Appendix N – Shadow Flicker Analysis

Shadow Flicker Study
South Deuel Wind Project
Deuel County, South Dakota

Prepared for:

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Project No: 193709367

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1.0 INTRODUCTION

Deuel Harvest Wind Energy South LLC (South Deuel Wind), an affiliate of Invenergy LLC, is proposing to develop a wind energy generation facility, known as the South Deuel Wind Project (Project), in Deuel County, South Dakota.

The Project will have a generating capacity of up to 260 megawatts (MW) alternating current at the point of interconnection and will feature up to 68 turbines ranging from 3.8 to 4.5 MW nameplate capacity each, depending on the final turbine model(s) selected. South Deuel Wind retained Stantec Consulting Services Inc. (Stantec) to conduct an analysis of potential shadow flicker from turbines at the 73 proposed locations.

The shadow flicker analyses completed for the Project consider the following three turbine models:

- An analysis with Siemens Gamesa (SG) model 4.4-164 turbines (97.5-meter hub height), utilizing 71 proposed turbine locations.[1]
- An analysis with Vestas model V163-4.5 turbines (98-meter hub height), utilizing 71 proposed turbine locations. [1]
- An analysis with General Electric (GE) model 3.8-154 turbines (98-meter hub height), utilizing 73 proposed turbine locations.

South Deuel Wind will construct and operate a subset of the turbine locations described in this report; therefore, expected annual shadow flicker hours will be less than the results of the analyses presented. Potential shadow flicker on existing residences within approximately 1.25 miles of the proposed turbine locations was assessed and the results for each model are summarized herein.

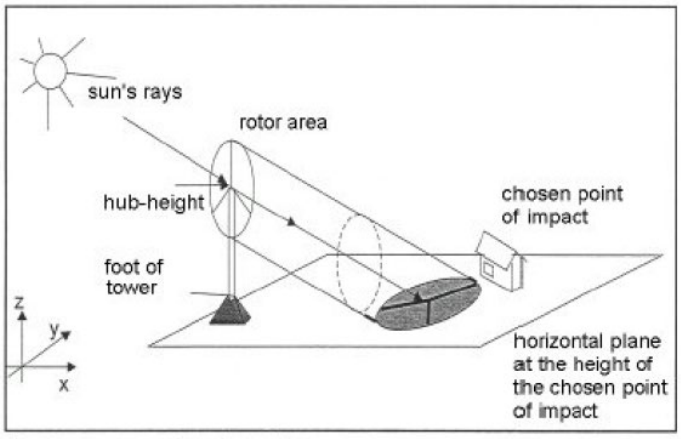
[1] The SG and Vestas turbine models do not include proposed turbine locations T-69 and T-76. Turbine locations T-69 and T-76 can only support the GE 3.8-154 turbine model due to shadow flicker requirements. However, these locations could accommodate SG and Vestas turbine models depending on the final turbine locations used for construction and mitigation methods implemented during operations.

2.0 SHADOW FLICKER AND REGULATIONS

2.1 DESCRIPTION OF SHADOW FLICKER

Shadow flicker is a term used to describe the intermittent change in the intensity of light cast on an area resulting from the rotation of an operating wind turbine's blades between the sun and an object. The presence and intensity of shadow flicker are dependent on many factors, including but not limited to the position of the sun in relation to the turbine and receptor, distance of receptor from turbine, physical characteristics of the turbine and blades, time of day, season of year, and topography of the Project area. Shadow flicker will only occur during daylight hours when skies are not overcast or cloudy. Turbines must be operational, as the flicker effect is caused by rotation of the blades as they intercept the sunlight cast on a receptor. When a turbine is not operating it may cast a stationary shadow, similar to other objects such as trees or utility poles.

The amount of shadow flicker received in an area is dependent on the alignment of the rotor blades in relation to the sun and receptor. Maximum shadow flicker is received when the sun is aligned with the turbine and receptor, and the turbine's rotor plane is perpendicular to the receptor. This alignment occurs when the wind is blowing directly from a source turbine towards a receptor. At times when the wind is blowing from other directions, the shadow cast on the target receptor is diminished and the shadow flicker effect passes more quickly.



Shadow flicker also diminishes as the distance between the source turbine and receptor increases. It is generally accepted that flicker becomes imperceptible beyond approximately 1,500 meters (4,921 feet). For turbines with a rotor diameter less than 150 meters the flicker effect is less pronounced due to dissipation and the relative ratio of the turbine blade to the sun disk area at distances between approximately 10 times the rotor diameter and 1,500 meters.

2.2 REGULATIONS WITHIN THE PROJECT AREA

The Project is proposed to be located within Deuel County, South Dakota. The Deuel County Zoning Ordinance Section 1215.03(13)(b) states that with respect to shadow flicker: "Limit for allowable shadow flicker at existing residences to no more than 30 hours annually."

3.0 SHADOW FLICKER ANALYSIS

The potential amount of shadow flicker on existing residences (also referred to as receptors) within the Project area was modeled using the Shadow module of EMD's WindPRO Version 3.6 software. WindPRO is an industry-accepted modeling program that calculates the number of hours per year that any given receptor may receive shadow flicker from the source turbines. The modeling program considers the attributes and positions of the wind turbines in relation to receptors within the area. The model also considers the sun's position as it passes through the Project area each day in addition to regional climatological information.

The results of the shadow flicker analyses include expected shadow flicker due to the operation of turbines considering each of the proposed turbine models.

3.1 SHADOW FLICKER ANALYSIS METHODS

A modeling analysis was completed to assess the expected shadow levels at receptors based on a series of assumptions. The WindPRO model calculates both a "potential" and "expected" scenario. The "potential" scenario provides the periods when shadow flicker *may* occur on a receptor; however, it is not representative of the shadow flicker that is expected to occur. The "potential" scenario assumes no cloud cover, the sun is always shining during daylight hours, and turbines are always operating and rotated to cast maximum shadow on a receptor. The "expected" amount of annual shadow flicker considers the percentage of sunshine based on local regional sunshine statistics; the alignment of the blades in relation to the receptor due to wind direction; and the amount of time that the blades would not be rotating due to wind speeds outside of the turbine's operating parameters. The "potential" scenario, as described, could not realistically occur; however, is useful as an indicator of the potential times within which shadow flicker may occur. The shadow flicker analysis uses a conservative 90% operational time for purposes of calculating the annual hours of expected shadow flicker.

The results provided in this report include the expected amount of shadow flicker annually on each receptor, given the climatological conditions of the area as previously described and assuming turbines were built at all proposed turbine locations in each model. Climatological information was acquired from the National Climatic Data Center (NCDC) and regional meteorological stations. The percentage of sunshine probability was estimated from an analysis of average sunshine statistics for the Project region.

The climatologically based expected hours of sunshine for the Project area are presented in Table 1 as a percentage of the total possible sunshine hours each month. The frequency of wind (hours per year) expected in 16 compass directions is summarized in Table 2. The total number of hours that turbines are able to cause shadow flicker takes into account non-operational time due to low or high wind speeds. The turbine types that South Deuel Wind proposes to use will generally operate when hub-height wind speeds are between 3 meters per second (m/s) and 30 m/s.

Table 1 Sunshine Probability (sun hours/possible sun hours)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.58	0.58	0.59	0.63	0.66	0.73	0.75	0.72	0.67	0.56	0.48	0.52

Table 2 Turbine Operational Time per Sector (hours per year)

N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
561	438	311	293	309	330	363	461	788	773	462	449	509	600	629	608	7,884

The effect of shadow flicker is also dependent on the physical characteristics of the turbine model and the distance between the source turbine and shadow receptor.

Shadow flicker analyses were completed for South Deuel Wind on three turbine models currently under consideration. Turbine locations in the Project layout remained static for each of the three turbine models under consideration, with one turbine model (GE 3.8-154) utilizing all 73 turbine locations while the other two turbine models only utilize 71 turbine locations (SG 4.4-164 and Vestas V163-4.5).

- 71 SG 4.4-164 turbines; 97.5-meter hub height; 164-meter rotor diameter
- 71 V163-4.5 turbines; 98-meter hub height; 163-meter rotor diameter
- 73 GE 3.8-154 turbines; 98-meter hub height; 154-meter rotor diameter

Coordinates (UTM Zone 14) of turbine locations are included in Appendix A. Elevations for turbines and receptors located within approximately 1.25 miles (2,012 meters) of the turbines were calculated using the National Elevation Dataset digitally acquired from the U.S. Geological Survey.

A total of 135 potential receptors (existing residences, schools, hospitals, churches, and cemeteries) within 1.25 miles of the proposed turbine locations were identified by South Deuel Wind and Stantec utilizing aerial imagery and on-site reconnaissance. Three of the identified receptors are non-residential, representing a church and two cemeteries. Forty-seven (47) of the 132 existing residences are owned by participants in the Project. Coordinates (UTM Zone 14) of the 132 existing residence locations are included in Appendix B.

The model utilizes a “greenhouse” approach which defines each receptor as a one-meter glass cube, representing a window able to receive shadow from all directions. Vegetation surrounding receptors may block or diminish the effect of shadow flicker; however, the reduction due to vegetation has not been considered in the results summarized in this report.

Shadow flicker is widely considered imperceptible at a distance greater than 1,500 meters; however, Stantec conservatively analyzed the impact at all distances when more than 20 percent of the sun would be covered by a turbine blade. Shadow flicker does not occur when the sun-angle is less than three degrees above the horizon, due to atmospheric diffusion.

3.2 SHADOW FLICKER ANALYSIS RESULTS

The amount of shadow flicker on receptors within the Project area was calculated based on the climatological history of wind speed, wind direction and percentage of sunshine for the turbine models described in Section 3.1. Potential blocking of shadow flicker due to vegetation adjacent to a receptor was not considered in this analysis.

Results of the analysis indicate that the majority of the 132 identified existing residences analyzed are expected to receive 10 hours or less of shadow flicker each year. The church and two cemeteries identified

within the area are also each expected to receive less than 10 hours of annual shadow flicker. All receptors are expected to receive no greater than 30 annual hours of shadow flicker, with the following exceptions:

- The SG turbine model indicates that three receptors, each owned by a Project participant, may receive greater than 30 annual hours of shadow flicker, prior to consideration of vegetative blocking or applied mitigation. One of the residences (R-329) is uninhabited; however, it was conservatively retained in the analysis in the event that it is occupied in the future.
- The Vestas turbine model indicates that two receptors (including the uninhabited receptor R-329), each owned by a Project participant, may receive greater than 30 hours of shadow flicker per year, prior to consideration of vegetative blocking or applied mitigation.
- The GE turbine model indicates that three receptors, (including the uninhabited receptor R-329), each owned by a Project participant, may receive greater than 30 annual hours of shadow flicker, prior to consideration of vegetative blocking or applied mitigation.

The final Project layout will include a subset of the proposed turbine locations, and South Deuel Wind has committed to limiting shadow flicker on the existing residences to 30 annual hours or less. South Deuel Wind will conduct additional analyses and implement further minimization measures, as necessary, to limit shadow flicker on existing residence to no more than 30 hours of shadow flicker per year. A summary of the shadow flicker results for each turbine model is provided in Table 3.

Table 3 Shadow Flicker Analysis Summary by Turbine Model

Expected Annual Shadow Flicker Hours	Existing Residences (SG 4.4-164)	Existing Residences (Vestas V163-4.5)	Existing Residences (GE 3.8-154)
Less than 10	86	82	85
10 – 20	32	34	30
20 – 30	14	16	17
Greater than 30	0*	0*	0*
* Final Project design will result in lower total shadow flicker impact. South Deuel Wind has committed to limiting shadow flicker on existing residences to a 30-annual-hour maximum.			

A detailed table of receptor locations and the Project's expected annual shadow flicker results is included in Appendix B for each proposed turbine model. The following information is included.

- Receptor identification number
- Coordinates of receptor location (UTM-Zone 14)
- Participation status in the Project (as of the time of this report)
- The expected annual hours of shadow flicker at receptor

Figures for each turbine model (Figures 1 through 3) are provided with iso-lines of expected shadow flicker hours per year. Expected shadow flicker results assume that all turbines within each model were constructed and operational at each of the turbine locations proposed.

3.3 SHADOW FLICKER MITIGATION METHODS

As stated previously, multiple turbine models are under consideration for the Project. Shadow flicker analyses were completed for three turbine models currently under consideration. As previously stated, South Deuel Wind will construct and operate a subset of the turbine locations within each model; therefore, expected annual shadow flicker hours will be less than the results of the analyses summarized herein.

- 59 out of 71 turbine locations would be required to achieve the Project capacity with SG 4.4-164 turbines.
- 57 out of 71 turbine locations would be required to achieve the Project capacity with Vestas V163-4.5 turbines.
- 68 out of 73 turbine locations would be required to achieve the Project capacity with GE 3.8-154 turbines.

Additionally, the blocking effects of existing vegetation, structures, and other physical barriers between the turbines and receptors were not considered in this analysis. For these reasons, the results overestimate the total shadow flicker impacts that would be anticipated for the final Project design and the actual shadow flicker impact on many receptors will be less than the modeled result given.

South Deuel Wind is committed to limiting shadow flicker to 30 hours per year or less at existing residences. Turbines are located at angles and distances from residences, so that the majority of residences in the Project area will experience little to no shadow flicker from the Project. South Deuel Wind will identify, manage, and mitigate shadow flicker overages using commercially reasonable mitigation measures. Mitigation measures that may be utilized include planting trees and/or vegetative buffers and turbine curtailment.

4.0 CONCLUSION

Potential shadow flicker from the South Deuel Wind Project on existing residences within approximately 1.25 miles of proposed turbine locations was assessed using WindPRO's Version 3.6 Shadow Module software. Analyses were completed for three potential Project turbine models and a total of 135 identified receptors (132 of which are existing residences). The analyses were completed using conservative model inputs, including assuming all turbines within each turbine model are operational. South Deuel Wind will construct and operate a subset of the turbine locations analyzed; therefore, expected annual shadow flicker hours will be less than the results of these analyses. Vegetation and obstacles such as barns, garages or silos may further reduce the effect of shadow flicker on individual receptors. South Deuel Wind will identify, manage, and mitigate shadow flicker overages using commercially reasonable mitigation measures.

Results of the shadow flicker analysis demonstrate that the Project can be operated in compliance with the Deuel County Zoning Ordinance and in compliance with the annual limit of 30 annual hours of shadow flicker on existing residences. South Deuel Wind has committed to limiting shadow flicker from the Project on existing residences to 30 hours or less.

FIGURES

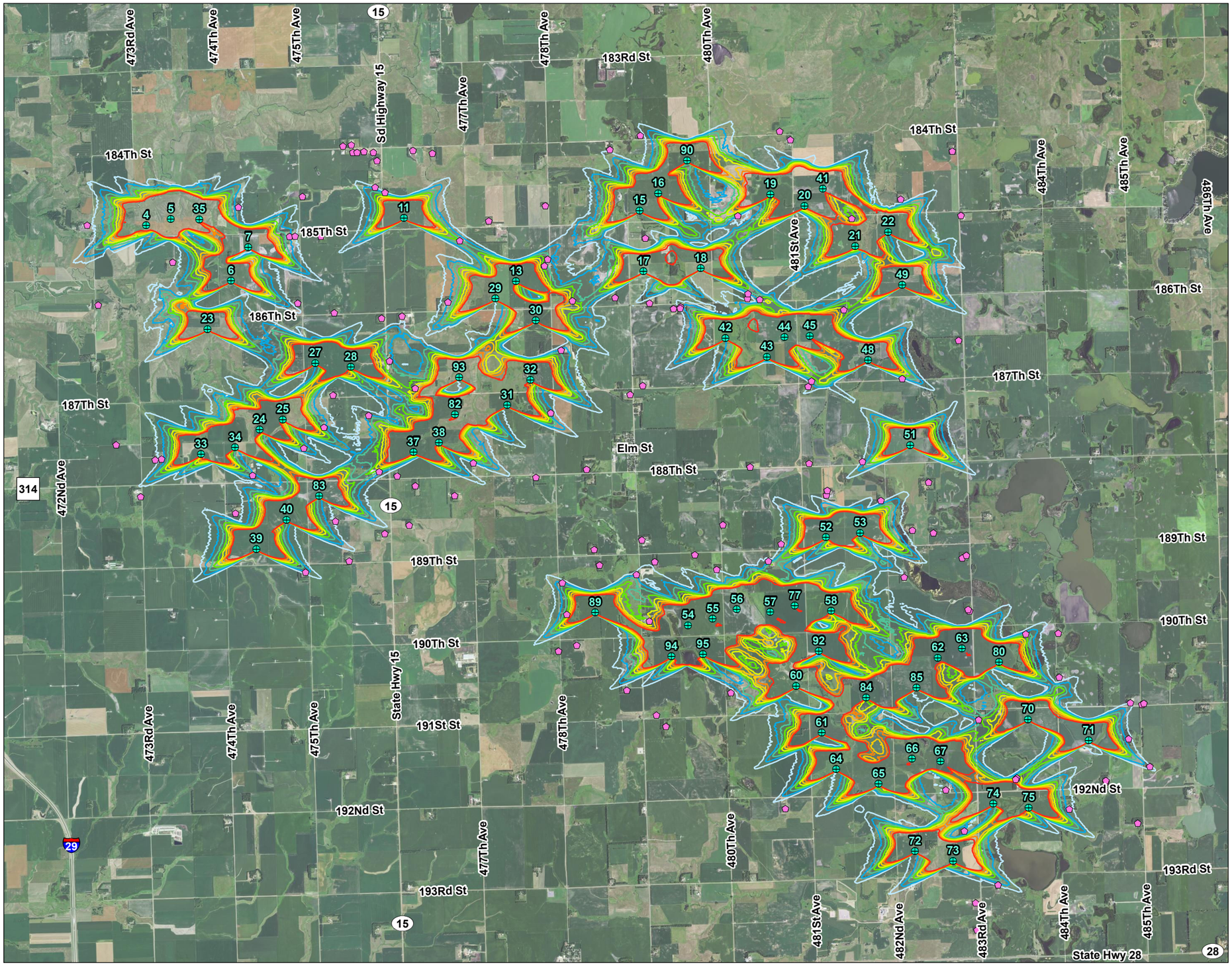


Figure No.
1

Title
Shadow Flicker Results
SG 4.4-164 Model

Client/Project 193709367
Deuel Harvest Wind Energy South LLC
South Deuel Wind

Project Location
Deuel Co., SD

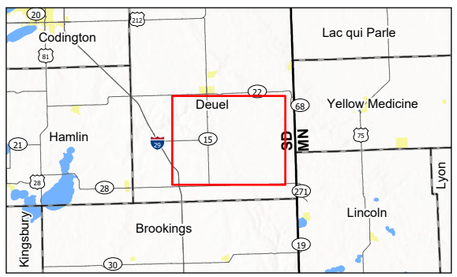
Prepared by JM on 2023-05-10
TR by JS on 2023-05-10
IR by JB on 2023-06-21

N

0 3,200 6,400 Feet
(At original document size of 11x17)
1:76,800

Legend
- Wind Turbine
- Sensitive Receptor

Expected Annual Shadow Flicker Hours
- 10
- 15
- 20
- 25
- 30
- 35
- 40
- 45



Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Stantec, Invenergy, USGS, NADS
3. Background: NAIP 2021

Stantec

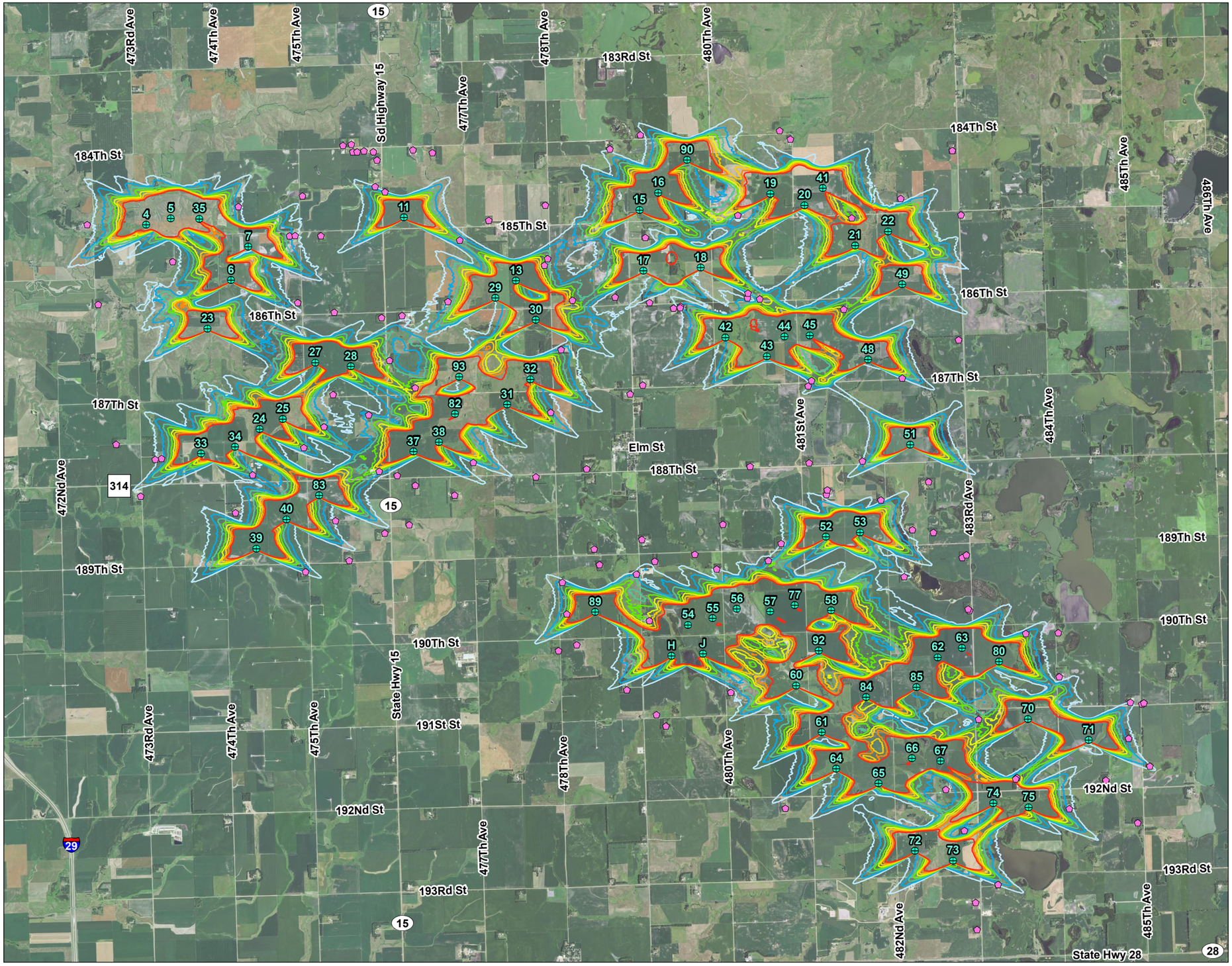


Figure No.

2

Title

Shadow Flicker Results
Vestas V163-4.5 Model

Client/Project 193709367

Deuel Harvest Wind Energy South LLC
South Deuel Wind

Project Location
Deuel Co., SD

Prepared by JM on 2023-05-10
TR by JS on 2023-05-10
IR by JB on 2023-06-21

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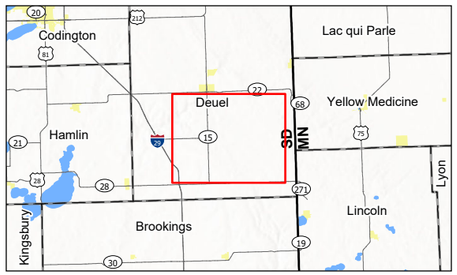

Notes

1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Stantec, Invenergy, USGS, NADS
3. Background: NAIP 2021

Stantec

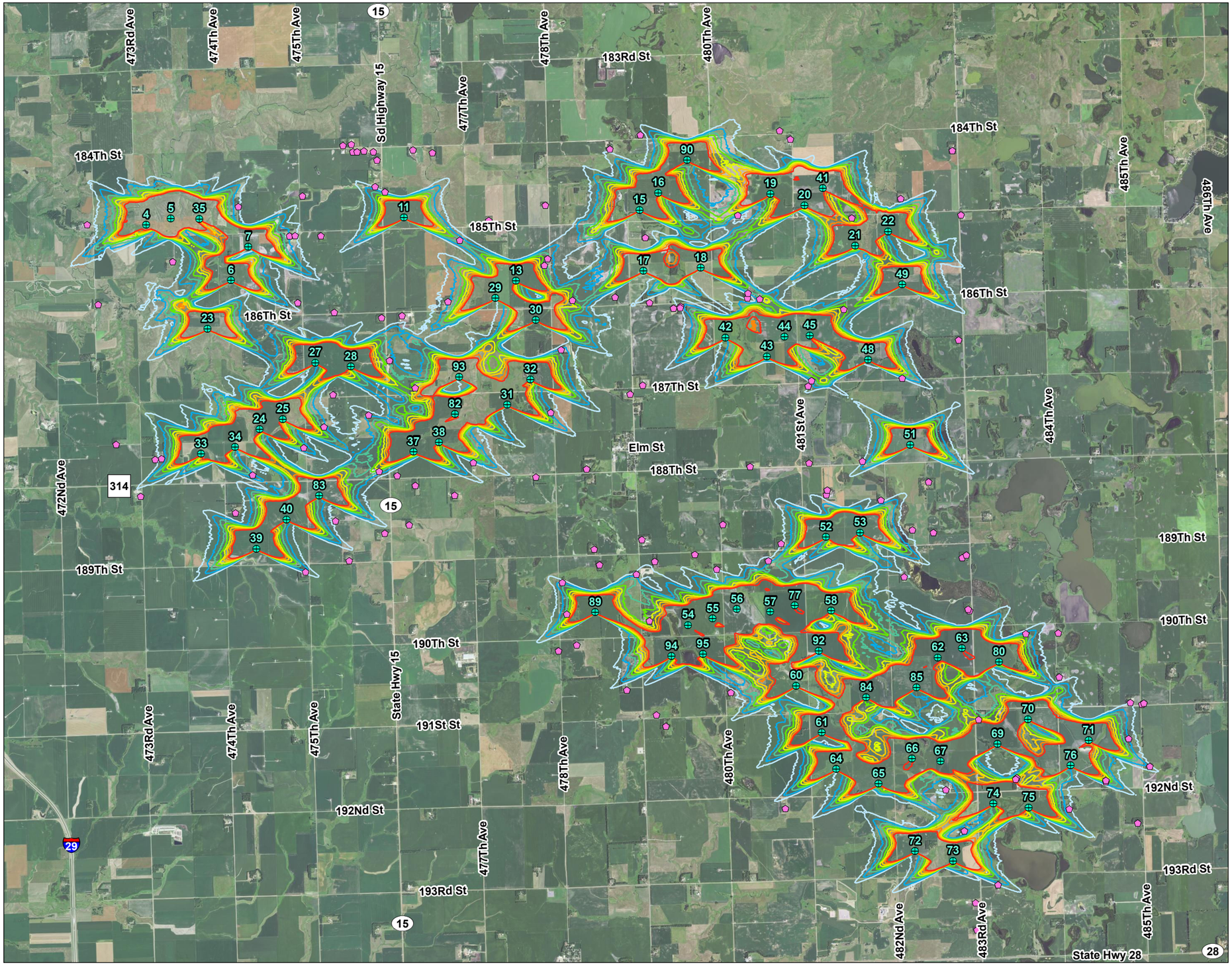

Figure No.

3

Title

Shadow Flicker Results
GE 3.8-154 Model

Client/Project 193709367

Deuel Harvest Wind Energy South LLC
South Deuel Wind

Project Location
Deuel Co., SD

Prepared by JM on 2023-05-10
TR by JS on 2023-05-10
IR by JB on 2023-06-21

N

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(At original document size of 11x17)
1:76,800

Legend

- Wind Turbine
- Sensitive Receptor

Expected Annual Shadow Flicker Hours

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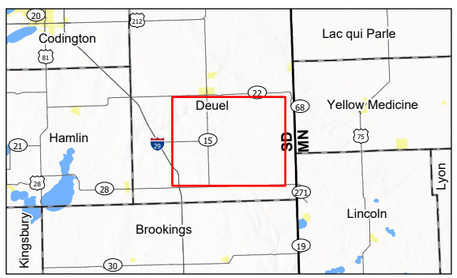

Notes
1. Coordinate System: NAD 1983 UTM Zone 14N
2. Data Sources: Stantec, Invenergy, USGS, NADS
3. Background: NAIP 2021

Stantec

APPENDICES

APPENDIX A

TURBINE COORDINATES

Appendix A-1: South Deuel Wind Project - Proposed Turbine Locations - SG Model

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-04	678,958	4,952,680
T-05	679,435	4,952,807
T-06	680,605	4,951,604
T-07	680,942	4,952,258
T-11	683,968	4,952,825
T-13	686,147	4,951,595
T-15	688,550	4,952,971
T-16	688,913	4,953,307
T-17	688,627	4,951,792
T-18	689,739	4,951,846
T-19	691,095	4,953,286
T-20	691,760	4,953,064
T-21	692,743	4,952,280
T-22	693,385	4,952,556
T-23	680,149	4,950,666
T-24	681,161	4,948,711
T-25	681,612	4,948,906
T-27	682,245	4,950,005
T-28	682,938	4,949,926
T-29	685,746	4,951,257
T-30	686,532	4,950,833
T-31	685,979	4,949,184
T-32	686,428	4,949,681
T-33	680,024	4,948,232
T-34	680,685	4,948,361
T-35	679,990	4,952,800
T-37	684,154	4,948,275
T-38	684,650	4,948,455
T-39	681,100	4,946,387
T-40	681,686	4,946,958
T-41	692,113	4,953,393
T-42	690,222	4,950,492
T-43	691,028	4,950,128
T-44	691,368	4,950,510
T-45	691,860	4,950,534
T-48	692,994	4,950,063
T-49	693,658	4,951,526
T-51	693,815	4,948,409
T-52	692,175	4,946,618
T-53	692,840	4,946,703
T-54	689,494	4,944,906
T-55	689,971	4,945,030
T-56	690,443	4,945,216

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-57	691,092	4,945,163
T-58	692,276	4,945,184
T-60	691,596	4,943,727
T-61	692,095	4,942,815
T-62	694,351	4,944,274
T-63	694,820	4,944,450
T-64	692,374	4,942,104
T-65	693,199	4,941,822
T-66	693,850	4,942,310
T-67	694,404	4,942,257
T-70	696,105	4,943,076
T-71	697,287	4,942,666
T-72	693,906	4,940,512
T-73	694,647	4,940,322
T-74	695,428	4,941,435
T-75	696,119	4,941,360
T-77	691,570	4,945,284
T-80	695,542	4,944,189
T-82	684,960	4,949,008
T-83	682,322	4,947,417
T-84	692,958	4,943,500
T-85	693,937	4,943,691
T-89	687,689	4,945,154
T-90	689,474	4,953,941
T-92	692,036	4,944,403
T-93	685,042	4,949,723
T-H	689,171	4,944,300
T-J	689,783	4,944,339

Appendix A-2: South Deuel Wind Project - Proposed Turbine Locations - Vestas Model

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-04	678,958	4,952,680
T-05	679,435	4,952,807
T-06	680,605	4,951,604
T-07	680,942	4,952,258
T-11	683,968	4,952,825
T-13	686,147	4,951,595
T-15	688,550	4,952,971
T-16	688,913	4,953,307
T-17	688,627	4,951,792
T-18	689,739	4,951,846
T-19	691,095	4,953,286
T-20	691,760	4,953,064
T-21	692,743	4,952,280
T-22	693,385	4,952,556
T-23	680,149	4,950,666
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T-30	686,532	4,950,833
T-31	685,979	4,949,184
T-32	686,428	4,949,681
T-33	680,024	4,948,232
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T-35	679,990	4,952,800
T-37	684,154	4,948,275
T-38	684,650	4,948,455
T-39	681,100	4,946,387
T-40	681,686	4,946,958
T-41	692,113	4,953,393
T-42	690,222	4,950,492
T-43	691,028	4,950,128
T-44	691,368	4,950,510
T-45	691,860	4,950,534
T-48	692,994	4,950,063
T-49	693,658	4,951,526
T-51	693,815	4,948,409
T-52	692,175	4,946,618
T-53	692,840	4,946,703
T-54	689,494	4,944,906
T-55	689,971	4,945,030
T-56	690,443	4,945,216

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-57	691,092	4,945,163
T-58	692,276	4,945,184
T-60	691,596	4,943,727
T-61	692,095	4,942,815
T-62	694,351	4,944,274
T-63	694,820	4,944,450
T-64	692,374	4,942,104
T-65	693,199	4,941,822
T-66	693,850	4,942,310
T-67	694,404	4,942,257
T-70	696,105	4,943,076
T-71	697,287	4,942,666
T-72	693,906	4,940,512
T-73	694,647	4,940,322
T-74	695,428	4,941,435
T-75	696,119	4,941,360
T-77	691,570	4,945,284
T-80	695,542	4,944,189
T-82	684,960	4,949,008
T-83	682,322	4,947,417
T-84	692,958	4,943,500
T-85	693,937	4,943,691
T-89	687,689	4,945,154
T-90	689,474	4,953,941
T-92	692,036	4,944,403
T-93	685,042	4,949,723
T-H	689,171	4,944,300
T-J	689,783	4,944,339

Appendix A-3: South Deuel Wind Project - Proposed Turbine Locations - GE Model

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-04	678,958	4,952,680
T-05	679,435	4,952,807
T-06	680,605	4,951,604
T-07	680,942	4,952,258
T-11	683,968	4,952,825
T-13	686,147	4,951,595
T-15	688,550	4,952,971
T-16	688,913	4,953,307
T-17	688,627	4,951,792
T-18	689,739	4,951,846
T-19	691,095	4,953,286
T-20	691,760	4,953,064
T-21	692,743	4,952,280
T-22	693,385	4,952,556
T-23	680,149	4,950,666
T-24	681,161	4,948,711
T-25	681,612	4,948,906
T-27	682,245	4,950,005
T-28	682,938	4,949,926
T-29	685,746	4,951,257
T-30	686,532	4,950,833
T-31	685,979	4,949,184
T-32	686,428	4,949,681
T-33	680,024	4,948,232
T-34	680,685	4,948,361
T-35	679,990	4,952,800
T-37	684,154	4,948,275
T-38	684,650	4,948,455
T-39	681,100	4,946,387
T-40	681,686	4,946,958
T-41	692,113	4,953,393
T-42	690,222	4,950,492
T-43	691,028	4,950,128
T-44	691,368	4,950,510
T-45	691,860	4,950,534
T-48	692,994	4,950,063
T-49	693,658	4,951,526
T-51	693,815	4,948,409
T-52	692,175	4,946,618
T-53	692,840	4,946,703
T-54	689,494	4,944,906
T-55	689,971	4,945,030
T-56	690,443	4,945,216

Turbine Identification	X (UTM 14)	Y (UTM 14)
T-57	691,092	4,945,163
T-58	692,276	4,945,184
T-60	691,596	4,943,727
T-61	692,095	4,942,815
T-62	694,351	4,944,274
T-63	694,820	4,944,450
T-64	692,374	4,942,104
T-65	693,199	4,941,822
T-66	693,850	4,942,310
T-67	694,404	4,942,257
T-69	695,513	4,942,595
T-70	696,105	4,943,076
T-71	697,287	4,942,666
T-72	693,906	4,940,512
T-73	694,647	4,940,322
T-74	695,428	4,941,435
T-75	696,119	4,941,360
T-76	696,933	4,942,173
T-77	691,570	4,945,284
T-80	695,542	4,944,189
T-82	684,960	4,949,008
T-83	682,322	4,947,417
T-84	692,958	4,943,500
T-85	693,937	4,943,691
T-89	687,689	4,945,154
T-90	689,474	4,953,941
T-92	692,036	4,944,403
T-93	685,042	4,949,723
T-H	689,171	4,944,300
T-J	689,783	4,944,339

APPENDIX B

RECEPTOR COORDINATES AND EXPECTED ANNUAL SHADOW HOURS

Appendix B: South Deuel Wind Project
Receptor Coordinates and Expected Annual Shadow Flicker (by Turbine Model)

Receptor ID "-P" Denotes Participant	X (UTM 14)	Y (UTM 14)	Expected Shadow (Annual Hours) SG Model	Expected Shadow (Annual Hours) Vestas Model	Expected Shadow (Annual Hours) GE Model
R-006	682,783	4,954,226	0:00	0:00	0:00
R-007	682,946	4,954,249	0:00	0:00	0:00
R-021	691,274	4,954,515	1:00	1:00	0:54
R-022-P	688,565	4,954,433	7:45	7:42	7:00
R-023	687,973	4,954,158	6:23	6:21	5:28
R-024	691,483	4,954,350	0:00	0:41	0:36
R-025	690,461	4,952,871	17:15	18:19	16:13
R-026	688,074	4,951,279	3:23	5:50	5:15
R-027-P	688,663	4,952,437	5:13	5:11	4:42
R-028-P	690,648	4,951,262	6:13	8:17	6:45
R-054	694,633	4,954,128	0:00	0:00	0:00
R-055	694,801	4,952,877	2:15	2:34	2:21
R-061	694,171	4,947,688	3:11	3:52	3:28
R-062-P	694,825	4,946,215	0:00	1:04	0:56
R-064	694,968	4,945,186	0:00	0:00	0:00
R-065	694,940	4,945,215	0:00	0:00	0:00
R-066-P	694,265	4,946,704	2:43	2:52	2:37
R-067-P	693,697	4,945,842	7:48	10:08	9:18
R-068	693,857	4,946,755	6:21	6:19	5:47
R-069-P	692,183	4,947,439	3:27	3:26	3:11
R-070-P	692,201	4,947,529	4:10	4:08	3:24
R-071	691,847	4,948,056	0:00	0:56	0:52
R-072-P	693,244	4,947,334	6:11	6:08	4:32
R-073-P	692,885	4,948,091	10:56	10:51	9:46
R-074-P	691,830	4,949,551	8:35	9:17	8:16
R-076	693,658	4,949,704	12:36	13:18	12:19
R-077	692,521	4,951,043	29:23	29:33	27:10
R-078-P	692,677	4,952,818	26:15	26:06	23:42
R-079-P	693,629	4,953,195	6:16	6:15	5:21
R-081	689,211	4,951,065	6:14	6:47	6:10
R-082	689,348	4,951,101	11:51	13:26	12:33
R-084	690,700	4,947,986	0:00	0:25	0:19
R-085	690,171	4,946,861	0:00	0:41	0:34
R-086	691,304	4,946,489	9:51	10:33	9:29
R-087	691,056	4,946,155	13:21	15:55	14:27
R-088	689,626	4,946,278	3:15	5:00	4:25
R-089	690,050	4,945,991	9:05	10:14	9:18
R-090	690,327	4,943,594	5:27	6:19	5:31
R-091-P	688,742	4,944,988	30:10*	30:00	27:31

**Mitigation methods will be utilized to limit annual shadow flicker to 30 hours or less.*

Appendix B: South Deuel Wind Project
Receptor Coordinates and Expected Annual Shadow Flicker (by Turbine Model)

Receptor ID "-P" Denotes Participant	X (UTM 14)	Y (UTM 14)	Expected Shadow (Annual Hours) SG Model	Expected Shadow (Annual Hours) Vestas Model	Expected Shadow (Annual Hours) GE Model
R-092-P	688,490	4,945,894	13:16	13:52	12:42
R-093	687,668	4,946,381	0:00	0:00	0:00
R-096	688,595	4,946,567	0:00	1:20	1:09
R-099-P	687,521	4,947,939	0:00	0:00	0:00
R-100	688,367	4,949,394	0:00	4:10	3:47
R-101	688,612	4,949,567	4:02	5:01	4:36
R-155	687,025	4,950,257	16:53	18:00	16:26
R-156-P	688,744	4,951,172	3:56	4:33	3:59
R-157	687,245	4,951,218	28:36	28:25	25:36
R-158	684,522	4,954,086	0:00	0:00	0:00
R-160	686,718	4,953,065	0:54	2:18	1:57
R-161	685,618	4,952,770	1:44	1:44	1:31
R-162	686,763	4,952,026	19:13	20:22	18:36
R-163-P	686,701	4,951,898	22:23	24:50	22:30
R-164	684,825	4,951,192	14:33	15:28	14:05
R-165	686,823	4,949,037	16:48	17:13	15:33
R-166-P	685,318	4,948,063	12:32	12:23	10:55
R-167	684,954	4,947,428	0:00	0:00	0:00
R-169-P	687,136	4,945,118	26:23	26:53	24:20
R-171	682,055	4,945,939	14:40	14:38	13:58
R-172	682,904	4,946,157	1:19	1:19	1:10
R-173-P	682,639	4,946,931	9:21	9:18	8:29
R-174	683,596	4,946,689	2:39	3:59	3:34
R-175-P	684,071	4,946,852	2:07	2:36	2:19
R-176-P	684,191	4,947,618	1:04	1:04	0:57
R-177-P	682,021	4,948,352	23:38	24:33	22:55
R-178-P	683,838	4,947,810	1:46	3:13	2:46
R-179-P	683,487	4,947,893	20:36	23:28	22:07
R-180-P	682,414	4,948,757	18:46	18:59	17:03
R-181-P	683,283	4,948,989	16:05	16:30	14:58
R-182-P	682,590	4,949,383	7:37	8:13	7:22
R-183	683,534	4,950,879	5:30	5:54	5:14
R-184-P	684,187	4,949,516	31:01*	32:07*	29:09
R-185-P	683,687	4,950,047	20:19	23:12	21:01
R-186	683,931	4,950,918	5:23	5:58	5:05
R-187	682,614	4,950,984	0:00	1:21	1:10
R-188	681,904	4,951,171	6:28	6:27	5:49
R-189-P	682,354	4,952,471	4:09	5:35	5:02
R-190-P	681,744	4,952,469	16:30	16:55	15:26

**Mitigation methods will be utilized to limit annual shadow flicker to 30 hours or less.*

Appendix B: South Deuel Wind Project
Receptor Coordinates and Expected Annual Shadow Flicker (by Turbine Model)

Receptor ID "-P" Denotes Participant	X (UTM 14)	Y (UTM 14)	Expected Shadow (Annual Hours) SG Model	Expected Shadow (Annual Hours) Vestas Model	Expected Shadow (Annual Hours) GE Model
R-191-P	681,852	4,952,474	11:59	12:30	11:20
R-192	681,995	4,953,245	4:52	6:08	5:25
R-193-P	683,599	4,953,325	12:14	12:11	10:11
R-194	683,408	4,953,427	9:52	9:49	8:32
R-195	683,445	4,953,942	0:00	0:00	0:00
R-196	684,144	4,954,141	0:00	0:00	0:00
R-197	682,975	4,954,103	0:00	0:00	0:00
R-198	683,057	4,954,103	0:00	0:00	0:00
R-200	680,749	4,953,038	12:22	12:18	11:24
R-201-P	679,472	4,951,968	7:20	7:16	6:36
R-203-P	681,026	4,947,823	19:31	19:28	17:53
R-204	679,255	4,948,141	12:13	12:56	11:43
R-205	680,693	4,947,086	7:27	7:23	6:42
R-209	678,849	4,947,407	0:05	2:37	2:14
R-212	678,372	4,948,416	1:25	1:48	1:35
R-215	678,023	4,951,135	0:00	1:04	0:58
R-216	677,809	4,952,687	8:11	8:09	7:32
R-228	686,974	4,944,404	0:00	0:27	0:24
R-229	689,063	4,942,940	0:00	0:00	0:00
R-231	691,386	4,941,341	1:18	1:18	1:07
R-241	695,114	4,938,981	0:00	0:00	0:00
R-242	695,522	4,939,858	11:44	11:42	11:04
R-243-P	694,867	4,940,907	13:18	13:14	13:23
R-244-P	694,506	4,941,706	11:38	12:24	11:38
R-245-P	695,887	4,941,939	27:50	28:23	31:14*
R-246-P	695,144	4,943,071	19:46	21:02	33:40*
R-251	696,693	4,944,753	4:43	4:54	4:25
R-252	696,711	4,943,897	6:03	6:40	6:07
R-253	698,095	4,943,400	9:55	10:36	9:44
R-255	698,061	4,942,700	12:11	13:50	15:55
R-256	697,618	4,941,862	1:47	2:14	24:57
R-257	696,907	4,941,333	12:36	12:54	11:46
R-258	698,238	4,941,058	0:00	0:45	0:41
R-280	683,190	4,954,120	0:00	0:00	0:00
R-281	683,374	4,954,104	0:00	0:00	0:00
R-282	694,755	4,950,448	0:57	0:57	0:50
R-283	696,061	4,944,738	19:43	20:00	18:17
R-286	695,086	4,939,509	0:00	0:00	0:00
R-289-P	685,053	4,952,387	23:13	23:07	21:11

**Mitigation methods will be utilized to limit annual shadow flicker to 30 hours or less.*

Appendix B: South Deuel Wind Project
Receptor Coordinates and Expected Annual Shadow Flicker (by Turbine Model)

Receptor ID "-P" Denotes Participant	X (UTM 14)	Y (UTM 14)	Expected Shadow (Annual Hours) SG Model	Expected Shadow (Annual Hours) Vestas Model	Expected Shadow (Annual Hours) GE Model
R-290	690,887	4,951,244	21:32	25:29	22:58
R-291	687,772	4,946,077	0:00	2:14	1:56
R-294	688,846	4,946,143	7:28	7:46	7:10
R-305	688,879	4,943,160	0:00	0:00	0:00
R-306	688,304	4,943,643	2:48	2:47	2:27
R-314-P	691,895	4,949,657	15:56	16:54	15:25
R-321	687,049	4,945,733	15:13	15:09	13:51
R-322	687,329	4,944,518	0:48	1:15	1:05
R-323-P	698,474	4,942,160	12:20	12:34	13:17
R-324-P	690,659	4,951,356	14:54	16:46	15:28
R-325	697,619	4,941,887	1:45	2:11	28:35
R-326	689,341	4,951,073	10:59	12:15	11:22
R-327	679,132	4,948,123	8:34	9:02	8:16
R-328-P	694,906	4,946,267	0:00	0:49	0:43
R-329-P	695,864	4,941,912	31:30*	32:10*	34:27*

**Mitigation methods will be utilized to limit annual shadow flicker to 30 hours or less.*