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Evaporation Reduction Using Pond Floats

Kaitlyn Chow
Douglas Smith (Ph.D.)

Publication No. WI-2016-13
08 December 2016

The Watershed Institute

Division of Science and Environmental Policy
California State University Monterey Bay
http://watershed.csumb.edu

100 Campus Center, Seaside, CA, 93955-8001
831 582 4696 / 4431

Contact:
dosmith@csumb.edu

Cite this report as:

Chow K. and Smith D. 2016. Evaporation Reduction Using Pond Floats. Prepared for the Santa Lucia Community Services District, California. The Watershed Institute, California State University Monterey Bay, Publication No. WI-2016-13, 11 pp.

Acknowledgements

We are grateful for the assistance and collaboration of:

- Forrest Arthur and Leif Utegaard (Santa Lucia Conservancy)
- Len Donovan (Pheonix Plastics)

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1 Introduction

The Santa Lucia Preserve is a low density, 20,000 acre development located in the uplands of the Carmel Watershed. The Santa Lucia Community Service District manages the water production and reclamation for the homeowners. Water reclamation, storage and reuse are key parts of their sustainable management system. The service district stores reclaimed water in several large-volume ponds (Fig. 1), but high summer temperatures and moderate winds drive evaporative loss from the ponds.

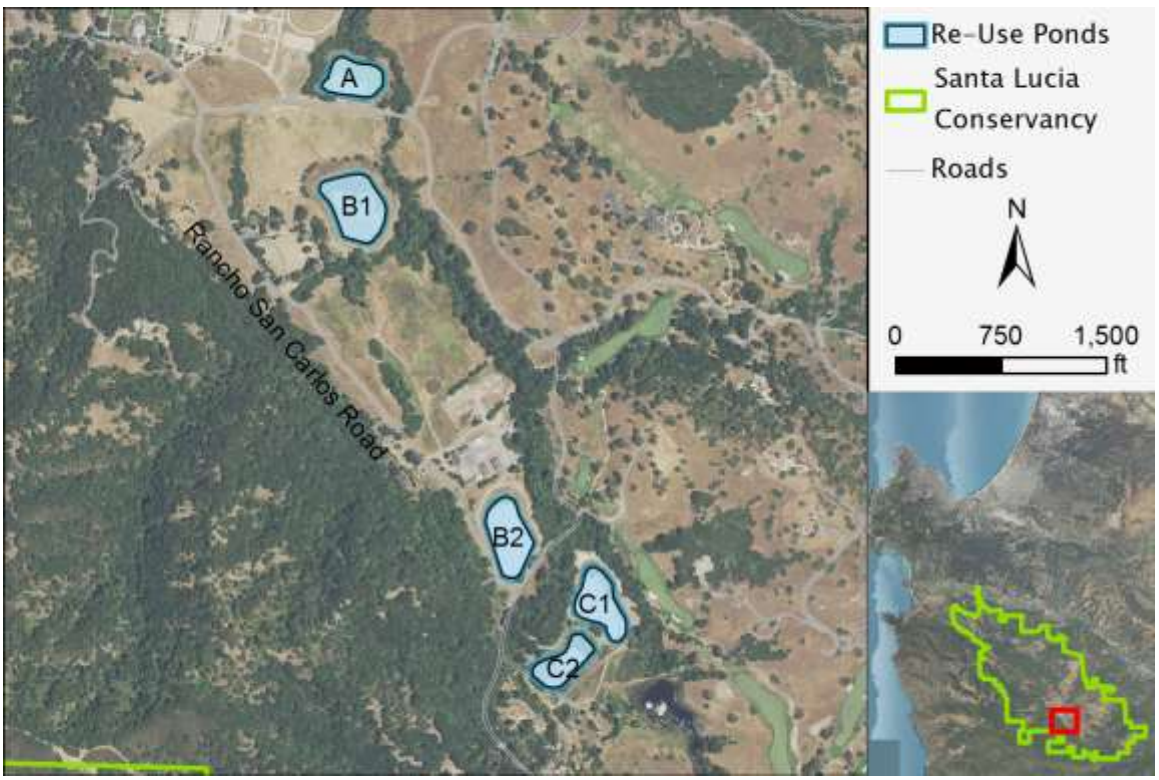

Figure 1: Reclamation ponds located in the Santa Lucia Preserve, Monterey County, California.

The district is considering different methods for reducing evaporation, such as covering the ponds with "Saturn Disk Floats" (Phoenix 2016). Saturn Disk floats (Fig. 2) are advertised to significantly reduce evaporation rates in ponds, but there has not been an independent study to quantify their evaporation reduction properties. The goal of this study is to assess how effective Saturn Disk floats are at retaining water in open ponds.

Figure 2: Close-up view of hexagonal Saturn Disk floats advertised as being able to reduce evaporation from open water (Phoenix 2016).

2 Methods

We compared evaporation rates in two identical, plastic lined ponds. One pond was open to the atmosphere and one pond was covered with Saturn Disk pond floats in accordance with the manufacturer's instructions. The pond dimensions were 10 ft on each side and 5 ft deep with vertical sides. The two ponds were placed close to each other to ensure the same external conditions affected both ponds (Fig. 3).

Figure 3: Two evaporation ponds. Left pond is open, and the right pond is covered with plastic floats.

A Level Troll 200 pressure transducer was placed at the bottom of each pond to record temperature and pressure at 30 minute intervals. A Level Troll barometric pressure sensor was placed nearby for atmospheric pressure corrections. The pond pressures and water temperatures were recorded for 67 summer days from July 20, 2016 to September 25, 2016. A nearby weather station recorded atmospheric conditions during the study period.

There was no rain during the study, so no adjustments were made to the record. The pond depths and temperatures were plotted for comparison. The depth trend for each pond was modeled as a linear function of time. The depth changes were converted to acre feet of reclamation pond volume by assuming that each pond in Figure 1 was shaped like a square pyramidal frustrum—an inverted truncated pyramid with square base, 3:1

side slopes, and an approximate depth of 14 ft. We used the "End-Area Formula" to calculate volume (V):

$$V = H/2 \times (A_1 + A_2)$$

where H is the depth, A_1 is the area at the base of the pond, and A_2 is the water surface area (Taube 2000).

Maximum surface areas were derived from a 2016 aerial photograph in ArcGIS.

3 Results

The experiment ran for 67 days between mid-July and late September. The covered and uncovered pond lost a total of 0.57 ft and 0.91 ft of water respectively (Fig. 4).

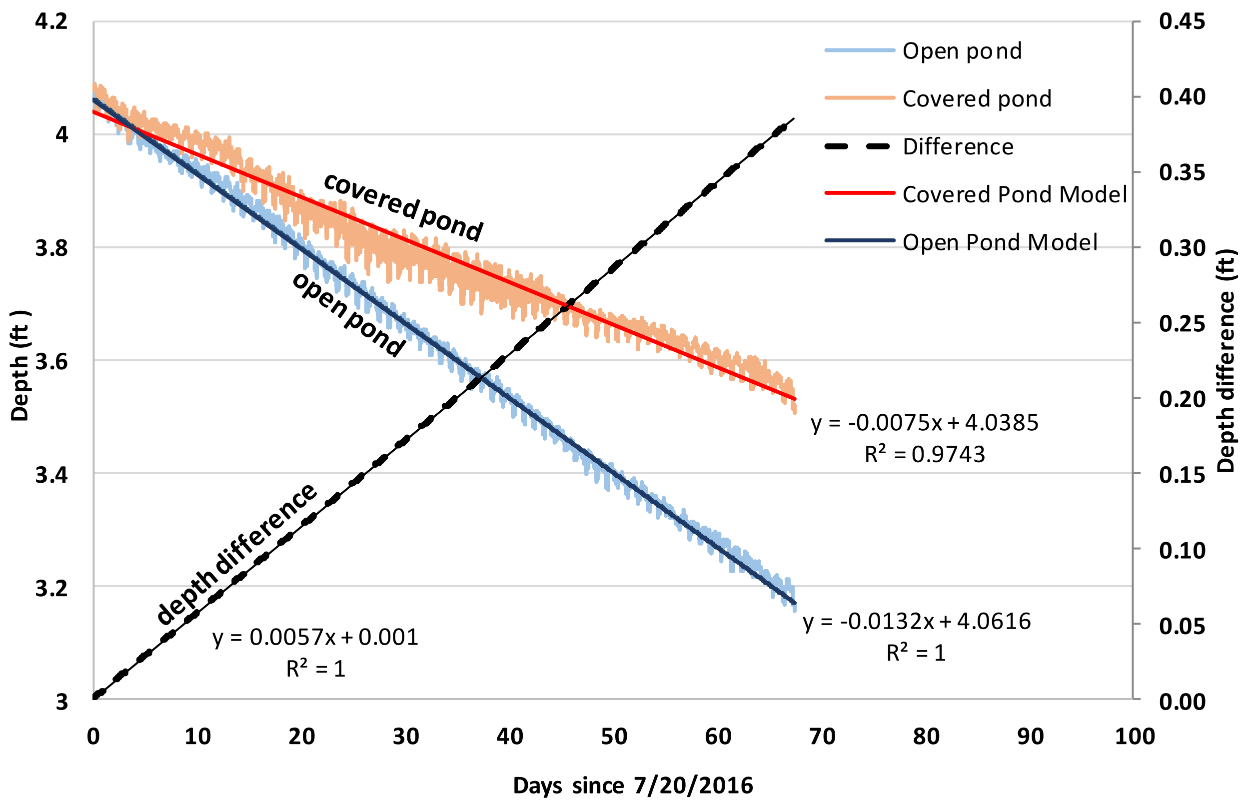

Figure 4: Depth changes in the two ponds during summer 2016.

Depth changes in the study ponds were extrapolated in space and time to estimate the volume changes in the existing reclamation ponds (Fig. 5). During the 70 day study period the disks would have saved approximately 10 acre-ft of water, and greater benefits would be attained at a rate of 0.133 af/day, the slope of the dashed black line in Figure 5. These volumetric calculations are based upon the simplified pond geometry described in the methods, actual volumes may be different.

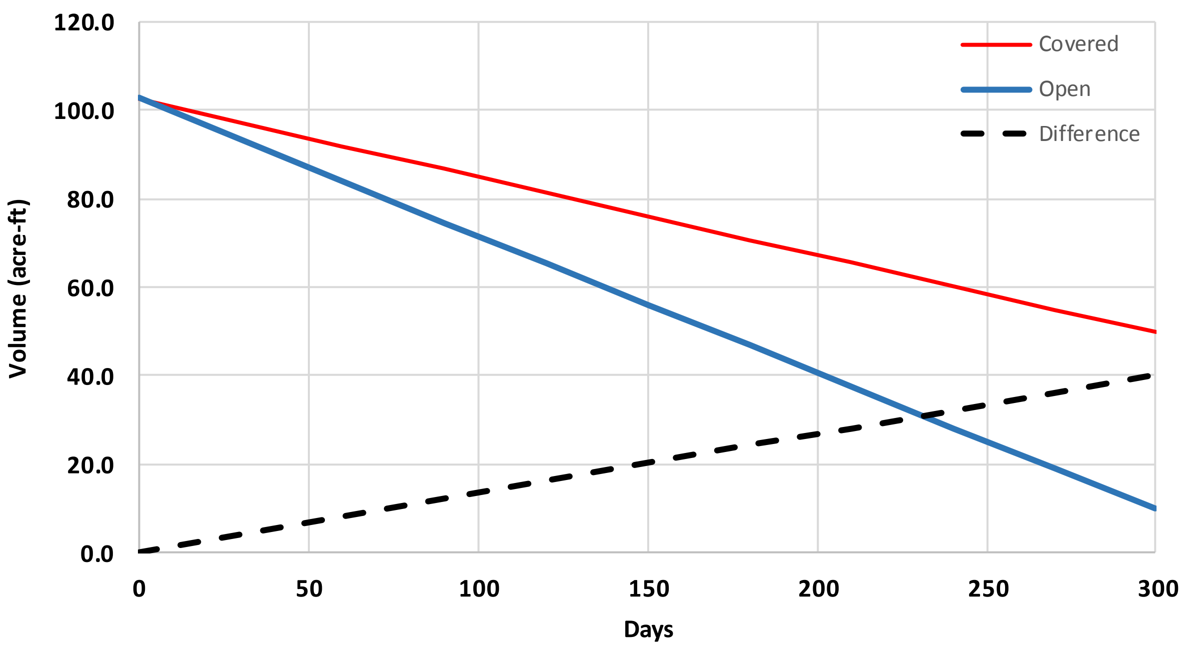

Figure 5: Estimated total volume changes in 5 existing reclamation ponds. Values are extrapolated beyond the 70 day study assuming that depth is a linear function of time.

Water temperature differences were also noted during the study. The open pond temperature exhibited stronger diurnal variation was and between 3 and 4 °C warmer than the covered pond (Fig. 6).

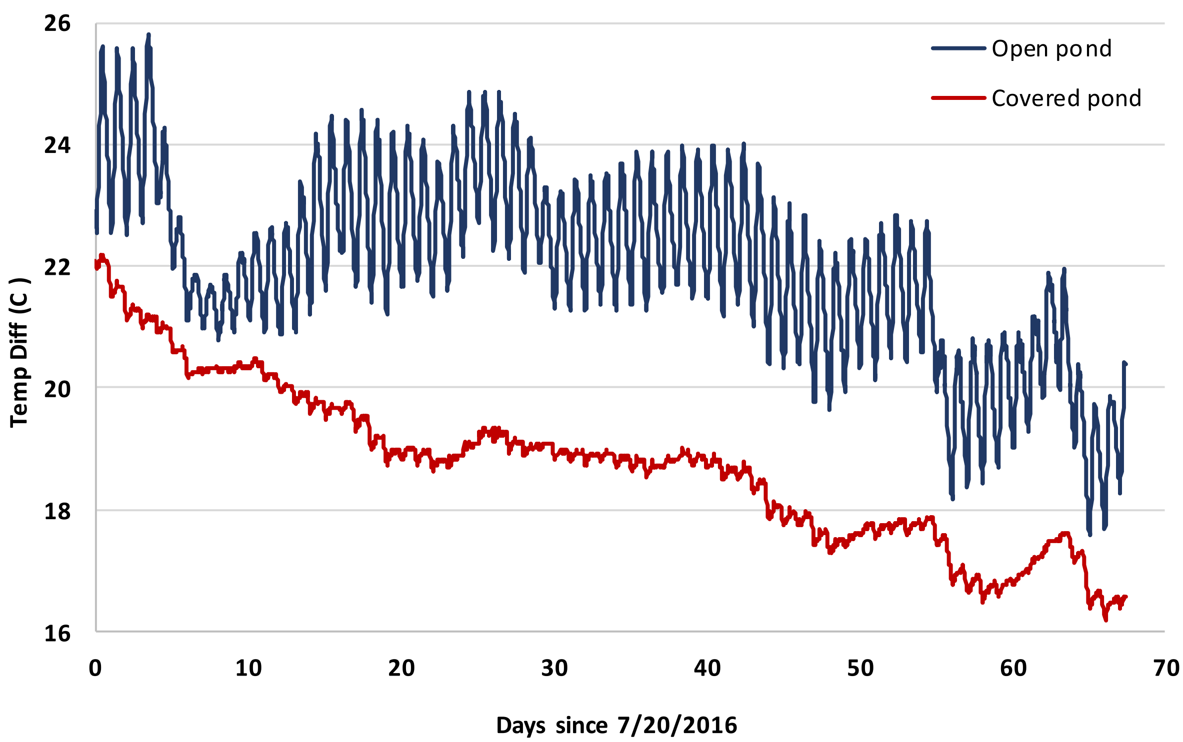

Figure 6: Water temperature variation in two ponds during 70 days in the summer.

Out of the available meteorological parameters, wind speed and atmospheric temperature correlate most closely with the observed ponds temperature (Fig. 7).

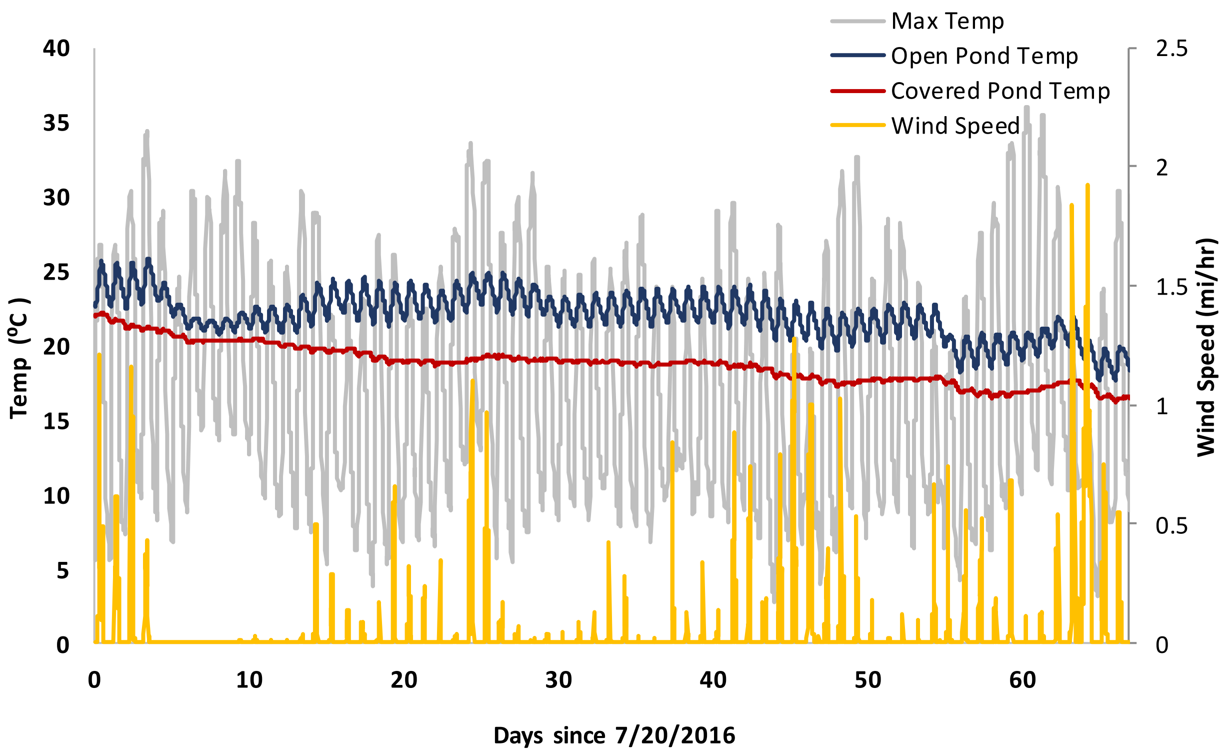

Figure 7: Water temperature, maximum atmospheric temperature, and wind speed during 70 days in the summer.

4 References

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