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MEMORANDUM

DATE:	2019-04-17	**RWDI Reference No.:** 1903089
TO:	Doug Hursh – Potter Lawson	**EMAIL:** dough@potterlawson.com
FROM:	Ryan Danks, P.Eng. - RWDI	**EMAIL:** ryan.danks@rwdi.com
	Jason Munn, P.Eng. - RWDI	**EMAIL:** jason.munn@rwdi.com
RE:	**Executive Summary of Solar Reflection Study Findings** **929 East Washington Avenue** **Madison, WI**	

Dear Mr. Hursh,

RWDI was retained by Potter Lawson Architects Inc. to investigate how sunlight will reflect from the proposed 929 East Washington Avenue development ('Proposed Project'), and what impacts those reflections may have on people and property in the vicinity. RWDI has extensive experience in the study of urban reflections; having been involved in over 100 studies around the globe investigating issues ranging from simple nuisance reflections, to dangerous reflections distracting drivers and pilots, and even cases where reflections caused thermal damage and injury.

RWDI's detailed analysis and technical report (dated April 17, 2019) which was included with this memorandum, covers in detail, the methodology, results and conclusions of the analysis. This memorandum is intended to provide a high-level, non-technical summary of the salient findings.

Background

It is imperative to understand that *any* contemporary building will reflect light, most commonly from windows and other glazed elements. A critical task of modern architecture is to balance the positive aspects of a building's windows (i.e. providing natural light and views) with the need to control the sunlight reflected from them. Completely eliminating reflections from a building would result in either very little fenestration, or windows that are highly shaded, reducing views and natural light for the occupants.

It is also important to understand that the reflectivity of glass is *not* a fixed value. The reflectivity of glass increases as light strikes at more glancing angles. Depending on how the local street grid aligns with the path of the sun, situations can be created whereby reflections can affect drivers and pedestrians *regardless* of the type of glass that is used.

Experiencing a reflection from a building is a common experience in urban areas and typically represents no more than a momentary irritant which is quickly forgotten. In many cases a reflection coincides with times when the sun is already generally in the field-of-view and is therefore not as easily noticed due to the much more intense direct sunlight. The goal of RWDI's investigation was to quantify reflections from the Proposed Project in terms of their intensities, frequencies and durations throughout the year so that reflections can be understood holistically and in context.

Methodology

Currently, there are no universally accepted approaches for simulating and categorizing urban reflections. In this work, RWDI has used a proprietary computational tool[1] to simulate the reflections from the Proposed Project over the course of an entire year at one-minute increments. Based on an analysis of the results, we have used an internally developed set of metrics[2] to assign a level of visual and thermal impact to the reflections.

RWDI's approach is intentionally conservative to ensure that no potential reflections are missed. Most importantly, this analysis neglects the effects of trees (i.e. foliage) and cloud cover since these factors create inconsistent levels of shade. For context, according to the U.S. National Oceanic and Atmospheric Administration (NOAA), sunshine is possible in Madison on average 54% of the time on an annual basis[3]. We also note that many streets near the project have mature trees which in summer, would likely reduce the effect of some reflections. In winter however, the trees would likely provide little benefit. Given these conservatisms, we would expect the actual frequencies of reflections to be *lower* compared to what is predicted by RWDI's study.

Observations and Conclusions

Reflections are predicted to occur within the field-of-view of drivers on East Washington Ave. and North Brearly St. as they approach the Proposed Project. However, the potential for these reflections only exists in 11 to 31 hours in total per year. In other words, reflections which may affect drivers are possible in less than 0.7% of daytime hours.

Some of these impacts occur due to reflections occurring at glancing angles. As noted in the Background section herein, this naturally enhances the reflectivity of the glazing, meaning that these

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[1] Danks, Ryan, and Joel Good. "Urban Scale Simulations of Solar Reflections in the Built Environment: Methodology and Validation." 2016 Proceedings of the Symposium on Simulation for Architecture and Urban Design. London. 2016.

[2] Danks, Ryan, Joel Good, and Ray Sinclair. "Assessing reflected sunlight from building facades: A literature review and proposed criteria." Building and Environment 103 (2016): 193-202.

[3] https://www1.ncdc.noaa.gov/pub/data/ccd-data/pctposrank.txt

impacts would occur regardless of the type of glass used in the Proposed Project. Further, many reflections on the streets occur when the sun would already be in a driver's field-of-view, making these reflections less impactful. This is because direct sunlight will dominate over any reflected light, and because drivers would expect glare at this time and would likely have already taken mitigative measures (i.e. sunglasses or lowering sun visors).

Reflections were also predicted to fall on 1002 East Washington Avenue for brief periods during a small fraction of the year. These reflections are possible in total between 36 and 133 hours per year, or 0.8% to 3% of daytime hours. We note that the most frequent impacts were seen on the lowest floors, which appear to be commercial rather than residential, and also that the trees on North Brearly Street may help reduce these impacts.

Reflections from the Proposed Project can also fall on Breese Stevens Field. This condition would be expected to occur for any glazed building at the location of the Proposed Project due to the orientation of the street grid and the site's proximity to the field. Reflections most commonly fall on the north corner of the field as well as on the north and northwest bleachers. These reflections occur between 44 to 111 hours per year, or 1% to 2.5% of the daytime annually. The majority of the bleachers are not predicted to be affected by reflections at all. At most the playing field is potentially exposed to reflections 40 hours per year in total (0.9% of the daytime annually). The street trees along East Washington Ave. are expected to help reduce the frequency of reflections reaching Breese Stevens Field.

RWDI's analysis also included an investigation of the potential for reflected solar energy to be focused or concentrated by the facetted northwest façade. The results indicate that while multiple reflections from this façade can converge, the maximum predicted intensity of these reflections was well below the peak intensity of naturally occurring sunlight.

In conclusion, it is RWDI's opinion that the solar reflection analysis of the Proposed Project does not indicate any significant potential for thermal impacts to people or property, and that the predicted visual impacts are typical of those seen in any urban environment.

Please do not hesitate to contact us if there are any further questions.

Yours truly,

ROWAN WILLIAMS DAVIES & IRWIN INC. (RWDI)

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