

# Shadow Flicker Assessment Technical Report

## Rail Tie Wind Project Albany County, Wyoming



*Prepared for:*

ConnectGen Albany County LLC

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## 1 INTRODUCTION

At the request of ConnectGen Albany County LLC (ConnectGen), Tetra Tech, Inc. (Tetra Tech) has prepared this shadow flicker assessment for the Rail Tie Wind Project (Project). This document is intended to provide reviewing regulatory agencies with information on potential occurrence of shadow flicker resulting from development of the Project.

### 1.1 Project Background

The Project is located in southeastern Albany County, Wyoming, and encompasses approximately 26,000 acres of rangeland on private and state lands near Tie Siding, Wyoming (Project Area; Figures 1-3). The Project would include up to 149 wind turbine generators (WTGs), each ranging between 3.0 to 6.0 megawatts (MW) in size, with a combined maximum generating capacity rating of 504 MW. The Project proposes to interconnect to the existing transmission system of the Western Area Power Administration (WAPA) via the Ault-Craig 345-kilovolt (kV) transmission line, which runs through the Project Area.

For construction planning and site optimization, the Project consists of two separate phases, each approximately 252 MW. Construction of the Project is expected to begin in 2021, and both phases could be fully operational by the end of 2022. As is common with large wind projects, the Project may require two years to fully construct. If additional time is required to facilitate construction, it is anticipated that the first 252 MW phase would be completed and fully operational by the end of 2022, and the second phase operational in 2023.

### 1.2 Analysis Area

The analysis area for this shadow flicker assessment incorporates sensitive receptors (e.g., residences, businesses, historic sites, etc.) within 2 miles of the Project Area.

## 2 REGULATORY FRAMEWORK

### 2.1 Federal Regulations

#### 2.1.1 National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires the disclosure of potential environmental impacts for projects with a federal action, through either a Categorical Exclusion, Environmental Assessment, or Environmental Impact Statement (EIS), as well as a process of public and agency review and comment.

WAPA's action on the interconnection request is considered a major federal action subject to NEPA, in accordance with Council on Environmental Quality (CEQ) regulations for implementing NEPA, and DOE NEPA Implementing Procedures (40 CFR Parts 1500–1508, 10 CFR Part 1021). This technical report provides information to assist WAPA in analysis of the potential effects to

the natural and human environments associated with approving or denying the interconnection request.

## 2.2 State Regulations

### 2.2.1 Wyoming Industrial Development Information and Siting Act

The Wyoming Department of Environmental Quality (WYDEQ) Industrial Siting Division (ISD) administers the Wyoming Industrial Development Information and Siting Act (Act; Wyoming Statute § 35-12-101:119) and the Rules and Regulations of the Industrial Siting Council (ISC), Chapters 1 and 2. The Act is designed to protect Wyoming's environmental, social, and economic fabric of communities from unregulated large-scale industrial development. By consolidating the review of 19 independent state agencies into one comprehensive permitting process, the Act offers a thorough analysis of the development's impacts to the public and affected agencies.

Pursuant to the Act, all wind energy projects consisting of 30 or more turbines (in all planned phases of the installation) and/or exceeding the statutory threshold construction cost amount of \$222.8 million are subject to review and approval by the ISC. For facilities permitted under Wyoming Statute (WS) § 35-12-102(a)(vii)(E) and (F), a site reclamation and decommissioning plan and a financial assurance plan are required pursuant to WS § 35-12-105(d) and (e).

As part of the review and approval process, the ISC requires submittal of an application that outlines the evaluation of potential project impacts and mitigation measures related to environmental, social, and economic resources. While there are no specific ISD regulations referencing shadow flicker, the regulations do include aesthetics as one of the environmental dimensions that must be taken into account in the evaluation of project environmental effects.

## 2.3 Local Regulations

### 2.3.1 Wind Energy Conversion System Permit

The Albany County Wind Energy Siting Regulations require all facilities with an aggregate generating capacity greater than 25 kilowatts to apply for a Wind Energy Conversion System (WECS) Use Permit (Albany County 2017). The application process involves the review and recommendation of the Planning and Zoning Commission and the approval of the Board of County Commissioners, as well as community input during a defined and requisite public hearing and comment period (§§18-5-502(a)). The WECS permit applicants must certify that the Project would comply with all applicable state and county zoning and land use regulations. As part of the application, potential impacts to resources such as economic, air quality, water quality, general nuisances, soil disturbance, wildlife, and cultural resources must be addressed. While there are no specific county regulations referencing shadow flicker, the WECS Use Permit regulations do have the following provisions that may relate to potential occurrence of shadow flicker:

- That the proposed WECS Project will not adversely affect the public health, safety, and welfare of the community (Section 12(F)(3)(f)(2)).

- General Nuisances. Minimize light, glare, heat, noise, vibration, odors, fumes, smoke, or other nuisances generated by the WECS Project that may affect off-site property owners- (Section 12(F)(3)(f)(4)(iv)).

### 3 BACKGROUND

A wind turbine's moving blades can cast a moving shadow on locations within a certain distance of a turbine. These moving shadows are called shadow flicker and can be a temporary phenomenon experienced at nearby receptors such as residences or public gathering places. The extent of shadow flicker depends on the time of year and day (which determine the sun's azimuth and altitude angles) and the wind turbine's physical characteristics (height, rotor diameter, blade width, and orientation of the rotor blades). Shadow flicker on surrounding properties generally occurs during low angle sunlight conditions, typically during sunrise and sunset. However, when the sun angle is very low (less than 3 degrees), sunlight passes through more atmosphere and becomes too diffused to form a coherent shadow. Shadow flicker does not occur when the sun is obscured by clouds or fog, at night, or when the source turbine(s) are not operating. In addition, shadow flicker occurs only when at least 20 percent of the sun's disc is covered by the turbine blades.

Shadow flicker intensity is defined as the difference in brightness at a given location in the presence and absence of a shadow. Shadow flicker intensity diminishes with greater receptor-to-turbine separation distance. Shadow flicker intensity for receptor-to-turbine distances beyond 2,000 meters (6,562 feet) is very low and generally considered imperceptible. In general, increasing proximity to turbines may make shadow flicker more noticeable, with the largest number of shadow flicker hours, along with greatest shadow flicker intensity, occurring nearest the wind turbines.

Shadow flicker frequency is related to the wind turbine's rotor blade speed and the number of blades on the rotor. From a health perspective, the low flicker frequencies associated with wind turbines are harmless, and public concerns that flickering light from wind turbines can have negative health effects, such as triggering seizures in people with epilepsy, are unfounded. Epilepsy Action (the working name for the British Epilepsy Foundation) states that there is no evidence that wind turbines can cause seizures (Epilepsy Action 2018). However, they recommend that wind turbine flicker frequency be limited to 3 Hz. For comparison, strobe lights used in discos have frequencies that range from about 3 Hz to 10 Hz (1 Hz = one flash per second). Since the Project's maximum wind turbine blade pass frequency, considering all three potential turbine model scenarios, is approximately 0.79 Hz (less than one alternation per second), no negative health effects to individuals with photosensitive epilepsy are anticipated.

## 4 METHODOLOGY

### 4.1 Project Components

As noted above, ConnectGen is currently considering a range of WTG models between 3.0 and 6.0 MW in size. In order to adequately quantify the potential shadow flicker from the Project, this analysis evaluates the following three turbine model representative layout scenarios being considered for installation: a layout consisting of 149 General Electric (GE) wind turbines (GE Layout); a layout consisting of 87 Vestas (V) wind turbines (Vestas Layout); or a layout consisting of 87 Siemens-Gamesa (SG) wind turbines (Siemens-Gamesa Layout; Figures 1-3). The representative turbine layouts being considered for the Project have the following specifications:

- **GE Layout—149 GE3.0-127 wind turbines:** Three-blade 127-meter rotor diameter with a hub height of 89 meters and generating capacity of 3.0 MW. The GE3.0-127 has a normal high rotor speed of 15.7 rotations per minute, which translates to a blade pass frequency of 0.79 hertz (Hz; 0.79 alternations per second). A total of 149 potential turbine locations were evaluated.
- **Vestas Layout—87 V162-5.6 wind turbines:** Three-blade 162-meter rotor diameter with a hub height of 125 meters and generating capacity of 5.6 MW. The V162-5.6 has a normal high rotor speed of 10.4 rotations per minute, which translates to a blade pass frequency of 0.52 Hz (0.52 alternations per second). A total of 87 potential turbine locations were evaluated.
- **Siemens-Gamesa Layout—87 SG6.0-170 wind turbines:** Three-blade 170-meter rotor diameter with a hub height of 115 meters and generating capacity of 6.0 MW. The SG6.0-170 has a normal high rotor speed of 10.7 rotations per minute, which translates to a blade pass frequency of 0.54 Hz (0.54 alternations per second). A total of 87 potential turbine locations were evaluated.

### 4.2 WindPro Analysis

An analysis of potential shadow flicker from the Project was conducted using the WindPro software package. As described above, the Project is considering multiple turbine model options, so three representative turbine model layouts were analyzed. For the GE layout, 149 potential turbine locations were evaluated. For the Vestas and Siemens-Gamesa layouts, 87 potential turbine locations were evaluated.

The WindPro analysis was conducted to determine potential occurrence of shadow flicker under realistic meteorological conditions (actual expected shadow). This analysis calculated the total amount of time (hours and minutes per year) that shadow flicker could occur at sensitive receptors surrounding the Project turbines. The realistic condition scenario is based on the following:

- The elevation and position geometries of the wind turbines and surrounding sensitive receptors. Elevations were determined using U.S. Geological Survey digital elevation model data. Position geometries were determined using geographic information systems and referenced to Universal Transverse Mercator (UTM) Zone 13 (NAD83).

- The position of the sun and the incident sunlight relative to the wind turbine and sensitive receptors on a minute-by-minute basis over the course of a year.
- Historical sunshine availability (percent of total potential available sunshine hours). Historical sunshine rates for the area (as summarized by the National Climatic Data Center [NOAA 2019] for nearby Cheyenne, Wyoming) used in this analysis are provided in Table 1.
- Estimated wind turbine operations and orientation based on wind data (wind speed and direction) measured at meteorological towers located on the Project site.
- Sensitive receptor viewpoints (i.e., house windows) were assumed to be directly facing the turbine-to-sun line of sight (“greenhouse mode”).

**Table 1: Historical Sunshine Availability for Cheyenne, WY**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
58%	66%	67%	66%	63%	64%	67%	70%	70%	67%	56%	57%

WindPro incorporates terrain elevation contour information and the analysis accounts for terrain elevation differences. The sun’s path, with respect to each turbine location, is calculated by the software to determine the cast shadow paths every minute over a full year. Sun angles less than 3 degrees above the horizon were excluded for the reasons identified earlier in Section 3. Since shadow flicker is only an issue when at least 20 percent of the sun’s disc is covered by the blades, WindPro uses blade dimension data to calculate the maximum distance from the turbine where shadow flicker must be calculated. Beyond this distance, the turbine would not contribute to the shadow flicker. It should be noted that WindPro provides a conservative estimate of shadow flicker because obstacles such as trees, haze, and visual obstructions (window facing, coverings) are not accounted for despite the likelihood of their reducing or eliminating shadow flicker at sensitive receptors.

A total of 184 potential sensitive receptor locations were identified within and near the Project area to be evaluated for potential shadow flicker effects. Sensitive receptor locations included occupied or potentially occupied residences, one fire station, one business, and two historic properties (Ames Monument and Dale Creek Crossing, both listed on the National Register of Historic Places). A sensitive receptor in the model is defined as a 1-meter-square area (approximate size of a typical window), 1 meter (3.28 feet) above ground level. Approximate eye level is set at 1.5 meters (4.94 feet). Figures 1 through 3 show the locations of all 184 sensitive receptors along with the potential turbine locations considered for each layout scenario.

There are no specific federal, state, or local regulations or ordinances outlining threshold requirements for potential occurrence of shadow flicker associated with development of the Project. However, the National Association of Regulatory Utility Commissioners (NARUC) recommends a threshold of 30 hours of shadow flicker per year at occupied buildings (NARUC 2012). For the purposes of this analysis, potential shadow flicker impacts were assessed against the widely used industry standard threshold of 30 hours per year, which is the threshold that is



cited in numerous state energy siting regulations and county zoning regulations across the country.

## 5 RESULTS

As expected, the results of the WindPro analysis predict that shadow flicker would be greatest at locations closer to the wind turbines. Figures 1 through 3 illustrate the WindPro-predicted shadow flicker occurrence for each of the turbine model layout scenarios.

Tables 2, 3, and 4 present the WindPro-predicted shadow flicker for the 10 sensitive receptors with the highest level of modeled shadow flicker (measured in hours/year) for each turbine model layout scenario. Table 5 summarizes the shadow flicker prediction statistics. The predicted shadow flicker for all 184 sensitive receptors is presented in Attachment A. For all three turbine model layout scenarios, all sensitive receptor locations had modeled shadow flicker below the industry standard threshold of 30 hours per year. The sensitive receptor with the highest level of shadow flicker for any layout scenario was determined to be Receptor 19, a participating landowner located in the southern portion of the Project Area. As outlined in Table 2, Receptor 19 had a maximum predicted shadow flicker of 25 hours and 6 minutes per year (associated with the GE Layout; Figure 1). This represents approximately 0.6 percent of the potential available daylight hours.

**Table 2: Top 10 Sensitive Receptors for WindPro-Predicted Shadow Flicker—GE Layout**

Receptor ID	Receptor Type	Project Participation Status	Expected Shadow Flicker Hours per Year (Hours/Year)
19	Residential	Participant	25:06
39	Residential	Participant	22:54
38	Residential	Non-Participant	14:48
184	Historic Site (Dale Creek Crossing)	Non-Participant	11:10
127	Residential	Non-Participant	9:58
117	Residential	Non-Participant	9:33
24	Residential	Participant	7:22
113	Residential	Participant	6:52
52	Residential	Non-Participant	2:54
1	Residential	Non-Participant	2:51

**Table 3. Top 10 Sensitive Receptors for WindPro-Predicted Shadow Flicker—Vestas Layout**

Receptor ID	Receptor Type	Project Participation Status	Expected Shadow Flicker Hours per Year (Hours/Year)
117	Residential	Non-Participant	16:17
184	Historic Site (Dale Creek Crossing)	Non-Participant	14:18
24	Residential	Participant	13:45
127	Residential	Non-Participant	13:41
19	Residential	Participant	13:39
1	Residential	Non-Participant	13:30

Receptor ID	Receptor Type	Project Participation Status	Expected Shadow Flicker Hours per Year (Hours/Year)
113	Residential	Participant	13:03
155	Residential	Non-Participant	12:25
39	Residential	Participant	11:51
119	Residential	Non-Participant	11:30

**Table 4. Top 10 Sensitive Receptors for WindPro-Predicted Shadow Flicker—Siemens-Gamesa Layout**

Receptor ID	Receptor Type	Project Participation Status	Expected Shadow Flicker Hours per Year (Hours/Year)
117	Residential	Non-Participant	18:26
184	Historic Site (Dale Creek Crossing)	Non-Participant	16:07
19	Residential	Participant	15:16
155	Residential	Non-Participant	15:01
24	Residential	Participant	14:39
1	Residential	Non-Participant	14:07
127	Residential	Non-Participant	13:39
113	Residential	Participant	12:48
119	Residential	Non-Participant	11:50
39	Residential	Participant	10:06

**Table 5. Statistical Summary of WindPro-Predicted Shadow Flicker—Number of Modeled Sensitive Receptors**

Cumulative Shadow Flicker Time (Expected)	Number of Modeled Sensitive Receptors		
	GE Layout	Vestas Layout	Siemens-Gamesa Layout
0 Hours	167	165	165
> 0 Hours ≤ 10 Hours	13	9	9
> 10 Hours ≤ 20 Hours	2	10	10
> 20 Hours ≤ 30 Hours	2	0	0
> 30 Hours	0	0	0
<b>Total</b>	<b>184</b>	<b>184</b>	<b>184</b>

## 6 POTENTIAL EFFECTS ANALYSIS

The analysis of potential shadow flicker from the Project on nearby sensitive receptors shows that shadow flicker effects associated with each turbine layout scenario are expected to be minor and well within acceptable industry-standard ranges for avoiding nuisance. All of the sensitive receptor locations had modeled shadow flicker below the industry standard threshold of 30 hours per year. The analysis assumes that the sensitive receptors all have a direct in-line view of the incoming shadow flicker sunlight and does not account for trees or other obstructions that may block sunlight. In reality, the windows of many houses will not face the sun directly during the key times of shadow flicker occurrence. For these reasons, shadow flicker occurrence is expected to be less than estimated in this conservative analysis.

### 6.1 Applicant-Proposed Environmental Protection Measures

ConnectGen has developed Environmental Protection Measures (EPMs) that when implemented would avoid or minimize adverse effects to environmental resources from construction, operations and maintenance, and decommissioning of the Project. Although potential shadow flicker effects associated with Project operation are not anticipated to be significant, the EPMs listed in Table 6 below would both directly and indirectly avoid or reduce potential shadow flicker effects from development of the Project.

**Table 6: Proposed Environmental Protection Measures Related to Shadow Flicker Impacts for the Rail Tie Wind Project**

Resource Category	Measure	Implementation			
		Preconstruction	Construction	Operations	Decommissioning
<b>General</b>					
GEN-1	The Project will be designed, constructed, and operated in compliance with Albany County Zoning Regulations (as amended) and Albany County Wind Energy Siting Regulations. Construction and operations activities will comply with all federal, state, and county environmental regulations, as applicable.	X	X	X	X
<b>Public Health and Safety</b>					
PHS-7	Wind turbines will be operated in conformance with the manufacturer's operational parameters.			X	

## 7 REFERENCES

Albany County. 2017. Albany County Zoning Resolution. Adopted: August 1, 1997. Last Updated August 1, 2017. Albany County Planning Department. Available online at: [http://www.co.albany.wy.us/Data/Sites/1/ZoningUpdated\\_8-1-17.pdf](http://www.co.albany.wy.us/Data/Sites/1/ZoningUpdated_8-1-17.pdf).

Epilepsy Action. 2018. Information Web Page on Photosensitive Epilepsy. British Epilepsy Association. Available online at: [http://www.epilepsy.org.uk/info/photo\\_other.html](http://www.epilepsy.org.uk/info/photo_other.html). Accessed March 2020.

NARUC (The National Association of Regulatory Utility Commission). 2012. Wind Energy & Wind Park Siting and Zoning Best Practices and Guidance for States. January 2012. Available online at: <https://pubs.naruc.org/pub/FA8663AC-A840-E8B3-FC1D-C7AFEC3ED9D6>. Accessed March 2020.

NOAA (National Oceanic and Atmospheric Administration). 2019. Comparative Climatic Data for the United States through 2018. National Centers for Environmental Information. Available online at: <https://www.ncdc.noaa.gov/ghcn/comparative-climatic-data>. Accessed March 2020.

## FIGURES

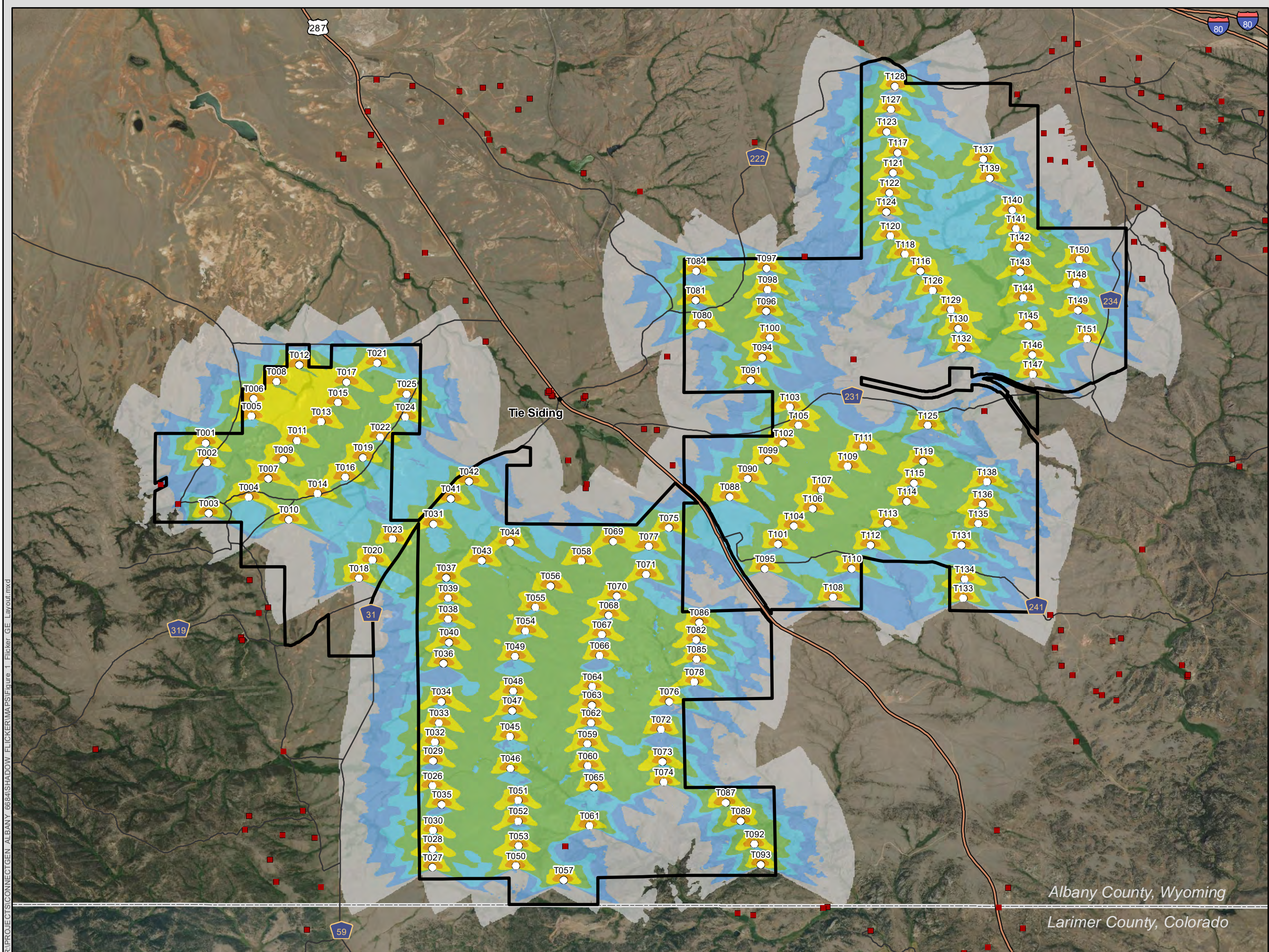
Figure 1: Expected Shadow Flicker Impact Area—GE Layout

Figure 2: Expected Shadow Flicker Impact Area—Vestas Layout

Figure 3: Expected Shadow Flicker Impact Area—Siemens-Gamesa Layout

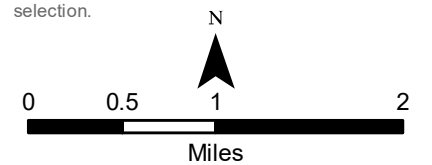
Figure 1  
Expected Shadow Flicker Impact Area – GE Layout

Albany County, WY



- Project Area
  - Turbine Location  
(GE 3.0-127, 89m hub height)
  - Sensitive Receptor
- Shadow Flicker (Hours per Year)
- < 15
  - 15
  - 30
  - 50
  - 100
  - 200
- State/County Boundary
  - Highways
  - County Roads

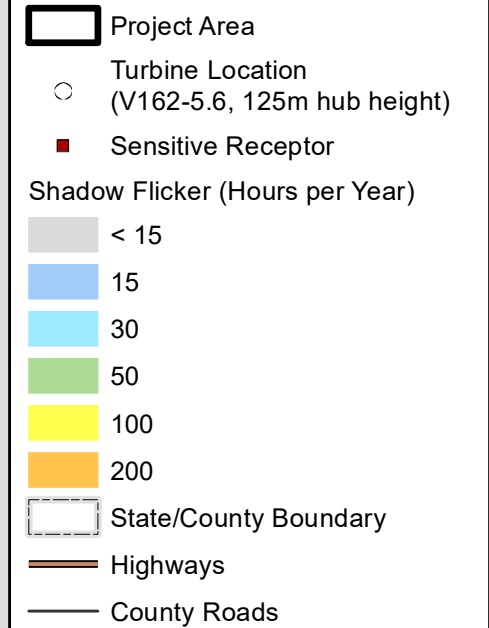
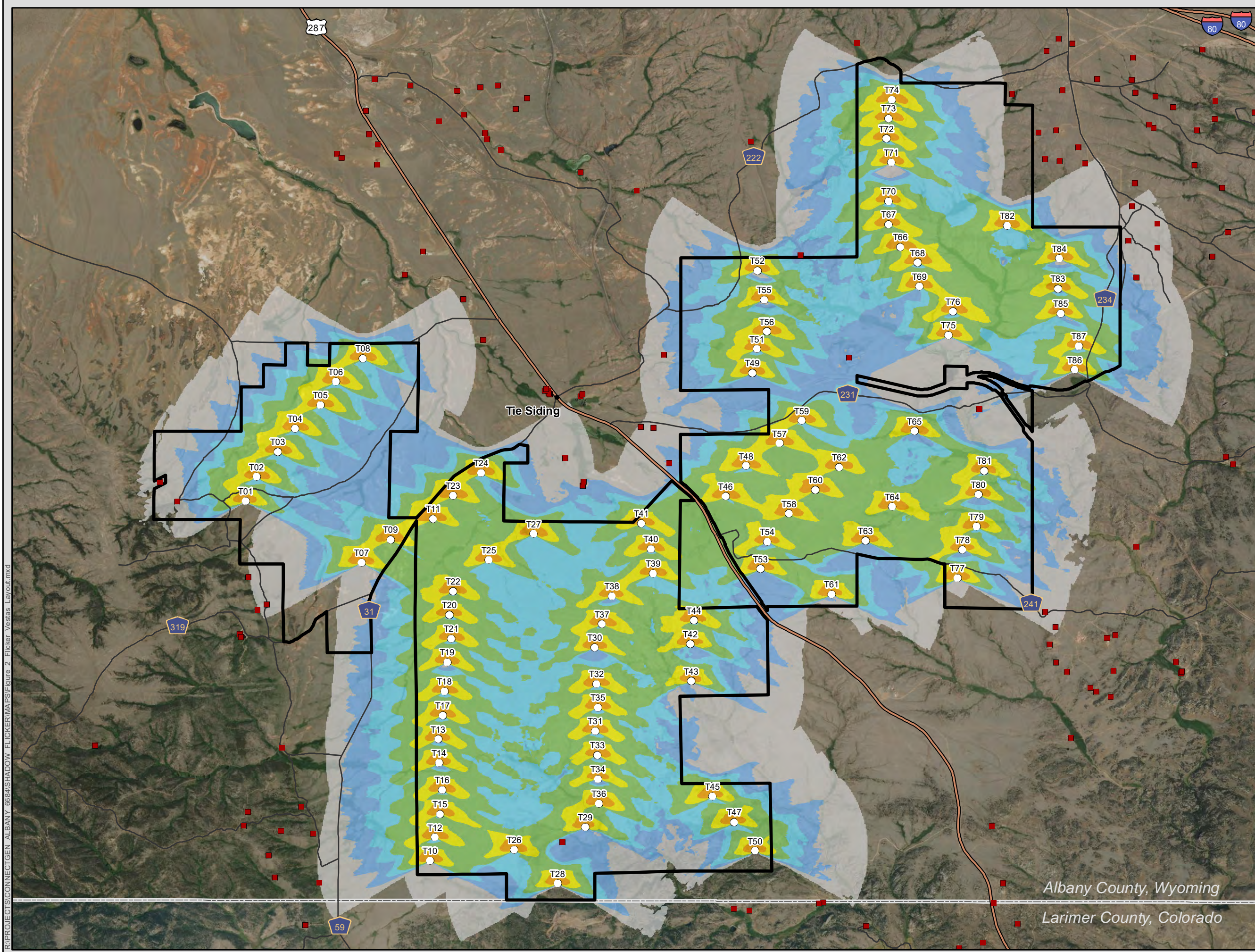
NOTE: WTG locations shown in the figure are representative and may change based on final engineering, environmental review and WTG model selection.



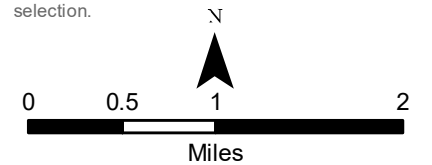
Albany County, Wyoming

Larimer County, Colorado

R:\PROJECTS\CONNECTGEN\_ALBANY\_6684\SHADOW\_FLICKER\MAPS\Figure 1\_Flicker\_GE\_Layout.mxd



NOTE: WTG locations shown in the figure are representative and may change based on final engineering, environmental review and WTG model selection.

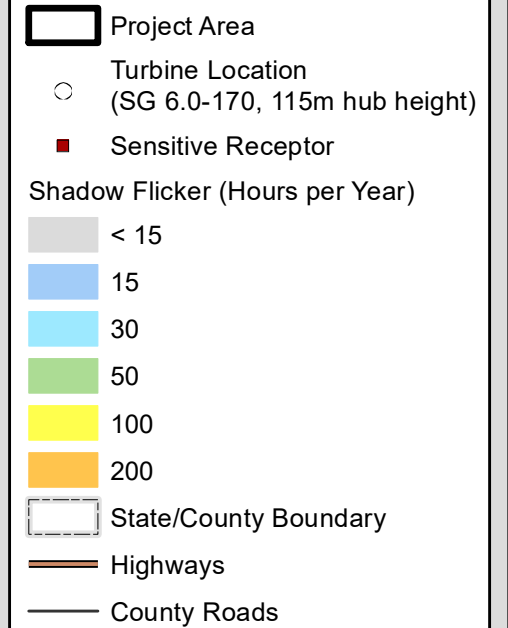
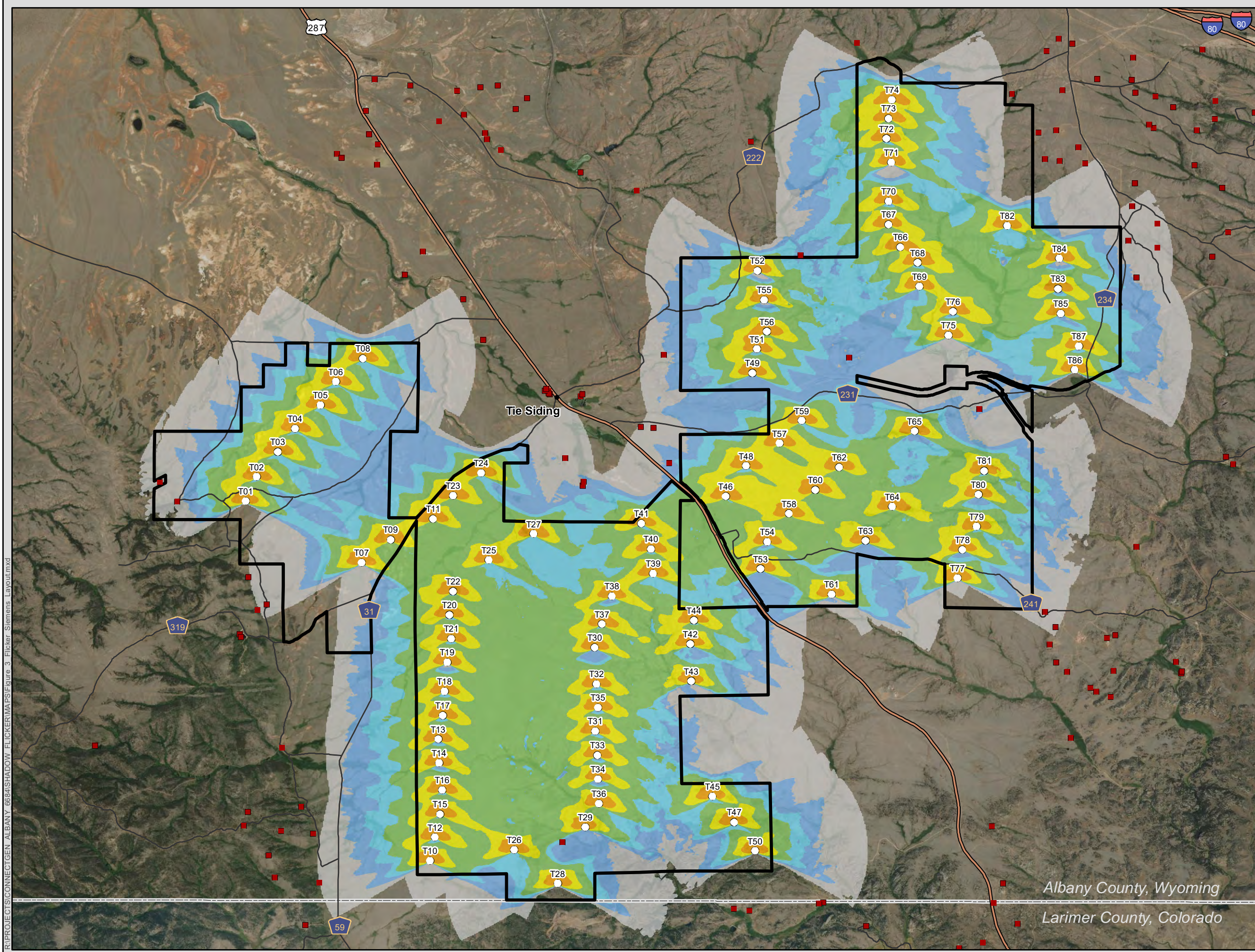


Albany County, Wyoming

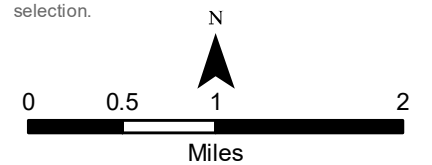
Larimer County, Colorado

R:\PROJECTS\CONNECTGEN\_ALBANY\_6684\SHADOW\_FLICKER\MAPS\Figure 2\_Flicker\_Vestas\_Layout.mxd





NOTE: WTG locations shown in the figure are representative and may change based on final engineering, environmental review and WTG model selection.



Albany County, Wyoming

Larimer County, Colorado

R:\PROJECTS\CONNECTGEN\_ALBANY\_6684\SHADOW\_FLICKER\MAPS\Figure 3\_Flicker\_Siemens-Layout.mxd

**APPENDIX A:**  
**Detailed Summary of WindPro Shadow Flicker Analysis Results**

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
1	Non-Participating Residence	457841.1	4546174.4	2:51	13:30	14:07
2	Non-Participating Residence	466463.4	4542962.8	0:00	0:00	0:00
3	Non-Participating Residence	466461.8	4543599.4	0:00	8:09	8:24
4	Non-Participating Residence	466663.5	4542784.8	0:00	0:00	0:00
5	Non-Participating Residence	467390.6	4543402.9	0:00	0:00	0:00
6	Non-Participating Residence	467094.9	4542498.0	0:00	0:00	0:00
7	Non-Participating Residence	467200.4	4542425.9	0:00	0:00	0:00
8	Non-Participating Residence	457798.7	4547804.5	0:00	0:00	0:00
9	Non-Participating Residence	457834.7	4547842.8	0:00	0:00	0:00
10	Non-Participating Residence	459130.0	4547235.6	0:00	4:07	4:28
11	Non-Participating Residence	457237.3	4547848.4	0:00	0:00	0:00
12	Non-Participating Residence	468305.9	4550509.2	0:00	0:00	0:00
13	Non-Participating Residence	468308.0	4550957.2	0:00	0:00	0:00
14	Non-Participating Residence	467855.1	4551273.1	0:00	3:13	2:56
15	Non-Participating Residence	466998.6	4552056.3	0:18	0:00	0:00
16	Non-Participating Residence	466532.5	4552098.0	0:58	0:00	0:00
17	Non-Participating Residence	466464.5	4552659.9	0:26	0:00	0:00
18	Non-Participating Residence	466143.1	4552618.2	1:17	0:00	0:00
19	Participating Residence	457465.2	4539680.1	25:06	13:39	15:16
20	Non-Participating Residence	462220.1	4538587.8	0:00	0:00	0:00
21	Non-Participating Residence	462145.6	4538558.5	0:00	0:00	0:00
22	Non-Participating Residence	465503.6	4538929.0	0:00	0:00	0:00
23	Non-Participating Residence	465296.1	4539973.0	0:00	0:00	0:00
24	Participating Residence	465073.4	4547575.6	7:22	13:45	14:39
25	Non-Participating Residence	456028.3	4548833.2	0:00	0:00	0:00
26	Non-Participating Residence	458826.1	4551551.4	0:00	0:00	0:00
27	Non-Participating Residence	463812.0	4555063.9	0:00	0:00	0:00
28	Non-Participating Residence	463977.5	4555524.7	0:00	0:00	0:00
29	Non-Participating Residence	465268.2	4556082.3	0:00	0:00	0:00
30	Non-Participating Residence	465350.3	4556351.3	0:00	0:00	0:00
31	Non-Participating Residence	465057.8	4556366.6	0:00	0:00	0:00
32	Non-Participating Residence	465521.9	4555438.1	0:00	0:00	0:00
33	Non-Participating Residence	464996.2	4555238.0	0:00	0:00	0:00
34	Non-Participating Residence	465493.2	4556177.6	0:00	0:00	0:00
35	Non-Participating Residence	466394.7	4555057.6	0:00	0:00	0:00
36	Non-Participating Residence	452082.0	4544015.8	0:00	1:27	1:15

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
37	Non-Participating Residence	451740.2	4544514.2	0:00	0:00	0:00
38	Non-Participating Residence	450119.9	4546248.2	14:48	3:59	3:43
39	Participating Residence	450446.0	4545890.4	22:54	11:51	10:06
40	Non-Participating Residence	454924.9	4550442.3	0:00	0:00	0:00
41	Non-Participating Residence	467517.7	4542799.4	0:00	0:00	0:00
42	Non-Participating Residence	466740.7	4541579.3	0:00	0:00	0:00
43	Non-Participating Residence	468749.8	4542756.9	0:00	0:00	0:00
44	Non-Participating Residence	467936.8	4545064.1	0:00	0:00	0:00
45	Non-Participating Residence	467788.8	4550643.2	2:27	6:26	5:58
46	Non-Participating Residence	467902.6	4551694.1	0:00	0:00	0:00
47	Non-Participating Residence	469604.9	4550803.7	0:00	0:00	0:00
48	Non-Participating Residence	470166.8	4551032.6	0:00	0:00	0:00
49	Non-Participating Residence	469492.6	4551611.1	0:00	0:00	0:00
50	Non-Participating Residence	470715.1	4551614.8	0:00	0:00	0:00
51	Non-Participating Residence	466869.1	4552347.8	0:00	0:00	0:00
52	Non-Participating Residence	466269.9	4552132.2	2:54	0:00	0:00
53	Non-Participating Residence	465665.0	4553320.6	0:00	0:00	0:00
54	Non-Participating Residence	466290.4	4554106.3	0:00	0:00	0:00
55	Non-Participating Residence	466767.2	4554237.8	0:00	0:00	0:00
56	Non-Participating Residence	466814.0	4555089.9	0:00	0:00	0:00
57	Non-Participating Residence	467841.4	4553573.4	0:00	0:00	0:00
58	Non-Participating Residence	467911.1	4553343.2	0:00	0:00	0:00
59	Non-Participating Residence	468244.6	4552702.2	0:00	0:00	0:00
60	Non-Participating Residence	465961.6	4555575.4	0:00	0:00	0:00
61	Non-Participating Residence	465778.6	4555900.3	0:00	0:00	0:00
62	Non-Participating Residence	463763.2	4556025.7	0:00	0:00	0:00
63	Non-Participating Residence	464233.4	4556210.2	0:00	0:00	0:00
64	Non-Participating Residence	464114.1	4556506.8	0:00	0:00	0:00
65	Non-Participating Residence	464507.9	4556494.0	0:00	0:00	0:00
66	Non-Participating Residence	469032.7	4552662.4	0:00	0:00	0:00
67	Non-Participating Residence	469359.9	4552867.4	0:00	0:00	0:00
68	Non-Participating Residence	452108.5	4539441.2	0:00	0:00	0:00
69	Non-Participating Residence	453033.1	4538940.1	0:00	0:00	0:00
70	Non-Participating Residence	452226.7	4539034.7	0:00	0:00	0:00
71	Non-Participating Residence	452918.8	4539839.5	0:00	0:00	0:00
72	Non-Participating Residence	452332.5	4539887.8	0:00	0:00	0:00

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
73	Non-Participating Residence	452703.5	4540326.6	0:00	0:00	0:00
74	Non-Participating Residence	451661.1	4539979.1	0:00	0:00	0:00
75	Non-Participating Residence	451735.5	4540238.5	0:00	0:00	0:00
76	Non-Participating Residence	452350.8	4541399.2	0:00	0:00	0:00
77	Non-Participating Residence	465327.1	4538574.8	0:00	0:00	0:00
78	Non-Participating Residence	465767.5	4538198.7	0:00	0:00	0:00
79	Non-Participating Residence	465131.8	4537845.6	0:00	0:00	0:00
80	Non-Participating Residence	466353.7	4543280.3	0:00	0:00	0:00
81	Non-Participating Residence	470173.1	4550498.5	0:00	0:00	0:00
82	Non-Participating Residence	470091.6	4552977.3	0:00	0:00	0:00
83	Non-Participating Residence	470509.2	4552657.7	0:00	0:00	0:00
84	Non-Participating Residence	470267.1	4553224.3	0:00	0:00	0:00
85	Non-Participating Residence	469374.6	4553183.5	0:00	0:00	0:00
86	Non-Participating Residence	467873.0	4553975.5	0:00	0:00	0:00
87	Non-Participating Residence	460593.0	4538469.6	0:00	0:00	0:00
88	Non-Participating Residence	460866.8	4538435.8	0:00	0:00	0:00
89	Non-Participating Residence	452777.1	4538168.2	0:00	0:00	0:00
90	Non-Participating Residence	464702.8	4537749.6	0:00	0:00	0:00
91	Non-Participating Residence	463004.1	4538156.9	0:00	0:00	0:00
92	Non-Participating Residence	457003.1	4535141.9	0:00	0:00	0:00
93	Non-Participating Residence	457788.9	4535076.3	0:00	0:00	0:00
94	Non-Participating Residence	469693.0	4546563.3	0:00	0:00	0:00
95	Non-Participating Residence	472199.6	4549975.6	0:00	0:00	0:00
96	Non-Participating Residence	456284.5	4553476.5	0:00	0:00	0:00
97	Non-Participating Residence	456826.9	4553244.9	0:00	0:00	0:00
98	Non-Participating Residence	456618.6	4553045.8	0:00	0:00	0:00
99	Non-Participating Residence	456343.2	4552296.0	0:00	0:00	0:00
100	Non-Participating Residence	456089.9	4552491.6	0:00	0:00	0:00
101	Non-Participating Residence	456055.5	4552608.9	0:00	0:00	0:00
102	Non-Participating Residence	455668.7	4552943.3	0:00	0:00	0:00
103	Non-Participating Residence	455544.0	4553378.4	0:00	0:00	0:00
104	Non-Participating Residence	454693.3	4553473.4	0:00	0:00	0:00
105	Non-Participating Residence	454045.5	4553587.1	0:00	0:00	0:00
106	Non-Participating Residence	453889.5	4553009.5	0:00	0:00	0:00
107	Non-Participating Residence	453942.9	4552582.9	0:00	0:00	0:00
108	Non-Participating Residence	453354.8	4552232.9	0:00	0:00	0:00

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
109	Non-Participating Residence	454094.2	4552028.8	0:00	0:00	0:00
110	Non-Participating Residence	465897.1	4556232.4	0:00	0:00	0:00
111	Participating Residence	457519.9	4546681.1	0:00	9:12	9:09
112	Non-Participating Residence	454595.0	4550028.6	0:00	0:00	0:00
113	Participating Residence	462696.7	4548511.4	6:52	13:03	12:48
114	Business	457213.1	4547904.8	0:00	0:00	0:00
115	Non-Participating Residence	457224.4	4547864.5	0:00	0:00	0:00
116	Non-Participating Residence	469211.1	4554940.8	0:00	0:00	0:00
117	Non-Participating Residence	459409.0	4546590.5	9:33	16:17	18:26
118	Non-Participating Residence	462832.8	4554243.0	0:00	0:00	0:00
119	Non-Participating Residence	459315.6	4548567.5	2:12	11:30	11:50
120	Non-Participating Residence	466268.3	4543875.2	2:33	7:37	7:56
121	Non-Participating Residence	471664.1	4540514.7	0:00	0:00	0:00
122	Non-Participating Residence	468765.6	4542795.8	0:00	0:00	0:00
123	Non-Participating Residence	468656.2	4542963.3	0:00	0:00	0:00
124	Non-Participating Residence	467455.8	4542327.6	0:00	0:00	0:00
125	Non-Participating Residence	469562.7	4546710.0	0:00	0:00	0:00
126	Non-Participating Residence	467552.3	4543457.8	0:00	0:00	0:00
127	Non-Participating Residence	467935.8	4549979.3	9:58	13:41	13:39
128	Non-Participating Residence	469318.1	4550356.0	0:00	0:00	0:00
129	Non-Participating Residence	468989.9	4552023.7	0:00	0:00	0:00
130	Non-Participating Residence	468605.3	4553078.6	0:00	0:00	0:00
131	Non-Participating Residence	468167.9	4552753.6	0:00	0:00	0:00
132	Non-Participating Residence	468271.3	4553277.2	0:00	0:00	0:00
133	Non-Participating Residence	467220.2	4553589.3	0:00	0:00	0:00
134	Non-Participating Residence	469133.9	4554130.1	0:00	0:00	0:00
135	Non-Participating Residence	466516.5	4554328.8	0:00	0:00	0:00
136	Non-Participating Residence	464174.4	4555637.5	0:00	0:00	0:00
137	Fire Station	465758.8	4556623.1	0:00	0:00	0:00
138	Non-Participating Residence	464263.3	4556819.7	0:00	0:00	0:00
139	Non-Participating Residence	463413.1	4556829.8	0:00	0:00	0:00
140	Non-Participating Residence	464024.2	4557132.4	0:00	0:00	0:00
141	Non-Participating Residence	464261.3	4557255.8	0:00	0:00	0:00
142	Non-Participating Residence	463172.7	4559266.5	0:00	0:00	0:00
143	Non-Participating Residence	457482.6	4556300.8	0:00	0:00	0:00
144	Non-Participating Residence	460902.4	4552456.3	0:00	0:00	0:00

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
145	Non-Participating Residence	457795.1	4551890.6	0:00	0:00	0:00
146	Non-Participating Residence	458893.8	4547253.7	0:00	2:57	2:47
147	Non-Participating Residence	453440.7	4552152.6	0:00	0:00	0:00
148	Non-Participating Residence	455658.7	4549583.2	0:00	0:00	0:00
149	Non-Participating Residence	457150.6	4547915.8	0:00	0:00	0:00
150	Non-Participating Residence	457170.6	4547944.6	0:00	0:00	0:00
151	Non-Participating Residence	451905.7	4543911.6	0:00	0:00	0:00
152	Non-Participating Residence	448952.8	4541437.1	0:00	0:00	0:00
153	Non-Participating Residence	451581.2	4543473.4	0:00	0:00	0:00
154	Non-Participating Residence	451605.8	4543417.9	0:00	0:00	0:00
155	Non-Participating Residence	457856.6	4546255.4	0:00	12:25	15:01
156	Non-Participating Residence	454098.7	4552406.5	0:00	0:00	0:00
157	Non-Participating Residence	461517.0	4535950.2	0:00	0:00	0:00
158	Non-Participating Residence	461684.8	4535966.4	0:00	0:00	0:00
159	Non-Participating Residence	461689.1	4536278.0	0:00	0:00	0:00
160	Non-Participating Residence	461373.9	4536629.4	0:00	0:00	0:00
161	Non-Participating Residence	462374.6	4536118.3	0:00	0:00	0:00
162	Non-Participating Residence	462570.2	4536034.6	0:00	0:00	0:00
163	Non-Participating Residence	462991.7	4536499.0	0:00	0:00	0:00
164	Non-Participating Residence	462602.1	4536457.6	0:00	0:00	0:00
165	Non-Participating Residence	462281.8	4536487.8	0:00	0:00	0:00
166	Non-Participating Residence	464535.6	4537553.5	0:00	0:00	0:00
167	Non-Participating Residence	464456.9	4537182.1	0:00	0:00	0:00
168	Non-Participating Residence	463865.6	4537223.5	0:00	0:00	0:00
169	Non-Participating Residence	463289.2	4536244.3	0:00	0:00	0:00
170	Non-Participating Residence	462341.2	4537295.0	0:00	0:00	0:00
171	Non-Participating Residence	462826.4	4536958.8	0:00	0:00	0:00
172	Non-Participating Residence	463065.4	4537590.4	0:00	0:00	0:00
173	Non-Participating Residence	463405.6	4537419.0	0:00	0:00	0:00
174	Non-Participating Residence	454494.2	4535026.0	0:00	0:00	0:00
175	Non-Participating Residence	463467.8	4536294.8	0:00	0:00	0:00
176	Non-Participating Residence	456713.8	4535212.4	0:00	0:00	0:00
177	Non-Participating Residence	455214.1	4552823.6	0:00	0:00	0:00
178	Non-Participating Residence	455977.8	4553439.9	0:00	0:00	0:00
179	Non-Participating Residence	471170.8	4550859.4	0:00	0:00	0:00
180	Non-Participating Residence	471403.3	4551251.6	0:00	0:00	0:00

Sensitive Receptor ID	Receptor Description	Easting	Northing	Shadow Flicker Impact (hours per year)		
				GE 3.0-127 89m HH (149)	V162-5.6 125m HH (87)	SG 6.0-170 115m HH (87)
181	Non-Participating Residence	464819.3	4557157.3	0:00	0:00	0:00
182	Non-Participating Residence	465136.9	4557163.3	0:00	0:00	0:00
183	Historic Site (Ames Monument)	466582.2	4553384.2	0:00	0:00	0:00
184	Historic Site (Dale Creek Crossing)	461812.9	4550378.4	11:10	14:18	16:07