Westbridge Renewable Energy

Eastervale Solar Project

Agrivoltaic Report and Agricultural Impact Assessment

Submitted To:

Westbridge Renewable Energy

Submitted By:

Tannas Conservation Services Ltd.

Box 31
Cremona, AB, T0M 0R0
www.tannasenvironmental.com

May 2025

Lead Authors

Steven Tannas, Ph.D., P.Ag., P.Biol.
Cassandra Schroeder, M.Ag., P.Ag.

Review By:

Steven Tannas, Ph.D., P.Ag., P.Biol.

Table of Contents

List of Tables

List of Figures

List of Appendices

1.0 Introduction

Tannas Conservation Services (TCS) was contracted by Eastervale Solar Inc. (Eastervale; ESI) to complete an agrivoltaic plan and agricultural impact assessment for the Eastervale Solar Project (the Project). The initial assessment and reporting occurred in 2023 and 2024, which determined that multiple agricultural activities would be compatible with the Project. In March of 2025, the original report was updated to meet the interim information requirements for Rule 007 (AUC, 2024) set out by the Alberta Utilities Commission (AUC) and to include the most recent facility design. The current plan includes a literature review, an overview of potential agricultural activities, an agricultural impact assessment, and details to demonstrate technically feasible agricultural practices that can be used on the Project lands. This plan was prepared by Professional Agrologists with a diverse background in agricultural operations in western Canada.

I, Steven Tannas, present this report as a Professional Agrologist and acknowledge my obligation to provide advice that is fair, objective and non-partisan.

1.1 Goals

The goals of this report are to:

1) Assess the types of agricultural production that are viable within the Project.
2) Assess the land capability and determine the appropriate type of agricultural production.
3) Provide recommendations that will allow for an agrivoltaic production system to exist in conjunction with the Project.
4) Address the interim information requirements for Rule 007 (AUC, 2024).

2.0 Background Information

The Project is located on privately owned land approximately 11km south of Hughenden, Alberta within the Municipal District of Provost No. 52. The area within the currently proposed fence area is approximately 764 acres (309 ha). As shown in Figure 2-1, the Project is located on the following quarter sections:

- SW 11-040-08-W4M
- NW 02-040-08-W4M
- SW 02-040-08-W4M
- NW 35-039-08-W4M
- SW 35-039-08-W4M
- SE 35-039-08-W4M
- SW 36-039-08-W4M
- NW 25-039-08-W4M

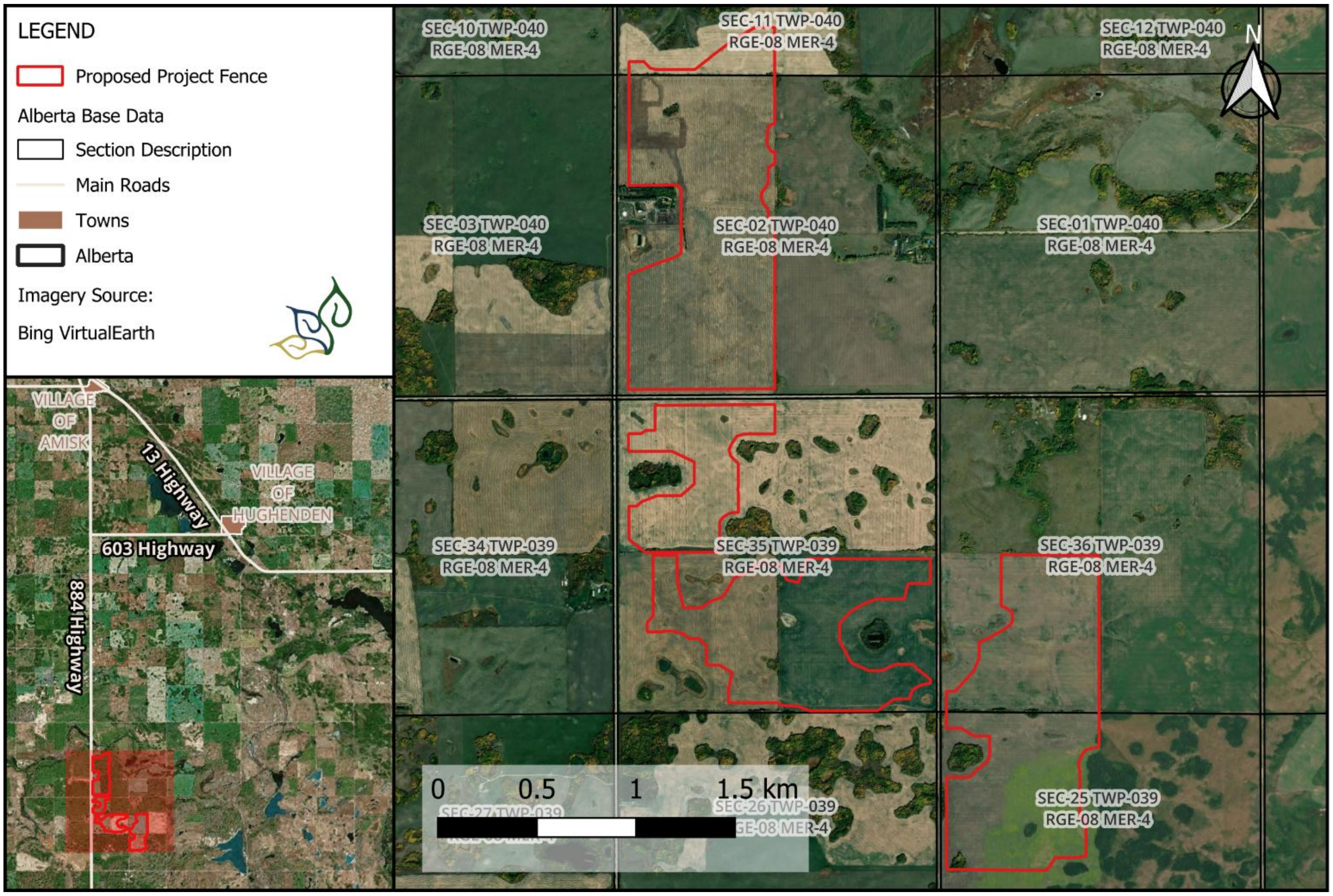


Figure 2-1: Project location and proposed project fence.

2.1 Solar Layout

The Project uses a fixed tilt racking system with 8.0 m (26.2ft) pitch spacing as shown in Figure 2-2. From the ground, there is about 0.8 m clearance to the lower panel edge, and about 3.1 m to the upper panel edge. There is 3.7 m of full height clearance. A map of the panel layout and further specifications are provided in Appendix A.

The Project fence, as shown in Figure 2-1 and Appendix A, is part of the solar layout and was sited to meet environmental and other project requirements. Although the Project fence may be used for grazing management, it is also an obstacle for equipment operation. The Project fence was considered when determining feasible agricultural uses and impacts.

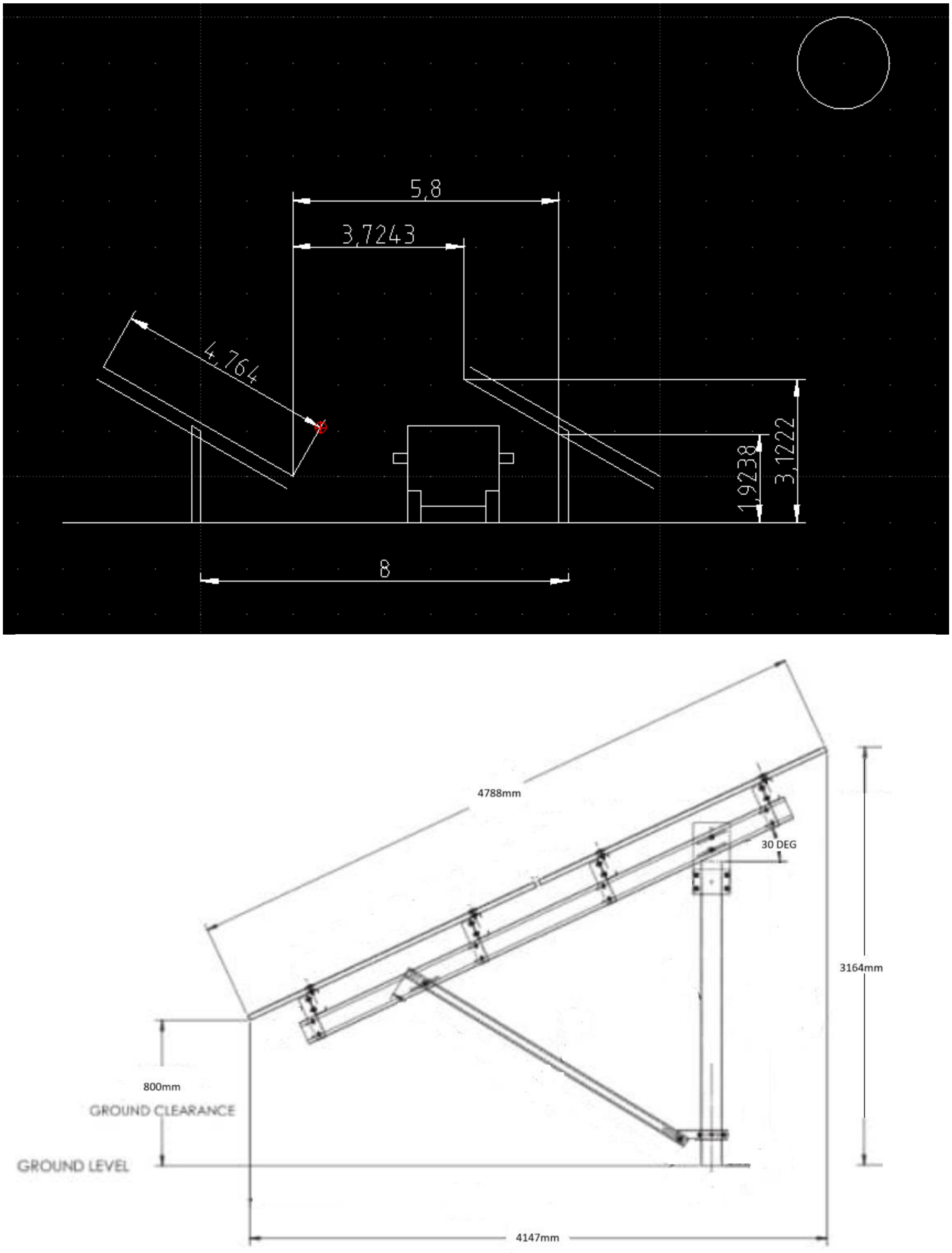


Figure 2-2: Panel arrangement and specifications.

2.2 Environmental and Soil Conditions

2.2.1 Ecoregion and Climate

The proposed Project is situated within the Central Parkland Natural Subregion (NSR) and is relatively close to the Northern Fescue Natural Subregion as can be seen in Appendix B. The Central Parkland Subregion is known for higher precipitation and lower evaporation than the Northern Fescue Subregion (Kupsch et al., 2013). Spanning from Stettler to Lloydminster, the southeastern Central Parkland Natural Subregion, has a mean daily temperature of 2.6°C and a total annual precipitation of 429 millimetres (mm) with the majority occurring between May and September (Kupsch et al., 2013).

The Central Parkland NSR has been modified over the past century through intensive cultivation and high rates of settlement in both urban and rural environments (Natural Regions Committee, 2006). The climate is intermediate between the dry, warm grasslands to the south and cooler, moist boreal forests to the north and west of this subregion. Scattered among the dominant cultivated landscape is a mosaic of aspen and prairie vegetation on remnant native parkland areas, typically occurring on hummocky till or eolian materials.

2.2.2 Soils

The Central Parkland boundary correlates closely to the boundaries of the agricultural regions within the Agricultural Region of Alberta Soil Information Database (AGRISID) and the Project is located in the soil correlation area 7 (Kupsch et al., 2013). This area is within the Vermilion Upland Eco District (Kupsch et al., 2013). The Project is located just into the thin black soil zone near the dark brown soil zone of Alberta.

As shown in Figure 2-3, the majority of the Project area is soil polygon 16781 which is an orthic black chernozem on medium textured (loam, clay loam) glacial till (EOR). The landform is hummocky with low relief (AGRASID, 2024). The secondary soil polygon in the Project is very similar, but with medium relief. A tiny portion on the south end of the Project area falls within a third soil polygon, with similar soils, but high relief. The areas of each soil polygon are presented in Table 2-1 along with the Land Suitability Rating System (LSRS) class for spring seeded small grains (SSSGs) from the Agricultural Regions of Alberta Soil Inventory Database 4.1 (AGRASID, 2024).

Table 2-1: Areas within the proposed project fence for each of the soil polygons.

Polygon ID	Map Unit Name	LSRS (SSSGs)	Hectares	Acres	Percent of Project Area
16781	EOR1/H1l	2HAT(10)	268.74	664.06	86.9%
16783	EOR1/H1m	2TM(10)	38.73	95.69	12.5%
16790	EOR2/H1h	4TM(8) - 5W(2)	1.80	4.45	0.6%
Total area of Class 2 Lands			**309.27**	**764.18**	**99.4%**

There are two agricultural assessments that can be made for land which includes the Land Suitability Ranting System (LSRS) in Alberta and the Canadian Land Inventory (CLI) nationally. The LSRS is a more recent assessment and as such is generally taken as the default assessment, but because they are based on different information and different scales, it is beneficial to understand how both systems rate the land.

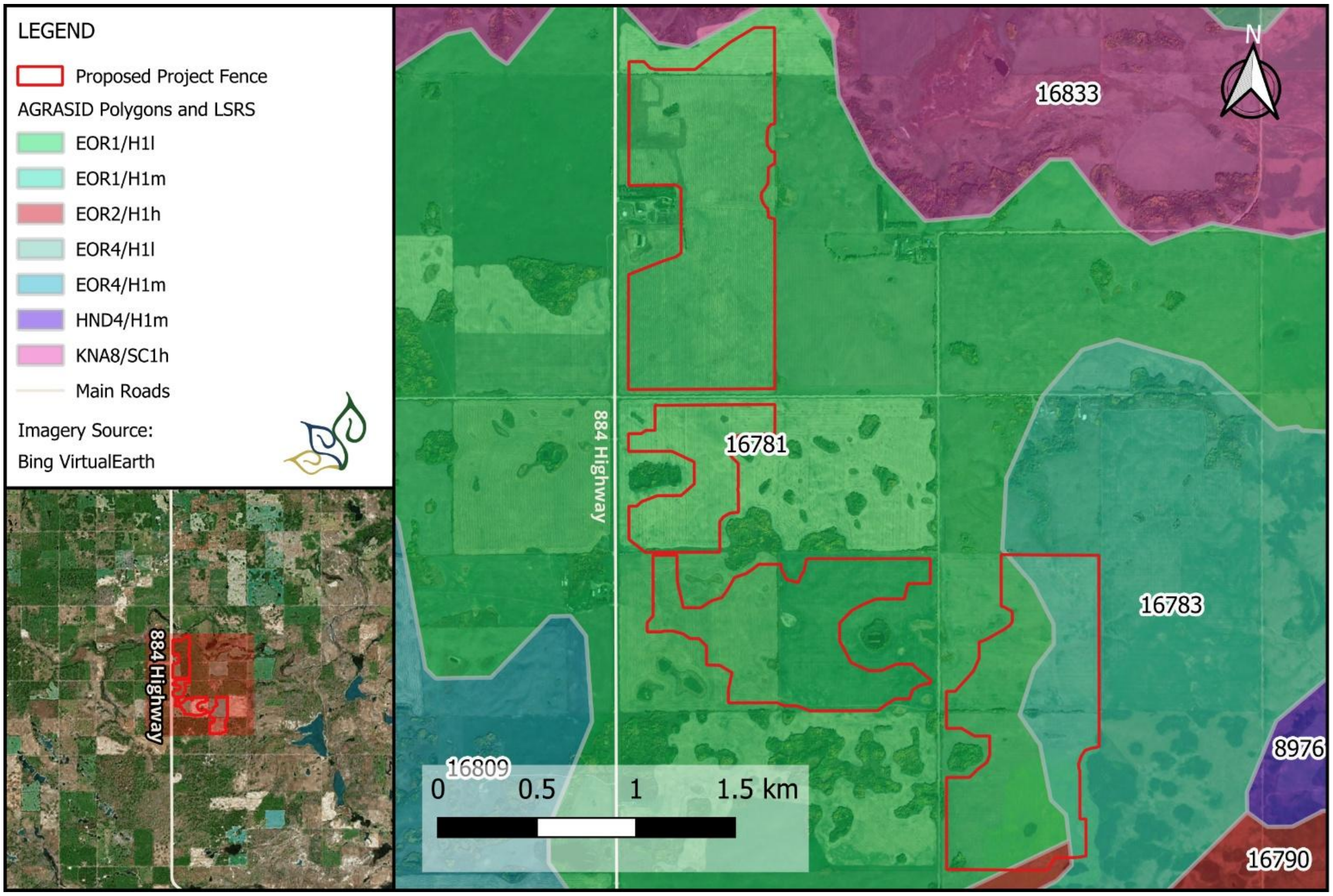


Figure 2-3: Soil polygons with LSRS for spring grains shown.

The LSRS classifies land suitability based on soil-climate-landscape potential and has identified the Project area is primarily Class 2 land (Table 2-1). Because the rating considers climate, there is no Class 1 land in Alberta. Class 2 land implies a slight limitation due to climate, and sometimes other factors like moisture and topography, but is still the highest rated land in Alberta. Overall, the soils on the Project area are suitable for spring grains, annual crop production and horticulture, which are some of the more valuable agricultural land uses in Alberta.

According to the Canadian Land Inventory (CLI), the agricultural soil class for most of the Project area (90%) is Class 3, with a combination of subclasses. This indicates a moderate limitation that restricts the range of crops or requires moderate conservation practices. The remainder of the soils (10%) have been identified as Agricultural Soil Class 6, which are soils that are capable only of producing perennial forage crops, and improvement practices are not feasible with a subclass indicating excess water (Government of Canada, 2023).

2.3 Existing Land Use

The Project lands are primarily used for annual crop production and forages. The cropping history gathered from landowners is presented in Appendix E and includes oats, barley, wheat, canola, peas and forage crops. Forage crops included corn grazing, swath grazing, silage, and yellowfeed.

Aerial photos and site assessments have confirmed existing land use and identified numerous watercourses and wetlands. Wetland presence has impacted both the solar layout and the agrivoltaic plan for the Project.

2.3.1 Current Irrigation Status

The Project area is not irrigated. Satellite imagery was reviewed for pivots, canals, and cropping patterns that would indicate if irrigation infrastructure present and no irrigation infrastructure was identified. Project landowners also confirmed that the land does not contain any irrigation infrastructure and has been used as a dryland agricultural system. The Project is not in, or nearby, an irrigation district. The irrigation districts in Alberta are all south of Township 29 (Government of Alberta, n.d.), and the Project is located further north along Townships 39 and 40. No Private Irrigation Water Licences were identified for the Project lands.

3.0 Agrivoltaic Literature Review

Agrivoltaics refers to a dual use system that simultaneously uses an area of land for both solar (i.e., photovoltaic) power generation and agriculture (Coşgun, 2021). Agrivoltaics can be adapted to many forms of agriculture including horticulture (e.g., outdoor or indoor greenhouse production), annual crop production, livestock production, and forage production (e.g., hay). The agrivoltaic systems that were considered for the Project include the production of annual grain crops, forages, grazing, and berry production.

Traditional photovoltaic power production, on its own, removes land from productive agricultural uses (Klenske, 2022). This results in a temporary land use change with no increase in overall agricultural output from the land, but instead simply provides a change in the output from agriculture to energy production. In contrast, agrivoltaic systems can result in total output per land area that exceeds either system alone. Land Equivalent Ratios (LER) calculations are a commonly used metric that provides a measure of the total output per land area. LERs balance the change in agricultural productivity and the change in electrical productivity to calculate the overall change in productivity. For agrivoltaic operations, LERs calculations typically result in a metric that is greater than one indicating an efficient use of land area (Amaducci et al., 2018; Campana et al., 2021; Dupraz et al., 2011). An overall increase of 35-73% in land output from synergies provided by utilizing agrivoltaic systems has been predicted by research (Dupraz et al., 2011). Agrivoltaic systems are viable uses of land that can produce both electricity and food in an efficient way.

3.1 Land Use and Agrivoltaics

The ability to produce agricultural products while also producing solar energy from the land has significant appeal at a national, provincial, and municipal scale. The positive economics resulting from multiple income sources from diversified products produced on the land base can support local industry and communities while contributing to the nation's economy.

The highest value land uses in Alberta include annual crop production and horticultural production, while grazing is often seen as a lower value land use. However, market trends, political events (e.g. tariffs), and production levels can result in changing revenues for various crops. Famers adapt to these changes and their own operational constraints to select crops for production. Similarly, exact land uses in an agrivoltaic system will need the flexibility to change with the economic environment.

3.1.1 Socio-economic Benefits of Agrivoltaics

The combination of photovoltaics (PV) and agriculture can be mutually beneficial to crop and solar energy production. Compared to facilities that produce only solar energy, agrivoltaic operations:

- conserve agricultural land base therefore aligning with municipal statutory documents for existing and future land use;
- provide long-term employment opportunities for the communities where projects are located, and;
- enhance the visual quality of solar projects by maintaining an agricultural aesthetic, reducing visual impact to adjacent lands.

3.1.2 Effect of Photovoltaic Infrastructure on Plants

The interaction of photovoltaics (PV) and agriculture may result in both positive and negative effects for each. Agriculture can have a positive impact on energy production. For instance, growing vegetation under PV panels can reduce daytime panel temperature resulting in increased energy production (Abidin et al., 2021; Barron-Gafford et al., 2019).The agriculture system can negatively impact energy production, due to factors such as increased spacing or increased dust. Solar infrastructure can in some cases have positive impacts on crop production, particularly when increased shading relieves moisture stress in hot dry environments. Conversely, shading caused by solar panels in cool moist environments may decrease productivity and increase disease pressure.

The interactions which occur between PV panels and the ambient environment have implications for agricultural productivity. The various conditions which can be altered by PV panels are displayed below in Table 3-1. PV panels can alter temperatures (Barron-Gafford et al., 2019; Coşgun, 2021), increase soil moisture (Barron-Gafford et al., 2019), decrease wind speed (Adeh et al., 2018), and reduce water use of crops (Barron-Gafford et al., 2019; Coşgun, 2021). These changes to microclimatic conditions result in a net benefit to plant growth, reduced drought stress (Barron-Gafford et al., 2019), greater food production, (Barron-Gafford et al., 2019) and a positive effect on PV panels by reducing heat stress (Barron-Gafford et al., 2019). The net result is that crops can have increased productivity in arid environments (Barron-Gafford et al., 2019), although impacts may vary by crop.

Temperature

PV infrastructure can alter temperatures although changes are usually small. The effects on plant growth depend on each specific species. Some research has noted that PV infrastructure has a minor impact on air temperature (significantly different on only 12 days of the season), mostly on calm, sunny days (Marrou et al., 2013). However, other research has noted that maximum daily temperatures can be as much as to 3 °C cooler during hot dry periods, and up to 2 °C warmer during cooler periods (Hudelson & Lieth, 2021). In one study, French agrivoltaic systems reduced soil temperatures in shaded areas by about 2 °C in (Marrou et al., 2013). Another effect of PV installations is that they can create a heated island effect similar to urban areas that raise the temperature within the installation (Barron-Gafford et al., 2019), but do not have the same effect on the surrounding ecosystem.

Soil Moisture

PV infrastructure can improve soil moisture conditions by changing the immediate microclimate which causes less evaporation and improved water balance. The presence of PV infrastructure can also result in improved water use efficiency which is beneficial to some plants causing an increase in overall productivity while lowering water input needs (Barron-Gafford et al., 2019). One study found that pasture grasses under PV infrastructure were 328% more water efficient (Adeh et al., 2018).

Wind Speed

Wind speed and direction can be altered by PV infrastructure, but changes are generally minor. The overall changes to wind speed depend on surrounding infrastructure. In one study, no significant impacts were noted on wind speed (Marrou et al., 2013), however other studies have found a significant reduction in wind speed (Adeh et al., 2018).

Shade

Shading from PV infrastructure can have negative impacts on crops by creating environmental gradients, which must be considered when preparing agronomic management. PV infrastructure can decrease solar radiation available for crop growth (Adeh et al., 2018). The ultimate impact of shading depends on the crop and the major stressors. Some species may have higher productivity due to shade while others are supressed by shade (Barron-Gafford et al., 2019). Shading may be beneficial during heat stress. The pattern of shading depends on panel arrangement. Arrangements such as checkerboard patterns or north-south orientations can improve the uniformity of light distribution (Cossu et al., 2018; Riaz et al., 2021). Additionally, panel density has more impact on radiation available for crop growth than panel tracking technologies (Amaducci et al., 2018). For example, one study found that changing spacing from 20 meters (m) to 5 m decreased crop yield by half (Campana et al., 2021). Photosynthetically active radiation was on average reduced by about 30% under tensile style panels with a row distance of 6.3 m and a height of 5 m (Weselek et al., 2021). In the absence of other stressors, decreased light is generally expected to decrease biomass accumulation and yields.

3.1.2.1 Microclimate

Microclimate modifications, such as increased shading from PV panels can vary depending on site conditions, including but not limited to location, topography, aspect and elevation. Furthermore, impacts of various microclimate modifications can have different impacts on different crops. Impacts can even vary with different varieties and stages of growth for the same crop. For example, shading in early stages of development can have substantial negative impacts, while shading in the heat of summer can reduce stress and improve plant growth. Additional examples of general interactions between solar arrays and crops are outlined in Table 3-1.

Table 3-1: Examples of factors that can influence how PV infrastructure is related to crop yields.

Factor	Category	Example
Crop Variety	Agronomic	There are a variety of differences in how crops respond to temperatures and stresses under solar panels
Crop Spacing	Agronomic	If light is limiting production than reducing plant populations can reduce competition between plants and improve individual yields
Panel Spacing	PV system	Influences light distribution, amount of shading, efficiency of equipment and operations
Crop type	Agronomic	Some crops are more suited to agrivoltaics, such as C3 crops with shade tolerance
Weather conditions	Environmental	Microclimatic impacts can bring daily conditions closer to the ideal growing conditions for the crop or be further from ideal

Factor	Category	Example
Stressors	Environmental	Shading can be beneficial if low moisture is stressing crop growth, but if disease was current stress than shading might have negative impacts on disease spread
Location	Environmental	Daylengths, sun angle, and other location parameters impact total radiation available
Panel height	PV system	More light scattering underneath with taller placement means less shading of the crop
Panel arrangement	PV system	Checkerboard or intermittent arrangements can mean less shading or more even shading Crop yields can be higher in north-south orientated panel rows than east-west rows (Austenson & Larter, 1969)
Panel type	PV system	Some panels block less light as they are more transparent
Crop Arrangement	Agronomic	Shade tolerant crops under panels and sun-loving crops between rows
Panel density	PV system	Portioning between energy and food outputs

3.2 Alberta and Agrivoltaics

3.2.1 Alberta Context

Alberta is located above the 49th parallel, and encompasses 64.2 million hectares (ha) of land of which 14% is in annual crop production. This represents a small percentage of the province, but a massive area, as the province of Alberta has a relatively large land mass. Solar development has largely been focused in cultivated areas which make up 20% of Alberta (Table 3-2). This means that solar development is commonly in competition with agricultural production. A modeling study found that solar power generation potential is greatest over croplands (Adeh et al., 2019). This due to similar environmental factors being favourable for both solar energy developments and crop production such as temperature, solar radiation, fewer wetlands, and flatter topography. The number of farms reporting solar energy production is increasing, with 8.7 % of farms in Alberta reporting solar production in 2021 (St.Pierre & McComb, 2023).

3.2.2 Alberta Climate and Crops

During the warmer months of July and August, lower moisture levels can often limit plant growth. When droughts occur, the duration of moisture stress is increased for crops. In these situations where moisture is limiting plant growth, shading from PV infrastructure can help to prevent moisture loss and improve growing conditions for crops.

Plants are often grouped into three categories on the basis of how they photosynthesize: C3, C4 and CAM. C4 plants tend to be adapted to hot environments and usually have higher light saturation points (Black, 1971; Pearcy & Ehleringer, 1984). Corn is an example of a C4 crop that is grown in Alberta. Most crops grown in Alberta, like wheat, oats, barley, and canola, are C3 plants (Table 3-3; Shooshtarian, 2021). Since C3 crops have lower light saturation points, they are generally better suited to agrivoltaic applications (Willockx et al., 2020).

Table 3-2: Production of key crops in Alberta adapted from Shooshtarian, 2021.

Key Crops in Alberta	10-year Average Production in '000 tonnes
Spring Wheat	8,593.9
Forages	8,382.2
Canola	5,764.9
Barley	4,563.6
Dry Peas	1,548.1
Durum Wheat	952.1
Sugar Beets	677.6
Oats	636.5
Winter Wheat	213.8
Lentils	196.9
Corn Grain	91.3
Flax	69.8
Fababeans	58.8
Dry Beans	58.5
Rye	44.6
Mustard Seed	39.2
Triticale	22.6

4.0 Recommended Agrivoltaic Systems

Not all agrivoltaic systems are appropriate in all situations. Therefore, consideration of the solar farm configuration, climate, soils and accessibility of markets must be considered to choose the appropriate agrivoltaic system for a specific project. An agrivoltaic system also requires that the landowner, the solar PV owner, or other third party can utilize the selected agrivoltaic system. This plan considers the current solar layout, project location and landowner and proponent input to develop a plan based on practical farming techniques that can be used in Alberta. The recommended farming activities for the site are Saskatoons, annual crops, forages, and grazing.

As shown in Figure 4-1, certain areas of the Project are designated for each of these activities (more detailed maps are provided in Appendix C). In addition to the solar layout, land history, and landowner input, this agrivoltaic plan prioritizes high value activities where feasible. This means that other agricultural uses may be possible, as shown in Table 4-1. Annual cropping is only suitable for areas without panels (panel spacing in this project is too narrow for cropping between rows). There is a significant area outside the project fence and some areas inside the project fence where panels are not located, and these areas can be used for annual cropping. Since Saskatoons are perennials, they will remain in the same area once planted. Grazing and silage or other forage production activities, such as haying, may be interchangeable in some circumstances, based on economic and landowner needs.

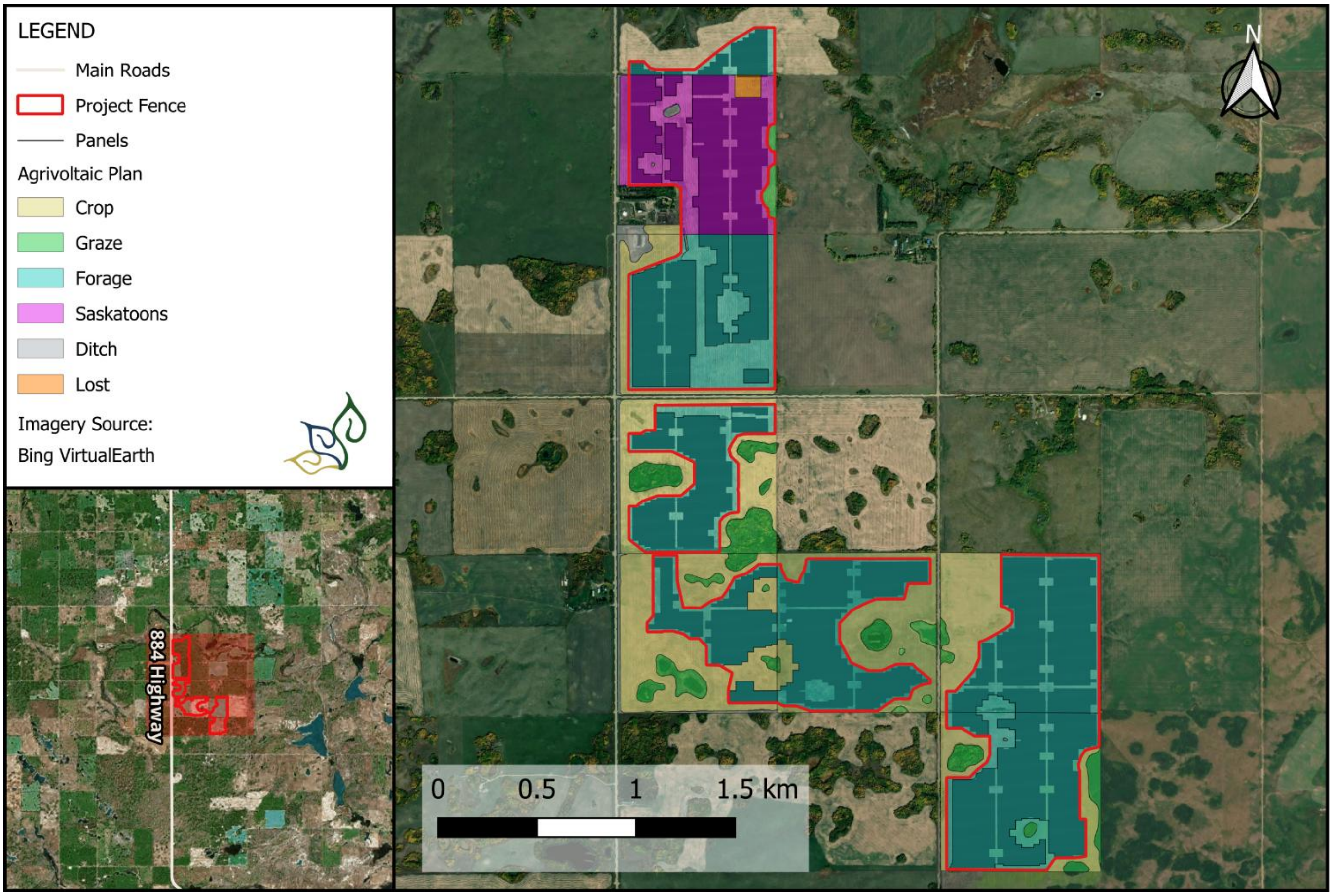


Figure 4-1: Agrivoltaic Plan Overview.

Table 4-1: Agrivoltaic areas and their compatible uses.

Designated Agrivoltaic Production Type	Possible Other Uses	Excluded Uses
Crop	Any – areas suitable for crop production can be used for silage, grazing, berries or any other use as needed by the landowner based on current needs	Most uses possible, similar to conventional systems
Graze	Much of the area designated for grazing, could also be used for hay or other forages, however some wetland areas can only be used for grazing.	Annual crop production
Forage	Most of these areas could also be used for grazing and can be used to produce a variety of different forages including silage and hay.	Annual crop production Saskatoons may not be possible in all forage areas, but most of the forage area could be used for Saskatoons.
Saskatoons	The Saskatoon area could also be used for forage production, including silage, hay or grazing. Other shrubs are also possible, such as black currents, haskaps, or dwarf sour cherries.	Annual crop production

Designated Agrivoltaic Production Type	Possible Other Uses	Excluded Uses
Ditch	Ditch areas (along roads, small wetland/tree areas) in some cases may be hayed or grazed, but were considered non-use (appeared to be presently unused in imagery)	Crops, silage, berries
Lost	This includes the substation area and several small strips of land that are difficult to access due to the project fence	Agricultural uses excluded

The agrivoltaic area used for mapping the agrivoltaic plan used the quarter section boundaries, minus the residence area on the NW-02-40-08-W4 and the area to the north of the project fence on the SW-11-40-08-W4 as shown in Appendix D Agrivoltaic Area. The agrivoltaic areas therefore includes areas both inside of and outside of the project fence as outlined in Table 4-2. The acres inside and outside of the panels is a general delineation of larger areas outside of the panels where productivity is unlikely to be impacted by shading and is not a strict outline of the panel boundaries.

Table 4-2: Breakdown of agrivoltaic areas for the Project.

Recommended Agrivoltaic Use	Outside the fence (no panels)	In fence, but no panels	Among Panels	Sum of Acres
Saskatoons	6.47	23.76	98.08	128.31
Crop	267	18.84	-	285.84
Forage	-	38.65	577.62	616.27
Graze	58.02	2.41	5.57	66.00
Lost				7.44
Ditch				19.04
Grand Total				**1122.9**

4.1 Saskatoons

Horticulture activities such as Saskatoon production generally provide the highest economic output per acre of land of any agricultural activity. Berries, like all fruits, may also benefit from lower light environments (Jain et al., 2021). The Project would develop a Saskatoon berry production agrivoltaic system on the north end of the Project area, covering about 128 acres as shown in Appendix C. Perennial grass cover would be established between the Saskatoon rows and the panels.

Eastervale intends to initiate horticultural production with berry production in one quarter section to establish the business concept and the paired land use methodology. Once established, the horticultural crop may be expanded to other quarters using a phased approach, gradually reducing forage crops areas that are suitable for horticultural land use. This will effectively use more project lands over time to produce high value horticultural crops thereby maximizing the overall use of high value agricultural lands in the MD of Provost.

The following sections provide a detailed discussion regarding berry production.

4.1.1 Saskatoon Varieties and Production

The Project intends to implement a horticultural solution by planting Saskatoons on one quarter section of the Project with the ability to expand to other areas of the Project, pending the success of the initial phase and market demands. Saskatoons are native to Alberta and as such, are well adapted to the site. There are many varieties available that are well suited to produce and harvest in an agrivoltaic system (Table 4-3). It is recommended that more than one cultivar is grown, to mitigate risks such as frost and yield variability (Spencer & Alberta. Alberta Agriculture and Rural Development., 2012a).

Saskatoons are a low maintenance shrub. However, during the early stages of establishment it is critical to ensure the shrub is not competing with other vegetation. Saskatoons have a very shallow root system and newly planted shrubs must be protected with a minimum buffer of 1.0 meter from other plants such as grasses and weeds. Chemical weed control prior to transplanting is recommended and mulch should be added to aid in weed suppression and moisture retention (Spencer & Alberta. Alberta Agriculture and Rural Development., 2012b).

Table 4-3: Most common Saskatoon berry varieties.

Cultivar	Average Yield	Average Height (meters)	Average Spread (meters)	Recommended Commercial Height (meters)	Recommended Commercial Spread (meters)	Harvest Season
Northline	High	4.0	6.0	2.5	~ 0.5	Late Cultivar
Smoky	Very High	4.5	4.5	2.5	~ 0.5	Mid Cultivar
Thiessen	High	5.0	6.0	2.5	~ 0.5	Early Cultivar

The orchard site characteristics can influence Saskatoon berry productivity and reduce limiting factors such as pests and disease. Saskatoons are tolerant to most soil types but are most productive in well drained soils with neutral pH and with 2 to 3 percent organic matter content (Spencer & Alberta. Alberta Agriculture and Rural Development., 2012b). The topography should allow for adequate drainage. Flat terrain and/or gentle slopes are suitable, but planting shrubs in areas at the slope bottom should be avoided due to the potential for soil be waterlogged and the micro-climate inducing frost damage. Other considerations include climate conditions and microclimatic conditions. Some examples include southeast and west slopes where there is reduced snow coverage, prevailing winds, early spring exposure bringing early flowering and northern facing slopes that have reduced sun exposure (Spencer & Alberta. Alberta Agriculture and Rural Development., 2012b). Shading in the agrivoltaic system will mimic north facing slopes with reduced sun exposure. Therefore, the microclimatic impacts from panels are expected to be beneficial for berry production.

Other considerations include wildlife such as birds, deer, moose and coyotes, which have been known to feed on Saskatoons. Perimeter fencing will be in place to help manage these concerns and additional management techniques can be adopted as needed.

The height of these shrubs are a potential concern for agrivoltaic operations, as Saskatoons can grow to 6 m (Tannas, 2004). However, pruning to about 2 m is recommended (Alberta Agriculture and Rural Development, 2012) and is standard practice for Saskatoon berries. The frequency of pruning requirements would vary across the different varieties under consideration. Generally, regular pruning will keep the shrubs productive and stimulate lateral growth, which would be beneficial for the method of pruning needed in an agrivoltaic system.

4.1.2 Establishment and Production Needs

Typically, planting machines and water wheel planters can be used for installing Saskatoons. Two to four labourers would be required for this component of the work and labour will be locally sourced where possible. A secondary option is to utilize tree planting crews. They can easily install this volume of plants with installation speeds between 1500-2500 plants per day installed per planter. A determination on how planting is completed will be made at a later date, depending on the finalized plan for agrivoltaics in the Project area.

The foregoing provides an estimate of timing for annual labor requirements:

- Fertilization is typically completed in the spring; however, fertilization timing may vary depending on the crop needs.
- Ongoing cultivation will not occur around the berry plants. Grass will be established outside of the berry rows prior to planting. Mulch will be laid around the base of the plants. This helps to retain moisture, reduce water needs and supresses weeds effectively. Mulch has been utilized very effectively in other Saskatoon farms within Alberta. Mulch application would only require one to two people to complete, using equipment.
- Pruning would occur in the dormant season (i.e., winter to early spring) and could occur between February to April depending on the amount of snow cover, seasonal weather, and annual farm plan. Mechanical pruners are available for Saskatoons and currant shrubs that remove side shoots, resulting in more compact shrubs and better growth conditions, which contributes to a higher yield and improved fruit quality. For example, the ROCH currant shoots cutter is used especially for currants and Saskatoons. There are a variety of tractor front/back pruning machines available in Canada. Pruning may, in certain growth periods, require higher labour support relative to other tasks, but it is anticipated that staffing would be handled by the berry farmer.
- At this time, there is no specific plan in place with respect to the need for bird deterrents. Netting is unlikely to be used as it is not practical at this scale. A finalized plan for agrivoltaics in the Project area will be completed in consultation with the berry farmer, and will identify whether and how bird deterrents will be managed including any labour that may be required.

Watering is required to establish young plants and is recommended for the first two years to assist with plant survival and establishment. Once the plants are established, supplemental irrigation may increase production, but is not necessary. However, many water sources exist in and around the Project area, so irrigation may be set up as required.

4.1.3 Harvesting and Spacing Needs

Orchard design must be carefully considered. Hand harvesting allows for narrow row spacing but is not economical for large-scale berry production. For operations larger than 40 acres mechanical harvesting is more feasible and economical than handpicking (Spencer & Alberta. Alberta Agriculture and Rural Development., 2012a). There are two primary types of mechanical equipment that can be used for berry harvesting; an upright harvester (over-the-row) and sideways harvester. There are limited equipment options that provide a combination of these two harvest techniques.

According to the University of Saskatchewan Fruit Program, there are a few factors to consider when selecting harvest equipment. An upright harvester is self propelled therefore more compact relative to a sideways harvester. This reduces the amount of space required to navigate equipment within the agrivoltaic operation. In addition, this harvester is ideal for taller shrubs (greater than 2-2.5m), however, it has a greater potential to damage the fruit. A sideways harvester requires additional equipment such as a tractor for propulsion but is ideal for shorter shrubs and accommodates a wider shrub spread. This machine may jam easily or break branches if they are brittle. The ideal machinery for an agrivoltaic system to accommodate limited spacing while maximizing yields is self-propelled, over-the-row with mirrored sideways, V-shaped shaking system with harvesting capability requiring 3.2m between rows for optimal spacing. This reduces the space required between rows while reducing production loss.

Regardless, harvest machinery should be closely monitored for performance as slight adjustments such as reduced vibration can ensure the successful harvest of ready fruit. In addition, 3-5 people are required to operate the equipment to operating, loading and stacking trays. Additional personnel monitor the efficiency of the harvester and suggest adjustments.

The Saskatoon shrubs will be specifically planted to prevent any significant shading of the panels. They will be located on the north side and in the shadow of each row of PV panels, which have a maximum height of roughly 3.4 meters. Figure 4-2 indicates relative positioning of shrub height and panels, to avoid shading the PV panels.

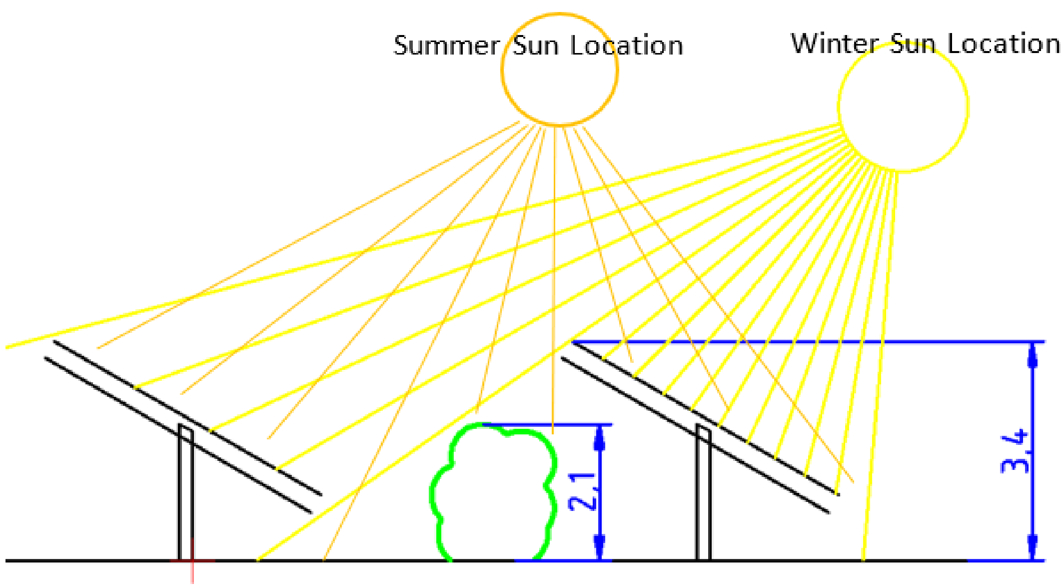


Figure 4-2: Placement of shrubs to minimize impacts to panels.

4.1.4 Processing

Close processing equipment and infrastructure must be considered, to ensure product quality. Harvested fruit must be brought down to a temperature between 0 degrees Celsius to 5 degrees Celsius (or frozen) within hours of harvesting to maximize the post-harvest lifespan of the fruit. This is best achieved by placing fruit in portable or permanent coolers immediately following harvest and prior to sorting. Once the ideal temperature has been reached, the berries must be sorted according to user-defined accept/reject thresholds. Infrastructure for housing, sorting, and packaging equipment must be considered. Produce pricing is market-driven, and typically

90 percent of fruit is frozen to maintain quality and provide opportunities for additional processing. Onsite equipment that provides individual quick freezing of fruit aids with high quality fruit preservation, and provides simplified packaging options.

4.1.5 Additional Horticultural Shrub Considerations

The orchard site conditions, equipment and processing of Saskatoon berries is like other berry crop production requirements and therefore may be considered as an additional or alternative horticultural crop without the need for extensive upgrades. Some other shrubs that would also be possible in the system are shown below in Table 4-4.

Table 4-4: Similar shrubs to consider within an agrivoltaics operation.

Cultivar	Average Yield	Average Height (meters)	Average Spread (meters)	Recommended Commercial Height (meters)	Recommended Commercial Spread (meters)	Season
Black Currants	High	1.5	1.5	2.5	~ 0.5	Mid Cultivar
Haskap	Very High	2.0	1.2	2.5	~ 0.5	Early Cultivar
Dwarf Sour Cherries	High	2.0	6.0	2.5	~ 0.5	Late Cultivar

The processing facility could provide processing services to offsite berry producers to maximize equipment utilization throughout the harvesting seasons.

4.1.6 Exporting and Food Certification

For food exports such as berries, there is specific certification required. This must be completed by the exporting entity. Currently there are very few federally licenced companies that export Saskatoons. A processing facility with expert certifications would be a significant asset. In addition, many domestic companies (grocery stores) ask for these higher levels of certification for domestic sales. Export capacity and food safety standards at the processing facility would increase revenue opportunities and allow for a much larger farm to exist. At a minimum, Canadian Food Inspection Agency (CFIA) certification is required.

4.1.6.1 International Trade

All international exports of Canadian agricultural products must be compliant with the requirements of the Canadian Food Inspection Agency (CFIA) and meet the requirements of the importing country (Government of Canada, 2023). The export process begins with a compliant food commodity and requires a valid CFIA export license or registration. These processes demonstrate to the CFIA that preventive control measures are in place and Canadian agricultural commodities will not pose a risk to the foreign public. The CFIA will submit requests to foreign countries receiving exported products on behalf of Canadian producers with a valid licence or registration.

A Preventive Control Plan (PCP) is required by businesses involved with the manufacture, preparation or labeling of food products. This plan demonstrates how hazards and risks to food commodities are controlled. This plan should cover the entirety of operation performed by the producing company. Export businesses will require documentation from suppliers that verifies the appropriate safety measures are put in place during food production. A large portion of the PCP is dedicated to the product traceability and lot accountability which enables products from a specific lot to be recalled in the event of an emergency.

The specific Acts and Regulations which are pertinent to the export process will depend on the type of food commodity being exported. Compliance with additional requirements from the foreign competent authority will be necessary before export. A guide to foreign country requirements is available on the CFIA website.

An abridged version of the requirements for agricultural food export are provided below.

General Requirements:

1) Valid export licence or registration;
2) Food product is manufactured in accordance with Canadian regulations;
3) Preventative food safety controls are in place;
4) Awareness of fees for certification, inspection, and sampling for agricultural products;
5) Traceability procedures in place for export products including suppliers and buyers ahead and behind in the export process;
6) All documents and records required for export;

Foreign Country Requirements

7) Awareness of requirements of the importing country;
8) Business is listed as an eligible establishment in the receiving country; and

Food-specific Requirements

9) Agricultural product meets the foreign certification body requirements, as well as those of Canada which have been recognised by the foreign authority.

4.1.6.2 Inter/Intra Provincial Trade

Agricultural products that are traded within and between provinces do not require a CFIA licence specific to that product. However, the product must have been manufactured, processed, treated, preserved, graded, packaged or labelled by a licence holder. A licence holder is an individual who has been issued a licence under paragraph 20(1)(a) or (b) of the *Safe Food for Canadians Act*. This paragraph authorizes a person under a licence or registration (and under certain circumstances) to trade food from one province to another (Government of Canada, 2023).

4.1.6.3 Retail/Food Supplier Sales

Food safety certification can provide an opportunity to supply food retailers such as grocery stores with produce. This recognition indicates the product has undergone rigorous testing and the producer has adopted the highest standards of food processing. This comprehensive implementation of food safety and quality management system is required to reach this market.

4.1.7 Local Resource Requirements and Community Engagement

Other considerations include resource requirements throughout the year and during harvest season. For a typical berry crop production that covers a quarter section, a minimum of two full-time staff are required during the growing season to maintain shrubs with pruning and vegetation management (weed control). During harvest, a minimum of 3-5 people is required to operate the harvester equipment, load and transport the harvested berries from the field location to cooler location. An additional 15-20 personnel are required to complete the processing, separating, packaging of fruit during the harvest season.

4.2 Annual Crop Production

Annual crop production in a major agricultural activity in the area. However, 10m panels spacing is preferred for equipment operation and better yields, which spacing typically requires a much larger land base to produce the same electricity yields. The row spacing for this Project is 8m, so annual crop production between rows of panels is not recommended.

Annual crop production is recommended within the Project but outside of the solar panel arrays. The majority of the annual crop area is planned to occur outside the project fence (due to various setbacks and buffers) and a few large areas within the fence where no solar arrays have been placed. These areas inside the project fence without panels are suitable for growing annual crops. Not all equipment used by all landowners will be suitable for the agrivoltaic system. However, sufficient common equipment is available for economic use of these areas (see Equipment Section). Annual crops were selected for areas with no panels, and as such, annual crop production on these lands remains very similar to traditional practices.

4.3 Forage Production

Forage production is planned for both open and paneled areas inside of the project fence (Table 4-2) as shown in Appendix C. Forage production can include silage and hay from annual or perennial crops. Silage is a high moisture feed typically made from annual cereal crops, often using varieties developed to produce higher forage biomass and less seed. Crops commonly used for silage include oats and barley, and sometimes rye, triticale, or corn. Given that corn is a C4 crop and is therefore more sensitive to reductions in light and heat, it was not considered as a practical option for silage production in the agrivoltaic system. Cereals may also be grown with legumes like peas or faba beans to increase the feed quality of the silage product.

Hay is most typically made from perennial forage crops that include grasses like smooth brome, crested wheatgrass, meadow bromegrass, or other grasses often with a legume like alfalfa. Harvesting hay includes cutting, raking, and baling, although raking (or swath turners) is not always practiced in all operations. Haybines, self-propelled harvesters, mower conditioners, and various other cutting equipment is available.

Although establishment of forages can require similar equipment to annual crop production, it has several advantages at harvest. First, harvesting equipment for forages is commonly available in narrower widths. Second, forage production produces less dust than grain production as plants are at a higher moisture content during harvest. Third, unlike grain production, which needs relatively uniform maturity for harvest, forages have a wide range of acceptable harvest maturity.

4.3.1 Management Considerations for Silage Crops

Growing conditions and stressors change throughout the growing season so regular scouting should be completed by farmers or agronomists to ensure the successful growth of the crops. Crop management can mostly follow standard practices, with a few additional considerations. Fertilization rates should be adapted to the expected yields in the agrivoltaic system. In addition to traditional weed management, sheep can be used to clean up weeds along panels after harvest.

A consideration that should extend to construction and maintenance activities, is that the choppers in a silage harvester are easily damaged by foreign debris. The site needs to be kept free of garbage, to minimize the risk of equipment damage.

4.3.2 Forage Production Impacts

A study in Oregon found that pasture grasses under solar panels were 328% more water efficient (Adeh et al., 2018), which resulted in 90% greater biomass production. The study area of research conducted by Adeh in 2018 was in a water limited environment. Another study in Germany, conducted over two years, found a yield reduction of 5-8% for a grass-clover mixture but this yield reduction was less than other crops in the study (Weselek et al., 2021).

4.3.3 Height and Spacing Needs

Since forages are less sensitive to shading than most grain crops, less space would be required between rows to minimize yield impacts. The main consideration for panel arrangement in forage-based agrivoltaics is equipment requirements. Equipment for haying and managing forages is available at narrower widths than those for grain crops. Therefore, areas where forage is grown can likely be combined with tighter panel arrangements. For example, a German study reviewed bifacial PV panels with a row distance of 6.3 m (a row width of 3.4 m) and a clearance height of 5 m (Weselek et al., 2021), while the Oregon based study had panels about 1 m high and 6 m apart (Adeh et al., 2018).

4.3.4 Forage Crop Utility

Annual forages are the second largest crop in Alberta by volume (Table 3-2). With over 40% of Canada's beef herd in Alberta (St.Pierre & McComb, 2023), it is understandable why forages are an important crop in Alberta. The use of the site for forage production shows a modest increase in economic value over grazing alone; therefore, forage production should be considered for the Project. The proposed panel spacing allows for effective use of the site by haying equipment that is of a standard commercial size. Hay production would also allow for weed control and prevention of erosion on the site. The only requirement for hay production is buried cables (below 30 cm) so that equipment can pass between each row of panels.

Forage lands may also be converted to Saskatoons, once the berry operation is established. This will be considered in a sustainable manner suited to the business case, growing success on the lands and local interest.

4.4 Grazing

Grazing is a small component of the plan with only about 66 acres of land designated to grazing (Appendix C). However grazing can be implemented in any of the agrivoltaic areas, especially the forage areas. It is also possible to have post-harvest grazing on the forage and crop lands, however post-harvest grazing was not included in the revenue analysis.

Sheep grazing is an easily implemented agricultural activity for solar facilities, but also tends to provide less agricultural revenue than some other options. It is recommended for its benefits of providing permanent vegetation cover and weed control, but where higher-value crops are available, they will likely be prioritized by the farmer. The only requirement for sheep is to ensure that wiring is protected or buried to prevent the sheep from chewing on them. Grazing allows maximum area to be utilized. Especially with temporary fencing, inconvenient and isolated areas can still be used for agricultural production by grazing. This includes areas like the those outside the project fence on the west side of NW-02-40-08-W4 (Appendix C), that would be otherwise difficult to utilize.

Any of the forage crops mentioned in the previous section, as well as native forage blends, would be suitable for grazing. Although the beef industry is well established in Alberta, sheep are the most proven grazing animals in agrivoltaic systems.

4.4.1 Height and Spacing Needs

PV panels will likely provide sufficient summer shelter, but water infrastructure will be required for grazing. The site should be reviewed before beginning grazing to ensure animal safety and well-being.

An advantage of grazing is that animals can graze right up to panel bases, whereas any alternative with equipment will require a few inches on either side to prevent damage to equipment and PV infrastructure. Sheep are a good choice because they are easy to handle with minimal handling facilities.

4.4.2 Grazing Management Considerations

Grazing management is both an art and a science that requires adaptation to current conditions while applying knowledge of both the livestock and forage resources. Guidance is provided on some key elements of grazing management as they relate to the agrivoltaic system in the following sections.

4.4.2.1 Fencing

Fencing allows for animal and pasture management, and in an agrivoltaic system it allows facility operations to occur while grazing. There are many options for temporary fencing used by producers. Temporary fencing will allow landowner preferences to be switched and allow for the small parcels to be utilized. Any key infrastructure that is particularly sensitive or poses a risk to animal health should be fenced off. Pre-grazing inspections should be completed before animals arrive for grazing to identify hazards and ensure fencing and other mitigations are implemented prior to animal arrival.

4.4.2.2 Animal Husbandry

General best management practices for livestock management should be followed including vaccination, regular monitoring, and mineral supplementation. Supplements can be used to help manage animal distribution. Contractors grazing in the agrivoltaic system should be competent in animal husbandry and be given onsite orientation.

Lambing is not recommended in the solar farm area. Lambing requires extra monitoring and facilities that may be an inconvenience in the agrivoltaic system. It is also a stressful time for livestock and lambing in their home environment would be preferred. Contractors or landowners should make plans to lamb outside of the Project site by adjusting their lambing schedule around their grazing schedule.

PV panels provide sufficient summer shelter. The site should be reviewed before beginning grazing to ensure animal safety and well-being. Wiring should be either protected or out of reach, to prevent chewing and rubbing that may impact infrastructure performance and animal health. A field-based risk assessment will allow contractors and management to identify and mitigate risks to animal health before the grazing season.

4.4.2.3 Watering

In addition to shelter and feed, sheep will need access to water. There are several existing dugouts evident in imagery that could potentially be used as water sources. Additionally, a wide range of totes are available for temporary water sources that would not require any permanent infrastructure in the solar layout. This type of watering also allows for additional distribution management by changing up the watering locations. Regular access to water is essential for the well-being of livestock, especially during hot periods. Livestock managers should be responsible for regular provision and monitoring of water sources during the grazing period. This watering system can also be used in the cropping area, if desired.

4.4.2.4 Grazing Systems

Many possible grazing systems exist, but rotational grazing is a common best management practice for maintaining healthy forage crops and building soil health. The separate pasture units allow for rotational grazing. The carrying capacity calculations assume that productive species are maintained in the stand which requires that plants have effective rest periods to recover from grazing. Rotational grazing provides this opportunity for rest.

4.4.2.5 Additional Vegetation Management

Grazing is an important tool to maintain vegetation height in the solar farm. Increasing management intensity will ensure more complete and uniform reduction of vegetation. With good herd management the need for additional vegetation management under the panels should be mostly eliminated. Invasive weeds may still be present, and should be managed according to provincial legislation. Many weed management tools are compatible with grazing. Sheep grazing is a tool to help manage weeds as sheep frequently include weedy type forbs in their diets. This approach will help to minimize the need for other management tools such as herbicides.

4.4.2.6 Range Management Principles

Managing the forage resource requires adaptive management to meet current conditions and Project needs. However, there are some key principles of grazing management that should always be taken into consideration when adapting the grazing management plan to current needs. These widely accepted basic principles are:

1. Balance livestock requirements with available forage;
2. Provide effective rest after a grazing event;
3. Avoid grazing during vulnerable periods; and
4. Distribute animals evenly across the landscape.

5.0 Equipment

The following is a discussion regarding equipment that would work in the agrivoltaic system. There are multiple options for most equipment that is required for the agricultural operations intended for the Project.

Seed Bed Preparation (Tillage) Equipment

With wider row spacing, there are more equipment options for tillage. An offset disk would be used for primary tillage and debris management in this scenario. Kello Bilt offer various styles and sizes including the model 225 which is available in widths from 10’2” (3.1m) to 16’9” (5.1m).

Secondary tillage would have more options, such as a rotary tiller such as those manufactured by Sovema. These are also available in various working widths. An example would be the model RTX-2 which is available from 1.8m up to 3m. These would be for secondary tillage and final seed bed preparation. Other options such as a field cultivator from CaseIH are small enough to fit between the panels.

Seeding Equipment

Suitable seeding equipment includes:

Box drills:

- John Deere 1520 double disc drill 15' (4.5m);
- John Deere 1590 no-till drill 10' (3.0m) and 15'(4.5m);
- Great Plains minimum-till drill 12' (3.7m), 15'(4.5m), or 24' (7.3m).

Air drill:

- Great Plains NTA 2007 (6.1m) and NTA 3007 (9.1m).

Crop Management Equipment

Crop management can include herbicide, fungicide, or natural spray applications. Demco, Fimco, and John Deere all have 3-point hitch style sprayers that could be used in the proposed spacing.

Forage Crop and Haying Equipment

Equipment for hay cutting will be limited to self-propelled options and pull-type equipment. All major equipment manufactures with haying equipment will have a self-propelled option. The example used for this is the New Holland speed rower. The speed rower has two available cutting heads that are under 6 m. The first is the conventional sickle-style haybine, which is 14'3" (4.3m) wide, and the Durabine 416 disc-cutter, which is 16'3" (4.9m) wide.

Hay rakes are used to assist with the drying process. There are two styles offered by various manufacturers that would be applicable for a 6m working width. Both bar rakes and rotary rakes are suitable options.

There are two options for baling that are applicable: small square bales, and round bales. Round bales are produced in various sizes and balers are available from several manufacturers. Any round baler will be able to be used between the panels. Small square balers are available in two styles: offset and inline. An offset baler would not be recommended for us ebetween panel rows because it puts the baler off to the side of the tractor. The larger width allows room for this, but is not always easily managed because equipment will need to pass through each row between panels twice to cover the width in many circumstances. An inline small square baler puts the baler directly behind the tractor. There is currently only one option for an inline small, that is the Massey Ferguson 1800 baler. With small square bales, bale handling also needs to be a consideration. For this, a bale accumulator is used. Norden MFG is a company that makes an accumulator, which is pulled behind the baler and groups them for easy pickup. Norden MFG also makes a bale grabber, which is mounted on a skid steer or tractor loader and can pick up the groups of bales and move and stack them.

Silage Harvesting

Fendt has a couple of options for silage harvesters with working widths under 7.0 m depending on the header attachments used. The taller body of the harvesters are typically on 3 to 4 meters wide, which will allow harvesters to clear the top edge of the panels. Claas has headers from 5.13 to 5.96 meters wide. Pick-up headers can be used if the crop is cut first, and the pick-up headers are narrower. John Deere has a 4.5 m wide pick-up header available.

Silage can be trucked with traditional tandem trucks normally used for hauling. With average yields, the harvester should be able to do an entire row with one truck. Most of the panel rows in the Project are less than 1 km long. However, the north end of the NW-East sector has a few rows that are about 1.4 km and on high production years this may require heavier trucks or other adjustments to make the full row length.

GPS (Global Positioning Systems)

Highly accurate GPS systems are available to support farming with narrow clearance between panel rows. With the use of a base station, various real-time kinematic GPS products can have accuracy levels of about one centimeter to one inch. These types of GPS systems will support equipment operations between panels while reducing collision risks with solar infrastructure.

Table 5-1: Links to equipment referred to this section.

New Holland	https://agriculture.newholland.com/en-us/nar/products/haytools-spreaders/speedrower-plus-sp-windrowers
New Holland	https://agriculture.newholland.com/en-us/nar/products/haytools-spreaders/windrower-headers
John Deere	https://www.deere.ca/en/seeding-equipment/
Great Plains	https://www.greatplainsag.com/en/implements/united-states/drills
CaseIH	www.caseih.com
Sprayers	https://www.demco-products.com/agriculture/application-equipment/sprayers/three-point-sprayers/rm-series-150-200-gallon
Sprayers	https://www.topairequip.com/3pt-sprayers/300-gallon/
Tillage	https://kello-bilt.com/products/offset-discs/84-model-225-offset
Haying	https://www.nordenmfg.com/product/accumulator-systems/
Tillage	http://sovemacanada.ca/catalogue/shop/soil-preparation/rotary-tillers/fixed/rtx-2/
Grains	https://www.macdon.com/products/d-series-draper/d65-series
Haying	https://www.masseyferguson.com/content/masseyfergusonglobal/en_ca/products/hay-and-forage/square-balers/mf-1800.html
Balers	https://www.deere.ca/assets/publications/index.html?id=ac5ef2b8#24
Horticultural	https://weremczukagro.com/en/products/prunning-machine/

	https://littauharvester.com/
Fimco Sprayers	https://www.fimcoindustries.com/category/sprayers/3-point-sprayers/
Silage Harvesters	https://www.fendt.com/int/agricultural-machinery/forage-harvester/fendt-katana https://www.claas.com/en-kr/agricultural-machinery/forage-harvesters/direct-disc https://www.deere.com/en/hay-forage/harvesting/self-propelled-harvester-heads-and-pickups/46r-hay-pickup/
GPS Systems	https://www.fieldbee.com/blog/accuracy-of-gps-why-does-it-matter-in-farming https://hawkexcavator.com/hawkvision-rtk-gps/ https://www.outbackguidance.com/

6.0 Disease Prevention

Reasonable measures should be taken to prevent disease establishment and to minimize the potential spread of clubroot to other land and property. Examples of such measures include the following:

- Clean equipment when leaving infested sites or areas;
- During wet conditions avoid equipment traffic where reasonable. This may include minimizing what equipment is used and where possible avoiding rutting of the soil and movement of excessive soil around on equipment. Equipment that does pick up excessive soil should be cleaned afterwards as a mitigation, and;
- Prepare and follow biosecurity protocols for staff and contractors.

Disease prevention measures should be taken both during construction and operations of the Project.

7.0 Agricultural Impacts

7.1 Agricultural Land Impacts

The Project is sited on Class 2 agricultural lands (see Soils section), which are the highest quality agricultural lands in the Province. There are approximately 4.1 million hectares (ha) or over 10 million acres of Class 2 land in Alberta (Government of Alberta, 2018). The Project fence encompasses 309 ha or 764 acres, which amounts to 0.007% of Alberta’s Class 2 agricultural land. Considering the Project footprint out of the 542,362 acres of Class 2 land in the MD of Provost, the Project impacts 0.057% of Class 2 land within the MD's boundaries.

7.2 Potential Production Impacts

Areas within the panel arrays may be impacted by shading. Since this project is in the Central Parkland NSR a slight reduction in productivity is expected in paneled areas due to reduced light. Published literature on production impacts in relevant crops were reviewed to consider possible production impacts. Research specific to Alberta ecoregions and to each crop type are not available, but considerations to general trends and research in other locations was considered when determining potential impacts to each of the recommended production systems.

Winter wheat

Previous studies on wheat and winter wheat grown in agrivoltaic systems have been completed in Europe (Weselek et al., 2019). On 9.5 m row widths, winter wheat yield was reduced by 19% in the first year and increased by 3% on a hotter drier year in a German study (Trommsdorff et al., 2021; Weselek et al., 2021). In France, durum wheat grown under two different PV panel densities matured 2-3 days later than the control (Marrou et al., 2013). In addition to impacting yield, shading can also impact wheat grain quality (Li et al., 2012).

Barley

Barley is well adapted to Alberta; more barley is grown here than in any other province (St.Pierre & McComb, 2023). Researchers in Oregon have reported that barley grows well in their agrivoltaic systems (Bellini, 2020). However, yield losses beneath panels are still expected (Trommsdorff et al., 2022). A Korean study found that barley production under PV panels was 11.5% lower (Nam et al., 2021; Turan et al., 2021). Barley is known for better tolerance of cooler climates and this may be linked to the lower drops in yield in agrivoltaic systems.

Oats and Other Cereals

Minimal field research has been completed on oats and other cereals in agrivoltaic systems. However, a modeling study in Sweden considered oats, and found that the optimal row spacing for this crop was 9.2m to optimize contributions of both electricity and crop production (Campana et al., 2021). Impacts of agrivoltaics on the productivity of cereals other than wheat have been generally expected to be neutral (Benghida & Sabrina, 2019; Jain et al., 2021).

Peas and Other Pulses

Peas are the main pulse (legume) crop grown in Alberta, and are well adapted to local conditions. Peas are a cool season crop and temperatures over 25 °C during flowering can cause flower abortion (Alberta Pulse Growers, 2023). Reduced temperatures near PV panels could reduce heat stress, however severe shading can also cause flower abortion (Meadley & Milbourn, 1971). Specific research on peas in agrivoltaic systems was not found. However, shading studies have found decreased levels of photosynthesis, decreased leaf area, and reduced biomass (Akhter, Hasanuzzaman, et al., 2009; Akhter, Rahman, et al., 2009). At 75% of full sun, biomass was similar to full sun but results depended on the variety of pea used (Akhter, Rahman, et al., 2009). Based on the characteristics of peas, neutral to negative impacts could be anticipated, but would need to be tested.

Faba beans are sometimes grown in silage mixtures. Faba beans were predicted to have neutral to slightly positive outcomes under agrivolatics in Spain (Moreda et al., 2021), but in Alberta this impact is less likely to be positive.

Silage and Forage Crops

Recent research evaluated the forage quality of durum wheat in Italy and found that yield was reduced, but the percent of protein and the calcium to phosphorous ration was improved (Dal Prà et al., 2024). In full light, durum wheat yielded 8.3 tonnes/ha, while it was reduced to 8.1 tonnes/ha in a standard agrivoltaic system and to 6.4 tonnes/ha under a more shaded solar system (Dal Prà et al., 2024). All the intended forage species for the Project area would be C3 species. C3 species are expected to be more resilient to the agrivoltaic environment than C4 species like corn. In particular, C3 cereals have shown proportionally less reduction in yield with shading than most other crop groups (Laub et al., 2022). Although increases in forage productivity have been identified in agrivoltaic systems (Adeh et al., 2018; Cuppari et al., 2021), this is only expected in environments with significant heat and drought stress. Some research has identified 5-8% reductions in forage productivity (Weselek et al., 2021) for forage crops in temperate climates.

7.2.1 Production Impacts for Calculations

Based on a professional interpretation of likely impacts at the specific Project location, the authors conclude the following production impacts are most likely:

- Saskatoons
  - None, they like shaded habitat and would often be shaded by other rows of saskatoon bushes.
- Annual crops
  - Outside project fence – no impacts expected;
  - Inside project fence – 5% reduction due to reduced efficiencies (turning, corners, disturbances).
- Forages
  - An 8% reduction in forage productivity and a 10% reduction due to infrastructure area and edge wastage for silage;
  - If grazing, an 8% reduction in forage productivity in paneled areas, but it is possible to graze around infrastructure efficiently so no further reductions for grazing were necessary.
- Grazing
  - 8% reduction in productivity in paneled areas;
  - No reduction in panel-free areas – grazing still efficient.

Areas categorized as ditches were also unused (based on imagery) prior to the Project, so the agricultural impact to those areas remains unchanged. There are 7.44 acres of lost agricultural productivity due to the substation and design constraints (Table 4-1, Appendix C).

7.3 Revenue Calculations

Revenue for the agricultural activities in the agrivoltaic system was calculated both annually and for a 30-year period. The 30-year period was used to account for the variation in productivity as Saskatoons are established.

7.3.1 Saskatoon Revenue

Berry production is assigned to the NW-02-40-08-W4 quarter section based on landowner preferences and panel arrangement. Approximately 128 acres are available in the quarter section for berry production, as there is some area allocated to a residence, the substation, and the project fence.

Revenue for Saskatoons was calculated over 30-years, as plants take time to establish and production changes throughout their life cycle (as shown in Table 7-1). Production data were adapted from an Alberta publication on Saskatoon berry production (Faye, 2008) with a 15% reduction after pruning. Over a 30-year period the total gross revenue is estimated at $22,706,017.28 on the 128 acres proposed for Saskatoon production.

Table 7-1: Saskatoon berry production and gross revenue.

Year	Production (lbs/10ac)	Production (lbs/ac)	Price ($/lb)	Revenue ($/ac)	Projected Revenue ($)
Year 1	0		$ 2.00	$ -	$ -
Year 2	0		$ 2.00	$ -	$ -
Year 3	0		$ 2.00	$ -	$ -
Year 4	5732	573	$ 2.00	$ 1,146.40	$ 146,739.20

Year	Production (lbs/10ac)	Production (lbs/ac)	Price ($/lb)	Revenue ($/ac)	Projected Revenue ($)
Year 5	14329	1433	$ 2.00	$ 2,865.80	$ 366,822.40
Year 6	28658	2866	$ 2.00	$ 5,731.60	$ 733,644.80
Year 7	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 8	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 9	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 10*	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 11	30449	3224	$ 2.00	$ 6,089.74	$ 779,486.72
Year 12	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 13	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 14	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 15*	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 16	30449	3224	$ 2.00	$ 6,089.74	$ 779,486.72
Year 17	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 18	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 19	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 20*	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 21	30449	3224	$ 2.00	$ 6,089.74	$ 779,486.72
Year 22	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 23	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 24	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 25*	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 26	30449	3224	$ 2.00	$ 6,089.74	$ 779,486.72
Year 27	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 28	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 29	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Year 30	35822	3582	$ 2.00	$ 7,164.40	$ 917,043.20
Total per acre				**$ 177,390.76**	
Projected Total 30-year Revenue					**$ 22,706,017.28**

* Rejuvenation recommended every 5 years after the first 10 years, in the year following rejuvenation a reduction in yield was allowed for.

This estimate is based on berry prices at $2.00/lb (Faye, 2008). Communications with Solstice Berry Farm during 2023/2024 (Foothills region) confirms that $2.00/lb remains a reasonable estimate for berry prices at this time. Prior to berry grading, the most recent data for wholesale berries reflects a price of $1-1.85 per pound. Following berry grading, good quality berries can reach as high as $2.50 per pound. The difference between the wholesale price and the graded price for quality berries supports the estimate of $2.00/lb.

7.3.2 Annual Crop Revenue

There are approximately 267 acres of cultivated land located within the Project Area (the quarter sections on which the Project is located) and outside the project fence that can continue to be used for annual cropping as per the farmer's preference. No significant impacts to agricultural production nor revenue are anticipated for areas outside of the project fence. No annual cropping is intended between panel arrays, however, as shown in Appendix C, there are some larger panel free areas inside the project fence that can be used for annual cropping or any other agricultural activity desired by the farmer. The area inside the fence in open areas is 19 acres. Since there will be some inconveniences operating inside of the project fence and potentially more corners and some wastage along edges, we have allowed for a 5% reduction in gross revenue for the approximately 19 acres of cropping area within the project fence. As shown in Table 7-2, the annual gross revenue from cropping in the agrivoltaic area is $87,305.66 and, for the 30-year projection, it would be $2,619,169.88. Price and yield assumptions are discussed in the following section, and are consistent with pre-project prices.

Table 7-2: Gross revenue from annual cropping in the agrivoltaic operation.

Annual Cropping	Acres	Revenue ($/ac)	Reduction Factor	Annual Gross Revenue	30-yr. Gross Revenue
Outside of project fence	267	$ 306.45	None	$81,820.90	$2,454,627.12
Inside of project fence	19	$ 306.45	5%	$5,773.43	$164,542.76
Total in agrivoltaic plan	**286**			**$87,305.66**	**$2,619,169.88**

7.3.2.1 Pre-project Crop Revenue

The Project is located in crop Risk Area 9, where yields are typically below provincial averages. Averages for Risk Area 9 are presented in Table 7-3. Common crops in the area include canola, wheat, and barley. Landowners also reported using the project lands for peas, oats, silage, and other forages (Appendix E). Since actual rotations are inconsistent, we used canola, wheat, and barley as a common rotation of high value crops. Individual landowner records are also highly variable. For these reasons, regional yield data was preferred for revenue calculations. Average yields for Risk Area 9 were used to calculate the average yield for the pre-project crops (AFSC, 2024a) as shown in the third column of Table 7-3.

Table 7-3: Average yields for selected dryland crops in Risk Area 9 within Alberta in bushels/acre.

Crop	Alberta 5yr Ave. 2019-2023	5yr Average Risk Area 9	2023 Risk Area 9	2022 Risk Area 9	2021 Risk Area 9	2020 Risk Area 9	2019 Risk Area 9
Canola Dryland	40	29.8	29	29	17	38	36
Wheat Dryland	47	32.6	29	29	19	43	43
Barley Dryland	67	51.4	48	53	25	64	67

Average pricing for the pre-panel crops was calculated using the 10-year average prices (Government of Alberta, 2024; Statistics Canada, 2024). Canola average price per bushel was $12.97, wheat was $7.72, and barley was

$5.47 as shown in Table 7-4. On a 3-year rotation this would be equivalent to $306.45 per acre of gross revenue. Within the agrivoltaic area there are approximately 1026 acres of cultivated land used for annual crop production as apparent in satellite imagery and shown in Appendix D. The estimated pre-project annual gross revenue from crop production is $314,412.91. Over 30-years, this would amount to $9,432,387.36 in gross agricultural revenue (in the absence of the Project).

Table 7-4: Pre-panel annual revenue calculations.

Crop	5-yr Ave. Risk Area 9 bu/ac	10-yr. Ave. Price $/bu	Pre-Project Annual Gross Revenue $/ac
Canola Dryland	29.8	$12.97	$386.51
Wheat Dryland	32.6	$7.72	$251.67
Barley Dryland	51.4	$5.47	$281.16
Average Gross Revenue $/ac Assuming a Three-Year Rotation		**$ 306.45**	

7.3.3 Forage Revenue

Forage production can be very diverse in terms of the activities, equipment, end products, and prices of those end products. To calculate revenue, we have included an upper range of production and values using silage of annual forages, and a lower range of production and values with perennial forages being used for grazing sheep. Silage production using annual cereals or mixed grains is technically feasible in the Project layout. Panel rows are wide enough and short enough to allow harvesting for traditional pit silage. However, sheep grazing is a widely proven agrivoltaic activity in solar facilities and is included as a minimum production option.

There are approximately 616 acres assigned to forage production in the agrivoltaic plan for this Project, all of which are inside the Project fence. Of this, there are about 39 acres in open areas within the Project fence, but the majority of the forage area is within the panels (Table 4-2).

7.3.3.1 Silage Scenario

To calculate gross revenue from silage production for the forage areas in the plan, provincially reported silage yield data and average prices were used. Yield data are reported by the type of silage as shown in Table 7-5. The five-year average for 2019 to 2023 was calculated for barely, oats, and mixed grain silage. Silage production was calculated using production data from the *Alberta 2023 Greenfeed and Silage Production Survey Results*, published by the Government of Alberta (Wong, 2024) and the silage crop rotation was calculated using barley, oats, and mixed grains in a 3-year rotation.

Table 7-5: Revenue per acre from silage production.

Silage Crop Type	5-Year Provincial Average (lbs/ac)	Estimated Average Yield for Agrivoltaics (lbs/ac)	5-year Average Silage Price ($/lb)	Gross Revenue With Agrivoltaics ($/ac)
Barley	10,391	9,467	$ 0.0391	$370.16
Oats	11,173	10,180	$ 0.0391	$398.04
Mixed Grains	13,459	12,263	$ 0.0391	$479.48
Plan Average (using 3-year rotation)		**10,637**	**$ 0.0391**	**$415.91**

Silage productivity in the agrivoltaic system is expected to be less than average due to factors such as shading, infrastructure, and harvest efficiency. To account for Project-specific differences in the agrivoltaic system, an 18% discount was applied to the average yields. This can be considered an 8% reduction in forage productivity, and a 10% reduction due to other factors, such as piling area and harvest losses along pilings. Pricing for silage was calculated using the most recent 5 years of data from the Agri-stability reports on forage prices in the Central region (AFSC, 2024). Prices are not categorized by silage type. For the calculated forage area of 616 acres the gross revenue from silage would be $256,198.53 annually or $7,685,955.82 for the 30-year expected life of the Project.

7.3.3.2 Grazing Scenario

To calculate the low range of value for the forage lands in this agrivoltaic plan, a typical perennial forage stand with sheep grazing was assumed. Forage availability is typically calculated using the Animal Unit Month (AUM), which is a standard volume of dry forage. The AUM represents the forage requirement of one mature cow (dry or without calf) weighing approximately 1000 lbs (455 kg) for one month (Government of Alberta, 2004). The AUM is applicable to other animal classes, but a conversion factor must be applied to relate the amount of forage to the animal class. An animal unit equivalent (AUE) is an adjustment to a standard animal unit that accounts for animals or other livestock class that weigh less than 1,000 lbs. In this case, the animals in question are sheep, which consume about one fifth of an animal unit (Alberta Sustainable Resource Development, 2008).

The Project area is in the Central Parkland natural subregion. Stocking rates for seeded pastures in this region are categorized based on dominant vegetation. The anticipated vegetation for the site is a brome/alfalfa mixture. The plant community CPB1 represents a common productive (or newer) tame pasture stand, also often used on hayland (Kupsch et al., 2013). Meadow brome, smooth brome, alfalfa, and Kentucky bluegrass are the major forage species in this plant community (Kupsch et al., 2013). Kentucky bluegrass is initially a minor species, but often increases in abundance as the stand ages. These species can be managed so that growth height stays below the panels. The forage areas are expected to be seeded to desirable productive species like the plant community CPB1 and maintained in a productive state with good grazing management. The recommended Ecologically Sustainable Stocking Rate (ESSR) for this plant community is 1.01 AUM/ac (Kupsch et al., 2013). The ESSR allows for up to half of biomass production to be used for ecological functions like nutrient cycling, soil protection, and habitat maintenance (Kupsch et al., 2013). The extra biomass, or carryover, also acts as a buffer in years when weather conditions result in below average forage production. With more intensive management in tame pasture systems, more production is often utilized, making the carrying capacity estimate for the forage lands conservative. Furthermore, an 8% reduction in forage productivity (equivalent to 0.93

AUM/ac) was assumed for areas with panels as shown in Table 7-6. The gross revenue in this scenario would be $172,573.06 annually, or $5,177,191.69 over 30-years (Table 7-6).

Table 7-6: Carrying capacity and revenue if forage lands are used to graze sheep.

Forage Lands for Grazing	Area (ac)	ESSR (AUM/ac)	Carrying Capacity (AUMs)	Value ($/AUM)	Annual Gross Revenue	30-Year Gross Revenue
In Panels	577	0.93	537.2	$299.49	$160,882.01	$4,826,460.45
Out of Panels	39	1.01	39.0	$299.49	$11,691.04	$350,731.24
Total	**616**		**576.2**	**$299.49**	**$172,573.06**	**$5,177,191.69**

The value per AUM was determined using provincially published prices and production estimates as show in Table 7-7. The more conservative price estimate was used over the more recent price estimate for the revenue calculations.

Table 7-7: Potential revenue calculations per AUM for sheep grazing.

Calculations for Revenue per AUM
• 1 AUM of forage supports 5 ewes for 1 month • In 6 months each ewe raises 1.5 lambs to 110 lbs • So 1 AUM produces 137.5 lbs of lamb (1.375 cwt)
Lamb prices (Government of Alberta, 2023a)
• 5-year average: $217.81/cwt • 2023 average: $258.07
Gross Revenue per AUM

• Using 5-year average prices
  ○ $299.49/AUM
• Using 2023 prices
  ○ $354.85/AUM

Using the carrying capacity of 576 AUMs, this is equivalent to supporting 480 ewes for a 6-month grazing period, as shown in Table 7-8.

Table 7-8: Number of ewes that can be supported on the forage lands if grazed.

Area	Agrivoltaic System Carrying Capacity (AUMs)	AUE Adjustment for Ewes	Available Animal Months for Ewes	Ewes Supported for a 6-month grazing period
In Panels	537.2	0.20	2686	448
Out of Panels	39.0	0.20	195	33
Totals	**576.2**		**2881**	**480**

7.3.4 Grazing Only Lands

There are about 67 acres of land suitable for grazing only. These areas are small, wetlands edges, or other areas that are not practical for major agricultural uses but are still grazeable. This includes areas both in and out of the project fence (Table 4-2). Within the project fence, some areas are paneled and others are not. Since these areas may not all be seeded to tame forage species, a different approach was used to determine the stocking rates. Since exact plant communities are not known for each small area, an average carrying capacity for the Central Parkland was used. This average rating of 0.26 AUM/ac was calculated from the average of all plant communities in the Central Parkland guide (Kupsch et al., 2013). A conservative 8% reduction was still applied to the paneled areas as shown in Table 7-9. This resulted in a gross revenue of $5,104.55 annually, or $153,136.52 over 30 years, for the grazing only areas in the agrivoltaic design.

Table 7-9: Carrying capacity and gross revenue from grazing only areas.

Grazing Only Areas	Area (ac)	ESSR (AUM/ac)	Carrying Capacity (AUMs)	Value ($/AUM)	Annual Gross Revenue	30-Year Gross Revenue
In Panels	6	0.24	1.3	$299.49	$399.02	$11,970.71
Out of Panels	60	0.26	15.7	$299.49	$4,705.53	$141,165.81
Total	**66**		**17.0**	**$299.49**	**$5,104.55**	**$153,136.52**

Using the carrying capacity of 17 AUMs, this is equivalent to supporting 44 ewes for a 2-month grazing period as shown in Table 7-10.

Table 7-10: Ewes supported for 2 months on the grazing only lands.

Area	Agrivoltaic System Carrying Capacity (AUMs)	AUE Adjustment for Ewes	Available Animal Months for Ewes	Ewes Supported for a 2-month grazing period
In Panels	1.33	0.20	7	3
Out of Panels	15.71	0.20	79	39
Totals	**17.04**		**85**	**44**

7.3.5 Revenue Comparison

The estimated pre-project annual gross revenue from crop production is $314,412.91. Over 30 years this would be $9,432,387.36 in gross agricultural revenue without the project.

Table 7-11: Pre-project revenue from annual cropping.

Pre-Project Cropping	Annual Gross Revenue	30-year Gross Revenue
Annual crop rotation (wheat, barely, canola)	$314,412.91	$9,432,387.36

With the agrivoltaic plan that grows silage in the forage areas, annual gross revenue for agrivoltaics would be $1,105,475.98, or $33,164,279.50 over 30 years. Using the forage areas for lower value forage production total gross revenue would be $1,021,850.51, which is $30,655,515.37 over 30-years. To present a moderate final estimate of gross agricultural revenue from the agrivoltaic system we used the average of high and low value forage production, which results in $1,063,663.25 (or $31,909,897.44 over 30-years) as shown in Table 7-12.

Table 7-12: Agrivoltaic gross agricultural revenue summary table.

Production Area	Annual Gross Revenue	30-year Gross Revenue
Saskatoons	$756,867.24*	$22,706,017.28
Cropping	$87,305.66	$2,619,169.88
Forage Lands (mid)**	$214,385.80	$6,431,573.76
Silage (high value)	$256,198.53	$7,685,955.82
Grazing (low value)	$172,573.06	$5,177,191.69
Grazing Only Lands	$5,104.55	$153,136.52
Agrivoltaic Total (mid)	**$1,063,663.25**	**$31,909,897.44**
Agrivoltaic Total (high)	$1,105,475.98	$33,164,279.50
Agrivoltaic Total (low)	$1,021,850.51	$30,655,515.37

*Revenue various throughout the lifecycle, the average from the 30-year projection is presented here. See Saskatoon Revenue section for details.
**Average of high and low forage values.

7.3.5.1 Change in Agricultural Gross Revenue

To evaluate the overall impact of the project on agriculture, the percent change in agricultural gross revenue was calculated. The following calculation was used to determine the percentage change in agricultural gross revenue:

$$\frac{\text{agrivoltaic gross revenue - pre-project gross revenue}}{\text{pre-project gross revenue}} \times 100\,\% = \frac{\$1,063,663.25 - \$314,412.91}{\$314,412.91} = 2.38 \times 100\% = 238\%$$

This calculation shows a 238% increase in the gross agricultural revenue with the agrivoltaic system. The significant increase in revenue is due to the implementation of Saskatoon production, which is a higher value crop. These systems include different crop types with different values, so using revenue allows for the most straightforward comparison of the two systems.

In addition, as many previous reports have included land equivalent ratios (LERs), which are commonly used in agrivoltaic research, these calculations are included below.

LERs can be calculated using the following formula (Dupraz et al., 2011):

LER = (Ag. AV/ Ag. Mono) + (Elec. AV/ Elec. Mono)

This calculation is a ratio of agricultural productivity and electric productivity pre- and post-Project development. The agricultural component would typically be calculated using the crop productivity in an agrivoltaic system over the crop productivity for the same crop without the solar infrastructure. However, as in previous AUC applications, the calculation has been simplified by using revenue for the pre-project agricultural operations and the post-project agrivoltaic system. The AUC also noted in decision commentary for the previous application made by ESI that they "do not find the inclusion of electricity generation in the LER to helpful" (Alberta Utilities Commission, 2025). As such it was not included in the calculation below.

$$\frac{\text{annual gross revenue of agrivoltaic crop system}}{\text{annual gross revenue of pre-project crop rotation}} = \frac{\$1{,}063{,}663.25}{\$314{,}412.91} = 3.38$$

This calculation yields a value of 3.38 for the Eastervale project. Removing the electric component of the calculation means that this value is no longer truly and LER, but a ratio between the pre-project and post-project gross revenues. As such, the 238% percentage change in agricultural gross revenue is a more simplistic and clear representation of change to agricultural production value for the lands.

7.4 Evaluating the Agrivoltaic System Performance

To monitor the performance of crops in the agrivoltaic system, land use records should be kept for the entire agrivoltaic area (Appendix D - Agrivoltaic Area Map). Land use records should include what agricultural activities occurred where and identify any areas that were not usable and the reason why. Activity-specific records are noted below, but if other agricultural activities are undertaken, similar records should be kept. Records should be kept yearly and reviewed every 5 years for the duration of the project. The records described in the following section are basic and similar to records kept by most producers. The review can also be simple, with the intent to identify and major discrepancies in productivity. Average results in the first 5-years will reflect that the system is being established, and ongoing records will help inform the overall agricultural productivity of the land. Record keeping is an important part of any agricultural operation, and will be especially useful for informing management in agrivoltaic systems. If some activities are not sufficiently productive in the agrivoltaic system, other agricultural activities will be considered. Potentially interchangeable agricultural activities for land in the project area are identified in Table 4-1. At minimum, sheep grazing is well established as a compatible agricultural activity in solar farms.

7.4.1 Saskatoons

In addition to the area grown, the density and age of plants should be included in production records. Yields should be recorded separately for areas both among the panels and outside of the panels. This data will provide feedback on the assumption that yields will be similar in both situations.

7.4.2 Annual Crops

The type of crop and the yields should be included in production records. It will also be helpful to note any constraints or production hinderances experienced by the farmers while cropping inside the project fence. Since most of the annual cropping area is outside the project fence, and no cropping is occurring among the panels, basic records should be sufficient for this project.

7.4.3 Forages

Records for forage should be kept that include the forage crop (with species components for mixed forage crops) and the harvested yield. Since the same crop can be harvested as different end products it is important to note the type of forage product produced on the land (e.g. hay, silage etc.). If grazing occurs in addition to other forage harvests, records should be kept as per the following section.

7.4.4 Grazing

The class (ewes, rams, lambs, or other livestock types), weights, dates in and dates out should be included for each grazing session.

8.0 Agricultural Impact Summary

Agrivoltaic production options for the Project have been thoroughly considered and TCS has determined that multiple agricultural activities are feasible within the Project area. The agricultural activities identified as feasible in this agrivoltaic report are Saskatoon production, annual crop production (outside panel arrays), forage production, and sheep grazing. Recommended agricultural activities were delineated as shown in Appendix C based on professional experience, solar facility design and the farmer's preferences and operational needs. The needs of the farmer may change over time, so different activities compatible in the production areas were identified. Although high quality agricultural land will be used for solar energy production in this Project, co-location of agricultural activities within the Project are feasible. Eastervale is committed to implementing agrivoltaic uses within the Project site to provide paired land use that is aligned with the MD of Provost Land Use Bylaw, the concerns of local stakeholders to maintain agricultural land use, and to provide a more appealing aesthetic to neighboring properties. Furthermore, with the implementation of the agrivoltaic plan proposed, the agricultural gross revenue for the lands was calculated to increase by 238%, representing a significant increase in agricultural revenue from the Project lands.

Certification Page

The experience and qualifications of Dr. Steven Tannas are presented in Appendix F.

I hereby certify that:

> The requested report was completed by qualified professionals (Steven Tannas) who considered all factors and influences that are within the scope of this assessment.
>
> No person at Tannas Conservation Services Ltd., or associated sub-consultant working on this project have any contemplated interest in the property being assessed.
>
> This report has been completed in conformity with the standards and ethics of the Alberta Institute of Agrologists and the Alberta Society of Professional Biologists.

Respectfully submitted:

Steven Tannas, PhD. P.Ag.
President/Senior Ecologist
Tannas Conservation Services Ltd.

References

Abidin, M. A. Z., Mahyuddin, M. N., & Zainuri, M. A. A. M. (2021). Solar photovoltaic architecture and agronomic management in agrivoltaic system: A review. In *Sustainability (Switzerland)* (Vol. 13, Issue 14). MDPI AG. https://doi.org/10.3390/su13147846

Adeh, E. H., Good, S. P., Calaf, M., & Higgins, C. W. (2019). Solar PV Power Potential is Greatest Over Croplands. *Scientific Reports*, *9*(1). https://doi.org/10.1038/s41598-019-47803-3

Adeh, E. H., Selker, J. S., & Higgins, C. W. (2018). Remarkable agrivoltaic influence on soil moisture, micrometeorology and water-use efficiency. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0203256

AFSC. (2024a). *Agriculture Financial Services Corporation: Yields Alberta 2024*. https://afsc.ca/?s=yield+Alberta

AFSC. (2024b). *AgriStability Program Price Lists: Forages*. https://afsc.ca/income-stabilization/agristability/agristability-price-lists/

AGRASID. (2024). *Agricultural region of Alberta soil inventory database (AGRASID) Version 4.1*. Government of Alberta; Agriculture and Agri-Food Canada, Research Branch, and Alberta Agriculture, Food and Rural Development, Conservation and Development Branch. https://soil.agric.gov.ab.ca/agrasidviewer/

Akhter, N., Hasanuzzaman, M., Rahman, M. M., & Nahar, K. (2009). Physiological Response of Garden Pea (Pisum sativum L.) Grown under Different Light Environment. *Botany Research International*, *2*(4), 304–309.

Akhter, N., Rahman, M., Sheikh, B., Rahman, M., & Nahar, K. (2009). Dry Matter Partitioning in Garden Pea (Pisum sativum L.) As Influenced by Different Light Levels. *Academic Journal of Plant Sciences*, *2*(4), 233–236. https://www.researchgate.net/publication/242694041

Alberta Agriculture and Rural Development. (2012). *Saskatoons in Alberta*.

Alberta Pulse Growers. (2023). *Field peas: Adaptation characteristics*. Agronomy. https://albertapulse.com/growing-peas/

Alberta Sustainable Resource Development. (2008). *Grazing management adjustments for healthy rangelands*. https://open.alberta.ca/dataset/88781d33-3869-46eb-9b7c-87ae86ce02af/resource/1fb7fdfe-2ea3-4ecc-a447-106da8aa822d/download/2008-grazingmanagementhealthyrangelands-2008.pdf

Alberta Utilities Commission. (2025, February 19). *Decision 28847-D01-2025*. AUC.

Amaducci, S., Yin, X., & Colauzzi, M. (2018). Agrivoltaic systems to optimise land use for electric energy production. *Applied Energy*, *220*, 545–561. https://doi.org/10.1016/j.apenergy.2018.03.081

AUC. (2024). *Rule 007 interim information requirements*. https://media.auc.ab.ca/prd-wp-uploads/regulatory_documents/Reference/Rule007-InterimInformationRequirements.pdf

Austenson, H. M., & Larter, E. N. (1969). Effect of direction of seeding on yields of barley and oats. *Canadian Journal of Plant Sciences*, *49*, 417–420.

Barron-Gafford, G. A., Pavao-Zuckerman, M. A., Minor, R. L., Sutter, L. F., Barnett-Moreno, I., Blackett, D. T., Thompson, M., Dimond, K., Gerlak, A. K., Nabhan, G. P., & Macknick, J. E. (2019a). Agrivoltaics provide mutual benefits across the food–energy–water nexus in drylands. *Nature Sustainability*, *2*(9), 848–855. https://doi.org/10.1038/s41893-019-0364-5

Barron-Gafford, G. A., Pavao-Zuckerman, M. A., Minor, R. L., Sutter, L. F., Barnett-Moreno, I., Blackett, D. T., Thompson, M., Dimond, K., Gerlak, A. K., Nabhan, G. P., & Macknick, J. E. (2019b). Agrivoltaics provide mutual benefits across the food-energy-water nexus in drylands. *Nature Sustainability*.

Bellini, E. (2020). *Agrivoltaics works better with leafy greens, root crops*.

Benghida, D., & Sabrina, B. (2019). Investment in agrophotovoltaics: Efficient solutions from Switzerland. *International Journal of Innovative Technology and Exploring Engineering*, *8*(12), 61–64. https://doi.org/10.35940/ijitee.L2497.1081219

Black, C. C. (1971). *Ecological implications of dividing plants into groups with distinct photosynthetic production capacities*.

Campana, P. E., Stridh, B., Amaducci, S., & Colauzzi, M. (2021). Optimisation of vertically mounted agrivoltaic systems. *Journal of Cleaner Production*, *325*. https://doi.org/10.1016/j.jclepro.2021.129091

Coşgun, A. E. (2021). The potential of Agrivoltaic systems in TURKEY. *Energy Reports*, *7*, 105–111. https://doi.org/https://doi.org/10.1016/j.egyr.2021.06.017

Cossu, M., Cossu, A., Deligios, P. A., Ledda, L., Li, Z., Fatnassi, H., Poncet, C., & Yano, A. (2018). Assessment and comparison of the solar radiation distribution inside the main commercial photovoltaic greenhouse types in Europe. *Renewable and Sustainable Energy Reviews*, *94*, 822–834. https://doi.org/10.1016/j.rser.2018.06.001

Cuppari, R. I., Higgins, C. W., & Characklis, G. W. (2021). Agrivoltaics and weather risk: A diversification strategy for landowners. *Applied Energy*, *291*. https://doi.org/10.1016/j.apenergy.2021.116809

Dal Prà, A., Miglietta, F., Genesio, L., Lanini, G. M., Bozzi, R., Morè, N., Greco, A., & Fabbri, M. C. (2024). Determination of feed yield and quality parameters of whole crop durum wheat (Triticum durum Desf.) biomass under agrivoltaic system. *Agroforestry Systems*, *98*(8), 2861–2873. https://doi.org/10.1007/s10457-024-00979-8

Dupraz, C., Marrou, H., Talbot, G., Dufour, L., Nogier, A., & Ferard, Y. (2011). Combining solar photovoltaic panels and food crops for optimising land use: Towards new agrivoltaic schemes. *Renewable Energy*, *36*(10), 2725–2732. https://doi.org/10.1016/j.renene.2011.03.005

Faye, S. (2008). *Economics of Saskatoon Berry Production: A Ten Acre Enterprise*.

Government of Alberta. (n.d.). *Irrigation in Alberta (part2)*. Retrieved January 8, 2025, from https://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr7197/$FILE/irrigationinalta-part2.pdf

Government of Alberta. (2004). Methodology for calculating carrying capacity and grazing capacity on public rangeland. *Alberta Sustainable Resource Development. Public Lands & Forests*. https://open.alberta.ca/dataset/5e93d3c6-3302-4d04-ab89-b89fe7172c24/resource/e66f2896-b595-4252-b8b8-d9af4f7535ee/download/2004-carryinggrazingcapacitymethodology.pdf

Government of Alberta. (2018). *Fragmentation and Conversion of Agricultural Land*. https://open.alberta.ca/dataset/855d8a6b-98d7-4a6f-901f-e4c3cd31af31/resource/c815fe57-f41c-4628-8501-942871066552/download/2017-report-card-alberta.pdf

Government of Alberta. (2023a). *Lamb market trends | Alberta.ca*. Agri-News. https://www.alberta.ca/agri-news-lamb-market-trends

Government of Alberta. (2023b, August 30). *Alberta Soil Information Viewer*. Https://Soil.Agric.Gov.Ab.ca/Agrasidviewer.

Government of Alberta. (2024). *Alberta Economic Dashboard: Grain Prices*. https://economicdashboard.alberta.ca/dashboard/wheat-price#

Government of Canada. (2023, April 25). *Food business activities that require a licence under the Safe Food for Canadians Regulations*. Canadian Food Inspection Agency.

Hudelson, T., & Lieth, J. H. (2021). Crop production in partial shade of solar photovoltaic panels on trackers. *2361*, *2361*. https://doi.org/10.1063/5.0055174/FORMAT/PDF

Jain, P., Raina, G., Sinha, S., Malik, P., & Mathur, S. (2021). Agrovoltaics: Step towards sustainable energy-food combination. *Bioresource Technology Reports*, *15*. https://doi.org/10.1016/j.biteb.2021.100766

Klenske, N. (2022, January 21). *To feed a growing population, farmers look to the sun*. European Commission: Horizon. The EU Research & Innovation Magazine. https://ec.europa.eu/research-and-innovation/en/horizon-magazine/feed-growing-population-farmers-look-sun

Kupsch, T., France, K., Loonen, H., Burkinshaw, A., & Willoughby, M. G. (2013). *Range plant community and range health assessment guidelines for the central parkland subregion of Alberta*.

Laub, M., Pataczek, L., Feuerbacher, A., Zikeli, S., & Högy, P. (2022). Contrasting yield responses at varying levels of shade suggest different suitability of crops for dual land-use systems: a meta-analysis. *Agronomy for Sustainable Resource Development*, *42*(51). https://doi.org/10.1007/s13593-022-00783-7/Published

Li, J., C., Li, H., Bo, Y., Liu, F., Jiang, D., Dai, T., & Cao, W. (2012). Effect of shading from jointing to maturity on high molecular weight glutenin subunit accumulation and glutenin macropolymer concentration in grain of winter wheat. *Journal of Agronomy and Crop Science*, *198*(1), 68–79. https://doi.org/10.1111/J.1439-037X.2011.00484.X

Marrou, H., Guilioni, L., Dufour, L., Dupraz, C., & Wery, J. (2013). Microclimate under agrivoltaic systems: Is crop growth rate affected in the partial shade of solar panels? *Agricultural and Forest Meteorology*, *177*, 117–132. https://doi.org/10.1016/j.agrformet.2013.04.012

Meadley, J. T., & Milbourn, G. M. (1971). The growth of vining peas. *The Journal of Agricultural Science*, *77*(1), 103–108. https://doi.org/10.1017/S0021859600023534

Moreda, G. P., Muñoz-García, M. A., Alonso-García, M. C., & Hernández-Callejo, L. (2021). Techno-economic viability of agro-photovoltaic irrigated arable lands in the eu-med region: A case-study in southwestern spain. *Agronomy*, *11*(3). https://doi.org/10.3390/agronomy11030593

Nam, C. H., Park, M. H., Yun, A. A., Ji, H. J., Choi, B. ram, & Sun, S. S. (2021). Study on Forage Production under Agrivoltaic System. *Journal of The Korean Society of Grassland and Forage Science*, *41*(1), 1–9. https://doi.org/10.5333/KGFS.2021.41.1.1

Natural Regions Committee. (2006). *Natural Regions and Subregions of Alberta*.

Pearcy, R. W., & Ehleringer, J. (1984). Comparative ecophysiology of C3 and C4 plants. *Plant, Cell & Environment*, *7*(1), 1–13. https://doi.org/10.1111/j.1365-3040.1984.tb01194.x

Riaz, M. H., Imran, H., Younas, R., & Butt, N. Z. (2021). The optimization of vertical bifacial photovoltaic farms for efficient agrivoltaic systems. *Solar Energy*, *230*, 1004–1012. https://doi.org/10.1016/j.solener.2021.10.051

Shooshtarian, A. (2021). *November 2021 Estimates Crop Production Alberta Highlights Agri-Food Statistics Update: Issue CR21-2 Release Information*. https://www.alberta.ca/agri-food-statistics-update.aspx

Spencer, Robert., & Alberta. Alberta Agriculture and Rural Development. (2012a). *Saskatoon berry production manual*. Alberta Agriculture and Rural Development.

Spencer, Robert., & Alberta. Alberta Agriculture and Rural Development. (2012b). *Saskatoon berry production manual*. Alberta Agriculture and Rural Development.

Statistics Canada. (2024). *Farm product prices, crops and livestock*. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3210007701&cubeTimeFrame.startMonth=01&cubeTimeFrame.startYear=2013&cubeTimeFrame.endMonth=03&cubeTimeFrame.endYear=2024&referencePeriods=20130101%2C20240301

St.Pierre, M., & McComb, M. (2023). *Alberta has the highest farm operating revenues in Canada*.

Tannas, K. (2004). *Common Plants of the Western Rangeland*. Alberta Agriculture and Rural Development.

Trommsdorff, M., Gruber, S., Keinath, T., Hopf, M., Hermann, C., & et al. Ise, F. (2022). *Agrivoltaics: Opportunities for Agriculture and the Energy Transition*. www.ise.fraunhofer.de

Trommsdorff, M., Kang, J., Reise, C., Schindele, S., Bopp, G., Ehmann, A., Weselek, A., Högy, P., & Obergfell, T. (2021). Combining food and energy production: Design of an agrivoltaic system applied in arable and vegetable farming in Germany. *Renewable and Sustainable Energy Reviews*, *140*. https://doi.org/10.1016/j.rser.2020.110694

Turan, N., Alparslan, M., Tarımsal, Ü., & Ve, Ü. (2021). Agrivoltaics and Their Effects on Crops: A review. In *Journal of Muş Alparslan University Agricultural Production and Technologies* (Vol. 2, Issue 2).

Weselek, A., Bauerle, A., Hartung, J., Zikeli, S., Lewandowski, I., & Högy, P. (2021). Agrivoltaic system impacts on microclimate and yield of different crops within an organic crop rotation in a temperate climate. *Agronomy for Sustainable Development*, 41–59. https://doi.org/10.1007/s13593-021-00714-y/Published

Weselek, A., Ehmann, A., Zikeli, S., Lewandowski, I., Schindele, S., & Högy, P. (2019). Agrophotovoltaic systems: applications, challenges, and opportunities. A review. In *Agronomy for Sustainable Development* (Vol. 39, Issue 4). Springer-Verlag France. https://doi.org/10.1007/s13593-019-0581-3

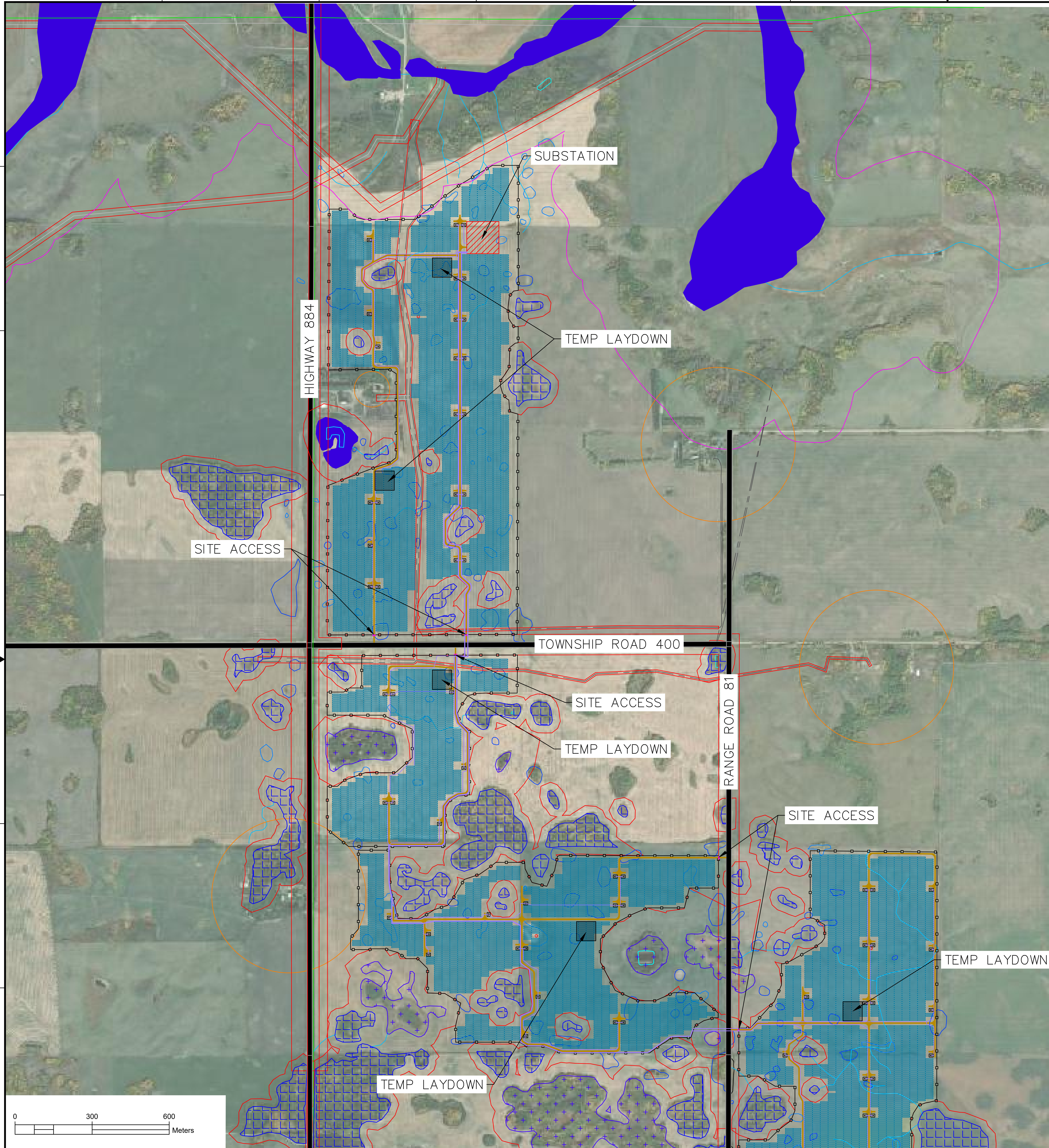
Willockx, B., Uytterhaegen, B., Ronsijn, B., Herteleer, B., & Cappelle, J. (2020). A standardized classification and performance indicators of agrivoltaic systems. *37th European Photovoltaic Solar Energy Conference and Exhibition.* https://doi.org/DOI:10.4229/EUPVSEC20202020-6CV.2.47

Wong, B. (2024). *Alberta 2023 Greenfeed and Silage Production Survey Results*.

Appendix A

Solar Layout

WSLEGAL\095329\00004\40950151v1



EASTERVALE SITE OVERVIEW - PLAN

SCALE: 1:9000
SUBSTATION COORDINATES: 52.419058, -111.049992

REV	DESCRIPTION	VERIFIED BY	APPROVED BY	DATE
AK	FOR COMMENTS	H. YAZDANPANAHI	H.YAZDANPANAHI	2025-03-26
AJ	FOR COMMENTS	H. YAZDANPANAHI	H.YAZDANPANAHI	2025-03-17
AI	FOR INFORMATION	H. YAZDANPANAHI	Y. BÉTOURNAY	2025-02-26
AH	FOR INFORMATION	H. YAZDANPANAHI	Y. BÉTOURNAY	2024-07-26

REVISIONS

FOR COMMENTS
NOT TO BE USED FOR CONSTRUCTION

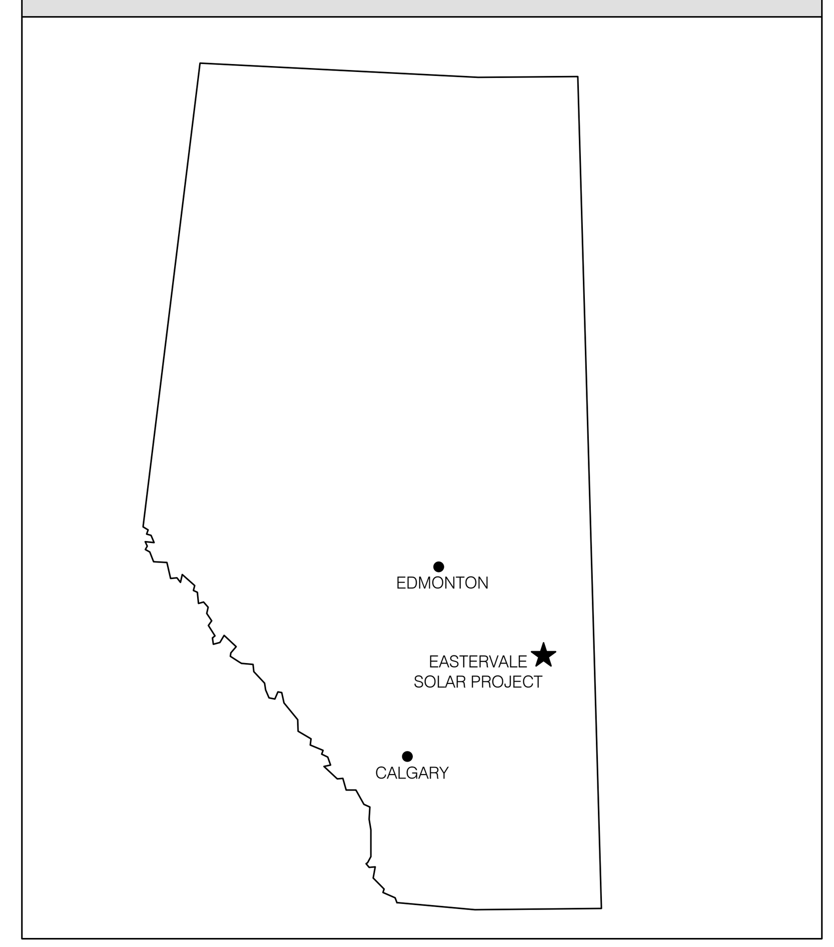
NOTES:

1. TOTAL FENCED AREA: 309.01 ha
2. TOTAL FENCE LENGTH: 19.4 km
3. TOTAL SITE ROAD LENGTH: 20.2 km
4. TOTAL AC COLLECTOR SYSTEM LENGTH: 48.3 km
5. FOR THE PURPOSE OF THIS LAYOUT, THE GROUND COVERAGE RATIO (GCR) HAS BEEN CALCULATED AS:

$$GCR = \frac{\text{MODULE LENGTH}}{\text{PITCH}}$$

6. DIMENSIONS:
   - SUBSTATION AREA: 125 x 125 m
   - TEMPORARY LAYDOWN AREAS: 75 x 75 m
7. THIS LAYOUT HAS BEEN DEVELOPED BASED ON GEO-REFERENCED WETLAND AND CONSTRAINT FILES PROVIDED BY THE CLIENT.
8. ALL CLASS I AND II WETLANDS ARE ASSUMED BUILDABLE AREA. ALL CLASS III AND ABOVE ARE ASSUMED NON-BUILDABLE AREA.
9. A 30m ROW HAS BEEN RESERVED ALONG THE EAST FENCE LINE NORTH OF THE SUBSTATION TO ACCOMMODATE FOR A POTENTIAL NEW TRANSMISSION LINE.
10. THE CURRENT DESIGN IS PRELIMINARY AND MAY NOT BE OPTIMIZED. A DETAILED PVSYST REPORT CAN BE COMPLETED ON THE CURRENT DESIGN.

SITE LOCATION



PV SYSTEM

PARAMETER	DESCRIPTION
PITCH SPACING	8.0 m
RACKING TYPE	FIXED TILT
NO. OF 2 IN PORTRAIT x 26 TABLES	8,779
MODULE QUANTITY (655W)	456,508
MODULE TYPE (BIFACIAL)	LONGI LR8-66HYD (655W)
MODULE ORIENTATION	PORTRAIT
MODULE TILT ANGLE	30 °
AC COLLECTOR SYSTEM (kV)	34.5
NO. OF U/G AC COLLECTOR FEEDERS	13
INVERTER TYPE	SMA MVPS SC4600-S2
INVERTER QUANTITY	67
STRING LENGTH	26 MODULES
DC CAPACITY (MWdc)	299.0
AC INVERTER CAPACITY (MWac)	308.2 (2.7% OVERBUILD)
AC GRID LIMIT (MWac)	300
DC/AC RATIO	0.997
GROUND COVERAGE RATIO	59.8%

LEGEND

DETAIL	DESCRIPTION
	PV TABLE - LONG (2 x 26 MODULES)
	AC COLLECTOR SYSTEM (U/G)
	DUGOUT
	FENCELINE
	INVERTER / TRANSFORMER SKID
	LAYDOWN AREAS
	MUNICIPAL ROADS + HIGHWAYS (EXISTING)
	SETBACKS (ROADS, OH & UG UTILITIES)
	PIPELINE
	RESIDENCE SETBACK
	SITE ACCESS
	SITE ROADS (NEW)
	SUBSTATION
	TOP OF BREAK SETBACK (100m)
	UTILITY - DISTRIBUTION LINE (EXISTING)
	UTILITY - TRANSMISSION LINE (EXISTING)
	WATERCOURSES
	WETLANDS (CLASS I)
	WETLANDS (CLASS II)
	WETLANDS (CLASS III)
	WETLANDS (CLASS IV)
	WETLANDS (CLASS V)
	WETLAND SETBACK
	WELL HEAD SETBACK

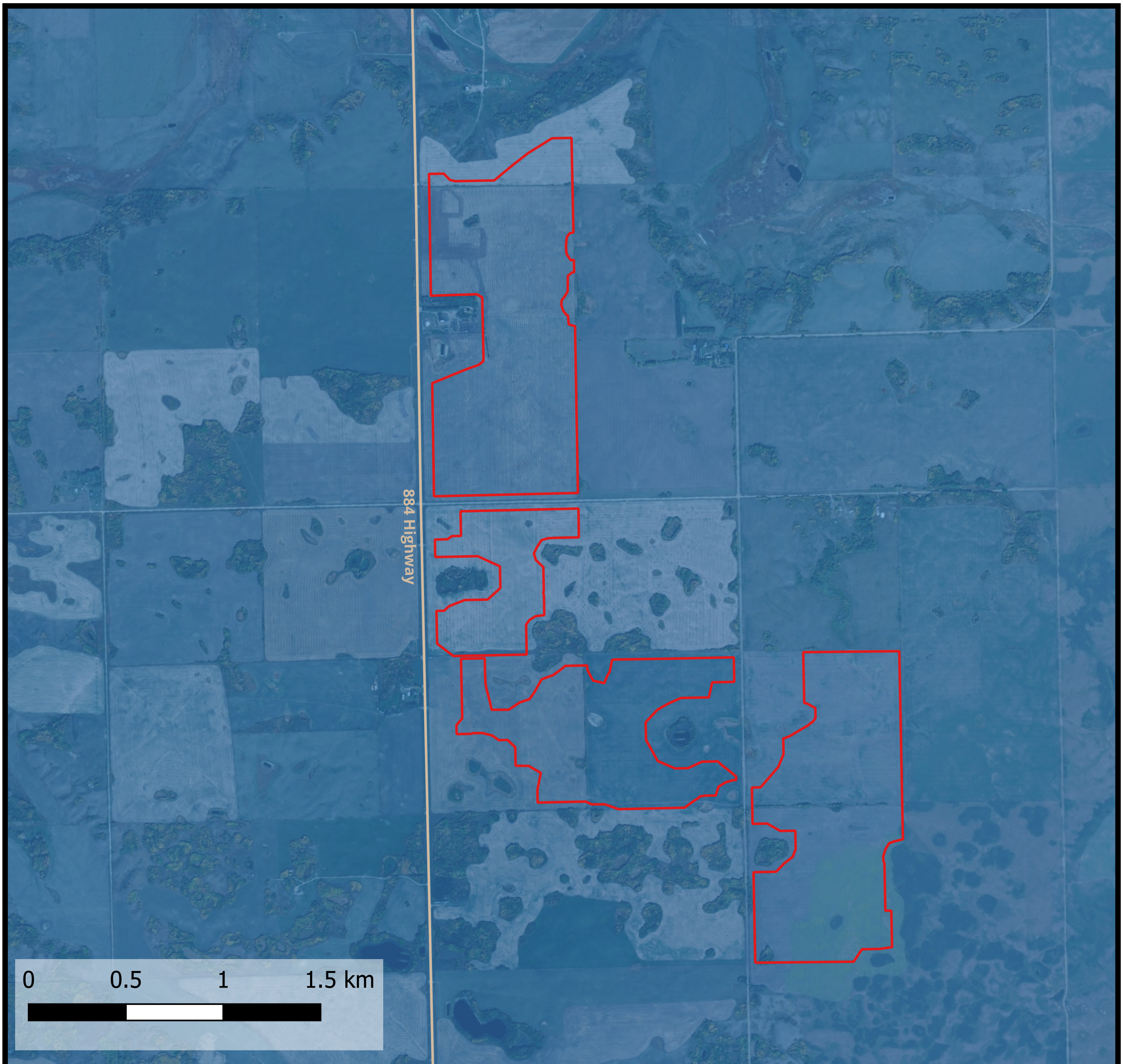
SEAL:

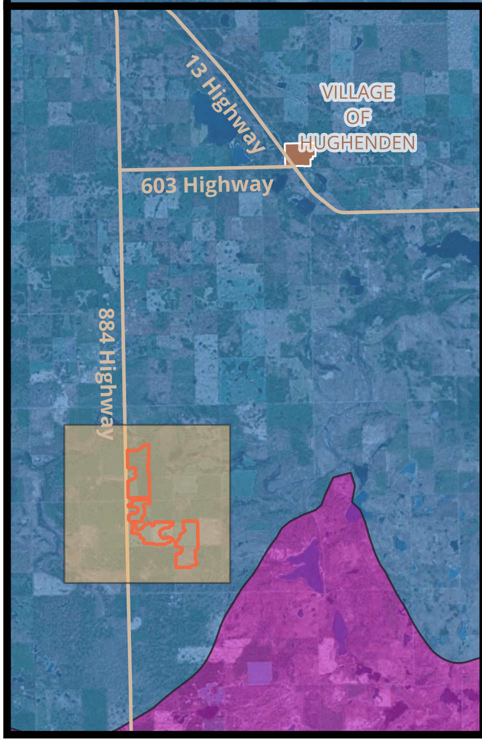
CLIENT: WESTBRIDGE ENERGY CORP

PROJECT:	EASTERVALE SOLAR PROJECT
TITLE:	ELECTRICAL SOLAR PV PLANT GENERAL ARRANGEMENT PRELIMINARY SITE PLAN
DESIGNED BY: E.MAZE	DRAFTED BY: E. MAZE
VERIFIED BY: H. YAZDANPANAHI	APPROVED BY: H.YAZDANPANAHI
SCALE: 1:9000	DATE: 2022-10-04
DRAWING No.: 7431003-000000-47-D20-0001	SHEET: 01 SIZE: A1 REV. AK

Appendix B

Ecoregion and Context Map





LEGEND

Proposed Project Fence

Alberta Base Data

Main Roads

Towns

Natural Subregions of Alberta

Central Parkland

Northern Fescue

Imagery Source:

Bing VirtualEarth

Tannas Conservation Services Ltd.

Estervale Solar Project

Location and Ecoregion

Scale:

1:28,000

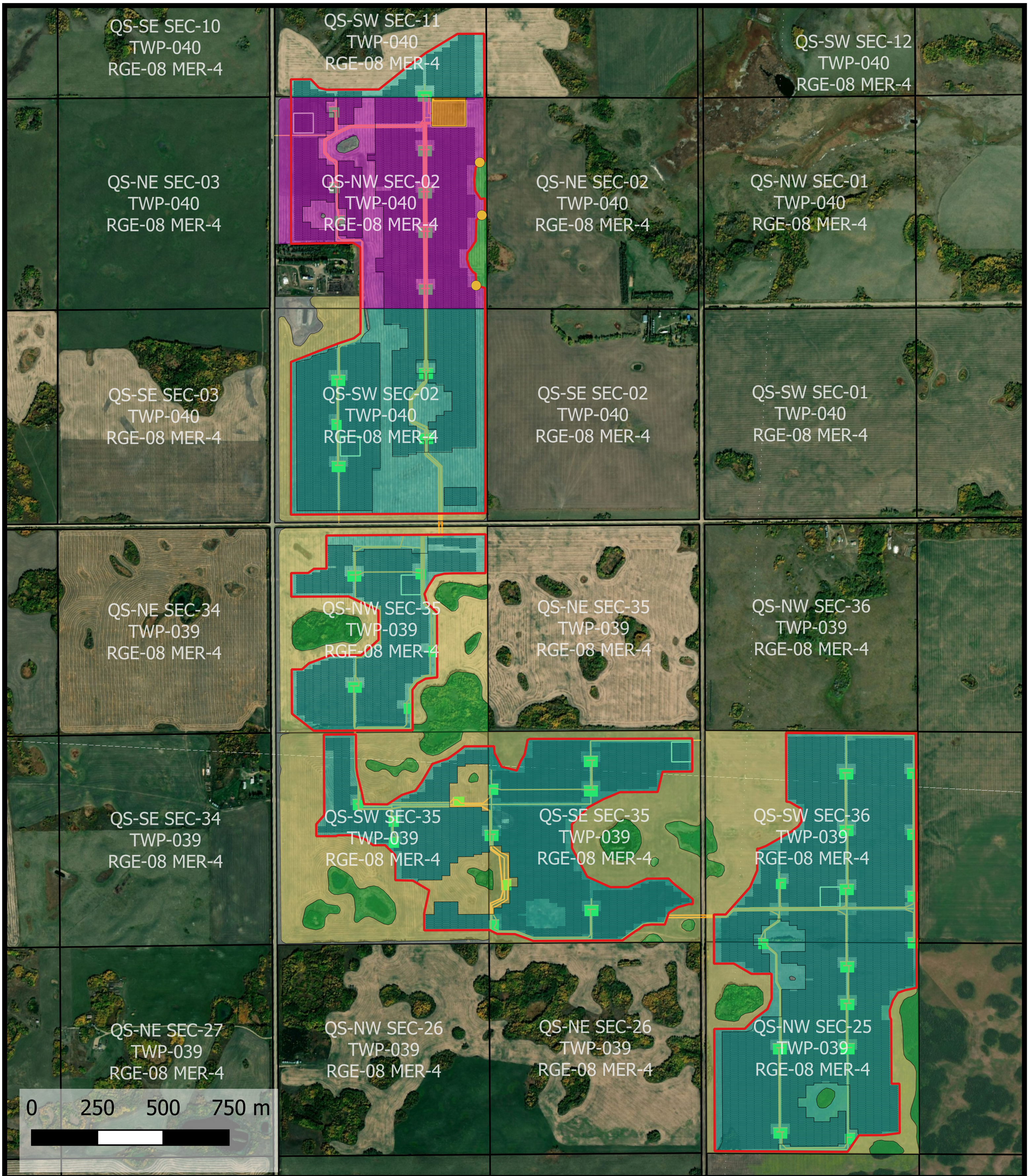
N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)

Appendix C

Agrivoltaic Design Map

WSLEGAL\095329\00004\40950151v1



LEGEND

Project Fence
Quarter Sections

Agrivoltaic Plan
- Crop
- Graze
- Forage
- Saskatoons
- Ditch
- Lost
- Livestock Gates

Solar Infrastructure
- Collector System
- Inverters
- Laydowns
- Panels
- Substation
- Road Center Line

Imagery: Bing VirtualEarth

Estervale Solar Project

Agrivoltaic Plan Overview

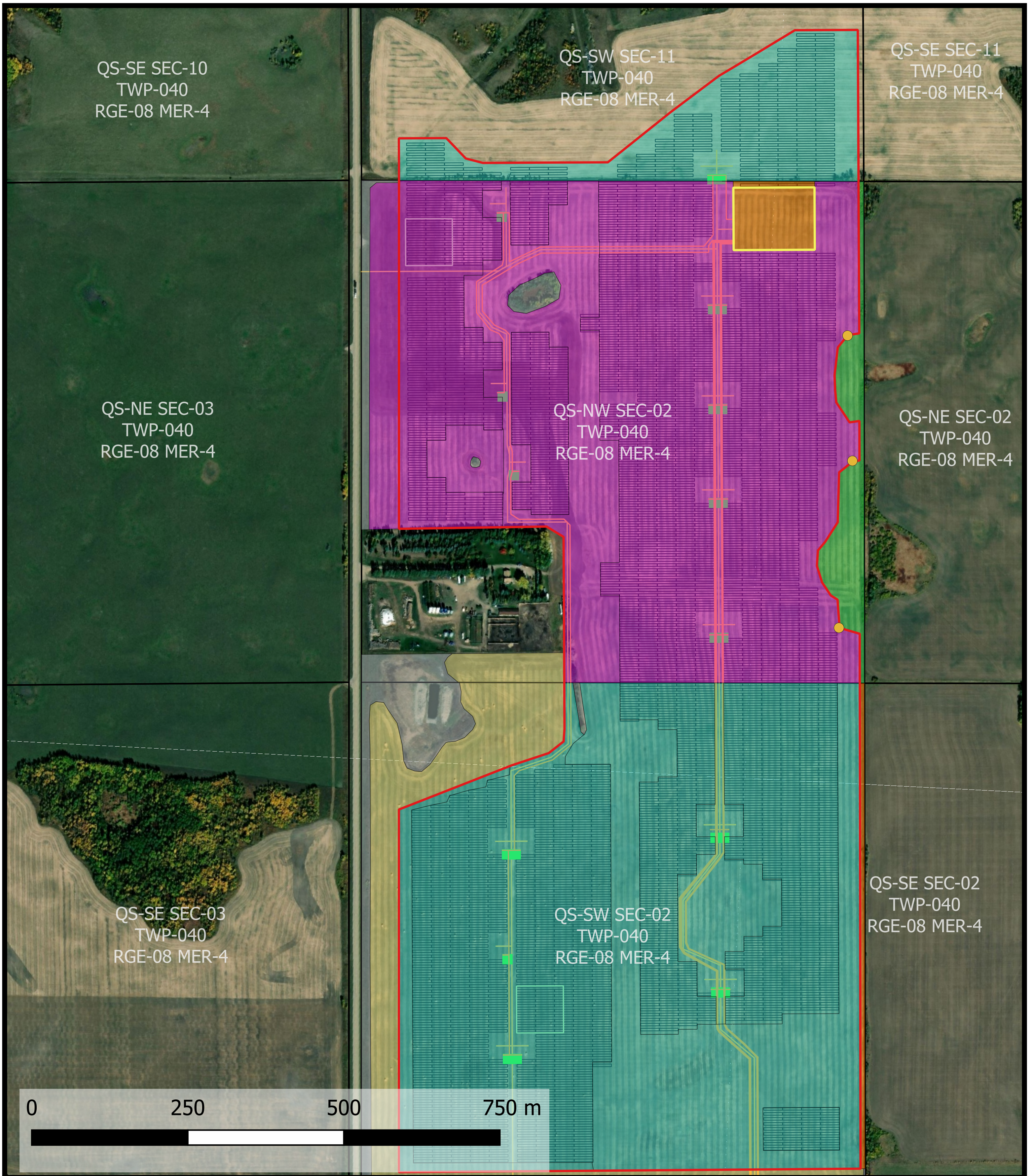
April 30, 2025

Tannas Conservation Services Ltd.

Scale:
1:19,000

N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)



LEGEND

Project Fence

Quarter Sections

Agrivoltaic Plan

- Crop
- Graze
- Forage
- Saskatoons
- Ditch
- Lost
- Livestock Gates

Solar Infrastructure

- Collector System
- Inverters
- Laydowns
- Panels
- Substation
- Road Center Line

Imagery: Bing VirtualEarth

Estervale Solar Project

Agrivoltaic Plan North

April 30, 2025

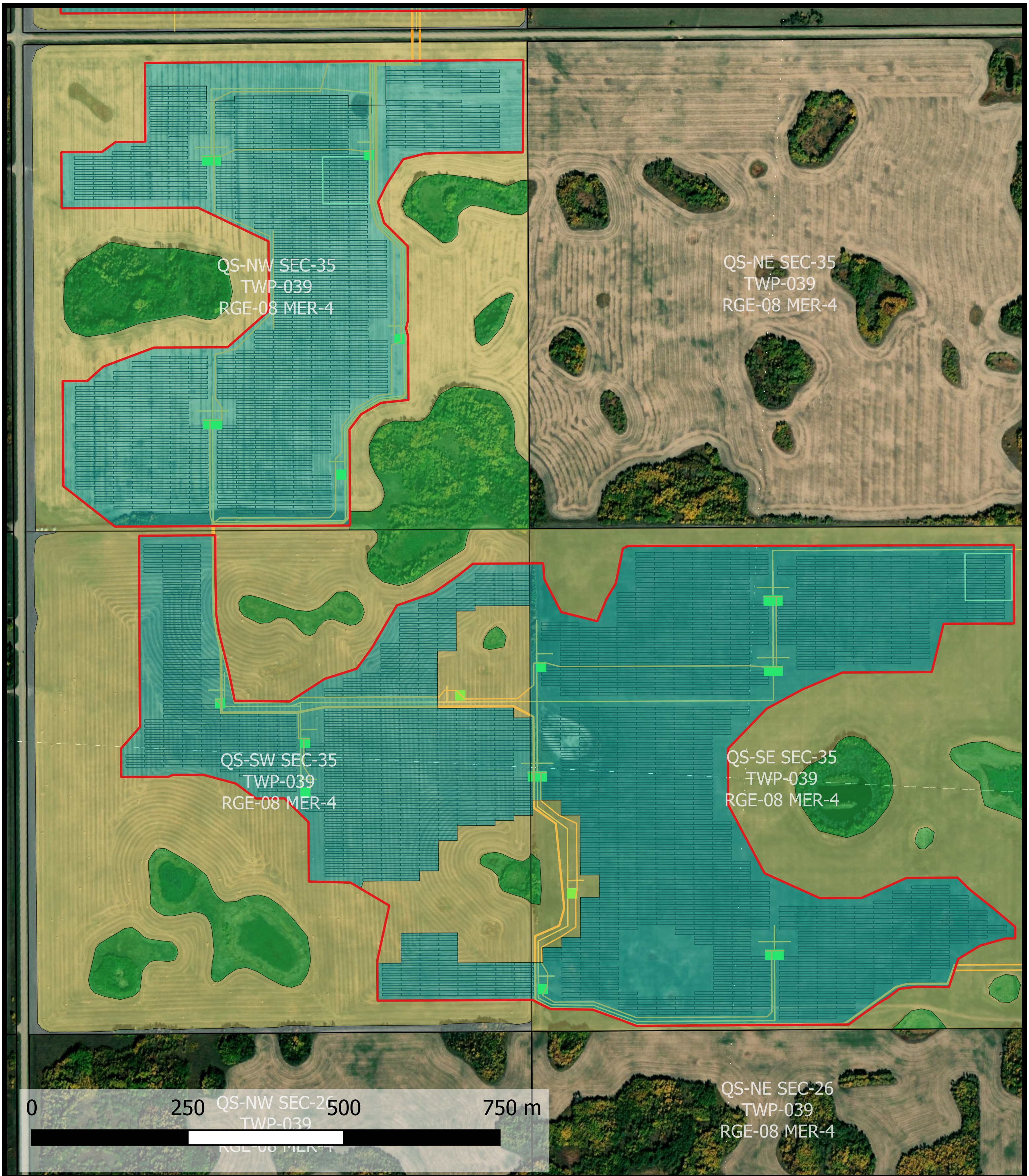
Tannas Conservation Services Ltd.

Scale:

1:8,000

N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)



LEGEND

Project Fence

Quarter Sections

Agrivoltaic Plan

- Crop
- Graze
- Forage
- Ditch
- Lost

Solar Infrastructure

- Collector System
- Inverters
- Laydowns
- Panels
- Road Center Line

Imagery: Bing VirtualEarth

Estervale Solar Project

Agrivoltaic Plan Central

April 30, 2025

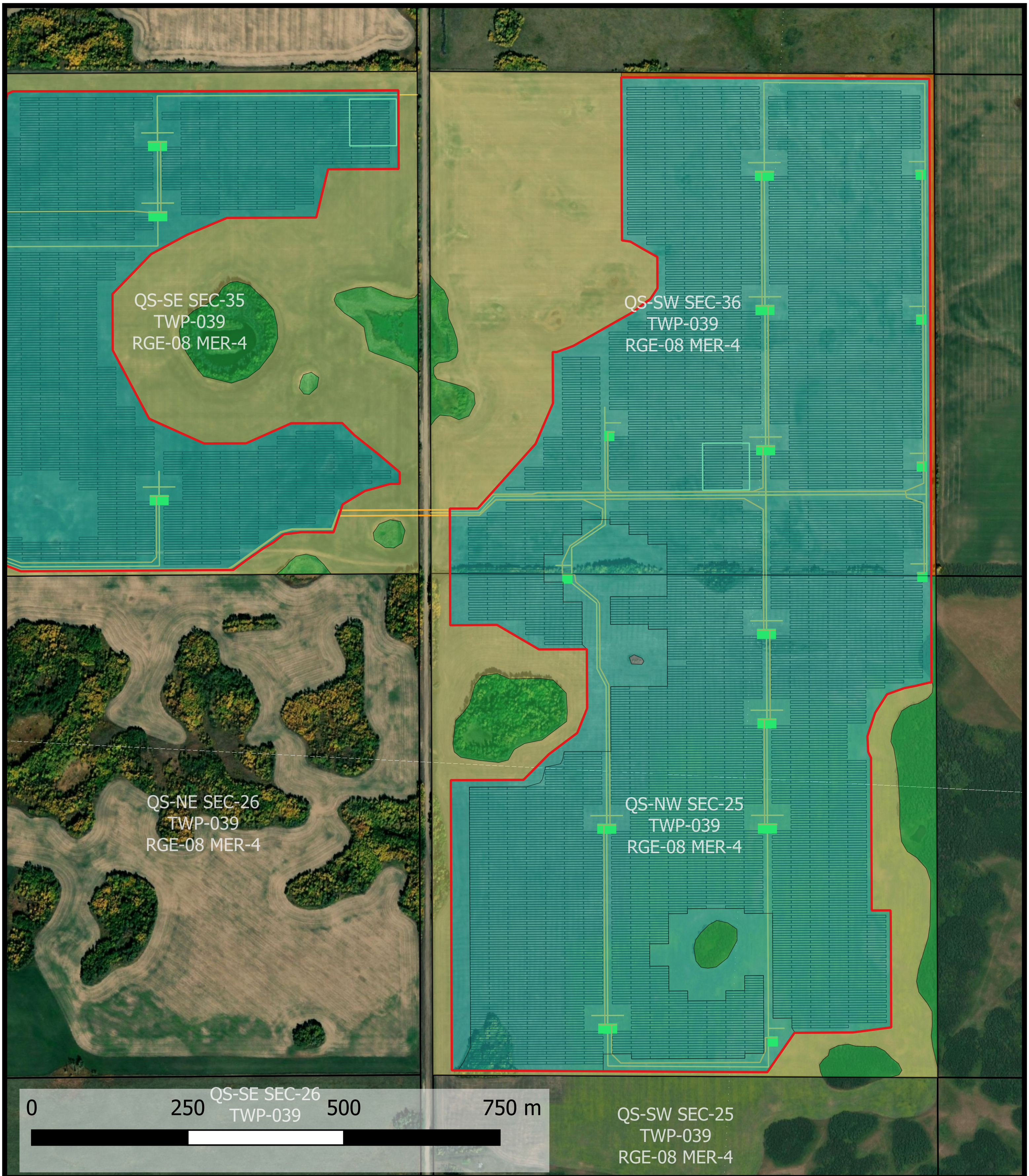
Tannas Conservation Services Ltd.

Scale:

1:8,000

N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)



LEGEND

Project Fence

Quarter Sections

Agrivoltaic Plan

- Crop
- Graze
- Forage
- Ditch
- Lost

Solar Infrastructure

- Collector System
- Inverters
- Laydowns
- Panels
- Road Center Line

Imagery: Bing VirtualEarth

Estervale Solar Project

Agrivoltaic Plan South

April 30, 2025

Tannas Conservation Services Ltd.

Scale:

1:8,000

N

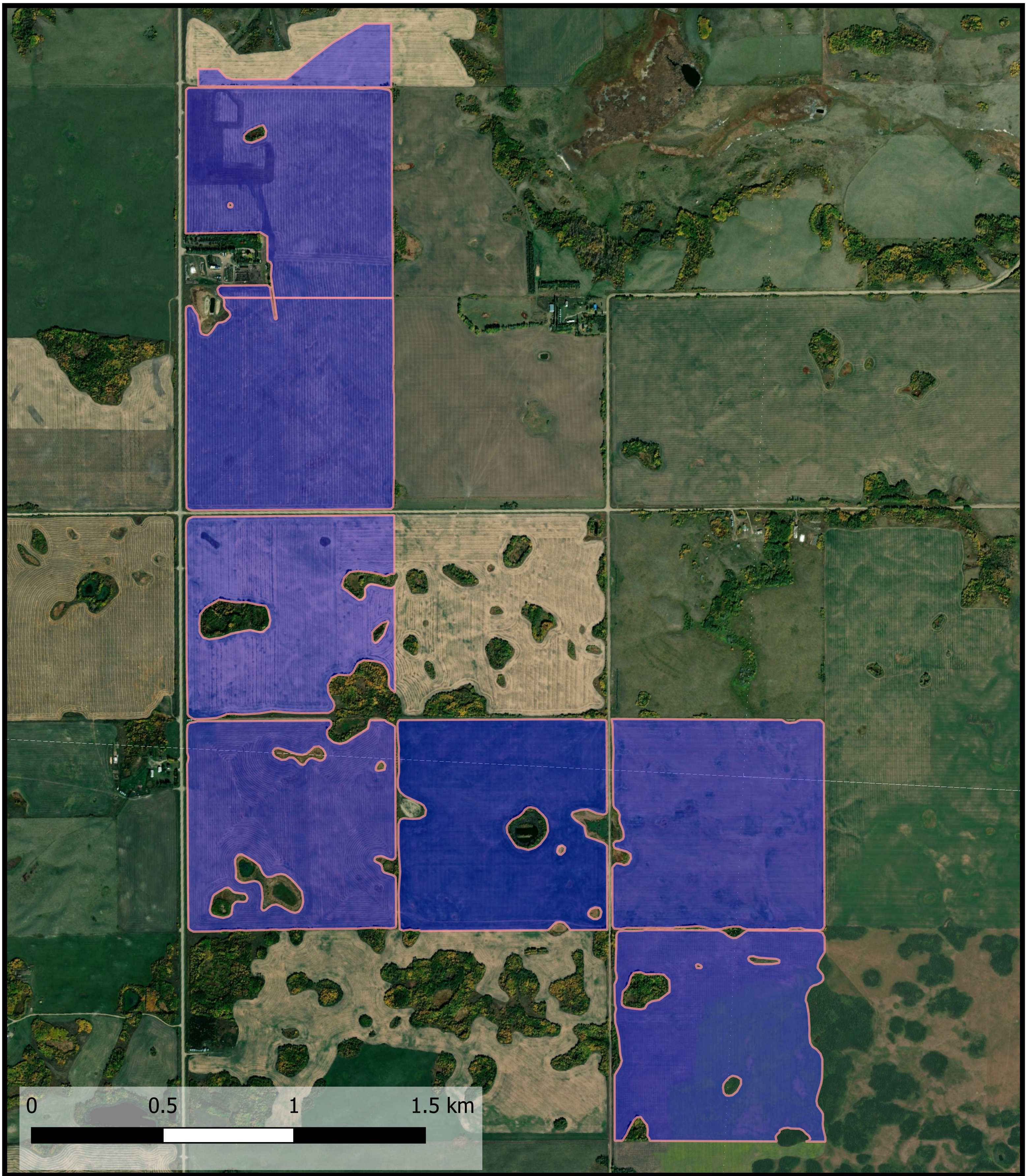
CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)

Appendix D

Cultivated Area

Agrivoltaic Area

WSLEGAL\095329\00004\40950151v1



LEGEND

Cultivated Area

Imagery Source:

Bing VirtualEarth

Estervale Solar Project

Cultivated Area Impacted by the Agrivoltaic Plan

Tannas Conservation Services Ltd.

Scale:

1:19,000

N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)

LEGEND

Agrivoltaic Area

Quarter Sections

Imagery: Bing VirtualEarth

Estervale Solar Project

Agrivoltaic Area

April 30, 2025

Tannas Conservation Services Ltd.

Scale:

1:19,000

N

CRS Authority ID: EPSG:3400
NAD83 / Alberta 10-TM (Forest)

Appendix E

Historical Cropping Information

WSLEGAL\095329\00004\40950151v1

Land Parcel	2019 Crop	2019 Yield	2020 Crop	2020 Yield	2021 Crop	2021 Yield	2022 Crop	2022 Yield	2023 Crop	2023 Yield	2024 Crop	2024 Yield
SW 11-040-08-W4M	Oat/barley mix (silage)	N/A	Oat/barley mix (silage)	N/A	Canola	38 bu/acre	Oat/barley mix (silage)	N/A	Corn (grazed)	N/A	Soft wheat (silage)	9 t/acre
NW 02-040-08-W4M	Oats	80 bu/acre	Barley	75 bu/acre	Canola	38 bu/acre	Wheat	39 bu/acre	Oats	80 bu/acre	Oat/barley mix (silage)	N/A
NW 02-040-08-W4M	Oats	80 bu/acre	Barley	75 bu/acre	Canola	38 bu/acre	Wheat	39 bu/acre	Oats	80 bu/acre	Oat/barley mix (silage)	N/A
SW 02-040-08-W4M	Oats	80 bu/acre	Barley	75 bu/acre	Canola	38 bu/acre	Wheat	39 bu/acre	Oats	80 bu/acre	Spring wheat (silage)/Oats	6 bu/acre (oats)
NW 35-039-08-W4M	Wheat	60 bu/acre	Oat/barley mix (silage)	10 t/acre	Canola	35 bu/acre	Barley	85 bu/acre	Soft white wheat silage	6.5 t/acre	Canola	20 bu/acre
SW 35-039-08-W4M	Canola	50 bu/acre	Oats (silage)	9 t/acre	Wheat	41 bu/acre	Canola	50 bu/acre	Oats (silage)	9 t/acre	Wheat	Unknown
SE 35-039-08-W4M	Oats (silage)	9 t/ac	Canola	43 bu/acre	Oats (silage)	6 t/acre	Wheat	53 bu/acre	Canola	43 bu/acre	Oats (silage)	Unknown
SE 35-039-08-W4M	Oats (silage)	9 t/ac	Canola	43 bu/acre	Oats (silage)	6 t/acre	Wheat	53 bu/acre	Canola	43 bu/acre	Oats (silage)	Unknown
SW 36-039-08-W4M	Canola	48 bu/acre	Wheat	55 bu/acre	Oats (silage)	6 t/acre	Canola	32 bu/acre	Wheat	52 bu/acre	Oats (silage)	Unknown
NW 25-039-08-W4M	Cereal/brassica mix	swath grazed	Oat/barley mix	swath grazed	Peas	23 bu/acre	Oat/barley mix	baled as yellowfeed	Canola	50 bu/acre	Barley	35 bu/acre
NW 25-039-08-W4M	Cereal/brassica mix	swath grazed	Oat/barley mix	swath grazed	Peas	23 bu/acre	Oat/barley mix	baled as yellowfeed	Canola	50 bu/acre	Barley	Unknown

Appendix F

Steven Tannas Resume

WSLEGAL\095329\00004\40950151v1

Steven Tannas B.Sc., Ph.D., P.Ag. P.Biol.

Tannas Conservation Services Ltd.

President

Senior Vegetation, Wetland, Reclamation, Bioengineering, and Reclamation Ecologist

Education

Ph.D. Range and Wildlife Management (Ecology), University of Alberta (2011)
B.Sc. Agriculture (Range and Pasture Management), University of Alberta (2004)

Designations/Affiliations

Member, Alberta Society of Professional Biologists

BC Institute of Agrologists

Alberta Institute of Agrologists

President, Tannas Conservation Services

Vice President, Eastern Slopes Rangeland Seeds Ltd

President, Great Plains Restoration Solutions

Years of Experience – 18

Areas of Expertise

Plant Identification, bioengineering, reclamation, wetlands, environmental monitoring, statistics, seed mix design, rangeland inventories, ecological land classification, EIA's, native seed harvests, and biophysical inventories.

Steven Tannas is a senior vegetation ecologist, reclamation specialist, wetland scientist, and a Professional Agrologist (P.Ag.) through the Alberta Institute of Agrologists (AIA). He is specialized as a vegetation ecologist and his work spans a wide range of practice areas centered on vegetative sciences. Dr. Tannas is an experienced plant taxonomist able to spot identify over 1000 species of plants, a restoration ecologist, rangeland Agrologist, bioengineering specialist and native plant propagation specialist. His primary areas of focus have been in Western Canadian ecosystems including: Alberta, BC, Saskatchewan, Manitoba, Yukon, NWT and Nunavut. He has extensive experience working with industry including oil and gas, power, mines and agriculture, and has extensive experience working with federal, provincial and municipal governments. Steven has 18 years of experience working with the energy industry across western Canada in his professional career and another 10 years prior apprenticing under Eastern Slopes Rangeland Seeds Ltd. In agriculture Steven acts as a Senior specialist in Agrivoltaic Planning with over 20 projects completed in the past 2 years and 9 AUC hearings completed. He is working with Olds College, along with industry in researching new techniques to integrate grazing, crop production and horticulture in to solar facilities.

Regions: Dry mixed grass, mixed grass, foothills fescue, aspen parkland, lower foothills, upper foothills, northern fescue, montane, and boreal forest, foothills parkland, Alpine, subalpine, tundra.

Education and Accreditation

• Doctorate of Range and Wildlife Management (Ecology), University of Alberta, Edmonton, Alberta, 2005 – 2011, *Mechanisms controlling invasion of Kentucky bluegrass into fescue grasslands in southern Alberta*)
• B.Sc. in Agriculture (Range and Pasture Management), University of Alberta, Edmonton, Alberta, 2000 – 2004

Certifications and Specializations

Qualified Wetland Science Practitioner – Alberta Environment and Parks
1) Range and Pasture Management Practice Area, 2) Wetland and Riparian Practice Area 3) Environmental Impact Assessment and Mitigation Planning Practice Area, 4) Land Conservation and Management Practice Area 5) Land Reclamation Practice Area

Positions

• President: Tannas Conservation Services Ltd. (2011-Present)
• President GP Restoration Solutions Inc. (2018-Present)
• Vice President: Eastern Slopes Rangeland Seeds Ltd. (2004-Present)

Awards

- **2016 Alberta Business Awards (Finalist)** Young Entrepreneur Award.
- **2016 Alberta Business Awards (Finalist)** Entrepreneur of the Year.
- **Alberta Emerald Award 2001** – Individual commitment for environmental research

Project Experience

Electrical Grid

- **General Land and Power - Sollair Solar Project Agrivoltaics Assessment and Planning** As the project manager and lead technical specialist I completed a comprehensive literature review of Agrivoltaic systems across the world and used this information to inform the potential design of an Agrivoltaic system for General Land and Power. I also was the expert witness who attended the AUC hearings for this work and am currently working with Olds College and Red Deer Polytechnic on long term Agrivoltaics research connected to this proposed facility.

- **Westbridge Energy – Estervale Agrivoltaic Assessment and Planning.** As the team lead and core specialist on this project I completed a literature review of the relevant Agrivoltaic systems for the project, assessed the projects potential use of agricultural production within the existing design and made recommendations on an approach to Agrivoltaics for one solar farm including saskatoon production, hay production and grazing. I acted as the technical lead in all reports, IR responses and will be the expert witness at the AUC hearing.
- **Westbridge Energy – Dolcy Agrivoltaic Assessment and Planning.** As the team lead and core specialist on this project I completed a literature review of the relevant Agrivoltaic systems for the project, assessed the projects potential use of agricultural production within the existing design and made recommendations on an approach to Agrivoltaics for the Dolcy solar farm. I have acted as the technical writing lead, expert witness at the AUC in June 2024, and technical lead in writing all IR responses.
- **PACE –Agrivoltaic Farm Plans.** As the team lead and core specialist on this project am currently designing the Agrivoltaics plan for 9 solar farms in Alberta and supporting on other projects. This work includes literature review, detailed field assessments, farm plan writing and regulatory support for each project. Currently 5 reports are complete and 4 are being completed in the Spring of 2025.
- **Acestes Power – Westlock Solar Project Agrivoltaics Plan.** I acted as the lead technical specialist putting together the grazing plan for this project and acting as the senior technical reviewer for my team. I made design recommendations, and worked with the existing project goals to find a suitable way to integrate grazing with PV panels. I acted as the expert witness at the AUC for this project.
- **Acconia– Lonne Butte Project Agrivoltaic Plan**. I acted as the lead technical specialist and senior reviewer on this project. I was responsible for guiding the design of the grazing plan acted as the senior reviewer for my team on this project. And supporting the project through the Hearing Process.
- **Acconia– Lonne Butte Project Agrivoltaic Plan**. I acted as the lead technical specialist and senior reviewer on this project. I was responsible for guiding the design of the grazing plan acted as the senior reviewer for my team on this project. And supporting the project through the Hearing Process.
- **Kâpîsimotêt Solar Project – Agrivoltaic Plan.** I acted as the lead technical specialist and senior reviewer on this project. I was responsible for guiding the design of the grazing plan acted as the senior reviewer for my team on this project.
- **Acestes Power – Ponoka Solar Project Agrivoltaic Plan**. I acted as the lead technical specialist and senior reviewer on this project. I was responsible for guiding the design of the grazing plan acted as the senior reviewer for my team on this project.
- **Alberta Utility Commission – Expert Report: Impacts of Energy Production on Agriculture.** As the project manager and senior technical author, I have been leading a team to assess the impacts of energy production on agriculture and assess the appropriate mitigation measures and reclamation requirements to mitigate impacts to agriculture in Alberta during energy development projects.
- **ATCO Pipelines and Liquids Global Business Unit, Environmental Assessment Report for a Proposed Pipeline Installation on Siksika Nation, Siksika, AB.** Project manager, rare plant specialist, mapping, technical writer creating an environmental protection plan and reclamation recommendations.
- **Oldman 2 Windfarm Ltd., Oldman 2 Wind Farm Post-Construction Monitoring, Pincher Creek, Alberta.** Environmental audits, reclamation planning, reclamation monitoring statistical analysis for wildlife mortality monitoring and statistical advice for the project during post construction monitoring
- **ATCO Electric, D63965 (Eagle Energy) Line Reroute, Eastern Alberta.** Wetland assessments, report writing and senior review

<u>**Expert Witness Testimony Experience (9 projects completed and multiple upcoming)**</u>

- **Alberta Utiliites Commission – Enquiry into the Ongoing Economic, Orderly and Efficient Development of Electricity Generation in Alberta:** I was the project manager of the team contracted by the AUC to complete an expert report into impacts of renewable energy on agriculture. I also acted as a technical writing lead as well as the lead expert witness for the report at the public hearing in December 2023.
- **General Land and Power - Sollair Solar Project Agrivoltaics Assessment and Planning:** As the project manager and lead technical specialist I completed a comprehensive literature review of Agrivoltaic systems across the world and used this information to inform the potential design of an Agrivoltaic system for General Land and Power. I also was the expert witness who attended the AUC hearings for this work and am currently working with Olds College and Red Deer Polytechnic on long term Agrivoltaics research connected to this proposed facility.
- **Westbridge** – **Dolcy Agrivoltaics Plan**: As the project manager and lead technical specialist I completed an assessment of the Dolcy project and acted as lead author for the Agrivoltaics Plan, IR responses and acted as the lead expert witness for Agrivoltaics at the AUC hearing in June 2024.