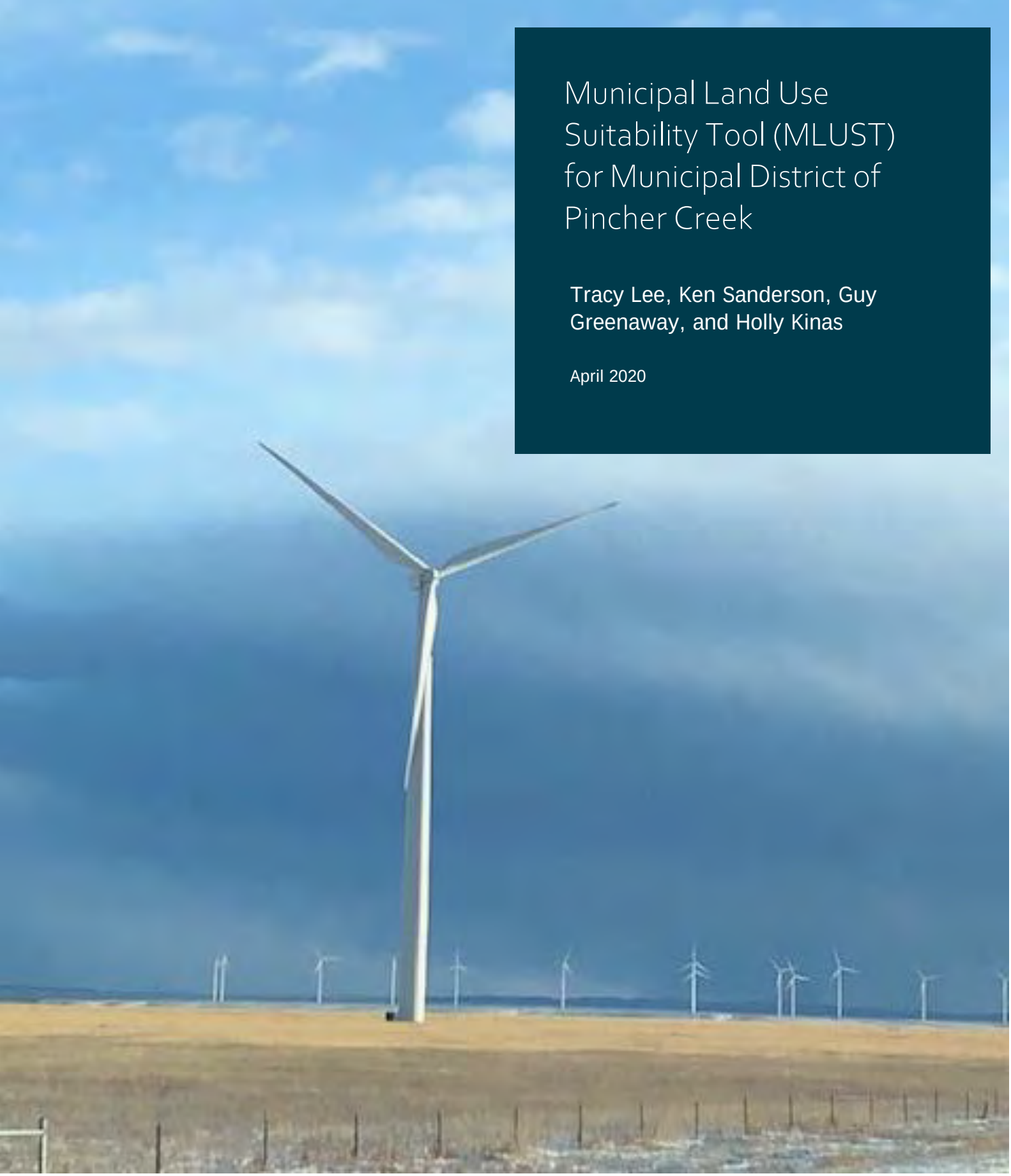

Municipal Land Use Suitability Tool (MLUST) for Municipal District of Pincher Creek

Tracy Lee, Ken Sanderson, Guy Greenaway, and Holly Kinas

April 2020

Miistakis Institute

OLDMAN RIVER REGIONAL SERVICES COMMISSION

M.D. of PINCHER CREEK

This report was made possible through a grant from Energy Efficiency Alberta

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Executive Summary

When municipal governments consider industrial scale solar or wind energy development, it immediately becomes clear that not everywhere is suitable for those activities, and not everywhere is unsuitable. For some areas it is a clear-cut 'yes' or 'no', but most areas sit somewhere on a continuum between those two extremes.

The Miistakis Institute and the Oldman River Regional Services Commission (ORRSC) developed the Municipal Land Use Suitability Tool (MLUST) to assist the Municipal District of Pincher Creek in identifying where renewable energy development is most suitable in consideration of high valued agricultural, ecological and cultural lands.

The MLUST process took six months to complete, engaged municipal stakeholders, made use of existing spatial datasets, and produced a series of map products to inform planning at the municipal scale.

MLUST engaged the municipal council and staff to identify features they valued on the landscape. Each feature was scored by stakeholders to determine each features conflict with wind and solar energy development. The most suitable areas for renewable energy development coincided with low probable conflict rating of other land uses. Renewable energy development suitability areas were also informed by removing No-Go Areas based on provincial, municipal and organizational regulations and Non-Development Areas based on existing settlement and Infrastructure.

The MLUST process identified 7.7% of the Municipal District of Pincher Creek, or 66,719 acres (270 km^2) as most suitable areas for wind energy development. MLUST identified 5.6% of the Municipal District of Pincher Creek, or 48,680 acres (197 km^2) as most suitable areas for solar energy development.

Here, we summarize the MLUST process that resulted in the identification of wind and solar energy development suitability areas in the Municipal District of Pincher Creek.

Where can renewable energy be developed?

To determine where wind and solar energy developments are suitable we considered resource availability, No-Go Areas as per regulations and Non-Development Areas due to existing settlement and infrastructure. The resources (wind speed and solar radiation) were deemed sufficient throughout the municipality in all calculations, although there are likely areas where wind speed and solar radiation are not optimal.

Removal of No-Go Areas and Settlement and Infrastructure from the land base resulted in 34% (wind) and 28% (solar) of the landscape identified as suitable for renewable

energy development. As a next step we considered the land base suitable for wind and solar energy development in consideration of other land uses.

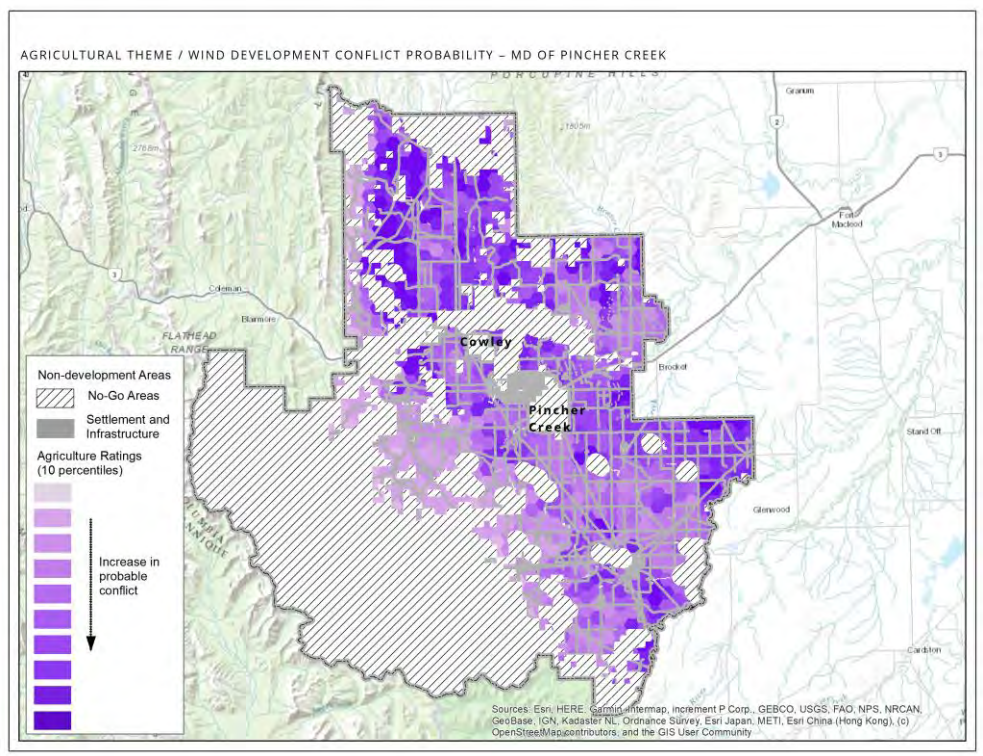
What other land uses did we value?

WE VALUED AGRICULTURE

Municipal stakeholders identified the highest valued lands from an agricultural perspective. They identified three agricultural features (listed in table below) and provided a Conflict Probability Rating based on values from 0 to 100; where higher values equate to a high agriculture value. Once agricultural features were assigned a Conflict Probability Rating, all 3 features were converted into a grid roughly the size of a section, then overlaid and the maximum value was assigned to produce an Agricultural Conflict Probability Rating Map for both wind and solar.

Agricultural Feature	Conflict Probability Rating (Wind)	Conflict Probability Rating (Solar)
1. Grazing Lands		
Native prairie	83	85
Tame pasture	60	70
2. Land Suitability Rating System (alfalfa, canola, spring grains and brome)		
LSRS Class 1: slight limitations to growth	68	78
LSRS Class 2: moderate limitations to growth	58	68
LSRS Class 3: severe limitations to growth	44	45
LSRS Class 4: very severe limitations to growth	38	33
3. Agricultural support		
Agri-business *	73	68
Agri-community *	68	65

*represent data gaps, features not represented on the map



Agricultural Conflict Probability Rating Map for wind energy development (as the purple colour darkens there is an increasing conflict with agricultural values). Maps to represent the Agricultural Conflict Probability Rating for solar can be found in full report.

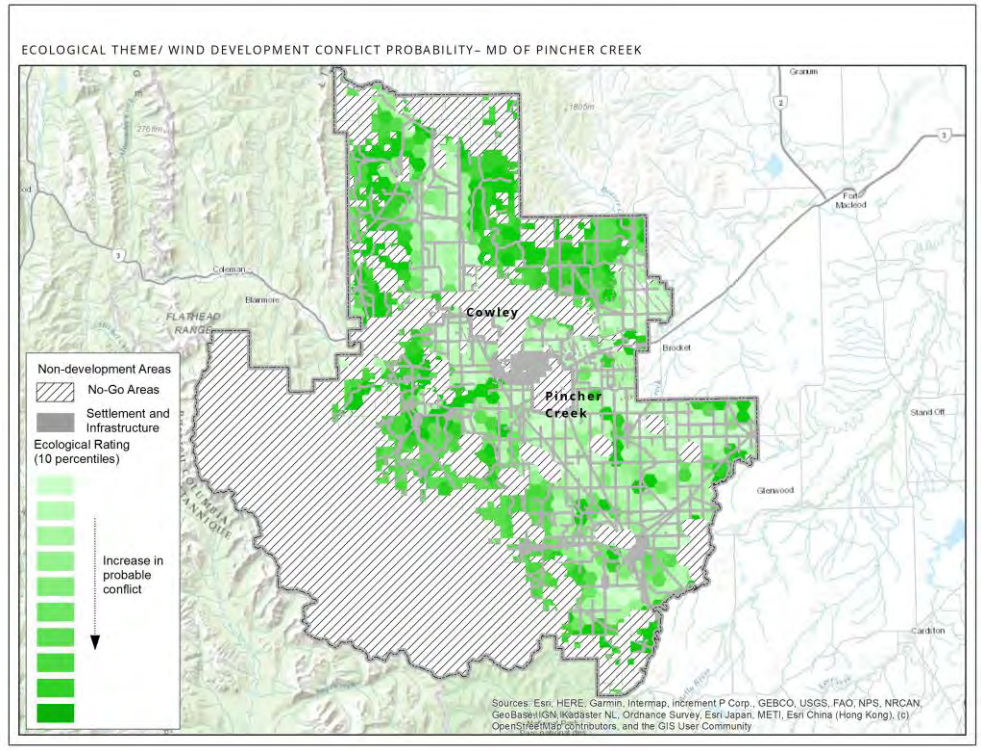
WE VALUED ECOSYSTEMS

Municipal stakeholders identified the highest valued lands from an ecological perspective. They identified five ecological features (listed in table below) and provided a Conflict Probability Rating based on values from 0 to 100; where higher values equate to a high ecological value. Once ecological features were assigned a Conflict Probability Rating, all 5 features were converted into a grid roughly the size of a section, then overlaid and the maximum value was assigned to produce an Ecological Conflict Probability Rating Map for both wind and solar.

Ecological Theme Features	Conflict Probability Rating (Wind)	Conflict Probability Rating (Solar)
1. Protected Areas		
Conservation easement	81	80
Private land owned for conservation	81	75
2. Wildlife Habitat		
Grizzly bear zones	68	83
Key wildlife and biodiversity zone	78	73

Ecological Theme Features	Conflict Probability Rating (Wind)	Conflict Probability Rating (Solar)
Native prairie	83	85
Riparian	85	85
Escarpment and coulees	75	80
3. Waterways		
Rivers	100	100
Streams and creeks	100	100
4. Waterbodies		
Un-named lake	75	78
Ground water aquifer re-charge*	75	78
5. Wetlands		
Group 1: area of wetland in section very high	100	100
Group 2: area of wetland within section high	75	75
Group 3: area of wetland in section medium	50	50
Group 4: area of wetland in section low	25	25
Group 5: area of wetland in section very low	0	0

*represent data gaps, features not represented on the map

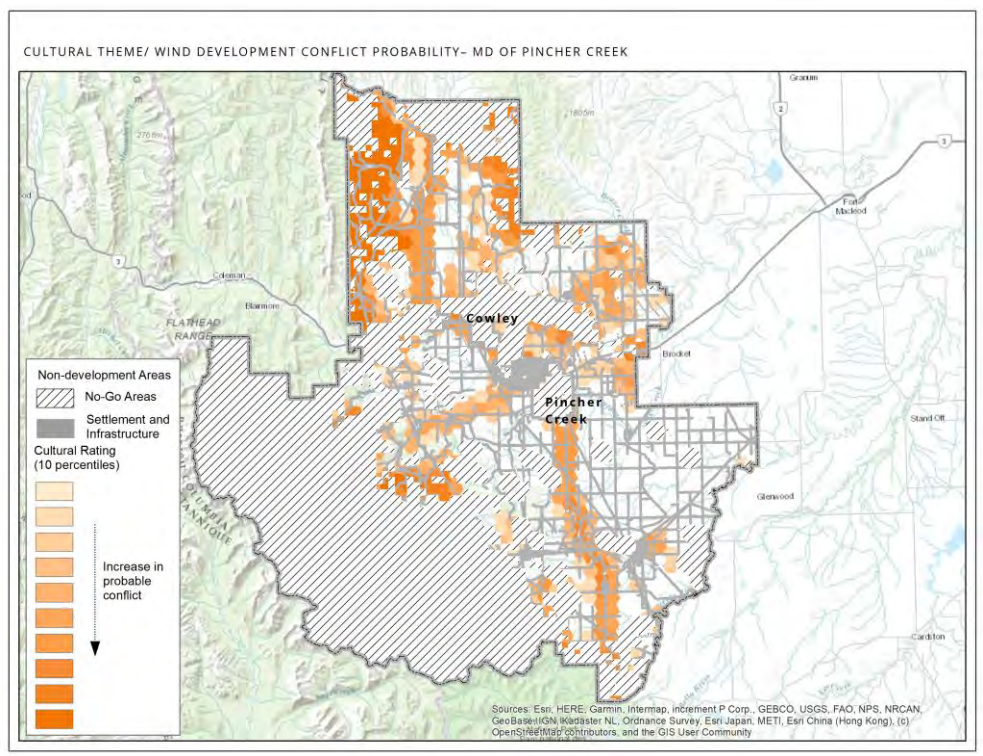


Ecological Conflict Probability Rating Map for wind energy development (as the green colour darkens there is an increasing conflict with ecological values). Maps to represent the Ecological Conflict Probability Rating for solar can be found in full report.

WE VALUED CULTURE

Municipal stakeholders identified the highest valued lands from a cultural perspective. They identified eleven scenic features and two historic resource classes (listed in table below) and provided a Conflict Probability Rating based on values from 0 to 100; where higher values equate to a high cultural value. Once cultural features were assigned a Conflict Probability Rating, all 13 features were converted into a grid roughly the size of a section, then overlaid and the maximum value was assigned to produce a Cultural Conflict Probability Rating Map for both wind and solar.

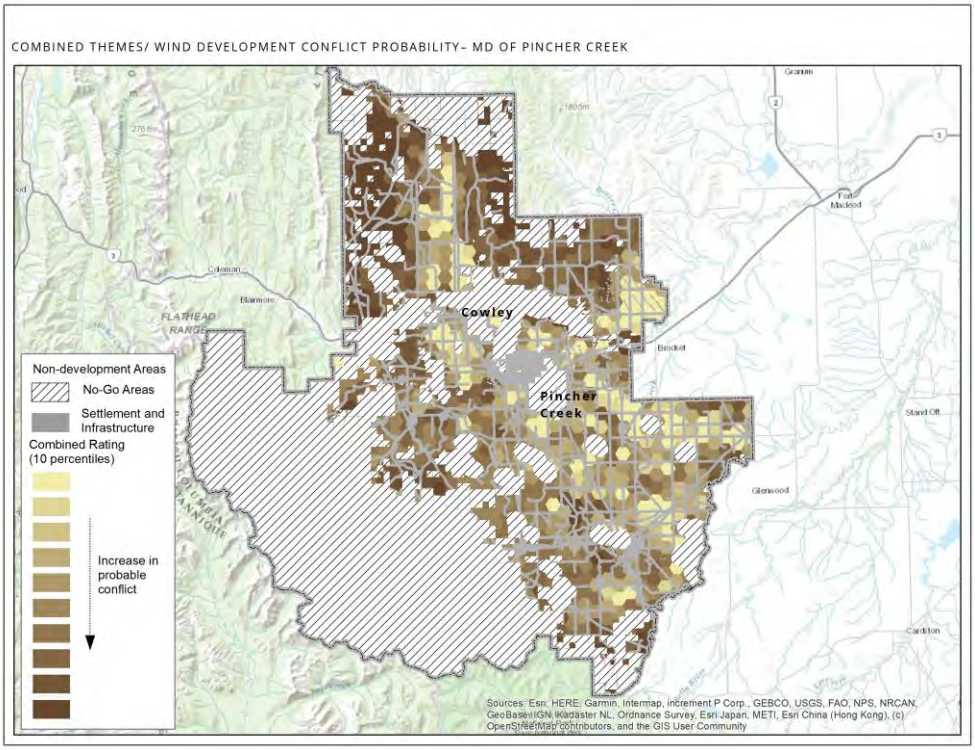
Cultural Feature	Conflict Probability Rating (Wind)	Feature Buffer (m) (Wind)	Conflict Probability Rating (Solar)	Feature Buffer (m) (Solar)
Scenic Resources				
Cowboy Trail	53	1000	60	1000
Waterton Lakes National Park	69	1500	60	1000
Hawks Nest	47	1000	50	1000
Porcupine Hills	66	1000	63	1000
DU Cabin	66	1000	60	1000
Beaver Mines Coal Mining Rail	34	500	40	500
Oldman Dam Stone House	44	500	40	500
West Castle Valley	53	1000	60	1000
Livingston Range	78	1500	63	1000
Heritage Acres	41	500	48	500
Historical Resource Value				
HRV class 3: contains a significant historic resource that will likely require avoidance	83	n/a	75	n/a
HRV class 4: contains a historic resource that may require avoidance	70	n/a	55	n/a



Cultural Conflict Probability Rating Map for wind energy development (as the orange colour darkens there is an increasing conflict with cultural value). Maps to represent the Cultural Conflict Probability Rating for solar can be found in full report.

Combining values……

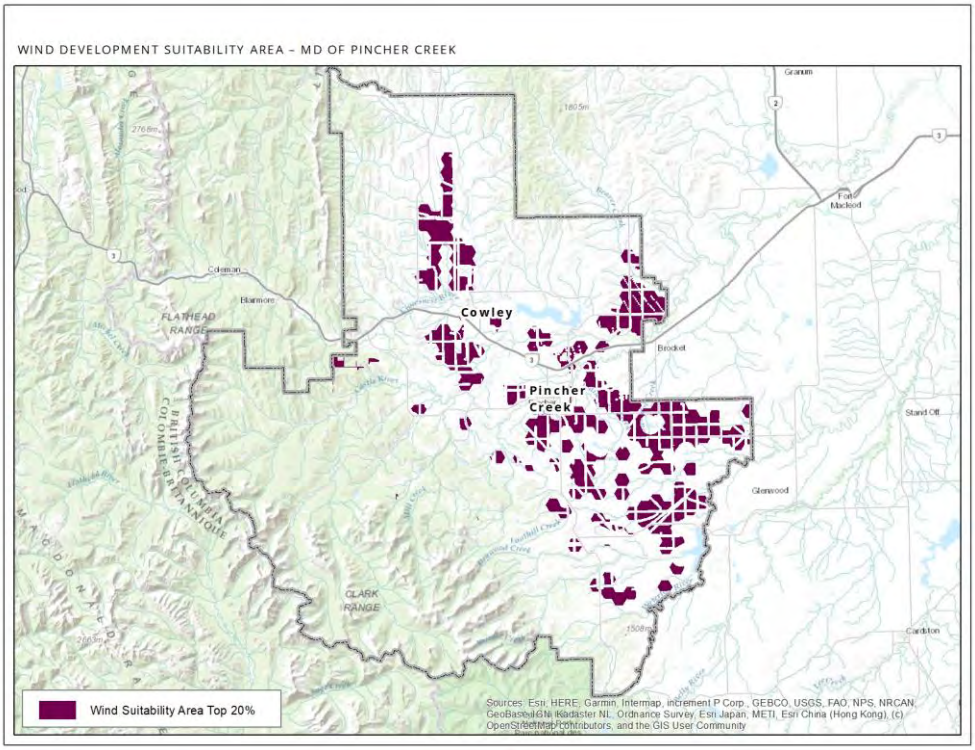
A combined map was developed by overlaying and summing the agricultural, ecological, and cultural Conflict Probability Rating maps. This approach highlighted areas of mutual high Conflict Probability Ratings and identifies on the landscape where renewable energy development may be less suitable.



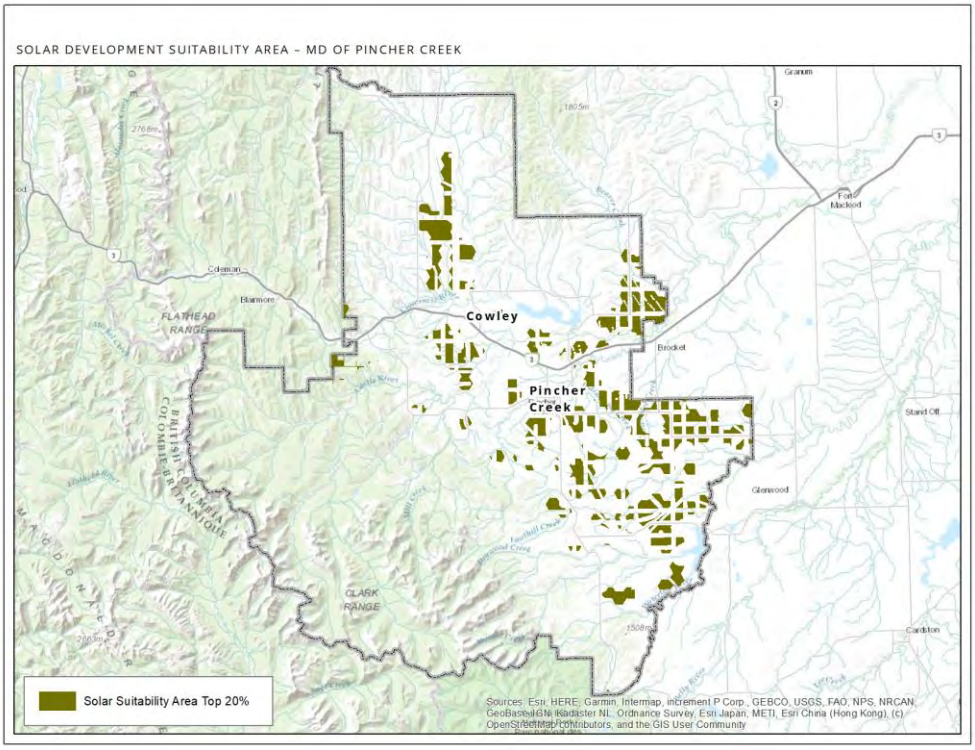
Composite Conflict Probability Rating Map for wind energy development (as the brown colour darkens there is an increasing conflict with other land uses). Map to represent the Combined Conflict Probability Rating for solar can be found in full report.

Most suitable areas for wind and solar energy development

Lastly, to identify the most suitable areas for wind and solar energy development, we used the inverse of the Combined Conflict Probability Rating Maps. On the maps below we highlight the lands that were identified as the most suitable (top 20%) for wind energy development (dark purple) and the lands most suitable (top 20%) for solar energy development (dark yellow). Municipal representatives with assistance from ORRSC can adjust the suitability level to encompass more or less land.



MLUST identified 7.7% of the M.D. of Pincher Creek, or 66,719 acres (270 km^2) as most suitable areas for wind energy development (displayed as dark purple).



MLUST identified 5.6% of the M.D. of Pincher Creek, or 48,680 acres (197 km^2) as most suitable areas for solar energy development (displayed as dark yellow).

Introduction

When municipal governments consider industrial scale solar or wind energy development, it immediately becomes clear that not everywhere is suitable for those activities, and not everywhere is unsuitable. For some areas it is a clear-cut 'yes' or 'no', but most areas sit somewhere on a continuum between those two extremes.

The Miistakis Institute and the Oldman River Regional Services Commission (ORRSC) developed the Municipal Land Use Suitability Tool (MLUST) to assist the Municipal District of Pincher Creek in identifying where renewable energy development is most suitable in consideration of high valued agricultural, ecological and cultural lands.

Background of Process

In 2018, the Miistakis Institute partnered with the County of Newell and Wheatland County, to develop a Least Conflict Lands (LCL) Decision Support Tool to inform sighting for renewable energy development. The LCL process and decision support tool was modeled after the Least Conflict Lands for Solar PV development in the San Joaquin Valley of California developed by Conservation Biology Institute, UC Berkeley School of Law, and Terrell Watt Planning Consultants[1]. The process was rapid (6 months) and resulted in a municipal scale, non-regulatory planning tool that could be used by municipalities facing renewable energy development interest.

In the County of Newell and Wheatland County this process aimed to identify areas for utility scale wind and solar energy developments while avoiding important agricultural, ecological, and cultural/scenic resources at a municipal scale. The process engaged 37 stakeholders including representatives from municipal staff and council, provincial government, irrigation districts and NGO's. The process resulted in a series of spatial models that identified conflict probability for the three land use themes: agricultural, ecological, and cultural/scenic resources[2]. In addition, industry identified suitability areas for wind and solar energy development. The resulting spatial models[3] identify areas of lowest ecological, agricultural and cultural/scenic Conflict Probability Rating, showing where in the municipality wind/solar energy development would be best suited (most compatible) with existing land use values.

[1] https://consbio.org/products/projects/san-joaquin-valley-planning
[2] (https://www.rockies.ca/project_info/MIR_LCL_Report_FINAL.pdf).
[3] https://databasin.org/galleries/56f3b57fa8e74f61b884e5f8c9943102

Upon completion of the LCL process, Miistakis partnered with ORRSC to identify improvements to the process and expansion of the tool to other rural municipalities in Alberta. ORRSC (municipal planning specialists) is well positioned to deliver MLUST as planners in southern Alberta. Improvements included expansion of the tool to consider other development types, clarity on function of feature within each theme, addition of a new settlement and infrastructure theme, adjustment of the engagement process to reduce time and focus on municipal council and staff and rebranding of the LCL decision support process and tool to MLUST.

Project Constraints

Decision Support

It is important to remember that the Municipal Land Use Suitability Tool (MLUST) is a decision-*support* tool, not a decision-*making* tool. The tool shows decision makers the relative suitability of various parts of the municipality for utility scale wind and/or solar energy development, but it is not appropriate for parcel level decisions.

The local government's final decision has two other critical mechanisms.

First, municipal councilors must incorporate numerous other factors (economic development priorities, landowner attitudes, costs to the municipality, etc.) when they make their decision. The MLUST tool aids this by identifying which areas might be more or less appropriate for this type of development.

Second, MLUST is a planning tool, but actual decisions about a specific wind or solar installation have many other considerations. Not the least of these is the specific development and building permits that would be needed, based on site-specific analyses, assessments, and approvals. The MLUST tool should never be construed as providing this site-specific direction.

Scale of Use

The 'scale' of the MLUST's applicability illustrates this well. The outputs of the MLUST process can be used to support development of statutory plans at two scales:

- the Municipal Development Plan (giving high-level indications of priorities, municipality-wide maps), or
- the Area Structure Plan (supporting board intentions for the type and general location of different types of development).

Spatial modeling

MLUST results in map products that represent low conflict areas for agriculture, ecological and cultural themes based on scoring of many different landscape features.

The process is dependent on the availability and accuracy of spatial data used to represent each feature. Sometimes features cannot be easily represented spatially and are therefore not included in the modeling.

Process Overview

The lead organizations, Miistakis Institute and ORRSC provided, managed and facilitated the MLUST process for the Municipal District of Pincher Creek. This included providing support and guidance to the Municipal District of Pincher Creek as they move through the steps of the process. Miistakis ran the GIS modelling.

Municipal stakeholders included all council representatives, and municipal staff members including CAO, Manager of planning, Environment and Agriculture Reps.; they participated in the engagement portions of the process, including two webinars, one survey per development type and a workshop.

A seven step process is used to create the Municipal Land Use Suitability Tool (Figure 1). There are many terms used during the MLUST process, to help you navigate the language and process, terms are defined below:

Conflict Probability Rating – A derived score indicating an estimated likelihood that the proposed development (wind or solar) will come into conflict with an identified land use value.

Quantification – The process of converting the qualitative scores (very low, low, medium, high, very high) to quantitative scores (0-100), such that they can be incorporated into the modelling.

Land Use Theme – The three high-level categories of land use incorporated into the MLUST process and modelling: Agricultural, Ecological, and Cultural/Scenic. Each theme is broken down further into 'Features.'

Feature – A subset of any of the three overarching land use Themes, used to break each Theme down into manageable, measurable land use values, and created to allow users to score different facets of a land use Theme.

No-Go Area – An area with a prohibition or restriction for wind and/or solar energy development due to an existing policy or regulatory constraint.

Scoring – The participant exercise of indicating if a given Feature was of value (very low, low, medium, high, very high) relative to the development type, indicating an inverse likelihood of compatibility.

Suitability Map – The ultimate product of the MLUST process, and the inverse of the Conflict Probability maps, showing where in the municipality wind/solar energy development would be best suited (most compatible) with existing land use values.

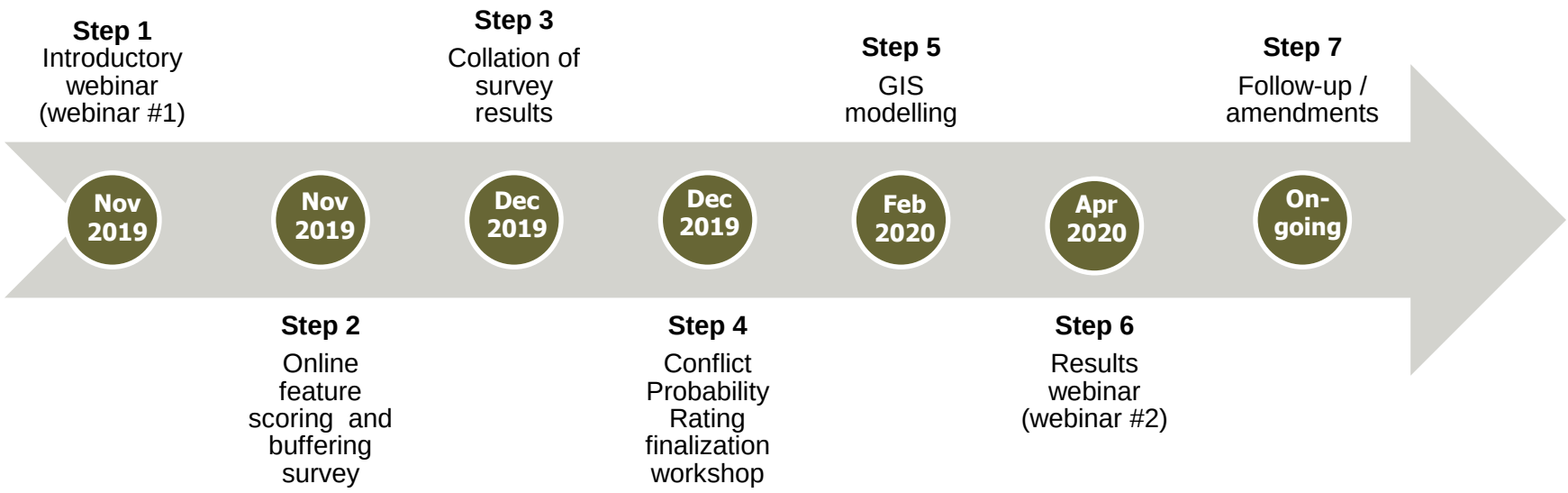


Figure 1: Process Timeline

The following outlines activities within each step:

Step 1: Introductory webinar (webinar #1) (START of process)

- Overview of the tool
- Walk-thru of the steps
- Theme/feature introduction

Step 2: Online feature scoring and buffering exercise

- Individual exercise completed by municipal participants 'Survey-style' exercise completed online
- Feature scoring and buffering of appropriate features for each land use theme

Step 3: Collation of survey results

- Completed by lead organization
- Integrated applicable development regulations and setbacks
- Quantified scores to create a Conflict Probability Rating for features
- Looked for areas of agreement / disagreement in survey results
- Designed in-person workshop based on survey results

Step 4: Conflict Probability Rating finalization workshop

- In-person workshop with municipal participants, held at the Municipal District of Pincher Creek Municipal Office on December 12, 2019
- Worked through all areas of variation to come to consensus

Step 5: GIS (Geographic Information System) modeling

- Lead organization undertook modelling exercise to convert Conflict Probability Rating into maps
- One map for each theme showing Combined Conflict Probability Rating, and one overall Suitability Map, which is the inverse of the Combined Conflict Probability Rating Maps, showing where in the Municipal District of Pincher Creek wind and solar energy development would be best suited (most compatible) with existing land use values.

Step 6: Results webinar (webinar #2)

- Lead organization presented the results of the modelling
- Modelling results were provided back at the scale of an MDP and the scale of an ASP
- Modelling results were provided with several thresholds ("deciles")

Step 7: Follow up / amendments

- A copy of all underlying materials was kept by the Municipal District of Pincher Creek, ORRSC, and the lead organization

- When changes are needed in the future (new data, changes in assumptions, new types of development), ORRSC will be able to support the changes

Modeling Overview

MLUST results in a series of map products, including Conflict Probability Rating maps for agricultural, ecological and cultural theme areas. Together these maps are combined to create Combined Conflict Probability Rating Map. To create the Suitability Maps for wind and solar energy development, No-Go areas and the Settlement and Infrastructure theme were combined and extracted from the Combined Conflict Probability Rating Map. Creating the maps required several steps to be performed in sequential order; the process is outlined in Figure 2.

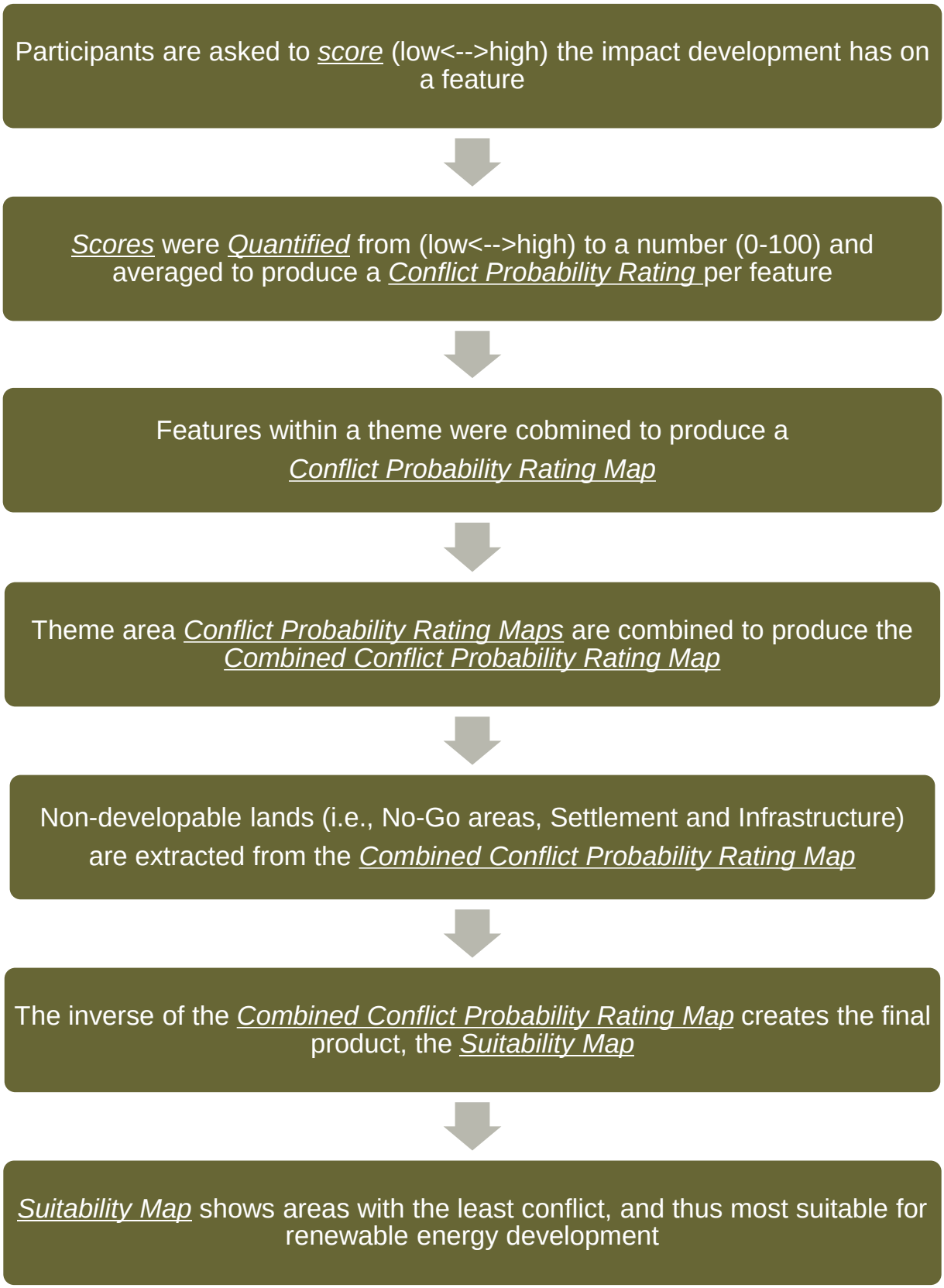


Figure 2: Conflict Probability Rating Process

Selection of Land Use Themes and Features

Themes were selected by the lead organization to represent all the land uses that may occur within the Municipal District of Pincher Creek, which may come into conflict with renewable energy development. During the first webinar participants were provided with a list of land use themes (Agricultural, Ecological, Cultural and Settlement and Infrastructure), and specific features within those theme areas. At the workshop, participants were provided with additional information for each theme and feature (Appendix A), including:

- Examples/further explanation for each feature,
- A list of available spatial layers relevant to that feature
- Renewable energy regulatory notes (if applicable)

As a first step at the workshop, all theme areas and features were confirmed with Municipal District of Pincher Creek participants with the exception of amendments made to the features included in the cultural theme area. A follow-up survey allowed for scoring and buffering of these amended features.

Feature Scoring and Buffering

Participants scored land use features within each theme through an online survey using *Survey Monkey* (https://www.surveymonkey.com/). Please see Appendix B: Solar Survey Exercise, for an example of the survey questions used. Similar questions were developed for the wind survey exercise.

Features were scored for their compatibility to wind or solar energy development, whereby very high scores represent very high conflict with wind and solar development.

No-Go areas based on provincial regulation, municipal policy, industrial or private restrictions were not scored but were included in the modeling.

In order to produce a model and results, several types of information were collected from the survey. For the cultural theme area, participants were asked to list features of cultural importance. These were then discussed at the workshop and scored in a follow-up survey.

In the settlement and Infrastructure theme participants were asked if a buffer should be applied to the footprint of the feature, and to select the size of the buffer (e.g., 50m, 100m, 1km). Buffers were selected by averaging the distances provided by participants, and then selecting the closest hundredth or thousandths place.

QUANTIFICATION OF THE SCORE

Each participant provided a qualitative score for features to indicate if a given feature was of value (very low, low, medium, high, very high) relative to the development type,

indicating an inverse likelihood of compatibility. If there was strong agreement of scores between participants (threshold of 60%), the score was quantified to a number as shown in Table 1, where 100 represent very high and the highest score

Table 1: Land use feature score and numerical quantification

Land Use Feature Score	Numerical Quantification
very high	100
high	75
medium	50
low	25
very low	0
do not include	0

If there was a less agreement between participants on scores (less than 60% threshold) scores were averaged across all participants equally to create a Conflict Probability Rating for that feature relative to wind and solar energy development. Conflict Probability Ratings at the high end would indicate a higher probability of wind / solar energy development coming into conflict with that land use, while scores at the lower end would indicate a low probability of conflict.

Bubble charts were used as a visual aid. For example Figure 3, shows a bubble chart for native prairie in the Agricultural theme, where 56% of the people scored this feature very high, 22% high and 22% medium. In the bubble charts, the **placement** of each circle (aligned with the scores from *Very Low* to *Very High*) and the **size** of the circle represents how many people chose each answer (bigger circles = more people). The **red line** represents the Conflict Probability Rating (average score) that was used for this feature in the GIS modelling in the native prairie example the average score was 83.

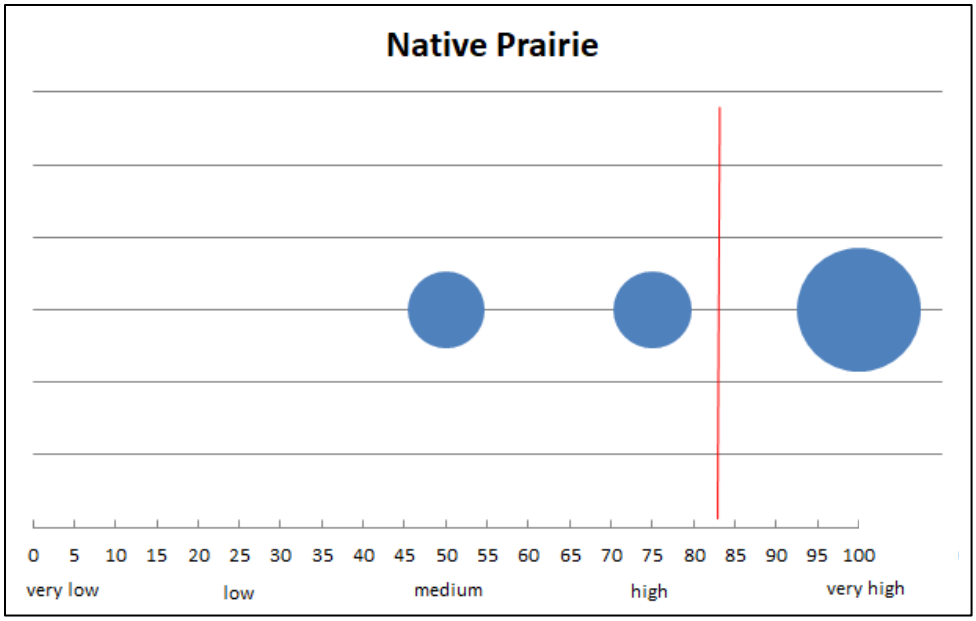


Figure 3: Native Prairie grazing value for Wind (Agricultural theme). Red line represents the Conflict Probability Rating of 83 (average score).

When discussing the features that had a low level of agreement (less than 60%) participants were asked:

- Do you have a different understanding since the survey? (of the issue or the context)
- Do you feel strongly about your answer?
- Is there something that others are not aware of?
- Do you want to change your answer

Following discussion on features with lower agreement in scores workshop participants were able to change their responses.

Modelling Process

To understand where land is suitable for wind and solar energy development, areas regulated as No-Go Areas by provincial, municipal and organizational policies and, Settlement and Infrastructure features' footprints and associated buffers were mapped. These areas are removed from the land base as they are not suitable for renewable energy development.

For the agricultural, ecological and cultural theme each feature was *scored* by participant (low <--> high potential for conflict), *quantified* (converted to '0 <--> 100'), and then *averaged* (across all participants) to create a Conflict Probability Rating for that feature relative to wind and solar energy development. A high Conflict Probability Rating indicates a higher probability of wind and solar energy development coming into

conflict with that land use, while ratings at the lower end indicate a low probability of conflict.

To map this, the Municipal District of Pincher Creek was first partitioned into equal-sized hexagons (equivalent to approximately 1 section each). Each feature was applied to the hexagon grid based on area occurring in the hexagon and its assigned wind/solar Conflict Probability Rating. To represent the entire theme for a given hexagon, the maximum value of that theme's underlying features was selected (taking the maximum value prevented double counting of features within the theme). Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

The Agricultural, Ecological, and Cultural Conflict Probability Rating Maps were combined to create a Combined Conflict Probability Rating Map. We extracted the Non-development Areas (based on No-Go Areas and Settlement and Infrastructure) from the combined Conflict Probability Ratings Map to produce wind and solar Suitability Maps. The wind and solar Suitability Maps, identify where in the Municipal District of Pincher Creek wind/solar energy development would be best suited (most compatible) with existing land use values.

Results

Here we present results of the process to identify Suitability Maps for solar and wind energy development in the Municipal District of Pincher Creek.

Where Can Renewable Energy Development Go?

To understand where there is Suitability for wind and solar energy development in the Municipal District of Pincher Creek we first assessed the resource availability as well as regulations that prohibit renewable energy development, documented as No-Go Areas. We also removed the Settlement and Infrastructure theme features as these are also Non-development Areas due to existing development.

When assessing the wind and solar resource availability for solar, it was acknowledged that solar radiation is higher in the eastern portion of Municipal District of Pincher Creek but no limits were placed on potential suitability for solar energy development. For wind, we mapped wind speeds less than 3m/sec as areas that may be less optimal for wind (Figure 4), although these areas were not removed from the potential renewable energy development areas or suitability areas in the final map products. The freely available wind speed data was developed at a national scale and may not accurately reflect conditions on the ground. The wind industry may find areas within these less

optimal wind speed areas where wind speeds can support wind energy development. In addition technological changes in wind turbines may further reduce the wind speed thresholds that are appropriate for wind energy development.

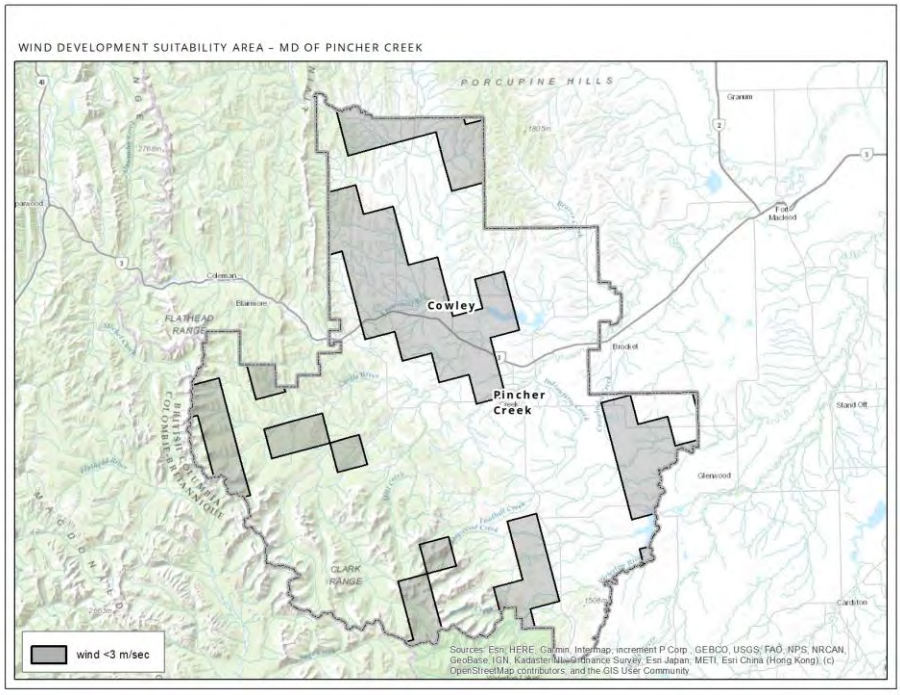


Figure 4: Areas of wind speed less than 3m/sec

Wind and Solar No-Go Areas

For wind and solar energy development the following No-Go Areas are presented in Table 2, based on regulations/policy (provincial, municipal and organizational policies). To map these areas, we merged spatial files representing each feature to develop a No-Go Area map for wind (Figure 5) and solar (Figure 6).

Table 2: No-Go Areas in Pincher Creek

No-go Feature	Regulation
Provincial Protected Areas	AEP Wind/Solar Directives
Municipal Parks and Open Space	Municipal Development Plan
Crown land	AEP Wind/Solar Directives
SALTS/NCC conservation lands	Organization Policy No Wind/Solar
Trumpeter Swans water and 800m buffer	AEP Wind/Solar Directives
Mountain Goat and Sheep Zones	AEP Wind/Solar Directives
Named Lakes and 1000m buffer	AEP Wind/Solar Directives

No-go Feature	Regulation
Historic Resource Value 1-2	Alberta Tourism and Culture
Burmis Lundbreck Corridor ASP	Municipal Statutory Plan for wind
Oldman Reservoir ASP (some parcels)	Municipal Statutory Plan for wind
Pincher Creek town with one QS boundary	Intermunicipal Development Plan (IDP) and land Use bylaw
Cowley town with one QS boundary	Intermunicipal Development Plan (IDP) and land Use bylaw

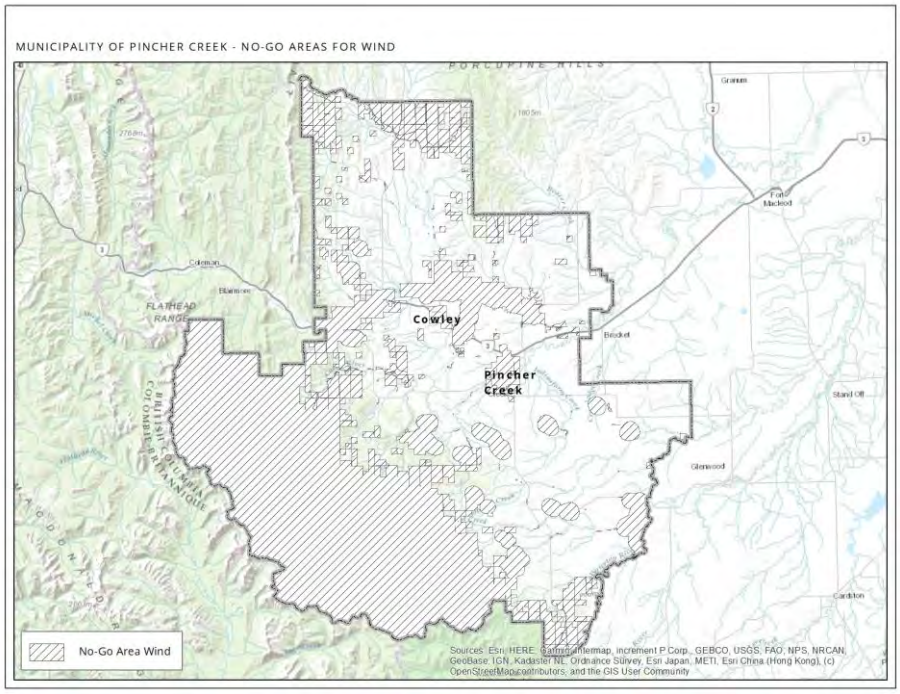


Figure 5: No-Go Areas in the Municipal District of Pincher Creek for wind energy development based on regulations/policy (provincial, municipal and organizational policies)

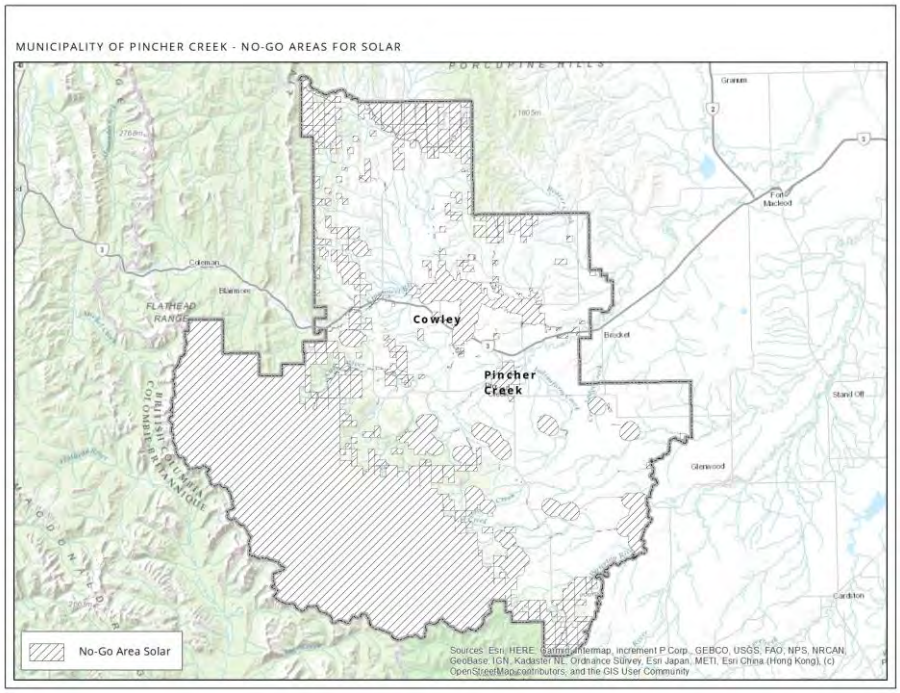


Figure 6: No-Go Areas in the Municipal District of Pincher Creek for solar energy development based on regulations/policy (provincial, municipal and organizational policies)

Settlement and Infrastructure Non-Development Areas

The Settlement and Infrastructure Theme represents Non-development Areas within the Municipal District of Pincher Creek. Each feature was given a buffer based on either a generated average from participant surveys (Table 3, survey results in Appendix C and D) or by-laws. For example for transmission lines, windmills, gravel roads, paved roads and railway lines we applied a buffer representing the tallest tower height in Municipal District of Pincher Creek (162.5m) plus 10% (179 m) for wind.

To map these features, we merged spatial files representing each feature with their appropriate buffer to develop a Settlement and Infrastructure Theme Non-development Areas map for both wind (Figure 7) and solar (Figure 8).

Table 3: Settlement and Infrastructure features, and designated buffers (m) (* represent data gaps, these features are not represented on the maps)

Settlement and Infrastructure	Feature Buffer (Wind)	Feature Buffer (Solar)
1. Rural residential		
Group Country residential	500	1000
Hamlets	500	1000
2. Rural Commercial (Non-Agricultural)		
Commercial establishment and subdivision	200	500
3. Rural industrial (non-agricultural)		

Settlement and Infrastructure	Feature Buffer (Wind)	Feature Buffer (Solar)
Solar Farm*	300	300
Wind farm (wind mills)	179	179
Transmission	179	No buffer
Oil and gas processing plant	300	300
Mineral extraction*	300	100
Processing plant*	300	300
Landfill	no buffer	300
4. Transportation		
Divided highway	300	300
Paved road	179	300
Gravel road	179	300
Airport	2000	1000
Airfields	365	1000
Railway	179	300
5. Water management		
Reservoir	no buffer	300
Treatment Plant	no buffer	no buffer

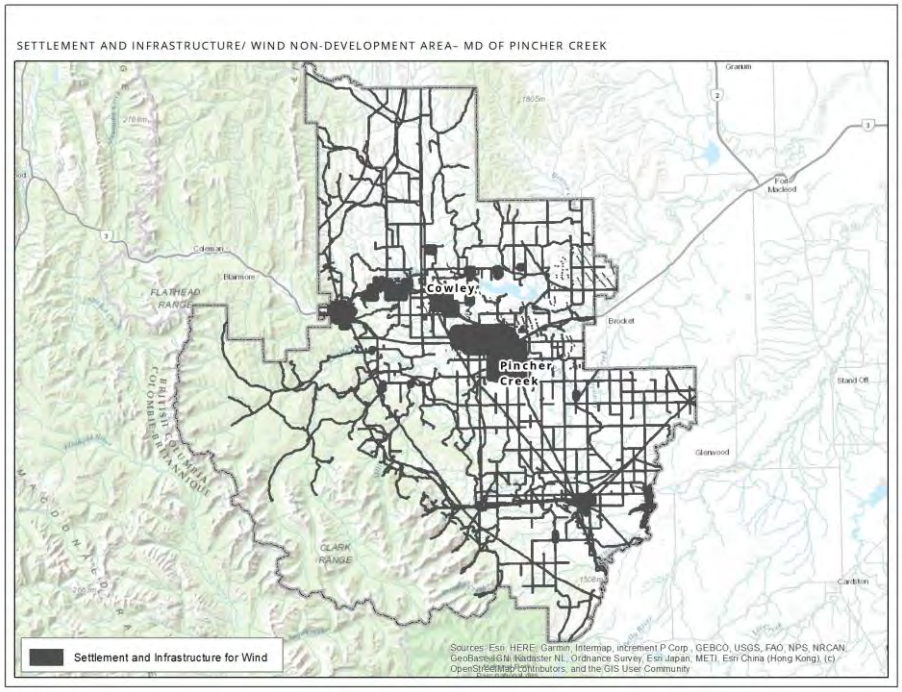


Figure 7: Settlement and Infrastructure Non-development Areas (Wind Development)

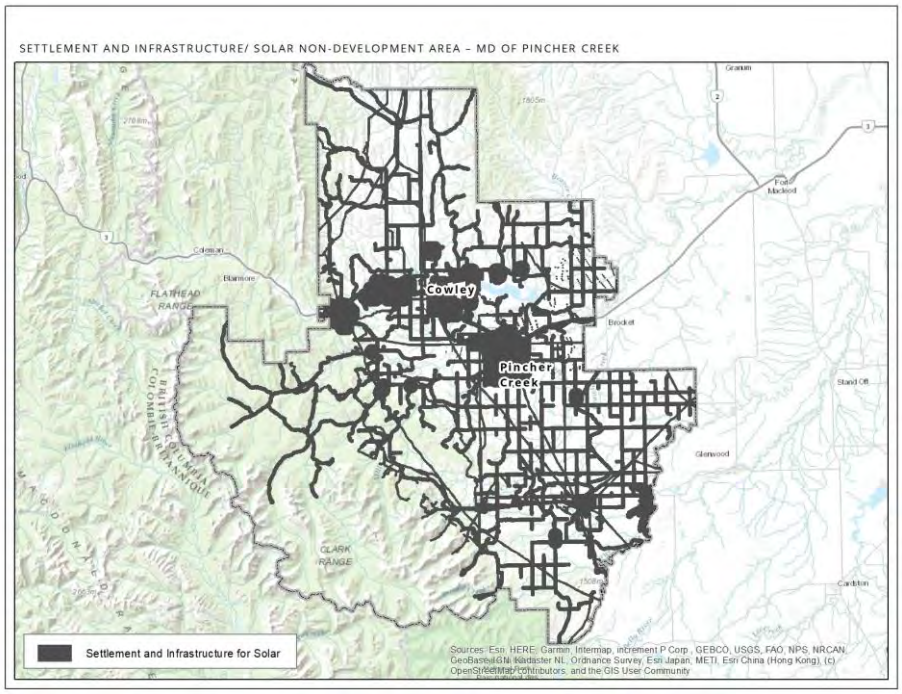


Figure 8: Settlement and Infrastructure Non-development Areas (Solar Energy Development)

Potential Areas for Renewable Energy Development

Using the No-Go Areas and Non-development Areas from Settlement and Infrastructure we determined that **34% (wind)** and **28% (solar)** of the landscape has the potential to support renewable energy development, as seen in Figure 9 and Figure 10 respectively. Although this creates a first step in understanding where renewable energy development is suitable it does not consider renewable energy development in relation to other land uses, such as agricultural, ecological and cultural values.

Based on this assessment within the Municipal District of Pincher Creek, 66%, or 571,308 acres (2312 km^2), are not suitable wind energy development and 72%, or 623,446 acres (2523 km^2), are not suitable for solar energy development.

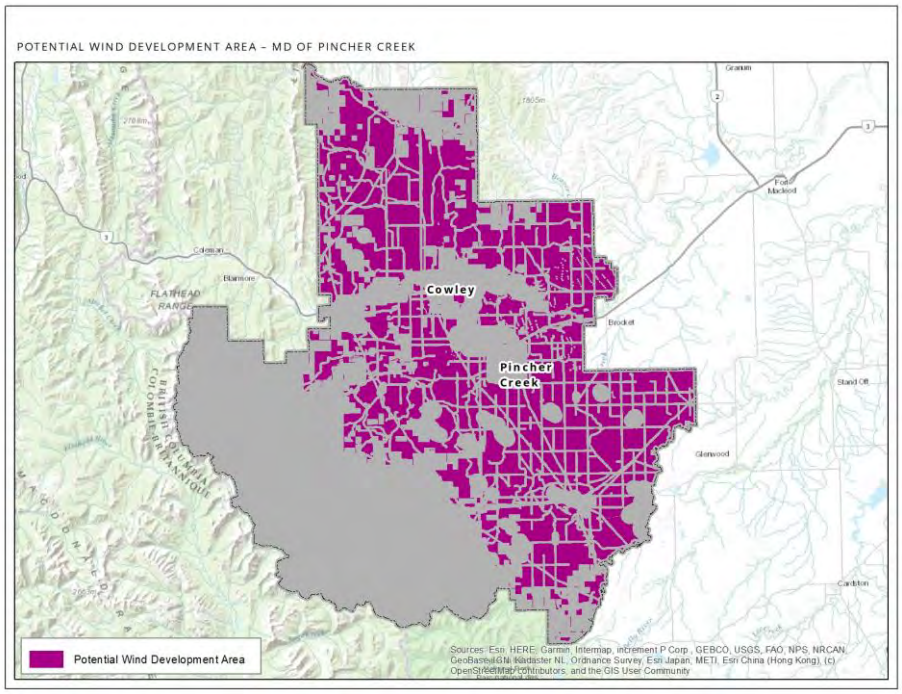


Figure 9: Potential land base for wind energy development

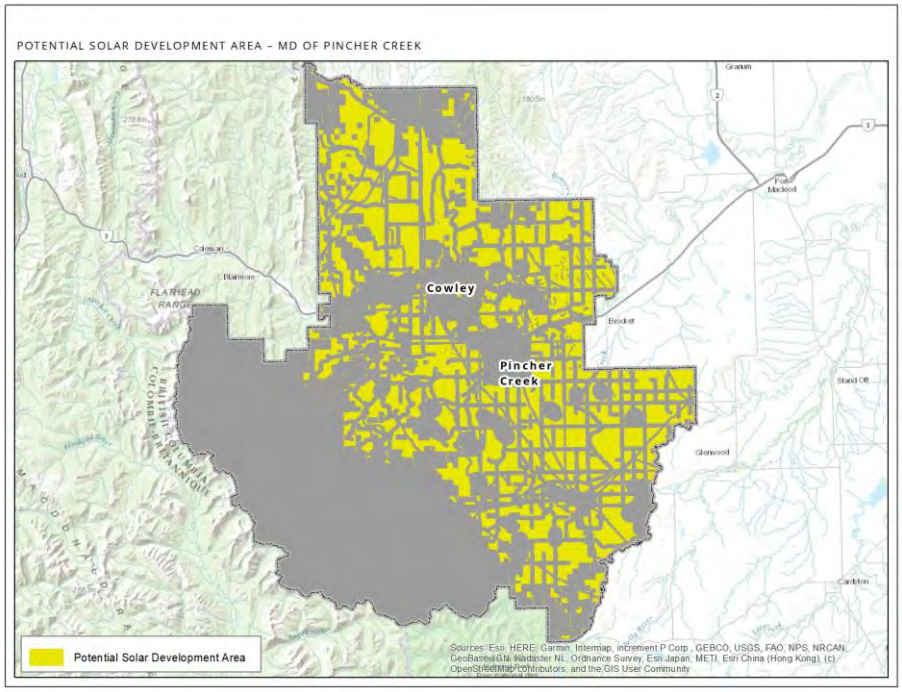


Figure 10: Potential land base for solar energy development

What Other Land Uses Did We Value?

Agricultural Theme

The features within the Agricultural Theme are listed in Table 4, with their Conflict Probability Rating relative to wind and solar energy development (survey results in Appendix C and D respectively)[4]. Features included in the modeling – Grazing Lands and Agricultural Land Suitability Rating System – are represented spatially in Appendix E.

Figure 11 and Figure 12 highlight the Agricultural Theme Conflict Probability Map for wind and solar energy development respectively with No-Go Areas removed.

Table 4: Agricultural Theme Features and Conflict Probability Ratings (*represent data gaps, features not represented on the map)

Agricultural Theme Features	Conflict Probability Rating (Wind)	Conflict Probability Rating (Solar)
1. Grazing Lands		
Native prairie	83	85
Tame pasture	60	70
2. Land Suitability Rating System (alfalfa, canola, spring grains and brome)		
LSRS Class 1: slight limitations to growth	68	78
LSRS Class 2: moderate limitations to growth	58	68
LSRS Class 3: severe limitations to growth	44	45
LSRS Class 4: very severe limitations to growth	38	33
3. Agricultural support		
Agri-business *	73	68
Agri-community *	68	65

[4] Agri-buisness and Agri-community represent a data gap for data and were not included in modeling.

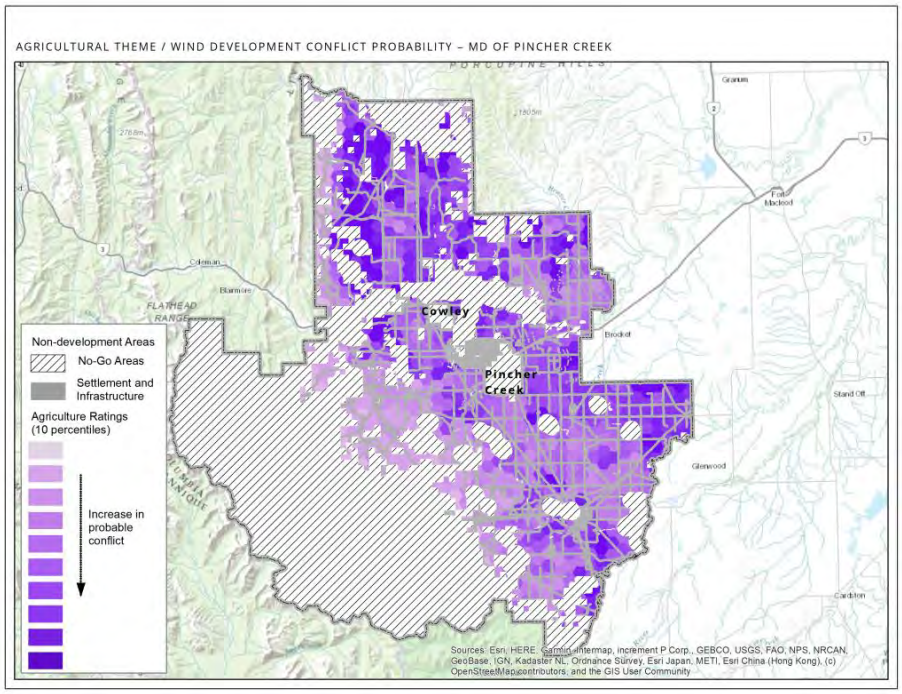


Figure 11: Agricultural Theme Conflict Probability (Wind Energy Development) with No-Go Areas displayed in white with black harsh marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

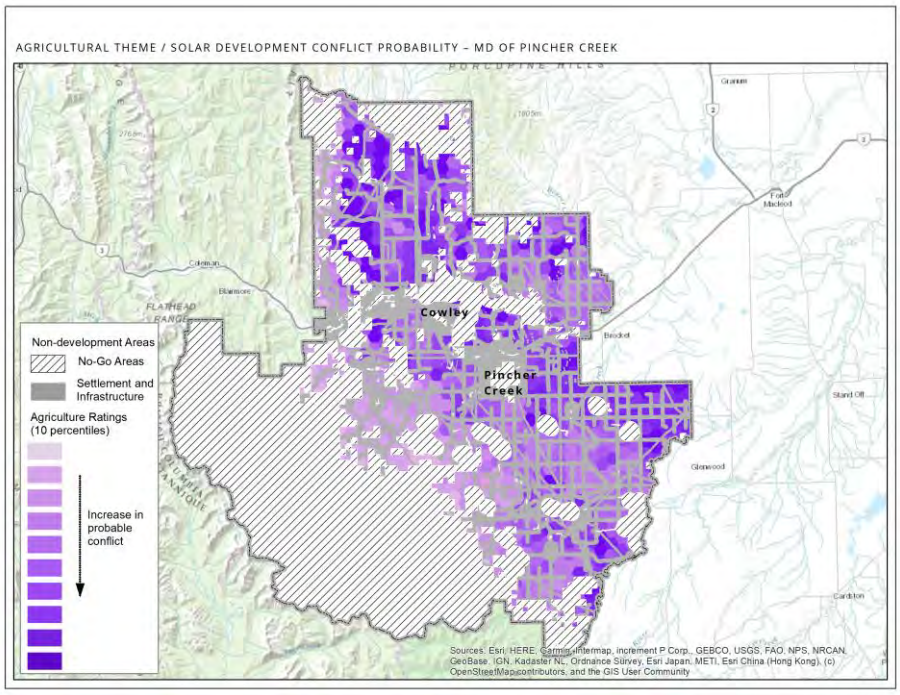


Figure 12: Agricultural Theme Conflict Probability (Solar Energy Development) with No-Go Areas displayed in white with black hash marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

Ecological Theme

The features within the Ecological Theme are listed in Table 5, with their Conflict Probability Rating relative to wind and solar energy development[5]. Many Ecological Theme features represent No-Go Areas and were not included in the Ecological Theme modeling. Wildlife movement areas were removed from modeling as this function is represented within the key wildlife and biodiversity zones. Features included in the modeling – wildlife habitat (key wildlife and biodiversity zones and grizzly bear core habitat, native prairie, riparian, waterways (rivers, streams and creeks), waterbodies (unnamed lakes and wetlands (Figure 13)) (see Appendix E for visual representation).

A Wetland Subcommittee Group (consisting of a subset of Pincher Creek MLUST participants and the project team) reviewed the wetland data available and agreed on an approach for incorporating wetlands into the Ecological Theme. Figure 13 displays wetlands based on the number of hectares of wetland occurring per section separated using quantiles into five equal categories; here the dark blue sections represent top 20% of data (the highest area of wetland relative to other sections). The number of hectares in the dark blue ranges from 15-100 hectares per section. All classes of wetland (A-D) were included in the calculation. Each of the five categories was given a Conflict Probability Rating of 100(represented as dark blue), 75 (top 40% represented as blue, 50 (resented as light blue) 25 (represented as green) and 0 (represented as yellow) (Figure 13).

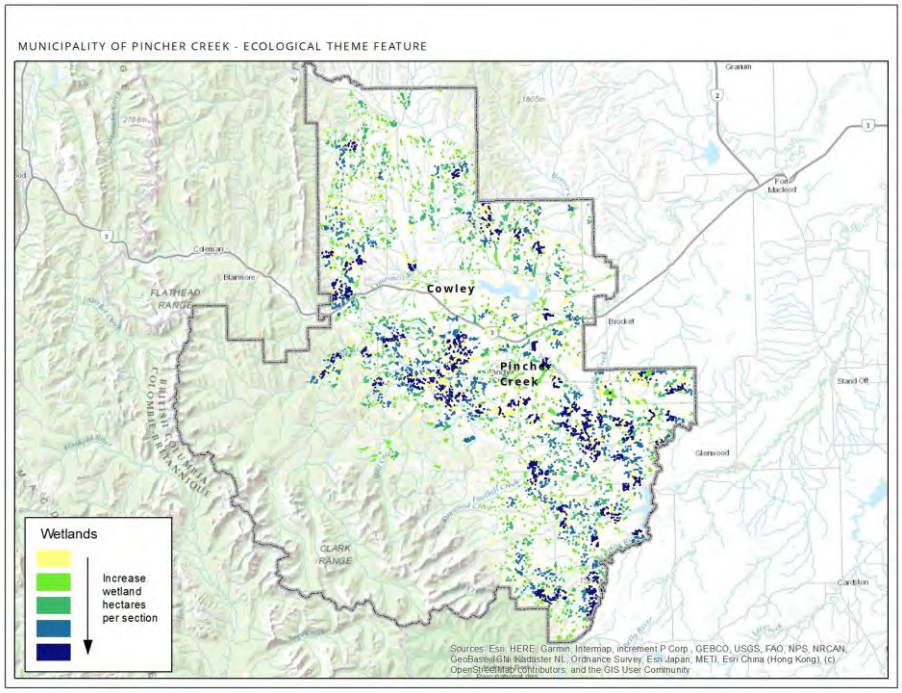


Figure 13: Waterbodies (wetlands) displayed as number of hectares per section, darker blue represents the highest number of hectares of wetland per section

[5] Ground water aquifer recharge, and coulees and escarpments represent a data gap for this theme and were not included in modeling.

Figure 14 and Figure 15 highlight the Ecological Conflict Probability Map in consideration of wind and solar.

Table 5: Ecological Theme Features and Conflict Probability Ratings, (*represent data gaps, features not represented on the map)

Ecological Theme Features	Conflict Probability Rating (Wind)	Conflict Probability Rating (Solar)
1. Protected Areas		
Conservation easement	81	80
Private land owned for conservation	81	75
2. Wildlife Habitat		
Grizzly bear zones	68	83
Key wildlife and biodiversity zone	78	73
Native prairie	83	85
Riparian	85	85
Escarpment and coulees	75	80
3. Waterways		
Rivers	100	100
Streams and creeks	100	100
4. Waterbodies		
Un-named lake	75	78
Ground water aquifer re-charge*	75	78
5. Wetlands		
Group 1: area of wetland in section very high	100	100
Group 2: area of wetland within section high	75	75
Group 3: area of wetland in section medium	50	50
Group 4: area of wetland in section low	25	25
Group 5: area of wetland in section very low	0	0

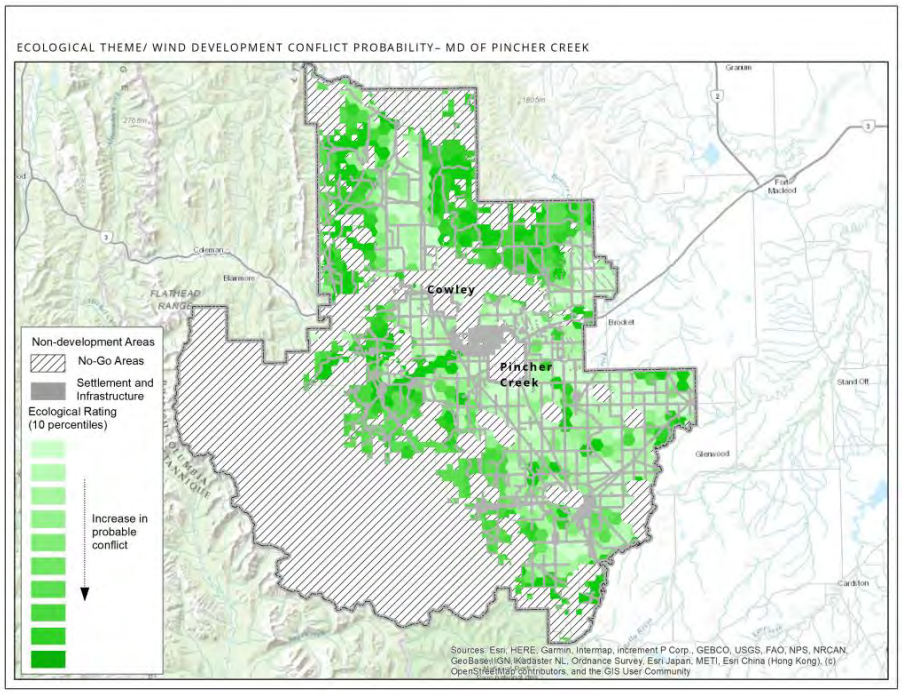


Figure 14: Ecological Theme Conflict Probability (Wind Energy Development) with No-Go Areas displayed in white with black hash marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

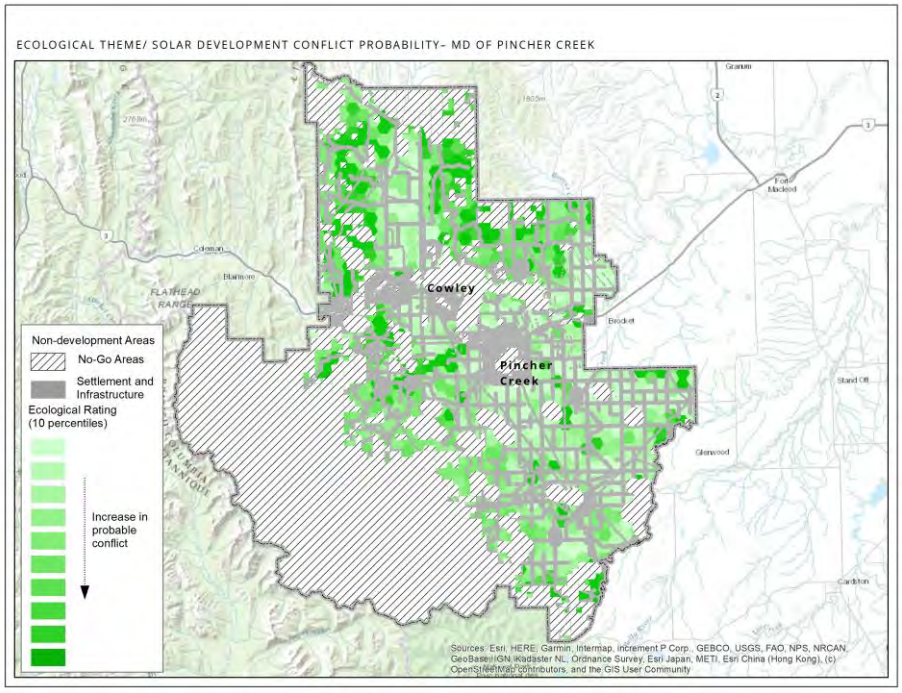


Figure 15: Ecological Theme Conflict Probability (Solar Energy Development) with No-Go Areas displayed in white with black hash marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

Cultural Theme

Cultural Theme features and their Conflict Probability Ratings and buffers are listed in Table 6, relative to wind and solar energy development (see appendix C and D for survey results). Historic Resource Value (HRV) Class 1 and 2 are included in the No-Go Areas and were not included in the Cultural Theme modeling. Features included those identified by participants via on-line survey and at the workshop, and HRV class 3 and 4 (see Appendix E for visual representation). Historic Resource Value Class 5 was removed from the analysis as these represent areas of possibility but where field assessment is necessary. A Cultural Sub-committee (consisting of a subset of Pincher Creek MLUST participants and the project team) reviewed the spatial representation of cultural features and requested re-considerations of the Livingston and Porcupine Range which had been identified using Government of Alberta boundaries. To more accurately capture where the mountain ranges meet prairie an elevation cut-off of 1500m was used (see Appendix E for a visual representation).

Figure 16 and Figure 17 highlight the Cultural Conflict Probability Rating in consideration of wind and solar respectively.

Table 6: Cultural Theme Features, Conflict Probability Ratings and Buffers (m)

Cultural Feature	Conflict Probability Rating (Wind)	Feature Buffer (Wind)	Conflict Probability Rating (Solar)	Feature Buffer (Solar)
1. Scenic Resources				
Cowboy Trail	53	1000	60	1000
Waterton Lakes National Park	69	1500	60	1000
Hawks Nest	47	1000	50	1000
Porcupine Hills	66	1000	63	1000
DU Cabin	66	1000	60	1000
Beaver Mines Coal Mining Rail	34	500	40	500
Oldman Dam Stone House	44	500	40	500
West Castle Valley	53	1000	60	1000
Livingston Range	78	1500	63	1000
Heritage Acres	41	500	48	500
2. Historical Resource Value				
HRV class 3: contains a significant historic resource that will likely require avoidance	83	n/a	75	n/a
HRV class 4: contains a historic resource that may require avoidance	70	n/a	55	n/a

Cultural Feature	Conflict Probability Rating (Wind)	Feature Buffer (Wind)	Conflict Probability Rating (Solar)	Feature Buffer (Solar)
HRV class 5: believed to contain a historic resource*	58	n/a	48	n/a

*HRV class 5 was not included in the modelling

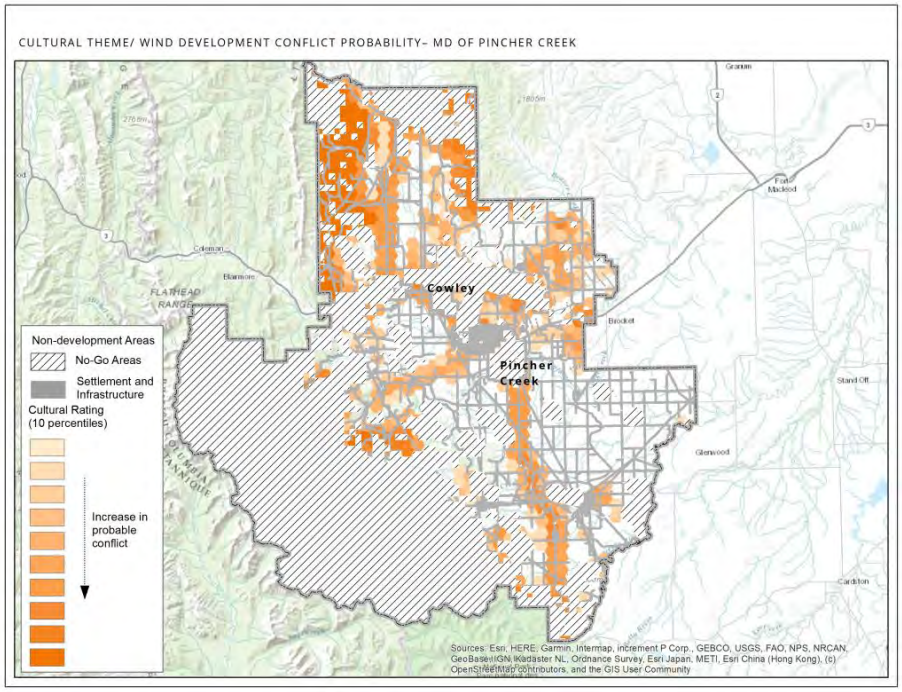


Figure 16: Cultural Theme Conflict Probability (Wind Energy Development) with No-Go Areas displayed in white with black hash marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

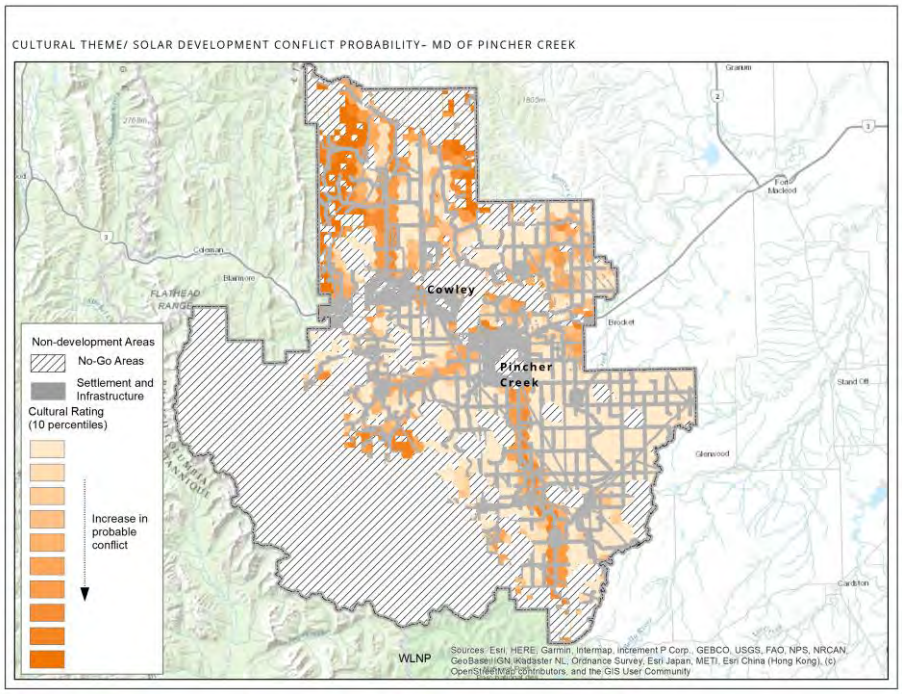


Figure 17: Cultural Theme Conflict Probability (Solar Energy Development) with No-Go Areas displayed in white with black hash marks. Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

Most Suitable Areas for Wind and Solar Energy Development

We summed the Agricultural, Ecological and Cultural Conflict Probability Rating Maps for both wind and solar to produce a Combined Conflict Probability Rating Map (Figure 18 and Figure 19). Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating the highest 10%.

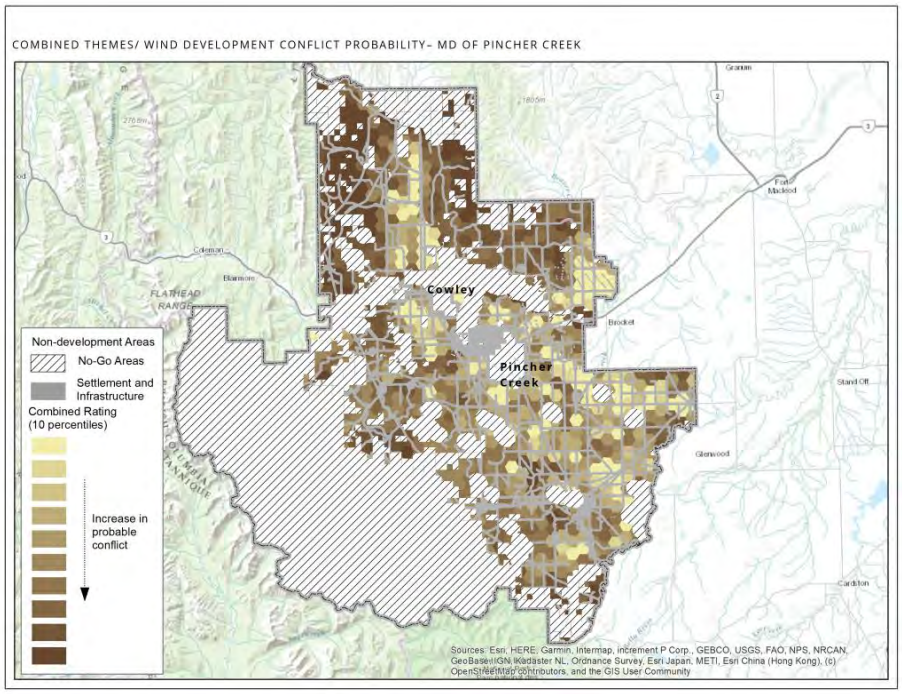


Figure 18: Combined Themes Conflict Probability (Wind Energy Development). Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

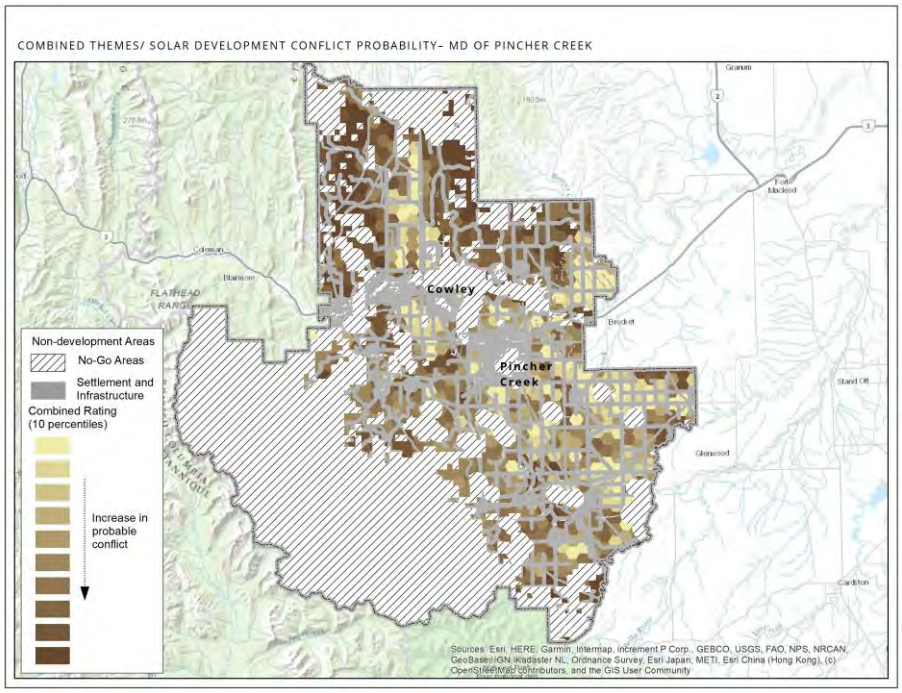


Figure 19: Combined Themes Conflict Probability (Solar Energy Development). Conflict Probability Rating values were converted into a range of 10 possible colours on a gradient, with the palest colour indicating a rating in the lowest 10%, and the darkest colour indicating a rating in the highest 10%.

To determine the Wind and Solar Energy Development Suitability Areas we used the inverse of the Combined Conflict Probability Rating Map to identify Wind and Solar Energy Development Suitability Areas (Figure 20 and Figure 24). Suitability Rating values were converted into a range of 5 possible colours on a gradient, with the palest colour indicating a rating in the lowest 20%, and the darkest colour indicates the highest 20%.

Areas representing less than 3 m/sec wind speed (National Wind Atlas[6]) are displayed in Figure 21 along with existing wind mills. Areas of low wind speed were not extracted from modeling because the wind data is from National scale and there are likely pockets within these areas where wind speed is appropriate.

Wind Energy Development Suitability Area (top 20%) is displayed in Figure 22 and represents 66,719 acres (270 km^2) or 7.7% of the Municipal District of Pincher Creek. Wind Energy Development Suitability Area (top 40%) is displayed in Figure 23 and represents 125,282 acres (507 km^2) or 14.4% of the Municipal District of Pincher Creek.

Solar Energy Development Suitability Area (top 20%) is displayed in Figure 25 and represents 48,680 acres (197 km^2) or 5.6% of the Municipal District of Pincher Creek. Solar Energy Development Suitability Area (top 40%) is displayed in Figure 26 and represents 93,406 acres (378 km^2) or 10.8% of the Municipal District of Pincher Creek.

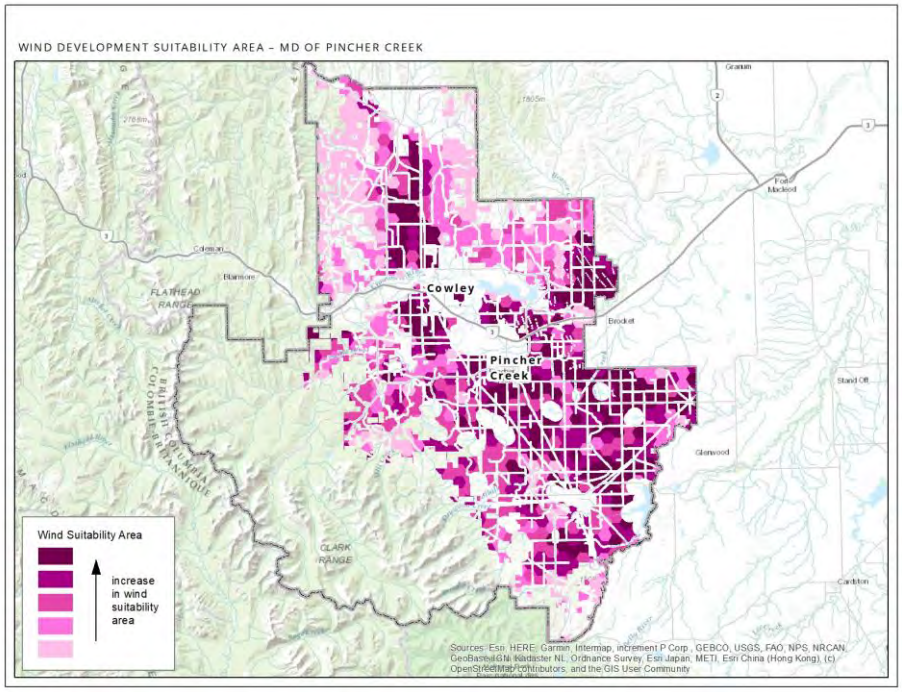


Figure 20: Wind Energy Development Suitability Area

[6] http://www.windatlas.ca/index-en.php

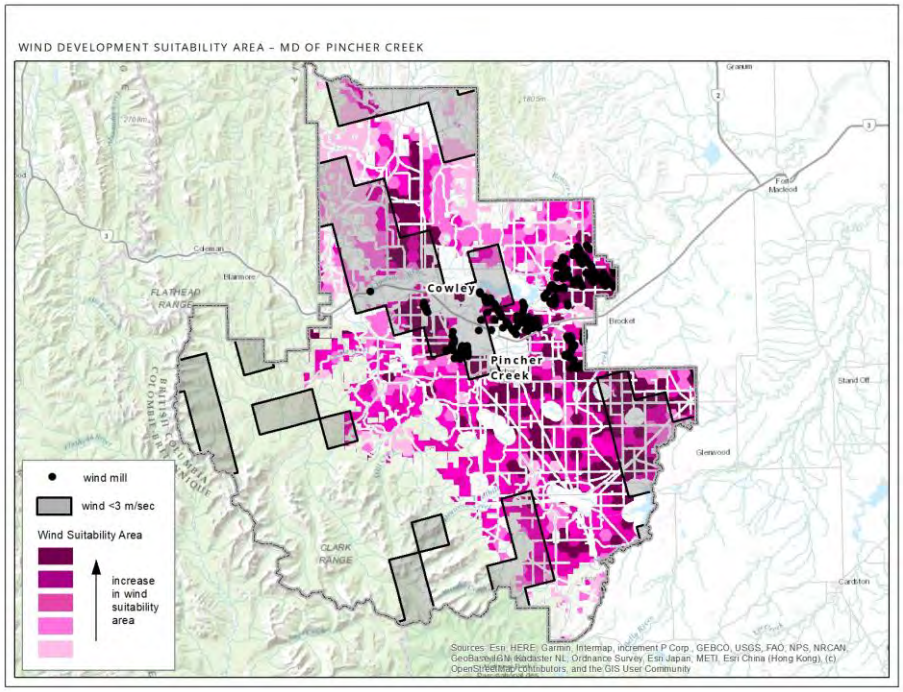


Figure 21: Wind Energy Development suitability Area with wind areas <3 m/sec

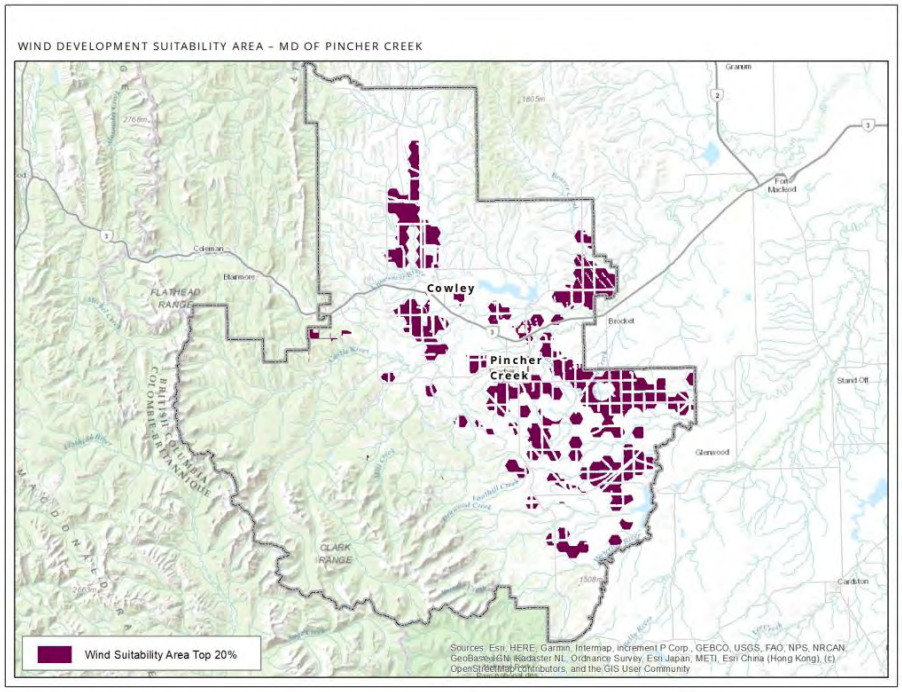


Figure 22: Wind Energy Development Suitability Area (top 20%)

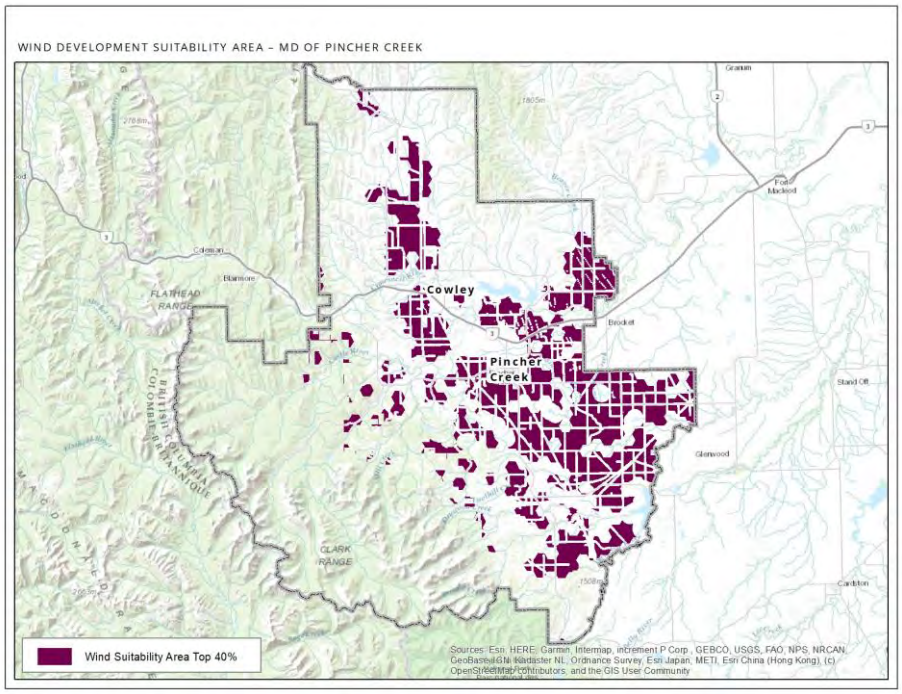


Figure 23: Wind Energy Development Suitability Area (top 40%)

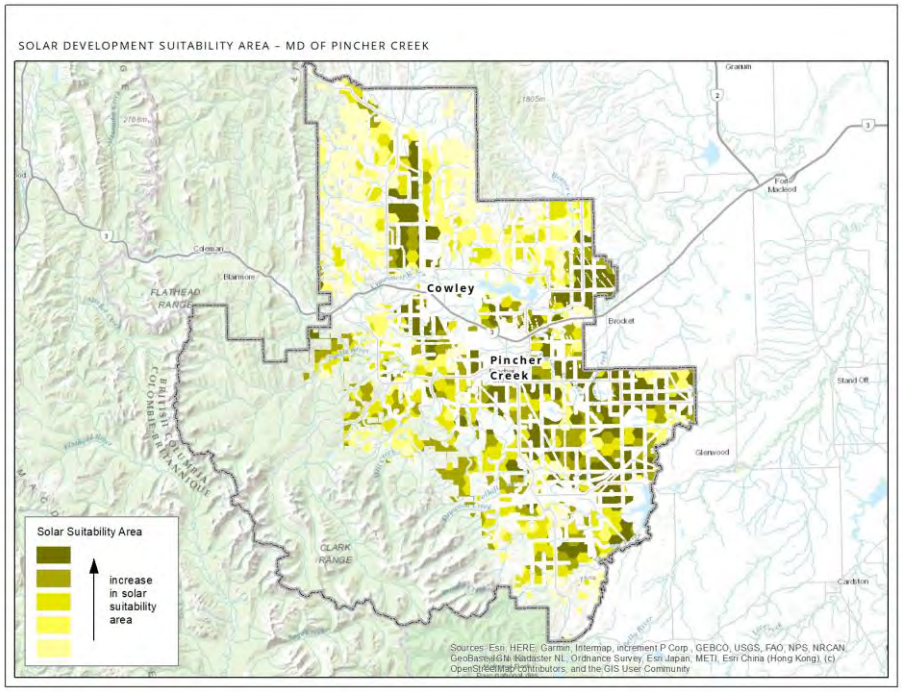


Figure 24: Solar Energy Development Suitability Area

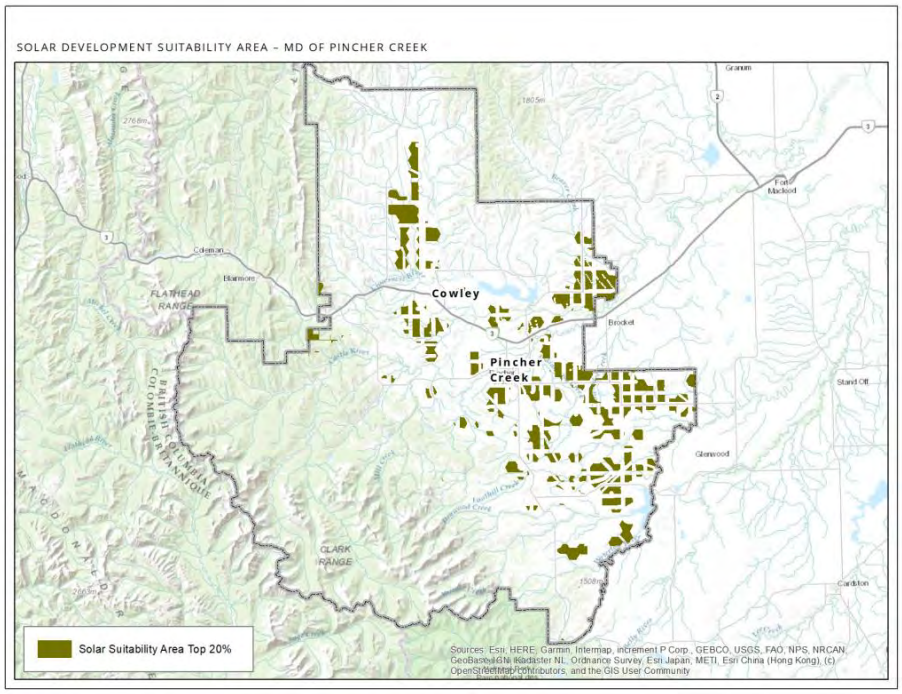


Figure 25: Solar Energy Development Suitability Area (top 20%)

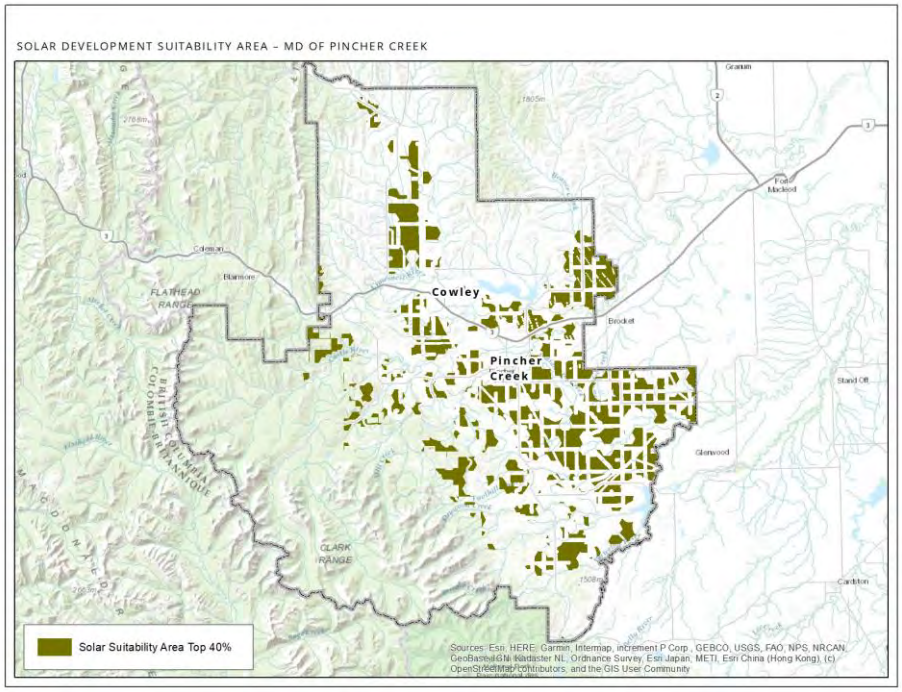


Figure 26: Solar Energy Development Suitability Area (top 40%)

Appendix A: Land Use Themes, Groups and Features

Legend:

Theme: Development, Agriculture, Settlement and Infrastructure, Cultural, and Ecological
Group: Broad groupings of the features (what goes into the model)
Feature: Elements of each group (what gets scored individually, then rolled up)
Example / explanation: Examples or explanations that can go into the user guide
Layers: The GIS layers that might be used to derive this

Settlement and Infrastructure

Group	Feature	Examples / Explanation	Layer	Renewable Energy Regulation notes
Urbanized areas	• Residential / commercial / industrial areas within cities and towns	Homes within residential subdivisions within towns, cities; Commercial or industrial areas or subdivisions within towns or cities.	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning, Government of Alberta Municipal Boundaries	**No-go - Prohibition of wind energy development in the Burmis Lundbreck Corridor ASP.** **Some prohibition in Oldman Reservoir ASP.** Urban fringe zoning precludes development of wind (approximately quarter section around PC and Cowley)
Rural residential				

	• Grouped Country residential	Rural residential subdivisions with properties). MDP only have GCR in ASPs and urban fringe of PC.	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning, Government of Alberta Municipal Boundaries	
	• Hamlet	Small unincorporated communities administered by rural or specialized municipalities	Government of Alberta Municipal Boundaries	Urban fringe around Pincher Station and Lundbreck
Rural commercial (non-agriculture)	• Commercial establishments and subdivisions	Commercial subdivision outside of settlements (e.g., highway commercial district); Commercial establishment outside of settlements (e.g., gas stations, garden centres, motels, work camps)	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (rural highway commercial)	
Rural industrial (non-agricultural)				
	• Solar farms	Utility-scale solar photovoltaic installations over a an area of land	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning, Heads up digitize	
	• Wind farms	Utility-scale cluster of wind turbines over an area of land	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (Wind	setbacks 7.5 m from property line, but if on road (height of tower plus 10%)

			farm industrial zone)	
	• Transmission	Rights-of-way for power lines and pipe lines	Government of Alberta Base Features, Industry Data if available	Apply Right of way/setbacks
	• Oil and gas processing plants	Petrochemical plants, refineries, gas plants. Sour gas facilities south of PC	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (multi-lot heavy rural industrial)	
	• Mineral extraction	Mines, gravel pits and sand stone mines	Province Mapped – sand stone approvals ASP has some gravel pits mapped, Digitizing gravel pits	
	• Power plants	Coal-fired power stations, dams, and associated buildings and facilities. Sour gas plants, and Old man	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning, Government of Alberta Base Features	
	• Landfills	Areas for the commercial disposal of any waste material by any means	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (landfill industrial)	
Transportation				
	• Divided highways		Government of Alberta Base Features	Alberta Transportation right of ways
	• Paved roads	Built and not built	Government of Alberta Base Features	Apply municipal by-law Height of wind tower plus 10%

	• Gravel roads	Built and not built	Government of Alberta Base Features	Apply Municipal by-law Height of wind tower plus 10%
	• Airports	Airstrips, runways, hangars, control towers, maintenance, exclusion zones.	Government of Alberta Base Features, Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (airport protection zone)	PC Airport vicinity protection zone – wind prohibited, Cowley airstrip – current no vicinity protection zone Currently in discussion proposed 4000m setback.
		Airfields (Cowley, private airfields)		
	• Railways	Railways, associated rail buildings, rail yards, stations, sidings, rights-of-way	Government of Alberta Base Features, Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning	Apply Right of way/setbacks Tower height plus 10%.
Water management				
	• Reservoirs	Areas of naturally-flowing water, dammed to provide water for human use. Waterton and Oldman	Government of Alberta Base Features	
	• Treatment plants	Industrial facilities for cleaning water for human consumption.	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning	

Agricultural Theme

Group	Feature	Examples / Explanation	Layers	Renewable Energy Regulation notes
Grazing land				
	• Native prairie	Unbroken natural prairie used for grazing livestock	Alberta Ground Vegetation Inventory (GVI), Alberta Biodiversity Monitoring Institute (ABMI) Human Footprint	Avoid public land (AEP)
	• Tame pasture	Managed pasture used for grazing livestock	Alberta Ground Vegetation Inventory (GVI)	
Cropland (unirrigated)				
	• Class 2	slight limitations to growth	Agriculture Regions of Alberta Soil Inventory Database (AGRASID)	
	• Class 3	moderate limitations to growth		
	• Class 4	severe limitations to growth		
	• Class 5	very severe limitations to growth		
Agriculture support				
	• Agri-business	Auction marts, feedlots / CFOs, seed cleaning plants, Processing plants, commercial greenhouses, aquaculture, hydroponic	Agriculture Regions of Alberta Soil Inventory Database (AGRASID)	

		operations		
	• Agricultural community	Ag society buildings, race tracks, and residences associated with (and located on) a farm or ranch.	Agriculture Regions of Alberta Soil Inventory Database (AGRASID)	

Ecological Theme

Group	Feature	Examples / Explanation	Layer	Renewable Energy Regulation notes
Protected areas (public)				
	• Municipal conservation lands	Municipal areas where development is restricted in favour of ecological conservation (e.g., environmental reserves, conservation reserves, natural area parks)	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning (R, MR designations). Environmental Reserves easements are not mapped	**No-go**
	• Provincial and national protected areas (recreation-focus)	Areas intended to provide some measure of environmental protection, where facility development is allowed (e.g., provincial and national protected areas recreational, heritage rangelands,	Government of Alberta Protected Areas, Alberta Conservation Area Lands	**No-go (AEP)**

		natural areas, public land use zones)		
	• Provincial protected areas (conservation-focus)	Provincial public lands intended to provide environmental protection, where facility development is restricted (e.g., ecological reserves, wilderness areas, wildland parks)	Government of Alberta Protected Areas	**No-go (AEP)**
	• Crown Land		Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning	**No-go (AEP)**
Protected areas (private)				
	• Conservation easement lands (ecological)	Private lands with title-attached restrictions in favour of conservation	Easement holder datasets.	SALTS and NCC no wind and solar policy
	• Private conservation lands owned	Private lands owned by land trusts and conservancies	Land trust and conservancy datasets.	SALTS and NCC no wind or solar policy
Wildlife habitat				
	• Species management areas or designations	E.g., complication of critical habitat for endangered species, ranges for Species of Concern (non-species at Risk), Key Wildlife and	Trumpeter Swans	SAR: AEP 101.1.2 trumpeter swans (**800m setback**)
			Mountain Goat and Sheep Zones	SAR: AEP 101.1.2

		Biodiversity Zones, Ramsar sites), Important Bird Areas.	Grizzly bear zone	AEP 101.1.3 Avoid unless threshold for linear density is exceeded then no-go
			Key wildlife and biodiversity zone	Avoid
	• Important wildlife habitat and vegetation areas	E.g., Compilation of riparian areas, native grasslands, wildlife movement zones, and important aquatic habitats	Native prairie (Grassland vegetation index and ABMI human footprint layer)	AUC Rule 007 Native Grassland is ranked a high sensitivity layer by AEP, and the Wildlife *Directive for Solar Energy Projects* and *Wildlife Directive for Alberta Wind Energy Projects* outline that native grasslands should be avoided
			Wildlife movement areas	Represented by key wildlife and biodiversity zones
			Riparian	
			Escarpment and coulees	Not included –data gap
Waterways (moving, lotic)		Includes all orders of streams, headwaters streams		
	• Rivers		Government of Alberta Base Features, Government of Canada CanVec	Avoid large permanent water courses – represented with 100m buffer
	• Streams and creeks		Government of Alberta Base Features, Government of Canada	Avoid small permanent water courses - represented with 45 m

			CanVec	buffer
	• Drainage ways	ephemeral waterways	Government of Alberta Base Features, Government of Alberta Digital Elevation Model	Not included –data gap
Waterbodies (standing, lentic)				
	• Lakes	Technically a class of wetland, includes all named lakes	Government of Alberta Base Features, Government of Canada CanVec	AUC Rule 007 AEP wind and solar directives have setback **no-go area of 1000m** on named lakes
	• Un-named lakes			
	• Classed wetlands	Includes all wetlands that under the Water Act would have to be replaced if lost	Alberta Merged Wetland Inventory, Alberta Biodiversity Monitoring Institute Wetland Inventory (for green zone)	AUC Rule 007 Water Act, Wetland Policy, SSRP, and Wildlife Directive for Solar Energy Projects and Wildlife Directive for Alberta Wind Energy Projects: no-**go with100m buffer** around wetlands classes as bog, fen, marsh, shallow open water and swamp.
	• Groundwater aquifer recharge areas	Infiltration zones, beaver ponds		Not included – data gap

Cultural Theme

Group	Feature	Examples / Explanation	Layer	Renewable Energy Regulation notes
Religious / cultural				
	• Religious facilities	Churches, church campuses, cemeteries, convents, mosques, temples	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning	Just include footprint
			St. Henry Church	
	• Sacred sites	Areas with demonstrated spiritual or religious significance	Alberta Historic Resources, Heads up digitize (in HRV?)	Not included -assumed covered in the HRV
	• First Nations Reserves		Government of Alberta Municipal Boundaries	Not included in analysis
Recreation				
	• Recreation facilities	Picnic areas, day use areas, boating access to reservoirs, golf courses, provincial recreation areas, ski hills, arenas, curling rinks, swimming pools, multi-rec buildings, amusement parks, campgrounds outside of urbanized areas	Municipal District of Pincher Creek Parcel Mapping or Landuse/Zoning	Just include footprint
	• Recreational rivers, lakes, reservoirs, and	Used for fishing, boating, swimming	Government of Alberta Base Features	Just include footprint

	streams			
Scenic				
	• Viewscapes	Composite landscapes of locally-valuable beauty visible from specific viewpoints	Cowboy Trail	
	• Scenic natural areas	Areas locally known for their natural beauty (e.g., forests, rivers, streams, lakes, riparian areas, open fields).	Waterton Lakes National Park	
			Hawks Nest	
			Porcupine Hills	
			DU Cabin	DU cabin bylaw
			Beaver Mines Coal Mining Rail	
			Oldman Dam Stone House	
			West Castle Valley	
			Livingston Range	
			Heritage Acres	
Historic resources				
	• Recognized historic resources	Heritage landscapes, Archeological sites, identified and classed by the provincial or municipal government	Government of Alberta Historic Resources (HRV 1-2)	AB Culture and Tourism: **HRV 1 and 2: no-go All other HRV classes are avoid.**
			HRV 3	
			HRV 4	
			HRV 5	

Wind and Solar Energy Development

Group	Feature	Examples / Explanation	Layer	Renewable Energy Regulation notes
Renewable Energy				
	• Wind	Suitability area for wind based on speed (Wind resource < 3m/sec is sub-optimal.	Government of Alberta Municipal Boundaries, Derived no-go areas	
	• Solar	Suitability area for solar based on solar radiation value	Government of Alberta Annual Solar Radiation 1971-2000, Government of Alberta Municipal Boundaries, Derived no-go areas	

Appendix B: Solar Survey Exercise

Municipal Development Suitability Tool for Solar Development

Hello... thank you for helping score and determine the features we should include in the MD of Pincher Creek's *Municipal Landuse Suitability Tool for Solar Energy Development.*

The features are gathered under four themes:

1. Agriculture;
2. Ecological;
3. Cultural; and
4. Settlements and Infrastructure.

You will be asked to provide a score to represent how you value each feature in relation to the theme area and in consideration of solar development.

The feature scores will be integrated into a model to help identify the high-value landscapes for each theme, and the most appropriate places for renewable energy development.

1

Agriculture Theme

The agriculture features you will be asked to score include:

- Grazing lands/pasture on native prairie and tame pasture;
- Lands of high value to support crops;
- lands of high value to support irrigated crops; and
- Agricultural community infrastructure.

The scores will help us identify high value agriculture lands in MD of Pincher Creek that are impacted by solar development.

1. Please score **grazing lands** in terms of their value to the agriculture theme:

	very high	high	medium	low	very low	do not include
Grazing land on native prairie	○	○	○	○	○	○
Grazing land on tame pasture	○	○	○	○	○	○

Comments:

2

2. Please score Land Suitability Rating Classes (LSRC) in terms of their value to the agriculture theme *(LSRC will be used to identify high value for growing crops).*

	very high	high	medium	low	very low	do not include
Land Suitability with slight limitations to growth	○	○	○	○	○	○
Land Suitability with moderate limitations to growth	○	○	○	○	○	○
Land Suitability with severe limitations to growth	○	○	○	○	○	○
Land Suitability with very severe limitations to growth	○	○	○	○	○	○

Other (please specify)

3. Please score Agri-business (auction marts, feedlots, seed cleaning plants, etc.) and Agricultural Community (ag society buildings, race tracks, etc.) in terms of their value to the agriculture theme.

	very high	high	medium	low	very low	do not include
Agri-business	○	○	○	○	○	○
Agricultural Community	○	○	○	○	○	○

Other (please specify)

3

4. Are there any features missing from the Agriculture Theme?

- ○ Yes
- ○ No

If yes, please list any missing features:

4

Municipal Development Suitability Tool for Solar Development

Ecological Theme

The ecological features you will be asked to score include:

- Municipal conservation lands
- Private conservation lands
- Species management designations
- Important wildlife habitat or vegetation areas
- Coulees and escarpments
- Groundwater aquifer recharge areas

The scores will help us identify high value ecological lands in the MD of Pincher Creek that are impacted by solar development.

The following features are listed as "no-go" based on regulations, they will be included in modelling but you will not be ask to score them:

- Crown Land
- Protected Areas
- Wetlands (with 100 m buffer)
- Large permanent rivers (with 100 m buffer)
- Smaller permanent watercourses (with 45 m buffer)
- Intermittent watercourses and springs (with 45 m buffer)
- Species at risk restricted areas (e.g., trumpeter swan and 800 m buffer)

5. Please score **conservation lands** in terms of their value to the ecological theme:

	very high	high	medium	low	very low	do not include
municipal conservation lands	○	○	○	○	○	○
private conservation lands	○	○	○	○	○	○

Comments:

5

6. Please score the following **species management areas or designations** in terms of their value to the ecological theme:

	very high	high	medium	low	very low	do not include
Key Wildlife and Biodiversity Zones	○	○	○	○	○	○
Grizzly Bear Zones	○	○	○	○	○	○

Comments:

7. Please score the following important **wildlife habitat or vegetation areas** in terms of their value to the ecological theme:

	very high	high	medium	low	very low	do not include
native grasslands	○	○	○	○	○	○
wildlife movement areas	○	○	○	○	○	○
riparian areas	○	○	○	○	○	○
escarpments and coulees	○	○	○	○	○	○

Comments:

8. Please score the following **waterways and water-bodies** in terms of their value to ecological theme:

	very high	high	medium	low	very low	do not include
lakes (unnamed)	○	○	○	○	○	○
groundwater aquifer recharge areas	○	○	○	○	○	○

Comments:

6

9. Are there any features missing from the Ecological Theme?

- ○ Yes
- ○ No

If yes, please list any missing features:

7

Municipal Development Suitability Tool for Solar Development

Cultural Theme

10. The following features were identified as important cultural features by MD Pincher Creek Municipal Land Use Suitability Tool participants. Please score each feature in terms of value to cultural theme and impacts from solar development.

	very high	high	medium	low	very low	do not include
Cowboy Tail	○	○	○	○	○	○
Livingston Range	○	○	○	○	○	○
Waterton Lakes National Park	○	○	○	○	○	○
Hawks Nest	○	○	○	○	○	○
Porcupine Hills	○	○	○	○	○	○
West Castle Valley	○	○	○	○	○	○
St. Henry's Church	○	○	○	○	○	○
Beaver Mines (coal mining rail)	○	○	○	○	○	○
Oldman Dam Stone House	○	○	○	○	○	○
Heritage Acres	○	○	○	○	○	○
DU Ranchland Cabins	○	○	○	○	○	○

8

Visual Aid: St. Henry's church and buffers within MD Pincher Creek

9

Visual Aid: St. Henry's church with buffers of different sizes

10

11. The following features were identified as important cultural features. Please select a buffer to apply when considering solar development (the scores provided above will be applied to selected buffer).

	0 m	300 m	500 m	1000 m	2000 m
Cowboy Tail	○	○	○	○	○
Livingston Range	○	○	○	○	○
Waterton Lakes National Park	○	○	○	○	○
Hawks Nest	○	○	○	○	○
Porcupine Hills	○	○	○	○	○
West Castle Valley	○	○	○	○	○
St. Henry's Church	○	○	○	○	○
Beaver Mines (coal mining rail)	○	○	○	○	○
Oldman Dam Stone House	○	○	○	○	○
Heritage Acres	○	○	○	○	○
DU Ranchland Cabins	○	○	○	○	○

Other:

11

12. Historic Resource Values (HRV) layer is provided by GOA to help developers, industry representatives, and regulators determine if a proposed development might affect historic resources. There are five classes, HRV class 1 and 2 are regulated as no-go and you are not asked to score them. Please score HRV class 3 to 5 based on their level of importance to the Cultural theme.

	very high	high	medium	low	very low	do not include
HRV class 3: contains a significant historic resource that will likely require avoidance	○	○	○	○	○	○
HRV class 2: contains a historic resource that may require avoidance	○	○	○	○	○	○
HRV class 5: high potential to contain a historic resource	○	○	○	○	○	○

Comments

12

Settlement and Infrastructure Theme

The following features are included in the survey even though they have specific rights-of-ways/setbacks that will be included in the modeling.

- divided highway
- paved road
- gravel road
- railway
- airport
- transmission line

Here we provide you with an opportunity to identify buffers that may be incorporated if larger than established setbacks (if a linear feature please gauge the distance from the features center-line) when considering solar development.

In addition many of the features listed below have municipal by-laws (please refer back to the attachment) which will be considered in the modeling.

13. please provide a buffer for the following urbanized areas, rural residential and rural commercial non-agriculture features (0 m = no buffer).

	0 m	100 m	300 m	500 m	1000 m	2000 m
Urbanized areas (residential/commercial areas in cities/towns)	○	○	○	○	○	○
Grouped County Residential	○	○	○	○	○	○
Hamlets	○	○	○	○	○	○
Commercial Establishments and Subdivisions	○	○	○	○	○	○

Comments

13

14. Please provide a buffer for the following rural industrial features non-agriculture (0 m = no buffer).

	0 m	100 m	300 m	500 m	1000 m	2000 m
Solar farms	○	○	○	○	○	○
Wind farms	○	○	○	○	○	○
Transmission	○	○	○	○	○	○
Oil and Gas Processing	○	○	○	○	○	○
Mineral Extraction	○	○	○	○	○	○
Power plants	○	○	○	○	○	○
Landfills	○	○	○	○	○	○

Comments

15. Please provide a buffer for the following transportation features (0 m = no buffer).

	0 m	100 m	300 m	500 m	1000 m	2000 m
divided highways	○	○	○	○	○	○
paved roads	○	○	○	○	○	○
gravel roads	○	○	○	○	○	○
airports	○	○	○	○	○	○
airfields	○	○	○	○	○	○
railways	○	○	○	○	○	○

Comments

14

16. Please provide a buffer for the following water management features (0 m = no buffer).

	0 m	100 m	300 m	500 m	1000 m	2000 m
Reservoirs	○	○	○	○	○	○
Treatment Plants	○	○	○	○	○	○

Comments

15

Appendix C: Wind Survey Results Summary

Here we present collated results of each survey question participants were asked to *score* from very low to very high for the three themes areas: agriculture, ecological and cultural.

In each table, the percent represents the participants who selected that *score*. *Scores* were *Quantified* from (low<-->high) to a number (0-100) and averaged to produce a *Conflict Probability Rating* per feature, which can be seen in the second table.

Bubble charts were used as a visual aid for the process. In the bubble charts, the **placement** of each circle (aligned with the scores from *Very Low* to *Very High*) and the **size** of the circle represents how many people chose each answer (bigger circles = more people).

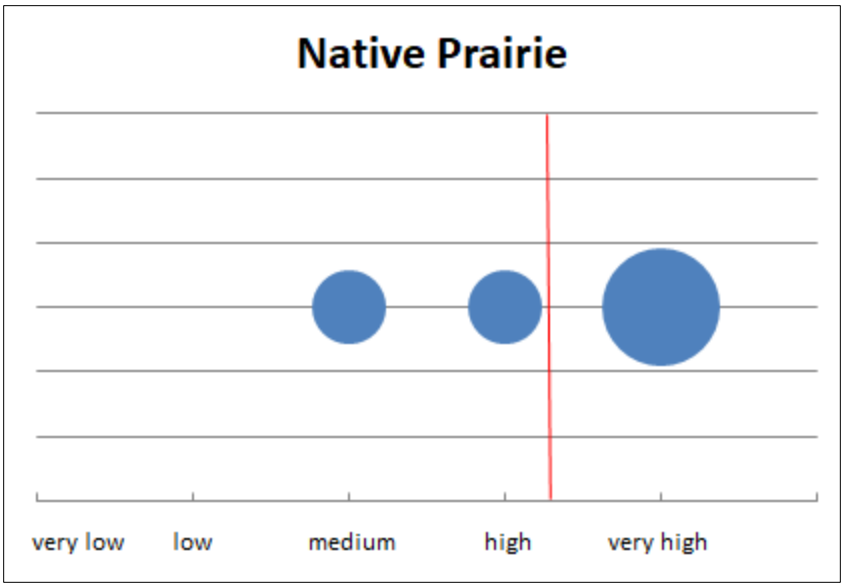
The **red line** represents the *Conflict Probability Rating* (average score) that was used in the GIS modelling.

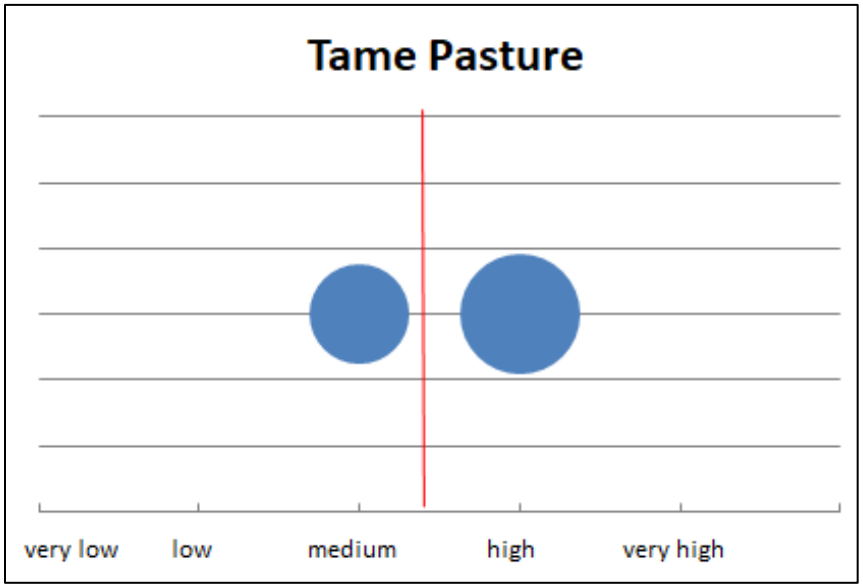
Agriculture Theme

1. *Grazing lands*

Grazing Land	very high	high	medium	low	very low
native prairie	56%	22%	22%	0%	0%
tame pasture	0%	60%	40%	0%	0%

Grazing Land	Conflict Probability Rating
Native Prairie	83
Tame Pasture	60

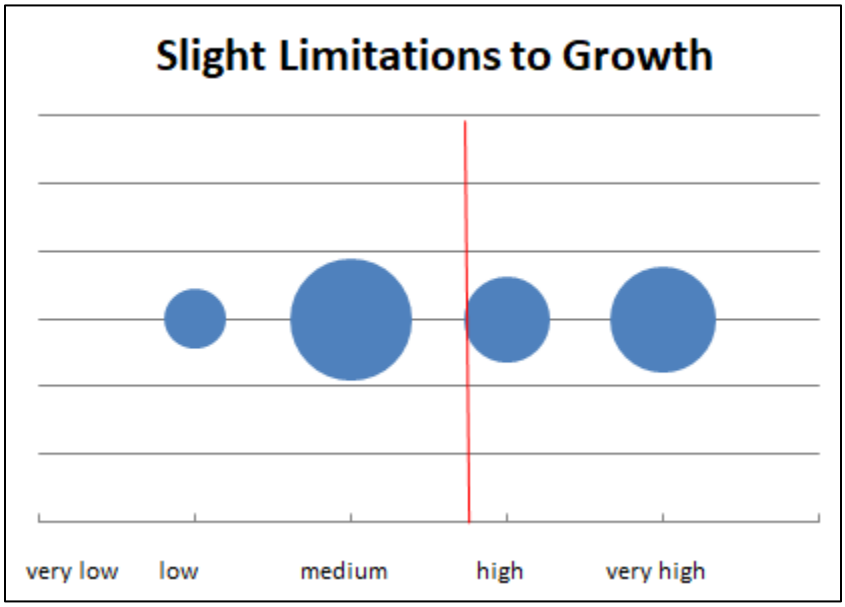


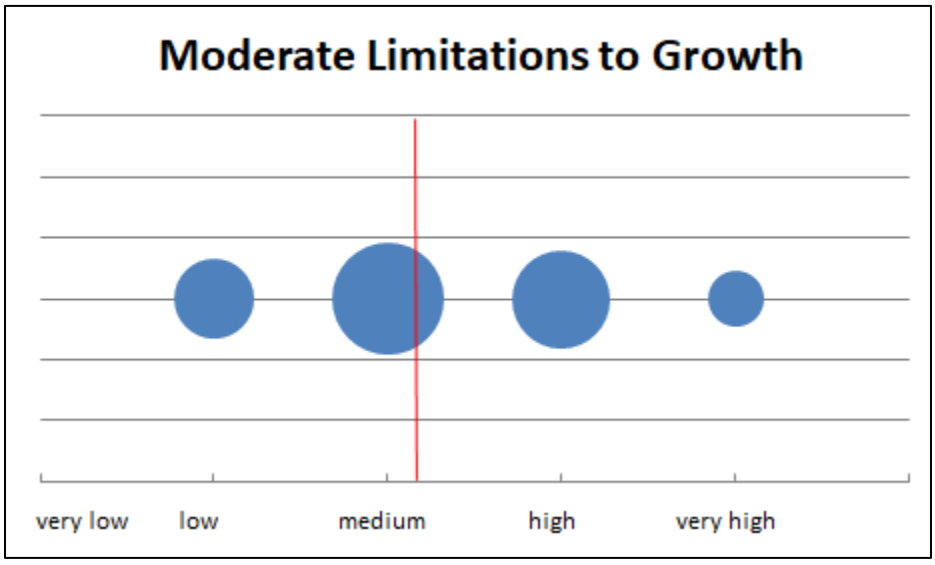


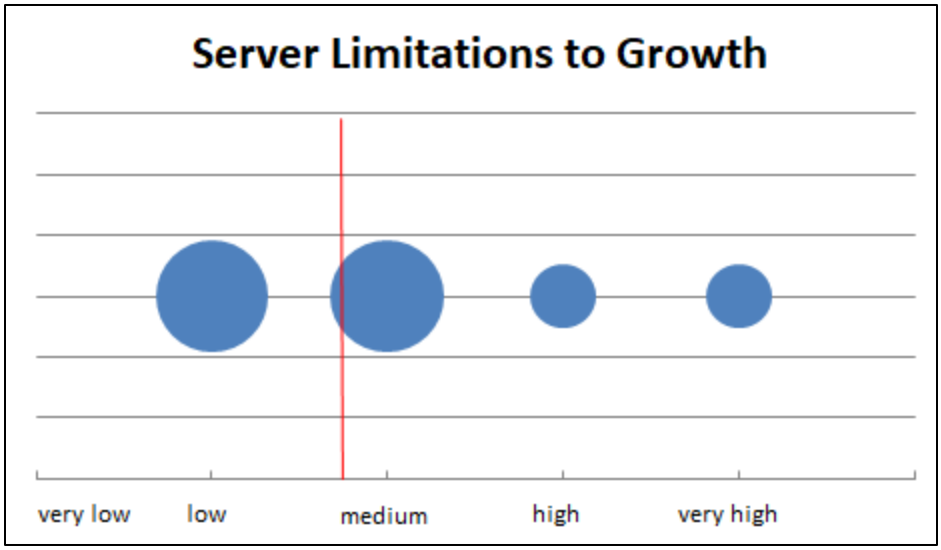
2. Land Suitability Rating Classes (LSRC)

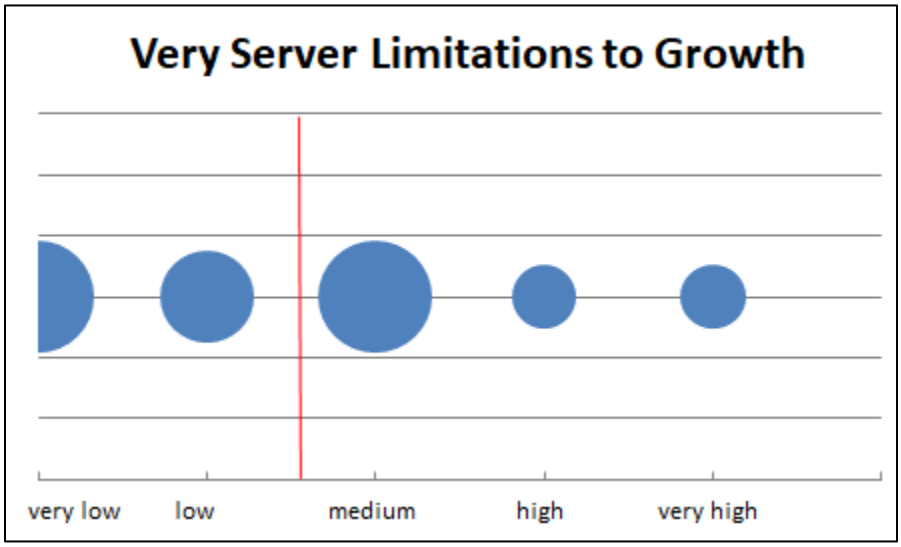
Land Suitability Rating Classes	very high	high	medium	low	very low
slight limitations to growth	30%	20%	40%	10%	0%
moderate limitations to growth	10%	30%	40%	20%	0%
severe limitations to growth	11%	11%	33%	33%	11%
very severe limitations to growth	10%	10%	30%	20%	30%

Land Suitability Rating Classes	Conflict Probability Rating
Land Suitability with slight limitations to growth	68
Land Suitability with moderate limitations to growth	58
Land Suitability with severe limitations to growth	44
Land Suitability with very severe limitations to growth	38





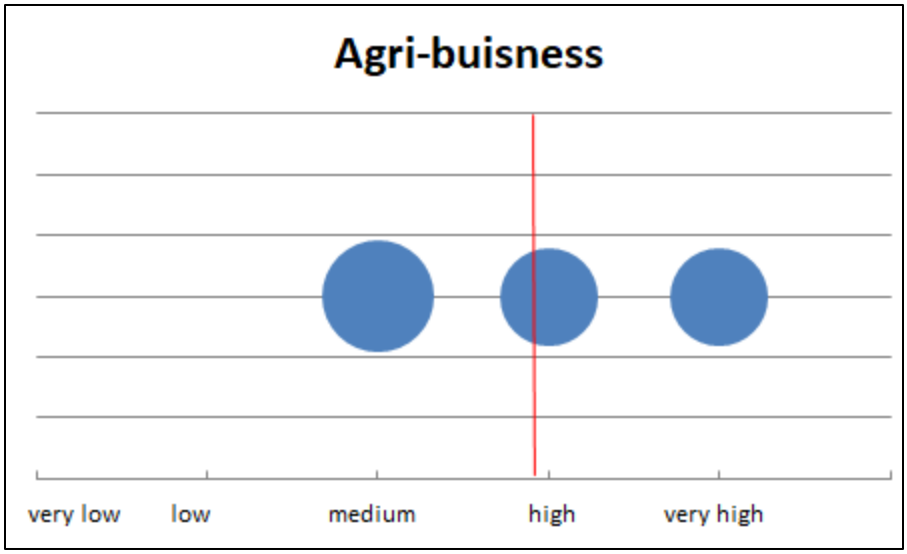


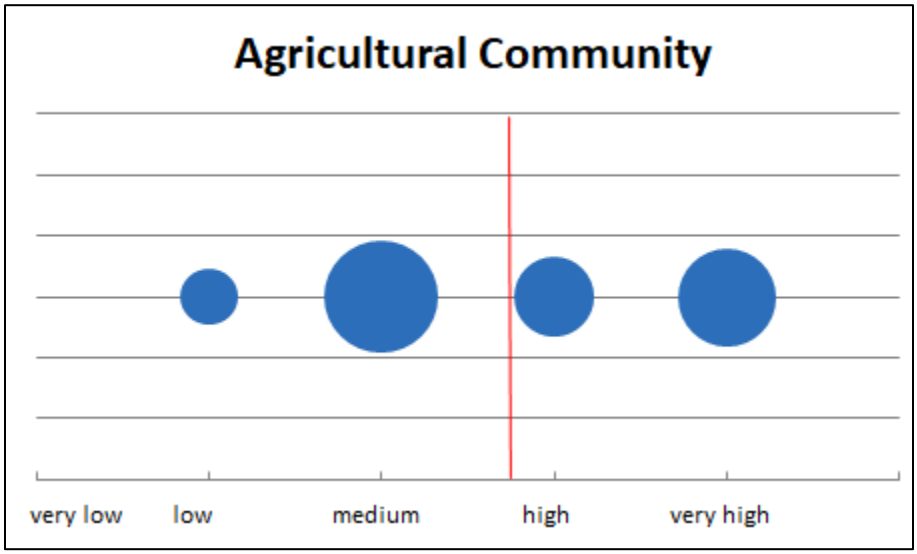


3. Agricultural Support

Agricultural Support	very high	high	medium	low	very low
Agri-business	30%	30%	40%	0%	0%
Agricultural Community	30%	20%	40%	10%	0%

Agricultural Support	Conflict Probability Rating
Agri-business	73
Agricultural Community	68


Agri-buisness
very low
low
medium
high
very high

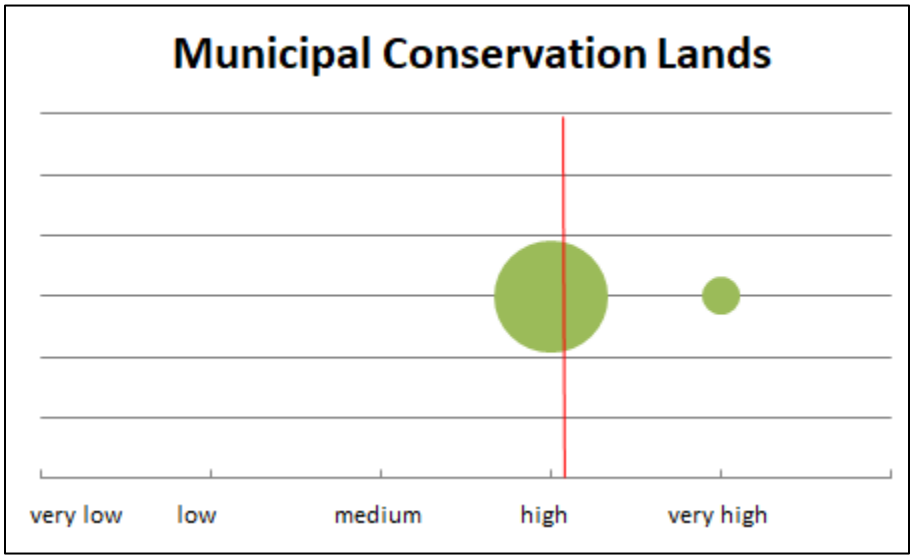

Agricultural Community
very low
low
medium
high
very high

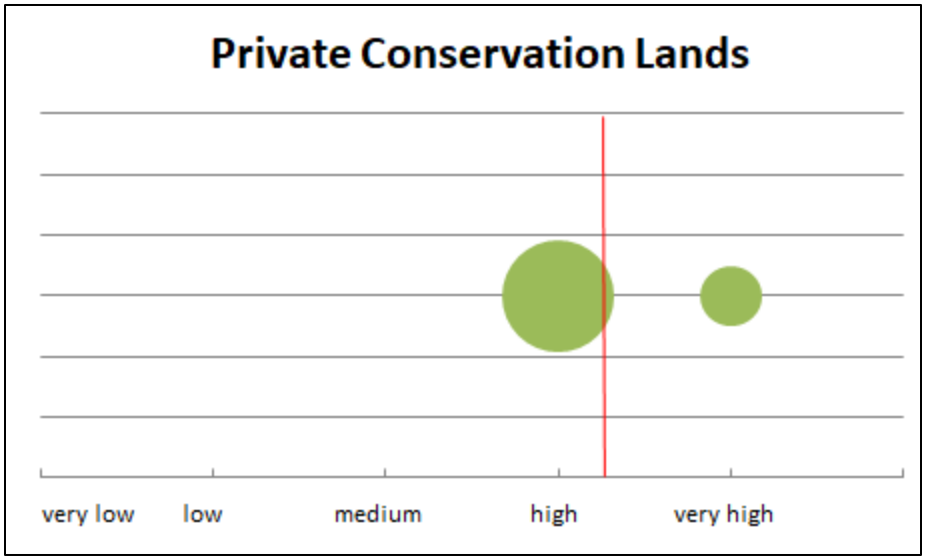
Ecological Theme

1. Protected and Conserved Areas

Protected Areas	very high	high	medium	low	very low	don't include
municipal conservation lands	10%	90%	0%	0%	0%	0%
private conservation lands	20%	70%	0%	0%	0%	10%

Protected Areas	Conflict Probability Rating
municipal conservation lands	78
private conservation lands	81

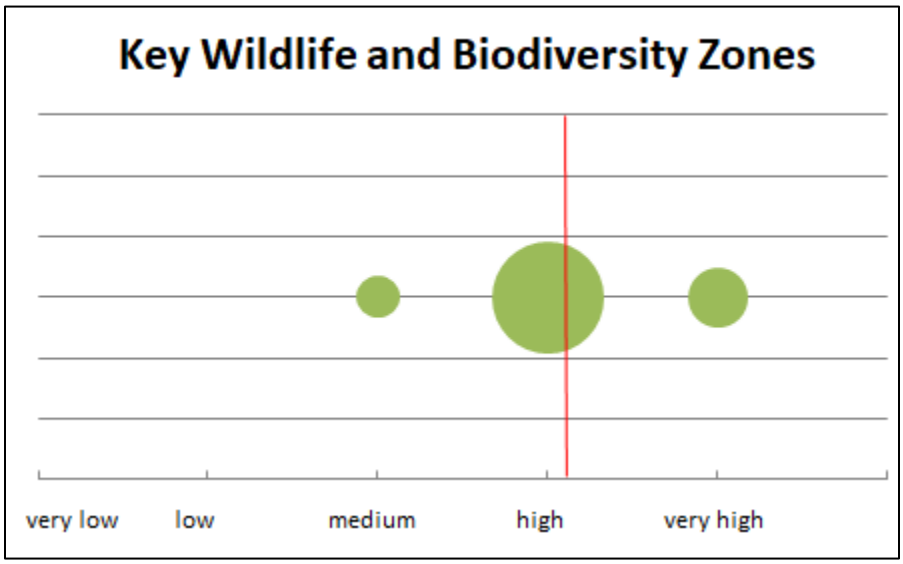


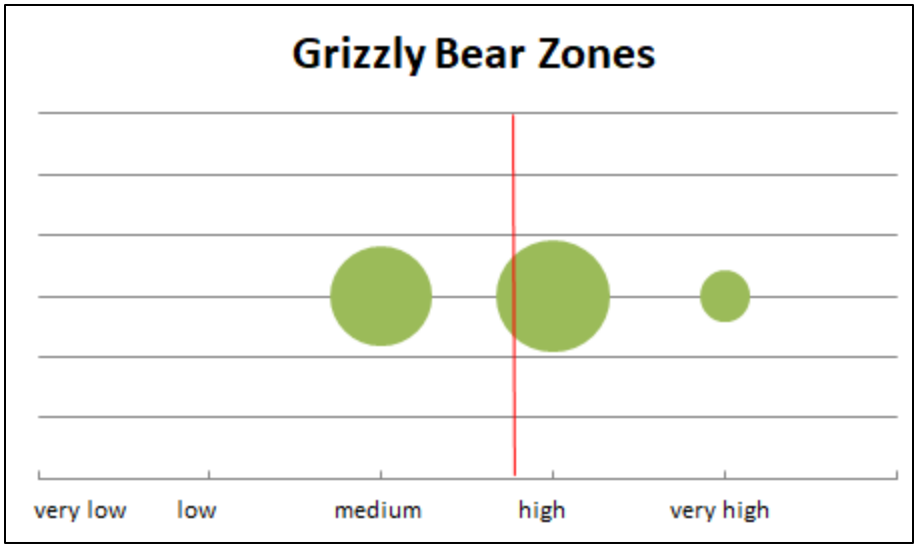


2. Wildlife Habitat – Species Management Area

Species Management Areas	very high	high	medium	low	very low
Key Wildlife and Biodiversity Zones	20%	70%	10%	0%	0%
Grizzly Bear Zones	10%	50%	40%	0%	0%

Species Management Areas	Conflict Probability Rating
Key Wildlife and Biodiversity Zones	78
Grizzly Bear Zones	68

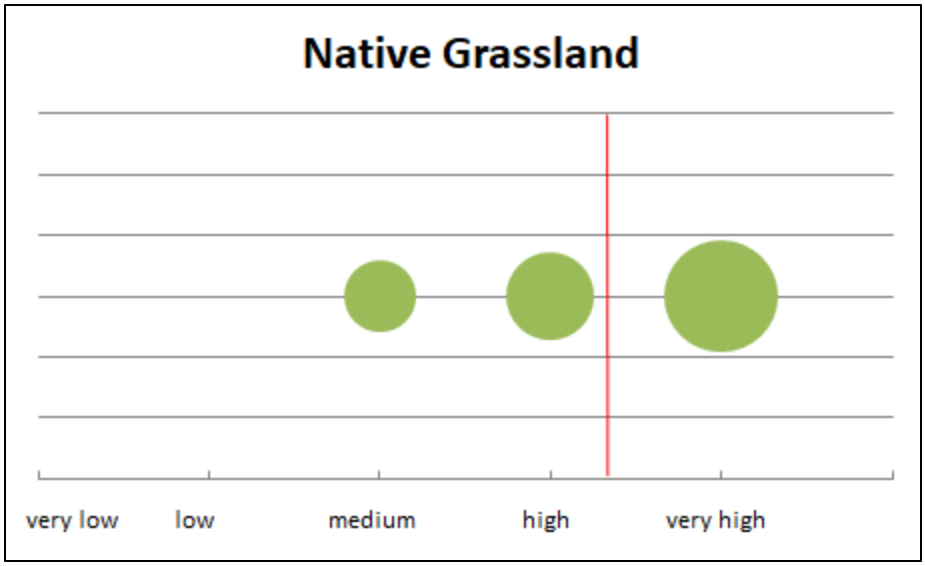


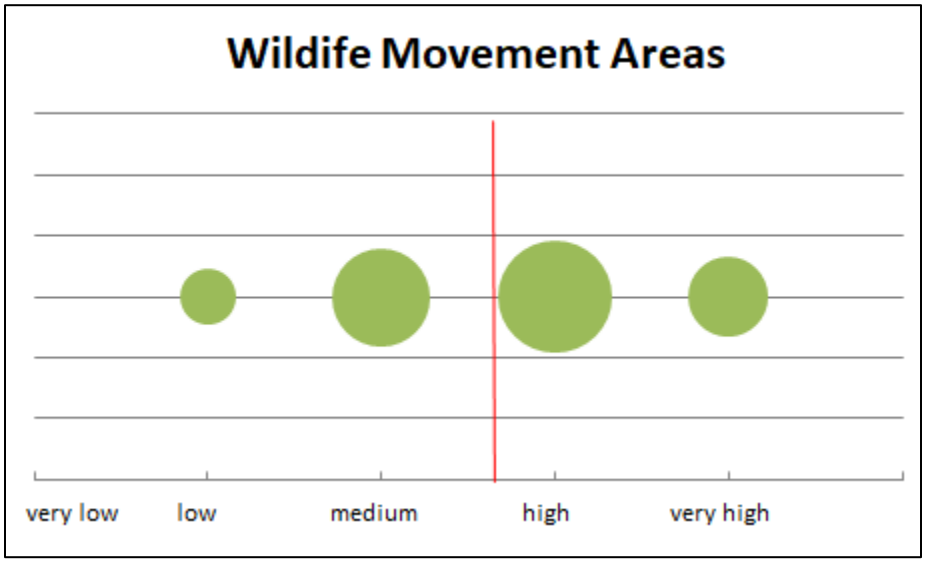


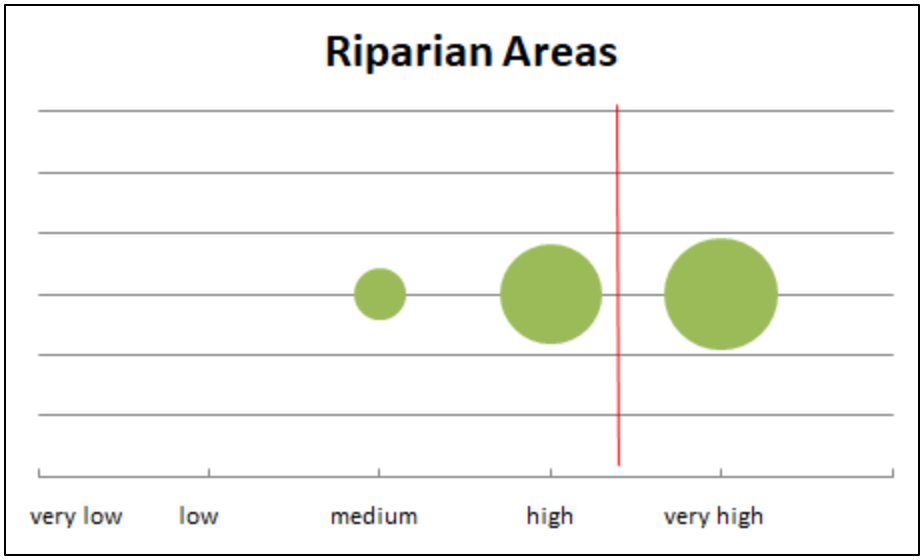
3. Wildlife Habitat – Wildlife Habitat or Vegetation Area

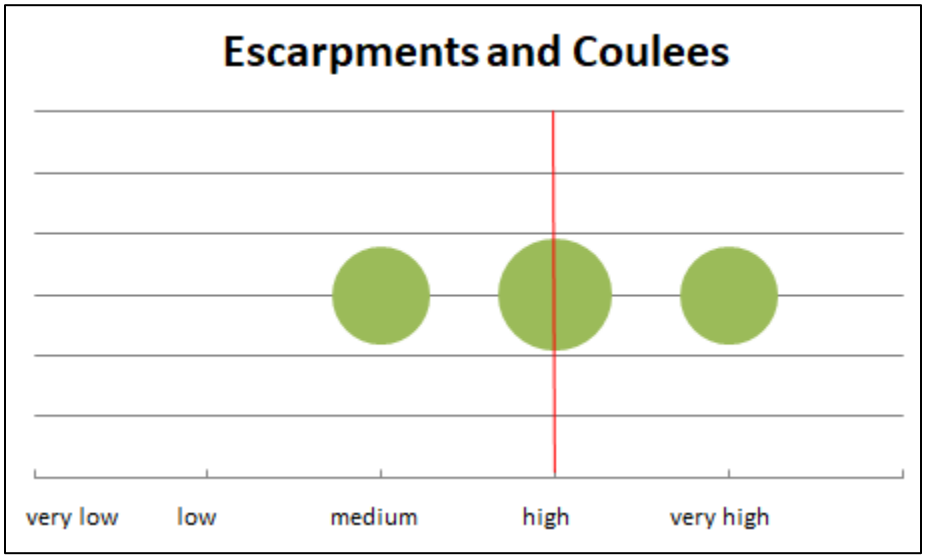
Wildlife Habitat or Vegetation Area	very high	high	medium	low	very low
native grasslands	50%	30%	20%	0%	0%
wildlife movement areas	20%	40%	30%	10%	0%
riparian areas	50%	40%	10%	0%	0%
escarpments and coulees	30%	40%	30%	0%	0%

Species Management Areas	Conflict Probability Rating
native grasslands	83
wildlife movement areas	68
riparian areas	85
escarpments and coulees	75


Native Grassland
very low
low
medium
high
very high


Wildife Movement Areas
very low
low
medium
high
very high



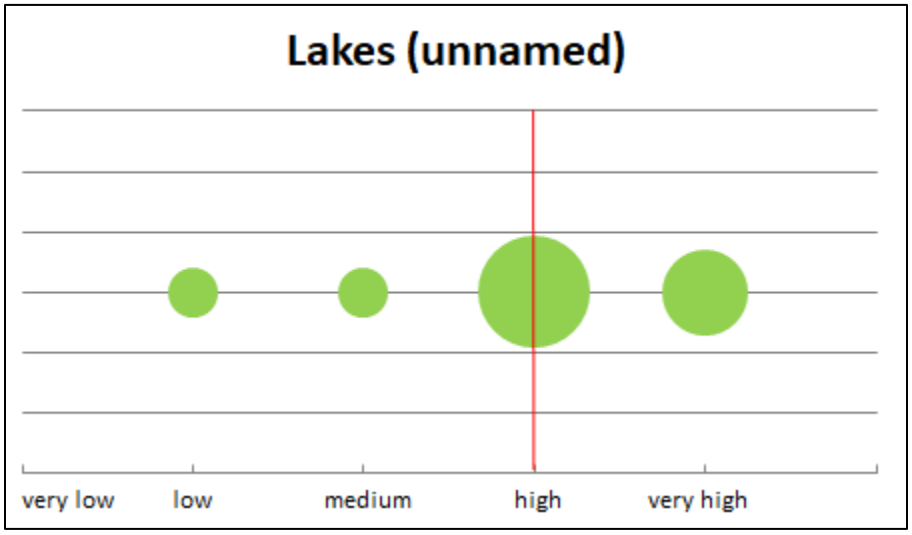


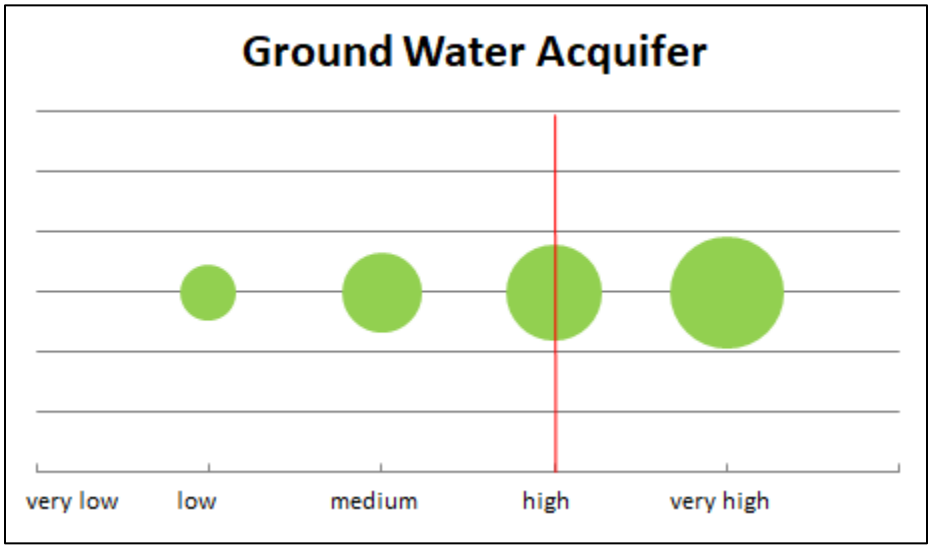
4. Waterways and Waterbodies

waterways and water-bodies	very high	high	medium	low	very low
lakes (unnamed)	30%	50%	10%	10%	0%
ground water aquifer recharge areas	40%	30%	20%	10%	0%

Waterways and water-bodies	Conflict Probability Rating
lakes (unnamed)	75

ground water aquifer recharge areas	75





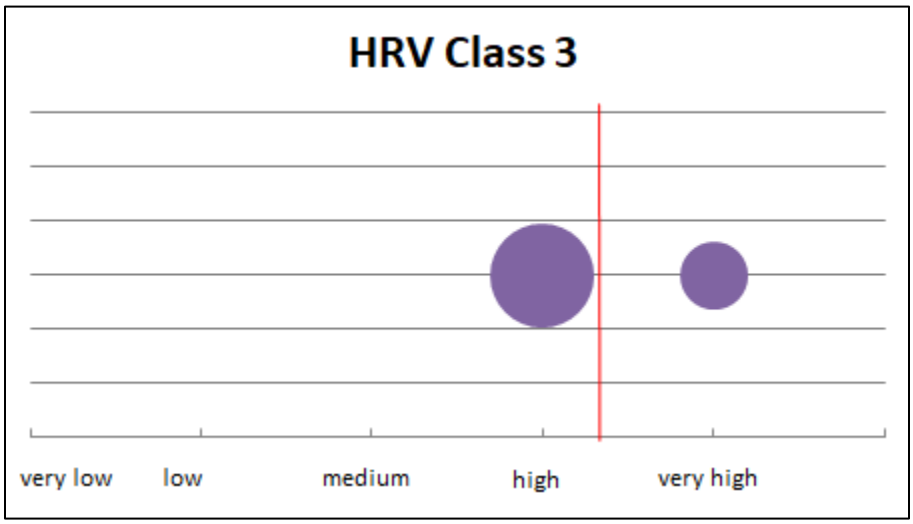
Cultural

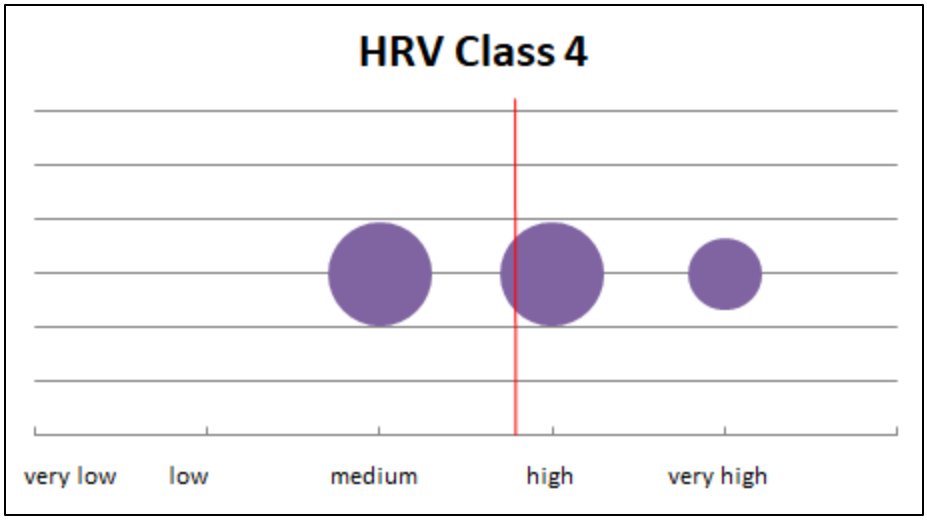
1. Historic Resource Value

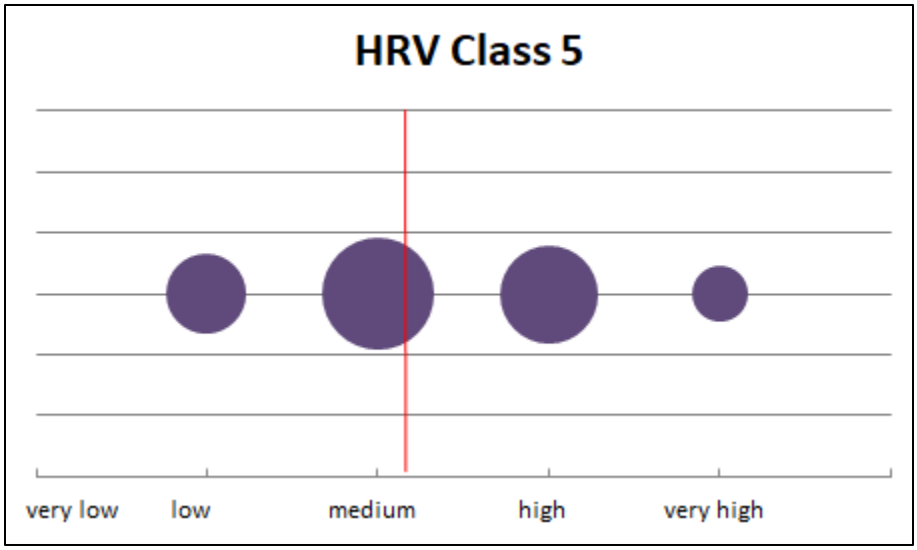
Historic Resource Values (HRV)	very high	high	medium	low	very low
HRV Class 3: contains a significant historic resource that will likely require avoidance	30%	70%	0%	0%	0%
HRV Class 4**: contains a historic resource that may require avoidance	20%	40%	40%	0%	0%
HRV Class 5: high potential to contain a historic resource	10%	30%	40%	20%	0%

*** NB: In the wind survey, this class was misidentified as Class 2*

Waterways and water-bodies	Conflict Probability Rating
HRV Class 3: contains a significant historic resource that will likely require avoidance	83
HRV Class 4**: contains a historic resource that may require avoidance	70
HRV Class 5: high potential to contain a historic resource	58







2. List of Cultural Sites

Cultural Sites	very high	high	medium	low	very low	do not include
Cowboy Tail	25%	38%	0%	0%	38%	0%
Livingston Range	38%	38%	25%	0%	0%	0%
Waterton Lakes National Park	25%	50%	13%	0%	0%	13%
Hawks Nest	25%	0%	38%	13%	13%	13%
Porcupine Hills	25%	38%	13%	25%	0%	0%
West Castle Valley	25%	25%	13%	13%	25%	0%
St. Henry's Church	25%	25%	13%	25%	13%	0%
Beaver Mines (coal mining rail)	13%	0%	38%	13%	13%	25%
Oldman Dam Stone House	13%	13%	38%	13%	13%	13%
Heritage Acres	13%	25%	13%	13%	25%	13%
DU Ranchland Cabins	38%	25%	13%	13%	13%	0%

Cultural Sites	Conflict Probability Rating
Cowboy Tail	53
Livingston Range	78
Waterton Lakes National Park	69
Hawks Nest	47
Porcupine Hills	66
West Castle Valley	53
St. Henry's Church	56
Beaver Mines (coal mining rail)	34
Oldman Dam Stone House	44
Heritage Acres	41
DU Ranchland Cabins	66

3. Buffers of Cultural Sites

Cultural Sites	0m	300m	500m	1000m	2000m
Cowboy Tail	38%	0%	13%	0%	38%
Livingston Range	0%	0%	13%	25%	38%
Waterton Lakes National Park	0%	0%	13%	25%	38%
Hawks Nest	13%	13%	38%	0%	25%
Porcupine Hills	13%	13%	25%	0%	38%
West Castle Valley	25%	13%	13%	13%	25%
St. Henry's Church	0%	13%	25%	25%	38%
Beaver Mines (coal mining rail)	50%	13%	25%	0%	13%
Oldman Dam Stone House	38%	13%	38%	0%	13%
Heritage Acres	50%	25%	13%	13%	0%
DU Ranchland Cabins	13%	13%	0%	13%	50%

Cultural Sites	buffer	refined buffer
Cowboy Tail	929	1000
Livingston Range	1417	1500
Waterton Lakes National Park	1417	1500
Hawks Nest	829	1000
Porcupine Hills	1043	1000
West Castle Valley	829	1000
St. Henry's Church	1163	1000
Beaver Mines (coal mining rail)	413	500
Oldman Dam Stone House	475	500
Heritage Acres	263	500
DU Ranchland Cabins	1329	1000

Appendix D: Solar Survey Results Summary

Here we present collated results of each survey question participants were asked to *score* from very low to very high for the three themes areas: agriculture, ecological and cultural.

In each table, the percent represents the participants who selected that *score*. *Scores* were *Quantified* from (low<-->high) to a number (0-100) and averaged to produce a *Conflict Probability Rating* per feature, which can be seen in the second table. The *Conflict Probability Rating* (average score) was used in the GIS modelling.

Agriculture Theme

4. Grazing lands

Grazing Land	very high	high	medium	low	very low
native prairie	50%	40%	10%	0%	0%
tame pasture	20%	40%	40%	0%	0%

Grazing Land	Conflict Probability Rating
Native Prairie	85
Tame Pasture	70

5. Land Suitability Rating Classes (LSRC)

Land Suitability Rating Classes	very high	high	medium	low	very low
slight limitations to growth	50%	20%	20%	10%	0%
moderate limitations to growth	30%	40%	0%	30%	0%
severe limitations to growth	10%	10%	50%	10%	20%
very severe limitations to growth	10%	0%	20%	50%	10%

Land Suitability Rating Classes	Conflict Probability Rating
Land Suitability with slight limitations to growth	78
Land Suitability with moderate limitations to growth	68
Land Suitability with severe limitations to growth	45

Land Suitability with very severe limitations to growth	36

6. Agricultural Support

Agricultural Support	very high	high	medium	low	very low
Agri-business	40%	10%	30%	20%	0%
Agricultural Community	30%	20%	30%	20%	0%

Agricultural Support	Conflict Probability Rating
Agri-business	68
Agricultural Community	65

Ecological Theme

5. Protected and Conserved Areas

Protected Areas	very high	high	medium	low	very low	don't include
municipal conservation lands	20%	80%	0%	0%	0%	0%
private conservation lands	30%	50%	10%	10%	0%	0%

Protected Areas	Conflict Probability Rating
municipal conservation lands	80
private conservation lands	75

6. Wildlife Habitat – Species Management Area

Species Management Areas	very high	high	medium	low	very low
Key Wildlife and Biodiversity Zones	40%	50%	10%	0%	0%
Grizzly Bear Zones	20%	50%	30%	0%	0%

Species Management Areas	Conflict Probability Rating
Key Wildlife and Biodiversity Zones	83
Grizzly Bear Zones	73

7. Wildlife Habitat – Wildlife Habitat or Vegetation Area

Wildlife Habitat or Vegetation Area	very high	high	medium	low	very low
native grasslands	60%	20%	20%	0%	0%
wildlife movement areas	40%	50%	10%	0%	0%
riparian areas	40%	60%	0%	0%	0%
escarpments and coulees	40%	40%	20%	0%	0%

Species Management Areas	Conflict Probability Rating
native grasslands	85
wildlife movement areas	83
riparian areas	85
escarpments and coulees	80

8. Waterways and Waterbodies

waterways and water-bodies	very high	high	medium	low	very low
lakes (unnamed)	30%	50%	20%	10%	0%
ground water aquifer recharge areas	33%	56%	0%	11%	0%

Waterways and water-bodies	Conflict Probability Rating
lakes (unnamed)	78
ground water aquifer recharge areas	78

Cultural

4. Historic Resource Value

Historic Resource Values (HRV)	very high	high	medium	low	very low
HRV Class 3: contains a significant historic resource that will likely require avoidance	40%	40%	10%	0%	10%
HRV Class 4: contains a historic resource that may require avoidance	30%	20%	20%	20%	10%
HRV Class 5: high potential to contain a historic resource	30%	10%	20%	20%	20%

Waterways and water-bodies	Conflict Probability Rating
HRV Class 3: contains a significant historic resource that will likely require avoidance	75
HRV Class 4: contains a historic resource that may require avoidance	55
HRV Class 5: high potential to contain a historic resource	48

5. List of Cultural Sites

Cultural Sites	very high	high	medium	low	very low
Cowboy Tail	20%	50%	0%	10%	20%
Livingston Range	20%	50%	10%	0%	20%
Waterton Lakes National Park	40%	20%	10%	0%	30%
Hawks Nest	20%	20%	30%	0%	30%
Porcupine Hills	30%	40%	0%	10%	20%
West Castle Valley	40%	20%	10%	0%	30%
St. Henry's Church	20%	10%	40%	0%	30%
Beaver Mines (coal mining rail)	20%	10%	20%	10%	40%
Oldman Dam Stone House	20%	0%	30%	20%	30%
Heritage Acres	20%	10%	30%	20%	20%
DU Ranchland Cabins	20%	40%	20%	0%	20%

Cultural Sites	Conflict Probability Rating
Cowboy Tail	60
Livingston Range	63
Waterton Lakes National Park	60
Hawks Nest	50
Porcupine Hills	63
West Castle Valley	60
St. Henry's Church	48
Beaver Mines (coal mining rail)	40
Oldman Dam Stone House	40
Heritage Acres	48
DU Ranchland Cabins	60

6. Buffers of Cultural Sites

Cultural Sites	0m	300m	500m	1000m	2000m
Cowboy Tail	25%	13%	0%	0%	63%
Livingston Range	13%	13%	13%	0%	63%
Waterton Lakes National Park	13%	13%	25%	0%	50%
Hawks Nest	25%	25%	13%	25%	25%
Porcupine Hills	13%	25%	0%	0%	63%
West Castle Valley	38%	0%	13%	0%	50%
St. Henry's Church	13%	38%	13%	25%	13%
Beaver Mines (coal mining rail)	38%	38%	13%	0%	13%
Oldman Dam Stone House	25%	38%	25%	0%	13%
Heritage Acres	38%	25%	25%	0%	13%
DU Ranchland Cabins	25%	13%	0%	13%	50%

Cultural Sites	buffer	refined buffer
Cowboy Tail	1288	1000
Livingston Range	1350	1500
Waterton Lakes National Park	1163	1000
Hawks Nest	763	1000
Porcupine Hills	1325	1500
West Castle Valley	1063	1000
St. Henry's Church	675	500
Beaver Mines (coal mining rail)	425	500
Oldman Dam Stone House	488	500
Heritage Acres	450	500
DU Ranchland Cabins	1163	1000

Appendix E: Spatial representation of key features

Modelling

Agricultural Theme

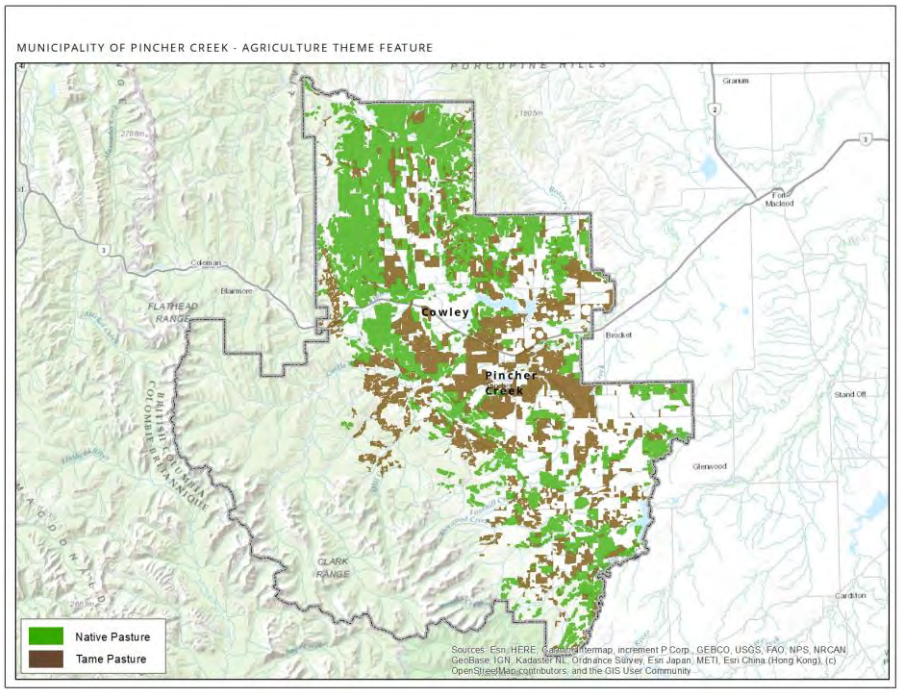


Figure 27: Grazing Lands

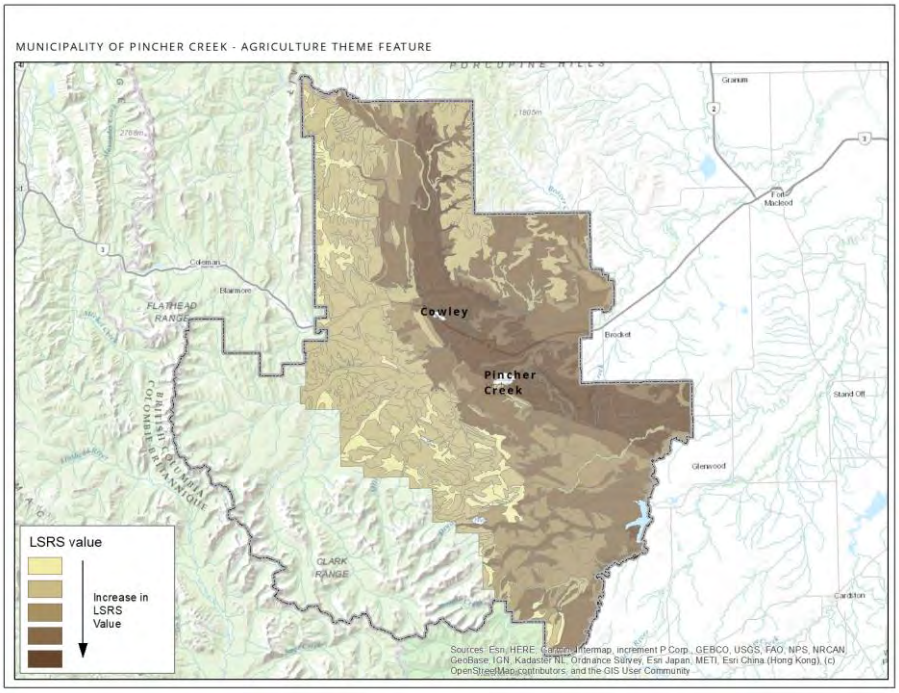


Figure 28: Agricultural Land Suitability Rating System (LSRS)

Ecological Theme

*The Native Prairie wildlife habitat feature is represented in the Agricultural theme, grazing lands (Figure 27).

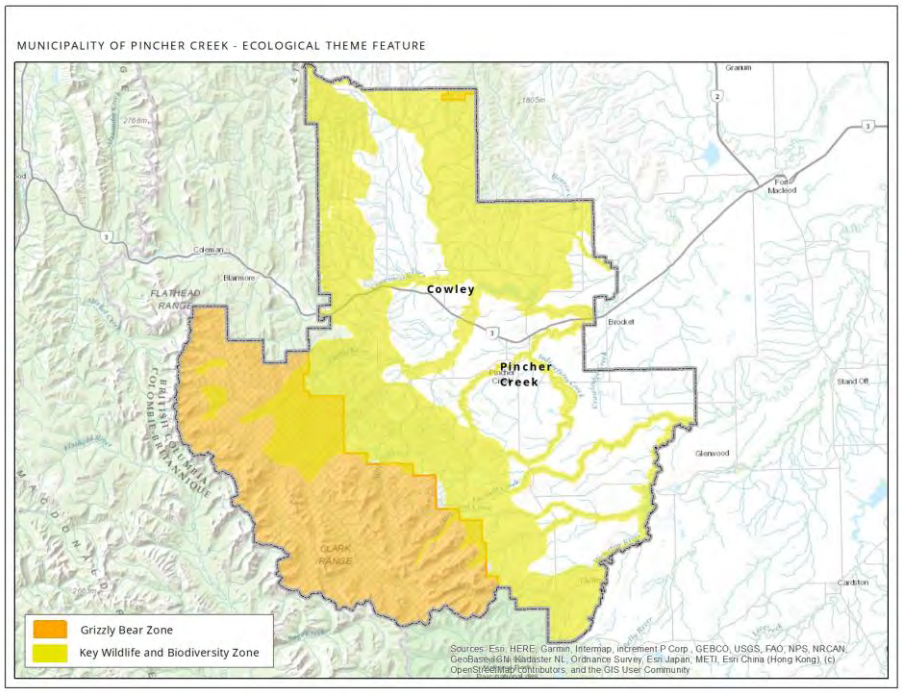


Figure 29: Wildlife Habitat Features (Grizzly bear zone and Key Wildlife and Biodiversity Zone)

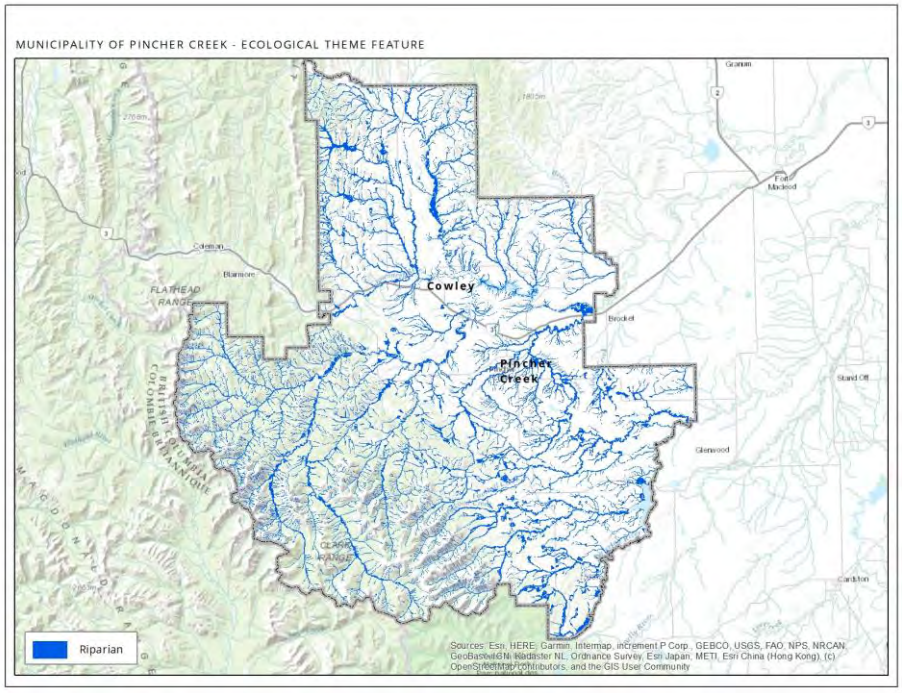


Figure 30: Wildlife Habitat Features (Riparian)

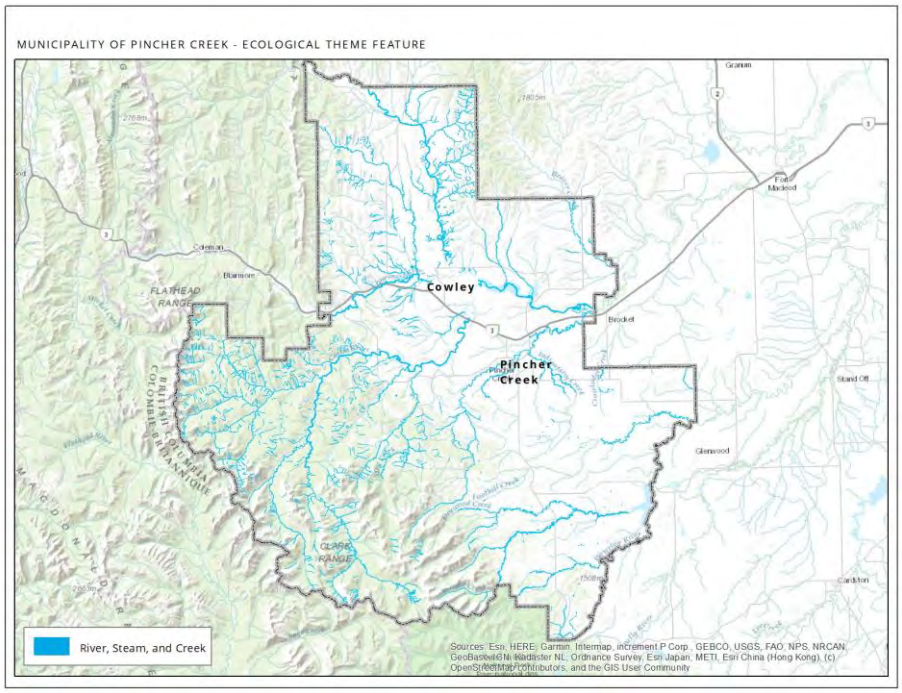


Figure 31: Waterways (River, Streams and Creeks)

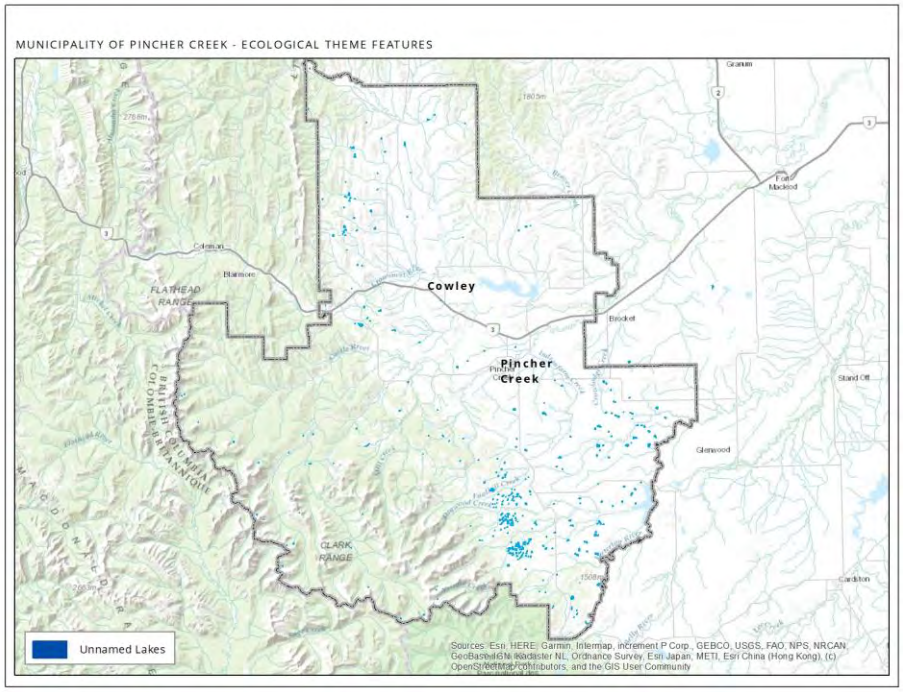


Figure 32: Waterbodies (Unnamed Lakes)

Cultural Theme

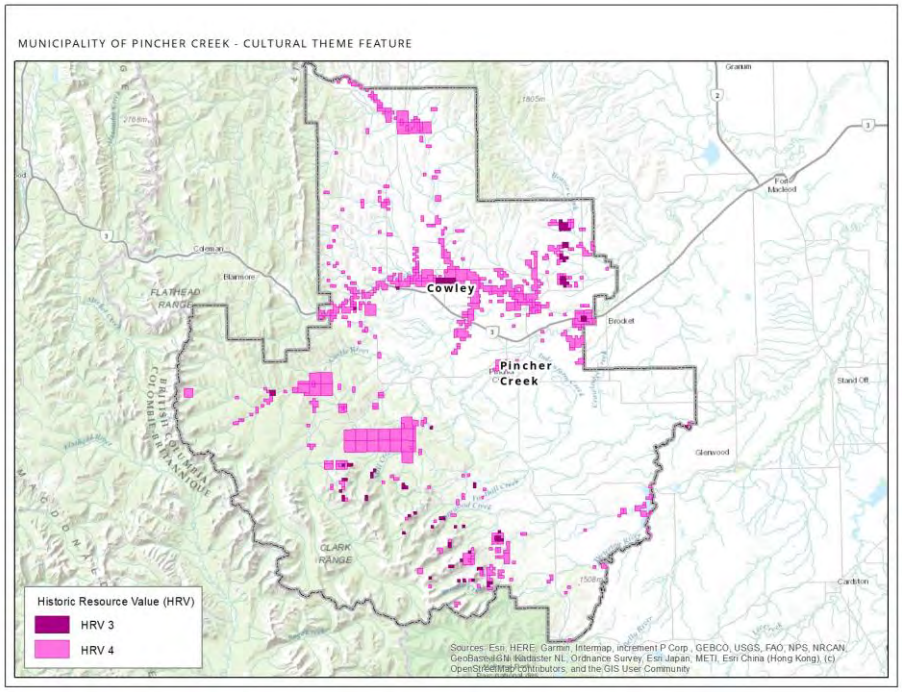


Figure 33: Historic Resource Value (HRV), class 1 and 2 are included in No-Go Areas and class 5 was removed from the modeling.

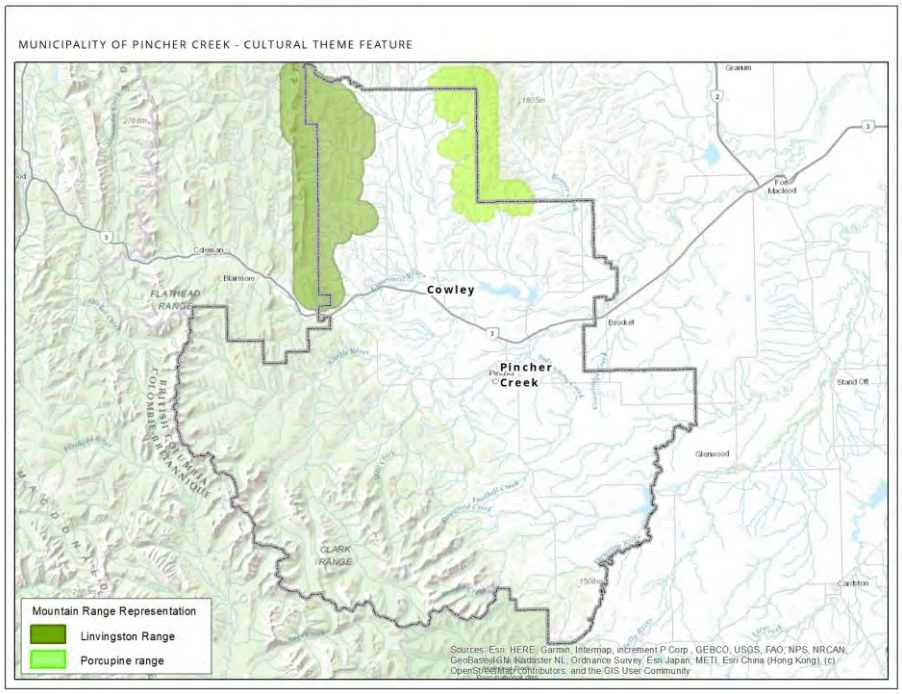


Figure 34: Livingston and Porcupine Mountain Ranges (used 1500m elevation cut-off)