



The Alberta Fish & Game Association is your voice in conservation

September 24, 2020

Keith McCrae, Director, Planning & Development Clearwater County
Box 550, 4340 – 47th Avenue
Rocky Mountain House, Alberta T4T 1A4

Re: Clearwater County – Land Use Bylaw Amendment Submission

Dear Sir,

On behalf of and in cooperation with its conservation property co-owners, the Alberta Conservation Association (ACA) and Trout Unlimited Canada (TUC), the Alberta Fish and Game Association (AFGA) is pleased to submit this Land Use Bylaw Amendment Submission completed as per Clearwater County Land Use Bylaw No. 714/01, Section 12.1, Application for Bylaw Amendment.

The AFGA, Alberta's oldest independent conservation association, active since 1908, shares in the management and ownership of a number of the conservation properties along both Clear Creek and the North Raven River, here in Clearwater County.

The North Raven River and Clear Creek are ecologically unique and environmentally sensitive spring-fed watercourses originating in Clearwater County. Their sensitivity to surface and subsurface development and the over five decades of rehabilitation that has gone into protecting this system makes it imperative that this special area receives the permanent protection it so richly deserves.

Regards,

Brian Dingreville, President Alberta Fish and Game Association

cc: Mr. Timothy Hoven, Reeve, Clearwater County
Honourable Jason Nixon, Minister of Environment and Parks
Mr. Todd Zimmerling, President and CEO, ACA
Dr. Jon Fennell, Water Resource Specialist
Ms. Silvia D'Amelio, Chief Executive Officer, TUC
Mr. Kevin Gardiner, Regional Manager, ACA
AFGA Executive
Delinda Ryerson, Executive Director, AFGA

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1. North Raven River - A World Class Treasure R1.pdf
2. 1983 BORNEUF Local Springs 1982_03.pdf
3. 2014 0703 SCAMMELL-RDAdvocate-Rehabilitation of North Raven River welcomed.pdf
4. 2000 KOMEX Stauffer Creek water report.pdf
5. 2014 0710 SCAMMELL-RDAdvocate-Saving the North Raven.pdf
6. 2001 RODTKA ACA Clear Creek Fishery Assessment.pdf
7. 2009 RDRWA Raven Subwatershed.pdf
8. 2016 CRUA Bow River Economic Importance.pdf
9. 2007 Watson, et al Impacts vs Contribution 37-2-6.pdf
10. 2015 Mountain Trout Fishing Economic Impacts on and Contributions to North Carolinas Economy.pdf
11. 2013 New Mexico DGF-Economics-of-Fishing-Hunting-and-Trapping-Final.pdf
12. 2004 HCL Clearwater County Regional Groundwater Assessment.pdf
13. 1995 Mead Direct and Cumulative Effects of Gravel Mining on Ground Water.pdf
14. 2006 BLACKPORT&GOLDER Applied Research on Source Water Protection Issues.pdf
15. 2018 0815 HANSEN Washington USA 3 - Tech Memo 33 - Hydrogeologic review of Mineral Extraction Code.pdf

A. AMENDMENT PURPOSE

The North Raven River and Clear Creek are ecologically unique and environmentally sensitive spring-fed watercourses originating in Clearwater County. Given their sensitivity to surface and subsurface development and the over five decades of rehabilitation that has gone into protecting these systems, it is imperative that this special area receives the permanent protection it so richly deserves.

We strongly support the first topic summary in the October 2017 Alberta Government report titled *“What We Heard: Stakeholder Feedback on the Sand and Gravel Program Review”* which stated: *“Stakeholders consistently agreed that decisions regarding extraction in the 1 in 100 year flood plain from rivers need to involve science-based decisions”*. To that end we prepared a professionally authenticated report that relied on published, science-based, primary source papers to identify and clarify our concerns with below water table development.

Our report identified an Area of Concern consisting of 33 quarter-sections of land in the immediate vicinity of the headwater springs of the North Raven River and Clear Creek. We propose that Clearwater County should establish a special Land Use District, consisting of these 33 quarter-sections of land, that offers increased protection for the headwater springs in its regulations. The identified Area of Concern currently all falls into Land Use District Agriculture District “A”.

The only intent of this proposed amendment is solely concerned with prohibiting all below water table development in this Area of Concern. We believe that any such development has the very real potential of harming the headwater springs and important groundwater sustaining flow of the North Raven River and Clear Creek.

The intent of this proposed amendment is not to limit or prevent any currently permitted activity in the Area of Concern. All these current agricultural, industrial, and residential activities would be grandfathered in.

The intent of this proposed amendment is not to reject any Discretionary Use within the Area of Concern, but rather to ensure it is limited to above water table activity. We only ask that the applicant commit to this limitation and submit in their development application an appropriate science-based assessment that identifies where the normal seasonal maximum water table can be expected. Our implicit assumption is that should the water table be contacted for any reason; the development activity would cease until remedial resolution is reached with Clearwater County.

To meet the intents stated above, we propose a new Land Use District titled:

CLEAR CREEK & NORTH RAVEN RIVER BUFFER “CCNRRB”

We began with the complete rules and regulations for the original Land Use District Agriculture District “A” (Land Use Bylaw section 13.4 (1)), and inserted two sections that address our concerns.

D. Discretionary Use Restrictions, and

E. Discretionary Use Development Application Disposition

These additional sections are highlighted in yellow in the proposed bylaw amendment.

13.4 (34) CLEAR CREEK & NORTH RAVEN RIVER BUFFER "CCNRRB"

THE GENERAL PURPOSE OF THIS DISTRICT IS TO PROVIDE A DEVELOPMENT BUFFER AROUND THE IDENTIFIED MAJOR HEADWATER SPRINGS OF BOTH CLEAR CREEK AND THE NORTH RAVEN RIVER.

A. PERMITTED USES

1. First Residence
2. Farming and non-residential farm buildings
3. Second residence on a lot that is 32 hectares (80 acres) or larger

B. DISCRETIONARY USES

1. Ancillary building or use
2. Cemetery
3. Community hall/centre
4. Drive-in theatre
5. Gravel and sand pit
6. Highway maintenance yard
7. Petroleum refining, gas processing or related installations with a total enclosed or developed building or plant space of less than 930 square metres (10,000 sq. ft.)
8. Public utility: landfill, waste transfer and associated facilities, sewage lagoon and other sewage treatment facilities, water treatment plant and associated facilities, public utility building
9. Radio, television and other communications tower and related buildings not exceeding 75 square metres (800 sq. ft.)
10. Recreation facility: publicly owned
11. Recreation facility or use for a local and/or private clientele or club only and not occupying more than 1 hectare (2.5 acres)
12. Sod farm or tree farm
13. Greenhouse with a floor area of less than 100 square metres (1,100 sq. ft.) or such larger area subject to the discretion of the Development Officer.
14. Guest house

C. DISCRETIONARY USES ALLOWED in this District ONLY where Incidental or Subordinate to the Principal Use of the lands contained in the current Certificate of Title.

1. Second and additional residences on a lot on which all of the requirements of Section 6.6 are satisfied
2. Abattoir

3. Airport or heliport occupying 2 hectares (5 acres) or less
4. Agricultural equipment service and sales
5. Auto-wreckers providing proper screening is employed
6. Dude ranch or vacation farm
7. Farm subsidiary occupation
8. Game farming or game ranching for viewing, tourism or recreational purposes
9. Home occupation
10. Kennel
11. Market gardening
12. Off-parcel drainage works
13. Riding or roping and livestock showing stable or arena
14. Sawmill or postmill with annual volume of at least 530 cubic metres (1/4 million board feet) of standing timber
15. Sod farm
16. Top soil stripping and sales
17. Tradesperson's business, including contractors for plumbing, heating, electrical carpentry, auto-body, mechanical, masonry, excavation, construction, trucking and the like.
18. Unoccupied and unserviced manufactured home storage (one only)
19. Veterinary clinic
20. Zoo

D. DISCRETIONARY USE RESTRICTIONS

1. All Discretionary Use Development Applications considered for approval after **"DATE OF ISSUE"** must satisfy the Discretionary Use Restrictions listed below.
2. No Discretionary Use Development shall remove material from below the normal seasonal maximum water table (i.e. first groundwater-bearing zone), such as sand/gravel/aggregate wet extraction.
3. No Discretionary Use Development shall create either a temporary or a permanent open water waterbody such as a pond or a lake, other than dugouts as permitted by Section 9.1.
4. No Discretionary Use Development shall permit any potentially harmful material to be deposited in the soil above the normal seasonal maximum water table, or in an aquifer below the water table, such as a petroleum refining or gas processing facility, a landfill, waste transfer facility, sewage lagoon or other sewage treatment facilities, or a water treatment plant.
5. No Discretionary Use Development shall create a major disturbance, either physical, chemical, or biological, below the normal seasonal maximum water table.

E. DISCRETIONARY USE DEVELOPMENT APPLICATION DISPOSITION

1. All Discretionary Use Development Applications shall include a full Environmental Assessment Report on the development's potential impact on

- the headwater springs of Clear Creek and the North Raven River.
2. All Discretionary Use Development Applications that intend to enter the ground must provide an appropriate science-based assessment that identifies where the normal seasonal maximum water table can be expected. Once the approved work begins, should the water table be contacted for any reason; the development activity shall cease until remedial resolution is reached with Clearwater County.
 3. All Discretionary Use Development Applications shall appear before the Municipal Planning Commission for disposition. This function cannot be delegated to the Development Officer.
 4. Only those Discretionary Use Development Applications that do not violate the restrictions listed in Section D above shall be considered for approval.
 5. A complete copy of the Discretionary Use Development Application shall be placed on the County website.
 6. All landowners in the Land Use District shall be notified of the Discretionary Use Development Application and where to find it on the County website.
 7. A Public Notice shall be placed on the County website and local, regular newspapers requesting submissions from those with an interest in the decision within 14 days.
 8. Based on the response to the Public Notice, the Municipal Planning Commission may decide to hold a Public Hearing. The Public Hearing process shall follow the relevant portions of Section 4.2 Appeal Hearing.

F. ACCEPTABLE LOT SIZE

1. Except as provided for in subsections 2, the acceptable lot size is all of the land contained in an existing lot unless otherwise approved by the Development Officer subject to:
 2. The new lot being used exclusively for the approved development; and
 3. The developer entering into an agreement and/or Letter of Undertaking with the Municipality regarding placing the intended use or development on the proposed lot.
4. Regarding a first residential parcel out of an unsubdivided quarter section or out of the largest agricultural parcel within a previously subdivided quarter section that does not already contain a residential subdivision:
5. Where the first residential parcel would include all or part of an existing farmstead, the parcel size shall not be less than 0.91 hectares (2.25 acres) or exceed a maximum of 2.83 hectares (7 acres) unless a larger parcel is deemed necessary by the Subdivision Authority to encompass existing residential amenities and facilities, such as shelter belts, wastewater and water services and driveways; and
6. Where the first residential parcel would not include the removal of an existing farmstead, the parcel size shall not be less than 0.91 hectares (2.25 acres) or exceed a maximum of 2.02 hectares (5.00 acres) and the provisions of Part 8 of this Bylaw.

G. MINIMUM DEPTH OF FRONT YARD

As required and/or approved pursuant to Section 10.3 and Figures 1 to 7 of the Supplementary Regulations.

H. MINIMUM WIDTH OF SIDE YARD

15 metres (50 feet) except for a corner site where the side yard shall be determined as though it were a front yard.

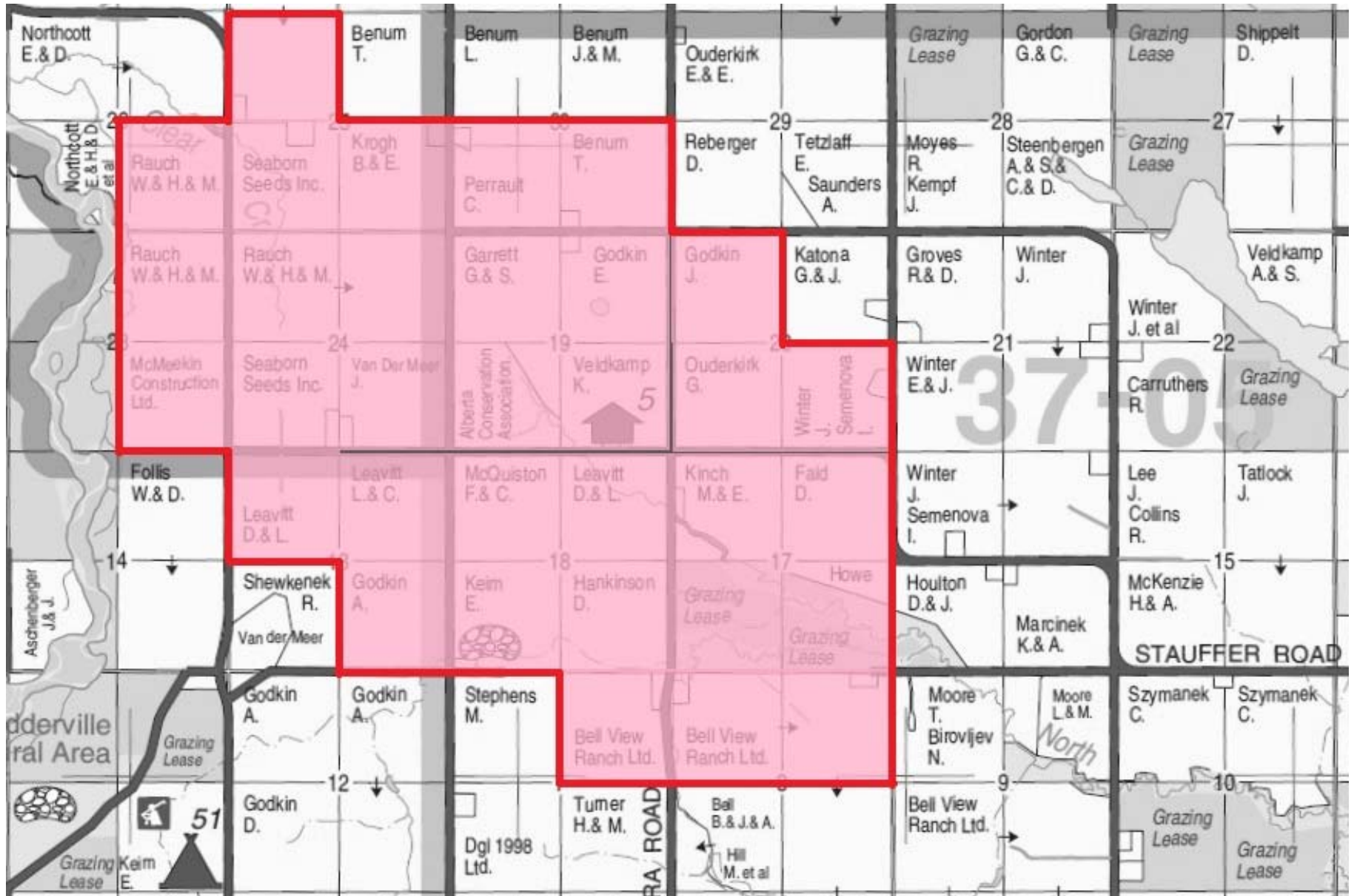
I. MINIMUM DEPTH OF REAR YARD

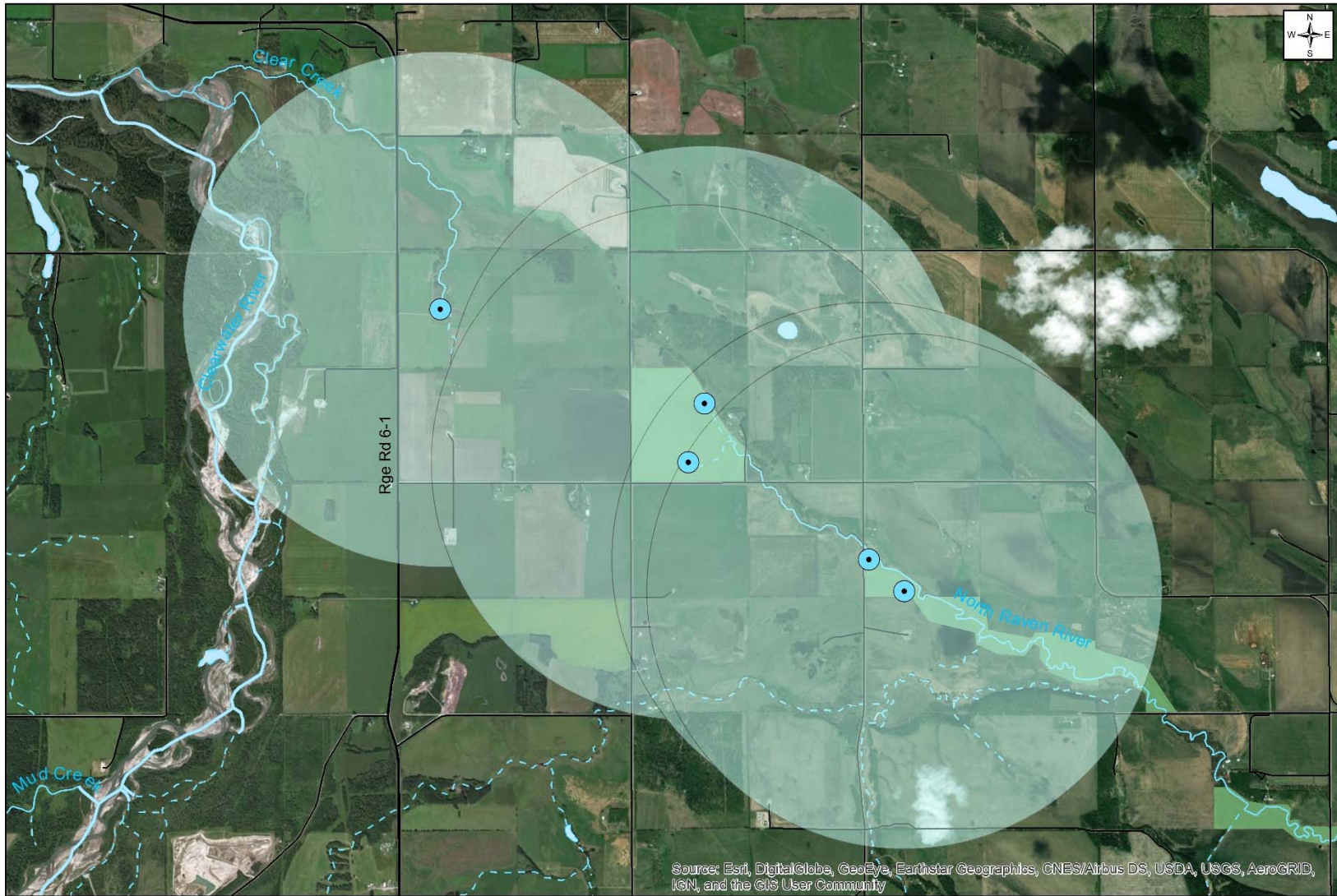
15 metres (50 feet) unless otherwise approved by the Development Officer.

NOTE: Lots created prior to this Bylaw coming into effect and not able to comply with the foregoing shall meet setback limits as determined by the Development Officer.

J. LANDSCAPING




1. In addition to other provisions of this Bylaw, the Development Officer may require landfill sites, gravel and sand pits, sewage facilities and other visually offensive uses to be screened from view with vegetation and/or other screening of a visually pleasing nature.
2. Reclamation to standards acceptable to the Development Officer may be required following abandonment of all or any portion of a gravel or sandpit, sawmill or other land surface disturbing operation.





Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

-  Naturally occurring springs
-  1,800 m buffer
-  ACA Conservation Sites



Map Creation: Alberta Conservation Association, January 2020
 Map Projection: NAD 1983 UTM 11N
 Base Data Provided by Spatial Data Warehouse Ltd.

C. AMENDMENT REASONS

A formal, professionally authenticated report was prepared in February 2020, detailing the nature of the Clear Creek and North Raven River headwater springs, the rehabilitation work of the past almost 50 years, and their particular sensitivity to subsurface development. It appears as the first entry under the tab Reference Documents, and is titled “The North Raven River – A World-Class Treasure in Clearwater County”. In addition, our landowner consultation process yielded other important points.

- The springs feeding the North Raven River come from an alluvial sand and gravel aquifer connected to the Clearwater River. They are Meinzer Class III springs. Only a few Alberta springs are larger, most notably Maligne Canyon Springs.
- The North Raven River is the only large, spring-fed river in Alberta’s white zone; primarily privately deeded or titled land.
- These springs deliver consistent water temperature, high water clarity, and sustained water flow all year around. These critical factors, along with the groundwater baseflow contributions, provide exceptional trout spawning and feeding habitat.
- The North Raven River contributes \$400,000/yr. to Alberta from direct angling activity alone. In addition, area businesses that depend on the river have indicated that some \$350,000 of their annual revenue is derived from the North Raven River.
- Several landowners also stated during the consultation process that the best 5-6 quarter-sections of farmland within our Area of Concern often generate annual crop revenues of \$100,000 per quarter-section.
- Rehabilitation and restoration began in 1973 with a Buck for Wildlife project. Since then, over \$10 million and tens of thousands of volunteer hours have been expended to deliver one of the greatest Alberta conservation stories.
- Water quality has been measured at various points along the North Raven River upstream of Secondary Highway 761. This information has been reported in several studies. Although all measured values generally met the current Canadian drinking water guidelines, some sample locations exceed those guidelines, as well as the Alberta guidelines associated with the protection of freshwater aquatic life¹.
- One of the greatest impacts a below water table development can have is the creation of a large pit that eventually fills with groundwater. Such a pond will remain part of the normal groundwater flow system, but will alter it by changing the configuration of the water table and exposing the groundwater to oxygen, thereby changing how certain trace elements in the sediments (notably chromium) mobilize into the groundwater and move down gradient towards the North Raven River and any landowner wells.

¹ <https://www.alberta.ca/water-quality-guidelines.aspx>

- A review of publicly available, primary literature provided two important aquifer assessments with respect to below water table disturbances. Turbidity plumes associated with a groundwater disturbance have been measured at distances up to 1,830 m downgradient. As well, thermal plumes associated with large ponds have been shown to dissipate in less than a one-year travel time at downgradient locations. This equates to <1,920 m for the subject area.

D-I. LEGAL LAND DESCRIPTION OF AFFECTED LAND

The Area of Concern is defined by a circular section 1.8 km in radius around the 5 springs feeding Clear Creek and the North Raven River. It consists of 33 quarter-sections.

Listed by quarter-section:

NE -07 -037 -05 -W5M
NE -08 -037 -05 -W5M
NW -08 -037 -05 -W5M
NE -17 -037 -05 -W5M
NW -17 -037 -05 -W5M
SE -17 -037 -05 -W5M
SW -17 -037 -05 -W5M
NE -18 -037 -05 -W5M
NW -18 -037 -05 -W5M
SE -18 -037 -05 -W5M
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SW -30 -037 -05 -W5M
NW -13 -037 -06 -W5M
SE -13 -037 -06 -W5M
SW -13 -037 -06 -W5M
NE -23 -037 -06 -W5M
SE -23 -037 -06 -W5M
NE -24 -037 -06 -W5M
NW -24 -037 -06 -W5M
SE -24 -037 -06 -W5M
SW -24 -037 -06 -W5M
NW -25 -037 -06 -W5M
SE -25 -037 -06 -W5M
SW -25 -037 -06 -W5M
SE -26 -037 -06 -W5M

E. LANDOWNER CONSULTATION SUMMARY

Through a search of land titles, we eventually identified 29 landowners, leaseholders, and renters over the 33 quarter-sections We refer to as the Area of Concern (see Section D-I. Affected Lands). All initial consultations were carried out in August and September 2020. We have had follow-up meetings with several parties.

Of the 29 identified landowners, leaseholders, and renters, we were able to contact 26 parties (90%), and had face-to-face meetings with 21 parties (72%). Of the remaining 5 parties, 3 were sent complete information packages by email. In all, 24 parties (83%) received our information package.

The information package consisted of an introduction (spoken or written), our paper titled “*North Raven River - A World Class Treasure*”, a draft of the proposed Land Use Bylaw Amendment, a promise to supply any of the reports we used in the preparation of our paper, and a request for input, comment and feedback on the proposal itself. A number of parties have requested and received further information.

Based on our discussions and interviews, we believe the majority of affected parties we were able to contact and present our information support this bylaw amendment submission.

Response	Number	%
Support the proposed bylaw amendment, as long as their major concerns are addressed	19	73%
Reject the proposed bylaw amendment (includes all the resource extraction companies)	4	15%
Indifferent/neutral towards the proposed bylaw amendment	3	12%

One significant observation made by several landowners was that the water level in their dugouts seemed to rise and fall along with water level changes for the Clearwater River. We have seen similar changes at the headwaters of all five springs as well.

Although a few of the parties contacted were willing to sign a formal support letter, most were reluctant to consider it, feeling that by signing they might compromise their relationship with neighbours who were not supportive of our case.

E-I. LANDOWNERS CONTACTED

Through a search of land titles, we eventually identified 29 landowners, leaseholders, and renters over the 33 quarter-sections of Affected Lands (see Section D-I. Affected Lands). A number of the land titles had not been updated with the new land owners.

Over August and September 2020, we were able to speak with 23 parties. 2 of those parties spoke for another 3 additional parties for a total of 26 parties contacted.

We were unable to reach 3 parties despite repeated calls, messages left, and notes taped to entry gates are left in white background.

E-II. LANDOWNER CONCERNS

The discussions held with all parties (landowners, leaseholders, and renters) generated numerous questions and concerns that had nothing to do with the proposed scope of this bylaw amendment submission. Those items are not included here (beaver management, fencing along the river, etc.).

A number of concerns were also registered that applied to landowner concerns specifically about gravel pit operations. Those items as well are beyond the proposed scope of this bylaw amendment submission. They are presented here for completeness, but will not be addressed by this submission.

Landowner Concerns within the Scope of this Submission

- How will the water table be determined?
 - The water table on my land has never been above 28 feet. Will I still be able to sell for gravel extraction?
- What will the impact on land values be?
- What will be the impact on taxes be?
- Shouldn't you really be protecting a much larger area than just the springs? We would like the rest of our land along the river included in this amendment.
- Very concerned about the potential impact on water quality due to an end-pit lake.
- Concerned that the County will decide whether or not this bylaw amendment is the best thing for the county but that the county does not have any hydrogeologists on staff.
- Do we have any concerns about sewage disposal for new acreages in the area?
- Will this proposal do anything to mitigate Clearwater flooding like that seen in 2005 & 2007?
- The Gravel industry has a code of practice and our licenses under the water act will hold us liable for any damage we create to the river and its springs. Isn't that enough for you?
- When it was in operation, why didn't the Cooper pit impact the North Raven River?
- Agriculture is a Permitted Use of land in your proposed bylaw amendment. Why does Section D4 have the phrase "...or other agricultural operation." when you are referring to Discretionary Uses of the land?
- You are not representing any value to the current agricultural production that would be lost if all the prime land near the McQuiston pit would become gravel pits. I know for a fact that some of the best quarters can yield \$100,000 annually.
- To ensure that science rules the day, you need to state in your submission under what conditions you would consider allowing below water table gravel extraction.
- How are you addressing feedlots in this proposal?
- How are you addressing pipelines with this proposal?
- How are you addressing oil exploration with this proposal?

Landowner Development Concerns outside the Scope of this Submission

- How will the gravel truck traffic be controlled?
 - Concerned when cattle need to be moved from pasture to pasture along the road where trucks could be as frequent as one every two minutes and drivers are paid by the load.
 - Concerned about school bus safety.
- As a gravel pit owner, how am I supposed to make any money/recover on my investment if I can't extract below the water table?
- This area is really the only one in the area that has good clean gravel within 50 km of Rocky Mountain House. If you sterilize it by prohibiting below water table access, where are we supposed to get our gravel?

E-III. LANDOWNER CONCERNS ADDRESSED

These landowner concerns fall within the scope of this submission:

1. How will the water table be determined?
 - a. The water table on my land has never been above 28 feet. Will I still be able to sell for gravel extraction?
2. What will the impact on land values be?
3. What will be the impact on taxes be?
4. Shouldn't you really be protecting a much larger area than just the springs? We would like the rest of our titled land along the river included in this amendment.
5. Very concerned about the potential impact on water quality due to an end-pit lake.
6. Concerned that the County will decide whether or not this bylaw amendment is the best thing for the county but that the county does not have any hydrogeologists on staff.
7. Do we have any concerns about sewage disposal for new acreages in the area?
8. Will this proposal do anything to mitigate Clearwater flooding like that seen in 2005 & 2007?
9. The Gravel industry has a code of practice and our licenses under the water act will hold us liable for any damage we create to the river and its springs. Isn't that enough for you?
10. When it was in operation, why didn't the Cooper pit impact the North Raven River?
11. Agriculture is a Permitted Use of land in your proposed bylaw amendment. Why does Section D4 have the phrase "...or other agricultural operation." when you are referring to Discretionary Uses of the land?
12. You are not representing any value to the current agricultural production that would be lost if all the prime land near the McQuiston pit would become gravel pits. I know for a fact that some of the best quarters can yield \$100,000 annually.
13. To ensure that science rules the day, you need to state in your submission under what conditions you would consider allowing below water table gravel extraction.
14. How are you addressing feedlots in this proposal?
15. How are you addressing pipelines with this proposal?
 - a. How are you addressing oil exploration with this proposal?

Concerns Addressed

1. WATER TABLE DETERMINATION

Our only aim in bringing this land use bylaw amendment submission forward is to provide formal protection for the springs and groundwater baseflow feeding Clear Creek and the North Raven River through prohibiting below water table discretionary use development activity. We do not oppose any above water table discretionary use development activity unless the result of that activity can be registered in the aquifer as an adverse impact.

To that end, it is imperative that any developer whose activity has the potential to register in the aquifer be required to complete a science-based assessment identifying where the normal seasonal maximum water table can be expected.

We would prefer to see a water table level monitoring program over a three-year time period to allow for yearly variations and seasonal from normal area precipitation patterns. One year of data collection may suffice if precipitation can be demonstrated to fall within the mean for every calendar month. If only one full calendar year of data exists, we would recommend that the county add a 3.3 foot (1 m) safety margin above the normal seasonal maximum water table to restrict the maximum depth of the permitted work. Once the approved work begins, should the water table be contacted for any reason; the development activity shall cease until remedial resolution is reached with Clearwater County.

What might a science-based assessment look like? We would begin with at least 3 monitoring wells widely spaced on the quarter-section, even on the property line to permit ease of use for agriculture. The water level (elevation above sea level) in these monitoring wells should be recorded at least twice per month, and more frequently (e.g. daily) during the spring and early summer when the highest Clearwater River water levels are expected. If anomalies arise in the water level tracking, they may need to be addressed with more wells. After one year of data has been gathered, the highest water table for that past year can be identified. Although this will not provide a complete assessment of the full range of water level changes possible, it will nonetheless be informative. We recommend that water level monitoring continue as long as the development work continues.

2. IMPACT ON LAND VALUATION

It is quite likely that land that had a value premium based on recoverable aggregate resources would have that premium reduced by the portion of the resource below the water table.

3. IMPACT ON CLEARWATER COUNTY TAXES

There are many factors that enter into a county's assessment of taxes due. We are not party to that process in Clearwater County, and cannot offer a knowledgeable opinion in the matter.

4. PROTECTION AREA SIZE

Our sole reason for bringing this land use bylaw amendment submission forward is to provide formal protection for the springs and groundwater baseflow feeding Clear Creek and the North Raven River. Our review of primary source literature indicates that a radius of 1.8 km around each spring accomplishes that objective. Expanding our Area of Concern, even if asked for by landowners, would compromise the original intent of our work.

5. END PIT LAKE IMPACT ON WATER QUALITY

We accept the criticism that our Area of Concern of a radius of 1.8 km around each spring may reflect a “worst-case” scenario of water quality impact on those springs, the underlying groundwater, and potentially adjacent landowner water wells. As reported by Mead, turbidity plumes can be seen up to 6,000 feet (1.83 km) down gradient of subsurface disturbances. According to Blackport and Golder, thermal plumes from gravel pits generally dissipated in less than a one-year travel time downgradient. Based on data for our aquifer, that converts to 1.92 km. We chose to use 1.8 km overall for our proposal.

It is a well understood phenomenon that an end pit lake changes the water chemistry. Aquifer water that is normally isolated from the atmosphere and is oxygen-deficient is exposed to surface conditions, warmed by the sun, and becomes oxygenated. It then reports back to the groundwater system on the downgradient side. The resulting changes to local conditions can potentially mobilizing undesirable compounds and move them further downgradient.

6. COUNTY HYDROGEOLOGISTS

While it may be true that Clearwater County does not have any professional hydrogeologists on staff, the county could retain one to review and provide an opinion on this proposal. There are many consultants throughout the province that could assist. We suggest that Clearwater County consider facilitating a study on the ground water within this Area of Concern, similar to that described in section 1 of this document.

7. ACREAGE SEWAGE DISPOSAL

Sewage disposal on acreages within the county can be regulated by the county. We expect that if the county accepts the intent and spirit of this submission, they will appropriately regulate sewage disposal in our Area of Concern.

8. CLEARWATER FLOOD MITIGATION

Recent flooding of the Clearwater River has created serious challenges for the county and area residents. The acceptance and implementation of this proposed bylaw submission by the county would do nothing to mitigate future Clearwater River overland floods.

However, if the proposed bylaw submission is not accepted, it is possible to imagine, some years down the road, where much of our Area of Concern has its aggregate deposits replaced by numerous end pit lakes. In a major Clearwater River flood event, it is conceivable that a new river channel could form by water captured by these pits, subsequent back-cutting erosion of the pit slopes, and creation of a preferential pathway focusing water flow into the North Raven River valley of the Red Deer watershed. Such an inter-basin flow change would not be welcomed by most regulators, and Albertans in general.

9. LIABILITY FOR DAMAGES

While it is true that industry can be held fully liable for any damage they do to the environment, there is ample evidence in this province that collecting on that liability can be problematic. Simply look to the work being done in Alberta by the Orphan Well Association. It is also quite possible that some types of damage to this spring- and groundwater-fed ecosystem are simply beyond our ability to repair, for example, a radical re-routing of where the springs appear. Given the special nature of Clear Creek and the North Raven River groundwater-fed ecosystems we feel that taking this particular risk is ill-advised.

10. COOPER PIT IMPACT

The Cooper pit lies in quarter-section SW-11-37-05-W5M. It is 4.4 km SW of the Leavitt springs, 5.1 km SW of the Stainbrook springs and 4.2 km SSW of the Clear Creek spring. We are unaware of any monitoring done to determine impact on these springs during the operation of the Cooper pit. In addition, our proposal defines our Area of Concern as a radius of 1.8 km around each spring. The Cooper pit falls outside of that area.

11. AGRICULTURAL USE OF THE LAND

Farming is a permitted land use in Agriculture District A. Any restriction on agricultural land use appearing under our heading of Discretionary Use Restrictions in our draft bylaw amendment proposal was inappropriate and has been removed in our final version.

12. VALUE OF AGRICULTURAL LAND USE

Our original report focused on the value of the North Raven River as a world-recognized tourism destination. We acknowledge that we did not consider the value of agricultural land production in that report. During our consultations with area landowners we received anecdotal evidence that the 4-6 best quarter-sections each yielded up to \$100,000 annually in agricultural production.

13. CONDITIONS TO PERMIT BELOW WATER TABLE OPERATION

Our sole purpose in bringing this land use bylaw amendment submission forward is to provide formal protection for the groundwater and springs feeding Clear Creek and the North Raven River. Our review of primary source literature has identified several reasons for concern with “below water table” operations. Given the special nature of Clear Creek and the North Raven River groundwater-fed ecosystems we cannot propose any conditions to permit below water table operation in our Area of Concern.

14. FEEDLOTS

The approval, authorization or registration of confined feeding operations (feedlots) that is required pursuant to the Agricultural Operation Practices Act is regulated by the Natural Resources Conservation Board (NRCB). Clearwater County's Land Use Bylaw, Section 11.1 clearly states that confined feeding operations are exempt from municipal control. We, however, do not support such operations given the concentrations of waste streams and risk of contamination to the groundwater in the Area of Concern.

15. PIPELINES AND OIL EXPLORATION

Both oil exploration activities and pipeline construction and operation are beyond the control of Clearwater County. Clearwater County's Land Use Bylaw, Section 3.2 (t) (ii) and (iii) clearly shows that wells and batteries within the meaning of the Oil and Gas Conservation Act or pipelines are outside county jurisdiction.

F. REFERENCE DOCUMENT INDEX

1. North Raven River - A World Class Treasure R1.pdf
2. 1983 BORNEUF Local Springs 1982_03.pdf
3. 2014 0703 SCAMMELL-RDAdvocate-Rehabilitation of North Raven River welcomed.pdf
4. 2000 KOMEX Stauffer Creek water report.pdf
5. 2014 0710 SCAMMELL-RDAdvocate-Saving the North Raven.pdf
6. 2001 RODTKA ACA Clear Creek Fishery Assessment.pdf
7. 2009 RDRWA Raven Subwatershed.pdf
8. 2016 CRUA Bow River Economic Importance.pdf
9. 2007 Watson, et al Impacts vs Contribution 37-2-6.pdf
10. 2015 Mountain Trout Fishing Economic Impacts on and Contributions to North Carolinas Economy.pdf
11. 2013 New Mexico DGF-Economics-of-Fishing-Hunting-and-Trapping-Final.pdf
12. 2004 HCL Clearwater County Regional Groundwater Assessment.pdf
13. 1995 Mead Direct and Cumulative Effects of Gravel Mining on Ground Water.pdf
14. 2006 BLACKPORT&GOLDER Applied Research on Source Water Protection Issues.pdf
15. 2018 0815 HANSEN Washington USA 3 - Tech Memo 33 - Hydrogeologic review of Mineral Extraction Code.pdf

The North Raven River – A World-Class Treasure in Clearwater County



Prepared by:


**Victor Benz
Environment Chair**

**Dr. Jon Fennell
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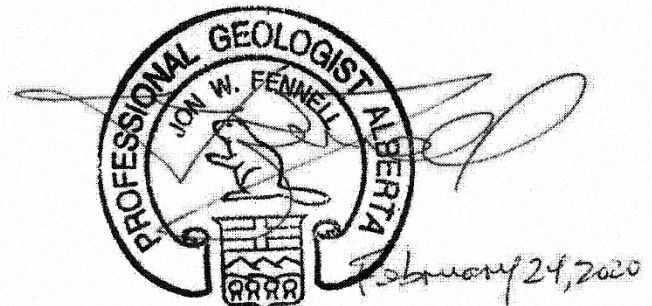
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24-FEBRUARY, 2020

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February 24, 2020

Applies only to hydrogeological and water quality content of this report.

Cover Photo Credit – ACA - Stephanie Fenson

1. EXECUTIVE SUMMARY

The North Raven River and Clear Creek are ecologically unique and environmentally sensitive spring-fed watercourses originating in Clearwater County. Given their sensitivity to surface and subsurface development and the over five decades of rehabilitation that has gone into protecting this system, it is imperative that this special area receives the permanent protection it so richly deserves.

The springs feeding the North Raven River come from an alluvial sand and gravel channel connected to the Clearwater River. They are Meinzer Class III springs. Only a few Alberta springs are larger, most notably Maligne Canyon Springs. Both Miette Hot Springs and Banff Hot Springs are a couple of orders of magnitude smaller than the springs sustaining the North Raven River.

These springs deliver consistent water temperature, high water clarity, and sustained water flow all year around. All three of these critical factors provide exceptional trout spawning and feeding habitat. Having spring sourced water as the primary contribution to overall flow is very rare for a stream of this size in Alberta.

The North Raven River contributes \$400,000/yr. to Alberta from direct angling activity alone. In addition, area businesses that depend on the river have indicated that some \$350,000 of their annual revenue is derived from the North Raven River.

The North Raven River was first stocked in the 1930s. By 1965, prevailing agricultural, ranching and forestry practices had reduced it to little more than a glorified cattle watering trough. Rehabilitation and restoration began in 1973 with a Buck for Wildlife project. Since then, over \$10 million and tens of thousands of volunteer hours have been expended to deliver one of the greatest Alberta conservation stories.

Water quality has been measured at various points along the North Raven River above Secondary Highway 761. Although all measured values generally meet the current Canadian drinking water guidelines, some sample locations exceed those guidelines, as well as the guidelines associated with the protection of freshwater aquatic life.

One of the greatest impacts a development can have is the creation of a large pond or pit. The pond will oxygenate the groundwater, thereby changing how certain trace elements in the sediments (notably chromium) mobilize into the groundwater and move towards the North Raven River.

A review of publicly available literature provides two important aquifer assessments with respect to below water table disturbance. Thermal plumes associated with a sustained disturbance should dissipate in less than a one-year travel time downgradient, <1,920 m. As well, turbidity plumes associated with groundwater disturbance can spread up to 1,830 m downgradient.

To protect this ecologically unique and environmentally sensitive region, the Alberta Fish and Game (AFGA) proposes:

- the creation of a 1.8 km buffer zone surrounding the headwater springs of the North Raven River & Clear Creek, and
- the initiation of a study to identify, inventory and assess all springs and major groundwater discharge areas feeding Clear Creek and North Raven River above Secondary Highway 761. These additional springs, once identified, would then be included in the buffer zone.

2. INTRODUCTION

The AFGA was founded in 1908 and is Alberta's oldest independent conservation group. This report compiled by the AFGA will address the North Raven River, its history, tourism impact, ecological uniqueness and significant environmental sensitivity.

The AFGA is a member of the Alberta Conservation Association (ACA). Along with several partners in conservation, it shares in the ownership and management of nine of the eleven sites in the immediate area. Other partners are Alberta Environment and Parks (AEP), Trout Unlimited Canada (TUC), Clearwater County, Red Deer County and local landowners.

These sites¹, from NW to SE are:

Name	Description	Area	Location	Major Partners
Clear Creek	Purchase	4 acres	SE-26-037-06-WSM	ACA, AEP, TUC
Clear Creek	Riparian Habitat Enhancement Agreements	18 acres	NW-24-36-7W5M SW-25-37-5 W5M	ACA, AFGA, TUC, Clearwater County
Leavitt	Purchase	125 acres	SW-19-03705-WSM	ACA, AFGA, TUC, Clearwater County
Stainbrook Springs	Purchase	17 acres	NW-17-037-05-WSM	ACA, AFGA, TUC
Coulson	Donation	10 acres	Part of NE-35-36-5 W5M	ACA, AFGA
North Raven River	Riparian Habitat Enhancement Agreements	83 acres	SE-19-37-5 W5M NW-9-37-5 W5M N-16-36-4 W5M	ACA, TUC,
North Raven River	Conservation Site	463 acres	Parts of: 30-036-04-WSM 25/36-036-05-WSM 02/09/10/11/16/17-036-05-WSM	ACA, AEP, AFGA, TUC, Clearwater County, Red Deer County,
Raven River	Riparian Habitat Enhancement Agreements	461	E-12-36-7, W5M W, SE-15-36-4 W5M SW-14-36-6 W5M NE-3-36-5 W5M NW-9-36-4 W5M N, SE-12-36-4 W5M NE-36-35-4 W5M S-16-36-4 W5M S-18-36-4 W5M NW-12-36-6 W5M SW-15-36-6 W5M NW-7-36-6 W5M S-14-36-4 W5M	ACA, AFGA, TUC, Red Deer County, Clearwater County
Drake	Purchase	133 acres	SE-17-036-04-WSM	ACA, AFGA
Porter	Purchase	155 acres	SW-17-036-04-WSM	ACA, AFGA
Raven River	Conservation Site	64	Parts of: SE-15-35-7 W5M SW-12-36-7 W5M NE-11-36-4 W5M	ACA, AFGA, TUC

All sites are either in Clearwater County or in Red Deer County.

¹ ACA communication 14 Jan 2020

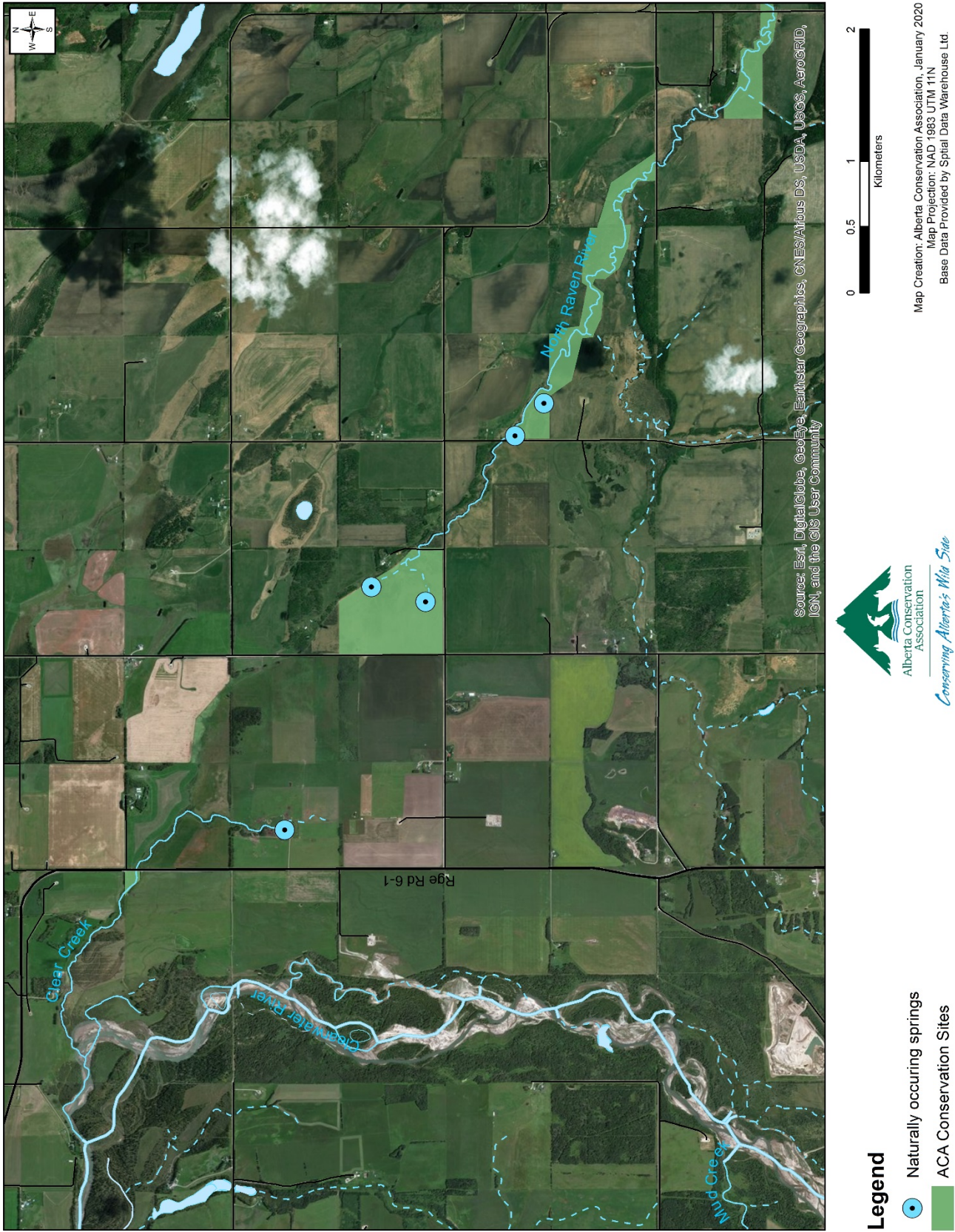


Figure 1. Clear Creek-North Raven River Headwater Springs

3. HISTORY OF THE NORTH RAVEN RIVER

The North Raven River is spring fed from an alluvial sand and gravel channel connected to the Clearwater River². There are four major springs that have been identified to date; two on the Leavitt property and two on the Stainbrook Springs property (Figure 1). Many more minor springs add to the flow over the first few kilometers of the river, with groundwater contributions occurring along the entire length.

The North Raven River originates 3.6 km east of the Clearwater River and flows generally in a SE direction until its confluence with the Raven River 18 km away, “as the crow flies”. The actual river is much longer, due to its meandering style.



Photo credit - ACA - Kevin Gardiner

Originally known as Stauffer Creek, it was first stocked with brown and brook trout in the 1930s³⁴.

Following the end of World War II, agricultural, ranching and forestry intensity increased significantly in this region⁵. Livestock grazing destroyed stream bank vegetation and cattle traffic caused erosion and degradation of the stream banks. By the early 1960s, Stauffer creek was little more than a glorified cattle trough. Banks were destroyed and it became a wide, wet, and muddy flat in many places.

In the late 1960s, a stream study was completed that “outlined the problems and proposed ways of rehabilitating the river: basically narrowing the river’s channel by rebuilding its banks, replanting willows to stabilize the banks and shade the stream, and fencing cattle away from the creek, except for specified, well-protected watering locations, including some off-stream ponds⁶.”

In 1973, the provincial government established the Buck for Wildlife Program (BFW) and the rehabilitation of Stauffer Creek was announced as its first project, as championed by the AFGA. The first land purchase was what is now the Buck for Wildlife parking lot where RR 53 crosses the North Raven River.



Photo Credit - TUC via Don Andersen

² Borneuf 1983

³ Don Andersen discussion 04 Jan 2020

⁴ Bob Scammell-Red Deer Advocate 03 July 2014

⁵ Komex 2000

⁶ Bob Scammell-Red Deer Advocate 10 July 2014

Led by a watershed resident and former AFGA President, Elmer Kure, initial work proceeded quickly.



Photo Courtesy of Bob Vanderwater

The rehabilitation program brought together provincial wildlife biologists, other government workers, streamside landowners, and many other volunteer organizations. Agreements were signed with streamside landowners supporting the construction and ongoing maintenance of livestock exclusion fences and watering/crossing sites to protect streambanks.

An Order-in-Council officially changed the name of Stauffer Creek to the North Raven River.

In 1997, the responsibility for maintenance at project sites was transferred from the BFW to the ACA. The ACA is a delegated administrative organization (DAO), operating at arms-length from the Alberta provincial government through independent directors, some of whom are appointed by the Minister of Environment and Parks.

The ACA is self-funded, and raises revenue through enhancement levies on various hunting and fishing licences and permits issued by the province. The ACA is specifically charged with many elements of conserving the fish, wildlife and habitat resources of Alberta⁷.

The ACA has continued the work on the North Raven River, negotiating new habitat lease agreements with landowners and terminating the old BFW agreements.

⁷ ACA Mandate & Roles 2014

In the new agreements, landowners are provided with new straightened fences, set further back from the stream and thus increasing the habitat area protected. In addition, landowners receive financial compensation to assist with stewardship of the project sites.



Photo Courtesy of Bob Vanderwater

Over these past 47 years, some \$10 million has been spent on the rehabilitation, enhancement and protection of the North Raven River, much of it within Clearwater County. Tens of thousands of volunteer hours have also been accrued and work continues to this day. This is arguably the greatest Alberta conservation story.

Clearwater County's Clear Water Land Care Program (formerly Rocky Riparian Group), has made significant investments in the Raven River drainage system through public outreach and education. Examples include demonstrations of off-site watering systems to agricultural producers, education on water quality, assisting landowners in grant applications targeted at riparian protection and proposing to partner with the ACA on an Eco-buffer project at the Leavitt Conservation Site starting in 2020. In addition, Clearwater County places Environmental Reserves (ER), which are "no disturbance" allowed areas, adjacent to streams, on properties along the North Raven River as a condition of approving natural-feature-related subdivisions.

Surveys conducted by the ACA continue to substantiate the creation of a world-class trout fishery. Most recently, in 2019, ACA counted more than 1600 redds⁸ (gravel nests made by spawning trout) between the headwater springs and Secondary Highway 761. The majority were in the stretch from the Stainbrook Springs property to the BFW parking lot on RR 53.

Clear Creek is a small stream (approximately 4 km long) that also originates from ground water flow from the Clearwater River, the same aquifer that feeds the North Raven River springs. The headwater springs of Clear Creek are approximately 1.6 km NW of the North Raven River headwater springs but Clear Creek flows westerly into the Clearwater River due to the minor elevation change between the two systems (Figure 2).

⁸ ACA unpublished report-Mike Rodtka email 09 Jan 2020

Significant monetary and volunteer hour investments have also been made on Clear Creek. Rodtka⁹ reported the sportfish catch in a 2001 survey represented a 357% increase from a previous survey in 1991. Clear Creek is considered important for sportfish rearing and spawning purposes but is not as an angling destination. In 2001, 70% of the sportfish catch were less than 100 mm fork length and therefore considered young of the year¹⁰. Also, in 2001, a bull trout was captured in the headwater spring of Clear Creek. This was the first cited capture of a bull trout in Clear Creek. Bull trout in the North and South Saskatchewan river basins in Alberta are listed as threatened under the federal Species at Risk Act (SARA) Committee on the Status on Endangered Wildlife in Canada.

⁹ Rodtka 2001

¹⁰ ibid

4. UNIQUE ASPECTS OF THE NORTH RAVEN RIVER

Three elements are critical to the creation of this world-class trout fishery:

- stable temperature,
- high clarity, and
- sustained flowrate.

The North Raven River and Clear Creek are a truly unique aquatic ecosystems due to the consistency in the water quality related to the groundwater springs forming the headwaters. The consistency in water temperature, clarity and flowrate are critical for these sensitive fish populations. For example, overwintering is a major limiting factor in most lotic (flowing water) systems. However, the headwaters of the North Raven River and Clear Creek remain ice free throughout the winter season, mitigating this concern. The steady provision of water by the springs and discharging groundwater, as well as agitation and oxygenation by the flowing water, provide perfect spawning conditions for salmonids. Most biologists consider the headwater reaches of the North Raven River a naturally occurring and unique fish spawning ground.

4.1 WATER TEMPERATURE

The headwater springs moderate the water temperature throughout the year.

“Water temperature in the North Raven River is relatively cool and stable, which is beneficial for trout. For example, during the summer of 2018 (June – August) ninety-five percent of hourly water temperature measurements taken at the headwaters of the North Raven River (Leavitt Springs) normally ranged between 5°C and 7°C (average: 6°C, minimum: 5°C, maximum: 11°C). For context, the 95th percentiles for air temperature (a driver of stream temperature) over the same timeframe in the general area were 4°C and 28°C (average temperature: 15°C, minimum: 0°C, maximum: 35°C).”(interim ACA report¹¹)

Trout are a cold-water species. It is very common to see particularly Brook Trout clustered around the headwater springs, where the water is the coolest¹². Brook Trout, one of the major trout species in the North Raven River¹³, prefer a temperature range of 14°C - 17°C¹⁴. The lethal temperature is 25°C¹⁵. The upper lethal temperature for developing eggs is listed as 12 °C¹⁶. Any significant temperature plume would immediately endanger any eggs laid near the headwater springs, which is the primary spawning area.

4.2 WATER CLARITY

Water clarity is a critical factor in the survival of trout eggs. Well-filtered water for the North Raven River is the result of being spring fed via a permeable gravel aquifer. The clear water also allows fish to feed on abundant prey species, all year.

Where most other Alberta streams experience numerous periods of turbid high water, limiting feeding, the North Raven River and Clear Creek do not.

¹¹ ACA unpublished report-Mike Rodtka email 09 Jan 2020

¹² Dean Baayens – private communication

¹³ Red Deer River State of the Watershed Report 2009

¹⁴ McClane’s New Standard Fishing Encyclopedia 1974

¹⁵ ibid

¹⁶ Freshwater Fishes of Canada 1973

4.3 WATER FLOWRATE

Borneuf measured the North Raven River minimum winter flowrate at about 34 cubic meters per minute ($0.57 \text{ m}^3/\text{s}$)¹⁷. A study conducted by Komex for PetroCanada in 2000¹⁸ confirmed the flowrate. This makes the North Raven River a Class III spring-fed stream on the Meinzer Classification Scale.

Only a few Alberta springs are larger, notably Maligne Canyon Springs. Miette Hot Springs and Banff Hot Springs are both smaller than the springs sustaining the North Raven River.

The late spring flowrate is dependent on the high-water stage of the Clearwater River due to snow melt, which effectively doubles the winter flowrate.

Rainfall and local snowmelt runoff will contribute to the stream flow and the turbidity of the North Raven River, but the overall consistent spring flow and groundwater discharge from the alluvial gravel system means the river water quickly clears, minimizing turbidity risk to the aquatic ecosystem.

¹⁷ Borneuf 1983

¹⁸ Komex 2000

5. TOURISM IMPACT

The North Raven River sees up to 3,000 angler-days per year. In part, this is because the upper half of the river never freezes due to the headwater spring water temperature. As such, the upper river is open to fishing throughout the year. The angler data is consistent with ACA surveys of 1986 and 1996¹⁹. For comparison, the Bow River sees about 177,600 angler-days²⁰ per year.



Photo Credit – TUC

Calculating the economic value of angling is notoriously difficult, as noted by Watson²¹. A literature review has yielded impact numbers with a range of \$60 - \$180 per fishing day. The primary difference is in the methodology.

A 2016 report²² identifies the estimated direct economic value of sport fishing in Alberta in 2010 at \$138 per fishing day. This value compares favourably with data for trout fishing in North Carolina²³ and New Mexico²⁴. Therefore, the estimated direct angling impact attributed to the North Raven River is about \$400,000 per year in perpetuity (not including inflationary costs).

¹⁹ Kevin Gardiner email 25 Nov 2019

²⁰ CRUA 2016

²¹ Watson 2007

²² CRUA 2016

²³ North Carolina 2015

²⁴ New Mexico 2013

Local businesses have been contacted as well. Tackle and Trails²⁵ in Rocky Mountain House has stated that they would lose about \$15,000 a year in business if the North Raven River were permanently damaged and angling opportunities were lost. Past owners of the Lazy M Guest Ranch²⁶, located right on the North Raven River, attribute \$6,000 - \$12,000 annually to trout fishing for the almost 20 years they operated the facility. They have recorded guests from all over Canada and the US; as well as visitors from the UK, EU, and even Russia.



Photo Credit - ACA via Kevin Gardiner

Although the primary economic impact is due to the world-class angling opportunities, the wildlife corridor established through this rehabilitation has become a favorite for birdwatchers and other wildlife enthusiasts, as recounted by the former owners of the Lazy M Guest Ranch.

The current owners of the Lazy M Guest Ranch have submitted a letter of concern to both Clearwater County and the Honourable Jason Nixon, Minister of Environment and Parks²⁷.

In it, they have stated that the primary reason they purchased the property was the North Raven River ecosystem.

“When choosing a location for our business the North Raven river bordering the property played a huge factor in the appraisal process. To have nearly one kilometer of an extremely unique 100% spring fed river within its boundaries made this location very attractive. The wild life and bird life attracted by the constantly flowing river year round also increased the environment to help us create a retreat where guests could escape the city life and live in nature for several days to “Rest Relax and Recharge” the motto for our business model. A 1.3 million dollar investment in the Clear Water County.”

In addition, they state an annual sales revenue of \$250,000 and an annual secondary impact on area businesses of \$50,000 to \$100,000.

We arrive at a figure of approximately \$750,000 annually, in perpetuity, for the economic impact of the North Raven River as it exists today.

²⁵ Kevin Gardiner email – 09 January 2020

²⁶ Kevin Gardiner email – 09 January 2020

²⁷ Kevin Gardiner email - 21 January 2020

6. LOCAL SETTING AND WATER QUALITY CONDITIONS

As noted previously, the North Raven River is a tributary stream to the Raven River and eventually the Red Deer River. Situated in the Red Deer River watershed, it is a unique trout stream flowing entirely through Alberta's white zone (settled area). Its existence is owed to contributions of freshwater springs and groundwater discharge from permeable sand and gravel deposits. This extends to the existing conservation areas, which relieve some of the surrounding development pressures.

Clear Creek is fed by the same aquifer, but flows in the opposite direction into the Clearwater River and eventually the North Saskatchewan River watershed.

To the west (about 3.6 km) is the Clearwater River, which is part of the North Saskatchewan River watershed. The divide between these two watersheds is situated somewhere between these two river systems.

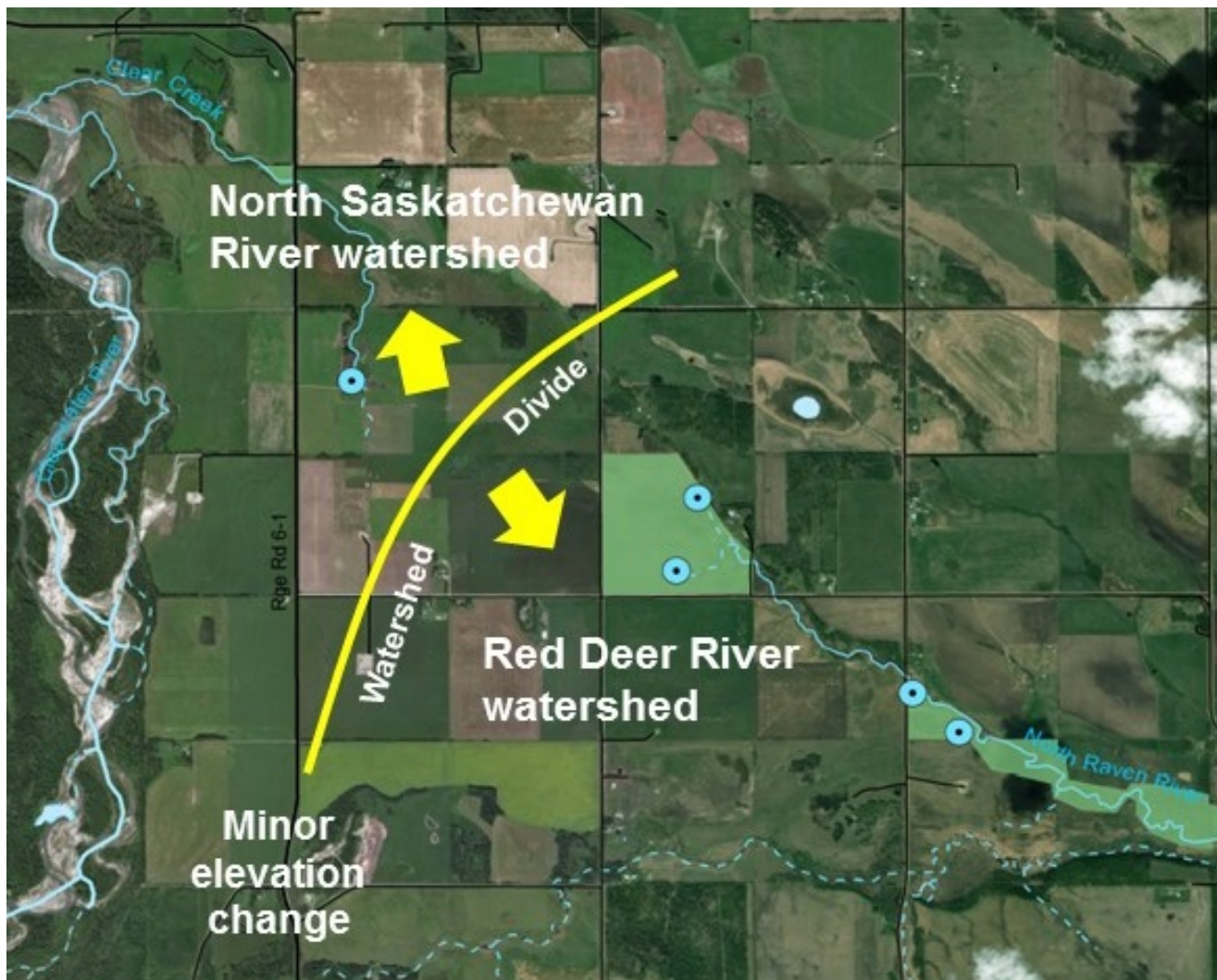


Figure 2. North Saskatchewan River – Red Deer River Watershed Divide

The Clearwater River is situated at a higher elevation than the North Raven River and flows towards the north, while the North Raven River flows from its headwater area in the Leavitt and Stainbrook Springs Conservation Areas towards the southeast eventually joining the eastward flowing Raven River near the town of Raven, Alberta.

Although there is a divide between the two river systems, the elevation difference is not significant (i.e. approximately 1 m) leading to the risk of flood inundation, which has occurred occasionally when the Clearwater River has breached its banks, most recently in 2007.

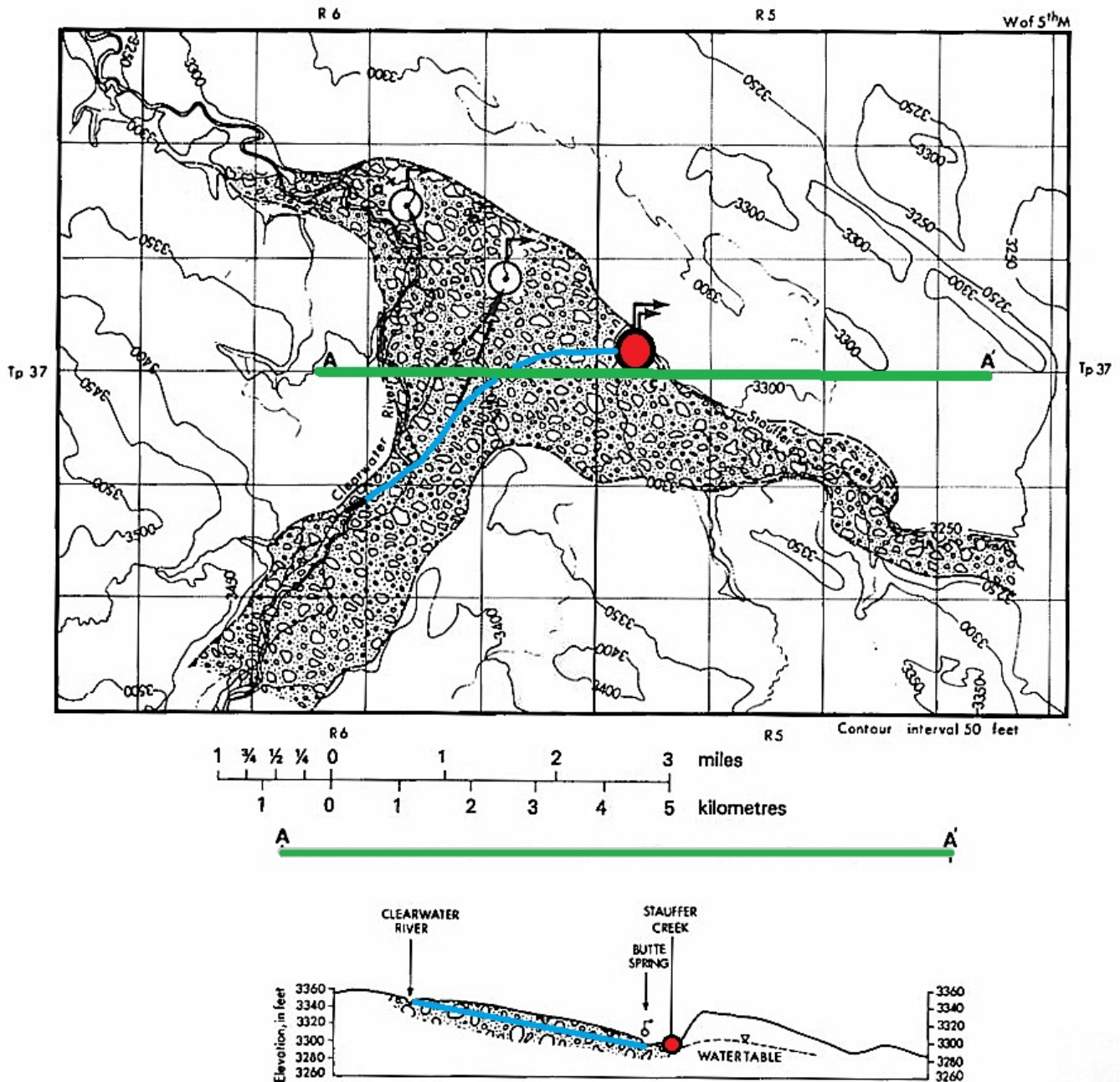


Figure 3. Mapped extent of alluvial sand and gravel within the Clearwater and North Raven River systems (Note: blue arrow = direction of groundwater flow; red dot = location of Stauffer Spring) ²⁸

In 1983, the presence of a relatively extensive and high yielding (permeable) sand and gravel deposit existing between the Clearwater River and the North Raven River was identified (Figure 3).

²⁸ Borneuf 1983

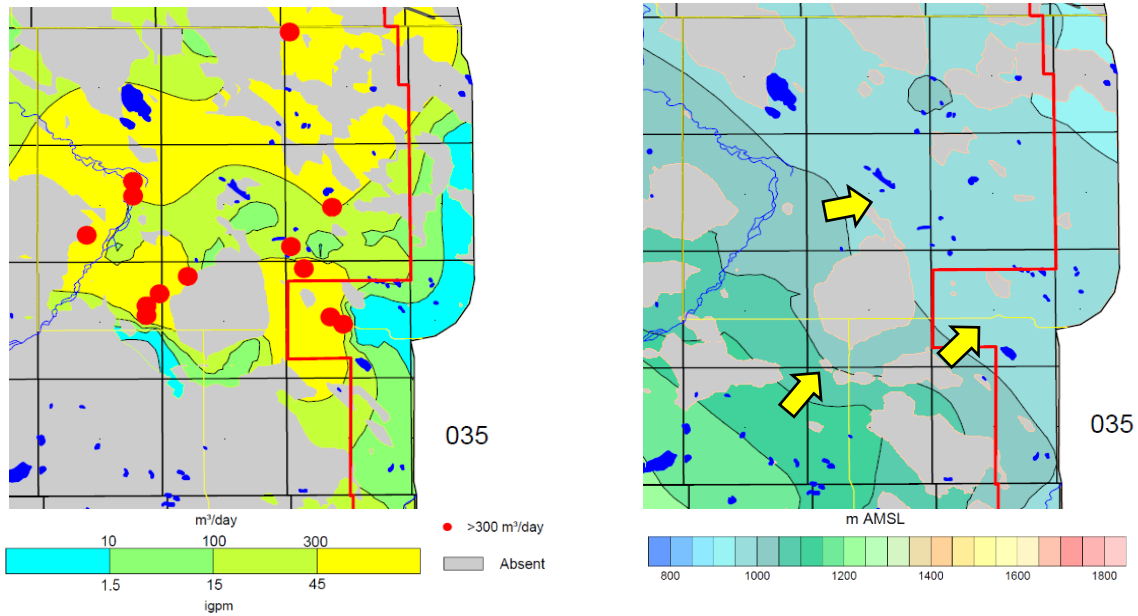


Figure 4. Distribution of sand and gravel deposits and apparent yield characteristics, left, and non-pumping water level elevations in surficial deposits based on water well less than 20 m deep (Note: yellow arrows indicate groundwater flow directions).²⁹

This was later confirmed by Hydrogeological Consultants Ltd.³⁰(Figure 4, left image). In combination with the generally eastward sloping groundwater surface elevations and the shallow upper 20 m groundwater interval (Figure 4, right image), contributions of groundwater from the Clearwater alluvial system into the North Raven River headwater area are consistent with the local setting.

To further substantiate connectivity between these two river systems, a review of water well records from locations between the two rivers was conducted. Figure 5 shows the locations of documented water wells with sand and gravel (S&G) deposits encountered within 10-15 m of the surface. Other than a few wells with no data provided (ND), the presence of a relatively contiguous sand and gravel deposit is substantiated.

²⁹ HCL 2004

³⁰ ibid

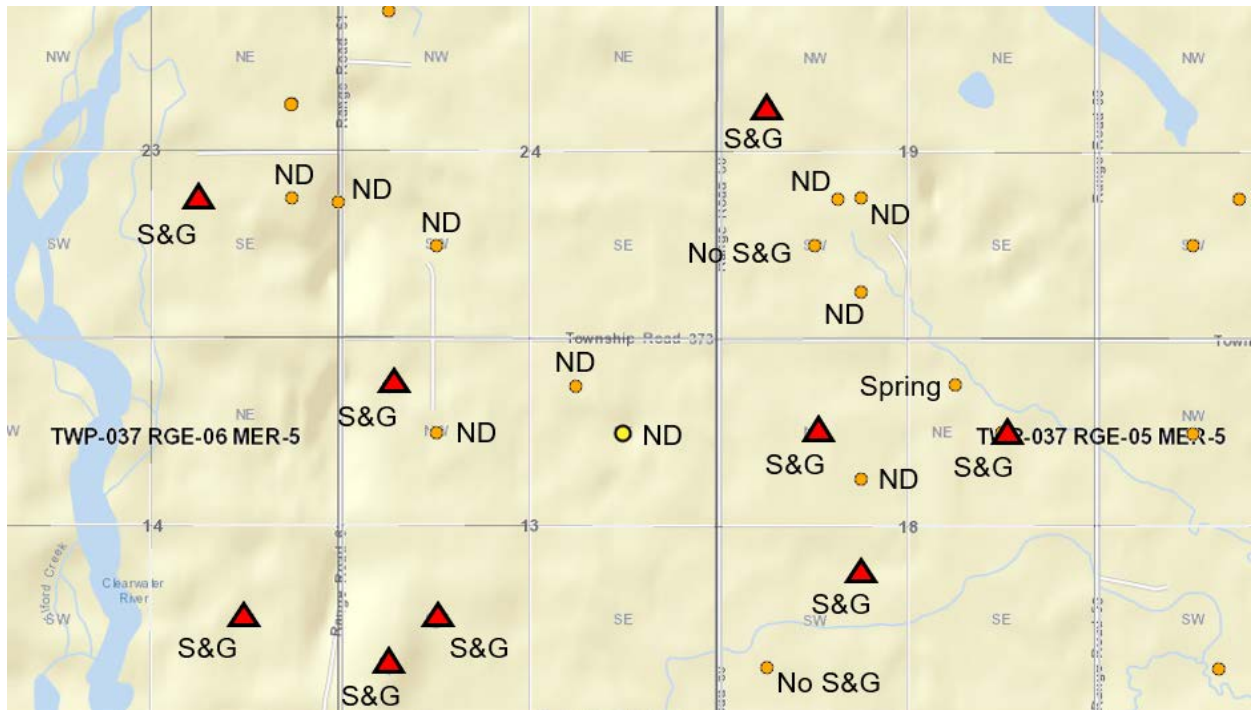


Figure 5. Locations of water wells where sand and gravel (S&G) has been identified at roughly the same depth interval in the upper 20 m of the subsurface. (Note: ND = no data)³¹

Estimates of the groundwater flow velocity in the sand and gravel deposits were made back in 1983 using measured hydraulic values and an assumed effective porosity of 35%. Given the considerable permeability associated with these granular deposits, a notably high travel rate of 5.3 metres per day, or about 2 kilometers per year has been documented³².

Review of available groundwater quality from water wells located throughout the study area indicates geochemical conditions consistent with a relatively fast flowing aquifer system (i.e. low groundwater mineralization). For example, the TDS (total dissolved solids) content of water sampled from Well 452525, located in SE-05-37-5 W5M, yielded a value of 353 mg/L³³. Water sampled from the Clearwater River at the same time yielded a TDS value of 315 mg/L. This represents an increase of only 38 mg/L over a distance of about 3 km, and is consistent with a limited amount of water-rock interaction and mineral dissolution.

Of particular note is the presence of comparatively elevated concentrations of certain nutrients and trace elements in the groundwater, in particular nitrate, chromium, copper, manganese, and zinc (Tables 1, 2a and 2b). Although all measured values generally meet the current Canadian drinking water guidelines³⁴ some sample locations exceed those guidelines, as well as those associated with the protection of freshwater aquatic life (FWAL)³⁵. This has implications for the North Raven River since that groundwater is the sustaining mechanism of flow in that river, whether it be from spring discharges or diffuse contributions through the base of the river (i.e. baseflow).

³¹ <http://groundwater.alberta.ca/WaterWells/d/>

³² Borneuf 1983

³³ Komex 2000

³⁴ Health Canada 2019

³⁵ GoA 2018

Review of water quality at local springs along the North Raven River, as well as water samples from the river itself (Tables 2a and 2b), similarly show elevated levels of nutrients (i.e. phosphorous and nitrate), as well as cadmium, chromium, and iron compared to anticipated background conditions. In some cases, the concentrations are approaching, or exceed, established long-term guideline values for the protection of freshwater aquatic life (FWAL).

With respect to phosphorous, the concentration noted at the Alberta Environment and Parks Stauffer Creek station AB05CB0030, measured at 0.028 mg/L in 1991, is consistent with meso-eutrophic conditions.³⁶ This is unexpected for such a pristine headwater area.

The suspected source and cause of the trace elements in the groundwater and receiving surface water is natural weathering of the aquifer sediments and dissolution of minerals containing these elements. As for the nutrients (nitrate and phosphorous), impacts from agricultural activities are the likely reason. The detection of faecal and total coliforms also suggests impacts from human and/or animal wastes on this sensitive river system (Tables 2a and 2b). Unfortunately, there is no water quality data available for the nearby Clear Creek, which is similarly spring-fed and groundwater-sustained, but the situation is likely the same.

³⁶ <http://st-ts.ccme.ca/en/index.html?lang=en&factsheet=167>

7. SENSITIVITY TO DISTURBANCE

The North Raven River and Clear Creek both originate from the extensive sand and gravel deposit beneath the area. Both water courses are sustained by groundwater that flows out of this sand and gravel deposit via springs and diffuse baseflow contributions, which serves to:

- maintain a wetted environment conducive to ensuring a healthy riparian buffer
- regulate stream temperatures and deliver nutrients to the aquatic species dependent upon and inhabiting those streams, and
- provide suitable and sustainable spawning and overwintering habitat to ensure the viability and proliferation of existing fish species and associated feedstock.

These two water features depend on the local groundwater and any changes to how and where this groundwater flows, as well as changes to the quality of that groundwater, will have ramifications. These streams originate in the local area unlike other rivers and streams, which are sustained by larger watersheds. The lack of any upstream contributions creates a sensitivity to disturbance that is not experienced by other river systems. Human development activities will have a more immediate impact on the local water balance and the smaller catchment areas.

Many types of surface and subsurface development have the ability to negatively impact shallow groundwater quality, quantity and flow conditions through direct and indirect means. These are expanded upon in the following section along with some challenges to consider post-development.

8. IMPACT OF SURFACE AND SUBSURFACE DEVELOPMENT (INCLUDING CREATED PONDS & LAKES)

It is evident that the North Raven River is already experiencing some degree of low-level impact to the groundwater and surface water from surrounding land development. By extension, future development can only be seen to exacerbate this situation and increase the risk profile for the local streams relying on the provision of clean, temperature-regulated groundwater. Future risk to the local streams and their reliant ecosystems is therefore associated with events such as:

- Spills and leaks of fuels or chemicals that may be used to support industrial activity.
- Subsurface releases of hydrocarbons and produced water from oil and gas wells, as well as related underground infrastructure (e.g. pipelines).
- Seepage and/or surface runoff of contaminated wastes from above or below ground waste management facilities (e.g. landfills) and confined feeding operations.
- Overuse of fertilizers and pesticides to promote crop yield.
- Physical disturbance of the subsurface by the removal of protective soil layers and excavation of the underlying sediments.

These risks have implications for both the quality of water discharging to local streams and water bodies as well as the local groundwater flow conditions. For example, Mead³⁷ studied the implications of gravel mining on local groundwater turbidity and found that in highly permeable aquifer systems turbidity levels remained elevated at values of around 2 NTU (Nephelometric Turbidity Unit) in water wells located up to 6,000 feet from these operations, or roughly 1.8 km. This matches the FWAL long-term exposure criterion for rivers like the North Raven River. Blackport and Golder³⁸ also found that thermal plumes from gravel pits generally dissipated in less than a one-year travel time downgradient of such subsurface disturbance. Although the thermal risk to nearby water bodies may be low for slower flowing groundwater systems, the same may not hold true for faster flowing systems, like the alluvial sand and gravel beneath this study area (i.e. 5.3 m/day, or 1,935 m/year).

Large excavations can also have an impact on local groundwater flow directions and water balance conditions. For example, when an excavation occurs below the water table and results in an open water surface, the water table will flatten. This results in a lowering of the water table on the upgradient side of the excavation and an increase in the water table on the downgradient side. Depending on how far the water table is lowered below the land surface, this could have implications for crop development. Similarly, the resulting increased drop from the land surface to pond increases the risk of land erosion and compromising of the pond edges by cascading runoff water, if inundated by an overland flood. Conversely, an increase in the water table at the downgradient end of the pond can lead to land stability issues, reduced accessibility for heavy machinery and increased geotechnical risk.

³⁷ Mead 1995

³⁸ Blackport Hydrogeology Inc. and Golder Associates 2006

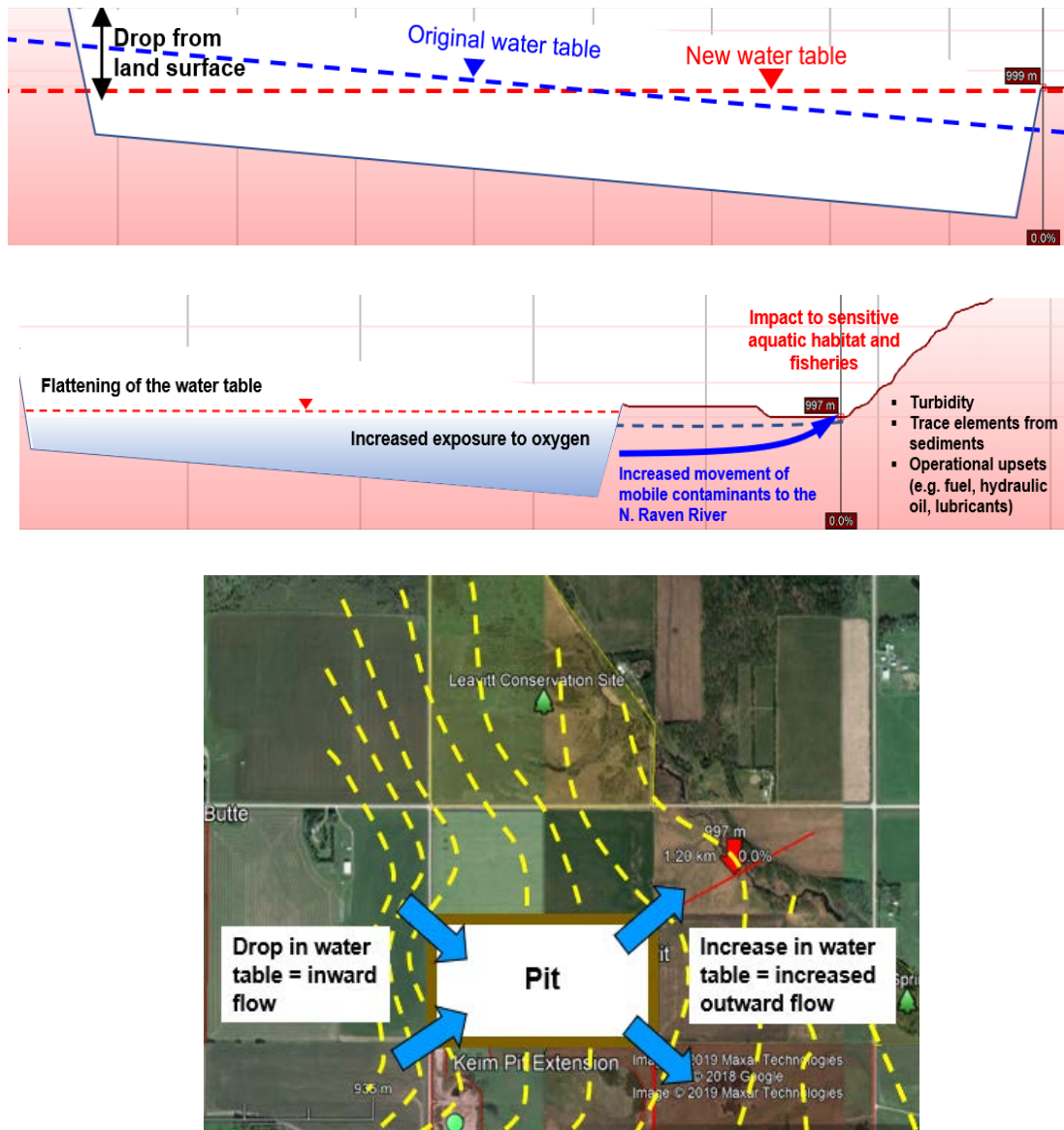


Figure 6. Influences on the physical and chemical conditions around a large excavation below the water table

Alteration of the local groundwater flow conditions and enhanced evaporative loss will also occur, which may adversely affect downgradient groundwater/surface water interactions (i.e. springs and baseflow discharges). In addition to the turbidity “migration” risk identified earlier, enhanced oxygenation of the groundwater being captured by the pond has the ability to alter local geochemical conditions and enhance the mobilization of naturally-occurring constituents like chromium, copper, zinc, etc. and increase their already elevated concentrations in the groundwater (and by extension the springs and local streams).

There are also residual issues that typically occur after the completion of excavation activities and the development of large artificial ponds and lakes. Notwithstanding the usual cost to maintain such constructions (which would fall to the County once a reclamation certificate is granted), the introduction of nutrients from nearby agricultural developments has the ability to alter water quality in such impoundments by enhancing the growth of algae, cyanobacteria and other oxygen-depleting organisms, reducing oxygen levels and shifting geochemical conditions. This can again change the mobility characteristics of certain constituents in the surrounding sediments and increase the risk to downgradient receptors to compromised groundwater.

The implications for receiving water bodies like the North Raven River and Clear Creek are obvious. Increased turbidity levels and temperature conditions can be harmful to sensitive aquatic habitat. This can, in turn, have negative effects on other reliant organisms and sensitive fish species. The release of contaminants, either directly or through alterations to subsurface conditions, can also result in adverse effects if generated at high enough concentrations. The most dangerous type of release would be a gradual, sustained, low-level release leading to long-term exposure without any mitigation.

The fact that the North Raven River and Clear Creek are sustained by discharge from springs and groundwater baseflow, that the local groundwater already contains elevated levels of certain potentially harmful constituents (i.e. trace elements), and the fact that the water flowing in the North Raven River is already showing signs of impact from area development (i.e. elevated nutrients) places these sensitive water courses at high risk compared to other less unique water bodies.

Based on the preceding, the following challenges with future development near the North Raven River and Clear Creek exist, which underscores the need to protect these sensitive and unique water courses:

- Further surface or subsurface development will disturb the natural groundwater flow conditions and alter important contributions from local springs and groundwater baseflow.
- Spills, leaks, and subsurface releases of natural or development-related contaminants (including turbidity from invasive activities) will adversely initially impact groundwater quality, and eventually the connected surface water systems sustaining the unique aquatic habitat.
- Large surface disturbances exposing the subsurface below the water table to oxygen and surface drainage will initially affect the chemistry of the groundwater and eventually the water quality in connected streams.
- The area is already heavily developed for agricultural purposes and is showing signs of influence on the local groundwater and surface water quality. Further development will not reduce this effect and will contribute to the cumulative impact.
- Future developments that may impact the local groundwater are not consistent with sustainable development goals and the need to “make room for nature” in our continuously developing watersheds.
- There are plenty of other less sensitive areas in Clearwater County that can accommodate development needs, while protecting the sensitive aquatic ecosystems of the North Raven River and Clear Creek.
- The provision of a 1.8 km protection zone around the known North Raven River and Clear Creek headwater springs will provide the necessary buffer against future development threats and ensure sustainability of these unique riverine settings.

9. PROTECTION PROPOSAL

Over the past decade, there have been a number of development applications submitted to Clearwater County that infringe upon the recommended buffer to protect the North Raven River and Clear Creek. Given the sensitivity of Clear Creek and the North Raven River to disturbances from land and subsurface development, and the efforts that have gone into protecting these types of lotic systems, it is imperative that this special area receives the permanent protection it so richly deserves.

A literature review on the impact of a significant disturbance of a gravel deposit below water table has yielded important recommendations.

- A 1995 study³⁹ from Thurston County, Washington stated that a 1978 Oregon Department of Environmental Quality study "... found a turbidity plume that extended more than a mile to the north (downgradient) of the gravel operation. ... Nearly all wells sampled within the first 6,000 feet of the turbidity plume were measured at 5 NTU or more. Many wells within the first 3,000 feet of the plume had turbidity levels of 10 NTU or more. Nearly all wells outside the plume had turbidities of 2 NTU or less." 6,000 feet converts to 1,829 m. Long-term (>24h) increases of greater than 2 NTU over background levels are considered to have unacceptable negative impacts on the aquatic environment.⁴⁰
- A 2018 Technical Memorandum⁴¹ from Thurston County, Washington stated that "... groundwater needs to be monitored up to 6,000 feet downgradient of the mine in gravel deposits."
- A 2006 study⁴² co-authored by Blackport Hydrogeology Inc. and Golder Associates "... reviewed additional thermal modeling assessments from unpublished reports and concluded that the thermal plumes from gravel pits generally dissipated in less than a one-year travel time downgradient of the gravel pit pond." The aquifer feeding the North Raven River has a calculated groundwater flow velocity through the gravel system of 5.3 m/day. This gives a one-year travel distance of 1920 m.

We therefore recommend a 1.8 km environmental buffer be implemented around the known headwater springs and sensitive reaches along North Raven River and Clear Creek. (Figure 7)

Secondly, a study should be conducted to identify, inventory and assess all springs and major groundwater discharge areas feeding Clear Creek and North Raven River above highway 761. These additional springs, once identified, would then also be buffered.

This environmental buffer zone would grandfather current approved agricultural and commercial developments at their current intensity levels.

³⁹ Mead 1995

⁴⁰ <https://www.dfo-mpo.gc.ca/Library/255660.pdf>

⁴¹ Hansen 2018

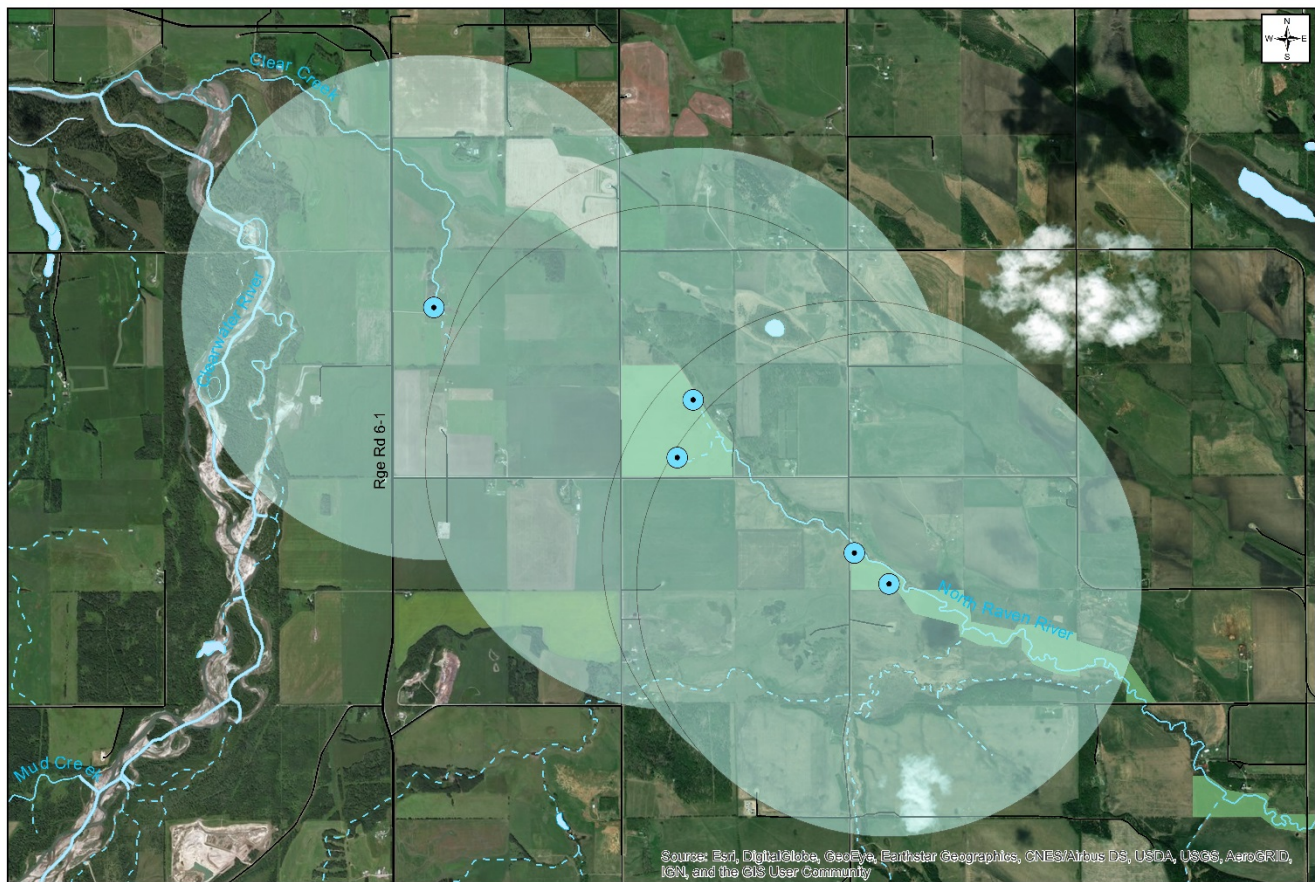
⁴² Blackport Hydrogeology Inc. and Golder Associates 2006

Under such a new regime, new developments or development amendments would be actively discouraged and would require a full environmental impact assessment that addresses, at a minimum:

- The protection of groundwater resources, both quality and quantity (including flow conditions)
- The protection of the North Raven River and Clear Creek aquatic ecosystems
- The protection of the North Raven River and Clear Creek wildlife habitat
- The potential impact on the 1.8 km riparian buffer from cumulative development effects

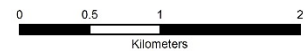
Several opportunities exist for more formal protection under Clearwater County's Land Use Bylaw.

- Modify the existing Agriculture Land Use District 'A' to include this 1.8 km buffer zone.
- Create a new, additional Agriculture Land Use District based on this 1.8 km buffer zone.
- Define this 1.8 km buffer zone as either an Environmental Reserve or Environmental Reserve Easement.



Legend

- Naturally occurring springs
- 1,800 m buffer
- ACA Conservation Sites



Map Creation: Alberta Conservation Association, January 2020
Map Projection: NAD 1983 UTM 11N
Base Data Provided by Spatial Data Warehouse Ltd.

Figure 7. Proposed 1.8 km buffer around the known headwater springs

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Alberta Environment and Parks, swg.requests@gov.ab.ca, data request for surface water quality on the North Raven River Stations AB05CB0030: Staffer Creek and AB05CB0040: North Raven River at Hwy 761, received January 8, 2020.

11.TABLES

Table 1. Selected metals and trace element concentrations in local groundwater

Location	Date	TDS	ANTIMONY (Sb)	CHROMIUM (Cr)	COPPER (Cu)	MANGANESE (Mn)	ZINC (Zn)
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
CDWQG 2019			0.006	0.05	2	0.12	5
GoA FWAL			--	0.001 (6+) 0.0089 (3+)	0.039		0.03
SE-37-06 W5M	19-Oct-95	--	0.001	0.0051	0.005	0.014	0.014
NW-17-36-06 W5M	12-Mar-09	--	0.001	0.0005	0.014	0.001	0.021
27-36-06 W5M	19-Oct-95	--	0.203	0.0043	0.066	0.002	0.061
15-36-05 W5M	19-Oct-95	--	<0.001	0.0035	0.009	0.001	0.002
NE-01-36-05 W5M	23-Jul-07	--	0.001	0.0005	0.002	0.062	0.007
NE-08-36-05 W5M	04-Sep-07	--	0.001	0.0005	0.002	0.153	0.004
NW-03-36-05 W5M	11-Aug-07	--	0.001	0.0005	0.009	0.006	0.001
SE-05-35-05 W5M	24-Feb-00	353	<0.0002	0.005	0.0036	0.040	0.012
NW-32-36-05 W5M	24-Feb-00	358	<0.0002	0.001	0.0003	0.030	0.003
NW-33-36-05 W5M	24-Feb-00	323	<0.0002	0.050	0.0008	0.080	0.006

Notes: CDWQG = Canadian drinking water quality guidelines

FWAL = freshwater aquatic life guidelines

yellow shading = values above CDWQG criteria;

green shading = values above FWAL guidelines

Cr⁶⁺ = hexavalent (more toxic form)

Cr³⁺ = trivalent (less toxic form)

Table 2a. Selected constituents measured in surface water (including springs) located within the study area.

STATION NAME	DATE	TDS	DISSOLVED P	TOTAL P	FECAL COLIFORMS	TOTAL COLIFORMS
		mg/L	mg/L	mg/L	# per 100 mL	# per 100 mL
GoA FWAL guidelines						
Komex 2000						
Clearwater River	7-Mar-00	315	<0.1	--	--	--
Stauffer Ck. Spring No.1	1-Mar-00	297	<0.1	--	--	--
Stauffer Ck. Spring No.2	1-Mar-00	298	<0.1	--	--	--
Stauffer Ck. Spring No.3	3-Mar-00	308	<0.1	--	--	--
Stauffer Ck. @ Sg-4	1-Mar-00	306	<0.1	--	--	--
AEP Stations						
Stauffer Creek	9-Feb-91	309	--	0.028	--	--
North Raven River @ Hwy 761	11-Apr-91	293	0.013	0.029	--	--
North Raven River @ Hwy 761	6-Jun-91	306	0.007	0.017	--	--
North Raven River @ Hwy 761	18-Jul-91	302	0.008	0.013	--	--
North Raven River @ Hwy 761	5-Sep-91	291	0.005	0.007	36	48
North Raven River @ Hwy 761	7-Oct-91	288	0.004	0.005	8	135

Notes: FWAL = freshwater aquatic life; yellow shading = values above FWAL criteria; green shading = above anticipated baseline values

Metals for Komex study = dissolved

Metals for AEP stations = total

TDS = total dissolved solids

P = phosphorous

Table 2b. Selected constituents measured in surface water (including springs) located within the study area.

STATION_NAME	DATE	NO ₃ + NO ₂	CADMIUM (Cd)	CHROMIUM ⁴³ (Cr)	COPPER (Cu)	IRON (Fe)	ZINC (Zn)
		mg/L as N	mg/L	mg/L	mg/L	mg/L	mg/L
GoA FWAL guidelines		3	0.00037	0.001 (6+) 0.0089 (3+)	0.043	0.03	0.03
Komex 2000							
Clearwater River	7-Mar-00	0.097	<0.0002	0.007	0.0050	<0.01	0.007
Stauffer Ck. Spring No.1	1-Mar-00	0.149	<0.0002	0.008	0.0012	<0.1	0.006
Stauffer Ck. Spring No.2	1-Mar-00	0.156	<0.0002	0.006	0.0005	<0.1	0.012
Stauffer Ck. Spring No.3	3-Mar-00	0.160	<0.0002	0.007	0.0015	<0.1	0.013
Stauffer Ck. @ Sg-4	1-Mar-00	0.151	<0.0002	0.006	0.0005	0.05	0.011
AEP Stations							
Stauffer Creek	9-Feb-91	0.240	0.0070	0.002	<0.001	0.235	<0.001
North Raven River @ Hwy 761	11-Apr-91	0.115	<0.001	0.002	<0.001	0.571	<0.001
North Raven River @ Hwy 761	6-Jun-91	0.032	0.0020	0.004	0.0100	0.393	0.002
North Raven River @ Hwy 761	18-Jul-91	0.017	0.0030	0.005	0.0020	0.222	0.001
North Raven River @ Hwy 761	5-Sep-91	0.005	0.0020	0.002	<0.001	0.155	<0.001
North Raven River @ Hwy 761	7-Oct-91	0.046	0.0010	0.003	0.0030	0.157	0.002

Notes: FWAL = freshwater aquatic life; yellow shading = values above FWAL criteria; green shading = above anticipated baseline values

Metals for Komex study = dissolved

Metals for AEP stations = total

Cr⁶⁺ = hexavalent (more toxic form)

Cr³⁺ = trivalent (less toxic form)

⁴³ Hexavalent Cr has not been specifically differentiated. According to information from https://www.carexcanada.ca/profile/chromium_hexavalent/: "Mean or median total chromium concentrations from rivers and streams in British Columbia, Alberta, Ontario, and Quebec were found to be between 4 – 7 µg/L, with 10 – 60% of the chromium as chromium [VI]". For the purpose of this assessment 30% of the measured Cr value has been assumed to be present with the hexavalent form.