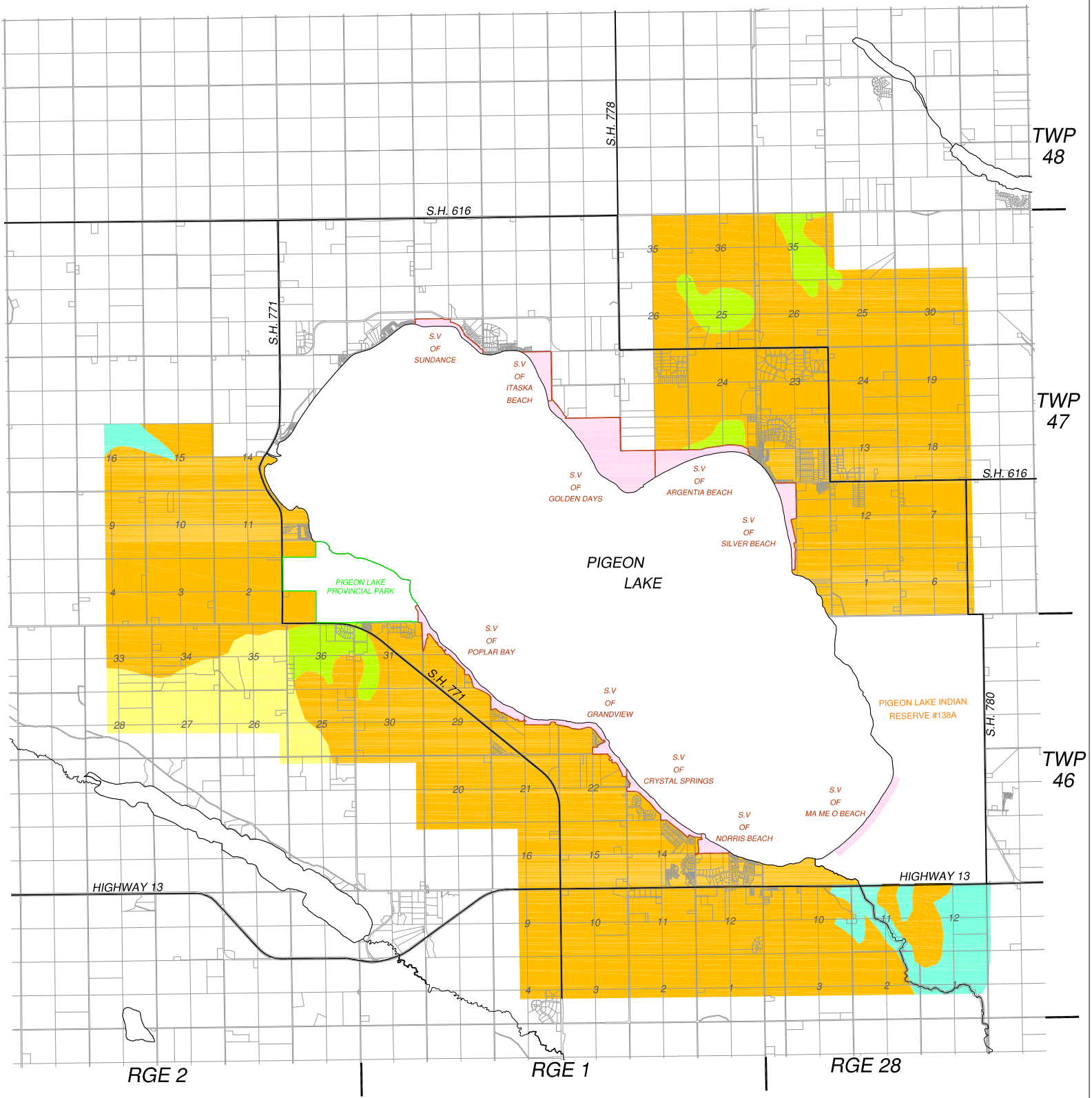


FIGURE 4.0
PIGEON LAKE AREA CONCEPT PLAN
SOIL CLASSIFICATIONS

CLASS 2
CLASS 3
CLASS 4
CLASS 5
CLASS 0

N

0 500 1000 2000 3000
METRES

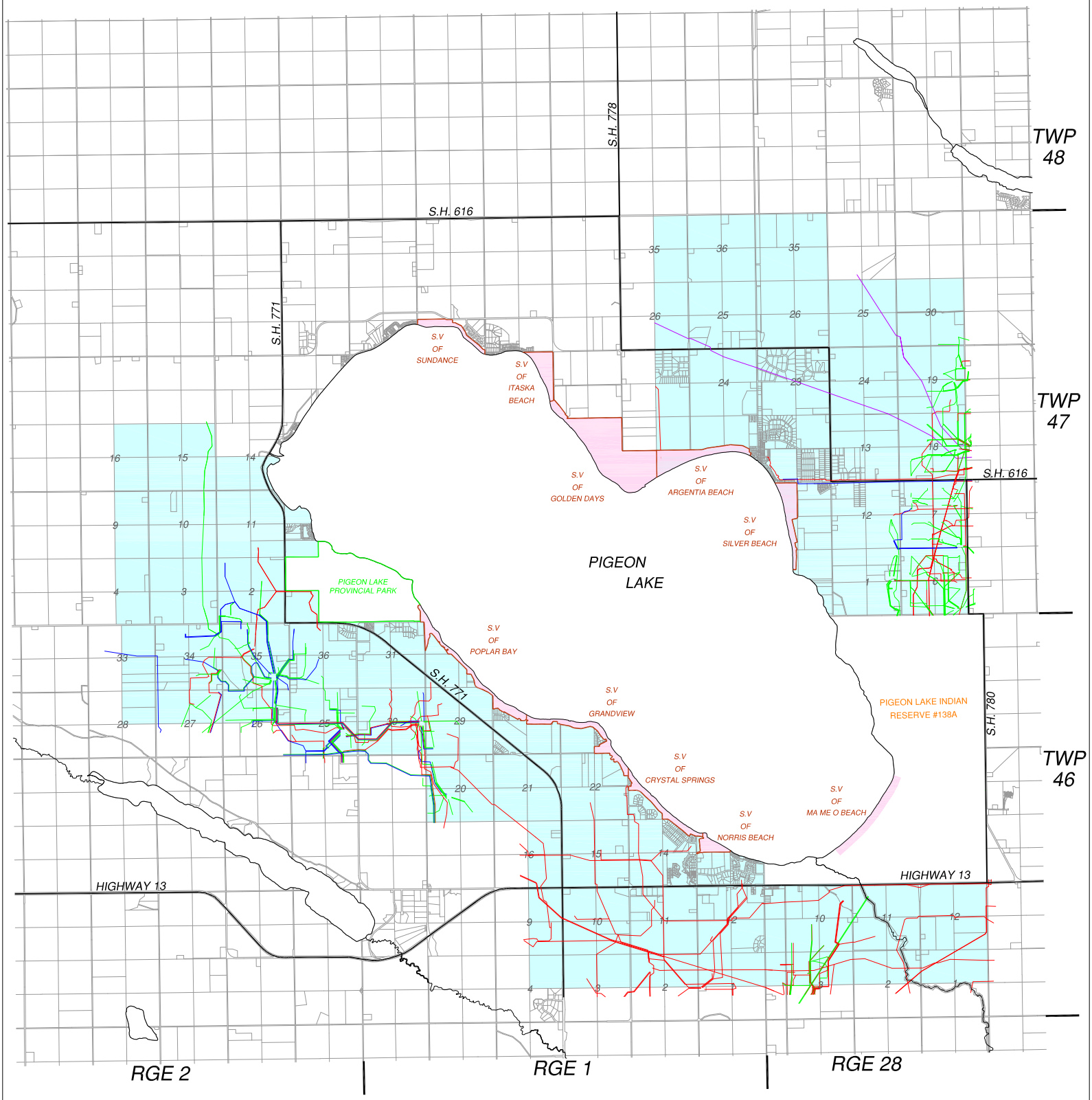


FIGURE 5.0
PIGEON LAKE AREA CONCEPT PLAN
OIL & GAS PIPELINES

GAS PIPELINE
OIL PIPELINE
WATER PIPELINE
LVP/HVP PIPELINE

Note: In addition to these registered pipelines unregistered pipelines may exist.

N

0 500 1000 2000 3000
METRES

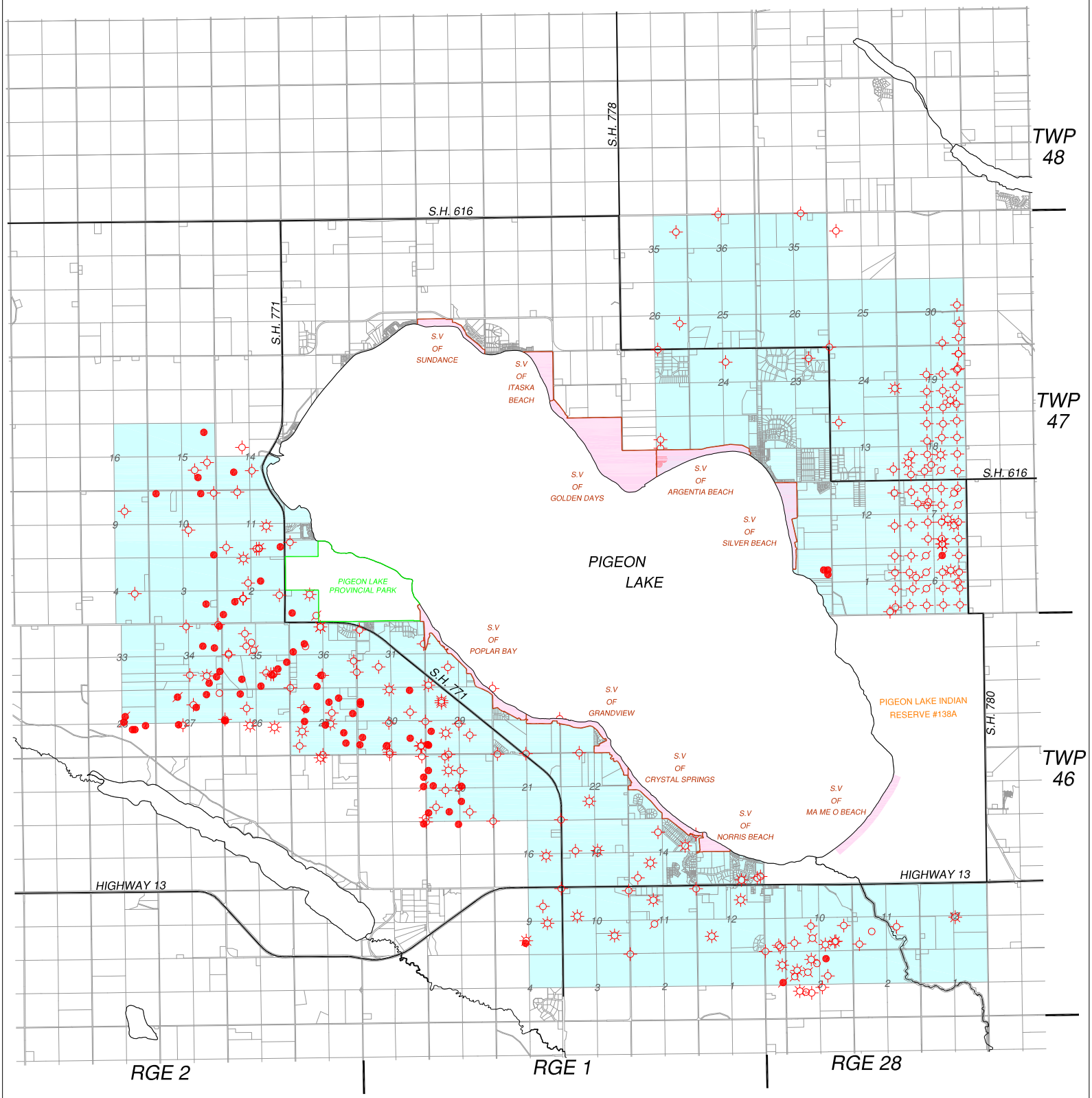


FIGURE 6.0
PIGEON LAKE AREA CONCEPT PLAN
OIL & GAS WELLS

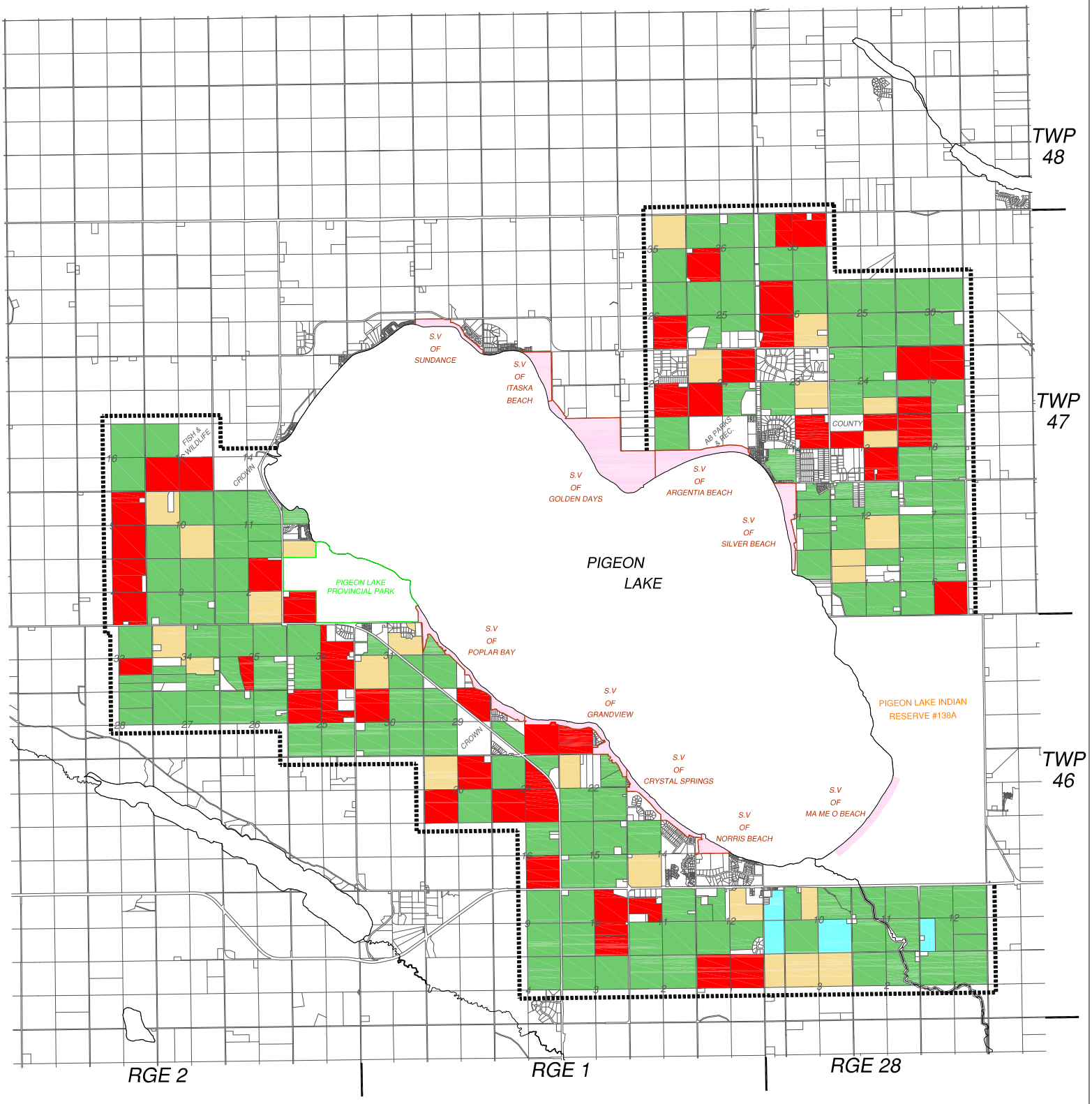
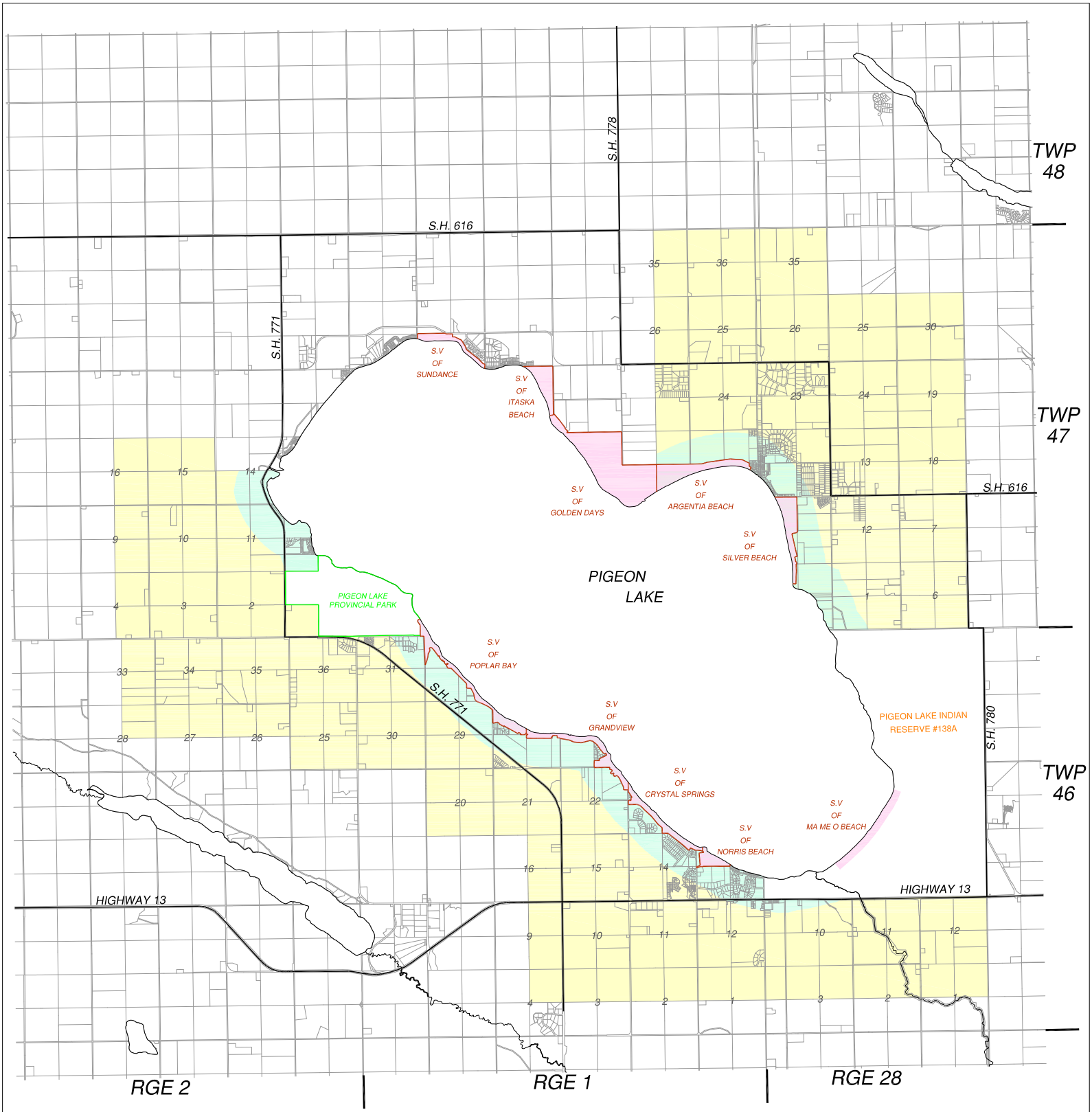


FIGURE 7.0
PIGEON LAKE
FARMLAND ASSESSMENT MAP



Lake shore land (800m from bed and shore of lake)

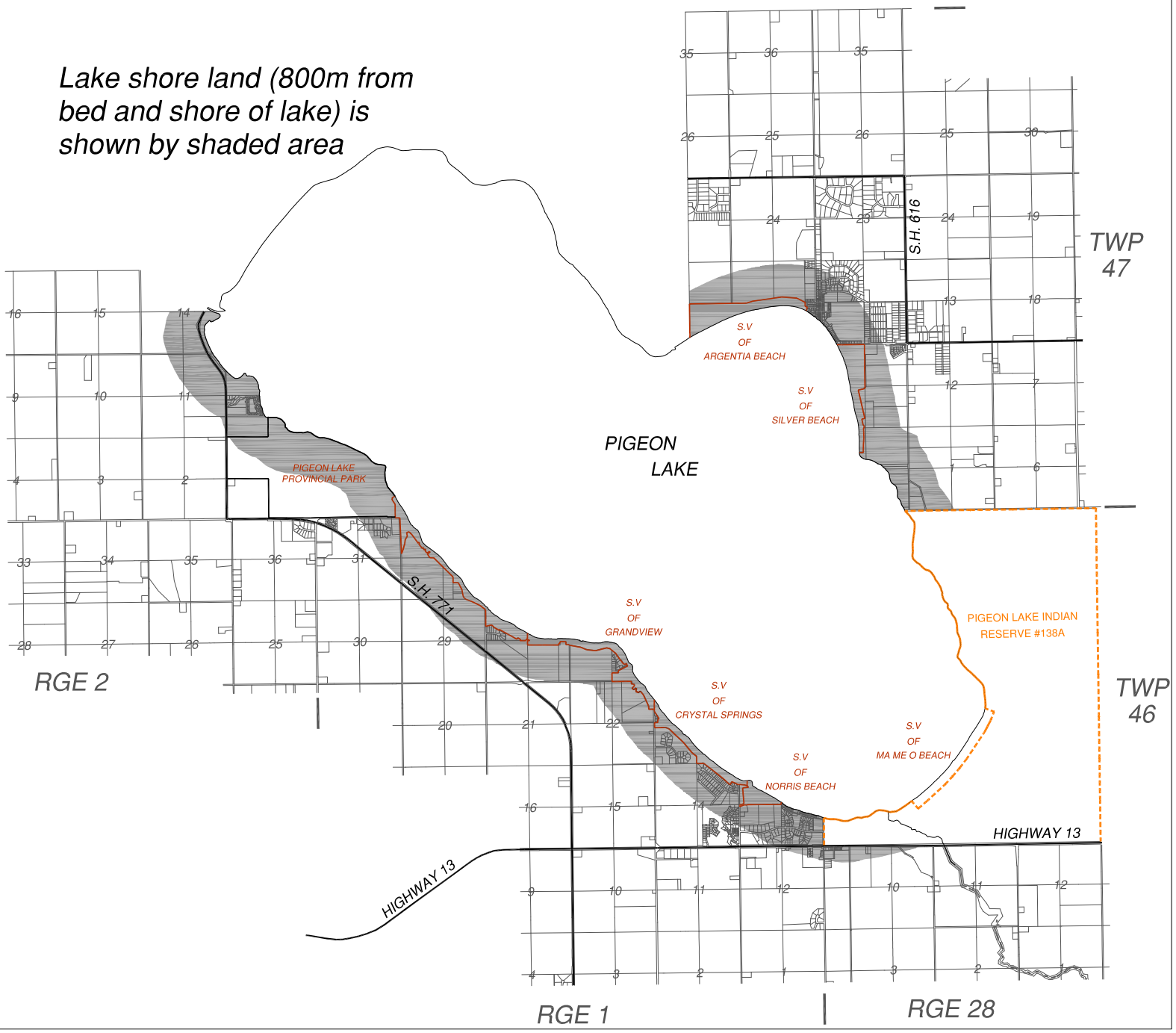
Mixed Use

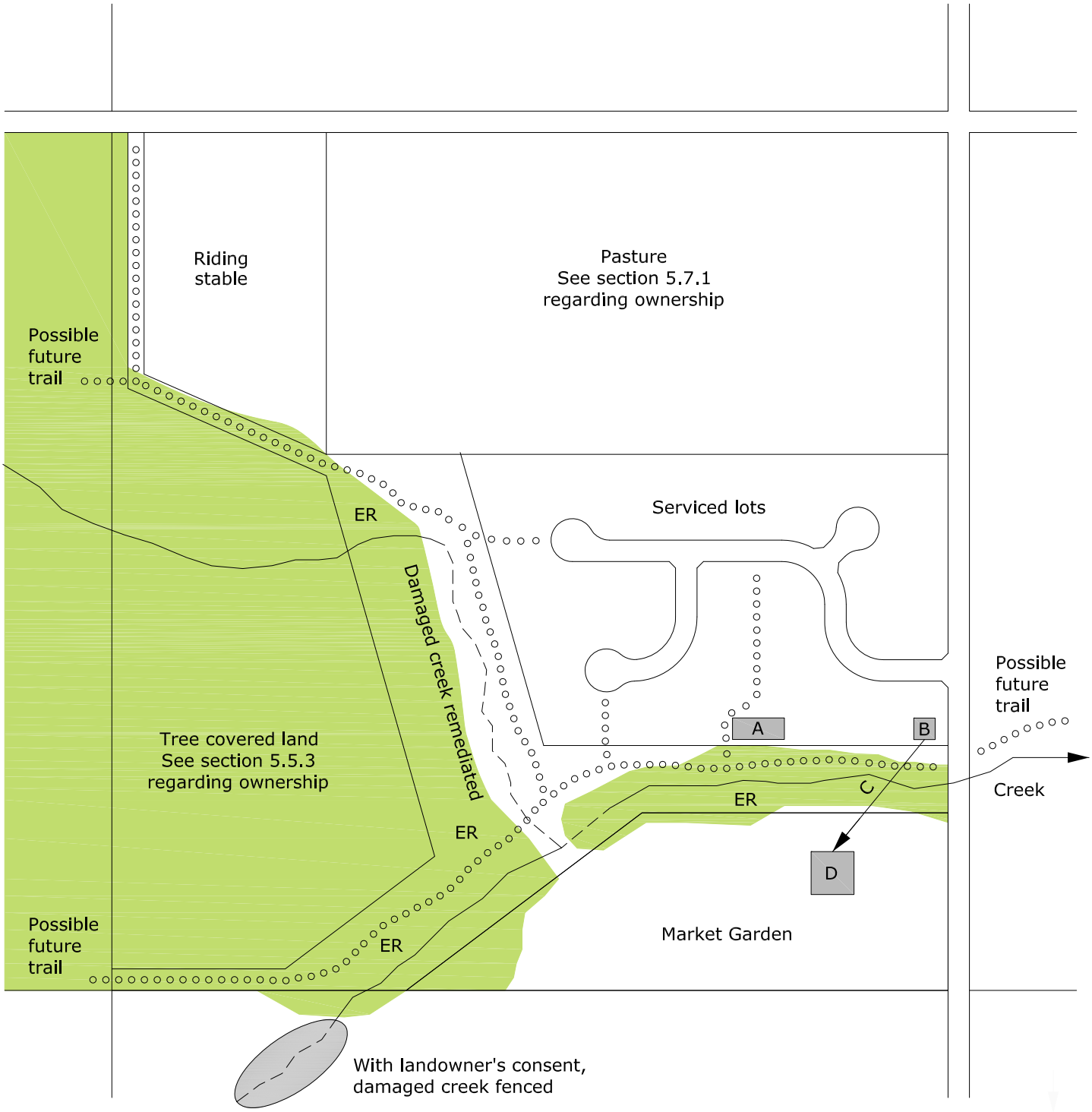
N

0 500 1000 2000 3000
METRES

FIGURE 8.0
PIGEON LAKE AREA CONCEPT PLAN
LAND USE MAP

FIGURE 9
PIGEON LAKE
STUDY AREA





Pigeon Lake Area Concept Plan
Figure 10: Reconciling Conservation and Development

- Creek in good condition
- Damaged creek
- Walking trails
- Tree covered land

A	Artificial marsh cleans runoff
B	Mechanical sewage treatment plant
C	Pipeline carries treated effluent
D	Irrigation pond
ER	Environmental Reserve