BDO Zone Rating: **'A'**

Biofuel Development Opportunity Zone Risk Rating

'A'

The Logan County, Colorado, BDO Zone for wheat straw is rated 'A.' The long-term outlook on price and quantity is deemed stable, and key scale-up risks can be addressed with reasonable mitigation measures.

Rating Parameters:

Category	Rated Quantity	Delivered Cost	BDO Zone Size
Round/Square Bales	100,000 ODT/yr	$82-$105/ODT	80-miles

BDO Zone Assets

- **There is a stable long-term outlook on wheat straw price and quantity, with strong inventory management practices in place.**
- **An ability to access larger supply basins exists by increasing participation rates through marginal increases in transport costs to support large scale biorefinery projects**
- **Supply chain components and logistics equipment are expected to scale up to support a large scale biorefinery project.**
- **There is a positively rated infrastructure asset profile.**

BDO Zone Liabilities

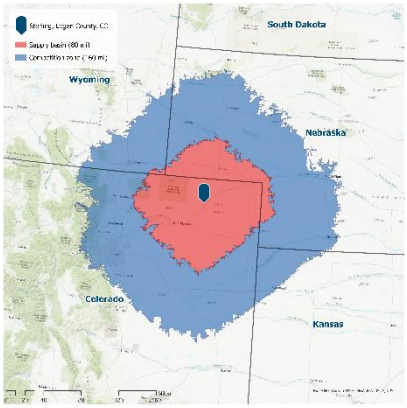
- **Energy price volatility can significantly impact grower-costs for inputs such as fuel, fertilizer, and equipment and on transportation costs to a biorefinery.**
- **The region lacks significant wheat straw collection and baling experience at scale to deal with supplier number and size.**
- **Dryland farmers may pass on straw market opportunities as the harvest represents a secondary transformation and valuable for soil health when left unharvested.**
- **Cattle feedlots in the BDO Zone can create temporary demand and affect feedstock prices for future biorefineries**

BDO Zone Risk Rating

The Logan County, CO, Biofuel Development Opportunity Zone is rated 'A,' or 'High Quality,' for 100,000 ODT/yr of Wheat Straw at $82 to $105/ODT delivered.

Risk Rating Grades are defined as follows: AAA (*highest quality*), AA (*very high quality*), A (*high quality*), and BBB (*good quality*).

Logan County BDO Zone



Scoring and Rating Methodology

In assessing the biomass supply chain risk for the Biofuel Development Opportunity (BDO) Zone, 52 Risk Indicators from the Canadian Standards for Biomass Supply Chain Risk (BSCR) were applied. These BDO Zone Risk Indicators are the subset of BSCR Risk Indicators applicable to evaluating feedstock risk within a BDO Zone.

Feedstock quantity is expressed in Oven-Dried Tons (ODT), while feedstock Price is expressed in US dollars and delivered to the plant yard, assuming the plant is located centrally in the BDO Zone.

The maximum transport distance from the plant of 80 miles is calculated assuming the maximum quantity in this BDO Zone Rating. Delivered feedstock costs for projects with medium volume requirements can be expected to be at the median of the BDO Zone's price range as the zone has frequent dry spells.

The BDO Zone rating is based on an aggregation of the scores assigned to each BDO Zone Risk Indicator

(RI) assessed in this report. First, each BDO Zone Risk Indicator is given a **Raw RI** score based on the research and analysis conducted on the feedstock supply chain in the region. Raw RI Scores are scaled between 1 (*low risk*) and 10 (*high risk*).

Next, each Risk Indicator is discounted, or "notched," based on the degree to which the uncertainty drivers are deemed addressable and whether there are reasonable expectations that mitigation measures could be put into place within the price parameters for this rating.

The **Notched Salience score** corresponds to the likelihood of each Risk Indicator's described risk materializing given the implementation of reasonable mitigation measures. To arrive at the Notched Salience score, Raw RI scores are reduced based on the efficacy of the likely mitigation measures. If applicable, notching occurs at one of 3 levels: 25%, 50%, or 75%.

The potential impact of each Risk Indicator on the supply chain is assessed and scored on a 10-point **Impact Level** scale as either *low (3.33), moderate (6.66), or high (9.99).* Impact level scores are based on assumptions that key measures were implemented to mitigate uncertainty drivers in the BDO Zone but failed to do so.

The **Loaded RI** score for each Risk Indicator is calculated as the product of Notched Salience and Impact Level scores. For example, Risk Indicator 3.22: Risk of Infestation has a Raw Risk Score of 2 and a Notched Salience score of 0.5 and its Impact Level is deemed high (9.99 out of 10). The final Loaded RI score for RI 3.22 is, therefore, 0.5 x 9.99 = 5.0 (out of 100).

Loaded RI scores of 33.33 or less are deemed *low risk*; scores greater than 33.33 and less than 66.66 are deemed *moderate risk*; and those that score 66.66 to 100 are deemed *high risk*.

The total risk rating for the BDO Zone is the average of all Loaded RI scores. The BDO Zone score for Logan County is ***15.24 out of 100, resulting in an 'A' designation.***

All scoring and rationale for each Risk Indicator are provided in Appendix A.

Analyst Notes

The Logan County BDO Zone presents several strong assets, including a lack of competition for wheat straw and an expected stable long-term outlook on feedstock price and quantity with strong inventory management practices.

There are substantial, large growers in the BDO Zone and access to a larger supply basin with marginal increases in transportation costs. The overall infrastructure to support a large project is very good.

Key Low-Risk Indicators

Most Loaded RI Scores are below 33.33 and thus deemed *low* risk.

Risks related to competition are all scored as *low*. This is because no large-scale facilities consuming Wheat Straw within the 160-mile (driving distance) competition zone surrounding Logan County, CO, are currently in operation. Cattle feedlots are the only consumers of wheat straw in the region, intaking up to 5% of generated wheat straw in the BDO Zone.

Risks related to infrastructure are also all scored as low as the BDO Zone has the key infrastructure in place to support a large-scale biorefinery project, including physical, social, logistics, workforce and permitting infrastructure.

The Loaded RI Score of *Risk Indicator 1.8. Feedstock Production Priority* is 24.97, or *low.* The initial grower outreach generated clear interest from a small core group of growers, with some equipment and experience in hay and straw markets.

The *Loaded RI Score of Risk Indicator 3.21, Long-Term Weather and Climate is 29.97.* Farm practices have adjusted to manage soil moisture and obtain reasonable winter wheat and other

grain crop yields. However, 2022 proved to be a difficult year in the area due to a severe drought. It appears that the weather pattern changed in April 2023, with excess moisture resulting from increased snow and rainfall.

Most farms in the Logan County BDO Zone are medium in size (815 acres), with several farmers cropping in the 3,000-to-5,000-acre range to produce various crops. Sizeable bio-based projects will require aggregations of individual smaller growers through custom service providers, either hay producers or baling crews. The degree of management complexity for this smaller farm size is significant but likely manageable. A large pool of suppliers will also bring with it positive supply chain attributes, as the presence of many suppliers can increase supply chain resilience. In years when the margins on the primary product (grain) are low, suppliers will want to negotiate higher prices for the secondary product (straw). Thus, working with a large pool of suppliers could be an advantage to negotiate pricing. The Loaded RI Score for RI 3.18 *Number, Size, Mix and Locations of Suppliers* is 29.97 and thus deemed relatively low risk.

Due to the present lack of a market for wheat straw regionally, grain farmers in the Logan County BDO Zone need to be more experienced in cost-efficient wheat straw harvesting at scale. Additionally, the area has a mixture of baler types deployed for harvesting straw. Some growers own square baling equipment ideal for storing and delivering wheat straw. While round balers are preferentially used on some livestock/grain farms. Differences in baling equipment and harvest practices among growers may result in variations in delivered feedstock quality unless a standard is set.

We assume that bio-based projects that locate in the Logan County BDO Zone will take measures to mitigate key risks. This expectation is indicated by the difference between Raw RI Scores and Notched Salience Scores for multiple Risk Indicators detailed in Appendix A.

The risks around harvesting, and collection equipment can be substantially mitigated by the vertical integration of a bio-project with wheat straw harvest/baling capacity or by engaging credible third parties to conduct harvest/baling activities. Scoring and this rating assume that such measures will be implemented.

We assess a low scale-up risk for *Risk Indicator 3.30. Capacity of Supply Chain Components and Equipment to Scale* with a Loaded RI score of 29.97 despite this indicator presenting a salient risk even with mitigation measures and a high impact if mitigation measures fail.

Key Moderate-Risk Indicators

The most significant risks in the Logan County BDO Zone wheat straw supply chain is 1) Seasonal Feedstock Supply Variation; 2) Supply Curve and Marginal Cost Curve; and 3) Diesel, Oil and Producer Price Index risks.

Seasonal Feedstock Supply Variation

Natural weather events can significantly impact annual wheat straw supplies in the Logan County BDO Zone. Wheat straw yields harvested could vary from 0.5 to 1.0 dry tons per acre, resulting in higher harvesting costs when yields are low. This category of risk presents moderate risk scores for this BDO Zone rating, with a Loaded RI Score of Risk Indicator *3.4 Seasonal Feedstock Supply Variation is 39.96*; Specific projects may be able to effectively mitigate this risk indicator through strong inventory management practices, increased participation rates, and an expansion of the supply basin. As the closest demand for wheat straw for bioprocessing will be in central Kansas, farmers outside the 80-mile zone would have an interest in supplying wheat straw.

Supply Curve and Marginal Cost Curve

Our analysis of supply curves for normal versus the one-in-ten year low indicates a minimum of 100,000 dry tons of straw available in the BDO Zone. On normal years, the amounts available increase to over 300,000 dry tons. Increasing the supply zone from 50 miles to 80 miles doubles feedstock availability. The cost of transporting the material from the outer third of the zone is marginal and estimated at $2.00/mile. The region has excellent road infrastructure for efficient transport movement in all directions.

Energy Cost

The Loaded RI Score of *Risk Indicator Diesel, Oil and Producer Price Index (PPI)* is 49.95, or *moderate,* as energy prices affect the annual cost for farm inputs, diesel during harvest, and transportation. Mitigation measures are somewhat limited by the external nature of this risk indicator. The BDO Zone diesel prices are in the medium US price range.

BDO Rating Parameters

To avoid undue market influences and prejudicing a project's ability to negotiate with suppliers, BDO Zone rating reports do not provide information on total feedstock cost breakdowns obtained during the assessment. This includes all costs associated with a third party's engagement and the development of a vertically integrated supply chain.

For this rating, we had received some limited feedback from growers augmented by proxy prices for grower ask, baling costs from the straw bedding market and estimates on potential next crop loss due to environmental conditions. Transportation costs were calculated using average distances based on supply curves and trucking costs typically used in the hay market for the region. Trucking costs are based on loaded miles.

The rating of the Logan County BDO Zone is based on total delivered costs of the feedstock in a price range of $82 to $105/ODT and at a maximum distance range of 80 mi for a total of 100,000 ODT/yr. The rated quantity assumes a 20% participation rate, as well as 1.2x required feedstock redundancy (BAM – Biomass Availability Multiple).

Infrastructure Profile

Logan County's infrastructure assets were scored on a scale of 0–10, with scores defined as follows: 0 (very good), 2 (good), 4 (reasonable), 6 (fair), 8 (poor), and 10 (insufficient). Overall, Logan County has a profile of positively rated infrastructure assets, with an average score of 15.24 out of 100. The score is based on the assessment of its Physical Infrastructure, Logistics, Social Infrastructure, and Workforce & Permitting. This score supplements the Logan County BDO Zone rating and supports its low-risk designation. The full infrastructure asset profile is detailed in Table 1.

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Figure 1: Risk Indicators (Sorted by Risk Level)

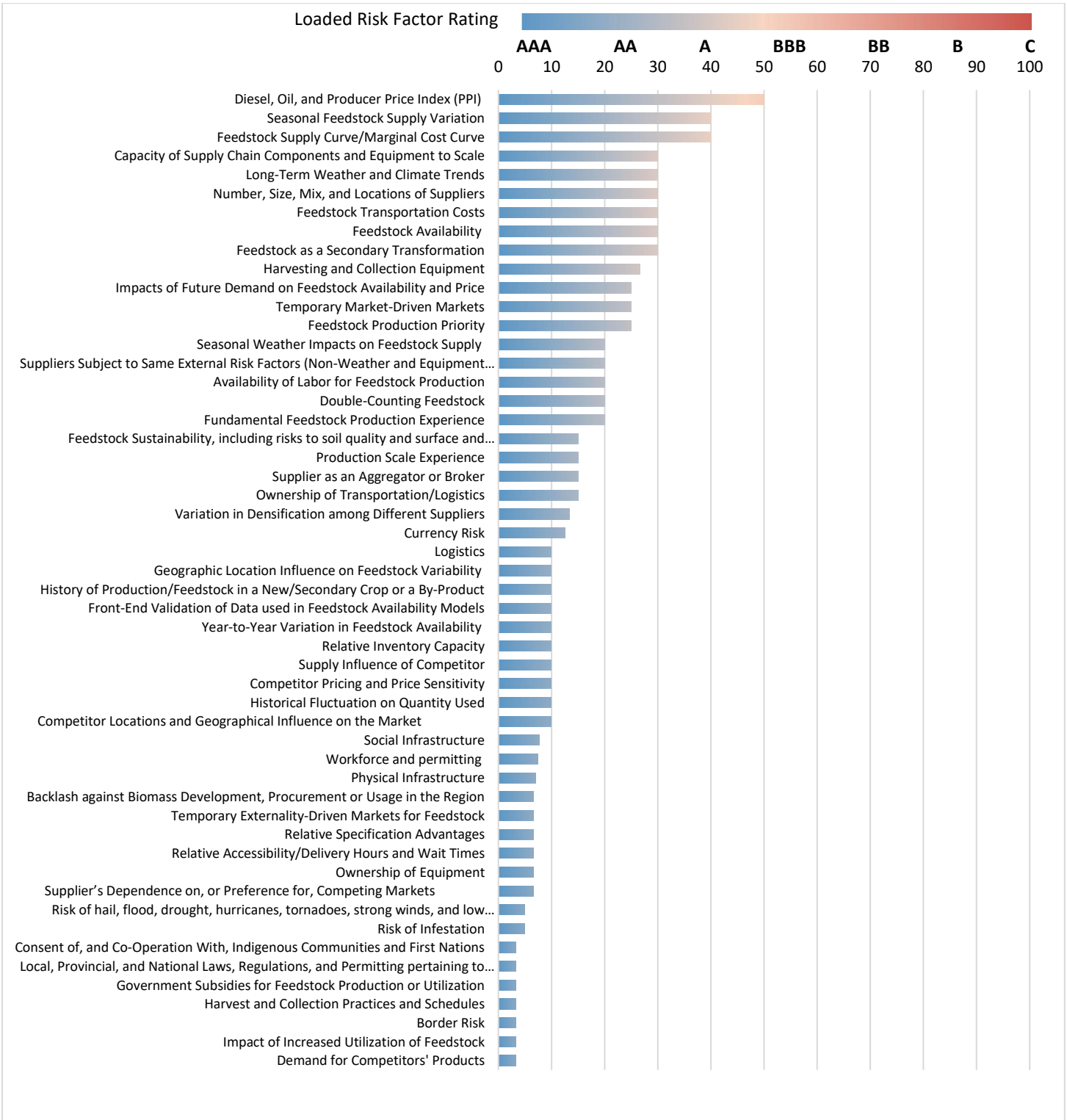


Table 1: Risk Indicators and Associated Scores

	Feedstock Supply Chain Risk Indicators	Raw RI Score	Notched Salience	Impact Level	Loaded RI Score
	Category 1: Supplier Risk				
1.1	Supplier's Dependence on, or Preference for, Competing Markets	2	2	3.33	6.66
1.2	Ownership of Equipment	2	2	3.33	6.66
1.3	Ownership of Transportation/Logistics	3	1.5	9.99	14.98
1.4	Supplier as an Aggregator or Broker	6	4.5	3.33	14.98
1.5	Feedstock as a Secondary Transformation	4	3	9.99	29.97
1.6	Fundamental Feedstock Production Experience	2	2	9.99	19.98
1.7	Production Scale Experience	3	1.5	9.99	14.98
1.8	Feedstock Production Priority	5	3.75	6.66	24.97
	Category 2: Competitor Risk				
2.1	Competitor Locations and Geographical Influence on the Market	1	1	9.99	9.99
2.2	Historical Fluctuation on Quantity Used	1	1	9.99	9.99
2.3	Competitor Pricing and Price Sensitivity	1	1	9.99	9.99
2.4	Impacts of Future Demand on Feedstock Availability and Price	5	2.5	9.99	24.98
2.5	Supply Influence of Competitor	1	1	9.99	9.99
2.6	Temporary Market-Driven Markets	5	3.75	6.66	24.97
2.7	Relative Inventory Capacity	1	1	9.99	9.99
2.8	Relative Accessibility/Delivery Hours and Wait Times	1	1	6.66	6.66
2.9	Relative Specification Advantages	2	1	6.66	6.66
2.10	Demand for Competitors' Products	1	1	3.33	3.33
	Category 3: Supply Chain Risk				
3.1	Feedstock Availability	6	3	9.99	29.97
3.2	Impact of Increased Utilization of Feedstock	1	1	3.33	3.33
3.3	Feedstock Supply Curve/Marginal Cost Curve	8	4	9.99	39.96
3.4	Seasonal Feedstock Supply Variation	6	4	9.99	39.96
3.5	Year-to-Year Variation in Feedstock Availability	1	1	9.99	9.99
3.6	Double-Counting Feedstock	4	2	9.99	19.98
3.7	Front-End Validation of Data used in Feedstock Availability Models	1	1	9.99	9.99
3.8	History of Production/Feedstock in a New/Secondary Crop or a By-Product	6	3	3.33	9.99
3.9	Diesel, Oil, and Producer Price Index (PPI)	5	5	9.99	49.95
3.10	Currency Risk	5	1.25	9.99	12.49
3.11	Border Risk	1	1	3.33	3.33
3.12	Temporary Externality-Driven Markets for Feedstock	1	1	6.66	6.66
3.13	Harvest and Collection Practices and Schedules	1	1	3.33	3.33
3.14	Harvesting and Collection Equipment	8	4	6.66	26.64
3.15	Variation in Densification among Different Suppliers	6	2	6.66	13.32
3.16	Availability of Labor for Feedstock Production	6	2	9.99	19.98
3.17	Feedstock Transportation Costs	3	3	9.99	29.97
3.18	Number, Size, Mix, and Locations of Suppliers	6	3.0	9.99	29.97
3.19	Suppliers Subject to Same External Risk Factors (Non-Weather and Equipment Based)	6	3	6.66	19.98
3.20	Seasonal Weather Impacts on Feedstock Supply	6	3	6.66	19.98
3.21	Long-Term Weather and Climate Trends	9	4.5	6.66	29.97
3.22	Risk of Infestation	2	0.5	9.99	5.0
3.23	Risk of hail, flood, drought, hurricanes, tornadoes, strong winds, and low temperatures	3	0.75	6.66	5
3.24	Government Subsidies for Feedstock Production or Utilization	1	1	3.33	3.33
3.25	Local, Provincial, and National Laws, Regulations, and Permitting pertaining to Biomass	1	1	3.33	3.33
3.26	Backlash against Biomass Development, Procurement or Usage in the Region	4	1	6.66	6.66
3.27	Consent of, and Co-Operation With, Indigenous Communities and First Nations	1	1	3.33	3.33
3.28	Feedstock Sustainability, including risks to soil quality and surface and groundwaters.	3	1.5	9.99	14.98
3.29	Geographic Location Influence on Feedstock Variability	1	1	9.99	9.99
3.30	Capacity of Supply Chain Components and Equipment to Scale	6	3	9.99	29.97
	Category 4: Infrastructure				
4.1	Physical Infrastructure	2.1	2.1	3.33	6.99
4.2	Logistics	3	3	3.33	9.99
4.3	Social Infrastructure	2.33	2.33	3.33	7.75
4.4	Workforce and Permitting	2.25	2.25	3.33	7.49
				Average	**15.24**



Logan County BDO Zone Independent Review Committee (IRC)

Brandon Mason – Producer and custom bailing
Andy Edson – Commodity Trader
Bob Lingreen – Owner of Circle L Irrigation, Cattle Feeder, ag producer
Jason Hovey – Agronomy Manager, CHS High Plains
Brad Erker – Director CO Wheat Growers
Jerry Sonnenberg – State Senator
Rose McEndaffer – Ag producer
Brent Young – CO State University Extension Ag Economist
Brandon Biesemeier – Ag producer Haxtun area
Trent Bushner – Ag producer

APPENDIX A: RISK INDICATOR SCORING METRICS

CATEGORY 1: SUPPLIER RISK

1.1. Supplier's Dependence On, or Preference For, Competing Markets

Rationale: Suppliers may have a vested interest or preference to supply to specific competitors for biomass feedstock. Preferences may be due to historical, long-term, or personal relationships, less stringent feedstock quality requirements, more flexible operating hours by competing markets, or suppliers' dependence on competing markets to accept or purchase other products/by-products. During periods of feedstock shortage suppliers may be more likely to allocate the scarce supply to a competitor, resulting in supply disruptions for the Proponent.	
Raw RI Score: The demand from the livestock sector for bedding is very small, likely less than 5% of the biomass available in the area but current custom balers would have allegiance to those markets. There is no other demand for wheat straw and farmers leave it in the field to protect soil moisture and enhance soil health. The Raw RI Score is deemed low. Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience: No adjustments. De-risking measures are not necessary for risk indicators with Raw RI Scores of 3 or less, as they are already at the lowest risk.	**Score 2.0**
Impact Level: RI Impact level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

1.2. Ownership of Equipment

Rationale: In most cases, suppliers that own or lease equipment for harvest, collection, and processing of feedstock are at a lower risk than those that do not. For example, third-party harvesting equipment may not be available when required, meaning that short harvest windows may be missed if a farmer and contractor cannot schedule convenient harvest times, resulting in quantity shortages. In some circumstances, relying on third-party equipment to harvest or produce feedstock can decrease supply chain risk. For instance, when harvesting agricultural residues such as corn stover, the use of third-party companies with standard equipment specializing in harvesting, collection, and transportation may decrease quality variations (e.g., ash content) of final feedstock.	
Raw RI Score: Farmers in the area deploy round and large square balers for hay and straw. Most farms use a 3x4x8 ft baler in the large square baler group. However, there are a few who use 4x4x8 ft balers. Farmers prefer round bales for livestock use, while producers and aggregators prefer large square bales for handling, storage, and hauling. Larger square bales fit better on commercial transport, reducing haulage costs. They also have a higher bulk density and lower harvest cost than round bales in commercial applications. Grain farmers without livestock on their farms would not have straw baling equipment. Area farmers would respond by using their equipment to bale straw if the demand was there. However, outside custom baler contractors would be needed to meet large commercial targets and ensure a timely	**Score 2**

and relatively short window for harvest. Custom third-party balers are available from out of state. A risk exists that some custom operators in the northwest states may be contracted elsewhere to bale hay and may not be available in a timely manner. When volume orders are large, custom operator rates are very competitive. Following grain harvest, the straw remains available for baling for a 3-to-4-week period, however farmers prefer seeing the straw baled soon after grain harvest. The Raw RI Score is deemed low. Raw RI Score is 2 out of 10.	
Notched Salience: RI 1.2 could be significantly mitigated by hiring of proven custom baler operators, including a few local operators. A commercial bale stacking equipment supplier maintains a contact list of interested third party operators that could be hired by the project to bale and aggregate on their behalf. Additionally, a very large custom hay operator located in Washington State could be interested. At the time of the straw harvest, farmers would not have issues with custom operators as the field conditions are dry eliminating concerns of soil compaction. If the project is larger than 100,000 ODT/yr, considerable coordination will be required to ensure an efficient harvest. Purchasing equipment for a short straw harvest period is unlikely as the equipment costs are significant. 12 to 15 large square balers dedicated to the project would be needed to bale within a 3–4-week window. As a result, the Raw RI Score is unnotched as the risk is already low.	**Score 2.0**
Impact Level: RI Impact level is deemed *low*. The risk of not being able to attract out-of-state custom balers from more southern states where the wheat harvest is completed earlier is a small risk. With appropriate planning and pricing, custom operators would be available. Local farmers would provide service mostly for their acreage committed to a project and a few would offer custom services to other local farmers.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

1.3. Ownership of Transportation/Logistics

Rationale: In most cases, suppliers that own or lease equipment necessary to transport biomass from forests or fields are at a lower risk than those that do not. However, in some circumstances, reliance on third parties to transport biomass is considered common practice and does not contribute to risk.	
Raw RI Score: Farmers with cattle are equipped to transport hay and straw. Few grain only producers would be equipped to transport straw as it is currently left in the field. Unless there are new investments in adding to existing fleets, insufficient transport will be available to meet a large project's demand. End of field storage of straw would be acceptable to farmers if the bales are removed by early spring. This would mitigate the transportation fleet size needed during the harvest, as the straw does not have to move off farm immediately. The transport fleet at the farm level would need to be supplemented by a commercial fleet to move the straw to a processing facility or intermediary storage yard. 10 to 12 trucks dedicated to moving straw would be required and met through a combination of farm and commercial trucks. Raw RI Score is 3 out of 10.	**Score 3**

Notched Salience: With adequate planning, sufficient transportation equipment can be obtained from commercial haulers. The Proponent can mitigate this risk by controlling all off-farm straw movement and making aggregation yards available for intermediate storage. Leaving hauling responsibilities to grain farmers could be problematic in terms of timing deliveries to a facility. Several trucking companies specialize in moving grain to ethanol facilities and have the logistical experience of just in time deliveries and could transfer this knowledge to fill a transportation gap. Building an additional fleet for the straw market will take time for investment in the equipment and train drivers. Three regional commercial carriers and an oil and gas carrier expressed interest in providing relief services. As a result, Raw RI Score is notched by 50%: Notched Salience is 1.5.	**Score 1.5**
Impact Level: RI Impact level is deemed *high.* A potential risk of inadequate transportation infrastructure would pose a significant risk to the project.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 14.98 out of 100.	**Score 14.98**

1.4. Supplier as an Aggregator or Broker

Rationale: Aggregators may effectively provide supply chain redundancy and eliminate the risk and complexity of dealing with multiple sources of supply by combining them into a single master contract. Aggregators can add much needed stability to biomass supply basins by increasing the offtake stability for both suppliers and markets. An aggregator can be a more reliable long-term offtake solution for suppliers by having access to multiple markets. Parallelly, they are also more reliable long-term suppliers for markets by having multiple suppliers – i.e., when a single supplier breaches, the aggregator can source from another.	
Raw RI Score: In the Ag sector, custom operators represent those with farm equipment and render service for a fee. The custom operators have well-trained staff and operate at a high level of efficiency. In the sale of agricultural commodities, farmers may sell on consignment through a broker and are paid by the broker. Alternatively, farmers may have an off-take agreement F.O.B. farm gate. In the latter case, the hauler is contracted to deliver to the processor, and the processor pays the farmer. In either case, there needs to be considerable trust between the farmer and the "purchaser" to make the arrangement work. A few farmer-aggregators work in the hay and straw market at very small volumes relative to the project size. On a medium-scale project, the developer may need to develop a relationship to purchase the straw through several aggregators, especially as the supply zone increases beyond 50 miles. The likelihood of aggregators having several markets is low. The Raw RI Score is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience: Careful planning of potential relationships throughout the BDO Zone to determine where potential aggregators might fit will mitigate this risk. As the distances to a project location increase, farmers become more difficult to commit as there is no known relationship, while a local aggregator might be best positioned to supply a market. The Raw RI score is notched by 25%. Notched Salience is 4.5.	**Score 4.5**

Impact Level: RI Impact level is deemed *low.* There is likely many straw producers likely to commit supply to a project, therefore, the potential for failing to develop sufficient aggregators is low.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 14.98 out of 100.	**Score 14.98**

1.5. Feedstock as a Secondary Transformation

Rationale: A secondary transformation is dependent upon the production of primary products, e.g., Wheat straw resulting from the production of Wheat. Risks are higher if the feedstock is a secondary transformation of a primary, more valuable product. It may not be economical for suppliers to produce biomass on their own in the absence of markets for the primary product.	
Raw RI Score: Straw is a secondary product from wheat production. Wheat harvested in Colorado has remained steady over the past 20 years, with individual croplands committed to wheat varying based on a multi-year crop rotation and market prices. Both domestic and global demand for wheat is strong, assuring continued production. Other than the bedding market, which is small, wheat straw is left unharvested for the protection of soil moisture and soil health enhancement. There is a risk of farmers introducing different grain headers on their combines where the wheat plant stem is not cut during the harvest of wheat. If farm equipment changes, it would result in additional cost for the straw harvest as an additional field pass would be required to swath the standing wheat plant prior to baling. RI Score is deemed slightly moderate. Raw RI Score is 4 out of 10.	**Score 4**
Notched Salience: RI 1.5 could be further reduced by enlarging the straw intake zone as there is no demand for straw elsewhere. Inventories could be managed by covering piles and building an 18-month supply capacity to manage year-to-year straw yield fluctuations. Proper extension of field harvest protocols could mitigate the risk of requiring an additional field pass. As a result, Raw RI Score is notched by 25%; Notched Salience is 3.	**Score 3.0**
Impact Level: RI Impact level is *high.* Other than a complete crop failure, the straw will be available to harvest. In the past 20- year records, this has not occurred, although the 2020 -2023 period is extremely dry and affected yields.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97 out of 100.	**Score 29.97**

1.6. Fundamental Feedstock Production Experience

Rationale: Risk is higher when a supplier has limited experience with planting, growing, harvesting, processing, and/or collecting biomass. Limited experience may be common for agricultural residue supply chains where farmers may have no previous experience. In cases where experience is lacking, Proponent should show that steps have been taken to ensure proper training, knowledge dissemination, and monitoring.	

Raw RI Score: Many farmers would have experience with hay or straw harvests. While grain-only farmers may have little experience, they would have knowledge based on other local farmer activities. Raw RI Score is deemed low. Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience: RI 1.6 could be significantly reduced by farmers selecting a custom operator that would have the experience. The storage and handling model would be new to farmers in the area but can be mitigated through appropriate information dissemination at farm meetings. As a result, Raw RI Score is unnotched as the risk is low.	**Score 2.0**
Impact Level: RI Impact level is deemed *high.* There is a risk, although small, that custom balers from out of the area could not be enlisted at a competitive price causing disruptions to the processor.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 19.98 out of 100.	**Score 6.66**

1.7. Production Scale Experience

Rationale: Scale-up entails risk. The risk is higher when suppliers have limited experience with production at the quantity of feedstock required.	
Raw RI Score: While the project size is medium-to-large, local growers' experience coupled with additional custom operators would be satisfactory for projects scaled at 100,000 ODT or less. An equipment manufacturer in central Kansas (Stinger) maintains a list of custom operators. Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience: RI 1.7 could be reduced by combining baling forces with both local and custom operators. Selecting an appropriate farm service provider to coordinate acreage, location, and harvest would increase confidence in the supply chain. As a result, Raw RI Score is notched by 50%: Notched Salience is 1.5.	**Score 1.5**
Impact Level: RI Impact level is deemed *high.* The impact of not obtaining early resources to work with farmers is high and could result in a larger intake area required to meet supply goals. An emerging straw project in central-south Kansas could disrupt resource availability for custom baling as the straw baling season occurs simultaneously.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 14.98 out of 100.	**Score 14.98**

1.8. Feedstock Production Priority

Rationale: When biomass feedstock is a secondary or non-core line of business, or when it is a by-product /residual from a more valuable primary product, suppliers may not put sufficient effort into consistently producing it. The risk of breach increases when production and/or delivery of feedstock compromises the supplier's ability to make a primary product. When biomass feedstock is a by-product of another main higher margin or main product (e.g., wheat straw), supply may not be a top priority for a supplier.	
Raw RI Score: Many factors exist that can affect a farmer's decision to sell straw in any given year. Examples include severe drought (as experienced in 2020-2022), pests (saw fly), grain yields, price, and crop failures. Preliminary contact with producers indicates curiosity and need to learn more. There were several enthusiastic grower/custom service operators servicing the livestock sector wanting to participate. Raw RI score is 5 out of 10.	**Score 5**
Notched Salience: Round table meetings with farmers are a good introductory step and should be followed with meetings with representatives of the supply chain who can answer grower concerns. As a result, Raw RI Score is notched by 25%: Notched Salience is 3.75.	**Score 3.75**
Impact Level: RI Impact level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 24.97 out of 100.	**Score 24.97**

CATEGORY 2: COMPETITOR RISK

2.1. Competitor Locations and Geographical Influence on the Market

Rationale: Competitors' locations relative to a Proponent plant can affect the viability of procuring feedstock and its cost. Accurate and detailed competitor mapping provides an understanding of the geographical influence a competitor may have, including competitive advantages such as short hauling.	
Raw RI Score: There is no competitor for wheat straw processing in the surrounding areas. The risk is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment required.	**Score 1.0**
Impact Level: RI Impact level is deemed *high,* should there be a large-scale operator entering the market.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.2. Historical Fluctuation of Quantity Used

Rationale: Clear understanding of key competitors' consumption of each type of feedstock utilized by the Proponent is essential to quantifying the risks associated with each competitor. Understanding historical trends of feedstock utilization can provide valuable information about feedstock price elasticity during shortages and insights into events impacting future supply conditions. It can also enable more accurate estimates of the sensitivity of feedstock availability to potential future consumption levels or to the impact of external events (e.g., weather events, structural economic changes, seasonality, or policy change).	
Raw RI Score: There are no historical competitors in the area as wheat straw has not been harvested for large commercial projects. This risk is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustments as de-risking measures are not needed.	**Score 1**
Impact Level: RI Impact level is deemed *high*.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.3. Competitor Pricing and Price Sensitivity

Rationale: Understanding how much competitors pay for different feedstock types is an essential step in determining competitiveness of Proponent. Historical prices paid by competitors provide insights into their procurement behaviors and ability/willingness to pay premiums for feedstock and exert pressure on Proponent's suppliers during times of feedstock shortage. Competitors who are able to offer higher prices for feedstock during feedstock shortages can pose significant risks to Proponent.	
Raw RI Score: There is no competitor as the straw bedding market through public auction occurs only a few times per year and is based on inventory for livestock use. There are no markets to establish prices commercially based on large-scale supply. The closest auction to Sterling is in Brush, Colorado. This risk is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: There is no requirement with Raw RI scores of 1 as the risk is low.	**Score 1.0**
Impact Level: RI Impact level is deemed *high.*	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.4. Impacts of Future Demand on Feedstock Availability and Price

Rationale: Future competitors for feedstock or an expansion of feedstock demand by current competitors can cause feedstock market disruption. Even before new competitors become operational, high interest in a supply basin can make suppliers overconfident, leading to a supplier-controlled market where short-term contracting becomes the norm and supply chain reliability is compromised for the Proponent. Once operational, new competitors increase demand for feedstock, potentially lowering availability and increasing costs. Existing competitors may seek to expand operations, increasing consumption of feedstock.	
Raw RI Score: There is no potential large-scale operator in the area. Once a project becomes operational, the risk of another project in the zone is low. In drought periods, livestock operators expand their use of straw as a feed ingredient to replace hay which can temporarily affect market prices for straw. The Raw RI Score is deemed moderate. Raw RI Score is 5 out of 10.	**Score 5**
Notched Salience: Inventory buildup is a key approach to mitigate this risk. Ensuring that farmers in the entire zone can participate in the supply chain from the onset is also a good strategy to ensure farmer participation when the supply is limited. Building a long-term relationship with local farmers helps a future biorefinery secure the straw supply and the price as farmers usually prefer to have a long-term demand for their straw rather than sporadic demands such as animal bedding and feed. As a result, Raw RI Score is notched by 50%: Notched Salience is 2.5.	**Score 2.5**
Impact Level: RI Impact level is deemed *high.* A new large-scale operator in the area would pose a significant risk competing for supply.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 24.98 out of 100.	**Score 24.98**

2.5. Supply Influence of Competitor

Rationale: In some cases, competitors may exert high degrees of pressure over local suppliers, effectively enabling them to control feedstock, especially during shortages. This control can stem from previous relationships between suppliers and competitor, often from verbal or "understood" agreements, or from a competitor being able to assist suppliers in times of surplus by maintaining large inventories enabling suppliers to continue supplying when other markets impose quotas. Understanding and planning around such soft risk factors is important. If such relationships exist in the Proponent's procurement area, they may indicate increased risk of feedstock shortage or pricing changes.	
Raw RI Score: There is no competitor to exercise pressure and there is widespread straw available from individual farmers. Raw RI Score is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**

Impact Level: RI Impact level is deemed *high.*	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.6. Temporary Market-Driven Markets

Rationale: Alternative, non-traditional, market-driven competitors for feedstock can drive feedstock demand in unusual circumstances. A Proponent using corn stover as a feedstock, for example, would not typically compete with higher-end animal feed markets due to quality issues. However, in times of significant hay shortage (e.g., during drought), farmers use corn stover in place of hay, driving up the price of feedstock and decreasing availability for bio-projects (Bergtold 2018).	
Raw RI Score: There are some market driven forces to use wheat straw as a feedstock during hay shortages despite straw having relatively low nutrient value. It would require treatment with a nitrogen source or blend with dry distillers' grain available from local ethanol plants to use as cattle feed. The demand for straw as a feed ingredient will reduce when hay is available, however some feedlots are likely to rely on straw as a feed ingredient. Following the 2022 straw harvest, prices were reported in the $150-$175/ton range. Raw RI Score is deemed moderate. Raw RI Score is 5 out of 10.	**Score 5**
Notched Salience: Planning for an annual 18-month inventory of straw will mitigate biomass shortages, however there will be impacts on the price as cattle producers increase the demand. Building a long-term relationship with local farmers helps future biorefinery projects secure the biomass supply and price as crop growers prefer to have a long-term demand for their straw rather than sporadic demands such as animal bedding and feed. Notched Salience is 25%.	**Score 3.75**
Impact Level: RI Impact level is deemed *moderate*, as the impact of a temporary market would be moderate.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 24.97 out of 100.	**Score 24.97**

2.7. Relative Inventory Capacity

Rationale: Storing inventory enhances one's competitiveness. The ability to store large inventories allows biomass Proponents to purchase inventory when prices are low, yielding economic advantages. Additionally, the ability to store inventory during feedstock supply surpluses enables competitors to continue to intake feedstock when the Proponent (with lesser inventory capacity) may be forced to put suppliers on quota. A larger inventory capacity creates supplier loyalty, increasing reliability while decreasing risk.	
Raw RI Score: The ability to store inventory for 18 months will not impact prices for farmers. Farmers need a set price to overcome the potential net effects of straw removal on soil moisture, impacting future crops and the cost to harvest the straw. Other than a limited demand in the livestock sector, there is no other demand. The raw RI Score is deemed low.	**Score 1**

Raw RI Score is 1 out of 10.

Notched Salience: There is no adjustment for low-risk items.	**Score 1.0**
Impact Level: RI Impact level is deemed *high*, as supply chain loyalties could be disrupted.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

2.8. Relative Accessibility/Delivery Hours and Wait Times

Rationale: The value attributed by suppliers to local markets is often directly related to the degree of flexibility the market provides in terms of delivery hours and the efficiency of discharge.	
Raw RI Score: There is no alternative market to consider. Raw RI Score is deemed low.	**Score 1**

Raw RI Score is 1 out of 10.

Notched Salience: No mitigation measures could be identified.	**Score 1.0**
Impact Level: RI Impact level is deemed *moderate*, as the supply chain would adjust to market conditions over time.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

2.9. Relative Specification Advantages

Rationale: When choosing a market, suppliers look at price as well as relative quality requirements or specifications. It is important to understand a competitor's feedstock quality specifications to accurately quantify the risk that a competitor can exert on the Proponent's supply chain.	
Raw RI Score: There are no competitors. If there were one, the quality spec would be based on moisture and soil contamination in delivered bales and bale size. Straw preserves at 15% moisture or less with minimal biological degradation. Minimal introduction of soil contamination during harvesting and collection is also key for biorefinery projects to reach their target production efficiency and yield, which can be achieved by working with experienced harvest custom groups. Bale size is critical to any project as it affects transportation and storage costs, equipment requirements at prepossessing and uniformity of feedstock flow. Some projects outside this market area specify only large square bales. If a bale size specification is set for the project, those farms currently using round balers could either decide not to participate or rely on custom baling services. The raw RI Score is deemed low.	**Score 2**

Raw RI Score is 2 out of 10.

Notched Salience: Grain farmers/crop growers are unlikely to have baling equipment, so their decisions would be unaffected. Bale specifications need to be well explained at grower meetings. Mitigation measures should be broad to avoid any miscommunication. Developing best practices and standard procedures for harvest, collection, storage, and transportation in collaboration with local farmers and harvest custom groups will help meet the quality specifications of the biorefinery projects.	**Score 1.0**

The Raw RI Score would be notched by 50%.	
Impact Level: RI Impact level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

2.10. Demand for Competitors' Products

Rationale: Increased demand for competitors' products can cause an increased demand for feedstock from the competitor, given that the competitor can increase its production capacity easily. For example, increased demand for biofuels due to a clean fuels policy can cause increased biofuel production by the competitor, thereby increasing demand for feedstock.	
Raw RI Score: There are no large-scale competitors in the area. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: Not required as this risk is low.	**Score 1.0**
Impact Level: RI Impact level is deemed *low*, as increasing production for cellulosic based materials is proven to be difficult and a lengthy process.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

CATEGORY 3: SUPPLY CHAIN RISK

3.1. Feedstock Availability

Rationale: Feedstock availability is calculated based on three variables: i) feedstock generation in addition to current markets; ii) Biomass Availability Multiple (BAM); iii) supplier participation rate. Biomass Availability Multiple (BAM) indicates the degree of redundancy in a Proponent's supply chain. While supplier participation rate indicates the proportion of suppliers likely to supply to a new project.	
Raw RI Score: With an average 800,000 acres of annual wheat produced consistently in the region, the straw byproduct is also available for harvest. However, farmers utilize straw mainly for soil moisture and erosion protection and minor acreage is harvested for the livestock bedding market. The BAM is set at 1.2x. The farm participation rate is untested but expects farmers to consider three factors to determine if it is economically profitable. The factors, as reported by Gan et. Al., 2012 are the cost of the harvest, the cost of nutrient loss, and the cost of increased soil erosion. In addition, in semi-arid zones, the cost associated with moisture loss impacting the next crop is one of the grower considerations. In this BDO zone, the soil has a high potassium content thus not requiring fertilization to offset straw removal. Raw RI is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience: Some of these risks can be mitigated through pricing and crop rotation where wheat is produced once every 3-4 years on a given acreage to effectively reduce harvesting straw in the same area	**Score 3.0**

repeatedly. Farmers interviewed have confirmed being on a 3 or 4-year crop rotation. A project can mitigate against supplier participation rates through farm information meetings and include extension staff to discuss the benefits of crop rotations and tradeoffs. In addition, the straw removal rate can be determined through Agricultural Extension Activities to minimize soil moisture and nutrient loss and erosion. Notched Salience Score: The Raw RI is notched by 50% as the mitigation potential is significant.	
Impact Level: RI Impact level is deemed *high.* The supply of straw is available, and its accessibility is based on individual producer decisions. If producers remain unconvinced to participate, the risk is significant.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.2. Impact of Increased Utilization of Feedstock

Rationale: Feedstock utilization in a supply basin can change over time. Existing consumers of feedstock can expand operations or new facilities may enter the market. Increased utilization puts additional pressure on feedstock and can lead to higher prices, feedstock disruptions, shortages, or supplier breaches.	
Raw RI Score: As producers and the Proponent develop mutual trust, the effort to access additional acreage will become easier. The potential entry of a new facility is a possibility with the location likely in other counties within the BDO Zone, as well as in towns with existing grain ethanol facilities. If this is the scenario, the new entrant zone would be different with an emphasis on their immediate area. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: De-risking measures are not required for indicators with a Raw RI Score of 1, as they are already the lowest risk. Notched Salience is 1.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.* If this is the scenario the new entrant zone would be different with emphasis in their immediate area. Accordingly, the supply pool would increase with minor impacts on quantities and prices. The only known straw bioprocessing project closest to Logan County is a single project in central-south Kansas.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.3. Feedstock Supply Curve / Marginal Cost Curve

Rationale: The greater the feasible transport distance, the greater the amounts of feedstock accessible to the Proponent, but at a higher delivered cost. The feedstock supply curve, also referred to as the marginal cost curve, is a function of feedstock availability over its cost, which is primarily, but not exclusively, a function of distance. The feedstock supply curve is used to determine the availability of redundant feedstock at various price points and the cost of replacing feedstock with substitutes located at different distances.	

Feedstock cost curves are useful in determining supply chain resilience. They provide information about the cost of feedstock availability in times of supply disturbance. Biomass supply chains are prone to supply disturbances over time. For instance, suppliers can become insolvent, or weather events can temporarily disrupt feedstock availability. When a disturbance occurs, the Proponent may need to source replacement feedstock from different suppliers at different locations and costs. A biomass supply curve indicates quantities of feedstock available at various price levels from suppliers generally located farther away than core suppliers.	
Raw RI Score: Based on grower and service provider feedback, zone pricing is common within the BDO zone. Examples of pricing include a cost per loaded mile of $ 4.75 with a distance range of greater than 20 miles up to 80 miles. Another charge of $2.75 is applied to distances within 40 miles, as is $ 6.00/loaded mile for distances in the 40 to 80 miles. The cost for going outside the BDO zone is significant as the hauler will only realize 1 load per day compared to 1.5 loads within the zone. Based on interviews with commercial haulers, the marginal cost for extra mileage beyond 80 miles is estimated at $ 2.00 per mile (range $1.89 to 2.25/mile). Raw RI Score is 8 out of 10.	**Score 8**
Notched Salience: De-risking measures require the Proponent to source outside the region as drought-related events will likely affect the entire region's crop. Based on the location of USDA Reports on straw auctions, the Proponent could require sourcing and haul from distances of 150 miles or more, resulting in significant cost increases. One auction located in Brush would likely be like Logan farmers' production pattern. The Proponent can develop a sourcing plan to address multi-year crop failures and carry a larger year-over-year inventory. The raw RI Score is notched by 50%.	**Score 4.0**
Impact Level: RI Impact level is deemed *high.* If there is no wheat straw outside the zone, the impact would be high.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 39.96 out of 100.	**Score 39.96**

3.4. Seasonal Feedstock Supply Variation

Rationale: Biomass supply can present significant seasonal supply variations. When combined with limitations associated with longer-distance transportation and storage, this can result in regional biomass supply imbalances (Golecha & Gan 2016) and manifest as supply shortages and higher costs for Proponents.	
Raw RI Score: Historical data does not indicate massive crop failures for this region. However, the 2020 crop was at a 10-year low, and the 2022 crop was reported as an unusual year with many crop failures. The harvested straw yield variation in very dry years could dip to 0.5 ODT/year or none compared to 0.75 to 1 ODT/year based on normal years. While impacting harvest acreage required and harvest cost, there could be limited supply to meet annual targets and require going into the 60 to 80-mile zone to access straw. The pressure on straw prices will be significant. Raw RI Score is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**

Notched Salience: De-risking measures required would include a purchase strategy for significant out of zone supply combined with a larger annual buildup of supply to stock an 18-month inventory. The raw RI Score is notched by 25%.	**Score 4.0**
Impact Level: RI Impact level is deemed *low.* The impact of a major negative supply variation would be significant affecting both availability and cost.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 39.96 out of 100.	**Score 39.96**

3.5. Year-to-Year Variation in Feedstock Availability

Rationale: Biomass can have significant year-to-year supply variations due to variability in yield from biomass harvesting operations, particularly with agricultural biomass.	
Raw RI Score: The equipment used for wheat straw harvesting is proven, and its performance is very high, such as grain harvest, baling, and end-of-field stacking equipment. Five high-density baler manufacturers and two field stacker companies are servicing the area. Year-to-year equipment operators are well-trained and remove potential variation. Raw RI Score is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: Mitigation for this risk is achieved automatically as the equipment used for harvest is equipped with sensors to enable adjustments for various parameters such as bale weights. Those adjustments can be initiated from the cab and are part of the precision agriculture training that equipment operators would have received. Notched Salience is low.	**Score 1.0**
Impact Level: RI Impact level is deemed *high.* If there is insufficient mechanical support to fix breakdowns or inadequate operator training, the impact would be high as farmers could decide to abandon the market.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.6. Double-Counting Feedstock

Rationale: Aggregators, intermediaries, or brokers organize and distribute feedstock produced by suppliers. If such sources of supply are used in assessing feedstock availability for BAMs or supply curves, the Proponent should be sure not to double count feedstock produced by one supplier and traded/supplied by an intermediary.	
Raw RI Score: There is a risk of overcounting acreage as farmers may elect to leave some fields unharvested for various reasons. Reliance on independent custom operators can lead to some double counting as well, creating a supply target shortfall at the end of the harvest season. Custom operators in the region also sell to feedlots and a feedstuff market developed in 2022. Raw RI Score is deemed low. Raw RI Score is 4 out of 10.	**Score 4**

Notched Salience: Mitigation can be achieved by deploying a field coordinator to manage the harvest by working with custom harvesters to coordinate field availability timing and who is performing the work at each location. Each field and harvest service provider should be uniquely identified, including a sub-identification of the baling crew. The Raw RI Score is notched by 50%.	**Score 2.0**
Impact Level: RI Impact level is deemed *high*. Inventory management is critical to keep costs down and enable proper planning decisions to adjust for any supply shortfall.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 19.98 out of 100.	**Score 19.98**

3.7. Front-End Validation of Data Used in Feedstock Availability Models

Rationale: Feedstock supply models can be complex. A lack of clarity about model assumptions and baseline data can result in confusion on the part of the capital markets and drive financing costs for biomass projects. The adequacy and credibility of assumptions and baseline data is paramount to credible model outputs.	
Raw RI Score: Appendix B of this rating lists all the assumptions used in the development of feedstock supply curves. The assumptions are based on interviews with farmers and extension staff in the BDO zone. Both published literature and a theoretical model used by the Oak Ridge National Laboratory, US, DOE model populated with both USDA and Colorado Department of Agriculture data to validate our estimates. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: There is no need to mitigate as the Raw RI risk is low.	**Score 1.0**
Impact Level: RI Impact level is deemed *high*. Potential uncertainty can lead to increased risk.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.8. History of Production / Feedstock Is a Secondary Crop or a By-Product

Rationale: If the feedstock is a new secondary crop or a by-product, suppliers may either lack sufficient experience to mitigate risk or be unable to react to it. Producers are also unlikely to prioritize producing these crops at the expense of higher-value commodities. For new crop types, inexperience in planting, harvesting, collection, and yield data may pose higher levels of risk. If the feedstock is a secondary crop, production can be subject to variables beyond suppliers' control (e.g., changing primary crop prices).	
Raw RI Score: There is a limited experience amongst a few large producers offering custom harvesting for the livestock market, but not at scale for a bioprocessing facility. Grain farmers are familiar with wheat production and may have baled Wheat Straw for personal use. Livestock farmers have some experience but not at scale. The Raw RI Score is deemed moderate.	**Score 6**

Raw RI Score is 6 out of 10.	
Notched Salience: Farmers are known to adapt well to new equipment and agriculture technologies. Introducing the harvest protocols would significantly mitigate limited farmer experience in the production of straw. As a result, Raw RI Score is notched by 50%.	**Score 3.0**
Impact Level: RI Impact level is deemed *low*. Farmers continuously assess new markets for their grains and livestock. In this case they would welcome the opportunity to consider being suppliers.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.9. Diesel, Oil and Producer Price Index (PPI)

Rationale: Diesel, oil, and Producer Price Index (PPI) can impact costs affiliated with harvesting feedstock and its collection over time. Sensitivities to worst case scenarios should be run.	
Raw RI Score: Wheat straw production is affected by fuel and oil prices, generally reflected in the cost of diesel. The input costs are also affected. Through the National Agricultural Statistics Service, USDA conducts surveys every five years to calculate the Index of Production Items, which is one of five components in the overall Prices Paid Index for Commodities and Services, Interest, Taxes, and Farm Wage Rates (PPITW). In addition, custom farm service provider rates are published annually by region. Accordingly, the Index of Production Items impacts harvest costs for labor associated with the straw harvest and transportation. The one segment hit significantly was the farm equipment manufacturers through energy costs and supply chain disruptions. Manufacturers are continually adjusting their equipment production calendars and price structure. Raw RI Score is 5 out of 10.	**Score 5**
Notched Salience: The factors affecting farm input and custom service fees are external to the farmer and project.	**Score 5.0**
Impact Level: RI Impact level is deemed *high*. The impact is significant as farmers will be reluctant to lock into multi-year pricing of the Wheat Straw.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 49.95 out of 100.	**Score 49.95**

3.10. Currency Risk

Rationale: If the Proponent's supply basin does not have enough feedstock, the proponent may need to meet their feedstock demand from another justification that has a different currency, as we have seen in the wood pellet industry, which is traded globally. This will expose the proponent to currency volatility.

Raw RI Score: The Proponent will likely need more knowledge of the region's supplier-farm production practices and aggregation relationships. Raw RI Score is deemed moderate. Raw RI Score is 5 out of 10.	**Score 5**
Notched Salience: The Proponent can hire a trusted agronomic source or create an alliance with a major farm input supplier with a track record in production research to be the interface with all farmer suppliers. Raw RI is notched by 75%; Notched Salience is 1.25	**Score 1.25**
Impact Level: RI Impact Level is deemed *high*. The supply basin lacks experience in medium to large scale procurement of feedstock.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 12.49 out of 100.	**Score 12.49**

3.11. Border Risk

Rationale: Where feedstock is transported to another country, there is a risk of exposure to border closures and crossing delays. The availability of trucks willing to do cross-border runs is limited, often decreasing supply chain flexibility and resilience. Plants near the US-Canada border which intake feedstock from both countries are exposed to these risks.	
Raw RI Score: The supply zone is completely within the US, mostly in Colorado and some supply zones in Nebraska. Raw RI Score is deemed low. Raw RI score is 1 out of 10.	**Score 1**
Notched Salience: This risk is unnotched as the risk is already low.	**Score 1.0**
Impact Level: RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.12. Temporary Externality-Driven Markets for Feedstock

Rationale: Alternative, non-traditional, externality-driven competitors for feedstock can drive feedstock demand (and cost) in unusual circumstances. For example, a Proponent using corn stover as a feedstock would not typically compete with the higher-end animal feed market. However, in times of significant hay shortage (e.g., during drought), farmers may use corn stover as hay replacement, driving the price of stover feedstock and decreasing its availability for bio-projects (Bergtold 2018).	
Raw RI Score: Wheat straw is used for animal feed during a feed shortage; however, not enough to generate public statistics. There is a more complex transformation where ammonia is used to add DDGs from ethanol facilities and nitrogen to straw to create nutritional value for ruminants. Farmers would prefer corn stover as a replacement feedstock. Therefore, the Raw RI Score is deemed low. Raw RI Score is 1 out of 10.	**Score 1**

Notched Salience: There is no need to notch as the risk is deemed low.	**Score 1.0**
Impact Level: RI Impact Level is deemed *moderate*. If such a market did develop to use Wheat Straw for nutritional purposes, it would create competition for Wheat Straw.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

3.13. Harvest and Collection Practices and Schedules

Rationale: Differences in harvest timing and practices can create a risk to both the quantity and quality of feedstock. For example, feedstock harvested by different suppliers in different windows can undergo different levels of exposure to sun, wind, and moisture, leading to variations in delivered feedstock quality. For example, agricultural feedstocks and energy crops have optimal harvesting windows to ensure minimal moisture content. In certain regions, these harvesting windows may coincide with heightened weather risks, such as frost or rain.	
Raw RI Score: In the BDO Zone, the climate is relatively uniform, resulting in a very tight grain harvest window from early July which can last up to three weeks. July is a very hot and dry period ideal for harvesting wheat straw at low moisture, which can extend to early August. Raw RI Score is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: As the risk is low, de-risking measures are unnecessary.	**Score 1.0**
Impact Level: RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.14. Harvesting and Collection Equipment

Rationale: Different types of harvesting and collection equipment used by suppliers can have a significant impact on the quality and availability of feedstock. The use of different types and combinations of harvesting, collection, and processing equipment among suppliers can lead to non-homogeneous feedstock. Equipment that is not designed specifically for biomass cultivation, harvesting, and collection can increase feedstock quality risks. Relevant equipment should be specified for the sake of product consistency and risk reduction.	
Raw RI Score: Grain combines are equipped for shredding straw when it is left unharvested. Those farmers currently harvesting wheat straw do so from the windrows left by combines. The adjustment to go from shredding to windrows on newer combines is easily done in the cab. The region currently has straw harvested using a combination of large square bales and round bales for the livestock bedding market. A round baler can produce similar bale weights to large 3x4x8 bales. Newer	**Score 8**

high density and 4x4x8 large square balers can densify at a rate of 13 to 16 lbs per cubic feet and thus produce heavier bales even with straw. Specifying baler types could discourage farmers from entering the market as the newer equipment is expensive and with only a short straw harvest season, entry costs are prohibitive. RI Score is deemed high. Raw RI Score is 8 out of 10.	
Notched Salience: Through farm meetings, best management practices can be explained to grain farmers inexperienced with wheat straw harvests. In sourcing custom baler services from outside the zone, the large square bale specification can be imposed without significant impact on services. As a result, Raw RI Score is notched by 50%: Notched Salience is 4.	**Score 4.0**
Impact Level: RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 26.64 out of 100.	**Score 26.64**

3.15. Variation in Densification Methods among Different Suppliers

Rationale: The shape and density of the unit in which feedstock is supplied can impact feedstock cost and quality. Standard feedstock densification modes for biomass consist of round or square bales, pellets, cubes, chips, or grindings. Additionally, bales of different densities can absorb moisture at different rates. In certain cases, round bales have been viewed as problematic due to their uneven moisture content distribution (Huhnke 2018).	
Raw RI Score: Round balers can produce a tightly rolled bale, as straw is a more flexible material than other agricultural biomass sources. However, moisture can be problematic when storing round bales, as they are difficult to pile compared to large square bales and allow moisture penetration from their sides. Thus, the use of large square balers leads to greater field efficiency for harvest, stacking and subsequent transportation. Bales produced with high-density balers are much better at avoiding moisture pick-up. At a processing facility, the use of large square and round bales simultaneously increases the process complexity as the material balance requirements of a facility are constantly changing according to bale type. Both types of balers can produce bales less optimal for storage. This can happen because of small windrows making it difficult to bale, and lack of equipment operator experience. The Raw RI Score is deemed moderate. Raw RI score is 6 out of 10.	**Score 6**
Notched Salience: Through outsourcing to supplement a limited availability of local large square custom service bale operators, homogeneous bale densities can be achieved and reduce the variation for most of the inventory.	**Score 2.0**

As a result, Raw RI Score is notched by 75%: Notched Salience is 2.	
Impact Level: RI Impact level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 13.32 out of 100.	**Score 13.32**

3.16. Availability of Labor for Feedstock Production

Rationale: Skilled labor shortages can be difficult to remedy in the short term. The availability of suitable regional labor can impact the ability to procure sufficient feedstock quantities on schedule. Labor risks are higher for greenfield facilities where supply chains are not yet active; or for Proponents for whom large feedstock requirements or the development of new (or expanded) supply chains demand significant additions to the local labor force.	
Raw RI Score: A project in Logan County would positively affect employment by adding seasonal work during harvest and permanent jobs to manage and deliver the feedstock to a facility. Farmers using personal balers and trucks to harvest and deliver straw would not require additional labor. The harvest custom groups also have their own experienced crew to harvest, collect and store bales at field side. As for transportation staff, it is estimated 5 drivers are required for commercial service to supplement farm capacity based on a total of 10 - 12 trucks requirement. This would include the transfer of straw bales from either farms or aggregation sites to a facility. Raw RI Score is deemed moderate. Raw RI score is 6 out of 10.	**Score 6**
Notched Salience: The risk of labor shortage to support transportation can virtually be eliminated through long term planning with commercial transport companies. As a result, Raw RI Score is notched by 75%: Notched Salience is 2.	**Score 2.0**
Impact Level: RI Impact Level is deemed *high*, as the harvest window is short and breakdowns in logistics equipment can have significant impacts on the on-time delivery of straw to the biorefinery site. The number of required harvests, collection, and transportation equipment to meet the annual demand of a large-scale biorefinery project is high and it requires close coordination between crop growers, logistics companies and the biorefinery to assure enough skilled labors are assigned to harvest, collect, store and transport straw including both equipment operators and the maintenance and repair crew and administration team.	**Score 9.99**
Loaded RI Score Loaded RI Score (Notched Salience × Impact Level) is 19.96 out of 100.	**Score 19.96**

3.17. Feedstock Transportation Costs

Rationale: Transportation is often one of the most significant cost components of biomass supply chains. The average transport cost and percentage of total feedstock cost attributable to transport should be known.	
Raw RI Score: Farmers and commercial truckers will likely deploy several transport types to haul large square bales. Within the BDO zone, an average distance is estimated at 53 loaded miles. On average, each transport will carry 32 large square bales. The cost of transporting straw is estimated at $ 19.00/dry ton. The area is well-serviced by commercial trucking firms, and rates are competitive. Based on a price of $105 per dry ton, transportation represents 18% of the delivered price of straw. Given that a small increase in transportation distance results in a significant expansion of the supply basin within the BDO Zone, the risk of rising transportation costs impacting delivery prices is low. Raw RI Score is deemed low. Raw RI score is 3 out of 10.	**Score 3**
Notched Salience: No adjustments necessary as de-risking measures are not needed for RI Scores of 3 or less.	**Score 3.0**
Impact Level: RI Impact Level is deemed *high.*	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.18. Number, Size, Mix and Locations of Suppliers

Rationale: Generally, a supply portfolio involving multiple suppliers of various sizes (and from multiple regions) is important for ensuring steady and uninterrupted feedstock supplies with minimal price fluctuations. If a small number of large suppliers provides a high proportion of total feedstock, a disruption or supplier breach will have a greater impact on the supply chain. In such cases the risk of disruption is lower, but the impact of those disruptions is higher. Conversely, many small suppliers are less likely to have the capacity to withstand internal disruptions and thus may be more likely to breach. Here, the risk of disruption is higher, but its likely impact is lower. The number of suppliers as well as the ratio of small to large suppliers should be optimized. There is no pre-determined number or optimal ratio of suppliers, although having too many or too few can both pose higher degrees of risk.	
Raw RI Score: The region is characterized by medium-sized farms with an average of 815 acres. According to the Department of Agriculture, about 45% of the wheat area harvested is in the range of 25-499 acres and over 55% are in the range of 500-1000+ acres. This leads to many individual farms having to supply wheat straw. A project would need to be supported by more than 200 farm suppliers. The need to coordinate timely information is required to have an effective harvest. Farmers will want to have the straw removed very soon after harvest to prevent weed growth. Stacking at the end of field for later delivery is an accepted practice. The Raw RI Score is high. Raw RI Score is 6 out of 10.	**Score 6**

Notched Salience: Hiring an agronomic coordinator like the one used in the grain sector, through the bioprocessing proponent will mitigate incidences of supply interruptions. Providing a farm web-based tool for communications could ensure the timeliness and accuracy of the data needed to manage daily field activities. Raw RI Score notched by 50%: Notched Salience is 3.0.	**Score 3.0**
Impact Level: RI Impact Level is deemed *high*, as plant interruptions would be costly.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97 out of 100.	**Score 29.97**

3.19. Suppliers Subject to Same External Risk Factors (Non-Weather and Equipment Based)

Rationale: When a single risk event can impact the feedstock production ability of all (or most) suppliers, then feedstock risk is higher and supply chain resiliency is lower. Resilience is maximized when biomass supply chains exhibit diversity in spatial location (i.e., geography), production practices, and other elements of supply chain structure such that the impact of single high-risk events has varying impacts on suppliers.	
Raw RI Score: The BDO Zone has homogeneous weather patterns deemed to be dry. The zone receives approximately 20 to 25 inches of rain annually, which is low. Some years there is only 15 inches or less of rainfall creating drought conditions. Within the zone, wheat production is widespread and consistently accounts for over one million acres. Once straw is harvested, the Proponent will require aggregation yards within the zone to use as temporary storage areas for the straw. These yards will likely be 25 miles apart. The raw RI Score is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience: The Proponent can mitigate against supply loss by distancing aggregation yards and separating straw piles within a yard to mitigate fire risks. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.	**Score 3.0**
Impact Level: RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 19.98 out of 100.	**Score 19.98**

3.20. Seasonal Weather Impacts on Feedstock Supply

Rationale: Seasonal weather impacts are defined as deriving from natural weather variations (i.e., spring thaws, rainy seasons, or dry seasons) as opposed to singular weather events (like fires, droughts, or hurricanes). Seasonal weather changes can be a significant risk factor affecting feedstock availability, quality, and price. Given the major influence weather has on multiple aspects of growing, harvesting, and transporting biomass, it is difficult to predict the availability of biomass at a given location with a high degree of

certainty. However, it is possible to generate reasonable upper/lower bound estimates of biomass production in any given year in a wider supply basin, using past data and statistical models. Such estimates are important in assessing feedstock risk and enable accurate assessment of the efficacy of Proponent's mitigation methods.	
Raw RI Score: The region is known to experience drought like growing seasons when weather patterns are influenced by the La Nina conditions. In drought conditions the harvestable straw yields will be at the low range of a 0.5 to 1 ODT/acre harvest. The Raw RI Score is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience: There is limited opportunity to increase the supply basin within a production year. Opportunities will exist to purchase out of zone straw at various regional hay and straw auctions during the late fall/early winter period. Additionally, the Proponent might intentionally purchase part of the annual supply needs from outside the zone to build resiliency. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.	**Score 3.0**
Impact Level: RI Impact Level is deemed *moderate*. A low harvest yield impact can be mitigated by accepting new suppliers into the project.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 19.98 out of 100.	**Score 19.98**

3.21. Long-Term Weather and Climate Trends

Rationale: In certain regions, climatic trends and significant potential changes to future weather patterns can create feedstock risk.	
Raw RI Score: Regional temperatures are expected to rise by as much as 5 degrees F by 2050 because of climate change (www.colorado.edu/CO_Climate_Report/index.html). Managing soil for moisture will increase in importance to have adequate moisture for crop growth. In addition, the straw removal rate needs to be determined through Agricultural Extension Activities to minimize moisture loss and soil erosion. The Raw RI score is deemed high. Raw RI Score is 9 out of 10.	**Score 9**
Notched Salience: Farmers will reexamine their multi-year crop rotation and select wheat varieties more suitable for conditions. Slight changes to straw harvest methods can be implemented to trap more field snow. Raw RI Score is notched by 50%: Notched Salience is 4.5.	**Score 4.5**
Impact Level: RI Impact Level is deemed *moderate.* The implementation of best practices can have a moderate impact on mitigating weather and climate change.	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97.	**Score 29.97**

3.22. Risk of Infestation

Rationale: Risk of future infestation, including its estimated consequences on feedstock supply, should be calculated into the overall risk profile.	
Raw RI Score: Environmental conditions can influence frequency and types of crop infestations. The extension advice and support for wheat production are extensive and farmers have excellent in-season markers to gage conditions and treat crops prior to major damage. Based on wheat grain production records, the region has managed disease issues without significant loss of production. On a field-by-field scale, some farmers have experienced losses and rely on crop insurance to cover production costs. The raw RI score is deemed low. Raw RI score is 2 out of 10.	**Score 2**
Notched Salience: Farmers will continue to be vigilant about both pests and disease monitoring and use the best agri-chemicals available to protect their crops. Continuous mitigation strategies affect the region. The Raw RI Score is notched by 75%. Notched Salience is 0.5.	**Score 0.5**
Impact Level: RI Impact Level is deemed *high*. Pest and disease outbreaks have a significant impact on yield and straw availability.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 5.0 out of 100.	**Score 5.0**

3.23. Risk of Extreme Weather Events—Hail, Flood, Drought, Hurricanes, Tornadoes, Strong Winds, and Extreme Low Temperature

Rationale: See BSCRS Standards RI 3.7.5 Risk of Hail; 3.7.6 Risk of Flood; 3.7.7 Risk of Drought; 3.7.8 Risk of Hurricanes, Tornadoes, Strong Winds; 3.9.7 Risk of Low Temperatures.	
Raw RI Score: The BDO zone is a large area. Severe weather events tend to happen on a much smaller geographical scale, usually limited to a community. Hail is a significant threat in the spring through the grain formation period of a wheat crop and can destroy a field. These occurrences pose a limited risk on wheat straw availability from the zone. The Raw RI Score is deemed low. Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience: The proponent can manage the risk by ensuring that straw is sourced from all areas within the BDO zone extending to the 80-mile radius. As a result, the Raw RI Score is notched by 75%. Notched Salience is 0.75.	**Score 0.75**
Impact Level: RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 5.0 out of 100.	**Score 5.0**

3.24. Government Subsidies for Feedstock Production or Utilization

Rationale: Feedstock directly subsidized through government programs can pose greater long-term risk than feedstock that is not. Subsidies may be subject to amendment or repeal, sometimes with minimal notice. NOTE: This risk indicator refers to direct feedstock subsidies only; it does not apply to government subsidies that pertain indirectly to the operations of the Proponent, such as Loan Guarantees, or to the markets for products produced by the Proponent.	
Raw RI Score: There are no government subsidies. This risk is deemed low. Raw RI Score is 1 out of 10.	**Score** **1**
Notched Salience: No adjustment.	**Score** **1.0**
Impact Level: Raw RI Impact level is deemed *low*.	**Score** **3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score** **3.33**

3.25. Local, Provincial, & National Laws, Regulations, & Permitting Pertaining to Biomass

Rationale: Feedstock whose production is directly dependent on local, provincial/state, or national laws and government regulations can pose greater long-term risk than feedstock which is not since laws and regulations may be subject to amendment or repeal. If biomass utilization requires specific permits (i.e., percentage removal of forest residues or corn stover, allowable cut limits, air emission, storage permits, rights-of-way, overweight permits for trucks, cross-border permitting for shipment of biomass, a chain of custody, or certification of sustainability) then likelihood of obtaining such permits and/or complying with permitting requirements should be examined.	
Raw RI Score: Right to Farm law protects both Colorado and Nebraska farmers from the regulatory burden and complaints about farm practices. The RI Risk is low. Raw RI Score is 1 out of 10.	**Score** **1**
Notched Salience: No adjustment.	**Score** **1.0**
Impact Level: RI Impact Level is deemed *low.*	**Score** **3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score** **3.33**

3.26. Backlash Against Biomass Development, Procurement or Usage in the Region

Rationale: Public backlash against biomass development in the Proponent region can directly impact Proponent's ability to procure, transport, trans-load, store, or utilize feedstock by affecting local policies, regulations, and the Proponent's ability to obtain necessary permitting.	
Raw RI Score: There could be a lack of acceptance by researchers concerned about soil health and soil moisture conservation. Farmers are likely to raise concerns at farm meetings. No public backlash against Wheat Straw biomass development is expected. The Raw RI Score is low to moderate. Raw RI Score is 4 out of 10.	**Score 4**
Notched Salience: Community information sessions and extension activities showing minimal negative impact of removal of straw on the soil health will alleviate public concerns. Meetings with researchers and farmers to share harvest plans withing a dryland production system will mitigate the risk. The Raw RI Score is notched by 75%. Notched Salience is 1.	**Score 1.0**
Impact Level: RI Impact Level is deemed *moderate.*	**Score 6.66**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

3.27. Consent of, and Co-Operation With, Indigenous Communities and First Nations

Rationale: Where new project development is on or near Indigenous or First Nation land, or when Indigenous or First Nations exert influence over feedstock producing areas, consent of, and co-operation with, Indigenous communities and First Nations decreases the Proponent's risk.	
Raw RI Score: No indigenous communities are involved in the BDO zone. This risk is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact Level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

3.28. Feedstock Sustainability, Including Risks to Soil Quality and Surface and Ground Waters

Rationale: Understanding a project's overall emissions and carbon intensity throughout the feedstock supply chain is essential to reducing risks related to carbon pricing mechanisms and related regulations. GHG emissions from production, harvest, and transportation can pose significant challenges to the Proponent's claims of carbon neutrality for biomass projects. Carbon emissions from harvested soils, as well as emissions from harvesting machinery or delivery trucks, can make the achievement of net-zero difficult. If a Proponent's financial model relies on carbon neutrality/GHG regulatory pricing frameworks, then an investigation into the feedstock's carbon emission status is essential.	
Raw RI Score: Harvesting wheat straw is a one-pass system following the grain harvest. The protocol calls for removing up to one dry ton per acre leaving behind approximately 4-6 inches of wheat stubble to protect the soil. The protocols also promote the use of high-density balers which increases the harvest and transportation efficiencies. Currently, straw is being left in fields to decompose while protecting the soil. GHGs are released during the decomposition process. This risk is deemed low. Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience: A RI of 3.28 could be moderately mitigated by outsourcing custom balers to those with high-density balers producing either 3x4x8 or 4x4x8 bales. Conducting extension activities showing the minimal negative impact of the removal of straw on soil health can show the sustainability of using wheat straw as a feedstock for biorefinery projects. The Raw RI score is notched by 50%. Notched Salience is 1.5.	**Score 1.5**
Impact Level: RI Impact Level is deemed *high*, as baling is the only form of densification available to farmers.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 14.98 out of 100.	**Score 14.98**

3.29. Geographic Location Influence on Feedstock Variability

Rationale: Feedstock from different regions may differ in quality due to variations in soil quality, topography, harvest practices, weather, fertilizer applied, etc.	
Raw RI Score: The BDO zone is homogenous producing uniform wheat straw. Raw RI Score is deemed low. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact Level is deemed *high*. It is important for a new project to have access to uniform feedstock for processing.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

3.30. Capacity of Supply Chain Components & Equipment to Scale

Rationale: Scale-up risk increases if supply chain components or underlying feedstock infrastructure necessary for these components cannot scale to handle Proponent feedstock requirements and throughput capacity. Capacity to scale should be demonstrated.	
Raw RI Score: The local farmers lack sufficient equipment to meet the supply needs. A few farmers do have high-density balers and field stackers that can be deployed for part of the inventory needs. It is unlikely that farmers would invest large capital sums to equip themselves with high-density balers and stackers. Custom balers are available from other regions to complement local equipment. Similar straw-based supply chains exist in other regions to enable production at scale. Raw RI Score is deemed moderate. Raw RI Score is 6 out of 10.	**Score 6**
Notched Salience: Proponent planning to secure custom operators will significantly reduce this risk of lacking scale. As a result, Raw RI Score is notched by 50%: Notched Salience is 3.0.	**Score 3.0**
Impact Level: RI Impact Level is deemed *high*. Field harvesting with balers is essential.	**Score 9.99**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 29.97 out of 100.	**Score 29.97**

CATEGORY 4.0: INFRASTRUCTURE RISKS

4.1 RISK FACTOR: PHYSICAL INFRASTRUCTURE

4.1.1 Land Parcel

Raw RI Score: Logan County has suitable land available in varying parcel sizes that include: (1) 236 acres, Sugar Factory Rail Park Site, located in Sugar Mill Rd, Sterling; (2) 1388 acres, State Land Board Site, located in 22777 US Hwy 6, Sterling; (3) 38 acres, C&F Company-Hereford Ave Site, located in 769 Hunt Way, Sterling; (4) 90 acres, T.Cass-Right of Way Road Site, located in 1399 Right-of-Way Road, Sterling; and (5) 80 acres, Farmland, located in 20864 County Road, Sterling. The most ideal location is the Sugar Factory Rail Park Site with access to highways/interstates, rail lines, and utility infrastructure on-site. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.1.2 City Ownership

Raw RI Score: The Sugar Factory site is owned privately and is open for sale/lease. This property encompasses 283 contiguous acres and the main site spans 236 acres, with an additional 47-acre privately owned parcel available adjacent to the northeast. Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 6.66**

4.1.3 Industrial Land Use Zone

Raw RI Score: Approved land use and zoning is in place for agricultural/industrial purposes, and the Sugar Factory site is suitable for heavy industrial development. Raw RI Score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.1.4 Natural Gas Line

Raw RI Score: The Sugar Factory site has natural gas service provided by Black Hills Energy, with a dedicated 6" gas line already present on the property. Additionally, the area is served by Xcel Energy, ensuring ample options for natural gas supply. Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.1.5 Electrical

Raw RI Score: The Sugar Factory site benefits from reliable electrical service provided by Xcel Energy. With access to a 3-phase power supply capable of supporting up to 10 MW, the property enjoys a lower overall rate for electricity. Additionally, the convenience of having a substation located less than a mile away from the site ensures efficient power distribution. Should there be a need for increased power capacity, the substation can be upgraded accordingly, further accommodating the development demands. Raw RI Score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.1.6 Fresh Water Supply

Raw RI Score: A large industrial well is available in the Sugar Factory site with water rights and no groundwater contamination. Although the property is situated outside city limits, it benefits from its proximity to the town, enabling the extension of pipelines from the municipal line to access city water. Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.1.7 Sewage Disposal Trunk Line

Raw RI Score: The city provides Sewer services with infrastructure available in certain areas of the Sugar Factory site. The Sterling Wastewater Treatment Plant collects and treats over 500 million gallons of wastewater through an extensive network of 60 miles of pipes. Raw RI score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low*.	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.1.8 Drainage and Stormwater Management

Raw RI Score: The Sugar Factory site features a well-designed drainage system, with an east-west drainage ditch that effectively manages water flow. Additionally, there is a strategically placed stormwater pond located on the property. With proper drainage and a dedicated stormwater pond, the property offers enhanced resilience against potential flooding and ensures efficient management of water resources. Raw RI score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.1.9 Available ICT (Information & Communication Technology) Services

Raw RI Score: High speed fiber optic is available with KCI.net. Other broadband service providers in the area are Vistabeam, Spectrum and Century Link. Raw RI score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.1.10 Infrastructure – Landfill/Alternative Markets for Waste Disposal

Raw RI Score: Logan County operates a landfill located at 24235 East Highway 6, Sterling, CO 80751, within 2-miles from the primary Sugar Factory site and is adjacent to the Industrial Park in the State Land Board Property. The county's solid waste disposal facilities are designed to handle municipal solid waste generated by residents and businesses in the area. In addition to waste disposal, Logan County also prioritizes recycling efforts through a collaborative partnership with Marick's Waste Disposal. Raw RI score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.2 Risk Factor: Logistics

4.2.1 Road and Highway Access and Intersection

Raw RI Score: Logan County in Northeast Colorado benefits from a robust transportation network with convenient highway access. Interstate 76 and Highways 6, 61, and 138 connect the county's largest city, Sterling, to the surrounding areas, providing seamless east-west and north-south movement. Located approximately 128 miles northeast of Denver, Logan County offers a strategic central location for businesses, with easy access to major corridors such as I-80, I-70, and I-25. This extensive highway system, including US-6, CO-138, CO-113, CO-63, CO-61, and CO-14, further enhances the county's transportation infrastructure, making it well-positioned for commercial growth and facilitating efficient logistics throughout the central United States. Furthermore, the Sugar Factory site has direct access to US Highway 6 and is within 1 mile of Interstate 76, connecting to I-80 going east and Denver to the west. Raw RI score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.2.2 Ocean/River Access

Raw RI Score: Logan County does not have direct access to rivers or oceans but benefits from an efficient rail transportation network that provides access to the Pacific coast ports. The Port of Houston in Texas, located 1,025 miles southeast of Logan County, offers a gateway for international trade and connects Logan County to global markets. The Port of Long Beach in California, the Port of Los Angeles, and the Port of Seattle offer additional transportation choices to international markets. Raw RI score is 7 out of 10.	**Score 7**
Notched Salience: No adjustment.	**Score 7.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 23.31 out of 100.	**Score 23.31**

4.2.3 Railway Service

Raw RI Score: Logan County boasts excellent rail access, with two Class-1 railroads operating within the community: Burlington Northern Santa Fe (BNSF) and Union Pacific (UP). These railways serve as primary carriers for products transported across the United States in all directions. The presence of local crews and rail yard tracks in Sterling allows for efficient car switching and storage, reducing demurrage charges. Additionally, the Nebraska Kansas Colorado Railway, a short-line railroad primarily utilized for grain and	**Score 1**

agricultural shipments, runs through Logan County, providing additional connectivity. This diverse rail network, coupled with a well-developed highway system, offers strong logistical advantages for businesses in the area.

Raw RI Score is 1 out of 10.

Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.2.4 Accessibility to Airport

Raw RI Score: Logan County benefits from convenient air transportation options. The Sterling Municipal Airport, also known as Crosson Field, is a general aviation airport located 3.5 miles west of the City of Sterling at 16562 Hwy 14. It is equipped with a 5200' runway and offers access to Av Gas and Jet-A fuels, facilitating the travel of small jets. Moreover, Denver International Airport is less than a two-hour drive from Sterling via Interstate 76. Additionally, there are major airports, such as Western Nebraska Regional Airport and Cheyenne Regional Airport, within a reasonable distance from Sterling, expanding travel options in the area.	**Score 3**

Raw RI Score is 3 out of 10.

Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.3 Risk Factor: Social Infrastructure

4.3.1 Healthcare Facilities

Raw RI Score: Logan County has an extensive network of healthcare services, including Sterling Regional Medical Center, a 25-bed acute care hospital that has been ranked in the Top 100 National Rural and Community Hospitals by Becker's Hospital Review in 2017 and 2018. In addition, UC Health Systems has been ranked in the Top 15 Health Systems Nationwide by IBM Watson Health. Other healthcare facilities in the area include Banner Family Care Clinic, Salud Family Health Center etc. Individuals with serious or complex conditions who require specialized treatment may also travel to Denver, which is about 128 miles from Logan County.	**Score 2**

Raw RI Score is 2 out of 10.

Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.3.2 Educational Facilities

Raw RI Score: Logan County provides a range of educational opportunities. Five schools offer K-12 education in Sterling, Caliche, Merino, Fleming, and Peetz; with Sterling Schools being recognized as a Top 50 School in the state. Northeastern Junior College, located in Sterling, offers programs in agriculture, health sciences, and business. Other educational institutions located near Logan County include Morgan Community College, which is 43 miles from Sterling, and the University of Northern Colorado, which is about 91 miles away. Raw RI score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.3.3. Recreational Facilities

Raw RI Score: Logan County provides an extensive range of sports and recreational activities, including boating, fishing, camping, hunting, golf courses, baseball, city parks, pools, cycling/ walking trails, fitness centers and sports leagues. Additionally, there is a Shooting Sports Complex covering 300 acres, and is a great spot for shooting enthusiasts. Raw RI score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.3.4. Cultural Facilities

Raw RI Score: There is a wide variety of cultural amenities in Logan County including art galleries, theatres/film, music, and festivals. Raw RI Score is 3 out of 10.	**Score 3**

Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.3.5. Public Safety Facilities

Raw RI Score: Logan County has a violent crime rate of 3.91 incidents per 1000 people, which is slightly higher than the national rate of 3.62 per 1000 people. The county also has a property crime rate of 28.76 incidents per 1000 people, which is significantly higher than the national rate of 17.91 per 1000 people. The City of Sterling Fire Department provides fire/emergency services; and the civil security emergency services are 24/7. Raw RI Score is 3 out of 10.	**Score 3**
Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.3.6 Housing

Raw RI Score: Logan County provides a diverse range of housing options, accommodating both rentals and ownership, with an average housing unit value of $177,100, and a monthly rent of $900, as of 2021. The region exhibits a healthy occupancy rate, with 91.08% of housing units currently occupied and 8.92% vacant. In terms of homeownership, there are 5,444 owners and 2,484 renters in the county, resulting in a homeownership rate of 66.5%, slightly below the national median of 73.2%. Raw RI score is 1 out of 10.	**Score 1**
Notched Salience: No adjustment.	**Score 1.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 3.33 out of 100.	**Score 3.33**

4.4 Risk Factor: Workforce and Permitting

4.4.1 Labor Availability

Raw RI Score: Logan County, with its diversified community focused on agriculture, industry, and services, is anchored by Sterling, the commercial hub for approximately 59,000 working age residents in Colorado's golden plains region. The county boasts a robust labor force of 17,728 individuals, displaying a labor force participation rate of 63.91%, and a low unemployment rate of 3.42%. Education levels are notable, with 89.3% of residents holding a high school diploma or higher, and 16.7% possessing a bachelor's degree or higher. The median age in Logan County is 38, and a significant portion (55.7%), falls between the ages of 20 and 59. Key industries encompass agriculture, construction, manufacturing, retail, education, and health. Overall, Logan County presents an attractive location for businesses and offers a promising economic environment. Raw RI score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.4.2 Labor Cost

Raw RI Score: In the Logan County, workers had an average hourly wage of $23.15 in 2021, lower than the Colorado average of $36.38, as reported by the U.S. Bureau of Labor Statistics. The minimum wage in Logan County exceeds the federal minimum wage, set at $9.54 per hour. The average annual wage for a resident of Logan County is $48,152, which is lower than the Colorado average of $75,660 per year. Raw RI score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

4.4.3 Training Programs / Community College

Raw RI Score: Northeastern Junior College in Sterling offers a diverse range of agriculture, health sciences, and business programs. The college's special training programs in Industrial & Wind Technician, Diesel & Auto Technician, and Welding & Fabrication contribute to developing a skilled labor force for various regional industries. Furthermore, the college has plans for expansion with funding of $16 million that starts in 2023. Raw RI score is 3 out of 10.	**Score 3**

Notched Salience: No adjustment.	**Score 3.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 9.99 out of 100.	**Score 9.99**

4.4.4 Permit Process

Raw RI Score: Logan County's website provides a comprehensive overview of the permitting process. The county has consistently demonstrated its commitment to fostering economic development and ensuring efficient processing. Typically, the permitting process for most projects in Logan County takes approximately 45 to 60 days. Raw RI score is 2 out of 10.	**Score 2**
Notched Salience: No adjustment.	**Score 2.0**
Impact Level: RI Impact level is deemed *low.*	**Score 3.33**
Loaded RI Score: Loaded RI Score (Notched Salience × Impact Level) is 6.66 out of 100.	**Score 6.66**

APPENDIX B: BACKGROUND RESEARCH

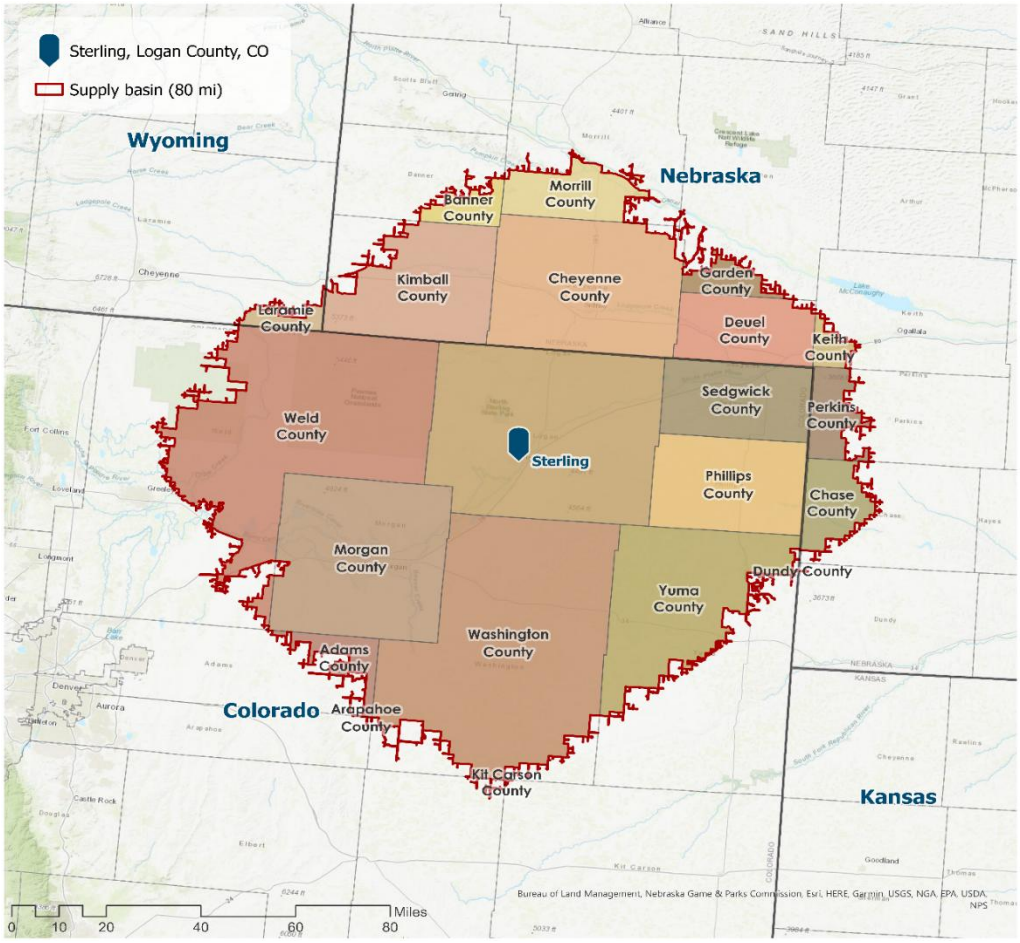
This appendix serves as a wheat straw availability background study to the BDO Zone Risk Rating for the Logan County, CO.

Background Research

Study Region

The study region is in Northeast Colorado and partly in Central-west Nebraska. The BDO Zone is centered in Sterling, Colorado and extends 80 miles in all directions. Sterling is the regional hub with excellent road access throughout the BDO Zone. The area has a thriving cattle industry that creates a small demand for straw. Wheat (winter and spring wheat) production accounts for approximately 6-800,000 acres harvested annually.

Map B1: Feedstock supply basin



Current Demand

Presently no large-scale facilities consuming wheat straw exist within the 160-mile competition zone (80-mile radius). A small processing facility (less than 25,000 dry tons) operates in Laramie, Wyoming (160 miles from Sterling).

Cattle feedlots, which predominately use wheat straw for bedding, are the only consumers in the region. Sokhansanj et al. (2006)[1] estimate that in the Prairies, 2.5% of generated wheat straw goes to cattle feedlots and we estimate up to 5% in all following calculations. Producer interviews substantiated our 5% estimate.

At least 95% of wheat straw is left in the field as dryland cropping practice. To account for sporadic tillage, we assume that 5% of Wheat Straw is tilled (weed, disease, etc.). Therefore, based on our assumptions, 90% of generated wheat straw is currently unused and potentially available to new buyers.

Assumptions

Potential Wheat Straw Availability

We utilized two approaches to determine the potential availability of wheat straw in the region. Potential (as opposed to actual) wheat straw availability is the amount of wheat straw that could be acquired from the supply basin. It does not consider the availability of equipment or other variables related to infrastructure that could affect actual availability. These variables are discussed later.

Approach 1: Theoretical Model

The theoretical potential availability of wheat straw, USDA data was used to attain acreage at each 10-mile distance interval from Sterling, Logan County.

The following are assumptions in our model:

- The total wheat straw that could be potentially acquired makes up between 40 to 50% of wheat grain yield
- Although rarely wheat straw is tilled, to remain conservative, we assume a tillage rate of 5%
- As previously stated, Prairie-wide estimates indicate that 2.5% of generated wheat straw is utilized as cattle bedding, and we estimate 5% in our calculations as it covers any use as a feedstock extender for cattle

Approach 2: Outreach to Growers and Transport Companies in Adjacent Area

To determine growers' willingness to supply wheat straw and to confirm wheat straw potential availability, assumptions based on previous studies in adjacent areas have been considered.

Growers tend to provide estimates based on actual bale weights and acre unit. For example, the price of wheat straw paid for by cattle feedlots is calculated per bale with moisture in the range of 10 to 15%. An average 12% was used in the study.

To determine the quantity of wheat straw per bale we assume a rough estimate of 1,100 pounds per square bale and 1,000 pounds per round bale. We recognize the number of bales per acre and the tonnage per bale can vary between

[1] Sokhansanj, S., Mani, S., Stumborg, M., Samson, R., and Fenton, J. (2006). Production and distribution of cereal straw on the Canadian prairies. Canadian Biosystems Engineering, Vol. 48.
https://www.researchgate.net/publication/236999871_Production_and_distribution_of_cereal_straw_on_the_Canadian_prairies

wheat straw farmers and cattle farmers and on the equipment used to harvest the straw. An average weight of 1000 lbs OD weight was used for calculation purposes.

Limitations to our methodology:

There are two main assumptions exist within the methodology:

1) Given fair wheat straw prices, growers will be willing to supply.
2) Once the biomass facility is commissioned and the price of the wheat straw becomes attractive and the supply chain develops, participation levels will increase.

Since large-scale markets for wheat straw do not exist, farmers may be underestimating potential problems and the effort it takes to collect and bale wheat straw at the proposed scale. Faced with the realities of actual wheat straw supply and regional soil moisture levels, some growers may decline to participate as they fear a negative impact on the following year's crop. Planting a cover crop to compensate for loss of soil moisture also has a negative impact on the next crop due to evapotranspiration.

Alternatively, growers who indicated that they are currently not interested in supplying may change their minds and supply once the Project demonstrates that it is a serious buyer, and that wheat straw can be a significant source of secondary income with a very positive margin for them. The grain farmer will not experience additional work as custom baling operators will complete the harvest work. Additionally, growers with negative experience in supplying straw for the cattle bedding market (for example, uneven demand or problems with the occasional twine left in the fields) might be initially reluctant to supply. This may change once a project demonstrates it is a reliable and profitable wheat straw buyer.

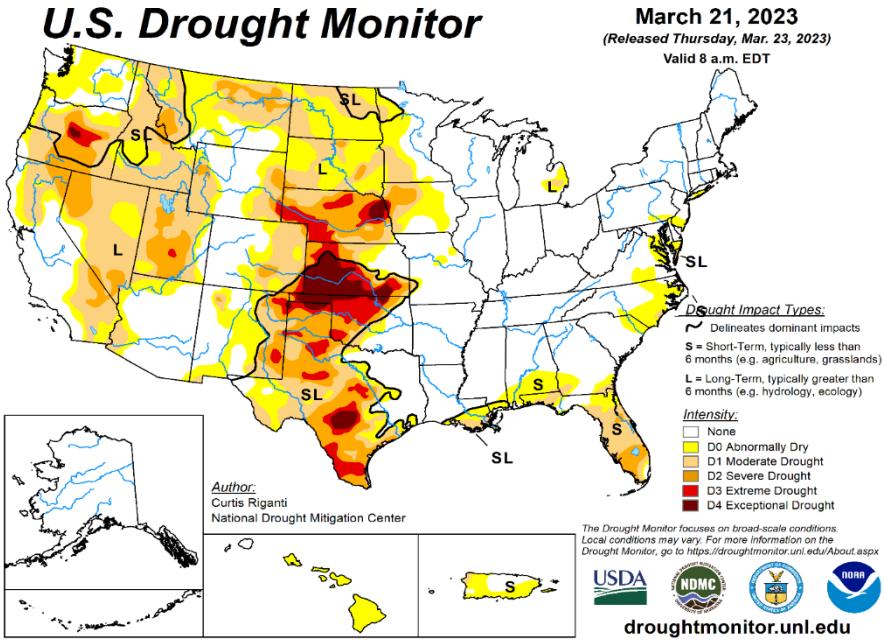
1-in-10-Year Low

Wheat production, and therefore wheat straw potential availability, varies from year to year. 1-in-10 low Wheat yield statistics are available from USDA. Our study based on the 2012 – 2021 period indicates that 2020 was a low year. Subsequently a second low year was experienced in 2022. The impact from a dry year is reduced straw yields and, in some cases, when conditions are severe, the crop is abandoned.

Drought conditions throughout the US are monitored weekly[2]. In our BDO zone, drought conditions have been reduced to mild whereas parts of Colorado remained the severe status. As winter wheat requires moisture from February to May, the 2023 crop will be somewhat lower than the ten-year average.

[2] https://droughtmonitor.unl.edu/Maps/MapArchive.aspx

Map B2: Drought Areas in the US



Wheat Straw Cost

Except for a relatively small cattle bedding market (estimated 5% of all potential wheat straw production), there is no market for wheat straw. Therefore, an understanding of the market price is limited. The bedding market is scattered and unreliable and often operates based on a "special deal" basis (for example, when neighbors sell to neighbors at a discounted price). Where a market is non-existent, the straw would be left in the field as ground cover. Consequently, trying to source new supplies in dry years can be problematic.

No index that tracks the price of wheat straw in the region or elsewhere exists, and for these reasons, we estimate price based on farmers' verbal indications from interviews within the region and some published auction sales of limited quantities in the region (Brush, CO).

Limitations: When interpreting prices verbally indicated by farmers, two limitations should be considered:

- With high demand for feedstock, prices can increase significantly. Farmers base their price indications on variables such as the Farmers provide 'ask' prices. In regular markets, ask prices tend to be higher than the market price as sellers attempt to raise prices. Therefore, reported 'ask' prices tend to overestimate the actual price. They also price their commodity at the high end of the market with the expectation that demand will not change over time. For example, we collected prices that were four to five times the price obtained during the 10-year period when there was virtually no demand. While Table 2 shows a "current low and high price, the long-term price suggested

would be in the $25 to $35 range. Once a large-scale facility significantly increases demand for straw, farmers may increase prices[3].

- The cost of replacing fertilizer is not an issue since soils in the region are high in potassium, however, the cost of baling, and the current market price for bedding straw may be overstated and extending those prices may be misleading.

Table 2 shows verbal price indications provided by farmers. Originally prices were provided with a bale as a unit. We converted these prices to ODT for consistency.

Table 2: Verbal Farm Prices and Analysis

	Unit	Low	High	Likely Scenario (RB)	Likely Scenario (LSB)
Wheat Straw Cost (paid to the wheat growers to access the straw)	$/ODT	30	50	$25-35	$25-35
Farm-gate Cost- Large Square (LSB)	$/ODT	36	52		$ 42
Farm-gate Cost – Round Bales (RB)	$/ODT	31	52	$44	
Total Farm-gate Cost	$/ODT	53 to 58	90	$74	$72
Transportation	$/ODT			$22.00	$ 19.00
Total (Material + Farmgate + Transportation)				$96	$ 91
Price/cost Uncertainty				+/- 10%	=/-10%
Harvest and Inventory Management*	$/ODT			$20	$20

*Reported for information purposes only.

Wheat Straw Cost: This cost refers to the price of wheat straw paid to farmers and calculated on a per dry ton basis with the following assumptions:

- The ODT of a 3x4 large square bale and a round bale are very similar and a value of one dry ton per two bales was used. At the field/farm level the actual bale weight would be in the 1100 to 1150 lbs. range with 10 to 12% moisture. Densifying straw into large square bales is difficult due to the dryness of the material. On the other hand, straw packs very tightly when creating large round bales.
- Two bales are required to create one ODT

Farm-gate cost: Farm gate cost includes material baling, collection, and stacking. In an interview with a few local farmers and a custom harvest group, the farm-gate cost ranges from $36 to $50/dry ton after conversion for dry matter.

Assumptions for our farm-gate cost are based on the 2021 Custom Rates for Colorado Farms.

[3] One way to mitigate price increases due to increased demand is through fixed-price contracts. At this point, however, we do not know whether farmers would be open to such agreements.

- Baling large squares cost $15 to $22/bale
- Yield 2 bales per dry ton results in a cost range between $30 to $44/Ton or $36 to 52/ODT
- Baling large round bales cost $13 to $25/bale
- Yield 2 round bales per dry ton results in a cost range of $26 to $50/Ton or $31 to $52/ODT
- Stacking at end of field $2.00 to $3.00/bale or $4.00 to $6.00/ton

Accordingly, the cost for wheat straw could range from $82.00/ODT to $105.00/ODT

Transportation Cost

We acquired a few verbal transportation cost indications, which were provided in $/loaded mile. These rates include one hour of loading and one hour of unloading and supplying the loader. Each truck driver is trained to load efficiently. Transporters establish zone rates with a minimum distance charge ranging from 20 to 30 miles and another rate from 30 to 50 miles. One interviewee charged $6.00 per loaded mile while another charges a higher rate for short hauls and a rate of $6.00 per loaded mile for any distance over 25 miles. For distances greater than 50 miles, a commercial rate excluding loading and strapping, of $2.00/mile was applied. The commercial; rates varied from $1.89 to $2.25/mile.

The average indicated cost of transporting wheat straw is $0.375 per loaded mile and per ODT with 95% of the feedstock availability. Transportation costs including loading and strapping is likely to add $18 to $20 per dry ton, slightly above the report 2021 Custom Rates for Colorado Farms; transportation rates provided above are expressed in $/loaded mile for an entire load. For modelling purposes, we estimated the cost per ODT. First, we estimated the number of bales that can fit on a trailer based on indications provided by companies. Then we converted these estimates to dry ton per trailer, arriving at a cost per mile per ODT.

To calculate the average distance travelled within a particular supply basin, we assume that the supply basin is circular. With that assumption in mind, we multiplied the distance to the edge of the supply basin by 60%. So, for an 80-mile supply radius, the average transportation distance is 50 miles, and the cost is $18.00 to $20/ODT depending on trucking configurations. Using a dedicated fleet of tractor 24 ft flatbed pulling two 30 ft trailers could reduce costs to lower than $15/ODT. Table 3 shows three types of trailers fit to transport square bales: 48 ft trailer, 53ft and super-B flatbed trailers. Between 24 and 36 square bales fit on a 48 ft trailer, between 26 and 39 bales on a 53 ft trailer and between 44 and 66 bales on a super-B flatbed. The maximum payload is in the range of 25-30 ODT. These estimates result in transportation costs of $0.20 - 0.24 ODT/loaded mile. However, in practice, bale density is usually lower than the numbers in Table 3 and the average actual payload is estimated to be 20 ODT. Thus, we use the average $0.30/ODT/loaded mile cost estimate in modelling.

Table 3: Number of bales per trailer indications (INL, 2016)

Truck Configurations[a]	*Load Limits*		*Payload*		*Maximum Load Bulk Density (DM lb/ft³)*
	Length (ft)	*GVW (lb)*	*Max (lb)*	*Square Bale Count*	
(1) 48-ft flatbed trailer	48[b]	80,000[b]	51,100	24 – 4×4×8-ft 36 – 3×4×8-ft	16.6 – 4×4×8-ft 14.8 – 3×4×8-ft
(2) 53-ft flatbed trailer	53[c]	80,000[b]	50,800	26 – 4×4×8-ft 39 – 3×4×8-ft	15.3 – 4×4×8-ft 13.6 – 3×4×8-ft
(3) 24-ft flatbed tractor pulling two 30-ft flatbed trailers	105[d,e]	105,500[d]	59,500	44 – 4×4×8-ft 66 – 3×4×8-ft	10.6 – 4×4×8-ft 9.4 – 3×4×8-ft

a. Impacts on transportation costs for these configurations are discussed in greater detail in Section 2.3.2.2.
b. Federal limits.
c. Common state maximum on National Network (NN) highways.
d. Allowable common limits in CO, ID, KS, ND, NE, OK, and SD for two trailing units on non-NN highways.
e. Overall truck length limit. Actual load length is 95 ft.

Note on minimum hours: Many trucking companies in the region are located on farms and at a distance to Logan County, and if engaged, would need to bring trucks to the area. For this reason, a minimum number of hours is sometimes required, as companies would not bring trucks in just for one haul. For example, one company would require advanced booking and a minimum guarantee of 5 to 7 loads per week. Another company would need to add trucks to their fleet to offer a dedicated service.

APPENDIX C: CHARTS AND TABLES

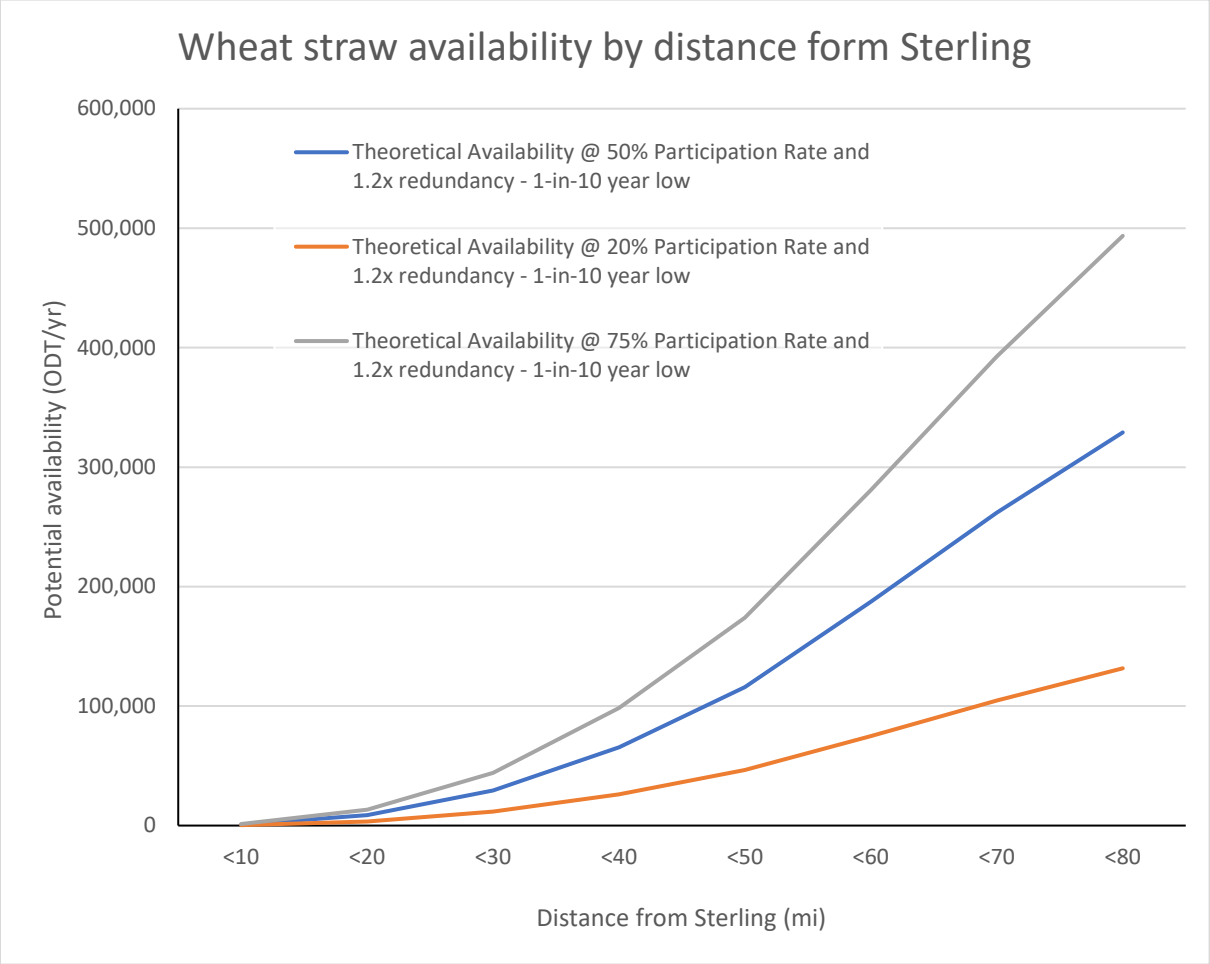
The following are charts and tables with results from research conducted for the purposes of this BDO Zone development.

Figure C1. Wheat straw availability by distance from Sterling at three participation rates



Assuming a lower participation rate at the beginning of the project, the maximum travel distance would be between 50 and 70 miles to collect sufficient biomass at 130,000 dry tons to meet a 100,000 dry ton harvest. In years when straw yields are low, the travel distance would increase to 80 miles (Figure C2). Initially, we are recommending a 20% participation rate as achievable through farm-based meetings. As the participation rate increases beyond 20%, the volume of straw available increases rapidly.

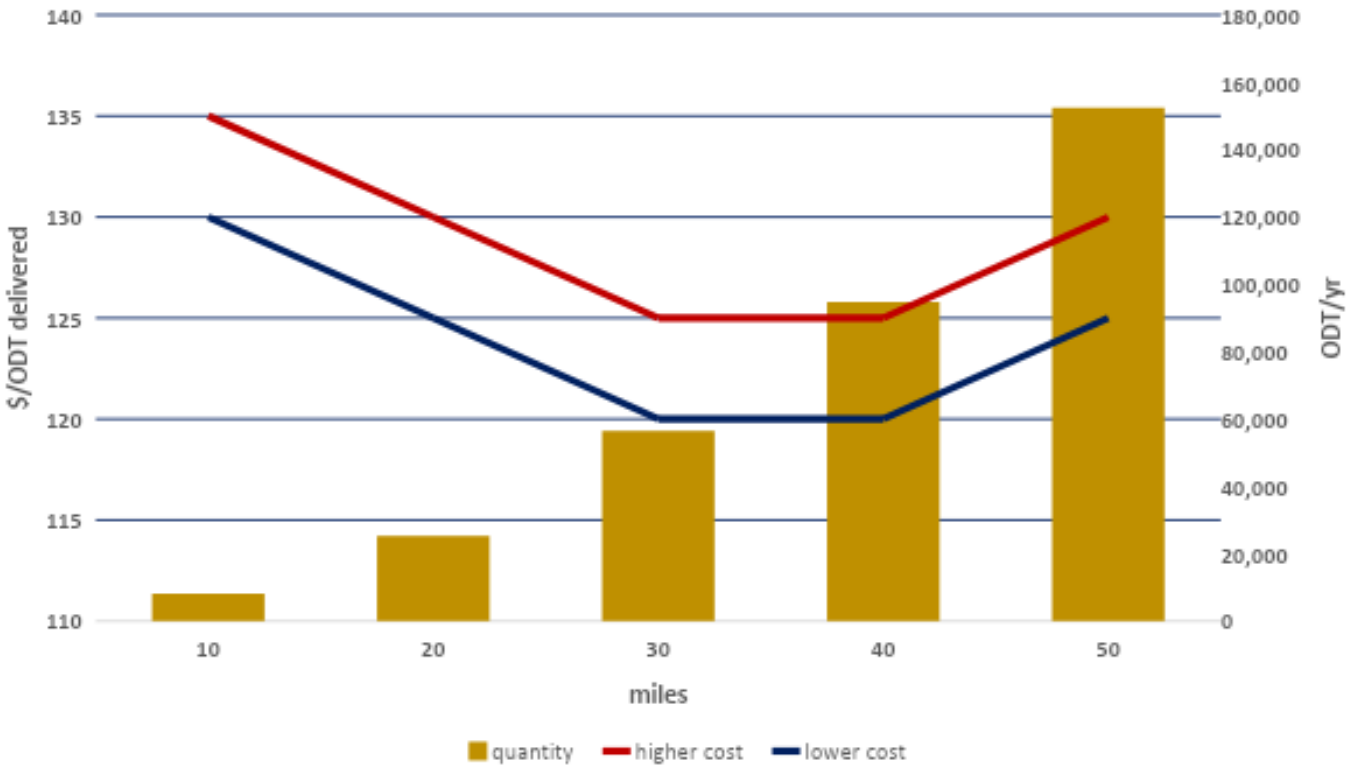
Figure C2. Wheat straw availability by distance from Sterling in a 1-in-10 year low.



Based on the one-in-ten year low, the wheat straw available from the BDO Zone is estimated at 131,000 dry tons/year (red line) with a 1.2x redundancy. Increasing the participation rate over time to 50% (blue line) could result in over 300,000 dry tons to support a bioprocessing facility.

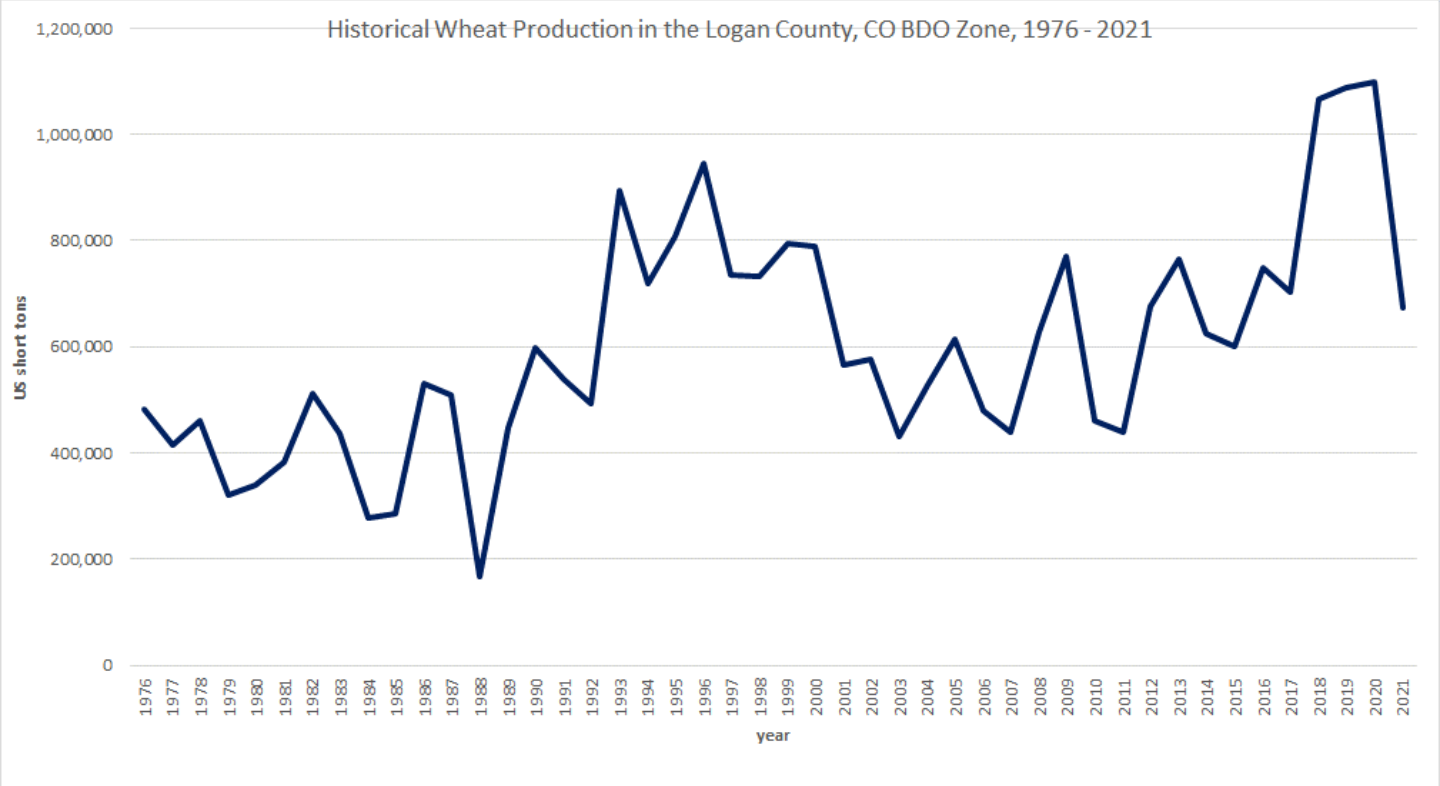
The low harvest year shifts the supply curve to the right, indicating the entire area is needed.

Figure C3. Marginal Wheat Straw cost as a function of quantity potentially available.



The major impact on the price range is the farmgate price set by the farmer. As the price changes, the curves will shift up or down accordingly.

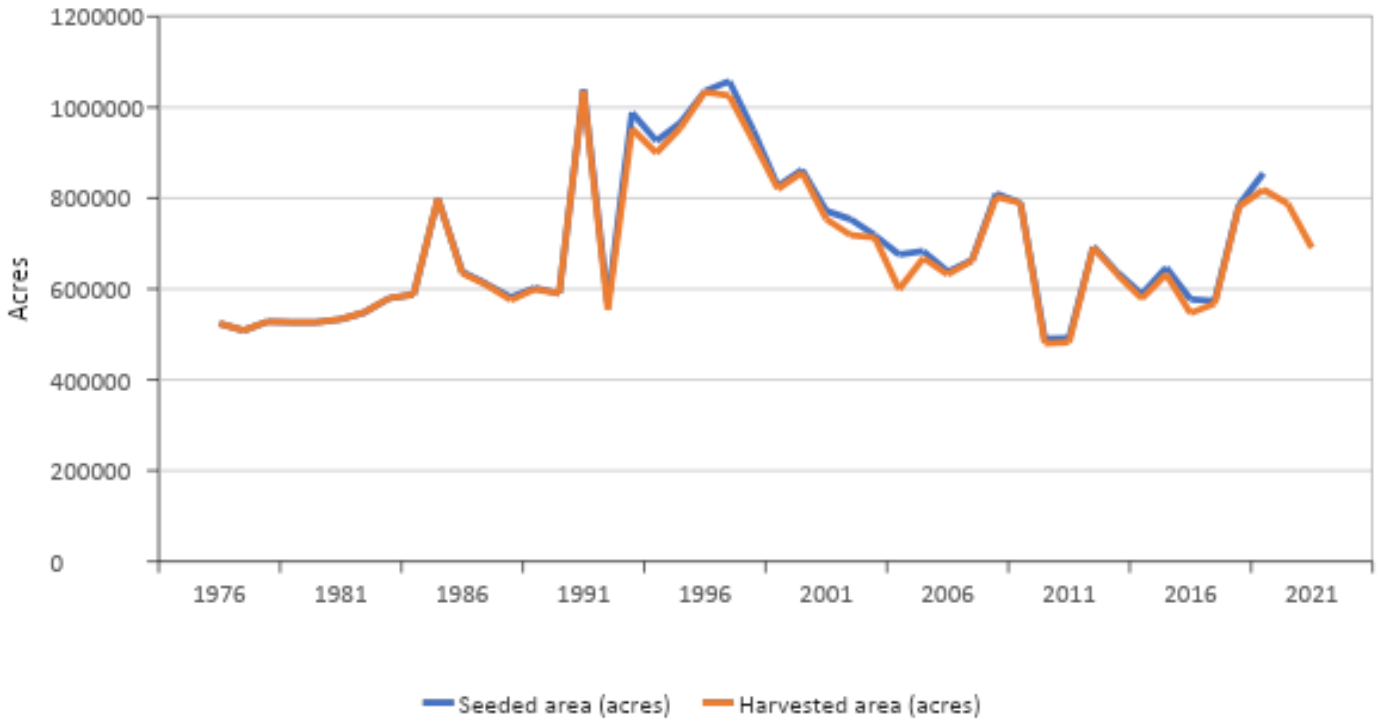
Figure C4. Historical Wheat production in the Logan County, CO BDO Zone, 1976 – 2020.



Yields vary considerably from year to year and are influenced largely by weather. Soil moisture preservation for dryland production is critical as well as timely March/April rainfall.

Wheat acreage (Figure C5) will fluctuate annually as farm decisions are affected by market prices for wheat and other crops, margins to farmers and emerging markets creating new demand. Given most of the region is in dryland production and the cattle inventory at a low point, the alternative use for the land is limited. New biofuel crops like camelina are unlikely to displace wheat as the summer temperatures are too high.

Figure C5. Historical area of wheat seeded and harvested in the Logan County BDO Zone.



The slight difference between planted acres to harvested acres is related to crop failures. The main factor tends to be hail affecting small pockets. Examining data specific to the Logan County BDO Zone for 2020 and 2021, three counties were severely affected by the 2020 drought, resulting in fields left unharvested for grain. These were Logan (-32%), Kit Carson (-31%), and Washington (-20%). Four counties harvested similar acres in 2020 and 2021. These were Cheyenne, Morgan, Sedgwick, and Yuma. The impact of the drought was variable throughout the BDO zone, hence the importance of having a strategy to source feedstock throughout the zone. Many farmers elected to produce green chop for livestock feed when the grain crop could not be salvaged.

Figure C6. Winter wheat harvested acres in Colorado showing a slight decline in production from 2012-2021.

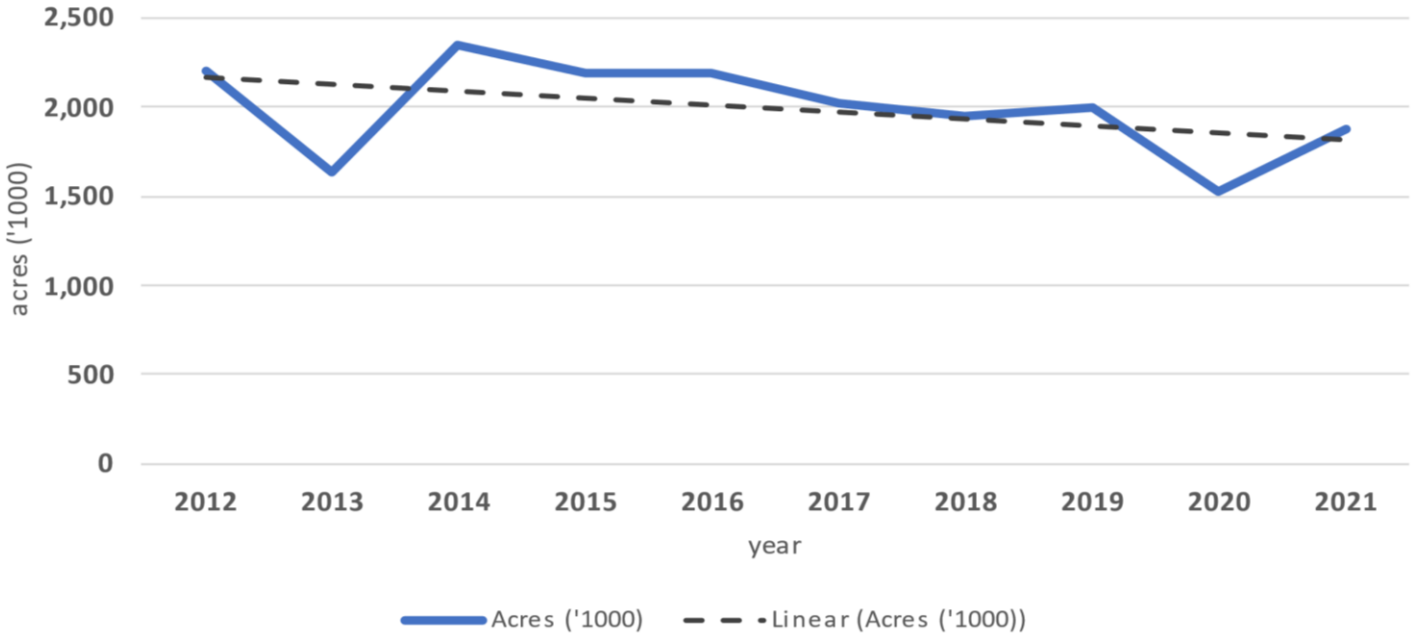
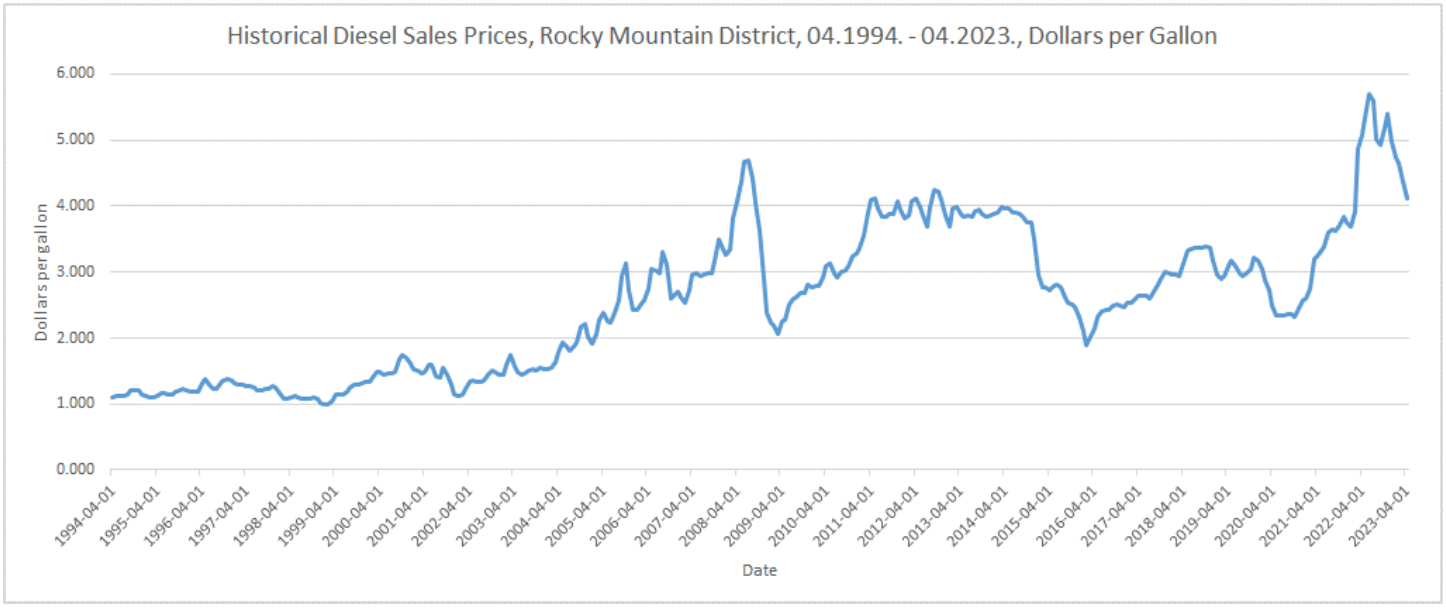
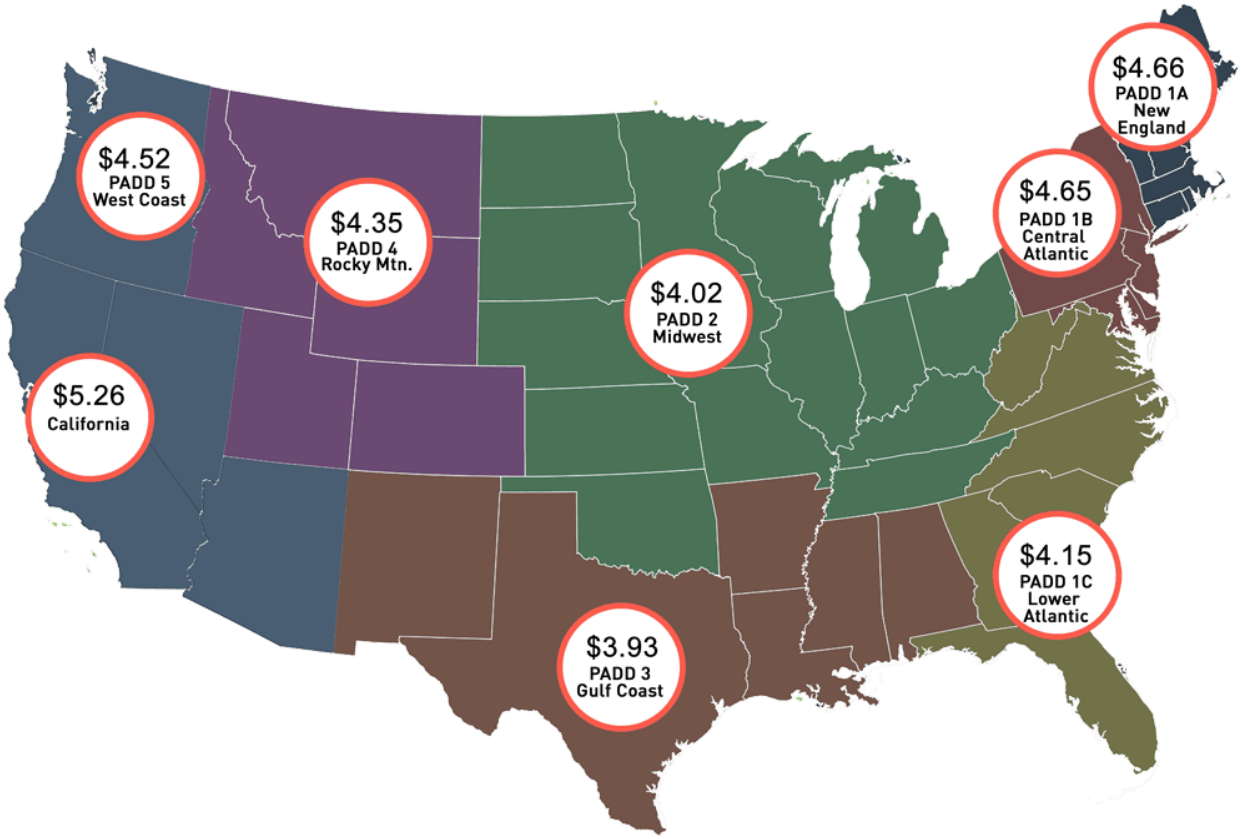


Figure C7. Historical diesel price in the Logan County region.



Diesel prices are directly affected by international policies on oil supply.

Figure C8. Map depicting diesel prices by region across the US.



Source: US Energy Information Administration (2023)

These prices reflect prices on March 23, 2023. Colorado prices are pegged at mid-range. Texas is the lowest while California is the highest.

Historical Industrial Product Price Index (PPI) 2000 – 2021

The PPI is a tool used to calculate farm production cost increases over time. While fuel is the principal component, other input costs increase over time. For example, geopolitical conflicts have caused major increases in fertilizer prices in 2021-2022 and have receded since then but remain high based on historical levels. Farm machinery costs are also tracked from year to year and machinery prices have followed the PPI.

From 2000 to 2019 the PPI increased slowly as inflation was under control. In 2020, coinciding with the COVID period costs escalated exponentially from an index of 100 to 121 over a two-year period. Farmers adjusted to the inflation pressures as commodity prices for grains were at high prices, leaving a positive margin.

APPENDIX D: INFRASTRUCTURE

Site selection of Logan County

Logan County has suitable land available in varying parcel sizes that include- (1) 236 acres- Sugar Factory Rail Park Site, located in Sugar Mill Rd, Sterling; (2) 1388 acres- State Land Board Site, located in 22777 US Hwy 6, Sterling; (3) 38 acres- C&F Company-Hereford Ave Site, located in 769 Hunt Way, Sterling; (4) 90 acres- T. Cass-Right of Way Road Site, located in 1399 Right-of-Way Road, Sterling; and (5) 80 acres- Farm land, located in 20864 County Road, Sterling.

ON-SITE INFRASTRUCTURE

Sugar Factory Rail Park Site - 236 acres

- This property encompasses 283 contiguous acres and is situated just outside the city limits. The main site spans 236 acres, and an additional 47-acre parcel is available adjacent to the northeast. With its flat topography, the land is currently utilized for agricultural production but holds significant potential for development. Privately owned, Zoned Heavy Industrial.
- Natural gas- Natural gas is provided by Black hills Energy with a 6" line on the property. Also, Xcel Energy provides a service in the area.
- Electrical- Electrical is provided by Xcel Energy, 3-phase, 10 MW, primary meter- lower rate overall, substation is located less than a mile from the property and can be upgraded if required.
- Water- Large industrial well available with water rights, and no ground water contamination. The property does not have a municipal line as it is outside city limits, but is located close to the town, and pipelines can be extended from the municipal line for city water.
- Sewer- Sewer services are provided by the city with infrastructure in parts of the property.
- Drainage and Stormwater management- Drainage ditch - east-west. Storm water pond present on the property.
- ICT services- Fiber optic is available with KCI.net. Multiple options for broadband with service providers such as Vistabeam, Spectrum and Century Link.
- Rail- Mainline switch and spur served by Burlington Northern Santa Fe and Union Pacific Rail Roads.
- Roads- Direct access to US Highway 6, and within 1 mile to Interstate 76 connecting to I-80 going east and Denver to the west.
- Property is located 2 miles from the MSW landfill.

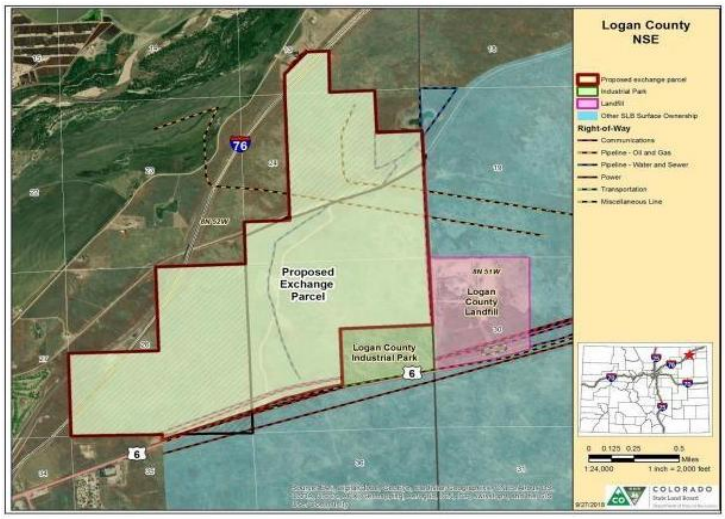
Map D1: Sugar Factory Rail Park Site



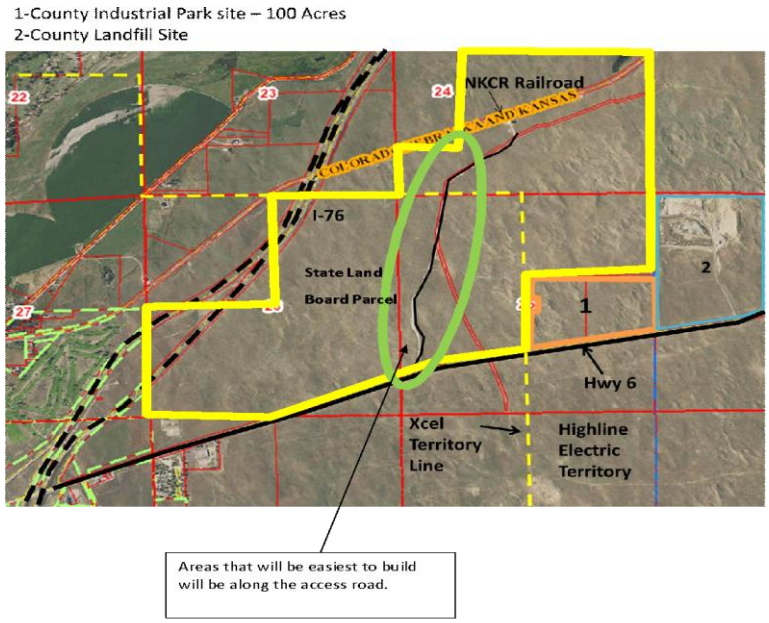
State Land Board Site – 1388 acres

- Greenfield site, in a designated Opportunity Zone. Agricultural land allowing heavy industrial use; only used for livestock grazing in the past; Flood Plain – No risk; Minimum Bid $1725/Acre.
- 100 acres Industrial Park, owned by county lies adjacent to the MSW landfill.
- Natural Gas- Can be served by Xcel or Black Hills Energy. Other large volume options are available.
- Electric- Rural Cooperative-Highline Electric Association; and Xcel Energy. Parcel sits on territory line.
- Water and Sewer- City of Sterling services are available. Private well and onsite septic is also possible.
- Fiber Optic Broadband- Multiple providers for up to 10 gig service.
- Nearby crude oil storage and pipeline available, ability for large scale solar installation on site.
- Transportation- Rail service from two providers less than 1 mile of site; US Highway 6 adjacent, Interstate 76 less than 3 miles; private roads to be constructed for property access from US Highway 6; Denver International Airport less than 2 hours.

Map D2: State Land Board Site



Map D3: Location of the County Industrial Park Site and Landfill Site



C&F Company - Hereford Ave – 38 acres

- Greenfield site; within city limits; privately owned; agriculture/ heavy industrial zoned.
- Electric and Natural Gas provided by Xcel Energy.
- Water and Sewer available through the City of Sterling. Property also has 1500 gallon per minute Ag well on site.
- Fiber optic broadband is available up to 1 Gigabit speed.
- Transportation- Within three miles of 4 lane divided Interstate 76, and one mile from 4 lane US highway 6; Rail service provided by Union Pacific.
- Site located close to the following: Xcel Energy substation allowing easy power supply upgrades; Ethanol Plant; Right-of-Way Road; and privately owned 80 acres parcel open for sale.

T. Cass - Right of Way Road – 90 acres

- Privately Owned and priced at $7,500 per acre; Zoning: usage to the north is agriculture; south is heavy industrial; Jurisdiction: Unincorporated Logan County, adjacent to City of Sterling city limits.
- Electric and Natural Gas are provided through Xcel Energy.
- Water and sewer available from City of Sterling. Infrastructure is adjacent to the property. Ag Irrigation well is on site with 1500 Gallon Per Minute output.
- Fiber optic broadband is available nearby up to 1 Gigabit speed.
- Transportation: Adjacent to the Union Pacific Railroad; accessible from state highway 138,
- within three miles of 4 lane divided Interstate 76, and one mile from 4 lane US highway 6; less than 2 hours from Denver International Airport.

Farmland – 80 acres

- The property is located just a mile outside of Sterling and is priced at $840,000.
- Water- Low Line Irrigation Water, along with a high-capacity irrigation well.
- The site is located north of the 90 acres T. Cass Right-of-Way Road Property; and used to be connected previously.

APPENDIX E: LEGAL DISCLAIMER

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