

# SHADOW FLICKER ANALYSIS – JONESFIELD TOWNSHIP

Meridian Wind Park

**B&V PROJECT NO. 198674**

**PREPARED FOR**

**DTE Electric Company**

**2 DECEMBER 2020**



## Table of Contents

<b>1.0</b>	<b>Executive Summary</b>	<b>1-1</b>
.....		
<b>2.0</b>	<b>Introduction and Modeling</b>	<b>2-1</b>
.....		
2.1	Shadow Flicker Overview.....	2-1
2.2	Study Methodology.....	2-1
<b>3.0</b>	<b>Study Results</b>	<b>3-1</b>
.....		
<b>Appendix A.</b>	<b>Shadow Flicker Receptors</b>	
	A-1	
<b>Appendix B.</b>	<b>Shadow Flicker Maps</b>	
	B-1	

### LIST OF TABLES

Table 2-1	Average Sunshine Hours from NSRDB (1998 to 2017)	2-2
.....		
Table 3-1	Predicted Shadow Flicker Impact Summary*	3-1
.....		

### LIST OF FIGURES

Figure 2-1.	Typical 30-hour Shadow Flicker Contour	2-3
.....		

## 1.0 Executive Summary

In accordance with the Wind Park Design Parameters letter sent from DTE to Jonesfield Township, dated May 15, 2019, DTE will keep shadow flicker at residential buildings to no more than 30 hours in a year. For purposes of this study, residential buildings include residences, schools, hospitals, churches, public libraries, and other occupied buildings.

Using modeling software that estimates shadow flicker using worst-case assumptions and historical sunshine data, it is estimated that over a typical year in Jonesfield Township, 30 residential buildings may experience 30 hours or more of shadow flicker each year prior to applying operational turbine controls, and 375 residential buildings are likely to experience less than 30 hours of shadow flicker, with 249 of the 375 residential buildings predicted to experience no shadow flicker.

The extent to which shadow flicker may fall upon residential buildings in excess of applicable limits will depend on whether existing vegetation and structures – which are not factored into the shadow flicker model – block the shadow cast by the turbine, and will also depend on future weather events. Where natural and man-made barriers to shadow flicker do not fully mitigate potential issues, additional mitigation measures, such as curtailment of turbine operations during defined periods, will be applied so that all wind turbines operate in compliance with township zoning requirements.

## 2.0 Introduction and Modeling

### 2.1 SHADOW FLICKER OVERVIEW

Like any tall structure, wind turbines can cast shadows in sunny conditions. As the wind turbine rotor turns, the blades can cast moving shadows, resulting in an effect known as shadow flicker. The strength of this effect depends greatly on distance and atmospheric conditions. Whether shadow flicker will fall on a property depends on the position of the sun and the yaw orientation of the turbine. Shadow flicker does not occur when the sun is obscured by clouds or fog at the turbine or receptor (a residential building), or when turbines are not operating. Shadow flicker also does not occur when the receptor is shaded by other objects, including trees or buildings.

The distance between a wind turbine and a shadow flicker receptor affects the strength of the shadows cast at the receptor, and therefore the perceptibility of the flicker effect. Shadows cast near a turbine are more distinct, while those cast farther away tend to be significantly less distinct, with weaker effect. Shadow flicker effects are typically considered negligible at distances greater than 10 rotor diameters (up to approximately 4,462 feet, or 0.85 miles, in this case.)

This report examines the predicted extent of shadow flicker that may fall on residential buildings in Jonesfield Township.

### 2.2 STUDY METHODOLOGY

WindFarmer is an industry-standard software program used to estimate potential shadow flicker effects on nearby receptors. The program calculates sun positions throughout the year and determines those positions relative to the wind turbines and any shadow receptors throughout a full year. The presence of shadow flicker at a given location and time is determined based on a line of sight calculation between the sun and the turbines, and the projection of the shadow from the turbine rotor to the receptor. The shadow flicker calculations include the effects of terrain on shadow projection and visibility.

The WindFarmer shadow model incorporates several very conservative assumptions that overestimate the number of hours that flicker may be visible, and tends to present what could be considered a “worst case” scenario. These assumptions include that the sky is always clear, the turbines are always operating and are always facing directly into the sun, creating maximum shadowed areas behind them. Under actual operating conditions, cloudy or hazy weather may reduce or eliminate the casting of defined shadows, buildings and trees may block the shadows, or turbines may be facing into oncoming wind in a manner that does not correspond to the position of the sun, and low wind or turbine maintenance periods may result in turbines idling during shading hours.

Inputs to the WindFarmer shadow flicker model include:

- All proposed wind turbine locations shown on the site plan submitted to Jonesfield Township as part of DTE’s special land use permit application, including primary

and alternate sites. The turbine layout is Revision 23, which is current as of November 4, 2020.

- The locations of all residential buildings within Jonesfield Township. Buildings were identified based on review of aerial photography.
- Elevation data from the USGS National Map at an approximately 10 meter (approximately 32.8 feet) resolution.

As the results of the WindFarmer model represent a worst-case scenario, statistical post-processing of the raw results is required to produce realistic results for a typical operating year. The primary inputs to the statistical analysis are historical weather and cloud cover data for the region and estimated typical wind conditions for the project site based on measurements at two SODAR wind profiling units within the project area.

Historical monthly sunshine data for the project area based on 20 years of annual data from 1998 to 2017 was also obtained from the National Solar Radiation Database (NSRDB) (<https://nsrdb.nrel.gov/>). Average sunshine hours for each month as a percent of total possible sunshine hours for is shown in Table 2-1.

**Table 2-1 Average Sunshine Hours from NSRDB (1998 to 2017)**

MONTH	SUNSHINE PERCENTAGE <sup>1</sup>
January	32%
February	40%
March	50%
April	52%
May	54%
June	60%
July	65%
August	61%
September	62%
October	47%
November	40%
December	35%
<b>Annual</b>	<b>52%</b>

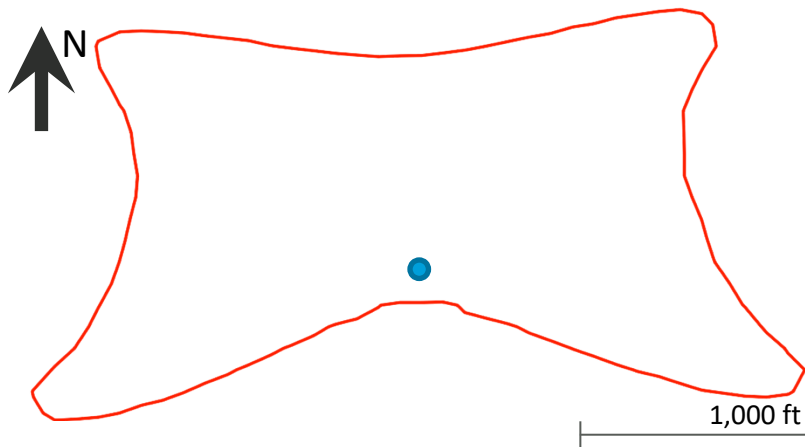
\* Calculated as percentage of sunny hours from sunrise to sunset

On an annual basis, approximately 52 percent of available daylight hours are considered sunny hours, capable of casting shadows. In addition, as turbines will not operate continuously because of low winds and maintenance, and will not always be oriented directly between the sun

and homes, it is estimated that actual shadow flicker effects will be significantly lower than the worst-case impacts forecast by the WindFarmer shadow model. Based on review of historical wind speed data and average sunshine hours, annual shadow flicker hours are estimated to be approximately 32 percent of the maximum “worst case” results calculated by the WindFarmer model for the Meridian Wind Park in a typical operating year.

Additionally, shadow flicker effects will typically be reduced by the presence of trees and awnings, which will also serve to reduce the actual perceived flicker impact hours, however these effects have not been incorporated into the results.

Figure 2-1 shows a representative annual 30-hour shadow flicker contour for a single wind turbine in Jonesfield Township, after accounting for sunshine hours and other effects as summarized above. A consolidated map of the project development area including cumulative effects from all wind turbines is included in Appendix B. A map book showing these cumulative effects and each identified receptor for all sections of Jonesfield Township is also included in Appendix B.



**Figure 2-1. Typical 30-hour Shadow Flicker Contour**

### 3.0 Study Results

DTE has committed to limit shadow flicker to no more than 30 hours per year at the nearest wall of a residential building. Table 3-1 summarizes the expected shadow flicker effect by hours for residential buildings located within Jonesfield Township.

**Table 3-1 Predicted Shadow Flicker Impact Summary\***

HOURS PER YEAR	TOTAL STRUCTURES	PERCENTAGE
0	249	61.5%
0 to 10	63	15.6%
10 to 20	45	11.1%
20 to 30	18	4.4%
Over 30	30	7.4%

\* Estimated, not actual hours, without mitigating conditions (trees, buildings) or operational controls factored in.

The predicated shadow flicker for each residential building examined as part of this study is provided in Appendix A. Where natural and man-made barriers to shadow flicker do not fully mitigate potential issues, additional mitigation measures, such as curtailment of turbine operations during defined periods, will be applied so that all wind turbines operate in compliance with township zoning requirements

In total, it is estimated that over a typical year in Jonesfield Township, 30 residential buildings may experience 30 hours or more of shadow flicker each year, and 375 residential buildings are likely to experience less than 30 hours of shadow flicker, with 249 of the 375 residential buildings predicted to experience no shadow flicker.

## Appendix A. Shadow Flicker Receptors

The table below summarizes the shadow flicker results by receptor, sorted by predicted impact in a typical year. Coordinates are NAD83 Michigan State Plane, South Zone, International Feet

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1225	13,127,604	713,034	30	79.9
SR_784	13,128,268	721,927	30	75.7
SR_1101	13,127,569	703,445	30	56.2
SR_799	13,138,069	719,643	30	53.2
SR_1415	13,127,840	703,578	30	52.8
SR_739	13,132,873	717,776	30	52.3
SR_736	13,127,558	719,720	30	50.5
SR_797	13,133,171	716,800	30	46.1
SR_1067	13,122,575	706,986	30	45.3
SR_728	13,127,797	718,470	30	45.2
SR_1169	13,133,266	707,564	30	43.9
SR_795	13,122,644	719,319	30	42.9
SR_1048	13,127,948	711,840	30	42.6
SR_337	13,138,301	719,913	30	42.4
SR_1081	13,127,830	713,368	30	42.0
SR_792	13,132,885	716,878	30	41.1
SR_1122	13,124,854	704,592	30	40.2
SR_335	13,132,880	716,445	30	39.6
SR_766	13,132,769	719,245	30	39.1
SR_722	13,125,290	722,047	30	35.7
SR_1156	13,138,094	701,197	30	35.3
SR_768	13,128,455	715,312	30	34.5
SR_1105	13,127,488	708,540	30	32.9
SR_1149	13,127,586	710,412	30	32.9
SR_798	13,133,125	718,561	30	32.7



RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1092	13,138,156	706,396	30	32.6
SR_1046	13,125,225	709,855	30	32.5
SR_1084	13,138,390	706,803	30	31.5
SR_777	13,138,123	720,427	30	31.3
SR_725	13,132,881	718,400	30	30.2
SR_1191	13,124,656	709,714	30	29.4
SR_1148	13,133,052	707,326	30	28.7
SR_1050	13,143,441	708,468	30	28.6
SR_1221	13,132,856	712,442	30	28.1
SR_1086	13,127,547	713,605	30	28.1
SR_1210	13,127,610	704,130	30	27.5
SR_774	13,132,313	721,920	30	27.1
SR_748	13,127,114	721,960	30	26.5
SR_769	13,138,382	721,448	30	26.4
SR_765	13,132,826	718,659	30	26.0
SR_793	13,133,073	720,744	30	25.3
SR_1055	13,138,110	706,955	30	24.9
SR_796	13,143,040	720,753	30	23.0
SR_1039	13,143,469	707,809	30	22.6
SR_755	13,138,120	718,210	30	21.8
SR_1075	13,143,347	708,705	30	21.7
SR_1151	13,133,113	707,971	30	21.2
SR_745	13,143,125	720,099	30	21.0
SR_789	13,143,287	720,994	30	19.4
SR_1076	13,133,120	713,162	30	18.9
SR_1155	13,122,704	718,501	30	18.1
SR_1069	13,138,452	709,635	30	18.0
SR_1199	13,133,085	710,012	30	17.2
SR_1157	13,137,907	702,191	30	17.0
SR_1117	13,138,387	702,823	30	16.5

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1212	13,124,040	710,339	30	15.8
SR_751	13,143,260	721,334	30	15.6
SR_1216	13,127,833	700,804	30	15.5
SR_1215	13,123,563	713,059	30	15.4
SR_1542	13,124,114	703,989	30	15.3
SR_1222	13,143,435	704,738	30	15.1
SR_1123	13,133,124	711,621	30	15.1
SR_1143	13,143,435	700,626	30	14.8
SR_1140	13,138,113	703,378	30	14.4
SR_1416	13,138,165	700,316	30	14.1
SR_1066	13,132,842	700,967	30	14.0
SR_747	13,140,134	721,927	30	13.9
SR_1100	13,138,152	700,522	30	13.8
SR_744	13,142,803	719,409	30	13.6
SR_1201	13,123,658	705,132	30	13.4
SR_727	13,138,353	716,654	30	13.3
SR_1378	13,122,655	711,664	30	13.1
SR_1095	13,123,035	710,737	30	13.0
SR_758	13,136,288	721,871	30	12.7
SR_752	13,143,051	718,369	30	12.5
SR_1077	13,132,870	713,974	30	11.9
SR_1197	13,122,912	710,140	30	11.7
SR_742	13,123,422	715,163	30	11.5
SR_1045	13,143,453	700,381	30	11.3
SR_1107	13,122,688	710,167	30	11.0
SR_1159	13,122,987	712,540	30	10.9
SR_1068	13,127,809	700,997	30	10.8
SR_782	13,132,851	715,545	30	10.6
SR_1136	13,132,857	702,612	30	10.6
SR_1223	13,143,471	709,037	30	10.6

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1085	13,136,136	704,480	30	10.5
SR_1217	13,143,416	702,651	30	10.5
SR_1153	13,128,330	710,125	30	10.5
SR_743	13,122,686	702,160	30	10.4
SR_1110	13,123,253	710,157	30	10.4
SR_1185	13,132,862	702,816	30	10.4
SR_1154	13,143,395	701,794	30	10.2
SR_1106	13,122,573	710,185	30	10.0
SR_1111	13,133,142	703,959	30	9.9
SR_1096	13,128,415	709,821	30	9.9
SR_1056	13,131,049	710,057	30	9.6
SR_1099	13,143,502	698,507	30	9.5
SR_1115	13,128,504	704,762	30	9.3
SR_1070	13,123,672	710,172	30	9.1
SR_1052	13,133,081	702,655	30	9.0
SR_778	13,138,396	717,318	30	8.9
SR_764	13,143,330	718,584	30	8.9
SR_1119	13,123,109	705,791	30	8.7
SR_783	13,143,178	718,808	30	8.6
SR_1161	13,138,147	713,199	30	8.6
SR_729	13,127,090	715,338	30	8.3
SR_334	13,127,832	717,328	30	7.9
SR_741	13,123,001	715,176	30	7.7
SR_1147	13,123,560	704,525	30	7.6
SR_1091	13,122,985	705,559	30	7.5
SR_1224	13,138,155	711,020	30	7.5
SR_776	13,139,737	715,961	30	7.4
SR_1170	13,138,094	708,742	30	7.1
SR_1044	13,143,452	700,199	30	7.1
SR_1182	13,123,293	705,019	30	7.1

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1218	13,122,633	713,105	30	7.0
SR_759	13,122,869	715,180	30	6.3
SR_1189	13,143,510	699,042	30	6.3
SR_1134	13,138,359	708,926	30	6.2
SR_1200	13,135,045	715,325	30	6.2
SR_787	13,140,090	715,793	30	6.2
SR_1207	13,138,119	711,530	30	6.0
SR_724	13,142,335	718,138	30	5.8
SR_786	13,135,141	715,334	30	5.7
SR_1183	13,138,372	713,039	30	5.7
SR_1205	13,143,359	699,478	30	5.4
SR_1088	13,122,957	705,061	30	5.3
SR_1058	13,139,528	709,939	30	5.1
SR_1064	13,138,380	711,734	30	5.1
SR_767	13,122,759	715,179	30	5.0
SR_1549	13,138,038	713,678	30	4.9
SR_1073	13,138,345	713,878	30	4.6
SR_1372	13,122,660	702,820	30	4.5
SR_1121	13,122,750	703,711	30	4.3
SR_1375	13,122,720	704,320	30	4.1
SR_1137	13,135,241	715,269	30	3.9
SR_1139	13,129,500	709,809	30	3.8
SR_1141	13,122,634	705,346	30	3.7
SR_1040	13,143,480	706,130	30	3.7
SR_1043	13,132,820	705,575	30	3.6
SR_1054	13,132,846	704,719	30	3.5
SR_1131	13,132,683	704,760	30	3.5
SR_1138	13,127,868	706,573	30	3.1
SR_1047	13,138,550	699,048	30	2.9
SR_738	13,129,774	715,117	30	2.8

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1062	13,133,028	704,727	30	2.7
SR_1104	13,132,790	706,726	30	2.7
SR_1391	13,130,255	705,044	30	2.5
SR_772	13,136,034	715,238	30	2.3
SR_1038	13,139,897	709,946	30	2.1
SR_773	13,136,173	715,229	30	2.1
SR_1114	13,132,870	699,964	30	1.8
SR_1082	13,130,476	704,770	30	1.7
SR_1093	13,143,464	698,122	30	1.5
SR_1057	13,130,689	704,784	30	1.5
SR_1171	13,130,978	704,794	30	1.2
SR_336	13,138,628	715,010	30	0.0
SR_723	13,122,620	699,450	30	0.0
SR_730	13,138,123	714,569	30	0.0
SR_733	13,138,324	714,870	30	0.0
SR_734	13,143,327	717,318	30	0.0
SR_737	13,122,584	698,334	30	0.0
SR_746	13,143,339	716,609	30	0.0
SR_749	13,122,585	698,578	30	0.0
SR_753	13,139,356	715,348	30	0.0
SR_754	13,138,110	714,733	30	0.0
SR_757	13,141,219	715,058	30	0.0
SR_760	13,138,936	715,292	30	0.0
SR_775	13,143,411	715,635	30	0.0
SR_779	13,138,689	715,267	30	0.0
SR_785	13,138,406	715,017	30	0.0
SR_788	13,138,357	715,775	30	0.0
SR_794	13,122,666	700,815	30	0.0
SR_917	13,122,623	695,765	30	0.0
SR_918	13,122,779	696,034	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_922	13,122,699	695,531	30	0.0
SR_924	13,123,000	695,566	30	0.0
SR_1049	13,142,332	708,948	30	0.0
SR_1053	13,138,633	704,160	30	0.0
SR_1063	13,133,094	697,477	30	0.0
SR_1065	13,138,184	696,968	30	0.0
SR_1071	13,127,907	697,259	30	0.0
SR_1072	13,132,842	697,644	30	0.0
SR_1078	13,132,567	697,930	30	0.0
SR_1083	13,140,453	704,408	30	0.0
SR_1089	13,132,462	696,873	30	0.0
SR_1090	13,132,927	697,736	30	0.0
SR_1094	13,132,812	696,858	30	0.0
SR_1102	13,132,901	696,904	30	0.0
SR_1103	13,132,632	697,229	30	0.0
SR_1108	13,131,618	696,846	30	0.0
SR_1109	13,133,086	697,586	30	0.0
SR_1112	13,142,892	709,996	30	0.0
SR_1113	13,138,137	704,423	30	0.0
SR_1120	13,143,507	697,734	30	0.0
SR_1124	13,143,462	697,571	30	0.0
SR_1125	13,128,064	699,060	30	0.0
SR_1126	13,127,812	699,368	30	0.0
SR_1127	13,138,154	696,339	30	0.0
SR_1129	13,131,887	696,871	30	0.0
SR_1130	13,138,150	714,227	30	0.0
SR_1132	13,132,576	696,864	30	0.0
SR_1135	13,130,930	696,862	30	0.0
SR_1144	13,132,933	696,838	30	0.0
SR_1145	13,132,924	697,049	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1146	13,131,293	696,848	30	0.0
SR_1150	13,132,912	697,266	30	0.0
SR_1152	13,137,936	713,863	30	0.0
SR_1160	13,141,494	709,996	30	0.0
SR_1162	13,132,407	697,248	30	0.0
SR_1167	13,132,611	696,977	30	0.0
SR_1168	13,132,610	697,054	30	0.0
SR_1174	13,138,407	696,953	30	0.0
SR_1175	13,132,934	697,176	30	0.0
SR_1179	13,127,880	697,692	30	0.0
SR_1180	13,132,771	697,939	30	0.0
SR_1188	13,138,399	697,102	30	0.0
SR_1190	13,131,189	696,840	30	0.0
SR_1195	13,138,135	704,822	30	0.0
SR_1198	13,132,757	696,867	30	0.0
SR_1202	13,132,920	697,570	30	0.0
SR_1203	13,136,241	709,969	30	0.0
SR_1204	13,127,901	696,912	30	0.0
SR_1208	13,132,818	697,023	30	0.0
SR_1209	13,132,945	697,964	30	0.0
SR_1211	13,138,136	714,042	30	0.0
SR_1220	13,131,535	696,892	30	0.0
SR_1226	13,133,095	696,940	30	0.0
SR_1227	13,133,097	696,826	30	0.0
SR_1228	13,133,088	697,027	30	0.0
SR_1229	13,133,098	697,393	30	0.0
SR_1236	13,128,964	695,534	30	0.0
SR_1237	13,138,404	696,308	30	0.0
SR_1238	13,138,455	695,053	30	0.0
SR_1239	13,126,342	695,537	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1244	13,138,457	695,140	30	0.0
SR_1245	13,137,204	696,448	30	0.0
SR_1246	13,137,915	696,511	30	0.0
SR_1247	13,138,196	696,519	30	0.0
SR_1248	13,138,440	696,568	30	0.0
SR_1249	13,138,412	696,094	30	0.0
SR_1251	13,138,946	696,300	30	0.0
SR_1252	13,138,407	695,857	30	0.0
SR_1253	13,125,670	695,826	30	0.0
SR_1254	13,126,631	695,782	30	0.0
SR_1255	13,127,334	695,573	30	0.0
SR_1256	13,126,862	695,800	30	0.0
SR_1257	13,126,959	695,821	30	0.0
SR_1258	13,127,805	695,865	30	0.0
SR_1259	13,126,081	695,487	30	0.0
SR_1261	13,128,224	695,586	30	0.0
SR_1262	13,135,771	696,459	30	0.0
SR_1263	13,135,750	696,341	30	0.0
SR_1264	13,137,678	696,497	30	0.0
SR_1265	13,139,586	696,240	30	0.0
SR_1266	13,139,482	696,349	30	0.0
SR_1267	13,139,006	696,560	30	0.0
SR_1268	13,135,599	696,365	30	0.0
SR_1269	13,127,834	695,597	30	0.0
SR_1270	13,127,037	695,847	30	0.0
SR_1272	13,129,162	695,938	30	0.0
SR_1274	13,127,282	695,896	30	0.0
SR_1275	13,128,248	695,862	30	0.0
SR_1277	13,138,459	695,283	30	0.0
SR_1278	13,126,211	695,503	30	0.0



RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1279	13,129,162	695,420	30	0.0
SR_1280	13,127,576	696,565	30	0.0
SR_1281	13,137,326	696,484	30	0.0
SR_1282	13,139,092	696,558	30	0.0
SR_1284	13,126,842	695,511	30	0.0
SR_1285	13,139,490	696,597	30	0.0
SR_1286	13,138,041	696,522	30	0.0
SR_1287	13,127,571	695,250	30	0.0
SR_1288	13,127,039	695,516	30	0.0
SR_1289	13,126,469	695,810	30	0.0
SR_1292	13,139,203	696,568	30	0.0
SR_1293	13,124,246	695,561	30	0.0
SR_1294	13,126,750	695,789	30	0.0
SR_1295	13,127,618	696,433	30	0.0
SR_1296	13,140,065	696,401	30	0.0
SR_1297	13,139,058	696,284	30	0.0
SR_1298	13,128,584	696,292	30	0.0
SR_1299	13,128,448	695,295	30	0.0
SR_1300	13,125,539	695,464	30	0.0
SR_1301	13,139,383	696,599	30	0.0
SR_1302	13,129,177	695,258	30	0.0
SR_1303	13,127,651	695,349	30	0.0
SR_1304	13,127,467	695,602	30	0.0
SR_1305	13,128,050	695,873	30	0.0
SR_1306	13,123,615	695,631	30	0.0
SR_1307	13,125,855	695,716	30	0.0
SR_1308	13,138,735	696,279	30	0.0
SR_1309	13,137,571	696,491	30	0.0
SR_1310	13,139,829	696,430	30	0.0
SR_1311	13,139,743	696,409	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1313	13,128,917	695,620	30	0.0
SR_1315	13,127,625	696,341	30	0.0
SR_1316	13,126,060	695,732	30	0.0
SR_1317	13,125,784	695,409	30	0.0
SR_1318	13,126,274	695,505	30	0.0
SR_1319	13,140,855	696,407	30	0.0
SR_1320	13,137,801	696,501	30	0.0
SR_1321	13,139,589	696,589	30	0.0
SR_1323	13,123,450	695,585	30	0.0
SR_1324	13,126,021	695,492	30	0.0
SR_1325	13,128,714	695,675	30	0.0
SR_1326	13,128,800	695,667	30	0.0
SR_1327	13,128,995	695,912	30	0.0
SR_1328	13,139,305	696,258	30	0.0
SR_1329	13,127,641	696,235	30	0.0
SR_1330	13,138,560	696,287	30	0.0
SR_1333	13,141,890	696,419	30	0.0
SR_1334	13,128,834	695,888	30	0.0
SR_1337	13,127,235	695,537	30	0.0
SR_1338	13,123,170	696,126	30	0.0
SR_1339	13,138,829	696,284	30	0.0
SR_1340	13,138,888	696,584	30	0.0
SR_1341	13,128,987	695,232	30	0.0
SR_1343	13,125,907	695,459	30	0.0
SR_1345	13,127,133	695,873	30	0.0
SR_1348	13,127,633	695,591	30	0.0
SR_1350	13,128,969	695,401	30	0.0
SR_1351	13,128,615	695,430	30	0.0
SR_1354	13,126,974	695,521	30	0.0
SR_1355	13,126,980	695,394	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1356	13,128,459	695,857	30	0.0
SR_1357	13,138,401	695,951	30	0.0
SR_1360	13,138,461	694,905	30	0.0
SR_1361	13,126,157	695,753	30	0.0
SR_1362	13,129,167	695,576	30	0.0
SR_1363	13,137,442	696,480	30	0.0
SR_1369	13,122,679	700,936	30	0.0
SR_1380	13,143,444	712,655	30	0.0
SR_1382	13,132,940	697,433	30	0.0
SR_1383	13,132,921	697,696	30	0.0
SR_1384	13,132,941	697,799	30	0.0
SR_1385	13,130,792	696,602	30	0.0
SR_1386	13,130,987	696,628	30	0.0
SR_1387	13,130,967	696,461	30	0.0
SR_1388	13,130,802	696,422	30	0.0
SR_1389	13,130,836	696,276	30	0.0
SR_1390	13,130,800	696,193	30	0.0
SR_1439	13,124,485	695,420	30	0.0
SR_1440	13,124,331	695,394	30	0.0
SR_1531	13,133,484	696,512	30	0.0
SR_1532	13,133,538	696,379	30	0.0
SR_1533	13,133,281	696,355	30	0.0
SR_1534	13,133,633	696,387	30	0.0
SR_1535	13,133,626	696,303	30	0.0
SR_1536	13,134,268	696,253	30	0.0
SR_1545	13,132,930	697,853	30	0.0
SR_1546	13,132,929	697,266	30	0.0
SR_492	13,122,608	693,591	30	0.0
SR_919	13,122,582	692,525	30	0.0
SR_920	13,122,608	694,194	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_921	13,122,961	695,270	30	0.0
SR_923	13,122,564	692,095	30	0.0
SR_925	13,122,586	692,269	30	0.0
SR_926	13,122,582	691,835	30	0.0
SR_927	13,122,577	691,970	30	0.0
SR_928	13,122,762	695,270	30	0.0
SR_929	13,122,614	694,405	30	0.0
SR_930	13,122,616	691,512	30	0.0
SR_931	13,122,582	692,410	30	0.0
SR_1231	13,132,792	692,153	30	0.0
SR_1232	13,132,964	692,196	30	0.0
SR_1233	13,127,526	694,212	30	0.0
SR_1234	13,127,927	690,916	30	0.0
SR_1235	13,138,153	694,591	30	0.0
SR_1240	13,127,250	692,452	30	0.0
SR_1241	13,133,142	693,633	30	0.0
SR_1242	13,127,452	693,775	30	0.0
SR_1243	13,127,994	692,576	30	0.0
SR_1250	13,129,243	694,928	30	0.0
SR_1260	13,127,917	695,146	30	0.0
SR_1271	13,127,580	691,241	30	0.0
SR_1273	13,127,586	693,494	30	0.0
SR_1276	13,138,224	691,098	30	0.0
SR_1283	13,127,617	691,500	30	0.0
SR_1290	13,127,384	693,090	30	0.0
SR_1291	13,140,857	693,964	30	0.0
SR_1312	13,143,493	691,204	30	0.0
SR_1314	13,127,511	694,883	30	0.0
SR_1322	13,133,168	693,966	30	0.0
SR_1331	13,138,235	691,272	30	0.0

RECEPTOR	X	Y	LIMIT	PREDICTED HOURS BEFORE MITIGATION
SR_1332	13,138,477	694,328	30	0.0
SR_1335	13,127,916	691,233	30	0.0
SR_1336	13,127,936	691,884	30	0.0
SR_1342	13,127,547	695,058	30	0.0
SR_1344	13,128,008	694,974	30	0.0
SR_1346	13,138,192	694,039	30	0.0
SR_1347	13,139,709	693,895	30	0.0
SR_1349	13,133,146	693,819	30	0.0
SR_1352	13,138,411	694,130	30	0.0
SR_1353	13,138,455	694,575	30	0.0
SR_1358	13,133,176	692,940	30	0.0
SR_1359	13,138,403	694,749	30	0.0
SR_1364	13,126,851	694,053	30	0.0
SR_1441	13,126,738	693,897	30	0.0
SR_1443	13,141,076	693,734	30	0.0
SR_1494	13,123,438	691,227	30	0.0
SR_1495	13,127,569	692,020	30	0.0
SR_1496	13,132,918	691,773	30	0.0
SR_1497	13,133,190	691,276	30	0.0
SR_1498	13,133,218	692,411	30	0.0

## Appendix B. Shadow Flicker Maps