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memorandum

date	March 31, 2022
to	Dave Kang, Project Manager, Apple
from	Erika Walther, Wildlife Biologist; Leonard Liu, Wildlife Biologist
subject	Addendum Regarding Lighting to Biological Review of Project Mirage

This memorandum supplements ESA's September 9, 2021, "Biological Review of the Mirage Sculpture" which found the artwork installation to be bird-friendly based on the inherent qualities of the glass and vertical design and placement of the cylinders. Specifically, this addendum evaluates the proposed lighting for the artwork, and concludes it is highly unlikely to pose a hazard to birds flying at night.

Most bird collisions occur during daylight hours and are largely a function of glass reflectance and transparency. A minority of bird collisions are caused by artificial light interfering with birds' navigation at night; thereby, impacting nocturnal migrants.[1] Migrating birds are thought to orient to Earth's magnetic field under monochromatic blue or green light, but are not able to do so under lights that lack those wavelengths, for example, monochromatic yellow or red.[2] However, it is not known what light level and distance is sufficient to interfere substantially with bird navigation.[3] Scientific studies addressing the risk to birds posed by night lighting are generally focused on large commercial installations, such as commercial buildings and oil drilling rigs. ESA is unaware of any scientific studies addressing the response by birds flying near ground-level to night lighting at the scale of Mirage.

Project Setting

The San Francisco Bay Area is within the Pacific Flyway, a major bird migration route, through which migrants fly at elevations of hundreds to thousands of feet in the sky. Migrating birds at night may also fly at lower elevations to avoid inclement weather, make corrections to their migration path, or descend in early morning to feed and rest. Mirage is located in the southern half of a roughly 1/3-acre olive orchard with landscape grass. This non-native habitat has very low plant diversity and limited value to wildlife, including limited nesting and foraging opportunities for birds. No portion of the Mirage project area is greater than 50 feet from a pedestrian path or the driveway. The orchard is bordered by North Tantau Avenue to the west, the Apple Park Visitor Center

[1] Christine Sheppard and Glenn Phillips. Bird-Friendly Building Design, 2nd Ed. (The Plains, VA: American Bird Conservancy, 2015).
[2] Longcore, T., and C. Rich. 2016. Artificial night lighting and protected lands: ecological effects and management approaches (revised August 2017). Natural Resource Report NPS/NRSS/NSNS/NRR—2017/1493. National Park Service, Fort Collins, Colorado.
[3] Christine Sheppard and Glenn Phillips. Bird-Friendly Building Design, 2nd Ed. (The Plains, VA: American Bird Conservancy, 2015).

to the south, and parking lots to the east and north. Baseline conditions for existing lighting include appropriate illumination for safe passage of pedestrians, bicycles, and cars on all sides of the olive orchard. Lampposts are present along the border of the parking area nearest the olive orchard and streetlighting is present along the east edge of North Tantau Avenue adjacent to the olive orchard (**Attachment A**). The Apple Park Visitor Center has a glass façade and is illuminated from within until 6:00 pm every day. The walkway and driveway between the Visitor Center and olive orchard are also illuminated.

Mirage is less than 7 feet high and is located in an urban area that already includes nighttime lighting. As discussed below, Mirage's lighting design with respect to lamp intensity, light spillage, and duration of use would, in ESA's professional opinion, have limited to no effect on birds flying near ground-level at night. For the same reasons, Mirage is not expected to attract or disorient nighttime migrants passing over the San Franciso Bay Area.

Mitigating Factors

Lamp Intensity. Low intensity lamps that emit fewer lumens are less likely to impact birds flying at night than high intensity lamps. The lamps proposed to illuminate Mirage are of low intensity – there will be single 145-lumen lamp installed under each cylinder. For comparison, 200 lumens are equivalent to a 25-watt incandescent bulb. In addition, lamps will be fitted with lenses and placed underneath the base of each cylinder; therefore, the perceived luminosity will be filtered and diminished by the cylinder glass (**Attachment B**).

Direction. Light that is targeted to its intended use and minimizes light spillage decreases impacts to birds flying at night. The lamps for Mirage will be placed directly under each glass cylinder, illuminating the glass from within, thereby minimizing light spillage. Photometric modeling of Mirage shows that there will be zero foot-candles[4] of light spillage lateral to the cylinders (**Attachment C**) and would not add to existing light levels at the project site (Attachment A). Photometric modeling above Mirage has not been done but would be fewer foot-candles than from the sides of the columns since the light must travel through seven feet of glass before exiting the top of the column.

Duration. Decreasing the duration of nighttime illumination decreases impacts to birds flying at night. The lighting for Mirage will be on a timer that shuts off lights at 11:00 pm, thereby having no potential to impact birds flying through the area from 11:00 pm through dawn. The 11:00 pm shutoff is also consistent with the City of Cupertino's Bird-safe Ordinance, *19.102.030 – C. Non-residential Indoor Lighting Requirements*.

Location. Mirage is proposed within a developed envelope that provides reduced habitat values for resident and migrating birds. The site is not a major feeding ground or stopover for avian species and new lighting at the site would not disrupt or diminish avian use of the surrounding urbanized area.

Conclusion

Due to Mirage's low height, low lamp intensity, lack of light spillage, limited illumination (not past 11:00 pm), and location within a largely urbanized area with existing nighttime lighting, the project is not expected to attract

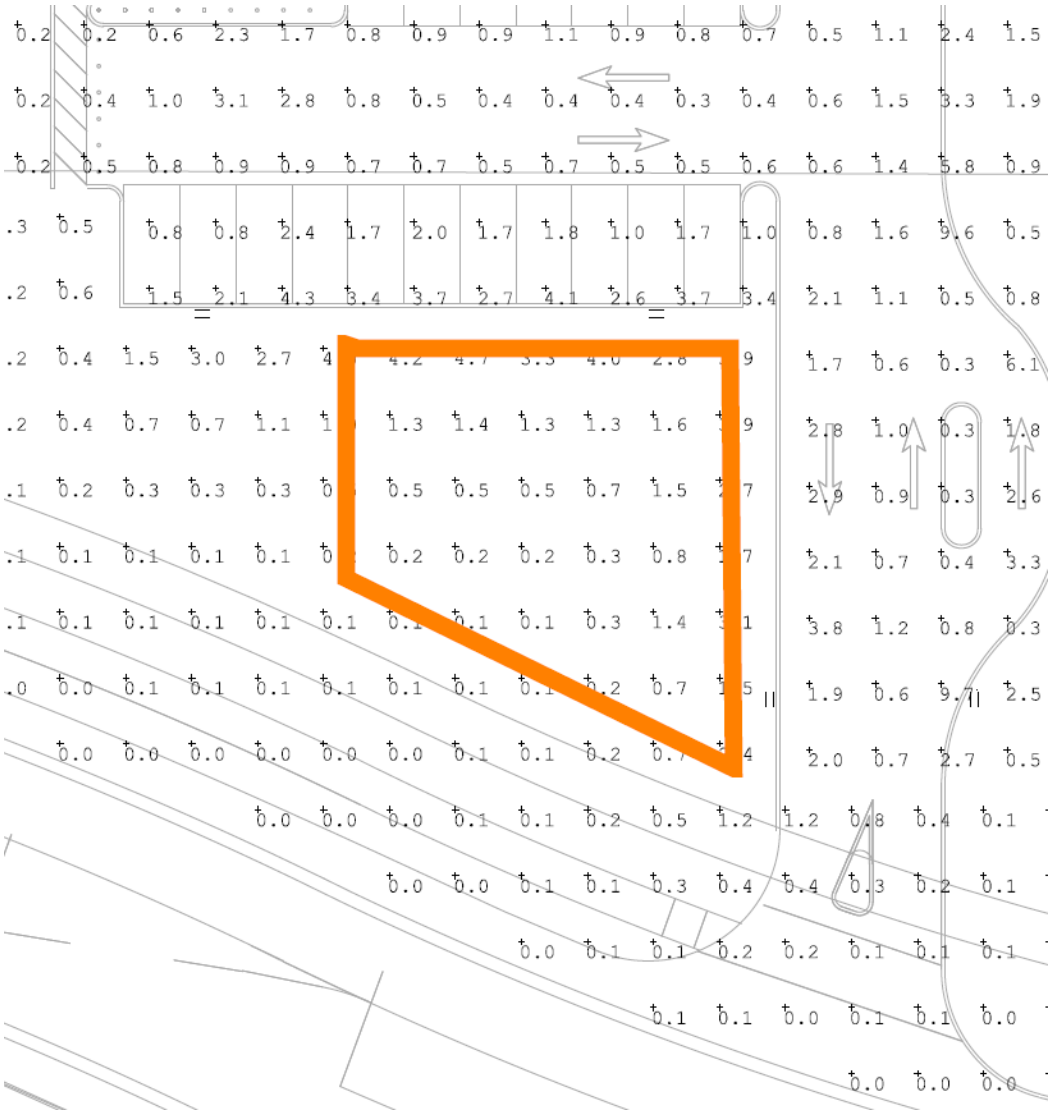
[4] One foot-candle is equivalent to one lumen per square foot.

or disorient migrating birds passing over the area at night and is highly unlikely to pose a risk to birds flying close to ground level at night.

This finding, combined with ESA's prior analysis, is consistent with the conclusion of the September 9, 2021, report that the Mirage artwork would not pose a hazard to birds.

Erika Walther, Wildlife Biologist, ESA

Attachment A – Photometric Study Showing Existing Light Levels (Foot-candles) at the Project Site (Pre-project)



Attachment B – Mock-up of Illuminated Cylinders

Attachment C – Photometric Study for Mirage Showing No Light Spillage (0 Foot-candles)