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## MEMORANDUM

**To:** Dan Fitzgerald  
Horizon Wind Energy  
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Albany, New York 12207

**From:** Ben Brazell  
Diane Enders

**Date:** September 7, 2010

**Reference:** Marble River Wind Farm  
Update Shadow Flicker Analysis  
EDR Project No. 10050

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### Comments:

#### Introduction

This memorandum report presents the findings of the updated shadow flicker analysis for a modification to the Marble River Wind Farm, and compares the anticipated shadow flicker from the current layout (74 Vestas V112 turbines) to the previous layout (109 Suzlon S88 turbines).

Shadow flicker refers to the shadows that a wind turbine casts over structures and observers at times of the day when the sun is directly behind the turbine rotor from an observer's position. During intervals of sunshine, wind turbine generators will cast a shadow on surrounding areas as the rotor blades pass in front of the sun, causing a flickering effect while the rotor is in motion. Shadow flicker is most pronounced in northern latitudes during winter months because of the lower angle of the sun in the winter sky. However, it is possible to encounter shadow flicker anywhere for brief periods after sunrise and before sunset (BLM, 2005). Shadow flicker does not occur when fog or clouds obscure the sun, or when turbines are not operating.

Shadow flicker can be experienced by residents living near wind turbines during times when the turbine rotor is between low angle sunlight and the residence. The distance between a wind turbine and a potential shadow flicker receptor (i.e., a residential structure) affects the intensity of the shadows cast by the blades, and therefore the intensity of flickering. Shadows cast close to a turbine will be more intense, distinct and focused. This is because a greater proportion of the sun's disc is intermittently blocked by the turbine (BERR, 2009). Obstacles such as terrain, vegetation, and/or buildings occurring between residences and wind turbines may significantly reduce or eliminate shadow flicker effects.

The location of shadow flicker can be predicted quite accurately using computer modeling programs and input data defining a "worst case" scenario. A worst case scenario would occur only when there

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are no clouds or fog, wind conditions allow continuous turbine operation, and the turbine rotor is continuously perpendicular to the sun and located between the observer/residence and the sun. However, this worst case is not what residents would actually experience, as turbines are not in continuous operation, are not always aligned perpendicular to the sun, and are not always between the residence and the sun. In addition, sunlight conditions vary daily and seasonally, sun intensity and duration varies seasonally, and obstacles that block shadows (terrain, vegetation and buildings) exist in most landscapes.

Shadow flicker effects are expressed in terms of frequency (hours per year) on receptors. Effects are not expressed in terms of potential health-related impacts, as blade pass frequencies for modern commercial scale wind turbines are so low they are considered harmless. According to the British Epilepsy Association, approximately five percent of individuals with epilepsy have sensitivity to light, and most people with photosensitive epilepsy are sensitive to flickering around 16-25 Hz (Hertz or Hz = 1 flash per second), although some people may be sensitive to rates as low as 3 Hz and as high as 60 Hz (British Epilepsy Association, 2007). Specific to wind power projects, the British Epilepsy Association (2007) states that there is no evidence that wind turbines can trigger seizures, and newer wind turbines are usually built to operate at a frequency of 1 Hz or less. Therefore, health effects due to projected shadow flicker are not anticipated or further evaluated. The primary concern with shadow flicker is the annoyance it could cause for adjacent homeowners.

#### Methods

This shadow-flicker modeling analysis was conducted using *WindPRO 2.6 Basis* software (WindPRO), and associated shadow module, which is a widely accepted modeling software package developed specifically for the design and evaluation of wind power projects. Input variables and assumptions used for shadow flicker modeling calculations for the Marble River Wind Farm include:

- Turbine coordinates provided by the Applicant.
- Coordinates for residential structures provided by the Applicant.
- USGS 1:24,000 topographic mapping and USGS digital elevation model (DEM).
- The rotor diameter and hub height for the Vestas V112.
- The annual wind rose was used to determine the directional frequency with which the proposed wind turbines would be oriented throughout the year.
- The average monthly percent of available sunshine values.
- No allowance was made for wind being below or above generation speeds. Blades are assumed to be moving during all daylight hours, thereby creating the most conservative estimate of the amount of time the rotors are moving.
- There is no shadow impact when the sun's elevation is less than 3 degrees above the horizon (due to the scattering effect of the atmosphere on low angle sunlight).
- There is no shadow impact when less than 20 percent of the sun is masked by the turbine blades, because this is not enough masking to create a detectable shadow.
- Shadow isolines (i.e., contours indicating total number of hours of shadowing per average year) were calculated based on the data and assumptions outlined above, using a 10 meter x 10 meter grid from the USGS DEM.
- The shadow isolines were used to illustrate the predicted shadow flicker (see Attachment A).

- The presence of intervening structures, vegetation, or other obstacles were not taken into account.

Based on these variables and assumptions, WindPRO was used to calculate the theoretical number of hours per year that shadow flicker would occur at any given location in the vicinity of the proposed Project.

The model calculations include the cumulative sum of shadow hours for all turbines. This omnidirectional approach reports total shadow-flicker results at a receptor regardless of the presence or orientation of windows at the receptor residence (i.e., it assumes shadows from all directions can be perceived at a residence, which may or may not be true). A receptor in the model is defined as a one square meter area, one meter above ground level; the actual dimensions of the house or window locations are not taken into consideration.

### Results

Output from the model includes the following information:

- Calculated shadow-flicker time (hours per year) at inventoried receptors.
- Tabulated and plotted time of day that receptors receive shadow flicker.
- Map showing turbine locations, identified shadow-flicker receptors, and projected shadow-flicker time (hours per year).

Each inventoried structure was evaluated to determine projected shadow flicker. Of the 249 inventoried structures evaluated in this study:

- 89 (36%) will not be affected at all,
- 2 (1%) will be affected less than 1 hour/year,
- 67 (27%) will be affected 1-10 hours/year,
- 71 (28%) will be affected 10-25 hours/year,
- 20 (8%) will be affected more than 25 hours/year,

A table containing the details associated with all receptors predicted to receive more than 10 hours of shadow flicker per year is provided in Attachment B (see also WindPro overview reports and calendars provided in Attachment C).

Table 1 below provides the details associated with the receptors predicted to receive more than 25 hours of shadow flicker per year.

**Table 1. Shadow Flicker Summary for Receptors Receiving Greater than 25hrs/year**

Receptor ID	Predicted Shadow Days/Year	Predicted Shadow Hours/Day (hh:mm/day)	Predicted Shadow Flicker Hours/Year (hh:mm:ss)
H-091	198	1:02	36:54:00
H-106	205	1:06	36:40:00
H-108	127	1:39	25:59:00
H-120	133	0:43	26:01:00
H-138	142	1:00	36:38:00
H-148	199	1:12	39:52:00
H-155	128	0:54	25:17:00
H-166	231	1:01	37:31:00
H-176	204	0:49	35:19:00
H-185	192	1:37	37:56:00
H-187	138	1:36	29:12:00
H-188	203	1:47	53:53:00
H-189	240	1:34	55:18:00
H-191	221	1:43	58:07:00
H-192	246	1:42	63:30:00
H-196	185	1:01	33:27:00
H-200	175	1:06	29:37:00
H-231	222	1:48	56:14:00
H-238	211	1:19	35:49:00
H-240	142	1:53	40:03:00

It is important to note that worst case or “first level” shadow flicker model assumptions are quite conservative, and as such, the analysis is expected to over-predict the impacts. For example, model inputs do not reflect local conditions at the receptor site that could block shadow flicker, such as trees and neighboring structures. The model also assumes that the receptor always has a window facing the direction of the sun, and that the receptor is occupied at all hours when shadow flicker may occur (i.e., from sunrise and sunset). These highly conservative assumptions over-predict potential impacts. In reality, site-specific factors such as trees, buildings, and window locations could significantly reduce the actual shadow flicker experienced at a given receptor. In addition, many of the modeled shadow flicker hours are expected to be of very low intensity, due to the distance of the proposed turbines from the affected receptors.

To more accurately predict the amount of shadow flicker a particular receptor will receive, site-specific obstacles that may block receptors from receiving shadow can be included in the WindPro model (“second level” analysis). Therefore, the following steps were undertaken to refine the shadow flicker analysis of the Marble River Wind Farm:

1. Site reconnaissance was performed at each of the 20 receptors predicted to receive greater than 25 hours of shadow flicker under the worst case or first level analysis, as described above.

2. Information obtained during the site reconnaissance was then compared to high resolution aerial photography of the site to determine the actual location of each obstacle with respect to nearby receptors and the wind turbines.
3. The aerial photography was then imported into the WindPro program and overlaid on the Marble River facility site (all maps are geo-referenced).
4. Using digitizing tools in WindPro, rectangles were drawn on the site to represent different types of obstacles. Each rectangle was assigned a width, length, and height to reflect the dimensions of the obstacle. Ten progressively more dense levels of porosity can also be assigned to each obstacle. Small porosity factors (.1, .2, etc.) were assigned to dense obstacles (like buildings and dense forest cover) while higher porosity factors were assigned to obstacles with much less density (such as trees with large spaces between them). Each obstacle was automatically assigned its correct elevation according to its position in the contour height object in WindPro.
5. Once all obstacles were drawn (digitized) in the model, WindPro used their properties to determine how they mitigate the impact of shadow flicker on the surrounding receptors.

The results of the “second level” shadow flicker analysis are presented in Table 2, below.

**Table 2. Summary of Shadow Flicker Results for Second Level Analysis**

Receptor ID	Obstruction Observed (with porosity factors in [ ])	Predicted First Level Shadow Flicker Hours/Year (hh:mm:ss)	Predicted Second Level Shadow Flicker Hours/Year w/obstructions (hh:mm:ss)
H-091	12m trees to east [.2] 12m trees-NW [.1] 12m trees west [.3]	36:54:00	0:00:00
H-106*	Open tree lines to north and west [.7] - (2) 18' bldgs to east and south [0]	36:40:00	4:08:00
H-108	12m trees west, south and east [.3]	25:59:00	15:07:00
H-120*	Open tree lines (hedge rows)	26:01:00	26:01:00
H-138*	12m trees to the east [.4]	36:38:00	36:38:00
H-148	12m trees to north and east [.2] Small 3m bldg to NW [0]	39:52:00	39:52:00
H-155	12m trees surround receptor [.3] evergreens to east [.1]	25:17:00	0:00:00
H-166	no obstructions	37:31:00	37:31:00
H-176*	12m trees the far west - 7m barn to NE [0] 12m tree mass to far west [.5]	35:19:00	35:19:00
H-185*	12m trees to the far east [.1]	37:56:00	37:56:00
H-187*	12m trees to near east [.3] and far west [.2]	29:12:00	18:56:00
H-188*	10m tree lines (hedge rows) to west and north [.8]	53:53:00	53:53:00
H-189*	10m tree lines to west [.8] 6m bldg to south east [0]	55:18:00	55:18:00
H-191*	12m small tree grouping to west [.5]	58:07:00	58:07:00
H-192*	12m small tree grouping to west [.5]	63:30:00	63:30:00

Receptor ID	Obstruction Observed (with porosity factors in [ ])	Predicted First Level Shadow Flicker Hours/Year (hh:mm:ss)	Predicted Second Level Shadow Flicker Hours/Year w/obstructions (hh:mm:ss)
H-196	12m trees to north, west and south [.2]	33:27:00	16:09:00
H-200*	12m trees to south, east and north [.2] tree row to west [.5] 6m building to west [0]	29:37:00	29:37:00
H-231	12m trees to NW [.1] (4) 6m bldgs east of receptor [0]	56:14:00	56:14:00
H-238	12m treeline to east [.3] 12m tree mass NW of receptor [.5]	35:49:00	35:49:00
H-240*	See receptor H-231	40:03:00	40:03:00

Based upon the second level analysis, six of the receptors that were initially modeled greater than 25 hours of flicker annually were also modeled for a reduction of between 34 and 100 percent based upon local site-specific factors. These factors included deciduous or coniferous tall growing vegetation in proximity to the structure that either partially screen or totally obstruct views towards the Project. Based upon the second level analysis, 14 receptors in the study area will experience shadow flicker hours in excess of 25 hours annually.

#### Discussion

TRC prepared a Shadow Flicker Analysis (first level analysis) using WindPRO modeling results for the previously approved Project layout (109 Suzlon S88 Turbines) determined that a total of 11 receptors could potentially experience shadow flicker more than 25 hours per year, with a maximum of 37 hours at one receptor (2007). Based upon a first level shadow flicker analysis, the current layout will result in an increase from 11 to 20 receptors that could potentially experience shadow flicker more than 25 hours per year. Additionally, the estimated maximum amount of shadow flicker per year increased from 37 to 63.5 hours. Of the 20 receptors anticipated to experience shadow flicker above 25 hours per year, 10 are project participants, and two are project participants of a separate parcel. Therefore, a total of eight non-participating residences are expected to experience shadow flicker in excess of 25 hours per year.

Based upon the second level analysis, six of the receptors that were initially modeled greater than 25 hours of flicker annually were also modeled for a reduction of between 34 and 100 percent based upon local site-specific factors. Based upon the second level analysis, 14 receptors in the study area will experience shadow flicker hours in excess of 25 hours annually. Of the 14 receptors anticipated to experience shadow flicker above 25 hours, 10 are project participants. Therefore a total of four non-participating residences are expected to experience shadow flicker in excess of 25 hours per year, based upon the second level analysis.

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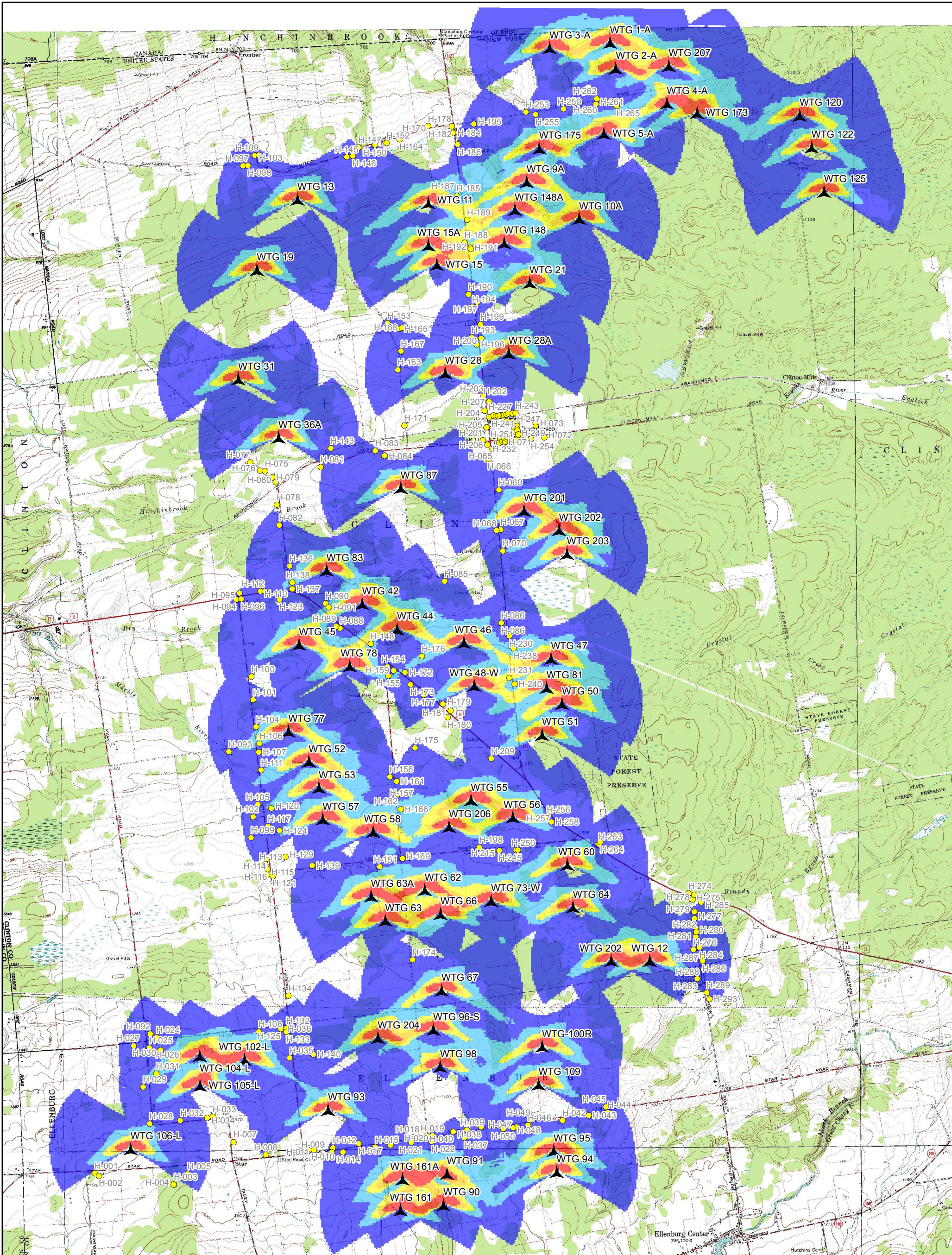
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**Title**  
**Marble River Wind Farm**  
 Towns of Clinton and Ellenburg,  
 Clinton County, New York

**Legend**

- Wind Turbine
- Receptor
- Shadow Hrs/Yr**
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100+

**Map Scale & Orientation**

**Notes**

Map Created: August 2010.

Base Map:  
 USGS 1:24,000 Brainardsville, Chateaugay,  
 Churubusco, Ellenburg Center, Ellenburg Depot  
 and Ellenburg Mountain Quadrangles.

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Projected Shadow Flicker Map



**Marble River Wind Farm****Shadow Flicker Summary for Receptors Receiving Greater than 10hrs/year**

<b>Receptor ID</b>	<b>Shadow days per year</b>	<b>Max Hrs/Day (hh:mm/day)</b>	<b>Predicted hh:mm:ss/year</b>
H-037	101	0:40	10:00:00
H-067	86	0:36	10:01:00
H-024	100	0:45	10:09:00
H-276	59	0:46	10:31:00
H-047	112	0:49	10:37:00
H-035	72	0:46	10:45:00
H-016	150	0:38	10:46:00
H-161	141	0:33	11:06:00
H-199	100	0:57	11:07:00
H-107	101	0:41	11:11:00
H-048	119	0:46	11:17:00
H-259	107	0:45	11:18:00
H-050	129	0:39	11:19:00
H-140	91	0:32	11:23:00
H-015	124	0:54	11:32:00
H-005	91	0:35	11:41:00
H-156	137	0:37	11:44:00
H-139	101	0:33	12:04:00
H-173	103	0:34	12:15:00
H-143	110	0:40	12:25:00
H-043	95	0:45	12:26:00
H-250	110	0:41	12:45:00
H-245	113	0:39	12:57:00
H-046	104	1:01	13:00:00
H-260	79	1:30	13:04:00
H-105	100	0:34	13:11:00
H-025	148	0:41	13:17:00
H-261	120	1:02	13:46:00
H-125	107	0:46	14:02:00
H-026	126	0:43	14:07:00
H-136	71	0:55	14:32:00
H-093	109	0:35	14:50:00
H-169	72	1:42	15:12:00
H-264	89	0:54	15:13:00
H-045	145	0:32	15:31:00
H-215	112	0:41	15:32:00
H-044	153	0:33	15:40:00
H-177	101	0:41	15:46:00
H-137	93	0:46	16:01:00
H-029	108	0:37	16:02:00
H-263	87	0:57	16:37:00
H-265	114	1:04	17:27:00
H-162	198	0:36	17:29:00
H-209	84	0:40	17:30:00
H-283	92	0:44	17:40:00
H-194	126	0:36	17:47:00
H-258	86	0:54	17:51:00

**Marble River Wind Farm****Shadow Flicker Summary for Receptors Receiving Greater than 10hrs/year**

<b>Receptor ID</b>	<b>Shadow days per year</b>	<b>Max Hrs/Day (hh:mm/day)</b>	<b>Predicted hh:mm:ss/year</b>
H-086	139	0:49	17:54:00
H-102	124	0:31	17:54:00
H-257	93	0:54	17:58:00
H-088	111	0:48	18:00:00
H-230	124	0:45	18:19:00
H-157	163	0:50	18:58:00
H-089	114	0:51	19:04:00
H-193	130	0:51	19:11:00
H-197	102	0:39	19:13:00
H-090	124	0:56	19:48:00
H-030	155	0:52	20:00:00
H-069	135	1:23	20:08:00
H-070	146	0:37	20:28:00
H-159	131	0:48	20:50:00
H-154	108	0:55	21:31:00
H-262	183	0:30	21:41:00
H-111	191	0:44	21:51:00
H-028	104	1:10	22:05:00
H-124	110	0:48	22:09:00
H-104	142	1:02	22:55:00
H-172	162	0:38	23:01:00
H-256	85	1:18	23:18:00
H-151	181	1:18	23:28:00
H-155	128	0:54	25:17:00
H-108	127	1:39	25:59:00
H-120	133	0:43	26:01:00
H-187	138	1:36	29:12:00
H-200	175	1:06	29:37:00
H-031	152	0:47	32:31:00
H-196	185	1:01	33:27:00
H-176	204	0:49	35:19:00
H-238	211	1:19	35:49:00
H-138	142	1:00	36:38:00
H-106	205	1:06	36:40:00
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H-240	142	1:53	40:03:00
H-188	203	1:47	53:53:00
H-189	240	1:34	55:18:00
H-231	222	1:48	56:14:00
H-191	221	1:43	58:07:00
H-192	246	1:42	63:30:00

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Main Result

Calculation: Marble River Wind Farm SFA-3

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

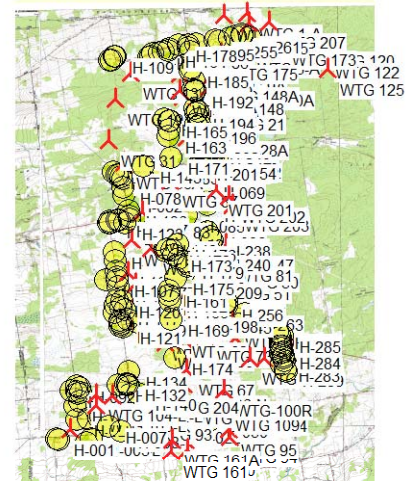
A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:

Height contours used: Height Contours: 10050 2m contours UTM-NAD83.wpo (1)

Obstacles not used in calculation

Eye height: 1.5 m

Grid resolution: 10 m



Scale 1:250,000

▲ New WTG

● Shadow receptor

### WTGs

WTG	UTM NAD83 Zone: 18			Row data/Description	WTG type		Power, rated [kW]	Rotor diameter [m]	Hub height [m]	RPM [RPM]
	East	North	Z		Valid	Manufact. Type-generator				
	UTM NAD83 Zone: 18			[m]						
WTG 102-L	581,243	4,970,715	432.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 104-L	580,689	4,970,760	428.2	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 105-L	580,694	4,970,390	434.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 106-L	579,838	4,969,600	450.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 109	584,893	4,970,431	408.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 10A	585,331	4,981,170	327.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 11	583,460	4,981,354	306.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 12	586,263	4,971,971	389.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 120	588,059	4,982,469	335.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 122	588,207	4,982,073	338.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 125	588,365	4,981,525	334.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 13	581,837	4,981,387	305.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 148	584,404	4,980,863	325.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 148A	584,532	4,981,277	317.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 15	583,569	4,980,589	327.5	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 15A	583,461	4,980,828	319.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 161	583,191	4,968,863	483.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 161A	583,214	4,969,246	464.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 173	586,787	4,982,492	329.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 175	584,828	4,982,041	307.9	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 19	581,340	4,980,512	316.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 1-A	585,700	4,983,358	310.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 201	584,669	4,977,545	363.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 202	585,787	4,971,971	398.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 202	585,104	4,977,308	368.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 203	585,208	4,977,014	373.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 204	582,897	4,970,995	418.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 206	583,764	4,973,619	408.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 207	586,431	4,983,073	320.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 21	584,724	4,980,373	334.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8
WTG 28	583,683	4,979,243	352.9	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS V112-3,000	3,000	112.0	94.0	12.8

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Project:

10050 Marble River Shadow Flicker Study\_3

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## SHADOW - Main Result

Calculation: Marble River Wind Farm SFA-3

...continued from previous page

UTM NAD83 Zone: 18			WTG type										
East	North	Z	Row data/Description	Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	RPM			
UTM NAD83 Zone: 18			[m]				[kW]	[m]	[m]	[RPM]			
WTG 28A	584,468	4,979,494	350.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 2-A	585,774	4,983,037	316.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 31	581,116	4,979,155	328.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 36A	581,620	4,978,433	344.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 3-A	584,951	4,983,286	298.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 42	582,670	4,976,379	374.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 44	583,106	4,976,066	382.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 45	581,889	4,975,869	369.2	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 46	583,935	4,975,905	392.5	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 47	585,014	4,975,710	384.5	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 48-W	584,067	4,975,370	396.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 4-A	586,473	4,982,587	322.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 50	585,156	4,975,154	390.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 51	584,913	4,974,768	393.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 52	582,020	4,974,418	379.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 53	582,145	4,974,096	385.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 55	584,034	4,973,951	407.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 56	584,552	4,973,743	409.5	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 57	582,196	4,973,705	387.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 58	582,822	4,973,551	396.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 5-A	585,629	4,982,227	309.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 60	585,235	4,973,156	400.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 62	583,468	4,972,834	406.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 63	582,982	4,972,452	404.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 63A	582,801	4,972,754	403.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 64	585,305	4,972,631	392.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 66	583,662	4,972,536	399.3	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 67	583,684	4,971,591	409.8	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 73-W	584,292	4,972,705	404.2	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 77	581,764	4,974,792	373.6	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 78	582,521	4,975,605	378.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 81	584,961	4,975,353	390.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 83	582,226	4,976,791	362.7	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 87	583,137	4,977,819	357.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 90	583,721	4,968,929	458.9	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 91	583,649	4,969,257	456.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 93	582,284	4,970,100	456.2	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 94	585,125	4,969,347	414.9	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 95	585,087	4,969,609	423.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 96-N	583,583	4,971,102	424.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 98	583,671	4,970,644	422.0	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG 9A	584,679	4,981,623	313.1	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		
WTG-100R	584,934	4,970,901	401.4	VESTAS V112 3000 112.0 !O!...	Yes	VESTAS	V112-3,000	3,000	112.0	94.0	12.8		

## Shadow receptor-Input

UTM NAD83 Zone: 18

No.	East	North	Z	Width	Height	Height	Degrees from	Slope of	Direction mode
				[m]	[m]	a.g.l.	south cw	window	
				[m]	[m]	[m]	[°]	[°]	
H-001	579,397	4,969,292	453.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-002	579,449	4,969,259	456.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-003	580,380	4,969,157	477.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-004	580,374	4,969,156	477.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-005	580,546	4,969,291	473.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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Project:

10050 Marble River Shadow Flicker Study\_3

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

...continued from previous page

**UTM NAD83 Zone: 18**

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H-007	581,114	4,969,689	457.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-008	581,518	4,969,534	466.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-009	581,958	4,969,574	470.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-010	582,079	4,969,602	469.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-011	582,112	4,969,598	469.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-012	582,346	4,969,625	469.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-013	582,334	4,969,569	470.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-014	582,474	4,969,571	468.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-015	582,871	4,969,634	462.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-016	583,059	4,969,663	455.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-017	582,668	4,969,680	462.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-018	583,418	4,969,769	442.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-019	583,508	4,969,779	438.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-020	583,582	4,969,785	438.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-021	583,318	4,969,696	448.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-022	583,571	4,969,709	442.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-024	580,152	4,970,979	427.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-025	580,062	4,970,851	426.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-026	580,091	4,970,794	426.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-027	579,870	4,970,874	424.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-028	580,073	4,969,910	444.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-029	579,988	4,970,365	432.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-030	580,202	4,970,820	427.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-031	580,150	4,970,532	430.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-032	580,453	4,969,953	450.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-033	580,854	4,970,000	446.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-034	580,786	4,969,985	448.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-035	581,805	4,970,734	428.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-036	581,780	4,971,005	420.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-037	583,976	4,969,760	429.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-038	584,182	4,969,893	423.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-039	584,006	4,969,856	427.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-040	583,839	4,969,834	430.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-041	584,450	4,969,923	420.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-042	585,195	4,969,980	425.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-043	585,516	4,970,046	408.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-044	585,753	4,970,085	403.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-045	585,731	4,970,154	403.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-046	584,764	4,969,921	428.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-047	584,621	4,969,897	426.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-048	584,580	4,969,885	425.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-049	584,793	4,969,985	428.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-050	584,460	4,969,874	422.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-065	584,271	4,978,305	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-066	584,215	4,978,179	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-067	584,379	4,977,304	366.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-068	584,330	4,977,291	367.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-069	584,354	4,977,797	361.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-070	584,407	4,977,039	371.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-071	584,760	4,978,480	356.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-072	584,915	4,978,451	356.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-073	584,807	4,978,596	355.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-074	584,803	4,978,637	355.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-075	581,453	4,978,011	341.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-076	581,390	4,978,018	340.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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Project:

10050 Marble River Shadow Flicker Study\_3

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

...continued from previous page

**UTM NAD83 Zone: 18**

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H-077	581,267	4,978,121	338.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-078	581,604	4,977,596	342.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-079	581,541	4,977,933	344.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-080	581,586	4,977,875	344.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-081	582,143	4,978,067	351.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-082	581,635	4,977,342	348.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-083	582,820	4,978,274	354.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-084	582,935	4,978,209	359.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-085	583,688	4,976,659	369.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-086	584,397	4,976,146	379.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-086	584,397	4,976,146	379.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-088	582,396	4,976,068	374.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-089	582,347	4,976,094	373.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-090	582,213	4,976,377	369.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-091	582,254	4,976,326	369.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-092	580,074	4,971,024	426.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-093	581,026	4,974,529	366.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-094	581,105	4,976,417	359.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-095	581,146	4,976,496	358.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-096	581,168	4,976,424	359.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-097	581,158	4,981,797	292.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-098	581,218	4,981,801	292.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-099	581,308	4,973,465	383.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-100	581,301	4,975,462	362.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-101	581,324	4,975,173	364.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-102	581,332	4,973,723	380.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-103	581,303	4,981,926	291.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-104	581,362	4,974,839	366.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-105	581,391	4,973,878	376.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-106	581,403	4,974,631	369.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-107	581,396	4,974,524	372.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-108	581,418	4,971,058	421.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-109	581,352	4,981,931	291.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-110	581,406	4,976,520	358.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-111	581,428	4,974,302	374.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-112	581,458	4,976,522	359.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-113	581,488	4,973,135	390.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-114	581,502	4,973,206	388.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-115	581,510	4,973,007	392.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-116	581,513	4,973,075	391.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-117	581,516	4,973,607	381.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-120	581,557	4,973,830	378.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-121	581,580	4,972,990	393.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-123	581,642	4,976,421	360.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-124	581,661	4,973,554	382.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-125	581,690	4,971,097	419.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-129	581,736	4,973,230	390.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-132	581,761	4,971,105	419.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-133	581,761	4,971,059	420.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-134	581,783	4,971,507	412.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-136	581,767	4,976,837	357.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-137	581,800	4,976,552	365.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-138	581,800	4,976,632	363.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-139	582,069	4,973,122	392.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-140	582,096	4,970,783	422.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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Project:

10050 Marble River Shadow Flicker Study\_3

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**EDR**217 Montgomery St.  
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Calculated:

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

...continued from previous page

**UTM NAD83 Zone: 18**

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H-143	582,269	4,978,300	346.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-145	582,444	4,981,913	291.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-146	582,516	4,981,926	292.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-147	582,585	4,982,034	285.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-148	582,778	4,975,877	381.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-150	582,794	4,982,062	291.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-151	582,908	4,973,113	398.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-152	582,936	4,982,089	292.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-153	582,960	4,979,856	340.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-154	582,988	4,975,593	387.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-155	583,000	4,975,482	386.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-156	583,023	4,974,229	392.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-157	583,029	4,973,940	397.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-159	583,063	4,975,550	388.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-161	583,110	4,974,175	393.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-162	583,124	4,974,017	397.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-163	583,092	4,979,279	349.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-164	583,096	4,982,136	292.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-165	583,117	4,979,788	344.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-166	583,162	4,973,828	401.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-167	583,131	4,979,509	351.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-168	583,141	4,979,801	344.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-169	583,188	4,973,218	402.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-170	583,135	4,982,186	291.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-171	583,177	4,978,587	349.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-172	583,204	4,975,524	392.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-173	583,274	4,975,376	392.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-174	583,323	4,971,963	406.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-175	583,336	4,974,591	393.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-176	583,411	4,975,728	392.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-177	583,439	4,975,250	393.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-178	583,449	4,982,301	296.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-179	583,677	4,975,137	390.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-180	583,737	4,974,971	390.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-181	583,773	4,975,054	388.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-182	583,745	4,982,300	294.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-184	583,758	4,982,222	294.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-185	583,812	4,981,441	308.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-186	583,817	4,982,076	297.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-187	583,840	4,981,534	304.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-188	583,911	4,980,859	324.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-189	583,943	4,981,143	315.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-190	583,966	4,980,219	332.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-191	583,982	4,980,800	327.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-192	583,988	4,980,783	327.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-193	584,004	4,979,686	344.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-194	584,010	4,980,064	334.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-195	584,016	4,982,331	301.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-196	584,069	4,979,598	346.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-197	584,072	4,980,122	332.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-198	584,142	4,973,361	411.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-199	584,116	4,979,847	339.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-200	584,125	4,979,673	344.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-201	584,152	4,978,408	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-202	584,158	4,978,924	351.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"

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Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

...continued from previous page

**UTM NAD83 Zone: 18**

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H-203	584,156	4,978,962	350.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-204	584,173	4,978,777	355.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-205	584,198	4,978,573	358.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-206	584,210	4,978,354	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-207	584,229	4,978,887	352.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-208	584,230	4,978,695	357.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-209	584,279	4,974,464	401.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-210	584,265	4,978,460	361.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-211	584,285	4,978,721	356.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-212	584,313	4,978,709	356.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-213	584,338	4,978,714	356.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-214	584,356	4,978,380	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-215	584,386	4,973,322	412.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-216	584,361	4,978,720	356.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-217	584,367	4,978,433	361.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-218	584,390	4,978,434	361.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-219	584,397	4,978,392	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-220	584,397	4,978,722	356.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-221	584,417	4,978,727	356.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-222	584,417	4,978,435	361.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-223	584,421	4,978,384	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-224	584,431	4,978,395	362.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-225	584,441	4,978,646	357.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-226	584,438	4,978,438	361.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-227	584,440	4,978,733	356.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-228	584,450	4,978,456	360.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-229	584,462	4,978,745	356.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-230	584,494	4,975,983	388.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-231	584,500	4,975,467	397.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-232	584,495	4,978,390	360.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-233	584,516	4,978,643	357.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-234	584,520	4,978,746	355.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-235	584,522	4,978,398	360.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-236	584,526	4,978,629	357.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-237	584,538	4,978,586	357.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-238	584,553	4,975,831	394.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-239	584,544	4,978,543	358.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-240	584,564	4,975,391	394.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-241	584,550	4,978,524	358.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-242	584,551	4,978,410	360.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-243	584,554	4,978,751	354.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-244	584,570	4,978,641	356.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-245	584,597	4,973,329	412.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-246	584,568	4,978,416	360.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-247	584,574	4,978,587	357.4	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-248	584,577	4,978,555	357.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-249	584,581	4,978,533	358.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-250	584,617	4,973,330	412.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-251	584,589	4,978,487	358.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-252	584,627	4,978,418	359.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-253	584,663	4,982,484	295.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-254	584,749	4,978,430	357.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-255	584,784	4,982,454	297.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-256	584,978	4,973,743	408.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-257	585,017	4,973,816	408.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"

To be continued on next page...



Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

...continued from previous page

**UTM NAD83 Zone: 18**

No.	East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
H-258	585,031	4,973,683	407.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-259	585,129	4,982,525	298.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-260	585,328	4,982,604	304.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-261	585,530	4,982,588	309.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-262	585,540	4,982,654	309.9	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-263	585,622	4,973,410	400.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-264	585,641	4,973,436	401.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-265	585,785	4,982,568	314.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-274	586,735	4,972,806	372.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-275	586,789	4,972,729	372.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-276	586,804	4,972,107	378.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-277	586,810	4,972,493	374.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-278	586,810	4,972,789	372.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-279	586,810	4,972,580	372.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-280	586,831	4,972,381	376.8	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-281	586,833	4,972,276	378.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-282	586,837	4,972,329	378.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-283	586,854	4,971,748	380.3	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-284	586,876	4,972,137	376.6	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-285	586,896	4,972,696	370.2	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-286	586,917	4,971,968	376.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-287	586,918	4,972,036	376.1	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-288	586,931	4,971,865	375.7	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-289	586,971	4,971,578	373.5	1.0	1.0	1.0	0.0	90.0	"Green house mode"
H-293	587,006	4,971,499	374.0	1.0	1.0	1.0	0.0	90.0	"Green house mode"

**Calculation Results**

Shadow receptor

No.	Shadow, worst case		Shadow, expected values	
	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H-001	0:00	0	0:00	0:00
H-002	0:00	0	0:00	0:00
H-003	0:00	0	0:00	0:00
H-004	0:00	0	0:00	0:00
H-005	40:15	91	0:35	11:41
H-007	0:00	0	0:00	0:00
H-008	0:00	0	0:00	0:00
H-009	0:00	0	0:00	0:00
H-010	0:00	0	0:00	0:00
H-011	0:00	0	0:00	0:00
H-012	13:07	40	0:28	2:56
H-013	12:27	39	0:28	2:58
H-014	18:52	47	0:33	4:15
H-015	76:52	124	0:54	11:32
H-016	59:04	150	0:38	10:46
H-017	51:00	91	0:39	7:40
H-018	0:00	0	0:00	0:00
H-019	5:29	22	0:20	1:04
H-020	18:56	42	0:33	3:53
H-021	37:09	59	0:47	5:00
H-022	45:31	70	0:47	9:24

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Shadow, worst case		Shadow, expected values	
	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H-024	50:01	100	0:45	10:09
H-025	65:19	148	0:41	13:17
H-026	63:51	126	0:43	14:07
H-027	33:15	88	0:31	7:25
H-028	106:06	104	1:10	22:05
H-029	48:02	108	0:37	16:02
H-030	99:44	155	0:52	20:00
H-031	99:50	152	0:47	32:31
H-032	28:02	58	0:38	7:22
H-033	0:00	0	0:00	0:00
H-034	0:00	0	0:00	0:00
H-035	37:21	72	0:46	10:45
H-036	33:40	60	0:43	9:33
H-037	46:19	101	0:40	10:00
H-038	31:03	83	0:30	7:00
H-039	20:42	60	0:28	4:30
H-040	35:56	76	0:32	7:42
H-041	55:09	117	0:37	9:48
H-042	19:09	36	0:41	3:16
H-043	58:17	95	0:45	12:26
H-044	58:08	153	0:33	15:40
H-045	61:38	145	0:32	15:31
H-046	93:15	104	1:01	13:00
H-047	60:10	112	0:49	10:37
H-048	63:05	119	0:46	11:17
H-049	54:28	70	0:56	7:19
H-050	61:46	129	0:39	11:19
H-065	0:00	0	0:00	0:00
H-066	0:00	0	0:00	0:00
H-067	37:05	86	0:36	10:01
H-068	32:26	81	0:34	8:48
H-069	123:15	135	1:23	20:08
H-070	59:59	146	0:37	20:28
H-071	0:00	0	0:00	0:00
H-072	0:00	0	0:00	0:00
H-073	0:00	0	0:00	0:00
H-074	0:00	0	0:00	0:00
H-075	0:00	0	0:00	0:00
H-076	0:00	0	0:00	0:00
H-077	0:00	0	0:00	0:00
H-078	0:00	0	0:00	0:00
H-079	0:00	0	0:00	0:00
H-080	0:00	0	0:00	0:00
H-081	0:00	0	0:00	0:00
H-082	34:10	68	0:35	4:48
H-083	21:50	44	0:38	2:56
H-084	26:13	44	0:45	3:24
H-085	27:52	60	0:34	5:57
H-086	79:15	139	0:49	17:54
H-086	79:15	139	0:49	17:54
H-088	61:22	111	0:48	18:00
H-089	65:58	114	0:51	19:04
H-090	70:04	124	0:56	19:48
H-091	129:46	198	1:02	36:54
H-092	41:40	94	0:39	8:10

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Shadow, worst case		Shadow, expected values	
	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]
H-093	43:48	109	0:35	14:50
H-094	23:42	67	0:29	3:42
H-095	27:48	66	0:29	4:05
H-096	33:55	80	0:30	5:08
H-097	24:16	55	0:34	4:24
H-098	30:19	66	0:36	5:04
H-099	16:51	46	0:29	5:35
H-100	0:00	0	0:00	0:00
H-101	66:20	100	0:47	9:41
H-102	51:58	124	0:31	17:54
H-103	32:21	62	0:37	4:24
H-104	92:32	142	1:02	22:55
H-105	42:28	100	0:34	13:11
H-106	126:51	205	1:06	36:40
H-107	47:25	101	0:41	11:11
H-108	123:11	127	1:39	25:59
H-109	24:58	52	0:36	3:24
H-110	22:40	56	0:32	7:58
H-111	90:01	191	0:44	21:51
H-112	28:06	66	0:34	9:59
H-113	0:00	0	0:00	0:00
H-114	0:00	0	0:00	0:00
H-115	0:00	0	0:00	0:00
H-116	0:00	0	0:00	0:00
H-117	27:06	55	0:38	8:21
H-120	78:01	133	0:43	26:01
H-121	0:00	0	0:00	0:00
H-123	5:02	22	0:17	1:53
H-124	63:23	110	0:48	22:09
H-125	63:13	107	0:46	14:02
H-129	0:00	0	0:00	0:00
H-132	41:08	78	0:42	9:30
H-133	37:29	68	0:43	9:29
H-134	0:00	0	0:00	0:00
H-136	51:07	71	0:55	14:32
H-137	47:24	93	0:46	16:01
H-138	105:31	142	1:00	36:38
H-139	41:47	101	0:33	12:04
H-140	35:36	91	0:32	11:23
H-143	48:16	110	0:40	12:25
H-145	40:56	83	0:34	8:51
H-146	34:55	88	0:32	7:37
H-147	29:32	72	0:29	6:25
H-148	160:46	199	1:12	39:52
H-150	5:34	24	0:17	0:45
H-151	118:04	181	1:18	23:28
H-152	0:00	0	0:00	0:00
H-153	29:18	67	0:30	4:18
H-154	70:29	108	0:55	21:31
H-155	84:13	128	0:54	25:17
H-156	58:44	137	0:37	11:44
H-157	81:44	163	0:50	18:58
H-159	66:19	131	0:48	20:50
H-161	58:09	141	0:33	11:06
H-162	76:16	198	0:36	17:29

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Shadow, worst case		Max shadow hours per day [h/day]	Shadow, expected values
	Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]
H-163	31:33	56	0:43	9:05
H-164	0:00	0	0:00	0:00
H-165	31:33	62	0:36	4:22
H-166	151:13	231	1:01	37:31
H-167	33:47	60	0:43	7:26
H-168	25:28	54	0:34	3:28
H-169	92:32	72	1:42	15:12
H-170	0:00	0	0:00	0:00
H-171	0:00	0	0:00	0:00
H-172	72:09	162	0:38	23:01
H-173	41:41	103	0:34	12:15
H-174	69:46	90	0:54	9:25
H-175	23:32	56	0:30	3:21
H-176	112:31	204	0:49	35:19
H-177	50:14	101	0:41	15:46
H-178	0:00	0	0:00	0:00
H-179	9:03	27	0:26	3:24
H-180	0:00	0	0:00	0:00
H-181	0:00	0	0:00	0:00
H-182	0:00	0	0:00	0:00
H-184	0:00	0	0:00	0:00
H-185	145:33	192	1:37	37:56
H-186	15:08	42	0:28	3:01
H-187	103:57	138	1:36	29:12
H-188	204:02	203	1:47	53:53
H-189	204:28	240	1:34	55:18
H-190	22:22	50	0:34	7:07
H-191	198:49	221	1:43	58:07
H-192	211:03	246	1:42	63:30
H-193	85:50	130	0:51	19:11
H-194	57:44	126	0:36	17:47
H-195	19:41	61	0:30	4:18
H-196	139:34	185	1:01	33:27
H-197	52:53	102	0:39	19:13
H-198	33:44	84	0:32	7:21
H-199	81:11	100	0:57	11:07
H-200	133:41	175	1:06	29:37
H-201	0:00	0	0:00	0:00
H-202	0:00	0	0:00	0:00
H-203	4:24	19	0:17	1:14
H-204	0:00	0	0:00	0:00
H-205	0:00	0	0:00	0:00
H-206	0:00	0	0:00	0:00
H-207	0:00	0	0:00	0:00
H-208	0:00	0	0:00	0:00
H-209	47:35	84	0:40	17:30
H-210	0:00	0	0:00	0:00
H-211	0:00	0	0:00	0:00
H-212	0:00	0	0:00	0:00
H-213	0:00	0	0:00	0:00
H-214	0:00	0	0:00	0:00
H-215	54:59	112	0:41	15:32
H-216	0:00	0	0:00	0:00
H-217	0:00	0	0:00	0:00
H-218	0:00	0	0:00	0:00

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Shadow, worst case		Max shadow hours per day [h/day]	Shadow, expected values
	Shadow hours per year [h/year]	Shadow days per year [days/year]		Shadow hours per year [h/year]
H-219	0:00	0	0:00	0:00
H-220	0:00	0	0:00	0:00
H-221	0:00	0	0:00	0:00
H-222	0:00	0	0:00	0:00
H-223	0:00	0	0:00	0:00
H-224	0:00	0	0:00	0:00
H-225	0:00	0	0:00	0:00
H-226	0:00	0	0:00	0:00
H-227	0:00	0	0:00	0:00
H-228	0:00	0	0:00	0:00
H-229	0:00	0	0:00	0:00
H-230	72:52	124	0:45	18:19
H-231	187:35	222	1:48	56:14
H-232	0:00	0	0:00	0:00
H-233	0:00	0	0:00	0:00
H-234	6:24	36	0:15	1:46
H-235	0:00	0	0:00	0:00
H-236	0:00	0	0:00	0:00
H-237	0:00	0	0:00	0:00
H-238	155:45	211	1:19	35:49
H-239	0:00	0	0:00	0:00
H-240	143:58	142	1:53	40:03
H-241	0:00	0	0:00	0:00
H-242	0:00	0	0:00	0:00
H-243	0:00	0	0:00	0:00
H-244	0:00	0	0:00	0:00
H-245	47:50	113	0:39	12:57
H-246	0:00	0	0:00	0:00
H-247	0:00	0	0:00	0:00
H-248	0:00	0	0:00	0:00
H-249	0:00	0	0:00	0:00
H-250	47:29	110	0:41	12:45
H-251	0:00	0	0:00	0:00
H-252	0:00	0	0:00	0:00
H-253	12:11	41	0:26	2:52
H-254	0:00	0	0:00	0:00
H-255	14:50	38	0:30	3:39
H-256	78:48	85	1:18	23:18
H-257	59:56	93	0:54	17:58
H-258	59:16	86	0:54	17:51
H-259	56:46	107	0:45	11:18
H-260	85:02	79	1:30	13:04
H-261	71:35	120	1:02	13:46
H-262	73:40	183	0:30	21:41
H-263	63:17	87	0:57	16:37
H-264	60:31	89	0:54	15:13
H-265	80:18	114	1:04	17:27
H-274	0:00	0	0:00	0:00
H-275	0:00	0	0:00	0:00
H-276	34:44	59	0:46	10:31
H-277	41:44	76	0:37	8:56
H-278	0:00	0	0:00	0:00
H-279	21:13	50	0:32	4:31
H-280	34:32	70	0:39	8:00
H-281	30:25	57	0:41	8:35

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Shadow, worst case			Shadow, expected values	
	Shadow hours per year [h/year]	Shadow days per year [days/year]	Max shadow hours per day [h/day]	Shadow hours per year [h/year]	
H-282	31:23	62	0:40	8:06	
H-283	59:33	92	0:44	17:40	
H-284	27:02	51	0:41	8:05	
H-285	4:39	22	0:16	0:59	
H-286	27:03	52	0:39	7:53	
H-287	25:28	50	0:39	7:41	
H-288	30:08	60	0:39	8:52	
H-289	11:41	36	0:24	3:18	
H-293	0:00	0	0:00	0:00	

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
WTG 102-L	VESTAS V112 3000 112.0 !O! hub: 94.0 m (71)	232:10	54:53
WTG 104-L	VESTAS V112 3000 112.0 !O! hub: 94.0 m (70)	196:37	60:43
WTG 105-L	VESTAS V112 3000 112.0 !O! hub: 94.0 m (69)	185:01	36:34
WTG 106-L	VESTAS V112 3000 112.0 !O! hub: 94.0 m (68)	174:23	41:09
WTG 109	VESTAS V112 3000 112.0 !O! hub: 94.0 m (67)	46:49	13:45
WTG 10A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (66)	0:00	0:00
WTG 11	VESTAS V112 3000 112.0 !O! hub: 94.0 m (65)	200:04	57:58
WTG 12	VESTAS V112 3000 112.0 !O! hub: 94.0 m (64)	290:54	79:38
WTG 120	VESTAS V112 3000 112.0 !O! hub: 94.0 m (63)	0:00	0:00
WTG 122	VESTAS V112 3000 112.0 !O! hub: 94.0 m (62)	0:00	0:00
WTG 125	VESTAS V112 3000 112.0 !O! hub: 94.0 m (61)	0:00	0:00
WTG 13	VESTAS V112 3000 112.0 !O! hub: 94.0 m (60)	131:16	23:33
WTG 148	VESTAS V112 3000 112.0 !O! hub: 94.0 m (59)	211:01	57:58
WTG 148A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (58)	82:14	24:58
WTG 15	VESTAS V112 3000 112.0 !O! hub: 94.0 m (57)	145:46	36:54
WTG 15A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (56)	134:10	36:49
WTG 161	VESTAS V112 3000 112.0 !O! hub: 94.0 m (55)	0:00	0:00
WTG 161A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (54)	260:26	47:29
WTG 173	VESTAS V112 3000 112.0 !O! hub: 94.0 m (74)	0:00	0:00
WTG 175	VESTAS V112 3000 112.0 !O! hub: 94.0 m (53)	96:41	19:22
WTG 19	VESTAS V112 3000 112.0 !O! hub: 94.0 m (52)	0:00	0:00
WTG 1-A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (51)	0:00	0:00
WTG 201	VESTAS V112 3000 112.0 !O! hub: 94.0 m (50)	106:54	17:37
WTG 202	VESTAS V112 3000 112.0 !O! hub: 94.0 m (48)	0:00	0:00
WTG 202	VESTAS V112 3000 112.0 !O! hub: 94.0 m (49)	88:32	25:44
WTG 203	VESTAS V112 3000 112.0 !O! hub: 94.0 m (47)	36:21	9:40
WTG 204	VESTAS V112 3000 112.0 !O! hub: 94.0 m (46)	20:23	6:46
WTG 206	VESTAS V112 3000 112.0 !O! hub: 94.0 m (45)	180:29	43:08
WTG 207	VESTAS V112 3000 112.0 !O! hub: 94.0 m (44)	31:53	11:42
WTG 21	VESTAS V112 3000 112.0 !O! hub: 94.0 m (43)	113:41	36:25
WTG 28	VESTAS V112 3000 112.0 !O! hub: 94.0 m (42)	242:06	51:15
WTG 28A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (41)	218:15	44:06
WTG 2-A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (40)	0:00	0:00
WTG 31	VESTAS V112 3000 112.0 !O! hub: 94.0 m (39)	0:00	0:00
WTG 36A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (38)	33:05	9:41
WTG 3-A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (37)	0:00	0:00
WTG 42	VESTAS V112 3000 112.0 !O! hub: 94.0 m (36)	134:21	41:00
WTG 44	VESTAS V112 3000 112.0 !O! hub: 94.0 m (35)	98:25	27:34
WTG 45	VESTAS V112 3000 112.0 !O! hub: 94.0 m (34)	163:12	37:21
WTG 46	VESTAS V112 3000 112.0 !O! hub: 94.0 m (33)	226:12	74:15
WTG 47	VESTAS V112 3000 112.0 !O! hub: 94.0 m (32)	179:12	47:47

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**SHADOW - Main Result****Calculation:** Marble River Wind Farm SFA-3

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No.	Name	Worst case [h/year]	Expected [h/year]
WTG 48-W	VESTAS V112 3000 112.0 !O! hub: 94.0 m (31)	242:12	64:27
WTG 4-A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (30)	35:14	10:20
WTG 50	VESTAS V112 3000 112.0 !O! hub: 94.0 m (29)	40:14	9:05
WTG 51	VESTAS V112 3000 112.0 !O! hub: 94.0 m (28)	47:35	17:30
WTG 52	VESTAS V112 3000 112.0 !O! hub: 94.0 m (27)	124:04	32:38
WTG 53	VESTAS V112 3000 112.0 !O! hub: 94.0 m (26)	186:54	53:40
WTG 55	VESTAS V112 3000 112.0 !O! hub: 94.0 m (25)	87:30	21:46
WTG 56	VESTAS V112 3000 112.0 !O! hub: 94.0 m (24)	135:32	40:51
WTG 57	VESTAS V112 3000 112.0 !O! hub: 94.0 m (23)	204:16	57:29
WTG 58	VESTAS V112 3000 112.0 !O! hub: 94.0 m (22)	162:56	39:21
WTG 5-A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (21)	201:41	35:48
WTG 60	VESTAS V112 3000 112.0 !O! hub: 94.0 m (20)	104:31	26:46
WTG 62	VESTAS V112 3000 112.0 !O! hub: 94.0 m (19)	121:33	23:29
WTG 63	VESTAS V112 3000 112.0 !O! hub: 94.0 m (18)	0:00	0:00
WTG 63A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (17)	99:12	17:22
WTG 64	VESTAS V112 3000 112.0 !O! hub: 94.0 m (2)	0:00	0:00
WTG 66	VESTAS V112 3000 112.0 !O! hub: 94.0 m (16)	30:08	4:49
WTG 67	VESTAS V112 3000 112.0 !O! hub: 94.0 m (15)	69:46	9:25
WTG 73-W	VESTAS V112 3000 112.0 !O! hub: 94.0 m (14)	0:00	0:00
WTG 77	VESTAS V112 3000 112.0 !O! hub: 94.0 m (13)	219:36	60:21
WTG 78	VESTAS V112 3000 112.0 !O! hub: 94.0 m (12)	296:04	78:41
WTG 81	VESTAS V112 3000 112.0 !O! hub: 94.0 m (11)	124:26	32:43
WTG 83	VESTAS V112 3000 112.0 !O! hub: 94.0 m (10)	200:28	61:18
WTG 87	VESTAS V112 3000 112.0 !O! hub: 94.0 m (9)	60:56	8:53
WTG 90	VESTAS V112 3000 112.0 !O! hub: 94.0 m (8)	0:00	0:00
WTG 91	VESTAS V112 3000 112.0 !O! hub: 94.0 m (7)	137:01	24:01
WTG 93	VESTAS V112 3000 112.0 !O! hub: 94.0 m (6)	15:14	4:03
WTG 94	VESTAS V112 3000 112.0 !O! hub: 94.0 m (1)	55:14	8:06
WTG 95	VESTAS V112 3000 112.0 !O! hub: 94.0 m (5)	322:20	59:15
WTG 96-N	VESTAS V112 3000 112.0 !O! hub: 94.0 m (73)	0:00	0:00
WTG 98	VESTAS V112 3000 112.0 !O! hub: 94.0 m (4)	0:00	0:00
WTG 9A	VESTAS V112 3000 112.0 !O! hub: 94.0 m (3)	53:48	14:19
WTG-100R	VESTAS V112 3000 112.0 !O! hub: 94.0 m (72)	0:00	0:00

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 1

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-031 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (279)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June				
1	07:34	07:17	06:36	07:02 (WTG 105-L)	06:39	05:47	05:14	05:50 (WTG 104-L)		
	16:25	17:04	17:43	34 07:36 (WTG 105-L)	19:23	20:00	20:34	47 06:37 (WTG 104-L)		
2	07:34	07:16	06:34	07:01 (WTG 105-L)	06:37	05:46	05:13	05:51 (WTG 104-L)		
	16:26	17:05	17:44	36 07:37 (WTG 105-L)	19:25	20:01	20:35	47 06:38 (WTG 104-L)		
3	07:35	07:15	06:32	07:00 (WTG 105-L)	06:35	05:44	05:13	05:51 (WTG 104-L)		
	16:27	17:07	17:46	39 07:39 (WTG 105-L)	19:26	20:02	20:36	47 06:38 (WTG 104-L)		
4	07:34	07:13	06:30	06:59 (WTG 105-L)	06:33	05:43	05:12	05:51 (WTG 104-L)		
	16:28	17:08	17:47	40 07:39 (WTG 105-L)	19:27	20:03	20:37	47 06:38 (WTG 104-L)		
5	07:34	07:12	06:29	06:58 (WTG 105-L)	06:31	05:41	05:12	05:52 (WTG 104-L)		
	16:29	17:09	17:48	41 07:39 (WTG 105-L)	19:28	20:05	20:37	47 06:39 (WTG 104-L)		
6	07:34	07:11	06:27	06:57 (WTG 105-L)	06:29	05:40	05:11	05:51 (WTG 104-L)		
	16:30	17:11	17:50	43 07:40 (WTG 105-L)	19:30	20:06	10 06:18 (WTG 104-L)	05:11	05:52 (WTG 104-L)	
7	07:34	07:10	06:25	06:56 (WTG 105-L)	06:28	05:39	06:01 (WTG 104-L)	05:11	05:52 (WTG 104-L)	
	16:31	17:12	17:51	44 07:40 (WTG 105-L)	19:31	20:07	17 06:22 (WTG 104-L)	20:39	46 06:38 (WTG 104-L)	
8	07:34	07:08	07:23	07:56 (WTG 105-L)	06:26	05:37	06:02 (WTG 104-L)	05:11	05:52 (WTG 104-L)	
	16:32	17:14	18:52	45 08:41 (WTG 105-L)	19:32	20:08	23 06:25 (WTG 104-L)	20:40	47 06:39 (WTG 104-L)	
9	07:34	07:07	07:21	07:55 (WTG 105-L)	06:24	05:36	06:01 (WTG 104-L)	05:10	05:52 (WTG 104-L)	
	16:34	17:15	18:54	45 08:40 (WTG 105-L)	19:33	20:09	26 06:27 (WTG 104-L)	20:40	46 06:38 (WTG 104-L)	
10	07:33	07:06	07:20	07:55 (WTG 105-L)	06:22	05:35	05:58 (WTG 104-L)	05:10	05:52 (WTG 104-L)	
	16:35	17:17	18:55	45 08:40 (WTG 105-L)	19:35	20:11	29 06:27 (WTG 104-L)	20:41	46 06:38 (WTG 104-L)	
11	07:33	07:04	07:18	07:54 (WTG 105-L)	06:20	05:33	05:57 (WTG 104-L)	05:10	05:53 (WTG 104-L)	
	16:36	17:18	18:56	46 08:40 (WTG 105-L)	19:36	20:12	32 06:29 (WTG 104-L)	20:42	46 06:39 (WTG 104-L)	
12	07:33	07:03	07:16	07:54 (WTG 105-L)	06:19	05:32	05:56 (WTG 104-L)	05:10	05:53 (WTG 104-L)	
	16:37	17:19	18:58	45 08:39 (WTG 105-L)	19:37	20:13	34 06:30 (WTG 104-L)	20:42	46 06:39 (WTG 104-L)	
13	07:32	07:01	07:14	07:54 (WTG 105-L)	06:17	05:31	05:55 (WTG 104-L)	05:10	05:54 (WTG 104-L)	
	16:38	17:21	18:59	45 08:39 (WTG 105-L)	19:38	20:14	36 06:31 (WTG 104-L)	20:43	45 06:39 (WTG 104-L)	
14	07:32	07:00	07:12	07:55 (WTG 105-L)	06:15	05:30	05:54 (WTG 104-L)	05:10	05:54 (WTG 104-L)	
	16:39	17:22	19:00	44 08:39 (WTG 105-L)	19:40	20:15	38 06:32 (WTG 104-L)	20:43	45 06:39 (WTG 104-L)	
15	07:31	06:58	07:10	07:55 (WTG 105-L)	06:13	05:29	05:54 (WTG 104-L)	05:10	05:54 (WTG 104-L)	
	16:41	17:24	19:02	43 08:38 (WTG 105-L)	19:41	20:17	39 06:33 (WTG 104-L)	20:44	46 06:40 (WTG 104-L)	
16	07:31	06:57	07:09	07:55 (WTG 105-L)	06:12	05:27	05:53 (WTG 104-L)	05:10	05:54 (WTG 104-L)	
	16:42	17:25	19:03	42 08:37 (WTG 105-L)	19:42	20:18	40 06:33 (WTG 104-L)	20:44	46 06:40 (WTG 104-L)	
17	07:30	06:55	07:07	07:55 (WTG 105-L)	06:10	05:26	05:53 (WTG 104-L)	05:10	05:55 (WTG 104-L)	
	16:43	17:27	19:04	41 08:36 (WTG 105-L)	19:43	20:19	41 06:34 (WTG 104-L)	20:45	45 06:40 (WTG 104-L)	
18	07:30	06:54	07:05	07:55 (WTG 105-L)	06:08	05:25	05:52 (WTG 104-L)	05:10	05:55 (WTG 104-L)	
	16:44	17:28	19:05	39 08:34 (WTG 105-L)	19:45	20:20	43 06:35 (WTG 104-L)	20:45	45 06:40 (WTG 104-L)	
19	07:29	06:52	07:03	07:56 (WTG 105-L)	06:06	05:24	05:52 (WTG 104-L)	05:10	05:55 (WTG 104-L)	
	16:46	17:29	19:07	37 08:33 (WTG 105-L)	19:46	20:21	43 06:35 (WTG 104-L)	20:45	45 06:40 (WTG 104-L)	
20	07:28	06:51	07:01	07:57 (WTG 105-L)	06:05	05:23	05:51 (WTG 104-L)	05:10	05:55 (WTG 104-L)	
	16:47	17:31	19:08	34 08:31 (WTG 105-L)	19:47	20:22	44 06:35 (WTG 104-L)	20:46	45 06:40 (WTG 104-L)	
21	07:27	06:49	06:59	07:58 (WTG 105-L)	06:03	05:22	05:51 (WTG 104-L)	05:10	05:55 (WTG 104-L)	
	16:48	17:32	19:09	31 08:29 (WTG 105-L)	19:48	20:23	45 06:36 (WTG 104-L)	20:46	45 06:40 (WTG 104-L)	
22	07:27	06:47	06:57	07:59 (WTG 105-L)	06:01	05:21	05:51 (WTG 104-L)	05:10	05:56 (WTG 104-L)	
	16:50	17:34	19:11	28 08:27 (WTG 105-L)	19:50	20:24	45 06:36 (WTG 104-L)	20:46	45 06:41 (WTG 104-L)	
23	07:26	06:46	06:55	08:02 (WTG 105-L)	06:00	05:20	05:50 (WTG 104-L)	05:10	05:56 (WTG 104-L)	
	16:51	17:35	19:12	23 08:25 (WTG 105-L)	19:51	20:25	46 06:36 (WTG 104-L)	20:46	45 06:41 (WTG 104-L)	
24	07:25	06:44	06:54	08:04 (WTG 105-L)	05:58	05:20	05:50 (WTG 104-L)	05:11	05:56 (WTG 104-L)	
	16:53	17:36	19:13	18 08:22 (WTG 105-L)	19:52	20:26	46 06:36 (WTG 104-L)	20:47	45 06:41 (WTG 104-L)	
25	07:24	06:42	06:52	08:09 (WTG 105-L)	05:56	05:19	05:51 (WTG 104-L)	05:11	05:57 (WTG 104-L)	
	16:54	17:38	15 07:27 (WTG 105-L)	19:14	7 08:16 (WTG 105-L)	19:53	20:27	46 06:37 (WTG 104-L)	20:47	45 06:42 (WTG 104-L)
26	07:23	06:41	07:09 (WTG 105-L)	06:50	05:55	05:18	05:50 (WTG 104-L)	05:11	05:56 (WTG 104-L)	
	16:55	17:39	21 07:30 (WTG 105-L)	19:16	19:55	20:28	47 06:37 (WTG 104-L)	20:47	46 06:42 (WTG 104-L)	
27	07:22	06:39	07:07 (WTG 105-L)	06:48	05:53	05:17	05:50 (WTG 104-L)	05:12	05:56 (WTG 104-L)	
	16:57	17:40	26 07:33 (WTG 105-L)	19:17	19:56	20:29	47 06:37 (WTG 104-L)	20:47	46 06:42 (WTG 104-L)	
28	07:21	06:37	07:04 (WTG 105-L)	06:46	05:52	05:16	05:51 (WTG 104-L)	05:12	05:57 (WTG 104-L)	
	16:58	17:42	31 07:35 (WTG 105-L)	19:18	19:57	20:30	47 06:38 (WTG 104-L)	20:47	45 06:42 (WTG 104-L)	
29	07:20		06:44	06:44	05:50	05:16	05:50 (WTG 104-L)	05:13	05:57 (WTG 104-L)	
	16:59		19:19	19:19	19:58	20:31	47 06:37 (WTG 104-L)	20:47	45 06:42 (WTG 104-L)	
30	07:19		06:42	06:42	05:49	05:15	05:50 (WTG 104-L)	05:13	05:57 (WTG 104-L)	
	17:01		19:21	19:21	20:00	20:32	47 06:37 (WTG 104-L)	20:47	46 06:43 (WTG 104-L)	
31	07:18		06:41	06:41	05:14	05:14	05:51 (WTG 104-L)			
	17:02		19:22	19:22	20:33	20:33	47 06:38 (WTG 104-L)			
Potential sun hours	286	291	369	404	459	1005	466	1374		
Total, worst case		93	935			1005		1374		
Sun reduction		0.37	0.37			0.44		0.47		
Oper. time red.		1.00	1.00			1.00		1.00		
Wind dir. red.		0.68	0.68			0.81		0.81		
Total reduction		0.25	0.25			0.35		0.38		
Total, real		23	233			354		516		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)



Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 2

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-031 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (279)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:14	05:57 (WTG 104-L)	05:41	06:07 (WTG 104-L)	06:18	06:53
	20:47	06:43 (WTG 104-L)	20:25	06:40 (WTG 104-L)	19:35	18:38
2	05:14	05:58 (WTG 104-L)	05:42	06:08 (WTG 104-L)	06:19	06:55
	20:47	06:44 (WTG 104-L)	20:24	06:39 (WTG 104-L)	19:33	18:37
3	05:15	05:57 (WTG 104-L)	05:43	06:09 (WTG 104-L)	06:20	06:56
	20:46	06:43 (WTG 104-L)	20:22	06:37 (WTG 104-L)	19:31	18:35
4	05:15	05:58 (WTG 104-L)	05:45	06:11 (WTG 104-L)	06:21	06:57
	20:46	06:44 (WTG 104-L)	20:21	06:36 (WTG 104-L)	19:29	18:33
5	05:16	05:58 (WTG 104-L)	05:46	06:13 (WTG 104-L)	06:22	06:58
	20:46	06:45 (WTG 104-L)	20:20	06:33 (WTG 104-L)	19:27	18:31
6	05:17	05:58 (WTG 104-L)	05:47	06:15 (WTG 104-L)	06:24	07:00
	20:46	06:44 (WTG 104-L)	20:18	06:30 (WTG 104-L)	19:26	18:29
7	05:17	05:58 (WTG 104-L)	05:48	06:20 (WTG 104-L)	06:25	07:01
	20:45	06:45 (WTG 104-L)	20:17	06:25 (WTG 104-L)	19:24	18:27
8	05:18	05:59 (WTG 104-L)	05:49	06:26	06:26	07:02
	20:45	06:45 (WTG 104-L)	20:16	19:22	18:25	18:15
9	05:19	05:58 (WTG 104-L)	05:50	06:27	06:27	07:03
	20:44	06:45 (WTG 104-L)	20:14	19:20	18:24	18:14
10	05:20	05:58 (WTG 104-L)	05:52	06:28	06:28	07:05
	20:44	06:45 (WTG 104-L)	20:13	19:18	18:22	18:13
11	05:20	05:59 (WTG 104-L)	05:53	06:29	06:29	07:06
	20:43	06:46 (WTG 104-L)	20:11	19:16	18:20	18:11
12	05:21	05:59 (WTG 104-L)	05:54	06:31	06:31	07:07
	20:43	06:46 (WTG 104-L)	20:10	19:14	18:18	18:11
13	05:22	05:58 (WTG 104-L)	05:55	06:32	06:32	07:08
	20:42	06:45 (WTG 104-L)	20:08	19:12	18:17	18:11
14	05:23	05:59 (WTG 104-L)	05:56	06:33	06:33	07:10
	20:42	06:46 (WTG 104-L)	20:07	19:11	18:15	18:11
15	05:24	05:59 (WTG 104-L)	05:57	06:34	06:34	07:11
	20:41	06:46 (WTG 104-L)	20:05	19:09	18:13	18:11
16	05:25	05:59 (WTG 104-L)	05:59	06:35	06:35	07:12
	20:40	06:46 (WTG 104-L)	20:04	19:07	18:11	18:11
17	05:26	06:00 (WTG 104-L)	06:00	06:37	06:37	07:14
	20:40	06:46 (WTG 104-L)	20:02	19:05	18:10	18:10
18	05:27	06:00 (WTG 104-L)	06:01	06:38	06:38	07:15
	20:39	06:46 (WTG 104-L)	20:01	19:03	18:08	18:08
19	05:27	06:00 (WTG 104-L)	06:02	06:39	06:39	07:16
	20:38	06:46 (WTG 104-L)	19:57	19:01	18:06	18:06
20	05:28	06:01 (WTG 104-L)	06:03	06:40	06:40	07:18
	20:37	06:46 (WTG 104-L)	19:56	18:59	18:04	18:04
21	05:29	06:01 (WTG 104-L)	06:05	06:41	06:41	07:19
	20:36	06:46 (WTG 104-L)	19:54	18:57	18:03	18:03
22	05:30	06:01 (WTG 104-L)	06:06	06:43	06:43	07:20
	20:36	06:46 (WTG 104-L)	19:52	18:55	18:01	18:01
23	05:31	06:02 (WTG 104-L)	06:07	06:44	06:44	07:22
	20:35	06:46 (WTG 104-L)	19:51	18:53	18:00	18:00
24	05:32	06:02 (WTG 104-L)	06:08	06:45	06:45	07:23
	20:34	06:46 (WTG 104-L)	19:49	18:52	18:00	18:00
25	05:34	06:02 (WTG 104-L)	06:09	06:46	06:46	07:24
	20:33	06:45 (WTG 104-L)	19:47	18:50	18:00	18:00
26	05:35	06:03 (WTG 104-L)	06:11	06:47	06:47	07:26
	20:32	06:45 (WTG 104-L)	19:45	18:48	18:00	18:00
27	05:36	06:03 (WTG 104-L)	06:12	06:49	06:49	07:27
	20:31	06:44 (WTG 104-L)	19:44	18:46	18:00	18:00
28	05:37	06:04 (WTG 104-L)	06:13	06:50	06:50	07:28
	20:30	06:44 (WTG 104-L)	19:42	18:44	18:00	18:00
29	05:38	06:05 (WTG 104-L)	06:14	06:51	06:51	07:30
	20:28	06:43 (WTG 104-L)	19:40	18:42	18:00	18:00
30	05:39	06:05 (WTG 104-L)	06:15	06:52	06:52	07:31
	20:27	06:42 (WTG 104-L)	19:38	18:40	18:00	18:00
31	05:40	06:06 (WTG 104-L)	06:16	06:53	06:53	07:32
	20:26	06:41 (WTG 104-L)	19:37	18:38	18:00	18:00
Potential sun hours	472	436	376	341	288	275
Total, worst case	1383	157	417	626		
Sun reduction	0.45	0.46	0.42	0.36		
Oper. time red.	1.00	1.00	1.00	1.00		
Wind dir. red.	0.81	0.81	0.68	0.68		
Total reduction	0.36	0.37	0.28	0.24		
Total, real	498	58	118	152		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-091 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (325)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.29	0.37	0.37	0.33	0.44	0.47	0.45	0.46	0.42	0.36	0.25	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
193	219	377	727	552	298	438	718	1,822	2,408	780	228	8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35 16:25	14:33 (WTG 45) 15:15 (WTG 45)	07:17 17:03	06:36 17:43	07:03 (WTG 44) 07:32 (WTG 44)	06:39 19:23
2	07:35 16:26	14:34 (WTG 45) 15:15 (WTG 45)	07:16 17:05	06:34 17:44	07:03 (WTG 44) 07:32 (WTG 44)	06:37 19:24
3	07:35 16:27	14:34 (WTG 45) 15:16 (WTG 45)	07:15 17:06	06:32 17:46	07:03 (WTG 44) 07:32 (WTG 44)	06:35 19:26
4	07:35 16:28	14:35 (WTG 45) 15:16 (WTG 45)	07:13 17:08	06:30 17:47	07:03 (WTG 44) 07:31 (WTG 44)	06:33 19:27
5	07:34 16:29	14:36 (WTG 45) 15:16 (WTG 45)	07:12 17:09	06:28 17:48	07:04 (WTG 44) 07:30 (WTG 44)	06:31 19:28
6	07:34 16:30	14:37 (WTG 45) 15:16 (WTG 45)	07:11 17:11	06:27 17:50	07:04 (WTG 44) 07:29 (WTG 44)	06:29 19:30
7	07:34 16:31	14:37 (WTG 45) 15:16 (WTG 45)	07:10 17:12	06:25 17:51	07:05 (WTG 44) 07:27 (WTG 44)	06:27 19:31
8	07:34 16:32	14:39 (WTG 45) 15:16 (WTG 45)	07:08 17:14	06:23 18:52	08:07 (WTG 44) 08:26 (WTG 44)	06:26 19:32
9	07:34 16:33	14:40 (WTG 45) 15:16 (WTG 45)	07:07 17:15	06:21 18:54	08:09 (WTG 44) 08:24 (WTG 44)	06:24 19:33
10	07:33 16:34	14:40 (WTG 45) 15:16 (WTG 45)	07:06 17:16	06:19 18:55	08:11 (WTG 44) 08:20 (WTG 44)	06:22 19:35
11	07:33 16:36	14:42 (WTG 45) 15:16 (WTG 45)	07:04 17:18	06:18 18:56	07:36 (WTG 42) 07:37 (WTG 42)	06:20 19:36
12	07:33 16:37	14:42 (WTG 45) 15:15 (WTG 45)	07:03 17:19	06:18 18:58	06:54 (WTG 42) 07:39 (WTG 42)	06:20 19:37
13	07:32 16:38	14:44 (WTG 45) 15:15 (WTG 45)	07:01 17:21	06:17 18:59	06:52 (WTG 42) 07:39 (WTG 42)	06:20 19:38
14	07:32 16:39	14:45 (WTG 45) 15:14 (WTG 45)	07:00 17:22	06:15 19:00	06:50 (WTG 42) 07:40 (WTG 42)	06:20 19:40
15	07:31 16:40	14:47 (WTG 45) 15:14 (WTG 45)	06:58 17:24	06:13 19:02	06:48 (WTG 42) 07:40 (WTG 42)	06:20 19:41
16	07:31 16:42	14:49 (WTG 45) 15:13 (WTG 45)	06:57 17:25	06:11 19:03	06:48 (WTG 42) 07:42 (WTG 42)	06:20 19:42
17	07:30 16:43	14:50 (WTG 45) 15:11 (WTG 45)	06:55 17:26	06:10 19:04	06:47 (WTG 42) 07:42 (WTG 42)	06:20 19:43
18	07:30 16:44	14:53 (WTG 45) 15:10 (WTG 45)	06:54 17:28	06:08 19:05	06:45 (WTG 42) 07:42 (WTG 42)	06:20 19:45
19	07:29 16:46	14:56 (WTG 45) 15:08 (WTG 45)	06:52 17:29	06:06 19:07	06:45 (WTG 42) 07:43 (WTG 42)	06:20 19:46
20	07:28 16:47	15:08 (WTG 45) 17:31	06:51 17:31	06:05 19:08	06:44 (WTG 42) 07:43 (WTG 42)	06:20 19:47
21	07:27 16:48	17:31 17:32	11 16	06:49 19:09	07:11 (WTG 44) 07:27 (WTG 44)	06:59 19:09
22	07:27 16:50	06:47 17:33	19	06:57 19:11	07:09 (WTG 44) 07:28 (WTG 44)	06:57 19:11
23	07:26 16:51	06:46 17:35	22	06:55 19:12	07:08 (WTG 44) 07:30 (WTG 44)	06:55 19:12
24	07:25 16:52	06:44 17:36	25	06:53 19:13	07:06 (WTG 44) 07:31 (WTG 44)	06:53 19:13
25	07:24 16:54	06:42 17:37	26	06:52 19:14	07:05 (WTG 44) 07:31 (WTG 44)	06:52 19:14
26	07:23 16:55	06:41 17:39	28	06:50 19:16	07:04 (WTG 44) 07:32 (WTG 44)	06:50 19:16
27	07:22 16:56	06:39 17:40	29	06:48 19:17	07:04 (WTG 44) 07:33 (WTG 44)	06:48 19:17
28	07:21 16:58	06:37 17:42	29	06:46 19:18	07:03 (WTG 44) 07:32 (WTG 44)	06:46 19:18
29	07:20 16:59			06:44 19:19		06:44 19:19
30	07:19 17:01			06:42 19:21		06:42 19:21
31	07:18 17:02			06:40 19:22		06:40 19:22
Potential sun hours	286	291	369	404	459	466
Total, worst case	621	205	231	1271	1114	
Sun reduction	0.29	0.37	0.37	0.33	0.44	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.75	0.67	0.67	0.78	0.78	
Total reduction	0.22	0.25	0.25	0.26	0.34	
Total, real	134	51	57	326	381	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-091 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (325)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

July		August		September		October		November		December		
1	05:13	05:41	06:55 (WTG 42)	06:17	06:54 (WTG 42)	06:53		06:34		07:13	14:24 (WTG 45)	
	20:47	20:25	07:45 (WTG 42)	19:35	43 07:37 (WTG 42)	18:38		16:46		16:17	34 14:58 (WTG 45)	
2	05:14	05:42	06:55 (WTG 42)	06:19	06:56 (WTG 42)	06:55		06:35		07:14	14:23 (WTG 45)	
	20:47	20:24	07:46 (WTG 42)	19:33	38 07:34 (WTG 42)	18:36		16:44		16:16	36 14:59 (WTG 45)	
3	05:14	05:43	06:54 (WTG 42)	06:20	06:57 (WTG 42)	06:56		06:36		07:16	14:23 (WTG 45)	
	20:46	20:22	07:46 (WTG 42)	19:31	35 07:32 (WTG 42)	18:35		16:43		16:16	36 14:59 (WTG 45)	
4	05:15	05:44	06:53 (WTG 42)	06:21	06:59 (WTG 42)	06:57	07:46 (WTG 44)	06:38		07:17	14:23 (WTG 45)	
	20:46	20:21	07:47 (WTG 42)	19:29	30 07:29 (WTG 42)	18:33	13 07:59 (WTG 44)	16:42		16:16	37 15:00 (WTG 45)	
5	05:16	05:46	06:52 (WTG 42)	06:22	07:02 (WTG 42)	06:58	07:44 (WTG 44)	06:39		07:18	14:23 (WTG 45)	
	20:46	20:20	07:47 (WTG 42)	19:27	24 07:26 (WTG 42)	18:31	18 08:02 (WTG 44)	16:40		16:16	39 15:02 (WTG 45)	
6	05:16	05:47	06:52 (WTG 42)	06:23	07:06 (WTG 42)	07:00	07:42 (WTG 44)	06:41		07:19	14:23 (WTG 45)	
	20:46	20:19	07:48 (WTG 42)	19:26	15 07:21 (WTG 42)	18:29	21 08:03 (WTG 44)	16:39		16:15	40 15:03 (WTG 45)	
7	05:17	05:48	06:51 (WTG 42)	06:25		07:01	07:40 (WTG 44)	06:42		07:20	14:23 (WTG 45)	
	20:45	20:17	07:48 (WTG 42)	19:24		18:27	24 08:04 (WTG 44)	16:38		16:15	40 15:03 (WTG 45)	
8	05:18	05:49	06:51 (WTG 42)	06:26		07:02	07:39 (WTG 44)	06:43		07:21	14:23 (WTG 45)	
	20:45	20:16	07:48 (WTG 42)	19:22		18:25	25 08:04 (WTG 44)	16:36		16:15	41 15:04 (WTG 45)	
9	05:18	05:50	06:50 (WTG 42)	06:27		07:03	07:39 (WTG 44)	06:45		07:22	14:24 (WTG 45)	
	20:45	20:14	07:48 (WTG 42)	19:20		18:24	27 08:06 (WTG 44)	16:35		16:15	41 15:05 (WTG 45)	
10	05:19	05:51	06:50 (WTG 42)	06:28		07:05	07:38 (WTG 44)	06:46		07:23	14:24 (WTG 45)	
	20:44	20:13	07:50 (WTG 42)	19:18		18:22	28 08:06 (WTG 44)	16:34		16:15	41 15:05 (WTG 45)	
11	05:20	05:53	06:50 (WTG 42)	06:29		07:06	07:37 (WTG 44)	06:47		07:24	14:24 (WTG 45)	
	20:44	20:11	07:50 (WTG 42)	19:16		18:20	28 08:05 (WTG 44)	16:33		16:15	42 15:06 (WTG 45)	
12	05:21	05:54	06:49 (WTG 42)	06:31		07:07	07:37 (WTG 44)	06:49		07:25	14:23 (WTG 45)	
	20:43	20:10	07:50 (WTG 42)	19:14		18:18	29 08:06 (WTG 44)	16:32		16:15	43 15:06 (WTG 45)	
13	05:22	05:55	06:49 (WTG 42)	06:32		07:08	07:36 (WTG 44)	06:50		07:25	14:24 (WTG 45)	
	20:42	20:08	07:50 (WTG 42)	19:12		18:16	29 08:05 (WTG 44)	16:31		16:15	43 15:07 (WTG 45)	
14	05:23	05:56	06:49 (WTG 42)	06:33		07:10	07:36 (WTG 44)	06:52		07:26	14:24 (WTG 45)	
	20:42	20:07	07:50 (WTG 42)	19:11		18:15	29 08:05 (WTG 44)	16:29		16:15	43 15:07 (WTG 45)	
15	05:23	05:57	06:48 (WTG 42)	06:34		07:11	07:37 (WTG 44)	06:53		07:27	14:25 (WTG 45)	
	20:41	20:05	07:49 (WTG 42)	19:09		18:13	28 08:05 (WTG 44)	16:28		16:15	43 15:08 (WTG 45)	
16	05:24	05:58	06:48 (WTG 42)	06:35		07:12	07:37 (WTG 44)	06:54		07:28	14:25 (WTG 45)	
	20:41	20:04	07:49 (WTG 42)	19:07		18:11	27 08:04 (WTG 44)	16:27		16:16	44 15:09 (WTG 45)	
17	05:25	06:00	06:48 (WTG 42)	06:36		07:14	07:37 (WTG 44)	06:57		07:28	14:25 (WTG 45)	
	20:40	20:02	07:49 (WTG 42)	19:05		18:09	26 08:03 (WTG 44)	16:26		16:16	44 15:09 (WTG 45)	
18	05:26	07:13 (WTG 42)	06:01	06:48 (WTG 42)	06:38		07:15	07:38 (WTG 44)	06:57		07:29	14:26 (WTG 45)
	20:39	12 07:25 (WTG 42)	20:01	06:48 (WTG 42)	19:03		18:08	24 08:02 (WTG 44)	16:25		16:16	44 15:10 (WTG 45)
19	05:27	07:10 (WTG 42)	06:02	06:48 (WTG 42)	06:39		07:16	07:39 (WTG 44)	06:58		07:30	14:26 (WTG 45)
	20:38	17 07:27 (WTG 42)	19:57	06:48 (WTG 42)	19:01		18:06	21 08:00 (WTG 44)	16:25		16:17	44 15:10 (WTG 45)
20	05:28	07:08 (WTG 42)	06:03	06:48 (WTG 42)	06:40		07:18	07:41 (WTG 44)	07:00		07:30	14:27 (WTG 45)
	20:37	22 07:30 (WTG 42)	19:56	06:48 (WTG 42)	18:59		18:04	18 07:59 (WTG 44)	16:24		16:17	44 15:11 (WTG 45)
21	05:29	07:06 (WTG 42)	06:04	06:48 (WTG 42)	06:41		07:19	07:42 (WTG 44)	07:01		07:31	14:27 (WTG 45)
	20:37	26 07:32 (WTG 42)	19:54	06:48 (WTG 42)	18:57		18:03	15 07:57 (WTG 44)	16:23		16:17	45 15:12 (WTG 45)
22	05:30	07:05 (WTG 42)	06:06	06:48 (WTG 42)	06:42		07:20	07:45 (WTG 44)	07:02		07:31	14:27 (WTG 45)
	20:36	28 07:33 (WTG 42)	19:52	06:48 (WTG 42)	18:55		18:01	8 07:53 (WTG 44)	16:22		16:18	45 15:12 (WTG 45)
23	05:31	07:03 (WTG 42)	06:07	06:48 (WTG 42)	06:44		07:22		07:03		07:32	14:27 (WTG 45)
	20:35	32 07:35 (WTG 42)	19:51	06:48 (WTG 42)	18:53		17:59		16:21	12 14:33 (WTG 45)	07:32	14:27 (WTG 45)
24	05:32	07:02 (WTG 42)	06:08	06:48 (WTG 42)	06:45		07:23		07:05		16:18	45 15:12 (WTG 45)
	20:34	34 07:36 (WTG 42)	19:49	06:48 (WTG 42)	18:51		17:58		16:21	17 14:47 (WTG 45)	07:32	14:29 (WTG 45)
25	05:33	07:01 (WTG 42)	06:09	06:49 (WTG 42)	06:46		07:24		07:06		16:19	44 15:13 (WTG 45)
	20:33	36 07:37 (WTG 42)	19:47	06:49 (WTG 42)	18:50		17:56		16:20	21 14:49 (WTG 45)	07:33	14:29 (WTG 45)
26	05:34	07:00 (WTG 42)	06:10	06:50 (WTG 42)	06:47		07:26		07:07		16:20	44 15:13 (WTG 45)
	20:32	39 07:39 (WTG 42)	19:45	06:50 (WTG 42)	18:48		17:55		16:19	24 14:52 (WTG 45)	07:33	14:29 (WTG 45)
27	05:35	06:59 (WTG 42)	06:12	06:50 (WTG 42)	06:48		07:27		07:09		16:20	44 15:13 (WTG 45)
	20:31	41 07:40 (WTG 42)	19:44	06:50 (WTG 42)	18:46		17:53		16:19	27 14:53 (WTG 45)	07:33	14:30 (WTG 45)
28	05:36	06:58 (WTG 42)	06:13	06:50 (WTG 42)	06:50		07:28		07:10		16:21	44 15:14 (WTG 45)
	20:30	43 07:41 (WTG 42)	19:42	06:50 (WTG 42)	18:44		17:52		16:18	29 14:54 (WTG 45)	07:34	14:31 (WTG 45)
29	05:38	06:57 (WTG 42)	06:14	06:51 (WTG 42)	06:51		07:30		07:11		16:22	43 15:14 (WTG 45)
	20:28	45 07:42 (WTG 42)	19:40	06:51 (WTG 42)	18:42		17:50		16:18	31 14:55 (WTG 45)	07:34	14:31 (WTG 45)
30	05:39	06:57 (WTG 42)	06:15	06:52 (WTG 42)	06:52		07:31		07:12		16:22	43 15:14 (WTG 45)
	20:27	46 07:43 (WTG 42)	19:38	06:52 (WTG 42)	18:40		17:49		16:17	33 14:57 (WTG 45)	07:34	14:32 (WTG 45)
31	05:40	06:56 (WTG 42)	06:16	06:52 (WTG 42)			07:32				16:23	42 15:14 (WTG 45)
	20:26	48 07:44 (WTG 42)	19:37	06:52 (WTG 42)			17:47				07:34	14:32 (WTG 45)
											16:24	43 15:15 (WTG 45)
Potential sun hours	472	436		376		341		288		274		
Total, worst case	469	1757		185		438		194		1301		
Sun reduction	0.45	0.46		0.42		0.36		0.25		0.28		
Oper. time red.	1.00	1.00		1.00		1.00		1.00		1.00		
Wind dir. red.	0.78	0.78		0.78		0.67		0.75		0.75		
Total reduction	0.35	0.36		0.33		0.24		0.19		0.21		
Total, real	164	629		60		105		36		271		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-106 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (340)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35 16:25	08:02 (WTG 53) 17:04	08:06 (WTG 53) 17:43	07:10 (WTG 52) 19:23	06:39 20:00	05:14 20:34
2	07:35 16:26	08:02 (WTG 53) 17:05	08:08 (WTG 53) 17:44	07:09 (WTG 52) 19:24	06:37 20:01	05:13 20:35
3	07:35 16:27	08:01 (WTG 53) 17:06	08:10 (WTG 53) 17:46	07:10 (WTG 52) 19:26	06:35 20:02	05:13 20:36
4	07:35 16:28	08:01 (WTG 53) 17:08	08:13 (WTG 53) 17:47	07:10 (WTG 52) 19:27	06:33 20:03	05:12 20:37
5	07:34 16:29	08:01 (WTG 53) 17:09	08:21 (WTG 53) 17:48	07:10 (WTG 52) 19:28	06:31 20:05	05:12 20:38
6	07:34 16:30	08:01 (WTG 53) 17:11	08:22 (WTG 53) 17:50	07:10 (WTG 52) 19:30	06:29 20:06	05:11 20:38
7	07:34 16:31	08:00 (WTG 53) 17:12	08:25 (WTG 53) 17:51	07:10 (WTG 52) 19:31	06:28 20:07	05:11 20:39
8	07:34 16:32	08:00 (WTG 53) 17:14	08:26 (WTG 53) 17:52	07:10 (WTG 52) 19:32	06:26 20:08	05:11 20:40
9	07:34 16:33	08:00 (WTG 53) 17:15	08:27 (WTG 53) 17:53	07:10 (WTG 52) 19:33	06:24 20:09	05:10 20:40
10	07:33 16:34	07:59 (WTG 53) 17:16	08:28 (WTG 53) 17:54	08:13 (WTG 52) 19:33	06:22 20:10	05:10 20:41
11	07:33 16:35	07:59 (WTG 53) 17:18	08:29 (WTG 53) 17:55	08:14 (WTG 52) 19:34	06:20 20:11	05:10 20:42
12	07:33 16:36	07:59 (WTG 53) 17:19	08:30 (WTG 53) 17:56	08:16 (WTG 52) 19:35	06:18 20:12	05:10 20:43
13	07:32 16:37	07:59 (WTG 53) 17:21	08:31 (WTG 53) 17:57	08:18 (WTG 52) 19:36	06:17 20:13	05:09 20:44
14	07:32 16:38	07:59 (WTG 53) 17:22	08:32 (WTG 53) 17:58	08:20 (WTG 52) 19:37	06:15 20:14	05:09 20:45
15	07:31 16:39	07:59 (WTG 53) 17:24	08:33 (WTG 53) 17:59	08:23 (WTG 52) 19:38	06:13 20:15	05:09 20:46
16	07:31 16:40	07:59 (WTG 53) 17:25	08:34 (WTG 53) 18:00	08:25 (WTG 52) 19:39	06:11 20:16	05:09 20:47
17	07:30 16:41	07:58 (WTG 53) 17:26	08:35 (WTG 53) 18:01	08:28 (WTG 52) 19:40	06:09 20:17	05:09 20:48
18	07:30 16:42	07:59 (WTG 53) 17:28	08:36 (WTG 53) 18:02	08:30 (WTG 52) 19:41	06:07 20:18	05:09 20:49
19	07:29 16:43	07:59 (WTG 53) 17:30	08:37 (WTG 53) 18:03	08:33 (WTG 52) 19:42	06:05 20:19	05:09 20:50
20	07:29 16:44	07:59 (WTG 53) 17:32	08:38 (WTG 53) 18:04	08:35 (WTG 52) 19:43	06:03 20:20	05:09 20:51
21	07:28 16:45	07:59 (WTG 53) 17:34	08:39 (WTG 53) 18:05	08:38 (WTG 52) 19:44	06:01 20:21	05:09 20:52
22	07:27 16:46	07:59 (WTG 53) 17:36	08:40 (WTG 53) 18:06	08:40 (WTG 52) 19:45	06:00 20:22	05:09 20:53
23	07:26 16:47	08:00 (WTG 53) 17:38	08:41 (WTG 53) 18:07	08:43 (WTG 52) 19:46	06:00 20:23	05:10 20:54
24	07:25 16:48	08:00 (WTG 53) 17:40	08:42 (WTG 53) 18:08	08:45 (WTG 52) 19:47	05:59 20:24	05:10 20:55
25	07:24 16:49	08:01 (WTG 53) 17:42	08:43 (WTG 53) 18:09	08:48 (WTG 52) 19:48	05:57 20:25	05:10 20:56
26	07:23 16:50	08:02 (WTG 53) 17:44	08:44 (WTG 53) 18:10	08:50 (WTG 52) 19:49	05:55 20:26	05:10 20:57
27	07:22 16:51	08:03 (WTG 53) 17:46	08:45 (WTG 53) 18:11	08:53 (WTG 52) 19:50	05:53 20:27	05:10 20:58
28	07:21 16:52	08:03 (WTG 53) 17:48	08:46 (WTG 53) 18:12	08:56 (WTG 52) 19:51	05:51 20:28	05:10 20:59
29	07:20 16:53	08:03 (WTG 53) 17:50	08:47 (WTG 53) 18:13	08:59 (WTG 52) 19:52	05:49 20:29	05:10 21:00
30	07:19 16:54	08:04 (WTG 53) 17:52	08:48 (WTG 53) 18:14	09:00 (WTG 52) 19:53	05:47 20:30	05:10 21:01
31	07:18 16:55	08:05 (WTG 53) 17:54	08:49 (WTG 53) 18:15	09:03 (WTG 52) 19:54	05:45 20:31	05:10 21:02
Potential sun hours	286	291	369	404	459	466
Total, worst case	732	430	432	865	1939	
Sun reduction	0.29	0.37	0.37	0.44	0.47	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.56	0.65	0.66	0.81	0.81	
Total reduction	0.16	0.23	0.24	0.35	0.37	
Total, real	116	100	103	299	716	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-106 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (340)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	06:00 (WTG 77)	05:41	06:18	06:53	07:13
2	05:14	06:01 (WTG 77)	05:42	06:19	06:55	07:14
3	05:15	06:02 (WTG 77)	05:43	06:20	06:56	07:16
4	05:16	06:03 (WTG 77)	05:44	06:21	06:57	07:17
5	05:16	06:04 (WTG 77)	05:45	06:22	06:58	07:18
6	05:16	06:05 (WTG 77)	05:46	06:23	06:59	07:19
7	05:17	06:06 (WTG 77)	05:47	06:24	07:00	07:20
8	05:18	06:07 (WTG 77)	05:48	06:25	07:01	07:21
9	05:19	06:08 (WTG 77)	05:49	06:26	07:02	07:22
10	05:19	06:09 (WTG 77)	05:50	06:27	07:03	07:23
11	05:20	06:10 (WTG 77)	05:51	06:28	07:04	07:24
12	05:21	06:11 (WTG 77)	05:52	06:29	07:05	07:25
13	05:22	06:12 (WTG 77)	05:53	06:30	07:06	07:26
14	05:23	06:13 (WTG 77)	05:54	06:31	07:07	07:27
15	05:24	06:14 (WTG 77)	05:55	06:32	07:08	07:28
16	05:24	06:15 (WTG 77)	05:56	06:33	07:09	07:29
17	05:25	06:16 (WTG 77)	05:57	06:34	07:10	07:30
18	05:26	06:17 (WTG 77)	05:58	06:35	07:11	07:31
19	05:27	06:18 (WTG 77)	05:59	06:36	07:12	07:32
20	05:28	06:19 (WTG 77)	06:00	06:37	07:13	07:33
21	05:29	06:20 (WTG 77)	06:01	06:38	07:14	07:34
22	05:30	06:21 (WTG 77)	06:02	06:39	07:15	07:35
23	05:31	06:22 (WTG 77)	06:03	06:40	07:16	07:36
24	05:32	06:23 (WTG 77)	06:04	06:41	07:17	07:37
25	05:33	06:24 (WTG 77)	06:05	06:42	07:18	07:38
26	05:34	06:25 (WTG 77)	06:06	06:43	07:19	07:39
27	05:35	06:26 (WTG 77)	06:07	06:44	07:20	07:40
28	05:37	06:28 (WTG 77)	06:09	06:46	07:22	07:42
29	05:38	06:29 (WTG 77)	06:10	06:47	07:23	07:43
30	05:39	06:30 (WTG 77)	06:11	06:48	07:24	07:44
31	05:40	06:31 (WTG 77)	06:12	06:49	07:25	07:45
Potential sun hours	472	436	376	341	288	274
Total, worst case	1595		13	796	615	194
Sun reduction	0.45		0.42	0.36	0.25	0.28
Oper. time red.	1.00		1.00	1.00	1.00	1.00
Wind dir. red.	0.81		0.66	0.66	0.56	0.56
Total reduction	0.35		0.27	0.23	0.14	0.15
Total, real	564		4	184	84	30

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-108 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (342)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	
1	07:34	13:23 (WTG 102-L)   07:17	06:36	16:32 (WTG 104-L)   06:39	05:47	05:14	
	16:25	97 15:47 (WTG 105-L)   17:04	17:43	28 17:00 (WTG 104-L)   19:23	20:00	20:34	
2	07:34	13:24 (WTG 102-L)   07:16	06:34	16:33 (WTG 104-L)   06:37	05:46	05:13	
	16:26	96 15:47 (WTG 105-L)   17:05	17:44	26 16:59 (WTG 104-L)   19:24	20:01	20:35	
3	07:34	13:24 (WTG 102-L)   07:15	06:32	16:35 (WTG 104-L)   06:35	05:44	05:13	
	16:27	97 15:48 (WTG 105-L)   17:07	17:46	23 16:58 (WTG 104-L)   19:26	20:02	20:36	
4	07:34	13:25 (WTG 102-L)   07:13	06:30	16:37 (WTG 104-L)   06:33	05:43	05:12	
	16:28	96 15:48 (WTG 105-L)   17:08	17:47	19 16:56 (WTG 104-L)   19:27	20:03	20:37	
5	07:34	13:26 (WTG 102-L)   07:12	06:28	16:39 (WTG 104-L)   06:31	05:41	05:12	
	16:29	96 15:49 (WTG 105-L)   17:09	17:48	14 16:53 (WTG 104-L)   19:28	20:05	20:37	
6	07:34	13:26 (WTG 102-L)   07:11	06:27		06:29	05:40	05:11
	16:30	94 15:48 (WTG 105-L)   17:11	17:50		19:30	20:06	20:38
7	07:34	13:27 (WTG 102-L)   07:10	06:25		06:28	05:39	05:11
	16:31	94 15:49 (WTG 105-L)   17:12	17:51		19:31	20:07	20:39
8	07:34	13:28 (WTG 102-L)   07:08	07:23		06:26	05:37	05:11
	16:32	92 15:49 (WTG 105-L)   17:14	18:52		19:32	20:08	20:40
9	07:34	13:29 (WTG 102-L)   07:07	07:21		06:24	05:36	05:10
	16:33	92 15:50 (WTG 105-L)   17:15	18:54		19:33	20:09	20:40
10	07:33	13:29 (WTG 102-L)   07:05	07:19		06:22	05:35	05:10
	16:35	90 15:49 (WTG 105-L)   17:17	18:55		19:35	20:11	20:41
11	07:33	13:30 (WTG 102-L)   07:04	07:18		06:20	05:33	05:10
	16:36	90 15:50 (WTG 105-L)   17:18	18:56		19:36	20:12	20:42
12	07:33	13:30 (WTG 102-L)   07:03	16:43 (WTG 104-L)   07:16		06:19	05:32	05:10
	16:37	88 15:49 (WTG 105-L)   17:19	9 16:52 (WTG 104-L)   18:58		19:37	20:13	20:42
13	07:32	13:32 (WTG 102-L)   07:01	07:14		06:17	05:31	05:10
	16:38	86 15:50 (WTG 105-L)   17:21	16 16:55 (WTG 104-L)   18:59		19:38	20:14	20:43
14	07:32	13:32 (WTG 102-L)   07:00	07:12		06:15	05:30	05:10
	16:39	84 15:49 (WTG 105-L)   17:22	20 16:58 (WTG 104-L)   19:00		19:40	20:15	20:43
15	07:31	13:34 (WTG 102-L)   06:58	07:10		06:13	05:29	05:09
	16:41	81 15:49 (WTG 105-L)   17:24	23 16:59 (WTG 104-L)   19:02		19:41	20:16	20:44
16	07:31	13:34 (WTG 102-L)   06:57	07:08		06:12	05:27	05:09
	16:42	78 15:48 (WTG 105-L)   17:25	26 17:01 (WTG 104-L)   19:03		19:42	20:18	20:44
17	07:30	13:35 (WTG 102-L)   06:55	07:07		06:10	05:26	05:09
	16:43	75 15:47 (WTG 105-L)   17:26	28 17:01 (WTG 104-L)   19:04		19:43	20:19	20:45
18	07:29	13:37 (WTG 102-L)   06:54	07:05		06:08	05:25	05:09
	16:44	71 15:47 (WTG 105-L)   17:28	30 17:03 (WTG 104-L)   19:05		19:45	20:20	20:45
19	07:29	13:38 (WTG 102-L)   06:52	07:03		06:06	05:24	05:10
	16:46	67 15:46 (WTG 105-L)   17:29	31 17:03 (WTG 104-L)   19:07		19:46	20:21	20:45
20	07:28	13:39 (WTG 102-L)   06:51	07:01		06:05	05:23	05:10
	16:47	58 15:42 (WTG 105-L)   17:31	32 17:03 (WTG 104-L)   19:08		19:47	20:22	20:46
21	07:27	13:40 (WTG 102-L)   06:49	06:59		06:03	05:22	05:10
	16:48	52 14:32 (WTG 102-L)   17:32	33 17:04 (WTG 104-L)   19:09		19:48	20:23	20:46
22	07:27	13:41 (WTG 102-L)   06:47	06:57		06:01	05:21	05:10
	16:50	51 14:32 (WTG 102-L)   17:33	33 17:04 (WTG 104-L)   19:11		19:50	20:24	20:46
23	07:26	13:42 (WTG 102-L)   06:46	06:55		06:00	05:20	05:10
	16:51	49 14:31 (WTG 102-L)   17:35	33 17:04 (WTG 104-L)   19:12		19:51	20:25	20:46
24	07:25	13:45 (WTG 102-L)   06:44	06:54		05:58	05:19	05:11
	16:52	46 14:31 (WTG 102-L)   17:36	33 17:04 (WTG 104-L)   19:13		19:52	20:26	20:47
25	07:24	13:47 (WTG 102-L)   06:42	06:52		05:56	05:19	05:11
	16:54	43 14:30 (WTG 102-L)   17:38	32 17:03 (WTG 104-L)   19:14		19:53	20:27	20:47
26	07:23	13:49 (WTG 102-L)   06:41	06:50		05:55	05:18	05:11
	16:55	40 14:29 (WTG 102-L)   17:39	31 17:02 (WTG 104-L)   19:16		19:55	20:28	20:47
27	07:22	13:50 (WTG 102-L)   06:39	06:48		05:53	05:17	05:12
	16:57	37 14:27 (WTG 102-L)   17:40	31 17:03 (WTG 104-L)   19:17		19:56	20:29	20:47
28	07:21	13:52 (WTG 102-L)   06:37	06:46		05:52	05:16	05:12
	16:58	33 14:25 (WTG 102-L)   17:42	29 17:01 (WTG 104-L)   19:18		19:57	20:30	20:47
29	07:20	13:55 (WTG 102-L)   06:35	06:44		05:50	05:16	05:13
	16:59	28 14:23 (WTG 102-L)   17:43	19:19		19:58	20:31	20:47
30	07:19	13:59 (WTG 102-L)   06:33	06:42		05:49	05:15	05:13
	17:01	21 14:20 (WTG 102-L)   17:44	19:21		20:00	20:32	20:47
31	07:18	14:05 (WTG 102-L)   06:31	06:40			05:14	
	17:02	10 14:15 (WTG 102-L)   17:45	19:22			20:33	
Potential sun hours	286	291	369	404	459	466	
Total, worst case	2132	470	110				
Sun reduction	0.29	0.37	0.37				
Oper. time red.	1.00	1.00	1.00				
Wind dir. red.	0.71	0.80	0.80				
Total reduction	0.20	0.30	0.30				
Total, real	434	139	33				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-108 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (342)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:14	05:41	06:18	06:53	06:34	07:13
	20:47	20:25	19:35	18:38	16:46	16:17
2	05:14	05:42	06:19	06:55	06:35	07:14
	20:46	20:24	19:33	18:36	16:44	16:17
3	05:15	05:43	06:20	06:56	06:36	07:15
	20:46	20:22	19:31	18:35	16:43	16:16
4	05:15	05:45	06:21	06:57	06:38	07:17
	20:46	20:21	19:29	18:33	16:42	16:16
5	05:16	05:46	06:22	06:58	06:39	07:18
	20:46	20:20	19:27	18:31	16:40	16:16
6	05:17	05:47	06:24	07:00	06:41	07:19
	20:46	20:18	19:26	18:29	16:39	16:16
7	05:17	05:48	06:25	07:01	06:42	07:20
	20:45	20:17	19:24	18:27	16:38	16:15
8	05:18	05:49	06:26	07:02	06:43	07:21
	20:45	20:16	19:22	18:25	16:36	16:15
9	05:19	05:50	06:27	07:03	06:45	07:22
	20:44	20:14	19:20	18:24	16:35	16:15
10	05:19	05:52	06:28	07:05	06:46	07:23
	20:44	20:13	19:18	18:22	16:34	16:15
11	05:20	05:53	06:29	07:06	06:47	07:24
	20:43	20:11	19:16	18:20	16:33	16:15
12	05:21	05:54	06:31	07:07	06:49	07:24
	20:43	20:10	19:14	18:18	16:32	16:15
13	05:22	05:55	06:32	07:08	06:50	07:25
	20:42	20:08	19:12	18:16	16:31	16:15
14	05:23	05:56	06:33	07:10	06:51	07:26
	20:42	20:07	19:11	18:15	16:30	16:15
15	05:24	05:57	06:34	07:11	06:53	07:27
	20:41	20:05	19:09	18:13	16:29	16:16
16	05:25	05:59	06:35	07:12	06:54	07:28
	20:40	20:04	19:07	18:11	16:28	16:16
17	05:25	06:00	06:37	07:14	06:55	07:28
	20:40	20:02	19:05	18:09	16:27	16:16
18	05:26	06:01	06:38	07:15	06:57	07:29
	20:39	20:01	19:03	18:08	16:26	16:16
19	05:27	06:02	06:39	07:16	06:58	07:30
	20:38	19:57	19:01	18:06	16:25	16:17
20	05:28	06:03	06:40	07:18	06:59	07:30
	20:37	19:56	18:59	18:04	16:24	16:17
21	05:29	06:05	06:41	07:19	07:01	07:31
	20:36	19:54	18:57	18:03	16:23	16:18
22	05:30	06:06	06:43	07:20	07:02	07:31
	20:36	19:52	18:55	18:01	16:22	16:18
23	05:31	06:07	06:44	07:21	07:03	07:32
	20:35	19:51	18:53	18:00	16:22	16:19
24	05:32	06:08	06:45	07:23	07:05	07:32
	20:34	19:49	18:52	17:58	16:21	16:19
25	05:33	06:09	06:46	07:24	07:06	07:33
	20:33	19:47	18:50	17:56	16:20	16:20
26	05:35	06:10	06:47	07:26	07:07	07:33
	20:32	19:45	18:48	17:55	16:20	16:20
27	05:36	06:12	06:49	07:27	07:08	07:33
	20:31	19:44	18:46	17:53	16:19	16:21
28	05:37	06:13	06:50	07:28	07:10	07:34
	20:29	19:42	18:44	17:52	16:18	16:22
29	05:38	06:14	06:51	07:30	07:11	07:34
	20:28	19:40	18:42	17:50	16:18	16:23
30	05:39	06:15	06:52	07:31	07:12	07:34
	20:27	19:38	18:40	17:49	16:17	16:23
31	05:40	06:16	06:53	07:32	07:13	07:34
	20:26	19:37	18:39	17:47	16:16	16:24
Potential sun hours	472	436	376	341	288	275
Total, worst case				588	1099	2992
Sun reduction				0.36	0.25	0.28
Oper. time red.				1.00	1.00	1.00
Wind dir. red.				0.80	0.70	0.71
Total reduction				0.29	0.17	0.20
Total, real				169	191	594

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Licensed user:

EDR

217 Montgomery St.

US-SYRACUSE, NY 13202

(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-120 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (352)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June	
1	07:34	07:17	06:36	06:39	05:47	05:14	05:49 (WTG 53)
	16:25	17:04	17:43	19:23	20:00	20:34	42 06:31 (WTG 53)
2	07:35	07:16	06:34	06:37	05:46	05:13	05:49 (WTG 53)
	16:26	17:05	17:44	19:24	20:01	20:35	43 06:32 (WTG 53)
3	07:35	07:15	06:32	07:04 (WTG 57)	06:35	05:44	05:13
	16:27	17:06	17:46	6 07:10 (WTG 57)	19:26	20:02	20:36
4	07:34	07:13	06:30	06:58 (WTG 57)	06:33	05:43	05:12
	16:28	17:08	17:47	17 07:15 (WTG 57)	19:27	20:03	20:37
5	07:34	07:12	06:29	06:55 (WTG 57)	06:31	05:41	05:12
	16:29	17:09	17:48	22 07:17 (WTG 57)	19:28	20:05	20:37
6	07:34	07:11	06:27	06:53 (WTG 57)	06:29	05:40	05:11
	16:30	17:11	17:50	26 07:19 (WTG 57)	19:30	20:06	20:38
7	07:34	07:10	06:25	06:51 (WTG 57)	06:28	05:38	05:11
	16:31	17:12	17:51	29 07:20 (WTG 57)	19:31	20:07	20:39
8	07:34	07:08	07:23	07:50 (WTG 57)	06:26	05:37	05:11
	16:32	17:14	18:52	32 08:22 (WTG 57)	19:32	20:08	20:40
9	07:34	07:07	07:21	07:49 (WTG 57)	06:24	05:36	05:10
	16:33	17:15	18:54	33 08:22 (WTG 57)	19:33	20:09	20:40
10	07:33	07:06	07:20	07:47 (WTG 57)	06:22	05:35	05:10
	16:35	17:16	18:55	36 08:23 (WTG 57)	19:35	20:11	20:41
11	07:33	07:04	07:18	07:46 (WTG 57)	06:20	05:33	05:10
	16:36	17:18	18:56	37 08:23 (WTG 57)	19:36	20:12	2 06:10 (WTG 53)
12	07:33	07:03	07:16	07:45 (WTG 57)	06:18	05:32	06:02 (WTG 53)
	16:37	17:19	18:58	38 08:23 (WTG 57)	19:37	20:13	14 06:16 (WTG 53)
13	07:32	07:01	07:14	07:45 (WTG 57)	06:17	05:31	06:00 (WTG 53)
	16:38	17:21	18:59	38 08:23 (WTG 57)	19:38	20:14	18 06:18 (WTG 53)
14	07:32	07:00	07:12	07:44 (WTG 57)	06:15	05:30	05:58 (WTG 53)
	16:39	17:22	19:00	39 08:23 (WTG 57)	19:40	20:15	22 06:20 (WTG 53)
15	07:31	06:58	07:10	07:44 (WTG 57)	06:13	05:28	05:56 (WTG 53)
	16:41	17:24	19:02	40 08:24 (WTG 57)	19:41	20:17	26 06:22 (WTG 53)
16	07:31	06:57	07:08	07:44 (WTG 57)	06:11	05:27	05:55 (WTG 53)
	16:42	17:25	19:03	39 08:23 (WTG 57)	19:42	20:18	28 06:23 (WTG 53)
17	07:30	06:55	07:07	07:44 (WTG 57)	06:10	05:26	05:54 (WTG 53)
	16:43	17:26	19:04	39 08:23 (WTG 57)	19:43	20:19	30 06:24 (WTG 53)
18	07:30	06:54	07:05	07:44 (WTG 57)	06:08	05:25	05:53 (WTG 53)
	16:44	17:28	19:05	38 08:22 (WTG 57)	19:45	20:20	32 06:25 (WTG 53)
19	07:29	06:52	07:03	07:43 (WTG 57)	06:06	05:24	05:52 (WTG 53)
	16:46	17:29	19:07	38 08:21 (WTG 57)	19:46	20:21	34 06:26 (WTG 53)
20	07:28	06:51	07:01	07:44 (WTG 57)	06:05	05:23	05:52 (WTG 53)
	16:47	17:31	19:08	36 08:20 (WTG 57)	19:47	20:22	35 06:27 (WTG 53)
21	07:27	06:49	06:59	07:44 (WTG 57)	06:03	05:22	05:51 (WTG 53)
	16:48	17:32	19:09	35 08:19 (WTG 57)	19:48	20:23	36 06:27 (WTG 53)
22	07:27	06:47	06:57	07:44 (WTG 57)	06:01	05:21	05:50 (WTG 53)
	16:50	17:33	19:11	33 08:17 (WTG 57)	19:50	20:24	38 06:28 (WTG 53)
23	07:26	06:46	06:55	07:46 (WTG 57)	06:00	05:20	05:50 (WTG 53)
	16:51	17:35	19:12	31 08:17 (WTG 57)	19:51	20:25	38 06:28 (WTG 53)
24	07:25	06:44	06:54	07:47 (WTG 57)	05:58	05:19	05:49 (WTG 53)
	16:52	17:36	19:13	28 08:15 (WTG 57)	19:52	20:26	39 06:28 (WTG 53)
25	07:24	06:42	06:52	07:48 (WTG 57)	05:56	05:19	05:50 (WTG 53)
	16:54	17:38	19:14	25 08:13 (WTG 57)	19:53	20:27	39 06:29 (WTG 53)
26	07:23	06:41	06:50	07:50 (WTG 57)	05:55	05:18	05:49 (WTG 53)
	16:55	17:39	19:16	20 08:10 (WTG 57)	19:55	20:28	40 06:29 (WTG 53)
27	07:22	06:39	06:48	07:52 (WTG 57)	05:53	05:17	05:49 (WTG 53)
	16:57	17:40	19:17	14 08:06 (WTG 57)	19:56	20:29	41 06:30 (WTG 53)
28	07:21	06:37	06:46		05:52	05:16	05:48 (WTG 53)
	16:58	17:42	19:18		19:57	20:30	42 06:30 (WTG 53)
29	07:20		06:44		05:50	05:16	05:49 (WTG 53)
	16:59		19:19		19:58	20:31	41 06:30 (WTG 53)
30	07:19		06:42		05:49	05:15	05:48 (WTG 53)
	17:01		19:21		20:00	20:32	42 06:30 (WTG 53)
31	07:18		06:40			05:14	05:49 (WTG 53)
	17:02		19:22			20:33	42 06:31 (WTG 53)
Potential sun hours	286	291	369	404	459	466	1282
Total, worst case			769		679		1282
Sun reduction			0.37		0.44		0.47
Oper. time red.			1.00		1.00		1.00
Wind dir. red.			0.70		0.81		0.81
Total reduction			0.26		0.35		0.38
Total, real			199		240		483

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-120 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (352)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:54 (WTG 53)	05:41	06:14 (WTG 53)	06:18	06:53
	20:47	06:37 (WTG 53)	20:25	19:35	18:38	07:25 (WTG 57)
2	05:14	05:55 (WTG 53)	05:42	06:19	06:55	08:03 (WTG 57)
	20:47	06:38 (WTG 53)	20:24	19:33	18:36	07:25 (WTG 57)
3	05:15	05:55 (WTG 53)	05:43	06:20	06:56	08:02 (WTG 57)
	20:46	06:38 (WTG 53)	20:22	19:31	18:35	07:25 (WTG 57)
4	05:15	05:55 (WTG 53)	05:44	06:21	06:57	08:01 (WTG 57)
	20:46	06:38 (WTG 53)	20:21	19:29	18:33	07:25 (WTG 57)
5	05:16	05:55 (WTG 53)	05:46	06:22	06:58	08:01 (WTG 57)
	20:46	06:38 (WTG 53)	20:20	19:27	18:31	07:26 (WTG 57)
6	05:16	05:55 (WTG 53)	05:47	06:23	07:00	08:01 (WTG 57)
	20:46	06:38 (WTG 53)	20:18	19:26	18:29	07:27 (WTG 57)
7	05:17	05:56 (WTG 53)	05:48	06:25	07:01	08:02 (WTG 57)
	20:45	06:39 (WTG 53)	20:17	19:24	18:27	07:28 (WTG 57)
8	05:18	05:55 (WTG 53)	05:49	06:26	07:02	08:02 (WTG 57)
	20:45	06:38 (WTG 53)	20:16	19:22	18:25	07:29 (WTG 57)
9	05:19	05:56 (WTG 53)	05:50	06:27	07:03	08:03 (WTG 57)
	20:44	06:39 (WTG 53)	20:14	19:20	18:24	07:30 (WTG 57)
10	05:19	05:56 (WTG 53)	05:51	06:28	07:05	08:03 (WTG 57)
	20:44	06:39 (WTG 53)	20:13	19:18	18:24	07:31 (WTG 57)
11	05:20	05:57 (WTG 53)	05:53	06:29	07:06	08:04 (WTG 57)
	20:44	06:39 (WTG 53)	20:11	19:16	18:22	07:32 (WTG 57)
12	05:21	05:56 (WTG 53)	05:54	06:31	07:07	08:04 (WTG 57)
	20:43	06:39 (WTG 53)	20:10	19:14	18:20	07:33 (WTG 57)
13	05:22	05:57 (WTG 53)	05:55	06:32	07:08	08:05 (WTG 57)
	20:42	06:39 (WTG 53)	20:08	19:12	18:18	07:34 (WTG 57)
14	05:23	05:57 (WTG 53)	05:56	06:33	07:10	08:05 (WTG 57)
	20:42	06:39 (WTG 53)	20:07	19:11	18:16	07:35 (WTG 57)
15	05:24	05:58 (WTG 53)	05:57	06:34	07:11	08:06 (WTG 57)
	20:41	06:39 (WTG 53)	20:05	19:09	18:13	07:36 (WTG 57)
16	05:24	05:58 (WTG 53)	05:59	06:35	07:12	08:06 (WTG 57)
	20:40	06:39 (WTG 53)	20:04	19:07	18:11	07:37 (WTG 57)
17	05:25	05:59 (WTG 53)	06:00	06:37	07:14	08:07 (WTG 57)
	20:40	06:39 (WTG 53)	20:02	19:05	18:09	07:38 (WTG 57)
18	05:26	05:59 (WTG 53)	06:01	06:38	07:15	08:07 (WTG 57)
	20:39	06:39 (WTG 53)	20:01	19:03	18:07	07:39 (WTG 57)
19	05:27	06:00 (WTG 53)	06:02	06:39	07:16	08:08 (WTG 57)
	20:38	06:39 (WTG 53)	19:57	19:01	18:06	07:40 (WTG 57)
20	05:28	05:59 (WTG 53)	06:03	06:40	07:18	08:08 (WTG 57)
	20:37	06:38 (WTG 53)	19:56	18:59	18:04	07:41 (WTG 57)
21	05:29	06:00 (WTG 53)	06:04	06:41	07:19	08:09 (WTG 57)
	20:37	06:37 (WTG 53)	19:54	18:57	18:03	07:42 (WTG 57)
22	05:30	06:00 (WTG 53)	06:06	06:42	07:20	08:09 (WTG 57)
	20:36	06:37 (WTG 53)	19:52	18:55	18:01	07:43 (WTG 57)
23	05:31	06:01 (WTG 53)	06:07	06:44	07:22	08:10 (WTG 57)
	20:35	06:36 (WTG 53)	19:51	18:53	17:59	07:44 (WTG 57)
24	05:32	06:02 (WTG 53)	06:08	06:45	07:23	08:10 (WTG 57)
	20:34	06:36 (WTG 53)	19:49	18:52	17:58	07:45 (WTG 57)
25	05:33	06:02 (WTG 53)	06:09	06:46	07:24	08:11 (WTG 57)
	20:33	06:35 (WTG 53)	19:47	18:50	17:56	07:46 (WTG 57)
26	05:34	06:03 (WTG 53)	06:10	06:47	07:26	08:11 (WTG 57)
	20:32	06:34 (WTG 53)	19:45	18:48	17:55	07:47 (WTG 57)
27	05:36	06:04 (WTG 53)	06:12	06:49	07:27	08:12 (WTG 57)
	20:31	06:33 (WTG 53)	19:44	18:46	17:53	07:48 (WTG 57)
28	05:37	06:05 (WTG 53)	06:13	06:50	07:28	08:12 (WTG 57)
	20:30	06:32 (WTG 53)	19:42	18:44	17:52	07:49 (WTG 57)
29	05:38	06:08 (WTG 53)	06:14	06:51	07:30	08:13 (WTG 57)
	20:28	06:32 (WTG 53)	19:40	18:42	17:50	07:50 (WTG 57)
30	05:39	06:09 (WTG 53)	06:15	06:52	07:31	08:13 (WTG 57)
	20:27	06:30 (WTG 53)	19:38	18:40	17:49	07:51 (WTG 57)
31	05:40	06:11 (WTG 53)	06:16		07:32	08:14 (WTG 57)
	20:26	06:28 (WTG 53)	19:37		17:47	07:52 (WTG 57)
Potential sun hours	472	436	376	341	288	274
Total, worst case	1164	11	486	290		
Sun reduction	0.45	0.46	0.42	0.36		
Oper. time red.	1.00	1.00	1.00	1.00		
Wind dir. red.	0.81	0.81	0.70	0.70		
Total reduction	0.36	0.37	0.29	0.25		
Total, real	420	4	143	73		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-138 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (363)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35	07:17	06:36	06:39	05:47	05:14
	16:25	17:04	17:43	17:23	20:00	20:34
2	07:35	07:16	06:34	06:37	05:46	05:13
	16:26	17:05	17:44	17:24	20:01	20:35
3	07:35	07:15	06:32	06:35	05:44	05:12
	16:27	17:06	17:46	17:26	20:02	20:36
4	07:35	07:13	06:30	06:33	05:43	05:12
	16:28	17:08	17:47	17:27	20:03	20:37
5	07:34	07:12	06:29	06:31	05:41	05:12
	16:29	17:09	17:48	17:28	20:05	20:38
6	07:34	07:11	06:27	06:29	05:40	05:11
	16:30	17:11	17:50	17:30	20:06	20:38
7	07:34	07:10	06:25	06:27	05:38	05:11
	16:31	17:12	17:51	17:31	20:07	20:39
8	07:34	07:08	06:23	06:26	05:37	05:10
	16:32	17:14	18:52	18:32	20:08	20:40
9	07:34	07:07	06:21	06:24	05:36	05:10
	16:33	17:15	18:54	18:33	20:10	20:40
10	07:33	07:06	06:20	06:22	05:34	05:10
	16:34	17:16	18:55	18:35	20:11	20:41
11	07:33	07:04	06:18	06:20	05:33	05:10
	16:36	17:18	18:56	18:36	20:12	20:42
12	07:33	07:03	06:16	06:18	05:32	05:10
	16:37	17:19	18:58	18:37	20:13	20:42
13	07:32	07:01	06:14	06:17	05:31	05:09
	16:38	17:21	18:59	18:38	20:14	20:43
14	07:32	07:00	06:12	06:15	05:30	05:09
	16:39	17:22	19:00	18:39	20:15	20:43
15	07:31	06:58	06:10	06:13	05:28	05:09
	16:40	17:24	19:02	18:41	20:17	20:44
16	07:31	06:57	06:08	06:11	05:27	05:09
	16:42	17:25	19:03	18:42	20:18	20:44
17	07:30	06:55	06:07	06:10	05:26	05:09
	16:43	17:26	19:04	18:43	20:19	20:45
18	07:30	06:54	06:05	06:08	05:25	05:09
	16:44	17:28	19:05	18:45	20:20	20:45
19	07:29	06:52	06:03	06:06	05:24	05:09
	16:46	17:29	19:07	18:46	20:21	20:46
20	07:28	06:51	06:01	06:05	05:23	05:09
	16:47	17:31	19:08	18:47	20:22	20:46
21	07:27	06:49	06:00	06:03	05:22	05:10
	16:48	17:32	19:09	18:48	20:23	20:46
22	07:27	06:47	06:00	06:01	05:21	05:10
	16:50	17:33	19:11	18:50	20:24	20:46
23	07:26	06:46	06:00	06:00	05:20	05:10
	16:51	17:35	19:12	18:51	20:25	20:47
24	07:25	06:44	06:00	06:00	05:19	05:10
	16:52	17:36	19:13	18:52	20:27	20:47
25	07:24	06:42	06:00	06:00	05:18	05:11
	16:54	17:37	19:14	18:53	20:28	20:47
26	07:23	06:41	06:00	06:00	05:18	05:11
	16:55	17:39	19:16	18:55	20:29	20:47
27	07:22	06:39	06:00	06:00	05:17	05:11
	16:56	17:40	19:17	18:56	20:30	20:47
28	07:21	06:37	06:00	06:00	05:16	05:12
	16:58	17:42	19:18	18:57	20:31	20:47
29	07:20		06:00	06:00	05:15	05:12
	16:59		19:19	18:58	20:31	20:47
30	07:19		06:00	06:00	05:15	05:13
	17:01		19:21	19:00	20:32	20:47
31	07:18		06:00	06:00	05:14	05:13
	17:02		19:22	19:01	20:33	20:47
Potential sun hours	286	291	369	404	459	466
Total, worst case		169	253		1512	1771
Sun reduction		0.37	0.37		0.44	0.47
Oper. time red.		1.00	1.00		1.00	1.00
Wind dir. red.		0.67	0.67		0.80	0.80
Total reduction		0.25	0.25		0.35	0.38
Total, real		42	63		532	665

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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US-SYRACUSE, NY 13202

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-138 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (363)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	06:06 (WTG 83)	05:41	06:14 (WTG 83)	06:17	06:53
	20:47	07:05 (WTG 83)	20:25	07:03 (WTG 83)	19:35	18:38
2	05:14	06:05 (WTG 83)	05:42	06:15 (WTG 83)	06:19	06:55
	20:47	07:04 (WTG 83)	20:24	07:03 (WTG 83)	19:33	18:36
3	05:14	06:06 (WTG 83)	05:43	06:16 (WTG 83)	06:20	06:56
	20:46	07:05 (WTG 83)	20:22	07:01 (WTG 83)	19:31	18:35
4	05:15	06:06 (WTG 83)	05:44	06:17 (WTG 83)	06:21	06:57
	20:46	07:06 (WTG 83)	20:21	07:00 (WTG 83)	19:29	18:33
5	05:16	06:06 (WTG 83)	05:46	06:18 (WTG 83)	06:22	06:58
	20:46	07:05 (WTG 83)	20:20	06:59 (WTG 83)	19:27	18:31
6	05:16	06:06 (WTG 83)	05:47	06:19 (WTG 83)	06:23	07:00
	20:46	07:06 (WTG 83)	20:19	06:58 (WTG 83)	19:26	18:29
7	05:17	06:07 (WTG 83)	05:48	06:20 (WTG 83)	06:25	07:01
	20:45	07:06 (WTG 83)	20:17	06:56 (WTG 83)	19:24	18:27
8	05:18	06:06 (WTG 83)	05:49	06:21 (WTG 83)	06:26	07:02
	20:45	07:06 (WTG 83)	20:16	06:54 (WTG 83)	19:22	18:25
9	05:18	06:07 (WTG 83)	05:50	06:23 (WTG 83)	06:27	07:03
	20:45	07:06 (WTG 83)	20:14	06:52 (WTG 83)	19:20	18:24
10	05:19	06:07 (WTG 83)	05:51	06:26 (WTG 83)	06:28	07:05
	20:44	07:07 (WTG 83)	20:13	06:50 (WTG 83)	19:18	18:22
11	05:20	06:07 (WTG 83)	05:53	06:29 (WTG 83)	06:29	07:06
	20:44	07:07 (WTG 83)	20:11	06:46 (WTG 83)	19:16	18:20
12	05:21	06:07 (WTG 83)	05:54	06:36 (WTG 83)	06:31	07:07
	20:43	07:07 (WTG 83)	20:10	06:39 (WTG 83)	19:14	18:18
13	05:22	06:07 (WTG 83)	05:55		06:32	07:08
	20:42	07:07 (WTG 83)	20:08		19:12	18:16
14	05:23	06:07 (WTG 83)	05:56		06:33	07:10
	20:42	07:07 (WTG 83)	20:07		19:11	18:15
15	05:23	06:08 (WTG 83)	05:57		06:34	07:11
	20:41	07:07 (WTG 83)	20:05		19:09	18:13
16	05:24	06:08 (WTG 83)	05:58		06:35	07:12
	20:41	07:08 (WTG 83)	20:04		19:07	18:11
17	05:25	06:08 (WTG 83)	06:00		06:36	07:14
	20:40	07:08 (WTG 83)	20:02		19:05	18:09
18	05:26	06:09 (WTG 83)	06:01		06:38	07:15
	20:39	07:08 (WTG 83)	20:01		19:03	18:08
19	05:27	06:08 (WTG 83)	06:02		06:39	07:16
	20:38	07:07 (WTG 83)	19:57		19:01	18:06
20	05:28	06:08 (WTG 83)	06:03		06:40	07:18
	20:37	07:07 (WTG 83)	19:56		18:59	18:04
21	05:29	06:09 (WTG 83)	06:04		06:41	07:19
	20:37	07:07 (WTG 83)	19:54		18:57	18:03
22	05:30	06:09 (WTG 83)	06:06		06:42	07:20
	20:36	07:07 (WTG 83)	19:52		18:55	18:01
23	05:31	06:09 (WTG 83)	06:07		06:44	07:22
	20:35	07:07 (WTG 83)	19:51		18:53	17:59
24	05:32	06:10 (WTG 83)	06:08		06:45	07:23
	20:34	07:07 (WTG 83)	19:49		18:52	17:58
25	05:33	06:10 (WTG 83)	06:09		06:46	07:24
	20:33	07:06 (WTG 83)	19:47		18:50	17:56
26	05:34	06:10 (WTG 83)	06:10		06:47	07:26
	20:32	07:06 (WTG 83)	19:45		18:48	17:55
27	05:35	06:11 (WTG 83)	06:12		06:49	07:27
	20:31	07:06 (WTG 83)	19:44		18:46	17:53
28	05:37	06:11 (WTG 83)	06:13		06:50	07:28
	20:30	07:05 (WTG 83)	19:42		18:44	17:52
29	05:38	06:12 (WTG 83)	06:14		06:51	07:30
	20:29	07:05 (WTG 83)	19:40		18:42	17:50
30	05:39	06:13 (WTG 83)	06:15		06:52	07:31
	20:27	07:05 (WTG 83)	19:38		18:40	17:49
31	05:40	06:14 (WTG 83)	06:16			07:32
	20:26	07:04 (WTG 83)	19:37			17:47
Potential sun hours	472	436		376	341	288
Total, worst case	1797	407			422	
Sun reduction	0.45	0.46			0.36	
Oper. time red.	1.00	1.00			1.00	
Wind dir. red.	0.80	0.80			0.67	
Total reduction	0.36	0.37			0.24	
Total, real	646	150			102	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker (WTG causing flicker first time)	Last time (hh:mm) with flicker (WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-148 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (370)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:34	14:29 (WTG 78)	07:17	14:39 (WTG 78)	06:35	06:38
	16:25	65 15:34 (WTG 78)	17:03	15:46 (WTG 78)	17:43	19:23
2	07:35	14:29 (WTG 78)	07:16	14:39 (WTG 78)	06:34	06:37
	16:26	66 15:35 (WTG 78)	17:05	15:46 (WTG 78)	17:44	19:24
3	07:35	14:29 (WTG 78)	07:15	14:39 (WTG 78)	06:32	06:35
	16:27	66 15:35 (WTG 78)	17:06	15:45 (WTG 78)	17:46	19:26
4	07:35	14:30 (WTG 78)	07:13	14:40 (WTG 78)	06:30	06:33
	16:28	66 15:36 (WTG 78)	17:08	15:45 (WTG 78)	17:47	19:27
5	07:34	14:30 (WTG 78)	07:12	14:42 (WTG 78)	06:28	06:31
	16:29	67 15:37 (WTG 78)	17:09	15:45 (WTG 78)	17:48	19:28
6	07:34	14:30 (WTG 78)	07:11	14:43 (WTG 78)	06:27	06:29
	16:30	68 15:38 (WTG 78)	17:11	15:45 (WTG 78)	17:50	19:29
7	07:34	14:30 (WTG 78)	07:10	14:43 (WTG 78)	06:25	06:27
	16:31	68 15:38 (WTG 78)	17:12	15:43 (WTG 78)	17:51	19:31
8	07:34	14:30 (WTG 78)	07:08	14:45 (WTG 78)	07:23	06:26
	16:32	68 15:38 (WTG 78)	17:14	15:43 (WTG 78)	18:52	19:32
9	07:34	14:31 (WTG 78)	07:07	14:45 (WTG 78)	07:21	06:24
	16:33	68 15:39 (WTG 78)	17:15	15:42 (WTG 78)	18:54	19:33
10	07:33	14:31 (WTG 78)	07:05	14:47 (WTG 78)	07:19	06:22
	16:34	68 15:39 (WTG 78)	17:16	15:41 (WTG 78)	18:55	19:35
11	07:33	14:31 (WTG 78)	07:04	14:48 (WTG 78)	07:18	06:20
	16:36	69 15:40 (WTG 78)	17:18	15:40 (WTG 78)	18:56	19:36
12	07:33	14:31 (WTG 78)	07:03	14:50 (WTG 78)	07:16	06:18
	16:37	69 15:40 (WTG 78)	17:19	15:39 (WTG 78)	18:58	19:37
13	07:32	14:32 (WTG 78)	07:01	14:52 (WTG 78)	07:14	06:17
	16:38	70 15:42 (WTG 78)	17:21	15:38 (WTG 78)	18:59	19:38
14	07:32	14:32 (WTG 78)	07:00	14:53 (WTG 78)	07:12	06:15
	16:39	70 15:42 (WTG 78)	17:22	15:36 (WTG 78)	19:00	19:40
15	07:31	14:32 (WTG 78)	06:58	14:55 (WTG 78)	07:10	06:13
	16:40	71 15:43 (WTG 78)	17:23	15:34 (WTG 78)	19:01	19:41
16	07:31	14:32 (WTG 78)	06:57	14:58 (WTG 78)	07:08	06:11
	16:42	71 15:43 (WTG 78)	17:25	15:32 (WTG 78)	19:03	19:42
17	07:30	14:32 (WTG 78)	06:55	15:01 (WTG 78)	07:07	06:10
	16:43	71 15:43 (WTG 78)	17:26	15:29 (WTG 78)	19:04	19:43
18	07:30	14:33 (WTG 78)	06:54	15:05 (WTG 78)	07:05	06:08
	16:44	71 15:44 (WTG 78)	17:28	15:26 (WTG 78)	19:05	19:45
19	07:29	14:33 (WTG 78)	06:52	15:12 (WTG 78)	07:03	06:06
	16:46	71 15:44 (WTG 78)	17:29	15:19 (WTG 78)	19:07	19:46
20	07:28	14:33 (WTG 78)	06:51	15:19 (WTG 78)	07:01	06:05
	16:47	72 15:45 (WTG 78)	17:31	15:17 (WTG 78)	19:08	19:47
21	07:27	14:33 (WTG 78)	06:49	15:22 (WTG 78)	06:59	06:03
	16:48	72 15:45 (WTG 78)	17:32	15:15 (WTG 78)	19:09	19:48
22	07:27	14:33 (WTG 78)	06:47	15:25 (WTG 78)	06:57	06:01
	16:50	72 15:45 (WTG 78)	17:33	15:13 (WTG 78)	19:10	19:50
23	07:26	14:35 (WTG 78)	06:46	15:28 (WTG 78)	06:55	06:00
	16:51	71 15:46 (WTG 78)	17:35	15:11 (WTG 78)	19:12	19:51
24	07:25	14:35 (WTG 78)	06:44	15:31 (WTG 78)	06:53	05:58
	16:52	71 15:46 (WTG 78)	17:36	15:09 (WTG 78)	19:13	19:52
25	07:24	14:35 (WTG 78)	06:42	15:34 (WTG 78)	06:52	05:56
	16:54	71 15:46 (WTG 78)	17:37	15:07 (WTG 78)	19:14	19:53
26	07:23	14:36 (WTG 78)	06:41	15:37 (WTG 78)	06:50	05:55
	16:55	71 15:47 (WTG 78)	17:39	15:05 (WTG 78)	19:16	19:55
27	07:22	14:36 (WTG 78)	06:39	15:40 (WTG 78)	06:48	05:53
	16:56	71 15:47 (WTG 78)	17:40	15:03 (WTG 78)	19:17	19:56
28	07:21	14:36 (WTG 78)	06:37	15:43 (WTG 78)	06:46	05:52
	16:58	70 15:46 (WTG 78)	17:42	15:01 (WTG 78)	19:18	19:57
29	07:20	14:36 (WTG 78)	06:35	15:46 (WTG 78)	06:44	05:50
	16:59	70 15:46 (WTG 78)	17:43	14:59 (WTG 78)	19:19	19:58
30	07:19	14:37 (WTG 78)	06:33	15:49 (WTG 78)	06:42	05:48
	17:01	69 15:46 (WTG 78)	17:44	14:57 (WTG 78)	19:21	20:00
31	07:18	14:38 (WTG 78)	06:31	15:52 (WTG 78)	06:40	05:46
	17:02	68 15:46 (WTG 78)	17:45	14:55 (WTG 78)	19:22	20:33
Potential sun hours	286	291	369	404	459	466
Total, worst case	2151	938	185	174	1103	
Sun reduction	0.29	0.37	0.37	0.33	0.47	0.47
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00
Wind dir. red.	0.76	0.76	0.76	0.76	0.81	0.81
Total reduction	0.22	0.28	0.28	0.25	0.38	0.38
Total, real	473	263	52	44	416	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-148 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (370)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:55 (WTG 44)	05:41	06:17	06:34	07:13
	20:47	06:34 (WTG 44)	20:25	19:35	16:46	16:17
2	05:14	05:56 (WTG 44)	05:42	06:19	06:35	07:14
	20:47	06:33 (WTG 44)	20:24	19:33	16:44	16:16
3	05:14	05:57 (WTG 44)	05:43	06:20	06:36	07:16
	20:46	06:33 (WTG 44)	20:22	19:31	16:43	16:16
4	05:15	05:58 (WTG 44)	05:44	06:21	06:38	07:17
	20:46	06:33 (WTG 44)	20:21	19:29	16:41	16:16
5	05:16	05:59 (WTG 44)	05:45	06:22	06:39	07:18
	20:46	06:32 (WTG 44)	20:20	19:27	16:40	16:16
6	05:16	06:00 (WTG 44)	05:47	06:23	06:41	07:19
	20:46	06:31 (WTG 44)	20:18	19:26	16:39	16:15
7	05:17	06:02 (WTG 44)	05:48	06:25	06:42	07:20
	20:45	06:31 (WTG 44)	20:17	19:24	16:38	16:15
8	05:18	06:02 (WTG 44)	05:49	06:26	06:43	07:21
	20:45	06:29 (WTG 44)	20:16	19:22	16:36	16:15
9	05:18	06:04 (WTG 44)	05:50	06:27	06:45	07:22
	20:44	06:28 (WTG 44)	20:14	19:20	16:35	16:15
10	05:19	06:06 (WTG 44)	05:51	06:28	06:46	07:23
	20:44	06:27 (WTG 44)	20:13	19:18	16:34	16:15
11	05:20	06:09 (WTG 44)	05:53	06:29	06:47	07:24
	20:44	06:25 (WTG 44)	20:11	19:16	16:33	16:15
12	05:21	06:12 (WTG 44)	05:54	06:31	06:49	07:25
	20:43	06:20 (WTG 44)	20:10	19:14	16:32	16:15
13	05:22	05:55	06:32	18:23 (WTG 45)	06:50	07:25
	20:42	20:08	19:12	18:49 (WTG 45)	16:30	16:15
14	05:23	05:56	06:33	18:22 (WTG 45)	06:51	07:26
	20:42	20:07	19:10	18:47 (WTG 45)	16:29	16:15
15	05:23	05:57	06:34	18:23 (WTG 45)	06:53	07:27
	20:41	20:05	19:09	18:46 (WTG 45)	16:28	16:15
16	05:24	05:58	06:35	18:23 (WTG 45)	06:54	07:28
	20:40	20:04	19:07	18:44 (WTG 45)	16:27	16:15
17	05:25	06:00	06:36	18:23 (WTG 45)	06:56	07:28
	20:40	20:02	19:05	18:42 (WTG 45)	16:26	16:15
18	05:26	06:01	06:38	18:23 (WTG 45)	06:57	07:29
	20:39	20:01	19:03	18:40 (WTG 45)	16:25	16:15
19	05:27	06:02	06:39	18:24 (WTG 45)	06:58	07:30
	20:38	19:57	19:01	18:38 (WTG 45)	16:25	16:15
20	05:28	06:03	06:40	18:25 (WTG 45)	07:00	07:30
	20:37	19:56	18:59	18:35 (WTG 45)	16:24	16:15
21	05:29	06:04	06:41	18:27 (WTG 45)	07:01	07:31
	20:37	19:54	18:57	18:34 (WTG 45)	16:23	16:15
22	05:30	06:06	06:42	18:30 (WTG 45)	07:02	07:31
	20:36	19:52	18:55	18:32 (WTG 45)	16:22	16:15
23	05:31	06:07	06:44	18:31	07:03	07:32
	20:35	19:51	18:53	17:59	12 15:40 (WTG 78)	16:18
24	05:32	06:08	06:45	17:58	12 15:52 (WTG 78)	16:18
	20:34	19:49	18:51	17:58	23 15:34 (WTG 78)	16:18
25	05:33	06:09	06:46	17:57	23 15:57 (WTG 78)	16:19
	20:33	19:47	18:50	17:56	30 15:30 (WTG 78)	16:19
26	05:34	06:10	06:47	17:56	30 16:00 (WTG 78)	16:20
	20:32	19:45	18:48	17:55	35 15:27 (WTG 78)	16:20
27	05:35	06:11	06:48	17:55	35 16:02 (WTG 78)	16:20
	20:31	19:44	18:46	17:54	40 15:24 (WTG 78)	16:20
28	05:36	06:13	06:50	17:53	40 16:04 (WTG 78)	16:21
	20:30	19:42	18:44	17:52	43 15:23 (WTG 78)	16:21
29	05:38	06:14	06:51	17:52	43 16:06 (WTG 78)	16:22
	20:28	19:40	18:42	17:50	47 15:20 (WTG 78)	16:22
30	05:39	06:15	06:52	17:50	47 16:07 (WTG 78)	16:22
	20:27	19:38	18:40	17:49	50 15:19 (WTG 78)	16:23
31	05:40	06:16	06:53	17:49	50 16:09 (WTG 78)	16:23
	20:26	19:37	18:39	17:47	53 15:17 (WTG 78)	16:24
Potential sun hours	472	436	376	341	288	274
Total, worst case	336		366	333	2037	2023
Sun reduction	0.45		0.42	0.36	0.25	0.28
Oper. time red.	1.00		1.00	1.00	1.00	1.00
Wind dir. red.	0.81		0.76	0.76	0.76	0.76
Total reduction	0.36		0.32	0.27	0.19	0.21
Total, real	121		117	91	386	430

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 15

Licensed user:

EDR

217 Montgomery St.

US-SYRACUSE, NY 13202

(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-155 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (376)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:34	07:17	06:35	06:38	05:47	18:42 (WTG 78)
	16:25	17:03	17:43	19:23	20:00	51 18:42 (WTG 78) 20:34 37 19:27 (WTG 78)
2	07:35	07:16	06:34	06:37	05:45	18:42 (WTG 78) 05:13 18:51 (WTG 78)
	16:26	17:05	17:44	19:24	20:01	51 19:33 (WTG 78) 20:35 36 19:27 (WTG 78)
3	07:35	07:15	06:32	06:35	05:44	18:41 (WTG 78) 05:12 18:51 (WTG 78)
	16:27	17:06	17:46	19:26	20:02	52 19:33 (WTG 78) 20:36 35 19:26 (WTG 78)
4	07:34	07:13	06:30	06:33	05:43	18:41 (WTG 78) 05:12 18:53 (WTG 78)
	16:28	17:08	17:47	19:27	20:03	53 19:34 (WTG 78) 20:37 33 19:26 (WTG 78)
5	07:34	07:12	06:28	06:31	05:41	18:40 (WTG 78) 05:12 18:53 (WTG 78)
	16:29	17:09	17:48	19:28	20:05	53 19:33 (WTG 78) 20:37 32 19:25 (WTG 78)
6	07:34	07:11	06:27	06:29	05:40	18:40 (WTG 78) 05:11 18:54 (WTG 78)
	16:30	17:11	17:50	19:29	20:06	54 19:34 (WTG 78) 20:38 31 19:25 (WTG 78)
7	07:34	07:10	06:25	06:27	05:38	18:40 (WTG 78) 05:11 18:55 (WTG 78)
	16:31	17:12	17:51	19:31	20:07	54 19:34 (WTG 78) 20:39 30 19:25 (WTG 78)
8	07:34	07:08	07:23	06:26	05:37	18:40 (WTG 78) 05:10 18:55 (WTG 78)
	16:32	17:14	18:52	19:32	20:08	54 19:34 (WTG 78) 20:40 29 19:24 (WTG 78)
9	07:34	07:07	07:21	06:24	05:36	18:40 (WTG 78) 05:10 18:56 (WTG 78)
	16:33	17:15	18:54	19:33	20:09	54 19:34 (WTG 78) 20:40 28 19:24 (WTG 78)
10	07:33	07:05	07:19	06:22	05:34	18:40 (WTG 78) 05:10 18:57 (WTG 78)
	16:34	17:16	18:55	19:35	20:11	54 19:34 (WTG 78) 20:41 27 19:24 (WTG 78)
11	07:33	07:04	07:18	06:20	05:33	18:40 (WTG 78) 05:10 18:58 (WTG 78)
	16:36	17:18	18:56	19:36	20:12	54 19:34 (WTG 78) 20:42 26 19:24 (WTG 78)
12	07:33	07:03	07:16	06:18	05:32	18:40 (WTG 78) 05:09 18:59 (WTG 78)
	16:37	17:19	18:58	19:37	20:13	54 19:34 (WTG 78) 20:42 24 19:23 (WTG 78)
13	07:32	07:01	07:14	06:17	05:31	18:41 (WTG 78) 05:09 19:00 (WTG 78)
	16:38	17:21	18:59	19:38	20:14	53 19:34 (WTG 78) 20:43 23 19:23 (WTG 78)
14	07:32	07:00	07:12	06:15	05:30	18:41 (WTG 78) 05:09 19:00 (WTG 78)
	16:39	17:22	19:00	19:40	20:15	53 19:34 (WTG 78) 20:43 23 19:23 (WTG 78)
15	07:31	06:58	07:10	06:13	05:28	18:40 (WTG 78) 05:09 19:01 (WTG 78)
	16:40	17:23	19:01	19:41	20:17	53 19:33 (WTG 78) 20:44 22 19:23 (WTG 78)
16	07:31	06:57	07:08	06:11	05:27	18:40 (WTG 78) 05:09 19:02 (WTG 78)
	16:42	17:25	19:03	19:42	20:18	53 19:33 (WTG 78) 20:44 21 19:23 (WTG 78)
17	07:30	06:55	07:07	06:10	05:26	18:41 (WTG 78) 05:09 19:02 (WTG 78)
	16:43	17:26	19:04	19:43	20:19	51 19:32 (WTG 78) 20:45 21 19:23 (WTG 78)
18	07:29	06:54	07:05	06:08	05:25	18:41 (WTG 78) 05:09 19:02 (WTG 78)
	16:44	17:28	19:05	19:45	20:20	51 19:32 (WTG 78) 20:45 20 19:22 (WTG 78)
19	07:29	06:52	07:03	06:06	05:24	18:42 (WTG 78) 05:09 19:03 (WTG 78)
	16:46	17:29	19:07	19:46	12 19:16 (WTG 78) 20:21 50 19:32 (WTG 78) 20:45 19 19:22 (WTG 78)	
20	07:28	06:50	07:01	06:05	05:23	18:43 (WTG 78) 05:09 19:03 (WTG 78)
	16:47	17:31	19:08	19:47	21 19:20 (WTG 78) 20:22 49 19:32 (WTG 78) 20:46 19 19:22 (WTG 78)	
21	07:27	06:49	06:59	06:03	05:22	18:43 (WTG 78) 05:10 19:03 (WTG 78)
	16:48	17:32	19:09	19:48	26 19:22 (WTG 78) 20:23 49 19:32 (WTG 78) 20:46 19 19:22 (WTG 78)	
22	07:27	06:47	06:57	06:01	05:21	18:44 (WTG 78) 05:10 19:03 (WTG 78)
	16:50	17:33	19:10	19:50	31 19:25 (WTG 78) 20:24 48 19:32 (WTG 78) 20:46 19 19:22 (WTG 78)	
23	07:26	06:46	06:55	06:00	05:20	18:44 (WTG 78) 05:10 19:04 (WTG 78)
	16:51	17:35	19:12	19:51	35 19:26 (WTG 78) 20:25 47 19:31 (WTG 78) 20:46 19 19:23 (WTG 78)	
24	07:25	06:44	06:53	05:58	05:19	18:44 (WTG 78) 05:10 19:04 (WTG 78)
	16:52	17:36	19:13	19:52	38 19:28 (WTG 78) 20:26 46 19:30 (WTG 78) 20:47 19 19:23 (WTG 78)	
25	07:24	06:42	06:52	05:56	05:18	18:45 (WTG 78) 05:11 19:03 (WTG 78)
	16:54	17:37	19:14	19:53	41 19:29 (WTG 78) 20:27 45 19:30 (WTG 78) 20:47 21 19:24 (WTG 78)	
26	07:23	06:41	06:50	05:55	05:18	18:46 (WTG 78) 05:11 19:04 (WTG 78)
	16:55	17:39	19:16	19:55	42 19:29 (WTG 78) 20:28 44 19:30 (WTG 78) 20:47 21 19:25 (WTG 78)	
27	07:22	06:39	06:48	05:53	05:17	18:46 (WTG 78) 05:11 19:03 (WTG 78)
	16:56	17:40	19:17	19:56	44 19:30 (WTG 78) 20:29 43 19:29 (WTG 78) 20:47 22 19:25 (WTG 78)	
28	07:21	06:37	06:46	05:52	05:16	18:47 (WTG 78) 05:12 19:03 (WTG 78)
	16:58	17:42	19:18	19:57	47 19:31 (WTG 78) 20:30 42 19:29 (WTG 78) 20:47 22 19:25 (WTG 78)	
29	07:20		06:44	05:50	05:15	18:48 (WTG 78) 05:12 19:03 (WTG 78)
	16:59		19:19	19:58	48 19:32 (WTG 78) 20:31 41 19:29 (WTG 78) 20:47 23 19:26 (WTG 78)	
30	07:19		06:42	05:48	05:15	18:48 (WTG 78) 05:13 19:02 (WTG 78)
	17:01		19:21	20:00	49 19:32 (WTG 78) 20:32 40 19:28 (WTG 78) 20:47 24 19:26 (WTG 78)	
31	07:18		06:40		05:14	18:50 (WTG 78)
	17:02		19:22		20:33	38 19:28 (WTG 78)
Potential sun hours	286	291	369	404	459	466
Total, worst case				434	1534	745
Sun reduction				0.33	0.44	0.47
Oper. time red.				1.00	1.00	1.00
Wind dir. red.				0.68	0.68	0.68
Total reduction				0.22	0.30	0.32
Total, real				97	459	238

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Licensed user:

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US-SYRACUSE, NY 13202

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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-155 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (376)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December	
1	05:13 20:47	19:02 (WTG 78) 20:25	05:41 20:25	18:51 (WTG 78) 19:35	06:17 18:38	06:53 16:46	07:13 16:17
2	05:14 20:47	19:01 (WTG 78) 20:24	05:42 20:24	18:51 (WTG 78) 19:33	06:19 18:36	06:55 16:36	07:14 16:16
3	05:14 20:46	19:01 (WTG 78) 20:22	05:43 20:22	18:50 (WTG 78) 19:31	06:20 18:35	06:56 16:35	07:16 16:16
4	05:15 20:46	19:02 (WTG 78) 20:21	05:44 20:21	18:50 (WTG 78) 19:29	06:21 18:33	06:57 16:34	07:17 16:16
5	05:16 20:46	19:00 (WTG 78) 20:20	05:45 20:20	18:50 (WTG 78) 19:27	06:22 18:31	06:58 16:33	07:18 16:16
6	05:16 20:46	19:00 (WTG 78) 20:18	05:47 20:18	18:50 (WTG 78) 19:26	06:23 18:29	07:00 16:32	07:19 16:15
7	05:17 20:45	19:00 (WTG 78) 20:17	05:48 20:17	18:50 (WTG 78) 19:24	06:25 18:27	07:01 16:31	07:20 16:15
8	05:18 20:45	18:59 (WTG 78) 20:16	05:49 20:16	18:50 (WTG 78) 19:22	06:26 18:25	07:02 16:30	07:21 16:15
9	05:18 20:44	18:59 (WTG 78) 20:14	05:50 20:14	18:50 (WTG 78) 19:20	06:27 18:23	07:03 16:29	07:22 16:15
10	05:19 20:44	18:59 (WTG 78) 20:13	05:51 20:13	18:51 (WTG 78) 19:18	06:28 18:22	07:05 16:28	07:23 16:15
11	05:20 20:44	18:59 (WTG 78) 20:11	05:52 20:11	18:51 (WTG 78) 19:16	06:29 18:20	07:06 16:27	07:24 16:15
12	05:21 20:43	18:57 (WTG 78) 20:10	05:54 20:10	18:51 (WTG 78) 19:14	06:31 18:18	07:07 16:26	07:24 16:15
13	05:22 20:42	18:57 (WTG 78) 20:08	05:55 20:08	18:52 (WTG 78) 19:12	06:32 18:16	07:08 16:25	07:25 16:15
14	05:23 20:42	18:57 (WTG 78) 20:07	05:56 20:07	18:52 (WTG 78) 19:10	06:33 18:15	07:10 16:24	07:26 16:15
15	05:23 20:41	18:56 (WTG 78) 20:05	05:57 20:05	18:52 (WTG 78) 19:09	06:34 18:13	07:11 16:23	07:27 16:15
16	05:24 20:40	18:56 (WTG 78) 20:04	05:58 20:04	18:53 (WTG 78) 19:07	06:35 18:11	07:12 16:22	07:28 16:16
17	05:25 20:40	18:56 (WTG 78) 20:02	06:00 20:02	18:54 (WTG 78) 19:05	06:36 18:09	07:14 16:21	07:28 16:16
18	05:26 20:39	18:55 (WTG 78) 20:01	06:01 20:01	18:55 (WTG 78) 19:03	06:38 18:07	07:15 16:20	07:29 16:16
19	05:27 20:38	18:54 (WTG 78) 19:57	06:02 19:57	18:56 (WTG 78) 19:01	06:39 18:06	07:16 16:19	07:30 16:17
20	05:28 20:37	18:54 (WTG 78) 19:56	06:03 19:56	18:58 (WTG 78) 18:59	06:40 18:04	07:17 16:18	07:30 16:17
21	05:29 20:36	18:53 (WTG 78) 19:54	06:04 19:54	18:59 (WTG 78) 18:57	06:41 18:03	07:19 16:17	07:31 16:17
22	05:30 20:36	18:53 (WTG 78) 19:52	06:06 19:52	19:01 (WTG 78) 18:55	06:42 18:01	07:20 16:16	07:31 16:18
23	05:31 20:35	18:53 (WTG 78) 19:51	06:07 19:51	19:03 (WTG 78) 18:53	06:44 17:59	07:21 16:21	07:32 16:18
24	05:32 20:34	18:52 (WTG 78) 19:49	06:08 19:49	19:23 (WTG 78) 19:08	18:53 06:45	17:59 07:23	16:21 07:32
25	05:33 20:33	18:52 (WTG 78) 19:47	06:09 19:47	19:18 (WTG 78) 18:51	06:46 17:58	07:24 16:21	07:33 16:19
26	05:34 20:32	18:52 (WTG 78) 19:45	06:10 19:45	18:51 (WTG 78) 18:50	06:47 17:56	07:25 16:20	07:33 16:20
27	05:35 20:31	18:51 (WTG 78) 19:44	06:11 19:44	18:50 (WTG 78) 18:48	06:48 17:55	07:26 16:19	07:33 16:21
28	05:36 20:30	18:51 (WTG 78) 19:42	06:13 19:42	18:49 (WTG 78) 18:46	06:49 17:53	07:27 16:18	07:34 16:22
29	05:38 20:28	18:51 (WTG 78) 19:40	06:14 19:40	18:48 (WTG 78) 18:44	06:51 17:52	07:29 16:17	07:34 16:22
30	05:39 20:27	18:50 (WTG 78) 19:38	06:15 19:38	18:47 (WTG 78) 18:40	06:52 17:50	07:31 16:16	07:34 16:23
31	05:40 20:26	18:51 (WTG 78) 19:37	06:16 19:37	18:46 (WTG 78) 18:39	06:53 17:49	07:32 16:15	07:34 16:24
Potential sun hours	472	436	376	341	288	274	
Total, worst case	1283	1057					
Sun reduction	0.45	0.46					
Oper. time red.	1.00	1.00					
Wind dir. red.	0.68	0.68					
Total reduction	0.31	0.31					
Total, real	393	331					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-166 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (385)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:34 16:25	15:14 (WTG 58) 15:49 (WTG 58)	07:17 17:04	15:12 (WTG 58) 16:13 (WTG 58)	06:35 17:43	07:10 (WTG 206) 07:50 (WTG 206)
2	07:34 16:26	15:14 (WTG 58) 15:50 (WTG 58)	07:16 17:05	15:13 (WTG 58) 16:13 (WTG 58)	06:34 17:44	07:09 (WTG 206) 07:50 (WTG 206)
3	07:34 16:27	15:14 (WTG 58) 15:51 (WTG 58)	07:14 17:06	15:12 (WTG 58) 16:12 (WTG 58)	06:32 17:46	07:10 (WTG 206) 07:50 (WTG 206)
4	07:34 16:28	15:14 (WTG 58) 15:52 (WTG 58)	07:13 17:08	15:13 (WTG 58) 16:13 (WTG 58)	06:30 17:47	07:10 (WTG 206) 07:49 (WTG 206)
5	07:34 16:29	15:14 (WTG 58) 15:54 (WTG 58)	07:12 17:09	15:14 (WTG 58) 16:13 (WTG 58)	06:28 17:48	07:10 (WTG 206) 07:49 (WTG 206)
6	07:34 16:30	15:14 (WTG 58) 15:55 (WTG 58)	07:11 17:11	15:13 (WTG 58) 16:12 (WTG 58)	06:27 17:50	07:10 (WTG 206) 07:48 (WTG 206)
7	07:34 16:31	15:13 (WTG 58) 15:55 (WTG 58)	07:09 17:12	15:14 (WTG 58) 16:12 (WTG 58)	06:25 17:51	07:10 (WTG 206) 07:47 (WTG 206)
8	07:34 16:32	15:14 (WTG 58) 15:56 (WTG 58)	07:08 17:14	15:15 (WTG 58) 16:12 (WTG 58)	06:23 18:52	08:12 (WTG 206) 08:46 (WTG 206)
9	07:34 16:33	15:14 (WTG 58) 15:58 (WTG 58)	07:07 17:15	15:15 (WTG 58) 16:11 (WTG 58)	06:22 18:54	08:12 (WTG 206) 08:45 (WTG 206)
10	07:33 16:34	15:13 (WTG 58) 15:58 (WTG 58)	07:05 17:16	15:16 (WTG 58) 16:11 (WTG 58)	06:22 18:55	08:13 (WTG 206) 18:32 (WTG 57)
11	07:33 16:35	15:13 (WTG 58) 16:00 (WTG 58)	07:04 17:18	15:16 (WTG 58) 16:10 (WTG 58)	06:20 18:56	08:14 (WTG 206) 18:34 (WTG 57)
12	07:33 16:36	15:13 (WTG 58) 16:01 (WTG 58)	07:03 17:19	15:18 (WTG 58) 16:10 (WTG 58)	06:18 18:58	08:15 (WTG 206) 18:35 (WTG 57)
13	07:32 16:37	15:13 (WTG 58) 16:02 (WTG 58)	07:01 17:21	15:18 (WTG 58) 16:09 (WTG 58)	06:17 18:59	08:18 (WTG 206) 18:36 (WTG 57)
14	07:32 16:38	15:12 (WTG 58) 16:02 (WTG 58)	07:00 17:22	15:20 (WTG 58) 16:08 (WTG 58)	06:15 19:00	08:21 (WTG 206) 18:37 (WTG 57)
15	07:31 16:39	15:13 (WTG 58) 16:03 (WTG 58)	06:58 17:24	15:20 (WTG 58) 16:07 (WTG 58)	06:13 19:01	18:21 (WTG 57) 18:39 (WTG 57)
16	07:31 16:40	15:12 (WTG 58) 16:04 (WTG 58)	06:57 17:25	07:29 (WTG 206) 16:06 (WTG 58)	06:11 19:03	18:20 (WTG 57) 18:41 (WTG 57)
17	07:30 16:41	15:12 (WTG 58) 16:04 (WTG 58)	06:55 17:26	07:23 (WTG 206) 16:05 (WTG 58)	06:10 19:04	18:20 (WTG 57) 18:42 (WTG 57)
18	07:29 16:42	15:12 (WTG 58) 16:04 (WTG 58)	06:54 17:27	07:21 (WTG 206) 16:05 (WTG 58)	06:08 19:05	18:19 (WTG 57) 18:43 (WTG 57)
19	07:29 16:43	15:12 (WTG 58) 16:06 (WTG 58)	06:52 17:28	07:19 (WTG 206) 16:04 (WTG 58)	06:06 19:05	18:19 (WTG 57) 18:44 (WTG 57)
20	07:28 16:44	15:12 (WTG 58) 16:06 (WTG 58)	06:50 17:29	07:17 (WTG 206) 16:01 (WTG 58)	06:05 19:07	18:19 (WTG 57) 18:44 (WTG 57)
21	07:27 16:45	15:11 (WTG 58) 16:07 (WTG 58)	06:49 17:31	07:16 (WTG 206) 15:59 (WTG 58)	06:59 19:08	18:20 (WTG 57) 18:44 (WTG 57)
22	07:27 16:46	15:11 (WTG 58) 16:08 (WTG 58)	06:47 17:32	07:14 (WTG 206) 15:57 (WTG 58)	06:57 19:09	18:20 (WTG 57) 18:43 (WTG 57)
23	07:26 16:47	15:11 (WTG 58) 16:09 (WTG 58)	06:46 17:33	07:13 (WTG 206) 15:52 (WTG 58)	06:55 19:10	18:21 (WTG 57) 18:42 (WTG 57)
24	07:25 16:48	15:12 (WTG 58) 16:09 (WTG 58)	06:44 17:35	07:13 (WTG 206) 16:09 (WTG 58)	06:53 19:12	18:24 (WTG 57) 18:40 (WTG 57)
25	07:24 16:49	15:12 (WTG 58) 16:10 (WTG 58)	06:42 17:36	07:12 (WTG 206) 16:07 (WTG 58)	06:52 19:13	18:26 (WTG 57) 18:39 (WTG 57)
26	07:23 16:50	15:12 (WTG 58) 16:11 (WTG 58)	06:41 17:37	07:11 (WTG 206) 16:07 (WTG 58)	06:50 19:14	18:35 (WTG 57) 18:35 (WTG 57)
27	07:22 16:51	15:11 (WTG 58) 16:11 (WTG 58)	06:39 17:39	07:11 (WTG 206) 16:06 (WTG 58)	06:48 19:16	05:55 19:55
28	07:21 16:52	15:11 (WTG 58) 16:11 (WTG 58)	06:37 17:40	07:10 (WTG 206) 16:06 (WTG 58)	06:46 19:18	05:52 19:56
29	07:20 16:53	15:11 (WTG 58) 16:12 (WTG 58)	06:36 17:42	07:10 (WTG 206) 16:06 (WTG 58)	06:44 19:19	05:50 19:58
30	07:19 16:54	15:12 (WTG 58) 16:12 (WTG 58)	06:35 17:43	07:10 (WTG 206) 16:06 (WTG 58)	06:42 19:21	05:48 20:00
31	07:18 16:55	15:12 (WTG 58) 16:12 (WTG 58)	06:34 17:44	07:10 (WTG 206) 16:06 (WTG 58)	06:40 19:22	05:46 20:00
Potential sun hours	286	291	369	404	459	466
Total, worst case	1559	1452	728	476		
Sun reduction	0.29	0.37	0.37	0.33		
Oper. time red.	1.00	1.00	1.00	1.00		
Wind dir. red.	0.79	0.75	0.71	0.78		
Total reduction	0.23	0.28	0.26	0.26		
Total, real	358	406	191	123		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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**EDR**  
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 Steve Curtis, scurtis@edrpc.com  
 Calculated:  
 8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-166 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (385)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.29	0.37	0.37	0.33	0.44	0.47	0.45	0.46	0.42	0.36	0.25	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
193	219	377	727	552	298	438	718	1,822	2,408	780	228	8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:41	06:17	06:53	07:56 (WTG 206)	08:34
2	05:14	05:42	06:19	06:55	07:53 (WTG 206)	08:35
3	05:14	05:43	06:20	06:56	07:51 (WTG 206)	08:36
4	05:15	05:44	06:21	06:57	07:49 (WTG 206)	08:38
5	05:16	05:45	06:22	06:58	07:49 (WTG 206)	08:39
6	05:16	05:47	06:23	07:00	07:47 (WTG 206)	08:40
7	05:17	05:48	06:25	07:01	07:46 (WTG 206)	08:42
8	05:18	05:49	06:26	07:02	07:45 (WTG 206)	08:43
9	05:19	05:50	06:27	07:03	07:45 (WTG 206)	08:45
10	05:19	05:51	06:28	07:05	07:44 (WTG 206)	08:46
11	05:20	05:53	06:29	07:06	07:44 (WTG 206)	08:49
12	05:21	05:54	06:31	07:07	07:44 (WTG 206)	08:49
13	05:22	05:55	06:32	07:08	07:43 (WTG 206)	08:50
14	05:23	05:56	06:33	07:10	07:43 (WTG 206)	08:51
15	05:23	05:57	06:34	07:11	07:43 (WTG 206)	08:53
16	05:24	05:58	06:35	07:12	07:43 (WTG 206)	08:54
17	05:25	06:00	06:36	07:14	07:43 (WTG 206)	08:55
18	05:26	06:01	06:38	07:15	07:44 (WTG 206)	08:57
19	05:27	06:02	06:39	07:16	07:45 (WTG 206)	08:58
20	05:28	06:03	06:40	07:17	07:45 (WTG 206)	08:59
21	05:29	06:04	06:41	07:19	07:47 (WTG 206)	09:01
22	05:30	06:06	06:44	07:20	07:48 (WTG 206)	09:02
23	05:31	06:07	06:43	07:21	07:50 (WTG 206)	09:03
24	05:32	06:08	06:42	07:23	07:51 (WTG 206)	09:05
25	05:33	06:09	06:42	07:24	07:54 (WTG 206)	09:06
26	05:34	06:10	06:41	07:25	15:52 (WTG 58)	07:07
27	05:35	06:12	06:40	07:27	15:50 (WTG 58)	07:08
28	05:37	06:13	06:40	07:28	15:49 (WTG 58)	07:10
29	05:38	06:14	06:39	07:30	15:48 (WTG 58)	07:11
30	05:39	06:15	06:39	07:31	15:47 (WTG 58)	07:12
31	05:40	06:16	06:39	07:32	15:46 (WTG 58)	07:14
Potential sun hours	472	436	376	341	288	274
Total, worst case		344	402	1351	1697	1064
Sun reduction		0.46	0.42	0.36	0.25	0.28
Oper. time red.		1.00	1.00	1.00	1.00	1.00
Wind dir. red.		0.78	0.78	0.71	0.79	0.79
Total reduction		0.36	0.33	0.26	0.20	0.22
Total, real		124	131	346	335	236

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-176 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (395)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:34	07:17	07:41 (WTG 48-W)	06:35	06:38	06:13 (WTG 46)
1	16:25	17:03	08:10 (WTG 48-W)	17:43	19:23	20:00 32 06:45 (WTG 46)
2	07:34	07:16	07:40 (WTG 48-W)	06:34	06:37	06:12 (WTG 46)
2	16:26	17:05	08:11 (WTG 48-W)	17:44	19:24	20:01 34 06:46 (WTG 46)
3	07:34	07:15	07:39 (WTG 48-W)	06:32	06:35	06:10 (WTG 46)
3	16:27	17:06	08:11 (WTG 48-W)	17:46	19:26	20:02 37 06:47 (WTG 46)
4	07:34	07:13	07:39 (WTG 48-W)	06:30	06:33	06:09 (WTG 46)
4	16:28	17:08	08:12 (WTG 48-W)	17:47	19:27	20:03 39 06:48 (WTG 46)
5	07:34	07:12	07:39 (WTG 48-W)	06:28	06:31	06:07 (WTG 46)
5	16:29	17:09	08:13 (WTG 48-W)	17:48	19:28	20:05 41 06:49 (WTG 46)
6	07:34	07:11	07:38 (WTG 48-W)	06:27	06:29	06:07 (WTG 46)
6	16:30	17:11	08:13 (WTG 48-W)	17:50	19:29	20:06 42 06:49 (WTG 46)
7	07:34	07:10	07:38 (WTG 48-W)	06:25	06:27	06:06 (WTG 46)
7	16:31	17:12	08:13 (WTG 48-W)	17:51	19:31	20:07 44 06:50 (WTG 46)
8	07:34	07:08	07:39 (WTG 48-W)	07:23	18:28 (WTG 78)	06:26
8	16:32	17:13	08:14 (WTG 48-W)	18:52	19:32	20:08 45 06:51 (WTG 46)
9	07:34	07:07	07:38 (WTG 48-W)	07:21	18:25 (WTG 78)	06:24
9	16:33	17:15	08:14 (WTG 48-W)	18:54	19:33	20:09 45 06:50 (WTG 46)
10	07:33	07:05	07:39 (WTG 48-W)	07:19	18:22 (WTG 78)	06:22
10	16:34	17:16	08:14 (WTG 48-W)	18:55	19:34	20:11 47 06:51 (WTG 46)
11	07:33	07:04	07:38 (WTG 48-W)	07:18	18:20 (WTG 78)	06:20
11	16:36	17:18	08:13 (WTG 48-W)	18:56	19:36	20:12 47 06:51 (WTG 46)
12	07:33	07:03	07:39 (WTG 48-W)	07:16	18:19 (WTG 78)	06:18
12	16:37	17:19	08:13 (WTG 48-W)	18:58	19:37	20:13 48 06:52 (WTG 46)
13	07:32	07:01	07:39 (WTG 48-W)	07:14	18:18 (WTG 78)	06:17
13	16:38	17:21	08:12 (WTG 48-W)	18:59	19:38	20:14 48 06:52 (WTG 46)
14	07:32	07:00	07:40 (WTG 48-W)	07:12	18:17 (WTG 78)	06:15
14	16:39	17:22	08:12 (WTG 48-W)	19:00	20:15	20:15 48 06:52 (WTG 46)
15	07:31	06:58	07:40 (WTG 48-W)	07:10	18:17 (WTG 78)	06:13
15	16:40	17:23	08:11 (WTG 48-W)	19:01	22:18	20:17 48 06:51 (WTG 46)
16	07:31	06:57	07:42 (WTG 48-W)	07:08	18:16 (WTG 78)	06:11
16	16:42	17:25	08:11 (WTG 48-W)	19:03	25:18	20:18 49 06:52 (WTG 46)
17	07:30	06:55	07:42 (WTG 48-W)	07:07	18:16 (WTG 78)	06:10
17	16:43	17:26	08:09 (WTG 48-W)	19:04	26:18	20:19 49 06:52 (WTG 46)
18	07:29	06:54	07:44 (WTG 48-W)	07:05	18:16 (WTG 78)	06:08
18	16:44	17:28	08:08 (WTG 48-W)	19:05	27:18	20:20 49 06:52 (WTG 46)
19	07:29	06:52	07:45 (WTG 48-W)	07:03	18:16 (WTG 78)	06:06
19	16:45	17:29	08:06 (WTG 48-W)	19:07	27:18	20:21 48 06:51 (WTG 46)
20	07:28	06:50	07:47 (WTG 48-W)	07:01	18:16 (WTG 78)	06:04
20	16:47	17:30	08:03 (WTG 48-W)	19:08	26:18	20:22 48 06:51 (WTG 46)
21	07:27	06:49	07:51 (WTG 48-W)	06:59	18:16 (WTG 78)	06:03
21	16:48	17:32	9 08:00 (WTG 48-W)	19:09	25:18	20:23 48 06:52 (WTG 46)
22	07:27	06:47		06:57	18:17 (WTG 78)	06:01
22	16:49	17:33		19:10	23:18	20:24 48 06:52 (WTG 46)
23	07:26	06:46		06:55	18:18 (WTG 78)	05:59
23	16:51	17:35		19:12	20:18	20:25 48 06:52 (WTG 46)
24	07:25	06:44		06:53	18:20 (WTG 78)	05:58
24	16:52	17:36		19:13	17:18	20:26 47 06:51 (WTG 46)
25	07:24	07:52 (WTG 48-W)		06:42	18:23 (WTG 78)	05:56
25	16:54	5 07:57 (WTG 48-W)		17:37	19:14	20:27 47 06:51 (WTG 46)
26	07:23	07:48 (WTG 48-W)		06:41	18:34 (WTG 78)	05:53
26	16:55	13 08:01 (WTG 48-W)		17:39	19:16	20:28 47 06:52 (WTG 46)
27	07:22	07:46 (WTG 48-W)		06:39	19:16	20:28 47 06:52 (WTG 46)
27	16:56	17 08:03 (WTG 48-W)		17:40	19:17	20:29 46 06:51 (WTG 46)
28	07:21	07:44 (WTG 48-W)		06:37	19:17	20:29 46 06:51 (WTG 46)
28	16:58	20 08:04 (WTG 48-W)		17:42	19:18	20:30 46 06:51 (WTG 46)
29	07:20	07:43 (WTG 48-W)		06:44	19:17	20:30 46 06:51 (WTG 46)
29	16:59	23 08:06 (WTG 48-W)		19:19	19:58	20:31 45 06:51 (WTG 46)
30	07:19	07:42 (WTG 48-W)		06:42	19:58	20:31 45 06:51 (WTG 46)
30	17:01	26 08:08 (WTG 48-W)		19:21	20:00	20:32 44 06:50 (WTG 46)
31	07:18	07:41 (WTG 48-W)		06:40	20:00	20:32 44 06:50 (WTG 46)
31	17:02	28 08:09 (WTG 48-W)		19:22	20:00	20:33 44 06:51 (WTG 46)
Potential sun hours	286	291	369	404	459	466
Total, worst case	132	626	335	89	1398	1101
Sun reduction	0.29	0.37	0.37	0.33	0.44	0.47
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00
Wind dir. red.	0.61	0.61	0.78	0.80	0.80	0.80
Total reduction	0.17	0.22	0.29	0.26	0.35	0.37
Total, real	23	140	96	23	485	408

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-176 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (395)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	06:16 (WTG 46)	05:41	06:15 (WTG 46)	06:17	06:53
	20:47	06:53 (WTG 46)	20:25	07:02 (WTG 46)	19:35	18:38
2	05:14	06:16 (WTG 46)	05:42	06:15 (WTG 46)	06:19	06:55
	20:47	06:53 (WTG 46)	20:24	07:02 (WTG 46)	19:33	18:36
3	05:14	06:16 (WTG 46)	05:43	06:15 (WTG 46)	06:20	06:56
	20:46	06:54 (WTG 46)	20:22	07:01 (WTG 46)	19:31	18:34
4	05:15	06:16 (WTG 46)	05:44	06:15 (WTG 46)	06:21	06:57
	20:46	06:55 (WTG 46)	20:21	07:01 (WTG 46)	19:29	18:33
5	05:16	06:16 (WTG 46)	05:45	06:16 (WTG 46)	06:22	06:58
	20:46	06:55 (WTG 46)	20:20	07:00 (WTG 46)	19:27	18:31
6	05:16	06:16 (WTG 46)	05:47	06:16 (WTG 46)	06:23	07:00
	20:46	06:55 (WTG 46)	20:18	06:59 (WTG 46)	19:25	18:29
7	05:17	06:16 (WTG 46)	05:48	06:17 (WTG 46)	06:25	07:01
	20:45	06:56 (WTG 46)	20:17	06:58 (WTG 46)	19:24	18:27
8	05:18	06:15 (WTG 46)	05:49	06:17 (WTG 46)	06:26	07:02
	20:45	06:56 (WTG 46)	20:16	06:57 (WTG 46)	19:22	18:25
9	05:18	06:15 (WTG 46)	05:50	06:18 (WTG 46)	06:27	07:03
	20:44	06:57 (WTG 46)	20:14	06:56 (WTG 46)	19:20	18:23
10	05:19	06:15 (WTG 46)	05:51	06:20 (WTG 46)	06:28	07:05
	20:44	06:58 (WTG 46)	20:13	06:56 (WTG 46)	19:18	18:22
11	05:20	06:15 (WTG 46)	05:52	06:21 (WTG 46)	06:29	07:06
	20:43	06:58 (WTG 46)	20:11	06:55 (WTG 46)	19:16	18:20
12	05:21	06:15 (WTG 46)	05:54	06:22 (WTG 46)	06:30	07:07
	20:43	06:58 (WTG 46)	20:10	06:53 (WTG 46)	19:14	18:18
13	05:22	06:15 (WTG 46)	05:55	06:23 (WTG 46)	06:32	07:08
	20:42	06:59 (WTG 46)	20:08	06:51 (WTG 46)	19:12	18:16
14	05:23	06:15 (WTG 46)	05:56	06:25 (WTG 46)	06:33	07:10
	20:42	06:59 (WTG 46)	20:07	06:49 (WTG 46)	19:10	18:15
15	05:23	06:15 (WTG 46)	05:57	06:27 (WTG 46)	06:34	07:11
	20:41	07:00 (WTG 46)	20:05	06:46 (WTG 46)	19:09	18:13
16	05:24	06:15 (WTG 46)	05:58	06:30 (WTG 46)	06:35	07:12
	20:40	07:00 (WTG 46)	20:04	06:42 (WTG 46)	19:07	18:11
17	05:25	06:15 (WTG 46)	06:00	06:36	07:14	07:14
	20:40	07:01 (WTG 46)	20:02	06:38	18:09	18:09
18	05:26	06:14 (WTG 46)	06:01	06:38	18:11 (WTG 78)	07:15
	20:39	07:00 (WTG 46)	20:01	06:38	18:20 (WTG 78)	18:08
19	05:27	06:14 (WTG 46)	06:02	06:39	18:07 (WTG 78)	07:16
	20:38	07:01 (WTG 46)	19:57	06:39	18:20 (WTG 78)	18:08
20	05:28	06:14 (WTG 46)	06:03	06:40	18:05 (WTG 78)	07:17
	20:37	07:01 (WTG 46)	19:56	06:40	18:23 (WTG 78)	18:06
21	05:29	06:13 (WTG 46)	06:04	06:41	18:04 (WTG 78)	07:19
	20:36	07:01 (WTG 46)	19:54	06:41	18:24 (WTG 78)	18:04
22	05:30	06:13 (WTG 46)	06:06	06:42	18:04 (WTG 78)	07:19
	20:36	07:02 (WTG 46)	19:52	06:42	18:26 (WTG 78)	18:03
23	05:31	06:13 (WTG 46)	06:07	06:44	18:02 (WTG 78)	07:20
	20:35	07:02 (WTG 46)	19:51	06:44	18:26 (WTG 78)	18:01
24	05:32	06:13 (WTG 46)	06:08	06:45	18:00 (WTG 78)	07:21
	20:34	07:02 (WTG 46)	19:49	06:45	18:27 (WTG 78)	17:59
25	05:33	06:13 (WTG 46)	06:09	06:46	17:59 (WTG 78)	07:23
	20:33	07:02 (WTG 46)	19:47	06:46	18:27 (WTG 78)	17:58
26	05:34	06:13 (WTG 46)	06:10	06:47	17:58 (WTG 78)	07:24
	20:32	07:02 (WTG 46)	19:45	06:47	18:28 (WTG 78)	17:56
27	05:35	06:13 (WTG 46)	06:11	06:48	17:58 (WTG 78)	07:25
	20:31	07:02 (WTG 46)	19:44	06:48	18:24 (WTG 78)	17:55
28	05:36	06:13 (WTG 46)	06:13	06:48	17:58 (WTG 78)	07:27
	20:30	07:02 (WTG 46)	19:42	06:48	18:23 (WTG 78)	17:53
29	05:38	06:13 (WTG 46)	06:14	06:50	17:57 (WTG 78)	07:28
	20:28	07:02 (WTG 46)	19:40	06:50	18:21 (WTG 78)	17:52
30	05:39	06:14 (WTG 46)	06:15	06:51	17:57 (WTG 78)	07:30
	20:27	07:02 (WTG 46)	19:38	06:51	18:18 (WTG 78)	17:50
31	05:40	06:15 (WTG 46)	06:16	06:52	17:57 (WTG 78)	07:31
	20:26	07:03 (WTG 46)	19:36	06:52	18:16 (WTG 78)	17:49
Potential sun hours	472	436	376	341	288	274
Total, worst case	1381	576	288	358	467	
Sun reduction	0.45	0.46	0.42	0.36	0.25	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.80	0.80	0.78	0.64	0.61	
Total reduction	0.36	0.36	0.32	0.23	0.15	
Total, real	490	209	93	81	70	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 21

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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-185 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (403)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.29	0.37	0.37	0.33	0.44	0.47	0.45	0.46	0.42	0.36	0.25	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
193	219	377	727	552	298	438	718	1,822	2,408	780	228	8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35 16:25 33	08:22 (WTG 148)   07:17 08:55 (WTG 148)   17:03	06:35 17:43	06:59 (WTG 148A)   06:38 16:59 (WTG 11)   19:23	17:14 (WTG 11)   05:47 18:15 (WTG 11)   20:00	06:29 (WTG 9A)   05:13 06:48 (WTG 9A)   20:34
2	07:35 16:26 33	08:22 (WTG 148)   07:16 08:55 (WTG 148)   17:05	06:34 17:44	06:57 (WTG 148A)   06:37 17:04 (WTG 11)   19:24	17:15 (WTG 11)   05:45 18:14 (WTG 11)   20:01	06:30 (WTG 9A)   05:13 06:45 (WTG 9A)   20:35
3	07:35 16:27 32	08:23 (WTG 148)   07:15 08:55 (WTG 148)   17:06	06:32 17:46	06:56 (WTG 148A)   06:35 17:08 (WTG 11)   19:26	17:15 (WTG 11)   05:44 18:12 (WTG 11)   20:02	06:33 (WTG 9A)   05:12 06:43 (WTG 9A)   20:36
4	07:35 16:28 33	08:23 (WTG 148)   07:13 08:56 (WTG 148)   17:08	06:30 17:47	06:54 (WTG 148A)   06:33 17:10 (WTG 11)   19:27	17:16 (WTG 11)   05:42 18:11 (WTG 11)   20:03	06:33 (WTG 9A)   05:12 06:43 (WTG 9A)   20:37
5	07:35 16:29 32	08:24 (WTG 148)   07:12 08:56 (WTG 148)   17:09	06:28 17:48	06:53 (WTG 148A)   06:31 17:12 (WTG 11)   19:28	17:17 (WTG 11)   05:41 18:10 (WTG 11)   20:05	06:33 (WTG 9A)   05:11 06:43 (WTG 9A)   20:38
6	07:34 16:30 32	08:25 (WTG 148)   07:11 08:57 (WTG 148)   17:10	06:27 17:50	06:52 (WTG 148A)   06:29 17:13 (WTG 11)   19:29	17:18 (WTG 11)   05:40 18:08 (WTG 11)   20:06	06:33 (WTG 9A)   05:11 06:43 (WTG 9A)   20:38
7	07:34 16:31 31	08:25 (WTG 148)   07:10 08:56 (WTG 148)   17:12	06:25 17:51	06:51 (WTG 148A)   06:27 17:14 (WTG 11)   19:31	17:19 (WTG 11)   05:38 18:06 (WTG 11)   20:07	06:33 (WTG 9A)   05:11 06:43 (WTG 9A)   20:39
8	07:34 16:32 31	08:26 (WTG 148)   07:08 08:57 (WTG 148)   17:13	06:23 18:52	07:51 (WTG 148A)   06:26 18:16 (WTG 11)   19:32	17:21 (WTG 11)   05:37 18:05 (WTG 11)   20:08	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:40
9	07:34 16:33 30	08:27 (WTG 148)   07:07 08:57 (WTG 148)   17:15	06:21 18:54	07:50 (WTG 148A)   06:24 18:17 (WTG 11)   19:33	17:23 (WTG 11)   05:36 18:03 (WTG 11)   20:10	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:41
10	07:33 16:34 30	08:27 (WTG 148)   07:06 08:57 (WTG 148)   17:16	06:19 18:55	07:50 (WTG 148A)   06:22 18:18 (WTG 11)   19:35	17:24 (WTG 11)   05:34 18:00 (WTG 11)   20:11	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:42
11	07:33 16:35 29	08:28 (WTG 148)   07:04 08:57 (WTG 148)   17:18	06:18 18:56	07:49 (WTG 148A)   06:20 18:19 (WTG 11)   19:36	17:26 (WTG 11)   05:33 17:58 (WTG 11)   20:12	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:42
12	07:33 16:37 27	08:30 (WTG 148)   07:03 08:57 (WTG 148)   17:19	06:16 18:57	07:49 (WTG 148A)   06:18 18:19 (WTG 11)   19:37	06:41 (WTG 9A)   05:32 17:55 (WTG 11)   20:13	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:42
13	07:32 16:38 27	08:30 (WTG 148)   07:01 08:57 (WTG 148)   17:21	06:14 18:59	07:49 (WTG 148A)   06:17 18:20 (WTG 11)   19:38	06:37 (WTG 9A)   05:30 17:51 (WTG 11)   20:14	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:43
14	07:32 16:39 25	08:31 (WTG 148)   07:00 08:56 (WTG 148)   17:22	06:12 19:00	07:49 (WTG 148A)   06:15 18:20 (WTG 11)   19:40	06:35 (WTG 9A)   05:29 17:51 (WTG 11)   20:15	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:43
15	07:31 16:40 24	08:32 (WTG 148)   06:58 08:33 (WTG 148)   17:23	07:10 19:01	07:50 (WTG 148A)   06:13 18:21 (WTG 11)   19:41	06:33 (WTG 9A)   05:28 17:55 (WTG 11)   20:17	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:44
16	07:31 16:41 22	08:33 (WTG 148)   06:57 08:35 (WTG 148)   17:25	07:08 19:03	07:51 (WTG 148A)   06:11 18:21 (WTG 11)   19:42	06:32 (WTG 9A)   05:27 17:55 (WTG 11)   20:18	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:44
17	07:30 16:43 20	08:35 (WTG 148)   06:55 08:36 (WTG 148)   17:26	07:06 19:04	07:51 (WTG 148A)   06:09 18:21 (WTG 11)   19:43	06:30 (WTG 9A)   05:26 17:55 (WTG 11)   20:19	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:45
18	07:30 16:44 18	08:36 (WTG 148)   06:54 08:54 (WTG 148)   17:28	07:05 19:05	07:52 (WTG 148A)   06:08 18:21 (WTG 11)   19:45	06:28 (WTG 9A)   05:25 17:55 (WTG 11)   20:20	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:45
19	07:29 16:45 14	08:38 (WTG 148)   06:52 08:38 (WTG 148)   17:29	07:03 19:07	07:53 (WTG 148A)   06:06 18:21 (WTG 11)   19:46	06:27 (WTG 9A)   05:24 17:55 (WTG 11)   20:21	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:46
20	07:28 16:47 9	08:41 (WTG 148)   06:51 08:50 (WTG 148)   17:30	07:01 19:08	07:55 (WTG 148A)   06:04 18:21 (WTG 11)   19:47	06:26 (WTG 9A)   05:23 17:55 (WTG 11)   20:22	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:46
21	07:27 16:48	08:41 (WTG 148)   06:49 17:32	06:59 19:09	07:59 (WTG 148A)   06:03 18:21 (WTG 11)   19:48	06:25 (WTG 9A)   05:22 17:55 (WTG 11)   20:23	06:33 (WTG 9A)   05:09 06:43 (WTG 9A)   20:46
22	07:27 16:49	08:42 (WTG 148)   06:47 17:33	06:57 19:10	17:12 (WTG 11)   06:01 18:21 (WTG 11)   19:50	06:26 (WTG 9A)   05:21 17:55 (WTG 11)   20:24	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:46
23	07:26 16:51	08:43 (WTG 148)   06:46 17:35	06:55 19:12	17:12 (WTG 11)   05:59 18:20 (WTG 11)   19:51	06:25 (WTG 9A)   05:20 17:55 (WTG 11)   20:25	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:47
24	07:25 16:52	08:44 (WTG 148)   06:44 17:36	06:53 19:13	17:12 (WTG 11)   05:58 18:21 (WTG 11)   19:52	06:25 (WTG 9A)   05:19 17:55 (WTG 11)   20:26	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:47
25	07:24 16:53	08:45 (WTG 148)   06:42 17:37	06:51 19:14	17:12 (WTG 11)   05:56 18:20 (WTG 11)   19:53	06:25 (WTG 9A)   05:18 17:55 (WTG 11)   20:27	06:33 (WTG 9A)   05:10 06:43 (WTG 9A)   20:47
26	07:23 16:55	08:46 (WTG 148)   06:41 17:39	06:50 19:16	17:12 (WTG 11)   05:55 18:19 (WTG 11)   19:55	06:25 (WTG 9A)   05:17 17:55 (WTG 11)   20:28	06:33 (WTG 9A)   05:11 06:43 (WTG 9A)   20:47
27	07:22 16:56	08:47 (WTG 148)   06:39 17:40	06:48 19:17	17:12 (WTG 11)   05:53 18:19 (WTG 11)   19:56	06:26 (WTG 9A)   05:17 17:55 (WTG 11)   20:29	06:33 (WTG 9A)   05:11 06:43 (WTG 9A)   20:47
28	07:21 16:58	08:48 (WTG 148)   06:37 17:41	06:46 19:18	17:12 (WTG 11)   05:51 18:18 (WTG 11)   19:57	06:26 (WTG 9A)   05:16 17:55 (WTG 11)   20:30	06:33 (WTG 9A)   05:12 06:43 (WTG 9A)   20:47
29	07:20 16:59	08:49 (WTG 148)   06:35 17:42	06:44 19:19	17:12 (WTG 11)   05:50 18:17 (WTG 11)   19:58	06:27 (WTG 9A)   05:15 17:55 (WTG 11)   20:31	06:33 (WTG 9A)   05:12 06:43 (WTG 9A)   20:47
30	07:19 17:00	08:50 (WTG 148)   06:33 17:43	06:42 19:20	17:13 (WTG 11)   05:48 18:16 (WTG 11)   20:00	06:28 (WTG 9A)   05:15 17:55 (WTG 11)   20:32	06:33 (WTG 9A)   05:13 06:43 (WTG 9A)   20:47
31	07:18 17:02	08:51 (WTG 148)   06:31 17:44	06:40 19:21	17:13 (WTG 11)   05:47 18:15 (WTG 11)   20:01	06:28 (WTG 9A)   05:14 17:55 (WTG 11)   20:33	06:33 (WTG 9A)   05:13 06:43 (WTG 9A)   20:47
Potential sun hours	286	291	369	404	459	466
Total, worst case	532	14	2386	1029	44	
Sun reduction	0.29	0.37	0.37	0.33	0.44	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.49	0.69	0.77	0.79	0.79	
Total reduction	0.14	0.25	0.28	0.26	0.34	
Total, real	75	4	663	263	15	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 22

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-185 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (403)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:41	06:17	17:25 (WTG 11)	06:53	07:13
2	05:14	05:42	06:19	17:23 (WTG 11)	06:55	07:15
3	05:14	05:43	06:20	17:21 (WTG 11)	06:56	07:16
4	05:15	05:44	06:21	17:18 (WTG 11)	06:57	07:17
5	05:15	05:45	06:22	17:16 (WTG 11)	06:58	07:18
6	05:16	05:46	06:23	17:14 (WTG 11)	07:00	07:19
7	05:17	05:48	06:24	17:12 (WTG 11)	07:01	07:20
8	05:17	05:49	06:26	17:10 (WTG 11)	07:02	07:21
9	05:18	05:50	06:27	17:08 (WTG 11)	07:03	07:22
10	05:19	05:51	06:28	17:06 (WTG 11)	07:05	07:23
11	05:20	05:52	06:29	17:04 (WTG 11)	07:06	07:24
12	05:21	05:54	06:30	17:02 (WTG 11)	07:07	07:25
13	05:21	05:55	06:32	17:00 (WTG 11)	07:08	07:25
14	05:22	05:56	06:33	16:58 (WTG 11)	07:10	07:26
15	05:23	05:57	06:34	16:56 (WTG 11)	07:11	07:27
16	05:24	05:58	06:35	16:54 (WTG 11)	07:12	07:28
17	05:25	05:59	06:36	16:52 (WTG 11)	07:14	07:29
18	05:26	06:01	06:38	16:50 (WTG 11)	07:15	07:29
19	05:27	06:02	06:39	16:48 (WTG 11)	07:16	07:30
20	05:28	06:03	06:40	16:46 (WTG 11)	07:18	07:30
21	05:29	06:04	06:41	16:44 (WTG 11)	07:19	07:31
22	05:30	06:05	06:42	16:42 (WTG 11)	07:20	07:32
23	05:31	06:07	06:44	16:40 (WTG 11)	07:22	07:32
24	05:32	06:08	06:45	16:38 (WTG 11)	07:23	07:32
25	05:33	06:09	06:46	16:36 (WTG 11)	07:24	07:33
26	05:34	06:10	06:47	16:34 (WTG 11)	07:26	07:33
27	05:35	06:11	06:48	16:32 (WTG 11)	07:27	07:33
28	05:36	06:13	06:50	16:30 (WTG 11)	07:28	07:34
29	05:37	06:14	06:51	16:28 (WTG 11)	07:30	07:34
30	05:38	06:15	06:52	16:26 (WTG 11)	07:31	07:34
31	05:40	06:16	06:54	16:24 (WTG 11)	07:32	07:34
Potential sun hours	472	436	376	341	288	274
Total, worst case		552	2005	968	185	1018
Sun reduction		0.46	0.42	0.36	0.25	0.28
Oper. time red.		1.00	1.00	1.00	1.00	1.00
Wind dir. red.		0.79	0.78	0.75	0.49	0.49
Total reduction		0.36	0.32	0.26	0.12	0.14
Total, real		197	644	256	22	138

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 23

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-187 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (405)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35	07:17	06:35	07:15 (WTG 148A) 06:38	05:47	05:13
	16:25	17:03	17:43	93 16:52 (WTG 11) 19:23	20:00	20:34
2	07:35	07:16	06:34	07:15 (WTG 148A) 06:37	8 07:00 (WTG 9A) 05:45	05:13
	16:26	17:05	17:44	93 16:52 (WTG 11) 19:24	07:08 (WTG 9A) 20:01	20:35
3	07:35	07:15	06:32	07:16 (WTG 148A) 06:35	16 06:56 (WTG 9A) 05:44	05:12
	16:27	17:06	17:46	91 16:52 (WTG 11) 19:26	07:12 (WTG 9A) 20:02	20:36
4	07:35	07:13	06:30	07:17 (WTG 148A) 06:33	20 06:53 (WTG 9A) 05:42	05:12
	16:28	17:08	17:47	88 16:51 (WTG 11) 19:27	07:13 (WTG 9A) 20:03	20:37
5	07:35	07:12	06:28	07:17 (WTG 148A) 06:31	23 06:51 (WTG 9A) 05:41	05:11
	16:29	17:09	17:48	86 16:51 (WTG 11) 19:28	07:14 (WTG 9A) 20:05	20:38
6	07:34	07:11	06:27	07:18 (WTG 148A) 06:29	25 06:50 (WTG 9A) 05:40	05:11
	16:30	17:10	17:50	82 16:50 (WTG 11) 19:29	07:15 (WTG 9A) 20:06	20:38
7	07:34	07:10	06:25	07:20 (WTG 148A) 06:27	27 06:48 (WTG 9A) 05:38	05:10
	16:31	17:12	17:51	76 16:49 (WTG 11) 19:31	07:15 (WTG 9A) 20:07	20:39
8	07:34	07:08	06:23	08:23 (WTG 148A) 06:26	29 06:48 (WTG 9A) 05:37	05:10
	16:32	17:13	18:52	70 17:49 (WTG 11) 19:32	07:17 (WTG 9A) 20:08	20:40
9	07:34	07:07	06:21	08:27 (WTG 148A) 06:24	30 06:47 (WTG 9A) 05:36	05:10
	16:33	17:15	18:54	60 17:48 (WTG 11) 19:33	07:17 (WTG 9A) 20:10	20:41
10	07:34	07:06	06:19	16:55 (WTG 11) 06:22	31 06:46 (WTG 9A) 05:34	05:10
	16:34	17:16	18:55	52 17:47 (WTG 11) 19:35	07:17 (WTG 9A) 20:11	20:41
11	07:33	07:04	06:18	16:55 (WTG 11) 06:20	31 06:45 (WTG 9A) 05:33	05:09
	16:35	17:18	18:56	51 17:46 (WTG 11) 19:36	07:16 (WTG 9A) 20:12	20:42
12	07:33	07:03	06:16	16:56 (WTG 11) 06:18	31 06:46 (WTG 9A) 05:32	05:09
	16:36	17:19	18:57	48 17:44 (WTG 11) 19:37	07:17 (WTG 9A) 20:13	20:42
13	07:32	07:01	06:14	16:57 (WTG 11) 06:17	31 06:45 (WTG 9A) 05:30	05:09
	16:38	17:20	18:59	46 17:43 (WTG 11) 19:38	07:16 (WTG 9A) 20:14	20:43
14	07:32	07:00	06:12	16:58 (WTG 11) 06:15	31 06:45 (WTG 9A) 05:29	05:09
	16:39	17:22	19:00	43 17:41 (WTG 11) 19:40	07:15 (WTG 9A) 20:15	20:43
15	07:31	06:58	07:10	17:01 (WTG 11) 06:13	30 06:45 (WTG 9A) 05:28	05:09
	16:40	17:23	19:01	39 17:40 (WTG 11) 19:41	29 07:14 (WTG 9A) 20:17	20:44
16	07:31	06:57	07:08	17:02 (WTG 11) 06:11	28 06:46 (WTG 9A) 05:27	05:09
	16:41	17:25	19:03	36 17:38 (WTG 11) 19:42	07:14 (WTG 9A) 20:18	20:44
17	07:30	06:55	07:06	17:04 (WTG 11) 06:09	27 06:46 (WTG 9A) 05:26	05:09
	16:43	17:26	19:04	31 17:35 (WTG 11) 19:43	07:13 (WTG 9A) 20:19	20:45
18	07:30	06:54	07:05	17:07 (WTG 11) 06:08	27 06:47 (WTG 9A) 05:25	05:09
	16:44	17:28	19:05	25 17:32 (WTG 11) 19:45	24 07:11 (WTG 9A) 20:20	20:45
19	07:29	06:52	07:03	17:10 (WTG 11) 06:06	24 06:48 (WTG 9A) 05:24	05:09
	16:45	17:29	19:07	18 17:28 (WTG 11) 19:46	23 07:11 (WTG 9A) 20:21	20:46
20	07:28	06:51	07:01	06:04	23 06:49 (WTG 9A) 05:23	05:09
	16:47	17:30	19:08	19:47	20 07:09 (WTG 9A) 20:22	20:46
21	07:27	06:49	06:59	06:03	16 06:50 (WTG 9A) 05:22	05:09
	16:48	17:32	19:09	19:48	16 07:06 (WTG 9A) 20:23	20:46
22	07:27	06:47	06:57	06:01	9 06:54 (WTG 9A) 05:21	05:10
	16:49	17:33	19:10	19:50	9 07:03 (WTG 9A) 20:24	20:46
23	07:26	06:46	06:55	05:59	05:20	05:10
	16:51	17:35	19:12	19:51	20:26	20:47
24	07:25	06:44	06:53	05:58	05:19	05:10
	16:52	17:36	19:13	19:52	20:27	20:47
25	07:24	06:42	06:51	05:56	05:18	05:10
	16:53	17:37	19:14	19:53	20:28	20:47
26	07:23	06:41	06:50	05:55	05:17	05:11
	16:55	17:39	19:16	19:55	20:29	20:47
27	07:22	06:39	06:48	05:53	05:17	05:11
	16:56	17:40	19:17	19:56	20:30	20:47
28	07:21	06:37	06:46	05:51	05:16	05:12
	16:58	17:41	19:18	19:57	20:31	20:47
29	07:20		06:44	05:50	05:15	05:12
	16:59		19:19	19:58	20:32	20:47
30	07:19		06:42	05:48	05:15	05:13
	17:00		19:21	20:00	20:32	20:47
31	07:18		06:40		05:14	
	17:02		19:22		20:33	
Potential sun hours	286	291	369	404	459	466
Total, worst case		1400	1128	508		
Sun reduction		0.37	0.37	0.33		
Oper. time red.		1.00	1.00	1.00		
Wind dir. red.		0.76	0.78	0.78		
Total reduction		0.28	0.29	0.26		
Total, real		393	324	130		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 24

Licensed user:

EDR

217 Montgomery St.

US-SYRACUSE, NY 13202

(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-187 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (405)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December					
1	05:13	05:41	06:17	06:44 (WTG 9A)	06:53	16:36 (WTG 11)	06:34	15:40 (WTG 11)	07:13		
	20:47	20:25	19:35	07:15 (WTG 9A)	18:38	47	17:23 (WTG 11)	16:46	16:17		
2	05:14	05:42	06:19	06:45 (WTG 9A)	06:55		16:35 (WTG 11)	06:35	15:43 (WTG 11)	07:15	
	20:47	20:24	19:33	07:16 (WTG 9A)	18:36	49	17:24 (WTG 11)	16:44	19	16:02 (WTG 11)	16:16
3	05:14	05:43	06:20	06:45 (WTG 9A)	06:56		16:33 (WTG 11)	06:36		15:50 (WTG 11)	07:16
	20:47	20:22	19:31	07:15 (WTG 9A)	18:34	51	17:24 (WTG 11)	16:43	6	15:56 (WTG 11)	16:16
4	05:15	05:44	06:21	06:45 (WTG 9A)	06:57		16:31 (WTG 11)	06:38			07:17
	20:46	20:21	19:29	07:14 (WTG 9A)	18:33	54	17:25 (WTG 11)	16:41			16:16
5	05:15	05:45	06:22	06:45 (WTG 9A)	06:58		08:01 (WTG 148A)	06:39			07:18
	20:46	20:20	19:27	07:13 (WTG 9A)	18:31	67	17:26 (WTG 11)	16:40			16:15
6	05:16	05:46	06:23	06:46 (WTG 9A)	07:00		07:58 (WTG 148A)	06:41			07:19
	20:46	20:19	19:26	07:11 (WTG 9A)	18:29	74	17:26 (WTG 11)	16:39			16:15
7	05:17	05:48	06:24	06:46 (WTG 9A)	07:01		07:55 (WTG 148A)	06:42			07:20
	20:45	20:17	19:24	07:10 (WTG 9A)	18:27	80	17:26 (WTG 11)	16:37			16:15
8	05:17	05:49	06:26	06:47 (WTG 9A)	07:02		07:53 (WTG 148A)	06:43			07:21
	20:45	20:16	19:22	07:07 (WTG 9A)	18:25	83	17:25 (WTG 11)	16:36			16:15
9	05:18	05:50	06:27	06:50 (WTG 9A)	07:03		07:52 (WTG 148A)	06:45			07:22
	20:45	20:14	19:20	07:06 (WTG 9A)	18:23	87	17:26 (WTG 11)	16:35			16:15
10	05:19	05:51	06:28	06:53 (WTG 9A)	07:05		07:50 (WTG 148A)	06:46			07:23
	20:44	20:13	19:18	07:02 (WTG 9A)	18:22	91	17:26 (WTG 11)	16:34			16:15
11	05:20	05:52	06:29	07:06			07:49 (WTG 148A)	06:47			07:24
	20:44	20:11	19:16		18:20	92	17:25 (WTG 11)	16:33			16:15
12	05:21	05:54	06:30	07:07			07:49 (WTG 148A)	06:49			07:25
	20:43	20:10	19:14		18:18	93	17:26 (WTG 11)	16:31			16:15
13	05:21	05:55	06:32	07:08			07:48 (WTG 148A)	06:50			07:25
	20:43	20:08	19:12		18:16	94	17:25 (WTG 11)	16:30			16:15
14	05:22	05:56	06:33	07:10			07:47 (WTG 148A)	06:52			07:26
	20:42	20:07	19:10		18:14	96	17:25 (WTG 11)	16:29			16:15
15	05:23	05:57	06:34	07:11			07:47 (WTG 148A)	06:53			07:27
	20:41	20:05	19:09		18:13	95	17:25 (WTG 11)	16:28			16:15
16	05:24	05:58	06:35	07:12			07:47 (WTG 148A)	06:54			07:28
	20:41	20:04	19:07		18:11	94	17:24 (WTG 11)	16:27			16:15
17	05:25	05:59	06:36	07:14			07:46 (WTG 148A)	06:56			07:29
	20:40	20:02	19:05		18:09	94	17:23 (WTG 11)	16:26			16:16
18	05:26	06:01	06:38	07:15			07:47 (WTG 148A)	06:57			07:29
	20:39	20:01	19:03		18:08	92	17:23 (WTG 11)	16:25			16:16
19	05:27	06:02	06:39	07:16			07:47 (WTG 148A)	06:58			07:30
	20:38	19:57	19:01		18:06	91	17:22 (WTG 11)	16:24			16:16
20	05:28	06:03	06:40	07:18			07:48 (WTG 148A)	07:00			07:30
	20:37	19:56	18:59		18:04	89	17:22 (WTG 11)	16:23			16:17
21	05:29	06:04	06:41	07:19			07:48 (WTG 148A)	07:01			07:31
	20:37	19:54	18:57		18:03	86	17:21 (WTG 11)	16:23			16:17
22	05:30	06:05	06:42	07:20			07:48 (WTG 148A)	07:02			07:32
	20:36	19:52	18:55		18:01	84	17:20 (WTG 11)	16:22			16:18
23	05:31	06:07	06:44	07:21			07:49 (WTG 148A)	07:04			07:32
	20:35	19:51	18:53		17:59	81	17:20 (WTG 11)	16:21			16:18
24	05:32	06:08	06:45	07:23			07:50 (WTG 148A)	07:05			07:32
	20:34	19:49	18:51		17:58	77	17:18 (WTG 11)	16:20			16:19
25	05:33	06:09	06:46	07:24			07:52 (WTG 148A)	07:06			07:33
	20:33	19:47	18:50		17:56	72	17:18 (WTG 11)	16:20			16:19
26	05:34	06:10	06:47	07:26			07:53 (WTG 148A)	07:07			07:33
	20:32	19:45	18:48		17:54	66	17:16 (WTG 11)	16:19			16:20
27	05:35	06:11	06:48	07:27			07:55 (WTG 148A)	07:09			07:34
	20:31	19:44	18:46		17:53	58	17:14 (WTG 11)	16:19			16:21
28	05:36	06:13	06:49	07:28			08:01 (WTG 148A)	07:10			07:34
	20:30	19:42	18:44		17:51	44	17:13 (WTG 11)	16:18			16:21
29	05:37	06:14	06:51	07:30			16:33 (WTG 11)	07:11			07:34
	20:29	19:40	18:42		17:50	38	17:11 (WTG 11)	16:17			16:22
30	05:38	06:15	06:52	07:31			16:35 (WTG 11)	07:12			07:34
	20:27	19:38	18:40		17:48	35	17:10 (WTG 11)	16:17			16:23
31	05:40	06:16	06:54	07:32			16:37 (WTG 11)				07:34
	20:26	19:37	18:39	17:47			17:07 (WTG 11)				16:24
Potential sun hours	472	436	376	341	288			274			
Total, worst case		271	467	2284	50			129			
Sun reduction		0.46	0.42	0.36	0.25			0.28			
Oper. time red.		1.00	1.00	1.00	1.00			1.00			
Wind dir. red.		0.78	0.79	0.76	0.81			0.48			
Total reduction		0.36	0.33	0.27	0.20			0.14			
Total, real		97	155	626	10			17			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 25

Licensed user:

EDR

217 Montgomery St.  
US-SYRACUSE, NY 13202  
(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-188 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (406)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
Minimum sun height over horizon for influence 3 °  
Day step for calculation 1 days  
Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June								
1	07:35	07:17	07:45 (WTG 21)	06:35	06:38	07:08 (WTG 148)	05:47	05:13						
	16:25	17:03	16:12 (WTG 15)	17:43	19:23	103	18:48 (WTG 15A)	20:00	20:34					
2	07:35	15:30 (WTG 15)	07:16	07:45 (WTG 21)	06:34	06:37	07:07 (WTG 148)	05:45	05:13					
	16:26	4	15:34 (WTG 15)	17:05	89	16:13 (WTG 15)	17:44	19:24	105	18:48 (WTG 15A)	20:01	20:35		
3	07:35	15:28 (WTG 15)	07:15	07:45 (WTG 21)	06:32	06:35	07:06 (WTG 148)	05:44	05:12					
	16:27	10	15:38 (WTG 15)	17:06	88	16:12 (WTG 15)	17:46	19:26	105	18:47 (WTG 15A)	20:02	20:36		
4	07:35	15:26 (WTG 15)	07:13	07:46 (WTG 21)	06:30	06:33	07:05 (WTG 148)	05:42	05:12					
	16:28	15	15:41 (WTG 15)	17:08	87	16:13 (WTG 15)	17:47	19:27	106	18:47 (WTG 15A)	20:03	20:37		
5	07:35	15:25 (WTG 15)	07:12	07:46 (WTG 21)	06:28	06:31	07:04 (WTG 148)	05:41	05:11					
	16:29	18	15:43 (WTG 15)	17:09	87	16:13 (WTG 15)	17:48	19:28	107	18:46 (WTG 15A)	20:05	20:38		
6	07:34	15:24 (WTG 15)	07:11	07:47 (WTG 21)	06:27	06:29	07:04 (WTG 148)	05:40	05:11					
	16:30	21	15:45 (WTG 15)	17:10	86	16:14 (WTG 15)	17:50	19:29	107	18:46 (WTG 15A)	20:06	20:38		
7	07:34	15:23 (WTG 15)	07:10	07:47 (WTG 21)	06:25	06:27	07:03 (WTG 148)	05:38	05:11					
	16:31	23	15:46 (WTG 15)	17:12	85	16:13 (WTG 15)	17:51	19:31	107	18:45 (WTG 15A)	20:07	20:39		
8	07:34	15:22 (WTG 15)	07:08	07:49 (WTG 21)	07:23	06:26	07:03 (WTG 148)	05:37	05:10					
	16:32	26	15:48 (WTG 15)	17:13	82	16:14 (WTG 15)	18:52	19:32	106	18:45 (WTG 15A)	20:08	20:40		
9	07:34	15:22 (WTG 15)	07:07	07:49 (WTG 21)	07:21	06:24	07:03 (WTG 148)	05:36	05:10					
	16:33	28	15:50 (WTG 15)	17:15	80	16:13 (WTG 15)	18:54	19:33	105	18:44 (WTG 15A)	20:10	20:40		
10	07:33	15:20 (WTG 15)	07:06	07:51 (WTG 21)	07:19	06:22	07:02 (WTG 148)	05:34	05:10					
	16:34	31	15:51 (WTG 15)	17:16	76	16:13 (WTG 15)	18:55	19:35	104	18:43 (WTG 15A)	20:11	20:41		
11	07:33	15:20 (WTG 15)	07:04	07:54 (WTG 21)	07:18	06:20	07:02 (WTG 148)	05:33	05:09					
	16:35	33	15:53 (WTG 15)	17:18	71	16:13 (WTG 15)	18:56	19:36	102	18:42 (WTG 15A)	20:12	20:42		
12	07:33	15:20 (WTG 15)	07:03	07:58 (WTG 21)	07:16	06:18	07:03 (WTG 148)	05:32	05:09					
	16:37	35	15:55 (WTG 15)	17:19	62	16:13 (WTG 15)	18:57	19:37	100	18:42 (WTG 15A)	20:13	20:42		
13	07:32	15:19 (WTG 15)	07:01	15:17 (WTG 15)	07:14	06:17	07:03 (WTG 148)	05:31	05:09					
	16:38	37	15:56 (WTG 15)	17:21	56	16:13 (WTG 15)	18:59	19:38	97	18:41 (WTG 15A)	20:14	20:43		
14	07:32	15:18 (WTG 15)	07:00	15:17 (WTG 15)	07:12	06:15	07:02 (WTG 148)	05:29	05:09					
	16:39	38	15:56 (WTG 15)	17:22	55	16:12 (WTG 15)	19:00	19:40	95	18:39 (WTG 15A)	20:15	20:43		
15	07:31	15:18 (WTG 15)	06:58	15:18 (WTG 15)	07:10	06:13	07:02 (WTG 148)	05:28	05:09					
	16:40	40	15:58 (WTG 15)	17:23	54	16:12 (WTG 15)	19:01	19:41	92	18:38 (WTG 15A)	20:17	20:44		
16	07:31	15:17 (WTG 15)	06:57	15:18 (WTG 15)	07:08	06:11	07:04 (WTG 148)	05:27	05:09					
	16:41	42	15:59 (WTG 15)	17:25	52	16:10 (WTG 15)	19:03	19:42	87	18:37 (WTG 15A)	20:18	20:44		
17	07:30	15:17 (WTG 15)	06:55	15:19 (WTG 15)	07:06	06:10	18:17 (WTG 15A)	06:10	07:04 (WTG 148)	05:26	05:09	05:33 (WTG 148A)		
	16:43	44	16:01 (WTG 15)	17:26	50	16:09 (WTG 15)	19:04	19:43	83	18:35 (WTG 15A)	20:19	20:45	4	05:37 (WTG 148A)
18	07:30	15:17 (WTG 15)	06:54	15:21 (WTG 15)	07:05	06:08	18:12 (WTG 15A)	06:08	07:04 (WTG 148)	05:25	05:09	05:33 (WTG 148A)		
	16:44	45	16:02 (WTG 15)	17:28	48	16:09 (WTG 15)	19:05	19:45	78	18:33 (WTG 15A)	20:20	20:45	5	05:38 (WTG 148A)
19	07:29	07:52 (WTG 21)	06:52	15:21 (WTG 15)	07:03	06:06	18:09 (WTG 15A)	06:06	07:05 (WTG 148)	05:24	05:09	05:34 (WTG 148A)		
	16:45	55	16:03 (WTG 15)	17:29	46	16:07 (WTG 15)	19:07	19:46	73	18:32 (WTG 15A)	20:21	20:46	5	05:39 (WTG 148A)
20	07:28	07:51 (WTG 21)	06:51	15:23 (WTG 15)	07:01	06:04	18:06 (WTG 15A)	06:04	07:06 (WTG 148)	05:23	05:09	05:34 (WTG 148A)		
	16:47	60	16:04 (WTG 15)	17:30	44	16:07 (WTG 15)	19:08	19:47	66	18:29 (WTG 15A)	20:22	20:46	6	05:40 (WTG 148A)
21	07:27	07:50 (WTG 21)	06:49	15:25 (WTG 15)	06:59	06:03	18:04 (WTG 15A)	06:03	07:06 (WTG 148)	05:22	05:09	05:34 (WTG 148A)		
	16:48	63	16:04 (WTG 15)	17:32	40	16:05 (WTG 15)	19:09	19:48	59	18:26 (WTG 15A)	20:23	20:46	6	05:40 (WTG 148A)
22	07:27	07:50 (WTG 21)	06:47	15:26 (WTG 15)	06:57	06:01	18:02 (WTG 15A)	06:01	07:08 (WTG 148)	05:21	05:10	05:34 (WTG 148A)		
	16:49	67	16:06 (WTG 15)	17:33	37	16:03 (WTG 15)	19:10	19:50	48	18:22 (WTG 15A)	20:24	20:46	6	05:40 (WTG 148A)
23	07:26	07:49 (WTG 21)	06:46	15:29 (WTG 15)	06:55	05:59	07:29 (WTG 148)	05:59	07:09 (WTG 148)	05:20	05:10	05:34 (WTG 148A)		
	16:51	71	16:07 (WTG 15)	17:35	32	16:01 (WTG 15)	19:12	19:51	30	07:39 (WTG 148)	20:25	20:47	6	05:40 (WTG 148A)
24	07:25	07:48 (WTG 21)	06:44	15:31 (WTG 15)	06:53	05:58	07:24 (WTG 148)	05:58	07:11 (WTG 148)	05:19	05:10	05:35 (WTG 148A)		
	16:52	74	16:08 (WTG 15)	17:36	28	15:59 (WTG 15)	19:13	19:52	26	07:37 (WTG 148)	20:27	20:47	5	05:40 (WTG 148A)
25	07:24	07:47 (WTG 21)	06:42	15:34 (WTG 15)	06:51	05:56	07:21 (WTG 148)	05:56	07:13 (WTG 148)	05:18	05:10	05:35 (WTG 148A)		
	16:53	78	16:09 (WTG 15)	17:37	21	15:55 (WTG 15)	19:14	19:53	21	07:34 (WTG 148)	20:28	20:47	4	05:39 (WTG 148A)
26	07:23	07:46 (WTG 21)	06:41	15:39 (WTG 15)	06:50	05:55	07:18 (WTG 148)	05:55	07:16 (WTG 148)	05:17	05:11			
	16:55	80	16:09 (WTG 15)	17:39	11	15:50 (WTG 15)	19:16	19:55	14	07:30 (WTG 148)	20:29	20:47		
27	07:22	07:46 (WTG 21)	06:39	15:40 (WTG 15)	06:48	05:53	07:16 (WTG 148)	05:53		05:17	05:11			
	16:56	81	16:10 (WTG 15)	17:40		19:17	86	18:47 (WTG 15A)	19:56	20:30	20:47			
28	07:21	07:45 (WTG 21)	06:37	15:41 (WTG 15)	06:46	05:51	07:14 (WTG 148)	05:51		05:16	05:12			
	16:58	84	16:11 (WTG 15)	17:41		19:18	91	18:47 (WTG 15A)	19:57	20:31	20:47			
29	07:20	07:44 (WTG 21)	06:34	15:42 (WTG 15)	06:44	05:50	07:12 (WTG 148)	05:50		05:15	05:12			
	16:59	85	16:10 (WTG 15)	17:42		19:19	95	18:47 (WTG 15A)	19:58	20:32	20:47			
30	07:19	07:44 (WTG 21)	06:32	15:43 (WTG 15)	06:42	05:48	07:10 (WTG 148)	05:48		05:15	05:13			
	17:00	86	16:11 (WTG 15)	17:43		19:21	98	18:47 (WTG 15A)	20:00	20:32	20:47			
31	07:18	07:45 (WTG 21)	06:30	15:44 (WTG 15)	06:40	05:47	07:09 (WTG 148)			05:14				
	17:02	87	16:12 (WTG 15)	17:44		19:22	100	18:47 (WTG 15A)		20:33				
Potential sun hours	286		291		369		404			459		466		
Total, worst case		1461		1554		925		2126					47	
Sun reduction		0.29		0.37		0.37		0.33					0.47	
Oper. time red.		1.00		1.00		1.00		1.00					1.00	
Wind dir. red.		0.75		0.76		0.77		0.77					0.80	
Total reduction		0.22		0.28		0.28		0.25					0.38	
Total, real		319		434		263		537					18	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker (WTG causing flicker first time)	Last time (hh:mm) with flicker (WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-188 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (406)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December									
1	05:13	05:41	06:17	07:01 (WTG 148)	06:53	06:34									
	20:47	20:25	19:35	18:41 (WTG 15A)	18:38	16:46									
2	05:14	05:42	06:19	07:01 (WTG 148)	06:55	06:35									
	20:47	20:24	19:33	18:42 (WTG 15A)	18:36	16:44									
3	05:14	05:43	06:20	07:01 (WTG 148)	06:56	06:36									
	20:47	20:22	19:31	18:42 (WTG 15A)	18:34	16:43									
4	05:15	05:44	06:21	07:00 (WTG 148)	06:57	06:38									
	20:46	20:21	19:29	18:42 (WTG 15A)	18:33	16:41									
5	05:15	05:45	06:22	07:00 (WTG 148)	06:58	06:39									
	20:46	20:20	19:27	18:42 (WTG 15A)	18:31	16:40									
6	05:16	05:46	06:23	07:00 (WTG 148)	07:00	06:41									
	20:46	20:19	19:26	18:42 (WTG 15A)	18:29	16:39									
7	05:17	05:48	06:24	06:59 (WTG 148)	07:01	06:42									
	20:45	20:17	19:24	18:41 (WTG 15A)	18:27	16:37									
8	05:17	05:49	06:26	06:59 (WTG 148)	07:02	06:43									
	20:45	20:16	19:22	18:41 (WTG 15A)	18:25	16:36									
9	05:18	05:50	06:27	07:00 (WTG 148)	07:03	06:45									
	20:45	20:14	19:20	18:41 (WTG 15A)	18:23	16:35									
10	05:19	05:51	06:28	07:00 (WTG 148)	07:05	06:46									
	20:44	20:13	19:18	18:41 (WTG 15A)	18:22	16:34									
11	05:20	05:52	06:29	07:00 (WTG 148)	07:06	06:47									
	20:44	20:11	19:16	18:40 (WTG 15A)	18:20	16:33									
12	05:21	05:54	06:30	07:01 (WTG 148)	07:07	06:49									
	20:43	20:10	19:14	18:39 (WTG 15A)	18:18	16:31									
13	05:21	05:55	06:32	07:01 (WTG 148)	07:08	06:50									
	20:43	20:08	19:12	18:38 (WTG 15A)	18:16	16:30									
14	05:22	05:56	06:33	07:02 (WTG 148)	07:10	06:52									
	20:42	20:07	19:10	18:38 (WTG 15A)	18:14	16:29									
15	05:23	05:57	06:34	07:03 (WTG 148)	07:11	06:53									
	20:41	20:05	19:09	18:36 (WTG 15A)	18:13	16:28									
16	05:24	05:58	06:35	07:05 (WTG 148)	07:12	06:54									
	20:41	20:04	19:07	18:36 (WTG 15A)	18:11	16:24									
17	05:25	05:59	07:22 (WTG 148)	06:36	07:06 (WTG 148)	07:14	15	16:24 (WTG 15)	16:27	80	15:42 (WTG 15)	16:15			
	20:40	20:02	16	07:38 (WTG 148)	19:05	82	18:35 (WTG 15A)	18:09	24	16:28 (WTG 15)	16:26	77	15:41 (WTG 15)	16:16	
18	05:26	06:01	07:19 (WTG 148)	06:38	07:07 (WTG 148)	07:15	18	16:01 (WTG 15)	06:57	70	15:42 (WTG 15)	16:16	77	15:41 (WTG 15)	16:16
	20:39	20:01	22	07:41 (WTG 148)	19:03	77	18:34 (WTG 15A)	18:08	30	16:31 (WTG 15)	16:25	74	15:42 (WTG 15)	16:16	
19	05:27	06:02	07:17 (WTG 148)	06:39	07:10 (WTG 148)	07:16	19	15:58 (WTG 15)	06:58	71	15:41 (WTG 15)	16:16	74	15:42 (WTG 15)	16:16
	20:38	19:57	27	07:44 (WTG 148)	19:01	69	18:32 (WTG 15A)	18:06	35	16:33 (WTG 15)	16:24	71	15:41 (WTG 15)	16:16	
20	05:28	06:03	07:15 (WTG 148)	06:40	07:13 (WTG 148)	07:18	20	15:57 (WTG 15)	07:00	72	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:37	19:56	30	07:45 (WTG 148)	18:59	58	18:30 (WTG 15A)	18:04	38	16:35 (WTG 15)	16:24	67	15:40 (WTG 15)	16:17	
21	05:29	06:04	07:13 (WTG 148)	06:41	17:47 (WTG 15A)	07:19	21	15:55 (WTG 15)	07:01	73	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:37	19:54	50	18:28 (WTG 15A)	18:57	41	18:28 (WTG 15A)	18:03	41	16:36 (WTG 15)	16:23	63	15:40 (WTG 15)	16:17	
22	05:30	06:05	07:11 (WTG 148)	06:42	17:49 (WTG 15A)	07:20	22	15:52 (WTG 15)	07:02	74	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:36	19:52	60	18:31 (WTG 15A)	18:55	38	18:27 (WTG 15A)	18:01	44	16:36 (WTG 15)	16:22	60	15:40 (WTG 15)	16:18	
23	05:31	06:07	07:09 (WTG 148)	06:44	17:50 (WTG 15A)	07:21	23	15:52 (WTG 15)	07:04	75	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:35	19:51	68	18:33 (WTG 15A)	18:53	35	18:25 (WTG 15A)	17:59	46	16:38 (WTG 15)	16:21	55	15:40 (WTG 15)	16:18	
24	05:32	06:08	07:08 (WTG 148)	06:45	17:51 (WTG 15A)	07:23	24	15:50 (WTG 15)	07:05	76	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:34	19:49	73	18:35 (WTG 15A)	18:51	31	18:22 (WTG 15A)	17:58	49	16:39 (WTG 15)	16:20	45	15:39 (WTG 15)	16:19	
25	05:33	06:09	07:07 (WTG 148)	06:46	17:54 (WTG 15A)	07:24	25	15:49 (WTG 15)	07:06	77	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:33	19:47	79	18:36 (WTG 15A)	18:49	25	18:19 (WTG 15A)	17:56	51	16:40 (WTG 15)	16:20	44	15:38 (WTG 15)	16:19	
26	05:34	06:10	07:06 (WTG 148)	06:47	17:57 (WTG 15A)	07:26	26	15:48 (WTG 15)	07:07	78	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:32	19:45	84	18:38 (WTG 15A)	18:48	18	18:15 (WTG 15A)	17:54	52	16:40 (WTG 15)	16:19	42	15:38 (WTG 15)	16:20	
27	05:35	06:11	07:05 (WTG 148)	06:48	17:52 (WTG 15A)	07:27	27	15:46 (WTG 15)	07:09	79	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:31	19:44	89	18:39 (WTG 15A)	18:46	17:53	54	16:40 (WTG 15)	16:19	40	15:37 (WTG 15)	16:21	71	15:41 (WTG 15)	16:16
28	05:36	06:13	07:04 (WTG 148)	06:50	17:53 (WTG 15A)	07:28	28	15:46 (WTG 15)	07:10	80	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:30	19:42	92	18:40 (WTG 15A)	18:44	17:51	55	16:41 (WTG 15)	16:18	39	15:37 (WTG 15)	16:21	71	15:41 (WTG 15)	16:16
29	05:37	06:14	07:03 (WTG 148)	06:51	17:50 (WTG 15A)	07:30	29	15:45 (WTG 15)	07:11	81	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:29	19:40	95	18:40 (WTG 15A)	18:42	17:50	56	16:41 (WTG 15)	16:17	37	15:37 (WTG 15)	16:22	71	15:41 (WTG 15)	16:16
30	05:38	06:15	07:02 (WTG 148)	06:52	17:48 (WTG 15A)	07:31	30	15:46 (WTG 15)	07:12	82	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:27	19:38	98	18:41 (WTG 15A)	18:40	17:48	64	16:42 (WTG 15)	16:17	35	15:36 (WTG 15)	16:23	71	15:41 (WTG 15)	16:16
31	05:40	06:16	07:02 (WTG 148)	06:53	17:47 (WTG 15A)	07:32	31	15:47 (WTG 15)	07:13	83	15:40 (WTG 15)	16:16	71	15:41 (WTG 15)	16:16
	20:26	19:37	100	18:41 (WTG 15A)	18:39	17:47	72	16:42 (WTG 15)	16:18	34	15:36 (WTG 15)	16:24	71	15:41 (WTG 15)	16:16
Potential sun hours	472	436	376	341	288	274									
Total, worst case		983	2105	726	2103	212									
Sun reduction		0.46	0.42	0.36	0.25	0.28									
Oper. time red.		1.00	1.00	1.00	1.00	1.00									
Wind dir. red.		0.77	0.77	0.78	0.74	0.79									
Total reduction		0.35	0.32	0.28	0.19	0.22									
Total, real		345	677	205	389	47									

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-189 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (407)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35	07:17	06:35	06:38	05:47	05:13
2	07:35	07:16	06:34	06:37	05:45	05:13
3	07:35	07:15	06:33	06:35	05:44	05:12
4	07:35	07:13	06:30	06:33	05:42	05:12
5	07:35	07:12	06:28	06:31	05:41	05:11
6	07:34	07:11	06:27	06:29	05:40	05:11
7	07:34	07:10	06:25	06:27	05:38	05:11
8	07:34	07:08	06:23	06:26	05:37	05:10
9	07:34	07:07	06:21	06:24	05:36	05:10
10	07:33	07:06	06:19	06:22	05:34	05:10
11	07:33	07:04	06:18	06:20	05:33	05:09
12	07:33	07:03	06:16	06:18	05:32	05:09
13	07:32	07:01	06:14	06:17	05:30	05:09
14	07:32	07:00	06:12	06:15	05:29	05:09
15	07:31	06:58	06:10	06:13	05:28	05:09
16	07:31	06:57	06:08	06:11	05:27	05:09
17	07:30	06:55	06:06	06:09	05:26	05:09
18	07:30	06:54	06:05	06:08	05:25	05:09
19	07:29	06:52	06:03	06:06	05:24	05:09
20	07:28	06:51	06:01	06:04	05:23	05:09
21	07:27	06:49	06:00	06:03	05:22	05:09
22	07:27	06:47	06:00	06:01	05:21	05:10
23	07:26	06:46	06:00	06:01	05:20	05:10
24	07:25	06:44	06:00	06:01	05:19	05:10
25	07:24	06:42	06:00	06:01	05:18	05:10
26	07:23	06:41	06:00	06:01	05:17	05:11
27	07:22	06:39	06:00	06:01	05:16	05:11
28	07:21	06:37	06:00	06:01	05:15	05:12
29	07:20	06:35	06:00	06:01	05:14	05:12
30	07:19	06:34	06:00	06:01	05:13	05:13
31	07:18	06:33	06:00	06:01	05:12	05:13
Potential sun hours	286	291	369	404	459	466
Total, worst case	629	2059	570	570	1524	1759
Sun reduction	0.29	0.37	0.33	0.33	0.44	0.47
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00
Wind dir. red.	0.72	0.69	0.79	0.79	0.70	0.66
Total reduction	0.21	0.25	0.26	0.26	0.31	0.31
Total, real	132	524	149	149	473	544

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-189 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (407)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:38 (WTG 9A)	05:41	06:35 (WTG 148A)	06:17	06:53
	20:47	20:10 (WTG 11)	20:25	19:57 (WTG 11)	19:35	18:38
2	05:14	05:38 (WTG 9A)	05:42	06:35 (WTG 148A)	06:19	06:55
	20:47	20:09 (WTG 11)	20:24	19:55 (WTG 11)	19:33	18:36
3	05:14	19:17 (WTG 11)	05:43	06:35 (WTG 148A)	06:20	06:56
	20:47	20:10 (WTG 11)	20:22	19:51 (WTG 11)	19:31	18:34
4	05:15	19:17 (WTG 11)	05:44	06:34 (WTG 148A)	06:21	06:57
	20:46	20:09 (WTG 11)	20:21	07:12 (WTG 148A)	19:29	18:33
5	05:15	19:18 (WTG 11)	05:45	06:33 (WTG 148A)	06:22	06:58
	20:46	20:10 (WTG 11)	20:20	07:13 (WTG 148A)	19:27	18:31
6	05:16	19:18 (WTG 11)	05:46	06:32 (WTG 148A)	06:23	07:00
	20:46	20:10 (WTG 11)	20:19	07:13 (WTG 148A)	19:26	18:29
7	05:17	19:18 (WTG 11)	05:48	06:32 (WTG 148A)	06:24	07:01
	20:45	20:10 (WTG 11)	20:17	07:13 (WTG 148A)	19:24	18:27
8	05:17	19:18 (WTG 11)	05:49	06:31 (WTG 148A)	06:26	07:02
	20:45	20:10 (WTG 11)	20:16	07:13 (WTG 148A)	19:22	18:25
9	05:18	19:19 (WTG 11)	05:50	06:31 (WTG 148A)	06:27	07:03
	20:45	20:11 (WTG 11)	20:14	07:13 (WTG 148A)	19:20	18:23
10	05:19	19:19 (WTG 11)	05:51	06:30 (WTG 148A)	06:28	07:05
	20:44	20:11 (WTG 11)	20:13	07:13 (WTG 148A)	19:18	18:22
11	05:20	19:19 (WTG 11)	05:52	06:31 (WTG 148A)	06:29	07:06
	20:44	20:10 (WTG 11)	20:11	07:14 (WTG 148A)	19:16	18:20
12	05:21	19:19 (WTG 11)	05:54	06:31 (WTG 148A)	06:30	07:07
	20:43	20:10 (WTG 11)	20:10	07:14 (WTG 148A)	19:14	18:18
13	05:21	19:20 (WTG 11)	05:55	06:30 (WTG 148A)	06:32	07:08
	20:43	20:10 (WTG 11)	20:08	07:14 (WTG 148A)	19:12	18:16
14	05:22	19:20 (WTG 11)	05:56	06:30 (WTG 148A)	06:33	07:10
	20:42	20:11 (WTG 11)	20:07	07:14 (WTG 148A)	19:10	18:14
15	05:23	19:21 (WTG 11)	05:57	06:30 (WTG 148A)	06:34	07:11
	20:41	20:11 (WTG 11)	20:05	07:13 (WTG 148A)	19:09	18:13
16	05:24	19:21 (WTG 11)	05:58	06:30 (WTG 148A)	06:35	07:12
	20:41	20:11 (WTG 11)	20:04	07:13 (WTG 148A)	19:07	18:11
17	05:25	19:21 (WTG 11)	05:59	06:30 (WTG 148A)	06:36	07:14
	20:40	20:09 (WTG 11)	20:02	07:12 (WTG 148A)	19:05	18:09
18	05:26	19:21 (WTG 11)	06:01	06:30 (WTG 148A)	06:38	07:15
	20:39	20:09 (WTG 11)	20:01	07:11 (WTG 148A)	19:03	18:08
19	05:27	19:22 (WTG 11)	06:02	06:31 (WTG 148A)	06:39	07:16
	20:38	20:09 (WTG 11)	19:57	07:11 (WTG 148A)	19:01	18:06
20	05:28	19:22 (WTG 11)	06:03	06:31 (WTG 148A)	06:40	07:18
	20:37	20:09 (WTG 11)	19:56	07:10 (WTG 148A)	18:59	18:04
21	05:29	19:23 (WTG 11)	06:04	06:32 (WTG 148A)	06:41	07:19
	20:37	20:09 (WTG 11)	19:54	07:09 (WTG 148A)	18:57	18:03
22	05:30	19:24 (WTG 11)	06:05	06:32 (WTG 148A)	06:42	07:20
	20:36	20:08 (WTG 11)	19:52	07:08 (WTG 148A)	18:55	18:01
23	05:31	19:24 (WTG 11)	06:07	06:33 (WTG 148A)	06:44	07:21
	20:35	20:08 (WTG 11)	19:51	07:07 (WTG 148A)	18:53	17:59
24	05:32	06:47 (WTG 148A)	06:08	06:33 (WTG 148A)	06:45	07:23
	20:34	20:07 (WTG 11)	19:49	07:05 (WTG 148A)	18:51	17:58
25	05:33	06:45 (WTG 148A)	06:09	06:35 (WTG 148A)	06:46	07:24
	20:33	20:06 (WTG 11)	19:47	07:03 (WTG 148A)	18:49	17:56
26	05:34	06:43 (WTG 148A)	06:10	06:37 (WTG 148A)	06:47	07:26
	20:32	20:05 (WTG 11)	19:45	07:02 (WTG 148A)	18:48	17:54
27	05:35	06:41 (WTG 148A)	06:11	06:39 (WTG 148A)	06:48	07:27
	20:31	20:04 (WTG 11)	19:44	06:59 (WTG 148A)	18:46	17:53
28	05:36	06:40 (WTG 148A)	06:13	06:42 (WTG 148A)	06:50	07:28
	20:30	20:03 (WTG 11)	19:42	06:56 (WTG 148A)	18:44	17:51
29	05:37	06:38 (WTG 148A)	06:14		06:51	07:30
	20:29	20:02 (WTG 11)	19:40		18:42	17:50
30	05:38	06:37 (WTG 148A)	06:15		06:52	07:31
	20:27	20:01 (WTG 11)	19:38		18:40	17:48
31	05:40	06:36 (WTG 148A)	06:16		07:32	
	20:26	19:59 (WTG 11)	19:37		17:47	93
Potential sun hours	472	436	376	341	288	274
Total, worst case	1627	1092	1188	1518	302	
Sun reduction	0.45	0.46	0.36	0.25	0.28	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.66	0.78	0.68	0.71	0.73	
Total reduction	0.30	0.36	0.24	0.18	0.20	
Total, real	482	394	291	269	62	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-191 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (409)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35	07:17	07:42 (WTG 21)	06:35	15:55 (WTG 15)	06:38
	16:25	17:03	30 08:12 (WTG 21)	17:43	52 16:47 (WTG 15)	19:23
2	07:35	07:16	07:42 (WTG 21)	06:34	15:55 (WTG 15)	06:37
	16:26	17:05	31 08:13 (WTG 21)	17:44	51 16:46 (WTG 15)	19:24
3	07:35	07:15	07:42 (WTG 21)	06:32	15:56 (WTG 15)	06:35
	16:27	17:06	38 16:24 (WTG 15)	17:46	50 16:46 (WTG 15)	19:26
4	07:35	07:13	07:42 (WTG 21)	06:30	15:57 (WTG 15)	06:33
	16:28	17:08	49 16:30 (WTG 15)	17:47	47 16:44 (WTG 15)	19:27
5	07:35	07:12	07:42 (WTG 21)	06:28	15:58 (WTG 15)	06:31
	16:29	17:09	56 16:33 (WTG 15)	17:48	45 16:43 (WTG 15)	19:28
6	07:34	07:11	07:43 (WTG 21)	06:27	15:58 (WTG 15)	06:29
	16:30	17:10	60 16:36 (WTG 15)	17:50	44 16:42 (WTG 15)	19:29
7	07:34	07:10	07:43 (WTG 21)	06:25	16:00 (WTG 15)	06:27
	16:31	17:12	62 16:37 (WTG 15)	17:51	40 16:40 (WTG 15)	19:31
8	07:34	07:08	07:43 (WTG 21)	06:23	17:02 (WTG 15)	06:26
	16:32	17:13	66 16:40 (WTG 15)	18:52	37 17:39 (WTG 15)	19:32
9	07:34	07:07	07:43 (WTG 21)	06:21	17:03 (WTG 15)	06:24
	16:33	17:15	67 16:40 (WTG 15)	18:54	34 17:37 (WTG 15)	19:33
10	07:33	07:06	07:44 (WTG 21)	06:19	17:05 (WTG 15)	06:22
	16:34	17:16	69 16:42 (WTG 15)	18:55	30 17:35 (WTG 15)	19:35
11	07:33	07:04	07:46 (WTG 21)	06:18	17:08 (WTG 15)	06:20
	16:35	17:18	70 16:44 (WTG 15)	18:56	24 17:32 (WTG 15)	19:36
12	07:33	07:03	07:46 (WTG 21)	06:16	17:11 (WTG 15)	06:18
	16:37	17:19	69 16:44 (WTG 15)	18:57	16 17:27 (WTG 15)	19:37
13	07:32	07:01	07:48 (WTG 21)	06:14	17:12 (WTG 15)	06:17
	16:38	17:21	69 16:46 (WTG 15)	18:59	19:38	94 19:05 (WTG 15)
14	07:32	07:00	07:49 (WTG 21)	06:12	17:15 (WTG 15)	06:15
	16:39	17:22	67 16:46 (WTG 15)	19:00	19:40	98 19:05 (WTG 15)
15	07:31	06:58	07:52 (WTG 21)	06:10	17:18 (WTG 15)	06:13
	16:40	17:23	63 16:47 (WTG 15)	19:01	19:41	100 19:04 (WTG 15)
16	07:31	06:57	07:57 (WTG 21)	06:08	17:21 (WTG 15)	06:11
	16:41	17:25	55 16:48 (WTG 15)	19:03	19:42	101 19:05 (WTG 15)
17	07:30	06:55	15:55 (WTG 15)	07:06	17:24 (WTG 15)	06:09
	16:43	17:26	53 16:48 (WTG 15)	19:04	19:43	103 19:04 (WTG 15)
18	07:30	06:54	15:55 (WTG 15)	07:05	17:27 (WTG 15)	06:08
	16:44	17:28	54 16:49 (WTG 15)	19:05	19:45	103 19:03 (WTG 15)
19	07:29	06:52	15:54 (WTG 15)	07:03	17:30 (WTG 15)	06:06
	16:45	17:29	55 16:49 (WTG 15)	19:07	19:46	103 19:03 (WTG 15)
20	07:28	06:51	15:55 (WTG 15)	07:01	17:33 (WTG 15)	06:04
	16:47	17:30	54 16:49 (WTG 15)	19:08	19:47	103 19:02 (WTG 15)
21	07:27	06:49	15:54 (WTG 15)	06:59	17:36 (WTG 15)	06:03
	16:48	17:32	55 16:49 (WTG 15)	19:09	19:48	103 19:01 (WTG 15)
22	07:27	06:47	15:54 (WTG 15)	06:57	17:39 (WTG 15)	06:01
	16:49	9 08:00 (WTG 21)	17:33	55 16:49 (WTG 15)	19:10	19:50
23	07:26	06:46	15:54 (WTG 15)	06:55	17:42 (WTG 15)	05:59
	16:51	14 08:03 (WTG 21)	17:35	56 16:50 (WTG 15)	19:12	19:51
24	07:25	06:44	15:54 (WTG 15)	06:53	17:45 (WTG 15)	05:58
	16:52	17 08:05 (WTG 21)	17:36	55 16:49 (WTG 15)	19:13	19:52
25	07:24	06:42	15:54 (WTG 15)	06:51	17:48 (WTG 15)	05:56
	16:53	19 08:06 (WTG 21)	17:37	55 16:49 (WTG 15)	19:14	19:53
26	07:23	06:41	15:54 (WTG 15)	06:50	17:51 (WTG 15)	05:55
	16:55	22 08:08 (WTG 21)	17:39	54 16:48 (WTG 15)	19:16	19:55
27	07:22	06:39	15:55 (WTG 15)	06:48	17:54 (WTG 15)	05:53
	16:56	24 08:09 (WTG 21)	17:40	53 16:48 (WTG 15)	19:17	19:56
28	07:21	06:37	15:55 (WTG 15)	06:46	17:57 (WTG 15)	05:51
	16:58	26 08:10 (WTG 21)	17:41	53 16:48 (WTG 15)	19:18	19:57
29	07:20	06:35	15:54 (WTG 15)	06:44	18:00 (WTG 15)	05:50
	16:59	27 08:10 (WTG 21)	17:41	16 18:37 (WTG 15A)	19:19	19:58
30	07:19	06:33	15:54 (WTG 15)	06:42	18:03 (WTG 15A)	05:48
	17:00	29 08:11 (WTG 21)	17:42	23 18:56 (WTG 15A)	20:00	80 18:47 (WTG 15A)
31	07:18	06:31	15:54 (WTG 15)	06:40	18:06 (WTG 15A)	05:47
	17:02	30 08:12 (WTG 21)	17:43	28 18:58 (WTG 15A)	20:33	05:14
Potential sun hours	286	291	369	404	459	466
Total, worst case		1573	537	2461	1139	
Sun reduction	0.29	0.37	0.37	0.33	0.44	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.60	0.75	0.80	0.76	0.78	
Total reduction	0.17	0.28	0.29	0.25	0.34	
Total, real	38	437	158	618	391	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-191 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (409)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:41	06:49 (WTG 148)	06:17	06:49 (WTG 148)	06:53
	20:47	20:25	49 07:38 (WTG 148)	19:35	18:04 (WTG 15A)	18:38
2	05:14	05:42	06:49 (WTG 148)	06:19	06:51 (WTG 148)	06:55
	20:47	20:24	51 07:40 (WTG 148)	19:33	18:04 (WTG 15A)	18:36
3	05:14	05:43	06:48 (WTG 148)	06:20	06:53 (WTG 148)	06:56
	20:47	20:22	52 07:40 (WTG 148)	19:31	18:03 (WTG 15A)	18:34
4	05:15	05:44	06:47 (WTG 148)	06:21	06:55 (WTG 148)	06:57
	20:46	20:21	54 07:41 (WTG 148)	19:29	18:03 (WTG 15A)	18:33
5	05:15	05:45	06:47 (WTG 148)	06:22	06:58 (WTG 148)	06:58
	20:46	20:20	54 07:41 (WTG 148)	19:27	18:01 (WTG 15A)	18:31
6	05:16	05:46	06:46 (WTG 148)	06:23	18:16 (WTG 15A)	07:00
	20:46	20:19	56 07:42 (WTG 148)	19:26	18:18 (WTG 15A)	18:29
7	05:17	05:48	06:45 (WTG 148)	06:24	18:16 (WTG 15A)	07:01
	20:45	20:17	57 07:42 (WTG 148)	19:24	18:17 (WTG 15A)	18:27
8	05:17	05:49	06:45 (WTG 148)	06:26	18:17 (WTG 15A)	07:02
	20:45	20:16	57 07:42 (WTG 148)	19:22	18:17 (WTG 15A)	18:25
9	05:18	05:50	06:44 (WTG 148)	06:27	18:18 (WTG 15A)	07:03
	20:45	20:14	58 07:42 (WTG 148)	19:20	18:17 (WTG 15A)	18:23
10	05:19	05:51	06:44 (WTG 148)	06:28	18:19 (WTG 15A)	07:05
	20:44	20:13	59 07:43 (WTG 148)	19:18	18:18 (WTG 15A)	18:22
11	05:20	05:52	06:44 (WTG 148)	06:29	18:20 (WTG 15A)	07:06
	20:44	20:11	60 07:44 (WTG 148)	19:16	18:19 (WTG 15A)	18:20
12	05:21	05:54	06:44 (WTG 148)	06:30	18:22 (WTG 15A)	07:07
	20:43	20:10	74 18:53 (WTG 15A)	19:14	18:20 (WTG 15A)	18:20
13	05:21	05:55	06:43 (WTG 148)	06:32	18:23 (WTG 15A)	07:08
	20:43	20:08	82 18:56 (WTG 15A)	19:12	18:24 (WTG 15A)	18:18
14	05:22	05:56	06:43 (WTG 148)	06:33	18:26 (WTG 15A)	07:10
	20:42	20:07	85 18:58 (WTG 15A)	19:10	18:24 (WTG 15A)	18:14
15	05:23	05:57	06:43 (WTG 148)	06:34	18:34 (WTG 15A)	07:11
	20:41	20:05	90 19:00 (WTG 15A)	19:09	18:35 (WTG 15A)	18:13
16	05:24	05:58	06:42 (WTG 148)	06:35	18:35 (WTG 15A)	07:12
	20:41	20:04	93 19:01 (WTG 15A)	19:07	18:11	18:11
17	05:25	07:09 (WTG 148)	05:59	06:42 (WTG 148)	06:36	07:14
	20:40	6 07:15 (WTG 148)	20:02	96 19:02 (WTG 15A)	19:05	18:09
18	05:26	07:05 (WTG 148)	06:01	06:42 (WTG 148)	06:38	07:15
	20:39	15 07:20 (WTG 148)	20:01	98 19:03 (WTG 15A)	19:03	18:08
19	05:27	07:03 (WTG 148)	06:02	06:43 (WTG 148)	06:39	07:16
	20:38	19 07:22 (WTG 148)	19:57	99 19:04 (WTG 15A)	19:01	18:06
20	05:28	07:01 (WTG 148)	06:03	06:42 (WTG 148)	06:40	07:17
	20:37	23 07:24 (WTG 148)	19:56	102 19:05 (WTG 15A)	18:59	18:04
21	05:29	07:00 (WTG 148)	06:04	06:42 (WTG 148)	06:41	07:19
	20:37	26 07:26 (WTG 148)	19:54	103 19:05 (WTG 15A)	18:57	18:03
22	05:30	06:58 (WTG 148)	06:05	06:42 (WTG 148)	06:42	07:20
	20:36	30 07:28 (WTG 148)	19:52	103 19:05 (WTG 15A)	18:55	18:01
23	05:31	06:57 (WTG 148)	06:07	06:43 (WTG 148)	06:44	07:21
	20:35	32 07:29 (WTG 148)	19:51	103 19:06 (WTG 15A)	18:53	17:59
24	05:32	06:56 (WTG 148)	06:08	06:43 (WTG 148)	06:45	07:23
	20:34	35 07:31 (WTG 148)	19:49	103 19:06 (WTG 15A)	18:51	17:58
25	05:33	06:55 (WTG 148)	06:09	06:43 (WTG 148)	06:46	07:24
	20:33	37 07:32 (WTG 148)	19:47	103 19:06 (WTG 15A)	18:49	17:56
26	05:34	06:54 (WTG 148)	06:10	06:44 (WTG 148)	06:47	07:26
	20:32	39 07:33 (WTG 148)	19:45	103 19:07 (WTG 15A)	18:48	17:54
27	05:35	06:53 (WTG 148)	06:11	06:45 (WTG 148)	06:48	07:27
	20:31	41 07:34 (WTG 148)	19:44	100 19:06 (WTG 15A)	18:46	17:53
28	05:36	06:52 (WTG 148)	06:13	06:45 (WTG 148)	06:50	07:28
	20:30	43 07:35 (WTG 148)	19:42	99 19:06 (WTG 15A)	18:44	17:51
29	05:37	06:51 (WTG 148)	06:14	06:46 (WTG 148)	06:51	07:30
	20:29	45 07:36 (WTG 148)	19:40	98 19:06 (WTG 15A)	18:42	17:50
30	05:38	06:50 (WTG 148)	06:15	06:47 (WTG 148)	06:52	07:31
	20:27	47 07:37 (WTG 148)	19:38	94 19:05 (WTG 15A)	18:40	17:48
31	05:40	06:49 (WTG 148)	06:16	06:47 (WTG 148)	18:40	07:32
	20:26	49 07:38 (WTG 148)	19:37	93 19:05 (WTG 15A)	18:37	17:47
Potential sun hours	472	436	376	694	1551	742
Total, worst case	487	2528	694	1551	742	742
Sun reduction	0.45	0.46	0.42	0.36	0.25	0.25
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00
Wind dir. red.	0.78	0.77	0.75	0.79	0.66	0.66
Total reduction	0.35	0.35	0.32	0.28	0.17	0.17
Total, real	171	893	219	440	122	122

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-192 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (410)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June						
1	07:35	07:17	07:41 (WTG 21)	06:35	16:00 (WTG 15)	06:38	18:43 (WTG 15A)	05:47	06:28 (WTG 148)	05:13	06:43 (WTG 148)	
	16:25	17:03	29 08:10 (WTG 21)	17:43	55 16:55 (WTG 15)	19:23	14 18:57 (WTG 15A)	20:00	91 18:58 (WTG 15A)	20:34	30 07:13 (WTG 148)	
2	07:35	07:16	07:40 (WTG 21)	06:34	16:00 (WTG 15)	06:37	18:38 (WTG 15A)	05:45	06:27 (WTG 148)	05:13	06:44 (WTG 148)	
	16:26	17:05	30 08:10 (WTG 21)	17:44	54 16:54 (WTG 15)	19:24	22 19:00 (WTG 15A)	20:01	88 18:55 (WTG 15A)	20:35	27 07:11 (WTG 148)	
3	07:35	07:15	07:39 (WTG 21)	06:32	16:01 (WTG 15)	06:35	18:35 (WTG 15A)	05:44	06:27 (WTG 148)	05:12	06:45 (WTG 148)	
	16:27	17:06	31 08:10 (WTG 21)	17:46	53 16:54 (WTG 15)	19:26	28 19:03 (WTG 15A)	20:02	85 18:54 (WTG 15A)	20:36	26 07:11 (WTG 148)	
4	07:35	07:13	07:40 (WTG 21)	06:30	16:01 (WTG 15)	06:33	18:33 (WTG 15A)	05:42	06:28 (WTG 148)	05:12	06:46 (WTG 148)	
	16:28	17:08	31 08:11 (WTG 21)	17:47	53 16:54 (WTG 15)	19:27	31 19:04 (WTG 15A)	20:03	78 18:51 (WTG 15A)	20:37	23 07:09 (WTG 148)	
5	07:35	07:12	07:40 (WTG 21)	06:28	16:01 (WTG 15)	06:31	18:31 (WTG 15A)	05:41	06:27 (WTG 148)	05:11	06:48 (WTG 148)	
	16:29	17:09	31 08:11 (WTG 21)	17:48	52 16:53 (WTG 15)	19:28	34 19:05 (WTG 15A)	20:05	69 18:46 (WTG 15A)	20:38	21 07:09 (WTG 148)	
6	07:34	07:11	07:40 (WTG 21)	06:27	16:01 (WTG 15)	06:29	18:29 (WTG 15A)	05:40	06:27 (WTG 148)	05:11	06:49 (WTG 148)	
	16:30	17:10	32 08:12 (WTG 21)	17:50	51 16:52 (WTG 15)	19:29	37 19:06 (WTG 15A)	20:06	61 07:28 (WTG 148)	20:38	19 07:08 (WTG 148)	
7	07:34	07:10	07:40 (WTG 21)	06:25	16:02 (WTG 15)	06:27	18:27 (WTG 15A)	05:38	06:27 (WTG 148)	05:11	06:50 (WTG 148)	
	16:31	17:12	31 08:11 (WTG 21)	17:51	49 16:51 (WTG 15)	19:31	40 19:07 (WTG 15A)	20:07	61 07:28 (WTG 148)	20:39	16 07:06 (WTG 148)	
8	07:34	07:08	07:40 (WTG 21)	07:23	17:03 (WTG 15)	06:26	18:27 (WTG 15A)	05:37	06:27 (WTG 148)	05:10	06:52 (WTG 148)	
	16:32	17:13	46 16:35 (WTG 15)	18:52	47 17:50 (WTG 15)	19:32	42 19:09 (WTG 15A)	20:08	60 07:27 (WTG 148)	20:40	13 07:09 (WTG 148)	
9	07:34	07:07	07:40 (WTG 21)	07:21	17:04 (WTG 15)	06:24	18:25 (WTG 15A)	05:36	06:27 (WTG 148)	05:10	06:55 (WTG 148)	
	16:33	17:15	53 16:39 (WTG 15)	18:54	45 17:49 (WTG 15)	19:33	44 19:09 (WTG 15A)	20:09	60 07:27 (WTG 148)	20:40	8 07:03 (WTG 148)	
10	07:33	07:06	07:41 (WTG 21)	07:19	17:05 (WTG 15)	06:22	18:24 (WTG 15A)	05:34	06:28 (WTG 148)	05:10	06:51 (WTG 148)	
	16:34	17:16	57 16:42 (WTG 15)	18:55	42 17:47 (WTG 15)	19:35	45 19:09 (WTG 15A)	20:11	59 07:27 (WTG 148)	20:41		
11	07:33	07:04	07:42 (WTG 21)	07:18	17:06 (WTG 15)	06:20	06:56 (WTG 148)	05:33	06:28 (WTG 148)	05:09		
	16:35	17:18	61 16:45 (WTG 15)	18:56	40 17:46 (WTG 15)	19:36	60 19:09 (WTG 15A)	20:12	59 07:27 (WTG 148)	20:42		
12	07:33	07:03	07:42 (WTG 21)	07:16	17:08 (WTG 15)	06:18	06:52 (WTG 148)	05:32	06:29 (WTG 148)	05:09		
	16:37	17:19	63 16:46 (WTG 15)	18:57	36 17:44 (WTG 15)	19:37	70 19:10 (WTG 15A)	20:13	57 07:26 (WTG 148)	20:42		
13	07:32	07:01	07:43 (WTG 21)	07:14	17:09 (WTG 15)	06:17	06:48 (WTG 148)	05:31	06:28 (WTG 148)	05:09		
	16:38	17:21	64 16:48 (WTG 15)	18:59	32 17:41 (WTG 15)	19:38	77 19:10 (WTG 15A)	20:14	57 07:25 (WTG 148)	20:43		
14	07:32	07:00	07:44 (WTG 21)	07:12	17:11 (WTG 15)	06:15	06:45 (WTG 148)	05:29	06:29 (WTG 148)	05:09		
	16:39	17:22	65 16:49 (WTG 15)	19:00	28 17:39 (WTG 15)	19:40	83 19:10 (WTG 15A)	20:15	56 07:25 (WTG 148)	20:43		
15	07:31	06:58	07:46 (WTG 21)	07:10	17:15 (WTG 15)	06:13	06:43 (WTG 148)	05:28	06:29 (WTG 148)	05:09		
	16:40	17:23	65 16:51 (WTG 15)	19:01	21 17:36 (WTG 15)	19:41	87 19:10 (WTG 15A)	20:17	55 07:24 (WTG 148)	20:44		
16	07:31	06:57	07:47 (WTG 21)	07:08	17:19 (WTG 15)	06:11	06:41 (WTG 148)	05:27	06:30 (WTG 148)	05:09		
	16:41	17:25	62 16:51 (WTG 15)	19:03	12 17:31 (WTG 15)	19:42	91 19:10 (WTG 15A)	20:18	54 07:24 (WTG 148)	20:44		
17	07:30	06:55	07:50 (WTG 21)	07:06	06:09		06:39 (WTG 148)	05:26	06:30 (WTG 148)	05:09		
	16:43	17:26	59 16:52 (WTG 15)	19:04		19:43	94 19:10 (WTG 15A)	20:19	53 07:23 (WTG 148)	20:45		
18	07:30	06:54	16:04 (WTG 15)	07:05	06:08		06:37 (WTG 148)	05:25	06:31 (WTG 148)	05:09		
	16:44	17:28	49 16:53 (WTG 15)	19:05		19:45	97 19:09 (WTG 15A)	20:20	51 07:22 (WTG 148)	20:45		
19	07:29	06:52	16:03 (WTG 15)	07:03	06:06		06:37 (WTG 148)	05:24	06:31 (WTG 148)	05:09		
	16:45	17:29	50 16:53 (WTG 15)	19:07		19:46	97 19:09 (WTG 15A)	20:21	51 07:22 (WTG 148)	20:46		
20	07:28	06:51	16:03 (WTG 15)	07:01	06:04		06:35 (WTG 148)	05:23	06:32 (WTG 148)	05:09		
	16:47	17:30	52 16:55 (WTG 15)	19:08		19:47	100 19:08 (WTG 15A)	20:22	49 07:21 (WTG 148)	20:46		
21	07:27	06:49	16:02 (WTG 15)	06:59	06:03		06:34 (WTG 148)	05:22	06:32 (WTG 148)	05:09		
	16:48	17:32	53 16:55 (WTG 15)	19:09		19:48	101 19:08 (WTG 15A)	20:23	48 07:20 (WTG 148)	20:46		
22	07:27	06:47	16:01 (WTG 15)	06:57	06:01		06:33 (WTG 148)	05:21	06:34 (WTG 148)	05:10		
	16:49	17:33	54 16:55 (WTG 15)	19:10		19:50	102 19:08 (WTG 15A)	20:24	47 07:21 (WTG 148)	20:46		
23	07:26	06:46	16:01 (WTG 15)	06:55	05:59		06:32 (WTG 148)	05:20	06:35 (WTG 148)	05:10		
	16:51	17:35	55 16:56 (WTG 15)	19:12		19:51	101 19:06 (WTG 15A)	20:25	45 07:20 (WTG 148)	20:47		
24	07:25	07:50 (WTG 21)	06:44	16:01 (WTG 15)	06:53		05:58	06:31 (WTG 148)	05:19	06:35 (WTG 148)	05:10	
	16:52	8 07:58 (WTG 21)	17:36	55 16:56 (WTG 15)	19:13		19:52	101 19:05 (WTG 15A)	20:27	44 07:19 (WTG 148)	20:47	
25	07:24	07:47 (WTG 21)	06:42	16:00 (WTG 15)	06:51		05:56	06:31 (WTG 148)	05:18	06:36 (WTG 148)	05:10	
	16:53	14 08:01 (WTG 21)	17:37	55 16:55 (WTG 15)	19:14		19:53	101 19:05 (WTG 15A)	20:28	42 07:18 (WTG 148)	20:47	
26	07:23	07:46 (WTG 21)	06:41	16:00 (WTG 15)	06:50		05:55	06:29 (WTG 148)	05:17	06:36 (WTG 148)	05:11	
	16:55	17 08:03 (WTG 21)	17:39	55 16:55 (WTG 15)	19:16		19:55	102 19:04 (WTG 15A)	20:29	41 07:17 (WTG 148)	20:47	
27	07:22	07:45 (WTG 21)	06:39	16:00 (WTG 15)	06:48		05:53	06:29 (WTG 148)	05:17	06:38 (WTG 148)	05:11	
	16:56	20 08:05 (WTG 21)	17:40	56 16:56 (WTG 15)	19:17		19:56	99 19:03 (WTG 15A)	20:30	39 07:17 (WTG 148)	20:47	
28	07:21	07:44 (WTG 21)	06:37	16:00 (WTG 15)	06:46		05:51	06:28 (WTG 148)	05:16	06:39 (WTG 148)	05:12	
	16:58	22 08:06 (WTG 21)	17:41	55 16:55 (WTG 15)	19:18		19:57	98 19:01 (WTG 15A)	20:31	37 07:16 (WTG 148)	20:47	
29	07:20	07:42 (WTG 21)			06:44		05:50	06:29 (WTG 148)	05:15	06:39 (WTG 148)	05:12	
	16:59	24 08:06 (WTG 21)			19:19		19:58	96 19:01 (WTG 15A)	20:32	36 07:15 (WTG 148)	20:47	
30	07:19	07:41 (WTG 21)			06:42		05:48	06:28 (WTG 148)	05:15	06:41 (WTG 148)	05:13	
	17:00	26 08:07 (WTG 21)			19:21		20:00	94 18:59 (WTG 15A)	20:32	33 07:14 (WTG 148)	20:47	
31	07:18	07:41 (WTG 21)			06:40				05:14	06:41 (WTG 148)		
	17:02	28 08:09 (WTG 21)			19:22				20:33	32 07:13 (WTG 148)		
Potential sun hours	286	291	369	404	459	466	183					
Total, worst case	159	1399	670	2188	1698	183	0.47					
Sun reduction	0.29	0.37	0.37	0.33	0.44	0.45	0.46					
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00	1.00					
Wind dir. red.	0.61	0.74	0.81	0.76	0.78	0.79	0.79					
Total reduction	0.18	0.27	0.30	0.25	0.34	0.37	0.37					
Total, real	28	382	199	546	583	67						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 32

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EDR

217 Montgomery St.

US-SYRACUSE, NY 13202

(315) 471 0688

Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-192 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (410)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December				
1	05:13	05:41	06:38 (WTG 148)	06:17	06:55 (WTG 148)	06:53	16:48 (WTG 15)	06:34	07:11 (WTG 21)	07:13
2	05:14	05:42	06:39 (WTG 148)	06:19	18:23 (WTG 15A)	06:55	16:46 (WTG 15)	06:35	07:10 (WTG 21)	07:15
3	05:15	05:43	06:40 (WTG 148)	06:20	18:24 (WTG 15A)	06:56	16:47 (WTG 15)	06:36	07:11 (WTG 21)	07:16
4	05:16	05:44	06:41 (WTG 148)	06:21	18:25 (WTG 15A)	06:57	16:48 (WTG 15)	06:37	07:12 (WTG 21)	07:17
5	05:17	05:45	06:42 (WTG 148)	06:22	18:26 (WTG 15A)	06:58	16:49 (WTG 15)	06:38	07:13 (WTG 21)	07:18
6	05:18	05:46	06:43 (WTG 148)	06:23	18:27 (WTG 15A)	06:59	16:50 (WTG 15)	06:39	07:14 (WTG 21)	07:19
7	05:19	05:47	06:44 (WTG 148)	06:24	18:28 (WTG 15A)	07:00	16:51 (WTG 15)	06:40	07:15 (WTG 21)	07:20
8	05:20	05:48	06:45 (WTG 148)	06:25	18:29 (WTG 15A)	07:01	16:52 (WTG 15)	06:41	07:16 (WTG 21)	07:21
9	05:21	05:49	06:46 (WTG 148)	06:26	18:30 (WTG 15A)	07:02	16:53 (WTG 15)	06:42	07:17 (WTG 21)	07:22
10	05:22	05:50	06:47 (WTG 148)	06:27	18:31 (WTG 15A)	07:03	16:54 (WTG 15)	06:43	07:18 (WTG 21)	07:23
11	05:23	05:51	06:48 (WTG 148)	06:28	18:32 (WTG 15A)	07:04	16:55 (WTG 15)	06:44	07:19 (WTG 21)	07:24
12	05:24	05:52	06:49 (WTG 148)	06:29	18:33 (WTG 15A)	07:05	16:56 (WTG 15)	06:45	07:20 (WTG 21)	07:25
13	05:25	05:53	06:50 (WTG 148)	06:30	18:34 (WTG 15A)	07:06	16:57 (WTG 15)	06:46	07:21 (WTG 21)	07:26
14	05:26	05:54	06:51 (WTG 148)	06:31	18:35 (WTG 15A)	07:07	16:58 (WTG 15)	06:47	07:22 (WTG 21)	07:27
15	05:27	05:55	06:52 (WTG 148)	06:32	18:36 (WTG 15A)	07:08	16:59 (WTG 15)	06:48	07:23 (WTG 21)	07:28
16	05:28	05:56	06:53 (WTG 148)	06:33	18:37 (WTG 15A)	07:09	17:00 (WTG 15)	06:49	07:24 (WTG 21)	07:29
17	05:29	05:57	06:54 (WTG 148)	06:34	18:38 (WTG 15A)	07:10	17:01 (WTG 15)	06:50	07:25 (WTG 21)	07:30
18	05:30	05:58	06:55 (WTG 148)	06:35	18:39 (WTG 15A)	07:11	17:02 (WTG 15)	06:51	07:26 (WTG 21)	07:31
19	05:31	05:59	06:56 (WTG 148)	06:36	18:40 (WTG 15A)	07:12	17:03 (WTG 15)	06:52	07:27 (WTG 21)	07:32
20	05:32	06:00	06:57 (WTG 148)	06:37	18:41 (WTG 15A)	07:13	17:04 (WTG 15)	06:53	07:28 (WTG 21)	07:33
21	05:33	06:01	06:58 (WTG 148)	06:38	18:42 (WTG 15A)	07:14	17:05 (WTG 15)	06:54	07:29 (WTG 21)	07:34
22	05:34	06:02	06:59 (WTG 148)	06:39	18:43 (WTG 15A)	07:15	17:06 (WTG 15)	06:55	07:30 (WTG 21)	07:35
23	05:35	06:03	07:00 (WTG 148)	06:40	18:44 (WTG 15A)	07:16	17:07 (WTG 15)	06:56	07:31 (WTG 21)	07:36
24	05:36	06:04	07:01 (WTG 148)	06:41	18:45 (WTG 15A)	07:17	17:08 (WTG 15)	06:57	07:32 (WTG 21)	07:37
25	05:37	06:05	07:02 (WTG 148)	06:42	18:46 (WTG 15A)	07:18	17:09 (WTG 15)	06:58	07:33 (WTG 21)	07:38
26	05:38	06:06	07:03 (WTG 148)	06:43	18:47 (WTG 15A)	07:19	17:10 (WTG 15)	06:59	07:34 (WTG 21)	07:39
27	05:39	06:07	07:04 (WTG 148)	06:44	18:48 (WTG 15A)	07:20	17:11 (WTG 15)	07:00	07:35 (WTG 21)	07:40
28	05:40	06:08	07:05 (WTG 148)	06:45	18:49 (WTG 15A)	07:21	17:12 (WTG 15)	07:01	07:36 (WTG 21)	07:41
29	05:41	06:09	07:06 (WTG 148)	06:46	18:50 (WTG 15A)	07:22	17:13 (WTG 15)	07:02	07:37 (WTG 21)	07:42
30	05:42	06:10	07:07 (WTG 148)	06:47	18:51 (WTG 15A)	07:23	17:14 (WTG 15)	07:03	07:38 (WTG 21)	07:43
31	05:43	06:11	07:08 (WTG 148)	06:48	18:52 (WTG 15A)	07:24	17:15 (WTG 15)	07:04	07:39 (WTG 21)	07:44
Potential sun hours	472	436	376	479	341	288	274			
Total, worst case	1082	2632	479	1648	525					
Sun reduction	0.45	0.46	0.42	0.36	0.25					
Oper. time red.	1.00	1.00	1.00	1.00	1.00					
Wind dir. red.	0.79	0.77	0.75	0.79	0.63					
Total reduction	0.35	0.35	0.31	0.28	0.16					
Total, real	382	927	150	465	82					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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8/3/2010 1:05 PM / 33

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-196 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (414)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:35 15:00 (WTG 28)	07:17 15:09 (WTG 28)	06:35 15:56 (WTG 28)	06:38 07:11 (WTG 28A)	05:47 08:00 (WTG 28A)	05:13 08:37 (WTG 28A)
2	07:35 15:01 (WTG 28)	07:16 15:10 (WTG 28)	06:34 15:56 (WTG 28)	06:37 07:08 (WTG 28A)	05:45 08:01 (WTG 28A)	05:13 08:35 (WTG 28A)
3	07:35 15:01 (WTG 28)	07:15 15:11 (WTG 28)	06:32 15:55 (WTG 28)	06:35 07:07 (WTG 28A)	05:44 08:03 (WTG 28A)	05:12 08:32 (WTG 28A)
4	07:35 15:01 (WTG 28)	07:13 15:12 (WTG 28)	06:30 15:54 (WTG 28)	06:33 07:05 (WTG 28A)	05:42 08:06 (WTG 28A)	05:12 08:28 (WTG 28A)
5	07:34 15:02 (WTG 28)	07:12 15:13 (WTG 28)	06:28 15:54 (WTG 28)	06:31 07:03 (WTG 28A)	05:41 08:10 (WTG 28A)	05:11 08:22 (WTG 28A)
6	07:34 15:02 (WTG 28)	07:11 15:15 (WTG 28)	06:27 15:53 (WTG 28)	06:29 07:02 (WTG 28A)	05:40 08:10 (WTG 28A)	05:11 08:22 (WTG 28A)
7	07:34 15:01 (WTG 28)	07:10 15:16 (WTG 28)	06:25 15:51 (WTG 28)	06:27 07:00 (WTG 28A)	05:39 08:10 (WTG 28A)	05:11 08:22 (WTG 28A)
8	07:34 15:02 (WTG 28)	07:08 15:18 (WTG 28)	06:23 15:51 (WTG 28)	06:26 08:00 (WTG 28A)	05:37 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
9	07:34 15:02 (WTG 28)	07:07 15:19 (WTG 28)	06:22 15:48 (WTG 28)	06:24 07:59 (WTG 28A)	05:36 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
10	07:33 15:02 (WTG 28)	07:05 15:22 (WTG 28)	06:19 15:47 (WTG 28)	06:22 07:58 (WTG 28A)	05:34 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
11	07:33 15:02 (WTG 28)	07:04 15:25 (WTG 28)	06:18 15:45 (WTG 28)	06:20 07:57 (WTG 28A)	05:33 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
12	07:33 15:02 (WTG 28)	07:03 15:28 (WTG 28)	06:16 15:40 (WTG 28)	06:18 07:56 (WTG 28A)	05:32 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
13	07:32 15:03 (WTG 28)	07:01 15:30 (WTG 28)	06:14 15:35 (WTG 28)	06:17 07:55 (WTG 28A)	05:31 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
14	07:32 15:02 (WTG 28)	07:00 15:32 (WTG 28)	06:12 15:30 (WTG 28)	06:15 07:55 (WTG 28A)	05:29 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
15	07:31 15:03 (WTG 28)	06:58 15:33 (WTG 28)	06:10 15:25 (WTG 28)	06:13 07:54 (WTG 28A)	05:28 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
16	07:31 15:03 (WTG 28)	06:57 15:33 (WTG 28)	06:08 15:20 (WTG 28)	06:11 07:54 (WTG 28A)	05:27 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
17	07:30 15:03 (WTG 28)	06:55 15:33 (WTG 28)	06:06 15:15 (WTG 28)	06:10 07:54 (WTG 28A)	05:26 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
18	07:30 15:04 (WTG 28)	06:54 15:33 (WTG 28)	06:04 15:10 (WTG 28)	06:08 07:53 (WTG 28A)	05:25 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
19	07:29 15:04 (WTG 28)	06:52 15:33 (WTG 28)	06:02 15:05 (WTG 28)	06:06 07:53 (WTG 28A)	05:24 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
20	07:28 15:04 (WTG 28)	06:50 15:33 (WTG 28)	06:00 15:00 (WTG 28)	06:04 07:53 (WTG 28A)	05:23 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
21	07:27 15:04 (WTG 28)	06:49 15:33 (WTG 28)	05:58 14:55 (WTG 28)	06:03 07:53 (WTG 28A)	05:22 08:10 (WTG 28A)	05:09 08:22 (WTG 28A)
22	07:27 15:04 (WTG 28)	06:47 15:33 (WTG 28)	05:56 14:50 (WTG 28)	06:01 07:53 (WTG 28A)	05:21 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
23	07:26 15:05 (WTG 28)	06:46 15:33 (WTG 28)	05:54 14:45 (WTG 28)	05:59 07:53 (WTG 28A)	05:20 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
24	07:25 15:05 (WTG 28)	06:44 15:33 (WTG 28)	05:52 14:40 (WTG 28)	05:58 07:54 (WTG 28A)	05:19 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
25	07:24 15:06 (WTG 28)	06:42 15:33 (WTG 28)	05:50 14:35 (WTG 28)	05:56 07:54 (WTG 28A)	05:18 08:10 (WTG 28A)	05:10 08:22 (WTG 28A)
26	07:23 15:06 (WTG 28)	06:41 15:33 (WTG 28)	05:48 14:30 (WTG 28)	05:55 07:54 (WTG 28A)	05:17 08:10 (WTG 28A)	05:11 08:22 (WTG 28A)
27	07:22 15:07 (WTG 28)	06:39 15:33 (WTG 28)	05:46 14:25 (WTG 28)	05:53 07:55 (WTG 28A)	05:17 08:10 (WTG 28A)	05:11 08:22 (WTG 28A)
28	07:21 15:07 (WTG 28)	06:37 15:33 (WTG 28)	05:44 14:20 (WTG 28)	05:51 07:55 (WTG 28A)	05:16 08:10 (WTG 28A)	05:12 08:22 (WTG 28A)
29	07:20 15:07 (WTG 28)	06:35 15:33 (WTG 28)	05:42 14:15 (WTG 28)	05:50 07:56 (WTG 28A)	05:15 08:10 (WTG 28A)	05:12 08:22 (WTG 28A)
30	07:19 15:08 (WTG 28)	06:34 15:33 (WTG 28)	05:40 14:10 (WTG 28)	05:48 07:57 (WTG 28A)	05:15 08:10 (WTG 28A)	05:13 08:22 (WTG 28A)
31	07:18 15:08 (WTG 28)	06:32 15:33 (WTG 28)	05:38 14:05 (WTG 28)	05:47 07:58 (WTG 28A)	05:14 08:10 (WTG 28A)	05:13 08:22 (WTG 28A)
Potential sun hours	286	291	369	404	459	466
Total, worst case	1499	481	1649	134		
Sun reduction	0.29	0.37	0.37	0.33		
Oper. time red.	1.00	1.00	1.00	1.00		
Wind dir. red.	0.78	0.76	0.68	0.68		
Total reduction	0.23	0.28	0.25	0.23		
Total, real	341	137	418	30		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)



Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-196 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (414)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:41	06:17	06:53	07:35 (WTG 28A)	06:34
	20:47	20:25	19:35	18:38	60 08:35 (WTG 28A)	16:46
2	05:14	05:42	06:19	06:55	07:35 (WTG 28A)	06:35
	20:47	20:24	19:33	18:36	59 08:34 (WTG 28A)	16:44
3	05:14	05:43	06:20	06:56	07:35 (WTG 28A)	06:36
	20:46	20:22	19:31	18:34	58 08:33 (WTG 28A)	16:43
4	05:15	05:44	06:21	06:57	07:35 (WTG 28A)	06:38
	20:46	20:21	19:29	18:33	57 08:32 (WTG 28A)	16:41
5	05:15	05:45	06:22	06:58	07:37 (WTG 28A)	06:39
	20:46	20:20	19:27	18:31	54 08:31 (WTG 28A)	16:40
6	05:16	05:47	06:23	07:00	07:37 (WTG 28A)	06:41
	20:46	20:18	19:25	18:29	53 08:30 (WTG 28A)	16:39
7	05:17	05:48	06:24	07:01	07:37 (WTG 28A)	06:42
	20:45	20:17	19:24	18:27	52 08:29 (WTG 28A)	16:37
8	05:18	05:49	06:26	07:02	07:38 (WTG 28A)	06:43
	20:45	20:16	19:22	18:25	49 08:27 (WTG 28A)	16:36
9	05:18	05:50	06:27	07:03	07:39 (WTG 28A)	06:45
	20:45	20:14	19:20	18:23	47 08:26 (WTG 28A)	16:35
10	05:19	05:51	06:28	07:05	07:40 (WTG 28A)	06:46
	20:44	20:13	19:18	18:22	44 08:24 (WTG 28A)	16:34
11	05:20	05:52	06:29	07:06	07:41 (WTG 28A)	06:47
	20:44	20:11	19:16	18:20	41 08:22 (WTG 28A)	16:33
12	05:21	05:54	06:30	07:07	07:43 (WTG 28A)	06:49
	20:43	20:10	19:14	18:18	38 08:21 (WTG 28A)	16:31
13	05:22	05:55	06:32	07:08	07:45 (WTG 28A)	06:50
	20:42	20:08	19:12	18:16	33 08:17 (WTG 28A)	16:30
14	05:22	05:56	06:33	07:10	07:47 (WTG 28A)	06:52
	20:42	20:07	19:10	18:14	28 08:15 (WTG 28A)	16:29
15	05:23	05:57	06:34	07:11	07:51 (WTG 28A)	06:53
	20:41	20:05	19:09	18:13	21 08:12 (WTG 28A)	16:28
16	05:24	05:58	06:35	07:12	07:56 (WTG 28A)	06:54
	20:41	20:04	19:07	18:11	9 08:05 (WTG 28A)	16:27
17	05:25	05:59	06:36	07:14	06:56	15:30 (WTG 28)
	20:40	20:02	19:05	18:09	16:26	15:30 (WTG 28)
18	05:26	06:01	06:38	07:15	06:57	14:39 (WTG 28)
	20:39	20:01	19:03	18:08	16:25	15:31 (WTG 28)
19	05:27	06:02	06:39	07:16	06:58	14:39 (WTG 28)
	20:38	19:57	19:01	18:06	16:24	15:30 (WTG 28)
20	05:28	06:03	06:40	07:17	07:00	14:39 (WTG 28)
	20:37	19:56	18:59	18:04	16:24	15:30 (WTG 28)
21	05:29	06:04	06:41	07:19	07:01	14:40 (WTG 28)
	20:37	19:54	18:57	18:03	16:23	15:31 (WTG 28)
22	05:30	06:05	06:42	07:20	07:02	14:40 (WTG 28)
	20:36	19:52	18:55	18:01	16:22	15:31 (WTG 28)
23	05:31	06:07	06:44	07:21	07:03	14:41 (WTG 28)
	20:35	19:51	18:53	17:59	16:21	15:32 (WTG 28)
24	05:32	06:08	06:45	07:23	07:05	14:41 (WTG 28)
	20:34	19:49	18:51	17:58	16:20	15:32 (WTG 28)
25	05:33	06:09	06:46	07:24	07:06	14:41 (WTG 28)
	20:33	19:47	18:49	17:56	16:20	15:31 (WTG 28)
26	05:34	06:10	06:47	07:25	07:07	14:42 (WTG 28)
	20:32	19:45	18:48	17:54	16:19	15:32 (WTG 28)
27	05:35	06:11	06:48	07:27	07:09	14:42 (WTG 28)
	20:31	19:44	18:46	17:53	16:19	15:32 (WTG 28)
28	05:36	06:13	06:50	07:28	07:10	14:42 (WTG 28)
	20:30	19:42	18:44	17:51	16:18	15:32 (WTG 28)
29	05:37	06:14	06:51	07:30	07:11	14:43 (WTG 28)
	20:28	19:40	18:42	17:50	16:18	15:32 (WTG 28)
30	05:39	06:15	06:52	07:31	07:12	14:44 (WTG 28)
	20:27	19:38	18:40	17:48	14 16:11 (WTG 28)	16:17
31	05:40	06:16	06:53	07:32	15:57 (WTG 28)	07:12
	20:26	19:36	18:40	17:47	21 15:53 (WTG 28)	16:17
Potential sun hours	472	436	376	341	288	274
Total, worst case			1179	738	1389	1305
Sun reduction			0.42	0.36	0.25	0.28
Oper. time red.			1.00	1.00	1.00	1.00
Wind dir. red.			0.68	0.68	0.78	0.78
Total reduction			0.29	0.25	0.20	0.22
Total, real			339	183	272	286

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-200 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (418)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June			
1	07:35	14:58 (WTG 28)	07:17	15:20 (WTG 28)	06:35	07:36 (WTG 28A)	06:38	05:47	05:13
	16:25	43 15:41 (WTG 28)	17:03	22 15:42 (WTG 28)	17:43	65 08:41 (WTG 28A)	19:23	20:00	20:34
2	07:35	14:58 (WTG 28)	07:16	08:07 (WTG 28A)	06:34	64 07:36 (WTG 28A)	06:37	05:45	05:13
	16:26	43 15:41 (WTG 28)	17:05	24 15:40 (WTG 28)	17:44	64 08:40 (WTG 28A)	19:24	20:01	20:35
3	07:35	14:59 (WTG 28)	07:15	08:00 (WTG 28A)	06:32	63 07:37 (WTG 28A)	06:35	05:44	05:12
	16:27	43 15:42 (WTG 28)	17:06	30 15:36 (WTG 28)	17:46	63 08:40 (WTG 28A)	19:26	20:02	20:36
4	07:35	14:59 (WTG 28)	07:13	07:57 (WTG 28A)	06:30	62 07:37 (WTG 28A)	06:33	05:42	05:12
	16:28	44 15:43 (WTG 28)	17:08	26 08:23 (WTG 28A)	17:47	62 08:39 (WTG 28A)	19:27	20:03	20:37
5	07:34	15:00 (WTG 28)	07:12	07:55 (WTG 28A)	06:28	61 07:37 (WTG 28A)	06:31	05:41	05:11
	16:29	43 15:43 (WTG 28)	17:09	31 08:26 (WTG 28A)	17:48	61 08:38 (WTG 28A)	19:28	20:05	20:38
6	07:34	15:00 (WTG 28)	07:11	07:53 (WTG 28A)	06:27	59 07:38 (WTG 28A)	06:29	05:40	05:11
	16:30	44 15:44 (WTG 28)	17:10	35 08:28 (WTG 28A)	17:50	59 08:37 (WTG 28A)	19:29	20:06	20:38
7	07:34	15:00 (WTG 28)	07:10	07:51 (WTG 28A)	06:25	57 07:38 (WTG 28A)	06:27	05:38	05:11
	16:31	44 15:44 (WTG 28)	17:12	39 08:30 (WTG 28A)	17:51	57 08:35 (WTG 28A)	19:31	20:07	20:39
8	07:34	15:00 (WTG 28)	07:08	07:50 (WTG 28A)	06:23	56 08:39 (WTG 28A)	06:26	05:37	05:10
	16:32	45 15:45 (WTG 28)	17:13	42 08:32 (WTG 28A)	18:52	56 09:35 (WTG 28A)	19:32	20:08	20:40
9	07:34	15:01 (WTG 28)	07:07	07:47 (WTG 28A)	06:21	55 08:40 (WTG 28A)	06:24	05:36	05:10
	16:33	45 15:46 (WTG 28)	17:15	46 08:33 (WTG 28A)	18:54	53 09:33 (WTG 28A)	19:33	20:09	20:40
10	07:33	15:01 (WTG 28)	07:05	07:47 (WTG 28A)	06:19	54 08:40 (WTG 28A)	06:22	05:34	05:10
	16:34	44 15:45 (WTG 28)	17:16	48 08:35 (WTG 28A)	18:55	52 09:32 (WTG 28A)	19:34	20:11	20:41
11	07:33	15:02 (WTG 28)	07:04	07:46 (WTG 28A)	06:18	51 08:41 (WTG 28A)	06:20	05:33	05:09
	16:35	44 15:46 (WTG 28)	17:18	50 08:36 (WTG 28A)	18:56	49 09:30 (WTG 28A)	19:36	20:12	20:42
12	07:33	15:02 (WTG 28)	07:03	07:44 (WTG 28A)	06:16	50 08:42 (WTG 28A)	06:18	05:32	05:09
	16:37	44 15:46 (WTG 28)	17:19	53 08:37 (WTG 28A)	18:57	46 09:28 (WTG 28A)	19:37	20:13	20:42
13	07:32	15:02 (WTG 28)	07:01	07:44 (WTG 28A)	06:14	47 08:43 (WTG 28A)	06:17	05:31	05:09
	16:38	45 15:47 (WTG 28)	17:21	54 08:38 (WTG 28A)	18:59	43 09:26 (WTG 28A)	19:38	20:14	20:43
14	07:32	15:02 (WTG 28)	07:00	07:42 (WTG 28A)	06:12	48 08:44 (WTG 28A)	06:15	05:29	05:09
	16:39	45 15:47 (WTG 28)	17:22	57 08:39 (WTG 28A)	19:00	39 09:23 (WTG 28A)	19:40	20:15	20:43
15	07:31	15:03 (WTG 28)	06:58	07:41 (WTG 28A)	06:10	49 08:46 (WTG 28A)	06:13	05:28	05:09
	16:40	45 15:48 (WTG 28)	17:23	58 08:39 (WTG 28A)	19:01	35 09:21 (WTG 28A)	19:41	20:17	20:44
16	07:31	15:04 (WTG 28)	06:57	07:41 (WTG 28A)	06:08	50 08:49 (WTG 28A)	06:11	05:27	05:09
	16:41	44 15:48 (WTG 28)	17:25	59 08:40 (WTG 28A)	19:03	29 09:18 (WTG 28A)	19:42	20:18	20:44
17	07:30	15:04 (WTG 28)	06:55	07:40 (WTG 28A)	06:06	51 08:52 (WTG 28A)	06:10	05:26	05:09
	16:43	44 15:48 (WTG 28)	17:26	60 08:40 (WTG 28A)	19:04	22 09:14 (WTG 28A)	19:43	20:19	20:45
18	07:30	15:05 (WTG 28)	06:54	07:40 (WTG 28A)	06:05	52 08:57 (WTG 28A)	06:08	05:25	05:09
	16:44	44 15:49 (WTG 28)	17:28	62 08:42 (WTG 28A)	19:05	11 09:08 (WTG 28A)	19:45	20:20	20:45
19	07:29	15:05 (WTG 28)	06:52	07:39 (WTG 28A)	06:03		06:06	05:24	05:09
	16:45	43 15:48 (WTG 28)	17:29	63 08:42 (WTG 28A)	19:07		19:46	20:21	20:45
20	07:28	15:06 (WTG 28)	06:50	07:39 (WTG 28A)	06:01		06:04	05:23	05:09
	16:47	42 15:48 (WTG 28)	17:30	63 08:42 (WTG 28A)	19:08		19:47	20:22	20:46
21	07:27	15:06 (WTG 28)	06:49	07:38 (WTG 28A)	06:59		06:03	05:22	05:09
	16:48	42 15:48 (WTG 28)	17:32	64 08:42 (WTG 28A)	19:09		19:48	20:23	20:46
22	07:27	15:07 (WTG 28)	06:47	07:37 (WTG 28A)	06:57		06:01	05:21	05:10
	16:49	41 15:48 (WTG 28)	17:33	65 08:42 (WTG 28A)	19:10		19:50	20:24	20:46
23	07:26	15:08 (WTG 28)	06:46	07:36 (WTG 28A)	06:55		05:59	05:20	05:10
	16:51	41 15:49 (WTG 28)	17:35	65 08:43 (WTG 28A)	19:12		19:51	20:25	20:47
24	07:25	15:09 (WTG 28)	06:44	07:37 (WTG 28A)	06:53		05:58	05:19	05:10
	16:52	39 15:48 (WTG 28)	17:36	66 08:43 (WTG 28A)	19:13		19:52	20:26	20:47
25	07:24	15:10 (WTG 28)	06:42	07:37 (WTG 28A)	06:51		05:56	05:18	05:10
	16:53	38 15:48 (WTG 28)	17:37	65 08:42 (WTG 28A)	19:14		19:53	20:28	20:47
26	07:23	15:11 (WTG 28)	06:41	07:36 (WTG 28A)	06:50		05:55	05:17	05:11
	16:55	37 15:48 (WTG 28)	17:39	66 08:42 (WTG 28A)	19:16		19:55	20:29	20:47
27	07:22	15:12 (WTG 28)	06:39	07:37 (WTG 28A)	06:48		05:53	05:17	05:11
	16:56	35 15:47 (WTG 28)	17:40	65 08:42 (WTG 28A)	19:17		19:56	20:30	20:47
28	07:21	15:13 (WTG 28)	06:37	07:37 (WTG 28A)	06:46		05:51	05:16	05:12
	16:58	34 15:47 (WTG 28)	17:41	64 08:41 (WTG 28A)	19:18		19:57	20:31	20:47
29	07:20	15:14 (WTG 28)			06:44		05:50	05:15	05:12
	16:59	31 15:45 (WTG 28)			19:19		19:58	20:31	20:47
30	07:19	15:15 (WTG 28)			06:42		05:48	05:15	05:13
	17:00	29 15:44 (WTG 28)			19:21		20:00	20:32	20:47
31	07:18	15:17 (WTG 28)			06:40			05:14	
	17:02	26 15:43 (WTG 28)			19:22			20:33	
Potential sun hours	286		291		369		404	459	466
Total, worst case	1271		1442		866				
Sun reduction	0.29		0.37		0.37				
Oper. time red.	1.00		1.00		1.00				
Wind dir. red.	0.77		0.62		0.62				
Total reduction	0.23		0.23		0.23				
Total, real	288		337		200				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-200 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (418)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December				
1	05:13	05:41	06:17	06:53	08:22 (WTG 28A)	06:34	07:17 (WTG 28A)	07:13	14:44 (WTG 28)	
	20:47	20:25	19:35	18:38	45 09:07 (WTG 28A)	16:46	47 08:04 (WTG 28A)	16:17	44 15:28 (WTG 28)	
2	05:14	05:42	06:19	06:55	08:20 (WTG 28A)	06:35	07:17 (WTG 28A)	07:14	14:44 (WTG 28)	
	20:47	20:24	19:33	18:36	48 09:08 (WTG 28A)	16:44	45 08:02 (WTG 28A)	16:16	44 15:28 (WTG 28)	
3	05:14	05:43	06:20	06:56	08:19 (WTG 28A)	06:36	07:20 (WTG 28A)	07:16	14:44 (WTG 28)	
	20:46	20:22	19:31	18:34	50 09:09 (WTG 28A)	16:43	41 08:01 (WTG 28A)	16:16	45 15:29 (WTG 28)	
4	05:15	05:44	06:21	06:57	08:17 (WTG 28A)	06:38	07:21 (WTG 28A)	07:17	14:44 (WTG 28)	
	20:46	20:21	19:29	18:33	53 09:10 (WTG 28A)	16:41	38 07:59 (WTG 28A)	16:16	45 15:29 (WTG 28)	
5	05:15	05:45	06:22	06:58	08:16 (WTG 28A)	06:39	07:23 (WTG 28A)	07:18	14:46 (WTG 28)	
	20:46	20:20	19:27	18:31	55 09:11 (WTG 28A)	16:40	35 07:58 (WTG 28A)	16:15	44 15:30 (WTG 28)	
6	05:16	05:46	06:23	07:00	08:15 (WTG 28A)	06:41	07:25 (WTG 28A)	07:19	14:46 (WTG 28)	
	20:46	20:18	19:25	18:29	57 09:12 (WTG 28A)	16:39	30 07:55 (WTG 28A)	16:15	44 15:30 (WTG 28)	
7	05:17	05:48	06:24	07:01	08:14 (WTG 28A)	06:42	07:28 (WTG 28A)	07:20	14:47 (WTG 28)	
	20:45	20:17	19:24	18:27	58 09:12 (WTG 28A)	16:37	25 07:53 (WTG 28A)	16:15	43 15:30 (WTG 28)	
8	05:18	05:49	06:26	07:02	08:12 (WTG 28A)	06:43	07:31 (WTG 28A)	07:21	14:47 (WTG 28)	
	20:45	20:16	19:22	18:25	60 09:12 (WTG 28A)	16:36	29 15:07 (WTG 28)	16:15	44 15:31 (WTG 28)	
9	05:18	05:50	06:27	07:03	08:12 (WTG 28A)	06:45	07:38 (WTG 28A)	07:22	14:48 (WTG 28)	
	20:45	20:14	19:20	18:23	61 09:13 (WTG 28A)	16:35	21 15:10 (WTG 28)	16:15	43 15:31 (WTG 28)	
10	05:19	05:51	06:28	07:05	08:11 (WTG 28A)	06:46	14:50 (WTG 28)	07:23	14:48 (WTG 28)	
	20:44	20:13	19:18	18:22	63 09:14 (WTG 28A)	16:34	23 15:13 (WTG 28)	16:15	43 15:31 (WTG 28)	
11	05:20	05:52	06:29	07:06	08:10 (WTG 28A)	06:47	14:48 (WTG 28)	07:24	14:49 (WTG 28)	
	20:44	20:11	19:16	18:20	63 09:13 (WTG 28A)	16:33	26 15:14 (WTG 28)	16:15	43 15:32 (WTG 28)	
12	05:21	05:54	06:30	07:07	08:10 (WTG 28A)	06:49	14:47 (WTG 28)	07:25	14:49 (WTG 28)	
	20:43	20:10	19:14	18:18	64 09:14 (WTG 28A)	16:31	29 15:16 (WTG 28)	16:15	42 15:31 (WTG 28)	
13	05:22	05:55	06:32	07:08	08:10 (WTG 28A)	06:50	14:46 (WTG 28)	07:25	14:49 (WTG 28)	
	20:42	20:08	19:12	18:16	64 09:14 (WTG 28A)	16:30	31 15:17 (WTG 28)	16:15	43 15:32 (WTG 28)	
14	05:22	05:56	06:33	07:10	08:09 (WTG 28A)	06:52	14:45 (WTG 28)	07:26	14:50 (WTG 28)	
	20:42	20:07	19:10	18:14	65 09:14 (WTG 28A)	16:29	34 15:19 (WTG 28)	16:15	42 15:32 (WTG 28)	
15	05:23	05:57	06:34	07:11	08:09 (WTG 28A)	06:53	14:44 (WTG 28)	07:27	14:51 (WTG 28)	
	20:41	20:05	19:09	18:13	66 09:15 (WTG 28A)	16:28	35 15:19 (WTG 28)	16:15	42 15:33 (WTG 28)	
16	05:24	05:58	06:35	07:12	08:09 (WTG 28A)	06:54	14:44 (WTG 28)	07:28	14:52 (WTG 28)	
	20:41	20:04	19:07	18:11	65 09:14 (WTG 28A)	16:27	37 15:21 (WTG 28)	16:15	42 15:34 (WTG 28)	
17	05:25	05:59	06:36	07:14	08:08 (WTG 28A)	06:56	14:43 (WTG 28)	07:28	14:51 (WTG 28)	
	20:40	20:02	19:05	18:09	66 09:14 (WTG 28A)	16:26	38 15:21 (WTG 28)	16:16	42 15:33 (WTG 28)	
18	05:26	06:01	06:38	07:15	08:09 (WTG 28A)	06:57	14:43 (WTG 28)	07:29	14:52 (WTG 28)	
	20:39	20:01	19:03	18:08	65 09:14 (WTG 28A)	16:25	39 15:22 (WTG 28)	16:16	42 15:34 (WTG 28)	
19	05:27	06:02	06:39	07:16	08:08 (WTG 28A)	06:58	14:42 (WTG 28)	07:30	14:53 (WTG 28)	
	20:38	19:57	19:01	18:06	65 09:13 (WTG 28A)	16:24	41 15:23 (WTG 28)	16:16	42 15:35 (WTG 28)	
20	05:28	06:03	06:40	07:17	08:09 (WTG 28A)	07:00	14:42 (WTG 28)	07:30	14:53 (WTG 28)	
	20:37	19:56	18:59	18:04	65 09:14 (WTG 28A)	16:24	41 15:23 (WTG 28)	16:17	42 15:35 (WTG 28)	
21	05:29	06:04	06:41	07:19	08:09 (WTG 28A)	07:01	14:42 (WTG 28)	07:31	14:54 (WTG 28)	
	20:37	19:54	18:57	18:03	64 09:13 (WTG 28A)	16:23	42 15:24 (WTG 28)	16:17	42 15:36 (WTG 28)	
22	05:30	06:05	06:42	07:20	08:09 (WTG 28A)	07:02	14:42 (WTG 28)	07:31	14:54 (WTG 28)	
	20:36	19:52	18:55	18:01	63 09:12 (WTG 28A)	16:22	42 15:24 (WTG 28)	16:18	42 15:36 (WTG 28)	
23	05:31	06:07	06:44	07:21	08:10 (WTG 28A)	07:03	14:42 (WTG 28)	07:32	14:54 (WTG 28)	
	20:35	19:51	18:53	17:59	62 09:12 (WTG 28A)	16:21	43 15:25 (WTG 28)	16:18	42 15:36 (WTG 28)	
24	05:32	06:08	06:45	07:23	08:10 (WTG 28A)	07:05	14:42 (WTG 28)	07:32	14:55 (WTG 28)	
	20:34	19:49	18:51	17:58	61 09:11 (WTG 28A)	16:20	44 15:26 (WTG 28)	16:19	42 15:37 (WTG 28)	
25	05:33	06:09	06:46	07:24	08:11 (WTG 28A)	07:06	14:42 (WTG 28)	07:33	14:55 (WTG 28)	
	20:33	19:47	18:49	2 08:46 (WTG 28A)	17:56	60 09:11 (WTG 28A)	16:20	44 15:26 (WTG 28)	16:19	42 15:37 (WTG 28)
26	05:34	06:10	06:47	08:35 (WTG 28A)	17:25	59 08:11 (WTG 28A)	16:19	44 14:43 (WTG 28)	07:33	14:56 (WTG 28)
	20:32	19:45	18:48	19 08:54 (WTG 28A)	17:54	59 09:10 (WTG 28A)	16:19	44 15:27 (WTG 28)	16:20	42 15:38 (WTG 28)
27	05:35	06:11	06:48	08:32 (WTG 28A)	17:27	57 08:11 (WTG 28A)	16:19	44 14:43 (WTG 28)	07:33	14:56 (WTG 28)
	20:31	19:44	18:46	27 08:59 (WTG 28A)	17:53	57 09:08 (WTG 28A)	16:19	44 15:27 (WTG 28)	16:21	42 15:38 (WTG 28)
28	05:36	06:13	06:50	08:29 (WTG 28A)	17:28	56 08:12 (WTG 28A)	16:18	45 14:42 (WTG 28)	07:34	14:57 (WTG 28)
	20:30	19:42	18:44	32 09:01 (WTG 28A)	17:51	56 09:08 (WTG 28A)	16:18	45 15:27 (WTG 28)	16:21	42 15:39 (WTG 28)
29	05:37	06:14	06:51	08:26 (WTG 28A)	17:30	54 08:13 (WTG 28A)	16:17	45 14:42 (WTG 28)	07:34	14:57 (WTG 28)
	20:28	19:40	18:42	37 09:03 (WTG 28A)	17:50	54 09:07 (WTG 28A)	16:17	45 15:27 (WTG 28)	16:22	42 15:39 (WTG 28)
30	05:39	06:15	06:52	08:23 (WTG 28A)	17:31	52 08:14 (WTG 28A)	16:17	44 14:44 (WTG 28)	07:34	14:57 (WTG 28)
	20:27	19:38	18:40	42 09:05 (WTG 28A)	17:48	52 09:06 (WTG 28A)	16:17	44 15:28 (WTG 28)	16:23	43 15:40 (WTG 28)
31	05:40	06:16		07:32	08:15 (WTG 28A)			07:34	14:57 (WTG 28)	
	20:26	19:36		17:47	50 09:05 (WTG 28A)			16:24	43 15:40 (WTG 28)	
Potential sun hours	472	436	376	341	288	274				
Total, worst case			159	1836	1122	1325				
Sun reduction			0.42	0.36	0.25	0.28				
Oper. time red.			1.00	1.00	1.00	1.00				
Wind dir. red.			0.62	0.62	0.73	0.77				
Total reduction			0.26	0.23	0.19	0.22				
Total, real			42	413	208	289				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Project:

10050 Marble River Shadow Flicker Study\_3

Printed/Page

8/3/2010 1:05 PM / 37

Licensed user:

EDR

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-231 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (449)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.29	0.37	0.37	0.33	0.44	0.47	0.45	0.46	0.42	0.36	0.25	0.28

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
193	219	377	727	552	298	438	718	1,822	2,408	780	228	8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June						
1	07:34	07:17	07:39 (WTG 50)	06:35	06:59 (WTG 81)	06:38	17:33 (WTG 48-W)	05:47	05:13	05:40 (WTG 47)		
16:25	17:03	07:53 (WTG 50)	17:43	39	07:38 (WTG 81)	19:23	43	18:16 (WTG 48-W)	20:00	20:34	49	06:29 (WTG 47)
2	07:34	07:16	07:38 (WTG 50)	06:34	06:58 (WTG 81)	06:37	17:34 (WTG 48-W)	05:45	05:13	05:40 (WTG 47)		
16:26	17:05	07:55 (WTG 50)	17:44	41	07:39 (WTG 81)	19:24	40	18:14 (WTG 48-W)	20:01	20:35	48	06:28 (WTG 47)
3	07:34	07:14	07:36 (WTG 50)	06:32	06:57 (WTG 81)	06:35	17:36 (WTG 48-W)	05:44	05:12	05:40 (WTG 47)		
16:27	17:06	07:56 (WTG 50)	17:46	61	17:10 (WTG 48-W)	19:26	36	18:12 (WTG 48-W)	20:02	20:36	49	06:29 (WTG 47)
4	07:34	07:13	07:35 (WTG 50)	06:30	06:55 (WTG 81)	06:33	17:37 (WTG 48-W)	05:42	05:12	05:41 (WTG 47)		
16:28	17:08	07:58 (WTG 50)	17:47	71	17:14 (WTG 48-W)	19:27	33	18:10 (WTG 48-W)	20:03	20:37	49	06:30 (WTG 47)
5	07:34	07:12	07:34 (WTG 50)	06:28	06:54 (WTG 81)	06:31	17:39 (WTG 48-W)	05:41	05:11	05:40 (WTG 47)		
16:29	17:09	07:59 (WTG 50)	17:48	78	17:16 (WTG 48-W)	19:28	28	18:07 (WTG 48-W)	20:04	20:37	49	06:29 (WTG 47)
6	07:34	07:11	07:32 (WTG 50)	06:27	06:53 (WTG 81)	06:29	17:41 (WTG 48-W)	05:40	05:11	05:41 (WTG 47)		
16:30	17:11	07:59 (WTG 50)	17:50	84	17:18 (WTG 48-W)	19:29	23	18:04 (WTG 48-W)	20:06	20:38	49	06:30 (WTG 47)
7	07:34	07:09	07:31 (WTG 50)	06:25	06:52 (WTG 81)	06:27	17:45 (WTG 48-W)	05:38	05:11	05:41 (WTG 47)		
16:31	17:12	08:01 (WTG 50)	17:51	88	17:19 (WTG 48-W)	19:31	14	17:59 (WTG 48-W)	20:07	20:39	49	06:30 (WTG 47)
8	07:34	07:08	07:30 (WTG 50)	06:23	07:51 (WTG 81)	06:26	18:01	05:37	05:10	05:41 (WTG 47)		
16:32	17:13	08:02 (WTG 50)	18:52	93	18:21 (WTG 48-W)	19:32	20:08	05:10	05:41 (WTG 47)			
9	07:34	07:07	07:28 (WTG 50)	06:21	07:51 (WTG 81)	06:24	05:36	05:10	05:41 (WTG 47)			
16:33	17:15	08:02 (WTG 50)	18:54	97	18:23 (WTG 48-W)	19:33	20:09	8	05:07 (WTG 47)	20:40	49	06:30 (WTG 47)
10	07:33	07:05	07:27 (WTG 50)	06:19	07:50 (WTG 81)	06:22	05:34	05:10	05:42 (WTG 47)			
16:34	17:16	08:02 (WTG 50)	18:55	99	18:23 (WTG 48-W)	19:34	20:11	15	06:11 (WTG 47)	20:41	48	06:30 (WTG 47)
11	07:33	07:04	07:26 (WTG 50)	06:18	07:50 (WTG 81)	06:20	05:33	05:10	05:42 (WTG 47)			
16:35	17:18	08:02 (WTG 50)	18:56	102	18:24 (WTG 48-W)	19:36	20:12	19	06:14 (WTG 47)	20:42	49	06:31 (WTG 47)
12	07:33	07:03	07:27 (WTG 50)	06:16	07:49 (WTG 81)	06:18	05:32	05:10	05:42 (WTG 47)			
16:37	17:19	08:03 (WTG 50)	18:57	104	18:24 (WTG 48-W)	19:37	20:13	22	06:16 (WTG 47)	20:42	49	06:31 (WTG 47)
13	07:32	07:01	07:26 (WTG 50)	06:14	07:49 (WTG 81)	06:17	05:31	05:10	05:43 (WTG 47)			
16:38	17:21	08:03 (WTG 50)	18:59	105	18:25 (WTG 48-W)	19:38	20:14	25	06:18 (WTG 47)	20:43	48	06:31 (WTG 47)
14	07:32	07:00	07:27 (WTG 50)	06:12	07:48 (WTG 81)	06:15	05:29	05:10	05:43 (WTG 47)			
16:39	17:22	08:03 (WTG 50)	19:00	107	18:25 (WTG 48-W)	19:39	20:15	27	06:18 (WTG 47)	20:43	49	06:31 (WTG 47)
15	07:31	06:58	07:26 (WTG 50)	06:10	07:48 (WTG 81)	06:13	05:28	05:10	05:43 (WTG 47)			
16:40	17:23	08:02 (WTG 50)	19:01	107	18:25 (WTG 48-W)	19:41	20:16	29	06:19 (WTG 47)	20:44	49	06:31 (WTG 47)
16	07:31	06:57	07:27 (WTG 50)	06:08	07:49 (WTG 81)	06:11	05:27	05:10	05:43 (WTG 47)			
16:42	17:25	08:03 (WTG 50)	19:03	107	18:26 (WTG 48-W)	19:42	20:18	31	06:20 (WTG 47)	20:44	49	06:31 (WTG 47)
17	07:30	06:55	07:27 (WTG 50)	06:06	07:49 (WTG 81)	06:10	05:26	05:10	05:43 (WTG 47)			
16:43	17:26	08:02 (WTG 50)	19:04	108	18:26 (WTG 48-W)	19:43	20:19	33	06:21 (WTG 47)	20:45	49	06:32 (WTG 47)
18	07:29	06:54	07:28 (WTG 50)	06:05	07:49 (WTG 81)	06:08	05:25	05:10	05:44 (WTG 47)			
16:44	17:28	08:02 (WTG 50)	19:05	107	18:26 (WTG 48-W)	19:44	20:20	35	06:22 (WTG 47)	20:45	48	06:32 (WTG 47)
19	07:29	06:52	07:28 (WTG 50)	06:03	07:49 (WTG 81)	06:06	05:24	05:10	05:44 (WTG 47)			
16:45	17:29	08:01 (WTG 50)	19:07	107	18:26 (WTG 48-W)	19:46	20:21	37	06:23 (WTG 47)	20:45	48	06:32 (WTG 47)
20	07:28	06:50	07:29 (WTG 50)	06:01	07:49 (WTG 81)	06:04	05:23	05:10	05:44 (WTG 47)			
16:47	17:30	08:01 (WTG 50)	19:08	105	18:26 (WTG 48-W)	19:47	20:22	38	06:23 (WTG 47)	20:46	48	06:32 (WTG 47)
21	07:27	06:49	07:30 (WTG 50)	06:59	07:49 (WTG 81)	06:03	05:22	05:10	05:44 (WTG 47)			
16:48	17:32	08:01 (WTG 50)	19:09	104	18:25 (WTG 48-W)	19:48	20:23	40	06:25 (WTG 47)	20:46	48	06:32 (WTG 47)
22	07:27	06:47	07:31 (WTG 50)	06:57	07:50 (WTG 81)	06:01	05:21	05:10	05:44 (WTG 47)			
16:49	17:33	08:01 (WTG 50)	19:10	102	18:25 (WTG 48-W)	19:50	20:24	41	06:25 (WTG 47)	20:46	48	06:32 (WTG 47)
23	07:26	06:46	07:32 (WTG 50)	06:55	07:51 (WTG 81)	05:59	05:20	05:10	05:43 (WTG 47)			
16:51	17:35	08:01 (WTG 50)	19:12	98	18:24 (WTG 48-W)	19:51	20:25	43	06:26 (WTG 47)	20:46	48	06:33 (WTG 47)
24	07:25	06:44	07:31 (WTG 50)	06:53	07:52 (WTG 81)	05:58	05:19	05:10	05:42 (WTG 47)			
16:52	17:36	08:01 (WTG 50)	19:13	95	18:24 (WTG 48-W)	19:52	20:26	44	06:26 (WTG 47)	20:47	48	06:33 (WTG 47)
25	07:24	06:42	07:09 (WTG 81)	06:51	07:53 (WTG 81)	05:56	05:18	05:11	05:41 (WTG 47)			
16:54	17:37	08:01 (WTG 50)	19:14	92	18:24 (WTG 48-W)	19:53	20:27	45	06:26 (WTG 47)	20:47	49	06:33 (WTG 47)
26	07:23	06:41	07:05 (WTG 81)	06:50	07:55 (WTG 81)	05:55	05:18	05:11	05:41 (WTG 47)			
16:55	17:39	08:01 (WTG 50)	19:15	87	18:23 (WTG 48-W)	19:55	20:28	46	06:27 (WTG 47)	20:47	49	06:34 (WTG 47)
27	07:22	06:39	07:04 (WTG 81)	06:48	07:56 (WTG 81)	05:53	05:17	05:11	05:41 (WTG 47)			
16:56	17:40	08:01 (WTG 50)	19:17	83	18:22 (WTG 48-W)	19:56	20:29	46	06:27 (WTG 47)	20:47	49	06:34 (WTG 47)
28	07:21	06:37	07:01 (WTG 81)	06:46	07:58 (WTG 81)	05:51	05:16	05:11	05:40 (WTG 47)			
16:58	17:41	08:01 (WTG 50)	19:18	76	18:21 (WTG 48-W)	19:57	20:30	47	06:27 (WTG 47)	20:47	49	06:34 (WTG 47)
29	07:20	06:44	07:01 (WTG 81)	06:44	08:01 (WTG 81)	05:50	05:15	05:11	05:41 (WTG 47)			
16:59	17:42	08:01 (WTG 50)	19:19	67	18:19 (WTG 48-W)	19:58	20:31	47	06:28 (WTG 47)	20:47	49	06:35 (WTG 47)
30	07:19	06:42	07:01 (WTG 81)	06:42	17:31 (WTG 48-W)	05:48	05:15	05:11	05:40 (WTG 47)			
17:01	17:43	08:01 (WTG 50)	19:20	47	18:18 (WTG 48-W)	20:00	20:32	48	06:28 (WTG 47)	20:47	49	06:34 (WTG 47)
31	07:18	06:40	07:01 (WTG 81)	06:40	17:31 (WTG 48-W)	05:47	05:14	05:11	05:40 (WTG 47)			
17:02	17:44	08:01 (WTG 50)	19:21	46	18:17 (WTG 48-W)	19:59	20:33	48	06:28 (WTG 47)			
Potential sun hours	286	291	369	404	459	466						
Total, worst case	10	840	2707	217	814	1460						
Sun reduction	0.29	0.37	0.37	0.33	0.44	0.47						
Oper. time red.	1.00	1.00	1.00	1.00	1.00	1.00						
Wind dir. red.	0.63	0.64	0.74	0.79	0.81	0.81						
Total reduction	0.18	0.23	0.27	0.26	0.35	0.38						
Total, real	2	196	734	56	287	550						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

10050 Marble River Shadow Flicker Study\_3

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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-231 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (449)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:46 (WTG 47)	05:41	06:05 (WTG 47)	06:17	06:53
	20:47	06:35 (WTG 47)	20:25	06:26 (WTG 47)	19:35	18:38
2	05:14	05:46 (WTG 47)	05:42	06:06 (WTG 47)	06:19	06:55
	20:46	06:35 (WTG 47)	20:24	06:24 (WTG 47)	19:33	18:36
3	05:14	05:46 (WTG 47)	05:43	06:07 (WTG 47)	06:20	06:56
	20:46	06:35 (WTG 47)	20:22	06:21 (WTG 47)	19:31	18:34
4	05:15	05:47 (WTG 47)	05:44		06:21	06:57
	20:46	06:36 (WTG 47)	20:21		19:29	18:33
5	05:16	05:47 (WTG 47)	05:45		06:22	06:58
	20:46	06:35 (WTG 47)	20:20	17:42 (WTG 48-W)	19:27	18:33
6	05:16	05:47 (WTG 47)	05:47	17:56 (WTG 48-W)	18:31	06:59
	20:46	06:36 (WTG 47)	20:18	17:38 (WTG 48-W)	18:29	18:31
7	05:17	05:48 (WTG 47)	05:48	17:30 (WTG 48-W)	07:01	06:42
	20:45	06:36 (WTG 47)	20:17	17:26 (WTG 48-W)	18:27	17:55 (WTG 48-W)
8	05:18	05:47 (WTG 47)	05:49	17:28 (WTG 48-W)	07:02	06:43
	20:45	06:36 (WTG 47)	20:16	17:31 (WTG 48-W)	18:25	17:52 (WTG 48-W)
9	05:18	05:48 (WTG 47)	05:50	18:04 (WTG 48-W)	07:03	06:45
	20:44	06:36 (WTG 47)	20:14	17:24 (WTG 48-W)	18:23	17:50 (WTG 48-W)
10	05:19	05:48 (WTG 47)	05:51	18:06 (WTG 48-W)	07:04	06:46
	20:44	06:37 (WTG 47)	20:13	17:24 (WTG 48-W)	18:22	17:46 (WTG 48-W)
11	05:20	05:48 (WTG 47)	05:52	18:07 (WTG 48-W)	07:06	06:47
	20:43	06:36 (WTG 47)	20:11	17:26 (WTG 48-W)	18:20	17:41 (WTG 48-W)
12	05:21	05:48 (WTG 47)	05:54	18:08 (WTG 48-W)	07:07	06:49
	20:43	06:36 (WTG 47)	20:10	17:24 (WTG 48-W)	18:18	17:32 (WTG 81)
13	05:22	05:48 (WTG 47)	05:55	18:09 (WTG 48-W)	07:08	06:50
	20:42	06:36 (WTG 47)	20:08	17:22 (WTG 48-W)	18:16	17:33 (WTG 81)
14	05:22	05:49 (WTG 47)	05:56	18:09 (WTG 48-W)	07:10	06:51
	20:42	06:37 (WTG 47)	20:07	07:52 (WTG 81)	18:14	17:34 (WTG 81)
15	05:23	05:49 (WTG 47)	05:57	18:10 (WTG 48-W)	07:11	06:53
	20:41	06:37 (WTG 47)	20:05	07:48 (WTG 81)	18:13	17:37 (WTG 81)
16	05:24	05:50 (WTG 47)	05:58	18:11 (WTG 48-W)	07:12	06:54
	20:40	06:37 (WTG 47)	20:04	07:46 (WTG 81)	18:12	17:39 (WTG 81)
17	05:25	05:50 (WTG 47)	06:00	18:11 (WTG 48-W)	07:13	06:55
	20:40	06:37 (WTG 47)	20:02	07:43 (WTG 81)	18:11	17:42 (WTG 81)
18	05:26	05:50 (WTG 47)	06:01	18:12 (WTG 48-W)	07:15	06:57
	20:39	06:36 (WTG 47)	20:00	07:41 (WTG 81)	18:09	17:50 (WTG 81)
19	05:27	05:51 (WTG 47)	06:02	18:11 (WTG 48-W)	07:16	06:58
	20:38	06:35 (WTG 47)	19:57	07:39 (WTG 81)	18:08	17:51 (WTG 81)
20	05:28	05:52 (WTG 47)	06:03	18:11 (WTG 48-W)	07:17	06:59
	20:37	06:35 (WTG 47)	19:56	07:37 (WTG 81)	18:06	17:49 (WTG 81)
21	05:29	05:53 (WTG 47)	06:04	18:10 (WTG 48-W)	07:19	07:01
	20:36	06:35 (WTG 47)	19:54	07:36 (WTG 81)	18:04	17:48 (WTG 81)
22	05:30	05:54 (WTG 47)	06:05	18:10 (WTG 48-W)	07:20	07:02
	20:36	06:35 (WTG 47)	19:52	07:35 (WTG 81)	18:01	17:47 (WTG 81)
23	05:31	05:55 (WTG 47)	06:07	18:11 (WTG 48-W)	07:21	07:03
	20:35	06:34 (WTG 47)	19:51	07:34 (WTG 81)	17:59	17:46 (WTG 81)
24	05:32	05:56 (WTG 47)	06:08	18:10 (WTG 48-W)	07:23	07:05
	20:34	06:34 (WTG 47)	19:49	07:33 (WTG 81)	17:58	17:45 (WTG 81)
25	05:33	05:57 (WTG 47)	06:09	18:09 (WTG 48-W)	07:24	07:06
	20:33	06:33 (WTG 47)	19:47	07:31 (WTG 81)	17:56	17:44 (WTG 81)
26	05:34	05:58 (WTG 47)	06:10	18:09 (WTG 48-W)	07:25	07:07
	20:32	06:32 (WTG 47)	19:45	07:30 (WTG 81)	17:55	17:43 (WTG 81)
27	05:35	05:59 (WTG 47)	06:11	18:08 (WTG 48-W)	07:27	07:08
	20:31	06:32 (WTG 47)	19:44	07:29 (WTG 81)	17:53	17:42 (WTG 81)
28	05:36	06:00 (WTG 47)	06:13	18:08 (WTG 48-W)	07:28	07:10
	20:29	06:31 (WTG 47)	19:42	07:30 (WTG 81)	17:51	17:41 (WTG 81)
29	05:38	06:01 (WTG 47)	06:14	18:07 (WTG 48-W)	07:29	07:11
	20:28	06:30 (WTG 47)	19:40	07:29 (WTG 81)	17:50	17:40 (WTG 81)
30	05:39	06:02 (WTG 47)	06:15	18:06 (WTG 48-W)	07:31	07:12
	20:27	06:28 (WTG 47)	19:38	07:28 (WTG 81)	17:48	17:39 (WTG 81)
31	05:40	06:03 (WTG 47)	06:16	18:05 (WTG 48-W)	07:32	07:13
	20:26	06:27 (WTG 47)	19:36	07:27 (WTG 81)	17:47	17:38 (WTG 81)
Potential sun hours	472	436	376	341	288	274
Total, worst case	1327	53	1954	1610	263	
Sun reduction	0.45	0.46	0.42	0.36	0.25	
Oper. time red.	1.00	1.00	1.00	1.00	1.00	
Wind dir. red.	0.81	0.81	0.75	0.69	0.63	
Total reduction	0.36	0.37	0.31	0.25	0.16	
Total, real	478	20	611	399	41	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

Project:

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-238 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (456)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June				
1	07:34	08:41 (WTG 81)	07:17	06:35	05:47	18:37 (WTG 46)	05:13			
	16:25	76 15:46 (WTG 48-W)	17:03	17:43	44 07:41 (WTG 47)	19:23	20:00	27 19:04 (WTG 46)	20:34	
2	07:34	08:42 (WTG 81)	07:16	06:34	06:56 (WTG 47)	06:37	05:45	18:39 (WTG 46)	05:13	
	16:26	75 15:46 (WTG 48-W)	17:05	17:44	46 07:42 (WTG 47)	19:24	20:01	24 19:03 (WTG 46)	20:35	
3	07:34	08:43 (WTG 81)	07:14	06:32	06:56 (WTG 47)	06:35	05:44	18:40 (WTG 46)	05:12	
	16:27	75 15:47 (WTG 48-W)	17:06	17:46	47 07:43 (WTG 47)	19:26	20:02	20 19:00 (WTG 46)	20:36	
4	07:34	08:44 (WTG 81)	07:13	06:30	06:54 (WTG 47)	06:33	05:42	18:43 (WTG 46)	05:12	
	16:28	73 15:47 (WTG 48-W)	17:08	17:47	50 07:44 (WTG 47)	19:27	20:03	15 18:58 (WTG 46)	20:37	
5	07:34	08:45 (WTG 81)	07:12	06:28	06:53 (WTG 47)	06:31	5 18:54 (WTG 46)	05:41	18:46 (WTG 46)	05:11
	16:29	72 15:48 (WTG 48-W)	17:09	17:48	51 07:44 (WTG 47)	19:28	7 18:59 (WTG 46)	20:04	18:46 (WTG 46)	05:11
6	07:34	08:46 (WTG 81)	07:11	06:27	06:53 (WTG 47)	06:29	17 18:47 (WTG 46)	05:40	18:46 (WTG 46)	05:11
	16:30	72 15:49 (WTG 48-W)	17:11	17:50	51 07:44 (WTG 47)	19:29	17 19:04 (WTG 46)	20:06	18:44 (WTG 46)	05:11
7	07:34	08:46 (WTG 81)	07:09	06:25	06:52 (WTG 47)	06:27	22 19:06 (WTG 46)	20:07	18:42 (WTG 46)	05:10
	16:31	70 15:48 (WTG 48-W)	17:12	17:51	52 07:44 (WTG 47)	19:31	22 19:06 (WTG 46)	20:07	18:42 (WTG 46)	05:10
8	07:34	08:47 (WTG 81)	07:08	06:23	07:51 (WTG 47)	06:26	27 19:09 (WTG 46)	20:08	18:40 (WTG 46)	05:10
	16:32	69 15:49 (WTG 48-W)	17:13	18:52	53 08:44 (WTG 47)	19:32	27 19:09 (WTG 46)	20:08	18:40 (WTG 46)	05:10
9	07:34	08:49 (WTG 81)	07:07	07:21	07:51 (WTG 47)	06:24	30 19:10 (WTG 46)	20:09	18:38 (WTG 46)	05:10
	16:33	68 15:50 (WTG 48-W)	17:15	18:54	54 08:45 (WTG 47)	19:33	30 19:10 (WTG 46)	20:09	18:37 (WTG 46)	05:10
10	07:33	08:50 (WTG 81)	07:05	07:19	07:51 (WTG 47)	06:22	33 19:11 (WTG 46)	20:11	18:36 (WTG 46)	05:10
	16:34	65 15:49 (WTG 48-W)	17:16	18:55	53 08:44 (WTG 47)	19:34	33 19:11 (WTG 46)	20:12	18:36 (WTG 46)	05:10
11	07:33	08:51 (WTG 81)	07:04	07:18	07:50 (WTG 47)	06:20	34 19:11 (WTG 46)	20:12	18:35 (WTG 46)	05:10
	16:35	64 15:50 (WTG 48-W)	17:18	18:56	54 08:44 (WTG 47)	19:36	34 19:11 (WTG 46)	20:12	18:35 (WTG 46)	05:10
12	07:33	08:53 (WTG 81)	07:03	07:16	07:50 (WTG 47)	06:18	37 19:13 (WTG 46)	20:13	18:35 (WTG 46)	05:10
	16:37	60 15:50 (WTG 48-W)	17:19	18:57	53 08:43 (WTG 47)	19:37	37 19:13 (WTG 46)	20:13	18:35 (WTG 46)	05:10
13	07:32	08:55 (WTG 81)	07:01	07:14	07:50 (WTG 47)	06:17	38 19:13 (WTG 46)	20:14	18:34 (WTG 46)	05:10
	16:38	58 15:51 (WTG 48-W)	17:21	18:59	53 08:43 (WTG 47)	19:38	38 19:13 (WTG 46)	20:14	18:34 (WTG 46)	05:10
14	07:32	08:57 (WTG 81)	07:00	07:12	07:50 (WTG 47)	06:15	39 19:13 (WTG 46)	20:15	18:33 (WTG 46)	05:10
	16:39	53 15:51 (WTG 48-W)	17:22	19:00	52 08:42 (WTG 47)	19:39	39 19:13 (WTG 46)	20:15	18:33 (WTG 46)	05:10
15	07:31	09:02 (WTG 81)	06:58	07:10	07:50 (WTG 47)	06:13	40 19:13 (WTG 46)	20:16	18:33 (WTG 46)	05:10
	16:40	44 15:51 (WTG 48-W)	17:23	19:01	51 08:41 (WTG 47)	19:41	40 19:13 (WTG 46)	20:16	18:33 (WTG 46)	05:10
16	07:31	15:12 (WTG 48-W)	06:57	07:08	07:51 (WTG 47)	06:11	41 19:14 (WTG 46)	20:18	18:32 (WTG 46)	05:10
	16:42	39 15:51 (WTG 48-W)	17:25	19:03	50 08:41 (WTG 47)	19:42	41 19:14 (WTG 46)	20:18	18:32 (WTG 46)	05:10
17	07:30	15:12 (WTG 48-W)	06:55	07:06	07:51 (WTG 47)	06:10	42 19:14 (WTG 46)	20:19	18:31 (WTG 46)	05:10
	16:43	39 15:51 (WTG 48-W)	17:26	19:04	49 08:40 (WTG 47)	19:43	42 19:14 (WTG 46)	20:19	18:31 (WTG 46)	05:10
18	07:29	15:13 (WTG 48-W)	06:54	07:05	07:51 (WTG 47)	06:08	42 19:14 (WTG 46)	20:20	18:31 (WTG 46)	05:10
	16:44	39 15:52 (WTG 48-W)	17:28	19:05	48 08:39 (WTG 47)	19:44	42 19:13 (WTG 46)	20:20	18:31 (WTG 46)	05:10
19	07:29	15:14 (WTG 48-W)	06:52	07:03	07:51 (WTG 47)	06:06	42 19:13 (WTG 46)	20:20	18:31 (WTG 46)	05:10
	16:45	37 15:51 (WTG 48-W)	17:29	19:07	47 08:38 (WTG 47)	19:46	42 19:14 (WTG 46)	20:21	18:31 (WTG 46)	05:10
20	07:28	15:14 (WTG 48-W)	06:50	07:01	07:52 (WTG 47)	06:04	42 19:14 (WTG 46)	20:21	18:31 (WTG 46)	05:10
	16:47	37 15:51 (WTG 48-W)	17:30	19:08	44 08:36 (WTG 47)	19:47	42 19:13 (WTG 46)	20:22	18:31 (WTG 46)	05:10
21	07:27	15:15 (WTG 48-W)	06:49	06:59	07:53 (WTG 47)	06:03	41 19:12 (WTG 46)	20:23	18:32 (WTG 46)	05:10
	16:48	36 15:51 (WTG 48-W)	17:32	19:09	42 08:35 (WTG 47)	19:48	41 19:12 (WTG 46)	20:23	18:32 (WTG 46)	05:10
22	07:27	15:16 (WTG 48-W)	06:47	06:57	07:53 (WTG 47)	06:01	41 19:13 (WTG 46)	20:24	18:31 (WTG 46)	05:10
	16:49	34 15:50 (WTG 48-W)	17:33	15 07:28 (WTG 47)	19:10	40 08:33 (WTG 47)	19:50	41 19:13 (WTG 46)	20:24	05:10
23	07:26	15:17 (WTG 48-W)	06:46	06:55	07:09 (WTG 47)	06:55	41 19:13 (WTG 46)	20:24	18:31 (WTG 46)	05:10
	16:51	33 15:50 (WTG 48-W)	17:35	22 07:31 (WTG 47)	19:12	37 08:31 (WTG 47)	19:51	41 19:12 (WTG 46)	20:25	05:10
24	07:25	15:18 (WTG 48-W)	06:44	06:53	07:31 (WTG 47)	06:53	41 19:12 (WTG 46)	20:25	18:31 (WTG 46)	05:10
	16:52	31 15:49 (WTG 48-W)	17:36	28 07:34 (WTG 47)	19:13	32 08:29 (WTG 47)	19:52	40 19:11 (WTG 46)	20:26	05:11
25	07:24	15:20 (WTG 48-W)	06:42	06:51	07:04 (WTG 47)	06:51	39 19:11 (WTG 46)	20:27	18:32 (WTG 46)	05:11
	16:54	30 15:50 (WTG 48-W)	17:37	32 07:36 (WTG 47)	19:14	29 08:27 (WTG 47)	19:53	39 19:11 (WTG 46)	20:27	05:11
26	07:23	15:21 (WTG 48-W)	06:41	06:50	07:02 (WTG 47)	06:50	37 19:09 (WTG 46)	20:28	18:33 (WTG 46)	05:11
	16:55	28 15:49 (WTG 48-W)	17:39	36 07:38 (WTG 47)	19:15	23 08:24 (WTG 47)	19:55	37 19:09 (WTG 46)	20:28	05:11
27	07:22	15:22 (WTG 48-W)	06:39	06:48	07:01 (WTG 47)	06:48	36 19:09 (WTG 46)	20:29	18:33 (WTG 46)	05:11
	16:56	25 15:47 (WTG 48-W)	17:40	39 07:40 (WTG 47)	19:17	15 08:19 (WTG 47)	19:56	36 19:09 (WTG 46)	20:29	05:12
28	07:21	15:24 (WTG 48-W)	06:37	06:46	06:59 (WTG 47)	06:46	35 19:08 (WTG 46)	20:30	18:35 (WTG 46)	05:12
	16:58	22 15:46 (WTG 48-W)	17:41	42 07:41 (WTG 47)	19:18	05:51	35 19:08 (WTG 46)	20:30	18:35 (WTG 46)	05:12
29	07:20	15:26 (WTG 48-W)	06:36	06:44	06:59 (WTG 47)	06:44	32 19:07 (WTG 46)	20:31	18:35 (WTG 46)	05:12
	16:59	18 15:44 (WTG 48-W)	17:41	42 07:41 (WTG 47)	19:19	05:50	32 19:07 (WTG 46)	20:31	18:35 (WTG 46)	05:12
30	07:19	15:29 (WTG 48-W)	06:35	06:42	06:59 (WTG 47)	06:42	30 19:05 (WTG 46)	20:32	18:35 (WTG 46)	05:13
	17:01	13 15:42 (WTG 48-W)	17:41	42 07:41 (WTG 47)	19:21	20:00	30 19:05 (WTG 46)	20:32	18:35 (WTG 46)	05:13
31	07:18		17:40	41 07:40 (WTG 47)	19:20	19:59		20:31	18:35 (WTG 46)	05:13
	17:02		17:39	40 07:39 (WTG 47)	19:19	19:58		20:30	18:35 (WTG 46)	05:13
Potential sun hours	286	291	369	404	459	466				
Total, worst case	1455	214	1220	903	93					
Sun reduction	0.29	0.37	0.37	0.33	0.44					
Oper. time red.	1.00	1.00	1.00	1.00	1.00					
Wind dir. red.	0.70	0.68	0.68	0.73	0.73					
Total reduction	0.20	0.25	0.25	0.24	0.32					
Total, real	294	54	305	216	30					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker
			(WTG causing flicker last time)

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Steve Curtis, scurtis@edrpc.com

Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-238 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (456)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December
1	05:13	05:41	06:17	06:53	07:30 (WTG 47)	08:34 (WTG 81)
2	05:14	05:42	06:19	06:55	07:29 (WTG 47)	08:33 (WTG 81)
3	05:14	05:43	06:20	06:56	07:29 (WTG 47)	08:32 (WTG 81)
4	05:15	05:44	06:21	06:57	07:28 (WTG 47)	08:32 (WTG 81)
5	05:16	05:45	06:22	06:58	07:29 (WTG 47)	08:31 (WTG 81)
6	05:16	05:47	06:23	06:59	07:28 (WTG 47)	08:31 (WTG 81)
7	05:17	05:48	06:24	07:01	07:28 (WTG 47)	08:32 (WTG 81)
8	05:18	05:49	06:25	07:02	07:28 (WTG 47)	08:32 (WTG 81)
9	05:18	05:50	06:26	07:03	07:29 (WTG 47)	08:32 (WTG 81)
10	05:19	05:51	06:27	07:04	07:29 (WTG 47)	08:31 (WTG 81)
11	05:20	05:52	06:28	07:05	07:29 (WTG 47)	08:31 (WTG 81)
12	05:21	05:53	06:29	07:06	07:30 (WTG 47)	08:31 (WTG 81)
13	05:22	05:54	06:30	07:07	07:31 (WTG 47)	08:31 (WTG 81)
14	05:22	05:55	06:31	07:08	07:31 (WTG 47)	08:32 (WTG 81)
15	05:23	05:56	06:32	07:09	07:32 (WTG 47)	08:32 (WTG 81)
16	05:24	05:57	06:33	07:10	07:32 (WTG 47)	08:32 (WTG 81)
17	05:25	05:58	06:34	07:11	07:33 (WTG 47)	08:32 (WTG 81)
18	05:26	05:59	06:35	07:12	07:33 (WTG 47)	08:32 (WTG 81)
19	05:27	06:00	06:36	07:13	07:34 (WTG 47)	08:32 (WTG 81)
20	05:28	06:01	06:37	07:14	07:34 (WTG 47)	08:32 (WTG 81)
21	05:29	06:02	06:38	07:15	07:35 (WTG 47)	08:32 (WTG 81)
22	05:30	06:03	06:39	07:16	07:35 (WTG 47)	08:32 (WTG 81)
23	05:31	06:04	06:40	07:17	07:36 (WTG 47)	08:32 (WTG 81)
24	05:32	06:05	06:41	07:18	07:36 (WTG 47)	08:32 (WTG 81)
25	05:33	06:06	06:42	07:19	07:37 (WTG 47)	08:32 (WTG 81)
26	05:34	06:07	06:43	07:20	07:37 (WTG 47)	08:32 (WTG 81)
27	05:35	06:08	06:44	07:21	07:38 (WTG 47)	08:32 (WTG 81)
28	05:36	06:09	06:45	07:22	07:38 (WTG 47)	08:32 (WTG 81)
29	05:37	06:10	06:46	07:23	07:39 (WTG 47)	08:32 (WTG 81)
30	05:38	06:11	06:47	07:24	07:39 (WTG 47)	08:32 (WTG 81)
31	05:39	06:12	06:48	07:25	07:40 (WTG 47)	08:32 (WTG 81)
Potential sun hours	472	436	376	341	288	274
Total, worst case		834	771	856	674	2325
Sun reduction		0.46	0.42	0.36	0.25	0.28
Oper. time red.		1.00	1.00	1.00	1.00	1.00
Wind dir. red.		0.73	0.69	0.68	0.75	0.64
Total reduction		0.33	0.29	0.24	0.19	0.18
Total, real		278	222	208	126	416

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	Last time (hh:mm) with flicker	(WTG causing flicker first time)	(WTG causing flicker last time)
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Calculated:

8/3/2010 11:21 AM/2.7.453

## SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-240 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (458)

### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760  
 Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April	May	June
1	07:34	07:17	06:35	07:17 (WTG 50)	06:38	07:21 (WTG 81)
	16:25	17:03	17:43	07:53 (WTG 50)	19:23	18:50 (WTG 48-W)
2	07:34	07:16	06:34	07:18 (WTG 50)	06:37	07:21 (WTG 81)
	16:26	17:05	17:44	07:51 (WTG 50)	19:24	18:50 (WTG 48-W)
3	07:34	07:14	06:32	07:19 (WTG 50)	06:35	07:20 (WTG 81)
	16:27	17:06	17:46	07:51 (WTG 50)	19:26	18:49 (WTG 48-W)
4	07:34	07:13	06:30	07:20 (WTG 50)	06:33	07:20 (WTG 81)
	16:28	17:08	17:47	07:49 (WTG 50)	19:27	18:49 (WTG 48-W)
5	07:34	07:12	06:28	07:22 (WTG 50)	06:31	07:20 (WTG 81)
	16:29	17:09	17:48	07:47 (WTG 50)	19:28	18:49 (WTG 48-W)
6	07:34	07:11	06:27	07:23 (WTG 50)	06:29	07:20 (WTG 81)
	16:30	17:11	17:50	07:44 (WTG 50)	19:29	18:48 (WTG 48-W)
7	07:34	07:09	06:25	07:26 (WTG 50)	06:27	07:20 (WTG 81)
	16:31	17:12	17:51	07:40 (WTG 50)	19:31	18:48 (WTG 48-W)
8	07:34	07:08	06:23	07:27 (WTG 50)	06:26	07:21 (WTG 81)
	16:32	17:13	17:52	07:38 (WTG 50)	19:32	18:48 (WTG 48-W)
9	07:34	07:07	06:21	07:29 (WTG 50)	06:24	07:21 (WTG 81)
	16:33	17:15	17:54	07:44 (WTG 50)	19:33	18:48 (WTG 48-W)
10	07:33	07:05	06:19	07:27 (WTG 50)	06:22	07:21 (WTG 81)
	16:34	17:16	17:55	07:47 (WTG 50)	19:34	18:47 (WTG 48-W)
11	07:33	07:04	06:18	07:25 (WTG 50)	06:20	07:21 (WTG 81)
	16:35	17:18	17:56	07:48 (WTG 50)	19:36	18:46 (WTG 48-W)
12	07:33	07:03	06:16	07:24 (WTG 50)	06:18	07:22 (WTG 81)
	16:37	17:19	17:57	07:52 (WTG 81)	19:37	18:46 (WTG 48-W)
13	07:32	07:01	06:14	07:22 (WTG 50)	06:17	07:23 (WTG 81)
	16:38	17:21	17:59	07:47 (WTG 81)	19:38	18:46 (WTG 48-W)
14	07:32	07:00	06:12	07:21 (WTG 50)	06:15	07:23 (WTG 81)
	16:39	17:22	18:00	07:51 (WTG 50)	19:39	18:45 (WTG 48-W)
15	07:31	06:58	06:10	07:19 (WTG 50)	06:13	07:24 (WTG 81)
	16:40	17:23	18:01	07:53 (WTG 50)	19:40	18:43 (WTG 48-W)
16	07:31	06:57	06:08	07:17 (WTG 50)	06:11	07:26 (WTG 81)
	16:42	17:25	18:02	07:55 (WTG 50)	19:41	18:42 (WTG 48-W)
17	07:30	06:55	06:06	07:15 (WTG 50)	06:10	07:27 (WTG 81)
	16:43	17:26	18:03	07:57 (WTG 50)	19:42	18:41 (WTG 48-W)
18	07:29	06:54	06:04	07:13 (WTG 50)	06:08	07:28 (WTG 81)
	16:44	17:27	18:04	07:59 (WTG 50)	19:43	18:40 (WTG 48-W)
19	07:29	06:52	06:02	07:11 (WTG 50)	06:06	07:30 (WTG 81)
	16:45	17:28	18:05	07:61 (WTG 50)	19:44	18:38 (WTG 48-W)
20	07:28	06:50	06:00	07:09 (WTG 50)	06:04	07:31 (WTG 81)
	16:46	17:29	18:06	07:63 (WTG 50)	19:45	18:37 (WTG 48-W)
21	07:27	06:49	05:58	07:07 (WTG 50)	06:03	07:32 (WTG 81)
	16:47	17:30	18:07	07:65 (WTG 50)	19:46	18:35 (WTG 48-W)
22	07:27	06:47	05:56	07:05 (WTG 50)	06:01	07:33 (WTG 81)
	16:48	17:31	18:08	07:67 (WTG 50)	19:47	18:34 (WTG 48-W)
23	07:26	06:46	05:54	07:03 (WTG 50)	06:00	07:34 (WTG 81)
	16:51	17:32	18:09	07:69 (WTG 50)	19:48	18:33 (WTG 48-W)
24	07:25	06:44	05:52	07:01 (WTG 50)	05:58	07:35 (WTG 81)
	16:52	17:33	18:10	07:71 (WTG 50)	19:49	18:32 (WTG 48-W)
25	07:24	06:42	05:50	06:59 (WTG 50)	05:56	07:36 (WTG 81)
	16:54	17:34	18:11	07:73 (WTG 50)	19:50	18:31 (WTG 48-W)
26	07:23	06:41	05:48	06:57 (WTG 50)	05:54	07:37 (WTG 81)
	16:55	17:35	18:12	07:75 (WTG 50)	19:51	18:30 (WTG 48-W)
27	07:22	06:39	05:46	06:55 (WTG 50)	05:53	07:38 (WTG 81)
	16:56	17:36	18:13	07:77 (WTG 50)	19:52	18:29 (WTG 48-W)
28	07:21	06:37	05:44	06:53 (WTG 50)	05:51	07:39 (WTG 81)
	16:58	17:37	18:14	07:79 (WTG 50)	19:53	18:28 (WTG 48-W)
29	07:20		05:42	06:51 (WTG 50)	05:50	07:40 (WTG 81)
	16:59		18:15	07:81 (WTG 50)	19:54	18:27 (WTG 48-W)
30	07:19		05:40	06:49 (WTG 50)	05:48	07:41 (WTG 81)
	17:01		18:16	07:83 (WTG 50)	19:55	18:26 (WTG 48-W)
31	07:18		05:38	06:47 (WTG 50)	05:47	07:42 (WTG 81)
	17:02		18:17	07:85 (WTG 50)	19:56	18:25 (WTG 48-W)
Potential sun hours	286	291	369	404	459	466
Total, worst case		691	1582	2024		
Sun reduction		0.37	0.37	0.33		
Oper. time red.		1.00	1.00	1.00		
Wind dir. red.		0.65	0.73	0.75		
Total reduction		0.24	0.27	0.25		
Total, real		165	428	500		

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)



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Calculated:

8/3/2010 11:21 AM/2.7.453

### SHADOW - Calendar

Calculation: Marble River Wind Farm SFA-3Shadow receptor: H-240 - Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (458)

#### Assumptions for shadow calculations

Maximum distance for influence 1,000 m  
 Minimum sun height over horizon for influence 3 °  
 Day step for calculation 1 days  
 Time step for calculation 1 minutes

Sunshine probability S/S0 (Sun hours/Possible sun hours) []

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec  
 0.29 0.37 0.37 0.33 0.44 0.47 0.45 0.46 0.42 0.36 0.25 0.28

Operational time

N NNE ENE E ESE SSE S SSW WSW W WNW NNW Sum  
 193 219 377 727 552 298 438 718 1,822 2,408 780 228 8,760

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October	November	December					
1	05:13	05:41	06:17	07:20 (WTG 81)	06:53	07:29 (WTG 81)	06:34	06:57 (WTG 50)	07:13		
	20:47	20:25	19:35	18:45 (WTG 48-W)	18:38	18	07:47 (WTG 81)	16:46	16:17		
2	05:14	05:42	06:19	07:20 (WTG 81)	06:55			06:35	06:59 (WTG 50)	07:14	
	20:46	20:24	19:33	18:46 (WTG 48-W)	18:36			16:44	14	07:13 (WTG 50)	16:16
3	05:14	05:43	06:20	07:19 (WTG 81)	06:56			06:36			07:15
	20:46	20:22	19:31	18:46 (WTG 48-W)	18:34			16:43			16:16
4	05:15	05:44	06:21	07:18 (WTG 81)	06:57			06:38			07:17
	20:46	20:21	19:29	18:45 (WTG 48-W)	18:33			16:41			16:16
5	05:16	05:45	06:22	07:17 (WTG 81)	06:58			06:39			07:18
	20:46	20:20	19:27	18:45 (WTG 48-W)	18:31			16:40			16:15
6	05:16	05:47	06:23	07:16 (WTG 81)	06:59		08:05 (WTG 50)	06:40			07:19
	20:46	20:18	19:25	18:44 (WTG 48-W)	18:29	9	08:14 (WTG 50)	16:39			16:15
7	05:17	05:48	06:24	07:15 (WTG 81)	07:01			06:42			07:20
	20:45	20:17	19:24	18:44 (WTG 48-W)	18:27	17	08:18 (WTG 50)	16:37			16:15
8	05:18	05:49	06:26	07:14 (WTG 81)	07:02			07:58 (WTG 50)			07:21
	20:45	20:16	19:22	18:43 (WTG 48-W)	18:25	22	08:20 (WTG 50)	16:36			16:15
9	05:18	05:50	06:27	07:15 (WTG 81)	07:03			07:56 (WTG 50)			07:22
	20:44	20:14	19:20	18:44 (WTG 48-W)	18:23	27	08:23 (WTG 50)	16:35			16:15
10	05:19	05:51	06:28	07:14 (WTG 81)	07:04			07:54 (WTG 50)			07:23
	20:44	20:13	19:18	18:43 (WTG 48-W)	18:22	30	08:24 (WTG 50)	16:34			16:15
11	05:20	05:52	06:29	07:13 (WTG 81)	07:06			07:52 (WTG 50)			07:24
	20:43	20:11	19:16	18:42 (WTG 48-W)	18:20	33	08:25 (WTG 50)	16:33			16:15
12	05:21	05:54	06:30	07:13 (WTG 81)	07:07			07:52 (WTG 50)			07:24
	20:43	20:10	19:14	18:41 (WTG 48-W)	18:18	34	08:26 (WTG 50)	16:32			16:15
13	05:22	05:55	06:32	07:12 (WTG 81)	07:08			07:50 (WTG 50)			07:25
	20:42	20:08	19:12	18:40 (WTG 48-W)	18:16	36	08:26 (WTG 50)	16:30			16:15
14	05:22	05:56	06:33	07:12 (WTG 81)	07:10			07:49 (WTG 50)			07:26
	20:42	20:07	19:10	18:38 (WTG 48-W)	18:14	38	08:27 (WTG 50)	16:29			16:15
15	05:23	05:57	06:34	07:12 (WTG 81)	07:11			07:49 (WTG 50)			07:27
	20:41	20:05	19:08	18:37 (WTG 48-W)	18:13	39	08:28 (WTG 50)	16:28			16:15
16	05:24	05:58	06:35	07:13 (WTG 81)	07:12			07:48 (WTG 50)			07:28
	20:40	20:04	19:07	18:36 (WTG 48-W)	18:11	39	08:27 (WTG 50)	16:27			16:16
17	05:25	06:00	06:36	07:12 (WTG 81)	07:13			07:47 (WTG 50)			07:28
	20:40	20:02	19:05	18:35 (WTG 48-W)	18:09	40	08:27 (WTG 50)	16:26			16:16
18	05:26	06:01	06:38	07:12 (WTG 81)	07:15			07:47 (WTG 50)			07:29
	20:39	20:00	19:03	18:33 (WTG 48-W)	18:08	41	08:28 (WTG 50)	16:25			16:16
19	05:27	06:02	06:39	07:12 (WTG 81)	07:16			07:47 (WTG 50)			07:30
	20:38	19:57	19:01	18:30 (WTG 48-W)	18:06	40	08:27 (WTG 50)	16:24			16:16
20	05:28	06:03	06:40	07:13 (WTG 81)	07:17			07:46 (WTG 50)			07:30
	20:37	19:56	18:18 (WTG 48-W)	18:59	86	18:28 (WTG 48-W)	18:04	41	08:27 (WTG 50)	16:24	16:17
21	05:29	06:04	06:41	07:13 (WTG 81)	07:19			07:47 (WTG 50)			07:31
	20:36	19:54	18:35 (WTG 48-W)	18:57	80	18:25 (WTG 48-W)	18:03	40	08:27 (WTG 50)	16:23	16:17
22	05:30	06:05	06:42	07:14 (WTG 81)	07:20			07:46 (WTG 50)			07:31
	20:36	19:52	18:37 (WTG 48-W)	18:55	72	18:22 (WTG 48-W)	18:01	40	08:26 (WTG 50)	16:22	16:18
23	05:31	06:07	06:44	07:15 (WTG 81)	07:21			07:47 (WTG 50)			07:32
	20:35	19:51	18:39 (WTG 48-W)	18:53	52	08:07 (WTG 81)	17:59	40	08:27 (WTG 50)	16:21	16:18
24	05:32	06:08	06:45	07:15 (WTG 81)	07:23			07:47 (WTG 50)			07:32
	20:34	19:49	18:40 (WTG 48-W)	18:51	50	08:05 (WTG 81)	17:58	39	08:26 (WTG 50)	16:21	16:19
25	05:33	06:09	06:46	07:16 (WTG 81)	07:24			07:47 (WTG 50)			07:33
	20:33	19:47	18:41 (WTG 48-W)	18:49	47	08:03 (WTG 81)	17:56	38	08:25 (WTG 50)	16:20	16:20
26	05:34	06:10	06:47	07:17 (WTG 81)	07:25			07:48 (WTG 50)			07:33
	20:32	19:45	18:43 (WTG 48-W)	18:48	44	08:01 (WTG 81)	17:55	36	08:24 (WTG 50)	16:19	16:20
27	05:35	06:11	06:48	07:19 (WTG 81)	07:27			07:49 (WTG 50)			07:33
	20:31	19:44	18:43 (WTG 48-W)	18:46	41	08:00 (WTG 81)	17:53	34	08:23 (WTG 50)	16:19	16:21
28	05:36	06:13	06:50	07:21 (WTG 81)	07:28			07:51 (WTG 50)			07:34
	20:29	19:42	18:44 (WTG 48-W)	18:44	36	07:57 (WTG 81)	17:51	31	08:22 (WTG 50)	16:18	16:22
29	05:38	06:14	06:51	07:22 (WTG 81)	07:29			07:52 (WTG 50)			07:34
	20:28	19:40	18:44 (WTG 48-W)	18:42	33	07:55 (WTG 81)	17:50	29	08:21 (WTG 50)	16:18	16:22
30	05:39	06:15	06:52	07:23 (WTG 81)	07:31			07:54 (WTG 50)			07:34
	20:27	19:38	18:45 (WTG 48-W)	18:40	26	07:51 (WTG 81)	17:48	26	08:20 (WTG 50)	16:17	16:23
31	05:40	06:16	06:53	07:24 (WTG 81)	07:32			07:55 (WTG 50)			07:34
	20:26	19:36	18:45 (WTG 48-W)		17:47	23	08:18 (WTG 50)				16:24
Potential sun hours	472	436	376	341			288				274
Total, worst case		824	2604	880	33						
Sun reduction		0.46	0.42	0.36	0.25						
Oper. time red.		1.00	1.00	1.00	1.00						
Wind dir. red.		0.75	0.75	0.65	0.65						
Total reduction		0.35	0.31	0.23	0.16						
Total, real		284	815	205	5						

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)		Last time (hh:mm) with flicker	(WTG causing flicker last time)

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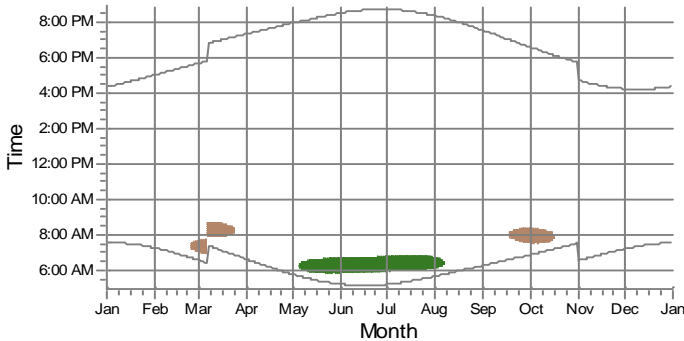
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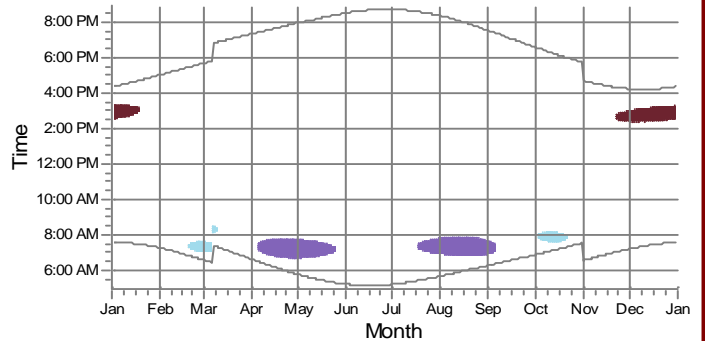
## SHADOW - Calendar, graphical

Calculation: Marble River Wind Farm SFA-3

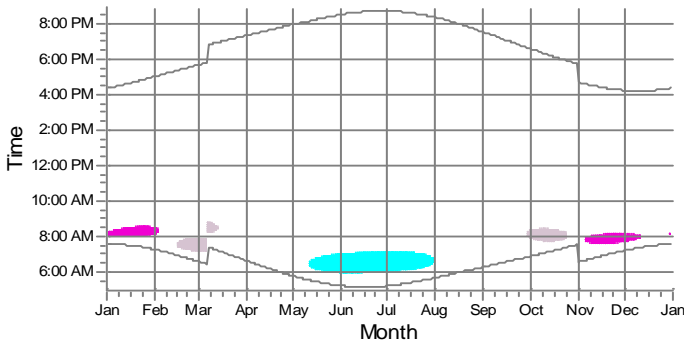
H-031: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (279)



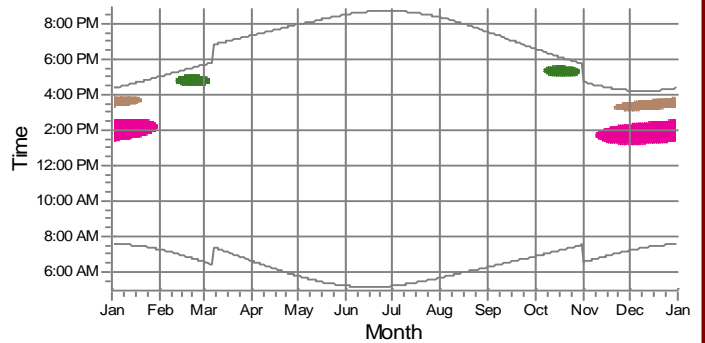
H-091: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (325)



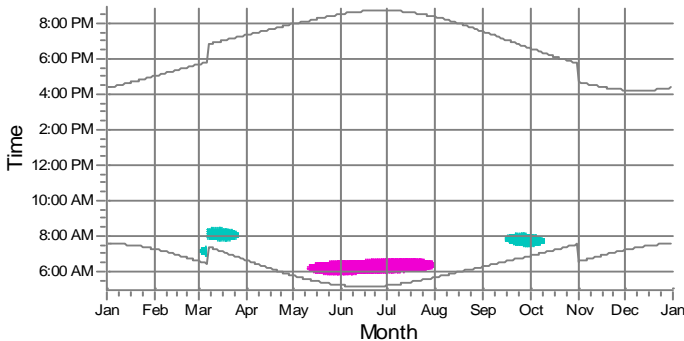
H-106: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (340)



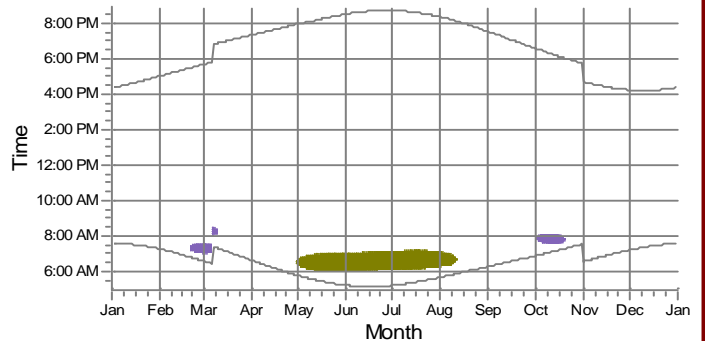
H-108: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (342)












H-120: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (352)



H-138: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (363)



WTGs

 WTG 83: VESTAS V112 3000 112.0 IOI hub: 94.0 m (10)	 WTG 53: VESTAS V112 3000 112.0 IOI hub: 94.0 m (26)	 WTG 44: VESTAS V112 3000 112.0 IOI hub: 94.0 m (35)	 WTG 104-L: VESTAS V112 3000 112.0 IOI hub: 94.0 m (70)
 WTG 77: VESTAS V112 3000 112.0 IOI hub: 94.0 m (13)	 WTG 52: VESTAS V112 3000 112.0 IOI hub: 94.0 m (27)	 WTG 42: VESTAS V112 3000 112.0 IOI hub: 94.0 m (36)	 WTG 102-L: VESTAS V112 3000 112.0 IOI hub: 94.0 m (71)
 WTG 97: VESTAS V112 3000 112.0 IOI hub: 94.0 m (23)	 WTG 45: VESTAS V112 3000 112.0 IOI hub: 94.0 m (34)	 WTG 105-L: VESTAS V112 3000 112.0 IOI hub: 94.0 m (69)	

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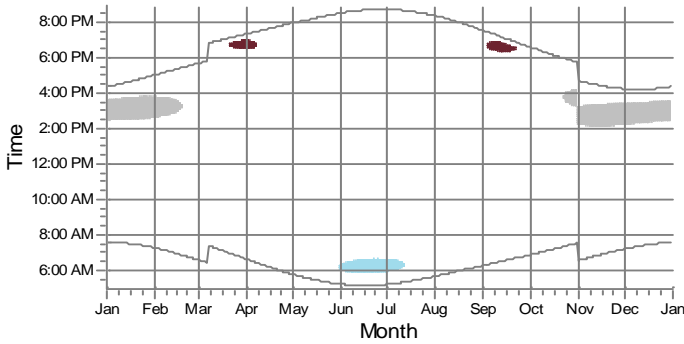
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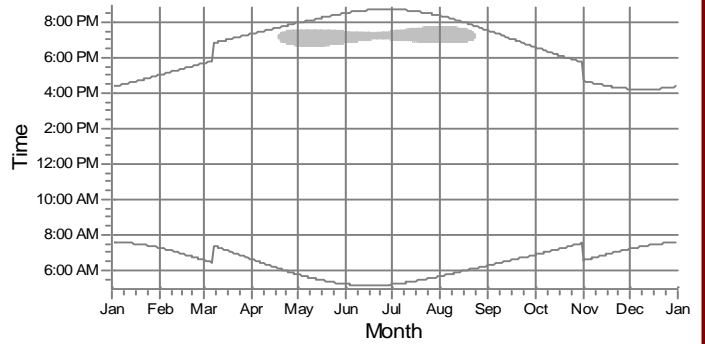
## SHADOW - Calendar, graphical

Calculation: Marble River Wind Farm SFA-3

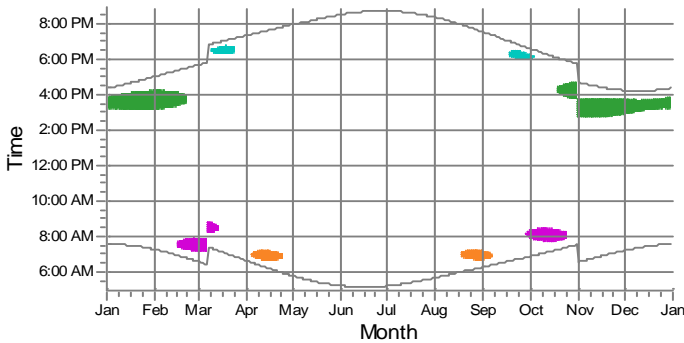
H-148: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (370)



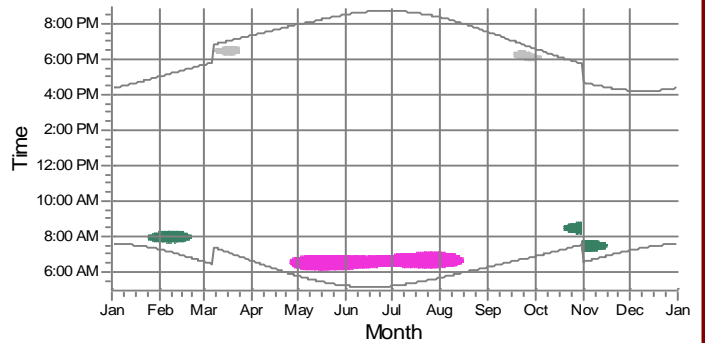
H-155: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (376)



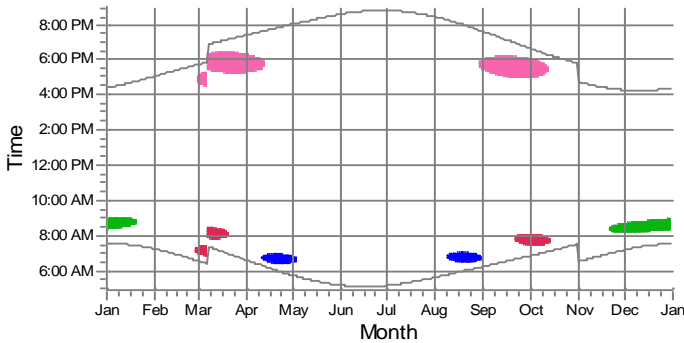
H-166: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (385)



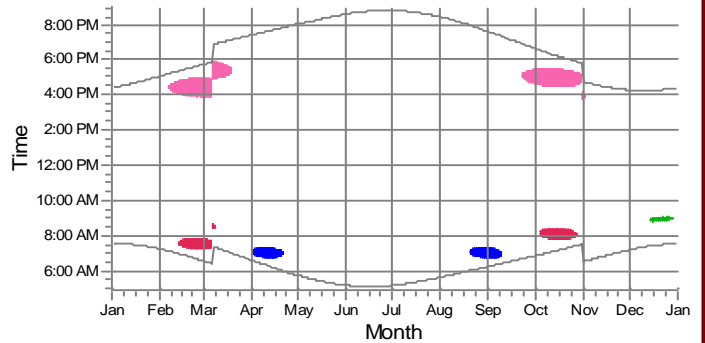
H-176: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (395)



H-185: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (403)



H-187: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (405)



WTGs

- WTG 9A: VESTAS V112 3000 112.0 IOI hub: 94.0 m (3)
- WTG 57: VESTAS V112 3000 112.0 IOI hub: 94.0 m (23)
- WTG 46: VESTAS V112 3000 112.0 IOI hub: 94.0 m (33)
- WTG 206: VESTAS V112 3000 112.0 IOI hub: 94.0 m (45)
- WTG 78: VESTAS V112 3000 112.0 IOI hub: 94.0 m (12)
- WTG 55: VESTAS V112 3000 112.0 IOI hub: 94.0 m (25)
- WTG 45: VESTAS V112 3000 112.0 IOI hub: 94.0 m (34)
- WTG 148A: VESTAS V112 3000 112.0 IOI hub: 94.0 m (58)
- WTG 58: VESTAS V112 3000 112.0 IOI hub: 94.0 m (22)
- WTG 48-W: VESTAS V112 3000 112.0 IOI hub: 94.0 m (31)
- WTG 44: VESTAS V112 3000 112.0 IOI hub: 94.0 m (35)
- WTG 148: VESTAS V112 3000 112.0 IOI hub: 94.0 m (59)
- WTG 11: VESTAS V112 3000 112.0 IOI hub: 94.0 m (65)

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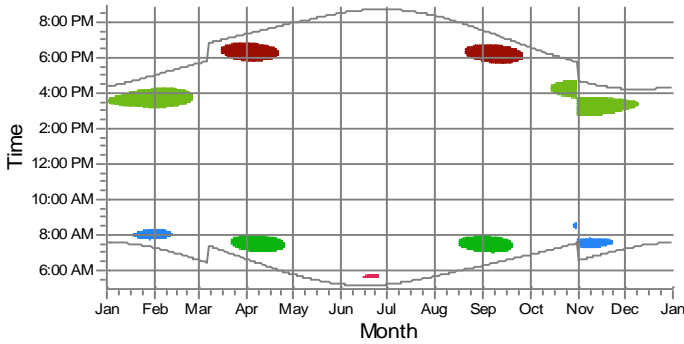
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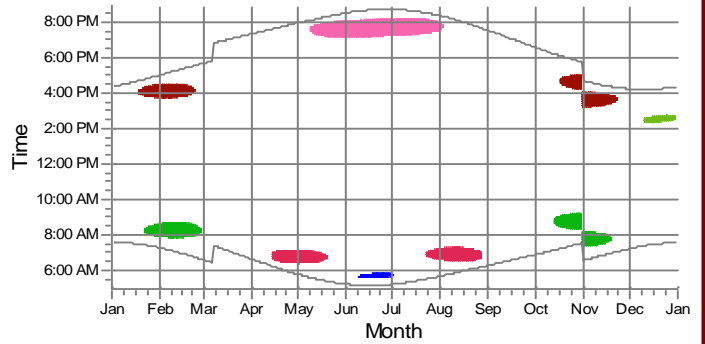
## SHADOW - Calendar, graphical

Calculation: Marble River Wind Farm SFA-3

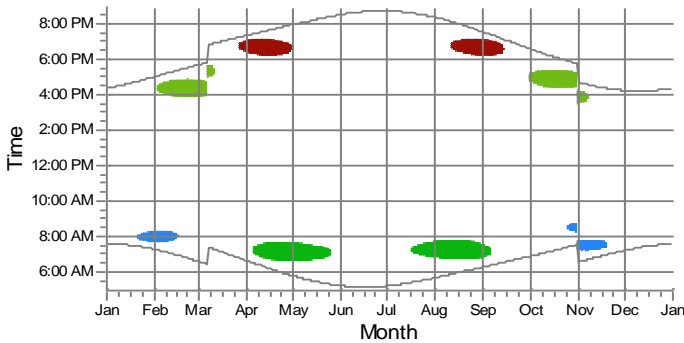
H-188: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (406)



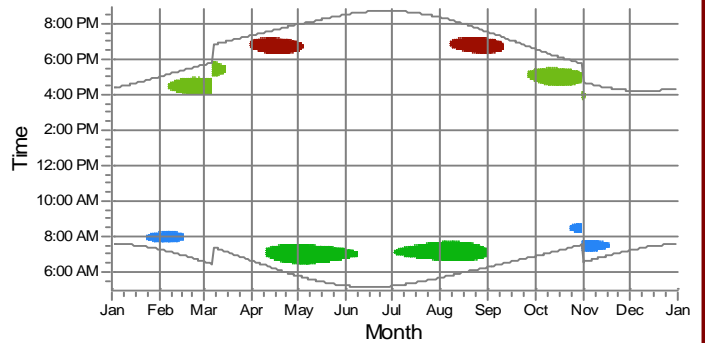
H-189: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (407)



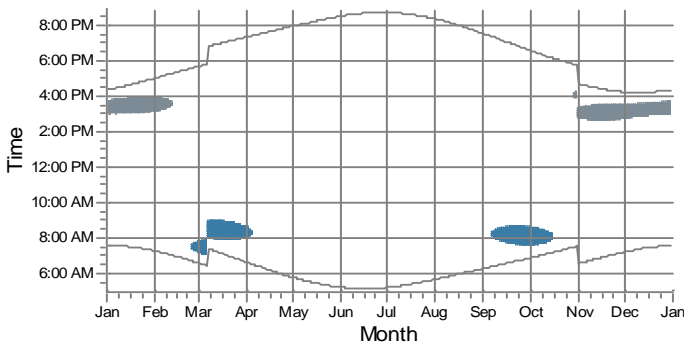
H-191: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (409)



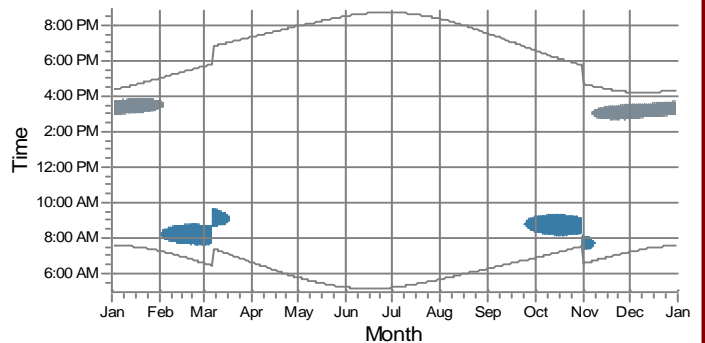
H-192: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (410)



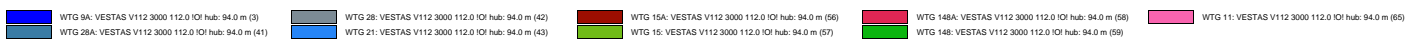
H-196: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (414)



H-200: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (418)



WTGs



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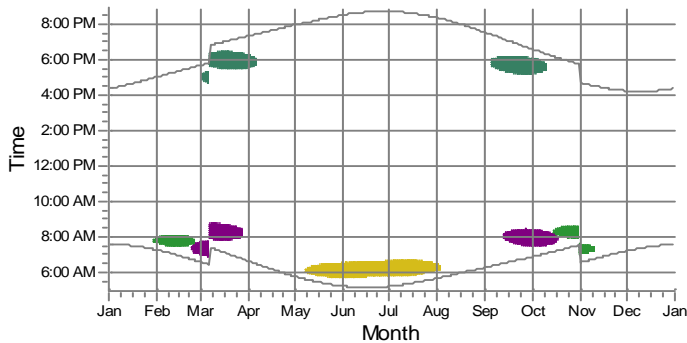
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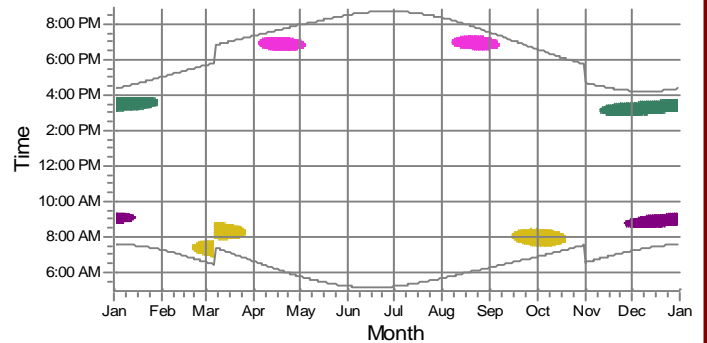
## SHADOW - Calendar, graphical

Calculation: Marble River Wind Farm SFA-3

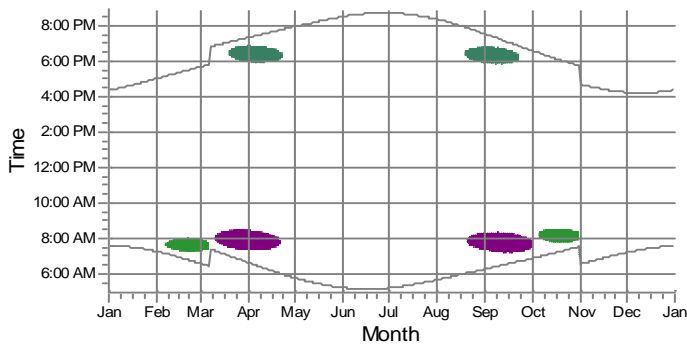
H-231: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (449)



H-238: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (456)



H-240: Shadow Receptor: 1.0 x 1.0 Azimuth: 0.0° Slope: 0.0° (458)



WTGs

WTG 81: VESTAS V112 3000 112.0 IOI hub: 94.0 m (11)

WTG 50: VESTAS V112 3000 112.0 IOI hub: 94.0 m (29)

WTG 48-W: VESTAS V112 3000 112.0 IOI hub: 94.0 m (31)

WTG 47: VESTAS V112 3000 112.0 IOI hub: 94.0 m (32)

WTG 46: VESTAS V112 3000 112.0 IOI hub: 94.0 m (33)